Establishing the European Geological Surveys Research Area to deliver a Geological Service for Europe

Deliverable 1.7

Information on selected projects

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GENERAL INTRODUCTION

15 proposals are selected by the GeoERA General Assembly on 06-04-2018

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1 GEO-ENERGY PROJECTS

1.1 3D geomodelling for Europe (3DGEO-EU)

Project Lead: BGR, Germany
Number of partners: 11
Total budget: 3,651,677€

Harmonization of geological data across geological, topographical, but especially across national borders is one of the most important work steps to create a base for trans-European assessments of resource potentials and possible conflicts of use of European subsurface. In the last decades a variety of different thematic maps were developed, but often not on a similar and consistent data base. Differences in the geological & geophysical interpretation (e.g. stratigraphy, velocity-model, structural interpretation, different methods of assessments) across the borders remain unchanged and were masked by generalizations in an overview scale. In the last years these “border-discontinuities” have become obvious by a variety of 3D-modeling projects. But workflows for harmonization of different geological 3D models are yet not established and proofed. In the proposed project we will show on the example of cross-border pilot areas how harmonization across the borders can be established and maintained with the progress of the national models. To support this harmonization, three work packages which focuses on method development aspects in regard of uncertainties of geological 3D models and their visualization, cross-border modeling of fault data, and 3D model consistency accompany the work in the pilot areas. The latter aspect will be demonstrated on the basis of case studies to show how 3D model consistency can be proofed. The methodologic advantages (agreements on best practices, optimized workflows, etc.) and the gain in experience on cross-border 3D harmonization work will be a keystone for further transnational harmonization projects.

#	Participant Legal Name	Institution	Country
1	Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) [Project Coordinator]	**BGR**	**Germany**
2	Ceska Geologicka Sluzba – Czech Geological Survey (CGS)	**CGS**	**Czech Republic**
3	Geological Survey of Denmark and Greenland (GEUS)	**GEUS**	**Denmark**
4	Landesamt für Bergbau, Geologie und Rohstoffe Brandenburg (LBGR)	**LBGR**	**Germany**
5	Landesamt für Umwelt, Naturschutz und Geologie Mecklenburg-Vorpommern (LUNG)	**LUNG**	**Germany**
6	Landesamt für Bergbau, Energie und Geologie Niedersachsen (LBEG)	**LBEG**	**Germany**
7	Landesamt für Geologie und Bergwesen Sachsen-Anhalt (LAGB)	**LAGB**	**Germany**
8	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO	**TNO**	**Netherlands**
9	Polish Geological Institute – National Research Institute (PGI-NRI)	**PGI**	**Poland**
10	Instituto Geológico y Minero de España (IGME-Spain)	**IGME**	**Spain**
11	State Research and Development Enterprise State Information Geological Fund of Ukraine (GEOINFORM)	**GEOINFORM**	**Ukraine**

1.2 Geological Analysis and Resource Assessment of selected Hydrocarbon systems (GARAH)

Project Lead: GEUS, Denmark
Number of partners: 8
Total budget: 1,060,707€

A harmonized, scientific based, geological analysis and assessment conventional and unconventional hydrocarbon resources will help member states to continue the transition to lower Carbon energy sources. This will contribute to climate commitments, and allow the planning for secure sources of affordable energy. The analysis and assessment of hydrocarbons will focus on two areas:

I. in Europe's major petroleum province – the North Sea a "Geological analysis and resource assessment of North Sea petroleum systems". This research includes the assessment of conventional and unconventional oil and gas resources in the most important hydrocarbon basin in Europe. This will enable the remaining resource to be better understood and managed, and identify options for multiple and alternative uses of the subsurface as producing fields come off-line.
II. with a pan-European view, "Hydrate assessment in the European continental margin and related risks".

The assessment of gas-hydrates resources in the European continental margin represents an information gap of pan-European interest. This will improve the understanding of the potential role that gas-hydrates may play in the future EU energy mix, as it will constitute a base-line for future projects pertaining the improvement of the European model of the GHSZ, related hazards and potential for geological storage of CO2. A catalogue evaluating the multiple-use of hydrocarbon reservoirs, as integrated or alternative use of the subsurface, together with an appraisal on risks and safety, will be produced. This study will provide and disseminate all the analytical data generated to a common EGDI database.

#	Participant Legal Name	Institution	Country
1	Geological Survey of Denmark and Greenland [Project Coordinator]	GEUS	Denmark
2	Instituto Geológico y Minero de España	IGME	Spain
3	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek	TNO	Netherlands
4	Bureau de Recherches Géologiques et Minières	BRGM	France
5	Bundesanstalt für Geowissenschaften und Rohstoffe	BGR	Germany
6	Natural Environment Research Council (British Geological Survey)	NERC (BGS)	United Kingdom
7	State Research and Development Enterprise State Information Geological Fund of Ukraine	GEOINFORM	Ukraine
8	Norwegian Petroleum Directorate	NPD (external partner)	Norway

1.3 Cross-border, cross-thematic multiscale framework for combining geological models and data for resource appraisal and policy support (GeoConnect³d)

Project Lead: RBINS, Belgium.
Number of partners: 19
Total budget: 1,827,753€

The GeoConnect³d project will develop and test a new methodological approach to prepare and disclose geological information for policy support and subsurface management. The improved approach will be developed and tested using two regional case studies – the Roer-to-Rhine region and the Pannonian Basin. These regional, cross-border case studies are chosen to be complementary and sufficiently different in geological setting and degree of implementation of subsurface exploitation and management, in order to maximize their pan-European relevance. The case studies will use a novel bottom-up approach that introduces two concepts that increase the geological understanding of an area and are aimed at providing a coherent geological context for evaluating subsurface applications and resolving subsurface management issues. The first new concept is the structural framework as a means of joining existing models of different scale and resolution to clarify the importance of planar structures in a way that makes the geology understandable to stakeholders involved in subsurface management. The second concept is that of geomanifestations. These specific expressions of geological processes are important sources of information for improving geological understanding. The structural framework models annotated with geomanifestations will allow the integration and evaluation of complex cross-thematic research. The two bottom-up regional case studies form the study material for a top-down, more generic evaluation of potentially interacting subsurface activities that allows revisiting and refining state-of-the-art methods. Valorisation of regional results at pan-European level is ensured by testing the methodologies in two smaller pilot areas in Germany and Ireland

#	Participant Legal Name	Institution	Country
1	Royal Belgian Institute of Natural Sciences – Geological Survey of Belgium ***(Project Coordinator)***	RBINS-GSB	Belgium
2	Vlaams Planbureau voor Omgeving	VPO	Belgium
3	Vlaams Instituut voor Technologisch Onderzoek VITO will act as a third party of VPO	VITO	Belgium
4	Federalni zavod za geologiju – Geological Survey of Federation of Bosnia and Herzegovina	FZZG	Bosnia and Herzegovina
5	Hrvatski Geološki Institut – Croatian Geological Survey	HGI-CGS	Croatia
6	Ceska Geologicka Sluzba – Czech Geological Survey	CGS	Czech Republic
7	Bureau de Recherches Géologiques et Minières	BRGM	France
8	Bundesanstalt für Geowissenschaften und Rohstoffe	BGR	Germany
9	Bayerisches Landesamt für Umwelt	LfU	Germany
10	Magyar Bányászati és Földtani Szolgálat – Mining and Geological Survey of Hungary	MBFSZ	Hungary
11	Department of Communications, Climate Action and Environment (GSI)	GSI	Ireland
12	Service Géologique du Luxembourg	SGL	Luxemburg
13	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek	TNO	Netherlands
14	Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy	PIG-PIB	Poland
15	Institutul Geologic al României	IGR	Romania
16	Geological Survey of Serbia	GSS	Serbia
17	State Geological Institute of Dionyz Stur	SGIDS	Slovakia
18	Geološki zavod Slovenije	GeoZS	Slovenia
19	State Research and Development Enterprise State Information Geological Fund of Ukraine	GeoInform	Ukraine

Non-funded partner

#	Participant Legal Name	Institution	Country
20	Geologischer Dienst Nordrhein-Westfalen	GD NRW	Germany

1.4 Hazard and Impact Knowledge for Europe (HIKE)

Project Lead: TNO, The Netherlands
Number of partners: 19
Total budget: 1,620,649€

The HIKE project aims to support research and assessments of induced hazards and impacts that are related to the exploitation of subsurface resources and capacities throughout Europe. This will be achieved through development, demonstration and implementation of harmonized subsurface data sets and methodologies, investigation of applied use cases, and facilitation of knowledge shared between geological surveys and stakeholders.
WP-2 focuses on the development of a European fault database covering a comprehensive set of static and dynamic geological and physical characteristics needed for the assessment of seismic hazards, ground movements, leakage and fluid migration, sealing capacities, fluid flow and other types of dynamic behaviour. This database will be developed, populated and tested in conjunction with several other GeoERA projects and external stakeholder involvement. WP-3 establishes novel hazard and impact research methods and investigates the added value of the established fault information in several case studies and geological settings across Europe. WP-4 concludes the research activities with future recommendations and the establishment of a share point for information, knowledge and preferred practices related to hazard and impact research. This share point is intended to provide a collaboration and knowledge exchange platform for future research by geological surveys and other stakeholders. WP-5 governs the embedding of the results into the GeoERA Information Platform.

#	Participant Legal Name	Institution	Country
1 (coord)	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO	**TNO**	**Netherlands**
2	Albanian Geological Survey	**AGS**	**Albania**
3	Geologische Bundesanstalt	**GBA**	**Austria**
4	Royal Belgian Institute of Natural Sciences – Geological Survey of Belgium	**RBINS-GSB**	**Belgium**
5	Geological Survey of Denmark and Greenland	**GEUS**	**Denmark**
6	Bureau de Recherches Géologiques et Minières	**BRGM**	**France**
7	Bundesanstalt für Geowissenschaften und Rohstoffe	**BGR**	**Germany**
8	Landesamt für Bergbau, Geologie und Rohstoffe Brandenburg	**LBGR**	**Germany**
9	Landesamt für Geologie und Bergwesen Sachsen-Anhalt	**LAGB**	**Germany**
10	Bayerisches Landesamt für Umwelt	**LfU**	**Germany**
11	Islenskar orkurannsoknir - Iceland GeoSurvey	**ISOR**	**Iceland**
12	Istituto Superiore per la Protezione e la Ricerca Ambientale	**ISPRA**	**Italy**
13	Servizio Geologico, Sismico e dei Suoli della Regione Emilia-Romagna	**SGSS**	**Italy**
14	Agenzia Regionale per la Protezione Ambientale del Piemonte	**ARPAP**	**Italy**
15	Lietuvos Geologijos Tarnyba prie Aplinkos Ministerijos	**LGT**	**Lithuania**
16	Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy	**PIG-PIB**	**Poland**
17	Laboratório Nacional de Energia e Geologia	**LNEG**	**Portugal**
18	Geološki zavod Slovenije	**GeoZS**	**Slovenia**
19	State Research and Development Enterprise State Information Geological Fund of Ukraine	**GEOINFORM**	**Ukraine**

1.5 HotLime, Mapping and Assessment of Geothermal Plays in Deep Carbonate Rocks – Cross-domain Implications and Impacts (Hotlime)

Project Lead: LfU, Bavaria, Germany
Number of partners: 16
Total budget: 1,658,728€

Hydrothermal systems in deep carbonate bedrock are among the most promising low-enthalpy geothermal plays across Europe. Apart from a few areas where viability of hydrothermal heat and power generation has been proved, most deep carbonate bedrock has received relatively little attention, because such rocks are perceived as 'tight'. Exploration and development of the deep subsurface is an acknowledged high-risk investment, particularly in low-enthalpy systems, where tapping suitable temperatures for geothermal energy commonly requires drilling to depths of more than 3 km. In order to de-risk these challenging geothermal plays, it is crucial to improve our understanding of geological conditions that determine the distribution and technical recoverability of their potential resources. The efficacy of carbonate-bedrock geothermal plays is crucially dependent on groundwater yield controlled by fracture conduits and karstification. This project will identify the generic structural controls in deep carbonate formations, through a comparison of geological situations and their structural inventory, as well as collation of deep borehole data and their petro- and hydro-physical characteristics. A consistent assessment and the sharing of knowledge – bringing all partners to a common high level – will result in uniformly applicable best practice workflows for estimation, comparison and prospectranking of hydrothermal resources in deep carbonate bedrock. Applied in specific target areas by means of 2D or 3D mapping and characterization, these spatial assessments will help in de-risking the set-up or maturation of regional plays, will reveal possible cross-domain implications, and will support sustainable subsurface management.

#	Participant Legal Name	Institution	Country
1 Project Coordination	Bayerisches Landesamt für Umwelt	**LfU**	**Germany**
2	Department of Communications, Climate Action and Environment (GSI)	**GSI**	**Ireland**
3	Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek	**TNO**	**The Netherlands**
4	Vlaams Gewest *represented by third party 4a / VITO*	**VLO**	**Belgium**
4a *)	Vlaamse Instelling voor Technologisch Onderzoek *VITO will act as third party of VLO*	**VITO** *)	**Belgium**
5	Geologische Bundesanstalt	**GBA**	**Austria**
6	Regierungspräsidium Freiburg	**LGRB**	**Germany**
7	Istituto Superiore per la Protezione e la Ricerca Ambientale	**ISPRA**	**Italy**
8	Geološki zavod Slovenije	**GeoZS**	**Slovenia**
9	Servizio Geologico, Sismico e dei Suoli della Regione Emilia Romagna	**RER-SGSS**	**Italy**
10	Hrvatski geološki institut - Croatian Geological Survey	**HGI-CGS**	**Croatia**
11	Ministry for Transport and Infrastructure	**MTI**	**Malta**
12	Agenzia Regionale per la Protezione Ambientale del Piemonte	**ARPAP**	**Italy**
13	State Information Geological Fund of Ukraine	**GEOINFORM**	**Ukraine**
14	Česká geologická služba	**CGS**	**Czech Republic**
15	Regione Umbria - Servizio geologico	**RU**	**Italy**
16	Institut Cartogràfic i Geològic de Catalunya	**ICGC**	**Spain**
Associate *)	Royal Belgian Institute of Natural Sciences – Geological Survey of Belgium	**RBINS-GSB** *)	**Belgium**

*) non-funded

1.6 Managing Urban Shallow geothermal Energy (MUSE)

Project Lead: GBA, Austria
Number of partners: 16
Total budget: 1,313,260€

MUSE investigates resources and possible conflicts of use associated with the use of shallow geothermal energy (SGE) in European urban areas and delivers key geoscientific subsurface data to stakeholders via a user-friendly web based GeoERA information platform (GIP). The assessment of geothermal resources and conflicts of use will lead to the development of management strategies considering both efficient planning and monitoring of environmental impacts to feed into general framework strategies of cities like Sustainable Energy Action Plans (SEAPs). The developed methods and approaches will be tested and evaluated together with input from local stakeholders in 14 urban pilot areas across Europe representative for different conditions of SGE use. The pilot areas are geologically and climatologically diverse and have a range of heating and cooling degree day characteristics, making the project outcomes and shared learnings relevant to the whole of Europe and beyond. In the MUSE project, we want to address all relevant aspects by capitalising upon existing knowledge, identifying and closing specific knowledge gaps and providing joint proposals on methodologies, criteria and concepts on SGE management. We adapt workflows to focus on local scale investigations suitable for densely-populated urban areas, where national heating and cooling demand is generally highest, and which will represent the most important SGE market in the future. The outcomes of the project represent a comprehensive collection of methods, approaches and tools, which can be transferred to other urban regions in Europe and adapted by other organisations.

#	Participant Legal Name	Institution	Country
1	Geologische Bundesanstalt	GBA	Austria
2	Natural Environment Research Council	NERC	United Kingdom
3	Institut Cartogràfic i Geològic de Catalunya	ICGC	Spain
4	Hrvatski Geološki Institut	HGI-CGS	Croatia
5	Ceska Geologicka Sluzba – Czech Geological Survey	CGS	Czech Republic
6	Bureau de Recherches Géologiques et Minières	BRGM	France
7	Geological Survey Ireland	GSI	Ireland
8	Royal Belgian Institute of Natural Sciences – Geological Survey of Belgium	RBINS-GSB	Belgium
9	Geološki zavod Slovenije	GeoZS	Slovenia
10	Instituto Geológico y Minero de España	IGME	Spain
11	Sveriges Geologiska Undersökning	SGU	Sweden
12	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO	TNO	Netherlands
13	Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy	PIG-PIB	Poland
14	State Geological Institute of Dionyz Stur	SGIDS	Slovakia
15	State Research and Development Enterprise State Information Geological Fund of Ukraine	GEOINFORM	Ukraine
16	Geological Survey of Denmark and Greenland	GEUS	Denmark

2 GROUNDWATER PROJECTS

2.1 Hydrological processes and Geological settings over Europe controlling dissolved geogenic and anthropogenic elements in groundwater of relevance to human health and the status of dependent ecosystems (HOVER)

Project Lead: BRGM, France
Number of partners: 30
Total budget: 2,999,814€

The challenge is to gain understanding of the controls on groundwater quality across Europe using the combined expertise and data held by member states. The project will address groundwater management issues related to drinking water, human and ecosystem health across Europe in relation to both geogenic elements and anthropogenic pollutants by data sharing, technical and scientific exchange between European GSOs. We will link our knowledge of geological settings and understanding of hydrogeological processes to the natural variability of groundwater quality and to the risk of transfer of anthropogenic dissolved compounds to aquifers. For natural water quality this will include evaluating health risks and spatial variability of concentrations of geogenic elements and using a common approach to assessing thermal and mineral water. For diffuse pollutant behaviour we will increase understanding of ecology and microbial diversity controls on transforming pollutants at groundwater-surface water transition zones, quantify groundwater age distributions and nitrate and pesticide travel times in the subsurface and their attenuation patterns for evaluating the efficiency of programme of measures, the design and assessment of monitoring programmes, pollution trends, and create EU-wide aquifer vulnerability maps by comparing assessment methods across Europe. New compounds will be addressed by developing a consistent approach to groundwater monitoring for organic emerging contaminants. Common standards, databases and maps will be developed and project outputs will include thematic maps and web service tools at pan-European scale and databases available through the Information Platform to increase political and public awareness and improve groundwater management at the EU scale.

#	Participant Legal Name	Country
1	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek – (TNO)	Netherlands
1a	DELTARES (DLT)	Netherlands
3	Geologische Bundesanstalt (GBA)	Austria
6	Vlaamse Milieu Maatschappij - Flanders Environment Agency (VMM)	Belgium
7	Federalni zavod za geologiju (Geological Survey of Federation of Bosnia and Herzegovina) (FZZG)	Bosnia-Herzegovina
9	Hrvatski Geološki Institut (HGI-CGS)	Croatia
10	Ministry of Agriculture, Natural Resources and Environment of Cyprus – Geological Survey Department (GSD CYPRUS -> GSD in HOVER)	Cyprus
11	Ceska Geologicka Sluzba – Czech Geological Survey (CGS)	Czech Republic
12	Geological Survey of Denmark and Greenland (GEUS)	Denmark
14	Geologian Tutkimuskeskus (GTK)	Finland
15	Bureau de Recherches Géologiques et Minières (BRGM) [Project Coordinator]	France
17	Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)	Germany
22	Landesamt für Bergbau, Energie und Geologie Niedersachsen (LBEG)	Germany
27	Mining and Geological Survey of Hungary (MBFSZ)	Hungary
28	Islenskar orkurannsoknir - Iceland GeoSurvey (ISOR)	Iceland
29	Geological Survey of Ireland (GSI)	Ireland
30	Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA)	Italy
39	Latvian Centre of Geology, Environment and Meteorology (LEGMC)	Latvia
40	Lietuvos Geologijos Tarnyba prie Aplinkos Ministerijos (LGT)	Lithuania
42	Ministry for Transport and Infrastructure (MTI)	Malta
44	Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy (PIG-PIB)	Poland
45	Laboratório Nacional de Energia e Geologia (LNEG)	Portugal
46	Institutul Geologic al României (IGR)	Romania
47	Geological Survey of Serbia (GSS)	Serbia
49	Geološki zavod Slovenije (GeoZS)	Slovenia
50	Instituto Geológico y Minero de España (IGME-Spain, IGME in HOVER)	Spain
51	Institut Cartogràfic i Geològic de Catalunya (ICGC)	Spain
52	Sveriges Geologiska Undersökning (SGU)	Sweden
53	State Research and Development Enterprise State Information Geological Fund of Ukraine (GEOINFORM)	Ukraine
54	Natural Environment Research Council (NERC)	United Kingdom
**	Eesti Geoloogiateenistus (EGT)	Estonia
**	Institut Royal des Sciences Naturelles de Belgique (RBINS-GSB)	Belgium
**	Landesamt für Bergbau, Geologie und Rohstoffe Brandenburg (LBGR)	Germany

**: non-funded partners

2.2 Resources of groundwater harmonized at cross-border and pan-European scale (RESOURces)

Project Lead: TNO, The Netherlands
Number of partners: 32
Total budget: 2,465,654€

Although EU member states generally have a comprehensive overview of the groundwater resources in their own homeland and have delineated groundwater bodies for the EU Water Framework Directive, a coherent overview of all fresh groundwater over Europe is not available for policy development and evaluation. The RESOURCE project proposal aims at demonstrating the potentials of the harmonization of information about Europe's groundwater resources through cross-border demonstrations projects, through harmonized characterization approaches for Karst and Chalk aquifers and through a first information product at Pan-European scale where available data is compiled and integrated to produce a map of the fresh groundwater resources of Europe. The set of deliverables of the RESOURCE project will provide good practices in providing harmonized data and information across borders for assessments of the 3D structure of aquifers, the water volumes available, and the water fluxes and water quality of the resource. Harmonization of such hydrogeological information is a prerequisite for any transboundary groundwater management. A range of regional and national stakeholders will be involved in the work in order to ensure both interaction with authorities that manage and protect groundwater resources and with end-users, thus maximizing dissemination of the results and providing them with easy-access tools through the cooperation with the GeoERA Information Platform Project, jointly prioritizing the information products that are most beneficial for society. The information products to be delivered will serve as a first prototype example of information to be accessible within a Geological Service for Europe.

No.	Acronym	Participant Legal Name	Institute	Country
1	TNO	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO [*Project Coordinator*]	Geological Survey of the Netherlands	Netherlands
1a	DLT	Deltares		Netherlands
2	AGS	Per Sherbimin Gjeologjik Shqiptar - Albanian Geological Survey		Albania
3	GBA	Geologische Bundesanstalt		Austria
6	VMM	Vlaamse Milieu Maatschappij		Belgium
6a	SCK	Belgian Nuclear Research Centre SCK•CEN		Belgium
7	FZZG	Federalni Zavod Za Geologiju - Geological Survey of Federation of Bosnia and Herzegovina		Bosnia and Herzegovina
9	HGI	Hrvatski Geološki Institut – Croatian Geological Survey		Croatia
10	GSD	Ministry of Agriculture, Natural Resources and Environment of Cyprus	Cyprus Geological Survey Department	Cyprus
11	CGS	Ceska Geologicka Sluzba – Czech Geological Survey		Czech Republic
12	GEUS	Geological Survey of Denmark and Greenland, GEUS		Denmark
14	GTK	Geologian Tutkimuskeskus - Geological Survey of Finland		Finland
15	BRGM	Bureau de Recherches Géologiques et Minières		France
27	MBFSZ	Magyar Bányászati és Földtani Szolgálat - Mining and Geological Survey of Hungary		Hungary
28	ISOR	Islenskar Orkurannsoknir - Iceland GeoSurvey		Iceland
29	GSI	Geological Survey of Ireland		Ireland
33	ARPA	Agenzia Regionale per la Protezione Ambientale del Piemonte		Italy
34	RT	Regione Toscana		Italy
39	LGMC	Latvijas Vides, Geologijas Un Meteorologijas Centrs Sia		Latvia
40	LGT	Lietuvos Geologijos Tarnyba prie Aplinkos Ministerijos - Lithuanian Geological Survey under the Ministry of Environment of the Republic of Lithuania		Lithuania
41	SGL	Administration Des Ponts et Chaussees Direction	Service Géologique du Luxembourg	Luxembourg
42	MTI	Ministry for Transport and Infrastructure		Malta
44	PIG	Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy		Poland
45	LNEG	Laboratório Nacional de Energia e Geologia		Portugal
46	IGR	Institutul Geologic al României		Romania
47	GSS	Geološki zavod Srbije - Geological Survey of Serbia		Serbia
49	GZS	Geološki zavod Slovenije		Slovenia

50	IGME	Instituto Geológico y Minero de España - Geological Survey of Spain		Spain
51	ICGC	Institut Cartogràfic i Geològic de Catalunya - Cartographic and Geological Institute of Catalonia		Spain
52	SGU	Sveriges Geologiska Undersökning		Sweden
53	GIU	State Research and Development Enterprise - State Information Geological Fund of Ukraine		Ukraine
54	NERC	Natural Environment Research Council	British Geological Survey	United Kingdom

Non-funded partners

No.	Acronym	Participant Legal Name	Institute	Country
13	EGT	Eesti Geoloogiakeskus		Estonia
35	RU	Regione Umbria	Servizio Geologico	Italy
	NRW	Geologischer Dienst Nordrhein-Westfalen		Germany

2.3 Tools for Assessment of ClimaTe change ImpacT on groundwater and adaptation Strategies (TACTIC)

Project Lead: GEUS, Denmark
Number of partners: 20
Total budget: 1,799,979€

Climate change already have widespread and significant impacts in Europe, which is expected to increase in the future. To reduce the damage, detailed assessments, based on a thorough understanding of the hydrological system, are required for the planning of optimal adaptation strategies. Groundwater plays a vital role for the inland freshwater cycle, and have the capability of buffering or enhancing the impact from extreme climate events causing droughts or floods, depending on the subsurface properties and the status of the system (dry/wet) prior to the climate event. Understanding and taken the hydrogeology into account is therefore essential in the assessment of climate change impacts. The Geological Survey Organisations in Europe acquire the necessary data and knowledge of the groundwater system and some Surveys already have high-end expertise in utilising this in climate change assessments. To streamline the assessments to produce harmonised results at EU scale, and to contribute to a general enhancement of the assessments, the Surveys will collaborate in TACTIC on the development of a research infrastructure for the advancement and harmonisation of climate change assessments utilising knowledge and data on the groundwater system, which is tested in pilots covering most climate challenges and hydrogeological conditions in Europe. Supplying data and results to a European Information Platform for storage and visualisation, TACTIC will further contribute to easy access of information relevant to climate change assessments, which may be used directly or integrated into future decision support systems.

#	Acronym	Participant Legal Name	Institution	Country
12	GEUS	Geological Survey of Denmark and Greenland [Project coordinator]		Denmark
1	TNO	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek	Geological Survey of the Netherlands	Netherlands
1a	DLT	Deltares		Netherlands
9	HGI-CGS	Hrvatski Geološki Institut		Croatia
14	GTK	GeologianTutkimuskeskus		Finland
15	BRGM	Bureau de Recherches Géologiques et Minières		France
17	BGR	Bundesanstalt für Geowissenschaften und Rohstoffe		Germany
27	MBFSZ	Mining and Geological Survey of Hungary		Hungary
29	GSI	Geological Survey of Ireland		Ireland
30	ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale		Italy
31	SGSS	Regione Emilia-Romagna		Italy
39	LEGMC	Latvijas Vides, Geologijas Un Meteorologijas Centrs Sia		Latvia
42	MTI	Ministry for Transport and Infrastructure		Malta
45	LNEG	Laboratório Nacional de Energia e Geologia		Portugal
47	GSS	Geološki zavod Srbije		Serbia
50	IGME[1]	Instituto Geológico y Minero de España		Spain
51	ICGC	Institut Cartogràfic i Geològic de Catalunya		Spain
52	SGU	Sveriges Geologiska Undersökning		Sweden
53	GEOINFORM	State Research and Development Enterprise State Information Geological Fund of Ukraine		Ukraine
54	NERC	Natural Environment Research Council	British Geological Survey	United Kingdom

2.4 Vulnerability of Shallow Groundwater Resources to Deep Sub-surface Energy-Related Activities (VOGERA)

Project Lead: BGS, UK
Number of partners: 6
Total budget: 433,781€

Vulnerability of shallow groundwater resources to deep sub-surface energy-related activities (VoGERA) will gather scientific evidence to investigate the relationship between industrial activity in the deep sub-surface and shallow groundwater resources, in a European context. The project will consider the possible impacts on groundwater from a range of sub-surface energy activities (geothermal energy, unconventional oil and gas exploitation, sub-surface storage and disposal of wastes) in a consistent manner. An approach to evaluating groundwater vulnerability from sub-surface activities that can be applied across Europe will be developed using this evidence, and the in-depth understanding gained will be used to improve awareness of these issues with decision makers and the public. This will aid better sub-surface spatial planning and policy development for deep sub-surface energy-related activities in relation to groundwater, thus allowing for the simultaneous protection of groundwater for future generations whilst recognizing the need for economic development. A strong link with stakeholders will ensure an approach that is fit-for-purpose and has maximum impact.
Conceptual models of shallow groundwater vulnerability to deep sub-surface energy activities will be developed using existing data and information and experience of GeoERA partners and from previous projects, and will be validated at a number of pilot study sites. These will be in different hydrogeological settings across Europe and will use a range of physical, chemical, isotopic and intercalibrated geophysical methods to identify and characterize contaminant pathway properties and their influence on groundwater vulnerability.

#	Participant Legal Name	Institution	Country
1	Natural Environment Research Council (NERC) [Project Coordinator]	British Geological Survey (BGS)	United Kingdom
2	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (TNO)	TNO	Netherlands
3	Vlaamse Milieu Maatschappij (VMM)	VMM	Belgium
3a	Belgian Nuclear Research Centre (linked third party of VMM)	SCK•CEN	Belgium
4	Mining and Geological Survey of Hungary (MBFSZ)	MBFSZ	Hungary
5	State Information Geological Fund of Ukraine	GeoInform	Ukraine
6	Geological Survey of Denmark and Greenland	GEUS	Denmark

3 RAW MATERIALS PROJECTS

3.1 European Ornamental stone resources (EuroLithos)

Project Lead: NGU, Norway
Number of partners: 16
Total budget: 1,100,357€

Ornamental stone has contributed significantly in shaping our rural and urban landscapes, through its use in our built heritage from different historical periods. Ornamental stone is today a raw material produced with great skills all over Europe, exploiting the vast diversity of European natural stone resources. Yet, the actual use of local and regional stone resources in Europe is decreasing, and so is the knowledge of the resources, traditions and skills. EuroLithos is founded on the idea that increased knowledge of the geology, quality and history of use of natural stone in Europe will stimulate both more sustainable use of stone resources in Europe for the benefit of SME's and our cultural heritage, and a sound land use management for the safeguarding of ornamental stone deposits.
EuroLithos addresses several aspects of the scope*: identify and map the type and quality of construction materials*, and *provide tools and protocols for the assessment and comparison of deposits*. EuroLithos will also address cultural heritage and building preservation aspects, since the maintenance of European heritage and a living stone industry are mutually dependent. EuroLithos will result in an ornamental stone knowledge base under the umbrella of EGDI, covering harmonised spatial data on European stone resources, atlas of resources and use, a directory of ornamental stone properties and guidelines for valorising ornamental stone heritage. EuroLithos will work in close collaboration with the GeoEra Information Platform. The EuroLithos consortium is composed of 16 partners from 14 countries, collectively forming a strong and innovative research group.

#	Participant Legal Name	Institution	Country
1	NORGES GEOLOGISKE UNDERSØKELSE NGU, Geological Survey of Norway [Project Coordinator]	**National geological survey**	**Norway**
2	LABORATORIO NACIONAL DE ENERGIA E GEOLOGIA I.P., LNEG	**National geological survey**	**Portugal**
3	SVERIGES GEOLOGISKA UNDERSÖKNING SGU, Geological Survey of Sweden	**National geological survey**	**Sweden**
4	INSTITUTO GEOLÓGICO Y MINERO DE ESPAÑA IGME, Geological Survey of Spain	**National geological survey**	**Spain**
5	INSTITOUTO GEOLOGIKON KAI METALLEFTIKON EREVNON IGME, Institute of Geology and Mineral Exploration	**National geological survey**	**Greece**
6	REGIONE EMILIA ROMAGNA SGSS, Servizio Geologico, Sismico e dei Suoli della Regione Emilia-Romagna	**Regional geological survey**	**Italy**
7	REGIONE TOSCANA RT, sistema informativo territoriale e ambientale – p.o. geologia	**Regional geological survey**	**Italy**
8	GEOLOŠKI ZAVOD SLOVENIJE GeoZS, Geological Survey of Slovenia	**National geological survey**	**Slovenia**
9	GEOLOGISCHE BUNDESANSTALT GBA, Geological Survey of Austria	**National geological survey**	**Austria**
10	INSTITUTUL GEOLOGIC AL ROMANIEI IGR, Geological Institute of Romania	**National geological survey**	**Romania**
11	STATE RESEARCH AND DEVELOPMENT ENTERPRISE STATE INFORMATION GEOLOGICAL FUND OF UKRAINE, GEOINFORM – SRDE "Geoinform of Ukraine"	**National geological survey**	**Ukraine**
12	GEOLOGICAL SURVEY OF IRELAND GSI	**National geological survey**	**Ireland**
13	INSTITUTO SUPERIORE PER LA PROTEZIONE E LA RICERCA AMBIENTALE ISPRA	**National geological survey**	**Italy**
14	HRVATSKI GEOLOSKI INSTITUT HGI-CGS, Croatian Geological Survey	**National geological survey**	**Croatia**
15	Cyprus Geological Survey Department GSD	**National geological survey**	**Cyprus**
16	SERVICE GEOLOGIQUE DU LUXEMBOURG SGL 'Geological Survey of Luxembourg'	**National geological survey**	**Luxembourg**

3.2 Forecasting and Assessing Europe's Strategic Raw Materials needs (FRAME)

Project Lead: LNEG, Portugal
Number of partners: 19
Total budget: 3,139,634€

Inevitably, Europe shows a growing and accelerating consumption of mineral commodities, which at the moment the question whether supply to meet demand is adequate or not cannot be answered with any certainty because secure supply is a matter of knowing the resources and the ability to exploit them with respect to sustainability. Non-energy minerals underpin our modern economy and are essential for manufacturing and renewable "green" energy supply technologies. Many critical and strategic minerals and metals may be collected through recycling of mining related waste materials. However, even with the important contribution from recycling, it will still be necessary to extract them from primary mineral deposits, focusing on applying new technologies for deep exploration and mining, turning low-grade ores to exploitable resources and reducing generation of mining wastes and large tailings by converting them to exploitable resources.

Project **FRAME** (Forecasting and Assessing Europe's Strategic Raw Materials Needs) is designed to research the critical and strategic raw materials in Europe, in scenarios as described above, by employing sound strategies and a partner base spread far and wide amongst those that have some of these raw materials. Through successful teamwork, there is the expertise and knowledge base to provide a significant innovative contribution towards knowing more about the potential primary deposits, predict new target areas/deposits and recognize the potential in secondary deposits.

FRAME is made up of eight work Packages (WP) designed to collect, extract and disseminate strategic and critical mineral data to fill existing knowledge gaps in this field.

#	Participant Legal Name	Institution	Country
1	Laboratório Nacional de Energia e Geologia, I. P. [Project Coordinator]	LNEG	Portugal
2	Federal Institute for Geosciences and Natural Resources	BGR	Germany
3	Bureau de Recherches Géologiques et Minières	BRGM	France
4	Czech Geological Survey	CGS	Czech Republic
5	Geological Survey of Estonia	GSE	Estonia
6	Geological Survey Sweden	SGU	Sweden
7	Geological Survey Ireland	GSI	Ireland
8	Geological Survey of Finland	GTK	Finland
9	Geological Survey of Croatia	HGI-CGS	Croatia
10	Greek Institute of Geology and Mineral Exploration	IGMEgr	Greece
11	Instituto Geológico y Minero de España	IGMEsp	Spain
12	Mining and Geological Survey of Hungary	MGSH	Hungary
13	Geological Survey of Norway	NGU	Norway
14	Polish Geological Institute	PGI-NRI	Poland
15	Royal Belgian Institute of Natural Sciences	RBINS	Belgium
16	State Informational Geological Fund of Ukraine	GeoInform - GIU	Ukraine
17	Institutul Geologic al Romaniei	IGR	Romania
18	Geološki Zavod Slovenije	GeoZS	Slovenia
19	Istituto Superiore per la Protezione e la Ricerca Ambientale	ISPRA	Italy

3.3 Seabed Mineral Deposits in European Seas: Metallogeny and Geological Potential for Strategic and Critical Raw Materials (MINDeSEA)

Project Lead: IGME, Spain
Number of partners: 8
Total budget: 783,285€

The project **MINDeSEA** results of the collaboration between eight GeoERA Partners and four Non-funded Organizations at various points of common interest for exploration and investigation on seafloor mineral deposits. This project addresses an integrative metallogenetic study of principal types of seabed mineral resources (hydrothermal sulfides, ferromanganese crusts, phosphorites, marine placers and polymetallic nodules) in the European Seas. The MINDeSEA working group has both knowledge of and expertise in such types of mineralisation, providing exploration results, sample repositories and databases to produce innovative contributions. The importance of submarine mineralisation systems is related to the abundance and exploitation-potential of many strategic metals and Critical Raw Materials (CRM), necessary for the modern society development.

The objectives of this project are the following: 1) Characterise deposit types; 2) Characterise the trace element content of the deposit type including CRM; 3) Identify the principal metallogenic provinces; 4) Develop harmonised mineral maps and datasets of seabed deposits incorporating GSO datasets, along with mineral-potential and prospectivity maps; 5) Demonstrate how the cases study results can be used in off-shore mineral exploration; 6) Analyse present-day exploration and exploitation status in terms of regulation, legislation, environmental impacts, exploitation and future directions. 7) Demonstrate efficiency of a pan-European research approach to understanding seabed minerals and modes of exploration. The methodology will include: procedures for submarine minerals exploration; mineral evaluation and seafloor minerals mapping; a web service that will disseminate procedures, maps and information to the general public, downstream users and decision makers.

#	Participant Legal Name	Institution	Country
1	Instituto Geológico y Minero de España [Project Coordinator]	**Geological Survey of Spain (IGME-Sp)**	**SPAIN**
2	Bundesanstalt für Geowissenschaften und Rohstoffe	**Federal Institute for Geosciences and Natural Resources (BGR)**	**GERMANY**
3	Institouto Geologikon kai Metalleftikon Erevnon	**Institute of Geology and Mineral Exploration (IGME-Gr)**	**GREECE**
4	Department of Communications, Climate Action and Environment	**Geological Survey of Ireland (GSI)**	**IRELAND**
5	Geological Survey of Norway	**Geological Survey of Norway (NGU)**	**NORWAY**
6	Laboratorio Nacional de Energia e Geologia	**Laboratorio Nacional de Energia e Geologia I.P. (LNEG)**	**PORTUGAL**
7	Sveriges Geologiska Undersökning	**Geological Survey of Sweden (SGU)**	**SWEDEN**
8	State Research and Development Enterprise State Information Geological Fund of Ukraine	**Geoinform of Ukraine (GIU)**	**UKRAINE**
9	Instituto Português do Mar e da Atmosfera	**Instituto Português do Mar e da Atmosfera (IPMA)** (non-funded partner)	**PORTUGAL**
10	Geosciences Institute	**Geosciences Institute (IGEO)** (non-funded partner)	**SPAIN**
11	United States Geological Survey	**United States Geological Survey (USGS)** (non-funded partner)	**UNITED STATES OF AMERICA**
12	Russian Ministry of Natural Resources	**Institute for Geology and Mineral Resources of the Ocean (VNIIOkeangeologia)** (non-funded partner)	**RUSSIA**

3.4 Mineral Intelligence for Europe (Mintell4EU)

Project Lead: GEUS, Denmark
Number of partners: 25
Total budget: 2,859,159€

The European Union has identified security of supply, improvement in environmental management and resource efficiency as key challenges for the raw materials sector. Data regarding the location and spatial distribution of primary and secondary raw materials, with respect to exploration, exploitation, production and trade activities, underpin decision making in government and industry. Given the dynamic character of such data, regular updates of comprehensive, reliable and harmonized information across borders are required. The overall aim of this proposal is to improve the European Knowledge Base on raw materials by updating the electronic Minerals Yearbook produced in the Minerals4EU project and to extend the spatial coverage and quality of data currently in the Minerals Inventory. The project will, furthermore, aim to increase the degree of harmonization, communication and interaction between existing data platforms, with the ambition of reaching a fully operational and reliable data knowledge management system, fulfilling the European needs and taking into account the Raw Materials Information System (RMIS) of the European Union. Importantly, the project will also integrate the electronic Minerals Yearbook into the Minerals4EU database, ensuring future sustainability as part of the EuroGeoSurveys-governed European Geological Data Infrastructure (EGDI). All results will be integrated in the GeoERA Information Platform that will, by end of the project, disseminate European raw materials intelligence in a uniform way to end users through a common web portal interface. Finally, the applicability of the UNFC classification system for obtaining more accurate Pan-European mineral inventories will be tested.

#	Participant Legal Name	Institution	Country
1	Geological Survey of Denmark and Greenland [Project Coordinator]	GEUS	Denmark
2	Bureau de Recherches Géologiques et Minières	BRGM	France
3	Instituto Geológico y Minero de España	IGME (Sp)	Spain
4	Cyprus Geological Survey Department	GSD	Cyprus
5	Geological Survey of Italy	ISPRA	Italy
6	Geological Survey of Norway	NGU	Norway
7	Geological Survey of Slovenia	GeoZS	Slovenia
8.	Geological Survey of Sweden	SGU	Sweden
9.	State Informational Geological Fund of Ukraine	GeoInform - GIU	Ukraine
10.	Statny Geologicky Ustav Dionyza Stura	SGIDS	Slovak Republic
11.	Laboratório Nacional de Energia e Geologia, I.P.	LNEG	Portugal
12.	Institute of Geology and Mineral Exploration	IGME (Gr)	Greece
13.	Hrvatski geološki institut - Croatian Geological Survey	HGI-CGS	Croatia
14.	Geological Survey of Finland	GTK	Finland
15.	Natural Environment Research Council (British Geological Survey)	NERC/BGS	United Kingdom
16.	Regierungspräsidium Freiburg (Landesamt für Geologie, Rohstoffe und Bergbau Baden-Württemberg)	LGRB	Germany
17.	Bundesanstalt für Geowissenschaften und Rohstoffe (The Federal Institute for Geosciences and Natural Resources)	BGR	Germany
18.	Geological Survey of Ireland	GSI	Ireland
19.	Geological Survey of Belgium	GSB-RBINS	Belgium
20.	Mining and Geological Survey of Hungary	MBFSZ	Hungary
21.	Service géologique du Luxembourg - Geological Survey of Luxembourg	SGL	Luxembourg
22.	GEOLOGICAL SURVEY OF SERBIA	GSS	Serbia
23.	Albanian Geological Survey	AGS	Albania
24.	Czech Geological Survey	CGS	Czech Republic
25.	Geological Survey of Federation of Bosnia and Herzegovina	FZZG	Federation of Bosnia and Herzegovina

4 GEOERA INFORMATION PLATFORM PROJECT (GIP-P)

Project Lead: GEUS, Denmark
Number of partners: 24
Total budget: 3,860,804€

It is the overall aim of GeoERA to integrate information and knowledge to support sustainable use of the subsurface. The geoscientific projects (GSPs) on subsurface energy, water and raw material resources will produce large amounts of geological data and information and the GeoERA Information Platform Project (GIP-P) will establish a common platform for organising, disseminating and sustaining the digital results of those projects.
The platform will include a central database, a metadatabase, a user friendly web-portal and a digital archive for organising reports and unstructured data. The portal will include facilities for visualising complex information like 3D/4D geological models. In order to ensure that the needs of the GSPs are fully identified and understood by the experts who will implement the platform, a specific organisation will be set up to liaise between those projects and the GIP-P.
Great effort will be put into adhering to European and international standards in order for the results to be as useful as possible for the whole of GeoERA and its external users thereby maximising the overall impact of the project. Techniques like Linked Open Data and multilingual thesauri will be implemented to ensure maximum interoperability of the data and services. The platform will be based on a coherent architecture which will take into account experiences gained in previous EU funded data harmonisation projects and be built as an extension to the European Geological Data Infrastructure (EGDI). The project will explore how the sustainability of the platform is ensured after the end of GeoERA.

#	Participant Name	Institution	Country
1 (Coor.)	GEUS	Geological Survey of Denmark and Greenland	Denmark
2	BGR	Bundesanstalt Für Geowissenschaften und Rohstoffe	Germany
3	TNO	Nederlandse Organistie voor Toegepast Natuurwetenschappelijk Onderzoek	The Netherlands
4	SGU	Sveriges Geologiska Undersökning	Sweden
5	GeoZS	Geoloski Zavod Slovenije	Slovenia
6	CGS	Ceska Geologicka Sluzba	Czech Republic
7	BRGM	Bureau de Recherches Geologiques et Minieres	France
8	NERC	Natural Environment Research Council	United Kingdom
9	ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale	Italy
10	GTK	Geologian Tutkimuskeskus	Finland
11	NGU	Geological Survey of Norway	Norway
12	RBINS	Institut Royal des Sciences Naturelles de Belgique	Belgium
13	GSI	Department of Communications, Energy and Natural resources	Ireland
14	IGME-ES	Instituto Geológico y Minero de Espana	Spain
15	GeoInform	State Research and Development Enterprise State Information Geological of Ukraine	Ukraine
16	GIR	Institutul Geologic al Romaniei	Romania
17	GBA	Geologische Bundesanstalt	Austria
18	SGSS	Servizio Geologico, Sismico e dei Suoli della Regione Emilia-Romagna	Italy
19	MBFSZ	MAGYAR BÁNYÁSZATI ÉS FÖLDTANI SZOLGÁLAT	Hungary
20	LfU	Bayerisches Landesamt fur Umwelt	Germany
21	LNEG	Laboratorio Nacional de Energia e Geologia I.P.	Portugal
22	PGI	Panstwowy Instytut Geologiczny – Panstwowy Instytut Badawczy	Poland
23	HGI-CGS	Hrvatski Geološki Institut	Croatia
24	ISOR	Íslenskar orkurannsóknir	Iceland

5 ANNEX - PROJECT PROPOSALS

1. 3DGEO-EU, 3D geomodeling for Europe
2. GARAH, Geological Analysis and Resource Assessment of selected Hydrocarbon systems
3. GeoConnect³d, Cross-border, cross-thematic multiscale framework for combining geological models and data for resource appraisal and policy support
4. HIKE, Hazard and Impact Knowledge for Europe
5. HotLime, Mapping and Assessment of Geothermal Plays in Deep Carbonate Rocks – Cross-domain Implications and Impacts
6. MUSE, Managing Urban Shallow geothermal Energy
7. HOVER, Hydrological processes and Geological settings over Europe controlling dissolved geogenic and anthropogenic elements in groundwater of relevance to human health and the status of dependent ecosystems
8. RESOURces, Resources of groundwater harmonized at cross-border and pan-European scale
9. TACTIC, Tools for Assessment of Climate change Impact on groundwater and adaptation Strategies
10. VoGERA, Vulnerability of Shallow Groundwater Resources to Deep Sub-surface Energy-Related Activities
11. EuroLithos, European Ornamental stone resources
12. FRAME, Cross-border, cross-thematic multiscale framework for combining geological models and data for resource appraisal and policy support
13. MINDeSEA, Seabed Mineral Deposits in European Seas. Metallogeny and Geological Potential for Strategic and Critical Raw Materials
14. Mintell4EU, Mineral Intelligence for Europe
15. GIP-P, GeoERA Information Platform

5.1 3DGEO-EU

Project Proposal

Project title: 3D Geomodeling for Europe

Project acronym: 3DGEO-EU

Project number: GeoE.171.005

HISTORY OF CHANGES		
Version	**Date**	**Amendment to Project Plan**
2	01-06-2018	Updated Table 3.3c) – information for IGME consistent with the formulas

COVER PAGE

Title of project proposal

3D geomodeling for Europe (3DGEO-EU)

Abstract (max. 250 words)

Harmonization of geological data across geological, topographical, but especially across national borders is one of the most important work steps to create a base for trans-European assessments of resource potentials and possible conflicts of use of European subsurface. In the last decades a variety of different thematic maps were developed, but often not on a similar and consistent data base. Differences in the geological & geophysical interpretation (e.g. stratigraphy, velocity-model, structural interpretation, different methods of assessments) across the borders remain unchanged and were masked by generalizations in an overview scale. In the last years these “border-discontinuities” have become obvious by a variety of 3D-modeling projects. But workflows for harmonization of different geological 3D models are yet not established and proofed. In the proposed project we will show on the example of cross-border pilot areas how harmonization across the borders can be established and maintained with the progress of the national models. To support this harmonization, three work packages which focuses on method development aspects in regard of uncertainties of geological 3D models and their visualization, cross-border modeling of fault data, and 3D model consistency accompany the work in the pilot areas. The latter aspect will be demonstrated on the basis of case studies to show how 3D model consistency can be proofed. The methodologic advantages (agreements on best practices, optimized workflows, etc.) and the gain in experience on cross-border 3D harmonization work will be a keystone for further transnational harmonization projects.

Please indicate the SRT

GeoEnergy – GE5-Advancements in developing and using 3D transnational geomodels

List of participants

#	Participant Legal Name	Institution	Country
1	Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) [Project Coordinator]	**BGR**	**Germany**
2	Ceska Geologicka Sluzba – Czech Geological Survey (CGS)	**CGS**	**Czech Republic**
3	Geological Survey of Denmark and Greenland (GEUS)	**GEUS**	**Denmark**
4	Landesamt für Bergbau, Geologie und Rohstoffe Brandenburg (LBGR)	**LBGR**	**Germany**
5	Landesamt für Umwelt, Naturschutz und Geologie Mecklenburg-Vorpommern (LUNG)	**LUNG**	**Germany**
6	Landesamt für Bergbau, Energie und Geologie Niedersachsen (LBEG)	**LBEG**	**Germany**

7	Landesamt für Geologie und Bergwesen Sachsen-Anhalt (LAGB)	**LAGB**	**Germany**
8	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO	**TNO**	**Netherlands**
9	Polish Geological Institute – National Research Institute (PGI-NRI)	**PGI**	**Poland**
10	Instituto Geológico y Minero de España (IGME-Spain)	**IGME**	**Spain**
11	State Research and Development Enterprise State Information Geological Fund of Ukraine (GEOINFORM)	**GEOINFORM**	**Ukraine**

1 Excellence

Aims and objectives

This project proposal relates to the SRT GE5 - Advancements in developing and using 3D transnational geomodels. The partners of the consortium aim to improve, develop and test methods for the harmonization of cross-border 3D geomodels in different geological situations and source data coverage, thus providing significant keystones to increase the effectiveness and applicability of 3D geomodel information in transnational settings towards the future goal of having coherently harmonized 3D geomodels across Europe.

Sustainable energy supply, in line with greenhouse gas reduction targets, increases the need for reliable assessments of subsurface geo-energy potential in the European Union. This potential includes conventional, unconventional, and renewable energy resources as well as storage options for energy carriers and CO_2. A good estimation of subsurface resources serves a sustainable spatial planning on European level and requires up-to-date geological basic information that is consistent across European member state borders in order to adequately inform stakeholders and decision makers. For this an appropriate provision and presentation of subsurface parameters and the 3-dimensional arrangement of geological strata, rock and fault properties are required, as it is provided by 3D geomodels.

Consistent and reliable results of resource assessments across borders can only be achieved if the used 3D geomodels are harmonized across borders, i.e. exhibit no border discontinuities. Previous pan-European assessments (e.g. assessments of CO_2 storage capacity) were often based on a compilation of not harmonized, heterogeneous geological base data with different levels of geological exploration, evaluated with different tools, data architectures, standards and dissemination platforms, thus providing inconsistent results.

This project focuses on the development and selection of standardized methods for generating harmonized coherent cross-border 3D geomodels that are able to support national and transnational spatial planning of the subsurface and it aims to apply and demonstrate these methods in a pan-European dimension. According to the scope of the SRT GE5 defined in the call announcement the project will tackle the following aspects:

1. Demonstrate challenges and possibilities of integrated and applied 3D modeling within a pan-European dimension and establish solutions for building and integrating 3D geomodels and databases in transnational geological settings. Different national and regional states of 3D modeling, various levels of detail and different methods of exploration due to the geologic situation and specific exploration interests still hamper the consistent harmonization and supply of subsurface information due to the heterogeneity of existing geological databases, standards, data services, maps and

geomodels. The development and evaluation of unified and substantially tested methods and workflows for cross-border harmonization of geological data and 3D geomodels holds the potential to significantly improve the development and supply of 3D subsurface information to stakeholders and decision makers in a pan-European dimension (responding to bullet 1 of the SRT scope).
2. Develop and provide technical methods and solutions in the field of cross-border harmonization. Results are applicable to multiple countries, regions and organisations in a wide range of geological settings and with different states of exploration. They are essentially necessary for the development, evaluation and application of regional to transnational geomodels and practical multinational case studies (responding to bullet 2 of the SRT scope).
3. Construct State-of-the-Art 3D geomodels in different European pilot areas to provide 3D model information for true interlacing/merger at European scale that can be used as examples and keystones for further transnational developments (responding to bullet 3 of the SRT scope).
4. Integration of the developed methodologies and geomodels into the GeoERA Information Platform (responding to bullet 1 and 3 of the SRT scope).

Relation to existing programmes and projects

This proposal builds in part upon methods and best practices developed and implemented in past EU projects (GeoMol - Interreg Alpine Space, GeORG - Interreg Upper Rhine, GeoPower - Interreg South Denmark-Schleswig-K.E.R.N, Geokin3DPyr – Interreg Pyrenees) that provided transnational 3D geomodels and assessed geo-energy potentials in specific trans-border geological settings, as well as national projects that are isolated up to now in the participating countries.

The project will however improve/adjust these methods to construct harmonized coherent cross-border geomodels in different geological settings in the Central European Basin System. Thus the project offers advanced mapping and 3D geomodeling strategies towards establishing regional to pan-European consistent cross-border geology and assessment of subsurface resources.

1.1 Concept and methodology

The general concept of the proposal is structuring the tasks in interacting work packages dealing with the development of 3D geomodels in various European pilot areas (responding to point 1. and 3. of the objectives), the development of specific methods/workflows for transnational harmonization and evaluation of geomodels (responding point 2. of the objectives) and the dissemination of results – models and methods - via the GeoERA Information Platform (point 4. of the objectives). On the one hand the work in the pilot areas will establish and provide databases and models for case studies that will be used for the methodological research and development, on the other hand these methods will be used in the transnational harmonization and evaluation of the models.

<u>Development of harmonized 3D geomodels in pilot areas</u>

Three pilot area work packages were defined in the Central European Basin System (see chapter 3),

- offshore area in the North Sea across the sector borders between the Netherlands, Germany and Denmark,
- onshore area at the border between Germany (Lower Saxony) and the Netherlands and
- onshore area between Poland and Germany (Mecklenburg-Vorpommern, Brandenburg).

These selected regions provide different geological situations and complexity, different levels of data density and exploration status. The well-studied area of the Central European Basin System, situated in Central and Northern Europe, is a very good test area to develop and enhance modeling methods needed for the development and application of regional to transnational geomodels, as it offers geological diversity in different basin settings, the occurrence of important energy and groundwater resources across a number of countries, and the presence of Geological Survey Organisations with the expertise and capacity to build 3D geomodels. This large test area covers many aspects relevant for pan-European decisions. It can thus act as an ideal study area for the development and application of unified and standardized cross-border harmonization aspects applicable to other areas on a pan-European level. An additional case study area was defined in the south-western Pyrenees for special method development regarding the very different geological setting and exploration situation (see below Method development).

The planned geomodeling work packages in the pilot areas require structural and stratigraphic information from detailed analysis and interpretation of various geophysical and well data. In the first phase of the project the involved partners will make an inventory of available data and existing 3D geomodels in the pilot areas on the different sides of the borders. Also the differences in existing model concepts will be examined. Based on that documented state-of-the-art for the pilot areas the partners will finally decide on the 3D geomodels (e.g. detailed work areas, structure, and resolution) to be built and harmonized across borders. Within the selected pilot areas the cross-border geology will be established by e.g. defining a common stratigraphic and structural framework, harmonizing seismo-stratigraphic interpretation concepts, construction of structural models and methods to check their geological consistency, cross-border mapping of reservoirs, and visualization of uncertainties.

<u>Method development</u>

To support work on geomodel harmonization in the pilot areas, three work packages are planned which focus on method development regarding (1) uncertainties of geological 3D models and their visualization, (2) cross-border modeling and parametrization of fault data and (3) evaluation and improvement of 3D geomodel consistency. The latter aspect will be demonstrated on the basis of additional case studies, defined to use and test multi-approach reconstruction workflows and tools, to show how 3D geomodel consistency can be proofed. One case study is defined in the south-western Pyrenees in a region where structural limitations (i.e. steep dips) have precluded the acquisition of reflection seismic data. To compensate lack of conventional seismic data, new gravimetric and magnetic data will be integrated with standard 3D reconstruction data to enhance certainty of 3D geomodels. The definition of such a case study in a very different geological setting in comparison with the pilot areas in the Central European Basin System broadens the scope of the research work in this project.

The project partners will also pursue networking and discussions with other GeoERA partners as well as involving external research institutions to elicit peer-expert opinion in regard of project topics (e.g. uncertainties of geomodels).

<u>Dissemination of results and contribution to the Information Platform</u>

The 3DGEO-EU project will establish and deliver methods, workflows, test cases, and model data for cross-border harmonization of 3D geomodels, applicable to other regions in Europe. The project incorporates a work package dedicated to the interaction with the Information Platform that coordinates information transfer within 3DGEO-EU.

1.2 Ambition

Harmonization of geological data and 3D geomodels across national borders is one of the most important steps to create a consistent base for pan-European assessments of resource potentials and possible conflicts of use. In the last decades a variety of different thematic maps were developed, but often not on a similar and consistent data base. Differences in the geological & geophysical interpretation (e.g. stratigraphy, velocity-model, structural interpretation, different methods of assessments) across the borders remain unchanged and were masked by generalisations in an overview scale. In the last years such border discontinuities have become obvious by a variety of 3D geomodeling projects. But workflows for harmonization of different geological 3D models are yet not established and proofed.

In the proposed project we will bring together European Geological Survey Organisations (GSO) to identify, prioritise and deliver the research needed towards establishing methods and workflows for harmonization of 3D geomodels across borders.

Selected pilot areas will serve as showcases to demonstrate how harmonization across the borders can be established. As one result, a set of cross-border consistent geomodels will be produced covering a range of geological settings, that can act as nuclei for further developments and can be utilized for cross-border resource assessments and subsurface use planning.

As another result the joint development and provision of technical methods and solutions that are applicable in multiple countries/regions with different geological settings and different state of exploration will help on the way from regional and national to transnational geomodels.

The experiences and outcome of the project will foster coordination processes between the GSOs in regard of cross-border geological modeling. The methodologic advantages and the gain in experience on cross-border 3D harmonization work will be a keystone for further transnational cooperation of the GSOs to produce more reliable pan-European assessments of subsurface resources and the establishment of a pan-European harmonized geological knowledge base in the future.

2 Impact

2.1 Expected impact

The cooperation of GSOs in this project to perform geomodeling work in well selected cross-border pilot areas and supported by work on method development issues will help to establish methods and workflows for cross-border harmonization of 3D geomodels, applicable to other border regions in Europe. The expected impacts can be specified as follows:

- Establishment of consistent data and model base in cross-border regions improves the state of knowledge and thus will lift up subsurface resource assessments studies in cross-border regions to a new level.
- Establishment of a set of cross-border consistent geomodels in the pilot areas that can be the nucleus for further transnational harmonization projects and the establishment of a pan-European harmonized geological knowledge base.
- Harmonization of stratigraphic as well as structural modeling workflows in border areas allow for a better comparability of results of cross-border assessments in the future.
- Development of methodologies for semantic and geometric harmonization of data and geomodels across borders.
- Improved visualization methods for uncertainties and optimized reconstruction and restoration workflows to reduce uncertainty of geomodels will help to enhance the reliability of 3D geomodels for future cross-border resource assessments at the European scale.
- Advanced mapping and 3D geomodeling strategies that allow for regional to pan-European cross-border consistency and integration, thus helping to adequately inform European stakeholders and decision makers on subsurface resources.
- Development of common and accepted standards and disseminate best practices for cross-border harmonization; applicable to other European countries.
- Existing links to other GeoERA projects like GE1-GARAP, GE4-HIKE, GE6-GeoConnect^{3}D will demonstrate the application of the models.

2.2 Measures to maximise impact

2.2.1 Dissemination and exploitation of results

A Project Dissemination and Exploitation Plan (DEP) will be set up at the beginning of the project to determine concrete measures in order to promote the results and to increase the impacts listed above, and to inform and engage the wider stakeholder community. The following elements will be part of that plan:

- Dissemination to academic researchers and networks through scientific publications and presentations at meetings and conferences.
- Engagement of other research institutes in regard of certain project topics, e.g. on methods for the visualization of geomodel uncertainties.
- Dissemination to stakeholders through dissemination channels of the GeoERA project and their participants.
- Dissemination of data and results through the Information Platform as a reference server of the project results.

- Active participation of the project in three obligatory GeoERA dissemination seminars (Kick-off Seminar, Mid-Term Seminar, and Final Seminar).
- Interactions with other GeoERA projects with the intention for collaboration and information exchange.

2.2.2 Communication activities

As part of the DEP the project will perform several communication activities, which will be specified in the DEP. The following activities will be part of the final plan:

- The project will use appropriate events, forums and other opportunities to support networking with peer-experts in regard of the project topics.
- International conferences will be attended with presentations on the project to increase the interest and recognition amongst stakeholders.
- The project will set up a web site to provide information about the main aims of the project and to present and promote the project results.
- The project will provide news on the project proceedings and on achieved results to the GeoERA Executive Board to be published in newsletters.
- Videoconferencing will be used for exchanging information and results and in seeking solutions.

2.3 Contribution of Project Proposal to the Information Platform or vice versa

The 3DGEO-EU project will establish new and innovative concepts and methods for pan-European cross-border harmonization efforts that will be applicable to the whole geoscience community handling with heterogenic geological data sets and models. The structure of the project comprising methodological and practical work packages handling with a wide range of geological and geophysical data, various states of exploration and knowledge as well as different kinds of 3D geomodels enables the project to contribute a comprehensive cross-thematic overview of concepts and methods dealing with cross-border harmonization. These methods will be performed on a variety of pilot areas and case studies straddling wide areas of Europe. To this end the 3DGEO-EU project will provide several kinds of information and data for the European Geo-Data Infrastructure (EGDI), i.e.:

- The 3DGEO-EU project will provide a comprehensive overview of the state of the art illustrating all issues challenging the harmonization of geomodels across geological, topographic and territorial borders.
- The 3DGEO-EU project will provide concise guidelines that will enable and support the whole geoscience community to harmonize geological 3D models across borders.
- The 3DGEO-EU project will describe methods for handling and communicating uncertainty and the requirements for its visualization, including example data to test different visualization methods.
- The 3DGEO-EU project will deliver harmonized 3D geomodels of cross-border regions and example data from various geological settings illustrating the scientific profits of cross-border harmonization, the benefits of the integration of new and innovative methods as well as the application of methods for the quantification and visualization of uncertainties in 3D geomodels.

WP7 (Information Platform Interface) will coordinate the interactions between the 3DGEO-EU project and the GeoERA-IP project. The following requirements and interactions are defined:

- The 3DGEO-EU project will develop the possibilities, in accordance with the legal conditions of the project partners, to deliver eligible geo-information used, processed and derived in 3DGEO-EU.

- The 3DGEO-EU project will develop and provide the requirements for the integration of derived 3D geomodels in the European Geo-Data Infrastructure (EGDI).
- WP7 will examine the 3DGEO-EU project’s communication and data exchange regarding the coordinated and verified requirements of the GeoERA-IP project standards to ensure the conformable delivery of standardized results.

3 Implementation

3.1 Work Plan – Work packages, deliverables

The work plan of this project consists of eight work packages.

Three cross-border pilot area work packages will show how harmonization across borders can be established (WP1-3). Accompanying the work in the pilot areas to support cross-border harmonization we have three method development work packages (WP3-6) which focus on aspects like uncertainties of geological 3D models, definition of optimized workflows and their visualization, cross-border modeling of fault data, and 3D model consistency. The experiences and various results coming from the work packages 1–6 have to be compiled, exchanged, discussed, and then channeled in order to finally present methods and harmonization workflows that are applicable on a pan-European level for cross-border studies in sediment basins with a comparable data distribution.

The Information Platform Interface work package (WP7) will govern the interactions with the GeoERA-IP project. Furthermore, communication and standardised knowledge exchange between this project and other GeoERA projects will be ensured and controlled by WP7.

In the following the work packages are briefly described:

<u>Cross-border pilot areas:</u>

WP1 Pilot area: onshore Dutch-German cross-border region

This pilot area work package develops a 3D geomodel of 12 main horizons (top Neogene-base Triassic), geothermal maps (depth, thickness and its properties) of Cenozoic reservoirs and a map of hydraulic barrier between deep saltwater and fresh groundwater in the northern onshore cross-border region of the Netherlands and Germany (Lower Saxony). This work packages will harmonize data and geological structures of the subsurface in an area that is intensively used for both energy and groundwater usage.

WP2 Pilot area: onshore German-Polish cross-border area

The aim is the development of harmonized geological 3D models for selected horizons and structures in the Polish-German cross-border region (horizons and structures in the Mesozoic and Permian strata; for energy storage, geothermal use, partially potential hydrocarbon reservoirs). The work will focus on two pilot areas of the Polish - North German Basin System covering a broad area of the Polish-German border: 1) the Gorzów-block and 2) the near border part of Szczecin Trough and their extension to the German side. The goals are to harmonize and update existing data inventories and interpretations in Poland and Germany; to establish harmonized (stratigraphical, seismostratigraphical, structural, geometrical) geological 3D models at the Polish and German border region using existing data inventories and (in close connection to WP6) employing potential field methods (gravimetry, magnetics) in addition to seismic investigations in less explored areas (cooperation with IGME and GE5-WP6)

WP3 Pilot area: offshore cross-border North Sea area between the Netherlands, Germany and Denmark

In this pilot area the existing national (and regional) geomodels will be integrated by harmonizing the stratigraphical boundaries, seismic interpreted lithostratigraphic horizons, the structural concepts and the velocities of the layers. To find and to exemplarily test efficient workflows for harmonization or the consistent translation between the established national concepts will be a main task of this work package. Finally a harmonized cross-border velocity model and a structural 3D depth model will be made together with a report which describes how to build transnational 3D geomodels based on our lessons learned.

<u>Method development:</u>

WP4 Method development – Uncertainty in geomodels

3D geological models are often created from ambiguous and uncertain data which are subject to error propagation during measurement and interpretation. Further they are often scarce and heterogeneous, so that the modeler depends on model-based interpretation, e.g. by assuming a certain tectonic regime or deformation style. Apart from the small scale reservoir models of the resource industries, these uncertainties are often neither evaluated nor shown to the users and stakeholders. Within this work package the different sources of uncertainty will be compiled, a classification of the different types of uncertainty formulated and test data sets for the different types of uncertainty provided. Subsequently these test data sets are used to test the state of the art visualization methods from computer graphics and as a basis for developing new methods.

WP5 Method development – Faults

This work package is closely connected to the planned GE4 project HIKE and focusses on consistent cross-border fault mapping- and characterization in all pilot areas of this project. For all harmonization areas, described in WP's 1, 2, and 3, one main task is to meet the requirements and specifications put forward by the Fault Database development under project HIKE. An important aspect of the latter project is to define common standards and methodologies to convert data between different faults formats and vintages, and to define a common way to model and characterize faults by building on best experiences. Through joint meetings with the experts of the GE4-HIKE project, these activities will be synchronized. Yet, the actual work on harmonization and consistent modeling of fault data will be performed in this work package.

WP6 Method development – Optimizing reconstructions of the subsurface to reduce structural uncertainty in 3D models

Achieving reliable and harmonized reconstructions across Europe needs sharing, discussing and findings agreements among the existent workflows used by the different geological surveys in order to: 1) overcome methodological problems (lack of seismic data, structural consistency, etc.), 2) to tackle cross-border harmonization (as an affordable and reliable way) and 3) to face future challenges (agreement on best practices). Besides of common methods (integration of geological mapping, structural and stratigraphic data, seismic sections, wells, etc.) this transversal WP will pay special attention to the integration of potential field geophysical data (GravMag), structural balanced sections and the application of restoration techniques as validation tools. This WP has tight connections with WP2, WP4 and WP5 and also with the GE-6 GeoConnect^{3}D project.

<u>Project management and result dissemination:</u>

WP7 Information Platform Interface

This work package will govern the interactions with the GeoERA-IP project and manage all kinds of communication and data exchange between the 3DGEO-EU project and other GeoERA projects, especially IP. Therefore WP7 will develop and evaluate all requirements of 3DGEO-EU WPs in dense accordance with the parts of the Project Data Management Plan relating to IP and EDGI to enable an efficient and consistent uptake and embedding of project results into the GeoERA-IP project.

WP8 Project Management and Coordination

This work package governs the overall coordination and management of the project, especially the preparation and implementation of the work plan, monitoring of project progress and the coordination of obligatory meetings and deliverables as defined by the GeoERA guidelines. The work includes to ensure communication among work packages, between partners and with the EC, as well as conflict and risk management and the interaction with the GeoERA Executive Board.

Figure 1 below explains the general concept of the work plan and the relationships between the work packages. More information about the work packages is provided in Table 3.1a (detailed description) and Table 3.1b (summary). Table 3.1c provides a full overview of all deliverables from the project. The chronological schedule of the work plan is displayed in a GANTT Chart (Figure 2).

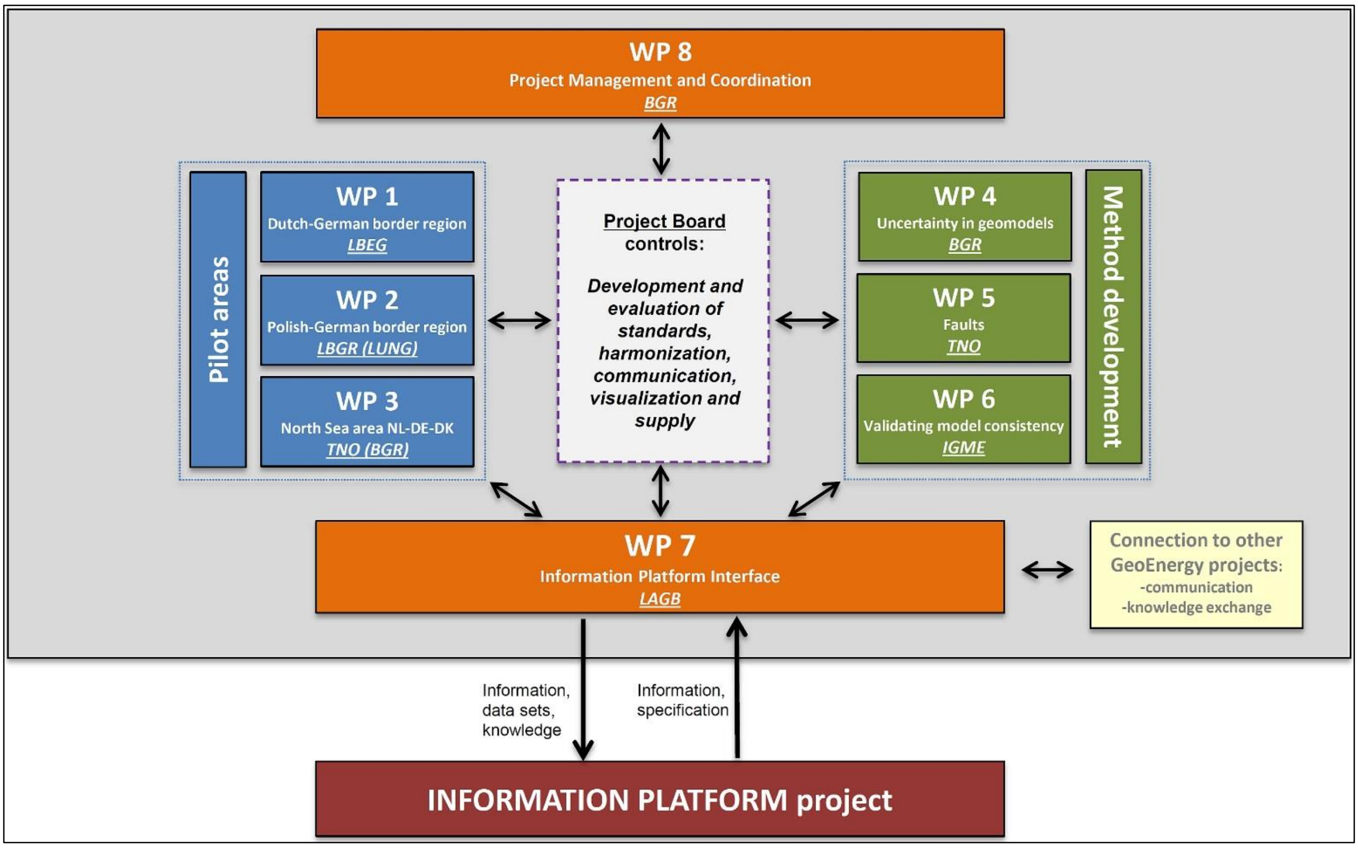

Figure 1: General depiction of the project logic and the interactions between the work packages. The violet framed box in the central part represents the efforts to compile, exchange, discuss and shape the WP results (to be controlled by the Project Board).

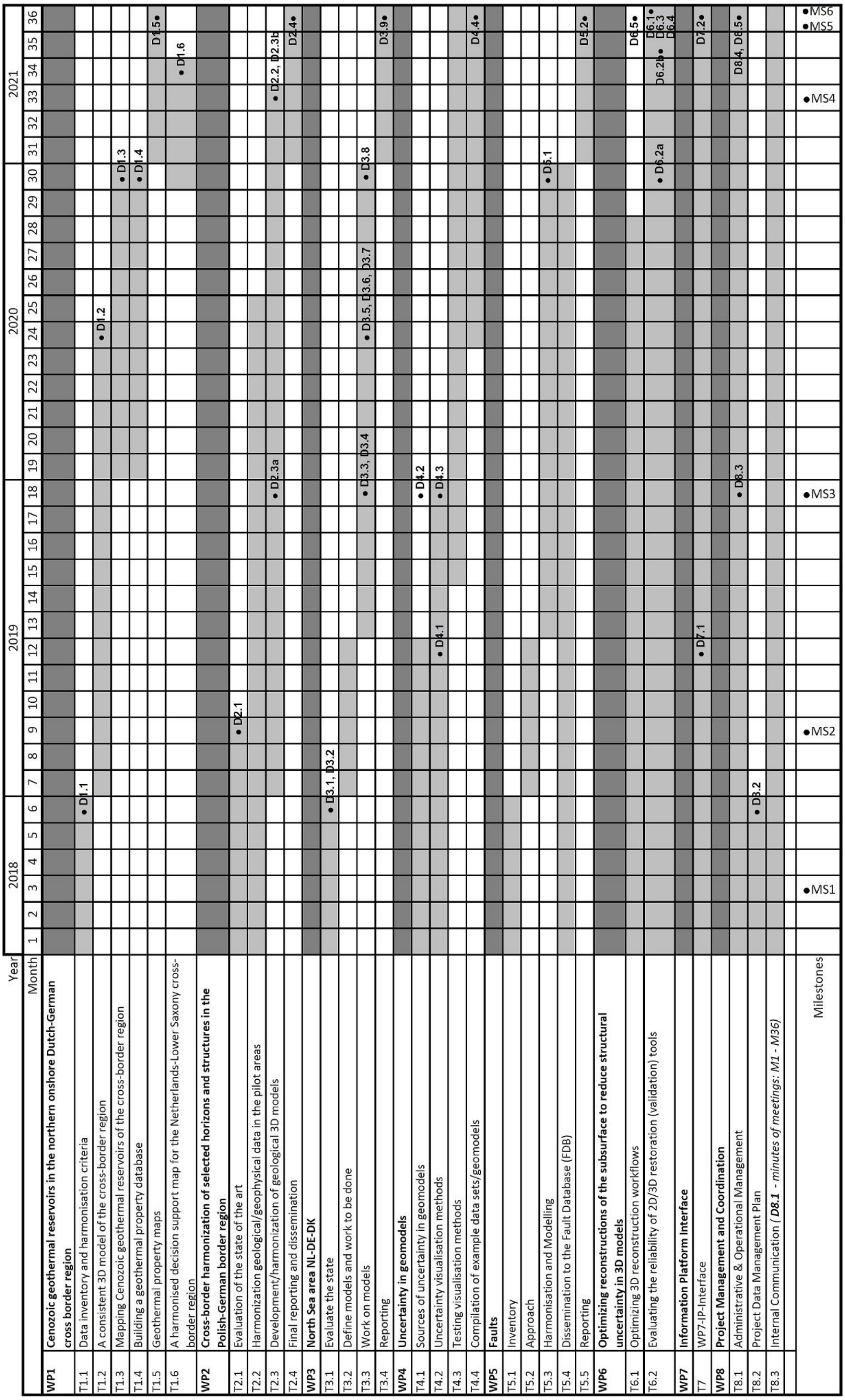

Figure 2: Gantt Chart; displaying the chronological schedule of the work plan.

3.2 Management structure, milestones and procedures

The overall project management structure is outlined in Figure 3 below. The project milestones are listed in Table 3.2a, and Table 3.2b provide details on the identified project risks and the proposed risk-mitigation measures.

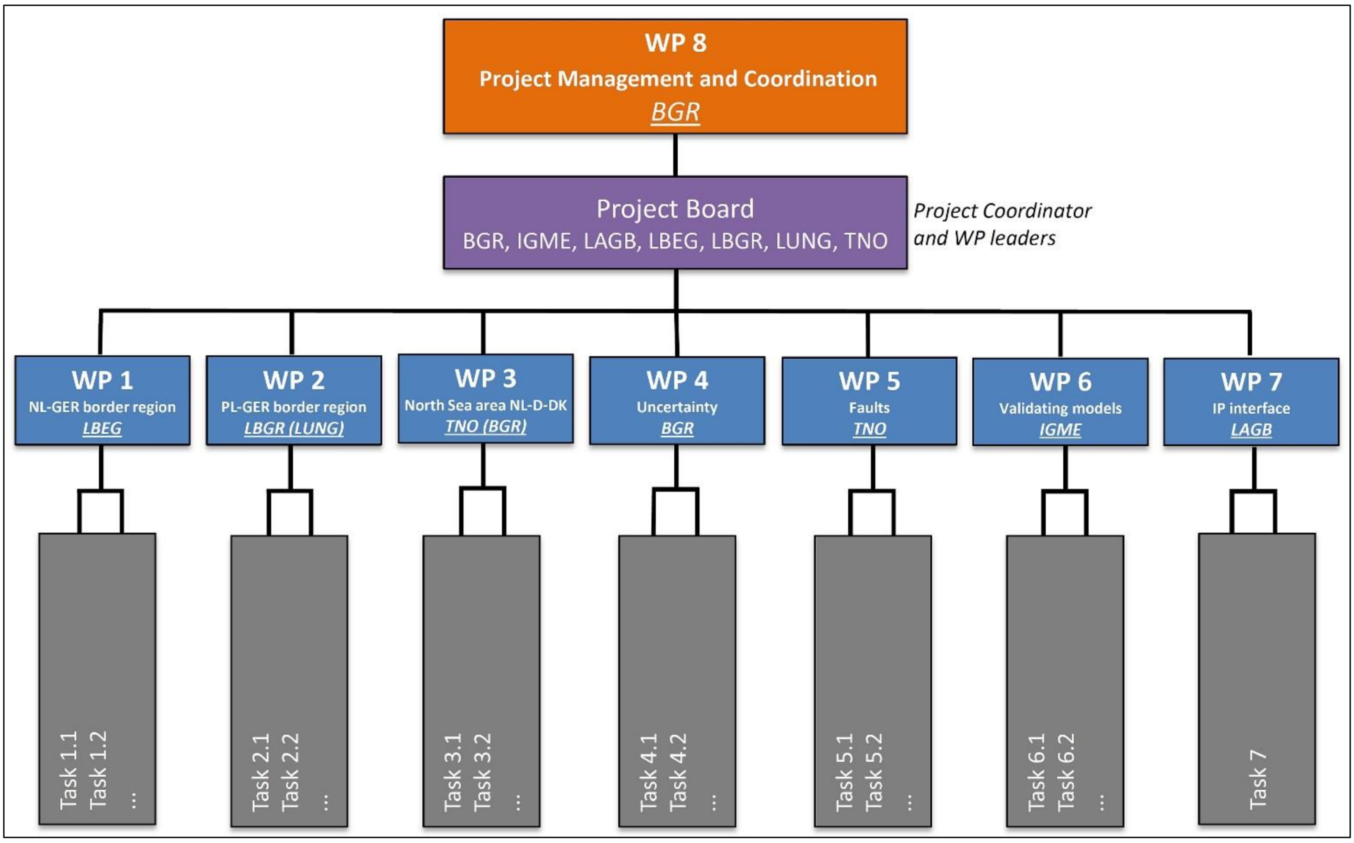

Figure 3: Schematic overview of the project management structure.

The project coordinator (WP8) and the leaders of the work packages (WP1-7) are responsible for the realization of the project milestones and the effective handling of critical risks related to the project implementation. The coordinator and the WP leaders are organized in a Project Board (see below), which will act as a supervisory body for the execution of the project, to ensure efficient decision making processing and efficient communication of decisions to all project partners. The different roles of project coordinator, WP leader, and Project Board are briefly described in the following.

Project coordinator: The primary role of the coordinator is to represent the consortium towards the EC and to the GeoERA Executive Board, as well as to be the promoter and controller of the overall progress of the project. The coordinator will be responsible for tasks such as:

- Ensuring smooth operation of the project: work plan maintenance, monitoring project progress with the help of the planned milestones, analyzing results, identification of problems and potential risks and finding appropriate solutions.
- To set up an efficient internal reporting system for communication and reporting on work package activities.
- To write periodic reports on progress of the project and partner activities.
- To submit all required reports and deliverables to the EU.
- Reporting to the Executive Board and the GeoERA Project Monitoring Officer.

Work package leaders: Each work package (WP) will be led by a WP leader (in WP2 and WP3 also with a co-leader). The WP leaders will be responsible for day-to-day management and coordination of their respective WP. Their tasks include:

- Assuring the quality of the work within the respective work package.
- Managing and reaching the respective deliverables and milestones of the WP.
- Reporting and managing any problems in their WP. Major problems will be discussed in (teleconference) meetings with the project coordinator (Project Board).
- Solving problems and managing the time schedule.
- Ensuring the flow of communication both inside and outside their respective WPs, including dissemination of the results generated within their WP.

All WP leaders have a seat in the Project Board to ensure direct communication lines between the WP's.

Project Board: The project coordinator and the work package leaders are organized in a Project Board that governs the day-to-day management and decision-making processes. The progress of the project will be monitored by means of regular reporting and meetings of the Project Board (regular teleconference meetings at monthly intervals, as well as face-to-face meetings at longer intervals). Based on the progress reports, the Project Board can identify major bottlenecks and find solutions for problems that may occur. Where needed, adaptations to the work plan of the project will be made, with the aim to ensure the delivery of the project results. Major adaptions have to be approved by the Project Board.

Internal quality & Risk assessment: The Project Board will closely follow up and control the progress of the project and the work done by each partner. Risk assessment will make use of a widely tested process for risk management, aimed at identifying, analyzing and prioritizing risks inherent in the project (related to WPs, tasks, partners) and then determining the appropriate actions to eliminate or mitigate them. Some likely critical risks have already been identified in the preparation of this proposal. These are listed in Table 3.2c, together with proposed risk mitigation measures.

Conflict resolution: In case of conflict, the WP leaders will have first responsibility to find an amicable solution, if appropriate in consultation with the project coordinator. In case the conflict cannot be resolved, the WP leader will put the issue forward to the GeoERA Executive Board.

3.3 Consortium as a whole

The consortium consists of 11 partner organizations, both national and regional GSO's, from 7 countries. The consortium is led by BGR (Germany).

The areas of jurisdiction of most involved project partner organizations cover different regions of the Central European Basin System. That well-studied region offers important energy and other subsurface resources. The Geological Survey Organizations of that area, which are involved in this project, provide a high expertise and capacity to build 3D geomodels and to do research on this field. Furthermore, those organizations aim to advance their experiences in the field of 3D geomodeling and also have strong intentions to harmonize cross-border 3D geomodels with neighboring countries.

Additionally, the partners not situated within the area of the Central European Basin System (CGS, IGME, GEOINFORM) will provide valuable contributions to the project, as they bring in experiences from work in different types of sedimentary basins and structural settings, e.g. experience in 3D geological modeling of predominantly crystalline rock environment, thus complementing the methodologies developed for sedimentary modeling performed by other project participants.

The consortium consists of a good mixture of national and regional organizations; very experienced partners that have gained much of their knowledge from various regional and national projects, practical use cases, and partly also from past collaborations in EU research projects and programmes. Some participants have worked together for several years and their communication is already well established.

The exchange of knowledge between such experienced partners and the interaction of the work packages concerning practical 3D gemodeling work in pilot areas and case studies together with the development of methods will favour the project goals to develop and establish methods and workflows for cross-border harmonization of 3D geomodels, applicable to other border regions in Europe. Also, this experienced group of diverse partners will contribute well to the identification and classification of sources of uncertainty in geomodels and to the development of visualization methods.

The interactions with other GeoERA projects with the intention for collaboration and information exchange and also the networking activities to involve external research institutions to elicit peer-expert opinion in regard of project topics will support and complement the consortium.

3.4 Resources to be committed

This section provides the details on resources committed to the project.

- Table 3.3a summarizes the total number of person months committed per project partner in each of the work packages.
- Table 3.3b provides an overview of all other direct costs (travel, equipment, other goods and services) for each project partner.
- Table 3.3c lists the overview of the requested budget, divided over the project partners.

Tables for section 3.1

Table 3.1a) Work package description (This table is **included** in the page limit!)

Please complete the table below for **each** work package:

Work package number	WP1	Lead beneficiary			LBEG	
Work package title	**Cenozoic geothermal reservoirs in the northern onshore Dutch-German cross-border region**					
Participant number	6	8				
Short name of participant	LBEG	TNO				
Person months per participant	72	8				
Start month	M1			End month	M36	

Objectives

This cross-border pilot area develops a 3D geomodel of 12 main horizons (top Neogene-base Triassic), geothermal maps (depth, thickness and its properties) of Cenozoic reservoirs and a map of hydraulic barrier between deep saltwater and fresh groundwater in the northern onshore cross-border region of the Netherlands and Germany (Lower Saxony). This project complements a study that strives to harmonize data and geological structures of the subsurface that is intensively used for both energy and groundwater usage.

Data and results for uptake in the IP will be communicated with and transferred to WP7 (IP Interface).

Description of work

Task 1.1 – Data inventory and harmonization criteria (M1 – M6)

An inventory will be made of the existing 3D models and input data of the participating countries, elucidating model concepts, coverage and uncertainties. Also an inventory of existing reservoir (distribution) maps and its properties (porosity, permeability, …) will be made. We will examine the differences in model concepts and input data, in scale and detail, including possible inconsistencies, and come up with a set of criteria for harmonization and matching of the cross-border information. Partners **LBEG**, TNO

Task 1.2 – A consistent 3D model of the cross-border region (M7 – M24)

A consistent harmonized 3D model of 12 main horizons (top Neogene-base Triassic) in the depth domain will be created using the available data and existing models on both sides of the Netherlands-Lower Saxony border. For this purpose existing 3D models (such as Geotectonic Atlas of Northwest Germany, SPBA, TUNB, DGM-deep) will be used. The main faults crossing the border will be harmonized. Partners **TNO**, LBEG

Task 1.3 – Mapping Cenozoic geothermal reservoirs of the cross-border region (M19 – M30)

Distribution, depth and thickness maps of geothermal reservoirs for the Cenozoic subsurface will be developed using the results of the 3D model (Task 1.2) and the lithostratigraphic data of these reservoirs in wells. The base Miocene and base Oligocene horizons will be remodeled at the Lower-Saxony part. If needed the harmonized 3D model of Task 1.2 will be adapted. Partners TNO, **LBEG**

Task 1.4 – Building a geothermal property database (M19 – M30)

Different properties like porosity, permeability and others of the Cenozoic reservoirs will be gathered and will be loaded into a database of geothermal properties for Cenozoic subsurface. Partners TNO, **LBEG**

Task 1.5 – Geothermal property maps (M31 – M36)

Geothermal property maps will be produced based on the geothermal reservoir maps (Task 1.3) and the geothermal property database (Task 1.4) using geostatistical methods. These maps will be harmonized at the border of the Netherlands and the Lower Saxony region. Partners: **TNO**, LBEG

Task 1.6 – A harmonized decision support map for the Netherlands-Lower Saxony cross-border region (M30 – M34)

For regional planning in an area with conflicts of different subsurface uses like groundwater supply, using and storage of geothermal energy, production of oil and gas and energy storage a decision support map will be developed using the results of Task 1.3. It shows the base and distribution of a very significant barrier (Rupel clay/ Rupel Formation) which protects the freshwater for damnifications caused by usage of the deeper subsurface. Partners **LBEG**, TNO

Deliverables

D1.1: Report including the inventory of existing data and models including a description of the cross-border model concepts and the set of harmonization criteria (M6)

D1.2: A harmonized 3D model of 12 main Cenozoic and Mesozoic horizons including the main harmonized fault planes (M24)

D1.3: Harmonized distribution, depth and thickness maps of Cenozoic geothermal reservoirs (M30)

D1.4: Database of geothermal properties (M30)

D1.5: Harmonized geothermal property maps (M36)

D1.6: Harmonized map of hydraulic barrier between fresh groundwater and the deep salt groundwater system as a decision support tool for planners (M34)

Work package number	2	Lead beneficiary	LBGR, LUNG (co-lead)
Work package title	**Cross-border harmonization of selected horizons and structures in the Polish-German border region**		

Participant number	4	5	9	10		
Short name of participant	LBGR	LUNG	PGI	IGME		
Person months per participant	24	36	31	3		
Start month	M1			End month	M36	

Objectives

Development of harmonized geological 3D models for selected horizons and structures in the Polish-German border region (horizons and structures in the Mesozoic and Permian strata; for energy storage, geothermal use, partially potential hydrocarbon reservoirs). The work will focus on two pilot areas of the Polish - North German Basin System covering a broad area of the Polish-German border: 1) the Gorzów-block and 2) the near border part of Szczecin Trough and their extension to the German side. The specific goals for WP-2 are:

- To harmonize and update existing data inventories and interpretations in Poland and Germany
- To establish harmonized (stratigraphical, seismostratigraphical, structural, geometrical) geological 3D models at the Polish and German border region based on existing data inventories
- To use potential field methods (gravimetry, magnetics) in addition to seismic investigations in less explored areas (cooperation with IGME and GE5-WP6)

Results for uptake in the IP will be communicated with and transferred to WP7 (IP Interface).

This WP has connections to WP6.

Description of work

Lead LBGR, Co-Lead LUNG; Contributors: all project partners. Contribution IGME: in the case study using potential field methods

In WP2 we will use and share (as permitted within relevant legal frameworks) existing data and knowledge from the WP-partners as well as methods and workflows that will be demonstrated and developed within the GE5 (WP4, WP5, WP6). The work will be structured in 4 main tasks:

Task 2.1 – Evaluation of the state of the art (M1 – M9)

- joint evaluation of previous national work in Poland and Germany (national geological/ geophysical data inventories, existing maps and 3D models), interstate cooperation Eastern Germany/Poland (before 1990) and international projects after 1990 with Polish-German participation/cooperation (Neogeodynamica baltica 1994-1998, MELA Morphotectonic Map of the European Lowland Area 2004-2008, SPBA Southern Permian Basin Atlas 2010, OneGeology 2008-2010, GEOPOLD 2010-2017) delivering a status report

Task 2.2 – Harmonization geological/geophysical data in the pilot areas M1 – M25)

- evaluation (including collection, compilation and validation) of available primary data (borehole information, logs, seismics, gravimetrics and magnetics) and definition of data sharing provisions
- harmonization of seismostratigraphic interpretation, well correlation and gravimetric/magnetic datasets
- geophysical inversion studies (interlink to GE5-WP6)
- tectonic regionalization and fault classification cross-border (interlink with GE5-WP5)

- identification of existing knowledge gaps, less investigated areas/horizons/strata

Task 2.3 – Development/harmonization of geological 3D models (M7 – M33)

- definition of kind and structure of the geological 3D-models (modelled horizons, spatial resolution, requirements due to the modeling software and the dissemination of results)
- development of 3D geological models and cross-border harmonization:
    - fault network model (interlink with GE5-WP5 and GE4-WP2 fault database)
    - stratigraphic model of seismic reflectors
    - use of potential field data in underexplored areas
        - case study: north western part of the Gorzów-block – cross-border harmonization of 3D geomodels and closing data gaps using gravimetrics and magnetics (interlink with GE5-WP6, cooperation between PGI, LBGR, LUNG, IGME)
    - detailed structural and stratigraphic model
    - parametric models (if possible)
    - consistency checks and identification of uncertainties (interlink with GE5-WP4 Uncertainties in geomodels)
- establish a final harmonized 3D geomodel for the pilot area 1) in M18
- establish a first harmonized 3D geomodel for the pilot area 2) in M33

Task 2.4 – Final reporting and dissemination (M31 – M36)

- Reporting on
    - methodological framework and workflow of data and model harmonization - best practices/ lessons learned/recommendations (interlinks with WP1, WP2, WP3, WP4, WP5, WP6)
    - ways to the development of Pan-European 3D-models based on the results of WP2 (interlinks with WP1, WP3, WP5)
- Providing content for the overall report GE5
- Providing content for the IP platform

Deliverables

D2.1: Status/State of the Art report on previous work and results in the Polish-German border region at national, interstate and international level (M9)

D2.2: Documentation of harmonization methods, workflows and results for different geological/geophysical datasets and levels of investigation (M33) including descriptions of:

D2.2a: Harmonized cross-border stratigraphic/seismostratigraphic correlation

D2.2b: Harmonized cross-border geophysical/petrophysical models (e.g. densities, velocities)

D2.2c: Harmonized cross-border structural interpretation

D2.3a and b: Improved and harmonized geological 3D models at the Polish-German border region for the pilot areas 1) (M18) and 2) (M33)

D2.4: Final report including best practices/ lessons learned/recommendations (M36)

Work package number	3	Lead beneficiary			TNO, BGR (co-lead)	
Work package title	**North Sea area NL-DE-DK**					
Participant number	1	3	8			
Short name of participant	BGR	GEUS	TNO			

Person months per participant	58	36	14			
Start month	M1			End month	M36	

Objectives

Integrate existing regional and national geomodels into a harmonized, consistent cross-border geomodel of the North Sea area NL-DE-DK by establishing criteria needed for the harmonization methods and testing these harmonization methods with the final goal to eliminate inconsistencies between existing geomodels.

Data and results for uptake in the IP will be communicated with and transferred to WP7 (IP Interface).

This WP has connections to the GE1 project GARAP.

Description of work

In WP3 we will use existing data and knowledge from the WP partners as well as methods and workflows that will be developed within the WP4, WP5, and WP6. The work will be structured in 4 main tasks:

Task 3.1 – Evaluate the state (M1 – M6)

- State of the art report – Define what should be harmonized (stratigraphic chart, velocity models, existing 3D models, structural concepts etc.).
- Define study area: cross-border areas should be defined in the North Sea at the borders DK-DE and DE-NL.
- Inventory of available data and decide which data can be shared (in a common database)
- A first generalized cross-border 3D depth model of (a part of) the Danish-German-Dutch Central Graben area (Entenschnabel area) will be created, needed for work in the GE1 project GARAP.

Task 3.2 – Define models and work to be done (M7 – M12)

- It will be defined how the existing national structural models will be harmonized. The various tasks of each partner as also the software that will be used during the project will be decided on.
- It will be decided which type of velocity model will be used. Probably seismic velocities will be gathered to get more control in areas without well control such as areas with thick Lower Jurassic and Triassic layers.
- The areas within the structural model will be defined that will be checked within WP6 on structural consistency (BGR), as also the properties of the model which should be implemented will be decided on.
- Modeling techniques and parameters will be adjusted to the chosen theme and challenges of each cross-border modeling study (e.g. fault/framework model, layer modeling, detailed local parametrized volume models). All developed component models will be consistently harmonized to each other to reveal a consistent overall model of all chosen cross-border study areas.
- It will be decided how the modeling and harmonization results will be visualized (link with IP: EGDI-development of 3D visualization).

Task 3.3 – Work on models (M13 – M30)

- A stratigraphic chart for the study area NL-DE-DK and a few lithostratigraphic/ chronostratigraphic correlation profiles will be prepared through the study area.
- Implementation of results and workflows of the methodology WP's. Preparation of results/ deliverables for the linked WP4 (proof of visualization of uncertainties in 3D models), WP5

(modeled faults and related metadata), and WP6 (Proof of structural consistency and concrete suggestions for consistent model solutions of underdetermined and generalized model parts).

- Lithostratigraphic work and structural analysis.
- Harmonizing the time model for seismic interpreted main horizons, including main fault planes.
- Harmonizing the velocity model.
- Harmonizing the depth model.

Task 3.4 – Reporting (M31 – M36)

- Reporting – Best practices/ lessons learned/ recommendations.
- Providing content by each task for the overall report.

Deliverables

D3.1: State of the art report (M6)

D3.2: A generalized 3D depth model of (a part of) the Entenschnabel region (M6)

D3.3: Harmonized stratigraphic chart for the North Sea area NL-DE-DK (M18)

D3.4: Lithostratigraphic/ chronostratigraphic correlation profiles through the study area (M18)

D3.5: Harmonized seismostratigraphic concepts and structural interpretations (M24)

D3.6: Summary of the harmonization work on time model for seismic interpreted main horizons incl. main fault planes (M24)

D3.7: Harmonized cross-border velocity model (M24)

D3.8: Harmonized structural 3D model in depth (M30)

D3.9: Final report incl. lessons learned (M36)

Work package number	4	Lead beneficiary							BGR	
Work	**Uncertainty in geomodels**									
Participant number	1	2	3	4	5	7	8	9	10	11
Short name of participant	BGR	CGS	GEUS	LBGR	LUNG	LAGB	TNO	PGI	IGME	GEOINFORM
Person months per participant	16	3	6	4	2	6	4	3	3	0.41
Start month	M1							End month	M36	

Objectives
Identify and classify sources of uncertainty in geomodels and finding visualization methods to make the user aware of it; generation of exemplary geomodels based on data from the pilot areas (connections to WP1, WP2, WP3) which can be used to test different visualization methods. Data and results for uptake in the IP will be communicated with and transferred to WP7 (IP Interface). This WP has methodological connections to and interaction with WP6.

Description of work
Task 4.1 – Sources of uncertainty in geomodels (M1 – M12) Identify the different sources of uncertainty in geomodels, gaining an overview if and how they are currently quantified and which further options exist for quantification (e.g. data density, quality of data, propagation of errors during data processing); establish a classification of different types of uncertainties and collecting requirements for their visualization; Task 4.2 - Uncertainty visualization methods (M1 – M18) Identify the different visualization methods for uncertain data which are state of the art in computer graphics; match these methods to the requirements for the visualization of geomodels and establish for which classes of uncertainty in geomodels further methods are needed; Task 4.3 – Testing visualization methods (M15 – M36) Testing the state-of-the-art visualization methods using data sets/geomodels from the pilot areas; Task 4.4 – Compilation of example data sets/geomodels (M24 – M36) Compilation of publicly available example data sets/geomodels (including documentation) which can be used to test different visualization methods.

Deliverables
D4.1: Report on state of the art of uncertainty visualization in computer graphics (M12) D4.2: Report on sources of uncertainties in geomodels and how they can be handled (M18) D4.3: Documentation of requirements for the visualization of uncertainties in geomodels which can be used as input for EGDI (M18) D4.4: Publicly available data sets/geomodels from the pilot areas (including documentation) which represent the different identified types of uncertainty and can be used for presenting the state of the art visualization methods and for further research on such methods (M36)

Work package number	5	Lead beneficiary						TNO	
Work package title	**Faults**								
Participant number	1	3	4	5	7	8	9	10	11
Short name of participant	BGR	GEUS	LBGR	LUNG	LAGB	TNO	PGI	IGME	GEOINFORM
Person months per participant	5	3	2	2	8	4.25	1	2	0.4
Start month	1						End month	36	

Objectives

Consistent cross-border fault mapping- and characterization in all pilot areas (WP's 1, 2, and 3) complying with the standard and requirements set by the Fault Database of GE4-HIKE. Preparation of harmonized fault data for uptake in the IP project (EGDI platform) through WP7. Project-to project communication (telcon's and meetings) for synchronization and mutual harmonization.

Description of work

For all harmonization areas, described in WP's 1, 2, and 3 and to be defined in the first year of the project, the following tasks apply. Within this project, this task will be fulfilled following the requirements and specifications put forward by the Fault Database development under project GE4 (HIKE). In the latter project, definition of common standards, methodologies to convert data between different formats and vintages, and best experiences on modeling and characterizing faults, will be dealt with. The actual work on fault consistency will be performed in this work package.

Task 5.1 – Inventory (M1 – M6)

- State of the art inventory:
  - Available data and decide which data can be shared
  - What are the formats of existing fault data
  - Listing of mis-fitting fault data (misfits may apply to dimensions (orientation & dip), scale, orientation or classification)

Task 5.2 – Approach (M7 – M12)

- Harmonization planning:
  - Where applicable, how can the fault formats be made suitable for uptake in the FDB of GE4 (HIKE)
  - Choice of methodology for harmonization (software, work-load distribution, etc.)

Task 5.3 – Harmonization and Modeling (M13 – M30)

- Actual work on combining and fitting the fault data using chosen software and partners (task 5.2)
- Fault – 3D Model consistency check
- Connecting faults to (litho)stratigraphy in order to define offset and age/activity parameters.

- Characterizing the harmonized faults by attributing fault parameters as required by the FDB GE4 (HIKE)

Task 5.4 – Dissemination to the Fault Database (FDB) (M1 – M30)

- Delivery of harmonized faults including attributes to the FDB of GE4 (HIKE)
- Handling feedback from the FDB
- Implement changes where necessary
- Final version upload to FDB

Task 5.5 – Reporting (M31 – M36)

- Reporting – Best practices/ lessons learned/ recommendations from and to the FDB.

Deliverables

D5.1: 3D fault objects with metadata and attributes directly delivered to the FDB of GE4-HIKE (M30)

D5.2: Report on methods applied, bottlenecks, best practises and accompanying text to the results (M36)

Work package number	6	Lead beneficiary		IGME			
Work package title	**Optimizing reconstructions of the subsurface to reduce structural uncertainty in 3D models**						
Participant number	1	4	5	7	9	10	11
Short name of participant	BGR	LBGR	LUNG	LAGB	PGI	IGME	GEOINFORM
Person months per participant	12	3	2	4	4	28	0.4
Start month	M1			End month	M36		

Objectives

Achieving reliable and harmonized reconstructions across Europe needs sharing, discussing and finding agreements among the existent workflows and methods used by the different geological surveys. In order to overcome methodological problems (poor quality or inconsistent data) and issues of individual geological surveys (lack of seismic and well data, structural inconsistencies, etc.) as well as to tackle cross-border harmonization efforts targeting on a pan-European geological information repository, this WP will develop and evaluate new practices on an interdisciplinary approach by the combination of internationally established geological and geophysical methods.

Besides of common methods (integration of geological mapping, structural and stratigraphic data, seismic sections, wells, etc.) this transversal WP will pay special attention to the integration of potential field geophysical data (GravMag), structural balanced sections and the application of restoration techniques as validation tools (limitations and reliability).

Data and results for uptake in the IP will be communicated with and transferred to WP7 (IP Interface).

This WP has tight connections with WP2, WP3, WP4 and also with WP5.

1) Optimizing 2D/**3D reconstruction and restoration workflows.**

2) Use & test multi-approach reconstruction workflows & tools in case-studies
(1.) SW Pyrenees (WP6); (2.) North Sea (WP3); (3) Northern German/Polish border (WP2);

The development of case and pilot studies within this project (including an example of the Pyrenees in this WP) together with networking-based discussions among the partners will enrich these goals.

Description of work

In WP6 we pursuit to optimize reconstruction workflows aiming to support model consistency, cross-border harmonization and to provide solutions for model parts with low data resolution. This will assist decision-making under reliable conditions for different uses of the subsurface. A two-fold approach is proposed:

Task 6.1 – Optimizing 3D reconstruction workflows (M1 – M28)

This WP focuses on potential field geophysics (gravimetrics and magnetics; gravmag) as a quick, cost-effective and resolutive method for the acquisition and supply of data usable in 3D modeling approaches combined with the construction of reliable balanced (and restored) cross-sections. Although large-area datasets of GravMag data exists in many countries and even if geometrical reconstructions are standard techniques applied especially by the E&P industry only few geological surveys have used and tested both methods during the last decades. In this task, we will demonstrate the benefits of both techniques to overcome the methodological challenges arising from heterogenic datasets and processing steps during cross-border harmonization efforts all over Europe. It has been used and tested by a few geological surveys during the last decades. We will also demonstrate the benefit for cross-border harmonization and the applicability for similar European cross-border studies.

Task 6.2 – Evaluating the reliability of 2D/3D restoration (validation) tools (M1 – M36)

Restoration methods are technical solutions frequently applied in areas of heterogeneous and scarce data. They apply geometric and mechanic assumptions to evaluate the consistency of 2D/3D reconstructions. If a model honors those rules it is said to be restorable and (then) potentially feasible. In this subtask we will evaluate and synthetize approaches and limitations of existing established methods and tools, based on case studies (especially the SW Pyrenees-WP6 and North Sea-WP3). We will pay special attention to evaluate uncertainties in structural modeling and interpretation with close connection to WP4-Uncertainty in geomodels).

Thus, in this WP we merge both approaches and propose three subtasks (subgoals):

6.2.1) To overcome methodological problems potential field geophysics and balanced and restored cross-sections are very powerful tools to fill gaps in areas where certainty of 3D models based on conventional (and expensive) data (e.g. reflection seismic, well, etc.) is hampered due to e.g. lack of seismic and well data. A case study in the Pyrenees will illustrate its potentiality in a region where structural limitations (i.e. steep dips) have precluded the acquisition of reflection seismic data. The main goal is to *compile, evaluate, reinterpret* and, finally, *integrate* standard 3D reconstruction data (maps, partial seismic coverage and a few wells) with new gravimetric and magnetic data together with balanced cross sections in a case study displaying complex basement/cover interactions. The study area was selected as a potential play for CO_2 storage in previous projects (ALGECO2) and displays a non-evaluated potential for Geothermal energy. This subtask (IGME) will also contribute with a database of faults to the WP5.

6.2.2) To tackle and support cross-border harmonization (as an affordable and reliable way) in an area, where the absence of cross-border geophysical data (particularly reflection seismic) precludes a reliable harmonization of geological 3D models (and all their implications) the application of potential field geophysics (*GravMag*) will be used to demonstrate its great potential as a powerful harmonization method. Usually large databases are available, if not, data acquisition is cost-effective (and affordable for geological surveys). Homogenization of data, procedures and technical solutions will be evaluated and agreed in order to establish best practices. The 3D model forecast in WP2 (**East Germany – West Poland**) displays very good conditions (large digital and analogical datasets) to test this concept and it will benefit from IGME's and other partners experience to illustrate the potential of *GravMag* as a harmonization tool.

6.2.3) To tackle future challenges (evaluation and agreement on best practices) the developments of 6.2.1 and 6.2.2 subtasks as well as the networking necessary to achieve them, will allow us to optimize best-practices that will be synthetized, discussed and reported. This process will be based on the identification and quantification of key challenges (particularly in *GravMag* as a harmonization tool and in restoration techniques) of case and pilot areas (structural setting/complexity, data distribution, data sources, data processing, software used and expected/resulting uncertainties, etc.). Standard approaches/suggestions (**workflows**) which could be compared and are feasible for all project partners as well as other European geological state authorities and institutes (standards without expensive software solutions), will be developed. This subtask has very tight connections with the GE-6 GeoConnect³D Project.

Deliverables

D6.1: Report-1: 3D model of the South western Pyrenees (M36)

D6.2a: Digital files 3D model of the South western Pyrenees (M30)

D6.2b: Major identified faults in the SW Pyrenean model; will also contribute to WP5-Faults (M35)

D6.3: Report-2 on the harmonization procedure carried out in the East GER/West Poland border (M36)

D6.4: Report-3: Case study North Sea – Structural uncertainties and their possible solutions by proof of structural consistency with restoration techniques (M36)

D6.5: Report-4: Optimized reconstructions workflows and best practices in 3D modeling (M36)

Work package number	7	Lead beneficiary		LAGB	
Work package title	**Information Platform Interface**				
Participant number	1	3	7	9	10
Short name of participant	BGR	GEUS	LAGB	PGI	IGME
Person months per participant	1	2	18	1	2

Start month	M1	End month	M36

Objectives
The objective of this work package is to lead the interactions with the GeoERA-IP project, to execute the parts of the Project Data Management Plan relating to IP and EDGI and to enable an efficient and consistent uptake and embedding of project results into the GeoERA-IP. WP7 will be responsible for communicating the requirements of the project to GeoERA-IP and vice versa ensure that the guidelines and standards provided by GeoERA-IP are properly implemented in the WP's 1 to 6 processes. Thus WP7 makes significant contributions to ensure the maintenance, dissemination as well as the sustainability of the results in 3DGEO-EU.

Description of work

The development of new and improved, cross-border harmonized data sets and models as well as the provision of standardized primary data, methods for cross-border harmonization of 3D geomodels, new compilations and derived data sheets are key aspects of the 3DGEO-EU project in the framework of GeoERA. Therefore, WP7 will deal with, organize and control the communication and data exchange between the thematic WPs to ensure a fair and openly accessible data and metadata provision within 3DGEO-EU, with other GeoERA projects and towards the GeoERA-IP project.

Task 7 – WP7-IP-Interface (M1 – M36); consists of several subtasks:

- Evaluating the possibilities and requirements of 3DGEO-EU WPs to provide primary data, compilations and derived data to make them findable, openly accessible and interoperable. Therefore a close communication with the GeoERA-IP project will ensure that, in accordance with the legal conditions of the project partners, eligible geo-information used, processed and derived in 3DGEO-EU can and will be transferred to the GeoERA-IP project and can be stored in the EGDI platform.
- The support of the GeoERA-IP project to define naming conventions and standards for 3D metadata based on established European and international standards (INSPIRE and CGI standards) for the storage, exchange and dissemination of project data will be managed and secured.
- Controlling the consideration of the Data Management Plan for every WP thus ensuring that primary data, compilations and derived data will be stored and exchanged including all restrictions (including metadata, standard identification mechanisms, keywords, versioning, etc.).
- Ensuring the communication, acceptance and application of effective means of communication, and standards for exchange between WPs of 3DGEO-EU and GeoERA projects. WP7 will hold affiliation lists of all partners and will frequently examine the WPs communication and data exchange regarding the requirements of the GeoERA-IP project standards to ensure a punctual and conformable delivery of standardized results.
- Supporting the execution and transfer of the data management plan.

Deliverables

D7.1: Requirements report to the GeoERA-IP development team (M12)
D7.2: Data exchange report including protocols of data and information exchange within 3DGEO-EU and towards the GeoERA-IP project/EGDI (M36)

Work package number	8	Lead beneficiary	BGR
Work package title	**Project Management and Coordination**		

Participant number	1					
Short name of participant	BGR					
Person months per participant	8					
Start month	M1			End month	M36	

Objectives

This Work Package addresses the overall financial, administrative and operational management of the project, especially the preparation and implementation of the work plan, the monitoring of project progress and the coordination of obligatory meetings and deliverables as defined by the GeoERA guidelines and Grant Agreement. Specific objectives of WP8 are:

- Daily management of the project (monitoring progress; communication among work packages, between partners and with the EC; financial management; reporting; decision making; conflict management)
- The organization of meetings and events (e.g. Kick-off Seminar, Mid-Term Seminar and the Final Seminar)
- Maintenance of the Consortium Agreement and ensuring ownership among the participants
- Risk management including IPR issues
- Interact with the GeoERA Executive Board

Description of work

Task 8.1 – Administrative & Operational Management (M1 – M36)

This task deals with activities as:

- Day-to-day monitoring of project progress
- Support decision making by the Project Board, and ensure implementation of decisions (D8.1)
- Coordinating the preparation of a project progress report (D8.3), a final project progress report (D8.4), and a synthesis report on the final project results (D8.5)
- Risk management
- Maintenance of the Consortium Agreement

Task 8.2– Project Data Management Plan (M1 – M6)

This task will prepare the Project Data Management Plan (D8.2) covering the data and results relevant for this project. The Plan will be in line with the requirements and guidelines described in GeoERA deliverable 1.3 – Data Management Plan.

Task 8.3 – Internal Communication (M1 – M36)

Efficient communication between all project participants, the GeoERA Executive Board and to other GeoERA projects. A transparent internal communication system will be set up, supported by electronic

means, e.g. web conference tools, exchange platforms, etc.

Deliverables
D8.1: Minutes of meetings (M1 – M36) D8.2: Project Data Management Plan (M6) D8.3: Project Progress Report (M18) D8.4: Final Project Progress Report (M36) D8.5: Synthesis Report on the final project results (with contributions from all project partners) (M36)

Table 3.1b) List of work packages (This table is not covered by the page limit)

Work package No.	Work Package Title	Lead Participant No.	Lead Participant Short Name	Person - Months	Start Month	End month
1	Cenozoic geothermal reservoirs in the northern onshore Dutch-German cross-border region	6	LBEG	80	1	36
2	Cross-border harmonization of selected horizons and structures in the Polish-German border region	4, 5 (co-lead)	LBGR, LUNG	94	1	36
3	North Sea area NL-DE-DK	8, 1 (co-lead)	TNO, BGR	108	1	36
4	Uncertainty in geomodels	1	BGR	47.41	1	36
5	Faults	8	TNO	27.65	1	36
6	Optimizing reconstructions of the subsurface to reduce structural uncertainty in 3D models	10	IGME	53.4	1	36
7	Information Platform Interface	7	LAGB	24	1	36
8	Project Management and Coordination	1	BGR	8	1	36
				Total person – months 442.46		

Table 3.1c) List of deliverables (This table is not covered by the page limit)

Deliverable number	Deliverable name	Work package number	Short name of lead participant	Type	Dissemination level	Delivery date (in months)
D1.1	Inventory report	1	LBEG	Report	PU	M6
D1.2	Harmonized 3D model	1	TNO	3D model	PU	M24
D1.3	Maps of Cenozoic geothermal reservoirs	1	LBEG	Digital data	PU	M30
D1.4	Database of geothermal properties	1	LBEG	Digital data	PU	M30
D1.5	Geothermal property maps	1	TNO	Digital data	PU	M36
D1.6	Map of hydraulic barrier	1	LBEG	Digital data	PU	M34
D2.1	State of the Art	2	LBGR/LUNG	Report	PU	M9
D2.2	Documentation methods, workflows and results	2	LBGR/LUNG	Report	PU	M33
D2.3a	Harmonized 3D geomodel pilot area 1)	2	LBGR/LUNG	3D model	PU	M18
D2.3b	Harmonized 3D geomodel pilot area 2)	2	LBGR/LUNG	3D model	PU	M33
D2.4	Final report incl. lessons learned	2	LBGR/LUNG	Report	PU	M36
D3.1	State of the art report	3	TNO/GEUS/ BGR	Report	PU	M6
D3.2	Generalized cross-border 3D depth model of (a part of) the Entenschnabel region	3	TNO/GEUS/ BGR	3D model	PU	M6
D3.3	Harmonized stratigraphic chart for the North Sea area NL-DE-DK	3	TNO/GEUS/ BGR	Report	PU	M18

D3.4	Lithostrati-graphic/ chronostrati-graphic correlation profiles through the study area	3	TNO/GEUS/ BGR	Report	PU	M18
D3.5	Harmonized seismostrati-graphic concepts and structural interpretations	3	TNO/GEUS/ BGR	Report	PU	M24
D3.6	Summary of the harmonization work on time model for seismic interpreted main horizons incl. main fault planes	3	TNO/GEUS/ BGR	3D model	PU	M24
D3.7	Harmonized cross-border velocity model	3	TNO/GEUS/ BGR	3D model	PU	M24
D3.8	Harmonized structural 3D models	3	TNO/GEUS/ BGR	3D model	PU	M30
D3.9	Final report incl. lessons learned	3	TNO/GEUS/ BGR	Report	PU	M36
D4.1	State of the art in uncertainty visualization	4	BGR	Report	PU	M12
D4.2	Sources of uncertainties in geomodels	4	BGR	Report	PU	M18
D4.3	Uncertainty visualization requirements for EGDI	4	BGR	Report	PU	M18
D4.4	Example data sets/geo-models containing uncertainty information	4	BGR	Gocad, VTK; including documen-tation	PU	M36
D5.1	3D fault objects with metadata and attributes	5	TNO	Map series, 3D models	PU	M30
D5.2	Reporting	5	TNO	Report	PU	M36

D6.1	Report on a 3D model of the South western Pyrenees	6	IGME	Report	PU	M36
D6.2a	3D model of the South western Pyrenees	6	IGME	Digital data	PU	M30
D6.2b	Major faults in the South western Pyrenees model	6	IGME	Digital Data	PU	M35
D6.3	Report on harmonization procedure with gravmag in East GER/ West Poland border	6	PGI, LBGR, LUNG, IGME	Report	PU	M36
D6.4	Report on case study North Sea	6	BGR	Report	PU	M36
D6.5	Optimized 3D reconstructions workflows	6	IGME, with all WP6 partners	Report	PU	M36
D7.1	Technical requirements for project data and results	7	LAGB	Report	PU	M12
D7.2	Data exchange report	7	LAGB	Report	PU	M36
D8.1	Minutes of meetings	8	BGR	Document	CO	M1 – M36
D8.2	Project Data Management Plan	8	BGR	Document	CO	M6
D8.3	Project Progress and Monitoring Report	8	BGR	Report	CO	M18
D8.4	Final Project Progress Report	8	BGR	Report	CO	M36
D8.5	Synthesis Report on final results	8	BGR, with contributions of all partners	Report	PU	M36

Tables for section 3.2

Table 3.2a) List of milestones (This table is not covered by the page limit)

Milestone number	Milestone name	Related work package(s)	Due date (in months)	Means of verification
1	Kick-off Seminar	1 – 8	M3	
2	State-of-the-Art and inventory in pilot areas documented	1 – 3	M9	Delivery of D1.1, D2.1, D3.1
3	Mid-Term Seminar	1 – 8	M18	
4	Harmonized cross-border 3D geomodels in Pilot areas	1 – 3	M33	Delivery of D1.2, D2.3a, D2.3b, D3.8
5	Final Seminar	1 – 8	M36	
6	Best practice and lessons learned for cross-border harmonization documented	1 – 8	M36	Delivery of D2.4, D3.9, D4.4, D5.2, D6.5, D8.5

Table 3.2b) List of critical risks for implementation (This table is not covered by the page limit)

Description of risk (indicate level of likelihood: Low/Medium/High)	Work package(s) involved	Proposed risk-mitigation measures
Loss of key project personnel – incomplete or bad performance, loss of direction/scope of project (Low)	1 – 7	The organisations with major roles in this project are substantial and have expertise in depth. Shared responsibilities within WP provide stability in case of unexpected key project personnel loss.
Deliverables not delivered on time leading to delays in project (Medium)	1 – 7	Day-to-day communication between coordinator and WP leaders and further between WP leaders and WP partners.
Delayed start of activities; shift of activities in the plan; potential prolongation of the project (Medium)	1 – 7	Efficient communication between all project participants is a core task in the project. Some participants have worked together in the past and their communication is already well established. Some participants have extensive experience in carrying out EU projects. The obligatory kick-off and mid-term seminars provide opportunities to discuss and decide on appropriate measures.
IPR issues – lack of agreement in intellectual property rights (Low)	8	Clear IPR Agreements made in the CA, which covers both overall GeoERA project and individual transnational projects. Project data management plan (WP8) and programme components dedicated to data management.
Data copyright issues – problems to get permission to publish developed data sets/3D geomodels from pilot areas (Medium)	1 – 7	Documentation of State-of-the-Art in pilot areas during a first project phase comprises an inventory of data accessibility and usability. With respect to the documented status (Milestone 2) the WPs will then finally define the 3D geomodels (areas, resolution, theme) to be build. Foreseeable copyright problems will be communicated with the data owners in an early project phase. If parts of geomodels can not be published via the IP, alternative solutions (e.g. publication on local web-viewer) will be communicated with the IP project.
Digital access to all previous information fails; or is not cost-effective (Low)	6	Most part of the info is hosted at the Geological Surveys. However, part of the info needed in the project (e.g. seismic lines in sgy format) may not be accessible. If access is not granted but analogic data exist, they can be digitalized w/o cost, but quality will be lower.
Weather conditions affect the data acquisition - high mountains regions (Low)	6	Field campaign period is overestimated considering this issue.

Table 3.3a) Summary of Staff Effort (This table is not covered by the page limit)

	WP 1	WP 2	WP 3	WP 4	WP 5	WP 6	WP 7	WP 8	Total Person- Months per Participant
1 / BGR			58	16	5	12	1	8	100
2 / CGS				3					3
3 / GEUS			36	6	3		2		47
4 / LBGR		24		4	2	3			33
5 / LUNG		36		2	2	2			42
6 / LBEG	72								72
7 / LAGB				6	8	4	18		36
8 / TNO	8		14	4	4.25				30.25
9 / PGI		31		3	1	4	1		40
10 / IGME		3		3	2	28	2		38
11 / GEOINFORM				0.41	0.4	0.4			1.21
Total Person Months	80	94	108	47.41	27.65	53.4	24	8	442.46

Table 3.3b) 'Other direct cost' items (travel, equipment, other goods and services)

(This table is not covered by the page limit)

Please complete the table below for each participant.

1 / BGR	Cost (€)	Justification
Travel	50,000	Participation in project and WP meetings, workshops, conferences
Equipment		
Other goods and services		
Total	50,000	
2 / CGS	Cost (€)	Justification
Travel	2,000	Participation in project and WP meetings, workshops, conferences
Equipment		
Other goods and services		
Total	2,000	
3 / GEUS	Cost (€)	Justification
Travel	20,606	Participation in project and WP meetings, workshops, conferences
Equipment		
Other goods and services		
Total	20,606	
4 / LBGR	Cost (€)	Justification
Travel	10,000.00	Travel costs and expenses of for meetings of the GeoERA consortium, project meetings on location in Europe, plus WP meetings
Equipment	18,837.50	Hardware, software licenses and consumables (according to administrative depreciation rules)
Other goods and services	34,512.50	according to technical/administrative operating expenses and depreciation rules
Total	63,335.00	

5 / LUNG	Cost (€)	Justification
Travel	12,675	Travel costs and expenses of for meetings of the GeoERA consortium, project meetings on location in Europe, plus WP meetings
Equipment	20,550	Hardware, software licenses and consumables (according to administrative depreciation rules)
Other goods and services	37,650	According to technical/administrative operating expenses and depreciation rules
Total	70,875	
6 / LBEG	Cost (€)	Justification
Travel	25,000	Travel costs: Participation in project and WP meetings, workshops, conferences
Equipment		
Other goods and services		
Total	25,000	
7 / LAGB	Cost (€)	Justification
Travel	30,000.00	Travel costs and expenses for meetings of the GeoERA consortium, project and WP meetings on location in Europe, plus meetings with the GeoERA-Information Platform
Equipment	12,250.00	Hardware, software licenses and consumables (according to administrative depreciation rules) for the whole duration of the project
Other goods and services	18,500.00	According to technical/administrative operating expenses and depreciation rules
Total	60,750.00	
8 / TNO	Cost (€)	Justification
Travel	20,000	Participation in project and WP meetings, workshops, conferences
Equipment		
Other goods and services		
Total	20,000	

9 / PGI	Cost (€)	Justification
Travel	26,000	Participation in project and WP meetings, workshops, conferences + additional travel costs for possible gravmag field data gathering in the border area. Justification for travel cost amounting to ca. 30% of PGI personnel cost: PM rate at PGI-NRI is 2000 EUR, thus is approx. three times lower than for other European surveys. Nonetheless, travel costs (airfare, hotels, daily allowance) are the same as for other surveys, especially if attending meetings abroad. Therefore travel costs shall not be 10% of our personnel cost but 30%, otherwise we would be able to attend just 1/3 of the meetings relevant to our PM contribution.
Equipment		
Other goods and services		
Total	26,000	
10 / IGME	Cost (€)	Justification
Travel	27,500	Networking meetings. Field trips for reviewing the current geological map, cross sections. Gravmag acquisition, processing and interpretation (meetings) (deliverables 6.1 and 6.2, but also 6.5). Meetings related to geological harmonization in the German/Polish border (deliverables 6.3 and also 6.5). Meetings related to geological consistency in the North Sea (deliverables 6.4 and 6.5).
Equipment		
Other goods and services	7,500	Services contracted for the reviewing and rebuilding of cross sections, the *gravmag* campaign in high mountain and support for the 3D modeling.
Total	35,000	*(Other direct costs plus direct costs of sub-contracting)*
11 / GEOINFORM	Cost (€)	Justification
Travel	3,000	3 meetings, one per each WP, @ €1000 per person per meeting
Equipment		
Other goods and services		
Total	3,000	

Table 3.3c) Financial table with requested budget (This table is not covered by the page limit)

Participant	(A) Direct personnel costs (EUR)	(B) Other direct costs; travel, equipment, infrastructure, other (EUR)	(C) Direct costs of sub-contracting (EUR)	(D) Indirect costs (= (A + B) *0,25) (EUR)	(E) Total estimated eligible costs (=A+B+C+D) (EUR)	(F) Reimburse-ment Rate (29,7%)[1]	(G) Requested EU contribution (=E*F)	(H) Surveys in-kind contribution = (E – G)
BGR	643,164.57	50,000	-	173,291.14	866,455.71	0.297	257,337.35	609,118.36
CGS	6,813.87	2,000	-	2,203.47	11,017.34	0.297	3,272.15	7,745.19
GEUS	377,687	20,606	-	99,573	497,866	0.297	147,866	350,000
LBGR	192,967.50	63,350.00	-	64,079.38	320,396.88	0.297	95,157.87	225,239.00
LUNG	222,000	70,875	-	73,218.75	366,093.75	0.297	108,729.84	257,363.91
LBEG	463,083.12	25,000	-	122,020.78	610,103.90	0.297	181,200.86	428,903.04
LAGB	192,790.80	60,750.00	-	63,385.20	316,926.00	0.297	94,127.02	222,798.98
TNO	193,035	20,000	-	53,259	266,294	0.297	79,089	187,205
PGI	80,000	26,000	-	26,500	132,500	0.297	39,352.50	93,147.50
IGME	167,000	27,500	7,500	48,625	250,625	0.297	74,436	176,189
GEOINFORM	5,818.61	3,000	-	2,204.65	11,023.26	0.297	3,273.91	7,749.35

[1] The EC Reimbursement rate for ERA-NETs is 33%. 10% of this Reimbursement rate is reserved for the Coordination Costs of GeoERA as agreed in the Grant Agreement. Therefore, the Reimbursement rate for GeoERA is these calculations results in 29,7%.

4 Members of the consortium (This section is not covered by the page limit)

4.1 Participants (applicants)

Please provide, for each participant, the following (if available):

- A description of the legal entity and its main tasks (e.g., from GeoERA proposal), with an explanation of how its profile matches the tasks in the proposal.
- A curriculum vitae or description of the profile of the persons, including their gender, who will be primarily responsible for carrying out the proposed research and/or innovation activities (*you can upload the CV in ISAAC under the tab Attachments – Curriculum Vitae*)
- A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.
- A list of up to 5 relevant previous projects or activities, connected to the subject of this proposal.
- A description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.
- [Any other supporting documents specified in the work programme for this call]

Name of organisation	Bundesanstalt für Geowissenschaften und Rohstoffe		
Participant Number/Short Name	1 / BGR	**Country**	Germany

BGR is an Authority and Research Institute of the Federal Republic of Germany within the portfolio of the Federal Ministry for Economic Affairs and Energy. BGR gives independent advice to the Federal Government on all geoscientific questions. It cooperates on the European level with the National Geological Surveys and is member of EuroGeoSurveys. BGR participates at both national and international levels in fundamental geological research. In cooperation with the geological surveys of the federal states and European nations BGR provides specialist geological information, maps, standards and methodologies. In a framework of national, European and international initiatives, BGR contributes to developing the geodata infrastructure (geoinformation business).

For a consistent and sustainable evaluation of subsurface use potentials and conceivably resulting conflicts of use across federal state borders and Germany-wide, BGR develops the relevant geological data and information. BGR's activities include the

- Investigation & characterization of the structural framework, petrography and stratigraphy
- Adaptation and improvement of methods for supra-regional structure analyses and modeling
- Analyses and evaluation of risk potentials related to the subsurface structure
- Construction of 3D subsurface models
- Investigation in regard to the evaluation of rocks for specific types of use
- Development and maintenance of data bases and information systems

BGR's activities in the German sectors of the North Sea, the Baltic Sea, as well as onshore are generally carried out in cooperation with the German state geological surveys and the geological surveys of neighbouring countries.

Persons who will be primarily responsible for carrying out the proposed activities;

Stefan Knopf (male) holds a Diploma (equivalent to MSc) in Earth Sciences and is a senior researcher at BGR. His research has covered petroleum geology, regional geology of Germany and especially various aspects regarding Carbon dioxide Capture and Storage (CCS). One main focus is to evaluate geological CO_2 storage potentials in Germany, which involves the development of capacity estimation methodologies. He was involved in EU projects like GeoCapacity and CO_2StoP which covered the issue of CO_2 storage potentials. His work also includes activities as a guest lecturer on CCS at the University of Hannover or for CGS Europe Spring Schools.

He has managed CCS projects regarding potential conflicts of use between CO_2 storage and geothermal energy use ("Geothermie-Atlas") and brine migration risks ("CO2BRIM"). Currently he is task leader in the EU project "ENabling Onshore CO_2 Storage in Europe" (ENOS), coordinating the contributions of 10 partner institutions to produce an e-learning series on CCS. Furthermore, he is currently one of the coordinators of the project "Subsurface Potentials for Storage and Economic Use in the North German Basin (TUNB)". In that project BGR cooperates with the geological survey organizations of the northern German federal states to construct a harmonized 3D model of the North German Basin. Stefan Knopf will serve as the main coordinator in the proposed project.

Fabian Jähne-Klingberg (male) is a structural geologist and special emphasis of his work (since 2006) is placed on the structural evolution of the Central European Basin. He especially is interested in the Late Cretaceous evolution of the Central European Basin as well as the complex halotectonic deformation of its sedimentary cover. To comprehend the distribution of the deformation within this complex basin, he focused on the assessment of the deformation style, the kinematics and the estimation of amounts for extension and shortening of several deformational events. These studies are carried out with the help of different structural restoration and balancing methods. Additionally, he also tries to establish an approach to catch and illustrate the structural uncertainties along with (seismic) interpreter bias and different geophysical methods, in order to create structural consistent and reliable 3D-models.

From 2009 to 2013 as research assistant in the "GPDN-Project" at the Federal Institute for Geosciences and Natural Resources (BGR), his main task was the seismic interpretation and structural modeling of the subsurface of the German North Sea. Since 2014 he coordinates the R&D works in the "TUNB"-project (a modeling project with the main goal to develop a 3D-model of the whole German Basin from the North Sea in the West to the German/Polish border in the East) and is responsible for the interpretation and modeling work in the German North Sea sector. In the course of geochemical mapping projects (e.g. GEMAS) in the last years he published several thematic overview maps of the geology of Europe.

Dr. Björn Zehner (male) received a Diploma in Geology (1998) from the University of Freiburg and a PhD (2002) from the University of Bonn. He has worked as a scientist with the Fraunhofer Institute for Media Communication, Schlumberger Cambridge Research, the Helmholtz Centre for Environmental Research – UFZ and with the Technical University (Bergakademie) in Freiberg. Since 2013 he has worked at the BGR – Federal Institute for Geosciences and Natural Resources in Berlin. His research focuses on 3D visualization and Virtual Reality in the geosciences and on 3D geological modeling, ranging from the development of new methods and workflows to practical software development.

Relevant publications:

Arfai, J., Jähne, F., Lutz, R., Franke, D., Gaedicke, C. & Kley, J. (2014). Late Palaeozoic to Early Cenozoic geological evolution of the northwestern German North Sea (Entenschnabel): New results and insights. – Netherlands Journal of Geosciences, FirstView: 1-28.

Jähne-Klingberg, F., Wolf, M., Steuer, S., Bense, F., Kaufmann, D., & Weitkamp, A. (2014). Speicherpotenziale im zentralen deutschen Nordsee-Sektor, Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover.

Wolf, M., Steuer, S., Röhling, H.G., Rebscher, D. & Jähne-Klingberg, F. (2015). Lithofacies distribution in the Central European Basin: A 3D Model of the Buntsandstein facies in the Central German North Sea. Zeitschrift der Deutschen Gesellschaft für Geowissenschaften, Vol. 166 (4), 341-359, Stuttgart, 10.1127/zdgg/2015/0039.

Zehner, B., Watanabe, N., Kolditz, O. (2010): Visualization of gridded scalar data with uncertainty in geosciences, Computers and Geosciences 36 (2010), Elsevier, p. 1268-1275, doi:10.1016/j.cageo.2010.02.010.

Zehner, B., Börner, J. H., Görz, I., Spitzer, K. (2015): Workflows for generating tetrahedral meshes for finite element simulation on complex geological structures, Computers and Geosciences 79 (2015), Elsevier, p. 105-117, doi:10.1016/j.cageo.2015.02.009.

Relevant previous projects or activities:

GPDN: Geopotenzial Deutsche Nordsee; end of project December 2013; http://www.gpdn.de/

Geotektonischer Atlas von Nordwest-Deutschland und dem deutschen Nordsee-Sektor (Tectonic Atlas of Northwest Germany and the German North Sea sector); final publication 2001

Speicher-Kataster Deutschland (Storage Catalogue of Germany); end of project March 2011; https://www.bgr.bund.de/EN/Themen/Nutzung_tieferer_Untergrund_CO2Speicherung/Projekte/CO2Speicherung+Nutzung/Abgeschlossen/speicherkataster_en.html?nn=1559828

Name of organisation	Ceska Geologicka Sluzba – Czech Geological Survey		
Participant Number/Short Name	2 / CGS	Country	Czech Republic

Ceska geologicka sluzba / Czech Geological Survey (CGS) is a research institute of the Ministry of Environment of the Czech Republic. The mission of the CGS, the history of which has started in 1919, is the performance of the state geological survey in the Czech Republic and research in geosciences. CGS leads and participates in basic and interdisciplinary research projects.

The main fields of expertise include:

•Geological research and mapping (regional geological research, geological and thematic mapping, paleontologic and biostratigraphic studies, geological heritage)

•Geochemistry and environmental studies (interaction atmosphere – biosphere –hydrosphere – geosphere, monitoring of element budgets, acidification of forest soils, organic pollutants, radon risk)

•Mineral resources and mining impact assessment (identification and assessment of resources, regional raw material policies, mitigation of mining impacts)

•Applied geology and natural risks (hydrogeological mapping and research, geological hazards, radioactive waste disposal, support of development planning)

The system of CGS district geologists and associated specialists assists in acquisition and assessment of data on the geological composition of the state territory and the CGS provides expert information to the authorities for the political, economical and environmental decision-making.

The survey's core skills include data management, geo-ICT and 3D-modeling. The organisation hosts the national repository for subsurface data and information and is the designated state advisor of all geological matters related to the Mining Act.

As the owner of the large geoscientific datasets from the whole Czech Republic area, the CGS recently has been developing a unified methodology of the data compilation and their subsequent use in geological 3D modeling. This activity is managed in cooperation with individual projects and contracts that involve production of the 3D geological models. The most important recently developed outputs include models for a high-speed railway tunnels, recalculation of mineral resources or siting of a deep radioactive waste repository.

For the 3D geological modeling the CGS is using MOVE sw. developed by the Midland valley Ltd. (www.mve.com). Integral part of the model production at the CGS is also an initial assessment of model credibility for purposes of safety analysis of radioactive waste deep repository potential localities.

In the proposed project CGS will contribute to identification and classification of sources of uncertainty in geomodels and to development of visualization methods to make the user aware of it. Based on its experience in 3D geological modeling of predominantly crystalline rock environment, CGS will complement and contribute to generalization of methodologies developed for the essentially sedimentary modeling performed by other project participants in the W - NW parts of Europe.

Jan Franěk (male) works as a structural geologist at the Czech geological survey (CGS). After defending his PhD thesis entitled "From microstructures to large-scale crustal deformations in collisional orogen: multidisciplinary approach" in 2007, he started to work at the CGS as a field-oriented scientist. Presently he coordinates and manages applied research projects oriented to heat and radioactive waste storage sites in the Czech Republic, in cooperation with industrial partners. Additionally the professional interests are also focused on field oriented research in structural geology, petrography and tectonics of very low to very high-grade metamorphic rocks, dynamics of orogenic processes, microstructural research, geological mapping and geology applied to mineral deposits. He has medium programming skills ranging from low-level languages like Pascal and its object-oriented successor Delphi, to high-level languages like Matlab. Presently he is deeply involved in 3D geological modeling projects at the CGS, where he combines all the above mentioned knowledge and experiences.

Publications:

Jelínek, J., Staněk, F., Vebr, L., Honěk, J. (2014): The spatial distribution of the lignite qualitative parameters and variant estimates of coal reserves: the Czech Part of the Vienna Basin. INTERNATIONAL JOURNAL OF EARTH SCIENCES, Vol. 103, No. 4, 1113-1123.

Bukovská, Z. – Švagera, O. – Jelének, J. – Franěk, J. (2016): Regional structural-geological 3D model of the Hrádek candidate locality. Radioactive waste repository authority (SURAO).

Franěk, J. (2017): Detailed structural-geological 3D model of the Magdaléna candidate locality. Radioactive waste repository authority (SURAO).

Koucká, L. – Kopačková V. (2015): QUANTools. ČGS, Praha. Software available at URL http://cgs-rs.g6.cz/hyperalgo.html

Moravcová, O. – Kondrová, L. – Kafka, Š. – Svítil, R. – Kramolišová, P. – Krejčí, Z. – Karbušická, S. (2013): Metadata catalogue of the ČGS - survey application. ČGS, Praha. Software available at URL http://micka.geology.cz

Relevant 3D projects:

Project title:	**3D structural-geological models of rock environment for deep repository of HLW**
From - to:	11/2014-01/2018
Client:	SÚRAO - State Office for Nuclear Safety of the Czech Republic
Consortium leader:	Czech Geological Survey
Total CGS budget:	12.1 mil. CZK
Part of the budget for 3D geological models:	12.1 mil. CZK
Project title:	**Research infrastructure for geothermal energy - RINGEN**
From - to:	2016-2019
Client:	Ministry of Education, Youth and Sports of the Czech Republic
Consortium leader:	Faculty of Science, Charles University
Total CGS budget:	4.2 mil. CZK
Part of the budget for 3D geological models:	1 mil. CZK
Project title:	**Geological model of selected parts of a high velocity train corridor Prague-Dresden**
From - to:	01/2017 – 01/2020
Client:	ŘSD – Directorate of roads and motoways of the Czech Republic

Consortium leader:	SŽDC
Total CGS budget:	8.1 mil. CZK
Part of the budget for 3D geological models:	1.0 mil. CZK
Project title:	**Evaluation of geological and other information in selected parts of Czech Moldanubicum for potential suitability of HLW repository EDU-Z siting**
From - to:	06/2016 – 01/2018
Client:	SÚRAO - State Office for Nuclear Safety of the Czech Republic
Consortium leader:	Czech Geological Survey
Total CGS budget:	8.0 mil. CZK
Part of the budget for 3D geological models:	0.5 mil. CZK
Project title:	**Shallow Geothermal Energy Planning, Assessement and Mapping Strategies in Central Europe - GeoPLASMA-CE**
From - to:	09-2016 - 08-2019
Client:	European Commission: Interreg Central Europe Programme
Consortium leader:	GBA - Geologisches Bundesanstalt
Total CGS budget:	319 326 EUR
Part of the budget for 3D geological models:	11 540 EUR

Infrastructure:

Available Hardware:

- Workstations specification: OS: Win 7, Memory: 24 GB Ram, CPU: Intel i7-4790 @ 3,6 GHz (8 cores), graphic: NVIDIA Quadro K2000

- Several servers serviced by IT service of CGS

Software:

- Digitization and editing of any spatial data is mostly done with ArcGIS by ESRI.

- To manage borehole information: specialized CGS database application is used, for 3D modeling is used export to a Microsoft Access interface for reinterpreting the lithological borehole data.

- The development of geological 3D models is mostly done with MOVE from Midland Valley ltd. Besides we are using PetroMod to work on specialized basin-related tasks.

Name of organisation	Geological Survey of Denmark and Greenland		
Participant Number/Short Name	3 / GEUS	Country	Denmark

GEUS is an independent research and advisory institution in the Danish Ministry of Energy, Utilities and Climate. GEUS conducts geological research to exploit and protect geological natural resources in Denmark and Greenland. Primary activities are research in water, energy, minerals and other natural resources.

GEUS provide geological advice to public authorities in nature, environment, climate, energy and raw materials issues and participate in the performance of tasks within these areas. GEUS is the national geological data centre and in that capacity make data and knowledge available to the authorities, educational institutions, government agencies, private enterprises and the public.

GEUS also undertakes assignments related to water, energy, minerals and the environment on a contractual basis for other public authorities, private companies and clients outside Denmark.

GEUS is part of Geocenter Denmark - a formalised cooperation between GEUS and the Geocience institutes at University of Copenhagen and Aarhus University.

In 2016, GEUS has a staff of 290 of which 210 hold a PhD or MSc degree, and around 50 PhD students and several MSc students are attached to GEUS for research training.

GEUS ensures that the advice of the Danish authorities and energy resource companies, in all energy work fields is based on the latest Danish and international geoscientific knowledge. In Denmark, the focus will be on preparing new licensing rounds, mapping and assessment tasks associated with CO2 storage offshore in Denmark as well as internationally, using recent and deposits as reservoir analogies, studies targeting shale gas etc. The main objectives are:

- Oil and gas in the North Sea and unconventional hydrocarbons onshore Denmark
- Sustainable energy from the subsurface.

Persons who will be primarily responsible for carrying out the proposed activities

Peter Britze (male), MSc in Geology, University of Copenhagen. Senior Consultant, former Head of Department, Department of Reservoir Geology. Former Chair and presently Deputy Chair of the EuroGeoSurveys GeoEnergy Expert Group dealing with geo-energy in Europe. Recognized as independent scientific advisor for EU DG ENER, DG ENV, DG RTD, and DG JRC on conventional and unconventional fossil fuels. AIB Commissioner for larger offshore installations in Denmark.

Project manager on commercial integrated multi-disciplinary chalk exploration and reservoir studies.

Geophysical expert in chalk reservoirs.

Technical supervisor and super user on all geophysical Landmark products. Expert in the integration of geological disciplines within the Landmark environment. Working with digital 2D and 3D seismic interpretations and mapping, post stack processing, inversion and generation of synthetic seismograms.

Professional awards: The Geological Award of Denmark 1996.

Henrik Vosgerau (male), Ph.D. in Geology, University of Copenhagen, Senior Researcher with 20 years experience with sedimentology, 3D photogrammetry, interpretation of depositional environments, lithostratigraphic and petrophysical log correlation, seismic mapping and sequence stratigraphy based on outcrop as well as subsurface studies as an input for the construction of geological models. Considerable knowhow on geological aspects relevant for energy recovery. Project leader experience from several interdisciplinary projects.

Karen L. Anthonsen (female) is a geologist and project manager at the Strategraphic Department in GEUS. She has a M.Sc. in Geology from University of Copenhagen (1997), and a business administration diploma in project management and organization (2003). Since 2007 she has been working in several international co-operation projects as EU GeoCapacity, ECCO and NORDICCS as sub package leader and work package leader. Karen was the project manager on the newly finished EUOGA project (2015-2017). She is a board member in the Norwegian research fund, CLIMIT.

Dr. Niels E. Poulsen (male) is senior scientist at GEUS. He holds a MSc (1984) and a PhD (1990) degree in geology from the University of Copenhagen. He is an expert in stratigraphy with emphasis on Jurassic stratigraphy and palynology. He became part of the CCS team at GEUS in 2009, and has participated in projects such as EU GeoCapacity, COACH, CO2ReMoVe, Mapping of the storage potential of CO2 in the eastern North See, Skagerrak, Kattegat and onshore Denmark, CGS Europe and TOPS. He is GEUS' representative in the CO2GeoNet (Member of executive committee (2011-present) and Treasurer (2013-present)) and ENeRG (president 2012-13). He was coordinator for the CO2StoP project and he participates now in the ENOS project (ENabling Onshore CO2 Storage in Europe) Management Board and Work Package leader for WP8 (Promoting CCS through Training and education).

Carsten M. Nielsen (male) has more than 20 years of experience as a reservoir engineer; working with reservoir evaluation, field development, reserve estimation, subsurface modeling and reservoir simulation, both as an expert/regulator at the Danish Energy Agency and as a researcher/advisor at the Geological Survey of Denmark and Greenland (GEUS). Carsten has been using his expertise with hydrocarbon fields in the Danish, Norwegian and British sectors of the North Sea, modeling storage of CO2 and natural gas and modeling geothermal energy production.

Relevant publications

Vejbæk OV, Britze P(eds) (1994) Geological map of Denmark Top pre-Zechstein. Geological Survey of Denmark Map Series No. 45.

Britze P, Japsen P, Andersen C (1995) The Danish Central Graben 'Top Chalk' and the Post Chalk Group. Geological Survey of Denmark Map Series No. 47.

Britze P, Japsen P, Andersen C (1995) The Danish Central Graben 'Base Chalk' and the Chalk Group. Geological Survey of Denmark Map Series No. 48.

Britze P, Japsen P, Andersen C (1995) The Danish Central Graben 'Base Cretaceous' and the Cromer Knoll Group. Geological Survey of Denmark. Geological Survey of Denmark Map Series No. 49.

Britze P, Japsen P, Andersen C (1995) The Danish Central Graben 'Base Upper Jurassic' and the Upper Jurassic. Geological Survey of Denmark Map Series No. 50.

Relevant previous projects or activities

Millennium Atlas

SPBA: Petroleum Geological Atlas of the Southern Permian Basin Area (2005-2010)

GASH: Gas Shales in Europe

Name of organisation	Landesamt für Bergbau, Geologie und Rohstoffe Brandenburg		
Participant Number/Short Name	4 / LBGR	Country	Germany

Brief description of the legal entity

LBGR is a subordinated state authority of the Ministry for Economic Affairs and Energy and the central geo-scientific state institution of the Federal State Brandenburg. LBGR provides geoscientific knowledge, data and planning-relevant documents for the protection and sustainable use of soil, groundwater, geothermal energy, raw materials and construction ground. For this reason LBGR maintains specialised information systems in the field of geology, hydrogeology, economical geology and geopedology. These information systems include the central repository for subsurface data of the Federal State of Brandenburg.

Short profile of staff member(s) who will be undertaking the work

Christoph Jahnke (male) senior geologist. Christoph holds a diploma in Crystallography from Humboldt-University Berlin (1991) and a diploma in Geology from the Technical University in Berlin (1997). From 1992 to 2000 he worked for several consulting companies providing geoscientific services and software development. 2000 he joined the Brandenburg Technical University in Cottbus. He worked as lecturer, scientist and project manager in the fields of 3D-modeling, hydrogeology, geochemistry in conjunction with mining damage and underground storage. Since 2014 he is an employee at the at State Office for Mining, Geology and Raw Materials Brandenburg (LGBR) within the project Subsurface Potentials for Storage and Economic Use in the North German Basin (TUNB).

Maik Schilling (male) junior geologist. Maik holds and diploma in engineering from the Technical University in Berlin (2012). From 2012 to 2014 he was working as scientist at German Research Center for Geosciences (GFZ Potsdam) in the field of geological 3D modeling. Since 2014 he is an employee at the State Office for Mining, Geology and Raw Materials Brandenburg (LGBR) within the project Subsurface Potentials for Storage and Economic Use in the North German Basin (TUNB) and works in geological 3D-modeling and software development.

Andreas Simon (male) holds a diploma in Geology (1988) from Technical University Berlin. After working for 4 years as scientist at the German Research Association for Soil Mechanics (Deutsche Forschungsgesellschaft für Bodenmechanik DeGeBo, Berlin) in the field of Engineering Geology and soil mechanics he joined 1993 the State Office for Mining, Geology and Raw Materials Brandenburg (LGBR). He was the head of the department Engineering Geology and works after restructuring of the LBGR now as official in 3D-Geology, Geology of the deeper underground and core repository (database development, management).

List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.

- Schilling, M., Jahnke, C. Simon, A. & Höding, T: Development of a 3D geomodel in Brandenburg in the framework of the TUNB project. GeoBremen - Annual Meeting of DGGV, DMG, 24th – 29th September 2017, Berlin, Germany.
- Schilling, M., Jahnke, C. Simon, A. & Höding, T.: Brandenburg 3D – delivering geological information to the public. GeoBerlin - Annual Meeting of DGGV, DMG, 4th – 7th October 2015, Berlin, Germany.
- Schilling, M., Jahnke, C. Simon, A. & Höding, T.: Brandenburg 3D – GIS goes underground, a geological 3D model for the public. The 17th annual conference of the International Association for Mathematical Geosciences, 5th – 13th September 2015, Freiberg (Saxony)
- Kempka, T., Herd, R., Huenges, E., Endler, R., Jahnke, C., Janetz, S., Jolie, E., Kühn, M.,Magri, F.,Meinert, P., Moeck, I., Möller, M., Munoz, G., Ritter, O., Schafrik, W., Schmidt-Hattenberger, C. Tillner, E., Voigt, H-J., Zimmermann, G. (2015): Joint Research Project Brine: Carbon Dioxide Storage in Eastern Brandenburg: Implications for Synergetic Geothermal Heat Recovery and Conceptualization of an Early Warning System Against Freshwater Salinization. In: Liebscher, A. & Münch, U. (Eds.): Geological Storage of CO2 – Long Term Security Aspects,

GEOTECHNOLOGIEN Science Report No. 22, Series: Advanced Technologies in Earth Sciences, p. 183-209. Springer • Schilling, M., Jahnke, C. Simon, A. & Höding, T.: Brandenburg 3D – a comprehensive 3D subsurface model, conception of an infrastructure node and a web application. 2nd European meeting on 3D geological modeling, 20th – 21st November 2014, Edinburgh, Scotland.
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.
• The Geological 3D-Modell of Brandenburg (WMS, WFS, W3DS): The subsurface of Brandenburg in depth down to 5000m, interactive web application. www.geo.brandenburg.de/Brandenburg_3D/portal.html (currently offline). • „Potenziale des unterirdischen Speicher- und Wirtschaftsraumes im Norddeutschen Becken (TUNB)“ (Subsurface Potentials for storage and economic use in the North of Germany) Duration: 2014-2021. Cooperation of BGR Bundesanstalt für Geowissenschaften und Rohstoffe and the Geological surveys of the norther Federal states of Germany (including LBGR) • “Brandenburg 3D – Development of a geological 3D Model of the subsurface for the state of Brandenburg). Duration: 2013, Cooperation of LBGR , GFZ German Research Center for Geoscience, several companies (ENGIE E&P Germany, DMT Group, …) • “brine” - CO2 storage in eastern Brandenburg: Implications for geothermal heat provision and conception of a salinisation early warning system. BMBF/DFG research program GEOTECHNOLOGIEN. Duration 2010-2013.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work

• Hardware and software for geological 3D modeling (workstations, internal LINUX-server , several external servers hosted IT service provider of Brandenburg, GIS and modeling software: ESRI, Paradigm GOCAD/SKUA, Postgres/Oracle databases)
• Within the project Brandenburg 3D (B3D) special infrastructure components have been developed at LBGR for storing, managing and publication of 2D and 3D geological information. All implemented parts are composed of free and open source software, e.g. Postgres/Postgis, Geoserver, Javascript Frameworks: The infrastructure contains 3 parts:
  o **Internal working platform (GeoIS)** for management and storing of 2D- and of 3D data.
  o **Service Platform (ISN)** containing a Postgres-DB (B3D-database – SDI) for publishing 2D and 3D data and the Geoserver software to deliver Open Webservices like WMS, WFS and W3DS.
  o **Web application with 2D- and 3D-Viewer** to present data to the public (www.geo.brandenburg.de/Brandenburg_3D/portal.html (currently offline)).

Name of organisation	Landesamt für Umwelt, Naturschutz und Geologie Mecklenburg-Vorpommern		
Participant Number/Short Name	5 / LUNG	**Country**	Germany

LUNG is the State Agency for Environment, Nature Conservation and Geology in Mecklenburg-Vorpommern, a federal state in NE Germany. It provides geoscientific knowledge, data and planning-relevant documents for the protection and sustainable use of soil, groundwater, geothermal energy, raw materials and construction ground . For this reason LUNG maintains specialised information systems in the field of geology, hydrogeology, economical geology and geopedology. These information systems include the central repository for subsurface data of the Federal State of Mecklenburg-Vorpommern. Projects of the survey include mapping of groundwater resources, determination of geothermal potential, large scale 3D modeling of deep subsurface structures, remediation of contaminated sites, mapping of soil erosion and determination of geohazards.

Dr. Karsten Obst (male) studied geology at the universities of Greifswald (Germany) and Lund (Sweden). After his PhD degree about mafic dykes in the Fennoscandian border zone he worked between 1998 and 2003 as scientific assistant at the University of Greifswald. He investigated magmatic systems and tectonic structures in the transition zone between Baltica and Avalonia. After a research stay at the University of Birmingham (UK) he works at the Geological Survey of Mecklenburg-Western Pomerania and is head of the department Subsurface Geology and Geothermal Energy. He collaborates with colleagues from other geological institutions in several projects concerning the structural evolution of the North German Basin and adjacent areas in the Baltic Sea. He is LEAR of the LUNG in the framework of GeoERA.

Sabine Matting (female) studied geology at the universities of Greifswald (Germany) and Szczecin (Poland) and received a master degree in 2012. After working as a research assistant at the University of Greifswald she is employed in research project at the Geological Survey of Mecklenburg-Western Pomerania with the goal to establish a 3D model of the north-eastern part of the North German Basin. She is responsible for the evaluation of well and seismic data used for the modeling procedures.

André Deutschmann (male) studied geography and geology at the University of Greifswald (Germany) and got a master degree in 2011. Between 2011 and 2014 he worked as a scientific assistant at the University of Greifswald. During this time he investigated faults and fault systems in northern Germany and adjacent Baltic Sea area mainly based on seismic data. Since 2014 he is member of the project group 3D modeling at the Geological Survey of Mecklenburg-Western Pomerania and an expert in using the software SKUA/GOCAD.

Publications:

OBST, K., BRANDES, J., MATTING, S. & DEUTSCHMANN, A. (2017): Progress on the way towards a 3D model of M-V: Salt structures, faults and lithostratigraphic layers of the Ludwigslust sub-area. – Abstract GeoBremen 2017, p. 625; Bremen.

SEIDEL, E., MESCHEDE, M. & OBST, K. (2018): The Wiek Fault System east of Rügen Island: origin, tectonic phases and its relationship to the Trans-European Suture Zone.– In: KILHAMS, B., KUKLA, P. A., MAZUR, S., MCKIE, T., MIJNLIEFF, H. F. & VAN OJIK, K. (eds) Mesozoic Resource Potential in the Southern Permian Basin. Geological Society, London, Special Publications, 469. https://doi.org/10.1144/SP469.10

OBST, K., DEUTSCHMANN, A., SEIDEL, E. & MESCHEDE, M. (2015): Steps towards a 3D model of the German Baltic Sea area - collaboration with academic research in the USO project.– 8th European Congress on Regional Geoscientific Cartography and Information Systems - Geological 3D Modeling and Soils: functions and threats, 44-45.

OBST, K., GEIßLER, M., FRANZ, M., ANSORGE, J., GRANITZKI, K. & HOFFMANN, N. (2007): The Central European Basin System - From the Bottom to the Top.– In: NIEDERMEYER, R.-O., PIOTROWSKI, A. & SCHÜTZE, K. [eds] *Geology cross-bordering the Western and Eastern European Platform.* Excursion Guide, Geo-Pomerania Szczecin 2007, *Biuletyn Państwowego Instytutu* **424**: 19-52.

FELDRAPPE, H., OBST, K. & WOLFGRAMM, M. (2007): Evaluation of sandstone aquifers of the North German Basin: a contribution to the „Geothermal Information System of Germany".– *Proceedings European Geothermal Congress 2007, Unterhaching, Germany* **pdf 248**: 1-8.

Infrastructure:

LUNG holds a variety of technical infrastructure for data processing, conversion, storage and modeling using several multi-core workstations and personal computers including GIS and 3D modeling software solutions.

Projects:

Project GeoFaces: Evaluation of geothermal reservoirs in the north-eastern part of the North German Basin, 2017-2020. Cooperation of LIAG Hannover, KIT Karlsruhe and LUNG

Project TUNB: „Potenziale des unterirdischen Speicher- und Wirtschaftsraumes im Norddeutschen Becken" (Subsurface Potentials for storage and economic use in the North of Germany), 2014-2021. Cooperation of BGR Bundesanstalt für Geowissenschaften und Rohstoffe and the Geological Surveys of the northern Federal States of Germany (including LUNG)

Project GeotIS: Development of a Geothermal Information System for Germany to provide information and data compilations on deep aquifers in Germany relevant for geothermal exploitation, 2006-2009. Cooperation of LIAG Hannover and other geological institutions in Germany (including LUNG)

Name of organisation	**Landesamt für Bergbau, Energie und Geologie Niedersachsen**		
Participant Number/Short Name	6 / LBEG	**Country**	Germany

Brief description of the legal entity
LBEG (Landesamt für Bergbau, Energie und Geologie) is Geological Survey of Lower Saxony (ERA project partner) and Mining Authority of Lower Saxony, Hamburg, Bremen and Schleswig-Holstein as well as the German continental shelf of the North Sea and a part of the German continental shelf of the Baltic Sea. The main responsibilities of the Geological Survey are development of geo-resources, protection of soil and groundwater, and state advisor of geological matters related to the Mining Act. The survey´s core skills are geological and hydrogeological mapping, hydrogeology, engineering geology, geothermal energy, soil science, geophysics, geochemistry, management of geo-data and geological 3D mapping. Projects of the survey include mapping of groundwater resources, determination of geothermal potential, large scale 3D modeling of the deeper underground, remediation of contaminated sites, mapping of soil erosion and determination of geo-hazards.
Main project tasks and qualifications:
LBEG will be WP leader of WP1, LBEG will be part of the Project Board. LBEG has a widely recognized expertise in 3D modeling and geothermal energy in Germany.
Short profile of staff member(s) who will be undertaking the work
Jörg Elbracht (male) head of the sub department Hydrogeology, holds a Diploma in Geology from the University of Hannover. Works more than 20 years as geologist and hydrogeologist in Lower Saxony, more than 15 years geological and hydrogeological mapping in Lower Saxony, more than 10 years head of geological and hydrogeological working-groups (e.g. 3D-modeling of quaternary deposits at German north-sea-sector (GPDN)), member of geothermal energy working groups. **Melanie Witthoeft** (female) scientific officer in the sub department Hydrogeology, holds a Diploma in Geosciences from the University of Hannover. Works for more than 10 years as geologist and hydrogeologist, in geological and hydrogeological mapping in Lower Saxony (e.g. map of hydraulic heads, geological and hydrogeological crosssections) and in data quality management.
List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.
• Pierau, R.; Schöner, R.: Facies reconstruction and aquifer properties of Lower cretaceous sandstones in the Lower Saxony Basin (North Germany) – a geothermal perspective. In: Mesozoic resource potential in the southern Permian Basin, 7.-9. September 2016, Burlington House Picccadilly, London: programme and abstract volume/convenors: Ben Kilhams… - London. – (2016), S.97-98 • Asprion, U.; Ertl, G.; Griffel, G.; Lange, M.; Elbracht, J.: The quaternary base of the German North Sea: first results of the project Geopotential of the German North Sea (GPDN) in: Gletscher, Wasser, Mensch – quartärer Landschaftswandel im peribaltischen Raum: 35. Hauptversammlung der Deutschen Quartärvereinigung DEUQUA; 12th Annual Meeting of the INQUA Peribaltic Working Group; Tagungsunterlagen, 13.-17. September 2010, Greifswald • LBEG: Geoberichte 24 - Leitfaden Erdwärmenutzung in Niedersachsen: rechtliche und technische Grundlagen. Hannover: LA f. Bergbau, Energie und Geologie, 2012. – 59 S.: Ill. Graph. Darst. 2012 Hannover

List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.
National and transnational projects: • Potentiale des unterirdischen Speicher- und Wirtschaftsraumes im Norddeutschen Becken (TUNB) – Subsurface Potentials for storage and economic use in the North German Basin; Duration: 2014-2021. Coorporation of BGR and the Geological Surveys of the northern Federal states of Germany (including LBEG) • GEOPOTENZIAL DEUTSCHE NORDSEE (GPDN) http://www.gpdn.de/ State related: • Der Geotektonische Atlas als 3D-Modell (GTA3D) http://www.lbeg.niedersachsen.de/geologie/3duntergrundmodelle/geotektonischer_atlas_3d_gta3d/839.html • Hydrogeological 3D-modeling of different areas in Lower Saxony which are of water economic interest • Hydrogeological and geological crosssections as information base (Stratigraphy, Petrography, Hydrostratigraphy) for hydrogeological 3D-models http://nibis.lbeg.de/cardomap3/?permalink=1orDWEsV
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work
• Public database on surface and subsurface information (groundwater, geology, soil, mining, geothermal energy) offering maps, boreholes, crosssections and 3D-models (http://nibis.lbeg.de/cardomap3/). • sub department (Section 2.6: Digital Cartography, 3D-Modeling) • sub department (Section 2.4: Center for Deep Geothermal Energy, Shallow Geothermal Energy)

Name of organisation	Landesamt für Geologie und Bergwesen Sachsen-Anhalt		
Participant Number/Short Name	7 / LAGB	Country	Germany

State office for geology and mining (LAGB) – Geological Survey (LAGB)

Landesamt für Geologie und Bergwesen (LAGB) – Abteilung Geologischer Dienst

Brief description of the legal entity:

LAGB is the subordinated state authority of the Ministry for Economy, Science and Digitalization as well as the central geo-scientific state institution of the Federal State Saxony-Anhalt. LAGB provides geoscientific knowledge, data and planning-relevant documents for the protection and sustainable use of soil, groundwater, geothermal energy, raw materials and construction ground. For this reason LAGB maintains specialised information systems in the field of geology, hydrogeology, economical geology and geopedology. These information systems include the central repository for subsurface data of the Federal State of Saxony-Anhalt.

Description of persons designated for 3DGEO-EU implementation:

Dr. Bodo-Carlo Ehling (male) studied geological mapping, search and exploration of natural mineral deposits at St. Petersburg Mining University (university degree in 1985) and received a Ph.D. from the Technical University of Freiberg (1992). From 1985 to 1991 he was a scientific associate at the Central Geological Institute in Berlin (ZGI) with a scientific focus on studies of natural mineral deposits in basement rocks of southern Saxony-Anhalt and Brandenburg. Since 1992 he works at the Geological Survey of Saxony-Anhalt and was involved in aspects of the deep subsurface, he was head of the departments “Central special services/Archives/Library”, “Central Geo-specific information systems” and “Applied Geology”. Since 2010 he is the head of the department “Geology” at the LAGB, which is the Geological Survey organization of Saxony-Anhalt. He is head of the sub-commission “Proterozoic-Silurian” in the German Stratigraphic Commission, member of various national committees and LEAR of the LAGB in the framework of GeoERA.

Dr. Klaus-Jörg Hartmann (male) studied agriculture at the universities of Munich, Kiel and Göttingen and got his PhD at the university of Kiel in soil science about dust transport and impact in holocene soils in 1992. 1992 – 1995 he was project leader to build up a soil science information system for the federal state of Brandenburg. Since 1995 Hartmann is employed at the geological survey of the federal state of Saxony-Anhalt. He is leader of the department “Geo-specific information systems and archives” (Fachinformationssysteme und Archive) and is entrusted with the development of geological data information systems. Since 2016 he is leader of the project group TUNB (Subsurface Potentials for Storage and Economic Use in the North German Basin) in the LAGB.

Dr. Alexander Malz (male) received a diploma (2010) in geology and a Ph.D. (2014) from the University of Jena. His Ph.D. addressed the structural evolution and kinematic differences between basement-involved shortening and tectonic inversion in central Germany and thin-skinned thrusting in the easternmost Jura fold-and-thrust belt. In 2015 he has been a postdoc candidate at the Department of Structural Geology and Geodynamics at the University of Göttingen, and he attempts to understand the geometry and kinematics of fault zones in sedimentary basins by the use of quantified structural models and 3D modeling techniques. Since 2016 he works at the LAGB within the project Subsurface Potentials for Storage and Economic Use in the North German Basin (TUNB). To his tasks belong the development of a 3D geological model of Saxony-Anhalt as well as issues concerning data preparation, management, cross-border harmonization and documentation.

Lars Schimpf (male) studied geology and palaeontology at the University of Halle-Wittenberg with a special focus on petrology and economic geology and received his diploma in 2012. From 2013 to 2017 he was scientific assistant at the chair of hydrogeology and environmental geology of the University of Halle-Wittenberg and developed methods for digitalization, generalization, visualization and storage of 3D geological models. Since 2017 he is employed at the geological survey of the federal state of Saxony-Anhalt (department “Geo-specific information systems and archives”) as an expert in geological information systems, data base administration, programming of interfaces as well as data management and conversation.

Christoph Nachtweide (male) studied geosciences at the University of Greifswald and received a bachelor of geology in 2012 and master of geosciences degree in 2014. From 2014 to 2015 he worked for Landesamt für Umwelt, Naturschutz und Geologie (Geological Survey of Mecklenburg-Vorpommern; LUNG) as a scientific assistant. Since 2016 he is employed at the LAGB within the project Subsurface Potentials for Storage and Economic Use in the North German Basin (TUNB). To his tasks belong preparation and management of geological subsurface data, cross-border harmonization aspects and the development of a 3D geological model of Saxony-Anhalt.

Dr. Ivo Rappsilber (male, consultative) received a diploma (1991) in geophysics from the Technical University of Freiberg and a PhD from the University of Halle-Wittenberg (2003). His studies focused on the structure and evolution of the northern Saale trough, a Late Paleozoic basin in southern Saxony-Anhalt, which were investigated based on the interdisciplinary and coupled use of seismic, gravimetric and magnetic data. Since 1991 he is employed at the LAGB as a geophysicist with tasks comprising the whole spectrum of geophysical measurements, investigations, modeling and seismological monitoring.

Publications:

v. Hagke, C. & Malz, A., (2018): Triangle Zones – Geometry, kinematics, mechanics, and the need for appreciation of uncertainties. Earth-Science Reviews 177, 24-42. (available online: Nov. 2017)

Nachtweide, C., Emmerlich, S. & Malz, A. (2017): Regional scale subsurface model of the Altmark, Saxony-Anhalt. GeoBremen 2017

Wycisk, P. & Schimpf, L. (2016): Visualising 3D geological models through innovative techniques. Zeitschrift der Deutschen Gesellschaft für Geowissenschaften (ZDGG) 167, 405-418. doi: 10.1127/zdgg/2016/0059

Obst, K.,Bödecker,St., Brauer, R., Fritzer, Th.,Garlipp, F., Gerling, J. P., Hartmann, K.-J., Heggemann, H., Katzschmann, L., Liebsch-Dörschner, Th., Müller, J., Seidemann, A., Strauß, R. & G. Wirsing (2015) Characterization of subsurface resources in Germany as a basis for evaluating underground space management. Z. geol. Wiss., Berlin 43; 1/2: 3 – 54

Rappsilber, I. (2001): Geophysikalische Untersuchungsmethoden – Ausgangspunkt der räumlichen geologischen Modellierung. Mitteilungen zur Geologie von Sachsen-Anhalt. Beiheft 4, 47-56.

Projects and research programme(s):

Personenkreis "Nutzung tieferer Untergrund" der Ad-Hoc-AG Geologie

Konzept für Bewertungsverfahren zur unterirdischen Raumnutzung (2014)

Potentiale des unterirdischen Speicher- und Wirtschaftsraumes im Norddeutschen Becken (TUNB) – Subsurface Potentials for storage and economic use in the North German Basin; Duration: 2014-2021. Coorporation of BGR and the Geological Surveys of the northern Federal states of Germany (including LAGB)

Infrastructure:

LAGB holds a variety of technical infrastructure for data processing, conversion and storage. Data processing, conversion and modeling can be done with several multi-core workstations and personal computers (OS: MS Windows 7/10, Ubuntu Linux) using established GIS and 3D modeling software solutions. Several servers hosted by the LAGB are applied to manage and provide huge databases (MySQL databases) of the LAGB. The overall database infrastructure is divided into three parts concerning the three dimensions (1D, 2D and 3D) of geo-information and geo-data.

Name of organisation	**Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO**		
Participant Number/Short Name	8 / TNO	**Country**	Netherlands

Brief description of the legal entity

TNO is a semi-independent Dutch research and technology organisation active in technical, earth, environmental, life, societal and behavioural sciences, focussing on healthy living, industrial innovation, energy, transport and mobility, built environment, the information society, and defence, safety and security. TNO will be represented in Geo-ERA through the Geological Survey of the Netherlands, which provides geoscientific data, information and knowledge for:

- sustainable management of earth resources and the environment in general (including assessment of induced hazards and impacts);
- safe living on subsiding lowlands;
- reduction of risks and costs in building and construction associated with ground conditions.

The survey's core skills include data management, geo-ICT and 3D-modeling. Its products and services are primarily targeted at the water, energy and building sectors (the latter in the broadest possible sense, including land use and environmental planning). The organisation hosts the national repository for subsurface data and information and is the designated state advisor of all geological matters related to the Mining Act. The survey's skills and services relate to its operational environment, determined mainly by its hydrocarbon resources, and the Dutch coastal and fluvial lowlands setting, which presents aggregate and groundwater resources, as well as the obvious water-related challenges.

Main project tasks and qualifications:

TNO will be WP leader of WP3 and WP5; TNO will contribute to WP1 and Wp4

As a major research organization in the Netherlands and coordinator of many international projects, TNO has an extensive track record. TNO has a widely recognized expertise in mapping and modeling studies, within the Netherlands as well as abroad. This expertise is supported by the national Geoscience Information Programme in which the subsurface is mapped and characterized.

Short profile of staff member(s) who will be undertaking the work

Hans Doornenbal, MSc. (male), EuroGeologist, studied exploration geophysics and structural geology and he graduated in 1980 at the Utrecht University. He has more than 37 years experience in database management, seismic interpretation, structural geology, mapping and project management, especially related to subsurface studies not only hydrocarbon E&P studies, but also geothermal and water potential studies. He has participated as team member and later as project manager in a variety of projects abroad (Yemen, Tanzania, Slovenia). Since 1998 at TNO-Geological Survey of the Netherlands he is project leader of the regional mapping project of the deep subsurface of the Netherlands. From 2005-2010 he was assigned as project manager of the SPBA-project with the aim to produce the "Petroleum Geological Atlas of the Southern Permian Basin Area". In 2009 he became project manager for the "GASH – European Black Shale Database" project, from 2011-2014 he was involved in the North Atlantic Tectonostratigraphic Atlas project and from 2015-2017 in the EUOGA project to make an inventory and assessment for shale gas resources in Europe.

Dr. Johan H. ten Veen (male), co-lead WP3, senior geologist (EuroGeologist), Johan holds a MSc from Vrije Universiteit Amsterdam (1991) and a PhD degree in Earth Sciences from Utrecht University (1998). He joined TNO in 2009 after an academic (research and lecturing) career in structural geology. At TNO he works as a structural geologist on the initiation, refinement and maintenance of national subsurface geomodels (www.dinoloket.nl). Next to this task, he is involved in projects centered around characterization of hydrocarbon and geothermal reservoirs and several cross-border basin studies (NW Europe focus). Currently Editor in Chief of the Netherlands Journal of Geosciences.

Hans Veldkamp, MSc. (male), co-lead WP3 , senior geologist, graduated from Vrije Universiteit Amsterdam. Employed by TNO since 1998, working on static modeling of the shallow and deep subsurface and geothermal resource and potential assessment. Treasurer of the Board for the Geothermal Platform of the Netherlands.

Dr. M. (Maryke) den Dulk (female), Geologist-geomodeler (EuroGeologist), Maryke has 14 years' experience in geomodeling following a MSc in Geology and PhD in Paleoclimatology at Utrecht University. She started working as a geomodeler in 2000. Seconded within one of the larger oil companies, she participated in production and exploration teams focusing on building structural models and providing mapping products. Maryke joined TNO in 2007 where she continued working as a geologist-geomodeler. In this role emphasis has been on building (regional) structural models, improving workflow systematics and scripting for handling large datasets, as well as combining seismic interpretation and modeling techniques to improve model quality of the publicly disseminated national subsurface models (Dinoloket.nl, nlog.nl).

Harry Middelburg, MSc. (male), scientific software engineer, studied structural geology and graduated from Vrije Universiteit Amsterdam in 1993. Employed by TNO since 1999 for his knowledge on Geospatial Information and mainly working on development of geospatial databases and new way of dissemination of data and information. Harry recently participated in the European ESTMAP project developing a database, is continuously involved in dissemination of TNO's geometry and property subsurface models and is currently working on TNO's fault database.

Dirk Munsterman (male) studied geology at the University of Utrecht where he received a M.Sc. (cum laude) in Sedimentary Geology, with specializations in paleo-environment and climate. Since 1980 his work as senior palynologist (pollen, spores and dinoflagellate cysts), stratigrapher, geologist and project manager for TNO is within the Permian-Early Pleistocene framework of mapping projects (like e.g. NCP 2a-g), field (e.g. Gullfaks) and basin (e.g. Central Graben, Vlieland and Lower Saxony) studies, thematic research (revision and update "Stratigraphic Nomenclature of The Netherlands"), and inventory ("Unconventionals", Shallow Gas, Thermal Energy) research. Dirk was interim co-manager, respectively coordinator of Geobiology team from 2011-2016 and has ample experience dealing with commercial projects funded in particular by oil companies. Papers are presented at https://www.researchgate.net/profile/DK_Munsterman.

Dr. Geert-Jan Vis (male), geologist (EuroGeol #1434). Geert-Jan holds a MSc from Utrecht University (2003) and a PhD degree in Earth Sciences from VU University Amsterdam (2009). He joined TNO in 2008 where he first worked for the Advisory Board for the Ministry of Economic Affairs (AGE). At present he works in the Geomodeling team, where he is involved in (borehole) stratigraphy and sedimentology related subjects in support of the modeling activities in the team. He is secretary of the Stratigraphic Committee of the Geological Survey of the Netherlands and associate-editor of the Netherlands Journal of Geosciences.

List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.

- Doornenbal, J.C. & Stevenson, A.G. (Eds) (2010): Petroleum Geological Atlas of the Southern Permian Basin Area. EAGE Publications b.v., Houten, 342 pp.
- Hopper, J. R., Funck, T., Stoker, M., Árting, U., Peron-Pinvidic, G., Doornenbal, J. C., and Gaina, C., 2014, Tectonostratigraphic Atlas of the North-East Atlantic Region: Copenhagen, Geological Survey of Denmark and Greenland (GEUS), p. 338.
- Kombrink, H., Doornenbal, J.C., Duin, E.J.T., den Dulk, M, van Gessel, S.F., ten Veen, J.H. and Witmans, N. (2012). New insights into the geological structure of the Netherlands; results of a detailed mapping project. Neth., J. Geol., 91(4), 419-446.

- Kramers, L., Van Wees, J.-D., Pluymaekers, M.P.D., Kronimus, A. and Boxem T. (2012). Direct heat resource assessment and subsurface information systems for geothermal aquifers; the Dutch perspective. Neth., J. Geol., 91(4), 637-649.
- Pluymaekers M.P.D, Kramers, L., Van Wees, J-D, Kronimus, A., Nelskamp, S., Boxem, T. and Bonté, D. (2012). Reservoir characterisation of aquifers for direct heat production: Methodology and screening of the potential reservoirs for the Netherlands. Neth., J. Geol., 91(4), 621-636
- Van Dalfsen, W., Doornenbal, J.C., Dortland, S. & Gunnink, J.L. (2006): A comprehensive seismic velocity model for the Netherlands based on lithostratigraphic layers. Netherlands Journal of Geosciences 85: 277-292.

List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.

Besides a programme lead role in national research, TNO has been and is strongly involved in various EU funded projects, the relevant ones being listed below.

- GEOHEAT.App (INTERREG IV Vlaanderen – Nederland, January 2013 – June 2014): Evaluation of the technical and economic feasibility of intermediate and deep geothermal energy as a sustainable source of heat for new and renovated buildings based on 6 case studies
- EUOGA: inventory and assessment for shale gas resources in Europe (2015-2017)

TNO was involved in various regional Joint Industry Projects, executed by mainly European Geological Surveys and sponsored by the oil industry:

- SPBA: Petroleum Geological Atlas of the Southern Permian Basin Area (2005-2010)
- GASH: Gas Shales in Europe
- NAGTEC: Tectonostratigraphic Atlas of the North-East Atlantic Region (2011-2014)

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work

BRO / Dino-Loket / NLOG: Portal and Repository of subsurface data and 3D models of the Netherlands. TNO maintains and disseminates all subsurface data from industry and in-house data acquisition programmes, including 3D seismic surveys, borehole data and seismic monitoring data. These data are public and available to the project.

Thermogis.nl: geothermal potential assessment of the Netherlands incl. a worldviewer

TNO owns highly specialized 3D geological and geo-mechanical modeling software that is commonly used by international industry and scientific research organizations. These tools are available to the project.

Name of organisation	Polish Geological Institute – National Research Institute (PGI-NRI)		
Participant Number/Short Name	9 / PGI	Country	Poland

PGI-NRI is a state research institution with over 600 high-qualified employees in field of geology, hydrogeology and environmental studies, who work on national and international projects. PGI-NRI's headquarters are located in Warsaw, Poland, and the company has seven local branches located in Kraków, Wrocław, Sosnowiec, Gdańsk, Kielce, Szczecin and Lublin. PGI-NRI undertakes scientific research and development in fields of earth science, biology, environment and engineering. It also acts as Polish Geological Survey and Polish Hydrogeological Survey and as such it undertakes numerous tasks focused on examining, documenting as well as assessing and protecting national natural resources including groundwater. As leading geological institution in the country, PGI-NRI provides scientifically based advice and support to local and national administration as well as undertakes initiatives focused on promoting and informing society about geological science and issues related to natural resources and their protection. PGI-NRI is constructing geological 3D models for over a decade and is also engaged in numerical modeling of geological processes.

Ewa Szynkaruk Ph.D. (female). Graduated from Faculty of Geology, Warsaw University, where she earned her M.Sc. degree (tectonics of a part of Polish Outer Carpathians). Earned her PhD in earth sciences at the National Autonomous University of Mexico (morphotectonics of an active fault system in the Trans-Mexican Volcanic Belt). For over 10 years an employee of PGI-NRI. In 2005 co-initiated modeling activities in PGI-NRI and since then has been involved in geomodeling in the organization. In 2014–2017 head of PGI-NRI GeoModeling Laboratory. Involved in cooperation between European geological surveys on geomodeling since it was first formulated in 2008. Co-author of modeling strategy for the Polish Geological Survey, including flagship serial modeling of sedimentary basins of Poland. Leader of the project aimed at developing a geomodel of the Gorzów block at the western border of Poland.

Urszula Stępień Ph.D. (female). Graduated from Faculty of Geology, Warsaw University, where she earned her M.Sc. degree (tectonics of SW part of Holy Cross Mts.) and PhD in earth sciences (using GIS and geostatistical methods in structural geology). For over 10 years an employee of PGI-NRI. Since 2007 has been involved in tasks related to international initiative OneGeology, with special concern to the implementation of standards for the exchange of geological data (eg. GeoSciML) to ensure interoperability of data through their semantic harmonization. Engaged in INSPIRE roles implementation in PGI. Leader of the project aimed to develop 3D geological model of the central part of Warsaw. Involved in projects on 3D modeling of sedimentary basins of Poland.

Zbigniew Małolepszy Ph.D. (male) holds a PhD in Geology from University of Silesia, Poland. He has 18 years of international research experience in exploration geosciences gained at Universities in Poland and USA. He possesses a sound working knowledge of a wide variety of subsurface interpretation and mapping methods in exploration for geo-energy resources and the reservoir characterization. Hands-on experience with modeling software (Petrel, GoCad, EarthVision, GeoGraphix) as well as GIS software. Geographical areas worked include Poland, USA, Peru, and Antarctica. Since 2015 works as principal geomodeller for PGI-NRI, involved in flagship projects of serial modeling of sedimentary basins of Poland (pilot project in Lublin basin and now in Gorzów block model).

Publications:

Chełmiński, J., Gogołek, T., Jasiński, Ł., Małolepszy Z., Nowacki Ł., Słodkowski, M., Stępień U., Szynkaruk, E., Tomaszczyk, M. + 23 others (2016). 3D model of sedimentary cover of Lublin basin. Project report, PGI-NRI, Warsaw, Poland.

Małolepszy, Z., Szynkaruk, E. (2015). Quantification of structural uncertainties in multi-scale models; case study of the Lublin Basin, Poland. EGU General Assembly, 2015, Vienna, Austria

Chełmiński J., Czapowski G., Małolepszy Z., Stępień U., Rosowiecka O., Nowacki Ł., (2016). Integration of subsurface data for refinement of geological structure of salt diapirs. Salt Review, 2016.

Szynkaruk, E. (2016) 3D modeling of deep geological structure – opportunities and challenges for Geological Surveys. 3rd Polish Geological Congress, Wrocław, Poland.

Głuszyński A., Tomaszczyk M., Kijewska S. & Małolepszy Z. (2015) Which structural style to choose for constructing 3D geological model of the Lublin basin? Constraints from 2D seismics. CETEG 2015, Kadan, Czech Republic.

Relevant projects include:

3D geological model of the sedimentary cover of Lublin basin (pre-Cambrian to Quaternary, 5 km deep parametric grid model).

Geological 3D model of Poland (major chronostratigraphic surfaces).

Geological 3D model of Warsaw subsurface.

Several models of salt structures.

Several models for CCS screening.

Several models for Hot Dry Rock geothermal screening.

Infrastructure and technical equipment:

Hardware: PGI modellers use Lenovo ThinkStations P910, each with 2x multicore intel xenon server processor, 128 GB RAM, PCI-E SSD type m2 disc + 2x HDD 3 TB 3,5, NVIDIA Quadro M6000 graphics (12 GB GDDR5, NVIDIA CUDA® Cores 3072, DirectX 12.0)

Software: PGI modellers use major oil and gas modeling software (Petrel, Gocad, VPmg) and various GIS software. Model visualization software are in-house developed Geo3Ddesktop and Geo3Dweb viewers (http://webcad.pgi.gov.pl/geo3d/pl/node/39).

Name of organisation	Instituto Geológico y Minero de España		
Participant Number/Short Name	10 / IGME	Country	Spain

Brief description of the legal entity

The Geological Survey of Spain (IGME) is a Public Research Organization founded in 1849 and is the main Earth Sciences Research Centre of Spain. It may advise Government administrations on geology, environment, hydrogeology, mineral resources, natural hazards and land use planning. IGME has strong cooperation links with Latin American Geological surveys. IGME has an overall staff of 400 people, 185 graduated and its activities encompasses (relevant to this project); Subsurface Geology and CO2 geological storage, Geoscientific Information Systems, Geophysics and Remote Sensing

Relevant projects During the past few years IGME has participated in 9 H2020 projects, one JPI Cultural Heritage, 6 EU contracts (DG Mar, DG GROW, DG DEVCO, DG ENERGY and DG ECHO), in the management committee of two COST actions, in the KIC of Raw Materials and an ERANET. In addition to the PLANAGEO contract in Angola and projects in Latin America (Dominican Republic, Colombia, Argentina, etc.). In the field of Geoenergy, somre relevant participations include: M4ShaleGas: "Measuring, monitoring, mitigating managing the environmental impact of shale gas". H2020. ENOS_ ENabling Onshore CO2 Storage in Europe. H2020. ESTMAP. DG Energy. EUOGA Geological evaluation of potential unconventional oil and gas resources in Europe. DG Energy. COST Action ES1405: Marine gas hydrate – an indigenous resource of natural gas for Europe (MIGRATE). IGME is member of the Spanish Technological Platform on CO2 www.pteco2.es and Spanish technological platform on Geothermal energy, GEOPLAT, www.geoplat.org .

Dr. Emilio L. Pueyo (male) **- WP6 Lead -** Permanent Researcher of the IGME since 2008 has published around 300 scientific contributions (65 of them in indexed journals). He has been Principal Investigator of 12 research projects (5 of them from the Spanish National Plan, 2 from the EU INTERREG III program, one TNA from the EPOS project [H2020], etc.) he has also advised 5 PhD [+ 1 ongoing] and 5 MSc projects. Tectonics, Structural Geology, Palaeomagnetism, Geophysical surveying. During the past 12 years he has been involved in numerous projects integrating structural geology, gravimetrics and magnetometrics and focused on 3D modeling (Pyrenees, Iberian Range). He, and his collaborators, have developed novel 3D restitution solutions involving paleomagnetic vectors and also a new method for fully 3D/4D control deformation patterns in analogue models (including sand boxes), which in turns represents a validation technique of subsurface reconstruction and restoration methods.

Five recent relevant publications:

Calvin, P.; Santolaria, P.; Casas, A.M.; Pueyo, E.L. (2017). Detachment fold vs. ramp anticline: A gravity survey in the southern Pyrenean front (External Sierras). Geological Journal. doi:10.1002/gj.2884

Pueyo E.L.; et al. (2016). Petrophysical properties in the Iberian Range and surrounding areas (NE Spain): 1-density. Journal of Maps, 12 (5), 836-844. doi:10.1080/17445647.2015.1084545

Ramón M.J.; Briz J. L.; Pueyo E.L.; Fernandez O. (2016). Horizon restoration by best-fitting finite element and rotation constraints: sensitivity of the meshes geometry and pin-element location. Mathematical Geosciences, 48 (4), 419-437. doi: 10.1007/s11004-015-9602-1

Ramón M.J.; Pueyo E. L.; Caumon G.; Briz J. L. (2016). Parametric unfolding of flexural folds using paleomagnetic vectors. Geological Society of London Special Publication 425 on Palaeomagnetism in Fold and Thrust Belts: New Perspectives Edited by Pueyo, E.L.; Cifelli, F.; Sussman, A.J.; Oliva-Urcia, B. 247-258. doi: 10.1144/SP425.6

Pueyo, E. L.; Oliva-Urcia, B.; Sussman, A.J.; Cifelli, F. (2016). Palaeomagnetism in Fold and Thrust Belts: Use with caution. Geological Society of London Special Publication on Palaeomagnetism in Fold and Thrust Belts: New Perspectives. Edited by Pueyo, E.L.; Cifelli, F.; Sussman, A.; Oliva-Urcia, B., 425 (1), 259-276. doi:/10.1144/SP425.14

Five recent relevant projects as Principal Investigator.

2017- Truly 4D control of analogue models under the CT scan using high X-Ray absorption materials. Financed by: Transnational Access Grant of the Earth Plate Observing System Project (EPOS)- WP16- Multi-scale laboratories (EU-H2020) **EPOS-TNA-MSL-2017-006**. Participants: IGME, Utrecht Univertiteit, GFZ Potsdam, Univ. Zaragoza, HUMS (Salud Aragon).

2015-2018- Detachment folds and diapirs; recognition, reconstruction, restoration advanced methodologies (DR3AM). **CGL2014-54118-C2-2-R.** RETOS Program Spanish Science National Plan I+D+I Participants: IGME, Universities of Zaragoza, Barcelona, Hospital “Royo Villanova” (Salud Aragon).

2010-2013- Consistent 3D restoration in complex structures by using structural and paleomagnetic 3D references (Pmag3DRest) **CGL2009-14214-BTE**. Coordinated in the frame of the project “Assessing the validity of 3D restoration methods: 3D structural reconstruction, paleomagnetism and analog modeling applied to evaluate complex structures and potential CO_2 reservoirs” (MR: E.L. Pueyo). Spanish Science National Plan I+D+I Participants: IGME, Universities of Zaragoza, Barcelona, Lehigh, Hospital “Royo Villanova” (Salud Aragon), ICT “Jaume Almera” (CSIC), BP exploration.

2009-2011- 3D Restoration of complex deformed surfaces: Validation of methods for subsurface reconstruction from CT simulations and natural examples of South Pyrenean front (3DR3)- Ref: **PI165/09**. Financed by: Aragonian Government Research Plan. Participants: IGME, Universities of Zaragoza, Barcelona, Lehigh (PA-USA), “Royo Villanova” Hospital (Salud Aragon), IES “Jaume Almera” (CSIC), BP, SAMCA, Gessal, CGS, Midland Valley Exploration, Endesa Generación

2009-2010- Subsurface geology project for the assessment of suitable areas and structures for geological storage in Spain (**ALGECO2**): Subproject: Pyrenees and Ebro Basin. Financed by: Geological Survey of Spain (MICINN)- Institute for the Restructuring of Coal Mining and Alternative Development of Mining Regions (MITT). Participants: IGME, Gessal, UZ, UB, EHU.

IGME Team

The human team presented in this project represents the merging of geophysicists (more than 30 years of experience) and structural geologists (>20 years) was formed more than 11 years ago and has tackled together several projects from the Spanish National Science Program on 3D reconstruction of potential CO2 reservoirs, salt structures, etc. Their skills include structural analysis, geological mapping, geophysics (seismic processing and interpretation, gravimetrics, geomagnetics), 3D reconstruction, geographic and geophysical information systems, digital processing of geo-scientific information and programming in several computer languages etc. Therefore, the project staff form by 15 researchers (and 2 geophysics technicians) is perfectly competent and has the know-how and skills to obtain success in this quest (endorsed for more than 50 SCI papers during the last 10 years and numerous technical reports).

Dr. Conxi Ayala (female): Geophysicist. Permanent researcher at IGME. 2.5D and 3D potential field modeling of the crustal and lithospheric structure of the Earth with special focus on collisional orogens and sedimentary basins. High resolution studies of the structure and physical properties of the upper crust in 2D and 3D, including the petrophysical characterization of the basement and the distribution of the physical properties on the sedimentary cover using several interpretation techniques (e. g. Euler deconvolution, gradient maps, lineament maps, etc.) and join gravity and magnetic modeling with the constraints of the available geological and geophysical information (refraction and reflection seismics, drillholes, etc.).

Dr. Carmen Rey-Moral (female): Geophysicist. Permanent researcher in the Geophysics Area of IGME my work involves acquisition, processing and interpretation of geophysical data (mainly gravity, magnetic and radiometric). I am also skilled in petrophysics, 2+1/2D geophysical modeling and 3D geological modeling (one of the main tasks of this project). My work has been developed in Spain, Dominican Republic and Angola.

Dr. Carlos Marin Lechado (male): Structural Geologists. Geomodeller. Permanent researcher at the Subsurface Geology and Geological Storage Department of the IGME. His main research interests are focused on the characterization of reservoirs (hydrocarbons, CO2, deep aquifers, etc) through 3D geological modeling. His recent contributions are related with the integration of surface cartographic data, geophysics and well data in 3D geological models. He has participated in 30 international papers and has participated in more than 50 contributions at international congresses.

Dr. Pilar Clariana (female): Structural Geologists. Geological mapping. I have developed my professional career in the field of geological mapping and especially in structural geology in the framework of different research and geological mapping projects. I have worked in the Andes and in the Pyrenees (mainly in the Axial Zone) where I did my PhD. This background can contribute to this project in which mapping review and structural analyses of the basement and cover units are proposed.

Dr. Félix Manuel Rubio Sánchez-Aguililla (male): Geophysicist. Mining Engineer with more than 30 years of experience in Geophysical prospecting. At present Head of the Geophysics and Remote sensing division of IGME. Expertise in data acquisition, processing, interpretation and 2D/3D modeling of potential field data. Geophysics team leader of technical/research projects that involved geophysical studies of potential structures used as geological storage sites. Also the use of microgravimetry as a monitoring tool in CO2 injection.

Juliana Martín León (female): Design and management of GIS projects and Geoprocessing. Geophysical Databases: Design and development of data loading processes. Compilation, revision a validation of geophysical information.

Dr. José Luis García Lobón (male): Associated Head of the Department. Specialist in Geophysics (gravimetrics, magnetometrics, EM, etc.) Expert in airborne geophysical survey design and interpretation. He has carried out investigations on petrophysical properties of rocks and integrated interpretation of aeromagnetic and gravity data. He was the Director-Coordinator of the Spanish Plan for Screening, selection and characterization of CO2 Storage sites, and other research activities on CO2 storage (ALGECO2) carried out by the Geological Survey of Spain (Instituto Geológico y Minero de España, IGME). He has also participated in numerous national and international research projects in Spain and Republica Dominicana: IBERSEIS, BREOGHAM, ZEEE, PLANAGEO (Angola) and more recently in the TOPOIBERIA consolider project as well as in the SIGEOF project. Has conducted several geophysical explorations. He has advised 10 formation fellowships in the IGME and IJA (CSIC) institutions.

Dr. Javier Navas Madrazo (male): Geophysicist (1981) and PhD in Mining Engineering (1990) with more than 25 years of experience in geophysical development projects. Main responsible in the generation of information systems and institutional databases in the Spanish geological service (IGME) related to geophysical data and geological cartography. Researcher responsible for the generation of magnetic and radiometric geophysical cartography.

Dr. Ruth Soto Marín (female): Structural Geologist. She has worked on structural geology using surface and subsurface data , analogue modeling, analyisis of magnetic and petro- fabrics and paleomagnetism techniques to solve tectonic problems . She has focused on the study of oblique structures in thrust-belts, the reconstruction of the extensional geometry of inverted sedimentary basins and salt tectonics in inverted scenarios. Her scientific career will contribute in the project taking into account her experience in the study of surface and subsurface data of thrust-belts and kinematic analysis of structures.

Dr. Pedro I. Ibarra Torre (male): Mining Engineer with 20 years of experience in Applied Geophysics. Wide experience in data acquisiction, processing and interpretation in several methodolgies as electrical and different electromagnetic prospecting, seismics and magnetics, applied in different areas as Deep research, Geological storage, Mining exploration, Hydrogeology and Geotechnics. Involvement in technical/research projects that include geophysical studies of potential structures used as geological storage sites.

Agustín González Duran (male) and **José Maria Llorente Delgado** (male): Geophysical technicians both with more than 30 years of experience in geophysical data acquisition (electrical, magnetic, seismic and gravimetric methods) and GPS system measurements. They have been involved in numerous National and International Projects carried out by the IGME.

Dr. Fernando Bohoyo Muñoz (male): Head of the Subsurface Geology and Geological Storage division of the IGME carries out his research from 1999 in the field of Tectonics, Geophysical Prospection and Marine Geology mainly in the Scotia Arc (Antarctica), Iberian Margin and the Betic Cordilleras. He has participated on 22 I+D+I National and European projects (leaded 3 of them), 34 SCI articles, 7 chapters in international peer-reviewed books.

Name of organisation	State Research and Development Enterprise State Information Geological Fund of Ukraine		
Participant Number/Short Name	11/ GEOINFORM	Country	Ukraine

Brief description of the legal entity

The State Research and Development Enterprise "State Informational Geological Fund of Ukraine" – SRDE “GeoInform of Ukraine”, or GeoInform, is the specialized research and development unit of the State Geological and Subsurface Survey of Ukraine which collects, stores, analyzes and provides information received from geological study and use of subsurface.

GIU conducts research work on monitoring of mineral resources of Ukraine on the basis of geological and mining activities during the year, recording deposits and making public the balance of mineral resources management of the State fund of deposits and occurrences (more than 10,000 objects recorded), synthesis and analysis of exploration for oil and gas, creating a system of state accounting of oil and gas wells, completion and maintenance of the State cadastre of mineral deposits and occurrences as well as State cadastre of groundwater deposits of Ukraine.

Description of persons designated for 3DGEO-EU implementation:

Dr. hab. Boris Malyuk (Male), Director for International Cooperation, graduated in 1981 from Department of Geology, Lviv University, Ukraine, and in 1999 from Centre of Geostatistics, Ecole des Mines de Paris, France. Obtained Candidate of Science (PhD) Degree in Geotectonics in 1984, and extended Doctor of Science Degree in Petrology in 1991. National Delegate of Ukraine to the EuroGeoSurveys.

Sergii Prymushko (Male), Director, with basic IT-background, has more than 30 years experience in management of geological information, including partitioned database systems.

Volodymyr Velychko (Male), Chief Engineer, at his position is responsible for hardware and software facilities and database development having basic IT-background. In the Project he will contribute to geoscientific data systems.

Dr. Igor Melnyk (Male), Deputy Director, Center for International Cooperation, with basic background in geology, has an experience in field works and research in geochemistry, hydrogeology and ecology (PhD in 1996), as well as geoinformatics and GIS applications.

Tetiana Biloshapska (Female), Chief Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1980. She is experienced in field works. She had studied mineral-resource base of Ukraine for more than 30 years, took part and led projects on prospecting and exploration of mineral deposits, conducted regional geological studies.

Galyna Polunina (Female). Leading Geologist. Graduated from Tyumen Industrial Institute under specialty 'Geology and Exploration of Oil and Gas Deposits' in 1975. She is working out with hydrocarbon deposits and oil and gas resources inventory of Ukraine for more than 40 years.

Larysa Ovdienko (Female). Leading Geologist. Graduated from Kyiv National University under specialty 'Hydrogeology' in 2004. She is experienced in operating activities from 'Ukrnafta' Joint-Stock Company, she worked out with oil and gas well water inflow, environmental problems of oil and gas industry.

Ivanna Pelykhovych (Female). Leading Geologist. Graduated from Ivano-Frankivsk State Technical University of Oil and Gas under specialty 'Geophysics' in 2001. She is experienced for more than 15 years in field geophysical surveys (seismic, well studies), their results interpretation and integration of results from exploration works for oil and gas in Ukraine.

Tamara Bardygola (Female). Interpreter, Center for International Cooperation. Graduated from Department of Mechanics and Mathematics, Kyiv University in 1988, under specialty "Mechanics of solid medium".

Publications:

Interactive map of mineral deposits of Ukraine (in Ukrainian):

http://geoinf.kiev.ua/wp/interaktyvna-karta-rodovyshch-korysnykh-kopalyn.htm

Interactive map of mineral licenses (in Ukrainian):

http://geoinf.kiev.ua/wp/interaktyvni-karty-spetsdozvoliv.htm

Interactive geological map of Ukraine 1:1 000 000 (in Ukrainian):

http://geoinf.kiev.ua/wp/Interaktyvna-heolohichna-karta-Ukrayiny.htm

Interactive geological map of Ukraine 1:1 000 000 (in English):

http://geoinf.kiev.ua/wp/Interactive-Geological-Map-of-Ukraine.htm

Interactive State Geological Map of Ukraine 1:200 000 (in Ukrainian with English entries):

http://geoinf.kiev.ua/wp/kartograma.htm

Projects and research programme(s)

- ESTMAP - EU
- EUOGA - EU
- NUMIRE – Norway-Ukraine (NGU/SGSSU)
- EIMIDA – Norway-Ukraine (NGU/Geoinform)

5 Ethics and Security (This section is not covered by the page limit)

5.1 Ethics

Have you completed an ethics self-assessment? (See “How to complete your ethics self-assessment”)

NO

The project proposal has been checked against the ethics sections in “H2020 Guidance — How to complete your ethics self-assessment: V5.2 – 12.07.2016”. This check did not raise any issues.

(If YES, upload this as an additional document in ISAAC under the tab *Attachments* – Other)

5.2 Security

Please indicate if your project will involve:

- Activities or results raising security issues: NO
- 'EU-classified information' as background or results: NO

(See for guidance this document)

5.2 GARAH

Geological Analysis and Resource Assessment of selected Hydrocarbon systems (GARAH)

Abstract
A harmonized, scientific based, geological analysis and assessment conventional and unconventional hydrocarbon resources will help member states to continue the transition to lower Carbon energy sources. This will contribute to climate commitments, and allow the planning for secure sources of affordable energy. The analysis and assessment of hydrocarbons will focus on two areas:

(i) in Europe’s major petroleum province – the North Sea a “Geological analysis and resource assessment of North Sea petroleum systems”,
This research includes the assessment of conventional and unconventional oil and gas resources in the most important hydrocarbon basin in Europe. This will enable the remaining resource to be better understood and managed, and identify options for multiple and alternative uses of the subsurface as producing fields come off-line.

(ii) with a pan-European view, “Hydrate assessment in the European continental margin and related risks”.
The assessment of gas-hydrates resources in the European continental margin represents an information gap of pan-European interest. This will improve the understanding of the potential role that gas-hydrates may play in the future EU energy mix, as it will constitute a base-line for future projects pertaining the improvement of the European model of the GHSZ, related hazards and potential for geological storage of CO_2.

A catalogue evaluating the multiple-use of hydrocarbon reservoirs, as integrated or alternative use of the subsurface, together with an appraisal on risks and safety, will be produced.

This study will provide and disseminate all the analytical data generated to a common EGDI database.

Please indicate the SRT
GeoEnergy – GE1-Fossil energy, energy security and climate action

List of participants

#	Participant Legal Name	Institution	Country
1	Geological Survey of Denmark and Greenland [Project Coordinator]	GEUS	Denmark
2	Instituto Geológico y Minero de España	IGME	Spain
3	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek	TNO	Netherlands
4	Bureau de Recherches Géologiques et Minières	BRGM	France
5	Bundesanstalt für Geowissenschaften und Rohstoffe	BGR	Germany
6	Natural Environment Research Council (British Geological Survey)	NERC (BGS)	United Kingdom

7	State Research and Development Enterprise State Information Geological Fund of Ukraine	GEOINFORM	Ukraine
8	Norwegian Petroleum Directorate	NPD (external partner)	Norway

1 Excellence

GeoEnergy – GE1-Fossil energy, energy security and climate action

The proportion of fossil fuels in the primary energy mix in many European member states is gradually declining. Nevertheless, crude oil and natural gas are expected to comprise a major, if not the largest, part in the European primary energy mix in the coming decades. During the transition period, they remain indispensable for the security of energy supply and also as feedstock for a multitude of industrial processes. Production in many hydrocarbon fields in the EU, however, is declining rapidly, which jeopardizes the security of energy supply and this may even hamper the transition to renewables itself.; there is therefore a requirement from many member state Governments to stimulate new areas of exploration in order to maintain a security of supply, and affordable energy for society, and enable a well-planned progression to a lower-carbon energy economy. Natural gas represents a lower carbon fossil fuel than oil or coal, and is a highly flexible resource to assist/help the transition to a low-carbon Europe.

To ensure aid a climate and environmental viable planned transition to lower-carbon/ renewable energy, the European Union has an obligation to demonstrate a reasonable and viable approach forward, with key information required including an independent and consistent appraisal of hydrocarbons, and options for optimal use of the subsurface, and thus secure this objective. This GARAH project demonstrates how these objectives can be achieved via four distinctive linked work sets:

1. A harmonized assessment of the main HC resources in Europe,
2. The utilization and risk assessment of Gas Hydrates - the most novel unconventional HC,
3. Evaluation of the multiple-use potential and impacts of hydrocarbon reservoirs, and climate neutral production methods,
4. Provide and disseminate the outcomes to a common EGDI database.

Aims and objectives
The overall goal for the GARAH study is to produce an independent, scientific based, harmonized, geological analysis and assessment of the conventional and unconventional hydrocarbon resources (microbial gas and thermogenic oil and gas) of the most important petroleum systems in Europe.

The study will focus on North Sea petroleum systems, which will improve the understanding of hydrocarbon resources, as well as our understanding of how to assess these resources. Focus is on the North Sea because it is the most prolific HC basin in Europe, where many of the conventional fields are in the decline. The countries around the North Sea are utilizing different technology solutions and different exploitation methodologies, where they can share experience with each other. For example, main production from the UK comes from clastic reservoirs and HP/HT fields, while they are under-explored in the Cretaceous Chalks. Denmark has vast experience in developing Chalk fields, but being new to HP/HT technology. The objective is to identify new under explored resources for future development, and to address knowledge gaps for unconventional resources. The results will feed into planning and policy activities for future exploration strategies. Furthermore, we will generate a consistent regional, characterization and evaluation of HC potential and exploration-risk offshore Europe. It will produce an updated harmonized resource and reserve estimation for HC sources according to international classifications.

The study will evaluate and generate a catalogue of the multiple-use (or sequential-use) potential and impacts of hydrocarbon reservoirs, including contribution to effective closure and connection to storage (including CO_2), maximizing enhanced hydrocarbons recovery, and thereby maximize the exploitation of HC. By utilizing the infra structure and the potential of associated geothermal-shale and or depleted reservoir schemes could enable the possibility of a climate neutral HC production.

A consistent method and data processing will allow for a basin wide estimate of the size and characteristic of resources, in the form of an internally consistent database, GIS map layers and a dictionary of terms.

The GARAH study will also look into the potential for gas hydrates offshore Europe, which may represent a large energy resource for future exploitation. Recently international drilling projects have demonstrated significant resource potential, e.g. offshore USA and Japan. The study will develop a harmonized model for the pan-European hydrate data infrastructure storing hydrate evidences (both direct and indirect), oceanographic variables e.g. seafloor temperature, heat flow data, bathymetry, sedimentation rates, and Gas Hydrates Stability Zones (GHSZ) thickness.

Gas hydrate information gaps and areas potentially affected by gas hydrate stability will be examined for the impacts on e.g. subsea infrastructure, and the potential links with geohazards will be identified. It also will provide recommendations on how future data should be collected and stored to be fully interoperable. This will constitute a base-line for future projects related to improving the European model of the gas hydrate stability zone (GHSZ), assess potential geohazards and risks, assess the abundance of sediment-hosted gas hydrates, and evaluate the role of CO_2-rich hydrates for the geological storage of CO_2.

All data from the GARAH project will be accessible in a common EGDI compliant database, which will enable incorporation, maintenance and dissemination of outcomes, for future scientific research, commercial activities, and planning policies in Europe.

Relation to existing programmes and projects

The European Unconventional Oil and Gas Assessment study (EUOGA) has generated a comprehensive database and a uniform resource assessment of the onshore pan-European shales. The same data collection and assessment methods will be utilized in the WP2 North Sea unconventional and conventional assessments. CO2StoP, UK CO2 Stored, Estmap and NORDICCS are projects that will be incorporated in the alternative usage and hazards project (Task 2E).

(i) Schovsbo, N.H., Doornenbal, H., Nelskamp, S., Pedersen, C.B., Tougaard, L., Zijp, M., Anthonsen, K.L., 2017: Review of results and recommendations. Delivery T8 of the EUOGA study (EU Unconventional Oil and Gas Assessment) commissioned by JRC-IET.
(ii) Poulsen, N.E., Holloway, S., Neele, F., Smith, N., and Kirk, K., 2014: CO2StoP Final Report. Project title: Assessment of CO2 storage potential in Europe. European Commission Contract No ENER/C1/154-2011-SI2.611598. 61 pp.
(iii) UK CO_2Stored online database map view (hosted and developed by the British Geological Survey and the Crown Estate)
(iv) NORDICCS: Total Nordic CO_2 storage capacity mapped until 2015: The Nordic CO_2 storage atlas has been produced with support from the NORDICCS Centre, performed under the Top-level Research Initiative CO_2 Capture and Storage program, and Nordic Innovation.
(v) ESTMAP: The ESTMAP project investigates the distributed potential to deploy energy storage (2015-2016). Online viewer: http://tno.maps.arcgis.com/apps/webappviewer/index.html?id=937305e2273847e0bc16503990f79d77

The hydrate study (WP3) will build on the data from the current MIGRATE (Marine gas hydrate - an indigenous resource of natural gas for Europe) COST action programme. There are several completed and ongoing projects, which will provide contributory information, including:

(i) Multi-disciplinary Comparison of Fluid Venting from Gas Hydrate Systems on the Mediterranean and Brazilian Continental Margins over Glacial-Interglacial Timescales (Project ID 656821; 2016-2019)
(ii) MIDAS: Managing Impacts of Deep-seA reSource exploitation (deep sea instability in the Black Sea and Svalbard Margin (ENV.2013.6.2-8; 2013-2016)
(iii) ANAXIMANDER: Study of gas hydrates under laboratory conditions (EVK3-CT-2002-00068; 2010)
(iv) HYDRAMED: Geological Assessment of Gas Hydrates in the Mediterranean Sea (Project ID 501814; 2004-2006)
(v) HYDRATECH: Techniques for the quantification of Methane Hydrates in European Continental Margins (EVK3-CT-2000-00043; 2001-2004).

1.1 Concept and methodology

The overall concept of GARAH is to collate an independent, scientific based, geological analysis and consistent assessment of the conventional and unconventional hydrocarbon resources in two categories:

- Geological analysis and resource assessment of North Sea petroleum systems
- Hydrate assessment in the European continental margin

Geological analysis and resource assessment of North Sea petroleum systems

This topic will improve the understanding of hydrocarbon resources in the EU. These include conventional oil and gas, in the most prolific basin in Europe e.g. the North Sea Basin. A consistent method and data processing will allow for a basin wide estimate of the size and characteristic of resources (and comparison between geographic areas), in the form of an internally consistent database, GIS map layers and a dictionary of terms. This will enable the hydrocarbon resources associated with these highly variable systems to be better understood and managed, partly by the appraisal and collation of information describing mature hydrocarbon fields, novel accumulations in frontier settings (e.g., Faroe-Shetland area; basement-hosted resources), and accumulations previously considered uneconomic (e.g., smaller volume reservoirs). There are also linkages to the development of storage (CO_2, CO_2-EOR, geothermal and energy carriers) and storage potential.

The GARAH study will describe and evaluate the various petroleum systems in the North Sea basin, which will improve the regional, cross boundary, geological knowledge, and resources estimates of conventional and unconventional petroleum systems, in terms of new hydrocarbon resource maps and tectonostratigraphic synthesis. The study will incorporate partner’s local knowledge and data, as well as publicly available but thus far uncollated information, with an associated publicly available database of un-interpreted and interpreted source data and dictionary of relevant terms. The source rock potential, re-evaluation of brown fields, mature fields, frontier plays will be appraised, and under-explored areas will be de-risked. This will enable the hydrocarbon resource associated with these highly variable systems to be better understood and managed, partly by the appraisal and collation of information describing mature hydrocarbon fields, novel accumulations in frontier settings, and accumulations previously considered uneconomic.

The assessment method utilized in the newly finalized EUOGA project will be the basis for the basin wide assessment, ensuring a coherent and harmonized HC resource assessment comparable to the pan-European shale gas and shale oil assessment.

In addition, a 3D basin model will be developed and used as a pilot study focused in the Danish, German, and Dutch Central Graben area, demonstrating the advantages and diminished uncertainties in areas with 3D modelling opportunities.

Hydrate assessment in the European continental margin

The GARAH study will identify knowledge gaps in the potential use hydrate resources in the European continental margin. This will improve the current state of knowledge on gas hydrates within the European continental margins, and will include both direct and indirect evidence for hydrate occurrence. In addition, the hydrate related oceanographic variables (i.e. geothermal gradient, seafloor temperature, etc.) and existing GHSZ thickness assessments will be collated.

Aided by GIS methods we will harmonize the existing hydrate related data in order to address these gaps. The proposed data infrastructure will improve the understanding of the role of hydrates in the EU, and it will provide a baseline for future projects pertaining to the improvement of the European model of the GHSZ, related risks, and geological storage of CO_2.

The outcomes of both of these activities will feed into an appreciation of opportunities for alternative or multiple uses of the subsurface, in some areas of declining exploration activity. These may include the opportunity for enhanced gas production allied with CO_2 capture from methane hydrates, or the potential for tapping the geothermal resource using hydrocarbon production infrastructure.

1.2 Ambition

It is the ambition of this project to generate a harmonized resource assessment of the conventional and unconventional HC of the North Sea, comparable with the results from the EUOGA project. The collation of cross-border data and homogenization of resource estimates are key issues for the succeeding the assessment.

Each geological survey has its own different databases, study approaches, software, routines, etc., which require bringing into a common consistent format, key factors will be detailed in the EGDI database.

The GARAH project will focus on furthering knowledge on key parameters for the exploitation of unconventional hydrocarbons that have been identified in the EUOGA project. Some of the most important are TOC%, HI, maturation, thickness, burial depth and history, porosity and permeability, mineralogy, and brittleness. For the conventional assessment of clastic as well as carbonate reservoirs, the targeted key parameters are porosity and permeability, trap mechanism, net/gross sand, trap closure, temperature and pressure. Unifying the interpretation of these parameters as well as combining the information in one homogenized database will be the main development here. In carbonate reservoirs, additional focus will be on the porosity and permeability trends of the Cretaceous Chalk formation and its ability to imbibe water, which have proven to be key factors in hydrocarbon exploitation as well as the porosity and permeability system of the Dinantian carbonates.

In addition to the above-mentioned assessment of conventional and unconventional reservoirs, it is also the ambition to demonstrate the advantages of a 3D model assessment in a pilot study area in the Danish, German and Dutch Central Graben, utilizing available 3D seismic data, the large well database, and production history.

The GARAH project will furthermore strive to develop a harmonized model for the pan-European hydrate data infrastructure. Particularly, a harmonized pan-European hydrate related GIS-database will be set up where evidence for hydrates (both direct and indirect), oceanographic variables (seafloor temperature, heat flow data, bathymetry, sedimentation rates, etc.) and GHSZ thickness will be stored.

The results of the North Sea assessment and the Gas Hydrate study will feed into an assessment of hazards associated with effective closure of mature fields and other use of the subsurface, including multiple and alternative use of assets and infrastructure. Our mission is to generate a catalogue of these multiple-use (or sequential-use) potential and impacts of hydrocarbon reservoirs, enabling synergies between various uses and securing a sustainable development, whilst reducing overall climate impact of fossil fuel use. For example, utilizing the infra structure and the potential of associated geothermal-shale and or depleted reservoir schemes could enable the possibility of a climate neutral HC production.

Finally, it is the ambition to upload all new analytical information to a common EGDI database generated in the GeoERA-IP project, and manage all kinds of communication and data exchange between the project partners within the project as well as between the GARAH project and other GeoERA projects.

The consortium partners are aware of the fact that the road towards a fully comprehensive and mature knowledge base regarding hydrocarbon resource assessment, hazards and impacts is beyond the scope of the project. The project therefore aims to pave the way towards this comprehensive result and to facilitate the cooperation and communication between the project partners.

2 Impact

2.1 Expected impact

A variety of different evaluation methods have been employed to assess the hydrocarbon resource in different areas of the EU. Consistent evaluation methods and data processing on newly released and legacy data will help rationalize the resource estimates across the EU, allowing for improved planning for the exploration, development and closure of hydrocarbon reservoirs.

Technology improvements may result in resources previously considered uneconomic (e.g., shale gas and methane hydrates) to be considered viable exploration targets in areas with little exploration history. The identification of these areas and quantification of resource will contribute to the development of planning strategies for member states in terms of licensing and policy development.

A consistent estimation of hydrocarbon resource will be a first step in assessing and quantifying the hydrocarbon reserves in the main hydrocarbon basin in Europe.

The GARAH project idea will result in the identification of new potential areas for hydrocarbon exploration, directly addressing the requirement for identifying secure energy HC sources. This will give further information regarding basin development and evolution, and the HC resources will be systematically assessed. Outcomes will therefore feed into planning and policy (licensing of areas for exploration) by Member States, commercial exploration strategies and also highlight remaining knowledge gaps which may inform about further academic research or programmes of exploration sponsored by member states. The datasets generated will also highlight areas of potential risks associated with exploitation of fossil fuels and the closure of mature fields. Areas with the potential for multiple uses of the subsurface that may require the development of appropriate legislation or guidance will also be identified, therefore partially mitigating delays in bringing energy to market that are related to those issues.

The generated catalogue of the multiple-use (or sequential-use) potential and impacts of hydrocarbon reservoirs will enable the European community to improve efficient, sustainable, and foster climate friendly use of the subsurface.

Our mission is to generate a catalogue of the multiple-use, enabling synergies between various uses and securing a sustainable development, whilst reducing overall climate impact of fossil fuel use. For example, utilizing the infra structure and the potential of associated geothermal-shale and or depleted reservoir schemes could enable the possibility of a climate neutral HC production.

The identification of potential hydrate resources in the European margins and provide a unified database and maps detailing potential distribution of gas hydrates (energy source), potential geohazard areas. In addition, we will aim to identify zones could be used to store CO_2 as a hydrate (subsurface CO_2 storage resource) within the European offshore and onshore areas.

The results will foster the development of new HC technologies in Europe and will feed into planning, policy (licensing of areas for exploration) by Member States, and commercial exploration strategies.

By mapping zones of interest, there will be a contribution to marine spatial planning, including possible conflicts between deep hydrocarbon resources; gas storage (i.e. CO_2, Hydrogen) positioning and impacts of deep sea infrastructure; fishing activities and deep-sea habitats; national security issues. The GARAH project will contribute to the development of appropriate legislation and guidance (e.g., storage vs. production, preservation).

The outcomes of this project idea will inform EU Member States of potential frontier plays in a pan-EU perspective, allowing for the currently poorly understood offshore methane hydrate and shale gas/oil resource to be acknowledged in developing legislation and regulation.

2.2 *Measures to maximise impact*

The project will establish a Project Dissemination and Exploitation Plan (DEP) at the project start. This plan will specify and elaborate the concrete measures for achieving the impacts described above and fostering stakeholder engagement. Below the draft outlines of this plan are summarized:

- The project will be represented at the three obligatory GeoERA dissemination seminars that the Projects need to actively join: 1) Kick-off meeting, and 2) annual meetings.
- This proposal already includes several collaboration initiatives with other GeoERA projects. These intentions for collaboration and exchange of information will be formalized upon the successful evaluation and granting of these projects.
- The project will actively engage relevant stakeholders and end-users that are involved in the selected use cases for testing, demonstrating and implementing established methods and information systems.
- The project will engage with other research institutes that are active in the field of HC research and which could be potential clients for the methods and data developed. The concrete institutes will be specified in the final DEP.

2.2.1 Communication activities

As part of the Project Dissemination and Exploitation Plan (DEP), the project will undertake the following communication activities. These activities will be formalized in the final DEP:

- The project will select several forums, events and peer-reviewed journals in which the results and achievement will be published.
- The project will set-up a dedicated website in which the project goals, structure, deliverables and partners are presented to stakeholders.
- The project participates in several joint events and workshops with other GeoEnergy/GroundWater/Raw Minerals projects to present the FDB and project achievements.
- The project is open to requests from the GeoERA Executive Board and the EGS secretariat to publish news on the project proceedings and deliverables in newsletters and at special occasions.

Communication between relevant GeoERA projects will be set up

2.2.2 Communication flow between partners

At the start of the project, a shared workspace will be created to enable sharing of data, documents, and project information between all Partners. The shared workspace will thus perform an important function in the overall communication flow among participants, and be support work-package management (monitoring and reporting progress of activities). Furthermore, e-mail communication will be instrumental. The dedicated mailing lists will be extended and updated at the start of the project to enable efficient e-mail communication.

2.3 *Contribution of Project Proposal to the Information Platform or vice versa*

The GARAH project will extend the existing EGDI structure to enable incorporation, maintenance and dissemination of outcomes. An element of this project will be the identification of critical geological units that represent hydrocarbon reservoirs. Their distribution will be mapped along with principal geological faults that will define the spatial extent of these units. The project outcomes will be EGDI compliant, and this data structure will be used as a foundation for the new assessments, ensuring new data is both EDGI compliant and compatible with the all GeoERA dataset. These volumes will contribute to other proposed assessments, ensuring a common approach to resource assessments. The results will provide improved access to integrated information of hydrocarbon resources. This will contribute to improving the dialogue between policy domains and stakeholders to support subsurface spatial planning and decision making. It will feed into pan European infrastructure projects e.g. OneGeologyEurope, EuroGeoSource and EMODNet. It will improve the ability of GSOs to effectively define future actions on with regard to improving key knowledge on geoenergy, mineral resources and/or geohazard through provision of a sustainable and expandable spatial information framework. It will support environmental assessment; risk analysis; spatial planning; evaluation and resolution of conflict of usage through implementation of standardised access (including INSPIRE compliant web services).

3 Implementation

3.1 Work Plan – Work packages, deliverables

Figure 3.1 below explains the general concept of the work plan and the relationships between the work packages. More information about the work packages is provided in Tables 3.1a (detailed description) and Table 3.1b (summary). Table 3.1c provides a full overview of all deliverables from the project.

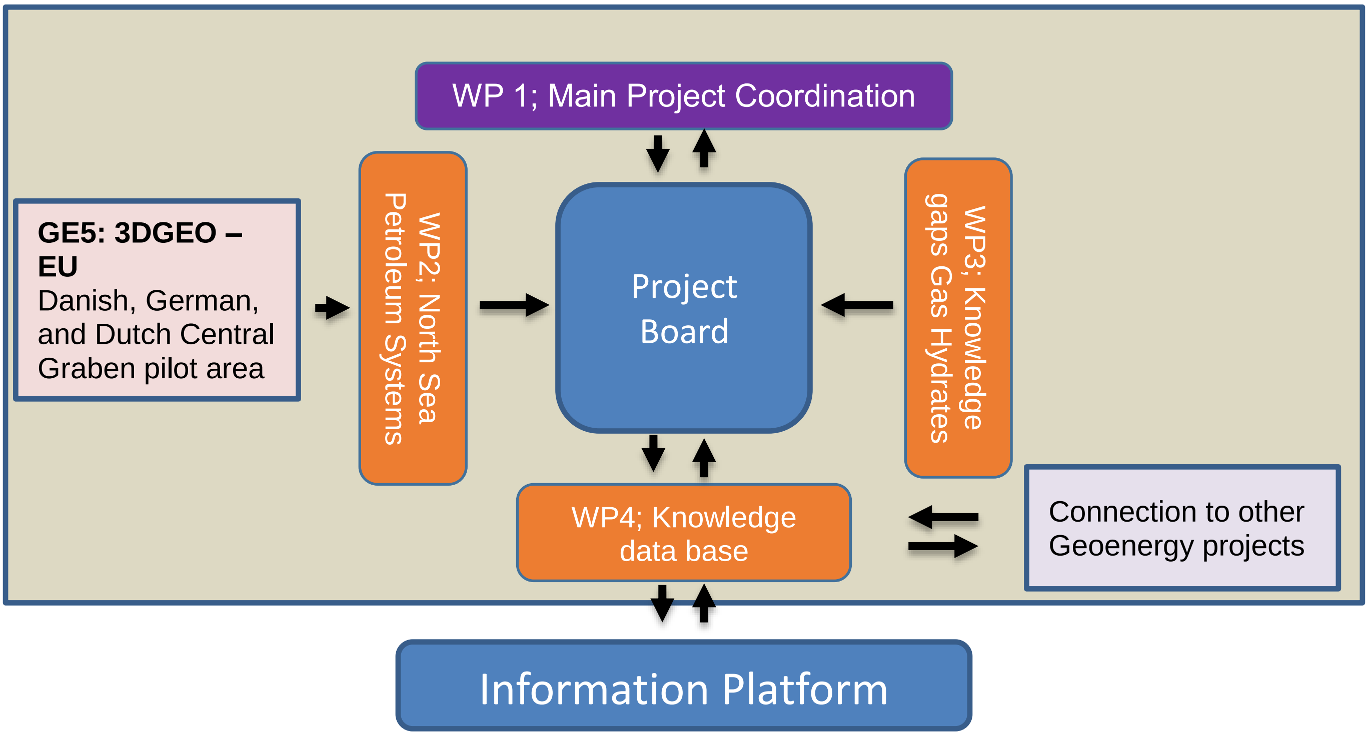

Figure 3.1: General concept of the work plan and the relationships between the work packages.

The GARAH work plan consists of four work packages.

WP1 (Project Coordination) governs the overall coordination and management of the project and carries the responsibility to ensure that all deliverables are achieved according to the agreed work plan. This includes among others the provision of obligatory monitoring and financial progress reports to the GeoERA Executive Board and the establishment of the Project Data Management Plan. WP 1 will furthermore coordinate the project representation at the mandatory GeoERA seminars (Kick-off Seminar, Mid-Term Seminar and the Final Seminar). The project Board will take care of out the day-to-day project governance and eventual decisions affecting the overall project.

WP2 (North Sea Petroleum Systems) will define the range of petroleum systems in the North Sea and populate a harmonized database detailing the oil and gas resource present in the UK, Dutch, German, Danish and Norwegian sectors. The work package will give a harmonized assessment of the conventional and unconventional using the methodology developed in the EUOGA project. The WP2 will also demonstrate the advantages of 3D model assessment in a pilot study area. This study area will be generated in the 3DGEO-EU project. This will feed into an assessment of hazard associated with effective closure of mature fields, including multiple and alternative use of assets and infrastructure (this will also cover the hazard associated with developing hydrates WP3).

WP3 (Addressing knowledge gaps in the hydrate assessment in the European continental) will develop a harmonized model for a pan-European gas hydrate data infrastructure. A GIS-database will be developed that includes key gas hydrate observations (both direct and indirect), relevant oceanographic variables (seafloor temperature, heat flow, bathymetry, sedimentation rates, etc.) and modelled hydrate stability thickness.

This work-package will identify the critical knowledge gaps and provide information on areas of interest for future joint projects. It will also provide recommendations on how future data should be collected and stored to be fully interoperable.

WP4 (Knowledge database): This work package will govern the interactions with the GeoERA-IP project and manage all kinds of communication and data exchange between the GARAH project and other GeoERA projects especially IP. Therefore, WP4 will develop and evaluate all requirements of GARAH WPs in dense accordance with the parts of the Project Data Management Plan relating to IP and EDGI to enable an efficient and consistent uptake and embedding of project results into the GeoERA-IP project.

Gantt Chart	**2018**		**2019**				**2020**				**2021**	
	Q3	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**
WP1												
Annual Project Meetings	X				X				X			X
WP Meetings (X), Skype (*)	X		*		X		*		X		*	
Board Meetings	X				X				X			X
Progress reporting			X				X				X	
Final report											Report	
Deliverables	D1.1	D1.2 D4.1	D1.3, D2.1 D3.1				D1.4	D2.4		D3.2, D4.2, D4.3	D1.5, D2.2, D2.3, D3.3	D1.6, D1.7, D2.6
Milestones	MS1	MS2, MS3			MS4			MS5	MS6	MS7	MS8, MS9, MS10, MS11	MS12, MS13, MS14, MS15
WP2												
Task 2A - DB	Harmonize DB		Report									
Task 2B- Petrol. System	Appraisal		Data collation and characterisation of PS								Report	
Task 2C - "EUOGA" assessments North Sea		Appraisal	Resource assessments								Report	
Task 2D - Pilot Study 3D assessment		Appraisal	Unconventional assessment				Report					
		Appraisal					Conventional assessment				Report	
Task 2E - Alternatives + Hazards	Appraisal								Generate Catalogue			Report
WP3												
Task 3A - Collection of data sources	Data collection and classification		Report									
Task 3B - Data Model structure and loading			Harmonize Gas Hydrates related DB						Input IP			
Task 3C - Results								Integration			Report	
WP4												
Task 4A - Requirements and standards	Synthesis	Report										
Task 4B - Online platform		Development										
Task 4C - Data implementation			Implementation					Prototyping		Report	Validation	Report
WP4 - Data input to IP (D4.5)			Data supply				Data supply		Data supply		Data supply	

Figure 3.2: Gantt Chart of the GARAH project. A detailed list of deliverables and milestones are found in Table 3.1c and Table 3.2a, respectively.

3.2 Management structure, milestones and procedures

The overall project management structure is presented in Figure 3.3 below. The project milestones are listed in Table 3.2a, and Table 3.2b provide details on the identified project risks and the proposed risk-mitigation measures.

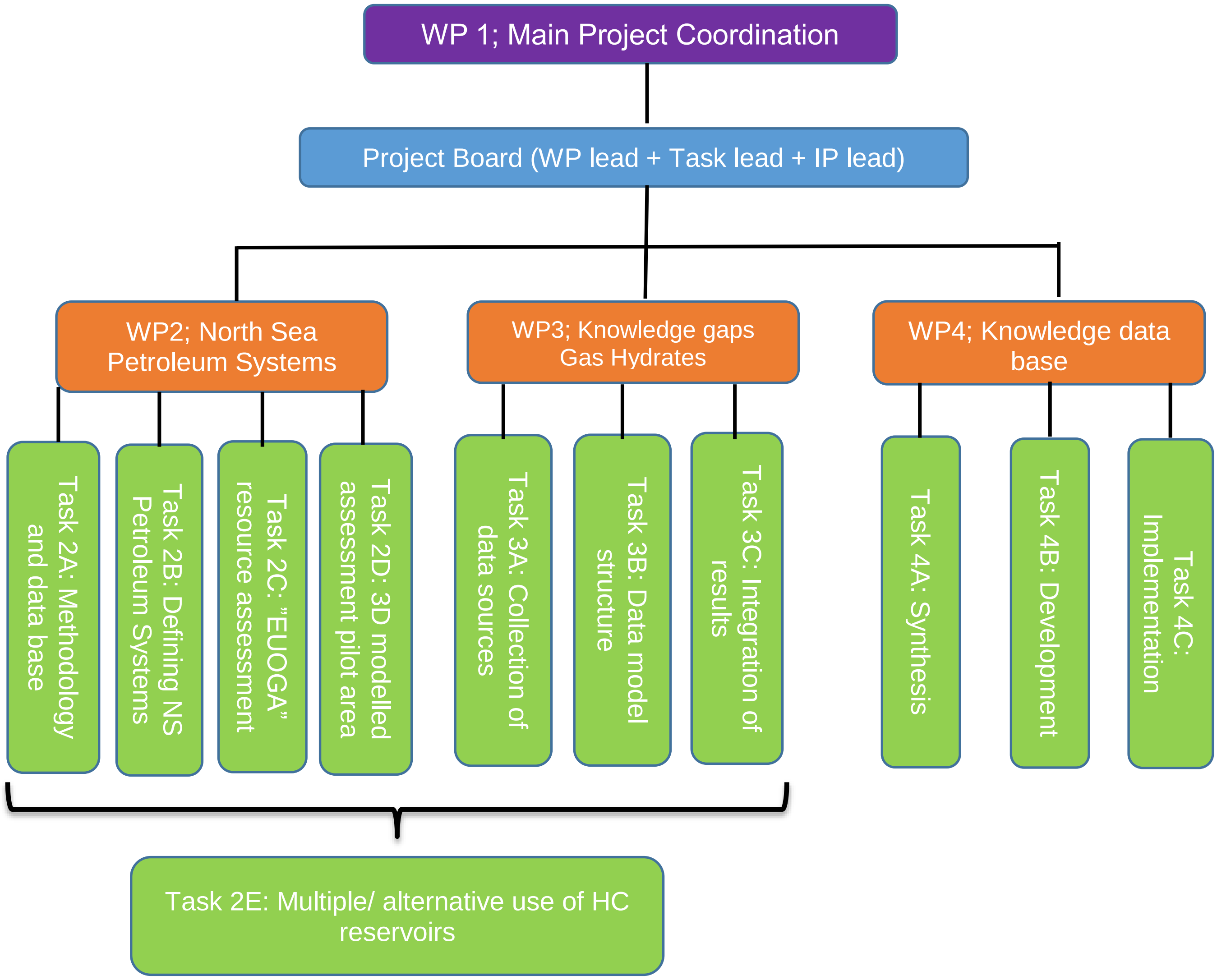

Figure 3.3: Overall project management structure

The project coordinator (WP-1) and work package and task leaders are responsible for the realization of the project milestones and effectively handling critical risks related to the project implementation. To that end the coordinator and work package leaders are organized in a Project Board that governs the day-to-day management and decision-making processes. Within the Work Packages additional task lead functions are assigned to the directly involved survey organizations.

GeoERA Executive Board and GeoERA Project Monitoring Officer: The project will ensure on-time and high-quality reporting to the Executive Board and the GeoERA Project Monitoring Officer. Reporting will follow a procedure that includes several verifications involving interactions among partners, the Project Board and the Coordinator. This method allows delivery of high quality reports providing a very accurate insight on the state of the project. Deliverables and milestones will follow an internal quality control procedure carried out by all partners represented in the project.

Internal reporting and communication: The Coordinator will put in place an internal reporting system to ensure the smooth, efficient and cost-effective implementation of the work plan. This reporting system will consist of templates for reporting on work package activities and related costs.

Internal communication, management of project progress and quality control: The progress of the project will be monitored by timeline-based regular reporting and meetings of the Project Board. The monitoring of the project at different levels is outlined below:

- The organizations/persons involved in the management of the WP's together form the Project Board and as such, they will work closely together on a daily basis. They will exchange information through a designated project share point, regular face-to-face and teleconference meetings and general communication means
- The project share point will also serve as the main platform for exchange of information with the other GeoERA participants.
- The Project Board will regularly (at least monthly) discuss the project progress.
- The WP Leaders will be responsible for reporting and managing any problems in their WP and discuss/solve these with the Task Leaders. Major problems will be discussed in (teleconference) meetings with the Coordinator (Project Board).
- Progress reports will be prepared by the participants of the WP's and assembled by the WP leaders.
- On basis of the progress reports, the Project Board will monitor progress of the project, identify major bottlenecks and find solutions for these problems.

Where needed, adaptations to the project plan will be made, with the aim to ensure the delivery of the project results as agreed with the GeoERA Executive Board. Major adaptations need to be approved by the Project Board. The progress reports will also form the basis for the Mid Term and Final reports for the GeoERA Executive Board and the GeoERA Project Monitoring Officer.

Internal quality & Risk assessment: The Project Board will closely follow up and control the progress of the project and the work done by each partner. Check lists (action database), will follow day-by-day partner contribution and interaction within the WPs in order to ensure project quality Risk assessment will make use of a classical and widely tested process for risk management, aimed at identifying, analysing and prioritizing risks inherent in the project (related to tasks, partners and projects) and then determining the appropriate actions to eliminate or mitigate them. Some likely critical risks have already been identified in the preparation of this proposal. These are listed in table 3.2b, together with proposed risk mitigation measures.

Conflict resolution: In case of conflict, the WP leaders will have first responsibility to find an amicable solution, if appropriate in consultation with the Coordinator. In case the conflict cannot be resolved, the WP leader will put the issue forward to the GeoERA Executive Board.

3.3 Consortium as a whole

The GARAH consortium consists of seven partner organizations and one external partner. The consortium is led by GEUS (Denmark).

The project partners and the two main research subjects cover different regions and geological settings in Europe. This way a comprehensive and representative overview with different sources and use cases is available to the project.

The partners in the project represent a good mix of organizations that are highly experienced in specific Hydro Carbon and Hydrate research and countries that are aiming to advance their experiences in these fields. The experienced partners have obtained most of their knowledge from practical national use cases and past collaborations in EU research projects. The exchange of knowledge and broader implementation of state-of-art data sets and methodologies is one of the main aims of the project.

The collaboration between all the key geological surveys and The Norwegian Petroleum Directorate (NPD) around the North Sea ensure the best possible database will be available for the project and that all analytical results are based on academic knowledge and documented experience at the highest level.

The experience with exploitation of hydrates is still in its research stage. The key European geological surveys with respect to Hydrates are partners in this consortium, with more than 30 years of experience in the field of the hydrate research and more than two hundred related scientific papers. Members of the Consortium are active members in the national and European gas hydrate related actions and projects such as CADHIS, GLOBANT, BIO-HYDRATES, GAS-HYDRATES, SUBVENT, or the EU Cost networks PERGAMON and MIGRATE. BRGM is founder member of the "GAS HYDRATES" Research Group (GDR) recently created by CNRS (French National Center for Scientific Research).

The hydrate related experience of the consortium is based on four main skills: (i) geochemistry-mineralogy, (ii) seismic, (iii) GIS-mapping and (iv) risk and hazard assessment, Thus the consortium brings together the necessary expertise and covers the entire value chain to reach the project's objectives. Moreover, this ensures a compact team, the transference of skills and the mutual learning process.

The established databases and methodologies will be tested and implemented in practical use cases involving various stakeholders. Through this approach the project aims to increase the exposure to end-users and to stay aligned with their needs.

The collaboration with other GeoERA project will further increase the exposure and highlight the broader cross-thematic interactions as described by the GeoERA Call for Proposals.

3.4 Resources to be committed

This section provides the details on resources committed to the project, according to the rules of H2020 and the GeoERA Grant Agreement.

Table 3.3a summarizes the total number of person months committed per partner in each of the work packages.

Table 3.3b provides an overview of all other direct costs (travel, equipment)

Table 3.3c lists the overview of the requested budget, divided over the project partners

Tables for section 3.1

Table 3.1a) Work package description (This table is **included** in the page limit!)

Please complete the table below for **each** work package:

Work package number	1	Lead beneficiary			GEUS	
Work package title	Main Project Coordination					
Participant number	1					
Short name of participant	GEUS					
Person months per participant	6					
Start month	M1			End month	M36	

Objectives

This Work Package addresses the overall financial, administrative and operational management of the project, especially the preparation and implementation of the work plan, the monitoring of project progress and the coordination of obligatory meetings and deliverables as defined by the GeoERA guidelines and Grant Agreement. Specific objectives of WP8 are:

- Daily management of the project (monitoring progress; communication among Work Packages, between partners and with the EC; financial management; reporting; decision making; conflict management)
- The organization of meetings and events (e.g. Kick-off Seminar, Mid-Term Seminar and the Final Seminar)
- Maintenance of the Consortium Agreement and ensuring ownership among the participants
- Risk management including IPR issues
- Interact with the GeoERA Executive Board

Description of work

Task 1A: Administrative & Operational Management (M1 – M36)

This task deals with activities as:

- Day-to-day monitoring of project progress
- Support decision making by the Project Board, and ensure implementation of decisions
- Coordinating the preparation of a project progress report, a final project progress report, and a synthesis report on the final project results.
- Risk management
- Maintenance of the Consortium Agreement

Task 1B: Project Data Management Plan (M1 – M6)

This task will prepare the Project Data Management Plan covering the data and results relevant for this project. The Plan will be in line with the requirements and guidelines described in GeoERA deliverable D1.3 – Data Management Plan.

Task 1C: Communication (M1 – M36)

Efficient communication between all project participants, the GeoERA Executive Board and to other GeoERA projects. A transparent internal communication system will be set up, supported by electronic means, e.g. web conference tools, exchange platforms, etc.)

Meetings
A Kick-off meeting will be arranged in month 1 with all participants. The meeting will provide essential information needed for the participants to deliver data as required in the guideline and data specification documents for GIS, geology and assessment. Yearly board and project meetings combined with ½ yearly WP meetings and monthly telecoms will ensure the process flow, and any delays and issues will be targeted and solved early in the process

Communication
As the main coordinator of the project GEUS will be in charge of the communication with GeoERA and all partners as well as coordination of communication and interdependencies between tasks. To ensure the progress, partners will communicate monthly via telecoms, email and dedicated cloud file sharing.

Quality and risk management
The quality of the maps and the assessment of the hydrocarbon resources heavily depend on the available data and the data quality for each basin assessed in this study. GEUS will ensure that these issues will be targeted at the workshops and in the communication with the NGS. Close communication between all partners will ensure that any delays can be targeted and solved early in the process.

External Communication
The GARAH will establish a web presence, and partners will participate in international meetings to disseminate the results of the project

Deliverables

D1.1 Dissemination and Exploitation Plan (DEP) (M3)
D1.2 Project Data Management Plan (M6)
D1.3 Annual progress reports 2018 (M8)
D1.4 Annual progress reports 2019 (M20)
D1.5 Annual progress reports 2020 (M32)
D1.6 Final Project report (M36)
D1.7 Project review with EU Stakeholders in a formal presentation (M36)

Work package number	2	Lead beneficiary			GEUS	
Work package title	North Sea Petroleum Systems					
Participant number	1	3	5	6	7	8
Short name of participant	GEUS	TNO	BGR	NERC (BGS)	GEOINFORM	NPD
Person months per participant	23	9.5	10	17	1.04	2
Start month	M1			End month	M34	

Objectives

To define the range of petroleum systems in the North Sea and populate a harmonized database detailing the oil and gas resource present in the UK, Dutch, German, Danish and Norwegian sectors. This will feed into an assessment of hazard associated with effective closure of mature fields, including multiple and alternative use of assets and infrastructure (this will also cover the hazard associated with developing hydrates from WP 3).

Description of work

In WP2 we will use and share existing data and knowledge from the WP-partners to define the North Sea petroleum systems and assess their resource potential. The work will be structured in 5 main tasks:

Task 2A: Methodology and data base

A joint evaluation of previous national work in the North Sea countries (national geological/ geophysical data inventories, existing maps and 3D models). All available primary data (borehole information, logs, seismics, gravimetrics and magnetics) will be collected compiled, validated, and data sharing provisions are defined.
A common harmonized database will be established where a common stratigraphic column is agreed upon, the study area, pilot study area, the Source Rock units, and reservoir units are defined. Also, a common database on key assessment parameters will be established.
The methodological framework and workflow of data and model harmonization - best practices/ lessons learned/recommendations will be disseminated in a report.

Task 2B: Defining the NS petroleum systems

A preliminary task is to complete a stakeholder analysis and review which will identify and define the amount and format of available relevant data (geochemical, structural, geological) and geographical coverage. Prioritisation of data collation will be subject to spatial and technological requirements of participant National Geological Surveys.

Unconventional systems

This activity will identify the principal source rocks of the North Sea based on a literature review to establish the state-of-the-art understanding, highlighting knowledge gaps in terms of stratigraphy and geography.
A programme of targeted data collation and interpretation will enable the key parameters and variables of the system to be quantified, across the North Sea using publicly available data held by the UK (BGS),

Netherlands (TNO), Germany (BGR) and Denmark (GEUS). In-kind support in the form of data will be negotiated with representative organisations from Norway. This will include the generation and collation of tectonostratigraphic models, geochemical data and burial history.

Clastic reservoir systems
This activity will characterise existing and potential conventional clastic reservoirs present in the North Sea study area, particularly those that can be defined as: Shallow reservoirs (up to 1.5km below seabed); High Pressure/High Temperature reservoirs; High permeability (including fractured); and Low Permeability (tight) reservoirs. This subtask will also identify and characterise areas where basement may form potential fractured (basement) reservoirs, and compare them with onshore analogues. In combination with subtask 2B1, the principal defined source rocks and reservoir units will be characterised to identify exploration targets. Both mature and frontier targets and plays will be characterised; in order to consistently assess mature, mature but underexplored, and frontier opportunities. Data gaps, whether geographical or with respect to petroleum systems, will be identified. Data use will rely on working closely across borders and with subtask 2B1 to identify publicly available data, data owners and, if necessary, request permissions. This subtask will also incorporate previous regional hydrocarbon-related data compilations where possible, for example, the Millennium Atlas, 21st Century Exploration Roadmap, Southern Permian Basin Atlas and NAG-TEC Atlas.

Carbonate reservoir systems
This activity will identify existing and potential carbonate reservoir intervals in the North Sea study area. The main focus will be on identifying the porosity and permeability system (e.g., primary vs. secondary porosity or fracture networks) and therefore assessing reservoir quality and potential storage capacity. The activity will concentrate primarily on the Upper Cretaceous Chalk Group (important carbonate reservoir interval in Denmark and Norway), the carbonates intervals of the Zechstein Group, and the Dinantian carbonates. Onshore outcrop and subsurface analogues will be used for the stratigraphic intervals that have little well coverage. Together with the source-rock units identified in Task 2B1, possible petroleum systems will be classified and grouped into mature or frontier opportunities, depending on the amount of past and present exploration and production activities. Data gaps will be identified and possible additional data gathering strategies discussed.

This task relies on publicly available data, as well as data and information made available from the participating national geological surveys. This task will also incorporate results from previous studies (e.g., Millennium Atlas, SPBA, NAG-TEC) and ongoing national and European studies aiming at deep carbonate reservoirs (e.g., ultra-deep geothermal energy).

Task 2C: Resource assessment

Task 2C concentrates on the resource assessment of the unconventional as well as conventional hydrocarbons in the North Sea basin. Collected data on the hydrocarbon resources from tasks 2A and 2B will be used in the assessment. For the unconventional resources such as shale gas and oil, the method developed and described in the “EUOGA” project (link) will be applied to ensure comparability with other European assessments. For the conventional resources, data from previously performed assessments at the respective national geological surveys will be collected and the EUOGA method will be adjusted for the assessment of conventional resources.

The main results of this task are a refined assessment of unconventional resources in the North Sea basin using a 4-step method, culminating in a probabilistic volumetric calculation of the GIIP/OIIP with P10, P50 and P90 assessments and an uncertainty evaluation as well as a general chance of success description. For the conventional resources, the assessment method will be adjusted and the previously published country specific assessments will be harmonized for cross-border comparability.

Task 2D: 3D petroleum system modelling resource assessment

A 3D petroleum system model based assessment of conventional and unconventional resources in a cross border (DK-NL-GER) pilot study area in the North Sea. The major geological element in the North Sea is the Central Graben, which stretches from the Netherlands to Norway. Each of the countries (DK-NL-GER) shares a part of this most important petroleum province in Europe.

The existing geological 3D models of the individual countries will be joined. The construction of a single model of the pilot study area will highlight the different interpretation and stratigraphic concepts of each country. Based on Task 2B identification of key potential shale source rock and reservoir formations, the combined 3D model will be populated with the source and reservoir rocks identified within the project as possible target formations. Furthermore, all layers will receive petro physical properties and for the source rocks, organic-geochemical data. Events of deposition, non-deposition and erosion will be defined and the basin evolution will be reconstructed. The model allows to calculate various output parameters, e.g. maturity of source rocks, transformation ratio and migration and trapping of hydrocarbons.
The 3D basin and petroleum systems model of the pilot study area allows for the first time a comprehensive understanding of the petroleum systems in the area and enables the calculation of generated petroleum amounts. Results of the 3D model for the identified potential unconventional and conventional oil and gas formations (Task 2B) will deliver an independent assessment of these resources and can be compared with the results from Task 2C.

Task 2E: Multiple/alternative use of HC reservoirs

This is a joint task between WP2 and WP3.

Options for alternative uses for hydrocarbon reservoirs (conventional as well as unconventional) will be appraised and a catalogue of options will be produced with associated GIS datasets referencing the technical resource assessment outputs from work packages 2.1, 2.2, 2.3 and 3. This will examine the integrated use of the subsurface (hydrocarbon extraction, storage, enhanced methods of production) as well as post-closure options. A profile of the suitability of geological structures for alternative technology uses will be generated. Options for synergies will be investigated and mapped to regions/ stratigraphic or geographical scenarios. These may include the potential for Geothermal technologies (EGS and EGS in HC media) or sequestration of CO_2 and CO_2 EOR.

Outputs will be a final report and associated GIS datasets.
Alternative usage

- Integrated use of the underground
- Synergies between various uses
- Detailed exploration of underground structures

The principal hazards associated with hydrocarbon production will be compiled using a series of case studies illustrating documented events from peer-review and grey literature. For some technologies (e.g., hydrate extraction), hazard maps will be generated, identifying areas less suitable for exploitation. This subtask will also detail relevant public-political issues (e.g., where use of the subsurface for a certain technology is preferential to other uses), instances of conflicts of interest between technologies or geographical areas, and the influence of major policy on utilisation of the subsurface.

Outputs will be a final report and associated GIS datasets.
Risks, hazards and mitigation

- Risks and safety
- Public or political issues
- Conflict of interests in the use of the underground
- Carbon abatement policy

Close corporation with the GeoERA HIKE project.

The underground offers both many resources and storage opportunities, and research is needed for development. Sharing tools and geological information on generic/common issues (e.g. 3D geological mapping, understanding hydro-thermo-chemical-mechanical and biochemical processes) will give synergies between various uses and can avoid conflicts in the utilization of the underground.

A new concept of an integrated underground storage atlas should include storage options for all range of possible stored media, such as natural gas, CO2, energy or waste materials, and should include available infrastructure in connection to these media (natural gas pipelines, CO2 emission sources, renewable energy sources, electrical grids, abandoned mines, depleted oil fields, nuclear power plants, etc.). The underground can be used for several purposes at the same site, but the depth, technical and economic requirements for various uses are often different. Preferred underground depth, temperature and pressure, water salinity, thickness of the reservoir and cap rocks, their porosity and permeability, internal and external structure of the storage site should be studied in detail. In this case, the shallowest resources are potable water and shallow geothermal energy, followed by gas storage, CO2 storage and deep geothermal energy, which potential is increasing with depth. CO2 capture, utilization and storage (CCUS) give new advanced options for synergy between CCS, hydrocarbons, heat and geothermal energy production using the same underground space. CCUS could offer a low-cost stepping stone for fossil fuel independency. The use of the underground for several purposes at the same time may cause conflict of priority, but they also could be applied in synergy.

Energy storage is a very new and important challenge opening a new research domain, which will play an increasingly important role in enabling the EU to develop a low-carbon electricity system. Increasing use of renewable energy sources (RES) for energy production (up to 20% to 2020 and much more in the following decades), largely coming from wind and solar power generation, and highly influenced by fluctuations in the weather, is causing a need for massive storage of electric energy. Electric energy storage technologies involving the use of underground offer large storage capacities and discharge rates. Among the options for large-scale storage in the underground are (i) underground pumped hydro-storage (UPHS), (ii) compressed air energy storage (CAES), and (iii) hydrogen storage from conversion power to gas. Each of these techniques requires the selection of appropriate geological formations (leached salt caverns, crystalline rocks, sedimentary porous rock, porous basalts, abandoned mines or natural underground cavities). Aquifer thermal energy storage (ATES) could be also mentioned, but this only applies to single building or to local heat grids.

Relevant datasets will be brought together in a project GIS, referencing the technical resource assessment outputs from work packages 2.1, 2.2, 2.3 and 3, and outputs from other GeoERA projects (e.g., HIKE), and other EU-funded initiatives (e.g., ESTMAP). Results will be summarized with a catalogue of options and a single summary report.

Deliverables

D2.1: Report on harmonised methodology and description of needed data availability for provide resource estimates. Decisions on study areas (M9)

D2.2: GIS layers illustrating principal source rocks and conventional reservoirs; tectonostratigraphic models; geochemical and geological databases in a consistent format; one overarching report detailing and summarising results (32).

D2.3: Updated assessment of the conventional and unconventional resources of the NS basin (M33).

D2.4: 3D model based assessment of potential unconventional in-place HC resources for specific shale formations in the cross-border pilot study area; GIS layers for specific source rock parameters of the shale formations. 3D petroleum system model as feedback/input to GE5 3DGEOMOD. Report on 3D PSM in pilot study area for unconventionals (M23)

D2.5: 3D model based assessment of potential conventional in-place HC resources for specific reservoir formations in the cross-border pilot study area; GIS layers for specific reservoir rock parameters (M33).

D2.6: Report describing a catalogue of hazards, alternative uses and case studies (M36).

Work package number	3	Lead beneficiary			IGME	
Work package title	Addressing knowledge gaps in the hydrate assessment in the European continental					
Participant number	1	2	4	6	7	
Short name of participant	GEUS	IGME	BRGM	NERC (BGS)	GEOINFORM	
Person months per participant	3.67	18	4	13	0.35	
Start month	M1			End month	M34	

Objectives

The objective of this work-package is to develop a harmonized model for a pan-European gas hydrate data infrastructure. A GIS-database will be developed that includes key gas hydrate observations (both direct and indirect), relevant oceanographic variables (seafloor temperature, heat flow, bathymetry, sedimentation rates, etc.) and modelled hydrate stability thickness.

This work-package will identify the critical knowledge gaps and provide information on areas of interest for future joint projects. It will also provide recommendations on how future data should be collected and stored to be fully interoperable. It will thus lay the groundwork for future projects related to improving models of the gas hydrate stability zone (GHSZ) along European margins. This is essential for assessments relating to geohazards and risks, assessments of the abundance of sediment-hosted gas hydrates, and evaluations of the role of CO_2-rich hydrates for the geological storage of CO_2.

Thus, this aim of work-package is to:

- Extend the existing European Geological Data Infrastructure (EGDI) structure to enable incorporation, maintenance, and dissemination of outcomes.
- Present the results in a GIS format at a scale and resolution suitable for integration with The European Marine Observation and Data Network (EMODnet) geological data.
- Present a knowledge gap analysis of areas with limited or no data and to assess the uncertainty and sensitivity errors in critical oceanographic parameters such as geothermal gradient and seafloor temperature measurements.

Outputs will also feed in to Task 2E (Multiple/alternative use of HC reservoirs) to aid the appraisal.

Description of work

To reach the objectives described above, this work-package has been divided into three tasks:

Task 3A: Collection of data sources to be implemented in the hydrate related GIS-database.

This task will be coordinated by BGS. The aim is to collect available data focused on hydrate research in a pan-European scope. Evidence of hydrates, samples, compositional analysis or seismic profiles, as well as geothermal gradient and seafloor temperature data, undercurrent distribution maps or GHSZ thickness assessment will be collected. A list of the pan-European gas hydrate related-data of interest to be incorporated into the GIS-database will be done where the location (source), accessibility/use, size, typology and state will be specified.

Each partner will compile lists of their own databases and accessible data. Depending on the data availability, this information will be classified into two groups: information ready to be implemented in the GIS-database in the present project, and information of interest to be implemented in future projects. Finally, this task will establish the commitment by the partners in any action for the Task 3C if necessary.

Task 3B: Definition of the data model structure and data loading.

This task will be coordinated by IGME. This task is dependent on the results of task 3A. The first step is to define a GIS data model structure based on the information compiled above. A harmonized data model consistent with the GeoERA Information Platform will be established.

The second step comprises the data loading and the metadata definitions according the specifications of the Information Platform, including a quality assessment of all data. Finally, the resulting GIS-data base will be delivered to the Information Platform for its widespread dissemination and diffusion.

Task 3C: Integration of results.

This task will be coordinated by IGME. This is a multidisciplinary task that will analyse that available data and identify critical data gaps for understanding gas hydrates along European continental margins. This task is coordinated with the task 2E.

A report on the current state hydrate related pan-European data will be published with free and public access. Based on this report, areas with low density or lack of data will be assessed in order to establish priority areas for future projects. In addition, it will supply tools to assess the uncertainties of key parameters and observations.

Depending on the outcome of task 2B, further activities could be undertaken, such as an assessment of the possibilities for future infrastructure projects, an analysis of areas of interest for gas exploitation and/or zones for CO2 storage. In areas where data is scarce or of poor quality, efforts will be directed to assess gaps or ways to improve the data or guidelines for future collection of data. In areas where the data quality is good and abundant, efforts will be devoted to add value to these data for use by multiple users.

Finally, a hydrate related-risk assessment could be also carried out to assess the impacts of possible destabilization of hydrate over seafloor; and the potential links with geohazards (e.g. seismicity).

Deliverables
D3.1: Report of available hydrate related data. This deliverable will be a report containing a list of the available hydrate related-data in a pan-European scope of interest to be incorporated into the GIS-database. The location (source), accessibility/use, size, typology and state will be specified (M9)

D3.2: Hydrate related GIS-database. This deliverable will be a GIS-database compliant with the Information Platform specifications (M27).

D3.3: Gas Hydrate overview report. This deliverable constitutes the documentation of the impact of this WP in establishing the information gaps; possible areas of interest; impacts of hydrate destabilization; potential CO_2 hydrates for the safe geological storage of CO_2, etc.) (M33).

Work package number	4	Lead beneficiary			GEUS		
Work package title	Knowledge data base						
Participant number	1	2	3	4	5	7	8
Short name of participant	GEUS	IGME	TNO	BRGM	BGR	BGS	GEOINFORM
Person months per participant	4	2	1		2		2.08
Start month	January 2019			End month	March 2021		

Objectives
The objective of this work package is to lead the interactions with the GeoERA-IP project, to execute the parts of the Project Data Management Plan relating to IP and EDGI and to enable an efficient and consistent uptake and embedding of project results into the GeoERA-IP. WP4 will be responsible for communicating the requirements of the project to GeoERA-IP and vice versa ensure that the guidelines and standards provided by GeoERA-IP are properly implemented in the WP's 2 and 3 processes. Thus, WP4 makes significant contributions to ensure the maintenance, dissemination as well as the sustainability of the results in GARAH.

Description of work
- The main objective is to identify and discuss requirements at the project start in close dialogue with the Information Platform (IP) team.
- Facilitate interoperability, standards and harmonization with other GeoERA projects to insure alignment of their EGDI output, so it follows the EGIP concepts including the organization of general geothermal information (e.g. themes on geothermal aquifer outlines, temperature maps, reservoir properties etc.
- This WP will coordinate interactions with WP2-3 and ensure that the principles and guidelines provided by the IP-team are followed.
- Facilitate the information generated in WP2-3 is provided and delivered. Finally, this WP will ensure that the information is uploaded to the EGDI repository as intended, and that needed functionality and extensions to the EGDI are developed
- Ensuring the communication, acceptance and application of effective means of communication, and standards for exchange between WPs of GARAH and other GeoERA projects. WP4 will

frequently examine the WPs communication and data exchange regarding the requirements of the GeoERA-IP project standards to ensure a punctual and conformable delivery of standardized results. Organise meetings and produce minutes of meetings

Task 4A: Synthesis: Determination of requirements and standards - External communication with EGDI team (M1-6)

Lead: GEUS, Contributors: all
Identify, list, discuss, describe and agree on in close connection with EGDI definition of requirements to insure how the EGIP concepts are followed and how results are merged into a shared (comprehensive) information model (i.e. data infrastructure, visualization of geo-information and themes etc.).

Task 4B: Development: Preparing and creating the online platform (M3-18)

Lead: GEUS; Contributors: all
Discussion on the need for and screening of requirements on an internal web information system. Design and testing of the web-platform of individual tools in cooperation with other WP's.

Task 4C: Implementation: Local data implementation (M6-24), IP data implementation and prototyping (M24-30), data validation and testing (M30-36)

Lead: GEUS; Contributors: all
Implementation of results into the internal web-platform: delivery of collected data from Case study areas (WP3).
Implementation of results into the Information Platform (IP): delivery of collected data from Case study areas (WP3). This requires communication with the EGDI team, to ensure that functionally and extensions are correctly implemented.
Check and proof of data and results in the EGDI portal.

Deliverables

D4.1: Preliminary data selection to provide relevant information in assessing hydrocarbon resources in subsurface i.e., IP guidelines, QA procedures (1 report, M6)

D4.2: Description of Extensions of EGDI (1 report, M30). Description of the work done on EGDI, guidelines for uploading, updating and consulting information.

D4.3: Assist in hydrocarbon resource planning (1 report, M30).

D4.4: Online available results (1 report, M35).

D4.5: Data input to IP (GIS data, M1-M34)

Table 3.1b) List of work packages *(This table is not covered by the page limit)*

Work package No.	Work Package Title	Lead Participant No.	Lead Participant Short Name	Person - Months	Start Month	End month
1	Main Project Coordination	1	GEUS	6	1	36
2	North Sea Petroleum Systems	1	GEUS	62.54	1	34
3	Knowledge gaps Gas Hydrates	2	IGME	39.02	1	34
4	Knowledge data base	1	GEUS	11.08	1	36
				118.64		

Table 3.1c) List of deliverables *(This table is not covered by the page limit)*

Deliverable number	Deliverable name	Work package number	Short name of lead participant	Type	Dissemination level	Delivery date (in months)
D1.1	Dissemination and Exploitation plan	1	GEUS	Report	Public	M3
D1.2	Project data management plan	1	GEUS	Report	Public	M6
D1.3	Annual progress report 2018	1	GEUS	Report	Public	M8
D1.4	Annual progress report 2019	1	GEUS	Report	Public	M20
D1.5	Annual progress report 2020	1	GEUS	Report	Public	M32
D1.6	Final Project report	1	GEUS	Report	Public	M36
D1.7	Project review with EU stakeholders – Formal presentation	1	GEUS	Report	Public	M36
D2.1	Data base & harmonization report	2	GEUS	Report	Public	M9
D2.2	Petroleum system report and GIS maps	2	BGS/TNO/ GEUS	Report	Public	M32
D2.3	Resource assess-ment „EUOGA“	2	GEUS/TNO	Report	Public	M33
D2.4	Resource assess-ment 3D pilot Unconventional	2	BGR/GEUS	Report	Public	M23
D2.5	Resource assess-ment 3D pilot Conventional	2	BGR/GEUS	Report	Public	M33
D2.6	Alternatives + risks	2 (& 3)	BGS/GEUS	Report	Public	M36
D3.1	Collection data report on available Hydrates data	3	BGS/IGME	Report	Public	M9
D3.2	Hydrates GIS-database	3	IGME	GIS	Public	M27

D3.3	Gas Hydrate overview report	3	IGME	Report	Public	M33
D4.1	Preliminary data selection, IP guidelines, QA procedures	4	GEUS	Report	Public	M6
D4.2	Description of Extensions - EGDI	4	GEUS	Report	Public	M30
D4.3	Assist in HC planning	4	GEUS	Report	Public	M30
D4.4	Online available results	4	GEUS	Report	Public	M35
D4.5	Data input to IP	4	GEUS	GIS data	Public	(M1-M34)

Tables for section 3.2

Table 3.2a) List of milestones *(This table is not covered by the page limit)*

Milestone number	Milestone name	Related work package(s)	Due date (in months)	Means of verification
MS1	Kick-off meeting/ seminar	1	M1	Delivery of D1.1, D1.3
MS2	Data review & Characterization method agreed	1,2,3	M6	Delivery of D1.2, D2.1, D3.1
MS3	Preliminary data selection, IP guidelines and QA procedures	4	M6	Delivery of D4.1
MS4	Annual project meeting/seminar 2019	1	M13	Delivery of D1.4
MS5	Pilot 3D Unconventional assessment	2	M23	Delivery of D2.4
MS6	Annual project meeting/seminar 2020	1	M25	Delivery of D1.5
MS7	Hydrate GIS data base	3	M27	Delivery of D3.2
MS8	Inventory of the North Sea petroleum systems	2	M32	Delivery of D2.2
MS9	Pilot 3D Conventional assessment	2	M33	Delivery of D2.4
MS10	Resource assessment of the North Sea	2	M33	Delivery of D2.3
MS11	Gas Hydrate overview	3	M33	Delivery of D3.3
MS12	All data in IP EGDI data base	4	M1-M34	Delivery of D4.5
MS13	Annual project meeting/seminar 2021	1	M 35	Delivery of D1.6
MS14	Catalogue of Hazards and alternative usage	2	M36	Delivery of D2.6
MS15	Presentation of the GARAH findings	1	M36	Delivery of D1.6, 1.7

Table 3.2b) List of critical risks for implementation *(This table is not covered by the page limit)*

Description of risk (indicate level of likelihood: Low/Medium/High)	Work package(s) involved	Proposed risk-mitigation measures
Loss of key project personnel – incomplete or bad performance, loss of direction/scope of project (Low)	WP 1 – 4	The organisations with major roles in this project are substantial and have expertise in depth. Shared responsibilities within WP provide stability in case of unexpected key project personnel loss.
Deliverables not delivered on time leading to delays in project (Medium)	WP 1 – 4	Day-to-day communication between coordinator and WP leaders and further between WP leaders and WP partners.
Delayed start of activities; shift of activities in the plan; potential prolongation of the project (Medium)	WP 1 – 4	Efficient communication between all project participants is a core task in the project. Some participants have worked together in the past and their communication is already well established. Some participants have extensive experience in carrying out EU projects. The obligatory kick-off and mid-term seminars provide opportunities to discuss and decide on appropriate measures.
IPR issues – lack of agreement in intellectual property rights (Low)	WP 1	Clear IPR Agreements made in the CA, which covers both overall GeoERA project and individual transnational projects. Project data management plan (WP1) and programme components dedicated to data management.
Data copyright issues – problems to get permission to publish developed data sets/3D geomodels from pilot areas (Medium)	WP 1 – 4	Documentation of State-of-the-Art in pilot areas during a first project phase comprises an inventory of data accessibility and usability. With respect to the documented status (Milestone 2) the WPs will then finally define the 3D geomodels (areas, resolution, theme) to be build. Foreseeable copyright problems will be communicated with the data owners in an early project phase. If parts of geomodels cannot be published via the IP, alternative solutions (e.g. publication on local web-viewer) will be communicated with the IP project.

Digital access to all previous information fails; or is not cost-effective (Low)	WP 2	Most part of the info is hosted at the Geological Surveys. However, part of the info needed in the project (e.g. seismic lines in sgy format) may not be accessible. If access is not granted but analogic data exist, they can be digitalized w/o cost, but quality will be lower.
Poor engagement with other GeoERA projects – incomplete feedback on mutual demands and expectations (medium)	WP 2-4	Cooperation and communication with other projects is a core task of PP. Through the GeoERA Grant Agreement a solid basis for cooperation and solving conflicts has been established
Poor engagement of some project partner (PP) and incomplete information on work status and IPR (low)	WP 1-4	Proactive Work Packages (1&4) dedicated to engaging with them.
Biased approach – PP developing a non-realistic / biased model in research activities (low)	WP 2-4	Effective internal communication measures in WP1; active involvement of all PP in all WP's

Table 3.3a) Summary of Staff Effort *(This table is not covered by the page limit)*

	WP1	WP2	WP3	WP4	Total Person- Months per Participant
1 / GEUS	6	23	3.67	4	36.67
2/ IGME			18	2	20
3 / TNO		9.5		1	10.5
4 / BRGM			4		4
5 / BGR		10		2	12
6 / NERC(BGS)		17	13		30
7 / GEOINFORM		1.04	0.35	2.08	3.47
8 / NPD (external partner)		2			2
Total Person Months	6	62.54	39.02	11.08	118.64

Table 3.3b) 'Other direct cost' items (travel, equipment, other goods and services)

(This table is not covered by the page limit)

Please complete the table below for each participant.

1 / GEUS	Cost (€)	Justification
Travel	20,828	Participation in 4 project meetings and WP meetings, 3 workshops, 2 conferences
Equipment		
Other goods and services		
Total	20,828	

2 / IGME	Cost (€)	Justification
Travel	18,000	Travel of 2 staff to 3 annual meetings (2 x 3 x €1500 = €7000); Travel of 1 staff to 3 additional Work Package meetings (1 x 3 x €1500 = €3500); Travel of 5 staff to 1 annual dissemination meeting (5 x 1 x €1500 = €7500)
Equipment	3,500	Computers, software and backups units
Other goods and services		
Total	21,500	

3 / TNO	Cost (€)	Justification
Travel	8,000	Travel of two staff to 3 annual meetings (2 x 3 x 750€); Travel of 1 staff to 3 additional Work Package meetings (1 x 3 x 750€); Travel of one staff to conferences (1 x 1250€)
Equipment		
Other goods and Services		
Total	8,000	

4 / BRGM	Cost (€)	Justification
Travel	3,634	Participation in project and WP meetings, workshops, conferences Travel of 1 staff to 3 project consortium meetings (kick-off, interim, final) (1 x 3 x €800 = €2400); Travel of 1 staff to 2 conferences (1 x 2 x €617 = €1234)
Equipment		
Other goods and services		
Total	3,634	

5 / BGR	Cost (€)	Justification
Travel	11,700	Participation in project and WP meetings, workshops, conferences Travel of 2 staff to 3 annual meetings and final project meeting (2 x 4 x €900 = €7200); Travel of 1 staff to 2 additional and 1 staff to 1 additional work package meetings ((1 x 2 + 1x 1) x €900 = €2700); Travel of 1 staff to 2 conferences (1 x 2 x €900 = €1800)
Equipment		
Other goods and services		
Total	11,700	

6 / NERC (BGS)	Cost (€)	Justification
Travel	16,843	Travel of 2 staff to 3 annual meetings (2 x 3 x €1150 = €6900); Hosting 1 annual meeting (€950 catering); Travel of 2 staff to 3 additional Work Package meetings (2 x 3 x €1150 = €6900); UK internal travel costs to discuss data provision by stakeholders including UK Oil and Gas Authority and individual companies, mostly based in Aberdeen and London (10 visits each at €209 = €2093)
Equipment		
Other goods and services		
Total	16,843	

7 / GEOINFORM	Cost (€)	Justification
Travel	6,000	3 project consortium meetings (kick-off, interim, final) and 3 WP meetings where GEOINFORM is involved, by EUR 1000 each
Equipment		
Other goods and services		
Total	6,000	

Table 3.3c) Financial table with requested budget *(This table is not covered by the page limit)*

Participant	(A) Direct personnel costs (EUR)	(B) Other direct costs; travel, equipment, infrastructure, other (EUR)	(C) Direct costs of sub-contracting (EUR)	(D) Indirect costs (= (A + B) *0,25) (EUR)	(E) Total estimated eligible costs (=A+B+C+D) (EUR)	(F) Reimbursement Rate (29.7%)[1]	(G) Requested EU contribution (=E*F)	(H) Surveys in-kind contribution = (E – G)
1 GEUS	320,566	20,828	0	85,349	426,743	0.297	126,743	300,000
2 IGME	87,808	21,500	0	27,327	136635	0.297	40,581	96,055
3 TNO	61,498	8,000	0	17,374	86,872	0.297	25,801	61,071
4 BRGM	30,285	3,634	0	8,480	42,398	0.297	12,592	29,806
5 BGR	77,200	11,700	0	22,220	111,100	0.297	32,997	78,103
6 NERC (BGS)	165,979	16,843	0	45,705	228,527	0.297	67,873	160,655
7 GEOINFORM	16,744	6,000	0	5,686	28,430	0.297	8,444	19,986
8 NPD	16,000	0	0	0	0	0	0	16,000

[1] The EC Reimbursement rate for ERA-NETs is 33%. 10% of this Reimbursement rate is reserved for the Coordination Costs of GeoERA as agreed in the Grant Agreement. Therefore, the Reimbursement rate for GeoERA is these calculations results in 29,7%.

4 Members of the consortium

(This section is not covered by the page limit)

4.1 Participants (applicants)

Name of organisation	Geological Survey of Denmark and Greenland		
Participant Number/Short Name	1 / GEUS	Country	Denmark

GEUS is an independent research and advisory institution in the Danish Ministry of Energy, Utilities and Climate. GEUS conducts geological research to exploit and protect geological natural resources in Denmark and Greenland. Primary activities are research in water, energy, minerals and other natural resources.

GEUS provide geological advice to public authorities in nature, environment, climate, energy and raw materials issues and participate in the performance of tasks within these areas. GEUS is the national geological data centre and in that capacity make data and knowledge available to the authorities, educational institutions, government agencies, private enterprises and the public.

GEUS also undertakes assignments related to water, energy, minerals and the environment on a contractual basis for other public authorities, private companies and clients outside Denmark.

GEUS is part of Geocenter Denmark - a formalised cooperation between GEUS and the Geoscience institutes at University of Copenhagen and Aarhus University.

In 2016, GEUS has a staff of 290 of which 210 hold a PhD or MSc degree, and around 50 PhD students and several MSc students are attached to GEUS for research training.

GEUS ensures that the advice of the Danish authorities and energy resource companies, in all energy work fields is based on the latest Danish and international geoscientific knowledge. In Denmark, the focus will be on preparing new licensing rounds, mapping and assessment tasks associated with CO2 storage offshore in Denmark as well as internationally, using recent and deposits as reservoir analogies, studies targeting shale gas etc. The main objectives are:

- Oil and gas in the North Sea and unconventional hydrocarbons onshore Denmark
- Sustainable energy from the subsurface.

Persons who will be primarily responsible for carrying out the proposed activities

Peter Britze (male), MSc in Geology, University of Copenhagen. Senior Consultant, former Head of Department, Department of Reservoir Geology. Former Chair and presently Deputy Chair of the EuroGeoSurveys GeoEnergy Expert Group dealing with geo-energy in Europe. Recognized as independent scientific advisor for EU DG ENER, DG ENV, DG RTD, and DG JRC on conventional and unconventional fossil fuels. AIB Commissioner for larger offshore installations in Denmark. Project manager on commercial integrated multi-disciplinary chalk exploration and reservoir studies. Geophysical expert in chalk reservoirs. Expert in the integration of geological disciplines. Working with digital 2D and 3D seismic interpretations and mapping, post stack processing, inversion and generation of synthetic seismograms. Professional awards: The Geological Award of Denmark 1996.

Tove Nielsen (female), PhD in Geology, University of Aarhus, a Senior Research Scientist at the National Geological Surveys of Denmark and Greenland (GEUS), has more than 30 years of work experience with seismic interpretation of topics related to marine geology, seabed processes, geohazard and gas hydrates. For 2 years she worked as Associate Professor in Arctic Marine Geology at the University of Svalbard, has been project manager and work package leader of several national and international research projects, and national representative in the gas hydrate EU Cost networks PERGAMON and MIGRATE.

John R. Hopper (male), PhD in Marine Geophysics, Columbia University. Senior Researcher with more than 25 years' experience with seismic acquisition, processing and interpretation, tectonic evolution of the North Atlantic and Arctic regions, geodynamic modelling of crust and mantle deformation, and links between tectonics and climate. Project manager for several large projects, including NAG-TEC, a collaboration between seven geological surveys to develop a new tectonostratigraphic atlas of the Northeast Atlantic region. National representative to the gas hydrate EU Cost network MIGRATE.

Anders Mathiesen (male), MSc in Geology, University of Copenhagen. Senior advisor and Geologist with more than 25 years of experience within subsurface exploration and exploitation, covering topics as geophysical and geological interpretation and mapping, numerical spatial modelling of maturity, flow and migration and geothermal assessment. He is very experienced in e.g. Petrel, PetroMod, ArcGIS and Web platforms. Furthermore, he has thorough knowledge and has worked with many aspects of general computer science and during the last years, he has been involved in various national and international 3D modelling projects.

Niels Schovsbo (male), PhD in Geology, University of Copenhagen. Senior Researcher with more than 15 years' experience with resource assessment evaluation of both conventional and unconventional plays. Team leader for national assessments of unconventional resources made with USGS and work package leader on the mapping of Unconventional resource in Europe (EUOGA). Experienced advisor for national and international governmental bodies as well as to the industry.

Relevant publications

1. Hopper, J.R., Funck, T., Stoker, M., Árting, U., Peron-Pinvidic, G., Doornenbal, H., and Gaina, C., 2014, Tectonostratigraphic Atlas of the North-East Atlantic Region. Geological Survey of Denmark and Greenland, Copenhagen, 340pp.

2. Ineson J, Surlyk F (eds), 2003: The Jurassic of Denmark and Greenland. Geological Survey of Denmark and Greenland Bulletin 1, 233-246.

3. Nielsen T, Laier T, Kuijpers A, Rasmussen TL, Mikkelsen NE & Nørgård-Pedersen N, 2014. Fluid flow and methane occurrences in the Disko Bugt area offshore West Greenland: indications for gas hydrates?. Geo-Marine Letters, 34, p. 511-523. DOI 10.1007/s00367-014-0382-2

4. Schovsbo, N.H., Nielsen, A.T., Gautier, D.L., 2014. The Lower Palaeozoic shale gas play in Denmark. Geological Survey of Denmark and Greenland Bulletin 31, 19–22.

5. Yang, S., Schulz, H.-M. Schovsbo, N.H., Bojesen-Koefoed, J.A., 2017. Oil-source rock correlation of the Lower Palaeozoic petroleum system in the Baltic Basin (northern Europe). AAPG Bulletin in press.

Relevant previous projects or activities

1. EUOGA: inventory and assessment for shale gas resources in Europe (2015-2017) JRC/PTT/2015/F.3/0027/NC

2. MIGRATE, COST project (https://www.migrate-cost.eu), WG3 (Environmental challenges), Lead author: Umberta Tinivella. GEUS participants: Tove Nielsen, John Hopper.

3. NAG-TEC, GEUS led atlas project funded by 19 oil companies
http://nag-tec.org

4. Assessment of the oil and gas resources in the Danish North Sea (2015) (in Danish)
http://www.geus.dk/geus-general/announcements/geus-baggrundsrapport-olie-gas-ressourcer_juli-2017.pdf

5. PERGAMON. Permafrost and gas hydrate related methane release in the Arctic and impact on climate change - European cooperation for long-term monitoring. COST ES0902 (11.11.2009 - 10.11.2013)PI: Jens Greinert. GEUS participants: Tove Nielsen.

Name of organisation	Instituto Geológico y Minero de España		
Participant Number/Short Name	2 / IGME	Country	Spain

The Geological Survey of Spain (IGME) is a self-governing Public Research Institution attached to the Ministry of Economy and Competitiveness. The main mission of IGME is to provide the State Administration and the general society, with precise knowledge and information regarding the Earth Sciences and related technologies for any development on the Spanish territory (onshore and offshore). In the marine environment, IGME is focused on the study of seafloor and sub-seafloor in the all fields of the geology, such as geological resources and minerals, geo-hazards, geo-environmental sciences and mapping. In this way, the IGME is the Coordinator of the Group of the Extension of the Spanish Continental Shelf Project, collaborator organism in the Economic Exclusive Zone of Spain mapping program and the MIGRATE COST Action (ES1405; Marine gas hydrate - an indigenous resource of natural gas for Europe).

Key persons:

Ricardo León, male, PhD in Marine Geology. He is a Senior Geologist at the Geological Survey of Spain (IGME) with over 20 years research experience in seabed fluid flow, geological active processes and seafloor mapping. He has worked in predictive numerical models for potential mapping of the gas hydrate stability zone in Antarctica, North-Atlantic Ocean and Arctic, as well as in the seafloor mapping for marine geohazards in seabed fluid leakage/hydrated areas. He has participated in 22 scientific projects related to marine geo-sciences with 37 papers in the SCI, (H-index is 14). He will be the leader of the work-package 3.

M. Pilar Mata, female, PhD in Geology, is an expert in sedimentary geochemistry and mineralogy. He has participated and leader many scientific projects related to sedimentary geology, with 46 papers in the SCI, (H-index is 21). He is currently the Spanish representative member of the cost action Marine gas hydrate - an indigenous resource of natural gas for Europe (MIGRATE).

Silvia Cervel, female, MSc. in Geology, is an expert in Geographic Information Systems (GIS); administration, design, development and implementation of databases; and geological 3D modelling. She has been participating technical projects related to databases focused on industrial raw materials (BDMIN), integration of GIS-databases (INTEBASI) and the 3D geological modelling of structures for geological deep storage (3DMODCO2).

María Isabel Reguera, female, PhD in Geology, is an expert in palaeoceanography, paleoclimatology and GIS-3D modelling. She has participated in 6 competitive scientific projects related to marine geo-sciences (PROMESS-1 and LASEA) and terrestrial geophysics (ALGECO2 and PROMINE), with 6 SCI papers and 19 non-indexed papers (h-index is 4). She is currently working in the FAUCES project (CTM2015-65461) related to geological risk factors associated to submarine canyons.

Julia Giménez Moreno, female, MSc. in Geology, is an expert in GIS and digital image processing and has participated in data infrastructure Programs such as Copernicus (former GMES) in projects financed by DG Agri, ESA and EEA and international digital data programs related to marine geology and environmental such as EMODnet Geology and High Resolution Seabed Mapping.

A list of up to 5 relevant publications, and/or products, services:

1. Martos-Villa, R. Mata. M.P. Sainz-Díaz, C.I. 2014. Characterization of CO2 and mixed methane/CO2 hydrates intercalated in smectites by means of atomistic calculations. Journal of Molecular Graphics and Modelling; 49C:80-90. DOI: 10.1016/j.jmgm.2014.01.008.

2. Martos-Villa, R., Guggenheim, S., Mata, M.P., Sainz-Díaz, C.I:, Nieto, F 2014. Interaction of methane hydrate complexes with smectites: experimental results compared to molecular models. American Mineralogist 99:401-414. DOI: 10.2138/am.2014.4570.
3. Martos-Villa, R. Mata, M.P., Francisco-Márquez, M. Sainz-Díaz, C.I. 2013 Crystal structure, stability and spectroscopic properties of methane and CO2 hydrate. Journal of Molecular Graphics and Modelling, 44, 253-265. DOI: 10.1016/j.jmm.2013.06.006.
4. León, R., Somoza, L. 2011. GIS-based mapping for marine geohazards in seabed fluid leakage areas (Gulf of Cadiz, Spain). Marine Geophysical Researches 32: 207-223.
5. MATLAB algorithm for the calculation of the Theoretical GHSZ thickness. Published in: León, R., Somoza, L., Giménez-Moreno, C.J., Dabrio, C.J., Ercilla, G., Praeg, D., Díaz-del-Río, V., Gómez-Delgado, M. 2009. A predictive numerical model for potential mapping of the gas hydrate stability zone in the Gulf of Cadiz. Marine and Petroleum Geology 26: 1564-1579.

A list of up to 5 relevant previous projects:

1. MIGRATE. Marine gas hydrate – an indigenous resource of natural gas for Europe. COST Action ES1405. Founding entity: COST. PI: Klaus WALLMANN (GEOMAR, Germany). IGME participants: Pilar Mata Campo (management group), Ricardo León (working group). 2015-1018.
2. SUBVENT. Submarine fluid emissions in the continental margins of Canary Islands and Gulf of Cádiz: geological processes and related mineral deposits. (CGL2012-39524-C02-02). Founding entity: CICYT, (Spain): 130,000€. IGME participants: Ricardo León (research staff). 2012-1016
3. CADHIS. Gas-Hydrates and Methane evidences in the Continental margin of the Gulf of Cádiz: derived submarine structures and interaction processes with clay-sediments. (RNM-3581). Universidad de Cádiz – IGME. PI: Pilar Mata Campo. 207.923,60 Euros.
4. GLOBANT. Antarctic oceanic gates and global change. (CTM2008-06386-C02-02). Founding entity: CICYT, (Spain): 111,925 €. IGME participants: Ricardo León (research staff). 2009-2013
5. PERGAMON. Permafrost and gas hydrate related methane release in the Arctic and impact on climate change - European cooperation for long-term monitoring. COST ES0902 (11.11.2009 - 10.11.2013) PI: Jens Greinert. IGME participants: Pilar Mata Campo and Ricardo León (working group). 2009-2013.

<table>
<tr><td>Name of organisation</td><td colspan="3">BUREAU DE RECHERCHES GÉOLOGIQUES ET MINIÈRES</td></tr>
<tr><td>Participant Number/Short Name</td><td>3 / TNO</td><td>Country</td><td>Netherlands</td></tr>
</table>

TNO is a semi-independent Dutch research and technology organisation active in technical, earth, environmental, life, societal and behavioural sciences, focussing on healthy living, industrial innovation, energy, transport and mobility, built environment, the information society, and defence, safety and security. Our mission is to apply and transfer scientific knowledge as well as provide top quality advice with the aim of strengthening the innovative power of industry and government. TNO will be represented in Geo-ERA through the Geological Survey of the Netherlands as well as the theme energy. The survey's core skills include data management, geo-ICT and 3D-modelling. The organisation hosts the national repository for subsurface data and information and is the designated state advisor of all geological matters related to the Mining Act. TNO Energy department is specialized in applied research and consultancy services for the oil and gas sectors. Teams of TNO have world class expertise in all major oil & gas exploration and production disciplines. Our staff composed of geoscientists, petroleum engineers, mathematicians, physicists, chemists, biologists and economists has extensive applied research and field studies expertise to optimally enhance exploration and development of assets.

Key persons:

Hans Doornenbal, MSc. (male), EuroGeologist, studied exploration geophysics and structural geology and he graduated in 1980 at the Utrecht University. He has more than 37 years experience in database management, seismic interpretation, structural geology, mapping and project management, especially related to subsurface studies not only hydrocarbon E&P studies, but also geothermal and water potential studies. He has participated as team member and later as project manager in a variety of projects abroad (Yemen, Tanzania, Slovenia). Since 1998 at TNO-Geological Survey of the Netherlands he is project leader of the regional mapping project of the deep subsurface of the Netherlands. From 2005-2010 he was assigned as project manager of the SPBA-project with the aim to produce the “Petroleum Geological Atlas of the Southern Permian Basin Area”. In 2009 he became project manager for the “GASH – European Black Shale Database” project, from 2011-2014 he was involved in the North Atlantic Tectonostratigraphic Atlas project and from 2015-2017 in the EUOGA project to make an inventory and assessment for shale gas resources in Europe.

Dr. Johan H. ten Veen (male), co-lead WP3, senior geologist (EuroGeologist), Johan holds a MSc from Vrije Universiteit Amsterdam (1991) and a PhD degree in Earth Sciences from Utrecht University (1998). He joined TNO in 2009 after an academic (research and lecturing) career in structural geology. At TNO he works as a structural geologist on the initiation, refinement and maintenance of national subsurface geomodels (www.dinoloket.nl). Next to this task, he is involved in projects centered around characterization of hydrocarbon and geothermal reservoirs and several cross-border basin studies (NW Europe focus). Currently Editor in Chief of the Netherlands Journal of Geosciences.

Kees Geel, MSc. (male) is a senior petroleum geologist. He holds an MSc degree in Geology from Utrecht University. Since 1985 he worked as a sedimentologist, petrophysicist, seismic interpreter, and reservoir geologist in various staff and consulting positions. In 1993, he accepted a position at Delft University as a research associate in reservoir geology. Later he was appointed assistant professor. Kees joined TNO in 2003 to work in the oil and gas department. He has been involved in a multitude of field development and exploration studies in various parts of the world. His main interests are in the field of integration of log analysis, petroleum engineering, and production geology.

Dr. Susanne Nelskamp (female) holds a German MSc equivalent in Geoscience (Dipl. Geowissenschaftlerin) from the University of Hannover, Germany and a PhD in Geology and Basin Modelling from RWTH Aachen University, Germany on the topic of basin modelling in the Netherlands. In 2008 she joined the basin modelling team at TNO and has since then worked on several basin modelling/petroleum system analysis projects, was part of the team that collected geological and geochemical data on possible shale gas horizons from European Geological Surveys for the international GASH project as well as the more recent EUOGA project, applied basin modelling for CO2 storage and geothermal energy research, has supervised MSc students and published and presented her work on several international conferences and workshops. Her current focus lies on organic geochemistry and basin modelling to study source rock evolution and hydrocarbon generation and migration processes.

Dr. Sander Houben (male) is a palynologist and exploration geologist at TNO. Sander holds a PhD-degree in Earth Sciences and has extensive knowledge and practical experience in integrative geological disciplines: notably biostratigraphy, palaeoceanography, and isotope- and organic geochemistry. His heart lies with developing new interdisciplinary applications, for paleoclimate, exploration and environmental monitoring purposes. He has (co)-authored >15 scientific publications, including 3 in the leading journals Nature and Science. He has been closely involved in and/or coordinated BSc and MSc-grade teaching, supervision of MSc and BSc theses and scientific outreach. In his current role at TNO, Sander is particularly involved in multidisciplinary basin analyses studies of the Mesozoic of the Middle East and North Sea areas and the Cenozoic of South America and the North Sea and the development of novel techniques and concepts.

List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.

1. Doornenbal, J.C. & Stevenson, A.G. (Eds) (2010): Petroleum Geological Atlas of the Southern Permian Basin Area. EAGE Publications b.v., Houten, 342 pp.
2. Hopper, J. R., Funck, T., Stoker, M., Árting, U., Peron-Pinvidic, G., Doornenbal, J. C., and Gaina, C., 2014, Tectonostratigraphic Atlas of the North-East Atlantic Region: Copenhagen, Geological Survey of Denmark and Greenland (GEUS), p. 338.
3. Ten Veen, J., Geluk, M., Kombrink, H., (eds.) (2012) Exploring the deep subsurface of the Netherlands. Commemorative volume on the centenary of KNGMG. Netherlands Journal of Geosciences, 91(4)
4. Ter Heege, J., Zijp, M., Nelskamp, S., Douma, L., Verreussel, R., ten Veen, J.H., de Bruin, G., Peters, M.C.A.M. (2015) Sweet spot identification in underexplored shales using multidisciplinary reservoir characterization and key performance indicators: Example of the Posidonia Shale Formation in the Netherlands. Journal of Natural Gas Science and Engineering, 27(2), 558-577.
5. Verreussel, R.M.C.H., Bouroullec, R., Munsterman, D.K., Dybkjaer, K., Geel, C.R., Houben, A.J.P., Kerstholt-Boegehold, S.J. (in press) Stepwise basin evolution of the Middle Jurassic to Early Cretaceous rift phase in the Central Graben area of Denmark, Germany and the Netherlands. Geological Society of London Special Publications

List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.

Besides a programme lead role in national research, TNO has been and is strongly involved in various EU funded projects, the relevant ones being listed below.

1. EUOGA: inventory and assessment for shale gas resources in Europe (2015-2017)

TNO was involved in various regional Joint Industry Projects, executed by mainly European Geological Surveys and sponsored by the oil industry:

2. SPBA: Petroleum Geological Atlas of the Southern Permian Basin Area (2005-2010)
3. GASH: Gas Shales in Europe
4. Hypo-Lias and predecessors: (Jurassic source rock identification)
5. Focus: (Upper Jurassic stratigraphy and structures)

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work

BRO / Dino-Loket / NLOG: Portal and Repository of subsurface data and 3D models of the Netherlands. TNO maintains and disseminates all subsurface data from industry and in-house data acquisition programmes, including 3D seismic surveys, borehole data and seismic monitoring data. These data are public and available to the project.

TNO owns highly specialized 3D geological and geo-mechanical modelling software that is commonly used by international industry and scientific research organizations. These tools are available to the project.

Name of organisation	**BUREAU DE RECHERCHES GÉOLOGIQUES ET MINIÈRES**		
Participant Number/Short Name	4 / BRGM	**Country**	France

BRGM, France’s leading public institution in the Earth Science field, has three main activities: scientific research, support for government policy, and international cooperation and development assistance. Its fields of expertise are site selection and characterization, predictive modelling, risk analysis, monitoring and safety management, thus addressing a wide range of the issues related to sub-surface exploration and exploitation. BRGM has been among the pioneers in research on CO_2 geological storage, coordinator of the FP7 CGS Europe project (2010-2013), a Pan-European Coordination Action on CO_2 Geological Storage involving 34 research institutes over 28 countries and currently involved in the ECCSEL H2020 INFRADEV-3 project on CCS Research Infrastructure that started mid 2015 (onshore and offshore). BRGM is coordinating since 2015 the Franco-Canadian NSERC-ANR funded project G-Baseline focusing on baseline definition for impact assessment of unconventional gas development. BRGM is founder member of the "GAS HYDRATES" Research Group (GDR) recently created by CNRS (French National Center for Scientific Research) for a 4-year period beginning on January 1, 2018.

Key persons:

André Burnol, Male, PhD Environmental Geochemistry (Grenoble University, 2009), MSc. of Physical Oceanography and Engineer Diploma of ENSTA ParisTech (1992) is the team leader for safety of underground exploitations at the Risk Division of BRGM. He has more than 20 years of experience in hydrogeochemistry and its research field concerns the coupling of physical and (bio)geochemical processes controlling the mass transfer between water, gas and solid phases in porous media. His current research topic concerns the safety of storages and exploitations of the sub-surface (e.g. CO_2 storage, gas hydrates, energy storage). He has investigated CO_2 hydrate as an alternative method for storing CO_2 in the French Exclusive Economic Zone (EZZ). He will be the leader of the "Geosciences Scientific Pole" from the "GAS HYDRATES" CNRS Research Group (GDR) recently created for a 4-year period beginning on January 1, 2018.

Isabelle Thinon, Female, PhD marine geology and geophysics (Bretagne occidentale University, 1999). She joined BRGM since 2002 and has more 15 years research experience in the geology of the continental margins (deep basin and shelf). From 2009, she's in charge of the project "continental shelf", on the geological knowledge of French marine territories by new acquisitions and geological mappings. She is a member of the scientific committee of the "Actions Marges" research program. She participated to the CO_2 geological storage (PICOREF, VASCO) and geothermal projects (Bouillante/Soulz).

Hideo Aochi, Male, Ph.D. seismology (Tokyo University, Japan, 2000). He joined BRGM since 2004, contributing in R&D on quantitative natural/induced seismic hazard assessment, also honoured by two prizes from Japan. He has 56 publications (citation=652, h-index=13 e.g. http://www.researcherid.com/rid/A-3281-2011). He coordinated the BRGM research program of seismic hazard (2005-2012), as well as two national (ANR funded) seismic hazard/risk projects. He has been also scientific leader of BRGM research teams in two European projects (MARSite and NEMOH).

A list of up to 5 relevant publications, and/or products, services:

1. **André Burnol**, "Roles of gas hydrates for CO_2 geological storage purposes", *In: Gas Hydrates 2, Broseta, D., Ruffine, L., & Desmedt, A. (Eds.)*, John Wiley & Sons, 2018. *In Press.*

2. **André Burnol**, **Isabelle Thinon**, Livio Ruffine, J.-M. Herri, *Influence of impurities (nitrogen and methane) on the CO2 storage capacity as sediment-hosted gas hydrates – Application in the area of the Celtic Sea and the Bay of Biscay*. International Journal of Greenhouse Gas Control, 35, doi: 10.1016/j.ijggc.2015.01.018, 2015.

3. **GASCO2**: software coupling GMT, GERG-2008 and CSMGem to calculate the Gas Hydrate Stability Zone (GHSZ) and the Negative Buoyancy Zone (NBZ).

4. **Isabelle Thinon** et al., *Deep structure of the Armorican Basin (Bay of Biscay): A review from Norgasis seismic reflection and refraction data*, Journal of the Geological Society of London, vol.160, n°1, p.99-116(18), 2003.
5. **Hideo Aochi**, Thomas Ulrich, John Douglas, *Stress accumulation in the Marmara Sea estimated through ground-motion simulations from dynamic rupture scenarios*, J. Geophys. Res., 122, 2219-2235, doi: 10.1002/2016JB013790, 2017.

A list of up to 5 relevant previous projects:

1. "**Assessment of the feasibility of CO_2 storage in the Russian Permafrost**", Project reference: INTAS 2006-1000025-9220, INTAS Thematic Call on Earth Sciences and Environment 2006, Permalink: http://cordis.europa.eu/project/rcn/86213_en.html, 2009.
2. "**BIO-HYDRATES**", BRGM project on the CO_2/CH_4 hydrate formation/dissociation in biotic and abiotic conditions – Experimental platform BIOREP and modeling" 2014.
3. "**In-situ CO_2 geological Storage in New-Caledonia**", CNRT "Nickel and its environment" project (http://www.cnrt.nc/), BRGM participants: **Isabelle Thinon**, Pascal Audigane. 2014.
4. "**MIGRATE**", COST project (https://www.migrate-cost.eu), WG3 (Environmental challenges), Lead author: Umberta Tinivella. BRGM participants: **André Burnol**, Fabienne Battaglia-Brunet. 1st annual report, 2016.
5. "**GAS HYDRATES**", CNRS French Research Group (GDR) founded by IFREMER, ENSTA, Mines ParisTech, IFPEN, IRSTEA and BRGM, 2018-2022.

Name of organisation	**Bundesanstalt für Geowissenschaften und Rohstoffe**		
Participant Number/Short Name	5 / BGR	**Country**	Germany

The BGR is the Federal Institute for Geosciences and Natural Resources in Germany and resembles the central geoscientific authority within the German Federal Government. It is subordinate to the Federal Ministry for Economic Affairs and Energy and part of Germany's federal scientific and technical infrastructure. It cooperates on the European level with the National Geological Surveys and is member of EuroGeoSurveys. BGR provides independent advice based on geoscientific research on all geoscientific questions.
In the field of energy resources BGR continuously analyses and evaluates global developments in reserves, resources, exploration and markets for the energy resources crude oil, natural gas, coal and uranium. BGR researches and develops new exploration methods and strategies in the run-up to industrial activities, in particular in marine frontier zones and in the field of unconventional energy resources. It also develops energy resource production concepts taking ecological, social and economic criteria in to consideration, in particular in terms of development policy measures.

Persons who will be primarily responsible for carrying out the proposed activities

Stefan Ladage, Male, Diploma in Geology (University Hamburg). Senior scientist in the petroleum geology group of BGR, former head of temporary unit "Shale gas and oil in Germany" and former project leader of the resource assessment of unconventionals in Germany (NIKO-Project). Over 20 years experience in marine geosciences, structural and petroleum geology. Member of the EuroGeoSurveys GeoEnergy Expert Group.

Rüdiger Lutz, Male, Dr. Geology (RWTH Aachen). He is a senior scientist in the petroleum geology group of BGR. He studied geology in Aachen and received his PhD from Aachen University (RWTH). During his postdoc he was teaching applied basin modelling and he was involved in various industry projects.
Since joining BGR in 2003 he actively participated in 15 marine scientific cruises all around the world. He worked on multi-channel, high-resolution seismic and bathymetry data acquisition as well as sediment sampling. His main research topics are seismic interpretation and basin and petroleum systems modelling.

Jashar Arfai, Male, Dipl. Geoscientist (Leibniz University Hannover), 2016 PhD (Georg August University Göttingen; Dissertation: Sedimentary development and structural setting of the northwestern German North Sea; Entenschnabel). Since 2009 research associate at the Federal Institute for Geosciences and Natural Resources (BGR) with over 8 years of research experience of the North Sea Basin including seismic and well-log interpretation, structural geology, sedimentology and petroleum system modelling.

Simon Müller, Male, MSc Applied Geosciences (RWTH Aachen University). He is a research geoscientist at the German Federal Institute for Geosciences and Natural Resources (BGR). Simon does research on shallow gas accumulations in the German North Sea. He conducted seismic interpretation and petroleum system modelling to investigate the local shallow gas play, including the Plio-Pleistocene reservoirs, migration pathways, and potential Jurassic thermogenic source rocks.

Relevant publications, and/or products, services

1. Arfai, J., Lutz, R. (2017) 3D basin and petroleum system modelling of the northwestern German North Sea (Entenschnabel). In: Bowman, M. & Levell, B. (eds) Petroleum Geology of NW Europe: 50 Years of Learning – Proceedings of the 8th Petroleum Geology Conference, Geological Society, London. doi:10.1144/PGC8.35.

2. BGR (2016) "Schieferöl – und Schiefergas in Deutschland: Potenziale und Umweltaspekte"; 197 pp; https://www.bgr.bund.de/DE/Themen/Energie/Downloads/Abschlussbericht_13MB_Schieferoelgaspotenzial_Deutschland_2016.pdf?__blob=publicationFile&v=5

3. Müller, S., Reinhardt, L., Franke, D., Gaedicke, C., Winsemann, J. (2018). Shallow gas accumulations in the German North Sea. Marine and Petroleum Geology 91, 139-151. doi: 10.1016/j.marpetgeo.2017.12.016.

4. Stück, H., Houseknecht, D., Franke, D., Gautier, D., Bahr, A., Ladage, S. (2015). Shale-Gas Assessment: Comparison of Gas-In-Place Versus Performance-Based Approaches. Natural Resources Research 25, 315-329. doi: 10.1007/s11053-015-9283-y.

5. http://www.gpdn.de/: website with products (eg. GIS-data) of the GPDN project

Relevant previous projects or activities

1. **GPDN:** Geo-Scientific Potential of the German North Sea (2009-2013): http://www.gpdn.de/
2. **NIKO:** „Erdöl und Erdgas aus Tongesteinen – Potenziale für Deutschland" (2011-2015)
3. **TUNB:** "Subsurface potentials for storage and economic use in the North German Basin" (2014-2021)

Name of organisation	**British Geological Survey**		
Participant Number/Short Name	6 / BGS	**Country**	United Kingdom

The British Geological Survey (BGS) is a component organization of the Natural Environment Research Council (NERC – legal entity), the UK's leading body for basic, strategic and applied research and monitoring in the environmental sciences. The BGS itself was founded in 1835 and is the world's longest established national geological survey. BGS seeks to advance the understanding of the structure, properties and processes of the solid Earth system through interdisciplinary surveys, monitoring and research for the benefit of society. BGS is a public sector organization responsible for advising the UK government on all aspects of geosciences, as well as providing impartial geological advice to industry, academia and the public. It is the UK's premier provider of objective and authoritative geoscientific data, information and knowledge for sustainable use of natural resources, reducing risk and living with the impacts of environmental change. BGS has over 600 staff with a range of experienced scientific and technical staff engaged in the collection of all types of geosciences data, its processing, interpretation, and archiving as well as the production of digital data products.

Key persons:

Keith Bateman, Male, MSc Geochemistry (Leeds University). He is a Senior Geochemist at the British Geological Survey (BGS) with over 30 years research experience in the design, execution and interpretation of experiments and computer simulations of rock-water interactions applied to the geological disposal of radioactive and hazardous wastes, CO_2 sequestration, geothermal energy, gas hydrates and the influence of microbes in geological environments. He has conducted methane hydrate formation/breakdown experiments to assess methodologies for monitoring gas release during the recovery of hydrate-rich core from the floor of deep oceans.

Edward Hough, Male, is a senior geologist with research interests in quantifying geological variability of shales and the resultant impact on hydrocarbon prospectivity, as part of the Energy Systems & Basin Analysis Directorate at the British Geological Survey based at Keyworth, Nottingham. Edward has over 20 years of largely field-based research into UK geology, built up through working on numerous strategic surveys and commissioned activities for clients including the EU, World Bank, UK regulatory bodies and international consultants. Field survey work has centred on the mapping of Carboniferous and Permo-Triassic basins in central and north-west England. Edward leads research by the British Geological Survey relevant to shale gas designed to answer two broad scientific questions: what are the geological controls on hydrocarbons in shales, and what are the geological influences associated with environmental concerns. Edward has researched potential gas shale horizons including the Carboniferous and Jurassic, and he has published on subjects including: shale prospectivity in the northern Pennine Basin; linkages between deposition, organic matter and mineralogy of the southern part of the Pennine Basin. Recent work is based in the Preston area, covering part of an area currently under active exploration for shale gas, and also investigating potential prospectivity of UK shales. Collaborative research interests include the co-supervision of 2 Ph.D. studies with the Universities of Manchester (Carboniferous shale diagenesis), and Newcastle (Shale geochemistry), and also the supervision of a Post-Doctoral Research Associate at BGS investigating the relationship between sediment facies and hydrocarbon prospectivity of Carboniferous shales in central England. Knowledge exchange and outreach activities have involved regular presentations of shale science to interested public groups and industry as an invited and keynote speaker (e.g., EAGE Special Lecturer, 'Shale Gas Perspectives' in 2011). Edward co-convened and co-chaired the 2014 SPE-EAGE European Unconventional Resources Conference and Exhibition has been interviewed on BBC National and Regional TV and radio, French National TV, and national and regional press and web.

Christopher Alan Rochelle, Male, PhD Geology (Leeds University) – 'Fluid-rock interaction in the Miravalles Geothermal Field, Costa Rica. Mineralogical and experimental studies'. He is a Senior Geochemist with over 30 years research experience into various aspects of the geochemistry of fluid-rock interactions. Work areas include geothermal systems, thermal energy storage, gas hydrates, CCS, subsurface disposal/storage of radioactive waste. He has extensive experience in the design, construction, operation and interpretation of fluid-rock experimental studies over a wide range of temperatures and pressures, and in the management of the work programmes. He has investigated CO_2 hydrate as a potential 'non-conventional' methodology for storing CO_2, either below the floor of deep oceans or below permafrost. He led studies using high resolution cryo-SEM to investigate hydrate-sediment-porewater relationships at pore scale.

Margaret Stewart, Female, PhD Geology (Imperial College) is the team leader for Petroleum Geoscience at the BGS with research background in 3D seismic interpretation. Margaret completed her PhD in 2008 looking at the shallow Quaternary geology of the central North Sea and worked for Neftex Petroleum consultants before joining BGS in 2011. She has worked largely on large international collaborative industry projects with a focus on the regional geology of the North Atlantic, in particular, the frontier areas west of Shetland and in the Rockall Basin, including the potential for gas hydrates as resource and hazard. Margaret is also a Business Development Manager for Energy; promoting and leading bids for energy-related tenders and leading the development of petroleum-related overseas work. She has extensive project management experience in the Petroleum Geoscience team and beyond.

A list of up to 5 relevant publications, and/or products, services:

1. Newport, S M, Jerrett, R M, Taylor, K G, Hough, E & Worden, RH. In Press. Sedimentology and microfacies of mud-rich slope successions: the Carboniferous Bowland Basin, NW England (UK). Journal of the Geological Society.
2. Cuss, RJ, Wiseall, AC & Hough, E. 2017. Bedding and fracture influence on hydraulic fractures. Deliverable report no. 1.3, European Union Horizon 2020 M4ShaleGas project, agreement number 640715.
3. Hennissen, JAI, Hough, E, Vane, CH, Leng, MJ, Kemp, SJ & Stephenson, MH. 2017. The prospectivity of a potential shale gas play: an example of the southern Pennine Basin (central England, UK). Marine & Petroleum Geology 86, 1047 - 1066.
4. Fleming, C; Hough, E; Kemp, S. 2016 Feasibility of ASD AgriSpec analysis to indicate mineralogy of a potential shale gas reservoir from West Lancashire, UK. Energy Procedia, 97. 326-333. 10.1016/j.egypro.2016.10.009
5. Gunn, D. A., Nelder, L. M., Rochelle, C. A., Bateman, K., Jackson, P. D., Lovell, M. A., Hobbs, P. R. N., Long, D., Rees, J. G., Schultheiss, P., Roberts, J. and Francis, T. (2002), Towards improved ground models for slope instability evaluations through better characterization of sediment-hosted gas-hydrates. Terra Nova, 14: 443–451.

A list of up to 5 relevant previous projects:

1. Unconventional Carboniferous Basins industry co-funded consortium (2014 – 2017)
2. BGS Unconventional Oil and Gas project (2009 – present)
3. BGS-DECC sponsored shale resource assessments (published 2013 – 2016)

Name of organisation	**SRDE "GEOINFORM OF UKRAINE"**		
Participant Number/Short Name	7 / GEOINFORM	**Country**	Ukraine

SRDE "GEOINFORM OF UKRAINE" (GEOINFORM)

The State Research and Development Enterprise "State Informational Geological Fund of Ukraine" – SRDE "GeoInform of Ukraine", or GeoInform, is the specialized research and development unit of the State Geological and Subsurface Survey of Ukraine which collects, stores, analyses and provides information received from geological study and use of subsurface.

GEOINFORM conducts research work on monitoring of mineral resources of Ukraine on the basis of geological and mining activities during the year, recording deposits and making public the balance of mineral resources management of the State fund of deposits and occurrences (more than 10,000 objects recorded), synthesis and analysis of exploration for oil and gas, creating a system of state accounting of oil and gas wells, completion and maintenance of the State cadastre of mineral deposits and occurrences as well as State cadastre of groundwater deposits of Ukraine. GEOINFORM is involved in the European and national projects ESTMAP, EUOGA, NUMIRE and EIMIDA.

Key persons:

Dr. hab. Boris Malyuk, male, Director, Center for International Cooperation, graduated in 1981 from Department of Geology, Lviv University, Ukraine, and in 1999 from Centre of Geostatistics, Ecole des Mines de Paris, France. Obtained Candidate of Science (PhD) Degree in Geotectonics in 1984, and extended Doctor of Science Degree in Petrology in 1991. National Delegate of Ukraine to the EuroGeoSurveys.

Dr. Igor Melnyk , male, Deputy Director, Center for International Cooperation, with basic background in geology, has an experience in field works and research in geochemistry, hydrogeology and ecology (PhD in 1996), as well as geoinformatics and GIS applications.

A list of up to 5 relevant publications, and/or products, services:

1. Interactive map of mineral deposits of Ukraine (in Ukrainian) http://geoinf.kiev.ua/wp/interaktyvna-karta-rodovyshch-korysnykh-kopalyn.htm
2. Interactive map of mineral licenses (in Ukrainian) http://geoinf.kiev.ua/wp/interaktyvni-karty-spetsdozvoliv.htm
3. Interactive geological map of Ukraine 1:1 000 000 (in Ukrainian) http://geoinf.kiev.ua/wp/Interaktyvna-heolohichna-karta-Ukrayiny.htm
4. Interactive geological map of Ukraine 1:1 000 000 (in English) http://geoinf.kiev.ua/wp/Interactive-Geological-Map-of-Ukraine.htm
5. Interactive State Geological Map of Ukraine 1:200 000 (in Ukrainian with English entries) http://geoinf.kiev.ua/wp/kartograma.htm

A list of up to 5 relevant previous projects:

1. ESTMAP - EU
2. EUOGA - EU
3. NUMIRE – Norway-Ukraine (NGU/SGSSU)
4. EIMIDA – Norway-Ukraine (NGU/Geoinform)

5 Ethics and Security (This section is not covered by the page limit)

5.1 Ethics

Do you have an ethics self-assessment? (See “How to complete your ethics self-assessment”)

NO

(If YES, please upload this as an additional document in ISAAC under the tab Attachments – Other)

5.2 Security

Please indicate if your project will involve:

- Activities or results raising security issues: NO
- 'EU-classified information' as background or results: NO

(See for guidance this document)

5.3 GeoConnect³d

Project proposals GeoERA
Stage Two Call

COVER PAGE

Title of project proposal

Short name:

GeoConnect³d

Title:

Cross-border, cross-thematic multiscale framework for combining geological models and data for resource appraisal and policy support

Abstract

The GeoConnect³d project will develop and test a new methodological approach to prepare and disclose geological information for policy support and subsurface management. The improved approach will be developed and tested using two regional case studies – the Roer-to-Rhine region and the Pannonian Basin. These regional, cross-border case studies are chosen to be complementary and sufficiently different in geological setting and degree of implementation of subsurface exploitation and management, in order to maximize their pan-European relevance. The case studies will use a novel bottom-up approach that introduces two concepts that increase the geological understanding of an area and are aimed at providing a coherent geological context for evaluating subsurface applications and resolving subsurface management issues. The first new concept is the structural framework as a means of joining existing models of different scale and resolution to clarify the importance of planar structures in a way that makes the geology understandable to stakeholders involved in subsurface management. The second concept is that of geomanifestations. These specific expressions of geological processes are important sources of information for improving geological understanding. The structural framework models annotated with geomanifestations will allow the integration and evaluation of complex cross-thematic research. The two bottom-up regional case studies form the study material for a top-down, more generic evaluation of potentially interacting subsurface activities that allows revisiting and refining state-of-the-art methods. Valorisation of regional results at pan-European level is ensured by testing the methodologies in two smaller pilot areas in Germany and Ireland.

Specific Research Topic

GeoEnergy – GE6-Enabling subsurface management and decision support

List of participants

Funded partners

#	Participant Legal Name	Institution	Country
1	Royal Belgian Institute of Natural Sciences – Geological Survey of Belgium ***(Project Coordinator)***	RBINS-GSB	Belgium
2	Vlaams Planbureau voor Omgeving	VPO	Belgium
3	Vlaams Instituut voor Technologisch Onderzoek VITO will act as a third party of VPO	VITO	Belgium
4	Federalni zavod za geologiju – Geological Survey of Federation of Bosnia and Herzegovina	FZZG	Bosnia and Herzegovina
5	Hrvatski Geološki Institut – Croatian Geological Survey	HGI-CGS	Croatia
6	Ceska Geologicka Sluzba – Czech Geological Survey	CGS	Czech Republic
7	Bureau de Recherches Géologiques et Minières	BRGM	France
8	Bundesanstalt für Geowissenschaften und Rohstoffe	BGR	Germany
9	Bayerisches Landesamt für Umwelt	LfU	Germany
10	Magyar Bányászati és Földtani Szolgálat – Mining and Geological Survey of Hungary	MBFSZ	Hungary
11	Department of Communications, Climate Action and Environment (GSI)	GSI	Ireland
12	Service Géologique du Luxembourg	SGL	Luxemburg
13	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek	TNO	Netherlands
14	Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy	PIG-PIB	Poland
15	Institutul Geologic al României	IGR	Romania
16	Geological Survey of Serbia	GSS	Serbia
17	State Geological Institute of Dionyz Stur	SGIDS	Slovakia
18	Geološki zavod Slovenije	GeoZS	Slovenia
19	State Research and Development Enterprise State Information Geological Fund of Ukraine	GeoInform	Ukraine

Non-funded partner

#	Participant Legal Name	Institution	Country
20	Geologischer Dienst Nordrhein-Westfalen	GD NRW	Germany

1 Excellence

The transition towards a clean and low carbon energy system (EU 2030 climate/energy framework, SET-Plan) will be accompanied by far-reaching changes in energy production. In line with this envisaged energy transition, the importance and use of the subsurface rapidly increases. Despite the vastness of subsurface space, only a fraction of it is suitable for the exploitation of geo-resources. The distribution and fitting combination of required conditions is determined by geological processes. We are, therefore, much constrained in where we can develop resources and capacities. Moreover, many applications have similar requirements (e.g. porous intervals, sealed volumes), which increases the chance of interferences and conflicts of interest.

Due to the increased focus on subsurface resources, local authorities and the EU are in need of transnational models and knowledge about the interaction between different subsurface activities and their impact in order to define a subsurface policy. In many cases, resources are intrinsically linked. Combining data on different resources can lead to a better understanding of the underlying processes and may help to evaluate the interaction between and the impact of different subsurface activities.

Fully aligned with the challenge of SRT GE6 (Enabling subsurface management and decision support), this project aims to define and test a **cross-thematic workflow to evaluate geological phenomena and subsurface activities in a cross-border setting**. The workflow will use a multi-scale approach that facilitates the integration of existing models in a coherent structural framework. Focusing on faults and determinant features integrated in models at different scales is an innovative, pragmatic means of resource appraisal supporting a **better understanding and management of the water-energy-raw materials nexus and potential impacts and risks of subsurface use**.

1.1 Aims and objectives

The prime aim of GeoConnect³d is the conversion of geological data into subsurface information and critical parameters that can be used for various geo-applications, decision-making and subsurface spatial planning. The methodology to make this translation will be developed and tested in **two regional case studies** involving different countries and regions. The case studies are chosen as representative for testing **common workflows in a cross-border, cross-thematic and multi-scale context**. The two case studies will **share similar methodological principles**, will use a similar workflow and have **complementary challenges** to increase the pan-European relevance of these test cases.

The ambition of the project reaches further than being an exercise on cross-border, cross-thematic mapping. Ultimately, the project will **pave the road for a new approach to be applied throughout Europe**, and therefore has a clear focus on demonstrating that the methodology can be transposed to other regions and geological settings. For this purpose, **two small-scale one-country pilots** are included to specifically **test the transferability of the methodology**.

Whereas the two regional case studies have a strong bottom-up approach, bridging the gap between the fundamental geological work and the policy level, a more typical approach is to rely on **generic, top-down assessments** to evaluate the impact of subsurface applications and to manage the subsurface. These generic approaches will be further developed in GeoConnect³d, especially by testing them against the results of the actual case studies. The goal here is to come to **well-substantiated best practices that, in a general way, highlight the complexity, as well as the main lessons, of subsurface management**.

The GeoERA context offers a unique opportunity to address **inter- and cross-thematic challenges**, which is at the very heart of the GeoConnect³d project objectives. GeoConnect³d takes maximum advantage of this situation by focussing strongly on one- and two-way relations with other GeoERA projects. This includes integrating data from other projects under the geoenergy theme (e.g. GE2-HotLime, GE4-Hike), as well as from projects under the groundwater and raw materials themes (e.g. GW1-HOVER, RM4-FRAME).

Optimizing the use and management of the subsurface requires **disclosure of cross-border, cross-thematic geo-information in a way that is understandable and tailored to the needs of different stakeholders and end-users**. Within GeoERA, the EGDI platform is developed for this purpose under the Information Platform theme.

1.2 Relation to existing programmes and projects

Judging from the number of projects, subsurface management is not at the heart of European funding programs, especially in a cross-thematic context. One of the pioneering projects is GeoMOL, funded as part of the European Territorial Cooperation (2007-2013). The geological setting of GeoMOL is the Alpine Foreland Basins, with the aim of mapping subsurface potentials. The project, however, stayed largely clear of subsurface management issues. A similar project is GeoORG, co-funded by the European Regional Development Fund (2008-2012), and of which the resulting geological model will be incorporated in WP3 (Roer-to-Rhine).

Thematically oriented research projects are more common, and will provide input either directly or through the thematic GeoERA projects that source them. These cover geothermal energy (TRANSENERGY, DARLINGe, and GEOHEAT.App), energy storage (Estmap), unconventional hydrocarbons (EUOGA), or CO_2 geological storage (GeoCapacity, CO_2Stop).

Nationally and regionally funded mapping projects are important background for GeoConnect³d and are briefly mentioned here for the sake of completeness. It is not only the models themselves, but also the experience behind them that are of relevance to GeoConnect³d. For the Roer-to-Rhine study these include the cross-border NL-BE projects H3O De Kempen and H3O Roerdalslenk, the Dutch DGM-diep V4 onshore geological model, the 3D geological model with 3D fault planes of Flanders (G3Dv2, G3Dv3), and the ongoing 3D subsurface modelling of Luxembourg. For the Pannonian Basin, a 3D geological model of basin area in Hungary, the major part of the basin, is available.

1.3 Concept and methodology

GSOs and administrations have their own approaches to collect, inventory and analyse subsurface data, leading to different disclosure of geological information. Any cross-border geological evaluation therefore requires a process to harmonize and integrate the necessary geological data and to define a common workflow. When defining such a process, it is important to take into account the local character of geological units, the way resources are defined and the practices used to analyse them. Also, differences in data quality and density, as well as in local policies, require adaptions. **Overarching workflows for pan-European evaluations therefore need to consider the local reality** and need to be tested at the local level. **Conversely, local policy may benefit from guidelines and standards defined at the European level** that set up efficient processes to evaluate cross-border geological phenomena.

Although GeoConnect³d features two central case studies that can be developed within the project itself, one of its most distinctive features is that it is not a stand-alone project. As far as possible, GeoConnect³d and its case studies will make use of technical and cross-thematic input from other projects. The interaction with other GeoERA projects is organized in WP2 and is conceptualised as a **three-stage process**.

The **basal level is geological understanding**. These comprise collecting available geological information, such as represented in geological maps and models, together with geological data that are informative about ongoing and past geological processes, referred to as geomanifestations, in a coherent structural framework. This level of knowledge is more than literature that collects the thematic information. Rather, it represents the pre-project state of understanding of the regional geology, and comprises the required context to, for example, understand the potential relations between different subsurface activities and their vertical or lateral footprints.

A **geomanifestation** is **defined** here as any distinct expression of an ongoing or past geological process at surface or at depth. Examples include seismicity, gas seeps, anomalous water chemistry in groundwater and springs, thermal anomalies, non-sedimentary mineral occurrences, jumps in hydraulic head, overpressurised zones and geomorphological disturbances.

A **structural framework model** is traditionally used complementary to a stratigraphic model, and showing the tectonic structures as isolated elements to better analyse or visualise the deformation regime or history of the modelled zone. The novelty in GeoConnect³d is that it will be used at a regional scale to connect existing detailed models.

It will also be combined with the (non-structural and non-stratigraphic) information from geomanifestations, in order to arrive to an **annotated (structural) framework model** that will be the basis for the regional study of subsurface management issues.

The **second level is thematic research**. This level can be prepared in other proposed GeoERA projects, if they receive funding, but is given its regional meaning in GeoConnect³d, where the results are analysed in light of policy related objectives, such as optimal use and cross-border sharing of geological resources.

Placing all information in a **structural framework** containing the relevant elements and illustrating the links and relations between the data, resources, and geological units is considered crucial. Structural frameworks are used as specialised models. The framework approach in GeoConnect³d takes their application a significant step further, using them as a **basis to structurally connect different sub-models and datasets on a regional scale** in order to analyse and document potential interactions, feedbacks and impacts (WP3, or R2R case). In WP4 (Pannonian Basin case) the focus is directly on realising an annotated structural framework model that will be used to ch**allenge the regional geological 3D-model, and thus the state-of-the-art geological understanding** of the basin with respect to fluid and heat flow. Linking geomanifestations to the regional framework model is also done in WP3 to visualise and improve cross-border geological knowledge.

The basic and thematic levels form the basis for **the final stage, in which subsurface management issues are raised.** This stage explicitly involves interaction with policy makers. The structural framework described above will be used to highlight those elements that need to be taken into account when (a) foreseeing problems or (b) actual issues related to subsurface management have arisen. This transparent representation of geological reality is used during the project as the basis for an interactive discussion round to identify research questions with a high policy relevance.

The case-based approach developed in WPs 3 and 4 is challenged in WP 5 with a more generic approach, in which subsurface activities are placed in a generalised context in order to assess their intrinsic value and potential degree of interaction, thereby making use of the unique project context of testing top-down assessment methods using the more detailed and specific pilot studies.

1.4 Ambition

GeoConnect³d is designed to be a **catalyst for a new series of pan-European projects, developing a new approach based on annotated structural frameworks that will enable more efficient realisation of cross-border projects in challenging geological settings**.

The building blocks of the methodology that will be explored within GeoConnect³d can be grouped into the different stages discussed above (fundamental geological understanding, thematic research, and subsurface management). Each of these is a research topic in its own right and up to now they have often been approached independently. However, adequately addressing the challenges that society is facing today requires a combined approach, which still needs to be transparent, have acceptable project scale and execution time, and result in applied as well as science-based outcomes. **For an efficient Europe, cross-border and cross-thematic issues require an encompassing methodology to bring together results in a harmonising and coherent context.** At the core of this new approach are the **annotated structural framework models, which GeoConnect³d puts forward** as an important tool that will allow pan-European projects to take on more complex challenges than is currently possible.

However, GeoConnect³d explicitly wants to go beyond the point of developing a new methodology, and also **demonstrate that its workflow is ready to be implemented at pan-European level**. The main testing and documenting is done in two cross-border case studies, but the maturity and universality of the approach is also demonstrated within the project in two independent one-country pilot studies. Thereby, the number of countries and organisations with hands-on experience is increased, but even more importantly, the method delivered after three years is not only fully developed and documented, but also demonstrated in four different case and pilot studies.

Although GeoConnect³d emphasises the importance of including regional context in a bottom-up methodology for optimal subsurface management, it fully acknowledges that **top-down assessments** have their place, for example to guide pan-European discussions or early-stage assessments. This, however, requires that these generic approaches are **realistic and compatible with regional case studies**. The difficulty seems to be that, while development and enhancement of top-down assessments for identifying potential subsurface conflicts and synergies is not a unique topic, the results are generally theoretical and lack practical verification.

This is not the case in GeoConnect³d, in which research into top-down assessment schemes is built around making direct use of the cross-border case studies as exemplar material. Creating this unique context significantly increases the level of expectation with respect to the reality of the lessons to be learned from top-down assessment strategies.

2 Impact

GeoConnect³d has the ambition to set new standards for integrating cross-border and cross-thematic geological information in annotated structural framework models that can serve as a basis for the management of geo-resources and to disclose the information in a way that is customized to the needs of the end-users.

To achieve this ambition, the project partners will:

- Develop and test new workflows to build large-scale structural geological models in a way that fosters collaboration and knowledge transfer between specialists from the different countries or regions, and that simplifies the closing of knowledge gaps by combining different data sources;
- Enrich the large-scale structural geological models with observations from different fields in order to advance the understanding of geological processes;
- Explore ways to serve the information needs of the different stakeholders that are involved in the exploitation of geo-resources and subsurface spatial planning;
- Develop and test new IT-solutions to visualize and disclose the geo-information embedded in the annotated structural framework models in a way that is customized to the needs of the end-users (with focus on regulators, planners and policy makers).

The workflows and tools that will be developed in GeoConnect³d will make it easier for the European GSOs to provide fundamental input to local and European policy levels, allowing for the proper uptake of geological information in future societal planning.

2.1 Expected impact

The energy transformation that is intimately linked to the growing awareness of the causes and consequences of climate change has diversified the interest in local geo-resources, including conventional and unconventional oil and gas, gas storage, thermal energy storage and geothermal energy. The fact that these resources share the same or adjacent reservoirs has led to the emergence of subsurface spatial planning as a new topic in applied geosciences. Especially where there are overlapping potential and interests in cross-border areas, a better alignment of national science and policy approaches is needed to come to an acceptable and fair use.

It is clear that **conflicts arising from the use of geological resources, the non-optimal use of geological resources, or overlooked synergies are issues that need to be avoided**. **This, however, requires a correct understanding** of the potential physical effects or interactions associated with exploitation of geoenergy resources, as well as groundwater and raw materials, where these potentially influence each other. This forms the starting point of GeoConnect³d.

GeoConnect³d will, through its two case studies and by developing more general evaluation schemes, act as a demonstration case for pan-European efforts in sharing and harmonizing national and regional data and building cross-border, cross-thematic geological models. The workflow for collecting, harmonizing and disclosing geological data for different applications and at different scales that will be developed within the project, can serve as a backbone for future services for applied geo-sciences in Europe, as well as for the definition and harmonization of regional, national and European policy with respect to geo-resources.

What is unique about the approach is the combination of data and knowledge from different geological disciplines. This will lead to new insights in complex geological processes. Trends or processes that appear to be erratic from one perspective can, in many cases, be understood when knowledge from other fields is taken into account. The same is true when evaluating the impact of subsurface activities, which can be misjudged when complex interactions between several processes are not considered or understood.

In addition, the project will provide two large and two smaller pilots that test and optimize concepts and standards for the harmonization, management, visualization and documentation of geo-information identified at the European level. Thereby, the project contributes to the long term ambition to **integrate Europe's information and knowledge on geo-resources to support sustainable use of the subsurface in addressing Europe's societal challenges.**

Following from above, GeoConnect³d will make substantial progress in the following pan-European challenges:

- Methodologies for **harmonising** and integrating cross-border, cross-thematic geo-information;
- **Mapping and modelling strategies for resource assessment** that allow cross-border, cross-thematic consistency;
- Methodologies to analyse the impact of resource exploitation using a cross-thematic approach;
- Methodologies to analyse the interaction between subsurface activities;
- Improved knowledge about complex geomanifestations;
- Tools to **disclose geo-information to decision makers** and other end-users.

As GeoConnect³d will bring together geo-research into a common context, it will improve the **valorisation of ongoing and past projects** on which it relies, facilitating the communication of their results. It adds value to ongoing and past national efforts in optimising the use of the underground. This includes preventing and managing potential competitive uses (e.g. interfering injection projects), and removing obstacles for further development of the subsurface.

This will be demonstrated in two larger case studies, and two one-country pilots for testing the transferability of the developed methodology. By putting the method into practice in this way**, direct results will be generated for 15 of the 16 countries in a challenging cross-border context** (Poland is the only participant without a concrete case or pilot study, but is a leading partner for setting up the generic evaluation in WP5).

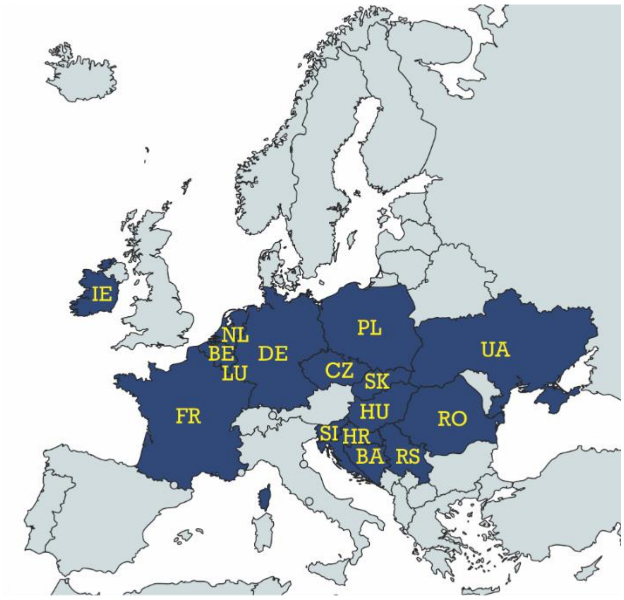

Figure 1: The 20 national and regional partner institutes represent 16 European countries.

At the same time, this approach will test and demonstrate the exchange of information and knowledge about geo-resources, thoroughly preparing the cross-border, cross-thematic evaluation methodologies to be scaled up to the European level. Apart from the 16 countries that will have been involved in developing and optimizing these methods (fig. 1), additional GeoERA partners will be asked to review the case studies as these are being developed and implemented. These other GSOs will reflect, using their own background and experience, on how this can foster pan-European implementation. The result will be a large group of European geoscientists that will be familiar with the GeoConnect³d workflow that will be proposed as a new template for post-GeoERA projects. The data structure will allow and even facilitate future maintenance and updates, encouraging it to be used in post-project initiatives.

GeoConnect³d will focus on understanding geological processes using advanced visual representations based on the annotated structural framework that allows explaining them, and translating their relevance and relation to exploitation of geological resources to stakeholders from different backgrounds. This again is an aspect that will pave the way for a more consistent and scientifically based national and European planning of the subsurface.

2.2 Measures to maximise impact

2.2.1 Dissemination and exploitation of results

Communication, dissemination and exploitation are the corner stones of H2020 Dissemination and Exploitation Plans (DEP), and are as such defined as *'Taking strategic and targeted measures for promoting the action itself and its results to a multitude of audiences, including the media and the public, and possibly engaging in a two-way exchange'* (Communication), *'The public disclosure of the results by any appropriate means, including by scientific publications in any medium'* (Dissemination), *and 'The utilisation of results in further research activities other than those covered by the action concerned, or in developing, creating and marketing a product or process, or in creating and providing a service, or in* *standardisation activities'* (Exploitation). A DEP will as such cover outreach activities (communication), transfer of knowledge (D), and valorise it towards societal challenges (E).

The table below summarizes the planned activities of the tentative DEP. Consult the deliverables and milestones table (tables 3.1c and 3.2a) for the timing of the related actions. Setting up the DEP is an action under task 1.4, and its implementation is discussed in the WP1 description.

Objective	Type	Target audience	Planned activities, channels	Involved WPs	C-D-E targets
Inform about the project, its objectives and activities Growing public awareness of subsurface as vulnerable resource	C	General public, Scientific community, Local stakeholders in the pilot areas, EU stakeholders, GeoERA group	Website ResearchGate project page Twitter Blog	WP 1, WP3-5 as main sources	100 visits 20 followers Messages are being retweeted Growing number of followers, and interest from science journalists
Interaction with regional stakeholders in R2R area Growing awareness of need for subsurface management	C,D,E	Local stakeholders in the pilot areas	Regional stakeholder event R2R	WP 3	Interest of stakeholders in results and in follow-up activities
Interaction with regional stakeholders in Pannonian Basin Growing awareness of need for subsurface management	C,D,E	Local stakeholders in the pilot areas	Regional stakeholder event Pannonian Basin	WP 4	Interest of stakeholders in results and in follow-up activities
Interaction with European stakeholders Growing awareness of need for subsurface management	C,D,E	EU stakeholders	Pan-EU stakeholder event	WP 5	EU stakeholders and those from other regions accept tested methodologies. Forward planning possible.
Scientific sharing of innovations and research results	D	Scientific community	Two or three IF publications (depending if efforts are joined)	WP 3-5	Publications accepted Publications cited
Sharing and interaction with GeoERA partners	D,E	GeoERA group	Presentations at kick-off, mid-term and final GeoERA events GeoERA partner review of methodologies (cf. T5.1)	WP1-5	Taking up of project methodologies in national/regional programs
Sharing developed methodologies	D, E	Scientific community and GeoERA group	Documentation of structural framework model methodology Documentation of geomanifestation data management Documentation of visualization techniques for complex spatial relations	WP1, 2	Recycling of developed methodologies and standards

2.2.2 Communication activities

Communication activities strongly focus on the underlying motivation of the GeoConnect³d project, which is that most players in society are insufficiently aware that the subsurface forms a precious and vulnerable resource. From a communication point of view, this is still a very much underexploited and highly rewarding topic that can be approached from different angles, using results as they become available throughout the project for the different regional cases.

Some communication channels discriminate according to their target groups, such as the project page on ResearchGate which is a free, but closed, community for researchers (members need to be an author of at least one publication). This allows for more targeted communication, which nearly always involves an aspect of dissemination because the information there is used by other researchers to orient or focus their research.

Less-discriminating channels target audiences that are primarily the general public, but also science journalists, stakeholders at policy levels, etc. This is possible because the starting point of communication is sustaining society, using geological research to consider sustainability aspects that are currently too out-of-view. The ongoing project will make it possible to communicate on this topic in a concrete and well-supported way.

While the website will act as a starting point for those who look for specific information on this topic, the blog sits on the other side of the communication spectrum, aiming to create an interested audience that follows interviews with a new researcher every two weeks. Having a blog is particularly important, because they are a prime source of information for science journalists when screening for topics.

A fast and universal medium is Twitter, which will be used to bring larger and smaller achievements of the project to the attention of different stakeholders. The benefit of Twitter is that the GeoConnect³d account can be directly linked to that of GeoERA, EuroGeoSurveys, and those of the partner institutes. A dedicated follower-group can thus be established relatively quickly, and an even wider group is informed of the existence of the project and its major milestones.

In addition to using these specific communication tools to support the above mentioned dissemination and exploitation actions, each of them will also offer specific communication opportunities, such as establishing dedicated network contacts.

2.3 Contribution of Project Proposal to the Information Platform or vice versa

The project will focus on combining existing models to build a coherent cross-border, cross-thematic geological framework. Documentation of the underlying data sources and models is essential for future use. The project will strive for the development of **INSPIRE-compliant meta-data for all the building blocks**.

GeoConnect³d will gather **cross-thematic data of two types that require dedicated attention because of their non-standard properties: structural planes and geomanifestations**. Therefore, they both are given particular attention in the project. Fault and other planar structures are the basic building blocks of the structural framework model, and therefore of crucial importance to the two regional case studies developed in WP3 and 4, as well as the one-country pilots in WP5, and the overarching European structural framework as a maximal scale extension of the regional studies. As the structural framework will be the first of its kind to be realised, with a slightly different scope in the different cases, estimating a-priori the amount of data entries is highly uncertain, but will certainly be expressed as hundreds of data entries or more. The standards and data structure will rely on the development of the Fault DataBase (FDB) in the GE4-HIKE project, but will also have to run in parallel to a large extent, because the FDB will not only be an end-point, but also act as a tool for the structural modelling. Therefore, next to having a dedicated task for interfacing with the IP project (T2.2), GeoConnect³d also has a similar task for interacting with GE4-HIKE to ensure efficient co-development (T2.3).

The aspect of **subsurface management requires additional functionality of the EGDI platform** that exceeds the requirements of other projects. It is the only project that has asked for support to display the structural framework models in three dimensions, in a semi-transparent way and with seamless multi-scale zooming displaying different levels of details of the planar elements that constitute the model. On top of this, existing 2D and 3D models of different types need to be shown as embedded in the framework and point data that represent geomanifestations need to be visually combined, preferentially in an annotated way.

This sets an additional challenge for the IP project, and communication between the project groups was opened during the preparation of the proposals, making use of what will become the interface communication channels. The joint evaluation on whether the requests of GeoConnect³d can be achieved by the Information Platform within the GeoERA goals and means were favourably concluded with demonstration tests of the **point-cloud approach**. This methodology queries databases containing planar objects using a mesh with an optimal orientation, and allows representing each plane in true 3D as a series of uniformly coloured points. This is a highly performing, compatible and flexible method that is fully in line with the visualisation goals of GeoConnect³d.

Geomanifestations are a diverse group of observations that are usually point, quite often time-series, and less commonly non-point objects. The term is coined within GeoConnect³d because of the central role they play in different parts of the project (especially WP3 and 4). In order to align the collection, storage and presentation of these data, a Project Data Management Plan (PDMP) will be put in place, of which version 1 will be proposed within the first 6 months of the project as part of T1.3 of WP1. The amount of data collected on geomanifestations will be large, especially where existing data sources can be used (such as on seismicity) or where they can be incorporated from other GeoERA projects, and the main challenge will be to maximise their diversity in such a way that each adds to better geological understanding.

The projects PDMP, guidelines for structural framework models, involvement in the FDB, and the support to EGDI are fully focused on realising live datasets and models. Furthermore, the one-country pilot studies will evaluate the appropriateness of the methodologies and data structure that are being set up in GeoConnect³d for future users.

3 Implementation

3.1 Work Plan – Work packages, deliverables

The GeoConnect³d project is built around the central mission of subsurface management: the three central work packages WP3, 4 and 5 strive to pave the road towards management by developing workflows and tools to translate geological models and data into information that is attuned to the needs of regulators, planners, policy makers and other end-users (fig. 2). WP3 and 4 represent regional case studies named after the geological territory they encompass: **Roer to Rhine graben, in short R2R (WP3), and Pannonian Basin (WP4). These case studies approach subsurface management bottom-up**, starting from a specific geological context and subsurface management issues that are actual or imminent. Both **case studies are similarly structured and share methodological principles**, but at the same time deploy their own strategy to **maximise effectiveness and complementarity**.

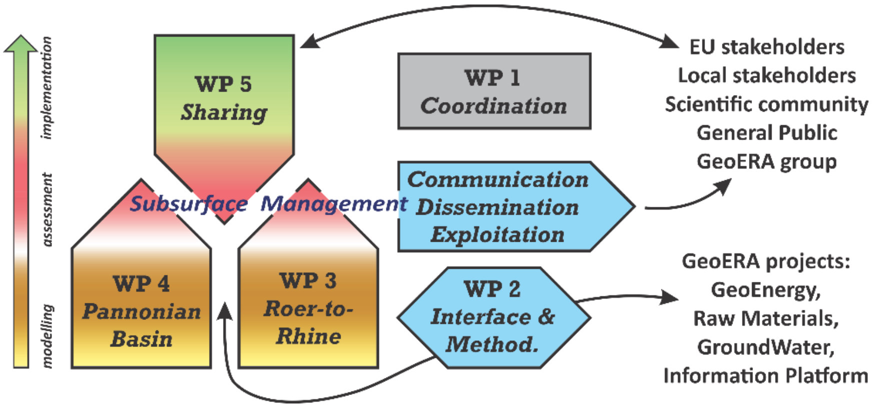

Figure 2: The work packages of GeoConnect³d are organised in a similar way as the SRTs in geoenergy: geological modelling are base activities that allow applied research (e.g. storage, geothermal energy, etc.). Together, they form input for subsurface management, to which all activities in GeoConnect³d build up, where relevant in a cross-thematic context. The cross-border case studies approach subsurface management from the bottom-up, keeping a regional focus, while WP5 will analyse the relationship with stakeholders and policy makers top-down, based on the findings of the case studies.

Each case is based on geological modelling that represents the current regional geological understanding. The structural framework approach is tested to its full potential in R2R, while in the Pannonian Basin it is invoked to challenge the state-of-the-art basin scale model. Geological understanding is advanced by linking geomanifestations to the structural framework, revealing overlooked structures and processes.

The Pannonian Basin, as a European geothermal hot spot, is a case that focusses strongly on geothermal energy, but will still rely on cross-thematic research and exchange of results. The R2R case is much less bound by one topic, and will focus strongly on the potential interaction of different types of subsurface activities. In order to do so, it will rely on available datasets and on additional cooperation from other approved GeoERA projects covering the themes geoenergy, raw materials and groundwater.

The coordination of **intra- and cross-thematic interaction is part of WP2** (fig. 2 and 3). In WP2, GeoConnect³d partners will meet with partners from other GeoERA projects to discuss the relevance and integration of their data and research questions into GeoConnect³d, as well as comment on the insights that are gained from the cross-thematic exercises performed in WPs 3 and 4. Especially for the R2R case, it is the thematic input that will provide the background for identifying and studying the subsurface management issues. Although the GeoERA ERA-NET frame provides the opportunity for close cooperation with projects that run in parallel, GeoConnect³d does not critically depend on input from any of those projects, as it has all the required cross-thematic expertise embedded in its own consortium.

WP2 includes two related tasks that enable the cases to deploy the structural framework approach. The fault-database developed in the HIKE project will be the shared instrument, as many of the structures in the structural framework can be identified with faults. **Also, the development of the actual methodology that underlies this approach will take place in WP2**.

The essential task of interacting with IP takes place partly through the HIKE project for all issues related to the fault database, since GeoConnect³d will act as a full-project case-study for that project. GeoConnect³d will directly communicate with the IP project for all other issues ranging from data structuring to browser-embedded visualisation.

Whereas WP3 and 4 are case based, **WP5 deploys a more generic and top-down approach towards subsurface management.** It is, at the same time, the WP in which the **results from the case studies are shared within GeoERA and readied for future application**. Sharing case-based results and developing generic schemes are activities that are intimately interwoven and therefore grouped in one WP. The generic approach involves considering generalised geological settings that form the background for managing and optimising the different subsurface activities that can potentially be deployed. An important part of advancing this approach is testing whether the ad hoc findings of the regional studies corroborate those of existing or internal project-developed generic schemes.

GeoConnect³d will develop and test workflows for pan-European deployment. This is largely done in the two specific case studies from which results are brought together and compared in WP5. This internal communication within GeoERA is part of WP5, and goes as far as actually transposing methodology into geological settings that are different from the two cross-border cases, as an ultimate test and demonstration.

The central topic of subsurface management also forms the prime starting point for external communication. The generic and two specific case studies require interaction with stakeholders, for which dedicated tasks in the respective WPs are foreseen. When it comes to distributing the generalised results, combined pan-European communication is foreseen. Since GeoConnect³d will maintain active links with other projects, such communication efforts will often be joint activities to maximize impact and minimize costs.

WP 1 concentrates all management activities, and is crucial for following up and connecting the activities in the individual work packages, as is detailed in its work package description.

A detailed description of each WP and its deliverables can be found in table 3.1a grouped with other tables at the end of this chapter. A tabulated overview of all WPs follows in table 3.1b, as well as a listing of all deliverables (table 3.1c) and project milestones (table 3.2a).

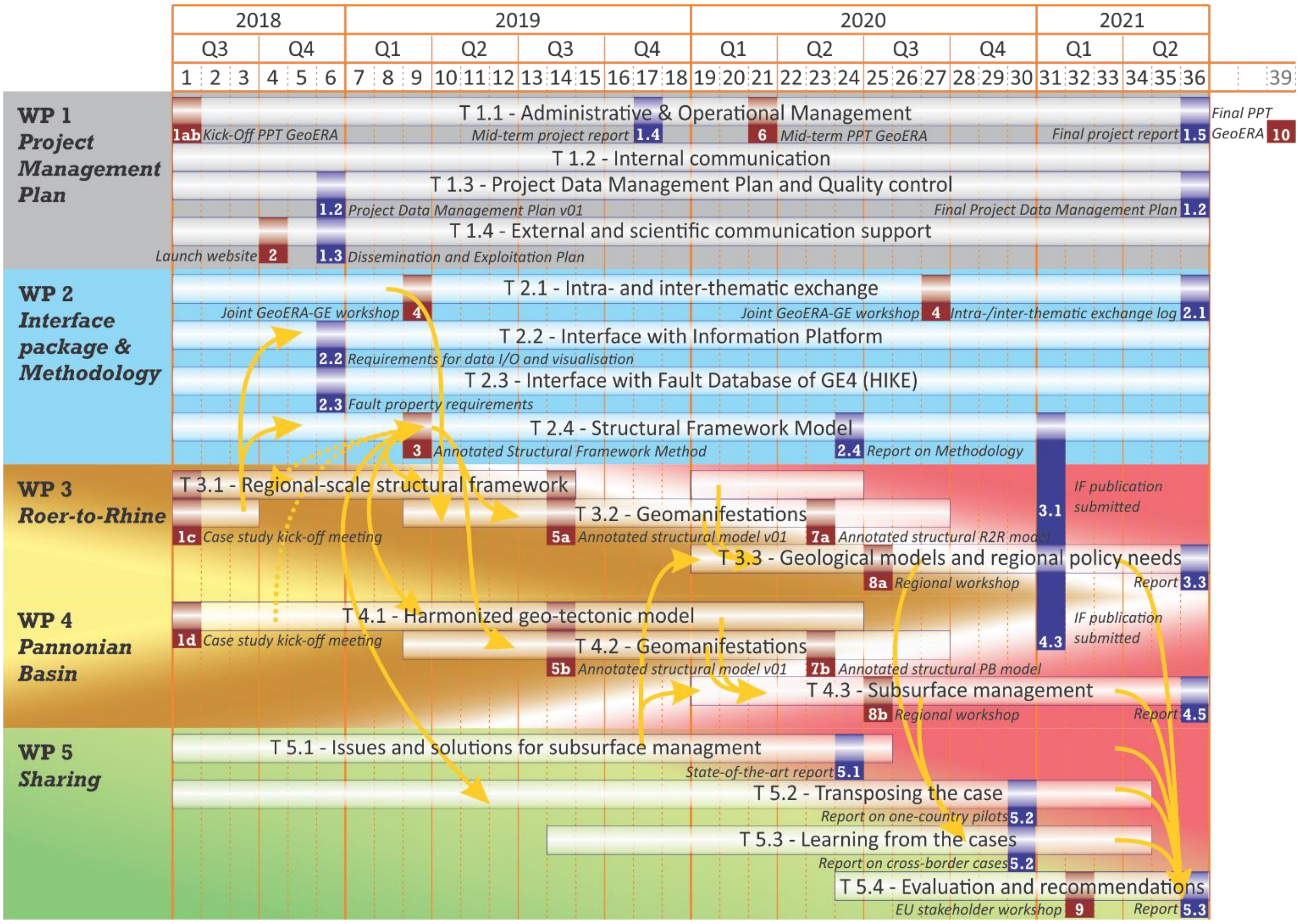

Figure 3: Gantt-chart with timing of the main tasks, deliverables (blue markings), milestones (red markings), and the different dependencies. The titles of deliverables and milestones are shortened compared to those in tables 3.1c (Deliverables) and 3.2a (Milestones).

GeoConnect³d is a project that handles data of different types that, as a group, require special attention. This is properly acknowledged by the dedicated Project Data Management Plan (task 1.3), in support of the GeoERA Data Management Plan (GeoERA deliverable 3.1) that will come in place by month 6 of the project timeline, and is also addressed by the interface package with GE4-HIKE (task 2.3), as has been outlined in more detail in §2.3.

3.2 Management structure, milestones and procedures

Overall project coordination is a shared responsibility of the Belgian key partners for WP1, RBINS-GSB and VITO, with VITO being the experienced partner to provide guidelines to the rest of the consortium regarding the administrative H2020 expectations and RBINS-GSB carrying the final responsibility for the interaction of the different partners, sticking to the timeline for deliveries and milestones, and meeting the overall objectives. In practice, however, with the responsibilities of all partners already well defined, this will be primarily a monitoring activity that is carried out through **the Project Management Board (PMB), in which all work package leaders (GSB-RBINS, TNO, VPO-VITO, MBFSZ, BRGM) have a seat**. The PMB will have a monthly telco and will physically meet at least once per year. As such, follow-up and decision-making becomes a joint management process with executive responsibilities within the work packages. The first PMB meeting will discuss appropriate voting rules that will be recorded in the minutes of the meeting for future reference, but the basic principle will be to make decisions by consensus.

GeoConnect³d is a challenging and ambitious project, considering the level of collaboration and interaction between different tasks and work packages. The PMB plays an essential role in orchestrating the timely flow of information and results, and the correct start-up of supporting or other parallel actions.

The near-continuous and strongly sequential activities, combined with a strong embedding of project responsibilities in individual work packages, and particular focus on foreseen interaction between partners and tasks, is a reliable strategy to minimise the implementation risks of a project that could otherwise easily derail (see table 3.2b for details and an overview of other identified critical implementation risks).

3.3 Consortium as a whole

The consortium is built around the national and regional geological Surveys of the two pilot areas, and additional partners that are experienced in subsurface management issues, or interested in the novel methodologies that are being developed and willing to further test and demonstrate their pan-European relevance. **The twenty partners represent a relevant portion of the GeoERA partners coming from North-West, Central and Eastern Europe, and, more importantly, geologically different areas**. The partners each have a well proven expertise and, depending on their national or regional mandates, range from European research institutes, to others that are more strongly focussed on national needs for geological services, to institutes that may engage at policy-making levels. This diversity is an absolute strength, given the overall goal of providing a scientific input for subsurface management, where insights of all of these levels come into play. Furthermore, it is important that each of the partners, especially those with a stronger national focus, have a clear interest in studying the regional context for understanding cross-border issues, as well as the development of generic tools for optimizing subsurface management in a pan-European context, for example because of the relevance for European climate goals.

3.4 Resources to be committed

For purposes of convenience, the number of person months required per work package are summarised in table 3.3a. An overview and where necessary justification of the direct costs is given in tables 3.3b. Table 3.3c is the financial table. All tables are included at the end of this chapter.

Table 3.1a) Work package description

Work package number	1	Lead beneficiary			RBINS-GSB	
Work package title	**Project Management Plan**					
Participant number	1	2	3	10	12	13
Short name of participant	RBINS-GSB	VPO	VITO	MBFSZ	SGL	TNO
Person months per participant	4	0.1	3	3	0.1	0.5
Start month	1			End month	36	

Objectives

To develop an effective and comprehensive administrative, financial and legal management that will ensure the successful execution of the project.

Specific objectives:

- To ensure the achievement of all project objectives in terms of time, quality and costs;
- To perform smooth and effective management and coordination of the consortium guaranteeing joint understanding among the project partners, and ensuring the right functioning of the governing bodies;
- To interact with the GeoERA Executive Board, in particular the GeoERA WP 4: “Follow-up and monitoring of projects resulting from the cofounded call”;
- To carry out periodic and fluid communications and high-quality technical and financial reporting of the project’s progress to GeoERA;
- Stimulate and coordinate external communication to stakeholders and the scientific community.

Description of work

T1.1 Administrative & Operational Management
*(**RBINS-GSB, VITO**, VPO, BRGM, MBFSZ, TNO)*
The project coordinator RBINS-GSB (WP1) and work package leaders TNO (WP2), VPO (WP3), MBFSZ (WP4), BRGM (WP5) and SLG (responsible for T1.4) are responsible for the realization of the project milestones and deliverables, as well as for effectively handling critical risks related to the project implementation. To that end the project coordinator, work package leaders and VITO will set-up a Project Management Board (PMB) that will govern the day-to-day management and decision-making processes. The PMB will organize regular meetings (monthly virtual meeting by Skype/WebEx, at least one physical meeting per year) to monitor project progress, to decide on corrective measure and to prepare for reporting. In order to limit time and costs for travelling, the meetings will be organized as side-events of the three plenary GeoERA meetings, the annual GeoEnergy Expert Group (GEEG) meetings of EuroGeoSurveys, or stakeholder meetings.

Tasks of the PMB include:

- Day-to-day monitoring of project progress (using appropriate tools: e.g. virtual and physical meetings and an actions database);
- Risk management;
- Coordinating the preparation of the project monitoring and progress reports required by the GeoERA Grant Agreement and the European Commission;

- Presentation of progress, results and highlights of the project on the GeoERA Review Meetings in the third month following the submission of the mid-term and final progress report;
- Maintenance of the Project Consortium Agreement.

VITO will assist the partners in preparing the mid-term and final progress report and in annual reporting of cumulative expenditure in accordance with the GeoERA guidelines on reporting procedures and monitoring indicators. The responsibility for timely delivery of the data (both technical / scientific and financial) needed for reporting lies with the work package leaders, with their actions being followed by the PMB.

T1.2 Internal communication
*(**RBINS-GSB**)*
RBINS-GSB will be responsible for internal project communication management, ensuring that an adequate level of communication exists among the consortium partners (i.e. through the preparation of minutes of management meetings and circulars to the consortium where appropriate).

RBINS-GSB will also be responsible for efficient communication with the GeoERA Executive Board and the other GeoERA projects that are related to GeoConnect³d. To this end, RBINS-GSB will set-up a transparent internal communication and data exchange system for the partners and with the GeoERA Executive Board, based principally on communication by e-mail and intranet archive, for the latter making use of the EuroGeoSurveys intranet that is at the disposal of the GeoERA partners.

T1.3 Project Data Management Plan and Quality control
*(**VITO**, VPO)*
Within the first 6 months of the project, VITO will prepare a first version of the Project Data Management Plan (PDMP). The document will describe how the research data collected and generated in the context of GeoConnect³d will be made findable, accessible, interoperable and reusable. The PDPM will be in line with the guidelines on FAIR Data Management in Horizon 2020 and will follow the templates provided in GeoERA Deliverable Data Management Plan Version 1. The PDMP will address:
- Specification with respect to the origin and the type of data that will be acquired or generated during the project and reasons for acquiring/generating the data;
- Measures that will be taken to make the data findable, including provisions for metadata;
- Measures that will be taken to make the data openly accessible;
- Measures that will be taken to make the data interoperable;
- Re-use;
- Allocation of resources and responsibilities;
- Data security;
- Ethical aspects;
- Other issues.

VITO will update the PDMP over the course of the project whenever significant changes arise (e.g. new data becomes available, changes in consortium policy, changes in consortium composition). A final version of the PDMP will be delivered at the end on the project (M36).
At the start of the project, VITO will prepare guidelines to provide all project partners with a project handbook to be referred to in the preparation of all project documents, in particular project deliverables. The project handbook will identify the key deliverables that will be peer-reviewed (by GeoERA or project internal experts) within this task to examine their consistency with the project tasks before they are formally transmitted to GeoERA. The Quality methodologies and procedures applied will be in line with ISO 9001 requirements, though a certain degree of flexibility will be retained due to the specific needs of a research project. For each identified deliverable, at least two experts will prepare a Review Form with feedback about the various aspects of the deliverable: presentation, readability, overall quality, technical relevance, etc. Deliverables' authors will have to answer to the expert and update the deliverable if needed and prepare a final version to be submitted to GeoERA.

T1.4 Dissemination and exploitation coordination and support
*(**RBINS-GSB, SGL**, VPO, VITO, BRGM, MBFSZ, TNO)*

This task supervises the bottom-up input for the Dissemination and Exploitation Plan (DEP) through WPs 3, 4 and 5 and follow-up of the actions defined in the DEP. RBINS-GSB will be responsible for writing the DEP. The DEP will be ready before month 6.

The dissemination and exploitations actions foreseen in the project are briefly discussed in section 2.2 and the respective work packages. The table in section 2.2.1 shows that project work is for a significant part valorised through communication targeting various stakeholder groups as well as through technical papers and presentations to share new results and methodologies with the scientific community. Within the consortium, different partners have different levels of experience in scientific writing or the setting up of policy related communications, partly linked to a different tradition within the participating institutes as to how much importance is attributed to this form of outreach activities, as is well demonstrated by the annual questionnaire results of EuroGeoSurveys. This is therefore a particular field where sharing of expertise can lead to gains for all partners, as well as for the project.
The PMB will encourage publication of results by author teams of mixed experience. An additional advantage of this top-down involvement is that authors can be assisted to obey the rules for open-access publishing under H2020, and that at all times an up-to-date overview of the publication efforts is kept.

External communication through social media has become a standard part of scientific projects and is a shared responsibility of SGL and RBINS-GSB. Through GeoERA, each project will have access to a customisable website. As is the case for the overall functioning of GeoConnect³d, the task leader will be responsible for setting-up the communication network, while the work package leaders will be asked to take action to provide content, when necessary with additional encouragement of the PMB.

In addition to these traditional social media outcome activities, the GeoConnect³d network will have a blog. This blog will provide regularly an interview with a geologist of the project regarding his work within the project as well as his personal fascination the topic.

Deliverables

- D1.1 - Minutes of virtual (monthly) and physical (annual) meetings of the PMB (RBINS-GSB; Report; M1 – M36)
- D1.2a,b - First and final version of the project Data Management Plan (VITO; Report; M6, M36)
- D1.3 - Dissemination and Exploitation Plan (RBINS-GSB; Report; M6)
- D1.4 - Mid-term Project Progress and Monitoring Report (RBINS-GSB; Report; M17)
- D1.5 - Project Final Report (RBINS-GSB; Report; M36)
- D1.6a,b,c - Cumulative Expenditure Report 2018, 2019, 2020 (VITO; Report; M6, M18, M30)

Work package number	2	Lead beneficiary					TNO			
Work package title	**Interface package & Methodology**									
Participant number	1	2	3	4	5	8	13	14	16	19
Short name of participant	RBINS-GSB	VPO	VITO	FZZG	HGI-CGS	BGR	TNO	PIG-PIB	GSS	Geo-Inform
Person months per participant	5	1.7	1.5	3	2	1.5	5	0.7	2	0.52
Start month	1					End month		36		

Objectives

- To define the specifications for GeoConnect³d's demands concerning the adequate representation of the project's outputs in the Information Platform (EGDI).
- To handle intra- and inter-thematic exchange of outputs and knowledge.
- To warrant the development, communication and archiving of developed structural framework modelling methods.

Description of work

T2.1 Intra- and inter-thematic exchange
*(**TNO**, HGI-CGS, GeoInform)*

One of the main challenges of GeoConnect³d is the uptake of geomanifestation data from other, intra- and inter-thematic, GeoERA projects. This is of particular importance for the regional case studies WPs 3 and 4. To warrant a proper administration of data, communication and feedback, this task will facilitate:

- Continuous communication, joint meetings and teleconferences with the intra GeoERA-Energy projects and projects within other GeoERA themes by the partners involved in those projects;
- Track meetings with the GeoConnect³d task-members coordinated by the task leaders;
- Generation of a report/logbook of decisions, data exchange, feedback, etc. throughout the project run;
- Feedback by the WP leaders to the PMB for overall orchestration and follow-up by other WP leaders or project partners.

T2.2 Interface with Information Platform
*(**TNO**, RBINS-GSB, HGI-CGS, BGR)*

Task 2.2 will be coordinated by TNO. Positioned at the interface between thematic research output and the operating system for visualization, querying and dissemination, this task requires a collective understanding and thus close collaboration of the geo-scientists (conceptual design, population and maintenance of expert vocabulary) and the IP experts (conceptual design, implementation and up-keeping of technical infrastructure). Central to this is the focus on faults and fault zones from diverse sources and integrating various kinds of geomanifestations at different scales and depths in a way that allows efficient mapping across different geological settings within the two regional case study areas (WP3 & WP4). IP interface activities are joined with that of the GE4-HIKE project (see task 2.3).
The main activities that tackle these challenges with IP are:

- Defining requirements for retrieval and upload of multi-scale fault data from the Fault Database, as far as not realised through the close collaboration between GE4 (HIKE) and IP;
- Find ways to realize the multi-scale experience, i.e. enable zooming functionality from Europe to voxel details with the scroll of a mouse;

- Develop methods to integrate/annotate the structural frame model with geomanifestation data;
- Develop methods to visualize the annotated multi-scale fault models.

This will be achieved by:

- Continuous communication, joint meetings and teleconferences with the IP Interface work package teams and the IP developers on stipulations and upload requirements (formats, rendering, etc.);
- Internal project communication with especially WP3 and WP4, as well as with the PMB, distributing clear instructions in form of guidelines that cover the expectations of the IP project team, as well as collecting feedback, questions and requirements from the GeoConnect³d partners;
- For the two regional case study areas (WP3 & WP4) preparation of structural framework maps with geomanifestation data and 3D models for the uptake into and dissemination via EGDI;
- Preparation of full metadata information for all disseminated products in the EGDI metadata system (MICKA);
- Provision and ministration of controlled technical vocabulary for the Semantic Web set up in IP WP4, aligned with the other projects to avoid ambiguousness and/or double-entries.

T2.3 Interface with Fault Database of GE4 (HIKE)
*(**TNO**, GSB-RBINS, PGI-PIB)*

As the Fault Database will be an integral part in EGDI, most of the requirements towards data I/O will be tackled by the GE4-HIKE project. To this end GeoConnect³d will ultimately be able to rely on the FDB's appropriate end-user functionality (i.e. selecting, retrieving and analysing fault data). Implementing the FDB will however take significant lead time, and since GeoConnect³d will be an early user of the FDB for its structural framework methodology, close follow-up of the FDB development and implementation are key for the correct data-preparation within GeoConnect³d. Task 2.3 will specifically focus on the type of information attributed to the faults and thus requires direct collaboration with GE4 (HIKE). Within the latter project, faults shall be defined as 2D or 3D spatial objects with associated static and dynamic geological, mechanical, petrophysical, chemical and thermal properties. The specifics for these properties will be importantly fed by input from GeoConnect³d, as it is one of the GeoERA projects that will directly use the faults at multiple scales by applying them as the backbone for various geomanifestation data.
Activities will be coordinated by TNO and include:

- Continuous communication, joint meetings and teleconferences with the GE4 and IP teams on fault attribute/property requirements (formats, rendering, etc.);
- Retrieval of test fault datasets of the two regional case study areas (WP3 & WP4) for the check of dissemination and query functionalities implemented;
- Feedback to GE4 and IP, and guidelines and instructions to GeoConnect³d partners (in WP3 & WP4) involved in structural framework modelling;
- Assistance for upload of final fault data as basis for structural framework.

T2.4 Structural Framework Model
*(**RBINS-GSB**, HGI-CGS, BGR, TNO, PGI-PIB, GSS)*

GeoConnect³d will connect models of different scale, detail, and origin by using **a fault-centred approach** using structural data at different scales. This approach is cross-thematic, cross-border and across different geological realms. Subsequently, GeoConnect³d will tie geological data and knowledge to this fault backbone by integrating and envisaging many types of geomanifestations in a **map-based approach.** This 2-step approach differs from the conventional geological mapping that focusses on characterising and mapping the spatial distribution of geological units, usually in a section view approach (seismic and well data), and in which faults are often considered as features of secondary importance. The workflow and approaches needed to realize the annotated structural framework will be defined in this task. Most of the data will come from external projects, so interaction and cooperation are key (dealt with in task 2.1). Special attention will be paid to enable uptake of geomanifestation data and/or interactive links with other GeoERA projects.

Realizing that GeoConnect³d acts as a local demonstration project for the exchange of information and knowledge about resources and their use between regions, the **methodologies** developed and tested for cross-border, cross-thematic evaluations need to be scaled up to the European level.

Activities will be coordinated by TNO include:

- Define workflows for setting up structural framework models, and update these as they are applied in the case and pilot studies;
- Define multiscale rules for seamlessly tying different levels/data layers of the model;
- Define compatibility requirements for shared framework elements that will allow to link existing maps and geological models with the framework model;
- Define the additional activities needed for translating existing fault datasets into a framework model;
- Design geomanifestation templates that describe the definitions and requirements for spatial representation in terms of scalability and visualization;
- Develop methodology/workflow to consistently integrate geomanifestation data into the framework model;
- Describe data upload in a manual to guarantee future amendments and maintenance, especially focussing on clarity for non GeoERA users, and as tested in WP5 (task 5.2).

At the regional kick-off workshops with partners of WP3 and 4, project partners will define the approach that will be used for the development of the structural framework that differs with respect of the scope of the regional case. This includes:

- The approach that will be used to create the structural framework, including the need for a common coordinate system for data compilation, interpretation and modelling;
- Discussion on required degree of homogenisation of models and data-sets (e.g. reference level(s), units, etc.);
- Definition of meta-data to be supplied with the (local) structural model(s) and geophysical data that underpins the structural framework.
- Ownership of the existing models and access to the raw data.

Deliverables

- D2.1 - Intra- and inter-thematic exchange logbook (TNO; Report; M1 – M36)
- D2.2 - Report (in conjunction with IP) on agreed requirements for data I/O and visualization of results (TNO & RBINS-GSB; Report; M6)
- D2.3 - Report on fault property requirements (in conjunction with GE4-HIKE) (TNO; Report; M6)
- D2.4 - Report and publication(s) on the two-step framework- geomanifestation methodology (RBINS-GSB; Report; M24)

Work package number	3	Lead beneficiary			RBINS-GSB	
Work package title	**Roer-to-Rhine**					
Participant number	1	2	3	12	13	20
Short name of participant	RBINS-GSB	VPO	VITO	SGL	TNO	GD NRW
Person months per participant	32.42	6.5	20.8	2.9	6.5	2
Start month	1			End month	36	

Objectives

The main objective of Roer-to-Rhine (R2R) is to implement and test a workflow to facilitate:

a) Cross-border, cross-thematic evaluation of geological resources and applications and;
b) Subsurface management and policy support for the exploitation of geo-resources.

R2R will focus on energy resources, but will integrate data related to ground water and raw materials in order to obtain a better understanding of the nature and origin of these resources and of the geological risks and influence radius of the exploitation of these resources.

Description of work

R2R focusses on the border regions between Belgium, The Netherlands, Germany, Luxembourg and France. Geologically, this area incorporates from North to South: the onshore southern North-Sea Basin, the Roer Valley Graben, the Variscan front zone with its Ardennian inliers, the western Eifel area, and the Upper Rhine Graben in the Alpine foreland. The name Roer-to-Rhine (R2R) is derived from the geological graben structures that form its boundaries. The study area was chosen to be limited in size, and yet include different geological domains and countries to allow for a regional exercise that is a realistic analogue for a pan-European exercise.

In order to disclose essential information for subsurface management and policy support, R2R will use the mapping approach in which revealing geological data and knowledge are tied to a cross-border structural framework, i.e. an annotated structural framework. Geomanifestations that will be used include seismicity, anomalous groundwater chemistry, hot springs, gas seeps, ore deposits, and jumps in hydraulic head. This approach can help refine and connect sub-regional geological models. Integration of data from different disciplines within the structural framework will improve our understanding of the processes responsible for the geomanifestations, and, in turn, improve our understanding of the available geological resources (e.g. sweet spots for geothermal energy, hydrocarbon or ore accumulations) and of the risks associated with subsurface use (e.g. likeliness for anomalous water chemistry, seismicity, leakage), and help to evaluate the interaction between competing subsurface activities and their impact on local socio-economics and environment.

The proposed work will consist of:

- Build a cross-border structural framework for the entire study area based on existing information on faults and determinant features (e.g. folds and unconformities);
- Link existing models at different scales and resolution (voxel (cf. RM2), 3D, resource models…) to this framework;
- Making an inventory of cross-border data on selected geomanifestations (seismicity, those indicative of channelled or blocked fluid and heat flow…) and harmonising these data;
- Tying the data on geomanifestations to the structural framework;

- Improving the structural framework based on new insights gained from the geomanifestations;
- Using the augmented structural framework to evaluate the impact of deep geothermal exploitation on other subsurface activities and to propose a concept for inclusive subsurface management and planning;
- Making the geological information readily accessible, understandable and tailored to the needs of multiple stakeholders and end-users (cf. EGDI).

The work is divided into three tasks.

T3.1 Regional-scale structural framework
*(**RBINS-GSB**, VPO, VITO, BRGM, SGL, TNO, NRW GD)*

In Task 3.1 a regional structural framework will be built. The framework will be derived from existing models, maps and cross sections, combined with geophysical data that will be calibrated using existing geological data, models, and maps. The geophysical data will also be used to frame the study area within a regional tectonic setting, and to define or refine the structural framework in places where the existing data are scarce or inconclusive. This will allow identifying the regionally important features of the structural framework that can be extended beyond the boundaries of the models and maps on which they are identified. Existing models for specific areas, include:

- The detailed 3D geological model with 3D fault planes of Flanders (G3Dv2, G3Dv3);
- The cross-border H3O geological model of the Roermond graben region between Flanders and the Netherlands;
- The Dutch DGM-diep V4 onshore geological model;
- The 3D subsurface model of Luxembourg that is currently being developed;
- The 3D model of the Upper Rhine Graben on the border between Germany, France and Switzerland (GeORG project);
- The Fault database (TNO, GE4).

For the connecting areas between the existing models, where 3D geological interpretations are missing or uncertain, the structural framework will be constructed largely relying on 2D maps and potential field data and seismic data that can be accessed through the project partners.

Input data will be at different scale and resolution, requiring a **multi-scale structural framework model**. The maximum zoom-out corresponds to the pan-European level in 2D, a level shared with the Pannonian Basin case (WP4), and will make use of earlier pan-European summaries coordinated by the BGR (e.g. IGME-5000). More detail is revealed when zooming in to the case study area, requiring multi-scale information for each marker.

The development of the framework methodology is part of WP2 (T2.4), allowing collaboration with WP2 – IP interface (T2.2), and in particular with the interface task to the Fault-Database in the HIKE project (T2.3). To discuss regional specificities of the methodologies, as well as to prepare input for WP2, a kick-off workshop will be organised by RBINS-GSB (Brussels). Follow-up meetings and progress meetings (videoconferences) will be held on a regular basis.

Building the structural framework model will be a shared effort by all partners involved in WP3. Each partner will be responsible for building the sub-model for their region / country according to the approach defined in T2.4:

- VPO – VITO and TNO will build a structural framework for the northern parts of the R2R area starting from the existing 3D models and potential field data;
- For Luxemburg, the structural framework will be produced in close collaboration between the RBINS-GSB and the SGL. The SGL coordinates currently a unique geological/geophysical geothermal prospection campaign in southern Luxembourg including boreholes and deep seismic reflection profiles, which will be a milestone in the understanding of the Luxembourgian geology. Results of this campaign will be available during the lifespan of the proposed project.
- RBINS-GSB will build the structural framework model between Flanders/the Netherlands and Luxemburg, covering parts of Germany (Nordrhein-Westfalen) in collaboration with NRW, using published and non-published geological data and geophysical data on the Ardennes and adjacent areas.

The partners will organize regular work meetings to discuss new insights and ensure alignment of the sub-models. RBINS-GSB will combine the sub-models in the regional structural framework model.

Using a similar approach, the R2R model will also incorporate the Upper Rhine basin to demonstrate that existing applied geoenergy 3D models can successfully be linked using a framework approach.

BGR will, through WP2, be involved for their experience with pan-European mapping that includes identification of structural elements and units at the scale of Europe. The structural framework model will use the Fault Database that is implemented through the HIKE project. This data repository will not be an end-point for the data gathered, but will be used as a tool and will therefore be part of the methodology. Visualisation of the information will be part of the IP project.

T3.2 Geomanifestations
*(**VPO**, RBINS-GSB, VITO, SGL, TNO, NRW GD)*

As a first step, all partners involved will make an inventory of available geomanifestations indicative of fault activity, elevated geothermal gradients, fluid and heat flow. The geomanifestations of particular interest are outlined below, with a link to related SRT's of RM and GW:

- Data on seismic activity / seismicity (link with GE4-HIKE);
- Mineral springs;
- Variations in hydraulic head (link with *GW1-HOVER and GW3-RESOURCE*);
- Water chemistry at surface and at depth (boreholes, caves, mine shafts); characterizing the chemical signature of deep fault-channelled groundwater (link with *GW1-HOVER, GW3-RESOURCE and GW4-VogERA*);
- Temperature anomalies at surface and at depth (link with *GW1-HOVER, GW3-RESOURCE, GW4-VogERA and GE2-Geo4Sure/Hotlime*);
- Gas seeps (e.g., CH_4, CO_2) at surface (springs) and at depth (boreholes, caves, mine shafts) (link with *GW1-HOVER*);
- Ore deposits including lead-zinc-copper deposits (*RM4-FRAME*).

Compared to the Pannonian Basin case, R2R will evaluate a large diversity of geomanifestations. VPO – VITO will screen the input of all WP3 partners, the availability and the quality of the data and propose an approach to combine the different datasets in a homogeneous and transparent way that allows for standardization (meta-data required) and harmonisation. VITO is also responsible for the Project Data Management Plan, extending the approach to the whole project.

The approach of geomanifestations within the project is a specific way of interpreting the required data models, relations between data-objects and standards, as required from the IP project. A gap analysis of these models and standards will take place and recommendations will be formulated for extension of the used standards and channelled to WP2. The decision will lie with WP2, which will ensure that the approach is similar for both WP3 and WP4. The interface with IP, as well as direct partner involvement in GW and RM projects, are put in place to guarantee that the GeoConnect³d approach for these datasets is compatible with other GeoERA projects gathering similar data. Within GeoConnect³d, the partners will start the discussion during the GeoConnect³d kick-off meeting, and confirm the approach to follow during the mid-term GeoConnect³d meeting.

Development of data-infrastructure is handled by the IP project. WP3 will make maximal use of decentralising data storage, and in addition will follow the philosophy that data is best kept close to the data manager. Maximal use will be made of external data servers, individual existing regional and national databases for subsurface information and seismicity. Moreover, linking to data repositories that are regularly updated ensures access to the most recent data with no or limited effort.

Once a first version of the regional structural framework is set up (see T3.1), the geomanifestation data will be integrated with the structural framework using 2D and 3D GIS. This will be done during one or more work sessions involving all partners who contribute to T3.2. General and local 2D and 3D models and existing, embedded models will be **annotated with properties of the mapped geomanifestations**, geo-resources and faults that are needed to assess reserves, trends and balances.

The geomanifestation – structural framework integration will allow:

- Outlining zones where (unknown) deeply sourced faults are expected; this information may be fed back into T3.1;
- Revealing the (multiple) role of faults regarding fluid flow;
- Outlining fault-controlled zones with high potential in terms of subsurface use (geothermal, ores…);
- Revealing driving mechanism behind the different geomanifestations.
- Better understanding of the relation between different tectonic units, and the fluid communication between them.

The annotated structural framework will form the basis for derived, thematic geological models for subsurface management, policy support and other uses at the regional (T3.3) and the European level (WP5).

T3.3 Geological models and regional policy needs
*(**VPO**, RBINS-GSB, VITO, SGL, TNO, NRW GD)*

T3.3 will serve as a case study to test how a bottom-up approach, assisted by customized visualisation tools, can be successful in reaching-out to civil servants and policy makers for in-depth discussions on subsurface management. The case study will focus on subsurface management in the R2R study area in relation to different geo-resources, possible subsurface applications (e.g., ground water production, underground gas storage, underground high-temperature thermal storage, CO_2 geological storage, etc.), and potential hazards.

The goal of subsurface management is to optimise the valorisation of the underground in both short and long time frames, which means taking into account returns of private investments, as well as equity aspects towards future generations. Defining a supported policy on subsurface management is a process that involves many stakeholders from different organizational (e.g., public, private, civil society) and political levels (i.e., federal, inter-regional, regional, local). At this point, WP3 and 5 meet, and the agenda and scenarios to discuss during stakeholder outreach will be jointly prepared, and afterwards evaluated.

Task 3.3 will **explore different ways to disclose essential data** on the subsurface in order to **involve the different stakeholders** in planning and organizing the exploitation of the subsurface. Target groups will be local, regional and federal civil servants and policy makers. The partners involved in T3.3 will use a multiple approach to evaluate customized disclosure of data including:

- Active support of the development of the point-cloud IT-tool to disclose the augmented structural framework developed in T3.1 & 3.2 and geo-information to the focus groups in an easily accessible and transparent way;
- Organization of an interactive workshop at the level of the R2R area (involving stakeholders from all countries/regions involved) to inform the target groups about the potential applications and valorisation of the deep subsurface and the possible footprint with respect to current and future activities;

Evaluation of the results of the workshop will focus on the success of joint (interactive) identification of subsurface management challenges and related research needs. The latter will be split up in those that can (partly) be answered based on the research and data gathered in GeoConnect³d, and those that require additional post-GeoERA research. WP 5 will evaluate the pan-European relevance of the subsurface management results of the R2R case study.

Deliverables

- D3.1 - Scientific publication of annotated R2R model (submitted) (RBINS-GSB; Publication; M31)
- D3.2 - Minutes of workshop on subsurface management and planning (VPO & VITO; Report; M32)
- D3.3 - Report on ways to disclose essential subsurface data and information to different stakeholders (VPO & VITO; Report; M36)

Work package number	4	Lead beneficiary			MBFSZ			
Work package title	**Pannonian Basin**							
Participant number	4	5	10	15	16	17	18	19
Short name of participant	FZZG	HGI-CGS	MBFSZ	GSR	GSS	SGIDS	GeoZS	Geo-Inform
Person months per participant	17	18.55	57	24	15	6	16	1.56
Start month	1				End month	36		

Objectives

The main objective of the Pannonian Basin is to:

- To build a beyond the state-of-the-art cross-border and cross-thematic geological and structural model of the Pannonian Basin covering territories from eight countries;
- Challenge this model by means of an annotated structural framework model with the goal to increase the geological understanding, including transport of fluids and heat for geothermal purposes;
- Provide methods and recommendations regarding subsurface planning and management.

Description of work

The case study area is situated in central Europe. It includes the border regions between Hungary, Slovakia, Ukraine, Romania, Slovenia, Croatia, Serbia and Bosnia-Herzegovina. Geologically this area is a large back-arc basin within the Alp-Carpathian orogene that formed during an Early-Middle Miocene crustal extension and is composed of several sub-basins, such as the Great Hungarian Plain, Danube basin, East-Slovakian basin, Drava trough, Sava trough, Mura-Zala basin, Békés basin, Makó basin. Under the several kilometres thick Mio-Pliocene sediments, the basement of the Pannonian basin is extremely diverse and shows a complex structure, built up of various metamorphic and non-metamorphic Paleo- and Mesozoic crystalline and sedimentary rocks. Both the basin fill and the basement rocks host a rich and great diversity of various geothermal resources, cold- and thermal water aquifers, conventional and unconventional hydrocarbon plays, much of them shared by neighbouring countries, and as such provide an ideal case-study setting for an integrated and multidisciplinary approach for subsurface management and planning.

Competition between various uses of the subsurface can be the result of the geological settings. Some geological features can be favourable for multiple uses e.g. thermal and/or mineral water production, recovery of hydrocarbons, CO_2 sequestration, gas storage and use of geothermal energy. In a number of places, one application precludes any other sustainable usage. The Pannonian basin of Central Europe is an extensive area where the management of geological and geo-spatial data is not harmonised between these countries. It is also an area where different geoenergy reservoirs often exist together (vertically and/or laterally). In addition, potable water aquifers can be influenced by geoenergy-bearing reservoirs when these are recovered, causing alterations in natural regimes.

This WP4 has a bottom up approach. The cross-border harmonized dual geological-structural model for the whole Pannonian basin provides a large-scale framework for detailed pilot area investigations, where various geomanifestations, mainly of hydrothermal nature, will be studied in detail, as well as their connections to major deformation zones and faults. Building on the results of the large-scale geo-structural model for the entire Pannonian Basin and the outcomes of the evaluation of geomanifestations on the pilot areas, various methods will be elaborated and tested in order to adequately assess the various geoenergy resources, their interrelationships, and the potential consequences and impacts resulting from exploitation. Therefore this case study will provide input to science-based governance planning for the geothermal resources of the Pannonian Basin. With existing thermal water usage and plans for increased geothermal energy utilization in all countries it can serve as a model for similar regions of Europe.

The main steps of the work:

- Establishing an integrated and coherent cross-border stratigraphic model for eight countries;
- Construction of a dual stratigraphic and structural framework model for the whole Pannonian Basin;
- Collecting and harmonising data on selected geomanifestations in pilot areas of the Mura-Zala Basin and the Battonya high between the Makó and Békés Basins;
- Annotating and evaluating geomanifestations in pilot areas
- Elaborate and test methods and tools for subsurface management:;
- Making the geological information readily accessible, understandable and tailored to the needs of multiple stakeholders and end-users (cf. EGDI).

WP4 is composed of the following three tasks:

T4.1 Harmonized geological-structural framework model
*(**MBFSZ**, FZZG, HGI-CGS, GSR, GSS, SGIDS, GeoZS, GeoInform)*

The aim is to develop a novel geological and tectonic modelling approach for the Pannonian Basin characterized by complex geological structures and as such to deliver an example for other regions of Europe. Based on the methodology to create the model itself, which will be is a complex tectonism influenced horizon model. The model will be investigated for the possible branching of faults from individual fault surfaces towards anastomosing fault zones in the deeper crust. In this modelling approach, deep seismic, magnetotelluric, geomagnetic, gravity data and derived maps and sections are incorporated.

The main task 4.1 steps are:

- Organisation of a kick-off workshop for partners to establish a common understanding and joint working methodology regarding the main stratigraphic and modelling questions. The project partners will define the approach that will be used for the development of a common stratigraphic chart and the structural framework as input for WP2;
- Bi- or multilateral research, consultations on key horizons, data exchange and follow-up meetings (including telcon/skype-conferences);
- Establishment of an eight countries cross-border harmonized stratigraphic chart for the synrift (Early to Middle Miocene) and postrift (Late Miocene, Plio-Pleistocene) sedimentary sequences.
- Building integrated and harmonized stratigraphic horizon models covering the territories of the eight participating countries or:
  1: Pre-Cenozoic basement (A),
  2: Miocene horizons: synrift top-basin bottom (B), post-rift delta slope (C),
  3: Base of the Quaternary (D);
- Building a structural framework for the entire study area, based on seismic, gravity and other deep crust imaging geophysical data in order to connect the basin forming synrift faults to lithospheric structures;
- Implementation of a combined horizon and structural model for the whole Pannonian Basin

The task will start early in the project in order to provide an overarching geological framework for pilot area evaluations and subsurface management.

T4.2 Geomanifestations
*(**MBFSZ**, FZZG, HGI-CGS, GSR, GSS, GeoZS, GeoInform)*

This task will attempt to analyse the occurrence and properties of selected geo-manifestations in two pilot areas at both local and regional scale. The pilot sites were selected based on two criteria: the first is to **confirm the 3D structural-geological model**, developed within task 4.1. This should confirm the modelled fault zones, providing also information on their permeability and any degree of interaction between the modelled reservoirs. The second selection criterion is their representativeness as areas with either existing or probable future **conflicts on subsurface management**.

Due to large geothermal potential of the Pannonian basin, it is expected that the majority of geomanifestations connected to regional fault zones are geothermal (thermal anomalies and anomalies in water chemistry, isotope composition, convection zones). However, cross-thematic focus will be ensured by also identifying and evaluating other geoenergy resources, e.g. hydrocarbons (also oil seeps), mineral anomalies (mineral water) and gas emissions (CO_2-mofettes or CH_4-mud volcanoes, noble gases), depending on each pilot area.

An inventory of geomanifestations will store their description, point data and photos while analysis will help to determine their 2D and 3D spatial distribution, and support the detailed structural-geological model of the Pannonian basin. Analysis of physical characteristics (appearance, extent, properties of soil, water, gas, etc.) will search for similarities and differences between each type of geomanifestation among the pilot areas, while temporal analysis will be possible only at places where time-series are available, e.g. thermal spring flow-rates, oil seeps occurrences and disappearances. Such information may provide information relevant for sustainable management of the subsurface land use, which in turn might be transferable to similar geological settings.

The pilot areas will serve to develop a generic model based on a joint evaluation of geomanifestations according to standards and principles of the GeoConnect³d project, which will be transferrable worldwide.

Pilot areas:

1. **The Zala-Mura sub-basin**

The Slovenian pilot area will comprise the western part of the Slovenian-Hungarian cross-border Mura-Zala sub-basin, a unit in the western part of the Pannonian basin. The mineral and thermo-mineral water, CO_2 emissions, potable water aquifers and geothermal convection zones occur along the Radgona-Vas-Répce-Baján-Rohonc-Ikva-Rába zone, while along the Ljutomer-Balaton fault zone, oil seeps and geothermal anomalies are expected. A set of about 20 noble gas analyses of mineral, thermal, thermo-mineral and oil waters will be analysed to help to identify depth and permeability of fault zones according to the mantle or crustal helium contribution. Analysis of geothermal anomalies will also be performed by using a regional 3D numerical model of flow and heat transport. Different fault zone permeability and extent (vertically and laterally) will be simulated to examine the potential 3D extent of these fault zones for the first time and to improve the geological-structural model being developed for the Pannonian basin.

2. **The Battonya high:**

The Hungarian pilot area in the Battonya region is situated on the southern part of the Great Hungarian Plain between two deep sub-basins (Makó-Trough and Békés Basin) of the Pannonian Basin at the Hungarian-Serbian cross-border region. There is a geothermal anomaly in the Battonya area supposed to be the result of higher transmissivity of the crystalline basement rocks. This higher value is supposed to be related to the higher density of fractures in the basement granite formation where groundwater can ascend from the neighbouring over-pressured deep sub-basins. This assumption will be verified with a 3D hydrogeological flow and heat transport model and by hydro-geochemical evaluation, using isotope data.

T4.3 Subsurface management
*(**MBFSZ**, FZZG, HGI-CGS, GSR, GSS, SGIDS, GeoZS, GeoInform)*

Within this task three main methods will be elaborated and implemented:

An interactive workshop will be organized for relevant stakeholders (ministries responsible for mining, groundwater management, licensing authorities, main users, etc.) from the eight countries involved, in order to collect experience, questions and demands related to subsurface management and planning. Each participant will be responsible to identify and contact stakeholders at national levels, whilst the common workshop will be organized in Budapest. This will serve as input for WP5.

A novel methodology, the so-called **benchmark evaluation**, will be further developed and applied in areas not assessed before. The basic method was developed in the Transenergy project (Prestor et al. 2015) and is further modified in the DARLINGe project, both covering W and S parts of the Pannonian Basin. The benchmark evaluation aims to quantify and evaluate different parameters of thermal water utilization that are decisive on the sustainable use of cross-border geothermal aquifers, and at comparing them between neighbouring countries. The method is composed of a set of reliable indicators that are calculated for specific utilisation, such as e.g. thermal efficiency, energy efficiency, reinjection rate, overexploitation, and that are based on objective calculations. In a **traffic-light model** of the Pannonian Basin, the horizon and the voxel model will be coloured according to how the different stratigraphic/tectonic units are favourable / not suitable for various types of utilisation, showing areas of conflicts deriving from co-use, where possible consecutive use, etc.

Deliverables

- D4.1 - Horizon and voxel 3D model, 3D fault plane surfaces of the main deformation zones in harmonisation with the stratigraphic model horizons (MBFSZ; Geological model; M24)
- D4.2 - A joint report on geomanifestations with their physical, spatial- and temporal (4D) analysis, validation of the 3D structural-geological model of the Pannonian basin based on their identification and evaluation of their relevance for spatial management at pilot areas. Only interpreted data will be included (MBFSZ & GeoZS; Report; M30)
- D4.3 - A scientific article on geomanifestations in the Pannonian Basin (IF paper, submitted) (MBFSZ & PB partners; Publication; M31)
- D4.4 - Report on the workshop results (MBFSZ; Report; M28)
- D4.5a - Report on the benchmark methodology and the results of indicator calculations and evaluations (MBFSZ; Report; M36)
- D4.5b - Applied (traffic-light) model (MBFSZ; Data model; M34)

Work package number	5	Lead beneficiary							BRGM						
Work package title	**Sharing the case studies**														
Participant number	1	2	3	4	5	6	7	9	10	11	13	14	16	18	19
Short name of participant	RBINS-GSB	VPO	VITO	FZZG	HGI-CGS	CGS	BRGM	LfU	MBFSZ	GSI	TNO	PIG-PIB	GSS	GeoZS	Geo-Inform
Person months per participant	6.5	0.2	0.5	3.1	3	3	12	12	3	12	1	11.3	4	2.9	0.52
Start month	1								End month	36					

Objectives

- Knowledge transfer from the WP3 and WP4 case studies as a basis for pan-European recommendations;
- Proposing improved methods for decision making for subsurface planning and management;
- Testing applicability of developed methods on smaller-scale pilot studies;
- Providing overall recommendations regarding subsurface planning and management.

Description of work

While the work in WP3 and WP4 is mainly “bottom-up” (starting from geological models and providing recommendations based on putting them in a regional context), this work-package will seek a more “top-down” approach for identifying issues and appropriate solutions. It will also help consolidating and comparing the findings of the main case-studies.

The work-package is composed of four tasks: the first task will look at the issues and solutions of subsurface management in a generic way, almost independently from the case studies, for a pan-European reach, the second task (Transposing the cases) complements the main case studies, with two one-country pilot studies; the third task (Learning from the cases) will look back at the main case studies (WP3 and WP4) for capitalising on the lessons learnt and the fourth task will summarize the findings from the four case/pilot studies as well as the generic approach.

T5.1 Issues and potential solutions for subsurface management as a generic pan-European topic *(**PGI-PIB**, RBINS-GSB, HGI-CGS, CGS, BRGM)*

This task allows to assess and propose methods and tools on a more generic level (i.e. not just dedicated to a specific area but applicable to any European country), following a top-down approach, complementary to the bottom-up approach used in WP3 and WP4.

5.1.1 Definition of issues and concepts

Conflicts of uses in the subsurface can arise in various forms. Similarly, synergies or facilitations can be diverse. This first step will define those various concepts and will help to make a classification. This will be useful for the whole project (in particular for WP3 and WP4) so the various partners can agree on the same terms and concepts. In addition to a terminology aspect, this task will also seek to better describe what issues are already encountered, what issues can be anticipated, and at which magnitude. This includes an inventory of activity, required geological settings, a description of potential influences, etc. A lot of material is already available in the literature. This task will be led by BRGM with inputs from all partners of the project.

5.1.2 Identification of stakeholder needs

The objective is to understand what is needed for subsurface management and planning. Stakeholders can be either be administration or governmental bodies; or parastatal and even private industries with interest in subsurface activities.

This can be divided in two activities: “elicitation” and “anticipation”. “Elicitation” will consist in gathering actual guidance and opinions from stakeholders, mainly, but not exclusively from the case studies. Outside of the case-studies where this activity is planned (interactive workshops in T3.3 and T4.3) a questionnaire will be prepared to identify stakeholders early in the project. Continuous contacts from the project partners with their national stakeholders will also be encouraged with regular follow-ups.

In addition, a small “anticipation” activity can help to complete the first elements. It is possible that at this stage, not all stakeholders might be sufficiently aware of the necessity of subsurface management, and therefore may not be able to provide useful recommendations. Here, partners of the project will be asked to provide a list of issues that they feel are important, as if they were decision makers. For instance key questions are:

- Should we reserve parts of the subsurface for future potential uses?
- What (subsurface) uses should have priority over others, and with what reliability can it be defined generally, and at what point does it need to be solved regionally with regard to local needs and geological conditions?
- How can we ensure that current (subsurface) use will not be affected by new uses?
- Etc.

5.1.3 Current state of the art of potential solutions

This sub-task will gather published reports or papers tackling with the subject of subsurface management and planning, focussing on the proposed solutions. This task will be complementary to task 5.3 (and thus WP3 and WP4), looking at potential development outside the project and outside Europe.

5.1.4 Improving the state of the art

The purpose of this sub-task is to identify any gaps between the potential issues (5.1.1), the needs (5.1.2) and the current solutions (5.1.3 and 5.3) and to propose potential solutions to address those gaps.

T5.2 Transposing the case
(GSI, LfU)

The purpose of this task is to provide an alternative test of the methods deployed within the main case studies (or adapted versions of the methods) to the pilot cases in Ireland and Germany (Molasse basin). Although these pilots do not have a trans-national context for geoenergy development and management, this is an important task because the GeoConnect^{3}d methods must be applicable to diverse geological and regional contexts, with relevant lessons for any European country. This task will also provide recommendations for task 5.4.

Ireland has a complex geology, created and modified during several tectonic cycles. The fault template of Ireland is more than the boundaries to different geological units; it controls basin stratigraphy, fluid pathways during successive heating events, loci of mineral deposits, limits of underground reservoirs or storage compartments. The geology of Ireland, for resource evaluation – minerals, geothermal energy, energy or CO_2 storage, groundwater use and protection – can be understood only with an understanding of the characteristics and displacement history of the faults. Ireland, therefore, will provide a good test case to validate and refine the methods developed in GeoConnect^{3}d. The analysis will be done in four steps:

1. Select a sub-set of faults that are known to have a complex history and a significant role in creating and modifying the geology of Ireland.
2. Characterise those faults for timing of displacement events, control on sedimentation in basins, fluid flow, etc. Data used will include geological mapping, airborne magnetic and EM geophysics

from Tellus surveys, borehole database, mineral occurrence database, stratigraphic cross-sections, field data on groundwater flow. (Tellus is an ongoing multi-annual national survey collecting high-resolution airborne geophysical and surface geochemical data, http://www.tellus.ie/)

3. Provide test area for transposition of the GeoConnect³d methodology as matured in WP3 and WP4, as recorded in the guidelines of WP2. Apply the GeoConnect³d methodology to analyse the occurrence of geological features and parameters along, at intersections of, and between the faults, in three dimensions.
4. Establish domains of potential, exploitation and protection for geoenergy, raw materials and groundwater applications. Demonstrate the cross-thematic relevance of GeoERA to aid planning decisions and address societal challenges.

The **Molasse Basin,** also called the North Alpine Foreland Basin, developed along the northern margins of the emerging Alpine orogeny. As a result of the Alpine thrust, the footwall of the Molasse Basin dips southward to depths of more than 5,500 m. Due to this significant depth, and despite having just an average geothermal gradient, certain parts of the Austro-German Molasse Basin bear more than 30 examples of the successful utilization of geothermal energy (up to 150°C) from low enthalpy, karstified and faulted limestone systems. Recent development setbacks, mainly due to insufficient groundwater yield, clearly show that the entire system is not fully understood yet and the role of the fault network has been substantially underrated. Thus, the hydrothermal system and its interaction with other subsurface potential utilizations (underground gas storage, declining hydrocarbon exploitation) need a significant review. Characterization of faults, their displacement history and interaction is crucial to all utilizations and hazard proneness, as the fault network defines the preferential flow paths (conduits) for hydrothermal fluids and groundwater, the compartmentalization of reservoirs, seal integrity/gas leakage, induced seismicity, etc.

Existing 3D geo-models of parts of the Bavarian Molasse Basin (featuring detailed 3D representations of the buried fault network), will be extended, merged and re-evaluated by novel approaches within the GE-2 HotLime project. They will then provide further test beds for transposition of the GeoConnect³d methodology and appraisal of their geological situation as a result of fault characteristics. This analysis will be implemented in parallel with GE2-HotLime (modelling the hydrothermal plays) and GE4-HIKE for immediate consideration of novel approaches in fault assessment and for shaping results to be fully compliant with uptake to the Fault Database as conceptualized in HIKE.

T5.3 Learning from the cases
*(**BRGM, RBINS-GSB**, HGI-CGS, CGS, MBFSZ, GSI, PGI-PIB, GSS, GeoZS, GeoInform)*

In this task the more generic and methodological aspects of the two main case studies (WP3 and WP4) will be extracted and the lessons learnt will be consolidated.

The main challenge is to provide a set of criteria for comparing the different case studies. The criteria will help in defining how "successful" the case studies are, and how (if) the methods used can be further optimised. BRGM will be in charge of providing the criteria with support from the other partners. The main questions for assessing the case studies are:

- What are the issues?
- What are the solutions that can solve the issues?
- What gaps are there that prevent providing an adequate solution?

These questions should be seen as guides for structuring the thinking process, a process that already started when outlining the project.

An evaluation board will be set up to review the case-studies with an external view. The board will be composed of GeoERA members not heavily involved in WP3 or WP4, possibly including invitees from outside the GeoConnect³d project.

T5.4 Evaluation and recommendations
*(**BRGM, PGI-PIB**, HGI-CGS, GSS, GeoZS)*

This task will summarize and compile the work performed in the rest of the work-package, trying to bring a more critical eye to the methods developed in the project and assessing their value to a pan-European ambition of subsurface planning and management.

As the final outcome of the project, the overall conclusions and recommendations will be provided to the various stakeholders: administration and public bodies, private companies, GSOs, etc.

A workshop will be organised as a conclusion of the project where both outcomes from case studies and the more generic findings will be presented. The subject of subsurface management could also be extended to gain interest from a larger source of stakeholders. For this purpose, negotiations with other projects such as the GE3-Muse project and GE-4 HIKE project to set up a joint event will be initiated before month 9 of the project, in coordination with the PMB.

Deliverables

- D5.1 - State of the art of subsurface planning and management, and avenues for improvement (PGI; Report; M24)
- D5.2a - Lessons learnt from Molasse Basin pilot (GeoERA: GE3-HotLime WP6/Task 6.3) - feeding into the HotLime Final Report (LfU; Report; M30)
- D5.2b - Lessons learnt from Irish case pilot (GSI; Report; M31)
- D5.2c - Lessons learnt from R2R case (VITO; Report; M32)
- D5.2d - Lessons learnt from Pannonian Basin case (MBFSZ; Report; M33)
- D5.3 - Overall conclusions and recommendations (BRGM; Report; M36)

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Table 3.1b List of work packages

Work package No.	Work Package Title	Lead Participant No.	Lead Participant Short Name	Person - Months	Start Month	End month
1	Project Management Plan	1	RBINS-GSB	10.70	1	36
2	Interface package & Methodology	13	TNO	22.92	1	36
3	Roer-to-Rhine	1	RBINS-GSB	71.12	1	36
4	Pannonian Basin	10	MBFSZ	155.11	1	36
5	Sharing the case studies	7	BRGM	75.02	1	36
Total				**334.87**		

Table 3.1c List of deliverables

Deliverable number	Deliverable name	WP	Short name of lead participant	Type	Dissemina-tion level	Delivery date (in months)
D1.1	Minutes of virtual (monthly) and physical (annual) meetings of the PMB	WP1	RBINS-GSB	Report	Project	M1 – M36
D1.2 a,b	First and final version of the project Data Management Plan	WP1	VITO	Report	Project	M6, 36
D1.3	Dissemination and Exploitation Plan	WP1	RBINS-GSB	Report	Project	M6
D1.4	Mid-term Project Progress and Monitoring Report	WP1	RBINS-GSB	Report	GeoERA	M17
D1.5	Project Final Report	WP1	RBINS-GSB	Report	H2020	M36
D1.6 a,b,c	Cumulative Expenditure Report 2018, 2019, 2020	WP1	VITO	Report	GeoERA	M6, 18, 30
D2.1	Intra- and inter-thematic exchange logbook	WP2	TNO	Report	GeoERA	M1 – M36
D2.2	Report (in conjunction with IP) on agreed requirements for data I/O and visualization of results	WP2	TNO & RBINS-GSB	Report	H2020 (EGDI)	M6
D2.3	Report on fault property requirements (in conjunction with GE4-HIKE)	WP2	TNO	Report	H2020 (EGDI)	M6
D2.4	Report and publication(s) on the two-step framework-geomanifestation methodology	WP2	RBINS-GSB	Report	Project	M24
D3.1	Scientific publication of the annotated R2R model (submitted)	WP3	RBINS-GSB	Publication	Open access	M31
D3.2	Minutes of the workshop on subsurface management and planning	WP3	VPO & VITO	Report	Project	M32
D3.3	Report on ways to disclose essential subsurface data and information to different stakeholders	WP3	VPO & VITO	Report	Project	M36
D4.1	Horizon and voxel 3D model, 3D fault plane surfaces of the main deformation zones in harmonisation with the stratigraphic model horizons	WP4	MBFSZ	Geological model	H2020	M24
D4.2	A joint report on geomanifestations with their physical, spatial- and temporal (4D) analysis, validation of the 3D structural-geological model of the Pannonian basin based on their identification and evaluation of their relevance for spatial management at pilot areas. Only interpreted data will be included	WP4	MBFSZ & GeoZS	Report	H2020	M30

Deliverable number	Deliverable name	WP	Short name of lead participant	Type	Dissemina-tion level	Delivery date (in months)
D4.3	A scientific article on geomanifestations in the Pannonian Basin (IF paper, submitted)	WP4	MBFSZ & PB partners	Publication	Open access	M31
D4.4	Report on the workshop results	WP4	MBFSZ	Report	GeoERA	M28
D4.5a	Report on the benchmark methodology and the results of indicator calculations and evaluations	WP4	MBFSZ	Report	H2020	M36
D4.5b	Applied (traffic-light) model	WP4	MBFSZ	Data model	H2020	M34
D5.1	State of the art of subsurface planning and management, and avenues for improvement	WP5	PGI	Report	H2020	M24
D5.2 a,b,c,d	Lessons learnt from Molasse Basin pilot (GeoERA: GE3-HotLime WP6/Task 6.3) - feeding into the HotLime Final Report Lessons learnt from Irish case pilot Lessons learnt from R2R case Lessons learnt from Pannonian Basin case	WP5	LfU GSI VITO MBFSZ	Report	GeoERA H2020	M30
D5.3	Overall conclusions and recommendations	WP5	BRGM	Report	H2020	M36

Table 3.2a List of milestones

Milestone number	Milestone name	Related work package(s)	Due date (in months)	Means of verification
M1 a,b,c,d	Outlook presentation of the project on the kick-off GeoERA meeting Kick-off project workshop Kick-off workshop R2R case study Kick-off workshop Pannonian Basin case study	WP1-5 WP2,3 WP2,4	M1	Minutes of meeting
M2	Launch of the GeoConnect³d website	WP2	M4	Website online
M3	Structure and guidelines for annotated structural framework methodology	WP2,3	M9	Guidelines to WP3,4
M4 a,b	First and second technical joint GeoERA-GE workshop	WP1-5	M9,27	GeoConnect³d minutes of meeting
M5 a,b	First version regional structural framework Structure for a data management system for geomanifestations	WP2,3	M14	Minutes of PMB meetings
M6 a,b	Presentation of progress, results and highlights of the project on the mid-term GeoERA Review Meeting Mid-term project workshop	WP 1-5	M21	Presentation given Minutes of meeting
M7 a,b	Inventory of available geomanifestations for the R2R and Pannonian Basin case studies	WP3,4	M23	Report
M8 a,b	R2R and Pannonian Basin regional workshops on subsurface management and planning	WP3	M25	Minutes of meeting
M9	Subsurface management workshop with pan-European outreach	WP5	M32	Presentations and feedback questionnaire
M10	Presentation of progress, results and highlights of the project on the final GeoERA Review Meeting	WP 1-5	M39	Presentation given

Table 3.2b List of critical risks for implementation

Description of risk *(level of likelihood: Low/Medium/High)*	**Work package(s) involved** *(Impact: Minor/Medium/Major)*	**Proposed risk-mitigation measures**
Medium: One or more of the projects involved in intra- or inter-exchange is not awarded funding	Mainly WP3 and 4 – Minor impact	Data and expert links will be hampered, but as only a small percentage of the exchange links will be affected, not in a vital way.
Low: HIKE proposal is not awarded funding, and the Fault Database is not developed	All – Medium impact	TNO, coordinator of HIKE, is involved as a major partner in GeoConnect³d. The in-house existing version of the FDB will be developed to meet the basic needs of GeoConnect³d.
Low: IP proposal is not awarded funding	All projects – Major impact	Funding set aside for IP will normally be released. Decision on appropriate use of these means then lies with the General Assembly of GeoERA. GeoConnect³d has the expertise in-house to come up with, or assist in an acceptable solution.
Medium: Dependency of regional and generic case work packages	Mainly WP3, 4 and 5 – Major impact	Communication based management strategy anchored in the functioning of the PMB, with clear definition of responsibilities at WP and task level.
Low: Poor engagement of policy-related stakeholders	All – Major impact	Regional stakeholders will be personally approached by the local partners. Pan-EU stakeholders will be invited for combined events, combining results from several projects, in order to maximize relevance for stakeholders.
Low: Project partner poorly performing, not performing on time, or dropping out	All – Minor to major impact	Quick detection by PMB, with mitigation measures ranging from reminding partner of responsibilities to replacing partner and excluding the partner from funding.
Low: Significant milestone and deliverable delay linked to ambitious project targets	Mainly WP3, 4 and 5 – Major impact	Supervision of PMB allowing top-down detection and intervention. Mitigation measures will likely rely on scalability of targets.
Low: Inability of Information Platform to deliver 3D structural framework visualisation	Mainly WP3, 4 and 5 – Major impact	This risk already has been largely prevented by up-front discussions with the IP project executers. If, against all expectations, this is not realised, non-web based commercial packages will be evaluated to perform a similar visual experience.

Description of risk *(level of likelihood: Low/Medium/High)*	**Work package(s) involved** *(Impact: Minor/Medium/Major)*	**Proposed risk-mitigation measures**
Low: IPR-issue conflicts	All – Major impact	IPR issues are in principle handled at GeoERA level; all partners are aware of the degree of sharing information and expertise. GeoConnect³d is a science based project, with focus on scientific valorisation of findings. WP6 guarantees fair acknowledgement of individual scientific achievements.
Low: Unequal work load distribution	All – Minor impact	Typical for projects in this kind of ERA-NET is that the engagement of individual partners is not only dictated by the needs of the project, but also determined by the total engagement of that partner in GeoERA. In GeoConnect³d this has been pre-discussed, and solved by shifting workload in cross-border areas from smaller to larger partners, with mutual consent.
Low: Other issues	All – Minor to major impact	All partners are experienced in working within projects, and have worked together in the past. The proposal had a lead time of over two years, and is therefore mature and well understood by all partners. This reduces the risk of unforeseen problems, and creates an atmosphere of pro-active problem solving.

Table 3.3a Summary of Staff Effort

	WP 1	WP 2	WP 3	WP 4	WP 5	Total Person- Months per Participant
GSB-RBINS	**4**	5	**32.42**		6.5	47.92
VPO	0.1	1.7	6.5		0.2	8.5
VITO	3	1.5	20.8		0.5	25.8
FZZG		3		17	3.1	23.1
HGI-CGS		2		18.55	3	23.55
CGS					3	3
BRGM					**12**	12
BGR		1.5				1.5
LfU					12	12
MBFSZ	3			**57**	3	63
GSI					12	12
SGL	0.1		2.9			3
TNO	0.5	**5**	6.5		1	13
PIG-PIB		0.7			11.3	12
GSR				24		24
GSS		2		15	4	21
SGIDS				6		6
GeoZS				16	2.9	18.9
GeoInform		0.52		1.56	0.52	2.6
GD NRW			2			2
Total Person Months	10.70	22.92	71.12	155.11	75.02	**334.87**

Table 3.3b 'Other direct cost' items (travel, equipment, other goods and services)

1 / RBINS-GSB	Cost (€)	Justification
Travel	14500	Traveling costs are estimated at 5% of personnel costs. These include the start, mid-term, and final GeoERA events, as well as project, WP and coordination meetings.
Equipment	0.00	NA
Other goods and services	16394.20	As coordinator, RBINS-GSB will host and organise several meetings: • 2 days stakeholder meetings (80 people) • 2 days of project meetings (20 people) • 4 days of WP3 (R2R-case) meetings
Total	30894.20	

2 / VPO	Cost (€)	Justification
Travel	7650	Traveling costs for attending start, mid-term and final GeoERA events, and project and WP meetings
Equipment	0.00	
Other goods and services	0.00	
Total	7650	

3 / VITO	Cost (€)	Justification
Travel	18000	Traveling costs for attending start, mid-term and final GeoERA events, and project and WP meetings
Equipment		
Other goods and services		
Total	18000	

4 / FZZG	Cost (€)	Justification
Travel	4366.36	We plan to attend all project meetings, concerning the direct implementation of the project, as well as at some public events. These include the start, mid-term, and final GeoERA events.
Equipment		
Other goods and services		
Total	4366.36	

5 / HGI-CGS	Cost (€)	Justification
Travel	5652	Costs for attending at least 3 workshops (start, mid, end) of GeoConnect^{3}d project and at two meetings of WP 4 (Pannonian basin).
Equipment		
Other goods and services		
Total	5652	

6 / CGS	Cost (€)	Justification
Travel	2000	Participation in project and stakeholder meetings. These include the start, mid-term, and final GeoERA events.
Equipment		
Other goods and services		
Total	2000	

7 / BRGM	Cost (€)	Justification
Travel	3930.63	Expenses for 3 plenary GeoERA meetings (start, mid-term, and final GeoERA events) + participation in WP5 workshop.
Equipment	0	-
Other goods and services	0	-
Total	3930.63	

8 / BGR	Cost (€)	Justification
Travel	2100	Participation in project and WP meetings. These include also GeoERA events (GeoERA kick-off, mid-term and final events)
Equipment		
Other goods and services		
Total	2100	

9 / LfU	Cost (€)	Justification
Travel	4000	Travel costs and expenses of 2 persons for 2 project meetings / WP5 workshops.
Equipment		
Other goods and services		
Total	4000	

10 / MBFSZ	Cost (€)	Justification
Travel	4500	Travel costs for attendance of 1-2 persons for project meetings. These include the start, mid-term, and final GeoERA events.
Equipment		
Other goods and services	500	organisation of national stakeholder meeting
Total	5000	

11 / GSI	Cost (€)	Justification
Travel	3000	Travel costs for 1-2 persons for WP5 meetings, plus the start, mid-term, and final GeoERA events.
Equipment		
Other goods and services		
Total	3000	

12 / SGL	Cost (€)	Justification
Travel	1500	Traveling costs for project and WP3 meetings. These include the start, mid-term, and final GeoERA events.
Equipment	0	
Other goods and services	0	
Total	1500	

13 / TNO	Cost (€)	Justification
Travel	6000	Traveling costs are estimated at 5% of personnel costs. These include the start, mid-term, and final GeoERA events, as well as project, WP and coordination meetings.
Equipment		
Other goods and services		
Total	6000	

14 / PIG-PIB	Cost (€)	Justification
Travel	9000	Travel costs and expenses of participation in project meetings, knowledge exchange workshops and conferences in Europe, estimated for 3 travels per year for 1 person. These include the start, mid-term, and final GeoERA events.
Equipment		
Other goods and services		
Total	9000	

15 / GSR	Cost (€)	Justification
Travel	3500	Traveling costs for attending start, mid-term and final GeoERA events, and project and WP meetings
Equipment		
Other goods and services		
Total	3500	

16 / GSS	Cost (€)	Justification
Travel	2000	Traveling costs for attending start, mid-term and final GeoERA events, and project and WP meetings
Equipment		
Other goods and services		
Total	2000	

17 / SGIDS	Cost (€)	Justification
Travel	3000	Traveling costs for project and WP3 meetings. These include the start, mid-term, and final GeoERA events.
Equipment		
Other goods and services		
Total	3000	

18 / GeoZS	Cost (€)	Justification
Travel	3000	Traveling costs for attending start, mid-term and final GeoERA events, and accompanying WP meetings for max 2 persons.
Equipment		
Other goods and services		
Total	3000	

19 / GeoInform	Cost (€)	Justification
Travel	1256.41	10% of direct personnel costs to attend project meetings (kick-off, mid-term and final).
Equipment		
Other goods and services		
Total	1256.41	

Table 3.3c Financial table with requested budget

Partici-pant	(A) Direct personnel costs (EUR)	(B) Other direct costs; travel, equip-ment, infra-structure, other (EUR)	(C) Direct costs of sub-contracting (EUR)	(D) Indirect costs (= (A + B) *0.25) (EUR)	(E) Total estimated eligible costs (=A+B+C +D) (EUR)	(F) Reim-bursement Rate (29.7%)[1]	(G) Requested EU contri-bution (=E*F)	(H) Surveys in-kind contribution = (E – G)
RBINS-GSB	327,883.98	30,894.20	0.00	89,694.55	448,472.73	29.7%	133,196.40	315,276.33
VPO	51,000.00	7,650.00	0.00	14,662.50	73,312.50	29.7%	21,773.81	51,538.69
VITO	270,146.00	18,000.00	0.00	72,036.50	360,182.50	29.7%	106,974.20	253,208.30
FZZG	30,564.53	4,366.36	0.00	8,732.72	43,663.61	29.7%	12,968.09	30,695.52
HGI-CGS	56,520.00	5,652.00	0.00	15,543.00	77,715.00	29.7%	23,081.36	54,633.64
CGS	7,029.00	2,000.00	0.00	2,257.25	11,286.25	29.7%	3,352.02	7,934.23
BRGM	78,612.70	3,930.63	0.00	20,635.83	103,179.16	29.7%	30,644.21	72,534.95
BGR	9,647.57	2,100.00	0.00	2,936.89	14,684.46	29.7%	4,361.28	10,323.18
LfU	79,800.00	4,000.00	0.00	20,950.00	104,750.00	29.7%	31,110.75	73,639.25
MBFSZ	99,225.00	5,000.00	0.00	26,056.25	130,281.25	29.7%	38,693.53	91,587.72
GSI	57,240.00	3,000.00	0.00	15,060.00	75,300.00	29.7%	22,364.10	52,935.90
SGL	19,500.00	1,500.00	0.00	5,250.00	26,250.00	29.7%	7,796.25	18,453.75
TNO	84,275.00	6,000.00	0.00	22,568.75	112,843.75	29.7%	33,514.59	79,329.16
PIG-PIB	24,000.00	9,000.00	0.00	8,250.00	41,250.00	29.7%	12,251.25	28,998.75
GSR	36,000.00	3,500.00	0.00	9,875.00	49,375.00	29.7%	14,664.38	34,710.62
GSS	18,795.00	2,000.00	0.00	5,198.75	25,993.75	29.7%	7,720.14	18,273.61
SGIDS	17,400.00	3,000.00	0.00	5,100.00	25,500.00	29.7%	7,573.50	17,926.50
GeoZS	66,150.00	3,000.00	0.00	17,287.50	86,437.50	29.7%	25,671.94	60,765.56
GeoInform	12,564.08	1,256.41	0.00	3,455.12	17,275.61	29.7%	5,130.86	12,144.75
Total	**1,346,352.86**	**115,849.60**	**0.00**	**365,550.61**	**1,827,753.07**		**542,842.66**	**1,284,910.41**

Budget estimation for non-funded partner

Partici-pant	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
GD NRW	30,000.00	0.00	0.00	0.00	30,000.00	NA	NA	30,000.00

[1] The EC Reimbursement rate for ERA-NETs is 33%. 10% of this Reimbursement rate is reserved for the Coordination Costs of GeoERA as agreed in the Grant Agreement. Therefore, the Reimbursement rate for GeoERA is these calculations results in 29.7%.

4 Members of the consortium

4.1 Participants (applicants)

#	Participant	Institution	Country
1	Kris Piessens	RBINS-GSB	Belgium
2	Yves Vanbrabant	RBINS-GSB	Belgium
3	Kris Welkenhuysen	RBINS-GSB	Belgium
5	Katrien De Nil	VPO	Belgium
6	Marleen Van Damme	VPO	Belgium
7	Helga Ferket	VPO	Belgium
8	Timothy Debacker	VPO	Belgium
9	Ben Laenen	VITO	Belgium
10	Jef Deckers	VITO	Belgium
11	Bernd Rombaut	VITO	Belgium
12	Natalija Samardžić	FZZG	Bosnia and Herzegovina
13	Hazim Hrvatović	FZZG	Bosnia and Herzegovina
14	Nermina Omerhodžić	FZZG	Bosnia and Herzegovina
15	Vedad Demir	FZZG	Bosnia and Herzegovina
16	Marko Špelić	HGI-CGS	Croatia
17	Staša Borović	HGI-CGS	Croatia
18	Vit Hladik	CGS	Czech Republic
19	Thomas Le Guenan	BRGM	France
20	Fernanda De Mesquita L. Veloso	BRGM	France
21	Fabian Jähne-Klingberg	BGR	Germany
22	Gerold Diepolder	LfU	Germany
23	Stephan Sieblitz	LfU	Germany
24	Johannes Großmann	LfU	Germany
25	Thomas Fritzer	LfU	Germany
26	Annamária Nádor	MBFSZ	Hungary
27	Gyula Maros	MBFSZ	Hungary
28	László Bereczki	MBFSZ	Hungary
29	Edit Babinszki	MBFSZ	Hungary
30	Teodóra Szőcs	MBFSZ	Hungary
31	Ágnes Rotár-Szalkai	MBFSZ	Hungary
32	Nóra Gál	MBFSZ	Hungary
33	László Zilahi-Sebess	MBFSZ	Hungary

34	Tamás Kerékgyártó	MBFSZ	Hungary
35	Brian McConnell	GSI	Ireland
36	Beatriz Mozo	GSI	Ireland
37	Robert Colbach	SGL	Luxemburg
38	Romain Meyer	SGL	Luxemburg
39	Petra Münzberger	SGL	Luxemburg
40	Johan H. ten Veen	TNO	Netherlands
41	Hans Doornenbal	TNO	Netherlands
42	Serge F. van Gessel	TNO	Netherlands
43	M. (Maryke) den Dulk	TNO	Netherlands
44	Harry Middelburg	TNO	Netherlands
45	Monika Konieczyńska	PIG-PIB	Poland
46	Olga Lipińska	PIG-PIB	Poland
47	Octavian Coltoi	GSR	Romania
48	Gabriel Bindea	GSR	Romania
49	Anca Marina Vijdea	GSR	Romania
50	Flori Marilena Culescu	GSR	Romania
51	Tanja Petrović Pantić	GSS	Serbia
52	Petar Stejić	GSS	Serbia
53	Milan Tomić	GSS	Serbia
54	Divna Jovanovic	GSS	Serbia
55	Rodoljub Gajić	GSS	Serbia
56	Balázs Kronome	SGIDS	Slovakia
57	Nina Rman	GeoZS	Slovenia
58	Andrej Lapanje	GeoZS	Slovenia
59	Dejan Šram	GeoZS	Slovenia
60	Miloš Markič	GeoZS	Slovenia
61	Dušan Rajver	GeoZS	Slovenia
62	Jure Atanackov	GeoZS	Slovenia
63	Boris Malyuk	GeoInform	Ukraine
64	Sergii Prymushko	GeoInform	Ukraine
65	Volodymyr Velychko	GeoInform	Ukraine
66	Igor Melnyk	GeoInform	Ukraine
67	Tetiana Biloshapska	GeoInform	Ukraine
68	Galyna Polunina	GeoInform	Ukraine

69	Iryna Mykhaylyk	GeoInform	Ukraine
70	Natalia Kovalenko	GeoInform	Ukraine
71	Heinz Elfers	NRW	Germany
72	Bernd Linder	NRW	Germany
73	Martin Salamon	NRW	Germany

4.2 Participants (applicants)

01 RBINS-GSB Belgium – Coordinator

Name of the organisation (Acronym)

Royal Belgian Institute of Natural Sciences – Geological Survey of Belgium (RBINS-GSB)

Brief description of the legal entity

The Royal Belgian Institute of Natural Sciences is a world-class research institute covering a wide range of disciplines from biology to geology, oceanography to taxonomy and paleontology to ecology. Two of its operational directorates (OD) participate to GeoERA, the OD Earth and History of Life, and also the OD Natural Environment.

The Directorate Earth and History of Life is the most important research centre devoted to Earth Sciences (geology, palaeontology and archaeosciences) in Belgium. It is composed of about 65 statutory and contractual staff members. Laboratories have a comprehensive range of modern equipment for mineralogical and petrophysical analysis. The Geological Survey of Belgium (GSB) is an autonomous subsection of the RBINS OD Earth. Created in 1896, the GSB is a key geological and mineralogical research centre developing both applied and fundamental research approaches. It is also an independent, non-commercial provider of geoscientific services. These services are oriented towards local, regional, federal, European and international authorities, as well as researchers of institutions/universities and research groups, private companies, NGO's and citizens. In spite of retaining this profile and strong societal focus, which is typical for the geological surveys of Europe, the GSB has at the same time become one of the most research-oriented Surveys in Europe, evidenced by a rapidly increasing scientific output in recent years.

Main persons involved

Kris Piessens (PhD, 15+ year experience, male) is one of the key members of the GeoEnergy team. He has been involved in CCS related research for 15 years, working on the interface between geological, economic, policy, engineering and regulatory aspects. He created the PSS (Policy Support System) simulator, for which he remains co-developer. Additional topics are shale gas, geothermal energy, geogenic release of CO_2, and Lower-Palaeozoic geology.

Yves Vanbrabant (PhD, 15+ year experience, male) has a strong background in structural geology, and will lead the development and deployment of the structural framework for the R2R case study. He is one of the leading experts on the geology of the Ardennes, and a proven research track for reservoir assessments for geo-energy purposes.

Kris Welkenhuysen (PhD, 10+ year experience, male) is currently leading the geo-energy team of the GSB, and is specialised in the multi-disciplinary assessment of geo-energy applications. Within the project, this is important for evaluation of optimal subsurface management strategies.

Relevant publications

Petitclerc, E., Welkenhuysen, K., Van Passel, S., Piessens, K., Maes, D. & Compernolle, T., 2017. Towards geological-economic modelling to improve evaluating policy instruments for geothermal energy – Case study for Belgium (Campine Basin). European Geologist, 43, p.10-15.

Compernolle, T., Welkenhuysen, K., Huisman, K., Piessens, K. & Kort, P., 2017. Off-shore enhanced oil recovery in the North Sea: The impact of price uncertainty on the investment decisions. Energy Policy, 101, 123-137.

Welkenhuysen, K., Rupert, J., Compernolle, T., Ramirez, A., Swennen, R., & Piessens, K., 2017. Considering economic and geological uncertainty in the simulation of realistic investment decisions for CO_2-EOR projects in the North Sea. Applied Energy, 185 (1), p.745-761.

Welkenhuysen, K., Brüstle, A.-K., Bottig, M., Ramírez, A., Swennen, R. & Piessens, K., 2016. A techno-economic approach for capacity assessment and ranking of potential options for geological storage of CO_2 in Austria. Geologica Belgica, 19 (3-4), p.237-249.

Welkenhuysen, K., Ramirez, A., Swennen, R. & Piessens, K., 2013. Strategy for ranking potential CO_2 storage reservoirs: a case study for Belgium. International Journal of Greenhouse Gas Control, 17, p. 431-449.

Relevant projects

MEET (EU H2020, 2018-2021): Multidisciplinary and multi-context demonstration of EGS exploration and Exploitation Techniques and potentials

ENOS (EU H2020, 2013-2019): Enabling Onshore Storage of CO_2 in Europe

EUOGA (EU H2020, 2016-2017): Geological evaluation of potential unconventional oil and gas resources in Europe

ACCESS (EU Europe-Aid, 2010-2012): Assistance in Clean Coal and Environmentally sound Storage Solutions: capacity building project on clean coal and CCS in Kazakhstan

PSS-CCS I, II & BeNe (Belspo, 2005-2010): Policy support System for Carbon Capture and Storage: Belgian umbrella projects for CCS potential assessment

Infrastructure, products and services

Geological maps of Belgium, boreholes database, field observations are available online through the webGIS portal developed by GSB (www.belgiumgeology.net).

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02 VPO Belgium

Name of the organisation (Acronym)

Vlaams Planbureau voor Omgeving (VPO) - Bureau for Environment and Spatial Development – Flanders

Brief description of the legal entity

VPO is the competent division of the Government of Flanders for raw materials, hydrocarbons and geothermal resources. The division is authorized to prepare and to execute the Flemish policy concerning (1) raw materials, (2) the sustainable use of the subsoil in the Flemish region and (3) geological research. In relation to these tasks, VPO performs data management and publishes data, maps and models. As the competent regional Flemish authority, VPO owns many of the envisaged data, in line with the scope and deliverables of the ERA-NET for the topics of Geo-energy and Raw Materials and has in-house expertise a) on geo-energy and raw materials for the Flemish region, b) in setting up and maintenance of databases, c) in subsurface geological mapping using geological and geophysical data and d) in the monitoring of the demand and use of raw materials.

VITO (Flemish Institute for Technological research) will be a third party of VPO in the ERA-NET on Applied Geosciences. The Flemish Knowledge Center of the Subsoil (VLAKO) is a Task Force within VITO that conducts policy-supporting research for VPO. This is arranged by 5-year agreements between the Government of Flanders and VITO. These agreements are made on high (ministerial) level and have already been in place for more than two decades. Many of the envisaged deliverables of the ERA-NET on Applied Geosciences are conducted by VITO and are commissioned by VPO.

Main persons involved

Katrien De Nil (MSc, 10+ year experience, female) holds a Master in Geology (KULeuven, 2002) and a Master in Engineering of Natural Resources and Risks (Institut Egid Bordeaux, 2003). She is a policy advisor at VPO, and is responsible for geological data management and publication for DOV (Databank Ondergrond Vlaanderen - Flanders Soil and Subsoil Database). She worked with different (OpenSource) GIS platforms and built knowledge of data management, standardization and (INSPIRE) data specifications. She often acts as a go-between when developing GIS-tools for the end users. She has years of experience in project management and publication of geological 3D modelling, which implies knowledge of webservices, metadata, exchange formats.

Marleen Van Damme (Engineer, 25+ year experience, female) is a Civil Engineer in Construction. Her current position is coordinator of DOV (Databank Ondergrond Vlaanderen - Flanders Soil and Subsoil Database) at VPO.

Helga Ferket (PhD, 15+ year experience, female) holds a Master and PhD in Geology (KULeuven). Currently, she is a policy advisor at VPO. After a PhD and postdoc career in hydrocarbon exploration, basin dynamics, geomodelling and geofluids in Belgium, Mexico and France, she joined the Flemisch Institute for Technological Research (VITO). There she gained further expertise in applied research in geothermal, minewater, CCS, geo-energy, geomodelling and in the geology and potential of the subsurface of Flanders. She joined VPO in 2013, where she is currently involved with geoenergy policy and legislation and with mapping and management of the subsurface of Flanders.

Timothy Debacker (PhD, 15+ year experience, male) holds a Master in Geology (UGent, 1996), a Master in Structural Geology and Rock Mechanics (Imperial College, London, 1997) and a PhD in Geology (UGent, 2001). After a long postdoctoral career in Europe and New Zealand, in which he was mainly involved in deformation mapping, he joined FROGTECH (Australia) in 2012, where he did consultancy work for the Australian government and the petroleum industry. He joined VPO in 2016, where he is now policy advisor. Through his academic work and work in the petroleum industry he gained expertise in geological mapping, structural geology and tectonics, GIS, potential field data analysis (gravity and magnetic data), seismic data interpretation and fabric analysis.

Relevant publications

Ferket, H. en Debacker, T., 2017. Sleutelen aan een structuurvisie voor de diepe ondergrond in Vlaanderen. Ruimte 34, 42-45. → *towards a vision for subsurface spatial planning;*

Ferket, H., Laenen, B. and Van Tongeren, P., 2010. Basin modeling of the Campine Basin; can we complete the puzzle? Schriftenreihe der Deutschen Gesellschaft für Geowissenschaften (SDGG) 68, p. 166. → *origin and potential of the Belgian – Dutch – German Campine Basin;*

Ferket, H., Laenen, B. and Van Tongeren, P., 2011. Transforming flooded coal mines to large-scale geothermal & heat storage reservoirs: what can we expect. In Rüde, Freund & Wolkersdorfer (Eds.): Mine Water – Managing the Challenges, 13-17. International Mine Water Association, Aachen, Germany.
EU “Minewater project” (Interreg-IIIb project, 2006-2008) and “Remining project” (FP6-Concerto, 2009-2012); major role in minewater projects in Heerlen (Netherlands) and Yellowknife (Canada) → *prediction and monitoring of flow, heat and chemistry (especially along faults) in flooded mines;*

Piessens, K., Welkenhuysen, K., Laenen, B., Ferket, H., Nijs, W., Duerinck, J., Cochez, E., Mathieu, Ph., Valentiny, D., Baele, J.-M., Dupont, N., Hendriks, Ch., 2012. Policy-support system for carbon capture and storage and collaboration between Belgium – The Netherlands "PSS-CCS". Belgian Science Policy, D/2012/1191/7, 335pp. → *inventory of potential & risks for geological storage of CO_2 in Belgian and Dutch reservoirs*

Herbosch, A & Debacker, T.N. (accepted). A new geological map of the outcrop areas of the Brabant Massif (Belgium). *Geologica Belgica*.

Relevant projects

GS-Soil, WP2-WP5, 2009-2012;

H3O- Roer Valley Graben: (Hydro)geological Model of the Ruhr Valley Graben with partners of Flanders Region, Belgium and the Netherlands;

H3O-De Kempen: (Hydro)geological Model of the Campine with partners of Flanders Region, Belgium and the Netherlands;

G3Dv2 & G3Dv3: Geological 3D Model of Flanders and Brussels-Capital Region (G3D, version 2 & version 3), partner VITO → *mapping and modelling of the Flemish subsurface*;

Geoheat-app: EU Interreg-IV project (2013-2014) Flanders – Netherlands "economische haalbaarheid van intermediaire en diepe geothermie voor het verduurzamen van de warmtevraag bij bouw- en renovatieprojecten" → *feasibility of using deep or intermediate geothermal energy for heating in the built environment in our regions (including cross-border geomodelling)*;

Infrastructure, products and services

Database Subsoil Flanders (Databank Ondergrond Vlaanderen, http://www.dov.vlaanderen.be): DOV is the public web portal through which 3 regional administrations deliver INSPIRE-compliant Open Data, available for re-use. The project partners deliver data on the geology, the natural resources, the soil, the hydrogeology, geotechnical characteristics and the groundwater licenses of Flanders.

- Portal: https://www.dov.vlaanderen.be/portaal/#MijnDovPage
- Main viewer: https://www.dov.vlaanderen.be/portaal/?module=verkenner#ModulePage
- Metadata catalogue: http://www.dov.vlaanderen.be/geonetwork
- Services: http://www.dov.vlaanderen.be/geoserver

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03 VITO Belgium

Name of the organisation (Acronym)

Vlaams Instituut voor Technologisch Onderzoek (VITO)

Brief description of the legal entity

VITO is a leading European independent research organization in the areas of clean tech and sustainable development, elaborating solutions for the large societal challenges of today. VITO provides innovative and high-quality solutions, whereby large and small companies can gain a competitive advantage, and advises industry and governments on determining their policy for the future. VITO has 772 highly-qualified employees who work on international projects all around the world. VITO's headquarters are located at Mol, Belgium. The total turnover of VITO amounted to about 174 million Euros in 2016.

VITO focuses on five different research programmes: sustainable chemistry, energy, health, materials management and land use. Each programme builds up a strong base of knowledge and skills, with added value for industry and society. VITO is working hard on sustainability and transition thinking as binding factors between the five research programmes. Through its multi-disciplinary research programmes, VITO is deeply involved in different technology platforms and technology associations inside and outside Europe.

The Geoconnect³d project will be carried out by the Unit "Geo & Atmospheric Modelling team" (GAME). GAME counts 37 researchers that have a strong background in geology, geophysics, on-shore exploration, data management, 3D spatial analysis and modelling of fluid flow and heat transfer in the underground. This expertise covers a wide range of applications including spatial planning, ground water management, underground storage of gasses and heat, coal bed methane production and the extraction of geothermal energy.

VITO participates in and coordinates several HORIZON 2020 projects. Researchers of GAME are currently involved in STORM, MATChING, CHPM2030 and DG ETIP.

Role & motivation to involve VITO as linked third party

VITO will act as a third party linked to VPO. VPO has a reference assignment with VITO for support in the field of knowledge accumulation and dissemination on the Flemish subsurface. Within the framework of this reference task, VITO carries out various research tasks relating to geological mapping and the estimation of raw material reserves.

Within this context of GeoConnect^{3}d, VPO has assigned tasks related to the development of the structural framework for Flanders and the integration of geomanifestations into the structural framework to VITO (WP3: R2R case study). Moreover, VITO will assist VPO in the definition of the overall methodologies (WP2) and in the communication activities foreseen in the project. Moreover, VITO will support the PMB on administrative issues and quality control (WP1).

The tasks that VITO will carry out within the framework of GeoConnect^{3}d are additional to the research tasks within the reference task. By engaging VITO as a linked third party, it is ensured that the expertise and models that VITO has built-up in the past is efficiently transferred to GeoConnect^{3}d and that the results of GeoConnect^{3}d are fully integrated into the models that VITO maintains within for VPO.

Main persons involved

Ben Laenen (PhD, male) graduated as a geologist in 1992 and obtained a PhD in Sciences - Geology in 1997 at the Catholic University of Leuven (Belgium). After his PhD, Ben Laenen worked as a post-Doc at the University of Köln (Germany). During that time he studied secondary oil migration in the Bashaw Reef complex (Alberta, Canada). Since 2000, Ben Laenen is employed as a researcher at VITO. He started as junior researcher the Energy department and he mainly worked on GIS related project, data management and 3D modeling of the subsurface. From 2006 till 2010, Ben Laenen worked as project leader in the Resources group. He planned and coordinates projects in the fields of geological exploration, gas- and CO_2-storage, waste conversion using CO_2 and geothermal energy. In September 2010, Ben Laenen was promoted to position of research coordinator. He is now responsible to define and elaborate the strategic research programs of VITO in the fields of deep geology and geothermal energy.

Jef Deckers (MSc, male) graduated as a geologist in 2011 at Ghent University (Belgium). After graduation, Jef Deckers was employed as a researcher at VITO. He worked as junior researcher as part of a team that creates 3D (hydro)geological models of the Flemish subsurface for the Flemish Government. From 2012 onwards, Jef Deckers worked as project leader for two cross-boundary project, called H3O-Roer Valley Graben and H3O-De Kempen. In these cross-boundary project, the subsurface of parts of the border region between Belgium and the Netherlands was modelled in 3D in close collaboration with TNO and Geological Survey of Belgium. In 2017, Jef Deckers was promoted to the position of project leader for the 3D (hydro)geological modelling of the Flemish subsurface for the Flemish Government (VLAKO).

Bernd Rombaut (MSc, male) graduated as a geologist in 2010 at the University of Ghent. From 2011 until early 2013 he was employed in Arnhem (The Netherlands) as a geothermal specialist at IF Technology, where he worked on several geothermal studies (exploration licenses, feasibility studies, regional potential studies, etc.). Since mid-2013, Bernd Rombaut has been active as a researcher at VITO. Most of the time he helped developing a 3D model of the subsurface of Flanders, with a focus on interpreting well log data and seismic data, and creating a 3D geological horizon and fault model.

Relevant publications

Deckers, J., 2016. The Late Oligocene to Early Miocene early evolution of rifting in the south-western part of the Roer Valley Graben. International Journal of Earth Sciences, 105(4), 1233-1243.

Deckers, J., Van Noten, K., Schiltz, M., Lecocq, T., Vanneste, K., 2018. Integrated study on the topographic and shallow subsurface expression of the Grote Brogel Fault at the boundary of the Roer Valley Graben, Belgium. Tectonophysics, 722, 486-506.

Deckers J, Vernes R, Dabekaussen W, Den Dulk M, Doornenbal H, Dusar M, Matthijs J, Menkovic A, Reindersma R, Walstra J, Westerhoff W, Witmans N 2014. Geologisch en hydrogeologisch 3D model van het Cenozoïcum van de Roerdalslenk in Zuidoost-Nederland en Vlaanderen (H3O-Roerdalslenk). VITOrapport, 2014/ETE/R/1, p 200

Loveless, S., Pluymaekers, M., Lagrou, D. and Laenen, B. 2014. Mapping the Geothermal Potential of Fault Zones in the Belgium-Netherlands Border Region. Energy Procedia 59: 351-358

Matthijs J, Lanckacker T, De Koninck R, Deckers J, Lagrou D, Broothaers M 2013. Geologisch 3D lagenmodel van Vlaanderen en het Brussels Hoofdstedelijk Gewest—versie 2. Studie uitgevoerd in opdracht van de Vlaamse overheid, afdeling Land en Bodembescherming, Ondergrond, Natuurlijke Rijkdommen. VITO-rapport 2013/R/ETE/43, pp 24

Relevant projects

VLAKO - Flemish knowledge centre for the management of databases for sub-surface applications in Flanders (2007 – 2018; funding: Flemish government, VPO): Static 3D-modelling of the geology of Flanders; geological data collection and management in the context of the Geosciences Database of Flanders (DOV: https://dov.vlaanderen.be/); resource mapping and policy support in the context of Flemish Decree on the Deep Subsurface and the Decree on the exploitation of Raw Materials.

H3O-Roer Valley Graben and –The Campine: In the H3O-Roer Valley Graben and H3O-De Kempen projects (funding for the Flemish part: Flemish government (currently VPO) and Flemish Environment Agency) 3D cross-boundary (hydro)geological models (including fault models) were created of the Flemish and Dutch parts of the central and northwestern parts of the Roer Valley Graben respectively. The H3O-projects were the result of a close collaboration between VITO, TNO and the Geological Survey of Belgium.

SALK - GeoWatt (2015 – 2018; supported by the EU, ERDF, Flanders Innovation & Entrepreneurship and the Province of Limburg): In the Activity 'Deep geothermal' of the GeoWatt project, innovative concepts and tools are developed to enhance the efficiency of deep geothermal use and minimising the risks for Lower Carboniferous Carbonates in Belgian Limburg.

GEOHEAT app (2013 – 2014; funding: INTERREG, ALBON, provinces of Antwerp and Limburg). Within the context of this INTERREG IV Vlaanderen – Nederland, VITO, TNO and Grontmij NL evaluated the technical and economic feasibility of intermediate and deep geothermal energy as a sustainable source of heat for new and renovated buildings based on 6 case studies. The project included cross-border mapping of geothermal aquifers, a techno-economic evaluation of the application of geothermal heating (and cooling) based on 6 case studies and discussion sessions with different stakeholders (i.e., civil servants of responsible departments in the Netherlands and Belgium, policy makers, project developers and financers). See https://geothermie.vito.be/nl/projecten/geoheat-app

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04 FZZG Bosnia and Herzegovina

Name of the organisation (Acronym)

Federalni zavod za geologiju – Geological Survey of Federation of Bosnia and Herzegovina (FZZG)

Brief description of the legal entity

The Geological Survey of the Federation of Bosnia and Herzegovina – Sarajevo (FZZG) is an independent institution under direct jurisdiction of the Government of the Federation of Bosnia and Herzegovina. Source of financing is 100% from the budget of the Federation of B&H.

FZZG is the successor of the Geological Institute Sarajevo, which was established in 1912. In this long period of time, there have been changes in the name and organizational structure and number of staff, but the main tasks have always stayed the same.

Nowadays, FZZG is the largest institution for geological research in Bosnia and Herzegovina with 29 employees, among which 16 geologists.

Main tasks of FZZG are:

- Development of geological, engineering geological, hydrogeological, seismotectonic, metallogenic and other geological maps;
- Development of Federal mineral resources management program;
- Exploration of mineral resources;
- Supervision of geological research of oil and gas;
- Performing list of strategic mineral resources for the Government of the Federation of B&H and proposals for their use;
- Preparation of geological maps for spatial planning, the construction of infrastructure facilities and mining operations, the development of forestry, agriculture, water supply, and the development of urbanization and infrastructure;
- Development of guidelines, standards and norms in geological research;
- Creation of databases of geological exploration.

Main persons involved

Natalija Samardžić (MSc, female) is a hydrogeologist and expert in FZZG for geothermal energy who works in the position of Advisor for hydrogeology and has 14 years of experience in hydrogeological research of mineral, thermal and thermomineral waters. She is the coordinator of the FZZG team in the current DARLINGe project (EU project), which deals with the geothermal energy of the Danube Region. She has experience in preparation of legal acts in the field of groundwater and geothermal energy management. The main international projects in which she was engaged, were APOPSBAL (2002-2005) and ANTHROPOL. PROT (2003-2005) - projects of the European Commission, Brussels, DanReGeotherm-DATA (2015) - EU project and Investigation of gases and isotopes in hyperalkaline waters of B&H, project in cooperation of FZZG and the National Institute of Geophysics and Volcanology from Italy (2016-2017). (natalija.samardzic@fzzg.gov.ba)

Hazim Hrvatović (PhD, male), geologist, Director of the Federal geological survey, leading oil and gas research expert in Bosnia and Herzegovina. He has more than 38 years of experience in geological mapping and preparation of drilling projects and strategic planning of exploration of mineral resources. The most important international projects in which he was involved, were APOPSBAL (2002-2005); ANTHROPOL. PROT (2003-2005); IGME 5000 (1994-2010); BSHAP - NATO Project (2007-2011); OneGeology (2008-…); GEMAS (2008-2013) and at present DARLINGe project (2017-…). (hazim.hrvatovic@fzzg.gov.ba)

Nermina Omerhodžić (MSc, female), geologist, specialist in database design and coal investigation. She has 23 years of experience as a geologist in coalmines, where she was engaged in geological research, coal quality and preparation for exploitation. In FZZG, she works in the position of Advisor for information technology at the GIS Sector since 2007. She is currently engaged in several international projects as an expert in GIS technology. (nermina.omerhodzic@fzzg.gov.ba)

Vedad Demir (MSc, male), geologist, is experienced in tasks related to engineering geology, geological mapping, structural geology and GIS. He is a team member making the new geological map of Bosnia and Herzegovina, 1:10 000, and making the engineering geological map of BiH. He has experience working with geo-science projects in Bosnia and Herzegovina and some EU funded projects (OneGeology, RoofOfRock, GEO-CRADLE). He has a master's degree in structural geology. (vedad.demir@fzzg.gov.ba)

Relevant publications

Geological Institute – Sarajevo, 1968-1990: Basic Geological Map of SFRY 1: 100 000 with Explanations – sections (sheets) of B&H, Edited and published by Federal Geological Survey (Yugoslavia) – Belgrade.

Miošić, 1978: Map of mineral, thermal and thermomineral waters of B&H with Explanation and Catalogue of waters; In the Map of mineral and thermal waters of Yugoslavia 1:500 000 (1983), Edited and published by Federal Geological Survey (Yugoslavia) - Belgrade.

Čičić, Miošić, 1986: Geothermal energy of Bosnia and Herzegovina, Monograph, Geological Institute – Sarajevo.

Hrvatović, H.: Geological guidebook through Bosnia and Herzegovina, Separate Monograph, Herald Geological, volume 25, Sarajevo, (2006).

Miošić, N., Samardžić, N. and Hrvatović, H., Geothermal potential and current status of their use and development, Bosnia and Herzegovina. Proceedings European geothermal congress, Pisa, Italy, 3 – 7 June 2013 (2013).

Relevant projects

Regional geothermal investigation:

- Bosanska Krajina Region (Miošić et al., 1982),
- Banja Luka Region (Miošić et al., 1983),
- Brčko Region (Miošić, 1983),
- Bihać Region (Miošić, Papeš, 1984)
- Semberija Region (Miošić et al., 1987),
- Spreča fault zone (Miošić et al., 1987).

Geothermal map of Bosnia and Herzegovina, 1:200.000 (Miošić, 1989).

Ravnik D., Miošić N. et al., (1992): Yugoslavia. Hurtig, E., Čermák, V., Haenel, R. and Zui, V., (Eds): Geothermal Atlas of Europe, Hermann Haak Verlagsgesellschaft mbH, Geographisch-Kartographische Anstalt Gotha, Germany, (1992).

Miošić N. (2002): Bosnia – Herzegowina. In Hurter, S. and Haenel, R. (Eds): Atlas of Geothermal Resources in Europe, European Commission, Research Directorate-General. Publ., No. 17811, 92 p. 89 plates, Luxembourg, (2002).

Miošić, Skopljak, Samardžić, Saletović, Begić, 2010: Cadastre and GIS database of mineral, thermal and thermomineral waters of Federation of B&H, Geological survey of Federation of Bosnia and Herzegovina.

Infrastructure, products and services

Library: FZZG has almost all Projects, Reports, Studies, Elaborates, Geological maps and other documents that represent geological investigation results of Geological survey Sarajevo since 1912 up to present, as well as the geological documentation of many other project designers and institutions that are obligated to submit documentation to FZZG in accordance with the Law on Geological Investigation.

ESRI Software: ArcGIS Desktop 10.3.1 and ArcGIS Server 10.3.1

Field Equipment: conductometers, pH meters, gas sampling equipment, GPS devices, tablets, etc

Oil and gas databases with all results of investigations carried out in Bosnia and Herzegovina

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05 HGI-CGS Croatia

Name of the Organisation (Acronym)

Hrvatski Geološki Institut – Croatian Geological Survey (HGI-CGS)

Brief description of the legal entity

HGI-CGS is the largest public research institute in the field of geosciences and geological engineering in Croatia with 66 experts and researchers and 12 junior researchers. The researchers at the HGI-CGS have experience and competence in the investigation of geothermal systems (protection, finding new resources, working on sustainable usage of existing one), groundwater systems (protection, finding new resources, working on sustainable usage of existing ones), geological mapping, solving problems in environment (landslides, flooding, soil contamination) and exploration of mineral resources. HGI-CGS has 3 departments: Geology, Hydrogeology and Engineering Geology, and Mineral Resources, including laboratories for hydrochemical, engineering geological and geochemical measurements. HGI-CGS has Geoportal, which contains information on publications of the Croatian Geological Survey and the published works of its employees, which are available for the public. HGI-CGS collaborates with many institutions of similar affiliation from Croatia and other countries. Beside scientific research and geological survey, the institute provides consulting services for external customers in the areas of its expertise.

Main persons involved

Marko Špelić (MSc, male) attended Faculty of mining, geology and petroleum engineering where he earned MSc degree of geology in 2014. He worked for nine months at the Croatian National History Museum, where in the beginning of 2016, he became associate expert at the Croatian Geological Survey

- Department of Geology. In the same year, he started a postgraduate study at the Faculty of mining, geology and petroleum engineering on the topic of subsurface mapping with proposed application to CCS and/or geothermal energy exploration.

Dr. Staša Borović (PhD, female) studied geology and geography at the Faculty of Science of the University of Zagreb and earned an MSc degree in both disciplines in 2009. After that, she became a research assistant at the HGI-CGS and earned a PhD in geological engineering at the Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb in 2015 by defending a thesis on hydrothermal systems research. She is currently working as a postdoctoral fellow at the Dpt. of Hydrogeology and Engineering Geology of HGI-CGS.

She collaborated on the fundamental projects of HGI-CGS: Geothermal map of the Republic of Croatia and Basic Hydrogeological Map of the Republic of Croatia, as well as on a number of EU and market-oriented projects concerning shallow and deep geothermal resources.

Relevant publications

Špelić, M., Malvić, T., Saraf V., Zalović, M. Remapping of depth of e-log markers between Neogene basement and Lower/Upper Pannonian border in the Bjelovar Subdepression (2016) Journal of Maps, 12 (1), pp. 45-52, DOI: 10.1080/17445647.2014.978909

Soldo, V., **Borović, S.**, Lepoša, L., Boban, L. Comparison of different methods for ground thermal properties determination in a clastic sedimentary environment (2016) Geothermics, 61, pp. 1-11, DOI: 10.1016/j.geothermics.2015.12.010

Borović, S., Marković, T., Larva, O., Brkić, Ž., Mraz, V. Mineral and thermal waters in the Croatian part of the Pannonian basin (2016) Environmental Earth Sciences, pp. 31-45, DOI: 10.1007/978-3-319-25379-4_2

Borović, S., Marković, I. Utilization and tourism valorisation of geothermal waters in Croatia (2015) Renewable and Sustainable Energy Reviews, 44, pp. 52-63, DOI: 10.1016/j.rser.2014.12.022

Borović, S., Marković, T., Larva, O. Protection of transboundary aquifers of Medimurje County (Croatia): Status and prospects (2015) International Journal of Environment and Health, 7 (3), pp. 197-214, DOI: 10.1504/IJENVH.2015.073194

Relevant projects

2009 – 2012 Geothermal map of the Republic of Croatia

2012 – now Basic Hydrogeological Map of the Republic of Croatia

2013 – 2015 GeoMapping – mapping of shallow geothermal potential in the Republic of Croatia (IPA project)

2015 – now DanReGeo-DATA - analysis of available data about geothermal phenomena in the Pannonian part and development of structure for a common data base (DTP project)

2017 – 2019 DARLINGe Danube Region Leading Geothermal Energy – geothermal research on a Pannonian basin scale level (DTP project)

Infrastructure, products and services

Instrument for *in-situ* and laboratory thermal properties measurement (ISOMET 2114, Applied Precision, Bratislava)

Midland Valley Move core application: software for structural modeling, interpreting data, cross-section digization etc

06 CGS Czech Republic

Name of the organisation (Acronym)

Ceska Geologicka Sluzba – Czech Geological Survey (CGS)

Brief description of the legal entity

Czech Geological Survey (CGS / Czech Republic) is the leading geological research institution in the Czech Republic. It is a state research institute supervised by the Ministry of Environment. Its staff counts about 300 people, round 200 of them being university graduates.

Geo-energy related activities of CGS have developed a significant knowledge in the field of geothermal energy, energy storage, CO_2 geological storage, subsurface management, multidisciplinary characterization of reservoir rocks and seals, data management, geo-ICT and 3D-modelling. CGS hosts the national repository of subsurface data and information and is the designated state advisor in all geological matters.

CGS has rich experience with participation in international research projects in many areas of geoscience, including European Framework Programs (FP6, FP7, Horizon 2020) and other types of multilateral cooperation. CGS is member of EuroGeoSurveys, CO_2GeoNet and the Czech national representative in ENeRG (European Network for Research in Geo-Energy).

Main persons involved

Vit Hladik (MSc, male) is research coordinator for Geo-Energy at the Czech Geological Survey. His professional focus is research and project management in the fields of subsurface management, energy storage and CO_2 geological storage. He acted as project coordinator of the FP6 CO_2NET EAST project (CO_2 capture and storage networking extension to new Member States) and REPP-CO_2 – a Czech-Norwegian project funded by Norway Grants, aiming at the preparation of a research CO_2-storage pilot project in Czechia, and he was Management Board member and WP leader of CGS Europe (FP7) and ENOS (H2020) projects. Vit serves as President of the European Network for Research in Geo-Energy (ENeRG) in 2018-2019, and is CGS representative in the GeoEnergy Expert Group of EuroGeoSurveys and the CO_2GeoNet network.

Vit possesses a MSc degree in applied geophysics from Charles University in Prague, and a MBA from Nottingham Trent University / Brno Business School.

Relevant publications

Beccaletto, L., Bader, A., Bialkowski, A., Jaudin, F., Hladík, V., Holeček J., Van Gessel, S., Meinke-Hubeny, F., Mulder, A. (2016): Geological subsurface data collection as a part of the European ESTMAP Project (Energy STorage Mapping and Planning). In Tahirkheli, S: International Geological Congress, Abstracts, 1216. – 35th International Geological Congress. Cape Town

Hatzignatiou, D., Riis, F., Berenblyum, R., Hladík, V., Lojka, R., Franců, J. (2011): Screening and evaluation of a saline aquifer for CO_2 storage: Central Bohemian Basin, Czech Republic. – International Journal of Greenhouse Gas Control 5, 6, 1429-1442. ISSN 1750-5836. DOI 10.1016/j.ijggc.2011.07.013

Šliaupa, S., Lojka, R., Tasáryová, Z., Kolejka, V., Hladík, V., Kotulová, J., Kucharič, L., Fejdi, V., Wojcicki, A., Tarkowski, R., Uliasz-Misiak, B., Šliaupiene, R., Nulle, I., Pomeranceva, R., Ivanova, O., Šogenova, A., Šogenov, K. (2013): CO_2 storage potential of sedimentary basins of Slovakia, the Czech Republic, Poland and the Baltic States. – Geological Quarterly 57, 2, 219-232. ISSN 1641-7291. DOI 10.7306/gq.1088

Relevant projects

Partner and Management Board member in CGS Europe (FP7, Pan-European coordination action on CO_2 Geological Storage);

Partner in ESTMAP (H2020, Energy Storage Mapping and Planning)

Coordinator of REPP-CO_2 (Preparation of a Research Pilot Project on CO_2 Geological Storage in the Czech Republic), Czech-Norwegian project funded by EEA/Norway Grants;

Provider of subsurface management related expertise and consultancy services to Czech regulators, especially the Ministry of Environment and Ministry of Industry and Trade

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07 BRGM France

Name of the organisation (Acronym)

Bureau de Recherches Géologiques et Minières (BRGM)

Brief description of the legal entity

BRGM is the reference public institution in France for Earth Science applications in the management of surface and subsurface resources and risks to face current and emerging social and environmental challenges. BRGM's activities are organised around scientific research, support to public policy development, international cooperation and mine safety. Building on geology as its core competence, BRGM develops expert knowledge in resource management, risk management and innovative ecotechnologies. As a Carnot Institute, BRGM works in particular to increase public-private partnerships under high-level scientific projects, strengthen the momentum of a network of partners in France, Europe and the world, increase research activities in the interests of socioeconomic entities and, add value to and transfer BRGM's R&D results. At European level, BRGM has been involved for many years in research programs, support to public policy development and international cooperation. BRGM is also involved in various interest groups and research networks in its areas of activity, such as the European Network for Research in Geo-Energy (ENeRG). BRGM has been among the pioneers in research on CO_2 geological storage, participating from 1993 in the first European research project (Joule II) and in the first pilots worldwide (Sleipner, Weyburn, In Salah, Nagaoka, Ketzin, Lacq-Rousse, Hontomín, etc.). Currently BRGM is leading the ENOS H2020 project that aims at enabling the development of CO_2 storage onshore in Europe.

Main persons involved

Thomas LE GUENAN (MSc, male) joined BRGM in January 2008 to work on safety issues for geologic storage of CO_2 under the Risks and CO_2 storage Safety department. He is now in charge of a scientific programme titled “risks and impacts of subsurface exploitation and competition of uses” which comprises a dozen BRGM projects on the subject. He holds a multidisciplinary master level degree from the Ecole Centrale Paris, a French non-specialized engineering school, and a Master of Science degree in environmental and land planning engineering from the Politecnico di Milano University. He was involved in several European projects, mainly on the subject of CO_2 storage risk assessment. He is currently a contributor of the ENOS H2020 project and was managing a project for French ministry of environment regarding conflict of uses in the subsurface.

Fernanda DE MESQUITA L. VELOSO (PhD, female) joined the BRGM in January 2017 to work at the department of Safety and Performance of Subsurface Uses – SPU. She is now in charge of geoscience aspects for safety use of subsurface exploitations. Before joining the BRGM, she worked for almost 5 years at Total, an oil and gas company, where she studied fractured reservoir, deep buried top seal behaviour and overpressure of reservoir and top seal. She also worked as well site geologist. She holds a PhD (Spain, 2015) on geological and reservoir modelling for studies of geological storage of CO_2 .

Relevant publications

Aochi, H., T. Le Guenan, and A. Burnol, On estimation of seismic risk with respect to development of subsurface exploitation strategies for energy purpose, Petrol. Geosci., 23, 298-305, doi:10.1144/petgeo2016-065, 2017

Le Guenan T., Gravaud I., Maragna C. et al. (2016) Analyse préliminaire des interactions entre les différents usages du sous-sol. Rapport final. BRGM/RP-66114-FR. *In French* (Report to the French administration on the interactions between various subsurface uses).

de Lary L., Le Guenan T., Manceau J-C. (2015) - Projet MARSE : approche de gestion des risques pour les exploitations du sous-sol. Rapport final. BRGM/RP-65676-FR, 48 p., 11 fig. Public Report. http://infoterre.brgm.fr/rapports/RP-65676-FR.pdf

Relevant projects

FP7 ULTimate CO_2 project (Understanding the Long-Term fate of geologically stored CO_2, 2011-2015)

ENOS H2020 (ENabling Onshore CO_2 Storage in Europe, 2016-2020)

DGPR (French Ministry of Environment, Directory of Risk Prevention) project on “multiples uses of the subsurface) – 2015

ADEME-BRGM project “Gestion du dogger” (management of the dogger aquifer) related to modelling potential interaction between deep geothermal doublet in the Paris Basin.

Infrastructure, products and services

BRGM has wide range of laboratories and experts on distinct disciplines, such as geoscience, enginery, computer science, chemistry, etc..

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08 BGR Germany

Name of the organisation (Acronym)

Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)

Brief description of the legal entity

BGR is an Authority and Research Institute of the Federal Republic of Germany within the portfolio of the Federal Ministry for Economic Affairs and Energy. BGR gives independent advice to the Federal Government on all geoscientific questions. It cooperates on the European level with the National Geological Surveys and is member of EuroGeoSurveys.

With this, BGR (www.bgr.bund.de) supports the federal government in their following objectives:

- Stimulating economic development
- Long-term protection and improvement of the quality of life
- Enhancing technical and scientific expertise

Based on its foundation articles, BGR performs duties in the following fields of scientific research:

Energy & Mineral Resources, Groundwater, Soil, Final Disposal of Radioactive Waste, Deep Subsurface Use, Geological CO_2 Storage, International Geoscientific Cooperation, Geoscientific Information and Fundamentals, Nuclear Weapons Test Ban; Geo-hazard Assessment

BGR participates at both national and international levels in fundamental geological research. In cooperation with the geological surveys of the federal states and European nations, BGR provides specialist geological information, maps, standards and methodologies. In a framework of national, European (EuroGeoSurveys) and international initiatives, BGR contributes to developing the geodata infrastructure (geoinformation business).

For a consistent and sustainable evaluation of subsurface use potentials and conceivably resulting conflicts of use across federal state borders and Germany-wide, BGR develops the relevant geological data and information. BGR's activities include the

- investigation & characterization of the structural framework, petrography and stratigraphy,
- adaptation and improvement of methods for supra-regional structure analyses and modeling,
- analyses and evaluation of risk potentials related to the subsurface structure,
- construction of 3D subsurface models,
- investigation in regard to the evaluation of rocks for specific types of use,
- development and maintenance of data bases and information systems.

BGR's activities in the German sectors of the North Sea, the Baltic Sea, as well as onshore are generally carried out in cooperation with the German state geological surveys and the geological surveys of neighbouring countries.

Main persons involved

Fabian Jähne-Klingberg (MSc, male) is a structural geologist (diploma) and special emphasis of his work (since 2006) is placed on the structural evolution of the Central European Basin. To comprehend the distribution of the deformation within this complex basin, he focused on the assessment of the deformation style, the kinematics and the estimation of amounts for extension and shortening of several deformational events. These studies are carried out with the help of different structural restoration and balancing methods. Additionally, he also tries to establish an approach to catch and illustrate the structural uncertainties along with (seismic) interpreter bias and different geophysical methods, in order to create structural consistent and reliable 3D-models.
Since 2014 he is responsible for the R&D work in the German North Sea sector. In the course of geochemical mapping projects (e.g. GEMAS) in the last years he published several thematic overview maps of the geology of Europe.

Relevant publications

Jähne, F. (2014). Chapter 2: Geology of Europe. 24 pp., 14 figs., 1 Table: In REIMANN, C., BIRKE, M., DEMETRIADES, A., FILZMOSER, P. & O'CONNOR, P. (eds.) (2014). Chemistry of Europe's Agricultural Soils. Part B: General Background Information and Further Analysis of the GEMAS Data Set. – Geol. Jb., B 103: 352 pp., 121 figs., 65 Tables, 3 App.; Hannover.Quelle: BGR

Arfai, J., Jähne, F., Lutz, R., Franke, D., Gaedicke, C. & Kley, J. (2014). Late Palaeozoic to Early Cenozoic geological evolution of the northwestern German North Sea (Entenschnabel): New results and insights. – Netherlands Journal of Geosciences, FirstView: 1-28.

Jähne-Klingberg, F., Wolf, M., Steuer, S., Bense, F., Kaufmann, D., & Weitkamp, A. (2014). Speicherpotenziale im zentralen deutschen Nordsee-Sektor, Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover

Müller, C., Jähne-Klingberg, F., von Goerne, G. Binot, F. & Röhling, H.-G. (2016). Vom Geotektonischen Atlas („Kockel-Atlas") zu einem 3D-Gesamtmodell des Norddeutschen Beckens: Basisinformationen zum tieferen Untergrund von Norddeutschland. Z. Dt. Ges. Geowiss. (German J. Geol.), 167 (2–3), p. 65–106, 21 figs., 4 tables, Stuttgart

Asch, K. (2005). IGME 5000: 1 : 5 Million International Geological Map of Europe and Adjacent Areas. BGR (Hannover).

Relevant projects

GPDN: Geopotenzial Deutsche Nordsee
http://www.gpdn.de/
End of project: December, 2013

GEMAS: Geochemical Mapping of Agricultural and Grazing Land Soil
https://www.bgr.bund.de/DE/Themen/Boden/Projekte/Ressourcenbewertung_und_management_laufend/Geochemische_Kartierung_GEMAS/GEMAS.html
End of project: June, 2017

Geotektonischer Atlas von Nordwest-Deutschland und dem deutschen Nordsee-Sektor
Tectonic Atlas of Northwest Germany and the German North Sea sector
Final publication: 2001

IGME 5000: More than just a map - A multinational GIS Project
https://www.bgr.bund.de/EN/Themen/Sammlungen-Grundlagen/GG_geol_Info/Karten/International/Europa/IGME5000/IGME_Project/IGME_Projectinfo.html

InSpEE: Information system salt structures: planning basis, selection criteria and estimation of the potential for the construction of salt caverns for the storage of renewable energies (hydrogen and compressed air)
https://www.bgr.bund.de/EN/Themen/Nutzung_tieferer_Untergrund_CO2Speicherung/Projekte/Nutzungspotenziale/Abgeschlossen/InSpEE_en.html?nn=1559828
End of project: September, 2015

Infrastructure, products and services

All means and expedients for the planned contribution and investigations be available at the BGR

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09 LfU Germany

Name of the Organisation LfU (Acronym)

Bayerisches Landesamt für Umwelt (LfU)

Brief description of the legal entity

Regional environment agency in charge for Bavaria, incorporating the legally mandated Geological Survey Organization with remits in geological and hydrogeological surveying, mapping and modelling, scientific advisor for geothermal issues and subsurface utilization, host of central archives/databases for all Bavarian subsurface information in line with the German Mining Law

Main persons involved

Dr. Gerold Diepolder (PhD, male), GeoERA project coordination: senior geologist, degree and PhD in geology at the University of Munich. Joined the Bavarian Geological Survey, GLA (now: Bavarian Environment Agency, LfU) in 1990 as a research associate with remits on hydrogeology and the

geopotential of the deep subsurface. Overseas assignment for the Federal Institute for Geosciences and Natural Resources (BGR) in Namibia in 2001.
2008-2016 head of the 3D study group of the German State Geological Surveys (Staatliche Geologische Dienste), lately realigned, now chief executive of the task force “3D geological models”. 2012–2015. Initiator, coordinator and lead of the transnational 3D modelling and geopotential assessment project GeoMol (www.geomol.eu), co-organizer of the informal European 3D Geological Modelling Community (www.3dgeology.org), active member of the OGC/IUGS-CGI Geoscience Domain Working Group. Gerold Diepolder is LEAR of the LfU and appointed GeoERA Program Manager mandated by the Bavarian State Ministry of the Environment and Consumer Protection.

Stephan Sieblitz (MSc, male), geomodelling, subsurface potential assessment: graduated in geology at the University of Munich in 1984, 10 years working experience with consulting geologists, joined the Bavarian Geological Survey (GLA) in 1999 as a GIS expert with fields of activity in 3D geological modeling, seismic interpretation, basin analysis and subsurface potential assessment.

Johannes Großmann (MSc, male), fault characterization, seismic hazard assessment: graduated in geosciences at Göttingen University. 2013-2015 project team geologist at Midland Valley Ltd. (Glasgow) with remits in structural geological modelling based on seismic data. Employed by LfU since 2016, working as geophysicist in field geophysics, reflexion seismics, and structural 3D modelling.

Dr. Thomas Fritzer (PhD, male), advisor, senior geologist, degree and PhD in geology at the University of Munich. Since 1997 he is working for the Bavarian Geological Survey / Bavarian Environment Agency – Geological Survey as an expert for basin geology, deep geothermal and underground gas storage. He is engaged in various task forces on geothermal issues and is government advisor in geothermal licensing procedures.

Relevant Publications

Diepolder, G.W. &. Schulz U. (2011): Tiefliegende Speicher- und Barrieregesteinskomplexe in Bayern – ein Überblick. – Schriftenr. dt. Ges. Geowiss. 74: 118-136, DOI: 10.1127/sdgg/74/2011/226

Diepolder, G.W. (2015): Das internationale Projekt GeoMol als Beispiel für die Erkundung von Geopotenzialen – Hintergründe, Implementierung und Rechtshemmnisse. In: Kment, M. (Hrsg.): Unterirdische Nutzungen – Systematisierung und planerische Steuerung, Gewinnpartizipation und Haftung. Schriften zum Infrastrukturrecht 3: 1-19 (Tübingen, Mohr Siebeck), ISBN: 978-3-16-153469-0

GEOMOL TEAM (2015): GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources. Project Report. 188 S. (Augsburg, LfU).

Relevant projects

2008-2011 Speicherkataster Deutschland (Storage catalogue of Germany) – Joint study of the German GSOs for screening the subsurface storage potential.

2009-2012: KLIP (Klimaprogramm Bayern 2020) - 3D-Untergrunderfassung des Alpenvorlands – Mehrwert für Erdwärmenutzung und Energiespeicherung (3D based capture of the pre-alpine subsurface – adding value to the use of geothermal energy and energy storage)

2012-2015:GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources (Interreg Alpine Space funded)

Infrastructure, products and services

LfU 3D Explorer: www.3dportal.lfu.bayern.de

Standortauskunft Oberflächennahe Geothermie (Information system shallow geothermal energy)
http://www.umweltatlas.bayern.de/mapapps/resources/apps/lfu_angewandte_geologie_ftz/index.html?lang=de&layers=service_ageo_18

Infra3D – development of data model and workflow for 3D subsurface potential assessment based on heterogeneous sources and a toolkit (webGIS) for the visualization of the 3D subsurface information from various domains exploiting the achievements of transnational 3D geo-energy assessment / distribution tools (under development)

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10 MBFSZ Hungary

Name of the organisation (Acronym)

Magyar Bányászati és Földtani Szolgálat – Mining and Geological Survey of Hungary

Brief description of the legal entity

The Mining and Geological Survey of Hungary (MBFSZ) was established on July 1st, 2017 by the merger of the Mining and Geological Office of Hungary (MBFH) and the Geological and Geophysical Institute of Hungary (MFGI). The Survey is a central governmental body supervised by the Ministry of National Development. It is supporting all state activities related to mining and geology and its mission is to support Hungary's economic competitiveness, the effectiveness of public services and policy by providing up-to-date geoscientific information for the government and the society relying on nearly 150 years traditions of geological-geophysical research and of mining administration. As a national geological survey MBFSZ is responsible to advance geoscientific knowledge of Hungary's landmass by systematic acquisition, interpretation, management and dissemination of geoscientific data. The current number of employees is 241, most of them highly qualified researchers in various fields of geology, geophysics, environmental sciences, mining administration and IT technology.

MBFSZ's core skills include geoscientific data management and integrated 3D geological-geophysical modelling, as well as national potential assessments for various mineral resources and preparation of concessions, especially geo-energy (hydrocarbon, geothermal, coal), study of geohazards, environmental geology and hydrogeology. The survey also maintains and operates several national geoscientific observatory and monitoring systems, e.g. magnetic, gravimetric, groundwater, etc. MBFSZ is a designated state advisor of geoscientific matters related to the Mining Act (1993 XLVIII) and the Governmental Decree 267/2006 (XII. 20.) defining state geological tasks.

Main persons involved

Annamária Nádor (PhD, female), senior geologist with more than 10 years of experience in deep geothermal systems, especially resource assessment, utilization and management strategies of transboundary geothermal aquifers in the Pannonian Basin. She has been leading /participating in several EU-funded geothermal projects, such as GeoDH, Geothermal ERANET, Transenergy, DARLINGe. She has been a member of the scientific team elaborating the draft specifications for geothermal of the UNFC-2009. She is the co-aouthor of more than 20 scientific papers and several book chapters on various aspects of geothermal energy.

Gyula Maros (PhD, male), senior geologist, expert in geological mapping, 3D modelling, structural geology. He has been work package leading /participating in several EU-funded geothermal and other projects, such as Transenergy, DARLINGe, PanGeo. He is experienced in leadership of various scientific projects. He is the co-author of more than 80 scientific papers, four books and several book chapters mainly in geology and subordinately on geological aspects of geothermal energy.

László Bereczki (PhD student, male), geophysicist, geologist, research fellow. Expert in seismic interpretation, geological 3D modelling, structural geology. He has been participating in an EU-funded geothermal project, DARLINGe. He is the co-author of the Hungarian geological basin 3D model and tectonic 3D model, and his results were published in conference papers. He is the winner of several awards founded for young geologists.

Edit Babinszki (PhD, female), geologist, expert in upper Miocene sedimentary sequences and magnethostratigraphy in the Pannonian basin. She has been participating in several EU-funded geothermal and other projects, such as Transenergy, DARLINGe. She is the co-author of more than 60 scientific papers and several book chapters in geology.

Teodóra Szőcs (PhD, female), head of the Hydrogeology Department at MBFSZ as well as vice president for finances and membership of the International Association of Hydrogeologists, and member of the EuroGeoSurveys Water Resources Expert Group. Participated in numerous EU-funded research projects, well experienced in hydrogeochemical evaluation, isotope data interpretation, thermal water surveys, transboundary issues and project coordination.

Ágnes Rotár-Szalkai (research fellow, female), senior hydrogeologist with more than 20 years of experience on hydrogeological assessment of regional groundwater and thermal water systems in large sedimentary basins especially monitoring of changes in groundwater levels and quantity assessment of groundwater bodies. She is also expertised in geothermal models and delineation and in characterization of hydrogeothermal reservoirs at regional scales. She has been participating in several EU-funded geothermal projects and is co-author of several scientific papers.

Nóra Gál (PhD, female), expert in hydrogeochemistry, water-rock interaction modelling, geothermal resource survey, GIS, thermal well cadastre.

László Zilahi-Sebess (PhD, male), senior geophysicist, expert in low-enthalpy geothermal exploration and exploitation, geophysical and geological interpretation and numerical geothermal modelling. He was the chief author of national geothermal potential assessment of Hungary where he initiated numerous novel methods, such as change of porosity with depth, regional assessment and variations of the geothermal gradient throughout the basin, the role of neotectonics, etc.

Tamás Kerékgyártó (research fellow, male), expert in geothermal resource survey, hydrogeochemistry, water-rock interaction modelling and hydrodynamic modelling.

Relevant publications

Lenkey, L., Raáb, D., Goetzl, G., Lapanje, A., Nádor, A., Rotár-Szalkai, Á., Rajver, D., Svasta, D., Zekiri, F. (2017): Litospheric scale 3D thermal model of the Alpine-Pannonian transition zone. –Acta Geodaetica Geophysica doi:10.1007/s40328-017-0194-8

Tóth, Gy., Rman, N., Rotár-Szalkai, Á., Kerékgyártó, T., Szőcs, T., Lapanje,A., Černák, R., Remsík, A., Schubert, G., Nádor, A. (2016): Transboundary fresh and thermal groundwater flows in the west part of the Pannonian Basin. - Renewable and Sustainable Energy Reviews, 57, pp. 439-454

Rotár-Szalkai, Á., Nádor, A., Szőcs, T., Maros, Gy., Goetzl, G., Zekiri, F. (2017): Outline and joint characterization of transboundary geothermal reservoirs at the western part of the Pannonian basin – Geothermics 70, pp. 1-16
http://dx.doi.org/10.1016/j.geothermics.2017.05.005

Falcone, G., Antics, M., Baria, R., Bayrante, L., Conti, P., Grant, M., Hogarth, R., Juliusson, E., Mijnlieff, H., Nádor, A., Ussher G., Young, K. (2016): Draft Specifications for the application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009) to Geothermal Energy Resources – ECE/ENERGY/GE.3/2016/6

Trumpy, E., Coro, G., Manzella, A., Pagano, P., Castelli, D., Calcagno, P., Nádor, A., Bragasson, T., Grellet, S. (2015): Building a European Geothermal Information Network using a Distributed e-Infrastructure. – International Journal of Digital Earth http://dx.doi.org/10.1080/17538947.2015.1073378

Relevant projects

DARLINGe Danube Region Leading Geothermal Energy (Danube Transnational Program, DTP1-099-3.2) - Project Coordinator

Geothermal ERANET (FP7-ERANET-2011-RTD/291866) - partner

Promote Geothermal District Heating Systems in Europe (Geo-DH) (Intelligent Energy - Europe IEE/11/813/SI.2.616373) - WP leader

Transenergy (Transboundary geothermal energy resources of Slovenia, Austria, Hungary and Slovakia) (Central Europe Program, 2CE124P3) - Project Coordinator

T-JAM (Screening of the geothermal utilization, evaluation of the thermal groundwater bodies and preparation of the joint aquifer management plan in the Mura-Zala basin (Operational Program Slovenia - Hungary 2007-2013, 4300-488/2008/8) - WP leader

Infrastructure, products and services

Digital database: GeoBank: national borehole database with more than 270 000 records http://www.mfgi.hu/hu/node/79

Web-map services (WMS, WFS): various geological (surface and subsurface), geophysical and applied geological maps of Hungary https://map.mbfsz.gov.hu/

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11 GSI Ireland

Name of the Organization (Acronym)

Department of Communications, Climate Action and Environment (GSI)

Brief description of the legal entity

The Geological Survey of Ireland (GSI) is a division of the Department of Communications, Climate Action and Environment. GSI is responsible for providing geological advice and information, and for the acquisition of data for this purpose. GSI produces a range of products including maps, reports and databases and acts as a knowledge centre and project partner in all aspects of Irish geoscience. It is also active in geoscience research as a funder, partner and research performer.

Main persons involved

Dr Brian McConnell (PhD, male). Trinity College Dublin. Head of Land Mapping, GSI. Brian manages the onshore bedrock and sub-soils mapping programme across Ireland. He also works on aspects of energy and geohazards, and is Council member for the European Plate Observing System project.

Beatriz Mozo (MSc, female). Master degree in Geology, Oviedo University Spain. Beatriz manages the National Geotechnical Borehole Database and develops 3D geological models at a range of scales and resolutions for superficial deposits and bedrock. Currently developing a national depth to bedrock map. Proficiency in a variety of software to capture, visualise and disseminate 3D models.

Relevant publications

Online bedrock and Quaternary geology mapping https://www.gsi.ie/en-ie/data-and-maps/Pages/Bedrock.aspx and https://www.gsi.ie/en-ie/data-and-maps/Pages/Quaternary.aspx

Mineral localities and exploration open file web services https://www.gsi.ie/en-ie/data-and-maps/Pages/Minerals.aspx

National Geotechnical Borehole Database
http://spatial.dcenr.gov.ie/GeologicalSurvey/GeoTechnicalViewer/index.html

Relevant projects

Tellus airborne geophysics (magnetic, electromagnetic, radiometric) and ground-based geochemistry survey, online viewer
http://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=6304e122b733498b99642707ff72f754

Groundwater 3D: karst, groundwater flow, water chemistry

IRETHERM (**IRE**land's geo**THERM**al potential), Science Foundation Ireland

Infrastructure, products and services

Geological data and map viewer https://www.gsi.ie/en-ie/data-and-maps/Pages/default.aspx

Groundwater web mapping service; aquifer, karst and tracer

Core store; national repository of 300km of borehole cores, accessible for e.g. rock property testing

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12 SGL Luxemburg

Name of the organisation (Acronym)

Service géologique du Luxembourg (SGL)

Brief description of the legal entity

The Service géologique du Luxembourg (SGL) ('Geological Survey of Luxembourg') is a department of the 'Administration des ponts et chaussées' (National roads authority), and hereby under the competence of the Ministry for sustainable development and infrastructures.

Founded in 1936, its main tasks are studies, advisory and research, primarily in the fields of geology, geotechnics, hydrogeology, geomorphology and mineral resources.

These include:

- engineering geology and geotechnical studies for various public works projects;

- geological hazards evaluations;

- geothermal energy investigations;

- mineral resources surveys;

- geological and other geoscientific mapping and related database management;

- geoscientific information management and supply to the public.

The SGL acts as a public service for various national governmental bodies and local communities and has the status of a national survey organization. It is founding member of EuroGeoSurveys and national representation of the IUGS.

During GeoERA, the Ministry for sustainable development and infrastructures will act as the research programme owner to which the SGL gives account to, by the intermediate of the directorate of the 'Administration des ponts et chaussées' (National roads authority).

Main persons involved

Robert Colbach (MSc, male): Head of geological survey since 2015. M.Sc. in geology and hydrogeology from the University of Montpellier and Avignon (F) in 1997. Joined SGL in 1997, responsible for general geology, geotechnical investigations, geological mapping as well as geographical information systems, database development and maintenance.
SGL's main administrative and technical responsible during the research projects OneGeology, Terrafirma and PanGeo.

Romain Meyer (PhD, male): Ph.D. in geology from the KU Leuven (B). Romain has a wide expertise in geology ranging from mineralogy, geochemistry to geophysics. He has been associated as researcher to the Massachusetts Institute of Technology MIT, the Norwegian Centre of Excellence for Geobiology, the GeoForschungsZentrum Potsdam, and has lectured general geology and geophysics as professor at the Washington and Lee University prior to joining the SGL in Mai 2017. In the last years, he contributed in numerous international cooperation projects like ESF EuroMARGINS, NSF MARGINS and NSF GeoPRISMS, and participated on different research expeditions e.g. IODP.

Petra Münzberger (PhD, female): Ph.D. in geology and palaeontology. Educated from the Technical University 'Bergakademie' Freiberg (D) in 2002. From 2002 to 2005, she had a research fellowship on geology, geomorphology and settlement history from the University of Regensburg. Worked since 2005 for the SGL as a contractual employee for geological exploration of roads and bridges, hydrogeological exploration, sedimentological and paleontological studies, geological cartography. Joined as permanent staff member in 2017.

Relevant publications

Dejonghe, L., Colbach, R.; Goemaere, E. (2017): The lithostratigraphy of the lower Devonian formations of the Eisleck region (northern Luxembourg). Comparison with their Belgian lateral equivalents, Geologica Belgica: 20/1-2.

Kummerow, J., Raab, S., Meyer, R. (2017): Understanding physical rock properties and their relation to fluid-rock interactions under supercritical conditions. Geophysical Research Abstracts, Vol. 19, EGU2017-14819-1.

Nozaka, T., Wintsch, R.P., Meyer, R. (2017): Serpentinization of olivine in troctolites and olivine gabbros from the Hess Deep Rift. – Lithos, 282-283, 201-214.

Nozaka, T., Meyer, R., Wintsch, R.P., Wathen, B. (2016): Hydrothermal spinel, corundum and diaspore in lower oceanic crustal troctolites from the Hess Deep Rift. – Contributions to Mineralogy and Petrology, 171:53, 1-14.

Meyer, R., van Wijk, J. (2015): The Interdisciplinary Earth: A Volume in Honor of Don L. Anderson. The Geological Society of America, Special Paper 514 and American Geophysical Union, Special Publication 71, 65-85. (INVITED)

Gillis, K. M., Snow, J. E., Meyer, R., et al. (2014): Primitive Layered Gabbros from Fast-Spreading Lower Oceanic Crust – Nature 505, 204-207.

Relevant projects

The SGL also has contributed to the following EU co-funded projects:

Terrafirma, OneGeology, PanGeo

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13 TNO Netherlands

Name of the organisation (Acronym)

Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (TNO)

Brief description of the legal entity

TNO is a semi-independent Dutch research and technology organisation active in technical, earth, environmental, life, societal and behavioural sciences, focussing on healthy living, industrial innovation, energy, transport and mobility, built environment, the information society, and defence, safety and security. TNO will be represented in Geo-ERA through the Geological Survey of the Netherlands, which provides geoscientific data, information and knowledge for:

- sustainable management of earth resources and the environment in general (including assessment of induced hazards and impacts);
- safe living on subsiding lowlands;
- reduction of risks and costs in building and construction associated with ground conditions.

The survey's core skills include data management, geo-ICT and 3D-modelling. Its products and services are primarily targeted at the water, energy and building sectors (the latter in the broadest possible sense, including land use and environmental planning). The organisation hosts the national repository for subsurface data and information and is the designated state advisor of all geological matters related to the Mining Act. The survey's skills and services relate to its operational environment, determined mainly by its hydrocarbon resources, and the Dutch coastal and fluvial lowlands setting, which presents aggregate and groundwater resources, as well as the obvious water-related challenges.

As a major research organization in the Netherlands and coordinator of many international projects, TNO has an extensive track record. TNO has a widely recognized expertise in mapping and modelling studies, within the Netherlands as well as abroad. This expertise is supported by the national Geoscience Information Programme in which the subsurface is mapped and characterized. TNO assists and advises the Dutch government in developing and executing a new policy and national structure plan on responsible and efficient use of the subsurface. This new policy extends on the existing Mining Law and associated regulations, among others by better focusing on the future consequences of certain choices and by taking into account alternative or interfering subsurface activities in the decision-making. TNO's support consists of local and regional evaluations of subsurface uses and the provision of data through a legal register for subsurface information.

Main persons involved

Dr. Johan H. ten Veen (PhD, male), co-lead WP3, senior geologist (EuroGeologist), Johan holds a MSc from Vrije Universiteit Amsterdam (1991) and a PhD degree in Earth Sciences from Utrecht University (1998). He joined TNO in 2009 after an academic (research and lecturing) career in structural geology. At TNO he works as a structural geologist on the initiation, refinement and maintenance of national subsurface geomodels (www.dinoloket.nl). Next to this task, he is involved in projects centered around characterization of hydrocarbon and geothermal reservoirs and several cross-border basin studies (NW Europe focus). Currently Editor in Chief of the Netherlands Journal of Geosciences.

Hans Doornenbal (MSc, male), EuroGeologist, studied exploration geophysics and structural geology and he graduated in 1980 at the Utrecht University. He has more than 37 years of experience in database management, seismic interpretation, structural geology, mapping and project management, especially related to subsurface studies not only hydrocarbon E&P studies, but also geothermal and water potential studies. He has participated as team member and later as project manager in a variety of projects abroad (Yemen, Tanzania, Slovenia). Since 1998 at TNO-Geological Survey of the Netherlands, he is project leader of the regional mapping project of the deep subsurface of the Netherlands. From 2005-2010 he was assigned as project manager of the SPBA-project with the aim to produce the "Petroleum Geological Atlas of the Southern Permian Basin Area". In 2009 he became project manager for the "GASH – European Black Shale Database" project, from 2011-2014 he was involved in the North Atlantic Tectonostratigraphic Atlas project and from 2015-2017 in the EUOGA project to make an inventory and assessment for shale gas resources in Europe.

Drs. Serge F. van Gessel (MSc, male), senior geoscientist and project manager. Serge holds an Msc degree from Utrecht University (1994). He joined TNO in 1998 after working as a consultant for the petroleum industry. Currently Serge is a senior advisor for the Ministry with specific focus on mining and subsurface exploration and development. Besides his duties at TNO, he is Chairman of the EuroGeoSurveys Geo-Energy Expert Group (since 2015) and theme coordinator of the Energy Theme in GeoERA.

Dr. M. (Maryke) den Dulk (PhD, female), Geologist-geomodeler (EuroGeologist), Maryke has 14 years' experience in geomodelling following a MSc in Geology and PhD in Paleoclimatology at Utrecht University. She started working as a geomodeler in 2000. Seconded within one of the larger oil companies, she participated in production and exploration teams focusing on building structural models and providing mapping products. Maryke joined TNO in 2007 where she continued working as a geologist-geomodeler. In this role emphasis has been on building (regional) structural models, improving workflow systematics and scripting for handling large datasets, as well as combining seismic interpretation and modeling techniques to improve model quality of the publicly disseminated national subsurface models (Dinoloket.nl, nlog.nl).

Harry Middelburg (MSc, male), scientific software engineer, studied structural geology and graduated from Vrije Universiteit Amsterdam in 1993. Employed by TNO since 1999 for his knowledge on Geospatial Information and mainly working on development of geospatial databases and new way of dissemination of data and information. Harry recently participated in the European ESTMAP project developing a database, is continuously involved in dissemination of TNO's geometry and property subsurface models and is currently working on TNO's fault database.

Relevant publications

Reijmer, J.J.G., Ten Veen, J., Jaarsma, B. and Boots, R. (2017). Seismic stratigraphy of Dinantian carbonates in the southern Netherlands and northern Belgium. Netherlands Journal of Geosciences 91(4) 353-380. DOI: 10.1017/njg.2017.33.

Van der Meulen, M.J., Doornenbal, J.C., Gunnink, J.L., et al. (2013). 3D geology in a 2D country: perspectives for geological surveying in the Netherlands: Netherlands Journal of Geosciences, v. 92, no. 4, p. 217-241.

Kombrink, H., Doornenbal, J.C., Duin, E.J.T., den Dulk, M, van Gessel, S.F., ten Veen, J.H. and Witmans, N. (2012). New insights into the geological structure of the Netherlands; results of a detailed mapping project. Neth., J. Geol., 91(4), 419-446.

Doornenbal, J.C. & Stevenson, A.G. (Eds) (2010): Petroleum Geological Atlas of the Southern Permian Basin Area. EAGE Publications b.v., Houten, 342 pp

STRONG: maps, models and datasets accompanying a study on subsurface policy strategy that relates to subsurface potential, activities (and their synergy) and possible consequences (available through www.nlog.nl).

Relevant projects

On a national level:

- STRONG - Inventory of all potential uses of the deep (>100m) part of the subsurface of the Netherlands and the Dutch part of the Continental Shelf.

Besides a program lead in national research, TNO has been and is strongly involved in various EU funded-, regional Joint Industry- and cross-border projects (all executed by mainly European Geological Surveys), the relevant ones being listed below.

- GEOHEAT.App (INTERREG IV Vlaanderen – Nederland, January 2013 – June 2014): Evaluation of the technical and economic feasibility of intermediate and deep geothermal energy as a sustainable source of heat for new and renovated buildings based on 6 case studies
- SPBA: Petroleum Geological Atlas of the Southern Permian Basin Area (2005-2010)
- NAGTEC: Tectonostratigraphic Atlas of the North-East Atlantic Region (2011-2014)
- Several cross-border geohydrological model building projects between NL, BE and GE (the so-called H3O projects)

Infrastructure, products and services

BRO / Dino-Loket (www.dinoloket.nl) / NLOG (www.nlog.nl): Portal and Repository of subsurface data and 3D models of the Netherlands. TNO maintains and disseminates all subsurface data from industry and in-house data acquisition programs, including 3D seismic surveys, borehole data and seismic monitoring data. These data are public and available to the project.

TNO owns highly specialized 3D geological and geo-mechanical modelling software that is commonly used by international industry and scientific research organizations. These tools are available to the project.

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14 PIG-PIB Poland

Name of the organisation (Acronym)

Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy (PIG-PIB)

Brief description of the legal entity

PIG-PIB is a state research institution with over 600 high-qualified employees in the field of geology, hydrogeology and environmental studies, who work on national and international projects. PIG-PIB's headquarters are located in Warsaw, Poland, and the company has seven local branches located in Kraków, Wrocław, Sosnowiec, Gdańsk, Kielce, Szczecin and Lublin. PIG-PIB undertakes scientific research and development in the fields of earth science, biology, environment and engineering. It also acts as Polish Geological Survey and Polish Hydrogeological Survey and as such, it undertakes numerous tasks focused on examining, documenting, as well as assessing and protecting national natural resources including groundwater. As the leading geological institution in the country, PIG-PIB provides scientifically based advice and support to local and national administrations, and it undertakes initiatives focused on promoting and informing society about geological science and issues related to natural resources and their protection.

PIG-PIB coordinated and was the main contributor to the national programme “Assessment of formations and structures suitable for safe CO_2 geological storage including monitoring plans” (2008-2012/2013; Ministry of Environment; deliverables: regional and case study reports on safe CO_2 geological storage, including studies on pilot CO_2 injection, and CO_2 storage atlas of Poland, as well as dissemination of knowledge on CCS and participating in public awareness events) and participated in CGS Europe and ECCSEL (FP7&H2020) EU projects. PIG-PIB has provided expertise to the first Polish demo project Bełchatów, and other planned CCS projects ("CCS ready" prefeasibility studies).

Since 2009, PIG-PIB has carried out a number of projects for the Ministry of Environment on assessment of prospective formations and resources of unconventional hydrocarbons. In 2012 the report "Assessment of shale gas and shale oil resources of the Lower Paleozoic Baltic-Podlasie-Lublin basin in Poland", based on results of laboratory measurements of core samples from 39 wells, was published and in 2014 the report on tight gas resources assessment. In 2015/16 a draft report on shale gas and oil resources, based on information from a large part of new wells, was completed (unpublished), and the new one, incorporating the information from the remaining new wells, is being completed. PIG-PIB is also disseminating knowledge about shale gas and oil exploration and production (e.g., the website http://infolupki.pgi.gov.pl/en/), assists the state government and local authorities in dealing with issues related to hydrocarbons exploration and production, and has organized and participated in events aiming to increase public awareness on unconventionals among the general public and local communities where shale gas and oil prospection and exploration wells were drilled.

Since 2010 PIG-PIB has been involved in assessment of environmental impact of unconventional hydrocarbons exploration, leading projects and performing desktop and field studies on several well sites in Poland commissioned by the Polish Government. The team involved in the topic has delivered several reports on actual impact and environmental response to site construction, well drilling, hydraulic fracturing and well testing. Experience and results have been presented on several conferences and workshops in Poland and within EU structures. This role requires close cooperation with administration, planners and industry.

The PIG-PIB has been developing 3D geological models for over a decade. We construct both structural and parametric models for detailed spatial analyses. The modelling team constructs regional-scale 3D models, e.g. a parametric model of an entire sedimentary basin (Lublin Basin), as well as local models for CCS, Hot Dry Rocks or shallow geothermal energy. We use commercial software (eg. GOcad / Skua, Petrel), open source (GRASS-GIS) and independently developed scripts. Besides static modelling, the PIG-PIB is also experienced in mathematical modelling of geological processes.

Main persons involved

Monika Konieczyńska (PhD, female). Graduated from the Faculty of Geology, Warsaw University, Department of Environmental Science, Central European University in Budapest, MSc in the Faculty of Science and Engineering, University of Manchester, post-graduate studies in Technology of unconventional natural gas production, hydrogeologists, PhD in earth sciences. Since 1995 in Państwowy Instytut Geologiczny, Department of Environmental Geology - scientific and applied projects on surface and groundwater and land contamination assessments and remediation, involved in CCS and unconventional hydrocarbons resources topics, with special concern of environmental hazards due to CO_2 underground storage and hydrocarbons exploration and production from unconventional oil and gas deposits. 2009-2011 - head of Department of Environmental Geology, since 2017 - head of Environmental Geology and Geochemistry Department in Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy, a member of GeoEnergy Expert Group within EuroGeoSurveys - Geological Surveys of Europe. Since 2011, leader of a joint team working on environmental aspects of hydrocarbons exploration and production, involved in the EERA (European Energy Research Allianz) Joint Program Shale Gas and the WssTP (The European Technology Platform for Water) Working Group Oil, Gas and Water.

Olga Lipińska (MSc, female), graduate of the Faculty of Geology of the Warsaw University; environmental protection specialisation (Master of Science degree in 2008), in Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy since 2009, currently Environmental Geology and Geochemistry Department; since 2010 senior specialist; participates in the works associated with the impact assessment of human activities on the natural environment. In 2011 she participated in the programme of study visits to the USA, related with shale gas development, organised by the US Department of State. Since 2012, she has participated in research on the impact of unconventional hydrocarbons exploration and exploitation, including hydraulic fracturing on the natural environment. In 2015, she completed two-term post-graduate studies in Technology of unconventional natural gas production. In 2017, she participated in the Pioneers into Practice Programme funded by the European Institute of Innovation & Technology; during one month placement in the Regional Environmental Agency in the Emilia-Romagna Region.

Relevant publications

Sidorczuk M., Rutkowski M., Kiersnowski H., Roszkowska-Remin J., Podhalańska T., Jasionowski M., Dyrka I., Jarosiński M., Wójcicki A., Janas M., Karcz P., Grotek I., Głuszyński A., Kijewska S., Roman M., Woźnicka M., Konieczyńska M., 2013 - *Shale gas as seen by Polish Geological Survey*. PIG-PIB. ISBN 978-83-7863-267-2.

Wójcicki A., Nagy S., Lubaś J., Chećko J., Tarkowski R., 2014 - *Assessment of formations and structures suitable for safe CO_2 storage (in Poland) including the monitoring plans (summary).* PIG-PIB, Warsaw, http://skladowanie.pgi.gov.pl/twiki/pub/CO2/WebHome/seq-summ.pdf

Konieczyńska M., Adamczak-Biały T., Brodecki A., Brzezińska A., Janica R., Dziekan-Kamińska E., Fajfer J., Feldman-Olszewska A., Felter A., Frydel J., Głuszyński A., Gryczko-Gostyńska A., Jarosiński M., Jożwiak K., Kordalski Z., Kowalewski T., Kijewska S., Lichtarski G., Lidzbarski M., Lipińska O., Mikołajków J., Nidental M., Otwinowski J., Pasierowska B., Pergół S., Podhalańska T., Roman M., Rosowiecka O., Sobień K., Starzycka A., Stec B., Śliwiński Ł., Waksmundzka M., Woźnicka M., Dzieniewicz M., Guzy P., Izydor G., Konopka E., Kotarba m., Kowalski T., Lewkiewicz-Kołysa A., Macuda J., Nagy S., Sechman H., Bernaciak M., Grzelak W., Janicki W., Korkosz A., Kozak k., Kudłak B., Męcik M, Zabiegała B., 2015 - *The Environment and Shale Gas Exploration*. Generalna Dyrekcja Ochrony Środowiska (General Director of Environmental Protection), ISBN 978-83-62940-97-4.

Macuda J., Konieczyńska M., 2015 - *Environmental Impact of exploration from unconventional gas deposits in Poland*. (Wpływ prac poszukiwawczych na środowisko w eksploracji niekonwencjonalnych złóż gazowych w Polsce). Ecological Chemistry and Engineering. S (ECOL CHEM ENG S.) 2015, 22(4), pp:703-717.

Konieczyńska M., Lipińska O., Fajfer J., Konon A., Wojcieszak Ł., Kwecko P., Mikołajków J., Jóźwiak K., 2017 - *Environmental Monitoring For Shale Gas*. M4ShaleGas Project Consortium, http://www.m4shalegas.eu/report.html

Relevant projects

The national programme "Assessment of formations and structures suitable for safe CO_2 geological storage including monitoring plans" (6 domestic partners, led by PIG-PIB, ordered by Ministry of Environment, addressing geological, safety and societal issues), 2008-2012/13.

CGS Europe (Pan-European coordination action on CO_2 Geological Storage, FP7 no. 256725), 2010-2013.

The environment and shale gas exploration - 7 exploration well site studies conducted in Poland addressing potential impact on soil-water environment, ambient air, landscape and acoustic climate with special focus on technology applied, process fluids and waste (4 domestic partners, led by PIG-PIB, ordered by the General Director of Environmental Protection), 2012-2015.

M4ShaleGas — Measuring, monitoring, mitigating, managing the environmental impact of shale gas (Horizon2020, GRANT AGREEMENT NUMBER — 640715, in Consortium led by TNO), 2015-2017.

Infrastructure, products and services

Software for constructing 3-D static geological models - Schlumberger Petrel and GOcad/Skua, modelling of flow of reservoir fluids - TOUGH2, modelling of fault integrity - Badleys T7

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15 GSR Romania

Name of the organisation (Acronym)

Institutul Geologic al României (IGR)

Brief description of the legal entity

The Geological Institute of Romania (Institutul Geologic al României- IGR) - R&D institute for Geology, Geophysics, Geochemistry and Remote Sensing - was founded in 1906 as national geological survey. Now it works under the Ministry of Research and Innovation. IGR includes two entities considered objectives of national importance: the National Museum of Geology and the Surlari Geomagnetic Observatory, the latter being part of the world geomagnetic network (Intermagnet) since 1998. IGR is organized in several subdivisions: *Georesources, Geothematic Maps, Geo-Hazards, GIS, database and remote sensing and Applied geonomic studies*.

The main mission of IGR is the elaboration of the national maps in various fields of geosciences. The scientific research in IGR covers the fields of mineral resources, geophysics, hydrogeology, geochemistry, palaeontology, structural geology, geohazards, monitoring of the environment in mining areas. Its activity is based on research projects (national and international), contracts with Governmental authorities and with private investors. IGR has scientists specialized in *raw materials* (aggregates, natural stone, industrial minerals, metallic ores), *energetic resources* (oil, shale gas, coal, geothermal resources), *geohazards* (landslides, subsidence, complex impact of mining waste and excavations), *mineralogy and geochemistry* (rock, soil, water, isotopes), *geoinformation* (mineral resources information networks, implementation of INSPIRE Directive in Romania), *hydrogeology* and *CO_2 storage*.

Main persons involved

Octavian COLȚOI (PhD, male), Senior Researcher – Geologist (Geological Institute of Romania - head of National Corestore).
Work experience: University of Bucharest, Faculty of Geology and Geophysics (University Assistant, 2002-2010), Geologist at OMV Petrom (2000-2001), Geotechnical domain (2006-2008) Geological Institute of Romania (Senior Researcher, 2008-present).
Expertise: petroleum geology (studies for the assessment of conventional and unconventional = shale gas hydrocarbon resources, underground storage of CO), seismic interpretation, regional geology, geology maps, aggregates / mineral resources.
Relevant international projects (as a leader/member of IGR team): GASH Project; Geochemical and stratigraphical characteristics of Silurian from eastern part of Moesian Platform – Romanian sector; EuroGeoSource; Assessment of the hydrocarbon potential of the Silurian source rocks from the Eastern part of Moldavian Platform; SARMa project, SNAP SEE project; MINATURA 2020, EUOGA, Geo-Cradle; MinService.

Gabriel BINDEA (PhD, male), Senior Researcher – Geologist (Geological Institute of Romania). Expertise: mineralogy, structural petrography, structural geology, geological maps, economic geology, ore petrology, geochemistry. Worked with the Geological Institute of Romania (1984 – present to mapping in magmatic and metamorphic terrains; projects of drillings and mining works for nonferrous ores; aggregates resources; preparation of scientific reports (including regional maps and databases) papers and presentations. (over 60 scientific reports as first author or contributor).
Relevant international projects (as a leader/member of IGR team): EuroGeoSource; SARMa project, SNAP SEE project; MINATURA 2020, EUOGA, Geo-Cradle; MinService.

Anca Marina VIJDEA (PhD, female), Senior Researcher - MSc in geophysics with a PhD in remote sensing (Geological Institute of Romania).
Expertise: she participated or was the leader of national research projects involving geophysics, remote sensing and GIS for resource exploration or environmental applications. Within the framework of internationally funded projects carried out at IGR, she led specific tasks related to remote sensing processing and multi-data sets analysis, technical and administrative project management and organization of the national team, often made up of participants from various institutes.
Relevant international projects (as a leader/member of IGR team): EuroGeoSource, ThermoMap, PanGeo, DANREGEOTHERM – DATA, URMA (Urban Risk Mapping – contract with ESA), DARLINGe.

Flori Marilena CULESCU (PhD student, female), Junior Researcher (Geological Institute of Romania).
Expertise: geo-hazard-landslides, water pollution, soil erosion, hydrogeology.
Relevant international projects (as a member of IGR team): National Core program (PN 09 21 03 04 - Surface and deep waters in the west of the Romanian Plain (Olt-Jiu-Danube). Economic and social implications ; PN 09 21 01 02 - Geological mapping of Romania's territory ; Landslide study in Poiana Campina, Pietris village, Prahova county ; PN 16 06 04 04 - The Petrographic Study of the Cândești gravel from Getic Piedmont ; PN 16 06 01 02 - Elaboration of the geological map of Romania at 1:50 000 scale ; PN 16 06 01 01 - Updating and digitizing of the national geo-thematic maps; PN 16 06 02 07 - Unconventional hydrocarbon energy resources through the current geological concepts). International project: MineService.

Relevant publications

Krautner Hans Georg, Bindea Gabriel (2002). Structural Units in the Pre-Alpine basement of the Eastern Carpathians. (Geologica Carpathica, International Geological Journal, volume 53, special issue, september 2002, pag.143-146)

M. Rosca, C. Bendea, A. M. Vîjdea (2016). Mineral and Thermal Waters of Romania. In Petar Papić (ed.) Mineral and Thermal Waters of Southeastern Europe. Environmental Earth Sciences 2016, Springer, pp. 97-114, ISBN: 978-3-319-25377-0 (Print) 978-3-319-25379-4 (Online)

Vîjdea Anca-Marina, Bindea G., Zoran M., Coltoi O., Dumitrica C. (2010). Monitoring mineral extraction and processing sites in the West and South West Romania by remote sensing-derived information and laboratory analyses, Scientific Annals of the School of Geology, Aristotle University of Thessaloniki, Special vol. 99, Proceedings of the XIXth Congress of the Carpathian Balkan Geologic Association, 23-26 September 2010, Thessaloniki, Greece, pp. 527-536

Coltoi, O., Nicolas, G., Safa, P., 2016. The assessment of the hydrocarbon potential and maturity of Silurian intervals from Eastern part of Moesian Platform – Romanian Sector. Marine and Petroleum Geology, Volume 77, Pages 653–667

Pene, C., Coltoi, O., 2005. Study of salt movement mechanisms in the Transylvanian Basin. Journal of the Balkan Geophysical Society, Vol. 8, Suppl. 1, p. 513-516, ISSN 1302 – 1672

Relevant projects

DARLINGe “Danube Leading Geothermal Energy”, (2017-2019) financed by the INTERREG Danube Transnational Programme

EUOGA – EU unconventional Oil and Gas Assesment (Geological Evaluation of Potential Unconventional Oil and Gas Resources in Europe)

Sustainable aggregates resources management (SARMa) Project

MINATURA2020 (2015-2018) – develop a concept and methodology for the definition and subsequent protection of “mineral deposits of public importance” in order to ensure their “best use” in the future and include them in a harmonised European regulatory/guidance/policy framework., http://minatura2020.eu

EuroGeoSource “EU Information and Policy Support System for Sustainable Supply of Europe with Energy and Mineral Resources” (2010-2013) - financed by the ERA CIP ICT-PSP Programme

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16 GSS Serbia

Name of the organisation (Acronym)

Geological Survey of Serbia (GSS)

Brief description of the legal entity

Geological Survey of Serbia (GSS) was formed based on the Mining and Geological Investigations Law („Official Gazette RS“, no. 88/2011) On 29. 06. 2012. GSS was formed from Geological Institute of Serbia, organization with long history. First organization was the Geological Institute of the Kingdom of Yugoslavia, formed 1930. Geological Survey of Serbia has three geological departments: Fundamental Geology, Mineral Resources, Geotechnic and Hydrogeology, as well as Groups for Geophysical investigation and Laboratory for rocks, ores, soil and water analysis. Our mission is to create geological, geomorphological, geochemical, hydrogeological and engineering geological maps, protect geodiversity and geoheritage, protection and promotion of the environment, investigation of mineral resource deposits.

Main persons involved

Tanja Petrović Pantić (PhD, female) is a senior hydrogeologist at Department of Geotechnic and Hydrogeology. She holds an MSc (2010) and a PhD (2014) in hydrogeothermal resources. Research focuses are thermal and mineral waters, geothermal energy, hydrogeochemistry.

Petar Stejić (PhD, male**)** is a senior advisor at Department of Geology. Specialist for the area of Pannonian basin and Vardar zone geotectonic units. Head of geological mapping Project in scale 1:50.000 (sheet Bačka Palanka 4). Specialist for Quaternary continental sedimentation.

Milan Tomić (Magister, male) is a hydrogeologist at Department of Geotechnic and Hydrogeology. Expert in creating hydrogeological maps 1: 100.000, mineral and thermal groundwater studies, spatial plan projects and Impact of Climate Change projects.

Divna Jovanovic (PhD, female) is a senior advisor at Department of Geology, head of Laboratory. Expert in sedimentology and geological mapping. Experienced in international collaboration, especially on Permian-Triassic boundary issue.

Rodoljub Gajić (PhD, male) is a senior advisor at Department of Geology. Specialist for the area of Carpatho-Balkan geotectonic unit. Specialist for Geological Mapping and Paleozoic stratigraphy. Head of geological mapping Project in scale 1:50.000 (several map sheets).

Relevant publications

Tomić, M., Lazić, M. 2017. Healing waters of Vojvodina as a potentional for development of the spa tourism. Book. Zadužbina Andrejević

Petrović Pantić, T., Veljković, Ž, Tomić, M., Samolov, K. 2017. Hydrogeology and vulnerability of groundwater to polluting in the area of National Park „Fruška Gora“, Vodoprivreda 0350-0519, Vol 49, 288-290, p.287-297

Gaudenyi, T., Nenadic, D., Stejic, P., Jovanovic, M., Bogicevic, K. 2015. The stratigraphy of the Serbian Pleistocene Corbicula beds. Quaternary International, vol. 357 br. , p. 4-21

Bogosavljević Petrović V., Jovanović D., Marić Stojanović M., Andrić V. 2017. The origin, production and use of quartz crystals in the Neolithic of Serbia: Vinča-Belo Brdo. Quaternary International, Volume 429, Part A, p. 24-34.

Gajić R., Jovanović D., Barjaktarović D., Stejić P., Pandurov M. 2016. The methodology and conception of developing Geological Map (GK-50) of Republic Serbia and synthesis of geological formations after finished map sheets. Third Congress of Geologists of Republic of Macedonia. Geologica Macedonica 4, Special edition, Volume 1, 43-46.

Relevant projects

Geological maps of Serbia, scale 1: 50 000,

Hydrogeological maps of Serbia, scale 1: 100 000

Study: The state and prospect of Vojvodina's medicinal waters usage in the function of development of spa and tourist complex

Update of geothermal resource database of Republic of Serbia

Hydrogeological map of Vojvodina 1:300.000

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17 SGIDS Slovakia

Name of the organisation (Acronym)

State Geological Institute of Dionýz Štúr (SGIDS), Slovakia

Brief description of the legal entity

The Institute as a contributory scientific-research organization is performing the activity of the state geological service. That involves solution of tasks of geological research and survey, creation, using and protection of information system in geology, registration, collecting, evidence and accessing of the results of geological work performed on the territory of the Slovak Republic. For that purpose, it has been doing mainly, systematic and complete geological research, design, making and evaluation of geological works. The Institute is responsible for national information system and registry in the field of geology "Geofond".

Main persons involved

Balázs Kronome (PhD, male) has experience more than 20 years in geological mapping, mesozoic stratigraphy, structural geology and the following data evaluation and analysis and GIS. In the last years he focused on 3D geological modelling. Formerly he was also lecturing regional geology at the Bratislava University.

Relevant publications

Kronome, B., Baráth, I., Nagy, A., Uhrin, A., Maros, Gy., Berka, R., Černák, R. (2014): Geological Model of the Danube Basin; Transboundary Correlation of Geological and Geophysical Data. Slovak Geological Magazine, 14, No. 2, p. 17-35

Maros Gy., Barczikayné Szeiler R., Fodor L., Gyalog L., Jocha-Edelényi E., Kercsmár Zs., Magyari Á., Maigut V., Orosz L., Palotás K., Selmeczi I., Uhrin A., Vikor Zs., Atzenhofer B., Berka R., Bottig M., Brüstle A., Hörfarter C., Schubert G., Weilbold J., Baráth I., Fordinál K., Kronome B., Maglay J., Nagy A., Jelen B., Lapanje A., Rifelj H., Rižnar I., Trajanova M. 2012: Summary report of Geological models of TRANSENERGY project. Manuscript - http://transenergy-eu.geologie.ac.at/

Relevant projects

TRANSENERGY - Transboundary Geothermal Energy Resources of Slovenia, Austria, Hungary and Slovakia, international project funded by Interreg programme - Central Europe, 2CE124P3, 2010-2013

Research on geological set-up and compilation of geological maps in problematic areas of the Slovak republic, funded by national sources

Geological map of Danube lowland - Danube plain, funded by national sources

3D geological map of the Slovak republic in scale 1:500 000, funded by national sources

Infrastructure, products and services

Geological maps of Slovakia, boreholes database, field observations are available online through the webGIS portal (www.geology.sk)

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18 GeoZS Slovenia

Name of the organisation (Acronym)

Geološki zavod Slovenije (GeoZS)

Brief description of the legal entity

Geological Survey of Slovenia (GeoZS) is a public research institute with app. 90 employees and established by the Government of the Republic of Slovenia. It carries out fundamental and applied research in regional geology, hydrogeology, geochemistry, sedimentology, paleontology, petrology, tectonics, geophysics, mineral resources and fossil energy, geothermal energy, geohazards, GIS and education. It provides a public service through scientific research programs and cooperation with universities. GeoZS is tightly involved in national and international research and professional communities worldwide. Activities are supported by Geological Information Centre, responsible for the collection, processing, storage and dissemination of geological data. We support national authorities and agencies in the process of concession granting for mining, and mineral and thermal water use. Our laboratories do petrological, mineralogical, geochemical and geothermal analyses.

The GeoZS geothermal team combines specialists in hydrogeology, regional geology, hydrogeochemistry, geothermal and geophysical measurements, and 3D and numerical modeling. The team performs basic geothermal research and resource evaluation, manages geothermal utilization database for Slovenia, surveys for exploration and exploitation of geothermal energy, and runs many applied, EU and research projects in deep and shallow geothermics. Within the project, GeoZS will participate at the Pannonian basin case study (WP2) and provide data for better spatial planning approach (WP3). We will provide the necessary geological and structural data for Slovenia to elaborate a uniform 3D model of the Pannonian basin. We will lead the activity on geomanifestations where we will work in more details on the pilot area of the Slovenian part of the Mura-Zala basin and provide information on spatial planning and conflicts in Slovenia.

Main persons involved

Dr. Nina Rman (PhD, female) is a research associate with experience in exploration and exploitation of low-enthalpy geothermal systems, hydrogeochemistry, isotopic and chemical composition of groundwater and gases and their origin, numerical modelling of flow and heat transfer and management of transboundary geothermal aquifers.

Andrej Lapanje (MSc, male) is a research and development associate with experience in geothermal exploration, development and monitoring, well design and operation, geophysical logging, hydrogeological mapping and management of groundwater resources.

Dejan Šram (male) has rich experience in 3D structural modelling, 3D numerical modelling of fluid and heat flow and spatial analysis in GIS. His profession are also field work and interpretation of geophysical well-logging data and in the last years he is active in several shallow and deep geothermal projects.

Dr. Miloš Markič (PhD, male) is an expert in coal geology and petrology of the Pannonian Basin and the Dinarides dealing also wih oil and gas geology and CO2 sequestration studies. He performs coal mapping and structural interpretation, interprets petrology of coals related to rock mechanical testing and gas sorption investigations and evaluates geothermal and hydrocarbon reserves.

Dušan Rajver (MSc, male) is a research and development associate with experience in deep and shallow geothermal exploration and exploitation, conduction-dominated geothermal systems, temperature logging, measurements of thermal conductivity and radiogenic heat production and geothermal database development and interpretation.

Dr. Jure Atanackov (PhD, male) is a research assistant in applied geophysics particularly shallow methods, including high-resolution seismic reflection, seismic refraction and electrical resistivity tomography, active tectonics and seismic hazard assessment.

Relevant publications

Jamšek Rupnik, P., Atanackov, J., Celarc, B., Jež, J., Novak, M., Milanič, B., Bavec, M. 2016: Active Faults. In: Novak, M, Rman, N. (eds.). *Geological atlas of Slovenia*. Ljubljana: Geološki zavod Slovenije, 94-95.

Lenkey, L., Raáb, D., Götzl, G., Lapanje, A., Nádor, A., Rajver, D., Rotár-Szalkai, A., Švasta, J., Zekiri, F. 2017: Lithospheric scale 3D thermal model of the Alpine-Pannonian transition zone. Acta geodaetica et geophysica, 22 pp., Online First, doi: 10.1007/s40328-017-0194-8.

Bräuer, K., Geissler, W. H., Kämpf, H., Niedermann, S., Rman, N. 2016: Helium and carbon isotope signatures of gas exhalations in the westernmost part of the Pannonian Basin (SE Austria/NE Slovenia): evidence for active lithospheric mantle degassing. Chemical geology, 422, 60-70.

Rajver, D., Lapanje, A., Rman, N. 2012: Possibilities for electricity production from geothermal energy in Slovenia in the next decade. Geologija, 55/1, 117-140.

Tóth, G. Rman, N., Rotár-Szalkai, Á., Kerékgyártó, T., Szőcs, T., Lapanje, A., Cernak, R., Remsík, A., Schubert, G., Nádor, A. 2016: Transboundary fresh and thermal groundwater flows in the west part of the Pannonian Basin. Renewable and Sustainable Energy Reviews, 57, 439-454.

Relevant projects

2009-2017 - Slovenian Environmental Agency: Elaboration of map of active faults in Slovenia

2010-2011 – HSE, TEŠ, TET, PV: Possibility for geological storage of CO2 in Slovenia

2010-2013 – Central Europe programme: TRANSENERGY - Transboundary Geothermal Energy Resources of Slovenia, Austria, Hungary and Slovakia

2012-2015 – Alpine Space programme: GeoMol - Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources

2017-2019 – Interreg Danube: DARLINGe - Danube Region Leading Geothermal Energy

2016 on – eGeologija: portal on inventory and collection of datasets in the field of geology

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19 GeoInform Ukraine

Name of the Organisation (Acronym)
State Informational Geological Fund of Ukraine (GEOINFORM / GIU)

Brief description of the legal entity
The State Research and Development Enterprise "State Informational Geological Fund of Ukraine" – SRDE “GeoInform of Ukraine”, or GeoInform, is the specialized research and development unit of the State Geological and Subsurface Survey of Ukraine, which collects, stores, analyzes and provides information received from geological study and use of subsurface.

GIU conducts research work on monitoring of mineral resources of Ukraine on the basis of geological and mining activities during the year, recording deposits and making public the balance of mineral resources management of the State fund of deposits and occurrences (more than 10,000 objects recorded), synthesis and analysis of exploration for oil and gas, creating a system of state accounting of oil and gas wells, completion and maintenance of the State cadaster of mineral deposits and occurrences as well as the State cadaster of groundwater deposits of Ukraine.

Description of persons designated for GeoConnect³d implementation:

Dr. hab. Boris Malyuk (PhD, male), Director for International Cooperation, graduated in 1981 from Department of Geology, Lviv University, Ukraine, and in 1999 from Centre of Geostatistics, Ecole des Mines de Paris, France. Obtained Candidate of Science (PhD) Degree in Geotectonics in 1984, and extended Doctor of Science Degree in Petrology in 1991. National Delegate of Ukraine to the EuroGeoSurveys.

Sergii Prymushko (male), Director, with basic IT-background, has more than 30 years experience in management of geological information, including partitioned database systems.

Volodymyr Velychko (male), Chief Engineer, at his position is responsible for hardware and software facilities and database development having basic IT-background. In the Project he will contribute to geoscientific data systems.

Dr. Igor Melnyk (PhD, male), Sector Chief, with basic background in geology, has an experience in field works and research in geochemistry, hydrogeology and ecology (PhD in 1996), as well as geoinformatics and GIS applications.

Tetiana Biloshapska (female), Chief Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1980. She is experienced in field work. She has studied mineral-resource base of Ukraine for more than 30 years, took part and led projects on prospecting and exploration of mineral deposits, conducted regional geological studies.

Galyna Polunina (female), Leading Geologist. Graduated from Tyumen Industrial Institute under specialty 'Geology and Exploration of Oil and Gas Deposits' in 1975. She is working out with hydrocarbon deposits and oil and gas resources inventory of Ukraine for more than 40 years.

Iryna Mykhaylyk (female), Leading Geologist, Division of Information Technologies. Graduated from Department of Geology, Taras Shevchenko Kyiv National University in 2010, under specialty "Geology".

Natalia Kovalenko (female), Leading Engineer, Division of Information Technologies. Graduated from Department of Transport Construction, Kyiv Autoroad Institute (nowadays – Transport University) in 1985, under specialty "Bridges and Tunnels", in 1989 graduated from special courses "Programming C++", education center "Uspikh", Kyiv, and in 2002 graduated from special courses "WEB-programming PHP, HTML, CSS", education center "Perspektiva", Kyiv.

Relevant publications

Interactive map of mineral deposits of Ukraine (in Ukrainian)
http://geoinf.kiev.ua/wp/interaktyvna-karta-rodovyshch-korysnykh-kopalyn.htm

Interactive map of mineral licenses (in Ukrainian)
http://geoinf.kiev.ua/wp/interaktyvni-karty-spetsdozvoliv.htm

Interactive geological map of Ukraine 1:1 000 000 (in Ukrainian)
http://geoinf.kiev.ua/wp/Interaktyvna-heolohichna-karta-Ukrayiny.htm

Interactive geological map of Ukraine 1:1 000 000 (in English)
http://geoinf.kiev.ua/wp/Interactive-Geological-Map-of-Ukraine.htm

Interactive State Geological Map of Ukraine 1:200 000 (in Ukrainian with English entries)
http://geoinf.kiev.ua/wp/kartograma.htm

Relevant projects

ESTMAP - EU

EUOGA - EU

NUMIRE – Norway-Ukraine (NGU/SGSSU)

EIMIDA – Norway-Ukraine (NGU/Geoinform)

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20 NRW Germany

Name of the organisation (Acronym)

Geologischer Dienst Nordrhein-Westfalen (GD NRW)

Brief description of the legal entity

GD NRW is the Geological Survey of North Rhine-Westphalia, being responsible for providing geological advice and information to the government and the public. The tasks of the Survey include geological and hydrogeological surveying, mapping and modelling. Other topics are soil, raw materials, geophysical and geotechnical underground properties as well as geothermal energy. We determine risk prevention data for underground hazards and operate an earthquake alarm system. GD NRW produces a range of products including maps, databases and publications. Many of these informations are freely accessible through our online services.

Main persons involved

Heinz Elfers (MSc, European Geologist, 30+ year experience, male) is leading the division “Geological Information Systems”. He has been involved in hydrogeological mapping and 3D modelling. In the context of federal state working groups in Germany, he is engaged in boreholeML, the German standard for exchanging borehole information.

Bernd Linder (MSc, 20+ year experience, male) is working in the division “Geological Information Systems”. He is specialized in hydrogeology and 3D geological modelling. He was involved in several cross-border projects with the Netherlands, including H3O-ROSE.

Martin Salamon (PhD, 19+ year experience, male) belongs to the department of geological investigation and mapping. He has much experience in the structure of the Lower Rhine Valley and is one of the leading geological scientists for the Variscian, especially in the Eifel Mountains. He is member of the stratigraphic commission of Germany and member of the Permanent Committee of the International Congress on Carboniferous and Permian Stratigraphy.

Infrastructure, products and services

https://www.gd.nrw.de

https://www.opengeodata.nrw.de/produkte/geologie/

5 Ethics and Security (This section is not covered by the page limit)

5.1 Ethics

Have you completed an ethics self-assessment? YES

The project proposal has been checked against the ethics sections in "H2020 Guidance —How to complete your ethics self-assessment: V5.2 – 12.07.2016". This check did not raise any issues. The checklist is included with the submitted documents in ISAAC.

5.2 Security

Please indicate if your project will involve:

- Activities or results raising security issues: NO
- 'EU-classified information' as background or results: NO

5.4 HIKE

Version History

HISTORY OF CHANGES	
Date	Amendment to Project Plan
12-01-2018	Version submitted
30-05-2018	Minor amendments: - Updated Table 3.1b. to be consistent with the staff effort/resource committed - Updated Table 3.3a. to be consistent with the staff effort/resource committed - Updated Table 3.3b. to be consistent with Table 3.4 “other indirect cost” of LNEG. Added 2.832,75 to “Other goods and services” and corrected the total to 7832,75 - Corrected minor typos in task descriptions: references to PGI-NRI changed into PIG-PIB. Removed question marks in Task 3.2 - Note: The changes in 3.1b, 3.3a and 3.3b do not have any effect on the final committed budgets in Table 3.4

COVER PAGE

Title of project proposal

HIKE: Hazard and Impact Knowledge for Europe

Abstract (max. 250 words)

The HIKE project aims to support research and assessments of induced hazards and impacts that are related to the exploitation of subsurface resources and capacities throughout Europe. This will be achieved through development, demonstration and implementation of harmonized subsurface data sets and methodologies, investigation of applied use cases, and facilitation of knowledge shared between geological surveys and stakeholders.

WP-2 focuses on the development of a European fault database covering a comprehensive set of static and dynamic geological and physical characteristics needed for the assessment of seismic hazards, ground movements, leakage and fluid migration, sealing capacities, fluid flow and other types of dynamic behaviour. This database will be developed, populated and tested in conjunction with several other GeoERA projects and external stakeholder involvement. WP-3 establishes novel hazard and impact research methods and investigates the added value of the established fault information in several case studies and geological settings across Europe. WP-4 concludes the research activities with future recommendations and the establishment of a share point for information, knowledge and preferred practices related to hazard and impact research. This share point is intended to provide a collaboration and knowledge exchange platform for future research by geological surveys and other stakeholders. WP-5 governs the embedding of the results into the GeoERA Information Platform.

Please indicate the SRT

GeoEnergy – GE4-Induced impacts and hazards

List of participants

#	Participant Legal Name	Institution	Country
1 (coord)	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO	**TNO**	**Netherlands**
2	Albanian Geological Survey	**AGS**	**Albania**
3	Geologische Bundesanstalt	**GBA**	**Austria**
4	Royal Belgian Institute of Natural Sciences – Geological Survey of Belgium	**RBINS-GSB**	**Belgium**
5	Geological Survey of Denmark and Greenland	**GEUS**	**Denmark**
6	Bureau de Recherches Géologiques et Minières	**BRGM**	**France**

7	Bundesanstalt für Geowissenschaften und Rohstoffe	**BGR**	**Germany**
8	Landesamt für Bergbau, Geologie und Rohstoffe Brandenburg	**LBGR**	**Germany**
9	Landesamt für Geologie und Bergwesen Sachsen-Anhalt	**LAGB**	**Germany**
10	Bayerisches Landesamt für Umwelt	**LfU**	**Germany**
11	Islenskar orkurannsoknir - Iceland GeoSurvey	**ISOR**	**Iceland**
12	Istituto Superiore per la Protezione e la Ricerca Ambientale	**ISPRA**	**Italy**
13	Servizio Geologico, Sismico e dei Suoli della Regione Emilia-Romagna	**SGSS**	**Italy**
14	Agenzia Regionale per la Protezione Ambientale del Piemonte	**ARPAP**	**Italy**
15	Lietuvos Geologijos Tarnyba prie Aplinkos Ministerijos	**LGT**	**Lithuania**
16	Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy	**PIG-PIB**	**Poland**
17	Laboratório Nacional de Energia e Geologia	**LNEG**	**Portugal**
18	Geološki zavod Slovenije	**GeoZS**	**Slovenia**
19	State Research and Development Enterprise State Information Geological Fund of Ukraine	**GEOINFORM**	**Ukraine**

1 Excellence

The exploitation of subsurface resources and capacities (e.g. hydrocarbons, geothermal, underground storage) is susceptible to induced effects and events from drilling activities, extraction and injection of fluids and gases, engineering of subsurface space, and the installation and abandonment of mining infrastructure. These effects can have an adverse or harmful impact on the natural and human environment (e.g. due to ground movements, seismic events, and unintended fluid migration and pollution). As such, subsurface exploitation activities are subject to the EIA Directive of the European Union (2011/92/EU and 2014/52/EU). This Directive obliges public and private projects to carry out and report an environmental impact assessment (EIA), which incorporates, among others, a description of the exploitation activities, the expected effects and impacts, and possible measures and alternatives that can be implemented to prevent, reduce or mitigate such impacts.

The here proposed development and public dissemination of common standards, novel predictive models and multi-purpose regional and transnational datasets on subsurface behaviour will support and improve future EIAs. This is complemented by improved exchange of knowledge and experience between the geological surveys and stakeholders involved. The following arguments underpin the benefits:

- Assessment of induced impacts, hazards and risks is often carried out on a case-by-case basis and restricted to the local extent of an exploitation activity. Occasionally, regional assessment studies are undertaken in order to investigate more generic hazard aspects and impacts related to a specific activity (e.g. shale gas exploitation impacts in the H2020 M4SHALEGAS project). With such local-oriented or technology-specific approaches there is much to gain by establishing joint methodologies, and standardizing and integrating information across different assets and use-cases in European countries.

- Reliably predicting subsurface effects in response to human activities (e.g. resolving the type of effect, chance of occurrence, location, magnitude and extent) poses a major technical and scientific challenge in this respect. Such predictions are prone to incorporate large uncertainties due to the highly complex nature of subsurface processes and the incompleteness of information to assess them properly. Consequently, it is often difficult to assess the risks imposed upon the society and environment. Geological surveys and research institutes can reduce these uncertainties and improve the prediction and assessment of induced effects by modelling and characterizing the subsurface, studying and monitoring its mechanical, chemical and thermal behaviour, and improving models and methodologies that describe subsurface processes.

Better hazard and impact assessments will ultimately help to prevent or mitigate risks to society and environment and reduce costs resulting from harmful effects.

Aims and objectives

This proposal responds to the above challenges and the GeoERA call objectives presented in **SRT GE4: Induced Impacts and Hazards**. The partners involved in this project will address these objectives and challenges through the following aims:

1. **To establish the foundations for a European knowledge and data sharing platform supporting national and transnational induced hazard and impact studies and EIAs** (responds to bullet 1 and 2 of SRT scope). This is achieved through:
    a. the collaboration between the partner organisations to address selected hazard and impact aspects, carrying out and linking different case studies across Europe and developing transnational data sets on subsurface behaviour and characteristics;
    b. the development of an online share point for above-mentioned data, case study results and knowledge documents that are broadly applicable to hazard/impact-related topics in different European geological settings.

2. **To improve the understanding of the complex nature and (induced) behaviour of faults and fault zones**. This is achieved by prioritizing the development of a first-of-its-kind European Information System for subsurface faults and associated deformation zones (hereafter Fault Database or FDB). The prioritization of the Fault Database in the context of this SRT is motivated by the fact that information on faults and deformation zones is often crucial for assessing the nature and occurrence of seismic hazards, ground movements, fluid migration, contamination,

and subsurface containment. As a centralized administration and standardisation of fault data is currently lacking in Europe, this project strives to improve, integrate and disclose relevant static and dynamic subsurface characteristics of faults and fault zones in various national and transnational geological settings (responds to bullet 3 and 4 of the SRT scope).

3. **To jointly develop novel methodologies and carry out practical case studies** (responds to bullet 3 and 4 of the SRT scope) with the purpose to:
    a. improve the current state of art in hazard and impact assessment
    b. demonstrate the applicability and added value of the FDB contents
    c. establish and investigate workflows and concepts that form the basis for knowledge sharing and future research collaboration.

4. **To optimize transparency, open access and inter-operability of information, and thereby serve the European science community and stakeholders**. To this end, the established results and databases will be embedded within the GeoERA Information Platform (responds to bullet 5 of the SRT scope). In collaboration with the GeoERA IP Project, the HIKE project will deliver the geological, technical and functional specifications that are required for the development of the aforementioned information systems and databases by the GeoERA IP (Information Platform) project. These specifications will also incorporate meta-data elements as well as a common semantics database in order to assist the cross-linking of information between different national data repositories and geoscience disciplines.

Through the achievement of the above objectives, the partners wish to **support knowledge sharing and joint research activities on induced hazards and impacts in the national and European context**. This common ERA-NET ambition is a primary requisite for the establishment of the more broadly aspired Geological Service for Europe (generic GeoERA objective). Through the assessment of practical use cases and methodologies, the project will also create further awareness among a broader group of potential stakeholders, while staying close to specific end-user needs (responds to bullet 5 of the SRT scope). The envisioned collaboration on cross-cutting aspects with other GeoERA projects and concurrent national and European projects will help the HIKE project to gain more critical mass and to extend its exposure and interaction between stakeholders and related science domains.

Relation to existing programmes and projects

Below a brief overview is given of several existing or recently completed research programmes and their relation to the proposed activities and deliverables described in this proposal:

FP7 SHARE project
The SHARE project (Seismic Hazard Harmonization in Europe) has established new standards in Probabilistic Seismic Hazard Assessment (PSHA) practice by a close cooperation of leading European geologists, seismologists and engineers. The objective of this project was a European wide probabilistic seismic hazard assessment across multiple disciplines spanning from geology to seismology and earthquake engineering. The project built a framework for integration across national borders, compiled relevant earthquake and fault data, and developed a sustainable, high-impact authoritative community-based hazard model assembled by seeking extensive expert elicitation and participation through multiple community feedback procedures. These results will be taken into account in the HIKE methodology developments and the building of the Fault Database. The SHARE project only considers seismogenic faults that are deemed capable of generating earthquakes of magnitude 5.5 or higher. HIKE significantly extends the SHARE results with new country information on a much broader defined fault population (including seismically inactive faults) prone to generate induced effects.

H2020 M4Shalegas project
M4ShaleGas stands for Measuring, Monitoring, Mitigating and Managing the environmental impact of shale gas and aims at addressing the specific challenge related to understanding, preventing and mitigating the potential environmental impacts and risks of shale gas exploration and exploitation. In particular, Sub-Program 1 (Impact of subsurface activities: Hydraulic fracturing, induced seismicity and well integrity) aligns with the scope of HIKE. Where relevant, the outcomes of the M4ShaleGas project will be taken into account in HIKE and considered for incorporation in the knowledge share point.

FP7 IMAGE project
The goal of the IMAGE (Integrated Methods for Advanced Geothermal Exploration) project is to develop an integrated geothermal exploration approach based on state-of-the-art scientific methods. One of the main pillars involves the understanding of processes and properties that control the spatial distribution of

critical exploration parameters from continental to local scales. In this respect the project focuses on the estimation of temperatures, in-situ stresses, fracture permeability and use of state of the art seismic imaging techniques towards hazard predictions, which can be deduced from field analogues, public datasets through modelling. For HIKE it is relevant to incorporate data from the rock property catalogues as well as adapt and incorporate novel methodologies developed under the IMAGE project.

EPOS platform
The EPOS mission is to integrate the diverse and advanced European Research Infrastructures for solid Earth science, and build on new e-science opportunities to monitor and understand the dynamic and complex solid-Earth System. The activities and outcomes of the HIKE project are complementary with the EPOS scientific vision and approach in which innovative multidisciplinary research creates a better understanding of the physical processes controlling dynamic processes in the earth (e.g. earthquakes). The main difference is that HIKE looks at these processes from an artificial (induced) perspective. The Fault Database can be a valuable contribution to research activities under EPOS.

Copernicus
Copernicus is a European Union Programme aimed at developing European information services based on satellite Earth Observation and in situ (non-space) data. The Copernicus programme is coordinated and managed by the European Commission. The development of the observation infrastructure is performed under the aegis of the European Space Agency for the space component and of the European Environment Agency and the Member States for the in situ component. Copernicus has been specifically designed to meet user requirements. Through satellite and in situ observations, the services deliver near-real-time data on a global level, which can also be used for local and regional needs. Copernicus is served by a set of dedicated satellites (the Sentinel families) and contributing missions (existing commercial and public satellites). Sentinel and contributing mission data are relevant for the HIKE project, in particular, for ground motion analyses.

1.1 Concept and methodology

Figure 1.1 illustrates the overall project logic and the main scientific tasks defining HIKE, i.e.:

1. Establish a database with fault information that is relevant for hazard and impact assessments.
2. Develop, improve and practice assessment methodologies in various case study areas.
3. Establish a knowledge share point for European hazard and impact research
4. Embed the results in the GeoERA Information Platform

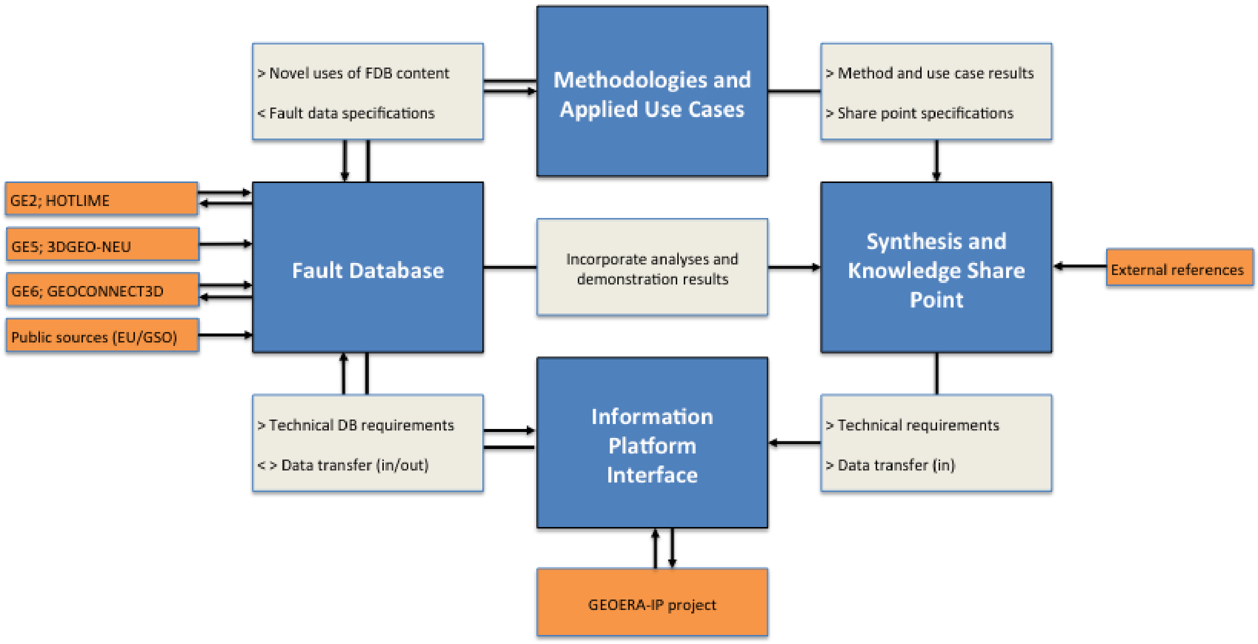

Figure 1.1: Overall project logic and interactions between the main project elements. The blue boxes depict the work packages; the grey boxes describe the main interactions; the orange boxes identify relations with external activities and resources.

The elements in the diagram and their mutual relationships are described in further detail below.

Fault Database concept:

The Fault Database (FDB) is one of the core deliverables of the HIKE project. It will describe and define faults and deformation zones as 2D or 3D spatial objects with associated static and dynamic geological, mechanical, petrophysical, chemical and thermal properties. The scientific specifications for parameterizing the faults will be obtained from applied use cases and studies that generate or utilize fault information. The HIKE project will interact with experts within and outside the GeoERA community in order to establish these specifications.

The faults are typically modelled and characterized using 2D and 3D geological mapping and structural reconstruction methods. Fault modelling is supported by borehole data, geophysical measurements, earth observation surveys, and various other reconnaissance techniques. In this respect the HIKE project will implement state of art and novel methodologies and workflows in order to improve fault characterization in various geological settings. Specific attention will be paid to resolving critical issues that hamper the integration of fault data from different sources and vintages. The project will establish a Fault Characterization Catalogue which describes the scientific specifications, quality standards, formats and applied methodologies underpinning the database contents and their relation to subsurface behaviour and effects.

The targeted extent of the FDB covers entire Europe[1] (both on- and off-shore), including all depth ranges and all geological settings covered by exploration and exploitation activities. The partners in the project consortium will be the primary contributors of fault data. In addition, the project seeks cooperation with other GeoERA projects and national geological programmes in order to collect supplementary fault data, in particular from modelling and characterization projects under GE2 (HotLime), GE5 (3DGEO-EU) and GE6 (GeoConnect³D). This collaboration will help to increase the spatial coverage of the FDB. The intention to collaborate and exchange information is described in each of the other proposals involved and shall be facilitated by joint technical workshops. Finally, the project will distribute the tools that will allow any organisation (also those not in the consortium) to link their local data repositories to the FDB.

The project will implement procedures to ensure the quality of data and compliance to the standards described in the fault characterization catalogue,

The FDB intends to support the use of fault data in a wide variety of applications at multiple scales (e.g. defining structural geological domains, assessing seismic hazards, determining ground movements, investigation of fluid migration and subsurface containment, etc.). To this end, the FDB will implement end-user functionality and tools for selecting, retrieving and analysing fault data. These tools and functionalities will be developed in conjunction with applied use cases and methods developed within the project. Additional external client applications will be engaged and investigated during the project.

Methodology development and use cases:

The project partners will elaborate novel methodologies and work on specific use cases with the final goal of improving hazard and impact assessments. These methodologies and case studies will be developed on top of proven and widely accepted concepts, thereby using datasets that will become (or are already) publicly available and datasets and methods that are common practice in the most state-of-the-art national and transnational research.

The initial phase of the project will focus on the elaborate definition and scoping of each case and methodology study. Special attention will be paid to the cross-cutting links with other cases investigated in HIKE, as well as the implementation of knowledge on fault behaviour. After the initial work on the case studies and methodologies, the project will define specific cross-cutting scenarios to be investigated, e.g.

[1] Through the cooperation with external parties and sources, HIKE will attempt to achieve the largest possible coverage within the financial and technical capabilities of the partners. The current partner commitments provide sufficient coverage for demonstration and implementation of the FDB. A comprehensive and detailed coverage for all of Europe is considered as a future target beyond the project scope and life time. To this end, the project will propose and implement guidelines for later continuation of fault data collection and further extension of the pan-European coverage.

with regards to the evaluation of the added value and applicability of the Fault Database information,. The results will be reported and incorporated into an overarching knowledge share point (see below), and considered for peer review publication. On the basis of the results and experiences, the project will provide recommendations and guidelines to stakeholders and end-users on how to extend the share point with new information and how to implement the contents into their own areas of interest.

Hazards and Impacts knowledge share point concept:

The knowledge share point represents a central repository and online access point for all data sources, state-of-art method reports and case study outcomes relevant to an improved hazard and impact assessment. The share point will be developed on the basis of meta-databases that incorporate links to locally hosted information sources. Thereby it will provide end-user oriented search and download functionalities. The definition and implementation of a common semantics database will assist in linking the various contents within the share point.

The specifications and functionalities of the knowledge share point will be determined from a synthesis of applied use cases, including literature studies and research that is part of the HIKE work plan. The database itself will be developed by the IP platform based on technical requirements delivered by HIKE. The knowledge base is intended to further evolve and grow as new information is added after the project lifetime. To this end the HIKE project will promote the platform at various stakeholder forums.

Information Platform interface

The database architecture of both the knowledge share point and the FDB will be developed and embedded into the GeoERA Information Platform by the GeoERA IP project. The HIKE project will establish and deliver the technical requirements, data standards and functionality criteria that are needed to develop the databases. To this end, the project incorporates a work package that is specifically dedicated to the interaction with the Information Platform and the coordination of information transfer within HIKE (e.g. implementation of guidelines for data upload and retrieval as provided by the IP project).

1.2 Ambition

The research area of induced hazards and impacts covers a wide range of subsurface uses and effects that are investigated using different data types, scientific disciplines and methodologies. Every individual environmental impact assessment is furthermore characterized by its unique location-specific conditions and criteria. The broadness and diversity of the subject forces the HIKE project to be selective regarding the topics and cases it can cover.

HIKE puts primary attention to faults and associated deformation zones. The importance of these subsurface features to hazard and impact research is widely acknowledged. Modelling and characterization of faults is a complex scientific task. Currently, it is not possible to obtain high quality and integrated fault information and apply it to different areas and use cases across Europe. Common standards and criteria for fault characterization are mostly lacking or poorly implemented at national and transnational scales.

The main ambition of HIKE is to establish a European information system containing high quality and user-oriented fault information, based on common standards and improved workflows for fault characterization. These workflows and standards must be implemented at the geological surveys of Europe in order to facilitate future continuation of maintenance of the database. The consortium partners share the further ambition to develop this system into a public end-user tool and information repository for applied hazard and impact studies. In this respect the project partners envision the following benefits for the various stakeholders:

- As the contents of the Fault Database (FDB) expand and improve, a statistically significant set of data becomes available to end-users and research studies. Such information can be used as an analogue in various assessments, and improves the understanding of fault parameterization and fault behaviour in general.

- The joint development of common standards and methodologies for modelling and characterizing faults will help many countries to improve their own national assessments.

- The demonstration and exchange of information in practical user cases will further stimulate the learning effect towards the broader stakeholder community and end-users of such information.

Another major ambition of HIKE is to better align, improve and facilitate the assessment of hazards and impacts in different settings and cases across Europe. With the joint development of assessment methods, workflows and datasets in various practical case studies across Europe, the HIKE partners strive to fulfil the broader ambition towards intensifying research collaboration on hazards and impacts, and improving transfer of knowledge. The development of a public and robust knowledge share point is intended to support this ambition. The partners take action to attract further stakeholder support in order to safeguard the future maintenance and expansion of this share point.

Last but not least, it is HIKE’s ambition to support and stimulate openness, transparency and accessibility of information and knowledge. These principles will be generic guidelines for the development of the databases.

2 Impact

2.1 Expected impact

The successful implementation of a European Hazards and Impacts knowledge share point will provide the foundation and platform for **the (future) alignment of national research on geo-energy related (induced) impact and hazard assessments across Europe**.

The gathering, harmonization and central dissemination of geosciences data sources, methodologies and case study results will deliver the means and support **to develop and improve methods to predict, prevent and mitigate hazardous and polluting effects induced by subsurface exploitation**.

By supporting measures to prevent and mitigate induced hazards and impacts, the project indirectly contributes to the **reduction of economic and societal costs resulting from such effects** by minimizing the risks.

Through the implementation and demonstration of real and actual use cases, the project will be better able to **translate the achievements and results to the policy and societal domains**.

The collaboration between project partners as well as between the project and other national/transnational studies is vital to **establishing common agreed and broadly applicable standards and functionalities in alignment with end-user needs** as well as to **increasing the effective deployment of innovation capacity in the entire research area**. This will help many countries **to improve their own assessment and determination of induced hazards and impacts**.

The open-access and dissemination of information via the GeoERA Information Platform will allow stakeholders and end-users to benefit from the established results and thereby **avoid unnecessary data acquisition and research costs**.

Last but not least, the transparency and open access to information are considered first principles and requisites for **public awareness creation**.

By the cooperation between the identified partners, the project will establish a clear **transnational focus**. Through the development of generic information sources and methodologies as well as national oriented sources and use cases, the project reaches out to both **national and European stakeholders and end-users**.

The public availability of information regarding hazards and impacts may be subject to confidentiality and other access restrictions that are imposed by national and local regulations. These restrictions cannot be resolved within the project, yet attempts will be made to include references where possible. Furthermore, it can be expected that certain use cases cannot be promoted by the project due to their political and societal sensitive nature.

2.2 Measures to maximise impact

2.2.1 Dissemination and exploitation of results

All work packages in HIKE are involved in communication, dissemination and exploitation activities in order to maximize the project impact. WP-1 will specifically govern the general (internal and external) communication and dissemination of project proceedings within the GeoERA community and towards EU stakeholders. WP-5 will take care of the dissemination and exploitation of the scientific results through the GeoERA Information platform (in collaboration with the GeoERA IP project). The dissemination and exploitation activities in WP-2, WP-3 and WP-4 are mainly focused on specific expert and user target groups such as the scientific community (e.g. by peer reviewed publications) and local/national/EU stakeholders to whom the results are directly relevant.

In order to ensure that the project results will reach the appropriate target audiences and succeed in maximizing their impact, a Project Communication, Dissemination and Exploitation Plan (CDEP) will be established that invokes all work packages. Below the draft objectives and activities of the concept CDEP are presented. This concept will be detailed in a formal CDEP by month 6 (deliverable D1.6). The Project Board (PB) will regularly update the CDEP if deemed necessary.

CDEP objective 1. Promotion of HIKE objectives and activities	
Target groups	General public, local/EU stakeholders, scientific community, GeoERA community
Planned actions	Set-up project website, establish project leaflet, engage stakeholders via visits and at public events. Participate in workshops of other projects and events.
Goals, expected results	Increased awareness of the project at relevant EU institutions, national stakeholders, and the science community
CDEP objective 2. Cross-thematic exchange and implementation of results in GeoERA	
Target groups	GeoERA community and associated scientific community
Planned actions	Three GeoERA seminars/reviews, two technical workshops. Specific collaboration is planned with GeoERA projects: HOTLIME (SRT GE2); 3DGEO-EU (SRT GE5); GeoConnect³D (SRT GE6). Other projects will be engaged to investigate collaboration on cross-cutting objectives and datasets.
Goals, expected results	Proper exchange and implementation of cross-cutting data and methods between HIKE and other GeoERA projects
CDEP objective 3. Implementation and embedding of project results at stakeholders	
Target groups	Scientific community, local/EU stakeholders,
Planned actions	External stakeholder involvement in practical use cases (WP3), and establishing the FDB (WP2) knowledge share point (WP4); Linking results to external stakeholder needs; Engage potential client platforms/end-users (e.g., EPOS, commercial tools) to use the results
Goals, expected results	Proven application of WP2 and WP3 outcomes in practical cases and third-party platforms. Awareness of potential added value at local/EU stakeholders
CDEP objective 4. Provide public access to digital project results	
Target groups	General public, local/EU stakeholders, scientific community, GeoERA community
Planned actions	Dissemination of Fault database and Knowledge share point contents through web services in the GeoERA Information Platform;
Goals, expected results	Online open access and availability of digital project results
CDEP Objective 5. Awareness of project results at science community and knowledge sharing	
Target groups	Scientific community, local/EU stakeholders, GeoERA community
Planned actions	Besides the technical reports listed in the deliverables, the project partners have the intention to publication the results in one or more research papers in scientific journals; Presentation of results is furthermore considered at expert workshops and conferences (to be specified).
Goals, expected results	Recognition of HIKE by the wider scientific community
CDEP Objective 6. Strengthen EU research and collaboration on induced impacts and hazards	
Target groups	Scientific community, local/EU stakeholders, GeoERA community
Planned actions	Establish guidelines and common standards with input from wider science community; Recommendations for future follow-up research; Support embedding of methodologies, practices and joint data sets at other institutes.
Goals, expected results	Foundation for future continuation and elaboration of results

2.2.2 *Communication activities*

The concept CDEP presented above includes various communication activities that are primarily directed to local and EU stakeholders, the science community and the GeoERA/Geological Survey community. The main objectives are to create awareness and thereby attract further interest to exploit the project results and invite for contributions on their specification, quality and coverage.

WP1 has the responsibility to set-up a dedicated project Web-site in which the project goals, activities, deliverables and partners are presented to general public and stakeholders.

Project partners will engage local stakeholders and research institutions to make them aware of the project activities and to consult them for using or improving the project results. In many cases contacts and communication channels are already established from past projects and long-lasting collaboration agreements. The practical case studies will in particular present opportunities for local stakeholder involvement and demonstrating the benefits of the developed information systems.

The general science community will be engaged and informed through presentations at expert workshops and conferences, and publications in peer-reviewed journals. The Project Board and Project Partners will together decide on which workshops and conferences will be visited and what messages and results will be broadcasted.

The GeoERA and Geological Survey community will be informed and involved via the various joint seminars and technical workshops foreseen in the work plan. These events primarily intend to exploit options for cross-cutting and cross-thematic collaboration.

The further communication strategy will be detailed at project start in the CDEP (deliverable D1.6).

2.3 Contribution of Project Proposal to the Information Platform or vice versa

The HIKE project will establish two new information components for the GeoERA Information Platform, i.e.:

- A **European Fault Database** containing spatial definitions and associated geotechnical parameters that are relevant for hazard and impact research as well as various other applications and fields of research. This component will be developed in WP2.
- A **Knowledge Share Point** containing references to state of art information repositories, methodology publications and case study reports that are relevant for knowledge exchange and best practice recommendation in the field of hazards and impacts research. This component will be developed in WP4.

WP-5 (Information Platform Interface) will coordinate the interactions between the HIKE project and the GeoERA-IP (Information Platform) project. The following requirements and interactions are defined:

- The HIKE project will develop the scientific specifications for both databases (WP2 and WP4). These specifications will be translated into technical database requirements by WP-5 in close cooperation with the GeoERA IP project. The requirements will be communicated to the appropriate developers.
- Based on the above-mentioned specifications, the GeoERA-IP project will develop and implement the Database architecture and assist in setting up functionalities that will allow GSOs to link their information to these databases.
- The IP project will provide concise technical guidelines that should be followed by data providers when uploading and linking their information in the databases

- Based on these technical guidelines, the HIKE project (WP-5) will establish and disseminate a user manual and guidelines for the use of the database. The GeoERA-IP project will provide assistance in the form of a review on this manual as well as technical support during testing and demonstrating both bases. This support covers the retrieval of information as well as the identification and solution of errors and database improvements.

- The IP-project coordinator will be finally responsible for appointing the IP-developers to the HIKE interface tasks and the development of the databases. The selection of personnel will however be discussed between the PBs of HIKE and IP.

- The maintenance and dissemination of the project results will be explained in the Project Data Management Plan (deliverable 1.4, Month 6). The project data will be disseminated through the GeoERA Information Platform and its exponent in EGDI (European Geological Data Infrastructure). The geological survey organizations will remain responsible for future maintenance and updates of their national data.

3 Implementation

The following sections explain the main elements and concepts of the Project Implementation Plan (PIP). During the first two months of the project the Project Coordinator and Project Board will together establish a detailed PIP. This plan will be approved by all partners represented in the Project Assembly..

3.1 Work Plan – Work packages, deliverables

The HIKE work plan comprises a total of five work packages, all of which closely interact with each other. Figure 3.1 below shows the project work package and task structure. Table 3.1a provides a detailed description of the work packages, tasks, deliverables and committed resources. Table 3.1c summarizes the project deliverables. The cumulative distribution of resources per WP (person months) is shown in Table 3.3a. Table 3.3c provides the total financial resources committed to the project by each partner. The proposed project timeline is illustrated in the Gantt chart in Figure 3.2.

Project work package and task structure

The following work packages are defined:

- **WP-1** governs the overall coordination and communication tasks of the project, including progress monitoring, financial administration, project decisions, internal communication, central coordination of interactions with other GeoERA projects and general dissemination of the project to external stakeholders.
- **WP-2** focuses on the development of the Fault Database and the processing of fault geometries and parameters. This WP also governs cross-cutting interactions with other projects that either provide or utilize fault information (in particular GeoERA projects GE2-HotLime, GE5-3DGEO-NEU and GE6-GeoConnect³D).
- **WP-3** covers methodology development and related hazard and impact research in selected case studies across Europe by studying the mechanisms that can lead to hazardous consequences (e.g. seismicity, subsidence, fluid migration, sealing & leakage).
- **WP-4** compiles the current state of art regarding hazard and impact assessments in Europe and establishes recommendations and a platform for knowledge and data sharing among the geological surveys of Europe and relevant stakeholders.
- **WP-5** governs the interactions with the GeoERA information platform including the technical requirements of the fault database and knowledge share point. This WP will also be responsible for the implementation of the Project Data Management Plan during the project lifetime.

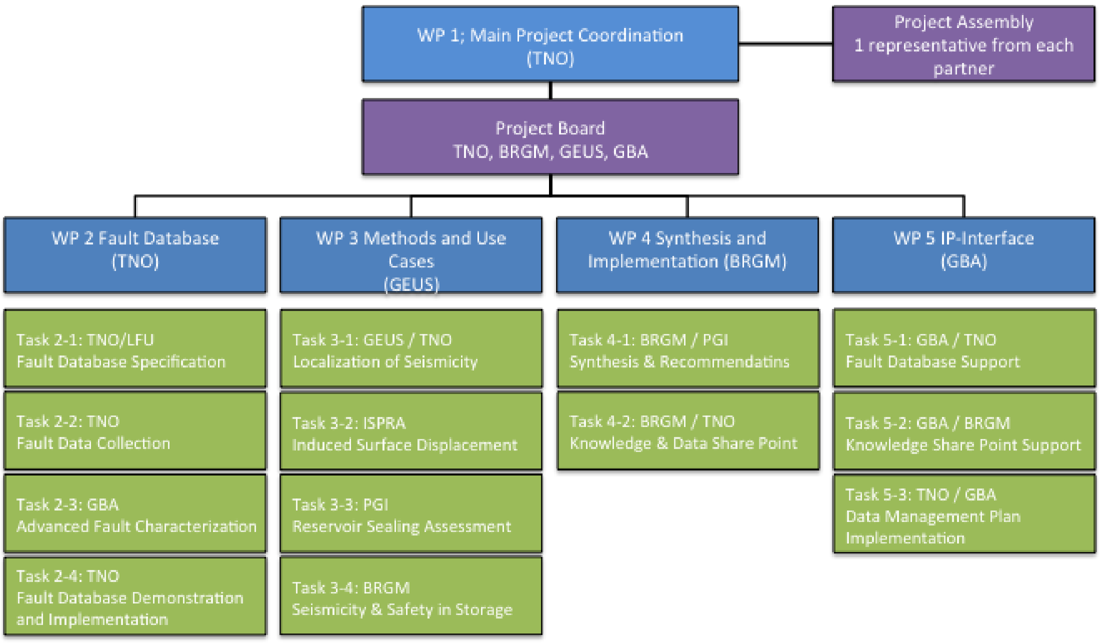

Figure 3.1: Schematic overview of the Project Management structure and main tasks

The matrix scheme below and the project logic in Figure 1.1 describe the main interactions that are foreseen between the different work packages in HIKE as well as with other projects. WP-1 facilitates these interactions by organizing technical project workshops, and by supporting further engagement of GeoERA projects and external stakeholders. The work packages will be responsible for the practical implementation the interactions.

		To:					
		WP-2	**WP-3**	**WP-4**	**WP-5**	**GeoERA IP**	**Other projects**
From	**WP-2**		Serve fault information	Report FDB applications	FDB and fault specifications and standards	Upload/Link fault data in FDB	Implement FDB contents
	WP-3	Feedback on fault specifications		Report case study results for synthesis	Feedback on share point specifications	Link study results & docs in share point	Investigate collaboration opportunities
	WP-4		Feedback on integrating practices		Share point specifications and standards	Link study results & docs in share point	Investigate external input
	WP-5	FDB data upload/linking guidelines	Share point data linking guidelines	Share point data linking guidelines		FDB / share point tech. requirements	FDB data upload/linking guidelines
	GeoERA IP				Technical guidelines		
	Other projects	Fault data		Investigate external input			

Project timeline and Gantt chart

The project identifies three main phases:

1) **Initial Phase (M1 to M6)**: Establishing the main organizational elements for project management and execution, including the detailed Project Implementation Plan (PIP), Communication, Dissemination and Exploitation Plan (DEP), and Data Management Plan (DMP). This phase will be used by most work packages to start working on technical specifications, elaborating the definition of use cases, scheduling interactions with other work packages and projects, and preparing the concepts and principles for methodology development. This period will furthermore be used to prepare and carefully plan all the concrete interactions with activities in other projects.
2) **Main Phase (M6 to M33)**: Main execution phase for the project research activities including data gathering and processing, developing and testing methodologies, elaborating case studies, etc.
3) **Final Phase (M33 to M39)**: Compilation and reporting of final results, QC and deployment of databases, final progress reporting and review event. Note that the technical project activities will end by M36.

Most work packages are defined for the entire three-year duration of the project.

The tasks in WP2 are more or less sequentially organized, going from database specification to data population and finally testing and implementation. The task on advanced fault characterization methodologies starts at the beginning of the project in order to benefit from the results when the fault database is populated.

The different tasks on method development and case studies in WP-3 can initially be executed in parallel. During the initial phase, the scoping of each case study will be elaborated, including identification of cross-cutting and complementary elements to other cases. During the first 18 months of the project, the WP3-tasks will primarily elaborate their base case scenarios. The cross-cutting aspects between the different case studies and the interaction with the fault database will mainly be investigated during the second half of the project, To this end WP-3 will establish an intermediate report specifying the concrete interaction scenarios to be investigated (deliverable D3.1). The results of these interactions will be reported in the final WP-3 reports.

WP-4 will start after the initial phase. The synthesis will first focus on an evaluation of publicly reported hazard and impact research cases and then gradually incorporate the findings and conclusions from the studies performed in WP-2 and WP3. The development of the knowledge share point will run more or less in parallel with the FDB development.

WP-5 follows the results and developments in WP-2, WP-3, and WP-4 (specification of the databases and upload of information). The management of the timeline together with the GeoERA IP platform will be essential in this respect in order to deliver the required database architecture and guidelines in time. The HIKE project foresees that the development of the databases will proceed through various prototypes and beta-versions. The final versions should be available at M25 (MS-7) in order to ensure that all contents are properly included and tested by M33. The implementation of the DMP will occur from M6 to the end of the project.

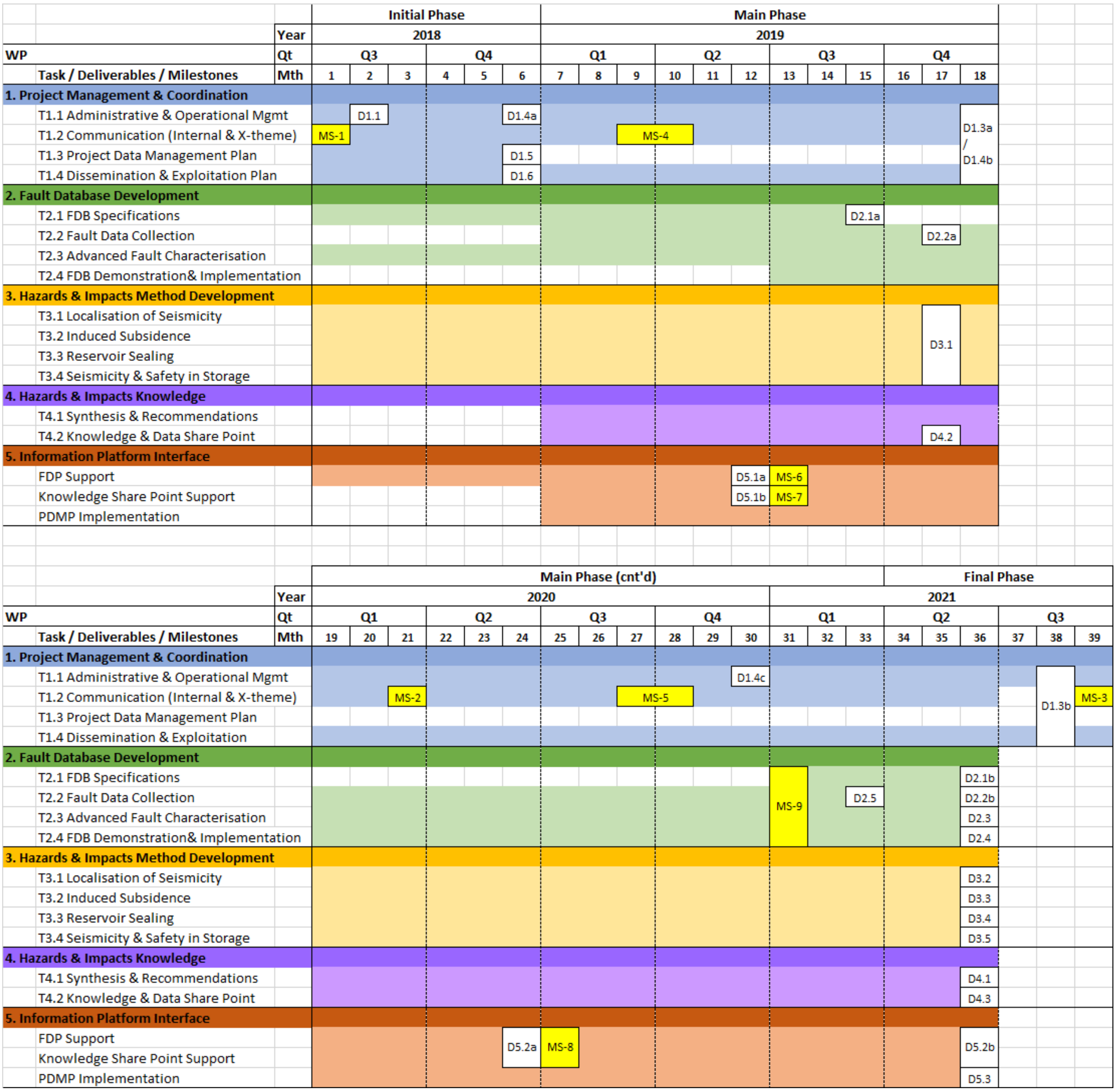

Figure 3.2: Project Gantt Chart

Work plan resources

WP-1 will incorporate resources from the project coordination and work package lead organizations only.

WP-2 incorporates contributions from all partners. The larger contributions are predominantly focused on the development of the fault database and its implementation and demonstration. Smaller contributions are mostly related to the provision and standardization of readily available data fault data from survey repositories. The project will incorporate data from other GeoERA projects as well. These projects will in most cases cover the efforts for modelling and mapping of faults.

The participation in WP-3 is mostly restricted to the partners involved in the study areas. Some partners are also participating in this work package for learning and experience purposes.

On its turn, WP-4 incorporates contributions from most partners in order to obtain a comprehensive synthesis and broadly evaluate how the project achievements can be further exploited and improved by the various national and regional institutes.

WP-5 mainly includes contributions from the partners responsible for development of the fault database and share point system.

3.2 Management structure, milestones and procedures

Project management roles and procedures

TNO is Lead Partner and responsible for the overall project coordination (WP-1). Mr. S.F. van Gessel will be the project coordinator. The other work packages are led by TNO (WP-2), GEUS (WP-3), BRGM (WP-4), and GBA (WP-5).

Each partner in the HIKE project appoints one person who represents the organization in the Project Assembly (PA). The PA will decide on matters that affect the entire project. This includes changes that affect the entire project including composition of the consortium, partner roles, timing of main deliverables and milestones, assignment of resources, partner contributions and budgets. The PA will approve the Project Implementation Plan. The PA will physically meet at the three main GeoERA seminars (M1, M21 and M39). On request of the project coordinator, the PA will meet via web conferences when needed.

The project coordinator and work package leaders are together organized in a Project Board (PB). The PB governs the day-to-day management of the project and takes decisions related to the execution of tasks and interaction with other projects and stakeholders. The work package leaders are responsible for the on-time realization and reporting of their own deliverables and the effective handling and mitigation of project risks at work package level. They will report the technical and financial progress of their work packages to the project coordinator. The coordinator will compile these contributions into a project progress report and cumulative expenditures report and submit these to the GeoERA Project Monitoring Officer via the prescribed online tools. The PB will meet via web conference at least once a month.

Task leaders coordinate the execution of technical project activities by the project partners. The task leaders will report any issues to their respective work package leader. The PB will decide on how to resolve these issues and, if needed, forward these decisions to the PA.

Internal communication:

The Coordinator will put in place an internal reporting system to ensure the smooth, efficient and cost-effective implementation of the work plan. This reporting system will consist of templates for reporting on work package activities and related costs.

The coordinator will also set-up a project share point to facilitate the transfer of data and administer project results and documents.

Project partners will be regularly informed on the overall project progress and project events by the coordinator and PB. Work package leaders and task leaders will communicate on task-specific and on technical issues.

Quality control and Risk management

Reporting will follow a procedure that includes several verifications involving interactions among partners, the PB and the Coordinator. This method allows delivery of high quality reports providing a very accurate insight on the state of the project. Deliverables and milestones will follow an internal quality control procedure carried out by all partners represented in the project. These procedures will be outlined in detail in the Project Implementation Plan. All deliverables and milestones are subject to final approval by the PA.

The Project Board will closely follow and control the progress of the project and the work done by each partner. Check lists (action database), will follow day-by-day partner contributions and interactions within the WPs in order to ensure project quality. Project risks will be managed using a classical and widely tested process for risk management, aimed at identifying, analysing and prioritizing risks inherent in the project (related to tasks, partners and projects) and then determining the appropriate actions to eliminate or mitigate them.

Some likely critical risks have already been identified in the preparation of this proposal. These are listed in table 3.2b, together with proposed risk mitigation measures.

Conflict resolution:

In case of conflict, the WP leaders will have first responsibility to find an amicable solution, if appropriate in consultation with the project coordinator. In case the conflict cannot be resolved, the WP leader will put the issue forward to the PA and, if needed, to the GeoERA Executive Board and General Assembly.

3.3 Consortium as a whole

Figure 3.3 shows a map of the participating countries and organizations in the project. The map also shows the potential additional extent that can be achieved through the collaboration with other GeoERA projects. These projects either provide fault data (thereby extending the European coverage) or represent practical use cases for the Fault Database.

The project partners cover different regions and geological settings in Europe. This way a comprehensive and representative overview of different sources and use cases is available to the project. The collaboration between NW-European, S-European, NE-European and Central European partners will be an important factor for the development of data frameworks and models that are broadly applicable to all countries of Europe. This is important to ensure the future extension and maintenance of the results.

The partners in the project represent a good mix of organizations that are highly experienced in specific hazards and impacts research and countries that are aiming to advance their experiences in this field. The experienced partners have obtained most of their knowledge from practical national use cases and past collaborations in EU research projects. The exchange of knowledge and broader implementation of state-of-art data sets and methodologies is one of the main aims of the project.

The established databases and methodologies will be tested and implemented in practical use cases involving various stakeholders. Through this approach the project aims to increase the exposure to end-users and to stay aligned with their needs.

The collaboration with other GeoERA project will further increase the exposure and highlight the broader cross-thematic interactions as described by the GeoERA Call for Proposals.

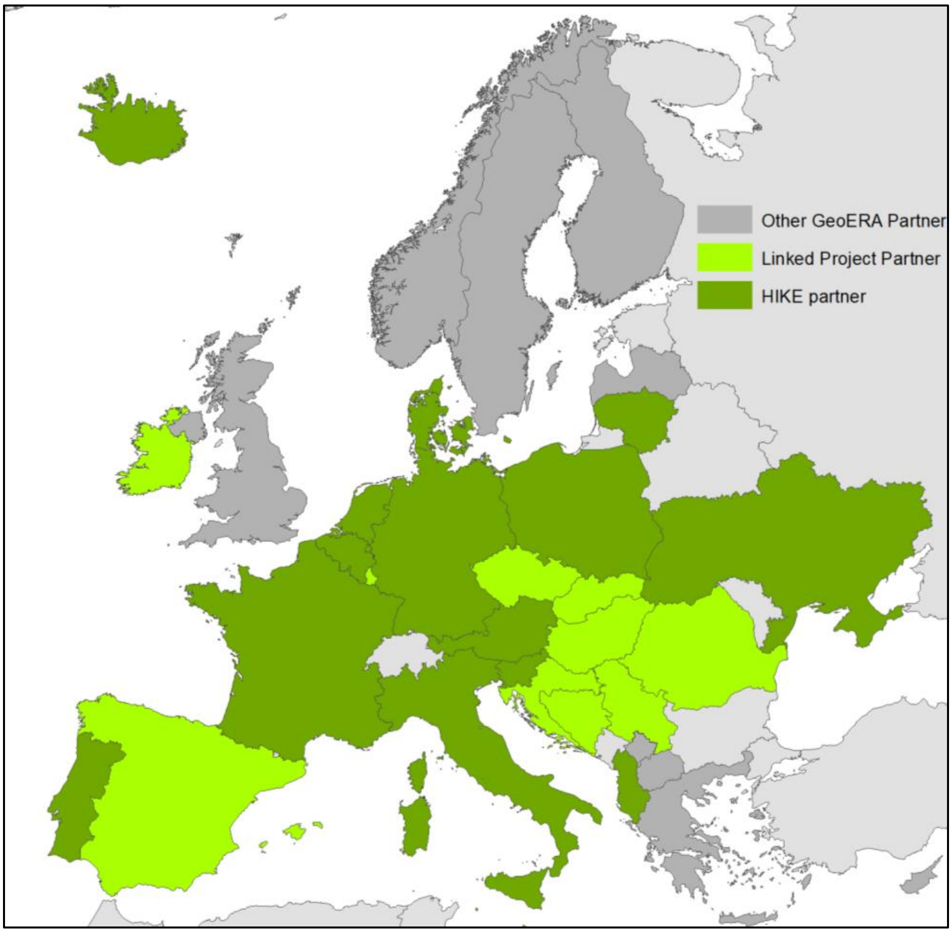

Figure 3.3: Map showing the partner countries participating in HIKE (dark green). The light green countries represent potential added contributions from projects linked to HIKE (i.e. SRT GE2-HOTLIME, SRT GE5: 3DGEO-EU and SRT GE-6: GeoConnect³D). HIKE will engage remaining GeoERA partners for in-kind provision of fault data. To that end, the project will deliver the required guidelines and tools.

3.4 Resources to be committed

This section provides the details on resources committed to the project.

Tables for section 3.1

Table 3.1a) Work package description (This table is **included** in the page limit!)

Please complete the table below for **each** work package:

Work package number	1	Lead beneficiary			TNO	
Work package title	Project Management and Coordination					
Participant number	1	5	6	3		
Short name of participant	TNO	GEUS	BRGM	GBA		
Person months per participant	4	1	1	1		
Start month	1			End month	39	

Objectives

This Work Package is concerned with the overall financial, administrative and operational management of the project, in particular the preparation and implementation of the work plan, the monitoring of project progress and the coordination of obligatory meetings and deliverables as defined by the GeoERA guidelines and Grant Agreement. Specific objectives for WP-1 are:

- Effective, timely and smooth daily management of the project (operating the Project Board, progress monitoring; communication between project partners and between Project Lead and GeoERA Executive Board; financial management; reporting; decision making; conflict management);
- Project representation at obligatory meetings and events (in particular the Kick-off Seminar, Mid-Term Project Review and Final Project Review);
- Organisation of Project Technical Workshops (internal and together with other GeoERA projects)
- Managing interactions with other GeoERA projects (establish cross-cutting and cross-thematic synergies, exchange of data and knowledge)
- Maintenance of the Project Consortium Agreement and ensuring ownership among the participants;
- Management and mitigating project risks including IPR matters.

Description of work

The Project Coordinator (TNO) and WP leads (GEUS, BRGM, GBA) together form the Project Board. This board has the task and responsibility to take decisions regarding the proceedings and

Inform the GeoERA Executive Board, in particular the GeoERA Monitoring and Reporting Officer on project progress and results. Fulfil the relevant obligations that are mentioned in the GeoERA project plan and Grant Agreement with respect to the scientific projects

Task 1.1 – Administrative & Operational Management (M1-36)

Lead: TNO; Contributors: GEUS, BRGM, GBA

The management structure of the project consortium and tasks of the various partners are presented in Chapter 3.2. Task 1.1 will deal with operational management activities including:

- Day-to-day monitoring of project progress (using appropriate tools, such as an Actions database);
- Elaborate the Project Implementation Plan (D1.1)
- Support decision making by the Project Board and/or Project Assembly, and ensure implementation of decisions (D1.2);
- Coordinating the preparation of project progress reports (D1.3a and D1.3b, to be submitted every 18 months through the GeoERA reporting e-tool) and yearly Cumulative Expenditure Reports (D1.4a-c) required by the GeoERA Grant Agreement and the European Commission;
- Risk management (see section 3.2.2);
- Maintenance of the Project Consortium Agreement

Task 1.2 – General Communication & Dissemination (M1-36)

Lead: TNO; Contributors: GEUS, BRGM, GBA (as WP leaders)

- Efficient communication between all project participants through an internal transparent communication and data exchange system
- Coordinate communications between HIKE and the GeoERA Executive Board
- Facilitate interactions with other GeoERA projects and between work packages through the organisation of joint technical workshops (MS-4 and MS-5, together with other GeoERA projects)
- Communicate project information and proceedings to the GeoERA community and external stakeholders, among others by setting up a project website and representating the project in three obligatory GeoERA seminars (MS-1: Kick-off, MS-2: Mid-term review and MS-3: Final review)

Task 1.3 – Project Data Management Plan (M1-6)

Lead: TNO; Contributors: GEUS, BRGM, GBA

This task will prepare the Project Data Management Plan (DMP) (D1.5) covering the data and results relevant for this project. The PDMP will be in line with the requirements and guidelines described in GeoERA deliverable 1.3 – Data Management Plan.

Task 1.4 – Project Communication Dissemination and Exploitation Plan (M1-39)

Lead: TNO; Contributors: GEUS, BRGM, GBA

This task will prepare and maintain the Project Communication, Dissemination and Exploitation Plan (CDEP) (D1.6). The plan will be updated by the Project Board if deemed necessary.

Deliverables / Milestones	
D1.1:	(M2) Detailed Project Implementation Plan
D1.2:	(M1-36) Minutes of Meetings
D1.3a/b:	(M18) Project Progress Report and (M36) Final Project Progress Report
D1.4a/b/c:	(M6, M18, M30) Yearly Cumulative Expenditure Reports
D1.5:	(M6) Project Data Management Plan

D1.6:	(M6) Project Communication, Dissemination and Exploitation Plan
MS-1:	(M1) Kick-Off Seminar (obligatory GeoERA event)
MS-2:	(M21) Mid-Term Project Review (obligatory GeoERA event)
MS-3:	(M39) Final Project Review (obligatory GeoERA event)
MS-4:	(Indicative M9/M10) technical workshop 1, planned together with other GeoERA projects
MS-5:	(Indicative M27/M28) technical workshop 2, planned together with other GeoERA projects

Work package number	2		Lead beneficiary				TNO			
Work package title	Fault Database Development									
Participant number	1	2	3	4	5	6	7	8	9	10
Short name of participant	TNO	AGS	GBA	RBINS GSB	GEUS	BRGM	BGR	LBGR	LAGB	LfU
Person months per participant	19,5	29	22	1,75	0,5	1	1,5	3	2,5	12
Participant number	11	12	13	14	15	16	17	18	19	
Short name of participant	ISOR	ISPRA	SGSS	ARPAP	LGT	PIG-PIB	LNEG	GEOZS	GEOIN FORM	
Person months per participant	1	9,5	2,5	0,5	2,5	6	13	7	0,34	
Start month	1						End month		36	

Objectives

Work Package 2 will focus on the development, demonstration and implementation of a 3D Fault Database (FDB) that is intended to underpin hazard and impact assessment across Europe as well as various other research areas/disciplines that rely on harmonized fault information. The principal scale of application in HIKE will be regional (national) to Pan European. The envisioned FDB should however also anticipate future application at more local (reservoir) scales. Results are considered for peer review publication.

The specific goals for WP-2 are:

- To establish uniform and widely applicable specifications and novel methods for fault characterization, based on practical use-case requirements that are identified from different areas and settings across Europe.

- The collect, process, harmonize and centrally store publicly available national and transnational fault information repositories into the established FDB architecture. The sources are primarily based on project partner contributions and inputs from associated GeoERA projects (in particular GE2-HotLime, GE5-3DGEO-EU and GE6-GeoConnect³D). The project will pursue the inclusion of additional repositories from non-participating countries and other GeoEnergy/GroundWater/Raw Minerals projects through the distribution of a common, open-source upload tool.
- To demonstrate the applicability of the FDB in various applied use cases. Partly these use cases are linked to other GeoERA projects (in particular GE2-HotLime and GE6-GeoConnect³D). Other use cases will be specified during the project execution.
- To deploy and disseminate the end results via the GeoERA Information Platform. The project will engage stakeholders and end users in order to increase the exposure of the FDB and to improve the practical applicability.

Description of work

Task 2.1: Fault Database Specifications

Lead TNO; Contributors: RBINS-GSB, BGR, LBGR, LAGB, LfU, ISPRA, SGSS, ARPAP, PIG-PIB, LNEG, LGT, GEOZS, GEOINFORM, GBA

Specification of a common and uniform European fault data model and the associated functional requirements of the FDB. These specifications will be determined by a desk study from various practical use cases, stakeholder requirements and an inventory of GSO experiences including prototypes from TNO (Netherlands), GBA (Austria) and the Central European GeoMol project. The specifications will be published in a scientific fault parameterization catalogue (D2.1a/b) and will be translated into technical database requirements by WP-5 (D5.1a), which are handed over to the GeoERA-IP project development team. The catalogue will incorporate the contents for a Semantics Web Service that is associated with the FDB. These semantics are needed to interlink information from heterogeneous sources based on common vocabulary and scientific terms

Task 2.2: Fault Data Collection

Lead TNO; Contributors: All project partners

Collection, processing and harmonization of fault data from various public repositories across Europe:

- Project partner archives and repositories
- Associate GeoERA projects (collaboration agreement)
- Archives and repositories from non-participating institutions

The collected fault data will be evaluated, standardized and processed into a format that is compatible with the established FDB data model (conform D2.1a/b and D5.1a). The harmonization will, among others, be achieved through the use of a common procedures and guidelines that will be delivered by the GeoERA-IP project through WP-5 (D5.2b). The collected and standardized data will be uploaded to and centrally disclosed via the GeoERA Information Platform (D2.5) and reported in a data collection report (D2.2a/b)

Task 2.3: Advanced Fault Characterization

Lead GBA; Contributors: ARPAP, LNEG, LfU

- Development and test of novel methods to derive advanced fault parameters from multiple geophysical data sets, such as airborne geo-magnetics and geo-electrics, potential field data, Satellite based imagery (SAR – Synthetic Aperture Radar), and shear wave seismic reflection data.

- Improved fault characterization may include, but are not restricted to subsurface continuation of faults covered in sedimentary basins, identification of hidden faults or faults with a small throw, width of fault zones at depth.
- Calibration of obtained results by independent methods, such as shallow geophysical methods, borehole data.
- Testing comparability of state-of-art fault parameterization for Austria, Portugal and possible other regions (e.g. Bavaria-Germany) with older geophysical data will form the basis for assessing the quality of older data and models as well. This could contribute to the quality factor for an entry in the fault database.
- Report the results and methodology (D2.3)

Task 2.4: Fault Database Demonstration and Implementation

Lead TNO; Contributors: RBINS-GSB, LBGR, LAGB, LfU, ISPRA, SGSS, ARPAP, PIG-PIB, LNEG, LGT, GEOZS, GEOINFORM, BRGM

The project will demonstrate the functionality, applicability and added value of the FDB in various practical use cases. These include implementations of the FDB and its contents in other projects in GeoERA (among others GE2-HotLime and GE6-GeoConnect³D) as well as use cases and analyses that will be defined and elaborated in the project (definition before M18 and elaboration/reporting before M36). The results will be summarized in a bundled case study report (D2.4) describing the implementation approach, effectiveness of the FDB and recommendations for improvement and broader implementation.

The FDB will allow for links with other third-party tools that rely on fault data input. To that end WP-5 will deliver a practical guidelines in conjunction with the Information Platform.

Deliverables / Milestones

D2.1a/b: (M9) Draft Fault Data Characterization Catalogue (report and digital link with online database) based on scientific use case specifications, and (M36) Final Fault Data Characterization Catalogue. This includes the definition of common scientific terms for the Semantics Web Server

D2.2a/b: (M17) an intermediate draft fault data collection report and (M36) a final fault data collection report describing the contents of the populated FDB with standardized and processed fault data embedded in the GeoERA Information Platform. The final fault data collection report also includes a country data evaluation and a European geological/statistical analysis and evaluation of the database contents (quality, extent, scale, applicability for research).

D2.3 (M36) Report on characterization results/methods, the quality of derived fault information, comparability of fault information originating from various locations/vintages/measurements, and future recommendations for advanced determination of fault parameters based on potential field and seismic reflection data.

D2.4: (M36) A bundled report on specific studies, test cases and projects in which the information from the FDB has been implemented. This report will describe and evaluate the implementation approach, the application results, the effectiveness of the FDB practical applications, and recommendations for improvement and broader implementation.

D2.5: (M33) All fault data (geometries, static and dynamic parameters) collected by the partners and external projects, embedded in the fault database framework established by the GeoERA IP project (interaction through WP-5)

MS-9: (M31) End of fault data collection, start for final processing and reporting

Work package number	3		Lead beneficiary		GEUS				
Work package title	Hazard and Impacts Method Development								
Participant number	1	5	6	11	12	14	15	16	19
Short name of participant	TNO	GEUS	BRGM	ISOR	ISPRA	ARPAP	LGT	PIG-PIB	GEOINF ORM
Person months per participant	6,5	11,5	4	4	5	4	1	15	0,34
Start month	1			End month		36			

Objectives

Work Package 3 presents a series of tasks that focus on the development of novel methodologies as well as on the investigation of local and regional case studies related to hazards and their impacts. The methodologies and case studies will address various sensitive mechanisms (e.g. seismicity, subsidence, fluid migration, sealing & leakage, etc.) in different geological settings. All cases with a common objective of evaluating how the collected fault data and characteristics (WP-2) may be used to assist, improve or validate the assessment of such mechanisms.

The specific objectives for WP-3 are to:

- Establish novel techniques that will serve of basis for hazard and impact assessment, and test these techniques in practical use cases across Europe. These cases involve different geological settings and subsurface utilizations.
- Evaluate the added-value of fault information collected in WP-2 for improving or validating novel and existing hazard and impact assessment approaches
- Exchange and compare assessment approaches and information uses between different case studies in HIKE and in other GeoERA projects, which focus on the investigation of induced hazards and impacts.

WP3 will benefit significantly from existing European infrastructures such as EPOS, EMSC and ORFEUS.

Description of work

Task 3.1: Advanced localization of seismicity events in Europe; Denmark, Netherlands and Iceland case study (GEUS, TNO, BRGM, ISOR)

Lead GEUS; Contributors: TNO, BRGM, LNEG, ISOR, LGT

- Compile existing information on seismic monitoring network in Europe and the velocity models used by the agencies for earthquake location.
- Detect areas where the uncertainties in earthquake location are mostly due to unreliable and poorly constrained seismic velocity models, and where new available data (geo-models, seismometers, well logs, tomographic studies, etc.) are likely to improve these models.
- Generate and apply enhanced seismic velocity models, both 1D and 3D, in case-study areas and demonstrate their impact to reducing earthquake location errors in these areas.

- Where possible obtain source parameters such as focal mechanism and magnitude to argue the causality concerning the regional/local stress field, existing fault structure and origin.
- Explore possibilities for off-shore monitoring of induced seismicity near production sites.
- Compare and validate the outcomes of this technology with mapped faults locations and characteristics and assess options to further narrow down the sources that trigger seismic events.
- Summarise the novel approaches and models from these case study areas into a new state of the art for earthquake location and monitoring in Europe, and to recommend future improvements that will enable their dissemination to other regions of Europe
- Consider and prepare a peer-review publication

The task interlinks with Task 3.2 (evaluation of methodologies for induced subsidence assessment, Po Basin case study), Task 3.3 (development and application of novel methods for reservoir sealing assessment; Poland case study), Task 3.4 (evaluation of seismic risk in CO2-injection, Rousse case study area).

Task 3.2: Evaluation of methodologies for induced surface displacements; Po Basin case study

Lead ISPRA; Contributors: ARPAP, BRGM, GEUS, PIG-PIB

- Description of the methodologies applied at national level in Italy for monitoring subsidence induced by fluid exploitation plants, and for assessing induced and/or triggered seismicity (dissemination of knowledge);
- Explanation of the limitations still not overcome by the applied technologies in quantitative absolute estimation of ground motion (through a description of a case study in the Po basin) and demonstration of the need of an affordable national and supra-national calibration system for PS-InSAR (Persistent Scatterers Interferometry by Synthetic Aperture Radar) displacement estimation;
- Description of the Italian PS Journal project (in progress), part of the Space Economy National Plan, aimed at producing services based on PS-InSAR and DS-InSAR (Distributed Scatterers Interferometry by Synthetic Aperture Radar) techniques and of the Copernicus initiative called EU Ground Motion Service (dissemination of knowledge);
- Identification and description of a study-area in the Po Plain region according to data availability (fault and ground motion data), where to analyse and compare tectonic deformation trend with ground motion data, in order to show the effectiveness of integrating information on ground deformation with the fault database.
- Application of the PS-InSAR technique over Piemonte region as a tool to assess the present-day crustal mobility that could correlate with the active faults distribution
- Recommendations for the utilisation of InSAR images on the CCS case study in Rousse, France (task 3.4).

This task interlinks with Task 3.1 (localization of seismic events), Task 3.4 (assessment of seismicity and safety in storage; Rousse, France), and WP2 (location and characterization of faults)

Task 3.3: Development and application of novel methods for reservoir sealing assessment; Poland case study

Lead PIG-PIB; Contributors: BRGM, TNO, GEUS

- Establish the data sets and parameters necessary for a reliable evaluation of formation sealing, including the applicability and effectiveness of fault data collected in the Fault Database (WP2)
- Apply state-of art sealing assessment methodologies (petroleum industry) on a case study area in northern Poland, using the assembled information from the local site as well as the fault database.
- Evaluate the seismicity and detection threshold for the case study area using advanced localization of seismicity events techniques (Task 3.1)
- Evaluate the applied methods and datasets and recommend best practices and standards for future data collection and sharing

This task interlinks with Task 3.1 (localization of seismic events), Task 3.4 (assessment of seismicity and safety in storage; Rousse, France), WP2 (location and characterization of faults)

Task 3.4: Assessment of seismicity and safety in storage; Rousse case study

Lead BRGM; Contributors: PIG-PIB, GEUS, ISOR

The main challenge facing onshore CCS is to ensure long-term safety of the CO2 storage. Among any industrial/technological risks, leakage and induced seismicity are main risks concerning CCS. The primary paths for leakage can be, among others, improper installation and/or abandoned wells and undiscovered geologic discontinuities such as faults. Faults reactivation by the injection of CO_2 may also induce seismicity. The objective of this case study is the assessment of distinct geological hazard in a safety CCS operation. Methodologies employed on tasks 3.1, 3.2 and 3.3 will be applied here in order to improve the evaluation of seismicity (induced?) in the area and the safety sealing of the reservoir. Concretely proposed actions are:

- To map faults and stress based on literature studies and to assess fault influence (location and characteristics) in the area of CO_2 storage, and the role of faults in safety storage in the area of injection well. These data will integrate FDB (WP2).
- To evaluate subsidence/ground deformation hazard based on fault and stress maps, processed InSAR images and recommendations from Task 3.2.
- To evaluate seismic events (from ~1980 to now) coupled to injection information in order to estimate the probability of induced seismic events
- Evaluation of seismicity location and magnitude detection threshold for the case study area using techniques from Task 3.1
- Evaluation of applicability of a Traffic Light System for mitigation of induced seismicity.

This task interlinks with Task 3.1 (localization of seismic events), and WP2 (location and characterization of faults)

Deliverables

D3.1: (M17) Intermediate report specifying the concrete interaction scenarios to be investigated between WP-3 case studies and the Fault Database contents

D3.2: (M36) Final case study report on improved localization of seismic events, Denmark, Netherlands, Iceland, including recommendations for improved monitoring and localization of seismic events in other regions of Europe.

D3.3: (M36) Final case study report on surface deformation assessment techniques, Po Basin area, Italy

D3.4: (M36) Final case study report on improved assessment of reservoir seals, Poland

D3.5: (M36) Final case study report on geological hazards and safety of subsurface injection, Rousse, France

Work package number	4			Lead beneficiary					BRGM	
Work package title	Hazards and Impacts Knowledge									
Participant number	1	2	3	4	5	6	7	8	9	10
Short name of participant	TNO	AGS	GBA	RBINS GSB	GEUS	BRGM	BGR	LBGR	LAGB	LfU
Person months per participant	6,25	1	1	0,25	1	6			0,5	
Participant number	11	12	13	14	15	16	17	18	19	
Short name of participant	ISOR	ISPRA	SGSS	ARPAP	LGT	PIG-PIB	LNEG	GEOZS	GEOIN FORM	
Person months per participant	1	1	0,5	0,5	0,5	15	2	0,5	0,8	
Start month	1						End month		36	

Objectives

Different practices/methodologies and information sources are employed at different GSO's and in various settings across Europe for the assessment of hazards induced by subsurface exploitation, as well as the assessment of hazard impacts on human, environment and economy. These methodologies and information are essential for the management and planning of subsurface use, for answering question to decision-makers, for advancing the state of the art of a given methodology and for facilitating societal awareness in the understanding of induced hazards. Sharing, managing and setting together this information is a challenge, as data is heterogeneous, complex and originated from distinct sources with different contents, details and/or materials.

The specific objectives for WP-4 are to:

- Improve the exchange of information and knowledge used in hazard and impact research, based on a synthesis of methods and sources applied on WP2 and WP3
- Implement a data management strategy to identify, store and integrate data resulting from case studies carried out at the geological surveys of Europe
- To provide recommendations for improving the implementation of hazard and impacts research results at various stakeholders

Description of work

Task 4.1. Synthesis and Recommendations

Lead BRGM / PIG-PIB; Contributors: All partners

- To establish a synthesis of existing practices, methods and data sources applied and developed in WP2 and WP3, which are aimed at assessing hazard and impacts induced by subsurface exploitations.
- To evaluate the common and different approaches for hazard assessment and impact reduction.
- To establish recommendations for improved implementation of geological survey research results at stakeholders
- Evaluate how national geoscience activities/stakeholders can benefit from HIKE research/results and how it (may) link to European and national settings.
- To recommend improvements to the continuity of the development and implementation of new knowledge, focus for future follow-up collaboration and data exchange between partners.

Task 4.2. Knowledge and Data Share Point

Lead BRGM; Contributors: TNO, GBA

Evaluate functional specifications and requirements for managing and sharing outcomes of WP2 and WP3 with other surveys and external stakeholders

Establish a common hazard and impact semantics database that can be used for categorizing and interlinking heterogeneous information generated from case study results

Implement the above data repository elements in EGDI (in conjunction with WP-5: IP Interface)

Deliverables

D4.1: (M36) Final project synthesis, recommendations and best practices report. This report summarizes all results and individual partner experiences from WP2 and WP3 activities and places these in the broader context of the induced hazards and impacts topic, e.g.:

- Lessons learnt from the case studies and the established knowledge and data repositories
- Incorporation of, and comparison with other case studies that are known from geological survey records or other references.
- Recommendations on how to expand the implementation of developed approaches and datasets to other geological surveys and stakeholders in Europe
- Identified knowledge gaps that are relevant to Europe and its Member States, and how to address these gaps based on the experiences of this project
- How to continue and extend the future collaboration on induced hazards and impacts research between the European Geological Surveys and other science institutes.

D4.2: (M17) Scientific specifications and requirements for the hazards and impacts data share point and definitions for the Semantics Web service

D4.3: (M36) Final data and knowledge share point report providing an overview and scientific evaluation of the contents as well as recommendations for their future extension, maintenance and application.

Work package number	5	Lead beneficiary		GBA	
Work package title	Information Platform Interface				
Participant number	1	3	6	10	12	
Short name of participant	TNO	GBA	BRGM	LfU	ISPRA	
Person months per participant	3,5	8	0,5	1	1	
Start month	1			End month	36	

Objectives

The objective of this work package is to govern the interactions with the GeoERA-IP project and to execute the parts of the Project Data Management Plan relating to IP and EDGI. To this end WP 5 will be responsible for communicating the project information platform requirements to GeoERA-IP and vice versa ensure that the guidelines and standards provided by GeoERA-IP are properly implemented in the WP-2 and WP-4 processes.

Description of work

Task 5.1 FDB support:

Lead GBA/TNO; Contributors: LfU, ISPRA

- Provision of the technical FDB requirements (deliverable D5.1a) based on the scientific specifications from WP2 This will be done in close cooperation with appointed IP experts
- Implementation of the guidelines and procedures (part of D5.2a) that must be followed by data providers in order to harvest or link their fault data into the FDB. These guidelines and procedures are established by the GeoERA-IP project. WP-2 will take care of any processing and harmonization tasks in order to ready the data for upload. Fault information shall in general reside at the local institutes and will then be live-linked to the central FDB using a common data harvesting system.
- Implement the procedures for accessing information from the FDB and provide technical support to WP-2 data collection. The procedures will be developed by the GeoERA-IP project. The implementation will take place in selected case studies. The procedures will be reported in an end-user manual (part of deliverable D5.2)

Task 5.2 Knowledge Share Point Support

Lead GBA/BRGM; Contributors: TNO

- Provision of the technical data repository requirements (deliverable D5.1b) based on the scientific specifications from WP4. This will be done in close cooperation with appointed IP experts.
- Technically assist with the inclusion/upload of information in the knowledge base, based on the GeoERA-IP prescribed guidelines and procedures (deliverable D5.2b).
- Implement the procedures for accessing information from the Knowledge Database and provide

technical support to WP4 Task 4.2. The procedures will be developed by the GeoERA-IP project. The implementation will take place in select case studies. The procedures will be reported in an end-user manual (part of D5.2b)

Task 5.3 Project Data Management Plan - Implementation

Lead GBA; Contributors: TNO

- Evaluate the final implementation and dissemination of the data via the GeoERA Information Platform, as an outcome of the Data Management Plan. This includes conclusions and recommendations on the future technical maintenance and use of the project results (D5.3)

Deliverables

D5.1a/b: Technical requirements for the Fault Database (M6) and the knowledge share point (M12) as input to the GeoERA-IP development team

D5.2a/b: (M24) Draft User Manual and (M36) Final User Manual describing data processing guidelines and procedures for the FDB and the knowledge share point, and how to access/link the data/database to client applications

D5.3: Final Project Data Management Implementation report and recommendations on the future maintenance, update and dissemination of the project results in the GeoERA Information Platform.

MS-6: (M7) Start of the Fault Database architecture development in the GeoERA Information Platform (by the GeoERA IP project team)

MS-7: (M13) Start of the Knowledge/data share point architecture development in the GeoERA Information Platform (by the GeoERA IP project team)

MS-8: (M25) Functional implementation of the final FDB and Knowledge Share Point data architecture in the GeoERA Information Platform

Table 3.1b) List of work packages (This table is not covered by the page limit)

Work package No.	Work Package Title	Lead Participant No.	Lead Participant Short Name	Person - Months	Start Month	End month
1	Project Management and Coordination	1	TNO	7	1	36
2	Fault Database Development	1	TNO	135,09	1	36
3	Hazards and Impacts Method Development	5	GEUS	51,34	1	36
4	Hazards and Impacts Knowledge Base Development	6	BRGM	37,80	1	36
5	Information Platform Interface	3	GBA	14	1	36
			Total person - months	245,23		

Table 3.1c) List of deliverables (This table is not covered by the page limit)

Deliverable number	Deliverable name	Work package number	Short name of lead participant	Type	Dissemi-nation level	Delivery date (in months)
D1.1	Project Implementation Plan	1	TNO	R	CO	2
D1.2	Minutes of Meetings	1	TNO	R	CO	1 - 36
D1.3a	Project Progress Report	1	TNO	R	CO	18
D1.3b:	Final Project Progress Report	1	TNO	R	CO	38
D1.4a	Cumulative Expenditure Report 2018	1	TNO	R	CO	6
D1.4b	Cumulative Expenditure Report 2019	1	TNO	R	CO	18
D1.4c	Cumulative Expenditure Report 2020	1	TNO	R	CO	30
D1.5:	Project Data Management Plan	1	TNO	R	CO	6
D1.6:	Project Communication, Dissemination and Exploitation Plan	1	TNO	R	CO	6
D2.1a:	Draft Fault Data Characterization Catalogue	2	TNO	R	CO	15
D2.1b:	Final Fault Data Characterization Catalogue	2	TNO	R	PU	36
D2.2a:	Mid-term fault data collection report	2	TNO	R	CO	17

D2.2b:	Final fault data collection report and database	2	TNO	R/data	PU	36
D2.3:	Final report on fault characterization and data	2	TNO	R/data	PU	36
D2.4:	Final report on FDB application and evaluation	2	GBA	R	PU	36
D2.5	Fault data collected by partners embedded in the Fault database, as developed by the GeoERA Information Platform	2	TNO	R/data	PU	33
D3.1	Mid-term report on definition of integrated case scenarios in WP3	3	GEUS	R	CO	17
D3.2:	Final case study report on improved localization of seismic events, Denmark, Netherlands, Iceland	3	GEUS	R	PU	36
D3.3:	Final case study report on subsidence assessment techniques, Po Basin area, Italy	3	ISPRA	R	PU	36
D3.4:	Final case study report on improved assessment of reservoir seals, Poland	3	PIG-PIB	R	PU	36
D3.5	Final case study report on seismicity and safety of subsurface injection, Rousse, France	3	BRGM	R	PU	36
D4.1:	Final project synthesis, recommendations and best practices report	4	BRGM	R	PU	36
D4.2:	Scientific specifications and requirements for the hazards and impacts data share point and definitions for the Semantics Web service.	4	BRGM	R	PU	17
D4.3	Final data and knowledge share point implementation and report	4	BRGM	R/data	PU	36
D5.1a:	Technical IP requirements of the Fault Database (in EGDI)	5	GBA/ TNO	R	CO	12
D5.1b:	Technical IP requirements of the knowledge share point (in EGDI)	5	GBA/ BRGM	R	CO	12
D5.2a:	Draft user manual for the Fault Database and the knowledge share point	5	GBA/ TNO	R	CO	24
D5.2b	Final user manual for the Fault Database and the knowledge share point	5	GBA/ BRGM	R	PU	36
D5.3	Final Project Data Management Implementation report	5	GBA	R	PU	36

Tables for section 3.2

Table 3.2a) List of milestones (This table is not covered by the page limit)

Milestone number	Milestone name	Related work package(s)	Due date (in months)	Means of verification
M1	Kick-off Seminar	1-5	1	Project started, Project work plan updated
M2	Mid-Term Project Review	1-5	21	Project progress Report (D1,2a)
M3	Final Project Review	1-5	39	Final Project progress Report (D1,2b)
M4	Technical workshop 1, planned together with other GeoERA projects	1-5	Indicative M9 / M10	Workshop proceedings
M5	Technical workshop 2, planned together with other GeoERA projects	1-5	Indicative M27 / M28	Workshop proceedings
M6	Start of Fault Database development and testing in EGDI (by GeoERA IP project)	2, 5	7	Technical requirements delivered to GeoERA IP project (D5.1a)
M7	Start of Knowledge Share Point development and testing in EGDI (by GeoERA IP project)	4, 5	13	Technical requirements delivered to GeoERA IP project (D5.1b)
M8	Start linking and harvesting of fault data and hazard/impact documents/data in EGDI	2,4, 5	25	Functional implementation of the FDB and Knowledge Share Point data architecture in EGDI
M9	End of fault data collection for final processing and reporting	2	31	Populated Fault Database online and functional/accessible for end users

Table 3.2b) List of critical risks for implementation (This table is not covered by the page limit)

Description of risk (indicate level of likelihood: Low/Medium/High)	Work package(s) involved	Proposed risk-mitigation measures
Medium: One or more of the projects involved in delivering fault data are not awarded for funding	WP 2	Medium impact (reduced coverage). The project already incorporates enough partners for a minimum required set of fault data and for developing and populating the database framework. HIKE will attempt to engage non-partner organisations to link their fault data available from national mapping programmes
Low: IP proposal is not awarded funding	All GeoERA projects	Major impact. Funding set aside for the Information Platform could flow back to the other themes. Decision on appropriate action then lies with the General Assembly of GeoERA. Partners will investigate measures to proceed with alternative available database solutions
Low: Poor engagement of some project partner and incomplete information on work status and IPR	WP 1-5	Major impact. Proactive and continuous management of partner relations. Appropriate communication management
Low: Biased or inconsistent approach – Partners not following standards and guidelines set	WP 2-5	Effective internal communication measures in WP1; active involvement of all partners in defining specifications, methods and scope.
Low: Loss of key project personnel, incomplete or bad performance, loss of direction/scope of project	WP 1-5	Minor – Major impact. Quick detection of issues and mitigation by PB. The organisations with major roles in this project are substantial and have in-depth expertise. Shared responsibilities within WPs and Tasks provide stability in case of unexpected key project personnel loss.
Low: Deliverables and Milestones not realized on time leading to delays in project through domino effect	WP 1-5	Medium – Major impact. Day-to-day communication between coordinator and WP leaders as well as between WP-leaders and Task leaders. Monitor project progress through an action database. Timely mitigating actions. Resolve major issues with PA involvement.
Low: Delayed start of activities; shift of activities in the plan; potential prolongation of the project	WP 1-5	Major impact. The GeoERA coordination prescribes obligatory Kick-Off and Mid-Term events which will help to keep the project on schedule. The PB and PA will consider mitigating actions in the PIP in order to get back on schedule
Low: Poor engagement with other GeoERA projects – incomplete feedback on mutual demands and expectations (e.g. late delivery or inability to deliver by GeoERA IP-project)	WP 2-5	Major impact. Many upfront discussions have taken place with the IP platform and other projects. Cooperation and communication with other projects is a core task of the PB and project partners. Through the GepoERA Grant Agreement a solid basis for cooperation and solving conflicts has been established. If needed, alternative

		available database solutions will be considered
Low: IPR issues – lack of agreement in intellectual property rights	WP 1	Major Impact: Clear IPR Agreements made in the GeoERA CA, which covers both overall GeoERA project and individual transnational projects. Project Data Management Plan (WP1) and specific programme component dedicated to data management.
Low: Other issues	WP 1-5	Minor to Major: Project partners are experienced in working together in projects. Major partners are experienced in EU project management. Issues will be resolved on a partner to partner basis. If needed, the PB or PA will decide on a solution.

Table 3.3a) Summary of Staff Effort (This table is not covered by the page limit)

	WP-1	WP-2	WP-3	WP-4	WP-5	Total Person- Months per Participant
1 / TNO	4	19,5	6,5	6,25	3,5	39,75
2 / AGS	0	29	0	1	0	30
3 / GBA	1	22	0	1	8	32
4 / RBINS-GSB	0	1,75	0	0,25	0	2
5 / GEUS	1	0,5	11,5	1	0	14
6 / BRGM	1	1	4	6	0,5	12,5
7 / BGR	0	1,5	0	0	0	1,5
8 / LBGR	0	3	0	0	0	3
9 / LAGB	0	2,5	0	0,5	0	3
10 / LfU	0	12	0	0	1	13
11 / ISOR	0	1	4	1	0	6
12 / ISPRA	0	9,5	5	1	1	16,5
13 / SGSS	0	2,5	0	0,5	0	3
14 / ARPAP	0	0,5	4	0,5	0	5
15 / LGT	0	2,5	1	0,5	0	4
16/ PIG-PIB	0	6	15	15	0	36
17 / LNEG	0	13	0	2	0	15
18 / GeoZS	0	7	0	0,5	0	7,5
19 / GEOINFORM	0	0,34	0,34	0,8	0	1,48
Total Person Months	7	135,09	51,34	37,80	14	245,23

Table 3.3b) 'Other direct cost' items (travel, equipment, other goods and services)

(This table is not covered by the page limit)

Please complete the table below for each participant.

1 TNO	Cost (€)	Justification
Travel	14.000,00	Participation at technical workshops and seminars
Equipment		
Other goods and services	2.000,00	Costs related to dissemination
Total	16.000,00	

2 AGS	Cost (€)	Justification
Travel	2.000,00	Participation in project and WP meetings.
Equipment	5.000,00	Hardware, software licenses and consumables (according to administrative depreciation rules)
Other goods and services		
Total	7.000,00	

3 GBA	Cost (€)	Justification
Travel	5.400,00	Travel, participation at project coordination meetings, workshops and events
Equipment		
Other goods and services		
Total	5.400,00	

4 RBINS-GSB	Cost (€)	Justification
Travel	879,25	Additional travel expenses for the HIKE project. Attendance of start, mid-term and final GeoERA meetings by the GSB-RBINS is guaranteed through other means.
Equipment		

Other goods and services		
Total	879,25	

5 GEUS	Cost (€)	Justification
Travel	7.200,00	Travel, participation at project coordination meetings, workshops and events
Equipment		
Other goods and services		
Total	7.200,00	

6 BRGM	Cost (€)	Justification
Travel	3.470,98	Travel, participation at project coordination meetings, workshops and events
Equipment		
Other goods and services		
Total	3.470,98	

7 BGR	Cost (€)	Justification
Travel	2.700,00	Participation in project and WP meetings. These include also GeoERA events.
Equipment		
Other goods and services		
Total	2.700,00	

8 LBGR	Cost (€)	Justification
Travel	2.500,00	Travel costs and expenses of 1 persons for annual project meetings on location in Europe, plus WP meetings

Equipment	1.750,00	Hardware, software licenses and consumables (according to administrative depreciation rules)
Other goods and services	3.150,00	according to technical/administrative operating expenses and depreciation rules
Total	7.350,00	

9 LAGB	Cost (€)	Justification
Travel	5.062,50	Flat charge of other direct costs in the federal administration (BMF II A 3 – H 1012-10/07/0001:013)
Equipment		
Other goods and services		
Total	5.062,50	

10 LfU	Cost (€)	Justification
Travel	8.000,00	Travel, participation at project workshops
Equipment		
Other goods and services		
Total	8.000,00	

11 ISOR	Cost (€)	Justification
Travel	10.000,00	Travel, participation at project workshops and events
Equipment		
Other goods and services		
Total	10.000,00	

12 ISPRA	Cost (€)	Justification

Travel	7.025,00	Travel costs and expenses of 2 persons for annual project meetings on location in Europe, plus 1/2 other meetings, plus WP meetings
Equipment	2.000	Hardware (according to depreciation rules)
Other goods and services		
Total	9.075	

13 SGSS	Cost (€)	Justification
Travel	1.134,90	Travel costs and expenses of 2 persons for annual project meetings on location in Europe
Equipment		
Other goods and services		
Total	1.134,90	

14 ARPAP	Cost (€)	Justification
Travel	2.456,00	Travel costs and expenses of 3 persons for annual project meetings on location in Europe
Equipment		
Other goods and services		
Total	2.456,00	

15 LGT	Cost (€)	Justification
Travel	2.400,00	Travel costs and expenses for annual Project and WP meetings.
Equipment		
Other goods and services		
Total	2.400,00	

16 PIG-PIB	Cost (€)	Justification
Travel	15.000,00	Travel costs and expenses of participation in project meetings, knowledge exchange workshops, and conferences in Europe, estimated for 3 travels per year for 2 persons
Equipment		
Other goods and services		
Total	15.000,00	

17 LNEG	Cost (€)	Justification
Travel	5.000,00	Travel costs and expenses of 2 persons for annual project meetings on location in Europe
Equipment		
Other goods and services	2.832,75	
Total	7832,75	

18 GEOZS	Cost (€)	Justification
Travel	3.000,00	Travel costs and expenses of 1 person for 3 project meetings on location in Europe
Equipment		
Other goods and services		Acquire new field data
Total	3.000,00	

19 GEOINFORM	Cost (€)	Justification
Travel	3.000,00	Participation of 1 person in 3 project meetings (kick-off, mid-term, and final), EUR 1000 each
Equipment		
Other goods and services		
Total	3.000	

Table 3.3c) Financial table with requested budget (This table is not covered by the page limit)

Participant	(A) Direct personnel costs (EUR)	(B) Other direct costs; travel, equipment, infrastructure, other (EUR)	(C) Direct costs of sub-contracting (EUR)	(D) Indirect costs (= (A + B) *0,25) (EUR)	(E) Total estimated eligible costs (=A+B+C+D) (EUR)	(F) Reimburse-ment Rate (29,7%)[2]	(G) Requested EU contribution (=E*F)	(H) Surveys in-kind contribution = (E – G)
TNO	€ 248.869,23	€ 16.000,00		€ 66.217,00	€ 331.086,23	29,7%	€ 98.332,70	€ 232.753,53
AGS	€ 21.000,00	€ 7.000,00		€ 7.000,00	€ 35.000,00	29,7%	€ 10.395,00	€ 24.605,00
GBA	€ 172.800,00	€ 5.400,00		€ 44.550,00	€ 222.750,00	29,7%	€ 66.156,75	€ 156.593,25
RBINS-GSB	€ 17.585,06	€ 879.25		€ 4,616.08	€ 23,080.39	29,7%	€ 6,854.88	€ 16,225.51
GEUS	€ 106.598,00	€ 7.200,00		€ 28.449,50	€ 142.247,51	29,7%	€ 42.247,51	€ 100.000,00
BRGM	€ 69.419,59	€ 3.470,98		€ 18.222,64	€ 91.113,21	29,7%	€ 27.060,62	€ 64.052,59
BGR	€ 9.647,57	€ 2.700,00		€ 3.086,89	€ 15.434,46	29,7%	€ 4.584,03	€ 10.850,42
LBGR	€ 17.542,50	€ 7.350,00		€ 6.223,13	€ 31.115,63	29,7%	€ 9.241,34	€ 21.874,28
LAGB	€ 16.065,90	€ 5.062,50		€ 5.282,10	€ 26.410,50	29,7%	€ 7.843,92	€ 18.566,58
LfU	€ 84.500,00	€ 8.000,00		€ 23.125,00	€ 115.625,00	29,7%	€ 34.340,63	€ 81.284,37
ISOR	€ 102.000,00	€ 10.000,00		€ 28.000,00	€ 140.000,00	29,7%	€ 41.580,00	€ 98.420,00
ISPRA	€ 90.750,00	€ 9.075,00		€ 24.956,25	€ 124.781,25	29,7%	€ 37.060,03	€ 87.721,22
SGSS	€ 11.349,00	€ 1.134,90		€ 3.120,98	€ 15.604,88	29,7%	€ 4.634,65	€ 10.970,23
ARPAP	€ 24.567,50	€ 2.456,70		€ 6.756,05	€ 33.780,25	29,7%	€ 10.032,73	€ 23.747,52
LGT	€ 2.4676,68	€ 2.400,00		€ 6.769,17	€ 33.845,858	29.7%	€ 10.052,22	€ 23.793,63
PIG-PIB	€ 72.000,00	€ 15.000,00		€ 21.750,00	€ 108.750,00	29,7%	€ 32.298,75	€ 76.451,25
LNEG	€ 56.767,25	€ 7.832,75		€ 16.150,00	€ 80.750,00	29,7%	€ 23.982,75	€ 56.767,25
GeoZS	€ 26.302,50	€ 3.000,00		€ 7.325,63	€ 36.628,13	29,7%	€ 10.878,55	€ 25.749,58
GEOINFORM	€ 7.116,29	€ 3.000,00		€ 2.529,07	€ 12.645,36	29,7%	€ 3.755,67	€ 8.889,69

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[2] The EC Reimbursement rate for ERA-NETs is 33%. 10% of this Reimbursement rate is reserved for the Coordination Costs of GeoERA as agreed in the Grant Agreement. Therefore, the Reimbursement rate for GeoERA is these calculations results in 29,7%.

4 Members of the consortium (This section is not covered by the page limit)

4.1 Participants (applicants)

<table>
<tr><td>Name of organisation</td><td colspan="3">Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO</td></tr>
<tr><td>Short name</td><td>TNO</td><td>Country</td><td>Netherlands</td></tr>
<tr><td colspan="4">Brief description of the legal entity</td></tr>
<tr><td colspan="4">TNO is a semi-independent Dutch research and technology organisation active in technical, earth, environmental, life, societal and behavioural sciences, focussing on healthy living, industrial innovation, energy, transport and mobility, built environment, the information society, and defence, safety and security. TNO is represented in Geo-ERA with the Geological Survey of the Netherlands, which provides geoscientific data, information and knowledge for:

• sustainable management of earth resources and the environment in general (including assessment of induced hazards and impacts);
• safe living on subsiding lowlands;
• reduction of risks and costs in building and construction associated with ground conditions.

The survey's core skills include data management, geo-ICT and 3D-modelling. Its products and services are primarily targeted at water, energy and building sectors (the latter in the broadest possible sense, including land use and environmental planning). The organisation hosts the national repository for subsurface data and information and is the designated state advisor of all geological matters related to the Mining Act. The survey's skills and services relate to its operational environment, determined among others by its hydrocarbon resources, geothermal resources, subsurface storage capacities, rock salt mining and the Dutch coastal and fluvial lowlands setting, which presents aggregate and groundwater resources including water-related challenges.

TNO is one of the main institutes and primary technical advisors in the Netherlands for research on induced subsurface impacts and hazards. TNO works together with several other large national and international institutions on this topic, including universities, governmental institutions and major operators.</td></tr>
<tr><td colspan="4">Main project tasks and qualifications:</td></tr>
<tr><td colspan="4">TNO is the overall Project Coordinator of the HIKE (Hazard and Impact Knowledge for Europe) project and has a leading role in several research tasks, among which the development of the Fault Database and development of novel methodologies and datasets for the assessment of seismicity. Besides the typical management and reporting tasks, the technical activities comprise among others:

- Specification and classification of fault and fault zone information and its application in deep and shallow subsurface assessments
- Mapping, modelling and analysing 3D fault characteristics and dynamic behaviour (in conjunction with modelling work in other GeoERA projects)
- Establishing the Fault Database infrastructure and its technical implementation (including involvement in the GeoERA Information Platform Project)
- Implementation of fault information and knowledge in specific hazard and impact use cases
- Developing novel methodologies for improved localisation of seismic events
- Establishing specifications for the induced hazard and impact knowledge share point
- Inventory and evaluation of relevant subsurface datasets and scientific documents for the share point
- Scientific reporting, presentation and publication</td></tr>
</table>

As a major research organization in the Netherlands and coordinator of many international projects, TNO has an extensive track record. TNO is widely acknowledged in (international) Hazard and Impact expert groups This expertise is supported by the national Geoscience Information Programme in which the subsurface is mapped and characterized (including faults and their natural and induced behaviour).
Short profile of staff member(s) who will be undertaking the work
Drs. Serge F. van Gessel (male), senior geoscientist and project manager. Serge holds a Msc degree from Utrecht University (1994). He joined TNO in 1998 after working as a consultant for the petroleum industry. Currently Serge is a senior advisor for the Ministry of Economic Affairs and Climate, with specific focus on mining and subsurface exploration and development. Besides his scientific and project management duties at TNO he is Chairman of the EuroGeoSurveys Geo-Energy Expert Group (since 2015) and theme coordinator of the Energy Theme in GeoERA. **Dr. Johan H. ten Veen (male),** co-lead WP3, senior geologist (EuroGeologist), Johan holds a MSc from Vrije Universiteit Amsterdam (1991) and a PhD degree in Earth Sciences from Utrecht University (1998). He joined TNO in 2009 after an academic (research and lecturing) career in structural geology. At TNO he works as a structural geologist on the initiation, refinement and maintenance of national subsurface geomodels (www.dinoloket.nl). Next to this task, he is involved in projects centered around characterization of hydrocarbon and geothermal reservoirs and several cross-border basin studies (NW Europe focus). Currently Editor in Chief of the Netherlands Journal of Geosciences. **Joana Esteves Martins (female):** Research innovator at TNO. Joana holds a Msc in Geophysics (2007) and an Engineering degree in Geodesy Engineering (2005), both from Sciences University of Lisbon 10 years of experience with satellite based remote sensing data (for urban planning, land cover classification, surface displacements and modelling) and 3 years of experience as business intelligence consultant. Joana joined TNO in 2015 where has been working as advisor for the minister and in European projects (IMAGE and GeMEX). In parallel, she is finishing her PhD dissertation at TU Delft, on the topic of combining Radar (PS/DS-InSAR) and Seismic (Ambient Noise) Interferometry observations to map magmatic plumbing systems in Iceland. **Drs. Rob van Ede**: project manager and data analyst at TNO-GDN data & information group. Member of the EGS Spatial Information Expert Group & facilitator for the INSPIRE Energy Resources thematic cluster. 12 Years of experience in GIS and spatial data management.
List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.
• Van Wees, J. D., L. Buijze, K. Van Thienen-Visser, M. Nepveu, B. B. T. Wassing, B. Orlic, and P. A. Fokker (2014), Geomechanics response and induced seismicity during gas field depletion in the Netherlands, Geothermics, 52(0), 206-219, doi: http://dx.doi.org.proxy.library.uu.nl/10.1016/j.geothermics.2014.05.004 • Netherlands Journal of Geoscience: special issue on the seismicity of the Groningen gas field in the Netherlands, end of 2017 available online, different papers in this special issue and TNO is guest editor. • Orlic, B. & Wassing, B.B.T. (2012). A study of stress change and fault slip in producing gas reservoirs overlain by elastic and visco-elastic caprocks. Rock Mechanics and Rock Engineering, , 15p.. doi:http://dx.doi.org/10.1007/s00603012-0347-6. • Doornenbal, J.C. & Stevenson, A.G. (Eds) (2010): Petroleum Geological Atlas of the Southern Permian Basin Area. EAGE Publications b.v., Houten, 342 pp. • Kombrink, H., Doornenbal, J.C., Duin, E.J.T., den Dulk, M, van Gessel, S.F., ten Veen, J.H. and Witmans, N. (2012). New insights into the geological structure of the Netherlands; results of a detailed mapping project. Neth., J. Geol., 91(4), 419-446.
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.
Besides a program lead role in national research, TNO has been and is strongly involved in scientific activities and coordinating various EU funded projects, the relevant ones for this project being listed below.

• IMAGE project (2013 – 2017), Integrated Methods for Advanced Geothermal Exploration, with a focus on seismic hazards. • DeStress (2016 – 2020) - optimise stimulation treatments while minimising environmental impacts • GEISER (2010 – 2013) - Geothermal Engineering Integrating Mitigation of Induced Seismicity in Reservoirs • M4ShaleGas (2015 – 2017)- Impact of subsurface activities: Hydraulic fracturing, induced seismicity and well integrity • SPBA (2005 – 2010)- Petroleum Geological Atlas of the Southern Permian Basin Area
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work
BRO / Dino-Loket / NLOG: Portal and Repository of subsurface data and 3D models of the Netherlands. TNO maintains and disseminates all subsurface data from industry and in-house data acquisition programmes, including 3D seismic surveys, borehole data and seismic monitoring data. These data are public and available to the project TNO owns highly specialized 3D geological and geo-mechanical modelling software that is commonly used by international industry and scientific research organizations. These tools are available to the project.

Name of organisation	**Albanian Geological Survey**		
Short name	AGS	**Country**	Albania
Brief description of the legal entity			
Albanian Geological Survey is a government organization, which operates according to the law nr. 111/2015 “For the Albanian Geological Survey” date 15/1022015 AGS was founded in1922, and its legal status is this of the scientific and technical adviser of the Albanian government in geosciences. AGS is under the ordinance of the Ministry of Industry and Energy. The General Director of AGS is legally the person charged to lead this institution and is its legal representative. AGS is funded by the state budged in accordance with the approved project according to the areas of the development program. Those areas are Regional Geology, Geology of Mineral Resources, Geology of Hydrocarbons, Hydrogeology, Marine Geology, Laboratory Analyses of Rocky and Water samples, Elaboration and Integration of Data in GIS System.			
Main project tasks and qualifications:			
The collect, process, of publicly available national fault information and harmonize them into the established FDB architecture (WP2) Disclosure of this data into the Geo-Era Information Platform, so that they can find practical use.			
Short profile of staff member(s) who will be undertaking the work			
PhD Candidate Sokol Marku (male), Joined AGS since 1998. Geologist, with experience in geological mapping, quaternary and marine geology. Actually responsible of AGS on international relationships. Technical editor of scientific periodical "Buletini i Shkencave Gjeologjike". Member of Marine Geology EG. Member of M4EU Foundation Management Board. **Dr. Ndoc Vukzaj (male).** Director of Geology Directorate in Albanian Geological Survey. Joined Albanian Geological Survey since 1978. Expert in field of regional geology and tectonic **Dr. Lavdie Moisiu (female).** Specialist in GIS and Data Base. Member of Department of Geo-Data Elaboration. Joined AGS since 1999. Experience in several international project where AGS was partner. **Eng. Vangjel Sylari (male**). Joined AGS since 2014. Previously war part of Institute of Gas and Petrol.			

Expert in field of hydrocarbon and natural gas reservoirs and their geological setting condition. **Eng. Siri Hamiti (male).** Expert in regional geology and tectonic. Joined AGS since 1979
List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.
Geological Map of Albania on scale 1:200.000 (2002) Series of multipurpose maps on scale 1:50.000 Project ESTMAP (subcontracted partner) Map of Geological Hazard on scale 1:200.000 in scale 1:200.000 (2000)
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work
The infrastructure of Geo-Data Elaboration Department. A quantity of reports archieved in Central Technical Archive of AGS

Name of organisation	**Geologische Bundesanstalt**		
Short name	GBA	**Country**	Austria
Brief description of the legal entity			
The **Geological Survey of Austria (GBA)** undertakes core programmes, such as geoscientific mapping of the Austrian territory. Applied tasks include assessment of mineral and ground water ressources, natural hazard mitigation & monitoring as well as geothermal exploration. Furthermore, GBA operates a geological information service, acts as a service for the public administration and participates actively in international research projects, in particular with EuroGeoSurveys, where it is a member of most expert groups. GBA's **Division of Geological Mapping** is running the national geological mapping programme, producing top quality geological map and datasets in a broad range of scales, as well as other types of basic geological information since more than 150 years. In the last years, efforts towards nation-wide homogenized datasets lead to the pioneering task to develop an advanced fault database incorporated in a multi-thematic geological map and linked with a semantic web (Thesaurus). The **Division of Applied Geosciences** consist of 5 departments (Mineral Resources, Hydrogeology and Geothermics, Engineering Geology, Geophysics and Geochemistry). Within this project, mainly the department of Geophysics will be involved. The **Department of Geophysics** focuses on the development and application of innovative technologies in the field of geophysics for raw-material exploration, groundwater and geological mapping and natural and man-made hazard mitigation (landslides, permafrost-monitoring, volcanism, abandoned mines monitoring, karst pollution protection) with special focus on airborne geophysics, geoelectrics and geolelectrical monitoring.			
Main project tasks and qualifications:			
GBA is mainly responsible for WP5 and is strongly involved in several tasks in WP2 focused on the development of the Fault Database. In addition, GBA leads Task 2.3, due to long-standing experience with interpretation of airborne geophysical and potential field data.			
Short profile of staff member(s) who will be undertaking the work			
Dr. Esther Hintersberger (female), co-lead task 2.3 and WP5, Project leader for the application of the national fault database to the county of Lower Austria. Esther holds a Msc degree in Geophysics (2005) and a PhD degree in Geology (2013) from the Potsdam University (Germany). After working in several projects related to paleoseismolgy and related hazard at the University of Vienna, Esther was involved in the design of the national fault database at the GBA.			

Mag. Ingrid Schattauer (female), working in task 2.3, geophysicist at the GBA. Ingrid holds a Msc degree in Geophysics from the University of Vienna (2005). Since 2002, she works in the field of airborne geophysics at the GBA and has 10 years of experience in analyzing airborne and potential field geophysical raster data sets for various applications.

Dr. Marc Ostermann (male), co-lead task 2.3 and WP5, Program Coordinator for Geomonitoring and Disaster Mitigation at the Geological Survey of Austria. Marc holds a Msc degree in Earth Sciences from the University of Innsbruck (2003) and PhD degree in Geology from the University of Innsbruck (2007). Marc has a strong background in geochronology, landslide research and Engineering Geology.

List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.

- Hintersberger, E., Iglseder, C., Schuster, R., Huet, B. (2017) The new database "Tectonic Boundaries" at the Geological Survey of Austria. Jahrbuch der Geologischen Bundesanstalt, 157.
- Hintersberger, E., Iglseder, C., Schuster, R., Bayer, I., Linner, M., Gruber, A., Huet, B., Reischer, J., Krenmayr, H.-G. (2016) The multifunctional geologic datasets of Austria (1:1.500.000.) – including a new classification scheme for "Tectonic Boundaries", In: Ortner, H. (Ed.), Abstract Volume of GeoTirol 2016, Annual Meeting of DGGV and PANGEO Austria, 25.-28. September 2016, Innsbruck (A), p. 116.
- Schattauer I., Römer A., Bailey R.L., Leonhardt R., Motschka K., Supper R., Schiller A.: Lateral Conductivity Variations within Austria and Its Surroundings by Extrapolating Airborne Electromagnetic Data: EAGE 2017: Second European Airborne Electromagnetics Conference, 2017, DOI: 10.3997/2214-4609.201702175
- Schiller A., Schattauer I., Ottowitz D.: Advanced data processing of airborne electromagnetic data for imaging hidden conduit networks in the coastal karst plain of Tulum (Mexico), Article in Boletín Geológico y Minero 127(1): 7-19, 2016
- Supper R., Stotter Ch., Schattauer I., Meurers B., Okuma S., Chiappini M., Deritis R.: High resolution airborne magnetic surveys to investigate the structure and system changes in active volcanic regions of southern Italy, Proceedings of the IUGG meeting in Sapporo, Japan, 2003

List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.

- Design of an Austria-wide fault data base integrated in a multi-thematic geological map connected with a semantic knowledge representation (Thesaurus). The multi-thematic map and the thesaurus are publically accessible via the homepage.
- Ongoing application of the national fault data base to the county of Lower Austria includes downscaling of the nation-wide information to local level and extending the associated unstructured information (e. g., outcrop descriptions).
- Continuous processing of airborne electromagnetic, gamma ray, and magnetic data for various purposes, including first attempts to characterize faults in airborne geomagnetic data.

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work

Multi-thematic geological map of Austria (1:1.5 Mio) including the fault data base with relevant kinematic information.

Internal geophysical database of the GBA includes ground-based geoelectrical data and airborne magnetic - electromagnetic - and radiometric (Potassium, Uranium and Thorium) datasets gathered between 1980 and 2014 at the GBA.

Technical equipment: Geoelectric devices (for Profiling and Monitoring), Equipment for Airborne measurements (Magnetics, Electromagnetics, Radiometry), equipment for borehole logging.

Name of organisation	**Royal Belgian Institute of Natural Sciences – Geological Survey of Belgium**		
Short name	RBINS-GSB	**Country**	Belgium

Brief description of the legal entity

The Royal Belgian Institute of Natural Sciences is a world-class research institute covering a wide range of disciplines from biology to geology, oceanography to taxonomy and paleontology to ecology. Two of its operational directorates (OD) participate to GeoERA, the OD Earth and History of Life, and also the OD Natural Environment.

The Directorate Earth and History of Life is the most important research centre devoted to Earth Sciences (geology, palaeontology and archaeosciences) in Belgium. It is composed of about 65 statutory and contractual staff members. Laboratories have a comprehensive range of modern equipment for mineralogical and petrophysical analysis. The Geological Survey of Belgium (GSB) is an autonomous subsection of the RBINS OD Earth. Created in 1896, the GSB is a key geological and mineralogical research centre developing both applied and fundamental research approaches. It is also an independent, non-commercial provider of geoscientific services. These services are oriented towards local, regional, federal, European and international authorities, as well as researchers of institutions/universities and research groups, private companies, NGO's and citizens. In spite of retaining this profile and strong societal focus, which is typical for the geological surveys of Europe, the GSB has at the same time become one of the most research-oriented Surveys in Europe, evidenced by a rapidly increasing scientific output in recent years.

Main project tasks and qualifications:

RBINS-GSB is involvement in WP2, and particularly the design and setting up of the FDB because of the direct relation of HIKE and GE6-GeoConnect³d.

Short profile of staff member(s) who will be undertaking the work

Kris Piessens (PhD, 15+ year experience, male) is one of the key members of the GeoEnergy team. He has been involved in CCS related research for 15 years, working on the interface between geological, economic, policy, engineering and regulatory aspects, and is cartographer for the Lower-Palaeozoic geology.

List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.

Petitclerc, E., Welkenhuysen, K., Van Passel, S., Piessens, K., Maes, D. & Compernolle, T., 2017. Towards geological-economic modelling to improve evaluating policy instruments for geothermal energy – Case study for Belgium (Campine Basin). European Geologist, 43, p.10-15.

Compernolle, T., Welkenhuysen, K., Huisman, K., Piessens, K. & Kort, P., 2017. Off-shore enhanced oil recovery in the North Sea: The impact of price uncertainty on the investment decisions. Energy Policy, 101, 123-137.

Welkenhuysen, K., Rupert, J., Compernolle, T., Ramirez, A., Swennen, R., & Piessens, K., 2017. Considering economic and geological uncertainty in the simulation of realistic investment decisions for CO_2-EOR projects in the North Sea. Applied Energy, 185 (1), p.745-761.

Welkenhuysen, K., Brüstle, A.-K., Bottig, M., Ramírez, A., Swennen, R. & Piessens, K., 2016. A techno-economic approach for capacity assessment and ranking of potential options for geological storage of CO_2 in Austria. Geologica Belgica, 19 (3-4), p.237-249.
Welkenhuysen, K., Ramirez, A., Swennen, R. & Piessens, K., 2013. Strategy for ranking potential CO_2 storage reservoirs: a case study for Belgium. International Journal of Greenhouse Gas Control, 17, p. 431-449.

List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.

MEET (EU H2020, 2018-2021): Multidisciplinary and multi-context demonstration of EGS exploration and Exploitation Techniques and potentials

ENOS (EU H2020, 2013-2019): Enabling Onshore Storage of CO_2 in Europe EUOGA (EU H2020, 2016-2017): Geological evaluation of potential unconventional oil and gas resources in Europe ACCESS (EU Europe-Aid, 2010-2012): Assistance in Clean Coal and Environmentally sound Storage Solutions: capacity building project on clean coal and CCS in Kazakhstan PSS-CCS I, II & BeNe (Belspo, 2005-2010): Policy support System for Carbon Capture and Storage: Belgian umbrella projects for CCS potential assessment
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work

Name of organisation	**Geological Survey of Denmark and Greenland**		
Short name	GEUS	**Country**	Denmark
Brief description of the legal entity			
The Geological Survey of Denmark and Greenland (GEUS) is an independent research and advisory institution in the Ministry of Energy, Utilities and Climate in Denmark. GEUS conducts geological surveys to exploit and protect geological natural resources in Denmark and Greenland. Primary activities are: research in water, energy, mineral and natural resources; data management, advisory services, and information to the public. The survey carries out scientific tasks in relation to the administration of legislation in areas such as water supply, raw materials and use of the subsurface. It also undertakes assignments related to energy, minerals, water and the environment on a contractual basis for other public authorities, private companies and clients outside Denmark.			
Main project tasks and qualifications:			
GEUS leads WP3 and Task 3.1, and contributes to seismological analysis, evaluation and coordination. In particular GEUS will work on methodologies using 3D velocity models for locating earthquakes, off-shore monitoring, and strategies for best practice monitoring of induced, low-magnitude seismicity. GEUS is a major research institution in Denmark and is deeply involved in European collaboration and projects. Currently GEUS-seismology is WP lead on a H2020 infrastructure project INTAROS (integrated Arctic observation study). GEUS is responsible for seismological monitoring in Denmark and Greenland, operates the national seismograph network, maintains the earthquake database, and participates in national and international research and infrastructure projects. GEUS is a member of the European seismological organizations EMSC and ORFEUS, participates actively in EPOS, and has a long record of international collaboration and harmonization within seismology. GEUS has carried out several studies on induced seismic hazards in Denmark.			
Short profile of staff member(s) who will be undertaking the work			
Tine B. Larsen, (female), is a senior research scientist with a Ph.D. in Geophysics and Scientific Computing. She has 20+ years of experience in seismology with a focus on natural and induced seismicity, microseismicity, earthquake swarms, monitoring strategies, nuclear test ban treaty, glacial earthquakes. She has published more than 40 journal papers in ISI registered scientific journals with 676 ISI citations and WoS h-index of 15. PI, co-PI and participant in several international research projects in Greenland. **Trine Dahl-Jensen, (female),** is a senior research scientist with a Ph.D. in geophysics and 25+ years of experience in seismology. Main research interests: natural and induced seismicity, monitoring strategies, polar seismology, receiver function analysis, tectonics. PI, co-PI and participant in numerous international research projects in Greenland and Denmark. **Peter H. Voss, (male),** is a research scientist with a Ph.D. in Geophysics and 15 years of experience in seismology. He has participated in more than a dozen field campaigns including several in Greenland. Main research interest is source parameters of earthquakes in Denmark and Greenland,			

expertise include real time data handling and signal processing. Participant in several international research projects in Greenland and Denmark, and WP-lead in H2020 project INTAROS (2016-2021).
List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.
• Gibbons SJ, Dahl-Jensen T, Harris, DB, Kværna T, Larsen TB, Paulsen B, Voss PH (2017) Locating Seismicity on the Arctic Plate Boundary using multiple-event techniques and empirical signal processing, Geophysical Journal International, 211, 161-1627, doi: 10.1093/gji/ggx398 • Gravesen P, Nilsson B, Binderup M, Larsen TB, Pedersen SAS (2013) Geology, seismic activity and groundwater conditions at six potential disposal sites for radioactive waste from Riso, Denmark. Geological Survey of Denmark and Greenland Bulletin 28, 13-16. • Voss P, Dahl-Jensen T, Larsen TB (2015) Earthquake Hazard in Denmark. GEUS Report 2015/24. • Larsen TB, Voss PH, Dahl-Jensen T, Rasmussen HP (2014) Earthquake swarms in Greenland, Geological Survey of Denmark and Greenland Bulletin 31, 75-78. • Dahl-Jensen T, Voss PH, Larsen TB, Gregersen S (2013) Seismic activity in Denmark: detection level and recent felt earthquakes. Geological Survey of Denmark and Greenland Bulletin 28, 41-44.
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.
GEUS seismology has contributed to a number of previous and ongoing projects relevant to HIKE: • EPOS - European Plate Observing System (EU Infrastructure, 2002-) • INTAROS – Funded under H2020. INTAROS will develop an efficient integrated Arctic Observation System by extending, improving and unifying existing and evolving systems in the different regions of the Arctic (2016-2021) • National study on assessing suitable locations for depositing low- and intermediate level radioactive waste (2012-) • Contributions to a scientific evaluation of international knowledge on shale gas in a Danish context. Report delivered 2016 • Seismic monitoring of a shale gas exploration well for Total (2014-2015). Data and report are confidential.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work
GEUS real-time seismograph network covering Denmark and Greenland, and the associated earthquake database will be used in HIKE. DanSeis – the Danish National pool of seismographs is available to GEUS, and data from the currently deployed OBS's and land seismographs in and around Skagerrak will be analysed in HIKE

Name of organisation	**Bureau de Recherches Géologiques et Minières**		
Short name	BRGM	**Country**	France
Brief description of the legal entity			
BRGM (Bureau de Recherches Géologiques et Minières) is the reference public institution in France for Earth Science applications in the management of surface and subsurface resources and risks to face current and emerging social and environmental challenges. BRGM's activities are organised around scientific research, support to public policy development, international cooperation and mine safety. BRGM has been certified ISO 9001 since 2004 and ISO 14001 since 2012, and applies an integrated management system which combines quality and environmental certification. Its analytical laboratories are accredited by the COFRAC since 1994. The BRGM is one of the Carnot institutes.			
Main project tasks and qualifications:			
Leadership of WP4 and task 3.5. BRGM was the coordinator of the FP7 CGS Europe project (2010-2013), a Pan-European Coordination Action on CO2 Geological Storage involving 34 research institutes over 28 countries. Currently BRGM is leading the ENOS H2020 project that aims at enabling			

the development of CO2 storage onshore in Europe.
Short profile of staff member(s) who will be undertaking the work
Fernanda DE MESQUITA L. VELOSO, Female, is in charge of geoscience aspects for safety use of subsurface exploitations. Before joined the BRGM, she worked for almost 5 years at Total, an oil and gas company, where she studied fractured reservoir, deep buried top seal behaviour and overpressure of reservoir and top seal. She holds a PhD (Spain, 2015) on geological and reservoir modelling for studies of geological storage of CO2 . **Hideo AOCHI**, Male, holds a Ph.D in seismology from Univ. Tokyo (Japan, 2000) and joined BRGM since 2004, contributing in R&D on quantitative natural/induced seismic hazard assessment, also honored by two prizes from Japan. He has 56 publications (citation=652, h-index=13 e.g. http://www.researcherid.com/rid/A-3281-2011). He coordinated the BRGM research program of seismic hazard (2005-2012), as well as two national (ANR funded) seismic hazard/risk projects. He has been also scientific leader of BRGM research teams in two European projects. **Thomas LE GUENAN**, Male, joined BRGM in January 2008 to work on safety issues for geologic storage of CO2 under the Risks and CO2 storage Safety department. He is now in charge of the safety criteria and impacts of CO2 storage programme, which comprises around 20 BRGM projects on the subject. He holds a multidisciplinary master level degree from the Ecole Centrale Paris, a French non-specialized engineering school, and a Master of Science degree in environmental and land planning engineering from the Politecnico di Milano University. He was involved in the EUROGIA+ CO2FieldLab and ANR SENTINELLE projects on monitoring protocols issues, and on the FP7 CO2CARE project on risk management issues. He is main author of the preliminary risk assessment performed for the ADEME TGR-BF project. He is currently a contributor of the ENOS H2020 project.
List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.
Aochi, H., T. Le Guenan, and A. Burnol, On estimation of seismic risk with respect to development of subsurface exploitation strategies for energy purpose, Petrol. Geosci., 23, 298-305, doi:10.1144/petgeo2016-065, 2017 Trovato, C., I. Lokmer, F. De Martin and H. Aochi, Long Period (LP) Events on Mt. Etna volcano (Italy): the influence of Velocity Structures on Moment Tensor Inversion, Geophys. J. Int., 207(2), 785-810, doi:10.1093/gji/ggw285, 2016 Veloso, F.M.L., Frykman, P., Nielsen, C.M., Soria, A.R., Meléndez, N., 2016. Outcrop scale reservoir characterisation and flow modelling of CO2 injection in the tsunami and the barrier island - tidal inlet reservoirs of the Camarillas Fm. (Galve Sub-basin, Teruel, NE Spain). International Journal of Greenhouse Gas Control, 55, pp. 60-72. de Lary, L., Manceau, JC., Loschetter, A., Rohmer, J., Bouc, O., Gravaud, I., Willaume, P., Yalamas, T. (2014) Quantitative risk assessment in the early stages of a CO2 geological storage project: implementation of a practical approach in an uncertain context. Greenhouse Gases: Science and Technology. DOI: 10.1002/ghg.1447. de Lary L., Le Guenan T., Manceau J-C. (2015) - Projet MARSE : approche de gestion des risques pour les exploitations du sous-sol. Rapport final. BRGM/RP-65676-FR, 48 p., 11 fig. Public Report in Frrench "MARSE project: Risk management approach applied on subsurface exploitations). http://infoterre.brgm.fr/rapports/RP-65676-FR.pdf
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.
BRGM has wide range of laboratories and experts on distinct disciplines, such as geosciences, enginery, computer science, chemistry, etc.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work
Platform: GERICO for manaGEment of RIsks for CO2 storage (http://gerico.brgm.fr/?lang=en)

Name of organisation	Bundesanstalt für Geowissenschaften und Rohstoffe		
Short name	BGR	**Country**	Germany

Brief description of the legal entity

BGR is an Authority and Research Institute of the Federal Republic of Germany within the portfolio of the Federal Ministry for Economic Affairs and Energy. BGR gives independent advice to the Federal Government on all geoscientific questions. It cooperates on the European level with the National Geological Surveys and is member of EuroGeoSurveys.

With this, BGR (www.bgr.bund.de) support the federal government in their following objectives:

- Stimulating economic development
- Long-term protection and improvement of the quality of life
- Enhancing technical and scientific expertise

Based on its foundation articles, BGR performs duties in the following fields of scientific research:

Energy & Mineral Resources, Groundwater, Soil, Final Disposal of Radioactive Waste, Deep Subsurface Use, Geological CO2 Storage, International Geoscientific Cooperation, Geoscientific Information and Fundamentals, Nuclear Weapons Test Ban; Geo-hazard Assessment

BGR participates at both national and international levels in fundamental geological research. In cooperation with the geological surveys of the federal states and European nations BGR provides specialist geological information, maps, standards and methodologies. In a framework of national, European (EuroGeoSurveys) and international initiatives, BGR contributes to developing the geodata infrastructure (geoinformation business).

For a consistent and sustainable evaluation of subsurface use potentials and conceivably resulting conflicts of use across federal state borders and Germany-wide, BGR develops the relevant geological data and information. BGR's activities include the

- Investigation & characterization of the structural framework, petrography and stratigraphy
- adaptation and improvement of methods for supra-regional structure analyses and modeling,
- analyses and evaluation of risk potentials related to the subsurface structure,
- construction of 3D subsurface models,
- investigation in regard to the evaluation of rocks for specific types of use,
- development and maintenance of data bases and information systems.

BGR's activities in the German sectors of the North Sea, the Baltic Sea, as well as onshore are generally carried out in cooperation with the German state geological surveys and the geological surveys of neighbouring countries.

Main project tasks and qualifications:

BGR will contribute to WP2 (Fault Database)

Short profile of staff member(s) who will be undertaking the work

Fabian Jähne-Klingberg (male) is a structural geologist and special emphasis of his work (since 2006) is placed on the structural evolution of the Central European Basin. He especially is interested in the Late Cretaceous evolution of the Central European Basin as well as the complex halotectonic deformation of its sedimentary cover. To comprehend the distribution of the deformation within this complex basin, he focused on the assessment of the deformation style, the kinematics and the estimation of amounts for extension and shortening of several deformational events. These studies are carried out with the help of different structural restoration and balancing methods. Additionally, he also tries to establish an approach to catch and illustrate the structural uncertainties along with (seismic) interpreter bias and different geophysical methods, in order to create structural consistent and reliable

3D-models.

From 2009 to 2013 as research assistant in the “GPDN-Project” at the Federal Institute for Geosciences and Natural Resources (BGR), his main task was the seismic interpretation and structural modeling of the subsurface of the German North Sea. Since 2014 he coordinates the R&D works in the “TUNB”-project (a modeling project with the main goal to develop a 3D-model of the whole German Basin from the North Sea in the West to the German/Polish border in the East) and is responsible for the interpretation and modeling work in the German North Sea sector. In the course of geochemical mapping projects (e.g. GEMAS) in the last years he published several thematic overview maps of the geology of Europe.

Heidrun Stück (female) is a graduated geoscientist and has written a thesis at the Centre for Geosciences at University of Göttingen about petrography and petrophysical properties of sediments. Since 2013 she is research assistant at the Federal Institute for Geosciences and Natural Resources (BGR), working in the “NIKO-Project” on unconventional resources and, actually, within the project “TUNB” as structural interpret contributing to a final 3D-underground model of the North German Basin. Within the TUNB-project her main tasks are/she is responsible for the interpretation of structural elements such as sedimentary structures, salt structures and faults. Additionally she investigates the impact of superimposition of structural elements on fluid migration and a possible genetic interaction between selected structures.

List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.

- Jähne, F. (2014). Chapter 2: Geology of Europe. 24 pp., 14 figs., 1 Table: In REIMANN, C., BIRKE, M., DEMETRIADES, A., FILZMOSER, P. & O’CONNOR, P. (eds.) (2014). Chemistry of Europe’s Agricultural Soils. Part B: General Background Information and Further Analysis of the GEMAS Data Set. – Geol. Jb., B 103: 352 pp., 121 figs., 65 Tables, 3 App.; Hannover.Quelle: BGR
- Arfai, J., Jähne, F., Lutz, R., Franke, D., Gaedicke, C. & Kley, J. (2014). Late Palaeozoic to Early Cenozoic geological evolution of the northwestern German North Sea (Entenschnabel): New results and insights. – Netherlands Journal of Geosciences, FirstView: 1-28.
- Stueck, H.L., Bense, F. & Jähne-Klingberg, F. (2017). Fluid migration paths through superimposed Cenozoic to Mesozoic faults and fault systems – A case study in the SW-German North Sea. International Meeting of Sedimentology (IMS), 33rd UAS & 16th ASF joint meeting, Toulouse, 10-12 October 2017.
- Müller, C., Jähne-Klingberg, F., von Goerne, G. Binot, F. & Röhling, H.-G. (2016). Vom Geotektonischen Atlas („Kockel-Atlas“) zu einem 3D-Gesamtmodell des Norddeutschen Beckens: Basisinformationen zum tieferen Untergrund von Norddeutschland. Z. Dt. Ges. Geowiss. (German J. Geol.), 167 (2–3), p. 65–106, 21 figs., 4 tables, Stuttgart
- Asch, K. (2005). IGME 5000: 1 : 5 Million International Geological Map of Europe and Adjacent Areas. BGR (Hannover).

List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.

GPDN: Geopotenzial Deutsche Nordsee
http://www.gpdn.de/
End of project: December, 2013

GEMAS: Geochemical Mapping of Agricultural and Grazing Land Soil
https://www.bgr.bund.de/DE/Themen/Boden/Projekte/Ressourcenbewertung_und_management_laufend/Geochemische_Kartierung_GEMAS/GEMAS.html
End of project: June, 2017

Geotektonischer Atlas von Nordwest-Deutschland und dem deutschen Nordsee-Sektor
Tectonic Atlas of Northwest Germany and the German North Sea sector
Final publication: 2001

IGME 5000: More than just a map - A multinational GIS Project https://www.bgr.bund.de/EN/Themen/Sammlungen-Grundlagen/GG_geol_Info/Karten/International/Europa/IGME5000/IGME_Project/IGME_Projectinfo.html Speicher-Kataster (Storage Catalogue of Germany): https://www.bgr.bund.de/EN/Themen/Nutzung_tieferer_Untergrund_CO2Speicherung/Projekte/CO2Speicherung+Nutzung/Abgeschlossen/speicherkataster_en.html?nn=1559828 End of project: March, 2011
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work
All means and expedients for the planned contribution and investigations be available at the BGR.

Name of organisation	**Landesamt für Bergbau, Geologie und Rohstoffe Brandenburg**		
Short name	LBGR	**Country**	Germany

Brief description of the legal entity

LBGR is a subordinated state authority of the Ministry for Economic Affairs and Energy and the central geo-scientific state institution of the Federal State Brandenburg. LBGR provides geoscientific knowledge, data and planning-relevant documents for the protection and sustainable use of soil, groundwater, geothermal energy, raw materials and construction ground. For this reason LBGR maintains specialised information systems in the field of geology, hydrogeology, economical geology and geopedology. These information systems include the central repository for subsurface data of the Federal State of Brandenburg.

Main project tasks and qualifications:

Project support WP2 fault data base, providing and testing fault data from East Germany

Short profile of staff member(s) who will be undertaking the work

Christoph Jahnke (male) senior geologist. Christoph holds a diploma in Crystallography from Humboldt-University Berlin (1991) and a diploma in Geology from the Technical University in Berlin (1997). From 1992 to 2000 he worked for several consulting companies providing geoscientific services and software development. 2000 he joined the Brandenburg Technical University in Cottbus. He worked as lecturer, scientist and project manager in the fields of 3D-modelling, hydrogeology, geochemistry in conjunction with mining damage and underground storage. Since 2014 he is an employee at the at State Office for Mining, Geology and Raw Materials Brandenburg (LGBR) within the project Subsurface Potentials for Storage and Economic Use in the North German Basin (TUNB).

Maik Schilling (male) junior geologist. Maik holds and diploma in engineering from the Technical University in Berlin (2012). From 2012 to 2014 he was working as scientist at German Research Center for Geosciences (GFZ Potsdam) in the field of geological 3D modelling. Since 2014 he is an employee at the State Office for Mining, Geology and Raw Materials Brandenburg (LGBR) within the project Subsurface Potentials for Storage and Economic Use in the North German Basin (TUNB) and works in geological 3D-modelling and software development.

List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.

- Schilling, M., Jahnke, C. Simon, A. & Höding, T: Development of a 3D geomodel in Brandenburg in the framework of the TUNB project. GeoBremen - Annual Meeting of DGGV, DMG, 24th – 29th September 2017, Berlin, Germany.
- Schilling, M., Jahnke, C. Simon, A. & Höding, T.: Brandenburg 3D – delivering geological information to the public. GeoBerlin - Annual Meeting of DGGV, DMG, 4th – 7th October 2015, Berlin, Germany.
- Schilling, M., Jahnke, C. Simon, A. & Höding, T.: Brandenburg 3D – GIS goes underground, a geological 3D model for the public. The 17th annual conference of the International Association for Mathematical Geosciences, 5th – 13th September 2015, Freiberg (Saxony)

• Kempka, T., Herd, R., Huenges, E., Endler, R., Jahnke, C., Janetz, S., Jolie, E., Kühn, M.,Magri, F.,Meinert, P., Moeck, I., Möller, M., Munoz, G., Ritter, O., Schafrik, W., Schmidt-Hattenberger, C. Tillner, E., Voigt, H-J., Zimmermann, G. (2015): Joint Research Project Brine: Carbon Dioxide Storage in Eastern Brandenburg: Implications for Synergetic Geothermal Heat Recovery and Conceptualization of an Early Warning System Against Freshwater Salinization. In: Liebscher, A. & Münch, U. (Eds.): Geological Storage of CO2 – Long Term Security Aspects, GEOTECHNOLOGIEN Science Report No. 22, Series: Advanced Technologies in Earth Sciences, p. 183-209. Springer • Schilling, M., Jahnke, C. Simon, A. & Höding, T.: Brandenburg 3D – a comprehensive 3D subsurface model, conception of an infrastructure node and a web application. 2nd European meeting on 3D geological modelling, 20th – 21st November 2014, Edinburgh, Scotland.
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.
• The Geological 3D-Modell of Brandenburg (WMS, WFS, W3DS): The subsurface of Brandenburg in depth down to 5000m, interactive web application. www.geo.brandenburg.de/Brandenburg_3D/portal.html (currently offline). • „Potenziale des unterirdischen Speicher- und Wirtschaftsraumes im Norddeutschen Becken (TUNB)" (Subsurface Potentials for storage and economic use in the North of Germany) Duration: 2014-2021. Cooperation of BGR Bundesanstalt für Geowissenschaften und Rohstoffe and the Geological surveys of the norther Federal states of Germany (including LBGR) • "Brandenburg 3D – Development of a geological 3D Model of the subsurface for the state of Brandenburg). Duration: 2013, Cooperation of LBGR , GFZ German Research Center for Geoscience, several companies (ENGIE E&P Germany, DMT Group, …) • "brine" - CO2 storage in eastern Brandenburg: Implications for geothermal heat provision and conception of a salinisation early warning system. BMBF/DFG research program GEOTECHNOLOGIEN. Duration 2010-2013.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work

• Hardware and software for geological 3D modelling (workstations, internal LINUX-server , several external servers hosted IT service provider of Brandenburg, GIS and modelling software: ESRI, Paradigm GOCAD/SKUA, Postgres/Oracle databases)
• Within the project Brandenburg 3D (B3D) special infrastructure components have been developed at LBGR for storing, managing and publication of 2D and 3D geological information. All implemented parts are composed of free and open source software, e.g. Postgres/Postgis, Geoserver, Javascript Frameworks: The infrastructure contains 3 parts:
  ○ **Internal working platform (GeoIS)** for management and storing of 2D- and of 3D data.
  ○ **Service Platform (ISN)** containing a Postgres-DB (B3D-database – SDI) for publishing 2D and 3D data and the Geoserver software to deliver Open Webservices like WMS, WFS and W3DS.
  ○ **Web application with 2D- and 3D-Viewer** to present data to the public (www.geo.brandenburg.de/Brandenburg_3D/portal.html (currently offline)).

Name of organisation	**Landesamt für Geologie und Bergwesen Sachsen-Anhalt**		
Short name	LAGB	**Country**	Germany
Brief description of the legal entity			
LAGB is a subordinated state authority of the Ministry for Economy and Science as well as the central geo-scientific survey of the Federal State Saxony-Anhalt. LAGB provides geoscientific knowledge, data and planning-relevant documents for the protection and sustainable use of soil, groundwater, geothermal energy, raw materials and construction ground. For this reason LAGB maintains specialised information systems in the field of geology, hydrogeology, economical geology and			

geopedology. These information systems include the central repository for subsurface data of the Federal State of Saxony-Anhalt.
Main project tasks and qualifications:
LAGB will support the HIKE project by providing and processing knowledge and data of faults available or derived from the data repository of Saxony-Anhalt.
Short profile of staff member(s) who will be undertaking the work
Dr. Klaus-Jörg Hartmann studied agriculture at the universities of Munich, Kiel and Göttingen and got his PhD at the university of Kiel in soil science about dust transport and impact in holocene soils in 1992. 1992 – 1995 he was project leader to build up a soil science information system for the federal state of Brandenburg. Since 1995 Hartmann is employed at the geological survey of the federal state of Saxony-Anhalt. He is leader of the department "Geo-specific information systems and archives" (Fachinformationssysteme und Archive) and is entrusted with the development of geological data information systems. Since 2016 he is leader of the project group TUNB (Subsurface Potentials for Storage and Economic Use in the North German Basin) in the LAGB. **Dr. Alexander Malz** received a diploma (2010) in geology and a Ph.D. (2014) from the University of Jena. His Ph.D. addressed the structural evolution and kinematic differences between basement-involved shortening and tectonic inversion in central Germany and thin-skinned thrusting in the easternmost Jura fold-and-thrust belt. In 2015 he has been a postdoc candidate at the Department of Structural Geology and Geodynamics at the University of Göttingen, and he attempts to understand the geometry and kinematics of fault zones in sedimentary basins by the use of quantified structural models and 3D modeling techniques. Since 2016 he works at the LAGB within the project Subsurface Potentials for Storage and Economic Use in the North German Basin (TUNB). To his tasks belong the development of a 3D geological model of Saxony-Anhalt as well as issues concerning data preparation, management, cross-border harmonization and documentation. **Lars Schimpf** studied geology and palaeontology at the University of Halle-Wittenberg with a special focus on petrology and economic geology and received his diploma in 2012. From 2013 to 2017 he was scientific assistant at the chair of hydrogeology and environmental geology of the University of Halle-Wittenberg and developed methods for digitalization, generalization, visualization and storage of 3D geological models. Since 2017 he is employed at the geological survey of the federal state of Saxony-Anhalt (department "Geo-specific information systems and archives") as an expert in geological information systems, data base administration, programming of interfaces as well as data management and conversation. **Christoph Nachtweide** studied geosciences at the University of Greifswald and received a bachelor of geology in 2012 and master of geosciences degree in 2014. From 2014 to 2015 he worked for Landesamt für Umwelt, Naturschutz und Geologie (Geological Survey of Mecklenburg-Vorpommern; LUNG) as a scientific assistant. Since 2016 he is employed at the LAGB within the project Subsurface Potentials for Storage and Economic Use in the North German Basin (TUNB). To his tasks belong preparation and management of geological subsurface data, cross-border harmonization aspects and the development of a 3D geological model of Saxony-Anhalt.
List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.
Malz, A., Nachtweide, C., Schimpf, L., Hartmann, K.-J. & Ehling, B. (2017): From 3D modeling to a statewide Fault Database – concepts and first experiences. GeoBremen 2017 Wycisk, P. & Schimpf, L. (2016): Visualising 3D geological models through innovative techniques. Zeitschrift der Deutschen Gesellschaft für Geowissenschaften (ZDGG) 167, 405-418. doi: 10.1127/zdgg/2016/0059 Malz, A., Kley, J. & Jähne-Klingberg, F. (2014): Is past deformation of continental interiors a key to understanding modern intraplate seismicity? AGU Fall Meeting. Abstract 20677. San Francisco. Hartmann, K.-J. & Dehner, U. (2003): Das Fachinformationssystem Boden [FIS-Boden] als Grundlage

zur Bearbeitung umweltrelevanter Fragestellungen, Köhne, S. & P. Wycisk (Hrsg.): Geowissenschaften und Umwelt – Handlungsoptionen für eine nachhaltige Raumentwicklung, UZU-Schriftenreihe Band 7, S. 109-117
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.
Personenkreis “Nutzung tieferer Untergrund” der Ad-Hoc-AG Geologie Konzept für Bewertungsverfahren zur unterirdischen Raumnutzung (2014) Potentiale des unterirdischen Speicher- und Wirtschaftsraumes im Norddeutschen Becken (TUNB) – Subsurface Potentials for storage and economic use in the North German Basin; Duration: 2014-2021. Coorporation of BGR and the Geological Surveys of the northern Federal states of Germany (including LAGB)
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work

Name of organisation	**Bavarian Environment Agency – Geological Survey, Bayerisches Landesamt für Umwelt – Geologischer Dienst**		
Short name	LfU	**Country**	Germany
Brief description of the legal entity			
Regional environment agency in charge for Bavaria, incorporating the legally mandated Geological Survey Organization with remits in geological and hydrogeological surveying, mapping and modelling, scientific advisor for geothermal issues and subsurface utilization, host of central archives/databases for all Bavarian subsurface information in line with the German Mining Law			
Main project tasks and qualifications:			
LfU assumes a role in different tasks of FBD design, development and implementation with particular attention to the definition of a generic data model for feature data of faults. LfU will contribute real case fault networks of different dimensionality, LoDs and exposure in order to cover all scenarios in the FDB properly. LfU has consolidated expertise in seismic interpretation for fault assessment, structural 3D geological modelling and in trans-national semantic harmonization of geological features. LfU is (among the 16 State GSOs of Germany) the spearhead for introducing a semantic web for 3D discovery metadata (an approach adopted by OCG/IUGS-CGI) and harmonization of model units including faults. LfU will be the link to GE2-HotLime, a major producer and provider of multi-dimensional fault information, as well as to IP WP4 setting up the Open Linked Data Sematic Web and knowledge base			
Short profile of staff member(s) who will be undertaking the work			
Dr. Gerold Diepolder (male), GeoERA project coordination: senior geologist, degree and PhD in geology at the University of Munich. Joined the Bavarian Geological Survey, GLA (now: Bavarian Environment Agency, LfU) in 1990 as a research associate with remits on hydrogeology and the geopotential of the deep subsurface. Overseas assignment for the Federal Institute for Geosciences and Natural Resources (BGR) in Namibia in 2001. 2008-2016 head of the 3D study group of the German State Geological Surveys (Staat¬liche Geologische Dienste), lately realigned, now chief executive of the task force “3D geological models”. 2012–2015 Initiator, coordinator and lead of the transnational 3D modelling and geopotential assessment project GeoMol (www.geomol.eu), co-organizer of the informal European 3D Geological Modelling Community (www.3dgeology.org), active member of the OGC/IUGS-CGI Geoscience Domain Working Group. Gerold Diepolder is LEAR of the LfU and appointed GeoERA Programme Manager mandated by the Bavarian State Ministry of the Environment and Consumer Protection. **Dr. Melanie Meyer (female),** degree and PhD in geology at the University of Erlangen. Joint the			

Bavarian Environment Agency – Geological Survey in 02/2015 and is mainly involved compilation and harmonization of fault information for the geological web-atlas of Bavaria, including fault characterization and set-up of the associated feature database.

Dr. Carolin von Groote-Bidlingmaier (female), studied Geography with a minor in Geoinformatics and completed her PhD on Geoinformatics at the University of Augsburg. Since 11/2015 she is working for the Bavarian Environment Agency – Geological Survey as a geographical computer scientist in the project Infra3D. Her main tasks are the data harmonization and historization as well as the development of automated (geographical) data processing tools in the context with 3D subsurface modelling and a webGIS toolkit.

Johannes Großmann, MSc. (male), geophysical methods application, velocity modelling: graduated in geosciences at Göttingen University. 2013-2015 project team geologist at Midland Valley Ltd. (Glasgow) with remits in structural geological modelling based on seismic data. Employed by LfU since 2016, working as geophysicist in field geophysics, reflexion seismics, and structural 3D modelling.

List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.

- Rohrmüller, J., Teipel, U., Geiß, E., Diepolder, G.W., Siemon, B. & Voß, W. (2009): Airborne Geophysical Remote Sensing vs. Field Mapping: a Structural Case Study From the Vilshofen Area (Bavaria). – 6th Congress on Regional Geological Cartography and Information Systems 2009, Proceedings I: 321-323 (Munich, LfU)
- Diepolder, G.W. &. Schulz U. (2011): Tiefliegende Speicher- und Barrieregesteinskomplexe in Bayern – ein Überblick. – Schriftenr. dt. Ges. Geowiss. 74: 118-136, DOI: 10.1127/sdgg/74/2011/226
- GEOMOL TEAM (2015): GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources. Project Report. 188 S. (Augsburg, LfU).
- Von Groote-Bidlingmaier, C., Jonietz, D. & Timpf, S. (2014): Calculating Route Probability from Uncertain Origins to a Destination, In: Gartner, G. & Huang, H. [eds.] Progress in Location-Based Services 2014, Lecture Notes in Geoinformation and Cartography 19 - 32. doi: https://doi.org/10.1007/978-3-319-11879-6_2

Diepolder, G.W. (2016): From GeoMol to EGDI – towards the integration of regional 3D geological datasets into the European Geological Data Infrastructure (EGDI). http://www.americangeosciences.org/sites/default/files/igc/1691.pdf

List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.

- 2009-2012: KLIP (Klimaprogramm Bayern 2020) - 3D-Untergrunderfassung des Alpenvorlands – Mehrwert für Erdwärmenutzung und Energiespeicherung (3D based capture of the pre-alpine subsurface – adding value to the use of geothermal energy and energy storage)
- 2012-2015:GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources
- Since 2016: Infra3D – development of data model and workflow for 3D subsurface potential assessment based on heterogeneous sources and a toolkit (webGIS) for the visualization of the 3D subsurface information from various domains exploiting the achievements of transnational 3D geo-energy assessment / distribution tools

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work

- LfU 3D Explorer: www.3dportal.lfu.bayern.de
- Standortauskunft Oberflächennahe Geothermie (Information system shallow geothermal energy) http://www.umweltatlas.bayern.de/mapapps/resources/apps/lfu_angewandte_geologie_ftz/index.html?lang=de&layers=service_ageo_18
- Infra3D – development of data model and workflow for 3D subsurface potential assessment based on heterogeneous sources and a toolkit (webGIS) for the visualization of the 3D subsurface information from various domains exploiting the achievements of transnational 3D geo-energy assessment / distribution tools (under development)

Name of organisation	Islenskar orkurannsoknir - Iceland GeoSurvey		
Short name	ISOR	**Country**	Iceland

Brief description of the legal entity

ÍSOR is a governmental non-profit service, research and training institute under the Icelandic Ministry for the Environment and Natural Resources. ÍSOR is one of the world's leading geothermal consulting and research institutes and stands for over 70 years of continuous experience in geothermal research, encompassing all disciplines of geosciences, drilling engineering, utilisation technology and reservoir physics and management. ISOR has been the main scientific leader in the successful geothermal development in Iceland and collect maintains and manages earth science data used in geothermal exploration. ÍSOR carries out geological mapping in Iceland as a part of overall service to the Icelandic geothermal sector. ÍSOR employees comprise about 80, most of which have academic degrees and long experience in geothermal research and training. Groups of specialisation include: geological mapping, borehole geology, geochemistry, hydrogeology, environmental sciences, well logging, geophysical exploration, borehole geophysics, marine geophysics, reservoir modelling, drilling engineering and geothermal utilisation. During the last five years, ISOR has installed permanent sensitive local seismic monitoring networks at all high-temperature geothermal areas that are utilised in Iceland as well as at one low geothermal field.

Main project tasks and qualifications:

ISOR participates in WP-2.2, WP-3.1, WP-3.4, WP-4.1 and WP-5.1. The main task will involve precise location of earthquakes and estimation of stress field in different areas. This is carried out in connection with surface exposure of fissure

Short profile of staff member(s) who will be undertaking the work

igridur Kristjansdottir (f): Geophysicist, M.Sc. in Geophysics, Ph.D. candidate in Seismology. Monitoring of induced and natural microseismic activity in geothermal fields. Advanced processing of seismic activity, e.g. expanding seismic catalogues using template matching techniques, double difference relative relo-cations using accurate time measurements obtained with cross correlation, and stress tensor evaluations from focal mechanisms.

Hanna Blanck (f): M.Sc. in seismology. She has worked for ÍSOR since 2014 after completing her M.Sc. degree at the University of Hamburg and the Icelandic Meteorological Office. She has been working analyzing both natural and induced seismicity in two of the exploited geothermal areas in Iceland. Through the IMAGE project she gained extensive knowledge on seismic network design, setup and maintenance. Completed a training course on the SeisComPRO software and worked extensively on various modules of the SeisComP3 and the SeisCompPRO software both in setup, calibration and application for microseismic data analysis.

List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.

Kristjánsdóttir, S., Agustsson, K. Flovenz, Ó. G., Geoffroy, L., Dorbath, C. (2014). *Diverse Focal Mechanism Solutions of Microseismic Events During Active Deformation in Krysuvik Geothermal Area, SW Iceland*, in 2009. Proceedings: Stanford Geothermal Workshop, 2014. California, USA.

Ágústsson, K., Kristjánsdóttir, S., Flóvenz, Ó. G., Gudmundsson, O. (2015). *Induced Seismic Activity during Drilling of Injection Wells at the Hellisheidi Power Plant, SW Iceland*. Proceedings: World Geothermal Congress, 2015. Melbourne, Australia.

Ziegler, M., Rajabi. M., Heidbach, O., Hersir, G. P., Ágústsson, K., Árnadóttir, S. and Zang; A. (2016). *The stress pattern of Iceland*. Tectonophysics, 674, (2016), 101–113.

Kim, D., Brown, L. D., Árnason, K., Ágústsson, K., and Blanck, H. (2017). *Magma reflection imaging in Krafla, Iceland, using microearthquake sources.* Journal of Geophysical Research: Solid Earth, 122, 5228–5242.

Kristján Ágústsson and Ólafur G. Flóvenz, 2005: *The Thickness of the Seismogenic Crust in Iceland*

and Its Implications for Geothermal Systems. Proceedings of the World Geothermal Congress 2005, 24-29 April 2005, Antalya, Turkey. 9p.
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.
IMAGE: Integrated Methods for Advanced Geothermal Exploration 2013-2017. The objective is to develop new methods to scrutinize and appraise geothermal systems in such a way that exploration wells can be sited with greater accuracy than before, thereby maximizing the success rate and reducing the cost of drilling associated with geothermal projects. DEEPEGS – Deployment of deep enhanced geothermal systems for sustainable energy business 2016-2020. The aim of this project is to drill deeper into the geothermal areas, as far as 4-5 km and study the possibility for utilizing energy from lower depths than previously. Three sites will be examined; the Reykjanes geothermal area in Iceland and geothermal areas in Valence and Vistrenque in France. Regular monitoring and mapping of seismic activity of geothermal areas and interpretation of data and consultation with respect to utilization of the areas.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work
Seismic networks are on-line and SeisComp3 pro is installed and used for data acquisition and analysis of seismic data. Well logging equipment includes sonic log, televiewer, video camera for wells and more. Extensive digital geological and tectonic maps are available for the project.

Name of organisation	**Istituto Superiore per la Protezione e la Ricerca Ambientale**		
Short name	ISPRA	**Country**	Italy
Brief description of the legal entity			
The Istituto per la Protezione e la Ricerca Ambientale (Italy) is a national public body, subject to the vigilance of the Ministry for Environment, Territory and Sea. The Institute results from the merging of three former institutions: the Agency for Environmental Protection and Technical Services (APAT), the Central Institute for Scientific and Technological Research Applied to the Sea (ICRAM) and the National Institute for Wildlife (INFS). ISPRA will be represented in Geo-ERA by the former Geological Survey of Italy that is now a Department of ISPRA. It undertakes technical-scientific activities to support policies and legislation on several environmental issues (e.g. land planning, natural hazard, etc.) and provides geological data collection, management and publication. In its role of Geological Survey of Italy, ISPRA is the reference institution for the geological information in Italy, including the official geological maps of the Italian territory, as well as several databases providing information about subsurface geology and geohazards. Such information has been used for the elaboration of numerous 3D geological models in the Italian territory. Most of available geological maps and databases are now INSPIRE-compliant and fully accessible via web. Harmonization activities have been conducted in the frame of EU funded projects, together with other national geological surveys that are members of EuroGeoSurveys.			
Main project tasks and qualifications:			
ISPRA is a member of the consortium of HIKE project and has role of contributor in different tasks, with particular attention in the development and implementation of the fault database; in addition ISPRA is task leader in the Evaluation of methodologies for subsidence assessment. ISPRA has a consolidated expertise in the natural hazards analysis, in 3D geological modelling and in active faults characterization, deriving from research and institutional activities and supported by national and international projects (i.e: GeoMol; ITHACA).			
Short profile of staff member(s) who will be undertaking the work			
Dr. Pio Di Manna (male): geologist, Unit for Geodynamics, Georesources, Geohazards. Degree in geological mapping and structural analysis at the University of Rome. The main research and institutional activities focus on natural hazards analysis, impact assessment and risk mitigation actions. The key research topics are: active tectonics; earthquake geology; faulting processes – active and			

capable faults; earthquake geological effects; Tsunami hazard assessment; paleoseismological analysis. **phD Chiara D'Ambrogi (female):** senior geologist, responsible of the Sector "Geological field survey, biostratigraphy and subsurface modeling". Graduated on geological field survey and mapping at University of Rome, she earned her PhD in 1999. Field of activity: 3D geological modeling, basin analysis, seismogenic faults characterization, subsurface geopotential assessment. She participated to national and European research projects. **Dr. Maria Pia Congi (female):** geologist, Unit for Geological Surveys System and National Geological Heritage. Senior expert in GIS, Spatial Database and OGC standards. Collaborates to the creation and maintenance of the Geological Survey of Italy Portal for the services and metadata production in compliance with the INSPIRE Directive. The main research and institutional activities focus on geological database implementation and management, data model and dissemination. **phD Valerio Comerci (male):** geologist Expert in geologic interpretation of InSAR data, subsidence, applied geology, natural hazards, active tectonics and earthquake geology. Member of the EuroGeoSurveys Earth Observation and Geohazards Expert Group. Coordinator for the publication of the chapters "Natural Hazards" and "Geological Hazards" of the ISPRA environmental data Yearbook.
List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.
• Maesano, F.E., D'Ambrogi, C. (2017) - Vel-IO 3D: a tool for 3D velocity model construction, optimization and time-depth conversion in 3D geological modeling workflow. Computers & Geosciences, 99, 171-182. doi: 10.1016/j.cageo.2016.11.013 • Maesano, F.E., D'Ambrogi, C. (2016) - Coupling sedimentation and tectonic control: Pleistocene evolution of the central Po Basin. Ital. J. Geosci., 135(3), 394-407. DOI: 10.3301/IJG.2015.17 • Maesano, F.E., D'Ambrogi, C., Burrato, P., Toscani, G. (2015) - Slip-rates of blind thrusts in slow deforming areas: Examples from the Po Plain (Italy). Tectonophysics, doi:10.1016/j.tecto.2014.12.007 • Guerrieri, L., Blumetti, A.M., Comerci, V., Di Manna, P., Michetti, A.M., Vittori, E., Serva, L. (2015) - Surface Faulting Hazard in Italy: Towards a First Assessment Based on the ITHACA Database. G. Lollino et al. (eds.), Engineering Geology for Society and Territory – Volume 5, DOI: 10.1007/978-3-319-09048-1_195 • Comerci, V., Vittori, E., Cipolloni, C., Di Manna, P., Guerrieri, L., Nisio, S., Succhiarelli, C., Ciuffreda, M., Bertoletti, E. (2015) - Geohazards monitoring in Rome from InSAR and in-situ data: outcomes of the PanGeo Project. Pure Appl. Geophys., v.1 72/11, 2997-3028. DOI: 10.1007/s00024-015-1066-1
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.
• GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources • ESTMAP – Energy Storage Mapping and Planning • EUOGA – EU Unconventional Oil and Gas Assessment • U-Geohaz - Geohazard impact assessment for urban areas • PanGeo – A GMES – Copernicus service enabling access to geological information
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work
ISPRA realizes activities on surveying, mapping, modeling, collection, management and dissemination of base geological and geothematic data at national level. ISPRA provides cognitive tools for proper territorial planning and management and, in particular, for the prevention, reduction and mitigation of geological risks and their interactions or conflicts with geoenergy exploitation. All the collected data are accessible at the ISPRA web portal and are available to the project (http://sgi.isprambiente.it/geoportal/catalog/main/home.page).

Name of organisation	**Servizio Geologico, Sismico e dei Suoli della Regione Emilia-Romagna**		
Short name	SGSS	**Country**	Italy

Brief description of the legal entity

SGSS is an technical entity of Emilia-Romagna region (public body). The present organisation was established in 2001 (DGR 2832_2001 and DGR 1526_2011) to support the regional government policies dealing with the environment and land planning. Since 1976 Emilia-Romagna region had a geological office, were many people of the present staff were already employed, that became SGSS in 2001. The mission of the Survey is to provide the Emilia-Romagna administration and society with basic up-to-date geological, pedological and geothematic information. The remit of the Survey at present encompasses activities related to the monitoring of specific natural processes which affect the territory of Emilia-Romagna (subsidence, saltwater intrusion in groundwater, landslides, sea storms), the reduction of seismic risk and the identification and study of natural resources (water,soil, geothermal energy, mining and aggregates resources). The survey's core skills include data management, geo-ICT and 3D-modelling.The basic geological knowledge, provided by the Geological, seismic and soil survey, is crucial to a wide range of social issues, including resource security/sustainability (energy, minerals, water), environmental monitoring, health and safety of citizens, and the development of secure infrastructures (natural hazards).

Main project tasks and qualifications:

SGSS has role of contributor with particular attention in the development and implementation of the fault database. SGSS has a consolidated expertise in the natural hazards analysis and in 3D geological modelling deriving from research at regional scale.

Short profile of staff member(s) who will be undertaking the work

Dr. Fabio Carlo Molinari (male): senior geologist, responsible for the research and characterization of the geothermal resource at the regional scale and deep 3D geological modeling. Graduated on geological field survey at University of Parma. Filed of activity: 3D geological modeling, basin analysis, seismogenic faults characterization, subsurface geothemal assessment. He participated to national and European research projects.

Dr. Alberto Martini (male): senior geologist, management and development of the geological database. Filed of activity: management and development of the geological database; 3D geological modeling. He participated to national and European research projects.

List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.

GEOMOL TEAM (2015) - GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources. Project Report. 188 S. (Augsburg, LfU)

Explanatory Notes of the Seismotectonic Map of Emilia-Romagna Region and Sorrounding Areas (2017)

List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.

GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources

Seismotectonic Map of Emilia-Romagna Region and Sorrounding Areas (2017)

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work

SGSS realizes activities on surveying, mapping, modeling, collection, management and dissemination of base geological and geothematic data at regional level. http://ambiente.regione.emilia-romagna.it/geologia

Name of organisation	**Agenzia Regionale per la Protezione Ambientale del Piemonte**		
Short name	ARPAP	**Country**	Italy

Brief description of the legal entity

ARPAP is a public body with independent status for administrative, technical-juridical, asset management and accounting purposes, and it is a leading centre of studies and applied research in the field of natural risk. Its aim is the development of methodologies and tools to assess, manage and minimise the geological risk. It operates under the oversight of the Chairman of the Executive Committee of the regional government so as to ensure compliance with the policy guidelines issued by the Piedmont Region in the fields of forecasting, preventive actions and preservation of the environment.

Arpa Piemonte is a member of a network of Agencies that includes the Higher Institute for Environmental Protection and Research (Istituto Superiore per la Protezione e la Ricerca Ambientale - ISPRA).

ARPAP perform the task of monitoring and preventing natural hazards and acquired full responsibility for all environmental protection and control functions.

ARPAP will be represented in Geo-ERA through the geological survey of the Piemonte region which provides geoscientific and elaboration data, information and knowledge to:

- address and management environmental problems;

- obtain in-depth knowledge of the territory and define appropriate measures for its enhancement and reduction of environmental risks.

Main project tasks and qualifications:

Short profile of staff member(s) who will be undertaking the work

Dr. Luca Mallen (male): senior geologist and senior GIS analyst in the Geological and Hydrogeological instability in the Department of Arpa Piemonte Torino. I graduated from the University of Turin (Italy) with a M.Sc. degree in Geological Sciences. Experienced in 3D geological modelling and GIS specialist and Domain Analyst in the field of geological and environmental software applications. I participated to national and European research projects.

PhD Michele Morelli (male): senior Geologist and Structural Geologist in the Geological and Hydrogeological instability in the Department of Arpa Piemonte Torino. Experienced in 3D geological modelling. I graduated from the University of Turin (Italy) with a M.Sc. degree in Geological Sciences. I received a Ph.D. from the University of Torino, for a research of remote sensing applied to structural geology. I have then work as research in the Geoscience and Earth Resources Institute of Italian National Research Council, for activity on remote sensing applied to fracturing of rock mass. I participated to national and European research projects.

Dr. Gabirele Nicolò (male): Geologist employed as senior GIS specialist in the Technical Functional Department of Arpa Piemonte (Torino, Italy). I graduated from the University of Turin with a M.Sc. degree in Geological Sciences and an Alpine Hydrogeology dissertation. During the first three years after graduation I worked as professional geologist in the field of geotechnics and geomorphological mapping. After that I was employed as GIS specialist and Domain Analyst in the field of geological and environmental software applications. At present in my job I deal mainly with spatial analysis and modelling in the field of geological and environmental applications. I participated to national and European research projects.

List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.

Morelli M., Piana F., Mallen L., Nicolò G., & Fioraso G (2011). Iso-Kinematic Maps from statistical

analysis of PS-InSAR data of Piemonte, NW Italy: Comparison with geological kinematic trends. Remote Sensing of Environment vol 115 (5), 1188-1201 Perrone, G., Morelli, M., Piana, F., Fioraso, G., Nicolò, G., Mallen, G., & Tallone, S. (2013). Current tectonic activity and differential uplift along the Cottian Alps/Po Plain boundary (NW Italy) as derived by PS-InSAR data. Journal of Geodynamics, 66, 65–78. Cravero M., Piana F., Ponti S., Tallone S., Balestro G. & Morelli M. (2007) Aggregated 3D simulation of "fracture ensembles" Geophysical Research Abstracts, Vol. 9, 08049, 2007 SRef-ID: 1607-7962/gra/EGU2007-A-08049© European Geosciences Union 2007.
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.
Alps GPS Quakenet: Alpine Integrated GPS Network: Real-Time Monitoring and Master Model for Continental deformation and Earthquake Hazard.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work
ARPAP: Portal and Repository of surface and subsurface data and 3D models of the Piemonte Region. ARPAP maintains and disseminates all data and in-house data acquisition programmes, including 3D modelling, borehole data and geologic data. These data are public and available to the project.

Name of organisation	**Lietuvos Geologijos Tarnyba prie Aplinkos Ministerijos**		
Short name	LGT	**Country**	Lithuania
Brief description of the legal entity			
LGT is an independent governmental institution, which directly carries out geological investigations necessary to the State and controls the system of geological information alongside the regulation of the use of subsurface. LGT is responsible for organization and execution of the State geological investigations (mapping, monitoring, etc.), State regulation and control of the use of subsurface (preparations of legal acts related to the use of underground; regulation of the use of subsurface: mining permits, permits for geological activity, groundwater permits, registration of geothermal systems, register of subsurface; supervision of monitoring programmes, engineering geological and ecogeological projects), creation and development of the system of State geological information and accumulation of data, development of international cooperation. LGT will be represented in Geo-ERA through the Lithuanian Geological Survey, which provides geoscientific data, information and knowledge for: • Implementation of the State policy in the field of the sustainable use of subsurface resources, development of their extraction, creation and implementation of the legal system regulating the investigation, use and protection of the subsurface; • Sustainable management of earth resources and the environment in general; • Subsurface and groundwater protection for public health care; • Prevention of geological hazards and reduction of risks associated with geological processes and subsurface conditions. The survey's core skills and services relate to subsurface investigations and protection, and include geological data management. Its products and services are primarily targeted at the groundwater, mineral resources and energy sectors (the latter in the broadest possible sense, including land use and environmental planning). The organisation hosts the national repository for subsurface data and information and is the designated state advisor of all geological matters related to the Subsurface Law.			
Main project tasks and qualifications:			

LGT would mostly contribute to in WP2 focussing on providing data and information for - collection, processing and harmonization of fault, well and seismic data from case study test area for common and uniform European fault data model also contributing the knowledge in demonstration the functionality, applicability and added value of such a model in various practical use cases in test area. Also LGT would contribute to WP 3 and WP4 providing seismic data and knowledge for advancing localization of seismicity events in low seismicity intracratonic areas where the uncertainties in low magnitude earthquakes recording/location are mostly due to unreliable and specific data.
Short profile of staff member(s) who will be undertaking the work
Dr. Lazauskienė Jurga, is head of the Department of Bedrock Geology at LGT and an Associate Professor at Vilnius University (Lithuania). Her activities at the LGT focuses on underground storage, geothermal energy; radioactive waste repositories potential assessment and seismotectonic issues of the subsurface related projects, geological mapping, creation on geological models of Earth sub-surface etc. Since year 1996 Dr. Jurga Lazauskiene carries out and co-ordinates the activities of geological and structural mapping. Since 2002 she participate in the activities dealing with the assessment of the disposal of spent nuclear fuel and underground storages in Lithuania. Dr. Lazauskienė was involved in the South Permian Atlas project; projects on the thermal maturation and burial history and the 3D modeling of the Baltic Sedimentary Basin. Dr. Lazauskienė was a co-leader of the IGCP 449 project “Devonian land-sea interaction: evolution of ecosystems and climate”. Since year 2002 she was actively involved in the IUGS activities, e.g. Commission on Geosciences for Environmental Management (GEM); participated in the EUROPROBE project. Her current research interests include sedimentary basin analysis, numerical modelling, tectonics and seismo-tectonic, geodynamics, seismicity analysis, hydrocarbon and geothermal potential related issues, geo-environmental issues in the wide regional context. Author/ co-author of over 40 research papers, more than 60 scientific reports and abstracts. Dr. Čyžiene Jolanta studied geology at Vilnius University (master degree diploma of Vilnius University received in 1997), in 2006 obtained PhD degree in Vilnius University and Technical University of Denmark). Since 1999 she worked in LGT as Head of Regional geology and Tectonics Subdivision of LGT; from 2014 march she works as Deputy Director of LGT. She is initiating, participating and leading research and geological investigation activities related to the on underground storage, geothermal energy; radioactive waste repositories potential assessment, the other environmental, tectonic and seismological issues, bedrock and oil geology in Lithuania, also dealing with structural geology and tectonic thematic. Author/co-author of over 30 research papers, more than 40 scientific reports and abstracts. **Gintarė Andriuškevičienė**, obtained Master degree in geology at Vilnius University in 2012. She has been working in LGT since 2012 mainly on geo-energy themes. She participates in the activities dealing with the assessment of underground storages potential in Lithuania: in 2012-2014 was the project leader of the LGT project “Evaluation of the potential of the local structures in the western Lithuania for CO2 storage“; in year 2012 – 2013 co-ordinated the LGT project „The methodology for the underground gas storage assessment in underground cavities" and was one of the co-author of final report.; was involved in the assement of the hydrocarbon resources in Western Lithuania. Since 2017 she is head of Region geology and Tectonic subdivision at the LGT. During her working years, Gintare took place in some EU funded projects such as EmodNet, EUOGA, Shale gas in Lithuania; Safe environment and economic profit. **Dr. Audrius Čečys** is the chief seismologist at the Lithuanian Geological Survey and an assistant Professor at Vilnius University (Lithuania). His work at the Lithuanian Geological Survey include seismological monitoring of Lithuania and surounding areas, and tectonic/seismotectonic projects. He participated in the EUROPROBE project. His current research interests include tectonics and seismo-tectonics, seismicity analysis, geo-environmental issues in the wide regional context.
List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.
1. “Compilation of the tectonic, geotectonic and geophysics data base for the potential construction sites of the Visaginas nuclear power plant; evaluation of the of the geological hazards” (Lazauskienė,

J, Čyžienė, J., Baliukevičius A.). 2. Wilde-Piorko M., Geissler W., Plomerova J., Grad M., Čyžienė J., Lazauskienė J., Motuza G., Šliaupa S.et al. 2008. PASSEQ 2006-2008: passive seismic experiment in Trans-European Suture Zone. Studia geophysica et geodaetica. 52, 3. 439-448. 3. Lazauskienė, J., Pacesa, A., Satkūnas, J. 2012. Seismotectonic and seismic hazard maps of Lithuania – recent implications of intracratonic seismicity in the Eastern Baltic Region. Geologija.vol. 54 (1), 1-9. 4. Knapmeyer-Endrun B. et al. 2013. Tracing the influence of the Trans-European Suture Zone into the mantle transition zone. Earth and Planetary Science Letters. 01/2013; 363:73-87. 5. Janutyte I., et al. 2013. Study of Local Seismic Events in Lithuania and Adjacent Areas Using Data from the PASSEQ Experiment. Pure and Applied Geophysics. 01/2013; 170(5):797-814.
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.
Relevant Projects 1. Preparation and execution of the "Program of the assessment of the seismicity of the territory of Lithuania for years 2007-2010". 2. Project „Integrated investigation of seismicity in the Lithuanian territory". 2013-2015. Software CRISIS99 (Ordaz et.al. 1999) was used for the numerical probablistic seismic hazard assessment of the territory of Lithuania. 3. The project "Passive seismic monitoring of the territory of Lithuania" within the framework of the international Passive Seismic Experiment in Trans-European Suture Zone (PASSEQ 2006-2007). 4. The project "Modelling of the tectonic dislocations Baltic Sea offshore 2003-2007. 5. The project of the seismological monitoring of Lithuania, 1999 -recent.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work
A large data set of geological, geophysical, seismic data (e.g. well log data of 271 wells (~3728 well logs); ~ 9 000 km of 2D, 3D seismic data) and interpreted results are accumulated in the archives and databases of LGT. The Subsurface Information Centre with the Core storage contains core of ~ 10 000 wells >1000 wells more than 2 km deep), that are available for the various applications. LGT is responsible for the seismological monitoring in Lithuania that is carried out from year 1999. The seismological network consists of four 1-component seismic stations with Guralp sensors installed in the boreholes and two very-broadband 3-component seismic stations with STS-2.5 sensors installed in vaults, which are included into GEOFON network. 8 portative seismic stations with integrated three-component seismic sensors (P3CSS) SARA SL-07 are available to record short period ground motions with frequency from ~ 4 to 100 Hz for: aftershocks after a major earthquake; explosions in quarries and construction sites; hydrofracturing and the other sources that induce short-period seismic waves monitoring.

Name of organisation	**Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy**		
Short name	PIG-PIB	**Country**	Poland
Brief description of the legal entity			
Polish Geological Institute- National Research Institute (PIG-PIB) is a state research institution with over 600 high-qualified employees in field of geology, hydrogeology and environmental studies, who work on national and international projects. PIG-PIB's headquarters are located in Warsaw, Poland, and the company has seven local branches located in Kraków, Wrocław, Sosnowiec, Gdańsk, Kielce, Szczecin and Lublin. PIG-PIB undertakes scientific research and development in fields of earth science, biology, environment and engineering. It also acts as Polish Geological Survey and Polish Hydrogeological Survey and as such it undertakes numerous tasks focused on examining, documenting as well as assessing and protecting national natural resources including groundwater. As leading geological institution in the country, PIG-PIB provides scientifically based advice and support to local and national administration as well as undertakes initiatives focused on promoting and informing society about geological science and issues related to natural resources and their protection. It is			

involved in comprehensive studies of geological structure of the country for practical use in national economy and environmental protection. Moreover, it is responsible for the country's security in supply of mineral resources, the groundwater management, for monitoring of the geological environment and warning against natural hazards and risks
Main project tasks and qualifications:
PIG-PIB leads a task about sealing assessment and contributes to fault data base. PIG-PIB has an expertise in hazard and impact assessment related to subsurface use for geo-energy purposes, in particular in CO_2 storage and hydrocarbon exploration and exploitation. PIG-PIB coordinated and was the main contributor to the national programme "Assessment of formations and structures suitable for safe CO_2 geological storage including monitoring plans" (2008-2012/2013; Ministry of Environment) and participated in CGS Europe and ECCSEL (FP7&H2020) EU projects. PGI has provided expertise to the first Polish demo project Bełchatów, and other planned CCS projects ("CCS ready" prefeasibility studies). Since 2010 PIG-PIB has been involved in assessment of environmental impact of unconventional hydrocarbons exploration, leading projects and performing desktop and field studies on several well sites in Poland commissioned by the Polish Government as well as being involved in M4ShaleGas Horizon2020 project as a WP leader. The PIG-PIB has been developing 3D geological models for over a decade. We construct both structural and parametric models for detailed spatial analyses. The modelling team is constructing regional-scale 3D models, e.g. a parametric model of an entire sedimentary basin (Lublin Basin), as well as local models for CCS, Hot Dry Rocks or shallow geothermal energy. We use commercial software (eg. GOcad / Skua, Petrel), open source (GRASS-GIS) and independently developed scripts. Besides static modelling, the PIG-PIB is also experienced in mathematical modelling of geological processes. PGI is a member of EERA Joint Programmes of Shale Gas, CCS and Geothermal and lead the European Science and Technology Network on Unconventional Hydrocarbon Extraction.
Short profile of staff member(s) who will be undertaking the work
Monika Konieczyńska, PhD, female - graduated from Faculty of Geology, Warsaw University, Department of Environmental Science, Central European University in Budapest, M.Sc. in Faculty of Science and Engineering, University of Manchester, post-graduate studies in Technology of unconventional natural gas production, hydrogeologists, PhD in earth sciences. Since 1995 in the Polish Geological Institute, Department of Environmental Geology - scientific and applied projects on surface and groundwater and land contamination assessments and remediation, involved in CCS and unconventional hydrocarbons resources topics, with special concern of environmental hazards due to CO_2 underground storage and hydrocarbons exploration and production from unconventional oil and gas deposits. 2009-2011 - head of Department of Environmental Geology, since 2017 - head of Environmental Geologyand Geochemistry Department in the Polish Geological Institute - National Research Institute, a member of GeoEnergy Expert Group within EuroGeoSurveys - Geological Surveys of Europe. Since 2011 - a leader of a joint team working on environmental aspects of hydrocarbons exploration and production, involved in the EERA (European Energy Research Allianz) Joint Program Shale Gas and the WssTP (The European Technology Platform for Water) Working Group Oil, Gas and Water. **Olga Lipińska, MSc, female** - graduate of the Faculty of Geology of the Warsaw University; environmental protection specialisation (Master of Science degree in 2008), in Polish Geological Institute – National Research Institute since 2009, currently Environmental Geology and Geochemistry Department; since 2010 senior specialist; participates in the works associated with the impact assessment of human activities on the natural environment. In 2011 she participated in the programme of study visits to the USA, related with shale gas development, organised by the US Department of State. Since 2012 she has participated in research on the impact of unconventional hydrocarbons exploration and exploitation, including hydraulic fracturing on the natural environment. In 2015 completed post-graduate studies in Technology of unconventional natural gas production. In 2017 she participated in Pioneers into Practice Programme funded by the European Institute of Innovation & Technology; during one-month placement in Regional Environmental Agency in Emilia-Romagna Region (Italy) she worked on geothermal resources (potential, application and environmental impact). **AndrzejGłuszyński, PhD, male** – graduate of the University of Wroclaw, Institute of Geological Sciences, and Warsaw School of Economics (Project Management postgraduate studies 2016-2017).

In Polish Geological Institute – National Research Institute since 2013, participates in the works associates with Interpretation of 2D and 3D seismic data (also interpretation of seismic attributes), subsurface geological mapping, building 3D static geological models in Petrel, well log correlation, unconventional hydrocarbons in Poland, structural mapping, structural logging of drill cores.

Maria Przyłucka, PhD, female – graduate of the Warsaw University of Technology, Faculty of Geodesy and Cartography; Photogrammetry and Remote Sensing specialization; PhD obtained in 2017 (Thesis title: Geostatistical analysis of the conditions of terrain surface subsidence identified using satellite interferometry in the Upper Silesian Coal Basin). In Polish Geological Institute – National Research Institute since 2010, currently Geohazards Programme; senior specialist; participates in the works associates with study of vertical ground deformations using radar interferometry techniques, use of terrestrial laser scanning to build 3D models of landslides, implementation of the statutory tasks of remote sensing and photogrammetry. Since 2015 Deputy Chair of EuroGeoSurveys Earth Observation

List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.

Konieczyńska M. et al,, 2015, The environment and shale gas exploration results of studies on the soil – water environment, ambient air, acoustic climate, process fluids and waste, Warsaw, Poland;

Konieczyńska M., Lipińska O., Fajfer J., Konon A., Wojcieszak Ł., Kwecko P., Mikołajków J., Jóźwiak K., 2017, Environmental monitoring for shale gas. M4ShaleGas -Measuring, monitoring, mitigating and managing the environmental impact of shale gas;

Przyłucka M., Herrera G., Graniczny M., Colombo D, & Béjar-Pizarro M. 2015, Combination of conventional and advanced DInSAR to monitor very fast mining subsidence with TerraSAR-X Data: Bytom City (Poland), Remote Sensing, 7(5), 5300-5328.

Głuszyński A., 2012, Basement of the Carpathian foredeep at Pilzno (SE Poland) in seismic data, MineraliaSlovaca 44/1/2012 p.83, StatnyGeologickyUstav, Bratislava;

Tomaszczyk M., Jarosiński M., 2017, The Kock Fault Zone as an indicator of tectonic stress regime changes at the margin of the East European Craton (Poland),Geological Quarterly. 61. 10.7306/gq.1380

List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.

M4ShaleGas -Measuring, monitoring, mitigating and managing the environmental impact of shale gas, the project funded by the European Union's Horizon 2020 Research and Innovation Programme and aimed at addressing the specific challenge related to understanding, preventing and mitigating the potential environmental impacts and risks of shale gas exploration and exploitation; work-package leader; 2015-2017

Geodynamic monitoring in the field of satellite interferometry of Polish salt domes belt and an attempt to determine the mobility of the salt in the Quaternary using electrical resistivity tomography and 3D modelling techniques, project funded by Polish Ministry of Environment

Study the possibility of applying digital 3D models acquired by close range photogrammetry techniques for monitoring landslides on the example of the slope in Plock and landslides in Dobrzyn the Vistula River, project funded by the statutory activities of PIG-PIB

PanGeo - Enabling Access to Geological Information in Support of GMES, project funded by EC 7th FP

SubCoast – GMES-service for monitoring and forecasting subsidence hazards in coastal areas around Europe, project funded by EC 7th FP

Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work

Software for constructing 3-D static geological models - Schlumberger Petrel and GOcad/Skua, modelling of flow of reservoir fluids - TOUGH2, modelling of fault integrity - Badleys T7

Name of organisation	**Laboratório Nacional de Energia e Geologia**		
Short name	LNEG	**Country**	Portugal

Brief description of the legal entity

The National Laboratory of Energy and Geology (LNEG) is a State Laboratory of the Ministry of Economy that makes RD&D oriented to the needs of society and enterprises, investing in a sustainable research, along with international best practices.

LNEG's mission is to promote technological innovation in science and technology oriented for economic development contributing to increase in competitiveness of economic agents in the context of sustainable progress of the Portuguese economy. In accordance with the Portuguese Government's strategies and policies for economic and social development, LNEG takes up the role of an interface between results generated by R&D programs and their technological transfer and integration into the energy and geology productive sector.

LNEG´s participation in a broad range of international projects confers it the role of a key partner for internationalization, as well as of a source of specialized information over a number of R&D fields.

LNEG inherited competencies from the former geological survey dating back to over 150 years. Accordingly, LNEG is the national repository for geological, geochemical, mineral resources, drill core, and groundwater geodatabases and is responsible for its maintenance as well as new data acquisition and public dissemination of scientific knowledge. http://geoportal.lneg.pt

LNEG provides consultancy on geology, geophysics, and hydrogeology to private companies, municipalities and governmental agencies in support of georesources, geohazards, environmental monitoring and land planning decisions and policies. Website: www.lneg.pt

LNEG has long-time experience in EU funded projects (OneGeology, OneGeology-Europe, AEGOS, PROMINE, EuroGeoSource, PanGeo, GeoSeas, Minerals4EU, PROSUM, MICA,).

The survey's core skills include geological, hydrogeological and coastal geology mapping, research on petrology and geochemistry, groundwater, coastal geology, geophysics, geo-resources, raw materials, and geoinformation

LNEG is theme coordinator (III/8, /20 and /21) of a national INSPIRE working group. Over the years LNEG has come to acquire international experience by carrying out joint development projects including joint research projects with other research institutes and EU Programmes, including Africa and South America.

Main project tasks and qualifications:

Advanced fault location and characterization technique using geophysical, geological and borehole data

Short profile of staff member(s) who will be undertaking the work

João Carvalho (male) holds a PhD in Physics (Solid Earth Geophysics, 2004) and a M.Sc. in Solid Earth Geophsyics (1997) both at University of Lisbon. He is a senior Geophysicist at LNEG where he develops and applies seismic and potential field methods to resources exploration, tectonics, environment, engineering, geothermics, etc. Participated in more than 30 research projects, supervised multiple post-docs, M.Sc., and graduation scholars. Published more than 30 papers in international peer-reviewed journals and book chapters and over 90 works in international and national congresses. Was vice-president of the Geology Section of LNEG's Scientific Council in 2012. Invited speaker and chairman in international conferences, he is also a collaborator of the Instituto Dom Luíz of the University of Lisbon and of the Centre of Geophysics of the University of Évora.

Ruben Pereira Dias (male), PhD by the University of Lisbon in 2001, Geologist, Coordinator of Portuguese geological and hydrogeological mapping and drill core library. Presently is researcher and

Head of the Geology, Hidrogeology and Coastal Geology Unit of the Laboratório Nacional de Energia e Geologia. Skills are mainly: Neotectonic and Sismotectonic and structural geology research; Geological Mapping of the Portuguese Cenozoic terrain; International Geological and geo-environmental mapping; air photo interpretation; Geological Hazard research; scientific orientation/supervision and land use planning activities. Has published several peer reviewed international and national papers papers and conference abstracts. Participated or validated Geological Mapping of Portugal, Macau e Mozambique and Map Explanation Booklet.

Elsa Cristina Ramalho (female), PhD in Geosciences (2013), develops her R&D research in LNEG since 1994. Her work is fundamentally dedicated to shallow and depth Geophysics Applied to mineral resources, groundwater and environment through the use of electrical, radiometrics, magnetics and geophysical logging methods. She is also focused in shallow and deep geothermal. Participated and/or coordinated more than 30 research projects with national, European and international funding and in more than 30 ATTs. Author and/or co-author of 1 book, 7 book chapters, 22 papers in international circulation ISI journals, more than 60 extended abstracts, more than 40 oral presentations and more than 100 scientific and technical reports. Cooperated in about 30 scientific events organizations and in the development of didactic materials and is often invited to lectures. Invited Teacher in the University of Lisbon for several subjects related with geophysics and geothermics. Belongs to the actual Executive and Editorial Commission of LNEG's journal Comunicações Geológicas. Represents LNEG in the international investigation networks Alcuenet, COST and training (Geotrainet).

Judite Fernandes (female) graduated in Economic and Applied Geology (1992) by the University of Lisbon, Portugal. Since 1996 integrates LNEG's Department of Geology, Hydrogeology and Coastal Geology and has been developing research and acquiring experience on: hydrogeology and hydrochemistry, hydrogeological mapping and GIS, flow and hydrogeochemical modelling, hydrogeophysics, geostatistics, saltwater intrusion, contamination and aquifer remediation, drilling and piezometer construction, aquifer testing, installation, operation and maintenance of monitoring equipment, land use planning activities, tenders for research grants, tenders for national projects, tenders for international projects, scientific orientation/supervision, national project management, planning and management, hydrogeological consultancy. Published over 40 papers and book chapters.

José Sampaio (male) possesses a degree in Geological Engineering from the University of Aveiro, Portugal (1994). In the scope of his activity at LNEG he has worked performed research in Hydrogeology involving general knowledge of geology, hydraulic, hydrology, geochemistry, climatology, geophysics, groundwater wells construction, geostatistics, and software applications. He is also experienced in hydrogeological data acquisition and processing, hydrogeological modelling and mapping, thermal and mineral waters prospecting and characterisation, hydrogeology of Azores volcanic islands and CO2 geological storage in saline aquifers. Produces technical and scientific reports of national and international projects and services delivery, manifold short hydrogeological advisory technical reports. Has published over 10 chapter books and presented multiple lectures on these subjects.

Susana Machado (female) has a MSc in Geodynamics by the University of Lisbon (1997) and graduated in Geology also by the University of Lisbon (1993). She is currently a Geologist at LNEG and has experience in Mesozoic sediments (mainly carbonate) mapping and thematic mapping, characterization and assessment of carbonate Geological heritage, land use planning activities, assessment of environmental impact studies, CO2 geological storage studies, Mesozoic geology consulting services and she is an editor of the national geological journal “Comunicações Geológicas”. Produced 5 peer-reviewed publications and over 20 abstracts in congresses.

Augusto Filipe (male) holds a degree in Mining Engineering by the Universidade of Coimbra (1986) and a post-graduation in Georesources by the Instituto Superior Técnico (2004). He has 29 years of experience in characterization and management of the portuguese mineral resources, creation and development of DBMS, management of mineral resources in GIS (highlight to the DBMS SIORMINP-Information System of Portuguese Occurrences and Mineral Resources), management and promotion

of national mineral resources (highlight to the support provided to the mining companies), experience in providing technical support to government agencies, academic institutions and others users. Produced over 60 publications and around 2000 technical reports. Contributed to the land-use of the national territory and provided mineral resources information to some European projects, such as INSPIRE, PROMINE, EUROGEOSOURCE, MINERALS4EU and MINATURA 2020.
List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.
• Carvalho, J., Ghose, R., Alves, D., Leote, J., 2016, Earthquake faulting-related deformation in soil evidenced in S-wave shallow reflection data: field results from Portugal, Geophysics, vol. 81 (5), IM97-IM108. doi:10.1190/geo2015-0040.1. • Ghose, R., Carvalho, J., Loureiro, A., 2013, Signature of fault zone deformation in near-surface soil visible in shear-wave seismic reflections. Geophysical Research Letters, 40 (6), 1074-1078, DOI: 10.1002/grl.50241. • Product: 2010, Geological Map of Portugal Scale 1: 1 000 000. Laboratório Nacional de Energia e Geologia, Lisboa, Portugal., http://geoportal.lneg.pt/geoportal/mapas/index.html • Service: 2017, Geoportal (interactive geological, borehole and other data visualization), http://geoportal.lneg.pt/ • Publication: Vilanova, S.P., Nemser, E., Besana-Ostman, G.M., Bezzeghoud, M., Borges, J.F., Brum da Silveira, A., Cabral, J., Carvalho, J., Cunha, P.P., Dias, R.P., Madeira, J., Lopes, F.C., Oliveira, C.S., Perea, H., García Mayordomo, J., Wong, I. Arvidsson, R., Fonseca J.F.D.B., 2014, Incorporating Descriptive Metadata into Seismic Source Zone Models for Seismic Hazard Assessment: A case study of the Azores-West Iberian region, Bulletin of the Seismological Society of America, 104 (3), https://pubs.geoscienceworld.org/ssa/bssa/article-abstract/104/3/1212/351442.
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.
• 2010-2012 EU research Project "COMET-Integrated Infrastructure for CO2 Transport and Storage in the West Mediterranean", financed by FP7 (3 Meuros) with the goal of identifying geological structures for CO2 storage in Western Mediterranean region (Portugal, Spain and Morocco). LNEG performed integrated study in the Lower Tagus Basin for feasibility based on geological model of reservoir, sealing properties and reservoir properties. Seismic reflection and borehole data with physical properties of geological formation were used to generate 3D velocity/structural model and identify major fault zones in the Lower Tagus Basin using seismic reflection, geological outcrop and well data. • 2010-2012 EU research Project "Promine - Nano-particle products from new mineral resources in Europe". Focused on creation of PAN-EU GIS-based mineral resource and advanced modeling system for the extractive industry, showing known and predicted, metallic and non-metallic mineral occurrence across the EU. Financed by FP7 (3 MEuros). LNEG performed the Modeling of the Neves Corvo-Alcoutim area of the Iberian Pyrite Belt, with identification of fault zones and construction of 3D geological models using seismic reflection, potential-field and drill-hole data. • 2010-2013 research project "ATESTA– Active Tectonics and Earthquake Scenarios for the Lower Tagus Valley" - PTDC/CTE-GIX/099548/2008, financed by the Portuguese Foundation for Science and Technology (200 KEuros). Starting with regional observations in instrumental and historical seismicity, geology and geodesy, the project aimed to identify and characterize active fault scarps susceptible to have produced historical earthquakes. Used high resolution geophysical imaging methods (reflection seismics, electrical tomography and ground-penetrating radar) to pinpoint the exact trace left by recent surface faulting. Opened paleoseismic trenches to observe buried ruptures directly, infer their relationship with the stratigraphy, measure co-seismic displacements and collect samples for dating. In the end, that zooming-in process will permit to characterize the fault(s) at all scales and yield the precise location of active faults, slip rate values, maximum magnitude (as a function of the fault's dimensions) and return periods (through the chronology of recent surface ruptures). The correlation with known historical earthquakes validate our findings. Based on fault geometry, segmentation and return periods, realistic earthquake scenarios for the Lower Tagus Valley

were proposed. LNEG carried out fault location and characterization using geophysical and geological outcrop data. • Research Project "SCENE– Site Condition Evaluation for National Seismic-Hazard Estimation" - PTDC/CTE-GIX/103032/2008, financed by the Portuguese Foundation for Science and Technology (200 KEuros), aims at gathering disperse subsurface geophysical, geotechnical and geological information performed for specific purposes at a national level; and at acquiring geotechnical and geophysical data to characterize near-surface-soil conditions and shear-wave velocity profiles where strong-motion instruments are deployed. These data will serve a dual-purpose in terms of direct applications: 1) the characterization of strong-motion sites which is information required both to address the applicability of sophisticated hazard-purpose ground-motion models, and to perform ground-motion modeling; 2) the development of a database relating near-surface lithology and shear-wave profiles for the upper 30 m that would allow the inclusion of first-order site effects in regional seismic hazard maps, thus better representing regional susceptibility due to ground shaking. LNEG's Taks was to perform near-surface characterization using seismic methods and borehole data. • 2007-2008: Protocol with the national Authority for Civil, Protection (SNBPC) "ERSTA- SeismicRisk and Tsunamis Study of Algarve", financed by SNBPC (122,4 Keuros), which aimed to develop a detailed emergency plan in case of earthquake and tsunamis occurrence; a GIS-based database with near surface properties, fault parameters, digital-terrain model, water penetration, etc. which allowed to establish different earthquake scenarios. LNEG estimated fault parameters from geophysical and geological outcrop data and determined of near surface P-wave and S-wave velocities in the Algarve region.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work
Borehole Database: LNEG is the national repository of well cores (oil, mining, etc.) and borehole reports for water supply and geotechnical RAS-24 modules Seismic data acquisition system (24) bits of 72 channels and seismic source for depth up to 1km EM (Electromagnetic) data acquisition system

Name of organisation	**Geološki zavod Slovenije**		
Short name	GeoZS	**Country**	Slovenia
Brief description of the legal entity			
Geološki zavod Slovenije - Geological Survey of Slovenia (GeoZS) is a public research institute with approximately 90 employees and established by the Government of the Republic of Slovenia. More than 60% of them have high education. GeoZS carries out fundamental and applied research in geology, e.g. regional geology, hydrogeology, geochemistry, sedimentology, paleontology, petrology, tectonics, geophysics, mineral resources, geothermal energy, geohazard, GIS and education, and provides a public service through scientific research programs and active cooperation with universities. GeoZS is tightly involved in national and international research and professional communities in Europe and worldwide, where it contributes to development of geo-sciences. All activities are supported by the Geological information Centre, responsible for the collection, processing, storage and dissemination of geological data. GeoZS supports national authorities and agencies (Ministry of the Environment and Spatial Planning, Slovenian Environmental Agency, Ministry of Infrastructure) in the process of concession granting for mining and thermal water use.			
Main project tasks and qualifications:			
The GeoZS structural geology and fault database team combines specialists in regional, structural geology, geomorphology and geophysics. The team performs research and database of active faults of Slovenia, as well as seismotectonics and seismic hazard studies and structural investigations for the various applicative and EU projects. Within the HIKE project GeoZS will be mainly involved in the WP2 activities with development, specifications, collection, population and implementation of a European			

Fault Database with data from Slovenia. There is already developed map of active faults of Slovenia, with all attributes. It is currently in process of cross-border harmonization with neighboring Austria Fault Database. Geological Survey of Slovenia will be partially involved also in the other WPs.
Short profile of staff member(s) who will be undertaking the work
Bogomir Celarc (male) holds a Ph.D in Geology from 2004. He is working at Geological Survey of Slovenia at the Department for regional geology as an expert for structural geology, regional geology, active faults, Triassic stratigraphy and geological hazards. He is part of various teams, dealing with the regional geology of Slovenia, map of active faults of Slovenia and also with various applicative and international projects. **Petra Jamšek Rupnik** (female) holds a Ph.D in Geology from 2013. She is working at Geological Survey of Slovenia at the Department for regional geology as an expert for geomorphology, tectonic geomorphology, active tectonics, seismotectonics and seismic hazard. She is involved in the various applied and scientific projects, with topics mainly focused on (tectonic) geomorphology and seismic hazard assessment. **Jure Atanackov** (male) holds a Ph.D in Geology from 2013. He is research assistant in applied geophysics (particularly shallow methods, including high-resolution seismic reflection, seismic refraction and electrical resistivity tomography), active tectonics and seismic hazard assessment.
List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.
MOULIN, Adrien, BENEDETTI, Lucilla, RIZZA, Magali, JAMŠEK RUPNIK, Petra, GOSAR, Andrej, BOURLÈS, Didier, KEDDADOUCHE, Karim, AUMAÎTRE, Georges, ARNOLD, Maurice, GUILLOU, Valery, RITZ, Jean-François. The Dinaric Fault System: large-scale structure, rates of slip and Plio-Pleistocene evolution of the transpressive northeastern boundary of the Adria microplate. Tectonics, ISSN 0278-7407, 2016, issue 10, vol. 35, str. 2258-2292, doi: 10.1002/2016TC004188. ZAJC, Marjana, CELARC, Bogomir, GOSAR, Andrej. Structural-geological and karst feature investigations of the limestone-flysch thrust-fault contact using low-frequency ground penetrating radar (Adria-Dinarides thrust zone, SW Slovenia). Environmental earth sciences, ISSN 1866-6280, 2015, vol. 73, no. 12, str. 8237-8249. http://dx.doi.org/10.1007/s12665-014-3987-x, doi: 10.1007/s12665-014-3987-x. ATANACKOV, Jure, JAMŠEK RUPNIK, Petra, CELARC, Bogomir, JEŽ, Jernej, NOVAK, Matevž, MILANIČ, Blaž, BAVEC, Miloš. Seizmotektonska parametrizacija aktivnih prelomov Slovenije. 2. del. (Seismotectonic paremetrisation of the active faults in Slovenia. 2nd part. Ljubljana: Geological Survey of Slovenia, 2015. 169 pp., 3 add. CELARC, Bogomir, MILANIČ, Blaž, JAMŠEK RUPNIK, Petra, ATANACKOV, Jure, TRAJANOVA, Mirka, KRALJ, Polona, BOLE, Bernarda. Glavne raziskave geo in hidrosfere za potrebe graditve odlagališča za nizko in srednje radioaktivne odpadke Vrbina, Krško, Geološke raziskave (Main investigations of geo- and hidro-sphere for the new low and intermediate radioactive waste disposal at Vrbina (Krško) : Final report. Ljubljana: Geological Survey of Slovenia, 2015. 52 pp. CELARC, Bogomir, MILANIČ, Blaž. Geološka spremljava v okviru varstva naravne dediščine: tektonsko strukturne značilnosti na območju trase in spremljajočih objektov HC Koper – Izola (Geological evaluation in the framework of the nature conservation: structural characteristics of the new highway Koper - Izola : report. Ljubljana: Geological Survey of Slovenia, 2015. 163 pp.
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.
Seismic Hazard Analysis for JEK 2 (Krško), financed by GEN Energija d.o.o., 2014-2018. Elaboration of seismotectonic maps, financed by ARSO – Slovenian Environment Agency, 2014-2017.

Elaboration of map of active faults in Slovenija, financed by ARSO – Slovenian Environment Agency, 2009-2013. Seismotectonic model of the Ljubljana Basin, financed by Slovenian Research Agency and Slovenian Environment Agency, 2009 – 2012.
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work
High-resolution seismic reflection survey equipment (ABEM Terraloc VI field seismograph: 2x for a total of 48 active channels; Seismic sources: GISCO ESS100 accelerated weight dropper, 12-gauge shotgun / firing rod, 8-kg sledgehammer; Geophones: 100 x 40 Hz and 100 x 100 Hz; Seismic cables with take-outs / connectors at maximum 6 m separation).

Name of organisation	**State Research and Development Enterprise State Information Geological Fund of Ukraine**		
Short name	GEOINFORM	**Country**	Ukraine
Brief description of the legal entity			
The State Research and Development Enterprise "State Informational Geological Fund of Ukraine" – SRDE “GeoInform of Ukraine”, or GEOINFORM is the specialized research and development unit of the State Geological and Subsurface Survey of Ukraine which collects, stores, analyzes and provides information received from geological study and use of subsurface. The GEOINFORM goals include realization of the State policy in the field of geology and use of subsurface through collecting, storage, processing and development of analytical information on the geological study of subsurface and mineral-resource base of Ukraine, provision of archive geological documents, analytical materials and other information production to the State and local executive authorities, enterprises, entities, organizations, public associations, as well as private persons in Ukraine and abroad, development and exploitation of digital information systems and data bases, management of the unified information system of subsurface use. GEOINFORM conducts research work on monitoring of mineral resources of Ukraine on the basis of geological and mining activities during the year, recording deposits and making public the balance of mineral resources management of the State fund of deposits and occurrences (more than 10,000 objects recorded), synthesis and analysis of exploration for oil and gas, creating a system of state accounting of oil and gas wells, completion and maintenance of the State cadastre of mineral deposits and occurrences as well as State cadastre of groundwater deposits of Ukraine.			
Main project tasks and qualifications:			
Participation in WP2, WP3 and WP4			
Short profile of staff member(s) who will be undertaking the work			
Dr. hab. Boris Malyuk (Male), Director for International Cooperation, graduated in 1981 from Department of Geology, Lviv University, Ukraine, and in 1999 from Centre of Geostatistics, Ecole des Mines de Paris, France. Obtained Candidate of Science (PhD) Degree in Geotectonics in 1984, and extended Doctor of Science Degree in Petrology in 1991. National Delegate of Ukraine to the EuroGeoSurveys. **Dr. Igor Melnyk (Male),** Sector Chief, with basic background in geology, has an experience in field works and research in geochemistry, hydrogeology and ecology (PhD in 1996), as well as geoinformatics and GIS applications. **Tetiana Biloshapska (Female),** Chief Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1980. She is experienced in field works. She had studied mineral-resource base of Ukraine for more than 30 years, took part and led projects on prospecting and exploration of mineral deposits, conducted regional geological studies.			

Galyna Polunina (Female), Leading Geologist. Graduated from Tyumen Industrial Institute under specialty 'Geology and Exploration of Oil and Gas Deposits' in 1975. She is working out with hydrocarbon deposits and oil and gas resources inventory of Ukraine for more than 40 years.
List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.
Interactive map of mineral deposits of Ukraine (in Ukrainian) http://geoinf.kiev.ua/wp/interaktyvna-karta-rodovyshch-korysnykh-kopalyn.htm Interactive map of mineral licenses (in Ukrainian) http://geoinf.kiev.ua/wp/interaktyvni-karty-spetsdozvoliv.htm Interactive geological map of Ukraine 1:1 000 000 (in Ukrainian) http://geoinf.kiev.ua/wp/Interaktyvna-heolohichna-karta-Ukrayiny.htm Interactive geological map of Ukraine 1:1 000 000 (in English) http://geoinf.kiev.ua/wp/Interactive-Geological-Map-of-Ukraine.htm Interactive State Geological Map of Ukraine 1:200 000 (in Ukrainian with English entries) http://geoinf.kiev.ua/wp/kartograma.htm
List of up to 5 relevant previous projects or activities, connected to the subject of this proposal.
• ESTMAP - EU • EUOGA - EU • NUMIRE – Norway-Ukraine (NGU/SGSSU) • EIMIDA – Norway-Ukraine (NGU/Geoinform)
Description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work

5 Ethics and Security (This section is not covered by the page limit)

5.1 Ethics

Have you completed an ethics self-assessment? (See "How to complete your ethics self-assessment")

YES

The project proposal has been checked against the ethics sections in *"H2020 Guidance —How to complete your ethics self-assessment: V5.2 – 12.07.2016".* This check did not raise any issues. The checklist is included with the oploaded documents in ISAAC.

(If YES, upload this as an additional document in ISAAC under the tab *Attachments* – Other)

5.2 Security

Please indicate if your project will involve:

- Activities or results raising security issues: **NO**
- 'EU-classified information' as background or results: **NO**

(See for guidance this document)

5.5 HotLime

COVER PAGE

Title of project proposal

HotLime –
Mapping and Assessment of Geothermal Plays in Deep Carbonate Rocks – Cross-domain Implications and Impacts

Abstract

Hydrothermal systems in deep carbonate bedrock are among the most promising low-enthalpy geothermal plays across Europe. Apart from a few areas where viability of hydrothermal heat and power generation has been proved, most deep carbonate bedrock has received relatively little attention, because such rocks are perceived as 'tight'. Exploration and development of the deep subsurface is an acknowledged high-risk investment, particularly in low-enthalpy systems, where tapping suitable temperatures for geothermal energy commonly requires drilling to depths of more than 3 km. In order to de-risk these challenging geothermal plays, it is crucial to improve our understanding of geological conditions that determine the distribution and technical recoverability of their potential resources.

The efficacy of carbonate-bedrock geothermal plays is crucially dependent on groundwater yield controlled by fracture conduits and karstification. This project will identify the generic structural controls in deep carbonate formations, through a comparison of geological situations and their structural inventory, as well as collation of deep borehole data and their petro- and hydro-physical characteristics. A consistent assessment and the sharing of knowledge – bringing all partners to a common high level – will result in uniformly applicable best practice workflows for estimation, comparison and prospect-ranking of hydrothermal resources in deep carbonate bedrock. Applied in specific target areas by means of 2D or 3D mapping and characterization, these spatial assessments will help in de-risking the set-up or maturation of regional plays, will reveal possible cross-domain implications, and will support sustainable subsurface management.

Please indicate the SRT

GeoEnergy – GE2 Geothermal energy

List of participants

(overleaf)

#	Participant Legal Name	Institution	Country
1 Project Coordination	Bayerisches Landesamt für Umwelt	**LfU**	**Germany**
2	Department of Communications, Climate Action and Environment (GSI)	**GSI**	**Ireland**
3	Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek	**TNO**	**The Netherlands**
4	Vlaams Gewest *represented by third party 4a / VITO*	**VLO**	**Belgium**
4a *)	Vlaamse Instelling voor Technologisch Onderzoek *VITO will act as third party of VLO*	**VITO *)**	**Belgium**
5	Geologische Bundesanstalt	**GBA**	**Austria**
6	Regierungspräsidium Freiburg	**LGRB**	**Germany**
7	Istituto Superiore per la Protezione e la Ricerca Ambientale	**ISPRA**	**Italy**
8	Geološki zavod Slovenije	**GeoZS**	**Slovenia**
9	Servizio Geologico, Sismico e dei Suoli della Regione Emilia Romagna	**RER-SGSS**	**Italy**
10	Hrvatski geološki institut - Croatian Geological Survey	**HGI-CGS**	**Croatia**
11	Ministry for Transport and Infrastructure	**MTI**	**Malta**
12	Agenzia Regionale per la Protezione Ambientale del Piemonte	**ARPAP**	**Italy**
13	State Information Geological Fund of Ukraine	**GEOINFORM**	**Ukraine**
14	Česká geologická služba	**CGS**	**Czech Republic**
15	Regione Umbria - Servizio geologico	**RU**	**Italy**
16	Institut Cartogràfic i Geològic de Catalunya	**ICGC**	**Spain**
Associate *)	Royal Belgian Institute of Natural Sciences – Geological Survey of Belgium	**RBINS-GSB *)**	**Belgium**

*) non-funded

1 Excellence

This proposal addresses SRT GE2 – GEOTHERMAL ENERGY: Geological evaluation of new deep geothermal plays in Europe

Geothermal resources in deep bedrock with low primary porosity and naturally enhanced secondary permeability, such as faults and karstification, present a promising potential to supply direct heat and/or power generation. Despite this potential, many deep-lying tight reservoirs of this sort have received relatively little attention so far. They are rarely at the forefront of geothermal exploration strategies, as the potentially high rewards from exploiting these resources are counter-balanced by high risk of exploration or geotechnical failure. On the other hand, proven and used plays like in the central North Alpine Molasse Basin, although seeming to have additional capacity, recently faced major setbacks on attempted extension of utilization due to a lack of full understanding of their overall system.

In order to de-risk these challenging geothermal plays, it is crucial to improve the understanding of geological conditions that determine the distribution and technical recoverability of their potential resources beyond and across national boundaries. This project proposes to align the evolving national research programs at GSOs that address this objective with the knowledge and lessons learned from more advanced deep hydrothermal plays, to eventually bring all GSOs involved to a common high level. Consistent mapping and comparison of the 3D distribution of geothermal reservoirs will facilitate provision of a comprehensive resource assessment methodology for harmonized Europe-wide estimation of all prospective and identified geothermal energy resources, including all relevant uncertainties.

Geothermal resources have an important role to play in realizing the transformation of the EU's energy system through delivering clean, sustainable and reliable energy to customers. Action 1 of the SET-PLAN asks for continued support for the advancement of renewable technologies such as geothermal energy and carrying out basic research to further its development.

Aims and objectives

New and emerging geothermal plays in Europe, such as deep carbonate bedrock, provide promising yet challenging future targets to raise the share of sustainable and non-intermittent resources in supplying heat and power. Deep carbonate bedrock is widespread in many parts of Europe. However, in addition to the presence of reservoirs with sufficient thicknesses, an important requirement for a successful geothermal development is adequate reservoir quality. As deep carbonate rocks are generally characterised by low primary porosity, hydrothermal circulation patterns in these rocks will be dependent on secondary porosity and permeability controlled by faults, fractures and dissolution processes such as karstification. Targeting faulted or fractured reservoirs for geothermal prospecting can be challenging and requires an advanced understanding of the fracture network environment to define; (i) the level of heterogeneity in the sub-surface (in terms of heat and fluid flow), (ii) an assessment of the general groundwater regime with respect to hot water yield and flow as well as hydrochemistry, and (iii) an optimised drilling programme.

Porosity and permeability can be significantly altered by diagenetic processes like compaction, karstification, (re-)mineralization and dolomitization. Karstification, in particular, is an effective way to create secondary porosity. It is important to consider that different parts of a carbonate platform may have different burial and diagenetic histories; for instance, the platform top is the first part of the platform that is exposed during a sea level drop and therefore has the largest potential for presence of meteoric karst. Platform slopes may be dissected by faults, which is an important consideration for predicting the presence of fractures and potential for hydrothermal karst. The latter situation adds further complexity, since fractures and faults in carbonates can become dissolutionally enhanced, or karstified, and form very transmissive conduits. Karst conduits are often structurally controlled and heavily influenced by the past and present tectonic regimes of a region. Considering the above highlights, the importance of understanding the association between carbonate facies (the platform position), faults and karst (permeability) in carbonate bedrock in order to deliver the greatest geothermal yields becomes evident. The occurrence and formation of deep karst on a basinal scale is poorly understood at present, mainly due to a lack of data.

HotLime aims to explore and evaluate the potential of carbonate basins for deep geothermal energy in a number of European regions by facilitating an **improved understanding of geological conditions that determine the distribution and technical recoverability of geothermal resources** in tight reservoirs with naturally enhanced secondary permeability. This will be achieved by **consistent mapping and evaluation of the 3D distribution and characteristics** of tight carbonate geothermal reservoirs **at European scales** by applying a common workflow adaptable to different geological settings. The **incorporation of these results within a common assessment framework for all deep geothermal reservoirs**, will collate insights of characteristics of different deep geothermal resources across Europe, and **improve the understanding of possible exploitation impacts and operational issues related to geological aspects**. Research questions to be addressed include: *What are the structural controls on deep karst formation? How does past and present carbonate dissolution present itself in deep carbonate basins? How can we find pathways of fluid flow in deep karstic fractures? How can we exploit those geothermal resources?*

Relation to existing programmes and projects

This project is highly complementary to current European research on deep geothermal energy under H2020, which largely focuses on various aspects of Enhanced (or Engineered) Geothermal Systems (EGS). In particular, DESTRESS (http://www.destress-h2020.eu) and DEEPEGS (https://deepegs.eu/) aim to improve drilling technologies by developing and testing new and improved models and innovative solutions down to super-critical conditions to routinely create EGS reservoirs. In addition to optimising stimulation treatments in EGS systems, on minimising environmental impacts such as seismic events or pollution of groundwater reservoirs. HotLime will also complement the newly EU-granted GEOTHERMICA (http://www.geothermica.eu/) through identification and assessment of geothermal resources, in order to demonstrate geothermal energy deployment within the energy system and develop paths to commercial large-scale implementation. The development of an integrated geothermal exploration approach – potentially suitable for adoption in HotLime – based on state-of-the-art scientific methods including, among other things low-cost reprocessing of old seismic, and passive seismic acquisition, was covered in IMAGE (*Integrated Methods for Advanced Geothermal Exploration*, http://www.image-fp7.eu/), a European project involving 20 partners from 9 different countries. The GeoElec (http://www.geoelec.eu/) project has assessed potential resources for producing electricity from geothermal energy.
At present, there is no EU-funded research action that directly addresses low primary-porosity geothermal plays with naturally enhanced secondary permeability. Deep geothermal research arising from the upcoming GEOTHERMICA call (final projects to be announced March 2018) could also complement and benefit from the outputs of HotLime.

The reservoirs targeted in the HotLime project are deeply buried and therefore known only from existing geophysical data and sparse bore holes. Their reservoir parameters like permeability and fracture density and distribution are currently poorly mapped. As the (primary) permeability is likely to be poor, geothermal wells may need to be stimulated, or be drilled to intersect fracture systems, which requires that (induced) seismicity be monitored. Given the hot brines targeted, special attention will need to be paid to the well design. Considering these aspects, HotLime will greatly benefit from past and present European research like GEISER (https://www.gfz-potsdam.de/en/section/geothermal-energy-systems/projects/completed-projects/geiser/), IMAGE, both finished, GeoWell (http://geowell-h2020.eu/), DESTRESS and SURE (http://www.sure-h2020.eu/), all three ongoing. GEISER (FP7, *Geothermal Engineering Integrating Mitigation of Induced Seismicity in Reservoirs*) addressed, among other topics, the mitigation of induced seismicity to an acceptable level. GeoWell (http://geowell-h2020.eu/) aims at developing reliable, cost effective and environmentally safe technologies for design, completion and monitoring of high-temperature geothermal wells. In SURE (*Novel Productivity Enhancement Concept for a Sustainable Utilization of a Geothermal Resource*) radial jetting is investigated as a cheap tool to enhance the inflow into a well. One of the reservoirs targeted for field experiments in the latter project are the Dinantian Limestones, which constitute the most important hot carbonate reservoir in Belgium and the Netherlands. The overall goal of DESTRESS is to optimise stimulation treatments in EGS systems while minimising environmental impacts such as seismic events or pollution of groundwater reservoirs. GEOHEAT.App (https://geothermie.vito.be/nl/projecten/geoheat-app, finished in 2014) evaluated the technical and economic feasibility of intermediate and deep geothermal energy as a sustainable source of heat for new and renovated buildings based on 6 case studies in Belgium and the Netherlands. Although limited by availability of actual production data, that study presented the first geothermal assessment of the Dinantian limestones in this cross-border domain.

1.1 Concept and methodology

Concept

The value of any geothermal project is founded on a proper characterization of the subsurface. This holds for the resource assessment and risk mitigation during the exploration and realisation (development) phase as well as for the production years.
The essential requirement for a successful geothermal development is a reservoir of sufficient thickness with an adequate reservoir quality (covered in WP2 Mapping and Characterization). This ensures that sufficient water can flow to the well and be produced to be used for heat supply and/or power production. The following parameters are crucial to determine the prospectivity of any proposed geothermal development, and are the minimum that will be tested for the case study areas considered within this project:

- The presence of a reservoir
- Permeability of that reservoir (primary or secondary)
- Gross thickness of the reservoir (base and top should be known)
- Internal and external facies distribution
- Ratio between the total reservoir thickness and the permeable part of the reservoir (net-to-gross ratio)
- Basic characteristics of groundwater flow
- Total dissolved solids (water chemistry)
- Geothermal gradient

All of the above parameters are uncertain; they have an expected value, a minimum (pessimistic) and a maximum (optimistic) estimate. In this regard, we anticipate collaboration with GW3-RESOURCE project, specifically WP5 on karst typology, as it may provide additional insights (and vice versa) into carbonate reservoir properties. Ultimately, the parameters and their associated uncertainty ranges will be used for calculating the expected amount of geothermal energy that can be produced (in WP3). The development of an assessment tool (calculator) will be covered by GE4-Geo4Sure. While it may be that only rough estimates can be made for many parameters, any improvement can lead to reducing the uncertainties and hence to better geothermal resource assessment. In turn, this can support policy and decision making. In that respect, much can be learned from deep carbonate play developments, whether successful or not (WP4). Analysis of these experiences may importantly feed into the definition of improved exploitation strategies, including the evaluation of risks and impacts and serve to support policy-making associated with development of deep carbonate plays. Using case studies applied in pilot areas, the added value of the methodologies will be assessed. The case studies will, in turn, deliver guidelines for stakeholders and end-users on how to implement HotLime's results in their own cases.

Methodology

The HotLime partnership will develop or adjust methodologies in the field of geothermal resource assessment. These methodologies will be founded on already proven and widely accepted concepts that are or have been practiced in more developed plays. The results will be reported and incorporated in the overarching knowledge base. The selected methodologies will specifically relate to

- subsurface characterization in terms of lithological, geochemical and mechanical properties based on available input data sets (borehole data, seismics, existing 3D models, map (series), and cross-sections, descriptive reports/publications);
- seismic interpretation (based on improved velocity models), geological 3D-modelling, temperature modelling;
- comparison of different modelling methods in pan-European target areas;
- knowledge transfer from well investigated target areas to less developed areas;
- assess the risk of induced hazards and of project failure from inadequately constrained geological data;
- seek transfer of geo-science based recommendations into national regulatory frameworks and EU level in order to increase the sustainability of subsurface utilization;
- transposition of the geo-science based recommendations and guidelines.

1.2 Ambition

Geothermal reservoirs are geologically complex structures that, since controlled by many factors, are challenging to model and characterize.
A major barrier to uptake of geothermal technology at deep subsurface levels is a lack of basic data (e.g., temperature gradients in the subsurface, thermo-physical and hydrogeological properties of the bedrock, etc.). While some of the key carbonate basins under consideration in HotLime feature adequate data coverage in their larger parts, other basins suffer from a paucity of data or their uneven distribution. To overcome the hurdle imposed by inconsistent data coverage, HotLime is geared towards cross-fertilization of the geologists' expertise and understanding based on their conceptual models of the geological evolution of carbonate basins and reservoirs. We will compare prospects using experience-based parameter values for further assessments. The joint development of a common assessment procedure for characterizing and modelling geothermal reservoirs, applicable to different points of departure, will help many countries to improve their own national assessments. The outputs from HotLime will assist in progressing geothermal technology adoption in those regions of the EU with carbonate bedrock, by collecting and providing reliable data and additional mapping products pertinent to the development of deep geothermal installations in carbonate environments. In particular, the outputs of HotLime will be of use in those regions where there is a need for a successful demonstration project for deep geothermal energy, as the results from HotLime can be used to pinpoint target locations for pilot boreholes and projects, and de-risk the enterprise for public and private funding bodies.

The consortium partners share the ambition to develop a common assessment procedure for characterizing and modelling geothermal reservoirs in carbonate bedrock and make it usable beyond the territorial reach of HotLime. However, a fully generic and mature appraisal procedure is beyond HotLime's available resources and scope, and so such an all-embracing outcome is not the specific aim of the project. Instead, the project's fundamental concepts, best practice workflows and the associated knowledge base will pave the way for future amplification and eventual universal applicability.
The cross-fertilizing collaboration among the project partners – contributing knowledge and experience from different geological settings across Europe and thereby bringing the partners to a common, higher level – will be an invaluable and mutual benefit, continuing after the end of the HotLime project. The expert network thus established, including stakeholders from other disciplines and beyond the territorial reach of HotLime, will safeguard sustained dialogue over future challenges of geothermal planning and its utilization, thus fulfilling the objectives and the spirit of European research cooperation.

HotLime's ambitions are consistent with the EU's target of emitting at least 40% less greenhouse gases by 2030 and to achieve sustainable growth. By supporting this shift towards a sustainable, low-carbon economy, HotLime will contribute to the 'resource efficient Europe – Flagship initiative under the Europe 2020 Strategy' (COM/2011/0021 final).

2 Impact

2.1 Expected impact

The planned cooperation between the partners will ensure HotLime's clear transnational focus. Developing generic information and methodologies based on and validated by trans-regional and cross-border use cases will serve national and European stakeholders and end-users. The joint development of a common procedure for assessing the viability of geothermal reservoirs and its application to different pilot areas will yield a common high level of understanding of hydrothermal systems in carbonate rock suites and will substantially contribute to an **improved and better harmonized European overview of prospective and identified geothermal energy resources**. Testing HotLime's approach in deep carbonate rock suites of contrasting geological settings and providing reliable data and additional mapping products pertinent to the development of deep geothermal installations will **increase the confidence in the prospectivity and potential contribution of those geothermal resources across Europe**. In addition, as deep carbonate rocks are widespread in many parts of Europe, the outputs of HotLime are applicable to promoting geothermal exploitation in many regions of the EU. This will **further stimulate green thermal energy uptake** especially **in urban regions** and populous areas with a high density of potential customers for direct heat use.

HotLime will increase awareness of the economic viability of deep geothermal installations in carbonate environments. Increased understanding and knowledge transfer and the provision of a consistent and data-driven knowledge base will aid the formulation of policy tools and strategies aiming for large-scale geothermal energy developments across Europe. Thus, the HotLime project will complement EU-funded programmes, including the new GEOTHERMICA, through identification and assessment of geothermal resources, in order to demonstrate geothermal energy deployment within the energy system and develop paths to commercial large-scale implementation. It will deliver a sound basis for further site specific, in-depth research and development.

Sharing the improved understanding of potential benefits and impacts from developing deep geothermal plays in carbonate aquifers will raise public awareness and support the social licence to operate. In some countries, demonstration of geothermal potential, including in deep carbonate basins, will facilitate and accelerate development of licencing regulations for commercial exploitation of geothermal energy.

2.2 Measures to maximise impact

2.2.1 Dissemination and exploitation of results

All HotLime work packages will be involved in communication, dissemination and exploitation measures to safeguard the project's impact at the best. WP1 will govern the internal and external communication and dissemination of project proceedings within the GeoERA community and towards EU stakeholders. Dissemination and exploitation activities in WPs 2 to 4, pooled and formalized in WP5, are focused on the scientific community, users and stakeholders of different levels to whom the results are relevant. WP6 will take care of the exchange and cross-fertilization with other GeoERA projects for mutually increased impact, WP7 of the dissemination and exploitation of the scientific results through GeoERA's Information Platform (IP), coactive with the IP project.

At the very beginning of its implementation, HotLime will establish a Project Dissemination and Exploitation Plan specifying all concrete measures apposite for achieving the impacts described above and fostering stakeholder engagement during the project's runtime and beyond. This will include:

- Active representation of HotLime at GeoERA's principal dissemination events, the Kick-off, Mid-Term and Final Seminars.
- Close collaboration and exchange with other GeoERA projects and provision of results via the GeoERA Information Platform. This includes (i) the integration of HotLime's fault information into the Fault Database of GE4-HIKE, (ii) the provision of use case(s) for GE4-HIKE to enable further fault characterisation and hazard assessment with respect to induced seismicity and seismogenic faults, (iii) close exchange with and the provision of use case(s) for GW3-RESOURCE, WP5 CHAKA on typology of karst aquifers, for the concerted assessment of impact with groundwater utilisation, as well as (iv) provision of use case(s) for subsurface management and decision support implementation e.g. in GE6-GeoConnet³d. This project-project interfacing (delineated in WP6) will be formalized in the Dissemination and Exploitation Plan since it is subject to the positive evaluation and granting of those projects.
- Stakeholder information: Involvement with all those institutions that can make use of, or are impacted by, HotLime's research results is an integral part of the project. These stakeholders include territorial and resources planners and regulators, energy suppliers, public utilities, interest groups and consultants from regional, national and EU levels
- Scientific community information: HotLime will engage the Geological Survey community, as well as other research institutes and academia, in order to promote results and to request feedback from researchers at the forefront of geothermal development. This will include lectures at relevant scientific symposia throughout HotLime's implementation and beyond, as specified in the Communication activities in 2.2.2.

Through the dissemination of information via EGDI, stakeholders and end-users will be able to directly benefit from the established results. Transparency and open access to information are considered first principles and requisites to serve stakeholders and for raising public awareness. However, because modern web service technologies may allow back-engineering of primary data, e.g. from 3D geo-models, disclosure of information partly based on classified data may be subject to confidentiality and other access restrictions imposed by national statutory provisions. To resolve these constraints is beyond the scope of the project, but references and links will be given to where the information can be obtained in line with the applicable data privacy clause.

2.2.2 Communication activities

HotLime will adopt the following communication measures that will be further specified and formalized in the project's Dissemination and Exploitation Plan:

- Scientific communication will include presentation of the state-of-the-art (e.g. on milestones) and results at selected scientific congresses and seminars, as well as publications in relevant scientific journals.
- Stakeholder communication will encompass panel(s) and face-to-face meeting(s) with institutions that can make use of, or are impacted by, HotLime's research results. A Brussels Information Day jointly with other SRTs involved in geothermal issues is envisaged.
- Corporate communication will embrace contributions to a joint GeoERA GeoEnergy Portal in a dedicated website presenting the goals, structure, deliverables and partners of HotLime, and, if requested, to information and publicity measures of the GeoERA Executive Board or EGS secretariat.
- Internal communication, such as cross-domain communication and collaboration with relevant SRTs, will be covered by HotLime's WP 6 (Project-Project Interface). The measures and interactions to be taken are specified in the WP6 description.

2.3 Contribution of Project Proposal to the Information Platform or vice versa

HotLime will substantially contribute to the GeoERA Information Platform project (IP) which will upgrade the European Geo Data Infrastructure (EGDI) to serve as GeoERA's central information repository and dissemination portal. HotLime will disclose its spatial information, the associated feature data and methodological approaches (toolkits, knowledge base, reports) via this hub.

The results of HotLime's research, the case studies in mapping and characterization of the key national/regional carbonate basins and the evaluation of their geothermal capacity, will deliver a variety of multidimensional spatial information, methods, knowledge and reports for online publication via EGDI. This requires that the EGDI is able to store, merge and visualize this data in various dimensionalities and levels of detail (LoD).

In the framework of this incremental development, implementation and population of the GeoERA IP HotLime will especially contribute to four components:

- the explorer/query tool for multi-dimensional spatial representations (3D geo- and parameter-models, corresponding depths-serialized 2D map series, and representations of baseline data distribution and coverage) preferably as part of a distributed organized system. Such dissemination and query tools should allow for appropriate end-user functionality (i.e. selecting, retrieving, analysing data) and representation (slicing, exploding, virtual boreholes);
- the European Fault Database containing spatial definitions and related feature data for fault characterization (conceptualized in GE4-HIKE).
- the Knowledge Base providing references/links to state of art information repositories, methodology publications and case study reports that are relevant for knowledge exchange and best practice recommendation. To this extent, an Open Linked Data Semantic Web should be implemented hosting also glossaries and keyword thesauri for tagging features and metadata and providing links underpinning information, making the system a true knowledge base serving all GeoERA Themes (developed and deployed in IP WP4, based on specifications from all GeoERA SRTs);
- the Metadata Information system (MICKA catalogue) acting as the central hub for search and discovery of spatial data and knowledge repositories by means of metadata keywords through augmenting the underlying controlled vocabulary for geological units, faults and technical terminology for geo-energy.

The extension and upgrade of European Geo Data Infrastructure has to be accomplished in close collaboration with the topical research projects and the IP, in order to meet all requirements on either side. To ensure interoperability, a common data model with joint specifications and guidelines will be developed in cooperation with the other GE projects, as specified in WP6 and 7, and the IP, basically building upon the concepts developed and established in EGIP (*European Geothermal Information Platform* http://egip.igg.cnr.it/). Following these pooled scientific specifications and demands, IP will, in accordance with the existing interoperability framework (INSPIRE, OGC, W3C, CGI), translate this into technical database architecture and requirements, develop the necessary functionalities, and compile guidelines for uploading and linking information. HotLime will cross-check the advancements by means of (iterative) prototyping and providing feedback, eventually ensuring a frictionless handover and implementation of data sets and spatial representations for dissemination through the EGDI portal. Based on the established procedure, HotLime will compile a user manual and guidelines for the use (and use limits) of its data and products, requesting the IP for review and assistance in dissemination.

HotLime's WP7 (IP Interface) will coordinate the interactions between the HotLime project, the GeoERA-IP project and other GE-projects' IP-Interface. The requirements and interactions are specified in the WP7 description.
All data management and modes of uptake and dissemination, basically following the FAIR Guiding Principles for scientific data management and stewardship, will be stipulated in the HotLime Data Management Plan (PDMP, D1.3). This PDMP will also set out the maintenance of HotLime's results beyond the projects duration, in principle the geological survey organizations will remain in charge of maintaining and updating their national/regional datasets.

3 Implementation

3.1 Work Plan – Work packages, deliverables

The overall implementation structure of the project is presented in the scheme below (Figure 3.1). This scheme describes the work packages (the detailed descriptions to be found in Tables 3.1a), their interaction with each other and the interdependencies with other GeoERA-GE project proposals, data- and knowledge transfer routes and the contributions to the Information Platform or vice versa.

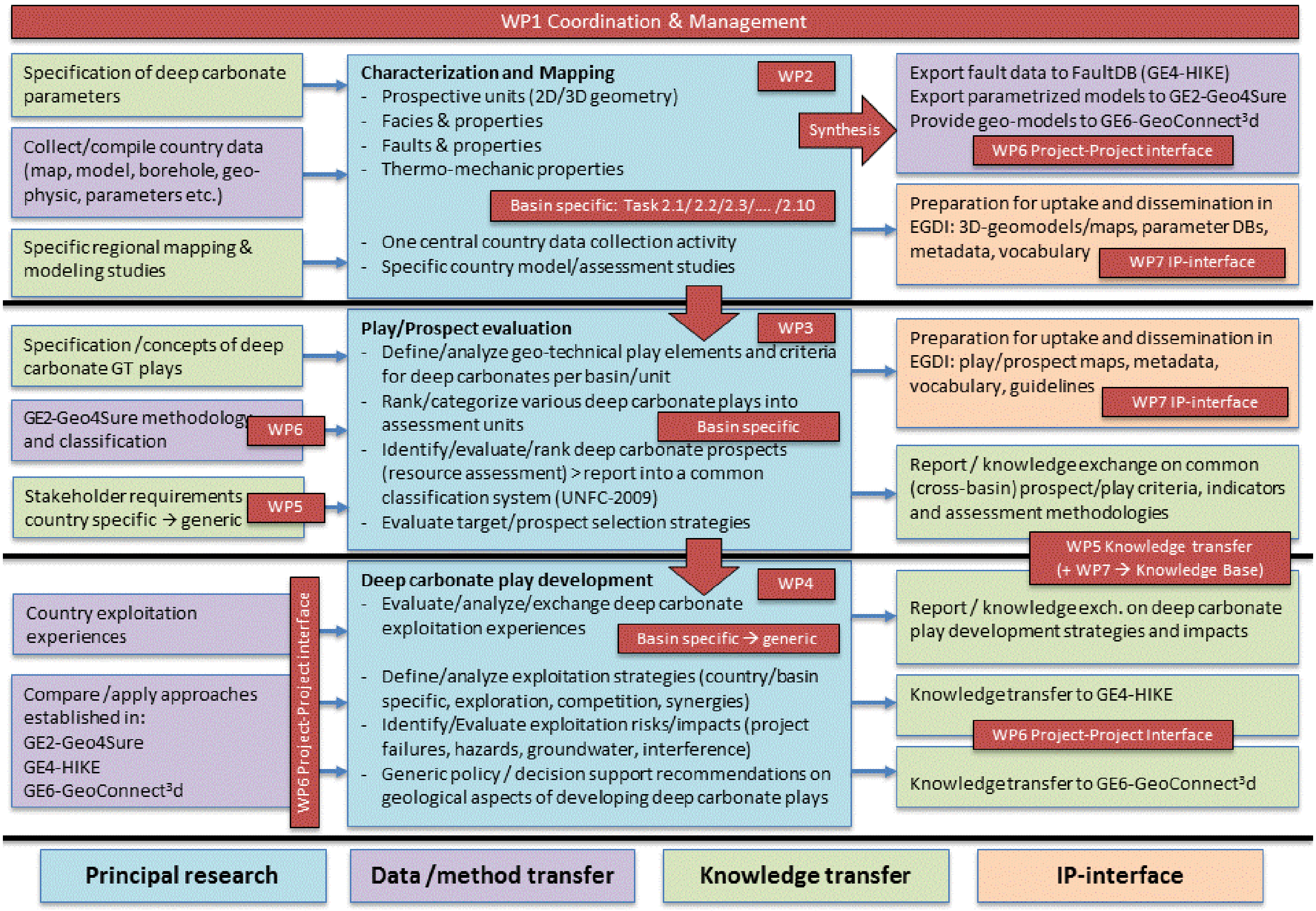

Figure 3.1 – HotLime implementation structure: WP 1, namely the Project Board, will govern the day-to-day project management; it will monitor the project progress and the work assigned to each partner. The core of HotLime implementation are the WPs 2, 3 and 4, representing the research proper, in a largely sequential, logical top-down approach, with some iteration between WPs as results emerge. Peripheral or service WPs 5, 6 and 7 are geared towards safeguarding the supplementation and support of the research proper by the findings of other projects and developments, as well as knowledge transfer and maximising the impact of HotLime's results through appropriate communication measures and optimized dissemination for exploitation by end-users.

3.2 Management structure, milestones and procedures

The HotLime partners involved in the management of work packages, LfU as the Project Coordinator (WP 1) as well as WP 6 and WP 7 lead, and the work package leaders LGRB (WP 2), TNO (WP 3), GSI (WP 4), HGI-CGS (WP 5) will form a Project Board working closely together on a daily basis: The Project Board governs the day-to-day management and decision-making processes and assumes responsibility for the adherence to the project milestones (see below) and the smooth handling of contingencies related to the project implementation. Thus, the Project Board will ensure the smooth and seamless work sequence in line with schedules and milestones. Within the work packages, responsibilities are decentralized and task lead functions are assigned to the survey organizations directly involved.

The Project Board will establish an internal reporting system to ensure the frictionless and efficient implementation of the work plan. This reporting system will be based on a formalized procedure and template for reporting on work package activities and related costs: Progress reports will be prepared by the participants of the WPs and compiled by the WP leaders. Based on those, the Project Board will monitor the project's progress, identify shortcomings and frictions if any, and find solutions for these issues. This close monitoring of the project progress and the early identification of risks are integral parts of the internal quality assessment.

Apart from this regular formalized reporting, the WP leaders are required to take on and mitigate any problems in their WP along with the task leaders. Major problems or issues likely to compromise any project-project interface will be addressed to the Coordinator and Project Board for conflict mitigation at short notice.

If required, to safeguard the delivery of the project results as agreed with the GeoERA Executive Board, adjustments of the project plan will be made. Major adaptations shall be approved by the Project Board. The regular progress reports also will make up the basis of the Mid-term and Final reports as required by the GeoERA Executive Board and Project Monitoring Officer.

Basically, the reporting procedure as described will ensure HotLime's sound and on-time reporting to the Executive Board and the Project Monitoring Officer. Reporting will follow verification procedures that involve interactions among partners, the Project Board and the Coordinator. This procedure allows for the delivery of sound reports providing a clear insight into the state of project implementation. Deliverables and milestones will follow an internal quality control procedure carried out by all partners represented in the project.

In order to provide for all contingencies, in case of tension or conflict, the WP leaders will act as first responder and are encouraged to find a consensual solution – if deemed appropriate, counselling with the Coordinator. In case the conflict cannot be resolved, the WP leader will address the issue to the Project Board and GeoERA Executive Board. Table 3.2b lists possible risks deemed serious or critical that have been identified in advance planning of the project implementation procedures, and provides appropriate risk mitigation measures.

The work-breakdown structure of HotLime is illustrated in a Gantt chart timeline for the work package implementation and milestones (Figure 3.2, overleaf).

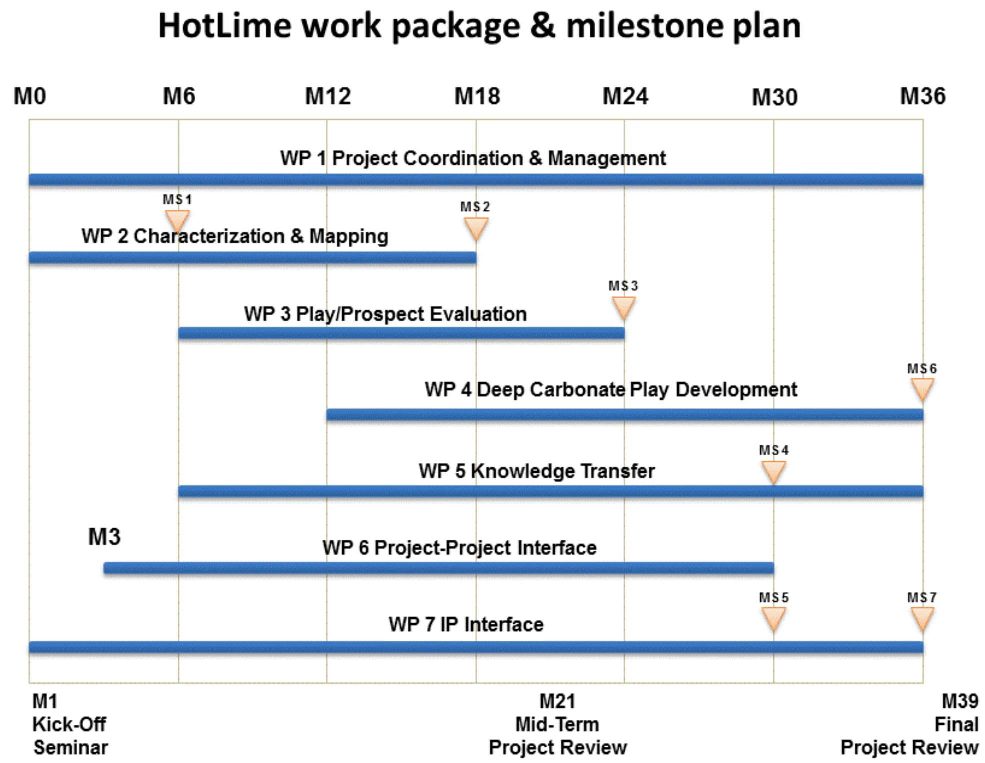

Figure 3.2 – Time lapse of HotLime's work package (WP) implementation and milestones (MS). The numbering of the milestones corresponds to Table 3.2a.
The lagged onset of work packages 3 and 4 is a consequence of the sequential implementation of the research proper. Performed in ten different case studies of distinct in-depth assessment, depending on the data availability, the subsequent work builds upon the emerging results of the preceding work package. As this advancement is not purely sequential but is a synergetic and iterative process work packages 2, 3, and 4 will run simultaneously for some time.
GeoERA's principal seminars (Kick-Off, Mid-Term, Final) are depicted as important time marker only as these obligatory events are not considered milestones.

3.3 Consortium as a whole

The HotLime consortium represents a promising mix of organizations that are well experienced in geothermal play assessment and related issues and countries that are aiming to advance their knowledge in this field. Accordingly, the roles and responsibilities assumed in the project are determined by expertise, data stock available, and the focus of national or regional research programmes. The experienced partners – as reflected by the leading roles in work packages – have obtained most of their knowledge from practical national use cases and past collaborations in EU research projects. The exchange of knowledge and broader implementation of commonly defined best practice and methodologies are the main aims of the project.

The project partners cover different regions and geological settings in Europe. Thereby, a comprehensive and representative overview of different geological settings and use cases is available to the project. The collaboration between partners with contrasting geological backgrounds will be an important factor in the development of assessment workflows and guidelines applicable in other European countries as well. This is important to ensure the future utilization and extension of HotLime's results.

To participate in and contribute to the knowledge transfer of this promising partnership, bringing together 15 State Geological Survey Organizations, two non-funded institutions (one partner, one associate) joined in the HotLime consortium. They are marked by asterisks (*) in the List of Participants on page 2. The partner's person-months commitment, is included in the following work package descriptions.

3.4 Resources to be committed

This section provides in three tables the details on resources commitment to the project in line with the H2020 and the GeoERA Grant Agreement:

- total number of person months committed per partner in each of the work packages (Table 3.3a),
- overview of all other direct costs such as travel expenses and equipment per partner (Tables 3.3b),
- overview of the requested budget per partner and in total (Table 3.3c).

Tables for section 3.1

Table 3.1a) Work package description (overall 7 WPs)

Work package number	**1**	Lead beneficiary		LfU	
Work package title	**HotLime Coordination and Management**				
Participant number	1	2	3	6	10
Short name of participant	LfU	GSI	TNO	LGRB	HGI-CGS
Person months per participant	6	2	1	4	1
Start month	1		End month		36

Objectives

- Perform daily management of the project (monitoring of progress, communication between partners/work packages and with the TC and GeoERA Executive Board, financial management; reporting, decision making, contingency and conflict management).
- Define rules & guidelines for internal collaboration and quality assurance of data & modes of delivery to other projects (follow-up data users) and the IP.
- Organize meetings (internal and with other projects), stakeholder integration and I&P measures, and project representation at obligatory GeoERA meetings and events (kick-off, mid-term, final).
- Prepare Data Management Plan and oversee data management throughout the lifetime of the project and the uptake into the IP.
- Maintenance of the Project Consortium agreement and ensuring ownership among participants.
- Coordinate the collaboration between HotLime and the IP in order to ensure that the requirements regarding management and dissemination of data and information are fully understood and handled accordingly (in cooperation and personal union with WP7).

Description of work

LfU (Project Coordinator) and the WP leads (GSI, TNO, LGRB, HGI-CGS) together form the Project Board acting as a steering group with responsibilities to monitor the project progress in line with all relevant regulations and proceedings and to inform the GeoERA Executive Board, in particular the GeoERA Monitoring and Reporting Officer, and to fulfil, with respect to the scientific projects, the obligations mentioned in the GeoERA Project Plan and Grant Agreement.

Task 1.1 – Administrative & Operational Management (M1-36): ***LfU***, *GSI, TNO, LGRB, HGI-CGS*

All project administration and operational management activities including:

- Day-to-day monitoring of project progress;
- Elaboration of the Project Implementation Plan (D.1.1.1);
- Support decision making and ensure the communication and implementation of decisions (D1.1.2);
- Coordinating the preparation and ensuring the timely submission of the Project Progress and Monitoring Report (D1.1.3) and the Final Project Progress Report (D1.1.4).
- Ensure high-quality technical and financial reporting (D1.1.5) of the project's progress to GeoERA.
- Sound risk and contingency management (see Table 3.2b).
- Maintenance of the Project Consortium Agreement.
- Coordination of I&P, specifically presentations at scientific symposia and papers in scientific publications/symposium proceeding.

Task 1.2 – Internal / external communication (M1-36): ***LfU***, *WP leads (GSI, TNO, LGRB, HGI-CGS)*
Efficient communication between all project participants and the GeoERA Executive Board, and the other GeoERA projects that are related to this project. An internal transparent communication and data exchange system for the partners will be set up. Preparation of the Project Communication and Exploitation Plan (D1.2), and updates when necessary.

Task 1.3 – Project Data Management Guidance (M1-6): ***LfU***, *All HotLime partners*
Set up of the Project Data Management Plan (PDMP) in line with the GeoERA deliverable 1.3 and the FAIR (Findable, Accessible, Interoperable, and Re-usable) Guiding Principles for scientific data management and stewardship, monitoring of adherence throughout HotLime's implementation.

Deliverables

D1.1.1: Detailed Project Implementation Plan (M3)
D1.1.2: Minutes of Meetings (M1-36)
D1.1.3: Project Progress and Monitoring Report (M18)
D1.1.4: Project Final Progress Report (M36)
D1.1.5: Annual Expenditure Reports (M12, M24, M36 = part of D1.1.4)
D1.2: Project Communication and Exploitation Plan (M6)
D1.3: Project Data Management Plan (M6)

Work package number	**2**			Lead beneficiary					LGRB						
Work package title	**Characterization and Mapping**														
Participant number	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16
Short name of participant	LfU	GSI	TNO	VITO	GBA	LGRB	ISPRA	GeoZS	SGSS	HGI-CGS	MTI	ARPAP	CGS	RU	ICGC
Person months per participant	16	18	8,25	6	3	18	16	2,5	4	5	2	9	2	2,7	6.5
Start month	1			End month					18						

Objectives
Specific regional mapping and modeling studies, characterization of deep carbonate rock suites by specifying parameters relevant for geothermal potential assessment, knowledge exchange between the partners

Description of work
General characterization of the key national/regional carbonate basins identified (cf. Tasks/Case Studies) in terms of potential geothermal targets and pan-European comparisons/analogues of study areas within HotLime partners, knowledge and best practice exchange incl. hands-on workshops regional/basin specific and overarching.

Characterization and mapping of geological structures:

- Collection and compilation of existing data for the target areas, to enable characterization and mapping of karstified carbonate rocks at depth, as well as fracture network environments in carbonate basins (data to include, e.g., maps, existing geo-models, borehole logs, geophysics, studies on carbonate depositional facies and tectonic history incl. conceptual models, outcrop analogues, synthesis of available literature and reports, etc.).
- Identification of data/knowledge gaps for each target area.
- Definition of target areas where baseline data allow for more detailed investigation.
- 3D model building resp. 2D mapping (depth serialised contour maps) of the prospective units and their geological framework (topset and footwall strata) and major fault structures.
- 3D characterization of the geological set-up WRT facies and lithological properties as well as fault zones with mechanic characteristics and its properties, and mechanic characteristics.
- Description of (spatial) uncertainties in the distribution, depth and properties of carbonates reservoir.

Investigation of subsurface temperatures and development of 3D temperature models:

- Collection of temperature data and generation of temperature model underpinned by conceptual models on the basin evolution
- New data measurements where needed (and feasible within scope of WP) to close data gaps (e.g., Case Study 2.3: geothermal gradient measurements from existing open boreholes coupled with thermal conductivity measurements from existing cores).
- Implementation of 3D temperature models based on different methods (geostatistical modelling, numerical modelling)

Collection of hydrothermal groundwater chemistry data:

- Specific task to collate hydrothermal groundwater chemistry data (links with Groundwater).

Delineation of promising geothermal plays and data preparation for subsequent HotLime WP as well as other projects:

- Project-wide review of all available information to allow for definition/delineation of promising prospective geothermal plays and their geological framework (these are to be implemented separately for different geological environments but following a uniform workflow).
- In depth comparison and analyses of the basin characteristics and preparation for play/prospect evaluation in WP3.
- Preparation of a comprehensive report including a catalogue of methods and required parameters, the best practice workflow for characterization and mapping of deep carbonate prospective geothermal reservoirs and the experiences of its application in different geological settings with diverse data coverage (summaries of implementing Tasks 2.1 – 2.10) (D2.0).
- Preparation of the fault network assessments for implementation in the FaultDB and further investigations in GE4-HIKE (coactive with WP6).
- Collocation, harmonization of rendering and feature data for the uptake to EGDI (coactive with WP7).

Tasks (Case Studies)

Mapping and characterization following the general workflow as described above, will be carried out in ten case studies of key national/regional carbonate settings, each with a special focus on specific issues identified in these hydrothermal plays. The case study areas are approximately outlined in the map below and are described in more detail in the following sections. The tasks will be implemented by the GSO(s) in charge of the respective areas between M6 and M18, progressing in parallel to allow all partners to exchange experience on the same step of the workflow and to track all necessary adaptions and improvements ascertained in any study area. Apart from the two hands-on workshops planned for the very beginning and around M9, this continuous knowledge exchange for best practice needs an intense communication continuing into the later-commencing WP3 and WP4.

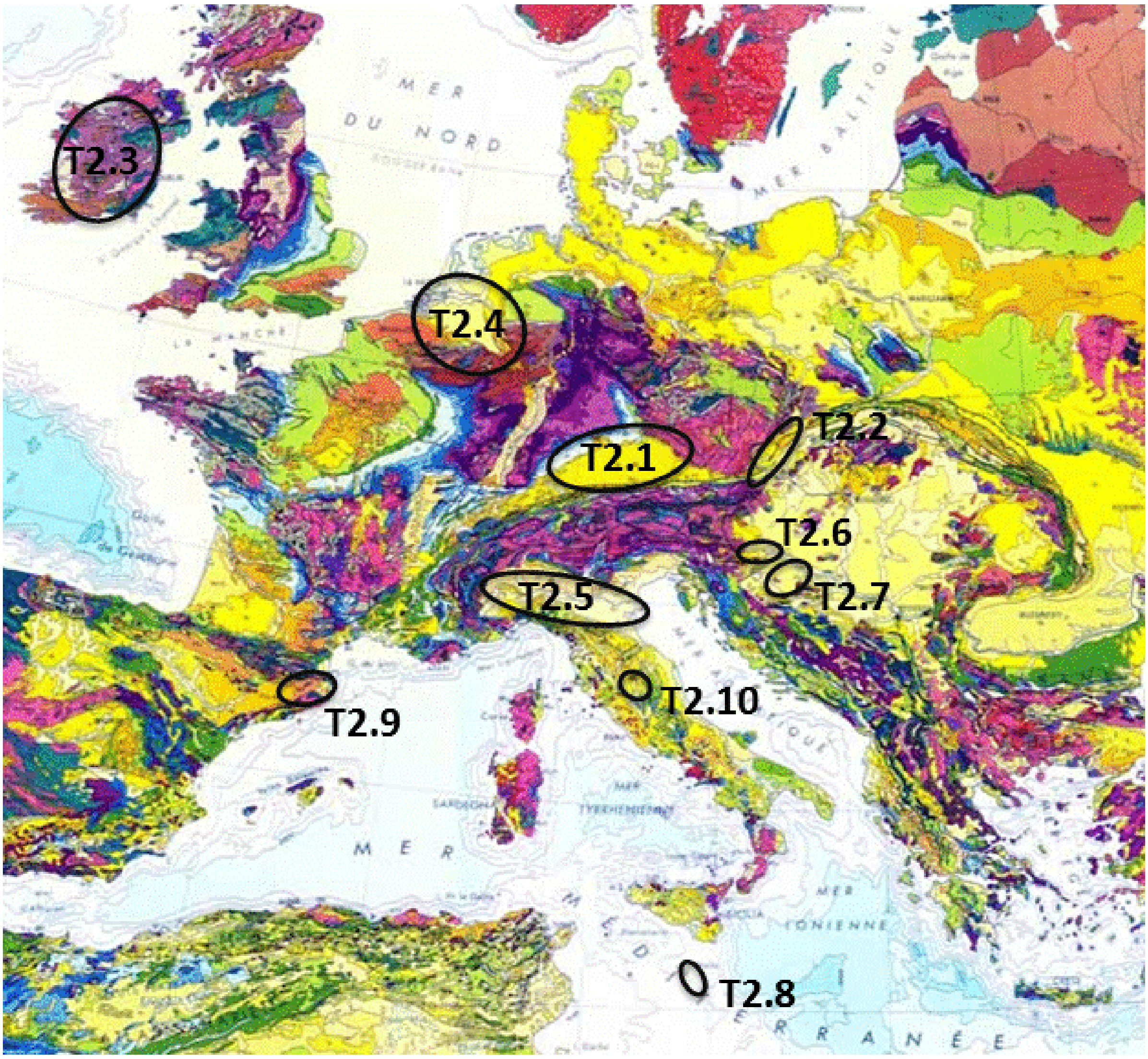

Figure 3.3 – Broad outline of the 10 Case Study areas (Tasks 2.1 – 2.10) for mapping and characterization the key national or regional carbonate basins, based on the International Geological Map of Europe 1:5.000.000.

Upper Jurassic carbonates of the North Alpine Molasse Basin (DE, AT, CZ): The North Alpine Foreland Basin aka Molasse Basin developed along the northern margins of the emerging Alpine orogeny. As a result of the Alpine thrust the footwall of the Molasse Basin, including thick carbonate rock layers of the Upper Jurassic, dips southward to depths of more than 5.500 m. Due to this enormous depth, despite an average geothermal gradient, certain parts of the Austro-German Molasse Basin bear striking examples for the successful exploitation of geothermal energy from low enthalpy karstified and fractured limestone systems. Recent setbacks, however, mainly due to insufficient groundwater yield, clearly show that the entire system is not fully understood yet and needs a significant spatial extension and augmented parameterization. Data stock, expertise and lessons learned from both paradigms, successful and unsuccessful, are imperative for analogical conclusions WRT the evaluation of play and prospect in other case studies with a sparse data base. The North Alpine Molasse Basin comprises two case studies:

- **T 2.1 – DE-AT area:** *LGRB, LfU, GBA* – Merger and harmonization of existing 3D geo-models in the German part comprising the cross-border area of Upper Austria, extension by the shallow subcrop and outcrop of the principal hydrothermal aquifer Upper Jurassic carbonate rock suite, thus covering its entire catchment area will enable the assessment of the recharge-discharge-equilibrium and possible impact on the groundwater regime in heavily utilized parts. 3D modelling and characterization of the fault network in line with the specifications of GE4 HIKE as well as property regionalization and facies distribution within the hydrothermal aquifer following joint stipulations and criteria will, allow for a uniform evaluation of all plays under consideration.
- **T 2.2 – CZ-AT area:** *GBA, CGS* – Cross-border characterization of carbonate hydrothermal aquifer and structural inventory by updating the existing 3D geo-model in the Austrian part and merger/harmonization with a newly established Czech geo-model. Respective Upper Jurassic carbonate rock suites are located below the transition zone of the Alpine Molasse Basin and the Carpathian Foredeep and thrust belt at about 1500 m below ground, overlaying the southeastern slopes of the Bohemian Massif. Major faults in this region are roughly trending NE-SW, confining half-graben structures exhibiting sedimentation areas of autochthonous, Mesozoic deposits.

Carboniferous carbonates in basins structures of Ireland (IE): Ireland has a complex basement geology, created and modified by several phases of the Caledonian tectonic cycle. The resulting structural template was reactivated during Carboniferous extension to form sedimentary basins and shelves that were variable through time, resulting in complex carbonate stratigraphy. Bounding faults provided fluid pathways for mineralisation and karstification, and subsequently accommodated Variscan compression and brittle fracturing. Thus, the fault pattern defines zones of both karstic and brittle-fracture high-permeability pathways for geothermal/hydrothermal fluids in these carbonate basins. Karstification and fluid flow in Irish limestones is also a topic of project GW3-RESOURCE, WP5 on typology of karst aquifer, in which GSI is also a partner, and there will be close exchange on this aspect between the projects. Many details of the carbonate stratigraphy, lateral and vertical facies changes, and fracture patterns within structural compartments are known from mapping and borehole drilling, but there has been very limited application of these data to the search for geothermal energy. In Ireland, there is a general coincidence of Carboniferous carbonate basins with heat demand and also potential locations for geothermal power plants (e.g. sites where old peat-burning power stations need to be replaced with renewable energy/heat supply).

- **T 2.3 – Lough Allen Basin and Clare Basin:** *GSI* – Particular activity will be directed at the Lough Allen Basin and the Clare Basin, where legacy hydrocarbon data including seismic and boreholes are available. The potential of other basins more closely aligned with heat demand, such as the Dublin Basin will also be investigated. These basins in Ireland are not, as yet, known to exceed 3 km in depth, so district heating will be the likely application of geothermal energy. GSI will: collate deep borehole data, paying attention to geothermal parameters (groundwater flow, temperature, water chemistry, karstic cavities, faults and fractures) and collect new data to close knowledge gaps (including re-logging core, thermal conductivity measurements from existing core, down-hole geothermal gradient measurements (fibre optic method), water chemistry).

Dinantian carbonates of the London-Brabant Massif flanks (BE, NL): The flanks of the London–Brabant Massif (from the UK to the Netherlands, Belgium, Germany and France) constituted a structural high in Early Carboniferous times where carbonate platforms developed. Various projects within the study area provide valuable information to constrain future assessments, including the geothermal well

Merksplas–Beerse (BE), the recent Californië doublets (CWG and CLG) and the Balmatt / Mol doublet.

- **T 2.4 – BE-NL cross-border area**: *TNO, VITO* – The study area is exemplary because it has sub-domains with different geological situations (karstification, fault- and fracture densities), data situation, and cross-domain issues (e.g. impact on groundwater, fault characterization, seismicity). Maps and models developed in past BE-NL cross-border initiatives like GEOHEAT, combined with outcrop analogues from the Namur-Dinant Basin in southern Belgium will be used to assess the geothermal potential. Combining the core material and geophysical well logs of all wells that transected the Dinantian carbonates with information from these outcrop analogues, reservoir properties will be assessed in 2 or 3 dimensions at an inter-well scale. Especially the relations between lithological units and fracture intensity (mechanical stratigraphy), and the characterization of an analogue fault damage zone, contribute to the understanding of the complex carbonate system as a geothermal reservoir.

Jurassic and Cretaceous carbonates of the Po Basin (IT): The Po Basin in northern Italy comprises the foreland area of the two active oppositely-verging fold-and-thrust belts the Southern Alps and the Northern Apennines. It consists of late Triassic - Eocene evaporitic–silicoclastic and carbonatic sequence deposited on the Adriatic paleomargin and covering the Variscan basement, followed by a thick pile of Cenozoic foredeep deposits, locally up to 8,000 meters, and by Quaternary shallow marine and continental sediments deposited in a generally regressive sequence. Well stratified Jurassic and Cretaceous sediments, of carbonatic platform to basin environment, possibly contain layers with geothermal potential for balneological use and direct heating.

- **T 2.5 – Po Basin:** *ISPRA, SGSS, ARPAP* - Trans-regional harmonization of subsurface geological data (2D maps and 3D geological models) into a comprehensive regional framework to enable characterization and mapping of target units for the entire basin (from Piemonte region, to the west, to the Adriatic coast line, to the east). This wide region is strategic for the geothermal resources but, at the same time, needs attention due to the possible interaction of resources exploitation with natural hazards (e.g. seismicity). The characterization of fault systems (Mesozoic inherited faults, active buried thrusts and their relationships) will be addressed, together with facies changes and properties of prospective units and their geological framework. The 3D fault network of this wide region will be a valuable input for the European Fault DB in GE4-HIKE project.

Triassic carbonates of the Southwestern Pannonian Basin (SI): The Pannonian Basin is an extensive Tertiary Basin which has been developed during the Carpathian orogeny. It is characterized by a major system of Neogene basins resting on highly deformed and complexly faulted bedrock of the Mesozoic to Precambrian. The Pannonian Basin in general features abundant geothermal potential, however, too little is known about the limitations of hydrothermal systems in the marginal sub-basins to ensure their sustainability in utilization.

- **T 2.6 – Krško-Brežice sub-basin:** *GeoZS* – This sub-basin of SE Slovenia belongs to the SW part of the Pannonian basin. The basement geothermal reservoir is formed in fractured and karstified Triassic carbonates. A large thermal water convection cell formed, resulting in a natural thermal spring which ceased due to exploitation of thermal water at three sites. Production of water is extensive, causing a possible regional depletion of the reservoir. This urges management intervention which foresees reinjection of waste thermal water back in the aquifer. In such non-porous systems, a large risk of cooled water breakthrough exists. Therefore, to be able to select the reinjection sites properly and to evaluate a possible interference to existing production sites, a sound 3D geological and structural model is needed wherefrom pathways for thermal ground flow could be identified. The structural information will be supplemented by the collection of thermal waters occurrences, hydrogeochemical properties of the water, time-series of its heads, and utilization parameters. We will interpret the data of previous projects such as Lignite exploration program from the 1980-ies (> 10.000 m of well logs and exploration underground mine workings; local tectonic interpretation), SHA-JEK II and Investigation for Intermediate Radioactive Waste Disposal (both focused on seismic hazard analysis by a seismotectonic model of the nuclear power plant in Krško), Transboundary aquifers between Slovenia and Croatia, DARLINGe, operational monitorings etc.

Triassic dolomites and Miocene limestones of the Zagreb geothermal field (HR):
Zagreb geothermal field consists of two „sub-fields“: Mladost (3 boreholes in operation) and KBNZ (6 boreholes, not in operation). Geothermal water of temperatures between 64 and 80 °C was identified in Triassic dolomites and Miocene Lithotamnium limestones or both (differing from one borehole to another). Most of the data (borehole data, loggings, seismic interpretations) from the extensive research in the 1980’s is available, but, at present, HGI-CGS has a limited expertise in their interpretation.

- **T 2.7 – Zagreb geothermal field:** *HGI-CGS* – Compilation and synthesis of the available data of the Zagreb geothermal field within the knowledge transfer of HotLime, mapping of the extension, depth and thickness of the prospective units and principal fault structures. Characterization of the geological set-up WRT facies and lithological properties as well as fault zones.

Tertiary and Mesozoic carbonate rocks close to the Pantelleria-Linosa-Malta rift complex (MT):
The Pantelleria-Linosa-Malta rift complex is a continental extensional zone which formed in the late Miocene to Pliocene and is still active today. It consists of three main grabens accompanied by recent volcanic activity as attested by the Pantelleria and Linosa volcanic islands. This rift complex divides the area surrounding the Maltese Islands in two main domains, a platform area in the north and a rift area in the south. The latter domain is likely to provide the right geological conditions for geothermal energy exploration and exploitation.

- **T 2.8 – Malta case study:** *MTI* - An assessment of the geothermal potential of Malta through an analysis of geothermal gradient data from deep exploration wells, the stratigraphy and facies of deep carbonates and regional heat flow maps of the Maltese Islands and surrounding areas. Available geological and well data will be used to identify provinces of high heat flow in the immediate vicinity of the Maltese Islands such as the Pantelleria-Linosa-Malta rift complex. Temperature gradients will be extracted from 13 deep exploration wells, both onshore and offshore, providing indicative heat flow estimates. An analysis of samples/cores/well log data from these wells provides lithostratigraphic information on the carbonates encountered at depth.

Lower Eocene Carbonates of the Tertiary Empordà Basin (Catalonia, ES): According to the IGME (Spanish Geological Survey) 80’s studies based on the information from old deep oil/gas wells and seismic profiles, different areas with different geothermal potential can be distinguished in Catalan Coastal Ranges. One of them is the Empordà Basin, NE Catalonia, where the occurrence of deep carbonate aquifers allows considering a possible target for low temperature geothermal resources.

- **T2.9 – Catalan case study:** *ICGC* – The Empordà basin is filled with a thick sequence of more than 2500m of Eocene, Neogene and Quaternary sediments. A system of normal faults with NW -SE direction is the determining factor of the structure into the basin. At the bottom of the Tertiary sediments, is situated the Girona Limestone Formation (GLF), with an average thickness of 80-150m. The old Girona-2 gas well cut this horizon at 812-924 m depths that produced, at artesian rate, geothermal fluid at temperatures around 50ºC. The corrected gradient was established at 42ºC/km. The geo-thermometers reveal values between 110 and 120ºC. To address its study, it will be collect old available data (seismic, old oil/gas wells), the available geological maps and the surface-based 3D geological model of Catalonia. The focus is to infer a first baseline 3D conductive thermal model to characterize the geothermal target. It will be reviewed the stratigraphy and facies and assess the GLF’s outcrops. The formation will be hydraulically assessed at shallow aquifers.

Tuscan-Umbria-Marche units (IT): West Umbria is located in the central part of the northern Apennines, in a geologically complex area, which includes the north-eastern sector of the Vulsino volcanic system, the south-eastern part of the Cetona ridge, the southern sector of the graben of the Valdichiana, the graben of Paglia-Tevere, the ridge of Mount Peglia, the Perugia massifs and the upper

Tiber valley. In the areas there are stratigraphic sequences referable to 4 different tectonic units, which were stacked during the Miocene compressive phase: Ligurian units, Tuscan units, Tuscan-Umbria units, Umbria-Marche units. Above these units are present, in discordant contact, deposits that have sedimented in the post-orogenic phase from the Pliocene to the current; these include alluvial deposits, travertines, vulcanites and continental and marine deposits. The structural structure is characterized by the presence of compressive structures (thrust), cut and displaced by successive Plio-Pleistocene extension structures, which have led to the formation of basins with NW-SE direction.

- **T2.10 – Umbria case study:** *RU* – Assessment of the geothermal potential of Umbria through, analysis of geothermal gradient data from deep exploration wells, the stratigraphy and facies of deep carbonates and regional heat flow maps. Available geological and well data will be used to identify provinces of high heat flow in the Tuscan-Umbria-Marche succession that is likely to provide suitable geological conditions for geothermal energy exploitation. Temperature gradients will be determined from 25 deep exploration wells and springs, providing indicative heat flow estimates. An analysis of samples/cores/well log data from these wells provides rock characteristics information on the carbonates encountered at depth.

Deliverables
D2.0: (M18) A comprehensive report on the best practice workflow and guidelines for characterization and mapping of deep carbonate hydrothermal plays, including

- a catalogue of methods (seismic interpretation, 3D modelling, etc.) and required parameters,
- possible modifications of the generic workflow for settings with insufficient data situations,
- summaries of implementing Tasks 2.1 – 2.10 (experiences and results of workflow application in different geological settings with diverse data coverage),
- generation and implementation of 3D temperature models based on different methods (geostatistical modelling, numerical modelling),
- description of (spatial) uncertainties in the distribution, depth and properties of the reservoirs.

Also part of this report (and attached separately to the spatial products) are descriptive reports accompanying the spatial representations: Improved 2D, 2.5D and 3D models (based on baseline data coverage) of prospective geothermal reservoirs will be compiled for each test case area, including the following items categorized in respect to data availability:

Cat.1: Minimum achievements:

- Depth and thickness of the reservoir rock modelled
- Fault distribution and attributes (maps, models)
- Temperature model, enabling temperature prediction at various depth levels which can be applied to the local situations.
- Hydraulic conductivity of the reservoir due to fractures, karst and dissolution supplemented by (primary/secondary) porosity and permeability data, where available and meaningful.

Cat.2: Ideal achievements:

- Basin-scale models for facies (e.g., division in platform top / slope / basin) distribution and primary reservoir quality as function of carbonate systems.
- Fracture model(s), maps or fracture density maps that can be applied to any location within the study area, and that can be used to predict flow behaviour of the reservoir
- Gravity-based maps that delineating basement structures (rationale: they control the facies distribution of carbonates.
- Groundwater chemistry data.

Cat.3: Optional achievements:

- Uncertainty maps of reservoir parameters (depth, thickness, temperature, permeability)

- Heat flow models and other thermal parameters to predict temperature
- Tectonic reconstruction studies
- Description of the tectonic history of the carbonates, in logical time steps tied to large scale prediction of fluid flow in relation to faulting and diagenesis.

Subject to the usual imponderability of research the following spatial information will be prepared (M18):

D2.1: A 3D geological model of the central Molasse Basin featuring the entire Upper Jurassic hydrothermal aquifer including its outcropping portions, its topset beds and footwall sedimentary sequences and the classified structural inventory, fully parameterized acc. to Cat.1 & 2, seamlessly matching the Austrian Molasse model. Appropriate input data for numerical groundwater modelling.

D2.2: A 3D structural and geological model of the geothermal reservoir situated in Jurassic limestones of the Molasse Basin Carpathian Foredeep transition zone in the AT-CZ cross border area, serving as input for temperature modeling. Output datasets will be provided according to Cat.1

D2.3: 3D geological models of the Lough Allen Basin and Clare Basin to Cat. 1 & 2 level, linking facies, structural history and secondary permeability. Report on identification of other prospective basins, with 2D or 2.5D to Cat. 1 & 2 levels

D2.4: Base and top maps (2.5D model) of Lower Carboniferous carbonates (both subsurface and in outcrop) covering Cat.1&2 and including 3D faults and fault maps at Lower Carboniferous level and carbonate facies distribution maps. Comprising Cat.3 data sets as well, such as uncertainty maps of reservoir depth and thickness (and effect on temperature model), heat flow models, description of tectonic history of the London Brabant Massif including diagenetic history.

D2.5: An improved 3D model of Po Basin from Piemonte region to the Adriatic coastline featuring buried Jurassic-Cretaceous prospective geothermal units and their geological framework (depth and thickness for the basin-wide units, faults geometries), including temperature model. Basin-scale model for facies distribution (e.g., division in platform top / slope / basin), relevant geothermal parameters and carbonate groundwater chemistry data according to Cat. 2

D2.6: A 3D structural and geological model of geothermal reservoir of Krško-Brežice sub-basin will be created corresponding to Cat.1, as the first-order approach of play assessment (WP3) and appropriate input for numerical groundwater modelling.

D2.7: Constructed model of the Zagreb geothermal field will conform to Cat.1, additionally including some features of Cat.2 (e.g. groundwater chemistry).

D2.8: A 2D structural and geological model of the geothermal reservoir close to the Pantelleria-Linosa - Malta rift complex will be created corresponding to Cat.1 and to Cat. 2 where data coverage allows.

D2.9: A 2D maps and 3D geological model (depth and thickness for the basin-wide units, faults geometries) of the Empordà Basin (NE Catalonia) according to Cat.1, focusing the geothermal reservoir situated in the Lower Tertiary Eocene Carbonates. For the Cat.3, a preliminary heat flow model and data sets such as uncertainty maps of reservoir depth and thickness (and the assessment of its sensibility on temperature model). The report also will include identification of other prospective basins with 2D maps (e.g. Olot basin).

D2.10: A 2D structural and geological model of the geothermal reservoir in the Tuscan-Umbria-Marche units will be created corresponding to Cat.1 and to Cat. 2 where data coverage allows.

Work package number	**3**			Lead beneficiary			TNO					
Work package title	**Play and Prospect Evaluation**											
Participant number	1	2	3	5	6	8	9	10	11	13	14	16
Short name of participant	LfU	GSI	TNO	GBA	LGRB	Geo ZS	SGSS	HGI-CGS	MTI	GEO IN FORM	CGS	ICGC
Person months per participant	6	6	4	1	4	2,2	4	3	2	0,61	0,5	3
Start month	6			End month			24					

Objectives
Provide means to quantitatively and qualitatively assess the expected amount of geothermal energy which can be produced, rank the assessed carbonate plays and classify them.

Description of work
Unlike the preceding WP2 the work in WP3 is pooled into one task as it builds upon the gradually enlarging and improving results of the WP2, emerging in different geological situations and to a different viability (depending on the data situation), feeding into a iterative process for generic and representative evaluation, classification and ranking. On the other hand, WP4 will provide a synopsis on lessons learned from carbonate exploitation experiences to iteratively support resource assessments. Such synergetic and iterative advancement cannot be formalized in individual tasks.
Task 3.1 – Play and Prospect Evaluation (M6-24): ***TNO**, all WP3 partners*
This task focuses on the development of flow performance and resource assessment models for deep carbonate rocks, and applying them on the reservoir models that result from WP2. The ThermoGIS approach (http://www.thermogis.nl/) will be used as a basis for the assessment. ThermoGIS is the Dutch national geothermal resource assessment tool, which is based on the 1D performance assessment tool DoubletCalc. Because ThermoGIS was originally developed for clastic reservoirs, it needs to be adapted in order to be applicable to carbonate reservoirs having a completely different permeability distribution.
To this end, suitable (readily available) fast models will be selected based on (public domain, in-house and/or commercial reservoir simulators (e.g. DoubletCalc, TOUGHREACT, FLAC). This task should be lined up with activities of GE2-Geo4Sure for methodology and classification (see WP6, Task 6.2). The assessment of carbonates in the latter project is also terra incognita. Therefore, initially, in particular, fast- and/ simplified model approaches will be considered, which allows fast swift computation of the reservoir performance and resulting resource assessment. These models need to be able to incorporate the static model input (resulting from WP2): reservoir depth, thickness and temperature, and, in particular the detailed and anisotropic representation of 3D permeability for karstified and/or fractured reservoirs, building from input from WP2. Results from more detailed interaction effects (chemical, mechanical, thermal) are taken into account in a simplified yet representative way
Setting up a quantitative conceptual methodology (tool) for carbonates that incorporates relevant properties and processes affecting flow, taking into account coupled processes of chemical, thermal and mechanical reactions in order to estimate the doublet performance to be fed into the assessment tool

must therefore be developed.
Preferably, the static model also incorporates the uncertainty of the major reservoir properties (usually permeability), in order to calculate a geothermal power expectation curve. Results from more detailed interaction effects (chemical, mechanical, thermal, as being developed in DESTRESS and/or SURE) may be taken into account in a simplified yet representative way. It should also include assessment of sensitivities, which in turns feeds into ways to optimize well completion and ways to stimulate wells and mitigate unsolicited flow performance. To this end the tasks develops representative scenarios of predictive models for (fractured) carbonate reservoirs and templates for model parameterization (under uncertainty).
Sub-tasks include the following:

- Define/analyze geo-technical play elements and criteria for deep carbonates per basin/unit
- Rank/categorize various deep carbonate plays into assessment units, this includes:
- Identify/evaluate/rank deep carbonate prospects (resource assessment)
- Report into a common classification system (update/use of UNFC-2009 for Geothermal Energy Resources).
- Evaluate target/prospect selection strategies
- Preliminary assessment of the potential of low-enthalpy geothermal reservoir through flow and heat transport modelling

Deliverables
D3.1.1: Report / knowledge exchange on common (cross-basin) prospect/play criteria, indicators and assessment methodologies, including description of assessment results per area (M30)
D3.1.2: Spatial (maps, 3D models) resource assessment in areas in focus (M24)
D3.1.3: Classification system for plays and propects (web based) (M24)
D3.1.4: Quantitative assessment tool for assessing the doublet performance and the resources (M24)

Work package number	**4**			Lead beneficiary				GSI			
Work package title		**Deep Carbonate Play Development**									
Participant number	1	2	3	4	5	8	9	10	14	16	
Short name of participant	LfU	GSI	TNO	VITO	GBA	Geo ZS	SGSS	HGI-CGS	CGS	ICGC	
Person months per participant	6	8	2,5	4	2	1,5	2	4	1	1,5	
Start month	12			End month				36			

Objectives
Learn from case studies of deep carbonate play development experiences in partner and third countries to improve future development strategies, identify and mitigate risks and support policy-making.

Description of work
This WP is geared towards a synopsis of play development experiences in one comprehensive report, thus not subdivided in tasks.
Task 4.1 – Deep Carbonate Play Development (M12-36): ***GSI***, *all WP4 partners*
This task compiles and evaluates case studies from deep carbonate exploitation experiences in partner and third countries. It is proposed to include, wherever appropriate data are available, review and appraisal of flow performance results (injectivity and productivity) from geothermal and other (hydrocarbon, groundwater) production and stimulation data.
Examples of play development experiences, including production data where available, that can be analysed include:
- the Greater Munich area geothermal “bonanza” with more than 25 geothermal installations in operation (but recently some failures and induced seismicity) and the Austria-Bavaria border area,
- the Upper Austria-Upper Bavaria cross-border region with 7 geothermal utilizations for balneology, heat and power generation (possibly at risk of overexploitation due to an unknown groundwater regime),
- the Californië doublet (NL),
- well tests of Dinantian carbonates in other Dutch wells (Uithuizermeeden, Luttelgeest, offshore wells),
- Belgian production data from Merksplas and experiences from the development of the Balmatt geothermal site (Mol),
- the Casaglia District Heating plant (Ferrara, IT),
- the Newcastle district heating project (Dublin)
- the Zagreb geothermal field (Mladost and KBNZ boreholes), and
- the Slovenian and Catalonian case studies.

Comparison with analogous, well-documented systems such as mature hydrocarbon fields can also be performed.
Backed by the lessons learned on how to improve resource assessment, the synopsis of all the above data and information will be employed to iteratively support resource assessments in WP3,
- analyze the application of deep carbonate play geothermal exploitation strategies to new or future developments in partner countries where appropriate, including consideration of demand, current exploration status, competition from and synergy with alternative energy sources,
- assess the risk of induced hazards (seismic, aquifer contamination) from the exploitation of deep carbonate geothermal reservoirs, in parallel with method development in GE4-HIKE (see WP6),
- assess experiences of project failure from inadequately constrained geological data, and
- conceptualize policy and decision-support recommendations on developing deep carbonate plays.

In some countries, demonstration of geothermal potential, including in deep carbonate basins, will facilitate and accelerate development of licensing regulations for commercial exploitation of geothermal energy. This WP will fuel knowledge transfer to potential industry and government regulators in the GSOs’ areas of competence. Based on this, generic recommendations relevant across the national legal situations will be compiled and formalized in WP5 on knowledge transfer and stakeholder engagement.

Deliverables
D4.1: Report on lessons to be learned from previous development experience for deep carbonate play strategies and impacts (M36)

Work package number	5			Lead beneficiary			HGI-CGS				
Work package title	**Knowledge Transfer**										
Participant number	1	2	3	5	6	7	8	9	10	13	14	16
Short name of participant	LfU	GSI	TNO	GBA	LGRB	ISPRA	Geo ZS	SGSS	HGI-CGS	GEO IN FORM	CGS	ICGC
Person months per participant	2	2	0,5	0,75	2	1,5	0,5	1	3	0,61	0,5	0,36
Start month	6			End month			36					

Objectives

- Formalizing the lessons learnt and the outcomes of internal knowledge exchange from WP2-4 and converting it into a more generic approach for Pan-European recommendations.
- Integration of stakeholders also from other domains for an effective knowledge transfer beyond the territorial reach of HotLime.
- Conceptualization and population of the knowledge base.

Description of work

HotLime is geared towards cross-fertilization of the geologists' expertise and understanding based on their conceptual model of the geological evolution and by comparing and using experience-based parameter values for further assessments. This "learning by teamwork" knowledge exchange is an integral part of implementing WP2 to 4. WP5 will formalize and convert it into a more generic approach and make it available to a wider audience. Integrating stakeholders from other domains facilitates an effective knowledge transfer beyond the territorial reach of HotLime in order to assess the untapped geothermal potential of other similar/analogous hydrothermal plays. With this sharing of the formalized and generic best practice approach, two levels on top of the inherent intra-project knowledge transfer are addressed: the stakeholder communication and the knowledge base.

Task 5.1 - Stakeholder communication (M6-36): ***HGI-CGS**, all WP5 partners*

Involving all those institutions that can make use of or are impacted by HotLime's research results (e.g. regulators/policy makers, utility, academic research, geological survey organizations beyond the HotLime consortium, NGOs/interest groups), is geared towards a better understanding of the requirements for geothermal planning, licensing and realization[1].

- Requirement elicitation will be performed within the scope of the case studies 2.1 - 2.10, resp. the subsequent play evaluations based upon, target-oriented and customized as national statutory provisions are disparate as are the regional geological situations they have to be applied to. Identified user requirements (WRT products, features, formats) will feed into WP7 for appropriate definition of

[1] Ireland e.g. is currently developing its regulations for licensing the exploitation of geothermal energy, so stakeholder engagement with, and knowledge transfer to, potential industry and Government regulators will be an important component of HotLime.

demands made on IP.

- Generic recommendations in order to improve the understanding of possible exploitation impacts and operational issues related to geological aspects in deep carbonate rocks, reflecting the lessons learned in WP2 to 4, will be collocated and communicated by means of guidelines in the HotLime Project Report as part of the knowledge base.
- Additionally, information of policy-makers and for strategic direction is addressed on a supra-national level. Centrepiece of this stakeholder information is the envisaged Brussels Information Day planned as a joint face-to-face information event of all GE projects addressing geothermal and related issues.

Task 5.2 - Knowledge Base (M6-36): ***LfU***, *GSI, TNO, LGRB, GBA, ISPRA, HGI-CGS*

The conceptualization and population of an information pool, serving the geoscientific community as well as cross-domain user groups, is a pivotal module of HotLime's reporting channels. The explicit and tacit knowledge applied and incorporated in the spatial information and disclosed via the EGDI web service will be made available for end-users the in a structured and sustainable way based on the Open Linked Data principles and meeting the requirements of a Semantic Web. The formalization for the uptake to the Semantic Web (set up in IP WP4), will be realized in WP7 (IP Interface).

- Summarizing the generic results of WP2-4, preparation of a concise user manual describing work flows and procedures, and guidelines on the use and use limitations of HotLime's spatial information.
- Setup of a semantics database for the glossary of technical terms (resp. links to existing controlled vocabularies of the semantic web) that can be used for categorizing and interlinking information from the user manual and those generated from case study results.
- Preparation of procedures for accessing information from the Knowledge Base (coactive with WP7).
- Preparation of above data repository elements for the implementation in EGDI (coactive with WP7).

Deliverables

D5.1.1: A synopsis outlining the (practised/planned) regulations for licensing the exploitation of geothermal energy in the HotLime partner countries (as part of the project report – M36).

D5.1.2: Generic recommendations WRT geological aspects to be considered in geothermal planning, licensing and realization (as part of the project report – M36).

D5.1.3: Subsurface planning information event jointly with other GE projects (by agreement, ~M30).

D5.2.1: Specifications/technical requirements for the geological data repository/semantic web in EGDI: managing and sharing knowledge on data, synthesis, recommendations and best practices of HotLime; input for formalization and preparation of uptake in WP7 (M18).

D5.2.2: Full glossary of technical terms (feature data code lists) for the EGDI Semantic Web (M30).

D5.2.3: Common knowledge base grounded on IP WP4 developments (linked data semantic web), including metadata on geo data sources, methodology, case studies, including a concise user manual for proper use of spatial information in subsurface planning and management (M36).

Work package number	6		Lead beneficiary		LfU				
Work package title	**Project-Project Interface**								
Participant number	1	2	3	6	7	8	10	12	16
Short name of participant	LfU	GSI	TNO	LGRB	ISPRA	GeoZS	HGI-CGS	ARPAP	ICGC
Person months per participant	2	2	1	2	2	0.5	3	1	1.5
Start month	3		End month		30				

Objectives

By its nature, HotLime features cross-topic intersections with various GE projects. Exploiting the synergies among these projects will further add value either-way and to theGE theme in general.
The Project-Project Interface is geared towards intensive knowledge transfer for preparing the takeover and uptake of data and information from/to other projects for further valorisation. This data transfer has to be prepared jointly in line with the requirements of the recipient project, because efficient data integration is subject to a common understanding of data origin, data processing, and its use limitations.

Description of work

HotLime's outcomes in general, but especially its parametrized 3D information, constitute a potential input into other GE projects. Applying novel and improved methods of other GE projects in HotLime case study areas as test beds will help to double-check these methods and to report HotLime's results into a common assessment framework for geothermal and related issues. To this end, early inter-project stipulations regarding feature data, formats, rendering and meta data are required which moreover ensure a basic standardization for concerted and so efficient data integration into EGDI and its consistent visualization.

Task 6.1 – HotLime-HIKE Interface (M3-36): ***LfU**, all WP6 partners*

Characterization of faults is crucial to both, HotLime as well as GE4-HIKE, even though with different but overlapping objectives: mapping preferential flow paths (conduits) for hydrothermal fluids, the compartmentalization of reservoirs, etc. on the one hand, and, seismic hazards, seal integrity, gas seep, etc. on the other. To attain these goals both projects will break fresh ground in combining novel approaches with established methods. Thus a continuous collaboration with HIKE is essential, as well as with other projects contributing to HIKE in a larger extent (e.g. GE6 GeoConnect^{3}d that will directly use the faults at multiple scales as the backbone for various geo-manifestation data).

- Continuous communication, web conferences and face-to-face meeting(s) with HIKE and IP, as well as GeoConnect^{3}d on fault attribute/property requirements (feature data, formats, rendering, etc.).
- Provision is made for a joint hands-on workshop tackling concrete case studies together and applying various methods to ensure a common understanding and eventually define a common best practice, envisaged e.g. are joint workshops on fault specifications (M9) and technical issues (ca. M28), both masterminded by HIKE.

- Deployment of test fault datasets for the check of feature data coherency as well as dissemination and query functionalities implemented.
- Feedback to HIKE (on concept) and IP (on concept implementation) and WP7 as most requirements towards appropriate end-user functionality will be tackled in WP7).
- Upload of final fault framework and associated feature data to the Fault Database (implemented via WP7).

Task 6.2 – HotLime-Geo4Sure Interface (M6-18): ***LfU**, GSI, TNO, HGI-CGI, ICGC*

Instructed by GE2-Geo4Sure (resp. its lead RBINS-GSB as associate of HotLime) selected 3D geo-models produced in WP2 will be customized according to the Geo4Sure requirements. Geo4Sure's methods and evaluation procedures will be applied for geothermal plays in deep carbonate bedrock in order to prove the validity resp. calibrate the method for these geothermal reservoirs and its geological settings. Comparison with results from proprietary, public domain and commercial reservoir simulators (DoubletCalc, TOUGHREACT, FLAC) as applied in WP2 uncertainty assessments.

- Continuous communication with Geo4Sure team on methods and evaluation procedures.
- Customization of selected HotLime geo-models and application of methods and evaluation procedures.
- Feedback to Geo4Sure and, if necessary, request for adaption/calibration of methodology.
- Cross-check with reservoir simulator applications in WP2 for methodology and classification

Task 6.3 – HotLime-GeoConnect^{3}d Interface (M18-30): ***LfU**, GSI, TNO, partners with suitable WP2 model*

In addition to the collaboration on fault attribute/property requirements (see Task 6.1) HotLime will contribute to GeoConnect^{3}d Task 5.3 “Generalising the cases” by providing suitable paradigms for definition of issues and concepts. To this end outcomes of WP2 which imply a possible conflict of uses will be selected and screened for their compliance with rules and methods of GeoConnect^{3}d. This will help to bring methods and tools of GeoConnect^{3}d to a more generic level and, on the other hand, to conceptualize HotLime's policy and decision-support recommendations in WP4. As the results of WP2 are not predictable, this HotLime-GeoConnect^{3}d cooperation cannot be formalized at this stage.

Task 6.4 – HotLime-CHAKA Interface: ***GSI**, TNO, LfU*

The principle cooperation with GW3-RESOURCE, WP5 on typology of karst aquifer (CHAKA), will be done within the HotLime tasks 2.3 and 2.4, investigating the same areas as CHAKA's demonstration and pilot studies. Fluid flow in deep karst and paleokarst is clearly a topic of interest to both projects and discoveries and data on such occurrences will be exchanged smoothly between them. As the level of collaboration and knowledge exchange will depend on discoveries during the data-gathering phase of each project, they cannot be formalized at this stage.

Deliverables

D6.1.1: Report on fault property requirements and exchange logbook on best practice (coactive with GE4-HIKE) (M18).

D6.1.2: (Principal) fault network of HotLime's spatial information implemented, discoverable and retrievable via the Fault Database (M36).

D6.2: Report on Geo4Sure application experiences and comparison with other simulation methods deployed (M24, afterwards part of the HotLime final report, also contribution to the Geo4Sure report).

D6.3: Exchange and geomanifestation methodology evaluation log (in conjunction with GeoConnect^{3}d: D5.2)) (internal report, M30, afterwards part of the HotLime final report).

Work package number	7		Lead beneficiary			LfU	
Work package title	**IP Interface**						
Participant number	1	3	6	7	10	16	
Short name of participant	LfU	TNO	LGRB	ISPRA	HGI-CGS	ICGC	
Person months per participant	6	2	6	2	1	1	
Start month	6		End month		36		

Objectives
To govern the interactions with the GeoERA-IP project and to execute the parts of the Project Data Management Plan (PDMP) relating to the Information Platform (EGDI). WP7 will be responsible for communicating the HotLime information platform requirements to GeoERA-IP and conversely ensuring that the guidelines and standards provided by GeoERA-IP are properly implemented in the WP2 to 5 processes. Preparation of HotLime's outputs for the uptake to the Information Platform (EGDI) safeguarding the standardized representation of geoscience information tackling data/semantic heterogeneity and diverse dimensionality in accordance with the existing interoperability framework (INSPIRE, OGC, W3C, CGI) and allowing its straightforward discovery.

Description of work – sequential procedure, throughout: ***LfU/LGRB**, all WP partners*
The systematic organization and joint representation of maps, models, and knowledge databases in EGDI requires cross-domain stipulations, and therefore close coordination with the other SRTs and projects as well as continuous collaboration with the IP in order to ensure that the requirements regarding management and dissemination of data and information are fully understood and handled accordingly.
HotLime's contributions in serving the IP/EGDI thus will accompany inter-project joint efforts.
Task 7.1 – Requirements and standards determination – communication with IP team(s) (M1-12)
Continuous communication and web conferences with (i) the IP-Interface WP teams of other GE projects (particularly GE4 HIKE for the specifications of the FaultDB) and (ii) the IP developers to jointly identify, describe and agree on stipulations and requirements in line with the DMP and EGIP concepts to ensure the merger of the projects results from different national repositories into a shared information model (data infrastructure, formats, harmonized rendering of geological and topical information, query toolkits, etc.) considering national statutory provisions.
Task 7.2 – Application to HotLimes products and provision of test datasets/prototypes (M6-18)
Customization of map series, 3D models and parameter dbases to the requirements imposed by IP, preparation and deployment of maps, models and datasets for prototyping and check of technical functionalities and toolkits in EGDI testbeds (coactive with WPs 2 and 3, continuous communication with IP).
Task 7.3 – Preparation of metadata, populating the knowledge base and semantic web (M18-30)

Tagging the metadata of all HotLime products with keywords, according to the IP's Task 7.2 specifications, to enable spatial information and related data for retrieval through discovery systems (search by keywords) via the EGDI Metadata Catalogue (MICKA). Setup of the HotLime Knowledge Base as part of the Linked Open Data Semantic Web developed in IP WP4 (Semantic Harmonization Issues). The knowledge base as well as keywords constitute integral parts of the semantic web hosting the controlled GeoERA project vocabularies as a full glossary for multilingual semantic text search (coactive with WP5 and in continuous feedback with IP WP4) (D7.2).

Task 7.4 – Data upload/implementation to/in EGDI (M24-30)

Implementation of HotLimes results into the information hub EGDI (also as a service to all partners not directly involved in WP7 to ensure that all requirements put forward are also centrally implemented): delivery of disclosable data pooled from case studies / play evaluations (WP2,3), including feature and meta data *). Implementation of web tools (WP3: D3.1.3., D3.1.4.) Assist IP WP4 for the inclusion of information in the overarching knowledge base (consistent with IP prescribed guidelines) and implementation of procedures for accessing information from the knowledge base.

The procedures will be reported in a user manual (part of D7.3).

Task 7.5 – Validation and testing (M30-36)

Evaluation of the final data implementation pertaining to the PDMP, and its dissemination via EGDI. Check and proof of spatial information retrievable via the EGDI portal, screening of discovery systems and query functionalities. Final test of web tools. Preparation of the project result implementation and dissemination report including recommendations on future maintenance and updating of the project results

*) This applies correspondingly to data being subject to access restrictions imposed by national statutory provisions (cf. 2.2.2 of Data Management Plan), e.g. detailed 3D geological models which enable the back-engineering of classified primary data . Those interoperable data will be implemented in proprietary/national repositories as part of a distributed organized system interlinked via the EGDI hub, or, are subject to an authorization for retrieval based on a bilateral data privacy statement, whereas the metadata provide the point of contact for direct approach.

Deliverables

D7.1: Specifications/technical requirements for EGDI’s spatial data repository and dissemination tool and the associated discovery system, as input to the GeoERA-IP development team (M6,12).

D7.2: Requirements catalogue for the implementation of the common knowledge base within the Semantic Web in EGDI, as input to the GeoERA-IP development team (M18).

D7.3: Final data and project results implementation and dissemination report (M36).

Table 3.1b) List of work packages (This table is not covered by the page limit)

Work package No.	Work Package Title	Lead Participant No.	Lead Participant Short Name	Person - Months	Start Month	End Month
1	Project Coordination	1	LfU	14	1	36
2	Characterization & Mapping	6	LGRB	118,95	1	18
3	Play/Prospect Evaluation	3	TNO	36,31	6	24
4	Deep Carbonate Play Development	2	GSI	32,5	12	36
5	Knowledge transfer	10	HGI-CGS	14,72	6	36
6	Project-Project Interface	1	LfU	15	3	30
7	IP Interface	1	LfU	18	1	36
			Total person-months	249,48		

Table 3.1c) List of deliverables (This table is not covered by the page limit)

Deliverable number	Deliverable name	Work package number	Short name of lead participant	Type	Disseminati on level	Delivery date (in months)
D1.1.1	Project Implementation Plan	1	LfU	Report	GeoERA internal	M3
D1.1.2	Minutes of Meetings	1	LfU	Minutes	GeoERA internal	M1-36
D1.1.3	Project Progress and Monitoring Report	1	LfU	Report	GeoERA internal	M18
D1.1.4	Final Project Progress Report	1	LfU	Report	public via GeoERA	M36
D1.1.5	Annual Expenditure Reports	1	LfU	Report	GeoERA internal	M12,24,36
D1.2	Project Communication and Exploration Plan	1	LfU	Report	public via GeoERA	M6
D1.3	Project Data Management Plan	1	LfU	Report	GeoERA internal	M6
D2.0	Summary report of resources mapping and characteriza-tion, catalogue of methods and required parameters, best practice and guidelines	2	LGRB	Report	public via IP	M18
D2.**1** – D2.**10**	Geology of prospective geothermal reservoirs parameterized / categorized	2	LGRB et al.	**10** Map series 3D models	public via IP	M18
D3.1.1	Best practice manual for resource assessment	3	TNO	report	public via IP	M30
D3.1.2	Spatial resource assessment in areas in focus	3	TNO	Map series 3D models	public via IP	M24
D3.1.3	Classification system for plays and prospects	3	TNO	Web-based tool	public via IP	M24
D3.1.4	Quantitative assessment tool for carbonate rocks	3	TNO	Web-based tool	public via IP	M24
D4.1	Report on deep carbonate play development strategies and impacts	4	GSI	Report	public via IP	M36
D5.1.1	Licensing regulations report	5	HGI-CGS	Report	public via IP	M36
D5.1.2	Geothermal planning recommendations	5	HGI-CGS	Report	public via IP	M36
D5.1.3	Joint information event	5	HGI-CGS	Report	public	~M30
D5.2.1	Specifications/technical requirements for data repository/semantic web	5	LfU	Report	IP	M18
D5.2.2	Glossary of technical terms (feature data code lists)	5	LfU	dbase	public via IP	M30

D5.2.3	Knowledge database	5	LfU	dbase	public via IP	M36
D6.1.1	Fault property requirements and exchange logbook	6	LfU	Report	GE4-HIKE	M18
D6.1.2	Implementation of fault network in FaultDB	6	LfU	dbase population	public	M36
D6.2	Geo4Sure application experiences and comparison	6	LfU	Report	GE2-Geo4Sure	M24
D6.3	Geomanifestation methodology evaluation log	6	LfU	Report	GE6-GeoConn.	M30
D7.1	Specifications/technical requirements for EGDI spatial data repository	7	LfU/LGRB	Report	IP	M6,12
D7.2	Requirements catalogue for the common knowledge base	7	LfU	Report	IP	M18
D7.3	Final data/project results implementation report	7	LfU	dbase population	public	M36

Tables for section 3.2

Table 3.2a) List of milestones (This table is not covered by the page limit)

Milestone number	Milestone name	Related work package(s)	Due date (in months)	Means of verification
MS 1	Concepts of 3D-modelling are coordinated	WP2	6	Concept available
MS 2	3D-models and map series available	WP2	18	3D models & maps
MS 3	Report and classification system are set	WP3	24	Report available
MS 4	Knowledge base prepared for upload	WP5	30	IP approval
MS 5	Data and product transfer to IP finalized	WP7	30	IP approval
MS 6	Play development report finished	WP4	36	Report available
MS 7	Final reports finalized, all data in EGDI	all	36	Reports available

Table 3.2b) List of critical risks for implementation (This table is not covered by the page limit)

Description of risk (indicate level of likelihood: Low/Medium/High)	Work package(s) involved	Proposed risk-mitigation measures
Low: Drop out of a partner, changes in the project consortium	All WPs	Adaption of the Project Implementation Plan, redistribution of the responsibilities of the dropped out partner, based on a joint partner decision. If case study affected see below.
Low: Drop out of key project persona l/ long-term unavailability due to illness; insufficient effort or capacity / loss of direction	All WPs	Stability through shared WP / Task responsibilities. Partners with major roles are solid in structure and capacity. All WP leads have a designated proxy.
Low: Poor engagement of project partner and incomplete information on work status and IPR	All WPs	Effective internal communication measures in WP1; active involvement of all PP in all WP's
Low to medium: Delay in producing deliverables feeding into subsequent work package(s)	WP2 to 5	Regular monitoring of project implementation by the Project Board. Identification of reasons of delay, specific mitigation measures. Sequential, but largely in parallel implemen-tation in personal union of core WPs 2-4 allows realignment of priorities until meeting the schedule is met again.
Low: Inability to design a flow performance and resource assessment models for deep carbonate rocks.	WP3	Existing tools for siliciclastic rocks need to be used in such way that the hydraulic properties of the carbonate reservoirs can be mimicked to the best extent.
Low: Drop out of partner or Medium: inability to deliver required characterization and mapping data.	WP2, WP4	Due to the GSO's regional/national mandate no external processing possible. The specific test area will be left out of further assessment, does not jeopardise the project per se.
Unpredictable: GE4-HIKE will not be granted and the European Fault Database will not be implemented	WP2, WP3, WP4	Faults information can still be used as part of the geo-models of the case study areas. Also the storage of fault data in EGDI in not directly at risk, however data and semantic harmoni-zation of fault data between the GeoERA projects cannot be provided.
Unpredictable: GE3-Geo4SURE will not be granted and a common methodology and classification cannot be set up	WP3	The deep carbonate assessment methodology needs to be designed within HotLime only and will not fully incorporate uncertainties as predicted by Geo4Sure.
Low: Outcomes include classified data and may not be disclosed in EGDI due to national regulations.	WP7	Discovery system provides metadata including point of contact for direct approach and authorized retrieval based on a data privacy statement
Low: Datasets delivered for EGDI do not meet the IP requirements	WP7	Clear agreements made in Project Data Management Plan (WP1). Joint implementation in WP7 coactive with data producing partners ensures early identification and remedy.
Low: GeoERA IP project is not granted or unable to meet the requirements specifically WRT 3D visualization and query	WP7 and all GeoERA projects	Products will be published via other websites/ web services, e.g. EGIP or EGDI as it is now. Spatial products will be converted (3D models → 2D map series). To be set up in D1.2 & 1.3.

Table 3.3a) Summary of Staff Effort (This table is not covered by the page limit)

Participant Number/ Short Name	WP 1	WP 2	WP 3	WP 4	WP 5	WP 6	WP 7	Total Person-Months per Participant
1 / LfU*	(6)	16	6	6	2	2	6	44
2 / GSI	2	18	6	8	2	2		38
3 / TNO	1	8,25	4	2,5	0,5	1	2	19,25
4a / VITO*		(6)		(4)				10
5 / GBA		3	1	2	0,75			6,75
6 / LGRB	4	18	4		2	2	6	36
7 / ISPRA		16			1,5	2	2	21,5
8 / GeoZS		2,5	2,2	1,5	0,5	0,5		7,2
9 / RER-SGSS		4	4	2	1			11
10 / HGI-CGS	1	5	3	4	3	3	1	20
11 / MTI		2	2					4
12 / ARPAP		9				1		10
13 / GEOINFORM			0,61		0,61			1,22
14 / CGS		2	0,5	1	0,5			4
15 / RU		2,7						2,7
16 / ICGC		6,5	3	1,5	0,36	1,5	1	13,86
Total Person Months	14	118,95	36,31	32,5	14,72	15	18	249,48

*) These participants decided not to request funding from the EC for the PMs in parentheses. Accordingly, these (PMs) are not included in the Financial table 3.3c, but considered in totals as indicated above and Table 3.1b.
LfU: as project coordination and management is part of the HotLime Coordinator's regular remits, LfU will not ask for granting of its 6 PM effort assigned to coordination and management.
VITO: principally does not request EC funding.

Table 3.3b) 'Other direct cost' items (travel, equipment, other goods and services)

(This table is not covered by the page limit)

Please note: Travel costs also include congress fees for those in charge of scientific communication.

Participant **1** / **LfU**	Cost (€)	Justification
Travel	15.000	Travelling costs are estimated at ~5% of personnel costs. These include the start, mid-term, and final GeoERA events, as well as project and coordination meetings and (inter-)WP workshops.
Equipment		
Other goods and services	3.000	As coordinator, LfU will co-host and co-organize a stakeholder meeting / Brussels Information Day*)
Total	18.000	

*) Should be organized & held in cooperation with other GE projects (see Task 5.1).
An agreement on if, how, & when is not yet made with the Theme Coordinator.

Participant **2** / **GSI**	Cost (€)	Justification
Travel	10.500	Travel costs and expenses of 2 persons for project kick-off and final meetings, annual WP2&3 meetings and 1 person at 3 co-ordination meetings.
Equipment		
Other goods and services		
Total	10.500	

Participant **3** / **TNO**	Cost (€)	Justification
Travel	14.000	Travel costs and expenses of 2 persons for project meetings. These include the kick-off, mid-term, and final GeoERA events, as well as WP and coordination meetings
Equipment		
Other goods and services		
Total	14.000	

Participant **4a** / **VITO**	Cost (€)	Justification
Travel		
Equipment		
Other goods and services		
Total	0	*VITO decided not to request funding from the EC for Other Direct Cost, thus no expenses indicated.*

Participant **5** / **GBA**	Cost (€)	Justification
Travel	1.900	Travel costs and expenses for one person for project meetings (Kick-off, WP2 harmonization meetings AT-CZ area, final meeting)
Equipment		
Other goods and services		
Total	1.900	

Participant **6** / **LGRB**	Cost (€)	Justification
Travel	15.000	Travel costs and expenses of 2 persons for project board meetings on location in Europe, plus WPs meetings/workshop and GeoERA meetings
Equipment	5.400	Hardware (according to depreciation rules)
Other goods and services		
Total	20.400	

Participant **7** / **ISPRA**	Cost (€)	Justification
Travel	9.000	Travel costs and expenses of 2 persons for annual project meetings on location in Europe, plus WPs meetings/workshops
Equipment	2.825	Hardware (according to depreciation rules)
Other goods and services		
Total	11.825	

Participant **8** / **GeoZS**	Cost (€)	Justification
Travel	3.000	Travel costs and expenses of 1-2 persons for project meetings (Kick-off, WP workshops, final meeting)
Equipment		
Other goods and services		
Total	3.000	

Participant **9** / **SGSS**	Cost (€)	Justification
Travel	2.022	Travel costs and expenses of 1 persons for annual project meetings on location in Europe, plus WPs meetings/workshops
Equipment	1.900	Hardware (according to depreciation rules)
Other goods and services		
Total	3.922	

Participant **10** / **HGI-CGS**	Cost (€)	Justification
Travel	4.800	Participation at project related workshops and meetings
Equipment		
Other goods and services		
Total	4.800	

Participant **11** / **MTI**	Cost (€)	Justification
Travel	2.400	Budget allocated to cover the cost of attendance of one person to a maximum of three key project meetings/workshops *)
Equipment		
Other goods and services		
Total	2.400	

*) Due to Malta's insularity travel generally is more expensive, requiring air travel with connecting flights.

Participant **12** / **ARPAP**	Cost (€)	Justification
Travel	4.913	Travel costs and expenses of 3 persons for annual project meetings on location in Europe and travel costs for WP2 and WP6
Equipment		
Other goods and services		
Total	4.913	

Participant 13 / **GeoInform**	Cost (€)	Justification
Travel	2.000	WP3 and WP5 workshops, EUR 1000 each
Equipment		
Other goods and services		
Total	2.000	

Participant **14** / **CGS**	Cost (€)	Justification
Travel	1.900	Travel costs and expenses for one person for project meetings (Kick-off, WP2 harmonization meetings AT-CZ area, final meeting),
Equipment		
Other goods and services	100	Consumables
Total	2.000	

Participant **15** / **RU**	Cost (€)	Justification
Travel	1.500	Budget allocated to cover the cost of attendance of a maximum of three key project meetings
Equipment		
Other goods and services		
Total	1.500	

Participant **16** / **ICGC**	Cost (€)	Justification
Travel	10.490	Travel costs for attendance of 1-2 persons for a maximum of five key project meetings along the 3 years of the project
Equipment		
Other goods and services		
Total	10.490	

Table 3.3c) Financial table with requested budget (This table is not covered by the page limit))

Participant	(A) Direct personnel costs (EUR)	(B) Other direct costs; travel, equipment, infrastructure, other (EUR)	(C) Direct costs of sub-contracting (EUR)	(D) Indirect costs (= (A + B) *0,25) (EUR)	(E) Total estimated eligible costs (=A+B+C+D) (EUR)	(F) Reimburse-ment Rate (29,7%)[2]	(G) Requested EU contribution (=E*F)	(H) Surveys in-kind contribution = (E – G)
1 / LfU	276800,00	18000,00	0	73700,00	368500,00	29,7%	109444,50	259055,50
2 / GSI	181260,00	10500,00	0	47940,00	239700,00	29,7%	71190,90	168509,10
3 / TNO	128499,00	14000,00	0	35624,75	178123,75	29,7%	52902,75	125221,00
4 / VPO	0,00	0,00	0	0,00	0,00	29,7%	0,00	0,00
4a / VITO	0,00	0,00	0	0,00	0,00	29,7%	0,00	0,00
5 / GBA	35405,00	1900,00	0	9326,25	46631,25	29,7%	13849,48	32781,77
6 / LGRB	204012,00	20400,00	0	56103,00	280515,00	29,7%	83313,00	197202,00
7 / ISPRA	118250,00	11825,00	0	32518,75	162593,75	29,7%	48290,34	114303,41
8 / GeoZS	25200,00	3000,00	0	7050,00	35250,00	29,7%	10469,25	24780,75
9 / RER-SGSS	39221,00	3922,00	0	10785,00	53928,00	29,7%	16016,00	37912,00
10 / HGI-CGS	48000,00	4800,00	0	13200,00	66000,00	29,7%	19602,00	46398,00
11 / MTI	12000,00	2400,00	0	3600,00	18000,00	29,7%	5346,00	12654,00
12 / ARPAP	49135,00	4913,00	0	13512,00	67560,00	29,7%	20065,32	47494,68
13 / GEO-INFORM	5860,47	2000,00	0	1965,12	9825,59	29,7%	2918,20	6907,39
14 / CGS	9085,00	2000,00	0	2771,25	13856,25	29,7%	4115,31	9740,94
15 / RU	9180,00	1500,00	0	2670,00	13350,00	29,7%	3964,95	9385,05
16 / ICGC	73425,71	10490,00	0	20978,93	104894,64	29,7%	31153,71	73740,93
Totals	1215333,18	111650,00	0	331745,05	1658728,23		492641,71	1166086,52

Please note: HotLime has a strong ambition to achieve cross-cutting collaboration and cross-fertilization among partners. Such cannot be done without physical meetings, especially workshops. As particularly smaller partners focus on the exchange of experience and best practices they might feature disproportional ‘other direct costs’ related to travel.

[2] The EC Reimbursement rate for ERA-NETs is 33%. 10% of this Reimbursement rate is reserved for the Coordination Costs of GeoERA as agreed in the Grant Agreement. Therefore, the Reimbursement rate for GeoERA is these calculations results in 29,7%.

4 Members of the consortium (This section is not covered by the page limit)

4.1 Participants (applicants)

Name of the Organisation LfU #1
Bayerisches Landesamt für Umwelt – Geologischer Dienst
Bavarian Environment Agency – Geological Survey

Brief description of the legal entity
Regional environment agency in charge for Bavaria, incorporating the legally mandated Geological Survey Organization with remits (WRT the objectives and scope of the project) in geological and hydrogeological surveying, mapping and modelling, scientific advisor for geothermal issues and subsurface utilization, host of central archives/databases for all Bavarian subsurface information in line with the German Mining Law

Main project tasks and qualifications
LfU is the HotLime Project Coordinator, will be lead of WP1, WP6 and WP7 and will contribute to all other work packages.
As the Geological Survey Organization in charge of Bavaria, where geothermal exploration and exploitation of a hydrothermal aquifer in karstified and fractured carbonate bedrock has an almost three-decade lasting history and revealed a true geothermal bonanza of presently more than 30 installations in operation, LfU has an extensive data stock and profound expertise and experience of the assessment and evaluation of low-enthalpy geothermal systems. As government advisor in geothermal licensing procedures LfU also is familiar with geological situations leading to setbacks and complete failures of geothermal projects. To share this knowledge and experience, but also to learn from other geological environments, is the principal objective to participate in HotLime. LfU is engaged in 3D mapping and characterization of the deep subsurface for a variety of utilizations, based on the various data from hydrocarbon E&P and geothermal projects. LfU has sound expertise in seismic interpretation for fault assessment and structural 3D geological modelling and in trans-national semantic harmonization of geological features. As lead of the 2012-2015 transnational GeoMol project incorporating 14 partners from 6 countries LfU has consolidated experience in project coordination and management.
LfU is the German spearhead for introducing the semantic web for harmonization of 3D model units and faults, as well as for metadata and setting up a knowledge base utilizing the Open Linked Data Sematic Web.

Description of persons designated for HotLime implementation:

Dr. Gerold Diepolder (male), HotLime project coordination: senior geologist, degree and PhD in geology at the University of Munich. Joined the Bavarian Geological Survey, GLA (now: Bavarian Environment Agency, LfU) in 1990 as a research associate with remits on hydrogeology and the geopotential of the deep subsurface. Overseas assignment for the Federal Institute for Geosciences and Natural Resources (BGR) in Namibia in 2001.
2008-2016 head of the 3D study group of the German State Geological Surveys (Staatliche Geologische Dienste), lately realigned, now chief executive of the task force “3D geological models”.
2012–2015 Initiator, coordinator and lead of the transnational 3D modelling and geopotential assessment project GeoMol (www.geomol.eu).
Co-organizer of the informal European 3D Geological Modelling Community (www.3dgeology.org).
Gerold Diepolder is LEAR of the LfU and appointed GeoERA Programme Manager mandated by the Bavarian State Ministry of the Environment and Consumer Protection.

Dr. Timo Spörlein (male), proxy and designated successor for HotLime coordination after 2020: senior geologist, head of LfU division “Deep Geology, Subsurface Potential”. Degree and PhD in geology at University of Erlangen.

(cont’d)

Stephan Sieblitz, Dipl.Geol. (male), geomodelling, geothermal potential assessment: graduated in geology at the University of Munich, research associate in remote sensing, 10 years working experience with consulting geologists, joined the Bavarian Geological Survey (GLA) in 1999 as a GIS expert with fields of activity in 3D geological modeling, seismic interpretation, basin analysis and subsurface potential assessment.

Johannes Großmann, MSc. (male), geophysical methods application, velocity modelling: graduated in geosciences at Göttingen University. 2013-2015 project team geologist at Midland Valley Ltd. (Glasgow) with remits in structural geological modelling based on seismic data. Employed by LfU since 2016 working as geophysicist in field geophysics, reflexion seismics, and structural 3D modelling.

Dr. Thomas Fritzer (male), advisor, senior geologist, degree and PhD in geology at the University of Munich. Since 1997 he is working for the Bavarian Geological Survey / Bavarian Environment Agency – Geological Survey as an expert for basin geology, deep geothermal and underground gas storage. He is engaged in various task forces on geothermal issues and is government advisor in geothermal licensing procedures.

Relevant Publications:

- Bayerisches Staatsministerium für Wirtschaft, Infrastruktur Verkehr und Technology (Bavarian State Ministry of Economy, Infrastructure, Traffic and Technology) [ed.] (2010): Bayerischer Geothermieatlas – Hydrothermale Energiegewinnung (Geothermal Atlas of Bavaria – Hydrothermal Energy Production). 94 S. (München, StMWIVT)
- Diepolder, G.W. (2011): 3D modelling at the Bavarian State Geological Survey – examples for cooperation towards 3D standards. – Geological Survey of Canada, Open File 6998: Three-Dimensional Geological Mapping, Workshop Extended Abstracts, Minneapolis, Minnesota – October 8, 2011: 17-21, https://doi.org/10.4095/289609
- Diepolder, G.W. &. Schulz U. (2011): Tiefliegende Speicher- und Barrieregesteinskomplexe in Bayern – ein Überblick. – Schriftenr. dt. Ges. Geowiss. 74: 118-136, DOI:10.1127/sdgg/74/2011/226
- GEOMOL TEAM (2015): GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources. Project Report, 188 S. (Augsburg, LfU).
- Diepolder, G.W. (2016): From GeoMol to EGDI – towards the integration of regional 3D geological datasets into the European Geological Data Infrastructure. http://www.americangeosciences.org/sites/default/files/igc/1691.pdf

Projects and research programme(s)

- 2009-2011: Speicherkataster Deutschland (Storage catalogue of Germany) – see: http://www.worldcat.org/title/geologische-charakterisierung-tiefliegender-speicher-und-barrierehorizonte-in-deutschland-speicher-kataster-deutschland/oclc/809030104
- 2010-2012: KLIP (Klimaprogramm Bayern 2020) - 3D-Untergrunderfassung des Alpenvorlands – Mehrwert für Erdwärmenutzung und Energiespeicherung (3D based capture of the pre-alpine subsurface – adding value to the use of geothermal energy and energy storage)
- 2012-2015: GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources (funded by Interreg Alpine Space Programme)

Infrastructure developments

- LfU 3D-Explorer: www.3dportal.lfu.bayern.de
- Standortauskunft Oberflächennahe Geothermie (Information system shallow geothermal energy) http://www.umweltatlas.bayern.de/mapapps/resources/apps/lfu_angewandte_geologie_ftz/index.html?lang=de&layers=service_ageo_18
- Infra3D – development of data model and workflow for 3D subsurface potential assessment based on heterogeneous sources and a toolkit (webGIS) for the visualization of the 3D subsurface information from various domains exploiting the achievements of transnational 3D geo-energy assessment / distribution tools

Name of the Organisation GSI #2
Geological Survey of Ireland

Brief description of the legal entity
The Geological Survey of Ireland (GSI) is a division of the Department of Communications, Climate Action and Environment. GSI is responsible for providing geological advice and information, and for the acquisition of data for this purpose. GSI produces a range of products including maps, reports and databases and acts as a knowledge centre and project partner in all aspects of Irish geoscience. It is also active in geoscience research as a funder, partner and research performer.

Main project tasks and qualifications
GSI will be WP leader for WP4 and will contribute to WP2, 3, 5 and 6.
As the national earth science agency for Ireland, GSI hosts extensive data on the geology of Ireland with which to conduct the characterization and mapping of WP2. As part of the Department of Communications, Climate Action and Environment, GSI is in direct contact with regulators and legislators on energy policy and so well-positioned for the geothermal play evaluation and development aspects of WPs3 and 4, and for the stakeholder knowledge transfer of WP5.

Description of persons designated for HotLime implementation:

Dr Brian McConnell PhD, Trinity College Dublin. Head of Land Mapping, GSI. Brian manages the onshore bedrock and sub-soils mapping programme across Ireland. He also works on aspects of energy and geohazards, and is Council member for the European Plate Observing System project.

Dr Sarah Blake: PhD, Dublin Institute for Advanced Studies and National University of Ireland Galway. Currently a post-doctoral researcher in the iCRAG Groundwater spoke based in University College Dublin, working on the quantitative assessment of the deep geothermal potential of a range of Irish geological settings. Sarah also works with Geological Survey Ireland on groundwater flow pathways in karst and non-karst rocks.

Beatriz Mozo: Master degree in Geology, Oviedo University Spain. Beatriz manages the National Geotechnical Borehole Database and develops 3D geological models at a range of scales and resolutions for superficial deposits and bedrock. Currently developing a national depth to bedrock map. Proficiency in a variety of software to capture, visualise and disseminate 3D models.

Relevant Publications
- Online bedrock and Quaternary geology mapping https://www.gsi.ie/en-ie/data-and-maps/Pages/Bedrock.aspx and https://www.gsi.ie/en-ie/data-and-maps/Pages/Quaternary.aspx
- National Geotechnical Borehole Database http://spatial.dcenr.gov.ie/GeologicalSurvey/GeoTechnicalViewer/index.html

Projects and research programme(s)
- Tellus airborne geophysics (magnetic, electromagnetic, radiometric) and ground-based geochemistry survey, online viewer http://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=6304e122b733498b99642707ff72f754
- Groundwater 3D: karst, groundwater flow, water chemistry

Infrastructure
- Geological data and map viewer https://www.gsi.ie/en-ie/data-and-maps/Pages/default.aspx
- Groundwater web mapping service; aquifer, karst and tracer
- Core store; national repository of 300 km of borehole cores, accessible for e.g. rock property testing

Name of the Organisation TNO #3
Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek

Brief description of the legal entity
TNO is a semi-independent Dutch research and technology organisation active in technical, earth, environmental, life, societal and behavioral sciences, focusing on healthy living, industrial innovation, energy, transport and mobility, built environment, the information society, defense, safety and security. TNO will be represented in Geo-ERA through the Geological Survey of the Netherlands, which provides geoscientific data, information and knowledge sustainable management of earth resources and the environment in general, safe living on subsiding lowlands, and reduction of risks and costs in building and construction associated with ground conditions.
The survey's core skills include data management, geo-ICT and 3D-modelling. Its products and services are primarily targeted at the water, energy and building sectors (the latter in the broadest possible sense, including land use and environmental planning). The organization hosts the national repository for subsurface data and information and is the designated state advisor of all geological matters related to the Mining Act. The survey's skills and services relate to its operational environment, determined mainly by its hydrocarbon resources, and the Dutch coastal and fluvial lowlands setting, which presents aggregate and groundwater resources, as well as the obvious water-related challenges.

Main project tasks and qualifications
TNO will be WP leader of WP3 and will contribute to WP2, 4, 5 and 6.
As a major research organization in the Netherlands and coordinator of many international projects, TNO has an extensive track record and is a widely recognized expertise in mapping and modelling studies, within the Netherlands as well as abroad. This expertise is supported by the national Geoscience Information Program in which the subsurface is mapped and characterized. These products are the main constituents of TNO's (national) geothermal assessment tools ThermoGIS and DoubletCalc. TNO's advises on policy and is the States designated institute for handling geothermal license applications.

Description of persons designated for HotLime implementation:

Dr. Johan H. ten Veen (male), co-lead WP3, senior geologist (EuroGeologist), Johan holds a MSc from Vrije Universiteit Amsterdam (1991) and a PhD degree in Earth Sciences from Utrecht University (1998). Employed by TNO since 2009, working as structural geologist on the initiation, refinement and maintenance of national subsurface geomodels. Involved in projects centered around characterization of hydrocarbon and geothermal reservoirs and several cross-border basin studies (NW Europe focus). Editor in Chief of the Netherlands Journal of Geosciences. Member of the EGS Geo-Energy Expert Group.

Serge van Gessel, MSc. (male), senior geoscientist and project manager. Senior advisor for MinEZ and MinBZK with specific focus on the Dutch Mining Law and subsurface exploration and development. Chairman of the EGS Geo-Energy Expert Group.

Hans Veldkamp, MSc. (male), co-lead WP3 , senior geologist, graduated from Vrije Universiteit Amsterdam. Employed by TNO since 1998, working on static modeling of the shallow and deep subsurface and geothermal resource and potential assessment. Treasurer of the Board for the Geothermal Platform of the Netherlands.

Publications

- Reijmer, J.J.G., Ten Veen, J., Jaarsma, B. and Boots, R. (2017). Seismic stratigraphy of Dinantian carbonates in the southern Netherlands and northern Belgium. Netherlands Journal of Geosciences 91(4) 353-380. DOI: 10.1017/njg.2017.33.
- Limberger, J., Van Wees, J.D., Pluymaekers, M, Tesauro, M., Lipsey, L., Bonte, D., Cloetingh, S. (2016). Constraining the thermal field of the European lithosphere with temperature observations. European Geothermal Congress, September 19-13. Strassburg.

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- Lipsey, L., Pluymaekers M., Goldberg T., van Oversteeg K., Ghazaryan L., Cloetingh S., van Wees J.D. (2016). Numerical modelling of thermal convection in the Luttelgeest carbonate platform, the Netherlands. Geothermics 64, p135-151.
- Reijmer, J.J.G., Ten Veen, J., Jaarsma, B. and Boots, R. (2017). Seismic stratigraphy of Dinantian carbonates in the southern Netherlands and northern Belgium. Netherlands Journal of Geosciences 91(4) 353-380. DOI: 10.1017/njg.2017.33.
- Van Wees J.D., Hopman J., Bruhn D., Scheck-Wenderoth M., Dezayes C., Vernier R., Flovenz O., Gylfi P., Manzella A. (2014). IMAGE: preliminary results on the EU funded research project Integrated Methods for Advanced Geothermal Exploration. WGC World Geothermal Congress Melbourne.
- Van Wees, J.D., Pluymaekers, M., Bonté, D., Gessel, S. van, Veldkamp, H. (2017). Unlocking geothermal energy from mature oil and gas basins: a success story from the Netherlands. In: Bertani, R. (ed): Perspectives for geothermal energy in Europe.

Projects and research programme(s)

- GEISER (EU-funded, TNO coordination, 2010-2013) – Geothermal Engineering Integrating Mitigation of Induced Seismicity in Reservoirs.
- GeoELEC (EU-funded, 2011-2013) – potential for geothermal electricity production.
- GEOHEAT.App (INTERREG IV, Vlaanderen – Nederland, 2013 –2014) – Evaluation of the technical and economic feasibility of intermediate and deep geothermal energy as a sustainable source of heat for new and renovated buildings based on 6 case studies.
- IMAGE (EU-funded, 2013- 2017) – Integrated Methods for Advanced Geothermal Explorationan integrated geothermal exploration approach based on state-of-the-art scientific methods.
- UDG (co-funded by MinEZ and private sector, 2018-2021) - Dutch Ultradeep Geothermal exploration and research program focusing on deep carbonates. Co-developed by TNO and EBN B.V.

Infrastructure

- Dinoloket (www.dinoloket.nl) – Subsurface data and model repository for the Netherlands
- NLOG (www.nlog.nl) – Netherlands repository for data, models and information in relation to the Dutch Mining Act (oil, gas and geothermal energy exploration and production in the Netherlands and the Dutch sector of the North Sea continental shelf.
- ThermoGIS (www.thermogis.nl) – Geothermal potential assessment of the Netherlands
- GeoELEC (http://www.geoelec.eu/test-geoelec-online-viewer) – geothermal electricity potential in Europe, methodology for geothermal resource assessment
- ThermoGIS world viewer (http://thermogis.nl/worldviewer/ThermoGISWorldEdition.html) – Worldwide geothermal potential
- DoubletCalc, DoubletCalc2D/3D (http://nlog.nl/en/tools) – Fast tools for calculating the geothermal power of doublet systems

Name of the organization: VLO #4
Vlaams Gewest (Vlaams Planbureau voor Omgeving)
Flemish region (Bureau for Environment and Spatial Development)

Brief description of the legal entity
The Bureau for Environment and Spatial Development is the competent division of the Government of Flanders for raw materials, hydrocarbons and geothermal resources. The division is authorized to prepare and to execute, by agreement of the competent minister, the Flemish policy concerning (1) raw materials, (2) the sustainable use of the subsoil in the Flemish region and (3) geological research. In relation to these tasks VLO performs data management and publishes data, maps and models. As the competent regional Flemish authority, VLO owns many of the envisaged data, in line with the scope and deliverables of the ERA-NET for the topics of Geo-energy and Raw Materials and has in-house expertise a) on geo-energy and raw materials for the Flemish region, b) in setting up and maintenance of databases, c) in subsurface geological mapping using geological and geophysical data and d) in the monitoring system for the demand and use of raw materials.
VITO (Flemish Institute for Technological research) will be a third party of VLO in the ERA-NET on Applied Geosciences. The Flemish Knowledge Center of the Subsoil (VLAKO) is a Task Force within VITO that conducts policy-supporting research for VLO. This is arranged by agreements for 5 years between the Government of Flanders and VITO. These agreements are made on high (ministerial) level and are already in place since more than 2 decades. Many of the envisaged deliverables of the ERA-NET on Applied Geosciences are conducted by VITO and are commissioned by VLO.

Name of the Organisation VITO #4a
Vlaamse Instelling voor Technologisch Onderzoek
Flemish Institute for Technological Research

Brief description of the legal entity
VITO, the Flemish institute for technological research, stimulates the sustainable development in Flanders and Europe and reinforces the economic and social position by providing innovative technological solutions and scientific advice and support. VITO consciously positions itself as an independent and client-oriented research organization. VITO focuses on five different research programme: sustainable chemistry, energy, health, materials management and land use. Each programme builds up a strong base of knowledge and skill, with added value for industry and society. The result is new and innovative research and a comprehensive range of scientific services.

Main project tasks and qualifications
VITO will contribute to WP2, in which it will mainly focus on mapping and characterization of Dinantian carbonates along the London-Brabant Massif, and WP3, in wich VITO will work on production data from the Merksplas geothermal wells and will share experiences from the development of the Balmatt geothermal site.
the project will be carried out by the Geology division of the Land use unit (GEO). Since 1998, GEO is actively involved in the development and deployment of geothermal energy in Belgium and the Netherlands. Initially, the focus was on the on the utilization of shallow aquifers in combination with heat pumps for direct heating and on the development of low-temperature energy storage systems (ATES and BTES). Since 2005, VITO focuses its research on deep geothermal energy applications and the application of low-enthalphy thermal energy for electricity production, industrial processes and district heating. For this project, VITO will build on its practical experience with the development of deep geothermal applications (e.g., Balmatt, Mol (BE), CWG Geothermie, Grubbenvorst (NL) en CLG Geothermie, Grubbenvorst (NL)) and on its a strong expertise in building 3D subsurface models and modelling of fluid flow and heat transfer in deep ground layers. *(cont'd)*

Description of persons designated for HotLime implementation:

Dr. Ben Laenen (male), as senior expert Ben Lanen will overview the research activities and review the deliverables. Moreover, he will contribute to the development of the dynamic model of the Carboniferous Limestone.

Eva van der Voet, MSc. (female), PhD student at VITO and KU Leuven, working on the Dinantian carbonates in the Campine-Brabant Basin (BE & NL) as a geothermal reservoir

Publications:

- Selçuk, E., Fowler, S., J., Harcouët- Menou, V. & Laenen, B. (2017): An Analytical Model of Porosity–Permeability for Porous and Fractured Media, *Transport in Porous Media* 120/2: 327-358, DOI:10.1007/s11242-017-0923-z, 2017
- Bos, S., & Laenen, B. (2017): Development of the first deep geothermal doublet in the Campine Basin of Belgium. *European Geologist* 43: 16–20.
- Loveless, S., Pluymaekers, M., Lagrou, D. & Laenen, B. (2014): Mapping the Geothermal Potential of Fault Zones in the Belgium-Netherlands Border Region. *Energy Procedia* 59: 351-358.

Projects and research programme(s)

- Balmatt geothermal project: Design and development of a geothermal system for the production of electricity and heat in North Belgium. The final goal is the commissioning of a geothermal co-generation plant for district heating and power generation at the Balmatt site in Mol. The project started with an in-depth evaluation of the geothermal potential of the Lower Carboniferous Limestone Group in the province of Antwerp (Flanders). The next phases included: I) organisation of a seismic survey, II) elaboration of a detailed model of the Carboniferous Limestone Group in the target area, III) preliminary design of the well field and surface installations, IV) class A cost estimate and development of a business model, V) permitting, VI) financing, VII) detailed well design, VIII) drilling of the first exploration well, IX) drilling of second (injection) well, X) Design and installation of geothermal CHP plant (to be commissioned in June 2018)
- SALK – GeoWatt (EFRO Vlaanderen (European Regional Development Fund), Flanders Innovation & Entrepreneurship and the Province of Limburg - June 2017 – May 2019): Development of innovative concepts and tools to enhance the efficiency of deep geothermal use and minimising the risks for Lower Carboniferous Carbonates in Belgian Limburg. The 'deep geothermal' activity is subdivided in 3 work-packages: (1) The starting point for every application in deep subsurface is the building of 3D geological model. Therefore all existing subsurface data (existing studies, boreholes, seismic) of the studied area (Limburg, N. Belgium) are selected, evaluated and interpreted. All data are combined in specialized 3D geological modelling software to study the potential of the carbonate reservoir. (2) To better understand the deep subsurface for geothermal use innovative geophysical techniques are developed and tested: we combine the data gathered with a electromagnetic (EM) field campaign (Controlled Source EM and Magnetotellurics in densly populated area) with existing 2D seismics. (3) We develop improved models for dynamic behaviour of subsurface during geothermal activities. More specifically we study carbonate and silica scaling on the performance of geothermal wells.
- GEOTHERMIE 2020 (EFRO Vlaanderen (European Regional Development Fund) - July 2013 – June 2015): Mapping of the technological and societal challenges for the development of deep geothermal energy and geothermal power generation in Flanders, and definition of policy recommendations and technological innovations for a sustainable utilisation of the local geothermal resources.
- GEOHEAT.App (INTERREG IV Vlaanderen – Nederland, January 2013 – June 2014): Evaluation of the technical and economic feasibility of intermediate and deep geothermal energy as a sustainable source of heat for new and renovated buildings based on 6 case studies.

Name of the Organisation GBA #5
Geologische Bundesanstalt – Fachabteilung Hydrogeologie & Geothermie
Geological Survey of Austria – Department of Hydrogeology and Geothermal Energy

Brief description of the legal entity
The Geological Survey of Austria (GBA) collects and interprets geoscientific information andevaluates them for the sustainable use in geoscience applications in Austria. Data gained aswell as the information derived are provided to the public in a systematic manner. In recentyears, a comprehensive expertise has been developed in the field of geological andnumerical 3D modelling, geodata management and dissemination via web-basedapplications. Further information can be found on the website of the Geological Survey (www.geologie.ac.at). GBA is also hosting the most comprehensive data collection of geoscientific data in Austria.

Main project tasks and qualifications
GBA will contribute to WP 2, 3, 4, & 5.
The Geothermal Energy Group within GBA has established a large, personal communication network to national stakeholders, policy makers and neighboring Geological Survey Organisations (GSO's) throughout numerous national- and EU-funded projects. Tasks carried out within HotLime will benefit from and expand this network, subsequently creating a sustainable foundation for future endeavours in the field of geothermal energy utilizations in Europe.

Description of persons designated for HotLime implementation:
Mag. Gregor Goetzl (male), will coordinate all activities concerning HotLime within theGeological Survey. Mr. Goetzl has gained substantial expertise in project managementfollowing more than 20 successfully completed national and international geothermal research projects carried out since 2004. He is heading the Geothermal Energy at the Geological Survey of Austria.
Clemens Porpaczy, MSc (male), is experienced in 3D geological modelling using the SKUA-GOCAD™ software suite. Mr. Porpaczy is working at the GBA since 2014 and was involved in the GeoMol Project and other national projects dealing with 3D Subsurface modelling. He will perform geomodelling within WP2, T.2.2. CZ-AT border area.

Relevant Publications
- GEOMOL TEAM (2015) - GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources. Project Report. 188 S. (Augsburg, LfU).
- Götzl, G., Bottig, M., Hoyer, S., Fuchsluger, M. & Rockenschaub, M. (2015): THERMTEC Thermisch-tektonische Modellierung orogenetischer Prozesse in den Ostalpen am Beispiel von Modellregionen - Tauernfenster (Brenner, Lungau / Pongau) und Mur-Mürzfurche / südliches Wiener Becken. Project Report, 163 S. (Wien, Geologische Bundesanstalt).
- Maros, G. (Hrsg.), Albert, G., Barczikayné Szeiler, R., Fodor, L., Gyalog, L., Jocha-Edelényi, E., Kercsmár, Z., Magyari, Á., Maigut, V., Maros, G., Nádor, A., Orosz, L., Palotás, K., Selmeczi, I., Uhrin, A., Vikor, Z., Atzenhofer, B., Berka, R., Bottig, M., Brüstle, A., Hörfarter, C., Schubert, G., Weilbold, J., Baráth, I., Fordinál, K., Kronome, B., Maglay, J., Nagy, A., Jelen, B., Lapanje, A., Rifelj, H., Rižnar, I. & Trajanova, M. (2012): Summary Report of geological models, TRANSENERGY – Transboundary Geothermal Energy Resources of Slovenia, Austria, Hungary and Slovakia, 189 S. (Vienna).

Projects and research programme(s)
- GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources (Interreg Alpine Space Programme)
- Transenergy – Transboundary Geothermal Energy Resources of Slovenia, Austria, Hungary & Slovakia (Interreg Central Europe Programme)

Infrastructure developments
- Web 3D Viewer (https://gisgba.geologie.ac.at/3dviewer/): Interactive web-visualization tool for 3D geo-models

Name of the Organisation LGRB #6
Regierungspräsidium Freiburg, Landesamt für Geologie Rohstoffe und Bergbau Baden-Württemberg

Brief description of the legal entity
Within the institutional setup of the State of Baden-Württemberg, Regierungspräsidium Freiburg is an authority located between the state's ministries and the local district authorities and municipalities. Its principal task is to pool and coordinate manifold tasks in nearly all spheres of life, as diverse as building and construction industries, agriculture, environmental protection, water management, geology and mining and transboundary cooperation with France and Switzerland. Department 9 (Landesamt für Geologie, Rohstoffe und Bergbau) acts as Regional Geological Survey and Mining Authority in the State of Baden-Württemberg. The Regional Geological Survey collects, keeps record of, processes and evaluates data about the substratum incl. groundwater, geothermal energy, geo-hazards and mineral resources. The public, e.g. government and administration bodies, companies, scientific institutions and citizens, has access to the survey´s geo-data and information. The survey´s geological data and information are applied in the fields of

- regional and national planning: urban land-use planning, regional planning;
- environmental impact studies and inspections
- environmental protection, especially groundwater and soil
- securing the supply of resources: drinking, mineral and thermal water; raw materials and mining, geothermal energy.

The surveys core skills include integrated, cross-disciplinary and transboundary geological mapping and modelling and data management in 2 and 3 dimensions. It provides data bases, information and knowledge for state-wide geoscientific data, e.g. the state-wide borehole database. The surveys products primarily targeted at administration, raw material industry and science in the water and geothermal energy sector.

Main project tasks and qualifications
LGRB will coordinate and lead WP2 and will contribute in WP 3, 5, 6 and 7.
As the geological service of the state of Baden-Württemberg, the LGRB is responsible for collecting, assessing and publishing geological subsurface information, including groundwater and mineral resources. In addition, it advises the state authorities.
The LGRB has a substantial knowledge and expertise in the fields of seismic interpretation, 3D geological modeling, subsurface temperature modeling, assessment of geopotentials and modern web technologies. As lead partner of the Interreg project GeORG (2008-2012), the LGRB has extensive project coordination and management skills. These could also be brought in profitably in the Interreg project "GeoMol" (2012-2015), in which the LGRB coordinated the work package "3D-Geology and potentials assessment methods".

Description of persons designated for HotLime implementation:
Isabel Rupf (female): co-lead WP2, senior geologist, responsible for the coordination of geoscientific services and products as well as for geological 3D-modelling. She studied Geology and Computational Sciences at the Universities of Freiberg and Chemnitz. Isabel Rupf coordinated the work packages 3D-Modelling and Geopotential Assessment in the transnational projects GeORG (Geopotentials of the Upper Rhine Graben, 2008-2012) and GeoMol (Geopotential Assessment of the Alpine Foreland Basins, 2012-2015). She is a mandated member of the German task force "3D geological models".
Carolin Tetzel (female): expert for geological 3D-modelling. She studied Geology and earned an MSc degree at the University of Hannover. After working some years as a 3D modeler for the State Geological of Niedersachsen she changed to the LGRB in 2013. Between 2013 and 2015, Carolin Tetzel was in charge for the development and maintenance of the geological model for shallow subsurface geothermal energy.

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Publications

- Rupf, I. & Nitsch, E. (2008): Das Geologische Landesmodell von Baden-Württemberg: Datengrundlagen, technische Umsetzung und erste geologische Ergebnisse. – LGRB-Informationen, 21: 81 S., 10 Beil.; Freiburg i. Br.
- GeORG-Projektteam (2013): Geopotenziale des tieferen Untergrundes im Oberrheingraben, Fachlich-technischer Abschlussbericht des INTERREG-Projekts GeORG. http://www.geopotenziale.eu
- GEOMOL TEAM (2015): GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources. Project Report. 188 S. (Augsburg, LfU).
- GeoMol LCA-Projektteam (2015): GeoMol – Geopotenziale für die nachhaltige Nutzung des tieferen Untergrundes in den Alpinen Vorlandbecken – Abschlussbericht des Pilotgebiets Bodensee-Allgäu. LGRB-Informationen 30, 142 S. (Freiburg, LGRB).

Projects and research programme(s)

- Interreg project GeORG – Geopotenziale des tieferen Untergrundes im Oberrheingraben (Interreg Programme Oberrhein/Rhin supérieur, 2008-2012)
- Interreg project GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources (Alpine Space Programme, 2012-2015)

Infrastructure

- LGRB Map Viewer: http://maps.lgrb-bw.de/
- LGRB Information System for Shallow Geothermal Energy: http://lgrb-bw.de/informationssysteme/geoanwendungen/isong
- GeORG Mapviewer including a cross section tool for the geological 3D-model and a metadata viewer: http://maps.geopotenziale.eu/?app=georg&lang=en

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Name of the Organisation ISPRA #7

Istituto Superiore per la Protezione e la Ricerca Ambientale
Italian Institute for Environmental Protection and Research

Brief description of the legal entity

ISPRA is the Italian Institute for Environmental Protection and Research that incorporates the mandate of the Geological Survey of Italy as institutional geological mapping agency. It realizes activities on surveying, mapping, modeling, collection, management and dissemination of base geological and geo-thematic data at national level. ISPRA provides cognitive tools for proper territorial planning and management and, in particular, for the prevention, reduction and mitigation of geological risks and their interactions or conflicts with geo-energy exploitation

Main project tasks and qualifications

ISPRA will contribute to HotLime WP2, 5, 6 and 7.
In its role of Geological Survey of Italy, ISPRA is the reference institution for the geological information in Italy; it provides geological data collection, database management and publication. It has a consolidated expertise in 3D geological modeling and subsurface characterization both for geo-energy and hazards assessment. It manages the web dissemination of national geological databases including subsurface maps, active faults, deep boreholes, and geophysical data.
ISPRA is the scientific reference institute for Ministry for Environment, Land and Sea; it undertakes technical-scientific activities for Environmental Impact Assessment on geo-energy licensing procedures, and to support policy and legislation on several environmental issues (e.g. land planning, natural hazard).

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Description of persons designated for HotLime implementation:

phD Chiara D'Ambrogi (female): senior geologist, responsible of the Sector "Geological field survey, biostratigraphy and subsurface modeling". Graduated on geological field survey and mapping at University of Rome, she earned her PhD in 1999. Field of activity: 3D geological modeling, basin analysis, seismogenic faults characterization, subsurface geopotential assessment. She participated to national and European research projects. Member of the EGS Geo-Energy Expert Group.

Dr. Pio Di Manna (male): geologist, Unit for Geodynamics, Georesources, Geohazards. Degree in geological mapping and structural analysis at the University of Rome. The main research and institutional activities focus on natural hazards analysis, impact assessment and risk mitigation actions. The key research topics are: active tectonics; earthquake geology; faulting processes – active and capable faults; earthquake geological effects; Tsunami hazard assessment; paleoseismological analysis. Member of the EGS Geo-Energy Expert Group

Dr. Mariapia Congi (female): geologist, Unit for Geological Surveys System and National Geological Heritage. Senior expert in GIS, Spatial Database and OGC standards. Collaborates to the creation and maintenance of the Geological Survey of Italy Portal for the services and metadata production in compliance with the INSPIRE Directive. The main research and institutional activities focus on geological database implementation and management, data model and dissemination.

Dr. Fernando Ferri (male): senior geophysicist, responsible of the Sector "Geophysical mapping and database". Degree in geophysics at University of Rome. Actual research activity and interests: potential fields geophysics applied to regional and basin geostructural studies, application of geophysical techniques to environmental, engineering, seismic microzonation problems. Geological storage of natural gas and carbon dioxide. Member of the EGS Geo-Energy Expert Group

Publications:

- F.E. Maesano & C. D'Ambrogi (2017) - Vel-IO 3D: a tool for 3D velocity model construction, optimization and time-depth conversion in 3D geological modeling workflow. Computers & Geosciences, 99, 171-182. doi: 10.1016/j.cageo.2016.11.013
- F.E. Maesano & C. D'Ambrogi (2016) - Coupling sedimentation and tectonic control: Pleistocene evolution of the central Po Basin. Ital. J. Geosci., 135(3), 394-407. DOI: 10.3301/IJG.2015.17.
- F.E. Maesano, C. D'Ambrogi, P. Burrato & G. Toscani (2015) - Slip-rates of blind thrusts in slow deforming areas: Examples from the Po Plain (Italy). Tectonophysics, doi:10.1016/j.tecto.2014.12.007.
- GEOMOL TEAM (2015) - GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources. Project Report. 188 S. (Augsburg, LfU).
- L. Piccardi, E. Vittori, A.M. Blumetti, V. Comerci, P. Di Manna, L. Guerrieri, M. Baglione, V. D'Intinosante (2017) - Mapping capable faulting hazard in a moderate-seismicity, high heat-flow environment: The Tuscia province (southern Tuscany-northern Latium, Italy), In Quaternary International, Volume 451, 2017, Pages 11-36, ISSN 1040-6182, https://doi.org/10.1016/j.quaint.2017.07.018.

Projects and research programme(s)

- GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources
- ESTMAP - EU
- EUOGA - EU

Infrastructure developments

- http://sgi.isprambiente.it/geoportal/catalog/main/home.page

Name of the Organisation GeoZS #8
Geološki zavod Slovenije

Brief description of the legal entity
Geological Survey of Slovenia (GeoZS) is a public research institute with app. 90 employees and established by the Government of the Republic of Slovenia. It carries out fundamental and applied research in regional geology, hydrogeology, geochemistry, sedimentology, paleontology, petrology, tectonics, geophysics, mineral resources and fossil energy, geothermal energy, geohazards, GIS and education. It provides a public service through scientific research programs and cooperation with universities. GeoZS is tightly involved in national and international research and professional communities worldwide. Activities are supported by Geological Information Centre, responsible for the collection, processing, storage and dissemination of geological data. We support national authorities and agencies in the process of concession granting for mining, and mineral and thermal water use. Our laboratories do petrological, mineralogical, geochemical and geothermal analyses.

Main project tasks and qualifications
GeoZS will contribute to HotLime WP2, 3, 4, 5, and 6.
The GeoZS team combines specialists in hydrogeology, regional geology, hydrogeochemistry, geothermal and geophysical measurements, 3D and numerical modeling. The team performs basic geothermal research, manages geothermal utilization database for Slovenia, surveys for exploration and exploitation of geothermal energy, and runs many applied projects on monitoring of geothermal wells and shallow geothermal boreholes. Within the project, GeoZS will elaborate the 3D geological and structural model of the Krško-Brežice basin (WP2), the 3D temperature and thermal water flow model (WP3), and present operational issues of thermal water use in carbonates and their mitigation in Slovenia (WP4). We plan to have minor field work to supplement the existing data.

Description of persons designated for HotLime implementation:

Dejan Šram (male), has rich experience in 3D structural modelling, 3D numerical modelling of fluid and heat flow and spatial analysis in GIS. His profession are also field work and interpretation of geophysical well-logging data and in the last years he is active in several shallow and deep geothermal projects.

Dr. Nina Rman (female), a research associate with experience in exploration and exploitation of low-enthalpy geothermal systems, hydrogeochemistry, isotopic and chemical composition of groundwater and gases and their origin, numerical modelling of flow and heat transfer and management of transboundary geothermal aquifers.

Mag. Andrej Lapanje (male), research and development co-worker with experience in geothermal exploration, development and monitoring, well design and operation, geophysical logging, hydrogeological mapping and management of groundwater resources.

MSc. Dušan Rajver (male), research and development associate with experience in deep and shallow geothermal exploration and exploitation, conduction-dominated geothermal systems, temperature logging, measurements of thermal conductivity and radiogenic heat production and geothermal database development and interpretation

Dr. Jure Atanackov (male), research assistant in applied geophysics particularly shallow methods, including high-resolution seismic reflection, seismic refraction and electrical resistivity tomography, active tectonics and seismic hazard assessment.

Dr. Petra Jamšek Rupnik (female) - is an expert for geomorphology, tectonic geomorphology, active tectonics, seismotectonics and seismic hazard. She is involved in the various applied and scientific projects, with topics mainly focused on (tectonic) geomorphology and seismic hazard assessment.

(cont'd)

Relevant Publications:

- Lapanje, A., Rman, N. 2016: Operational issues in geothermal energy in Europe. In: Schreiber, S. et al.: Operational issues in geothermal energy in Europe. Reykjavík: Coordination Office, Geothermal ERA NET, 51-54.
- Rajver, D., Ravnik, D. 2003: Geothermal characteristics of the Krško basin, Slovenia, based on geophysical research. Physics and chemistry of the earth, 28/9-11, 443-455.
- Lapanje, A., Rman, N. 2009: Thermal and thermomineral water. In: Novak, M. et al. (eds.): The Geology of Slovenia, 553-560, GeoZS.
- Šram, D., Rman, N., Rižnar, I., Lapanje, A. 2015: The three-dimensional regional geological model of the Mura-Zala basin, northeastern. Geologija, 58/2, 139-154.
- Gosar, A., Komac, M., Poljak, M. 2005: Structural model of the pre-Tertiary basement in the Krško basin. Geologija, 48/1, 23-32.

Projects and research programme(s)

- 2012-2015 – Alpine Space programme: GeoMol - Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources
- 2013-2015 - Site investigation for the medium and low level radioactive waste repository at Vrbina (Krško Basin - E Slovenia)
- 2014-2017 – Environmental Agency of Slovenia: Hydrogeological numerical model of groundwater flow and heat transfer in deep geothermal groundwater body in the northeastern Slovenia
- 2014-2018 - Seismic Hazard Analysis for JEK 2 – Seismotectonic model of the Krško Basin and surroundings for seismic hazard analysis for the new nuclear power plant
- 2016 on – eGeologija: portal on inventory and collection of datasets in the field of geology
- 2017-2019 – Interreg Danube: DARLINGe - Danube Region Leading Geothermal Energy

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Name of the Organisation SGSS #9

Servizio Geologico, Sismico e dei Suoli (Regione Emilia Romagna, Italia)
Geological, Seismic and Soil Survey (Emilia Romagna Region, Italy)

Brief description of the legal entity

SGSS is the regional geological service. It realizes activities on surveying, mapping, modeling, collection, management and dissemination of base geological and geothematic data at regional level. SGSS provides database for territorial planning and thematic maps for the assessment and management of geological and hydrogeological criticalities such as landslides, subsidence, seismicity and salt water intrusion. in recent years the service has been concerned with the characterization of the geothermal resource at the regional scale for both low and medium enthalpy.

Main project tasks and qualifications

SGSS will contribute in WP 2, 3, 4, 5, and 6.
SGSS has sound expertise in temperature modelling and will contribute it knowledge about the geothermal projects in the Emilia part of the Po Plain, especially the Casaglia District Heating plant.

Description of persons designated for HotLime implementation:

Dr. Fabio Carlo Molinari (male): senior geologist, responsible for the research and characterization of the geothermal resource at the regional scale and deep 3D geological modeling.
Graduated on geological field survey at University of Parma. Filed of activity: 3D geological modeling, basin analysis, seismogenic faults characterization, subsurface geothemal assessment. He participated to national and European research projects.

(cont'd)

Dr. Alberto Martini (male): senior geologist, management and development of the geological database. Filed of activity: management and development of the geological database; 3D geological modeling. He participated to national and European research projects.

Publications:

- GEOMOL TEAM (2015) - GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources. Project Report. 188 S. (Augsburg, LfU)
- Explanatory Notes of the Seismotectonic Map of Emilia-Romagna Region and Sorrounding Areas (2017)

Projects and research programme(s)

- GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources
- GEOPOWER Geothermal energy to address energy performance strategies inesidential and industrial buildings (http://www.geopower-i4c.eu/)

Name of the Organisation HGI-CGS #10
Croatian Geological Survey

Brief description of the legal entity
HGI-CGS is the largest public research institute in the field of geosciences and geological engineering in Croatia with 66 experts and researchers and 12 junior researchers. The researchers at the HGI-CGS have experience and competence in the investigation of geothermal systems (protection, finding new resources, working on sustainable usage of existing one), groundwater systems (protection, finding new resources, working on sustainable usage of existing one), geological mapping, solving the problems in environment (landslides, flooding, soil contamination) and exploration of mineral resources. HGI-CGS has 3 departments: Geology, Hydrogeology and Engineering Geology and Mineral Resources, including laboratories for hydrochemical, engineering geological and geochemical measurements. HGI-CGS has Geoportal, which contains information on publications of the Croatian Geological Survey and the published works of its employees which are available for the public. HGI-CGS collaborates with many institutions of similar affiliation from Croatia and other countries. Beside scientific research and geological survey, the institute provides consulting services for external customers in the areas of its expertise.

Main project tasks and qualifications
HGI-CGS will be WP5 lead and will contribute to all other work packages.
HGI-CGS has experience and competence in the investigation of geothermal systems (protection, finding new resources, working on sustainable usage of existing one), borehole data interpretation and hydrothermal systems research.

Description of persons designated for HotLime implementation:
Dr. Staša Borović (female) studied geology and geography at the Faculty of Science of the University of Zagreb and earned MSc degree in both disciplines in 2009. After that she became a research assistant at the HGI-CGS and earned a PhD in geological engineering at the Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb in 2015 by defending a thesis on hydrothermal systems research. She is currently working as a postdoctoral fellow at the Dpt. of Hydrogeology and Engineering Geology of HGI-CGS.
She collaborated on the fundamental projects of HGI-CGS: Geothermal map of the Republic of Croatia and Basic Hydrogeological Map of the Republic of Croatia, as well as on a number of EU and market-oriented projects concerning shallow and deep geothermal resources and groundwater research for water supply and protection purposes. *(cont'd)*

She is the author of a number of scientific publications listed below, and a member of Croatian Geological Society (member of Governing board), International Association of Hydrogeologists (secretary of the Croatian National Chapter) and the International Geothermal Organization. She is the editor of Annual Report of HGI-CGS and of the Explanatory notes of the Basic Hydrogeological Map publications.

Marko Špelić (male) attended Faculty of mining, geology and petroleum engineering where he earned MSc degree of geology in 2014. He worked for nine month at Croatian National History Museum whereupon in the beginning of 2016, he became associate expert at Croatian Geological Survey - Department of Geology. In the same year he started postgraduate study at Faculty of mining, geology and petroleum engineering on the topic of subsurface mapping with proposed application to CCS and/or geothermal energy exploration.

Publications:

- Borović, S., Marković, T., Larva, O., Brkić, Ž., Mraz, V. Mineral and thermal waters in the Croatian part of the Pannonian basin (2016) Environmental Earth Sciences, pp. 31-45, DOI: 10.1007/978-3-319-25379-4_2
- Borović, S., Marković, I. Utilization and tourism valorisation of geothermal waters in Croatia (2015) Renewable and Sustainable Energy Reviews, 44, pp. 52-63, DOI: 10.1016/j.rser.2014.12.022
- Borović, S., Marković, T., Larva, O. Protection of transboundary aquifers of Medimurje County (Croatia): Status and prospects (2015) International Journal of Environment and Health, 7 (3), pp. 197-214, DOI: 10.1504/IJENVH.2015.073194
- Marković, T., Borović, S., Larva, O. Geochemical characteristics of thermal waters of Hrvatsko zagorje (2015) Geologia Croatica, 68 (1), pp. 67-77, DOI: 10.4154/gc.2015.05
- Špelić, M., Malvić, T., Saraf V., Zalović, M. Remapping of depth of e-log markers between Neogene basement and Lower/Upper Pannonian border in the Bjelovar Subdepression (2016) Journal of Maps, 12 (1), pp. 45-52, DOI: 10.1080/17445647.2014.978909

Projects and research programme(s)

- 2009 – 2012 Geothermal map of the Republic of Croatia
- 2012 – now Basic Hydrogeological Map of the Republic of Croatia
- 2013 – 2015 GeoMapping – mapping of shallow geothermal potential in the Republic of Croatia (IPA project)
- 2015 DanReGeo-DATA - analysis of available data about geothermal phenomena in the Pannonian part and development of structure for a common data base (DTP project)
- 2017 DARLINGe Danube Region Leading Geothermal Energy – geothermal research on a Pannonian basin scale level (DTP project)

Infrastructure

Midland Valley Move core application: software for structural modeling, interpreting data, cross-section digitalization etc.; instrument for *in-situ* and laboratory thermal properties measurement (ISOMET 2114, Applied Precision, Bratislava)

Name of the Organisation MTI #11
Ministry for Transport and Infrastructure

Brief description of the legal entity
Malta will be represented in the GeoERA Energy theme through the Continental Shelf Department (CSD) within the Ministry for Transport and Infrastructure. The CSD performs the function of the Malta Geological Survey.

Description of persons designated for HotLime implementation:
Dr Charles Galea (male) is a Principal Scientific Officer at the Continental Shelf Department. He is a geoscientist by background and is the coordinator of the GeoERA project in Malta. He has nearly 25 years of experience in the field of petroleum exploration with extensive knowledge of Maltese carbonate geology.

Projects and research programme(s)
- EMODnet (Geology) – Seabed mapping of Malta's marine waters. Phase 2 (2013-2016) and Phase 3 (2017-2019)
- A preliminary assessment of the geothermal power generation potential of Malta – research prepared by Dr. G. Debono for the CSD, MTI (2004)

Name of the Organisation ARPAP #12
Agenzia Regionale per la Protezione Ambientale – Piemonte

Brief description of the legal entity
ARPAP is a public body with independent status for administrative, technical-juridical, asset management and accounting purposes, and it is a leading center of studies and applied research in the field of natural risk. Its aim is the development of methodologies and tools to assess, manage and minimize the geological risk. It operates under the oversight of the Chairman of the Executive Committee of the regional government so as to ensure compliance with the policy guidelines issued by the Piedmont Region in the fields of forecasting, preventive actions and preservation of the environment. ARPAP performs the task of monitoring and preventing natural hazards and acquired full responsibility for all environmental protection and control functions.

Description of persons designated for HotLime implementation:
Dr. Luca Mallen (male): senior geologist and senior GIS analyst in the Geological and Hydrogeological instability in the Department of Arpa Piemonte Torino. I graduated from the University of Turin (Italy) with a M.Sc. degree in Geological Sciences. Experienced in 3D geological modelling and GIS specialist and Domain Analyst in the field of geological and environmental software applications. I participated to national and European research projects.
Michele Morelli PhD (male): senior Geologist and Structural Geologist in the Geological and Hydrogeological instability in the Department of Arpa Piemonte Torino. Experienced in 3D geological modelling. I graduated from the University of Turin (Italy) with a M.Sc. degree in Geological Sciences. I received a Ph.D. from the University of Torino, for a research of remote sensing applied to structural geology. I have then work as research in the Geoscience and Earth Resources Institute of Italian National Research Council, for activity on remote sensing applied to fracturing of rock mass. I participated to national and European research projects.
Dr. Gabirele Nicolò: Geologist employed as senior GIS specialist in the Technical Functional Department of Arpa Piemonte (Torino, Italy). I graduated from the University of Turin with a M.Sc. degree in Geological Sciences and an Alpine Hydrogeology dissertation. During the first three years after graduation I worked as professional geologist in the field of geotechnics and geomorphological mapping. After that I was employed as GIS specialist and Domain Analyst in the field of geological and

environmental software applications. At present in my job I deal mainly with spatial analysis and modelling in the field of geological and environmental applications. I participated to national and European research projects.

Dr. Anselmo Cucchi: senior Geologist in the Geological and Hydrogeological instability in the Department of Arpa Piemonte Torino. I graduated from the University of Pavia (Italy) with a M.Sc. degree in Geological Sciences and with B.Sc degree in Natural Sciences and Technology. During the first year after graduation I worked as professional geologist in the field of geotechnics and hydrogeological and geomorphological mapping. After that I was employed as geology-landslides specialist and data Analyst in the field of systems of instrumental control of landslides. At present in my job I deal mainly landslides monitoring and geoenviromental analysis. I participated to national and European research projects.

Publications:

- F. Piana, G. Fioraso, A. Irace, P. Mosca, A. d'Atri, L.Barale , P. Falletti, G. Monegato, M. Morelli, S. Tallone, G.B. Vigna (2017). Geology of Piemonte Region (NW Italy, Alps-Apennines junction zone). Pubblicato sul Journal of Maps, Francis & Taylor Group Publ., UK.
- CARG (Geological CARtography of Italy) project - Carta Geologica d'Italia 1:50.000: Sheets: Fogli n. 132-152-153 BARDONECCHIA (2002), n. 154 SUSA (2002), n. 157 TRINO (2004), n. 155 Torino Ovest (2009), n. 156 Torino Est (2009), n. 211 Dego (2010), n. 194 Acqui Terme, n. 196 Cabella Ligure.
- Perrone, G., Morelli, M., Piana, F., Fioraso, G., Nicolò, G., Mallen, G., & Tallone, S. (2013). Current tectonic activity and differential uplift along the Cottian Alps/Po Plain boundary (NW Italy) as derived by PS-InSAR data. Journal of Geodynamics, 66, 65–78.

Infrastructure developments

- http://www.arpa.piemonte.gov.it/approfondimenti/temi-ambientali/geologia-e-dissesto/bancadatiged

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Name of the Organisation GeoInform #13
State Informational Geological Fund of Ukraine

Brief description of the legal entity
The State Research and Development Enterprise "State Informational Geological Fund of Ukraine" – SRDE GeoInform, is the specialized research and development unit of the State Geological and Subsurface Survey of Ukraine which collects, stores, analyzes and provides information received from geological study and use of subsurface. GIU conducts research work on monitoring of mineral resources of Ukraine on the basis of geological and mining activities during the year, recording deposits and making public the balance of mineral resources management of the State fund of deposits and occurrences (more than 10,000 objects recorded), synthesis and analysis of exploration for oil and gas, creating a system of state accounting of oil and gas wells, completion and maintenance of the State cadastre of mineral deposits and occurrences as well as State cadastre of groundwater deposits of Ukraine.

Description of persons designated for HotLime implementation:

Dr. hab. Boris Malyuk (Male), Director for International Cooperation, graduated in 1981 from Department of Geology, Lviv University, Ukraine, and in 1999 from Centre of Geostatistics, Ecole des Mines de Paris, France. Obtained Candidate of Science (PhD) Degree in Geotectonics in 1984, and extended Doctor of Science Degree in Petrology in 1991. National Delegate of Ukraine to the EuroGeoSurveys.

Dr. Igor Melnyk (Male), Sector Chief, with basic background in geology, has an experience in field works and research in geochemistry, hydrogeology and ecology (PhD in 1996), as well as geoinformatics and GIS applications.

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Tetiana Biloshapska (Female), Chief Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1980. She is experienced in field works. She had studied mineral-resource base of Ukraine for more than 30 years, took part and led projects on prospecting and exploration of mineral deposits, conducted regional geological studies.

Natalia Korpan (Female). Chief, Division of mineral deposits and reserves inventory. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1986. She had studied geology of coal and peat deposits and their reserves inventory for 30 years.

Ganna Sankina (Female). I-category Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology'. She is working in the field of geology for more than 15 years, is experienced in field works in the course of geological mapping in the scale 1:200 000. She is managing the State inventory of oil and gas wells as well as compilation and analysis of these data.

Publications:

- Interactive map of mineral deposits of Ukraine (in Ukrainian) http://geoinf.kiev.ua/wp/interaktyvna-karta-rodovyshch-korysnykh-kopalyn.htm
- Interactive map of mineral licenses (in Ukrainian) http://geoinf.kiev.ua/wp/interaktyvni-karty-spetsdozvoliv.htm
- Interactive geological map of Ukraine 1:1 000 000 (in Ukrainian) http://geoinf.kiev.ua/wp/Interaktyvna-heolohichna-karta-Ukrayiny.htm
- Interactive geological map of Ukraine 1:1 000 000 (in English) http://geoinf.kiev.ua/wp/Interactive-Geological-Map-of-Ukraine.htm
- Interactive State Geological Map of Ukraine 1:200 000 (in Ukrainian with English entries) http://geoinf.kiev.ua/wp/kartograma.htm

Projects and research programme(s)

- ESTMAP - EU
- EUOGA - EU
- NUMIRE – Norway-Ukraine (NGU/SGSSU)
- EIMIDA – Norway-Ukraine (NGU/Geoinform)

Name of the Organisation CGS #14

Česká geologická služba

Brief description of the legal entity

The Geological Czech Geological Survey (CGS) is a research institute of the Ministry of Environment of the Czech Republic. CGS leads and participates in basic and interdisciplinary research projects. The main fields of expertise include geological research and mapping, 3D modeling, hydrogeology, geochemistry and environmental studies, mineral resources and mining impact assessment, and applied geology and natural risks, hazards, support of development planning. CGS manages geological databases and web-based applications at www.geology.cz.

Description of persons designated for HotLime implementation:

Dr. Juraj Franců (male) will coordinate HotLime activities in the Czech Geological Survey. He is a geologist, geochemist, and basin modeler, he has gained expertise in projects dealing with basin evolution, oil and gas, and hydrogeochemistry. He is a head of the Central Laboratory Brno.

Dr. Miroslav Pereszlényi (male) is experienced in 3D geological modelling and basin potential evaluation using software for seismics, well logs, geothermics. Mr. Pereszlényi worked in numerous basins in the Alpine-Carpathian region as well as on other continents. He will perform geomodelling in the CZ-AT border area.

Dr. Vít Hladík (male) will deal with geo-energy issues

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Mgr. Lukáš Jurenka (male) is a PhD. student working at the CGS on petrophysical properties evolution, mineral neoformations and water-rock interactions. He is experienced in 3D geological modelling and well log analysis.

Mgr. Martin Paleček (male) is a GIS specialist. He will take care of map and formats compatibility in the CZ-AT contact region.

Publications

- Franců, J., Perszlényi, M., Riis, F., Prokop, O., Jurenka, L., Krejčí, O., Hladík, V. (2017): 3D geological model of potential CO2 storage: Abandoned oil and gas field LBr-1 in the Vienna basin. In Dixon, T., Laloui, L., Twinning, S.: Energy Procedia, 114, 2772–2788. – Elsevier. DOI 10.1016/j.egypro.2017.03.1393
- Francu J., Radke M., Schaefer R.G., Poelchau H.S., Caslavsky J., Bohacek Z., 1996. Oil-oil and oil-source rock correlation in the northern Vienna basin and adjacent Flysch Zone. In: Oil and Gas in Alpidic Thrustbelts and Basins of Central and Eastern Europe. G. Wessely and W. Liebl, eds., EAPG Spec. Publ. No. 5, Geological Society Publishing House, Bath, pp. 343-354.
- Krejci O., Francu J., Poelchau H.S., Müller P., Stranik Z., 1996. Tectonic evolution and oil and gas generation model in the contact area of the North European Platform with the West Carpathians. In: Oil and Gas in Alpidic Thrustbelts and Basins of Central and Eastern Europe. G. Wessely and W. Liebl, eds., EAPG Spec Publ. No. 5, Geological Society Publishing House, Bath, pp. 177-186.
- Myslil V., Burda J., Francŭ J., Stibitz M. (2002) Czech Republic. In: Hurter S. and Haenel R., eds., Atlas of Geothermal Resources in Europe. EUR, Luxembourg, Belgium, 17811, 26-27, 77-78 and Plates 13 and 14 (8 p.) ISSN 1018-5593 ISBN 92-828-0999-4.

Projects and research programme(s)

- EUOGA – EU (2015-2016)
- ENOS – Enabling Onshore CO2 Storage (2016-2020)
- H2020 LC16 M4ShaleGas
- Norway Funds – REPP-CO2

Infrastructure

- Geological database and digital maps of the Czech Republic http://www.geology.cz
- Groundwater and deep aquifer data
- Core store; national repository

Name of the Organisation RU #15

Regione Umbria – Servizio geologico e competenze regionali in materia di acque pubbliche

Brief description of the legal entity

RU (Geological Survey) is a technical entity of Regione Umbria (public body). Its missions and activities are: increasing knowledge and understanding of geology, groundwater resources, raw materials and geothermal issues) performing regional studies even through Geological Data Base and GIS to support policy makers and local governments providing them with essential information and technical assistance needed to regulate with uniform laws geological activities and manage natural resources even through long-term planning and legislation; Evaluation of geologic and earthquake hazard even through geology, seismic and geomorphology mapping of the territory in Umbria and the dissemination of geological data and information to the general public; Hydrogeological risk assessment, pursuing landslide investigations and forecasts, providing technical assistance to respond to landslide emergencies and strategic approaches for the mitigation of hydrogeological risk in terms of economic cost and of environmental safety, including procedures for the protection of infrastructures with relevant environmental impact; Management of regional seismographic network and geotechnical control stations. *(cont'd)*

Description of persons designated for HotLime implementation:

Dr. Andrea Motti (male): senior geologist. He works for RU since 1992, expert in geology, structural geology, seismic hazard. Author of 65 publications (geological mapping, geological survey, seismic hazard, geological engineering, web mapping). Public works inspector.

Dr. Norman Natali (male): senior geologist. He works for RU since 1998, expert in ICT and GIS analysis and modeling, database management, and development of cartographic web applications.

Publications

- Study for Umbria regional assessment of geothermal resources, (2015) Regione Umbria Ed.
- 1:10.000 regional geological map (276 sheets),
- 1:10.000 regional seismic hazard maps (276 sheets).
- 1:100.000 regional hydrogeological map and 1:25.000/1:10.000 regional hydrogeological maps.

Projects and research programme(s)

- SISMA (EU project on System Integration for Security Management Activities) as Lead Partner.
- CARG (1:25.000 geological and geothematic map of Italy)
- IFFI (Inventory of landslide phenomena in Italy)

Infrastructure

RU has license and works with GIS software ArcGIS by ESRI, QGIS.

Name of the Organisation ICGC #16

Institut Cartogràfic i Geològic de Catalunya

Brief description of the legal entity

The Institut Cartogràfic i Geològic de Catalunya (ICGC) (Cartographic and Geological Institute of Catalonia) is the official mapping and geological survey of the autonomous government of Catalonia. ICGC was created in 2014 and belongs to the Department of Territory and Sustainability of the Government of Catalonia. The ICGC sum-up the legacies of the former cartographic and geological agencies, both created in 1982. The ICGC has a staff around 270 people and is a beginning-to-end cartographic and geological institution. ICGC is the reference centre in geological sciences and geo-information in Catalonia. It comprises different fields, as applied geology and geophysics, seismic information systems, geological resources: geo-energies, hydrogeology, soils; in characterization, assessment, modelling and mapping. As a geo-information agency, ICGC is producing in Catalonia topographic products, DTM & DSM, orthoimagery, geological and geo-thematic maps in various scales and databases. ICGC has participated or is currently participating in a number of EU funded international projects related to geosciences.

Description of persons designated for HotLime implementation:

Ignasi Herms Canellas (male). He is Certificate of advanced studies-CAS on Exploration & Development of Deep Geothermal Systems in the Centre d'Hydrogéologie et de Géothermie de l'Université de Neuchâtel in 2016. MSc degree in Natural Resources (UPC, 2012), MSc degree in GIS (UdG, 2011), a BSc degree in Geology from the (UAB, 1999) and a BSc in Technical Mining Engineering (UPC, 1999). Postgraduate in groundwater hydrology (CIHS, UPC, 2002). Over 18 years of experience in hydrogeology, assessment geothermal systems, 3D groundwater and thermal modelling and simulation and GIS deployment. Professor in the field of hydrogeological mapping and deep geothermal in The International Groundwater Hydrology Course (FCIHS and UPC). Advisor for MSc theses related to deep geothermal in the MSc of Reservoir Geology and Geophysics (UB and UAB). From 2014 has been working as Head of the Geological Resources Area at ICGC. He is currently in progress in his PhD on karst hydrogeology (UPC). He has contributions at international congresses to geothermal and groundwater resources. *(cont'd)*

Georgina Arnó Pons (female). She is postgraduate in groundwater hydrology (CIHS, UPC, 2007). BSc in Geology at the UB (2001). Since 2014, she is the head of the hydrogeological and geothermal group team at ICGC. She has over 16 years of experience in the development of projects related to groundwater and mapping. She is specialized in analyses of groundwater and thermal data and 3D groundwater modelling. She is co-author of several articles and posters related to groundwater and geothermal. Since 2014, she acts as professor in the field of groundwater assessment and mapping in the International Groundwater Hydrology Course (FCIHS and UPC). She is the head of the ICGC's projects: 'Atlas for shallow geothermal energy in Catalonia', and the Hydrogeological Mapping Project of Catalonia.

Montse Colomer Casas (female). She has a BSc in Geology by the UB (1996). Since 2014, takes part as senior technician of the hydrogeological and geothermal group team at ICGC. She has over 20 years of experience in the development of geological and geo-resources projects. She is specialized in analyses of geological data, mapping and 3D geological modelling.

Víctor Camps (male): He is BSc in Geology (UB 2002). Since 2014 he takes part as senior technician of the hydrogeological and geothermal group team at ICGC. He has over 10 years of experience in processing of hydrogeological and geothermal data and hydrogeological mapping.

Relevant publications

- Colomer, M., Herms, I., Arnó, G., Camps, V.: Application of 3D modeling for groundwater management. 8th European Congress on: Regional Geoscientific Cartography and Information System (EUREGEO). Barcelona, June 2015.
- Herms, I. "Geothermal resources assessment in Catalonia for district heating systems by means of the USGS volumetric method together with Monte Carlo simulations". (Report) CAS DEEGEOSYS Exploration & Development of Deep Geothermal Systems (2016).
- Herms, I., Arnó, G. "*Hydrogeological information and cartographic databases. Perspectives in the digital field*". Emergent Hydrogeology (traduced). | 50 CIHS 2016. ISBN 978-84-921469-3-2. (2016)
- Colomer, M., Herms, I. et al. "*Digital distribution in vector format of data from the Hydrogeological Map of Catalonia at scale 1:25 000*". Emergent Hydrogeology (traduced). | 50 CIHS 2016. ISBN 978-84-921469-3-2. (2016)
- Piris, G., Griera, A., Gòmez, E., Herms, I., Goula, X.,Simulation of induced seismicity associated with fluid injection in single fractures: influence on the fracture slip regime. 5th European Geothermal Workshop - Characterization of Deep Geothermal Systems. Karlsruhe (Germany 12-13/10/2017)

Projects and research programme(s)

NERIES (FP7), SISPYR (INTERREG), EBRO-ADMICLIM (LIFE+), Wi-GIM (LIFE+), iCOAST (EU Civil Protection Instrument).

Relevant infrastructure

ICGC maintain databases, datasets, and models on earth sciences for the territory of Catalonia (NE Spain), making them freely available through its web site: http://www.icgc.cat . ICGC is the designer of the SIGWEB Platform called INSTAMAPS. https://www.instamaps.cat. ICGC use this platform to disseminate geological data, e.g. the borehole database of Catalonia (BDSoc)

- Web-based viewer of the BDSOc - Borehole database of Catalonia (last update: 29.900 boreholes): http://www.icgc.cat/en/Public-Administration-and-Enterprises/Tools/Geoindex-viewers/Geoindex-Sondejos ICGC elaborates different geological and geo-thematic mapping products. The following will be relevant for the project:
- Geological map 1:50.000 of Catalonia: http://www.icgc.cat/en/Public-Administration-and-Enterprises/Downloads/Geological-and-geothematic-cartography/Geological-mapping/Geological-map-of-Catalonia-1-50.000

(cont'd)

- GT V. Hydrogeological map 1:25.000 of Catalonia: http://www.icgc.cat/en/Public-Administration-and-Enterprises/Downloads/Geological-and-geothematic-cartography/Hydrogeological-cartography/GT-V.-Hydrogeological-map-1-25.000
- Hydrogeological Area Map of Catalonia 1:250.000: http://www.icgc.cat/en/Public-Administration-and-Enterprises/Downloads/Geological-and-geothematic-cartography/Hydrogeological-cartography/Hydrogeological-Area-Map-of-Catalonia-1-250.000-MAH250M-v01r01-2017

ICGC has license and works with several 3D geological and geo-thematic modelling and GIS software, like GOCAD, 3DGEOMODELLER, MOVE 2D/3DKinematics by Midland Valley, FEFLOW by DHI, SubsurfaceViewer by INSIGHT; ArcGIS by ESRI, QGIS, SURFER, and other.

5 Ethics and Security (This section is not covered by the page limit)

5.1 Ethics

Have you completed an ethics self-assessment?

YES/NO

The project proposal has been checked against the ethics sections in "H2020 Guidance - How to complete your ethics self-assessment: V5.2 – 12.07.2016". This check did not raise any issues.

Ticked "NO" throughout, the checklist is included with the submitted documents in ISAAC.
Uploaded to ISAAC / Attachments – Other on 05/01/2018

5.2 Security

Please indicate if your project will involve:

- Activities or results raising security issues: (YES/**NO**)
- 'EU-classified information' as background or results: (YES/**NO**)

5.6 MUSE

Title of project proposal

Managing **U**rban **S**hallow geothermal **E**nergy (MUSE)

Abstract (max. 250 words)

MUSE investigates resources and possible conflicts of use associated with the use of shallow geothermal energy (SGE) in European urban areas and delivers key geoscientific subsurface data to stakeholders via a user-friendly web based GeoERA information platform (GIP). The assessment of geothermal resources and conflicts of use will lead to the development of management strategies considering both efficient planning and monitoring of environmental impacts to feed into general framework strategies of cities like Sustainable Energy Action Plans (SEAPs). The developed methods and approaches will be tested and evaluated together with input from local stakeholders in 14 urban pilot areas across Europe representative for different conditions of SGE use. The pilot areas are geologically and climatologically diverse and have a range of heating and cooling degree day characteristics, making the project outcomes and shared learnings relevant to the whole of Europe and beyond. In the MUSE project, we want to address all relevant aspects by capitalising upon existing knowledge, identifying and closing specific knowledge gaps and providing joint proposals on methodologies, criteria and concepts on SGE management. We adapt workflows to focus on local scale investigations suitable for densely-populated urban areas, where national heating and cooling demand is generally highest, and which will represent the most important SGE market in the future. The outcomes of the project represent a comprehensive collection of methods, approaches and tools, which can be transferred to other urban regions in Europe and adapted by other organisations.

SRT

GeoEnergy – GE2-Geothermal energy

List of participants

#	Participant Legal Name	Institution	Country
1	Geologische Bundesanstalt	GBA	Austria
2	Natural Environment Research Council	NERC	United Kingdom
3	Institut Cartogràfic i Geològic de Catalunya	ICGC	Spain
4	Hrvatski Geološki Institut	HGI-CGS	Croatia
5	Ceska Geologicka Sluzba – Czech Geological Survey	CGS	Czech Republic
6	Bureau de Recherches Géologiques et Minières	BRGM	France
7	Geological Survey Ireland	GSI	Ireland
8	Royal Belgian Institute of Natural Sciences – Geological Survey of Belgium	RBINS-GSB	Belgium
9	Geološki zavod Slovenije	GeoZS	Slovenia
10	Instituto Geológico y Minero de España	IGME	Spain

11	Sveriges Geologiska Undersökning	SGU	Sweden
12	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO	TNO	Netherlands
13	Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy	PIG-PIB	Poland
14	State Geological Institute of Dionyz Stur	SGIDS	Slovakia
15	State Research and Development Enterprise State Information Geological Fund of Ukraine	GEOINFORM	Ukraine
16	Geological Survey of Denmark and Greenland	GEUS	Denmark

1 Excellence

MUSE – Managing Urban Shallow geothermal Energy addresses the topic "Geothermal energy and groundwater in urban areas" within the SRT GE2 – Geothermal Energy.

It covers various aspects of closed- and open-loop shallow geothermal energy (SGE) systems in European urban areas for heating, cooling and seasonal heat storage. MUSE deals with pooling and harmonisation of state-of-the-art methods on assessing resources and conflicts of use associated with SGE in densely settled areas. It will contribute to the joint GeoERA knowledge infrastructure (e.g. GeoERA knowledge vocabularies). The project will propose concepts to minimise unwanted impacts on the subsurface, especially on chemical and quantitative status of shallow groundwater bodies, by taking into account interference of competing SGE installations. 3D subsurface planning focusing on near-surface installations will be used to characterise the implementing factors of the SGE installations. Therefore, based on the experiences gained at 14 urban pilot areas across Europe, the project leads to interoperable quality standards for assessing, planning, managing and monitoring efficient SGE use and will promote proven and promising technical concepts for contributing to the decarbonisation of European cities.

MUSE also covers policy aspects with strong local stakeholder involvement in the selected urban pilot areas to develop and promote strategies and action plans tailored for local use of shallow geothermal resources. Furthermore, MUSE will support transfer of knowledge by disseminating the produced outputs *via* dedicated web tools implemented in the GeoERA Information Platform (GIP) and via direct stakeholder-targeted consultations and training in the chosen pilot areas. This active dialogue also intends to raise awareness on existing gaps and hurdles related to the legal framework, licensing and management procedures associated with sustainable SGE use, and will also address EU energy and climate targets.

Aims and objectives

The overall aim of MUSE is to support methodologies and concepts for an efficient and sustainable use of shallow geothermal energy (SGE) in urban areas for heating, cooling and seasonal heat storage that can be implemented across Europe. To reach this goal, we set the following objectives:

1) Identifying, summarising and developing state-of-the-art methods including **harmonised standards** for:
   - Quantifying the potential of SGE use in urban areas for open- and closed-loop systems and conveying it to energy planners and investors;
   - Cost-efficient geophysical exploration and monitoring tools including thermal response test (TRT) measurements;
   - Assessing conflicts of use associated with open- and closed-loop systems in urban areas;
   - Monitoring and evaluating the efficiency and impacts (environmental, land-use, land planning) of shallow geothermal installations.

2) Develop strategies for **efficient and sustainable use** of SGE in European urban areas by means of:
   - Evaluating current regulation and permitting of SGE use in selected urban pilot areas to identify strengths and weaknesses in terms of level of environmental protection;
   - Identifying and promoting prospective technical concepts based on SGE for heating and cooling supply as well as seasonal storage (e.g. low temperature heating and cooling grids);
   - Summarising criteria, strategies and actions for planning, managing and monitoring of SGE use in cities and developing actions for stakeholders.

3) **Transfer of methods and integrate into strategies** in specific urban pilot areas across Europe with involvement of external stakeholders:
   - Cost-efficient exploration of the shallow subsurface, suitable for urban environments, for estimating the resources for SGE use;
   - Monitoring the thermal state of the subsurface, especially shallow groundwater bodies, for assessing conflicts of use associated with SGE use;
   - Assessment and mapping of resources and conflicts of use associated with SGE utilisation;
   - Operational monitoring for assessing the efficiency and thermal impact of existing SGE installations;
   - Tools to support development of tailor-made strategies for planning, managing and monitoring of SGE in close collaboration with local stakeholders;

- Targeted communication and transfer of knowledge to decision-makers and other stakeholders;
- Support the integration of SGE use into action plans, (e.g. SEAPs);
- Displaying spatial output datasets via web services (maps, location specific data queries) integrated in the GeoERA Information Platform.

4) Contributing to the **overall GeoERA objectives** by:
   - Knowledge exchange and interacting with projects covering overlapping and cross-cutting aspects of SGE use in urban areas, such as groundwater protection and 3D spatial planning;
   - Provide technical concepts and datasets for implementing geoscientific knowledge related to SGE use in the EGDI information platform.

Non-objectives: MUSE does not include very shallow horizontal closed loop collector systems, nor artificial aquifers related to ATES, and does not focus on new drilling and probe technologies, nor on detailed economic analyses or detailed business models.

Relation to existing programmes and projects

MUSE will capitalise on results from various previous international projects, and cooperate with ongoing projects dealing with SGE use in the framework of knowledge exchange activities organised in work package WP6 (see also chapter 3.1). MUSE will directly cooperate with the currently ongoing projects GeoPLASMA-CE (Interreg Central Europe) and GRETA (Interreg Alpine Space), CatchmentCARE (Interreg VA), IMAGE, SURE and GEOWELL (all H2020), as participants of MUSE are also engaged in the mentioned projects. Furthermore, MUSE wants to connect itself to the ongoing project Cheap-GSHPs (H2020) and to capitalise outcomes from the accomplished projects ThermoMap (ICT PSP), REGEOCITIES (Intelligent Energy Europe), SUB-URBAN (COST) and ESTMAP (H2020). Moreover, MUSE will benefit from numerous ongoing and accomplished national projects and initiatives executed by the participants of the project with regard to datasets available in the selected pilot areas and methods as well as concepts developed.

The relation between MUSE and the above mentioned international projects is presented in the subsequent table 1.1:

Table 1.1: Relation to existing international projects

International Project	Developing and compiling methods, workflows and concepts related to SGE	Developing and compiling strategies and actions for managing SGE use	Targeted stakeholder communication and contribution to GeoERA Information Platform
GeoPLASMA-CE	Methods for mapping and modelling of resources and conflicts of use (closed- and open loop systems) TRT measurements	Strategies and actions developed for pilot areas and case studies Assessment and evaluation of legal framework and regulations	Guidelines on stakeholder interaction Web dissemination tools (web portal)
GRETA	Methods for mapping and modelling of resources and conflicts of use (closed- and open loop systems)	Energy planning concepts considering SGE Assessment and evaluation of legal framework and regulations	Stakeholder trainings
CatchmentCARE	Concepts of groundwater monitoring	Groundwater preservation	
IMAGE	Innovative exploration methods for the shallow subsurface in urban areas		

International Project	Developing and compiling methods, workflows and concepts related to SGE	Developing and compiling strategies and actions for managing SGE use	Targeted stakeholder communication and contribution to GeoERA Information Platform
SURE	Innovative geothermal drilling methods.		
GEOWELL	Innovative methods for monitoring of wells		
ThermoMap	Methods for mapping shallow geothermal resources: climatic conditions, groundwater, administrative data		Visualisation of resources, information environment on SGE potentials
REGEOCITIES		Evaluation and summary of legal framework. Strategies and actions for managing SGE use in cities.	
SUB-URBAN TU1206	Good practices in 3D and 4D mapping/modelling of the subsurface below cities Groundwater, Geothermal modelling & monitoring at city-scale	Spatial subsurface urban planning and management	Visualisation of the subsurface below cities
ESTMAP	Mapping of geodata related to seasonal heat storage		

Furthermore, MUSE is related to or supports fulfilling the following EU programmes and international initiatives:

- Renewable Energy Directive 2009/28/EC by supporting and fostering the use of SGE in urban areas,
- Energy Efficiency Directive 2012/27/EU by promoting seasonal heat storage,
- Directive 2006/118/EC on protection of groundwater against pollution and deterioration by proposing thermal management strategies of groundwater bodies,
- Directive 2001/81/EC on national emission ceilings for certain atmospheric pollutants and
- Directive 2008/50/EC on ambient air quality and cleaner air for Europe by supporting measures for a decarbonisation of heating and cooling supply in European cities.

Finally, MUSE will relate to the IEA ECEA Annex 21 and DIN EN ISO 17628 on standards for Thermal Response Tests.

1.1 Concept and methodology

MUSE intends to pool knowledge on managing the efficient and sustainable use of shallow geothermal energy in European cities. This covers the uppermost tens to hundreds of meters of the subsurface, and very shallow aquifers accessed by geothermal schemes within the 0 to 400 m depth range. The project flow abides by a process circle, which consists of the following main stages:

Stage 1 covers **compilation of methods and workflows** for providing key geoscientific data and creating strategies for sufficient and sustainable SGE use. The work includes the exploration and monitoring of the subsurface, assessing, processing and mapping of key data, as well as creation, evaluation and validation of static and dynamic (process-oriented) models. The topics addressed cover the geological structure and hydrogeological and hydrochemical settings, rock and sediment thermal properties and the thermal state of the subsurface.

The pooling of knowledge will be realised by specific surveys within the project consortium, additional literature studies and both physical as well as web-based workshops to harmonise methods and close knowledge gaps. These workshops will also be accessible to experts outside the project consortium, particularly local authorities wanting to develop planning strategies for the protection of subsurface energy and water resources.
As the planning and management of SGE is affected by local geological settings of heterogeneous origin, we do not aim to produce large-scale transboundary data layers. Instead, we want to create a catalogue of joint methods appropriate for urban areas applicable to the thermal characteristics of the pilot regions, using the internationally adopted 'degree day' approach to energy management. To achieve this goal we will pool the knowledge and harmonise methods where necessary to derive joint minimum good practice and develop methodologies and workflows to fill existing knowledge gaps.

We will collect existing technical and administrative knowledge among the 16 project partners to **compile different strategies for managing SGE use in cities** including the whole process circle of planning, licensing and monitoring to guarantee efficient and sustainable geothermal installations and foster innovative promising concepts of use. The management circle does not just depend on the geoscientific knowledge of the subsurface settings, it also needs to include the legal framework, administrative procedures, social dimensions and policies, as well as aspects of land-use and spatial planning in 3D. The pooling of knowledge leads to a catalogue of strategies and actions linked to energy supply and environmental targets for urban areas (e.g. Sustainable Energy Action Plans – SEAPs).
The views of a geoscientific expert do not necessarily match the perception of administrative bodies or political decision makers. Indeed, experiences from the Interreg Central Europe project GeoPLASMA-CE show that stakeholder interviews and related SWOT analyses are powerful tools for raising awareness and for identifying challenges in SGE use, as seen from different stakeholder perspectives. For these reasons, we aim to create concepts for **targeted communication with local stakeholders and decision makers**.

Furthermore, we will also compile technical concepts for web services on SGE on the GeoERA Information Platform (GIP). Until now, such web-based information systems are only established in a few European countries like Germany and the Netherlands. Linked to web-based management systems (licensing, monitoring of use), web platforms represent efficient technical tools to foster SGE use.

Stage 2 of the project will focus on the **implementation of joint methods and workflows in 14 pilot areas** across Europe. All of them represent urban areas affected by different climatic and geological conditions, legal settings, different supply and infrastructure as well as different thematic focuses of the proposed investigations. Using the compiled concepts and standards will lead to interoperable and comparable project outputs. In this stage, local stakeholders will be integrated in the implementation process to jointly derive strategies and specific actions for establishing sound management concepts on local SGE use, and enhancing the impact of MUSE. The different pilot areas, which are evenly distributed across Europe (see figure 2.1), will act as test and demonstration sites for applying modern management approaches strongly based on geoscientific data and expert knowledge. These cities represent early adopters of shallow geothermal energy and are future champions of sustainable management approaches.

Stage 3, the **final stage** of MUSE, will cover a **feedback round from the pilot areas** to the initially compiled catalogues of methods, workflows and concepts. Based on the outcomes and lessons learned in the pilots gathered at a joint feedback workshop, we will transfer the preliminary collection of **methods and concepts** into a **final version for general dissemination** to other regions in Europe. This will be supported by the publishing of spatial datasets on a modern web service, hosted on the GeoERA Information Platform (GIP) for planning and managing SGE use.

1.2 Ambition

Managing shallow geothermal energy use is related to many geoscientific topics like hydrogeology and hydraulics, heat transfer in aquifers and aquitards, hydrochemistry, borehole and well techniques, geoengineering and geohazards (e.g. karstic regions and swellable rocks). However, it also covers issues related to energy economics, heating and cooling systems and subsurface spatial use, as well as energy- and land-use planning.

A significant body of geoscientific knowledge is already available from numerous national and international projects. However, these projects often address only a few specific issues within the above-mentioned topics, or cover only single regions or a few European countries. This leads to various and partly contradictory methods and concepts to address resources and conflicts of use, and to fragmented strategies for managing efficient and sustainable SGE use. In this context, it should be mentioned that even a uniform definition of SGE is not yet available for Europe as a whole.

At the moment, there is a challenge in efficiently conveying geoscientific datasets on resources and possible conflicts to decision-makers (managing authorities, planners, city administrations and investors). In particular, the overall cumulative effect of competing SGE uses can be difficult to assess from static gesocientific datasets like thermal conductivities or expected maximum thermal capacities of SGE installations. Therefore, MUSE is aiming to provide valid solutions for allowing interactive decision support. This can be realised by interactive web services and local- to regional-scale dynamic process models of user interaction. Both aspects will be addressed in the project. We want to further develop interactive web services, which for example have been established in the project GeoPLASMA-CE (www.geoplasma-ce.eu) and demonstrate the use of coupled thermal- hydraulic process models for acknowledging interference of use.

Doing so, we include the whole process-chain of managing SGE from data assessment to licensing, monitoring, land-use and energy planning and web-based data display. We want to address all relevant aspects by capitalising on existing knowledge, identifying and closing specific knowledge gaps and providing joint proposals on methodologies, criteria and concepts on SGE management. We will adapt existing workflows to the needs of local scale **urban areas**, **which will represent the most important SGE market in the future** and derive, together with local stakeholders, suitable strategies and specific actions to include SGE in future urban energy supply and environmental protection concepts.

To summarise, the **ambition of MUSE is to develop a comprehensive and integrated set of methods, concepts and strategies allowing for local-scale management of shallow geothermal energy in European urban areas,** which can later be applied by other Geological Survey Organisations or comparable entities in other European cities.

2 Impact

2.1 Expected impact

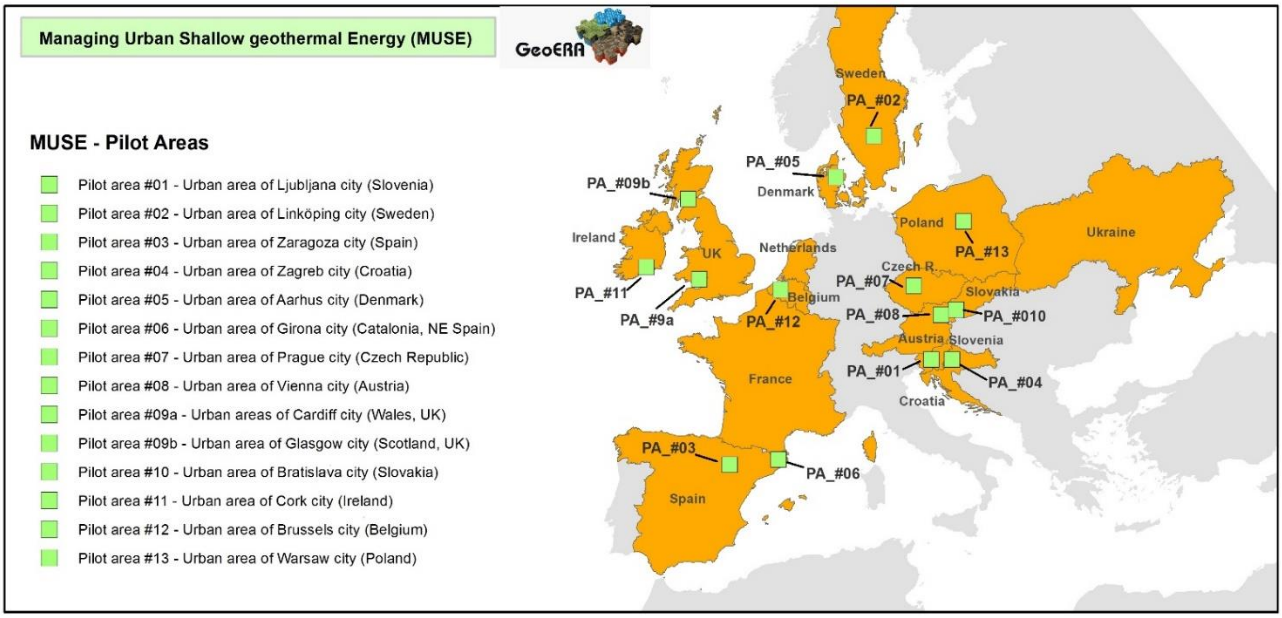
The European Union already faces a rather high degree of urbanisation (74.8% according to the World Bank), which is expected to further increase in the upcoming decades. Therefore, strategies and actions on the uptake of green energy supplies in Europe need to focus on urban areas. Here, shallow geothermal energy (SGE) use for heating, cooling and seasonal storage has the potential to become a key instrument for reducing the dependency on energy imports and lowering emissions by enhancing the decarbonisation of the heating and cooling market. Although around two thirds of the total installed capacities and more than 85% of all investments in the European geothermal sector is related to SGE use (European Geothermal Energy Council, Market Report 2015, fifth edition April 2016), these simple and very adaptable heating and cooling techniques still suffer from a lack of visibility and awareness by the general public. The Market Report 2015 also reveals that the top five nations of SGE use in Europe (Sweden, Germany, France, Switzerland and Norway) account for 69% of the overall installed capacities, thus indicating that SGE use has a large potential in many other countries across Europe.

The GeoDH project (http://geodh.eu/) concluded that “more than 25% of the EU population lives in areas directly suitable for deep geothermal district heating”. In contrast, the general suitability of applying SGE methods for low temperature heating and cooling supply is expected to be significantly higher compared to deep geothermal systems. In general, the application of closed-loop systems is only limited to land-use restrictions (e.g. groundwater protection zones or problematic geological conditions) and already existing subsurface installations. Based on a recent survey in Vienna (Austria), closed-loop systems may either provide or store energy of up to 7,000 MWh/ha/year. Moreover, the entire heating and cooling demand of Vienna referring to the year 2015 could be supplied by closed-loop systems occupying less than only 17% of the available city area (WC-33 project executed by the Geological Survey of Austria).

Taking the above-mentioned aspects into account, MUSE addresses measures to enhance and manage sustainable and efficient use of SGE methods for fostering green energy uptakes in Europe. The project contributes to the following aims of the Specific Research Topic GE2 and the GeoERA programme in general:

- Delivery of a well-documented knowledge base (catalogue of joint methods and workflows) for local-scale assessment of resources and possible conflicts related to shallow geothermal energy in cities.
- Developing interoperable quality standards and criteria for supervising the whole management circle including exploration and assessment, planning & licensing as well as monitoring of use and related impact on the subsurface, especially on shallow groundwater bodies. In this context, the project especially addresses the problems of mutually interfering SGE installations.
- Developing strategies and related actions (roadmaps), as well as policy tools, for managing and supporting SGE use in cities. This also includes the evaluation of the current legal framework on regulating and support for shallow geothermal energy.
- Identifying and describing proven and promising technical concepts of SGE use for heating, cooling and seasonal heat storage.
- Describing technical and environmental risks related to inappropriate SGE use and providing risk intervention and mitigation measures.
- Demonstrating the developed methods, workflows and concepts in 14 urban pilot areas across Europe (see also figure 2.1).
- Developing modern web-based information- and decision-support systems for investors and regulators.
- Involving local stakeholders in the pilot areas by targeted communication and transfer of knowledge activities to ensure a long-term impact of MUSE with regard to enhancing the use of SGE to reduce greenhouse gas emissions and improve air quality and urban well-being.

Figure 2.1 Participating countries and selected pilot areas of MUSE



After the end of MUSE, all results can be transferred to other Geological Survey Organisations or similar entities to be used in other European urban areas. The comprehensive toolboxes provided by MUSE aim to cover all relevant aspects dealing with possible future SGE use in European urban areas. This is seen as the most important added value of MUSE beside the tailored thematic outputs, strategies and web services for the pilot areas.

To achieve these aims, MUSE integrates Geological Survey Organisations from 15 European countries and 14 selected urban areas, which face different geological, climatological and socio-economic settings with regard to the present heating and cooling market, legislation and regulation. The participating countries and selected pilot areas are shown in figure 2.1.

2.2 *Measures to maximise impact*

2.2.1 Dissemination and exploitation of results

As mentioned above, the low level of visibility and awareness amongst decision-makers related to SGE in many European countries may represent the biggest barrier to achieve the expected impact. Therefore, we have dedicated a work package (WP6) within MUSE to targeted communication, and have already started to contact local stakeholders in the pilot areas while preparing this proposal. As a result, the project has already received 16 expressions of interest letters from stakeholders from 9 participating countries. These letters are attached to the proposal.

Dissemination and exploitation activities involve all work packages of MUSE, although general communication and dissemination is associated with work package WP1, and targeted dissemination and exploitation is located in WP5 (see also chapter 3). In the following, we present a general Communication, Dissemination and Exploitation (C-D-E) Plan related to MUSE (table 2.1). In the beginning of the project, the preliminary C-D-E Plan will further be developed into a detailed plan, which will also be regularly updated during the project implementation.

Table 2.1 Preliminary Communication, Dissemination and Exploitation (C-D-E) Plan

C-D-E- objective	Type	Target audience	Planned activities, channels	Involved WPs	C-D-E targets
Inform about the project, its objectives and activities	C	General public Scientific community Local stakeholders in the pilot areas EU & national stakeholders GeoERA group	Website Leaflet Project logo Corporate identity templates Contact address to MUSE	WP1	100 visits 300 print-outs or downloads of the leaflet
General support of GeoERA and knowledge exchange on cross-cutting topics	C,D	GeoERA group EU & national stakeholders Scientific community	Obligatory GeoERA dissemination seminars Knowledge exchange workshops	WP6, all thematic WPs	3 seminars 2 workshops
Disseminate the results of MUSE to scientific- and expert communities	D	Scientific community EU & national stakeholders	Cumulative research paper (special journal issue) Present the project at conferences and expert workshops	WP1, all thematic WPs	1 cumulative research paper 5 presentations
Link the outcomes of MUSE to the GeoERA knowledge infrastructure	D	Scientific community GeoERA group	GeoERA project vocabularies	All thematic WPs	20 links to MUSE
Raise the awareness on SGE for decarbonisation of European cities	D	EU & national stakeholders Local stakeholders General public	Fact sheets of evaluated SGE concepts	WP2	1 catalogue of fact sheets
Adapt joint methods, workflows and concepts in other urban areas in Europe	D,E	GeoERA group Geological surveys Scientific community	Catalogue of methods and guidelines	WP2, WP3, WP5	2 guidelines

C-D-E- objective	Type	Target audience	Planned activities, channels	Involved WPs	C-D-E targets
Promote strategies and actions for enhancing efficient and sustainable SGE in the pilot areas	D, E	Local stakeholders in the pilot areas	Guidelines Workshops, trainings, consultation & interviews Fact sheets showcasing the pilot areas	WP2, WP3, WP4, WP5	1 guideline 14 workshops and trainings 14 fact sheets
Online web services on SGE	E	Local stakeholders in the pilot areas GeoERA group Geological surveys	Web services presenting output datasets at the pilot areas	WP4, WP5	web services integrated in GIP with online SGE specific help

2.2.2 Communication activities

The communication activities described above are related to the three following key messages that MUSE wants to convey:

- "*Shallow geothermal energy has the potential to significantly support the transition towards decarbonised and self-sufficient European cities";*
- *"Efficient and sustainable SGE use requires integrative management and policy concepts";*
- *"Existing knowledge and strategies needs to be compiled and harmonised for transferring to other urban regions in Europe".*

As shown in table 2.1, the planned communication activities receive support from all work packages, involve the majority of the project consortium and address both targeted as well as general audiences. Communication activities during the project implementation will be linked to activities in WP1, WP5 and WP6. We intend to benefit from joint GeoERA activities (WP1 and WP6) and de-centralise targeted local stakeholder interaction in WP5 based on joint guidelines.

After the end of the project, dissemination and exploitation will be based on the outcomes of MUSE, realised by:

- The compilation of methods and guidelines disseminated through the project website (WP2, WP3);
- The achieved management strategies in the pilot areas, which are ready to feed into local strategies (e.g. SEAPs) and provide working examples for other regions (WP4);
- The achieved web services for the pilot areas, as well as the infrastructure developed for the GeoERA Information Platform (GIP) (WP4, WP5).

Collaboration with local stakeholders in urban areas (decision-makers and administrative bodies) is an important aspect of MUSE, and is addressed in WP5. Therefore, management strategies related to SGE use will include the assessment of local requirements and expectations (e.g. joint SWOT analyses during interviews and consultations), feedback workshops and knowledge transfer activities.

Furthermore, we will perform structured communication inside GeoERA and MUSE to pool knowledge and seek synergies with other project teams in cross-cutting topics. Internal communication will be realised by feedback and knowledge-exchange workshops (WP6).

With regard to maximising the scientific impact of MUSE, we intend to also pool our scientific dissemination activities by publishing important results at the end of the project as short papers in a thematic issue of a geoscientific journal.

In MUSE, we follow an open-access data strategy. All output datasets produced in the pilot areas, which are hosted on the GIP platform will also be accessible for downloads as GIS datasets in a standard format.

A joint metadata description protocol, linked to a data-management and data delivery plan (WP5) will support a transparent documentation of used input data. Furthermore, public access will be provided to reports and the Knowledge Infrastructure related to MUSE.

2.3 Contribution of Project Proposal to the Information Platform or vice versa

MUSE intends to interact with the GeoERA Information Platform (GIP) on the following interfaces:

- General dissemination of the project at a specific website within the GeoERA web-portal.
- Contribution to the GeoERA general knowledge infrastructure not related to spatial data.
- Development of web services on shallow geothermal energy at the GIP.

The interaction with the GIP is specifically addressed in WP5 of the project. See WP5 for a detailed description of the proposed workflow etc.

Project website

The project requires a static website including a Content Management System (CMS) for the general presentation of the projects (project summary, contacts, news and archive) and the publishing of produced documents (project leaflet and reports etc.). The website will be serviced and updated by the project team. After the end of the project no updates of this website are planned.

GeoERA Knowledge infrastructure
MUSE wants to contribute to the planned “GeoERA project vocabularies” infrastructure focusing on technical terms relevant for SGE use. The minimum ambition of the project covers the set-up of joint vocabularies in English language. Depending on the staff commitment of the participants, we will aim at also providing translated terms in at least some involved languages. Furthermore, we would like to link our report-based outputs to the knowledge base.

Web services on shallow geothermal energy use
MUSE will deliver spatial output datasets on the resources and areas of limitations associated with shallow geothermal energy (SGE) use for 14 pilot areas. We want to use these data to set up web services related to the planning and managing of SGE use. The aimed web services require the following functionalities:

i. <u>display of GIS-based datasets</u> (grid-based and vector datasets),
ii. <u>location-specific data query</u> of (i) leading to automated PDF report generation;
iii. <u>simple interactive data extraction – as well as processing routines</u> linked to (ii).
The interactive operations cover linear interpolation of nodal datasets (e.g. values form serial datasets at specific depths) as well as simple mathematical on-the-fly calculations (e.g. for calculating the heat transfer rate at variable annual operational hours).

The scenic display or mathematical operations associated with 3D datasets are not the focus of MUSE. However in relation to the main functionality (ii), the project would be interested in the extraction of virtual 1D (borehole) profiles from geometrical 3D subsurface models. MUSE also aims to allow the download of GIS-based datasets from the web services by the public.

A detailed specification of the requirements will be made in collaboration with the GIP team at the start of the project, see WP5.

The partners working in specific pilot areas (WP4) are responsible for the development of the individual datasets. The WP5 team interacts with the GIP teams for setting up and testing the web services, and providing guidelines on preparing output datasets to the WP4 team. The delivery of datasets to the web services located at the GIP will be realised by the WP5 team.

During data collection in WP4, a distinction between static and dynamic datasets will be made, and a technical guide for uploading of data to the portal made. Furthermore, it will be investigated to what extent local stakeholders and national surveys will be able to update the dynamic datasets in the future. How data will be preserved after the end of GeoERA is regarded as a more general question that has to be addressed in a context larger than the MUSE project.

3 Implementation

3.1 Work Plan – Work packages, deliverables

General structure and interaction

The Work Plan of MUSE considers one management and general communication and dissemination work package (WP1), three thematic work packages (WP2 to WP4), one work package dealing with targeted external communication and delivery of results to GIP (WP5) and one work package addressing cross-cutting topics and cooperation with other project teams inside GeoERA (WP6). The work packages closely interact with each other. Referring to the overall project structure, the methodological work packages WP2 and WP3 establish the theoretical foundation considering methods, workflows and concepts that will be applied in the pilot areas (WP4) and used for stakeholder interaction and utilisation of results (WP5). The thematic outputs produced will feed into web services linked to the GIP (WP5). Two joint workshops addressing all WPs (project month 9 and 27) represent the central linking point between the WPs.

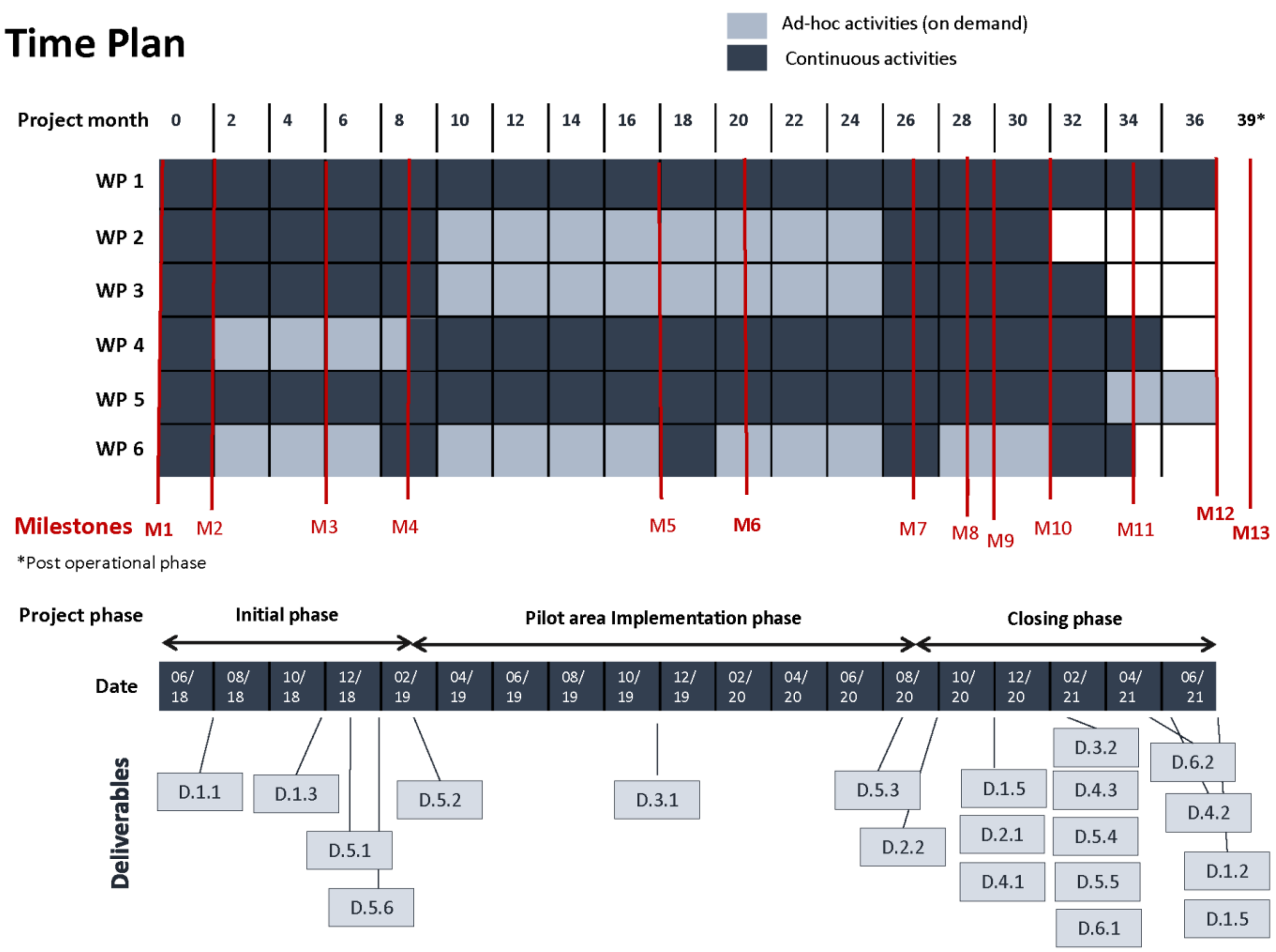
Distribution of resources

Due to the relatively large numbers of pilot areas, WP4 represents the work package with the highest staff commitment inside MUSE (29.3%). The methodological work packages WP2 and WP3 together cover 29.6% of the committed person months. Targeted stakeholder communication and interaction with the GIP team consumes 19.3% of the overall person months committed, while interaction with other GeoERA projects on cross-cutting topics in WP6, mainly considering workshops and web conferences, occupies only 10.5% of staff involvement. The coordination of MUSE, including obligatory progress and financial reporting, covers 11.4% of the committed overall person months.

Time plan

Due to strong interaction, the WPs cover most of the project duration (see figure 3.1). To allow a clear identification of workloads, we distinguish between phases of (i) ad-hoc and on-demand activities within a WP and (ii) phases with continuous or concentrated activities within a WP (see figure 3.1). In that context, the methodological work packages WP2 and WP3 will be reduced to on-demand ad-hoc activities during the concept implementation in the pilot areas (WP4 and WP5) and resume concentrated activities during the closing phase of MUSE for integrating feedbacks received from the pilot areas.

Figure 3.1 Time table



3.2 *Management structure, milestones and procedures*

Organisational structure and roles in the project

Participant GBA will be responsible for the overall project as Project Lead. Mr. Goetzl will be the project coordinator and is experienced in coordinating international projects dealing with geothermal energy. Furthermore, a Project Office (PO) will be located at GBA consisting of the project coordinator and a financial manager. The PO will act as an interface between the project consortium and the GeoERA programme coordination.

The Project Assembly consists of a representative from each project partner and will act as an internal steering- and decision-making body. It will physically meet on an annual basis and will meet through regular two-monthly web conferences (assembly web conference - AWC).

The Project Board (PB) consists of the Work Package Leaders (WPL) and the project managers (project coordinator, financial manager and communication manager). The communication manager coordinates all general external communication and dissemination activities, organised within the management and dissemination work package WP1. Mrs. Staša Borović (partner HGI-CGS) will be the project's communication manager and will act, together with the project coordinator, as the "face of MUSE" to the outside world. The PB regularly reports to the Project Assembly via the AWC, and will meet virtually at regular monthly Project Board web conferences (BWC). Additional ad-hoc web conferences will be organised on demand.

The WPLs are responsible for the thematic coordination and the implementation of the project at the WP level. Each WPL is supported by Task Leaders and participants coordinating the execution of tasks and the preparation of deliverables. Together with interested project partners they form WP-related Core Working Teams. The Task Leaders and participants coordinating the preparation of deliverables are listed in the tables 3.1a to 3.1c. The WPL is responsible for organising regular and/or ad-hoc web conferences of the associated WP core team.

An External Evaluation and Advisory Board (EEAB) will provide external quality control and advisory support to MUSE. The Geoenergy Theme Coordinator, lead partners of projects with overlapping and cross-cutting topics relevant for MUSE, project observers and local stakeholders as well as internationally recognised experts in SGE research will be invited to join the EEAB. It is planned to organise up to three physical EEAB meetings in the lifetime of MUSE. Initially, EEAB meetings are planned around project month 12 and 24. An additional third EEAB meeting will probably take place in the framework of the GeoERA mid-term seminar (project month 18).

Internal communication

The Project Lead will provide an internal, cloud-based document and data exchange platform. The Project Lead will also provide the infrastructure for hosting web conferences. WP-related contact lists and e-mail groups will also be available to ensure a sound communication. The project team may get in contact with the Project Office using a dedicated e-mail address.

Quality control measures, decision making and reporting

At the beginning of MUSE, a detailed Project Implementation Plan (PIP) will be developed by the Project Board. It will contain a detailed work plan, dissemination & exploitation plan, a detailed risk and contingency plan, as well as a detailed management plan. The PIP represents the main internal controlling and monitoring document of the project progress and will be updated during regular web conferences and partner meetings. In general, the Project Board has the power to propose updates to the PIP, while the Project Assembly is the final decision-making body. Votes on decisions can be achieved during physical meetings of the Project Assembly or web conferences (AWC and ad-hoc conferences announced at least one week before the meeting).

The Project Lead takes the overall responsibility to collect, compile and provide the obligatory documents reporting to the GeoERA programme management. Support will be provided by the Project Board concerning the topic-related reporting of progress and by the project participants, who are responsible for the preparation of their related financial and progress reporting documents.

Project milestones

In MUSE, there are a total of 13 milestones (see table 3.2a). Three of them (M1, M6, M13) cover inclusion activities predefined by the GeoERA programme (joint kick-off-, midterm- and final seminar). The first four milestones (M1 to M4) delineate the so called initial phase of the project, ending with the first joint project workshop on thematic aspects (M4) scheduled for project month 9. The milestones M5 (beta version of web platform) to M8 (elaboration of output datasets, project month 29) delineate the implementation phase of the project in the pilot areas. It also includes the second and final joint project workshop on thematic aspects (M7). The closing phase of MUSE covers predominately communication and dissemination milestones like the implementation of the outputs to the GeoERA Information Platform (M10), the submission of the cumulative research papers (M9) and the achievement of targeted stakeholder trainings in the pilots (M11). The operational phase of MUSE closes in project month 36 (M12). The final milestone of MUSE is set by the GeoERA final seminar and the delivery of the obligatory final report to the GeoERA programme. (M13, project month 39 in the post operational phase of MUSE). The milestones are also shown in figure 3.1.

Innovation- and risk management

MUSE aims at sharing and pooling existing knowledge from previous projects among the participants. Unlocking potentials of further innovation will be supported by interactive cooperation in workshops and by the specific work performed in the pilot areas. Innovation management will be the responsibility of the Project Board. The overall coordination of innovation and knowledge pooling will be the responsibility of the project coordinator (Mr. Gregor Goetzl).

Implementation of thematic risk management will be the responsibility of the Project Board, while administrative risks will be managed by the Project Office and the Project Assembly. The pre-identified risks of MUSE are shown in table 3.2b. As the project aims at pooling, harmonising and complementing existing expert knowledge we do not see critical risks (high likelihood and significant impact). Sources of risks include limited access to data and sites in the pilot areas, and a delay in deliverables that feed into other work packages. Due to the structure of the project implementation, most deliverables will be finalised during the closing phase of MUSE. Monitoring of the implementation progress will be necessary to ensure a timely accomplishment of those deliverables. A specific risk register and contingency plan will be defined in the beginning of MUSE and regularly updated during the project implementation.

3.3 Consortium as a whole

The consortium consists of 16 Geological Survey Organisations from 15 European countries. MUSE does not involve additional parties except for external participants of the EEAB. The consortium as a whole has an expert level of knowledge regarding SGE: Fourteen out of 16 partners have already performed national studies on related topics including exploration, geoscientific modelling, resource and conflict mapping. Some of the participating Geological Survey Organisations also represent managing authorities or perform consulting on behalf of authorities. Six out of 16 partners already participated in international projects dealing with aspects of SGE use (e.g. projects GeoPLASMA-CE, GRETA, ThermoMap or SUB-URBAN). Five partners already cooperated with each other in one or more of the before mentioned international projects. Furthermore, in 10 out of 14 pilot areas MUSE can capitalise on existing data and knowledge from previous projects and activities for further improving in WP4.

The consortium is strongly committed to all objectives set in MUSE. Twelve out of 16 partners are involved in all six work packages. Thirteen partners contribute with their expert knowledge to the compilation of methods, workflows and concepts concerning technical aspects of SGE planning and use in WP2. The same number of partners will be involved in designing strategies and action plans of SGE use in urban areas. Fifteen out of 16 partners will then implement and evaluate the joint catalogues of methods, strategies and actions in the 14 pilot areas and participate at the targeted communication with and transfer of knowledge to local external stakeholders in WP4 and WP5. These activities also involve those partners not that experienced in assessing and managing SGE in urban areas as MUSE will offer profound guidelines, developed in WP2 and WP3. Finally, 13 partners committed themselves to actively support the GeoERA objectives beyond the scope of MUSE by coordinating cross-project activities, participating at knowledge exchange workshops and web conferences as well as supporting the development of tailored web tools for presentation of information about SGE on the GIP.

In MUSE, the average person months (PM) commitment per partner amounts to 12, which leads to two groups inside MUSE populated by 8 participants each: The first group cover those partners with staff involvement clearly above average between 15.5 and 23.5 PM. It consists of the partners representing the core working teams inside the work packages. The second group shows staff involvement between 2,06 and 9 PM contributing to specific aspects of MUSE (e.g. exploration, monitoring or cross-cutting topics) or just actively follow the project by exchanging knowledge and addressing specific aspects of SGE in the pilots (e.g. pilot area Prague). Moreover, all partners ensured staff capacities in WP1 to support the overall project coordination (e.g. participating at Project Assembly meetings) and to provide the obligatory reporting to the GeoERA programme.

For more information of the expertise available in the consortium please see chapter 4.

3.4 *Resources to be committed*

Table 3.1a Work package description

Work package number	**1**	**Lead beneficiary**			**GBA**	
Work package title	Project management, internal communication and general dissemination					
Participant number	1	2	3	4	5	6
Short name of participant	GBA	NERC	ICGC	HGI-CGS	CGS	BRGM
Person months per participant	4,5	1,56	2	3	0,5	0,25
Participant number	7	8	9	10	11	12
Short name of participant	GSI	RBINS-GSB	GeoZS	IGME	SGU	TNO
Person months per participant	0,25	1	0,5	2	1	0,5
Participant number	13	14	15	16		
Short name of participant	PIG-PIB	SGIDS	GEOINFORM	GEUS		
Person months per participant	2	0,5	0,25	2		
Start month	1			End month	36	

Objectives
Work package WP1 aims at the following objectives:

- Ensure a smooth internal communication, project implementation and reporting to the programme management
- Support a continuous information flow and workflow inside MUSE
- Establish efficient decision-making and project control measures
- Implement quality control measures
- Disseminate the project and its outcomes to scientific and professional experts, local and national government, as well as the general public.

Description of work
WP1 covers the following main tasks:

<u>Task 1.1 Internal coordination and communication (GBA)</u>
At the beginning of MUSE, a project implementation plan (PIP) including a detailed work plan as well as a detailed communication and dissemination plan (D&E) will be established. The initial PIP will be updated during regular teleconferences (1 to 2 month frequency) and meetings of the Project Assembly. Task 1.1 also includes internal communication tools in terms of document exchange servers, web-conference rooms and e-mail lists related to the work packages.

Task 1.2 Project control and reporting to the programme management (GBA)

A Project Office (PO) consisting of the project- and the financial manager, located at the Project Lead will be set-up at the beginning of MUSE. The PO will take the role of the "Monitoring and Reporting Officer" of MUSE and act as an interface between the project team and the GeoERA coordination. It will organise the periodic thematic and financial reporting to the programme. The partners contribute by preparing their related reports. The project office also collects requests and proposals on changes to the PIP, which need to be discussed and may lead to decisions at the Project Assembly meetings. Furthermore, the PO will manage internal quality control and financial controlling measures of the project implementation.

Task 1.3 External quality control (GBA)

The Project Board organises an External Evaluation and Advisory (EEAB) board, which will meet in up to three physical EEAB meetings associated with regular meetings of the Project Assembly. The EEAB members give a written statement on the project implementation including recommendations after each meeting, which will be commented on by the Project Board. The summary reports will be delivered to the GeoERA programme.

Task 1.4 General dissemination (HGI-CGS)

The activities listed in general dissemination include the set-up of a project logo, project leaflet and the set-up and updating of the main project website. General dissemination also includes the presentation of the project at relevant events, general networking activities as well as the participation at, and optionally co-hosting of, targeted events. Furthermore, a joint cumulative research paper will be published in a special issue on "Application of shallow geothermal energy use in European urban areas" in an internationally-recognised journal. The project team members contribute to this publication by extended abstracts on their focused research topic(s) within MUSE. The overall editorial coordination will be realised by the Communication Manager with support of the communication team.

Deliverables

- **D 1.1 Initial and updated Project Implementation Plans (3 reports)**: The initial version will be developed within the first 3 months of MUSE and afterwards updated during regular web conferences and periodical meetings.

- **D 1.2 Summary reports on the outcomes of the External Evaluation and Advisory Board meetings (3 reports)**: The summary reports will include the written statements of the EEAB members and related comments by the Project Board.

- **D 1.3 Project leaflet (1 leaflet in English language)**: The project leaflet gives general information on the project objectives and its proposed outputs. A digital copy will be available on the project general website.

- **D 1.4 Project presentations at scientific and targeted events (>5 oral or poster presentations)**: The project team will present MUSE at different scientific conferences and other external events, including the World Geothermal Congress 2020, organised by IGA.

- **D 1.5 Cumulative research article published in a special journal issue on "shallow geothermal application in European urban areas" (1 cumulative research paper issue)**: The cumulative paper hosts several short articles contributed by the project partners on different research topics within MUSE and will be submitted within the project life-span.

Work package number	2	Lead beneficiary				GBA
Work package title	Technical aspects of shallow geothermal energy use in urban areas					
Participant number	1	2	3	4	8	9	10
Short name of participant	GBA	NERC	IGCG	HGI-CGS	RBINS-GSB	GeoZS	IGME
Person months per participant	5	2,23	4,2	3	2	0,5	6
Participant number	11	12	13	14	15	16	
Short name of participant	SGU	TNO	PIG-PIB	SGIDS	GEOINFORM	GEUS	
Person months per participant	3	1	3,4	1	0,35	4	
Start month	1			End month	30		

Objectives

WP2 addresses all technical aspects associated with shallow geothermal energy (SGE) use. This includes exploration techniques for the shallow subsurface, mapping of resources and possible conflicts of use, geoscientific modelling and monitoring of use. It also covers innovative technical solutions (good practices) as well as bad practices.

The main objectives of WP2 are identifying, harmonising and compiling state-of-the-art methods and workflows for:

- Assessing resources for SGE use in urban areas for open- and closed-loop systems.
- Assessing conflicts of use associated with SGE use in urban areas for open- and closed-loop systems.
- Cost-efficient exploration tools including Thermal Response Test (TRT measurements).
- Best adapted methodologies for operational monitoring of the performance of SGE installations, and passive monitoring of the environmental impact in different geological settings.

Furthermore, WP2 aims include:

- Identifying proven and promising concepts based on SGE use for heating and cooling supply and seasonal storage (e.g. low temperature grid or high temperature storage).
- Identifying risks and possible hazards due to inappropriate technical concepts and operation.
- Contribute to the build-up of a GeoERA knowledge infrastructure.

Description of work

Work package WP2 intends to provide the technical foundation for implementation activities in the selected urban pilot areas (WP4) and developing strategies and concepts of management (WP3). For that purpose we consider the following tasks:

<u>Task 2.1: On-site exploration and monitoring techniques (TNO)</u>

Based on assessing the existing knowledge inside the project team and literature research, state-of-the-art techniques for exploring and monitoring the subsurface (solid rocks and groundwater bodies) in densely-settled urban areas will be evaluated and compiled. This includes innovative and low-cost geophysical exploration, groundwater monitoring, petrophysical measurements and Thermal Response

Tests (TRT). Task 2.1 also addresses benchmark strategies to make measurements comparable giving special emphasis to TRT measurements and groundwater monitoring.

Task 2.2: Assessment and mapping of resources (GBA)
Existing experience with resource assessment inside the project team and the scientific community will be gathered, evaluated and compiled. There is also a focus on the application of modelling techniques (geological, hydrological and thermal flow-models) to fill data gaps and investigate the dynamic interaction between SGE use and the subsurface. Furthermore, validation and calibration of geoscientific models by monitoring, as well as the mutual design of monitoring programs based on numerical process models, will be examined in this task. Remaining gaps in methods and workflows will be discussed within designated, topic-related working groups inside WP2 to achieve harmonised solutions.

Task 2.3: Assessment of possible conflicts of use, risks and environmental impact associated with SGE use (IGME)
This task will investigate negative interferences between SGE use and the subsurface environment focusing on the preservation of good conditions and avoiding hazards to shallow groundwater bodies below urban conglomerates. The planned activities will consider hydraulic, thermal, chemical and microbiological conditions of shallow groundwater bodies. Furthermore, technical risks and non-efficient or non-sustainable concepts (bad practices) will be identified and characterised. Task 2.3 also addresses topics like competitive subsurface use (subsurface spatial planning) and critical geological settings like fault zones, karstified environments or swellable rocks.

Task 2.4: Identification and characterisation of proven and prospective technical solutions for SGE based heating and cooling supply including seasonal heat storage (ICGC)
Innovative and prospective technical solutions will be assessed and characterised by means of joint evaluation criteria. The assessment itself will be based on internal surveys within the project team, the activities in the selected pilot areas (WP4), communication with external stakeholders (WP5) and on general web and literature research. Operators of identified technical solutions will be contacted and interviewed. In the final stage of this task, a good practice workshop participated in by operators is proposed.

Task 2.5: Proof of concepts and elaboration of guidelines and catalogues (GBA)
In the framework of at least two interdisciplinary workshops, jointly organised together with the other technical work packages inside MUSE, the actual outcomes of tasks 2.1 to 2.4 will be discussed and concluded. In the first step, a preliminary catalogue of methods and workflows concerning the technical aspects of managing SGE use in urban areas will be compiled. Based on the feedback from testing and implementing the proposed methods in the pilot areas (WP4), all proposed concepts will be reviewed and compiled to a final version for dissemination. This task will also cover the preparation of the deliverables D.2.1 and D.2.2.

Deliverables

- **D 2.1 Catalogue of evaluated methods and guidelines on exploration, assessment and technical monitoring of shallow geothermal energy use in urban regions (1 report)**: The catalogue summarises harmonised concepts based on joint quality criteria and minimum standards. This includes workflows for exploration, data-processing, mapping and geoscientific modelling as well as validation measures related to resources of closed- and open-loop systems. It also covers recommendations on efficient and low impact thermal use of the subsurface and how to deal with possible technical and environmental risks. The catalogue will also include a “lessons learned” chapter from the experiences gained in the pilot areas.

- **D 2.2 Catalogue of factsheets of evaluated and characterised SGE concepts of use in urban areas (1 report)**: The identified technologies will be categorised into good existing practice, proven concepts, future concepts and bad practice. The catalogue will cover concepts of open- and closed loop systems as well as Underground Thermal Energy Storage (UTES). For overview purposes, the catalogue will give an overall comparison of specific installation costs (e.g. EUR/MW installed capacity) for shallow geothermal systems in the pilot areas.

Work package number	**3**	**Lead beneficiary**			**IGME**	
Work package title	Management strategies and action plans for a sustainable and efficient use of shallow geothermal energy					
Participant number	1	2	4	5	7	8
Short name of participant	GBA	NERC	HGI-CGS	CGS	GSI	RBINS-GSB
Person months per participant	2	1.4	2	1	0,25	0.5
Participant number	9	10	11	13	14	15
Short name of participant	GeoZS	IGME	SGU	PIG-PIB	SGIDS	GEO-INFORM
Person months per participant	0.5	8	0.5	3,6	0,5	0.45
Participant number	16					
Short name of participant	GEUS					
Person months per participant	0.5					
Start month	1			End month	32	

Objectives

WP3 is addressing administrative and political aspects of SGE use in European urban areas. In close collaboration with WP2 (technical aspects of SGE use), WP4 (testing and implementation in the pilot areas) and WP5 (targeted communication), it aims at:

- Evaluating currently-existing regulation measures for SGE in Europe with focus on the addressed pilot areas.
- Proposing scientific-based guidelines for managing SGE use in specific geo-environments of urban areas.
- Providing a sound basis for tailored management strategies including the whole regulation circle (planning – licensing – monitoring – adapted planning)
- Proposing specific measures and actions for integrating SGE use into urban energy supply and climate as well as environmental protection action plans (e.g. SEAPs).

Description of work

WP3 addresses policy and regulatory instruments dealing with the management of SGE in urban areas. It considers the whole process chain from a geoscientific point of view starting at the legal framework and procedures, policies to guidelines and strategies and specific actions for an efficient management of SGE. WP3 consists of four main tasks:

Task 3.1 Current legal status, procedures and policies dealing with SGE use (PIG-PIB):

In a first step, we assess the current legal framework, procedures and policies in the pilot areas as well as on the EU level through an internal partner survey. This survey also addresses the role of national geological surveys in the management process. Previous compilations of the legal framework for shallow geothermal use in different member states (e.g. projects ReGeoCities, GRETA and

GeoPLASMA-CE) will be included in the assessment. In a second step, we apply an evaluation scheme, adapted from the above-mentioned previous projects, to compare the background in the participating countries. This then leads to an analysis of deficiencies and good practices.

Task 3.2 Joint criteria for managing efficient and low impact SGE use in urban areas (IGME):
Based on the outcomes of task 3.1 as well as based on additional surveys within MUSE and other relevant GeoERA projects (supported by WP6), we develop joint criteria for the key points of the full management circle on SGE use (assessment of potentials/conflicts – planning of use – licensing – monitoring – update of planning). The criteria will refer to aspects like thermal impact on the subsurface, cumulative effects of competing SGE uses, prevention of technical risks and failures, technical quality standards, efficiency indicators and prioritisation of use. The joint criteria will be discussed and finalised during a joint workshop of all thematic work packages and a knowledge exchange workshop for integrating other relevant GeoERA project teams.

Task 3.3 Integrating SGE into European urban heating and cooling strategies and action plans (GBA):
In a first step, the project team assesses and lists suitable instruments for including SGE use in existing or future strategies and action plan of European cities. The related topics may cover enforcement of renewables, energy supply, climate change- and emission mitigation measures as well as environmental protection or energy independency. Based on the input of the project team gathered through internal surveys and web-based workshops, we define corner stones for preparing tailored strategies for the use of SGE in cities, which are later compiled into a general guideline. Starting at general goals associated with the use of SGE, the guideline will cover specific targets based on quantified benchmarks (e.g. installed capacities or environmental indicators) at a defined time scale and a roadmap of specific actions to be taken to reach them. The draft version of this guideline will be discussed in the above-mentioned joint workshops and will afterwards define the starting point of the targeted communication and interaction with external stakeholders in the pilots (WP5).

Task 3.4 Proof of concept and finalisation of guidelines for the integration of SGE (IGME):
The feedback on applying the draft guideline from the project partners in the pilot areas (WP4) will be analysed during a second joint workshop covering all thematic work packages of MUSE. The joint analysis covers aspects like lessons learned from stakeholder interaction, impact achieved in the pilots, or comparability of developed strategies and actions. Based on the outputs of this workshop, a revised final version of the guidelines on integrating SGE into European heating and cooling strategies will be developed.

Deliverables

- **D 3.1 Report on the current legal framework, procedures and policies on SGE use in selected European cities (1 report)**: The report will showcase and compare regulation and incentive measures for SGE use in the investigated European cities. It will highlight existing gaps, deficiencies as well as good practices, and will give proposals in regard to resource ownership, licensing systems (e-government) as well as simplified regulations and administrative procedures.

- **D 3.2 Guideline for integrating and managing the use of SGE in urban areas (1 report)**: This document addresses decision-makers, planners and management authorities in cities, and lists and describes sound concepts for integrating and managing the use of SGE from a joint geoscientific expert view. The guidelines will show criteria and indicators of efficient and sustainable use, and offer concepts to include SGE in energy planning and environmental as well as climate protection actions in cities. It will provide a template for developing general strategies and to derive specific actions, summarised in a roadmap. It addresses both, Geological Survey Organisations (consulting) and local stakeholders (realisation of strategies). It will also showcase the strategies developed in selected pilot areas of MUSE.

Work package number	**4**	**Lead beneficiary**			**ICGC**	
Work package title	Testing and implementation of developed methods and workflows in urban pilot areas across Europe					
Participant number	1	2	3	4	5	7
Short name of participant	GBA	NERC	ICGC	HGI-CGS	CGS	GSI
Person months per participant	4	7,93	8,6	4	1	4
Participant number	8	9	10	11	12	13
Short name of participant	RBINS-GSB	GeoZS	IGME	SGU	TNO	PIG-PIB
Person months per participant	5	2,5	4	3	4	4,2
Participant number	14	16				
Short name of participant	SGIDS	GEUS				
Person months per participant	1	3				
Start month	1			End month	34	

Objectives

The overall goal of WP4 is to support a common deployment framework in terms of:

- Evaluation of methods for site prospecting (e.g. geophysical) and site monitoring workflows including state-of-the-art tools in real urban cases.
- Testing and implementing developed joint methods of assessment and mapping shallow geothermal energy (SGE) resources (derived from WP2) in specific urban pilot areas and case studies for open- and closed-loop systems. It will assess scientific methodologies and workflows in order to allow comparison of different kinds of parameters as a function of data availability.
- Testing and implementing developed joint methods for assessing conflicts of use associated with SGE (derived from WP2) in specific urban pilot areas and case studies for open- and closed-loop systems.
- Assessment and evaluation of existing regulation measures and application of the developed methods and management concepts (derived from WP3) for SGE in specific urban pilot areas and case studies for open- and closed-loop systems.
- Producing documented spatial output datasets in the pilot areas for the web-based GeoERA Information Platform (cooperation with WP5): The outputs are represented by maps for SGE resource quantification, thermal conductivity/ground temperature distribution, location of existing installations.
- Providing a feedback on the applicability of methods and workflows to the work packages WP2 and WP3.

Description of work
WP4 addresses the testing and validating of the concepts and workflows developed in WP2 and WP3 in different relevant urban pilot areas across Europe. The pilots are located in different geographical, climatological, geological and socio-economic (SGE market) environments, and have different requirements and interests. The selected pilots cover different aspects of MUSE and can represent models for other European regions to emulate.

Task 4.1 Coordination of work and establishing interfaces to the other work packages (ICGC).
The coordination of the activities between the participants of WP4 and between the other work packages interacting with WP4 is organised by regular web conferences and two partner workshops. The first joint workshop (milestone M4) will focus on the implementation of the preliminary catalogue of methods, workflows and management guidelines (output of the work packages WP2 and WP3) in the pilot areas. Furthermore it organises cooperation between partners with respect to joint or similar field surveys in the pilots.
The second joint workshop at the terminal phase of WP4 (milestone M7), intends to provide feedback to the work packages WP2 and WP3 on the applicability and lessons learned from applying the proposed workflows and concepts. Furthermore, it organises the delivery of achieved thematic outputs in the pilot areas to the GeoERA Information Platform (WP5).
In between the workshops, thematic and operational coordination will be ensured by ad-hoc surveys among the participants of WP4 and periodic web conferences. The activities also include knowledge exchanges between pilot areas for implementing process-modelling concepts and for modelling support (co-lead by IGME).

Task 4.2 Pilot case study urban area of Ljubljana city, Slovenia (GeoZS)
The pilot case study covers areas inside the city in which conflicts between open loop systems and groundwater drinking wells may be expected in the future. The aim of the pilot area is to analyse potential hazards and interferences, and to integrate these aspects into strategies and actions for integrated groundwater management.

Task 4.3 Pilot case study urban area of Linköping city, Sweden (SGU)
The intention of the pilot is to evaluate the pre-investigations with respect to the composition of the bedrock mass and groundwater conditions. Existing well and thermal data will be available for the GeoERA project, as well as the possibility to perform additional measurements and tests in the existing wells. The geological survey is today working on compiling maps of the thermal properties of the bedrock, based on models of modal composition of rocks and TCS measurements, as well as collecting TRT and DTR data from SGE systems. The Linköping pilot will give an opportunity to further evaluate these data, as well as testing the relevance and relationship between different types of datasets. The operator has committed to let us use the data involving the properties necessary for the modelling and to be a stakeholder contact.

Task 4.4. Pilot case study urban area of Zaragoza city, Spain (IGME)
Situated in the central part of the Ebro valley in the city of Zaragoza, NE Spain, the pilot case study acts as an exemplar for urban areas in a relatively warm climate. In this area, an urban unconfined aquifer exists with different water extractions uses: water supply, recreational use and open-loop heat pump systems. The work focus is set on the assessment of SGE resources and possible conflicts of use, on groundwater monitoring and on the development of tailored management strategies.

Task 4.5 Pilot case study urban area of Zagreb city, Croatia (HGI-CGS)
The pilot case study will include continuous monitoring of groundwater levels and temperatures in two open-loop heat pump systems in Zagreb, which are abstracting and re-injecting the water from/into the shallow gravelly alluvial aquifer used for public water supply. The systems differ significantly in their size, so a comparison of their effects on the subsurface will be conducted.

Task 4.6 Pilot case study urban area of Aarhus city, Denmark (GEUS)
Situated in the municipal area of Aarhus, the aim of the pilot case study is to investigate the possibilities of integrating SGE and energy storage in a mature central heating system. A catalogue of relevant SGE technologies prepared in WP2 will feed into a current update of the heating plans for Aarhus. Further

on, the work will focus on the local possibilities of energy storage, mapping of potential sites for storage and extraction of heat; mapping potential conflicts; prioritising possible sites in relation to expected yield and proximity to the existing grid; and the integration of the results into the local energy plans.

Task 4.7 Pilot case study urban area of Girona city, Catalonia - NE Spain (ICGC)
Covering the urban area of Girona city, this pilot case study acts as a model for urban areas of a poorly-developed SGE market. Until now, only a few closed-loop systems exist. The activities will focus on data collection, ground characterisation, 3D modelling and mapping of SGE resources. It is planned to monitor groundwater levels and the ground thermal regime, and to perform additional TRT measurements. These data will be used for developing future strategies and action plans for managing SGE in a developing market.

Task 4.8 Pilot case study urban area of Prague city, Czech Republic (CGS)
The pilot case study is situated in the urban area of the city of Prague. The aim is to investigate and evaluate existing SGE use, including examples of existing good and bad practices related to SGE use. Special attention will be paid to subsurface use conflicts. Based on the screening of the current legal framework in WP3, further activities in Prague will focus on the development of general management strategies and specific actions in cooperation with the city administration.

Task 4.9 Pilot case study urban area of Vienna city, Austria (GBA)
The urban area of Vienna in the area south of the river Danube is the pilot case study area that acts as an exemplar for a well-developed market related to SGE use. The planned activities will focus on the assessment of SGE resources and possible conflicts of use due to overexploitation. Emphasis will be put on ensuring an efficient and sustainable shallow geothermal management in a prominent shallow aquifer, and on future strategies to include SGE into public heating and cooling grids. It will also address the validation of geo-scientific models for both open- and closed-loop systems. This will be realised by groundwater temperature monitoring and TRT measurements.

Task 4.10 Pilot case study urban areas of Cardiff and Glasgow cities, UK) (NERC)
The pilot case studies in the UK cover the areas of Cardiff city (Wales) and Glasgow city (Scotland). Both pilot areas are mainly focused on open-loop systems, but are quite different. Cardiff is accessing the shallow gravel aquifer that underlies the city, whereas the Glasgow pilot area is exploiting a network of abandoned coal mines for seasonal cavern thermal energy storage (CTES). The planned activities will focus on monitoring and subsurface process modelling (thermal and hydraulic impact on groundwater bodies) and storage efficiency of the CTES test site in Glasgow with regard to mine–groundwater interaction. Finally, groundwater monitoring data (temperature, hydraulic head), as well as additional surveys on the thermal rock and soil parameters (e.g. TRT measurements), will calibrate and evaluate the achieved process models.

Task 4.11 Pilot case study urban area of Bratislava city, Slovakia (SGIDS)
The pilot case study is situated in the urban area of Bratislava, in the southwest of the Slovak Republic. The activities will focus on the monitoring of thermal, hydraulic and chemical regime of shallow aquifers. The partner will use the results to evaluate possible conflicts of use between drinking water supply and SGE use.

Task 4.12 Pilot case study urban area of Cork city, Ireland (GSI)
The pilot case study is situated in the city of Cork, in south-west Ireland. There are established open loop systems (heating and cooling) in a glacio-fluvial sand and gravel aquifer next to the River Lee. In MUSE, the partner will use an existing geological 3D framework model for characterising the shallow subsurface below the city of Cork. The partner will also integrate data on existing SGE use and subsurface and groundwater properties from a local stakeholder. In a last step, resource and conflict maps will be created, which will act as a basis for future planning and management of SGE use.

Task 4.13 Pilot case study urban area of Brussels city, Belgium (GSB-RBINS)
This pilot area will act as an exemplar for exploring the shallow subsurface in an urban environment. In cooperation with partner #12 (TNO), different exploration methods like passive seismic monitoring (geological build-up), thermal diffusivity and thermal conductivity scanning on rock samples, TRT

measurements and groundwater surveys will be used for characterising the shallow subsurface below Brussels with regard to SGE use. The achieved underground model will finally be used for generating resource maps.

<u>Task 4.14. Pilot case study: Urban areas of Warsaw city, Poland</u> (PIG -PIB)
Thematic focus and objectives in this area will include a preparation of a GIS database, gathering of borehole data, geophysical investigations in areas not well covered with archival boreholes. As an effect a 2D/3D model for pilot area will be developed and calibrated with the use of archival TRT results and additional TRT measurements performed in MUSE. The achieved model will be used to create geothermal potential maps (scale 1:10 000) at depths 30, 70, 100 and 130 m below surface for thermal conductivity and specific heat transfer rate. As a last step, a spatial layer of environmental conflicts and hazards will be prepared. All output datasets will be shown at the IP.

Deliverables

- **D 4.1. Fact sheets on the pilot areas including the main findings of MUSE (13 fact sheets)**: The fact sheets are intended to give an overview of (1) the current situation on SGE use, (2) the outline of relevant constraints and impacts of SGE use and (3) a summary of the activities and results achieved. The fact sheets represent living documents updated during the project implementation and will be published on the project website.

- **D 4.2. Summary report about the outcomes in the pilot areas (1 report)**: The summary report covers the activities undertaken in all pilot areas as well as the results achieved. It also contains comparative conclusions and lessons learned on the testing and implementation of methods and workflows developed in work packages WP2 and WP3. Individual reports on the pilot areas addressed in MUSE, prepared by the task leaders, will be included as annexes to the summary report.

- **D.4.3 Documented thematic output datasets for web presentation of selected pilot area**: The thematic output datasets represent spatial datasets (GIS based vector- and raster datasets as well as 3D datasets), which will be compiled by the task leaders and transferred to WP5 for later web hosting. All datasets produced will be accompanied by annotation reports, which will also be published on the GIP related web platform.

Work package number	5	Lead beneficiary		GEUS	
Work package title	Information systems, targeted communication and stakeholder interaction				
Participant number	1	2	3	4	5	7
Short name of participant	GBA	NERC	ICGC	HGI-CGS	CGS	GSI
Person months per participant	6	2,23	1,8	4	0,5	0,5
Participant number	8	9	10	11	13	14
Short name of participant	RBINS- GSB	GeoZS	IGME	SGU	PIG-PIB	SGIDS
Person months per participant	7	0,5	1,19	1	4,4	0,5
Participant number	15	16				
Short name of participant	GEOINFORM	GEUS				
Person months per participant	0,66	6,5				
Start month	1			End month	36	

Objectives

WP5 supports targeted communication with external stakeholders in the pilot areas and the specific dissemination of the project outputs at the GeoERA Information Platform (GIP). It therefore aims to:

- Design and test an end-user oriented display interface for local authorities and other stakeholders (web information systems within the EGDI framework) for presenting the thematic outcomes from pilot areas.
- Deploy publically-accessible web-tools for displaying on the GIP the spatial datasets from the pilot areas.
- Support the build-up of a knowledge-base at GeoERA (e.g. "GeoERA project vocabularies")
- Integrate local stakeholders in the pilot areas into the development and implementation process of tailored strategies to manage SGE in urban conglomerates across Europe. To maximise capitalisation of the results, political and administrative stakeholders in the pilot areas will be integrated into the project from the beginning to communicate specific needs and provide data, knowledge and feedback.
- Transfer the project outcomes to local stakeholders for developing specific actions in the pilot areas by targeted consultation, workshops and trainings. By doing so, we want to disseminate the project results about opportunities and possible conflicts associated with SGE use in European urban areas.

Description of work

Work package WP5 contains the following four main tasks addressing the development of web-based data presentation and targeted communication with external stakeholders in the pilot areas:

Task 5.1 Screening of requirements on a web information system (GBA)

At the beginning of this task, the specific requirements for the project team on functionalities and data formats to be displayed at the GeoERA Information Platform will be assessed and evaluated in cooperation with GIP team during a workshop. In addition, pre-existing concepts and accessible prototypes of previous international projects like GeoPLASMA-CE will be included in the screening. The planned assessments also include a thorough analysis of SGE-related semantic differences and required data attributes.

Task 5.2 Design and testing of web-tools related to SGE (GEUS)
This task is covers the design of the new web functionalities identified in task 5.1, as well as testing of both new and existing web functionalities using either topic related synthetic datasets or already available project output datasets. The work will again be carried out in collaboration with the GeoERA IP team through feedback loops until a proven beta-version of the web platform has been achieved.

Task 5.3 Data and knowledge implementation at the information platform (RBINS-GSB)
In a first step, a guideline on data transfer from the pilot areas (WP4) to the GeoERA Information Platform will be developed in collaboration with the GIP team and communicated to the project team at a joint workshop. During this workshop, a "project Data Management Plan" (DMP) and delivery plan (topics, formats, metadata documentation and delivery date) will be defined in a collaboration between the WP4 and WP5 team. The DMP will describe how the data produced by MUSE will be FAIR: findable, accessible, interoperable and reusable. In a second stage of this task, the output datasets produced in the individual pilots will be collected from a joint WP4–WP5 data "inbox", checked for conformity and implemented to the GeoERA Information Platform based on the delivery plan. At end of the project, data will be available on the GeoERA Information Platform to ensure future use and possible inclusion of data sets from other urban areas in Europe at a later stage. This task also organises the delivery of information and outputs of the work package WP2 and WP3 to the joint GeoERA knowledge infrastructure. In cooperation with the GIP team, the thematic and technical interfaces between MUSE and the joint knowledge infrastructure will be designed. The WP5 core working team will then instruct the partners working in WP2 and WP3 in delivering to the knowledge infrastructure.

Task 5.4 Targeted communication to local stakeholders in the pilot areas (GBA)
In this task, the focus is on the administrative and political aspects of SGE management and not so much on technical issues. In the beginning, a targeted communication strategy will be developed by the core team of WP5. Then, the partners responsible for the pilot areas identify and contact relevant stakeholders for inclusion in the project implementation. The first stage of task 5.4 focusses on stakeholder workshops, consultations and interviews putting emphasis on joint SWOT analyses related to SGE use in urban areas. In the second stage, joint concepts for implementing the outcomes of MUSE in energy supply and environmental protection strategies and action plans (e.g. SEAPs) will be developed in collaboration with the local stakeholders through feedback workshops. Finally, the partners responsible for pilot areas provide targeted training for local users on the project outcomes in the pilots also including the web platform provided by GIP.

Deliverables

- **D 5.1 White Book of the web platform related to MUSE (1 report)**: The White Book contains the specification of output data formats, required SGE data types and attributes, expected semantics and the description of required functionalities related to the display on the GIP.

- **D 5.2 Data Management Plan for MUSE (1 report):** The DMP will define the FAIR use of the data produce by MUSE. Therefore it will contains and resume the type of data, their origin, size, versioning, accessibility, interoperability, …, as well as backup and maintenance procedures. A first version of the DMP will be realised within the first 6 month of the project and updated over the course of MUSE.

- **D 5.3 Guideline on the delivery of geodata and knowledge related to SGE to the GeoERA Information Platform (1 report)**: The guideline includes all requirements, including metadata documentation and INSPIRE conformity, for transferring geodata related to SGE use to the GIP. It will be published to assist future SGE use in urban areas outside MUSE.

- **D 5.4. Guideline on the use of the SGE web platform tools at the Information Platform (1 report)**: The guideline describes all functionalities of the SGE web platform developed in

GeoERA. It will be used in the end-user training and published for future application in urban areas outside MUSE.

- **D 5.5 Publically-accessible web platform inside the GIP on SGE use (1 web platform)**: The web platform will display the thematic output datasets of 14 pilot areas, which act as examplars for a future expansion to other urban areas in Europe.

- **D.5.5 Contributions to the joint GeoERA knowledge infrastructure (1 tool)**: The methods, workflows and concepts, developed in WP2 and WP3 will be linked to the joint GeoERA knowledge infrastructure (e.g. project vocabulary).

- **D 5.6 Guideline on targeted communication to stakeholders on shallow geothermal use in urban areas (1 report)**: The strategy acts as a guideline for targeted stakeholder communication and training by the project team in the pilot areas. It will be connected to deliverable D.3.2 (Guideline for integrating and managing the use of SGE in urban areas) and be tested in the pilots. It will include concepts and templates for stakeholder interviews, joint brainstorming activities (e.g. performing SWOT analyses) and knowledge transfer activities. The final version of the strategy, tested in the pilot areas of MUSE, will be published for enabling transfer of knowledge to other urban areas in Europe.

Work package number	**6**	**Lead beneficiary**		**HGI-CGS**	
Work package title	Cross-cutting issues and capitalising on knowledge inside GeoERA					
Participant number	1	2	3	4	6	9
Short name of participant	GBA	NERC	ICGC	HGI-CGS	BRGM	GeoZS
Person months per participant	2	0,45	1,5	4	3,75	1,5
Participant number	10	11	13	14	15	16
Short name of participant	IGME	SGU	PIG-PIB	SGIDS	GEOINFORM	GEUS
Person months per participant	0,19	0,5	2,4	2,5	0,35	1
Start month	1			End month	33	

Objectives

As MUSE is addressing the energy use of the shallow subsurface in urban conglomerates, the project is interfacing with other projects under the umbrella of GeoERA dealing with the following research topics:

- Existing or possible conflicts in the shallow subsurface between water supply, heat supply and mineral resources extraction in urban areas with different geological settings.
- Methods and concepts for 3D subsurface spatial planning in urbanised areas.

WP6 therefore generally aims at leveraging synergies with other projects, and will:

- Establish an institutional interface to other projects in the Geo-Energy Specific Research Topics (SRTs) and GeoERA themes Groundwater and Mineral Resources.
- Exchange knowledge and harmonise methods and strategies in overlapping research topics.
- Co-organise joint events in pilot areas covered by several projects.

Description of work

Work package WP6 consists of two main tasks:

Task 6.1 Identification of relevant cross-cutting research topics and projects for capitalising synergies within the GeoERA programme (HGI-CGS)

In a first step, we will identify overlapping research topics with projects inside GeoERA. This will be reinforced during the joint GeoERA events through the support of the MUSE WP leaders. Based on this, direct communication channels will be established through periodic telephone conferences and e-mail communication. The WP6 team will also capitalise on direct linkages inside the project team and to other ongoing international project teams.

Task 6.2 Knowledge exchange and cross-project capitalisation activities (BRGM)

After establishing contacts and communication channels in task 6.1, we will focus on joint activities covering cross-cutting topics. Those activities are represented by Knowledge Exchange Workshops (KEW) organised by MUSE on the topics identified before and by joint communication activities to stakeholders, and joint surveys in pilot areas addressed by other projects inside GeoERA. The KEWs will also be open to be attended by international project teams outside of GeoERA.

Deliverables

- **D.6.1 Knowledge exchange workshops on cross cutting topics relevant for MUSE (at least 3 workshops)**: The Knowledge Exchange Workshops intend to establish defined outreach activities. All workshops will consist of a presentation and discussion / active group work session and will be documented by minutes and photo protocols.

- **D.6.2 Activity report on capitalising activities with other project teams inside GeoERA (1 report)**: The activity report will log and summarise all major activities also including minutes of trans-project telephone conferences and joint activities in overlapping pilot areas. It will be complemented by a conclusion on the achieved impact of MUSE and a *lessons learned* chapter.

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Table 3.1b List of work packages

Work package No.	Work Package Title	Lead Participant No.	Lead Participant Short Name	Person - Months	Start Month	End month
1	Project management, internal communication and general dissemination	1	GBA	21.8	1	36
2	Technical aspects of shallow geothermal energy use in urban areas	1	GBA	35.7	1	30
3	Management strategies and action plans for a sustainable and efficient use of shallow geothermal energy	10	IGME	21.2	1	32
4	Testing and implementation of developed methods and workflows in urban pilot areas across Europe	3	ICGC	56.2	1	34
5	Information systems, targeted communication and stakeholder interaction	16	GEUS	37.0	1	36
6	Cross-cutting issues and capitalising on knowledge inside GeoERA	4	HGI-CGS	20.1	1	33
				192.0		

Table 3.1c List of deliverables

Deliverable number	Deliverable name	Work package number	Short name of lead participant	Type	Dissemination level	Delivery date (in months)
D1.1	Initial and updated Project Implementation Plans	WP1	GBA	Report	CO	2
D.1.2	Summary reports on the outcomes of the External Evaluation and Advisory Board meetings	WP1	GBA	Report	CO	36
D.1.3	Project leaflet	WP1	HGI-CGS	Leaflet	PU	6
D.1.4	Project presentations at scientific and targeted events	WP1	HGI-CGS	Presen-tations, Poster	PU	36
D.1.5	Cumulative research article published in a special journal issue on "shallow geothermal application in European urban areas"	WP1	HGI-CGS	Article	PU	30
D.2.1	Catalogue of evaluated methods and guidelines on exploration, assessment and technical monitoring of shallow geothermal energy use in urban regions	WP2	GBA	Report	PU	30
D.2.2	Catalogue of factsheets of evaluated and characterised SGE concepts of use in urban areas	WP2	ICGC	Report	PU	28
D.3.1	Report on the current legal framework, procedures and policies on SGE use in selected European cities	WP3	PIG-PIB	Report	PU	18

D.3.2	Guideline for integrating and managing the use of SGE in urban areas	WP3	IGME	Report	PU	32
D.4.1	Fact sheets on the pilot areas including the main findings of MUSE	WP4	NERC	Fact sheet	PU	30
D.4.2	Summary report of the outcomes in the pilot areas	WP4	ICGC	Report	PU	34
D.4.3	Documented thematic output datasets for web presentation of selected pilot area	WP4	GBA	Dataset	PU	32
D.5.1	White Book of the web platform related to MUSE	WP5	GEUS	Report	PU	7
D.5.2	Data Management Plan for MUSE	WP5	RBINS-GSB	Report	PU	6 - 32
D.5.3	Guideline on the delivery of geodata and knowledge related to SGE to the GeoERA Information Platform	WP5	RBINS-GSB	Report	PU	9
D.5.4	Guideline on the use of the SGE web platform tools at the Information Platform	WP5	GEUS	Report	PU	27
D.5.5	Publically-accessible web platform inside the GIP on SGE use	WP5	RBINS-GSB	Web tool	PU	32
D.5.6	Contributions to the joint GeoERA knowledge infrastructure	WP5	RBINS-GSB	Web tool	PU	32
D.5.7	Guideline on targeted communication to stakeholders on shallow geothermal use in urban areas	WP5	GBA	Report	PU	8

D.6.1	Knowledge exchange workshops on cross cutting topics relevant for MUSE	WP6	BRGM	workshop	PU	32
D.6.2	Activity report on capitalising activities with other project teams inside GeoERA	WP6	HGI-CGS	Report	PU	33

Table 3.2a List of milestones

Milestone number	Milestone name	Related work package(s)	Due date (in months)	Means of verification
M1	Project kick-off	All WPs	1	WP leaders participate at joint GeoERA kick-off seminar
M2	Kick-off with Information Platform team	WP5, WP4	2	Joint workshop of WP5 and WP4 core working teams with GIP teams
M3	Project website online and general dissemination instruments available (e.g. joint layouts, project and consortium logo)	WP1	6	Initial version of project website including general information on project launched
M4	**Joint project workshop #1**: delivery of methods, workflows and guidelines for application in the pilot areas	All WPs	9	Project team members working in the addressed work packages attend the joint workshop
M5	Beta-version of the web platform ready to use	WP5	18	Beta version of web platform containing all aimed functionalities has been successfully tested
M6	Project midterm	All WPs	21	WP leaders participate at joint GeoERA midterm review seminar
M7	**Joint project workshop #2**: Data delivery and feedback loop on methods and workflows	All WPs	27	Project team members working in the addressed work packages attend the joint workshop
M8	Accomplishment of field measurements and elaboration of output datasets	WP4	29	All output datasets created in the pilot areas are ready for delivery to GIP
M9	Cumulative research paper submitted	WP1	30	All short articles by the partners to the joint special issue have been delivered to the journal
M10	Transfer of data form the pilot areas to the information platform	WP4, WP5	32	Data delivery (WP4) and conformity check (WP5) successfully accomplished for all output datasets of the pilot areas
M11	Stakeholder workshops and trainings in the urban pilot areas	WP5, WP4	35	All targeted communication activities in the pilot areas have been accomplished
M12	Operational project closure	All WPs	36	All project related operational activities accomplished
M13	Project closure (administration)	All WPs	39*	WP leaders participate at joint GeoERA closure seminar and final reports to GeoERA programme delivered.

*Post operational phase of MUSE

Table 3.2b List of critical risks for implementation

Description of risk (indicate level of likelihood: Low/Medium/High)	*Work package(s) involved*	*Proposed risk-mitigation measures*
Changes in the project consortium due to partner withdrawal Likelihood: low	All WPs	Adaption of the PIP (transfer of responsibility of the affected partner) based on a Project Assembly decision.
Changes of key staff members inside the project team Likelihood: low to medium	All WPs	The affected partner will try to replace the key staff member. If this is not possible, the project consortium decides to transfer the related responsibility among the consortium.
Delay in producing deliverables which feed into other work packages Likelihood: low to medium	All WPs	Regular monitoring of project implementation by the Project Board. Identification of sources of delay and definition of specific mitigation measures. If a delay is unavoidable, it will be communicated to the Project Assembly for approving the adapted work plan.
Insufficient number of research papers inside the MUSE team available for the planned special journal issue Likelihood: low to medium	WP1	All partners having a distinctive staff cost budget in WP1 will be encouraged to prepare papers. In case of insufficient number of articles from inside the project team, we will consider external contributions.
Limited or restricted access to external data protected by data privacy rules Likelihood: low to medium	WP4	Adapt location of pilot area and try to get in contact with data owners as soon as possible. Find freely accessible proxies for restricted data.
Denied access to field sites for measurements and monitoring activities inside the pilot areas Likelihood: low	WP4	Timely arrangement of permits or identification of comparable alternative field sites.
Datasets delivered for web presentation do not meet the joint standards Likelihood: medium	WP4, WP5	Partners preparing data to be displayed at the GIP will receive a guideline and a training early in the project. Data delivered, which do not meet the joint standards will be refused and returned to the responsible partner for amendments. The time table of MUSE considers sufficient time for data control and data amendments.

Planned technical solutions for web display (white book) cannot be realised in full during the implementation process Likelihood: low	WP5	The concept of the web presentation will be developed in agreement with specialists from the GIP team inside GeoERA. It will define minimum- (high realisation priority) and optimum functionalities (lower-ranked realisation priority). For minimum functionalities, simplified alternative solutions will be identified in case of realisation problems.
Limited interest and feedback from local stakeholders in the pilot areas Likelihood: low to medium	WP5	Local stakeholders have partly been addresses during the project preparation phase (see attached Expression of Interest letters). To avoid lack of interest or feedback from stakeholders, the partners are asked to perform preferably direct stakeholder interaction (personal interview or consultation) instead of E-Mail communication. Finally, the reasons for negative or reduced stakeholder feedback will be considered in the conclusions of deliverable D.5.6 dealing with stakeholder interaction.

Table 3.3a Summary of Staff Effort

	WP1	WP2	WP3	WP4	WP5	WP6	Total Person-Months per Participant
P1/GBA	4.5	5	2	4	6	2	**23.5**
P2/NERC	1.56	2.23	1.4	7.93	2.23	0.45	**15.8**
P3/ICGC	2	4.2		8.6	2	1.5	**18.3**
P4/HGI-CGS	3	3	2	4	4	4	**20**
P5/CGS	0.5		1	1	0.5		**3**
P6/BRGM	0.25					3.75	**4**
P7/GSI	0.25		0.25	4	0.5		**5**
P8/RBINS-GSB	1	2	0.5	5	7		**15.5**
P9/GeoZS	0.5	0.5	0.5	2.5	0.5	1.5	**6**
P10/IGME	2	6	8	4	1.19	0.19	**21.38**
P11/SGU	1	3	0.5	3	1	0.5	**9**
P12/TNO	0.5	1		4			**5.5**
P13/PIG-PIB	2	3.4	3.6	4.2	4.4	2.4	**20**
P14/SGIDS	0.5	1	0.5	1	0.5	2.5	**6**
P15/GEOINFORM	0.25	0.35	0.45		0.66	0.35	**2.06**
P16/GEUS	2	4	0.5	3	6.5	1	**17**
Total Person Months	**21.81**	**35.68**	**21.2**	**56.23**	**36.98**	**20.14**	**192.04**

Table 3.3b 'Other direct cost' items (travel, equipment, other goods and services)

P1/GBA	Cost (€)	Justification
Travel	5000	Participation of staff members except Gregor Goetzl at project related meetings and workshops. The travel costs of Gregor Goetzl are covered in kind outside of MUSE.
Equipment	0	
Other goods and services	2000	Reimbursement of travel costs for members of External Evaluation and Advisory Board outside the GeoERA consortium. Conference fees related to presentations given by Gregor Goetzl will be carried by GBA outside of MUSE.
Total	**7000**	

P2/NERC	Cost (€)	Justification
Travel	10164	Participation at project related workshops and meetings. Travel costs to pilot areas Cardiff and Glasgow.
Equipment		
Other goods and services		
Total	**10164**	

P3/ICGC	Cost (€)	Justification
Travel	13650	Participation at project related workshops and meetings. Travel costs to pilot area Girona. Project presentation at a conference
Equipment		
Other goods and services	200	Conference fee
Total	**13850**	

P4/HGI-CGS	Cost (€)	Justification
Travel	4300	Participation at project related workshops and meetings.
Equipment		
Other goods and services	500	Congress fees
Total	**4800**	

P5/CGS	Cost (€)	Justification
Travel	2000	Participation at project related workshops and meetings.
Equipment		
Other goods and services		
Total	**2000**	

P6/BRGM	Cost (€)	Justification
Travel	1200	Participation at project related workshops and meetings.
Equipment		
Other goods and services		
Total	**1200**	

P7/GSI	Cost (€)	Justification
Travel	3700	Participation at project related workshops and meetings. Travel costs to pilot area Cork.
Equipment	0	Thermal Response Tests possibly undertaken in selected boreholes. Costs absorbed by GSI as in-kind outside of MUSE.
Other goods and services		
Total	**3700**	

P8/RBINS-GSB	Cost (€)	Justification
Travel	6000	Participation at project related workshops and meetings.
Equipment	1500	Expendable items for performing laboratory and field measurements (e.g. TRT measurements).
Other goods and services	**2500**	In situ and laboratory analyses/tests for Brussels pilot area and others pilots areas. Hosting at least one meeting at Brussels
Total	**10000**	

P9/GeoZS	Cost (€)	Justification
Travel	3000	Participation at project related workshops and meetings.
Equipment		
Other goods and services		
Total	**3000**	

P10/IGME	Cost (€)	Justification
Travel	7000	Participation at project related workshops and meetings. Travel costs to pilot area Zaragoza. Travel costs for presenting MUSE at a conference.
Equipment	7000	Purchase of software license FEFLOW version 7.1 for performing coupled thermal-hydraulic transport modelling in the related pilot area and to provide modelling support for partners in other pilot areas.
Other goods and services		
Total	**14000**	

P11/SGU	Cost (€)	Justification
Travel	5000	Participation at project related workshops and meetings. Travel costs to pilot area Linköping.
Equipment		
Other goods and services		
Total	**5000**	

P12/TNO	Cost (€)	Justification
Travel	2000	Participation at project related workshops and meetings. Travel costs to pilot area Brussels.
Equipment	4000	Rental of seismic surveying equipment for activities in the pilot area Brussels.
Other goods and services		
Total	**6000**	

P13/PIG-PIB	Cost (€)	Justification
Travel	8000	Participation at project related workshops and meetings. Travel costs for presenting MUSE at a conference.
Equipment		
Other goods and services	500	Conference fee
Total	**8500**	

P14/SGIDS	Cost (€)	Justification
Travel	3000	Participation at project related workshops, meetings and field measurements.
Equipment		
Other goods and services		
Total	**3000**	

P15/GEOINFORM	Cost (€)	Justification
Travel	1480	Participation at project related workshops and meetings.
Equipment		
Other goods and services		
Total	**1480**	

P16/GEUS	Cost (€)	Justification
Travel	7200	Participation in project related workshops and meetings as PB member Travel costs to the pilot area Aarhus. Travel costs for presenting MUSE at two conferences.
Equipment		
Other goods and services	2800	Conference fees. Hosting a least one meeting in Aarhus or Copenhagen
Total	**10000**	

Table 3.3c Financial table with requested budget

Partici-pant	(A) Direct personnel costs (EUR)	(B) Other direct costs; travel, equipment, infrastructure, other (EUR)	(C) Direct costs of sub-contracting (EUR)	(D) Indirect costs (= (A + B) *0,25) (EUR)	(E) Total estimated eligible costs (=A+B+C+D) (EUR)	(F) Reimbursement Rate (29,7%) [1]	(G) Requested EU contribution (=E*F)	(H) Surveys in-kind contribution = (E – G)
P1/ GBA	122,410	7,000	0	32,353	161,763		48,042	113,721
P2/ NERC	87,787	10,164	0	24,488	122,439		36,363	86,076
P3/ ICGC	96,923	13,850	0	27,693	138,466		41,123	97,343
P4/ HGI-CGS	48,000	4,800	0	13,200	66,000		19,601	46,399
P5/ CGS	6,814	2,000	0	2,204	11,018		3,271	7,747
P6/ BRGM	23,924	1,200	0	6,281	31,405		9,326	22,079
P7/ GSI	27,900	3,700	0	7,900	39,500		11,731	27,769
P8/ RBINS-GSB	112,866	10,000	0	30,717	153,583		45,613	107,970
P9/ GeoZS	21,030	3,000	0	6,008	30,038		8,920	21,118
P10/ IGME	98,000	14,000	0	28,000	140,000		41,579	98,421
P11/ SGU	67,050	5,000	0	18,013	90,063		26,748	63,313
P12/ TNO	32,329	6,000	0	9,582	47,911		14,229	33,682
P13/ PIG-PIB	50,000	8,500	0	14,625	73,125		21,717	51,406
P14/ SGIDS	20,000	3,000	0	5,750	28,750		8,538	20,210
P15/ GEOINFORM	9,879	1,480	0	2,840	14,199		4,216	9,983
P16/ GEUS	122,000	10,000	0	33,000	165,000		49,005	115,995
SUM	**946,912**	**103,694**	**0**	**262,654**	**1,313,260**		**390,022**	**923,238**

[1] The EC Reimbursement rate for ERA-NETs is 33%. 10% of this Reimbursement rate is reserved for the Coordination Costs of GeoERA as agreed in the Grant Agreement. Therefore, the Reimbursement rate for GeoERA is these calculations results in 29,7%.

4 Members of the consortium

4.1 *Participants (applicants)*

4.1. Geologische Bundesanstalt (GBA)

<table>
<tr><td>Name of organisation</td><td colspan="3">Geologische Bundesanstalt (Project Lead)</td></tr>
<tr><td>Short name</td><td>GBA</td><td>Country</td><td>Austria</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">The Geological Survey of Austria is performing geoscientific research in Austria since the late 1070s. In 2004, Gregor Goetzl started to build up a geothermal research working team at GBA. Since then, GBA was involved and leading more than 20 national and international projects on shallow- and deep geothermal research topics. In the past 4 years, the research focus was set on managing shallow geothermal energy. GBA was involved in the set-up of the first interactive web based information system in Austria covering the state of Salzburg. GBA is also consulting the city administration of Vienna on managing strategies and resource maps associated to SGE use. The city of Vienna will be a pilot area of MUSE. Currently, GBA is involved in the international Interreg projects GRETA and GeoPLASMA-CE addressing shallow geothermal energy. In GeoPLASMA-CE (www.geoplasma-ce.eu), GBA is responsible for the overall project coordination.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">Project Lead (Gregor Goetzl)
Lead of WP1 and WP2
Lead of tasks 1.1, 1.2 1.3, 3.3, 4.9 (pilot area Vienna) and 5.1
Coordination of deliverables D.1.1, D.1.2, D.2.1, D.4.2 and D.5.6
Core teams of all WPs</td><td colspan="2">Coordinating international research projects
Resource assessment related to closed- and open loop systems
Groundwater monitoring
Process modelling (coupled thermal-hydraulic)
Thermal conductivity measurements and Thermal Response Test measurements
Management strategies on SGE use</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Gregor Goetzl, MSc (male)
Gregor Goetzl studies Geophysics at the University of Vienna and is working in geothermal topics since 2004. He participated at more than 20 national and international projects addressing shallow- and deep geothermal aspects. Gregor Goetzl is well experienced in coordinating research projects. Currently, he is coordinating the international Interreg Central Europe project GeoPLASMA-CE dealing with managing SGE use in central Europe. Gregor Goetzl will be the coordinator of MUSE.

Cornelia Steiner, MSc (female)
Cornelia Steiner studied Geology and Hydrogeology at the University of Salzburg and joined the geothermal working group at GBA in 2016. Since then, she has been supporting the consultation of the city administration of Vienna for managing SGE. As an expert for open loop systems, she was responsible for harmonizing workflows on open loop systems and performs the research activities in the Austrian pilot area in GeoPLASMA-CE. Cornelia Steiner will perform the research in the pilot area Vienna in MUSE.

Martin Fuchsluger, MSc (male)
Martin Fuchsluger studies Geophysics at the University of Vienna and joined the geothermal research team at GBA in 2011. Since then, he has become the expert on closed loop systems in the working group. In the past, he elaborated resource maps for the state of Salzburg and the city of Vienna. He is also responsible for performing Thermal Response Tests (TRT) at GBA. In MUSE, Martin Fuchsluger will support the set-up of joint methods and workflows related to closed loop systems and perform TRT- and thermal conductivity measurements.</td></tr>
</table>

Publications, infrastructure / technical equipment
Publications A. Casasso, B. Piga, R. Sethi, J. Prestor, S. Pestotnik, M. Bottig, **G. Goetzl**, P. Zambelli, V. D'Alonzo, R. Vaccaro, P. Capodaglio, M. Olmedo, A. Baietto, C. Maragna, F. Böttcher, K. Zoesseder; 2017; The GRETA project: the contribution of near-surface geothermal energy for the energetic self-sufficiency of Alpine regions; ACQUE SOTTERRANEE, Vol. 6/1; PagePress. **G. Goetzl**; 2017; Das Projekt GeoPLASMA-CE - neue Planungs- und Bewirtschaftungsansätze der oberflächennahen Geothermie in Österreich und Zentraleuropa; VÖBU Forum; Vol. 42, November 2017; Vereinigung Österreichischer Bohr-, Brunnenbau und Spezialtiefbauunternehmungen (VÖBU), Wien (German language). J. Goldbrunner & **G. Goetzl**; 2016; Geothermal Energy Use, Country Update for Austria; proceedings European Geothermal Congress 2016, Strasbourg, France, 19 -24 September 2016. **M. Fuchsluger**, A.K. Bruestle & **G. Goetzl**; 2015; Numerical simulation of Borehole Heat Exchanger Fields for long-term storage in combination with groundwater utilization in an artificially regulated aquifer for urban district planning; proceedings FEFLOW conference 2015; Berlin, Germany, 21 – 23 September 2015. **M. Fuchsluger** & **G. Goetzl**; 2014; Advantages of 3D FEM numerical modeling over 2D, analyzed in a case study of transient thermal-hydraulic groundwater utilization; Geophysical Research Abstracts Vol. 16, EGU2014-1403; EGU General Assembly 2014. **Infrastructure and technical equipment** • FEFLOW, Comsol Multiphysics: numerical process modelling • Thermal Response Test device (prototype, UIT Dresden): in situ measurements of the thermal conductivity in borehole heat exchangers • Multi probe groundwater temperature observation device (developed by GBA) • Data archives covering the pilot area Vienna: lithological borehole profiles, results of TRT measurements, time series of groundwater temperatures and elevation, licensed closed- and open loop systems in Vienna
Relevant projects/activities
• GeoPLASMA-CE (Interreg Central Europe, 2016 – 2019): managing SGE use in Central Europe, set-up of web based decision support systems • GRETA (Interreg Alpine Space. 2015 – 2018): Managing SGE use in Alpine regions • Degent-Net (FFG, Austria): low temperature heating and cooling grids in Vienna • WC-33 (City of Vienna, 2013 – 2017): Resource assessment in the city of Vienna and developing new management strategies on SGE use. • SC-27 (Government of Salzburg, 2015 – 2017): Elaboration of resource maps of closed- and open loop systems and consulting the set-up of a web based information system.

4.2. *Natural Environment Research Council (NERC/BGS)*

Name of organisation	**Natural Environment Research Council**		
Short name	NERC	**Country**	United Kingdom

Organisation profile

The BGS is a component institute of the Natural Environment Research Council (NERC) and the national geological survey of Great Britain and is a world-leading supplier of objective, authoritative and up-to-date geoscientific expertise and information supporting decision-making for government, commerce and the public. We hold the digital geological mapping information for the UK at scales of 1:1M, 1:250 000, 1: 50 000 and some areas at 1:10 000. The two primary layers are the superficial and bedrock geology. In addition we also hold information on the depth to bedrock, the parent material of the soil layers and the depth to groundwater. The BGS is engaged in research to provide accurate site specific information for the design of ground source collector loops. Through the GeoReport service we provide site specific assessments of the suitability of a site for closed or open loop GSHP. In 2010 BGS were a partner of the ThermoMap consortium that won funding from the EU ICT-PSP programme to investigate the regional shallow geothermal potential in Europe. In 2012 BGS were co-funded by the Environment Agency to develop a web tool for open loop GSHP suitability in England and Wales (http://mapapps2.bgs.ac.uk/gshpnational/home.html). Sustainability and incorporation of GSHPs into urban heat networks is actively researched through modelling and monitoring of installed systems.

Roles / tasks in the project	**Special relevant skills**
• Task lead 4.10: pilot areas Cardiff and Glasgow • Coordination of deliverable D.4.1 • Core working group WP2, WP4 and WP5 • Contribution to all WPs	• Resource estimations • Thermal properties • Monitoring of SGE installations • UK regulations for SGE • Sustainability modelling

Short profile of staff member(s) who will be undertaking the work

Dr Jonathan Busby (male)

Jon Busby is a geophysicist with 35 years' experience of geophysical and geothermal projects. He is currently the BGS Team Leader for Renewables and Energy Storage and is actively involved in shallow and deep geothermal research. He led the BGS input to a European project to provide suitability maps for shallow geothermal ground collector systems and has worked extensively on UK heat flow and the temperature distribution within the shallow sub-surface. He has interests in providing quantitative information for the design of shallow geothermal ground collector loops. He has led a wide variety of projects from multinational research projects to commercial projects for a single client. He represents the UK on the International Energy Agency Geothermal Technical Cooperation Programme and advises the UK Department for Business, Energy and Industrial strategy on geothermal issues. He has published widely on geothermal in the peer reviewed scientific literature, technical publications and magazine articles. Jon will work with the thermal property, temperature and groundwater pumping data and input into the resource assessments tasks. He will contribute to the dissemination of the outputs within the scientific literature and to interested stakeholder groups.

Mr. David Boon (male)

David Boon has Masters of Science in Engineering Geology and 12 years' experience specialising in ground investigation and hazard and risk mapping for geo-engineering projects. He initiated the Cardiff Geothermal Observatory in 2014 and was Principal Investigator in a UK government Innovation project in 2015 that proved shallow groundwater as a sustainable heat source for low carbon district heating. He brings experience of environmental geology, subsurface investigation and geotechnical design, 3D mapping technologies, thermal/geotechncial properties characterisation. He will lead Task on WP 4 (pilots) and will act as liaison officer with City Authority (Cardiff City Council) and other NERC/BGS projects. He will take a lead role in financial and project management of the pilot task and project dissemination to UK government, industry, academia, and the wider stakeholder community. He has published on shallow geothermal and geohazards in the peer reviewed scientific literature, technical publications and magazine articles.

Dr. Corinna Abesser (female)
Corinna Abesser is a Numerical Modeller with over 20 years' experience in groundwater research projects focused on sustainable renewable energy. She was technical lead and manager of a project that developed an online decision support tool 'Mapping open-loop ground source heat pump (GSHP) potential' and participated in the development of a tool that maps GSHP suitability in England and Wales at the 1:250k scale. Co-funded by the Environment Agency, this work supported councils, planners and developers in identifying suitable locations for GSHP installation and/or in estimating renewable resources of a given area. She will provide technical expert input into the groundwater and heat flow modelling in WP4 and will attend techncial seminars and some project meetings. She will manage the installation and commissioning of the DTS fibre optic monitoring system. She will contribute to dissemination work package, through attendance at academic conferences, technical seminars and paper writing.

Mr. Gareth Farr (male)
Gareth Farr is a Chartered Geologist/Hydrogeologist (CGEOL) with over 12 years' experience of field based hydrogeology, regulation and research, primarily within Wales, UK. Gareth has a detailed understanding of environmental legislation and regulation of GSHP in the UK, groundwater protection and management, working for Environment Agency Wales (2002-2013). Gareth will bring his detailed knowledge of the groundwater licensing regime and the permitting regime for water abstraction and discharge for GWHP, both of which will be required for any large ground source heat investigation. He will also provide input into the dissemination work package, leading stakeholder visits (WP4), and attendance at academic conferences and paper writing. He has published on shallow geothermal and groundwater science in the peer reviewed scientific literature, technical publications and magazine articles and provides training in wetland monitoring and management for Water Industry professionals.

Publications, infrastructure / technical equipment

Farr, G.J., Patton, A.M., Boon, D.P., James, D.R., Williams, B., Schofield, D.I. 2017 Mapping shallow urban groundwater temperatures, a case study from Cardiff, UK. *Quarterly Journal of Engineering Geology and Hydrogeology*, **50** (2). 187-198. 10.1144/qjegh2016-058
Busby, J. 2016. Thermal conductivity and diffusivity estimations for shallow geothermal systems. *Quarterly Journal of Engineering Geology and Hydrogeology*, **49**, 138-146.
David Boon, Gareth Farr, Ashley Patton, Rhian Kendall, Laura James, Corinna Abesser, Jonathan Busby, David Schofield, Debbie White, Daren Gooddy, David James, Bernie Williams, David Tucker, Steve Knowles, Gareth Harcombe. 2016. The contribution of geology and groundwater studies to city-scale ground heat network strategies: A case study from Cardiff, UK. EGU General Assembly Conference Abstracts 18, 4983.
Abesser, C., Lewis, M. A., Marchant, A. P., Hulbert, A. G. 2014. Mapping suitability for open-loop ground source heat pump systems: a screening tool for England and Wales, UK. *Quarterly Journal of Engineering Geology and Hydrogeology*, **47**, 373-380.
Busby J P, Lewis M, Reeves H and Lawley R, 2009. Initial geological conditions before installing ground source heat pump systems. *Quarterly Journal of Engineering Geology and Hydrogeology*, v **42**, 295-306.

Infrastructure and Technical Equipment
The BGS, through its public sector partners, will arrange access to its urban pilot sites for field experiments (geophysical investigations). This includes access to boreholes /water well infrastructure for Thermal Response Tests (TRT). We may also have grouted Fibre Optic

DTS cables in borehole arrays (pending funding) that can be used for calibration studies with other DTS users. BGS is planning to drill 20 boreholes to a depth of 120 m deep boreholes through unconsolidated Quaternary sediments and Triassic bedrock in 2019 (pending funding); the UK partner will also provide access to spare core samples for thermal conductivity and diffusivity testing, and other testing and analysis.
The NERC will provide the BGS team with access to its open mapping data and subsurface databases (e.g. Single Onshore Borehole Index) and 3D geological and thermal modelling software (GSI3D & FEFLOW) and GIS (ESRI). NERC/BGS will host links to the GeoERA Web pages and provide IT infrastructure. We also have a percussive drill rig (Dando Terrier for UK drilling), borehole temperature and water level sensors, physical properties testing laboratories, core storage facilities, core scanning facility, thermal conductivity meters (KD2 Pro needle probe and field probe) for thermal analysis of soil/soft rock samples.

Relevant projects/activities

- Monitoring of groundwater temperatures and levels in Cardiff City (2013-present).
- Ground Heat Network at a City Scale: Innovate UK funded project (2015) comprising a private/public partnership between WDS Green Energy (SME), BGS and Cardiff City Council.
- GGERFS (Glasgow Geothermal Energy Research Field Site).
- ThermoMap (EU ICT-PSP programme form 2010-2013)
- The open loop GSHP screening tool for England and Wales developed by BGS and the Environment Agency. http://mapapps2.bgs.ac.uk/gshpnational/home.html.

4.3. *Cartographic and Geological Institute of Catalonia (ICGC)*

<table>
<tr><td>Name of organisation</td><td colspan="3">Institut Cartogràfic i Geològic de Catalunya</td></tr>
<tr><td>Short name</td><td>ICGC</td><td>Country</td><td>Spain</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">The Institut Cartogràfic i Geològic de Catalunya (ICGC) is the official mapping and geological survey of the autonomous government of Catalonia. ICGC was created in 2014 and belongs to the Department of Territory and Sustainability of the Government of Catalonia. The ICGC brings together the legacies of the former cartographic and geological agencies, both created in 1982. The ICGC has a staff around 270 people and is a beginning-to-end cartographic and geological institution. ICGC is the reference centre in geological sciences and geo-information in Catalonia. It comprises different fields, as applied geology and geophysics, seismic information systems, geological resources: geo-energies, hydrogeology, soils, in either characterization, assessment, modelling and mapping. As a geo-information agency, ICGC is producing in Catalonia topographic products, DTM & DSM, orthoimagery, geological and geothematic maps in various scales and databases. ICGC has participated or is currently participating in a number of EU funded international projects related to geosciences.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">• WP4 lead
• Task lead 2.4, 4.1 and 4.7
• Coordination of deliverables D.2.2 and D.4.2
• Core working team WP2
• Contribution to WP5, WP6</td><td colspan="2">• Groundwater and geothermal resource assessment
• Geological 3D modelling
• Hydrogeological and thermal modelling and simulation
• GIS mapping, and databases at regional to local scale</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Ignasi Herms Canellas (male)
Ignasi holds a Certificate of Advanced Studies - CAS on Exploration & Development of Deep Geothermal Systems from the Centre d'Hydrogéologie et de Géothermie de l'Université de Neuchâtel in 2016. MSc degree in Natural Resources (UPC, 2012), MSc degree in GIS (UdG, 2011), a BSc degree in Geology from the (UAB, 1999) and a BSc in Technical Mining Engineering (UPC, 1999). Postgraduate in groundwater hydrology (CIHS, UPC, 2002). Over 18 years of experience in hydrogeology, assessment geothermal systems, 3D groundwater and thermal modelling and simulation and GIS deployment. Professor in the field of hydrogeological mapping and deep geothermal in The International Groundwater Hydrology Course (FCIHS and UPC). Advisor for MSc theses related to deep geothermal in the MSc of Reservoir Geology and Geophysics (UB and UAB). 2014 has been working as Head of the Geological Resources Area at ICGC.

Georgina Arnó Pons (female)
Postgraduate in groundwater hydrology (CIHS, UPC, 2007). BSc in Geology (UB, 2001). Head of the hydrogeological and geothermal group team at ICGC. Over 16 years of experience in projects related to groundwater and mapping. She is specialized in analyses of groundwater and thermal data and 3D groundwater modelling. She is co-author of several articles and posters related to groundwater and geothermal. Professor in groundwater assessment and mapping in the International Groundwater Hydrology Course (FCIHS and UPC). Head of the project ‘Atlas for shallow geothermal energy in Catalonia’ and Head of the Hydrogeological Mapping Project of ICGC.

Montse Colomer Casas (female)
BSc in Geology by the UB (1996). Since 2014, takes part as senior technician of the hydrogeological and geothermal group team at ICGC. Over 20 years of experience in the development geo-resources projects. She is specialized in analyses of geological data, mapping and 3D geological modelling.

Víctor Camps (male)</td></tr>
</table>

Senior geologist and hydrogeologist of the hydrogeological and geothermal group team at ICGC. He has over 10 years of experience in processing of hydrogeological and geothermal data and hydrogeological mapping.

Publications, infrastructure / technical equipment

Arnó, G., Herms, I., Camps, V., Vicenç, M., **Colomer, M.,** Ascaso, E. The new digital Atlas of Catalonia for Shallow Geothermal Energy (Exploration and Planning). June 15, 2016 EGC2016 - European Geothermal Congress 2016

Colomer, M., Herms, I., Arnó, G., Camps, V.: Application of 3D modeling for groundwater management. 8th European Congress on: Regional Geoscientific Cartography and Information System (EUREGEO). Barcelona. June 2015.

Herms, I. "Geothermal resources assessment in Catalonia for district heating systems by means of the USGS volumetric method together with Monte Carlo simulations". (Report) CAS DEEGEOSYS Exploration & Development of Deep Geothermal Systems (2016).

Herms, I., Arnó, G. "*Hydrogeological information and cartographic databases. Perspectives in the digital field*". (traduced). Hidrogeología emergente | 50 CIHS 2016. ISBN 978-84-921469-3-2. **(**2016)

Colomer, M., Herms, I. et al. "*Digital distribution in vector format of data from the Hydrogeological Map of Catalonia at scale 1:25 000*". (traduced) Hidrogeología emergente | 50 CIHS 2016. ISBN 978-84-921469-3-2. (2016)

Relevant infrastructure

ICGC maintain databases, datasets, and models on earth sciences for the territory of Catalonia (NE Spain), making them freely available through its web site: http://www.icgc.cat. ICGC elaborates different geological and geo-thematic mapping products. e.g.

- Web-based viewer of the BDSOc - Borehole database of Catalonia (last update: 29.900 boreholes): http://www.icgc.cat/en/Public-Administration-and-Enterprises/Tools/Geoindex-viewers/Geoindex-Sondejos.
- Geological map of urban areas 1:5.000 of Catalonia: http://www.icgc.cat/en/Public-Administration-and-Enterprises/Downloads/Geological-and-geothematic-cartography/Geological-mapping/GT-III.-Geological-map-of-urban-areas-1-5.000. The geological map of urban areas is a 1:5.000 scale geological map and geothematic applied to all municipalities of over 10,000 inhabitants.
- GT V. Hydrogeological map 1:25.000 of Catalonia: http://www.icgc.cat/en/Public-Administration-and-Enterprises/Downloads/Geological-and-geothematic-cartography/Hydrogeological-cartography/GT-V.-Hydrogeological-map-1-25.000

ICGC has license and works with a huge variety of modelling and GIS software, like GOCAD, 3DGEOMODELLER, Midland Valley MOVE, FEFLOW-DHI, SubsurfaceViewer by INSIGHT; ArcGIS, QGIS, SURFER, and other.

Relevant projects/activities

- NERIES (FP7),
- SISPYR (INTERREG)
- EBRO-ADMICLIM (LIFE+),
- Wi-GIM (LIFE+), iCOAST (EU Civil Protection Instrument).

4.4. *Croatian Geological Survey (HGI-CGS)*

<table>
<tr><td>Name of organisation</td><td colspan="3">Hrvatski geološki institut (HGI-CGS)</td></tr>
<tr><td>Short name</td><td>HGI-CGS</td><td>Country</td><td>Croatia</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">HGI-CGS is the largest public research institute in the field of geosciences and geological engineering in Croatia with 66 experts and researchers and 12 junior researchers. The researchers at the HGI-CGS have experience and competence in the investigation of geothermal resources (protection, exploration, shallow subsurface utilization), groundwater systems (protection, finding new resources, working on sustainable usage of existing one), geological mapping, environmental hazards (landslides, flooding, soil contamination) and exploration of mineral resources. HGI-CGS has 3 departments: Geology, Hydrogeology and Engineering Geology and Mineral Resources, including laboratories for hydrochemical, engineering geological and geochemical measurements. HGI-CGS has Geoportal, which contains information on publications of the Croatian Geological Survey and the published works of its employees which are available for the public. HGI-CGS collaborates with many institutions of similar affiliation from Croatia and other countries. Beside scientific research and geological survey, the institute provides consulting services for external customers in the areas of its expertise.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">WP6 lead
Lead of tasks 1.4 (communication manager), 4.5 (pilot area Zagreb) and 6.1
Coordination of deliverables D.1.3, D.1.4, D.1.5 and D.6.2
Core team WP2, WP3 and WP5
Contribution to all WPs</td><td colspan="2">Rock and sediment thermal properties measurement
Groundwater protection
Borehole/well design
Pumping test analyses
Determination of hydraulic/hydrogeological parameters
Publication editing
Organization of professional and scientific meetings for diverse number and type of participants
EU funded projects implementation</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Dr. Staša Borović (female)
Studied geology and geography at the Faculty of Science of the University of Zagreb and earned MSc degree in both disciplines in 2009. After that she became a research assistant at the HGI-CGS and earned a PhD in geological engineering at the Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb in 2015 by defending a thesis on hydrothermal systems research. She is currently working as a postdoctoral fellow at the Dpt. Of Hydrogeology and Engineering Geology of HGI-CGS.
She collaborated on the fundamental projects of HGI-CGS: Geothermal map of the Republic of Croatia and Basic Hydrogeological Map of the Republic of Croatia, as well as on a number of EU and market-oriented projects concerning shallow and deep geothermal resources and groundwater research for water supply and protection purposes. She is the author of a number of scientific publications listed below, and a member of Croatian Geological Society (member of Governing board), International Association of Hydrogeologists (secretary of the Croatian National Chapter) and the International Geothermal Organization. She is the editor of Annual Report of HGI-CGS and of the Explanatory notes of the Basic Hydrogeological Map publications.
Dr. Kosta Urumović (male)
Studied geological engineering at the Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb and earned MSc degree in 2006. He worked as a drilling supervisory engineer for CROSCO for 3 years, after which he became a research assistant at the HGI-CGS and earned a PhD in geological engineering at the same faculty in 2013 by defending a thesis on hydrogeological properties of clastic deposits. He is currently working as a scientific associate at the Dpt. Of Hydrogeology and Engineering Geology of HGI-CGS.</td></tr>
</table>

He collaborated on the fundamental project of HGI-CGS Basic Hydrogeological Map of the Republic of Croatia, as well as on a number of EU and market-oriented projects concerning shallow and deep geothermal resources and groundwater research for water supply and protection purposes.
He is the author of a number of scientific publications listed below, and a member of Croatian Geological Society and International Association of Hydrogeologists.

Publications, infrastructure / technical equipment

Kurevija, T., Macenić, M., **Borović, S.** Impact of grout thermal conductivity on the long-term efficiency of the ground-source heat pump system (2017) Sustainable Cities and Society, 31, pp. 1-11, DOI: 10.1016/j.scs.2017.02.009
Soldo, V., Boban, L., **Borović, S.** Vertical distribution of shallow ground thermal properties in different geological settings in Croatia (2016) Renewable Energy, 99, pp. 1202-1212, DOI: 10.1016/j.renene.2016.08.022
Soldo, V., **Borović, S.**, Lepoša, L., Boban, L. Comparison of different methods for ground thermal properties determination in a clastic sedimentary environment (2016) Geothermics, 61, pp. 1-11, DOI: 10.1016/j.geothermics.2015.12.010
Borović, S., Marković, T., Larva, O., Brkić, Ž., Mraz, V. Mineral and thermal waters in the Croatian part of the Pannonian basin (2016) Environmental Earth Sciences, pp. 31-45, DOI: 10.1007/978-3-319-25379-4_2
Borović, S., Marković, I. Utilization and tourism utilization of geothermal waters in Croatia (2015) Renewable and Sustainable Energy Reviews, 44, pp. 52-63, DOI: 10.1016/j.rser.2014.12.022

Infrastructure

Instrument for *in-situ* and laboratory thermal properties measurement (ISOMET 2114, Applied Precision, Bratislava)

Relevant projects/activities

- Geothermal map of the Republic of Croatia (1991 – 2012)
- Basic Hydrogeological Map of the Republic of Croatia (since 1991)
- GeoMapping – mapping of shallow geothermal potential in the Republic of Croatia (IPA project, 2013 – 2015)
- DanReGeo-DATA – analysis of available data about geothermal phenomena in the Pannonian part and development of structure for a common data base (DTP project, 2015)
- DARLINGe Danube Region Leading Geothermal Energy – geothermal research on a Pannonian basin scale level (DTP project, 2017 – 2019)

4.5. *Czech Geological Survey (CGS)*

<table>
<tr><td>Name of organisation</td><td colspan="3">Ceska Geologicka Sluzba – Czech Geological Survey</td></tr>
<tr><td>Short name</td><td>CGS</td><td>Country</td><td>Czech Republic</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">Czech Geological Survey (CGS) is a research institute of the Ministry of Environment of the Czech Republic. The main task of the CGS is to provide state geological survey in the Czech Republic and research in geosciences. CGS provides expert information to the national authorities for the political, economic and environmental decision-making. The main fields of expertise include geological research and mapping, geochemistry and environmental studies, mineral resources and mining impact assessment, applied geology and natural risks. Research activity of CGS comprises of internal projects and projects supported by the domestic and international research funding agencies. International cooperation involves bilateral treaties, international development cooperation agenda, the Horizon 2020 EU program, the funding mechanisms of the EHP/Norway, the environment-related operational programs or the cross-border operational programs.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">• Lead task 4.8 (pilot area Prague)
• Contribution to WP3 and WP5</td><td colspan="2">• Groundwater and geothermal resource assessment and mapping
• GIS mapping, and creation of national databases and maps
• CZ regulations and policy knowledge for SGE</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Jan Holeček Ph.D. (male)
Graduated from Charles University in Prague in specialty of geology – geochemistry in 2004, earned doctor degree (Ph.D.) in science engineering at Faculty of Mechatronics, Informatics and Interdisciplinary Studies at the Technical University of Liberec. Works as researcher at Czech geological survey in Prague since 2004. His research interests include applied hydrogeology and hydrochemistry, geothermal energy, hazardous waste storage in rock environment and microstructural analysis of pore space in hard rocks. He has cooperated on several international geothermal energy focused projects as coordinator and lead of Czech side recently.

Jaroslav Řihošek (male)
Graduated from Charles University in Prague in specialty of geology – petrology in 2014. Works as researcher at Czech geological survey in Prague since 2017. His research interests include hazardous waste storage in rock environment and hydrogeology aspects in geothermal energy exploration.</td></tr>
<tr><td colspan="4">Publications, infrastructure / technical equipment</td></tr>
<tr><td colspan="4">• DANREGEOTHERM – analysis of available data about geothermal phenomena in the Czech Republic (2015)
• CZE certified methodical guidelines: Methodology for determining the level of protection when exploiting thermal energy of the earth´s crust - a methodological study of policy and requirements for geothermal energy utilization (2015)
• GeoPLASMA-CE (Interreg Central Europe, 2016 – 2019): managing SGE use in Central Europe, coordination of research activities in work package WP3 “Pilot activies”.
• RINGEN, RINGEN+ - research activities in national research infrastructure for geothermal energy (hydrogeology, mapping, geochemical modeling, geology) (2016-2019)
• Study of limiting thermal conditions for placement of high level waste repository, Study of thermal conditions of the rock environment at candidate localities for situation of high level waste repository, (Radioactive waste repository authority of CZE, 2017)</td></tr>
<tr><td colspan="4">Relevant projects/activities</td></tr>
</table>

- GeoPLASMA-CE (Interreg Central Europe, 2016 – 2019)
- Danube Region Geothermal Concept, DANREGEOTHERM (OP Danube region DanReg-Start, 2014-2015)
- Methodology for determining the level of protection when exploiting thermal energy of the earth´s crust, Geothermal (Technological agency of the Czech Republic, program Beta, No.: TB030MZP024, 2014-2015)

4.6. French Geological Survey (BRGM)

<table>
<tr><td>Name of organisation</td><td colspan="3">Bureau de Recherches Géologiques et Minières</td></tr>
<tr><td>Short name</td><td>BRGM</td><td>Country</td><td>France</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">BRGM (Bureau de Recherches Géologiques et Minières) is the French geological survey. It was created in 1959 and is France's reference public institution for Earth Science applications in the management of surface and subsurface resources and risks. BRGM's activities are focused on increasing geological knowledge and understanding surface and subsurface phenomena related in particular to groundwater, mineral and geo-energy resources. By addressing major environment and sustainability issues, BRGM provides support for public policies and decision making, and contributes to the development of innovative technologies featuring research in public and private partnership, at national and international level.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">• Lead of task 6.2
• Coordination of deliverable D.6.1</td><td colspan="2">• Subsurface spatial planning
• Coordination workshops.</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Dr. Fernanda M.L. Veloso (female)
She is geologist and is in charge of geoscience aspects for safety use of subsurface exploitations at SPU (Subsurface Performance and Uses) unity of DRP (Risk and Pervention) department of BRGM since Jan. 2017. Before she joined the BRGM, she worked for almost 5 years at Total (oil and gas company).
Thomas LE GUENAN (male)
Joined BRGM in January 2008 to work on safety issues for geologic storage of CO2 under the Risks and CO2 storage Safety department. He is now in charge of the safety criteria and impacts of CO2 storage programme. He is main author of the preliminary risk assessment performed for the ADEME TGR-BF project. He is currently a contributor of the ENOS H2020 project.</td></tr>
<tr><td colspan="4">Publications, infrastructure / technical equipment</td></tr>
<tr><td colspan="4">De Lary L., Le Guenan T., Manceau J-C. (2015) – Projet MARSE : approche de gestion des risques pour les exploitations du sous-sol. Rapport final. BRGM/RP-65676-FR, 48 p., 11 fig. Public Report. http://infoterre.brgm.fr/rapports/RP-65676-FR.pdf
Le Guenan T., Gravaud I., Maragna C. et al. (2016) Analyse préliminaire des interactions entre les différents usages du sous-sol. Rapport final. BRGM/RP-66114-FR. In French (Report to the French administration on the interactions between various subsurface uses).
Mapping of Shallow Geothermal risks: http://www.brgm.fr/projet/cartographie-nationale-risques-lies-geothermie-minime-importance</td></tr>
<tr><td colspan="4">Relevant projects/activities</td></tr>
<tr><td colspan="4">• ULTimate CO2 – Understanding the Long-Term fate of geologically stored CO2 (FP7, 2011-2015)
• ENOS – Enabling Onshore CO2 Storage in Europe, 2016-2020): http://www.enos-project.eu/ (H2020, 2016 – 2020)
• “Gestion du dogger” (management of the dogger aquifer) related to modelling potential interaction between deep geothermal doublet in the Paris Basin (ADEME-BRGM).</td></tr>
</table>

4.7. *Geological Survey Ireland (GSI)*

Name of organisation	Geological Survey Ireland (Department of Communications, Climate Action and the Environment)		
Short name	GSI	**Country**	Ireland
Organisation profile			
Founded in 1845, Geological Survey Ireland is the Republic of Ireland's public earth science knowledge centre. We are a division of the Department of Communications, Climate Action and Environment (DCCAE). We provide free, open and accurate data and maps on Ireland's subsurface to landowners, the public, industry, and all other stakeholders, within Ireland and internationally. In addition, we act as a project partner in interpreting data and developing models and viewers to allow people to understand the underground.			

Roles / tasks in the project	**Special relevant skills**
• Lead of task 4.12 (pilot area Cork) • Contribution to WP3 and WP5	• Characterisation and mapping of hydrogeological and shallow geothermal systems • Creation of national databases and maps • Creation of 3D urban geological models • Hydrogeological data interpretation

Short profile of staff member(s) who will be undertaking the work

Taly Hunter Williams (female)
Taly is a Senior Hydrogeologist with expertise in groundwater characterisation, shallow geothermal energy and hydrochemistry. She holds a BSc in Geology and MSc in Hydrogeology. She is a member and former Secretary of the Geothermal Association of Ireland, IAH (Irish Group), a member of the EuroGeoSurveys Water Resources Expert Group, and formerly member of the EuroGeoSurveys Energy Expert Group.

Sarah Blake (female)
Sarah is a Hydrogeologist and Geothermal expert. She has expertise in warm springs characterisation through geophysical and hydrochemical investigations, and was awarded her PhD for this study in 2016, following an MSc in hydrogeology and a BSc in Geology. She also has expertise in groundwater pathway characterisation.

Beatriz Mozo Lopez (female)
Beatriz is a Geologist in the Geotechnical Section of GSI's Land Mapping Unit. She has created 3D subsurface geological models for Dublin and Cork, and worked on the Sub-Urban Cost network in WG2 (3D and 4D mapping/modelling).

Contract staff (m/f)
Suitably qualified contract staff member to be appointed.

Publications, infrastructure / technical equipment

Geological Survey Ireland (2015) Ground Source Heat and Shallow Geothermal Energy Homeowner Manual. Managed by N. H. Hunter Williams and M. Lee.
National shallow geothermal energy (ground source heat collector) suitability maps (2016). Managed by N. H. Hunter Williams and M. Lee.
S. Blake, T. Henry, J. Murray, R. Flood, M.R. Muller, A.G. Jones,V. Rath, Volker (2016) Compositional multivariate statistical analysis of thermal groundwater provenance: A hydrogeochemical case study from Ireland. Applied Geochemistry v.75 pp. 171-188.
A.G. Jones, S. Daly, J. Vozar, V. Rath, J. Campanya, S. Blake, R. Delhaye, T. Farrell, T. Fritschle, N. Willmot Noller, M. Long, T. Waters, and the IRETHERM team (2015) IRETHERM: Developing a Strategic and Holistic Understanding of Ireland's Geothermal Energy Potential through Integrated Modelling of New and Existing Geophysical, Geochemical and Geological Data. Proc. World Geothermal Congress 2015, Melbourne, Australia, 19-25 April 2015.

R. Pasquali, G. Ll. Jones, J. Burgess, N.H. Hunter Williams (2016) Geothermal Energy Use, Country Update for Ireland. European Geothermal Congress 2016. Strasbourg, France, 19-24 Sept 2016. GSI has a distributed temperature sensor (DTS) and a thermal conductivity probe. It has access to an experimental thermal response test (TRT) rig and lab-based thermal conductivity measurement equipment. GSI has its own drill rig that can auger through unconsolidated sediments, and retrieve bedrock cores to about 900 m. GSI has 2D national ground source heat collector suitability maps, 2D national groundwater resource (aquifer) map, geotechnical databases, including groundwater levels, and 3D quaternary geological models of the subsurface beneath Dublin and Cork cities, along with bedrock surface models.
Relevant projects/activities
• GSI Shallow Geothermal Energy project. https://www.gsi.ie/en-ie/programmes-and-projects/geoenergy/projects/Pages/Shallow-geothermal-energy.aspx • IRETHERM. www.iretherm.eu. IRETHERM studied eight different “types” of geological environments to identify those that may host geothermal resources: deep aquifers or hot, dry rock. GSI was project partner. • Irish Ground Thermal Properties database. http://irishgroundtherm.com/. Data acquisition and spatial database for ground thermal properties. Part-funded by GSI. • Sub-Urban COST project. http://sub-urban.squarespace.com/. European network of Geological Surveys, Cities and Research Partners working together to improve how we manage the ground beneath our cities (COST- European Cooperation in Science and Technology, 2014-2017). GSI participated in WG2 on 3D subsurface modelling.

4.8. Geological Survey of Belgium-Royal Belgian Institute of Natural Sciences (RBINS-GSB)

Name of organisation	Geological Survey of Belgium-Royal Belgian Institute of Natural Sciences		
Short name	RBINS-GSB	**Country**	Belgium

Organisation profile

The Geological Survey of Belgium (GSB) is an autonomous subsection of the Royal Belgian Institute of Natural Sciences. Created in 1896, the GSB is a key geological and mineralogical research centre developing both applied and fundamental research approaches.
The GSB conducts scientific services and research projects related to Geo Energy, Raw Materials, Dynamics of sedimentary basins and data infrastructure. GSB also carried out all major exploration campaigns of the Belgian subsurface, including deep boreholes and all major geophysical surveys (seismic reflective profiles, gravimetry, aeromagnetic,…). The scientific valorization of the data, the rock and mineral collections, including all the deep borehole cores and samples from the Belgian subsurface are also the responsibility of GSB and this valorization task can be conducted through a modern analytical equipment facility.
It also an independent, non-commercial provider of geoscientific services. These services are oriented towards local, regional, federal, European and international authorities, as well as researchers of institutions/universities, private companies, NGO's and citizens. The data collections are globally freely available for consultation.

Products and services

Geological maps of Belgium, boreholes database, field observations are available online through the webGIS portal developed by GSB (www.belgiumgeology.net).

Roles / tasks in the project	Special relevant skills
• Lead of task 4.12 (pilot areas Brussels) and 5.3 • Coordination of deliverables D.5.2, D.5.4 and D.5.5, support for coordination of D.2.1 • Core working team WP2 • Contribution to WP3	• Rock thermal properties • Assessment and mapping of shallow geothermal potential • E-TRT and pumping test analyses • GIS mapping, 3D urban geological models • Geophysical characterization of the subsurface

Short profile of staff member(s) who will be undertaking the work

Estelle Petitclerc (female)

Is a geologist-geophysics with 12 years of experience. She joined the Geological Survey of Belgium in 2005 where she is in charge of all geothermal-related projects at GSB. She is mainly involved in geothermal potential assessments: potential reservoir identification, geo-economic modelling for assessment of the geothermal sector development in Belgium and on thermal characterization of Belgian subsoil for optimizing shallow geothermal application. Estelle Petitclerc is currently the work package leader of the exploration and potential assessment of Brussels Capital Region (BruGeo project). She is the representative for Belgium in the EuroGeoSurveys expert group on Geothermal Energy, and a member of the geothermal energy expert group of EFG (European Federation of Geologists), she is also an active member of the team producing the country update for Belgium for EGEC.

Prof. Dr Xavier Devleeschouwer (male)

Is a sedimentary geologist with 18 years of experience. He worked as a research assistant for different universities in Belgium before joining permanently the staff of the Geological Survey of Belgium in 2004. His main activities are dedicated to three topics: i) urban geology using geological data (drillings and geotechnical data) to develop 2D and 3D geological (and hydrogeological) models in and around the Brussels Region; ii) geological hazards using PSInSAR data in Belgium (subsidence and uplift linked to groundwater fluctuations but also those associated to coal mine activities); iii) sedimentology and stratigraphy analyses of sedimentary rocks aiming at identifying the detrital fluxes in relation with sea-level and climatic fluctuations using many proxies in carbonate series. He is teaching sedimentology at the University of Brussels and Namur and is the co-promotor of two PhD thesis and has supervised around 15 MSc thesis. He has participated in several international and European projects like PANGEO and is still leading several regional projects on the geology of Brussels.

Pierre-Yves Declercq (male)
Is a geologist with 15 years of experience in Geo-Informatics support at the Geological Survey of Belgium including database and webGIS management. Therefore he has been involved in several EU-projects such as Onegeology, EuroGeoSources, PanGeo, and Thermomap. He is currently doing applied scientific research on human induced geohazard using Radar Interferometry.

Publications, infrastructure / technical equipment

Petitclerc, E., Vanbrabant, Y. (2011) [in French]. Développement de la plate-forme géothermique de la Wallonie. SPW-DGO4 [https://energie.wallonie.be/fr/la-geothermie-profonde.html?IDC=6173]

Rapport collectif (2011) [in French]. Etude des obstacles à la géothermie profonde (basse et haute énergie). SPW-DGO4 [https://energie.wallonie.be/fr/la-geothermie-profonde.html?IDC=6173]

Petitclerc, E., Laenen, B., Lagrou, D., Hoes, H. (2016). Geothermal Energy use, Country Update for Belgium. European Geothermal Congress 2016, Strasbourg, France, 19-24/09/2016, 9p.
Loveless, S., Hoes, H., Petitclerc, E., Licour, L. And Laenen, B. (2015). Country Update for Belgium. Proceedings World Geothermal Congress 2015, Melbourne, Australia, 6 p.

Petitclerc, E., Welkenhuysen, K., Van Passel, S., Piessens, K., Maes, D., Compernolle, T. (2017). Towards geological-economic modelling to improve evaluating policy instruments for geothermal energy – Case study for Belgium (Campine Basin). European Geologist Journal, 43, pp. 10-15.

Relevant projects/activities

- **BruGeo** (Regional and EU-Funding) www.geothermie.brussels : 2016-2020.

- **ThermoMap (FP 7 ICT-PSP)** http://www.heatunderyourfeet.eu/useful-tools/thermomap-mapping-shallow-geothermal-potential-across-europe/ : 2006-2010.

- **Brustrati3D (Regional project)** Coordinator. https://www.naturalsciences.be/fr/science/do/94/scientific-research/research-projects/project/754) aims to develop the 3Dgeological model of Brussels.
-

  BE-TEMPER project (Federal State Funding: permanent research activity) Coordinator. https://www.naturalsciences.be/sites/default/files/BeTemper.pdf

- **CHPM2030** (H2020) http://www.chpm2030.eu : 2016-2019.

4.9. *Geological Survey of Slovenia (GeoZS)*

<table>
<tr><td>Name of organisation</td><td colspan="3">Geološki zavod Slovenije</td></tr>
<tr><td>Short name</td><td>GeoZS</td><td>Country</td><td>Slovenia</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">GeoZS is a public research institute with 90 employees, among them more than 60% with higher education. It carries out fundamental and applied research in the field of geology (e.g. geological mapping, assessment of natural (geological) hazards, expertise on groundwater, mineral resources, geothermal energy resources and natural geological heritage). All activities are supported by the Geological information Centre, responsible for the collection, processing, storage and dissemination of geological data. GeoZS is involved in the preparation of strategic and planning documents for national and local authorities related to water and geothermal energy resources.
GeoZS is the leading research institution in the field of geothermal energy in Slovenia, performing field measurements, shallow and deep borehole surveys, geophysical logging, monitoring, data interpretation and mathematical modelling. It supports national authorities and agencies (Ministry of the Environment and Spatial Planning, Slovenian Environment Agency, Ministry of Infrastructure) in the process of concession granting for utilization of geothermal aquifers in Slovenia and assessment of geothermal potential on a national level. Additional supportive activities are monitoring and management of databases for geothermal energy use, wells and water protected areas.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">• Lead of task 4.2 (pilot area Ljubljana)
• Contribution to WP3, WP5 and WP6</td><td colspan="2">• 3D geological, groundwater flow/transport and heat transport modelling
• Management of shallow geothermal and groundwater resources in urban areas</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Mitja Janža, PhD (male)
Senior researcher with experiences in the fields of hydrological and geothermal modelling, groundwater resources management, and GIS/spatial analysis.

Andrej Lapanje, MSc (male)
Research and development associate with experience in geothermal exploration, development and monitoring, well design and operation, geophysical logging, hydrogeological mapping and management of groundwater resources.

Dejan Šram, BSc (male)
Researcher with experience in 3D structural modelling, 3D numerical modelling of fluid and heat flow and spatial analysis in GIS. His profession are also field work and interpretation of geophysical well-logging data and in the last years he is active in several shallow and deep geothermal projects.</td></tr>
<tr><td colspan="4">Publications, infrastructure / technical equipment</td></tr>
<tr><td colspan="4">Janža M. 2017. Management of the groundwater resource beneath the city of Ljubljana. Procedia Engineering 209: 100–103.
Janža M, Lapanje A, Šram D, Rajver D. 2017. Challenges of sustainable use of groundwater resources in an urban area (Ljubljana case study). In: Posavec K and Marković T (eds) Groundwater Heritage and Sustainability : 44th Annual Congress of the International Association of Hydrogeologists (IAH). IAH: Dubrovnik.
Janža M, Lapanje A, Šram D, Rajver D, Šram D. 2017b. Research of the geological and geothermal conditions for the assessment of the shallow geothermal potential in the area of Ljubljana, Slovenia. Geologija 60/2: 309-327.
Janža M. 2015. A decision support system for emergency response to groundwater resource pollution in an urban area (Ljubljana, Slovenia). Environmental Earth</td></tr>
</table>

Sciences 73: 3763–3774.
Jamnik B, Janža M, Prestor J. 2012. Project INCOME: developing a comprehensive approach for Slovenian aquifer management. Water21.

Infrastructure and/or any major items of technical equipment

Thermal Conductivity Scanner (Lippmann and Rauen GbR)

KD2 Pro thermal properties analyser – portable field and lab thermal properties analyser (DECAGON DEVICES)

FEFLOW 7.0 – groundwater flow/transport and geothermal processes modelling software (DHI)

MIKE SHE 2011 – groundwater flow/ transport modelling software (DHI)

Relevant projects/activities

- GeoPLASMA-CE – Shallow Geothermal Energy Planning, Assessment and Mapping Strategies in Central Europe (Interreg, Central Europe, 2016-2019)
- GRETA – Near-surface Geothermal Resources in the Territory of the Alpine Space (Interreg Alpine Space, 2015-2018)
- AMIIGA – Integrated Approach to Management of Groundwater quality In functional urban Areas (Interreg Central Europe 2016-2019)
- INCOME – Improved management of contaminated aquifers by integration of source tracking, monitoring tools and decision strategies (LIFE+, 2009-2012)
- Sub-Urban - European network of Geological Surveys, Cities and Research Partners working together to improve how we manage the ground beneath our cities (COST- European Cooperation in Science and Technology, 2014-2017)
- GEO.POWER - exchange of best practices related to low enthalpy energy supply (Interreg IVC Programme, 2011-2012)

1.10. Geological Survey of Spain (IGME)

<table>
<tr><td>Name of organisation</td><td colspan="3">Instituto Geológico y Minero de España</td></tr>
<tr><td>Short name</td><td>IGME</td><td>Country</td><td>Spain</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">The Geological Survey of Spain (IGME) was founded in 1849 as the main Earth Sciences Research Centre of Spain. It is a Public Research Organization acting as an autonomous institution attached to the Ministry of Economy and Competitiveness with a total of 400 employees, of which 185 are graduated. IGME is specialized in various fields of activity such as geology, environment, hydrogeology and natural resources. IGME provides expert knowledge of all aspects of geoscience, and is the responsible for advising the Spanish government and its Autonomous Community governments on the sustainable development of its territory and resource management. For more than a decade, IGME has been developing different strategies for the management of shallow geothermal resources in urban areas. The alluvial aquifer under the city of Zaragoza (Spain) has served as an experimental city scale laboratory to study the thermal, hydraulic, geochemical and microbiological impacts induced by groundwater heat pump (GWHP) systems.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">• Lead of WP3
• Lead of tasks 2.3, 3.2, 3.4 and 4.4 (pilot area Zaragoza)
• Coordination of deliverable D.3.2
• Core working team WP2 and WP4
• Contribution to WP5 and WP6</td><td colspan="2">• 3D Groundwater flow and heat transport modelling
• Management of shallow geothermal resources in urban groundwater bodies</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Miguel Mejías Moreno (male)
Senior expert in groundwater quality and resources management. Head of the Area of Applied Hydrogeology in the Spanish Geological Survey.

Eduardo Garrido Schneider (male)
Senior expert in urban hydrogeology and shallow geothermal energy expert.

Dr. Alejandro García Gil (male)
Expert in 3D groundwater flow and heat transport modelling.</td></tr>
<tr><td colspan="4">Publications, infrastructure / technical equipment</td></tr>
<tr><td colspan="4">Publications:

The thermal consequences of river-level variations in an urban groundwater body highly affected by groundwater heat pumps, Science of the Total Environment 485–486 (2014) 575–587 .

Development of concepts for the management of thermal resources in urban areas, Journal of Hydrology 548 (2017) 697–715.

Relaxation factor for geothermal use development – Criteria for a more fair and sustainable geothermal use of shallow energy resources, Geothermics 56 (2015) 128–137.

Recovery of energetically overexploited urban aquifers using surface water, Journal of Hydrology 531 (2015) 602–611.

A city scale study on the effects of intensive groundwater heat pump systems on heavy metal contents in groundwater, Science of the Total Environment 572 (2016) 1047–1058

GIS-supported mapping of low-temperature geothermal potential taking groundwater flow into account, Renewable Energy 77 (2015) 268e278</td></tr>
</table>

Infrastructure:

- Monitoring of an urban aquifer intensively exploited by GWHP systems
- 42 point geothermal monitoring network with dataloggers (continuous monitoring)
- 70 GWHPs (37 Monitored)

Relevant projects/activities
• IMPACTER (2010-2014): Study of the thermal impact caused by GWHPs in the city of Zaragoza • GEOTERZ (2016-present): The application of a groundwater flow and heat transport numerical model for the simulation of management strategies of geothermal installations in the city of Zaragoza

1.11. Geological Survey of Sweden (SGU)

<table>
<tr><td>Name of organisation</td><td colspan="3">Sveriges Geologiska Undersökning (Geological Survey of Sweden)</td></tr>
<tr><td>Short name</td><td>SGU</td><td>Country</td><td>Sweden</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">SGU is the national agency for issues relating to bedrock, soil and groundwater in Sweden. SGU is a governmental body governed by The Ministry of Enterprise and Innovation. At present SGU has about 240 employees and an annual turnover that totals c. 43 M€. SGU has extensive expertise in geology, geophysics, geochemistry and economic geology relevant to the current project proposal.
SGU holds the national archive for geoscientific information which is important for assessing viable shallow geothermal energy projects, e.g. the survey maintains a substantial well data base on geothermal and groundwater wells. The survey performs also R&D within the field of investigating the thermal properties of rocks and constructing thematic prognosis maps for geothermal energy. Besides this the survey is member of the EGS-Geoenergy Expert Group and has as such been involved in several EU funded joint projects related to geoenergy, i.e. CO2Mustang, ESTMAP, EUOGA and the ongoing H2020 project CHPM2030. The latter aims to develop a novel and potentially disruptive technology solution that can help satisfy the European needs for energy and strategic metals in a single interlinked process.
SGU has also acted as partner in the COST Action TU1206 Sub-Urban, supported by COST (European Cooperation in Sciences and Technology), and the European Union's H2020 programme. Sub-Urban is a network to improve understanding and the use of the ground beneath our cities. SGU acted as lead partner in the compilation of the report TU1206 COST Sub-Urban WG2 Report: Groundwater, Geothermal Modelling and Monitoring at City-Scale – Reviewing European practice and knowledge exchange.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">Lead of task 4.3 (pilot area Linköping)
Core team WP2
Contribution to all WPs</td><td colspan="2">Mapping and characterization of the bedrock and its thermal properties
Geophysical characterization of the subsurface
Management of well data
Groundwater mapping and assessment of conflicts of use associated to SGEs</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">PhD Mikael Erlström (male)
Is presently project coordinator of the geoenergy group at SGU and adjunct professor at the Department of Geology at Lund University. Recent work has involved compilation of a report describing geoscientific information valuable for the design of shallow geothermal systems. Erlström started his professional and scientific career in the early 1980-ties working with subsurface investigations of deep aquifers regarding utilization for geothermal energy and storage of natural gas. During the 1990-ties Erlström became programme manager at SGU for commissions on geoenergy and as such involved in numerous projects on pre-investigations for geothermal energy and subsequently CO2 storage. Erlström has since the late 1990-ties, been project leader for bedrock mapping projects besides continuing his work with assessing and investigating geothermal resources. Much of the geothermal work has been performed in joint collaboration with GEUS, in projects funded by the Danish Research Foundation of the Danish Agency for Science, Technology and Innovation, i.e. the project "The geothermal energy potential in Denmark - reservoir properties, temperature distribution and models for utilization" (DSF-No. 2104-09-0082) and the Innovation Fund Denmark funded project "GEOTHERM – Geothermal energy from sedimentary reservoirs – Removing obstacles for large scale utilization (6154-00011B). Erlström has also participated in the EU H2020 funded ESTMAP and EUOGA projects and acted as Work Package leader for WP2 "Site characterization" in an EU–funded project "MUSTANG" (EU contract 227286, seventh framework programme).
Dr. Gerhard Schwarz (male)</td></tr>
</table>

Is State Geophysicist at SGU and Associate Professor in Solid Earth Physics at Uppsala University. He started his scientific career in geophysics in the late 1970s investigating the regional geothermal anomaly of Tuscany by means of deep electromagnetic soundings. These studies were funded within the First Framework Programme of the European Commission, and were a landmark in the development of EU-wide geothermal energy research. This work was followed in the Second Framework Programme with investigations of the Travale geothermal field, Italy. His work has made him a specialist in analysing and modelling the geothermal properties of rock and bedrock domains. In recent years, Dr Schwarz has bedom involved in the COSC deep drilling project. He is also working on characterisation of thermal properties of upper crustal rocks in Sweden, with the purpose of improving heat extraction from both the shallow and deep subsurface, and describing deep crustal heat production and flux. Since 2016 Schwarz is a member of the CHPM2030 project, funded within the H2020 programme and developing an “orebody-EGS”.

PhD Peter Dahlqvist (male)

Expert in hydrogeology and modelling of groundwater i sedimentary bedrock. He is presently project leader of several groundwater regional mapping projects and internal R&D projects related to subsurface 3D modelling of sedimentary bedrock and aquifers. He has been SGUs participant in the COST project and as such co-editor of the final report “*Groundwater, Geothermal Modelling and Monitoring at City-Scale. Reviewing European practice and knowledge exchange. TU1206 COST Sub-Urban WG2 Report”.* Previously he worked at the county government with ground water management issues.

State geologist Mattias Gustafsson (male)

Groundwater specialist and has long experience from certifying drillers and drilling companies performing SGTs, and contacts with stakeholders. Has since the mid 1990-ties worked with groundwater mapping and teaching and certifying drillers that perform shallow groundwater and geoenergy wells. Presently project manager of groundwater mapping projects as well as regional information officer at the survey. He is presently also the SGU representative in the EGS- groundwater group.

PhD Claes Mellqvist (male)

Bedrock geologist specialized in using modal data for assessing the thermal properties and the construction of geothermal prognosis maps.

Publications, infrastructure / technical equipment

Erlström, M., Mellqvist, C., Schwarz, G., Gustafsson, M. & Dahlqvist, P., 2015: Geologisk information användbar för bedömning och design av geoenergianläggningar – en översikt (Geological information applicable for the design of shallow geothermal systems – an overview). Sveriges Geologiska Undersökning, rapport 2015:24, 52 s. (in Swedish).

Bonsor, H.C., **Dahlqvist, P.,** Moosmann, L., Classen, N., Epting, J,. Huggenberger, P., Garica-Gil, A., Janźa, M., Laursen, G., Stuurman R., & Gogu, C.R., 2017: Groundwater, Geothermal Modelling and Monitoring at City-Scale. Reviewing European practice and knowledge exchange. TU1206 COST Sub-Urban WG2 Report

Equipment

The survey has a thermal conductivity scanner (TCP) which can be used for thermal measurements on cores and rock specimens. The survey has also equipment for logging temperatures in boreholes

Relevant projects/activities

COST (2015-17). Groundwater, Geothermal Modelling and Monitoring at City-Scale. Reviewing European practice and knowledge exchange.
Geoenergy communication platform (2017-ongoing): National geothermal cooperation forum between national agencies and authorities involved in SGEs. Coordinated by SGU.

1.12. Netherlands Organisation for Applied Research (TNO

Name of organisation	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek		
Short name	TNO	Country	The Netherlands

Organisation profile
TNO is the leading research institute in the Netherlands on shallow geothermal energy with involvement in many international projects for almost two decades, including the coordination of EU research programs for subsurface geothermal storage in aquifers, gas, oil, and other reservoirs. Recently, TNO has performed national and international contract work for site specific evaluations of geothermal projects. TNO has expertise over the entire chain from exploration to production of geothermal energy. TNO is also the leading organization for the IMAGE project, the EU international program on geothermal energy with many partners from industry, academia and research organisations. On an international scale, TNO is active in the sustainable energy industry, including geothermal, CCS, battery storage, e.g. well and pipeline flow assurance, sensor development, basin modelling, geological modelling, seismic interpretations, reservoir engineering, prospect evaluation, and production forecasting to portfolio management.

Roles / tasks in the project	Special relevant skills
• Lead of task 2.1 • Support of task 4.13 (pilot area Brussels)	• Subsurface exploration in urban environment • Well monitoring • Drilling technique

Short profile of staff member(s) who will be undertaking the work

Dr. S.F.A. (Stefan) Carpentier (male)

Is a geophysicist in the Applied Geo Sciences group of TNO. He conducts projects in seismic imaging and monitoring for sustainable energy and petroleum targets. Stefan has 15 years' experience in geophysics; seismics is his particular expertise. He obtained his BSc and MSc in geophysics from Utrecht University and graduated in modeling of anisotropic wave propagation. A PhD in geophysics led to his dissertation on statistical analysis and imaging of noisy deep seismic reflection data. A subsequent post-doc at ETH Zurich involved Stefan in seismic imaging of geohazards, varying from New Zealand fault systems to Swiss landslides. Another 3,5 years in geophysical consultancy with T&A Survey made him familiar with commercial application and project leading in geothermal exploration. Currently at TNO, he develops seismic data conditioning algorithms for use in seismic re-processing, 4D seismic inversion, seismic interferometry and seismic interpretation. The application of these techniques is mostly on imaging and monitoring of geothermal and CCUS reservoirs.

MSc. B.F. (Bob) Paap (male)

Is an applied geophysicist with a broad experience in fundamental and experimental (field) research. Bob Paap started his career in 2006 as a geophysicist with TNO, providing specialist advice for geological, geo-technical and environmental projects. While working for Deltares - in which part of TNO was integrated in early 2008 – he was with the Applied Geology and Geophysics Group. In that period he was involved in a great number of both onshore and offshore geophysical survey campaigns, participating both as team member and project leader. As a result, he is very well versed in both planning and practical aspects of geophysical field experiments and survey campaigns. During this period he developed a special interest in combining multiple geophysical measurement techniques for locating and delineating buried objects (e.g. UXO, pipelines and wrecks). In 2013 he returned to TNO and is now working at the Sustainable Geo Energy group. He works on the development of innovative approaches for passive seismic monitoring of subsurface CO2 storage, geothermal production and conventional oil and gas production. His research work focuses on using geophysical observations to develop a comprehensive understanding of geological settings and subsurface processes.

Drs. V.P. (Vincent) Vandeweijer (male)

Is geologist, geophysicist and project manager in TNO's Applied Geosciences team. He started his career at a consultant company specialized in high resolution seismic in 2000, where he has worked on a broad range of assignments involving seismic acquisition, processing, interpretation and reporting. Later he also became project manager of the development and production of seismic acquisition equipment. Since 2006, Vincent has worked at TNO in the Applied Geosciences team, where he mainly works as a project manager, geologist or geophysicist on projects related to CO2 storage and geothermal energy, but also on more classical exploration projects for the oil and gas industry. He has been involved in numerous national and international projects for commercial clients as well as the national government and the European union. His research interests are very much focused towards subsurface imaging and monitoring, with a key link to low impact and sustainability. Vincent holds an MSc in geology from the Vrije Universiteit Amsterdam.
Publications, infrastructure / technical equipment
Boullenger, B. Verdel, A.R., Paap, B.F., Thorbecke, J. and Draganov, D., 2016, Studying CO2 storage with ambient-noise seismic interferometry: A combined numerical feasibility study and field-data example for Ketzin, Germany, Geophysics, Volume 80, No. 1, P.1-13 Carpentier, S., Steeghs, P., Boxem, T., Seismic reprocessing and attributes for geothermal exploration: a case study in Friesland, Netherlands, 2016, Proceedings EGC 2016, Paper ID: 628, Abstract ID: 74 Carpentier, S., Steeghs, P., Zhang, Y., Leeuwenburgh, O., Data conditioning of 4D seismic timelapse data for improved inversion of reservoir pressure and saturation, 2017, Proceedings EAGE IOR 2017, Paper ID: We P206 Paap, B.F., Verdel, A.R., Meekes, J.A.C., Steeghs, T.P.H., Vandeweijer, V.P. and Neele, F., 2014, Four years of experience with a permanent seismic monitoring array at the Ketzin CO2 storage pilot site, Energy Procedia, Volume 63, pp 4043-4050 Steeghs, P., Vandeweijer, V., Mosher, C., Li, J., de Kleine, M., 2015, Acquisition and processing of a high resolution 3D seismic survey – offshore Netherlands, 2015, Proceedings EAGE 2015, Paper ID: Th N107 01. **Technical equipment:** - 64 Sercel seismic stations, 3-component, broadband, fully digital, Wireless
Relevant projects/activities
• Integrated Methods for Advanced Geothermal Exploration (IMAGE), (EU FP7 project, coordinator) • GEOWELL, (H2020) • DESTRESS(H2020) • SURE, (H2020) • Derisking shallow geothermal exploration with new methods in Berlin (National project, coordinator)

1.13. Polish Geological Institute - National Geological Institute (PIG-PIB)

Name of organisation	Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy		
Short name	PIG-PIB	**Country**	Poland

Organisation profile

PGI-NRI is involved in comprehensive studies of geological structure of Poland for practical use in national economy and environmental issues. It is especially responsible for the country's energy security, supply of mineral resources, groundwater management, monitoring of the geological environment and warning systems with respect to natural hazards and risks. Other major activities of PGI-NRI comprise also: acquisition, storage, processing and dissemination of geological and geo-environmental information on the entire territory of Poland, expertise on a wide array of geological issues for the state administration and local authorities, editing and publishing maps, atlases, periodicals and series of publications in geology and cooperation with geological surveys and organizations involved in geological research in other countries.

In the framework of the valorization of energy resources, PIG-PIB assessed the potential of renewable energy including deep and shallow geothermal energy. PGI-NRI has undertaken several research projects dealing with (i) deep, geothermal water intakes and their evaluation to use for district heating and recreational purposes, (ii) investigation of economically suitable areas for future installation of hot dry rock geothermal systems and (iii) construction of models and shallow geothermal maps usable to optimize the proper location and power of ground source heat pumps.

The basis of all mentioned studies is the information stored in the Central Geological Database (including vast boreholes data) and collection of numerous geological documents stored in the National Geological Archive.

PIG-PIB has fairly vast experience in cooperation with regional and local administration in land use planning by providing a wide range of information and conducting problem analyses. Moreover, the PGI-NRI is the custodian of much of the country's geo-scientific information and runs the state geological archives. The important platform for international cooperation of the PGI-NRI is the EuroGeoSurveys (EGS), the organization of national geological surveys of Europe.

Roles / tasks in the project	**Special relevant skills**
• Lead of task 3.1 and 4.14 (pilot area Warsaw) • Coordination of deliverable D.3.1 • Core working group WP2, WP3, WP5 and WP6	• Mapping and assessing shallow geothermal energy potential • TRT measurements and interpretation of results • laboratory measurements of geothermal properties of rock, soils and fluids • Developing strategies on SGE management

Short profile of staff member(s) who will be undertaking the work

Maciej Kłonowski (male)

Is a PhD senior researcher specialized in hydrogeology, hydrogeochemistry of natural and contaminated groundwaters, shallow geothermal energy, environmental geology, CO2 capture and storage, hydrogeology of deposits of hydrocarbons. Dr. Kłonowski has been involved in several national and international projects for over 20 years of his scientific career at PGI-NRI, including the most recent: TransGeoTherm, GeoPLASMA-CE and Geothermal4PL (project co-ordinator). He also possess four years' experience of employment as the scientific officer and assistant to the Secretary General of the Association of the European Geological Surveys EuroGeoSurveys based in Brussels. Since 2010 Maciej Kłonowski is an expert of the Working Group G5 "Data management" of the International Commission on the Protection of the Oder against Pollution. Dr. Kłonowski is an author of several scientific papers as well as hydrogeological maps and reports.

Edyta Majer (female)

Is a PhD in geotechnical engineering. She is a Head of Environmental and Engineering Geology Program of PGI (with staff consisting of over 70 people). Member of numerous professional organizations including: Polish Committee of Environmental and Engineering Geology (PKGIŚ), Polish Standardization Committee (PKN) and Warsaw Geotechnical Laboratories Group (WGLG). Her professional areas of interest include landfill protective clay barriers and site investigation for large linear infrastructure projects (mostly highways and railways). Author of numerous guidelines and handbooks. Author and co-author of over 70 ground investigation reports and expertises for large engineering projects (including A1 Highway in Poland – co-author of Engineering Geological Report, Piaseczno Sulphur Open Cast Pit Mine landslide engineering-geological report, New 833 MW Block of Bełchatów Power Plant engineering-geological report, etc…). She has geological qualifications certificate – category VI for determination of engineering-geological and foundation conditions for hydrotechnical structures, surface infrastructure of mines and underground storage of waste and resources.

Marta Sokołowska (female)

Is a PhD in geotechnical engineering, and specialist in determining foundation conditions and site investigations. Works in Environmental and Engineering Geology Program of PGI. Author and co-author of over 100 ground investigation reports and expertises for large engineering projects (including A1 Highway in Poland – co-author of Engineering Geological Report, Piaseczno Sulphur Open Cast Pit Mine landslide engineering-geological report, New 833 MW Block of Bełchatów Power Plant engineering-geological report, etc…). Long-time member of research team led by Ms. Edyta Majer. Since 2005 is a secretary of Warsaw Geotechnical Laboratories Group (WGLG) and a member of ELGIP since 2008. She has geological qualifications certificate – category VII for determination of and foundation conditions for engineering structures.

Grzegorz Ryżyński (male)

Senior specialist in Environmental and Engineering Geology Program of PGI. Specialized in site investigation and GIS mapping. Over 6 years of practical experience in site investigation in large engineering projects (New 833 MW Block of Bełchatów Power Plant geotechnical supervision, 2007-2008, New 460 MW Block of Turów Power Plant – coordination of in situ geotechnical investigations, co-author of ground investigation report). Author of over 40 ground investigation reports and expertises and 4 scientific articles. Since 2013 involved in administration of Engineering Geological Database project in PGI (Oracle database, GIS spatial layers management, GeoStar 7BDGI borehole database Interface). He has geological qualifications certificate – category VII for determination of and foundation conditions for engineering structures. Active member of ELGIP Geothermal Group. Since 2015 Management Committee Member of COST Action TU1405 GABI. Author of R&D report in Building Research Institute on seasonal ground freezing depth monitoring system.

Wiesław Kozdrój (male)

Is a PhD in Earth Sciences, Research officer of PGI since 1995; in 2007-2010 Technical Adviser for geological mapping and geochronology Dept. in Saudi Geological Survey (Jeddah, Saudi Arabia); at present Adjunct in the Energy Security Programme of PGI; awarded Abraham Gottlieb Werner Medal (2002) from Deutsche Geologische Gesselschaft (DGG). He has 30 years of experience in geological and structural mapping, geochemistry, geochronology and geotectonic evolution of metamorphic rocks. He has worked in numerous R&D projects in Poland and in collaboration with foreign geological surveys especially in regional, geological mapping at different scales and gained experience in supervising multi-staff scientific projects. His recent research is focused on evaluation of shallow geothermal potential with use of 3D modelling and mapping tools. In 2012-2014 he was Leader of EU project “TransGeoTherm: Geothermal energy for Transboundary Development of the Neisse Region. Pilot Project”. Author or co-author of 100+ publications, maps and geological documentations.

Publications, infrastructure / technical equipment

Kozdrój W., Kłonowski M., Mydłowski A., Ziółkowska-Kozdrój M.,Badura J., Przybylski B., Russ D., Zawistowski K, Domańska U., Karamański P., Krentz O., Hofmann K, Riedel P., Reinhardt S, and Bretschneider M., 2014 - 3D geological modelling and geothermal mapping – the first results of the transboundary Polish – Saxon project "TransGeoTherm", Geophysical Research Abstracts, Vol.16, EGU2014-5132,2014, EGU General Assembly 2014

Website (www.transgeotherm.eu) with published maps of shallow geothermal potential as a planning tool to optimise ground source heat pumps,

Website (atlasy.pgi.gov.pl) – database of Engineering Geological Database Project (acronym BDGI) with engineering-geological borehole and spatial data for large cities in Poland

Jankowski S, Hrechka A, Szymański Z, Ryżyński G. "Modelling engineering-geological layers k-nn and neural networks" published in "Neural Networks and artificial intelligence, 8th international Conference, ICNNAI 2014, Brest, Belarus, Proceedings Series: Communications in Computer and Information Science, Vol. 440, Springer 2014

Majer E, Sokołowska M, Ryżyński G. „Identyfikacja ryzyka geologicznego w procesie inwestycyjnym (Identication of geological risk in construction proces)" published in Proceedings of Conference: "XXVIII Warsztaty Pracy Projektanta Konstrukcji (XXVIII Workshops for Structural Engineers)", Wisła, 5-8 march 2013, Poland

Relevant projects/activities

- GeoPLASMA-CE Shallow Geothermal Energy Planning, Assessment and Mapping Strategies in Central Europe (Interreg Central Europe, 2016 – 2019)
- TransGeoTherm: Geothermal energy for Transboundary Development of the Neisse Region. (Interreg Germany – Poland, 2012-2014),
- Engineering Geological Database (2013-2016, financed by the National Fund for Environmental Protection and Water Management, within framework of the Polish Geological Survey activities).
- Guidelines for site investigation of degraded land areas (Ministry of Environment, 2011-2012) *https://www.mos.gov.pl/g2/big/2012_11/141ae6270e3787f8e55d37d7cb5e80a6.pdf*
- COST Action TU1206 Sub-Urban: A European network to improve understanding and use of the ground beneath our cities (duration of the action 2013 – 2017)
- Geothermal4PL Support for the sustainable development and use of shallow geothermal energy in the areas covered by the Mieszkanie Plus programme in Poland

1.14. Slovak Geological Institute of Dionýz Štúr (SGIDS)

Name of organisation	State Geological Institute of Dionyz Stur		
Short name	SGIDS	Country	Slovakia

Organisation profile

The Institute as a contributory scientific-research organization is performing the activity of the state geological service. That involves solution of tasks of geological research and survey, creation, using and protection of information system in geology, registration, collecting, evidence and accessing of the results of geological work performed on the territory of the Slovak Republic. For that purpose it has been doing mainly systematic and complete geological research, design, making and evaluation of geological works. The Institute is responsible for national information system and registry in the field of geology “Geofond”.

Roles / tasks in the project	Special relevant skills
• Lead of task 4.11 (pilot area Bratislava) • Core working team WP6 • Contribution to WP2, WP3 and WP5	• Evaluation of groundwater regime • Assessment and monitoring of groundwater parameters • Elaboration of geological, hydraulic and geothermal models.

Short profile of staff member(s) who will be undertaking the work

PhD, Radovan Černák (male)
Experience in design of geological works, groundwater regime monitoring, evaluation of rock environment hydraulic properties with more than 15 years’ experience.

PhD, Jaromír Švasta (male)
Experience in evaluation of hydraulic properties of the rock environment, water regime, hydraulic and geothermal modelling, groundwater vulnerability evaluation, with more than 15 years’ experience.

Publications, infrastructure / technical equipment

Malík, Peter - Černák, Radovan - Švasta, Jaromír 2015: Comparison of resistive hydraulic properties of granitoids, metamorphic and carbonate rocks from specific discharge data. Engineering Geology for Society and Territory. Volume 3 - River Basins, Reservoir Sedimentation; IAEG XII Congress Volumes, ISBN 978-3-319-10303-7, Springer International Publishing, s. 549-556

Prestor, Joerg - Szőcs, Teodóra - Rman, Nina - Nádor, Annamária - Černák, Radovan - Lapanje, Andrej - Schubert, Gerhard - Marcin, Daniel - Benkova, Katarina - Götzl,Gregor : Benchmarking - Indicators of Sustainability of Thermal Groundwater Management, Proceedings World Geothermal Congress 2015, Melbourne, Australia, 19-25 April 2015, ISBN: 9781877040023

Bujnovský, Radoslav - Koco, Štefan - Švasta, Jaromír - Gáborík, Štefan - Panák, Martin - Malík, Peter 2015: Strategické aspekty ochrany vôd pred difúznym znečistením živinami z využívania poľnohospodárskej pôdy. In: Vedecký obzor / Scientific Horizon, 7. ročník - 2/2015, ISSN 1337-9054, s. 16-22

Malík, Peter - Slaninka, Igor - Švasta, Jaromír - Michalko, Juraj 2015: Oxygen Isotope Composition Snapshot of Spring Waters in a Karstified Plateau, 5th International Symposium on Karst Aquifers (ISKA5), Malaga, Spain, October 14-16, 2014.: Environmetal Earth Sciences. Vol. 1. Springer-Verlag, 2015. - ISBN 978-3-642-17434-6

Relevant projects/activities

- GeoPLASMA-CE - Shallow Geothermal Energy Planning, Assessement and Mapping Strategies in Central Europe (Interreg, Central Europe, 2016-2019)

- Groundwater vulnerability research for the management of sustainable groundwater use in the Bratislava Self-governing Region.

- Identification and evaluation of alternative drinking groundwater sources, pilot area of Bratislava Self-governing Region.

1.15. *State Informational Geological Fund of Ukraine (GEOINFORM)*

Name of organisation	State Research and Development Enterprise State Information Geological Fund of Ukraine		
Short name	GEOINFORM	**Country**	Ukraine

Organisation profile

The State Research and Development Enterprise "State Informational Geological Fund of Ukraine" – SRDE “GeoInform of Ukraine”, or GeoInform, is the specialized research and development unit of the State Geological and Subsurface Survey of Ukraine which collects, stores, analyses and provides information received from geological study and use of subsurface.

GIU conducts research work on monitoring of mineral resources of Ukraine on the basis of geological and mining activities during the year, recording deposits and making public the balance of mineral resources management of the State fund of deposits and occurrences (more than 10,000 objects recorded), synthesis and analysis of exploration for oil and gas, creating a system of state accounting of oil and gas wells, completion and maintenance of the State cadastre of mineral deposits and occurrences as well as State cadastre of groundwater deposits of Ukraine.

Roles / tasks in the project	**Special relevant skills**
• Contribution to all WPs	• Database design and web services for subsurface data

Short profile of staff member(s) who will be undertaking the work

Dr. hab. Boris Malyuk (male)
Director for International Cooperation, graduated in 1981 from Department of Geology, Lviv University, Ukraine, and in 1999 from Centre of Geostatistics, Ecole des Mines de Paris, France. Obtained Candidate of Science (PhD) Degree in Geotectonics in 1984, and extended Doctor of Science Degree in Petrology in 1991. National Delegate of Ukraine to the EuroGeoSurveys.

Dr. Igor Melnyk (male)
Sector Chief, with basic background in geology, has an experience in field works and research in geochemistry, hydrogeology and ecology (PhD in 1996), as well as geoinformatics and GIS applications.

Tetiana Biloshapska (female)
Chief Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1980. She is experienced in field works. She had studied mineral-resource base of Ukraine for more than 30 years, took part and led projects on prospecting and exploration of mineral deposits, conducted regional geological studies.

Galyna Polunina (female)
Leading Geologist. Graduated from Tyumen Industrial Institute under specialty 'Geology and Exploration of Oil and Gas Deposits' in 1975. She is working out with hydrocarbon deposits and oil and gas resources inventory of Ukraine for more than 40 years.

Larysa Ovdienko (female)
Leading Geologist. Graduated from Kyiv National University under specialty 'Hydrogeology' in 2004. She is experienced in operating activities from 'Ukrnafta' Joint-Stock Company, she worked out with oil and gas well water inflow, environmental problems of oil and gas industry.

Ivanna Pelykhovych (female),
Leading Geologist. Graduated from Ivano-Frankivsk State Technical University of Oil and Gas under specialty 'Geophysics' in 2001. She has more than 15 years’ experience in field geophysical surveys (seismic, well studies), their results interpretation and integration of results from exploration works for oil and gas in Ukraine.

Publications, infrastructure / technical equipment

Interactive map of mineral deposits of Ukraine (in Ukrainian) http://geoinf.kiev.ua/wp/interaktyvna-karta-rodovyshch-korysnykh-kopalyn.htm Interactive map of mineral licenses (in Ukrainian) http://geoinf.kiev.ua/wp/interaktyvni-karty-spetsdozvoliv.htm Interactive geological map of Ukraine 1:1 000 000 (in Ukrainian) http://geoinf.kiev.ua/wp/Interaktyvna-heolohichna-karta-Ukrayiny.htm Interactive geological map of Ukraine 1:1 000 000 (in English) http://geoinf.kiev.ua/wp/Interactive-Geological-Map-of-Ukraine.htm Interactive State Geological Map of Ukraine 1:200 000 (in Ukrainian with English entries) http://geoinf.kiev.ua/wp/kartograma.htm
Relevant projects/activities
• ESTMAP (H2020) • EUOGA (H2020) • NUMIRE – Norway-Ukraine (NGU/SGSSU) • EIMIDA – Norway-Ukraine (NGU/Geoinform)

1.16. *The Geological Survey of Denmark and Greenland (GEUS)*

<table>
<tr><td>Name of organisation</td><td colspan="3">Geological Survey of Denmark and Greenland</td></tr>
<tr><td>Short name</td><td>GEUS</td><td>Country</td><td>Denmark</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">GEUS is an independent research and advisory institution in the Danish Ministry of Energy, Utilities and Climate. GEUS conducts geological research to exploit and protect geological natural resources in Denmark and Greenland. Primary activities are research in water, energy, minerals and other natural resources. GEUS provide geological advice to public authorities in nature, environment, climate, energy and raw materials issues and participate in the performance of tasks within these areas. GEUS is the national geological data centre and in that capacity make data and knowledge available to the authorities, educational institutions, government agencies, private enterprises and the public. GEUS also undertakes assignments related to water, energy, minerals and the environment on a contractual basis for other public authorities, private companies and clients outside Denmark.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">• Lead of WP5
• Lead of tasks 4.6 (pilot area Aarhus) and 5.2
• Core working team WP2
• Contribution to WP3 and WP6</td><td colspan="2">• Mapping of shallow geothermal resources
• Assessment of thermal conductivity in glacial sediments
• Web services</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Dr. Claus Ditlefsen (male)
Has about thirty years' professional experience in glacial geology and mapping of groundwater and mineral resources. Prior to his present appointment at GEUS he worked in private consultancy for a number of years advising authorities on different topics related to geological resources. He has recently been project manager on a three year inter-institutional project investigating closed loop borehole for energy extraction for the Danish Ministry of Energy, Utilities and Climate and is currently managing a similar project aimed at mapping the possibilities for geological heat storage in Denmark.

Anders Juhl Kallesøe (male)
Geologist at GEUS with more than 6 years of professional experience in 3D geological modelling, interpretation of glacial geology, mapping of groundwater and mineral resources and GIS analyses of geological data. Prior to his present appointment at GEUS, Anders was working in private consultancy with projects related to geothermal ATES systems and 3D geological and hydrogeological mapping of groundwater resources.

Martin Hansen (male)
Geologist of education employed as Chief Consultant at GEUS. Has about 30 years of experience in geological data management. Have been working in the area spanning computer sciences and geology for the first 15 years mainly working with GEUS' environmental databases and doing geological and hydrogeological modelling, dual porosity flow modelling. For the last 15 years, mainly doing project management on most of GEUS central geological related databases and geological data management for vide range of data covering geological, geophysical, groundwater, oil and gas and geo- and hydro-chemical data and marine raw materials.</td></tr>
</table>

Publications, infrastructure / technical equipment
Ditlefsen, C., Rasmussen P. & Højberg A. L. (2016): 3D modelling of borehole heat exchangers at hydrogeological conditions typical of the north European lowlands, sensitivity studies from Denmark. Proceedings of the European Geothermal Congress 2016. Ditlefsen, C., Sørensen, I., Slott, M. & Hansen, M. (2014): Estimating thermal conductivity from existing soil descriptions. – A new web based tool for planning of ground source heating and cooling. Geological Survey of Denmark and Greenland Bulletin 31. 55-58, GEUS 2014. Ditlefsen, C., Sørensen, I., Bjørn, H., Balling, I.M., Højberg, A.L. and Vangkilde-Pedersen, T.: GeoEnergy – a national shallow geothermal research project. European Geothermal Congress 2013. Ditlefsen, C., Møller, I. Sørensen, I., Bjørn, H., Højberg, A. L. & Vangkilde-Pedsersen, T. 2013: Ground Source heating, - Elements in a sustainable energy supply. Science for the Environment 2013. Mapping knowledge needs for future horizons. 3-4 October 2013. Aarhus. Danish Centre for Environment and Energy. Conference Book, 27 only. Ditlefsen, C. & Vangkilde-Pedersen, T. 2012: Shallow geothermal energy in Denmark - current status and trends. 74th. EAGE Conference & Exhibition 2012. 4-7 June 2012. Copenhagen. European Association of Geoscientists and Engineers. Abstract volume, 2
Relevant projects/activities
• REGEOCITIES (H2020). • Closed loop boreholes - knowledge, tools and best practice (Danish Energy Agency 2012-2014). • Mapping of the potential for geological heat storage in Denmark. (Danish Energy Agency 2017-2019).

List of attachments

No.	Country Code	Title	File
1	UK	Expression of Interest: City of Cardiff Council	*GE2_MUSE_EoI_Cardiff.pdf*
2	DK	Expression of Interest: Municipality of Aarhus	*MUSE_Aahurs Letter_of Support.pdf*
3	HR	Expression of Interest: Hidro-Geo Projekt d.o.o. (SME, Croatia)	*HR-ZG-EoI_MUSE_HGP.pdf*
4	ES	Expression of Interest: Catalan Water Agency - AGAN	*GE2_MUSE_LoI_Urban_Girona.pdf*
5	AT	Expression of Interest: Magistratsabteilung MA20, city of Vienna	*Letter_of_Intent_Vienna.pdf*
6	CZ	Expression of Interest: Department of environmental protection, city of Prague	*GE2_MUSE_EoI_Prague.pdf*
7	HR	Expression of Interest: University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering (Croatia)	*HR-ZG-EoI_MUSE_FMGPE.pdf*
8	HR	Expression of Interest: IKEA Hrvtska d.o.o. (Croatia)	*HR-ZG-EoI_MUSE_IKEA.pdf*
9	IE	Expression of Interest: Geothermal Association of Ireland	*GE2_MUSE_EoI- Geological Survey Ireland - GAI 20180103.pdf*
10	IE	Expression of Interest: Sustainable Energy Authority of Ireland	*GE2_MUSE_EoI_template - Geological Survey Ireland - SEAI.pdf*
11	IE	Expression of Interest: University College Cork	*GE2_MUSE_EoI_template - Geological Survey Ireland - UCC (JW 04-01-17).pdf*
12	SE	Expression of Interest: Tekniska Verken I Linköping AB	*EOI Linkoping pilot sweden.pdf*
13	BE	Expression of Interest: Bruxelles Environement - IBGE	*MUSE_EoI_IBGE_Brussels.pdf*
14	ES	Expression of Interest: Ebro Hydrographic confederation	*EoI_IGME_ZARAGOZA_SPAIN.pdf*
15	HR	Expression of Interest: University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture	*HR-ZG-EoI_MUSE_FMENA.pdf*
16	ES	Statement of participant IGME on the purchase of the updated version of the numeric modelling software FEFLOW in MUSE.	*180109-01_Statement_IGME_FEFLOW.pdf*
17	IE	Expression of Interest: Cork City Council	*GE2_MUSE_EoI_Cork-City_Council.pdf*
18	--	Ethics self-assessment sheet	*MUSE_self-assessment.pdf*

5 Ethics and Security

5.1 Ethics

Do you have an ethics self-assessment?

YES

The project proposal has been checked against the ethics sections in “H2020 Guidance —How to complete your ethics self-assessment: V5.2 – 12.07.2016”. This check did not raise any issues. The checklist is included with the submitted documents in ISAAC.

5.2 Security

Please indicate if your project will involve:

- Activities or results raising security issues: NO
- 'EU-classified information' as background or results: NO

5.7 HOVER

TITLE OF PROJECT PROPOSAL

H*ydrogeological processes and Geological settings* ***over*** *Europe controlling dissolved geogenic and anthropogenic elements in groundwater of relevance to human health and the status of dependent ecosystems - HOVER*

ABSTRACT

The challenge is to gain understanding of the controls on groundwater quality across Europe using the combined expertise and data held by member states. The project will address groundwater management issues related to drinking water, human and ecosystem health across Europe in relation to both geogenic elements and anthropogenic pollutants by data sharing, technical and scientific exchange between European GSOs[1]. We will link our knowledge of geological settings and understanding of hydrogeological processes to the natural variability of groundwater quality and to the risk of transfer of anthropogenic dissolved compounds to aquifers. For natural water quality this will include evaluating health risks and spatial variability of concentrations of geogenic elements and using a common approach to assessing thermal and mineral water. For diffuse pollutant behaviour we will increase understanding of ecology and microbial diversity controls on transforming pollutants at groundwater-surface water transition zones, quantify groundwater age distributions and nitrate and pesticide travel times in the subsurface and their attenuation patterns for evaluating the efficiency of programme of measures, the design and assessment of monitoring programmes, pollution trends, and create EU-wide aquifer vulnerability maps by comparing assessment methods across Europe. New compounds will be addressed by developing a consistent approach to groundwater monitoring for organic emerging contaminants. Common standards, databases and maps will be developed and project outputs will include thematic maps and web service tools at pan-European scale and databases available through the Information Platform to increase political and public awareness and improve groundwater management at the EU scale.

Groundwater – GW1-Drinking water, human and ecosystem health

LIST OF PARTICIPANTS

#	Participant Legal Name	Country
1	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek – (TNO)	Netherlands
1a	DELTARES (DLT)	Netherlands
3	Geologische Bundesanstalt (GBA)	Austria
6	Vlaamse Milieu Maatschappij - Flanders Environment Agency (VMM)	Belgium
7	Federalni zavod za geologiju (Geological Survey of Federation of Bosnia and Herzegovina) (FZZG)	Bosnia-Herzegovina
9	Hrvatski Geološki Institut (HGI-CGS)	Croatia
10	Ministry of Agriculture, Natural Resources and Environment of Cyprus – Geological Survey Department (GSD CYPRUS -> GSD in HOVER)	Cyprus
11	Ceska Geologicka Sluzba – Czech Geological Survey (CGS)	Czech Republic
12	Geological Survey of Denmark and Greenland (GEUS)	Denmark
14	Geologian Tutkimuskeskus (GTK)	Finland
15	Bureau de Recherches Géologiques et Minières (BRGM) [Project Coordinator]	France
17	Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)	Germany
22	Landesamt für Bergbau, Energie und Geologie Niedersachsen (LBEG)	Germany
27	Mining and Geological Survey of Hungary (MBFSZ)	Hungary
28	Islenskar orkurannsoknir - Iceland GeoSurvey (ISOR)	Iceland
29	Geological Survey of Ireland (GSI)	Ireland
30	Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA)	Italy
39	Latvian Centre of Geology, Environment and Meteorology (LEGMC)	Latvia
40	Lietuvos Geologijos Tarnyba prie Aplinkos Ministerijos (LGT)	Lithuania
42	Ministry for Transport and Infrastructure (MTI)	Malta

[1] GSO : Geological Survey Organisation

44	Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy (PIG-PIB)	Poland
45	Laboratório Nacional de Energia e Geologia (LNEG)	Portugal
46	Institutul Geologic al României (IGR)	Romania
47	Geological Survey of Serbia (GSS)	Serbia
49	Geološki zavod Slovenije (GeoZS)	Slovenia
50	Instituto Geológico y Minero de España (IGME-Spain, IGME in HOVER)	Spain
51	Institut Cartogràfic i Geològic de Catalunya (ICGC)	Spain
52	Sveriges Geologiska Undersökning (SGU)	Sweden
53	State Research and Development Enterprise State Information Geological Fund of Ukraine (GEOINFORM)	Ukraine
54	Natural Environment Research Council (NERC)	United Kingdom
**	Eesti Geoloogiateenistus (EGT)	Estonia
**	Institut Royal des Sciences Naturelles de Belgique (RBINS-GSB)	Belgium
**	Landesamt für Bergbau, Geologie und Rohstoffe Brandenburg (LBGR)	Germany

**: non-funded partners

1 EXCELLENCE

1.1 Objectives in Relation to the Specific Research Topic (SRT)

Groundwater quantity and quality is of great importance for the economic development of Europe as it is the most important resource for drinking water, irrigation and industrial uses. Groundwater as such and as locally the main contributor to surface water is also a pillar to ecosystem health. Quality of the groundwater is linked to physico-chemical parameters such as temperature, pH, redox potential and the presence of dissolved elements from geogenic (natural) or anthropogenic origin. The project objective is to link the geological settings and hydrogeological processes to the natural quality of groundwater and to the risk of transfer of anthropogenic dissolved elements to aquifers. The technical and scientific fundamentals of the HOVER project are the geological knowledge and comprehensive understanding of the hydrogeological processes involved in the transfer of organic and inorganic elements of natural and anthropogenic origin. Project findings are designed to increase political and public awareness and improve groundwater management at the EU scale. Thus, information and communication technologies involved will allow producing databases, maps and web service tools at pan-European scale that will be made available for a large public through the Information Platform (IP project). As specified in the Groundwater Specific Research Topics of the GW1 (GEOERA joint call document N°9), the HOVER project addresses groundwater management issues, drinking water, human and environmental health, linked to the presence and spatial variability of high concentrations of geogenic elements and the vulnerability to anthropogenic impacts for nutrients (mainly nitrate), pesticides and emerging contaminants.

The project comprises 8 work packages and is directed towards data exchange and database construction for the needs of the development of specific elements in relation to the SRT:

- Determining the natural variability of concentration of elements of geogenic origin depending on the geological and hydrogeological settings, evaluate by the mean of indicators the health risks and benefits and assess using a common approach thermal and mineral water
- Increasing the understanding of how groundwater ecology and microbial diversity determine contaminant-transforming processes at European groundwater-surface water (GW-SW) transition zones
- Assessing nitrate and pesticide travel times in saturated and unsaturated zones and where possible attenuation patterns for a number of relevant European settings for evaluating the efficiency of programme of measures
- Demonstrating the use of groundwater age distributions for the design and assessment of monitoring programmes, pollution trends and history and the evolution of groundwater quality
- Assessing vulnerability of the upper aquifer to pollution using GIS and comparing vulnerability assessment methods used depending on data available and the different hydrogeological conditions in Europe
- Developing a consistent approach to groundwater monitoring for Organic Emerging Contaminants (ECs) in terms of sampling, site selection, monitoring frequency and methodology (including analytical

techniques) and to ensure it is effective and data are comparable across the range of European geological and environmental settings

The HOVER project will also address the development of common standards, database and maps. The database, at the interface of the Information Platform Project will contain information on: soil properties geological characteristics, hydrogeological processes, data quality and physico-chemical parameters, dominating pressure at wells or well subterranean catchments.
One of the objectives of the project is the collaboration of a large number of GSO’s for data sharing, technical and scientific exchange that will permit taking into consideration all geological and hydrogeological specificities of Europe in the final products proposed.

1.2. Relation to existing EU programmes and projects – examples of more specific projects

The project is strongly linked to the **Water Framework Directive** (2000/60/EC) and the **Groundwater Directive** (2006/118/EC) since it will provide a basis at a European scale for the estimation of the natural background level necessary for the estimation of the chemical quality of the water, for the design of the monitoring network in relation to emerging contaminants, for a better understanding of the time lags for trend reversal and for evaluation the efficiency of programme of measures. It give also elements of understanding of the hydrogeological functioning such as relation between groundwater and surface water or attenuation processes, needed for the evaluation of the chemical status.

Various topics related to the implementation of the WFD are discussed under the **Working Group on Groundwater** (WGGW) of the Common Implementation Strategy (CIS) of the European Community. For example an initiative was launched three years ago aiming at defining the concept and methodology of a Groundwater Watch List. NERC and BRGM belong to this Initiative Group and will ensure knowledge exchange in relation to emerging contaminants. Various project partners are part of the CIS WGGW and are involved in WG initiatives such as threshold values, trend assessment…

BRIDGE (FP6-policies - Background cRiteria for the Identification of Groundwater Thresholds, Hinsby et al., 2008, Wendland et al., 2008) and **BaSeLiNe** (FP5 - Natural Baseline Quality in European Aquifers: a basis for aquifer management) former EU projects permitted to establish the bases for the estimation of the natural background levels and calculation of threshold values. Many of the eurogeosurveys involved in HOVER were partners of these two projects.

GTK and BRGM are involved in the **AgriAs-project** (Evaluation and management of As contamination in agricultural water and soil) for the EC WATERWORKS2015 ERA-NET Call: Joint WaterJPI Call on Sustainable management of water resources in agriculture, forestry and freshwater aquaculture sectors initiated in 2017. The project is directly linked to HOVER WP3. Data collected and information on the natural origin of arsenic will be an important support to AgriAs to reach its wide objectives.

The CE-project **TRANSENERGY – Transboundary Geothermal Energy Resources of Slovenia, Austria, Hungary and Slovakia** which started in 2010 involved the geological surveys of the 4 countries and will provide various data from the five pilot sites studied. Also **DARLINGe** - Danube Region Leading Geothermal Energy project (2017/2019 Interreg Danube Transnational Programme*)* for a more efficient thermal water management applying geological and hydrogeological models and hydrogeochemical and isotope hydrology data interpretation involved GEO-ZS, HGI-CSG, IGR, FZZG. The project has cross thematic relevance for HOVER and the geoenergy theme of GeoERA.

The WP on GW-SW relation relates to the **BONUS Soils2Sea** and the **ACWAPUR** projects both funded by EU Programs and national research agencies. The WP will benefit from results on nitrate transforming processes in the subsurface being the focus of **Bonus Soils2Sea.** This work package also relates to **ACWAPUR** where transformation of emerging contaminants are studied in soil and sediments during managed aquifer recharge.

The **COST Action 620** “Vulnerability and risk mapping for the protection of karst aquifers” project is closely related to the WP7. The outputs of the project and subsequent studies will be evaluated in task one of the WP (intercomparaison of existing methods).

A sub-group on groundwater of the working group on Prioritisation of emerging substances in the monitoring programs was created three years ago under the **NORMAN** network (Network of reference laboratories, research centres and related organisations for monitoring of emerging environmental substance). This working group is led by BRGM who is also in charge of the WP related to emerging contaminants.

1.3. Concept and methodology

1.3.1. The Project Proposal and the main ideas, models or assumptions involved

The overall concept underpinning the project proposal is the application of our excellent knowledge of the geological and hydrogeological properties of the subsurface and their functioning as dominant drivers of the concentration variability of natural and anthropogenic elements in groundwater coupled with the necessity to share data and develop IT (information technology) tools for water resource management.

Concentrations of elements in European groundwater are very diverse as was recently underlined by the European Commission in taking into account the large ranges of concentrations of dissolved element of natural origin within the Water Framework Directive for establishing the chemical status of groundwater and for risk assessment. Project activities related to geogenic diversity are mainly included in the work package 3 on **Hydrogeochemistry and health: Mapping groundwater characteristics for the management of aquifers naturally enriched in dissolved elements.**

High concentrations of elements in groundwater result in human health concerns and for good status objectives for groundwater itself and associated surface waters. Unacceptably high concentrations of Potentially Toxic Geogenic Trace Elements (PTGTEs), such as arsenic, in drinking water can pose a serious risk to human health and therefore recommendations for best management practice in the context of naturally high concentration are proposed. Determination of the anticipated concentrations of some critical elements (toxic or undesirable elements) of natural origin was tackled previously in European scale projects involving various eurogeosurveys (NERC, BRGM, TNO, BGR…). The HOVER project intends to update and improve the methods developed based on the most recent scientific developments and knowledge and the improvement of chemical data monitoring (lower quantification limits, more frequent measurements). A very large number of countries involved (22), representing all geological / hydrogeological settings will participate in these specific activities that aimed at strengthening the methodology and mapping various management indicators (Natural background level NBL, HydroGeoToxicity (HGT) indicator).

The concentration of elements in groundwater is one of the major criteria for defining special water such as mineral or thermal water. Thermal and mineral water are strongly connected with special geological structures and they represent important natural resources naturally enriched in geogenic elements. Thermal waters and medical springs are mostly used in spas due to their medicinal benefit. Exchanging information on the specific characteristics of these special waters would first be needed before developing a pan European information layer. Mapping this strategic resource is conducted to enhance the awareness of these special types of groundwater among professionals and public.

The implications of the interactions between groundwater (GW) and surface water (SW) in the GW-SW transition zone are related to both geogenic and anthropogenic elements. The GW-SW transition ("hyporheic") zone is a hotspot for biogeochemical processes controlling contaminant degradation. The specific aim of **WP4 on Linking aquifer microbial ecology and diversity to contaminant transforming processes at European groundwater-surface water transition zones** is to 1) increase our understanding of how groundwater ecology and microbial diversity impact contaminant transforming processes in GW-SW transition zones and 2) provide knowledge on GW-SW diversity and its potential use for GW management as a first step toward the development of a European GW ecosystem assessment scheme.

Nitrate and pesticides continue to be of major concern for groundwater use and environmental impact.and these are address within WP5 **Nitrate and pesticides transport from soil to groundwater receptors**. This WP aims to develop an understanding of the transport of nitrate (N) and pesticides (PST) in groundwater both for travel times in the unsaturated and saturated zones and for attenuation by denitrification in anoxic zones. This will result in a better understanding at the Pan European scale of the time lags for trend reversal, following programmes of measures to reduce N or PST applications to take effect in groundwater and associated surface water.

In close collaboration with WP5 e.g. on transfer time of nitrate, WP 6 **Groundwater *Age DIS*tributions and residence times in European aquifers** intends 1) to establish a harmonized database on groundwater age tracers and indicators currently existing in EU member states 2) to develop a good practice protocol on the application of age indicators for estimation of groundwater age distributions in time and space, 3) to demonstrate the use of groundwater age distributions for various hydrogeological purposes and 4) to test and develop new techniques for estimating age distributions of groundwater bodies and water supplies wells with residence times mainly in the age range of 10 to 1000 years.

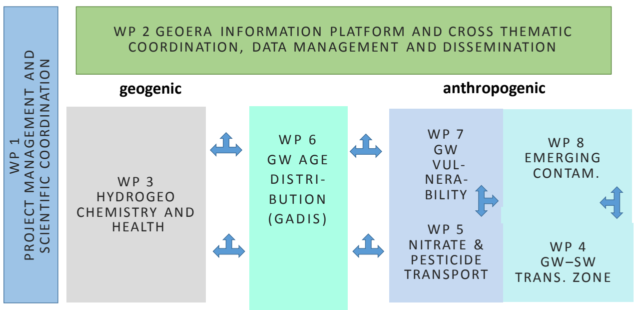
Vulnerability maps is a widely used tool for groundwater management. The **WP7 Harmonized vulnerability to pollution mapping of the upper aquifer** will permit to carry out: 1) Investigation, comparison and potential extension of methods for assessment of groundwater vulnerability to pollution in Europe, 2) Harmonization of data referring to pan European, cross-border and national scale, 3) Assessments of vulnerability of the upper aquifer to pollution using GIS, 4) Identifying specific areas of high aquifer vulnerability and 5) Data for the GeoERA Information Platform (GIP).

In recent years some compounds, which are not well monitored, and have poorly known chemical behaviour or degradation products have raised the attention of scientists and water managers. These elements called “emerging contaminants” are the focus of **WP8 Effective monitoring of emerging contaminants: development and validation of new assessment methods.** This work package will develop a consistent approach to GW monitoring for Organic Emerging Contaminants (ECs) in terms of sampling, site selection, monitoring frequency and methodology (including analytical techniques) and to ensure it is effective and data are comparable across the range of European geological and environmental settings.

Finally, **WP2 GeoERA Information Platform (GIP) and cross thematic coordination, data management and dissemination** will define requirements for and facilitate data delivery to the GeoERA Information Platform from the different work packages and develop a communication, dissemination and exploitation plan in close collaboration between the WP and project leaders, the groundwater theme coordinator and the GeoERA secretariat.

1.3.2 Main elements of the WP proposal and their interrelationship

The HOVER project is built around 6 technical WPs (WP3-8, see figure) and two coordination WPs (WP1-2). WP3 consider natural geogenic processes while WP4, 5, 7 and 8 considers groundwater with anthropogenic impacts. WP6 on GW age distribution considers both geogenic and anthropogenic water types and the location of the modern water interface as a vulnerability indicator for deeper aquifers. WP7 considers the vulnerability of upper shallow aquifers.)



Overall objective of this GeoERA initiative is the compilation and delivery of harmonized, findable, accessible, interoperable and reusable geodata, contributing to national and EU general activities in the Common Implementation Strategy (CIS) of the WFD. Monitoring data will be compiled and made available for the different activities. Most of the GSO’s involved in the project are in charge of their national groundwater monitoring databases.

By combining rock geochemistry and hydrochemistry with hydrogeological features (fractures, recharge, caption and discharge zones etc.) we will define main settings associated with concentration anomalies for contaminants and hazardous elements of natural origin, incl. time scales and vulnerability of aquifers to pollution in most of Europe (see below figure)

1.3.3 National or international research and innovation activities linked to the project proposal
Most of the eurogeosurveys are deeply involved in the national groundwater quality and quantity monitoring and associated database management. Also many of these institutes are producing geological, hydrogeological or other thematic maps related to groundwater at local, basin and national scales. Various institutes were involved in the determination of natural background level at the national scale. The activities of each institutes and expertise to lead innovation activities can be found in Annex 4 and table 3.3.

1.3.4 Methodologies developed
One of the major problems in determining the natural background level in groundwater is to discriminate between dissolved elements from geogenic and anthropogenic origins, most particularly in areas where human activities are well developed. Over recent years and following the implementation of the WFD, the quality of qualitative monitoring has improved in most EU countries. Improved sampling frequency and density, and lower detection limits permit sophisticated data treatment today. Additional information were also acquired such as trace elements released by human activities. In this project, it is proposed to perform statistical test analyses using monitoring data, and complementary information (geological and hydrogeological settings, land use). The statistical data treatment focuses on the comparison of the distribution of concentrations of major, minor and trace elements depending on different geological, lithological, land use contexts. Non-parametric methods such as Kruskal-Wallis testing will be used. As the Kruskal-Wallis H test cannot tell which specific groups of your independent variable are statistically significantly different from each other it is necessary, additionally, proceed to a post hoc test (for example Nemenyi post hoc test). The data treatment are realised from an independent way for each of the discrete variable (see below statistical data treatment proposed).

Also to determine the area of influence of each of the studies pressure or natural geology/lithology automatic data treatment using GIS may be employed. The generated dataset will be combined with other physico-chemical parameters such as pH or redox to precise the natural occurrence of elements and explain variability of concentrations in similar context.

Where data are insufficient in number or quality, it is proposed to work by analogies. For that purposes the geological and hydrogeological settings will be grouped by classes of similar characteristics. For example 186 hydrogeochemical units were defined for the purpose of mapping of the regional background values of the groundwater systems (German Association of Geology Services). The classes or type-settings may be used also for studying nitrate transfer, vulnerability or transit time.

The data statistic may be plotted (median, min, max of concentrations, 90th percentile) in order to obtain information at the EU scale on areas with anomalies. Ordinary Kriging will be used to estimate and elaborate specific elements mapping. These maps can be compared directly to the mineral and thermal groundwater resources defined elsewhere.

Indicators may be easier tools than simple dataset statistics for water management. One of the indicator that will be proposed is the HydroGeoToxicity (HGT) indicator defined as the quotient between the concentration of a particular Potentially Toxic Geogenic Trace Elements (PTGTE) in a specific water sample and the upper limit value for that element in potable water according to the (WHO) drinking water regulations (Giménez-Forcada et al., 2017a, 2017b). Other indicators may be proposed and developed so the complex links between a concentration of a specific elements in groundwater and the various rocks and processes where the water is flowing could be represented and used for various water management and health perspectives.

The determination of the homogeneous units/type-settings or classes, combining soils, geological and hydrogeological settings will be the starting point for various work packages. The units or classes to be determined could be "homogeneous" in terms of elements able to be released in groundwater, in term of transfer of water and related contaminants from soil to the saturated zone along the unsaturated zone and within the saturated zone, determining as such the vulnerability of upper aquifers.

Mapping at the pan-European scale is not straightforward as the interoperability issues between data of different origin (from thematic and countries) and the 3D aspects need to be solved. This work will be undertaken in direct collaboration with the Information technology Platform. The work will need to be done in a series of steps: collect the geological surveys information on available data and format, develop tool to collect uniformity, (re) interpret, manage and visualize data, provide pan European information layers using specific format such as WMS and then enhance the awareness among professionals and general public.

The goal of the vulnerability WP is to prepare vulnerability maps reflecting these causalities, resulting in products at the Pan European (1:1.5 Mio), supra-regional (1:1.5 Mio), cross-border (1:250k) and optionally national scale, each referring to the potential aquifer vulnerability to pollution. Parametric system methods for assessing vulnerability (rating systems such as DRASTIC, GOD, AVI; point count system models, such as SINTACS, EPIK) are used for establishing these maps. These methods will be evaluated and applied according to the aforementioned criteria.

Overall lag times for type-sites of different hydrogeological settings will be combined with harmonised monitoring data and process indicators to develop overview maps of N and PST travel time. We will apply a similar approach to denitrification.

At small scale, a specific study will be carried out related to the groundwater-surface water relationship in order to assess the environmental impact. Sediments will be sampled from the hyporheic zone of different European river systems and characterized in terms of microbial diversity and potential for sorption and degradation of selected contaminants, including nitrate. The microbial community structure of the sediments will be determined by 16sRNA amplicon sequencing and related to the presence of contaminant degrading bacteria determined by qPCR as well as hydrological and geochemical conditions of the specific site. Finally, relationships between sorption, degradation, presence of degrader genes, as well as hydrological and geochemical characteristics at the GW-SW interface will be established.

Projects are proposed to be carried out at three different scales: pan-European studies with the objectives of covering the largest number of countries in thematic maps or indicators, multi-pilot projects including a great number of functioning classes/units so results could be extend to other countries and small scale, demonstration or methodological studies that meant to produce guidelines, recommendation for good practices or to propose advances for further scientific developments.

In that sense, some activities would lead to thematic maps including most of the participating countries. This is the purpose of WP3 proposing a map of natural water quality and health including thermal and mineral water over Europe. In addition, a vulnerability map to pollution of the upper aquifer will be built.

For developing water quality management tools, Pan-European activities will use geological/lithological contexts as much as possible. These activities are the assessment of N travel times and attenuation patterns (WP5), the establishment of the spatial distribution of groundwater age and vulnerability classes in selected countries, spatial distribution of some selected emerging contaminant.

Lastly, many proposed activities will lead to recommendations for monitoring (age indicators, emerging contaminant), preparation of guidance on i) characterizing agrochemical travel time in the unsaturated and saturated zones, ii) good practice protocol and recommendations for the combined use of different age indicators and models, iii) recommendations on statistical data treatment to evaluate influence of anthropogenic pressure on groundwater dissolved elements or vi) on the use of microbial diversity measures for monitoring contaminant transforming processes at GW-SW transition zones.

1.4 Ambition

Water quality is one of the major problems in European aquifers, with various areas with high content of toxic elements of natural origin (Reimann and Birke, 2010), nitrate and pesticides concentrations over the quality standards for human use (report from the commision to the european parliament and the council on the Implementation of the Water Framework Directive (2000/60/EC) River basin Management plans, 2012; Life's blueprint for water resources, European union, 2012) or degradation of associated ecosystems due to nutrients. Beyond the evaluation of groundwater quality at sampling point or water bodies it is necessary to understand the geological and hydrogeological settings related to the geogenic chemicals and the pressure and transfer processes of the anthropogenic elements. The HOVER projects will put great emphasis on the European scale of the application of the results and therefore would base most of the study on the description and definition of "type-setting" allowing extension of the information acquired at large scale.

Thermal and mineral waters, medical springs are important natural resources. Thermal waters and medical springs are mostly used in spas due to their medicinal benefit. Mineral waters are extremely important for beverage industry. One of the important deliverable of WP3 is getting a Europe-wide overview on special groundwater (thermal and mineral) which are of great economic value and an overview of the anomalies in trace elements based on a uniform method. Some transboundary projects are on-going (**TRANSENERGY, DARLINGe**) and national maps and inventory of thermal and mineral resources exist in most countries. The objective of the project for high salinity water is to use existing data and knowledge developed within the national or multi-partnered projects, in order to establish a map of these special water on a homogeneous way at a European scale.

Groundwater forms an important source of potable water in Europe. The Drinking Water Directive (98/83/EC) imposes stringent quality criteria, for drinking water. For various trace elements, such as arsenic, the legislation establishes limits that are often exceeded, even under natural conditions. The geological matrix and hydrogeological processes are what largely determines the presence of certain trace elements in groundwater. Unacceptably high concentrations of arsenic and other Potentially Toxic Geogenic Trace Elements (PTGTE) in drinking water can pose a serious risk to human health and mapping probabilities of exceedance of the threshold permitted by the Water Framework Directive allow delimiting the most vulnerable areas. The existing geostatistical techniques are a common tool for the evaluation of these maps, though, there is no agreement on which of the methods is the best. Elements such as As, Ba, Cd, Cr, Cu, F, Fe, Hg, Mn, Pb, Ni, Se, Sn or Zn are potentially present in groundwater and may create management problems linked to human and environmental health. Studies at pan-European scale based on chemical analyses of some tap water (Flem et al. 2015) or bottled water (Reimann and Birke, 2010) as well as the threshold values reported to the EU commission (commission staff working document accompanying the Report from the Commission in accordance with Article 3.7 of the Groundwater Directive 2006/118/EC on the establishment of groundwater threshold values, SEC(2010)166 final) are giving a first overview of the spatial distribution and importance of anomalies of the main dissolved elements of geogenic origin in Europe. However none of these studies proceeded to a systematic analyses of the concentrations of dissolved elements in the groundwater in relation to the geological/hydrogeological settings. There is a need then to share the new methodological advances used to determine the natural background level (NBL), to link the results obtained to geological/hydrogeological type-settings in order to build maps and developed at European scale some management indicators. One of these indicators will be the HydroGeoToxicity (HGT) indicator defined as the quotient between the concentration of a particular Potentially Toxic Geogenic Trace Elements (PTGTE) in a specific water sample and the upper limit value for that element in environmental or drinking water regulations (WFD, Drinking Water Directive, WHO). This indicator was tested successfully in some part of Spain (Gardiola-Albert et al., 2017).

The interface between groundwater and surface water is a highly active zone for geochemical and microbial processes. This so called hyporheic zone potentially could provide conditions favourable for the degradation of pollutants such as pesticides, fertilizers and other organic contaminants (Batioglu-Pazarbasi et al., 2013), either before groundwater is discharged into surface waters, or vice versa when pollutants enter groundwater from surface water bodies (e.g. by river bank infiltration). For the WP 4, the ambition is to provide a framework for harmonization of a groundwater ecosystem assessment scheme in Europe, mentioned as a challenge in the recent report from the WFD CIS Groundwater working group (Robertson et al., 2017). It is hypothesised that microbial diversity measures can be used to identify contaminant degradation potentials controlling contaminant fate at the GW-SW interface. It is also hypothesised that the microbial diversity is shaped by the discharge of contaminants as well as hydrological and geochemical parameters, especially the redox conditions. The WP take a European approach because contamination of groundwater and surface water bodies is a problem throughout Europe. The WP will reveal similarities between microbial diversity of European hyporheic zones and environmental parameters controlling this as a first step towards the development of a European ecosystem assessment scheme.

Nitrate and pesticides remain widespread anthropogenic groundwater pollutants in Europe, despite interventions under the EU Water Framework Directive and the Nitrates Directive. Subsurface transport can be slow, with delays of up to decades between the implementation of catchment measures and responses in abstracted groundwater quality. Redox reactions add considerably to the uncertainty of nitrate breakthrough. It is still highly challenging to evaluate the impact of reductions in agrochemical loadings on groundwater and surface water quality. Whilst some member states have attempted to quantify groundwater lags and denitrification (Wang et al. 2012), little work has addressed this at the European scale (Ascott et al., 2017). Within the WP5, we aim to overcome difficulties by harmonization of data and developing a conceptual framework that accounts for the different hydrogeological conditions in Europe and allows parameterisation of similar settings across member states.

Groundwater quality and protection closely relates to the spatial and temporal distribution of groundwater age and residence time of the protected groundwater body (Hinsby et al., 2007). GSO's and other European research organisations have applied groundwater dating for decades to improve the understanding of groundwater flow and transport and currently an increasing amount of authorities, water supplies and bottled water companies use groundwater dating by many different tracers for assessing the vulnerability of aquifers towards pollution, contaminant trends and history. However, no general overview of existing data and good practice guidance exist in Europe. The "GADIS" WP6 will collate data and continue developing research and knowledge obtained in several previous EU projects such as Palaeaux (Edmunds and Milne, 2001; Hinsby et al., 2001), Baseline (Edmunds and Shand, 2008), and national programmes (e.g. Kloppmann et al., 1998, Broers, 2004, Gooddy et al., 2006, Gourcy et al., 2009, Hansen et al., 2011, Sonnenborg et al., 2016). These projects have provided important contributions e.g. for understanding the relation between groundwater age and quality in relation to EU groundwater policy (Hinsby et al., 2007), the management of transboundary groundwater resources (Szocs et al., 2013) and the distribution of hydraulic parameters of groundwater models required to simulate spatial distributions of groundwater ages in 3D (Meyer et al., 2017). Very recent work demonstrate the importance of understanding age structure of the groundwater resources, globally e.g. for assessing the vulnerability of aquifers (e.g. Jasechko et al., 2017). The WP will built on and further develop recent research findings regarding groundwater age distributions obtained mainly from EU and national research programmes at GSO's and develop databases, maps and cross sections illustrating the current knowledge about groundwater age distributions in major parts of Europe. Finally, it will consolidate the collaboration between GSOs and leading groundwater dating research institutions and laboratories in Europe

Vulnerability maps are widely used, as it is an important tool for groundwater management and protection at drinking water wells/spring up to national scale. Various methods were developed depending on data availability, scale mapping, hydrogeological characteristics (specific method for karstic areas for example). The Groundwater Vulnerability Maps show the vulnerability of groundwater to a pollutant discharged at ground level based on the hydrological, geological, hydrogeological and soil properties. Other approaches could also be used based on the depth of the unsaturated zone and the capabilities of water to infiltrate (using for example the Index of Development and Persistence of the River network, IDPR). The ambitions beyond the WP7 and vulnerability assessment are to compare methods applied in Europe, to propose a harmonized methodology and maps enabling a pan-European view of groundwater vulnerability to pollution. The workpackage will provide coherent dataset and evaluate the best way to map the information at a pan-European scale not yet proposed.

Organic emerging contaminants (ECs) are now being widely detected at trace concentrations in groundwater (GW) in Europe (Lapworth et al., 2012). These include a wide range of personal care products, lifestyle compounds, pharmaceuticals, newly detected pesticides and metabolites and industrial intermediates and products. Existing monitoring data are contributing to the establishment of a GW "watch list" of emerging pollutants as required by the Groundwater Directive 2006/118/EC (amended by Directive 2014/80/EU), however the wide range of compounds found means that the different monitoring approaches, including sampling and analytical methods, applied to date can lead to different results, outcomes and therefore considerable uncertainty. The project will develop indicators based on risk-assessment principles to link the potential leaching of ECs in groundwater with geological setting and land use, anthropogenic activities, chemical and hazard properties and co-occurring tracers based on comparable data collected across Europe.

2 IMPACT

2.1. Expected impact

The results of WP3 are of importance – first of all – for water management. There will be an international exchange about different approaches concerning special groundwater. WP3 will deliver a WMS (web Map service) which is not only interesting for the water management of bottled mineral water, but also for the beverage industry (at the AQUA 2015 - International Hydrogeology Congress in Rome it was criticised by a representative of a European association of mineral water producers that there do not exist a pan European overview on mineral water). Furthermore an overview on medical springs and spas could be of interest for tourism industry and health service.

The work package will also increase political and public awareness of health issues related to groundwater quality permitting, by developing and mapping indicators, a quick overview on a homogeneous way of the sectors with high concentration of toxic or adverse effect dissolved elements.

Delineating the range of concentration of elements of natural origin over European aquifers will be of great support for the implementation of the water framework and groundwater directive in giving a homogeneous basis for deriving at national level the threshold values to be used in the evaluation of the chemical status and the risk evaluation.

Based on indicators and maps best practices in GW management recommendation will be proposed on i) data quality monitoring, ii) data treatment, iii) delineation of indicators in relation to geological families and case studies of specific GW exploitation in areas of high natural background level would be compiled.

The development of a framework for groundwater ecosystem assessment (WP4) will provide information on presence of degraded bacteria and potential degradation activity and reduce costly monitoring of contaminants at the GW-SW interface in future. Evaluating the potential degradation of the surface water (rivers, humid zones,..) due to groundwater, requested by the WFD and helping management of drinking water wells, is quite complex and need a great amount of data. Looking for indicators such as bacteria is one of the tool with good application perspectives at basin scale.

The proposed work under WP5 should lead to the development of better groundwater protection strategies through establishing travel times for nitrate and pesticides from infiltration to recharge and discharge zones, and thus the time lag between measures and trend reversal and the recovery of water quality. This will assist stakeholders in the evaluation of measures including NVZ (nitrate vulnerable zone) designations. This data is also needed at the time of making the evaluation of the efficiency of programme of measures to reduce impact of pollution pressure associated to diffuse agriculture. Indeed, delay between the application of corrective actions and the decreasing trend of contaminant concentrations in groundwater makes difficult not only the confirmation of the efficiency of measures but also the awareness of stakeholders.

Geological and hydrogeological settings will also be the entry point to classify the samples in age intervals (WP6) as an indicator of the susceptibility/vulnerability of the aquifers to contamination from human activities on the surface, elevated toxic geogenic elements in deeper aquifers and overabstraction. This information, combined with other indicators, is of great importance for better groundwater protection strategies. The project will aim at demonstrating the use of groundwater age distributions for design and assessment of monitoring programmes, pollution trends and history and the evolution of groundwater quality (chemical status).

The main outcome of the project idea developed under WP7 will be harmonized assessment products for groundwater vulnerability to pollution. The main deliverables are maps that can be used in groundwater management, subsurface spatial planning and environmental decision-making processes both at least national and regional scales, and at a cross-border scale. The project will result in methodological harmonization and the establishment of data interoperability at Cross Border, Pan European optionally national scales. More in detailed the project will permit to contribute to national and EU general activities in fulfilling the objectives of the WFD, and to national and regional authorities in environmental assessment and strategic and regional planning; support European-level strategic assessment, planning and forecasts and provide coherent, pan-European dataset for testing the impact of policy changes (e.g. intensified agriculture or reduced nutrient application) on groundwater;

The WP8 will help European countries to identify ECs of high concern regarding global pan-European settings and adapted to local specific contexts and knowledge and will:

- allow wide access to reliable data to support decision making such as groundwater protection
- New challenges in sampling and analytical methodologies developments regarding the increase of the number of substances of interest and the need for streamlining the ECs monitoring across Europe
- A key outcome will be an overview of GW monitoring status of ECs across Europe. Collected ECs occurrence data will be supplied to the European Commission Data Base IPCHEM.
- The development of novel methods to link EC presence with anthropogenic activities, environmental conditions and co-occurring tracers will help to identify hot spots regarding GW contamination by ECs.
- Identify what are the chemical properties that can be used to estimate the leaching potential of ECs to GW and to evaluate how to take into account usage data in risk assessment procedure
- supporting the implementation of the GW "watch list", definition of pollutants of concern and subsequent consideration for Annex I and II revision, further work is required to ensure effective monitoring is undertaken that is consistent across the EU and enables long term protection of GW, human health and GW dependent ecosystems.

Overall impact of this GeoERA initiative is the compilation and delivery of harmonized, interoperable and comparable geoscientific information, contributing to national and EU general activities in fulfilling the objectives of the WFD. The degree of harmonization depends on data availability, scale of investigation and applied methodology. The improved databases and visualization tools proposed related to thermal and mineral water distribution, natural background levels and related indicators, vulnerability assessment, on groundwater age tracers and indicators currently existing in EU member states are some of the products

that will be produce at pan-European scale for supporting health and environmental issues related to the quality of groundwater.
Also best practice guidance from demonstration projects will be proposed in different hydrogeological settings to support harmonized management strategies and most widely:

- to apply statistical data treatment related to the development and mapping of indicators
- to define the best methodology to organize and visualize data collected
- to test and develop new techniques for estimating age distributions of groundwater bodies
- to monitor key parameters with reference to environmental context, geological setting and risk assessment

2.2. Measures to maximize impact

Three seminars will be held, kick-off seminar (within the first 3 months of the beginning of the project), mid-term seminar (M18) and the final seminar (M34). All HOVER project partners will participate but also the other eurogeosurveys and participants of the other GEOERA when interested and most particularly the Information Platform. These seminars will be divided in three parts; a first time needed for exchange and strengthening collaboration between project partners, second time to ensure collaboration with other GEOERA partners and GEOERA projects, especially the Information Platform project and the last time devoted to public and stakeholder awareness.

The project progress will be presented at least once a year to the WFD CIS (Common Implementation Strategy) working group on groundwater and also, especially for emerging contaminant to the CIS working group on chemicals.

The Advisory Board will be used to communicate with the European Environmental Agency, the Joint Research Center, the EC and the International association of Hydrogeologist (IAH). The GEOERA website and GEOERA Information Portal will be the main mean for day-to-day communication.

Also each of the work packages are including internal seminars and workshop dedicated to the work organisation and exchange of information between eurogeosurveys. This is an essential part for the HOVER project considering that as many as possible pan-European products will be proposed.

A specific workshop will be organised together with the WP3 and WP7 but also partners involved in the WP6 of the RECHARGE project dedicated to Pan-EU Groundwater Resources Map and partners of the Information Platform project. The workshop that may be organised around M18 will be especially dedicated to groundwater mapping.

The production of papers will also be promoted considering different type of audience: Academic and scientific community by publications in peer-reviewed journals, at scientific conferences, web sites; Policy makers by recommendations, web site, newsletters, maps; Stakeholders by Web sites, presentation, technical publication, maps; General public by articles in national press, flyers/brochures and project/work package partners by GeoERA dissemination seminars (Kick-off, Mid-Term, Final Seminar), GeoERA intranet, project member meetings/workshops. Are already planned an Internal workshop on modelling lag times for nitrate and pesticides (WP5) and Journal papers on modelling lag times at the European scale and on denitrification (WP6).

Dissemination activities will be implemented throughout the entire project duration with messages tailored to the receivers/audiences. At the early project stage, focus is on raising awareness about the project, at the end of the project on achievements and deliverables.

2.3. Contribution of Project Proposal to the Information Platform or vice versa

As the cross-thematic integration of information is an important aspect to be addressed in GeoERA most of the Workpackages will develop specific deliverables based on Spatial Information that effectively integrates all ICT-related and technical issues (database and dissemination). These deliverables are clearly identified to be directly linked to the GeoEra Information Platform. The platform will address the development of a common geoscience information platform capable of integrating up-to-date data, interpretations and models from different and distributed sources.

The databases compiled in WP3, 5, 6, 6 and 8 will be prepared together with IT experts of the Information Platform to insure interoperability and homogeneity of data. At pan-European scale data to be compiled concerned soil, geological and hydrogeological environment. Data collected within the project and raw data already available but also created data such as indicators would be made available through the Information platform. In turn, the Information Platform will give support to prepare the final products such as maps and web services. The most direct links with the Information Platform identified are:

- **Data compilation and database** preparation in order to make them available through web services in all WP
- **Delineation of hydrogeological type–setting** prepared in collaboration with WP3, WP5, WP6, WP7 and WP8 – the hydrogeological type-setting is an important intermediate product as it will be used for most of the WP, may be used to complete information in some sectors/countries not having data/not involved in the project and may be used in the future by the GW community to develop other thematic maps or products
- Preparation of **maps and web services** in WP3, WP5, WP6, WP7 and WP8

Communication with the Information platform will be made through information meeting between the coordinators of both projects and IT experts and WP leader for the technical issues. Also a meeting is planned at the beginning of the project between the Project Board committee and the IP coordinators in order to define the respective expectations (data format, tools, INSPIRE requirements,..). A mid-project meeting, before initiating the various tasks aiming at building maps and web services is also proposed.

3. QUALITY AND EFFICIENCY OF THE IMPLEMENTATION

3.1. Work Plan – Work packages, deliverables

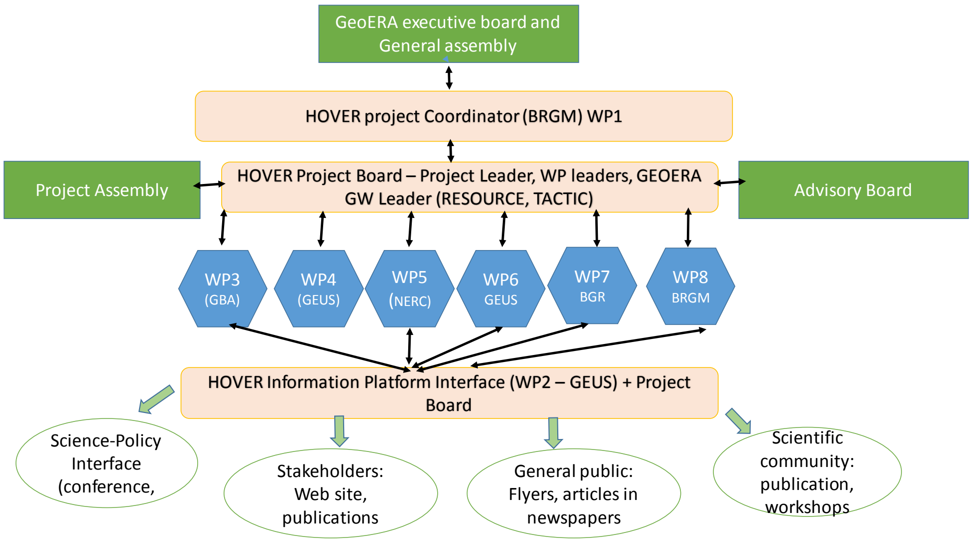
The HOVER project is composed of two management and coordination workpackages and 6 technical WP as described in 1.3.2. One workpackage is dedicated to the study of element of natural (geogenic) origin in groundwater and four WK are focusing on anthropogenic contaminants (nitrate, pesticides and organic emerging contaminants) and their transfer from soil to the aquifer through the unsaturated zone and transport within the saturated zone. One (WP6), centred on groundwater age distribution, is of both geogenic and anthropogenic concern. The timing of the different work packages and their components is given in the below Gantt. In red colour, the activities with most inter-correlations (related to hydrogeological type-settings and vulnerability) and in green the tasks more specially linked to the Information Platform (see also 2.3).

3.2. Management structure, milestones and procedures

As described in the GEOERA Project Agreement the governance bodies are : **Project Assembly** (PA) as the ultimate decision-making body of the Project Consortium ; **Project Board** (PB) as the supervisory body for the execution of the Project which shall report to and be accountable to the Project Assembly and consist of the Project Lead and the WP Leaders ; The **Project Lead** is the legal entity acting as the intermediary between the Parties and the GeoERA Executive Board; **Work Package Leads** (WPL) lead the different Work Packages ; **Task leads** (TKL) lead the different tasks of work packages.

The management and coordination of the project will be led by the **Coordinator** BRGM (French Geological Survey). BRGM will be the official contact between the participants and the GeoERA General Assembly and Executive Board and amongst the project partners. BRGM is responsible for the overall execution and progress of the project, including planning and content. A working team, staff of BRGM well experienced in European project coordination, scientific and technological outputs, planning and communication, financial and administrative issues, will support the project coordinator. The coordinator will be responsible for the communication of all relevant project information from the GeoERA Executive Board to the partners, for regular reporting, for the distribution of funding to the partners, for establishing and maintaining consortium agreement in cooperation with the Project Assembly. To do so, the coordinator will implement the scientific orientations decided by the Project Board (PB), coordinate progress reporting, prepare formal decisions together with the SC and plan the corresponding meetings. Concerning the project activities, the coordinator will monitor the progress of the activities on a regular basis and organize the Consortium Meetings and Workshops.

The coordinator (BRGM) in close connection with the PB will carry out the general management of the project (covered by the work package WP1). The general organisation is illustrated schematically below.



The **Project Board** (PB) is the executive board of the project where the progress of the overall project is discussed in depth. The chairman is the Project Coordinator. Each of the member of the PB have the responsibility to insure full involvement in project decision of the partners actively participating in their respective workpackages. The Project Board does the operational steering of the project in terms of scientific goals, progress, finance, quality, dissemination and exploitation and will discuss the scientific and technological progress; in relation to the SRT call.

The **Workpackages leaders** belong to the Project Board. They will insure the adequate development of the technical and scientific work planed within their workpackages. They report regularly to the Project Leader. They have in charge the preparation of the WP workshops during the general GEOERA meetings. For technical and organisational issues they have the support of the task leaders.

Project Assembly (PA) is the formal decision-making and arbitrary body. The PA is responsible for the execution of the project in terms of science, management and finances. All partners will have a seat in the PA giving the right to vote. In addition, the progress, achievements and overall course of the project will be discussed in the PA. The PA will convene at the three consortium meetings.

The **Advisory Board** is meant to provide experience from the knowledge and management point of view and to give advice to the Project Board based on past or present position in International organisations or partners of International project related to topics developed in HOVER. The Advisory Board will be convened to the three annual project meetings. The two experts composing the advisory board will also be consulted from time to time on an informal mode (visio/web conf). The Advisory Board is composed by:
Adam Porowski (Poland) - specialist in groundwater origin and isotope hydrogeology at the Institute of Geological Sciences PAS, Vice-president of the IAH Commission on Mineral and Thermal Waters.
Johannes Grath (Austria) – Head of unit Groundwater, GW science and policy expert at the Environmental Agency of Austria (Umweltbundesamb) – Chair the EU CIS Working Group Groundwater

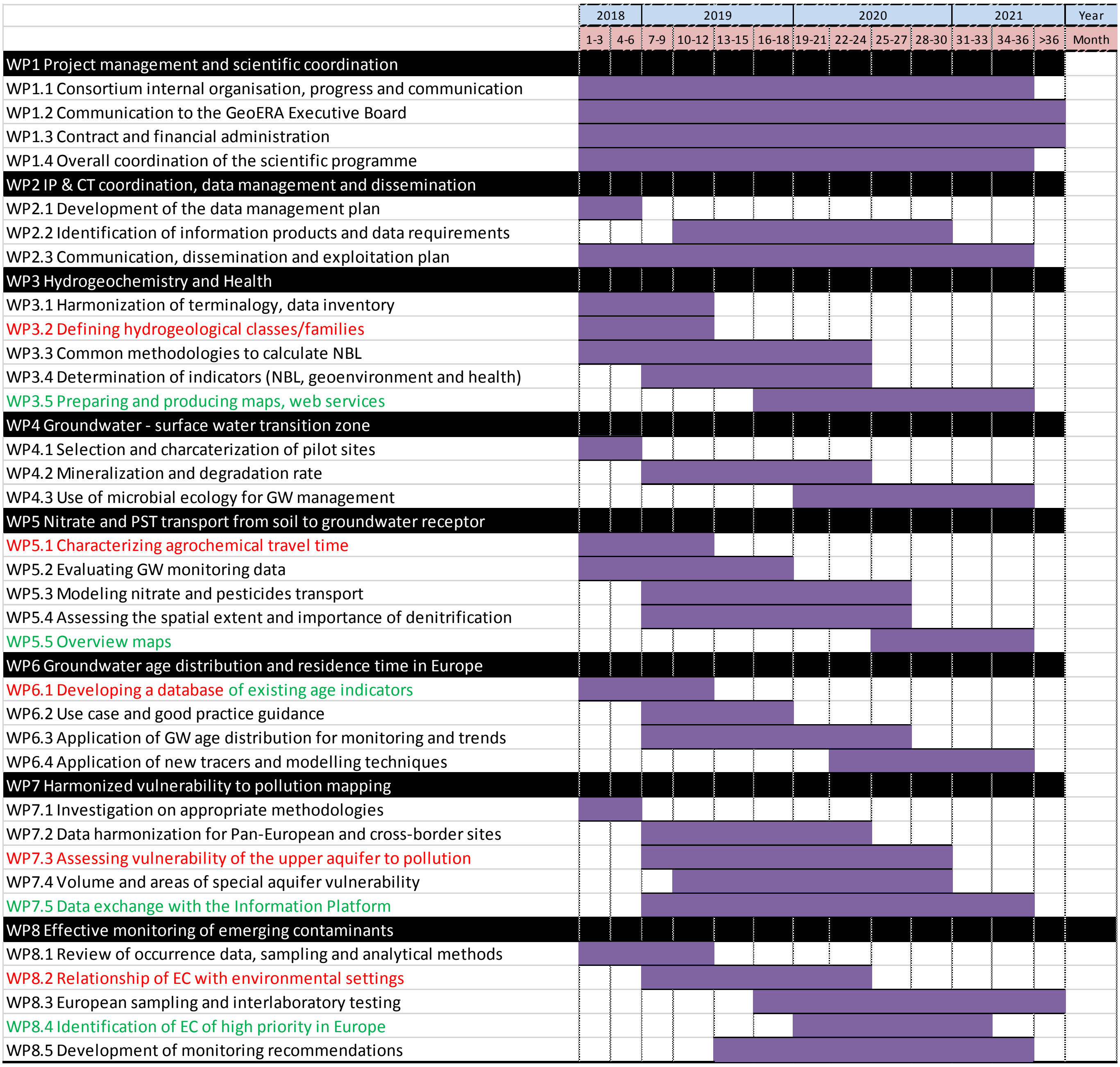
The schedule of different HOVER meetings is shown below:

	2018		2019				2020				2021			Year
	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-30	31-33	34-36	>36	Month
HOVER meetings														
Project Assembly (kick-off, Mid-term, Final)														
Project Board meetings														
Advisory Board meetings														
Workpackages meetings (eventually combined with other GEOERA projects)														
Information Platform seminars														

For optimisation purposes, the advisory board, Consortium assembly, Project Board committee and workpackages meetings will be organised at the same period and place. The time of the second seminar with the GIP team will be proposed around Month 18 in agreement with other GEOERA projects.

It is also proposed to organised one additional workshop about 6-8 months after the beginning of the project in order to discuss more in details the two activities related to the preparation of the hydrogeological-settings and vulnerability assessment. The Project Board will met at that time also. A first evaluation of project's progress is needed soon after the initiation of the project. This workshop could, if considered necessary, be combined with workshops of the GEOERA project RESOURCE and TACTIC as some activities have already been identified as having scientific links. Various web workshops could additionally be organised by the WP leaders within the duration of the projects. In addition it is scheduled to have regular web meeting between the groundwater project coordinators (every 3 months) and it will be decided whether additional face-to-face meetings are required at these meetings.

The schedule of HOVER activities can be summarized as follow:



3.3 Consortium as a whole

As nearly all partners are GSO's they have considerable knowledge and expertise in geology and hydrogeological functioning of their own country. Due to different hydrogeological settings and involvement in EU projects, the GSO's have developed different experience and expertise in groundwater management. The synthesis of GSO expertise relevant for HOVER is given in the following table[2].

Key elements **of the topic and of HOVER objectives**	**Number and names of HOVER participants supplying skills & experiences relating to the key elements** *(see also section 1.3)*	
Building database and web services	20	BRGM, TNO, BGR, ICGC, MBFSZ, ISPRA, NERC, IGR, GEUS, GeoZS, IGME, GBA, EGT, GSB, LNEG, GSI, FZZG, LGT, GEOINFORM, LBGR
Multicriteria analysis and GIS	17	BRGM, BGR, ICGC, MBFSZ, ISPRA, IGR, GEUS, GeoZS, IGME, GBA, EGT, GSI, FZZG, ISOR, LGT, GEOINFORM, LBGR
Geo ICT (information and communication technologies)	6	BRGM, TNO,DLT, IGR, GEUS, GEOINFORM
Hydrogeological processes	17	BRGM, TNO, ICGC, MBFSZ, ISPRA, MTI, NERC, IGR, PIG-PIB, GEUS, GeoZS, IGME, LEGMC, GBA, EGT, GSI, GTK
Geological and lithological characteristisation	24	BRGM, TNO, DLT, BGR, ICGC, MBFSZ, ISPRA, MTI, GSS, IGR, PIG-PIB, GEUS, HGI-CGS, GeoZS, IGME, GBA, LBEG, EGT, LNEG, GSI, FZZG, ISOR, LGT, GEOINFORM
Groundwater (bio)geochemistry	15	BRGM, TNO,DLT, ICGC, MBFSZ, IGR, PIG-PIB, GEUS, GeoZS, IGME, LEGMC, GBA, EGT, GSI, GTK
Modelling of groundwater flow and solute transport through saturated zone	12	BRGM, DLT, MBFSZ, NERC, IGR, GEUS, HGI-CGS, GeoZS, IGME, EGT, GTK, ISOR
Hyporheic zone processes and interactions between GW and SW	6	BRGM, TNO, DLT, GEUS, LEGMC, GSI
Statistical data treatment	13	BRGM, TNO, DLT, BGR, SGU, MBFSZ, ISPRA, GEUS, GeoZS, IGME, LEGMC, GBA, GSI
Analyses of emerging contaminant	6	BRGM, TNO, DLT, NERC, PIG-PIB, GBA
Isotope and environmental tracers including age dating	10	BRGM, TNO, MBFSZ, PIG-PIB, GEUS, HGI-CGS, GeoZS, EGT, GSD, GTK
Pressure and impact analyses of diffuse origin contaminants (nitrate and pesticides)	13	BRGM, TNO, DLT, BGR, NERC, PIG-PIB, GEUS, HGI-CGS, GeoZS, LEGMC, GSI, GSD, GTK
Assessing and predicting the mobility and impacts of pollutants from soils to groundwater	8	BRGM, MBFSZ, NERC, GEUS, HGI-CGS, EGT, GSI, GTK
Mapping of water resources	22	BRGM, TNO, BGR, ICGC, SGU, MBFSZ, ISPRA, GSS, IGR, PIG-PIB, GEUS, GeoZS, GBA, EGT, GSB, LNEG, GSI, FZZG, ISOR, LGT, GEOINFORM, LBGR
Groundwater Monitoring	13	BRGM, TNO, SGU, VMM, MBFSZ, PIG-PIB, GEUS, IGME, GSB, LNEG, GSD, ISOR, LGT
Policy-support and dissemination towards national and European Institutes	18	BRGM, TNO, BGR, VMM, MBFSZ, ISPRA, MTI, NERC, IGR, PIG-PIB, GEUS, GeoZS, GBA, GSI, GSD, GTK, ISOR, LGT,

3.4 Resources to be committed

Table 3.1a) Workpackage description

Workpackage number	**WP1**	**Lead beneficiary**			**BRGM**			
Work package title	Project management and Scientific coordination							
Participant number	1	3	12	15	17	54		

[2] NOTE! Deltares (DLT, Netherlands) participates in the HOVER as "Third Party" for TNO as indicated in the Grant Agreement of GeoERA. It is listed separately in the financial tables and work package descriptions in order to make clear where they will contribute to HOVER.

Participant short name	TNO	GBA	GEUS	**BRGM**	BGR	NERC		
Person-months per participant:	1	2	2	9	2	1		

Start month	1	End month	39

Objectives

The main objective of WP 1 is administrative, and scientific management of the consortium including communication to the GeoERA Executive Board, Internal and external administrative management, project internal communication and management, financial and management reporting, legal aspects for consortium management, risk management within the project, overall coordination of the scientific programme and activities, coordination of day-to-day technical

Description of work

Task 1.1 – Consortium internal organisation, progress and communication (Lead: BRGM)

- Organisation and administration of Consortium meetings
- Administrative support to workshops, project meetings, conference etc.
- Controlling the timely realisation of deliverables and milestones
- Overall project risk management
- Adaptation and initialisation of measures to guarantee the success of the project
- Design, initialisation and follow-up of contingency plans

Task 1.2 – Communication to the GeoERA Executive Board (Lead: BRGM)

- Focused contact and keeping Executive Board updated on project progress
- General information gateway and responsibility to react and answer specific requests
- Preparation and delivery of periodic progress reports (annual expenditure reports, midterm and final reports – all delivered within 60 days following the period covered)
- Preparation of meetings and interactions between the Advisory Board and the Project Board
- Follow-up on responses received from the GeoERA Executive Board

Task 1.3 - Contract and financial administration (Lead: BRGM)

- Allocation of budgets, transfer of funds
- Updates on accounting and contractual rules (including consortium agreement)
- Preparation of financial data for detailed implementation
- Preparation of audits and cost statements
- Annual summary expenditure report

Task 1.4 – Overall coordination of the scientific programme (Lead: BRGM)

- Preparation and follow-up of a detailed implementation plan during the entire project
- Supervision of work package coordination and support to cross-cooperation between work packages and other relevant projects funded through GeoERA (in coordination with WP2)
- Support to implementation of the scientific work at work package level
- Content management of scientific workshops and organisation of the scientific and technical topics to be discussed at the Consortium Meetings

Deliverables

D1.2a: Project progress report – **M20**
D1.2b: Final project report - **M38**
D1.3a: Cumulative expenditure report 2018 - **M7**
D1.3b: Cumulative expenditure report 2019 - **M19**
D1.3c: Cumulative expenditure report 2020 - **M31**
D1.3c: Cumulative expenditure report 2021 - **M39**

Workpackage number	WP2	Lead beneficiary			GEUS				
Work package title	GeoERA Information platform (GIP) and cross thematic coordination, data management and dissemination								
Participant number	3	12	15	17	54				
Participant short name	GBA	**GEUS**	BRGM	BGR	NERC				
Person-months per participant:	1.5	5	1	1.5	1				
Start month	1				**End month**	36			

Objectives
1. To define and coordinate data and information handling from all HOVER WPs and develop a Data Management Plan (DMP) in collaboration with the GIP team in order to make HOVER data findable, accessible, interoperable and reusable according to GeoERA D1.3 and the “FAIR” principles of H2020.
2. To develop a project communication, dissemination and exploitation plan including social media, the project web site and scientific journals. Where required in collaboration with the other themes and the GeoERA secretariat and following the dissemination and exploitation plan (D5.1) of GeoERA.

Description of work

Task 2.1: Development of the data management plan (Lead: GEUS)
A database management plan (DMP) will be established in close cooperation with the GIP Project team, using the provided DMP template developed by the GeoERA secretariat. The DMP is established to support the interaction between the GIP and the HOVER projects and facilitate identification and description of HOVER data to be provided for the GIP.

Task 2.2 Identification of information products and data requirements (Lead: GEUS)
Definition of requirements for data provided to the GIP. Priority will be given to products, which have most benefit to stakeholders of the work under HOVER. Once products from HOVER become available through WP deliverables, the data will be provided to the GIP project for integration in a prototype system. Special attention will be given to the pan-European datasets to be delivered under WP3, 6 and 7 (if possible also WP5 and WP8), in order to make prototyping and implementation efficient within the GIP project. HOVER WP leaders and partners will test data accessibility and GIP functionalities in the different development phases of GIP in collaboration with the GIP team. Information and metadata about HOVER will be included and classified according to the societal challenges of Horizon 2020 in the recently developed European Inventory of Groundwater Research (EIGR). The groundwater theme coordinator will schedule web-meetings together with the HOVER coordinator and the coordinators of the other groundwater projects every third month to coordinate and prioritize data provision for GIP among the groundwater projects and WPs. Where necessary, the web-meetings will be supplemented with face-to-face meetings.

Task 2.3: Communication, dissemination and exploitation plan (Lead: GEUS)
Dissemination of the pan-European work will be established by organizing meetings in conjunction with stakeholder groups at European level, including CIS Working Group on Groundwater, the European Environmental Agency, the Joint Research Centre and other CIS groups wherever relevant. The GeoERA website and Information Platform will be key in those dissemination events and social media

will be included to promote events. The production of peer-reviewed papers in international journals will be promoted through this task, prioritizing and integrating project results of the HOVER project and bringing together scientists working in the Groundwater Theme. The HOVER project will cooperate with the GeoERA secretariat and other projects funded under GeoERA to establish the best possible dissemination strategy.

Deliverables

D.2.1: Data management plan (Internal report) **– M6**
D.2.2a: Definition of data requirements for GIP based on GIP recommendations (internal technical note) – **M8-16**
D.2.2b: Provision of data for upload and testing of GIP second version (internal technical note) – **M18-M30**
D.2.3a: Communication, dissemination and exploitation plan (Internal report) – **M8**
D.2.3b: Article(s) submitted to international peer reviewed journal(s) – **M36**

Work package number	**WP3**	**Lead beneficiary**			**GBA**				
Work package title	Hydrogeochemistry and health: Mapping groundwater characteristics for the management of aquifers naturally enriched in dissolved elements								
Participant number	3	6	7	11	12	15	27	28	29
Participant short name	**GBA**	VMM	FZZG	CGS	GEUS	BRGM	MBFSZ	ISOR	GSI
Person-months per participant:	12	5.8	11	11	3	4	6.5	3.8	5
Participant number	30	39	40	42	44	45	46	47	49
Participant short name	ISPRA	LEGMC	LGT	MTI	PIG-PIB	LNEG	IGR	GSS	GEOZS
Person-months per participant:	5	2	2.5	2	2	3	3	8	7.5
Participant number	50	51	52	53	Non-funded				
Participant short name	IGME	ICGC	SGU	GEOINFORM	RBINS-GSB				
Person-months per participant:	16	6	5	3.8	2				
Start month	1				**End month**	36			

Objectives

- To propose a common methodology to identify the main geological factors and hydrogeological processes regulating the distribution of natural concentrations (Natural background Level) of selected dissolved elements including Potentially Toxic Geogenic Trace Elements (PTGTE) possibly affecting human heath
- To harmonize terminologies and criteria for classification of special water (mineral, thermal water) and for aquifer areas with naturally high concentration of some specific elements
- To propose and calculate indicators comparable over Europe and its wide geological diversity applicable for groundwater management purposes
- To produce pan European information layers of special waters and indicators of chemical anomalies of natural origin

Description of work

Task 3-1: Harmonization of terminology, inventory of available information on mineral, thermal and highly mineralized groundwater (lead: GBA)

First, a big effort must be undertaken to build up a harmonized terminology for characterising the mineral, thermal and highly mineralized groundwater (called “special” water) as there exist variable national classifications. This concerns water temperature, outflow, pressure, mineralization, gas content, purity, residence time and utilization. The same is due to the national approach concerning the definition of the “anomalies” of natural origin of dissolved elements in groundwater. Also the parameters and data existing in each country should be listed. The result will be an inventory of available data. The results concerning the harmonized nomenclature can be delivered to project „GeoERA Information Platform“, WP4 „Semantic harmonization issues“. Afterward, the involved Surveys will make an investigation on the availability of own data on special groundwater and the selected trace elements as well as their geological background. The result will be an inventory of available data. The investigation will be done by a sending out questionnaires and additional personal contacts in order to clarify open questions.

Task 3-2: Defining lithological/geological water families based on information available at EU scale (lead: GEUS)

Concentrations of dissolved elements in groundwater is directly linked to the mineral composition of rocks/sediments and geochemical processes such as redox, ion exchange, precipitation, dissolution, weathering etc. The geological factors controlling occurrence and distribution of dissolved elements are numerous and of different importance. Different approaches of grouping rock formations depending on their potential of mineral release and the working were developed already and allowed to delineate areas of potentially high concentration in some trace elements. Analysing the different approaches and the data available in the countries would permit to propose a methodology allowing delineating hydrogeological type settings that could be related to trace elements concentration in groundwater. Having a reasonable number of families is needed in order to propose a prospective approach in sector with no water quality data. This task is in straight collaboration with task 1 of WP5.

Task 3-3: Proposing a common methodology to calculate the natural concentration of dissolved elements based on lithological/geological families taking into account possible anthropogenic influences (Lead: BRGM)

The methods used in BRIDGE (Wendland et al. 2007) consisted in using only sampling points exempt of anthropogenic influence (upward basin, GW with low NO_3 concentrations…). However, this approach limits the natural background level determination to some specific areas. Studying the anthropogenic pressure and relating activities to specific dissolved elements would permit to determine the expected NBL in some elements in area under agricultural, industrial (including mining) and urban influence. The accuracy of this approach would depend on the information on the anthropogenic activities (databases on typology of activities) and the association between activities and dissolved elements released. Matrix linking specific activities to determined pollutants exists today in some countries and may be improved and adapted to other EU countries. Based on the aquifer/sectors of aquifer typologies determined in 3.2 and pressure types, statistical data treatment would be used in order to select the most representative water points, eventually to re-group different typologies and to calculate the basic dataset statistics such as centiles, median, outliers for each element of interest (mainly trace elements). Some sophisticated non-parametric statistical tests may be used, depending on the number of data available.

Task 3-4: Natural background levels and health - determination and selection of indicators for GW management (lead IGME)

The direct use of dissolved elements concentrations, because of high range of values due to the great numbers of parameters involved in the water-rocks interactions is difficult. Therefore indicators should be proposed to relate the NBL and lithological/geological environment with human health and GW management, such as the HydroGeoToxicity (HGT) indicator defined as the quotient between the concentration of a particular PTGTE in a specific water sample and the upper limit value for that element in potable water according to the drinking water regulations. Other indicators may be proposed and developed so the complex links between a concentration of a specific element in groundwater and the various rocks and processes where the water is flowing could be represented and used for various water management and health perspectives. Other existing indicators, from the more simple ones such as centile90 or sophisticated will be compiled and will be evaluated in regards to the potential use and capacity to represent the naturally high concentration areas in relation to the lithological context at the scale of EU or large region is a challenge.

Task 3-5: Preparing and producing maps, web map service and associated explanatory information (Lead: GBA)
Firstly, it would be necessary to produce a data model and then a legend for the planned web services, which will be documented in a report. In the frame of this task, the best methodology to organize and visualize such data should be found. International standards like the international standard legend for hydrogeological maps, INSPIRE etc. have to be taken under consideration. The available data will be collected in the delivery format determined in task 3.1. Furthermore a multi-lingual legend suitable for WMS will be produced in the language of the project partners. WMSs will highlight regions with special waters (thermal and mineral waters), litho/geological regions (determined in task 3.2) with elevated concentration of the selected tracer elements, and indicators designed in task 3.4. Also associated publication (map notices, guidances for mapping and indicator calculation, scientific article) will be proposed wherever relevant. The final data and information products from WP3 developed for the GeoERA Information Platform will be prioritized in WP2 together with the other WP leaders.

Deliverables
D.3-1: Database for concentrations of dissolved elements and associated parameters and harmonized terminology to define thermal and mineral water (Database and associated technical report) – **M12**
D.3-2: A litho-geological classification system based on the capacities of rocks to release elements to GW including development of the methods in some EU countries (Report) – **M12**
D3.3: Data set of the results of the statistical data treatment allowing the preparation of the raw elements for the tasks 4 and 5 i.e. concentrations of elements of natural origin per typologies (Report and database)– **M24**
D3.4: Compilation of indicators, analyses of possible use at pan-European scale and test application in countries of contrasted main litho/geology (Report) – **M24**
D3.5a: Data model and the legend of the planned web service (Report) - **M24**
D3.5b: Development of European exposure maps of selected elements (and indicators) based on GIS interpolation of measurements (Maps and related scientific publications) – **M33**
D3.5c: Support to GIP for the development of a Web Services with multi-lingual legend concerning special ground water in Europe – **M33**

Work package number	**WP4**		**Lead beneficiary**			**GEUS**		
Work package title	Linking aquifer microbial ecology and diversity to contaminant transforming processes at European groundwater-surface water transition zones							
Participant number	12	15	29	39	38	53		
Participant short name	**GEUS**	BRGM	GSI	LEGMC	IGR	GEOINFORM		
Person-months per participant:	16	6	1	1.5	1	0.7		
Start month	1			End month	36			

Objectives

- Increase our understanding of how groundwater ecology and microbial diversity determine contaminant-transforming processes at European groundwater-surface water (GW-SW) transition zones.
- To provide knowledge on GW-SW diversity and its potential use for GW management as a first step toward the development of a European GW ecosystem assessment scheme.

Description of work

Task 4.1 Selection and characterization of European sites (lead: GEUS)

A number of field sites will be identified in Denmark, Latvia, Ireland, and France. In Latvia the sites are 1) a pristine GW fed creek near Rucava, Southwestern Latvia and 2) a site impacted by agriculture and urban activities in Daugavpils City next to Daugava river. Both the Rucava and the Daugavpils sites have several monitoring wells installed and water quality data are available. In France the sites are 1) the GW fed Ariège river basin where there is an alluvial plain under high agricultural pressure that has led to a contamination of the aquifer by several pesticides and nitrate and 2) a site along the river Rhône with river bank infiltration. In Denmark a site along the Sillerup Creek or a site along the Knud stream have been selected. Both sites are impacted by agriculture and screens for geochemical measurements are planned to be installed. It is also planned to have an Irish site, but this has not been identified yet. No sites have been selected in Ukraine, but GEOINFORM will contribute with comparisons to Ukrainian sites and associated data. The characterization of the sites will be optimized to best exploit already existing data. Detailed information on hydraulic heads and hydraulic conductivities near and below the surface water body will be obtained using driven wells with short screens. The groundwater will be sampled at intervals and analyzed for groundwater chemistry, including EC, pH, Eh, dissolved O_2, iron, ammonium, nitrate, sulfate and relevant contaminants. In addition seepage meters will be installed to directly measure the GW-SW flux and for analysis of contaminant concentrations. Sediments will be sampled as intact cores, sealed on-site to maintain the redox conditions, and shipped to relevant partners for task 4.2 and 4.3.

<u>Task 4.2 Degradation and mineralisation rates (lead: GEUS</u>)

The effect of organic carbon, redox conditions, pH, and temperature on contaminant degradation and mineralisation will be determined for the selected European GW-SW sediments. Degradation and mineralisation rates will be determined from microcosm studies with sediments and water using ^{14}C labelled pollutants. The following organic pollutants have already been selected: The pesticides MCPA, bentazone, and atrazine, the pesticide residue 2,6 dichlorobenzamide, the antibiotics sulfadiazine, and erythromycin and the steroid hormone 17β-estradiol. More will be included following inputs from WP 9 on the most dominant emerging pollutants found in European groundwater. Furthermore, the potential for removal of nitrate by denitrification in the GW-SW transition zones will be studied.

<u>Task 4.3 Use of microbial ecology and community composition of European GW-SW sites for GW management (lead: BRGM)</u>

<u>SubTask 4.3.1. Characterization of bacterial diversity using 16S rRNA amplicon sequencing</u>: DNA will be extracted from GW-SW sediments and used for 16S rRNA amplicon sequencing and qPCR of marker genes involved in degradation of organic contaminants and nitrogen cycling (e.g. *tfd, atz, nir, hzo, amoA*). The qPCR results will be used to further identify and quantify specific degrading bacteria within the community. The bioinformatics will focus on linking the bacterial community composition to the presence of marker genes and contaminant degradation rates obtained from task 4.2. To pinpoint the controlling parameters that determine bacterial diversity at the GW-SW interface multivariate statistical analyses will be used. Here the redox conditions, and chemical and hydrological parameters will be used to explain the variation in the bacterial community compositions. Finally, (dis)similarities between the bacterial communities of the different sediments will be determined by indirect gradient analysis (e.g NMDS, PCA) and by the calculation of diversity indices (richness and Shannon index).*The outcome is information on the bacterial ecology of European GW-SW transition zones, including the presence of specific degrading bacteria following contaminant exposure.*

<u>SubTask 4.3.2. Implementation of microbial diversity as a tool for monitoring water quality and identifying abnormalities – what future on a European scale?</u> This task will look into the question of the

use of microbial diversity as an integrating tool for monitoring groundwater. Indeed, the regular monitoring of a huge number of emerging molecules is both costly and time consuming, whereas a single DNA extraction followed by sequencing gives access to total bacterial diversity. More and more studies are also emerging using DNA to monitor other bioindicators of water quality (macro fauna). This task will work with the results from subtask 4.3.1 where the sensitivity of bacterial diversity in relation to GW-SW chemistry will be assessed, as well as a review of the literature to identify European case studies of the impact of environmental GW parameters on bacterial diversity. The task aims to lay the foundations for wider knowledge of GW diversity and its potential use for GW management (Robertson et al., 2017).

Deliverables

D.4-1: Characterization of field sites based on existing and measured data as input to task 4.3 (report) – **M16**

D.4-2: Degradation and mineralisation of selected contaminants in European GW-SW transition zones as input to task 4.3 (report) – **M24**

D.4-3: The use of microbial diversity measures for monitoring contaminant transforming processes at GW-SW transition zones (report) – **M35**

Work package number	**WP5**	**Lead beneficiary**		**NERC**			
Work package title	Nitrate and pesticides transport from soil to groundwater receptors						
Participant number	1	1c	9	10	12	15	29
Participant short name	TNO	DLT	HGI-CGS	GSD	GEUS	BRGM	GSI
Person-months per participant:	12	3.7	7	3	11	5.5	1
Participant number	39	42	49	53	54		
Participant short name	LEGMC	MTI	GEOZS	GEOINFORM	**NERC**		
Person-months per participant:	1.5	1	10	0.7	7		
Start month	1			**End month**	36		

Objectives

- Develop an atlas of geological/hydrogeological settings relevant to agrochemical transport across Europe and collate datasets characterizing these settings (in relation to task 2 of the WP3). These will provide conceptual models of key European settings
- Assess nitrate (N) and pesticide (PST) travel times and where possible attenuation patterns for a number of relevant European settings for evaluating regulatory timescales for achieving good status and/or trend reversal For N this will be a contribution towards Pan-European N vulnerability assessment including modelling of storage in the unsaturated zone
- Provide datasets characterizing N and PST transport in a useful format to the Information Platform Theme
- Develop transport models able to simulate contaminant discharge through the unsaturated zone and produce maps of groundwater travel time
- Produce maps of areas of potential denitrification/low redox in groundwater

Description of work

Task 5-1 – Characterizing agrochemical travel time in the unsaturated and saturated zones (lead: NERC)

This first task will define a series of conceptual models addressing time scales related to N and PST transport in the subsurface and the understanding of lag times between the implementation of measures and improvement of groundwater quality at receptors. The first step will be to establish geological/hydrogeological type settings with similar characteristics across Europe, e.g. using existing datasets. These should provide a common basis for use in other work packages, e.g. WP3 and WP7. A number of type sites representing these different settings will be selected for use in Task 3. The unsaturated zone for each type-setting will be parameterized using both existing datasets and making limited new field measurements of unsaturated zone profiles for N. The distribution of travel times will be assessed using established modelling methods. Travel times in the saturated zone will be assessed using existing datasets and coordinated with WP6. Conceptual models of overall lag times will be developed using these type-sites for illustration of different hydrogeological settings.

Task 5-2 – Evaluating groundwater monitoring data (Lead: TNO)

Data from existing groundwater quality monitoring networks will be assessed and harmonized in order to provide information about the transport of N and PST. This includes analysis using process indicators such as N_2 -excess characterization, redox indicators (such as Fe and Mn and dissolved gas concentrations CH_4, H_2S, N_2, O_2) and age indicators (from existing $^3H/^3He$ data). This will be extended using shallow monitoring programs as an early warning indicator of PST leaching to groundwater following on from the registration process. The information on groundwater N and PST distribution and behavior over time will be used to calibrate and validate the coupled models in Task 3.

Task 5-3 – Modelling nitrate and pesticide transport through unsaturated and saturated zones to groundwater receptors (Lead: NERC)

The process understanding from the type-sites from Task 5.1 will be combined with available European-scale datasets to develop a European map of lag times and timescale of pollutant impact on drinking water sources, surface water and groundwater dependent ecosystems. For N, national fertilizer applications and leaching time series will be assessed to characterize peak N applications across Europe. Modelling of unsaturated zone timescales will be extended across Europe. Attenuation processes could include denitrification using spatial data from Task 5.4 and PST sorption and degradation rates from partner and literature data (linked to WP4). This will be coupled with saturated zone modelling and residence time indicators including WP6 and calibrated and validated using data from Task 5.2 to quantify the amount of pollutant stored in the saturated and unsaturated zones, and to provide estimated lag times and attenuation for mapping agrochemical transport towards receptors such as streams and drinking water production sites in Task 5.

Task 5-4 – Assessing the spatial extent and importance of denitrification (lead: BRGM)

To assess the spatial extent and importance of denitrification, we will evaluate and harmonize of N contamination patterns in relation to redox processes, using well established monitoring networks in pilot areas in England, Denmark, Flanders, France and the Netherlands, using a range of methods including process indicators such as N_2 -excess characterization, redox indicators (such as Fe and Mn and dissolved gas concentrations CH_4, H_2S, N_2, O_2) and age indicators (from existing $^3H/^3He$ and CFC data) as a signal for denitrification. This will be combined with existing denitrification potential mapping e.g. from England and Denmark.

Task 5-5 – Overview maps (lead: NERC)

Designing data output display/formats including overview maps over areas of Europe, with methodology to extend this to the European scale. These will indicate lag times and attenuation involved in N and PST transport. These will have wide application e.g. to contribute to Nitrate Vulnerability Zone designation or verification and to N vulnerability mapping (WP7).

Deliverables D.5-1: Atlas of geological/hydrogeological settings found across Europe with selected type sites (Report and map) – **M12** D.5-2: Datasets with characterization of these settings relevant for agrochemical transport (dataset) – **M18** D.5-3: Assessments of N travel times and attenuation patterns for a number of relevant European settings (report) outputs of task 5.3 and 5.4 – **M28** D.5-5: Maps of groundwater-N travel time – pan-European if there are sufficient partners – **M34**

Work package number	**WP6**		**Lead Beneficiary**			**GEUS**		
Work package title	***G**roundwater **A**ge **DIS**tributions and residence times in European aquifers (**"GADIS")***								
Participant number	1	1a	3	9	10	12	15	27	42
Participant short name	TNO	DLT	GBA	HGI-CGS	GSD	**GEUS**	BRGM	MBFSZ	MTI
Person-months per participant:	8.5	3.7	2.5	7.5	3	11.5	5	7	2.7
Participant number	46	49	50	52	53	Non-funded			
Participant short name	IGR	GEO ZS	IGME	SGU	Geo-inform	EGT Estonia			
Person-months per participant:	2	6.5	1	2	1	1			
Start month	1					End month	36		

Objectives

1.To establish a harmonized database on groundwater age tracers and indicators currently existing in EU member states (GSO's) and develop different age / residence time intervals suitable for classifying age structures and degree of protection of European aquifers on *maps and cross sections on the information platform (EGDI).*

2. To identify and describe a number of important European aquifers with a significant amount of age indicators as use cases and develop a good practice protocol on the application of age indicators for estimation of groundwater age distributions in time and space (including a sampling guide).

3. To demonstrate the use of groundwater age distributions for design and assessment of monitoring programmes, pollution trends and history and the evolution of groundwater quality (chemical status).

4. To test and develop new techniques for estimating age distributions of groundwater bodies with residence times mainly in the age range of 10 to 1000 years. Demonstration pilots at a number of drinking water well fields in contributing countries are developed to establish a common methodology for characterization of the age distribution of pumped wells by using a suite of tracers and models.

Description of work

<u>Task 6-1: Developing a database of existing groundwater age indicators in Europe (lead: GEUS)</u>

The task establishes an overview of groundwater age indicators applied in Europe by the use of questionnaires to involved partners and it develops a harmonised database for the analytical results, estimated average ages and groundwater age distributions. The indicators include radioactive (e.g. ^{3}H, ^{85}Ar, ^{39}Ar, ^{14}C) and stable isotopes (e.g. ^{3}He, ^{4}He, ^{13}C, ^{2}H, ^{18}O) as well as industrial gases (eg. CFCs and SF_6) as well supporting data required for estimation of groundwater ages (recharge temp., elevation, noble gas contents). It furthermore defines and classify the samples in age intervals as an indicator of the susceptibility/vulnerability of the aquifers to contamination from human activities on the surface, elevated toxic geogenic elements in deeper aquifers and overabstraction. The task relates to activities in WP3, WP5 and WP7.

Task 6-2: Use cases and good practice guidance (lead: MBFSZ)
Five to ten European aquifers with a significant amount of groundwater age indicators preferably corroborated by groundwater flow models are identified and presented as use cases for demonstration of good practices and management applications. The task includes developing a good practice protocol and recommendations for the combined use of different age indicators and models, and a groundwater sampling guide for collecting groundwater samples intended for the analysis of different age indicators.

Task 6-3: Application of groundwater age distributions for design and assessment of monitoring programmes and trend assessment (lead: BRGM).
This task develops good practices guidance on the estimation and application of groundwater age distributions for the design and evaluation of the results of groundwater monitoring programmes e.g. for assessment of trends / evolution of groundwater quality in time and space, and the efficiency of programme of measures for drinking water wells with high content of nitrate or pesticides.

Task 6-4: Application of new tracer and modelling techniques for estimation of groundwater age distributions in the age range 10-1000 years in water supply wells (lead: TNO).
Nitrate, pesticides and emerging contaminants contaminates drinking water supplies all over Europe. Understanding groundwater age distributions of water supply wells with long screens significantly improve the management of well fields and knowledge of contaminant transport, fate and history. The task investigates and develops guidance on the estimation and application of new methods for the assessment of groundwater age distributions in water supply wells with long screens and groundwater ages in the range of 10 – 1000 years.

Deliverables
D.6-1a: Database for concentrations of groundwater age indicators, estimated mean ages and age distributions, vulnerability classes and associated guidance (Database and associated technical guidance) – **M18**

D.6-1b: A classification system based on groundwater age distributions defining shallow and deep aquifer vulnerability classes indicating the risk of pollution and elevated concentrations of geogenic elements (REPORT) – **M12**

D.6-1c: Maps and cross sections on the information platform / EGDI showing spatial distribution of groundwater age and vulnerability classes in selected European aquifers (Web service) – **M24**

D.6-2: Collection of use cases including good practice guidance and age indicator sampling guide (REPORT) – **M18**

D.6-3: Recommendations for estimating groundwater age distributions and the application of these in groundwater monitoring and quality estimation (including trend assessment) (REPORT) – **M24**

D.6-4: Investigation of age distributions in water supply wells with long screens and recommendations for application of tracers and models mainly for estimating groundwater ages between 10 and 1000 years (REPORT) – **M30**

Work package number	**WP7**		**Lead Beneficiary**			**BGR**				
Work package title	Harmonized vulnerability to pollution mapping of the upper aquifer									
Participant number	3	12	14	15	17	22	27	29	40	44
Participant short name	GBA	GEUS	GTK	BRGM	**BGR**	LBEG	MBFSZ	GSI	LGT	PIG-PIB
Person-months per participant	4,5	2,5	1,4	1	12	4,5	5	4,5	2,5	3,5
Participant number	46	49	50	51	53	Non-funded				
Participant short name	IGR	GEOZS	IGME	ICGC	Geo-inform	LBGR				
Person-months per participant	2,7	5,5	5	7	1	1				
Start month	1					End month		36		

Objectives

- Investigation, comparison and potential extension of index methods for groundwater vulnerability assessment to pollution,
- Interoperabilization of spatial data basis for vulnerability assessment (e.g. soil, subsoil and aquifer properties available),
- Assessment of selected point information from representative drill logs and selected cross sections to get a specific view on the hydrogeological structure at pan European and at cross-border pilot areas scale,
- Presenting the geospatial information results using the Information Platform.

Description of work

Task 7-1: Investigation and selection of appropriate methodologies (lead: BGR)

Numerous parametric system methods for assessing aquifer vulnerability to pollution are used for establishing vulnerability maps (rating systems such as GOD, AVI; point count index system models, such as SINTACS, DRASTIC, EPIK). Existing groundwater vulnerability assessments elaborated by the individual European geological surveys differ in methodology, input parameters and applicability in the given hydrogeological setting. For supranational enhancement of vulnerability of the upper aquifer to pollution, further investigations in a preferably interoperabilized procedure of mapping extent and nature of the geological layers and characteristics that control the resilience of the groundwater resources, need to be conducted on the cross-border pilot area and pan-European scale.
To reach this target, internationally existing and usually applied index methodologies for assessing relative groundwater vulnerability to pollution of the upper aquifer have to be investigated, compiled, compared, assessed and assigned to the respective scale according spatial information.

Task 7-2: Harmonization of data referring to pan European and cross-border pilot area scale (Lead: BGR)

The basis for aquifer vulnerability assessments is provided by specific attribute data of the underground (e.g. soil, geology, depth to water table, etc.). Particularly in transboundary studies, these data often suffer from incompatible scale and variable quantity and quality of input information. In order to adopt the scale-dependent harmonized index methods for aquifer vulnerability to pollution mapping by the European Geological Surveys identified within Task 1, an interoperabilized definition of input parameters and data base is mandatory. Existing geological, hydrogeological, hydrogeochemical, meteorological and soil data of national and international organizations (e.g. WMO, FAO, JRC, igrac,

Geological Surveys, environmental institutions…) need to be taken into account. The International Hydrogeological Map of Europe (IHME1500) and its derivatives offer a central hydrogeological data pool to be improved and used by the work package partners. On selected cross-border pilot areas additionally higher resolution input data, such as extend and thickness of the aquifer and the overburden, depth of the water table, detailed lithological information obtained by representative drill logs, structures derived from local and regional cross sections, will be taken into account.
To reach this target selected national and international input data sets for the respective vulnerability assessment methodologies have to be investigated, compiled, compared and potentially assigned to the respective scale-dependent spatial information. Data bases are to be established at the partners and are to be connected using given geo data infrastructure techniques.

Task 7-3: Assessing vulnerability of the upper aquifer to pollution using GIS (lead: ICGC)
Mapping of spatial information to assess vulnerability of the upper aquifer to pollution at pan European and selected cross-border pilot areas scales requires the application of geoinformation systems. Spatial information needed for this assessment are data related to soil properties (e.g., filter function) and aquifer properties (e.g., known/potential karst and fissured areas, type of rock/cavity,…). Data compilation is in straight collaboration with WP3, WP5, WP6 and WP8. To reach this target the mapping of aquifer vulnerabilities to pollution, applying the methodologies identified in WP7-1 at the respective scales, will be conducted using Geoinformation Systems (GIS). Spatial information at the pan-European scale will be elaborated from BGR on the basis of the "International Hydrogeological Map of Europe (IHME1500)". Depending on data availability and general feasibility, the mapped aquifer vulnerabilities will be validated based on expert knowledge and, optionally, based on available independent spatial information on aquifer contamination. During data compilation, particular attention will be drawn to the interoperability of the utilized Geoinformation Systems (GIS) concerning data bases and models, data transformations (to raster and/or polygons) and output files (including feature information and meta data). Moreover, discrepancies along administrative units need to be harmonized (geometries and attribute information) by each of the cross-border partners.

Task 7-4: Volumes and areas of special aquifer vulnerability to pollution (lead:IGME)
In addition to the spatial maps, optionally in selected national pilot areas results about the volume of an aquifer that is over a certain threshold or in certain level or class of vulnerability will be obtained and represented by using 2D schematic cross section of the aquifer.
To reach this target several specific volumes will be defined from the vulnerability maps taking into account the geometry and hydrogeological properties of the aquifer. A vulnerability index for the groundwater body corresponding to the spatial method chosen will be defined taking into account the information included in the cited 2D sections of the aquifer. The effects on the vulnerability will be summarized in a visual way with a conceptual 2D/2.5D schematic cross section in combination with a map of the lateral extend of the aquifer.

Task 7-5: Data exchange with the Information Platform (Lead BGR)
Through the whole compilation and aggregation process interfaces will be established to the unit of partner organization participating in the Information Platform project in order to efficiently deliver the data to the GeoERA data service for Europe.

Deliverables
D.7-1: Comparison of international commonly applied index methodologies for assessing the vulnerability of the upper aquifer to pollution. Report – **M6**
D.7-2: Compilation of the examination results of the data sets of input data for the respective methodologies assessing vulnerability of the upper aquifer to pollution. Report and dataset – **M24**
D.7-3: Provision of scale and data-dependent products on the vulnerability of the upper aquifer to pollution using GIS. Maps and dataset – **M30**
D.7-4: Delivering of cross sections and maps of extend of selected aquifers in specific national pilot areas – Maps and associated report – **M30**
D.7-5: Delivery of the scale- and data-dependent spatial information products on the vulnerability of the upper aquifer to pollution using geo data infrastructure techniques (e.g. WMS/WFS/atom feeds) in order to efficiently deliver the data to the GeoERA data service for Europe. Dataset – **M34**

Work package number	WP8	Lead beneficiary			BRGM				
Work package title		Effective monitoring of emerging contaminants: development and validation of new assessment methods							
Participant number	1	15	40	42	44	49	50	52	53	54
Participant short name	TNO	**BRGM**	LGT	MTI	PIG-PIB	GeoZS	IGME	SGU	Geoinform	NERC
Person-months per participant:	8.5	7	2.5	1.5	5.5	8	6	2.5	1	6
Start month	1					**End month**	36			

Objectives

This work package will develop a consistent approach to GW monitoring for Organic Emerging Contaminants (ECs) in terms of sampling, site selection, monitoring frequency and methodology (including analytical techniques) and to ensure it is effective and data are comparable across the range of European geological and environmental settings. Specific objectives are:

- Assessment of status and scope of monitoring of groundwater for organic emerging contaminants (ECs) across Europe;
- Develop recommendation for statistical analysis of monitoring data and evaluate existing results in terms of geological setting and land use/anthropogenic activities.
- Provide multi-country/pan European information GIS layers on selected ECs
- Develop recommendations to enable effective monitoring for current / future emerging contaminants and key pollutants of concern on a Europe-wide basis;
- Develop indicators based on risk-assessment principles to link the potential leaching of ECs in groundwater with geological setting and land use, anthropogenic activities, chemical and hazard properties and co-occurring tracers.

Description of work

Task 8.1 : Review of GW occurrence data, sampling and analytical methods for ECs across Europe (Lead: NERC)

Task 1 aims to provide a review of existing monitoring results for organic ECs for each partner across Europe (national studies considered as a priority). ECs sampling methods – including both passive and active samplers, and macro and micro biomonitoring (linked to WP5) – and analytical methods – ranging from specific compound suites to screening and non-target screening methods – used by EuroGeoSurvey laboratories will be reviewed and shared as well. Results will be collected and reviewed to identify those with high quality and comparable data. Selected comparable ECs occurrence data will be mapped at the European scale. As the results will be reinterpreted in Task 2, context data of monitoring sites (geological setting and land use, anthropogenic activities, wells technical description) will be collected as far as possible.

Task 8.2- Relationship of ECs with environmental setting (lead IGME)

The relationship of detected compounds in GW with hydrogeological characteristics, anthropogenic activities, and hydro-climatic and environmental settings will be assessed in Task 2. This will be in relation to WP3, WP5, WP6 and WP7. Using the data and metadata gathered in Task 1, statistical tests for discriminant and canonical variate analysis will be applied to identify natural and anthropogenic forcing factors which may relate the presence of ECs in GW. These factors include hydrological considerations (GW recharge, age and vulnerability and redox status) and anthropogenic activities/land use management considerations. After an inventory of potential usage and origins of ECs of high concern, compounds known as being characteristic of one specific pressure will be used to assess links between land use and ECs occurrence in GW. Co-occurring contaminants and tracers will be statistically identified.

Task 8.3: European sampling and interlaboratory testing (lead TNO)
Based on knowledge of task 1 and 2 new sampling analyses on emerging compounds will be undertaken that includes interlaboratory testing. Analyses are directed to a number of pilot areas defined under the GW1 proposal and is directed towards potential hotspots for emerging contaminants transport in Europe. We will test the hypotheses under Tasks 1 to 2 to test effective monitoring in practice on some specific potentially contaminated sites.

Task 8.4: Identification of ECs of high concern in connection with European initiative (Lead: BRGM)
ECs of high importance to groundwater will be identified on the basis their properties (mobility, degradability and toxicity and eco-toxicity) and usage at the EU scale. Work will focus in particular on methods for combining and aggregating occurrence data and chemical properties to prioritize ECs regarding their GW leaching potential and hazard. Novel indicators will be developed, tested and validated using the pan-European occurrence data collected in Tasks 1 and 3.

Task 8.5: Development of monitoring recommendations (Lead BRGM)
Setting up an effective monitoring network for groundwater quality requires defining both lists of sampling sites and substances, and methods for sampling and analyzing these chemicals in water. Based on the results of the first 4 tasks, a framework for establishing key parameters and appropriate monitoring methodologies for groundwater will be developed to obtain comparable European data. This will lead to the development of monitoring recommendations appropriate for the range of partner backgrounds and expertise. A rigorous statistical approach will be used to inform this process to ensure an optimal number of sites and the substances to deliver a sustainable and cost-effective approach for future monitoring.

Deliverables
D.8-1. Critical review report of European monitoring results for organic emerging contaminants (report) - **M12**
D.8-2. Report with recommendations for monitoring of key parameters with reference to environmental context, geological setting and risk assessment – **M24**
D.8-3. Report describing new sampling analyses and interlaboratory tests directed towards potential hotspots for emerging contaminants transport (report) – **M35**
D.8-4. GIS-layers published by a GeoERA (EGDI) web service on the selected ECs (dataset) – **M32**
D.8-5. Concrete proposal and design for an EU wide monitoring program customized to emerging pollutants of high concern - **M35**

Table 3.1b) List of work packages
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WP No	Work package Title	Lead No	Lead Participant short-name	Person Months	Start-Month	End Month
1	Project management and scientific coordination	15	BRGM	17	1	39
2	GIP & CT coordination, data management and dissemination	12	GEUS	10	1	36
3	Hydrogeochemistry and health: Mapping groundwater characteristics for the management of aquifers naturally enriched in dissolved elements	3	GBA	127.9	1	36
4	Linking aquifer microbial ecology and diversity to contaminant transforming processes at European groundwater-surface water transition zones	12	GEUS	26.2	1	36
5	Nitrate and pesticide transport from soil to groundwater receptors	54	NERC	63.4	1	36
6	***G**roundwater **A**ge **DIS**tributions and residence times in European aquifers (**"GADIS"**)*	12	GEUS	63.9	1	36
7	Harmonized vulnerability to pollution mapping of the upper aquifer	17	BGR	62.6	1	36
8	Effective monitoring of emerging contaminants: development and validation of new assessment methods	15	BRGM	48.5	1	36
			Total Person Month	**419.5**		

Table 3.1c) List of deliverables
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Internal = GeoERA

Delivrable No	Delivrable name	WP No	Short Name of Lead	Type	Dissemination Level	Delivery Date (in months)
D.2-1	Data Management Plan	2	GEUS	Report	internal	6
D.7-1	Comparison of international commonly applied index methodologies for assessing the vulnerability of the upper aquifer to pollution clarifying differences in parameterization, weighting and final assessment	7	BGR	Report	Internal	6
D.1-3a	Cumulative expenditure report Y1	1	BRGM	Report	internal	7
D.2-3a	Communication, dissemination and exploitation plan	2	GEUS	Report	internal	8
D.2-2a	Definition of data requirements for GIP based on GIPrecommendations	2	GEUS	Technical Note	Internal	8 and 16

D.3-1	Database for concentrations of dissolved elements and associated parameters and harmonized terminology to define thermal and mineral water (Database and associated technical report	3	GBA	Database Report	Internal	12
D.3-2	A litho-geological classification system based on the capacities of rocks to release elements to GW including development of the methods in some EU countries	3		Report	Internal	12
D.5-1	Atlas of geological/hydrogeological settings found across Europe with selected type sites	5	NERC	Report Map	Internal	12
D.6-1b	A classification system based on groundwater age distributions defining shallow and deep aquifer vulnerability classes indicating the risk of pollution and elevated concentrations of geogenic elements	6	GEUS	Report	Internal Policy Makers Scientific community	12
D.8-1	Critical review report of European monitoring results for organic emerging contaminants	8	NERC	Report	Internal	12
D.4-1	Characterization of field sites based on existing and measured data as input to task	4	GEUS	Report	Internal	16
D.5-2	Datasets with characterization of the settings relevant for agrochemical transport	5	TNO	Database	Internal	18
D.6-1a	Database for concentrations of groundwater age indicators, estimated mean ages and age distributions, vulnerability classes and associated guidance	6	GEUS	Database Report	Policy Makers Scientific community	18
D.6-2	Collection of use cases including good practice guidance and age indicator sampling guide	6	MBFSZ	Report	Scientific community	18
D.2-2b	Provision of data for upload and testing of GIP second version	2	GEUS	Technical Note	internal	18 and 30
D.1-3b	Cumulative expenditure report Y2	1	BRGM	Report	internal	19
D.1-2a	Project progress report	1	BRGM	Report	internal	20
D.3-3	Data set of the results of the statistical data treatment allowing the preparation of the raw elements for the tasks 4 and 5 i.e. concentrations of	3	BRGM	Database report	Internal	24

	elements of natural origin per lithogeological units					
D.3-4	Compilation of indicators, analyses of possible use at pan-European scale and test application in countries of contrasted main litho/geology	3	IGME	Report	Scientific community Policy Makers Internal	24
D.3-5a	Data model and the legend of the planned web service (Report	3	GBA	Report	Internal	24
D.4-2	Degradation and mineralisation of selected contaminants in European GW-SW transition zones as input to task 4.3	4	GEUS	Report	Internal Scientific community	24
D.6-1c	Maps and cross sections on the information platform / EGDI showing spatial distribution of groundwater age and vulnerability classes in selected European aquifers	6	GEUS	Web service	Policy Makers General public	24
D.6-3	Recommendations for estimating groundwater age distributions and the application of these in groundwater monitoring and quality estimation	6	BRGM	Report	Policy Makers	24
D.7-2	Compilation of the examination results of the international data sets of input data for the respective methodologies assessing vulnerability of the upper aquifer to pollution	7	BGR	Report Database	Internal	24
D.8-2	Recommendations for monitoring of key parameters with reference to environmental context, geological setting and risk assessment	8	IGME	Report	Policy Makers Scientific community	24
D.5-3	Assessments of N travel times and attenuation patterns for a number of relevant European settings	5	NERC	Report	Internal Scientific community	28
D.6-4	Investigation of age distributions in water supply wells with long screens and recommendations for application of tracers and models mainly for estimating groundwater ages between 10 and 1000 years	6	TNO	Report	Scientific community	30
D.7-3	Provision of scale- (pan European, cross-border pilot area) and data-dependent	7	ICGC	Maps Database	Scientific community Internal	30

	(quantity, quality) products on the vulnerability of the upper aquifer to pollution using GIS					
D.7-4	Delivering of cross sections and maps of extend of selected aquifers in specific national pilot areas	7	IGME	Maps Report	Internal Scientific community	30
D.1-3c	Cumulative expenditure report Y3	1	BRGM	Report	internal	31
D.8-4	GIS-layers published by a GeoERA (EGDI) web service on the selected ECs	8	BRGM	Database	Policy Makers Scientific community General public	32
D.3-5b	Development of European exposure maps of selected elements (and indicators) based on GIS interpolation of measurements	3	GBA	Maps Articles Flyers	Scientific community Policy Makers Internal General Public Medias	33
D.3-5c	Web Services with multi-lingual legend concerning special ground water in the EU participating countries	3	GBA	Web service	Policy Makers Internal General Public Medias Industry	33
D.5-5	Maps of groundwater-N travel time – pan-European if there are sufficient partners	5	NERC	Map	Policy Makers Scientific community	34
D.7-5	Delivery of the scale and data-dependent spatial information products on the vulnerability of the upper aquifer to pollution using geo data infrastructure techniques in order to efficiently deliver the data to the GeoERA data service for Europe	7	BGR	Database	Policy Makers Scientific community General public	34
D.4-3	The use of microbial diversity measures for monitoring contaminant transforming processes at GW-SW transition zones	4	BRGM	Report	Policy Makers	35
D.8-3	New sampling analyses and interlaboratory tests directed towards potential hotspots for emerging contaminants transport	8	TNO	Report	Internal	35
D.8-5	Concrete proposal and design for an EU wide monitoring program customized to emerging pollutants of high concern	8	BRGM	Report	Policy Makers	35
D.2-3b	Article(s) submitted to international peer reviewed journal(s)	2	GEUS	Articles	Scientific community	36
D.1-2b	Final project report	1	BRGM	Report	internal	38
D.1-3d	Cumulative expenditure report final	1	BRGM	Report	internal	39

Table 3.2a) List of Milestones
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Milestone No	Milestone name	Related WP	Due date (in months)	Means of verification
1	Kick-off meeting	all	1	Report on the detailed WP plans and summary of discussion reviewed by Project Board Committee
2	WP and PB meeting	all	8	Progress report by WP leader and update of the risk of implementation by PB
3	Seminar with IP	All except WP4	18	Technical documents on map and web services needs and IT specificities reviewed by PB et IP coordinator
4	Mid-term meeting	all	20	Progress reports verified by PB and Advisory Board
5	Project Board meeting	All	26	Progress report by WP leader
6	Final meeting	All	36	Final reports verified by PB and Advisory Board

Table 3.2b) List of critical risks for implementation
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Description of Risk	***Level of likehood***	***Work package(s) involved***	***Proposed risk-mitigation measures***
Insufficient data or data quality to calculate the indicators linked to highly mineralized groundwater	High for some dissolved elements (Zn, Al…) Medium for the most common toxic elements (such as As)	WP3	*Proposing hydrogeological type- settings will permit to have a critical look at the compiled data and make a strong selection of data to be used in the statistical data treatment. The hydrogeological type settings would be based on geological and hydrogeological information and on major dissolved elements, usually of good quality and sufficient number. Some elements may also not be considered for the indicator development.*
Data density not sufficient to permit statistical data treatment proposed to discriminate natural from anthropogenic origin of dissolved elements in densely populated areas	Medium	WP3	Some elements could be discarded from the database in sector with high industrial, agriculture and urban areas. It is also possible to work by analogies using information available in other countries/sectors. The area under important/multiple pressure could, in some cases, not be taken into consideration.
Limited number of pilot sites to have a wide EU representativeness of bacterial diversity	High	WP4	One of the objectives of the WP is to make progress in the use of microbial ecology and community composition of European GW-SW site and data collected with the project will be completed by existing information. Although covering all European representative sites is far beyond the objectives of this project, as it

			would need specific EU project and additional funds.
Overview map indicating lag times and attenuation involved in N and PST transport cannot be produced since insufficient partners could provide adequate data for this task	High	WP5	Designing data output display/formats and methodology to extend it to the European scale will be developed. Some cross-border or national maps may be produced instead of pan-European product. However the use of existing information (from WHYMAP for example) at European scale and possibilities to combine different methods depending on data available in the different countries would be the preparation of such map possible.
It is not possible to create vulnerability maps including all EU countries	Low	WP7	Definition of hydrogeological-type settings should allow data extrapolation in some cases – Also external data could be used such as the WHYMAP products in order to propose a pan European map – In addition the possibilities of using various vulnerability assessment method would made possible working in some countries with less/different data
A small number of countries would be involved in the European sampling and interlaboratory testing	Medium	WP8	Advances in emerging contaminant monitoring and analyses the EU countries are disparate. In addition, funds are limited for this activity. Therefore, the number of the EC to be analysed and number of analyses may be limited. In order to make the best use of the available resources, the efforts will concentrate on the elements highlighted in the different tasks of this WP (of high concern due to their properties or prevalence)

Table 3.3a) Summary of Staff Effort
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Please indicate the number of person/months over the whole duration of the planned work, for each work package, for each participant. Identify the work-package leader for each WP by showing the relevant person-month figure in **bold**.

	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	Total Person-Months per participants
1 /TNO	1				12.0	8.5		8.5	30
1a/DLT					3.7	3.7			7.4
3/GBA	2	1.5	**12.0**			2.5	4.5		22.5
6/VMM			5.8						5.8
7/FZZG			11.0						11
9/HGI-CGS					7.0	7.5			14.5
10/GSD					3.0	3.0			6
11/CGS			11.0						11
12/GEUS	2	5	3.0	16.0	11.0	**11.5**	2.5		51
14/GTK							1.4		1.4

15/BRGM	**9**	1	4.0	6.0	5.5	5.0	1.0	7.0	38.5
17/BGR	2	1.5					**12.0**		15.5
22/LBEG							4.5		4.5
27/MBFSZ			6.5			7.0	5.0		18.5
28/ISOR			3.8						3.8
29/GSI			5.0	1.0	1.0		4.5		11.5
30/ISPRA			5.0						5
39/LEGMC			2.0	1.5	1.5				5
40/LGT			2.5				2.5	2.5	7.5
42/MTI			2.0		1.0	2.7		1.5	7.2
44/PIG-PIB			2.0				3.5	5.5	11
45/LNEG			3.0						3
46/IGR			3.0	1.0		2.0	2.7		8.7
47/GSS			8.0						8
49/GEOZS			7.5		10.0	6.5	5.5	8.0	37.5
50/IGME Spain			16.0			1.0	5.0	6.0	28
51/ICGC			6.0				7.0		13
52/SGU			5.0			2.0		2.5	9.5
53/GEOINFORM			3.8	0.7	0.7	1.0	1.0	1.0	8.2
54/NERC	1	1			7.0			6.0	15
*EGT						(1)			(1)
*RBINS-GSB			(2)						(2)
*LBGR							(1)		
Total Person Months	17	10	127.9	26.2	63.4	63.9	62.6	48.5	419.5

* Non-funded partners (not considered for calculation Total Person Month)

Table 3.3b) ‘Other direct cost’ items (travel, equipment, other goods and services)
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Please complete the table below for each participant.

1/TNO	Cost (€)	Justification
Travel	20000	Participation to all HOVER meetings, field trips related to sampling for emerging contaminants and age tracers
Equipment	20000	Consumables for fieldwork, sampling and chemical and tracer analysis for WP8 Emerging contaminant and WP6 Age Distributions
Other goods and Services		
Total	40000	

1a/DLT	Cost (€)	Justification
Travel	4700	HOVER meetings and field work
Equipment		
Other goods and Services		
Total	4700	

3/GBA	Cost (€)	Justification

Travel	8000	Project board meetings
Equipment		
Other goods and Services		
Total	8000	

6/VMM	Cost (€)	Justification
Travel	3500	HOVER meetings
Equipment		
Other goods and Services		
Total	3500	

7/FZZG	Cost (€)	Justification
Travel	1400	HOVER meetings
Equipment		
Other goods and Services		
Total	1400	

9/HGI-CGS	Cost (€)	Justification
Travel	3600	Travel to project meetings, visits to pilot sites
Equipment		
Other goods and Services		
Total	3600	

10/GSD CYPRUS	Cost (€)	Justification
Travel	4600	HOVER meetings – Cost high due to
Equipment		
Other goods and Services		
Total	4600	

11/CGS	Cost (€)	Justification
Travel	1700	travel to HOVER meetings, fieldwork
Equipment	1000	field equipment, software
Other goods and Services		
Total	2700	

12/GEUS	Cost (€)	Justification
Travel	20000	(as a justification for the amount being higher than the indicted 15%, it is to be noted that travelling from Malta (do to insularity) is generally more expensive than from other EU countries requiring air travel with connecting flights)
Equipment	18800	Consumable and analyses for age dating
Other goods and Services		
Total	38800	

14/GTK	Cost (€)	Justification
Travel	1500	Travel cost to project meetings
Equipment		
Other goods and Services		
Total	1500	

15/BRGM	Cost (€)	Justification
Travel	20000	Participation to all HOVER meetings as global coordinator of the project for up to 3 persons
Equipment	20000	Analytical tests included on emerging contaminant (WP8) and microbial experiments/microbial diversity measures (WP4)
Other goods and Services		
Total	40000	

17/BGR	Cost (€)	Justification
Travel	5000	Participation to project board meetings
Equipment		
Other goods and Services		
Total	5000	

22/LBEG	Cost (€)	Justification
Travel	2700	Participation to HOVER meetings
Equipment		
Other goods and Services		
Total	2700	

27/MBFSZ	Cost (€)	Justification
Travel	4100	Travels to meetings Pilot site visits, fieldwork, sampling
Equipment		
Other goods and Services		
Total	4100	

28/ISOR	Cost (€)	Justification
Travel	3000	Participation to HOVER meetings
Equipment		
Other goods and Services		
Total	3000	

29/GSI	Cost (€)	Justification

Travel	3000	Participation to HOVER meetings
Equipment		
Other goods and Services		
Total	3000	

30/ISPRA	Cost (€)	Justification
Travel	5550	Participation to project meetings and visits to pilot sites
Equipment		
Other goods and Services		
Total	5550	

39/LEGMC	Cost (€)	Justification
Travel	1700	travels to attend 2 project meetings
Equipment		
Other goods and services		
Total	1700	

40/LGT	Cost (€)	Justification
Travel	1700	Travels to attend 2 project meetings
Equipment		
Other goods and Services		
Total	1700	

42/MTI	Cost (€)	Justification
Travel	8000	travels to attend 3 project meetings (kick-off, mid-term, final), and 1 WP meeting (as a justification for the amount being higher than the indicted 15%, it is to be noted that travelling from Malta (do to insularity) is generally more expensive than from other EU countries requiring air travel with connecting flights)
Equipment		
Other goods and Services		
Total	8000	

44/PIG-PIB	Cost (€)	Justification
Travel	7000	travels to international meetings; national field trips related to sampling for emerging contaminants
Equipment	8800	Consumables (printing materials, shipment costs). Additional costs associated with sampling and analyses for emerging

		contaminants, including purchase of materials such as bottles, filters, reagents, shipping, etc. Min 10 samples
Other goods and Services		
Total	15800	

45/LNEG	Cost (€)	Justification
Travel	1700	Travel to HOVER meetings
Equipment/consumables		
Other goods and services		
Total	1700	

46/IGR	Cost (€)	Justification
Travel	3000	Travel to HOVER meetings and field missions
Equipment/consumables	2210	Sampling and analyses
Other goods and services		
Total	5210	

47/GSS	Cost (€)	Justification
Travel	2000	Travel to HOVER meetings
Equipment/consumables		
Other goods and services		
Total	2000	

49/GEOZS	Cost (€)	Justification
Travel	10500	Travel to HOVER meetings
Equipment/consumables	3000	Additional costs associated with sampling and analyses, including purchase of materials such as bottles, filters, reagents, shipping, etc.
Other goods and services		
Total	13500	

50/IGME SPAIN	Cost (€)	Justification
Travel	9000	Travel to HOVER meetings, field missions

Equipment/consumables	3000	Analyses and consumables
Other goods and services		
Total	12000	

51/ICGC	Cost (€)	Justification
Travel	7500	Travel costs for attendance of 1-2 persons for a maximum of six key project meetings/workshops
Equipment		
Other goods and Services		
Total	7500	

52/SGU	Cost (€)	Justification
Travel	6000	Travel to HOVER meetings
Equipment/consumables		
Other goods and services		
Total	6000	

53/GEOINFORM	Cost (€)	Justification
Travel	5500	travels to attend projects meetings (kick-off, mid-term, final)
Equipment		
Other goods and Services		
Total	5500	

54/NERC	Cost (€)	Justification
Travel	7000	travels to attend project board meetings
Equipment		
Other goods and Services		
Total	7000	

Table 3.3c) Financial table with requested budget
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Participants	A Direct Personnel Costs (€)	B Other direct costs travel, equipment	C Direct costs of subcontracting	D Indirect costs (A+B)*0.25	E Total eligible costs (=A+B+C+D)	F Reimbursement Rate -29,70%	G Requested EU contribution =F	H Surveys In-Kind Contribution =(E-G)
TNO	192870	40000	0	58218	291088	29,70%	86453	204635
DLT	58974	4700	0	15919	79593	29,70%	23639	55954
GBA	112500	8000	0	30125	150625	29,70%	44736	105889
VMM	40000	3500	0	10875	54375	29,70%	16149	38226
FZZG	14555	1400	0	3989	19943	29,70%	5923	14020
HGI-CGS	34800	3600	0	9600	48000	29,70%	14256	33744
GSD	27000	4600	0	7900	39500	29,70%	11732	27769
CGS	24970	2700	0	6918	34588	29,70%	10272	24315
GEUS	384905	38800	0	105926	529631	29,70%	157300	372330
GTK	9180	1500	0	2670	13349	29,70%	3965	9385
BRGM	284672	40000	0	81168	405840	29,70%	120535	285306
BGR	99691	5000	0	26173	130864	29,70%	38867	91998
LBEG	27000	2700	0	7425	37125	29,70%	11026	26099
MBFSZ	29138	4100	0	8309	41547	29,70%	12339	29207
ISOR	32300	3000	0	8825	44125	29,70%	13105	31020
GSI	51092	3000	0	13523	67615	29,70%	20082	47534
ISPRA	27500	5550	0	8263	41313	29,70%	12270	29043
LEGMC	5077	1700	0	1694	8471	29,70%	2516	5955
LGT	15750	1700	0	4363	21813	29,70%	6478	15334
MTI	26640	8000	0	8660	43300	29,70%	12860	30440
PIG-PIB	29150	15800	0	11238	56188	29,70%	16688	39500
LNEG	14963	1700	0	4166	20829	29,70%	6186	14642
IGR	51507	5210	0	14179	70897	29,70%	21056	49840
GSS	21480	2000	0	5870	29350	29,70%	8717	20633
GEOZS	131250	13500	0	36188	180938	29,70%	53738	127199
IGME	126728	12000	0	34682	173410	29,70%	51503	121907
ICGC	68815	7500	0	19079	95394	29,70%	28332	67062
SGU	70775	6000	0	19194	95969	29,70%	28503	67466
GEOINFORM	39625	5500	0	11281	56406	29,70%	16753	39653
NERC	87185	7000	0	23546	117731	29,70%	34966	82765
Total	2140091	259760	0	599963	**2999814**		890945	2108869

4 MEMBERS OF THE CONSORTIUM

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Please note that the presentation of the members of the consortium has been intentionally limited to 1 page for each partner.

<table>
<tr><td>Name of organisation</td><td colspan="3">1. Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO</td></tr>
<tr><td>Short name</td><td>TNO</td><td>Country</td><td>Netherlands</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">TNO is a semi-independent Dutch research and technology organisation active in technical, earth, environmental, life, societal and behavioural sciences, focussing of healthy living, industrial innovation, defence, safety and security. The Geological Survey of the Netherlands (TNO-GSN) provides geoscientific data, information and knowledge for sustainable management of earth resources and the environment. TNO-GSN is the national information provider on subsurface data, including the 3D groundwater information products REGIS, GeoTop and webservices such as Groundwater Tools.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">Participant in WP5, WP6 & WP8</td><td colspan="2">Building databases and web services for subsurface and groundwater data
Integrated interpretation of hydrological, hydrochemical and hydrogeological datasets towards custom made information products</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Dr. Hans Peter Broers (m): senior expert groundwater quality & groundwater modelling at TNO-GSN, specialising in groundwater-surface water interaction and tracer hydrogeology. Vice-chair of the EGS Water Resources Expert Group. Coordinator of several EU Framework Proposals and work packages (FP6 Aquaterra, FP7 MARS). Drs. Ronald Vernes (m) senior expert and project manager at TNO-GSN. Responsible for the national 3D hydrogeological model REGIS II, project initiator and manager of the cross border hydrogeological harmonization H3O-projects with Belgium and Germany. Dr. Willem Jan Zaadnoordijk (m): senior hydrogeologist at TNO-GSN and guest researcher at Technical University Delft. Experienced in groundwater modeling, modeling of piezometric time series and groundwater surface water interaction.</td></tr>
<tr><td colspan="4">Publications, infrastructure / technical equipment</td></tr>
<tr><td colspan="4">National DINO database on subsurface information (boreholes, groundwater heads and qroundwater quality) and 3D geomodels GeoTOP and REGIS II (www.dinoloket.nl), timeseries models for heads DINO database (www.grondwatertools.nl)
Publications:
Visser A., H.P. Broers, R. Purtschert, J. Sültenfuss and M.de Jonge (2013). Groundwater travel time distributions at a public drinking water supply well field derived from multiple age tracers (85Kr, 3H, noble gases and 39Ar). Water Resources Research 49(11):7778-7796
Geer F.C., M.F.P. Bierkens and H.P. Broers (2008) Groundwater monitoring strategies. Encyclopedia of Hydrological Sciences. DOI: 10.1002/0470848944.hsa316
Broers, H.P. & B. van der Grift (2004) Regional monitoring of temporal changes in groundwater quality. Journal of Hydrology 296:192-220
Berendrecht, W.L., F.C. van Geer (2016) A dynamic factor modeling framework for analyzing multiple groundwater head series simultaneously, Journal of Hydrology, 536, 50-60.
Zaadnoordijk, W.J., M. Bakker (2013) Application of spatial time-series analysis to determine calibration targets for transient groundwater models, in: proceedings MODFLOW and More 2013 Translating Science into Practice, June 2-5, 2013, IGWMC, Colorada School of Mines, Golden CO, USA.</td></tr>
<tr><td colspan="4">Relevant projects/activities</td></tr>
<tr><td colspan="4">H3O (2013-present): cross-border harmonization of 3D hydrogeological models within the Dutch-Belgian cross-border region.
FP 6 Aquaterra (partner): Trends in groundwater quality and interpretation of groundwater-surface water interaction in a number of European pilots.
FP6 BRIDGE (partner): policy support for the EU Groundwater Directive.</td></tr>
</table>

Name of organisation	**1a. Deltares**		
Short name	Deltares	**Country**	The Netherlands

Organisation profile

Deltares is an independent institute for applied research in the field of water and subsurface. Deltares works on smart solutions, innovations and applications for people, environment and society. Deltares employs over 800 people and is based in Delft and Utrecht. The unit subsurface and groundwater systems is based in Utrecht. Deltares is working in modelling, development of software and databases, laboratory and monitoring activities. Deltares hosts the national hydrological model, the Netherlands Hydrological Instruments (NHI), the integrated model for soil, subsurface and surface water for water quantity and nutrient modelling). The groundwater modelling team in Utrecht works closely with the geological modelling team at TNO, the modelling team for the vadose zone at Wageningen University and the surface water modelling team of Deltares in Delft. The team has broad experience in developing and applying hydrological models within research and projects for water quantity and water quality, including the interaction of surface water and ground water and impact of climate change as well as social and economic scenario's.

Roles / tasks in the project	**Special relevant skills**
Within GeoERA Deltares works as subcontractor of TNO.	• Integrated hydrological modelling on national scale, water quantity and water quality • Modelling on different scales (local, regional national, continental /world wide scale). • Hydrological characterisation of GW

Short profile of staff member(s) who will be undertaking the work

Marta Faneca Sanchez (f) is specialized in the analysis of groundwater systems, and in groundwater modelling on a regional, national and global scale.
Bas van der Grift (m) has a extensive scientific background in water quality and environmental geochemistry.
Gijs Janssen's (m) expertise is ground water quality, soil pollution, uncertainty analysis and geohydrology. Gijs has a broad experience in ground water modelling (reactive transport modelling density dependent flow, transport modelling, inverse modelling).
Timo Kroon (m) experience focusses on integrated hydrological modelling of groundwater and surface water. Timo is project leader of the NHI (Netherlands Hydrological Instrument) for water quantity and water quality and involved in many modelling projects within the Netherlands.

Publications, infrastructure / technical equipment

B. van der Grift, H.P. Broers, W. Berendrecht, et al. High-frequency monitoring reveals nutrient sources and transport processes in an agriculture-dominated lowland water systemHydrology and Earth System Sciences 20 (5), 2016
Janssen, G.M.C.M., J.R. Valstar and S.E.A.T.M. van der Zee Measurement network design including travel time determinations to minimize prediction uncertainty Water, Water Resources Research 2008.
De Lange, W.J., Prinsen, G.F., Hoogewoud, J.C. et al An operational, multi-scale, multi-model system for consensus-based, integrated water management and policy analysis: The Netherlands Hydrological Instrument. Environmental Modelling & Software, 2014.

Relevant projects/activities

Netherlands Hydrological Instrument (NHI), (2005,--) lead by Deltares. (www.nhi.nu).
Netherlands Water Quality Instrument (2015,--) lead by Deltares and Wageningen University and Research. Based on the national hydrological model an nutrient model for the Netherlands is developed. The model wil be applied in 2018 for national policy studies.
Global scale ground water modelling using MODFLOW and PCRGLOB. In cooperation with Utrecht University a global MODFLOW model, coupled to the PCRGLOB model is developed.

Name of organisation	3. Geologische Bundesanstalt		
Short name	GBA	Country	Austria

Organisation profile

The **Geological Survey of Austria (GBA)** undertakes core programmes, such as geoscientific mapping of the Austrian territory. Applied tasks include assessment of mineral and ground water ressources, natural hazard mitigation & monitoring as well as geothermal exploration. Furthermore, GBA operates a geological information service, acts as a service for the public administration and participates actively in international research projects, in particular with EuroGeoSurvey, where it is a member of most expert groups.

Roles / tasks in the project	Special relevant skills
Coordination of WP3 Participant in WP1, WP2, WP6 & WP7	- Groundwater mapping - Radionuclides in groundwater

Short profile of staff member(s) who will be undertaking the work

Gerhard Schubert (m) is the Head of Austria's Geological Survey's Department Hydrogeology and Geothermal Energy. He was involved in several EU-funded projects as responsible partner and is member of the EGS Water Resources Expert Group.

Publications, infrastructure / technical equipment

The following recent publications applies to project GW1: :

*<u>SCHUBERT</u>, G, BERKA, R., KATZLBERGER, Ch., MOTSCHKA, K., DENNER, M., GRATH, J. & PHILIPPITSCH, R. (2017: Radionuclides in groundwater, rocks and stream sediments in Austria - results from a recent survey. – Special Publications, Radon, Health and Natural Hazards, Geological Society of London. (*https://doi.org/10.1144/SP451.10*)*

*ELSTER, D., GOLDBR UNNER, J., WESSELY, G., NIEDERB ACHER, P., <u>SCHUBERT</u>, G., BERKA, R., PHILIPP ITSCH, R. & HÖRHAN, T. (2016): Erläuterungen zur geologischen Themenkarte Thermalwässer in Österreich 1:500.000. – 296 S., Wien. (*http://opac.geologie.ac.at/wwwopacx/wwwopac.ashx?command=getcontent&server=images&value=Erlaeuterungen_Thermalwaesser.pdf *and* http://opac.geologie.ac.at/wwwopacx/wwwopac.ashx?command=getcontent&server=images&value=Karte_Thermalwaesser_Scan_400.pdf*)*

*<u>SCHUBERT</u>, G. (Red.) (2015): Trinkbare Tiefengrundwässer in Österreich. – Abhandlungen der Geologischen Bundesanstalt, 64, 179 S., Wien. (*https://www.bmlfuw.gv.at/dam/jcr:17ad0c30-d42d-4c20-ac13-ddab607cb97c/AB0064_Gesamt_Trinkbare%20Tiefengrundw%C3%A4sser%20in%20%C3%96sterreich.pdf *and* https://www.bmlfuw.gv.at/dam/jcr:bc3a402a-5ac0-4c58-9c0a-69b11ee6013d/TGW-Karte%5B1%5D_web.pdf*)*

LOISHANDL-WEISZ, H., WEMHÖNER, U., SCHARTNER, CH., <u>SCHUBERT</u>, G., SCHEDL, A. & PHILIPPITSCH, R. (2012): Metalle im Grundwasser Österreichs. Karten und Erläuterungen. – 63 S., 13 Beilagen, Umweltbundesamt, Wien. (https://www.google.at/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwi46oSPzvfXAhWBmBoKHUIMChMQFggvMAE&url=https%3A%2F%2Fwww.bmlfuw.gv.at%2Fdam%2Fjcr%3Aebb5c343-9c26-4092-a2e3-78e10825db70%2FMetalle_im_Grundwasser_Letztfassung%2520032013_Karten_und_Erl%25C3%25A4uterungen.pdf&usg=AOvVaw3vCdNDkzuvauc4ZCTFJZ2I)

Relevant projects/activities

The following ongoing national projects of the Austrian Geological Survey refer to project GW1:

- *Hydrogeological Map of Austria 1 : 500 000 - Update*
- *Hydrogeological Map of Upper Austria 1 : 200 000, explanatory notes*
- *Mineral Water and Medical Springs in Austria (map 1 : 500 000 and explanatory notes)*
- *Uranium in Groundwater*
- *Geochemical Background and Baseline Values in Austrian groundwater (in cooperation with Umweltbundesamt)*

<table>
<tr><td>Name of organisation</td><td colspan="3">6. Vlaamse Milieu Maatschappij (Flanders Environment Agency)</td></tr>
<tr><td>Short name</td><td>VMM</td><td>Country</td><td>Belgium</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">Flanders Environment Agency (VMM) is an internally independent government agency with powers of jurisdiction under supervision of the Flemish Minister of the Environment, Nature and Agriculture. VMM's legal basis is the decree of 05/04/1995 (Belgian Official Journal of 03/06/1995). The mission of VMM is to contribute to the realisation of the objectives of the environmental policy by preventing, limiting and eliminating the harmful effects to water systems (including groundwater) and the atmosphere and by reporting on the state of the environment and to the realisation of the objectives of integrated water management.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">Participant in WP3</td><td colspan="2">- Groundwater quality monitoring
- Status assessment of groundwater quality
Policy development on groundwater and drinking water</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Kris Van den Belt (m) graduated as a biologist and holds a phd in biology. He is head of the groundwater and local water management section of VMM and is representing Flanders in the CIS Working Group Groundwater and the European network of drinking water regulators.
Ralf Eppinger (m) graduated as a geologist in 1995 and holds a phd in geology (2008). He leads the groundwater monitoring team of the groundwater and local water management section of VMM and is representing Flanders in the CIS Working Group Groundwater.
Griet Heuvelmans (f) graduated as bio-engineer in 2001 and holds a phd in bio-engineering (2005) from the University of Leuven. She works at the groundwater and local water management section of VMM and is mainly involved in the initiation and coordination of studies in support of groundwater policy and management.</td></tr>
<tr><td colspan="4">Publications, infrastructure / technical equipment</td></tr>
<tr><td colspan="4">- Groundwater quality data: 2 monitoring campaigns per year on > 5000 screens since 2004. Screen are distributed over all groundwater layers in Flanders and data are used for reporting groundwater quality in the framework of EU directives
- Groundwater quality database and web-portal for data dissemination
- Publications for a wider audience (in Dutch), a.o. 'Heavy metals in groundwater in Flanders', 'Pesticides in groundwater in Flanders', 'Quality of drinking water in Flanders in 2016'
.</td></tr>
<tr><td colspan="4">Relevant projects/activities</td></tr>
<tr><td colspan="4">- Reporting the qualitative status of groundwater bodies to EU
- Preparing policy and legislation concerning groundwater (e.g. setting natural background concentrations and threshold values for groundwater quality) and drinking water in Flanders
- Participating in international working groups on groundwater (e.g. CIS Working group Groundwater) and drinking water (e.g. ENDWARE)
- Disseminating groundwater information to the general public in Flanders, via publications and a web-portal (dov.vlaanderen.be)</td></tr>
</table>

Name of organisation	7. Federalni zavod za geologiju (Geological Survey of Federation of Bosnia and Herzegovina)		
Short name	FZZG	**Country**	Bosnia and Herzegovina

Organisation profile

Geological Survey of Federation of Bosnia and Herzegovina carries out researching, expert-analytical and other tasks in area of fundamental and regional geologic researches of interest for the Federation referring to producing the basic geologic, hydrogeologic, engineering-geologic, seismologic-tectonic and other geologic maps and carries out preparation for printing thereof

Roles / tasks in the project	Special relevant skills
Participating in WP3	• Building databases for groundwater • Characterisation and mapping of hydrogeological systems

Short profile of staff member(s) who will be undertaking the work

Hazim Hrvatović (m): Director Federal Institute for Geology; key expert for structural geology and geological mapping.
Ferid Skopljak (m): Assistant director, key expertise is research and protection of groundwater. He has experience of 27 years in hydrogeological studies
Jasminka Nikolić (f):senior hydrogeologist, expert in hydrogeological mapping
Ćazim Šarić (m): - Senior hydrogeologist, expert in exploration of groundwater dynamics and protection of groundwater resources; expert for GIS.
Nermina Omerhodžić (f): key expert for GIS

Publications, infrastructure / technical equipment

1. Map of mineral, thermal and thermomineral waters of B&H with Explanation and Catalogue of waters (Miošić, 1978) in the frame of Map of mineral and thermal waters of Yugoslavia (1983).
2. Investigations of regime and balance of mineral, thermal and thermomineral waters of Bosnia and Herzegovina (Slišković, Plavkić, Miošić, 1982, 1985, 1990).
3. Geothermal Atlas of Europe – B&H (Miošić, 1987).
4. Geothermal map of Bosnia and Herzegovina, 1:200.000 (Miošić, 1989).
5. Atlas of Geothermal Resources in Europe – B&H (Miošić, 1994).
6. Global Heat Flow Data Base (GHFDB) – B&H (Miošić, 1988).
7. Cadastre and GIS database of mineral, thermal and thermomineral waters of Federation of B&H (Miošić, Skopljak, Samardžić, Saletović-Nikolić, Begić, 2010).

Relevant projects/activities

1. APOPSBAL (2002-2005);
2. ANTHROPOL. PROT (2003-2005);
3. IGME 5.000.000 (1994-2010);
4. BSHAP, NATO Project (2007-2011);
5. OneGeology (2008.);
6. GEMAS (2008-2013);
7. DanReGeotherm-DATA (2015);

Name of organisation	**9. Hrvatski geološki institut – Croatian Geological Survey**		
Short name	HGI-CGS	**Country**	Croatia

Organisation profile

Croatian Geological Survey (HGI-CGS) is the foremost public research institute in the field of geosciences and geological engineering in Croatia (HR). HGI-CGS is divided into three departments: Department of Hydrogeology and Engineering Geology, Department of Mineral Resources and Department of Geology. HGI-CGS collaborates with many institutions of similar affiliation, organizations and faculties in the country and neighbouring countries. Beside scientific research, the institute provides consulting services for private companies and stakeholders. HGI-CGS basic activity includes long-term project of producing Basic Geological Maps of the Republic of Croatia among which is also Basic Hydrogeological Map. Regarding groundwater resources HGI-CGS experts have experience and competence in groundwater protection, modelling and solving various groundwater connected environmental problems.

Roles / tasks in the project	Special relevant skills
Participant in WP5 & WP6	• Characterisation and mapping of hydrogeological systems • Modelling of groundwater flow and solute transport through saturated zone • Groundwater age dating

Short profile of staff member(s) who will be undertaking the work

Željka Brkić (f): - Senior Research Associate at Croatian Geological Survey, Department of hydrogeology and engineering geology. Leader of the projects linked to the implementation of the EU Water Framework Directive in Croatia.

Ozren Larva (m): - Senior Research Associate at Croatian Geological Survey, Department of hydrogeology and engineering geology with expertise in exploration of groundwater dynamics and protection of groundwater resources, vulnerability and risk assessment and modelling of groundwater flow and solute transport.

Publications, infrastructure / technical equipment

Brkić, Ž., Kuhta, M. & Hunjak, T. (2018): Groundwater flow mechanism in the well-developed karst aquifer system in the western Croatia: insights from spring discharge and water isotopes. Catena, 161, 14-26.

Brkić, Ž., Briški, M. & Marković, T. (2016): Use of hydrochemistry and isotopes for improving the knowledge of groundwater flow in a semiconfined aquifer system of the Eastern Slavonia (Croatia). Catena, 142, 153-165.

Marković, T., Brkić, Ž. & Larva, O. (2013): Using hydrochemical data and modelling to enhance the knowledge of groundwater flow and quality in an alluvial aquifer of Zagreb, Croatia. Science of Total Environment, Vol. 458-460;. 508-516.

Larva, O., Marković, T. & Mraz, V. (2010): Hydrodynamic and hydrochemical conditions at the groundwater source "Pašino vrelo", with a focus on its development. Geologia Croatica Vol 63 (3): p 299-312.

Relevant projects/activities

- TRANITAL – Origin, fate and transport modelling of nitrate in the Varaždin alluvial aquifer
- ISTRA-HIDRO – Sustainable management of transboundary groundwater between Trieste and Kvarner bay
- DARLINGe – Danube Region Leading Geothermal Energy; Interreg Danube Transnational Programme; 2017-2019.

Name of organisation	10. Cyprus Geological Survey Department		
Short name	GSD	**Country**	Cyprus

Organisation profile

The Cyprus Geological Survey Department (G.S.D.) was established in 1950 with a mandate to consult the state on geological matters. It is a state-funded public institution under the Ministry of Agriculture, Rural Development and Environment and its mission is to safeguard the public interest through the identification, the exploitation and protection of mineral and groundwater resources, the investigation and assessment of the geological environment and geohazards, the monitoring and assessment of seismicity, the investigation of foundation conditions, the protection and promotion of sites of geological and mining heritage and the production and dissemination of unbiased geological information to society.

Roles / tasks in the project	Special relevant skills
Participant in WP5 & WP6	• Groundwater qualitative and quantitative monitoring and reporting • Groundwater exploration in fractured systems

Short profile of staff member(s) who will be undertaking the work

Christos Christofi (m): Senior Geological Officer, head of hydrogeology and drilling section. Groundwater exploration and hydrochemistry. National representative in Working Group Groundwater within the Common Implementation Strategy of the Water Framework Directive.
Theodosia Herakleous (f)
Michales Rigas (m)

Publications, infrastructure / technical equipment

- *Konstantinou K., Kallergis G. and Christofi C. 2005. Study of groundwater flow regime in fractured formations with data from dataloggers: The Troodos Ophiolite Complex (2005). In G. Stournaras et al. (Eds.), Proceedings of 7th Panhellenic Hydrogeological Conference, Athens 2005*
- *Christofi C and Konstantinou K. 2011. Nitrogen sources and denitrification potential of Cyprus aquifers, through isotopic investigation on nitrates. In: N. Lambrakis et al. (Eds.), Advances in the Research of Aquatic Environment, Vol. 2: DOI 10.1007/978-3-642-24076-8.*
- *Konstantinou K., Rigas M. and Christofi C. 2014. Concentration and distribution of arsenic, cadmium, lead and mercury in the groundwater bodies of Cyprus (2014). In K. Voudouris, G (Eds.), Advances in the Research of Aquatic Environment, Vol. 1: 978-960-88816-62-2.*
- *Rigas M., Christofi C. and Konstantinou K 2017. Volume analysis using the ManKendall test of nitrate concentration of groundwater in Cyprus. 11th International Hydrogeological Conference, Athens 2017, Conference proceedings V.2.*

Relevant projects/activities

GSD hydrogeology database (Hydrogeoanalyst) holds ground, surface and precipitation water quality data (and quantitative, where applicable). Furthermore, geological logging data are also stored in the database.

Name of organisation	**11. Ceska geologicka sluzba / Czech Geological Survey**		
Short name	CGS	**Country**	Czech Republic

Organisation profile

Ceska geologicka sluzba / Czech Geological Survey (CGS) is a research institute of the Ministry of Environment of the Czech Republic. The mission of the CGS, the history of which has started in 1919, is the performance of the state geological survey in the Czech Republic and research in geosciences. CGS leads and participates in basic and interdisciplinary research projects.
The main fields of expertise include hydrogeological research and mapping; geochemistry and environmental studies (interaction atmosphere – biosphere –hydrosphere – geosphere, monitoring of element budgets, acidification of forest soils, organic pollutants, radon risk); applied geology and natural risks (hydrogeological mapping and research, radioactive waste disposal, support of development planning).
The system of CGS district geologists and associated specialists assists in acquisition and assessment of data on the geological composition of the state territory and the CGS provides expert information to the authorities.

Roles / tasks in the project	Special relevant skills
Participant in WP3	- data management - GIS - Web Map Services

Short profile of staff member(s) who will be undertaking the work

Eva Kryštofová (f) Researcher, district hydrogeologist. Involved in mapping projects, including special GW mapping initiated by the Radioactive Waste Repository Authority. Experienced in hydrogeological map compilation and data assessment.
Iva Kůrková (f) Researcher, district hydrogeologist. Involved in mapping projects and applied hydrogeological projects. Experienced in hydrogeological and hydrochemical data assessment.
Both were involved in EU-funded project " Review of groundwater resources in the Czech Republic".

Publications, infrastructure / technical equipment

- Map application presenting the hydrogeological zones of the Czech Republic territory as defined in 2005. http://mapy.geology.cz/hydro_rajony/index_EN.html?config=config_EN.xml
- Map application giving key information about boreholes. http://mapy.geology.cz/GISViewer/?mapProjectId=15&cultureInfo=en
- Map application giving information about surface water chemistry (Czech only): http://mapy.geology.cz/chemismus_vod/
- CGS hosts the national repository for subsurface data and information including hydrogeological information (water heads, hydrochemistry, pumping tests).

Relevant projects/activities

- Hydrogeological mapping of the Czech Republic territory at different scales http://www.geology.cz/extranet-eng/science/natural-resources/ground-waters/hydrogeological-mapping
- Review of groundwater resources in the Czech Republic. This already finished project included reassessing of groundwater resources within app. one third of the territory of the Czech Republic. An integral part of the project is the development of methodological steps for the future periodical updating of groundwater resources including the water quality.

Name of organisation	12. Geological Survey of Denmark and Greenland, GEUS		
Short name	GEUS	**Country**	Denmark

Organisation profile

GEUS is an independent research and advisory institution in the Danish Ministry of Energy, Utilities and Climate. Primary activities are research in water, energy, minerals and other natural resources. GEUS provide geological advice to public authorities in nature, environment, climate, energy and raw materials issues and participate in the performance of tasks within these areas. GEUS is the national geological data centre and in that capacity make data and knowledge available to the authorities, educational institutions, government agencies, private enterprises and the public.

Roles / tasks in the project	Special relevant skills
Coordinator of WP2, WP4 & WP6 Participant in WP1, WP3, WP5, & WP7	• Groundwater quality monitoring and assessment, drinking water quality and health, groundwater dating, microbial ecology, transport and degradation of pesticides and emerging contaminants

Short profile of staff member(s) who will be undertaking the work

Jens Aamand (m) – professor, research microbiologist, expert in microbial degradation of organic contaminants, **Klaus Hinsby (m):** Senior Scientist/Hydrogeologist, theme coordinator for GeoERA groundwater, Chair of the EGS Water Resources Expert Group and EGS representative in the EU Working Group Groundwater, expert in groundwater dating. **Lærke Thorling (f):** Senior Adviser/Chemist/Physicist, Expert in groundwater chemistry, monitoring and statistical analysis, member of the EGS Water Resources Expert Group and the CIS Working Group Groundwater. **Birgitte Hansen (f):** Senior Scientist/ Hydro-geochemist, Expert in groundwater nitrate vulnerability, drinking water quality and health, statistical analysis and synthesis of geochemical and hydrogeological data. **Anette Rosenbom (f)**, Senior Scientist, expert in pesticide leaching, degradation and transport, responsible for the Danish Pesticide Leaching Assessment Programme.

Publications, infrastructure / technical equipment

Batioglu-Pazarbasi, M, N. Milosevic, F. Malaguerra, P. J. Binning, H. -J Albrechtsen, P. L. Bjerg, and ***J. Aamand*** *2013. Discharge of landfill leachate to streambed sediments impacts the mineralization potential of phenoxy acid herbicides depending on the initial abundance of tfdA gene classes. Environ. Poll 176: 275-283*

Hansen B., *Sonnenborg, T.O., Møller, I., Bernth, J.D., Høyer, A.-S., Rasmussen, P., Sandersen, P.B.E. & Jørgensen, F. (2016). Nitrate vulnerability assessment of aquifers. Environ. Earth Sci. 75:999, doi:10.1007/s12665-016-5767-2.*

Hansen B, Thorling L*, Dalgaard T, et al. (2011) Trend Reversal of Nitrate in Danish Groundwater - a Reflection of Agricultural Practices and Nitrogen Surpluses since 1950. Environmental Science & Technology 45(1): 228–234. doi:10.1021/es102334u*

Hinsby K*.; Condesso de Melo MT and Dahl M (2008) European case studies supporting the derivation of natural background Levels and groundwater threshold values for the protection of dependent ecosystems and human health. Sci Total Env, 401: 1-20*

Rosenbom A*, Olsen P, Plauborg F, et al. (2015) Pesticide leaching through sandy and loamy fields – Long-term lessons learnt from the Danish Pesticide Leaching Assessment Programme. Environmental Pollution, 201: 75–90.*

Lead of the Danish Pesticide Leaching Assessment Programme, including monitoring sites, modern laboratories for microbial and chemical analyses including organic contaminants, drilling facilities, Access to national databases on groundwater quality etc.

Relevant projects/activities

- National Groundwater Monitoring Programme (2007-date) http://www.geus.dk/DK/publications/groundwater_monitoring/Sider/1989_2015.aspx
- The Pesticide Leaching Assessment Programme: http://pesticidvarsling.dk/om_os_uk/uk-forside.html
- DnMARK (2013-2017): Health effects of nitrate in groundwater and drinking water: http://dnmark.org/?page_id=887&lang=en
- Accelerated water purification during artificial recharge of aquifers - a tool to restore drinking water resources (**ACWAPUR**) EU – ERANET collaboration (JPI) coordinated by GEUS, J. Aamand

Name of organisation	14. Geologian Tutkimuskeskus		
Short name	GTK	Country	Finland

Organisation profile

The Geological Survey of Finland (GTK) is a European competence centre on assessment and sustainable use of geological resources operating under the Ministry of Economic Affairs and Employment. The person-years worked amounts to 450 of which 50% are highly qualified professionals in various aspects of geology, environmental sciences, geophysics, geochemistry and IT technology, many of them with strong international background. GTK´s groundwater services include hydrogeological mapping and 3D modelling, flow and transport modelling, water quality and vulnerability assessment, groundwater management, training and capacity building, isotopes in groundwater investigations, especially related to the managed aquifer recharge.

Roles / tasks in the project	Special relevant skills
Participant in WP7	• Mapping and modelling of groundwater using different novel technologies including gravity survey, GPR, remote sensing and LiDAR. • Groundwater flow and reactive transport modelling and mapping.

Short profile of staff member(s) who will be undertaking the work

Samrit Luoma (f) is a Geologist, Groundwater modeller and GIS expert at GTK. Involved in several European Programme's projects related to groundwater and environmental impacts studies e.g. EU-Life+ Environmental Programme, and the EU Spatial Planning Observation Network (ESPON), the EU Programme for Critical Infrastructure Protection in the Baltic Sea Region (CIP) project, and the INTERREG IIIB Baltic Sea Region projects. Groundwater modeller for the EAKR Project - groundwater flow and reactive transport modelling for the aquifers in Finland (2016-2018), the POVEYTKE project - development of the methods for groundwater monitoring and vulnerability assessment of aquifers in south Finland (2015-2017).
Tiina Kaipainen (f) is a Geologist and project manager. Project manager of multiple projects concerning geological structure of groundwater areas in Southern Finland. Also involved in groundwater - surface water interaction (the H&O stable isotopes).

Publications, infrastructure / technical equipment

- Luoma, S., Okkonen, J. & Korkka-Niemi, K. 2016. Comparison of the AVI, modified SINTACS and GALDIT vulnerability methods under future climate-change scenarios for a shallow low-lying coastal aquifer in southern Finland. Hydrogeology J., doi:10.1007/s10040-016-1471-2
- Luoma, S. & Okkonen, J. 2014. Impacts of Future Climate Change and Baltic Sea Level Rise on Groundwater Recharge, Groundwater Levels, and Surface Leakage in the Hanko Aquifer in Southern Finland. Water 2014, 6(12), 3671-3700; doi:10.3390/w6123671.
- Luoma, S., Okkonen, J., Korkka-Niemi, K., Hendriksson, N. & Backman, B. 2015. Confronting the vicinity of the surface water and sea shore in a shallow glaciogenic aquifer in southern Finland. Hydrol. Earth Syst. Sci., 19, 1353-1370, 2015, doi:10.5194/hess-19-1353-2015.
- Okkonen, J. & Neupauer, RM., 2016. Capture zone delineation methodology based on the maximum concentration-Preventative groundwater well protection areas for heat exchange fluid mixtures. Water Resources Research 52 (5), 4043-4060, doi: 10.1002/2016WR018715.

Relevant projects/activities

- **EAKR KArhinkangas** (2016-2018) - Groundwater flow and reactive transport modelling for the shallow aquifers in Finland.
- **POVEYTKE** (2015-2017) - (http://www.vhvsy.fi/files/upload_pdf/7425/Julkaisu%2077-2017%20POVEYTKE-loppuraportti.pdf in Finnish).
- **BaltCICA** (2009-2012) - Climate Change: Impacts, Costs and Adaptation in the Baltic Sea Region. (http://www.baltcica.org).
- **RAMAS** (2006-2008) - Risk Assessment and Risk Management Procedure for Arsenic in the Tampere Region. (http://projects.gtk.fi/ramas).

Name of organisation	**15. Bureau de Recherches Géologiques et Minières**		
Short name	BRGM	**Country**	France

Organisation profile

BRGM (Bureau de Recherches Géologiques et Minières) is the French geological survey. It was created in 1959 and is France's reference public institution for Earth Science applications in the management of surface and subsurface resources and risks. BRGM's activities are focused on increasing geological knowledge and understanding surface and subsurface phenomena related in particular to groundwater, mineral and geo-energy resources. By addressing major environment and sustainability issues, BRGM provides support for public policies and decision making, and contributes to the development of innovative technologies featuring research in public and private partnership, at national and international level.

Roles / tasks in the project	**Special relevant skills**
Overall coordination proposed project Coordination of WP1 & WP 8 Participant in WP2, WP3, WP4, WP5, WP6 & WP7	• Analysis of groundwater quality monitoring data and scientific expertise on emerging pollutants • Multicriteria analyses and mapping • Mapping of hydrogeological Systems • Assessing and predicting the mobility and impacts of pollutants in soils and groundwater • Establishing natural concentrations of pollutants in the environment

Short profile of staff member(s) who will be undertaking the work

Chrystelle Auterives (f): Expert in groundwater quality and interference with terrestrial ecosystems. Pesticide transfer from soil to saturated zone
Stéphanie Pinson (f): Developer of the IDPR method, bases of the vulnerability map in France
Alexandre Brugeron (m): Hydrogeologist and GIS expert – Coordinator of the French hydrogeological reference system.
Laurence Gourcy (f): Head of the "assessment and evaluation of water knowledge" unit at the D3E Department, member of the EuroGeoSurveys Water Resources Expert Group
Benjamin Lopez (m): expert in emerging contaminant – Leader of the Norman network sub-group 1 on **Prioritisation of Contaminants of Emerging Concern in Groundwater**
Jennifer Hellal (f) – microbiologist and biogeochemist, expert in interactions between microbial communities and water pollutants (organic and inorganic)

Publications, infrastructure / technical equipment

Lopez B., Ollivier P., Togola A., Baran N., Ghestem J-P., 2015. Screening of French groundwater for regulated and emerging contaminants. Science of the Total Environment 518–519 (2015) 562–573
Gourcy L., Baran N., Vittecoq B., 2009. Improving the knowledge of pesticide and nitrate transfer processes using age-dating tools (CFC, SF_6, ^3H) in a volcanic island. Journal of contaminant hydrology, 108, 107-117.
Wendland F., Berthold G, Blum A. et al., 2008. Derivation of natural background levels and threshold values for groundwater bodies in the Upper Rhine Valley (France, Switzerland, Germany). Desalinisation, vol.226 (1-3), 160-168.
Hellal J, Guédron S, Huguet L et al. (2015). Mercury mobilization and speciation linked to bacterial iron oxide and sulfate reduction: A column study to mimic reactive transfer in an anoxic aquifer. J Contaminated Hydrology, vol.180, 56-68
Tools developments in "R" such as QUALINET - A tool for statistical and multicriteria analyses of groundwater data and HYPE - A statistical tool for analysis of trends and breaks in GW quality records

Relevant projects/activities

http://www.brgm.eu/project/karst-floods-characterization-development-of-management-tools
http://www.brgm.eu/project/multimethod-geophysics-survey-to-detect-characterise-karsts
http://www.brgm.eu/project/hydrogeological-map-of-africa
http://www.brgm.eu/news-media/new-hydrogeological-map-of-france
http://ades.eaufrance.fr

Name of organisation	17. Federal Institute for Geosciences and Natural Resources		
Short name	BGR	**Country**	Germany

Organisation profile

BGR is an Authority and Research Institute of the Federal Republic of Germany within the portfolio of the Federal Ministry for Economic Affairs and Energy. BGR gives independent advice to the Federal Government on all geoscientific questions. It cooperates on the European level with the National Geological Surveys and is member of EuroGeoSurveys. BGR harmonizes methods taking into account hydrogeological and hydrogeochemical data as well as information on soil. BGR's International Hydrogeological Map of Europe at the scale of 1:1.500.000 (IHME1500) could serve as information basis for standardization. The interpretation of national information is performed using standardized methods for all of Germany, developed in close collaboration with the Federal State Geological Surveys, such as the aquifer vulnerability map to pollution at the scale of 1:200.000 or the groundwater recharge map at the scale 1:2.000.000.

Roles / tasks in the project	Special relevant skills
Coordination of WP7	• Hydrogeological mapping at various scales. • Building databases and web services for subsurface and groundwater data. • Interpretation of hydrogeological datasets towards custom-made information products.

Short profile of staff member(s) who will be undertaking the work

Jörg Reichling (m): senior hydrogeologist and groundwater expert. Head of sub-department „Basic Information Groundwater and Soil" at BGR. Member of the EGS Water Resources Expert Group.
Stefan Broda (m): senior groundwater expert and project manager at BGR. Head of unit "Spatial information on groundwater". Responsible for the national (Hydrogeological Map of Germany) and international hydrogeological data base (WHYMAP).
Andreas Günther (m): senior geologist and project manager at BGR. Responsible for the IHME1500.

Publications, infrastructure / technical equipment

National database on subsurface information at the scale of 1:200.000 (Hydrogeological Map of Germany; Mean Annual Groundwater Recharge of Germany; Aquifer Vulnerability Map to Pollution; hydrogeochemical Groundwater Background Level Values), International database on subsurface information at the scale of 1:1.500.000 (IHME1500) and 1:25.000.000 (WHYMAP)

Ad-hoc-AG Hydrogeologie (2016): Regionale Hydrogeologie von Deutschland - Die Grundwasserleiter: Verbreitung, Gesteine, Lagerungsverhältnisse, Schutz und Bedeutung. - Geologisches Jahrbuch Reihe A, Heft 163: 456 S., ISBN 978-3-510-96852-7

Duscher, K., Günther, A., Richts, A., Clos, P., Philipp, U. and Struckmeier,W. (2015): The GIS layers of the "International Hydrogeological Map of Europe 1:1,500,000" in a vector format. - Hydrogeol. J.; DOI 10.1007/s10040-015-1296-4

Günther, A., Van Den Eeckhaut, M., Malet, J.-P., Reichenbach, P., and Hervás, J. (2014): Climate-physiographically differentiated Pan-European landslide susceptibility assessment using spatial multi-criteria evaluation and transnational landslide information. Geomorphology, 224, pp. 69-85.

Relevant projects/activities

- International Hydrogeological Map of Europe IHME1500 including lithological harmonization.
- World-wide Hydrogeological Mapping and Assessment Programme WHYMAP - World Karst Aquifer Map, Vulnerability to floods and droughts.
- Protection potential to pollution of aquifer in Germany.

Name of organisation	22. Landesamt für Bergbau, Energie und Geologie (LBEG) – Geologischer Dienst für Niedersachsen		
Short name	LBEG	**Country**	Germany

Organisation profile

LBEG (Landesamt für Bergbau, Energie und Geologie) is Geological Survey of Lower Saxony (ERA project partner) and Mining Authority of Lower Saxony, Hamburg, Bremen and Schleswig-Holstein as well as the German continental shelf of the North Sea and a part of the German continental shelf of the Baltic Sea. The main responsibilities of the Geological Survey are development of geo-resources, protection of soil and groundwater, and state advisor of geological matters related to the Mining Act. The survey´s core skills are geological and hydrogeological mapping, hydrogeology, engineering geology, soil science, geophysics, geochemistry, management of geo-data and geological 3D mapping. Projects of the survey include mapping of groundwater resources, determination of geothermal potential, large scale 3D modeling of the deeper underground, remediation of contaminated sites, mapping of soil erosion and determination of geo-hazards.

Roles / tasks in the project	Special relevant skills
Participant in WP7	• Geological, hydrogeological and soil mapping. • Building databases and web services for surface, subsurface and groundwater data.

Short profile of staff member(s) who will be undertaking the work

Dr. Jörg Elbracht (m) head of the sub department Hydrogeology, geologist. Works as geologist and hydrogeologist in Lower Saxony, geological and hydrogeological mapping in Lower Saxony, head of geological and hydrogeological working-groups (e.g. 3D-modelling of quaternary deposits at German north-sea-sector (GPDN)).
Melanie Witthöft (f) scientific officier in the sub department Hydrogeology, geoscientist. Works as geologist and hydrogeologist and in geological and hydrogeological mapping in Lower Saxony (e.g. map of hydraulic heads, geological and hydrogeological crosssections).

Publications, infrastructure / technical equipment

Public database on surface and subsurface information (groundwater, geology, soil, mining) offering maps, boreholes, crosssections and 3D-models (http://nibis.lbeg.de/cardomap3/).

- HERMANN, F., CHEN, S., HEIDT, L., ELBRACHT, J., ENGEL, N., KUNKEL, R., MÜLLER, U., RÖHM, H., VEREECKEN, H. & WENDLAND, F. (2013): Zeitlich und räumlich hochaufgelöste flächendifferenzierte Simulation des Landschaftswasserhaushalts in Niedersachsen mit dem Modell mGROWA. Hydrologie u. Wasserbewirtschaftung, 57 (5), 206-224, 9 Abb., 3 Tab., Koblenz (BfG)
- Deus, N.; Elbracht, J.; Siemon, B.: 3D-Modelling of the salt-/fresh water interface in coastal aquifers of Lower Saxony (Germany) based on airborne electromagnetic measurements (HEM) – in: AquaConSoil Copenhagen 2015 : 13th International UFZ_Deltares Conference on Sustainable Use and Management of Soil, Sediment and water Resources, 9-12 June 2015, Copenhagen, Denmark; programme, book of abstracts. – Copenhagen. – (2015), S.76-77
- Röhm, H.: Grundwasser-Monitoring: Erstellung geologischer und hydrostratigrafischer Schnitte zur Umsetzung der EG-WRRL, Teil 2 – Hannover: la F: Bergbau; Energie und Geologie

Relevant projects/activities

- Geological and hydrogeological crosssections showing the structures and characteristics of groundwaterreservoir in Lower Saxony (https://www.lbeg.niedersachsen.de/boden_grundwasser/grundwasser/hydrogeologische_schnitte/hydrogeologische-schnitte-627.html)
- Hydrogeological maps (groundwater quality, vulnerability, aquifer types of shallow subsurface rocks , groundwater heads) at different scales (https://www.lbeg.niedersachsen.de/karten_daten_publikationen/karten_daten/grundwasser/729.html)
- Project partner in TOPSOIL (http://www.topsoil.eu/)

Name of organisation	27. Mining and Geological Survey of Hungary		
Short name	MBFSZ	**Country**	Hungary

Organisation profile

The Mining and Geological Survey of Hungary (MBFSZ) was established on 1st July 2017 by the merger of the Hungarian Office for Mining and Geology and the Geological and Geophysical Institute of Hungary. It provides background support to the Ministry of National Development and gives advice on policy matter to the Ministry. MBFSZ carries out scientific research in the fields of geology, hydrogeology, geophysics, mining and climate policy. MBFSZ is the designated state institution dealing with groundwater. Furthermore it operates a national groundwater observation system – 140 monitoring wells form part of the National Groundwater Monitoring System (quantity). Based on the Ministerial Decree 101/2007. (XII.23) MBFSZ operates the National Hydrogeological Archive.

Roles / tasks in the project	Special relevant skills
Participant in WP3, WP6 & WP7	• National and cross-border hydrogeochemical hydrogeology surveys with special emphasis on thermal waters, hydrodynamic and water-rock interaction modelling • Building databases and web services for subsurface and groundwater data

Short profile of staff member(s) who will be undertaking the work

Teodóra Szőcs (f): Chief hydrogeologist, hydrogeochemist, head of the Hydrogeology Department at MBFSZ. She coordinated a team of scientists and worked as expert responsible for the background values, threshold values and evaluation of chemical status of GW.

Ágnes Rotár Szalkai (f): senior expert in hydrogeology, geothermal resource survey, responsible for the operation of the groundwater monitoring network. She took part in the evaluation of chemical status of the groundwater bodies in Hungary in the framework of the WFD.

Nóra Gál (f): Expert in hydrogeochemistry, water-rock interaction modelling, geothermal resource survey, GIS, thermal well cadastre. She took part in the determination of background values and evaluation of chemical status of the groundwater bodies in Hungary.

Tamás Kerékgyártó (m): expert in geothermal resource survey, hydrogeochemistry, water-rock interaction modelling and hydrodynamic modelling. He took part in the evaluation of chemical status of the groundwater bodies in Hungary.

Publications, infrastructure / technical equipment

T. Szocs, S. Frape, R. Gwynne, L. Palcsu, 2017: Chlorine stable isotope and helium isotope studies contributing to the understanding of the hydrogeochemical characteristics of old groundwater. Procedia Earth and Planetary Science pp. 877-880 DOI information: 10.1016/j.proeps.2017.01.004

T. Szocs, N. Rman, M. Suveges, L. Palcsu, Gy. Toth, A. Lapanje, 2013: The application of isotope and chemical analyses in managing transboundary groundwater resources. Applied Geochemistry 32 (2013) 95–107

Relevant projects/activities

Coordinator of the **DARLINGe** - Danube Region Leading Geothermal Energy project (1 January 2017 – 30 June 2019 Interreg Danube Transnational Programme*)*.

Coordinator of the „**TRANSENERGY** – Transboundary Geothermal Energy Resources of Slovenia Austria, Hungary and Slovakia” (2010-2013 – 2CE124P3), project, which provided tools for sustainable use of geothermal resources at the Western part of the Pannonian Basin.

Coordinator of the **NAGiS** - National Adaptation Geo-information System project, whose objective was to develop a multipurpose geo-information information system.

Name of organisation	**28. Islenskar orkurannsoknir (Iceland GeoSurvey) ISOR**		
Short name	ISOR	**Country**	Iceland

Organisation profile

ISOR is a governmental non-profit service, research and training institute under the Icelandic Ministry for the Environment and Natural Resources. ISOR is one of the world's leading geothermal research organizations and stands for over 70 years of continuous experience in geothermal research, encompassing all disciplines of geosciences, drilling engineering, utilisation technology and reservoir physics and management. ISOR has been the main scientific leader in the successful geothermal development in Iceland. Iceland GeoSurvey carries out mapping of water drainage, groundwater systems and groundwater flow where the interaction of surface and subsurface flow and rock formations is outlined.

Roles / tasks in the project	Special relevant skills
Participant in WP3	• Characterizing and mapping of hydrogeological data at national scale • 3D geological modelling • Integrated interpretation of geochemical, hydrogeological and hydrological data

Short profile of staff member(s) who will be undertaking the work

Steinunn Hauksdóttir (f): Director natural resources**.** Supervision, marketing and project management of projects in the fields of geothermal research and utilization and natural resources. Geologist/Geochemist with experience in geothermal mapping, sampling of fluids and rocks. Supervision of various Information Technology projects and systems.
Árni Hjartarson (m): Senior hydrogeologist**.** Geological mapping and hydrogeology of volcanic regions; Groundwater recearch and advice for municipal water works. Stratigraphy in basaltic and volcanic terrains. Borehole geology, interpretation of temperature and pressure data from boreholes. Hydrogeological modelling.
Dadi Thorbjornsson (m): Senior Hydrogeologist**.** Geochemical studies such as sampling, chemical modelling and interpretation, hydrogeological studies (including assessment of hydrogeological properties of reservoirs rocks), reservoir monitoring, conceptual modelling, environmental studies, well testing.
Vaiva Cypaité (f): Hydrogeologist. Modelling hydrogeological data with Visual MODFLOW flex, ArcGis, AutoCad. Evaluation of hydrogeological conditions and geothermal potential in D. Riese. Hydrogeology, geology and geothermal resources of Iceland, groundwater flow, sedimentary aquifers.

Publications, infrastructure / technical equipment

Árni Hjartarson and Thórólfur H. Hafstad 2010: *Water resources registry of Iceland*. Report and dataset for National Energy Authority.
Vaiva Cypaité 2015: *Determination of groundwater flows in SW Iceland with environmental tracers.* M.Sc. thesis University of Iceland.
Postgres and Oracle Database management system, ESRI-GIS geographical information system, iTOUGH2, Visual MODFLOW flex, LeapFrog and PETREL 3D visualization and modelling.

Relevant projects/activities

Numerous projects for various clients, including municipalities and potable water suppliers regarding water exploration, drilling, protection, polllution, mapping. Also work for preparations for hydropower plants including mapping, modelling and consulting. E.g.:
Thorolfur H. Hafstad and Vaiva Cypaite 2017: Vogar. Exploration well for water supply and suggested need of water protection areas. Report for HS Veitur, Iceland.
Thórólfur H. Hafstad, Vaiva Cypaité, Steinunn Hauksdóttir 2016: Hydrogeological study of waterbasin of Stora-Laxa at Laxarsgljufur. Report for National Power of Iceland.
Árni Hjartarson et al. 1992-1997: Hydrogeological Maps of the Reykjavík Capital Area.

Name of organisation	29. Geological Survey Ireland (Department of Communications, Climate Action and the Environment)		
Short name	**GSI/DCCAE**	**Country**	Ireland

Organisation profile

Founded in 1845, Geological Survey Ireland is the Republic of Ireland's public earth science knowledge centre. We are a division of the Department of Communications, Climate Action and Environment. We provide free, open and accurate data and maps on Ireland's subsurface to landowners, the public, industry, and all other stakeholders, within Ireland and internationally. In addition, we act as a project partner in interpreting data and developing models and viewers to allow people to understand the underground.

Roles / tasks in the project	Special relevant skills
Participant in WP3, WP4, WP5, WP7.	• Hydrochemical data interpretation • Creation of national databases and maps • Groundwater vulnerability mapping • Characterisation and mapping of hydrogeological systems • Establishing natural concentrations of pollutants in the environment

Short profile of staff member(s) who will be undertaking the work

Katie Tedd (f) Senior Hydrogeologist, expert in hydrochemistry, developed Natural Background Levels for Ireland.
Taly Hunter Williams (f) Senior Hydrogeologist with expertise in groundwater resources estimation and hydrochemistry. Member of the EuroGeoSurveys Water Resources Expert Group.
Contract staff (m/f) Suitably qualified contract staff member to be appointed.

Publications, infrastructure / technical equipment

K.M. Tedd, C.E. Coxon, B.D.R. Misstear, D. Daly, M. Craig, A. Mannix and N.H. Hunter Williams (2017) Assessing and Developing Natural Background Levels for Chemical Parameters in Irish Groundwater. EPA Research Report (2007-FS-WQ-16-S4).
E.R. McGrory, C. Brown, N. Bargary, N.H. Hunter Williams, A. Mannix, C. Zhang, T. Henry, E. Daly, S. Nicholas, B.M. Petrunic, M. Lee, L. Morrison (2017) Arsenic contamination of drinking water in Ireland: A spatial analysis of occurrence and potential risk. STOTEN 579: 1863–1875.
K.M. Tedd, C.E. Coxon, B.D.R. Misstear, D. Daly, M. Craig, A. Mannix, N.H. Hunter Williams (2014) An integrated pressure and pathway approach to the spatial analysis of groundwater nitrate: A case study from the southeast of Ireland. STOTEN 476-477C:460-476
Geological Survey Ireland. National Groundwater Chemistry Database and Chemistry Typology Maps. K.M. Tedd and N.H.Hunter Williams.
N.H. Hunter Williams, B.D.R. Misstear, D. Daly and M. Lee (2013) Development of a national groundwater recharge map for the Republic of Ireland. QJEGH. 46(4):493-506.

Relevant projects/activities

CatchmentCARE (2017-2021). Catchment Community Action for Resilient Ecosystems. InterReg VA.
Groundwater3D https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/projects/gw3d/Pages/default.aspx
Protecting Drinking Water https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/projects/protecting-drinking-water/Pages/default.aspx

Name of organisation	30. Istituto Superiore per la Protezione e la Ricerca Ambientale		
Short name	ISPRA	**Country**	Italy

Organisation profile

ISPRA (Italy) is a national public body, subject to the vigilance of the Ministry for Environment, Territory and Sea. The Institute results from the merging of three former institutions: the Agency for Environmental Protection and Technical Services (APAT), the Central Institute for Scientific and Technological Research Applied to the Sea (ICRAM) and the National Institute for Wildlife (INFS). ISPRA will be represented in Geo-ERA by the former Geological Survey of Italy that is now a Department of ISPRA. It undertakes technical-scientific activities to support policies and legislation on several environmental issues (e.g. land planning, natural hazard, etc.) and provides geological data collection, management and publication. In its role of Geological Survey of Italy, ISPRA is the reference institution for the geological information in Italy, including the official geological and geothematic maps of the Italian territory, as well as several databases providing information about subsurface geology and geohazards.

Roles / tasks in the project	Special relevant skills
Participant in WP3	• Characterisation and mapping of hydrogeological Systems • Building databases and web services for subsurface and groundwater data • Natural hazard risk assessment and natural resource protection and management

Short profile of staff member(s) who will be undertaking the work

Barbara DESSI (f): hydraulic Engineer, researcher technologist on natural hazard risk assessment and natural resource protection and management. Member of the Water Resource EGS Expert Group. Author of several scientific papers and technical reports.
Rossella Maria GAFÀ (f): Geologist, researcher technologist on hydrogeological issues. Author of scientific papers and technical reports.
Lucio MARTARELLI (m): Geologist, senior researcher technologist on hydrogeological issues. EGS Water Resource Expert Group member. Author of several scientific papers and technical reports.
Gennaro Maria MONTI (m): Geologist, researcher technologist on hydrogeological issues. Author of scientific papers and technical reports.
Anna Rosa SCALISE (f): Geologist, senior researcher technologist on hydrogeological issues. Author of several scientific papers and technical reports.
Angelantonio SILVI (m): Cartographer, expert in GIS cartography and hydrogeological mapping. Author of several scientific papers and technical reports.

Publications, infrastructure / technical equipment

- Antonakos A., Martarelli L., Scalise A.R. et al. (2009) - International Hydrogeological Map of Europe 1:1.500.000 scale. Sheet D6 Athina. (Nikas K., Strub H. & Winter P., coords.). BGR/UNESCO, Hannover (Germany).
- Dessì B., Martarelli L., Spizzichino D. (2015) - Italy. In: EuroGeoSurveys "Wonder water. The value of water". Brussels.
- La Vigna F., Mazza R., Amanti M., Martarelli L., Conte G., Falcetti S., Gafà R.M., Monti G.M., Roma M., Silvi A. et al. (2016) - Groundwater of Rome. Journal of Maps Vol. 12 , N.S1, 88-93.
- Wu Aimin, Conte G., Martarelli L., Ma Rong (2016) - Understanding and Discussion on Hydrogeological Map of Italy-Guideline to Survey and Mapping. Hydrog. Engin. Geol. 43, 166-172.

Relevant projects/activities

- EPOS, European Plate Observing System (http://www.epos-ip.org).
- CEWP, China Europe Water Platform - PI Focus Area: Rural Water and Food Security (http://cepw.eu).

Name of organisation	**39. State limited liability company “Latvian Centre of Geology, Environment and Meteorology”**		
Short name	LEGMC	**Country**	Latvia

Organisation profile

LEGMC is State limited liability company under the Ministry of Environmental Protection and Regional Development and it is the central legal body in Latvia at subsoil field comprising geology, hydrogeology, and geophysics. According to Law on Subsoil the main tasks of LEGMC in the field of subsoil can be divided as follows: 1) estimation and approval of mineral and groundwater reserves and determination of extraction areas; 2) geological and hydrogeology data preparation for government, municipalities and private sector; 3) reporting for national and international institutions. LEGMC also ensures water quality and quantity monitoring, as well as data quality control and availability of these data for public, maintenance of data base on use of water resources, river basin management (preparation of River Basin Management Plans), preparation of for national and EU institutions, as well as calculation of flood territories.

Roles / tasks in the project	**Special relevant skills**
Participant in WP3, WP4 & WP5	• Responsible for national Latvian groundwater monitoring • Holder of the largest hydrogeological database in Latvia (abstraction well data, monitoring data, water chemistry)

Short profile of staff member(s) who will be undertaking the work

Inga Retiķe (f). Hydrogeology expert and responsible for reporting to EK (WFD and River Basin Management Plans, Nitrates directive), preparation of national reviews related to water quality and quantity issues, project coordination related to water management issues. She is currently a PhD aspirant at University of Latvia and working with multivariate statistics and long term water quality data; assessment of N fate in shallow groundwater under agricultural pressure, surface-groundwater interaction in coastal areas (e.g. sea water intrusion at city “Liepāja”).

Publications, infrastructure / technical equipment

Retike, I., Kalvans, A., Popovs, K., Bikse, J., Babre, A., Delina, A. 2016. Geochemical classification of groundwater using multivariate statistical analysis in Latvia. Hydrology Research. Vol. 47, Issue 4.

Babre, A., Kalvāns, A., Popovs, K., Retiķe, I., Dēliņa, A., Vaikmäe, R., Martma, T. 2016. Pleistocene age paleo-groundwater inferred from water-stable isotope values in the central part of the Baltic Artesian Basin. Isotopes in Environmental and Health Studies. Vol. 52, Issue 6.

Retike, I., Delina, A., Bikse, J., Kalvans, A., Popovs, K., Pipira, D. 2016. Quaternary groundwater vulnerability assessment in Latvia using multivariate statistical analysis. 22nd International Scientific Conference Research for Rural Development, 2016; The Latvia University of Agriculture, Jelgava; Latvia; 18-20 May 2016. Volume 1, 2016, Pages 210-215.

Relevant projects/activities

- Second cycle River Basin Management Plans in Latvia.
- Report to EK under Nitrates directive
- **The Administration of Latvian Environmental Protection Fund project “Improvement of groundwater characterisation and status assessment for the next cycle River Basin management period” 2017.**
- ERDF, Interreg Central Baltic project "Innovative, sustainable remediation" (INSURE).
- Latvia- Lithuania cross border cooperation program project "Sustainable Rainwater Sewerage Management for Improved Environmental Quality of the Lielupe River Basin".

Name of organisation	**40. Lietuvos geologijos tarnyba prie Aplinkos ministerijos (Lithuanian Geological Survey under the Ministry of Environment of the Republic of Lithuania)**		
Short name	LGT	**Country**	Lithuania

Organisation profile

LGT is an independent governmental institution, which directly carries out geological investigations necessary to the State and controls the system of geological information alongside the regulation of the use of subsurface. LGT will be represented in Geo-ERA through the Lithuanian Geological Survey. The survey's core skills and services relate to subsurface investigations and protection, and include geological data management. Its products and services are primarily targeted at the groundwater, mineral resources and energy sectors (the latter in the broadest possible sense, including land use and environmental planning). The organisation hosts the national repository for subsurface data and information and is the designated state advisor of all geological matters related to the Subsurface Law.

Roles / tasks in the project	**Special relevant skills**
Participant in WP3, WP7 & WP8	• Characterisation and mapping of hydrogeological systems • Groundwater quality monitoring • Status assessment of groundwater quality • Natural resource protection and management

Short profile of staff member(s) who will be undertaking the work

Rasa Radiene (f): Head of Hydrogeology Department. Initiating, participating and leading research and hydrogeological investigation activities related to the environmental and groundwater issues.
Jurga Arustiene: Head of groundwater monitoring sub-division. Initiating, participating and leading research and hydrogeological investigation activities related to the environmental and groundwater issues.
Petras Pūtys. Chief specialist. Cartographer, expert in GIS cartography and hydrogeological mapping.
Jurgita Kriukaitė. Chief specialist. Hydrogeologist, expert in groundwater quality monitoring and assessment.

Publications, infrastructure / technical equipment

Pūtys P. The Map of Groundwater Recharge on a scale of 1:200 000. Report 2013. - Vilnius : LGT
Gedžiūnas P. Mineral water mapping at a scale 1:400 000. Report 2010. - Vilnius : LGT
Arustienė J., Kadūnas K. Investigative groundwater monitoring of active substances of plant protection products. Lithuanian Geological Survey Annual Report 2016. - Vilnius : LGT, 2017.
Arustienė J. Overview of Water Protection Problems in Groundwater Bodies of Lithuania. Lithuanian Geological Survey: Annual Report 2013. - Vilnius : LGT, 2014.
Arustienė J., Giedraitis R., Karmazinas B. Natural background levels of main aquifers. Groundwater Monitoring in Lithuania 2006 : Bulletin. - Vilnius : LGT, 2007.
Groundwater information system – containing DB's of groundwater quality, groundwater resources.

Relevant projects/activities

- Assessment and reporting the chemical status of groundwater bodies to EU
- Participating in international working groups on groundwater (e.g. CIS Working group Groundwater)
- Programme of State Geological Investigations 2016-2020 "Geoenergy and Safe Environment" of Republic of Lithuania
- Development and management of Groundwater information system

Name of organisation	42. Ministry for Transport and Infrastructure		
Short name	MTI	**Country**	Malta

Organisation profile

Malta will be represented in the GeoERA Groundwater theme through the Continental Shelf Department (CSD) within the Ministry for Transport and Infrastructure. The CSD performs the function of the Malta Geological Survey .

Roles / tasks in the project	Special relevant skills
Participation in WP3, WP5, WP6 & WP8	• EU water policy • Island and coastal aquifer hydrogeology • Sea-water intrusion • Management of water resources under water scarcity conditions.

Short profile of staff member(s) who will be undertaking the work

Albert Caruana (m) is the Director General of the Continental Shelf Department and oversees Malta's overall participation in GeoERA**. Charles Galea (m)** is a Principal Scientific Officer at the CSD. He is a geoscientist by background and is a coordinator of the GeoERA project in Malta. **Manuel Sapiano (m):** Water Director for Malta, responsible for coordinating the implementation of EU Water Policies in the Maltese islands. Represents Malta on the Groundwater Working Group within the WFD CIS. A hydro-geologist by profession with specialisation in coastal and island groundwater management. **Michael Schembri (m)**, Senior Officer managing the implementation of the EU Water Framework and Floods Directives. Also coordinates hydrological spatial data management systems and groundwater monitoring framework. **Henry Debattista (m):** technical officer providing support on groundwater data management and groundwater modelling exercises.

Publications, infrastructure / technical equipment

National groundwater monitoring framework (quality and quantity) and groundwater database (borehole logs, groundwater level and groundwater quality).

Publications:

*Mangion, J., **Sapiano, M., 2006.** Malta Water Resources Review. Food and Agriculture Organisation of the United Nations. Rome, Italy.*

*Mangion, J**., Sapiano, M. 2007.** The Mean Sea Level Aquifer – Malta and Gozo, in: Edmunds et al. (eds), Natural Groundwater Quality. Blackwell Publishing, Oxford, United Kingdom.*

*Stuart, M.E., Maurice, L., Heaton, T.H.E., **Sapiano**, **M.,** Micallef Sultana, M., Gooddy, D.C. & Chilton, P.J. 2010. Groundwater residence time and movement in the Maltese islands – A geochemical approach. - Applied Geochemistry, 25, 609-620.*

*Heaton, T.H.E., Stuart, M.E., **Sapiano**, **M.** & Micallef Sultana, M. 2012**.** An isotope study of the sources of nitrate in Malta's groundwater. - Journal of Hydrology, Vols. 414/415, 244–254.*

*__Sapiano, M., Schembri. M__., Brincat, C. 2013**.** State of water resources in Mediterranean Islands, in MEDIWAT, Sustainable management of environmental issues related to water stress in Mediterranean islands, Final conference proceedings.*

Relevant projects/activities

MARSOL – Demonstrating managed aquifer recharge as a solution to water scarcity and drought (7th Framework Programme)

MORISO – Monitoring of groundwater resources to limit saline intrusion and pollution by nitrates (Interreg Italia-Malta 2007-2013)

ERDF346 – Assessment of sub-surface groundwater discharge in the Maltese islands (ERDF 2017-2013)

WATERMAP- Development and utilization of vulnerability maps for the monitoring and management of groundwater resources (INTERREG-Archimed)

Name of organisation	**44. Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy**		
Short name	PIG-PIB	**Country**	Poland

Organisation profile

The Polish Geological Institute was founded in 1919 and is the oldest Polish nation-wide scientific institution. It is involved in comprehensive studies of geological structure of the country for practical use in national economy and environmental protection. In addition to scientific activities in all fields of modern geology the Institute was entrusted with the tasks of the Polish Geological Survey and the Polish Hydrogeological Survey. Moreover, it is responsible for the country's security in supply of mineral resources, the groundwater management, for monitoring of the geological environment and warning against natural hazards and risks.

Roles / tasks in the project	**Special relevant skills**
Participation in WP3, WP7, WP8	Analysis of groundwater quality monitoring data ; QC/QA procedures in groundwater monitoring; Hydrogeological cartography and Vulnerability mapping; Characterization and mapping of mineral waters.

Short profile of staff member(s) who will be undertaking the work

Anna Kuczyńska (f): environmental engineer; 15 years of experience, including 5 years of academic research. Expert in assessing and managing groundwater resources on local and national scales; groundwater quality monitoring; vulnerability and risk assessments.
Michał Wyszomierski MSc.(m): geologist**;** 15 years of experience in hydrogeological and geological assessments, including geological cartography. Expert in QA/QS procedures in groundwater monitoring.
Marzena Nowakowska MSc.(f): hydrogeologist; 10 years of experience. Expert in mineral and water resource management, groundwater chemistry and groundwater cartography.
Magdalena Nidental MSc. (f): hydrogeologist (additional specialization in environmental protection) ; over 10 years of experience. Expert in hydrogeological assessment, hydrogeological cartography, groundwater vulnerability and water quality.
Agnieszka Felter MSc (f): hydrogeologist; 20 years of experience. Expert in mineral water resources; groundwater chemistry; hydrogeological assessments on local and national scales.

Publications, infrastructure / technical equipment

Kuczyńska A., 2017, *Results of a pilot study on the assessment of pharmaceuticals in groundwater in samples collected from the national groundwater monitoring network*, Przegląd Geologiczny tom 65 nr 11/1 Listopad 2017
Kuczyńska A., Janica R., 2017, *Analysis of the influence of sewage from diffuse sources to groundwater quality based on an example of work of the polish hydrogeological survey intervention team*, Przegląd Geologiczny tom 65 nr 11/2 Listopad 2017
Herbich P., Nidental M., Woźnicka M., 2007, *Methodological Guidelines of Creating GIS Database Information Layers of Hydrogeological Map of Poland 1:50000" First Aquifer – Groundwater Vulnerability and Water Quality*, Współczesne problemy hydrogeologii, część 2, Kraków 2007
Jóźwiak K., Mikołajków J., Nidental M., Woźnicka M., *The question of the groundwater vulnerability assessment with the Hydrogeological Map of Poland 1:50 000 and Major Groundwater Reservoirs projects as the case studies*, in press

Relevant projects/activities

Assessment of pharmaceuticals in groundwater samples taken from the national groundwater monitoring network in Poland.

Name of organisation	**45. Laboratório Nacional de Energia e Geologia**		
Short name	LNEG	**Country**	Portugal

Organisation profile

The National Laboratory of Energy and Geology (LNEG) is a State Laboratory of the Ministry of Economy that makes RD&D oriented to the needs of society and enterprises. LNEG ensures state functions by developing knowledge of the geological and hydrogeological infrastructure of the emerging territory, coastal zones, and contributing to related activities such as exploration and valorization of endogenous resources, prevention and mitigation of geological risks, environment and land use planning and correlated strategic innovative technologies. LNEG undertakes as within its core functions the research on CO2 storage, geothermal assessment and land use valorization. LNEG is also responsible for integrated management and availability of geoscientific contents regarding the Portuguese territory in digital format.

Roles / tasks in the project	Special relevant skills
Participant in WP3	• National responsible for hydrogeological assessment and thematic mapping at several scales. • Building databases and web services for groundwater data.

Short profile of staff member(s) who will be undertaking the work

The staff is from the Department of Geology, Hydrogeology and Coastal Geology:
José Sampaio (m): senior hydrogeologist. Skills on hydraulic, hydrology, geochemistry, geophysics, climatology, boreholes construction and testing, hydrogeological mapping, karst aquifers, volcanic islands aquifers and CO2 geological storage in saline aquifers.
Ana Paula Pereira (f): senior hydrogeologist, expert in hydrogeological mapping and in Geographical Information Systems. Coordinates the project "Hydrogeologic map - Sheet 2 (scale 1/200 000)" at LNEG.
Rayco Marrero-Diaz (m): senior hydrogeologist, expert in hydrogeochemistry. Nowadays, he is a LNEG's collaborator and is carrying out a low-enthalpy geothermal assessing project.
Carla Midões (f): senior hydrogeologist, expert in integration of the geologic and hydrogeologic information on SIG with sight to the attainment of Hydrogeology cartography of Portugal and Thematic Cartography.
Judite Fernandes (f): senior hydrogeologist, expert on flow and hydrogeochemical modeling, hydrogeophysics, geostatistics, saltwater intrusion, aquifer contamination, aquifer testing, drilling and piezometer construction, monitoring equipment.
Pedro Patinha (m): senior mining engineer, expert in mapping and Geographical Information Systems. He currently works at the "Geoscientific Information Unit" of LNEG and is responsible for the LNEG's GeoPortal infrastructure development.

Publications, infrastructure / technical equipment

Infrastructure: Geoportal (databases and web services for groundwater data). LNEG's geoPortal is an infrastructure of integrated services to support the management and visualization of spatial data, which aims to provide, in a web environment, geo-referenced information related to the various activities of the LNEG. This application has the following features: 1) Metadata Catalogue: A search and query engine for LNEG's data (according to ISO 19139), which provides information about the existence and availability of Institutional Geographic Information; 2) Online Databases: A set of applications that enables the query of institutional data; 3) Map Viewer: A view and download service of LNEG's maps and spatial information.
Publications:
Portuguese hydrogeological and hydrogeochemical mapping (scales 1/200 000) and explanatory books.
Portuguese geological mapping (scales 1/50 000) and explanatory books, which includes a hydrogeology chapter (national cover).
AMARAL, H.I.F; MIDÕES, C.; KIPFER, R. (2017) - Helium evidences of mantle degassing to the groundwater of Madeira Island - Portugal. Applied Geochemistry 81, 98-108.
MARRERO-DIAZ, R.; RAMALHO, E. C. (2015). Características geoquímicas das antigas nascentes termominerais de Alfama (Lisboa, Portugal): estudo preliminar do seu potencial geotérmico e hidromineral. Comunicações Geológicas, 102 (Fascículo Especial I), p. 129-132. (ISSN: 0873-948X; e-ISSN: 1647-581X).
MARRERO-DIAZ, R.; CARVALHO, M.R.; POLICARPO, A.; CARREIRA, P. (2015). Tracing Groundwater Salinization of Thermomineral Waters in Estoril Region by Geochemical and Isotopic Approach. "International Symposium on Isotope Hydrology: Revisiting Foundations and Exploring Frontiers - CN225", Book of extended synopses. Vienna, Austria. 136, p. 86-89.
POLICARPO, A.; CARVALHO, M.R.; MARRERO, R.; CARREIRA, P. (2014) - Origem da Mineralização das Águas Termais da Região de Lisboa. "XII Congresso da Água da Associação Portuguesa de Recursos Hídricos", Lisbon, Portugal, 5-7 March.
REIMANN & BIRKE (eds.): Geochemistry of European Bottled Water 2010. 280 p., 28 figs, 6 tab., 2 app., 67 element maps, data CO. 27 x 21 cm. ISBN 978-3-443-01067-6

Relevant projects/activities

Geoportal (http://geoportal.lneg.pt/), Building databases and web services for groundwater data.
Portuguese hydrogeological and hydrogeochemical assessment and mapping (scales 1/200 000 and 1/50 000
HYDROTHERMAL: Physical-Chemical Conceptual Model of Lower Cretaceous Geothermal Reservoir at Lisbon Region (Portugal).
GEOALFAMA: Characterization and geothermal / hydromineral exploitation of the thermo-mineral waters in the Alfama area (Lisbon, Portugal).
EGEM - Evaluation of the geothermal energy potential of Madeira Island.
ERHSISMA – Groundwater resources of S. Miguel Island – Azores (Portugal).
GEOCHEMISTRY OF EUROPEAN BOTTLED WATER

Name of organisation	**46. Institutul Geologic al României**		
Short name	IGR	**Country**	Romania

Organisation profile

Institutul Geologic al României was founded in 1906, with the mission of a national geological survey. Now, its research activity covers the fields of mineral resources, hydrocarbon resources, geophysics, hydrogeology, geochemistry, geohazard and geological mapping.
During the late decades, IGR has participated in national and international projects dedicated to raw materials (aggregates, metallic ores, secondary resources), energetic resources (oil, shale gas, geothermal resources), geohazards (landslides, complex impact of mining waste and excavation), geoinformation (mineral resources information networks, implementation of INSPIRE Directive in Romania, free access to geoinformation), ground water chemistry (composition of mineral water, influence of mine waters on surface and undeground water sources), CO_2 storage.

Roles / tasks in the project	**Special relevant skills**
Participant in WP3, WP4, WP6 &WP7	• Building databases for groundwater data • National responsible for creating hydrogeological maps and spatial plans

Short profile of staff member(s) who will be undertaking the work

Diana Persa (f) - researcher with experience in spatial groundwater modelling, statistical analysis, GIS analysis, water resources management, groundwater vulnerability assessment.
Radu Farnoaga (m)- senior researcher - research and protection of drinking water resources, the technical projects regarding water supply wells design, completion and testing; processing and interpretation of the data provided by the above-mentioned wells, water resources management.
Albert Baltres (m)- senior researcher expert in geology, geomorphology, and geological mapping.
Marian Munteanu (m): experience in economic geology, geological exploration, ore deposits, environmental impact of mining; reserve/resource classification, implementation of INSPIRE Directive in Romania, themes Geology and Mineral Resources.
Stefan Marincea (m) - senior researcher mineralogy, crystal chemistry, geochemistry, petrology.

Publications, infrastructure / technical equipment

- Geological Maps of Dobrogea, scale 1:50 000.
- Delineation and characterization of geothermal reservoirs in the Southern part of the Pannonian Basin.
- Area mapping of superficial geothermic resources by soil and groundwater data in Constanta County, Romania, Diana Perşa, Anca Vijdea, The Journal of Environmental Protection and Ecology, BENA,2012.
- Basic measures against diffuse pollution in water quality of the ground water bodies and surface water bodies, Rosu Alina Letitia, Damian Gabriela, Persa Diana, published in The papers of the XXIII Conference of The Danubian Countries on The Hydrological Forecasting and Hydrological Bases of Water Management, August 2006, Belgrade - Republic of Serbia.
- Significant sources of diffuze pollution for Dobrogea Region, Romania - H.Uzun, D. Persa. Published in The Official Journal of Balkan Environmental Association, 2004, vol. 2.

Relevant projects/activities

- Hydrogeological Maps of Romania, scales 1:500 00, and 1:50 000.
- Maps of thermal and mineral waters
- Combined Heat Power and Metals, acronym: CHPM2030, financed by Horizon 2020 (http://www.chpm2030.eu/)
- Danube Region Leading Geothermal Energy, acronym: DARLINGe financed by INTERREG Danube Transnational Programme (http://www.interreg-danube.eu/approved-projects/darlinge).

<table>
<tr><td>Name of organisation</td><td colspan="3">47. Geological Survey of Serbia</td></tr>
<tr><td>Short name</td><td>GSS</td><td>Country</td><td>Serbia</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">GSS was formed based on the Mining and Geological Investigations Law („Official Gazette RS“, no. 88/2011) On 29. 06. 2012. Geological Survey of Serbia was formed from Geological Institute of Serbia, organization with long history. First organization was the Geological Institute of the Kingdom of Yugoslavia, formed 1930. Geological Survey of Serbia has three geological departments: Fundamental Geology, Mineral Resources, Geotechnic and Hydrogeology, as well as Groups for Geophysical investigation and Laboratory for rocks, ores, soil and water analysis. Our mission is to create geological, geomorphological, geochemical, hydrogeological and engineering geological maps, protect geodiversity and geoheritage, protection and promotion of the environment, investigation of mineral resource deposits.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">Participant in WP3</td><td colspan="2">Building databases for groundwater data
National responsible for creating hydrogeological maps and spatial plans
Groundwater monitoring</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Tanja Petrović Pantić (f) is a senior hydrogeologist at Department of Geotechnic and Hydrogeology. Research focuses are thermal and mineral waters, geothermal energy, hydrogeochemistry.
Milan Tomić (m): hydrogeologist at Department of Geotechnic and Hydrogeology. Expert in creating hydrogeological maps 1: 100.000, mineral and thermal groundwater studies, spatial plan projects and Impact of Climate Change projects.
Katarina Samolov (f): Fellow worker on GW projects and participant in UNDP Beware Project of Unifying landslide data standards and creating landslide database.
Mihajlo Mandić (m) Engineer of geology and speleologist. Senior hydrogeologist at Geological Survey of Serbia, Department of Geotechnic and Hydrogeology. Expert for karst areas and in creating hydrogeological maps 1: 100 000 and studies;</td></tr>
<tr><td colspan="4">Publications, infrastructure / technical equipment</td></tr>
<tr><td colspan="4">
Nikolov, J., Todorovic, N., <u>Petrović Pantić, T</u>. Forkapic, S., Mrdja, D., Bikit, I., Krmar, M., Veskovic, M. (2012) Exposure to radon in the radon spa Niška Banja, Serbia, Radiation Measurements, Volume 47, Issue 6, p. 443-450 Radiation Measurements.
<u>Petrović, T.,</u> Zlokolica-Mandić, M., Veljković, N., Papić, P., Stojković, J. (2012) Chapter 19. Geochemistry of Bottled Water in Serbia, in F.F. Quercia and D. Vidojevic (eds.), Clean Soil and Safe Water, NATO Science for Peace and Security Series C: Environmental Security, XVII, 247-266 p, Springer, Dordrecht
<u>Petrović, T.,</u> Zlokolica, Zlokolica-Mandić, M., Veljković, N., Papić, P., Poznanović, M., Stojković, J., Magazinović, S. (2012) Macro and micro elements of bottled waters and water from public water supply in Serbia, Chemical Industry 66 (1) 107-122
<u>Petrović, T</u>., Zlokolica-Mandić, M., Veljković, N., Vidojević, N. (2010) Hydrogeological Conditions for the Forming and Quality of Mineral Waters in Serbia, Journal of Geochemical Exploration 107 (2010), pp. 373-381
</td></tr>
<tr><td colspan="4">Relevant projects/activities</td></tr>
<tr><td colspan="4">
Hydrogeological maps, scale 1:100.000
Spatial plans of Municipalities of Republic of Serbia
Geochemistry of European Bottled Water
Alternative groundwater sources for public water supply
Update of geothermal resource database of Republic of Serbia
</td></tr>
</table>

Name of organisation	49. Geološki zavod Slovenije		
Short name	GeoZS	Country	Slovenia

Organisation profile

Geološki zavod Slovenije – Geological Survey of Slovenia (GeoZS) is a public research organisation established by the Government of the Republic of Slovenia. The Survey carries out fundamental, applied, developmental and object research within all geological branches and related fields of work. It consists of research – programme groups and geological expert services. The main goals are contributing to the knowledge about geological composition of the national territory, production of geological maps, assessment of geological hazards, natural and anthropogene, to living environments, assessment of threats to geological environment due to pollution and other anthropogene factors, assessment of groundwater, mineral resources and geothermal energy resources, assessment of natural geological heritage, and development of geological knowledge and research methods.

Roles / tasks in the project	Special relevant skills
Participant in WP3, WP5, WP6, WP7 & WP8	- Hydrogeochemistry - Unsaturated zone - Groundwater modelling and GIS

Short profile of staff member(s) who will be undertaking the work

Janko Urbanc (m) **-** senior researcher with experiences in the fields of research and protection of drinking water resources, water resources management, groundwater hydrochemistry, isotope geochemistry and tracer hydrology, agricultural impacts on groundwater quality

Nina Mali (f) – Head of Hydrogeology Department, senior researcher with experience in GW protection, GW pollution, water resources management , and research of unsaturated zone, responsible for GW protection areas

Sonja Cerar (f) **–** young expert of groundwater quality and spatial modelling at GeoZS. Experienced in statistical analysis and spatial groundwater modelling with GIS.

Anja Koroša (f) - young researcher, experienced in GW pollution (emerging contaminants in GW)

Nina Rman (f) – research associate with experience in exploration, monitoring and management of low-enthalpy geothermal system, transboundary aquifers, mineral and thermal water and mofettes

Publications, infrastructure / technical equipment

Mali, N., Cerar, S., KoroŠa, A., Auersperger, P. Passive sampling as a tool for identifying micro-organic compounds in groundwater. Science of the total environment, ISSN 0048-9697, 2017, vol. 593/594, str. 722-734, doi: 10.1016/j.scitotenv.2017.03.166. [COBISS.SI-ID 2609493],

Cerar, S., Mali, N. Assessment of presence, origin and seasonal variations of persistent organic pollutants in groundwater by means of passive sampling and multivariate statistical analysis. Journal of geochemical exploration, ISSN 0375-6742. [Print ed.], 2016, vol. 170, str. 78-93,

Rman, N. Hydrogeochemical and isotopic tracers for identification of seasonal and long-term over-exploitation of the Pleistocene thermal waters. Environmental monitoring and assessment, ISSN 0167-6369, April 2016, vol. 188, no. 4, str. 242-[262] str.

Relevant projects/activities

- Life project INCOME **-** Improved management of contaminated aquifers by integration of source tracking, monitoring tools and decision strategies (2009 – 2012)
- Improved water and nutrient use efficiency in plant production to protect drinking water sources (2017 - 2020)
- Groundwater age determination in deep aquifers of Slovenia (2011 – 2014)
- Study of pharmaceutical residue transport processes in gravel aquifers (2009 – 2012)
- Hydrogeological numerical model of groundwater flow and heat transfer in deep geothermal groundwater body in the northeastern Slovenia - natural state and production models (2014-2017)

Name of organisation	50. Instituto Geológico y Minero de España (Geological Survey of Spain)		
Short name	*IGME*	***Country***	*Spain*

Organisation profile

The Geological Survey of Spain (IGME) is a Public Research Organization, an autonomous institution attached to the Ministry of Economy and Competitiveness. It was founded in 1849 and is the main Earth Sciences Research Centre of Spain. A staff of 400 employees, 185 graduated, specialized in various fields of activity such as geology, environment, hydrogeology, mineral resources, natural hazards and land use planning. IGME-Spain facilities, including its headquarters, project offices in several places around the country, laboratories, warehouses, drill core repository, library and museum, are equipped with advanced technology and technical resources. IGME-Spain is the national centre for the creation of knowledge infrastructure, information and R&D in Earth Sciences.

Roles / tasks in the project	***Special relevant skills***
Participant in WP3, WP6, WP7 & WP8	• *Analysis of groundwater natural quality and distribution of Potentially Toxic Geogenic Trace Elements (PTGTE) in European countries.* • ***V**ulnerability mapping at national scale* • ***M**apping of hydrogeological Systems*

Short profile of staff member(s) who will be undertaking the work

***Elena Gimenez Forcada (f)**. Expert in hydrogeochemistry research (trace element behaviour) and environmental health (medical geology). Leader of the HidroGeoTox Project, about distribution of HydroGeoToxicity by toxic elements related to geological environment.*
***Juan Grima Olmedo (m).** Senior hydrogeologist, expert in groundwater quality and risk assessment. Protection and sustainable use of soil.*
***David Pulido-Velazquez (m).** Field of expertise in assessment of groundwater quantity and quality issues. Team member in EU projects (eg. GENESIS, GESHYDRO,GESINH-IMPADAPT.*
***Juan de Dios Gómez Gómez (m).** Senior hydrogeologist, expert in groundwater modeling, coastal aquifers, GIS and vulnerability mapping. Member of the EuroGeoSurveys Water Resources Expert Group.*

Publications, infrastructure / technical equipment

***Giménez-Forcada. E.**; Vega-Alegre, M.; Timón-Sánchez, S. (2017). Characterization of regional cold-hydrothermal inflows enriched in arsenic and associated trace-elements in the southern part of the Duero Basin (Spain), by Multivariate Statistical Analysis. Science of the Total Environment 593–594: 211–226.*
***Giménez-Forcada, E.**; Timón-Sánchez, S.; Kohfahl, C. (2017). Distribution of Hydrogeotoxicity by Arsenic and Uranium in the SE edge of the Duero Basin, Spain. Journal of Geochemical Exploration 183: 197–205.*
***Grima, J., Luque, J.A., Mejía et al.** (2015). Methodological approach for the analysis of groundwater quality in the framework of the Groundwater Directive. Environmental Earth Sciences (2015) 74:4039–4051.*

*Peña-Haro, S., Llopis-Albert, C., Pulido-Velazquez, M., **Pulido-Velazquez, D**., 2010. Fertilizer standards for controlling groundwater nitrate pollution from agriculture: El Salobral-Los Llanos case study, Spain, Journal of Hydrology 392 (2010) 174–187, doi: 10.1016/j.jhydrol.2010.08.006*

Relevant projects/activities

***IGME-2303. 2013-2017.** Identification of geo-environmental factors that control the distribution of arsenic and other PTGTPs as a management tool in the hydrological planning of groundwater masses with hidrogeotoxic risk (HydroGeoTox Project). Instituto Geológico y Minero de España (Geological Survey of Spain). Elena Giménez Forcada, main researcher.*

Name of organisation	**51. Institut Cartogràfic i Geològic de Catalunya (Cartographic and Geological Institute of Catalonia)**		
Short name	ICGC	**Country**	Spain

Organisation profile

The ICGC is the official mapping and geological agency of the autonomous government of Catalonia. The ICGC sum-up the legacies of the former cartographic and geological agencies, both created in 1982 and belongs to the Department of Territory and Sustainability of the Government of Catalonia. The ICGC has a staff around 270 people and is a beginning-to-end cartographic and geological institution comprising: a) data acquisition owning 3 airplanes and 7 sensors, skilled staff in the use of satellite imagery, geophysical instrumentation and geotechnics equipment, b) processing capabilities, c) technical support to land and urban planning, d) geological resources analysis (hydrogeology, geoenergies, mineral resources and soils), d) geological hazards assessment and prevention. One of the main missions of the ICGC is to obtain, process, supply and disseminate geoscientific information on the Catalan territory.

Roles / tasks in the project	Special relevant skills
Participation in WP3 & WP7	• Hydrogeological mapping, 3D geomodelling • Building and manage databases and web services • Applied geochemistry • Groundwater resources estimation

Short profile of staff member(s) who will be undertaking the work

Joan Palau (m): Ph.D. in Geology. Professor in the University of Barcelona during 3 years in the petrology and geochemical department. More than 35 years of professional experience working as CEO in *Geocat, Gestió de projectes. S.A.* and currently Deputy Director of Geology and Geophysics at ICGC. Degree in Business administration. **Ignasi Herms (m)**: head of the geological resources department at ICGC. Senior geologist, hydrogeologist and mining engineer technician, project coordinator and expert on groundwater modelling. Project coordinator of: GIS programs for hydrogeological and soil mapping, applied hydrogeology for civil/mining works and environmental impact, 3D reservoir flow and applied hydrochemistry. PhD (in progress) at Mining Engineering and Natural Resources Department (EPSEM-UPC) titleholder *'Hydrogeochemistry in the karst aquifer system of the massif Port del Comte"*. **Georgina Arnó (f)**: project manager and responsible for the hydrogeology and geothermal team at ICGC. Senior geologist and hydrogeologist expert on groundwater mapping and modelling. Collaborating teacher on groundwater at Polytechnic University of Catalonia (UPC). **Montse Colomer (f):** senior geologist and hydrogeologist. Expert in GIS programs, hydrogeology mapping, databases and 3D geological modelling. **Víctor Camps (m):** senior geologist and hydrogeologist. Expert in acquisition and processing of hydrogeological and geothermal data and hydrogeological mapping.

Publications, infrastructure / technical equipment

Herms, I., Arnó, G. (2016). "Información hidrogeológica y base cartográfica continua. Perspectivas en el ámbito digital". Jornada Hidrogeología emergente | 50 CIHS 2016. ISBN 978-84-921469-3-2.
Colomer, M., Herms, I. et al. (2016). "Distribución digital en formato vectorial de datos del Mapa Hidrogeológico de Catalunya a escala 1:25 000". Jornada Hidrogeología emergente | 50 CIHS 2016. ISBN 978-84-921469-3-2.
Arnó, G., Camps, V., Colomer, M. et al (2016). Caracterización geoquímica ambiental de las aguas subterráneas en el ámbito del complejo minero de Bellmunt y el Molar (Priorat). Jornada Hidrogeología emergente. 50 CIHS. ISBN 978-84-921469-3-2.
Navarro, A., Arnó, G., Camps, V., et al (2016). Incidencia ambiental de las actividades mineras en la zona del Priorat (Tarragona). IX Congreso de la Sociedad Geológica de España. Huelva.
Navarro, A., Herms, I., Cirés et al. (2016). Estimación del fondo geoquímico para metales en suelos y sedimentos en el antiguo distrito minero del Priorat (Tarragona). IX Congreso de la Sociedad Geológica de España. Huelva.
Database on subsurface information (boreholes, water point's database, groundwater heads and groundwater quality data). Geological and Hydrogeological maps at different scales and WMS available at http://icgc.cat/Administracio-i-empresa/Eines/Visualitzadors-Geoindex.

Relevant projects/activities

- *Groundwater vulnerability mapping*
- *Special springs inventory and database creation and management*
- *Hydrogeological database generation and management*
- *Hydrogeological mapping at 1:25 000 scale including new data acquisition*
- *Aquifer characterization and delimitation*

<table>
<tr><td>Name of organisation</td><td colspan="3">52. Sveriges Geologiska Undersökning</td></tr>
<tr><td>Short name</td><td>SGU</td><td>Country</td><td>Sweden</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">The Geological Survey of Sweden (SGU) is the national expert agency for issues relating to bedrock, soil and groundwater in Sweden. One key task is to meet society's need for geological information. SGU is a governmental body governed by The Ministry of Enterprise and Innovation.
•Supporting the increase of mineral exploration interest and the sustainable development of mining, and quarrying industry
•Promoting the use of geological information in societal planning
•Consolidating and strengthening geological research in Sweden
•Bringing geology and geo-scientific knowledge to the fore in social debate and in schools
The Mining Inspectorate is a separate decision-making body within SGU. It is responsible for issuing permits for minerals exploration and exploitation under the Swedish Minerals Act.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">Participant in WP3, WP6 & WP8</td><td colspan="2">• Hydrogeological mapping
• Building and manage databases and web services
• Applied geochemistry
Groundwater resources estimation</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Mattias Gustafsson (m): Leader of SGU groundwater resources mapping
Lena Maxe (f): Senior expert groundwater quality
Lars-Ove Lång (m): Senior expert groundwater quality and groundwater resources mapping
Lars Rosenqvist (m): Reseacher, groundwater quality and mapping
Anna Ladenberger (f): Senior expert geochemistry</td></tr>
<tr><td colspan="4">Publications, infrastructure / technical equipment</td></tr>
<tr><td colspan="4">Griffioen, J., van Helvoort, P.-J., Edmunds, M., Wendland, F., Jongbloed, R., van der Wal, J.-T., Holthaus, K., van der Grift, B., Gerritse, J., Jeannot, R., Kalevi, K., Gustafsson, J., Witzak, S., Kania, J. & Rozanski, K., 2006: BRIDGE. Background criteria for the identification of groundwater thresholds. Deliverable 7: State-of-the-art knowledge on behaviour and effects of natural and anthropogenic groundwater pollutants relevant for the determination of groundwater thresholds values. Final reference report.</td></tr>
<tr><td colspan="4">Relevant projects/activities</td></tr>
<tr><td colspan="4">http://resource.sgu.se/produkter/sgurapp/s1301-rapport.pdf
http://grundvatten.nu/modelgroundwater/client-sgu/index.html.
http://resource.sgu.se/produkter/sgurapp/s1603-rapport.pdf</td></tr>
</table>

Name of organisation	**53. State Research and Development Enterprise “State Informational Geological Fund of Ukraine”**		
Short name	GEOINFORM	**Country**	Ukraine

Organisation profile

The State Research and Development Enterprise "State Informational Geological Fund of Ukraine" – SRDE “GeoInform of Ukraine”, or GEOINFORM is the specialized research and development unit of the State Geological and Subsurface Survey of Ukraine which collects, stores, analyzes and provides information received from geological study and use of subsurface. GEOINFORM conducts research work on monitoring of mineral resources of Ukraine on the basis of geological and mining activities during the year, recording deposits and making public the balance of mineral resources management of the State fund of deposits and occurrences (more than 10,000 objects recorded), synthesis and analysis of exploration for oil and gas, creating a system of state accounting of oil and gas wells, completion and maintenance of the State cadastre of mineral deposits and occurrences as well as State cadastre of groundwater deposits of Ukraine.

Roles / tasks in the project	**Special relevant skills**
Participant in WP3, WP4, WP5, WP6, WP7 & WP8	Building databases and web services for subsurface data

Short profile of staff member(s) who will be undertaking the work

Dr. hab. Boris Malyuk (m): Director for International Cooperation. National Delegate of Ukraine to the EuroGeoSurveys. In the Project he will contribute to general project management and geoscientific data systems.
Natalia Pyshna (f): Chief, Division of groundwater resources inventory. She has experience in the sphere of hydrogeological studies for fresh and mineral water of Ukraine for more than 30 years. She represents SGSSU in the EU project 'Water Initiative for Eastern Partnership' (EUWI+4EaP).
Larysa Lopata (f): Senior Hydrogeologists, Division of groundwater resources inventory. She has experience in the sphere of hydrogeological studies for mineral groundwater of Ukraine for more than 10 years.
Mykola Danevych (m): Leading Hydrogeologists. He has experience in the sphere of hydrogeological and geological-ecological studies for more than 10 years.
Lesia Babichenko (f): Leading Hydrogeologists. She is experienced in hydrogeological studies, environment protection, specifically, groundwater protection.

Publications, infrastructure / technical equipment

Interactive map of mineral deposits of Ukraine (in Ukrainian)
http://geoinf.kiev.ua/wp/interaktyvna-karta-rodovyshch-korysnykh-kopalyn.htm
Interactive map of mineral licenses (in Ukrainian)
http://geoinf.kiev.ua/wp/interaktyvni-karty-spetsdozvoliv.htm
Interactive geological map of Ukraine 1:1 000 000 (in Ukrainian)
http://geoinf.kiev.ua/wp/Interaktyvna-heolohichna-karta-Ukrayiny.htm
Interactive geological map of Ukraine 1:1 000 000 (in English)
http://geoinf.kiev.ua/wp/Interactive-Geological-Map-of-Ukraine.htm
Interactive State Geological Map of Ukraine 1:200 000 (in Ukrainian with English entries)
http://geoinf.kiev.ua/wp/kartograma.htm

Relevant projects/activities

ESTMAP - EU
EUOGA - EU
NUMIRE – Norway-Ukraine (NGU/SGSSU)
EIMIDA – Norway-Ukraine (NGU/Geoinform)

Name of organisation	54. Natural Environment Research Council (British Geological Survey)		
Short name	NERC	**Country**	United Kingdom

Organisation profile

The British Geological Survey (BGS) is a component body of the Natural Environment Research Council (NERC), the UK's largest funder of independent environmental science including basic, strategic and applied research and monitoring, training and innovation. BGS was founded in 1835 and is the world's longest established national geological survey. BGS seeks to advance the understanding of the structure, properties and processes of the solid Earth system through interdisciplinary surveys, monitoring and research for the benefit of society. BGS is a public sector organization responsible for advising the UK government on all aspects of geosciences, as well as providing impartial geological advice to industry, academia and the public. It is the UK's premier provider of objective and authoritative geoscientific data, information and knowledge for sustainable use of natural resources, reducing risk and living with the impacts of environmental change.

Roles / tasks in the project	Special relevant skills
Coordinating WP5 Participant in WP1, WP2 & WP8	• Large scale modelling of N transport in groundwater • Databasing and geospatial data analysis, • Analysis of groundwater quality monitoring data • Expertise on emerging pollutants

Short profile of staff member(s) who will be undertaking the work

Marianne Stuart (f) has over 30 years experience at BGS in groundwater quality research including emerging contaminants, agrochemicals, chlorinated solvents, microbiological problems and risk assessment. **Matthew Ascott (m)**, hydrogeologist at BGS with 6 years' experience in hydrogeological research and industry. Experience in large scale modelling of nitrate in the unsaturated zone and groundwater, groundwater-surface water interactions and macronutrient cycling. **Lei Wang (m)**, a groundwater modeller at BGS with expertise in agricultural diffuse water pollution, hydrological and hydrogeological modelling and environmental real-time modelling. He is the owner of the nitrate time bomb (NTB) model, which has been successfully applied at the catchment, national and global scales and attracted research funding from NERC, EA and DEFRA. **Dan Lapworth (m)**, a hydrogeochemist with 17 year experience at BGS in groundwater contaminant research including pesticides, emerging contaminants, nutrients (C, N and P) and pathogens. Had a 6 month secondment to BRGM in 2011-12 on emerging contaminants.

Publications, infrastructure / technical equipment

Ascott, M.J., Gooddy, D.C., Wang, L., Stuart, M.E., Lewis, M.A., Ward, R.S. and Binley, A.M. (2017) Global patterns of nitrate storage in the vadose zone. Nature Communications 8(1), 1416.

Lapworth D J, Baran N, Stuart M E, Manamsa K, Talbot J.(2015) Persistent and emerging micro-organic contaminants in Chalk groundwater of England and France. Environmental Pollution, 203, 214-225.

Wang, L., Stuart, M.E., Bloomfield, J.P., Butcher, A.S., Gooddy D.C., McKenzie, A.A., Lewis, M.A., Williams, A.T. (2012) Prediction of the arrival of peak nitrate concentrations at the water table at the regional scale in Great Britain. Hydrological Processes 26, 226-239.

Lapworth D J, Baran, N, Stuart M E, and Ward R S. (2012) Emerging contaminants: A review of occurrence, sources and fate in groundwater. Environmental Pollution, 163, 287-303.

Stuart M E, Lapworth DJ, Crane E J and Hart A. (2012) Review of risk from potential emerging contaminants in UK groundwater, Science of the Total Environment, 416, 1-21.

Relevant projects/activities

1. BGS research project on nitrate modelling in the unsaturated zone at the global scale
2. BGS research project on national scale emerging contaminants
3. UK Environment Agency funded research projects on national scale mapping and modelling for quantifying denitrification potential and Nitrate Vulnerable Zone Designation
4. DEFRA-funded projects on assessing nitrate mitigation measures - Demonstration Test Catchments and a field tool kit for ecological targeting of agricultural diffuse pollution mitigation measures
5. EU-funded project assessing the sources of nitrate pollution of groundwater in Malta
6. Membership of European Commission's WFD CIS Groundwater Expert Group
7. Membership of the European Commission working group for the Groundwater Watch List

Name of organisation	**Eesti Geoloogiateenistus (non-funded)**		
Short name	EGT	**Country**	Estonia

Organisation profile

The Geological Survey of Estonia (GSE) is a state agency responsible the activities in geology and hydrogeology in Estonia and operates under the governance of Minister of Economy. GSE assembles the geology, hydrogeology and environmental expertise in one place and its main aim is to provide the high-quality information to other state agencies, local authorities and businesses for environmental research, the planning processes and the management of mineral resources in Estonia.

The main activities and competencies of the Geological Survey of Estonia are in following fields of geological mapping; marine geological surveys, mineral resources surveys, hydrogeology and geophysical research, and environmental research. EGT is also responsible for compiling, updating and management of geology, hydrogeology databases, the storage of drill cores and rock samples and it conducts the seismic, groundwater, and seacoast surveillance.

Roles/tasks in the project	**Special relevant skills**
Participant in WP7	Building databases Groundwater modelling Geological Mapping Groundwater geochemical studies

Short profile of staff member(s) who will be undertaking the work

Andres Marandi (m), PhD: *– Head of Hydrogeology Department. Has long-term experience of international research projects. Professional experience in the field of groundwater modelling and geochemical studies.*
Valle Raidla (m), PhD: *senior hydrogeologist. Is responsible for geochemical and isotope studies of groundwater.*
Maile Polikarpus(f), MSc*: – hydrogeologist. Is responsible for groundwater modelling studies and compilation of GIS databases of groundwater.*

Publications, infrastructure / technical equipment

Gerber, C.; Vaikmäe, R.; Aeschbach, W.; Babre, A.; Jiang, W.; Leuenberger, M.; Lu, Z-T. ; Mokrik, R.; Müller, P.; ***Raidla, V****.; Saks, T.; Waber, H.; Weissbach, T.; Zappala, J. C.; Purtschert, R. (2017). Using 81Kr and noble gases to characterize and date groundwater and brines in the Baltic Artesian Basin on the one-million-year timescale. Geochimica et Cosmochimica Acta, 205, 187−210.10.1016/j.gca.2017.01.033.*

Pärn, Joonas; ***Raidla, Valle****; Vaikmäe, Rein; Martma, Tõnu; Ivask, Jüri; Mokrik, Robert; Erg, Katrin (2016). The recharge of glacial meltwater and its influence on the geochemical evolution of groundwater in the Ordovician-Cambrian aquifer system, northern part of the Baltic Artesian Basin. Applied Geochemistry, 72, 125−135.10.1016/j.apgeochem.2016.07.007.*

Islam, M. B.; Firoz, A. B. M.; Foglia, L.; ***Marandi, A.;*** *Khan, AR.; Schuth, C.; Ribbe, L. 2017. A regional groundwater-flow model for sustainable groundwater-resource management in the south Asian megacity of Dhaka, Bangladesh. Hydrogeology Journal Volume: 25: 3, 617-637*

Sahib, L.; ***Marandi, A****.; Schueth, C. 2016. Strontium isotopes as an indicator for groundwater salinity sources in the Kirkuk region, Iraq. Science of the Total Environment. 562: 935-945*

Marandi, A., *Karro, E., Polikarpus, M., Jõeleht, A., Kohv, M., Hang, T., Hiiemaa, H. 2013. Simulation of the hydrogeologic effects of oil-shale mining on the neighbouring wetland water balance: case study in north-eastern Estonia. Hydrogeology Journal, 21(7), 1581 – 1591.*

Relevant projects/activities

Groundwater Modelling of Regional Mining effects in NE Estonia.
Assessment of the Status of Groundwater Bodies in Estonia
Hydrogeological Mapping of Estonia
Geochemical Studies of the Groundwater of Mining Areas in Estonia

Name of organisation	Royal Belgian Institute of Natural Sciences – Geological Survey of Belgium (non-funded)		
Short name	RBINS-GSB	**Country**	Belgium

Organisation profile

The Geological Survey of Belgium (GSB) is an autonomous subsection of the RBINS OD Earth. Created in 1896, the GSB is a key geological and mineralogical research centre developing both applied and fundamental research approaches. It is also an independent, non-commercial provider of geoscientific services. These services are oriented towards local, regional, federal, European and international authorities, as well as researchers of institutions/universities and research groups, private companies, NGO's and citizens. In spite of retaining this profile and strong societal focus, which is typical for the geological surveys of Europe, the GSB has at the same time become one of the most research-oriented Surveys in Europe, evidenced by a rapidly increasing scientific output in recent years.

Roles / tasks in the project	**Special relevant skills**
Participants in WP3	• 3D geomodelling of cross-border regions • Building databases and web services for subsurface and groundwater data • Integrated interpretation of hydrochemical and hydrogeological datasets

Short profile of staff member(s) who will be undertaking the work

Vanessa Heyvaert (PhD, 15 year of experience, female) is a quaternary geologist specialised in coastal and fluviatile deposits, and coordinator of the groundwater related projects at the RBINS-GSB.
Kris Piessens (PhD, 15+ year experience, male) is one of the key members of the GeoEnergy team. He has been involved in CCS related research for 15 years, working on the interface between geological, economic, policy, engineering and regulatory aspects, but also more fundamental topics such as geogenic release of CO_2 in springs.

Publications, infrastructure / technical equipment

- Makarewicz M., Welkenhuysen K., Dhaerens D., Piessens K. 2016. Measuring the amount of CO2 in oversaturated waters by mass balance: an overview of trials and errors. Abstract for the 5th International Geologica Belgica Congress 2016, Mons, Belgium.
- Burlet C., Vanbrabant Y., Piessens K., Welkenhuysen K., Verheyden S. 2015. Niphargus: A silicon band-gap sensor temperature logger for High-precision environmental monitoring. Computers & Geosciences 74:50-59. DOI 10.1016.
- Möller I., Piessens K., Welkenhuysen K., Janssens R., Schloemer S. 2012. Geogenic CO_2 releases in Belgium and Germany as natural analogues for the development and evaluation of monitoring tools and methods. Schriftenreihe der Deutschen Gesellschaft für Geowissenschaften 80:445
- Geological maps of Belgium, boreholes database, field observations are available online through the webGIS portal developed by GSB (www.belgiumgeology.net).

Relevant projects/activities

- RESPONSE (BELSPO - national funding agency, 2016-2020): Reactive transport modelling of point source contamination in soils and groundwater.
- H3O-De Kempen (ALBON – regional funding, 2015-2017): Geological and hydrogeological 3D-model of the Cenozoicum of the Campine Basin in Middle-Brabant and Flanders.
- H3O-Roerdalslenk (VMM & ALBON – regional funding, 2012-2014): Geological and hydrogeological 3D-model of the Cenozoicum of the Roer Graben in South-East Netherlands and Flanders.

Name of organisation	Landesamt für Bergbau, Geologie und Rohstoffe Brandenburg (non-funded)		
Short name	LBGR	**Country**	Germany

Organisation profile

LBGR is a subordinated state authority of the Ministry for Economic Affairs and Energy and the central geo-scientific state institution of the Federal State Brandenburg. LBGR provides geoscientific knowledge, data and planning-relevant documents for the protection and sustainable use of soil, groundwater, geothermal energy, raw materials and construction ground. For this reason LBGR maintains specialised information systems in the field of geology, hydrogeology, economical geology and geopedology. These information systems include the central repository for subsurface data of the Federal State of Brandenburg.

Roles / tasks in the project	**Special relevant skills**
Participant in WP7 (non-funded partner)	• hydrogeological mapping, • building databases and web services for hydrogeological data

Short profile of staff member(s) who will be undertaking the work

Silvio Janetz (m): hydrogeologist and GIS specialist at LBGR. He has working experience as scientist in the fields of environmental geology, hydrogeology and groundwater modelling. Since 2013 he is an employee at the State Office for Mining, Geology and Raw Materials Brandenburg (LGBR) and responsible for 2D/3D hydrogeological mapping and hydrogeological database development in the state of Brandenburg.

Publications, infrastructure / technical equipment

Janetz, S. & Reyes, S. (2015): Von der hydrogeologischen Karte zum dreidimensionalen Grundwasserleitermodell – Stand und Perspektiven der hydrogeologischen Landesaufnahme in Brandenburg. (*From hydrogeological map to 3D groundwater model – state and prospects of the hydrogeological mapping in the state of Brandenburg*). Schriftenreihe des Landesamtes für Umwelt, Naturschutz und Geologie Mecklenburg-Vorpommern - 2015, Heft 1, Güstrow, S. 78

Kempka, T., Herd, R., Huenges, E., Endler, R., Jahnke, C., Janetz, S., Jolie, E., Kühn, M.,Magri, F.,Meinert, P., Moeck, I., Möller, M., Munoz, G., Ritter, O., Schafrik, W., Schmidt-Hattenberger, C. Tillner, E., Voigt, H-J., Zimmermann, G. (2015): Joint Research Project Brine: Carbon Dioxide Storage in Eastern Brandenburg: Implications for Synergetic Geothermal Heat Recovery and Conceptualization of an Early Warning System Against Freshwater Salinization. In: Liebscher, A. & Münch, U. (Eds.): Geological Storage of CO_2 – Long Term Security Aspects, GEOTECHNOLOGIEN Science Report No. 22, Series: Advanced Technologies in Earth Sciences, p. 183-209. Springer

Janetz, S.; Jahnke, C.; Tillner, E.; Kempka, T.; Röhmann, L.; Kühn, M. (2013): Effects of brine displacement on pressure and salinity increases in a regional freshwater aquifer complex with respect to CO2 storage in saline subsurface formations, In: General Assembly of the European Geosciences Union 2013, 07 - 12 April 2013, Vienna (Austria). Geophysical Research Abstracts. 10 (EGU2013-9559).

Relevant projects/activities

- hydrogeological maps and cross-sections at the scale of 1:50.000 to 1:300.000
- Database for groundwater and subsurface information
- “brine” - CO2 storage in eastern Brandenburg: Implications for geothermal heat provision and conception of a salinisation early warning system. BMBF/DFG research project GEOTECHNOLOGIEN. Duration 2010-2013.

5 ETHICS AND SECURITY

5.1 Ethics

Have you completed an ethics self-assessment? YES, see Table below

Does your research involve Human Embryonic Stem Cells (hESCs)?	NO
Does your research involve human participants?	NO
Does your research involve human cells or tissues	NO
Does your research involve personal data collection and/or processing?	NO
Does your research involve animals?	NO
In case non-EU countries are involved, do the research related activities undertaken in these countries raise potential ethics issues?	NO
Does your research involve the use of elements that may cause harm to the environment, to animals or plants?	NO
Does your research involve the use of elements that may cause harm to humans, including research staff?	NO
Does this research involve dual-use items in the sense of Regulation 428/2009, or other items for which an authorisation is required?	NO
Could your research raise concerns regarding the exclusive focus on civil applications?	NO
Does your research have a potential for misuse of research results?	NO
Any other ethics issues that should be taken into consideration ?	NO

5.2 Security

Please indicate if your project will involve:

- Activities or results raising security issues: NO
- 'EU-classified information' as background or results: NO

Cited references

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Broers H (2004). The spatial distribution of groundwater age for different geohydrological situations in the Netherlands: implications for groundwater quality monitoring at the regional scale. Journal of Hydrology, 299(1-2): 84–106.

Edmunds W.M. Milne, C.J. (2001). Palaeowaters in Coastal Europe: Evolution of Groundwater Since the Late Pleistocène. Geol.Soc. Special Publ. 189. Geological Society, London, UK.

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Flem et al. 2015. Inorganic chemical quality of European tap-water. 2. Geographical distribution. https://doi.org/10.1016/j.apgeochem.2015.01.016

Giménez-Forcada, E.; Timón-Sánchez, S.; Kohfahl, C. (2017b). Distribution of Hydrogeotoxicity by Arsenic and Uranium in the SE edge of the Duero Basin, Spain. *Journal of Geochemical Exploration* 183: 197–205.

Giménez-Forcada. E.; Vega-Alegre, M.; Timón-Sánchez, S. (2017a). Characterization of regional cold-hydrothermal inflows enriched in arsenic and associated trace-elements in the southern part of the

Duero Basin (Spain), by Multivariate Statistical Analysis. *Science of the Total Environment* 593–594: 211–226.

Gooddy D, Darling G, Abesser C, Lapworth D.J. (2006) Using chlorofluorocarbons (CFCs) and sulphur hexafluoride (SF6) to characterise groundwater movement and residence time in a lowland Chalk catchment. Journal of Hydrology, 330(1-2): 44–52.

Gourcy L, Baran N, Vittecoq B (2009) Improving the knowledge of pesticide and nitrate transfer processes using age dating tools (CFC, SF_6, ^3H) in a volcanic island. J. Cont. Hydrol. 108(3-4): 107–117.

Guardiola-Albert C., Pardo-Iguzquiza E. Giménez-Forcada E. (2017) – Métodos estadísticos para la elaboración de mapas de probabilidad de riesgo hidrogeotoxico (HGT) por altas concentraciones de As en las aguas subterráneas. Aplicación a la distribución de HGT en la provincia de Ávila (España). Ingeniería del Agua 21.1.

Hansen B, Thorling L, Dalgaard T, et al. (2011) Trend Reversal of Nitrate in Danish Groundwater - a Reflection of agricultural practices and Nitrogen Surpluses since 1950. Env Sci & Techn. 45(1): 228–234.

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Hinsby, K., Purtschert, R. & Edmunds, W.M. 2007: Groundwater age and quality. In: Quevauviller, P. (ed.): Groundwater Science and Policy, 217-239. Royal Society of Chemistry. London.

Hinsby K, de Melo T, Dahl M (2008) European case studies supporting the derivation of natural background levels and groundwater threshold values for the protection of dependent ecosystems and human health. Sci. Total Environ. 401(1-3): 1–20.

Jasechko S, Perrone D, Befus K, et al. (2017) Global aquifers dominated by fossil groundwaters but wells vulnerable to modern contamination. Nature Geoscience 10(6): 425–429

Kloppmann W, Dever L, Edmunds WM (1998) Residence time of Chalk groundwaters in the Paris Basin and the North German Basin: a geochemical approach. Applied Geochemistry 13(5): 593–606.

Lapworth, D.J., Baran N., Stuart M.E, Ward R.S. (2012). Emerging organic contaminant in groundwater: a review of sources, fate and occurrence. Environ. Pollut. 163, **DOI:** 10.1016/j.envpol.2011.12.034

Meyer, R., Engesgaard, P., Hinsby, K et al., (2017). Estimation of effective porosity ….combining particle tracking, automated calibration and C-14 dating: A case study of a complex coastal aquifer system. Hydrogeol. J., submitted.

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Robertson A., Griebler, C. Malard, F. Galassi, D. Hose G. (2017). Report on Groundwater Ecology, June 2017. Summary report https://circabc.europa.eu/w/browse/05171857-09cb-4e34-a9c5-3d98e3fd0a86

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Szocs T, Rman N, Süveges M, et al. (2013) The application of isotope and chemical analyses in managing transboundary groundwater resources. Applied Geochemistry 32: 95–107.

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Wendland F, Blum A, Coetsiers, et al. (2007) European aquifer typology: a practical framework for an overview of major groundwater composition at European scale. Environmental Geology 55(1): 77–85.

5.8 RESOURces

Title of project proposal

RESOURCE: **RESOUR**ces of groundwater, harmonized at **C**ross-Border and Pan-**E**uropean Scale

Abstract
Although EU member states generally have a comprehensive overview of the groundwater resources in their own homeland and have delineated groundwater bodies for the EU Water Framework Directive, a coherent overview of all fresh groundwater over Europe is not available for policy development and evaluation. The RESOURCE project proposal aims at demonstrating the potentials of the harmonization of information about Europe's groundwater resources through cross-border demonstrations projects, through harmonized characterization approaches for Karst and Chalk aquifers and through a first information product at Pan-European scale where available data is compiled and integrated to produce a map of the fresh groundwater resources of Europe. The set of deliverables of the RESOURCE project will provide good practices in providing harmonized data and information across borders for assessments of the 3D structure of aquifers, the water volumes available, and the water fluxes and water quality of the resource. Harmonization of such hydrogeological information is a prerequisite for any transboundary groundwater management. A range of regional and national stakeholders will be involved in the work in order to ensure both interaction with authorities that manage and protect groundwater resources and with end-users, thus maximizing dissemination of the results and providing them with easy-access tools through the cooperation with the GeoERA Information Platform Project, jointly prioritizing the information products that are most beneficial for society. The information products to be delivered will serve as a first prototype example of information to be accessible within a Geological Service for Europe.

This proposal is related to GeoERA call SRT GW3
Groundwater – GW3-Harmonization of groundwater resources information at cross-border to Pan-European scale

List of participants *(Numbers of participants as listed in the GeoERA Grant Agreement)*

No.	Acronym	Participant Legal Name	Institute	Country
1	TNO	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO [*Project Coordinator*]	Geological Survey of the Netherlands	Netherlands
1a	DLT	Deltares		Netherlands
2	AGS	Per Sherbimin Gjeologjik Shqiptar - Albanian Geological Survey		Albania
3	GBA	Geologische Bundesanstalt		Austria
6	VMM	Vlaamse Milieu Maatschappij		Belgium
6a	SCK	Belgian Nuclear Research Centre SCK•CEN		Belgium
7	FZZG	Federalni Zavod Za Geologiju - Geological Survey of Federation of Bosnia and Herzegovina		Bosnia and Herzegovina
9	HGI	Hrvatski Geološki Institut – Croatian Geological Survey		Croatia
10	GSD	Ministry of Agriculture, Natural Resources and Environment of Cyprus	Cyprus Geological Survey Department	Cyprus
11	CGS	Ceska Geologicka Sluzba – Czech Geological Survey		Czech Republic
12	GEUS	Geological Survey of Denmark and Greenland, GEUS		Denmark
14	GTK	Geologian Tutkimuskeskus - Geological Survey of Finland		Finland
15	BRGM	Bureau de Recherches Géologiques et Minières		France
27	MBFSZ	Magyar Bányászati és Földtani Szolgálat - Mining and Geological Survey of Hungary		Hungary

No.	Acronym	Participant Legal Name	Institute	Country
28	ISOR	Islenskar Orkurannsoknir - Iceland GeoSurvey		Iceland
29	GSI	Geological Survey of Ireland		Ireland
33	ARPA	Agenzia Regionale per la Protezione Ambientale del Piemonte		Italy
34	RT	Regione Toscana		Italy
39	LGMC	Latvijas Vides, Geologijas Un Meteorologijas Centrs Sia		Latvia
40	LGT	Lietuvos Geologijos Tarnyba prie Aplinkos Ministerijos - Lithuanian Geological Survey under the Ministry of Environment of the Republic of Lithuania		Lithuania
41	SGL	Administration Des Ponts et Chaussees Direction	Service Géologique du Luxembourg	Luxembourg
42	MTI	Ministry for Transport and Infrastructure		Malta
44	PIG	Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy		Poland
45	LNEG	Laboratório Nacional de Energia e Geologia		Portugal
46	IGR	Institutul Geologic al României		Romania
47	GSS	Geološki zavod Srbije - Geological Survey of Serbia		Serbia
49	GZS	Geološki zavod Slovenije		Slovenia
50	IGME	Instituto Geológico y Minero de España - Geological Survey of Spain		Spain
51	ICGC	Institut Cartogràfic i Geològic de Catalunya - Cartographic and Geological Institute of Catalonia		Spain
52	SGU	Sveriges Geologiska Undersökning		Sweden
53	GIU	State Research and Development Enterprise - State Information Geological Fund of Ukraine		Ukraine
54	NERC	Natural Environment Research Council	British Geological Survey	United Kingdom

Non-funded partners

No.	Acronym	Participant Legal Name	Institute	Country
13	EGT	Eesti Geoloogiakeskus		Estonia
35	RU	Regione Umbria	Servizio Geologico	Italy
	NRW	Geologischer Dienst Nordrhein-Westfalen		Germany

1 Excellence

Objectives and relation to the call and the SRT GW3

Although EU member states generally have a comprehensive overview of the groundwater resources in their own homeland and have delineated groundwater bodies for the EU Water Framework Directive (WFD), a coherent overview of all fresh groundwater over Europe is not available for policy development and evaluation. The RESOURCE project proposal aims at demonstrating the potentials of the harmonization of information about Europe's groundwater resources through cross-border demonstrations projects, through harmonized characterization approaches for important aquifer types and through a first information product at Pan-European scale where available data is compiled and integrated to produce a map of the fresh groundwater resources of Europe. As such this proposal addresses the Specific Research Topics of the call, such as addressed under GW3 (GeoERA 2017[1]). The set of deliverables anticipated under the RESOURCE project will provide good practices in providing harmonized data and information across borders for proper assessments of water volumes, fluxes and water quality at a cross-border scale, which up to now are nearly absent but are needed for successful water planning and management in Europe, especially in a transboundary setting. The Pan-EU mapping approach and the cross-border demonstration projects under RESOURCE will lead to example products of a harmonized pan-European assessment of the 3D structure of aquifers, the volumes of water involved and its quality. Harmonization of hydrogeological information and harmonized 3D characterization of aquitards and aquifers is a prerequisite for any transboundary groundwater management. The RESOURCE proposal includes the following elements of research and development that address the scope of the call:

- Two cross-border demonstration projects that set a new standard for harmonization across borders, not only for 3D geological structures but also for hydrological characteristics such as groundwater heads, fluxes and water quality; these demonstration projects should be considered as a first step towards harmonization at European scale.
- Involvement of stakeholders in the cross-border demonstration projects in order to show and evaluate how synchronized cross-border information adds value to cross-border aquifer management and promotes sustainably prioritizing of different uses of shallow and deep groundwater resources.
- A truly pan-European effort to create a consistent pan-European information product that yields a spatial overview of the volume and depth of Europe's fresh groundwater resources, including a first estimate of total abstraction rates from the resource and the identification of deep paleo waters that may function as strategic reserves
- Creation of a common methodological framework for characterization of karst aquifers and their vulnerability, with a guidance for managing and protecting various karst aquifer types.

Relation to existing EU programmes and projects

The project will build upon previous work that the geological surveys and other institutes performed on groundwater resources (such as the FP6 BRIDGE and FP7 Aquaterra and GENESIS projects) and on the advice given by the geological surveys of Europe in the implementation process of the EU WFD (EC 2000) and Groundwater Directive (GWD, EC 2006) such as Working Group C on Groundwater. The information products to be delivered by RESOURCE, in cooperation with the proposed GeoERA Information Platform Project, will serve as a first prototype example of information to be accessible within a future Geological Service for Europe. RESOURCE will cooperate closely with the GeoERA Information Platform Project, and will develop and use common templates and a data management plan in order to create the information products that are most beneficial. RESOURCE has dedicated tasks to deliver this.

1.1 Concept and methodology

1.1.1 Motivation and underlying ideas

The mapping of the subsurface and the available groundwater resources has always been pursued at the scale level of individual nations and EU member states. Moreover, current EU regulation strongly advocates the member states own assessment, risk analysis and reporting of groundwater quantity and quality data. For example, the WFD asks countries to delineate their groundwater bodies individually and assessing the quantity and the quality of the resource, using country specific thresholds for the

[1] GeoERA Joint Call Document No. 9. Call Announcement and Scientific Scope. Satge 2 Project Proposals. Oct 17th, 2017.

evaluation of concentrations and water balance calculations. As a result, a coherent overview of all fresh groundwater over Europe is not available for policy development and evaluation, nor has cross-border cooperation has been promoted much. Some good practice examples projects, such as the H3O project between Belgium and the Netherlands have shown the high potential of cross-border cooperation and the harmonization of hydrogeological data. Examples from other areas, such as the United States (Figure 1) has taught us that hydrogeological mapping and data reporting needs a multi-scale approach, where the level of detail and resolution changes between regional and national characterization and supranational assessments and upscaling and simplification of classifications and assessments is necessary to obtain sensible information products at the supranational scale.

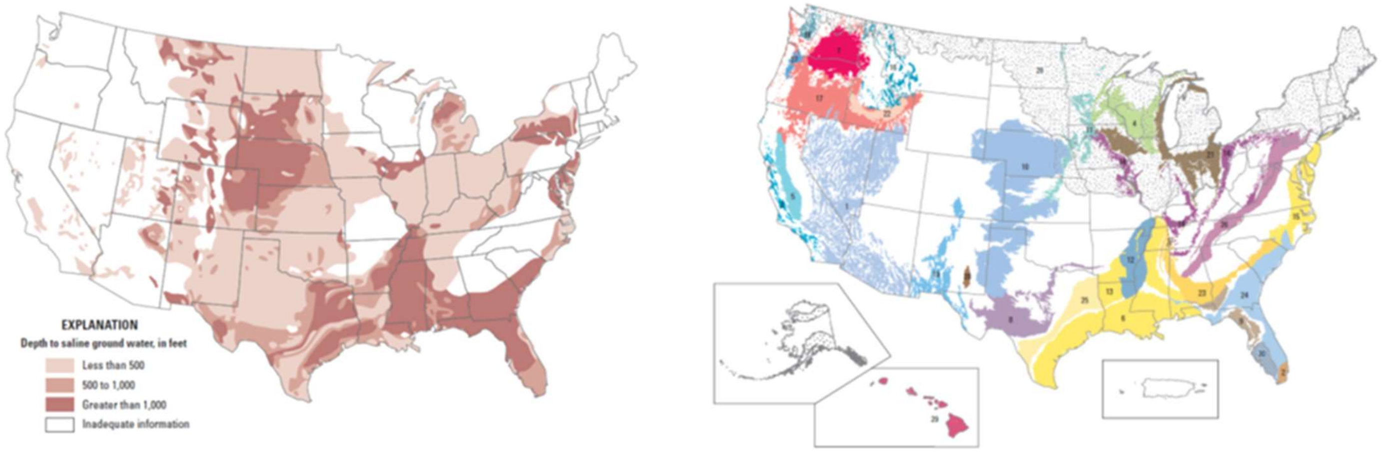


Figure 1 Examples of maps available for the US, made available by the USGS, that show the depth to saline water (left) and the 30 principal fresh groundwater aquifers (USGS Circular 1323)

In order to fill this gap, the RESOURCE project intends to bring together a large number of European national and regional Geological Surveys to develop an approach for both cross-border and pan-European mapping of the fresh groundwater resources of Europe. The GeoERA framework presents a unique opportunity to establish the required cooperation and communication. The project will work at different spatial scales in three main types of activities:

1. Cross-border demonstration projects between surveys of adjacent aquifers and aquitards
2. Methodological demonstration projects, covering specific types of hydrogeological settings
3. Mapping Europe’s fresh groundwater resources at a pan-European scale.

1.1.2 Main elements of the proposal and their interrelationship

The RESOURCE project is built around 4 technical work packages (Figure 2), two of them relating to cross-border demonstration projects (WP3 and 4), one consisting of a methodological demonstration project on Karst and Chalk aquifers (WP5) and one pan-EU mapping effort (WP6). One additional work package is directed to creating a strong link with the Information Platform Activity under GeoERA and includes task for dissemination and communication of the project results (WP2). Coordination of the work is brought under WP1.

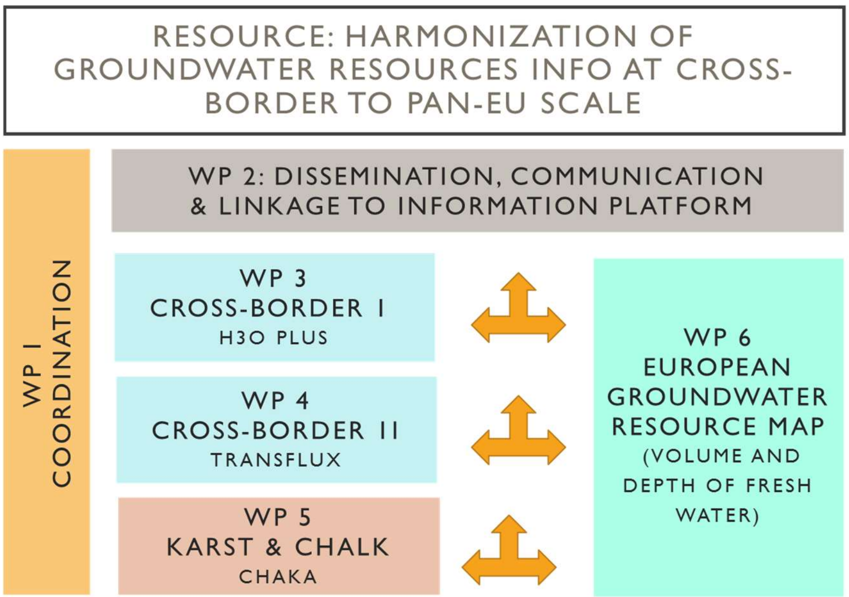


Figure 2 Overall structure of the RESOURCE project

The two cross-border demonstration projects may set a new standard for harmonization across borders, not only for geology but also for hydrological data such as heads and water quality. The intention is to find similarities and differences of approaches tested and needed in the two areas and to use the mutual inspiration for harmonizing the project deliverables and to use it as learning material for further harmonization at the larger EU scale and intermediate supra-national scales. Special attention is paid to karst and chalk aquifers in Europe, as they form very important but vulnerable resources for drinking water production and river base flows. The pan-EU information product complements those demonstration projects and builds on their results, harmonizing data at the larger scale of the EU as a total, and for the first time bring a European assessment of available fresh groundwater and old paleo waters that may require additional protection.

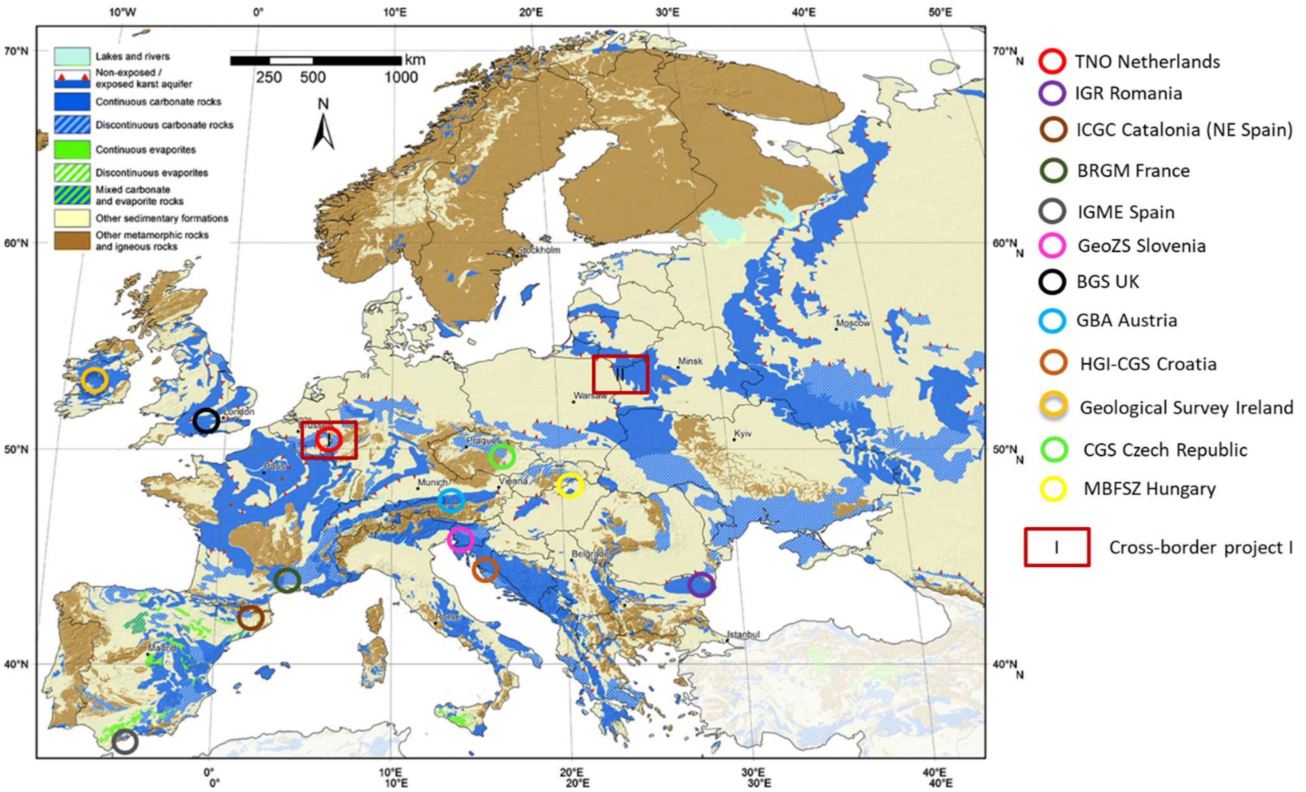


Figure 3 Demonstration projects and pilot areas. The legend shows the main areas with karstic aquifers in Europe in blue colours. Round symbols show the pilot areas of WP7 "Karst & Chalk", rectangles show the cross-border demonstration projects

The cross-border demonstration projects are centred in areas where many subsurface activities strive for prioritization and cross-border harmonization would promote improved aquifer management and subsurface spatial planning, enabling water managers to balance the pressure of the many activities demanded and the ecosystem services that the groundwater/subsurface can provide. These areas are typically in areas with high population density and/or intensive environmental pressures (Figure 3). Therefore, stakeholders will engage in these projects, such as regional authorities responsible for groundwater management in the greater cross-border area, drinking water supply companies and national or regional government bodies that perform groundwater management at national and supranational level. The pilot areas of the Karst & Chalk work package (WP5) are spread over Europe in order to test characterization methodologies in different hydrogeological settings and climates (Figure 3). The pan EU groundwater resources maps and information products cover as many nations as possible, promoting the cooperation between the participating surveys to build information products that support European policy making, for example in elucidating resources that are important as strategic reserves.

1.2 Ambition

1.2.1 Pan-European information products

The anticipated pan EU mapping product goes well beyond the existing material available to the EU, such as the existing Hydrogeological Map of Europe that gives information about the types of aquifers with groundwater resources (Figure 4), but gives no information on depths or volumes of available fresh groundwater or the extent and quality of the resources. No other project at EU scale have yet proposed or realized a map giving this basic information at EU scale, neither has a cooperation between the geological surveys been established on the groundwater aspects. Previously, a group of Geological Surveys was involved in supporting the European Commission on the drafting of the EU Groundwater

Directive and its Guidance's (e.g. EC 2007, 2009)[2]), and the FP6 Support Action BRIDGE has focused on establishing a standard for the derivation of background concentrations and threshold values in groundwater over Europe, leading to a European map of Aquifer Typologies (Figure 5). The newly proposed groundwater resources map takes another approach by collecting data on the depths and volumes of aquifers and aquitards and the corresponding salinity at a 10 x 10 and/or 25 x 25 km grid, thus realizing a spatial scale that is feasible to achieve our goals at European scale, and also gives sufficient resolution to identify the main patterns and to interpret the recharge and the abstractions from the resource. The eventual product will be useful for policy makers, but will also substantially improve the base characterization needed for European and global scale groundwater models, describing flow and transport to rivers and seas (e.g. Wada et al. 2014[3]).

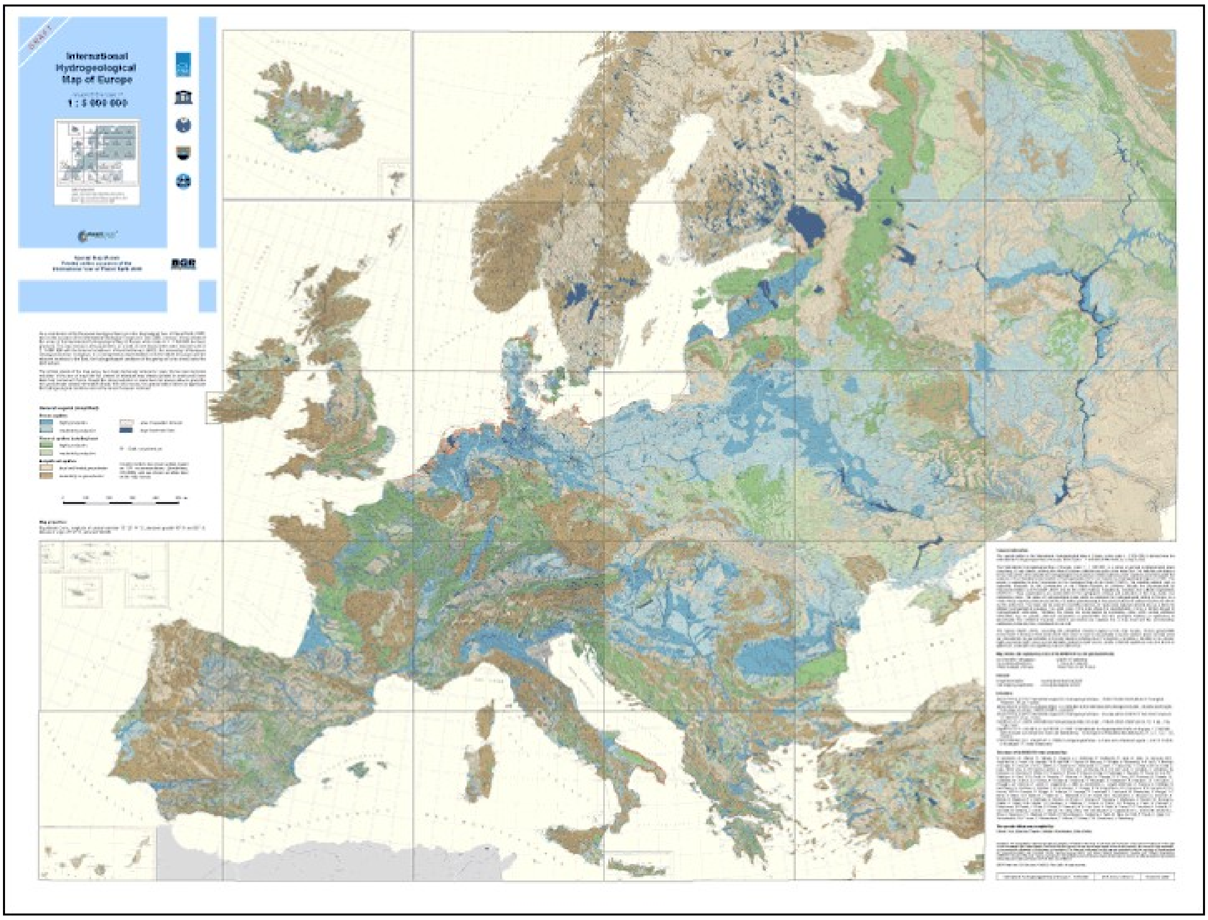


Figure 4 The hydrogeological map of Europe. (https://www.bgr.bund.de/EN/Themen/Wasser/Projekte/laufend/Beratung/Ihme1500/ihme1500_mosaikkarte5mio_en.html;jsessionid=9A5DBA7017ED2AAA30C7126AED9E35C7.2_cid331?nn=1546392)

[2] EC 2007. Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Guidance Document 15. Guidance on Groundwater Monitoring. Technical report 002-2007.

EC 2009. Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Guidance Document 18. Guidance on Groundwater Status and Trend Assessment. Technical report 2009-026.

[3] Wada, Y., Wisser, D. and Bierkens, M.F.P. (2014). Global modelling of withdrawal, allocation and consumptive use of surface water and groundwater resources. Earth System Dynamics, 2014, 5.1: 15.

1.2.2 Cross-border demonstration projects

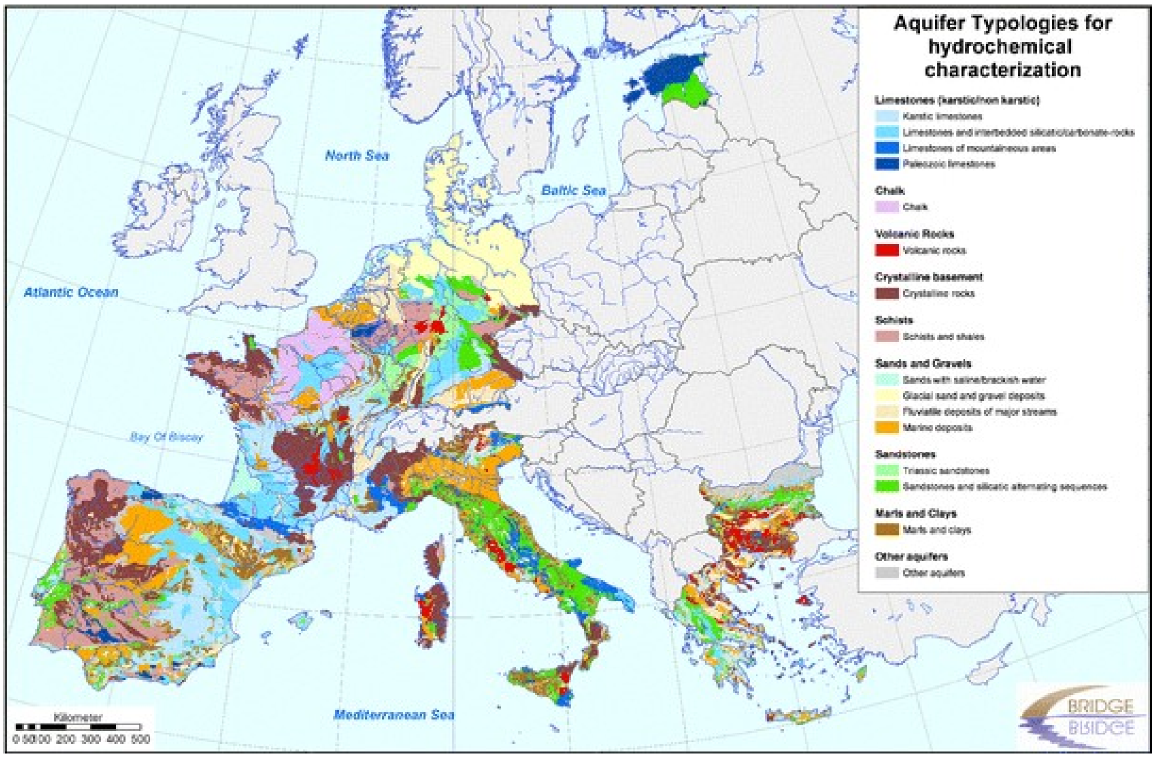


Figure 5 BRIDGE map of Aquifer Typologies. Wendland et al. (2008) Environmental Geology 55:77–85

Harmonisation of geological and hydrogeological information and harmonized 3D characterization of aquitards and aquifers is a prerequisite for any transboundary groundwater management. Given the structure of the European Society and EU administrative setting, cross-border work in not very typical within the groundwater community. No previous EU Framework Project has been called for that integrates the groundwater data at a European scale, contrasting to other work on subsurface data, such as the potentials for mining or extraction of (unconventional) fossil fuels that have attracted EU funding. EU Directives focusing on water (WFD and GWD) have left member states with important decisions on delineation of resources, on chemical thresholds and on water balancing, yielding a high degree of flexibility and national inventories but less appeal for cross-border or EU-scale harmonization. That is why GeoERA strives to stimulate cross-border demonstration projects that establish such a 3D cross-border harmonization. The demonstration project selected under the RESOURCE project establish an advanced demonstration of transboundary and cross-disciplinary assessments, because they build on existing development work in some parts of Europe, making the assessments more useful for decision-making and policy support in the field of subsurface spatial planning. For example, the work in WP 3 extends the established bi-national geological harmonization (Figure 6) into a common interpretation of aquifer hydraulic properties, cross-border groundwater depletion patterns, groundwater age distributions and water and solute balances

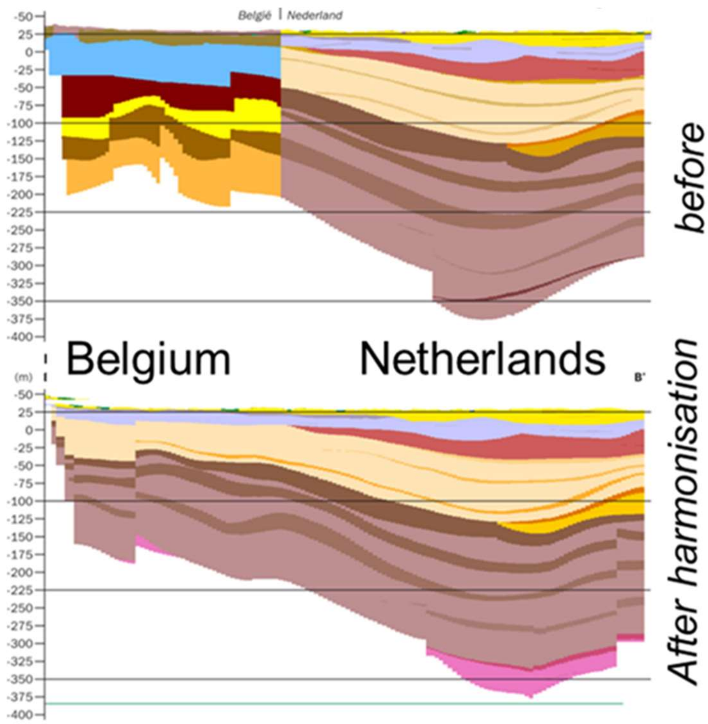


Figure 6 Established example of cross-border harmonization of 3D GeoModels (H3O project Netherlands-Flanders)

in a heavily used cross-border aquifer system where many subsurface activities compete for prioritization. WP 4 aims to integrate the 3D hydrogeological structure in a groundwater flow model, describing fluxes between Poland and Lithuania. Together, the work under RESOURCE for the first time creates good demonstration sites where we will test and define common harmonized approaches for characterizing and 3D mapping of hydrogeological and stratigraphic units and for consistent characterisation and analysis of data on groundwater heads, fluxes, groundwater quality and age structure. The GeoERA call creates a clear opportunity enhancing the motivation for the required cooperation's with additional funding at an appropriate scale, making the Geo-Information available for supranational and EU stakeholders. We regard the experience to be gained in harmonizing methodologies and data between the two cross-border demonstration projects as a necessary first step towards harmonization at the larger EU scale, elucidating similarities and differences of approaches between the demonstration projects and finding ways to bridge disparities. The ultimate goal is to translate the information gained from the demonstration projects and EU scale mapping into useful information for decision makers, thus disseminating information to stakeholder groups and the EU CIS working groups.

1.2.3 Karst & Chalk pilot projects

Carbonate aquifers constitute strategic groundwater resources in many European countries. Several large European cities rely entirely or predominantly on karst aquifers such as Vienna in Austria (1.8 million), Rome in Italy (2.9 million) or Montpellier in France (0.4 million). Their adequate management can be challenging especially when they are karstified, because of their high vulnerability and/or high discharge variability. It is therefore important to acquire adequate methodologies to evaluate the degree of karstic behaviour of these aquifers and adjust protection strategies accordingly. Although a first effort has been accomplished to map the world's Karst aquifers (Chen et al. 2017[4], Figure 7), there is still a lot unknown about the characteristics of these systems, including information about the dual porosity signature and the corresponding travel time distributions that govern the breakthrough of contaminants towards natural springs and drinking water productions sites. The Karst & Chalk work package intends to extend the scientific knowledge on Karst & Chalk behaviour, comparing existing methodologies used in the different partners countries to characterize the hydrogeological and hydrochemical response of karst systems, but also by comparing protection strategies between different countries. Based on the inventory, a joint methodological framework will be tested in a large number of pilot areas that are clearly different in several aspects, including climate, degree of karstification, types of rock and vegetation cover and monitoring approaches (Figure 3). The methodology will be consolidated in order to become applicable for aquifer management. Special attention will be paid to covered carbonate aquifers where karst features may be difficult to detect, therefore making their characterization more challenging. The work will build on previous work[5] to improve the typology of Karst aquifers by adding new technologies that became available recently, including high-frequency monitoring (Van Geer et al. 2016[6]) which provides promising information about the karst hydrodynamics and vulnerability.

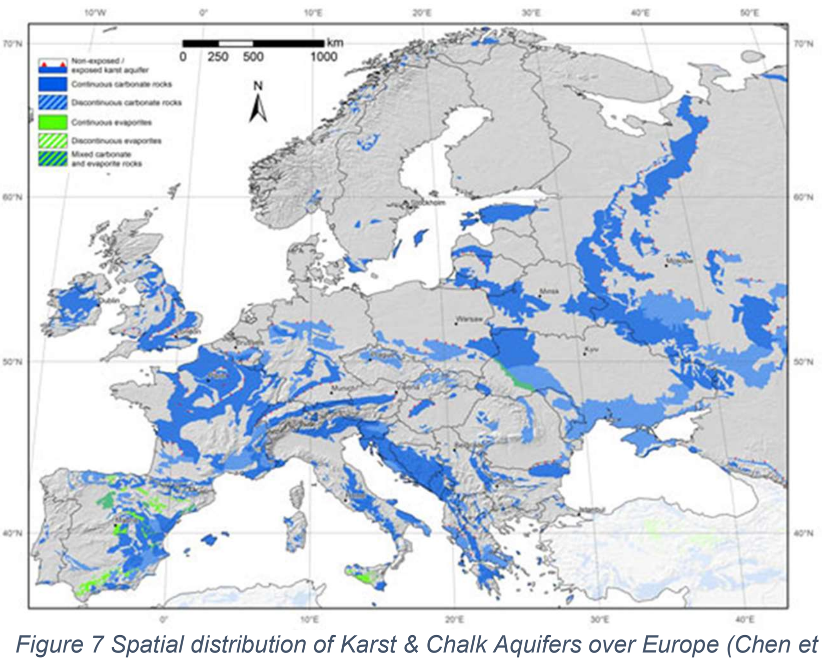


Figure 7 Spatial distribution of Karst & Chalk Aquifers over Europe (Chen et al. 2017)

4 Chen Z. et al. 2017. Hydrogeol J (2017) 25:771–785

5 Mangin 1974 Annales de Spéléologie, 29(3):283–332; 29(4):495–601; 30(1):21–124

6 Van Geer et al. 2016 Hydr.Earth Syst. Sc.20: 3619-3629

2 Impact

2.1 Expected impact

Groundwater is the most important resource for fresh water for human consumption, irrigation and industrial and other uses and delivers base flow to river systems with associated ecosystems. Although EU member states deliver information about their “groundwater bodies” to the EU for the Water Framework Directive, this does not yet lead to a harmonized pan-European assessment of the 3D structure of aquifers, the volumes of water involved and its quality. This predicament was also identified at the EU Working Group C on Groundwater, dedicated to the Common Implementation of the WFD and GWD, but the EC Directives offer a lot of responsibility and flexibility to its member states. However, harmonisation of geological and hydrogeological information and harmonized 3D characterization of aquitards and aquifers is a prerequisite for any transboundary groundwater management and RESOURCE strives to stimulate advanced cross-border demonstration projects that establish such a 3D cross-border harmonization, in order to eventually harmonize data and information at a Pan-European scale. To date there has been no attempt to make pan-European harmonized compilations of available groundwater and hydrogeology data. Key aim of this the approach followed under RESOURCE is to deliver stakeholder access to relevant harmonized groundwater data for sustainable and integrated management of the subsurface and integrated surface and subsurface spatial planning in accordance with EU policies. This will benefit not just the groundwater research community, but also public and private partners and public-private partnerships developing sustainable water policies and innovative water and environment solutions. Innovative and broadly applicable solutions and products for sustainable water management will support and preserve Europe’s leading role in this area. We intend to deliver synchronized information that can be used for cross-boundary aquifer management and subsurface spatial planning, in areas where many subsurface activities strive for prioritization. The proposed project yield information and methods for water managers to balance the pressure of the many activities demanded and the ecosystem services that the groundwater/subsurface can provide, both at cross-border scale and EU scale. Therefore, the results will be relevant for regional authorities responsible for groundwater management in the greater cross-border area, to drinking water supply companies and to the member states governments that perform groundwater management at national and supranational level, including the definition of national strategic groundwater reserves, as in the Netherlands (Broers et al. 2015[7]). Additionally, the EU scale maps will help member states and the commission to obtain an up to date overview of groundwater resources and special groundwater at a appropriate scale for policy development and evaluation.

The project will yield considerable progress beyond the current state-of-the-art in demonstrating the merits of 3D cross-border geologic and hydraulic and chemical characterization, as such enabling groundwater managers of cross-border regions to manage their resources with a good understanding of geological structure, groundwater flow and age patterns in order to prioritize competing uses of the subsurface and effectively protect their resources. Stakeholders will be involved in the two cross-border projects in order to support and promote cross-border discussions, decisions and policy-making, regarding subsurface resource management, exploitation and associated impacts. As such, the RESOURCE project aims to provide a strong impulse to consolidate the cooperation and communication between national/regional subsurface surveys and national and EU stakeholders that deal with groundwater management and protection. The overview of European groundwater resources that we strive to achieve (Figure 8) will yield useful information to derive information on the depletion of groundwater resources in relation to the recharge to the groundwater systems, and the well-protected deeper paleo resources that may be used as strategic reserves. This would promote a more integrated approach towards realizing national and EU societal challenges that are linked with the protection and sustainable management of EU’s fresh groundwater resources, supporting the interfacing between DG’s (e.g. GROW, ENER, ENV, RTD) and various policy departments.

[7] Broers H.P., Stuurman R. en W. de Lange (2015) A first set-up for the delineation of National Groundwater Reserves. Deltares report 1209468-011 BGS-001 (in Dutch)

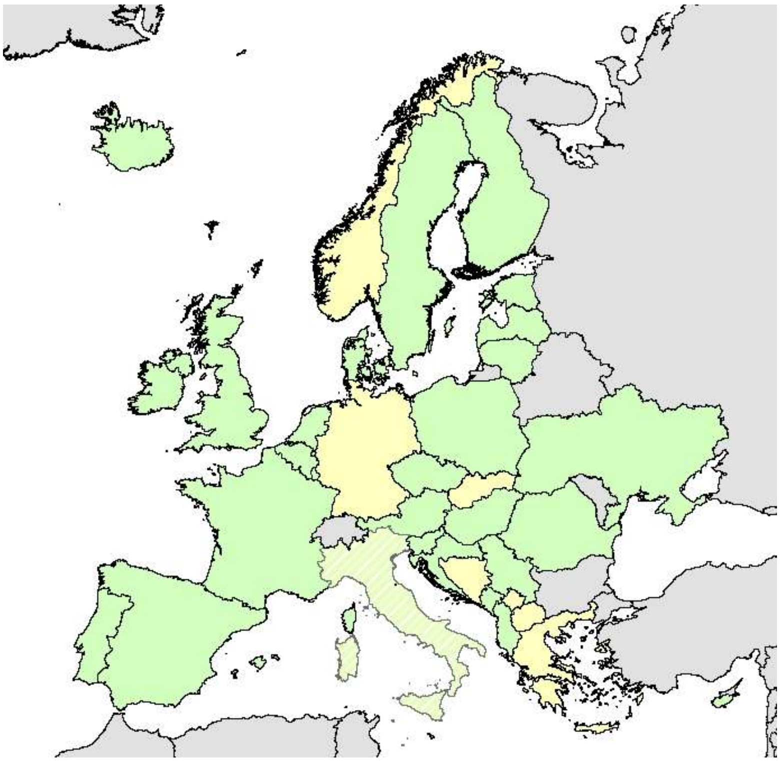


Figure 8 Spatial extent of the pan-European groundwater resources map to be created under WP6. Green: participating surveys, dashed green: country covered partially through contribution of regional surveys, yellow: survey not yet contributing, grey: not a GeoERA partner.

Through the cooperation with the GeoERA Information Platform, the results will be accessible through easy-access tools for regional authorities responsible for groundwater management in the greater cross-border area, drinking water suppliers and member state governments that perform groundwater management at national and supranational level. Open access to these results will enable private companies and/or research institutions to develop new groundwater services on top of the integrated climate, groundwater-surface water models and results e.g. in public-private partnerships and competitive and collaborative environments.

The work will provide improved access to downloadable hydraulic and (hydro)chemical parameters of main European aquifers and aquitards (or groundwater bodies) that can be implemented in groundwater models and coupled surface water - groundwater models at regional and EU scale, and can be applied to the assessment of trends in groundwater quantitative and chemical status based on both human health and well-being and good status objectives for groundwater dependent or associated ecosystems. At EU scale, the Pan-EU mapping effort yields an information product that visualizes the extent and importance of Europe's main aquifer systems including important characteristics such as volumes, depths of confining and permeable layers and the depth of the salt-fresh water interface. This adds considerably to the current information delivered by member states, as in practice the WFD groundwater bodies are administrative units and have been delineated and analysed in diverging ways across Europe. Often depths and volumes are not registered for the WFD. By providing a harmonized map of depth and volumes of European groundwater, together with first estimates of abstracted volumes, groundwater recharge and surface water discharge, we can make a major step forward. The maps to be provided do not intend to break up groundwater systems into administrative groundwater bodies, but rather emphasize the connectivity across borders and thus gives insight in transnational important systems. By creating the maps, we will use the experiences gained by the cross-border demonstration projects that are part of RESOURCE. A map of the depth and volume of fresh groundwater as a principal resource of water for the EU can be considered as a basic information layer, needed for almost all attempts to manage groundwater at a scale larger than member states and to formulate policy goals for groundwater within the EU. Indirectly, the map of the depth of fresh water resources gives information about residence times of groundwater in the subsurface, which yields information about the long-term susceptibility of groundwater systems. The maps and water balance estimates also form the basis for more thorough analysis of the development of groundwater systems in time, for example in modelling studies that address global change effects on water demands or the long-term effects of groundwater contamination by diffuse agricultural use or by local industrial spills. As such, the cooperation and exchange of information with the other groundwater projects that will be funded under GeoERA, will be stimulated by organizing central Consortium Assembly meetings together with the other projects, in order to collectively exchange ideas within the whole groundwater community within the geological surveys in GeoERA (see section 3.1.2).

2.2 Measures to maximise impact

2.2.1 Dissemination, exploitation of results and communication activities

RESOURCE has a dedicated work package (WP2) to disseminate and communicate its results. The communication about the projects result will include the organisation of workshops for stakeholders in the cross-border and methodological demonstration projects under WP's 3, 4 and 5. Dissemination of the pan-European work will be established by organizing meetings in conjunction with stakeholder groups at European level, including CIS Working Group C on Groundwater, the European Environmental Agency, the Joint Research Centre and other CIS groups wherever relevant. Table 2.1 gives an overview of the stakeholders that will be involved in RESOURCE. The cooperation with the Advisory Board will be used to communicate with NGO's and organisations such as the International Association of Hydrogeologist and the International Hydrological Program including its transboundary activities. The GeoERA website and GeoERA Information Portal will be key in those dissemination events and social media will be included to promote events. The production of peer-reviewed papers in international journals will be promoted through this task under WP2, prioritizing and integrating project results of the RESOURCE project and bringing together scientists working in the Groundwater Theme. The RESOURCE project will cooperate with the GeoERA secretariat and other projects funded under GeoERA to establish the best possible dissemination strategy.

Table 2.1 – Stakeholders involved in RESOURCE

Work package	Stakeholders to be involved
WP 2 Dissemination, communication and linkage to the GeoERA Information Platform	CIS Working Group C on Groundwater European Environmental Agency Joint Research Centre
WP 3 H3O-PLUS	Regional and national authorities: • Province of Noord-Brabant (NL) • Province of Limburg (NL) • Landesamt für Natur, Umwelt und Verbraucherschutz Nordrhein-Westfalen (D) Drinking Water Supply: • Waterleiding Maatschappij Limburg (NL) • De Watergroep (BE) • Brabant water (NL)
WP 4 TRANSFLUX	Regional and national authorities • National Water Management Authority (PL) • Regional Water Management Authority, Białystok (PL) • Polish-Lithuanian Commission on Transboundary Waters • Regional Inspectorate of Environmental Protection in Białystok (PL)
WP 5 CHAKA: Karst & Chalk	Regional and national authorities • Province of Limburg (NL) • Waterboard Limburg (NL) • Catalan Water Agency (E) • General Directorate for Water Management (HU) • North-Hungarian Water Directorate • Region of Andalucía (E) • Bundesministerium für Nachhaltigkeit und Tourismus (A) • UBA - Umweltbundesamt (A) • HRVATSKE VODE (Croatian waters) • Rhone Mediterranean Corse Water Agency (F) • Constanta County Council (RO)

Work package	Stakeholders to be involved
	• Romanian Waters National Administration • Dobrogea – Littoral' Water Basin Administration (RO) • Environment Agency, England (UK) • Natural Resources Wales (UK) • Environmental Protection Agency (IRL) • Office of Public Works (IRL)) • National Federation of Group Water Schemes (IRL) Drinking Water Supply & Nature Conservation: • North Hungarian Regional Waterworks (Hu) • Waterleiding Maatschappij Limburg (NL) • Andalusian Environmental and Water Agency • S.C. RAJA S.A. Constanta (RO) • Nature Conservation Agency of the Czech Republic • Portsmouth Water (UK) • Affinity Water (UK) • British Cave Research Association (UK) • Irish Water
WP6 Pan-EU Groundwater Resources	CIS Working Group C on Groundwater International Association of Hydrogeologists UNESCO International Hydrological Program European Environmental Agency Finnish Environmental institute Ministry of Infrastructure & Water (NL) Ministry of Environment MAPAMA (E) Portuguese Environmental Agency UBA - Umweltbundesamt (A) Environment Agency, England (UK)

2.3 Contribution of Project Proposal to the Information Platform or vice versa

RESOURCE will cooperate closely with the GeoERA Information Platform Project, and will develop and use common templates and data management plana in order to create the information products that are most beneficial. The compiled data and the maps provided by this project will be shared on the Information Platform, which is promoted by intensive interaction between work done for this project idea and the workers in the IP project. Work package 2 has dedicated tasks to deliver this. Using the commonly agreed data management plan, RESOURCE will prioritize the information products to focus on, which have most benefit to the stakeholders of the work under RESOURCE. Once products from RESOURCE become available through WP deliverables, the data will be provided to the GIP project for prototyping of the eventual information products. Special attention will be given to the pan-European dataset to be delivered under WP6, in order to make prototyping and implementation efficient within the GIP project. The close links between RESOURCE and the Information Platform Project will yield direct accessibility to GeoERA results, including links between nationally maintained databases and EU-level information.

3 Implementation

3.1 Work Plan – Work packages, deliverables

3.1.1 Structure of work packages within RESOURCE

In the RESOURCE proposal we distinguish 6 work packages (WP's, see Figure 2). WP 1 focuses on the overall coordination of the proposed project, guarding the overall objectives and managing the progress from week to week. WP1 is also determined to link the individual technical work packages, by providing a communication and management structure that stimulates the interaction between the individual work packages and helps to define best practice in harmonizing approaches and cross-border regions. WP 2

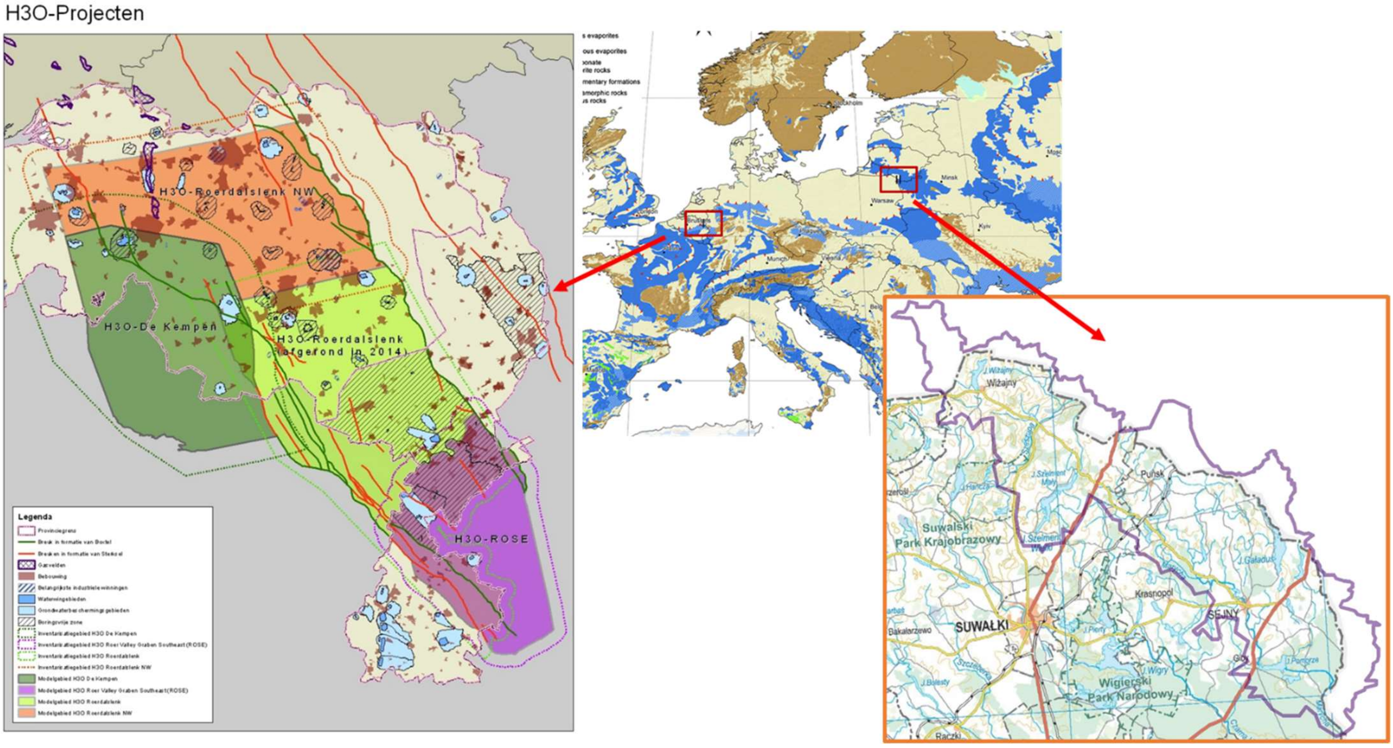


Figure 9 Hydrogeological harmonisation in two cross-border regions across Europe

takes care of the linkages between the RESOURCE proposal and the GeoERA Information Platform Activity, ensuring that objectives from both projects will be accomplished, thus making groundwater information developed in the project to be shared through the Information Platform that is a major result of the overall GeoERA program. All WP leaders are represented in WP2 in order to assure the outcomes. WP2 also has specific tasks and deliverables for the dissemination of the project results to stakeholders involved in groundwater management and policy, to the scientific community and the general public, making the information products developed under RESOURCE and the Information Platform available to society.

Two of the WP's in RESOURCE are targeted at cross-border demonstration projects (see section 1.2.2 and Figure 9 for the locations). Here, WP3 builds on the work done in previous cross-border harmonization work in the Roer Valley Graben. We intend to use the experiences of 3D cross-border harmonization (see Figure 6) to kickstart the work in the other region and to extend the harmonisation in the H3O project towards hydraulic properties of the distinguished aquitards and aquifers, to groundwater composition and age and towards harmonized methods to analyse cross-border water level depletion patterns and resource management practices. WP4 aims at harmonizing the Polish-Lithuanian border aquifers by means of a dynamic flow model, this complementing the H3O study with a numerical model and flow and transport quantification.

Work package 5 focuses on typologies for karst and chalk areas; both karstified limestones and fractured chalk form important groundwater resources, but often with a complicated regime that includes fast flow routes that makes them chemically vulnerable, and slow baseflows of older uncontaminated water that mixes at the springs and wells. The WP will test and evaluate innovative methods for measurement and interpretation to come up with an improved characterization that will be tested in pilots across Europe. Figure 3 shows the pilot areas that are part of this work, ranging from Chalk in the Netherlands and the UK to large karstified resources in France, Spain, Romania and Croatia. Figure 10 gives an overview of the tasks under this work package, illustrating how different kind of measurements can be integrated in a Karst conceptual model which can be used for management of the resources.

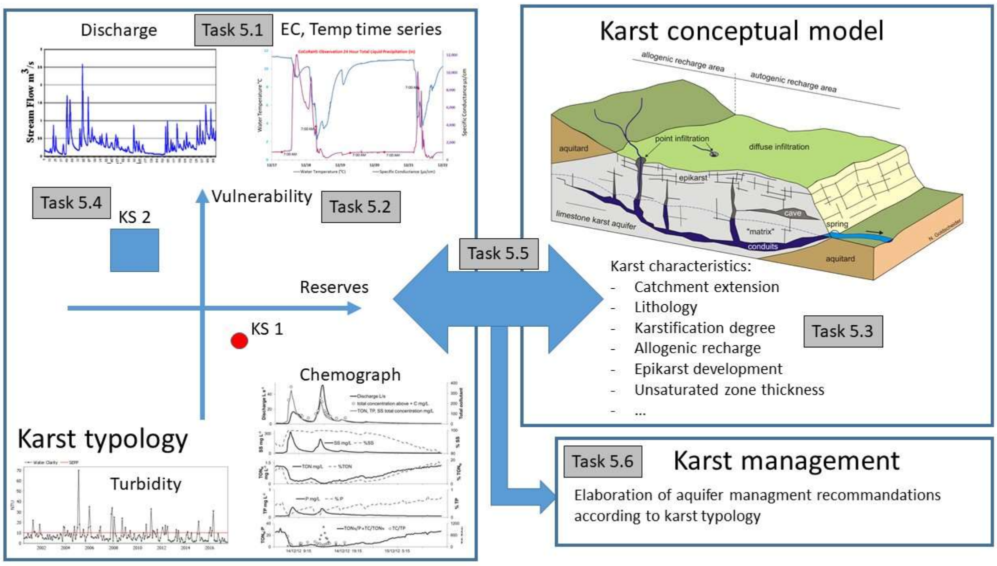


Figure 10 Project and tasks diagram. Example of the classification of 2 karst systems (KS 1 and 2) into a typology with five rating parameters (two along the axis, three described by the shape, the size and the colour of the symbol

While work packages 3 to 5 focus on a regional or supra-national scale, WP6 aims to deliver a truly European product showing the depth and volume of the European groundwater resources. The work package creates a template in order to collect the required data from all participating surveys based on a grid approach, the population of the information product will be done by the individual surveys and the data will be compiled and aggregated to become a flagship product at the Information Platform showing Europe's principal aquifer systems. Using data from national surveys and global scale models, we will also make a first estimate of the water balance of these systems which can be used by stakeholders at European ad national level. Additionally, and when both proposals will be funded, we will create a link with the GW1 WP6 work package to identify the main aquifers within Europe that contain paleo waters that may need specific protection regimes and create an extra layer to the EU map on groundwater resource to visualize the paleo resources and to determine total volumes and the recharge situation.

A detailed description for the 6 work packages is given in Table 3.1a

Table 3.1a Description of the Work Packages WP1 to WP6

Work package number	**WP 1**	**Lead beneficiary**			**TNO**				
Work package title	**Organisational and Scientific Coordination**								
Participant number	1	12	44	15	6				
Participant short name	TNO	GEUS	PIG	BRGM	VMM				
Person-months per participant:	10	2.5	1	2	1				
Start month	1			End month		36			

Objectives

WP 1 aims at the administrative, financial, organisational, technical and scientific management of the consortium. Therefore, the main objectives of WP 1 are:

- Communication to the GeoERA Executive Board
- Internal and external administrative management
- Project internal communication and management
- Financial and management reporting
- Legal aspects for consortium management
- Risk management within the project
- Overall coordination of the scientific programme and activities
- Coordination of day-to-day technical management issues
- Cooperation with the Advisory Board and Project Board.

Description of work

The project management tasks under the responsibility of the Coordinator and the Administrative and Operational Assistance are the following:

<u>Task 1.1 – Consortium internal organisation, progress and communication</u>

- Organisation and administration of Project Assemblies and meetings
- Administrative support to workshops, project meetings, conference etc.
- Controlling the timely realisation of deliverables and milestones
- Overall project risk management
- Adaptation and initialisation of measures to guarantee the success of the project
- Design, initialisation and follow-up of contingency plans

(Partners **TNO,** GEUS, BRGM) - Months 1–48.

<u>Task 1.2 – Communication to the GeoERA Executive Board, Advisory Board and Project Board</u>

- keeping Executive Board updated on project progress
- general information gateway and responsibility to react and answer specific requests
- preparation and delivery of periodic progress reports (annual activity and management reports, final report – all delivered within 45 days following the period covered)
- Preparation of meetings with the Advisory Board and the Project Board
- Organisation of continuous information flow to the Advisory Board and back to the Project Board
- Reporting to the Advisory Board and back to the Project Board
- Initialisation of responses on feedback received from the Advisory Board
- Follow-up and reporting on responses to on feedback received from the Advisory Board

(Partner **TNO,** GEUS, BRGM**)** - Months 1–48.

<u>Task 1.3 - Contract and financial administration</u>

- Allocation of budgets, transfer of funds
- Updates on accounting and contractual rules (including consortium agreement)
- Preparation of financial data for detailed implementation
- Preparation of audits and accumulative cost statements
- Summary accumulative expenditure report

(Partner **TNO**) **-** Months 1–48.

Task 1.4 – Overall coordination of the scientific programme

- Preparation and follow-up of a detailed implementation plan during the entire project
- Supervision of work package coordination and support to cross-cooperation between work packages and other relevant projects funded through GeoERA
- Support to implementation of the scientific work at work package level
- Content management of scientific workshops and organisation of the scientific and technical topics to be discussed at the Project Assemblies

Partners (**TNO**, GEUS, BRGM, PIG) - Months 1 – 48.

Deliverables

1.1 annual activity reports and financial and management reports M7, M19, M31
1.2 summary reports for Advisory Board meetings M12, M24
1.3 final management report and financial report M37

Work package number	WP 2	Lead beneficiary			GEUS				
Work package title	**Dissemination, communication and linkage to the GeoERA Information Platform**								
Participant number	1	6	12	15	44				
Participant short name	TNO	VMM	GEUS	BRGM	PIG				
Person-months per participant:	2	1	4	1.6	1				
Start month	1			End month		36			

Objectives

1. Develop a data management plan (DMP) in order to make products/data produced by RESOURCE findable, accessible, interoperable and reusable according to the "FAIR" principles of H2020 and GeoERA D1.3
2. Identify information products and data requirements from the RESOURCE work packages as input for the GeoERA Information Platform Portal (GIP) and ensure communication with the GIP Project
3. To develop a project communication, dissemination and exploitation plan including social media, the project web site and scientific journals. Where required in collaboration with the other themes and the GeoERA secretariat according to the dissemination and exploitation plan of the GeoERA programme (D5.1).

Description of work

Task 2.1: Development of the data management plan

In close cooperation with the GIP Project, and using their provided template, a data management plan will be established to support the interaction between the GIP and the RESOURCE project. The data management plan includes a planning for testing of the prototypes that become available through time. *Partners: **GEUS**, TNO, BRGM, PIG, VMM*

Task 2.2 Identification of information products and data requirements

Using the data management plan, we will prioritize the information products to focus on, which have most benefit to the stakeholders of the work under RESOURCE. Once products from RESOURCE become available through WP deliverables, the data are provided by the individual WP's to the GIP project for prototyping of the eventual information products. WP2 will keep track of the process and advice on the best way to interact with the GIP project. Special attention will be given to the pan-European dataset to be delivered under WP6, in order to make prototyping and implementation efficient within the GIP project; feedback to the prototype is given in M30 (Milestone 6). The coordinator of WP2 will schedule internal web-meetings together with all the coordinators of funded GeoERA groundwater projects every third month for coordination of data provision for GIP among the groundwater projects. Where necessary, the web-meetings will be supplemented with face-to-face meetings. The task coordinator will ensure that metadata about the RESOURCE project is included in the newly established European Inventory of Groundwater Research (EIGR). *Partners: **GEUS**, BRGM, TNO, PIG, VMM*

Task 2.3: Communication, dissemination and exploitation plan

Communication about the projects result will include the organisation of workshops for stakeholders in the cross-border and methodological demonstration projects under WP's 3, 4 and 5. Dissemination of the pan-European work will be established by organizing meetings in conjunction with stakeholder groups at European level, including CIS Working Group C on Groundwater, the European Environmental Agency, the Joint Research Centre and other CIS groups wherever relevant. The GeoERA website and GeoERA Information Platform (GIP) will be key in those dissemination events and social media will be included to promote events. The production of peer-reviewed papers in international journals will be promoted through this task under WP2, prioritizing and integrating project results of the RESOURCE project and bringing together scientists working in the Groundwater Theme. The RESOURCE project will cooperate with the GeoERA secretariat and other projects funded under GeoERA to establish the best possible dissemination strategy as outlined in the overall dissemination and exploitation plan of GeoERA (D5.1). Partners: ***GEUS**, BRGM, TNO, PIG, VMM*

Deliverables

2.1: First draft of Data management plan (M6)

2.2: Definition of prioritized Information Products for the GeoERA Information Platform as input for the GIP meeting on Groundwater (M16)

2.3: RESOURCE internal Workshop for streamlining the Information Flow towards the GIP (M24)

Work package number	**WP 3**	**Lead beneficiary**			**VMM**					
Work package title	**H3O-PLUS: Harmonized information for subsurface spatial planning and management in a transboundary lowland aquifer system**									
Participant number	1	6	6a							
Participant short name	TNO	VMM	SCK	NRW						
Person-months per participant:	39	27.2	3	2[8]						
Start month	1			End month		36				

Objectives

The objective of the cross-border demonstration project H3O+ is to create harmonized information over the Dutch, Flemish and German area of the Roer Valley Graben - a heavily used cross-border aquifer system, where many subsurface activities strive for prioritization- for the following aspects:

- hydraulic properties of cross-border aquifers and aquitards
- stratification of groundwater composition (such as fresh-salt interface and base line quality)
- groundwater age distribution within the most important aquifers used for drinking water supply and water balances of these individual, cross border aquifers including quantification of recharge fluxes, recharge patterns and discharge routes
- common cross-border analysis of depletion patterns due to abstractions and mining activities based on harmonized methods
- a harmonized cross-border overview of groundwater protection and utilization strategies on different sides of common borders

Description of work

<u>Task 3.1 – Harmonisation criteria</u>

This particular work package of the project builds further on previous cross-border initiatives where the first step - 3D harmonization of the extension and depths of shallow and deep aquitards and aquifers – has already been accomplished. The work package takes the harmonization a step further, developing common standards to harmonize data on hydraulic properties, groundwater quality, groundwater age, hydraulic heads, groundwater fluxes and depletion patterns, Task 3.1 sets common criteria for this further harmonization, analyzing and re-interpreting tools and methods that have been applied previously on both sides of the bordering regions and countries. *(Partners TNO, **VMM**, SCK, NRW), Months 1-12*

<u>Task 3.2 – Harmonisation of hydraulic properties of aquitards and aquifers</u>

A common database of hydraulic properties of the cross-border aquifers and aquitards will be established based on the common criteria defined under Task 3.1, Special attention will be given to the characterization of hydraulic properties of the faults that compartment the region and create preferential flows paths or flow blocking. *Partners **TNO**, SCK, VMM, NRW), Months 12-32*

<u>Task 3.3 – Harmonisation of groundwater quality data and age distributions</u>

Using the criteria set under Task 1 we will bring the cross-border existing groundwater quality together and analyze them in a harmonized way, elucidating the stratification of groundwater composition with depth, such as the interface between salt and fresh groundwater or redox zonation. Tracer based groundwater age distributions of well fields and observation wells will be aggregated and analysed based on common interpretation methods (cooperation with WP 7 of project proposal GW 1). *(Partners **TNO**, SCK, VMM, NRW), Months 12-32)*

<u>Task 3.4 – Harmonisation of volumes, water balances and recharge and discharge fluxes</u>

Using the criteria set under Task 1 the total volumes of water, recharge fluxes and recharge routes and discharge routes (abstractions, seepage) will be assessed for the most important aquifers in the cross-border region to enable cross-border analysis of the water balance of the groundwater system. *(Partners **TNO**, SCK, VMM, NRW), Months 12-32)*

[8] NRW contributes as a non-funded partner (see section 3.3)

Task 3.5 – Cross-border patterns of groundwater depletion
Trends in time series of groundwater heads and cross-border patterns of groundwater depletion will be analysed through time space analysis, based on existing methods developed in the participating countries. *Partners **TNO**, SCK, VMM, NRW), Months 12-32)*

Task 3.6 – Cross-border protection and management strategies
The consortium will explore the current protection and management strategies for shallow resources and deep paleo resources in the region, cooperating with the regional stakeholders involved in the project, and create an information and visualization system that helps groundwater managers to harmonize groundwater strategies (input towards and cooperation with the Information Platform). *Partners **VMM**, TNO, BRW, participating group of stakeholders, Months 24-36*

Deliverables
3.1 – Report describing the criteria set for cross-border harmonisation of groundwater data - M12
3.2 – Database of hydraulic properties of prime aquifers and aquitards and fault zones M-32
3.3 – Database and 3D visualisation of groundwater composition and age - M32
3.4 – Report describing the water balances, recharge and discharge fluxes and routes - M32
3.5 – Database and 3D maps of cross-border patterns of groundwater depletion and recharge -M32
3.6 – Report with overview of groundwater management strategies on different sides of common borders – M36

Work package number	**WP 4**	**Lead beneficiary**			**PIG**					
Work package title	**TRANSFLUX: Harmonization of data, monitoring and modelling in a transboundary setting**									
Participant number	40	44	53							
Participant short name	LGT	PIG	GIU							
Person-months per participant:	5	13	1							
Start month	1			End month		36				

Objectives

Groundwater is a vital source of recharge for surface waters, therefore it’s chemical and quantitative state can influence the quality and quantity of transboundary watercourses. We aim to develop a numerical hydrodynamic model for the Lithuanian-Polish cross-border area that will cover the Quaternary multi-aquifer system for the transboundary river basins. The project has two fundamental research aims: the determination of the transboundary groundwater flow directions in the cross-border area and the estimation of the volume of groundwater, which flows through the state border between Poland and Lithuania. This research is directed on the identification and harmonisation of the hydrogeological system, integrating the information through a numerical model in order to examine the groundwater regime in the area covering the eastern border area of Poland and the western boundary zone of Lithuania, that has never been accomplished up to date. Outputs of the project can be a basis for the further research, which will be aimed at the evaluation of influences of climatic changes on the groundwater/surface water flow regime using climatic scenarios in the numerical model.

Description of work

Task 4.1 – Comparison and unification of methods for groundwater modelling in Poland and Lithuania

We will compare and examine results and differences in existing hydrogeological numerical model concepts, which were previously elaborated in the participating countries, in order to choose best practices and solutions for the joint cross-border model. The harmonization includes the modelling software applied, the model discretization, the hydraulical and lithological parameters and the model boundaries. Results from existing hydrodynamic models of GWB on the Polish side, and LGT models on the Lithuanian side will be helpful for the harmonized hydrogeological cross-border flow model. *Partners: **PIG**, LGT, ,GIU, Months 1-6*

Task 4.2 –Integrated evaluation and harmonization of the hydrogeological data set for modelling purposes

Each partner of the consortium will provide geological, hydrogeological and other data essential for groundwater modelling purposes. The data are as yet available in unique geographic coordination systems used in Poland and in Lithuania, and need to be evaluated in a common projection within the GIS environment that will provide the input for the numerical model. *Partners: **PIG**, LGT, GIU, Months 6-15*

Task 4.3 – Unification and harmonization towards a hydrogeological dataset and the model parameters and layers for the multi-aquifer system

This task aims to delineate the aquifers and aquitards for modelling purposes for the Polish-Lithuanian cross-border area and to harmonize the hydrogeological data set, with data on thickness, depth of the top and the bottom of model layers, as well as spatial extent of the main aquifers and aquitards and their transboundary connections. The preparation of this model input actually provides the harmonized cross-border hydrogeological schematization in a grid of relevant scale to the project area. *Partners: **PIG**, **LGT**, GIU, Months 15-24*

Task 4.4 – Set-up of a hydrodynamic model for Polish-Lithuanian cross-border area

This task includes the set-up of the numerical groundwater flow model and the calibration and verification of the model. Once calibrated the model is used to quantify the transboundary groundwater flow directions and fluxes in the cross-border area. The model will yield a harmonized description of the groundwater regime in the Polish-Lithuanian cross-border area, assessing the volume of groundwater that flows through the state border between Poland and Lithuania. *Partners: **PIG**, LGT, GIU, Months 24-36*

Deliverables

4.1 – Comparison and unification of methodic applied in groundwater modelling in Poland and in Lithuania. Choosing and development of best methodology - M6

4.2 – Integration of data in a common dataset - M15

4.3 – Harmonized hydrogeological dataset and model input - M24

4.4 – Report describing the hydrodynamic model for the Polish-Lithuanian cross-border area and map showing the transboundary groundwater flow directions and fluxes in the multi-aquifer system - M36

Work package number	**WP 5**	**Lead beneficiary**				**BRGM**				
Work package title	**CHAKA: Typology of karst and chalk aquifers and recommendations for their management**									
Participant number	1	3	7	9	11	15	27	29	46	
Participant short name	TNO	GBA	FZZG	HGI	CGS	BRGM	MBFSZ	GSI	IGR	
Person-months per participant:	10.6	4	3.6	10	2	10.1	6	11.5	4	
Participant number	49	50	51	54						
Participant short name	GZS	IGME	ICGC	NERC						
Person-months per participant:	5.5	9.2	9.8	6						
Start month	1			End month		36				

Objective

Karst aquifers represent a widespread water resource in Europe (Figure 3 and 7 of this proposal). The main objective of the project is to develop a joint methodological framework for characterizing karst aquifer resources with the aim of solving water management issues (quantity and quality). The approach will be constructed, tested and validated in various geological environments (limestone, chalk, dolomite, covered/barren karst systems) and different hydrogeological datasets (measurements from springs or wells/piezometers, frequent vs. scarce measurement frequency) based on a selection of different sites from the project partnership. The specific objective is to achieve a joint classification typology that should be applicable to a large spectrum of karstic environments, and to associate it to recommendations regarding aquifer management (aquifer protection, monitoring strategies, exploitation).

Description of work

Classically, due to their high degree of heterogeneity, the understanding of karst aquifers hydrogeology relies on the monitoring of the main outlet of the aquifer, considering it as the right proxy in order to characterize the karst as a whole entity. Until now, the proposed approach has focused on discharge time series analysis using several types of tools (spectral analysis, recession curve analysis). The output is then used to propose a typology of karst aquifers: see Mangin (1974)[9] for example. During the last decades, we have measured additional parameters: temperature, turbidity, electrical conductivity. They provide promising information about the karst hydrodynamics and vulnerability that should be used in order to propose a new and more complete typology of karst aquifers. The project is organized in 6 tasks described here below and illustrated on Figure 10 of section 3.1.1.

<u>Task 5.1: State-of-the art: share existing methods/approaches used in the different Partners countries to classify karst aquifer responses from time series analysis</u>

Each partner will present the existing approaches of carbonate aquifer characterization used in his country. Differences and complementarity of the different approaches will be discussed. The potential gaps will be identified. The study will focus on time series of physico-chemical parameters (water levels, electrical conductivity, temperature, turbidity, fluorescence of water) measured at the main outlet or additional piezometers and input data (rainfall, sinkhole discharge). Different questions will be discussed separately depending on the hydrogeological datasets and on the nature of the monitoring points (spring, observation well):

Question 1: high frequency measurements at the spring. Which parameters should be monitored? At which time step? What are the most reliable interpretation methods enabling aquifer flow and dispersion of contaminants characterization?

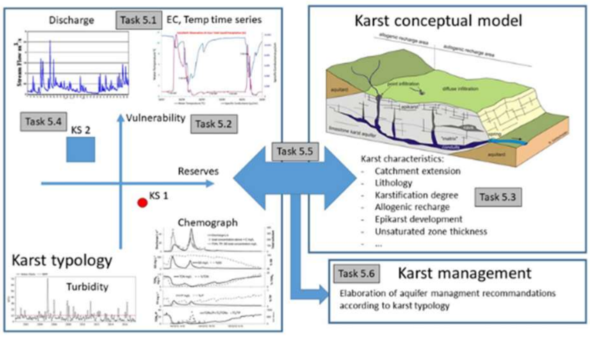
Question 2: low frequency measurements at the spring. What is the minimal frequency under which aquifer flow characterization is no longer possible?

Question 3: which parameter for which question? How can we mix hydrodynamic (water level, discharge rate) and physico-chemical (EC, temperature, turbidity) time series measurements? What amount of information provided by those time series is redundant and what amount is new and complementary?

[9] Mangin A (1974) Contribution to the hydrodynamics of karst aquifers. Annales de Spéléologie, 29(3):283–332; 29(4):495–601; 30(1):21–124

Question 4: which are the hydrologic signatures of the different types of karst aquifers? Which global typology?

Question 5: which spatial distribution of measurements? How many measurements in wells (intercepting karst conduits or not), caves, overflow springs etc. are needed to capture the karst flow characteristics at the scale of the recharge area? (Partners: **IGME**, all partners in WP5 – Months 1-12)



Task 5.2: Propose a classification typology of karst aquifers

Through the above questions, we will identify several indicators[10], leading to several classifications of karst aquifer. A unique classification is not expected, as each question brings a specific monitoring strategy and thus dedicated parameter's analysis: reserves classification (discharge analysis), transfer classification (chemo graph analysis), recharge type classification (chemo graph, turbidity, fluorescence analysis), vulnerability classification (turbidity analysis). These classifications should then be merged into a global typology of karst aquifers.
(Partners: **BRGM**, all partners in WP5– Months 12-18)

Task 5.3: Identify relevant case studies

In each country participating to the project, we will identify several karst systems according to two following constraints: (i) the availability of various data long time series on the monitored spring or wells and (ii) the diversity of karst aquifers in Europe (climate, geology, recharge conditions) should be well considered. We will gather the main characteristics (catchment extension, lithology, karstification degree, type of recharge, epikarst development, vadose zone depth) of those karst systems in order to propose a conceptual model for each of them.
We could initiate a collaboration with the WOKAM[11] project.
(Partners: **HGI**, all partners in WP5 – Months 1-18)

Task 5.4: Test the proposed classification(s) and typology on the case studies

Each partner will test the classification on a few karst systems case studies (2-3) in his country corresponding each to different situation (e.g., covered limestone, barren limestone, chalk, observations at a spring or at observation wells). We will define the relevant "hydrologic signatures" able to build a global typology (see Figure 10 with an example of a typology including 5 rating parameters).
(Partners: **ICGC**, all partners in WP5– Months 18-30)

Task 5.5: Consolidate the methodological framework

We will compare the resulting classification with the main characteristics of the karst systems (Figure 10) in order to verify the ability of the typology to properly characterize the specificities of each karst system. Based on the tests results, the methodological framework will be consolidated in order to achieve a joint typology that should be applicable to a large spectrum of karst environments.
(Partners: **BRGM** all partners in WP5– Months 18-30)

Task 5.6: Elaborate aquifer management recommendations

We will associate this framework of classification and typology to recommendations regarding aquifer management (aquifer protection, monitoring strategies, exploitation, vulnerability to climate change..) according to the characteristics of each type of aquifer. The objective is to provide to water users a robust decision support tool in order to guide the management of the water resources in karst context using a simple diagnosis from data monitoring.
(Partners: **GSI**, all partners in WP5 – Months 30-36)

Deliverables

5.1 - New karst aquifer typology – M18
5.2 – Detailed conceptual hydrogeological models for pilot areas and case studies M 24
5.3 – Water management recommendations in relation with the typology – M36

[10] Indicator is a parameter characterizing a time series. For example, the ratio Qmax/Qmin is a simple indicator of the variability of discharge rate at the spring

[11] CHEN, Z., AULER, A.S., BAKALOWICZ, M. et al. (2017): The World Karst Aquifer Mapping project: concept, mapping procedure and map of Europe. Hydrogeol J 25: 771-785. https://doi.org/10.1007/s10040-016-1519-3

Work package number	WP 6	Lead beneficiary				TNO				
Work package title		Pan-EU Groundwater Resources Map								
Participant number	1	1a	2	3	6	9	10	11	12	13[12]	14
Participant short name	TNO	DLT	AGS	GBA	VMM	HGI	GSD	CGS	GEUS	EGT	GTK
Person-months per participant:	13.6	10.6	28.9	2.9	1	6.8	2	7.7	9.2	1.5	1.5
Participant number	15	27	28	29	33	34	35[12]	39	40	41	42
Participant short name	BRGM	MBFSZ	ISOR	GSI	ARPA	RT	RU	LGMC	LGT	SGL	MTI
Person-months per participant:	4.2	5.8	5.2	10.1	4	3.6	0.75	0.25	1	1	1.5
Participant number	44	45	46	47	49	50	51	52	53	54	
Participant short name	PIG	LNEG	IGR	GSS	GZS	IGME	ICGC	SGU	GIU	NERC	
Person-months per participant:	2	3.9	3.9	0.5	7	8.9	7.8	0.25	1	2.9	
Start month	1		End month			36				

Objectives

Although EU member states generally have a comprehensive overview of the groundwater resources and have delineated groundwater bodies for the EU Water Framework Directives, a coherent overview of all fresh groundwater over Europe is not available for policy development and evaluation. This project idea aims to harmonize data and integrate and compile available data to produce a map of the fresh groundwater resources of Europe. No other project at EU scale have yet proposed or realized a map giving this basic information at EU scale.

Description of work

Task 6.1 – Criteria for harmonization across Europe

We intend to develop a set of criteria to harmonize the information about depths and volumes of groundwater resources to be complied from the individual surveys databases. The overall idea is to aggregate information about the average depths of aquifers and aquitards and the fresh-salt interface at a 10x10 and/or 25x25 km grid scale. The task will deliver a template that can be used by all participating surveys to collect the required data.
*(Partners **TNO**, GZS, GEUS, NERC, GSI, GBA, IGME, HGI, MBFSZ, CGS Months 1-9)*

Task 6.2 – Collection of data on depths and volumes

The participating surveys collect the data at the grid scales defined under Task 6.1, indicating the average depths and thicknesses of the aquifers and aquitards, and the depth of the fresh-salt interface.
*(Partners: **GZS**, all GeoERA committed Geosurveys listed, Months 9-21)*

Task 6.3 – Compilation of the map

The delivered data will be aggregated to obtain the EU scale information on depths and volumes of fresh groundwater, thus identifying the principal fresh aquifers systems of Europe. This includes the depth to the saline groundwater and/or towards the hydrogeological lower boundary of the aquifer systems providing fresh groundwater. The compiled information also yields the an estimate of the total volume of water available to human and other uses
*(Partners GZS, **TNO**, PIG, BRGM, GEUS, NERC, DLT, GSI, GBA, IGME, HGI, MBFSZ, CGS, Months 18-36)*

Task 6.4 – First estimate of water balance of EU's principal groundwater resources

Existing information on groundwater uses for irrigation, public supply and industrial uses, such as available in global and continental models and international databases like IGRAC's, will be compiled to make a first estimate of the overall water balance of principal, often transboundary fresh aquifer systems of Europe
*(Partners **DLT,** TNO, IGME, GEUS, NERC, BRGM, MBFSZ, CGS. Months 24-36)*

[12] EGT and RU contribute as non-funded partners (see section 3.3)

Task 6.5 – Data exchange with the Information Platform
Through the whole compilation and aggregation process an interface will be established with the Information Platform in order to efficiently deliver the data to the GeoERA data service for Europe
*(Partners **IGME**, GEUS, GZS, TNO, Deltares), Months 1-34)*

Deliverables
6.1 – Template that can be used by all participating surveys to collect the required data - M12
6.2 – Database with information on volumes and depths at 10x10 and/or 25x25 km grids – M24
6.3 – Map showing the depth and volume of fresh groundwater, including the position of the fresh-salt water interface – M32
6.4 – Dataset to be included in the Information Platform – M34
6.5 – Report describing the first estimate of Europe's water balance of fresh groundwater – M36

3.1.2 Timing of work packages and their components

The Gant chart of Figure 11 shows the timing of the work to be delivered in the RESOURCE project, showing how the milestones and deliverables of the different work packages are developed over the 3-year project phase, and how they interact through time. Milestones are indicated in blue and deliverables in white. See Tables 3.1c and Table 3.2a for a complete list of deliverables and milestones.

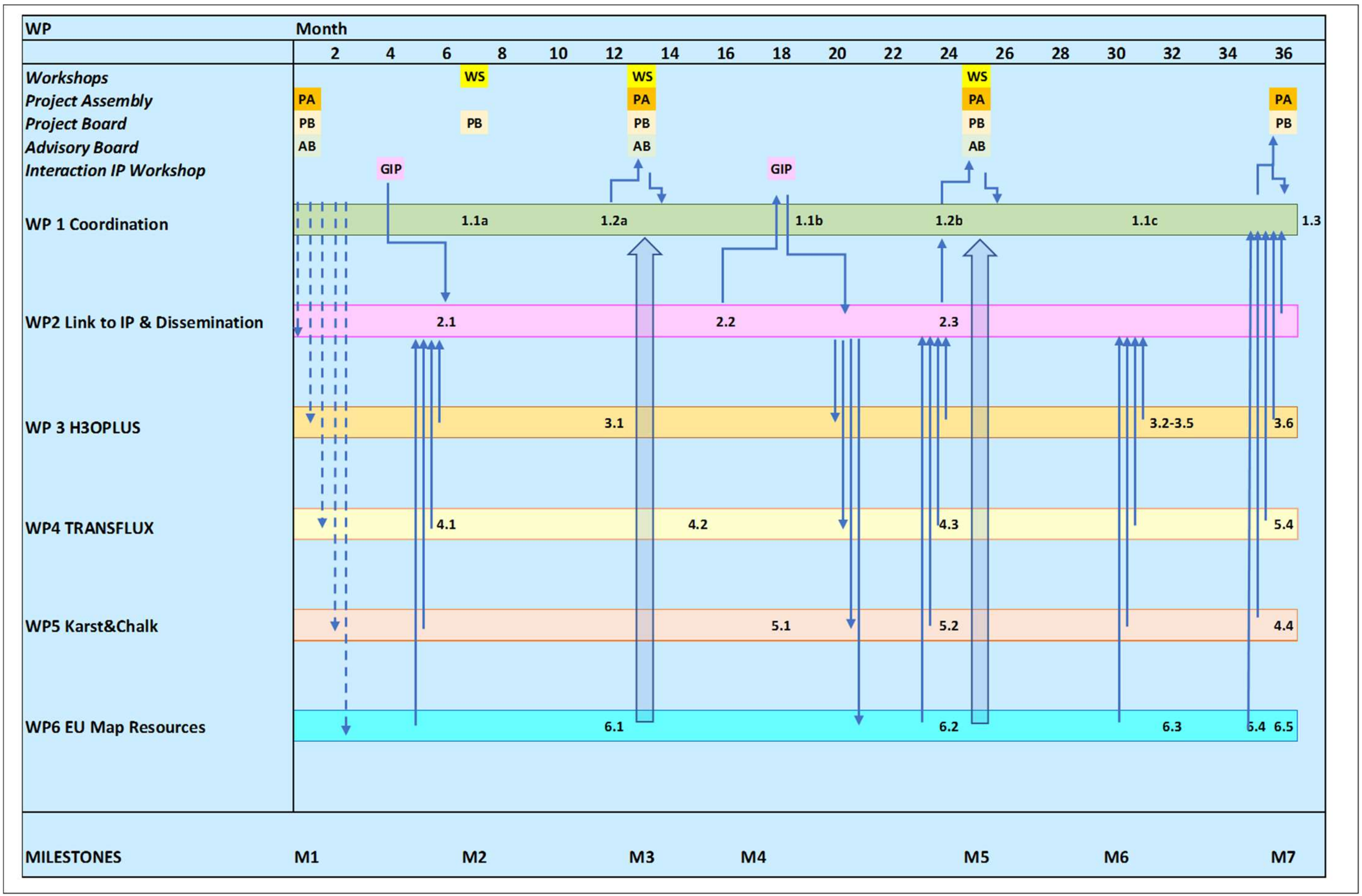


Figure 11: Main interactions between the different work packages coupled to the deliverables (black numbers), milestones (lowest line) and the planned meetings in the project. See Table 3.2a for the complete list of milestones. PA = Project Assembly meeting, WS= workshop for the Work Package Teams.

Communication and cooperation is an essential element in RESOURCE and is facilitated by three dedicated multiple-days workshops where participants of all the work packages will join forces and discuss and plan project progress. The work package coordinators will team up during these workshops to stimulate the exchange between the work packages, to discuss and prioritize the inputs to the Information Platform. The Project Assembly meetings are planned to join up with other funded groundwater theme projects, in order to bring scientists from the different projects together and to mutually discuss progress and further opportunities for interaction. Moreover, regular Project Board meetings will be organized to discuss and overcome possible problems in producing deliverables due to yet unforeseen circumstances. The Advisory Boards members are present at these occasions to help steering the process and help to define sound solutions for any emerging problems. In two specific meetings the project teams will interact with the GeoERA Information Platform GIP in order to define feasible and realistic information products and to discuss the progress within the overall RESOURCE project.

3.2 Management structure, milestones and procedures

The general management of the project (covered by the work package WP 1) will be carried out by the coordinator (TNO) in close connection with the Project Board. The general organisation is described hereafter and shown in Figure 12. The meetings envisage mentioned are listed in Figure 11.

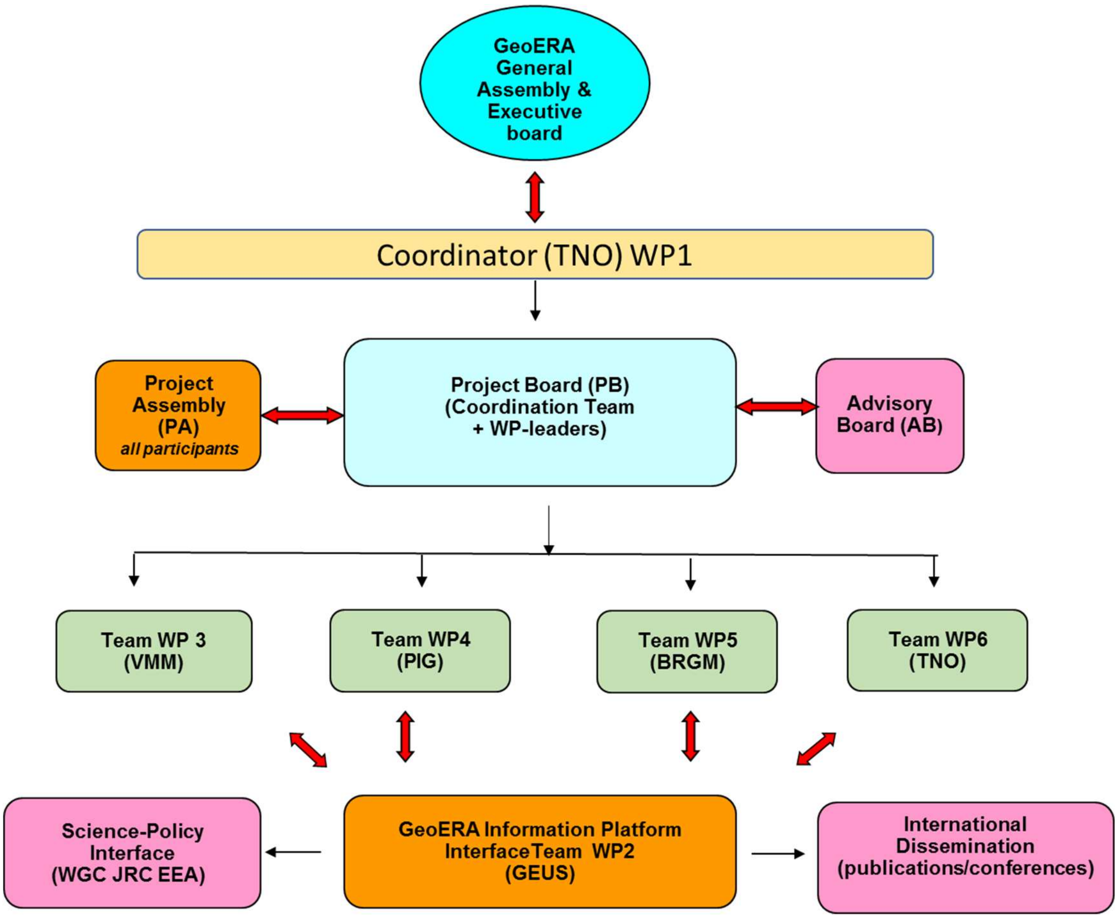


Figure 12 Proposed Coordination and Management structure

Coordination and coordination team
The management and coordination of the project is led by the Coordinator TNO Geological Survey of the Netherlands. TNO will be the official contact between the participants and the GeoERA General Assembly and Executive Board and amongst the project partners. TNO is responsible for the overall execution and progress of the project, including planning and content. The project coordinator will be supported by a science coordination assistance who is responsible for the scientific and technological quality of the project and an administrative and operation coordination assistance supporting the coordinator on management, planning and communication in the project as well as for financial and administrative issues (TNO). The coordinator will be responsible for the communication of all relevant project information from the GeoERA Executive Board to the partners, for regular reporting, for the distribution of funding to the partners, for establishing and maintaining consortium agreement in cooperation with the Project Assembly. To do so, the coordinator will implement the scientific orientations decided by Project Board (PB) and Project Assembly (PA), coordinate progress reporting, prepare formal decisions by PB and PA and plan the corresponding meetings. Concerning the project activities, the coordinator will monitor the progress of the activities on a regular basis and organize the Project Meetings and Workshops.

Project Board (PB)
The Project Board (PB) is the executive board of the project where the progress of the overall project is discussed in depth and decisions to be taken by the Project Assembly are prepared. The chairman is the Coordinator. The Project Board consists of the Coordination Team and the WP-leaders. The PB does the operational steering of the project in terms of scientific goals, progress, finance, quality, dissemination and exploitation and will discuss the scientific and technological progress; in relation to the SRT call. The PB will meet during the GW3 workshops (see Figure 11).

Project Assembly (PA)
The Project Assembly (PA) is the formal decision making and arbitrary body. The PA is responsible for the execution of the project in terms of science, management and finances. All partners will have a seat in the PA which is positioned with a representative with voting authority. Also, the progress, achievements and overall course of the project will be discussed in the PA. The PA will convene at the

three annual consortium meetings, that are preferably organized simultaneously with the GeoERA dissemination Seminars (GeoERA Kick-off, Mid-Term and Final seminars).For important issues and major threats to the project, which are indicated by the Project Board, the Coordinator may decide to call for an extraordinary meeting of the PA. The PB will follow up on scientific and technological progress and helps tuning towards the Science & Technology program, deciding on amending and the contract if necessary.

Advisory Board (AB)

The Advisory Board that was established provides knowledge and experience from the policy and management point of view will act as a sparring partner to the Project Board giving external feedback and advice about:

- the relevance of different research objectives,
- the tuning and amending of the work program,
- the facilitation to organise the inter-disciplinary work between the work packages and with other projects funded under GeoERA,
- the harmonisation of the demonstration projects and the pan-European mapping and the GeoERA Information Platform deliverables
- the scientific and technological progress,
- the results and quality of scientific results.

The AB will advise the Project Board and the Project Assembly in particular on key problems to be solved. Three well recognised experts representing European and international institutions are invited to be member of the Advisory Board and have confirmed their commitment. The envisaged composition of the Advisory Board is the following:

UNESCO	Dr. Alice AURELI, UNESCO International Hydrological Programme
GEUS:	Prof. Jens-Christian REFSGAARD Renowned Senior Expert
IAH	Prof. Stephen FOSTER, Former president of the International Association of Hydrogeologists

Ms Alice Aureli has a PhD in Hydrogeology and works in the UNESCO Water Sciences Division since 1989. She is the Chief of the Groundwater Resources and Aquifer Systems Section of UNESCO's International Hydrological Programme. She is responsible for, amongst others, the International Shared Aquifers Resources Management (ISARM) programme. This role has led her to supervise the work of the interdisciplinary group that advised the UN International Law Commission to prepare the Draft Articles on the Law of Transboundary Aquifers. An important aspect of her work has been on scientific and policy-related issues surrounding groundwater governance. Ms Aureli is the author of a large number of publications and has also served as editor of various international journals.

Jens Christian Refsgaard is a Professor in Water Resources at the Geological Survey of Denmark and Greenland (GEUS). He is fellow of the Danish Academy of Technical Sciences (ATV) and member of the of Scientific Technological Board of the European Joint Programming Initiative Water (Water JPI). Previously he was coordinator of FP4-UNCERSDSS (1996-1998), FP5-HarmoniRiB (2002-2006) and BONUS SOILS2SEA (2014-2018) and he was WP leader in many EU FP projects. Jens is a regular reviewer of EU FP proposals and projects and published more than 130 journal papers (H index 33 at ISI Web of Science).

Stephen Foster is former president of the International Association of Hydrogeologists (IAH) and is currently Visiting Professor of Hydrogeoscience at University College London. He has exceptional international experience in groundwater assessment, management and protection, and has held the following senior posts: WHO-Groundwater Advisor for Latin America & Caribbean (1986-89), British Geological Survey-Divisional Director (1990-99), World Bank-Groundwater Management Team Director (2001-11) & Global Water Partnership-Senior Adviser (2012-15). He was one-of-three founders of the UK Groundwater Forum (a multi-stakeholder cross-sector platform) and a member of the EC-Groundwater Working Group during 1998-2006.

Work Package Coordinators

For each of the Work Packages the WP Coordinator will organize the work and perform the operational tasks to manage the work between the partners. The work within RESOURCE is distributed over tasks which will be coordinated by one of the surveys who is responsible for the timing and scientific quality of the deliverables to be committed. The WP coordinator will keep track on the scientific progress and timing of the work and organizes the workshops for the WP Team during the general GeoERA Workshops (see Figure 11). Together with the task coordinators the progress of the work will be discussed, and general operational issues will be tackled. In case of emerging difficulties with timing or contents the WP Coordinator will contact the Coordinator of RESOURCE and the Project Board and Project Assembly may be involved in solving these problems (see above). The WP coordinator reports to the Overall Coordinator of RESOURCE.

The Team Coordinator of WP2 has specific tasks in connecting the work within RESOURCE with the work in the GeoERA Information Platform Project and in organising dissemination activities in the direction of stakeholders such as the European Working Group C on Groundwater (CIS) and institutions such as the EEA and JRC. The WP2 coordinator is responsible for the prioritizing of information products to be delivered to the IP Theme, in close cooperation with the overall Coordinator of RESOURCE. In case of disagreements between project partners and the coordinators of WP1 and WP 2, a decision may be asked for the PB and PA. The WP2 coordinator is also responsible for establishing the international exchange of project results, through peer-reviewed publications, conference presentations and alike.

3.3 Consortium as a whole

The consortium is composed of 33 National and Regional Geological Surveys and 2 research institutes with a national task on providing complementary geodata (Deltares, SCK). The consortium covers a wide range of knowledge and experience related to groundwater flow and transport, hydrogeological; characterization and 3D geomodels. Many of the surveys have a long-standing cooperation in policy support to their national governments. Moreover, through EuroGeoSurveys, the organization of Geological Surveys within the EU, the surveys and their researchers have been active in policy support to the European Commission. For example, many of the surveys and their researchers were involved in supporting the Commission with the drafting of the EU Groundwater Directive (EU 2006) and many of the accompanying guidance's, chairing activities and drafting groups and attending conferences and meetings of the EU CIS Working Group on Groundwater. Still, at present the surveys take leading roles in activities of the CIS Working Group. As such, the surveys have been active in advising on monitoring programs, background concentrations, threshold values, groundwater body delineation and methods to derive chemical and quantitative status, and the detection of trends and trend reversal.

Table 3.3.1 - Expertise of the consortium

Key elements of the topic and of RESOURCE objectives	**Number and names of RESOURCE participants supplying skills & experiences relating to the key elements**	
Hydrogeological characterization of the subsurface	33	all
3D Geomodels	9	TNO, DLT, NERC, GEUS, BRGM, RT, GZS, MBFSZ, IGR
Groundwater flow and transport modelling	15	TNO, DLT, NERC, BRGM, GEUS, PIG, IGME, SCK, SGU, ICGC, GZS, EGT, IGME, MBFSZ, IGR, SCK
National groundwater database	14	TNO, NERC, GEUS, BRGM, HGI, ICGC, VMM, GZS, SGU, EGT, MBFSZ, MTI, CGS
EU scale mapping of groundwater information	8	TNO, BRGM, NERC, GEUS, DLT, HGI, CGS, IGR
Groundwater Monitoring	11	TNO, BRGM, GEUS, NERC, PIG, HGI, VMM, SCK, EGT, MBFSZ, MTI
Karst hydrogeology and characterization of groundwater regimes	16	TNO, NERC, BRGM, HGI, CGS, ICGC, GZS, IGME, GBA, FZZG, MBFSZ, GSI, IGR, GZS, MBFSZ, IGR
Isotope and environmental tracers	9	TNO, BRGM, NERC, GEUS HGI, SCK, GZS, EGT, MBFSZ
Groundwater (bio)geochemistry	8	TNO, BRGM, GEUS, NERC, CGS, ICGC, EGT, MBFSZ
Policy-support and dissemination towards European Commission, CIS working groups and international stakeholders	12	TNO, BRGM, GEUS, NERC, IGME, PIG, VMM, IGME, DLT, IGR MBFSZ, MTI

The surveys maintain and operate their national databases on subsurface information and groundwater data, having developed methods for 3D hydrogeological modelling, efficient database systems for groundwater quality data and groundwater heads and many are active in groundwater flow and transport modelling (Table 3.3.1). Table 3.3.1 shows that all key elements of the topic and the relating RESOURCE objectives are covered by the skills and experiences of the RESOURCE participants. This ensures the capability of the consortium as a whole to achieve the project objectives. Furthermore, it can be concluded that the composition of the consortium is well balanced reflected by the geographical distribution (see Figures 3 and 8), the experience of the participants and the complementarity between

them. The consortium as a whole includes a wide variety of disciplines: from fundamental science to applied consultancy & services and policy support.
The surveys typically work within their national territory and only marginally pay attention to cross-border patterns or even data at the larger scale of the European Union and further. Therefore, working on the harmonisation of data and 3D geo-models is a relatively new phenomenon, but the expertise of the surveys covers the work under the RESOURCE proposal completely and thus have the common ambition for cooperation to achieve geo-information products at the larger cross-border and European scale. The surveys will use their established networks, such as the EU Working Group C on Groundwater, the Water Expert Group of EuroGeoSurveys and the established stakeholder groups at national level to disseminate the results from the RESOURCE project. Together the RESOURCE project brings together a high-quality team with good interdisciplinary skills and a track record of delivering high quality, novel science and end-user relevant research, demonstrated in projects funded by the EU Framework Programme, such as FP6 BRIDGE, FP7 Aquaterra, FP7 RISKBASE, H2020 MARS, H2020 Kindra, COST 620 etc. Some more information on these previous projects is summarized below:

- FP 6 BRIDGE: the so-called ‘policy-support project’ project developed a methodology for the derivation of environmental threshold values for groundwater, in close cooperation with the European Commission (DG Environment) and stakeholders (WG C Groundwater under the WFD Common Implementation Strategy). The method developed was adopted in the final version of the GWD.
- FP 7 AQUATERRA provided the scientific basis for an improved river basin management through a better understanding of the river-sediment-soil-groundwater system as a whole, by integrating both natural and socio-economics aspects at different temporal and spatial scales (Barth et al. 2009[13]).
- FP 6 RISKBASE: Risk reviewed and synthesised the outcome of previous FP6 projects that were related to integrated risk assessment-based management of the water/sediment/soil system at the river-basin scale.
- H2020 MARS studies the groundwater contribution to ecological quality of rivers and streams in a multi-receptor approach.
- The COST Action 620 “Vulnerability and risk mapping for the protection of karst aquifers” project is closely related to the WP5.
- H2020 KINDRA developed the European Inventory of Groundwater Research (EIGR) which stores classified metadata on European Groundwater Research and management projects conducted within EU and national research programs and make them easily available for analysis and visualization.

The project is supported by a number of non-funded partners, that have not undersigned the GeoERA Grant Agreement, but later decided that they would like to support specific activities of the proposal, particularly populating the information database for the pan-European groundwater resources map. The non-funded parties will confirm their participation in the Project Agreement phase once the proposal is granted. The Geological Survey of Nordrhein-Westfalen (NRW) will provide information for the cross-border project H3O-PLUS.

Non-funded partners in RESOURCE	**Non-funded partners that support the work package and will help populating the database and 3D geomodels**
WP3 H3O-PLUS	NRW (Geological Survey of Nordrhein-Westfalen, Germany): 2 pm
WP 8 EU Groundwater Resources Map	RU (Italy, region Umbria): 0.75 pm EGT (Estonia): 1.5 pm

The SCK (Belgian Nuclear Research Centre SCK•CEN) and Deltares (Netherlands) will participate in the RESOURCE project as Third Parties as indicated in the Grant Agreement of GeoERA. They are listed in this proposal as individual participants, but formally work under the responsibility and financial agreements with TNO and VMM, respectively. They are listed separately in the financial tables and work package descriptions in order to make clear where these parties will contribute to RESOURCE.

[13] Barth et al. (2009) Mobility, turnover and storage of pollutants in soils, sediments and waters: Achievements and results of the EU project AquaTerra. A review. Agronomy for Sustainable Development 29 (1), pp. 161-173

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3.4 Resources to be committed

Table 3.1b) List of work packages

Work package No.	Work Package Title	Lead Participant No.	Short Name	Person - Months	Start Month	End month
1	Organisational and Scientific Coordination	1	TNO	16.5	1	36
2	IP & CT coordination, Data management and dissemination	12	GEUS	9.6	1	36
3	H3O-PLUS: Harmonized information for subsurface spatial planning and management in a transboundary lowland aquifer system	6	VMM	69.2	1	36
4	TRANSFLUX: Harmonization of data, monitoring and modelling in a transboundary setting	44	PIG	18	1	36
5	CHAKA: Typology of karst aquifers and recommendations for their management	15	BRGM	86.3	1	36
6	Pan-EU Groundwater Resources Map	1	TNO	154.9	1	36
	Total for the funded partners		Total person - months	354.4		
	Including the non-funded partners			358.65		

Table 3.1c) List of deliverables
WS= Workshop, R= Report, N= Note, D= Database, M=Maps

number	Deliverable name	Work package number	Short name of lead	Type	Delivery date (in months)
4.1	Comparison and unification of methods applied in groundwater modelling in Poland and in Lithuania. Choosing and development of best methodology	4	PIG	R	6
2.1	First draft of Data Management Plan	2	GEUS	R	6
1.1	Annual activity reports and financial and management reports M7, M19, M31	1	TNO	R	7, 19, 31
1.2	Summary reports for Advisory Board meetings	1	TNO	R	12, 24
3.1	Report describing the criteria set for cross-border harmonisation of groundwater data	3	VMM	R	12
6.1	Template that can be used by all participating surveys to collect the required	6	TNO	R	12
4.3	Integration of data in a common dataset	4	PIG	D	15
2.2	Definition and prioritized Information Products for the GeoERA Information Platform as input for the GIP meeting on Groundwater	2	GEUS	N	16
5.1	New karst aquifer typology	5	BRGM	R	18
2.3	Workshop for streamlining the Information Flow towards the GIP (M24)	2	GEUS	WS	24
4.3	Harmonized hydrogeological dataset and model input	4	PIG	D	24
5.2	Detailed conceptual hydrogeological models for pilot areas and case studies	5	BRGM	R	24
6.2	Database with information on volumes and depths at 10x10 and/or 25x25 km grids	6	GZS	D	24
3.2	Database of hydraulic properties of prime aquifers and aquitards and fault zones	3	TNO	D	33
3.3	Database and 3D visualisation of groundwater composition and age	3	TNO	D	32
3.4	Report describing the water balances, recharge and discharge fluxes and routes	3	TNO	R	32
3.5	Database and 3D maps of cross-border patterns of groundwater depletion and recharge	3	TNO	D, M	32
6.3	Map showing the depth and volume of fresh groundwater, including the position of the fresh-salt water interface	6	TNO	M	32

6.4	Dataset to be included in the Information Platform	6	IGME	D	34
4.4	Report describing the hydrodynamic model for the Polish-Lithuanian cross-border area and map showing the transboundary groundwater flow directions and fluxes in the multi-aquifer system	4	PIG	R	36
3.6	Report with overview of groundwater management strategies on different sides of common borders	3	VMM	R	36
5.3	Water management recommendations in relation with the typology	5	BRGM	R	36
6.4	Report describing the first estimate of Europe's water balance of fresh groundwater	6	DLT	R	36
1.3	Final management and financial report	1	TNO	R	37

WS= Workshop, R= Report, N= Note, D= Database, M=Maps

Table 3.2a) List of milestones

Milestone number	Milestone name	Related work package(s)	Due date (in months)	Means of verification
M1	Project Assembly (Kick-off)	All 8	1	Summary report verified by Project Board and Advisory Board
M2	Workshop of all WP's and Project Board Meeting	All 8	6	Progress verified by Project Board
M3	Project Meeting (PA), Advisory Board Meeting, Project Board meeting and Workshops of the 8 WP's	All 8	13	Summary report verified by Project Board and Advisory Board
M4	Combined workshop with the GeoERA Information Platform to discuss templates and data delivery	WP 2	17	
M5	Project Meeting (PA), Advisory Board Meeting, Project Board meeting and Workshops of the 8 WP's	All 8	25	Summary report verified by Project Board and Advisory Board
M6	Testing the GIP prototype for RESOURCE products providing feedback towards GIP project	WP2	30	Feedback towards GIP project through internal technical note or presentation at GIP meeting
M7	Final meeting of RESOURCE presenting the results to the GeoERA Executive Board	All	36	Verified by Project Board and Advisory Board

Table 3.2b) List of critical risks for implementation

Description of risk	Work packages involved	Level	Proposed risk-mitigation measures
Not all partners are able to contribute to the EU map WP6	WP6	Medium	Due to the different nature of the geological surveys of Europe, especially the surveys from federal states, such as Germany and Italy, have difficulty to embrace the current EU mapping effort based on 25x25 km grids. Within RESOURCE the consortium will bridge those gaps by introducing data from other sources such as the IGRAC database (UNESCO) and peer-reviewed information sources. The idea is to define a follow-up after three years of RESOURCE that will manage to complete the effort in the years after. The WP and Task Coordinators within WP6 will take the initiative for a workshop on this issue.
Insufficient data in some countries on the fresh-salt water interface or the depths and volumes of aquitards and aquifers	WP6	Medium	In cooperation with the surveys involved, the consortium will make a best estimate for the pan-EU map and create a plan for with recommendations to assess the necessary data in future. We will use information that is already integrated in Global Modelling Efforts and/or existing database (such as IGRAC's) to make the best possible estimates.
Not all partners have existing datasets from monitoring their Karst & Chalk systems	WP5	Low	The concepts derived under WP5 will be valuable resources for partners that want to extend their work on characterizing their karst systems. We accept that not all pilot areas will deliver the same amount of detail, but are confident that partners are able to learn from the others, giving a boost to Karst & Chalk research in the years after RESOURCE.
Not all WP's will deliver data to the GeoERA Information Platform at spatial scales that are relevant for EU assessments	WP2	Low	Within WP2, and in close agreement with the Project Board, we will prioritize the information products that are most valuable for the EU groundwater community and put our efforts first at those products. The pan-EU map will have high priority anyhow.

Not all partners have sufficient resources to come to all meetings of the RESOURCE project to discuss progress	WP6	Low	We intend to use video conferencing to establish contacts between all the partners, to discuss progress and further aims and to decide about data provision and desired data quality. We have very good experiences using modern video technologies during the definition phase of the proposal. We reserved resources to visit some surveys that are not able or allowed to travel much.

Table 3.3a) Summary of Staff Effort

	WP1	WP2	WP3	WP4	WP5	WP6	Total Person-Months
TNO	10	2	39		10.6	13.6	75.2
DLT						10.6	10.6
AGS						28.9	28.9
GBA					4	2.9	6.9
VMM	1	1	27.2			1	30.2
SCK			3			0	3
FZZG					3.6	0	3.6
HGI					10	6.8	16.8
GSD						2	2
CGS					2	7.7	9.7
GEUS	2.5	4				9.2	15.7
GTK						1.5	1.5
BRGM	2	1.6			10.1	4.2	17.9
MBFSZ					6	5.8	11.8
ISOR						5.2	5.2
GSI					11.5	10.1	21.6
ARPA						4	4
RT						3.6	3.6
LEGMC						0.25	0.25
LGT				5		1	6
SGL						1	1
MTI						1.5	1.5
PIG-PIB	1	1		13		2	17
LNEG						3.9	3.9
IGR					4	3.9	7.9
GSS						0.5	0.5
GZS					5.5	7	12.5
IGME SPAIN					9.2	8.9	18.1
ICGC					9.8	7.8	17.6
SGU						0.25	0.25
GEOINFORM				1		1	2
NERC					6	2.9	8.9
Total funded	16.5	9.6	69.4	18	86.3	154.9	354.4
EGT (non-funded)						1.5	1.5
RU (non-funded)						0.75	1
NRW (non-funded)			2				2
Total incl. non-funded	16.5	9.6	71.4	18	86.3	157.25	358.65

Table 3.3b) 'Other direct cost' items (travel, equipment, other goods and services)

1 / TNO	Cost (€)	Justification
Travel	24500	Travel to RESOURCE meetings, travel to individual participants under WP6 to coordinate the pan-EU effort, fieldwork travel in Karst WP and travel costs for the 4 advisory board members
Equipment/consumables	36500	Equipment and consumables for sampling and analysing springs within WP5 Karst
Other goods and services		
Total	61000	

1a / DLT	Cost (€)	Justification
Travel	4800	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	4800	

2 / AGS	Cost (€)	Justification
Travel	3000	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	3000	

3 / GBA	Cost (€)	Justification
Travel	5000	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	5000	

6 / VMM	Cost (€)	Justification
Travel	6000	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	6000	

6a / SCK	Cost (€)	Justification
Travel	2000	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	2000	

7 / FZZG	Cost (€)	Justification
Travel	3000	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	3000	

9 / HGI	Cost (€)	Justification
Travel	4080	Travel to RESOURCE and KARST meetings; fieldwork
Equipment/consumables	0	
Other goods and services	0	
Total	4080	

10 / GSD	Cost (€)	Justification
Travel	3600	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	3600	

11 / CGS	Cost (€)	Justification
Travel	1770	Travel to RESOURCE meetings, fieldwork, travel between branch offices in Czech Rep.
Equipment/consumables	500	field equipment, software
Other goods and services	0	0
Total	2270	

12 / GEUS	Cost (€)	Justification
Travel	13822	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	13822	

Total	3000

14 / GTK	Cost (€)	Justification
Travel	1500	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	1500	

15 / BRGM	Cost (€)	Justification
Travel	15500	Travel to RESOURCE meetings fieldwork etc., task coordinators meeting
Equipment/consumables	0	
Other goods and services	0	
Total	15500	

27 / MBFSZ	Cost (€)	Justification
Travel	2400	Travel to RESOURCE meetings, fieldwork
Equipment/consumables	0	
Other goods and services	0	
Total	2400	

28 / ISOR	Cost (€)	Justification
Travel	5000	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	5000	

29 / GSI	Cost (€)	Justification
Travel	5050	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	5050	

33 / ARPA	Cost (€)	Justification
Travel	1965	Travel costs and expenses of 3 persons for annual project meetings on location in Europe
Equipment/consumables	0	
Other goods and services	0	
Total	1965	

34 / RT	Cost (€)	Justification
Travel	2284	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	2284	

39 / LGMC	Cost (€)	Justification
Travel	900	Participation by video conferencing
Equipment/consumables	0	
Other goods and services	0	
Total	900	

40 / LGT	Cost (€)	Justification
Travel	1200	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	1200	

41 / SGL	Cost (€)	Justification
Travel	850	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	850	

42 / MTI	Cost (€)	Justification
Travel	1450	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	1450	

44 / PIG-PIB	Cost (€)	Justification
Travel	11600	Travel to RESOURCE meetings & bilateral meetings with LGT
Equipment/consumables	0	
Other goods and services	0	
Total	11600	

45 / LNEG	Cost (€)	Justification
Travel	1800	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	1800	

46 / IGR	Cost (€)	Justification
Travel	4746	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	4746	

47 / GSS	Cost (€)	Justification
Travel	134	Field work, participation by video conferencing
Equipment	0	
Other goods and services	0	
Total	134	

49 / GZS	Cost (€)	Justification
Travel	4400	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	4400	

50 / IGME Spain	Cost (€)	Justification
Travel	8065	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	8065	

51 / ICGC	Cost (€)	Justification
Travel	13479	Travel costs for attendance of 2 persons for a maximum of six key project meetings/workshops along the 3 years of the project; and fieldwork (WP Karst)
Equipment/consumables	0	
Other goods and services	0	
Total	13479	

52 / SGU	Cost (€)	Justification
Travel	500	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	500	

53 / GEOINFORM	Cost (€)	Justification
Travel	966	Travel to RESOURCE meetings
Other goods and services	0	
Total	966	

54 / NERC	Cost (€)	Justification
Travel	16819	Travel to RESOURCE meetings
Equipment/consumables	0	
Other goods and services	0	
Total	16819	

Table 3.3c) Financial table with requested budget

Participant	(A) Direct personnel costs (EUR)	(B) Other direct costs; travel, equipment, infrastructure, other (EUR)	(C) Direct costs of sub-contracting (EUR)	(D) Indirect costs (= (A + B) *0,25) (EUR)	(E) Total estimated eligible costs (=A+B+C+D) (EUR)	(F) Reimburse-ment Rate (29,7%)[14]	(G) Requested EU contribution (=E*F)	(H) Surveys in-kind contribution = (E – G)
TNO	481703	61000	0	135676	678378	29.70%	201478	476900
DLT	87370	4800	0	23042	115212	29.70%	34218	80994
AGS	14450	3000	0	4363	21813	29.70%	6478	15334
GBA	34500	5000	0	9875	49375	29.70%	14664	34711
VMM	181200	6000	0	46800	234000	29.70%	69498	164502
SCK	36900	2000	0	9725	48625	29.70%	14442	34183
FZZG	4763	3000	0	1941	9704	29.70%	2882	6822
HGI	40320	4080	0	11100	55500	29.70%	16484	39017
GSD	9000	3600	0	3150	15750	29.70%	4678	11072
CGS	22019	2270	0	6072	30361	29.70%	9017	21344
GEUS	118550	13822	0	33093	165465	29.70%	49143	116322
GTK	9835	1500	0	2834	14169	29.70%	4208	9961
BRGM	125765	15500	0	35316	176582	29.70%	52445	124137
MBFSZ	18585	2400	0	5246	26231	29.70%	7791	18441
ISOR	44200	5000	0	12300	61500	29.70%	18266	43235
GSI	96565	5050	0	25404	127019	29.70%	37725	89294
ARPA	18710	1965	0	5169	25843	29.70%	7675	18167
RT	11779	2284	0	3516	17579	29.70%	5221	12358
LGMC	254	900	0	289	1443	29.70%	428	1014
LGT	12600	1200	0	3450	17250	29.70%	5123	12127
SGL	6500	850		1838	9188	29.70%	2729	6459
MTI	5550	1450	0	1750	8750	29.70%	2599	6151
PIG	45050	11600	0	14163	70813	29.70%	21031	49781
LNEG	14551	1800	0	4088	20439	29.70%	6070	14368
IGR	46866	4746	0	12903	64515	29.70%	19161	45354
GSS	1343	134	0	369	1846	29.70%	548	1297
GZS	43406	4400	0	11951	59757	29.70%	17748	42009
IGME	79466	8065	0	21883	109414	29.70%	32496	76918
ICGC	93290	13479	0	26692	133461	29.70%	39638	93823
SGU	1863	500	0	591	2954	29.70%	877	2076
GIU	9665	966	0	2658	13289	29.70%	3947	9342
NERC	46727	16819	0	15886	79432	29.70%	23591	55841
total	***1763343***	***209180***	***0***	***493131***	***2465654***		***732299***	***1733355***

[14] The EC Reimbursement rate for ERA-NETs is 33%. 10% of this Reimbursement rate is reserved for the Coordination Costs of GeoERA as agreed in the Grant Agreement. Therefore, the Reimbursement rate for GeoERA is these calculations results in 29,7%.

4 Members of the consortium

4.1 Participants (applicants)

Name of organisation	**1. Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO**		
Short name	TNO	**Country**	Netherlands

Organisation profile

TNO is a semi-independent Dutch research and technology organisation active in technical, earth, environmental, life, societal and behavioural sciences, focussing of healthy living, industrial innovation, defence, safety and security. The Geological Survey of the Netherlands (TNO-GSN) provides geoscientific data, information and knowledge for sustainable management of earth resources and the environment. TNO-GSN is the national information provider on subsurface data, including the 3D groundwater information products REGIS, GeoTop and webservices such as Groundwater Tools.

Roles / tasks in the project	Special relevant skills
Overall coordination proposed project Coordination of WP1 & WP 6 Participant of WP3 and WP 5	• 3D geomodelling of cross-border regions • Building databases and web services for subsurface and groundwater data • Integrated interpretation of hydrological, hydrochemical and hydrogeological datasets towards custom made information products

Short profile of staff member(s) who will be undertaking the work

Dr. Hans Peter Broers (m): senior expert groundwater quality & groundwater modelling at TNO-GSN, specialising in groundwater-surface water interaction and tracer hydrogeology. Vice-chair of the EGS Water Resources Expert Group. Coordinator of several EU Framework Proposals and work packages (FP6 Aquaterra, FP7 MARS). **Ir. Ronald Vernes (m)** senior expert and project manager at TNO-GSN. Responsible for the national 3D hydrogeological model REGIS II, project initiator and manager of the cross border hydrogeological harmonization H3O-projects with Belgium and Germany. **Dr. ir. Willem Jan Zaadnoordijk (m)**: senior hydrogeologist at TNO-GSN and guest researcher at Technical University Delft. Experienced in groundwater modelling, modelling of piezometric time series and groundwater surface water interaction.

Publications, infrastructure / technical equipment

National DINO database on subsurface information (boreholes, groundwater heads and groundwater quality) and 3D geomodels GeoTOP and REGIS II (*www.dinoloket.nl*), timeseries models for heads DINO database (*www.grondwatertools.nl*)

Publications:

Visser A., H.P. Broers, R. Purtschert, J. Sültenfuss and M.de Jonge (2013). Groundwater travel time distributions at a public drinking water supply well field derived from multiple age tracers (85Kr, 3H, noble gases and 39Ar). Water Resources Research 49(11):7778-7796

Geer F.C., M.F.P. Bierkens and H.P. Broers (2008) Groundwater monitoring strategies. Encyclopedia of Hydrological Sciences. DOI: 10.1002/0470848944.hsa316

Broers, H.P. & B. van der Grift (2004) Regional monitoring of temporal changes in groundwater quality. Journal of Hydrology 296:192-220

Berendrecht, W.L., F.C. van Geer (2016) A dynamic factor modelling framework for analyzing multiple groundwater head series simultaneously, Journal of Hydrology, 536, 50-60.

Zaadnoordijk, W.J., M. Bakker (2013) Application of spatial time-series analysis to determine calibration targets for transient groundwater models, in: proceedings MODFLOW and More 2013 Translating Science into Practice, June 2-5, 2013, IGWMC, Colorada School of Mines, Golden CO, USA.

Relevant projects/activities

- H3O (2013-present): cross-border harmonization of 3D hydrogeological models within the Dutch-Belgian cross-border region.
- FP 6 Aquaterra (partner): Trends in groundwater quality and interpretation of groundwater-surface water interaction in a number of European pilots.
- FP6 BRIDGE (partner): policy support for the EU Groundwater Directive.

Name of organisation	1a Deltares		
Short name	DLT	Country	The Netherlands

Organisation profile

Deltares is an independent institute for applied research in the field of water and subsurface. Throughout the world, Deltares works on smart solutions, innovations and applications for people, environment and society. The main focus is on deltas, coastal regions and river basins. Deltares has close cooperation with institutes and governments in the Netherlands and abroad. Within the Netherlands Deltares works closely with for example Rijkswaterstaat (Ministry of Infrastructure and Water management of the Netherlands) and the Dutch Water Boards, as well as with other research institutes and universities. Deltares employs over 800 people and is based in Delft and Utrecht. The unit subsurface and groundwater systems is based in Utrecht. Deltares has a tradition in working with groundwater and surface water within the Netherlands and throughout the world. This includes modelling, development of software and databases, but also laboratory and monitoring activities. Within Deltares there's a strong believe in openness and transparency; especially open source and stimulation of free availability of data and models. Deltares hosts the national hydrological model, the Netherlands Hydrological Instruments (NHI), the integrated model for soil, subsurface and surface water for water quantity and nutrient modelling). The instruments are used by Dutch governments (ministries, provinces, water boards) and drinking water companies for strategic purposes, for example the implementation in the Dutch Delta Programme (impact of climate change on the Dutch Water Management) and the Water Framework Directive, but also for operational purposes, for example real time modelling of surface water and ground water in order to manage the available surface water within in the Netherlands. The groundwater modelling team in Utrecht works closely with the geological modelling team at TNO, the modelling team for the vadose zone at Wageningen University and the surface water modelling team of Deltares in Delft. There's also intensive cooperation with i.e. the global modelling team at University of Utrecht (PCRGLOB) and the US Geological Survey (MODFLOW). The team has broad experience in developing and applying hydrological models within research and projects for water quantity and water quality, including the interaction of surface water and ground water and impact of climate change as well as social and economic scenario's.

Roles / tasks in the project	Special relevant skills
Within GeoERA Deltares works as subcontractor of TNO in WP6.	• Integrated hydrological modelling on national scale, water quantity and water quality • Modelling on different scales (local, regional national, continental /world wide scale). • Hydrological characterisation of groundwater

Short profile of staff member(s) who will be undertaking the work

Marta Faneca Sanchez (female) is hydrogeologist at Deltares. She is specialized in the analysis of groundwater systems, and in groundwater modelling on a regional, national and global scale. She has an extensive experience in different ground water related studies within the Netherlands, Spain South America and Asia. Her projects include the combination of modelling, field work and collaborative processes, as well as the analysis of the climate and socio-economic scenarios. **Neeltje Goorden** (female) is a (geo)hydrologist at Deltares. She has extensive experience in projects related to (geo) hydrological modelling, flood and drought forecasting systems (FEWS), ground water contamination and subsidence models. Next to her work in the Netherlands and elsewhere in Europe she has an extensive experience in Asia (Indonesia), where she set up an integrated groundwater modelling framework with the Indonesian counterparts. **Bas van der Grift** (male, PhD) has a extensive scientific background in water quality and environmental geochemistry. His experience ranges from land use and pollution of the shallow soil and groundwater up to the assessment of the quality of deeper groundwater and quantitative assessments through advanced groundwater quality modelling. Recently he has finished a PhD research project to study the controls on phosphate transport in surface water in rural catchments. **Gijs Janssen** (male, PhD) is a senior hydrologist at Deltares. The base of his expertise is ground water quality, soil pollution, uncertainty analysis and geohydrology. Gijs has a broad experience in ground water modelling (reactive transport modelling density dependent flow, transport modelling, inverse modelling). Gijs is involved in different modelling projects at Deltares, on a regional and national scale, including the NHI nutrient modelling on a national scale. **Timo Kroon** (male) is a senior hydrologist at Deltares. His experience focusses on integrated hydrological modelling of groundwater and surface water. Timo is project leader of the NHI (Netherlands Hydrological Instrument) for water quantity and water quality and involved in many modelling projects within the Netherlands, including impact studies of climate change and socio-economic scenario's. Besides he is involved in strategic Research on the Water Energy Food Nexus, including developments of global modelling of water and food security. **Gualbert Oude Essink** (male, PhD) is senior hydrogeologist at Deltares, Unit Subsurface and Groundwater Systems, and part time Associate professor at Utrecht University with a scientific background from three universities (Delft University, Utrecht University, Free University Amsterdam). His expertise is on groundwater in the coastal zone, with a focus on variable-density groundwater flow and coupled salt transport in regional and local groundwater systems Gu has an extensive experience in groundwater modelling in coastal zones around the world

Publications, infrastructure / technical equipment

B. van der Grift, H.P. Broers, W. Berendrecht, J.C. Rozemeijer, L.A. Osté, J. Griffioen. High-frequency monitoring reveals nutrient sources and transport processes in an agriculture-dominated lowland water systemHydrology and Earth System Sciences 20 (5), 2016

Faneca Sànchez, M., Gunnink, J., van Baaren, E.S., Oude Essink, G.H.P., Elderhorst, W., de Louw, P.G.B., Siemon, B., Auken, E. Modelling climate change effects on a Dutch coastal groundwater system using airborne Electro Magnetic measurementsHydrol. Earth Syst. Science, 2012.

Janssen, G.M.C.M., J.R. Valstar and S.E.A.T.M. van der Zee Measurement network design including travel time determinations to minimize prediction uncertaintyWater, Water Resources Research 2008.

De Lange, W.J., Prinsen, G.F., Hoogewoud, J.C., Veldhuizen, A., Verkaik, J., Oude Essink, G.H.P., van Walsum, P.E.V., Delsman, J.R., Hunink, J.C., Massop, H.T.L., Kroon, T. An operational, multi-scale, multi-model system for consensus-based, integrated water management and policy analysis: The Netherlands Hydrological Instrument. Environmental Modelling & Software, 2014.

Oude Essink, G.H.P., E.S. van Baaren, P.G.B. de Louw Effects of climate change on coastal groundwater systems: A modeling study in the Netherlands, Water Resources Research 2008

Relevant projects/activities

- . Netherlands Hydrological Instrument (NHI), (2005,--) lead by Deltares. Since 2005 Deltares and Wageningen University and Research have been developing the integrated national hydrological model for groundwater, soil water and surface waters in the Netherlands. The model consists of an open toolbox with open databases, mostly open software and tools, as well as sets of data for national and regional applications that can be used in water management studies in the Netherlands (www.nhi.nu).
- Netherlands Water Quality Instrument (2015,--) lead by Deltares and Wageningen University and Research. Based on the national hydrological model a nutrient model for the Netherlands is developed. The model wil be applied in 2018 for national policy studies. Also, regional pilots are started to improve the model on the regional scale.
- Fresh – salt groundwater in the coastal zone for the Netherlands lead by Deltares. Within several projects, in addition to the NHI project, impact assessment of climate change on fresh water resources is studied.
- iMOD (Interactive MODeling); special version of open source MODFLOW software with graphical user interface. iMOD contains an accelerated Deltares version of MODFLOW with fast, flexible and consistent sub-domain modeling techniques, to handle very large, high resolution groundwater modeling and geo-editing of the shallow and deep subsurface.

Global scale ground water modelling using MODFLOW and PCRGLOB. In cooperation with Utrecht University a global MODFLOW model, coupled to the PCRGLOB model is developed. The global model is used for global impact studies (e.g. climate change, Sustainable Development Goals, water security) and used as starting point to develop national and regional studies in areas where groundwater models are missing

Name of organisation	2. Albanian Geological Survey		
Short name	AGS	Country	Albania

Organisation profile
Albanian Geological Survey is a government organization, which operates according to the law nr. 111/2015 “For the Albanian Geological Survey” date 15/1022015 AGS was founded in1922, and its legal status is this of the scientific and technical adviser of the Albanian government in geosciences. AGS is under the ordinance of the Ministry of Industry and Energy. The General Director of AGS is legally the person charged to lead this institution and is its legal representative. AGS is funded by the state budged in accordance with the approved project according to the areas of the development program. Those areas are Regional Geology, Geology of Mineral Resources, Geology of Hydrocarbons, Hydrogeology, Marine Geology, Laboratory Analyses of Rocky and Water samples, Elaboration and Integration of Data in GIS System .

Roles / tasks in the project	Special relevant skills
Participation in WP6	

Short profile of staff member(s) who will be undertaking the work
Sokol Marku (m): in role of the project coordinator for Albania. Geologist, with professional carrier in Albanian Geological Survey since 1997.

Publications, infrastructure / technical equipment
Please provide a list of up to 5 relevant publications and/or products, services (including widely used datasets or software), any significant infrastructure/technical equipment or other achievements relevant to the proposal.

Relevant projects/activities
http://www.gsa.gov.al/alb/products/Q_Hidrogjeologji.html

Name of organisation	**3. Geologische Bundesanstalt**		
Short name	GBA	**Country**	Austria

Organisation profile

The **Geological Survey of Austria (GBA)** undertakes core programmes, such as geoscientific mapping of the Austrian territory. Applied tasks include assessment of mineral and ground water resources, natural hazard mitigation & monitoring as well as geothermal exploration. Furthermore, GBA operates a geological information service, acts as a service for the public administration and participates actively in international research projects, in particular with EuroGeoSurvey, where it is a member of most expert groups.

Roles / tasks in the project	**Special relevant skills**
Participant in WP5 & WP6	Hydrogeology, GIS, Web Map Services

Short profile of staff member(s) who will be undertaking the work

Gerhard Schubert (m) is the Head of Austria's Geological Survey's Department Hydrogeology and Geothermal Energy. He was involved in several EU-funded projects as responsible partner and is member of the EGS Water Resources Expert Group.

Publications, infrastructure / technical equipment

Publications concerning hydrogeological maps and karst aquifers in Austria:

Schubert, G. (2000): Water Resources – Drinking Water. – In: Neubauer, F. and Hoeck, Aspects of Geology in Austria, Mitteilungen der Geologischen Gesellschaft, 92, Vienna. (http://www.uibk.ac.at/downloads/oegg/Band_92_295_311.pdf)

Schubert, G. (Ed.) (2003): Hydrogeologische Karte von Österreich 1:500.000. Hydrogeological Map of Österreich 1:500.000. – Geological Survey of Austria, Vienna. (http://gisgba.geologie.ac.at/ArcGIS/rest/services/AT_GBA_HYD500/MapServer)

Schubert, S., Berka, R. (2007): Hydrogeologische Karte von Oberösterreich 1:200 000. – Geological Survey of Austria, Vienna. (http://opac.geologie.ac.at/ais312/dokumente/hydroOOE_200.pdf)

Tschistiakov, A., Schubert, G., & Heger, H. (2008):EWater - The European Distributed Hydrogeological Information System. – Computeranwendungen in Hydrologie, Hydrogeologie und Geologie: Beiträge zur COG-Fachtagung Salzburg 2007, S.47-50, ISBN 978-3-87907-449-5.

Relevant projects/activities

- *International hydrogeological map of Europe 1:1,500,000 (IHME1500): Sheet D5 Budapest (published 2013)*
- *EC eContentplus project "eWater: The European multilingual ground water information system" (see http://www.iwra.org/congress/2008/resource/authors/abs133_article.pdf)*
- *At the moment an update of the Hydrogeological Map of Austria 1 : 500 000 is planned.*

Name of organisation	6. Vlaamse Milieu Maatschappij (Flanders Environment Agency)		
Short name	VMM	**Country**	Belgium

Organisation profile

Flanders Environment Agency (VMM) is an internally independent government agency with powers of jurisdiction under supervision of the Flemish Minister of the Environment, Nature and Agriculture. VMM's legal basis is the decree of 05/04/1995 (Belgian Official Journal of 03/06/1995). The mission of VMM is to contribute to the realisation of the objectives of the environmental policy by preventing, limiting and eliminating the harmful effects to water systems and the atmosphere and by reporting on the state of the environment and to the realisation of the objectives of integrated water management.

Roles / tasks in the project	Special relevant skills
Coordination of WP3 Partner in WP 1,2 and 6	• Groundwater quantity and quality monitoring (in pilot area) • Status assessment of groundwater quantity and quality incl. trend assessments • Policy development on groundwater and drinking water

Short profile of staff member(s) who will be undertaking the work

Cis Slenter (f) graduated as physical geographer in 2001 at the University of Utrecht. She works at the groundwater and local water management section of VMM and is responsible for groundwater policy development and groundwater management in the north-eastern part of Belgium (Meuse system and Roer Valley Graben), one of the pilot areas of this project proposal. **Griet Heuvelmans (f)** graduated as bio-engineer in 2001 and holds a PhD in bio-engineering (2005) from the University of Leuven. She works at the groundwater and local water management section of VMM and is mainly involved in the initiation and coordination of studies in support of groundwater policy and management. **Ralf Eppinger (m)** graduated as a geologist in 1995 and holds a PhD in geology (2008). He leads the groundwater monitoring team of the groundwater and local water management section of VMM and is representing Flanders in the CIS Working Group Groundwater.

Publications, infrastructure / technical equipment

- Groundwater quantity and quality data: 2 monitoring campaigns per year on > 5000 screens since 2004 for groundwater quality, monthly (or more frequent) measurements of groundwater heads. Screen are distributed over all groundwater layers in Flanders and data are used for reporting groundwater quantity in the framework of EU directives
- Time series models for explaining climatic variation in phreatic groundwater heads: Heuvelmans, G., Louwyck, A., Lermytte, J. 2011. Distinguishing between management-induced and climatic trends in phreatic groundwater levels. Journal of hydrology 411, 108-119.
- Groundwater database and web-portal for data dissemination dov.vlaanderen.be

Relevant projects/activities

- H3O (2013-present): cross-border harmonization of 3D hydrogeological models within the Dutch-Belgian cross-border region.
- Regional groundwater model of the Meuse system (2007). Initiated and coordinated by VMM, developed by University of Brussels.
- Trend analysis of the anthropogenic pressure and impact on confined groundwater bodies (2016). Initiated and coordinated by VMM, developed by IMDC.
- Monitoring and modelling of groundwater and surface water in support of the river restoration project in the valley of Abeek and Lossing (located in the pilot area). Initiated and coordinated by VMM.

Name of organisation	6a. Belgian Nuclear Research Centre SCK•CEN		
Short name	SCK•CEN	**Country**	Belgium

Organisation profile

As a foundation of public utility, the Belgian Nuclear Research Centre conducts research into nuclear energy and ionising radiation for civilian use, and develops nuclear technologies for socially valuable purposes. This is achieved by means of independent, fundamental and applied research, and by providing advice, training, services and products. The Engineered and Geosystems Analysis unit, which is part of the expert group Waste and Disposal, conducts research and provides services related to (long-term) radioactive waste disposal management – the activities are centred around the following themes: Performance assessments, Processes in engineered barrier systems, Computational issues in porous systems and Modelling flow and transport in soil/aquifer systems.

Roles / tasks in the project	Special relevant skills
Participant of WP3	• Upscaling of hydro(geo)logical parameters • Hydrostratigraphy of the southern North Sea basin • Integrated groundwater modelling • Groundwater-surface water interactions

Short profile of staff member(s) who will be undertaking the work

Dr. Bart Rogiers (m): junior expert groundwater modelling and geostatistics
Dr. Katrijn Vandersteen (v): senior expert groundwater and surface water modelling
Dr. Matej Gedeon (m): senior expert groundwater modelling and hydrostratigraphy
Dr. Koen Beerten (m): senior expert (hydro)stratigraphy

Publications, infrastructure / technical equipment

GSIS database (restricted) with geological, hydrogeological and hydrological data of the Mol-Dessel region (Campine area, N Belgium)

Publications:

Beerten, K., Wemaere, I., Gedeon, M., Labat, S., Rogiers, B., Mallants, D., Salah, S., Leterme, B., 2010. Geological, hydrogeological and hydrological data for the Dessel disposal site. Project near surface disposal of category A waste at Dessel – Version 1. NIROND–TR 2009–05E.

Gedeon M., Wemaere I., Marivoet J.- Regional Groundwater Model of North-East Belgium.- In: Journal of Hydrology, 335:1-2(2007), p. 133-139.- ISSN 0022-1694

Gedeon, M., Mallants, D., Vandersteen, K., Rogiers, B., Laloy, E., 2011. Hydrogeological modelling of the Dessel site. Overview report. Project near-surface disposal of category A waste at Dessel. NIROND-TR 2008-15E – Version 2.

Rogiers B, Vienken T, Gedeon M, Batelaan O, Mallants D, Huysmans M, Dassargues A (2014) Multi-scale aquifer characterization and groundwater flow model parameterization using direct push technologies. Environmental Earth Sciences 72: 1303-1324.

Vandersteen, K., Gedeon, M., Beerten, K., 2014. A synthesis of hydraulic conductivity measurements of the subsurface in Northeastern Belgium. Geologica Belgica, 17, 196-210.

Relevant projects/activities

- Project near surface disposal of category A waste at Dessel (third party/contractor for NIRAS): 2006-present
- Future floodplains project (partner, SBO-project for FWO): 2017-2021
- FEMCA project (contractor for VMM): 2015-2016
- Peatlands project (partner, FWO-project): 2017-2021

<table>
<tr><td>Name of organisation</td><td colspan="3">7. Federalni zavod za geologiju (Geological Survey of Federation of Bosnia and Herzegovina)</td></tr>
<tr><td>Short name</td><td>FZZG</td><td>Country</td><td>Bosnia and Herzegovina</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">Geological Survey of Federation of Bosnia and Herzegovina carries out researching, expert-analytical and other tasks in area of fundamental and regional geologic researches of interest for the Federation referring to producing the basic geologic, hydrogeologic, engineering-geologic, seismologic-tectonic and other geologic maps and carries out preparation for printing thereof</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">Participant in WP6</td><td colspan="2"></td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Dr.sc. Ferid Skopljak (m): Assistant director, key expertise is research and protection of groundwater. He has experience of 22 years in hydrogeological studies</td></tr>
<tr><td colspan="4">Publications, infrastructure / technical equipment</td></tr>
<tr><td colspan="4">.</td></tr>
<tr><td colspan="4">Relevant projects/activities</td></tr>
<tr><td colspan="4"></td></tr>
</table>

Name of organisation	9. Hrvatski geološki institut – Croatian Geological Survey		
Short name	HGI	**Country**	Croatia

Organisation profile
Croatian Geological Survey (HGI) is the foremost public research institute in the field of geosciences and geological engineering in Croatia (HR). HGI is divided into three departments: Department of Hydrogeology and Engineering Geology, Department of Mineral Resources and Department of Geology. HGI collaborates with many institutions of similar affiliation, organizations and faculties in the country and neighbouring countries. Beside scientific research, the institute provides consulting services for private companies and stakeholders. HGI basic activity includes long-term project of producing Basic Geological Maps of the Republic of Croatia among which is also Basic Hydrogeological Map. Regarding groundwater resources, both in karst and alluvium systems HGI experts have experience and competence in protection, identification of new resources and solving various groundwater connected environmental problems.

Roles / tasks in the project	**Special relevant skills**
Participant in WP5 & WP6	• Producing GIS based hydrogeological maps • Analysis of hydrological, hydrochemical and hydrogeological datasets for karst system characterization

Short profile of staff member(s) who will be undertaking the work
Dr. **Andrej Stroj** (m): Scientific Associate at Croatian Geological Survey, Department of hydrogeology and engineering geology with extensive experience in hydrogeological explorations in karst environment for scientific and applied projects. Participated or leaded more than 30 expert projects. Dr. **Ozren Larva** (m): Senior Research Associate at Croatian Geological Survey, Department of hydrogeology and engineering geology with expertise in exploration of groundwater dynamics and protection of groundwater resources, vulnerability and risk assessment and modelling of groundwater flow and solute transport.

Publications, infrastructure / technical equipment
Terzić, J., Stroj, A., Frangen, T. (2012): Hydrogeologic investigation of karst system properties by common use of diverse methods: a case study of Lička Jesenica springs in Dinaric karst of Croatia. Hydrol. Proc. 26/21; 3302-3311. *Kuhta, M., Stroj, A., Brkić, Ž. (2012): Hydrodynamic characteristics of Mt. Biokovo foothill springs in Croatia. Geol. Croat. 65/1; 41-51.* *Brkić, Ž., Larva, O., Urumović, K. (2010): The quantitative status of groundwater in alluvial aquifers in norther Croatia. Geol. Croat. 63/3; 283-298.*

Relevant projects/activities
• Basic Hydrogeological Map of the Republic of Croatia 1:100.00 • DRINKADRIA - Networking for Drinking Water Supply in the Adriatic Region • PROLINE-CE – Efficient Practices of Land Use Management Integrating Water Resources Protection and Non-structural Flood Mitigation Experiences • ISTRA-HIDRO – Sustainable management of transboundary groundwater between Trieste and Kvarner bay

Name of organisation	10. Cyprus Geological Survey Department		
Short name	GSD	Country	Cyprus

Organisation profile

The Cyprus Geological Survey Department (G.S.D.) was established in 1950 with a mandate to consult the state on geological matters. It is a state-funded public institution under the Ministry of Agriculture, Rural Development and Environment and its mission is to safeguard the public interest through the identification, the exploitation and protection of mineral and groundwater resources, the investigation and assessment of the geological environment and geohazards, the monitoring and assessment of seismicity, the investigation of foundation conditions, the protection and promotion of sites of geological and mining heritage and the production and dissemination of unbiased geological information to society.

Roles / tasks in the project	Special relevant skills
Participant in WP6	• Groundwater qualitative and quantitative monitoring and reporting • Groundwater exploration in fractured systems

Short profile of staff member(s) who will be undertaking the work

Christos Christofi: Senior Geological Officer, head of hydrogeology and drilling section. Groundwater exploration and hydrochemistry. National representative in Working Group Groundwater within the Common Implementation Strategy of the Water Framework Directive.

Mrs. Theodosia Herakleous

Mr. Michales Rigas

Publications, infrastructure / technical equipment

GSD hydrogeology database (Hydrogeoanalyst) holds ground, surface and precipitation water quality data (and quantitative, where applicable). Furthermore, geological logging data are also stored in the database.

- *Konstantinou K., Kallergis G. and Christofi C. 2005. Study of groundwater flow regime in fractured formations with data from dataloggers: The Troodos Ophiolite Complex (2005). In G. Stournaras et al. (Eds.), Proceedings of 7th Panhellenic Hydrogeological Conference, Athens 2005*
- *Christofi C and Konstantinou K. 2011. Nitrogen sources and denitrification potential of Cyprus aquifers, through isotopic investigation on nitrates. In: N. Lambrakis et al. (Eds.), Advances in the Research of Aquatic Environment, Vol. 2: DOI 10.1007/978-3-642-24076-8.*
- *Konstantinou K., Rigas M. and Christofi C. 2014. Concentration and distribution of arsenic, cadmium, lead and mercury in the groundwater bodies of Cyprus (2014). In K. Voudouris, G (Eds.), Advances in the Research of Aquatic Environment, Vol. 1: 978-960-88816-62-2.*
- *Rigas M., Christofi C. and Konstantinou K 2017. Volume analysis using the ManKendall test of nitrate concentration of groundwater in Cyprus. 11th International Hydrogeological Conference, Athens 2017, Conference proceedings V.2.*

Relevant projects/activities

Name of organisation	11. Ceska geologicka sluzba		
Short name	CGS	**Country**	Czech Republic

Organisation profile
Ceska geologicka sluzba / Czech Geological Survey (CGS) is a research institute of the Ministry of Environment of the Czech Republic. The mission of the CGS, the history of which has started in 1919, is the performance of the state geological survey in the Czech Republic and research in geosciences. CGS leads and participates in basic and interdisciplinary research projects. The main fields of expertise include hydrogeological research and mapping; geochemistry and environmental studies (interaction atmosphere – biosphere –hydrosphere – geosphere, monitoring of element budgets, acidification of forest soils, organic pollutants, radon risk); applied geology and natural risks (hydrogeological mapping and research, radioactive waste disposal, support of development planning). The system of CGS district geologists and associated specialists assists in acquisition and assessment of data on the geological composition of the state territory and the CGS provides expert information to the authorities.

Roles / tasks in the project	**Special relevant skills**
Participant in WP5 & WP6	• data management • GIS • Web Map Services

Short profile of staff member(s) who will be undertaking the work
Eva Kryštofová (f) Researcher, district hydrogeologist. Involved in mapping projects, including special GW mapping initiated by the Radioactive Waste Repository Authority. Expierenced in hydrogeological map compilation and data assessment. **Iva Kůrková (f)** Researcher, district hydrogeologist. Involved in mapping projects and applied hydrogeological projects. Experienced in hydrogeological and hydrochemical data assessment. Both were involved in EU-funded project “ Review of groundwater resources in the Czech Republic”.

Publications, infrastructure / technical equipment
• Map application presenting the hydrogeological zones of the Czech Republic territory as defined in 2005. http://mapy.geology.cz/hydro_rajony/index_EN.html?config=config_EN.xml • Map application giving key information about boreholes. http://mapy.geology.cz/GISViewer/?mapProjectId=15&cultureInfo=en • CGS hosts the national repository for subsurface data and information including hydrogeological information (water heads, hydrochemistry, pumping tests).

Relevant projects/activities
• Hydrogeological mapping of the Czech Republic territory at different scales http://www.geology.cz/extranet-eng/science/natural-resources/ground-waters/hydrogeological-mapping • Review of groundwater resources in the Czech Republic. This already finished project included reassessing of groundwater resources within app. one third of the territory of the Czech Republic. An integral part of the project is the development of methodological steps for the future periodical updating of groundwater resources.

Name of organisation	12. Geological Survey of Denmark and Greenland, GEUS		
Short name	GEUS	**Country**	Denmark

Organisation profile

GEUS is an independent research and advisory institution in the Danish Ministry of Energy, Utilities and Climate. GEUS conducts geological research to exploit and protect geological natural resources in Denmark and Greenland. Primary activities are research in water, energy, minerals and other natural resources. GEUS provide geological advice to public authorities in nature, environment, climate, energy and raw materials issues and participate in the performance of tasks within these areas. GEUS is the national geological data centre and in that capacity make data and knowledge available to the authorities, educational institutions, government agencies, private enterprises and the public. GEUS also undertakes assignments related to water, energy, minerals and the environment on a contractual basis for other public authorities, private companies and clients outside Denmark.

Roles / tasks in the project	Special relevant skills
Coordinator of WP2 Participant of WP1 and WP6	• Experts in 3D geological modelling including cross-border regions and various techniques • Experts in integrated interpretation of geo-chemical, hydrogeological and hydrological data

Short profile of staff member(s) who will be undertaking the work

Klaus Hinsby, Msc: Senior Scientist/Hydrogeologist, Chair of the EGS Water Resources Expert Group and EGS representative in the EU Working Group Groundwater. **Dr. Flemming Jørgensen:** Senior Scientist/Geologist, Expert in 3D geological modelling techniques, geological interpretation of geophysical data, buried Quaternary valleys. **Peter Sandersen, Msc:** Senior Adviser/Geologist, Expert in Quaternary geology, geomorphology/morphotectonic analysis and 3D geological modelling. **Dr. Anne-Sophie Høyer Christensen:** Scientist/Geologist, Expert in 3D geological modelling and geological interpretation of geophysical data. **Thomas Vangkilde-Pedersen, Msc.:** Head of department/Geophysicist, Expert in Groundwater mapping, seismic methods and geophysical well logging.

Publications, infrastructure / technical equipment

National Jupiter database on borehole information (lithology, groundwater heads and groundwater quality) and various regional 3D geological models. Publications:

Høyer A-S, Vignoli G, Hansen TM, Vu LT, Keefer DA & Jørgensen F (2017) Multiple-point statistical simulation for hydrogeological models: 3-D training image development and conditioning strategies. Hydrology and earth system sciences. 21, 6069-6089.

Sandersen, P.B.E., Vangkilde-Pedersen, T., Jørgensen, F., Thomsen, R., Tulstrup, J. & Fredericia, J., 2016: Towards a national 3D geological model of Denmark. In: Garde, A.A., Bennike, O., Thrane, K. & Watt, W.S (eds): Review of Survey activities 2015. Geological Survey of Denmark and Greenland Bulletin 35, 27-30.

Jørgensen F, Høyer A-S, Sandersen PBE, He X & Foged N, (2015) Combining 3D geological modelling techniques to address variations in geology, data type and density – An example from Southern Denmark, Computers & Geosciences, 81, August 2015, 53-63.

Høyer A-S, Jørgensen F, Foged N, He X & Christiansen AV (2015) Three-dimensional geological modelling of AEM resistivity data – A comparison of three methods, Journal of Applied Geophysics, 115, 0, 65-78.

Sandersen PBE (2008) Uncertainty assessment of geological models – a qualitative approach. In: Refsgaard JC, Kovar K, Haarder E, Nygaard E. (eds.), 2008: Calibration and Reliability in Groundwater Modelling: Credibility of Modelling. IAHS Redbook ModelCARE 2007.

Relevant projects/activities

- National Groundwater Programme in Denmark (2007-2020): Detailed local and regional 3D geological models, vulnerability mapping, buried Quaternary Valleys and Miocene aquifers.
- Saltcoast (2014-2018): Building 3D geological and hydrological model for analysis of saltwater intrusion and groundwater residence times in aquifers of low-lying coastal areas in the Danish/German border region.
- ERGO (2013-2016): Developing new modelling methodology enabling fast and consistent modelling of very large data sets.

Name of organisation	**14. Geological survey of Finland**		
Short name	GTK	**Country**	Finland

Organisation profile

Geological Survey of Finland (GTK) is a European competence centre on assessment and sustainable use of geological resources. GTK provides expertise that serves the interests of the society as a whole. Working closely with our partners, we create solutions that lead to new technologies and that can promote sustainable growth.
GTK's Groundwater unit focuses on structural surveys and modelling of groundwater formations, groundwater/surface water interactions, groundwater geochemistry, as well as hydrogeological monitoring and modelling of different natural, infrastructural and industrial environments

Roles / tasks in the project	**Special relevant skills**
GTK participates in WP6 Pan-EU Groundwater Resources Map especially tasks 2 and 3	• 3D and groundwater flow modelling in quaternary (glacofluvial) aquifers • GIS and data management. Building databases, web services and information products for subsurface and groundwater data • Integrated interpretation of geological, hydrological and geochemical data

Short profile of staff member(s) who will be undertaking the work

Anu Eskelinen (M.Sc) (f) is a geologist and project manager in GTK, specialising in quaternary aquifers, modelling the structure of the aquifers and data management.
Miikka Paalijärvi (M.Sc, Quaternary Geology) (m),has specialized in hydrogeology and aggregate and rock material research. He has been employed at Geological Survey of Finland for 15 years, and for the last two years as a Senior Specialist.

Publications, infrastructure / technical equipment

GTK's geological map and interface services (http://en.gtk.fi/informationservices/map_services/ and http://en.gtk.fi/informationservices/interface_services/), e.g. superficial deposit mapping data, geochemical baselines data, etc.
Lähde – National groundwater data platform (will be published in 2018)
SYKE Open information and data (e.g. groundwater quality and amount in Finland) is managed/provided by SYKE (Finnish Environment Institute). This open data and information is also available for this project.

Relevant projects/activities

GTK implements 10-15 glaciofluvial deposit (3D - groundwater flow) modelling – projects annually. These projects are mostly co-operation projects with Finnish environmental authorities, local municipalities and waterworks. The aim of these projects is the better understanding and management of Finnish aquifers (structure, volume, risk assessment, vulnerability).
These project reports (in Finnish) can be loaded from Hakku (https://hakku.gtk.fi/).

Name of organisation	15. Bureau de Recherches Géologiques et Minières		
Short name	BRGM	**Country**	France

Organisation profile
BRGM (Bureau de Recherches Géologiques et Minières) is the French Geological Survey. It was created in 1959 and is France's reference public institution for Earth Science applications in the management of surface and subsurface resources and risks. BRGM's activities are focused on increasing geological knowledge and understanding surface and subsurface phenomena related in particular to groundwater, mineral and geo-energy resources. By addressing major environment and sustainability issues, BRGM provides support for public policies and decision making, and contributes to the development of innovative technologies featuring research in public and private partnership, at national and international level.

Roles / tasks in the project	**Special relevant skills**
Coordinator of WP5 Participant of WP1, WP2 and WP6	• Building databases, web services and GIS/databases application for groundwater data; Integrated interpretation of these datasets towards custom made information products • Characterizing and mapping of hydrogeological data at national scale • Karst hydrogeology: groundwater resource and vulnerability mapping, time series interpretation, water management recommendations for water users and stakeholders • Karst aquifer modelling using various approaches: lumped, reservoir, determinist models

Short profile of staff member(s) who will be undertaking the work
Vincent Bailly-Comte (m) graduated in 2008 as Civil Engineer from University of Orléans, MSc. in hydrology from University of Avignon (France), and as PhD in Hydrology from University of Montpellier (France). He is hydrologist and expert in the field of karst hydrology, with a focus on vulnerability assessment based on dye tracing and monitoring of natural fluorescence of organic matter. He is responsible for the Fontaine de Nîmes (France) observatory dedicated to the analysis of transport of dissolved natural organic and particulate matter (SNO karst network, http://www.sokarst.org). **Jean-Baptiste Charlier (m)** graduated in 2007 as MSc. in Geology from University of Besançon (France), and as PhD in Hydrology from University of Montpellier (France). He is hydrogeologist and expert in the field of karst hydrology. His main activities involved on innovative monitoring of water quality, solute transport and hydrogeological modelling. He is responsible for an observatory of water quality in karstic catchments in the French Jura Mountains (QUARSTIC network). **Bernard Ladouche (m)** graduated in 1993 as MSc. in Hydrology and quantitative Hydrogeology from University of Paris 6 (France), and as PhD in Hydrology from University of Paris 6. His main activities is assessment of the groundwater resource of karstic systems by hydrochemical (isotopic analysis and datation) and hydrological characterisation, data processing and spectral analysis, groundwater modelling with global models. **Jean-Christophe Marechal (m)** graduated in 1992 as MSc. (Eng.) in Geology from University of Liege (Belgium), as MSc. In Karst Hydrogeology from University of Neuchâtel (Switzerland) and as PhD in Technical Sciences from Ecole Polytechnique Fédérale de Lausanne. He is a senior hydrogeologist, specialised in fractured rock and karst aquifer hydrogeology. He has lead several multi-partners projects on karst hydrogeology and is the Head of the Unit New water resources and Economy. **Alexandre Brugeron (m)** graduated in 2007 as MSc. (Eng.) in Geology from National School of Geological Engineering (ENSG, Nancy). As hydrogeologist and GIS expert at BRGM, he is responsible for French hydrogeological reference database BDLISA that aims to locate and characterize all water-bearing geological formations across France (inland and overseas territory). He is also involved in several studies dealing with groundwater resource assessment, groundwater policy and management and geoscientific mapping. **Delphine Allier (f)** graduated in 2005 as MSc. (Eng.) in Environment/Hydrology from National School of Civil Engineering (ENTPE, Lyon). As hydrogeologist and GIS expert, she works at BRGM as Lead Expert for Hydrogeological GIS/database applications to water resources assessment, risk evaluation, preservation and management and is actually responsible for a study on groundwater resources estimation and mapping at the national scale.

Publications, infrastructure / technical equipment
• Charlier J.-B., B. Ladouche, and J.-C. Maréchal, (2015) - Identifying the impact of climate and anthropic pressures on karst aquifers using wavelet analysis. Journal of Hydrology, 523:610-623, DOI 10.1016/j.jhydrol.2015.02.003. • Ladouche, B., Maréchal, J-C., Dorfliger, N. (2014) - Semi-distributed lumped model of a karst system under active management, Journal of Hydrology 509, 215-230, doi: 10.1016/j.jhydrol.2013.11.017 • National hydrogeological reference database BDLISA : compiles mapping and characterization of aquifers/aquitards in France inland and overseas territories (http://www.sandre.eaufrance.fr/atlas/srv/fre/catalog.search/metadata/769f36e0-eb23-4014-ad63-fb468fcd7488 + *new website will be released in 2018 at this address :* www.eaufrance.bdlisa.fr); • Seguin J.J, Allier D., Pinson S. (2014). From the new aquifer reference system BDLISA in France to the hydrogeological map of France at a scale of 1/1 000 000. 41st IAH International Congress "Groundwater: Challenges and Strategies", Sep 2014, Marrakech, Morocco. 2014.
Relevant projects/activities

- Fontaine de Nimes karst observatory monitoring under the SNO Karst (http://www.sokarst.org/index.asp?lang=en), National Observing Service of INSU, part of Research Infrastructure OZCAR
- Karst groundwater resources mapping on the Plateau de Sault (http://sigesmpy.brgm.fr/spip.php?article350)
- QUARSTIC network for water quality in karstic catchments in the Jura Mountains (http://www.eaudoubsloue.fr/donnees/qualite-de-leau) Hydrogeological map of Africa at 1/10 M scale in the framework of the "GIS-Africa Network" project (2003-2005), with the support of UNESCO : http://www.brgm.eu/project/hydrogeological-map-of-africa
- Hydrogeological map of France at 1/1 M scale (2014): http://www.brgm.eu/news-media/new-hydrogeological-map-of-france
- http://www.brgm.eu/project/karst-floods-characterization-development-of-management-tools
- http://www.brgm.eu/project/multimethod-geophysics-survey-to-detect-characterise-karsts

Name of organisation	**27. Mining and Geological Survey of Hungary**		
Short name	MBFSZ	**Country**	Hungary

Organisation profile

The Mining and Geological Survey of Hungary (MBFSZ) was established on 1st July 2017 by the merger of the Hungarian Office for Mining and Geology and the Geological and Geophysical Institute of Hungary. It provides background support to the Ministry of National Development and gives advice on policy matter to the Ministry. In addition to administering mining concessions MBFSZ carries out scientific research in the fields of geology, hydrogeology, geophysics, mining and climate policy. It also manages the mining, geological, and geophysical data center in Hungary.
MBFSZ is the designated state institution dealing with groundwater, significantly contributing to the regular update of the National River Basin Management Plans required by the Water Framework Directive (quality and quantity assessment of groundwater bodies). Furthermore, it operates a national groundwater observation system – 140 monitoring wells form part of the National Groundwater Monitoring System (quantity). Based on the Ministerial Decree 101/2007. (XII.23) MBFSZ operates the National Hydrogeological Archive.

Roles / tasks in the project	**Special relevant skills**
Participant in WP5 (Typology of karst aquifers and recommendations for their management) and WP6 (Pan-EU Groundwater Resources Map)	• Hydrograph analytical techniques • Contribution to the implementation of EU Water Framework Directive (coordinator of groundwater tasks for RBMPs) • National Accreditation for groundwater sampling and laboratory analyses • Operation of National Groundwater Monitoring System • National and cross-border hydrogeochemical - isotope hydrogeology surveys with special emphasis on thermal waters, hydrodynamic and water-rock interaction modelling • Hydrogeological studies for geothermal concessions • Building databases and web services for subsurface and groundwater data

Short profile of staff member(s) who will be undertaking the work

Attila Kovács (m): PhD, is a senior researcher at the Mining and Geological Survey of Hungary and at a research group of the Hungarian Academy of Sciences with 20 years of international experience in hydrogeology and groundwater modelling. He has worked on a large variety of consulting and academic projects, including water resource protection, contaminated sites, nuclear waste disposal, mining, geothermal, climate change impact assessment and geotechnical investigations. Dr Kovács is an internationally recognized expert in karst hydrogeology and modelling, and published several scientific papers and book chapters on these topics. Dr Kovács has developed novel hydrograph analytical techniques and clarified some fundamental aspects of the hydraulic functioning of karst and fractured hydrogeological systems. Dr Kovács has instructed academic courses in karst hydrogeology and groundwater modelling in several countries. **Teodóra Szőcs (f)**: PhD, chief hydrogeologist, hydrogeochemist will coordinate work related to the “Groundwater” topic. She is head of the Hydrogeology Department at MBFSZ as well as vice president for finances and membership of the International Association of Hydrogeologists, and member of the EuroGeoSurveys Water Resources Expert Group. Participated in numerous EU-funded research projects, well experienced in hydrogeochemical evaluation, isotope data interpretation, thermal water surveys, transboundary issues and project coordination. She coordinated a team of scientists and worked as the hydrogeochemical expert responsible for the background values, threshold values and evaluation of chemical status of the groundwater bodies in Hungary in the framework of the first and second River Basin Management Planning. **Ágnes Rotár Szalkai (f)**: senior expert in hydrogeology, geothermal resource survey and project coordinator, responsible for the operation of the groundwater monitoring network of MBFSZ with leading role in several EU projects. She took part in the evaluation of chemical status of the groundwater bodies in Hungary in the framework of the first and second River Basin Management Planning. **Nóra Gál (f)**: PhD, expert in hydrogeochemistry, water-rock interaction modelling, geothermal resource survey, GIS, thermal well cadastre. She took part in the determination of background values and evaluation of chemical status of the groundwater bodies in Hungary in the framework of the first and second River Basin Management Planning. **Tamás Kerékgyártó (m)**: expert in geothermal resource survey, hydrogeochemistry, water-rock interaction modelling and hydrodynamic modelling. He took part in the evaluation of quantitative and qualitative status of the groundwater bodies in Hungary in the framework of the second River Basin Management Planning.

Publications, infrastructure / technical equipment

Kovács A., Szőcs T. (2016). Reactivation of karst springs after regional mine dewatering in the Tata area, Hungary. In: Stevanovic, Z., Kresic, N., Kukuric, N. eds. Karst without Boundaries. IAH Selected Papers No. 23. pp. 337-358. CRC Press.

Kovács, A., Perrochet, P., Darabos, E., Lénárt, L., Szűcs, P. (2015): Well hydrograph analysis for the characterisation of flow dynamics and conduit network geometry in a karstic aquifer, Bükk Mountains, Hungary. Journal of Hydrology, 530, pp. 484-499

Kovács, A. & Perrochet, P. (2008): A quantitative approach to spring hydrograph decomposition. Journal of Hydrology, Vol. 352, pp. 16-29

T. Szocs, S. Frape, R. Gwynne, L. Palcsu, 2017: Chlorine stable isotope and helium isotope studies contributing to the understanding of the hydrogeochemical characteristics of old groundwater. Procedia Earth and Planetary Science pp. 877-880 DOI information: 10.1016/j.proeps.2017.01.004

T. Szocs, N. Rman, M. Suveges, L. Palcsu, Gy. Toth, A. Lapanje, 2013: The application of isotope and chemical analyses in managing transboundary groundwater resources. Applied Geochemistry 32 (2013) 95–107

GeoBank: national borehole database

Cadastre and **cartographic documentation of wells**, operation of **National Groundwater Archive**

NAGiS: geo-information database based on processed data derived from several other databases

Relevant projects/activities

MBFSZ (and its precursors MFGI, MÁFI) took part in numerous international, EU co-financed projects, often taking a leading role at the project implementation level.
MBFSZ is the coordinator of the **DARLINGe** - Danube Region Leading Geothermal Energy project (1 January 2017 – 30 June 2019 Interreg Danube Transnational Programme*)* carried out by 15 partners from 6 countries in Central, South-East and Eastern Europe to make the Danube region less dependent on imported fossil fuels, by making an efficient use of deep, untapped geothermal resources and where possible, introducing more efficient thermal water management.
MBFSZ was the coordinator of the „**TRANSENERGY** – Transboundary Geothermal Energy Resources of Slovenia Austria, Hungary and Slovakia" (2010-2013 – 2CE124P3), project, which provided tools for sustainable use of geothermal resources at the Western part of the Pannonian Basin. MBFSZ was responsible for the establishment of geological, hydrogeological and geothermal models at the project area.
MBFSZ was the Hungarian coordinator in the **T-JAM** project "Screening of the geothermal utilization, evaluation of the thermal groundwater bodies and preparation of the joint aquifer management plan in the Mura-Zala basin" (Operational Programme Slovenia - Hungary 2007-2013, 4300-488/2008/8), responsible for the geoscientific models, hydrogeochemical and isotope hydrogeology survey and elaboration of the recommendations on a joint transboundary thermal groundwater management (2009-2011).
MBFSZ was the coordinator of the **NAGiS** - National Adaptation Geo-information System project, whose objective was to develop a multipurpose geo-information information system that can facilitate policy-making, strategy-building and decision-making processes related to the impact assessment of climate change and the adoption of necessary adaptation measures in Hungary (financed by the European Economic Area (EEA) Grant; 2013-2016). The work continues in the NAGiS 2 project.
MBFSZ coordinated and carried out the work to establish and revise the background values, threshold values and chemical status of the groundwater bodies in Hungary in the framework of the first and second national **River Basin Management Planning**

<table>
<tr><td>Name of organisation</td><td colspan="3">28. Islenskar orkurannsoknir (Iceland GeoSurvey) ISOR</td></tr>
<tr><td>Short name</td><td>ISOR</td><td>Country</td><td>Iceland</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">ISOR is a governmental non-profit service, research and training institute under the Icelandic Ministry for the Environment and Natural Resources. Iceland GeoSurvey carries out mapping of water drainage, groundwater systems and groundwater flow where the interaction of surface and subsurface flow and rock formations is outlined. ISOR is one of the world’s leading geothermal research organizations and stands for over 70 years of continuous experience in geothermal research, encompassing all disciplines of geosciences, drilling engineering, utilisation technology and reservoir physics and management. ISOR has been the main scientific leader in the successful geothermal development in Iceland.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">Participant in WP6</td><td colspan="2">• Characterizing and mapping of hydrogeological data at national scale
• 3D geological modelling
• Integrated interpretation of geochemical, hydrogeological and hydrological data</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Steinunn Hauksdóttir (f): Director natural resources. B.Sc. in geology, M.Sc. in Geology, volcanology. Supervision, marketing and project management of projects in the fields of geothermal research and utilization and natural resources. Geologist/Geochemist with experience in geothermal mapping, sampling of fluids and rocks. Supervision of various Information Technology projects and systems.
Árni Hjartarson (m): Senior hydrogeologist B.Sc. in Geology, M.Sc. in Hydrogeology and Ph.D. in Geology. Geological mapping and hydrogeology of volcanic regions; Groundwater research and advice for municipal water works. Stratigraphy in basaltic and volcanic terrains. Borehole geology, interpretation of temperature and pressure data from boreholes. Tunnelling and tunnel consultancy, Hydrogeological modelling; Run-off measurements and interpretation; Quaternary geology research.
Dadi Thorbjornsson (m): Senior Hydrogeologist. B.Sc. in Geology, M.Sc. Applied hydrogeology. The experience includes geochemical studies such as sampling, chemical modelling and interpretation, hydrogeological studies (including assessment of hydrogeological properties of reservoirs rocks). Several years of project management experience including management of drilling projects, reservoir monitoring projects, conceptual modelling, environmental studies, well testing, resistivity studies and seismic studies.
Vaiva Cypaité (f): Hydrogeologist, B.Sc. in Environmental hydrogeology and geoengineering and M.Sc. in Geology. Modelling hydrogeological data with Visual MODFLOW flex, ArcGis, AutoCad. Evaluation of hydrogeological conditions and geothermal potential in D.Riese. Hydrogeology, geology and geothermal resources of Iceland, groundwater flow, sedimentary aquifers, instrumental analysis by Ion Chromatograph and Mass Spectrograph.</td></tr>
<tr><td colspan="4">Publications, infrastructure / technical equipment</td></tr>
<tr><td colspan="4">Árni Hjartarson and Thórólfur H. Hafstad 2010: Water resources registry of Iceland. Report and dataset for National Energy Authority.
Vaiva Cypaité 2015: Determination of groundwater flows in SW Iceland with environmental tracers. M.Sc. thesis University of Iceland.
Postgres and Oracle Database management system, ESRI-GIS geographical information system, iTOUGH2, Visual MODFLOW flex, LeapFrog and PETREL 3D visualization and modelling.</td></tr>
<tr><td colspan="4">Relevant projects/activities</td></tr>
<tr><td colspan="4">Numerous projects for various clients, including municipalities and potable water suppliers regarding water exploration, drilling, protection, pollution, mapping. Also work for preparations for hydropower plants including mapping, modelling and consulting. E.g.:
Thorolfur H. Hafstad and Vaiva Cypaite 2017: Vogar. Exploration well for water supply and suggested need of water protection areas. Report for HS Veitur, Iceland.
Thórólfur H. Hafstad, Vaiva Cypaité, Steinunn Hauksdóttir 2016: Hydrogeological study of water basin of Stora-Laxa at Laxarsgljufur. Report for National Power of Iceland.
Árni Hjartarson et al. 1992-1997: Hydrogeological Maps of the Reykjavík Capital Area.</td></tr>
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Name of organisation	29. Geological Survey of Ireland		
Short name	GSI	**Country**	Ireland

Organisation profile

Founded in 1845, Geological Survey Ireland is the Republic of Ireland's public earth science knowledge centre. We are a division of the Department of Communications, Climate Action and Environment. We provide free, open and accurate data and maps on Ireland's subsurface to landowners, the public, industry, and all other stakeholders, within Ireland and internationally. In addition, we act as a project partner in interpreting data and developing models and viewers to allow people to understand the underground.

Roles / tasks in the project	Special relevant skills
Participant in WP5 & WP6	• Creation of national databases and maps • Mapping and characterisation of karst systems • Characterisation and mapping of hydrogeological systems • Characterisation of aquifer properties and groundwater resources

Short profile of staff member(s) who will be undertaking the work

Caoimhe Hickey (f) Hydrogeologist, expert in karst hydrogeology and water resources in karst systems, manages karst database.
Ted McCormack (m) Groundwater engineer with expertise in 3D dynamic modelling of karst systems, with particular focus on flooding.
Taly Hunter Williams (f) Senior Hydrogeologist with expertise in groundwater resources estimation and hydrochemistry. Member of the EuroGeoSurveys Water Resources Expert Group.
Contract staff (m/f) Suitably qualified contract staff member to be appointed.

Publications, infrastructure / technical equipment

T. McCormack, Y. O'Connell, E. Daly, L.W. Gill, T. Henry, M. Perriquet (2017) Characterisation of karst hydrogeology in Western Ireland using geophysical and hydraulic modelling techniques. J. Hydrology: Regional Studies 10(C):1
C. Hickey (2010) The Use of Multiple Techniques for Conceptualisation of Lowland Karst, a case study from County Roscommon, Ireland. Acta Carsologica / Karsoslovni Zbornik 39(2):331-346.
C. Kelly, N.H. Hunter Williams, B.D.R. Misstear, K. Motherway (2015) Irish Aquifers Properties: A reference manual and guide. GSI/EPA.
N.H. Hunter Williams, B.D.R. Misstear, D. Daly and M. Lee (2013) Development of a national groundwater recharge map for the Republic of Ireland. QJEGH. 46(4):493-506.
Geological Survey Ireland. National Karst Feature and Water Tracing Databases. Managed by C. Hickey and S. Raymond. Geological Survey Ireland. National Groundwater Vulnerability, Aquifer and Recharge maps. Managed by N. H. Hunter Williams, S. Carey and M. Lee.
Laboratory and field spectral fluorometers and autosamplers, supporting expertise in karst system characterisation.

Relevant projects/activities

Groundwater3D https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/projects/gw3d/Pages/default.aspx
Protecting Drinking Water https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/projects/protecting-drinking-water/Pages/default.aspx
GWFlood https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/projects/gwflood/Pages/default.aspx

<table>
<tr><td>Name of organisation</td><td colspan="3">33. Agenzia Regionale per la Protezione Ambientale – ARPA del Piemonte</td></tr>
<tr><td>Short name</td><td>ARPA</td><td>Country</td><td>Italy</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">ARPAP is a public body with independent status for administrative, technical-juridical, asset management and accounting purposes, and it is a leading centre of studies and applied research in the field of natural risk. Its aim is the development of methodologies and tools to assess, manage and minimise the geological risk. It operates under the oversight of the Chairman of the Executive Committee of the regional government so as to ensure compliance with the policy guidelines issued by the Piedmont Region in the fields of forecasting, preventive actions and preservation of the environment. ARPAP performs the task of monitoring and preventing natural hazards and acquired full responsibility for all environmental protection and control functions.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">Participant in WP6</td><td colspan="2"></td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Luca Mallen: senior Geologist and senior GIS analyst in the Geological and Hydrogeological instability in the Department of Arpa Piemonte Torino. I graduated from the University of Turin (Italy) with a M.Sc. degree in Geological Sciences. Experienced in 3D geological modelling and GIS specialist and Domain Analyst in the field of geological and environmental software applications. I participated to national and European research projects. Michele Morelli: senior Geologist and Structural Geologist in the Geological and Hydrogeological instability in the Department of Arpa Piemonte Torino. Experienced in 3D geological modelling. I graduated from the University of Turin (Italy) with a M.Sc. degree in Geological Sciences. I received a Ph.D. from the University of Torino, for a research of remote sensing applied to structural geology. I have then work as research in the Geoscience and Earth Resources Institute of Italian National Research Council, for activity on remote sensing applied to fracturing of rock mass. I participated to national and European research projects. Gabirele Nicolò: Geologist employed as senior GIS specialist in the Technical Functional Department of Arpa Piemonte (Torino, Italy). I graduated from the University of Turin with a M.Sc. degree in Geological Sciences and an Alpine Hydrogeology dissertation. During the first three years after graduation I worked as professional geologist in the field of geotechnics and geomorphological mapping. After that I was employed as GIS specialist and Domain Analyst in the field of geological and environmental software applications. At present in my job I deal mainly with spatial analysis and modelling in the field of geological and environmental applications. I participated to national and European research projects. Anselmo Cucchi: senior Geologist in the Geological and Hydrogeological instability in the Department of Arpa Piemonte Torino. I graduated from the University of Pavia (Italy) with a M.Sc. degree in Geological Sciences and with B.Sc degree in Natural Sciences and Technology. During the first year after graduation I worked as professional geologist in the field of geotechnics and hydrogeological and geomorphological mapping. After that I was employed as geology-landslides specialist and data Analyst in the field of systems of instrumental control of landslides. At present in my job I deal mainly landslides monitoring and geoenviromental analysys. I participated to national and European research projects.
Coordinating manager:</td></tr>
<tr><td colspan="4">Publications, infrastructure / technical equipment</td></tr>
<tr><td colspan="4">F. Piana, G. Fioraso, A. Irace, P. Mosca, A. d'Atri , L.Barale , P. Falletti, G. Monegato, M. Morelli, S. Tallone, G.B. Vigna (2017). GEOLOGY OF PIEMONTE REGION (NW Italy, Alps-Apennines junction zone). Pubblicato sul Journal of Maps, Francis & Taylor Group Publ., UK.
CARG (Geological CARtography of Italy) project - Carta Geologica d'Italia 1:50.000: Sheets: Fogli n. 132-152-153 BARDONECCHIA (2002), n. 154 SUSA (2002), n. 157 TRINO (2004), n. 155 Torino Ovest (2009), n. 156 Torino Est (2009), n. 211 Dego (2010), n. 194 Acqui Terme, n. 196 Cabella Ligure.</td></tr>
<tr><td colspan="4">Relevant projects/activities</td></tr>
<tr><td colspan="4">• http://www.arpa.piemonte.gov.it/approfondimenti/temi-ambientali/geologia-e-dissesto/bancadatiged</td></tr>
</table>

Name of organisation	34. Regione Toscana		
Short name	RT	**Country**	Italy

Organisation profile

Tuscany Region is one of the 20 local Italian regional governments; among the guiding principles of the Region there are: defence of the soil and subsoil and buried resources, protection from hydrogeological (landslides and floods) and seismic hazard, respect for the ecological balance, environmental protection, biodiversity conservation, promoting the culture of respect for the animals, protection and enhancement of historic, art and landscape; promoting an environment leading to business competitiveness, based on innovation, research and training. Among the environmental management and sustainable development, the most relevant issues are: organisation of the waste cycle, protection from pollution, remediation of polluted sites, renewable energy sources, inland and seawater conservation, prevention of flood, landslides and earthquakes risk. RT has a framework of policies dealing with geological, hydrological and hydrogeological management, also to combat coastal erosion and salt water intrusion.

Roles / tasks in the project	Special relevant skills
Participant in WP6	

Short profile of staff member(s) who will be undertaking the work

Guide Lavorini (m): graduated in Applied Geophysics at University of Florence in 1993, senior geologist, he has worked in RT since 2003; expert in geology, geomorphology, geoengeneering and geological mapping. Presently head of P.O. Geology, Pedology and Geological Data Bases of RT. **Sandra Elisei (f):** graduated in Economy at University of Florence in 1995; expert in financial subjects and marketing; presently business and financial consultant in RT; having worked at other UE projects (Life+ and Horizon2020), in Geo Era acts for RT as Project accountant.

Publications, infrastructure / technical equipment

- G.Gabbani, G.Lavorini, S.Piro, *Analisi della fratturazione di rocce compatte con metodologie geofisiche elettromagnetiche impulsive (GPR) e a basso numero di induzioni [Joints System Analysis in intrusive rocks with geophysical methods (Ground Probing Radar and electromagnetic VLF transducer)]* Quaderni di Geologia Applicata, 2,1997, Pitagora, Bologna.
- G.Gabbani, G.Lavorini, L.Pacini, *Ricostruzione 3D di un fenomeno franoso dell'alta Val di Bisenzio [3D modeling of a landslides in Bisenzio Valley, Italy]*, International Geophysical Symphosium, Bochum, 2001.
- Curatore della SEZIONE TERRA *dell'Atlante Geoambientale della Toscana* [Editor of "TERRA CHAPTER" of the *Geoenvironmental* Atlas of Tuscany], Istituto Geografico De Agostini, Novara, Settembre 2006.
- G.Gabbani, G.Lavorini, L.Pacini*, Modellazione 3D di un acquifero inquinato da trielina con metodologie geofisiche non convenzionali,[3D modeling of Trieline Pollution in underground water with unconventional geophysical methods]*, FIST, Bellaria, 2003.

G. Lavorini, *La Campagna GPS dopo il Terremoto in Abruzzo [GPS surveys at the aftermath scenary of heavy earthquake in Abruzzo, Italy]*, IL GEOLOGO, 2009.

Relevant projects/activities

- Interregional Project of Geological Map of Central Italy and Northern Appennine.
- Life+ Imagine Project, Project Technical Manager. http://www.life-imagine.eu/home/
- GEOBASI Project (Definition of standard values in geochemical composition of fresh water in underground and surface watertables with special regards to metallic cationes and inorganic dangerous aniones), Regione Toscana, University of Florence, University of Pisa, University of Siena and CNR – IGG of Pisa.
- European Innovation Partnership on Water - Strategies and actions to bring Managed Aquifer Recharge scientific based solutions,and techniques to the industry - MAR(Solutions) to MAR-ket. *http://www.eip-water.eu/*
- Partner of Horizon2020 FREEWAT – A software for Hydrogeological Balances. http://*www.freewat.eu/*

Name of organisation	39. State limited liability company "Latvian Centre of Geology, Environment and Meteorology"		
Short name	LGMC	**Country**	Latvia

Organisation profile

LEGMC is State limited liability company under the Ministry of Environmental Protection and Regional Development and it is the central legal body in Latvia at subsoil field comprising geology, hydrogeology, and geophysics. According to Law on Subsoil the main tasks of LEGMC in the field of subsoil are collection and reprocessing of geological information and maintenance of the State Geological Fund. These tasks can be divided as follows: 1) estimation and approval of mineral and groundwater reserves and determination of extraction areas; 2) geological and hydrogeology data preparation for government, municipalities and private sector; 3) reporting for national and international institutions.
LEGMC also ensures water quality and quantity monitoring, as well as data quality control and availability of these data for public, maintenance of data base on use of water resources, river basin management (preparation of River Basin Management Plans), preparation of for national and EU institutions, as well as calculation of flood territories.

Roles / tasks in the project	Special relevant skills
Participant in WP6	• Responsible for national Latvian groundwater monitoring (both quantity and quality) • Holder of the largest hydrogeological database in Latvia (abstraction well data, monitoring data, water chemistry)

Short profile of staff member(s) who will be undertaking the work

The responsible person will be **Inga Retiķe.** She is a hydrogeology expert at LEGMC and is responsible for reporting to EK (WFD and River Basin Management Plans, Nitrates directive), preparation of national reviews related to water quality and quantity issues, project coordination related to water management issues (e.g. groundwater dependent ecosystems, methodologies for groundwater body delineation under WFD) etc. She is currently a PhD aspirant at University of Latvia and working with multivariate statistics and long term water quality data.

Publications, infrastructure / technical equipment

Retike, I., Kalvans, A., Popovs, K., Bikse, J., Babre, A., Delina, A. 2016. Geochemical classification of groundwater using multivariate statistical analysis in Latvia. Hydrology Research. Vol. 47, Issue 4.

Babre, A., Kalvāns, A., Popovs, K., **Retiķe, I.**, Dēliņa, A., Vaikmäe, R., Martma, T. 2016. Pleistocene age paleo-groundwater inferred from water-stable isotope values in the central part of the Baltic Artesian Basin. Isotopes in Environmental and Health Studies. Vol. 52, Issue 6.

Retike, I., Delina, A., Bikse, J., Kalvans, A., Popovs, K., Pipira, D. 2016. Quaternary groundwater vulnerability assessment in Latvia using multivariate statistical analysis. 22nd International Scientific Conference Research for Rural Development, 2016; The Latvia University of Agriculture, Jelgava; Latvia; 18-20 May 2016. Volume 1, 2016, Pages 210-215.

Relevant projects/activities

- Second cycle River Basin Management Plans in Latvia (Inga Retiķe was one of the developers of groundwater part) 2016.
- **The Administration of Latvian Environmental Protection Fund project "Improvement of groundwater characterisation and status assessment for the next cycle River Basin management period" 2017 (Inga Retiķe was the developer of the methodology for identification of groundwater bodies in Latvia).**
- ERDF, Interreg Central Baltic project "Innovative, sustainable remediation" (INSURE) (Inga Retiķe is currently working in this project, activities related groundwater pollution modeling).
- Latvia- Lithuania cross border cooperation programme project "Sustainable Rainwater Sewerage Management for Improved Environmental Quality of the Lielupe River Basin" (Inga Retiķe worked in this project; activities related to shallow groundwater quality).

Name of organisation	**40. Lietuvos geologijos tarnyba prie Aplinkos ministerijos (Lithuanian Geological Survey under the Ministry of Environment of the Republic of Lithuania)**		
Short name	LGT	**Country**	Lithuania

Organisation profile

LGT is an independent governmental institution, which directly carries out geological investigations necessary to the State and controls the system of geological information alongside the regulation of the use of subsurface. LGT will be represented in Geo-ERA through the Lithuanian Geological Survey. The survey's core skills and services relate to subsurface investigations and protection, and include geological data management. Its products and services are primarily targeted at the groundwater, mineral resources and energy sectors (the latter in the broadest possible sense, including land use and environmental planning). The organisation hosts the national repository for subsurface data and information and is the designated state advisor of all geological matters related to the Subsurface Law.

Roles / tasks in the project	Special relevant skills
Participant in WP4 & WP6	• Characterisation and mapping of hydrogeological systems • Groundwater quality and quantity monitoring • Status assessment of groundwater quality and quantity

Short profile of staff member(s) who will be undertaking the work

Rasa Radiene: Head of Hydrogeology Department. Initiating, participating and leading research and hydrogeological investigation activities related to the environmental and groundwater issues.
Dr. Jurga Arustiene: Head of groundwater monitoring sub-division. Initiating, participating and leading research and hydrogeological investigation activities related to the environmental and groundwater issues.
Petras Pūtys. Chief specialist. Cartographer, expert in GIS cartography and hydrogeological mapping.
Jurgita Kriukaitė. Chief specialist. Hydrogeologist, expert in groundwater quality and quantity monitoring and assessment.

Publications, infrastructure / technical equipment

Pūtys P. The Map of Groundwater Recharge on a scale of 1:200 000. Report 2013. - Vilnius : LGT
Giedraitis R. Assessment of hydrogeological parameters of active water circulation zone. Vilnius, LGT, 2010. Report - 81 p. + 1 apl. + CD : 24 pav. + 10 graf. doc.
Available resources of Upper-Middle cretacious aquiferous system. Final report: projects: Assessment of groundwater resources in Lithuania/ Gregorauskas M., Klimas A., Bendoraitis A.; Lietuvos geologijos tarnyba, UAB „Vilniaus hidrogeologija“. - Vilnius, 2012. - 2 d. - 175 p. + 1 apl. + 1 žml. + CD : 84 pav. + 17 graf. dok.
Groundwater Monitoring in the Lithuanian cross-border areas in 2016 . Lithuanian Geological Survey Annual Report 2016. - Vilnius : LGT, 2017. - P. 24-27 : iliustr.
Groundwater information system – containing DB's of groundwater quality, groundwater resources.

Relevant projects/activities

- Programme of State Geological Investigations 2016-2020 “Geoenergy and Safe Environment” of Republic of Lithuania;
- State groundwater monitoring programme in transboundary areas;
- Development and management of Groundwater information system;

Name of organisation	**41. Service géologique du Luxembourg**		
Short name	SGL	**Country**	Luxembourg

Organisation profile

The Service géologique du Luxembourg (SGL) ('Geological Survey of Luxembourg') is a department of the 'Administration des ponts et chaussées' (National roads authority), and hereby under the competence of the Ministry for sustainable development and infrastructures.
Founded in 1936, its main tasks are studies, advisory and research, primarily in the fields of geology, geotechnics, hydrogeology, geomorphology and mineral resources.
These include:
- engineering geology and geotechnical studies for various public works projects;
- geological hazards evaluations;
- geothermal energy investigations;
- mineral resources surveys;
- geological and other geoscientific mapping and related database management;
- geoscientific information management and supply to the public.

The SGL acts as a public service for various national governmental bodies and local communities and has the status of a national survey organization. It is founding member of Eurogeosurveys and national representation of the IUGS.
During GeoERA, the Ministry for sustainable development and infrastructures will act as the research programme owner to which the SGL gives account to, by the intermediate of the directorate of the 'Administration des ponts et chaussées' (National roads authority).

Roles / tasks in the project	**Special relevant skills**
Participant in WP6	Geological mapping, geographical information systems, hydrogeology

Short profile of staff member(s) who will be undertaking the work

Robert Colbach (male): Head of geological survey since 2015. M.Sc. in geology and hydrogeology from the University of Montpellier and Avignon (F) in 1997. Joined SGL im 1997, responsible for general geology, geotechnical investigations, geological mapping as well as geographical information systems, database development and maintenance. SGL's main administrative and technical responsible during the research projects OneGeology, Terrafirma and PanGeo.
Romain Meyer (male): Ph.D. in geology from the KU Leuven (B). Romain has a wide expertise in geology ranging from mineralogy, geochemistry to geophysics. He has been associated as researcher to the Massachusetts Institute of Technology MIT, the Norwegian Centre of Excellence for Geobiology, the GeoForschungsZentrum Potsdam, and has lectured general geology and geophysics as professor at the Washington and Lee University prior to joining the SGL in Mai 2017. In the last years, he contributed in numerous international cooperation projects like ESF EuroMARGINS, NSF MARGINS and NSF GeoPRISMS, and participated on different research expeditions e.g. IODP.
Petra Münzberger (female): Ph.D. in geology and palaeontology. Educated from the Technical University 'Bergakademie' Freiberg (D) in 2002. From 2002 to 2005 she had a research fellowship on geology, geomorphology and settlement history from the University of Regensburg. Worked since 2005 for the SGL as a contractual employee for geological exploration of roads and bridges, hydrogeological exploration, sedimentological and paleontological studies, geological cartography. Joined as permanent staff member in 2017.

Relevant projects/activities

The SGL also has contributed to the following EU co-funded projects:
Terrafirma, OneGeology, PanGeo, IGME5000.
INSPIRE data provider for Luxembourg

Name of organisation	42. Ministry for Transport and Infrastructure		
Short name	MTI	Country	Malta

Organisation profile

Malta will be represented in the GeoERA Groundwater theme through the Continental Shelf Department (CSD) within the Ministry for Transport and Infrastructure. The CSD performs the function of the Malta Geological Survey

Roles / tasks in the project	Special relevant skills
Participant in WP6.	• EU water policy • Island and coastal aquifer hydrogeology • Sea-water intrusion • Management of water resources under water scarcity conditions.

Short profile of staff member(s) who will be undertaking the work

Dr Albert Caruana (m) is the Director General of the Continental Shelf Department and oversees Malta's overall participation in GeoERA**. Charles Galea (m)** is a Principal Scientific Officer at the CSD. He is a geoscientist by background and is a coordinator of the GeoERA project in Malta. **Manuel Sapiano (m):** Water Director for Malta, responsible for coordinating the implementation of EU Water Policies in the Maltese islands. Represents Malta on the Groundwater Working Group within the WFD CIS. A hydro-geologist by profession with specialisation in coastal and island groundwater management. **Michael Schembri (m)**, Senior Officer managing the implementation of the EU Water Framework and Floods Directives. Also coordinates hydrological spatial data management systems and groundwater monitoring framework. **Henry Debattista (m):** technical officer providing support on groundwater data management and groundwater modelling exercises.

Publications, infrastructure / technical equipment

National groundwater monitoring framework (quality and quantity) and groundwater database(borehole logs, groundwater level and groundwater quality).

Publications:

*Mangion, J., **Sapiano, M., 2006.** Malta Water Resources Review. Food and Agriculture Organisation of the United Nations. Rome, Italy.*

*Mangion, J**., Sapiano, M. 2007.** The Mean Sea Level Aquifer – Malta and Gozo, in: Edmunds et al. (eds), Natural Groundwater Quality. Blackwell Publishing, Oxford, United Kingdom.*

*Stuart, M.E., Maurice, L., Heaton, T.H.E., **Sapiano**, **M.,** Micallef Sultana, M., Gooddy, D.C. & Chilton, P.J. 2010. Groundwater residence time and movement in the Maltese islands – A geochemical approach. - Applied Geochemistry, 25, 609-620.*

*Heaton, T.H.E., Stuart, M.E., **Sapiano**, **M.** & Micallef Sultana, M. 2012**.** An isotope study of the sources of nitrate in Malta's groundwater. - Journal of Hydrology, Vols. 414/415, 244–254.*

Sapiano, M., Schembri. M., *Brincat, C. 2013**.** State of water resources in Mediterranean Islands, in MEDIWAT, Sustainable management of environmental issues related to water stress in Mediterranean islands, Final conference proceedings.*

Relevant projects/activities

- MARSOL – Demonstrating managed aquifer recharge as a solution to water scarcity and drought (7th Framework Programme)
- MORISO – Monitoring of groundwater resources to limit saline intrusion and pollution by nitrates (Interreg Italia-Malta 2007-2013)
- ERDF346 – Assessment of sub-surface groundwater discharge in the Maltese islands (ERDF 2017-2013)
- WATERMAP- Development and utilization of vulnerability maps for the monitoring and management of groundwater resources (INTERREG-Archimed)

Name of organisation	44. Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy		
Short name	PIG	Country	Poland

Organisation profile

The Polish Geological Institute (PIG) was founded in and is the oldest Polish nation-wide scientific institution. It is involved in comprehensive studies of geological structure of the country for practical use in national economy and environmental protection. In addition to scientific activities in all fields of modern geology the Institute was entrusted with the tasks of the Polish Geological Survey and the Polish Hydrogeological Survey. Moreover, it is responsible for the country's security in supply of mineral resources, the groundwater management, for monitoring of the geological environment and warning against natural hazards and risks.

Roles / tasks in the project	Special relevant skills
Coordination of WP4 Tomasz Gidziński Participant in WP6: Agnieszka Piasecka	Groundwater modelling, elaboration of groundwater regional reports for major groundwater basins and groundwater safe yield for river basins, groundwater monitoring network development, transboundary groundwater monitoring, hydrogeological field investigations, GIS. Elaboration of groundwater regional reports for major groundwater basins and their protection zones, elaboration of groundwater safe yield documentation, hydrogeological field investigations, GIS.

Short profile of staff member(s) who will be undertaking the work

Tomasz Gidziński: Chief specialist in PIG-NRI Hydrogeology and Environmental Geology Program. Program. Over 15 years of experience in hydrogeological and environmental geology studies. Member of bilateral working group of water protection of Polish-Lithuanian Commission of Cooperation on Transboundary Waters. **Rafał Janica:** Chief specialist in PIG-NRI Hydrogeology and Environmental Geology Program. Deputy of Hydrogeology and Environmental Geology Program. Over 20 years of experience in hydrogeological, environmental geology and engineering geology studies. Expert at groundwater modelling. Member of bilateral working group of water protection of Polish-Lithuanian Commission for Cooperation on Transboundary Waters. **Michał Galczak:** Chief specialist in PIG-NRI Hydrogeology and Environmental Geology Program. Over 12 years of experience in hydrogeological studies. GIS specialist. **Agnieszka Piasecka**: Specialist in PIG-NRI Hydrogeology and Environmental Geology Program. Over 7 years of experience in hydrogeological studies.

Publications, infrastructure / technical equipment

[1] Conceptual model of groundwater body GWB No. 22 (which is located in the boundary zone of Poland with Lithuania). Gidziński T., 2009 (in Polish).
[2] Conception of reorganization of national observation-research groundwater monitoring network", Bulletin of the Polish Geological Institute No 445, part 1; *Current Challenges in Hydrogeology*, p. 255-267, Warsaw, Poland, Kazimierski B., Gidziński T., 2011.
[3] Comparison of Ukrainian and Polish groundwater monitoring methodologies in the case of tests made at monitoring points located in the border area, p.159-181; Groundwater Management in the East of the European Union. Transboundary Strategies for Sustainable Use and Protection of Resources. Nałęcz T., Gidziński T., 2011. Springer-Science.
[4] Execution of the work program and hydrogeological reports establishing safe yield of groundwater for needs of carrying out of water management balances and elaboration of water use conditions of water region and a drainage basin. Work program for establishment of groundwater safe yield for *Pregoła* river basin. Gidziński T., Honczaruk M., Janica R., Jarmułowicz –Siekiera M., Kucharczyk K., 2013 (in Polish).
[5] Hydrodynamic numerical model of groundwater body GWB No. 22. Janica R., Gidziński T., 2014 (in Polish).
[6] Execution of the regional hydrogeological report on establishment of protection areas for the major groundwater basin MGB No. 410 (Opoczno) in connection with establishing of protection areas for major groundwater basin No. 410 (Opoczno). *Śmietański L., Olesiuk G., Honczaruk., Śliwiński Ł., Filar S., Piasecka A., Szydło M., 2011 (in Polish).*

[7] Execution of the regional hydrogeological report on establishment of protection areas for the major groundwater basin MGB No. 141 (basin of lower Wisła river) in connection with establishing of protection areas for major groundwater basin No. 141 (basin of lower Wisła river). *Piasecka A., et al. 2013 (in Polish).* [8] Execution of the appendix to the regional hydrogeological report on establishment of protection areas for the major groundwater basin MGB No. 224 (Subzbiornik Podlasie) in connection with establishing of protection areas for major groundwater basin No. 224 (Subzbiornik Podlasie). *Piasecka A., et al. 2015 (in Polish).* [9] GIS data base of major groundwater basin MGB No. 410 (Opoczno), 2011., MGB No. 141 (basin of lower Wisła river), 2013., MGB No. 224 (Subzbiornik Podlasie), *Piasecka A., 2015.*
Relevant projects/activities
NATO project "Sustainable Use and Protection of Groundwater Resources Trans-boundary Water Management". Members of the project: Tomasz Gidziński, Rafał Janica, et al. T. Gidziński - Project manager: "Reorganization, development and adaptation of the national groundwater observation network to requirements of the Water Framework Directive (WFD)". 2009-March. 2012. Project manager of the task of Polish Hydrogeological Survey: Groundwater monitoring in boundary areas of Poland for needs of compliance of international agreements and for international cooperation purposes. T. Gidziński, 2012- rec. T. Gidziński, R. Janica – Experts of bilateral working group of water protection of Polish-Lithuanian Commission for Cooperation on Transboundary Waters A. Piasecka – Team member of the control commission for the major groundwater basins (MGBs) project

Name of organisation	45. Laboratório Nacional de Energia e Geologia		
Short name	LNEG	Country	Portugal

Organisation profile

The National Laboratory of Energy and Geology (LNEG) is a State Laboratory of the Ministry of Economy that makes RD&D oriented to the needs of society and enterprises. LNEG ensures state functions by developing knowledge of the geological and hydrogeological infrastructure of the emerging territory, coastal zones, and contributing to related activities such as exploration and valorization of endogenous resources, prevention and mitigation of geological risks, environment and land use planning and correlated strategic innovative technologies. LNEG undertakes as within its core functions the research on CO2 storage, geothermal assessment and land use valorization. LNEG is also responsible for integrated management and availability of geoscientific contents regarding the Portuguese territory in digital format.

Roles / tasks in the project	Special relevant skills
Work Package Participant WP6	• National responsible for hydrogeological assessment and thematic mapping at several scales. • Building databases and web services for groundwater data.

Short profile of staff member(s) who will be undertaking the work

The staff is from the Department of Geology, Hydrogeology and Coastal Geology:
Ana Paula Pereira (f): senior hydrogeologist, expert in hydrogeological mapping and experienced in geographical information systems. **Carla Midões (f):** senior hydrogeologist, expert in integration of the geologic and hydrogeologic information on SIG with sight to the attainment of Hydrogeology cartography of Portugal and Thematic Cartography. **José Sampaio (m):** Senior hydrogeologist, expert in wells construction, aquifer tests, geochemistry, geophysics, and climatology. Hydrogeological mapping/explanatory books. Studies of the karst aquifer MCE (Portugal) and aquifers of volcanic islands (Azores). CO2 storage in saline aquifers. **Judite Fernandes (f):** senior hydrogeologist, expert on flow and hydrogeochemical modeling, hydrogeophysics, geostatistics, saltwater intrusion, aquifer contamination, aquifer testing, drilling and piezometer construction, monitoring equipment. **Rayco Diaz (m):** senior hydrogeologist, expert in hydrogeochemistry. Nowadays, he is LNEG collaborator and is carrying out a low-enthalpy geothermal assessing project in the LNEG. **Pedro Patinha (m):** is a mining engineer. He currently works at the "Geoscientific Information Unit" of LNEG, is a responsible for the LNEG's geoPortal infrastructure and is expert in mapping and Geographical Information Systems.

Publications, infrastructure / technical equipment

Infrastructure: Geoportal (databases and web services for groundwater data). LNEG's geoPortal is an infrastructure of integrated services to support the management and visualization of spatial data, which aims to provide, in a web environment, geo-referenced information related to the various activities of the LNEG. This application has the following features: 1) Metadata Catalogue: A search and query engine for LNEG's data (according to ISO 19139), which provides information about the existence and availability of Institutional Geographic Information; 2) Online Databases: A set of applications that enables the query of institutional data; 3) Map Viewer: A view and download service of LNEG's maps and spatial information. This application has been fully developed in the context of INSPIRE European Directive (Infrastructure for Spatial Information in Europe) and that it is in accordance with the principles and standards established by this Directive.

Publications:

Portuguese hydrogeological and hydrogeochemical mapping (scales 1/200 000) and explanatory books.

Portuguese geological mapping (scales 1/50 000) and explanatory books, which includes a hydrogeology chapter (national cover).

Almeida, C., Jesus, M. R., Fernandes, J., 1997. Definition, Characterization and Mapping of Portugal Aquifers Systems. Published by FCUL/INAG, 236 p.

Comissão de Coordenação Regional do Alentejo (CCR-A), eds, Study of the Groundwater Resources of Alentejo Region (ERHSA), Évora, 2001.

Relevant projects/activities

Geoportal (http://geoportal.lneg.pt/), Building databases and web services for groundwater data.

Portuguese hydrogeological and hydrogeochemical assessment and mapping (scales 1/200 000 and 1/50 000)

PANGEO - Enabling Access to Geological Information in Support of GMES/Copernicus, http://www.pangeoproject.eu/

OneGeology Europe - creation of dynamic digital geological map data for the Europe, http://www.onegeology.org/

Geo-Seas Project - Pan-European infrastructure for management of marine and ocean geological and geophysical data, http://www.geoseas.eu/

COMET, Integrated Infrasctruture for CO2 Transport and Storage in the West Mediterranean, (CO2 Geological Storage), Colaborative Project, EU 7th Framework Programme (2010-2012). http://comet.lneg.pt

ERHSA Project - Study of the Groundwater Resources of Alentejo Region (southern area of Portugal)

Name of organisation	46. Institutul Geologic al României		
Short name	IGR	Country	Romania

Organisation profile

Institutul Geologic al României was founded in 1906, with the mission of a national geological survey. Now, its research activity covers the fields of mineral resources, hydrocarbon resources, geophysics, hydrogeology, geochemistry, geohazard and geological mapping.
During the late decades, IGR has participated in national and international projects dedicated to raw materials (aggregates, metallic ores, secondary resources), energetic resources (oil, shale gas, geothermal resources), geohazards (landslides, complex impact of mining waste and excavation), geoinformation (mineral resources information networks, implementation of INSPIRE Directive in Romania, free access to geoinformation), ground water chemistry (composition of mineral water, influence of mine waters on surface and underground water sources), CO_2 storage.

Roles / tasks in the project	Special relevant skills
Participation in WP5 & WP6	• Building databases for groundwater data • National responsible for creating hydrogeological maps and spatial plans

Short profile of staff member(s) who will be undertaking the work

Diana Persa - researcher with experience in spatial groundwater modelling with GIS, and statistical analysis, GIS analysis, and water resources management, groundwater vulnerability assessment. **Dr. Radu Farnoaga -** senior researcher with experience in the fields of research and protection of drinking water resources, elaboration of the technical projects regarding water supply wells design, completion and testing; processing and interpretation of the data provided by the above-mentioned wells, water resources management. **Dr. Albert Baltres** - senior researcher expert in geology, geomorphology, and geological mapping. **Dr.Marian Munteanu:** experience in economic geology, geological exploration, ore deposits, environmental impact of mining; reserve/resource classification, implementation of INSPIRE Directive in Romania, themes Geology and Mineral Resources. **Dr. Stefan Marincea** - senior researcher mineralogy, crystal chemistry, geochemistry, petrology.

Publications, infrastructure / technical equipment

- Geological Maps of Dobrogea, scale 1:50 000.
- Delineation and characterization of geothermal reservoirs in the Southern part of the Pannonian Basin, Ágnes Rotár-Szalkai, László Zilahi-Sebes, Ágnes Gulyás, Gyula Maros, László Bereczki, Annamária Nádor, Andrej Lapanje, Tamara Markovic, Ana Vranjes, Radu Farnoaga, Natalja Samardzic, Boban Jolovic.
- Area mapping of superficial geothermic resources by soil and groundwater data in Constanta County, Romania, Diana Perşa, Anca Vijdea, The Journal of Environmental Protection and Ecology,BENA,2012.
- The Basic measures against diffuse pollution in water quality of the ground water bodies and surface water bodies, Rosu Alina Letitia, Damian Gabriela, Persa Diana, published in The papers of the XXIII Conference of The Danubian Countries on The Hydrological Forecasting and Hydrological Bases of Water Management, 28 - 31 August 2006, Belgrade - Republic of Serbia.
- Significant sources of diffuze pollution for Dobrogea Region, Romania - H.Uzun, D. Persa. Published in The Official Journal of Balkan Environmental Association, 2004, vol. 2.

Relevant projects/activities

- Hydrogeological Maps of Romania, scales 1:500 00, and 1:50 000.
- Maps of thermal and mineral waters.
- Combined Heat Power and Metals, acronym: CHPM2030, financed by Horizon 2020 (http://www.chpm2030.eu/)
- Danube Region Leading Geothermal Energy, acronym: DARLINGe financed by INTERREG Danube Transnational Programme (http://www.interreg-danube.eu/approved-projects/darlinge).

Name of organisation	47. Geological Survey of Serbia		
Short name	GSS	Country	Serbia

Organisation profile
GSS was formed based on the Mining and Geological Investigations Law („Official Gazette RS“, no. 88/2011) On 29. 06. 2012. Geological Survey of Serbia was formed from Geological Institute of Serbia, organization with long history. First organization was the Geological Institute of the Kingdom of Yugoslavia, formed 1930. Geological Survey of Serbia has three geological departments: Fundamental Geology, Mineral Resources, Geotechnic and Hydrogeology, as well as Groups for Geophysical investigation and Laboratory for rocks, ores, soil and water analysis. Our mission is to create geological, geomorphological, geochemical, hydrogeological and engineering geological maps, protect geodiversity and geoheritage, protection and promotion of the environment, investigation of mineral resource deposits.

Roles / tasks in the project	Special relevant skills
Participation in WP6	• Building databases for groundwater data • National responsible for creating hydrogeological maps and spatial plans • Groundwater monitoring

Short profile of staff member(s) who will be undertaking the work
Tanja Petrović Pantić (PhD) (f) is a senior hydrogeologist at Department of Geotechnic and Hydrogeology. She holds an MSc (2010) and a PhD (2014) in hydrogeothermal resources. Research focuses are thermal and mineral waters, geothermal energy, hydrogeochemistry. **Katarina Samolov (MS) (f):** Engineer of geology (hydrogeology), Department of Geotechnic and Hydrogeology and PhD student at University of Belgrade. Fellow worker on Groundwater projects and participant in UNDP Beware Project of Unifying landslide data standards and creating landslide database.

Publications, infrastructure / technical equipment
• Petrović Pantić T., Mandić M., Samolov K. (2016) Hydrogeology and water management issues in the areas of Kosmaj, Mladenovac, Smederevo and Smederevska Palanka, Vodoprivreda 0350-0519, Vol. 48 (2016) No. 282-284 p. 267-275 • Petrović Pantić T., Veljković Ž., Samolov K. (2015) Creating the basic hydrogeological maps (BHGM) with purpose of managing the groundwater resources in Serbia, IWA 7th Eastern European Young Water Professional Conference • Petrović, T., Zlokolica-Mandić, M., Veljković, N., Papić, P., Stojković, J. (2012) Chapter 19. Geochemistry of Bottled Water in Serbia, in F.F. Quercia and D. Vidojevic (eds.), Clean Soil and Safe Water, NATO Science for Peace and Security Series C: Environmental Security, XVII, 247-266 p, Springer, Dordrecht • Petrović, T., Zlokolica-Mandić, M., Veljković, N., Papić, P., Poznanović, M., Stojković, J., Magazinović, S. (2012) Macro and micro elements of bottled waters and water from public water supply in Serbia, Chemical Industry 66 (1) 107-122 • Petrović, T., Zlokolica-Mandić, M., Veljković, N., Vidojević, N. (2010) Hydrogeological Conditions for the Forming and Quality of Mineral Waters in Serbia, Journal of Geochemical Exploration 107 (2010), pp. 373-381

Relevant projects/activities
• Hydrogeological maps, scale 1:100.000 • Spatial plans of Municipalities of the Republic of Serbia • Alternative groundwater sources for public water supply • Preparation of technical basis for creating the hydrogeological maps

Name of organisation	49. Geološki zavod Slovenije		
Short name	GZS	Country	Slovenia

Organisation profile

Geological Survey of Slovenia (GZS) is a public research organisation established by the Government of the Republic of Slovenia. The Survey carries out fundamental, applied, developmental and object research within all geological branches and related fields of work. It consists of research – programme groups and geological expert services. The research programs cover all the fields of geology that are of national importance. The main goals are contributing to the knowledge about geological composition of the national territory, production of geological maps, assessment of geological hazards, natural and anthropogenic, to living environments, assessment of threats to geological environment due to pollution and other anthropogenic factors, assessment of groundwater, mineral resources and geothermal energy resources, assessment of natural geological heritage, and development of geological knowledge and research methods.

Roles / tasks in the project	Special relevant skills
Participant in WP6 – resources map Participant in WP5 - karst	• Hydrogeological modelling • Remote sensing • Statistical analysis • Spatial modelling with GIS

Short profile of staff member(s) who will be undertaking the work

dr. Mitja Janža (m) - senior researcher with experiences in hydrological modelling, GIS analysis, remote sensing, and water resources management.
dr. Sonja Cerar – researcher with experiences in groundwater quality and protection, spatial groundwater modelling with GIS, and statistical analysis.
dr. Janko Urbanc - senior researcher with experiences in the fields of research and protection of drinking water resources, water resources management, groundwater hydrochemistry, isotope geochemistry and tracer hydrology, agricultural impacts on groundwater quality

Publications, infrastructure / technical equipment

- *CERAR, Sonja. A spatial model of groundwater chemical composition in Slovenia in GIS environment : Ph. D. thesis. Ljubljana: 2016. pp 187.*
- *JANŽA, Mitja, ŠRAM, Dejan, MEZGA, Kim, ANDJELOV, Mišo, UHAN, Jože. The assessment of the required groundwater quantity for the conservation of groundwater dependent ecosystems and the achievement of a good ecological status of surface waters. Geologija. 2016, 59/2, pp. 221-232. doi:10.5474/geologija.2016.000*
- *JANŽA, Mitja. Impact assessment of projected climate change on the hydrological regime in the SE Alps, Upper Soča River basin, Slovenia. Natural hazards, 2013, 67/3, pp. 1025-1043, doi: 10.1007/s11069-011-9892-7.*
- *KOMAC, Marko, URBANC, Janko. Assessment of spatial properties of karst areas on a regional scale using GIS and statistics - the case of Slovenia. Journal of caves and karst studies : a publication of the National Speleological Society, 74/ 3, pp. 251-261, doi:* 10.4311/2010ES0188R.
- *URBANC, Janko, MEZGA, Kim, ZINI, Luca. An assessment of capacity of Brestovica - Klariči karst water supply (Slovenia). Acta carsologica, 2012, 41/ 1, pp. 89-100,* http://carsologica.zrc-sazu.si/downloads/411/Mezga.pdf.

Relevant projects/activities

- *Preparation of expert basis and support in implementation of Water framework directive (Directive 2000/60/EC) in the field of groundwater (2013-2015)*
- *HYDROKARST - Karstic aquifer as strategic cross-border water source (Interreg Italia – Slovenia, 2012 – 2015)*
- *ASTIS - Underground waters cross-borders aquifer Isonzo/Soča (Interreg Italia – Slovenia, 2011 – 2014)*
- *Istra-Hidro - Sustainable transboundary groundwater resources management between Gulfs of Trieste and Kvarner (2013-2015)*
- *Improved management of contaminated aquifers by the integration of source tracking, monitoring tools and decision strategies INCOME, (LIFE) (2009-2012)*

Name of organisation	50. Instituto Geológico y Minero de España (Geological Survey of Spain)		
Short name	IGME-Spain	Country	Spain

Organisation profile

The Spanish Geological Survey (IGME) is a Public Research Organization, an autonomous institution attached to the Ministry of Economy and Competitiveness. It was founded in 1849 and is the main Earth Sciences Research Centre of Spain. A staff of 400 employees, 185 graduated, specialized in various fields of activity such as geology, environment, hydrogeology, mineral resources, natural hazards and land use planning. IGME-Spain facilities, including its headquarters, project offices in several places around the country, laboratories, warehouses, drill core repository, library and museum, are equipped with advanced technology and technical resources. IGME is the national centre for the creation of knowledge infrastructure, information and R&D in Earth Sciences.

Roles / tasks in the project	Special relevant skills
Participation in WP5 & WP6	Time series analysis, spectral analysis, geostatistical analysis, GIS analysis, Remote Sensing Analysis, Statistical Analysis. Characterisation and mapping of hydrogeological Systems.

Short profile of staff member(s) who will be undertaking the work

Eulogio Pardo-Igúzquiza (m) Senior Researcher. 101 SCI papers. Marie Curie Fellowship. Ramón y Cajal Fellowship. Postdoctoral positions in Massachusetts Institute of Technology (USA), University of Leeds (UK) and University of Reading (UK).
David Pulido-Velazquez (m), Senior Researcher. Field of expertise in hydrology and water resources. Research at country scale (Pulido-Velazquez et al., 2017). Team member in EU projects (eg. GENESIS (GW and Dependent Ecosystems) FP7; leader Projects: GESHYDRO (Future scenarios of surface and GW hydrology); GESINH-IMPADAPT (Impacts and adaptation to GC). 21 Q1 papers.
Juan de Dios Gómez-Gómez (m). Senior hydrogeologist, expert in groundwater modeling, coastal aquifers, water resources assessment and management and GIS. Member of the EuroGeoSurveys Water Resources Expert Group.
Juan José Durán Valsero (m). Senior Researcher. Director of the Department of Geological Resources.

Publications, infrastructure / technical equipment

Pardo-Igúzquiza E., Durán-Valsero J.J., Dowd P.A., Guardiola-Albert C., Liñan-Baena C. and Robledo-Ardila P.A., 2012. Estimation of spatio-temporal recharge of aquifers in mountainous karst terrains: application to Sierra de las Nieves (Spain). Journal of Hydrology, 470-471, 124-137.
Pardo-Igúzquiza, E., Durán, J.J, Luque-Espinar, J.A., Robledo-Ardila, P.A., Martos-Rosillo, S., Guardiola-Albert, C., Pedrera, A., 2015. Karst massif susceptibility from rock matrix, fracture and conduit porosities: a case study of the Sierra de las Nieves (Málaga, Spain). Environmental Earth Sciences, 74, 7583–7592.
Pulido-Velazquez, D., Collados-Lara, Antonio-Juan, Alcalá, Francisco J., 2017, Assessing impacts of future potential climate change scenarios on aquifer recharge in continental Spain. Journal of Hydrology. Published on line. https://doi.org/10.1016/j.jhydrol.2017.10.0770022-1694/_ 2017 Elsevier B.V. All rights reserved.

Relevant projects/activities

- Development of novel geomathematical methods for advanced karst research: implications in climate change and planetary geology. Research Project CGL2015-71510-R
- ENV.2008.2.1.2.1 GA 226536 CP-IP, GENESIS (23/4/2009-23/4/2014). Groundwater and Dependent Ecosystems. European Commission's 7th Framework Programme. Coordinator: J. Klove (Univ. of Oulu).
*- CGL2013-48424-C2-2-R. **GESINH-IMPADAPT (**1/1/2014- 31/12/2016**)**: Generation, simulation and integration of future hydrological scenarios within the analysis of **impacts and adaptation to global change** on WR systems. National Research Program. Plan Estatal de I+D+I 2013). **PI): D. Pulido-Velazquez** (IGME).*
*- CGL2009-13238-C02-01. GESHYDRO (01/01/2010 – 30/06/2014): **Generation and simulation of future scenarios** of surface and groundwater hydrology. National Research Program (Plan Nacional I+D+i 2008-2011). **PI: D. Pulido-Velazquez** (IGME).*

Name of organisation	51. Institut Cartogràfic i Geològic de Catalunya (Cartographic and Geological Institute of Catalonia)		
Short name	ICGC	**Country**	Spain

Organisation profile

The ICGC is the official mapping and geological agency of the autonomous government of Catalonia. The ICGC sum-up the legacies of the former cartographic and geological agencies, both created in 1982 and belongs to the Department of Territory and Sustainability of the Government of Catalonia. The ICGC has a staff around 270 people and is a beginning-to-end cartographic and geological institution comprising: a) data acquisition owning 3 airplanes and 7 sensors, skilled staff in the use of satellite imagery, geophysical instrumentation and geotechnics equipment, b) processing capabilities, c) technical support to land and urban planning, d) geological resources analysis (hydrogeology, geoenergies, mineral resources and soils), d) geological hazards assessment and prevention. One of the main missions of the ICGC is to obtain, process, supply and disseminate geoscientific information on the Catalan territory.

Roles / tasks in the project	Special relevant skills
• *Participation in WP5 (chalk&karst) Tasks 5.1, 5.2, 5.4 and 5.5* • *Participation in WP6 (gw resources map) Tasks 6.1, 6.2, 6.3, 6.4 and 6.5*	• Hydrogeological mapping • 3D geomodelling • Building and manage databases and web services • Applied geochemistry • Groundwater resources estimation

Short profile of staff member(s) who will be undertaking the work

Dr. Joan Palau (m): Ph.D. in Geology. Professor in the University of Barcelona during 3 years in the petrology and geochemical department. More than 35 years of professional experience working as CEO in *Geocat, Gestió de projectes. S.A.* and currently Deputy Director of Geology and Geophysics at ICGC. Degree in Business administration. **Mr. Ignasi Herms (m)**: head of the geological resources department at ICGC. Senior geologist, hydrogeologist and mining engineer technician, project coordinator and expert on groundwater modelling. Project coordinator of: GIS programs for hydrogeological and soil mapping, applied hydrogeology for civil/mining works and environmental impact, 3D reservoir flow and applied hydrochemistry. PhD (in progress) at Mining Engineering and Natural Resources Department (EPSEM-UPC) titleholder *'Hydrogeochemistry in the karst aquifer system of the massif Port del Comte''.* **Ms. Georgina Arnó (f)**: project manager and responsible for the hydrogeology and geothermal team at ICGC. Senior geologist and hydrogeologist expert on groundwater mapping and modelling. Collaborating teacher on groundwater at Polytechnic University of Catalonia (UPC). **Ms. Montse Colomer (f):** senior geologist and hydrogeologist. Expert in GIS programs, hydrogeology mapping, databases and 3D geological modelling. **Mr. Víctor Camps (m):** senior geologist and hydrogeologist. Expert in acquisition and processing of hydrogeological and geothermal data and hydrogeological mapping.

Publications, infrastructure / technical equipment

Herms, I., Soler, A., Jorje, J., Vadillo, I. (2017). Isotopic and hydrogeochemical characterization of karst aquifer in the Port del Comte massif (Lleida, Spain). KG@B 2015, International Conference on Groundwater in Karst. 20-26 June 2015. Birmingham, UK

Herms, I. (2017). Aplicación de la geoquímica isotópica del agua a la comprensión del modelo conceptual del acuífero carbonatado kárstico del macizo del Port del Comte (Lleida, Spain)'. XII CONGRESO NACIONAL Y XI IBÉRICO DE GEOQUÍMICA (Linares, Jaén)

Arnó, G., Camps, V., Colomer, M. et al (2016). Caracterización geoquímica ambiental de las aguas subterráneas en el ámbito del complejo minero de Bellmunt y el Molar (Priorat). Jornada Hidrogeología emergente. 50 CIHS. ISBN 978-84-921469-3-2.

Navarro, A., Arnó, G., Camps, V., et al (2016). Incidencia ambiental de las actividades mineras en la zona del Priorat (Tarragona). IX Congreso de la Sociedad Geológica de España. Huelva.

Navarro, A., Herms, I., Cirés et al. (2016). Estimación del fondo geoquímico para metales en suelos y sedimentos en el antiguo distrito minero del Priorat (Tarragona). IX Congreso de la Sociedad Geológica de España. Huelva.

Database on subsurface information (boreholes, water point's database, groundwater heads and groundwater quality data). Geological and Hydrogeological maps at different scales and WMS available at http://icgc.cat/Administracio-i-empresa/Eines/Visualitzadors-Geoindex.

Relevant projects/activities

- *Hydrogeological database generation and management*
- *Hydrogeochemistry in karst aquifers systems*
- *Hydrogeological mapping at 1:25 000 scale including new data adquisition*
- *Aquifer characterization and delimitation*
- *Groundwater vulnerability mapping*

Name of organisation	52. Sveriges Geologiska Undersökning		
Short name	SGU	**Country**	Sweden

Organisation profile

The Geological Survey of Sweden (SGU) is the national expert agency for issues relating to bedrock, soil and groundwater in Sweden. One key task is to meet society's need for geological information. SGU is a governmental body governed by The Ministry of Enterprise and Innovation.
•Supporting the increase of mineral exploration interest and the sustainable development of mining, and quarrying industry
•Promoting the use of geological information in societal planning
•Consolidating and strengthening geological research in Sweden
•Bringing geology and geo-scientific knowledge to the fore in social debate and in schools
The Mining Inspectorate is a separate decision-making body within SGU. It is responsible for issuing permits for minerals exploration and exploitation under the Swedish Minerals Act.

Roles / tasks in the project	Special relevant skills
Participant in WP5 & WP6	• Hydrogeological mapping • Groundwater resources estimation

Short profile of staff member(s) who will be undertaking the work

Mattias Gustafsson (m): Leader of SGU groundwater resources mapping.

Publications, infrastructure / technical equipment

https://www.sgu.se/en/groundwater/
https://apps.sgu.se/kartvisare/kartvisare-grundvattenmagasin.html

Relevant projects/activities

Please provide a list of up to 5 relevant projects or activities connected to the subject of the proposal.

Name of organisation	53. State Research and Development Enterprise “State Informational Geological Fund of Ukraine”		
Short name	GIU	**Country**	Ukraine

Organisation profile
The State Research and Development Enterprise "State Informational Geological Fund of Ukraine" – SRDE “GeoInform of Ukraine”, or GEOINFORM is the specialized research and development unit of the State Geological and Subsurface Survey of Ukraine which collects, stores, analyzes and provides information received from geological study and use of subsurface. GEOINFORM conducts research work on monitoring of mineral resources of Ukraine on the basis of geological and mining activities during the year, recording deposits and making public the balance of mineral resources management of the State fund of deposits and occurrences (more than 10,000 objects recorded), synthesis and analysis of exploration for oil and gas, creating a system of state accounting of oil and gas wells, completion and maintenance of the State cadastre of mineral deposits and occurrences as well as State cadastre of groundwater deposits of Ukraine.

Roles / tasks in the project	**Special relevant skills**
Participation in WP4 & WP6	Building databases and web services for subsurface data

Short profile of staff member(s) who will be undertaking the work
Dr. hab. Boris Malyuk (m): Director for International Cooperation, graduated in 1981 from Department of Geology, Lviv University, Ukraine, and in 1999 from Centre of Geostatistics, Ecole des Mines de Paris, France. Obtained Candidate of Science (PhD) Degree in Geotectonics in 1984, and extended Doctor of Science Degree in Petrology in 1991. National Delegate of Ukraine to the EuroGeoSurveys. In the Project he will contribute to general project management, raw materials and geoscientific data systems. **Tetiana Biloshapska (f):** Chief Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1980. She is experienced in field works. She had studied mineral-resource base of Ukraine for more than 30 years, took part and led projects on prospecting and exploration of mineral deposits, conducted regional geological studies. **Natalia Pyshna (f):** Chief, Division of groundwater resources inventory. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1987. She has experience in the sphere of hydrogeological studies for fresh and mineral water of Ukraine for more than 30 years. She represents SGSSU in the EU project 'Water Initiative for Eastern Partnership' (EUWI+4EaP). **Larysa Lopata (f):** Senior Hydrogeologists, Division of groundwater resources inventory. Graduated from Kyiv National University under specialty 'Hydrogeology' in 2004. She has experience in the sphere of hydrogeological studies for mineral groundwater of Ukraine for more than 10 years. **Mykola Danevych (m):** Leading Hydrogeologists, Division of groundwater resources inventory. Graduated from Kyiv National University under specialty 'Geography, Geoecology' in 2003. He has experience in the sphere of hydrogeological and geological-ecological studies for more than 10 years. **Lesia Babichenko (f):** Leading Hydrogeologists, Division of groundwater resources inventory. Graduated from Ukraine National Technical University 'Kyiv Polytechnic Institute' under specialty 'Ecology' in 2007. She is experienced in hydrogeological studies, environment protection, specifically, groundwater protection.

Publications, infrastructure / technical equipment
Interactive map of mineral deposits of Ukraine (in Ukrainian) http://geoinf.kiev.ua/wp/interaktyvna-karta-rodovyshch-korysnykh-kopalyn.htm Interactive map of mineral licenses (in Ukrainian) http://geoinf.kiev.ua/wp/interaktyvni-karty-spetsdozvoliv.htm Interactive geological map of Ukraine 1:1 000 000 (in Ukrainian) http://geoinf.kiev.ua/wp/Interaktyvna-heolohichna-karta-Ukrayiny.htm Interactive geological map of Ukraine 1:1 000 000 (in English) http://geoinf.kiev.ua/wp/Interactive-Geological-Map-of-Ukraine.htm Interactive State Geological Map of Ukraine 1:200 000 (in Ukrainian with English entries) http://geoinf.kiev.ua/wp/kartograma.htm

Relevant projects/activities
ESTMAP - EU EUOGA - EU NUMIRE – Norway-Ukraine (NGU/SGSSU) EIMIDA – Norway-Ukraine (NGU/Geoinform)

<table>
<tr><td>Name of organisation</td><td colspan="3">54. Natural Environment Research Council</td></tr>
<tr><td>Short name</td><td>NERC</td><td>Country</td><td>United Kingdom</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">The Natural Environment Research Council (NERC) is the UK's largest funder of independent environmental science including basic, strategic and applied research and monitoring. The British Geological Survey (BGS), one of its research institutes, will represent NERC. BGS is the world's longest established national geological survey. It seeks to advance the understanding of the structure, properties and processes of the solid Earth system through interdisciplinary surveys, monitoring and research for the benefit of society. BGS is a public sector organization responsible for advising the UK government on all aspects of geosciences, as well as providing impartial geological advice to industry, academia and the public.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">Participant in WP5 & WP6</td><td colspan="2">• Hydrogeological 3D-mapping; aquifer properties, vulnerability and risk modelling
• Groundwater protection policy and development of risk assessment tools
• Mapping and modelling of karst systems
• Integrated management of groundwater and forecasting of future behaviour</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Robert Ward: BGS' Director of Groundwater Science. He is UK nominated representative on the European Commission (EC) expert advisory group for groundwater (WG C)/
John Bloomfield: Principal Hydrogeologist with specialism in groundwater system behavior under impacts of environmental change
Lou Maurice: Senior hydrogeologist who is a karst hydrogeology specialist and is currently a NERC Knowledge Exchange Fellow on the topic.
Andrew Newell: Senior Geologist -expert in 3D geological modelling using SKUA-GOCAD and GIS</td></tr>
<tr><td colspan="4">Publications, infrastructure / technical equipment</td></tr>
<tr><td colspan="4">NERC KE Fellowship – www.bgs.ac.uk/research/groundwater/about/karstAquifers/home.html
BGS Groundwater Science - http://www.bgs.ac.uk/research/groundwater/
Allen, D., Darling, W., Davies, J., Newell, et al., 2014. Groundwater conceptual models: implications for evaluating diffuse pollution mitigation measures. Quarterly Journal of Engineering Geology and Hydrogeology 47, 65-80.
Maurice, L.D. et al. 2012. The nature and distribution of flowing features in a porous limestone aquifer with small-scale karstification. Journal of Hydrology. 438-439, 3-15.
Mackay, J.D.; Jackson, C.R.; Brookshaw, A.; Scaife, A.A.; Cook, J.; Ward, R.S. 2015. Seasonal forecasting of groundwater levels in principal aquifers of the United Kingdom. Journal of Hydrology, 530. 815-828. 10.1016/j.jhydrol.2015.10.018</td></tr>
<tr><td colspan="4">Relevant projects/activities</td></tr>
<tr><td colspan="4">http://www.bgs.ac.uk/research/groundwater/waterResources/
http://www.bgs.ac.uk/research/groundwater/waterResources/GroundwaterInUK/
http://www.bgs.ac.uk/research/groundwater/modelling/
http://www.bgs.ac.uk/research/groundwater/catchment/
www.bgs.ac.uk/research/groundwater/about/karstAquifers/home.html</td></tr>
</table>

Name of organisation	13. Eesti Geoloogiakeskus		
Short name	EGT	Country	Estonia
Organisation profile			
The Geological Survey of Estonia (GSE) is a state agency responsible the activities in geology and hydrogeology in Estonia and operates under the governance of Minister of Economy. GSE assembles the geology, hydrogeology and environmental expertise in one place and its main aim is to provide the high-quality information to other state agencies, local authorities and businesses for environmental research, the planning processes and the management of mineral resources in Estonia. The main activities and competencies of the Geological Survey of Estonia are in following fields of geological mapping; marine geological surveys, mineral resources surveys, hydrogeology and geophysical research, and environmental research. GSE is also responsible for compiling, updating and management of geology, hydrogeology databases, the storage of drill cores and rock samples and it conducts the seismic, groundwater, and seacoast surveillance.			
Roles / tasks in the project		**Special relevant skills**	
Participant in WP6		Building databases Groundwater modelling Geological Mapping Groundwater geochemical studies	
Short profile of staff member(s) who will be undertaking the work			
Andres Marandi (m), PhD: – Head of Hydrogeology Department. Has long-term experience of international research projects. Professional experience in the field of groundwater modelling and geochemical studies. **Valle Raidla (m), PhD:** senior hydrogeologist. Is responsible for geochemical and isotope studies of groundwater. **Maile Polikarpus(f), MSc**: – hydrogeologist. Is responsible for groundwater modelling studies and compilation of GIS databases of groundwater.			
Publications, infrastructure / technical equipment			
- *Gerber, C.; Vaikmäe, R.; Aeschbach, W.; Babre, A.; Jiang, W.; Leuenberger, M.; Lu, Z-T. ; Mokrik, R.; Müller, P.; **Raidla, V**.; Saks, T.; Waber, H.; Weissbach, T.; Zappala, J. C.; Purtschert, R. (2017). Using 81Kr and noble gases to characterize and date groundwater and brines in the Baltic Artesian Basin on the one-million-year timescale. Geochimica et Cosmochimica Acta, 205, 187−210.10.1016/j.gca.2017.01.033.* - *Pärn, Joonas; **Raidla, Valle**; Vaikmäe, Rein; Martma, Tõnu; Ivask, Jüri; Mokrik, Robert; Erg, Katrin (2016). The recharge of glacial meltwater and its influence on the geochemical evolution of groundwater in the Ordovician-Cambrian aquifer system, northern part of the Baltic Artesian Basin. Applied Geochemistry, 72, 125−135.10.1016/j.apgeochem.2016.07.007.* - *Islam, M. B.; Firoz, A. B. M.; Foglia, L.; **Marandi, A.;** Khan, AR.; Schuth, C.; Ribbe, L. 2017. A regional groundwater-flow model for sustainable groundwater-resource management in the south Asian megacity of Dhaka, Bangladesh. Hydrogeology Journal Volume: 25: 3, 617-637* - *Sahib, L.; **Marandi, A**.; Schueth, C. 2016. Strontium isotopes as an indicator for groundwater salinity sources in the Kirkuk region, Iraq. Science of the Total Environment. 562: 935-945* - ***Marandi, A.,** Karro, E., Polikarpus, M., Jõeleht, A., Kohv, M., Hang, T., Hiiemaa, H. 2013. Simulation of the hydrogeologic effects of oil-shale mining on the neighbouring wetland water balance: case study in north-eastern Estonia. Hydrogeology Journal, 21(7), 1581 – 1591.*			
Relevant projects/activities			
Groundwater Modelling of Regional Mining effects in NE Estonia. Assessment of the Status of Groundwater Bodies in Estonia Hydrogeological Mapping of Estonia Geochemical Studies of the Groundwater of Mining Areas in Estonia			

Name of organisation	35 Regione Umbria – Servizio Geologico		
Short name	RU	Country	Italy

Organisation profile

RU (Geological and Seismic Survey) is a technical entity of Regione Umbria (public body). Its missions and activities are: Increasing knowledge and understanding of geology, groundwater resources, raw materials and geothermal issues) performing regional studies even through Geological Data Base and GIS to support policy makers and local governments providing them with essential information and technical assistance needed to regulate with uniform laws geological activities and manage natural resources even through long-term planning and legislation; Evaluation of geologic and earthquake hazard even through geology, seismic and geomorphology mapping of the territory in Umbria and the dissemination of geological data and information to the general public; Hydrogeological risk assessment, pursuing landslide investigations and forecasts, providing technical assistance to respond to landslide emergencies and strategic approaches for the mitigation of hydrogeological risk in terms of economic cost and of environmental safety, including procedures for the protection of infrastructures with relevant environmental impact; Management of regional seismographic network and geotechnical control stations.

Roles / tasks in the project	Special relevant skills
Participant in WP6	

Short profile of staff member(s) who will be undertaking the work

Andrea Motti (m): born in 1962, senior geologist, he works for RU since 1992, expert in geology, structural geology, seismic hazard. Author of 65 publications (geological mapping, geological survey, seismic hazard, geological engineering, web mapping. Presently head of P.O. “Geological characteristics of the Umbria area”. Public works inspector.

Publications, infrastructure / technical equipment

Relevant projects/activities

Name of organisation	Geologischer Dienst Nordrhein-Westfalen		
Short name	NRW	**Country**	Germany

Organisation profile

GD NRW is the Geological Survey of North Rhine-Westphalia, being responsible for providing geological advice and information to the government and the public. The tasks of the Survey include geological and hydrogeological surveying, mapping and modelling. Other topics are soil, raw materials, geophysical and geotechnical underground properties as well as geothermal energy. GD NRW produces a range of products including maps, databases and publications. Many of these informations are freely accessible through our online services.

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Roles / tasks in the project	Special relevant skills
Contribution to WP3 H3O-plus (non-funded)	• Hydrogeological characterisation • 3D geomodelling of cross-border regions • GIS

Short profile of staff member(s) who will be undertaking the work

Heinz Elfers (m): Senior Scientist/Geologist; head of the sub department “Geological Information Systems”, data mamagement, hydrogeological mapping

Bernd Linder (m): Senior Scientist/Geologist, experiences in 3D geological modelling, cross-border projects, hydrogeology

Publications, infrastructure / technical equipment

Hydrogeological mapping (scales 1/50 000, 1/100 000)
Geological mapping (scales 1/50 000, 1/100 000)
WMS-Services, WFS-Services

Relevant projects/activities

- H3O-ROSE (2016-present): cross-border harmonization of 3D hydrogeological models within the Dutch-German cross-border region.
- Hydrogeological 3D-modelling of different areas in North-Rhine Westphalia as base for hydrological modelling
- https://www.gd.nrw.de
- https://www.opengeodata.nrw.de/produkte/geologie/

5 Ethics and Security

5.1 Ethics

Have you completed an ethics self-assessment? YES, see Tabel below

Does your research involve Human Embryonic Stem Cells (hESCs)?	NO
Does your research involve human participants?	NO
Does your research involve human cells or tissues	NO
Does your research involve personal data collection and/or processing?	NO
Does your research involve animals?	NO
In case non-EU countries are involved, do the research related activities undertaken in these countries raise potential ethics issues?	NO
Does your research involve the use of elements that may cause harm to the environment, to animals or plants?	NO
Does your research involve the use of elements that may cause harm to humans, including research staff?	NO
Does this research involve dual-use items in the sense of Regulation 428/2009, or other items for which an authorisation is required?	NO
Could your research raise concerns regarding the exclusive focus on civil applications?	NO
Does your research have a potential for misuse of research results?	NO
any other ethics issues that should be taken into consideration	NO

5.2 Security

Please indicate if your project will involve:

- Activities or results raising security issues: NO
- 'EU-classified information' as background or results: NO

5.9 TACTIC

Title of project proposal

Tools for Assessment of ClimaTe change ImpacT on Groundwater and Adaptation Strategies (TACTIC)

Abstract (max. 250 words)
Climate change already have widespread and significant impacts in Europe, which is expected to increase in the future. To reduce the damage, detailed assessments, based on a thorough understanding of the hydrological system, are required for the planning of optimal adaptation strategies. Groundwater plays a vital role for the inland freshwater cycle, and have the capability of buffering or enhancing the impact from extreme climate events causing droughts or floods, depending on the subsurface properties and the status of the system (dry/wet) prior to the climate event. Understanding and taken the hydrogeology into account is therefore essential in the assessment of climate change impacts. The Geological Survey Organisations in Europe acquire the necessary data and knowledge of the groundwater system and some Surveys already have high-end expertise in utilising this in climate change assessments. To streamline the assessments to produce harmonised results at EU scale, and to contribute to a general enhancement of the assessments, the Surveys will collaborate in TACTIC on the development of a research infrastructure for the advancement and harmonisation of climate change assessments utilising knowledge and data on the groundwater system, which is tested in pilots covering most climate challenges and hydrogeological conditions in Europe. Supplying data and results to a European Information Platform for storage and visualisation, TACTIC will further contribute to easy access of information relevant to climate change assessments, which may be used directly or integrated into future decision support systems.

Please indicate the SRT
Groundwater – GW2-Tools for climate change impact assessment and adaptation

List of participants

#	Acronym	Participant Legal Name	Institution	Country
12	GEUS	Geological Survey of Denmark and Greenland [Project coordinator]		Denmark
1	TNO	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek	Geological Survey of the Netherlands	Netherlands
1a	DLT	Deltares		Netherlands
9	HGI-CGS	Hrvatski Geološki Institut		Croatia
14	GTK	GeologianTutkimuskeskus		Finland
15	BRGM	Bureau de Recherches Géologiques et Minières		France
17	BGR	Bundesanstalt für Geowissenschaften und Rohstoffe		Germany
27	MBFSZ	Mining and Geological Survey of Hungary		Hungary
29	GSI	Geological Survey of Ireland		Ireland
30	ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale		Italy
31	SGSS	Regione Emilia-Romagna		Italy
39	LEGMC	Latvijas Vides, Geologijas Un Meteorologijas Centrs Sia		Latvia

42	MTI	Ministry for Transport and Infrastructure		Malta
45	LNEG	Laboratório Nacional de Energia e Geologia		Portugal
47	GSS	Geološki zavod Srbije		Serbia
50	IGME[1]	Instituto Geológico y Minero de España		Spain
51	ICGC	Institut Cartogràfic i Geològic de Catalunya		Spain
52	SGU	Sveriges Geologiska Undersökning		Sweden
53	GEOINFORM	State Research and Development Enterprise State Information Geological Fund of Ukraine		Ukraine
54	NERC	Natural Environment Research Council	British Geological Survey	United Kingdom

1 Excellence

1.1 Aims and objectives

The Synthesis Report[2] of the fifth assessment report by the Intergovernmental Panel on Climate Change (IPPC) concludes that human influence on climate change is clear and growing. The European Environmental Agency reports recent studies to show that the observed climate changes are already having widespread impact on ecosystems, economic sectors and human health and well-being in Europe[3]. The impact of climate changes are, however, different in the different regions of EU, where the Mediterranean region is prone to heatwaves and droughts, while the northern regions are subject to increased coastal flooding, more extreme precipitation and inland flooding. More extreme weather conditions are anticipated with generally less precipitation in summer but more during winter, and the impact is expected to increase in the future, both with respect to droughts and coastal as well as inland flooding, possibly with a very strong increase in the overall climate hazard[4]. At EU level, total water abstraction is almost evenly distributed between groundwater and rivers[5]. However, while surface waters react rapidly to meteorological conditions, groundwater, with a volume approximately 30 times larger than surface water, has a unique buffering capacity and plays a crucial role on the inland freshwater cycle and thus also on the impact from climate change. Groundwater aquifers provide a reliable water resource in most European countries, but drier summers with increased water demands, e.g. for irrigation, may lead to overexploitation resulting in a declining groundwater table, which will accelerate river water infiltration and drying-out of rivers, sea/saltwater intrusion and risk of land subsidence. Under more humid conditions, more intense rainfalls will increase flooding frequency. If the subsurface is dry prior to heavy rainfall, the groundwater system can absorb large quantities of waters and thereby lower the risk for flooding. If, on the other hand, the subsurface is close to saturation, or rainfall intensities exceed infiltration capacities, the flooding will be magnified. Data and a thorough understanding of the groundwater system and its interaction with surface waters and climate is thus a prerequisite for a sound assessment of climate change impacts. However, all hydrogeological systems are complex and differ throughout Europe. Assessments and adaptation strategies should thus build strongly on the knowledge in the member states, i.e. the European Geological Survey Organisations (GSOs) with respect to groundwater data and knowledge. This is in accordance with EU climate adaptation strategy[6] that is

[1] IGME refers to IGME-Spain in this document
[2] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.
[3] EEA report 1/2017: Climate change, impacts and vulnerability in Europe 2016, An indicator-based report
[4] JRC, 2015: Resilience of large investments and critical infrastructures in Europe to climate change, https://ec.europa.eu/jrc/en/publication/resilience-large-investments-and-critical-infrastructures-europe-climate-change
[5] EEA, 2017: Use of freshwater resources, https://www.eea.europa.eu/data-and-maps/indicators/use-of-freshwater-resources-2/assessment-2/#use-of-freshwater-resources
[6] EU, 2013: The EU Strategy on adaptation to climate change, https://ec.europa.eu/clima/sites/clima/files/docs/eu_strategy_en.pdf

structured around three objectives of which the first is to promote action by the Member States. In some GSOs, assessment of climate change has not historically been a focus, while other GSOs are already advanced, but utilise different tools and approaches reflecting tradition and available data. There is therefore a need to advance climate change assessments in the GSOs and to harmonise results from different approaches in order to obtain comparable results that can be used in EU policy making on climate change adaptation strategies.

The overall vision of TACTIC is to enhance the utilisation of data and knowledge acquired by the GSOs of the subsurface system, which is essential in understanding the freshwater system and the impacts of climate change. To reach this vision, the objective of TACTIC is to contribute to the development of coherent and transparent assessments of climate change impacts on groundwater and surface water, supporting improved EU policy making, and providing decision support for stakeholders and decision makers. To accomplish this, TACTIC will develop **an infra-structure among European Geological Survey Organisations** for collaboration to advance and harmonise climate change assessments within the GSOs. The specific TACTIC objectives are to:

- Review the GSOs to identify and **collect readily available data** required to understand the groundwater system and utilise tools and models to assess climate change impact and evaluate effect of adaptation strategies.
- Provide all stakeholders and decision makers **easy access** to maps, data and results collected or produced during the assessments carried out in TACTIC, by providing and uploading this to the GeoERA **Information Platform**.
- Fostering **knowledge sharing** among the GSOs by working closely together on the use of various tools and models with co-development of **best practice protocols** to support a larger uptake of the tools by the GSOs.
- Develop **guidelines** describing available tools, data requirements and the **harmonisation** of results to upload to GIP.
- **Demonstrate** the use of tools to assess climate change impact and adaptation strategies in pilots covering various challenges, hydrogeological conditions and geographical areas to provide **transnational assessments.**
- Develop a **roadmap** for future developments among the GSOs for the advancement of climate change research, which will be based on review of current state-of-the-art and state-of-praxis and experiences obtained from the assessments in the pilot areas.

1.2 Relation to work programme

TACTIC relates to the GeoERA joint call and addresses the topic: *GW2 – Tools for climate change impact assessment and adaptation* and addresses the specific challenges and scope of the topic (in grey boxes) as described below.

> A prerequisite for the selection and design of optimal and sustainable solutions to climate or global change […] is a thorough understanding of the system, and detailed assessments of current and future impacts and its associated uncertainties

TACTIC will conduct detailed assessments on climate change impact and evaluate possible adaptation strategies in pilot areas covering a wide range of hydrogeological conditions and expected future climate changes. Estimates of future conditions will be associated with estimates of uncertainty.

> The aim is to develop a research infrastructure among the European Geological Surveys to advance and harmonize the assessments of present and future primary and secondary impacts of climate change, and develop tools needed for the design of optimal adaptation strategies in water resources systems across relevant scales. To achieve this guidelines based on best practice protocols and state-of-the-art should be developed which acknowledge the current tools/approaches used as well as data availability and accessibility, and provide directions for advancement.

Geology and hydrogeology are crucial in understanding the land-based freshwater cycle and impacts from climate change. The GSOs are in this respect the leading organisations on data and knowledge on the subsurface. While several GSOs already demonstrate high-end research expertise in climate change assessments, others are new to this discipline. Further, different approaches and tools are used by the different Surveys. An underpinning approach in TACTIC is thus to optimise the exchange of knowledge between the partners, which will advance future assessments of climatic change in the EU based on approaches recognising the importance of a thorough understanding of the subsurface system. TACTIC will develop a common research infrastructure by making tools and approaches available, enabling easy use of readily available data for optimal assessments. This will be achieved by the development of a common toolbox - the TACTIC Toolbox - based on existing tools used in the GSOs and literature reviews. The TACTIC Toolbox will be accompanied by best practice descriptions to enhance their uptake and assure a harmonised utilisation. Existing best practices will be evaluated and used as a starting point and supplemented where necessary. Best practices will further be integrated into guidelines on how to select the appropriate tools and approaches, given specific challenges and data availability. Guidelines will also include processing of results uploaded to the GeoERA Information Platform (GIP) to harmonise results by different GSOs utilising different tools. Data relevant to hydrogeological assessments will further be collected from the GSOs and made available through the GIP, which is an essential element of the research infrastructure.

Hydrogeological data readily available e.g. for modelling purposes should be harmonized and prepared for the Information Platform

For each climate change topic addressed in TACTIC relevant data for assessments and adaptation will be identified, from which a joint questionnaire is developed and circulated to all GSOs. A specific Work Packages is devoted to a close collaboration with GeoERA Information Platform project to ensure that data are collected in a correct format for storage and display in the GIP.

… analyse the utilization of satellite data (earth observed satellite data products) to enhance European-wide data acquisition and/or assessments, e.g. of overexploitation of groundwater, water table decline and land subsidence.

Use of satellite data will be explored in different ways. Data on soil moisture will be utilised to improve recharge estimations at aquifer scale using a lumped modelling approach. At the EU-scale satellite data on potential evapotranspiration will be used to provide a Pan-European map of estimated groundwater recharge. Satellite data are further used to identify and qualitatively characterise aquifer storability and address land subsidence.

The developed approaches and methodologies will be demonstrated by assessments and analysis of sustainable management strategies in pilot areas covering various hydrogeological conditions and management structures at different scales

Forty pilots have been selected within 15 European countries with different hydrogeological conditions and climate change challenges. Each pilot will be subject to climate change assessments, and effects of adaptation strategies is evaluated in a subset of the pilots. In selected areas multiple tools/approaches will be tested, which allows a comparison between assessments based on different tools, which will feed into the development of guidelines.

1.3 Relation to existing programmes and projects

Climate change impact assessments and adaption strategies are high on the agenda and several international projects have been devoted to this topic. TACTIC is therefore related to several existing ongoing projects. However, with its focussed objective of enhancing climate change assessments by acknowledging the importance of the groundwater system within the hydrological cycle, and the engagement of GSOs in the member states, TACTIC will complement the existing studies. Optimal synergy between TACTIC and existing projects are ensured by the participation of TACTIC partners in the existing projects listed in Table 1.1.

Table 1.1 Examples of existing projects related to TACTIC and with participation of TACTIC partners

Project / website / Program / coordinator /	Aim and objectives	Relation to TACTIC
KINDRA / www.kindra-project.eu / H2020 / Univ. Sapienza, Italy	To develop a classification system and inventory of European Groundwater Research	Groundwater research databases and research gaps
NAIAD / www.naiad-nbs.eu / H2020 / Duero River Basin Authority, Spain	To develop concrete Nature Based Solutions in response to flood and drought risks at 9 demo sites across the EU	Application of integrated tools for climate change impact assessment and adaptation

SubSol / www.subsol.org / H2020 / KWR, the Netherlands	To bring coastal subsurface water solutions to the market	Managed aquifer recharge as a tool to control salt water intrusion etc.
SEAMOUNT / www.seamount.eu / BONUS / Evologics, Germany	New innovative underwater vehicles for studying submarine groundwater discharge and associated nutrient fluxes	Coastal zone hydrogeology and application of models
Soils2Sea / www.soils2sea.eu / BONUS / GEUS, Denmark	Reducing nutrient loadings to the Baltic Sea	Application of integrated gw-sw models for integrated gw-sw management and climate change adaptation
Topsoil / www.topsoil.eu / ERDG/NSR / Central Region Denmark	Sustainable solutions and possibilities and improvement of water quality and quantity supporting environmental, financial and human benefits	Groundwater flooding, saltwater intrusion, MAR, application of integrated models for climate change adaptation
AQUACLEW /none yet/ JPI climate/SMHI Sweden	Advance the quality and usability of climate services for a number of water related sectors	Application of integrated model to assess climate change impacts
NAGiS / http://nater.mbfsz.gov.hu/en/ / European Economic Area (EEA) / MBFSZ	Develop a multipurpose geo-information system facilitating policy-making, strategy-building and decision-making for impact assessment of climate change and adaptation measures in Hungary.	Application of integrated tools for climate change impact assessment and adaptation

1.4 Concept and methodology

(a) Concept

The overall concept of TACTIC is to develop a research infrastructure among the Geological Survey Organisations by fostering collaboration with knowledge sharing, exchange of data, tools/approaches and joint development of best practice protocols and guidelines for use in future assessments, see Figure 1.1. Specific collaboration will be realised in several activities

- A **survey** on data, existing tools and knowledge will be carried out among all GSOs, including GSOs not participating in TACTIC. The objectives of the survey are 1) to identify data within the GSO that are relevant for hydrological assessments (also beyond climate change impacts) and that can be shared on the GeoERA Information Platform. 2) Establish a comprehensive overview of the extent to which the GSOs have already been engaged in climate change assessments and adaptations and which tools have been used.
- **Joint use** and comparison of climate change assessment **tools**. Based on the survey of tools applied in the GSOs combined with a literature review, suitable state-of-the-art tools will be selected for the TACTIC Toolbox and for each tool a best practice protocol on their use will be developed making the tools readable applicable for other GSOs.
- Climate change assessments and evaluation of adaptation strategies will be carried out in 40 **pilot areas**, which represent a large variability in European hydrogeological conditions and climate change challenges. In some areas different tools will be used to assess the same challenge, by which results and advantages/disadvantages of different approaches can be compared.
- Building on the best practice and experiences from the pilots, **guidelines** will be developed with recommendations on selecting and using tools for harmonised assessments of different climatic challenges given different data availabilities. The guidelines will include advice on choosing climate projections to evaluate (Representation Concentration Pathways - RCPs, climate models and time-slices), and ways to harmonise output results for upload to the GIP. The aim of the guidelines is to assist Geological Surveys with methodologies that can be applied to produce comparable results in the form of easily-accessible Pan-European maps or datasets. The

ultimate aim is to provide harmonised information to stakeholders and policy makers to support them in taking integrated decisions across Europe.

- Three levels of stakeholders are relevant to TACTIC. At the pilot scale, relevant stakeholders will be informed on the pilot activities and results of the assessments, as well as the overall objectives of TACTIC. These stakeholders may be locally situated, but will also include regional to national agencies and authorities responsible for designing climate change adaptations and mitigations. At cross-border to EU-scale, stakeholders will include institutions and companies involved in climate change research or consultancy. The third group of stakeholders are all GSOs that are not partners in TACTIC and will be the stakeholder group with the largest day-to-day involvement during the project lifespan.

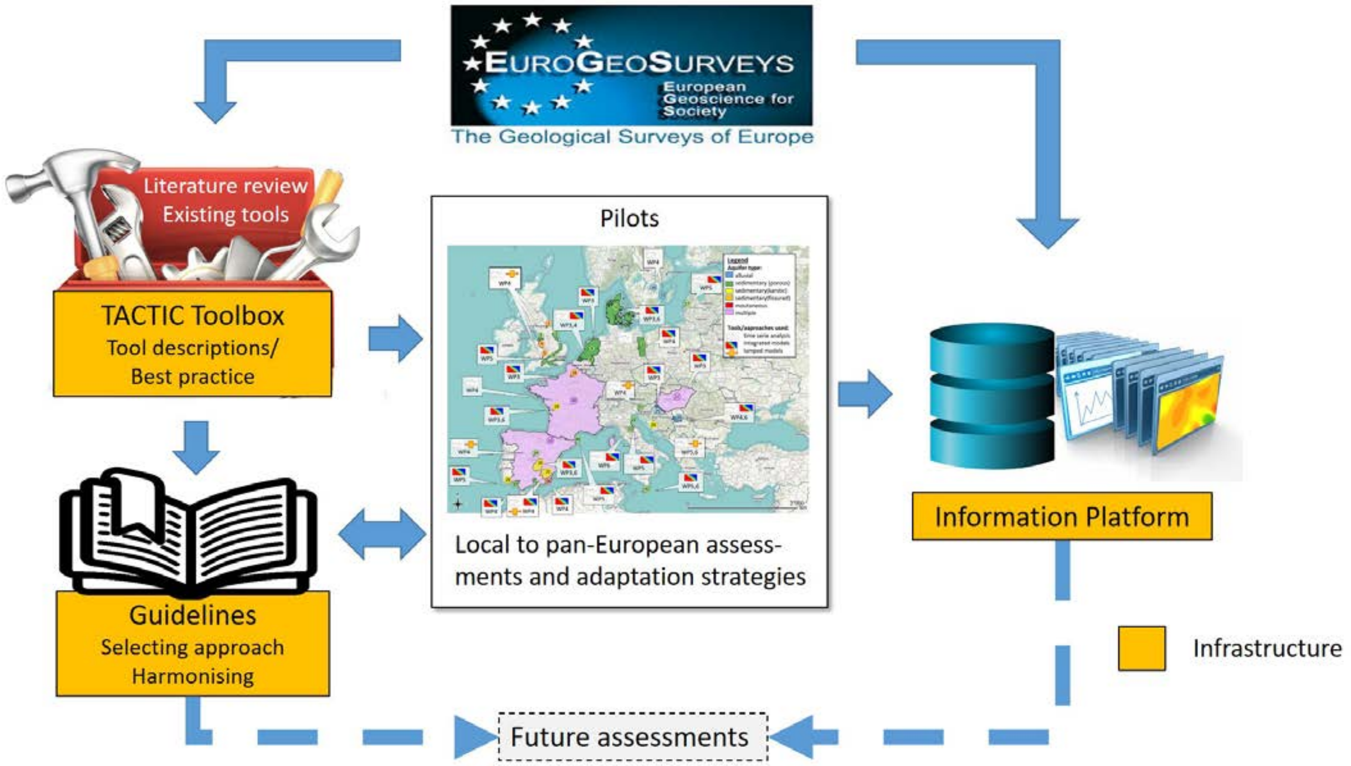

Figure 1.1. The overall concept of TACTIC.

(b) Methodology

Effects of climate changes on the freshwater hydrological cycle may manifest themselves in many different ways, and often the groundwater system plays a key role in determining the magnitude, as well as the spatial and temporal timing, of the impacts. TACTIC addresses several of the most critical geohazards that may have profound costs both economically, environmentally and socially, and which already occur or are expected to occur within a near future. These include groundwater-dependent floods and droughts, groundwater- surface water interactions including groundwater dependent eco-systems, changes in groundwater recharge and groundwater depletion caused by overexploitation. We will establish a common European Knowledgebase, improving existing knowledge by generating new useful, harmonized information at different spatial scales and integrating regional and national research resources. In TACTIC the climate change impacts are addressed in four work packages:

- WP3 will focus on challenges related to groundwater- surface water interaction, which includes 1) changes in shallow groundwater that may lower or raise the groundwater table and cause exacerbate surface flooding, 2) groundwater-dependent ecosystems and, 3) groundwater droughts. To address these complex problems tools/approaches capable of describing both systems and their interaction are required, and the activities in the WP will focus on integrated modelling. A special task is devoted to examining how climate change scenarios are most adequately propagated in the numerical models.

- WP4 addresses groundwater recharge and vulnerability. This will primarily be carried out by statistical models to analyse existing time series, and lumped models, which, compared to integrated models, are less complex to utilise and less data hungry. This WP will also utilise satellite data both to improve estimates of recharge at the aquifer scale by the lumped modelling approach, and by developing a data-driven estimate of the groundwater recharge for the entirety of Europe. Satellite data are further applied in combination with numerical modelling to evaluate land subsidence in response to a declining groundwater table.
- Overexploitation of the groundwater resource will lower the groundwater table, which may alter the groundwater flow direction and result in saline water up-coning and/or saltwater intrusion in coastal areas. Even relatively small concentrations of salt in water will affect its quality and render it unusable for consumption, irrigation and most other uses without treatment. Sea/salt water intrusion is thus a major challenge, which is likely to increase under future climate changes and WP5 has therefore been devoted to assess this.
- Water resources systems can be very vulnerable, and impacts from climate change may be critical. Further, the costs of damages due to climate change is estimated to be up to six time larger than the cost of implementation of efficient adaptation measures[7]. It is therefore essential that effective adaptation strategies are developed where possible; and given the high uncertainty related to projections of future climate conditions, these adaptation strategies must be flexible and robust. Based on the assessments in WPs 3-5, selected pilots will be included in WP6 where the use of tools/approaches to address adaptation strategies will be analysed.

Different approaches and tools can be used to assess climate change impact and address effects of adaptation strategies. The tools/approaches most optimal for an assessment vary from case to case dependent not only on the specific challenges, but also on data availability, existing system knowledge, as well as the available resources. Furthermore, differences in institutional cultures may have favoured the use of different approaches. Among the GSOs already engaged in climate change assessments and adaptation numerous different approaches exist, and the first step for each climate change topic (WP3 – 6) will therefore be to make a survey of all GSOs (also beyond TACTIC partners), to collect information on available data that can be included in the GIP and experiences on climate change assessments and tools used for this. The survey will be complemented by a literature review from which state-of-the-art and state-of-practice can be compared and possible needs for further development identified. For each topic, selected approaches/tools will be included in the TACTIC Toolbox supported by a best practice description on their use, either by linking to existing best practices, where they have already been developed in sufficient details, or by developing new where required. A workshop early in the project will be devoted to a presentation and thorough discussion of pilots and the appropriate tools to use for the assessments in the different pilots. Where relevant, webinars will be arranged giving an introduction to the various tools/approaches for the efficient uptake among the partners.

The TACTIC Toolbox will consist of tools/methods and approaches enabling the GSOs to undertake climate change impact assessments and evaluation of effects of adaptation scenarios. Physically, the toolbox will be made up of best practice protocols describing “how-to-use” the tools/approaches, required data, strengths and weaknesses, pitfalls and links to complementary material and/or downloads of specific software. For harmonisation, all descriptions will follow a protocol developed in WP2. Tools/approaches selected for the toolbox will be based on existing tools/approaches used in the Surveys, literature reviews and utilisation of existing projects providing tool and data on climate change projections[8,9,10]. Different type of tools will be evaluated for inclusion: 1) tools/approaches to undertake the assessments, e.g. statistical models, integrated models, index based methods etc., 2) supporting tools, e.g. for data management, identification of observation “out-liers”, and uncertainty assessments, and 3) tools/approaches required to utilise climate projections, i.e. downscaling and bias-corrections.

[7] http://www.2020-horizon.com/Water-cycle-under-future-climate-i2053.html
[8] http://www.copernicus.eu/
[9] http://swicca.climate.copernicus.eu/
[10] http://cordex.org/

For each climate change topic, relevant data will be identified and coordinated in WP2 where a joint questionnaire to be sent to all GSO will be developed. WP2 will also coordinate the survey in TACTIC with surveys in other projects funded under the groundwater theme in the joint GeoERA call, and will collaborate closely with the GeoERA Information Platform project to ensure that data collected and results produced in TACTIC can be effectively stored, displayed and disseminated according to the "FAIR" principles[11].

Providing a large geographical coverage and most variations in hydrogeological conditions and climate change impacts in Europe, 40 TACTIC pilots have been identified, Figure 1.2 and Table 1.1. Based on the available data, resources and existing skills/experiences, an approach has also been indicated for each pilot, but this is subject to final confirmation when the TACTIC Toolbox has been developed. The pilots vary in scale from the small scale of representative aquifers, increasing to national to Pan-European scale. Approaches used to assess groundwater recharge and vulnerability are primarily centred on principal aquifers, i.e. aquifers from which abstraction is of high importance to support domestic and/or industrial usage and where loss of water availability will have large economic and social impacts. Groundwater recharge is the driver for renewal of the groundwater resource, and understanding changes in recharge is thus vital for assessing the future availability of groundwater. Using satellite data, a Pan-European map of net precipitation will be developed. Pilots used to study groundwater – surface water interactions and sea/salt water intrusion take a catchment to national scale approach, where assessments are based on distributed modelling using different modelling systems and concepts. The wide variation in pilot areas (with different data availabilities), scales and tools/approaches applied, provides a unique opportunity to compare the assessments and make recommendations for future assessments, which will be included in a guideline.

Identical assessments utilising different tools may not necessarily be directly comparable. This can be due to both the input, such as the choice of climate scenarios projections, time slices etc. and the output structure of the tools being applied. Analysing the tools and assessments in the pilots, the TACTIC guidelines will include recommendations on the selection of tools and climate projections in order to obtain comparable assessments across EU. This will include data types and formats for upload to the GIP.

Table 1.1 Overview of TACTIC pilots, the main issues in relation to climate change and the primary water use (Drinking water (Drink), Irrigation (Irr) and Industry (Ind)

	Case study name	Main issues	Primary water use
1	Magnesian limestone aquifer	Recharge assessment / Sea-water intrusion	Drinking water / Irrigation / Industry
2	Mersey Sandstone aquifer	Sea-Water intrusion	Drinking water / Irrigation / Industry
3	Chalk aquifer	Drought, flooding, major aquifer for water resources	Drinking water / Irrigation / Industry
4	Permo-triassic sandstone aquifer	Recharge assessment / drouaght and flooding	Drinking water / Irrigation / Industry
5	Devonian / Carboniferous aquifer	Recharge assessment / drought and flooding	Drinking water / Irrigation / Industry
6	South downs	Sea-Water intrusion	Drinking water / Irrigation / Industry
7	Jurrassic limestone aquifer	Drought, flooding	Drinking water / Irrigation / Industry
8	Netherlands	Global change adaptation	Drinking water / Irrigation / Industry
9	De Raam	Sustainable agriculture and climate resilience	Irrigation / nature / drinking water
10	Denmark	Flooding, Global change adaptation	Drinking water and irrigation
11	Storåen-Sunds	Flooding	Drinking water
12	Falster - chalk aquifer	Salt water intrusion and depletion (Floods)	Drinking water / Irrigation
13	South-Central Jutland	Sea water intrusion, recharge assesment, vulnerability assesment	Drinking water and irrigation
14	Germany North-East	Vulnerability assessment	Drinking water/ Irrigation
15	Löttorp	Drougts	Drinking water
16	Kisa	Recharge assesment	Drinking water

[11] Wilkinson M, Dumontier M, Aalbersberg Ij, et al. (2016) The FAIR Guiding Principles for scientific data management and stewardship. Scientific Data 3: sdata201618 – www.nature.com/sdata, doi:10.1038/sdata.2016.18.

	Case study name	Main issues	Primary water use
17	Liepaja	Sea-water intrusion	Drinking water/ Industry
18	Avre sub-basin	Drought	Drinking water / Irrigation
19	Boutonne	Drought	Irrigation
20	France	Recharge assessment, vulnerability assessment	Drinking water / Irrigation / Industry
21	Po plain	Recharge assessment / drought and flooding	Drinking water / Irrigation / Industry
22	costal aquifer of the Emilia-Romagna Region	Sea-Water intrusion	Irrigation
23	Marecchia river alluvial fan	Recharge assessment/ Drougts / Ecosystems	Drinking water / Irrigation / Industry
24	Vrana lake and polje area	Sea-Water intrusion/Ecosystems/Global change adaptation	Drinking water / Irrigation
25	Drava-Mura aquifer	Ecosystems	Drinking water
26	Posavina	Recharge assessment / drought and flooding/ climate change impact	Irrigation/Industry/Drinking water
27	Hungary	Depletion, vulnearbility assessment, recharge assessment	Drinking water and irrigation
28	Lviv (West Ukraine)	Recharge assesment, vulnerability assesment	Drinking water/ Industry
29	Starokostyantyniv (Central Ukraine)	Recharge assesment, vulnerability assesment	Drinking water/ Industry
30	Izmail (South Ukraine)	Recharge assesment, vulnerability assesment	Drinking water/ Industry
31	Campina de Faro Aquifer System	Sea-Water intrusion	Irrigation / Industry
32	Alto Genil Basin (Granada)	Drought/Climate change impacts/Subsidence	Drinking water / Irrigation / Industry
33	Upper Guadiana Basin	Ecosystems, Droughts, Global change adaptation	Irrigation
34	Segura River Basin	Drought	Drinking water / Irrigation / Industry
35	Lorca (Segura Basin)	Depletion	Drinking water / Irrigation / Industry
36	Plana de Oropesa- Torreblanca	Sea-Water intrusion	Drinking water / Irrigation
37	Plana de Vinaroz	Sea-Water intrusion	Drinking water / Irrigation / Industry
38	The Fluvia-Muga delta plain	Sea-Water intrusion	Drinking water / Irrigation / Industry
39	Continental Spain	Drought/Climate change impacts	Drinking water / Irrigation / Industry
40	Malta aquifer	Droughts, Sea-Water intrusion, Depletion	Drinking water/Irrigation

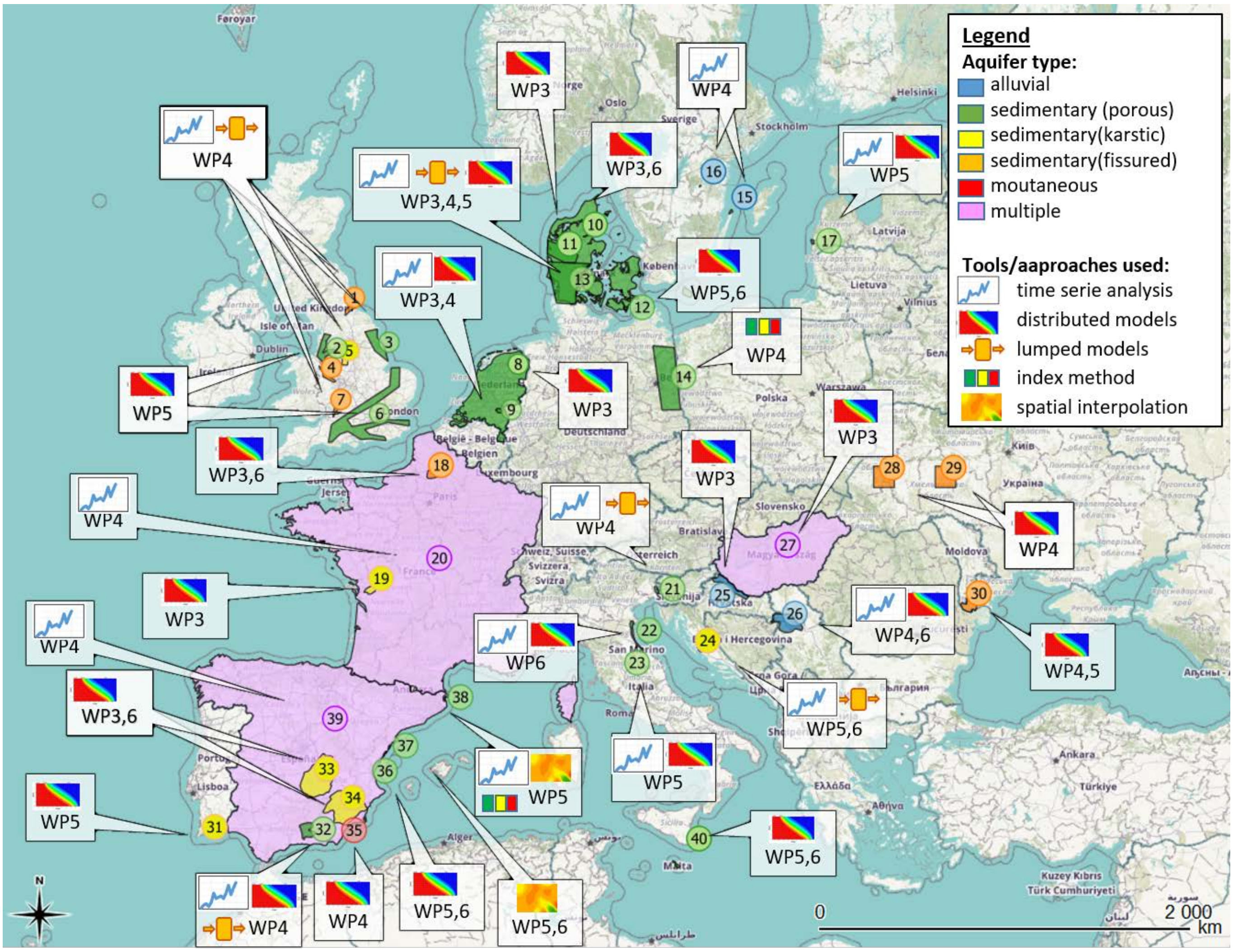

Figure 1.2 Location of pilots with indication of tool expected to be applied and association to work packages.

1.5 Ambition

The European Environmental Agency (EEA) maintains a set of climate change indicators designed to answer key policy questions. Several indicators are related to the freshwater cycle, such as indicators related to river flow and floods, droughts and agriculture (growing season and water demand). Several indicators are based on models to inter- and extrapolate the measurements in space and time. Current models applied are based on rainfall-runoff models with simplified description of the subsurface[12] thus ignoring the profound effect of groundwater in buffering or enhancing the impact of long term climate change and short term climate variability. Other models applied are large scale models in very coarse resolutions, which do not allow the importance of local to regional scale heterogeneities to be taken into account[13]. Although various indicators have been developed for groundwater sustainability[14,15] no such indicator is included in the list maintained by EEA.

The ambition of TACTIC is to enhance the climate change impact assessments in the GSOs that are rooted in the data and knowledge acquired by the individual member states, which, among other things, can be used to improve the basis for development of scientifically sound climate change indicators

[12] L. Alfieri, P. Burek, L. Feyen, and G. Forzieri (2015) Global warming increases the frequency of river floods in Europe, HESS, 19, 2247-2260
[13] K. Stahl, L. M. Tallaksen, J. Hannaford, H. A. J. van Lanen (2012) Filling the white space on maps of European runoff trends: estimates from a multi-model ensemble, HESS 12, 2035-2047
[14] Henriksen, H. J., L. Troldborg, A. L. Højberg, and J. C. Refsgaard (2008), Assessment of exploitable groundwater resources of Denmark by use of ensemble resource indicators and a numerical groundwater-surface water model, Journal of Hydrology, 348, 224-240
[15] Vishnu P. Pandey, Sangam Shrestha, Saroj K. Chapagain, Futaba Kazama (2011) A framework for measuring groundwater sustainability, Env. Sci & Policy, 14, 396-407

needed for policy and decision-making at EU-scale. TACTIC will achieve this ambition through the four following:

- Facilitate and encourage **climate changes studies by all GSOs in Europe**. Several of the TACTIC partners do not undertake climate change assessments currently. It is the ambition that these GSOs, through the **joint development of toolbox and best practice**, and through undertaking assessments in the pilots and collaborating on the synthesis across pilots, will be qualified to carry out climate change assessments by the end of the project. This will enable the GSOs to plan their strategy on further development and improve their input in formulating national climate change adaptation strategies. The infrastructure will be the backbone for outreach to the GSOs not involved in TACTIC. Recommended tools and approaches will be provided in the TACTIC Toolbox together with best practice on their use. Analytical/statistical and lumped model approaches will be described in a detail that allows their immediate uptake by GSOs. Overall descriptions will be provided for more complex approaches, such as numerical groundwater and integrated hydrological modelling, with links to existing guidelines. Furthermore, a **knowledge group** will be defined consisting of TACTIC partners with specific knowledge in the use of the different approaches, who may be contacted, when additional assistance is needed. The TACTIC **guidelines** will include descriptions on how to select an appropriate tool, based on the specific challenge, available data and current skills. The guidelines will include a description of pros and cons of the different approaches in the toolbox and thereby contribute to the **advancement** of the assessments by guiding the selection of the most optimal approach, which may require collection of additional data and additional skills. The guidelines will further provide harmonised approaches for undertaking and interpreting selected key assessments, which makes the results from different areas comparable. Engaging more GSOs in the assessments of climate change by utilising hydrogeological data and adequate tools will provide assessments well beyond state-of-the-art in many countries where simple approaches are currently used.
- TACTIC includes 40 pilots covering a large variation in challenges and hydrogeological conditions, for which a site specific assessment will be carried out. These pilots will provide a show case **demonstrating** the wide spread use of the tools, the results they can produce and, in selected pilots, how they can be used in the development of optimal adaptation strategies.
- Assessment of climatic change and other aspects related to the hydrological cycle, requires knowledge and data on the subsurface system. Currently, these data are stored in national GSOs using different database systems, which makes it difficult to use these data in cross-border studies for the development of harmonised assessments. TACTIC will go beyond state-of-the-art by making data available through the common GeoERA **Information Platform.** This will be achieved by developing questionnaires to identify and collect data relevant for hydrological/hydrogeological assessments in the GSOs. Standard formats for storage and visualisation will be defined in close collaboration with the Information Platform project. Standards will similarly be defined for storage and visualisation of results based on different approaches demonstrated in TACTIC. Populating the GIP with data, will significantly reduce the resources required for future assessments involving multiple countries. Furthermore, access to a large number of data collected under various hydrological conditions, will encourage the development and validation of new tools and thereby **advance** hydrological assessments of climate change and other challenges related to hydrology. It is thus the ambition that the demonstration in Pilot areas in TACTIC will inspire more GSOs to contribute to the population of the GIP with basic data and results from climate change assessments, also beyond the TACTIC project.
- Together with subsurface data, recharge estimates are a prerequisite for assessing groundwater resource and its development throughout time. When integrated hydrological models are used, recharge estimates are calculated internally from precipitation and evapotranspiration. However, many other tools require external estimates. In TACTIC recharge estimates will be developed in different ways. Using a lumped model approach recharge estimates representative at the aquifer scale will be estimated in 40 pilots covering a large geographical area in Europe. In addition, **satellite** data on evapotranspiration will be combined with precipitation and data on surface runoff to develop a **Pan-European** map of net precipitation. This map will provide a unique observation-based spatial overview of the evapotranspiration, net precipitation and recharge patterns across Europe, useful for several applications, such as improved recharge input for groundwater models, groundwater vulnerability to abstraction and climate change. Especially

related to climate change, the satellite-based net precipitation mapping can be used for large scale impact assessment of changes in net precipitation patterns across Europe without requiring European scale hydrological impact modelling.

2 Impact

2.1 Expected impact

The expected impact of TACTIC is first and foremost to provide: "*Improved support to EU decision and policy making by contributing to the development of coherent and transparent assessments of climate change impacts on groundwater and surface water using common and integrated approaches, methodologies and tools consistent across the different European countries",* as required in the GeoERA call text for the groundwater specific research topic "Tools for climate change impact assessment and adaptation".

TACTIC will do so by compiling and harmonising European subsurface databases on the common GeoERA Information Platform providing findable, accessible, interoperable and reusable data according to the "FAIR" principles e.g. in the form of tables of hydraulic parameters, maps, cross sections and model results in collaboration with the GeoERA Information Platform and the other GeoERA themes. These data are required for scientifically sound climate change impact assessments, decision and policy making, and the developed databases and maps will demonstrate where e.g. data for sound assessments are missing in order to be able to make projections with an acceptable uncertainty.
The improved decision support data and tools will be easily accessible via the GeoERA information Platform primarily for stakeholders involved in the development of sustainable management of Europe's water resources and climate change adaptation. Hence, it will provide data for the development of on-top services by e.g. private consulting companies contracted by authorities to develop services at local to Pan-European scale, and it will promote the development of new monitoring instruments and networks required for cost-efficient monitoring and assessment of the chemical and quantitative status of the water resources according to the Water Framework and Groundwater directives and the Blueprint to Safeguard Europe's Water Resources.

In addition to the expected impacts mentioned in the call text for the specific research topic covered by this proposal, TACTIC will contribute to support, provide data and improve the understanding of the following important issues related to climate change impacts on the status of European water resources and hence sound decision making, sustainable management and adaptation in relation to:

- Potential consequences, hazards (e.g. land subsidence) of groundwater abstraction and interactions with other subsurface activities as well as climate change, droughts and floods;
- Open access to modelling results enabling private companies and/or research institutions to develop new groundwater services on top of the integrated climate, groundwater-surface water models and results e.g. in public-private partnerships and competitive and collaborative environments;
- Improved role of Europe in developing innovative solutions and products for sustainable water management, conjunctive use, adaptation strategies and protection of freshwater resources, globally;
- Improved access to downloadable hydraulic parameters of main European aquifers and aquitards (or groundwater bodies) needed for e.g. model development;
- Improved tools for assessment of groundwater quantitative and chemical status based on good status objectives of groundwater dependent terrestrial and associated aquatic ecosystems according to EU directives and guidance;
- State-of-the-art tools for decision support that allow to elaborate the cost-effectiveness of measures and to support sustainable decision making in relation to the water-food-energy nexus;

2.2 Measures to maximise impact

2.2.1 Dissemination and exploitation of results

The expected impact will be maximized in close collaboration with the GeoERA executive board and the TACTIC advisory board, which includes important stakeholders representing end-users and professionals working as decision makers, consultants and scientists. Together with the executive and advisory boards, TACTIC will develop a roadmap for the further development of tools and databases that will be required for advanced and strong European research on climate change impact assessment and adaptation in all regions of Europe.

The TACTIC project has a dedicated work package (WP2) led by the groundwater theme coordinator to disseminate and exploit the obtained results, technical guidance and good practice protocols as wells as scientific reports and publications, via the GIP. The dissemination of regional and Pan-European work will be established in collaboration with the other groundwater projects (and where required the other GeoERA themes) by organizing meetings with stakeholder groups at European level. This include the CIS Working Group C on Groundwater, the European Environmental Agency, the Joint Research Centre and other CIS groups wherever relevant. The cooperation with the Advisory Board will be used to communicate with NGO's and organisations such as the International Association of Hydrogeologists, the International Hydrological Program including its transboundary activities e.g. in order to demonstrate the relevance of TACTIC for implementing the sustainable development goals of the United Nations and promoting research for global sustainability as e.g. developed and promoted within the Future Earth Program[16].

The GeoERA website and the GIP will be key in those dissemination events and social media (LinkedIn, Researchgate, Twitter and Facebook) will be included to promote events and e.g. demonstrate the relevance of TACTIC and GeoERA in general for global programmes such as the Sustainable Development Goals of the United Nations and the up-coming International Decade of Action "WATER FOR SUSTAINABLE DEVELOPMENT", 2018-2028[17].

Finally, the production of peer-reviewed papers in international journals will be promoted through this task under WP2, prioritising and integrating the results of the TACTIC project and bringing together scientists working on climate change impact assessment and adaptation in the groundwater theme. The TACTIC project includes three partners who are in the top 10 most active groundwater research institutes in Europe and, together with the other project partners, they will ensure the publication of the most relevant project outcomes. The TACTIC project will cooperate closely with the GeoERA Secretariat and other projects funded under GeoERA to establish the best possible dissemination strategy e.g. via the communication work package of the overall GeoERA programme (WP5).

2.2.2 Communication activities

TACTIC will produce information materials and publications to communicate main GeoERA objectives and results tailored towards all relevant stakeholders and interested audiences including:

- Policy and decision makers: Policy briefs and recommendations, flyers, GeoERA web site (Newsletters etc.), maps on the GeoERA Information Platform
- Stakeholders: GeoERA website and Information Platform, conference presentations, technical publication, maps, good practice protocols and guidance
- General public: Flyers and brochures, newsletters on the GeoERA website, project presentation and outcomes in national and social media
- Academic and scientific community: publications in peer-reviewed journals and at scientific conferences, GeoERA web site and Information Platform, good practices protocols and guidance
- Project/work package partners: GeoERA dissemination seminars (Kick-off, Mid-Term, Final Seminar), the GeoERA intranet, GeoERA web site and Information Platform, project member meetings/workshops

2.2 Contribution of Project Proposal to the Information Platform or vice versa

TACTIC will cooperate closely with the GeoERA Information Platform Project and the other GeoERA projects primarily via WP2 and the groundwater theme coordinator, and develop and use common templates and data management plans in order to create the information products that are most

[16] http://www.futureearth.org/open-network-powered-future-earth
[17] https://www.un.org/water decade 2018-2028/

beneficial to the end-users. The compiled data and the maps provided by this project will be shared on the GIP, which is promoted by intensive interaction between work done for this project and the partners and contact point of the project team of the GeoERA Information Platform. Work package 2 has dedicated tasks to deliver this. Using the commonly agreed data management plan, TACTIC will prioritize the information products to focus on, which have most benefit to the stakeholders of the work under TACTIC. Once products from TACTIC become available through WP deliverables, the data will be provided to the GIP project for prototyping of the eventual information products. Special attention will be given to the Pan-European dataset to be delivered under WP6, in order to make prototyping and final implementation efficient within the GIP project. The close links between TACTIC and the GIP Project will yield findable, accessible, interoperable and reusable data developed according to the general GeoERA data management plan (D1.3) and the “FAIR” principles of Horizon 2020.

3 Implementation

3.1 Work Plan – Work packages, deliverables

TACTIC is organised in six work packages (WPs). Project coordination (WP1) will be led by GEUS, but includes all work package leaders to ensure a strong and coherent management of the WP activities and the progress and deliverables of the entire project. The project coordinator and all WP leaders will further collaborate on project dissemination, interaction with the GeoERA Information Platform project and topics for cross-coordination between activities in the WPs and the other projects funded under the GeoERA joint call (WP2). Cross-coordination includes the development of joint questionnaires that will be send to GSOs to collect data and information of current approaches used to address climate change and similar hydrogeological challenges. Cross-WP coordination will further be used in the development of the TACTIC Toolbox including best practice protocols and guidelines.

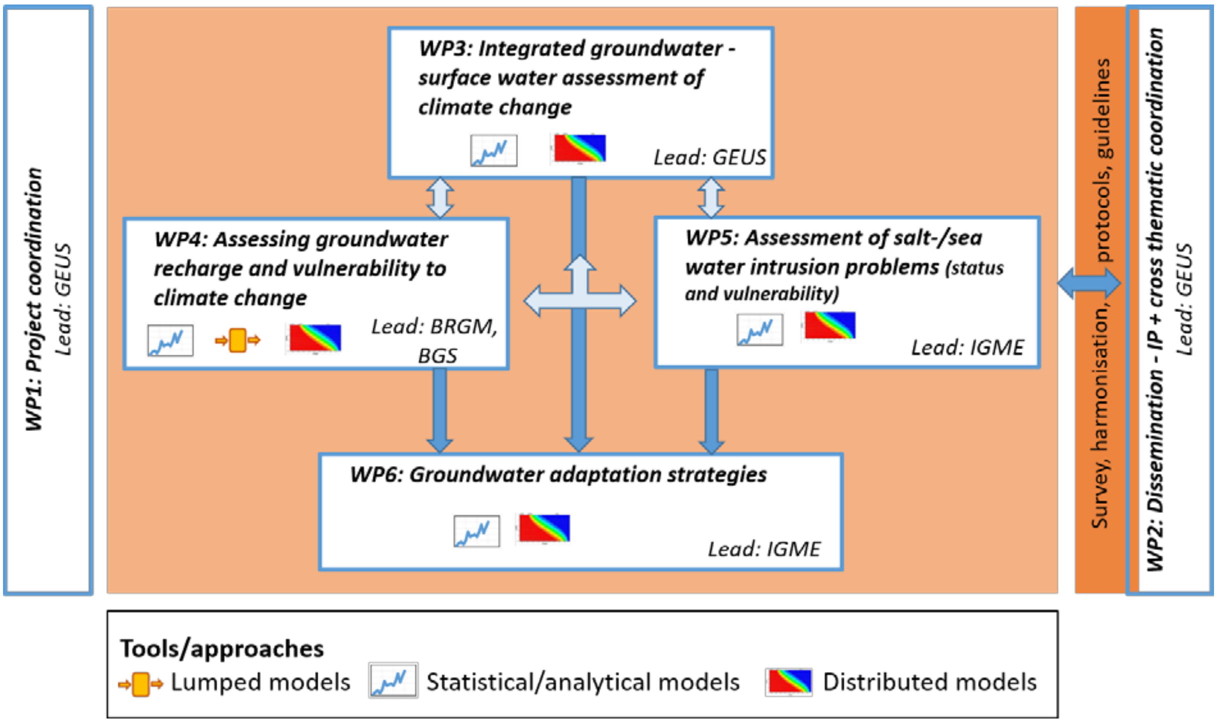

Figure 3.1 Work package structure and interlinkages.

WPs 3-5 are organised by different topics related to climate change impact in order to enhance collaboration and knowledge exchange among partners on the specific topics, and share a common overall structure, namely: 1) Survey the GSOs by contributing to the development of a joint questionnaire, 2) assessments of impacts and adaptation strategies in pilots, 3) individual WP-specific tasks, and 4) contribute to the development of best practice protocols and guidelines. Within each work package different GSOs participate by contributing with a pilot case in which the assessment is undertaken by one or several tools and by the joint development of protocols and guidelines. The timing of activities in the work packages, deliverables and Milestones are provided in Figure 3.2.

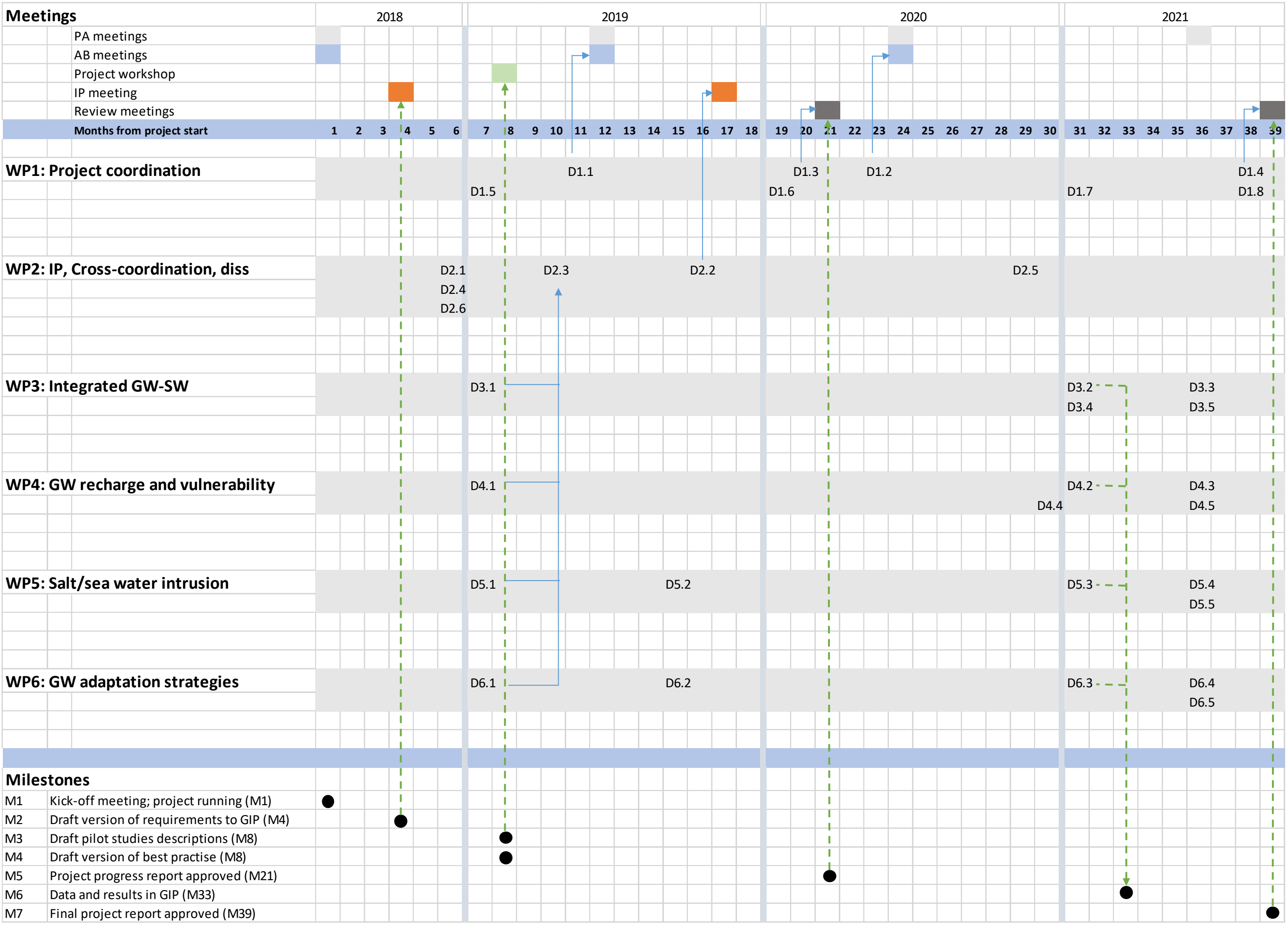

Figure 3.2 Overview of deliverables and Milestones and major dependencies.

Table 3.1a Description of work packages WP1 to WP6

Work package number	1	Lead beneficiary			GEUS	
Work package title	**Project coordination**					
Participant number	12	15	50	54		
Short name of participant	GEUS	BRGM	IGME	NERC		
Person months per participant	10	2	3	2		
Start month	1			End month	36	

Objectives

The objective of WP1 is to ensure an effective management of the project with respect to the administrative, financial, organisational and scientific aspects. The central objectives are:

- To guarantee a smooth communication and decision-making process between consortium partners
- To ensure a timely execution of activities and development of deliverables in accordance to the project plan
- To monitor the project progress and identify shortfalls
- To coordinate the financial and scientific management and reporting of the project
- To report and communicate with the GeoERA Secretariat and Executive Board
- To organise project meetings and interaction with the TACTIC Advisory Board

Description of work

Task 1.1: Internal project planning, administration and monitoring (Lead partner: GEUS, Other partners BRGM, IGME, NERC), M1-36

The overall project coordination and planning of the project will include:

- Monitoring of project progress and the timely realisation of deliverables and milestones.
- An overall risk management of the project by early identification of possible risks and design of measures that is suggested to the Project Assembly
- Implementation of measures to guarantee the successful execution of the project
- Administrative and technical organisation of TACTIC consortium meetings and other project meetings, workshop etc. organised during the project
- Design, initialise and follow-up on contingency plans

The internal planning and management will be realised by the Project Board, who will meet every second month via video-link for up-to-date monitoring of progress and rapid intervention when needed.

Task 1.2: Project communication and reporting (Lead partner: GEUS, other partners: BRGM, IGME, NERC), M1-36

This task will ensure an effective and up-to-date communication between the TACTIC consortium and the GeoERA General Assembly and Executive Board, as well as the TACTIC Advisory Board. Led by the project coordinator, the Project Board will be responsible for timely and high quality reporting to GeoERA Secretariat and General Assembly according to the GeoERA reporting procedures and monitoring indicators, including the periodical reporting on scientific/technological and financial progress and status. If critical unforeseen issues arise, the project coordinator will, based on the risk management, provide suggestions for solutions to the GeoERA General Assembly, and solutions agreed upon by the GeoERA General Assembly will be initiated by the Project Board. Input from the Advisory Board is optimised by providing a summary report on the TACTIC activities to the Board prior to the meetings at month 12 and 24 and advice from the Advisory Board will be initiated and monitored by the Project Board.

Task1.3 Contract and financial administration (GEUS), M1-36

Led by the project coordinator the Support Management Team (SMT) is responsible for the financial and contractual administration, including allocation of budgets and transfer of funds and updating the accounts and contractual rules. The SMT will also prepare the financial data for detailed implementation and produce the cumulative expenditure reports based on partner inputs.

Deliverables

D1.1: Summary report for the second TACTIC Advisory Board meeting (M11)
D1.2: Summary report for the third TACTIC Advisory Board meeting (M23)
D1.3: Project progress report (M20)
D1.4: Final project report (M38)
D1.5: Cumulative expenditure report 2018 (M7)
D1.6: Cumulative expenditure report 2019 (M19)
D1.7: Cumulative expenditure report 2020 (M31)
D1.8: Final financial report (M38)

Work package number	2	Lead beneficiary		GEUS	
Work package title	**Cross coordination, data management, interaction with GeoERA Information Platform and dissemination**				
Participant number	12	15	50	54		
Short name of participant	GEUS	BRGM	IGME	NERC		
Person months per participant	6	2	2	2		

Start month	1	End month	36

Objectives

- Develop a data management plan in order to make products/data produced by TACTIC findable, accessible, interoperable and reusable.
- Identify products/requirements from WPs project toward the GeoEra Information Platform (GIP) and ensure close collaboration in order to optimise data/product availability through the GIP
- To develop common frameworks for producing protocols and guidelines on data tools/approaches for climate change assessment
- To develop a project communication, dissemination and exploitation plan including social media, the project web site and scientific journals.

Description of work

Task 2.1: Development of data management plan (GEUS), M1-6
Following the template, included in the GeoEra D1.3 and the H2020 “FAIR” principles on Findable, Accessible, Interoperable and Reusable, a data management plan will be establish in collaboration with the GIP project, to ensure correct handling of data and smooth interchange with GIP.

Task 2.2: Identification of requirements, test and upload to the Information Platform (Lead partner: GEUS. Other partners: BRGM, IGME, NERC) M1-31
Based on the inventories developed in WP 3-6 on data needed to set-up and execute the tools and type of results produced by the assessments, requirements to the GeoERA Information Platform will be defined in dialogue with the GeoERA Information Platform project in the initial stage of the project. TACTIC workpackage leaders will further contribute in testing the GIP in two phases. Finally, Task 2.2 will ensure that metadata on TACTIC is uploaded to the European Inventory of Groundwater Research (EIGR) recently developed in Horizon 2020 and hereby open the possibility for the GIP team to explore ways of linking GIP data with EIGR data and vice versa.

Task 2.3: Survey and collect tools and data (Lead partner: BRGM, Other partners: GEUS, IGME, NERC), M6-30
A questionnaire will be developed from the inventories produced in WP 3-6, to survey the GSOs in a harmonised way, on data relevant for climate change assessments (and other hydrological assessments) for inclusion in the Information Platform. The survey will further include a survey on tools/approaches used for climate change assessments and adaptation strategies among non-TACTIC partners and data available on this topic in EIGR and the knowledge base on subsurface water solutions developed by the Horizon 2020 projects KINDRA and SubSol[18], respectively.

Task 2.4: Development of protocols for tool descriptions and guidelines (Lead partner: GEUS, Other partners: BRGM, IGME, NERC), M1-36
Tools and approaches included in the TACTIC Toolbox will be accompanied by a best practice description on their use. For harmonisation, a common protocol for these descriptions will be produced in task 2.4, which will be populated in WP 3-6. The protocol will consist of a template with predefined topics to include in the tool description, e.g. required data, strengths and weaknesses, pitfalls and links to complementary material and/or downloads, together with instructions on how to complete the descriptions. Similarly, a protocol is produced for the development of harmonised guidelines in WP 3-6, which will include the tool descriptions, but extended to include guidelines on how to select the appropriate tool and produce harmonised results.

Task 2.5: Communication, dissemination and exploitation plan (Lead partner: GEUS, Other partners:), M1-36
The communication, dissemination and exploitation plan will follow the guideline developed by the GeoERA Secretariat and main dissemination activities will be closely coordinated and planned together with the GeoERA Secretariat to establish the best possible dissemination strategy.

[18] See list of TACTIC related projects in section 1 of the proposal

Dissemination of the pan-European work will be established e.g. by organizing meetings in conjunction with meetings of stakeholder groups at European level, including CIS Working Group on Groundwater, the European Environmental Agency, the Joint Research Centre and other CIS groups wherever relevant. The GeoERA website and Information Platform will be key in those dissemination events and social media will be included to promote events. The production of peer-reviewed papers in international journals will be agreed on within this task, prioritizing and integrating project results of the TACTIC project and bringing together scientists working in the Groundwater Theme.

Deliverables
D2.1: Data management plan (M6)
D2.2: Definition of requirements to GIP following recommendations from the GIP project (M16)
D2.3: Questionnaire to survey GSOs on data and tools (M10)
D2.4: Protocol for best practice descriptions of tools (M6)
D2.5: Protocol for guidelines (M29)
D2.6: Communication, dissemination and exploitation plan (M6)

Work package number	3	Lead beneficiary			GEUS				
Work package title	**Integrated groundwater - surface water assessment of climate change**								
Participant number	12	1	1a	9	15	27	50	53	
Participant short name	GEUS	TNO	DLT	HGI-CGS	BRGM	MBFSZ	IGME	Geo-inform	
Person-months per participant:	17	6	9	9	6	3.5	9	0.9	
Start month	1				End month	36			

Objectives

- To review state-of-the-art and survey use of models, tools and data availability in the GSOs to assess Climate and Global Change impacts on groundwater-surface water interaction.
- To evaluate the use of integrated groundwater-surface water modelling to assess impacts of climate change on groundwater and surface water.
- To develop protocols and methodological guidelines for advanced and harmonized assessments of climate change impacts by integrated modelling in the GSOs.
- To demonstrate the project developments (tools and methods) by a sample of studies (Pilots) that will cover different hydrological and management particularities in EU.

Description of work
Task 3.1: Review of tools and methods and identification of data requirements (Lead partner: GEUS. Other partners: all WP3 partners), M1-8.
A review of state-of-the-art for assessing climate change impact on groundwater-surface water interaction by integrated models is carried out and compared to methods/model systems used by TACTIC partners. Based on this, models systems/methods are selected for inclusion in the TACTIC Toolbox. Furthermore, an inventory of data required to develop and run the models is produced as input to the survey in task 2.3.

Task 3.2: Climate change impacts on shallow groundwater (Lead partner: GEUS. Other partners: Deltares, MBFSZ), M7-33
The uppermost groundwater table will change under future conditions because of groundwater recharge change due to climate change and secondary changes, e.g. changes in land use. In this task, the average changes in groundwater levels will be in focus. Pilot areas will be analysed with integrated models (e.g. 3D physically-based groundwater-surface water models simulating overland flow, rivers and lakes, the unsaturated zone, and the saturated zone). The impacts on shallow groundwater will be investigated at local levels with high-resolution models covering areas of 25 km^2 – 500 km^2, with one

pilot in Denmark, the Storåen-Sunds Pilot, and on regional to country scale (>5000 km^2) in two pilots covering Hungary and Denmark, respectively.

Task 3.3: Groundwater dependent ecosystems (Lead partner: HGI-CGS. Other partners: IGME), M7-33

Groundwater dependant ecosystems (GWDE) are very sensitive to changes in shallow groundwater levels and groundwater seepage to, and interaction with, surface waters. Both terrestrial and aquatic GWDE will be affected by climate change, and this task aims to analyse how these types of GWDE can be assessed optimally with several types of hydrological models. Calibrated numerical models will be used to assess future global change impact (i.e. climate change induced and anthropogenic change- e.g. increased groundwater exploitation rate for drinking water supply and irrigation) on the quantitative status of groundwater in aquifer systems that is vital for the sustainability of terrestrial GWDE. This is done in the Drava River alluvial plain, northern Croatia, where 20% of an alluvial aquifer system heavily exploited for drinking water is covered by terrestrial GWDE. In Spain, focus will be on the Upper Guadiana Basin where strong natural interaction between groundwater and surface water gives rise to over one hundred wetlands that make up UNESCO's Mancha Húmeda Biosphere Reserve. This pilot also highlights the strong conflict between GWDE and groundwater abstraction.

Task 3.4: Groundwater flooding and droughts (Lead partner: BRGM. Other partners: IGME, GEUS), M7-33

In this task, we will examine historical groundwater flooding and droughts, and their evolution according to future climate scenarios in different pilot sites in Spain and France. Integrated hydrological model outputs (recharge, groundwater/surface water exchange, river flow) and data available on sites will be used in this analysis. The idea is to reference past events and evaluate the evolution of these extremes in the context of global change in order to assess the resilience of aquifers to climate change and provide information and tools for decision-making in adaptation to climate change. According to the specificities of each pilot site, the focus will be on droughts and / or floods depending on the climatic context and their future evolution. In France, we focus on two pilot sites: the Avre sub-basin (650 km2) located in Somme river and the Boutonne catchment located in northern part of Aquitaine basin for which several drought periods seem to be renewed with increased frequency in the last decade and could be accentuated under climate change. In Spain, the Upper Guadiana Basin, with frequent and intensive drought periods, will also be a pilot.

Task 3.5: Propagation of climate change in integrated models (Lead partner: TNO. Other partners: DLT, IGME, GEUS, MBFSZ, HGI-CGS), M7-33

The task will investigate changes (climate change, and secondary changes such as land use, urbanisation and others) and their effect on the integrated groundwater-surface water system. This will include an evaluation of a reference set-up that can be used across the GSOs, i.e. choice of climate change projection(s) and methods to downscale and propagate scenarios, which will provide input for the guideline in task 3.6. Utilisation of data-driven methods is further studied. The data-driven methods can cover large areas and long periods with little effort and will be used to separate the effects of various changes and determine whether the response of the hydrological system has changed. A methodology will be developed and tested to improve and validate integrated models using these insights and will be used to further evaluate the effects of large scale changes in the past and how to project the hydrological effects of future climate changes. In Spain, the Segura River Basin (18870 km^2) will be used as pilot, in Denmark the Danish National Water Resource Model covering the entire Denmark will be used (www.vandmodel.dk), and in the Netherlands, the Netherlands Hydrological Instrument (http://www.nhi.nu) will be applied.

Task 3.6: Tool descriptions and guidelines (Lead partner: GEUS. Other partners: Deltares, TNO IGME, BRGM, HGI-CGS, MBFSZ, Geoinform, LGT), M6-36.

Each of the tools included in the TACTIC Toolbox will be supplemented by a best practice description, which are developed in task 3.6 by populating the protocol produced in task 2.4. A first version will be ready prior to the assessments in the pilots, but is subject to revision based on feedback from partners during the assessments and the survey among all GSOs. For complex model systems, best practice description will strongly draw on existing best practice from scientific and grey literature. Based on the research in task 3.2-3.5 and review of state-of-the-art, a guideline for integrated hydrological modelling is developed according to the protocol developed in task 2.4. The guideline will include the final versions of the best practice tool descriptions and guidance in selecting optimal models/approaches taking availability of data into consideration. Further, the guideline will include guidance and standards defining a reference climate change scenario (i.e. choice of climate model, period etc.) and storing of model results in the GIP, to allow comparison of results by different model systems applied at different scales across European countries as well as generation of Pan European maps.

Deliverables

D3.1: Inventory on data and results for groundwater-surface water (M7). Inventory listing data needed for and type of results obtained from the assessments, including specific requirements for the storage and visualisation in GIP. (**GEUS +** all WP3 partners)

D3.2: Pilots description and assessment report for groundwater – surface water (M31). A technical report describing the pilot areas in details in terms of hydrogeological settings, major challenges, available data and tools applied in the study as well as results from the assessments in the pilots. All results are further uploaded to the GIP. All partners are responsible for describing their pilot case and results, (**GEUS** + all WP3 partners).

D3.3: Journal paper on climate change assessment in EU (M36) on the assessments and the regional variation on climate change impact on groundwater for Europe. (**GEUS** + pilot case partners).

D3.4: Technical note on propagation of climate change projections in integrated models to assess future groundwater conditions. (M31) (**TNO** + DLT, IGME, GEUS, MBFSZ, HGI-CGS)

D3.5: Guideline for integrated modelling (M36). GEUS is, together with the task leaders in WP3 responsible for the development of the guidelines for integrated groundwater – surface water modelling.

Work package number	4	Lead beneficiary		BRGM and NERC							
Work package	**Assessing groundwater recharge and vulnerability to climate change**										
Participant number	12	1	14	15	17	29	30	47	50	52	53	54
Short name of participant	GEUS	TNO	GTK	BRGM	BGR	GSI	ISPRA	GSS	IGME	SGU	Geoinform	NERC
Person months per participant	10	3	3	7	6.5	4.5	6.5	6.5	9	5.4	0.9	8
Start month	1			End month			36					

Objectives

- To review state-of-the-art and survey the GSOs on tools, approaches and data availability to assess groundwater recharge and vulnerability under climate change.
- To identify principal aquifers in the involved countries assisted by satellite data
- To demonstrate the use of methods and tools to assess actual groundwater recharge and its evolution and aquifer vulnerability under climate change.
- To use satellite data to assess subsidence linked with withdrawals.
- To develop a Pan-European map of estimated net precipitation and groundwater recharge.
- To develop protocols and methodological guidelines for advanced and harmonized assessments of climate change impacts on groundwater by analytical/statistical and lumped model approaches in the GSOs.

Description of work

Task 4.1: Review of tools and methods and identification of data requirements (Lead partner: BRGM. Other partners: all WP4 partners) M1-8.
A review of state-of-the-art for assessing groundwater recharge and vulnerability to climate change by analytical/statistical and lumped models is carried out and compared to tools/approaches used by TACTIC partners. Based on this, tools/approaches are selected for inclusion in the common toolbox. Furthermore, data required to develop and execute tools/approaches are identified and included in the inventory of data developed in task 2.3.

Task 4.2: Identification of principal aquifers and their characteristics aided by satellite data (Lead partner: NERC. Other partners: all WP4 partners) M7-33
Radar satellite applications, InSAR for example, have recently revealed a very useful tool to improve aquifer characterisation and management. InSAR data will be used to improve the delimitation of compressible and less permeable areas and, in high elastic materials, to estimate groundwater level evolution and aquifer storage variations to determine the significance of the bedrock holding the groundwater.

Task 4.3: Recharge estimation and its evolution under climate change scenarios in the principal aquifers (Lead partner: NERC. Other partners: BRGM, ISPRA, SGU, TNO, IGME, GTK, GSI, GEUS) M7-33
In this task, a lumped modelling approach will be applied in pilots throughout Europe and, for selected pilots, results will be compared with other approaches. Rainfall, evaporation, land use and soil data are necessary but are not all well described at continental scale. We will study how hydrological variables deduced from earth observed satellite data - acquired by sensors on board low Earth orbiting satellites, e.g. ERS-1/2 and ENVISAT of the European Space Agency (ESA) – can be used to get widely distributed data and to refine the calibration of lumped models. Monte Carlo approach will be introduced to quantify uncertainties linked with the models results. Numerical results will be compared with those obtained using existing national models like in Denmark and the Netherlands and analysis of piezometric and hydrologic time series. In a second step, climate change scenario developed in WP6 will be used in calibrated lumped models to estimate climate change impact on aquifer recharge.

Task 4.4: Analysis of long-term piezometric time series to evaluate aquifer vulnerability to climate change (Lead partner: BRGM. Other partners: NERC, GEUS, BGR, SGU, TNO, IGME, GSI) M7-33
Groundwater vulnerability estimation methods can be grouped into three categories: index methods, statistical procedures, process-based methods, and/or a combination of these methods. This task will focus on the application of statistical analysis methods of time series and the implementation of an index based method. Both methods will be applied and compared in selected pilots in different hydrogeological contexts in Europe and precision of the methods when downscaling from large (EU/national/regional) to local scale will be addressed. The methods will be evaluated with respect to what types of vulnerabilities they are able to assess and their usefulness over different spatial scales across the selected pilot sites. Long time-series of aquifer levels or spring discharge will be used to estimate the climatic variability or climatic trends over the last 80 to 100 last years.

Task 4.5: Assessment of subsidence in aquifer systems using DInSAR satellite data (IGME) M7-33
Numerical groundwater flow models and synthetic aperture radar differential interferometry (DInSAR) that detects surface movements will be used to understand subsidence related with groundwater withdrawal and calibrate hydrogeological and geomechanical 3D models. SAR-derived deformation series will be compared with piezometric change data and soft soils thickness data in order to evaluate a first relationship between them and improve the conceptual and physical hydrogeological model. Groundwater storage will be estimated by combining measurements of changes in groundwater levels over time and area with estimates of storativity. The historical analysis of satellite SAR images since 1992 will permit to implement robust numerical 3D models that can be used to understand the impact of global change into aquifer systems. The task will focus on Lorca pilot in Spain but a feasibility study will be performed to know if it could be applied elsewhere (aquifer having subsidence problems, enough piezometric data, good response of InSAR).

Task 4.6: Development of a satellite based net precipitation and recharge map at the pan-European scale (Lead partner: GEUS. Other partners: NERC, IGME) M7-33
Actual evapotranspiration is a main component of the water balance and highly variable in time and space, but rarely monitored. Based on existing remote sensing techniques, a land surface temperature based actual evapotranspiration mapping will be conducted for clear-sky conditions and interpolated to all weather conditions for a monthly climatological European actual evapotranspiration estimate in a kilometre scale resolution. Combined with gridded precipitation products and data on surface runoff, the satellite based mapping can be utilized to map net precipitation and groundwater recharge. This approach will be compared with results obtained by an empirical distributed precipitation-recharge model where evapotranspiration is estimated from an empirical model. Recharge estimation will also be compared to results obtained in task 4.3. The final product will provide a unique observation based spatial overview of the evapotranspiration, net precipitation and recharge patterns across Europe. This information will be useful for several applications, such as improved recharge input for groundwater models in data sparse regions, groundwater vulnerability to abstraction and climate change.

Task 4.7: Tool descriptions and guidelines (Lead partner: BRGM. Other partner: all WP4 partners) M6-36
Best practice tool descriptions are developed in this task for tools included in the TACTIC Toolbox by populating the protocol developed in task 2.4. A first version will be ready prior to the assessments in the pilots, but is subject to revision based on feedback from partners during the assessments and the survey among all GSOs. Based on the research in task 4.2-4.6 and review of state-of-the-art a guideline for assessment of groundwater recharge and vulnerability based on analytical/statistical/lumped models is developed. The guideline will include the final versions of the best practice tool descriptions and guidance on selecting optimal models/approaches taking data availability into consideration. Further, the guideline will include guidance and standards defining a reference climate change scenario (i.e. choice of climate model, period etc.) and storing of model results in the GIP, to allow comparison of results by different model systems applied at different scales across European countries as well as generation of Pan-European maps.

Deliverables
D4.1: Inventory listing data needed for and type of results obtained from the assessment of recharge and groundwater vulnerability (M7) including specific requirements for the storage and visualisation in GIP. (**BRGM** + all WP4 partners)
D4.2: Pilots description and assessment report for recharge and groundwater vulnerability (M31). A technical report describing the pilot areas in details in terms of hydrogeological settings, major challenges, available data and tools applied in the study as well as results from the assessments in the pilots. A map displaying aquifer vulnerability to climate change estimated with an index method will be generated as part of the deliverable. All results are further uploaded to the GIP. (**NERC** + all WP4 partners)
D4.3: Journal paper on aquifer recharge variability and trends (M36). Journal paper will be developed on the aquifer recharge variability and trends over the past century using time series analysis (**BRGM**).
D4.4: Pan-European net-precipitation map (M30) based on satellite data and hydrological observations. The map will available via the GIP (**GEUS**)
D4.5: Guideline for groundwater recharge and vulnerability (M36). Development of guidelines on recharge assessment, on aquifer vulnerability to climate change assessment and on modelling piezometric –deformation relationship from DInSAR data will be developed based on the experiences from the pilot areas and the literature review (**NERC** + task leaders of WP4).

<table>
<tr><td>Work package number</td><td>5</td><td colspan="3">Lead beneficiary</td><td colspan="7">IGME</td></tr>
<tr><td>Work package</td><td colspan="11">Assessment of salt-/sea water intrusion status and vulnerability</td></tr>
<tr><td>Participant number</td><td>12</td><td>9</td><td>31</td><td>39</td><td>42</td><td>45</td><td>50</td><td>51</td><td>53</td><td>54</td><td></td></tr>
</table>

Short name of participant	GEUS	HGI-CGS	SGSS	LEGM	MTI	LNEG	IGME	ICGC	GEOINFORM	NERC		
Person months per participant	3	6	2	1.5	4	9	21	5.6	0.9	2		
Start month	1			End month			36					

Objectives

- To review state-of-the-art and survey the GSOs on information and approaches to assess salt-/sea water intrusion (SWI) status and vulnerability.
- To develop a method to summarize in a harmonized way SWI problems (status and vulnerability) at different scales.
- To demonstrate the utility of the proposed methods and tools in selected pilots
- To develop protocols and methodological guidelines for advanced and harmonized assessments of salt/sea water intrusion in the GSOs.

Description of work

Task 5.1: Review of information and approaches to assess salt-/sea water intrusion status and vulnerability.
(Lead partner: IGME. Other partners: HGI-CGS, LNEG, ICGC, GEUS, MTI, NERC, LEGMC, GEOINFORM), M1-8
A critical review of state-of-the-art literature on assessment of salt/seawater intrusion (SWI) and vulnerability will be produced, including the data monitored and applied techniques (conventional in situ measurement in monitoring network, land and airborne geophysical approaches, etc). It will also include a review of models and tools that can be employed, which can span from simple interpolation methods to complex numerical models with density dependent flow and sharp interfaces. Based on the review, models and tools are selected for the inclusion in the common toolbox, and an inventory on data required to construct and execute the models/tools is developed and will feed into task 2.3 for a joint questionnaire to the GSOs.

Task 5.2: Developing a method to summarize in a harmonized way SWI status and vulnerability at different scales (Lead partner: IGME. Other partners: HGI-CGS, LNEG, ICGC, GEUS, SGSS, MTI, NERC, LEGMC, GEOINFORM), M1-15
A method based on indices and variables will be developed to generate harmonised and elaborated information on status and vulnerability of GW bodies in relation to SWI. Information at different spatial scales will be generated, moving from maps to 2D representative conceptual cross section and lumped indices. The maps can be generated by applying different tools, such as numerical groundwater flow and transport models, conceptual models and spatial interpolation techniques. The sensitivity of the affected areas to the threshold employed to define them will be studied. This threshold will be defined with the natural background level in the aquifer, which in some cases can be defined in a distributed way considering its spatial variability. The proposed indices-based method will be implemented in a general GIS tool to facilitate its application and comparison between SWI problems in different GW bodies and temporal periods. Adaptation of the proposed method for using it in karst setting will be considered for the Croatia pilot. The resilience and trends of the system can be deduced from time series of indices. We also intend to analyse impacts of potential global change scenarios (climate change and Land Use and Land cover Change scenarios).

Task 5.3: To demonstrate the utility of the proposed method (Lead partner: IGME . Other partners: HGI-CGS, LNEG, ICGC, GEUS, SGSS, MTI, NERC, LEGMC, GEOINFORM), M7-33
The method will be applied in different pilot cases. These will include different typologies of coastal and island aquifers in order to demonstrate that it could be applied to any case study to obtain even national or Pan-European Results. Using the method, we will obtain harmonized and elaborated information about SWI status and vulnerability at different scales and time horizons (historical and future) that may

help in management decision making process. In selected pilots a comparison will be made between results obtained by applying interpolation techniques and other approaches.

Task 5.4: Tool descriptions and guidelines (Lead partner: IGME. Other partners: HGI-CGS, LNEG, ICGC, GEUS, SGSS, MTI, NERC, LEGMC, GEOINFORM**)**, M6-36.
Using the protocol developed in task 2.4, best practice tool descriptions are developed in this task. A first version will be ready prior to the assessments in the pilots, but subject to revision based on feedback from partners during the assessments and the survey among all GSOs. Based on the method developed in task 5.2 and its demonstration together with the review of state-of-the-art, a guideline for assessing SWI status and vulnerability will be developed. The guideline will include guidance in selecting optimal models/approaches taking availability of data into consideration. Further, the guideline will include standards for storing results in the GIP, to allow comparison of results by different approaches applied in different pilots across European

Deliverables
D5.1: Inventory on data and results for sea/salt water intrusion (M7). Inventory listing data needed for and type of results obtained from the assessments, including specific requirements for the storage and visualisation in GIP. (**IGME** + WP5 partners)
D5.2: Harmonised method for assessing status and vulnerability (M15) Technical note describing and illustrating a harmonised method to assess status and vulnerability of aquifers subject to salt-/sea water intrusion based on variables, indices and conceptual representations. (**IGME** + task 5.2 partners)
D5.3: Pilots description and assessment report for sea/salt water intrusion (M31). A technical report describing the pilot areas in details in terms of hydrogeological settings, major challenges, available data and tools applied in the study as well as results from the assessments in the pilots. A map displaying the results for all pilots will be generated as part of the deliverable. All results are further uploaded to the GIP. (**IGME** + All WP5 partners)
D5.4: Journal paper demonstrating the application of the method in pilots (M36). (**IGME** + WP5 parnters)
D5.5: Guideline for assessment of salt/sea water intrusion (M36) (**IGME** + task leaders of WP5).

Work package number	6		Lead beneficiary			IGME			
Work package title		**Groundwater adaptation strategies**							
Participant number	12	9	15	27	31	42	47	50	53
Short name of participant	GEUS	HGI-CGS	BRGM	MBFSZ	SGSS	MTI	GSS	IGME	GEOIN-FORM
Person months per participant	3	1.5	2	2	2	3	5.5	21	0.9
Start month	1				End month		36		

Objectives
- Review (state of the art and practice) of adaptation strategies in relation to groundwater.
- Develop and test a new method for developing climate scenarios and exploring how to select climate scenarios for defining adaptation strategies
- Application of integrated models to evaluate effect of adaptation strategies related to shallow groundwater, dependent and associated ecosystems, flooding and droughts as well as sea/salt water intrusion
- Develop and test a methodology for sustainable operation of droughts
- Development of protocols and guidelines on selected methods and adaptation strategies

Description of work
Task 6.1: Review (state of the art and practice) of adaptation strategies related to groundwater

(Lead partner: IGME. Other partners: GSS, MTI, GEOINFORM, MBFSZ, GEUS), M1-15
The adaptation measures can be classified in terms of measures on the demand of resources, like land use and land cover change, modernization and adaptation in irrigation techniques and economic instruments, and the range of mitigation/adaptation measures on the offer, which mainly lean towards obtaining complementary resources. A review of the different types of adaptation measures and strategies will be performed with focus on the role of groundwater in developing sustainable strategies to reduce potential impacts for different groundwater related issues (e.g. groundwater-surface water interactions and salt/sea water intrusion). Different Conjunctive Use (CU) measures (including managed aquifer recharge (MAR) techniques), which have been used to help in the achievement of sustainable management of droughts and to reduce sea water intrusion problems in coastal areas, will be included in the review. Based on the review an inventory on methods/strategies and data requirements are developed as input to the questionnaire developed in task 2.3.

Task 6.2: Definition of scenarios: climate change projections and adaptation scenarios (Lead partner: IGME. Other partners: GSS, MTI, GEOINFORM, MBFSZ, GEUS), M1-15
Climate change projections are not meant to be predictions of future climate. They are consistent pictures of a plausible future climate, and a basis to evaluate potential impacts against. To make information relevant for specific case studies we need to translate them to regional-local scale. In addition to products available from the climate modelling community (e.g. from CONVEX), we will, for selected pilots, test different methods to perform this translation by applying downscaling techniques and ensembles (equi-feasible and non-feasible) of projections based on a multi-criteria analysis depending on the objectives targeted. For example, a method will be proposed to generate ensemble scenarios to assess drought, reducing the bias in drought statistics (frequency, duration, magnitude and intensity). To assess adaptation strategies two types of approaches can be applied: top-down, which is focussed on the analyses of the physical vulnerability; and bottom-up, which tries to assess social vulnerability. The bottom-up approach defines plausible scenarios and adaptation measures through participatory processes and workshops with the main actors. The top-down approach intends to identify optimal measurement programs for the different climatic scenarios by using model simulations. The top-down approach is commonly used and will be applied in most TACTIC pilots, while the bottom up approach will be explored in few selected pilots such as the Upper Guadiana Basin, with involvement of stakeholders together with the River Basin Authority and regional Water agency.

Task 6.3: Adaptation strategies to reduce impacts of groundwater-surface water interaction (shallow groundwater, dependent and associated ecosystems, flooding and droughts)
(Lead partner: GEUS. Other partners: IGME, BRGM), M24-36
In this task, we demonstrate the application of integrated modelling for assessments of climate change impacts and the effects of adaptation strategies in relation to groundwater-surface water interactions. Utilising the Danish national water resources model (the DK-model), an evaluation will be made of how forced infiltration (local area recharge) as an adaptation strategy to reduce surface water runoff, will affect the shallow groundwater table countrywide. At a regional scale, different conjunctive use adaptation strategies to reduce impacts on groundwater-dependent ecosystems will be evaluated for the Upper Guadiana Basin in Spain. Selected adaptation strategies to reduce drought impacts will be also analysed in the Avre sub-basin of the Somme basin in France. The integrated models used for simulating climate and global change impacts on groundwater in WP3, will be reused to evaluate the adaptation strategies. Thus, effect from climate or global change can be directly compared with the effects of adaptation strategies for the same geographical area.

Task 6.4: Adaptation strategies to reduce impacts on sea/salt water intrusion
(Lead partner: IGME**.** Other partners: HGI-CGS, MTI, GEUS), M12-36
Adaptation strategies to reduce impacts on sea water intrusion will be assessed in this task. The models and methods proposed in WP5 in order to assess and summarise impacts of climate change on sea water intrusion will be employed to assess potential adaptation strategies. It will be applied in Plana de Oropesa-Torreblanca aquifer (Spain) and Vrana lake and polje area (Croatia). Furthermore, the Falster – chalk aquifer pilot will provide examples of the assessment of the application of new subsurface water solutions based on e.g. managed aquifer recharge as evaluated in the related EU Horizon 2020 project "SubSol" (www.subsol.org). Experiences from this can also feed into the pilots in Spain and Croatia.

Task 6.5 Sustainable operation of droughts (Lead partner: IGME. Other partners: SGSS, MTI), M6-36
This task includes two activities: 1) Identification of aquifers suitable for drought adaptation strategies. Based on the assessment of historical and future vulnerability to pumping performed in WP 4 we will propose a method to identify aquifers potentially useful to define CU adaptation strategies. 2) Assessing droughts, their propagation, and CU adaptation strategies. Information on the temporal correlation between meteorological and operational droughts (problems to supply water demands) in the system may be used to define anticipated measures to reduce operational droughts. We propose a novel approach to analyse historical and future potential droughts and their propagation at different spatio-temporal scales, based on plausible monthly future climate scenarios, taking drought statistics of historical series into account, and Regional Climatic Models simulations. Several techniques will be explored and the sensitivity of the drought propagation (performed by hydrological, agronomic and management models) will be analysed in the Segura Basin (Spain).

Task 6.6 Protocols and guidelines (Lead partner: IGME. Other partners: GEUS, HGI-CGS, MTI, GSS, SGSS, BRGM, Geoinform, LGT), M29-36.
The methods developed in task 6.2 and 6.5 will be included in the common toolbox and descriptions on their use will be developed by populating the protocols from task 2.4. The descriptions, together with the review of state-of-the-art, will be further developed into guidelines, which will e.g. include recommendations on pumping rates and their spatial distribution as well as results from tasks 6.3 and 6.4 illustrating the use of models to assess effects of selected adaptation strategies. The guideline will also include standards for storing model results in the GIP.

Deliverables
D6.1: Inventory on data and results for adaptation (M7). Inventory listing data needed for and type of results obtained from the assessments, including specific requirements for the storage and visualisation in GIP. (**IGME** + all WP6)
D6.2: Scenarios development (M15) development of climate change projections and adaptation scenarios. (**IGME** + GSS, MTI, GEOINFORM, GEUS)
D6.3: Pilots description and assessment report for adaptation (M31). A technical report describing the pilot areas in details in terms of hydrogeological settings, major challenges, available data and tools applied in the study as well as results from the assessments in the pilots. All results are further uploaded to the GIP. (**IGME** + All WP6 partners)
D6.4: Journal paper on adaptation strategies to reduce impacts on droughts (M36)
D6.5: Guideline on adaptation strategies (M36). Development of a general guideline on adaptation strategies using the framework developed in task 2.4 and experiences from the pilot areas and the literature review. (**IGME +** all task leaders in WP6**)**

3.2 Management structure, milestones and procedures

Efficient management of the TACTIC project will be ensured by clear responsibilities and professional planning together with communication and progress monitoring. For a project with the complexity of TACTIC, project management is best effectuated by a single project coordinator supported by a strong **Project Board** consisting of the WP-leaders and the project coordinator. The project coordinator is responsible for the day-to-day management and execution of the project and will interact frequently through management meetings every second month via video link to efficiently implement and monitor the project, ensure optimal interaction between work packages and quickly react to opportunities and emerging needs. Project coordination also includes a **Management Support Team** (MST) to support on financial and legal aspects, Figure 3.3. The work **package leaders** are responsible for the detailed technical coordination in the work packages. To ensure coordination between TACTIC and other groundwater projects funded under the joint GeoERA call, the groundwater **Theme Coordinator** is leading the work package on cross-coordination and interaction with the GeoERA Information Platform.

All consortium partners will enter into a Project Agreement (PA) based on the DESCA 2020 model with minor modifications. The Governance structure of the TACTIC consortium, including operational rules and decision making procedures, will be laid down in detail in the CA. The most important elements are described below.

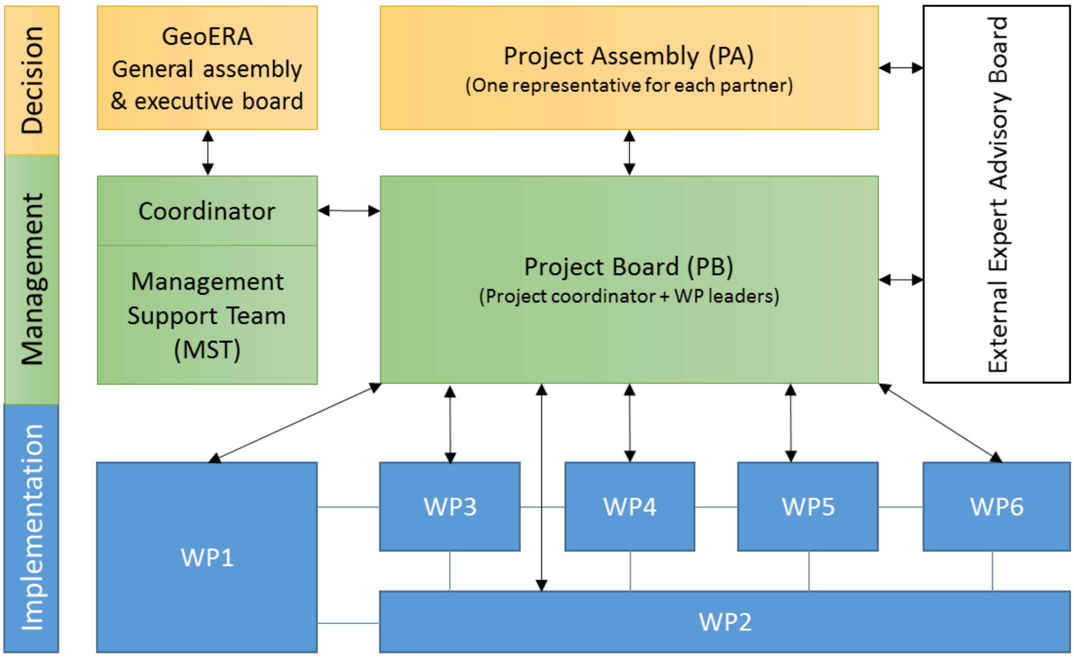

Figure 3.2 Organisational structure of TACTIC.

Project coordinator: TACTIC will be coordinated by partner 12 (GEUS). The coordinator will be responsible for the overall project managing, including monitoring of the project progress and ensure that deliverables and milestones of high quality are met within the financial and time resources, for reporting and communicating with the GeoERA General Assembly and Executive Board; and, for maintaining communication between the Project Assembly, internal management teams and the Advisory Board ensuring a smooth, transparent and efficient execution of the project. Further, the project coordinator is responsible for distributing funds to partners and developing and maintaining the Project Agreement. GEUS is represented by **Anker Lajer Højberg** who holds a Ph.D. in hydrological modelling and has a position of senior researcher at GEUS. Since 2005 he has been the manager of the Danish national water resource model (DK-model), which is an integrated hydrological model covering the entire Denmark and used as the backbone in numerous studies to support national management and legislation including climate change impacts. Anker Lajer Højberg is currently coordinating the Danish research project TReNDS (innovation fond Denmark, 4106-00027B) and is work package leader in the H2020 project WaterProtect (H2020-RUR-2016-727450). In addition to current project management, he has coordinated 20+ small and large complex projects with both nationally and internationally character in his 16 years at GEUS. In addition the administrative responsibilities, the project coordinator will work actively in optimising the project output by encouraging team work, knowledge exchange and collaboration between all parties and work package activities. He will closely follow the project progress and interact to ensure consistency in the work and delivered documents.

Management Support Team (MST): Supporting the project coordinator the MST will be composed of designated legal and financial experts and led by the coordinator. The MST will be reinforced by GEUS' permanent EU Project Office which has extensive experience in all aspects of managing EU projects, and comprises both legal, economic and project management expertise. The MST shall assist and facilitate the work of the Coordinator in the day-to-day management of the Project, and assist the Coordinator and the Executive Board in executing the decisions of the General Assembly. The Financial Secretary will assist the Coordinator by managing adequate financial reporting, compliance of all budgets and cash flow.

Project Board: The members of the Project Board are the WP leaders and the project coordinator. The Project Board shall work on the effective and efficient implementation of the project, especially by: (i) supporting the coordinator in preparing project meetings and meetings with the funding authority and in preparing related data and deliverables; (ii) assisting the coordinators in preparing reports and materials to the funding authority; (iii) reporting on the work progress and quality monitored in the WPs, (iv) monitoring and assuring exchange of information between WPs; (v) advising the general assembly, if adjustment to the work plan is required, which cannot be managed internally in the WP, such as issues which have implication for the project deliverables, or revision of tasks and/or partner budgets.

Project Assembly (PA): The PA consists of all partners and is the ultimate decision-making body of the project consortium and has overall responsibilities for the scientific and financial management of the project. It will be able to decide on changes to the project plan and allocation of the project budget as further laid out in the Project Agreement. All partners will have a seat in the PA by a representative with voting authority. Four PA meetings will be arranged during the project, where video link will be offered for participation.

Work packages leaders (WPL): The WP leaders in TACTIC have been selected based on their qualification to manage and their technical skills and strategic interest in the content and output of the particular WP. In addition to fulfilling their function in the Project Board the WP leader is responsible for the day-to-day management and technical coordination of the WP, where she/he: (i) ensures coherence, usability, compliance of the project and WP objective and goals and implements the decisions of the General Assembly affecting the WP; (ii) supervises and assesses progress and quality of work, supports the WP participants with operative, technical advice (iii) solves problems, manages time schedule with long and short term planning, makes well-reasoned proposals for adjustments and improvements in the work plan; (iv) submits the WP deliverables on time; (v) handles conflicts on WP level, reports breach of obligations of any team member/party. All WP leaders are part of the Project Board.

TACTIC Advisory Board (TAB): An advisory board has been established, which will contribute by bringing in additional knowledge and provide guidance on the project implementation and improvements. The TAB will interact with the project partners at three project meeting, providing feedback and recommendations for the project development. Important aspects for the TAB will be advising on: (i) developing the research infrastructure, especially focussing on how the infrastructure can be optimised to achieve a widespread use by GSOs (both TACTIC partners and non-partners) and stakeholders in future assessments and the development of decision support system utilising the infrastructure, as well as encourage all GSOs in participating in the upload of data and results to the GeoERA Information Platform; (ii) developing a roadmap for the future advancement of climate change and global change assessments by the European GSOs.

Three highly respected experts in different fields of research with specific knowledge on hydrogeological assessments and application of tools and models representing scientists and other professionals within hydrogeology has been invited and accepted to be a member of the TAB:

- Professor Roland Barthel, PhD in Geology with focus on hydrogeology in 2000 at Würzburg University, Germany. Working for private consultancies parallel to PhD and until 2001. From 2001 to 2011, senior researcher at the Institute for Modelling Hydraulic and Environmental Systems and coordinator within the international Master's Program "Water Resources Engineering and Management". 2012 scientific coordinator of the Helmholtz Water Network and the German Water Science Alliance at the Centre of Environmental Research, Leipzig, Germany. Since 2012 Professor in Hydrogeology, Department of Earth Sciences, University of Gothenburg, Sweden. Chair of the Swedish Section of the International Association of Hydrogeologists. Member of the Panta Rhei working group "Transdisciplinarity". PI and main applicant in several large interdisciplinary research projects, e.g. RiverTwin (EU, FP6), GLOWA-Danube (German Ministry of Education and Research) which involved an intensive stakeholder dialogue.
- Dr. Alberto Pistocchi, Master in Environmental Engineering and Land Planning (1997) hons, Master in Philosophy (2002) hons and PhD in Georesources Engineering and Geotechnologies (2001) at the University of Bologna, Italy. In 2012, he obtained the Italian National Scientific Qualification of Associate Professor in the class of Land Planning. During 2000-2004, he has been the lead planner of the Emilia Romagna regional river basins masterplan, addressing flood risk mapping and the protection of aquatic ecosystems through land use and water abstractions regulation. In 2001, he co-founded GECOsistema, an innovative SME developing spatial decision support systems for environmental applications, of which he was the R&D director until 2004 and

during 2010-2013. He was an adjunct professor of Land Planning at the University of Urbino in 2003-2004, and of Spatial Decision Support Systems at the University of Trento in 2010-2013 and 2015-2016. As a scientific project officer at the European Commission, DG JRC, he has been working during 2004-2009 on continental scale transport modelling. Since 2014 he works on the assessment of hydromorphological alterations and water quality on European water bodies as well as on the appraisal of river basin management options in the context of the EU Water Framework Directive.

- Professor Marco Petitta, PhD, is Full Professor of Hydrogeology at Sapienza University of Rome, Italy, teaching Basic Hydrogeology, Groundwater Hydrodynamic and Applied Hydrogeology, with more than 25 years of activity in groundwater field. He is author of about 70 papers on international journals and more than 100 articles on national journals and proceedings. He is coordinating the European Project Horizon2020 KINDRA (2015-2017), dedicated to a knowledge inventory for hydrogeology research. Member of International Association of Hydrogeologists (IAH) since 1997, he was Chairman of the Italian Chapter (2012-2016) and Chair of the 42nd International Congress of IAH, AQUA2015. He is currently Vice-President of IAH for Western and Central Europe. He is also member of the Council of the Italian Geological Society, Coordinator of the Panel of Experts in Hydrogeology of the EFG (European Federation of Geologists) and Member of the EC Working Group of Groundwater, for the Common Implementation Strategy of Water Directives. He serves in the Editorial Board of Environmental Earth Sciences, Geofluids, Italian Journal of Engineering Geology and Environment, Groundwater for Sustainable Development. International research links are active among Europe and with University of Waterloo, Canada, with G360 Research Center of Guelph, Canada, with Sustech Shenzhen University, China. associated professor at Sapienza University in Rome

3.3 Consortium as a whole

The consortium includes 20 national or regional GSOs and one research institution from a total of 18 countries in Europe, with a large geographical coverage from south to north and east to west. The competences of the consortium cover all aspects relevant to hydrological assessments on climate change, with specific emphasis on geology and hydrogeology. Fundamental skills of the GSOs includes geologic and hydrogeological mapping and characterisation, maintenance of regional or national databases on geology and geoscientific observations, and responsibility for regional to national scale monitoring programmes on groundwater heads and quality, used as the backbone for reporting to EU and related directives. As regional to national surveys, a key mission is to provide, use and disseminate knowledge on the subsurface system for the benefit of the society. Most GSOs thus have significant experience in bringing the data and knowledge of the hydrological system into play and interacting with relevant stakeholders at all levels from single individuals to decision- and policy-makers in agencies and ministries.

The consortium therefore brings together the leading institutions on understanding and assessing the groundwater systems within the countries represented in TACTIC. The majority of partners have also been involved in assessments of current groundwater status and some on the assessment of impacts due to climate change. Climate change impacts have been assessed following different approaches from setting up conceptual models and overall water balance assessments, to statistical analysis and complex modelling. Hosting long time series of groundwater head, time series analysis has been the primary approach in several GSOs to understand aquifer vulnerability, provide short- to medium-term predictions on the development and likely risk for drought as well as assessing impacts due to climate change. Different methodologies have been utilised in different GSOs, which provides a unique opportunity to exchange experiences and knowledge and evaluate and test possible further developments of the tools applied.

Modelling by simple lumped models or complex models including both surface- and groundwater or specialised density-dependent flow models to assess sea/salt water intrusion, have similarly been taken up by several GSOs. The experiences with modelling, however, vary greatly from partners willing to start using models, via little experiences, to partners running national integrated models for more than 20 years. The large diversity will foster an active learning lab with exchanges of previous experiences and future ideas, which will support the development of a future roadmap for advancing hydrological modelling to provide hydrological assessments relevant to decision- and policy-makers at national, cross-border and EU-scale.

While many of the TACTIC partners already have considerable and scientifically well-documented experiences in using various tools for assessing groundwater status and development, other partners do not, but are eager to participate in the project to acquire the necessary knowledge to undertake these assessments independently. These partners will contribute by selecting and applying tools for selected pilot(s) in their country, using the protocols developed on application of tools and approaches. This provides a valuable opportunity for input in the co-development of protocols, and guidelines, to ensure they are sufficiently targeted at users with little or no previous experiences.

With the strong engagement of the GSOs in regional and national assessments and advisory, the geological surveys provide an excellent platform to disseminate and ensure a high uptake in European countries of the tools, protocols and guidelines developed during TACTIC.

The key skills and infrastructures for a successful implementation of TACTIC are matched with the partners in Table 3.3. This shows that all the required skills/infrastructures are represented by several partners, and that the consortium as a whole possesses the competences for meeting the objectives of the project. It also illustrates that the consortium is well balanced, by having partners with complementing skills, while at the same time having partners with comparable skills to maximise further development of tools and approaches.

Table 3.3 Skills and infrastructures of the TACTIC consortium

Key skills and infrastructures relevant to TACTIC	Number and short names of TACTIC partners with infrastructure/experiences	
Hydrogeological characterisation of the subsurface	20	All GSOs
Groundwater monitoring, groundwater head and/or quality	12	GEUS, TNO, HGI-CGS, BRGM, BGR, IGME,SGU, NERC, ISPRA, MTI, SGSS, MBFSZ
Regional/national databases on groundwater levels and/or quality	16	GEUS, TNO, HGI-CGS, BRGM, BGR, IGME,SGU, NERC, GTK, ISPRA, GEOINFORM, MTI, LEGMC, SGSS, MBFSZ, GSI
Conceptual modelling of the subsurface including water balance assessments	7	GSS, LNEG, IGME, GEOINFORM, MTI, MBFSZ, GSI
Time series analysis/statistical modelling	8	TNO, BRGM, IGME, SGU, GTK, LNEG, LEGMC, BGR
Lumped modelling	3	NERC, BRGM, IGME
Integrated hydrological modelling including groundwater and surface water	5	GEUS, DLT, HGI-CGS, BRGM, IGME,
Sea/salt water assessments, including but not limited to density dependent flow modelling	5	GEUS, IGME, MTI, NERC, ICGC
Experiences on climate change assessments	11	GEUS, TNO, DLT, BRGM, IGME, NERC, GTK, LNEG, MBFSZ, GSI
Policy support and dissemination to national/international stakeholders	11	GEUS, TNO,BRGM, IGME, NERC, GTK, ISPRA, MTI, SGSS, MBFSZ, GSI

The project does not include non-funded partners. Deltares (Netherlands) will participate as a Third Party as indicated in the Grants Agreement of GeoERA. They are included in the project description as an independent partner, to make their contribution to TACTIC visible, but formally work under the responsibility and financial agreement with TNO.

3.4 Resources to be committed

Table 3.1b) List of work packages

Work package No.	Work Package Title	Lead Participant No.	Lead Participant Short Name	Person - Months	Start Month	End month
1	Project Coordination	12	GEUS	17	1	36
2	Cross coordination, data management, interaction with GeoERA Information Platform and dissemination	12	GEUS	12	1	36
3	Integrated groundwater - surface water assessment of climate change	12	GEUS	60	1	36
4	Assessing groundwater recharge and vulnerability to climate change	15 & 54	BRGM & NERC	70	1	36
5	Assessment of salt-/sea water intrusion status and vulnerability	50	IGME	55	1	36
6	Groundwater adaptation strategies	50	IGME	41	1	36
				256		

Table 3.1c) List of deliverables

Deliverable number	Deliverable name	WP number	Short name of lead participant	Type	Dissemination level	Delivery date (in months)
D1.1	Summary report for the second TACTIC Advisory Board meeting	1	GEUS	R	CO	11
D1.2	Summary report for the third TACTIC Advisory Board meeting	1	GEUS	R	CO	23
D1.3	Project progress report	1	GEUS	R	PU	20
D1.4	Final project report	1	GEUS	R	PU	38
D1.5	Cumulative expenditure report 2018	1	GEUS	R	CO	7
D1.6	Cumulative expenditure report 2019	1	GEUS	R	CO	19

D1.7	Cumulative expenditure report 2020	1	GEUS	R	CO	31
D1.8	Final financial report	1	GEUS	R	CO	38
D2.1	Data management plan	2	GEUS	R	PU	6
D2.2	Definition of requirements to GIP following recommendations from the GIP project	2	GEUS	N	PU	16
D2.3	Questionnaire to survey GSOs on data and tools	2	BRGM	O	PU	10
D2.4	Protocol for best practice descriptions of tools	2	GEUS	O	CO	6
D2.5	Protocol for guidelines	2	GEUS	O	CO	29
D2.6	Communication, dissemination and exploitation plan	2	GEUS	R	PU	6
D3.1	Inventory on data and results for groundwater-surface water	3	GEUS	N	PU	7
D3.2	Pilots description and assessment report for groundwater-surface water	3	GEUS	R	PU	31
D3.3	Journal paper on climate change assessment in EU	3	GEUS	A	PU	36
D3.4	Technical note on propagation of climate change projections in integrated models	3	TNO	N	PU	31
D3.5	Guideline for integrated modelling	3	GEUS	R	PU	36
D4.1	Inventory on data and results for recharge and groundwater vulnerability	4	BRGM	N	PU	7
D4.2	Pilots description and assessment report for recharge and groundwater vulnerability	4	NERC	R	PU	31
D4.3	Journal paper on aquifer recharge variability and trends	4	BRGM	A	PU	36
D4.4	Pan-European net precipitation map	4	GEUS	M	PU	30
D4.5	Guideline for groundwater recharge and vulnerability	4	NERC	R	PU	36
D5.1	Inventory on data and results for sea/salt water intrusion	5	IGME	N	PU	7
D5.2	Harmonised method for assessing status and vulnerability	5	IGME	O	PU	15
D5.3	Pilots description and assessment report for sea/salt water intrusion	5	IGME	R	PU	31
D5.4	Journal paper demonstrating the application of the method in pilots	5	IGME	A	PU	36
D5.5	Guideline for assessment of salt/sea water intrusion	5	IGME	R	PU	36

D6.1	Inventory on data and results for adaptation	6	IGME	N	PU	7
D6.2	Scenarios development	6	IGME	O	PU	15
D6.3	Pilots description and assessment report for adaptation	6	IGME	R	PU	31
D6.4	Journal paper on adaptation strategies to reduce impacts on droughts	6	IGME	A	PU	36
D6.5	Guideline on adaptation strategies	6	IGME	R	PU	36

CO = confidential (internal project deliverables and to GeoERA executive board), PU = public, R = report, N = note, M = maps, A = Peer reviewed journal paper, O = other (questionnaire, protocols, methods)

Table 3.2a) List of milestones

Milestone number	Milestone name	Related work package(s)	Due date (in months)	Means of verification
M1	Kick-off meeting; project running	All	1	Minutes from kick-off meeting approved by the PA
M2	Draft version of requirements to GIP	3 – 6	4	Input provided to the first meeting with the GIP project
M3	Draft pilot studies descriptions	3 – 6	8	Draft report presented and approved at the project workshop
M4	Draft version of best practise	2 – 6	8	Draft report presented and approved at the project workshop
M5	Project progress report approved	1	21	Project progress report approved by the GeoERA executive board
M6	Data and results in GIP	3 – 6	33	Data and results from pilots have been uploaded to the GIP
M7	Final project report approved	1	39	Project progress report approved by the GeoERA executive board

Table 3.2b) List of critical risks for implementation

Description of risk (indicate level of likelihood: Low/Medium/High)	Work package(s) involved	Proposed risk-mitigation measures
Partner is not able to identify relevant pilot(s) with adequate data for assessments (Low)	WP 3-6	All GSOs are responsible for collecting groundwater head data and hydrogeological. If other necessary data, e.g. climate, are missing for present conditions, existing coarse scale EU data will be used

Assessments not carried out in pilots due to insufficient skills by the partners to undertake the assessments by the proposed tools (Medium)	WP 3-6	The TACTIC consortium includes partners with significant expertise in climate change assessments by different tools. Knowledge exchange and collaboration will thus be optimised during the project through the development of best practice, an early workshop on pilots and tools and by the establishment of a knowledge group of experts that will offer support during the TACTIC project
It will not be possible to deliver relevant data to the GeoERA Information Platform (Low)	WP2	In close collaboration with the GIP and the other GeoERA groundwater projects, data collected in TACTIC will be prioritised for optimal value of the data. This will prioritise both data for readily use with large spatial coverage and data required to advance the climate change assessments at cross-border scale.

Table 3.3a) Summary of Staff Effort

	WP1	WP2	WP3	WP4	WP5	WP6	Total Person-Months per Participant
12 GEUS	10	6	17	10	3	3	49
1 TNO			6	3			9
1a DLT			9				9
9 HGI-CGS			9		6	1.5	16.5
14 GTK				3			3
15 BRGM	2	2	6	7		2	19
17 BGR				6.5			6.5
27 MBFSZ			3.5			2	5.5
29 GSI				4.5			4.5
30 ISPRA				6.5			6.5
31 SGSS					2	2	4
39 LEGMC					1.5		1.5
42 MTI					4	3	7
45 LNEG					9		9
47 GSS				6.5		5.5	12
50 IGME	3	2	9	9	21	21	65
51 ICGC					5.6		5.6
52 SGU				5.4			5.4
53 GEOINFORM			0.9	0.9	0.9	0.9	3.6
54 NERC	2	2		8	2		14
Total Person Months	17	12	60	70	55	41	256

Table 3.3b) 'Other direct cost' items (travel, equipment, other goods and services)

1. TNO	Cost (€)	Justification
Travel	3210	Travel to TACTIC meetings
Equipment	0	
Other goods and services	0	
Total	3210	

1a. DLT	Cost (€)	Justification
Travel	3666	Travel to TACTIC meetings
Equipment	0	
Other goods and services	0	
Total	3666	

9. HGI-CGS	Cost (€)	Justification
Travel	2220	Travel to TACTIC meetings
Equipment	0	
Other goods and services	0	
Total	2220	

12. GEUS	Cost (€)	Justification
Travel	33100	Travel to 5 TACTIC meetings (five persons) 2 Meetings with GIP (two persons) 2 review meetings (two persons) Reimbursement for Advisory Board Arrange two project meetings Travel to local pilot site
Equipment	4000	Installation/monitoring at pilot site
Other goods and services	0	
Total	37100	

14. GTK	Cost (€)	Justification
Travel	1000	Travel to TACTIC meetings
Equipment	0	
Other goods and services	0	
Total	1000	

15. BRGM	Cost (€)	Justification
Travel	9000	5 project meetings 2 meetings with GIP Organising one TACTIC project meeting
Equipment	0	
Other goods and services	0	
Total	9000	

17. BGR	Cost (€)	Justification
Travel	5000	Travel to TACTIC meetings
Equipment	0	
Other goods and services	0	
Total	5000	

27. MBFSZ	Cost (€)	Justification
Travel	1000	Travel to TACTIC meetings
Equipment	0	
Other goods and services	0	
Total	1000	

29. GSI	Cost (€)	Justification
Travel	1250	Travel to TACTIC meetings
Equipment	0	
Other goods and services	0	
Total	1250	

30. ISPRA	Cost (€)	Justification
Travel	5000	Travel to TACTIC meetings (two persons)
Equipment	0	
Other goods and services	0	
Total	5000	

31. SGSS	Cost (€)	Justification
Travel	1000	Travel to TACTIC meetings
Equipment	0	
Other goods and services	0	
Total	1000	

39. LEGMC	Cost (€)	Justification
Travel	1000	Travel to TACTIC meetings
Equipment	0	
Other goods and services	0	
Total	1000	

42. MTI	Cost (€)	Justification
Travel	1388	Travel to TACTIC meetings
Equipment	0	
Other goods and services	0	
Total	1388	

45. LNEG	Cost (€)	Justification
Travel	2500	Travel to TACTIC meetings
Equipment	0	
Other goods and services	0	
Total	2500	

47.GSS	Cost (€)	Justification
Travel	3300	Travel to TACTIC meetings
Equipment	0	
Other goods and services	0	
Total	3300	

50. IGME	Cost (€)	Justification
Travel	10000	- 5 project meetings are planned (~5000 €) - 2 travels as WP leader for meetings with GIP (~2000 €) - Travel to pilots. 2 Meetings with stakeholders with 2 persons of the project (~1000 €) - Travel to Conferences (2 conferences; 2000 €)
Equipment/consumables	0	
Other goods and services	5500	- Review by native speakers of documents written in English (articles, posters, brochures). These expenses can be around 900 €. - Payment of two Open Access Publications. (~2500 €) - Registrations in Conferences (2 conferences; ~1000 €) - Organization of the stakeholder meetings (coffees, etc): 1000 €.
Total	15500	

51. ICGC	Cost (€)	Justification
Travel	5818	Travel to TACTIC meetings and pilot site
Equipment	0	
Other goods and services	0	
Total	5818	

52. SGU	Cost (€)	Justification
Travel	1788	Travel to TACTIC meetings
Equipment	0	
Other goods and services	0	
Total	1788	

53. GEOINFORM	Cost (€)	Justification
Travel	3000	Travel to TACTIC meetings
Equipment	0	
Other goods and services	0	
Total	3000	

54. NERC	Cost (€)	Justification
Travel	6941	Travel to TACTIC meetings Arranging one TACTIC project meeting
Equipment	0	
Other goods and services	0	
Total	6941	

Table 3.3c) Financial table with requested budget

Participant	(A) Direct personnel costs (EUR)	(B) Other direct costs; travel, equipment, infrastructure, other (EUR)	(C) Direct costs of sub-contracting (EUR)	(D) Indirect costs (= (A + B) *0,25) (EUR)	(E) Total estimated eligible costs (=A+B+C+D) (EUR)	(F) Reimburse-ment Rate (29,7%)[19]	(G) Requested EU contribution (=E*F)	(H) Surveys in-kind contribution = (E – G)
GEUS	372596	37100	0	102424	512120	29.7%	152100	360020
TNO	57780	3210	0	15248	76238	29.7%	22643	53595
DLT	65342	3666	0	17252	86260	29.7%	25619	60641
HGI-CGS	39600	2220	0	10455	52275	29.7%	15526	36749
GTK	12609	1000	0	3402	17011	29.7%	5052	11959
BRGM	130169	9000	0	34792	173961	29.7%	51666	122295
BGR	41806	5000	0	11702	58508	29.7%	17377	41131
MBFSZ	8663	1000	0	2416	12078	29.7%	3587	8491
GSI	22500	1250	0	5938	29688	29.7%	8817	20870
ISPRA	35750	5000	0	10188	50938	29.7%	15128	35809
SGSS	14085	1000	0	3771	18857	29.7%	5600	13256
LEGMC	2400	1000	0	850	4250	29.7%	1262	2988
MTI	25900	1388	0	6822	34109	29.7%	10130	23979
LNEG	45000	2500	0	11875	59375	29.7%	17634	41741
GSS	10740	3300	0	3510	17550	29.7%	5212	12338
IGME	291551	15500	0	76763	383814	29.7%	113993	269821
ICGC	29676	5818	0	8873	44367	29.7%	13177	31190
SGU	32184	1788	0	8493	42465	29.7%	12612	29853
GEOINFORM	17396	3000	0	5099	25496	29.7%	7572	17923
NERC	73556	6941	0	20124	100621	29.7%	29884	70736
Total	1329303	110680	0	359996	1799979		534594	1265385

[19] The EC Reimbursement rate for ERA-NETs is 33%. 10% of this Reimbursement rate is reserved for the Coordination Costs of GeoERA as agreed in the Grant Agreement. Therefore, the Reimbursement rate for GeoERA is these calculations results in 29,7%.

4 Members of the consortium

4.1 Participants (applicants)

Name of organisation	**1. Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO**		
Short name	TNO	**Country**	Netherlands
Organisation profile			
TNO is a semi-independent Dutch research and technology organisation active in technical, earth, environmental, life, societal and behavioural sciences, focussing of healthy living, industrial innovation, defence, safety and security. The Geological Survey of the Netherlands (TNO-GSN) provides geoscientific data, information and knowledge for sustainable management of earth resources and the environment. TNO-GSN is the national information provider on subsurface data, including the 3D groundwater information products REGIS, GeoTOP and webservices such as Groundwater Tools.			
Roles / tasks in the project		**Special relevant skills**	
Participant of WP3 and WP 6		• (Spatial) time series modelling e.g. to create specific calibration targets • Uncertainty quantification of subsurface information • Confidence analysis	
Short profile of staff member(s) who will be undertaking the work			
Dr. Willem Jan Zaadnoordijk (m): senior hydrogeologist at TNO-GSN and guest researcher at Technical University Delft. Experienced in groundwater modeling, modeling of piezometric time series and groundwater surface water interaction. **Aris Lourens (m)**: senior hydrogeologist at TNO-GSN. Experienced in groundwater modeling and model calibration.			
Publications, infrastructure / technical equipment			
• Witte, Leunk, Cirkel, Aarts, Zaadnoordijk (2015) background decline of groundwater table and recharge in Noord-Brabant (Achtergrondverlaging en grondwateraanvulling in Noord-Brabant; in Dutch), Stromingen, 24 (4), 53-65. • Berendrecht & van Geer (2016) A dynamic factor modelling framework for analysing multiple groundwater head series simultaneously, Journal of Hydrology, 536, 50-60. • Zaadnoordijk, Borren, Inckel, Verstraelen (2017) Groundwater response to drop in river levels caused by a damaged weir, presentated at AEM2017, 20-21 May 2017, Golden CO, USA, see: http://aem2017.cege.umn.edu/assets/pdf/Collected_abstracts_AEM_2017.pdf • http://www.dinoloket.nl: head database and (hydro)geological models			
Relevant projects/activities			
• Upscaling of head observations for the Dutch national groundwater model (resolution 250m x 250m) • Creating database with response of groundwater to precipitation and evaporation for national piezometer database & investigation of approaches for identifying other influences • http://www.grondwatertools.nl: tools for time series analysis and head contouring			

Name of organisation	**1a. Deltares**		
Short name	DLT	**Country**	The Netherlands
Organisation profile			

Deltares is an independent institute for applied research in the field of water and subsurface. Throughout the world, Deltares works on smart solutions, innovations and applications for people, environment and society. The main focus is on deltas, coastal regions and river basins.
Deltares has close cooperation with institutes and governments in the Netherlands and abroad. Within the Netherlands Deltares works closely with for example Rijkswaterstaat (Ministry of Infrastructure and Water management of the Netherlands) and the Dutch Water Boards, as well as with other research institutes and universities. Deltares employs over 800 people and is based in Delft and Utrecht. The unit subsurface and groundwater systems is based in Utrecht.
Deltares has a tradition in working with groundwater and surface water within the Netherlands and throughout the world. This includes modelling, development of software and databases, but also laboratory and monitoring activities. Within Deltares there's a strong believe in openness and transparency; especially open source and stimulation of free availability of data and models.
Deltares hosts the national hydrological model, the Netherlands Hydrological Instruments (NHI), the integrated model for soil, subsurface and surface water for water quantity and nutrient modelling). The instruments are used by Dutch governments (ministries, provinces, water boards) and drinking water companies for strategic purposes, for example the implementation in the Dutch Delta Programme (impact of climate change on the Dutch Water Management) and the Water Framework Directive, but also for operational purposes, for example real time modelling of surface water and ground water in order to manage the available surface water within in the Netherlands.
The groundwater modelling team in Utrecht works closely with the geological modelling team at TNO, the modelling team for the vadose zone at Wageningen University and the surface water modelling team of Deltares in Delft. There's also intensive cooperation with a.o. the global modelling team at University of Utrecht (PCRGLOB) and the US Geological Survey (MODFLOW). The team has broad experience in developing and applying hydrological models within research and projects for water quantity and water quality, including the interaction of surface water and ground water and impact of climate change as well as social and economic scenario's.

Roles / tasks in the project	**Special relevant skills**
Within GeoERA Deltares works as subcontractor of TNO.	• Integrated hydrological modelling on national scale, water quantity and water quality • Modelling on different scales (local, regional national, continental /world wide scale). • Hydrological characterisation of ground water

Short profile of staff member(s) who will be undertaking the work

Marta Faneca Sanchez (female) is hydrogeologist at Deltares. She is specialized in the analysis of groundwater systems, and in groundwater modelling on a regional, national and global scale. She has an extensive experience in different ground water related studies within the Netherlands, Spain South America and Asia. Her projects include the combination of modelling, field work and collaborative processes, as well as the analysis of the climate and socio-economic scenarios.
Neeltje Goorden (female) is a (geo)hydrologist at Deltares. She has extensive experience in projects related to (geo) hydrological modelling, flood and drought forecasting systems (FEWS), ground water contamination and subsidence models. Next to her work in the Netherlands and elsewhere in Europe she has an extensive experience in Asia (Indonesia), where she set up an integrated groundwater modelling frameworks with the Indonesian counterparts.
Bas van der Grift (male, PhD) has a extensive scientific background in water quality and environmental geochemistry. His experience ranges from land use and pollution of the shallow soil and groundwater up to the assessment of the quality of deeper groundwater and quantitative assessments through advanced groundwater quality modelling. Recently he has finished a PhD research project to study the controls on phosphate transport in surface water in rural catchments.
Gijs Janssen (male, PhD) is a senior hydrologist at Deltares. The base of his expertise is ground water quality, soil pollution, uncertainty analysis and geohydrology. Gijs has a broad experience in ground water modelling (reactive transport modelling density dependent flow, transport modelling, inverse modelling). Gijs is involved in different modelling projects at Deltares, on a regional and national scale, including the NHI nutrient modelling on a national scale.

Timo Kroon (male) is a senior hydrologist at Deltares. His experience focusses on integrated hydrological modelling of groundwater and surface water. Timo is project leader of the NHI (Netherlands Hydrological Instrument) for water quantity and water quality and involved in many modelling projects within the Netherlands, including impact studies of climate change and socio-economic scenario's. Besides he is involved in strategic Research on the Water Energy Food Nexus, including developments of global modelling of water and food security.
Gualbert Oude Essink (male, PhD) is senior hydrogeologist at Deltares, Unit Subsurface and Groundwater Systems, and part time Associate professor at Utrecht University with a scientific background from three universities (Delft University, Utrecht University, Free University Amsterdam). His expertise is on groundwater in the coastal zone, with a focus on variable-density groundwater flow and coupled salt transport in regional and local groundwater systems Gu has an extensive experience in groundwater modelling in coastal zones around the world.

Publications, infrastructure / technical equipment

- B. van der Grift, H.P. Broers, W. Berendrecht, J.C. Rozemeijer, L.A. Osté, J. Griffioen. High-frequency monitoring reveals nutrient sources and transport processes in an agriculture-dominated lowland water systemHydrology and Earth System Sciences 20 (5), 2016
- Faneca Sànchez, M., Gunnink, J., van Baaren, E.S., Oude Essink, G.H.P., Elderhorst, W., de Louw, P.G.B., Siemon, B., Auken, E. Modelling climate change effects on a Dutch coastal groundwater system using airborne Electro Magnetic measurementsHydrol. Earth Syst. Science, 2012.
- Janssen, G.M.C.M., J.R. Valstar and S.E.A.T.M. van der Zee Measurement network design including travel time determinations to minimize prediction uncertaintyWater, Water Resources Research 2008.
- De Lange, W.J., Prinsen, G.F., Hoogewoud, J.C., Veldhuizen, A., Verkaik, J., Oude Essink, G.H.P., van Walsum, P.E.V., Delsman, J.R., Hunink, J.C., Massop, H.T.L., Kroon, T. An operational, multi-scale, multi-model system for consensus-based, integrated water management and policy analysis: The Netherlands Hydrological Instrument. Environmental Modelling & Software, 2014.
- Oude Essink, G.H.P., E.S. van Baaren, P.G.B. de Louw Effects of climate change on coastal groundwater systems: A modeling study in the Netherlands, Water Resources Research 2008.

Relevant projects/activities

- Netherlands Hydrological Instrument (NHI), (2005,--) lead by Deltares. Since 2005 Deltares and Wageningen University and Research have been developing the integrated national hydrological model for groundwater, soil water and surface waters in the Netherlands. The model consists of an open toolbox with open databases, mostly open software and tools, as well as sets of data for national and regional applications that can be used in water management studies in the Netherlands (www.nhi.nu).
- Netherlands Water Quality Instrument (2015,--) lead by Deltares and Wageningen University and Research. Based on the national hydrological model an nutrient model for the Netherlands is developed. The model wil be applied in 2018 for national policy studies. Also regional pilots are started to improve the model on the regional scale.
- Fresh – salt groundwater in the coastal zone for the Netherlands lead by Deltares. Within several project, in addition to the NHI project, impact assessment of climate change on fresh water resources is studied.
- iMOD (Interactive MODeling); special version of open source MODFLOW software with graphical user interface. iMOD contains an accelerated Deltares version of MODFLOW with fast, flexible and consistent sub-domain modeling techniques, to handle very large, high resolution groundwater modeling and geo-editing of the shallow and deep subsurface.
- Global scale ground water modelling using MODFLOW and PCRGLOB. In cooperation with Utrecht University a global MODFLOW model, coupled to the PCRGLOB model is developed. The global model is used for global impact studies (e.g. climate change, Sustainable Development Goals, water security) and used as starting point to develop national and regional studies in areas where groundwater models are missing.

Name of organisation	9. Hrvatski geološki institut – Croatian Geological Survey		
Short name	HGI-CGS	Country	Croatia

Organisation profile

Croatian Geological Survey (HGI-CGS) is the foremost public research institute in the field of geosciences and geological engineering in Croatia (HR). HGI-CGS is divided into three departments: Department of Hydrogeology and Engineering Geology, Department of Mineral Resources and Department of Geology. HGI-CGS collaborates with many institutions of similar affiliation, organizations and faculties in the country and neighbouring countries. Beside scientific research, the institute provides consulting services for private companies and stakeholders. HGI-CGS basic activity includes long-term project of producing Basic Geological Maps of the Republic of Croatia among which is also Basic Hydrogeological Map. Regarding groundwater resources, both in karst and alluvium systems HGI-CGS experts have experience and competence in groundwater protection and solving various groundwater connected environmental problems.

Roles / tasks in the project	Special relevant skills
Participant of WP3 & WP7	• Modelling of groundwater flow and solute transport • Analysis of hydrological, hydrochemical and hydrogeological datasets for karst system characterization

Short profile of staff member(s) who will be undertaking the work

Dr. **Andrej Stroj** (m): Scientific Associate at Croatian Geological Survey, Department of hydrogeology and engineering geology with extensive experience in hydrogeological explorations in karst environment for scientific and applied projects. Participated or leaded more than 30 expert projects.
Dr. **Ozren Larva** (m): Senior Research Associate at Croatian Geological Survey, Department of hydrogeology and engineering geology with expertise in exploration of groundwater dynamics and protection of groundwater resources, vulnerability and risk assessment and modelling of groundwater flow and solute transport.

Publications, infrastructure / technical equipment

Kuhta, M., Stroj, A., Brkić, Ž. (2012): Hydrodynamic characteristics of Mt. Biokovo foothill springs in Croatia. Geol. Croat. 65/1; 41-51.
Marković, T., Brkić, Ž. & Larva, O. (2013): Using hydrochemical data and modelling to enhance the knowledge of groundwater flow and quality in an alluvial aquifer of Zagreb, Croatia. Science of Total Environment, Vol. 458-460;. 508-516.
Larva, O., Marković, T. & Mraz, V. (2010): Hydrodynamic and hydrochemical conditions at the groundwater source "Pašino vrelo", with a focus on its development. Geologia Croatica Vol 63 (3): p 299-312.

Relevant projects/activities

- DRINKADRIA - Networking for Drinking Water Supply in the Adriatic Region
- TRANITAL – Origin, fate and transport modelling of nitrate in the Varaždin alluvial aquifer
- ISTRA-HIDRO – Sustainable management of transboundary groundwater between Trieste and Kvarner bay

Name of organisation	12. Geological Survey of Denmark and Greenland		
Short name	GEUS	Country	Denmark

Organisation profile

The Geological Survey of Denmark and Greenland (GEUS) is an independent research and advisory institution in the Danish Ministry of Energy, Utilities and Climate. The areas of expertise of GEUS are geoscientific studies, research, consultancy and geological mapping. GEUS' overall mission is to provide, use and disseminate knowledge of geological materials, processes and relations that are important for the use and protection of the country's natural resources. GEUS is part of Geocenter Denmark - a formalised cooperation between GEUS and the Geocience institutes at University of Copenhagen and Aarhus University. In 2016, GEUS has a staff of 290 of which 210 hold a PhD or MSc degree, and around 50 PhD students and several MSc students are attached to GEUS for research training.

GEUS has a long tradition in working with groundwater, water resources and quality issues, including laboratory, modelling and monitoring activities. GEUS hosts the national databases in relation to geology, geophysics and groundwater related data and is responsible for co-ordination of the Danish monitoring programme on groundwater. The hydrological modelling group has established and further develops an integrated national hydrological model covering Denmark. The model has been used for numerous research and development studies related to quantity and quality by integrated surface and groundwater assessments under present as well as impact of climatic change. The model provides a basic tool for the national and regional water authorities for implementation of the Water Framework Directive in Denmark.	
Roles / tasks in the project	**Special relevant skills**
GEUS will be responsible for the overall coordination of the project and is Work Packages leader of WP2 and WP3. GEUS further participates in all Work Packages in several tasks as task leader	• National model center for national scale integrated hydrological modelling • National responsible for groundwater monitoring • Hydrological characterisation • Application of novel technologies to include satellite in model calibration
Short profile of staff member(s) who will be undertaking the work	
Anker Lajer Højberg (PhD) (male) is a senior researcher at GEUS. He holds a MSc (1996) in hydrology and a PhD (2001) in reactive transport modelling. His fields of expertise are hydrology and integrated modelling at various scales including water quantity and quality issues. Since 2005 he has been the project manager of the Danish National Water Resource Model (www.model.dk). He has additionally lead the development of a national nitrogen model for the Danish Ministry of Environment and Food (2013-2015) and coordinates the Danish strategic research project Transport and reduction of Nitrate in Danish Landscapes at Various Scales (TReNDS) (www.nitrate.dk), and is WP-leader in the EU H2020 project WaterProtect (www.water-protect.eu). He is author and co-author of more than 80 peer reviewed journals papers, conference papers and book chapters. 1000+ ISI citations in ISI registered international scientific journals (h-index=15). **Jacob Kidmose** (PhD) (male) is a senior researcher at GEUS. He holds a MSc (2007) in geology and a PhD (2010) in groundwater – surface water interaction. His scientific experience focusses on integrated hydrological modelling of groundwater – surface water interaction under changing conditions such as changing climate, implementation of adaptations strategies and other anthropogenic processes affecting groundwater. Currently, Jacob is are developing an integrated modelling framework for Copenhagen to analyse the effect of nature based solutions (blue – green climate adaptation measures) on groundwater and urban hydrology in general (NAIAD – horizon 2020 GA No 730497). Jacob has also been developing a large scale hydro-stratigraphical geological model of the trans-boundary German - Denmark area in the project CLIWAT EU INTEREG IV research project in collaboration with Landesamt für Natur und Umwelt des Landes Schleswig-Holstein. His is co-author of the Danish best-practice hydrological modelling guideline. Publication record includes 15 peer reviewed ISI journals papers with 100+ ISI citations and an h-index of 8. **Klaus Hinsby** (male) is a senior research hydrogeologist at GEUS. He is chair of the Water Resources Expert Group of EuroGeoSurveys, and theme coordinator for GeoERA groundwater. He has more than 20 years of experience working on EU projects, and is currently leading work packages e.g. in two Horizon 2020 projects developing a European inventory on groundwater research (www.kindraproject.eu) and new methods to control saltwater intrusion in coastal aquifers (www.subsol.org). He is a specialist in groundwater and subsurface characterisation by use of hydrochemical analyses, geophysical logging, environmental tracers and groundwater dating etc. He has been part of the European Commissions Working Group Groundwater of the Common Implementation Strategy for the Water Framework Directive for more than 10 years. He has special experience and knowledge in derivation of groundwater natural backgrounds and threshold values according to the Groundwater directive as well as issues related to climate change impacts on groundwater and surface water such as sea level rise, salt water intrusion and nutrient loadings to groundwater and ecosystems. **Simon Stisen** (PhD) (male) is a senior researcher at GEUS. He holds a MSc (2003) in hydrology and a PhD (2007) in Remote sensing and hydrological modelling. His research focuses on distributed hydrological modelling, especially related to integration of satellite data and parameter estimation.	

Currently his main activities are centered around spatial model evaluation through his lead of the SPACE project (www.space.geus.dk).His experience includes coordination of a large research and development project with international partners and long-term involvement in the HOBE (Hydrological Observatory) Center of excellency (hobecenter.dk). Additionally he is heavily involved in the development and maintenance of the Danish National Water Resource Model (www.model.dk). His publication record includes 43 peer reviewed ISI journals papers with 1000+ ISI citations and an h-index=18.
Hans Jørgen Henriksen (male) is a senior advisor hydrologist at GEUS. He holds a MSc in hydrology (1982) and a Master in Psychology of Organisation (2006). Project leader and participant in several national and international research projects: NORDRESS - Nordic Centre of Excellency in Resilience and Societal Security. Hydrological modelling of climate change effects on groundwater and extreme runoff; Hydrological early warning system with national water resource model; Web based implementation of DK model based aquifer sustainability and ecological flow indicators for second river basin management plan for Denmark. NAIAD - Nature Insurance value: Assessment and demonstration (H2020-SC5-2016). His publication record includes 30 peer reviewed papers in ISI registered scientific journals with 1000+ ISI citations and an h-index = 18.

Publications, infrastructure / technical equipment

- Højberg, A.L., Troldborg, L., Stisen, S., Christensen, B.B.S. & Henriksen, H.J. (2013) Stakeholder driven update and improvement of a national water resources model, Environmental Modelling & Software, 40, 202-213. Doi:10.1016/j.envsoft.2012.09.010 Stakeholder driven update
- Seaby, L.P., Refsgaard, J.C., Sonnenborg, T.O. & Højberg, A.L. (2015) Spatial uncertainty in bias corrected climate change projections and hydrogeological impacts. Hydrological Processes, 29 (20), 4514-4532. http://dx.doi.org/10.1002/hyp.10501
- Mendiguren, G.; Koch, J.; and Stisen, S (2017) Spatial pattern evaluation of a calibrated national hydrological model - a remote sensing based diagnostic approach. Hydrology and Earth System Sciences Discussions, 1-28. 4 2017.
- Kidmose J, Troldborg L, Refsgaard JC, Bischoff N. 2015. Coupling of a distributed hydrological model with an urban storm water model for impact analysis of forced infiltration. Journal of hydrology, 525, 506-520.
- Kidmose J, Refsgaard JC, Troldborg L, Seaby LP, and Escrivà MM. 2013. Climate change impact on groundwater levels: ensemble modelling of extreme values, Hydrol. Earth Syst. Sci., 17, 1619-1634, doi:10.5194/hess-17-1619-2013.

Relevant projects/activities

- **Danish National Water Resources and Nitrogen Model** (1996 -) Coordinated by GEUS. Since 1996 GEUS has been developing a national water resources model. The model comprise a national consistent tool that are used in numerous project related to water management at the national scale, such as assessment of the sustainable groundwater resource, impact of climate change, water balances at groundwater body levels for reporting to EU and transport and degradation of nitrate. (www.vandmodel.dk)
- **AQUACLEW** (2017 -) The overall goal of AQUACLEW is to use innovative research techniques and integrated co-development with users to advance the quality and usability of several climate services for a number of water related sectors.
- **SPACE** (2014-2019) The aim of this project is to develop a theoretical framework and new methodologies for spatial hydrological model evaluation that are required to advance the current state-of-the-art within distributed hydrological modelling. The project addresses three components of spatial pattern performance improvement in hydrological modelling: 1) Development of new performance metrics designed to evaluate the spatial pattern performance of distributed environmental models. 2) Establishment of appropriate spatial pattern observations of key hydrological states and fluxes based on satellite remote sensing data. 3) Development of new spatial parametrization and calibration frameworks that will allow the simulated spatial patterns to be optimized.
- **CLIWAT (2008-2011) -** Adaptive and sustainable water management and protection of society and nature in an extreme climate – a special issue from the project is available at: https://www.hydrol-earth-syst-sci.net/special_issue149.html

- **NAIAD** aims to operationalise the insurance value of ecosystems (Nature Based Solutions) to reduce the human and economic cost of risks associated with water (floods and drought) by developing and testing - with key insurers and municipalities - the concepts, tools, applications and instruments (business models) necessary for its mainstreaming. Available at http://www.naiad-nbs.eu/.

Significant infrastructure and/or any major items of technical equipment
Modelling center of the integrated Danish National Water Resources Model

<table>
<tr><td>Name of organisation</td><td colspan="3">14. Geological survey of Finland</td></tr>
<tr><td>Short name</td><td>GTK</td><td>Country</td><td>Finland</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">Geological Survey of Finland (GTK)
The Geological Survey of Finland (GTK) is a European competence centre on assessment and sustainable use of geological resources. GTK provide expertise that serves the interests of the society as a whole. Working closely with our partners, we create solutions that lead to new technologies and that can promote sustainable growth.

GTK’s Groundwater unit focuses on groundwater/surface water interactions, groundwater geochemistry, as well as hydrogeological monitoring and modelling of different natural, infrastructural and industrial environments</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">GTK participates in
- setting the criteria of pan-european map
- collection and preparation of national data sets
- conducting spatial analyses and estimates according instructions and
- GW recharge and GW resource map drawings</td><td colspan="2">GTK has experience on:
- geochemical water quality
- isotope hydrogeology
- groundwater monitoring
- groundwater resources
- data management</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Hendriksson Nina Maria (PhD in Geology) (female; maiden name Kortelainen) is a Senior Scientist at GTK, Groundwater unit since 01/2016. 1996 – 2015 worked in the GTK’s Research Laboratory (Isotope Geology); responsible on isotope hydrogeological studies in 2000 – 2015. Main research targets have been related to water chemistry and isotopes in managed aquifer recharge and groundwater – surface water interaction and monitoring. Experience on the MFA (the ministry of foreign affairs) foreign projects in the Central Asia (2014 – on going).
Olli Antero Sallasmaa (MSc) (male) is a geologist at GTK. He holds MSc (1998) in geology. His scientific experience focuses mainly on GIS and remote sensing. Throughout his career in GTK his work topics have been with geological and hydrogeological properties of glaciogenic quaternary deposits. He has studied eskers from two point of view: as a source of gravel aggregates and as typical shallow aquifers in Finland. His publication record consists of applied reports for finnish local authorities.</td></tr>
<tr><td colspan="4">Publications, infrastructure / technical equipment</td></tr>
<tr><td colspan="4">▪Niinikoski, P.I., Hendriksson, N.M., and Karhu, J.A. (2016). Using stable isotopes to resolve transit times and travel routes of river water: a case study from southern Finland. Isotopes Environ. Health Stud. 52, 380–392.
▪Luoma, S., Okkonen, J., Korkka-Niemi, K., Hendriksson, N., Backman, B., and others (2015). Confronting the vicinity of the surface water and sea shore in a shallow glaciogenic aquifer in southern Finland. Hydrol. Earth Syst. Sci., 19, 1353–1370.</td></tr>
</table>

▪**Hendriksson, N.**, *Karhu, J., and Niinikoski, P. (2014). 18O, 2H and 3H Isotopic Composition of Precipitation and Shallow Groundwater in Olkiluoto. Posiva Oy. Working Report 2014-69. Available from: www.posiva.fi/files/3943/WR_2014-69.pdf*
▪***Kortelainen, N.M.***; *Karhu, Juha A. 2009. Geochemical and isotopic evolution of high-pH groundwater in a carbonate-bearing glacigenic aquifer, SW Finland. Hydrology Research 40 (1), 19-31.*
▪***Kortelainen, N.M.***; *Karhu, Juha A. 2004. Regional and seasonal trends in the oxygen and hydrogen isotope ratios of Finnish groundwaters: a key for mean annual precipitation. Journal of Hydrology 285 (1-4), 143-157.*
▪ ***Sallasmaa, O.***, *Ahonen, J., Palmu, J.-P. , Putkinen, N. Superficial deposits thickness 1:1 000 000 map of Finland. Thickness of superficial deposits in Finland; http://www.geologinenseura.fi/winter_meeting/abstracts_newnum_pdf/S11_1_227.pdf*

Relevant projects/activities

▪*Co-operation with the IAEA/WMO Global Network of Isotopes in Precipitation (GNIP http://www-naweb.iaea.org/napc/ih/IHS_resources_gnip.html. GTK has been operating three national precipitation stations since 2000.*

Name of organisation	**15. Bureau de Recherches Géologiques et Minières**		
Short name	BRGM	**Country**	France

Organisation profile

BRGM (Bureau de Recherches Géologiques et Minières) is the French geological survey. It was created in 1959 and is France's reference public institution for Earth Science applications in the management of surface and subsurface resources and risks. BRGM's activities are focused on increasing geological knowledge and understanding surface and subsurface phenomena related in particular to groundwater, mineral and geo-energy resources. By addressing major environment and sustainability issues, BRGM provides support for public policies and decision making, and contributes to the development of innovative technologies featuring research in public and private partnership, at national and international level.

Roles / tasks in the project	**Special relevant skills**
BRGM is Work Packages leader of WP4 and participate in WP3 and WP6	• Groundwater modelling • Tools development for groundwater management • Groundwater vulnerability to climate change

Short profile of staff member(s) who will be undertaking the work

Nada Amraoui (PhD) (female) is senior research hydrogeologist at BRGM. She holds a MSc (1992) in civil Engineering and a PhD (1996) in civil Engineering (flow in unsaturated zone). Her fields of expertise are hydrology and integrated modelling at various scales. She managed and contribute to the development of several regional models in France dedicated to groundwater resource management and used in many research works. She was actively involved in several EU and INTERREG research projects (AQUATERRA; FLOOD1 …) dealing with the flow and transport modelling in vadose zone and aquifers systems integrating groundwater – surface water interaction. She contributed as a modelling expert to the French national project "EXPLORE 2070" dealing to evaluate the future climate change effects on water resource and to develop possible adaptation strategies. Currently Nadia is in charge of the national project "Aqui-FR", which aims to set up a national hydrogeological modelling platform.
Nolwenn Croiset (female) is a senior hydrogeologist, expert in groundwater modelling and environmental statistics. Her experience includes many developments of methodologies and tools dedicated to time series analysis for supporting public policies mainly.
Dominique Thiéry (male) graduated from the French National School of Hydraulic of Grenoble (ENSMG) and obtained a Master's degree at the University of California, Berkeley (USA), in Civil Engineering (Hydrology) in 1975. He is currently research and development project manager with the BRGM Water and Environment direction. The research projects that he manages are concerned with hydrosystems modelling in the saturated and vadose zone. He has developed models addressing flow and transport in groundwater and rivers in connection to Climate Change. He has lectured in hydrology in several countries (France, Germany, Morocco, Vietnam) and supervised PhD students at

BRGM. He has been involved in many studies in France and abroad (e.g. Nigeria, Botswana, Saudi Arabia, Niger, Vietnam, Mexico). Member of AIHS/CNFGG, he is author of over 400 publication and congress written presentations. **Jean-Pierre Vergnes** (PhD) (male) is a senior research hydrogeologist at BRGM. He hold a MSc (2009) in hydraulic and fluid mechanics and a PhD (2012) in groundwater modelling for climate applications. His scientific experience focuses on hydrological modelling at various scale for research and operational purposes. Since 2014, he strongly contributes to the development of a national hydrogeological modelling platform for the French Biodiversity Agency. His experience includes various projects related to groundwater resource management and impact studies for public authorities or water agencies. His experience includes the study of the interactions between groundwater, land surface and atmosphere for climate and hydrological applications. In particular, he developed a groundwater model specifically dedicated to large-scale climate applications.
Publications, infrastructure / technical equipment
• Thiéry, D., Amraoui, N., Noyer, M-L. (2017), Modelling flow and heat transfer through unsaturated Chalk – Validation with experimental data from the ground surface to the aquifer. Journal of Hydrology (2017), doi: https://doi.org/10.1016/j.jhydrol.2017.11.041 • Nicolle, P., Pushpalatha, R., Perrin, C., François, D., Thiéry, D., Mathevet, T., Le Lay, M., Besson, F., Soubeyroux, J.-M., Viel, C., Regimbeau, F., Andréassian, V., Maugis, P., Augeard, B., and Morice, E. 2014 - Benchmarking hydrological models for low-flow simulation and forecasting on French catchments. Hydrol. Earth Syst. Sci., 18, 2829-2857. doi:10.5194/hess-18-2829-2014. Online version: http://www.hydrol-earth-syst-sci.net/18/2829/2014/. • Habets F, Ackerer, P, Amraoui, N. & al., (2015) Aqui-FR, un système multi-modèle hydrogéologique à l'échelle nationale. Géologues 105–109. • Le Cozannet G. Amraoui N. Baills A. 2015 : Vulnerability and adaptation to climate change – contribution from the Geosciences - BRGM | Geosciences journal, special issue : Climate Change and the Geosciences - pages 18-29. • Thiéry, D., Amraoui, N., Gomez, E., Pédron, N., Seguin, J.J. 2011 - Regional model of groundwater management in North Aquitania aquifer system: Water resources optimization and implementation of prospective scenarios taking into account climate change. In Water Security in the Mediterranean Region, NATO Science for Peace and Security Series C: Environmental Security. 2011, pp 275-290 • Vergnes J-P. and Decharme B. (2012) : A simple groundwater scheme in the TRIP river routing model : global off-line evaluation against GRACE terrestrial water storage estimates and observed river discharges. *Hydrol. Earth Syst. Sci.* 16(10), 3889–3908. doi: 10.5194/hess-16-3889-2012. • Lopez B. Croiset N., Gourcy L. (2014) : HYPE: a WFD tool for the identification of significant and sustained upward trends in groundwater time series. EGU General Assembly 2014, 27/04-2/05, Vienna, id.14687
Relevant projects/activities
http://www.brgm.eu/project/towards-more-accurate-predictions-of-climate-change-impacts-on-water-resources *http://www.brgm.eu/project/towards-more-effective-communication-of-groundwater-data* *http://www.brgm.eu/project/tempo-modelling-tool-to-support-hydrosystem-management* *4.2 **Aqui-FR:** a national multi-model hydrogeological system. This project aims at providing monitoring and forecasts of the groundwater resource evolution in France, as well as long-term projections. To do so, the Aqui-FR project relies on existing hydrogeological applications. https://www.metis.upmc.fr/~aqui-fr/index_eng.html* *4.3 **MARTHE**: Modelling software developed by the BRGM. 3D modelling of flows and mass and energy transfers in hydro-systems. Modelling includes aquifers, rivers and vadose zones.* *4.4 **HYPE** - A statistical tool for analysis of trends and breaks in groundwater quality records, developed in 2013*

Name of organisation	**17. Federal Institute for Geosciences and Natural Resources**		
Short name	BGR	**Country**	Germany
Organisation profile			

BGR is an Authority and Research Institute of the Federal Republic of Germany within the portfolio of the Federal Ministry for Economic Affairs and Energy. BGR gives independent advice to the Federal Government on all geoscientific questions. It cooperates on the European level with the National Geological Surveys and is member of EuroGeoSurveys. BGR harmonizes methods taking into account hydrogeological and hydrogeochemical data as well as information on soil. BGR's International Hydrogeological Map of Europe at the scale of 1:1.500.000 (IHME1500) could serve as information basis for standardization. The interpretation of national information is performed using standardized methods for all of Germany, developed in close collaboration with the Federal State Geological Surveys, such as the aquifer vulnerability map to pollution at the scale of 1:200.000 or the groundwater recharge map at the scale 1:2.000.000.	
Roles / tasks in the project	**Special relevant skills**
WP4: Work Package Participant	• Hydrogeological mapping at various scales. • Building databases and web services for subsurface and groundwater data. • Interpretation of hydrogeological datasets towards custom-made information products.
Short profile of staff member(s) who will be undertaking the work	
Dr. Jörg Reichling (m): senior hydrogeologist and groundwater expert. Head of sub-department „Basic Information Groundwater and Soil" at BGR. Member of the EGS Water Resources Expert Group. **Dr. Stefan Broda (m):** senior groundwater expert and project manager at BGR. Head of unit "Spatial information on groundwater". Responsible for the national (Hydrogeological Map of Germany) and international hydrogeological data base (WHYMAP). **Dr. Andreas Günther (m)**: senior geologist and project manager at BGR. Responsible for the IHME1500.	
Publications, infrastructure / technical equipment	
National database on subsurface information at the scale of 1:200.000 and smaller (Hydrogeological Map of Germany; Mean Annual Groundwater Recharge of Germany; Aquifer Vulnerability Map to Pollution; hydrogeochemical Groundwater Background Level Values), International database on subsurface information at the scale of 1:1.500.000 (IHME1500) and 1:25.000.000 (WHYMAP) Publications: *Ad-hoc-AG Hydrogeologie (2016): Regionale Hydrogeologie von Deutschland - Die Grundwasserleiter: Verbreitung, Gesteine, Lagerungsverhältnisse, Schutz und Bedeutung. - Geologisches Jahrbuch Reihe A, Heft 163: 456 S., ISBN 978-3-510-96852-7* *Duscher, K., Günther, A., Richts, A., Clos, P., Philipp, U. and Struckmeier,W. (2015): The GIS layers of the "International Hydrogeological Map of Europe 1:1,500,000" in a vector format. - Hydrogeol. J.; DOI 10.1007/s10040-015-1296-4* *Günther, A., Van Den Eeckhaut, M., Malet, J.-P., Reichenbach, P., and Hervás, J. (2014): Climate-physiographically differentiated Pan-European landslide susceptibility assessment using spatial multi-criteria evaluation and transnational landslide information. Geomorphology, 224, pp. 69-85.* *Hölting, B., Haertle, T., Hohberger, K.-H., Nachtigall, K. H., Villinger, E., Weinzierl, W. and Wrobel, J.-P. (1995): Konzept zur Ermittlung der Schutzfunktion der Grundwasserüberdeckung.- Geol.Jb. 63, Reihe C; Hannover (BGR).Neumann, J. (2009): Flächendiffernzierte Grundwasserneubildung von Deutschland. Entwicklung und Anwendung des makroskaligen Verfahrens HAD-GWNeu.- Geol.Jb. SC6, Reihe C; Hannover (BGR).* *BGR-product: Groundwater Recharge (HAD 5.5 2003): https://geoviewer.bgr.de/mapapps/resources/apps/geoviewer/index.html?lang=de&tab=grundwasser&cover=grundwasser_had_55_wms* *BGR-product: Vulnerability of main aquifer in Germay (SGWU 2005): https://geoviewer.bgr.de/mapapps/resources/apps/geoviewer/index.html?lang=de&tab=grundwasser&cover=grundwasser_sgwu_ags*	
Relevant projects/activities	

- International Hydrogeological Map of Europe IHME1500 including lithological harmonization.
- World-wide Hydrogeological Mapping and Assessment Programme WHYMAP - World Karst Aquifer Map, Vulnerability to floods and droughts.
- Protection potential to pollution of aquifer in Germany.

<table>
<tr><td>Name of organisation</td><td colspan="3">27. Mining and Geological Survey of Hungary</td></tr>
<tr><td>Short name</td><td>MBFSZ</td><td>Country</td><td>Hungary</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">The Mining and Geological Survey of Hungary operates as a governmental organisation that was established on 1 July 2017 through the merger of the Geological and Geopgysical Institute (previously known as the former Hungarian Geological Institute, est. in 1869 and the Eötvös Loránd Geophysical Institute, est. in 1907) and the Hungarian Office for Mining and Geology.
The MBFSZ besides administrative and governmental tasks, is responsible for undertaking research and development activity in the fields of hydrogeology, geology, geophysics, agrogeology, environmental science, and geochemistry.
One of the main activities of the institute is the professional support for the adaptation of the Water Framework Directive. The MFGI maintains the national groundwater monitoring system, which consists of 179 groundwater bores collecting hydrogeological data from karst and confined aquifer systems. 81 of the 179 wells comprise the monitoring network of the EU Water Framework Directive. The survey has more than 250 employees. The MFGI puts emphasis on international cooperation and has lead several EU founded projects such as TRANSENERGY, EuroGeoSource, ThermoMap, PanGeo, Geo-DH, PLASMON, DORIS, NAMs, CGS Europe, Geothermal ERA_NET (FP7), STORM, SNAP-SEE. The institute maintains a continuous collaboration with the geological institutes of neighbouring countries including Romania, Slovakia, Austria and Slovenia and has been involved and managed several large-scale transboundary projects. The institute has a large collection of scientific software licances to be used throughout the project including Feflow, ArcGIS, Aquachem, etc. Powerful workstations are available for undertaking numerical model calculations.
Besides a wide range of geophysical instruments, the institute has its own analytical laboratory with a wide range of analytical instruments such as ICP-MS, ICP-OES, AAS, Ion chromatograph, FTIR, GC, XRD and SEM among others. The laboratory has a complete water analysis capability. The institute has its own fleet of field vehicles.
Research results produced at the institute are published in international papers, the institute’s annual report, maps and other publications. MFGI is the primary institution in Hungary responsible for groundwater research and management.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">Participation and technical expertise in WP3 and WP7. Conceptualisation, groundwater modelling, data analysis, etc.</td><td colspan="2">• Implementation water framework directive
• Regional scale groundwater modelling
• Transboundary groundwater management
• National groundwater monitoring
• Hydrological characterisation</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Dr Attila Kovács, is a Senior Researcher with 20 years of international experience in hydrogeology and groundwater modelling. He has worked on a large variety of consulting and academic projects, including water resource protection, contaminated sites, nuclear waste disposal, mining, geothermal, climate change impact assessment and geotechnical investigations. Dr Kovács is an internationally recognized expert in karst hydrogeology and modelling, and published several scientific papers and book chapters on these topics. Dr Kovács has developed novel hydrograph analytical techniques and clarified some fundamental aspects of the hydraulic functioning of karst and fractured hydrogeological systems.
Dr Kovács awarded his PhD from the Centre for Hydrogeology and Geothermics of the University of Neuchâtel, Switzerland in 2003. Since then, he has been active internationally both in industry work and academic research. Dr Kovács has instructed academic courses in karst hydrogeology and groundwater modelling in several countries.</td></tr>
</table>

***Éva Kun** is a researcher with 20 years of experience in the fields of groundwater modelling, water resources protection and climate change impact assessment studies. She took part in the NAGiS an CC-Waters climate change impact assessment studies.*
***Tamás Kerékgyártó** is an expert in geothermal resource survey, hydrogeochemistry, water-rock interaction modelling and hydrodynamic modelling. He took part in the evaluation of quantitative and qualitative status of the groundwater bodies in Hungary in the framework of the second River Basin Management Planning.*

Publications, infrastructure / technical equipment

Kovács, A., Marton, A., Tóth, Gy., Szőcs, T. (2016): Climate change impact on shallow groundwater conditions in Hungary. In: Pálvölgyi, T., Selmeczi, P. (eds.) Knowledge Dissemination, Adaptation and Climate Change. Geological and Geophysical Institute of Hungary. pp. 33-40. ISBN 978-963-671-308-9.

Kovács, A., Marton, A., Tóth, Gy., Szőcs, T. (2016): Quantitative investigation of climate change impact on shallow groundwater conditions in Hungary. Hungarian Hydrological Bulletin, 96/1, 21-32.

Kovács A., Szőcs T. (2016). Reactivation of karst springs after regional mine dewatering in the Tata area, Hungary. In: Stevanovic, Z., Kresic, N., Kukuric, N. eds. Karst without Boundaries. IAH Selected Papers No. 23. pp. 337-358. CRC Press.

Kovács, A., Perrochet, P., Darabos, E., Lénárt, L., Szűcs, P. (2015): Well hydrograph analysis for the characterisation of flow dynamics and conduit network geometry in a karstic aquifer, Bükk Mountains, Hungary. Journal of Hydrology, 530, pp. 484-499

Kovacs, A., Perrochet, P, Király, L. & Jeannin, P-Y. (2005): A quantitative method for the characterization of karst aquifers based on spring hydrograph analysis. Journal of Hydrology, Vol. 303, pp. 152-164

Relevant projects/activities

*MBFSZ was the coordinator of the **NAGiS** - National Adaptation Geo-information System project, whose objective was to develop a multipurpose geo-information information system that can facilitate policy-making, strategy-building and decision-making processes related to the impact assessment of climate change and the adoption of necessary adaptation measures in Hungary (financed by the European Economic Area (EEA) Grant; 2013-2016). The work continues in the NAGiS 2 project.*

*MBFSZ is the coordinator of the **DARLINGe** - Danube Region Leading Geothermal Energy project (1 January 2017 – 30 June 2019 Interreg Danube Transnational Programme) carried out by 15 partners from 6 countries in Central, South-East and Eastern Europe to make the Danube region less dependent on imported fossil fuels, by making an efficient use of deep, untapped geothermal resources and where possible, introducing more efficient thermal water management.*

*MBFSZ was the coordinator of the „**TRANSENERGY** – Transboundary Geothermal Energy Resources of Slovenia Austria, Hungary and Slovakia" (2010-2013 – 2CE124P3), project, which provided tools for sustainable use of geothermal resources at the Western part of the Pannonian Basin. MBFSZ was responsible for the establishment of geological, hydrogeological and geothermal models at the project area.*

*MBFSZ was the Hungarian coordinator in the **T-JAM** project "Screening of the geothermal utilization, evaluation of the thermal groundwater bodies and preparation of the joint aquifer management plan in the Mura-Zala basin" (Operational Programme Slovenia - Hungary 2007-2013, 4300-488/2008/8), responsible for the geoscientific models, hydrogeochemical and isotope hydrogeology survey and elaboration of the recommendations on a joint transboundary thermal groundwater management (2009-2011).*

MBFSZ coordinated and carried out the work to establish and revise the background values, threshold values and chemical status of the groundwater bodies in Hungary in the framework of the first and second national River Basin Management Planning

Name of organisation	29. Geological Survey Ireland (Department of Communications, Climate Action and the Environment)		
Short name	**GSI/DCCAE**	**Country**	Ireland

Organisation profile
Founded in 1845, Geological Survey Ireland is the Republic of Ireland's public earth science knowledge centre. We are a division of the Department of Communications, Climate Action and Environment. We provide free, open and accurate data and maps on Ireland's subsurface to landowners, the public, industry, and all other stakeholders, within Ireland and internationally. In addition, we act as a project partner in interpreting data and developing models and viewers to allow people to understand the underground.

Roles / tasks in the project	Special relevant skills
Participant in WPs: 6	• Groundwater recharge estimation • Creation of national databases and maps • Characterisation and mapping of hydrogeological systems • establishing

Short profile of staff member(s) who will be undertaking the work
Taly Hunter Williams (f) Senior Hydrogeologist with expertise in groundwater resources estimation and hydrochemistry. Member of the EuroGeoSurveys Water Resources Expert Group. **Katie Tedd (f)** Senior Hydrogeologist, expert in hydrochemistry and hydrogeology, analysed groundwater levels in SE Ireland. **Michael Sheehy (m)** member of EGS expert group on Earth Observation and Geohazards. Advisory role to WP only. **Contract staff (m/f)** Suitably qualified contract staff member to be appointed.
Publications, infrastructure / technical equipment
N.H. Hunter Williams, B.D.R. Misstear, D. Daly and M. Lee (2013) Development of a national groundwater recharge map for the Republic of Ireland. QJEGH. 46(4):493-506. K.M. Tedd, C.E. Coxon, B.D.R. Misstear, D. Daly and N.H. Hunter Williams (2012) Hydrogeological insights from groundwater level hydrographs in SE Ireland. QJEGH 45(1):19-30. B.D.R. Misstear, L. Brown and N.H. Hunter Williams (2008) Groundwater recharge to a fractured limestone aquifer overlain by glacial till in County Monaghan, Ireland. QJEGH 41(4):465-476. C. Kelly, N.H. Hunter Williams, B.D.R. Misstear, K. Motherway (2015) Irish Aquifers Properties: A reference manual and guide. GSI/EPA. Geological Survey Ireland. National Groundwater Recharge map, Groundwater Levels and Aquifer Parameters Databases.
Relevant projects/activities
GSI/EPA funded study: High-Resolution Gridded Datasets of Hydro-Climate Indices for Ireland. GWFlood https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/projects/gwflood/Pages/default.aspx Groundwater3D https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/projects/gw3d/Pages/default.aspx Protecting Drinking Water https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/projects/protecting-drinking-water/Pages/default.aspx

Name of organisation	30. Istituto Superiore per la Protezione e la Ricerca Ambientale		
Short name	ISPRA	**Country**	Italy
Organisation profile			

ISPRA (Italy) is a national public body, subject to the vigilance of the Ministry for Environment, Territory and Sea. The Institute results from the merging of Agency for Environmental Protection and Technical Services (APAT), Central Institute for Scientific and Technological Research Applied to Sea (ICRAM) and National Institute for Wildlife (INFS). ISPRA will be represented in Geo-ERA by the Geological Survey of Italy that is now a Department of ISPRA. It undertakes technical-scientific activities to support policies and legislation on several environmental issues (e.g. land planning, natural hazard, etc.) and provides geological data collection, management and publication. In its role of Geological Survey of Italy, ISPRA is the reference institution for the geological information in Italy, including the official geological and geothematic maps of the Italian territory, as well as several databases providing information about subsurface geology and geohazards.

Roles / tasks in the project	**Special relevant skills**
Participant in WP6, aiming to contribute to several tasks.	• Characterisation and mapping of hydrogeological Systems • Building databases and web services for subsurface and groundwater data • Natural hazard risk assessment and natural resource protection and management

Short profile of staff member(s) who will be undertaking the work
Barbara DESSI (f): hydraulic Engineer, researcher technologist on natural hazard risk assessment and natural resource protection and management. Member of the Water Resource EGS Expert Group. Author of several scientific papers and technical reports. **Rossella Maria GAFÀ (f)**: Geologist, researcher technologist on hydrogeological issues. Author of scientific papers and technical reports. **Lucio MARTARELLI (m):** Geologist, senior researcher technologist on hydrogeological issues. EGS Water Resource Expert Group member. Author of several scientific papers and technical reports. **Gennaro Maria MONTI (m):** Geologist, researcher technologist on hydrogeological issues. Author of scientific papers and technical reports. **Anna Rosa SCALISE (f):** Geologist, senior researcher technologist on hydrogeological issues. Author of several scientific papers and technical reports. **Angelantonio SILVI (m):** Cartographer, expert in GIS cartography and hydrogeological mapping. Author of several scientific papers and technical reports.
Publications, infrastructure / technical equipment
- Antonakos A., Martarelli L., Scalise A.R. et al. (2009) - International Hydrogeological Map of Europe 1:1.500.000 scale. Sheet D6 Athina. (Nikas K., Strub H. & Winter P., coords.). BGR/UNESCO, Hannover (Germany). - Conte G., Del Bon A., Gafà R.M., Martarelli L., Monti G.M. (2015) - Rainfall analysis during the period 1984-2014 in Rome (Central Italy). Italian Journal of Groundwater 4/142, 33-45. - Dessì B., Martarelli L., Spizzichino D. (2015) - Italy. In: EuroGeoSurveys “Wonder water. The value of water”. Brussels. - Furnari S., Martarelli L., Moroni M. (2008) - Hydrogeological model in a test area of the Alban Hills, Rome, Central Italy. In: Paliwal B.S. (ed.) “Global Groundwater Resources and Management”. Chapter 12, 185-205. Scientific Publishers (India), Jodhpur.
Relevant projects/activities
- EPOS, European Plate Observing System (http://www.epos-ip.org). - CEWP, China Europe Water Platform, Focus Area Rural Water & Food Security (http://cepw.eu). - Geoportal of Geol.Surv. of Italy (http://sgi.isprambiente.it/geoportal/catalog/main/home.page).

Name of organisation	**31. Servizio Geologico Sismico e dei Suoli Regione Emilia-Romagna**		
Short name	SGSSS	**Country**	Emilia-Romagna Region - ITALY
Organisation profile			

SGSS (Geological, seismic and soil survey) is a technical entity of Emilia-Romagna Region (public body) which was established in 1976 to support the regional government policies dealing with the environment and land planning. The mission of the Survey is to provide the regional administration and society with basic up-to-date geological, pedological and geo-thematic information. SGSS supported and supports the Emilia-Romagna Region in groundwater policy and planning, and in the implementation of the Water and Groundwater EU Directives, with studies, maps, survey and monitoring. SGSS is involved in regional and local projects on groundwater monitoring and planning, and in the production of monitoring and studies related to subsidence due to groundwater withdrawal. Other SGSS fields of expertise are monitoring of specific natural processes which affect the territory of Emilia-Romagna (coastal erosion, landslides, sea storms, …..), the identification and study of natural resources (water, soil, hydrocarbon, geothermal energy, raw materials), and the reduction of seismic risk.	
Roles / tasks in the project	**Special relevant skills**
Partner in WP 5 : Assessment of salt-/sea water intrusion problems (status and vulnerability). WP 6 : Groundwater adaptation strategies.	• Planning and implementation of a MAR plant in an alluvial fan • Responsible for groundwater monitoring in costal aquifer • Subsurface 3D definition of aquifers and aquitard • Contribution in implementation of EU water Directives for groundwater
Short profile of staff member(s) who will be undertaking the work	
Paolo Severi (male) is a senior geologist, collaborator of SGSS since 1989. His fields of expertise are geological survey and mapping in Apennines and Po Plain (surface and subsurface), groundwater and land subsidence. He has been the scientific coordinator of 7 Geological Sheet 1:50.000 scale of the geological Map of Italy (CARG Project), and realised many geological maps 1.10.000 scale. He is the project manager of many regional and local hydrogeological projects, including managed aquifers recharge (MAR) plant in Marecchia rivers alluvial fan, and of the groundwater monitoring network of the phreatic costal aquifer. He coordinated groundwater survey and studies during and after the 2012 heart quake in Emilia area (Italy). He works at the geological and hydrogeological implication in the hydrocarbon research, abstraction and storage. He has been the Regional coordinator for BVM, EWATER, SNAP SEE, EU Projects and now for GEOERA EU Project. Since 2014 he is Contract Professor at the Bologna University (teaching: Geological Survey of the Po Plain). He also is involved as author or co-author in more than 40 scientific publication (article, chapter of book, book, conference paper, poster, technical report) (h-index = 6). **Luciana Bonzi** (female) is a collaborator of SGSS since 2004 with the role of official expert in regional policy and technical studies. She is an hydrogeologist graduated at the University of Milan. She collaborates in the studies and management of groundwater with a particular attention to: groundwater monitoring; salt water intrusion in costal aquifers; geological reconstruction and subsurface mapping of aquifers and aquicludes in Po Plain; subsidence analysis and its fluids extraction relationship; managed aquifers recharge (MAR). She was part of working groups in the BVM and SNAP SEE EU projects. She collaborates to the implementation of the Emilia-Romagna Information System and deals with the monitoring networks of SGSS, as measurements of piezometric level and subsidence. She contributes to the activities and he is part of the team of the Functional Center of Civil Protection. **Lorenzo Calabrese** (PhD) (male) is a collaborator of SGSS since 2000 with the role of official expert in regional policy and technical studies. He has a Ph.D. in sedimentary geology and a long experience as stratigrapher, specializing in 3D geological modeling applied to hydrogeological, geotechnical and coastal dynamics studies. He worked as surveyor and editor for the national geological cartographic project at 1:50000 scale (CARG project). He was part of working group in the Cadsealand, Plancoast, Coastance, Micore, Shape and Coastgap EU projects. He collaborates to the implementation of the Emilia-Romagna Information System of Coast and Sea and deals with the monitoring networks of SGSS, as measurements of piezometric level and subsidence. He contributes to the activities related to coastal risk cartography (in Accordance with EU directive 2007/60) and he is part of the team of the Functional	

Center of Civil Protection. He is author or co-author of more than 40 scientific publication (article, chapter of book, book, conference paper, poster, technical report) and he scores h-index = 11.
Publications, infrastructure / technical equipment
Geological cartography (https://applicazioni.regione.emilia-romagna.it/cartografia_sgss/user/viewer.jsp?service=geologia) - Geological map at scale 1:50.000 (derived from the database of the CARG Project - Geological Map of Italy, including subsurface geological maps, available in http://www.isprambiente.gov.it/Media/carg/emilia.html) and 1:10.000 scale. The portal contains also others geological, pedological and geothematic information : landslides inventory data, geological cross sections, geognostic tests (more than 85.000 including boreholes, cone penetration tests, water wells stratigraphy), soil cartography, springs and aquifers data, sea-cost data, geological heritage and cavities information and maps. **3D geological modeling** (http://ambiente.regione.emilia-romagna.it/geologia/temi/geologia/3d) - SGSS implements geological model, displaying in 3D subsurface geology (thickness of geological formations, faults, folds ...) at different scales. Along the Adriatic coast has been produced a very detailed reconstruction of the phreatic coastal aquifer located in the first 30 meters below the topographic level, in order to define aquifers and aquitard distribution. In GEOMOL EU project (http://www.geomol.eu/home/index_html) has been analyzed a deep portion of the subsurface of the central part of the Emilia plain (until 3.000 – 4.000 mt), useful for studies on deep aquifers and in seismotectonic analyses. **Groundwater reserves in the Emilia-Romagna Region (1998)** *(*http://ambiente.regione.emilia-romagna.it/geologia-en/divulgazione/pubblicazioni/cartografia-geo-tematica/groundwater-reserves-in-the-emilia-romagna-region*)* - 9 maps in scale 1:250.000 of the three main acquifers identified in the alluvial plane and a technical report. This study is the result of a three-year period collaboration between SGSS and the main Italian Oil&gas Company (ENI). The main results of this work are: - propose a new hydrogeological and stratigraphical model for the subsurface of the Po plain - 3D model of the Emilia-Romagna region aquifers; - locate the biggest and largely protected aquifers which constitute a strategic reserve; - mapping the recharge areas of the Plain aquifers. **Groundwater reserves in the Ferrara Province (2007) (**http://ambiente.regione.emilia-romagna.it/geologia/divulgazione/pubblicazioni/cartografia-geo-tematica/risorse-idriche-sotterranee-della-provincia-di-ferrara**). -** The publication is a down scaling of the regional graundwater maps (see above point), and reports 4 structural maps (scale 1:250.000) and 3 hydrogeological sections (scale 1:100.000). Ferrara Province is a very particular area: includes a large part of the ancient Po Delta, with many areas lower than the sea level (until 4 meters below s.l.), with large problems on salt water intrusion (surficial waters and aquifers), and land subsidence. **The sea-coast information system** (http://ambiente.regione.emilia-romagna.it/geologia-en/cartografia/webgis-banchedati/sistema-informativo-mare-costa) is an interactive website offering access to the coastal and marine maps of Emilia-Romagna Region. This information constitutes a crucial asset for the monitoring and the analysis of coastal risks (sea storms, groundwater, subsidence) and represents the starting point to develop more specific data applications. Data and maps on monitoring of the phreatic aquifer and on land subsidence are available on this site.
Relevant projects/activities

Aquifer recharge in the alluvial fan of the Marecchia river (Rimini) (http://ambiente.regione.emilia-romagna.it/geologia-en/divulgazione/pubblicazioni/articoli-su-riviste-specialistiche/managed-aquifer-recharge-in-the-marecchia-alluvial-fan-rimini-italy-start-of-the-test-and) - A project started in 2014 with an experimentation period of two years, is now one of the measure of the Water management plan in compliance with the Water European Directive. The main goals are to manage the draught crisis due to climatic change; to improve water quality (affected by nitrate pollution); to counteract subsidence and salt water intrusion. The project consists in conveying into quarry lake (extension 16.000 m^2), located in the recharge area of the alluvial fan, an additional volume of water through a channel which takes water from the Marecchia river. To verify the recharge efficacy (qualitative and quantitative) a special monitoring network consisting of 30 measuring points has been implemented. The recharge efficiency is estimated in 700.000 - 1.000.000 m^3 per year, depending to meteorological and groundwater conditions.
Regional Groudwater monitoring network (http://ambiente.regione.emilia-romagna.it/geologia-en/cartografia/webgis-banchedati **and** https://www.arpae.it/index.asp?idlivello=112**) -** piezometric level and groundwater quality data are available in 560 water wells in Emilia-Romagna alluvial plain. Depth varies from 5 to 615 meters, medium density is 1 well every 22 km^2. Data are available since 1976. This very large amount of data permitted to implement groundwater policy and groundwater planning during time, and now supports the implementation of EU directives.
Phreatic costal aquifer **monitoring network (**https://applicazioni.regione.emilia-romagna.it/cartografia_sgss/user/viewer.jsp?service=costa and http://ambiente.regione.emilia-romagna.it/geologia/archivio_pdf/acque/FreaticoCostiero_IlGeologo.pdf/view**)** – A monitoring network created in the spring of 2009, by the SGSS, along 130 km of the Emilia-Romagna coast, which constitutes an in-depth study of the regional network (see point above).
The network is composed up to 37 piezometers, which are approximately 10 to 25 meters deep. The measures consist of groundwater level, temperature and electrical conductivity each meter in depth. A total of 15 measurement campaigns were carried out, initially on a quarterly basis, and from mid-2012 on a half-yearly basis. Data collected, allowed to define groundwater body for the implementation of the water EU Directive.
Census of spring (https://applicazioni.regione.emilia-romagna.it/cartografia_sgss/user/viewer.jsp?service=rocce_magazzino) - In collaboration with the local technical autorities, a regional **census of springs** in the North Apennines has been set in motion to determine their distribution, as well as flow and water characteristics. The first results of this census, which will build up a database on the region's springs, have made it possible to compile detailed thematic maps for the identification and study of rock-reservoirs.
Involvement in European projects
BVM - Bassins versants mediterranees (2005 – 2007) (http://ambiente.regione.emilia-romagna.it/geologia/divulgazione/progetti-europei/bvm-bacini-dei-versanti-mediterranei**).**
An EU project for the exchange of information on the planning and integrated management of catchment areas, between the MEDOCC space and the Maghreb regions. SGSS developed a pilot project for the recovery of alternative ground water resources in the aquifers along the Po river.

Infrastructure / technical equipment

SW for 3D geological modelling
Equipment for continuous measurements of level, temperature and electrical conductivities in groundwater
GPS equipment for land monitoring

Name of organisation	**39. State limited liability company "Latvian Centre of Geology, Environment and Meteorology"**		
Short name	LEGMC	**Country**	Latvia
Organisation profile			

LEGMC is State limited liability company under the Ministry of Environmental Protection and Regional Development and it is the central legal body in Latvia at subsoil field comprising geology, hydrogeology, and geophysics. According to Law on Subsoil the main tasks of LEGMC in the field of subsoil are collection and reprocessing of geological information and maintenance of the State Geological Fund. These tasks can be divided as follows: 1) estimation and approval of mineral and groundwater reserves and determination of extraction areas; 2) geological and hydrogeology data preparation for government, municipalities and private sector; 3) reporting for national and international institutions. LEGMC also ensures water quality and quantity monitoring, as well as data quality control and availability of these data for public, maintenance of data base on use of water resources, river basin management (preparation of River Basin Management Plans), preparation of for national and EU institutions, as well as calculation of flood territories.	
Roles / tasks in the project	**Special relevant skills**
Partner in WP5- Assessment of salt-/sea water intrusion problems (status and vulnerability). Case study- Sea water intrusion at "Liepāja" city, Latvia	• Responsible for national Latvian groundwater monitoring (both quantity and quality) • Holder of the largest hydrogeological database in Latvia (abstraction well data, monitoring data, water chemistry)
Short profile of staff member(s) who will be undertaking the work	
The responsible person will be **Inga Retiķe.** She is a hydrogeology expert at LEGMC and is responsible for reporting to EK (WFD and River Basin Management Plans, Nitrates directive), preparation of national reviews related to water quality and quantity issues, project coordination related to water management issues (e.g. groundwater dependent ecosystems, methodologies for groundwater body delineation under WFD) etc. She is currently a PhD aspirant at University of Latvia and working with multivariate statistics and long term water quality data, as well sea water intrusion assessment in Liepāja city.	
Publications, infrastructure / technical equipment	
Retike, I., Kalvans, A., Popovs, K., Bikse, J., Babre, A., Delina, A. 2016. Geochemical classification of groundwater using multivariate statistical analysis in Latvia. Hydrology Research. Vol. 47, Issue 4. Babre, A., Kalvāns, A., Popovs, K., **Retiķe, I.**, Dēliņa, A., Vaikmäe, R., Martma, T. 2016. Pleistocene age paleo-groundwater inferred from water-stable isotope values in the central part of the Baltic Artesian Basin. Isotopes in Environmental and Health Studies. Vol. 52, Issue 6. **Retike, I.**, Delina, A., Bikse, J., Kalvans, A., Popovs, K., Pipira, D. 2016. Quaternary groundwater vulnerability assessment in Latvia using multivariate statistical analysis. 22nd International Scientific Conference Research for Rural Development, 2016; The Latvia University of Agriculture, Jelgava; Latvia; 18-20 May 2016. Volume 1, 2016, Pages 210-215. Bikse, J., **Retike, I.**, Kalvans, A. 2016. Historical evolution of seawater intrusion into groundwater at city Liepaja, Latvia. 2016. The role of hydrology towards water resources sustainability, Nordic Water 2016, XXIX Nordic Hydrological Conference, August 8-10, 2016,Kaunas, Lithuania.	
Relevant projects/activities	
• Second cycle River Basin Management Plans in Latvia (Inga Retiķe was one of the developers of groundwater part) 2016. • **The Administration of Latvian Environmental Protection Fund project "Improvement of groundwater characterisation and status assessment for the next cycle River Basin management period" 2017 (Inga Retiķe was the developer of the methodology for identification of groundwater bodies in Latvia).** • ERDF, Interreg Central Baltic project "Innovative, sustainable remediation" (INSURE) (Inga Retiķe is currently working in this project, activities related groundwater pollution modeling). • Latvia- Lithuania cross border cooperation program project "Sustainable Rainwater Sewerage Management for Improved Environmental Quality of the Lielupe River Basin" (Inga Retiķe worked in this project; activities related to shallow groundwater quality).	

Name of organisation	**42. Ministry for Transport and Infrastructure**

Short name	MTI	Country	Malta
Organisation profile			
Malta will be represented in the GeoERA Groundwater theme through the Continental Shelf Department (CSD) within the Ministry for Transport and Infrastructure. The CSD performs the function of the Malta Geological Survey .			

Roles / tasks in the project	Special relevant skills
Supporting the implementation of (participants in) WP4, WP5, WP6	• EU water policy • Island and coastal aquifer hydrogeology • Sea-water intrusion • Management of water resources under water scarcity conditions.

Short profile of staff member(s) who will be undertaking the work
Dr Albert Caruana (m) is the Director General of the Continental Shelf Department and oversees Malta's overall participation in GeoERA**.** **Charles Galea (m)** is a Principal Scientific Officer at the CSD. He is a geoscientist by background and is a coordinator of the GeoERA project in Malta. **Manuel Sapiano (m):** Water Director for Malta, responsible for coordinating the implementation of EU Water Policies in the Maltese islands. Represents Malta on the Groundwater Working Group within the WFD CIS. A hydro-geologist by profession with specialisation in coastal and island groundwater management. **Michael Schembri (m)**, Senior Officer managing the implementation of the EU Water Framework and Floods Directives. Also coordinates hydrological spatial data management systems and groundwater monitoring framework. **Henry Debattista (m):** technical officer providing support on groundwater data management and groundwater modelling exercises.
Publications, infrastructure / technical equipment
National groundwater monitoring framework (quality and quantity) and groundwater database(borehole logs, groundwater level and groundwater quality). Publications: *Mangion, J., **Sapiano, M., 2006.** Malta Water Resources Review. Food and Agriculture Organisation of the United Nations. Rome, Italy.* *Mangion, J**., Sapiano, M. 2007.** The Mean Sea Level Aquifer – Malta and Gozo, in: Edmunds et al. (eds), Natural Groundwater Quality. Blackwell Publishing, Oxford, United Kingdom.* *Stuart, M.E., Maurice, L., Heaton, T.H.E., **Sapiano**, **M.,** Micallef Sultana, M., Gooddy, D.C. & Chilton, P.J. 2010. Groundwater residence time and movement in the Maltese islands – A geochemical approach. - Applied Geochemistry, 25, 609-620.* *Heaton, T.H.E., Stuart, M.E., **Sapiano**, **M.** & Micallef Sultana, M. 2012**.** An isotope study of the sources of nitrate in Malta's groundwater. - Journal of Hydrology, Vols. 414/415, 244–254.* ***Sapiano, M., Schembri. M.**, Brincat, C. 2013**.** State of water resources in Mediterranean Islands, in MEDIWAT, Sustainable management of environmental issues related to water stress in Mediterranean islands, Final conference proceedings.*
Relevant projects/activities
MARSOL – Demonstrating managed aquifer recharge as a solution to water scarcity and drought (7th Framework Programme) *MORISO – Monitoring of groundwater resources to limit saline intrusion and pollution by nitrates (Interreg Italia-Malta 2007-2013)* *ERDF346 – Assessment of sub-surface groundwater discharge in the Maltese islands (ERDF 2017-2013)* *WATERMAP- Development and utilization of vulnerability maps for the monitoring and management of groundwater resources (INTERREG-Archimed)*

Name of organisation	45. Laboratório Nacional de Energia e Geologia		
Short name	LNEG	**Country**	Portugal

Organisation profile	
The National Laboratory of Energy and Geology (LNEG) is a State Laboratory of the Ministry of Economy that makes RD&D oriented to the needs of society and enterprises. LNEG ensures state functions by developing knowledge of the geological and hydrogeological infrastructure of the emerging territory, coastal zones, and contributing to related activities such as exploration and valorization of endogenous resources, prevention and mitigation of geological risks, environment and land use planning and correlated strategic innovative technologies. LNEG undertakes as within its core functions the research on CO2 storage, geothermal assessment and land use valorization. LNEG is also responsible for integrated management and availability of geoscientific contents regarding the Portuguese territory in digital format.	
Roles / tasks in the project	**Special relevant skills**
Work Package Participant – GW2-WP5	• National responsible for hydrogeological assessment and thematic mapping at several scales. • Building databases and web services for groundwater data.
Short profile of staff member(s) who will be undertaking the work	
The staff is from the Department of Geology, Hydrogeology and Coastal Geology: **Judite Fernandes (f):** senior hydrogeologist, expert on flow and hydrogeochemical modeling, hydrogeophysics, geostatistics, saltwater intrusion, aquifer contamination, aquifer testing, drilling and piezometer construction, monitoring equipment. **Carla Midões (f):** senior hydrogeologist, expert in integration of the geologic and hydrogeologic information on SIG with sight to the attainment of Hydrogeology cartography of Portugal and Thematic Cartography. **José Sampaio (m):** senior hydrogeologist. Skills on hydraulic, hydrology, geochemistry, geophysics, climatology, boreholes construction and testing, hydrogeological mapping, karst aquifers, volcanic islands aquifers and CO2 geological storage in saline aquifers. **Ana Paula Pereira (f):** senior hydrogeologist, expert in hydrogeological mapping and experienced in Geographical Information Systems **Rayco Marrero-Diaz (m)**: senior hydrogeologist, expert in hydrogeochemistry. Nowadays, he is LNEG's collaborator where is carrying out a low-enthalpy geothermal assessing project.	
Publications, infrastructure / technical equipment	
Infrastructure: Geoportal (databases and web services for groundwater data). LNEG's geoPortal is an infrastructure of integrated services to support the management and visualization of spatial data, which aims to provide, in a web environment, geo-referenced information related to the various activities of the LNEG. This application has the following features: 1) Metadata Catalogue: A search and query engine for LNEG's data (according to ISO 19139), which provides information about the existence and availability of Institutional Geographic Information; 2) Online Databases: A set of applications that enables the query of institutional data; 3) Map Viewer: A view and download service of LNEG's maps and spatial information. This application has been fully developed in the context of INSPIRE European Directive (Infrastructure for Spatial Information in Europe) and that it is in accordance with the principles and standards established by this Directive. Publications: Portuguese hydrogeological and hydrogeochemical mapping (scales 1/200 000) and explanatory books. Portuguese geological mapping (scales 1/50 000) and explanatory books, which includes a hydrogeology chapter (national cover). *Martínez-Moreno, F.J.; Monteiro-Santos, F.A.; Bernardo, I.; Farzamian, M.; Nascimento, C.; Fernandes, J.; Casal, B.; Ribeiro, J.A, 2017. 1D and quasi-2D joint inversion of TDEM and DCR data to evaluate seawater intrusion in coastal areas: a case of study in Algarve (South of Portugal). Groundwater and Global Change in the Western Mediterranean Area. pp. 333 - 338. Springer, 2017. ISBN 978-3-319-69356-9. DOI: 10.1007/978-3-319-69356-9.* *Francés, A. P., Ramalho, E., Fernandes, J., Groen, M., Hugman, R., Khalil, M. A., De Plaen, J. & Monteiro Santos, F. A., 2015. Contribution of hydrogeophysics to the hydrogeological conceptual model of the Albufeira-Ribeira de Quarteira coastal aquifer in Algarve, Portugal. Hydrogeology Journal, November 2015, Volume 23, Issue 7, pp 1553-1572, doi: 10.1007/s10040-015-1282-x. © Springer-Verlag Berlin Heidelberg 2015.*	

Lídia Quental, Elsa Ramalho, Elias Daudi, M. João Batista, Judite Fernandes, Dino Milisse, Ruben Dias e J. Tomás Oliveira, with the colaboration of Gracio Cune, Gabriel Balate, Ussene Ussene e Almiro Magaia, 2011.Environmental Mapping of Grande Beira Region, Mozambique, scale 1:50000 and Explanatory Note (45p). Digital Version. *M. J. Batista, J. Fernandes, E. Ramalho, L. Quental, R. Dias, D. Milisse, V. Manhiça, U. Ussene, G. Cune, E. X. Daudi, J. T. Oliveira, 2011. Geochemical Characterisation of Soils And Sediments Of The City Of Beira, Mozambique: A Preliminary Approach. In MAPPING THE CHEMICAL ENVIRONMENT OF URBAN AREAS, Christopher Johnson, Alecos Demetriades, Juan Locutura And Rolf Tore Ottesen, 584p. ISBN:978-0-470-74724-7. ©2011 John Wiley & Sons, Ltd.* *Helena I.F. Amaral, Judite Fernandes, Michael Berg, Réne P. Schwarzenbach and Rolf Kipfer, (2009). "Assessing TNT and DNT groundwater contamination by compound-specific isotope analysis and 3H-3He groundwater dating: a case study in Portugal", Chemosphere, Vol. 77, p. 805-812, doi:10.1016/j.chemosphere.2009.08.011.*
Relevant projects/activities
Portuguese hydrogeological and hydrogeochemical assessment and mapping (scales 1/200 000 and 1/50 000); Project **FREEZE** - Submarine *FREshwater dischargEs*: *characteriZation and Evaluation* study on their *impact* on the *Algarve coastal ecosystem*; Project **ERHSA** - *Study of the Groundwater Resources of Alentejo* Region (southern area of Portugal). Project Environmental Mapping of Beira Region, Mozambique, scale 1/50 000. Project **WAT** – Water and Territories, http://www.waterandterritories.eu/portail/index.php

Name of organisation	**47. Geological Survey of Serbia**		
Short name	GSS	**Country**	Serbia
Organisation profile			
GSS was formed based on the Mining and Geological Investigations Law („Official Gazette RS", no. 88/2011) On 29. 06. 2012. Geological Survey of Serbia was formed from Geological Institute of Serbia, organization with long history. First organization was the Geological Institute of the Kingdom of Yugoslavia, formed 1930. Geological Survey of Serbia has a three geological departments: Fundamental Geology, Mineral Resources, Geotechnic and Hydrogeology, as well as Group for Ecology and Geophysical investigation and Laboratory for rocks, ores, soil and water analyses. Our mission is to create geological, geomorphological, geochemical, hydrogeological and engineering geological maps, protect geodiversity and geoheritage, protection and promotion of the environment, investigation of mineral resource deposits.			
Roles / tasks in the project		**Special relevant skills**	
Participation in WP4 and WP6		• Building databases for groundwater data and landslide data • National responsible for creating hydrogeological and engineering geological maps and spatial plans • Groundwater and landslide monitoring	
Short profile of staff member(s) who will be undertaking the work			
Milan Tomić (Magister) (m): hydrogeologist at Department of Geotechnic and Hydrogeology. Expert in creating hydrogeological maps 1: 100.000, mineral and thermal groundwater studies, spatial plan projects and Impact of Climate Change projects. **Aleksandra Gulan (BS) (f):** advisor, Department of Geology. National Delegate of Republic of Serbia in EuroGeoSurvey. Worked on many projects incl. geochemical mapping, environmental protection, geomechanics. **Tanja Petrović Pantić (PhD) (f)** is a senior hydrogeologist at Department of Geotechnic and Hydrogeology. She holds an MSc (2010) and a PhD (2014) in hydrogeothermal resources. Research focuses are thermal and mineral waters, geothermal energy, hydrogeochemistry. **Katarina Samolov (MS) (f):** Engineer of geology (hydrogeology), Department of Geotechnic and Hydrogeology. Fellow worker on projects (hydrogeological maps 1: 100.000 and studies) and participant			

in UNDP Beware Project of Unifying landslide data standards and creating landslide database. PhD student, research focus: Impact of climate changes on groundwater.
Saša Todorović (BS) (m) Engineer of geology. Head of Geotechnical department at Geological Survey of Serbia, Department of Geotechnic and Hydrogeology. Member of Earth Observation and GeoHazard Expert Group. Project coordinator on projects: Engineering geological maps 1: 100.000, Spatial plans, Serbian landslide database; Participant in UNDP Beware Project of Unifying landslide data standards and creating landslide database.

Publications, infrastructure / technical equipment

- Veljkovic, Ž., Petrovic Pantic, T. Tomic, M. Mandic, M., Samolov K. (2016) Vulnerability of groundwater to pollution in the area of National park „Fruska Gora“ XXIV International conference "Ecological truth" Vrnjačka Banja, Serbia
- Tomić, M. (2014) Impact of Climate Factors and Surface Water on Shallow Aquifer of Northern Backa, 16. Geological Congress, Gornji Milanovac, Serbia
- Petrović Pantić, T. , Veljković, Ž., Tomić, M., Samolov K. (2017) Hydrogeology and vulnerability of groundwater to polluting in the area of National park „Fruska Gora“, Vodoprivreda 0350-0519, Vol. 49 (2017) No. 288-290

Relevant projects/activities

- Impact of climate change to groundwater on the territory of Sava River Basin in the Republic of Serbia (2017-)
- Impact of climate factors and Surface water on shallow aquifer of Northern Backa (2012)
- Spatial plans of Municipalities of Republic of Serbia
- Hydrogeological maps and Engeeniring geological maps, scale 1:100.000
- Hydrogeological research of surface water- groundwater regime in Zasavica catchment and impact on Zasavica Nature Reserve

Name of organisation	**50. Organisation Name: Instituto Geológico y Minero de España (IGME)**		
Short name	IGME	**Country**	Spain

Organisation profile

The Spanish Geological Survey (IGME) was founded in 1849. Today IGME is a self-governing Public Research Institution specialized in Earth Sciences, attached to the Ministry of Economy, Industry and Competitiveness. The IGME research program includes the next research lines related with this project: Groundwater sustainable management, Global Change impacts and adaptation strategies, and Geological Hazards. The main mission of IGME is to provide the State Administration, the Autonomous Regions Administrations and the general society, with precise knowledge and information regarding the Earth Sciences and related technologies for any development on the Spanish territory. With a staff of 401 employees, IGME has 78 permanent researchers and 59 pre-and post-doctoral researchers.

Roles / tasks in the project	Special relevant skills
Participation in all the Work Packages (WPs) Leader of WP5 (Assessment of salt-/sea water intrusion status and vulnerability) and WP6 (Groundwater and adaptation strategies).	**Hydrological and management models, time series analysis, spectral analysis, geostatistical analysis, GIS analysis, Remote Sensing Analysis, Statistical Analysis**

Short profile of staff member(s) who will be undertaking the work

Dr. David Pulido-Velazquez (male). Senior Researcher. Field of expertise in Water Resources Systems analyses, special emphasis on the study of **impacts** and **adaptation** to global change (CG). 21 Q1 papers. Participation in 16 research projects. Experience as Principal investigators (6).
Dr. Eulogio Pardo-Igurquiza (male) Senior Researcher. 101 SCI papers (h-index= 28). Marie Curie Fellowship. Ramón y Cajal Fellowship. Postdoctoral positions in Massachusetts Institute of Technology (USA), University of Leeds (UK) and University of Reading (UK). Field of expertise in geostatistical analysis, time series analysis, spectral analysis, Remote Sensing.
Juan de Dios Gómez-Gómez (male) Senior hydrogeologist, expert in groundwater modeling, coastal aquifers, water resources assessment and management and GIS. Member of the EuroGeoSurveys Water Resources Expert Group.
Dra. Africa de la Hera Portillo (female) Senior Researcher. Field of expertise in environmental hydrogeology with special emphasis on groundwater dependent ecosystems and surface-groundwater interactions. Participation in six of them funded by the EC, being Principal investigator in the last two of them (NeWater and NAIAD).
Dr. Gerardo Herrera (male) Senior researcher. Chairman of the Earth Observation and Geohazards expert group of the EuroGeosurveys, observer of the UNESCO-IHP working group on land Subsidence. Participation in 35 research projects. Coauthor of 44 SCI papers (h-index=21). Research interests in geohazards InSAR monitoring and modelling focus on subsidence.
Dra. Carolina Guardiola-Albert (female) Filed of expertise in flow and transport modelling and application of geostatistics in Earth Science disciplines. Participation in more than 30 projects, more than 50 papers.
Miguel Mejías Moreno (male). Senior Technician. Hydrogeologist, 22 years of experience in technical and research projects in the Guadiana River Basin. Member of the Junta de Gobierno and Consejo del Agua of the Hydrographic Demarcation of the Guadiana River. Member of the Tablas de Daimiel National Park Patronato. Participation in more than 70 projects and more than 50 papers.

Publications, infrastructure / technical equipment

Pulido-Velazquez, D.*, Collados-Lara, Antonio-Juan, Alcalá, Francisco J., 2017, Assessing impacts of future potential climate change scenarios on aquifer recharge in continental Spain. J. of Hydrology. https://doi.org/10.1016/j.jhydrol.2017.10.0770022-1694/_ 2017 Elsevier B.V.*
Escriva-Bou, A., Pulido-Velazquez, M. and ***Pulido-Velazquez, D****, 2017. The Economic Value of Adaptive Strategies to Global Change for Water Management in Spain's Jucar Basin. J. of Water Resources Planning and Management: 143(5), DOI: 10.1061/(ASCE)WR.1943-5452.0000735.*
Llopis-Albert, C. and ***Pulido-Velazquez, D.,*** *2015. Using MODFLOW code to approach transient hydraulic head with a sharp-interface solution. Hydrol. Process 29 (8): 2052–2064, 15. DOI: 10.1002/hyp.10354.*
De la Hera, A. *and Murillo Díaz, J.M. (2014). Identification of wetland water sources for environmental flow assessment: a case study of the Miguel Ibañez wetlands (Segovia, Spain). Hydrological Sciences Journal, DOI: 10.1080/02626667.2014.895831.*
Béjar-Pizarro, M., ***Guardiola-Albert, C.,*** *García-Cárdenas, R. P.,* **Herrera, G.,** *Barra, A., López Molina, A., ... & García-García, R. P. (2016). Interpolation of GPS and Geological Data Using InSAR Deformation Maps: Method and Application to Land Subsidence in the Alto Guadalentín Aquifer. Remote Sensing, 8(11), 965.*
IGME holds a large hydrogeological research of more than 100 years and a database with over 120,000 water observation points all around the Spanish territory. Its main tasks related to groundwater are protection, restoration, improvement of knowledge and state evaluation of aquifers. It also holds the Geohazards InSAR laboratory and Modelling Group that combines satellite observations, with geo-thematic layers, in situ observations and modeling to advance in the understanding and assessment of Geohazards.

Relevant projects/activities

- CGL2013-48424-C2-2-R. **GESINH-IMPADAPT (**1/1/2014- 31/12/2016**)**: Generation, simulation and integration of future hydrological scenarios within the analysis of **impacts and adaptation to global change** on WR systems. National Research Program (MINECO-DG investigacion. Plan Estatal de I+D+I 2013). **Principal Investigator (PI): D. Pulido** (IGME).
- CGL2009-13238-C02-01. GESHYDRO (01/01/2010 – 30/06/2014): **Generation and simulation of future scenarios** of surface and groundwater hydrology. National Research Program (Plan Nacional I+D+i 2008-2011). **PI and coordinator: D. Pulido** (IGME).
- **Drought analysis** and adaptation strategies of WR systems to potential future scenarios considering impacts of global change; (21/10/2013-15/12/2015). Funded by IGME (MINECO). **PI: D. Pulido**.
- **New Approaches to adaptive water management under uncertainty (NeWater)** (FP6, Contract No: 511179 (GOCE)). 2005-2009. Coordinator: C. Pahl-Wostl (Univ. Osnabrueck, Germany). **PI: A. de la Hera** (IGME).
- ESP2013-47780-C2. Study of geological-geotechnical risks by exploitation of aquifers by spatial and terrestrial techniques. Applications to urban structures and infrastructures. National Research Program. IP: José Fernández (IGME). 01/01/2014-31/12/16.

<table>
<tr><td>Name of organisation</td><td colspan="3">51. Institut Cartogràfic i Geològic de Catalunya (Cartographic and Geological Institute of Catalonia)</td></tr>
<tr><td>Short name</td><td>ICGC</td><td>Country</td><td>Spain</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">The Cartographic and Geological Institute of Catalonia (ICGC) is the official mapping and geological survey of the autonomous government of Catalonia. ICGC was created in 2014 and belongs to the Department of Territory and Sustainability of the Government of Catalonia. The ICGC sum-up the legacies of the former cartographic and geological agencies, both created in 1982. The ICGC has a staff around 270 people and is a beginning-to-end cartographic and geological institution. ICGC is the reference centre in geological sciences and Geo-information in Catalonia. It comprises different fields, as applied geology and geophysics, seismic information systems, geological resources: geo-energies, hydrogeology, soils, in characterization, assessment, modelling and mapping. As a geo-information agency, ICGC is producing in Catalonia topographic products, DTM & DSM, orthoimagery, geological and geothematic maps in various scales and databases. ICGC has participated in a number of EU funded international projects related to geosciences.</td></tr>
<tr><td colspan="2">Roles / tasks in the project</td><td colspan="2">Special relevant skills</td></tr>
<tr><td colspan="2">Participation in GW2 - WP5 (Assessment of salt-/sea water intrusion problems (status and vulnerability), in the following tasks:
Task W5.1
Task W5.3</td><td colspan="2">• Hydrogeological mapping
• 3D geological and hydrogeological modelling
• Building and manage databases and web services
• Applied geochemistry
• Groundwater resources estimation</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Mr. Ignasi Herms (m): He obtained his MSc in Natural Resources from Polytechnic University of Catalonia (UPC), his MSc in Geographic Information Systems from University of Girona (UdG), the Bachelor degree in Geology from the Autonomous University of Barcelona (UAB, 1999) and the Bachelor degree in Technical Mining Engineering from UPC (1999). He is also postgraduate in groundwater hydrology (CIHS, UPC, 2002). With over 18 years of experience, he has participated in national and international projects, of public and private funding. He is specialized in hydrogeology, 3D groundwater modelling and GIS deployment. He acts as professor in The International Groundwater Hydrology Course (FCIHS and UPC), and he has advised various theses in the Master degree of Reservoir Geology and Geophysics (UB and UAB). He is currently in progress in his PhD on hydrogeology (UPC). From 2014 he work as the Head of the Geological Resources Area at ICGC. He has contributions at international congresses on groundwater resources. Ms. Georgina Arnó (f): She is postgraduate in groundwater hydrology (CIHS, UPC, 2007). She got her bachelor degree in Geology at the UB (2001). Since 2014, she is the head of the hydrogeological and geothermal group team at ICGC. She has over 16 years of experience in the development of projects related to groundwater and mapping. Since 2014, she acts as professor in the field of groundwater assessment and mapping in the International Groundwater Hydrology Course (FCIHS and UPC). She is the head of the Hydrogeological</td></tr>
</table>

Mapping Project of ICGC. **Ms. Montse Colomer (f):** She has a Bachelor degree in Geology by the UB (1996). Since 2014, takes part as senior technician of the hydrogeological and geothermal group team at ICGC. She has over 20 years of experience in the development of geological and geo-resources projects. She is specialized in analyses of geological data, mapping and 3D geological modelling. **Mr. Víctor Camps (m):** senior geologist and hydrogeologist. Expert in acquisition and processing of hydrogeological and geothermal data and hydrogeological mapping.			
Publications, infrastructure / technical equipment			
Herms, I., Arnó, G. (2016). "*Hydrogeological information and cartographic databases. Perspectives in the digital field*". (traduced). Jornada Hidrogeología emergente | 50 CIHS 2016. ISBN 978-84-921469-3-2. **Colomer, M., Herms, I. et al. (2016).** "*Digital distribution in vector format of data from the Hydrogeological Map of Catalonia at scale 1:25 000*". (traduced) Jornada Hidrogeología emergente | 50 CIHS 2016. ISBN 978-84-921469-3-2. Databases, datasets and other geothematic information ICGC produce, are freely distributed on line from its web site http://www.icgc.cat / ICGC is the designer of the SIGWEB Platform called INSTAMAPS. ICGC use this platform to disseminate geological data, e.g. the borehole database of Catalonia: http://www.icgc.cat/en/Public-Administration-and-Enterprises/Tools/Geoindex-viewers/Geoindex-Sondejos ICGC work on different kind of geological modelling commercial platforms: GOCAD, 3D Geomodeller, MOVE from Midland Valley, SubsurfaceViewer by INSIGHT – GSI3D , FEFLOW, Visual Modflow.			
Relevant projects/activities			
- *Hydrogeological map of Catalonia at 1:25.000 scale: http://www.icgc.cat/en/Public-Administration-and-Enterprises/Downloads/Geological-and-geothematic-cartography/Hydrogeological-cartography/GT-V.-Hydrogeological-map-1-25.000* - *Map of hydrogeological areas in Catalonia 1:250.000: http://www.icgc.cat/en/Public-Administration-and-Enterprises/Tools/Geoindex-viewers/Geoindex-Cartografia-hidrogeologica* - *Hydrogeological specific maps at the line coast: http://www.icgc.cat/en/Public-Administration-and-Enterprises/Downloads/Geological-and-geothematic-cartography/Hydrogeological-cartography/Other-hydrogeological-maps* - *The geological map of Catalonia 1:50.000: http://www.icgc.cat/en/Public-Administration-and-Enterprises/Downloads/Geological-and-geothematic-cartography/Geological-mapping/Geological-map-of-Catalonia-1-50.000*			

Name of organisation	**52. Sveriges Geologiska Undersökning**		
Short name	SGU	**Country**	Sweden
Organisation profile			
The Geological Survey of Sweden (SGU) is the national expert agency for issues relating to bedrock, soil and groundwater in Sweden. One key task is to meet society's need for geological information. SGU is a governmental body governed by The Ministry of Enterprise and Innovation. •Supporting the increase of mineral exploration interest and the sustainable development of mining, and quarrying industry •Promoting the use of geological information in societal planning •Consolidating and strengthening geological research in Sweden •Bringing geology and geo-scientific knowledge to the fore in social debate and in schools The Mining Inspectorate is a separate decision-making body within SGU. It is responsible for issuing permits for minerals exploration and exploitation under the Swedish Minerals Act.			
Roles / tasks in the project		**Special relevant skills**	
Participant in WP4			
Short profile of staff member(s) who will be undertaking the work			

Mattias Gustafsson (m): Leader of SGU groundwater resources mapping and is member of the EGS Water Resources Expert Group. **Carl-Erik Hjerne (m):** Project leader Expanded national groundwater network of Sweden **David Eveborn (m):** Researcher groundwater levels and recharge **Bo Thunholm (m):** Senior expert national groundwater network of Sweden
Publications, infrastructure / technical equipment
http://grundvatten.nu/modelgroundwater/client-sgu/index.html *https://www.sgu.se/grundvatten/grundvattennivaer/grafer-for-grundvattennivaer-per-station/* *http://resource.sgu.se/produkter/regeringsrapporter/2017/RR1709.pdf*

Name of organisation	**53. State Research and Development Enterprise “State Informational Geological Fund of Ukraine”**		
Short name	GEOINFORM	**Country**	Ukraine
Organisation profile			
The State Research and Development Enterprise "State Informational Geological Fund of Ukraine" – SRDE “GeoInform of Ukraine”, or GEOINFORM is the specialized research and development unit of the State Geological and Subsurface Survey of Ukraine which collects, stores, analyzes and provides information received from geological study and use of subsurface. GEOINFORM conducts research work on monitoring of mineral resources of Ukraine on the basis of geological and mining activities during the year, recording deposits and making public the balance of mineral resources management of the State fund of deposits and occurrences (more than 10,000 objects recorded), synthesis and analysis of exploration for oil and gas, creating a system of state accounting of oil and gas wells, completion and maintenance of the State cadastre of mineral deposits and occurrences as well as State cadastre of groundwater deposits of Ukraine.			
Roles / tasks in the project		**Special relevant skills**	
Participation in WP3, WP4, WP5, WP6		Building databases and web services for subsurface data	
Short profile of staff member(s) who will be undertaking the work			
Dr. hab. Boris Malyuk (m): Director for International Cooperation, graduated in 1981 from Department of Geology, Lviv University, Ukraine, and in 1999 from Centre of Geostatistics, Ecole des Mines de Paris, France. Obtained Candidate of Science (PhD) Degree in Geotectonics in 1984, and extended Doctor of Science Degree in Petrology in 1991. National Delegate of Ukraine to the EuroGeoSurveys. In the Project he will contribute to general project management, raw materials and geoscientific data systems. **Sergii Prymushko (m):** Director, with basic IT-background, has more than 30 years experience in management of geological information, including partitioned database systems. **Volodymyr Velychko (m):** Chief Engineer, at his position is responsible for hardware and software facilities and database development having basic IT-background. In the Project he will contribute to geoscientific data systems. **Dr. Igor Melnyk (m):** Deputy Director, Center for International Cooperation, with basic background in geology, has an experience in field works and research in geochemistry, hydrogeology and ecology (PhD in 1996), as well as geoinformatics and GIS applications. **Tetiana Biloshapska (f):** Chief Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1980. She is experienced in field works. She had studied mineral-resource base of Ukraine for more than 30 years, took part and led projects on prospecting and exploration of mineral deposits, conducted regional geological studies. **Natalia Pyshna (f):** Chief, Division of groundwater resources inventory. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1987. She has experience in the sphere of hydrogeological studies for fresh and mineral water of Ukraine for more than 30 years. She represents SGSSU in the EU project 'Water Initiative for Eastern Partnership' (EUWI+4EaP). **Larysa Lopata (f):** Senior Hydrogeologists, Division of groundwater resources inventory. Graduated from Kyiv National University under specialty 'Hydrogeology' in 2004. She has experience in the sphere of hydrogeological studies for mineral groundwater of Ukraine for more than 10 years.			

Mykola Danevych (m): Leading Hydrogeologists. Graduated from Kyiv National University under specialty 'Geography, Geoecology' in 2003. He has experience in the sphere of hydrogeological and geological-ecological studies for more than 10 years. **Lesia Babichenko (f):** Leading Hydrogeologists. Graduated from Ukraine National Technical University 'Kyiv Polytechnic Institute' under specialty 'Ecology' in 2007. She is experienced in hydrogeological studies, environment protection, specifically, groundwater protection. **Tamara Bardygola (f):** Interpreter, Center for International Cooperation. Graduated from Department of Mechanics and Mathematics, Kyiv University in 1988, under specialty “Mechanics of solid medium”.
Publications, infrastructure / technical equipment
Interactive map of mineral deposits of Ukraine (in Ukrainian) http://geoinf.kiev.ua/wp/interaktyvna-karta-rodovyshch-korysnykh-kopalyn.htm Interactive map of mineral licenses (in Ukrainian) http://geoinf.kiev.ua/wp/interaktyvni-karty-spetsdozvoliv.htm Interactive geological map of Ukraine 1:1 000 000 (in Ukrainian) http://geoinf.kiev.ua/wp/Interaktyvna-heolohichna-karta-Ukrayiny.htm Interactive geological map of Ukraine 1:1 000 000 (in English) http://geoinf.kiev.ua/wp/Interactive-Geological-Map-of-Ukraine.htm Interactive State Geological Map of Ukraine 1:200 000 (in Ukrainian with English entries) http://geoinf.kiev.ua/wp/kartograma.htm
Relevant projects/activities
ESTMAP – EU EUOGA - EU NUMIRE – Norway-Ukraine (NGU/SGSSU) EIMIDA – Norway-Ukraine (NGU/Geoinform)

Name of organisation	**54. Natural Environment Research Council as represented by the British Geological Survey**		
Short name	NERC	**Country**	United Kingdom
Organisation profile			
The British Geological Survey (BGS), a component body of the NERC, is the UK’s premier centre for earth science information and expertise, with over 450 scientists and annual budget of ~£48 million. BGS is responsible for advising UK Government and its agencies on all aspects of geosciences, including the hydrogeosciences. NERC/BGS manages the UK’s National Groundwater Level Archive and the UK’s National Hydrological Monitoring Programme; undertakes hydrogeological analysis and interpretation of groundwater level data and, in collaboration with the UK’s Environment Agency and the UK’s Met. Office, provides monthly summaries of the status of groundwater resources in the UK and forecasts. NERC/BGS undertook the Future Flows and Groundwater Levels project, produced the first national groundwater recharge model of the UK, and is currently using this to model the national-scale impacts of climate change on groundwater recharge for the Environment Agency. NERC/BGS works closely with the UK water industry and other stakeholders on issues related to groundwater sustainability. Internationally, NERC/ BGS has worked extensively for many of the principal development agencies including DFID, EU, World Bank, the Development Banks, WHO and UN agencies. NERC/BGS has an extensive record of high-quality research and successfully funded proposals focussing on the application of numerical modelling tools for the conservation and management of water resources together with an international track record in groundwater quality research related to natural baseline chemistry.			
Roles / tasks in the project		**Special relevant skills**	
NERC/BGS role is to complete tasks in WP2 to provide the partners with input to produce the European scale recharge map. NERC/BGS is also a partner in WP5 with a role to study aquifer vulnerability to saline intrusion. NERC/BGS will provide partners with the tools and the assitance when		• UK’s premier centre for earth science information and expertise • Responsible for advising UK Government and its agencies on all aspects of geosciences, including the hydro-geosciences • Development and application of models for improved understanding of hydrological and	

required to accomplish the workpackage tasks. NERC/BGS will also contribute to the dessimnation of the project output through scientific papers, conferences, and electronic output.	groundwater processes and for resources management under future climate predictions.

Short profile of staff member(s) who will be undertaking the work
Andrew Hughes (PhD) (male) is a Principal Groundwater Modeller at the British Geological Survey and is the scientific lead for Integrated Environmental Modelling (IEM). He has over 25 years modelling experience including simulating gas flow through the unsaturated zone, regional groundwater flow saline intrusion / brine movement and recharge modelling. He has authored over 30 peer-reviewed papers on topics such as integrated modelling, groundwater and volcanic islands, water resource assessment, flow to wells and the quantification of recharge. He has built a number of numerical models of brine movement and saline intrusion as well as using modelling to investigate the impacts of climate change on water resources. **Christopher Jackson** (PhD) (male) is a Principal Groundwater Modeller at the British Geological Survey, where he leads the Groundwater Science Directorate's Environmental Change and Impact Theme, and a team of groundwater modellers working on a diverse portfolio of groundwater flow and transport modelling research relating to, for example: groundwater resources, drought and floods, diffuse pollution, contaminant transport, hydrological forecasting, and climate change impacts. **Majdi Mansour** (PhD) (male) is a senior groundwater modeller at the British Geological Survey. His main expertise at NERC/BGS includes the development and application of numerical models to simulate groundwater flows and contaminants in porous medium for the characterisation of aquifer properties, and the management and protection of groundwater resources under current and future climates. Majdi is a co-author of the distributed recharge model ZOODRM (www.oomodels.info) used to estimate potential recharge at a national scale for Great Britain. **Vasileios Christelis** (MSc) (male) is a researcher at the British Geological Survey with expertise in the simulation of variable density flows in coastal aquifers. He also works on the application of surrogate models to reduce the computational cost of complex, highly parameterised numerical models. Currently, he applies numerical models to study water resources under drought conditions.
Publications, infrastructure / technical equipment
• Jackson, C., Mackay, J., Ward, R., Pachocka, M., Brookshaw, A., Scaife, A. 2014. The science behind the Hydrological Outlook seasonal groundwater level forecasts. [Poster] In: Groundwater Modelling Workshop: Pushing the Boundaries, Birmingham, UK, 2014. (Unpublished) http://nora.nerc.ac.uk/507455/. • Hughes, A., Mansour, M.M., Wang, L. 2012. Mitigation potential of horizontal Ground Coupled heat pumps for current and future climatic conditions: UK environmental modelling studies. http://www.ceh.ac.uk/sci_programmes/Water/FutureFlowsandGroundWaterLevels.html http://www.met.reading.ac.uk/~ass98av/GROMIT/Home.html [Output (Electronic)] • Mackay, J.D., Jackson, C.R., Brookshaw, A., Scaife, A.A., Cook, J., Ward, R.S. 2015. Seasonal forecasting of groundwater levels in principal aquifers of the United Kingdom. Journal of Hydrology. 530, 815-828, doi:10.1016/j.jhydrol.2015.10.018. • Mackay, J.D., Jackson, C.R., Wang, L. 2014. A lumped conceptual model to simulate groundwater level time–series. Environmental Modelling and Software, 61. 229–245. • Prudhomme, C., Hannaford, J., Harrigan, S., Boorman, D., Knight, J., Bell, V., Jackson, C., Svensson, C., Parry, S., Bachiller-Jareno, N., Davies, H., Davis, R., Mackay, J., Mckenzie, A., Rudd, A., Smith, K., Bloomfield, J., Ward, R., Jenkins, A. 2017. Hydrological Outlook UK: an operational streamflow and groundwater level forecasting system at monthly to seasonal timescales. Hydrological Sciences Journal (In press).
Relevant projects/activities

- Hydrological outlook led by the Centre for Ecology & Hydrology (NERC/CEH) and in collaboration with the British Geological Survey (NERC/BGS), the Environment Agency (EA), the Met Office (MO), the Scottish Environment Protection Agency (SEPA), Natural Resources Wales (NRW), and the Rivers Agency Northern Ireland (RA) to provide an insight into future hydrological conditions across the UK. (http://www.hydoutuk.net/)
- UK Recharge Modelling with EA. Estimation of groundwater recharge and assessment of groundwater resources under future climate scenarios.
- Baseline chemistry of groundwater in UK aquifers: a programme of research on the baseline chemistry of groundwater from aquifers in England, Wales and Scotland to: characterise groundwater quality, establish the dominant controlling processes, and interpret the baseline groundwater conditions, against which impacts of pollution can be assessed (http://www.bgs.ac.uk/research/groundwater/quality/BaselineUK/home.html)

5 Ethics and Security

5.1 Ethics

Have you completed an ethics self-assessment? (See “How to complete your ethics self-assessment”)

NO

The project proposal has been checked against the ethics sections in “H2020 Guidance —How to complete your ethics self-assessment: V5.2 – 12.07.2016”. This check did not raise any issues. The checklist is included with the submitted documents in ISAAC.

5.2 Security

Please indicate if your project will involve:

- Activities or results raising security issues: NO
- 'EU-classified information' as background or results: NO

5.10 VoGERA

Title of project proposal

VoGERA: Vulnerability **o**f Shallow **G**roundwater Resources to Deep Sub-surface **E**nergy-**R**elated **A**ctivities

Abstract (max. 250 words)
Vulnerability of shallow groundwater resources to deep sub-surface energy-related activities (VoGERA) will gather scientific evidence to investigate the relationship between industrial activity in the deep sub-surface and shallow groundwater resources, in a European context. The project will consider the possible impacts on groundwater from a range of sub-surface energy activities (geothermal energy, unconventional oil and gas exploitation, sub-surface storage and disposal of wastes) in a consistent manner. An approach to evaluating groundwater vulnerability from sub-surface activities that can be applied across Europe will be developed using this evidence, and the in-depth understanding gained will be used to improve awareness of these issues with decision makers and the public. This will aid better sub-surface spatial planning and policy development for deep sub-surface energy-related activities in relation to groundwater, thus allowing for the simultaneous protection of groundwater for future generations whilst recognizing the need for economic development. A strong link with stakeholders will ensure an approach that is fit-for-purpose and has maximum impact.

Conceptual models of shallow groundwater vulnerability to deep sub-surface energy activities will be developed using existing data and information and experience of GeoERA partners and from previous projects, and will be validated at a number of pilot study sites. These will be in different hydrogeological settings across Europe and will use a range of physical, chemical, isotopic and intercalibrated geophysical methods to identify and characterize contaminant pathway properties and their influence on groundwater vulnerability.

This proposal is a response to SRT GW4
Groundwater – Contribute to Groundwater management and interactions with Energy and Mining in rural and urban areas.

List of participants (participant numbers refer to this proposal)

#	Participant Legal Name	Institution	Country
1	Natural Environment Research Council (NERC) [Project Coordinator]	British Geological Survey (BGS)	United Kingdom
2	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (TNO)	TNO	Netherlands
3	Vlaamse Milieu Maatschappij (VMM)	VMM	Belgium
3a	Belgian Nuclear Research Centre (linked third party of VMM)	SCK•CEN	Belgium
4	Mining and Geological Survey of Hungary (MBFSZ)	MBFSZ	Hungary
5	State Information Geological Fund of Ukraine	GeoInform	Ukraine
6	Geological Survey of Denmark and Greenland	GEUS	Denmark

1 Excellence

The VoGERA Project Proposal addresses a component of the GW4 SRT – Contribute to Groundwater Management and Interactions with Energy and Mining in Rural and Urban areas. The proposal intentionally does not cover all topics under the GW 4 call, but has selected topics to yield a compact, well-focused proposal.

In recent years there has been increasing interest in the use of the deep sub-surface for energy related activities in Europe, due to concerns for energy security and a demand to meet international targets to cut greenhouse gas emissions and increase the supply of energy from renewables (as defined in the European Commission's '2020 climate and energy package'). Sub-surface energy-related industries include conventional and unconventional oil and gas exploitation, geothermal energy and sub-surface storage (energy or CO_2)/disposal of (e.g. radioactive) waste. These industries may impact the sub-surface by introducing new chemicals (potential pollutants), disturbing/mobilizing existing natural contaminants within rocks, or by changing the permeability structure of the rock (introducing new pathways). These represent additional **hazards** which may impact groundwater and subsequently ecosystems and human health. However, the **vulnerability** of groundwater to these hazards is not uniform, and varies depending on the geological and hydrogeological setting in addition to the industrial processes and risk management measures being applied.

It is necessary to understand and manage the hazards and risks associated with potentially harmful activities in order to meet the environmental objectives of the EU Water Framework Directive (2000/60/EC) and Groundwater Directive (2006/118/EC) i.e. protect groundwater for future generations. Groundwater protection has traditionally focused on safeguarding water resources from hazards at (or near) the surface. As a result, the risks from near-surface activities are relatively well understood and managed. The controversy surrounding the shale gas industry development in Europe has highlighted the lack of information and systematic practices across the EU for managing a range of hazards to groundwater from energy related activities in the deep sub-surface. This has led to significant public concern about the possible impacts of some of these activities. In response, a number of European Member States have announced bans on the extraction process of hydraulic fracturing (e.g. France and Ireland) and more countries have moratoria on the industry until more is known about the potential hazards and risks. Only a handful of Member States, including Poland and parts of the UK (England) are already in the incipient stages of development. On the other hand, other energy related activities in the deep sub-surface (e.g. geothermal, nuclear waste disposal, conventional hydrocarbons and Carbon Capture and Storage) are either well-established or being actively encouraged across more states, since it is recognized that use of these technologies can both boost national economies and/or directly help to achieve international climate change goals – fewer concerns have been voiced about the impact of these sub-surface industries on groundwater. Since considerations for practitioners assessing groundwater vulnerability are likely to be comparable across these sub-surface industries there is a clear requirement for a consistent, unbiased, approach based upon the best possible knowledge available. The VoGERA project would thus be timely in its undertaking responding to these rapidly developing industries and subsequent public pressure currently confronting many European Member States. A European wide approach to assessing groundwater vulnerability to these activities will allow for a consistent advancement of these industries.

The scientific outputs from VoGERA will be designed to support evidence-based decision making and an integrated approach to management of groundwater vulnerability and associated hazards across Europe in relation to deep sub-surface activities. The information and knowledge gained as part of the project will also be made readily accessible to all stakeholders, including the public, to increase awareness of where groundwater is vulnerable, the reasons for this and how it the ways in which vulnerable groundwater can be protected whilst at the same time allowing responsible use of the sub-surface for the benefit of European citizens and the economy.

Aims and objectives

The **aim** of the VoGERA Project is to improve scientific understanding of the vulnerability of shallow groundwater (predominantly potable water, water for other human uses and water supporting ecosystems) from deep sub-surface industrial energy-related activities. The VoGERA project will specifically focus on sub-surface aspects of energy-related industrial activities, including geothermal energy production, unconventional oil and gas exploitation, sub-surface storage and disposal of wastes. The project will consolidate cooperation between GeoERA partners and European stakeholders and expertise will be combined with the improved scientific understanding gained within the project to provide a consistent approach to assessing and managing the vulnerability of shallow groundwater to deep sub-surface activities across Europe. The outcomes of the project will be used to increase understanding of these issues among decision makers and the public and promote implementation of recommended management procedures which will allow for the simultaneous protection of groundwater for future generations in line with the EU Water Framework Directive/Groundwater Directive whilst recognizing the need for economic development.

The VoGERA project proposal will address the scope of the call through the following **objectives:**

- Investigate the relationship between deep energy activities and shallow groundwater resources, and in particular identify contaminant pathways (such as fault zones, abandoned wells) and their impact on groundwater flow and water quality through four pilot studies. The pilot studies will be conducted in different hydrogeological settings across Europe (UK, Belgium, the Netherlands and Hungary) and utilize a range of physio-chemical, hydrogeological and geophysical methods.
- Formulate a conceptual framework for the assessment of the vulnerability of shallow groundwater from energy-related activities in the deep sub-surface, which can be used to improve integrated management of sub-surface resources and support three-dimensional spatial planning depending on the (hydro)geological conditions.

The objectives can be translated into the following scientific outputs;

- Improved understanding of the relationship between deep energy activities and shallow groundwater resources, and in particular the contaminant pathways in a range of different hydrogeological settings.
- A series of conceptual models to characterize groundwater vulnerability and identify potential contaminant pathways between industrial activities in the deep sub-surface (and associated infrastructure) and shallow groundwater resources (potable water and/or water for other human uses, less than 400m below ground level).
- A series of groundwater vulnerability assessments for the pilot areas, with maps or 3D models showing relevant geological factors, such as the presence of faults and the vertical separation distance between shallow groundwater and targets for potential industrial activity in the sub-surface (e.g. hydrocarbon source rocks, geothermal sources).
- A consistent approach for assessing the vulnerability of shallow groundwater from deep industrial activities that can be universally applied across Europe the application of which will be demonstrated for the four pilot sites/areas.

Relation to existing EU programmes and projects

The VoGERA project addresses challenges set by a number of EU programmes, including;

- Horizon 2020: Secure, Clean and Efficient Energy to support the transition to a reliable, sustainable and competitive energy system; Climate Action, Environment, Resource Efficiency and Raw Materials to increase European competitiveness at the same time as assuring environmental integrity.
- SET-Plan: To accelerate the development and deployment of low-carbon technologies.
- The EU Water Framework Directive – integrated river basin management for Europe Directive 2000/60/EC (WFD) and its daughter Groundwater Directive (GWD) 2006/118/EC on the protection of groundwater against pollution and deterioration.

The VoGERA project will be able to build upon previous work from a number of EU projects and complement a number of concurrent projects as outlined below. These projects generally address one to two energy technologies and may cover a range of linked environmental impacts. The VoGERA project will draw on expertise gained in these projects, which include those from pilot studies, numerical modelling and literature reviews from across Europe, to inform conceptual models focusing specifically on groundwater issues. A number of these studies will also propose ways of assessing and managing risk for individual technologies which will be reviewed as part of this project. Efforts will be made to encourage knowledge exchange between VoGERA and these projects.

- 2018-2021 EU H2020 **SECURe project (Sub-surface Evaluation of Carbon capture and storage and Unconventional Risk).** The VoGERA project will run alongside this project which will gather scientific evidence for risk mitigation and monitoring for environmental protection to underpin sub-surface geoenergy development and to recommend best practice for unconventional hydrocarbon production and geological CO_2 storage. Knowledge from the unconventional and CO_2 monitoring and risk assessment development as part of the SECURe project will be exchanged with the VoGERA project and applied to a greater range of technologies. The VoGERA project will focus on the groundwater specific aspects. NERC and TNO are partners in this project.
- 2015-2018 H2020 **FracRISK (Furthering the Knowledge Base for Reducing the Environmental Footprint of Shale Gas Development).** This project is developing a knowledge-base from numerical modelling of hydraulic fracturing (fracking) of shale gas reserves in Europe, and a decision support tool for risk quantification of the released substances based on geological information. Information generated in this project will be used to inform groundwater vulnerability assessments in VoGERA.
- 2015-2018 EU H2020 **SHEER project (Shale gas Exploration and Exploitation induced Risks)**. This project will develop a probabilistic procedure for assessing short and long-term risks associated with groundwater contamination and shale gas, in addition to other envinronmental risks, associated with enhanced sub-surface permeability. This will be tested against existing and new data for monitoring in a planned hydraulic fracturing in Pomerania. Knowledge from the groundwater monitoring and risk assessment development as part of the SHEER project will be exchanged with the VoGERA project and applied to a greater range of technologies.
- 2015-2017, EU H2020 **M4ShaleGas (Measuring, Monitoring, Mitigating, Managing the Environmental Impact of Shale Gas)**. A report entitled “Risk assessment of impacts of groundwater quantity and quality” (Jacobsen et al., 2015[1]) provided a review of data and existing best practices from Europe, U.S.A. and Canada, and the environmental problems related to groundwater contamination. This project recognized the difficulties in extrapolating information on contaminant pathways, based on review of North American experience, in terms of legislation, regulation and geological differences. The VoGERA project proposes to concentrate on a number of these issues by focusing on deep sub-surface energy activities in a European context and thereby address the significant knowledge gaps that currently exist. NERC, TNO and GEUS were involved with this project.
- 2011-2013, EU 7th Framework **CO2CARE (CO2 Site Closure Assessment Research)** to research the requirements of safe and long-term CO2 storage site abandonment including well abandonment and long-term integrity; reservoir management and prediction from closure to the long-term; risk management methodologies for long-term safety inlcuding groundwater monitoring for gases. TNO and NERC were involved in this project.
- The VoGERA project will take into consideration the results of the geothermal focused projects which dealt or deal with geothermal energy utilization and its potential transboundary impact on groundwater in the western and southern part of the Pannonian Basin: 2017-2019 Interreg Danube Transitional Programme **DARLINGe (Danube Region Leading Geothermal Energy)** project; 2009-2011 EU Interreg V-A Slovenia – Hungary **T-JAM**; 2010 to 2013 EU CENTRAL EUROPE/ERDF **Transenergy (Transboundary Geothermal Energy Resources of Slovenia, Austria, Hungary and Slovakia)**. MBFSZ has been involved in these projects.
- The 2013-2017 **TOPS (Technology Options for Coupled Underground Coal Gasification and CO_2 Capture and Storage)** project also considered impacts on groundwater.

[1] Jacobsen OS, Johnsen AR, Gravesen P, Schovsbo NH (2015) *Risk Assessment of Impacts on Groundwater quantity and Quality* (online). M4ShaleGas Consortium.
Available from: http://www.m4shalegas.eu/downloads/M4ShaleGas%20-%20D8.1%20-%20Risk%20assessment%20of%20impacts%20on%20groundwater%20-%20Nov.%202015.pdf 11 January 2018.

1.1 Concept and methodology

The impact of the shale gas industry on groundwater, and subsequently human and environmental health, has been well publicized in North America (e.g. Jackson, 2014[2]) (Figure 3) and is one of the key concerns for opponents to the industry. Although not as prominent, links between geothermal and unconventional hydrocarbons are being made therefore with time, concerns relating to shallow groundwater and other sub-surface uses may also arise with other industries. While EU nations have a strong background in protecting groundwater from threats at the surface (e.g. surface spillages) little is known about the sub-surface threats to shallow groundwater. Threats to shallow groundwater from energy industries include the introduction of new chemicals (potential pollutants) into the rock mass, disturbing/mobilising existing natural contaminants within rocks and/or changing the permeability structure of the rock (introducing new pathways). A coherent strategy for dealing with these sub-surface threats across the industries and across Europe is currently lacking. The VoGERA project proposal seeks to fill this gap by developing a common conceptual understanding of the vulnerability of shallow groundwater presented by deep energy related activities and approach to assessing groundwater vulnerability in a European context.

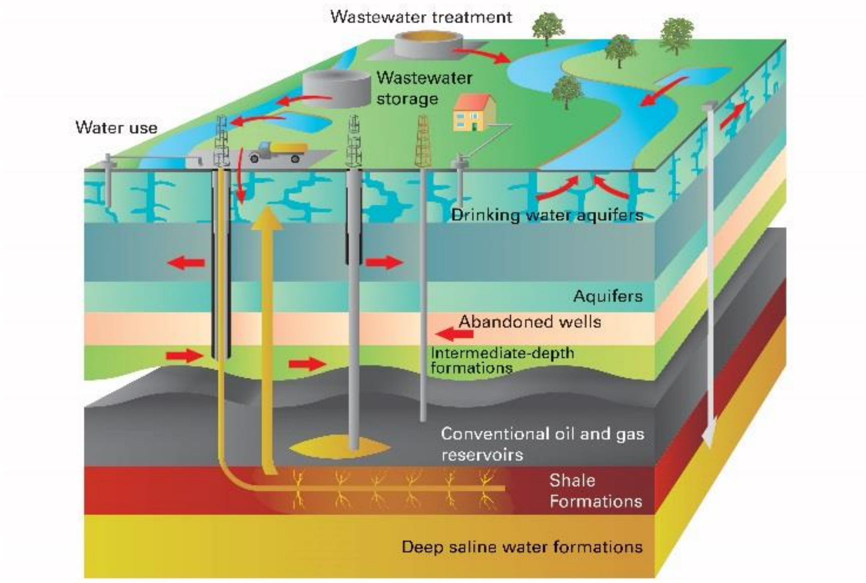

Figure 1 Potential pathways for the contamination of groundwater from shale gas (Loveless et al., in press[3]).

The VoGERA project is built around two technical work packages (Figure 2). As indicated in the SRT, WP3 "**Process understanding**" will focus on improving understanding of the potential pathways between deep sub-surface energy activities and shallow groundwater. This will be achieved through detailed analysis (new and existing) of hydrogeological, chemical, isotopic, and geophysical information for up to four identified pilot sites. The other technical work package, WP4 "**Conceptual framework for vulnerability characterization"**, will develop a conceptual framework for the vulnerability characterization of shallow groundwater to deep energy activities which can be used to inform experimental design in WP3. The conceptual frameworks will be iterated with results from WP3 and used to develop an integrated approach to assess vulnerability.

[2] Jackson RB, Vengosh A, Carey JW, Davies R, Darrah TH, O'Sullivan F, Pétron G (2014) The Environmental Costs and Benefits of Fracking, *Anny. Rev. Environ. Resour.* 39:327-362, doi 10.1146/annrev-environ-031113-144051

[3] Loveless SE, Bloomfield JP, Ward R, Hart, A, Davey I, Lewis MA (*in press*) Characterising the vertical separation of shale-gas source rocks and aquifers across England and Wales (UK). *Hydrogeology Journal.*

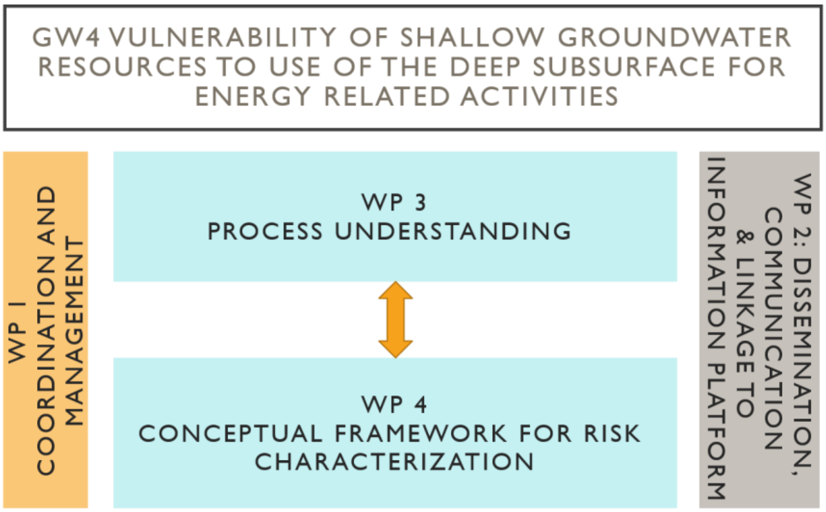

Figure 2 Overall structure of the VoGERA project

The body of research and investigations emerging from North America around the shale gas industry (e.g. (e.g. Di Giulio et al., 2011[4]; Osborn et al., 2011[5]; Vengosh et al., 2014[6]; Moritz et al., 2015[7]; Di Giulio and Jackson, 2016[8]; Llewellyn et al., 2016[9]) indicates that there are a large number of geological and hydrogeological factors which influence the vulnerability of shallow groundwater to sub-surface energy-related activities. Conceptual understanding will be framed in terms of the source-pathway-receptor (SPR) paradigm favored for risk assessment processes in the WFD and its associated Common Implementation Strategy technical guidance (EC, 2010[10]). Key geological factors include; the distance between the source and the receptor – greater distances require greater driving forces and allow for a greater amount of adsorption and reactions before reaching the receptor; faulting – permeable faults can act as flow pathways; karst – voids created from rock dissolution can be flow conduits; rock type – thick mudstones can prevent contaminant transport due to their low permeability and capacity for adsorption; rock rheology and stress – induced fractures will travel further in certain rock types and under certain stress conditions; presence of abandoned wells and mines – introduce anthropogenic pathways into rock (Figure 3). Each of the above factors will combine to produce an intrinsic vulnerability of shallow groundwater to a particular source or sub-surface energy activity and each factor can vary significantly across Europe.

The VoGERA project will investigate these factors through four hydrogeological pilot investigations. Pilot studies will be located in different geological and hydrogeological settings (in the UK, the Netherlands, transboundary between the Netherlands and Belgium, and Hungary) since pathways may behave differently in different settings, for example, in some cases geological structures and discontinuities such as faults can prevent fluids from flowing (e.g. when they behave as traps for hydrocarbons), but in others

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[4] DiGiulio DC, Wilkin C, Miller C, Oberly G (2011) DRAFT: Investigation of Ground Water Contamination near Pavillion, Wyoming. Environmental Protection Agency.

[5] Osborn SG, Vengosh A, Warner NR, Jackson RB (2011) Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing, Proceedings of the National Academy of Sciences of the United States of America 108(20):8172-8176

[6] Vengosh A, Jackson RB, Warner N, Darrah TH, Kondash AA (2014) Critical Review of the Risks to Water Resources from Unconventional Shale Gas Development and Hydraulic Fracturing in the United States, Environmental Science and Technology 48, 8334-8348.

[7] Moritz A, Hélie J-F, Pinti DL, Larocque M, Barnetche D, Retailleau S, Lefebvre R, Gélinas, Y (2015) Methane baseline concentrations and sources in shallow aquifers from the shale gas-prone region of the St. Lawrence lowlands (Quebec, Canada), Environmental Science and Technology, 49:4765-4771.

[8] DiGiulio DC, Jackson, RB (2016) Impact to Underground Sources of Drinking Water and Domestic Wells from Production Well Stimulation and Completion Practices in the Pavillion, Wyoming, Field, Environmental Science & Technology 50(8):4524-4536.

[9] Llewellyn GT, Dorman FJL, Westland D, Yoxtheimer PG, Sowers TE, Humston-Fulmer, Brantley SL (2016) Evaluating a groundwater supply contamination incident attributed to Marcellus Shale gas development, PNAS, 112(20):6325-6330

[10] EC (2010) Common Implementation Strategy for the Water Framework Directive (2000/60/EC) – Guidance on Risk Assessment and the Use of Conceptual Models For Groundwater, Guidance document No. 26, Technical Report 2010-042, Luxembourg, ISBN-13 978-92-79-16699-0, N° Catalogue - KH-31-10-604-EN-C, DOI 10.2779/53333

can allow fluids to flow along them (e.g. in the cases of hot springs) (Bense et al., 2011[11]). The pilot studies are also in locations with different potential energy applications in order to investigate and compare pathways and shallow groundwater vulnerability in relation to particular sub-surface energy uses (e.g. shale gas/geothermal).

Physico-chemical data including stable isotope, dating/residence time indicators, temperature and hydraulic head/flow data in combination with geophysical methods where possible, will be used to identify pathways between the deep sub-surface and shallow groundwater. These data will be assessed in combination with information about background conditions such as regional hydraulic head gradients, to evaluate whether or not there is evidence for localized hydraulic perturbation caused by the identified pathways that would affect groundwater vulnerability. Pilot sites in the Netherlands and Belgium focus on the potential pathways along important faults (the Rauw Fault in Belgium near Mol and the Peel Boundary Fault in the Netherlands near Veghel). The Vale of Pickering (UK), a site that is likely to undergo hydraulic fracturing for shale gas and also conventional gas exploitation in the near future and faults and karst are a feature of the geology. The Pannonian Basin, Hungary, has been the focus of investigations into deep and shallow geothermal groundwater flow pathways for a number of previous EU projects. The existing infrastructure, 3D geological models and available data for the pilot studies will be used in order to make in-depth assessments of shallow groundwater vulnerability in the VoGERA project. These sites are also of key national importance since they are sites where there is active interest for energy use in the sub-surface. A number of stakeholders (such as the Dutch water companies) have already shown their interest in being involved.

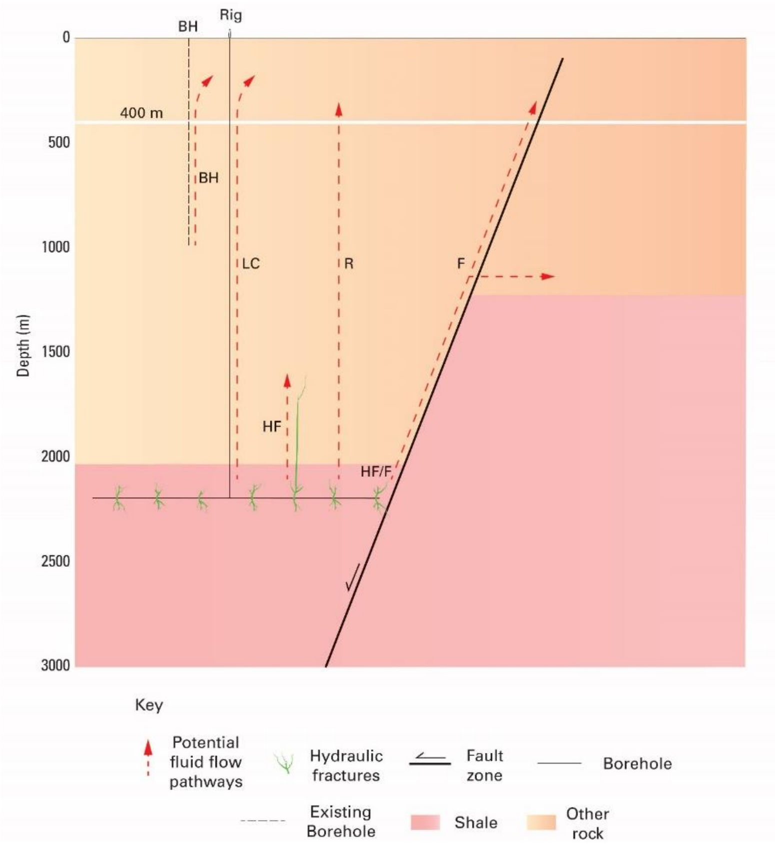

*Figure 3 Potential **sub-surface** pathways for the contamination of groundwater from shale gas shown by red arrows, BH is abandoned borehole, LC is leaky casing, HF is hydraulic fracture, F is fault. Diagram to scale.*

In light of the hydrogeological pilot site investigations a consistent approach to evaluate vulnerability of shallow groundwater to sub-surface activities in a range of European hydrogeological settings will be developed. The approach will make best use of information readily available to decision makers. Existing 3D geological models will be used to aid the vulnerability assessments and used as tools to communicate the variations in groundwater vulnerability between sites and industries. Assessments of the groundwater vulnerability at each of the pilot study sites will be made and illustrated with maps and/or 3D models

[11] Bense V, Gleeson T, Loveless S, Bour O, Scibek J (2013) Fault zone hydrogeology, *Earth-Science Reviews,* 127: 171-192.

demonstrating the application of the approach and used to communicate vulnerability factors to stakeholders. It is anticipated that conceptual models and a vulnerability assessment approach can be used as tools to aid evidence-based decision making, and to improve communication of scientifically complex and controversial issues to the public and to consider responsible co-use of the sub-surface

WP3 will inform, and be informed by WP4 and conceptual models and vulnerability methodologies will be assessed in the light of information from WP3. A good 3D understanding of the sub-surface is vital in order to conduct realistic and worthwhile vulnerability assessments. As such use will be made of existing or new 3D geological models, such as the model that has been developed for the Dutch-Belgian border area in the H3O projects and that developed as part of the Vale of Pickering monitoring strategy (UK).

Co-ordination of all of the work packages and project progress (budget, timing and progress) will be undertaken within WP1. WP2 includes the dissemination and communication of the VoGERA project to stakeholders and the public through a series of accessible documents and meetings, in addition to co-ordination with other GeoERA projects and the GeoERA Information Platform (GIP).

The relevance of the VoGERA project proposal is demonstrated by the large number of cross-thematic and inter-disciplinary interactions. It specifically bridges the apparent divergence in paradigms between securing the safety of groundwater resources for future generations and recognizing that development of deep sub-surface energy activities is vital for our future energy security, economic growth and achieving international climate goals. The interaction of VoGERA with the other GeoERA call themes is shown in Figure 4.

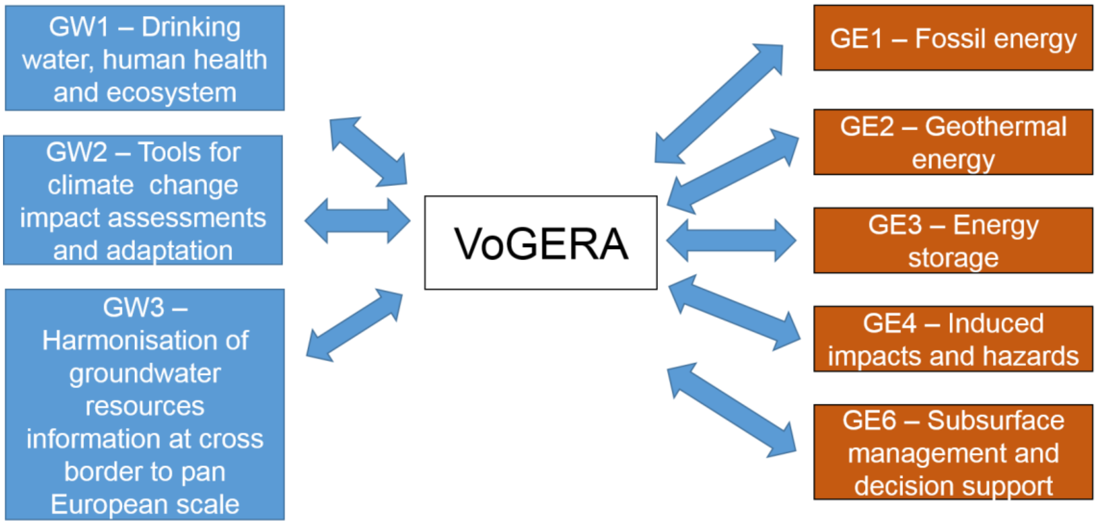

Figure 4 Relationship of VoGERA project proposal to GeoERA Theme A, geo-energy (orange, right side) and Theme B, groundwater (blue, left side) SRTs.

The Specific Research Topics (SRTs) **GE1** to **GE3** in **Theme A**, the Geo-Energy related topics will aim to improve understanding of onshore hydrocarbons (including unconventional gas), geothermal and energy storage. VoGERA will improve understanding of possible contaminant pathways related to these sub-surface energy activities in a European setting and allow for dissemination of this information to remove barriers to development due to a lack of awareness or fear of the unknown. **GE4** is designed to improve the essential geological knowledge-base for predicting and preventing adverse consequences of exploitation of the sub-surface. VoGERA will generate knowledge that will be directly applicable to this SRT. **GE6** is focused on the understanding and management of risks from multiple uses of the sub-surface and deep and shallow connections in the sub-surface. VoGERA will aid this SRT by improving understanding of the individual risks, an essential building block in understanding cumulative risks. VoGERA will also make use of the results of the GE projects, such as the proposed fault database, sharing pilot sites and information where possible. It will also try to make specific links with GE6 (Sub-surface management and decision support) in order to exchange knowledge gained regarding methods and recommendations for sub-surface planning and management.

VoGERA will also interact with other SRTs in **Theme B,** Groundwater; **GW1** aims to understand geogenic diversity. Hydrochemical baselines obtained as part of this project will provide information on the vulnerability of groundwater from existing geogenic and anthropogenic sources and serve as a useful input to future vulnerability assessments for practitioners. There will also be valuable collaboration in the design of monitoring systems. **GW2** – Tools for climate change impact assessment and adaptation develops harmonized databases and good practice protocols for numerical groundwater and integrated groundwater-surface water models. Tools that can be applied to assess and quantify the vulnerability and impact of deep sub-surface related activities. The 3D mapping of groundwater distribution across Europe as part of **GW3** will also serve as an important input into VoGERA, helping to define the three-dimensional separation of possible sub-surface energy activities and shallow groundwater in the pilot areas and also as a valuable input for practitioners looking to assess vulnerability in the future.

The VoGERA partners are involved with many of the projects, or have or strong contacts with institutions involved with the listed EU programmes and will encourage knowledge exchange and best use of data and information. In addition to European projects, GeoERA partners have been participating in a range of relevant national and international research projects, which will complement and allow for transferal of expertise to the VoGERA project.

There have been a number of projects attempting to characterize the risk to groundwater from sub-surface hydrocarbon activities in the UK. NERC and the Environment Agency (England) created a series of maps identifying the vertical separation between shales (shale gas source rocks) and aquifers across England and Wales (Loveless et al., *in press*, http://www.bgs.ac.uk/research/groundwater/shaleGas/aquifersAndShales/maps/home.html). A follow-on project, 3D Groundwater Vulnerability (http://www.bgs.ac.uk/research/groundwater/shaleGas/3DGWV/home.html) characterized the risk to groundwater from sub-surface hydrocarbon activities in England using a series of conceptual models of contamination pathways. The main focus of this work was to develop a Tier 1 prototype methodology for assessing vulnerability and risk of groundwater to deep hydrocarbon activities. The models drew predominantly on research that originated in North America and the rest of the world, under differing geological conditions and where there is a lack of baseline studies. These conceptual models and methodology will serve as a starting point for an integrated approach for shallow groundwater vulnerability assessments across Europe in WP4 which can be further developed with partners and stakeholders, and be extended to account for non-hydrocarbon related deep sub-surface industries. In addition, NERC has been conducting groundwater baseline monitoring around two locations of expected shale gas exploitation, including the Vale of Pickering, which includes real-time monitoring of hydrochemical characteristics. NERC will bring the experience of these investigations into the design phase of WP3 on process understanding. It is also foreseen that the open-access data collected in these investigations can be used in the data analysis of WP3.

TNO have been developing further the work initiated under the CO2CARE project, monitoring methane gas and characterizing gas in groundwater for example to aid the detection of gas leakage from reservoirs to the shallow groundwater (Schout et al., 2017[12]). Recently, TNO has started a sampling campaign focusing on the gas composition of the shallow groundwater in the provinces of Noord-Brabant and Limburg, using their dedicated monitoring networks, leading to a first baseline of methane and methane isotopes and other gases such as H_2S in the groundwater up to a depth of 25 m below surface. Through the research programme KarDySaG, TNO has been investigating the application age tracers and noble gas characterization in those areas, leading to well-characterized age distributions of both shallow groundwater (Visser et al., 2008[13]) and deeper groundwater used for the drinking water supply (Visser et al. 2013[14]). The material collected in these studies will further be explored in VoGERA to investigate

[12] Schout, G., Hartog, N., Hassanizadeh, S.M. & Griffioen, J. (2017) Impact of an historic underground gas well blowout on the current methane chemistry in a shallow groundwater system, *PNAS*, doi: 10.1073/pnas.1711472115
[13] Visser, A., H.P. Broers, & M.F.P. Bierkens (2008) Dating degassed groundwater with 3H/3He, *Water Resources Research,* 43(10), W10434.
[14] Visser A., H.P. Broers, R. Purtschert, J. Sültenfuss and M.de Jonge (2013). Groundwater travel time distributions at a public drinking water supply well field derived from multiple age tracers (85Kr, 3H, noble gases and 39Ar). *Water Resources Research,* 49(11):7778-7796.

pathways, including fault zones, towards shallow groundwater resources, cooperating with water supply companies in the south of the Netherlands. Results of the recent OPERA programme (the third Research Programmeme for the Geological Disposal of Radioactive Waste) in the Netherlands focusing on pathways and failure modes of a sub-surface repository will be taken into account for the conceptual models and guidance of the data collection.

VMM and TNO are – together with some other partners – cooperating in the 'H3O' programme. 'H3O' includes a series of projects (H3O Roer valley graben, H3O De Kempen and H3O Rose) involving cross-border harmonization of 3D hydrogeological models within the Dutch-Belgian-German cross-border region. Within these projects, transboundary 3D hydrogeological models have been developed, including a fault model. These models can for example be used within VoGERA to produce vertical distance and fault maps and design pilot investigations in for the Rauw Fault. One of the proposed pilot areas is located in the H3O study region.

SCK•CEN is involved in various Research, Development & Demonstration projects related to nuclear waste management, as well as the assessment of waste repository performance. Many of these are commissioned by ONDRAF/NIRAS, the nuclear waste management agency, as an example we mention the cAt-project (2006-present). In this project, an extensive site characterization campaign of the Mol-Dessel area was conducted, which led to the development and testing of hydrogeological and transport models covering the domain above the Boom Clay. In addition, SCK•CEN has been involved in various safety and feasibility studies related to geological disposal of nuclear waste. Currently, research actions are being defined in a larger framework between SCK•CEN and ONDRAF/NIRAS which aims at monitoring the hydrogeology along and across the Rauw fault, northeast Belgium. SCK•CEN is also involved in the Future Floodplains and Peatlands projects, where hydrogeological models are being developed to understand past and future geo-eco-hydrological change.

A range of stakeholders from government decision makers, EU project participants to GeoERA Theme and GeoERA project coordinators will be consulted to inform and shape the questions and concepts that should be considered during the course of the project from a cross-disciplinary viewpoint. This will happen at a number of stages within the process through WP2.

1.2 Ambition

Previous field investigations into the pathways between deep sub-surface energy activities and shallow groundwater have been predominantly focused in North America. This has been recognised in the research community (e.g. M4 ShaleGas, see section 1.1). However, geological settings in Europe may be much more complex due to their structural history (Ward et al., 2015[15]). The VoGERA project will address this by conducting investigations at pilot study sites, which are designed to answer key questions relating to the pathways between deep sub-surface energy activities and shallow groundwater in a specifically European context.

Various conceptual models exist regarding contamination pathways from deep in the sub-surface to groundwater and the subsequent shallow groundwater vulnerability. The 3D Groundwater Vulnerability project in England produced conceptual models for other hydrocarbon industries however, such conceptual models do not currently exist for many of the other sub-surface energy industries (e.g. geothermal and energy storage). The VoGERA project will for the first time extend these conceptual models of the relationships between deep sub-surface industrial activities and shallow groundwater and enable direct comparison of shallow groundwater vulnerability between the different industries thus allowing for transparent and consistent decision making and 3D spatial planning.

Field investigations and conceptual models developed as part of the VoGERA project for the deep to shallow sub-surface will help to bridge a gap in knowledge and data (e.g. hydraulic conductivity, flow pathways, water quality) around the zone between 400 m bgl (shallow groundwater) and 1km depth (typical

[15] Ward R, Stuart ME, Bloomfield JP (2015) The hydrogological aspects of shale gas extraction in the UK, Issues in Environmental Science and Technology 39(39):122-150.

depths of oil and gas reservoirs). In addition it will help to bring together the largely disparate scientific communities within Europe. The interations between VoGERA and the other funded GeoERA projects and research topics will be important in enabling this. Early attempts have been made to collect the necessary data in other parts of Europe (Schout et al., 2017) the VoGERA project will build on this previous research in order to help filling the gap between the deep and shallow research communities regarding the risks of the deep activities towards groundwater resources.

There is a general lack of guidance for decision-makers and sub-surface spatial planners that can be used to assess impacts of sub-surface energy activities across Europe. A number of countries have developed informal decision-making tools such as the NERC and the Environment Agency (England) 3DGWV methodology, although decision-making remains relatively ad-hoc. MBFSZ has developed a vulnerability and resilience assessment for hydrocarbon and geothermal concessions which has been applied in Hungary since 2012 with more than 50 potential concessional areas having been assessed to date. However, VoGERA will, for the first time, provide a unified approach to support decision makers in assessing the vulnerability of shallow groundwater to deep industrial activities that has been developed for use across Europe and based on the best evidence available and specifically considering a European context. The testing of the approach with pilot study areas and data will also enable the first extensive testing of the vulnerability assessment approaches. The approach to assessing groundwater vulnerability will be a potentially innovative outcome of the project to aid in decision-making about the use of the sub-surface. Efforts will be made to develop this approach such that it is fit-for-purpose and therefore it is foreseen that this will influence decision-makers from across the EU. All the approaches, data and information produced as part of the VoGERA project will be made open access through reports, web-pages and scientific papers. WP1 will continuously monitor for innovation potential that emerges as part of the VoGERA project and report to the GeoERA consortium as it arises.

2 Impact

2.1 Expected impact

Due to the nature of the VoGERA project there are planned and expected to be multiple beneficiaries of the project resulting in the expected impacts mentioned in the Scientific Scope and those not mentioned in the Scientific Scope. The table below describes how the beneficiaries will use or benefit from the project and will have impact for them.

Project outcomes	**Beneficiaries and how they will use or benefit from the outcome**	**Expected impact**
WP3: Hydrogeological pilot studies for investigating the relationship between deep sub-surface activities and shallow groundwater	*Sub-surface research institutes and other research communities* will benefit from the data generated and the pilot investigation design. Regional and local authorities and stakeholders such as drinking water supply companies will benefit from the increased understanding of the geology at the pilot sites.	*Improved knowledge-sharing across Europe, in particular in relation to intercalibration procedures and standards for geophysical and monitoring equipment used for sub-surface characterization and designing investigations to assess groundwater vulnerability to deep sub-surface industrial activities.* *Consolidated cooperation and communication between national/regional sub-surface research institutes and European stakeholders that deal with groundwater resource management.* Data generated will allow further research into the potential pathways and processes though, for example, numerical modelling. Improved groundwater management and sub-surface spatial planning for pilot areas.

WP4: Jointly developed conceptual models of groundwater vulnerability to deep sub-surface energy activities and possible pathways	*Sub-surface research institutes and groundwater resource managers in relation to energy and WFD, Groundwater Directive and EU Energy Policy*. *Institutes will benefit from a common understanding of groundwater vulnerability from deep sub-surface activities and will be able to use these in communication with the public.*	*Consolidated cooperation and communication between research institutes and stakeholders in relation to this topic.* Harmonized understanding and management of the groundwater vulnerability. Improved communication with the public and understanding within communities.
WP4: A series of vulnerability assessments for the pilot study sites, with maps/models to show relevant aspects from geological models, such as the presence of faults and the vertical separation distance between shallow groundwater and targets for potential industrial activity in the sub-surface.	Sub-surface research institutes, groundwater resource managers, decision makers and the public will benefit from understanding the geometric relationship between groundwater and sub-surface activities in the context of shallow groundwater vulnerability in the pilot areas.	Improved understanding and management of the hazards related to specific geological settings. Improved communication with the public.
WP4: Jointly developed approach to assessing groundwater vulnerability to deep sub-surface energy activities.	Groundwater resource managers and decision makers will have access to a common approach to assessing risks which can be used as guidance to dealing with pressures on the sub-surface. Public and sub-surface energy industries.	*Better planning of sub-surface uses enhancing the possibilities for geothermal energy, energy storage of heat or waste products and conventional and unconventional hydrocarbons thereby helping Member States in reducing reliance on imported fossil fuels for energy supply, and helping countries to meet their CO_2 targets.* *Consolidated cooperation and communication between national/regional sub-surface research institutes and European stakeholders that deal with groundwater resource management.* More transparent and uniform decision-making and planning.

NOTE: Impacts in italics relate to impacts specified in the proposal call.

Figure 5 Table listing project outcomes, beneficiaries and impact

Improved sub-surface spatial planning by groundwater managers and decision-makers will depend on the applicability of conceptual models and vulnerability assessment approaches, therefore it will be vital to understand stakeholder needs. In addition, the impact will be sensitive to the current legislation and regulation regarding these technologies and use of the deep sub-surface for energy related activities and the necessity to take other factors into account when making decisions. Achieving the expected impacts will necessarily rely on the engagement of policy makers and regulators from a range of different countries and their willingness to implement any developed methodologies or conceptual understandings. Theoretically, a greater understanding of the issues at hand should provide decision-makers with the confidence to allow development of these industries under the right circumstances, however, there is a large amount of negative public opinion surrounding some of these activities and therefore this may have an influence on the achieved impacts of the project. By consulting with stakeholders during the project there is greater likelihood that the outcomes will meet their needs and be presented in a way that maximises use. In addition, WP2, and the responsibility for dissemination and communication will be led by VMM who perform a regulation role therefore there is guaranteed input and interaction with a stakeholder from at least one country.

2.2 Measures to maximize impact

2.2.1 Dissemination and exploitation of results

The VoGERA WP2 is designed to coordinate dissemination, communication and the relationship with the GeoERA Information Platform (GIP). VoGERA will adhere to the overall dissemination, communication and exploitation plan of the GeoERA project. Results will be disseminated both via project specific channels administered by the VoGERA participants and the wider GeoERA network. We will seek to interact with the GIP and adhere to GeoERA communication/dissemination guidelines.

Figure 6 is a summary of dissemination activities that are designed to engage with project beneficiaries to maximize impact of the project outcomes. These are described in more detail below.

Dissemination activity	Beneficiaries
Stakeholder workshops	Decision-makers and policy-makers from regional and local authorities Regulators from GeoERA partner countries GeoERA representatives from other GE and GW GeoERA projects Representatives from similar EU projects
Technical resources and information through the GIP	Decision-makers and policy-makers from regional and local authorities or regulators from GeoERA partner countries Sub-surface research institutes and GeoERA partners involved in other GeoERA projects Public Groundwater/energy consultancies
Webpage and high-level summaries	General public Decision-makers and policy-makers from regional and local authorities or regulators from GeoERA partner countries Groundwater/energy consultancies
Scientific papers and publications	Sub-surface research institutes Other research communities within Europe Groundwater/energy consultancies

Figure 6 Summary of dissemination activities and beneficiaries.

Stakeholder workshops at project meetings.
Stakeholders (Figure 6) will be included in the three main project meetings; the kick-off meeting, review meeting and final review meeting. At the beginning of the project, project ideas and expected outcomes will be discussed and the experiences of stakeholders taken on board to shape the key questions and approaches to be taken within the project and to understand current best practice. From the start of the project and on-going, meetings will ensure that the needs of stakeholders are understood and the products and outcomes shared to meet these needs. Towards the end of the project workshops will encourage familiarization of stakeholders with the risk approach and results of the pilot studies. It will also allow for feedback from the stakeholders and optimization of outcomes.

Technical resources and information to stakeholders
Throughout the project technical updates and information from the project will be provided to stakeholders in the form of reports, in addition to making data from the pilot studies and the geological models available. Feedback will be sought to ensure the final products are fit-for-purpose. This will predominantly be carried out through the GIP. A number of technical reports and science-policy briefs on different aspects of the project and/or for scientific research community and decision-makers/regulators will also be available on the project website.

Public information about the risks to shallow groundwater from deep sub-surface energy activities
High level summaries of the project will predominantly be made available on the project webpage and it will be specifically made accessible and easy to understand. Vulnerability maps and other public facing information produced during the project will also be made available.

Presentations and scientific papers for the science community
Results of the project will be presented to the groundwater scientific and consultancy community at European and International (e.g. EGU, IAH) and national conferences (e.g. the Dutch Platform Geothermie, Hydrogeology Group of the Geological Society). In addition, the publication of a number of open access peer-reviewed scientific papers (e.g. Hydrogeology Journal, Science of the Total Environment, Hydrology and Earth System Science, Water Resources Research) is expected. A number of technical reports will also be available on the project website

2.2.2 Communication activities

Communications will enhance the dissemination strategy in terms of ensuring that targeted information is prepared and delivered via outlets visible to the relevant stakeholders. In addition to VoGERA specific communications, the project will liaise with GeoERA as whole to maximise reach and impact. These outputs will be reviewed by project management prior to publication as needed to ensure quality, content and timeliness. Communication activities undertaken as part of VoGERA will include:

Information/Newsletter Articles/Press – The VoGERA consortium will prepare materials outlining the project and its findings which can be disseminated via the, project website overarching GeoERA platform, national/local press and news outputs/web pages of participating organisations as appropriate.
Target Audience – Public, Researchers, Consultancies, Policy and Decision Makers.

Social Media – Twitter, LinkedIn and Facebook pages will be set up for the VoGERA project. Project updates (e.g. meeting announcements, outcomes, progress, results) will be announced through these media to inform all stakeholders. These media platforms also allow for feedback and interaction from stakeholders thus encouraging two-way flow of ideas throughout the project and encouraging engagement.
Target Audience - Public, Researchers, Consultancies, Policy and Decision Makers.

Blogs – Occasional blog/longer Facebook posts will be written to summarize new findings or results and point stakeholders to new research and published on the internet via participant and GeoERA channels.
Target Audience - Public, Researchers, Consultancies, Policy and Decision Makers.

Conferences - Presentations of project results to the groundwater scientific and consultancy community at European, International (e.g. EGU, IAH) and National Conferences (e.g. the Dutch Platform Geothermie, Hydrogeology Group of the Geological Society).
Target Audience – Sector Specific Researchers.

Input to Policy and Public Discussion – Public facing information in an easily accessible format will be made available via the project website and where appropriate, researchers will engage with policy and decision makers to inform and discuss issues explored by the VoGERA research.
Target Audience – Public, Policy and Decision Makers.

2.3 Contribution of Project Proposal to the Information Platform or vice versa

The VoGERA project will use the GeoERA Information Platform (GIP) to host a webpage for the project which will be kept updated with progress, hold deliverables and data produced by the project, including all relevant scientific papers, technical and plain language reports.

Hydrochemical and geophysical information will be generated as part of WP3 for three of the pilot sites. For all four pilot sites existing data will be gathered. These data, and their interpretations will be made available in standard formats (e.g. excel or access databases, LAS files). Models and vulnerability maps for the pilot sites will be generated as part of WP4, also in standard formats (ArcGIS or PDFs). The exact format of data delivered will depend on the volumes generated, and decided on by the WP leads, project coordinator and GIP coordinators and IT experts in addition to input from stakeholders. Reviews and models will be provided as standard PDFs if applicable. The data provided for the vulnerability approach will depend on the development of the approach and most appropriate format. Metadata and an assessment of quality will be provided with each data package.

The lead for WP2 will work closely with the GIP in order to decide the data, information and format that will be used for information generated within the project that will be stored on the GIP and write the Data Management Plans. There are two key meetings, the first in Month 6, to discuss overall objectives and discuss format and outputs, standards for data storage and exchange. There will be another meeting around Month 24 in order to review the final products (maps/models and other data). The requirements of the IP will be kept in mind when considering outputs at other project meetings and the WP2 lead will keep in regular contact. Following the closure of the project data will be stored on the GIP in accordance with practices.

Prior to commencement of the project, all participants will define protocols and contractual obligations to protect their foreground and background intellectual property. As such, the consortium will sign a consortium agreement (DESCA model), establishing a legal framework for the protection of intellectual property rights (IPR). All outputs will be monitored for their innovation potential and if/when identified they will be protected and plans made to ensure that these can be effectively exploited/licenced/published for the benefit of project partners and the EU. All partners will respect the privacy of their collaborators with regards to existing IPR agreements.

New Intellectual property generated as part of the VoGERA project, for example, geochemical and geophysical data generated from the pilot studies, conceptual models and approach to assessing groundwater vulnerabulity and the vulnerability models generated for the pilot sites will be assessed for protection needs and commercial applicability (e.g. exploitation via licensing or collaboration with a suitable SME) at the biannual project meetings. Comprehensive review and protection of intellectual property rights (IPR) are fundamental to driving innovation and competitiveness within the EU. Initial research outputs will be reported to WP Leads and then subsequently the Project Lead for review as a dedicated agenda item and a strategy for IPR and innovation management discussed and developed. This protection will ensure that outputs are effectively exploited to achieve maximum impact.

3 Implementation

3.1 Work Plan – Work packages, deliverables

For the VoGERA proposal we have identified four work packages (Figure 2 and Figure 7), described below.

WP 1– Coordination and management

WP1 comprises the management and co-ordination of the proposed project. It is the role of this work package to facilitate coordination and communication between the three other work packages, and ensure delivery of milestones, deliverables and impact. This WP includes **Day-to-day coordination (Task 1.1)**, **Budgeting and expenditure (Task 1.2), Coordination of deliverables (Task 1.3)** for the whole project, **Facilitation of communication between WPs (Task 1.4)**, **Organization of project-wide meetings (Task 1.5)** and **Tracking risks and innovation potential (Task 1.6)** and reporting these back to GeoERA. All WP leads are involved in WP1 in order to ensure links between the WPs.

WP2 – Cross thematic coordination, data management, interaction with the GIP

WP2 concerns dissemination and communication of the project findings to stakeholders and the public. It will also link with the GIP and thereby to the numerous other relevant GeoERA projects. Further information on the links with and role of the GIP are described in Section 2.3. This WP includes development of a **Data Management Plan (Task 2.1)**, **Streamlining to the GIP (Task 2.2)** and **Communications, dissemination and exploitation (Task 2.3)** of the results to stakeholders and the public. All WP leads are involved in WP2 in order to ensure effective pathways to impact for the other WPs.

WP3 – Process understanding

WP3 is focused on demonstrating and understanding particular processes and pathways between deep energy activities and shallow groundwater through information and data review and pilot studies. WP3 will begin with a data review of processes and pathways from deep sub-surface energy activities to shallow groundwater, including assessing the infrastructure and data available at the pilot areas, **Data review**, **Task 3.1** (Month 1 to 6). Based on the Data review, further data collection and hydrogeological and geophysical investigations will be planned for the pilot sites, ensuring a harmonized data collection phase between the sites in **Task 3.2, Planning data collection**, (Month 6 to Month 12). The hydrogeological investigations at the pilot sites **Task 3.3, Pilot investigations,** will take place from Months 13 to 24 and the results will be combined with the existing data (Task 3.1). Months 25 to 32 will be used for analysis and testing of the preliminary methodology developed in Task 3 from WP4 (Task 4.2) and to produce groundwater vulnerability assessments illustrated with maps/geological models to show shallow groundwater vulnerability at the pilot study sites, **Task 3.4, Vulnerability assessments at the pilot study sites**. Documentation and reporting will be carried out during execution of the tasks and combined into reports in **Task 3.5, Documentation and reporting**.

WP4 – Conceptual framework for vulnerability characterization
WP4 will begin with the development of conceptual models for a range of deep sub-surface energy activities and their processes and hazards for shallow groundwater based on literature review and experience of the participants (**Conceptual models of pathways, Task 4.1,** Month 1 to 12). A preliminary approach will be developed for assessing the risks and vulnerability to groundwater (**Developing vulnerability methodology, Task 4.2,** Month 12 to 21). The conceptual models from Task 4.1 and the preliminary methodology of Task 4.2 will also evaluated with stakeholder input and results from the pilot studies in WP3 (**Methodology evaluation, Task 4.3,** Month 24 to 32;). The methodology will be revisited and modified according to feedback as part of the evaluation process. Documentation will be carried out during execution of the tasks and combined into reports (**Documentation and reporting, Task 4.4**).

WP3 and 4 will run along-side each other, with a high level of interaction and feedback between the work packages. Task 3.2 will take account of the conceptual models from Task 4.1 to ensure that collection of additional data will be as effective as possible. Vulnerability mapping of the pilot sites in Task 3.4 will begin with the relevant (hydro)geological aspects identified in Task 4.1. Task 4.3 is strongly dependent on the analyses for the pilots in 3.4.

Further information about these work packages, resourcing, timing and deliverables are presented below in Figure 7.

		Quarter												
Task	Description	1	2	3	4	5	6	7	8	9	10	11	12	13
1.1	Day to day coordination													
1.2	Budgeting and expenditure			CE(M7)				CE(M19)				CE(M31)		FF(M38)
1.3	Coordinate deliverables	KR (M3)						PR(M20)						FR(M38)
1.4	Facilitate communication													
1.5	Meeting organization	KO(M1)	PM(M6)		PM(M12)		PM(M18)	RM(M21)	PM(M24)		PM(M30)		FM(M36)	
1.6	Track risks and innovation potential													
2.1	Data management plan		DP(M6)				GIP(M18)				GIP(M30)			
2.2	Streamlining to GIP						IP(M16)		WS(M24)					
2.3	Comms, dissemination and exploitation	WS(M1)			CP(M12)			WS(M21)					WS(M36)	
3.1	Data review													
3.2	Data collection plan				TR(M12)									
3.3	Pilot investigations and data analysis								TR(M24)					
3.4	Vulnerability assessment at pilot sites											TR(M32)		
3.5	Documentation and reporting													
4.1	Conceptual models of pathways				TR(M12)									
4.2	Develop vulnerability methodology													
4.3	Methodology evaluation												TR(M36)	
4.4	Documentation and reporting													

Figure 7 project planning (PM = project meeting; KO = kickoff meeting; RM = review meeting; FM = final review meeting; KR = Kick-off report; PR = progress report; FR = final reportTR = Technical Report; W = webpage; CE = Estimated cumulative expenditure; FF, Final Finanacial Expenditure; CP = communication plan; GM = GeoERA Information Platform meeting; WS = Workshop; DP = Data Management Plan; GIP = GeoERA information platform testing IP = Prioritized information products)

3.2 Management structure, milestones and procedures

VoGERA will employ robust management structures and procedures in order to successfully complete the project, delivering technical and dissemination/exploitation outputs to the highest quality standard. The project is organized into four WP (see figure 3) covering overarching project management (WP1), dissemination of outputs and coordination with the Information Platform (WP2) and technical work (WP3 and WP4). The project will be led by NERC with Dr Sian Loveless acting as VoGERA project lead. To ensure effective management and coordination of the WP's the following governance bodies will be established:

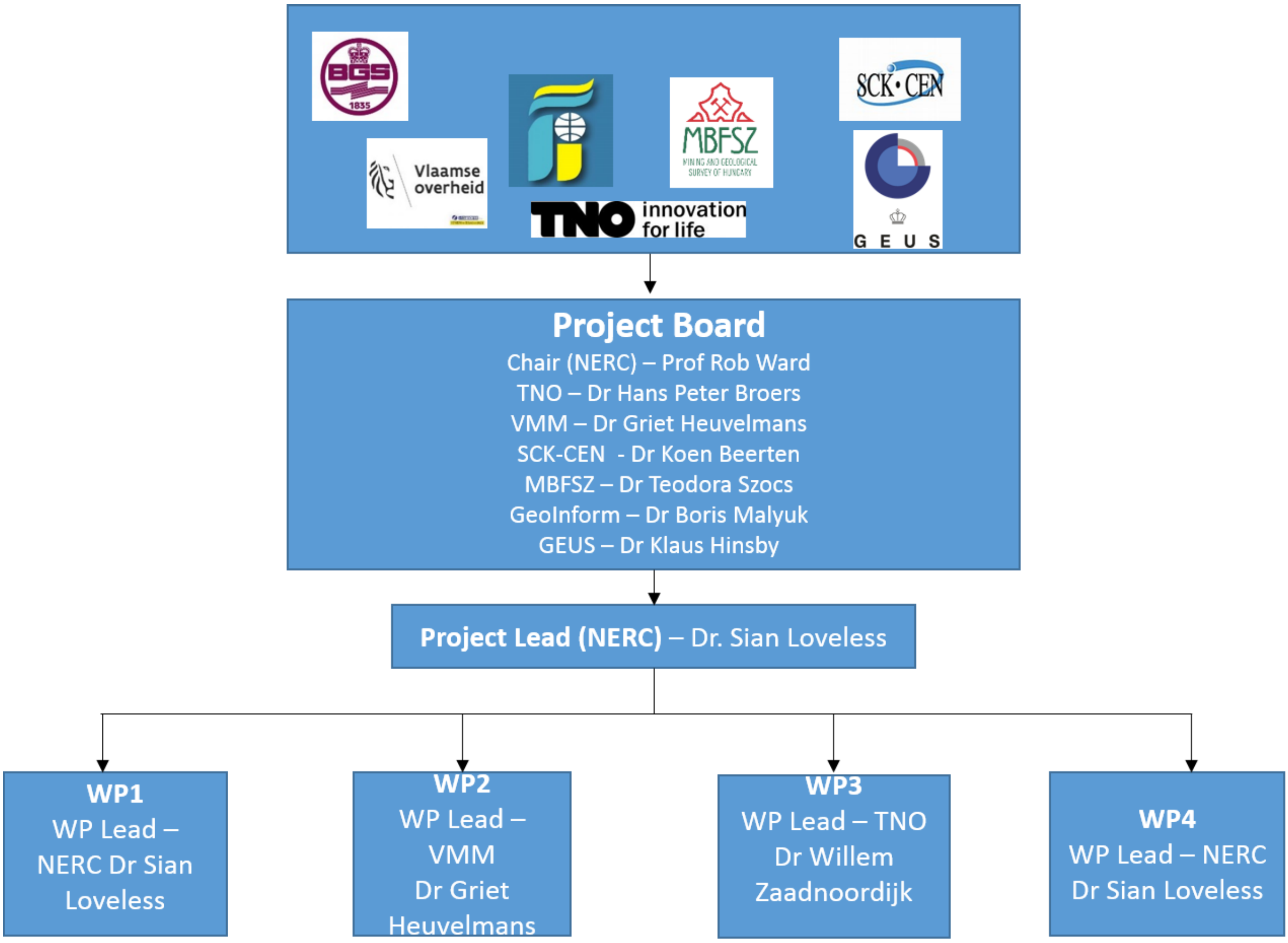

Figure 8 VoGERA Project Organizational Structure.

Project Assembly: The Project Assembly will be the ultimate decision-making body of the consortium where all participants will have one vote. They will provide top-level strategic decision making and experience to ensure successful project delivery having decision making powers to amend appendix 1, modify the project plan and consortium.

Project Board: The Project Board will be chaired by Prof. Rob Ward (NERC) and comprise a representative from each participation organization. As the main supervisory body for the project, their responsibilities will include overseeing outputs, quality assurance, dissemination, exploitation, data management, innovation management, conflict resolution and risk review for VoGERA as a whole. They will meet every six months for the duration of the project. The project meetings, either in person or via Skype will be held in order to check on progress and issues arising.

Project Lead: The Project Lead will be responsible for the day-to-day management of the project and act as the contact for communication between the overall consortium, Project Board and overarching GeoERA management. Responsibilites will include ensuring fulfilment of work obligations by partners and the successful accomplishment of deliverables and milestones; leading the project board including leading on dissemination/exploitation, risk mitigation, innovation and data management; coordination of the reporting responsibilities and ensuring effective communication channels are established and maintained.

Work Package Lead: Each WP will have a leading organsiation and staff member who will oversee the work from their organisation and other participants towards achieving the outlined deliverables. They will ensure completion of the outline tasks and deliverables; liaise with and provide report contents to the Project Lead; ensure effective communciation throughout WP staff; solve technical issues where possible and monitor and maintain high quality outputs.

Theme Coordinator: The Project Lead and other relevant staff will liaise with the appointed GeoERA theme coordinator, providing detail and updates to facilitate exploiation of synergies between all projects in the theme.

Periodic consortium meetings will be held for the duration of the project. After an initial kick-off meeting arranged within the first three months of the project, the project consortium will meet every six months either in person or via Skype with discussion covering project work, technical outputs, dissemination/exploitation/communication outputs, risks, innovation management, interaction with the GIP and other relevant issues. Additional to these large meetings there will be contractual review meetings (kick-off, mid-term and final) and also idea exchange workshops for relevant staff. Further meetings will be arranged (either ad hoc or regular) by staff e.g. Work Package leads to ensure continued collaboration and progress. Records of all meetings will be kept for future reference. Reports (progress and financial across two reporting periods required by the GeoERA programme) will be compiled by the Project Lead with input e.g. presentations and summary sections from the WP lead and participating staff. The WP2 Lead will also be involved in this process in order to make sure that the greatest possible impact can be gained from the outputs.

A number of milestones have been identified which outline key achievements and decision making points (table 3.2a). Key decisions to be made include: WP3: Plan for investigations; WP4: Decide on initial and final conceptual models and WP4: Decide on initial and final methodology. These decisions will be made at the relevant project meetings.

The organizational structure will allow for effective communication between the WP's, and the six-monthly meetings will ensure that all participants are kept up to date on the progress and results of the other WP's. This is vital for cross-seeding ideas between the WP's. There are a number of key decisions (above) that need to be made at a number of points throughout the project and meetings will be the most efficient way of doing this. Each year there will be at least one face-to-face meeting for all participants, whereas to limit costs and travel, the other meeting could be via Skype or video-conferencing. Regular communication will also be encouraged outside of these formal meetings, via email, teleconferences and shared working drives. There will additional supplementary support available to the Project Lead at NERC from research administration staff including support for finance, events and communications. Specialist staff will be able to provide advice and support to facilitate effective and comprehensive project management. The robust structure will additionally facilitate mitigation of issues e.g. realization of risks or conflict resolution, by allowing issues and decision making to be escalated and robustly discussed.

Innovation will be encouraged and innovation management discussed at the six-monthly meetings as a dedicated agenda item to ensure all exploitable outcomes are identified and managed. Innovation ideas and outputs will be recorded by the relevant WP and if appropriate, communicated back to the GeoERA community. If appropriate, further protection of IPR and outputs will be investigated to ensure that innovation outcomes can be exploited in the longer term.

VoGERA will be working with experienced researchers and established organizations and so overall the project is considered to be low risk. Risks have been assessed and continued assessment as part of the Project Board meetings will ensure that any risks are identified and mitigated prior to any effect on the project delivery. The pilot study sites will be sites known to the partners involved and generally where they themselves have existing data and infrastructure. Therefore the risks that may be associated with getting data in WP3 and 4 will be minimized. Sites will also be re-assessed for their appropriateness during WP3 Task 2. The Kick-off meeting (WP1, M1-3) will be an important step in establishing a network of engaged stakeholders which will continue to engage throughout the project therefore allowing a greater chance of impact. The progress of the project will be regularly reviewed in terms of expenditure and deliverables. Critical risks related to project implementation and their proposed mitigation measures are provided in table 3.2b.

3.3 Consortium as a whole

The consortium comprises sub-surface research organizations and regulators with extensive knowledge of hydrogeology and geology, both in nationally and internationally. All of the partners have experience leading or participating in EU projects and therefore a track-record of collaboration and delivering to a high standard. NERC has experience of coordinating EU projects.

NERC and TNO have been actively involved with the development of the Water Framework Directive and Groundwater Directive and its associated guidance. At a national scale, VMM and MBFSZ have experience in policy development concerning groundwater protection and are also responsible for the groundwater monitoring as part of the WFD in Flanders and the River Basin Management Plans in Hungary respectively. VMM is also involved in groundwater policy development at EU scale by participating in the CIS Working Group on Groundwater. TNO has close ties with Provincial Governments and water supply companies who will provide the additional data for use in the Dutch pilot study. NERC have strong links to the Environment Agency (the regulator in England) having worked with them extensively for shale gas monitoring, a study of abandoned wells, methane baseline and a previous 3D groundwater vulnerability project looking at hydrocarbon activities. These close links to local and national government and water companies will be important to provide stakeholders to review conceptual models, pilot study results and the vulnerability approach.

Consortium partners have experience investigating and monitoring sub-surface pathways for contaminants to groundwater from CO2 storage (NERC, TNO), methane (NERC, GEUS) and geothermal waters (MBFSZ) using geochemical and geophysical monitoring techniques. TNO, SCK•CEN and BGS have experience of site characterization and monitoring, and SCK•CEN and TNO have particular experience monitoring fluid flows along fault zones including the cross-border Rauw fault and the Peel Boundary Fault, which will serve as pilot sites. Furthermore, through the participation of SCK•CEN the availability of hydro(geo)logical modelling expertise is guaranteed. TNO has close ties with Provincial Governments and water supply companies will provide the available data. NERC have been conducting groundwater investigations into the baseline chemistry and geology at the future Vale of Pickering shale gas site for the last few years thus have access to a network of boreholes and infrastructure for further monitoring and investigations at the site. MBFSZ have conducted previous investigations at the geothermal Great Hungarian Plain for several years and therefore have access to a large quantity data with which to assess potential contamination pathways and groundwater vulnerability.

NERC have just completed a project to develop a prototype methodology to assess the vulnerability of groundwater to hydrocarbon activities in the sub-surface working closely in conjunction with the Environment Agency (England) and will be able to develop this within the project. MBFSZ have also developed a methodology of vulnerability and resilience assessment for hydrocarbon and geothermal concessions which has been applied in Hungary since 2012. More than 50 potential concessional areas have been assessed.

All of the partners have experience in 3D geological and hydrogeological modelling and mapping, and TNO and VMM have past experience in cross-border 3D hydrogeological modelling. Partners also have experience of dissemination and communication and the involvement of GEUS in WP2 will provide strong links with the GIP.

3.4 *Resources to be committed*

Table 3.1a) Work package description

Work package number	1	Lead beneficiary		NERC			
Work package	Co-ordination and management						
Participant number	1	2	3	3a	4	5	6
Short name of participant	NERC	TNO	VMM	SCK•CEN	MBFSZ	GEOINFORM	GEUS
Person months per participant	3.14	0.6	0.5	0.5	0.5	0.25	0
Start month	1			End month	36		

Objectives

1. Co-ordinate the project day to day
2. Keep track of budgets and deliver yearly estimated cumulative expenditures
3. Ensure timely delivery of deliverables from the WPs
4. Facilitate communication with the Theme coordinator, GeoERA, and other GeoERA project coordinators, Project Assembly and Project Board
5. Facilitate co-ordination and communication between the three other work package leads
6. Organize kick-off meeting, review meeting and final review meeting
7. Track risks and innovation potential

Description of work

Task 1.1 Day to day coordination (**NERC**)
Co-ordinate the project day to day.

Task 1.2 Budgeting and expenditures (**NERC**, TNO, VMM, SCK•CEN, MBFSZ, GEOINFORM)
Each partner will keep records of work done for each member of the project team and all supporting documents for sub-contracting and other costs in accordance with Horizon 2020 rules. Project timesheets, invoices and other documentation supporting costs will be kept by every project partner for a period of five years after payment of the balances. WP leads will keep a track of WP budgets and NERC will keep track of budgets for all of the WP and deliver yearly annual Estimated Cumulative Expenditures to the Project Board, Project Assembly and the designated MRO and estimates will be shared with the Executive Board in December of the year it refers to. A final financial report will be delivered in Month 38.

Task 1.3 Coordinate deliverables (**NERC**, TNO)
Identify deliverables, including project reports, scientific papers websites and deliverables and plan in advance with the other WP leads to ensure their timely delivery. A mid-term review report summarizing progress from all WPs will be delivered in Month 20 and a final project report will be delivered in Month 38.

Task 1.4 Facilitate communication (**NERC**)
Facilitate communication between WP leaders, with the Theme coordinator, the designated MRO, and other GeoERA project coordinators, Project Assembly and Project Board by arranging meetings and phone calls. Facilitate coordination and communication between the three other WP leads when identified and necessary.

Task 1.5 Meeting organization (**NERC**, TNO, VMM, MBFSZ)
The kick-off meeting, review meeting and final review meeting will aim to be organized at the locations of the pilot studies so that a field trip can be incorporated in order for all partners to understand the scientific set-up and geological and hydrogeological situation. Therefore each of the partners with a pilot study (NERC, TNO/VMM, MBFSZ) will take the lead in arranging a meeting around their pilot sites. This will also encourage the engagement of decision-makers and other stakeholders to participate from a number of regions. NERC will be responsible for organizing the six-monthly meetings with all partners, the Project Assembly and the Project Board.

Task 1.6 Track risks and innovation potential (**NERC**, TNO, VMM, SCK•CEN, MBFSZ, GEOINFORM)
A dynamic risk assessment will be undertaken through the duration of the project in order to identify any potential problems and deal with these as soon as possible. Conversely, the progress of the project will be monitored for any emerging innovation potential and the GeoERA consortium will be informed as it arises. Both of these will be assessed at the six-monthly meetings.

Deliverables

- 1.1 Kick-off meeting summary (Month 3)
- 1.2 Project review report (Month 20)
- 1.3 Final project report (Month 38)
- 1.4 Cumulative Expenditure report (Month 7, 19, 31)
- 1.5 Final financial report (Month 38)

Work package number	2	Lead beneficiary		VMM			
Work package	Cross thematic coordination, data management, interaction with GeoERA Information						
Participant number	1	2	3	3a	4	5	6
Short name of participant	NERC	TNO	VMM	SCK•CEN	MBFSZ	GEOINFORM	GEUS
Person months per participant	1.54	1.5	1.5	0	0.5	0.25	1
Start month	1			End month	36		

Objectives

1. To define and coordinate information for databases and the GIP from VoGERA with other GeoERA projects, and develop a Data Management Plan (DMP) in collaboration with the GIP team in order to make data findable, accessible, interoperable and reusable according to GeoERA D1.3 and the H2020 "FAIR" principles.

2. To develop a project communication, dissemination and exploitation plan through social media, the project web site and scientific journals. Where required this will be in collaboration with the other themes and the GeoERA secretariat.

Description of work

Task 2.1 Development of the data management plan (**GEUS**, NERC, TNO, VMM)

A database management plan (DMP) will be established in close cooperation with the GIP Project team, using the provided DMP template developed by the GeoERA secretariat. The DMP is established to support the interaction between the GIP and the VoGERA project and facilitate identification of VoGERA data to be provided for the GIP. This will be reviewed and refined later in the project. W2 will coordinate the testing of the VoGERA prototype and final GIP with the GIP project, due to be completed in Months 18 and 30.

Task 2.2 Streamlining the information flow toward the GeoERA Information Platform (GIP) (**GEUS**, TNO**,** NERC, SCK•CEN, MBFSZ**)**

A workshop will be organized with the work package leaders and coordinators of the pilots to line up expectations of delivery and reception of information from the pilots in WP3 and WP4 to the GeoERA Information Platform (GIP) towards the end of the project. Using the DMP, information products to focus on for the GIP will be selected according to VoGERA's iDAT and IT needs. Priority will be given to the products which have most benefit to the stakeholders of the work under VoGERA. Once products from VoGERA become available through WP deliverables, the data will be provided to the GIP project for integration in a prototype system. VoGERA WP and task leaders will test data accessibility and GIP functionalities in the different phases of development of the portal in collaboration with the GIP team. Information and metadata about VoGERA will be included and classified according to the societal challenges of Horizon 2020 in the recently developed European Inventory of Groundwater Research (EIGR). WP 2 will keep track the deliverables from WP3 and 4 and advise on the best way to interact with the GIP. The GeoERA groundwater project coordinators will schedule internal web-meetings together with the theme coordinator every third month for coordination of data provision for GIP among the groundwater projects. Where necessary, the web-meetings will be supplemented with face-to-face meetings.

Task 2.3 Communication, dissemination and exploitation (**TNO**, NERC, VMM, SCK•CEN, MBFSZ, GEOINFORM, GEUS)

A communication plan will be developed for the VoGERA project by Month 12. Communication about the project's results will include the organisation of workshops for stakeholders in the technical projects. Dissemination of the pan-European work will be established by organizing three workshops in conjunction with stakeholder groups at European level, including CIS Working Group on Groundwater, the European Environmental Agency, the Joint Research Centre and other CIS groups wherever relevant. Regional stakeholders will also be invited to attend the workshops and provide feedback on the project. The GeoERA website and GIP will be key in the dissemination events and social media will be included to promote events. The production of peer-reviewed papers in international journals will be promoted through this task under WP2, prioritizing and integrating project results of the VoGERA project and bringing together scientists working in the Groundwater Theme. The VoGERA project will cooperate with the GeoERA secretariat and other projects funded under GeoERA to establish the best possible dissemination strategy.

Deliverables

2.1: Draft data management plan (Month 6)

2.2: List of prioritized Information Products for the GeoERA Information Platform as input for the GIP meeting on Groundwater in M18 (Month 16)

2.3 Prioritised data to the GIP (Month 38)

2.4: Communication plan (Month 12)

2.5: Workshops for European and regional stakeholders (Month 1, 21, 36)

2.6 Open access scientific publications and presentations at national and international conferences (continuous)

Work package number	3	Lead beneficiary			TNO		
Work package title	Process understanding						
Participant number	1	2	3	3a	4	5	6
Short name of participant	NERC	TNO	VMM	SCK•CEN	MBFSZ	GEOINFORM	GEUS
Person months per participant	4.17	11.4	1	5	3	0.25	0
Start month	1			End month	36		

Objectives

1. Identify and evaluate potential contaminant migration pathways on and controls on fluid flow/transport behavior using chemical, isotopic and geophysical methods at four pilot study sites.
2. Produce groundwater vulnerability assessments at the pilot study sites illustrated with geological maps/models.

Description of work

Task 3.1 Data review (**TNO**, NERC, SCK•CEN, MBFSZ)

During the first six months of the VoGERA project Task 3.1 will compile a review of existing data and information on discontinuities and structures that are potential pathways (identified in conjunction with WP4) and their controls on fluid flow. Information sources will include peer reviewed publications, regional geology guides, water companies, mine plans and maps and data collected as part of previous projects from the selected pilot sites.

Task 3.2 Planning data collection (**SCK•CEN**, NERC, VMM, MBFSZ, GEOINFORM)

The four pilot study sites are expected to include the Vale of Pickering, UK (shale gas/conventional gas), the Rauw Fault zone, Belgium/the Netherlands, the Peel Boundary Fault in the Netherlands, and the Pannonian Basin, Hungary. The pilot sites have been chosen because there is extensive data collection infrastructure (e.g. accessible boreholes which can be sampled) and/or pre-existing data at these sites. Pilot site locations will be confirmed in this task according to their accessibility and the availability of data gathered in Task 3.1. This task will also involve the design of the investigations at each of the study sites to support development and testing of the vulnerability model(s). Design specifications will include locating additional existing data needed in order to analyze sub-surface pathways, identification of borehole locations for further data collection and sampling, the geochemical and piezometric sampling (timescales and numbers of samples) and analysis to be undertaken and possible locations for geophysical investigations or further hydrogeological testing.

Task 3.3 Pilot investigations and data analysis (**TNO**, NERC, SCK•CEN, MBFSZ)

In Task 3.3 the impacts of potential pathways (e.g. faults) on fluid flow and groundwater vulnerability will be evaluated at the four pilot sites according to the data collection plan. This will be investigated using a range of physico-chemical data including stable isotope, dating/residence time indicators, temperature and hydraulic head/flow data in combination with geophysical methods where possible, to establish flow paths between the deep sub-surface and shallow groundwater. These data will be assessed in combination with information about background conditions such as regional hydraulic head gradients, to evaluate whether or not there is evidence for localized hydraulic perturbation caused by the identified pathways that would affect groundwater vulnerability and be complemented with a baseline characterization of the gas composition in the shallow groundwater. Tracer techniques to be used include noble gas composition, methane and methane isotopes, ^{3}He and ^{4}He, and age tracers such as ^{14}C.

Task 3.4 Groundwater vulnerability assessment for pilot study sites (**TNO**, NERC, VMM, SCK•CEN, MBFSZ)

Task 3.4 will use the approach to assess shallow groundwater vulnerability to deep sub-surface energy activities developed in Task 4.2 to produce groundwater vulnerability assessments that could be illustrated using maps and/or 3D geological models showing shallow groundwater vulnerability at the four pilot sites in terms of potential pathways/barriers to contamination. These will consider the vertical separation distance between shallow groundwater and potential energy activity in the sub-surface and key pathways or geological barriers such as fault zones as a vulnerability modifying factor. The assessments will make use of advanced 3D models previously developed for the pilot sites. These will be used a) to aid in communicating shallow groundwater vulnerability with stakeholders and to b) assess the wide scale applicability of the approach developed in Task 4.2 at a range of sites.

Task 3.5 Documentation and reporting (**TNO**, NERC, VMM, SCK•CEN, MBFSZ, GEOINFORM)

Task 3.5 will run concurrently with Tasks 3.1 to 3.4 and coordinate the reporting of the project progress, literature review, data collection plan, data collection and analysis, and groundwater vulnerability assessments for the pilot study sites.

Deliverables

3.1: Technical report on evidence for potential pathways for groundwater contamination from sub-surface energy activities and investigation/ data collection plan technical report (Month 12)

3.2: Report on the characterization of potential pathways and effects on fluid flow in pilot areas (Month 24)

3.3: Groundwater vulnerability assessments for the pilot study sites (Month 32)

Work package number	4	Lead beneficiary			NERC		
Work package	Conceptual framework for vulnerability characterization						
Participant number	1	2	3	3a	4	5	6
Short name of participant	NERC	TNO	VMM	SCK•CEN	MBFSZ	GEOINFORM	GEUS
Person months per participant	3.49	4.7	4	0	2	0.25	0
Start month	1			End month	36		

Objectives

1. Identify and develop a set of conceptual models for potential contaminant pathways between industrial activity in the deep sub-surface and shallow groundwater resources (<400 m bgl).
2. Develop a consistent screening methodology for characterizing the vulnerability of shallow groundwater from deep industrial activities.

Description of work

Task 4.1 Conceptual models for pathways between industrial activity in the deep sub-surface and shallow groundwater (**MBFSZ**, NERC, TNO, VMM, SCK•CEN, GEOINFORM)

Task 4.1 will provide a suite of conceptual models identifying potential pathways or barriers different industrial energy activities in the deep sub-surface and linkages to shallow groundwater. Deep energy activities in the sub-surface will include conventional hydrocarbons, unconventional hydrocarbons (shale gas, coal bed methane, underground coal gasification), deep geothermal energy, waste disposal (nuclear and other) and gas storage. A representative range of geological conditions across Europe will be considered and situations where negative impacts might occur. A key outcome will be a series of diagrams/conceptual models identifying and explaining the potential pathways under each scenario. These will be used to inform, Tasks 3.1, 3.2 and 3.3 and Task 4.3 and will consider findings from Task 3.1.

Task 4.2 Develop a consistent methodology for characterizing the vulnerability of shallow groundwater (<400 m bgl) from deep industrial activities (**NERC**, TNO, VMM, SCK•CEN, MBFSZ, GEOINFORM)

Task 4.2 will develop a consistent methodology for characterizing the vulnerability of shallow groundwater (< 400 m bgl) from deep industrial activities which can be used to underpin shallow groundwater vulnerability assessment and 3D sub-surface planning. It will enable comparable assessments of risk across Europe to be carried out when combined with risk assessment tools. This will be informed by the conceptual models of shallow groundwater vulnerability developed in Task 4.1 and evaluation of potential pathways from Task 3.1. NERC will contribute to the project, and share a Tier 1 prototype methodology developed for the Environment Agency (England) to assess groundwater vulnerability to sub-surface hydrocarbon industries and MBFSZ will share a vulnerability and resilience assessment methodology which has been successfully applied for hydrocarbon and geothermal concession licensing in Hungary. These will provide starting points for developing a methodology that is applicable more broadly at the EU level. Where possible, recommendations will be made on information needs for conceptual model refinement and physico-chemical indicators that should be part of the environmental impact monitoring/verification scheme. This will also take into consideration the outcomes of GW1-WP8 (harmonized vulnerability to pollution mapping of the upper aquifer). The methodology will be developed alongside the data analysis for the pilot studies and then tested against these, this will then be evaluated and the methodology refined.

<u>Task 4.3 Methodology evaluation</u> (**VMM**, NERC, TNO, SCK•CEN, MBFSZ, GEOINFORM)
The vulnerability methodology will be evaluated against outcomes from the pilot studies (Task 3.3) to improve the vulnerability methodology and demonstrate that it can be applied across Europe and is fit-for-purpose. It will also be assessed for suitability as a tool to support achievement of requirements and objectives defined in the EU Water Framework and Groundwater Directives. The findings will be fed back into Task 4.2 in order to refine the methodology.

<u>Task 4.4 Documentation and reporting</u> (**NERC**, NERC, VMM, SCK•CEN, MBFSZ, GEOINFORM)
Task 5 will run concurrently with Tasks 4.3 to 4.4 and lead on coordinating the reporting of the project progress, conceptual diagrams, methodology and evaluation for WP4.

Deliverables

4.1 Expanded diagrams of conceptual models identifying potential pathways for industrial activity in the deep sub-surface and shallow groundwater vulnerability that are representative of the range of deep sub-surface activities and geo-environmental settings in Europe (Month 12).

4.2 Technical report on the common methodology for characterizing the vulnerability of shallow groundwater to deep industrial activities and methodology evaluation in relation to EU Water Framework and Groundwater Directives. (Month 36)

Table 3.1b) List of work packages

Work package No.	Work Package Title	Lead Participant No.	Lead Participant Short Name	Person - Months	Start Month	End month
1	Co-ordination and mangement	1	NERC	5.49	1	36
2	Dissemination, communication, linkage to Information Platform	3	VMM	6.29	1	36
3	Process understanding	2	TNO	24.82	1	36
4	Conceptual framework for risk characterization	54	NERC	14.44	1	36
				Total person – months: 51.04		

Table 3.1c) List of deliverables

Deliverable number	Deliverable name	Work package number	Short name of lead participant	Type	Dissemination level	Delivery date (in months)
1.1	Kick-off meeting summary	1	NERC	Summary report	CO	3
1.2	Project review report	1	NERC	Report	CO	20
1.3	Final project review report	1	NERC	Report	CO	38
1.4	Cumulative Expenditure report	1	NERC	Report	CO	7, 19, 31
1.5	Final financial report	1	NERC	Report	CO	38
2.1	Data management plan	2	GEUS	Report	CO	6
2.2	List of prioritized Information Products for the GIP	2	GEUS	List of prioritised data	CO	16
2.3	Prioritised data to GIP	2	GEUS	Data	CO	38
2.4	Communication plan	2	TNO	Report	CO	12
2.5	Workshops for stakeholders	2	TNO	Workshop outputs	PU	1, 21, 36
2.6	Open access scientific publications and presentations at national and international conferences	2	TNO	Abstract/ presentation/ punclications	PU	ongoing
3.1	Technical report on evidence for potential pathways for groundwater contamination from sub-surface energy activities and data collection plan	3	TNO	Technical report	PU	12
3.2	Technical report on the characterization of potential pathways and effects on fluid flow in pilot areas	3	TNO	Technical report	PU	24
3.3	Groundwater vulnerability assessments for pilot study sites	3	TNO	Report	PU	32

4.1	Expanded diagrams of conceptual models identifying potential pathways for industrial activity in the deep sub-surface and shallow groundwater vulnerability	4	MBFSZ	Diagrams	PU	12
4.2	Common methodology for characterizing the vulnerability of shallow groundwater to deep industrial activities.	4	VMM	Report	PU	36

NOTE: CO is confidential within the entire GeoERA consortium, according to the Model Grant Agreement, PU is Public; it will be made fully public.

Table 3.2a) List of milestones

Milestone number	Milestone name	Related work package(s)	Due date (in months)	Means of verification
1	Kick-off meeting	WP1 to 4	1-3	Meeting held
2	Review meeting	WP1 to 4	20	Meeting held
3	Final review meeting	WP1 to 4	38	Meeting held
4	Data management plan (DMP)	WP2	6	DMP report completed
5	Workshop for streamlining the Information Flow and final data input towards the GIP	WP2	24	Workshop held
6	Data review: Evidence for potential pathways for groundwater contamination from sub-surface energy activities	WP3	12	Presentation at project meeting
7	Investigation /data collection plan	WP3	12	Presentation at project meeting
8	End of data collection and analysis	WP 3	24	Presentation at project meeting
9	Groundwater vulnerability assessments for pilot study sites	WP3	32	Presentation at project meeting
10	Conceptual models	WP4	12	Presentation at project meeting
11	Common methodology for characterizing the vulnerability of shallow groundwater to deep industrial activities	WP 4	36	Presentation at project meeting

Table 3.2b) List of critical risks for implementation

Description of risk (indicate level of likelihood: Low/Medium/High)	Work package(s) involved	Proposed risk-mitigation measures
Medium: Lack of data for assessing processes/pathways for WP 3	WP3	Ensure sites chosen have adequate data/ infrastructure as part of the investigation planning with sufficient access and permissions. This should be reviewed and if necessary different sites chosen.
Medium: processes/pathways not active at pilot sites, which are important elsewhere	WP3	Ensure variety in pilot sites and use existing data and literature from other sites
Medium: Vulnerability assessment approach developed in WP 4 is not fit-for-purpose	WP4	Good communication with decision-makers from the start of the project and ensure their needs are well understood.
Medium: Lack of stakeholder engagement with outputs	WP2	Ensure dissemination and involve key stakeholders from the start.
Low: Project viewed hostilely by public/seen as promoting controversial industries	All	Ensure project objectives and progress are transparent throughout the project, keeping good dissemination and communications.
Low: Not delivering on time	All	Keep good communication and hold regular-update meetings. Ensure WP leaders inform of problems early on in the process.
Low: Delivering over-budget	All	Keep good communication and hold regular-update meetings with finances. Ensure WP leaders inform of problems early on in the process.
Low: Changes in staff at participant organisations.	All	If a change of staff is anticipated, project management will be notified and a comprehensive handover will be undertaken to ensure continuity of work to minimize impact to the project.
Low: Lack of consensus within the VoGERA consortium.	All	Management structures to achieve effective and efficient decision-making have been outlined. However, the project leaders can hold pragmatic negotiation to reach any required resolution of conflicts with an outlined voting procedure followed if negotiation is unsuccessful.
Medium: Unforseen technical issues arise which the consoritum cannot mitigate	WP3 and WP4.	The issue would be escalated to project management and alternative solutions sought, e.g. staff within participant organizations with complementary expertise.

Table 3.3a) Summary of Staff Effort

	WP1	WP2	WP3	WP 4	Total Person-Months per Participant
1. NERC	3.14	1.54	4.17	3.49	12.34
2. TNO	0.6	1.5	11.4	4.7	18.2
3. VMM	0.5	1.5	1	4	7
3a. SCK•CEN	0.5	0	5	0	5.5
4. MBFSZ	0.5	0.5	3	2	6
5. GEOINFORM	0.25	0.25	0.25	0.25	1
6. GEUS	0	1	0	0	1
Total Person Months	5.49	6.29	24.82	14.44	51.04

Table 3.3b) 'Other direct cost' items (travel, equipment, other goods and services)

1. NERC	Cost (€)	Justification
Travel	14,681	Travel and subsistence for kick-off, interim and final meetings, for project coordinator and two WP leads to each
Equipment	0	
Other goods and services	0	
Total	14,681	

2. TNO	Cost (€)	Justification
Travel	14,681	Travel and subsistence for kick-off, interim and final meetings for two WP leads and additional project member
Equipment	9319	Equipment for monitoring, sampling and laboratory analysis
Other goods and services	0	
Total	24,000	

3. VMM	Cost (€)	Justification
Travel	0	Travel and subsistence covered within personnel costs
Equipment	0	
Other goods and services	0	
Total	0	

3a. SCK•CEN	Cost (€)	Justification
Travel	4000	Travel and subsistence covered for project staff involved with WP3 for the kick-off, interim and final meetings
Equipment	0	
Other goods and services	0	
Total	4000	

4. GEOINFORM	Cost (€)	Justification
Travel	3000	Travel and subsistence for kick-off, interim and final meetings for one project member
Equipment	0	
Other goods and services	0	
Total	3000	

5. MBFSZ	Cost (€)	Justification
Travel	1200	Travel and subsistence for kick-off, interim and final meetings
Equipment	0	
Other goods and services	0	
Total	1200	

6. GEUS	Cost (€)	Justification
Travel	0	Input will be coordinated through video conferencing/email or organized as part of the GIP
Equipment	0	
Other goods and services	0	
Total	0	

Table 3.3c) Financial table with requested budget

Participant	(A) Direct personnel costs (EUR)	(B) Other direct costs; travel, equipment, infrastructure, other (EUR)	(C) Direct costs of sub-contracting (EUR)	(D) Indirect costs (= (A + B) *0,25) (EUR)	(E) Total estimated eligible costs (=A+B+C+D) (EUR)	(F) Reimbursement Rate (29,7%)[1]	(G) Requested EU contribution (=E*F)	(H) Surveys in-kind contribution = (E – G)
1. NERC	58124	14576	0	18175	90875	29.70%	26990	63885
2. TNO	116589.2	24000	0	35147	175737	29.70%	52194	123543
3. VMM	33750	0	0	11250	45000	29.70%	13365	31635
3a. SCK•CEN	67650	4000	0	17913	89562.5	29.70%	26600	62962
4. MBFSZ	9450	1200	0	2663	13313	29.70%	3954	9359
5. GEOINFORM	4832	3000	0	1958	9790	29.70%	2908	6882
6. GEUS	7604	0	0	1901	9505	29.70%	2823	6682
Total	**297999.2**	**46776**	**0**	**89006**	**433782**	**29.70%**	**128833**	**298266**

NOTE: Direct and indirect costs of VMM covered in personnel costs

4 Members of the consortium

4.1 Participants (applicants)

1. Natural Environment Research Council
2. Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO
3. Vlaamse Milieu Maatschappij (Flanders Environment Agency)
3a. Belgian Nuclear Research Centre SCK•CEN (Linked third party of Vlaamse Milieu Maatschappij)
4. Mining and Geological Survey of Hungary
5. State Research and Development Enterprise “State Informational Geological Fund of Ukraine”
6. The Geological Survey of Denmark and Greenland (GEUS)

[1] The EC Reimbursement rate for ERA-NETs is 33%. 10% of this Reimbursement rate is reserved for the Coordination Costs of GeoERA as agreed in the Grant Agreement. Therefore, the Reimbursement rate for GeoERA is these calculations results in 29,7%.

<table>
<tr><td>Name of organisation</td><td colspan="3">1. Natural Environment Research Council</td></tr>
<tr><td>Short name</td><td>NERC</td><td>Country</td><td>United Kingdom</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">The Natural Environment Research Council (NERC) is the UK's largest funder of independent environmental science including basic, strategic and applied research and monitoring. The British Geological Survey (BGS), one of its research institutes, will represent NERC. BGS is the world's longest established national geological survey. It seeks to advance the understanding of the structure, properties and processes of the solid Earth system through interdisciplinary surveys, monitoring and research for the benefit of society. BGS is a public sector organization responsible for advising the UK government on all aspects of geosciences, as well as providing impartial geological advice to industry, academia and the public on groundwater risk and protection issues.</td></tr>
<tr><td>Roles / tasks in the project</td><td colspan="3">Special relevant skills</td></tr>
<tr><td>Project coordinator, WP 1 and 4 lead, and participant in all work packages</td><td colspan="3">• Hydrogeological 3D-mapping; aquifer properties, vulnerability and risk modelling
• Groundwater protection policy, development of risk assessment tools
• Development of environmental monitoring programmes. Integrated management of groundwater and forecasting of future behaviour</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Sian Loveless (f): Senior Hydrogeologist with expertise in understanding structural controls on groundwater flow, geothermal energy and management of national project on assessing risks associated with unconventional hydrocarbons. Robert Ward (m): BGS' Director of Groundwater Science and hydrogeologist with expertise in groundwater protection policy, risk assessment and monitoring. UK nominated representative on the European Commission (EC) expert advisory group for groundwater (CIS WG C) and member of the EuroGeoSurveys Water Resources Expert Group. Jenny Bearcock (f): Hydrochemist – expert in baseline characterisation and water-rock-interactions, mapping and evaluation of groundwater quality data.Rachel Bell (f): Hydrogeologist and lead on national shale gas monitoring programmeme coordinating field-based activities and study of impacts of abandoned hydrocarbon wells on groundwater. Andrew Newell (m): Senior geologist – specialist in 3 D geological modelling, conceptual model development and visualization.</td></tr>
<tr><td colspan="4">Publications, infrastructure / technical equipment</td></tr>
<tr><td colspan="4">• Bell, R.A. et al. 2017 A baseline survey of dissolved methane in aquifers in Great Britain. Science of the Total Environment, 601-602. 1803-1813.
• Stuart, M.E.. 2012 Potential groundwater impact from exploitation of shale gas in the UK. Nottingham, UK, British Geological Survey, 33pp. (OR/12/001)
• Smedley, P L et al. 2017. Establishing the baseline in groundwater chemistry in connection with shale-gas exploration: Vale of Pickering, UK. Procedia Earth and Planetary Science, 17. 678-681.
• Ward, R.S et al. 2017 Environmental Baseline Monitoring Project. Phase II, final report. British Geological Survey, 163pp.
• Ward R.S. et al. 2015 The hydrogeological aspects of shale gas extraction in the UK. In: Hester, R.E.; Harrison, R.M., (eds.) Fracking. Royal Society of Chemistry, 121-150. (Issues in environmental science and technology).</td></tr>
<tr><td colspan="4">Relevant projects/activities</td></tr>
<tr><td colspan="4">Investigation of groundwater impacts from abandoned hydrocarbon wells:
http://www.bgs.ac.uk/research/groundwater/shaleGas/abandoned-hydrocarbon-wells.html
National groudnwater methane baseline study:
http://www.bgs.ac.uk/research/groundwater/shaleGas/methaneBaseline/home.html
Vertical separation of hydrocarbon bearing shales and overlying aquifers (iHydro):
http://www.bgs.ac.uk/research/groundwater/shaleGas/aquifersAndShales/home.html
Development of 3D groundwater vulnerability screening methodology:
http://www.bgs.ac.uk/research/groundwater/shaleGas/3DGWV/home.html
Integrated environmental (baseline) montoring at two UK shale gase sites:
http://www.bgs.ac.uk/research/groundwater/shaleGas/monitoring/yorkshire.html</td></tr>
</table>

<table>
<tr><td>Name of organisation</td><td colspan="3">2. Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO</td></tr>
<tr><td>Short name</td><td>TNO</td><td>Country</td><td>Netherlands</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">TNO is a semi-independent Dutch research and technology organisation active in technical, earth, environmental, life, societal and behavioural sciences, focussing of healthy living, industrial innovation, defence, safety and security. The Geological Survey of the Netherlands (TNO-GSN) provides geoscientific data, information and knowledge for sustainable management of earth resources and the environment. TNO-GSN is the national information provider on sub-surface data, including the 3D groundwater information products REGIS, GeoTOP and webservices such as Groundwater Tools.</td></tr>
<tr><td>Roles / tasks in the project</td><td colspan="3">Special relevant skills</td></tr>
<tr><td>Participant in WP1 and 4 and 3, WP 3 lead</td><td colspan="3">• 3D geomodelling and geophysics
• Building databases and web services for sub-surface and groundwater data
• Integrated interpretation of hydrological, hydrochemical and hydrogeological datasets towards custom made information products</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Dr. Hans Peter Broers (m): senior expert groundwater quality & groundwater modelling at TNO-GSN, specialising in groundwater-surface water interaction and tracer hydrogeology. Vice-chair of the EGS Water Resources Expert Group. Coordinator of several EU Framework Proposals and work packages (FP6 Aquaterra, FP7 MARS). Drs. Ronald Vernes (m) senior expert and project manager at TNO-GSN. Responsible for the national 3D hydrogeological model REGIS II, project initiator and manager of the cross border hydrogeological harmonization H3O-projects with Belgium and Germany. Prof. J. Griffioen (m) holds a chair in Water Quality Management at the Univeristy of Utrecht and is senior hydrogeochemist at TNO with a track record in risks from deep activities towards groundwater. Dr. Willem Jan Zaadnoordijk (m): senior hydrogeologist at TNO-GSN and guest researcher at Technical University Delft. Experienced in groundwater modeling, modeling of piezometric time series and groundwater surface water interaction.</td></tr>
<tr><td colspan="4">Publications, infrastructure / technical equipment</td></tr>
<tr><td colspan="4">• National DINO database on shallow sub-surface information (boreholes, groundwater heads and qroundwater quality) and 3D geomodels GeoTOP and REGIS II (www.dinoloket.nlwww.dinoloket.nlwww.dinoloket.nl), timeseries models for heads DINO database (www.grondwatertools.nlwww.grondwatertools.nlwww.grondwatertools.nl)
• National database (www.nlog.nlwww.nlog.nlwww.nlog.nl) on deep sub-surface information (borelogs, seismic data, production data, geomodels and other datasets)
Publications:
• Visser A., H.P. Broers, R. Purtschert, J. Sültenfuss and M.de Jonge (2013). Groundwater travel time distributions at a public drinking water supply well field derived from multiple age tracers (85Kr, 3H, noble gases and 39Ar). Water Resources Research 49(11):7778-7796
• Berendrecht, W.L., F.C. van Geer (2016) A dynamic factor modeling framework for analyzing multiple groundwater head series simultaneously, Journal of Hydrology, 536, 50-60.
• Schout, G., Hartog, N., Hassanizadeh, S.M. & Griffioen, J. (2017) Impact of an historic underground gas well blowout on the current methane chemistry in a shallow groundwater system, PNAS, doi: 10.1073/pnas.1711472115</td></tr>
<tr><td colspan="4">Relevant projects/activities</td></tr>
<tr><td colspan="4">• H3O (2013-present): cross-border harmonization of 3D hydrogeological models within the Dutch-Belgian cross-border region.
• FP 6 Aquaterra (partner): Trends in groundwater quality and interpretation of groundwater-surface water interaction in a number of European pilots.
• FP6 BRIDGE (partner): policy support for the EU Groundwater Directive.</td></tr>
</table>

<table>
<tr><td>Name of organisation</td><td colspan="3">3. Vlaamse Milieu Maatschappij (Flanders Environment Agency)</td></tr>
<tr><td>Short name</td><td>VMM</td><td>Country</td><td>Belgium</td></tr>
<tr><td colspan="4">Organisation profile</td></tr>
<tr><td colspan="4">Flanders Environment Agency (VMM) is an internally independent government agency with powers of jurisdiction under supervision of the Flemish Minister of the Environment, Nature and Agriculture. VMM’s legal basis is the decree of 05/04/1995 (Belgian Official Journal of 03/06/1995). The mission of VMM is to contribute to the realisation of the objectives of the environmental policy by preventing, limiting and eliminating the harmful effects to water systems and the atmosphere and by reporting on the state of the environment and to the realisation of the objectives of integrated water management.</td></tr>
<tr><td>Roles / tasks in the project</td><td colspan="3">Special relevant skills</td></tr>
<tr><td>Participant in WP1 to 4</td><td colspan="3">• Groundwater quantity and quality monitoring
• Status assessment of groundwater quantity and quality including trend assessments
• Policy development on groundwater/drinking water</td></tr>
<tr><td colspan="4">Short profile of staff member(s) who will be undertaking the work</td></tr>
<tr><td colspan="4">Cis Slenter (f) graduated as physical geographer in 2001 at the University of Utrecht. She works at the groundwater and local water management section of VMM and is responsible for groundwater policy development and groundwater management in the north-eastern part of Belgium (Meuse system and Roer Valley Graben), one of the pilot areas of this project proposal. Griet Heuvelmans (f) graduated as bio-engineer in 2001 and holds a PhD in bio-engineering (2005) from the University of Leuven. She works at the groundwater and local water management section of VMM and is mainly involved in the initiation and coordination of studies in support of groundwater policy and management. Ralf Eppinger (m) graduated as a geologist in 1995 and holds a PhD in geology (2008). He leads the groundwater monitoring team of the groundwater and local water management section of VMM and is representing Flanders in the CIS Working Group Groundwater.</td></tr>
<tr><td colspan="4">Publications, infrastructure / technical equipment</td></tr>
<tr><td colspan="4">• Groundwater quantity and quality data: two monitoring campaigns per year on > 5000 screens since 2004 for groundwater quality, monthly (or more frequent) measurements of groundwater heads. Screens are distributed over all groundwater layers in Flanders and data are used for reporting groundwater quantity in the framework of EU directives
• Time series models for explaining climatic variation in phreatic groundwater heads: Heuvelmans, G., Louwyck, A., Lermytte, J. 2011. Distinguishing between management-induced and climatic trends in phreatic groundwater levels. Journal of Hydrology 411, 108-119.
• Groundwater database and web-portal for data dissemination dov.vlaanderen.beGroundwater database and web-portal for data dissemination dov.vlaanderen.bedov.vlaanderen.be</td></tr>
<tr><td colspan="4">Relevant projects/activities</td></tr>
<tr><td colspan="4">• H3O (2013-present): cross-border harmonization of 3D hydrogeological models within the Dutch-Belgian cross-border region.
• Regional groundwater model of the Meuse system (2007). Initiated and coordinated by VMM, developed by University of Brussels.
• Trend analysis of the anthropogenic pressure and impact on confined groundwater bodies (2016). Initiated and coordinated by VMM, developed by IMDC.
• Monitoring and modelling of groundwater and surface water in support of the river restoration project in the valley of Abeek and Lossing (located in the pilot area). Initiated and coordinated by VMM.</td></tr>
</table>

Name of organisation	**3a. Belgian Nuclear Research Centre SCK•CEN (Linked third party to VMM)**		
Short name	SCK•CEN	**Country**	Belgium

Organisation profile

As a foundation of public utility, the Belgian Nuclear Research Centre conducts research into nuclear energy and ionising radiation for civilian use, and develops nuclear technologies for socially valuable purposes. This is achieved by means of independent, fundamental and applied research, and by providing advice, training, services and products. The Engineered and Geosystems Analysis unit, which is part of the expert group Waste and Disposal, conducts research and provides services related to (long-term) radioactive waste disposal management – the activities are centred around the following themes: Performance assessments, Processes in engineered barrier systems, Computational issues in porous systems and Modelling flow and transport in soil/aquifer systems.

Roles / tasks in the project	**Special relevant skills**
Participant in WP1 and 3	• Hydrogeological monitoring • Upscaling of hydro(geo)logical parameters • Hydrostratigraphy of the southern North Sea basin • Integrated groundwater modelling

Short profile of staff member(s) who will be undertaking the work

Dr. Bart Rogiers (m): junior expert groundwater modelling and geostatistics
Dr. Katrijn Vandersteen (v): senior expert groundwater and surface water modelling
Dr. Matej Gedeon (m): senior expert groundwater modelling and hydrostratigraphy
Dr. Koen Beerten (m): senior expert (hydro)stratigraphy

Publications, infrastructure / technical equipment

- Beerten, K. et al., 2010. **Geological, hydrogeological and hydrological data for the Dessel disposal site.** Project near surface disposal of category A waste at Dessel – Version 1. NIROND–TR 2009–05E.
- Gedeon M., Wemaere I., and Marivoet J. 2007. **Regional Groundwater Model of North-East Belgium.** Journal of Hydrology, 335:1-2, p. 133-139.- ISSN 0022-1694
- Gedeon, M. et al. 2011. **Hydrogeological modelling of the Dessel site.** Overview report. Project near-surface disposal of category A waste at Dessel. NIROND-TR 2008-15E – Version 2.
- Rogiers B, et al. 2014. **Multi-scale aquifer characterization and groundwater flow model parameterization using direct push technologies.** Environmental Earth Sciences 72: 1303-1324.
- Rogiers, B et al. 2013. **The usefulness of outcrop analogue air permeameter measurements for analysing aquifer heterogeneity: testing outcrop hydrogeological parameters with independent borehole data.** Hydrology and Earth System Sciences 17, 5155-5166.

Relevant projects/activities

- NIRAS-SCK framework agreement, https://www.niras.be/geologischeberging (third party/contractor for NIRAS): 2015-2020
- Project near surface disposal of category A waste at Dessel (third party/contractor for NIRAS): 2006-present
- Future floodplains project, http://www.futurefloodplains.be/ (partner, SBO-project for FWO): 2017-2021
- FEMCA project (contractor for VMM): 2015-2016
- Peatlands project (partner, FWO-project): 2017-2021

Name of organisation	4. Mining and Geological Survey of Hungary		
Short name	MBFSZ	Country	Hungary

Organisation profile

The Mining and Geological Survey of Hungary (MBFSZ) was established on 1st July 2017 by the merger of the Hungarian Office for Mining and Geology and the Geological and Geophysical Institute of Hungary. It provides background support to the Ministry of National Development and gives advice on policy matter to the Ministry. In addition to administering mining concessions MBFSZ carries out scientific research in the fields of geology, hydrogeology, geophysics, mining and climate policy. It also manages the mining, geological, and geophysical data center in Hungary. MBFSZ is the designated state institution dealing with groundwater. Furthermore it operates a national groundwater observation system – 140 monitoring wells form part of the National Groundwater Monitoring System (quantity). Based on the Ministerial Decree 101/2007. (XII.23) MBFSZ operates the National Hydrogeological Archive.

Roles / tasks in the project	Special relevant skills
Participant in WP1, WP2, WP3 and WP4	• National and cross-border hydrogeochemical hydrogeology surveys with special emphasis on thermal waters, hydrodynamic and water-rock interaction modelling • Building databases and web services for sub-surface and groundwater data

Short profile of staff member(s) who will be undertaking the work

Teodóra Szőcs (f): PhD, head of the Hydrogeology Department at MBFSZ, vice president for of the International Association of Hydrogeologists. Participated in numerous EU-funded research projects, well experienced in hydrogeochemical evaluation, isotope data interpretation, thermal water surveys, transboundary issues and project coordination. **Ágnes Rotár Szalkai (f)**: senior expert in hydrogeology, geothermal resource survey and project coordinator, responsible for the operation of the groundwater monitoring network of MBFSZ with leading role in several EU projects. **Nóra Gál (f)**: PhD, expert in hydrogeochemistry, water-rock interaction modelling, geothermal resource survey, GIS, thermal well cadastre. **Tamás Kerékgyártó (m)**: expert in geothermal resource survey, hydrogeochemistry, water-rock interaction modelling and hydrodynamic modelling.

Publications, infrastructure / technical equipment

T. Szocs, S. Frape, R. Gwynne, L. Palcsu, 2017: Chlorine stable isotope and helium isotope studies contributing to the understanding of the hydrogeochemical characteristics of old groundwater. Procedia Earth and Planetary Science pp. 877-880 DOI information: 10.1016/j.proeps.2017.01.004

T. Szocs, N. Rman, M. Suveges, L. Palcsu, Gy. Toth, A. Lapanje, 2013: The application of isotope and chemical analyses in managing transboundary groundwater resources. Applied Geochemistry 32 (2013) 95–107

GeoBank: national borehole database

- **Cadastre** and **cartographic documentation of wells**, operation of **National Groundwater Archive**

Relevant projects/activities

Coordinator of the **DARLINGe** - Danube Region Leading Geothermal Energy project (1 January 2017 – 30 June 2019 Interreg Danube Transnational Programmeme).

Coordinator of the „**TRANSENERGY** – Transboundary Geothermal Energy Resources of Slovenia Austria, Hungary and Slovakia" (2010-2013 – 2CE124P3), project, which provided tools for sustainable use of geothermal resources at the Western part of the Pannonian Basin.

- Coordinator of the **NAGiS** - National Adaptation Geo-information System project, whose objective was to develop a multipurpose geo-information information system.ProgrammeProgramme

Name of organisation	**5. State Research and Development Enterprise "State Informational Geological Fund of Ukraine"**		
Short name	GEOINFORM	**Country**	Ukraine

Organisation profile
The State Research and Development Enterprise "State Informational Geological Fund of Ukraine" – SRDE "GeoInform of Ukraine", or GEOINFORM is the specialized research and development unit of the State Geological and Sub-surface Survey of Ukraine which collects, stores, analyzes and provides information received from geological study and use of sub-surface. GEOINFORM conducts research work on monitoring of mineral resources of Ukraine on the basis of geological and mining activities during the year, recording deposits and making public the balance of mineral resources management of the State fund of deposits and occurrences (more than 10,000 objects recorded), synthesis and analysis of exploration for oil and gas, creating a system of state accounting of oil and gas wells, completion and maintenance of the State cadastre of mineral deposits and occurrences as well as State cadastre of groundwater deposits of Ukraine.

Roles / tasks in the project	**Special relevant skills**
Participation in WP1 to 4	Database design and web services for sub-surface data

Short profile of staff member(s) who will be undertaking the work
Dr. hab. Boris Malyuk (m): Director for International Cooperation, graduated in 1981 from Department of Geology, Lviv University, Ukraine, and in 1999 from Centre of Geostatistics, Ecole des Mines de Paris, France. Obtained Candidate of Science (PhD) Degree in Geotectonics in 1984, and extended Doctor of Science Degree in Petrology in 1991. National Delegate of Ukraine to the EuroGeoSurveys. In the Project he will contribute to general project management, raw materials and geoscientific data systems. **Tetiana Biloshapska (f):** Chief Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1980. She is experienced in field works. She had studied mineral-resource base of Ukraine for more than 30 years, took part and led projects on prospecting and exploration of mineral deposits, conducted regional geological studies. **Natalia Pyshna (f):** Chief, Division of groundwater resources inventory. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1987. She has experience in the sphere of hydrogeological studies for fresh and mineral water of Ukraine for more than 30 years. She represents SGSSU in the EU project 'Water Initiative for Eastern Partnership' (EUWI+4EaP). **Mykola Danevych (m):** Leading Hydrogeologists, Division of groundwater resources inventory. Graduated from Kyiv National University under specialty 'Geography, Geoecology' in 2003. He has experience in the sphere of hydrogeological and geological-ecological studies for more than 10 years.

Publications, infrastructure / technical equipment
• Interactive map of mineral deposits of Ukraine (in Ukrainian): http://geoinf.kiev.ua/wp/interaktyvna-karta-rodovyshch-korysnykh-kopalyn.htm • Interactive map of mineral licenses (in Ukrainian): http://geoinf.kiev.ua/wp/interaktyvni-karty-spetsdozvoliv.htm • Interactive geological map of Ukraine 1:1 000 000 (in Ukrainian): http://geoinf.kiev.ua/wp/Interaktyvna-heolohichna-karta-Ukrayiny.htm • Interactive geological map of Ukraine 1:1 000 000 (in English): http://geoinf.kiev.ua/wp/Interactive-Geological-Map-of-Ukraine.htm • Interactive State Geological Map of Ukraine 1:200 000 (in Ukrainian with English entries): http://geoinf.kiev.ua/wp/kartograma.htm

Relevant projects/activities
ESTMAP - EU EUOGA - EU NUMIRE – Norway-Ukraine (NGU/SGSSU) EIMIDA – Norway-Ukraine (NGU/Geoinform)

Name of organisation	Geological Survey of Denmark and Greenland		
Short name	GEUS	**Country**	Denmark

Organisation profile

The Geological Survey of Denmark and Greenland (GEUS) is an independent research and advisory institution in the Danish Ministry of Energy, Utilities and Climate. The areas of expertise of GEUS are geoscientific studies, research, consultancy and geological mapping. GEUS' overall mission is to provide, use and disseminate knowledge of geological materials, processes and relations that are important for the use and protection of the country's natural resources. GEUS is part of Geocenter Denmark - a formalised cooperation between GEUS and the Geocience institutes at University of Copenhagen and Aarhus University. In 2016, GEUS has a staff of 290 of which 210 hold a PhD or MSc degree, and around 50 PhD students and several MSc students are attached to GEUS for research training.

GEUS has a long tradition in working with groundwater, water resources and quality issues, including laboratory, modelling and monitoring activities. GEUS hosts the national databases in relation to geology, geophysics and groundwater related data and is responsible for co-ordination of the Danish monitoring programmeme on groundwater. The hydrological modelling group has established and further develops an integrated national hydrological model covering Denmark. The model has been used for numerous research and development studies related to quantity and quality by integrated groundwater and surface water assessments. The model provides a basic tool for the national and regional water authorities for implementation of the Water Framework Directive in Denmark.

Roles / tasks in the project	**Special relevant skills**
WP2	• Groundwater chemical status assessment according to EU directives, geophysical logging, groundwater sampling and dating, hydrogeological characterization

Short profile of staff member(s) who will be undertaking the work

Klaus Hinsby (m): Senior Scientist/Hydrogeologist, theme coordinator for GeoERA groundwater, Chair of the EGS Water Resources Expert Group and EGS representative in the EU Working Group Groundwater, expert in groundwater dating and application of borehole logging in hydrogeological investigations. He has some experience in application of slimline logging and hydraulic testing of petroleum exploration wells in Portugal and Vietnam conducted in a previous EU project (FRACARES) and a project funded by DANIDA (the Danish programme for development cooperation).
Klaus Hinsby participated in the initiation and proposal development phase of the Horizon2020 project M4shalegas, http://www.m4shalegas.eu/ .

Publications, infrastructure / technical equipment

Buckley, D.K., Hinsby, K., & Manzano, M. 2001. Application of geophysical borehole logging techniques to examine coastal aquifer palaeohydrogeology. Geological Society, London, Special Publication, no. 189, 251-270.

Klinkby, L., Hinsby, K. Zinck-Jørgensen, K., Bojesen-Koefoed, J., Bonson, C., Small, S., Silva, A.R., Manzocchi, T., Walsh, J. & Patsoules, M. 2001: Geophysical logging and hydraulic testing in a fractured carbonate. GSA 2001 Annual Meeting & Exposition. A Geo-Odysse. Boston, Massachusetts, U.S.A. 1-10 November, 2001. Geological Society of America. Proceedings.

Hinsby K, and Abatzis I.2004. Petroleum geology modelling tools of relevance to groundwater investigations. – Geologisk Tidsskrift 2004 2: 10–11 (in Danish)

GEUS has a slimline borehole logging equipment with a winch able to go to a depth of 2000 m and a wide range of logging tools.

Relevant projects/activities

M4shalegas: Measuring, Monitoring, Mitigating, Managing the Environmental Impact of Shale Gas.
http://www.m4shalegas.eu/

5 Ethics and Security (This section is not covered by the page limit)

5.1 Ethics

The project proposal has been checked against the ethics sections in "H2020 Guidance —How to complete your ethics self-assessment: V5.2 – 12.07.2016". This check raised one issue, discussed below. The checklist is included with the submitted documents in ISAAC.

Does your research involve the use of elements that may cause harm to humans, including research staff?

The research will involve an element of field research which could, like any field work, has the potential to cause harm to research staff. Research staff will abide by recognized procedures to help keep themselves and others around them safe including, conducting and adhering to health and safety risk assessments for each site and field campaign, as required within their own institution and thereby EU and national law. Keeping Researchers will be warned and advised on potential dangers. They will also: keep careful notes of all research engagements, ensuring all projects are adequately staffed, using mobile phones to keep in touch with the research base, formally notifying authorities, carrying if necessary, carry authorized identification and preparation and training covering techniques for conflict, threats, abuse or compromising situations, debrief and assess health and safety with WP leads and report any health and safety incidents. In particular, it should be noted that some of the topics (e.g. shale gas) under investigation are highly contentious in some areas. Staff will be warned about potential issues that may arise with the public and they should consult their institutions health and safety advisers to find out how these issues should be dealt with. Staff will be removed (or remove themselves) from potentially dangerous situations.

5.2 Security

Please indicate if your project will involve:

- Activities or results raising security issues: (NO)
- 'EU-classified information' as background or results: (NO)

(See for guidance this document)

5.11 EuroLithos

Title of project proposal

EuroLithos: Eruopean Ornamental stone resources

Abstract (max. 250 words)

Ornamental stone has contributed significantly in shaping our rural and urban landscapes, through its use in our built heritage from different historical periods. Ornamental stone is today a raw material produced with great skills all over Europe, exploiting the vast diversity of European natural stone resources. Yet, the actual use of local and regional stone resources in Europe is decreasing, and so is the knowledge of the resources, traditions and skills. EuroLithos is founded on the idea that increased knowledge of the geology, quality and history of use of natural stone in Europe will stimulate both more sustainable use of stone resources in Europe for the benefit of SME's and our cultural heritage, and a sound land use management for the safeguarding of ornamental stone deposits.

EuroLithos addresses several aspects of the scope*: identify and map the type and quality of construction materials*, and *provide tools and protocols for the assessment and comparison of deposits*. EuroLithos will also address cultural heritage and building preservation aspects, since the maintenance of European heritage and a living stone industry are mutually dependent. EuroLithos will result in an ornamental stone knowledge base under the umbrella of EGDI, covering harmonised spatial data on European stone resources, atlas of resources and use, a directory of ornamental stone properties and guidelines for valorising ornamental stone heritage. EuroLithos will work in close collaboration with the GeoEra Information Platform. The EuroLithos consortium is composed of 16 partners from 14 countries, collectively forming a strong and innovative research group.

Please indicate the SRT

Raw Materials – RM2B-Natural stone

List of participants

#	Participant Legal Name	Institution	Country
1	NORGES GEOLOGISKE UNDERSØKELSE NGU, Geological Survey of Norway [Project Coordinator]	**National geological survey**	**Norway**
2	LABORATORIO NACIONAL DE ENERGIA E GEOLOGIA I.P., LNEG	**National geological survey**	**Portugal**
3	SVERIGES GEOLOGISKA UNDERSÖKNING SGU, Geological Survey of Sweden	**National geological survey**	**Sweden**
4	INSTITUTO GEOLÓGICO Y MINERO DE ESPAÑA IGME, Geological Survey of Spain	**National geological survey**	**Spain**
5	INSTITOUTO GEOLOGIKON KAI METALLEFTIKON EREVNON IGME, Institute of Geology and Mineral Exploration	**National geological survey**	**Greece**
6	REGIONE EMILIA ROMAGNA SGSS, Servizio Geologico, Sismico e dei Suoli della Regione Emilia-Romagna	**Regional geological survey**	**Italy**
7	REGIONE TOSCANA RT, sistema informativo territoriale e ambientale – p.o. geologia	**Regional geological survey**	**Italy**
8	GEOLOŠKI ZAVOD SLOVENIJE GeoZS, Geological Survey of Slovenia	**National geological survey**	**Slovenia**
9	GEOLOGISCHE BUNDESANSTALT GBA, Geological Survey of Austria	**National geological survey**	**Austria**
10	INSTITUTUL GEOLOGIC AL ROMANIEI IGR, Geological Institute of Romania	**National geological survey**	**Romania**
11	STATE RESEARCH AND DEVELOPMENT ENTERPRISE STATE INFORMATION GEOLOGICAL FUND OF UKRAINE, GEOINFORM – SRDE “Geoinform of Ukraine”	**National geological survey**	**Ukraine**
12	GEOLOGICAL SURVEY OF IRELAND GSI	**National geological survey**	**Ireland**
13	INSTITUTO SUPERIORE PER LA PROTEZIONE E LA RICERCA AMBIENTALE ISPRA	**National geological survey**	**Italy**
14	HRVATSKI GEOLOSKI INSTITUT HGI-CGS, Croatian Geological Survey	**National geological survey**	**Croatia**
15	Cyprus Geological Survey Department GSD	**National geological survey**	**Cyprus**
16	SERVICE GÉOLOGIQUE DU LUXEMBOURG SGL 'Geological Survey of Luxembourg'	**National geological survey**	**Luxembourg**

1 Excellence

Natural stone has to a great extent contributed in shaping our rural and urban landscapes. No other geological material plays such an important role as a bearer of historic significance through its use in our built heritage through different periods. Being high-level heritage such as unique pieces of art, tombstones, medieval castles and churches, pre-historic monuments or modern architecture, or the low-level use of roofing slate, dry-stone walls or paved roads forming the more subtle pieces of distinct cultural landscapes, stone use do reflect our historical and cultural development.

Natural stone is today a raw material produced with great skills all over Europe, SME's and larger enterprises exploiting the vast diversity of European natural stone resources. Today's European stone industry is not only large and important (c. 8,5 billion Euro annually1) but also highly dispersed throughout Europe, making a backbone industry for particularly rural areas. In Italy alone, there are more than 1000 stone quarrying enterprises and the sector in total employed more than 50 000 in 20112.

Yet, the actual use of local and regional stone in Europe is decreasing, mostly related to a general lack of knowledge among key authorities, builders and architects about the role of stone in architecture, identity and heritage, their geological characteristics, and the importance of using autochthonous ornamental stone in built cultural heritage maintenance and restoration. We believe that increased knowledge of the geology, quality and history of use of natural stone in Europe will stimulate both more sound use of local stone resources in Europe for the benefit of SME's and our cultural heritage, a more sound land use management for the safeguarding of the ornamental stone deposits, allowing the compatibility between their exploitation and the preservation of other natural and heritage values.

The above aspects are acknowledged in the challenges given in: *RM2 Construction material* (Raw Material Specific Research Topics, Joint Call Document No 9).

EuroLithos will address the general aspects of the scope*: identify and map the type and quality of construction materials*, and *provide tools and protocols for the assessment and comparison of deposits using standard criteria*. EuroLithos will, moreover, pay particular attention to additional information such as cultural heritage and building preservation aspects; this is of particular importance to natural stone, since the maintenance and preservation of European heritage and a living stone industry are mutually dependent.

EurLithos will approach the specific points given in the scope as shown in Table 1.

Table 1. RM2 scopes and EuroLithos approach.

Scope RM2	EuroLihos approach
Develop inventories in conjunction with the Information Platform	Propose and deliver contribution to the IP *central database, web-portal and digital archive*, propose and deliver standardized spatial information tailored for Natural Stone resources to the EGDI.
information of Europe's exploitation sites and prospective areas of ornamental stone deposits and provide a visualization which can be used for land-use planning	Country and regional case studies addressing one or several: spatial distribution of geological units of importance for natural stone production (provinces), quarries and quality, use and heritage. Close liaison with H2020 projects MINATURA2020 and MinLand.

1 CBI market survey 2010: The natural stone and stone products market in the EU

2 http://www.stat.immcarrara.com/uk/STAT/stone-sector/stone-sector-intro.asp

Explore the applicability and interoperability of standard codes among partners for harmonised reporting of resources	Natural stone will be addressed as a case study in the RM1 WP UNFC. EuroLithos will provide an assessment of codes and propose a G-axis coding for UNFC
Ensure data coherence within a given raw material and among GeoERA partner countries	From EN standards and INSPIRE, demonstrate the adaptability of classification and standards and provide guideline for data description and coherence for natural stone
Provide appropriate input to SRT RM1	Assess and provide guideline for input of spatial data, and demonstrate through data delivery for selected partner countries
Provide advice on how forecasting for the demand of these materials can be improved so that policy formulation and government resource management can be enhanced and capital investment by industry can be prioritised	For natural stone, such generic forecast studies will have little impact. EuroLithos will instead provide advice on how government authorities can improve their resource management through collaboration, i.e. for improving both heritage management and SME conditions.
Provide readily accessible information and easy to use decision making tools for the public and local authorities, respectively	Providing guidelines and best practices for different aspects of importance to natural stone management, and provide easy accessible and readable atlases aimed at raising the interest and awareness of natural stone production, history and use.

Aims and objectives

The overall objective of the project is to contribute to increase the intrinsic value of European ornamental stones. In our view, this will stimulate more use (and thus production) of European stone and contribute to the maintenance, preservation and continuation of European cultural heritage. The two objectives are closely linked, in that achievements in one area have a positive impact on the other.

In the context of the GeoEra partnership, the best way of contributing to meet the objectives is a natural stone information platform, providing documentation, databases and recommendations covering the most important aspects of natural stone resources in Europe; partly, by feeding existing solutions, and partly by adding new ones. The project main goals can be broken down to the following more specific ones:

1) Identify and define: a descriptive framework for natural stone resources in Europe;

2) Collect and characterize: following the framework, carry out an inventory of natural stone resources in partner countries;

3) Make an atlas: template and trial versions for a geological atlas on natural stone on a European and country level linked to databases and directories

4) Make a directory: database of stones and their properties

5) Identify heritage values: producing guidelines for assessing heritage values to natural stone

6) Communicate and collaborate: stakeholder interaction and communication, building networks for continuation;

7) Integrate and distribute: harmonise and provide data to the forthcoming solutions provided by RM1 and IP1

8) Promote and disseminate: promoting natural stone information platform to stakeholders

9) Maintenance and continuation: secure long-term life and growth of EuroLithos solutions.

Relation to existing programmes and projects

There are numerous projects, activities and networks in and beyond Europe, that are addressing natural stone. Some of these are/have been funded by EC, others are commercial or non-profit research networks. EuroLithos will seek to liaison closely with ongoing activities and harvest from past activities. The most important activities to be considered are listed below.

<u>Standards</u>

There are several EN standards addressing natural stone, from terminology to technical standards for different products. In particular, the CSN EN 12670 (Natural stone – Terminology) and CSN EN 12440 (Natural stone - Denomination criteria) are important to take into consideration within the GeoEra scope3. In addition, the INSPIRE standard will be important. EuroLithos will not aim at changing the standards, but in case there are contradictions between EN and INSPIRE we will seek to propose solutions.

<u>Ongoing H2020 projects</u>

EuroLithos will have strong liasions (shared partnership) with several ongoing H2020 projects that possibly can overlap the goals of EuroLithos. Our aim is to coordinate the work to avoid overlaps and stimulate compliancy. The projects are: MinLand (Raw materials and land-use), MinFuture4 (raw materials and material flows), MinGuide5 (mineral policy guide for Europe) and ORAMA.

<u>Terminated and soon to be terminated FP projects</u>

Minatura 20206 is a H2020 project aiming at establishing a common framework for “mineral resources of public importance”. The project will terminate January 31 2018. Several EuroLithos partners have been participating, and we will explore the results of the project and integrate into relevant areas within EuroLithos.

Minerals4EU7 was a FP7 project supplying a portal for spatial data on mineral resources in Europe, including a technical harvesting system for extracting data from national databases and harmonising them. Minerals4 EU will form the spine of the future products from RM1 and IP1, and EuroLithos will seek to use the framework of Minerals4EU for establishing a harmonised spatial data structure for natural stone.

QuarryScapes8 was an FP6 project run by the coordinator of EuroLithos. The results from QuarryScapes can be useful for assessing heritage values for stone quarries and quarry landscapes.

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3 https://www.en-standard.eu/csn-en-12670-natural-stone-terminology/

4 http://minfuture.eu/

5 http://www.min-guide.eu/

6 http://minatura2020.eu/

7 http://www.minerals4eu.eu/

8 http://www.quarryscapes.no/

OSNET (ornamental stone network in Europe)

Historic Quarries, project led by CHC - Research Group for Archaeometry and Cultural Heritage Computing: http://www.historic-quarries.org/

IGCP Project 637 - Heritage Stone Designation: http://www.unesco.org/new/en/natural-sciences/environment/earth-sciences/international-geoscience-programme/igcp-projects/earth-resources/project-637-new-2015/

Roof of Rock - Limestone as the common denominator of natural and cultural heritage along the karstified part of the Adriatic coast. The Adriatic IPA project lead by the Geological Survey of Slovenia: http://www.roofofrock.eu/

Other EU processes

The introduction of GI's for non-agricultural products may have great influence on European natural stone production.

The European Commission is exploring the possibility of extending GI protection to non-agricultural products at EU-level to harmonise the patchwork of laws that exist at national level. This would affect traditional non-agricultural products, from Carrara marble to Scottish tartans9.

The EuroLithos project will keep a view to this process and make sure that the outcome of the project will be useful for establishing GI's for natural stone.

National inventories and databases

There are several innovative solutions in national databases and repositories that can inspire the work in EuroLithos and be of importance to the stakeholders. EuroLithos will explore these and provide links on the information platform.

International NGO's and commercial projects

The IUGS Subcommision: heritage stone10, is seeking to *promote greater prominence for natural stone that has been used in artistic and architectural masterpieces, and heritage building, as well as routine historic stone applications.* The sub-commission has several hundred members all over the world, and have actively promoted stone heritage through several volumes of papers in internationally acknowledged publications. EuroLithos will collaborate with the subcommission on both scientific papers and promotional acitivites.

There are many commercial databases on natural stone internationally and in Europe specifically. EuroLithos cannot relate to all. We have picked the *Deutsches Natursteinarchiv am Europäischen Fortbildungszentrum11* at Wunsiedel, Germany. This is a comprehensive collection of samples from

9 http://ec.europa.eu/growth/industry/intellectual-property/geographical-indications/non-agricultural-products_en

10 http://globalheritagestone.com/

11 http://efbz.de/wp/archiv/

more than 6000 deposits around the world, with technical information such as petrography and physical properties. They also have an *Online version of the largest stone collection in the world*12*.* EuroLithos will explore the mutual interests between our activities and seek to find collaborators for the IP.

ASMOSIA13 is a multi-disciplinary research network on the studies of marble and other rocks used in the Antiquities. Its aim is to *promote the exchange among its members in all fields related to the study of marble and other stones of art historical or archaeological interest*. EuroLithos will seek to build a fruitful cooperation with ASMOSIA on the promotion of knowledge and publications related to the European heritage.

1.1 Concept and methodology

The Geological surveys in Europe see on an every-day basis the disappearance and closure of natural stone SME's in Europe. There are many reasons for this development; large enterprises produce cheaper than small ones, import from low-cost countries is cheaper than domestic/European production, legislations tend to be of more advantage to large enterprises than small, and last but not least, ornamental stone deposits are being sterilized due to land use management issues.

Simultaneously, we see a silent and gradual deterioration of heritage values related to the use of natural stone, since local and regional sources of stone are becoming un-accessible. The traditional diversity of stone characterizing cities and rural landscapes is, in many places, turned into carpets of the cheapest stone available on the present market.

We think there is a connection between the two development patterns; that the lack of knowledge, of good guidelines and of available information about stone resources in Europe and their significance, unintentionally stimulate both. Our main hypothesis is that by providing such services, the market for high-quality stone product, made by producers anchored in traditional stone materials and crafts, will increase instead of deteriorate.

This is not a view grounded in nostalgia, romancing the stone of the past, nor an attempt to steer around market mechanisms. It is simply about acknowledging facts, that quality, provenance, traditions in use and heritage values are important aspects that should be evaluated when making decisions. And, that such considerations are important to take into account before sterilizing traditional quarry areas by other land-use or protection measures.

These issues make stone different from most other raw material commodities; it is not only about the quality and price of a beneficiated product that can be compared whatever the origin. It is also to a high degree about a commodity carrying a "backpack" of other values of importance; aesthetic, historic, heritage quality and craft traditions. Such considerations were important when the EU Parliament passed the GI for non-agricultural products. Several stone producing areas were used as examples for the need of doing such.

We therefore conclude that the content of the IP for natural stone needs to address this complexity, and carry three perspectives as shown in Figure 1.

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12 http://www.natursteinonline.de/steinsuche/dnsa_datenbank.html

13 http://asmosia.willamette.edu/

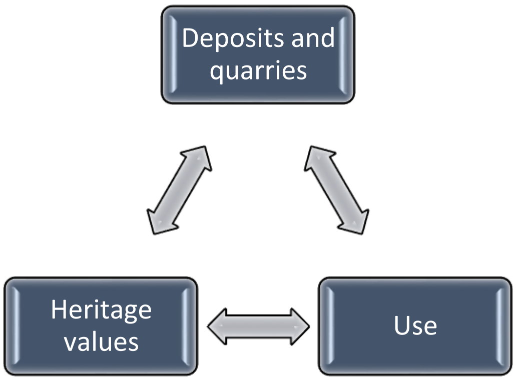
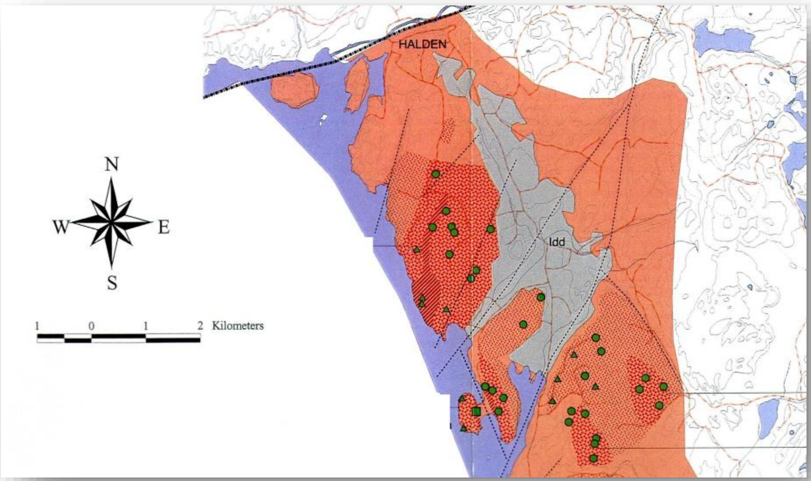


Figure 1. The three perspectives that should form the content of the IP for Natural stone.

"**Deposits and quarries**" includes information about geology and extraction. Stone exploitation through different historical periods follow geological units, and by combining information about the geology (geological maps and rock characteristics) with quarrying activity and history, it is possible to make an inventory of key geological units of significance on local, national and European scale.

The geological surveys are the keepers of relevant data, and thus the ones that can develop a harmonised and comparable display of the diverse stone resources in Europe.



Example of map displaying quarries (green points), geological unit (red) and qualities within (nuances of red) in a granite production area14

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14 Gautneb, H., Øvereng, O. & Heldal, T. (1999) Granittforekomster i Halden Kommune, Geological Survey of Norway report 99,061.

The use of stone is partly about where and when specific stones have been and are presently applied for architectural and structural purposes, and partly about the quality-in-use (durability, physical and chemical properties).

Regarding the use distribution pattern of stones in different periods, the sources of information are fragmented and poor. Several geological surveys have published “city-walks” and similar guides disseminating the use of stone in cities and regions151617. Through the ASMOSIA organization18, several studies of the stone use and distribution in Antiquity have been published in proceedings and other books. The IUGS subcommittee Heritage Stone has published several volumes in international journals19. In some countries (such as Sweden20, UK21) cooperation between geological surveys and heritage authorities has resulted in regional or national inventories. Through the Adriatic IPA CBC Programme Project RoofOfRock - Limestone as the common denominator of natural and cultural heritage along the karstified part of the Adriatic coast, Slovenia, Italy, Croatia and Bosnia and Herzegovina established a joint platform for platy limestone valorisation (http://www.roofofrock.eu/publication/). One of the most However, there is no harmonised approach, methodology or common framework for such. Neither is there any access to such data on a European scale.

A key challenge in the EuroLithos project is to create a framework for an information repository providing access to information about use patterns for European stones. Collectively, the partners have much experience in providing such on a regional or national scale. Key stakeholders will be heritage authorities.

Regarding quality aspects, modern use of stone basically relies on two sources of information: performance in use and a range of standardized characterization and testing methods (CEN, ISO, ASTM). The information is usually provided by the supplier to the buyer. Although there are some commercial directories on a national and international scale (i.e. British Isles22), the most comprehensive is the *Deutsches Natursteinarchiv* mentioned above. EuroLithos will explore the needs and possibility for linking such information to the geological provinces, in order to provide geological stone provinces with a “quality identity card”. Key stakeholders are stone industry companies and federations, EuroRock and stone testing labs.

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15 Castaño de Luis, R. 2011: *Fósiles urbanos de León; Recorridos paleontológicos desde el Campus de Vegazana hasta el Albéitar*, Universidad de León, Oficina Verde, 78 pp.

16 Novak, M. 2016: *A geological tour of Ljubljana : natural stone in cultural monuments*. Municipality of Ljubljana, Department for environmental protection, 37 pp.

17 Mobile and/or web applications: Paleourbana, TOURinSTONES, Geoguide Rome, Geoguide Lausanne, Trieste Itinerary: Geo-paleontological Route in the city, Geološka šetnja Zagrebom, LondonPavementGeology).

18 ASMOSIA: Association for the Study of Marble & other Rocks used in Antiquity (www.asmosia.org)

19 Geological Society Special Publications, 407. Global Heritage Stone: Towards International Recognition of Building and Ornamental Stones; Episodes 38-2. Global Heritage Stone Resource. An update; Geoscience Canada 43-1. Heritage Stones of the World; Geosciences Review, 2016: The value of original natural stone in the context of architectural heritage.

20 Sundner et al. (1996) Stenen i Tiden från 1000-talet til 1940. Riksantikvarieämbetet, Stockholm, Sweden.

21 Straegic stone study (https://www.bgs.ac.uk/mineralsuk/buildingStones/StrategicStoneStudy/EH_project.html)

22 Natural stone directory UK and Ireland

Stone heritage values basically concerns information of relevance for establishing the importance of stone resources and quarry areas for built heritage, cultural landscapes and craft traditions.

Historic quarry landscapes may have *intrinsic* value, as landscapes displaying man's interaction with stone as a material through historical periods. Eurolithos will build on methodology and description systems developed in the FP6 project QuarryScapes, and develop guidelines for how this can be addressed on different scales in Europe.

Stone provinces and quarries have important values related to their use in built heritage; from monumental constructions and cities, to local housing and walls characterising cultural landscapes. The need for authentic replacement stone for restauration and/or stone for maintaining the aesthetic quality of i.e. historic city centres is urgent, and too often the information of such is lacking or the quarries are sterilized. EuroLithos will create guidelines and methods for how to assess such values of stone deposit areas and how to achieve the necessary information.

Traditional stone production is strongly linked to craft traditions, which are as diverse as the geology. For instance, the craft developed in one particular slate deposit may be completely useless in another. If GI ever will be possible for natural stone production, crafts will be one of the key qualifying factors. EuroLithos will, based on case studies, develop a framework on how to describe and compare craft traditions.

The key stakeholders regarding heritage values are cultural heritage authorities, restoration workshops and the IUGS subcommittee "Heritage Stone".

Example of a marble quarry landscape of high intrinsic value: Aliki, Thasos, Greece, quarried from the ancient Greek period through to the Bysantine Period.

1.2 Ambition

State-of-the-art on information about European natural stone resources can be summarized:

- National databases owned by the geological surveys on the distribution of quarries and deposits in various detail. In most cases, there is no display of geological units/provinces linked to quarries
- Basic information from national databases displayed through Minerals4EU
- Fragmented inventories (national and regional scale) on natural stone and heritage
- Fragmented directories of natural stone properties, and none linked to provinces/quarry regions

Our main ambition is to improve the quality and extent of information and lift it to a European level, by

- Enhancing and harmonising the amount of spatial information provided by national surveys to the information platform
- Create a framework for a directory of natural stone properties linked to geological units
- Create best practice documents from case studies
- Create a set of guidelines for industry and decision makers on how to assess values of stone deposits and types
- Introduce an Atlas of European stones (description system), including templates and national cases.

Limitations

Only approximately 1/3 of the European countries have partnership in the project. This is in itself a strong limitation. Moreover, the project has limited resources available. Thus, our ambition is not to make a comprehensive, European database, but rather frameworks, systems and show-cases that easily can be expanded to a pan-European scale.

This raises some further issues. Although the geological surveys gradually can fill in the spatial datasets needed based on templates and procedures developed by EuroLithos, the future success of the natural stone IP will probably depend on the possibilities for other stakeholders to actively use the IP and contribute with data. This will create technical challenges and need for specific liaison with the RM5.

The project will address particular issues that are uniquely related to natural stone. We have chosen to not make particular efforts on environment and footprints, with the exception of what is described below under “Impact”. There are several reasons for this: 1) since natural stone production is about formatting rock (and not use much energy for crushing them and even more for putting the crushed rock together for making something reminding the original rock) we consider that energy consumption is covered by the perspective of the project. 2) This will also apply for transport. 3) Waste handling is a big issue in most mining activities including ornamental stone, but due to budget limitations the project cannot deal with it.

2 Impact

2.1 Expected impact

Impacts described in the RM2 scope:

Improved knowledge-sharing across Europe through a common understanding of Europe's raw material sources and an increased understanding of Europe's construction raw material deposits as a prerequisite to supplying Europe's construction raw material needs

By lifting knowledge from national to European levels, and providing solutions for harmonised and comparable data, the project will improve cross-European knowledge sharing. Accompanied by guidelines the project will also contribute to a common understanding of European natural stone resources, their value and significance, and create a platform for further development.

When it comes to European supply, natural stone is not among the critical raw materials, and theoretically, Europe may survive well by using concrete and imported stone for future construction. However, a lot of values will be lost on the way; heritage, crafts and traditions. "Raw material needs" is not just a quantitative measure, regarding stone it is primarily qualitative. For a community, the closure of the last local stone quarry may be critical enough, causing loss of both heritage values and economic development.

Contribution to environmental friendly raw materials production

Key factors of importance to the environmental performance of natural stone production are transport and energy consumption.

Since the project seeks to provide methods and information that can facilitate the process of including other aspects than price in, for example, tenders, it will be of benefit to regional and local stone industries. This will imply that such SMEs' can strengthen their market position, particularly in the rural areas of Europe. The project will in this respect provide tools for the SME's themselves (i.e. historical importance of their stone, their craft) and to the decision makers (using heritage values and/or geological information more actively in tenders). It is our view that these factors will stimulate a higher awareness of local and regional sources of stone, and consequently, reduce transport distances.

The project will not directly target energy consumption in natural stone production, but indirectly, we will claim that the upgrading of values related to local/regional sources and craft, contributes to improving the conditions for SMEs', and in general, small companies use smaller machines and more craft than big ones.

Provision of relevant information for the construction sector (including architectural and cultural heritage preservation) facilitating the conservation of Europe's national monuments, protected structures and the built environment in general

The project will make the world easier for those that are in charge of Europe's built heritage, and for those who want to develop business from that. It will not only provide information and guidelines on how to find and employ authentic sources, but also facilitate the search for alternatively "matching" sources in case the former is not available.

Stimulation of the consolidation of the cooperation and communication between national/regional subsurface organizations and European stakeholders that deal with spatial planning in relation to Energy, Mining and Urban Areas

One of the main focuses of the project is the spatial distribution of geological formations of importance to our built heritage. This alone will provide tools for spatial planning, where the weighing of significance for different land use is crucial. Moreover, a valorisation tool for the intrinsic value of quarries and quarry landscapes we believe is equally useful.

Other main impacts

The project will create a framework and an information platform that will meet many of the requirements that a future GI for non-agricultural products will bring. Thus, the project will facilitate the implementation of EC work on this task.

2.2 Measures to maximise impact

1.1.1 Dissemination and exploitation of results

Ornamental stone is a geological resource attracting interest from a diversity of sectors in the society, and also from the general audience. Being of such great importance for the quality of the every-day landscapes surrounding us, many people will at some stage have opinions of cases related to the use of stone.

EuroLithos will need to perform a dissemination strategy involving a certain degree of tailoring dissemination products to different kinds of audience. For the **general public**, we will provide showcases and information on the web displaying “exciting” aspects of ornamental stone. We will also develop promotion products, around the context of a European stone poster” (see WP2). We will also ensure that the atlas products will be attractive to the “interested audience”.

Eurolithos must relate to a diversity of **professional groups**, from industry and construction, to historians and architects. We have defined particular organizations and groups that we will give priority (see below). In addition to the website, newsletter and annual stakeholder day will be central in the dissemination activities. We will also engage in writing articles in professional magazines.

EuroLithos has a component of research, and we find it important to secure **scientific publication** from the project. This will at least involve a particular EuroLithos volume after the project end.

1.1.2 Communication activities

A key challenge in the project is the vast number of potential stakeholders. The ornamental stone industry is clearly important, but counting thousands of enterprises, most of them SME’s. We will approach Euroroc (European & International Federation of Natural Stone Industries) actively and seek cooperation. Euroroc consists of the national stone federations from most European countries. In addition, we will go directly to the national federations within the partner countries.

Stakeholders related to land-use planning define an even larger and more heterogenous group. Here, we will relate to national contacts from each of the partners, and liaison with the MINLAND project.

Yet even more complicated is the groups of stakeholders involved in decisions about selecting stone for buildings. We have chosen to focus on two: architect organisations and state building enterprises. The latter is present in most countries, and are responsible for government buildings and to a large extent maintenance and restoration of the most important stone-built heritage. We will harvest the national entities within the partner countries.

The national cultural heritage authorities are important stakeholders. Several of the partners have active collaboration with these, and we will approach such authorities within the partner countries. In some countries, there are national or regional restoration workshops. We will also approach such in the partner countries.

The geological surveys of Europe (those that do not participate in the project) are also important stakeholders. We assume that links and information via Eurogeosurveys will make them regular “customers” on the project web.

Since the project is rather small, we cannot arrange meetings and workshops with all relevant stakeholders. Thus, we will exploit the significant national networks carried by the partners. Partly, the partners will communicate with the stakeholders in their own country, and partly we will distribute a regular newsletter. Within the first 6 months of the project, we will make an extensive mailing list for the newsletter, and the first will be distributed when the website is ready. The newsletter will also contain information about annual “stakeholder day” and how to attend. Moreover, the first newsletter will link to a questionnaire on the website for stakeholders to “give advice” to the project activities. The last newsletter will link to a questionnaire for evaluation of the project results and how to secure the “afterlife” and continuation of activities. All newsletters will link to stakeholder page where they can deliver comments and views.

2.3 Contribution of Project Proposal to the Information Platform or vice versa

EuroLithos will create input to the information platform of relevance to ornamental stone. This will include:

- Spatial data, including distribution of known and unknown resources, mining sites and districts, productive geological units/prospective areas. The data will be harvested from national databases.
- Spatial data on the use of ornamental stone (buildings, monuments, other). The data entries should be made centrally
- Database on specific stone types (directory of ornamental stone properties) including “identity card” for ornamental stone types. The data entries should be made centrally.
- Archive of national atlases of ornamental stone
- Archive of guidelines and case studies

The description of the data and requirements to the IP will be ready month 6.

From the IP, we will expect:

- Technical development and design of pilot ornamental stone directory database, and help during testing for final solution
- Adaption and technical solutions for the spatial data of relevance to ornamental stone
- Repository for publications: atlas, guidelines and case studies

Eurolithos will in addition contribute to the UNFC work package RM1: making guideline for using UNFC G-axis on ornamental stone resources.

3 Implementation

3.1 Work Plan – Work packages, deliverables

(Set up a work-plan with work packages and deliverables, providing: - a brief presentation of the overall structure of the work plan; - timing of the different work packages and their components; - detailed work description, i.e.: description of each work package and deliverables (table 3.1a) and a list of work packages (table 3.1b). Include details of resources to be allocated to each workpackage).

The main products of EuroLithos will be developed in WP3, 4 and 5. These three WP’s addresses the main challenges; need for spatial data and “atlas” type information (WP3), need for a harmonised directory, or “identity card” for ornamental stone (WP4), and finally the need for assessing heritage values (WP5). It is practical and useful do divide the efforts in these three WP’s, exploring different aspects of ornamental stone resources.

WP6 represent the liaison with the IP. WP3-5 will feed into this, defining information types and requirements. WP6 will bridge the EuroLithos with the IP.

WP2 will communicate and disseminate the project results and efforts, and in particular create a good collaboration with stakeholders. Figure 2 shows the overall structure and workflow of the project, whilst Figure 3 shows a Gantt chart for WP's, tasks and deliverables.

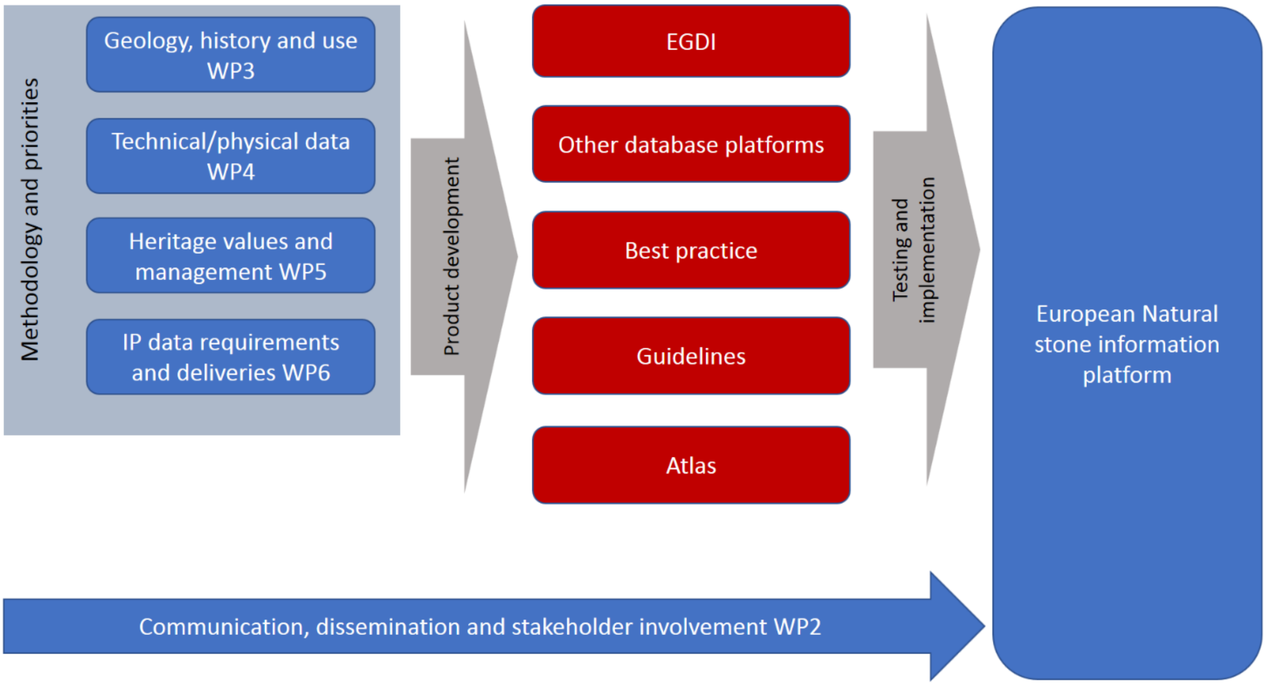


Figure 2. Structure and workflow of the EuroLithos project.

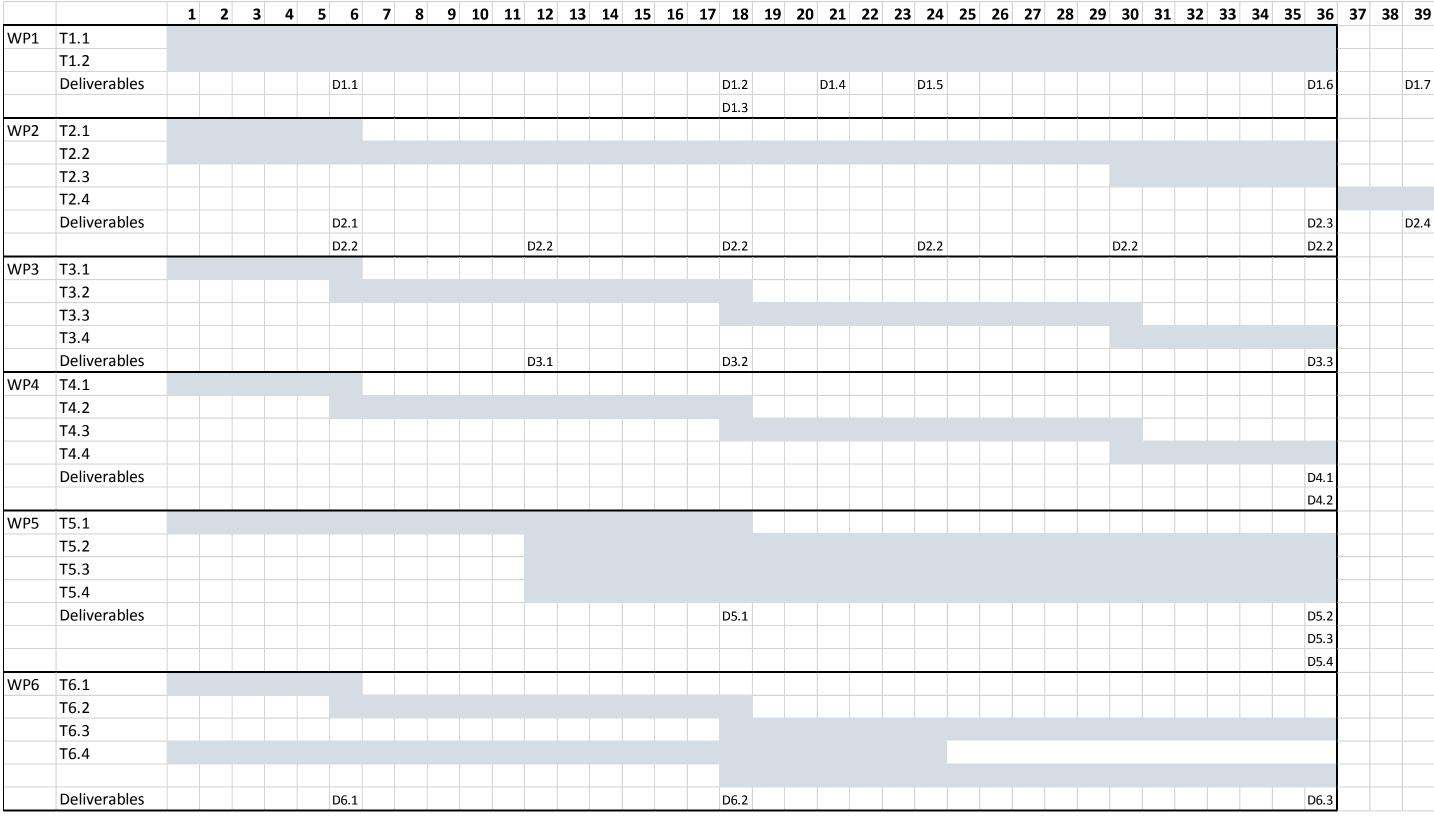


Figure 3. Gantt chart of work packages, tasks and deliverables.

Table 3.1a) Work package description

Work package number	1	Lead beneficiary			**NGU**	
Work package title	Project management					
Participant number	**1**					
Short name of participant	**NGU**					
Person months per participant	**2**					
Start month	1			End month	36	

Objectives The main objective of this WP is to secure a proper coordination and management of the project. This will include: Monitor and manage the progress and quality of the project achievements Ensure good coordination and communication between WP's and tasks Liaison with other GeoEra projects Manage the project financial issues and risks

Description of work T1.1 – project consortium meetings. The kick-off meeting will be in M1. Thereafter, annual meetings will be in M12 and M24, and last closure meeting in M36. T1.2 – Management and reporting. This will be carried out according to the GeoEra requirements.

Deliverables D1.1 - Cumulative expenditures report 1 (M6) D1.2 - Project Progress Report 1 (M18)

D1.3 - Cumulative expenditures report 2 (M18) D1.4 - Project review meeting presentation 1 (M21) D1.5 - Cumulative expenditures report 3 (M24) D1.6 - Final Project Progress Report 2 (M36) D1.7 - Project review meeting presentation 2 (M39)

Work package number	2	Lead beneficiary			**NGU**	
Work package title	Dissemination and communication					
Participant number	**1**	2	5	8	11	
Short name of participant	**NGU**	LNEG	IGME GR	GeoZS	GIU	
Person months per participant	**2**	0,5	1	0,5	2,5	
Start month	1			End month	36	

Objectives

The main objective of this WP is to ensure that the project and its results are disseminated and communicated to relevant audience and stakeholders. Moreover, to secure internal workflow and communication among the partners.

EuroLithos is relevant to a large number of stakeholders in different sectors of the society; industry, land-use planning, architects, local and regional administrations, historians, etc. It is a large challenge to design a dissemination strategy reaching these. We will try to solve this by putting extra effort into stakeholder communication with several tools.

Case studies, methods and practices that will be developed in the project deserve proper scientific publishing. Thus, we will create a volume of peer-reviewed papers from the project to be published after the project end.

The objective may be broken down to the following goals:

Establish and run a project web site

Identifying national and international stakeholders

Make and distribute a specific stakeholder newsletter

Include “stakeholder day” in annual project meetings

Make showcases and promotional products for the general audience

Provide aid to WP3 on layout and printing of atlas

Publish a volume of scientific papers from the project results

Description of work

T2.1 – Project Web site. This will contain information about the project and the results, and internal work rooms for the partners to ensure efficient writing and editing. The website will also display “showroom” where the partners can contribute with relevant examples of communicating ornamental stone, and we will make promotional products such as a European Ornamental stone poster. The website will preferably be a part of the GeoEra main site. M0-6

T2.2 – Stakeholder communication. The partners will collectively identify a large number of relevant stakeholders within the first 6 months of the project. A specific stakeholder newsletter will be sent regularly twice a year. The annual meetings will include a specific stakeholder day. Key stakeholders (such as European federations and organizations) will be more actively approached. M0-36

T2.3 – Printed Atlases; WP2 will provide layout and printing of atlases developed in WP3. M30-36

T2.4 – Volume of scientific papers will be made after the project end. Papers will be delivered by month 36 and assumed publication date will be Month 39.

Deliverables

D2.1 – Project web site M6

D2.2 – Stakeholder newsletter M6, 12, 18, 24, 30, 36

D2.3 – Printed atlases M36

D2.4 – Scientific volume M39

Work package number	3	Lead beneficiary				**LNEG**	
Work package title	Atlas of European Ornamental Stones						
Participant number	1	**2**	3	4	5	6	8
Short name of participant	NGU	**LNEG**	SGU	IGME Sp	IGME Gr	SGSS	GeoZS
Person months per participant	4	**10**	1,5	2	6	6	4
Participant number	9	10	11	12	13	14	15
Short name of participant	GBA	IGR	GIU	GSI	ISPRA	HGI-CSG	GSD
Person months per participant	3	7	3,5	4	5	4,2	1
Start month	1				End month	36	

Objectives

Europe has a great tradition in the exploitation and use of natural stones since antiquity, either by taking advantage of its structural functions for the construction of the most primitive edifications, or in some of the most beautiful art-pieces of Humanity, and their most common current use in building cladding and flooring. Therefore, ornamental stones are an almost unprocessed mineral raw material that is part of the daily life of the European people. Nevertheless, there is a general lack of knowledge about their provenance and short-, medium- and long-term available resources to meet current and future needs of Europe. On the other hand, that availability depends not only on the quantity of existing resources but also on the accessibility conditions for their exploitation.

With this in mind, the main objective of WP3 is to establish the framework and develop a first edition of an Atlas of European Ornamental Stones and to integrate this into the European Raw Materials Knowledge Base (EURMKB) in close connection with the GeoEra Information Platform.

The Atlas will be a science-based information system which will identify, collect and harmonize existing available data on the provenance of European Ornamental Stones, particularly on what respects the geology, available resources, prospective areas, quarrying sites and competing land uses with emphasises on those that may threaten or sterilize the resource. In addition, a directory of quarrying districts and sites will be established for the European Ornamental Stones.

Strong interconnections will be established with WP4 and WP5 in order to achieve coherent databases regarding the stones' provenance, their technical characteristics and specifications and associated heritage values.

The deliverables of this WP are designed to be fully integrated into the information platform and for this purpose harmonization needs regarding the integration of the ornamental stone resources into the international reporting codes will be discussed.

Description of work

T3.1 – Data inventory, descriptions and requirements for the IP. This task will feed into D6.1 (M0-6)

T3.1 - Establish the main guidelines for the Atlas content and respective modules. This task will be achieved in two steps. Firstly, a preliminary definition of the spatial data contents regarding the geology of the ornamental stone producing districts, productive geological units, mining sites and quarries, ornamental lithotypes, resources' availability assessments, land use planning and environmental issues, and other relevant spatial data and topics that should be considered. Secondly the description and analysis of the available data in each country partner from inputs received in T3.2 (Data Inventory). Inputs regarding harmonization needs have to be received from WP 6 (M6-18)

T3.3 – Make a template that will serve as guidelines to country-level Atlas. This implies selecting which information will be delivered at country-level, how it will be presented (maps, data sheets), in which kind of support (hard copy, digital), and how it will be delivered to the Information Platform (M18-30)

T3.5 – Production of country atlases, including best practice examples regarding:

- The geology of the current and relevant old/historic mining districts of ornamental stones, the productive geological units, and prospective areas.
- The location of the current and relevant old/historic ornamental stones mining districts, mining sites (clusters of quarries) or isolated quarries.
- Known ornamental stone deposits and available resources
- Land use planning constraints and threats (nature conservation areas, infrastructures, urban spreading, etc.) that are sterilizing ornamental stone deposits or may sterilize them (M30-36)

Deliverables

D3.1: Summary on the nature and type of available spatial data in each country partner and framework for the Atlas. Report M12

D3.2: Country-level and European-level Atlas templates for input of harmonized data. Report M18

D3.3: Country-level atlases and a European Atlas of Ornamental Stones. Printed and digital versions M36

Work package number	4	Lead beneficiary				**IGME Gr**					
Work package title	DIRECTORY OF ORNAMENTAL STONE PROPERTIES										
Participant number	1	2	3	4	**5**	7	8	10	11	13	15
Short name of participant	NGU	LNEG	SGU	IGME Sp	**IGME Gr**	RT	GeoZS	IGR	GIU	ISPRA	GSD
Person months per participant	2	4	1,5	3	**15**	1	3	6,9	2,5	4	4
Start month	1			End month	36						

Objectives

A key challenge in the selection of ornamental stones for construction or restoration purposes, is the lack of comparable information. There are requirements to be met on the performance of tests according to EN standards, but these do not provide enough or relevant information for the selection of stone for i.e. restoring historic monuments.

The main objective of this WP is to develop a European “identity card” for ornamental stone, providing basic information regarding their composition, physical properties and “performance in use” criteria. The “identity card” will form the core of a European directory (or database) of ornamental stone properties. While the Atlas will address the geological and geographical distribution of ornamental stone, the “identity card” will represent the technical characterization of each stone.

The first goal is to establish the content of the “identity card”, which properties to include and how to display them (template).

The second goal is to develop a pilot (aided by the IP) and finally establish a working directory for selected partner countries, accompanied by guidelines.

Description of work

T4.1 - Defining content of “identity card”/directory: this include the use of names and terminology, petrographic information, geological context, physical properties, performance criteria etc. The task will investigate and exploit existing standards and the need for additional data. This task will feed into the D6.1, definitions and requirements for the IP (M0-6).

T4.2 - Technical solution – making and testing pilot directory, establishing structure for data delivery and storage, and connection to Atlas and other databases. This task will be carried out in close cooperation with WP6 and feed into the D6.2, prototype of directory (M6-18)

T4.3 - Publishing the directory for selected partner countries. Creating pan-European databases with coordinated structure for data storage and comparability of their features. (M18-36). T4.4 - Guidelines for using the directory (M30-36)

Deliverables
D4.1: Working version of the directory containing information from selected countries M36 D4.2: Guideline for using the Directory M36

Work package number	5	Lead beneficiary			**Croatian Geological Survey (HGI-CGS)**	
Work package title	ORNAMENTAL STONE HERITAGE					
Participant number	1	2	4	5	7	8
Short name of participant	NGU	LNEG	IGME-Sp	IGME Gr	RT	GeoZS
Person months per participant	4	3	3	1	0,75	5
Participant number	10	11	12	**14**	15	
Short name of participant	IGR	GIU	GSI	**HGI-CSG**	GSD	
Person months per participant	6	2,5	1,5	**10**	1	
Start month	1			End month	36	

Objectives
Through millennia, ornamental stone resources have provided easy accessible materials for construction, art and tools. In Europe, stone is a key ingredient in the region's diversified and rich heritage, from the Neolithic to modern architecture. The numerous sites where stone resources have

been exploited are in themselves a rich heritage, displaying evidence of ancient technologies, trade and the development of our cities. Some stone resources have been exploited continuously for several thousand years, others only for short lived campaigns.

The stone resources are closely linked to the faces of our urban and rural landscapes. More than we acknowledge in our every-day surroundings, the local geology has been transformed into the buildings, streets and monuments that we appreciate, and in some cases it has been exported to distant places because of unique quality. To maintain the stone-built heritage and the cultural landscapes, the original sources of stone must be available, or at least, stones of similar quality and appearance. This makes a link between built heritage and stone resources highly important. Moreover, there are needs for tools for establishing such links and assess the importance of the stone resources for the built heritage. For example, the resources exploited in antiquity for trading across the whole Roman empire may be of European importance, whilst a quarry that has supplied stone for housing in a village have a local value.

The interaction between stone resources and humans has produced a rich and diversified immaterial heritage, namely crafts and skills. Although most modern quarries are industrialised and apply rather standardised technology, there are still examples of living, traditional crafts, doing it “the old way”. For restoration and cultural heritage maintenance, traditional skills may even be necessary. Moreover, some stone types (i.e. roofing slates) cannot be produced without applying traditional skills.

The main objective of this WP is to establish tools that can facilitate and aid the process of valorisation of stone resources. We believe that such tools will contribute to better maintenance of stone-built heritage, better conditions for SME’s and better protection of stone resources in land-use planning.

As described above, the tools will address three aspects of stone heritage; the intrinsic value of stone quarries and quarry landscapes, the value of stones from their use in stone-built heritage, and the traditional crafts. This will result in three guidelines, one on each aspect.

At least two case studies will be performed on each aspect, used for demonstrating, testing and illustrating the guidelines.

Description of work

T5.1 - Case studies illustrating the tasks below. Before the case studies, concepts and methodologies will be addressed, making the baseline for each group of case studies (M0-18)

T5.2 - Ornamental stone resource value assessment – including a framework for description and characterization of stone quarries and quarry landscapes, defining the best methodological practice to assess the values of such, and provide examples and practices for exploiting heritage values (i.e. tourism, education). The task will include at least two relevant case studies (M12-36).

T5.3 - Stone and built heritage – develop methods for practical inventories of stone resources and built heritage, including a framework for assessing the importance of stone types for maintenance, restoration and new construction. The task will include at least two relevant case studies (M12-36).

T5.4 - Stone and intangible heritage (crafts) – focused on the unitary designation and description of the immaterial crafts in a way that can be used in the heritage stone assessments. The task will include at least two relevant case studies (M12-36)

Deliverables

D5.1: Case study collection. Report M18

D5.2: Best practices and guideline: How to assess values of stone types, quarries and quarry landscapes (including glossary of terms). Guideline M36

D5.3: Best practices and guideline: How to do inventories of links between stone resources and built heritage. Guideline M36

D5.4: Best practices and guideline: how to approach crafts for value assessments (code of protection for safeguarding of the intangible heritage natural stones). Guideline M36

Work package number	6	Lead beneficiary			**NGU**	
Work package title	LINK TO INFORMATION PLATFORM					
Participant number	**1**	2	5	8	11	
Short name of participant	**NGU**	LNEG	IGME Gr	GeoZS	GIU	
Person months per participant	**4**	2~~0~~,5	1	0,5	2,5	
Start month	1			End month	36	

Objectives

RM2 challenge:

Europe has a rich heritage of monuments and buildings of world and national importance, which require maintenance. Yet, the level of information on ***occurrence****,* ***distribution****,* ***quality*** *and* ***quantity*** *of the original building material is variable and scattered throughout Europe. In addition, an increasing interest in cultural heritage preservation and stone for building purposes may produce an increasing requirement for specific raw materials with particular properties (physical, mechanical and chemical).*

EuroLithos will provide an information structure covering the aspects described in the challenge.

From the RM2 scope:

Tools and protocols for the assessment and comparison of deposits using standard criteria (e.g. geological, physical, mechanical, chemical, historical and aesthetic) should be developed and established while classification and standard codes for the classification of resources need to be considered. Results should be summarized, harmonized and accessible so that planning and environmental regulations are met (i.e. land-use planning requirements).

The main objective of this WP is to secure the integration of the information structure generated by EuroLithos with the Information Platform. In addition, the WP will contribute to RM1 with an assessment of UNFC G-axis applicable to ornamental stone resources.

The main objective can be broken down to the following goals:

- identify and discuss requirements in close dialogue with the Information platform (IP) team.
- ensure that the principles and guidelines provided by the IP-project is followed and implemented.
- Facilitate the development of database (directory of natural stone properties) and digital archives through necessary integration with the IP-project
- Define spatial data types (based on INSIRE and Minerals4EU templates) of relevance to ornamental stone resources and land-use planning and deliver a pilot version from selected partners
- Assess the use of UNFC geology axis for ornamental stone resource classification

Description of work

The tasks in this WP described below, will ensure that the requirements of this project are fully understood and considered in the IP-project. A dedicated collaboration structure coordinated though this WP toward the IP-project WP1, will be established at an early phase (M0-1).

The following tasks will be carried out:

T6.1 - IP Requirements: this task will define and describe data types and requirements for the IP. It will be carried out in close interaction with the IP project. (M0-6)

T6.2 - Prototyping: his task will basically include liaison and communication with the IP for developing prototypes of databases and archives. (M6-18)

T6.3 - Testing and implementation: this task will, in close collaboration with the IP, conduct necessary testing and evaluation of technical solutions in order to move from prototypes to implementation (M18-36)

T6.4 - UNFC on ornamental stone resources: this task will develop a framework for applying UNFC geological resource classification for natural stone (M0-24)

Deliverables

D6.1: Definitions and requirements for the IP. Report M6

D6.2: Evaluation of IP prototypes. Report M24

D6.3: Application of UNFC for ornamental stone resources. Report M24

Table 3.1b) List of work packages

Work package No.	Work Package Title	Lead Participant No.	Lead Participant Short Name	Person - Months	Start Month	End month
1	Project management	1	NGU	2	1	36
2	Dissemination and communication	1	NGU	7	1	36
3	Atlas of European Ornamental Stones	2	LNEG	63,45	1	36
4	Directory of ornamental stone properties	4	IGME Gr	48,15	1	36
5	Ornamental Stone heritage	14	HGI-CSG	37	1	36
6	Link to information platform	1	NGU	~~8~~10,5	1	36
				168,1		

Table 3.1c) List of deliverables

Deliverable number	Deliverable name	Work package number	Short name of lead participant	Type	Dissemination level	Delivery date (in months)
D1.1	Cumulative expenditures report 1	1	NGU	Report	Administrative	6
D1.2	Project Progress Report 1	1	NGU	Report	Administrative	18
D1.3	Cumulative expenditures	1	NGU	Report	Administrative	18

	report 2					
D1.4	Project review meeting presentation 1	1	NGU	Presentation	Administrative	21
D1.5	Cumulative expenditures report 3	1	NGU	Report	Administrative	24
D1.6	Final Project Progress Report 2	1	NGU	Report	Administrative	36
D1.7	Project review meeting presentation 2	1	NGU	Presentation	administrative	39
D2.1	Project web site	2	NGU	Website	General	6
D2.2	Stakeholder newsletter	2	NGU	Newsletter	General	6-36
D2.3	Printed atlases	2	NGU	Booklets	General	36
D2.4	Scientific volume	2	NGU	Book	Scientific	39
D3.1	framework for the Atlas	3	LNEG	Report	Professional	12
D3.2	Country- and European-level Atlas templates	3	LNEG	Report	Professional	18
D3.3	Country-level atlases	3	LNEG	Publication	General	36
D4.1	Working version of the directory containing information from selected countries	4	IGME Gr	Database	Professional	36
D4.2	Guideline for using the Directory	4	IGME Gr	Guideline	General	36
D5.1	Case study collection	5	HGI-CGS	Report	Professional	18
D5.2	Best practices and guideline: How to assess values of stone types, quarries and quarry landscapes	5	HGI-CGS	Guideline	General	36
D5.3	Best practices and guideline: How to do inventories of links between	5	HGI-CGS	Guideline	General	36

	stone resources and built heritage.					
D5.4	Best practices and guideline: how to approach crafts for value assessments	5	HGI-CGS	Guideline	General	36
D6.1	Definitions and requirements for the IP		NGU	Report	Professional	6
D6.2	Evaluation of IP prototypes		NGU	Report	Professional	24
D6.3	Application of UNFC for ornamental stone resources		NGU	Report	Professional	24

3.2 Management structure, milestones and procedures

Since the project is quite small, we aim at designing a simple and efficient management structure (Figure 4 and time schedules Figure 5).

The project Lead is Tom Heldal, Geological Survey of Norway.

The Steering Committee is composed by the Project Lead and 3 additional WP Leaders. They will be monitoring the progress of the project activities and meet with three months intervals. The steering committee will be responsible for finding solutions to any delays or deviations from the work plan, and for any necessary actions. It will also decide on minor budget issues, approve progress reports and prepare for general assemblage meetings. The steering committee will manage and organize stakeholder dissemination and communication efforts. It will also be responsible for final approving of deliverables. In case of disagreements, decisions will be made by simple majority. The Project lead will have two votes, the WP leaders one each.

The general assembly (16 partners) will meet annually, but may be called for making decisions per email or skype-meetings in between. At the Kick-off meeting, the general assembly will decide detailed responsibilities for tasks and deliverables within the WP's. It will contribute to evaluate deliverables in a two weeks period before deadline, and will be responsible for making decisions on issues that the Steering Committee chose to present to the General Assembly. In case of disagreements, decisions in the General Assembly will be made by 2/3 majority.

The WP leaders are responsible for all tasks and deliverables in the WP. The Steering Committee will, after advice from the general assembly at the kick-off meeting, decide the more detailed responsibilities on tasks and deliverables.

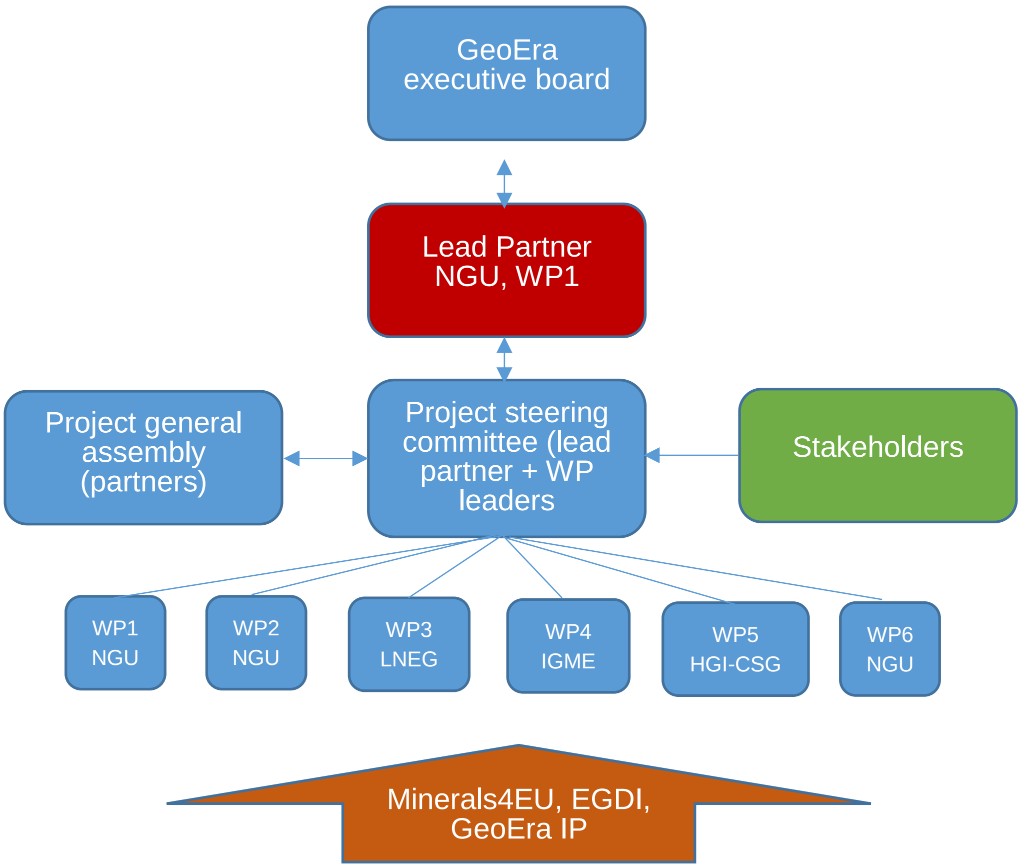


Figure 4. Management structure of EuroLithos

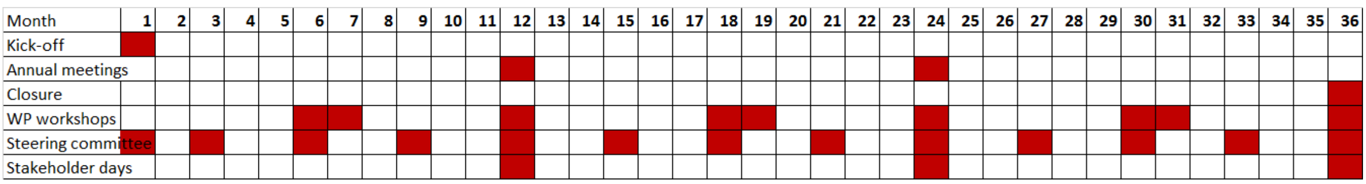


Figure 5. Meeting schedule for EuroLithos.

Table 3.2a) List of milestones.

Milestone number	Milestone name	Related work package(s)	Due date (in months)	Means of verification
M1	Kick-off meeting	1	1	Minutes
M2	Case studies selected	5	3	
M3	Requirements for the IP	3,4,5,6	6	Reports
M4	Annual meeting 2019	all	12	Minutes
M5	Prototype portal	3,4,5	18	
M6	Annual meeting 2020	All	24	Minutes
M7	Case studies completed	3,4,5	24	
M8	Results available through GeoEra	All	36	
M9	Final meeting	All	36	Minutes
M10	Scientific publication	All	39	

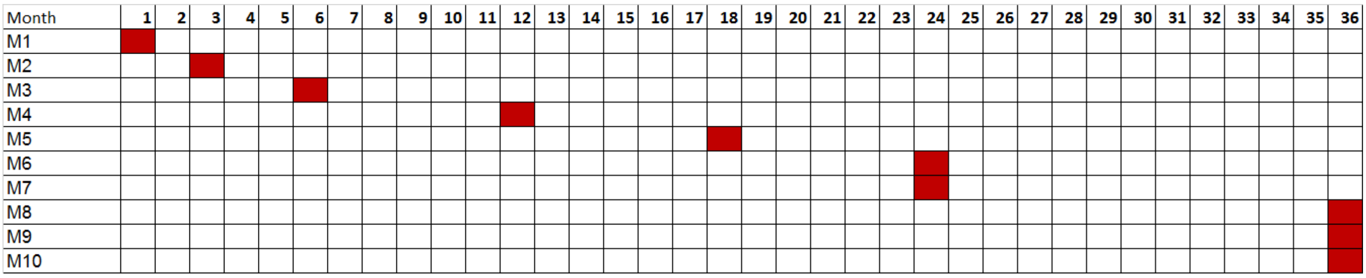


Figure 6. Gantt diagram of milestones.

Table 3.2b) List of critical risks for implementation (This table is not covered by the page limit)

Description of risk (indicate level of likelihood: Low/Medium/High)	Work package(s) involved	Proposed risk-mitigation measures
General lack of fulfilment of objectives and goals (medium)	All	Risk analyses, diagnosis and monitoring routines will be addressed at the Kick-Off meeting. The Steering committee will address risks in their meetings and monitor the progress of the tasks and deliverables.
Financial risks (low)	All	The lead partner will establish a robust system for financial reporting and monitoring.
Partner withdrawal (medium)	All	Will be regulated in the Consortium Agreement
Failure off technical solutions (medium)	WP6	This mainly relate to potential technical problems with prototypes and other solutions made in

		collaboration with the IP. We will meet this by having a close and regular communication with IP, and propose regular and short meeting itervals during the most critical periods (M0-M18)

3.3 Consortium as a whole

The EuroLithos project will be run by a strong and representative consortium. 16 partners in 14 countries, collectively cover all the areas of interest in the project. Moreover, most of them have a strong national or regional record of projects related to ornamental stone. 14 of them carry the role of national geological surveys, and thus have national responsibilities on databases and such (data providers). Most of the partners have experience in European projects.

From the 16 partners, 57 scientists and technicians will be involved in the project, 38 male and 19 female. The coordinator has long international experience in relevant activities, and did coordinate an FP6 project on the heritage value of stone quarry landscapes. It is our conclusion that the consortium is highly competent and collectively represent a unique opportunity for lifting ornamental stone from national to European platforms.

3.4 Resources to be committed

Table 3.3a) Summary of Staff Effort (This table is not covered by the page limit)

SHORT NAME	WP1	WP2	WP3	WP4	WP5	WP6	TOTAL PM's PER PARTICIPANT
1 NGU	2	2	4	2	4	4	18
2 LNEG		0.5	10	4	3	2.5	20
3 SGU			1.5	1.5			3
4 IGME			2	3	3		8
5 IGME Gr		1	6	15	1	1	24
6 SGSS			6				6
7 RT			1.5	1	0		2.5
8 GeoZS		1	4.5	4	5	0.5	15
9 GBA			3				3
10 IGR			7	6.9	6		19.9
11 GEOINFORM		2.5	3.5	2.5	2.5	2.5	13.5
12 GSI			4		1.5		5.5
13 ISPRA			5	4			9
14 HGI-CSG			4.2		10		14.2
15 GSD			1	4	1		6
16 SGL			0.25	0.25			0.5
TOTAL PM's	2	7	63.45	48.15	37	10.5	168.1

Table 3.3b) 'Other direct cost' items (travel, equipment, other goods and services)

1 NGU	Cost euro	Justification
Travel	15000	Meetings, travels *10
Equipment		
Other goods and services	10000	Layout and printing costs, publications
Total	25000	

2 LNEG	Cost euro	Justification
Travel	14400	Meetings, travels *9
Equipment		
Other goods and services		
Total	14400	

3 SGU	Cost euro	Justification
Travel	3200	Meetings, travels *2
Equipment		
Other goods and services		
Total	3200	

4 IGME	Cost euro	Justification
Travel	9600	Meetings, travels *6
Equipment		
Other goods and services		
Total	9600	

5 IGME Gr	Cost euro	Justification
Travel	14400	Meetings, travels *9
Equipment		
Other goods and services		
Total	14400	

6 SGSS	Cost euro	Justification
Travel	950	Meetings, travels *2
Equipment		
Other goods and services	2600	support data entry
Total	3550	

7 RT	Cost euro	Justification
Travel	1200	Meetings, travels *2
Equipment		
Other goods and services		
Total	1200	

8 GeoZS	Cost euro	Justification
Travel	3000	Meetings, travels *3
Equipment		
Other goods and services		
Total	3000	

9 GBA	Cost euro	Justification
Travel	3000	Meetings, travels *3
Equipment		
Other goods and services		
Total	3000	

10 IGR	Cost euro	Justification
Travel	5440	Meetings, travels *4
Equipment	0	Stationery, birotics, maintenance, training etc.)
Other goods and services	500	
Total	5940	

11 GEOINFORM	Cost euro	Justification
Travel	6500	Meetings, travels *3
Equipment		
Other goods and services		
Total	6500	

12 GSI	Cost euro	Justification
Travel	€4 000	Meetings, travels *5
Equipment	€0	
Other goods and services	€500	Miscellaneous (photography, stationery etc.)
Total	€4 500	

13 ISPRA	Cost euro	Justification
Travel	3000	Meetings, travels *3
Equipment		
Other goods and services		
Total	3000	

14 HGI-CSG	Cost euro	Justification
Travel	5000	Meetings, travels *5
Equipment		
Other goods and services	4800	WP5; printing of publications
Total	9800	

15 GSD	Cost euro	Justification
Travel	3870	Meetings, travels *5
Equipment		
Other goods and services	0	
Total	3870	

16 SGL	Cost euro	Justification
Travel	750	Meetings, travels *1
Equipment		
Other goods and services	0	
Total	750	

Table 3.3c) Financial table with requested budget

Participant	(A) Direct personnel costs	(B) Other direct costs; travel, equipment, infrastructure, other	(C) Direct costs of subcontracting	(D) Indirect costs (= (A + B) *0,25)	(E) Total estimated eligible costs (=A+B+C+D)	(F) Reimbursement Rate (29,7%)	(G) Requested EU contribution (=E*F)	(H) Surveys in-kind contribution = (E-G)
1 NGU	135 000	25 000		40 000	200 000	29.7	59 400	140 600
2 LNEG	80 540	14 400		23 735	118 675	29.7	35 246	83 429
3 SGU	22 350	3 200		6 388	31 938	29.7	9 485	22 452
4 IGME	41 200	9 600		12 700	63 500	29.7	18 860	44 641
5 IGME Gr	74 400	14 400		22 200	111 000	29.7	32 967	78 033
6 SGSS	25 770	3 550		7 330	36 650	29.7	10 885	25 765
7 RT	8 490	1 200		2 423	12 113	29.7	3 597	8 515
8 GeoZS	52 500	3 000		13 875	69 375	29.7	20 604	48 771
9 GBA	16 200	3 000		4 800	24 000	29.7	7 128	16 872
10 IGR	30 348	5 940		9 072	45 359	29.7	13 472	31 888
11 GEOINFORM	65 232	6 500		17 933	89 665	29.7	26 631	63 034
12 GSI	35 750	4 500		10 063	50 313	29.7	14 943	35 370
13 ISPRA	49 500	3 000		13 125	65 625	29.7	19 491	46 134
14 HGI-CSG	102 240	9 800		28 010	140 050	29.7	41 595	98 455
15 GSD	25 806	3 870		7 419	37 095	29.7	11 017	26 078
16 SGL	3 250	750		1 000	5 000	29.7	1 485	3 515
Total	768 576	111 710		220 071	1 100 357		326 806	773 551

4 Members of the consortium (This section is not covered by the page limit)

4.1 Participants (applicants)

2 Partner 1 (Project Lead). NORGES GEOLOGISKE UNDERSØKELSE NGU, Geological Survey of Norway

Overall description of Survey Organisation
GEOLOGICAL SURVEY OF NORWAY, founded in 1858, is a government agency under the Ministry of Trade, Industry and Fisheries (NFD). NGU shall actively contribute to ensuring that geoscientific knowledge is utilized for the effective and sustainable management of the nation's natural resources and environment. NGU provide services and information within a large range of geoscience subjects, such as mineral resources (metals, industrial minerals, natural stone and aggregate), geological hazards, environmental issues, marine geology, regional geophysics and land use planning. NGU provides databases on mineral and aggregate resources to Norway's national information infrastructure and to the European mineral resource data platforms. NGU has participated in several European projects aimed at harmonizing data sets across borders, to the benefit of national and international land use planning, and industrial development and innovation. NGU has 200 employees, of which approximately 65% are scientists.

Products and services
NGU works to identify and evaluate potential deposits of industrial minerals, ores, natural stone and aggregate which may be of future economic significance. The user target is industry, public administration, and other stakeholders. Information is gathered and stored in NGUs mineral resource databases which are accessible through www.ngu.no and www.prospecting.no. NGU uses mineralogical and geochemical techniques for the characterization of mineral resources and has a well equipped laboratory for both mineral and rock characterization.

Relevant Publications

Partner	Type	Reference
NGU	Service	2017, Metals, industrial minerals and natural stone database http://geo.ngu.no/kart/mineralressurser_mobil/?lang=eng
	Publication	Heldal, T. (2009): Constructing a quarry landscape from empirical data. General perspectives and a case study at the Aswan West Bank, Egypt. In: Abu-Jaber, N., Bloxam, E.G., Degryse, P. & Heldal, T. (eds.): QuarryScapes: ancient stone quarry landscapes in the Eastern Mediterranean. Geological Survey of Norway Special Publication 12, 125-155,
	Publication	Heldal T and Meyer GB. (2011). The rise and fall of the Hyllestad millstone quarry landscape, Western Norway. Williams D and Peacock D, editors. In: Bread for the people: The archaeology of mills and milling. Archaeopress. 325 p.

	Publication	Heldal, T. and Meyer, G. (2014) Assessment of Ancient Stone Quarry Landscapes as Heritage Sites. In Lollino, G., Giordan, D., Marunteanu, C., Christaras, B., Yoshinori, I. and Margottini, C. (eds) Engineering Geology for Society and Territory – Volume 8 Preservation of Cultural Heritage. Proceedings of the XII International IAEG Congress, Torino 2014, Springer, 253-257
	Publication	Heldal, T., Meyer, G. and Dahl, R. (2014) Global stone heritage: Larvikite, Norway. In: Pereira, D., Marker, B. R., Kramar, S., Cooper, B. J. and Schouenborg, B. E. (eds) Global Heritage Stone: Towards International Recognition of Building and Ornamental Stones. Geological Society, London, Special Publications, 407, doi:10.1144/SP407.14

Involvement in other relevant European and national projects

Partner	Type of project/activity	Description
Pan-European + Eastern Mediterranean	FP6 Project	QuarryScapes; conservation of ancient stone quarry landscapes in the Eastern Mediterranean (Coordinator 2005-2009)
Pan-European	FP7 project	Minerals4EU; Pan-European data portal on mineral resources (2013-2015)
Pan-European	H2020 project	MinFuture, Ongoing; Global material flows and demand-supply forecasting for mineral strategies
Pan-European	H2020 project	MINLAND, ongoing. Mineral resources in sustainable land-use planning
Norwegian	Norwegian Research Council	Millstone; The Norwegian Millstone Landscape (quarry landscapes)

Profiles of key staff members

Tom Heldal (male) is the Director of the Georesources and Environment division at the Geological Survey of Norway. He is a geologist, educated (MSc) from the University of Bergen in 1987. Heldal has been working with different issues related to mineral resources for many years, particularly natural stone. He has more than 40 peer-reviewed papers on the subject. Heldal has been coordinating an FP6 project and has been involved in UNFC working groups on both national and Nordic scale.

Kari Aslaksen Aasly (female) is heading the Natural Construction Materials team at the Geological Survey of Norway. She is an economic geologist, educated (MSc) from the Norwegian University of Science and Technology in Trondheim in 2000. Aasly has been working with different issues related to natural construction materials, both hard rock aggregates and natural stone. She has been involved in the Nordic UNFC working group.

Gurli Birgitte Meyer (female) is a scientist in the Natural Construction Materials Team at the Geological Survey of Norway. Meyer is an experienced researcher in igneous petrology and economic geology educated (PhD) from the University of Aarhus in 1999. She has experience in exploration, surveying and mineralogical analysis and has participated in several national and international projects related to mineral resources and geoheritage.

Jakob Kløve Keiding (male) is a senior scientist at the Geological Survey of Norway. He is an igneous petrologist educated (PhD) from the University of Aarhus, Denmark in 2007. Keiding has extensive field experience with a focus on geological mapping and sampling, and has conducted fieldwork in Namibia, South Africa and the Arctic area (Norway, Iceland and Greenland). He has a divers geological background on petrology, geochemistry, construction materials and economic geology. Relevant current projects include research on micro-fractures' influence on rock quality and assessment, characterization and mapping of Norwegian ornamental stone resources.

Cyprien Habimana (male), MSc Management (National University of Rwanda 1978) is a senior adviser in the HR and Resources Management division at the Geological Survey of Norway. He has been the Project Administrative Officer of all EU Projects NGU has been involved in since 2006. He acts also as the Legal Entity Appointed Representative (LEAR) for the Geological Survey of Norway.

3 Partner 2, LABORATORIO NACIONAL DE ENERGIA E GEOLOGIA I.P., LNEG

Overall description of Survey Organisation

LNEG is an R&D institution oriented to respond to the needs of society and enterprises. Betting on a sustainable research and for sustainability through the generation of knowledge of our territory. Side by side with what´s best done internationally, LNEG guarantees to have in its areas of competence an adequate response to the needs of the business sector. We do Science in energy and geology with a view to its application in advanced solutions for leveraging our economy. The Portuguese National Laboratory for Energy and Geology (LNEG) is a State laboratory of the Ministry of Economy that makes R&D oriented to the needs of society and enterprises, investing in a sustainable research, along with the international best practices, ensures that its areas of expertise allow an adequate response to the needs of the business sector. LNEG is aware that cooperative work and networking can optimize skills and that knowledge sharing is a tool for success, so it is an active partner of the major networks and collaborative platforms in the areas of energy and geology. LNEG´s mission is to promote technological innovation science and technology oriented for economic development contributing to increase competitiveness of economic agents in the context of sustainable progress of the Portuguese economy.

Products and services

The Department of Mineral Resources and Geophysics (URMG) of LNEG, which participates in the project, is one of the largest of the institution and includes the areas of Geophysics and Mineral Resources where the main scientific capacities are in metallic mineral resources, ornamental stones, and ceramic raw materials.

Relevant Publications/services

Partner	Type	Reference
LNEG	Service	Ongoing: Geoportal, http://geoportal.lneg.pt/
LNEG	Service	Ongoing: Database on Portuguese Ornamental Stones, http://rop.lneg.pt/rop/index_en.php
LNEG	Product	2008, Atlas, Cartografia Temática do Anticlinal - Zona dos Mármores. (Paper Edition)
LNEG	Product	2000, Book, Granitos e Rochas Similares de Portugal. http://www.lneg.pt/download/7255/index.html
LNEG	Product	2006, Book, Mármores e Calcários Ornamentais de Portugal, http://www.lneg.pt/download/7310/index.html

Involvement in other relevant European and national projects

Partner	Type of project/activity	Description
LNEG	Project 1	OSNET –Thematic Network on Ornamental and Dimensional Stones, funded by the European Commission, under the Competitive and Sustainable Growth Programme.
LNEG	Project 2	EuroGeoSource - Data portal, which allows access by Internet to the aggregated geographical information on geo-energy and mineral resources.
LNEG	Project 3	Minerals4EU – EU Mineral intelligence network structure providing data, information and knowledge on mineral resources around Europe.
LNEG	Project 4	MINATURA2020 – Aimed to define Mineral Resources of Public Importance and how to safeguard them in land use planning across Europe
LNEG	Project 5	Project FCT (Science and Technology Foundation) PTDC/CTE-GIN/70704/2006 (SCHISTRESOURCE) - From 01-10-2007 to 30-03-2011.
LNEG	Activity 1	Cluster da Pedra Natural – Portuguese Natural Stone Cluster aimed to technology transference and cooperation between ornamental stone companies and R&D institutions as a way to increase the productivity and competitiveness of the Portuguese ornamental stones sector

Relevant infrastructure

Partner	Type	Description
LNEG	Infrastructure/	Ornamental Stones Laboratory – Equipped for a full technological characterization of ornamental stones.

Profiles of key staff members

Jorge M. F. Carvalho (male) is a geologist holding a Ph.D. in Economical and Environmental Geology from the Faculty of Sciences of the University of Lisbon. He is a researcher from the LNEG (the Portuguese Geological Survey) since 1991. He was elected twice (2009 and 2012) as a board member of the Associação Valorpedra – the Portuguese Natural Stone Cluster for the Portuguese Association of Natural Stones, and was appointed as member of the board of EDM, SA (a state-owned company for the environmental recovery of abandoned mining sites) during 2014 – 2016. His main research topic is the exploration and evaluation of industrial minerals and rocks, with emphasis on ornamental stone deposits and is the author of more than 100 scientific publications. He coordinated and participated in several research projects related to the above area of interest. Currently participates in the EU projects MINATURA2020 and MINLAND, both related to the safeguard of mineral deposits of public importance in land use planning.

José Vítor Vieira Lisboa (male) is a geologist and holds a Ph.D. in Geosciences (University of Aveiro, Portugal). He is a researcher at LNEG, which area of specialization (24 years' experience) is non-metallic mineral resources, while its area of expertise is ceramic raw materials. In the specialization domain he has developed R&D activity on the ornamental stone deposits characterization and evaluation, besides mineral resources mapping and databases, while also supplying geological information concerning mineral resources for Portuguese local and regional land use planning processes. In the expertise domain the main activity has been dedicated to the ceramic raw materials characterization and evaluation. He participates in international working groups/R&D projects. Lisboa is author/coauthor of 38 scientific publications, besides a large number of technical reports on mineral resources issues.

Daniel P. S. de Oliveira (male) holds a Ph.D. in Economic Geology from the University of the Witwatersrand (Rep. of South Africa) and a Ph.D. in Geology from the Faculty of Science of the University of Lisbon (Portugal). His area of specialty is the metallogenesis and petrography of mineral deposits. Additionally he works in geochronology, geochemistry and geological mapping, critical raw materials for Europe, Rare Earth elements and has been involved as a consultant at European level. He has coordinated and participated in a number of national and international projects. He is currently the Head of the Mineral Resources and Geophysics Research Unit in LNEG and the Chair of the Mineral Resources Expert Group of EuroGeoSurveys.

Cristina Isabel Paulo de Carvalho (female) holds a PhD on Geology from the Faculty of Sciences and Technology of the New University of Lisbon and is Head of the Departments of Natural Stones and of Ceramic Raw Materials, at the Science and Mineral Technology Unit of LNEG. She has a vast experience on natural stone testing methods and is member of CEN/TC 246 — Technical Committee (TC) for

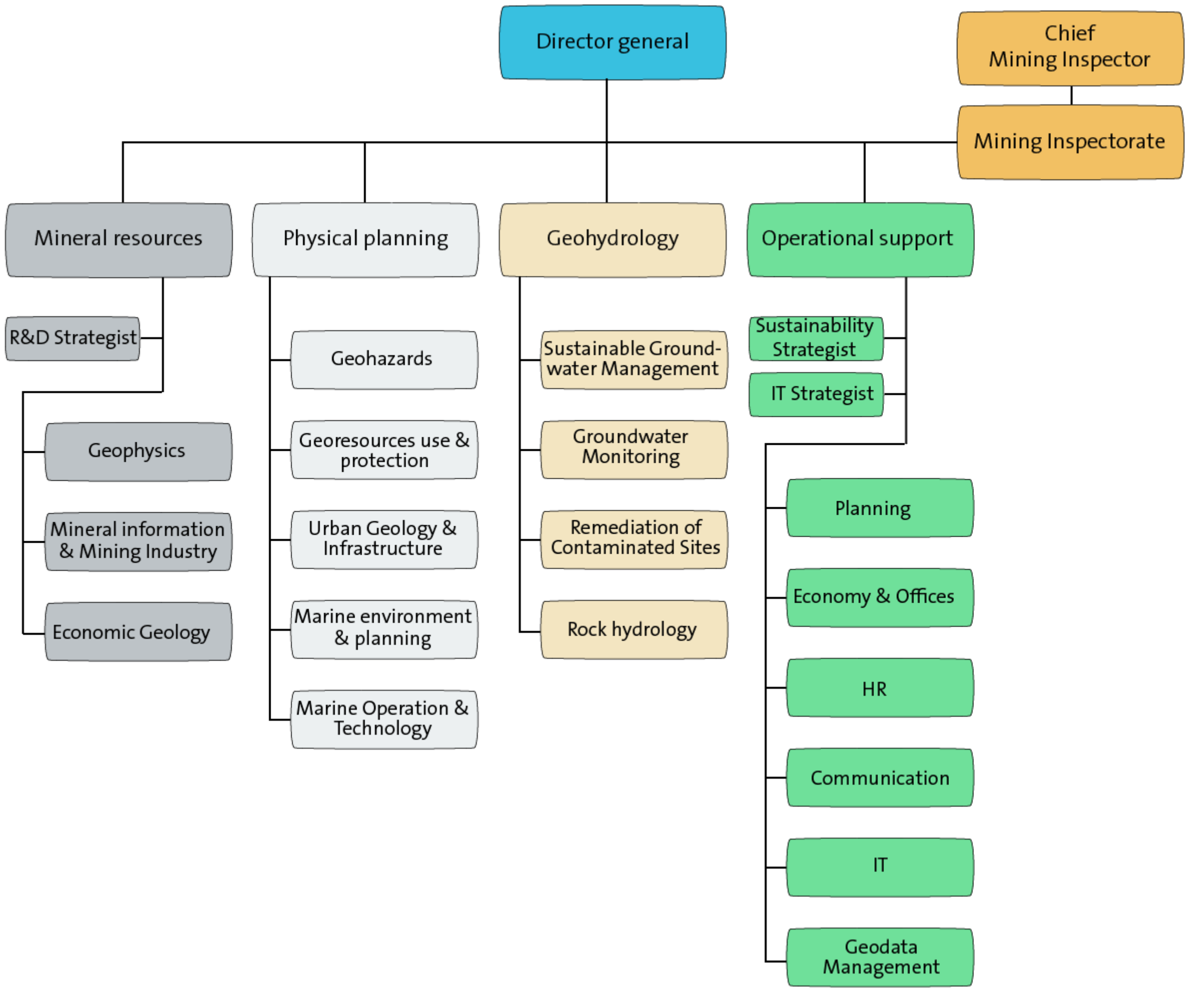
Natural Stones (246) of the European Committee of Standardization (CEN), since 2005. Cristina is author of 13 peer-reviewed publications.

4 Partner 3, SVERIGES GEOLOGISKA UNDERSÖKNING SGU, Geological Survey of Sweden

Overall description of Survey Organisation

Geological Survey of Sweden (SGU), founded in 1858, is a government agency under the Ministry of Industry. SGU is the directive authority for the effective use of soil, bedrock and groundwater. SGU is the directive authority for viable use of the country's mineral resources and a promoter of sustainable growth and business in the sector. SGU provides services and information in a large number of geosciences, such as mineral resources, geological hazards, geological conservation values, environmental issues, marine geology, geophysics and land use planning. SGU provides databases on mineral and aggregates to national stakeholders and to the European mineral resource platforms. SGU has participated in several European projects. SGU has 250 employees, and a large proportion Ph.D. Organizationally is Mining Inspectorate a part of SGU, and is headed by the Chief Mining Inspector who decides on matters falling under the Minerals Act.

The following schema shows how the SGU is organized:



Products and services

In the natural resources main task is to

- supporting the development of the mining, rock and mineral industries
- handling issues on exploration and extraction permits in accordance with the Minerals Act
- supervising operators' compliance with the Minerals Act
- promoting the sustainable use of groundwater resources

In the physical planning main task is to

- promoting the use of geological information
- promoting sustainable development and responsible use of groundwater resources
- being responsible for remediation and restoration of contaminated sites
- being responsible for the environmental objective Good-Quality Groundwater

SGU contributes to the development of knowledge through

- promoting geological awareness and knowledge
  in the public debate
- strengthening geology as a subject in schools
- improving and strengthening geological expertise

SGU contributes to geological research through

- close contact with universities and schools of higher education
- participation in international projects
- supervision of dissertation projects and theses
- four adjunct professors
- support to R&D (funding SEK 6 million/Year)

Relevant Publications/service

Access to SGU information
Web services at sgu.se

- order or download our products using GeoLagret
- create pdf maps from our databases
  in the Map Generator
- access information from our databases in map viewers, mobile apps and via Web Map Services (WMS)
- subscribe to SGU news

Involvement in other relevant European and national projects

Partner	Type of project/activity	Description
Sweden, Norwey, Denmark/Greenland,Finland	Europian Regional Development Fund	PNASTINA (Promotion of Natural Stone Industry in the Northern Areas)
Pan-European	FP7 project	Minerals4EU; Pan-European data portal on mineral resources (2013-2015)
SGU	National	Different projects of Industrial Rocks & Minerals mapping in different Geological Units of the country

Profiles of key staff members
Thomas Eliasson (male)

Current position senior geologist,

Education:

- 1982–83 Graduate studies, University of Toronto
- 1978–82 M.Sc., University of Gothenburg

Positions after education

- 1993-current Senior Geologist, Geological Survey of Sweden (SGU)

- 1991 Geologist, Sveriges Geologiska AB (SGAB), 4 mounts part time: Research regarding hydrothermal alteration in fault zones
- 1983-1993 Research assistant, Department of geology, Chalmers University of Technology and University of Gothenburg: Research tasks regarding extraction of geothermal energy from dry crystalline rocks
- 1982-1983 Research and teaching assistant, University of Toronto, Canada
- 1982 Research assistant, nuclear chemistry, Chalmers University of Technology, (8 moths). Research tasks: research on the transport of radioactive nuclides in bedrock
- 1979-1987 Field geologist, SGU, 9 seasons: uranium exploration and bedrock mapping

Selected academic activities

- 2006: Discussion leader licentiatseminarium. Department of Earth Sciences, University of Gothenburg: Drake, H. 2006. Fracture fillings and red-strained wall rock in the Simpevarp area, SE Sweden.
- 1995 till 2017: Assistant supervisor for 19 bachelor and master studies at the Department of Earth Sciences, University of Gothenburg. main adviser
- 2012 till 2017. Department of Earth Sciences, University of Gothenburg: Bedrock geology excursion in the Idefjorden Terrane: Part of the Regional geology course. Organizer and excursion leader.
- 2012 till 2017: Department of Earth Sciences, University of Gothenburg: Applied Geology. One day of teaching and excursion leader
- 2000 and 2015: Organizer and excursion leader for a number of field trips in the Sveconorvegian orogen. Academic institutions as well for NGU and SGU
- 2005 to 2017: Organizer and teacher in short courses in applied geology for consultants and government officials.

Relevant experience:

- Knowledge of Swedish ornamental stone resources.

Popular science in selection

- Bohusgranit, I: BOHUSLÄN. Yearbook 2002. Kustnatur: s 109–111. Eliasson, T.
- Sveriges Nationalatlas, Temaband Västra Götaland. 2003: s 91-95. Eliasson, T, Lundqvist, I. & Sivhed, U.
- Sturkell, E., Eliasson, T., Lange, U. 2012: Fasader i Göteborg, *Geologiskt forum* 76, 10–14.
- Sturkell, E., Eliasson, T., Lange, U. 2014: Stenen berättar stadens historia. *Byggnadskultur* 26–29.
- From 2003 to 2017. On behalf of the county administrative board in Västra Götaland. A total of about 45 excursions with a total of about 800 participants in nature reserve in northern Bohuslän with a focus on geology. Excursions are conducted in free time.

Mugdim Islamovic (male)
Current position: Head of division Georesources use and protection

Education:

- 1982–87 BSc Mining Geology, University of Belgrade

Relevant experience:

- Chef Geologist in Natural stone quarry Handöl (soapstone) and Brunflo (limestone)
- Program Manager, Mineral market analysis
- Minerals4EU
- EURARE

Mugdim has been working with different issues related to natural construction materials, both hard rock aggregates and natural stone.

5 Partner 4, INSTITUTO GEOLÓGICO Y MINERO DE ESPAÑA IGME, Geological Survey of Spain

Overall description of Survey Organisation

The Geological Survey of Spain (Instituto Geológico y Minero de España-IGME) was created in 1849. Is a self-governing Public Research Institution attached to the Ministry of Economy, Industry and Competitiveness
The IGME´s scientific and technical activity aims to strengthen its major research lines, both the forthcoming and the traditional ones. This dynamism meets society´s growing sensitivity to geological hazards, groundwater, sustainable management, soil contamination, environmental impact of mining and global change effects reduction, in keeping with international protocols. Likewise, it is meant to improve IGME´s insertion in the Science-Technology-company system as a self-governing Public Research Institution relations with universities, public administrations, the business sector and other self-governing Research Institutions.
The main mission of Geological Survey of Spain (IGME) is to provide the state Administration, the Autonomous Regions Administrations and the general society, with precise knowledge and information regarding the Earth Sciences and related technologies for any development on the Spanish territory.

Products and services

The functions of the Geological Survey of Spain (IGME) are:

- Studies, analysis and research in the field of Earth Sciences and Technologies.
- Generation of basic scientific knowledge.
- Information, technical-scientific assistance and advice to public administrations, economic agents and society in general, concerning geology, hydrogeology, geoenvironmental sciences, geological resources and minerals.
- Interdisciplinary relations with other areas of knowledge, contributing to the best understanding of the territory and of the processes that form and modify it, to the sustainable use of its resources and the conservation of the geological and hydrogeological heritage.
- Preparing and implementing budgets of R&D&I and knowledge infrastructures in national and international programmes, within the scope of its competences.

The Department of Research Geological Resources of IGME, which participates in the project, is one of the largest of the institution and include the area of Mineral Resources where the main scientific capacities are in natural stone and monumental heritage and ornamental stones.

Relevant Publications/services

Partner	Type	Reference
IGME	Service	Mineral Resources Database http://doc.igme.es/bdmin

IGME	Service	Ongoing: Database of the National Inventory of historical quarries associated with Architectural Heritage of Spain.
IGME	Service	Ongoing: Database Construrock
IGME	Product	Geological National Mapping to Scale 1:50,000 (1.200 sheets). All the country covered
IGME	Product	Industrial Rocks & Minerals Mapping of Spain to scale 1:200,000 (93 sheets). All the country covered

Involvement in other relevant European and national projects

Partner	Type of project/activity	Description
IGME	Project 1	INCHAPA- National Inventory of historical quarries associated with Architectural Heritage of Spain.
IGME	Project 2	SIG/PAM- Geoscientific Information System associated with Monumental Architectural Heritage.
IGME	Project 3	Different projects of Industrial Rocks & Minerals mapping in different Geological Units of the country
IGME	Project 4	Rocks characterization of the rocks used in the construction of the Architectural Heritage of the St. James Way.
IGME	Project 5	CONSTRUROCK- scientific network for monumental architectural heritage and the preservation of historic quarries

Important relevant infrastructure

Partner	Type	Description
IGME	Infrastructure/	Natural Stones Laboratory – Equipped for a full technological characterization of natural stones.
IGME	Infrastructure/	Geochemistry Laboratory
IGME	Infrastructure/	A network of 12 Institute offices throughout the country
IGME	Infrastructure/	[illegible] vehicles

Profiles of key staff members

Enrique Miguel Álvarez Areces (male). Geologist.
Education:

- 2015 PhD – Geology. University of Oviedo, Spain.

- 2013 Master in Engineering Geology. Faculty of Sciences, Complutense University of Madrid, Spain.
- 2009 Master Geological Resources and Geotechnic. Faculty of Sciences, University of Oviedo, Spain.
- 2004 Degree in Geology. Faculty of Sciences, University of Oviedo, Spain.

Positions after education

- 2014-current: Geologist, IGME – Instituto Geológico y Minero de España
- 2011-2013: Geologist, freelance, Portugal.
- 2007-2011: Formación Personal Investigador. Geologist, IGME – Instituto Geológico y Minero de España.
- 2006-2007: Geologist, SIEMCALSA-Sociedad de Investigación e Investigación Minera de Castilla y León, S.A.

Relevant experience:

- Knowledge of Spanish ornamental stone resources.
- Participation in several Spanish R&D projects related to the exploration, exploitation and safeguarding of natural stone deposits.
- Participation in several Spanish R&D projects related to the natural/artificial weathering of building stones used in the architectural heritage.

Production (No per category, if suitable)

- Books (main authorship): 3, 13 (chapters)
- Peer-reviewed publications: 11
- Other publications: 47
- Abstracts and presentations/posters: 39
- Reports: 26
- Lecturing/courses: 5

José Manuel Baltuille Martín (male), Senior Geologist (Researcher).

Education:

- 1994 Master, Suficiencia Investigadora, Faculty of Geology, Complutense University of Madrid, Spain.
- 1975 Degree Degree in Geology. Faculty of Sciences, Complutense University of Madrid, Spain.

Positions after education

- 2017 – present Responsible of the Unit of Natural Stone and Monumental Heritage. IGME – Instituto Geológico y Minero de España
- 2013 – 2017 Director of the Department of Geoscientific Infrastructure and Services. IGME – Instituto Geológico y Minero de España
- 2008 – 2013 Head of the Area of Mining Infrastructure. IGME- Instituto Geológico y Minero de España
- 2000 – 2008 Head of the Area of Rocks and Industrial Minerals. IGME- Instituto Geológico y Minero de España

Relevant experience:

- Knowledge of Spanish ornamental stone resources.
- Direction in several Spanish R&D projects related to the exploration, exploitation and safeguarding of natural stone deposits.
- Participation in several Spanish R&D projects related to the petrologic and petrophysic characterization of ornamental stones
- Support to the mineral, environmental and land use government policies.

Production (No per category, if suitable)

- Books (main authorship): 33
- Peer-reviewed publications: 140
- Other publications: 14
- Abstracts and presentations/posters: 108
- Reports: > 250
- Lecturing/courses: 5

Javier Martínez Martínez (male), Senior Researcher.
Education:

- 2008 PhD – Engineering Geology. University of Alicante, Spain
- 2003 Degree in Engineering Geology. Faculty of Sciences, University of Alicante, Spain

Positions after education

- 2008 – 2011: Teaching possition (Assistant Lecturer) at University of Alicante
- 2011-2017: Teaching possition (Assistant Lecturer – 22c) at University of Alicante
- 2008 – 2017: Member of the Laboratory of Applied Petrology (Associated Unit with the Higher Council for Scientific Research –CSIC-)
- 2017 – current: Senior Researcher, IGME

Relevant experience:

- Knowledge of Spanish ornamental and dimension stone resources.
- Participation in several Spanish R&D projects related to the petrologic and petrophysic characterization of ornamental stones.
- Participation in several Spanish R&D projects related to the natural/artificial weathering of building stones used in the architectural heritage.

Production (No per category, if suitable)

- Books (main authorship): 1, 35 (chapters)
- Peer-reviewed publications: 30
- Other publications: 24
- Abstracts and presentations/posters: 36 (international conferences) + 30 (Spanish conferences)
- Reports: 16
- Invited Lecturing/courses (different than those given at University as Assistant Lecturer): 9

Ana Gimeno García (female), Senior Engineer (Researcher).
Education:

- 2005 Master in Soil Mechanics and Foundation Engineering. Center of Studies and Experimentation of Public Works (CEDEX).
- 1992 Mining Engineer. Higher Technical School of Mines (Madrid). Geology and Geophysics, Polytechnic University of Madrid, Spain

Positions after education

- 2016 – current: Responsible for General Laboratories , IGME
- 2013–2016: Responsible for Natural Stone and Technological Testing Laboratory, IGME
- 1993-2013: Engineer,in Mineralugical and stone Laboratories, IGME

Relevant experience:

- Wide experience in physical-mechanical characterization of stone materials.
- Experience in conducting and coordinating laboratory essays, data processing and interpretation, and reporting.

- Participation in natural stones networks (CONSTRUROCK, GTLPN) and in several spanish R&D projects related to the of ornamental stone characterization.

Production (No per category, if suitable)

- Books (main authorship): - (chapters)
- Peer-reviewed publications: -
- Other publications: 11
- Abstracts and presentations/posters: 2
- Reports: >50
- Lecturing/courses: 2

Jorge Fernández Suárez (male), Geologist (Hired Researcher).

Education:

- 2013 PhD – Geology. University of Oviedo, Spain
- 2008 Postgraduation in minning explotation. University of Vigo, Galicia, Spain
- 2003 Degree in Geology. Faculty of Sciences, University of Oviedo, Spain

Positions after education

- 2015 – current: IGME – Instituto Geológico y Minero de España
- Researcher in Geomaterial.
- 2012 – 2014: Sidercal Minerales, S.A. Geology manager.
- 2010 – 2012: IGME – Instituto Geológico y Minero de España
- Researcher in Natural Stone.
- 2009 – 2010: Caleras de San Cucao, S.A. Geology manager.
- 2005 – 2008: IGME – Instituto Geológico y Minero de España
- Researcher in Natural Stone.
- 2005 – IBERPOTASH, S.A. Geology manager.
- 2004 – Rio Narcea Gold Mines, LTD. Mine geologist

Relevant experience:

- Knowledge of Spanish ornamental stone resources.
- Participation in several Spanish R&D projects related to the exploration, exploitation and safeguarding of natural stone deposits.
- Support to the mineral, environmental and land use government policies.

Production (No per category, if suitable)

- Books: 11
- Cartographies: 8
- Other publications: 16
- Reports: 26

6 Partner 5, INSTITOUTO GEOLOGIKON KAI METALLEFTIKON EREVNON IGME, Institute of Geology and Mineral Exploration

Overall description of Survey Organisation

IGME is the major geological research organization in Greece, authorized by the Ministry of Environment and Energy. For more than 40 years IGME contributes to the country’s growth and social welfare in terms of evaluating and securing the sustainable use of natural resources (water, geothermal

energy, soils and minerals). IGME participates in European Research and Development programs and in Regional projects co-funded by the Structural Funds, covering all fields of earth and environmental sciences. It conducts public and contract-based services in basic geological research, exploration and evaluation of mineral deposits, geothermal fields, hydrogeological surveys, geochemical and geotechnical studies, environmental control and monitoring and special studies on safe disposal sites for industrial and domestic solid wastes.
The number of staff employed on a permanent basis is 216 (geoscientists, technical and administrative personnel), complemented by contract/fixed-term personnel in the frame of various projects.

Products and services

LITHOS Laboratory, which participates in the project, has been established in 1999. They are active in offering services to the Ornamental Stones Sector, as well as in participating in various research projects and other relevant activities.
In the Organization Chart of the Hellenic Geological Survey (the Institute of Geology and Mineral Exploration - I.G.M.E.), the Legal Entity appointed by law to advise the State on Geoscience issues, LITHOS stands under the Economic Geology Department.
LITHOS is accredited by the Hellenic Accreditation System (E.SY.D.) since 2002, following the standard ELOT EN ISO/IEC 17025. The Laboratory personnel consist of two Ph.D. Geologists, one Ph.D. Mining Engineer, and one Mining Technician, all of them highly experienced in the Ornamental Stones field.
Two of the scientists, namely one of the Geologists and the Mining Engineer, are current members of the "Technical Committee 77 - Natural Stones" ("TE 77") of the Hellenic Organization for Standardization (EL.O.T.). TE 77 is the Hellenic equivalent of the EU Committees CEN/TC 246, 178, and 128.
LITHOS are well equipped with up-to-date certified testing machines and apparatuses, this being an important factor for carrying out high quality testwork according to the European (EN) and/or other international Standards. Nevertheless, its "Scope of Accreditation" includes only "Test Methods" according to EN Standards, being fully harmonized with the current practice in EU Member-States.
For maintaining reliability in the process of determining the various technical mechanical properties of ornamental stones, LITHOS participate successfully in annually organized PT schemes together with other relevant European Laboratories.
Some EN Standards determine "Requirements" for various ornamental stone final products, aiming at assigning the "CE marking" on them, in relation to their potential applications. For those final products and applications, CE marking has become obligatory in Greece since 2008. Consequently, the lack of CE marking will render these products unable to face competition in the European and international markets.
To this effect, LITHOS, in their continuous effort towards upgrading the services offered, may refer to their existing capability to perform all the tests necessary for any producer or other interested person to assign the CE marking on the aforementioned products.
The objective of LITHOS Laboratory is to always maintain the traditionally high standards in the services offered, thus contributing, through the strengthening of the relevant Sector's competitiveness, in the increase of the Hellenic Ornamental Stones share in the European and international markets.

Relevant Publications/service

Partner	Type	Reference
IGME Gr	Service	Directory of Greek Ornamental and Structural Stones http://www.igme.gr/index.php/erevnitika-antikeimena/ergastiria#εργαστήριο-«λιθοσ»-παρέχει-

		υπηρεσίες-στον-κλάδο-των-διακοσμητικών-πετρωμάτων-αθήνα

Involvement in other relevant European and national projects

Partner	Type of project/activity	Description
IGME Gr	Project 1	OSNET –Thematic Network on Ornamental and Dimensional Stones, funded by the European Commission, under the Competitive and Sustainable Growth Programme.
IGME Gr	Project 2	Minerals4EU – EU Mineral intelligence network structure providing data, information and knowledge on mineral resources around Europe.

Relevant infrastructure

Partner	Type	Description
IGME Gr	Infrastructure/	LITHOS Ornamental Stones Laboratory – Equipped for a full technological characterization of ornamental stones.

Profiles of key staff members

Kostas Laskaridis (male), Tel: + 30 213 133 7316, E-mail:laskaridis@igme.gr, Director of Economic Geology Department, Technical responsible of LITHOS Laboratory.

LASKARIDIS KOSTAS: Dr. rer. nat. University of Erlangen-Nuernberg, Geologist, Head in the Economic Geology Dept. of I.G.M.E.. He is Technical Responsible for the Accredited Ornamental Stones Quality Control Laboratory “LITHOS” of IGME, since 1999. For more than 25 years he is actively involved in European and National R&D projects for Ornamental Stones and Industrial Minerals. Most recent activity comprised the involvement in Min4EU project. Presently National Delegate of IGME at EuroGeoSurveys (EGS) and member of the Mineral Resources Expert Group at EGS.

Mike Patronis (male), Tel: + 30 213 133 7322, E-mail:patronis@igme.gr, Technical vice Manager of LITHOS Laboratory.

Dr. Michael E. PATRONIS, Mining and Metallurgical Engineer (NTUA), Senior Researcher in the Economic Geology Dept. of IGME. Technical vice Manager of “LITHOS” Ornamental Stones Quality Control Laboratory (IGME). Current and past activities include ornamental stones testing and quality control, as well as participation in the scientific team of various national and EU Research Projects.

Nikolaos Androulakakis (male), Tel: + 30 213 133 7241, E-mail:nandr@igme.gr, Position: Director of ICT Department

ANDROULAKAKIS NIKOLAOS received his HBSc in Electrical Engineering, MSc and PhD in GeoInformatics from the National Technical University of Athens. He is a Member of: Member of

Technical Chamber of Greece (TEE-TCG) since 1980, Member of Hellenic Society of Geographic Information Systems (HellasGI), Member of Hellenic Association of Computer Engineers (HACE).
He has an excellent knowledge of information systems and Geoinformatics and is proficient in the use of latest technology software, both commercial and open-source, such as ArcGIS, QGIS, Geoserver, ArcGIS Server, POSTGRESQL, POSTGIS, Open Layers, etc.

Relational Databases: PostgreSQL/POSTGIS
GIS: ArcGIS , QGIS
Programming Languages: Javascripts, Python, Visual Basic
WEB GIS : ArcGIS server, Geoserver, Geonetwork
Web Technology: XML, GML, KML, various API's (google, openlayers, GeoExt, etc)
CMS : Joomla, WordPress
LMS : Moodle, Udemy

He has participated as a coordinator or research associate in many projects funded by the 2nd CSF, 3rd CSF and the NSRF, and also in numerous EU programs.He has authored several books and also worked as an educator in the field of Geoinformatics and e-learning. He has taught at the Technological Educational Institutes (TEI) of Halkida (1990-2000) and Athens (2000-2010) as a research associate, at the School of Rural and Surveying Engineering of NTUA, when writing his PhD thesis and at the Training Institute of the Greek National School of Public Administration.He has served as a board member (2000-2008) and Vice President (2004-2006) of the Hellenic Society of Geographic Information Systems (HellasGI) and has recently been appointed as a Board Member of the Vocational Training Centre of the Region of Attica and Board Member of the Greek National Centre for Public Administration and Local Government (EKKDA).
Professional Experience Record
1984-210: IGME, ICT Dept, Geothermal Energy Dep, General Director Office. System Analyst, GIS consultant
2011-2014: Region Of Attica (Athens): Vice Governor for E-government and Transparency
2014-2015: National Centre of Public Administration, Deputy Director of National School of Public Administration
2015 – Present: IGME, ICT Manager

Demetrios Sgouros (Male), Tel: + 30 2313325690, E-mail:dim@thes.igme.gr, Position: ICT Officer, Thessaloniki
DEMETRIOS SGOUROS is an ICT officer at IGME's Branch in Thessaloniki, northern Greece. He entered service with IGME in 1984.He is highly qualified and experienced in Geographical Information Systems (ArcGIS, QGIS, GRASS GIS, gvSIG, SAGA-GIS, uDig), Geoserver, Mapserver, Degree, Mapnik, Databases (MySQL, PostgreSQL, PostGIS, MsSQL, Oracle, Access e.t.c), Geonetwork, Development of Web-GIS.
He has participated in several EU funded projects, namely NuPulse, Nemisref, Promine, InGeoClouds, OneGeology, Minerals4EU, EuRare .

7 Partner 6, REGIONE EMILIA ROMAGNA SGSS, Servizio Geologico, Sismico e dei Suoli della Regione Emilia-Romagna

Overall description of Survey Organisation

The Emilia-Romagna Region is a public body with exclusive competences in many fields of activity. The General Directorate for Territorial and Enviromental Care has several employees, among them the 34 ones belonging to the Geological, Seismic and Soil Survey (Servizio Geologico, Sismico e dei Suoli, SGSS).

Among the competences of SGSS, the application of geological and soil knowledge to support environmental and agricultural policies; land-use, water resources, mining and quarying planning; sustainable exploitation of natural resources and assessment of effects of climate change. Data are stored in data bases, partly available in the SGSS web-site. Geological and thematic maps are the main products of the Survey.

Within SGSS, geological maps of the Emilia-Romagna Region are available at 1:10,000 scale, as a result of nearly 30 years of studies carried out in collaboration with Universities and partly funded by national programmes, linked with soil protection policies in the early '90s. This knowledge is the basis for the development of applied studies in the field of groundwater, raw materials, geothermal energy and information geographic systems, carried out by SGSS. These activities are oriented to applicative purposes and produce thematic maps and reports suitable to the needs of public bodies and professional geologists.

SGSS is a member of the GeoERA consortium; it is a partner in the Raw Materials project "EuroLithos", contributing to WP3 Atlas of European Ornamental Stones.

Products and services

Webgis and Interactive Cartography of Emilia-Romagna region (Northern Italy): maps and download data on Geology, Landslides, Soil, Groundwater and Springs, Coast morphology, Geosites at various scales. 19 themes related to several databases.
http://ambiente.regione.emilia-romagna.it/geologia/cartografia/webgis-banchedati

Thematic maps on geology, landslides, aquifers etc. for land use planning: Piani Territoriali di Coordinamento Provinciale (PTCP)
Thematic maps on aquifers, at various scales, for:

(2005) Piano di Tutela delle Acque della Regione Emilia-Romagna,
http://ambiente.regione.emilia-romagna.it/acque/temi/piano-di-tutela-delle-acque
(2010, 2015), Piani di Distretto idrografico, after the Water Framework Directive.
http://ambiente.regione.emilia-romagna.it/acque/temi/piani%20di%20gestione

Publications

AA. VV. (2012) - Manuale d'uso per la tutela e la gestione del paesaggio nel Parco regionale dei Sassi di Roccamalatina. MIBACT, Provincia di Modena, Ente Gestore Parchi e Biodiversità Emilia Centrale, Regione Emilia-Romagna. 106 pp. In: http://territorio.regione.emilia-romagna.it/paesaggio/pubblicazioni/i-sassi
Benini A., De Nardo M.T., Severi P. (2009) - Carta Geologica d'Italia alla scala 1:50.000, Foglio 238, Castel San Pietro Terme. Serv. Geol. d'It.
Bettelli G., De Nardo M.T. (2001) – Geological outlines of the Emilia-Romagna Apennines (Italy) and introduction to the rock units cropping out in the area of landslides reactivated in the 1994-1999 period. Quaderni di Geologia Applicata (8) 1. Pitagora editore, Bologna
Bonaposta D., De Nardo M.T., Marasmi C., Romagnoli M., Rizzati A., con contributi di Sciuto P.F. e Parisi A. (2017) - Studio per un Atlante delle risorse minerarie storiche dell'Emilia-Romagna. Regione Emilia-Romagna, in stampa.
Carmignani L., Antompaoli M. L., Bocci M., Chiereghin F., Fantozzi P. L., Graziosi B., Meccheri M., Sciuto P. F. (2002) - Studi conoscitivi sui bacini marmiferi industriali di Carrara: un contributo per la gestione pianificata dell'attività' Quaderni di Studi e Documentazione, 24, Suppl. GEAM, Vol.XXXIX, 1 - 104
Cerrina Feroni A., Ottria G., Vescovi P., Catanzariti R., De Nardo M.T., Tellini C. (2002) - Carta Geologica d'Italia alla scala 1:50.000, Foglio 217, Neviano degli Ardiuni. Serv.Geol. d'It.

De Nardo M.T. (2015) - Individuazione e classificazione delle unità geologiche ofiolitiche ed ofiolitifere dell'Appennino emiliano-romagnolo. Note Illustrative alla carta Pedogeochimica della pianura emiliano-riomagnola. Report in: http://mappegis.regione.emilia-romagna.it/gstatico/documenti/dati_pedol/unita_geo_ofiolitiche.pdf
Ottonello G., Bokreta M. and Sciuto P.F. (1996): Parametrization of energy and interaction in garnets: end-member properties. American Mineralogist, 81, 429-447.
Papani G., De Nardo M. T., Bettelli G., Rio D., Tellini C. & Vernia L. (2002) - Carta Geologica d'Italia alla scala 1:50.000, Foglio 218, Castelnuovo ne' Monti. Serv.Geol. d'It.
Peive A. A., Zittellini N., Perfiliev A.S., Masarovich A.O., Rasniztzin I.N., Turco N.N., Simonov V.A., Averianov S.B., Bortoluzzi D., Bulicev A.A., Gasperini L., Ghilod D.A ., Gladun V.A., Ievgrafov L. M., Iefimov V.N., Kolobov V.I., Ligi M., Lodolo E., Piertzev A.N., Sokolov S.I., and Sciuto P.F. (1994): Structure of Mid-Atlantic Ridge at the Bouvet Triple Junction. Doklady Akademii Nauk (Russian Academy of Science) 338, 645-648.
Trukhin VI, Bagin VI, Bagina OL, Zhilyaeva VA, Bulychev AA, Gilod LA, Lidzhi M, Lodolo E, Sciuto F, Tomilin EF. (1999) Magnetism of the Bouvet mid-ocean ridge, South Atlantic. Fizika Zemli 1, 3-18
Trukhin VI, Bagin VI, Bagina OL, Zhilyaeva VA, Bulychev AA, Gilod DA, Lidgi M, Lodolo E, Sciuto F, Shreider AA. (1998) Ocean bottom magnetism of the southern mid-Atlantic ridge. Fizika Zemli, 4 33-46
Valloni R., Amorosi A., Cibin U., De Donatis M., De Nardo M.T., Farina M., Ghiselli F., Martelli L., Martini A., Ottria G., Piccin A., Pizziolo M. & Severi P., 1991. Proposta di classificazione macroscopica delle areniti. Acta Naturalia de l'Ateneo Parmense, 27/1-4, 5-26.
Viel G., De Nardo M.T., Montaguti M. (2003) – Schema Direttore della Pericolosità Geoambientale. Regione Emilia-Romagna

Involvement in other relevant European and national projects
Participation in UE Projects on quarrying and mining:
SARMa, Sustainable Aggregates Resource Management, SGSS as a partner (2009-2012)
MINATURA2020, Mineral resources of public importance, collaboration within the partner General Directorate for Territorial and Enviromental Care of Emilia-Romagna Region

Profiles of key staff members

Maria Teresa De Nardo (female): M.Sc in Earth Sciences, post-graduate course in field surveying and geological mapping. From 1990 to 2004 functionary within SGSS; since 2004, functionary with specific responsibility on geology and natural resources in the Emilia-Romagna mountain sector (Northern Apennines). Geological mapping within the Emilia-Romagna Apennines for the CARG Project - Geological Cartography of Italy at the scale of 1:50.000. Thematic mapping on groundwater resources, historically exploited mineral and lithic resources in Emilia-Romagna Apennines, use of GIS programmes.

Pier Francesco Sciuto (male): M.Sc in Earth Sciences, Ph.D. in Geochemistry, scholarship in Geochemistry and Applied Geology, Contract Researcher in Applied Geology. Expeditions for geophysic and geological survey in Egypt, Antarctic (Bouvet, Triple Junction) and Atlantic Ocean (Romanche FZ). Contract Professor in Earth Science for Geoinformatics module. From 2002 to 2009 consultant of SGSS; since 2009 functionary at SGSS.

8 Partner 7, REGIONE TOSCANA RT, sistema informativo territoriale e ambientale – p.o. geologia

Overall description of Survey Organisation

Tuscany Region is one of the 20 local Italian regional governments; among the guiding principles of the Region there are: defence of the soil and subsoil and buried resources, protection from hydrogeological (landslides and floods) and seismic hazard, respect for the ecological balance, environmental protection, biodiversity conservation, promoting the culture of respect for the animals, protection and enhancement of historic, art and landscape; promoting an environment leading to business competitiveness, based on innovation, research and training. Among the environmental management and sustainable development, the most relevant issues are: organisation of the waste cycle, protection from pollution, remediation of polluted sites, renewable energy sources, inland and seawater conservation, prevention of flood, landslides and earthquakes risk. RT has a framework of policies dealing with geological, hydrological and hydrogeological management, also to combat coastal erosion and salt water intrusion.

Tuscany Region is represented in GeoERA by the Sistema Informativo Territoriale e Ambientale (SITA) – P.O. Geologia, Pedologia e BD Geotematiche.

SITA is a member of the GeoERA consortium; it is a partner in the Raw Materials projects, contributing to RM1 – WP6, RM2A – WP3, RM2A – WP6, RM2B – WP3 and RM2B - WP4.

Products and services

Webgis and Interactive Cartography of Tuscany Region (Central Italy): maps and download data on Geology, Landslides, Soil, Groundwater, Lithology, Biostatigraphic Data, and Geosites at various scales.
http://www.regione.toscana.it/geologia
http://www502.regione.toscana.it/geoscopio/geologia.html
http://www502.regione.toscana.it/geoscopio/cartoteca.html

Relevant Publications

- G.Gabbani, G.Lavorini, S.Piro, *Analisi della fratturazione di rocce compatte con metodologie geofisiche elettromagnetiche impulsive (GPR) e a basso numero di induzioni [Joints System Analysis in intrusive rocks with geophysical methods (Ground Probing Radar and electromagnetic VLF transducer)]* Quaderni di Geologia Applicata, 2,1997, Pitagora, Bologna.
- G.Gabbani, G.Lavorini, L.Pacini, *Ricostruzione 3D di un fenomeno franoso dell'alta Val di Bisenzio [3D modeling of a landslides in Bisenzio Valley, Italy]*, International Geophysical Symphosium, Bochum, 2001.
- G.Lavorini, D.Morini er al., *The "Regione Toscana" project of geological mapping*, 32° IGC, Florence, 2004.
- Curatore della SEZIONE TERRA dell'*Atlante Geoambientale della Toscana [*Editor of "TERRA CHAPTER" of the *Geoenvironmental Atlas of Tuscany]*, Istituto Geografico De Agostini, Novara, Settembre 2006.
- G.Gabbani, G.Lavorini, L.Pacini, *Modellazione 3D di un acquifero inquinato da trielina con metodologie geofisiche non convenzionali,[3D modeling of Trieline Pollution in underground water with unconventional geophysical methods]*, FIST, Bellaria, 2003.
- P.Conti, G. Lavorini et al., A seamless DataBase for a digital geological map of central italy: the case of Emilia – Romagna, Marche, Tuscany and Umbria Regions, GIT 2017.
- G. Lavorini, C. Principe. L.M. Vezzoli, *Il Vulcano di Monte Amiata, R*egione Toscana, 2017.

Involvement in other relevant European and national projects

- Interregional Project of Geological Map of Central Italy and Northern Appennine.
- Life+ Imagine Project, Project Technical Manager.
  http://www.life-imagine.eu/home/

- GEOBASI Project (Definition of standard values in geochemical composition of fresh water in underground and surface watertables with special regards to metallic cationes and inorganic dangerous aniones), Regione Toscana, University of Florence, University of Pisa, University of Siena and CNR – IGG of Pisa.
- European Innovation Partnership on Water - Strategies and actions to bring Managed Aquifer Recharge scientific based solutions,and techniques to the industry - MAR(Solutions) to MAR-ket. http://www.eip-water.eu/
- Partner of Horizon2020 FREEWAT – A software for Hydrogeological Balances. http://www.freewat.eu/

Profiles of key staff members

Guide Lavorini (male): graduated in Applied Geophysics at University of Florence in 1993, senior geologist, he has worked in RT since 2003; expert in geology, geomorphology, geoengeneering ad geological mapping. Presently head of P.O. Geology, Soil and Geological Data Bases of RT.

Sandra Elisei (female): graduated in Economy at University of Florence in 1995; expert in financial subjects and marketing; presently business and financial consultant in RT; having worked at other UE projects (Life+ and Horizon2020), in Geo Era acts for RT as Project accountant.

9 Partner 8, GEOLOŠKI ZAVOD SLOVENIJE GeoZS, Geological Survey of Slovenia

Overall description of Survey Organisation

The Geological Survey of Slovenia (GeoZS) is a public research institute established by the Government of the Republic of Slovenia, tightly involved in national and international research and professional communities in Europe and worldwide. Staff of the research department Mineral Resources and Environmental Geochemistry performs fundamental and applied geological research in the following fields:

- Geological exploration and evaluation of mineral deposits (dimension stone, gravel and sand, clays, etc.), construction materials end energy raw materials (coal, hydrocarbons)
- In a role of the Public Mining Service supports the Ministry responsible for mining
- Intensely involved in numerous EU projects dealing with mineral resources expert groundwork for sustainable management of mineral resources and related spatial planning
- Project documentation on exploration activities (expert reports on reserves, mining research projects, environmental impact assessment etc.)
- Development and maintenance of databases and maps concerning mineral resources
- Mineral Yearbook on national level
- Scientific and expert publications (articles, books, etc.)

The Regional Geology department conducts a wide range of regional-geological research, thus enhancing the knowledge about the geology of Slovenia. The synthesis of this research is shown on basic and thematic geological maps, which are used for planning, management and control of sustainable development of our country.
GeoZS was a lead partner among others of the Adriatic IPA CBC project RoofOfRock, as well as of the recent EIT RM project MineService and is involved in different EC funded projects on mineral resources (Horizon2020, EIT RM).
GeoZS is involved in the proposed project as an institution of knowledge, which expert teams are constantly gaining new knowledge and developing new methodological approaches and tools that are applicable to different locations or fields. In this project existing knowledge is going to be complemented and upgraded, using data of previous researches and from the information system of the Mining Public Service (Mining Registry Book). Our experiences in fields of natural stone provenance and its use for cultural heritage will help in developing of Atlas and its integration into existing information systems.

Products and services

GeoZS	Service & Product	On-going, **Public Mining Service** – supports the Ministry responsible for mining in the areas of mineral policy, sustainable mineral resource management and spatial planning at a national level, development and maintenance of mineral resource databases. **Mining Registry Book** (web application): https://ms.geo-zs.si/

Relevant Publications

Partner	Type	Reference
GeoZS	Publication	Breda Mirtič, Ana Mladenovič, Anton Ramovš, Andreja Senegačnik, Jože Vesel, Nada Vižintin, 1999. Slovenski naravni kamen (**Slovenian Natural Stone**), Ljubljana : Geological Survey of Slovenia : Slovenian National Building and Civil Engineering Institute : University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geology, pp. 133, URL: http://www.geo-zs.si/index.php/en/?option=com_content&view=article&id=225
GeoZS	Publication	Matevž Novak, Nina Rman (eds), 2016. Geološki atlas Slovenije = **Geological Atlas of Slovenia**. Ljubljana: Geological Survey of Slovenia, pp. 124. (The Geological Atlas of Slovenia significantly increases accessibility of the Slovenian spatial geological data. The collected material reflects high practical value of geoscientific research and the data obtained for environmental planning, management and monitoring along with environmentally sustainable development.) URL: http://www.socgeol.it/files/download/libri/zlozenka_geo_atlas_angl%20pravilna.pdf
GeoZS	Publication	**Mineral Resources Bulletin** (mineral yearbook of the Public Mining Service in Slovene and English) URL (Slovene- annual): http://www.geo-zs.si/PDF/PeriodicnePublikacije/Bilten_2016.pdf URL (English-biennial): http://www.geo-zs.si/index.php/en/products/publications2/periodicals/mineral-resources

Involvement in other relevant European and national projects

Partner	Type of project/activity	Description
GeoZS	Project 1	**Roof Of Rock**: The aim was to establish a joint platform for sustainable platy limestone use, preservation and promotion, create relevant guidelines and to upgrade both individual and joint capacities in preserving this common natural and cultural heritage element along the karstified part of the Adriatic coast.URL: http://www.roofofrock.eu/
GeoZS	Project 2	**MINATURA2020**: Developing a concept and methodology for the definition and subsequent protection of "mineral deposits of public importance" in order to ensure their "best use" in the future is to be included in a harmonised European regulatory/guidance/policy framework. URL: http://minatura2020.eu/
GeoZS	Project 3	**Minerals4EU**: Designed to meet the recommendations of the Raw Materials Initiative and will develop an EU Mineral intelligence network structure delivering a web portal, a European Minerals Yearbook and foresight studies. URL: http://www.minerals4eu.eu
GeoZS	Project 4	**OneGeology-Europe**: The project has made geological spatial data held by the Geological Surveys of Europe more easily discoverable, accessible and shareable. It made a significant contribution to the progress of INSPIRE – i.e. develop systems and protocols to better enable the discovery, viewing, downloading and sharing of core European spatial geological data. URL: http://www.europe-geology.eu/onshore-geology/geological-map/onegeologyeurope/

Profiles of key staff members

Snježana Miletić (female), Junior Expert at the Mineral Resources and Environmental Geochemistry Department.
Education:
- 2016 - present: PhD – Geology, University of Ljubljana, Faculty of Civil and Geodetic Engineering
- 2005 – 2012: BSc – Geology, University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geology.

Positions after education
- 2013 - present: Junior Expert at the Geological Survey of Slovenia, Mineral Resources and Environmental Geochemistry Department

Relevant experience:
- On-going research: doctoral thesis in characterisation and provenance determination of the building stone material from Roman Celeia

- Diploma thesis: Provenance of the material from sediment rocks from archaeological site Mošnje
- Participation in different EC funded projects on mineral resources
- Publication of scientific, professional and popular science articles

Production (No per category, if suitable)

- Peer-reviewed publications: 1, 2 in print
- Other publications: 10
- Abstracts and presentations/posters: 9
- Lecturing/courses: 1

Mirka Trajanova (female), researcher at the Regional geology Department.

Education:

- 2009-2013 PhD, University of Ljubljana
- 1973-1979 BSc.– Geology (earlier 5 years study program), University of Ljubljana

Positions after education:

- 2009-2014: Head of the Department for mineralogy, sedimentology and petrology
- Employed as researcher 1.2. 1989 to present at GeoZS
- 1985-1.2.1989: principal engineer in Mining-metallurgical Institute of Mines and Ironwork Skopje, Macedonia
- Employed 1979, from 1981-1985: principal engineer in Fe-Ni industry in Kavadarci, Macedonia

Relevant experience:

- responsible for mineralogical and petrological investigations in mines, mineral processing and smelter processes
- researcher in petrology of igneous and metamorphic rocks (field and laboratory research)
- research for road constructional works (highways, tunnels, shafts), geohazard, hydrogeology (drinking and thermal waters), for nuclear waste repository, HE power plants, mineral resources, and other needs (environment, archaeology etc.)
- collaboration in EU founded projects
- chairperson of the Slovenian committee for geoscience and geoparks (IGGP) at UNESCO Slovenia, member of the executive committee: of the Slovenian national commission for UNESCO, national Forum of geoparks, UNESCO L'Oreal for Women in science, and national representative in the IUGS and CBGA.

Production (No per category, if suitable):

- Books (main authorship): co-author 2, chapters - 7
- Peer-reviewed publications: 17
- Other publications: 12 + 3 in print
- Abstracts and presentations/posters: 56
- Reports: 229 in GeoZS and over 100 in Macedonia (not evidenced in GeoZS archive)
- Lecturing/courses: 1982-1988: assistant for Crystallography and Micro-physiography at the Faculty Kiril-Metod in Štip, Macedonia; course in petrology for students of civil engineering (Faculty for civil engineering and geodesy)

Matevž Novak (male), Scientific associate at the Regional Geology Department.

Education:

- 2000-2008: PhD – Geology, University of Ljubljana
- 1991-2000: BSc – Geology, University of Ljubljana

Positions after education:

- 2011-present: Research associate at the Geological Survey of Slovenia, Regional Geology Department
- 2000-2011: Research assistant at the Geological Survey of Slovenia, Regional Geology Department

Relevant experience:

- Geological mapping
- Research in fields of Paleozoic biostratigraphy, paleontology, sedimentology
- Working in fields of natural stone provenience and its use in cultural heritage
- Leadership and cooperation in national and EU projects
- Editing of geological maps and books
- Publication of scientific, professional and popular science articles
- Representing GeoZS in boards of professional and amateur societies and geoparks
- Presenting of geological topics to general public through lecturing, guiding excursions and media
- President of the Slovenian Geological Society (2014-present)

Production (No per category, if suitable):

- Books (main authorship): 6
- Peer-reviewed publications: 73
- Other publications: 52
- Abstracts and presentations/posters: 46
- Reports: 49
- Lecturing/courses: 3

10 Partner 9, GEOLOGISCHE BUNDESANSTALT GBA, Geological Survey of Austria

Overall description of Survey Organisation

The Geological Survey of Austria (GBA) is the largest geoscientific research centre in Austria. Its legal mandate is clearly defined and it is subordinate to the Federal Ministry of Science and Research. The task of GBA is to study and document the geology of the country systematically, continuously and overall. With its expertise and the systematic production of geological maps GBA provides the basis for a number of societal needs. Main activities at GBA therefore are geological mapping, the study of mineral resources, thermal resources, the discussion of all types of geological hazards and investigations for the sustainable supply of drinking water. A lot of measurements in the field and laboratory analyses complement the work of its staff of mapping, economic and engineering geologists as well as hydrogeologists. In Austria, the combination of all these geoscientific disciplines and methods is unique and reason for the competence of GBA, as in fact for any other national geological survey. GBA's library, archives and collections store knowledge and objects from around the world.

Products and services

The Department of Mineral Resources in special, operates the archives for quarries, mines and hydrocarbons in Austria, which are a permanent data collection with inputs dated massively since the beginning of the 20th century. Within this collection surface near deposits of construction materials and industrial minerals comprise a large quantity. The information about the natural stone quarries in Austria is accessible within them.

Relevant Publications/services

Partner	Type	Reference
	Service	Ongoing, Interaktives Rohstoff Informationssystem (IRIS Online)http://www.arcgis.com/home/item.html?id=c1255d236ac84cd68fc02fd037a5ed8d
	Product	Ongoing, webservices, library and publications https://www.geologie.ac.at/en/services/library/?R=%252Fetc%252; http://opac.geologie.ac.at/ais312/

Involvement in other relevant European and national projects

Partner	Type of project/activity	Description
Universität Salzburg	Historic Quarries	http://hq.chc.sbg.ac.at/

Profiles of key staff members

Beatrix Moshammer (female), Geologist in the Department of Mineral Resources.
Education:

- 1978 - 1987 Dr. phil. - Earth Sciences Karl Franzens University Graz Austria

Positions after education

- 2000 – present Geological Survey Austria, Department of Mineral Resources, direct employment
- 1992 – 2000 Geological Survey Austria, employment contracts
- 1988 – 1991 ÖMV-AG, service contracts

Relevant experience:

- Expertise concerning Austria's limestone, marble and dolomite occurrences, the related extraction industry and the industrial application of these mineral raw materials based on projects carried out by the staff of the department and ongoing data acquisition for example by means of involvement with legal statements.
- Represantation in mineral raw material authority proceedings for carbonate rocks legally commisioned to the Geological Survey.
- Contributions to the in-house published geological maps and explanatory notes concerning mineral raw materials, with special regard to carbonate rocks.
- Geological and stratigraphical investigations of selected carbonate rock formations, in connection with the quarrying industry.
- "Building stone landscapes" and cultural heritage of relevant stones in the area of Vienna.
- Additional special analyzing techniques are Whiteness measurement and pXRF.

Albert Schedl (male), Geologist at the Department of Mineral Resources.
Education:

- 1974-1982 Dr. phil. University of Vienna (Institute of Geology)

Positions after education

- 1989 – present Geological Survey Austria, Department of Mineral Resources, direct employment
- 1987-1989 Geological Survey Austria, Department of Mineral Resources, employment contracts
- 1982-1986 Junior Geologist AUSTROMINERAL

Relevant experience:

- Expertise concerning information systems on Mineral Ressources - IRIS Interactive Raw Materials Information System and Mine Inventory of Austria
- Coordination of the programme 'Geochemical Survey of Austria' and Co-editor of the 'Geochemical Atlas of Austria'
- Expert on ores and evaluation of critical raw materials in Austria
- Contributions to the implementation of the EU Mine Waste Directive and other environmental risk assessment projects concerning abandoned mine sites in Austria
- Representation in mineral raw material authority proceedings for basaltic stones, coal and ores legally commissioned to the Geological Survey

11 Partner 10, INSTITUTUL GEOLOGIC AL ROMANIEI IGR, Geological Institute of Romania

Overall description of Survey Organisation

Geological Institute of Romania (Institutul Geologic al României - IGR) - R&D institute for Geology, Geophysics, Geochemistry and Remote Sensing - was founded in 1906 as national geological survey. Now it works under the National Authority for Scientific Research and Innovation, which is coordinated by the Ministry of Education. IGR holds three entities considered of national importance: the National Museum of Geology, the National Drill Core Repository and the Surlari Geomagnetic Observatory, from 1998 being part of the world geomagnetic network (Intermagnet). IGR is organized in several subdivisions: Georesources, Geothematic Maps, Geo-Hazards, GIS, database and remote sensing and Applied geonomic studies.

Products and services

The main mission of IGR is the elaboration of the national maps in various fields of geology. The scientific research in IGR covers the fields of mineral resources, geophysics, hydrogeology, geochemistry, paleontology, structural geology, geohazard, monitoring of the environment in mining areas. IGR is a non-profit entity. Its activity is based on research projects (national and international), contracts with Governmental authorities and with private investors. IGR has high specialized scientists in raw materials (aggregates, building materials, metallic ores, secondary resources), energetic resources (oil, shale gas, coal, geothermal resources), geo-hazards (landslides, subsidence, complex impact of mining waste and excavation), mineralogy and geochemistry (rock, soil, water, isotopes), geoinformation (mineral resources information networks, implementation of INSPIRE Directive in Romania), hydrogeology and CO_2 storage.

Relevant Publications/services

Partner	Type	Reference
IGR	Product	Ongoing: *Geoportals* and *Thematic maps of Romania* – various maps and atlases at different scales for Romanian territory (geological, magnetic, mineral resources, hydrogeological, tectonic, geochemical etc.); http://81.196.111.132/testgeo2/, http://harti.igr.ro/geofizica-v1/, http://igr.ro/index.php?optiune=51
IGR	Product	Ongoing: Romanian Journal of mineral deposits, founded 1910 by the Geological Institute of Romania, ISSN 1220-5648, part of Romanian Journal of Earth Sciences group of journals; http://rjes.igr.ro/
IGR	Service	Ongoing: National Museum of Geology, showing on 2300 sq. 14 basis exhibition in geological field and many other temporary/thematic exhibition, Mobile National Patrimony Thesaurus with the first time minerals discovered on Romanian Territory, scientific – cultural events; http://www.geology.ro/
IGR	Service	Ongoing: Surlari Geomagnetic Observatory – from 1943 permanent monitoring of the geomagnetic field, the gravitational field as well as other geophysical parameters; http://www.igr.ro/observator/
IGR	Service	Ongoing: geo-hazards, mineralogy, archaeometry, contaminated sites services for private companies or R&D unites (*landslides/risk maps and studies, mineralogical test reports, expertize reports, technical reports*); http://igr.ro/index.php?optiune=47

Involvement in other relevant European and national projects

Partner	Type of project/activity	Description
IGR	Project 1	MinService Mining / Mineral Support Service, with the main aim to create a partnership network to spread and implement the Best Available Mining/Minerals Services and to transfer the procedures and data to each partner (2016-2019)
IGR	Project 2	MINATURA2020 – Aimed to define Mineral Resources of Public Importance and how to safeguard them in land use planning across Europe (2015-2018), http://minatura2020.eu/wp-content/uploads/2016/02/MINATURA_poster_A1_Romanian.pdf
IGR	Project 3	Minerals4EU – EU Mineral intelligence network structure providing data, information and knowledge on mineral resources around Europe (2013-2015); http://www.minerals4eu.eu/
IGR	Project 4	MININVENTORY – Statistical Information on EU Raw Materials Deposits, which will allows to implement an action plan for harmonization of EU mineral resources data (2013-2014); http://www.minventory.eu/
IGR	Project 5	SARMa - Sustainable Aggregates Resource Management, contract SEE EoI/A/151/2.4/X – had established a common approach for sustainable aggregate resources management in the countries of project members, including updated data infrastructure and competence strengthening, (2012-2014); http://www.igr.ro/proiecte/sarma/

Relevant infrastructure

Partner	Type	Description
IGR	Infrastructure	MICROCOSMOS Laboratory - for Mineralogical and geochemical characterization of minerals and raw materials – optical microscopy and scanning electron microscopy, energy-dispersive spectroscopy and wavelength dispersive spectroscopy, RAMAN spectroscopy
IGR	Infrastructure	Determination of mineral phases: X-ray diffraction, Fourier transform infrared spectrometry, thermal analysis
IGR	Infrastructure	LGGA - Ambiental Geology and Geophysics Laboratory – for small-scale Earth observation (unmanned aerial vehicle, 3D terrestrial Laser Scanner, Ground penetrating RADAR, electrometric measurements in landslides and secondary mineral areas or land planning etc.); http://igr.ro/index.php?optiune=47
IGR	Infrastructure	Geophysical measurements for monitoring or different scientific projects or economical services; http://igr.ro/index.php?optiune=42

Profiles of key staff members

Valentina Cetean (female), Senior Geologist (Scientific Researcher II).
Education:

- 2014 Postgraduation – Business Operation and Delivery product manager. Codex & Ministry of Labour. Bucharest, Romania
- 2013 Postgraduation - Specialist in management and contaminated sites rehabilitation. Geo Remediation Ltd. & Ministry of Labour. Bucharest, Romania
- 2010 PhD – River aggregates management and capitalization thesis. University from Bucharest, Romania
- 2004 Master in Science - Environment Management. “Politehnica” Bucharest University, Romania
- 1990 Degree in Geology. Faculty of Geology and Geophysics, University from Bucharest, Romania

Positions after education

- 2015 – current: Senior Geologist, Geological Institute of Romania (IGR), Geo-Hazard Department, Bucharest, Romania
- 2010 – 2015: PROSPECTIUNI SA Bucharest - Manager of Promediu & Laboratory Department, Senior geologist and Environment expert, Mineralogist
- 2004 – 2010: Scientific Researcher, PROCEMA GEOLOGI Ltd., Bucharest
- 1990 – 2004: Scientific Researcher, PROCEMA SA (Institute for Design and Research for Buiding Materials), Bucharest

Relevant experience:

- Knowledge of Romanian ornamental and dimension stone resources and properties.
- Project manager for private and R&D researches related to the exploration, exploitation and environmental issues of ornamental/dimension stone deposits.
- Archaeometry and cultural heritage.
- Geological and environmental expertize for contaminated sites.

Production (No per category, if suitable)

- Books (main authorship): -, 8 chapters
- Peer-reviewed publications: 18
- Other publications: 11
- Abstracts and presentations/posters: 31
- Reports: 88
- Petrographycal and mineralogical test reports: 1440 (from each 110 ornamental/ dimension stones, 680 crushed stone, 650 river aggregates)
- Lecturing/courses: 2

12 Partner 11, STATE RESEARCH AND DEVELOPMENT ENTERPRISE STATE INFORMATION GEOLOGICAL FUND OF UKRAINE, GEO INFORM – SRDE “Geoinform of Ukraine”

Overall description of Survey Organisation

The State Research and Development Enterprise "State Informational Geological Fund of Ukraine" – SRDE “GeoInform of Ukraine”, or GeoInform, is the specialized research and development unit of the State Geological and Subsurface Survey of Ukraine which collects, stores, analyzes and provides information received from geological study and use of subsurface.

Products and services

GIU conducts research work on monitoring of mineral resources of Ukraine on the basis of geological and mining activities during the year, recording deposits and making public the balance of mineral resources management of the State fund of deposits and occurrences (more than 10,000 objects recorded), synthesis and analysis of exploration for oil and gas, creating a system of state accounting of oil and gas wells, completion and maintenance of the State cadastre of mineral deposits and occurrences as well as State cadastre of groundwater deposits of Ukraine.

Relevant Publications/services

Interactive map of mineral deposits of Ukraine (in Ukrainian)
http://geoinf.kiev.ua/wp/interaktyvna-karta-rodovyshch-korysnykh-kopalyn.htm
Interactive map of mineral licenses (in Ukrainian)
http://geoinf.kiev.ua/wp/interaktyvni-karty-spetsdozvoliv.htm
Interactive geological map of Ukraine 1:1 000 000 (in Ukrainian)
http://geoinf.kiev.ua/wp/Interaktyvna-heolohichna-karta-Ukrayiny.htm
Interactive geological map of Ukraine 1:1 000 000 (in English)
http://geoinf.kiev.ua/wp/Interactive-Geological-Map-of-Ukraine.htm
Interactive State Geological Map of Ukraine 1:200 000 (in Ukrainian with English entries)
http://geoinf.kiev.ua/wp/kartograma.htm

Involvement in other relevant European and national projects

- Minerals4EU - EU
- ProSUM - EU
- NUMIRE – Norway-Ukraine (NGU/SGSSU)
- EIMIDA – Norway-Ukraine (NGU/Geoinform)

Profiles of key staff members

Dr. hab. **Boris Malyuk** (Male), Director for International Cooperation, graduated in 1981 from Department of Geology, Lviv University, Ukraine, and in 1999 from Centre of Geostatistics, Ecole des Mines de Paris, France. Obtained Candidate of Science (PhD) Degree in Geotectonics in 1984, and extended Doctor of Science Degree in Petrology in 1991. National Delegate of Ukraine to the EuroGeoSurveys.

Sergii Prymushko (Male), Director, with basic IT-background, has more than 30 years experience in management of geological information, including partitioned database systems.

Volodymyr Velychko (Male), Chief Engineer, at his position is responsible for hardware and software facilities and database development having basic IT-background.

Dr. **Igor Melnyk** (Male), Sector Chief, with basic background in geology, has an experience in field works and research in geochemistry, hydrogeology and ecology (PhD in 1996), as well as geoinformatics and GIS applications.

Tetiana Biloshapska (Female), Chief Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1980. She is experienced in field works. She had studied mineral-resource base of Ukraine for more than 30 years, took part and led projects on prospecting and exploration of mineral deposits, conducted regional geological studies.

Natalia Chupryna (Female). Leaging Geologist. Graduated from Lviv State University under specialty 'Geological mapping, prospecting and exploration of mineral deposits' in 1981. She is experienced in field works, took part in projects on geological mapping in the scale 1:200 000, as well as studies of non-metal mineral deposits.

Natalia Korpan (Female). Chief, Division of mineral deposits and reserves inventory. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1986. She had studied geology of coal and peat deposits and their reserves inventory for 30 years.

Ganna Sankina (Female). I-category Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology'. She is working in the field of geology for more than 15 years, is experienced in field works in the course of geological mapping in the scale 1:200 000. She is managing the State inventory of oil and gas wells as well as compilation and analysis of these data.

13 Partner 12, GEOLOGICAL SURVEY OF IRELAND GSI

Overall description of Survey Organisation
The Geological Survey of Ireland (GSI) is a division of the Department of Communications, Climate Action and Environment (DCCAE). GSI is responsible for providing geological advice and information, and for the acquisition of data for this purpose. GSI produces a range of products including maps, reports

and databases and acts as a knowledge centre and project partner in all aspects of Irish geoscience. It is also active in geoscience research as a funder, partner and research performer.

Products and services

GSI serves its customer needs through a range of operational programmes and support services: The Information Management Programme underpins all of our activities in the delivery of geological information to our customers. The Surveying Programmes (Bedrock Geology, Quaternary Geology, Marine Geology and Geophysics) are on-going and provide information to the Applied Programmes, as well as producing maps and reports used directly by a wide range of external customers. The Applied Programmes (Groundwater, Minerals, Geotechnical, and Geological Heritage) are largely project oriented and provide solutions to specific customer needs. The activities of these Programmes help to build their respective databases. The Research Programme is an overarching programme providing funding and research support for geosciences in Ireland.

Relevant Publications/services

Partner	Type	Reference
	Service	Ongoing: The Office of Public Works (OPW) has responsibility for the maintenance and upkeep of public buildings. GSI provides advice to the OPW on the type, nature and source of stone material used in public buildings. This includes providing Continuing Professional Development Courses to OPW personnel.
	Service	Ongoing: The National Monuments Service (NMS) has responsibility for the maintenance and upkeep of national monuments. GSI provides advice to the NMS on the type, nature and source of stone material used national monuments. This includes providing Continuing Professional Development Courses to NMS personnel.
	Service	Ongoing: Within its minerals databases GSI maintains information Irish stone; stone used in Irish public buildings and national monuments where information is available; and information on dimension stone quarries

Profiles of key staff members

Gerry Stanley (male), Senior Geologist (Head of Minerals Programme).
Education:

- 1991 - 1992 MSc – Mining Engineering. Camborne School of Mines, Camborne, UNITED KINGDOM
- 1977 - 1979 MSc – Geology. Acadia University, Wolfville, Nova Scotia, B4P 2R6, CANADA
- 1973 - 1977 BSc (Hons) – Geology. University College Dublin, Dublin, IRELAND

Positions after education:

- 1999 - present Senior geologist, Geological Survey of Ireland, Beggars Bush, Haddington Road, Dublin D04 K7X4, IRELAND, Head of Minerals Programme. Responsible for minerals databases, minerals promotion and minerals related projects including mine waste inventories, aggregate potential mapping and minerals research.
- 1992 - 1999 Geologist, Geological Survey of Ireland, Beggars Bush, Haddington Road, Dublin D04 K7X4, IRELAND, Responsible for minerals databases, mineral exploration and a number of research projects.
- 1988 - 1992 Exploration geophysicist, Conroy Petroleum and Natural Resources plc. (later Arcon Mines, later Lundin Mining). Various addresses. Responsible for carrying out all geophysical programmes. Also part responsible for the development of the Galmoy Zn - Pb deposit in Co. Kilkenny, Ireland.
- 1984 - 1988 Geologist, Geological Survey of Ireland, Beggars Bush, Haddington Road, Dublin D04 K7X4, IRELAND, Responsible for development of a data release scheme, monitoring and regulating mineral exploration in Ireland.
- 1982 - 1984 Geophysical field crew leader, Williams Geophysics, Ballinclea Heights, Killiney, Co. Dublin, IRELAND,
- 1979 - 1982 Exploration geologist, Marathon Minerals Ireland Ltd., Canada House, St. Stephen's Green, Dublin 2, IRELAND, Supervising drilling, geochemical and geophysical exploration surveys in Ireland.

Relevant experience:

- Knowledge of Irish Dimension Stone resources.
- Database experience.
- Participant in several EC funded and collaborative projects.
- Organiser of several major minerals related conferences (SGA - 2007; AAG - 2003; NAMS – 1999, 2001, 2003, 2005, 2007, 2009).

14 Partner 13, INSTITUTO SUPERIORE PER LA PROTEZIONE E LA RICERCA AMBIENTALE ISPRA

Overall description of Survey Organisation

The Geological Survey of Italy is a Department of the National Institute for Environmental Protection and Research (ISPRA).

The Geological Survey of Italy was established in 1873 and its main task was the creation and the publication of the Geological Map of Italy. It is today composed of a team of 140 people working with enthusiasm to protect and preserve our territory and to promote its geological knowledge.

The main goal is a constant activity of research and data production, collection and analysis, aiming at promoting a rational, fair and sustainable use of resources, at reducing risks due to natural and anthropogenic causes and at supporting Public Administrations (e.g. Ministry of the Environment). In particularly, next to the activity of geological mapping, the Geological Survey of Italy (GSI) monitors the state of soil and subsoil, develops geological, stratigraphic, geophysical, geomorphological and hydrogeological analyses to better understand the geological structure of the territory and the dynamics that modify it. It also contribute to natural risks mitigation, with particular care to hydrogeological risks, through data production, collection, analysis and development of specific databases.

Despite the strong contraction of production in recent years, the mining industry of solid mineral resources remains an important sector of the Italian economy. Italy, since last decade, is trying to address

national legislation, in line with the European directives, towards environmental sustainability, raw materials' recycling and territorial planning.
The ownership of national mining policies is headed by the Ministry of Economic Development (MISE) and the collection of statistical data is carried on by ISTAT and MISE, but the transversality of the subject and the strong environmental impacts of the active and abandoned extractive sites, make the Geological Survey of Italy (and ISPRA), the backbone and necessary element of any future sustainable development policy of the sector, even with regard to the reconversion of the abandoned mining areas for cultural purposes.

Products and services

The Geological Survey of Italy is currently carrying on activities concerning the standardization of statistical information on raw materials, primary and secondary, environmental studies of quarries and mines (restoration of extractive sites, mine waste deposits) and cultural exploitation (for tourism) of mining parks and museums.

Main persons involved: Marco Di Leginio, Fiorenzo Fumanti, Mauro Lucarini, Lucio Martarelli

Relevant Publications

Partner	Type	Reference
ISPRA (GSI)	Product	Geoportal and Thematic Maps of Italian territory http://sgi.isprambiente.it/geoportal/catalog/main/home.page
ISPRA (GSI)	Product	Environmental Data Yearbook – Section on Extractive Activities (Mines and Quarries Production) http://annuario.isprambiente.it/
ISPRA (GSI)	Product	Quality of Urban Environment – Annual Report on Urban Mine Sites http://www.areeurbane.isprambiente.it/it
ISPRA (GSI)	Service	Mineral Wastes Inventory (Legislative Decree n.117/2008) http://www.isprambiente.gov.it/files/miniere/Inventario_Aggiornamento_2017.pdf

Involvement in other relevant European and national projects

Partner	Type of project/activity	Description
ISPRA (GSI)	Project 1	Re.Mi. (National Network of Mining Parks and Museums)- aimed both at connecting all the sites involved in the recovery of abandoned mining areas as industrial heritage tourism resource, and also at strengthening the regulatory framework.
ISPRA (GSI)	Project 2	Minerals4EU – aimed at developing an EU Minerals Intelligence Network (2013-2015), containing data and metadata on mineral resources.

ISPRA (GSI)	Project 3	MICA – aimed at building up a Minerals Intelligence Capacity Analysis, defining the Ontology of EU mineral resources (2015-2017).
ISPRA (GSI)	Project 4	FORAM – aimed at developing an European platform of international experts and stakeholders for the creation of a World Raw Materials Forum (WFRM), supporting a better international cooperation on raw materials policies and investments (2016-2018).

Profiles of key staff members

Mauro Lucarini (male), Geologist (Scientific Researcher III).
Education:

- 2014, SpeleoArchaeology Trainee Attendance
- 2010, New Technical Standards for Constructions Trainee Attendance
- 2007, Teacher Professional Qualification
- 2004, Geologist Professional Qualification
- 2002, Safety Coordinator in Worksites Qualification
- 2002, EIA Technical Consultant Professional Qualification
- 2001, Master's Degree in Geological Sciences at Roma Tre University

Positions after education

- 2003-current: Researches on Geological Hazards; Studies on Coastal Geology (GECO_07 Research Programme-batimetry surveys, submarine core drillings-); Cataloguing Earthquake Environmental Effects; Studies and Analyises on Floods and Monitoring of Soil Defense Works; Reports on Contaminated Sites and on Remediation Analysis; Studies on Soil Bioenginering; Studies and Analyses on Environmental Impact Assessment; Geoarchaeological investigations; Reports and Studies on Extractive Industry (EU Projects on Raw Materials, Quarries and Mines Databases, etc.).
- 2001-2003: Core drillings, well drillings, geotechnical investigations (Geologist, SO.GEO. s.r.l.)
- 2000-2001: Training on the job in some Tivoli quarry sites (Trainee Geologist, Roma Tre University)

Relevant experience:

- Coordination and support of actions related to extraction activities from national level to international level (Member of the Mineral Resources Expert Group of Eurogeosurveys, point of contact of EU Projects);
- Knowledge of extractive industry sector (and legal framework), from extraction to production of non-energy mineral raw materials with the related by-products and the subsequent restoration of the mine/quarry sites.
- Geological and Groundwater Expertise for Environmental Impact Assessment concerning Gasducts, Geothermal Exploration and Oil and Gas Exploration;
- Geological and Geomorphological Expertise on Hydrogeological Hazards;
- Geoarchaeologist researcher (studies on pedo-stratigraphic units, archaeological remains, ornamental stones and lithics).

Production (No per category, if suitable)

- Books (main authorship): 1 Chapter
- Peer-reviewed publications: 8
- Other publications: 8
- Abstracts and presentations/posters: 26
- Reports: >50

- Lecturing/courses: 1

Lucio Martarelli (male), Geologist (senior Researcher Technologist).
Education:

- 1991-1993. Two-year fellowship granted by the Italian "Consiglio Nazionale delle Ricerche", as training researcher in the field of Mineral Deposits and Applied Geochemistry
- 1991. Training certificate, after public examination, as a professional geologist.
- 1990. Degree in Geological Sciences at the "Università degli Studi di Roma La Sapienza – Dipartimento di Scienze della Terra",

Positions after education:

- 2001-up-to-date: Geologist at the Geological Survey of Italy (2008 up-to-date in ISPRA, Istituto Superiore per la Protezione e la Ricerca Ambientale; 2002 to 2008 in APAT, Agenzia per la Protezione dell'Ambiente e per i Servizi Tecnici Nazionali; 2001-2002 in PCM-DSTN, Presidenza del Consiglio dei Ministri - Dipartimento per i Servizi Tecnici Nazionali)
- 1998-2001: Technician applied to research activities at the Italian "Consiglio Nazionale delle Ricerche - Centro di Studio per gli Equilibri Sperimentali in Minerali e Rocce"
- 1995-1998: Freelance activities with the "Università degli Studi di Roma La Sapienza – Dipartimento di Scienze della Terra" for supporting some research projects
- 1993-1995: Freelance activities with private companies involved in geological investigations

Relevant experience:

- research activities in the frame of projects in the field of groundwater resources and hydrogeology (e.g., hydrogeological survey, hydrogeological information management, hydrogeological mapping)
- research activities in the frame of projects in the field of Mineral Deposits and Applied Geochemistry, mainly concerning mineralizations of the western Mediterranean Area

Production (No per category, if suitable)

- Books (main authorship): 2 (coauthor of chapters)
- Peer-reviewed publications: 33
- Other publications: 5
- Abstracts and presentations/posters: 31
- Reports: 10

Marco Di Leginio (male), Geologist (Scientific Researcher III).
Education:

- 2002, Web Developer with GIS technologies
- 2002, Geologist Professional Qualification
- 2001, Degree cum laude in Geological Sciences at the "Università degli Studi di Roma La Sapienza"

Positions after education:

- 2003-up-to-date: Geologist at the Geological Survey of Italy. Main tasks: reports on Contaminated Sites and on Remediation Analysis, supporting activity on strategic environmental impact assessment (SEA), reports and studies on Extractive Industry (EU Projects on Raw Materials, Quarries and Mines Databases, etc.).
- 2002-2003: Measures of static water level in wells and flow rate in the north part of Latium. Continued Coordinated Collaboration Roma Tre University – Department of Earth Sciences

Relevant experience:

- Member of the EGS (EuroGeoSurveys) Mineral Resources Expert Group.

- ISPRA-ISTAT working group to support the project: “Human pressure and natural hazards”
- Environmental reporting specifically to soil themes (Coordinator of “Geosfera” chapter in the Environmental data yearbook);

15 Partner 14, HRVATSKI GEOLOSKI INSTITUT HGI-CGS, Croatian Geological Survey

Overall description of Survey Organisation

The Croatian Geological Survey (HGI-CGS) is the principal public research institute in Croatia in the field of geosciences and geological engineering. It undertakes fundamental and applied geoscience research for the benefit of the society and economy of Croatia. Major science disciplines within The Croatian Geological Survey (HGI-CGS) include geological surveying and mapping, hydrogeology, engineering geology, mineral resources, and geochemistry. The Croatian Geological Survey (HGI-CGS) acquires and publishes geological data over the entire territory of the Republic of Croatia.

Products and services

The Croatian Geological Survey (HGI-CGS) organizes this information into a form that provides substantive guidance to both the national and regional planning processes in Croatia. The Croatian Mining Act (2013) places HGI-CGS as the main authority for collecting, storing and distributing all geological data related to exploration of all types of mineral resources (energy and non-energy).
The Department for Mineral Resources is the coordinate of the national project the Mineral Resource Map of Croatia which integrates both geological, mining and policy data related to mineral resources. The mineral resource research staff of HGI-CGS investigate the potential of mineral resources and develop policy plans and advice for both the Mining directorate as well as local authorities in order to enhance the rational and sustainable management of mineral resources.
The department for mineral resources will be involved in WP3 (Atlas) as partner and as work package leader in WP 5 (Natural Stone Heritage).The main goal in WP3 will be providing the geological data for information system on European natural stone. In WP5 as work package leader scientist from the department with partners will through a methodological approach provide best practices and guideline how to assess values of stone types, quarries and quarry landscapes afterwards how to do inventories of links between stone resources and built heritage and describe crafts in a way that can be used in assessments.
The main activities will be provided by Department for mineral resources and Department of Geology at Croatian Geological Survey.

Relevant Publications

Dedić, Ž., Ilijanić, N., Miko, S.; Mineralogical-petrographical study of evaporites from Mali Kukor, Vranjkovići and Slane Stine quarry (Upper Permian evaporites from Dalmatia, Croatia), Geologia Croatica, article in press. 2017.

Miko, S., Dedić, Ž.,: MINLEX - Study on the legal framework for mineral extraction and permitting procedures for exploration and exploitation in the EU, str.41-42, Dreistetten, Austria, August 2016
Dedić, Ž., Miko, S.: Foresight Study: Thematic Report II, Societal Challenges of mineral raw materials accessibility; Aggregates plans and their future: a view from South East Europe (SEE) countries Topic: Access to European Mineral Raw Material (MRM) deposits, 2015.
Horváth, Z., Miko, S., Sári, K. and Dedić, Ž.: A Vision of Best Practices for Aggregates Planning in South East Europe, SNAP-SEE Project, www.snapsee.eu. doi: 10.5474/snapsee-WP5-EN, Publisher: ©SNAP-SEE project 2014.
Kovačević, E., Miko, S., Dedić, Ž., Hasan, O., Lukšić, B., Zoran P.: Past mining and present quarrying impacts on the Dalmatian karst environment, Croatia, // 15th Meeting of the Association of European Geological Societies, Georesources and public policy: research, management, environment, 16-20 September 2007, Tallinn, Estonia //

Involvement in other relevant European and national projects

1. The Mineral Resources Map of Croatia. 1993-2013. Funding: Ministry of Science and Education (MZOŠ) http://www.hgi-cgs.hr/karta-mineralnih-sirovina-RH.htm
2. Sustainable Aggregate Resource Management-SARMa. SEE cooperation program. 2009-2011, SARMa had established a common approach for sustainable aggregate resources management in the countries of project members, including updated data infrastructure and competence strengthening, (2012-2014), http://www.sarmaproject.eu/
3. Minventory: DG Growth 2013, Statistical Information on EU Raw Materials Deposits, which will allows to implement an action plan for harmonization of EU mineral resources data (2013-2014), https://ec.europa.eu/growth/tools-databases/minventory/content/minventory
4. Sustainable Aggregates Planning in South East Europe SNAP-SEEproject, SEE cooperation program. 2012-2014, Sustainable Aggregates Resource Management, developing a toolkit to support national / regional planning of primary and secondary aggregates in Eastern European Area' countries, http://www.snapsee.eu/
5. Minerals Intelligence network for Europe Minerals4EU Funding Scheme: FP7-NMP-2013-CSA. 2013-2015, EU Mineral intelligence network structure providing data, information and knowledge on mineral resources around Europe, http://www.minerals4eu.eu/

Profiles of key staff members

Dr. **Vlatko Brčić**, male, vlatko.brcic@hgi-cgs.hr +385 1 6160 725

Research associate at Croatian Geological Survey (Department of Geology). Fields of scientific and professional interests: carbonate sedimentology, cartography, stratigraphy and geochemistry. Author and co-author of several scientific papers https://bib.irb.hr/lista-radova?autor=314341 . Associate on projects: Croatian Science Foundation, Adriatic IPA CBC Programme, H2020, INTERREG, ADRION, EUOGA.

Erli Kovačević Galović, female, ekovacevic@hgi-cgs.hr, +385 1 61 60 743

Engineer of Geology, Expert associate at Croatian Geological Survey, Department for mineral resources. Has 13 years of experience in the area of mineral resources, mostly as field, GIS and database specialist with a specific interest in bauxites. Active participant in a number of mineral resources related projects, national (Map of Mineral Resources of Croatia) and international (SARMa, SNAP-SEE, MICA, PROSUM, FORAM).

Željko Dedić, male, zdedic@hgi-cgs.hr; +385 1 61 60 743; +385 98 543 535

Engineer of Geology, Expert Advisor, Croatian Geological Survey, Department for mineral resources, with more than 10 years of experience in mineral resources (studies of raw materials; spatial planning, gypsum, cement raw materials, aggregates, GIS and database specialist, geochemistry and tectonics of gypsum deposits, economic geology and spatial planning). Author and co-author in more than 30 reports and papers. Actively participates in mineral resources related projects KMS (Map of Mineral Resources of Croatia), SARMa, SNAP-SEE, Minerals4EU, MICA, PROSUM, GEO-ERA, FORAM and GEO-CRADLE. on behalf of Croatian Geological Survey. Member of the Mineral Resources Expert Group EGS.

Dr. **Slobodan Miko**; smiko@hgi-cgs.hr, +385 1 6160 788.

Dr. Slobodan Miko, Senior research scientist, Director General of Croatian Geological Survey, adjunct Ass. Prof. at RGNF (Zagreb Uni.) Geology of Ore Deposits, member of EGS Mineral resources expert group (MREG). Croatian partner Coordinator for mineral resources related projects SARMa, SNAP-SEE, Minerals4EU, MICA, PROSUM, GEO-ERA, EMODnet Geology II (marine resources). Areas of mineral research are: aggregates, bauxite, gypsum and clays, economic geology, mineral resource availability and spatial planning related to mineral extraction.

Mr. **Boris Kruk**, male, bkruk@hgi-cgs.hr; +385 1 61 60 747;
Engineer of Geology, Expert Advisor, Croatian Geological Survey, Department for mineral resources, with more than 30 years of experience in mineral resources (studies of raw materials; spatial planning, gypsum, cement raw materials, aggregates, geochemistry and tectonics of gypsum deposits, economic geology and spatial planning). Author and co-author in more than 100 reports and papers. Actively participates in mineral resources related projects KMS (Map of Mineral Resources of Croatia), SARMa, SNAP-SEE on behalf of Croatian Geological Survey.

Dr **Marija Horvat**, female, mhorvat@hgi-cgs.hr, +385 1 6160 762

Marija Horvat, PhD, Research Associate in Department of Geology (Croatian Geological Survey) and Assistant Professor at University of Zagreb (Faculty of Mining, Geology and Petroleum Engineering). Fields of scientific and professional interests are mineralogy and petrology. Currently she has involved in geological mapping and petrography of igneous and volcanic rocks and sediment deposits. She is co-author at 1 book, and co-author of 8 scientific papers published in journals indexed by SCI, Current Contents, WoS or Scopus and 20 conference proceedings and summaries and author and co-author of 23 reports on natural stone testing. She is the technical editor of scientific journal Geologia Croatica.

Dr. **Nikolina Ilijanić**, nilijanic@hgi-cgs.hr; +385 1 6160 745

Dr. Nikolina Ilijanić, Research Associate, Head of Department for Mineral Resources, Croatian Geological Survey, specialized in the mineralogical analysis of raw materials, sediments and soils during the work in Croatia Geological Survey on XRD analysis, environmental magnetism and geochemistry of Quaternary sediments and soils. Author of 1 CC paper, 4 papers in other journals, 4 papers in conference proceedings, 1 chapter in book/exscursion guide and 59 scientific abstracts in conference proceedings from domestic and international conferences, and at the moment, 1 CC paper and 1 paper in other journals is accepted for publication, while 3 are under revision. Actively participated in mineral resources related projects KMS (Map of Mineral Resources of Croatia), SARMa, SNAP-SEE, MICA.

16 Partner 15. CYPRUS GEOLOGICAL SURVEY DEPARTMENT GSD

Overall description of Survey Organisation

The Cyprus Geological Survey Department (G.S.D.) was established in 1950 with a mandate to consult the state on geological matters. It is a state-funded public institution under the Ministry of Agriculture, Rural Development and Environment and its mission is to safeguard the public interest through the identification, the exploitation and protection of mineral and groundwater resources, the investigation and assessment of the geological environment and geohazards, the monitoring and assessment of seismicity, the investigation of foundation conditions, the protection and promotion of sites of geological and mining heritage and the production and dissemination of unbiased geological information to society.

Relevant Publications/services

Economic Geology Section of GSD holds a database of historic and current information of the mineral resources of Cyprus. GSD operates several drilling rigs that are used among others for the exploration of mineral resources. Also the Chemical and the Engineering Geology and Industrial Minerals Laboratories are used for the characterization of the mineral resources.

- Mineral Resources Map of Cyprus, (Greek), Nicosia 2007
- Mineral Resources Map of Cyprus, (English), Nicosia 2007

Involvement in other relevant European and national projects

- Minerals4EU - EU
- ProSUM - EU
- National project for defining new quarry areas (GSD)

Profiles of key staff members

Christodoulos Hadjigeorgiou (Male): He holds an MSc in Geology from the SUNY at Stony Brook, New York, USA. He specializes in Geology and Industrial Minerals (e.g. mineralogy, petrography, quality control of industrial minerals, rehabilitation of abandoned mines and quarries, sustainable development of natural resources). Since 2010, he is a Senior Geological Officer and is the Head of the Economic Geology Section at GSD. Apart from involvement in public organization, he has longstanding experience as a Geologist in private quarrying companies. He serves as an expert Member of the Mirror Committee in the field of Civil Engineering of the Cyprus Standards Organization covering issues concerning mineral raw materials. He is the Chair of the National Technical Committee for the Natural Stones.

George Hadjigeorgiou (Male): He holds an MSc degree in neotectonics from the National and Kapodistrian University of Athens in Greece and Post Graduate Diploma in Public Sector and MBA from the Mediterranean Institute of Management in Cyprus. He is currently employed as a Geological Officer at the Economic Geology Section of the Geological Survey Department of Cyprus. His current research activities involve: exploration for mineral resources including, mapping, drilling, characterization and reserve calculation of mineral recourses. The mineral resources that are explored for the local needs are currently building stones, aggregates, armourstones, and umbers.

Ioulia Georgiadou (Female): She holds a Bachelor in Geology and MBA. Since 2011, she is employed as a Geological Officer at the Economic Geology Section of the Geological Survey Department of Cyprus. Her current research activities involve: exploration for mineral resources including, mapping, drilling, characterization and reserve calculation of mineral recourses. The mineral resources that are explored for the local needs are currently aggregates, building stones and armourstones.

Andreas Zissimos (Male): He is currently working at the Cyprus Geological Survey as a Geological Officer and he is in charge of the chemical laboratory of the Department. His research falls in the area of applied and environmental geochemistry and works on projects of geochemical mapping of the soils of Cyprus, urban geochemistry, environmental pollution from chemicals, the chemical characterisation of geological (mineral) raw materials such as construction materials, and natural pigments.

Joseph Pekris (Male): He is currently working at the Cyprus Geological Survey Department (2012-to date) as a Civil Engineer. He is in charge of the Engineering Geology and Industrial Minerals Laboratory of GSD and carries out series of tests, using different methods for the physical and mechanical characterization of soils, building stones, aggregates and industrial minerals.

17 Partner 16. SERVICE GÉOLOGIQUE DU LUXEMBOURG SGL 'Geological Survey of Luxembourg'

Overall description of Survey Organisation

The Service géologique du Luxembourg (SGL) ('Geological Survey of Luxembourg') is a department of the 'Administration des ponts et chaussées' (National roads authority), and hereby under the competence of the Ministry for sustainable development and infrastructures.

Founded in 1936, its main tasks are studies, advisory and research, primarily in the fields of geology, geotechnics, hydrogeology, geomorphology and mineral resources.
These include:
- engineering geology and geotechnical studies for various public works projects;
- geological hazards evaluations;
- geothermal energy investigations;
- mineral resources surveys;
- geological and other geoscientific mapping and related database management;
- geoscientific information management and supply to the public.

The SGL acts as a public service for various national governmental bodies and local communities and has the status of a national survey organization. It is founding member of Eurogeosurveys and national representation of the IUGS.

During GeoERA, the Ministry for sustainable development and infrastructures will act as the research programme owner to which the SGL gives account to, by the intermediate of the directorate of the 'Administration des ponts et chaussées' (National roads authority).

Publications

Dejonghe, L., **Colbach, R.**; Goemaere, E. (2017): The lithostratigraphy of the lower Devonian formations of the Eisleck region (northern Luxembourg). Comparison with their Belgian lateral equivalents, Geologica Belgica: 20/1-2.

Kummerow, J., Raab, S., **Meyer, R.** (2017): Understanding physical rock properties and their relation to fluid-rock interactions under supercritical conditions. Geophysical Research Abstracts, Vol. 19., EGU2017-14819-1.

Nozaka, T., Wintsch, R.P., **Meyer, R.** (2017): Serpentinization of olivine in troctolites and olivine gabbros from the Hess Deep Rift. – Lithos, 282-283, 201-214.

Nozaka, T., **Meyer, R.**, Wintsch, R.P., Wathen, B. (2016): Hydrothermal spinel, corundum and diaspore in lower oceanic crustal troctolites from the Hess Deep Rift. – Contributions to Mineralogy and Petrology, 171:53, 1-14.

Meyer, R., van Wijk, J. (2015): The Interdisciplinary Earth: A Volume in Honor of Don L. Anderson. The Geological Society of America, *Special Paper 514 and American Geophysical Union, Special Publication 71, 65-85. (INVITED)*

Gillis, K. M., Snow, J. E., **Meyer, R.**, et al. (2014): Primitive Layered Gabbros from Fast-Spreading Lower Oceanic Crust – Nature 505, 204-207.

Involvement in other relevant European and national projects

The SGL also has contributed to the following EU co-funded projects:
Terrafirma, OneGeology, PanGeo

Profiles of key staff members

Robert Colbach (male):

Head of geological survey since 2015. M.Sc. in geology and hydrogeology from the University of Montpellier and Avignon (F) in 1997. Joined SGL im 1997, responsible for general geology, geotechnical investigations, geological mapping as well as geographical information systems, database development and maintenance.

SGL's main administrative and technical responsible during the research projects OneGeology, Terrafirma and PanGeo.

Romain Meyer (male):

Ph.D. in geology from the KU Leuven (B). Romain has a wide expertise in geology ranging from mineralogy, geochemistry to geophysics. He has been associated as researcher to the Massachusetts Institute of Technology MIT, the Norwegian Centre of Excellence for Geobiology, the GeoForschungsZentrum Potsdam, and has lectured general geology and geophysics as professor at the Washington and Lee University prior to joining the SGL in Mai 2017. In the last years, he contributed in numerous international cooperation projects like ESF EuroMARGINS, NSF MARGINS and NSF GeoPRISMS, and participated on different research expeditions e.g. IODP.

Petra Münzberger (female):

Ph.D. in geology and palaeontology. Educated from the Technical University 'Bergakademie' Freiberg (D) in 2002. From 2002 to 2005 she had a research fellowship on geology, geomorphology and settlement history from the University of Regensburg. Worked since 2005 for the SGL as a contractual employee for geological exploration of roads and bridges, hydrogeological exploration, sedimentological and paleontological studies, geological cartography. Joined as permanent staff member in 2017.

5 Ethics and Security (This section is not covered by the page limit)

5.1 Ethics

Have you completed an ethics self-assessment? (See “How to complete your ethics self-assessment”)

NO, but we will declare the following:

Does your research involve Human Embryonic Stem Cells? NO
Does your research involve human participants? NO
Does your research involve human cells or tissues? NO
Does your research involve personal data collection and/or processing? NO
Does your research involve animals? NO
In case non-EU countries are involved, do the research related activities undertaken in these countries raise potential ethics issues? NO
Does your research involve the use of elements that may cause harm to the environment, to animals or plants? NO
Does your research involve the use of elements that may cause harm to humans, including research staff? NO
Does this research involve dual-use items in the sense of Regulation 428/2009, or other items for which an authorisation is required? NO
Could your research raise concerns regarding the exclusive focus on civil applications? NO
Does your research have a potential for misuse of research results? NO
Any other ethics issues that should be taken into consideration YES; the only relevant ethical issue is the involvement of stakeholders and creating an emailing list for distribution of newsletter. We will declare the following:

- No stakeholder will be included in the list if they do not grant permission to it
- Although the stakeholders will be asked for advice during the progress of the project, such inputs will not be treated in any systematic way, will not be published and the inputs will be deleted when the project is ended

5.2 Security

Please indicate if your project will involve:

- Activities or results raising security issues: (NO)
- 'EU-classified information' as background or results: (NO)

5.12 FRAME

Title of project proposal

Forecasting and Assessing Europe's Strategic Raw Materials needs **(FRAME)**

Abstract (max. 250 words)

Inevitably, Europe shows a growing and accelerating consumption of mineral commodities, which at the moment the question whether supply to meet demand is adequate or not cannot be answered with any certainty because secure supply is a matter of knowing the resources and the ability to exploit them with respect to sustainability. Non-energy minerals underpin our modern economy and are essential for manufacturing and renewable "green" energy supply technologies. Many critical and strategic minerals and metals may be collected through recycling of mining related waste materials. However, even with the important contribution from recycling, it will still be necessary to extract them from primary mineral deposits, focusing on applying new technologies for deep exploration and mining, turning low-grade ores to exploitable resources and reducing generation of mining wastes and large tailings by converting them to exploitable resources.

Project **FRAME** (Forecasting and Assessing Europe's Strategic Raw Materials Needs) is designed to research the critical and strategic raw materials in Europe, in scenarios as described above, by employing sound strategies and a partner base spread far and wide amongst those that have some of these raw materials. Through successful teamwork, there is the expertise and knowledge base to provide a significant innovative contribution towards knowing more about the potential primary deposits, predict new target areas/deposits and recognize the potential in secondary deposits.

FRAME is made up of eight work Packages (WP) designed to collect, extract and disseminate strategic and critical mineral data to fill existing knowledge gaps in this field.

Please indicate the SRT
Raw Materials – RM4-Forecasting and assessing Europe's Strategic Raw Materials needs.

List of participants

#	Participant Legal Name	Institution	Country
1	Laboratório Nacional de Energia e Geologia, I. P. [Project Coordinator]	**LNEG**	**Portugal**
2	Federal Institute for Geosciences and Natural Resources	**BGR**	**Germany**
3	Bureau de Recherches Géologiques et Minières	**BRGM**	**France**
4	Czech Geological Survey	**CGS**	**Czech Republic**

5	Geological Survey of Estonia	**GSE**	**Estonia**
6	Geological Survey Sweden	**SGU**	**Sweden**
7	Geological Survey Ireland	**GSI**	**Ireland**
8	Geological Survey of Finland	**GTK**	**Finland**
9	Geological Survey of Croatia	**HGI-CGS**	**Croatia**
10	Greek Institute of Geology and Mineral Exploration	**IGMEgr**	**Greece**
11	Instituto Geológico y Minero de España	**IGMEsp**	**Spain**
12	Mining and Geological Survey of Hungary	**MGSH**	**Hungary**
13	Geological Survey of Norway	**NGU**	**Norway**
14	Polish Geological Institute	**PGI-NRI**	**Poland**
15	Royal Belgian Institute of Natural Sciences	**RBINS**	**Belgium**
16	State Informational Geological Fund of Ukraine	**GeoInform - GIU**	**Ukraine**
17	Institutul Geologic al Romaniei	**IGR**	**Romania**
18	Geološki Zavod Slovenije	**GeoZS**	**Slovenia**
19	Istituto Superiore per la Protezione e la Ricerca Ambientale	**ISPRA**	**Italy**

1 Excellence

Europe shows an inevitably growing and accelerating consumption of mineral commodities. At the moment the question whether supply to meet these demands is adequate or not cannot be answered with any certainty because secure supply is a matter of knowing the resources and the ability to exploit them with respect to sustainability.

It is well established and broadly accepted by now that non-energy minerals underpin our modern economy. They are essential for manufacturing and renewable "green" energy supply. Most of the environmental technologies and applications (e.g. wind turbines, photovoltaic cells, electric and hybrid vehicles) allowing energy production from renewable resources will use, so called, high-tech metals (e.g. Rare Earth Elements (REE), Platinum Group Elements (PGE), niobium, lithium, cobalt, indium, gallium, vanadium, tellurium, selenium) that were derived or refined from minerals, which Europe is strongly import dependent on. More specific, industrial trends, particularly clean and carbon-reducing technologies, are disrupting traditional metal sectors, with a robust drive in the development of battery-raw material metals. We need to calculate the volumes of critical and potentially strategic metals (e.g. cobalt, niobium, vanadium, antimony, PGE and REE) and minerals that are currently not extracted in Europe. We further need to understand how high-tech elements are mobilised, where they occur and why some are associated with specific major industrial metals.

The high import dependence of strategic (STR) and critical raw materials (CRM) has a serious impact on the sustainability of the EU manufacturing industry. This problem can only be solved by more intense and advanced exploration for new mineral deposits on land and the marine environment. Seafloor mineral resources receive growing European interest with respect to the exploration potential of REE, cobalt, selenium, tellurium and other high-tech metals.

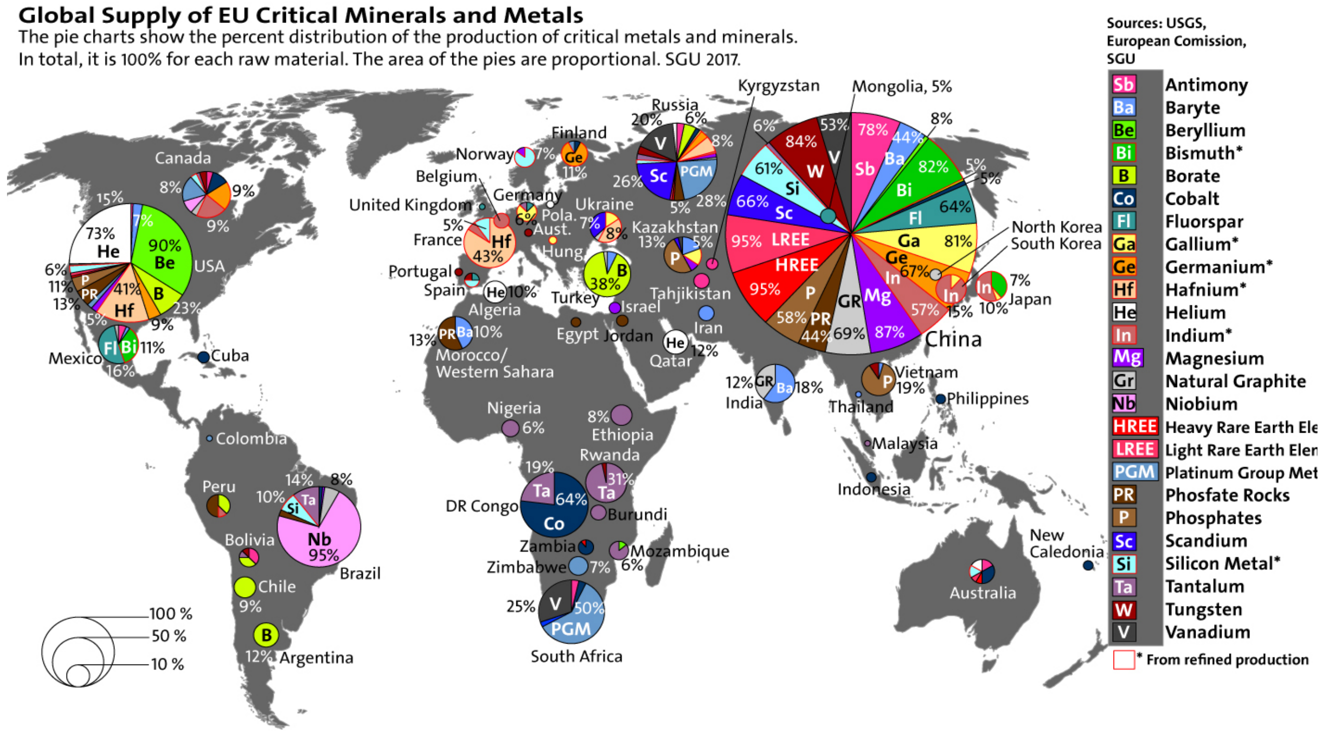


Figure 1 – Map of the global supply of EU critical materials

Many critical minerals and metals may be collected through recycling of mining related waste materials. However, even with the important contribution from recycling, to secure resource efficient supply it will still be necessary to extract primary mineral deposits, focusing on applying new technologies for deep exploration and mining, turning low- grade ores to exploitable resources and reducing generation of mining wastes and large tailings by converting them to exploitable resources and solving environmental footprint and land-use challenges.

As well as the dependence on extra-EU supply concerns (Fig. 1), the production of many materials is reliant on a few countries. This concentration of supply also poses concern as these few countries dominate supply of individual or several materials: Brazil (niobium), USA (beryllium), South Africa (platinum), DRC (cobalt) and China (REE, antimony, magnesium, and tungsten). Twenty countries are the largest suppliers of the CRM contributing with 90% of supply. All major suppliers of the individual critical raw materials fall within this group of twenty countries (Fig. 1). At the same time all are predicted to experience demand growth, with lithium, niobium, gallium and heavy rare earth element forecast to have the strongest rates of demand growth, exceeding 8% per year for the rest of the decade. In addition, Russia is known to have an active programme on materials stockpiles and export restrictions, China has from time to time tightened the export quotas for REE ostensibly to secure internal supply, and the US has long had a stockpile for strategic defense materials.

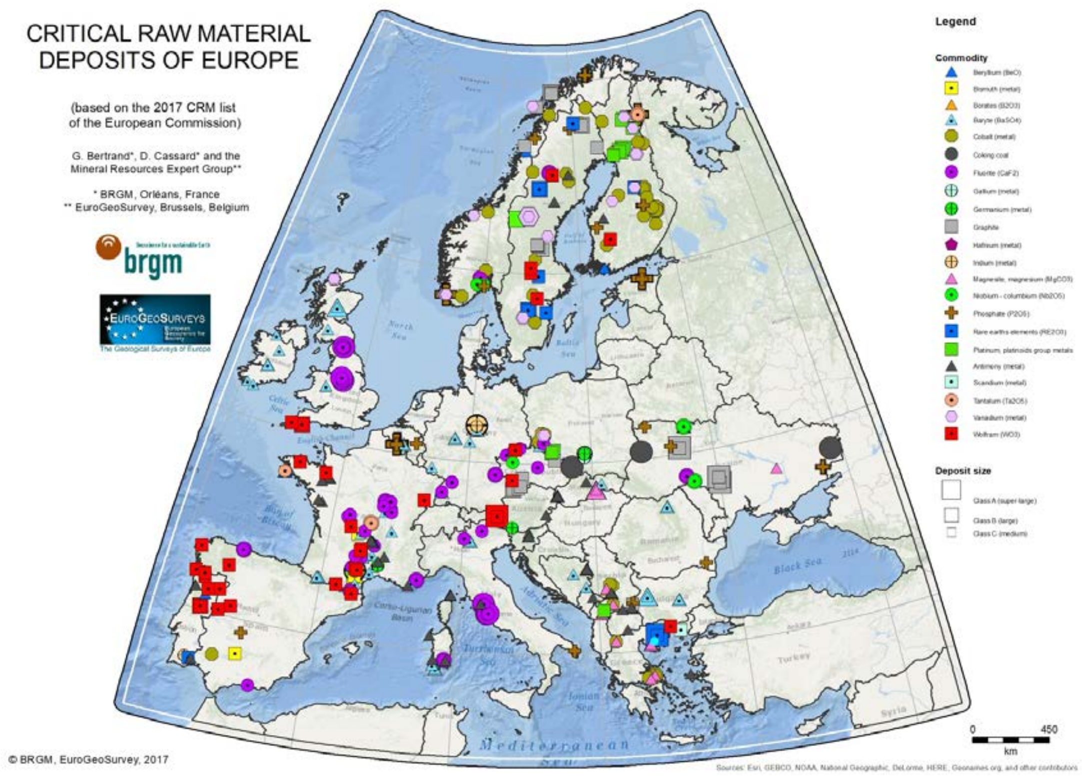


Figure 2 – Critical Raw Material deposits of Europe map; 2017 edition – updated after release of CRM list 11/2017.

There is a need on exploration focus by challenging more effective CRM exploration and better understanding of their metallogenetic setting and mineral potential. Discovery of new STR and CRM resources needs enhanced information on surface and subsurface geology, new concepts of mineral resource potential, particularly in underexplored areas of limited geological knowledge and projects facilitating the need to span the geosciences and be truly multidisciplinary. The question about "where are undiscovered critical mineral resources likely to exist, and how much undiscovered mineral resource may be present" needs to be answered. All of the processes involved in the formation of a CRM deposit type, a good understanding of why CRM mineral deposits occur where they do (Fig. 2), ore exploration models and resource assessment studies, make significant steps to be taken. Irrespective of the CRM exploration potential level, better understanding of the geology and metallogeny, and delivery of high-quality CRM maps may lead to new or little-known types of CRM ore deposits and ore-forming systems. In addition, future CRM exploration will likely need to focus increasingly on blind deposits. The European Union has recognized these challenges and has reacted since 2008 with its Raw Materials Initiative, following Communications (COM(2008) 699 final; COM(2011) 25 final;) and the List of Critical Raw materials. Many National Geological Surveys have supported the European Commission in identifying potential bottlenecks on CRM as well as providing information how to overcome physical shortages. However, all these activities are punctual, on individual basis and hence, not lasting.

Aims and objectives

Unlike "more common metals" such as copper, zinc, lead and iron, many CRM do not form the main commodity (-ies) produced from operating mines, but are instead recovered as by-products ('companion metals') of the primary ores at some stage during processing. Europe has a rich and diverse mineral endowment including CRM, and a map showing the distribution of selected CRM deposits of Europe, based on the ProMine database was published by EGS's Mineral Resources Expert Group during 2016 and an updated version base on the new CRM list was delivered in December 2017. Despite these efforts, there is still need for a more comprehensive pan-European identification and compilation of mineral potential and metallogenic areas of CRM. Such metallogenic areas can be defined by the presence of mineral occurrences and deposits, past and active mines, previous and ongoing exploration activities, favorable bedrock geology, geophysical signatures, geochemistry and predictive/prospectivity mapping.

The present project will build on previously and currently developed pan-European and national databases, and expand the strategic and CRM knowledge trough a compilation of mineral potential and metallogenic areas of critical raw materials resources in Europe, focused on related metal associations on land and the marine environment. Secondary resources, in terms of historical mining wastes and potential by-products will also be considered. The mineral resources targeted will have to extend beyond the current EU CRM list and include also minerals and metals (e.g. lithium, copper, and manganese) that are strategic for the European downstream industry in the mid- and long-term perspective.

To develop metallogenic research and models at regional and deposit scales, with special attention to strategic critical minerals for which the EU is highly dependent, in support of more efficient exploration and mining the following specific objectives need to be addressed:

- Identify and define the strategic minerals and metals that will make part of the metallogenetic map and related interpretations, focused on the current list of CRM, but considering also the strategic importance of some of those which were among the original candidates, such as phosphate rock, lithium, graphite, cobalt, niobium, tantalum, and others such as selenium, silver, copper, manganese, lead and iron ore. All minerals and metals collected and selected to be part of the metallogenetic map will simply go under the term CRM.
- Produce a metallogenetic map and increase the knowledge on the CRM endowments and resource potential in Europe and EU seas, based on,
    - Mineralisations and deposits on land and the marine environment in which CRM make the main commodities, e.g. REE minerals related to carbonatite, nepheline syenites, pegmatites or paleoplacers, tungsten deposits related to granites, lithium feasible pegmatites, graphite hosted by schists.

- Mineralisations and deposits on land and the marine environment in which CRM make associated commodities, e.g. REE in bauxite deposits and manganese nodules; cobalt in nickel deposits and ferromanganese crusts; vanadium in iron-titanium deposits;, indium and tellurium in VMS and epithermal gold deposits
    - Secondary resources, in terms of historical and modern mineral-based mining wastes (waste rocks, processing tailings, metallurgical residues) and by-products, e.g. REE in apatite concentrates related to iron extraction and red mud derived from alumina refining; indium in the waste streams of lead-zinc sulphide mining.

- Better understanding of the ore genetic links between major deposit types and hosted critical mineral and metal associations. Understanding also the mineralizing processes in different environments, including current deep sea, and using this understanding to predict and develop new mineral deposits or deposit types. This research also involves the characterization of ores, rocks, primary and secondary deposits etc. for significant elements and minerals, whose importance has increased and/or which represent cases where the occurrence is poorly understood or constrained. This objective and target will be interlinked and interactive with the tasks undertaken and the achievements resulted from GeoERA RM3 Metallogeny that will address the main deposit types and commodities.

- Be able to identify conditions and processes involved in the formation of the STR and CRM-potential deposits and develop conceptual models for their formation.
- Predictive targeting based on GIS exploration tools, of high potential mineral provinces and mining districts.
- Provide potential CRM resource estimates based on the UNECE classification system in close cooperation with RM 1/WP 5 on UNCF system.
- Display and distribute the map and description on the Information platform.
- Highlight mineral resources criticality to high-tech economy and downstream sectors.

This project will collect and act as a source of mineral information data that will support the continuous work going on in the DG-Grow, Raw Materials Supply Group and the Ad Hoc Working Group on Criticality of the EU commission.

Relation to existing programmes and projects:

European projects including the CRM dimension are M4EU, EuRare, ProSUM, ProMine and SCRREEN. An important output from the M4EU project is the European minerals knowledge data platform (EUMKDP) and the Minerals Yearbook. The ProSUM project which has just finished at year end 17 delivered the EU Urban Mine Knowledge Data Platform (EU-UMKDP), including also mining wastes. There are also national projects going on targeting the ore potential of CRM at country level. EuRare has compiled an overview of REE metallogenetic belts in Europe. However, no pan-European map of major metallogenic provinces for a suite of CRM has been published.

1.1 Concept and methodology

The project is based on sound concepts of mineral expertise taking into account the varied knowledge base from the experts from the various partners that are involved in the project. Each of these is geographically based on specific sites of metallogenic relevance and has demonstrated previous expertise in each of the elements and minerals to be investigated. They will build on from previous research and provide elements that will lead to producing mineral resource and predictability maps demonstrating regional potential for STR and CRM in Europe.

The methodology will implement tried and tested methods of mineral exploration, mineral evaluation and graphical representation to be easy enough to read and be understood by the general public, downstream users and decision makers.

1.2 Ambition

Geopolitical and economic events dictate the “next hottest metals or elements”. It is with this in mind that previously obtained results on mineral knowledge must not be regarded as final. The EU Commission recognises this and has implemented a policy of updating their “Critical Raw Materials for Europe” list every three years. This is precisely because the minerals world is extremely volatile and dynamic. Therefore, this project has at the outset already a reason for being: to update current minerals knowledge based on the latest geopolitical and economic demands that are being made on the sustainable supply of Europe.

Furthermore, Europe’s mineral potential is far from being known. It is only by gathering new data and reinterpreting “old” mineral data in light of new metallogenic models and data that we may be in the forefront of mineral exploration, exploitation, prospectivity and make Europe as independently as possible from world supply disruptions. This is what makes this ambitious project go beyond that state of the art based on current data because the nature of this project will be transnational.

Taking into account the long period of time (from exploration to mining takes about 15 years) needed for the CRM value chains to be fully operational detailed knowledge on European CRM occurrences and deposits is needed. Gathering and reevaluating existing data as well as new exploration results will form the base for future exploitation activities. Historical mining sites have seldom been investigated with regard to their CRM or STR inventory. Their remaining primary ore and their mine waste could add to the CRM supply from European sources. Were infrastructure is still in place, it could lower also the time to supply.

2 Impact

2.1 Expected impact

The EU have deemed critical raw materials a core topic and that shows from the work continuously carried out and funded, e.g. EIP on Raw Materials, CRM list, ERECON, M4EU, EuRare, ProSUM, ProMine and SCRREEN. Additionally, geopolitical events make the chosen elements vary and some of the elements not initially contemplated as critical may become strategic in nature. Their longevity on either of these “lists” or “labels” is a constant analysis of several factors at a particular point in time. The FRAME Consortium is continually working to update and improve the concept and data used in those EU programmes. An important output from the M4EU project is European Union Raw Materials Knowledge Base (EURMKB), and the Minerals Yearbook. The ProSUM project which has just finished at year end 2017 delivered the EU Urban Mine Knowledge Data Platform (EU-UMKDP), including also mining wastes. There are also national projects going on targeting the ore potential of CRMs at country level. EuRare has compiled an overview of REE metallogenetic belts in Europe.

The European Commission[1] has already acknowledge SRM metallogenetic knowledge is crucial to a wide range of societal issues, including sustainability in the area of energy, minerals, water)EIP Raw Materials Strategic Implementation Plan), environmental monitoring, health and safety of citizens, and the development of secure infrastructure (natural hazards). The mineral resources sector is the source of a significant proportion of CRM on which the society depends on. It supports regional communities, creates employment, provides facilities and enhances services, including health, education and welfare, through its contribution to local, regional and national economies.

[1] COM(2008) 699 final; COM(2011) 25 final; EIP Raw Materials Strategic Implementation Plan, COM(2017) 490 final.

Access to STR and CRM is essential to industrial and social development and economic growth and well-being of Europe. Europe's geology favours the formation of exploitable ore deposits for primary sourcing of many CRM and the project will highlight regions with greatest potential and thereby generate predictive targets and increase the exploration investments on best quality prospects. This will make a key action concerning the improvement of the pan-European critical minerals deposit and mineral-based waste database, ensuring that all available European data are current and have been checked for quality and accuracy at the national level, and to make them accessible in a seamless way to all users helping business and other stakeholders to optimise their investment.

RM4's FRAME (Forecasting and assessing Europe's Strategic Raw Materials needs) is a critical look beyond the traditional CRM list taking into account the mineral expertise present in the project consortium and member states in order to impact generally on:

1. Develop an updated knowledge base based on existing and newly acquired data,
2. Define the state-of-the-art with regards these elements and minerals,
3. Inventory possible secondary sources of these elements and minerals in historic mine sites,
4. Develop new products that make visualization of the data simpler, e.g. maps,
5. Develop new metallogenic models for CRM and strategic minerals and hence,
6. Develop predictability maps where possible,
7. Disseminate the knowledge base through a wide community of potential shareholders, European, national and regional policy makers, exploration companies and the general public,
8. Significantly contribute towards a common spatial data platform and *one-stop-shop* for verified, quality minerals data.

The main impacts already referred to in the Scientific Scope of the Call are reinforced by specific impacts of project FRAME - Forecasting and assessing Europe's Strategic Raw Materials needs:

- Continuously reinforced synergy at international level and reduced fragmentation of raw materials research and associated innovation efforts across Europe facilitating a more efficient use of natural resources, minimizing waste and improving recycling;

    - WP 2 and WP 3 will facilitate the generation of a holistic and common view for Europe of exploration knowledge and reserves of Strategic Raw Materials in Europe and internationally.
    - Better understand the metallogeny and ore prospectivity of EU's primary and secondary CRM and STR resources on land and the marine environment. This will improve the knowledge base and thereby increase the potential for secure and sustainable supply and also an expected impact in the minerals markets.
    - Dissemination of an innovative approach for the better use of STR through the EU stakeholders' network.
    - Promotion of better mining practices by promoting recycling and reusing of old tailings reevaluated for strategic commodities.

- Technical solutions helping the market to enhance the exploration phase, making it more efficient and less invasive, and optimising the performance and cost of deposit exploration (e.g. re-evaluating old mines);

    - Promote innovative geophysical techniques developed in projects such as SmartExploration throughout European mineral projects of strategic raw materials to reduce exploration investments and increase scarce but high value commodities.
    - Increasing knowledge of Strategic and Critical Raw Materials by-products of old and ongoing mines. FRAME will focus WP 2 and WP 3 in looking for new markets for the studding commodities in order to bring awareness of new uses for those commodities.

- Innovative solutions for mineral exploration and development (e.g. KDD techniques, including Data Mining, of newly created Knowledge Bases such as EU-RMKB), helping business and other stakeholders to optimize their investment;

    - o Modelling techniques and predictive mapping may be of high importance to develop decisions in exploration and further in exploitation will be tested in WP 4, WP 5 and WP 6 to increase exploration frontiers.
    - o New analytical approaches may also open frontiers to new Strategic raw materials in known and unknown areas and Strategic commodities.
    - o Develop new viable uses/markets for strategical raw materials such as lithium, passing from ceramic industry to energy industry.

- Data and tools to facilitate the re-use and recycling of mineral-based waste;

    - o WP 7 tasks and achievements will contribute to better understanding of the metallogeny and ore prospectivity of EUs secondary CRMs resources on land in previously worked areas. This will improve the CRM knowledge base and thereby increase the potential for secure and sustainable supply indigenous to the EU.
    - o This will make a key action concerning the improvement of the pan-European critical minerals deposit and mineral-based waste database, ensuring that all available European data are current and have been checked for quality and accuracy at the national level, and to make them accessible in a seamless way to all users helping business and other stakeholders to optimise their investment.

- Reduction of the import dependency of Europe's industries for critical raw materials

    - o WP 4, WP 5 and WP 6 will extend reserves throughout an exploration effort of commodities such as phosphates, lithium, graphite, cobalt, niobium and tantalum in with the aim to reducing dependence from outside countries.

2.2 Measures to maximise impact

2.2.1 Dissemination and exploitation of results

FRAME addresses reduction of the import dependency of Europe's industries for critical raw materials. The dissemination and exploitation plan will be included in a comprehensive Communication strategy plan, defining objectives, targets, messages and tools. The focus of the plan will be on disseminating information on the project progress and results, promoting its benefits, as well as fostering the connections with past and ongoing initiatives related to RM4.

Besides internal communication FRAME will foster the already established National Geological Services in Europe common network of key stakeholders including other EU project groups such as the currently established EU project INFACT via its own structure EuroGeoSurveys (EGS) and through national experts invited by various Directorate Generals of the European Commission (in particular GROW, RTD, ENERGY, JRC, MARE) will keep the relevant units and officers well informed of all developments of interest and provide advice on any issues relating to the subsurface when requested. A Collaboration Agreement exists between EGS and DG JRC to improve scientific cooperation and knowledge sharing. In addition, EGS has an Agreement on Cooperation with the European Environment aims to secure a long-term cooperation in integrating environmental and geo-scientific data, information and knowledge. With such well-established contacts in place, RM4 will be able to exploit these existing networks to ensure the relevant services at EU level are kept well informed of progress.

The information will be coherent with the project's main objectives and milestones, will be relevant to the stakeholders who is directed to, and will be timely but most of all dynamic to adapt to necessary changes as work progresses. Each step of information dissemination will be supported by Work Packages regular updates to WP 2. Internal communication among the Consortium members and WPs will be therefore baking up, and at the basis of, external communication towards the public.

At the early stage of the project, the plan will focus on seeking the most fruitful collaboration where needed. Bringing high quality information to stakeholders and foster a two-way dialogue will be based on tailored communication tools, such as the production of communication materials, website, news, organisation of events (ex. Workshops). In principle, WP 2 will exploit both online and offline channels, to maximise the impacts. WP Lead will use its wide network to disseminate information, both at EU and National level. WP Lead may attend and give keynote speeches at high-level events. Informing adequately policy makers in charge of Raw Materials management, industry, general public, etc. will result in higher awareness about the specific project's deliverables and importance of Reduction of the import dependency of Europe's industries for critical raw materials.

At a later stage of the project, the focus will be on disseminating the project's progress and ongoing efforts. Such information will be used to illustrate the challenges of Reduction of the import dependency of Europe's industries for critical raw materials to interested stakeholders, primarily policy makers at local, regional and national level. Meetings, identified with the collaboration of the Consortium, will be the main mean to share the identified good practices, for exchanging ideas and influence future policy developments. A dissemination event will be organised half way of the project to ensure that current results are made available and to stimulate interest in the view of the final outcomes. Special attention will be also given to address the social licence to operate issue, therefore speaking to, among others, the general public. The language used will be targeted to no-scientific audiences, to make accessible and understandable the scientific topics/results to a large public. The goal will be to facilitate Raw Materials policy making.

Finally, the outcomes and final results of RM4 will be disseminated via several tools. In addition to social media and one-to-one involvement based on RM4' Consortium, the dissemination activities will also include classic public relations tools such as participation in exhibitions, preparation of press kits, and attendance of conferences and side events if possible. To reach European politicians and policy makers the project will organise presentations summing up the key outcomes of RM4, to be delivered in specialized workshops for Governmental officers. To increase the effectiveness of the communication efforts in such types of specialised forums the project will rely on highly credible sources (meaning respected spokespersons) recognised in and by the policy making community.

Given the importance of the regional and local component in the project, "Forecasting and assessing Europe's Strategic Raw Materials needs" will be promoted both at EU level and at local level. Efforts will be directed towards seeking coordination of actions across EU Member States to ensure the widest possible geographic coverage, especially in those areas that are sensitive for the project purposes. The dissemination plan will propose the collaboration with national and international media (magazine, newspaper, etc.) that will ensure broader visibility to the project and deeper exploitation of the results. This will be achieved with the support of the WP press contacts/press officers network.

The dissemination activities will also seek connections with ongoing initiatives relevant to the Project. In this regards, online and offline channels will be exploited to make visible mutual benefits of projects responding to similar challenges (i.e. attending events organized by related projects, promotion online of initiatives or events, creating opportunities for RM4 visibility on connected projects platform, etc.)

2.2.2 Communication activities

These activities will be targeted on RM4 main stakeholders, but communications will be open to any interested parties, respecting a principle of full transparency of the actions. The plan will identify the most suitable communication tools that will be based on three main pillars: (i) the production of communication materials, (ii) organisation of events (Workshops, focus groups, etc.), (iii) attendance in strategic international and European events where to promote the project and meet potential stakeholders.

In line with messages and targets, several channels will be used along the project lifetime:
Visual identity and Templates: as indicated in WP 2, a visual identity will foster the project recognition among the audiences and will help to convey messages across different channels, raising the visibility of Forecasting and assessing Europe's Strategic Raw Materials needs. The visual identity will include graphics (logos, colour code, etc.) and templates for presentations, reports, deliverables, etc.

All partners will:
- support communication activities;
- assist in the implementation of the GeoERA Project Communications and Dissemination Strategy and Plan of Activities;
- include the GeoERA logo and website address on at least one page of their organisational website;
- include the GeoERA web address and contact details in external communications related to the project;
- use GeoERA appropriate templates for relevant project-related communications;

Project website: this will be considered the main tool for setting up two-way communications. In particular, the Hub & Spoke model will be used to integrate different web platforms in one. The Hub & Spoke will allow to be constantly updated and to disseminate information simultaneously across platforms. Content will be easily shared, messaging will be better managed and the whole dissemination will be more efficient.

This dynamic, multimedia website will foresee two communication flows, from the Consortium to the stakeholders and vice versa. The website will be the "gate" to collect stakeholder's feedback, therefore it will feature a Contact section to be used to submit any enquire by general public. It will display the project's public deliverables and milestones in a dedicated section. The website will be updated on a constant basis, and will feature information related to the project's activities such as the participation to events, organization of meetings, findings and results, etc. This will be achieved by setting up a News and Events section, among others. All the Consortium will provide relevant and timely information to be publicised, and information will be collected from stakeholders through oral and/or written interviews. As connecting the project with ongoing related initiatives and projects is a key objective, there will be a special section featuring such information (and mutual publicity will be sought).

News-feed: the project activities (deliverables, events, presentations, etc.) will be communicated to attract a growing audience and will serve to raise awareness on the project main objectives, achievements, events, etc. The information will also be suitable to be spread across different channels (i.e. linking if possible with social media).

Materials: promotional and informational materials will be produced with the collaboration of all Work Packages. In particular, an institutional brochure including information on the RM1 objectives and WPs will be printed and distributed to strategic events. The number of brochures printed will be heavily dependent on the size and type of event attended or meeting organized, to avoid any useless waste of materials.

Organisation of events: several meetings and Workshops will be organized along the project lifetime. In particular, there will be: (i) a Validation Workshop, at an earlier stage of the project, to check the correctness of activities and adjust when necessary; (ii) a Peer Learning Workshop; (iii) a Final event where to present the final outcomes and exploitation activities (WP 2).
Attendance of events: the project team will seek to disseminate the results by giving presentations and speeches at key events (Conferences, Meetings, etc.), networking and meeting stakeholders. The scope will be to engage with policy makers, civil society and scientists.

2.3 Contribution of Project Proposal to the Information Platform or vice versa

The common denominator between all GeoERA themes is the objective to provide and disseminate spatial information on their respective resources and underpinning geological data. As the cross-thematic integration of spatial information is an important aspect to be addressed in GeoERA data platform. The platform will be based on results obtained during the development of the European Geological Data Infrastructure (EGDI) and the various technical packages of RM4 will feed into this platform on all levels to create a common database and one-stop-shop for validated minerals information.

3 Implementation

3.1 Work Plan – Work packages, deliverables

Table 3.1a) Work package descriptions:

Work package number	**1**	Lead beneficiary			Laboratório Nacional de Energia e Geologia, I.P. (LNEG)	
Work package title	**Project Coordination**					
Participant number	1					
Short name of participant	LNEG					
Person months per participant	18					
Start month	1			End month	36	

Objectives

Forecasting and Assessing Europe's Strategic Raw Materials Needs (FRAME) specifically builds upon the following work packages:

WP 1 (Coordination/Lead) is the coordination and management work package lasting for the duration of the project. The first milestone occurs in Month 1 with a project inception meeting in order to commence work. WP 1 will deliver required management reports and ensure timely alignment of deliverables and milestones. WP 1 will be linked to clustering of researchers and results through the scheduling and organization of one kick-off meeting, two networking Workshops, five Consortium Meetings, three National (Regional / Local) Workshops and a final project meeting.

WP 2 (Communications, Dissemination and Exploitation) will vehicle and disseminate information on the project, its progress and results to the wider community operating in the field of mineral policies and land management in the EU and beyond. WP 2 will focus in developing and implementing a comprehensive communication strategy plan that will define the project multiple stakeholders, messages and tools, as well as will implement a wide range of communications activities to fulfil its goals in accordance with the coordinator. WP 2 will receive inputs from all Work Packages for communicating their research in an understandable way to both scientific and non-scientific audiences with the help from the coordinator, who will make sure this communication works.

WP 3 (Critical and Strategic Minerals Map) will produce a map of the current 27 Critical Raw Materials and also of the strategic raw materials for Europe, namely the ECE's and conflict minerals. WP 3 will be the backbone of the project with links to the other WP's with whereas the leader will provide the links.

WP 4 (Critical Raw Materials associated with phosphate deposits and associated black shales) WP 4 is dedicated to the evaluation of economic potential of igneous and sedimentary phosphate deposits (and their host black shales) in Europe, especially regarding critical and strategic raw materials (CRM). WP 4 will feed in to WP 3 and subsequently also supply data to WP 2 and coordinator will provide conditions for the communication promoting meetings and work sessions between WPs.

WP 5 (Energy Critical Elements) The main objectives of this WP are to concentrate on strategic minerals and elements, namely lithium, graphite and cobalt, which are all considered vital to current energy storage equipment and drivers of today's technological societal mainstay. WP 5 interconnects and will feed in to WP 2 and WP 3. Another objective that the coordinator needs to help by promoting communication and workshops between the three raw materials specialists and the other WP specialists.

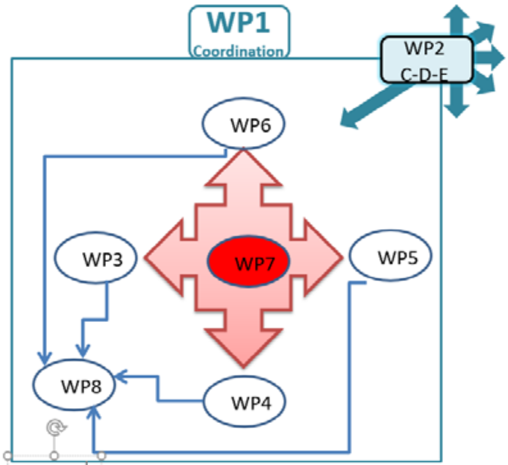


Figure 3

WP 6 (Conflict Minerals) Although the term "conflict minerals" is normally applied to a group of several metals as well as minerals, including the columbite-tantalite group of minerals, also known as "coltan" (from which tantalum is derived), and additionally cassiterite (tin); gold; wolframite (tungsten); or their derivatives, this WP will focus solely on tantalum and niobium, the so called indispensable twins because of their affinity to occur in similar and very specific geological settings and their important applications in electronic superconducting technology, general high-technology applications, and alloy industries. WP 6 interconnects and will feed in to WP 2 and WP 3.

WP 7 (Historical mine sites revisited). Based on the concept that today's mine dump is potentially tomorrow's mine, this WP will create a database of potential locations where some or all of the strategic and critical raw materials may be found in European mine sites. Where possible this potential will be measured and evaluated. This WP will strongly link with WP 2, 3, 4, 5, 6 and 8. The interlinking nature of the work packages can be seen in Fig. 3. This link will also be promoted by WP 1 with a workshop and work sessions between WP 3, 4, 5 and 6.

WP 8 (Link to Information Platform) The cross-thematic integration of information is an important aspect to be addressed in GeoERA and therefore the objective of this WP is to provide and disseminate spatial information on the respective resources and underpinning geological data identified in the technical work packages of the project. It has a link to all WP's of the project and will provide data in a format that will allow it to be uploaded to data platforms in a future date. The WP 8 role will be of most important to make sure that data produced will be effectively introduced in the Information Platform.

Description of work

The purpose of work package 1 is to lead, manage, coordinate and monitor the progress of the project, and ensure that the project meets the objectives stated for the work described in the Grant Agreement and that WP leaders and partners respect the timeline and deliverables.

Task 1.1 - Manage the WP leaders and monitor the project progress against deliverables, milestones, tasks and use of resources. This work package is in charge of the leadership, coordination and project management tasks, including organizing the consortium meetings, steering the Management Committee, coordinating the reporting, and consulting with the advisory board. All participants are required to adhere to the project management procedures (D1.1).

- Keep track of progress and costs against budgeted expenditure.
- Report on progress and expenditure; process claims and validate that the project expenditure is in accordance with the eligibility criteria and the grant agreement.
- Provide procedures on ethical requirements (D1.2), including (a) an informed consent procedure for workshops, conferences, events with external participants, surveys and interviews, (b) a procedure to protect submitted personal data (POPD).
- The reporting part will run for the entire duration of the project and will consist of:
  - A compilation of management reports (D1.4, D1.6) incl. expenditure against profile.
  - Collated participant statements on expenditure and associated administrative documents, audit certificates, and the submission of consolidated reports to the European Commission.
  - Preparation of reports and required documentation and submitting these to the Commission (D1.4, D1.6, D1.7).

Task 1.2 - Organise Management meetings: Several meetings and workshops are foreseen to ensure timely and to the point work with in the project and towards related GeoERA projects. This includes kick-off meeting, workshops, regular consortium meetings where ever appropriate by using online tools, and a final meeting.

Task 1.3 - Management of the Consortium:

- Adopt the terms of reference (governance) in collaboration with the Management Committee (D1.3).
- Organise, administer and report to Advisory Board meetings (D1.5)

Deliverables

D1.1 Description of work M3
D1.2 Ethical requirements (consent procedures, protection of personal data) M3
D1.3 Terms of reference (governance) M3
D1.4 Management report (submission of consolidated report to the European Commission) M18
D1.5 Management report (submission of consolidated report to the European Commission) M24
D 1.6 Final Report M36

Milestones

M1.1 Kick off meeting M1
M1.2 dissemination of progress achievements M6, M12, M18, M24, M30, M36
M1.3 Final Meeting - The reporting part will run for the entire duration of the project and will consist of a compilation of management reports (D1.3, D1.4) incl. expenditure against profile.

Work package number	**2**	Lead beneficiary					Laboratório Nacional de Energia e Geologia, I.P. (LNEG)			
Work package title	**Communication, Dissemination and Exploitation**									
Participant number	1	2	3	4	5	6	7	8	9	10
Short name of participant	LNEG	BGR	BRGM	CGS	GSE	SGU	GSI	GTK	HGI-CGS	IGMEgr
Person months per participant	18	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Participant number	11	12	13	14	15	16	17	18	19	
Short name of participant	IGMEsp	MGSH	NGU	PGI-NRI	RBINS	GeoInform-GIU	IGR	GeoZS	ISPRA	
Person months per participant	0.5	0.5	0.5	1	0.5	0.5	1	1	0.5	
Start month	1					End month	36			

Objectives

The objective of WP 2 is to widely disseminate the project results during the duration of the project as well as to maximize its impacts after the end of the project. WP 2 will focus in developing and implementing a comprehensive communication strategy plan that will define the project multiple stakeholders and the most suitable channels to reach them. WP 2 will support the technical and management project Work Packages in communicating their research in an understandable way for scientific and no-scientific audiences. In particular, WP 2 will:

- Disseminate information on the project, its progress and results to the wider community operating in the field of Forecasting and assessing Europe's Strategic Raw Materials needs in the EU and beyond, including national, local, regional public authorities, other interested third parties and the general public;
- Ensure that the project benefits are clearly and systematically promoted, and foster a two-way dialogue with stakeholders;
- Raise awareness and visibility on the importance of improving Europe's framework conditions for Forecasting and assessing Europe's Strategic Raw Materials needs (FRAME);
- Foster the connection with existing EU and Member States initiatives and projects relevant to the Project outcomes.

Description of work

Task 2.1 Communication Strategy & Plan: WP 2 will produce a Communication strategy, presenting the communication strategic objectives, and a detailed Communication Plan aimed at achieving them (Fig. 2). The communication strategy will define dissemination goals, segment the audience and establish dissemination channels. The Communication Plan will define resources to be allocated, media to be used, messages and sources. This will take into account the complexity of actors within the RM4 project. The focus will be on the major audiences: policy makers dealing with Raw Materials resources challenges; national, regional and local administrators and public institutions responsible for Raw

Materials management; civil society, industry and the general public. Specific attention will be given to assessing the suitability and effectiveness of the communication activities that will be put in place to re-adapt actions whether necessary. In particular, the strategic communication objectives will be measurable, therefore several indicators will be identified (i.e. visitors of the project website, number of news issued, social media engagements, feedback provided by stakeholders) and will give insight on future actions. This task will include also the development of a coherent visual identity in support to the communication main messages. The visual identity will include graphics (logos, colour code, etc.) and templates for presentations, reports, deliverables.

The Communication plan will identify dissemination opportunities that may arise (e.g. workshops, articles, interviews) and for which tailored tools may be developed. Dedicated informational and promotional materials will be produced to reach target audiences, in collaboration with the other WPs. The materials will be aligned in messaging and layout as defined in the Communication plan and will be meant for both online and offline distribution, in order to maximize impacts. A communication guideline will be distributed among WP leaders to ensure a common strategy of communication and circulation between the other WP and WP 2 and in close cooperation with the GeoERA secretariat. As main online channel, a website will be set up and will ensure a two-way communication between the project consortium and a broad range of stakeholders.

Task 2.2 Dissemination of project results: Following the main objectives of WP 2, this WP will disseminate the project results to target stakeholders by implementing tailored communication activities that will follow the project progress and deliverables. Dissemination on digital channels will be a priority, propelled by the website and social media (e.g. Facebook, YouTube). These channels will seek synergies with partners to maximise the dissemination of information. A Hub&Spoke model will be used to integrate different web platforms in one hub, which will be the project website, so that content will be easily shared, messaging will be better managed and dialogues will be stimulated along social media, thus making dissemination more efficient.

Specific attention will be given to the promotion of the project results produced by other Working Packages to better illustrate the concrete challenges of Forecasting and assessing Europe's Strategic Raw Materials needs providing technical solutions helping the market to enhance the exploration phase. The project outcomes will be presented in an understandable way for non-scientific audiences, in order to facilitate their adoption as a tool for policy makers and interested parties.

A range of communication materials will be produced (i.e. brochures, leaflets, newsletters, videos, infographics, etc.) with the support of the other WPs. Furthermore, this task will seek the collaboration of national and international media (specialised and general magazines and newspapers) that will ensure broader visibility to the project.

Task 2.3 Exploitation of results: The exploitation activities will ultimately make the Forecasting and assessing Europe's Strategic Raw Materials needs project more visible and accessible. The Contribution to self-sufficiency of strategic/critical raw materials within Europe, final outcome of FRAME, will be extensively promoted to its recipients (practitioners, investors, industry). These activities will improve the base for further investments, as results will be more predictable, and will give insight on future strategic/critical raw materials actions. During the project period one workshop will be organised with the purpose of facilitating the appraisal of the project outcomes, namely on Forecasting and assessing Europe's Strategic Raw Materials needs. To boost dissemination to specific target audiences, the existing network already available within the FRAME Consortium will be used, and tailored messages will be conveyed using social media channels. FRAME Partners are already involved in several EU H2020 projects focused on raw materials topics. FRAME will use this dissemination channel to spread the results and discussions widely within and over Europe. Some project partners are also regular participants of various working groups, panels and EU initiatives, and these interactions will provide an additional opportunity to improve the outcomes of each work package, and supply widest reaching opportunities for dialogue with policy makers and public agencies. The Plan for the dissemination and exploitation of the FRAME's results are shown in Fig. 4.

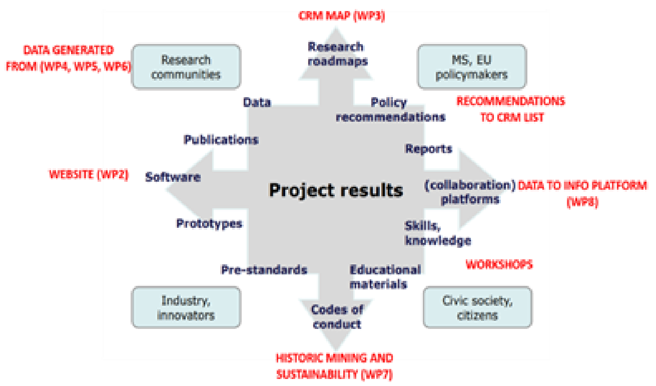


Figure 4 – Adaptation of the Dissemination plan model of H2020

Deliverables

D2.1 Communication strategy – M1
D2.1 Visual identity (Logo, Templates, Project site, etc.) – M2
D2.3 Collection of Information materials (Leaflet, Website, Media kits etc.) –M36
D2.4 Organization of events:
D2.4.1 Workshop- M18
D2.4.2 Final event – M36
D2.5 Triannual newsletters – M4, M8, M12, M16, M20, M24, M30
D2.6 Final Newsletter – M36

Milestones

M2.1 Report on Communication strategy - M1
M2.2 Visual identity, logo design – M2
M2.3 Digital newsletters delivery to consortium - M4, M8, M12, M16, M20, M24, M30
M2.4 Events documentation – M18, M36
M2.5 Final digital newsletter delivery to consortium – M36

Work package number	**3**	Lead beneficiary						Geological Survey of Sweden (SGU)	
Work package title	**Critical and Strategic Raw Materials Map of Europe**								
Participant number	1	3	4	6	7	9	10	11	12	16
Short name of participant	LNEG	BRGM	CGS	SGU	GSI	HGI-CGS	IGMEgr	IGMEsp	MGSH	GeoInform-GIU
Person months per participant	4	1.2	3	15	4	1.45	3	6	6	5,02
Participant number	17	18								
Short name of participant	IGR	GeoZS								
Person months per participant	12,5	5								
Start month	1					End month	36			

Objectives

To develop metallogenic research and models at regional and deposit scales as well as prospectivity maps, with special attention to strategic critical minerals for which the EU is highly dependent, in support of more efficient exploration and mining the following specific objectives need to be addressed:

- Identify and define the strategic minerals and metals that will make part of the metallogenetic map and related interpretations, focused on the current list of CRM, but considering also the strategic importance of some of those which were among the original candidates, such as lithium, tellurium, selenium, silver, iron ore and others. All minerals and metals collected and selected to be part of the metallogenetic map will simply go under the term CRM.
- Produce metallogenetic map and increase the knowledge on the CRM endowments and resource potential in Europe and EU seas.
- Better understanding of the ore genetic links between major deposit types and hosted critical mineral and metal associations. Understanding also the mineralizing processes in different environments, including Europe’s deep sea areas, and using this understanding to find and develop new mineral deposits or deposit types.
- Be able to identify conditions and processes involved in the formation of the CRM-potential deposits and develop conceptual models for their formation.
- Predictive targeting based on GIS exploration tools, of high potential mineral provinces and mining districts.
- Provide potential CRM resources estimates based on the UNECE classification system
  European scale prospectivity maps were produced 5 years ago by the ProMine project, using a relatively basic approach (Weight of Evidence, for most of them). They deserve to be improved using a more appropriate methodology for a continental scale approach and considering the latest (2017) CRM list. The main objective of the present task is to produce a renewed and updated set of continental scale mineral prospectivity maps, covering all EU member states and neighbouring countries (Ukraine, Balkans, Norway, Switzerland, etc.), (according to the 2017 CRM list from the European Commission, and based on the availability of data, i.e. known mineral deposits of targeted commodities). These prospectivity assessments will benefit from the latest developments

in “data driven” mineral prospectivity methods that allow mapping at continental scale (i.e., CBA, or “Cell Based Association” method developed by BRGM).

- Display and distribute the map and description on the Information platform.
- Highlight mineral resources criticality to high-tech economy and downstream sectors.

Description of work

Produce metallogenetic map and increase the knowledge on the CRM endowments and resource potential in Europe and EU seas, based on collecting information of:

- Mineralisations and deposits on land and the marine environment (linkages to all relevant WPs of RM3A) in which CRM make the main commodities, e.g. REE minerals related to carbonatite, nepheline syenites, pegmatites or paleoplacers, tungsten deposits related to granites, lithium feasible pegmatites, graphite hosted by schists.
- Mineralisations and deposits on land and the marine environment in which CRM make associated commodities, e.g. REE in bauxite deposits and manganese nodules; cobalt in nickel deposits and ferromanganese crusts; vanadium in iron-titanium deposits;, indium and tellurium in VMS and epithermal gold deposits.
- Secondary resources, in terms of historical and modern mineral-based mining wastes (waste rocks, processing tailings, metallurgical residues) and by-products, e.g. REE in apatite concentrates related to iron extraction and red mud derived from alumina refining; indium in the waste streams of lead-zinc sulphide mining.
- Prospectivity assessments for a continental scale approach for a selection of STR and CRM materials (according to the 2017 CRM list from the European Commission, and based on the availability of data, i.e. known mineral deposits of targeted commodities). These prospectivity assessments will benefit from the latest developments in “data driven” mineral prospectivity methods that allow mapping at continental scale (i.e., CBA, or “Cell Based Association” method developed by BRGM).

Deliverables

D3.1 Producing a report describing the methodology used for the identification and selection process of the CRM to be included in the metallogenetic map. M3

D3.2 Providing a data platform, digital version of metallogenic map and related description report highlighting the endowment and exploration potential of CRM in Europe. M28

D3.3 Producing a predictivity map outlining the CRM exploration potential areas and the major prospective minerals belts. M32

D3.4 Providing CRM data and intelligence to EURMKB (RM1) and the GeoERA information platform. M34

D3.5 Prospectivity maps of CRM in Europe. M24

Milestones

M3.1 Methodology for collecting CRM data from primary (land and marine) and secondary sources - M4

M3.2 Metallogenetic map of CRM in Europe- M29

M3.3 CRM and STR predictivity and mineral exploration potential map-M34

Work package number	**4**		Lead beneficiary				Royal Belgian Institute of Natural Sciences (RBINS)		
Work package title	**Critical Raw Materials in phosphate deposits, and associated black shales**								
Participant number	1	4	5	7	13	15	16		
Short name of participant	LNEG	CGS	GSE	GSI	NGU	RBINS	GeoInform-GIU		
Person months per participant	3	2	2	2.5	6	26	1,67		
Start month	1					End month	36		

Objectives

This work package (WP 4) “Critical Raw Materials in phosphate deposits, and associated black shales” is dedicated to the assessment of economic potential of igneous and sedimentary phosphate deposits (and their host black shales) in Europe, especially regarding Critical Raw Materials (CRM). These deposits could significantly contribute to a secure sustainable access to a large proportion of Europe’s requirement for these CRM. This project proposal is therefore consistent with the SRT “RM4 – Forecasting and Assessing Europe’s Strategic Raw Materials Needs”. More precisely, this WP aims to provide an overview about phosphate mineralization (and associated economically interesting black shales). It will comprise detailed mineralogical and geochemical characterization of key phosphate deposits, sedimentary and igneous in origin. These metallogenic, mineralogical and geochemical studies will help to decipher the processes leading to CRM enrichment in these deposits. Since part of the phosphorites in Europe are hosted within metalliferous black shales, the latter will be considered as well, with the view of a combined and rational exploitation of these resources. Another aim is the development of a procedure to prepare and analyze samples from phosphate deposits. This would be helpful to provide internally consistent geochemical data at a European level for this type of mineralization. Finally, the data from the project will contribute to databases, such as those from Minerals4EU, the European Union Raw Materials Knowledge Base (EURMKB), SRT RM1, and the GeoERA Information Platform.

Despite the obvious interest, most phosphate deposits, and their host-rocks, have not been studied for some time (a few decades), especially with respect to their potential for CRM. The identification of the economic potential of phosphate deposits, whether they are of sedimentary or igneous origin, could significantly contribute to secure access to many elements listed as critical by the EC. The aim of this project is to provide an overview of phosphate mineralization (and economically interesting black shales) in Europe, with special emphasis on their CRM content. The project aims to identify new areas of interest for CRM.

More precisely, the objectives are:

- Mineralogical and geochemical data will be acquired on selected phosphate deposits and occurrences. WP partners have access to data and samples of phosphate deposits/occurrences (as well as host-rocks) within their respective countries. This will facilitate (1) the development of databases on these deposits, and (2) access to samples for mineralogical and geochemical studies.
- Investigate more carefully a selection of key phosphate deposits, which will be representative of the different types of phosphate mineralization encountered in Europe. The goal will be (i) to provide an up-to-date scientific overview about the genesis of phosphate deposits in Europe, (ii) to determine more clearly the potential for and speciation of CRM in phosphate deposits (and host metalliferous black shales), and (iii) to investigate the processes leading to their enrichment.

- Establish a procedure for sample preparation and analysis of phosphate samples with the objective of providing internally consistent geochemical data on a European level.
- An enhanced database will be developed, compiling data collected during this project and information from the literature and older databases. These data will be integrated into existing databases, such as Minerals4EU, the European Union Raw Materials Knowledge Base (EURMKB), SRT RM1, and the GeoERA Information Platform. They will also be available in map format.

The expertise of the partners in the fields of ore geology, mineralogy, and geochemistry, and access to relevant, state-of-the-art facilities (SEM, XRD, Raman spectroscopy, XRF, ICPMS) available at GSB, CGS will significantly contribute to achieving these goals. Most of the WP partners have been collaborating on these topics for several years through Expert Groups established by EuroGeoSurveys (MREG and GEEG) Moreover, some of the WP partners are already involved in national and international projects, the outcomes of which will contribute to the present WP. Examples include EuroGeoSource, Minventory, Minerals4EU, SCREEN (Solutions for Critical Raw Materials), MIREU (EU network of mining and metallurgy regions), and ORAMA (Optimising quality of information in Raw Materials data collection across Europe). The expertise of, and cooperation between the partners will be further developed within this project.

Description of work

The objectives of this WP will be achieved through the following integrated steps.

Task 4.1 Prepare an overview of the phosphate deposits and occurrences in Europe by compiling an integrated database – from the literature and older databases: The data that will contribute to the development of the database are:

- the different commodities/CRM associated with phosphate deposits (P, F, REE, and others);
- the size of the deposits according to their known tonnages (and at least the possibility to discriminate occurrences from deposits, when the tonnage of deposits is not known);
- the type and origin of the phosphorus-phosphate mineralization and deposits (sedimentary, volcano-sedimentary, igneous, hydrothermal, Fe-apatite deposits, unspecified);
- the age of the deposits/occurrences and the host rock; (v) the commodities/CRM (Be, Sb, Co, PGM, V and Cr) associated with black shales, when applicable and available.
- The information (and maybe structure) of the Minerals4EU database will be used to develop the new database. The partners of this WP will provide information from within their own countries. Data from other European countries will be collected by WP 4 partners from readily available literature and data sources.

Task 4.2 Acquisition of new mineralogical and geochemical data on representative samples from phosphate deposits/occurrences (and their host-rocks), in order to determine their potential to host CRM, and the speciation of the latter. The deposits/occurrences should be as numerous as possible and distributed widely. To achieve that goal, each partner will select and study samples from its own country. For countries not in this WP, samples may be selected for those countries from partner organisations within the WP with large sample collections, such as GSB. These samples will be studied by WP partners.

From a geochemical point of view, the economic potential of phosphate mineralization will be assessed by whole-rock analyses comprising major elements, trace elements, and PGE (in case of black shales). An analytical protocol will be developed in order to obtain harmonized data is presented. The project aims to establish a procedure to prepare and analyse phosphate samples with the goal to provide internally consistent geochemical data at the European level for this type of mineralization. Most of these analyses will be carried out using instrastructure available within the partners. Further REE, F and PGM analyses will be obtained using ICPMS, in Geological Surveys such as CGS or BRGM. Wherever the samples are analysed, particular attention will be paid to the consistency of the analyses. Well-tested phosphate standards will be prepared/obtained and made available for all laboratories to ensure analytical homogeneity and comparability. In order to carry out mineralogical investigations several analytical techniques will be used, depending on the needs: X-ray diffraction (XRD), optical microscopy (including cathodoluminescence), scanning electron microscopy (SEM) coupled with energy dispersive spectrometer (EDS), Raman spectroscopy, and possibly electron microprobe. These facilities are commonly found in the Geological Surveys involved in this WP (GSB, CGS). If not available GSB will provide access to XRD, SEM and Raman spectroscopy.

Task 4.3 Detailed metallogenic studies of key phosphate deposits. These case studies will examine both sedimentary and igneous-related phosphate deposits, medium to large in size, with a view to future exploitation. The selection of deposits will be as representative as possible. This metallogenic approach could also be applied to black shales (hosting phosphorites), if the latter appear promising regarding their CRM content. For the study of these deposits, a careful petrographic study will be carried out. Apart from the analytical techniques evoked for objective 2, cathodoluminescence (CL) microscopy could be used to detect the presence and the level of REE-enrichment in apatite. The chemistry of minerals hosting CRM (such as apatite in phosphate deposits, or sulphides in metalliferous black shales) will be further investigated using electron microprobe and LA-ICP-MS analyses. The changes of apatite chemistry - and from an economic point of view, its REE and F enrichment - will provide crucial information about sedimentary processes/diagenesis in the case of phosphorites, and the involvement of different types of fluids (late-magmatic/metasomatic/hydro-thermal/supergene) in an igneous context. Further, oxygen, carbon and strontium isotopic compositions could be measured to provide additional information about the origin of the phosphate deposits. Oxygen and Sr isotopes are commonly used to emphasize (late-) magmatic/hydrothermal/supergene mineralizing processes in igneous environments. Carbon, oxygen and strontium isotopic compositions are also well suited for sedimentary deposits, to compare diagenetic apatite and seawater signatures. Other isotopic analyses (Pb, Nd, S) could be considered for the study of metalliferous black shales. Moreover, if possible, an up-to-date 'order of magnitude' estimate of the resources will be provided. Any publicly available information on phosphate (and any CRM content) reserves will also be collated and compiled. The combination of these new data sets will lead to (i) a better understanding of the CRM distribution and enrichment within these deposits, and constrain the processes which have led to these enrichments, and (ii) identify and highlight the potential of these deposits regarding the CRM.

Task 4.4 Data migration to specific databases. Finally, all the data acquired and developed within the project will be made available and integrated into the following databases: Minerals4EU, the European Union Raw Materials Knowledge Base (EURMKB), SRT RM1, and the GeoERA Information Platform in both web-viewer and atlas formats.

Deliverables

D4.1 Overview of the phosphate deposits and occurrences in Europe under the form of a database and map(s). M6

D4.2 New mineralogical and geochemical data on samples from phosphate deposits/occurrences (+ host black shales). These samples should be as numerous and as widely geographically distributed as possible, and coming from different types of deposits. M20

D4.3 Detailed metallogenic studies of key phosphate deposits. The selection of deposits aims to be as representative as possible of the phosphate deposits encountered in Europe. M30 D4.4 Development of a procedure to prepare and analyse phosphate deposits with the objective to provide internally consistent geochemical data at a European level for this type of mineralization M32 D4.5 Providing Phosphate data and intelligence to EURMKB (RM1) and the GeoERA information platform. M34 **Milestones:** M4.1 Partners identify the case studies/regions (key phosphate/black shale deposits) to study M4 M4.2 Partners (1) approve the list of samples to investigate in order to provide D4.2, (2) decide where the analyses will be carried out, and analyses to perform. M8 M4.3 Final report and end of the WP. M35

Work package number	5	Lead beneficiary						Geological Survey of Norway (NGU)			
Work package title	**Energy Critical Elements**										
Participant number	1	3	4	6	7	8	11	13	16	17	18
Short name of participant	LNEG	BRGM	CGS	SGU	GSI	GTK	IGMEsp	NGU	GEOInform-GIU	IGR	GeoZS
Person months per participant	6	8.7	5.0	6.15	3.5	8	2	7,5	6,675	36	4
Start month	1						End month		36		

Objectives Natural graphite, lithium and cobalt are essential components in modern and mobile energy storage technology, most notably in rechargeable lithium-ion batteries. The current work package will investigate, generate and compile data on the occurrence and production of these “energy critical elements” in order to provide a better and more accurate basis for exploration and exploitation, as well as land use management, and to provide high quality mineral intelligence data to the European data portals. Natural graphite and cobalt are both critical raw materials in the 2017 EU criticality assessment, while lithium is located above the supply risk threshold. The main application of **natural graphite** today is for refractories in the manufacture of steel and other metals. However, it is believed that the consumption for batteries will grow significantly over the coming years with increased electrification in the transport sector. Today natural graphite is produced in Norway, Austria and Ukraine, with Norway as the largest European supplier to the EU. In addition to Norway, The Czech Republic, Slovakia, Sweden and Finland are known to have potential for natural graphite. A pan-European compilation of resources, resource potentials, and geological data for natural graphite is essential in order to understand and assess the European potential for energy critical elements, and is a major objective in the work package. The main application of **Lithium** today is for rechargeable batteries (Roskill 2016). Despite numerous European lithium ore deposits, used for ceramic industry needs, all batteries are made of non-European

lithium. In Europe, lithium resources occur in several forms, including hard rock hosted and geothermal brines. Portugal, Spain, Austria, Finland, France, Czech Republic, Germany and Ireland among others, have high potential for Li-rich pegmatites and granites. Unknown/unconventional Li deposit types have not be considered, and a review of European Li ore deposit types & models is needed to improve mining exploration ore targeting. Knowledge on these resources (Minerals4EU, ProMine) are heterogeneous and considerably reduces the possibility for an exhaustive assessment of European reserves. The goal is first to complete existing databases and to extend them by the use of data augmentation. A second objective is to estimate the lithium reserves, of all types in Europe.

In the global perspective, **cobalt** is typically produced as byproduct of nickel production; the only significant exception to this rule is the deposits in the southernmost Democratic Republic of Congo (DRC) where cobalt is predominantly associated with copper mineralizations. Globally, economical cobalt deposits can be classified to three major types: 1) lateritic Ni-Co ores, 2) certain cobalt-enriched sedimentary rock-hosted copper deposits (only in DRC), and 3) mafic-ultramafic rock associated sulphidic Ni-Cu-PGE ores. Finland is currently the only EU country producing cobalt from its mines. In the entire Europe, also Russia has mine production of cobalt, from the Pechenga nickel mines. All countries producing nickel do have potential to also produce cobalt, as these two metals overwhelmingly occur in same ore minerals. However for the entire Europe, the mine production data available indicate no cobalt production in countries producing nickel: including Albania, Greece, Kosovo, Macedonia, Norway, Poland, and Spain. That these countries do not recover cobalt from their mined nickel ores suggests challenges in ore processing/recovery and/or insignificant cobalt concentrations in the ore, causing processing to be uneconomical. Globally significant cobalt refining has been done in Finland for decades. During years 1997−2003, Finland was even the largest cobalt refiner in the world. After that, China took over the leading position, but Finland is still the second biggest refiner globally. Annual refined cobalt production in Finland has ranged between 8 000 – 12 500 tpa.

Description of work

Task 5.1. GRAPHITE: Provide an overview of geological provinces with known resources or potential for natural graphite in Europe. This includes a compilation of past and present graphite production and potential future prospects. Generate an overview of available exploration data, including drill cores, geophysics and other relevant data.

- Characterize the geological setting of graphite mineralisations in different countries through detailed case studies of representative deposits or prospects. The characterization should include (1) Host and country rock association, petrography and mineralogy; (2) Radiometric age; (3) Tectonics and structures; (4) Metamorphism and tectono-metamorphic history.
- Where available, case studies should include data from (1) XRD, Raman spectroscopy, stable isotope analyses; (2) Image analysis and in situ grain size distribution; (3) Beneficiation results.

Task 5.2. LITHIUM: Upgrade data on European lithium hard-rock deposits within the Minerals4EU database; Format all outcomes for integration in the Information Platform according to INSPIRE standards and the EU Raw Materials Knowledge Base (EU-RMKB).

- Develop and validate a simple method for data augmentation of the existing pan-European database (Minerals4EU).
- Provide an overview of known lithium ore deposit types, associated characteristics and spatial distribution in EU, and estimate the potential for new sedimentary/hydrothermal Li deposits types.
- Evaluation of lithium ore deposit as a source of other CRM – W, Nb, Ta, REE … as a complex ores.

- Overview of suitable beneficiation methods.

Task 5.3. COBALT: Provide an overview of known deposit types where cobalt occurs in significant concentrations in Europe. This includes a compilation of past and present production and potential for new discoveries.

- Provide an overview of geological provinces with known resources or potential for cobalt in Europe. Generate an overview of available exploration data.
- Characterize the geological setting of cobalt mineralization styles in different countries.

Characterize mode of cobalt occurrence in different mineralization style for better understanding of the processing requirements.

Deliverables

D5.1 Provide mineral potential and prospectivity maps of key mineral provinces in Europe with deposits of, or potential for, energy critical elements (natural graphite, lithium, cobalt) in collaboration with WP 3. M 28

D5.2 Develop and/or review models for the formation of natural graphite, lithium and cobalt in Europe. M 30

D5.3 Report: Energy critical metals and minerals in Europe; occurrence, types, characteristics, formation, and future potential for European production. M 32

D5.6 Provide INSPIRE-compliant harmonised data on deposits and prospects of natural graphite, lithium and cobalt for the EURMKB (RM1). M34

Milestones:

M5.1 Establish an overview of known European prospects and deposits of natural graphite, hard rock lithium and cobalt as a working base for WP 5 (M4)

M5.2 Report on occurrence, types, characteristics, formation, and future potential for the production of natural graphite, lithium and cobalt from European sources (M32)

M5.3 Map of Cobalt, Graphite, Lithium deposits (including deposits where cobalt is a significant byproduct) M32

M5.4 Relevant Metallogenic maps M34

Work package number	6	Lead beneficiary			Geological Survey of Sweden (SGU)	
Work package title	**Conflict free Nb-Ta for the EU**					
Participant number	1	6	16	11	18	
Short name of participant	LNEG	SGU	GeoInform-GIU	IGMEsp	GeoZS	
Person months per participant	2	9	1,67	18,6	3	
Start month	1			End month	36	

Objectives

The chemically related elements niobium (Nb) and tantalum (Ta) are two of the most particular critical metals (critical raw materials; CRM), of which Ta, and associated Nb are extensively sourced as so-called conflict mineral from the central African region today. As such, their mine production is associated with abhorrent and often slave-like conditions for mine workers, which include children, as well as being a fundamental source of income for local warlords. While legislation is now in part being enforced to "guarantee" conflict-free Nb and Ta in industrial products, this is very far from being without major caveats. An alternative, or complimentary action to this, is to find potential sources of these rare metals within the EU and associated countries.

The main objectives of this WP are therefore to do a survey of the pan-European distribution of the conflict metals Nb-Ta and also enhance their exploration interest and potential in order to produce them ethically and indigenous to the Community. The deposits will be classified based on genetic type and subdivided as to timing of formation and regional distribution. As far as possible, the detailed ore mineralogy of Nb-Ta will be collated and described for the assessed deposits/mineralisations, to maximise the usefulness with regards to processing and associated evaluation parameters of their economic potential. Potential by-products, not least of other critical or strategic metals and minerals will be taken into account. This survey and its outcomes will also form the basis for developing recommendations for future exploration for these metals in Europe. Another important objective is to discuss and make draft recommendations for future projects to improve conditions for Nb-Ta and other CRM production in central Africa.

Description of work

Task 6.1. Collection and integration of geological and mineralogical/metallogenic data on Nb-Ta. Nb-Ta mineralisations are typically associated with granites and specifically granitic pegmatites, such as generally known from e.g. the Palaeoproterozoic bedrock of the Fennoscandian Shield and several younger granites and granitic pegmatite fields in Europe. Niobium is also present in pyrochlore-group minerals in carbonatitic as well as syenitic rocks, which have a much more restricted distribution. Geological and mineralogical/metallogenic data from pan-European sources will be integrated in order to create a new dataset on the distribution and systematics of Nb-Ta mineralisation in Europe. Conventional as well as unconventional primary source types (e.g. granites, granitic pegmatites, greisens, syenitic to phonolitic rocks, carbonatites) will be considered.

Regions with increased potential will be specifically assessed (e.g. Fennoscandia, Iberian Peninsula, SW England, Ireland, Massif Central/France and East central Europe). This will entail accessing and synthesising information that is available to the public and academia, as well as, when available, additional datasets, including e.g. exploration reports.

Task 6.2 Collect new data on selected deposits. Based on data compilation in Task 6.1, a selection of deposits from key areas will be sampled and analysed, both as to total chemistry as well as specific mineral chemistry of Nb-Ta and associated CRM, and their textures and grain sizes. An initial case study focusing on Swedish deposits will be undertaken, but this can potentially be expanded to include the entire Fennoscandian shield, and other regions in Europe.

Task 6.3. Develop recommendations for future exploration in Europe for Nb and Ta. Utilising findings of the task 6.1 and 6.2 as a baseline study for assessing the potential for Nb-Ta in Europe, the identified prospective regions and their character of mineralisation will also be used to develop recommendations for future exploration.

Task 6.4. Discussion of the potential for relieving European import dependence of Nb-Ta. While legislation, both within the EU and USA, is now being enforced to "guarantee" conflict-free Nb and Ta in industrial products, this is very far from being a simple solution, both with regards to the handling and transparency within any chosen process of classification of metal origins, and to the blunt avoidance of produce from central African sources which do not have a conflict situation. Any discussion of conflict minerals must address the conditions of Nb-Ta production in central Africa with the aim to suggest improvement and functional solutions to these prevalent issues. A discussion will be brought forward on the potential of intra-European production of Nb-Ta to decrease the now total dependence on imports. This will highlight selected mineralisations or regions with the best potential based on the knowledge base that has been created in task 6.1, 6.2 and 6.3.

Deliverables

D.6.1. A report on the distribution and systematics of Nb-Ta mineralisations in Europe, including a case study. This will include new INSPIRE compliant data of selected Nb-Ta deposits that will be available for integration into the EURMKB (RM1) and the GeoERA Information Platform. M24

D.6.2. A report outlining recommendations for future exploration in Europe for Nb-Ta. M30

D.6.3. A discussion and draft outlining the possibilities for relieving European import dependence and improvement of conditions for Nb-Ta production in central Africa. M34

D6.4. Providing Nb-Ta mineralisations in Europe data and intelligence to EURMKB (RM1) and the GeoERA information platform. M35

Milestones:

M6.1. Regional overview of the distribution and systematics of Nb-Ta in Europe. M24.

M6.2. Recommendations for future exploration of Nb-Ta in Europe. M30.

Work package number	**7**	Lead beneficiary						Federal Institute for Geosciences and Natural Resources (BGR)		
Work package title	**Historical mining sites revisited**									
Participant number	1	2	3	4	6	7	10	13	14	15
Short name of participant	LNEG	BGR	BRGM	CGS	SGU	GSI	IGMEgr	NGU	PGI/-NRI	RBINS
Person months per participant	3	43,5	1	3	2	2	8	6	6	6,2
Participant number	16	17	18	19						
Short name of participant	GeoInform-GIU	IGR	GeoZS	ISPRA						
Person months per participant	1,67	12,5	2	4,3						
Start month	1					End month		36		

Objectives

The project aims at improving European regional geological and metallogenic knowledge regarding future potential of existing mine sites and will contribute to improving pan-European geological information on CRM by providing an overview and case studies on critical raw materials contained in known European deposits while focus will be given to former highly and longtime active mining regions.

The project will feed site-specific data of ore deposits with CRM potential into the pan-European knowledge base on raw materials and thus broaden the understanding of the raw material potential in Europe (including secondary raw materials from mine wastes).

The project will generate data and additional information which will be harvested into the GeoERA Information Platform and contributes also to the improvement of transparent information flow and general knowledge improvement.

Information provided by the project can contribute to special planning topics and ensure an integration of raw material potential into future land use and policy planning and thus to the optimal use and sustainable management of the subsurface.

Knowledge generated in the project can be used as an additional source of information by European, national and regional policy makers, industry and other stakeholders.

Description of work

Europe is largely dependent on raw materials imports and thus relies on global markets and supply from international sources. Nevertheless, Europe has a long mining history and umpteen deposits have been mined even for hundreds of years. Some of those deposits are still in production today. The project will identify traditional mining regions or sites, which have the potential to feed in to Europe’s demand of raw materials in the future. It will include not only the main commodities of the deposits examined, but also focus on by-products such as high-tech metals and CRM (both further summarized as CRM herein). These metals might be produced as primary raw materials from the mining and beneficiation process or be contained in mine waste/tailings.

Task 7.1 Develop criteria for the identification of case studies and identification of potential case studies: As a first step mining sites and regions will be identified using existing data bases and projects, the surveys' expertise and literature studies. Criteria to identify those deposits will be developed within the project by all partners. Specific attention will be given to mining sites, which for geological reasons provide high potential to host CRM but not mined for those so far. D1 will be a report on the selection criteria and process. *Partners* LNEG, BRGM, CGS, SGU, GSI, IGMEgr, NGU, PGI/NRI, RBINS, GeoInform, IGR, GeoZS and ISPRA*, Months 1-7.*

Task 7.2 Case studies on RM potential from historic mine sites or regions: The project partners will study some of the deposits identified in detail to further assess the potential for CRM further. These case studies might involve site visits conducted by the partners to gather additional information and to collect samples, which will be analyzed in the partner surveys to evaluate the potential for CRM. Also, previous work of the partner surveys on specific deposits will be taken into account and existing data will be incorporated. The case studies will serve as examples for Europe's remaining CRM potential and can contribute to the revitalization of underused former mining regions. Hence, case studies will focus on known but unexploited deposits as well as on existing mines and mine wastes. The latter provide also the potential to reduce existing negative environmental impact of raw material production. These studies will be accomplished by fieldwork (sample collection) and laboratory work (analysis at the partners' laboratory facilities) including preliminary work on processing (by IGME -Greece) where appropriate. *Partners* LNEG, BRGM, CGS, SGU, GSI, IGMEgr, NGU, PGI/NRI, RBINS, GeoInform, IGR, GeoZS and ISPRA*, Months 3-24.*

Task 7.3 Study European RM potential (especially CRM) from known deposits: The case studies will be supplemented by investigations on additional mine sites, deposits and mining regions at a broader level by employing data, results and expertise from previous projects in Geological Surveys. The aim is to get an as comprehensive overview over the European raw material potential from known deposits as possible to assess the amount of CRM in the regions and sites examined. *Partners* LNEG, BRGM, CGS, SGU, GSI, IGMEgr, NGU, PGI/NRI, RBINS, GeoInform, IGR, GeoZS and ISPRA*, Months 3-24.*

Task 7.4 Compilation of results in Final Report: Main findings and results will be compiled in a final report, which will draw conclusions on the European CRM potential and, wherever applicable, highlight specific site related topics that might be obstacles for the exploitation of those raw materials (legal conditions; cross-border aspects; extraction techniques related to the special geological conditions; environmental aspects etc.). Hence, the project will a) provide an overview over the European CRM potential, b) draw conclusions on the possible future exploitation of European ore deposits. *Partners* LNEG, BRGM, CGS, SGU, GSI, IGMEgr, NGU, PGI/NRI, RBINS, GeoInform, IGR, GeoZS and ISPRA*, Months 24-30.*

Task 7.5 Data migration into the Mineral Inventory database (RM1): Relevant site-specific information, especially on the case studies, will be fed into the Mineral Inventory database created in RM1 by the project partners. Close cooperation with RM1 and a coherent template shall ensure that all requirements for the Information Platform are met. *Partners* LNEG, BRGM, CGS, SGU, GSI, IGMEgr, NGU, PGI/NRI, RBINS, GeoInform, IGR, GeoZS and ISPRA*, Months 28-36.*

Relation to existing EU projects and programs: The proposed project will make use of existing database from projects and in particular Minerals4EU to identify regions/specific sites, where deposits already are or have been mined. The EU-list on CRM will be taken into account while special attention are given on the remaining potential of CRM.

Scientific impact: The project will increase knowledge on Europe’s raw material potential taking into account Europe’s need for CRM. It will broaden the understanding of the raw material potential in Europe (including secondary raw materials from mine wastes) throughout its feed of site-specific data into the pan-European knowledge base on raw materials. It will contribute to the geological understanding of the ore deposits examined and touch on aspects concerning raw material extraction.

The knowledge generated on the Europe’s remaining CRM potential is are delivered to feed into policy decisions, spatial planning aspects and be a support to the industry. Thus the results can become a valuable input for special planning with regard to raw materials.

Deliverables

- D7.1 Report 1: Potential target areas identified / Overview concerning potential and criteria –M8
- D7.2 Template for content of case studies to ensure consistent data collection in line with requirements of the GeoERA Information Platform – M10
- D7.3 Report 2: Case studies – M24
- D7.4 Report 3: Final Report – M30
- D7.5 Site info in raw materials data bank and GeoERA IP – M34

Milestones:

- M7.1 Partners approve criteria to identify sites/regions for case studies and to identify the set of case studies – M4
- M7.2 technical data migration test phase – M31
- M7.3 Final report and end of the WP – M35

Work package number	**8**	Lead beneficiary					Laboratório Nacional de Energia e Geologia, I.P. (LNEG)			
Work package title	**Link to Information Platform**									
Participant number	1	2	3	4	5	6	7	8	9	10
Short name of participant	LNEG	BGR	BRGM	CGS	EGK	SGU	GSI	GTK	HGI-CGS	IGMEgr
Person months per participant	5	1	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Participant number	11	12	13	14	15	16	17	18	19	
Short name of participant	IGMEsp	MGSH	NGU	PGI/-NRI	RBINS	GeoInform-GIU	IGR	GeoZS	ISPRA	
Person months per participant	0,5	0,5	0,5	1	0,5	1,14	1	1	0,5	
Start month	1					End month		36		

Objectives

The main objective is to identify and discuss requirements in close dialogue with the Information platform (IP) team.

Furthermore, this work-package is to ensure that the principles and guidelines provided by the GIP-project is followed and implemented.

Facilitate that the information generated is provided to the improvement of the European Union Raw Materials Knowledge Base (EURMKB), as crucial input to the minerals yearbook and inventory information system (RM1), and ensure the information uploaded to the EGDI repository and extensions.

Description of work

The tasks in this WP described below, will ensure that the requirements of this project are fully understood and considered in the IP-project. A dedicated collaboration structure coordinated though this WP toward the IP-project WP 1, will be established at an early phase (M1). In addition, the following tasks will be carried out:
Task 8.1: Requirements (M6-9) - Internal IT requirements to be able to deliver final data package to Information Platform. Task undertaken by lead partner in collaboration with internal IT experts
Task 8.2: Prototyping (M14-18) - Testing of internal means in terms of data storage, treatment and delivery. Task undertaken by lead partner in collaboration with central GeoERA Information Platform.
Task 8.3: Testing and implementation (M24-36) - testing and implementation/delivery of external links and delivery to central data platforms. In collaboration with all lead partners of WPs and central GeoERA Information Platform.

Deliverables

D8.1	Deliver, in conjunction with the central GeoERA Information Platform a norm for data format and delivery M6
D8.2	Implement IT equipment infrastructure capable of interacting with internal system requirements to ensure delivery and increase the reliability of data and information to the EURMKB M12
D8.3	Assist in the data planning for the raw materials under study M6-36
D8.4	Final compilation of data and delivery to central GeoERA IP M36
Milestones:	
M8.1	Report on the data normative and format requirements M18
M8.2	Report of data and intelligence delivery to GeoERA IP M36

Table 3.1b) List of work packages

Work package No.	Work Package Title	Lead Participant No.	Lead Participant Short Name	Person - Months	Start Month	End month
WP 1	Coordination/Lead	1	LNEG	18	1	36
WP 2	Communications, Dissemination and Exploitation	1	LNEG	31	1	36
WP 3	Critical and Strategic Minerals Map	6	SGU	81,67	1	36
WP 4	Critical Raw Materials associated with phosphate	15	RBINS	46,17	1	36
WP 5	Energy Critical Elements	13	NGU	84,48	1	36
WP 6	Conflict Minerals	6	SGU	37,27	1	36
WP 7	Historical mining sites revisited	2	BGR	99,17	1	36
WP 8	Link to Information Platform	1	LNEG	17,64	1	36
				Total person - months	415,40	

Table 3.1c) List of deliverables

Deliverable #	Deliverable name	Work package number	Short name of lead participant	Type (1)	Dissemi-nation level (2)	Delivery date (in months)
D1.1	Description of work	1	LNEG	R	CL	3

D1.2	Ethical requirements(consent procedures, protection of personal data)	1	LNEG	R	CL	3
D1.3	Terms of reference (governance)	1	LNEG	R	CL	3
D1.4	Management report (submission of consolidated report to the European Commission)	1	LNEG	R	CL	18
D1.5	Management report (submission of consolidated report to the European Commission)	1	LNEG	R	CL	36
D1.6	Final Report	1	LNEG	DEC	PU	36
D2.1	Communication strategy	2	LNEG	R	CL	1
D2.2	Visual identity (Logo, Templates, Project site, etc.)	2	LNEG	DEC	PU	1
D2.3	Collection of Information materials (Leaflet, Website, Media kits etc.)	2	LNEG	DEC	PU	36
D2.3.2	Organization of events:	2	LNEG	DEC	PU	See below:
D2.3.3	Workshop	2	LNEG	DEC	PU	18
D2.4	Final event	2	LNEG	DEC	PU	36
D2.5	Triannual newsletters	2	LNEG	DEC	PU	4, 8, 12, 16, 20, 24, 30
D2.6	Final Newsletter	2	LNEG	DEC	PU	36
D3.1	Producing a report describing the methodology used for the identification and selection process of the CRM to be included in the metallogenetic map	3	SGU	R	CL	3
D3.2	Providing a data platform, digital version of metallogenic map and related description report highlighting the endowment and exploration potential of CRM in Europe	3	SGU	DEC	CL	28
D3.3	Producing a predictivity map outlining the CRM exploration potential areas and the major prospective minerals belts	3	SGU	R	PU	32
D3.4	Providing CRM data and intelligence to EURMKB (RM1) and the GeoERA information platform	3	SGU	R	PU	34
D3.5	Prospectivity maps of CRM in Europe	3	SGU	R	PU	24
D4.1	Overview of the phosphate deposits and occurrences in Europe under the form of a database and map(s)	4	RBINS	R	PU	6
D4.2	New mineralogical and geochemical data on samples from phosphate deposits/occurrences (+ host black shales). These samples should be as numerous and as widely geographically distributed as possible, and coming from different types of deposits	4	RBINS	R	CL	20

D4.3	Detailed metallogenic studies of key phosphate deposits. The selection of deposits aims to be as representative as possible of the phosphate deposits encountered in Europe	4	RBINS	R	PU	30
D4.4	Development of a procedure to prepare and analyse phosphate deposits with the objective to provide internally consistent geochemical data at a European level for this type of mineralization	4	RBINS		External	32
D4.5	Providing Phosphate data and intelligence to EURMKB (RM1) and the GeoERA information platform	4	RBINS	R	PU	34
D5.1	Provide mineral potential and prospectivity maps of key mineral provinces in Europe with deposits of, or potential for, energy critical elements (natural graphite, lithium, cobalt) in collaboration with WP 3	5	NGU	R	PU	28
D5.2	Develop and/or review models for the formation of natural graphite, lithium and cobalt in Europe	5	NGU	R	PU	30
D5.3	Report: Energy critical metals and minerals in Europe; occurrence, types, characteristics, formation, and future potential for European production	5	NGU	R	PU	32
D5.4	Map of Cobalt, Graphite, Lithium deposits (including deposits where cobalt is a significant byproduct)	5	NGU	R	PU	32
D5.5	Relevant Metallogenic maps	5	NGU	R	PU	34
D5.6	Provide INSPIRE-compliant harmonised data on deposits and prospects of natural graphite, lithium and cobalt for the EURMKB (RM1)	5	NGU	O	CL	34
D6.1	A report on the distribution and systematics of Nb-Ta mineralisations in Europe, including a case study. This will include new INSPIRE compliant data of selected Nb-Ta deposits that will be available for integration into the EURMKB (RM1) and the GeoERA Information Platform	6	SGU	R	PU	24
D6.2	A report outlining recommendations for future exploration in Europe for Nb-Ta	6	SGU		External	30
D6.3	A discussion and draft outlining the possibilities for relieving European import dependence and improvement of conditions for Nb-Ta production in central Africa	6	SGU	R	PU	34
D6.4	Providing Nb-Ta mineralisations in Europe data and intelligence to EURMKB (RM1) and the GeoERA information platform	6	SGU	R	PU	35

D7.1	Report 1: Potential target areas identified / Overview concerning potential and criteria	7	BGR	R	PU	8
D7.2	Template for content of case studies to ensure consistent data collection in line with requirements of the GeoERA Information Platform	7	BGR	other	PU	10
D7.3	Report 2: Case studies	7	BGR	R	CO	24
D7.4	Report 3: Final Report	7	BGR	DEC	CO	30
D7.5	Site info in raw materials data bank and GeoERA IP	7	BGR	DEC	PU	34
D8.1	Deliver, in conjunction with the central GeoERA Information Platform a norm for data format and delivery	8	LNEG	R	CL	6
D8.2	Implement IT equipment infrastructure capable of interacting with internal system requirements to ensure delivery and increase the reliability of data and information to the EURMKB	8	LNEG	other	CL	12
D8.3	Assist in the data planning for the raw materials under study	8	LNEG	other	CL	06-36
D8.4	Final compilation of data and delivery to central GeoERA IP	8	LNEG	DEC	CL	36

Codes Used:
(1) R: Document, Report (Excluding the periodic or final report)
DEC: Websites, patents filing, market studies, press & media actions, videos, etc.
OTHER: Software, technical diagram, etc.
(2) PU =Public, fully open, e.g. web
CO =Confidential, restricted under conditions set out in Model Grant Agreement
CI =Classified, information as referred to in Commission Decision 2001/844/EC

3.2 Management structure, milestones and procedures

Table 3.2a) List of milestones

Milestone number	Milestone name	Related work package(s)	Due date (in months)	Means of verification
M1.1	Kick-off meeting	1	1	Event occurrence
M1.2	dissemination of progress achievements	1	6, 12, 18, 24, 30, 36	Delivery of reports
M1.3	Final Meeting	1	36	Event occurrence
M2.1	Report on Communication strategy	2	1	Delivery of report
M2.2	Visual identity, logo design	2	2	Delivery and implementation

M2.3	Digital newsletters delivery to consortium	2	4, 8, 6, 12, 16, 20, 24, 30	Delivery
M2.4	Events documentation	2	18, 36	Delivery
M2.5	Final digital newsletter delivery to consortium	2	36	Delivery of report
M3.1	Methodology for collecting CRM data from primary (land and marine) and secondary sources	3	4	Delivery of report
M3.2	Metallogenetic map of CRM in Europe	3	29	Delivery of report
M3.3	CRM and STR predictivity and mineral exploration potential map	3	34	Delivery of report
M4.1	Partners identify the case studies/regions (key phosphate/black shale deposits) to study	4	4	Delivery of report
M4.2	Partners (1) approve the list of samples to investigate in order to provide D4.2, (2) decide where the analyses will be carried out, and analyses to perform	4	8	Delivery of report
M4.3	Final report and end of the WP	4	35	Delivery of report
M5.1	Establish an overview of known European prospects and deposits of natural graphite, hard rock lithium and cobalt as a working base for WP5	5	4	Delivery of report
M5.2	Report on occurrence, types, characteristics, formation, and future potential for the production of natural graphite, lithium and cobalt from European sources	5	32	Delivery of report
M5.3	Map of Cobalt, Graphite, Lithium deposits (including deposits where cobalt is a significant byproduct)	5	32	Delivery of report
M5.4	Relevant Metallogenic maps	5	34	Delivery of report
M6.1	Regional overview of the distribution and systematics of Nb-Ta in Europe	6	24	Delivery of report
M6.2	Recommendations for future exploration of Nb-Ta in Europe	6	30	Delivery of report
M7.1	Partners approve criteria to identify sites/regions for case studies and to identify the set of case studies	7	4	Delivery of report
M7.2	technical data migration test phase	7	31	Delivery of report

M7.3	Final report and end of the WP	7	35	Delivery of report
M8.1	Report on the data normative and format requirements	8	18	Delivery of report
M8.2	Report of data and intelligence delivery to GeoERA IP	8	36	Acceptance by coordinator of IP

Table 3.2b) List of critical risks for implementation

Description of risk (indicate level of likelihood: Low/Medium/High)	Work package(s) involved	Proposed risk-mitigation measures
Insufficient stakeholder involvement i.e.· Imbalanced representation *within* stakeholder groups (e.g. geographical, gender, sectors). Level: LOW	WP3- WP7	aim for diversity from the start; i.e. measures to involve and attract stakeholders in WP8 are designed this way
		permanent assessment of stakeholder presence and targeted continuous recruitment of underrepresented groups
		actively focus on the lack of input from certain groups, use the multiplier programme and “attract and hold” methodology in online community management (OCM) to keep stakeholders
		take great care to properly design the stakeholder engagement strategy (i.e. identification of right participants, their invitation and maintaining communication with multiplier organisations)
		coordinate stakeholder engagement strategy with other projects.
		increase the relevance of FRAME by selection of highly relevant and attractive topics, participation of and ‘sponsorship’ by high-level stakeholders, and invitations in the name of high-level bodies (EC).
		setup of public FRAME identity and website at a very early stage
Delays in task execution, particularly event organisation	All WPs	Clear and just time frame constraints at the beginning of the project
		apply guidelines for organising and running events will prevent any delays regarding process-design
		in-built project design (i.e. inter-linked WPs still allow for most of the tasks to be conducted to some extent independently)

Insufficient physical presence of Partners in physical meetings. Level: LOW	WP2- WP7	possibility to attend the meetings virtually through online tools
		excellent virtual communication tools allow for an open and inclusive work of the stakeholder groups, reduce the need for physical presence in meetings and thus increase the participation of underrepresented stakeholders. This underlies the careful need to remain within already predefined tight budgets
Decreasing interest of stakeholders to actively participate in meetings: Level: LOW	WP2- WP7	apply an early invitation policy guaranteeing that different people attend the meetings
		virtual tools will increase the likelihood of participation because not linked with any cost, people can attend from their home institutions
		visibility and accountability of participants to ensure interest
Low degree of output legitimation		online consultation and validation with ALL relevant stakeholders
·Lack of impartiality		open the platform for everybody to register
Institutional restricting activities amongst partners. Level: LOW	ANY	Sharing competence and functions between the partners, withhold of payment of non-performing partner, exclusion of the defaulting partner, transfer of tasks and funding to another partner
Inter-partner conflict: Level: LOW	ANY	Open and regular communications, quick response to possible problems, material availability, involvement of partners in management, management structure of disputes
Delays in finalising all input into data repository: Level: LOW	WP3- WP7	Use of strong management within WP2 and WP3 to intervene and find solution when problem arise
Non-availability of data in case studies. Level: LOW	WP3 -WP7	Prompt action of WP lead and task lead to find a realistic case to achieve the desired information out of.
Project outcomes appealing to specific stakeholder group and not to others. Level: LOW	WP3 -WP7	Strict and clear project management and consortium compositions to achieve the production of balanced project outcomes. Focus on scientific approaches and transparent procedures as the guides for results. High emphasis on not only consultations but creation of ownership through shared learning.

3.3 Consortium as a whole

Forecasting and Assessing Europe's Strategic Raw Materials Needs (FRAME) specifically finds expertise in the partners with more experience in the strategic and critical raw materials in Europe using their experience in projects such as Promine, Eurogeosource, EuRare, Prosum. The coordination and associated tasks of WP1 will be ensured by LNEG with a long experience in European and international projects. LNEG will manage the connection between WPs and provide the information produced in the previous WPs, to WP 8. The collaboration between WPs will be managed by a coordination committee composed of the leaders of WP1. LNEG will also be responsible for communication, dissemination and exploitation. This task will be carried out by a specific team within the institution, with experience in promoting the institution's activities and will be fundamental in the dissemination activities, identity of project, website development and organization of meetings.

WP 3 (Critical and Strategic Minerals Map) will produce a map of the current 27 Critical Raw Materials and also of the strategic raw materials for Europe, namely the ECE's and conflict minerals. WP3 will be the backbone of the project with links to the other WP's will be led by SGU with experience in leading EuRare and other projects related to mineral deposits. SGU will be supported by a team of experts from BRGM, CGS, GSI, HGI.CGS, IGME-Gr, IGME-Es, MGSH, GeoInform, IGR, GeoZS and LNEG who have a great experience in thematic mapping, gathering mineral resource data and correlating them with important geological/mineralising events. BRGM will take a sub lead in this work package defining methodologies to produce predictivity maps of important mineral regions in Europe with the help of the WP partners.

WP 4 (Critical Raw Materials associated with phosphate deposits and associated black shales) WP 4 is dedicated to the evaluation of economic potential of igneous and sedimentary phosphate deposits (and their host black shales) in Europe, especially regarding critical and strategic raw materials (CRM). WP 4 will feed in to WP 3 and subsequently also supply data to WP 2, 3 and 8 and will be lead by RBINS with expertise in phosphate deposits of both igneous and sedimentary origin that will interact with LNEG, CGS, GSE, GSI, NGU and GeoInform in countries with more or less bigger phosphate deposits that will be excelent case studies for the project and to feed the Information Platform.

Lead by NGU, WP 5 (Energy Critical Elements) The main objectives of this WP are to concentrate on strategic minerals and elements, namely lithium, graphite and cobalt, which are all considered vital to current energy storage equipment and drivers of today's technological societal mainstay. WP5 interconnects and will feed in to WP2, 3 and WP8. The minerals specialists from NGU, BRGM, LNEG, SGU, GSI, GTK, IGMEsp, CGS, GeoInform, IGR and GeoZS work together to reach the project objectives. The correspondent specialists of all partners involved will communicate with NGU and GTK.

WP 6 (Conflict Minerals) Although the term “conflict minerals” is normally applied to a group of several metals as well as minerals, including the columbite-tantalite group of minerals, also known as “coltan” (from which tantalum is derived), and additionally cassiterite (tin); gold; wolframite (tungsten); or their derivatives, this WP will focus solely on tantalum and niobium, the so called indispensable twins because of their affinity to occur in similar and very specific geological settings and their important applications in electronic superconducting technology, general high-technology applications, and alloy industries. SGU (Lead), LNEG, GeoInform, IGMEsp and GeoZs will compile and characterize these two Nb-Ta Strategic minerals for Europe. WP 6 interconnects and will feed in to WP 2, WP 3 and WP 8.

WP 7 (Historical mine sites revisited). Based on the concept that today's mine dump is potentially tomorrow's mine, this WP will create a database of potential locations where some or all of the strategic and critical raw materials may be found in European mine sites. Where possible this potential will be measured and evaluated. This WP will strongly link with WP 3, 4, 5, 6 because the known deposits of phosphates, energetic and conflict minerals are in some European countries almost all abandoned and a secondary resource is important to investigate. The work package will be led by BGR with a strong input from most of the project partners. LNEG, BRGM, CGS, SGU, GSI, IGMEgr, NGU, PGI/NRI, RBINS, GeoInform, IGR, GeoZS and ISPRA will collaborate in this work package that will feed data into WP 2, 3 and 8.

Lastly, WP 8 (Link to Information Platform) The cross-thematic integration of information is an important aspect to be addressed in GeoERA and therefore the objective of this WP is to provide and disseminate spatial information on the respective resources and underpinning geological data identified in the technical work packages of the project. It has a link to all WP's and all partners of the project and will receive and provide data in a format that will allow it to be uploaded to data platforms in a future date. This WP will also be assured by LNEG combining coordination of the teams by WP1 leadership and dissemination of results WP.

3.4 Resources to be committed

Table 3.3a) Summary of Staff Effort

	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	Total Person-Months per Participant
LNEG/1	18	18	4	3	5	2	3	5	58
BGR/2		3	1				43,5	2	49,5
BRGM/3		0,5	6,7		7,1		1	0,5	15,8
CZS/4		0,5	3	2	5		3	0,5	14
EGK/5		0,5		2				0,5	3
SGU/6		0,5	17		6,2	9		0,5	33,2
GSI/7		0,5	8	2,5	3,5		2	0,5	17
GTK/8		0,5			8			0,5	9
HGI-CGS/9		0,5	1,45					0,5	2,45
IGMEgr/10		0,5	3				8	0,5	12
IGMEsp/11		0,5	6		2	18,6		0,5	27,6
MGSH/12		0,5	6					0,5	7
NGU/13		0,5		6	1		6	0,5	14
PGI/-NRI14		1	3	3		3	6	1	17
RBINS/15		0,5		26			6,2	0,5	33,2
GeoInform - GIU/16		0,5	5,02	1,67	6,68	1,67	1,67	1,14	18,35
IGR/17		1	12,5		36		12,5	1	63
GeoZS/18		1	5		4	3	2	1	16
ISPRA/19		0,5					4,3	0,5	5,3
Total Person Months									415,4

Table 3.3b) 'Other direct cost' items (travel, equipment, other goods and services)

1/LNEG WP1 Coordination (*)	Cost (€)	Justification
Travel	€30 000	20 person meetings @ €1500 per person per meeting

Equipment	€4 935	2 PC's for management and coordination
Other goods and services	€8 500	Analytical services (120 samples - prep., delivery, disposal), Sundries
Total	€43 435	

1/LNEG WP2 C D E (*)	Cost (€)	Justification
Travel	€30 000	20 person meetings @ €1500 per person per meeting
Equipment	€5 630	2xPC with suitable characteristics (graphic design), camera and data show equipment
Other goods and services	€26 370	Organisation of events, Renting of suitable rooms, catering, fliers, dissemination materials, software licences
Total	€62 000	

1/LNEG WP8- Data IP(*)	Cost (€)	Justification
Travel	€7 500	5 person meetings @ €1500 per person per meeting
Equipment	€10 000	Data information platform, hardware, software and licences
Other goods andservices	€400	Sundries
Total	€17 900	

(*) LNEG leads three of the 8 WPs and hence budgets are split. LNEG also contributes data in other WPs

2/BGR	Cost (€)	Justification
Travel	€ 15000	Meetings and field work
Equipment		
Other goods and services	€ 3100	Analytics for 30 samples
Total	€ 18100	

3/BRGM	Cost (€)	Justification
Travel	€ 18000,00	6 meetings including all expenses (travel, accommodation, etc), i.e. 1 in 2018; 2 in 2019; 2 in 2020; 1 in 2021
Equipment		
Other goods and services	€ 2500,00	Conference participation; for open access publications
Total	€ 20500.00	

4/CZS	Cost (€)	Justification
Travel	€4 000	Kick-off meetings, Expert meetings
Equipment		
Other goods and Services	€1 603	Chemical and mineralogical analyses
Total	€5 603	

5/GSE (Estonia- Non-Funded Partner)	Cost (€)	Justification
Travel	€4500	Travel costs
Equipment		
Other goods and services		
Total	€4500	

6/SGU	Cost (€)	Justification
Travel	€13 000	Attending kick-off, progress and final meetings and field work WP3, WP5, WP6.
Equipment		
Other goods and Services	€5 000	Analysis of CRM in 30 samples. Production of 25 polished thin sections. SEM analyses (2,5 days at lab).
Total	€18 000	

7/GSI	Cost (€)	Justification
Travel	€6 400	8 person meetings @ €800 per person per meeting
Equipment		
Other goods and Services	€500	Miscellaneous (photography, stationery etc.)
Total	€6 900	

8/GTK	Cost (€)	Justification
Travel	€10 000	Attending kick-off, progress and final meetings and field work WP3, WP5, WP6.
Equipment		
Other goods and Services	€5 000	Analysis of CRM in 30 samples. Production of 25 polished thin sections. SEM analyses (2,5 days at lab).
Total	€15 000	

9/HGI-CGS	Cost (€)	Justification
Travel	€500	travel costs to sampling sites
Equipment		
Other goods and services	€500	analysis of mineral raw materials
Total	€1000	

10/IGMEgr	Cost (€)	Justification
Travel	€14 400	3 persons @1600 @3 travel
Equipment		
Other goods and services		
Total	€14 400	

11/IGMEsp	Cost (€)	Justification
Travel	€22500	Travel expenses and field work
Equipment	€5500	GPS and Chemical Reagents
Other goods and services	€6000	Open access costs
Total	€34000	

12/MGSH	Cost (€)	Justification
Travel	€1 100	travel to project meetings
Equipment		
Other goods and services		
Total	€1 100	

13/NGU	Cost (€)	Justification
Travel	€12 000	Progress and management meetings
Equipment		
Other goods and services		
Total	€12 000	

14/PGI	Cost (€)	Justification
Travel	€8 400	1-2 persons @700 @12 travels
Equipment		
Other goods and Services	€3 000	Chemical and mineralogical analyses
Total	€ 11400	

15/RBINS	Cost (€)	Justification
Travel	7 876,39 €	Meeting and travel
Equipment		
Other goods and Services	€6 300	5,000 for analyses, 1,300 for organization of meetings (2 one day meetings at the GSB-RBINS)
Total	€14176,39	

16/GeoInform	Cost (€)	Justification
Travel	€8626,53	Meeting and travel expenses
Equipment		
Other goods and services		
Total	€8626,53	

17/IGR	Cost (€)	Justification
Travel	€20 000	Meeting and travel expenses
Equipment		
Other goods and services		
Total	€20 000	

18/GeoZS	Cost (€)	Justification
Travel	€6 000	Meeting and travel expenses
Equipment		
Other goods and Services	€1 000	Analytical services
Total	€7000	

19/ISPRA	Cost (€)	Justification
Travel	€2 500	Meeting and travel expenses
Equipment		
Other goods and services		
Total	€2 500	

Table 3.3c) Financial table with requested budget

	Direct personnel costs	Other direct costs; travel, equipment, infrastructure, other	Direct costs of sub-contracting	Indirect costs (= (A + B) *0,25)	Total estimated eligible costs (=A+B+C +D)	Reimburse-ment Rate (29,7%)[1]	Requested EU contribution	Surveys in-kind contribution
	(EUR)	(EUR)	(EUR)	(EUR)	(EUR)		(=E*F)	= (E – G)
Laboratório Nacional de Energia e Geologia, I. P. [Project Coordinator]	303796,38	123335,00	0,00	106782,84	533914,22	0,297	158572,52	375341,70
Federal Institute for Geosciences and Natural Resources	318369,65	18100,00	0,00	84117,41	420587,06	0,297	124914,36	295672,70
Bureau de Recherches Géologiques et Minières	125553,06	20500,00	0,00	36513,25	182566,00	0,297	54222,27	128343,73
Czech Geological Survey	33190,00	5603,00	1380,00	9698,25	49871,25	0,297	14811,76	35059,49
Estonian Geological Survey **(1)**	7800,00	4500,00	0,00			0,297		
Geological Survey Sweden	246967,50	18000,00	0,00	66241,88	331209,38	0,297	98369,18	232840,19

Geological Survey Ireland	110500,00	6900,00	0,00	29350,00	146750,00	0,297	43584,75	103165,25
Geological Survey of Finland	63000,00	15000,00	0,00	19500,00	97500,00	0,297	28957,50	68542,50
Geological Survey of Croatia	17640,00	1000,00	0,00	4660,00	23300,00	0,297	6920,10	16379,90
Greek Institute of Geology and Mineral Exploration	37200,00	14400,00	0,00	12900,00	64500,00	0,297	19156,50	45343,50
Instituto Geológico y Minero de España	121523,14	34000,00	4000,00	38880,79	198403,93	0,297	58925,97	139477,96
Mining and Geological Survey of Hungary	11025,00	1100,00	0,00	3031,25	15156,25	0,297	4501,41	10654,84
Geological Survey of Norway	153750,00	12000,00	0,00	41437,50	207187,50	0,297	61534,69	145652,81
Polish Geological Institute	51000,00	11400,00	0,00	15600,00	78000,00	0,297	23166,0	54834,00
Royal Belgian Institute of Natural Sciences	249065,72	14176,39	0,00	65810,53	329052,64	0,297	97728,63	231324,01
State Information al Geological Fund of Ukraine	88682,47	8626,53	0,00	24327,25	121636,24	0,297	36125,96	85510,28
Institutul Geologic al Romaniei	157500,00	20000,00	0,00	44375,00	221875,00	0,297	65896,88	155978,13
Geološki Zavod Slovenije	56000,00	7000,00	0,00	15750,00	78750,00	0,297	23388,75	55361,25
Istituto Superiore per la Protezione e la Ricerca Ambientale	29000,00	2500,00	0,00	7875,00	39375,00	0,297	11694,38	27680,63

Estonia is a non-funded partner. They will contribute 12300€ of their own funds towards FRAME.

4 Members of the consortium (This section is not covered by the page limit)

4.1 Participants (applicants)

Partner 1 – LNEG

Laboratório Nacional de Energia e Geologia, I.P.

LNEG is an R&D institution oriented to respond to the needs of society and enterprises. Betting on a sustainable research and for sustainability through the generation of knowledge of our territory. Side by side with what´s best done internationally, LNEG guarantees to have in its areas of competence an adequate response to the needs of the business sector. We do Science in energy and geology with a view to its application in advanced solutions for leveraging our economy. The Portuguese National Laboratory for Energy and Geology (LNEG) is a State laboratory of the Ministry of Economy that makes R&D oriented to the needs of society and enterprises, investing in a sustainable research, along with the international best practices, ensures that its areas of expertise allow an adequate response to the needs of the business sector. LNEG is aware that cooperative work and networking can optimize skills and that knowledge sharing is a tool for success, so it is an active partner of the major networks and collaborative platforms in the areas of energy and geology. LNEG´s mission is to promote technological innovation science and technology oriented for economic development contributing to increase competitiveness of economic agents in the context of sustainable progress of the Portuguese economy.

The Department of Mineral Resources and Geophysics (URMG) of LNEG, which participates in the project, is one of the largest of the institution and includes the areas of Geophysics, Geology, Metallic Resources, Ornamental Rocks, Aggregates, Heavy Mineral studies and Metallogeny, Mineralogy, Geochemistry, Remote Sensing, etc.

A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.

Partner	Type	Reference
LNEG	Publication	Authors, year, title, publication, pp, URL
	Service	Current, Geoportal, http://geoportal.lneg.pt/
	Product	Carta Radiométrica de Portugal, à escala de 1:500.000 (2013); ISBN (Digital Edition): 978-989-675-027-5; ISBN (Paper Edition): 978-989-675-028-2 Carta de Ocorrências Mineiras do Alentejo e Algarve, à escala 1:400.000 (2013); ISBN (Digital Edition): 978-989-675-029-9; ISBN (Paper Edition): 978-989-675-030-5 Carta de Depósitos Minerais de Portugal (Região Norte) à escala 1:200.000 (2014); ISBN (Digital Edition): 978-989-675-035-0; ISBN (Paper Edition): 978-989-675-034-3 Carta Geoquímica de Cobre em Solos, Zona Sul Portuguesa, Faixa Piritosa Ibérica, à escala 1:400.000 (2016); ISBN (Paper Edition): 978-989-675-044-2

		Carta Radiométrica (Contagem Total), Zona Sul Portuguesa, Faixa Piritosa Ibérica, à escala 1:400.000 (2016); ISBN (Paper Edition): 978-989-675-045-9 Carta Gravimétrica (Anomalia de Bouguer), Zona Sul Portuguesa, Faixa Piritosa Ibérica, à escala 1:400.000 (2016); ISBN (Paper Edition): 978-989-675-046-6 Carta Magnética (Campo Total Reduzido do IGRF), Zona Sul Portuguesa, Faixa Piritosa Ibérica, à escala 1:400.000 (2016); ISBN (Paper Edition): 978-989-675-047-3

- **A list of up to 5 relevant previous projects or activities, connected to the subject of this proposal.**

Partner	Type of project/activity	Description
LNEG	Promine	Nano-particle products from new mineral resources in Europe. The philosophy behind ProMine is to stimulate the extractive industry to deliver new products to manufacturing industry.
	EuroGeoSource	EuroGeoSource is a data portal, which allows access by Internet to the aggregated geographical information on geo-energy (oil, gas, coal etc.) and mineral resources (metallic and non-metallic minerals, industrial minerals and construction materials: gravel, sand, ornamental stone etc.), coming from a wide range of sources in a significant coverage area of Europe (ten countries). The project was funded by the Competitiveness and Innovation Framework Programme (CIP), under the Policy Support Programme (PSP), Geographic Information Theme.
	Minerals4EU	The Minerals4EU project is designed to meet the recommendations of the Raw Materials Initiative and will develop an EU Mineral intelligence network structure delivering a web portal, a European Minerals Yearbook and foresight studies. The network provides data, information and knowledge on mineral resources around Europe, based on an accepted business model, making a fundamental contribution to the European Innovation Partnership on Raw Materials (EIP RM), seen by the Competitiveness Council as key for the successful implementation of the major EU2020 policies.
	MICA	The MICA project contributes to on-going efforts towards the establishment of a stakeholder tailored product, namely the "European Union Raw Materials Intelligence Capacity Platform" (EU-RMICP).
	PROSUM	The ProSUM Project aims to provide an inventory of secondary raw materials, particularly critical raw materials, arising in WEEE, ELVs, waste batteries and mining wastes. This inventory will support the EU European

		Innovation Partnership's Strategic Implementation Plan to build an EU raw materials knowledge base.

- **A description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.**

Partner	Type	Description
LNEG	Infrastructure	Geoportal
	item 1	SIORMINP – Mineral deposit database of Portugal
	Archive	Archive of all mineral occurrences reports, both historic and current

Profile of key-staff members

Daniel P. S. de Oliveira holds a Ph.D. in Economic Geology from the University of the Witwatersrand (Rep. of South Africa) and a Ph.D. in Geology from the Faculty of Science of the University of Lisbon (Portugal). His area of specialty is the metallogenesis and petrography of mineral deposits. Additionally he works in geochronology, geochemistry and geological mapping, critical raw materials for Europe, Rare Earth elements and has been involved as a consultant at European level. He has coordinated and participated in a number of national and international projects. He is currently the Head of the Mineral Resources and Geophysics Research Unit in LNEG and the Chair of the Mineral Resources Expert Group of EuroGeoSurveys. *Role in the project:* D. Oliveira will lead RM4

Maria João Batista: PhD in Geosciences. Deputy Head of Mineral Resources and Geophysics Unit. About 24 years working in exploration and environmental geochemistry. Has been a participant in several EU funded projects including Mineo (5th FWP), Utpia (INTERREG IIIA), ESPON-HAZARDS (ESPON); PROMINE (7th FWP), EuroGeoSource (7th FWP), Minerals4EU (7th FWP), ProSUM (H2020), EXPLORA (ALENTEJO2020), ZOM3D (ALENTEJO2020), starting SmartExploration (H2020). Current Research Interests: Exploration geochemistry, Environmental geochemistry, Geochemical mapping at different scales, Multivariate statistics, Geostatistics; Predictive Modelling applied to exploration. Author and co-author of several articles, abstracts in conferences and book chapters (SCOPUS ID: 7005481948; orcid.org/0000-0003-0197-1004, h-Index 13). *Role in the project: MJBatista will assist in management and collaborate on* WP1 and WP4, 5 and 6.

Rute Salgueiro: PhD in Geology/Metallogeny. Researcher at LNEG, with 20 years of experience in mineral resources and mineral deposits area with participation in several national and international projects funded by the European Union in the previous and current framework program (EuroGeoSource, Min4EU, ProSUM). Development of R&D activity and thematic maps, mainly on REE minerals, gold, sulphide and iron deposits exploration. Head of the Heavy Minerals Laboratory, since 2000. Coordination of LNEG contribution to regional land use planning policies processes, since 2012. *Role in the project: R. Salgueiro will collaborate on* WP3, 4, 5 and assist in project management

João Xavier Matos, is a Senior Geologist at the LNEG's Mineral Resources and Geophysics Research Unit, since 1990. Currently is PhD student in Metallogeny and Master in Economic and Applied Geology, by the Faculty of Sciences, University of Lisbon. He is currently responsible for LNEG Aljustrel Drill Core Store, collaborating with ID projects related to Mineral Exploration, Geological and Mining Mapping and Stratigraphy in the southern of Portugal, especially in the Iberian Pyrite Belt massive sulphide European Mining province and Ossa Morena Zone. Presently is research He is currently responsible for the

Alentejo2020 EXPLORA and ZOM 3D projects and for the LNEG activities of the GEO-FPI Interreg POCTEP project. *Role in the project: JXMatos will collaborate on* WP7

Augusto Bento Filipe holds a Degree in Mining Engineering by the University of Coimbra (Portugal) and a Post Graduate in Georesources by the *Instituto Superior Técnico* - IST (Portugal). His area of specialty is in characterization, management and promotion of Portuguese mineral resources. He has been involved in the Creation and development of DBMS, management of mineral resources in GIS (highlight to the DBMS SIORMINP - Information System of Portuguese Occurrences and Mineral Resources). He also contributes for the territory management (PDMs and PROts). He had provided mineral resources information to some European projects: Inspire, Promine, Eurogeosource, Minerals4EU and Minatura 2020. *Role in the project: ABFilipe will collaborate on* WP3, 4, 5 and 7

Carlos M. C. Inverno was awarded degrees of BSc and License in Geology by the Univ. de Lisboa, Portugal in 1973 and 1975, respectively, and a PhD in Geology by Colorado School of Mines in 1991. He was a postdoctoral researcher at the Univ. Tasmania and its Centre for Ore Deposit Research (CODES) in 2000-2001 and earned Tenure at the Univ. Lisboa in 2008. He worked successively with the Bureau of Mines and Geological Survey of Portugal, Univ. Lisboa, Univ. Nova de Lisboa (Invited Professor) and for the last 23 years has been a Senior Researcher successively at Instituto Geológico e Mineiro, INETI and Laboratório Nacional de Energia and Geologia (LNEG) and also at the Centro de Recursos Minerais, Mineralogia e Cristalografia (CREMINER), Faculdade de Ciências, Univ. Lisboa (up to 2011). His main interests have been Sn, W, Au, REE, Li and VMS exploration and metallogenesis, having led/participated in Portuguese and E.U. projects in these fields, and he was co-advisor in 5 PhD and 1 MSc theses held at Portuguese, U.K. and South African universities and 1 post-doctorate at LNEG. *Role in the project: C.Inverno will collaborate on* WP3, 4, 5 and 6

Rita Solá: PhD Geology - Mineralogy, Petrology and Geochemistry (2007); Assistant Researcher at LNEG -Geology Unit. She has been working extensively on igneous and metamorphic petrology, geochemistry and geochronology applied to systematic geological mapping. Involved in several projects of geochronology and regional geology and magmatism. In addition to the geological mapping projects, she currently participates in mineral exploration projects of Iberian Pyrite Belt, namely in Neves-Corvo Mine. *Role in the project: R.Solá will collaborate on* WP WP3, 4, 5 and 6

Pedro L.T. Ferreira has a PhD in Earth Science – Geochemistry and Petrology, by the National Oceanographic Centre, University of Soutampton (UK), since 2006. Researcher at LNEG for the last 26 Years. Domain of specialization and scientific activity: Research involving geochemical studies of igneous rocks using major-, trace element, volatiles and isotopic studies as a means to explore sub-oceanic mantle melting processes, source evolution and magma differentiation along the upper mantle and Earth's crust. Systematic geologic mapping at 1/25 000 scale in Portugal territory (Paleozoic terrains) inside the national state project "Research of geological infrastructure and geological resources – Portuguese geological maps". Petrography of igneous rocks and volcanic rocks' textures, and their relationship with the physical volcanism types. Geologic mapping in intrusive and volcanic terrains in Antarctica. He was the Portuguese Representative in the InterRidge Steering Committee between 2009 and 2016. P Ferreira will collaborate in Project Management, WPs 3, 4, 5, 6, 7 and 8

Zélia Pereira holds a Ph.D. in Stratigraphy from the University of Porto (Portugal). Her area of specialty and research is Palynostratigraphy. Additionally she works in supporting data for geological mapping, biostratigraphic detailed age control and correlations on sedimentary basins, high resolution stratigraphy applied to exploration on economic resources in the mining and energy sector (coal, oil and gas) and geological heritage. She has participated in a number of national and international projects. She is currently the General Secretary of the CIMP (Commission Internationale de la Microflore du Paléozoique). *Role in the project: ZPereira will collaborate on* WP7

Teresa P. Silva is graduated in Technologic Chemistry from the Faculty of Sciences of the University of Lisbon (Portugal) and presented a dissertation equivalent to PhD to the Tropical Research Institute, in Minerochemistry. She is currently working as a researcher in LNEG-Laboratório Nacional de Energia e Geologia, mainly within the fields of mineralogy, geochemistry, X-ray analytical techniques including synchrotron radiation, spectroscopy (XANES, EXAFS). She has participated in several national and international projects and is co-author of more than 50 publications in national and international scientific journals with revision, in addition to numerous communications in conferences. *Role in the project: in TPSilva will collaborate on Project Management and* WP2, 3 and 7

Lídia Quental: M.Sc. in Georesources and Ph.D in Engineering Sciences from Technical University of Lisbon. Since 2000, she is a remote sensing expert using multi-source data and methodologies to improve knowledge in thematic areas of geosciences. She participates in several EU and transnational R&D projects related to raw materials, digital platforms and environmental risk assessment of mining areas. She is currently the Head of Geoscientific Information Research Unit in National Laboratory for Energy and Geology (LNEG). *Role in the project: LQuental will lead and collaborate on* WP8

Aurete Pereira is a geologist working at the Geoscientific Information Unit in LNEG. She graduated in geology from the Faculty of Sciences, University of Porto, and holds a MSc in Science & GIS from the Nova Information Management School, University of Lisbon. She won the CEN/TC 287 Award for Excellence in INSPIRE 2013 with her work in implementing the INSPIRE Geology Data Model in Geological Map Production in Portugal. Currently, she coordinates the INSPIRE-LNEG working group. Her area of specialty is information management and digital geological map production. She has participated in a number of national and international projects. *Role in the project: APereira will collaborate on* WP8

Gabriel Luís holds a Ph.D. in Mining Engineering and a M.Sc. in Mineralurgia and Mining Planning from the Technical University of Lisbon. He is a Research Assistant at the Portuguese Laboratory for Energy and Geology (LNEG) where during 12 years headed the Geoscientific Information Research Unit. He was responsible for several projects in the area of management and provision of spatial data related to geology and energy (e.g. OneGeology, OneGeology-Europe, AEGOS, LNEG's geoPortal). He also has participated in the following national and international projects: Min4EU, PanGeo, COMET, ENERGEO, LNEG2.0, EuroGeoSource, BAH, GeoSeas, PLANAGEO. He represents LNEG in the CO-SNIG and in the Spatial Data Interest Communities for INSPIRE. His research interests are geostatistics, modeling and mineral resource assessment, geoscience information systems, digital field data systems and geovisualisation. *Role in the project: GLuis will collaborate on* WP8

Pedro Patinha is a mining engineer at the Portuguese Laboratory of Energy and Geology (LNEG). He graduated in Mining Engineering (1991) and holds a MSc in Mineralurgy and Mining Planning (1994) from the Instituto Superior Técnico, Lisbon. He currently works at the "Geoscientific Information Unit" of LNEG and is expert in mapping and Geographical Information Systems. *Role in the project: PPatinha will collaborate on* WP8

Maria João Andrade de Almeida Dias Ferreira: graduation in Economics, 1976/1977 - Technical University of Lisbon. Posgraduation in Microeconomic Theory, Macroeconomic Theory and Economic Statistical and Econometric by the Instituto Gulbenkian da Ciência (Portugal). Head of Planning, Information and Communication Unit in National Laboratory for Energy and Geology (LNEG) since 2008, being responsible for planning and information and communication activities at internal and external levels, involving institutional website and Intranet, promotion of dissemination actions, management of image rights and the interface with the media. *Role in the project: MJFerreira will lead and collaborate on* WP2

Isabel Real: Degree in History at the Autonomous University of Lisbon (UAL). Senior Technician responsible for the preparation and follow-up of internal and external events (lectures, meetings, workshops, conferences), regarding in all logistics, such as (reservation of rooms, computer facilities, support material to be made available / pamphlets), flags, catering, etc. Ensure the compilation and treatment of information related to the activity developed for inclusion in the Plan, Activity Report and Semiannual Material Execution Report of the institution. *Role in the project: IReal will collaborate on* WP2

Teresa Calabaça: Expert on web content management and web content production. Manage institutional website and Intranet; manage LNEG's presence on Social Networks; give support to webmaster network; manage image rights and logo usage; participate in collaborative activities and projects with LNEG's R&D Units. Enhance public awareness of LNEG activities through events and other dissemination actions, at national and international levels; LNEG interface with the media. Knowledge of HTML, CMS, CSS, JavaScript, Dreamweaver and MS Office. *Role in the project: TCalabaça will collaborate on* WP2

Filipe Barreira: Graduated in Communication Design from Faculty of Fine Arts – University of Porto. Senior designer responsible for graphic and web design of internal reports, books, project logos, brochures/leaflets/pamphlets, posters, scientific posters, websites, e-newsletters, online books and reports, CG 3D illustration and animation of scientific content for books, reports, newsletters, posters and web content. *Role in the project: FBarreira will collaborate on* WP2

Maria José Leal: Degree in Information Management. She is a Senior Technician in National Laboratory for Energy and Geology (LNEG) and develops work in the Administration, management and updating of contents of the LNEG Portal and Intranet. *Role in the project: MJLeal will collaborate on* WP2

Maria Leonor Charaes dos Santos Gil André: Graduation in 'Geography and Regional Planning', 1988/1992 – UNL (Universidade Nova de Lisboa). Last Year of Course: ERASMUS student at University of Ulster at Coleraine, Northern Ireland. From February 1993 to February 2005 she worked at DGDR (Directorate-General for Regional Development): from February 1994 to February 2005, in Cohesion Fund's National Coordination, monitoring the application and execution phases of projects co-financed by the Cohesion Fund of the European Union, in the area of Transport, Ports and Environment; and in the area of EU enlargement to the Central and Eastern European countries, particularly training sessions to representatives of Ministries of these countries on the implementation and management of the Cohesion Fund (experience of Portugal).Since February 2005 she works at LNEG (National Laboratory of Energy and Geology), first at Financial and Patrimonial Management Department, then at Information and Comunication Department, developing Information and Communication activities at internal and external levels, namely promoting the Institution's activities, through the holding of events at LNEG and many other dissemination actions. *Role in the project: MLAndré will collaborate on* WP2

Partner 2 – BGR

The Federal Institute for Geosciences and Natural Resources (BGR)
The Federal Institute for Geosciences and Natural Resources (BGR) is the central geo-scientific authority providing advice to the German Federal Government in all georelevant questions. The BGR is a federal institute accountable to the Federal Ministry for Economic Affairs and Energy (BMWi) of Germany. BGR provides neutral and independent advice and information about all geoscientific and natural resource issues.

The BGR's work is supported by a modern scientific-technical infrastructure. Laboratories, collections, equipment and technical expertise are developed and provided as required for executing specific projects. In addition, central technical services such as the library, public relations work and information technology guarantee documentation and target-group oriented provision of data, information and publications.

Concerning related GeoERA raw materials topics the BGR is working in the fields of the economic geology, ore geology and mineralogy, the availability of mineral resources, development cooperation and the exploration of marine raw materials. As consultants to the German Federal Government and the German Industry the BGR continuously analyses and evaluates global mineral resource potentials and markets for metals, industrial minerals and non-metals. The BGR researches and develops new exploration methods and strategies in the run-up to industrial activities, in particular for high-tech metals, critical raw materials and specific industrial minerals. The BGR develops resource and development policy instruments and concepts for utilising mineral resources based on ecological, social and economic criteria. With the DERA (German Mineral Resources Agency) the BGR hosts the central platform for information and consulting services on non-renewable resources (metals, industrial minerals, rocks, and energy resources). This includes expert knowledge of resource efficiency and secondary raw materials.

Within GeoERA RM4 the BGR will lead the WP “Historical mine sites revisited”. The BGR expertise is based on broad in-house expert knowledge on raw materials and experience from a variety of national and international research projects.

- **A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.**

Partner	Type	Reference
BGR	Publication	DERA – Deutsche Rohstoffagentur in der Bundesanstalt für Geowissenschaften und Rohstoffe (2017): DERA- Rohstoffliste 2016. DERA Rohstoffinformationen 32: 116 S., Berlin, 2017. ISBN: 978-3-943566-88-8
BGR	Publication	BGR – Bundesanstalt für Geowissenschaften und Rohstoffe (2017): Deutschland – Rohstoffsituation 2016. – 190 S.; Hannover.978-3-943566-43-7 (PDF)
BGR	Publication	Tercero, L., Buijs, B., Sievers, H. (2012): Limits to the critical raw materials approach. Proceedings of the ICE - Waste and Resource Management, Volume 165, Issue 4, 01 November 2012, pages 201 – 208 , ISSN: 1747-6526, E-ISSN: 1747-6534
BGR	Publication	Bundesanstalt für Geowissenschaften und Rohstoffe (BGR, Germany) & Information Center of Ministry of Land and Resources (ICMLR, China) (2016): Supply and Demand of Lithium and Gallium. ISBN: 978-3-943566-33-8

- **A list of up to 5 relevant previous projects or activities, connected to the subject of this proposal.**

Partner	Type of project/activity	Description
BGR	Minerals4EU project	H2020 project www.minerals4eu.eu
BGR	MICA project	H2020 project www.mica-project.eu
BGR	SCRREEN project	H2020 project www.scrreen.eu

BGR	FORAM project	H2020 project www.foramproject.eu
BGR	POLINARIS project	FP7 project

- **A description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.**

Partner	Type	Description
BGR	Laboratories and large equipment's	Geochemical, mineralogical, petrological analytical facilities, incl. XRF, XRD, SEM, EMP
BGR	BLA-GEO	Cooperation and Networking infrastructure of the Federal Authorities and State Geological Services of Germany

Profile of key-staff members

Dr. Henrike Sievers: Henrike Sievers is a geologist and holds a doctoral degree in natural sciences from the RWTH Aachen University. She has more than 15 years professional experience in the field of metallic raw materials and joined the BGR Mineral Economics team in 2009. Prior to that, she was working for the copper industry in the field of environment and sustainability and she was a research scientist on metallic raw material flows at the RWTH Aachen University (2000-2005)

Within the BGR Henrike was engaged in several projects and studies on resource availability and criticality, including international working groups. She is member of the Mineral Resources Expert Group of EuroGeoSurveys and the EU SC05 Advisory Group. Henrike was leading work packages in the EU-funded projects Polinares and Minerals4EU and is involved in other EU-funded projects like MICA, SCRREEN or FORAM. *Role in the project:* H. Sieves will lead RM4, WP7 “Historical mine sites revisited”.

Dr. Antje Wittenberg: Antje Wittenberg is a postgraduate natural scientist (Diploma degree in Mineralogy 1993, Doctor degree in natural sciences 1997, both Leibniz University Hannover) and senior scientist with over 20 years of experience on research in raw materials and materials sciences, more than 7 years on academic lecturing as well as 11 years on governmental bodies concerning geological resources. She’ s the BGR representative on Raw Materials Supply Group of EU and member of the ad-hoc working group on critical raw materials as well as further European working groups and networks.

In 2008 Antje Wittenberg was seconded to BMZ followed by a secondment to the European Commission from 2009 to 2011. As Seconded National Expert she was heavily involved in all aspects on the Raw Materials Imitative, in the development of the European Innovation Partnership on Raw Materials, and the development of the EIT KIC on Raw Materials.

Since 2013 she is also a scientific member of the BGR research group on marine massive sulphides and member of the scientific cruise team of the exploration license Germany holds in the Indic Ocean. *Role in the project:* Antje Wittenberg will work in RM4, WP7.

Dr. Michael Szurlies: Michael Szurlies holds a PhD in geology with more than 15 years experience in the fields of energy and mineral resources and leads the unit “Availability of Mineral Resources” at BGR. His unit advises the Federal Government, the German industry and the public on issues related to worldwide exploration and mining activities as well as the availability of mineral resources.

M. Szurlies is member of the German delegation at the International Study Groups on Lead-Zinc, Nickel, and Copper and holds a vice chair in the Standing Committee of the Lead and Zinc Study Group and is a member of the Mineral Resources Expert Group of EuroGeoSurveys. His current activities focus on exploration and mining activities on base metals. *Role in the project*: As head of unit, M. Szurlies is coordinating the activities of the staff involved in the project.

Doris Homberg-Heumann: Doris Homberg-Heumann is responsible for BGR's raw material databases: Ms Homberg-Heumann is member of the German delegation at the International Study Groups on Lead-Zinc, Nickel, and Copper and holds a vice chair in the Environmental and Economics Committee of the International Nickel Study Group. Moreover, she coordinates BGR's work with regard to the International Study Groups on raw materials.

Role in the project: D. Homberg-Heumann will support BGR's contribution by compiling data on raw materials supply.

PD Dr. Torsten Graupner (Male): Torsten Graupner holds a PhD in geology with more than 20 years of experience in the fields of mineral resources and leads the BGR research topic "World-wide raw material potentials of metals of strategic economic importance". His graduate and post-graduate research at universities in Germany and the University of Toronto (Canada) focused on the genesis of gold and tungsten deposits in Central Asia. Key aspects of his research at the BGR include the characterization of complex non-conventional deposit types in order to identify new potentials of high-tech metal supply. His current research activities focus on the development of innovative concepts for exploration activities for mineral deposits, mining and ore processing. *Role in the project:* Torsten Graupner will contribute data on ancient ore deposits in Germany to RM4 WP7.

Partner 3 – BRGM

Overall description of Survey Organisation

BRGM, the French geological survey (www.brgm.fr), is France's reference public institution for Earth Science research and applications in the management of surface and subsurface resources and risks.

BRGM has an extensive experience in national to continental-scale syntheses including data compilation, storage and diffusion covering all fields of geosciences with lighthouses projects like SIG Afrique or SIG Andes among others. BRGM is known at European level for developing Knowledge Data Platforms and associated expert systems through some flagship EU-FP7 and H2020 projects like ProMine, Mineral4EU and MICA. BRGM also contributed to the development and the implementation of the INSPIRE Mineral resources (MR) data model and its international version ERML

For about 10 years, through research programs as well as development of new predictivity modelling methods (ex: Cell-Based Association) combining geological and available geophysical data, these have turned to the development of new metallogenic models, still under development, for lithium ore deposits.

In the GeoERA project, BRGM will be the task coordinator for Lithium in WP5 and also contribute to WP3 and WP7

Products and services

France portal: http://infoterre.brgm.fr and associated WMS services

Mineralinfo : www.mineralinfo.fr

Publications

Christmann P, Gloaguen E, Labbé JF, Melleton J, Piantone P. – 2015. CHAPTER 1 Global Lithium Resources and Sustainability Issues. In : Chagnes (ed) « Lithium Process Chemistry », Elsevier, pp 1-40.

Cassard D., Bertrand G., Billa M., Serrano J.J., Tourlière B., Angel J.M., and Gaál G. 2015 ProMine Mineral Databases: New Tools to Assess Primary and Secondary Mineral Resources in Europe. In: Weihed P. (Ed). 3D, 4D and Predictive Modelling of Major Mineral Belts in Europe, 9–58. Mineral Resource Reviews. Springer International Publishing.

Deveaud, S., Gumiaux, C., Gloaguen, E. and Branquet, Y. 2013. “Spatial statistical analysis applied to rare-element LCT-type pegmatite fields: an original approach to constrain faults–pegmatites–granites relationships”. Journal of Geosciences, 58: 163-182.

Melleton, J., Gloaguen, E., Frei, D., Novák, M. and Breiter, K. 2012. “How are the emplacement of rare-element pegmatites, regional metamorphism and magmatism interrelated in the Moldanubian domain of the Variscan Bohemian massif, Czech Republic ?”. Canadian Mineralogist, 50: 1751-1773.

Involvement in other relevant European and national projects

Minerals4EU: http://www.minerals4eu.eu

ProMine: http://promine.gtk.fi

ANR Variscan Pegmatites (VARPEG) https://varpeg.cnrs-orleans.fr/

Profile of key-staff members

Eric Gloaguen: PhD in Geology. Economic geologist. Project coordinator for several internal or business research projects. Also involved in several mining exploration and geological mapping projects. Since 2008, Eric works on metallogenic models for LCT pegmatites mainly in the Variscan belt in framework of national, international or private projects (ANR VARPEG, LABEX VOLTAIRE, ERA-MIN NewOreS). Eric is also involved in different academic courses and post-doc, thesis and masters supervision on LCT pegmatites and rare-metal granites.

Jérémie Melleton: PhD in Geology. Geochronologist and geochemist. Post-doctoral fellow (2009-11) on LCT pegmatites in Portugal, Spain, France and Czech Republic. Project coordinator for an internal research project on the use of hydrogeochemistry for exploration of critical metals and also involved in EU funded projects. Co-advisor of a PhD project on quartz chemistry of rare-elements system (example of the Beauvoir rare elements granite, France). Member of Labex Voltaire (ISTO – BRGM), project #2 “rare elements associated with crustal magmatism”, also involved in different academic courses and thesis supervision (Deveaud PhD on LCT pegmatites).

Guillaume Bertrand: PhD in Geology. Structural geologist, digital exploration and mineral resource databases, GIS and predictivity mapping. Participant to numerous FP7 and H2020 EU co-funded projects (e.g. ProMine, Minerals4EU, EuRare, MICA, SCRREEN, etc.); task and WP leader in several of them (e.g. REFRAM, MIREU, etc.). Manager of scientific projects on mineral prospectivity mapping and co-organizer of the 2017 Mineral Prospectivity conference (24-26 October 2017, Orléans, France).

Partner 4 – Czech Geological Survey (CGS)

Czech Geological Survey (CGS) (Česká geologická služba) is a research institute of the Ministry of Environment of the Czech Republic. The mission of the CGS, the history of which has started in1919, is the performance of the state geological survey in the Czech Republic and research in geosciences. CGS leads and participates in basic and interdisciplinary research projects.

The main fields of expertise include:

- Geological research and mapping (regional geological research, geological and thematic mapping, paleontologic and biostratigraphic studies, geological heritage)
- Geochemistry and environmental studies (interaction atmosphere – biosphere –hydrosphere – geosphere, monitoring of element budgets, acidification of forest soils, organic pollutants, radon risk)
- Mineral resources and mining impact assessment (identification and assessment of resources, regional raw material policies, mitigation of mining impacts)
- Applied geology and natural risks (hydrogeological mapping and research, geological hazards, radioactive waste disposal, support of development planning)

The system of CGS district geologists and associated specialists assists in acquisition and assessment of data on the geological composition of the state territory and the CGS provides expert information to the authorities for the political, economic and environmental decision-making.

Research of the mineral resources is focused on sources of critical and national strategic raw materials. The research is supported by national raw materials knowledge base (large geological archive – Geofond, spatial databases from which most of them support INSPIRE) and laboratory with wide spectrum of chemical and mineralogical analysis. Main solved project “CEEMIR” Centre for Economic and Ecological Mining of CRM fits all solved topics associated with CRM mineral deposits and their indicators, include geoinformatics, metallogeny, mineralogical and geochemical properties, ore body modelling, mineral processing and economy of CRM.

- **A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.**

Partner	Type	Reference
CGS	Publication	Breiter, K. – Ďurišová, J. – Hrstka, T. – Korbelová, Z. – Vaňková, M. H. – Galiová, M. V. – Kanický, V. – Rambousek, P. – Knésl, I. – Dobeš, P. – Dosbaba, M. (2017a): Assessment of magmatic vs. metasomatic processes in rare-metal granites: A case study of the Cínovec/Zinnwald Sn–W–Li deposit, Central Europe. – Lithos 292-293, 198-217. ISSN 0024-4937.
CGS	Publication	Breiter, K. – Korbelová, Z. – Chládek, Š. – Uher, P. – Knésl, I. – Rambousek, P. – Honig, S. – Šešulka, V. (2017b): Diversity of Ti–Sn–W–Nb–Ta oxide minerals in the classic granite-related magmatic–hydrothermal Cínovec/Zinnwald Sn–W–Li deposit (Czech Republic). – European Journal of Mineralogy 29, 4, 727-738. ISSN 0935-1221.
CGS	Publication	Knésl, I. – Jandová, T. – Rambousek, P. – Breiter, K. (2015): Calibration of portable XRF spectrometer in Sn-W ore-bearing granites: application to Sn-W mineralization in the Cínovec deposit (Erzgebirge / Krušné Hory Mts., Czech Republic). – Inżynieria Mineralna - Journal of the Polish Mineral Engineering Society 2015, 2, 67-72.

CGS	Publication	Rambousek, P. – Vymazalová, A. – Poňavič, M. – Pašava, J. (2017): EU critical raw materials in the Czech Republic – Cínovec (Zinnwald) ore district. In Mercier-Langevin P. et al: Mineral Resources to Discover. Proceedings of the 14th Biennial SGA Meeting, Quebéc, Canada,volume 4, s. 1365-1366. – Society for Geology Applied to Mineral Deposits. ISBN 978-2-9816898-0-1
CGS	Publication	**Kříbek, B. (1991):** Metallogeny, structural, lithological and time controls of ore deposition in anoxic environment. Mineralium Deposita 26, 122–131.

CGS	Publication	Starý, J. – Sitenský, I. – Mašek, D. – Hodková, T. – Novák, J. – Vaněček, M. – Kavina, P. (2016b): Mineral commodity summaries of the Czech Republic 2015. 420 s. – Ministerstvo životního prostředí. Praha. ISBN 978-80-7075-921-9
CGS	Publication	Poňavič, M. – Scheib, A. (2014): Distribution of Selenium in European Agricultural and Grazing Land Soils. In Reimann, C., Birke, M., Demetriades, A., Filzmoser, P. & O'Connor, P: Chemistry of Europe's Agricultural Soils, Part B General background information and further analysis of the GEMAS data set, s. 131-144. – Schweizerbart. Hannover. ISBN 978-3-510-96847-3

- **A list of up to 5 relevant previous projects or activities, connected to the subject of this proposal.**

Partner	Type of project/activity	Description
CGS	Project 1	**Minerals4EU**
	Funded by FP7, 2012-2014	CGS as a member of consortium support work in the field geoinformatics (metadata catalogue, INSPIRE transposition minerals data), case studies- mining waste usage etc.
CGS	Project 2	**ProSUM**
	Funded by H2020, 2015-2017	CGS also a member of consortium. Main task solved in metadata calalogue building, characterization of mining waste features, dissemination of results.
CGS	Project 3	**CEEMIR - Centre for Economic and Ecological Mining of CRM**
	Funded by Czech Technology Agency, 2014-2019	CGS is a member of consortium, which of is leading by Mining University of Ostrava. CGS is directly responsible for archive studies of CRM, mineralogical and

		geochemical investigations for prospecting, metallogeny, ore quality and environmental aspects.
CGS	Project 4	**Rare metals**
	Funded by Czech Technology Agency, 2015-2016	Geochemical, mineralogical and technology characteristic of important mineral rare metals resource in the Czech Republic territory. Technology tests on selected localities. Proposals for changes of important related legal rules. Commodities: W, Li, Nb, Ta, Rb, Ag, Au, Mn

CGS	Project 5	**Old Mining Maps**
	MZP- Czech Environmental Ministry 2014-2015	Digitalisation of old miming maps for recognisation of old mining workings
CGS	Project 6	**Re-Os**
	Czech Grant Agency 2014-2016	Main goals of the project: 1/ Re-Os geochronology of ore mineralizations within the Bohemian Massif, 2/ identification of possible metal sources and their relationship to geotectonic units, 3/ U-Pb geochronology of host rocks, 4/ trace element geochemistry of sulphides and effects on Re-Os.

- **A description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.**

Partner	Type	Description
CGS	Infrastructure/item 1	SurIS – State information raw material system: http://mapy.geology.cz/GISViewer/?mapProjectId=13&cultureInfo=en
	Infrastructure/item 2	Old Mining maps – mining maps from archives of CR: http://mapy.geology.cz/GISViewer/?mapProjectId=13&cultureInfo=en
	Infrastructure/item 3	Mining Waste Inventory – Inventory of Mining Waste Facilities: http://mapy.geology.cz/GISViewer/?mapProjectId=13&cultureInfo=en
	Infrastructure/item 4	Abandoned Mining Sites http://mapy.geology.cz/GISViewer/?mapProjectId=13&cultureInfo=en

	Infrastructure/item 5	Laboratories – Inorganic central laboratories, Electron microscopy and electron probe micro-analysis, isotopes laboratory etc.: http://www.geology.cz/extranet-eng/services/laboratories

Profile of key-staff members

Petr Rambousek, received M.Sc. (RNDr.), diploma in Economic Geology and Geochemistry at Faculty of Sciences, Charles University in Prague, Czech Republic. The second diploma in Geoinformatics and Environmental Geology received in retraining study on Technical University Ostrava, faculty of Mining and Geology, Czech Republic. The main area of his activity is mineralogy, geochemistry and metallogeny of mineral deposits, including prospecting and geological mapping. He worked also in geoinformatic (GIS) and environmental geology (mining impacts mapping, mining waste). He has been leader of many national projects, now he is solving mineralogical and geochemical properties of CRM sources (CEEMIR project). He participated in EU projects PECOMINES, EO MINERS, MINERALS4EU and ProSUM. He participated in international project of CGS in Zambia, Vietnam and Iran. He is currently the head of Department of Mineral Resources Research and Mineral Policy, he is member of MREG.

He is coordinator of RM theme in proposed GeoERA project in CGS. He is responsible for RM4/WP3 and RM4/WP7, he will participate in WP5a.

Tereza Peterková, holds M.Sc. in Geology (Petrology, Ore geology, Geochemistry) from Charles University in Prague, Czech Republic and she spent exchange semester (M.Sc.) in Technical University of Clausthal, Germany (in German). She is currently studying Ph.D. in Ore geology and petrology, Charles University in Prague, Czech Republic, focused on Sn-W-Li-Mo greisen systems in Erzgebirge. She has practical experience with exploration from Gold exploration internship, Mineral Exploration Network (Finland) Ltd., one season in Spain. She participated in EU projects Minerals4EU and ProSUM. Her present position is geologist, junior scientist. She will be responsible for RM4/WP5a.

Khaldoun Al-Bassam, male, Iraqi scientist, graduated in 1974, with a Ph.D. degree in Mineralogy and Geochemistry from the University of Wales (Cardiff), U.K. with special emphasis on East Mediterranean phosphorite deposits. Worked for Iraq Geological Survey for more than 40 years as Scientific Researcher, Head of phosphorite exploration projects in Iraq, strategic planning for the mineral sector in Iraq and as the General Director of Iraq Geological Survey for the period 2005-2013. Worked as co-chairman of Working Group 4; IGCP P-roject-156 (Phosphorites) for the life- time of the project. He led several research projects in industrial geology, mineral exploration, environmental geochemistry and assessment of mineral deposits. He is the Editor-in-Chief of the Iraqi Bulletin of Geology and Mining since 2005. He joined the Czech Geological Survey in 2014 as Scientific Researcher and took the responsibility of conducting an internal research project on the Cenomanian-Turonian phosphate occurrences and associated glauconitic black shales in the Bohemian Cretaceous Basin. Over his carrier he has published more than 100 research papers in International and Iraqi journals and supervised several postgraduate studies in Geology in the Iraqi universities. He will participate in RM4/WP4.

Jaromír Starý, male, holds a PhD. in Economic Geology from VŠB - Technical University of Ostrava - Faculty of Mining and Geology, Geological Engineering and M.Sc. diploma (1986) in Economic Geology and Geochemistry in Faculty of Sciences, Charles University in Prague, Czech Republic. His professional work is focused to minerals statistic and creating of the Minerals Information System of the CGS (SurIS). He is an expert for the Czech mineral base, especially for kaolin, feldspar, tungsten and lithium. His professional career is connected with the Geofond, former central information institution for geology, since 2012 department of CGS. During his career he was expert worker and last 7 years director of the Geofond until its dissolution in the end 2011. Since 2012 he is the Head of Mineral Deposits Department. He will participate in RM4/WP5.

Michal Poňavič, male, received M.Sc. (RNDr.) diploma in Geochemistry at Faculty of Sciences, Charles University in Prague, Czech Republic. He participated in many national projects, he is now CGS coordinator of national project CEEMIR focused on CRM. He participated in EU projects URGE and GEMAS. His professional activities are oriented on microelements in soils, metallogeny, application of clay minerals in environmental technology and geology of graphite. He is now in position of senior scientist. He will participate in RM4/WP3.

Jan Pašava, male, received diploma in Economic Geology and Geochemistry at Faculty of Sciences, Charles University in Prague, Czech Republic. He holds CSc. (Ph.D.) from Academy of Sciences, Prague (Czech Republic) in Economic Geology. His specialization area is black shales mineralization, isotopic dating, metallogeny. He participated in many national and international projects, mainly under UNESCO and SGA – IGCP projects. He has also rich educational practice with organizing training courses. He has very high publication production. He is now Research director of CGS, he is member of many international organisations, currently occupies position of Executive Secretary of SGA. He will participate in RM4/WP4.

Bohdan Kříbek, male, graduated at the Faculty of Science, Charles University in Prague, Czech Republic and he has been teaching for a long time as an Associate Professor at the Department of Economic Geology at the same faculty. In 1992-1993, he worked as a visiting professor at the University of Nancy, France. Since 1994, he has been working as a senior research fellow and project manager in the Czech Geological Survey. He participated or was in charge of many projects focused on geological mapping and evaluation of mineral potential in Iraq, China, Finland, Mongolia and in a number of African countries (Namibia, Zambia, Burkina Faso, Mali, Ghana). In the Czech Republic, he has been working on projects concerning uranium and graphite deposits and deposits of construction materials. He is member of the International Cooperation and Development Task Force (ICDTF) under the Mineral Resources Expert Group (MREG) of the EuroGeoSurveys, member of the Society for Geology Applied to Mineral Deposits (SGA) and of the International Association on the Genesis of Ore Deposits (IAGOD). He is specialist for investigation of organic matter in ore forming processes. The results of his investigation are published in many international periodics and books.

He will be responsible for solving tasks CGS in RM4/WP5b.

Partner 5 – Geological Survey of Estonia

The Geological Survey of Estonia (GSE) is a research-oriented state agency which commenced its operation on January 1st, 2018 under the governance of the Ministry of Economic Affairs and Communication. The main tasks GSE will be responsible are: geological mapping; coordination and exploration activities related to georesources with the main focus on phosphate rock, black shale, metal ores and groundwater resources as well as on environmental geology issues. The GSE will serve the society as the premier provider of objective and authoritative geoscientific data, information and expert services to governmental institutions, private sector and public.

- **A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.**

Partner	Type	Reference
GSE	Publication	Decrée, S., Ihlen, P. M., Schiellerup, H., Hallberg, A., Demetriades, A., Raha, M. and Soesoo, A., 2017. Potential of phosphate deposits in Europe. *SGA News*, 41, 14–20. [https://www.researchgate.net/publication/319165653_Potential_of_phosphate_deposits_in_Europe]

GSE	Publication	Bauert, H., Soesoo, a., and Hade, S., 2015. Strategic raw materials of Estonia. Conference at Rakvere, 16–17.10.2015, 57 pp [https://www.researchgate.net/publication/283255735_Strategic_raw_materials_of_Estonia_Conference_volume-2015_Rakvere_16-17_Oct]
GSE	Publication	Puura, V., Soesoo, A., Voolma, M., Konsa, M. and Aosaar, H., 2017. Petrography and mineralogy of the Attarat Um Ghudran oil shale, central Jordan. Oil Shale 34, 110–128. [http://kirj.ee/public/oilshale_pdf/2017/issue_2/Oil_Shale-2017-2-110-128.pdf]
GSE	Publication	Kallemets, K., 2016. Economic sustainability of Estonian shale oil industry until 2030. Oil Shale, 33, 272–289. [http://www.kirj.ee/public/oilshale_pdf/2016/issue_3/Oil_Shale-2016-3-272-289.pdf]
GSE	Publication	Voolma, M., Soesoo, A., Hade, S. and Kallaste, T., 2013. Geochemical heterogeneity of Estonian graptolite argillite. Oil Shale, 30, 377–401. [http://kirj.ee/public/oilshale_pdf/2013/issue_3/Oil-2013-3-377-401.pdf]

- **A list of up to 5 relevant previous projects or activities, connected to the subject of this proposal.**

Partner	Type of project/activity	Description
GSE	Black shale deposit exploration	A. Soesoo was responsible for accomplishing geological exploration of the Attarat Um Ghudran black shale deposit in central Jordan in years 2006 to 2014. This deposit exploration involved among others the following activities – geological mapping as well as a thorough petrographical, mineralogical and geochemical characterisation of raw material for the shale-fueled 550 MW power plant. [https://www.enefit.com/jordan]
GSE	Geological exploration and research activities on Estonian phosphorites and black shales were not politically favoured in Estonia since mid-1980ies	Notes: 1) Geological Survey of Estonia was legally established and started to operate on January 1st, 2018; 2) GSE foresees both resources as primary targets for near-future scientific and techonological studies

Alvar Soesoo holds a Ph.D. in geochemistry and tectonics from the Monash University, Australia and a PostDoc experience from Canada working on the Voisey Bay deposit, Labrador. His area of specialty is geochemistry of magmatic and sedimentary rocks, modelling of geochemical processes and fluid/melt transport, mineralogy and petrology. He is involved in studies of Jordan oil shale, black shales from Estonia and Fennoscandia, geotectonics and geochronology, REE studies of phosphorites and metallogenesis in the crystalline basement of Estonia and elsewhere. He has coordinated and participated in a number of national and international projects related to ore exploration, geological mapping geochemical studies. He has been working as a Professor at three universities, and as a project manager at the Ministry of Economic Affairs and Communications (preparational works in 2017, related to establishing the Geological Survey of Estonia). Role in the project: WP2: activities related to public outreach and publications on Estonian black shales; WP4: sedimentological, mineralogical and geochemical studies as well as resource and commodity estimates of the Furongian – Tremadocian black shales in Estonia

Kalev Kallemets holds M.A. in international finance from Estonian Business School and is completing his Ph.D. at Tallinn University of Technology on oil shale industry economic perspectives. His interests are resource economics and he lectures this subject to B.A. courses at his alma mater. Mr. Kallemets developed and executed a phosphate deposit program (consisting of 14 different technical and economic studies) at Viru Keemia Grupp in years 2011 to 2014 which were used to implement the phosphate rock scoping study. He has developed further investigation steps on phosphate rock mining and processing technologies. Having served as member of Estonian Parliament and since 2015 as a councelor for the Ministry of Economic Affairs and Communications, he has contributed to updating Estonian raw materials policies as well as initiating a new funding mechanism for further research of national mineral resources. Role in the project: WP2, WP4: technological and economical studies of sedimentary phosphorites in Estonia; WP8: public outreach expertise at various political levels

Heikki Bauert holds a M.Sc. degree in geology from the University of North Carolina at Chapel Hill (USA) and currently is compliting his Ph. D. in Geology at the Tallinn University of Technology (Estonia). His research interests have been focused on lithology and geochemistry of kukersite oil shales in Estonia and on geochemistry of carbonate rocks in the Appalachian Basin, on zircon dating of K-bentonites in Baltoscandia as well as on palaeoenvironmental and palaeoclimatological studies of Ordovician rocks in Baltica and Laurentia. He has coordinated and managed two EU funded Central Baltic INTERREG projects in the past 10 years, promoting sustainable geotourism in the Baltic Sea region and serves as a national contact point in Estonia for the UNESCO Global Geoparks Programme. As the Head of the Georesources Department in the Geological Survey of Estonia, he will be responsible for further exploration of Estonian mineral resources and raw materials, including phosphate rocks and black shales. Role in the project: WP2: activities related to public outreach and publications on sedimentary phosphorites in Estonia; WP4: sedimentological, mineralogical and geochemical studies as well as resource estimates of the Furongian – Tremadocian sedimentary phosphorites in Estonia.

Partner 6 – Geological Survey of Sweden (SGU)

The Geological Survey of Sweden (SGU) is the national agency for issues relating to bedrock, soil and groundwater in Sweden. SGU is a governmental body governed by The Ministry of Enterprise and Innovation. At present SGU has about 240 employees and an annual turnover that totals c. 43 M€. SGU has extensive expertise in geology, geophysics, geochemistry and economic geology relevant to the current project proposal.

SGU is part of EIT KIC on Raw Materials consortium and participates in the EuRare, ProSUM, X-Mine, SCRREEN, MINLAND and FORAM projects, and has contributed to Minerals4EU. SGU has been active in building the Fennoscandian Ore Deposit Database FODD, together with Norwegian, Finnish and Russian counterparts. SGU is currently working on projects in the Bergslagen mining district in south central Sweden with a focus on critical raw materials from both primary and secondary resources. SGU´s recently finished Barents project has included work on mineralisation systems in northernmost Sweden in order to guide future exploration.

SGU is a member of ETP-SMR High Level Group and participates in the Raw Materials Supply Groups, the ad hoc working group on criticality. SGU is also involved in EGS Mineral Resource Expert Group and in DG Growth's operational groups in terms of the strategic implementation of the actions included in the European Innovation Partnership on Raw Materials.

- **A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.**

Partner	Type	Reference
SGU	Publication	Goodenough, K.M., Schilling, J., Jonsson, E., Kalvig, P., Charles, N., Tuduri, J., Deady, E.A., Sadeghi, M., Schiellerup, H., Müller, A., Bertrand, G., Arvanitidis, N., Eliopoulos, D.G., Shaw, R.A, Thrane, K. & Keulen, N. 2016: Europe's rare earth element resource potential: an overview of metallogenetic provinces and their geodynamic setting. *Ore Geology Reviews* 72, 838-856.
SGU	Publication	SGU Periodic Publication, 2011: Mineralmarknaden. Tema: Specialmetaller Periodisk publikation 2011:01 Report on Special metals (in Swedish).
SGU	Publication	Hallberg, A., Bergman, T., Gonzalez, J., Larsson, D., Morris , G.A., Perdahl, J.A., Ripa, M., Niiranen, T. & Eilu, P. Metallogenic areas in Sweden. In Eilu, P. (ed.) 2012: Mineral deposits and metallogeny of Fennoscandia. *Geological Survey of Finland. Special paper 53*.
SGU	Publication	Stephens, M.B., Ripa, M., Lundström, I., Persson, L., Bergman, T., Ahl, M., Wahlgren, C.-H., Persson, P.-O. & Wickström, L., 2009: Synthesis of the bedrock geology in the Bergslagen region, Fennoscandian Shield, south-central Sweden. Sveriges geologiska undersökning Ba 58, 259 s.
SGU	Publication	Hallberg, A., Bergman, T., Gonzalez, J., Morris. G.A, Perdahl, J.A., Reginiussen, H. & Ripa M. Sweden. In Boyd et.al (eds.) Mineral resources in the Arctic. Geological Survey of Norway Special Publication.

- **A list of up to 5 relevant previous projects or activities, connected to the subject of this proposal.**

Partner	Type of project/activity	Description

SGU	Fennoscandian Ore Deposit Database (FODD)	The Fennoscandian Ore Deposit Database (FODD) is a comprehensive database on metallic mines, deposits and significant occurrences in Fennoscandia. Cooperation between Finland, Norway, Sweden and Russia.
SGU	Mineral Resources in the Arctic	Information on the most important metal- and diamond deposits in regions north of 60ºN in eight countries in the Arctic has been assembled in a book (accompanied by a map) and in a database. Cooperation between Norway, Sweden, Finland, Iceland, USA, Canada, Denmark/Greenland and Russia.
SGU	Barents Project	3-year project gathering modern geological data from northern Sweden. The project has resulted in more than 30 reports covering geology, geophysics, geochemistry and mineral deposits.
SGU	ProSUM	A main objective of ProSUM is to deliver the Urban Mine Knowledge Data Platform which is a centralised database of all available data and information on arisings, stocks, flows and treatment of waste electrical and electronic equipment (WEEE), end-of-life vehicles (ELVs), batteries and mining wastes.
SGU	EuRare	The main goal of the EuRare project was to set the basis for the development of a European REE industry through: • **Mapping,** characterization and technological and economic evaluation of the REE resources in Europe • The development, optimization and demonstration of innovative technologies for the efficient exploitation • The development of an Integrated Knowledge Management System EU REE resources

- **[Any other supporting documents specified in the work programme for this call]**

Please provide

Profile of key-staff members

- **Nikolaos (Nikos) Arvanitidis (male):** BSc, MSc, PhD as geologist from Geological Institute of Stockholm University. Economic Geologist with more than 40 years professional experience as: Researcher at the Geological Institute of Stockholm University in Sweden, R&D Project Manager on mineral exploration and development projects and Regional Division Director at the Institute of Geology and Mineral Exploration (IGME) in Greece, Senior Specialist at the Geological Survey of Finland (GTK), Head of Bedrock and Geochemistry Division at the Geological Survey of Sweden (SGU). I have though years got involved in EU-level positions and activities as Chair of the Mineral Resources Expert Group at EuroGeoSurveys (EGS), member of the European Technology Platform for Sustainable Mineral Resources (ETP SMR). Member of Raw Materials Supply Group, the working groups on Criticality and Rare Earth Elements (ERECON) and the Operational Groups of European Innovation Partnership on Raw Materials.

- **Torbjörn Bergman (male)** is educated at Stockholm University and has a Ph. Lic. degree in Ore Geology (1994). He has been employed at the Geological survey of Sweden since 1995 and has been working with bedrock mapping, documentation of Swedish mineral deposits and is responsible for the Swedish mineral resources database. He has also been working as a consultant for the Swedish Nuclear Waste Management Company (SKB) and is author and co-author of more than 20 reports. He is currently involved in the international project, Fennoscandian Ore Deposit Database (FODD) and contributor to the Special Paper 53 (2012) concerning Fennoscandian ore deposits published by Geological Survey of Finland (GTK). Since 2013 Torbjörn also is involved in EuRare.
- **Anders Hallberg (male)**: received his PhD at Uppsala University in 1993. In his thesis he showed the Enåsen Gold deposit to be an old analogue to younger epithermal hi-sulphidation gold deposit. After his dissertation he was employed by the Geological Survey of Sweden (SGU) and stationed at the Mineral Resources Information Office in Malå, Northern Sweden, where the main task was to provide relevant geological information to the rapidly growing exploration industry. Data for the first national mineral resources database and for the Fennoscandian Ore Deposit Database was gathered, compiled and published with his active participation. After ten years in the North he was stationed at SGUs head office in Uppsala where he continued the work with mineral and mining statistics and co-authored publications in economic geology. During two periods, he also worked as a consultant for the mining and exploration industry. Recently his work has expanded into information and statistics on mining waste, both in national and international projects including the ProSUM project.
- **Erik Jonsson (male):** PhD in mineralogy, petrology and geochemistry; senior geologist at SGU, and adjunct professor at Uppsala University. Erik has been working extensively on bedrock geology, mineralogy and mineral deposits, with over 25 years of field experience. Involved in several projects on rare and critical metals, including EU-funded ones such as EuRare and SCRREEN.
- **Edward Lynch (male):** Ph.D. in economic geology, specialising in intrusion-related magmatic-hydrothermal systems. Edward has over 15 years experience in the geoscience and the mineral exploration sectors. Presently, his research focuses on the Proterozoic evolution and metallogeny of Sweden (Norrbotten and Bergslagen ore districts), with an emphasis on granite-related tungsten and shear zone-hosted copper-gold mineralization.
- **Helge Reginiussen (male).** PhD in metamorphic and igneous petrology. He has been employed at SGU since 2002 working as a geologist and senior geologist. He held a position at SGUs Mineral Resources Information office in Malå for ten years working with mineral resources information activities towards exploration companies and researchers. He was the project leader for SGUs recently finished hyperspectral drillcore imaging project. Helge is now at the division of mineral information and mining industry at SGU Uppsala where he is involved in a project related to critical raw materials from both primary and secondary sources. He is currently SGUs member of EuroGeoSurveys Mineral Resources Expert Group (MREG).

Partner 7 – Geological Survey Ireland (GSI)

The Geological Survey of Ireland (GSI) is a division of the Department of Communications, Climate Action and Environment (DCCAE). GSI is responsible for providing geological advice and information, and for the acquisition of data for this purpose. GSI produces a range of products including maps, reports and databases and acts as a knowledge centre and project partner in all aspects of Irish geoscience. It is also active in geoscience research as a funder, partner and research performer. GSI serves its customer needs through a range of operational programmes and support services: The Information Management Programme underpins all of our activities in the delivery of geological information to our customers. The Surveying Programmes (Bedrock Geology, Quaternary Geology, Marine Geology and Geophysics) are on-going and provide information to the Applied Programmes, as well as producing maps and reports used directly by a wide range of external customers. The Applied Programmes (Groundwater, Minerals, Geotechnical, and Geological Heritage) are largely project oriented and provide solutions to specific customer needs. The activities of these Programmes help to build their respective databases. The Research Programme is an overarching programme providing funding and research support for geosciences in Ireland.

- **A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.**

Partner	Type	Reference
	Service	Ongoing. Mineral localities in Ireland. https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228
	Publication	McArdle, P. 1987. Rare earths in Ireland - the potential for deposits. Geol. Surv. Ire. Rep. Ser. (RS 87/2). 10pp.
	Publication	McArdle, P. & Kennan , P.S. 1987. The distribution, genesis and potential of tungsten, lithium and associated metal deposits on the SE margin of the Leinster Granite. Geol. Surv. Ire. Bull. 4, 27-40.
	Publication	McArdle, P., Williams, F.M., Doyle, E.M., Kennan, P.S., Moore-Lewy, G., Gallagher, V. & O'Connor, P.J. 1989. The metallogenic relationships of mineralisation along the southeast margin of the Leinster Granite. Geol. Surv. Ire. Rep. Ser. RS 86/2. 57pp.

- **A list of up to 5 relevant previous projects or activities, connected to the subject of this proposal.**

Partner	Type of project/activity	Description
	Project: Minerals4EU	GSI were a partner to this Europe wide project which delivered the EU-Minerals Knowledge Data Platform.
	Project: ProSUM	GSI were a third party to this Europe wide project which delivered the EU-Urban Mine Knowledge Data Platform. GSI's contribution centred on CRM in mine waste.
	Project: Characterisation of Mining Waste	A preliminary study on the content of mine waste in Ireland with special reference to CRM. A research project paid for by GSI and carried out by Aurum Exploration Services Ltd.

- **A description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.**

Partner	Type	Description
	Infrastructure/item 1	Field portable XRF.

- **[Any other supporting documents specified in the work programme for this call]**

Not applicable

Profile of key-staff members

EurGeol **Gerry Stanley** PGeo holds degrees in geology (BSc Hons and MSc from University College Dublin and Acadia University Canada, respectively) and in mining engineering (MSc from the Camborne School of Mines). He has worked in the private sector in mineral exploration and development and for government both as a minerals regulator and researcher. He is currently Head of the Mineral Section in Geological Survey Ireland. His interests are in carbonate hosted zinc-lead deposits, minerals construction materials, minerals data management and minerals potential mapping. He is Deputy Chair of the Mineral Resources Expert Group at EuroGeoSurveys and has served as President (and other roles) in the Irish Association for Economic Geology and the Institute of Geologists of Ireland.

Partner 8 – Geological Survey of Finland (GTK)

The Geological Survey of Finland (GTK) (www.gtk.fi) is a leading European competence centre on assessment and sustainable use of geological resources. Established in 1885, GTK is an expert organization under Finland's Ministry of Employment and the Economy. GTK employ approximately 430 full-time staff and is effectively engaged in tasks as a national geoscience data centre at the local, national and international level. GTK provides expertise and geological data that serves the interests of our clients, stakeholders and society as a whole. Due to the long and comprehensive mining and exploration history, GTK has a comprehensive geodata is available in Finland. Furthermore, the national drill core archive, located at Loppi southern Finland, is a home to about four million metres of drill cores from more than 31,000 locations of drilling performed in exploration, mining, rock construction and other activities.

- **A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.**

Partner	Type	Reference
GTK	Publication	Rasilanen et al. 2017, Assessment of undiscovered metal resources in Finland. Ore Geology Reviews, Volume 86, June 2017, Pages 896-923 https://doi.org/10.1016/j.oregeorev.2016.09.031 Authors, year, title, publication, pp, URL
GTK	Service	2014, Map service Mineral Deposits and Exploration, http://gtkdata.gtk.fi/mdae/index.html

Profile of key-staff members

Tuomo Törmänen PhD, University of Oulu, Finland. He is a specialist in VMS and Mafic-Ultramafic Ni-Cu-(Co)-PGE deposit geology. He has been a key person for the Assessment of undiscovered metal resources in Finland.

Jukka Konnunaho, PhD, Univerisity of Oulu, Finland. EuroGeologist. He is currently the project manager of the Ni-Cu-Co mineral potential mapping project of GTK. He has industry and survey experience on exploring Ni-Cu-Co deposits.

Konnunaho, J., Hanski, E.J., Bekker, A., Halkoaho, T.A.A., Hiebert, R.S., Wing, B.A 2013. The Archaean komatiite-hosted, PGE-bearing Ni-Cu sulphide deposit at Vaara, eastern Finland: evidence for assimilation of external sulphur and post-depositional desulphurization. Mineralium Deposita, 48: 967-989

Konnunaho, J., Halkoaho, T.A.A., Hanski, E.J., Törmänen, T. 2015. Komatiite hosted Ni-Cu-PGE deposits of the Finland. In: Maier W, O'Brian H, Lahtinen R (Eds.) Mineral Deposits of Finland. Elsevier, 93-128

Konnunaho, J., Hanski, E.J., Wing, B., Bekker, A., Lukkari, S., Halkoaho, T. 2015. The Hietaharju PGE-enriched komatiite-hosted sulfide deposit in the Archean Suomussalmi greenstone belt, eastern Finland. Ore Geology Review, 72 (1): 641-658

Törmänen, T., Konnunaho, J., Hanski, E., Moilanen, M., and Heikura, P. 2015. The Paleoproterozoic komatiite-hosted PGE mineralization at Lomalampi, central Lapland greenstone belt. Mineralium Deposita, 51: 411-430.

Kalevi Rasilainen, Pasi Eilu, Tapio Halkoaho, Timo Heino, Irmeli Huovinen, Markku Iljina, Heikki Juopperi, Tuomo Karinen, Niilo Kärkkäinen, Antero Karvinen, Asko Kontinen, Olavi Kontoniemi, Jukka Kousa, Laura S. Lauri, Kirsi Lepistö, Jouni Luukas, Hannu Makkonen, Tuomo Manninen, Tero Niiranen, Jarmo Nikander, Kimmo Pietikäinen, Jorma Räsänen, Pekka Sipilä, Peter Sorjonen-Ward, Markku Tiainen, Mikko Tontti, **Tuomo Törmänen**, Kaj Västi 2017. Assessment of undiscovered metal resources in Finland. Ore Geol. Rev. 86: 896-923.

Rasilainen, K., Eilu, P., Äikäs, O., Halkoaho, T., Heino, T., Iljina, M., Juopperi, H., Kontinen, A., Kärkkäinen, N., Makkonen, H., Manninen, T., Pietikäinen, K., Räsänen, J., Tiainen, M., Tontti, M., **Törmänen, T**. 2012. Quantitative mineral resource assessment of nickel, copper and cobalt in undiscovered Ni-Cu deposits in Finland [Electronic resource]. Geologian tutkimuskeskus. Report of Investigation 194. Espoo: Geologian tutkimuskeskus. 514 p. Electronic publication.

Partner 9 – **Hrvatski geološki institut - Croatian Geological Survey**

The Croatian Geological Survey (HGI-CGS) is the principal public research institute in Croatia in the field of geosciences and geological engineering. It undertakes fundamental and applied geoscience research for the benefit of the society and economy of Croatia. Major science disciplines within The Croatian Geological Survey (HGI-CGS) include geological surveying and mapping, hydrogeology, engineering geology, mineral resources, and geochemistry. The Croatian Geological Survey (HGI-CGS) acquires and publishes geological data over the entire territory of the Republic of Croatia.

The Croatian Geological Survey (HGI-CGS) organizes this information into a form that provides substantive guidance to both the national and regional planning processes in Croatia. The Croatian Mining Act (2013) places HGI-CGS as the main authority for collecting, storing and distributing all geological data related to exploration of all types of mineral resources (energy and non-energy).

The Department for Mineral Resources is the coordinate of the national project the Mineral Resource Map of Croatia which integrates both geological, mining and policy data related to mineral resources. The mineral resource research staff of HGI-CGS investigate the potential of mineral resources and develop policy plans and advice for both the Mining directorate as well as local authorities in order to enhance the rational and sustainable management of mineral resources.

The department for mineral resources has explored through the 20th century most of the Croatian bauxite deposits and has a GIS data base containing locations of more than 10,000 and historical mining sites. The scientist from the department in the past 5 years published a number of papers related to bauxites. One of the principal goals within main tasks will be merging and evaluating data originating from previous scientific and professional studies and papers and those collected during selected field visits.

The main activities will be provided by Department for mineral resources at Croatian Geological Survey.

- **A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.**

1. Dedić, Ž., Ilijanić, N., Miko, S.; Mineralogical-petrographical study of evaporites from Mali Kukor, Vranjkovići and Slane Stine quarry (Upper Permian evaporites from Dalmatia, Croatia), Geologia Croatica, article in press. 2017.

2. Miko, S., Dedić, Ž.,: MINLEX - Study on the legal framework for mineral extraction and permitting procedures for exploration and exploitation in the EU, str.41-42, Dreistetten, Austria, August 2016.

3. Dedić, Ž., Miko, S.: Foresight Study: Thematic Report II, Societal Challenges of mineral raw materials accessibility; Aggregates plans and their future: a view from South East Europe (SEE) countries Topic: Access to European Mineral Raw Material (MRM) deposits, 2015.

4. Horváth, Z., Miko, S., Sári, K. and Dedić, Ž.: A Vision of Best Practices for Aggregates Planning in South East Europe, SNAP-SEE Project, www.snapsee.eu. doi: 10.5474/snapsee-WP5-EN, Publisher: ©SNAP-SEE project 2014.

5. Peh, Z.; Kovačević Galović, E.: Geochemistry of Istrian Lower Palaeogene bauxites — Is it relevant to the extent of subaerial exposure during Cretaceous times?. // Ore geology reviews. 63 (2014) ; 296-306

- **A list of up to 5 relevant previous projects or activities, connected to the subject of this proposal.**

1. **The Mineral Resources Map of Croatia.** 1993-2013. Funding: Ministry of Science and Education (MZOŠ) http://www.hgi-cgs.hr/karta-mineralnih-sirovina-RH.htm
2. **Sustainable Aggregate Resource Management**-SARMa. SEE cooperation program. 2009-2011, SARMa had established a common approach for sustainable aggregate resources management in the countries of project members, including updated data infrastructure and competence strengthening, (2012-2014), http://www.sarmaproject.eu/
3. **Minventory**: DG Growth 2013, Statistical Information on EU Raw Materials Deposits, which will allows to implement an action plan for harmonization of EU mineral resources data (2013-2014), https://ec.europa.eu/growth/tools-databases/minventory/content/minventory
4. **Sustainable Aggregates Planning in South East Europe** SNAP-SEEproject, SEE cooperation program. 2012-2014, Sustainable Aggregates Resource Management, developing a toolkit to support national / regional planning of primary and secondary aggregates in Eastern European Area' countries, http://www.snapsee.eu/
5. **Minerals Intelligence network for Europe** Minerals4EU Funding Scheme: FP7-NMP-2013-CSA. 2013-2015, EU Mineral intelligence network structure providing data, information and knowledge on mineral resources around Europe, http://www.minerals4eu.eu/

- **A description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.**

1. *GIS data base of the Croatian bauxite deposits*
2. *Smear slides*
3. *Magnetic susceptiblity measurements*
4. *Mineralogical and clay mineral analysis*
5. *Grain size analysis*
6. *Geochemical analysis-AAS*
7. *SEM-EDS*

Profiles of experts:

Željko Dedić, male, zdedic@hgi-cgs.hr; +385 1 61 60 743; +385 98 543 535

Engineer of Geology, Expert Advisor, Croatian Geological Survey, Department for mineral resources, with more than 10 years of experience in mineral resources (studies of raw materials; spatial planning, gypsum, cement raw materials, aggregates, GIS and database specialist, geochemistry and tectonics of gypsum deposits, economic geology and spatial planning). Author and co-author in more than 30 reports and papers. Actively participates in mineral resources related projects KMS (Map of Mineral Resources of Croatia), SARMa, SNAP-SEE, Minerals4EU, MICA, PROSUM, FORAM and GEO-CRADLE on behalf of Croatian Geological Survey. Member of the Mineral Resources Expert Group EGS.

Dr. Slobodan Miko; male, smiko@hgi-cgs.hr, +385 1 6160 788.

Dr. Slobodan Miko, Senior research scientist, Director General of Croatian Geological Survey, adjunct Ass. Prof. at RGNF (Zagreb Uni.) Geology of Ore Deposits, member of EGS Mineral resources expert group (MREG). Croatian partner Coordinator for mineral resources related projects SARMa, SNAP-SEE, Minerals4EU, MICA, PROSUM, GEO-ERA, EMODnet Geology II (marine resources). Areas of mineral research are: aggregates, bauxite, gypsum and clays, economic geology, mineral resource availability and spatial planning related to mineral extraction.

Erli Kovačević Galović, female, ekovacevic@hgi-cgs.hr, +385 1 61 60 743

Engineer of Geology, Expert associate at Croatian Geological Survey, Department for mineral resources. Has 13 years of experience in the area of mineral resources, mostly as field, GIS and database specialist with a specific interest in bauxites. Active participant in a number of mineral resources related projects, national (Map of Mineral Resources of Croatia) and international (SARMa, SNAP-SEE, MICA, PROSUM, FORAM).

Mr. Boris Kruk, male, bkruk@hgi-cgs.hr; +385 1 61 60 747;

Engineer of Geology, Expert Advisor, Croatian Geological Survey, Department for mineral resources, with more than 30 years of experience in mineral resources (studies of raw materials; spatial planning, gypsum, cement raw materials, aggregates, geochemistry and tectonics of gypsum deposits, economic geology and spatial planning). Author and co-author in more than 100 reports and papers. Actively participates in mineral resources related projects KMS (Map of Mineral Resources of Croatia), SARMa, SNAP-SEE on behalf of Croatian Geological Survey.

Partner 10 – Geological Survey of Greece (IGME gr)

IGME is the national geological research organization of Greece, authorized by the Ministry of Environment and Energy. For more than 60 years IGME contributes to the country's growth and social welfare in terms of evaluating and securing the sustainable use of natural resources (mineral resources, water, geothermal energy, soils). IGME has participated and carried out numerous European Research and Development projects as well as Regional projects co-funded by the Structural Funds, covering all fields of it's activity.

It conducts public and contract-based services in basic geological research, exploration and evaluation of mineral deposits, in geothermal fields, hydrogeological surveys, geochemical and geotechnical studies,beneficiation and mineral processing of metallic and industrial minerals both in laboratory and pilot plant scale , biotechnological treatment of wastes , investigations on valorization of wastes and for their ability to research produce high added value products , environmental control and monitoring and special studies on safe disposal, environmental characterization of solid wastes according to European and International test protocols.

More specifically, IGME has carried out project funded by European Structural funds (3rd Community Support) on elaborating inventory with abandoned mines of the greek territory.

Also, in the frame of Promine European Project, it has been constructed database of secondary mineral resources (concentrations related to mining and downstream activities), the ProMine Anthropogenic Concentration (AC) database.

In the Department of Mineral Processing it has been established Laboratory for the Toxicity Characterisation of Solid industrial wastes offering services to the industrial and mining sector, Environmental Inspectors , research projects, authorities, Ministries, etc.The laboratory is accredited by the Hellenic Accreditation System (E.SY.D.) since 2010, following the standard ELOT EN ISO/IEC 17025. The Laboratory personnel consists of two Chemical Engineers (one M.Sc and one Ph.D) and one Mining Technician, all of them highly experienced. Department of Mineral Processing as well as the Laboratory for Toxicity, which stands under it, are well equipped with up-to-date infrastructure.

The number of staff employed in IGME-Gr on a permanent basis, is 216 (geoscientists, technical and administrative personnel), complemented by contract/fixed-term personnel in the frame of various projects.

Products and services

www.igme.gr

http://www.igme.gr/index.php/en/εργα/

Publications (selected works)

KEITH-ROACH,M., GRUNDFELT,B., HOGLUND, L.O., KOUSA, A., POHJOLAINEN, E., MAGISTRATI, P., **AGGELATOU, V**., OLIVIERI, N., FERRARI, A., 2014: „Environmental Legislation and Best Practice in the Emerging European Rare Earth Element Industry „ **Proceedings** ERES2014: 1st European Rare Earth Resources Conference, Milos, Greece.

Papasiopi, N**.,** Xenidis, A**., Angelatou, V.,** Liakopoulos, A., Drougkas , J., 2009 “Assessment of major acid generation sources in the mining site of Agios Filippos, Kirki, GR”, , Proceedings of the 3rd International Conference on Advances in Mineral Resources Management and Environmental Geotechnology (Amireg) 2009, pp. 333-338.

Critical mineral raw materials from anthropogenic concentrations, 2012 PROMINE (All partners)

Angelatou, V., Drosos , E**.,** 2015: Utilisation of mining waste for the development of added value final products, in proceedings of International Conference "Industrial waste and wastewater treatment and valorization", Athens, Greece.

Eliopoulos, D.G., and Kilias, S.P., 2011: Marble–Hosted Submicroscopic Gold Mineralization at Asimotrypes Area, Mount Pangeon, Southern Rhodope Core Complex, Greece. *Economic Geology*, v. 106, p.751-780.

Eliopoulos, D .G., Economou-Eliopoulos M., Apostolikas, A., Golightly, J.P., 2012: Geochemical features of nickel-laterite deposits from the Balkan Peninsula and Gordes, Turkey: The genetic and environmental significance of arsenic. *Ore Geology Reviews*, v. 48, p. 413-427.

Eliopoulos, D.G., and Economou-Eliopoulos, M., 2013: Palladium and Platinum in hydrothermal systems: The case of porphyry-Cu systems and sulfides associated with ophiolite complexes. In: Proceedings of the 13th International Congress, Chania, Bulletin of the Geological Society of Greece, vol. XLVII 2013, p.

Eliopoulos, D.G., Economou-Eliopoulos, M., and Zhelyaskova-Panayiotova, M., 2014: Critical factors controlling Pd and Pt potential in porphyry-Cu-Au deposits; Evidence from the Balkan Peninsula. *Geosciences*, 4, 31-49: doi: 10.3390/geosciences 4010031.

K.M. Goodenough, J. Schilling, P. Kalvig, N. Charles, J. Tuduri, E.A.Deady, M. Sadeghi, H.Schiellerup, A. Muller, G. Bertrand, N. Arvanitidis, **D.G. Eliopoulos,** R.A. Shaw, K. Thrane, N. Keulen, 2016.Europe’s rare earth element resource potential: An overview of REE metallogenetic provincesand their geodynamic setting. Ore Geology Reviews, 72, 838-856

Laskaridis, K., 2014 : Greek Marble through the Ages: An Overview of the Greek Marble Producing Areas and the Stone Sector of Today”, “V Global Stone Congress 2014”, Antalya Turkey

Laskaridis K., Patronis, M., Kousseris I., 2013: Inter-Laboratory Characterization of Building and Decorative Limestones from Cyprus”, Ioannou Ioannis, Modestou Sevasti, Fournari Revekka, 6th International Congress “Science and Technology for the Safeguard of Cultural Heritage in the Mediterranean Basin”, Athens, Greece.

Patronis, M., **Laskaridis,K.,** Niaou ,M., 2012 : Relationship between Breaking Moments at the Dowel Hole and at Flexure under Concentrated Load of Ornamental Stones”, “Global Stone Congress 2012”, Alentejo (Borba), Portugal

Laskaridis, K., Perdikatsis, V., 2009 : Characterisation of the timeless white marble and quarrying activity in Thassos, in Y. Maniatis (ed.), ASMOSIA VII, The Study of Marble and Other Stones in Antiquity – Proceedings of the 7th International Conference of the Association for the Study of Marble and Other Stones in Antiquity, BCH Suppl., 51, pp. 309-317.

Participation in European Projects

IGME - Gr has participated in numerous European projects such as : TRAWMAR, REFILL, RESEPAR, BRITE –EURAM BR-5350, SORPMET, BIOMINE , ProMine, Minerals4EU, EuRare, PROSUM, GEOCRADLE, etc

Profile of key-staff members

ANGELATOU VASILIKI: M.Sc. Chemical Engineer, Senior researcher, Head of Mineral Processing Department of I.G.M.E. She is also Technical Responsible for the Accredited Solid Waste Characterisation Laboratory of IGME, since 2010. More than 28 years' experience in Hydrometallurgy, biohydrometallurgy, environmental engineering applications of biotechnology, mineral processing and establishing EN- 17025 Quality Systems for Industrial Solid Waste Characterization. Involved in various European and national R&D projects, such as TRAWMAR, REFILL, BRITE –EURAM BR-5350, SORPMET, BIOMINE, ProMine, EuRare, PROSUM etc

ELIOPOULOS DEMETRIOS, Dr., entered service with IGME in 1985. He received his H.B.Sc in Natural Sciences from the Athens University, his M.Sc in Economic Geology from the University of Western Ontario, Canada, and his Ph.D in Economic Geology at the University of Southampton, United Kingdom. His research interests are focussed on the metallogenesis of precious and base metal sulphide deposits, PGE in hydrothermal systems, Ni-laterites and Cu-porphyry systems, databases for handling and processing large geological data, and expert systems. He has 30 years of experience in co-ordinating and leading R&D EU, national and international mineral exploration projects. Also, he has working experience from Canada, Ontario Geological Survey and Private Companies for precious metals exploration. The Greek Academy of Science and Letters awarded him in 1991 for his contribution to the science of Economic Geology. He is member of several geological organisations, Fellow member of the Society of Economic Geologists and currently representative for the Students Chapter in Greece. He participated as Council member of the Society for Geology Applied to Mineral Deposits (SGA) for 8 years

LASKARIDIS KOSTAS: Dr. rer. nat. University of Erlangen-Nuernberg, Geologist, Head in the Economic Geology Dept. of I.G.M.E.. He is Technical Responsible for the Accredited Ornamental Stones Quality Control Laboratory "LITHOS" of IGME, since 1999. For more than 25 years he is actively involved in European and National R&D projects for Ornamental Stones and Industrial Minerals. Most recent activity comprised the involvement in Min4EU project. Presently National Delegate of IGME at EuroGeoSurveys (EGS) and member of the Mineral Resources Expert Group at EGS.

PALAIOKOSTAS GEORGIOS: Geologist (National Kapodistrian University of Athens) in the Economic Geology Dept. of IGME Current and past activities include studies of Industrial Minerals and Rocks, Applied Geostatistics, GIS and electronic mapping, as well as participation in the scientific team of various national and EU Research Projects

Partner 11 – Instituto Geológico y Minero de España (IGMEsp)

5 Members of the consortium

The Geological Survey of Spain (Instituto Geológico y Minero de España - IGME) (http://www.igme.es) was created by a Royal Decree of 12th July 1849 with the original denomination of "Commission for the Geological Chart of Madrid and the Kingdom". Today IGME is a self-governing Public Research Institution attached to the Ministry of Economy and Competitiveness. Staffs include about 400 people, which about up to 50% are highly qualified professionals.

The main mission of IGME is to provide the State Administration, the Autonomous Regions Administrations and the general society, with precise knowledge and information regarding the Earth Sciences and related technologies for any development on the Spanish territorySurvey activities are focused on studies, analysis and research in the field of Earth Sciences and Technologies including geology, mineral resources, environmental impact of mining, geophysics, geochemistry, geological hazards, active processes and global change.

International references cover a wide spectrum of teamwork in South America and Africa countries. IGME has contributed to the EU co-funded projects OneGeologyEurope, Minerals4EU and EuRare and is member of the INSPIRE Europe and it has extensive experience in the study of mineral deposits, having carried out numerous projects of its own as well as participating in international projects related to mineral resources, as ProMine, Foram, MIN-GUIDE, ProSUM, MICA or H2020. INTERREG Geo-FPI between others.

The IGME participates in the GeoEra project in the RM1Knowledge Base, RM2B Dimension Stone, RM3 Marine Deposits and RM4 Critical Raw Materials. In the Critical Raw Materials project IGME Spain will contribute to WP6.

- *A list of up to 5 relevant publications, and/or products, services*

Partner	Type	Reference
IGME Spain	Publication	Díez-Montes, A., García Crespo,J., Ayala,C., García Lobón,J.L., Sánchez-García, T., Rey-Moral,C., Bellido,F., Rubio, F.M., Martín-Alfageme, S., Mediato J.F., Tornos, F. (2015). Modelling of the Río Tinto area. In: *Weihed, P. (Ed.) 3D, 4D and Predictive Modelling of Major Mineral Belts in Europe.Springer, Mineral Resource Reviews, Part IV, 10. The Iberian Pyrite Belt and Ossa Morena Zone*, pp 209-229. DOI 10.1007/978-3-319-17428-0
	Publication	Sánchez-García, T., Bellido, F., Mediato, J., García-Lobón, J.L., García, J., Ayala, C., Rey-Moral, C., Rubio, F.M., Díez-Montes, A., Martin-Alfageme, S., Tornos, F., Martínez, C. (2015) Modelling of the Cala area (Ossa-Morena Zone). In: *Weihed, P. (Ed.) 3D, 4D and Predictive Modelling of Major Mineral Belts in Europe, Springer, Mineral Resource Reviews, Part IV,12, The Iberian Pyrite Belt and Ossa Morena Zone*, pp 263-296. DOI 10.1007/978-3-319-17428-0.
	Publication	López-Moro, F.J.; Moro, M.C.; Timón, S.M., Cózar, J. (2013). Constraints regarding gold deposition in episyenites: the Permian episyenites associated with the Villalcampo Shear Zone, central western Spain. International Journal of Earth Sciences, 102:721-744. 5
	Publication	van Staal C.R., Whalen, J.B., Valverde-Vaquero, P., Zagorevski A. & Rogers, N. (2009) Pre-Carboniferous, episodic accretion-related, orogenesis along the Laurentian margin of the northern Appalachians In: *Murphy, J. B., Keppie, J. D. & Hynes, A. J. (eds) Ancient Orogens and Modern Analogues. Geological Society, London, Special Publications*, 327, p. 271–316.ISBN: 1-86239-289-7.

	Publication	Timón, S.M., Moro, M.C., Cembranos, M.L. (2009). Mineralogical and physiochemical evolution of the Los Santos scheelite skarn, Salamanca, NW Spain. Economic Geology, 104: 961-995.
	Service	Online. BDMIN (Mineral resources database) http://info.igme.es/catalogo/?tab=2
	Service	Online. Geological Maps service, http://info.igme.es/cartografiadigital/geologica/Geode.aspx
	Service	Spanish Geological Survey maps http://info.igme.es/cartografiadigital/portada/Default.aspx?language=en
	Product	Panorama Minero is an annual publication in digital format. It contains the main data on uses, national production, foreign trade, world production and prices of mineral substances produced in Spain. http://www.igme.es/PanoramaMinero/PMLin.htm

- *A list of up to 5 relevant previous projects or activities*

Partner	Type of project/activity	Description
IGME Spain	**FORAM**	FORAM is working “towards a world forum on raw materials” and as such establish a large and comprehensive network of stakeholders in the raw materials sector. http://www.foramproject.net/
	POMINAL	POMINAL:Study of the mining potential of the territory of Andalusia, own IGME project that just started at the end of 2017
	Planageo project (Angola)	It covers the overall national territory with geological cartography and resources mapping, geophysical surveys with acquisition of magnetic, radiometric airborne and gravity data. One of IGME’s tasks is the research of mineral raw materials, by studying and characterizing rock and mineral deposits of potential economic interest
	Minerals4EU Minerals Intelligence Network for Europe (2013-2015) FP7-CSA- NMP.2013.4.1-3	Minerals Intelligence Network for Europe (2013-2015) FP7-CSA- NMP.2013.4.1-3 (http://www.minerals4eu.eu).Team member and one WP Leader. The Minerals4EU project is designed to meet the recommendations of the Raw Materials Initiative and will develop an EU Mineral intelligence network structure delivering a web portal, a European Minerals Yearbook and foresight studies.
	ProMine	ProMine develop the first pan-European GIS-based database containing the known and predicted

	Nano-particle products from new mineral resources in Europe (2009-2013) FP7-NMP-2008-LARGE-2	metalliferous and non-metalliferous resources, which together define the strategic reserves (including secondary resources) of the EU. IGME were a partner to this Europe project. It awarded as the best project 2014 of all the projects launched under the EU Framework Programmes in the field of Industrial Technologies at Industrial Technologies conference in Athens, June 2014. (http://promine.gtk.fi)
	MICA	MICA contributes to establishment of a raw materials knowledge infrastructure in Europe, by identifying and integrating data, methods and tools relevant to raw materials stakeholder needs (EU-RMICP). http://www.mica-project.eu/

- *A description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.*

Partner	Type	Description
IGME	U-Pb Geochronology laboratory	The Spanish geological survey (IGME) has a geochronology laboratory equipped with a Triton TIMS mass spectrometer and a clean lab, where U-Pb dating is done by isotope dilution (ID). U-rich minerals like zircon, monazite, xenotime, titanite and rutile are dated after mineral separation using a Wilfley table and Frantz magnetic separator and hand picking under a binocular scope. Zircon is chemically abraded (CA technique, Mattison, 2005). The laboratory has participated in the Earthtime interlaboratory experiment (www.earth-time.org), and it is capable of producing high-precision U-Pb ages with uncertainties around 0.1%.
	(LA)-MC-ICP-MS	Multiple element analyses
	SEM	Imaging and feature scanning, study of chips / thin sections, to perform detailed morphological studies, image composition using backscattered electrons and chemical composition by means of EDS analysis
	XRD	Mineral identification, clay structural studies
	Geotek multi sensor core logger mscl	Scan witnessing multiparameter
	Cathodoluminescence microscope stage	Technosyn 8200 MK5 cold cathode luminoscope attached to a Nikon optical microscope

	Technosyn 8200 MK5	Cold cathode luminoscope attached to a Nikon optical microscope
	Linkam MSD 600	Heating and freezing stage attached to a Leica optical microscope, for the study of fluid inclusions microthermometry
	Petrographic microscopes and XRF	Equipments and laboratories for sample preparation for all these analytical techniques
	Geographical Information Systems	Software for the treatment of geographic information
	3D geological modelling software	Software for the treatment of 3D geological information (GoCad and eMove software)

Profiles of key staff members

Dr. Luis Somoza (male) is currently the head of the Marine Geological Mapping Division at the Geological Survey of Spain (IGME). His obtained Doctor of Science Degree in 1989 at the Department of Geodynamic of the "Complutense University of Madrid" (UCM). He has also been researcher at the Spanish Oceanographic Institute (IEO). He has mainly worked on the Iberian continental margins, Canary Islands and Scotia Sea (Antarctica), where he has been involved in several national and international oceanographic cruises and research projects since 1999. He has representative for Spain in the Council and Assembly of the International Seabed Authority (ISA). Presently, he leads the Project for Extension of the Continental Shelf of Spain according the United Nations Convention for the Law of the Sea (UNCLOS). He has published up to 85 papers in SCI-ranked international journals concerning marine geology.

Dr. Teresa Medialdea (female) is currently a member of the research staff in the Marine Geological Mapping Division at the Geological Survey of Spain (IGME), where she has been working since 1984. She has participated in several research projects and geological mapping projects in the Spanish Continental margin and Antarctica and has been involved in numerous oceanographic cruises related to these projects. At present she represents the Geological Survey of Spain in the Marine Geology Expert Group of Eurogeosurveys and in the EMODnet- Geology project, where she is resposible of the Geological maps of the Spanish Continental margin.

Dr. Javier González (male) is currently a member of the research staff in the Marine Geological Mapping Division at the Geological Survey of Spain (IGME). He is graduated in 1999 from Department of Geology, Salamanca University (USAL). His obtained Doctor of Science Degree in seafloor manganese deposits in 2008 at Department of Crystallography and Mineralogy of the "Complutense University of Madrid" (UCM). He has mainly worked on the Iberian continental margins, Canary Islands and Scotia Sea (Antarctica), where he has been involved in several national and international oceanographic cruises and research projects related to marine mineral deposits since 2004. He is an expertise on ferromanganese deposits, phosphorites and associated Critical Raw Materials along the continental margins of Iberia and the Canary Archipelago.

Susana Mª Timón-Sánchez (female), Senior Research Scientist. Ph. D. in Geology. Her main research interests are in the geology of ore deposits and the hydrothermal processes associated: mineralogy and geochemistry (stable and radiogenic isotopes, geochronology, and fluid inclusions microthermometry), dominantly in Spain with special emphasis in granite-related Sn-W deposits. She has participated in 21 research projects, 13 of them competitive, has worked in agreements with companies, has conducted 22 publications, 10 of them international, and 12 conference contributions. She was professor of mineralogy and crystallography at the University of Salamanca and currently, she is member of the Mineral Resources Research Group of the Department of Geology and lecturer in Applied Environmental Geology (MSc) at the same university.

Teresa Sánchez-García (female), Senior Research Scientist, 25 years of experience in geology and geological cartography in basement areas of Spain and Portugal. Research work in the IGME, specializing in the study of basement areas, in petrology and geochemical issues of igneous and metamorphic rocks. Until now the research was focused on the study of the origin of magmatism both Pre-Varisco and Varisco of the areas of Ossa-Morena and Surportuguesa, with the development of geological maps of synthesis. Currently more focused on the relationships of magmatism and mineral systems, applied to the improvement of new exploration models and technologies and the development of 3D geological models.

Alejandro Díez-Montes (male). He was awarded License in Geology by the Univ. de Salamanca (Spain) in 1987. Ph.D. in Geology from the Faculty of Science of the University of Salamanca (Spain) in 2006. Geologist with 30 years of experience in areaa of specialty is the geological mapping, petrography, geochemistry, geochronology and metallogenesis of mineral deposits. He has coordinated and participated in a number of national and international projects. Has been a participant in several EU funded projects including GEO-FPI Interreg POCTEP project, PROMINE (7th FWP).

Pablo Valverde-Vaquero (male), Senior Research Scientist. Ph. D. Memorial University of Newfoundland (Canada). Head of the IGME Geochronology Laboratory with 25 years of experience in U-Pb geochronology by ID-TIMS in Memorial Univ. of Nfld. (Canada), Univ. Giessen (Germany), Geological Survey of Canada, Ottawa (Canada) and Spanish Geological Survey, IGME. He has substantial geological mapping experience which included mapping in remote parts of southern and central Newfoundland and has collaboration mapping projects at IGME. He has provided geochronological support for the ARCO project (Geological Map of the Dominican Republic) and currently he is providing support for the PLANAGEO (Geological Map of Angola at 1: 200. 000 scale. Books (main authorship): 3 (Chapters); Peer-reviewed publications (SCI): 26, H factor (SCI web site), 15; 7 Geological Maps at 1:25.000 and 1:50.000 scale; Abstracts and presentations/posters: 57.

José Mediato (male),Senior Research Scientist. Ph. D. in Geology specialized in "Analysis of Sedimentary Basins" with 17 years of experience. The research activity has been develop in the IGME and four years in a private company, and has focused on the geological cartography and the sedimentary analysis of Paleozoic, Mesozoic and Quaternary deposits. During the first period in the IGME the research was focused on the analysis of sea level oscillations and tectonic from the study fluvial, coastal and marine deposits. The main activity in the company was focused on works of geological and geomorphological cartography in national and international projects. Since 2011 I am working in the IGME and the research activity has been dedicated to the development of 3D geological models of mineral deposits and CO_2 storages.

Jesús García-Crespo (male), 23 years of experience in GIS applied to geology, contributing to the digital geological map at 1:50 000 scale and the digital continuous map of Spain. In the last 7 years worked in the IGME in the fields of GIS and 3D modelling, in areas such as mining, energy resources, carbon capture and sequestration and natural hazards. Nowadays working in the update and quality control of the continuous geological map, the development of cartographic products and the methodologies for the integration of other thematic cartographies, consistent with the INSPIRE directive.

Partner 12 – Mining and Geological Survey of Hungary (MBFSZ)

The **Mining and Geological Survey of Hungary** (MBFSZ) was established on July 1st, 2017 by the merger of the Mining and Geological Office of Hungary (MBFH) and the Geological and Geophysical Institute of Hungary (MFGI). The Survey is a central governmental body supervised by the Ministry of National Development. It is supporting all state activities related to mining and geology and its mission is to support Hungary's economic competitiveness, the effectiveness of public services and policy by providing up-to-date geoscientific information for the government and the society relying on nearly 150 years traditions of geological-geophysical research and of mining administration. As a national geological survey MBFSZ is responsible to advance geoscientific knowledge of Hungary's landmass by systematic acquisition, interpretation, management and dissemination of geoscientific data. The current number of employees is 241, most of them highly qualified researchers in various fields of geology, geophysics, environmental sciences, mining administration and IT technology.

MBFSZ's core skills include geoscientific data management and integrated 3D geological-geophysical modelling, as well as national potential assessments for various mineral resources and preparation of concessions, especially geo-energy (hydrocarbon, geothermal, coal), study of geohazards, environmental geology and hydrogeology. The survey also maintains and operates several national geoscientific observatory and monitoring systems, e.g. magnetic, gravimetric, groundwater, etc. MBFSZ is a designated state advisor of geoscientific matters related to the Mining Act (1993 XLVIII) and the Governmental Decree 267/2006 (XII. 20.) defining state geological tasks.

- A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.

Partner	Type	Reference
MBFSZ	Publication	Gatter, I. Molnár, f., Földessy, J., Zelenka, T., Kiss, J., **Szebényi, G.** 1999: High- and Low-Sulphidation Epithermal Mineralization of the Mátra Mountains, Northeast Hungary. — Society of Economics Geologist Guidebook series vol. 31. 1999. pp. 155-179. [in Epithermal Mineralization of the Western Carpathians (Edited by F. Molnár, J. Lexa & J. W. Hedenquist) Guidebook Prepared for Society of Economic Geologists Field Conference - 4-13 September, 1999]
MBFSZ	Publication	Fodor, B., Tóth, Gy., Somody, A., **Szebényi, G.** 2004: Mining, Mining Waste and Related Environmental Issues in Hungary. — In: Mining, Mining Waste and related Environmental Issues: Problems and Solutions in Central and Eastern European Candidate Counties. Report of JRC Enlargement Project PECOMOINES (Inventory, Regulatitions and Environmental Impact of Toxic Mining Wastes in Preaccession Countries – Eds. G. Jordan and M. D'Alessandro. European Commission Directorate General Joint Researche Centre, Ispra, Italy, EUR 20868, pp. 79-90.
MBFSZ	Publication	Földessy, J., **Szebényi, G**. 2008: The mineralizations of the Recsk deeps and Lahóca – short geological overview. — In: J. Földessy, É. Hartai (eds.): GEOSCIENCES Publications of the University of Miskolc Series A, Mining, Volume 73, Miskolc University Press, pp. 85-98, ISSN 1219-008X
MBFSZ	Publication	**Török, K.** (2012): On the origin and fluid content of some rare crustal xenoliths and their bearing on the structure and evolution of the crust beneath the Bakony–Balaton Highland Volcanic Field (W-Hungary). International

		Journal of Earth Sciences: Volume 101, Issue 6, Page 1581-1597, DOI: 10.1007/s00531-011-0743-2
MBFSZ	Publication	**Török, K.**, Bali, E., Szabó, Cs. & Szakál, J.A. (2003): Sr-barite droplets associated with sulfide blebs in clinopyroxene megacrysts from basaltic tuff (Szentbékkálla, Western Hungary). Lithos 66/3-4, 275-289
MBFSZ	Publication	De Vivo, B., **Török, K.**, Ayuso, R.A., Lima, A., Lirer, L. (1995): Fluid inclusion evidence for magmatic silicate/saline/CO2 immiscibility and geochemistry of alkaline xenoliths from Ventotene island (Italy). Geochimica Cosmochimica Acta, 59, 2941-2953.

o A list of up to 5 relevant previous projects or activities, connected to the subject of this proposal.

Partner	**Type of project/activity**	**Description**
MBFSZ	SNAP SEE/WP Leader	Sustainable Aggregates Planning in South East Europe – contribution to the preparation of Tool Box including data and methodology, stakeholder consultations, planning scheme and guidance with joint vision (FP7, www.snapsee.eu)
MBFSZ	MINATURA2020/WP Leader	Concept on Mineral Deposits of Public Importance with preparation and contribution to guidance, joint vision and stakeholder consultation (H2020, www.minatura2020.eu)
MBFSZ	MINERALS4EU/Partner	Minerals Intelligence Network with data service, knowledge base, good practices (FP7 - www.minerals4Eu.eu)
MBFSZ	Mineral potential assessment of non-metallic solid mineral resources	National project from 2013 with the development of methodology and survey on access to minerals. Reports (2013, 2014, 2015, 2016) are available in the MBFSz Data Repository, Hungary.
MBFSZ	Modernization of national inventory harmonized by international systems	National project from 2013 with the development of methodology (bridging for energy and non-energy resources). Reports (2013, 2014, 2015, 2016) are available in the MBFSz Data Repository, Hungary.

o A description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.

Partner	**Type**	**Description**
MBFSZ	digital database	GeoBank: national borehole database with more than 270 000 records http://www.mfgi.hu/hu/node/79

MBFSZ	web-map services (WMS, WFS)	various geological (surface and subsurface), geophysical and applied geological maps of Hungary https://map.mbfsz.gov.hu/
MBFSZ	laboratory	ICP-MS, FTIR-ATR

Profile of key-staff members

Géza Tivadar **Szebényi** (male): M.Sc. in Geology/Mining. Mining authority senior geologist of Hungarian Mining and Geological Survey (MBFSZ). He workt as chief geologist of construction of National Radioactive Waste Repository in Bátaapáti (Hungary), as assessment geologist in Hungarian Geological Survey (Dept. of Inventory of Mineral resources), as chief geologist of Recsk copper and zink deposit (Hungary). He has foreign country experiences (Mongolia).

Kálmán Török PhD in Geology (male): Kálmán has been working in basic research with metamorphic rocks and fluid inclusions for more than 30 years as well as responsible for the geochemical and ore deposits research and handling of archive exploration/resource data at the Survey (MBFSZ).

Zsolt Tóth (male): Zsolt has M.Sc. in Geology and currently studying Economics. He is a young professional, he had internships at MOL Group, at RAG Hungary and RAG Austria as a geologist intern. He started his career at MBFSZ he was working directly for the president and now he is workinag at the Business Development and Analysis Department of MBFSZ.

Partner 13 – Geological Survey of Norway (NGU)

GEOLOGICAL SURVEY OF NORWAY, founded in 1858, is a government agency under the Ministry of Trade, Industry and Fisheries (NFD). NGU shall actively contribute to ensuring that geoscientific knowledge is utilized for the effective and sustainable management of the nation's natural resources and environment. NGU provide services and information within a large range of geoscience subjects, such as mineral resources (metals, industrial minerals, natural stone and aggregate), geological hazards, environmental issues, marine geology, regional geophysics and land use planning. NGU provides databases on mineral and aggregate resources to Norway's national information infrastructure and to the European mineral resource data platforms. NGU has participated in several European projects aimed at harmonizing data sets across borders, to the benefit of national and international land use planning, and industrial development and innovation. NGU has 200 employees, of which approximately 65% are scientists.

NGU works to identify and evaluate potential deposits of industrial minerals and ores which may be of future economic significance. The user target is industry, public administration, and other stakeholders. Information is gathered and stored in NGUs mineral resource database that is accessible through www.ngu.no and www.prospecting.no. NGU uses mineralogical and geochemical techniques for the characterization of mineral resources and has a well equipped laboratory for both mineral and rock characterization. NGU will contribute with maps, knowledge and data on the distribution and composition of known resources.

- **A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.**

Partner	Type	Reference
NGU	Service	2017, Industrial minerals database, http://geo.ngu.no/kart/mineralressurser_mobil/
EuroGeoSurvey	Service	2015, Minerals4EU, http://minerals4eu.brgm-rec.fr/
	Publication	Gautneb, H.; Knezevic, J.; Johannesen, N. E.; Wanvik, J. E.; Engvik, A.; Davidsen, B.; Rønning, J.S. 2017: Geological and ore dressing investigations of graphite occurrences in Bø, Sortland, Hadsel and Øksnes municipalities, Vesterålen, Nordland County, Northern Norway 2015-2016. NGU report. 2017.015. http://www.ngu.no/upload/Publikasjoner/Rapporter/2017/2017_015.pdf
	Publication	Ihlen P.M, Schiellerup H., Gautneb H., Skår Ø. 2013: Characterization of apatite resources in Norway and their REE potential - A review. Ore Geology Review, vol 58, 126-147 https://ac.els-cdn.com/S016913681300259X/1-s2.0-S016913681300259X-main.pdf?_tid=8e4cf4c2-d513-11e7-86e3-00000aacb35d&acdnat=1511966743_33b2086936688d32f30a706b7b156c4e
Publication		Boyd, R., Gautneb, H. 2016: Mineral resources in Norway; potential and strategic importance, 2016 update. NGU report 2016.034. http://www.ngu.no/upload/Publikasjoner/Rapporter/2016/2016_034.pdf

- **A list of up to 5 relevant previous projects or activities, connected to the subject of this proposal.**

Partner	Type of project/activity	Description
EuroGeoSurvey	Project	Minerals4EU; Pan-European data portal on mineral resources (2013-2015)
Pan-European	Project	EuRare; /th Framework Program project on the resources, processing, and supply of REE's to Europe. Norwegian investigations included REE in igneous phosphates (2012-2017)
NGU + Nordland county council	Project	Graphite investigations in Lofoten and Vesterålen (ongoing - geophysical and geological surveying)
NGU	Project	Investigation of graphite in Northern Norway (ongoing – geology, geochemistry, ore genesis)
NGU + Nordland county council	Project	Investigation of apatite deposits in Nordland County, Norway (ongoing)

- **A description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.**

Partner	Type	Description
	NGU Laboratories	Advanced rock and mineral analyses, including LA-ICP-MS, SEM, XRF, C-S-N by combustion analyses, and mineral separation.
	NGU Geomatics	Resource databases – data and development

Profile of key-staff members

Dr Henrik Schiellerup (male) is heading the Mineral Resources team at the Geological Survey of Norway. He is an economic geologist with specialty in igneous petrology. Dr Schiellerup obtained his PhD from the Norwegian University of Science and Technology in Trondheim, Norway, in 2001, and his MSc from the University of Aarhus, Denmark, in 1991. From 1991 to 1993 he received a research fellowship from the Nordic Volcanological Institute in Reykjavik, Iceland, working with Pleistocene volcanology.

Håvard Gautneb MSc. (male) is a researcher and industrial minerals specialist at the Geological survey of Norway (NGU). He has a MSc. in geology from University of Bergen, Norway in 1987. He has been working at NGU since 1989, with the geology of Industrial minerals deposits. His special field of competence is the geology of natural graphite deposits. He is the Norwegian representative in Eu commission Working group on critical materials.

Siv. Ing. Peter M. Ihlen (male) is emeritus at the Geological Survey of Norway where he recently retired from his position as research scientist (qualified professor) in economic geology. He has 44 years experience with mineral resources geology since he received his MSc in 1973 at the Norwegian University of Science and Technology in Trondheim, Norway. He has since then specialized in hydrothermal mineral deposits and igneous apatite deposits. Recieved a NATO Fellowship grant in 1979 for fluid inclusion study at the University of New Mexico, USA. He has also worked as lecturer in ore geology at Copenhagen University in 1996-1997.

Janja Knežević (female): M.Sc. in Geology/Geophysics, University of Belgrade. Since 2006 Janja has been working as Database geologist, Exploration geologist with experience in exploration of precious metals according the National Instrument 43-101 guidelines, and as Teaching Assistant. Since 2013 has been working with NGU georessources, databases, improving data and structure for land management applications and exploration. From 2016 Janja has been working with geological and geophysical exploration of graphite deposits in Norway.

Partner 14 – Polish Geological Institute (PGI-NRI)

The Polish Geological Institute –National Research Institute (PGI-NRI) was founded on the 7th of May 1919. It is involved in comprehensive studies of geological structure of the country for practical use in national economy and environmental protection. In addition to scientific activities in all fields of modern geology the Institute was entrusted with the tasks of the Polish Geological Survey and the Polish Hydrogeological Survey. Moreover, it is responsible for the country's security in supply of mineral resources, the groundwater management, for monitoring of the geological environment and warning against natural hazards and risks. For over 20 years PGI-NRI maintains geological and hydrogeological databases, in which information on over 160 000 boreholes, 830 000 geological reports and 13 000 deposits has been collected. These information are shared by web applications to geological administration units and in thinner scope to society. In February 2009, the Council of Ministers bestowed the Polish Geological Institute the status of National Research Institute. PGI-NRI is responsible for the comprehensive studies of the geological structure of Poland as well as for the evaluation of national minerals resources including resources.

- **A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.**

Partner	Type	Reference
PGI-NRI	Publication	Szamalek et al. (eds.); 2017, Mineral Resources of Poland, 180 pp. + 8 maps;http://geoportal.pgi.gov.pl/css/surowce/images/2017/pdf/mineral_resources_of_poland_2017.pdf
	Publication	Mikulski, 2013, The occurrence of tellurium and bismuth in the gold-bearing polymetallic sulfide ores in the Sudetes (SW Poland), 15-34, https://www.min-pan.krakow.pl/Wydawnictwa/GSM302/mikulski.pdf
	Service	System of management and protection of mineral resources in Poland – MIDAS; http://geoportal.pgi.gov.pl/midas-web
	Service	The Central Geological Database - CBDG; http://baza.pgi.gov.pl
	Product	***5.1 The balance of mineral resources deposits in Poland as of 31.12.2016.; http://www.pgi.gov.pl/en/dokumenty-pig-pib-all/publikacje-2/bilans-zasobow/4895-bilans-zasobow-zloz-kopalin-w-polsce-2016/file.html***

- **A list of up to 5 relevant previous projects or activities, connected to the subject of this proposal.**

Partner	Type of project/activity	Description
	OneGeology - Europes Contentplus	PGI-NRI were a partner to this project
	EU Information and Policy Support System for Sustainable Supply of Europe with Energy and Mineral Resources – EuroGeoSource	PGI-NRI were a partner to this project and a leader of one task.
	Minerals4EU - Minerals Intelligence Network for Europe	PGI-NRI were a partner to this project
	European Marine Observation and Data Network (EMODnet),	PGI-NRI were a partner to this project

	The verification of the current knowledge of REE occurrence in Poland with the pilot studies of their prospective concentration.	National project

- **A description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.**

Partner	Type	Description
	ICP-MS	**ICP-MS** (inductively coupled plasma mass spectrometry)- ELAN DRC II, Perkin Elmer (USA), **Determined parameters:** minor and trace elements
	ICP-OES	**ICP-OES** (hinductively coupled plasma optical emission spectrometry) - iCAP 6500 DUO, Thermo-Scientific (GB) - Panorama V, Jobin-Yvon (Francje) **Determined parameters:** major, minor and trace elements
	FAAS	**FAAS** (flame atomic absorption spectrometry) - Solaar 939 QZ, ATI Unicam (GB) **Determined parameters:** major and trace elements
	ETA-AAS	**ETA-AAS** (electrothermal atomization atomic absorption spectrometry) - PE 4100 ZL, Perkin Elmer (USA) - Solaar 939 QZ, ATI Unicam (GB) **Determined parameters:** trace elements - As, Au, Pt, Pd, Cd, Pb, Al, Cr, Mn, V, Se
	CAMECA-SX100	**CAMECA SX 100 electron microprobe** – one of the most innovative probes in the world. Precise determination of trace elements within micro-areas has many applications in various studies, among others, in mineralogical and petrographical investigations, environmental protection studies, microbiology, and archaeology.

- **[Any other supporting documents specified in the work programme for this call]**

Profiles of key staff members

Stanislaw Z. Mikulski (male):

M.Sc., Ph.D., and D.Sc., in Economic Geology. For almost 30 years conducted research on various aspects of Ore deposit geology, prospecting, mineralogy and geochemistry of non-ferrous and precious metals especially of the orogenic gold, Mo-Cu(±W) porphyry systems, saprolitic nickel deposits, zinc-lead deposits of the MVT and Cu- sediment hosted deposits. Field experience in prospecting metallic ores in Europe, Asia and North America. Leader of several scientific projects granted by the Polish Scientific Board and national leader of the UNESCO IGCP and INTAS projects. Head of the Economic Geology Department in PGI-NRI (2004-2006), and Mineral Resources Program (2012-2013). Scientific Secretary of the PGI-NRI (2013-2016) and deputy of Mineral Resources Program (2014-2017). Member of the SGA Council (2018-2020).

Slawomir Oszczepalski (male): M.Sc., Ph.D., and D.Sc. in Economic Geology. Graduated from Warsaw University (Faculty of Geology). Employed in PGI since 1974. Over 40 years of experience in prospecting and research for Cu sediment hosted deposits in Poland and beyond. Currently on the associate professor position in Polish Geological Institute - National Research Institute in Warsaw.

Katarzyna Sadlowska (female): M.Sc. in the stratigraphic and prospecting geology at the Faculty of Geology, Warsaw University, Poland. Employed in PGI since 2007. 10 years of experience in GIS projects (analyst, project and database manager) applied to mineral deposits.

Partner 15 - Royal Belgian Institute of Natural Sciences (RBINS)

The Geological Survey of Belgium (GSB) is a research and service department of the Royal Belgian Institute for Natural Sciences (RBINS). The GSB-RBINS raw material group has developed an expertise in metallogeny and applied mineralogy. Its expertise covers a wide range of mineral resources, including phosphate deposits (Belgium, Burundi, South Africa), Iron, Zinc and Lead deposits (Belgium) and copper, cobalt and manganese (DR-Congo, New Caledonia, Burkina Faso and South Africa). Applied research at GSB-RBINS also includes advancing spectrometric techniques (Raman, infrared absorption, LIBS) combined with geochemical analyses for the characterisation of critical minerals, with an emphasis on their application on complex and heterogeneous ores.

The GSB-RBINS raw material group has been involved in numerous joint projects, financed both by European and national institutions (including EuroGeoSource, AEGOS, GECO, One Geology Europe, GESTCO, PSSCCS projects I and II, Minerals4EU, MICA, FORAM). The RBINS-GSB-RBINS also maintain several raw materials related public web services (http://gisel.naturalsciences.be/gisel/gisel.html; www.gecoproject.org, http://www.minerals4eu.eu), and is managing the most active communication platform for Geoscientists in Belgium and Luxembourg (http://www.blugublg.be).

- **A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.**

Partner	Type	Reference
GSB-RBINS	Publication	Decrée, S., Boulvais, P., Cobert, C., Baele, J.M., Gardien, V., Tack, L., Demaiffe, D., 2015. Mineralogical, geochemical and isotopic (C and O) characterization of a complex (REE and HFSE) mineralized system related to the Matongo carbonatite (Burundi). Precambrian Research, 269: 281-295.

GSB-RBINS	Publication	Decrée, S., Boulvais, P., Tack, L., André, L., Baele, J.M., 2016. Fluorapatite in carbonatite-related phosphate deposits: the case of the Matongo carbonatite (Burundi). Mineralium Deposita, 51: 453-466.
GSB-RBINS	Publication	Decrée, S., Ihlen, P.M., Schiellerup, H., Hallberg, A., Demetriades, A., Raha, M., Soesoo, A., 2017. Potential of phosphate deposits in Europe. SGA News 41, 14-20.
GSB-RBINS	Publication	Decrée, S., Ihlen, P.M., Schiellerup, H., Hallberg, A., Demetriades, A., Raha, M., Soesoo, A., 2017. The potential of phosphate and associated Critical Raw Materials in Europe. 14th Biennial Meeting, Quebec City, Canada. Abstract book vol.4, 1515-1518.
GSB-RBINS	Publication	Decrée, S., Ihlen, P.M., Schiellerup, H., Hallberg, A., Demetriades, A., Raha, M., Soesoo, A., 2017. Phosphate and associated strategic elements: a European perspective. SEG 2017: Ore Deposits of Asia: China and Beyond, Beijing, China.

- **A list of up to 5 relevant previous projects or activities, connected to the subject of this proposal.**

Partner	Type of project/activity	Description
GSB-RBINS	Activity 1	Characterization and potential of the Ciply phosphatic chalk deposits (Mons basin, Belgium)
GSB-RBINS	Activity 2	Characterization of the apatite-bearing black shales in the Stavelot Massif (Belgium)
GSB-RBINS	Activity 3	Phosphate deposits and occurrences in Belgium: A review
GSB-RBINS	Activity 4	Study of the Phalaborwa apatite deposits (South Africa)

- **A description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.**

Partner	Type	Description
GSB-RBINS	Equipment 1	Environmental scanning electron microscope (ESEM, FEI), with Energy Dispersive Spectroscopy (EDS), Wavelength Dispersive spectroscopy (WDS) and Electron backscatter diffraction (EBSD) (EDAX equipment)
GSB-RBINS	Equipment 2	Raman microspectrometer (Brücker Senterra)

GSB-RBINS	Equipment 3	X-ray diffractometer (XRD, PANanlytical Empyrean)
GSB-RBINS	Equipment 4	Rock preparation equipment (Fritsch crusher, Fritsch planetary mill and McCrone micronizing mill)
GSB-RBINS	Equipment 5	Optical microscopy

Profile of key-staff members

Sophie Decrée: obtained her PhD in Sciences (Geology) at the ULB (University of Brussels) in 2004. She is ore geologist at the GSB/RBINS since 2014, and working on REE and phosphate deposits since 2010. She is a member of the Geochemistry Expert Group, and PI of three projects funded by Belgian Science Policy Office.

Christian Burlet: obtained his Master in Geology in 2002 from the University of Liège (Belgium). He started his career at the Geological Survey of Belgium in 2007 in applied Mineralogy (DRC oxidized ores), followed by FP7 and H2020 CSA projects on raw materials (Minerals4EU, MICA, FORAM). He is a member of the EuroGeoSurveys Minerals and Raw Materials Expert Group and the DG-Grow Raw Materials Supply Group. He is currently working on the Brugeo FEDER project (geothermie.brussels) that aims to develop geothermal energy in Brussels.

Thierry Leduc: PhD in Sciences (Mineralogy) (2013, University of Liège, Belgium). Since 2001, he has been working as mineralogist at the RBINS, managing collections and related databases. He is also in charge of the laboratories at the GSB.

Thomas Goovaerts: M.Sc. in Geology (2012, University of Leuven, Belgium). He is working as geologist technician since 2014

Marleen De Ceukelaire: Msc in Sciences (University of Gent , 1985) is conservator of the collections geology at the Royal Institute of Natural Sciences – section Heritage. Will play an important role in WP7.

Partner 16 - State Informational Geological Fund of Ukraine (GeoInform-GIU)

State Informational Geological Fund of Ukraine (GeoInform - GIU)

- The State Research and Development Enterprise "State Informational Geological Fund of Ukraine" – SRDE “GeoInform of Ukraine”, or GeoInform, is the specialized research and development unit of the State Geological and Subsurface Survey of Ukraine which collects, stores, analyzes and provides information received from geological study and use of subsurface.
- GIU conducts research work on monitoring of mineral resources of Ukraine on the basis of geological and mining activities during the year, recording deposits and making public the balance of mineral resources management of the State fund of deposits and occurrences (more than 10,000 objects recorded), synthesis and analysis of exploration for oil and gas, creating a system of state accounting of oil and gas wells, completion and maintenance of the State cadastre of mineral deposits and occurrences as well as State cadastre of groundwater deposits of Ukraine.
- **A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.**

Publications:

Interactive map of mineral deposits of Ukraine (in Ukrainian)

http://geoinf.kiev.ua/wp/interaktyvna-karta-rodovyshch-korysnykh-kopalyn.htm

Interactive map of mineral licenses (in Ukrainian)

http://geoinf.kiev.ua/wp/interaktyvni-karty-spetsdozvoliv.htm

Interactive geological map of Ukraine 1:1 000 000 (in Ukrainian)

http://geoinf.kiev.ua/wp/Interaktyvna-heolohichna-karta-Ukrayiny.htm

Interactive geological map of Ukraine 1:1 000 000 (in English)

http://geoinf.kiev.ua/wp/Interactive-Geological-Map-of-Ukraine.htm

Interactive State Geological Map of Ukraine 1:200 000 (in Ukrainian with English entries)

http://geoinf.kiev.ua/wp/kartograma.htm

- o **A list of up to 5 relevant previous projects or activities, connected to the subject of this proposal.**

Projects and research programme(s)

- Minerals4EU - EU
- ProSUM - EU
- NUMIRE – Norway-Ukraine (NGU/SGSSU)
- EIMIDA – Norway-Ukraine (NGU/Geoinform)

Profile of key-staff members

- **Dr. hab. Boris Malyuk** (Male), Director for International Cooperation, graduated in 1981 from Department of Geology, Lviv University, Ukraine, and in 1999 from Centre of Geostatistics, Ecole des Mines de Paris, France. Obtained Candidate of Science (PhD) Degree in Geotectonics in 1984, and extended Doctor of Science Degree in Petrology in 1991. National Delegate of Ukraine to the EuroGeoSurveys.
- **Sergii Prymushko** (Male), Director, with basic IT-background, has more than 30 years' experience in management of geological information, including partitioned database systems.
- **Volodymyr Velychko** (Male), Chief Engineer, at his position is responsible for hardware and software facilities and database development having basic IT-background. In the Project he will contribute to geoscientific data systems.
- **Dr. Igor Melnyk** (Male), Deputy Director, Center for International Cooperation, with basic background in geology, has an experience in field works and research in geochemistry, hydrogeology and ecology (PhD in 1996), as well as geoinformatics and GIS applications.
- **Tetiana Biloshapska** (Female), Chief Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1980. She is experienced in field works. She had studied mineral-resource base of Ukraine for more than 30 years, took part and led projects on prospecting and exploration of mineral deposits, conducted regional geological studies.

- **Natalia Korpan** (Female). Chief, Division of mineral deposits and reserves inventory. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1986. She had studied geology of coal and peat deposits and their reserves inventory for 30 years.
- **Ganna Sankina** (Female). I-category Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology'. She is working in the field of geology for more than 15 years, is experienced in field works in the course of geological mapping in the scale 1:200 000. She is managing the State inventory of oil and gas wells as well as compilation and analysis of these data.
- **Iryna Mykhaylyk** (Female), Leading Geologist, Division of Information Technologies. Graduated from Department of Geology, Taras Shevchenko Kyiv National University in 2010, under specialty “Geology”.
- **Natalia Kovalenko** (Female), Leading Engineer, Division of Information Technologies. Graduated from Department of Transport Construction, Kyiv Autoroad Institute (nowadays – Transport University) in 1985, under specialty “Bridges and Tunnels”, in 1989 graduated from special courses “Programming C++”, education center “Uspikh”, Kyiv, and in 2002 graduated from special courses “WEB-programming PHP, HTML, CSS”, education center “Perspektiva”, Kyiv
- **Tamara Bardygola** (Female). Interpreter, Center for International Cooperation. Graduated from Department of Mechanics and Mathematics, Kyiv University in 1988, under specialty “Mechanics of solid medium”.

Partner 17 - Geological Institute of Romania (IGR)

Geological Institute of Romania (Institutul Geologic al României**- IGR)** - R&D institute for Geology, Geophysics, Geochemistry and Remote Sensing - was founded in 1906 as national geological survey. Now it works under the Ministry of Research and Innovation. IGR includes two entities considered objectives of national importance: the National Museum of Geology and the Surlari Geomagnetic Observatory, the latter being part of the world geomagnetic network (Intermagnet) since 1998. IGR is organized in several subdivisions: *Georesources, Geothematic Maps, Geo-Hazards, GIS, database and remote sensing and Applied geonomic studies*.

The main mission of IGR is the elaboration of the national maps in various fields of geosciences. The scientific research in IGR covers the fields of mineral resources, geophysics, hydrogeology, geochemistry, paleontology, structural geology, geohazard, monitoring of the environment in mining areas. Its activity is based on research projects (national and international), contracts with Governmental authorities and with private investors. IGR has scientists specialized in *raw materials* (aggregates, natural stone, industrial minerals, metallic ores), *energetic resources* (oil, shale gas, coal, geothermal resources), *geo-hazards* (landslides, subsidence, complex impact of mining waste and excavations), *mineralogy and geochemistry* (rock, soil, water, isotopes), *geoinformation* (mineral resources information networks, implementation of INSPIRE Directive in Romania), *hydrogeology* and *CO_2 storage*.

- **A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.**

Partner	Type	Reference
IGR	Article	Mărgineanu R.M., Blebea-Apostu A.-M., Celarel A., Gomoiu C.M., **Costea C., Dumitraș D., Ion A.,** Duliu O.G. 2014. Radiometric, SEM and XRD investigation of the Chituc black sands, southern Danube Delta, Romania, Journal of Environmental Radioactivity, 138, 72-79.Popescu Gh. C.,

IGR	Article	Neacșu A., **Cioacă M.,** Buia G., 2013. Tellurium, selenium and cadmium resources in the waste dumps of Săcărâmb area (Apuseni Mountains), Romania. A preliminary estimation. Carpathian Journal of Earth and Environmental Sciences, 8, 199-206.
IGR	Article	**DUMITRAŞ, D.G., MARINCEA, Ş.**, BILAL, E. & HATERT, F. (2008): Apatite-(CaOH) in the fossil bat guano deposit from the "dry" Cioclovina Cave, Şureanu Mountains, Romania. Canadian Mineralogist, 46, 2, 431-445.
IGR	Article	**MARINCEA, Ş.** (2006): Suanite in two boron-bearing magnesian skarns from Romania: data on a longtime ignored mineral species. Neues Jahrbuch für Mineralogie, Abhandlungen, 182, 2, 183-192.
IGR	Article	**MARINCEA, Ş.** (2001): Magnesian borates and associated minerals in the Cacova Ierii skarn deposit (Apuseni Mountains, Romania). Geonomos, 8, 1, 1-7.

- **A list of up to 5 relevant previous projects or activities, connected to the subject of this proposal.**

Partner	Type of project/activity	Description
IGR	Project 1 (H2020)	MINATURA2020 (2015-2018) – develop a concept and methodology for the definition and subsequent protection of "mineral deposits of public importance" in order to ensure their "best use" in the future and include them in a harmonised European regulatory/guidance/policy framework., http://minatura2020.eu Partner
IGR	Project 2 (H2020)	X-MINE (2017-2020) - Real-Time Mineral X-Ray analysis for efficient and sustainable mining. http://www.xmine.eu/ Partner
IGR	Project 3 (FP7)	Minerals4EU – EU Mineral intelligence network structure providing data, information and knowledge on mineral resources around Europe (2013-2015). http://www.minerals4eu.eu/ Partner
IGR	Project 4 (European Commission - DG Enterprise and Industry - Raw materials policy)	MINVENTORY – Statistical Information on EU Raw Materials Deposits, which will allows to implement an action plan for harmonization of EU mineral resources data (2013-2014); http://www.minventory.eu/ Partner

IGR	Project 5 (National project)	2011-2012 – Geological synthesis report regarding the non-metallic mineral resources (graphite, talc, asbestos, Al-silicates, garnet) from the South Carpathians. Lead. Beneficiary: Ministry of Economy of Romania.

- **A description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.**

Partner	Type	Description
IGR	Infrastructure	MICROCOSMOS Laboratory – for Mineralogical and geochemical characterization of minerals and raw materials – optical microscopy and scanning electron microscopy, energy-dispersive spectroscopy and wavelength dispersive spectroscopy, RAMAN spectroscopy. http://www.igr.ro/microcosmos/
IGR	Infrastructure	Determination of mineral phases: X-ray diffraction, Fourier transform infrared spectrometry, thermal analysis.
IGR	Infrastructure	LGGA - Ambiental Geology and Geophysics Laboratory – for small-scale Earth observation (unmanned aerial vehicle, 3D terrestrial Laser Scanner, Ground penetrating RADAR, electrometric measurements in landslides and secondary mineral areas or land planning etc.); https://erris.gov.ro/index.php?&cfFId=200&ddpN=1693097241&we=d3cdf3482aed0446e2532b946e1769a8&wf=dGFCall&wtok=65a105a477beb181539e9a59aaebda0588f51db4&wtkps=S7QytqoutjK1Uiovyc4pVrLOtDIzNzQyNbYuBsooFWemKIFYllZKuWkmGSX5pgX5yeWWiWklyZVGhpVVyblGuoWZxuVmqbqGJUlFmeXFIOVGQNNSlaz9rGsB&wchk=0f1b781991a4b7cf7b6ae2088eb0cd64ebd23718

Key persons:

Marian MUNTEANU (Male); Title: Dr.; Position: Senior Researcher (Geological Institute of Romania). Languages: Romanian (mother tongue), French, English. Biography. Nationality: Romanian. Expertise: economic geology, ore petrology, mineralogy, geochemistry and structural geology. Worked with the ARGES Exploration Company (for base metals in South Carpathians, 1985-1987), Geological Institute of Romania (Bucharest, scientific research in metallogeny and economic geology, 1987-1999; 2010-present), National Agency for Mineral Resources (Bucharest, public servant, 1999-2004), University of the Witwatersrand (Johannesburg, research on Ni-Cu-PGE mineralization in China, 2004-2008) and Anglo Platinum (exploration for Ni-Cu-PGE in China, 2008-2009). Relevant projects: SUSMIN-Instruments for gold sustainable mining (2014-2016, ERA-MIN); MAXI-Mineral Analysis using X-ray imaging (2014-2016, ERA-MIN); Minerals4EU-Minerals Intelligence Network for Europe (FP7, 2013-2015).

Ştefan MARINCEA (Male). **Title**: PhD.; **Position**: Senior Researcher; Ph.D. in Mineralogy (Romania) and Génie des Procédés (France). **Languages**: Romanian (mother tongue), French, English. **Nationality**: Romanian. Senior research scientist, employed by GIR since 1987. Previous expertise as exploration geologist (1985-1987). Honorary Collaborator of University in Liège (Belgium), Corresponding Member of

Royal Society of Sciences in Liège**. Published papers**: 72 articles (23 ISI-ranked), 3 chapters in thematic monographs. Coordinated research projects: 51. **Expertise** in mineralogy, ore deposits, geochemistry, ore processing. Expertise in management of projects and enterprises (2 diplomas). Teaching experience as associated Lecturer and Professor in Romania, Belgium and France. **Relevant projects**: **MAXI**-Mineral Analysis using X-ray imaging (2014-2016, ERA-MIN); **CHPM2030**-Combined Heat, Power and Metal extraction from ultra-deep ore bodies (2015-2018, H2020).

Negulescu Elena (female): **Title**: PhD; **Position**: Senior Researcher; *Ludovic Mrazec* award of the Romanian Academy (2002). **Languages**: Romanian (mother tongue), French, English. **Nationality**: Romanian. Research studies in mineralogy, petrology and petrogenesis of metamorphic rocks, geochronology, geothermobarometry, and numerical modelling; research studies regarding metallic and non-metallic mineral raw materials: graphite, Ni-Cu-Co, Li-bearing pegmatites. Training and experience in Electron Microprobe Analysis Technique, EDS, WDS analysis, X-ray mapping. Author and co-author of more than 50 articles published in peer-reviewed journals, books and chapter in books, conference papers and geological reports, poster presentations to international conferences like Goldschmidt, AGU Fall Meeting, EGU, International Geological Congress, CBGA. Membership of scientific or professional associations: Geochemical Society, American Geophysical Union (AGU), European Geophysical Union (EGU), Geological Society of Romania (SGR).

Gavril SĂBĂU (male). Title: PhD; **Position**: Senior Researcher; *Ludovic Mrazec* award of the Romanian Academy (2002). **Languages**: Romanian (mother tongue), French, English. **Nationality**: Romanian. Main topics covered: mineralogy, petrology and ore deposits: Ti-Nb-REE in alkaline rocks, Li-bearing pegmatites, graphite, Ni-Cu-Co. Head of the National Geothematic Maps Division (2003-2006), head of the Regional Geology, Geochemistry and Mineral Resources Dept. (2006-2008), scientific director of the Geological Institute of Romania (2011-2012), head of the Facilities of National Interest (2015-2017) of the Geological Institute of Romania. Manager in national and international research projects and grants, academic cooperations, and research contracts. Convener to AGU Fall Meeting 2007, San Francisco CA, invited speaker to Universität Tübingen (Institut für Geowissenschaften), Universität Wien, Fakultät für Geowissenschaften, Geographie und Astronomie, and Uni-Stuttgart. Author and co-author of more than 70 articles published in peer-reviewed journals, books and chapter in books, conference papers and geological reports, participation to international conferences like Goldschmidt, AGU Fall Meeting, EGU, International Geological Congress, CBGA.Membership of scientific or professional associations: Geochemical Society, American Geophysical Union (AGU), European Geophysical Union (EGU), Geological Society of Romania (SGR).

Delia-Georgeta DUMITRAS (Female), **Title**: Dr., **Position**: Senior Researcher, Dr. (Ph.D.) in Mineralogy (Romania and France). **Languages**: Romanian (mother tongue), French, English. **Nationality**: Romanian. Senior research scientist, employed by GIR since 1999. **Expertise**: Mineralogy, including cave mineralogy, skarn mineralogy, pegmatite mineralogy and processing artifacts mineralogy; X-ray powder diffractometry; Fourier transform infrared absorption spectrometry; thermal analysis; thermal analysis coupled with infrared absorption spectrometry. Head of the Laboratory of Mineralogy (authorized by CNCAN). **Relevant projects**: **MAXI**-Mineral Analysis using X-ray imaging (2014-2016, ERA-MIN); **PEDIOL**-Ecological products based on diatomaceous earth and essential oils for the residues and contaminants reduction from the food chain (2014-2017, funded by Ministry of Education); **CHPM2030**-Combined Heat, Power and Metal extraction from ultra-deep ore bodies (2015-2018, Horizon 2020).

Partner 18 - Geological Survey of Slovenia (GeoZS)

Geološki zavod Slovenije – Geological Survey of Slovenia (GeoZS) is a public research organisation (approx. 90 people employed) established by the Government of the Republic of Slovenia. The Survey carries out fundamental, applied, developmental and object research within several geological branches and related fields of work. It consists of research – programme groups and geological expert services. The research programmes cover fields of groundwater and geochemistry, mineral resources, and regional geology. The main goals are contributing to the knowledge about geological composition and structural setting of the national territory, production of geological maps, assessment of natural or anthropogenic geo-hazards, assessment of environmental pollution, study of groundwater, mineral deposits and geothermal energy together with their resource estimation, geological heritage assessment and development of geological knowledge and research methods.

Products, services and publications:

Partner	Type	Description
GeoZS	Service	Ongoing**, Slovenian public mine service**. https://ms.geo-zs.si/.
Geo-ZS	Product	*Annual, **Mineral Resources – Annual Bulletin about mineral resources in Slovenia*** *http://www.geo-zs.si/index.php/publikacije2/periodi%C4%8Dne-publikacije/mineralne-surovine*
GeoZS	Publication	*Novak, M., Rman, N. (edit.), (2016): **Geological Atlas of Slovenia**. Ljubljana; Gelogical Survey of Slovenia.*
GeoZS	Publication	Žibret, G. (2016): **Slovenia: mineral policy**. In: Tiess G, Majmuder T, Cameron T (edit): Encyclopedia of mineral and energy policy. Berlin; Heidelberg: Springer. DOI 10.1007/978-3-642-40871-7_39-1
GeoZS	Publication	Tychsen, J., Komac, M., Šinigoj, J., Žibret, G., Krivic, M., Jemec Auflič, M., Adetunji, A. (2015): **Support to formulate artisanal mining (ASM) needs and strategy plus a pilot study (small area) using satellite remote sensing & GIS to outline an inventory methodology, Nigeria** : final report. København; Ljubljana: Geological Survey of Slovenia. 72 p.

Involvement in other relevant European and national projects

Partner	*Type of project/activity*	*Description*
GeoZS	*Project 1: EO-MINERS*	*Earth Observation for Monitoring and Observing Environmental and Societal Impacts of Mineral Resources Exploration and Exploitation. 2010-2013. GeoZS contributed as a partner project dealing with earth observation application to mining exploration and exploitation.*
GeoZS	*Project 2 : Minerals4EU*	*Mineral Intelligence Network for Europe. 2013-2015. GeoZS was a WP leader in this Europe wide project,*

		which delivered the EU-Minerals Knowledge Data Platform.
GeoZS	*Project 3: iVAMOS!*	*Viable Alternative Mine Operating System. 2015-2018. GeoZS contributes as a partner in innovative project, which will provide modern solutions for mining in flooded open pits.*
GeoZS	*Project 4: UNEXMIN*	*Autonomous Underwater Explorer for Flooded Mines. 2016-2019. GeoZS is a WP leader in a project developing autonomous prototypes for exploration of flooded underground mines.*
GeoZS	*Project 5: MINATURA*	*Concept on Mineral Deposits of Public Importance with their protection and preparation of joint stakeholder vision 2015-2018. GeoZS is a WP leader*

- A description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.

Partner	Type	Description
GeoZS	Infrastructure/item 1	**SEM-EDS equipment**; JEOL JSM-6490LV unit equipped with Oxford INCA Energy 350 PentaFETx3 EDS analyser.

Profiles of key staff members

Klemen Teran (male) is a geologist and Ph.D. candidate dealing with geochemistry of urban sediments, study of mineral resources deposits and geochemical data processing together with their visual presentation. In past he has been involved in several mining exploration projects on Balkan Peninsula. Currently he collaborates in several EU funded projects dealing with research an innovation of mining exploration equipment.

Manja Žebre, Ph.D. (female) is a geographer and an expert in GIS analysis in geomorphology. She is a junior researcher with 2 years of post-PhD experiences in the fields of GIS mapping and spatial analysis, glacial and periglacial geomorphology, and Quaternary geology. She is currently involved in several international collaborations studying Quaternary sediments in the Mediterranean carbonate areas. Her main contribution to the project will be her knowledge on spatial analysis and GIS modelling.

Gorazd Žibret, Ph.D. (male) is a mineral resources expert. He is senior researcher and head of research group "Mineral Resources", with almost 20 years of experiences in the fields of mineral resources assessment, secondary mineral resources, environmental and urban geochemistry and data mining in geology. His past and present involvement in several international projects, dealing with mineral resources policy and development of the mining exploration technology, will be a valuable help towards meeting the project objectives.

Mirka Trajanova, Ph.D. (female) is senior petrologist at the Geological survey of Slovenia. Her main topics are investigations in the area of Eastern Alps in Slovenia from petrological and structural point of view. Besides, she collaborates in a project tasks connected with mineral resources and hydrogeology.

She obtained rich experience in mineralogical and petrological research of iron ore deposits and products of their processing while working in Fe-Ni industry in Kavadarci, FYR Macedonia, and iron works in Skopje, FYR Macedonia.

Partner 19 – Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA)

The Geological Survey of Italy is a Department of the National Institute for Environmental Protection and Research (ISPRA).

The Geological Survey of Italy was established in 1873 and its main task was the creation and the publication of the Geological Map of Italy. It is today composed of a team of 140 people working with enthusiasm to protect and preserve our territory and to promote its geological knowledge.

The main goal is a constant activity of research and data production, collection and analysis, aiming at promoting a rational, fair and sustainable use of resources, at reducing risks due to natural and anthropogenic causes and at supporting Public Administrations (e.g. Ministry of the Environment). In particularly, next to the activity of geological mapping, the Geological Survey of Italy (GSI) monitors the state of soil and subsoil, develops geological, stratigraphic, geophysical, geomorphological and hydrogeological analyses to better understand the geological structure of the territory and the dynamics that modify it. It also contribute to natural risks mitigation, with particular care to hydrogeological risks, through data production, collection, analysis and development of specific databases.

Despite the strong contraction of production in recent years, the mining industry of solid mineral resources remains an important sector of the Italian economy. Italy, since last decade, is trying to address national legislation, in line with the European directives, towards environmental sustainability, raw materials' recycling and territorial planning.

The ownership of national mining policies is headed by the Ministry of Economic Development (MISE) and the collection of statistical data is carried on by ISTAT and MISE, but the transversality of the subject and the strong environmental impacts of the active and abandoned extractive sites, make the Geological Survey of Italy (and ISPRA), the backbone and necessary element of any future sustainable development policy of the sector, even with regard to the reconversion of the abandoned mining areas for cultural purposes.

The Geological Survey of Italy is currently carrying on activities concerning the standardization of statistical information on raw materials, primary and secondary, environmental studies of quarries and mines (restoration of extractive sites, mine waste deposits) and cultural exploitation (for tourism) of mining parks and museums.

Main persons involved: Marco Di Leginio, Fiorenzo Fumanti, Mauro Lucarini, Lucio Martarelli, Monica Serra

- **A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.**

Partner	Type	Reference
ISPRA (GSI)	Product	Geoportal and Thematic Maps of Italian territory http://sgi.isprambiente.it/geoportal/catalog/main/home.page

ISPRA (GSI)	Product	Environmental Data Yearbook – Section on Extractive Activities (Mines and Quarries Production) http://annuario.isprambiente.it/
ISPRA (GSI)	Product	Quality of Urban Environment – Annual Report on Urban Mine Sites http://www.areeurbane.isprambiente.it/it
ISPRA (GSI)	Service	Mineral Wastes Inventory (Legislative Decree n.117/2008) http://www.isprambiente.gov.it/files/miniere/Inventario_Aggiornamento_2017.pdf

- **A list of up to 5 relevant previous projects or activities, connected to the subject of this proposal.**

Partner	Type of project/activity	Description
ISPRA (GSI)	Project 1	Re.Mi. (National Network of Mining Parks and Museums)- aimed both at connecting all the sites involved in the recovery of abandoned mining areas as industrial heritage tourism resource, and also at strengthening the regulatory framework.
ISPRA (GSI)	Project 2	Minerals4EU – aimed at developing an EU Minerals Intelligence Network (2013-2015), containing data and metadata on mineral resources.
ISPRA (GSI)	Project 3	MICA – aimed at building up a Minerals Intelligence Capacity Analysis, defining the Ontology of EU mineral resources (2015-2017).
ISPRA (GSI)	Project 4	FORAM – aimed at developing an European platform of international experts and stakeholders for the creation of a World Raw Materials Forum (WFRM), supporting a better international cooperation on raw materials policies and investments (2016-2018).

- **[Any other supporting documents specified in the work programme for this call]**

Not applicable

- **A curriculum vitae or description of the profile of the persons, including their gender, who will be primarily responsible for carrying out the proposed research and/or innovation activities (*you can upload the CV in ISAAC under the tab Attachments – Curriculum Vitae*)**

Affiliation: ISPRA - Geological Survey of Italy

Name: **Mauro Lucarini**

Address: Vitaliano Brancati Street n. 48 – 00144 Rome (Italy)

Position: Geologist (Scientific Researcher III)

Gender: Male

Date of birth: 26th April 1975

Nationality: Italian

Education:

- **2004**, Geologist Professional Qualification
- **2002**, EIA Technical Consultant Professional Qualification
- **2001**, Master's Degree in Geological Sciences at Roma Tre University

Positions after education

- **2003-current**: Researches on Geological Hazards; Studies on Coastal Geology (GECO_07 Research Programme-batimetry surveys, submarine core drillings-); Cataloguing Earthquake Environmental Effects; Studies and Analyises on Floods and Monitoring of Soil Defense Works; Contaminated Sites and on Remediation Analysis; Studies on Soil Bioenginering; Studies and Analyses on Environmental Impact Assessment; Geoarchaeological investigations; Reports and Studies on Extractive Industry (EU Projects on Raw Materials, Quarries and Mines Databases, etc.).
- **2001-2003**: Coring, well drillings, geotechnical investigations (Geologist, SO.GEO.).
- **2000-2001**: Training on the job in some Tivoli quarry sites (Trainee Geologist).

Relevant experience:

- Coordination and support of actions related to extraction activities from national level to international level (Member of the Mineral Resources Expert Group of Eurogeosurveys, point of contact of EU Projects);
- Geological and Groundwater Expertise for Environmental Impact Assessment concerning Gasducts, Geothermal Exploration and Oil and Gas Exploration;
- Geological and Geomorphological Expertise on Hydrogeological Hazards;
- Geoarchaeologist researcher (studies on pedo-stratigraphic units, archaeological remains, ornamental stones and lithics).

Affiliation: ISPRA - Geological Survey of Italy

Name: **Lucio Martarelli**

Address: Via Vitaliano Brancati n. 48 – 00144 Rome (Italy)

Position: Geologist (senior Researcher Technologist)

Gender: Male

Date of birth: 15th July 1961

Nationality: Italian

Education:

- **1991-1993.** Two-year fellowship granted by the Italian "CNR", as training researcher in the field of Mineral Deposits and Applied Geochemistry.
- **1991.** Training certificate, after public examination, as a professional geologist.
- **1990.** Degree in Geological Sciences at the "Università degli Studi di Roma La Sapienza – Dipartimento di Scienze della Terra".

Positions after education:

- **2001-up-to-date**: Geologist at the Geological Survey of Italy (2008 up-to-date in ISPRA); 2002 to 2008 in APAT, Agenzia per la Protezione dell'Ambiente e per i Servizi Tecnici Nazionali; 2001-2002 in PCM-DSTN, Presidenza del Consiglio dei Ministri - Dipartimento per i Servizi Tecnici Nazionali).
- **1998-2001**: Technician applied to research activities at the Italian "CNR- Centro di Studio per gli Equilibri Sperimentali in Minerali e Rocce".
- **1995-1998**: Freelance activities with the "Università degli Studi di Roma La Sapienza – Dipartimento di Scienze della Terra" for supporting some research projects.
- **1993-1995**: Freelance activity with private firms involved in geological investigations.

Relevant experience:

- research activities in the frame of projects in the field of groundwater resources and hydrogeology (e.g., hydrogeological survey, hydrogeological information management, hydrogeological mapping).
- research activities in the frame of projects in the field of Mineral Deposits and Applied Geochemistry, mainly concerning mineralizations of the western Mediterranean Area.

Affiliation: ISPRA - Geological Survey of Italy

Name: **Marco Di Leginio**

Address: Via V. Brancati n. 48 – 00144 Rome (Italy)

Position: Geologist (Scientific Researcher III)

Gender: Male

Date of birth: 01th April 1975

Nationality: Italian

Education:

- **2002**, Web Developer with GIS technologies
- **2002**, Geologist Professional Qualification
- **2001**, Degree *cum laude* in Geological Sciences at the "Università degli Studi di Roma La Sapienza"

Positions after education:

- **2003-up-to-date**: Geologist at the Geological Survey of Italy. Main tasks: reports on Contaminated Sites and on Remediation Analysis, supporting activity on strategic environmental impact assessment (SEA), reports and studies on Extractive Industry (EU Projects on Raw Materials, Quarries and Mines Databases, etc.).
- **2002-2003**: Measures of static water level in wells and flow rate in the north part of Latium. Continued Coordinated Collaboration Roma Tre University – Department of Earth Sciences

Relevant experience:

- Member of the EGS (EuroGeoSurveys) Mineral Resources Expert Group.
- ISPRA-ISTAT working group to support the project: “Human pressure and natural hazards”
- Environmental reporting specifically to soil themes (Coordinator of “Geosfera” chapter in the Environmental data yearbook);

Affiliation: ISPRA - Geological Survey of Italy

Name: **Fiorenzo Fumanti**

Address: Via Vitaliano Brancati n. 48 – 00144 Rome (Italy)

Position: Geologist (Scientific Researcher)

Gender: Male

Date of birth: 13th April 1960

Nationality: Italian

Education:

- **1998.** Ph.D in Earth Sciences at the University of Rome “La Sapienza”
- **1991.** Training certificate as Expert Field Geologist at School for professional formation, L’Aquila
- **1990.** Training certificate, after public examination, as a professional geologist
- **1989.** Master Degree in Geological Sciences at the University of Rome “La Sapienza”

Positions after education:

•**1999-up-to-date:** Geologist at the Geological Survey of Italy (2008 up-to-date in ISPRA, Italian National Institute for Environmental Protection and Research; 2002 to 2008 in APAT, Agency for Environmental Protection and Technical Services; 1999-2002 in ANPA, National Agency for Environmental Protection)

•**1995-1999:** Consultant and Field geologist for Aquater Ltd. and Italeco Ltd. and other private companies

•**1989-1999:** Consultant and Field geologist for University “La Sapienza”, Department of earth sciences, and for private companies

Relevant experience:

•Geological survey and facies analysis of volcanic and sedimentary rocks

•Modelling of debris flow

•Activities on Italian and European soil policies

•National data collection and management on active and ceased quarries and mines.

Affiliation: ISPRA - Geological Survey of Italy

Name: **Monica Serra**

Address: Vitaliano Brancati Street n. 48 – 00144 Rome (Italy)

Position: Geologist (Scientific Researcher III)

Gender: Female

Date of birth: 22th January 1970

Nationality: Italian

Education:

- **2013,** Technician for the sustainable management of beached posidonia oceanica - Professional Qualification
- **2003,** Internship at USDA - Natural Resources Conservation Service (N.R.C.S.) - National Soil Survey Center (N.S.S.C.), in Lincoln, Nebraska - U.S.A to study G.I.S. techniques in the geological and pedological field
- **2000,** Geologist Professional Qualification
- **1998-2001**, PhD in "Defense and soil conservation, environmental vulnerability and hydrogeological protection"
- **1996,** Degree in Geological Sciences

Positions after education

- **2005-today**: ISPRA Geologist employee
- **1999-2006**: Geological survey and creation of geological maps within the national CARG Project as a Professional Geologist.
- **2004**: Lecturer of Gemmology in “Gold and silver working man” training course.

Relevant experience:

- Participation, as ISPRA expert, to the Twinning Project "Management System on Drinking Water Monitoring in Chief Sanitary Inspectorate": adaptation of Poland to the European water directives with in situ inspections, (2007).
- Technical support to the activities planned by the environmental requalification project in the Pancevo region (Serbia-Montenegro), specific activity "Monitoring of groundwater", with in situ inspections and piezometric surveys (2006).

5 Ethics and Security

5.1 Ethics

Have you completed an ethics self-assessment? YES, See table below. Additional doc has been attached in submission platform.

Does your research involve Human Embryonic Stem Cells (hESCs)?	NO
Does your research involve human participants?	NO
Does your research involve human cells or tissues	NO
Does your research involve personal data collection and/or processing?	NO
Does your research involve animals?	NO
In case non-EU countries are involved, do the research related activities undertaken in these countries raise potential ethics issues?	NO
Does your research involve the use of elements that may cause harm to the environment, to animals or plants?	NO
Does your research involve the use of elements that may cause harm to humans, including research staff?	NO
Does this research involve dual-use items in the sense of Regulation 428/2009, or other items for which an authorisation is required?	NO
Could your research raise concerns regarding the exclusive focus on civil applications?	NO
Does your research have a potential for misuse of research results?	NO
any other ethics issues that should be taken into consideration	NO

5.2 Security

Please indicate if your project will involve:

- Activities or results raising security issues: No
- 'EU-classified information' as background or results: No

5.13 MINDeSEA

COVER PAGE

Title of project proposal

Seabed Mineral Deposits in European Seas: Metallogeny and Geological Potential for Strategic and Critical Raw Materials (MINDeSEA)

Abstract

*The project **MINDeSEA** results of the collaboration between eight GeoERA Partners and four Non-funded Organizations at various points of common interest for exploration and investigation on seafloor mineral deposits. This project addresses an integrative metallogenetic study of principal types of seabed mineral resources (hydrothermal sulfides, ferromanganese crusts, phosphorites, marine placers and polymetallic nodules) in the European Seas. The MINDeSEA working group has both knowledge of and expertise in such types of mineralisation, providing exploration results, sample repositories and databases to produce innovative contributions. The importance of submarine mineralisation systems is related to the abundance and exploitation-potential of many strategic metals and Critical Raw Materials (CRM), necessary for the modern society development.*

The objectives of this project are the following: 1) Characterise deposit types; 2) Characterise the trace element content of the deposit type including CRM; 3) Identify the principal metallogenic provinces; 4) Develop harmonised mineral maps and datasets of seabed deposits incorporating GSO datasets, along with mineral-potential and prospectivity maps; 5) Demonstrate how the cases study results can be used in off-shore mineral exploration; 6) Analyse present-day exploration and exploitation status in terms of regulation, legislation, environmental impacts, exploitation and future directions. 7) Demonstrate efficiency of a pan-European research approach to understanding seabed minerals and modes of exploration. The methodology will include: procedures for submarine minerals exploration; mineral evaluation and seafloor minerals mapping; a web service that will disseminate procedures, maps and information to the general public, downstream users and decision makers.

Please indicate the SRT

Raw Materials – RM3-Metallogeny – Geological potential

List of participants

#	Participant Legal Name	Institution	Country
1	Instituto Geológico y Minero de España [Project Coordinator]	**Geological Survey of Spain (IGME-Sp)**	**SPAIN**
2	Bundesanstalt für Geowissenschaften und Rohstoffe	**Federal Institute for Geosciences and Natural Resources (BGR)**	**GERMANY**
3	Institouto Geologikon kai Metalleftikon Erevnon	**Institute of Geology and Mineral Exploration (IGME-Gr)**	**GREECE**
4	Department of Communications, Climate Action and Environment	**Geological Survey of Ireland (GSI)**	**IRELAND**

5	Geological Survey of Norway	**Geological Survey of Norway (NGU)**	**NORWAY**
6	Laboratorio Nacional de Energia e Geologia	**Laboratorio Nacional de Energia e Geologia I.P. (LNEG)**	**PORTUGAL**
7	Sveriges Geologiska Undersökning	**Geological Survey of Sweden (SGU)**	**SWEDEN**
8	State Research and Development Enterprise State Information Geological Fund of Ukraine	**Geoinform of Ukraine (GIU)**	**UKRAINE**
9	Instituto Português do Mar e da Atmosfera	**Instituto Português do Mar e da Atmosfera (IPMA)** (non-funded partner)	**PORTUGAL**
10	Geosciences Institute	**Geosciences Institute (IGEO)** (non-funded partner)	**SPAIN**
11	United States Geological Survey	**United States Geological Survey (USGS)** (non-funded partner)	**UNITED STATES OF AMERICA**
12	Russian Ministry of Natural Resources	**Institute for Geology and Mineral Resources of the Ocean (VNIIOkeangeologia)** (non-funded partner)	**RUSSIA**

1 Excellence

In response to the GeoERA Call (grant agreement No 731166) on contributing to the sustainable use and responsible management of the subsurface, maximising its added value, while minimising environmental impacts and footprints we propose the following study entitled MINDeSEA.

Security of mineral supply has been identified by the European Commission as a priority challenge facing the raw materials sector. The 2017 list of Critical Raw Materials (CRM) now reflects societies growing demand for an ever-increasing number and quantity of elements and minerals that supply the green energy and technology markets.

The MINDeSEA project aims to identify seafloor deposits of metallic minerals and assess the potential for marine strategic minerals and CRM. While minerals mined from terrestrial reserves currently supply the international market, interest in marine minerals has been growing. The EC's Blue Growth strategy estimated that "By 2020, 5% of the world's minerals, including cobalt, copper and zinc could come from the ocean floors. This could rise to 10% by 2030. Global annual turnover of marine mineral mining can be expected to grow from virtually nothing to €5 billion in the next 10 years and up to €10 billion by 2030." It is our expert opinion that in order for such large scale marine mineral extraction to come into effect, and resulting economic benefits to become a reality, further quantitative and qualitative analysis, as proposed here are required.

Aims and objectives

This study will publish marine resource information, cases study and maps; identify areas for responsible resource exploration and extraction; inform management and Marine Spatial Planning.

This proposal addresses the need to share and extend state of the art knowledge and information relating to submarine minerals, metallogenic studies, standards and technologies across the European community. In addition we aim to emphasise the importance of varied marine deposits and evaluate their potential to provide succeeding generations with a supply of base metals and CRM. While the elemental value of marine mineral is well understood this is contrasted with a real lack of information on the regional geological processes involved in their formation; their accurate geographical distribution and concentrations. Therefore we propose modern metallogenic studies are necessary for developing new exploration methods where off-shore mineral deposits are proven and speculated. We intend to draw recommendations for future target areas, studies and standards to be used across Europe as part of this project.

The **specific aim** for this project proposal is to stablish the metallogenic context for different seabed mineral deposits with economic potential in the pan-European setting.

The **objectives** include: **1**) Characterise deposit types; **2**) Characterise the trace element content of the deposit type including CRM; **3**) Identify the principal metallogenic provinces; **4**) Develop harmonized mineral maps and datasets of seabed deposits incorporating GSO datasets, along with mineral-potential and prospectivity maps; **5**) Demonstrate how the cases study results can be used in off-shore mineral exploration; **6**) Analyse present-day exploration and exploitation status in terms of regulation, legislation, environmental impacts, exploitation and future directions. **7**) Demonstrate efficiency of a pan-European research approach to understanding seabed minerals and modes of exploration.

Relation to existing programmes and projects

The RM3A MINDeSEA project will take existing international collaborations and initiatives, EU programmes and projects, listed below, into account.

One example is the Minventory project where a number of 'bridging projects' has been proposed to be carried out in order to determine the realisable potential in this area and to attempt a large scale harmonisation project

Programme project initiative	Project type/EU program	Project Description	Interaction anticipated
Minerals4EU	Funded by the EC	The Minerals4EU project is designed to meet the recommendations of the Raw Materials Initiative and will develop an EU Mineral intelligence network structure delivering a web portal, a European Minerals Yearbook and foresight studies.	The MINDeSEA will provide data, information and knowledge on mineral resources in European Seas
EMODNET III Geology. WP7 Marine Minerals	Funded by the EC through the EMFF	The European Marine Observation and Data network (EMODnet) compiles environmental information on 7 themes including geology. Now in its third phase, EMODnet III Geology continues to update and further develop a framework for mapping marine minerals across all European seas for work package 7 Marine minerals. 11 different types of occurrences and deposits are mapped including raw materials and hydrocarbons.	With the involvement of the EMODnet Geology WP7 leader in our proposal. We intend to closely collaborate and ensure outputs of both projects are complimentary and productive.
The European MSP Platform	DG MARE	The European MSP Platform is designed to offer support to all EU Member States in their efforts to implement Maritime Spatial Planning (MSP).	With the adoption of the EU Directive on Maritime Spatial Planning (2014/89/EU), all coastal EU Member States are required to prepare cross-sectoral maritime spatial plans by 2021. This project will enable support for MSP by gaining and sharing specialised knowledge on oceanic strategic minerals and CRM.
Blue Mining	Funded by the EC (Seventh Framework Programme)	An international European consortium of 19 large industry and research organisations on various maritime fields of expertise, the “Blue Mining” consortium, will develop solutions that will bring sustainable deep sea mining a big step closer.	Cooperative supporting with data and knowledge. Assessment of exploration and exploitation of European seabed mineral resources
Blue Nodules	Funded by the EC Horizon2020	It is a research and innovation project to develop a deep sea mining system for the harvesting of polymetallic nodules from the sea floor with minimum environmental impact	Cooperative support with data and knowledge. Assessment of exploration and exploitation of European seabed mineral resources
MarineETech	Funded by NERC	The scientific approach led by MarineE-tech is holistic and interdisciplinary. It assesses the complex interplay between key processes in seafloor	With the involvement of the MarineETech non-funded partners from IGME-Sp and GSI in our proposal. We intend to closely

		ferromanganese-cobalt-rich deposit formation and the potential environmental impacts of recovery.	collaborate and ensure outputs of both projects are complimentary and productive.
MIDAS	Funded by the EC (Seventh Framework Programme)	Managing impacts of deep sea resource exploitation	Cooperative supporting with data and knowledge. Assessment decision makers on exploration and exploitation of European seabed mineral resources
International Seabed Authority (ISA)	International waters	Management, regulations, datasets and mapping for deep sea mineral resources exploration and exploitation beyond the national jurisdictions	With the involvement of the ISA Assessors, Contractors and Members as BGR (T. Kuhn), the USGS (J. Hein), VIINO (G. Cherkashov) in our proposal. We intend to closely collaborate and ensure outputs of both are complimentary and productive.
RMIS	Directorate-General (DG) Joint Research Centre (JRC)	The European Commission's (EC) Raw Materials Information System (RMIS).	Mutual feedback between databases to improve repositories of information, policies and activities
EGDI	Eurogeosurveys	EGDI is EuroGeoSurveys' European Geological Data Infrastructure. It provides access to Pan-European and national geological datasets and services from the Geological Survey Organizations of Europe.	With the involvement of the EDGI Partners in our proposal. We intend to closely collaborate and ensure outputs of both projects are complimentary and productive.
The INSPIRE "Geology and Mineral Resources"	The European Commission	Data Specification on Mineral Resources –Technical Guidelines	The MINDeSEA will apply the INSPIRE guidelines where possible
Minventory	The European Commission	Large scale harmonisation project	The MINDeSEA will provide data, information and knowledge on mineral resources in European Seas
InterRidge	International cooperative organization	Interdisciplinary, international studies of oceanic spreading centres	With the involvement of InterRidge country partners in our proposal, promoting cooperation of mid-Atlantic ridge mineralisation research, also included the Mediterranean and hot-spot islands.
ASMWG & AORA	International working group EU, USA, Canada	Interdisciplinary (Atlantic seabed mapping, ecosystems, aquiculture)	The MINDeSEA will provide data, information and knowledge on mineral resources in European Atlantic Ocean

1.1 Concept and methodology

The Earth provides mineral resources that are vital for human life. As global demand grows, especially for strategic metals and critical raw materials (CRM) crucial for low-carbon energy production and new technologies, there is a proportionate risk of increasing supply shortage for resources that are identified as critical to Europe's economy. A major element in Europe's long term economic strategy is to ensure security of supply for these strategic metals as part of the Blue Growth Strategy developing sectors that have a high potential for sustainable jobs and growth as seabed mining.

Seafloor mineral deposits represent the most important yet least explored resource of CRM and base metals on the planet. These polymetallic deposits include: nodules rich in manganese, copper and nickel; crusts rich in cobalt, tellurium, rare earth elements and platinum group elements; phosphorites rich in phosphorous, yttrium and rare earth elements; seafloor massive sulphides rich in copper, zinc and gold. In addition, economically important marine placer deposits accumulate elements like tin, titanium, thorium and gold (e.g., Hein et al., 2003; 2015; 2016; Rona, 2008; Hannington et al., 2011; ISA, 2017; Cherkashov et al., 2017). It is this combination of traditional (base) metals and the extreme enrichment in critical elements that makes the varied types of seafloor mineral deposits particularly interesting to both science and society. For example, a recent estimate of the global resource, based on the sparse data available, infers a dry mass of ferromanganese crusts on the seafloor of 35 x 10^9 tonnes (Halbach et al., 2017). In a rapidly changing global economic landscape, recovering deep-sea minerals has gone from a distant possibility to a likely reality within just a decade.

	Polymetallic Nodules	**Fe-Mn Crusts and phosphorites**	**Seafloor Massive Sulfides**
Geological setting	Abyssal basins	Seamounts and continental margins	Mid-ocean ridges Island arc systems
Major components	Mn, Ni, **Co**, Cu	**Co**, Mn, Cu, **P**, **REE**	Cu, Zn, Pb, Au, Ag
Minor components/ Byproducts	Mo, Li, **REE**, Tl, Zr, Ti, **Ga**	**Te**, Mo, **Bi**, **W**, Ti, **Pt**, V, **Nb**, **Y**	Se, **Te**, **Ge**, **Bi**, As, Cd, **Ga**, Tl, **In**
Global resources, million tons (Reference)	38 900	35 100 (Halbach et al., 2017)	4 000
Resources in "Prime zones", mln t (Reference) CCZ – Clarion-Clipperton Zone NPPCZ – North Pacific Prime Crust Zone NAEZ – North Atlantic Equatorial Zone	21 100 (CCZ) (Hein et al., 2013)	7 533 (NPPCZ) (Hein et al., 2013)	100 (NAEZ)

Geological setting and global resources of deep-sea mineral deposits (Modified from Cherkashov et al., 2017)

On a global scale, processes controlling the formation and distribution of seafloor mineral deposits are reasonably well understood (e.g., Usui and Someya, 1997; Hein et al., 2000; 2013; Hannington et al., 2011; Muiños et al., 2013; Bau et al., 2014; González et al., 2016; Kuhn et al., 2017). Much of this knowledge, however, is drawn from sparse sampling across wide ocean basins. A fundamental gap in understanding the role of local-scale subaqueous controls on the formation of seafloor mineral deposits remains. Localised mechanisms such as: fluid flow, magmatism, faulting, micro-topography, ocean currents and current upwelling, biological productivity, sedimentation rates, microorganisms, and water mass composition are considered crucial to controlling the formation, composition and preservation of seafloor mineral deposits. Yet, quantitative information and studies of local-scale processes as well as their relative corresponding impact on mineral accumulations are almost completely absent. Similarly, the capacity to predict and measure environmental impacts of potential seafloor mineral resource exploitation is in its infancy. There is not, yet, enough valuable information available to draft robust recommendations or regulations relating to responsible submarine mineral extraction.

In response to the GeoERA Call (grant agreement No 731166) on contributing to the sustainable use and responsible management of the subsurface, maximising its added value, while minimising environmental impacts and footprints; a group of 8 European Geological Surveys are proposing this project for seafloor mineral deposits under the SRT on *Raw Materials – RM3-Metallogeny – Geological potential*.

This proposal is a collaborative project, led by the Geological Survey of Spain (IGME), who is duly authorised by the other 7 consortium participants to submit the project proposal on their behalf. The partnership includes both GeoERA Beneficiaries and Non-funded Parties. Non-funded participants are organisations with responsibility for coastal, marine geological investigation and mineral resources studies and mapping in their respective countries. Four Organizations (the Instituto Português do Mar e da Atmosfera, IPMA; the United States Geological Survey, USGS; the All-Russia Scientific Research Institute for Geology and Mineral Resources of the Ocean, VNIIOkeangeologia; and the Geosciences Institute, IGEO) outside of the GeoERA consortium will participate in the project as Non-funded Partners. These participants host important databases, they have an international reputation for excellence in both science and technology, and are internationally-known experts on seafloor mineralisation and hydrothermal systems, which are relevant and strengthen the proposal.

The geographical scope of the proposed work programme, with a pan-European ambition, includes all the regional seas around Europe comprising the Atlantic Ocean, the Mediterranean Sea, the Baltic Sea and the Black Sea.

Any significant advance in understanding seafloor mineral deposits and their potential environmental impacts requires the development and implementation of new metallogenic studies and technologies. This proposal addressed the need to share and extend state of the art knowledge and information relating to submarine minerals, metallogenic studies, standards and technologies across the European community. In addition, we aim to emphasise the importance of varied marine deposits and evaluate their potential to provide succeeding generations with a supply of base metals and CRM. While the elemental value of marine minerals are well understood, there is a real lack of information on the regional geological processes involved in mineral formation, accurate geographical distribution of concentrated mineralisation and quantitative analysis of known mineral accumulations. Therefore we propose modern metallogenic studies are necessary for developing new exploration methods where off-shore mineral deposits are proven and speculated. We intend to draw recommendations for future target areas, studies and standards to be used across Europe as part of this project.

The methodology will include: procedures for submarine minerals exploration; mineral evaluation and seafloor minerals mapping; a web service that will disseminate procedures, maps and information to the general public, downstream users and decision makers.

It is proposed this project will compile and standardise fragmented marine data and data products, then make thees available through the GeoERA Information Platform (IP). All data, metadata, data products and information made available through the IP will be quality controlled and adhere to INSPIRE guidelines and Open Geospatial Consortium (OGC) standards for geospatial data. Data and data product available via previous and current geological and geophysical data aggregation and harmonisation projects such as GeoSeas and EMODnet will be incorporated and used to better the outputs of this project.

The data and map products will include information on the European seabed mineral resources including: volcanogenic massive sulphides; ferromanganese crusts, phosphorites and critical raw materials; marine placer deposits; polymetallic nodules; and exploration for submarine minerals throughout Europe. It is also envisaged that data will be displayed on the Minerals4EU portal and the European Geological Database Infrastructure (EGDI) portal.

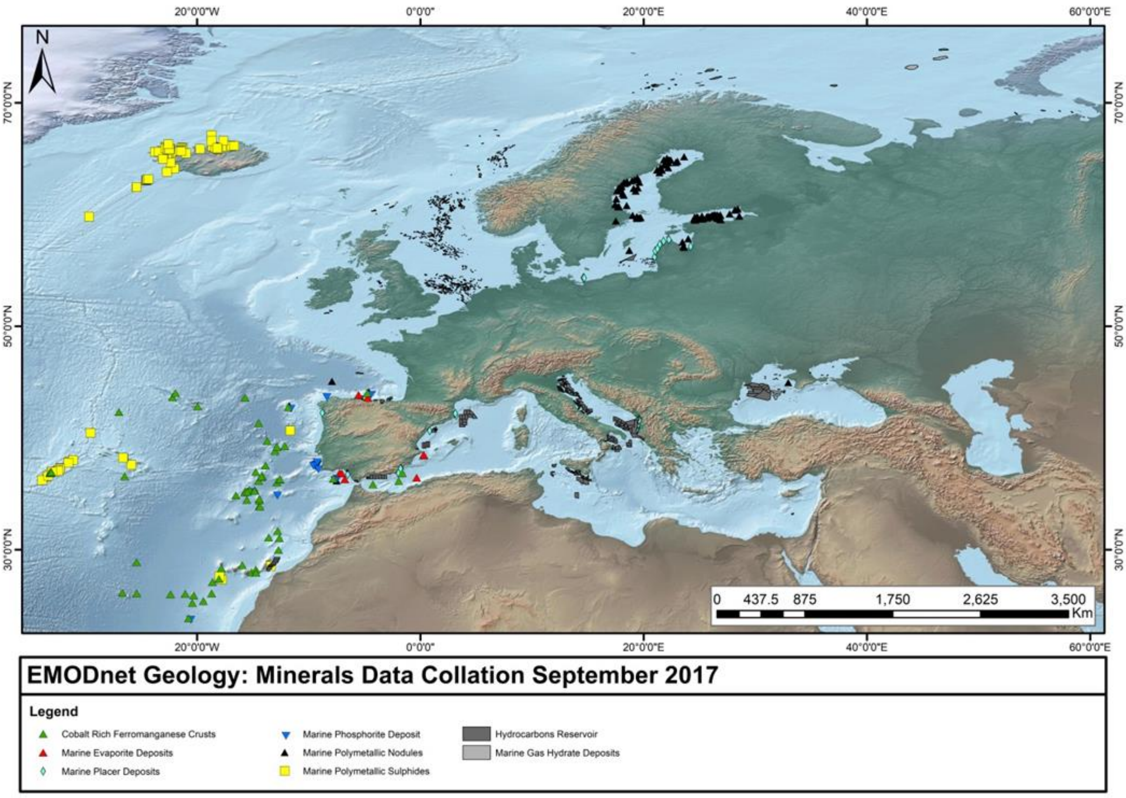
All interpretative products will be based on primary information owned by the project partners and data providers; these will be supplemented with additional information in the public domain to produce new database compilations and derived datasets such as geochemical data on critical raw materials. Where the most up-to-date mineral deposits information is held on third-party websites, arrangements will be made for web-mapping services to incorporate these data. The project will aim to provide transnational QC'ed and mineral harmonised resource datasets and maps; genetic/predictive models for resources and analysis of impact assessments for European seabed mineral resources.

The project will be for the duration of 36 months.

1.2 Ambition

Varied studies on European seabed minerals have been conducted over past decade by research organisations and industry. A literature review has concluded these studies employ differing objectives and scientific-technical criteria, none of which quantitatively or qualitatively assess marine CRM.

- Born to satisfy proactive European strategies such Marine Knowledge 2020 and the Blue Growth strategy, the data collation project *EMODnet-Geology* provides a basic catalogue of nine different types of submarine mineral deposits in all European seas with associated metadata and attributes where available.
- Initiatives like the *Atlantic Action Plan*, the *Atlantic Ocean Research Alliance (AORA)* and the *Atlantic Seabed Mapping International Working Group* concentrate on the need to complete Atlantic seabed mapping and progress open source data availability.
- Projects such as *Blue Mining*, *Blue Nodules*, *Marine E-Tech* and *MIDAS* are collaboratively working on marine resource discovery, resource assessment and exploitation technologies.



EMODnet Geology Project: Marine mineral occurrences map.

Despite these efforts, there is still need for a more comprehensive pan-European identification and compilation of mineral potential and classification of metallogenic seafloor mineral deposits. Owing to the success of the aforementioned strategies, actions and projects, we have come a long way in establishing frameworks for harmonising marine data and defined data standards. Communication and sharing of best practices has improved substantially. We anticipate this project will take these achievements further, assist in revitalising the marine and maritime economy in the EU Atlantic area and create standards for best practice exploration. MINDeSEA also aims to provide guidance for the management of impacts resulting from deep sea resource exploitation.

Most EC funded projects (H2020) have, thus far, ignored CRM associated with pan European seafloor deposits. It is therefore necessary that this proposed in-depth study commence with the status and feasibility of marine CRM, base and strategic metals at its core. Comprising a metallogenic revision, that combines exploratory and laboratory unified criteria to determine present resources and estimate their economic potential; we anticipate this project will evaluate the economic and social viability for CRM, base and strategic metals. It is our ambition that the adoption of common standards and exchange of best practices across systems will ensure progressive convergence and interoperability of the big geoscience data infrastructures in Europe -such as EGDI- thus facilitating long-term sustainability for the benefit of the end users.

MINDeSEA aims to contribute to a better understand of metallogenic seabed mineral deposits in all European seas. The Project will contribute to an integrative study through the participation of expert groups from across Europe and the United States with expertise pertaining to varying types of seabed mineral resources. Our vision is to provide knowledge and guidance for decision makers to systematically and effectively manage seabed mineral deposits across Europe. Results from legacy and ongoing projects such as *Blue Mining* and *EMODnet-Geology* will be integrated and updated where appropriate. Results of this project will be added to the *European Union Raw Materials Knowledge Base* (EURMKB).

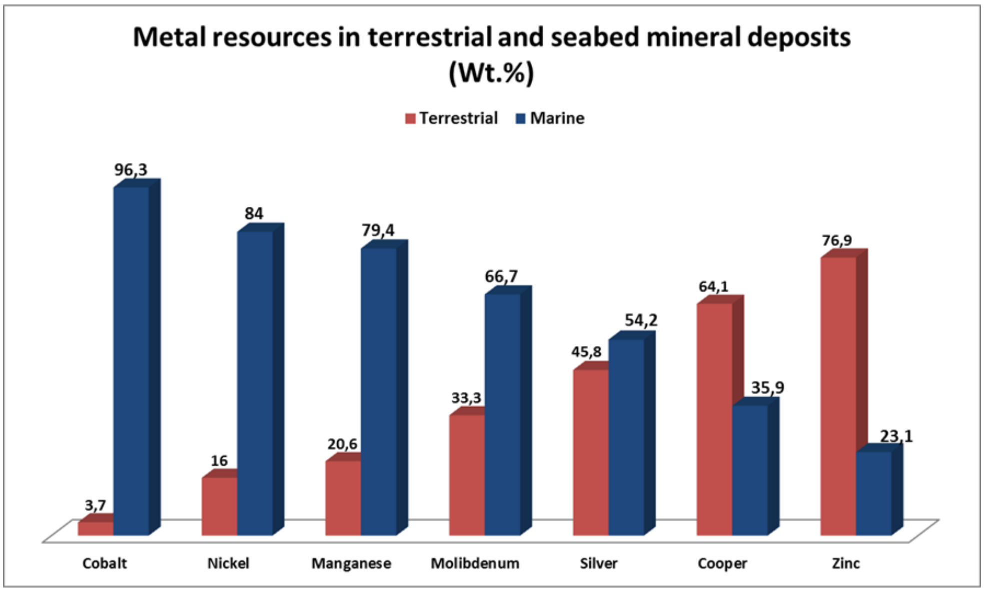
MINDeSEA will develop **advances** in:

- Defining approaches to exploration that will improve off-shore metallogenic studies
- Locating marine critical raw materials, where known quantities have been mapped in associated mineral accumulation within European Seas
- Producing harmonised and standardised mineral-potential and prospectivity maps and databases in a pan-European setting
- Demonstrating how case study results can effectively be used in mineral exploration
- Producing informative products that will better educate the EC and Society regarding the CRM potential in European Seas
- Promoting the development of robust environmental policy for exploitation of seabed mineral resources in Europe

Particular **innovation potentials** include:

- Definition of metallogenic provinces for off-shore mineral deposits in the pan-European setting
- Characterization of critical minerals and elements for submarine deposits
- Map of the off-shore critical raw materials in Europe
- Differentiation of data gaps in underexplored areas with high geological potential to host CRM deposits within European waters
- Proposals of pilot zones with high mineral-potential for future exploration

The Project will be closely collaborating with SRT RM1, RM4 and the Information Platform. It will incorporate comprehensive, reliable and harmonised information on seabed mineral deposits throughout European Seas.



446	*684*	*22,586*	*40*	*1.3*	*761*	*540*
17	*130*	*5,846*	*20*	*1.1*	*1,360*	*1,800*

Estimated metals percentage of resources and millions of tons reserves in terrestrial versus submarine mineral deposits. Source: USGS.

2017 CRMs (27)			
Antimony	Fluorspar	LREEs	Phosphorus
Baryte	Gallium	Magnesium	Scandium
Beryllium	Germanium	Natural graphite	Silicon metal
Bismuth	Hafnium	Natural rubber	Tantalum
Borate	Helium	Niobium	Tungsten
Cobalt	HREEs	PGMs	Vanadium
Coking coal	Indium	Phosphate rock	

Table of current Critical Raw Material's.

2 Impact

2.1 Expected impact

The implementation of this Project Proposal will contribute to achieving the following scientific or societal impacts:

- Provide integrated reliable data and information of the off-shore resources, useful for economic and social agents for the selection of viable mine sites and the design of environmentally sound and efficient seabed mining systems for the future.

- Support exploration and development of marine mineral raw materials by improving our knowledge and understanding of the occurrence of critical raw materials and base metals on submarine mineral deposits. As a consequence, the cost of exploration will be reduced.

- Future marine-based mining of critical raw materials, especially cobalt (Co), tellurium (Te), niobium (Nb), rare earth elements (REEs) and platinum group elements (PGEs), will contribute to reducing Europe's import dependency for these metals. This will support both the maintenance and creation of jobs within Europe.

- Develop cooperation and collaboration ties between researchers in the different partner organisations and countries participating in the project, contributing towards reducing duplication of research – both in terms of data acquisition as well as resource potential modelling.

- Additionally, the identification of data gaps and target areas will facilitate more directed and transnational future projects.

To do this, MINDeSEA will, though a series of key work packages, develop research that will:

• Give a comprehensive overview of seafloor mineral deposits in European Seas. This will be novel as a metallogenic-geological potential study of the different types has never been achieved for European seas. Therefore, the accomplishment of this research will represent a substantial advance in the state of knowledge relating to the genesis and importance of European seafloor metallogenic mineralisation

• Extend our knowledge and understanding for the geological characteristics of seabed mineralisations, their origin and evolution, relations with the tectonic activity and the sedimentary systems as well as the water masses composition and distribution.

• Improve the information available on the role exerted by the different local and regional factors on the deposits formation and the location of metals of economic interest.

• Understand the key processes for critical raw material concentration on submarine minerals, using modern laboratory technics and experimental models.

• Establish reference zones used as potential areas for increasing the knowledge on the processes of the different types of seafloor mineral deposits and their economic potential for critical and strategic metals.

• Determine the interest of the metallogenic studies on seafloor mineralisation to the development of technical, legal and environmental regulations for their future exploitation in the European Seas.

• To increase the existing information on the seabed mineralisations and their importance in local and global biodiversity, and to evaluate their vulnerability to processes derived from the anthropic activity.

• To improve the knowledge of natural processes by means of mathematical-GIS modelling and the accomplishment of simulations.

2.2 Measures to maximise impact

2.2.1 Dissemination and exploitation of results

The MINDeSEA project addresses metallogeny for seabed mineral deposits and their geological potential for strategic and critical metals in European Seas. All project partners will use platforms and knowledge networks available to them nationally and internationally in order to disseminate information about progress and results of the project. Resources such as websites, newsletters, annual reports, dissemination at conferences and meetings, social media, etc will all be embraced by the project participants, full engagement will be coordinated by the dedicated dissemination WP.

EuroGeoSurveys (EGS) has an established network of key stakeholders already in place. Various Directorate Generals in the European Commission (in particular DG GROW, DG RTD, DG ENERGY, DG JRC, DG MARE).Through the EGS expert groups, national experts keep the relevant units and officers well informed of all developments of interest and provide advice on any issues relating to the subsurface and seafloor when requested. A Collaboration Agreement exists between EGS and DG JRC to improve scientific cooperation and knowledge sharing. In addition, EGS has an Agreement on Cooperation with the European Environment, which aims to secure a long-term cooperation in integrating environmental and geo-scientific data, information and knowledge. All these structures support correct communication of project progresses and results to the EU users.

The objective is to ensure effective and widespread dissemination and two-way communication of the activities and outcomes achieved within the project, during and also after the MINDeSEA project. Dissemination will highlight the benefits that this project will bring to target groups cross the European Union and beyond. MINDeSEA will cover critical raw materials maps, as well as metallogeny, these will be an important aspect in dissemination information.

The main focus for dissemination will be the Information Platform, which will be upgraded during the project progress and include digital products, such as newsletters, journal articles, press releases, flyers and social media tools. Workshops dedicated to the main themes of the work packages (jointly with other SRTs), press releases generating outside interest, soliciting feedback from users / decision makers, information leaflets, announcements in newsletters, website, popular media. Contributing to marine-science education, scientific outreach through publication in peer-reviewed journals, link up with Maritime Policy, WFD, MSFD, Marine Spatial Planning.

2.2.2 Communication activities

The project, and especially Work Package 2 (Communication, Dissemination and Exploitation), will co-operate with the GeoERA Secretariat in its efforts to disseminate the results to stakeholders including policy makers, industry and academia. The proposed measures will ensure widespread dissemination of the Project products, through targeted contact with stakeholders and other users of marine geological information. Collaboration with other SRTs, will further ensure widespread dissemination.
Through the dissemination activities, stakeholders will be made aware of the project activities and results. Dissemination will show how the results of the project, such as mineral-potential and prospective maps, that can help inform stakeholders inform sustainable practices. Communications in international forums such as the Underwater Mining Conference, Goldschmidt Conference, Society of Economic Geologists Conferences or the European Geosciences Union will give visibility among the community of geoscientists, economic geologists, metallurgical industries or marine technological enterprises.

The preliminary activities planned for broadcasting, internationalising and exploiting the results of this research are as follows:
1) Attendance to national and international, multidisciplinary congresses and conferences includingEGS, EUG, IUGS, EAG, GS, SEG, AAPG, IGCP and the IAS.
2) Publication of papers in national and international journals. Some of these international journals are those in which the researchers involved in the Project MINDeSEA have published other previous studies (see attached CV): Mar. Geol.; G-Cubed; Ore Geol. Rev. Chem. Geol.; Springer Books; Deep-Sea Res.; J. Marine Syst., etc.
3) Accomplishment of workshops national/international focused on the integration of results with other GeoERA and European projects that focus on similar topics.

4) Dissertation of Doctoral Theses (PhD), Master Theses; Working-training experiences for last year students from national and international Universities.
5) Creation (and continuous update) of a Web page displaying the aims, methodologies and activities of the project.
6) Press release and media news (national and international) and of educational videos showing the main operations carried out in the sampling and data acquisition.
7) Conferences in research and education institutions. The Week of Science and Open Days are considered of interest for a further transference of information to the centres of education, as well as to the general public.
8) Internships in foreign centres and research institutions of international relevance that work in similar topics. The dissemination of our results in these centres may allow the interchange of knowledge and are seen as of great value in completing the aims of this project.

2.3 Contribution of Project Proposal to the Information Platform or vice versa

The MINDeSEA project will work in conjunction with the GeoERA Information Platform (IP) to establish the best approach to publishing project results publicly, to the best possible standard and method with respect to the themes diverse audience. The project will work with the IP and be guided by their expert knowledge. It is envisaged assistance will be required of the projects Information specialists in: the development of maps for the various submarine mineral deposit types; spatial representation of seabed mineral deposits within a GIS framework; assistance in development databases for particular marine raw materials commodities and prospectivity maps; harmonise existing and future aggregate database and GIS data. The project will require input also to assist in adding the data and results of concurrent ongoing projects. Linkages to the other SRTs or Themes, GeoEnergy and Groundwater, databases and information systems may require the brokering of network connections, recommendations relating to data integration and General IT assistance. MINDeSEA will collaborate with and exchange information with existing infrastructure projects and programmes such as EMODnet Geology WP7 Minerals, the European Union Raw Materials Knowledge Base (EURMKB) and Minerals4EU database. The project will aim to disseminate: data, data products, reports, information and communications material through the GeoERA Information Platform (IP) in EGDI compliant formats. Whilst also adhering to INSPIRE rules and standards.

MINDeSea will complete objectives to an exemplary standard, for which necessary collaboration with the GeoERA IP will be co-ordinated and managed by a dedicated IP WP 8. Contact with the IP will be established in the first phase of the project. This will ensure the project aims and objectives are delivered completed and included in the GeoERA portal. New standards, classifications and recommendations will to be developed and included in the GeoERA website. The IP's standards and classification approach will be closely monitored so tall products are compatible with all GeoERA spatial information frameworks, thus improving the efficiency and support of marine special planning, environmental management and policy making.

3 Implementation

3.1 Work Plan – Work packages, deliverables

The work programme will be managed within a series of work packages dealing with the compilation of seabed mineral deposits data at a scale of 1:250,000 and more detailed scale when possible. There are 8 work packages described in detail in the tables 3.1a. A Project GANNT chart (Appendix 1, page 78) summarises the schedule to achieve the project objectives.

Standards and procedures will be informed by those of the existing and ongoing EU projects and programs for example: EMODnet Geology and INSPIRE. Standards established during the project and project results will be customised to fit into Minerals4EU/GeoERA Information Platform. Methodologies and approaches to defining the CRM potential will be published with guidelines for further researchers where data-gaps exist and recommendations for policy and environmental management.

3.2 Management structure, milestones and procedures

The Project will be co-ordinated by the Geological Survey of Spain (IGME). The Project Co-ordinator will work with the work package (WP) leaders to deliver all of the project outputs as described in the detailed work package descriptions in Section 3.1. The WP leaders have each been involved in the same role in the MINDeSEA preparatory phase. The WP leaders are:

WP1. Project Management and Coordination. The Geological Survey of Spain (IGME).

WP2. Communication, Dissemination and Exploitation. The Geological Survey of Spain (IGME).

WP3. Seafloor Massive Sulphide Deposits. The Geological Survey of Norway (NGU).

WP4. Ferro-manganese crusts, phosphorites and Critical Raw Materials. The Geological Survey of Spain (IGME).

WP5. Marine placer deposits. Institute of Geology and Mineral Exploration (IGME-Greece).

WP6. Polymetallic nodules. Laboratorio Nacional de Energia e Geologia I.P. (LNEG).

WP7. Exploration in the Atlantic, Mediterranean, Baltic and Black Sea. The Geological Survey of Spain (IGME).

WP8. Link to Information Platform. The Geological Survey Ireland (GSI).

The Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), the Geological Survey of Sweden (SGU) and Geoinform of Ukraine (GIU) complete the partnership for the project. Four legal entities outside the GeoERA consortium will participate in project as Non-funded Partners: the Instituto Português do Mar e da Atmosfera (IPMA), the United States Geological Survey (USGS), the All-Russia Scientific Research Institute for Geology and Mineral Resources of the Ocean and the Geosciences Institute (IGEO).

The project will be for the duration of 36 months and will be divided into three phases as stated in the documents and the GANNT chart (Appendix 1).

Phase 1. Months 0-12. The construction of the products and the link to Information Platform.

Phase 2. Months 13-24. The consolidation of all data products.

Phase 3. Months 25-36. The convergence phase during which the MINDeSEA link to Information Platform will be fine-tuned to ensure convergence with the other SRT and Themes under GeoERA.

<u>Risks relating to project implementation</u>:

Loss of key staff. The Co-ordinating organisation (Geological Survey of Spain, IGME) is a large, publicly funded institution with a number of senior scientists. Collectively IGME's staff experience, and that of the institutes within the project consortium, of managing major international programmes and EC projects, insure back-up cover for any risks associated with staff changes. Therefore we envisage risks associated with completion of the project as minimal to nil.

Providing mineral-potential and prospectivity maps may be more challenging, due to the fact that such information may not be available to all partners (e.g. third party data subject to confidentiality or commercial sensitivity). All project partners have proven access to national marine minerals information and data – as well as to complementary geodynamic data required for modelling – much of which have been/are being harmonised in the frame of EMODnet – Geology project. The specific Project data management plans must explain and justify each case of data access restrictions.

3.3 Consortium as a whole

The MINDeSEA consortium comprise an expert group from 8 countries (Germany, Greece, Ireland, Norway, Portugal, Spain, Sweden and Ukraine) that own public access datasets to address seabed mineral deposits metallogeny, potential and prospectivity maps in the pan-European setting. The consortium includes both Partners and Non-funded Parties, most of whom are organisations with responsibility for coastal and marine geological studies and mapping in their respective countries. The coordination and associated tasks of WP1 will be ensured by IGME-Sp with a long experience in European and international projects. All 8 national proponent countries are involved in the EMODnet-Geology Project-WP7 Mineral; we will work in mutual benefit with the WP7 Minerals. Synergy with other large European geoscience initiatives such as EGDI (European Geological Data Infrastructure) and EPOS (European Plate Observing System) will be achievable by the fact that several MINDeSEA partners play active roles in these projects also.

Partners from Norway and Sweden bring information from seas to the north of the regional seas which is well demonstrated for example by the Norwegian MAREANO sea floor mapping project. Sweden hosts an important database on sediments chemistry and environmental chemistry in the Baltic Sea. Germany and Spain will provide important Laboratory infrastructures (Geochemistry and Mineralogy) and expertise for detailed analysis of Critical Raw Material mineralisation. Ireland, Portugal and Spain will be bring marine minerals information from the northeast Atlantic and Macaronesia region continuing with the experience acquired during the EMODnet-Geology Project, national seabed mapping programmes and research initiatives. The participation of Greece, Spain and Ukraine will bring information from the Mediterranean Sea and the Black Sea. The proposed research here will benefit of expertise in seafloor mineralisation and leading science programmes and international cooperation added by Non-funded Partners from USGS, VNIIOkeangeologia, IPMA and IGEO. They will provide and disseminate information on the respective resources and underpinning geological data identified in the technical work packages of the project. Moreover the partners will search for cooperation with international marine geological organisations with important databases in marine minerals like the International Seabed Authority (ISA) and the INTERRIDGE Program.

3.4 Resources to be committed

Please see below a breakdown of all WP’s and their committed resources.

Table 3.1a) Work package description

Work package number	1	Lead beneficiary	**IGME-Sp (Spain)**
Work package title	**Management and Coordination**		
Participant number	50		
Short name of participant	**IGME-Sp**		
Person months per participant	12		
Start month	1	End month	36

Objectives

- To manage the overall project, ensure delivery of the outputs and outcomes as agreed with the European Commission.
- To assess and evaluate the project and its results.

Description of work

The coordination and overall management of the project will utilise the project management expertise of partner institutions together with the expertise of WP leaders. The overall coordination will be the responsibility of the Geological Survey of Spain (IGME) who will be responsible for all contractual arrangements and reporting to the GeoERA and the European Commission, and will carry out the operational technical and financial management. Project management by the IGME and WP management by nominated partners are described in Section 3.2.

The IGME will have overall responsibility for co-ordination of the project including ensuring that deadlines/milestones are achieved; reports are delivered on schedule; the project will be represented at meetings organised by the EC to report progress and collaborate with other GeoERA Themes and SRTs, final deliverables are reported on time; finance are managed. The Co-ordinator will be instigate a formal Project Board comprising the Project Lead as chair and the WP Leaders as steering committee or board members. The project team will meet twice a year during the (36 month) duration of the project, to ensure that the outputs are delivered to schedule. Further meetings will be called and conducted via phone conferencing as required.

Deliverables

- D1.1: Biannual Internal Progress Reports will be compiled and submitted to the Raw Materials Theme Coordinator outlining: meetings held, difficulties encountered, inventories of data starting at Month 6 of the project and continuing throughout the 36 months. M6, M12, M18, M24, M30, M36

- D1.2: A first interim Project Progress Report will be delivered in month 18 (M18) according the timetable indicated in the GeoERA Project Implementation Document Nº1. The interim report will include Project Progress Report template (Reporting Template Document 2B) with a summary of work completed and what remains to be done; the challenges faced; the effort (percentage of project resources) spent on the preparation of and access to data in each country, the access to data from international sources'. providing the data infrastructure to give access and make data accessible across countries, and developing standards.

- D1.3: A Final Project Progress Report will be delivered at the end of the Project in month 36 (M36) according the timetable indicated in the GeoERA Project Implementation Document Nº1. The Final Report will include the Final Project Progress Report template (Reporting Template Document 2C) with a description of the work that was done during the project; the challenges faced; an analysis of performance and lessons learned; an analysis of sustainability of the project; a 15-page executive summary that can be read by a non-specialist.

- D1.4: Cumulative expenditure reports gathering information of all partners regarding costs incurred in each calendar year according the timetable indicated in the GeoERA Project Implementation Document Nº1. M6, M18, M30

The WP1 includes the following milestones:

- M1.1: Kick-off meeting. M1
- M1.2: Project Progress Report. M18
- M1.3: Final Project Progress Report. M36
- M1.4: Final meeting. M36

Work package number	2		Lead beneficiary	IGME-Sp (Spain)								
Work package title	**Communications, Dissemination & Exploitation**											
Participant number	50	17	26	29	43	45	52	53	Non-funded			
Short name of participant	**IGME-Sp**	**BGR**	**IGME-Gr**	**GSI**	**NGU**	**LNEG**	**SGU**	**GIU**	**IGEO**	**IPMA**	**USGS**	**VNIIO**
Person months per participant	4.5	1	0.5	1	0.5	0.5	0.5	0.8	0.5	0.5	1	1
Start month	1			End month	36							

Objectives

- Maximum possible awareness of the MINDeSEA deliverables on seafloor mineral deposits in the European seas will be promoted amongst the main stakeholders and users of marine geological and economic geology data.

- To ensure that the MINDeSEA project is fully aware and complementary to the objectives of other SRTs within GeoERA.

Description of work

The aim of this work package is to ensure widespread dissemination and exploitation of the MINDeSEA products, through targeted contact with stakeholders and other users of the economic geology community and marine geological information. The input will be puting the resources of the project partners to disseminate information (websites, newsletters, annual reports, social media etc) along with specific targeted dissemination at conferences and meetings.

Dissemination of WP material will be made via the GeoERA Information Platform. The WP will ensure project material will be communicated at available opportunities. Suitable platforms will be identified at which we can raise awareness of the data and products, these are to include national websites and linked information websites. The MINDeSEA partners, which include the principal marine geological organisations in their respective countries bring their specialist knowledge of the users of marine geological data to the communication, dissemination & exploitation work package and will promote the project and GeoERA in general through participation at national and international meetings, workshops and conferences that focus on marine science and mineral resources. Factsheets and PowerPoint presentations on the specific deliverables of the MINDeSEA project will be delivered. Collaboration with other initiatives will further ensure widespread dissemination. Broader collaboration and knowledge exchange with marine geology organisations outside Europe (e.g. the USA and the International Seabed Authority) can be developed through the MINDeSEA progress.

Deliverables

- D2.1: WP2 Communications, Dissemination & Exploitation Task Guide, to outline the work schedule, specific deliverables and provide detailed instructions to project partners. M4

- D2.2: Digital dissemination will be based particularly on the Information Platform. Others include digital products, such as newsletters, journal articles, press releases, infographics, flyers and social media tools. M1-36

- D2.3: Workshops dedicated to the main themes of the work packages (jointly with other SRTs?). M8, M15, M21, M28, M36

- D2.4: Report summarizing the resources of the project partners to disseminate information (websites, newsletters, flyers and social media tools, annual reports etc) along with specific targeted dissemination at conferences and meetings. M36

The WP2 includes the following milestones:

- M2.1: Creation-management and digital dissemination on the website and apps. M6-36

- M2.2: Report summarising the resources of the project partners to disseminate information. M34

Work package number	3	Lead beneficiary		NGU (Norway)				
Work package title	**Seafloor Massive Sulphide Deposits**							
Participant number	43	29	45	50	Non-funded			
Short name of participant	**NGU**	**GSI**	**LNEG**	**IGME-Sp**	**IGEO**	**IPMA**	**USGS**	**VNIIO**
Person months per participant	3	1	1	3	2	0.5	2	3
Start month	1	End month	36					

Objectives

The objective of the current work package on marine sulphides is to gather existing vent and deposit data and making these available through European mineral resource portals: EGDI/Minerals4EU/EMODnet Geology WP7 Minerals and the EURMKB (RM1). Case studies will provide new compositional data from known and sampled mineralisation. The inclusion of the sea floor mineralisation in European web portals is important for an accurate assessment of the European resource potential and inventory. In addition, the data generated and compiled on modern SMS deposits will facilitate comparative studies on, and the classification of, ancient VMS deposits. The work package therefore aims to improve the existing genetic understanding and exploration models, and provide a better basis for future exploration and prospectivity mapping of both on-shore and off-shore deposits.

Description of work

Seafloor massive sulphides (SMS) are modern equivalents of on-shore (ancient) volcanogenic massive sulphides (VMS) which have been important exploration and mining targets through history in many regions of Europe. VMS deposits are generally stratiform accumulations of sulphides formed at or just beneath the seafloor as a result of certain volcano-magmatic events. The sulphides are precipitated from hot hydrothermal solutions when they come in contact with cold seawater. Deposits of this type that are forming today are known as seafloor massive sulphides and the associated sulphurous plumes are called black or white smokers (e.g., Scott, 1997; Hannington et al., 2004; 2011; Rona, 2008; Cherkashov, 2017).

VMS deposits are among the most important deposit types for a number of commodities, including copper (Cu), zinc (Zn), lead (Pb), silver (Ag) and gold (Au). In addition, they may contain economic grades of cobalt (Co), tin (Sn), barite ($BaSO_4$), sulphur (S), selenium (Se), indium (In), bismuth (Bi), tellurium (Te), gallium (Ga) and germanium (Ge). Several of these minor constituents are considered Critical Raw Materials by the EC. The modern equivalents are found along present day spreading ridges and other sub-marine volcanic centres, and have received increasing attention of late as a possible source for base, precious and special metals.

Data from ancient VMS deposits are the basis for present-day knowledge of the composition, structure and formation of SMS deposits. Many active and formerly active vent sites have been located, but only a few have been investigated in any detail. Globally, extraction is planned in only one or two known SMS deposits, and the prospect for significant future metal production from SMS deposits is currently unclear, even though the theoretical resource potential remains high. Various types of SMS are present in European waters, both in the Atlantic Ocean and Mediterranean See, where active sea floor venting has been found in connection with both mid ocean ridge volcanism, arc and intra plate volcanism.

A number of European countries are currently exploring the deep sea for copper, zinc, and noble metal mineralisation related to active and extinct oceanic volcanism. Mapping and exploration is taking place both in domestic and international waters, and is conducted by both private enterprises and public geoscience institutions, such as the European national geological surveys. For geological surveys the prime motivation is to gather information on the prospectivity, occurrence and importance of deposits, and ensuring that resources are mapped, and made known and available for future exploration and exploitation.

The WP3 includes the following tasks:

T3.1 Compilation of existing data on SMS deposits and mineralisation in European waters. Existing relevant databases, such as those maintained by EMODnet Geology and Interridge programs, will be consulted. The data will be re-formatted for inclusion into European mineral resource portals.

T3.2 Gathered data and information will be expanded with case studies where possible. Case studies should add compositional data, including base, precious and special metals.

T3.3 Perform a review of all collected and compiled data in terms of genetic models for formation of SMS deposits

T3.4 Present an assessment of the mineral potential for European SMS deposits.

Deliverables

- D3.1: WP3 Seafloor Massive Sulphide Deposits Task Guide, to outline the work schedule, specific deliverables and provide detailed instructions to project partners. M3
- D3.2: Provide harmonised data for European SMS deposits, including their classification and potential for critical elements. Data to be integrated into the European resource databases and information systems, including the EURMKB (RM1) and EGDI. M1-36
- D3.3: Develop and/or review the models for the formation of European SMS deposits (report). M28
- D3.4: Assess the potential for SMS mineral deposits within the European territory based on data generated by this study (report). M36

The WP3 includes the following milestones:

- M3.1: Database and metallogenetic map on Seafloor Massive Sulphide Deposits in European Seas. M30
- M3.2: Report summarising the metallogenic settings and CRM potential on Seafloor Massive Sulphide Deposits in European Seas. M30
- M3.3: Seafloor Massive Sulphide Deposits predictive and mineral exploration potential map. M34

Work package number	4	Lead beneficiary	IGME-Sp (Spain)				
Work package title	**Ferro-manganese Crusts, Phosphorites and Critical Raw Materials**						
Participant number	50	17	45	53	Non-funded		
Short name of participant	**IGME-Sp**	**BGR**	**LNEG**	**GIU**	**IGEO**	**IPMA**	**USGS**	**VNIIO**
Person months per participant	8	6	1	0.5	2	0.5	2	1
Start month	1		End month	36			

Objectives

- Characterise the deposit type (ferromanganese crusts or phophorites) by compiling relevant data on the classification, geological setting, terrain, age, mineralogical and chemical composition, morphology, textural types, and other controlling parameters.

- Characterize the trace element content of the deposit type including Critical Raw Materials (CRM) for base, noble and technological metals. Study controlling factors on the occurrence of CRM.

- Identify the principal metallogenic provinces where such deposits occur, taking into account spatial and temporal attributes, and provide models of formation.

- Develop harmonized mineral maps and datasets of ferromanganese crusts and phosphorites incorporating GSO datasets (geophysics or samples geochemistry), along with mineral-potential and prospectivity maps. Settings and locations of marine minerals on the EU´s Critical Raw materials list.

- Demonstrate how the case study results can be used in mineral exploration

•	Analyse present-day status in terms of regulation, legislation, environmental impacts exploitation and future directions of ferromanganese crusts, and phosphorites and demonstrate the efficiency of a pan-European research approach for mineral exploration.

Description of work

Marine ferromanganese crust deposits are potential mineral resources that contain base metals and strategic and critical elements such as cooper (Cu), cobalt (Co), vanadium (V), nickel (Ni), titanium (Ti), platinum group elements (PGEs) or rare earth elements (REEs). Traditionally, marine precipitates are defined as: a) purely hydrogenetic when all constituents are derived from cold seawater, (b) diagenetic, when all constituents are derived from cold sediment pore water; and (c) hydrothermal when precipitation occurs in the vicinity of hydrothermal vent sites from fluids with temperatures higher than ambient bottom waters. Hydrogenetic Fe-Mn crusts occur throughout the global ocean on seamounts, ridges and plateaus, where currents have kept the rocks free of sediment for millions of years. Some ferromanganese (Fe-Mn) crusts exhibit a mixed origin, primarily either hydrothermal-hydrogenetic or hydrogenetic-diagenetic (Hein et al., 2000; 2003; 2013; Muiños et al. 2013; Bau et al., 2014; Marino et al., 2017).

In many places, marine phosphorites are accompanied by Fe-Mn crust mineralisations on the seafloor of continental shelves and slopes along the western continental margins of the Atlantic Ocean. Some thick Fe-Mn crusts also contain carbonate fluorapatite, which was incorporated into the crusts during specific periods prior to middle Miocene during main Cenozoic episodes of phosphatization. These deposits are related to strong upwelling along the continental margins and seamounts. Marine phosphorites are known to concentrate rare earth elements and yttrium (REY) during early diagenetic formation (Hein et al., 1993; 2016; González et al., 2016). Although there are several references to ferromanganese crusts and their association with phosphorites in the literature, the genetic models for explaining their relationship and metal concentration are still poorly understood.

Research on phosphorites and Fe-Mn deposits have traditionally had two main purposes: 1) their economic importance as potential sources of phosphate for agriculture and metals, rare earth elements plus yttrium (REY), among others, required for high-tech and green-tech applications; and 2) their potential as archives for the study of paleoceanographic events.

Phosphorite and ferromanganese crust deposits are frequently associated, and widespread on the seafloor of continental shelves and slopes along the western continental margins of the Atlantic Ocean, also occurring on seamounts, banks and plateaus. They are especially abundant on the volcanic seamounts and ridges from the Macaronesia region (Canary-Madeira-Açores Islands).

The proposal is to compile fragmented marine data products and metadata on areas explored and investigated for ferromanganese crusts and phosphorites and make them available through an information platform. The portal will provide access to data and metadata held by each organisation based on standards developed in the Geo-Seas and EMODnet-Geology project and data products compiled at a scale of 1:250,000.

This WP will establish the location, extension and formation processes of individual European ferromanganese crusts and phosphorites; how critical metals are concentrated on the mineralisation; where they occur and why they are associated with particular minerals. This is a necessary study, to identify areas with potential CRM deposits as sources of strategic and rare metals within the EU and associated countries waters.

The WP4 includes the following tasks:

T4.1	Compilation of existing data on ferromanganese crusts and phosphorites mineralisation in European waters. Existing relevant databases, such as those maintained by EMODnet and

	Interridge programs, will be consulted. The data will be re-formatted for inclusion into European mineral resource portals.
T4.2	Information gathered will be developed with case study based work (see attached document).
T4.3	Literature and projects will be scrutinized to recover compositional data on European ferromanganese crusts and phosphorite deposits and their CRM associated.
T3.4	Perform a review of all collected and compiled data in terms of genetic models for formation of ferromanganese crusts and phosphorite deposits and concentration of CRM.
T4.5	Present an assessment of the mineral potential for European ferromanganese crusts and phosphorite deposits.

Deliverables

- D4.1: WP4 Ferromanganese crusts, phosphorites and critical raw materials Task Guide, to outline the work schedule, specific deliverables and provide detailed instructions to project partners. M3
- D4.2: INSPIRE-compliant harmonised datasets and maps of marine ferromanganese crusts and phosphorites and their associated CRM for the European sea basins. M1-36
- D4.3: Mineral-potential and prospectivity maps, where such information is available. M36
- D4.4: Models of formation for the main provinces of ferromanganese crusts and phosphorites occurrence, as defined through this study. M28
- D4.5: Report highlighting the endowment and exploration potential of CRM associated with submarine ferromanganese crusts and phosphorites in Europe. M30
- D4.6: Literature review report on present-day status of regulation, legislation and exploitation of ferromanganese crusts and phosphorites, with emphasis on the impact of a pan-European research approach. M36
- D4.7: The results of the case study will be presented in a separate project report. M36

The WP4 includes the following milestones:

- M4.1: Database and metallogenetic map on ferromanganese crusts and phosphorites and their associated strategic and CRM in European Seas. M30
- M4.2: Report summarizing the metallogenic settings and CRM potential on ferromanganese crusts and phosphorites in European Seas. M30
- M4.3: Ferromanganese crusts and phosphorite deposits predictive and mineral exploration potential map. M34
- M4.4: Case study predictive and mineral-potential maps. M36

Work package number	5	Lead beneficiary	IGME-Gr (Greece)		
Work package title	**Marine Placer Deposits**				
Participant number	26	45	50	53	
Short name of participant	**IGME-Gr**	**LNEG**	**IGME-Sp**	**GIU**	**IPMA**
Person months per participant	5	0.5	3	0.5	1
Start month	1	End month	36		

Objectives

- Provide a systematic characterisation of marine placer deposits, by means of geological setting, sourcing, age, mineral content and other controlling factors.
- Identify the main provinces where such deposits occur, taking into account spatial and temporal attributes, and provide models of formation.
- Develop harmonised datasets and maps of marine placer deposits for the European seas, along with mineral-potential and prospectivity maps.
- Establish synergy with on-shore RM research projects to use common standards and methodologies where applicable.
- Analyse present-day status in terms of regulation, legislation and exploitation of placer deposits and demonstrate the efficiency of a pan-European research approach for mineral exploration.

Description of work

Marine placer deposits have received much attention during marine exploration. They comprise detrital heavy metallic minerals and gemstones, eroded from, usually igneous, source rocks on land and transported to sea, mostly by rivers. Thereby placer deposits are concentrated by water motions (waves, tides, currents). The most important of these minerals, from an economical aspect, are: cassiterite (tin), ilmenite and rutile (titanium), zircon (zirconium), chromite (chromium), monazite (thorium), magnetite (iron), gold; the principle gemstone is diamond.

The potential for the occurrence of placer deposits within the sedimentary accumulations of the continental shelf is significant. However, current knowledge is sparse, mostly limited to seafloor deposits on shallow waters which are more accessible for exploration. Thus, the need for an integrated research approach on the European seas is imminent, given the present-day RM demands and exploitation technological advances, towards sustainable use and management of the subsurface. In addition to the coastal zone, the whole continental margin must be considered to examine whether Pleistocene sea level fluctuations could have concentrated heavy minerals in deeper waters.

Towards this scope, the main provinces of marine placer deposits' occurrence have to be defined, complemented by modelling of the sourcing mechanism. An on-shore to off-shore approach could be adopted, where possible parent rocks (geological structure), transport mechanism (hydrological regime) and concentration mechanisms (morphology and water movements) would be used to model confirmed deposits and provide mineral-potential estimates.

The WP5 includes the following tasks:

T5.1 Compilation of existing data on placer deposits in European waters. Existing relevant databases, such as those maintained by EMODnet and Interridge programs, will be consulted. The data will be re-formatted for inclusion into European mineral resource portals.

T5.2 Literature and projects will be scrutinized to recover compositional data on European placer deposits.

T5.3 Perform a review of all collected and compiled data in terms of genetic models for formation of placer deposits.

T5.4 Present an assessment of the mineral potential for European placer deposits.

Deliverables

- D5.1: WP5 Marine Placer Deposits Task Guide, to outline the work schedule, specific deliverables and provide detailed instructions to project partners. M3

- D5.2: INSPIRE-compliant harmonised datasets and maps of marine placer deposits for the European sea basins. M1-36

- D5.3: Mineral-potential and prospectivity maps, where such information is available. M36

- D5.4: Models of formation for the main provinces of placer occurrence, as defined through this study. M28

- D5.5: Literature review report on present-day status of regulation, legislation and exploitation of placer deposits, with emphasis on the impact of a pan-European research approach. M36

The WP5 includes the following milestones:

- M5.1: Database and metallogenetic map on Marine Placer Deposits in European Seas. M30
- M5.2: Report summarizing the metallogenic settings for Marine Placer Deposits in European Seas. M30
- M5.3: Marine Placer Deposits predictive and mineral exploration potential map. M34

Work package number	6	Lead beneficiary	LNEG (Portugal)						
Work package title	**Polymetallic Nodules**								
Participant number	45	17	50	52	53	Non-funded			
Short name of participant	**LNEG**	**BGR**	**IGME-Sp**	**SGU**	**GIU**	**IGEO**	**IPMA**	**USGS**	**VNIIO**
Person months per participant	5	5	3	2.5	0.5	1	4	2	1
Start month	1		End month	36					

Objectives

The main objective of WP6 is to compile, analyse and deliver the information on the existing occurrences of polymetallic nodules in the European margins, in order to assess the European resource potential and inventory on polymetallic nodules. The data on the composition and genesis of the polymetallic occurrences will be made available through European mineral resource portals: EGDI/Minerals4E, EURMKB (RM1) and EMODnet Geology. Case studies (already sampled prior to this project and made available by project members) will be selected and further investigated in order to provide a better constraint on the composition and formation processes of the representative occurrences of polymetallic nodules in European Seas. This WP will also provide the basis for polymetallic nodules prospect identification and evaluation in European waters and identify key areas of missing information for future exploration and prospectively mapping.

Description of work

Polymetallic nodules occur in abyssal plains (~4000 – 6000 mm water depth) of all major oceans as two-dimensional deposits rich in metals of economic interest such as manganese (Mn), nickel (Ni), copper (Cu), cobalt (Co), molybdenum (Mo), titanium (Ti), lithium (Li), platinum-group elements, and rare earth elements (REE). The nodules consist of micro-layers of ferromanganese oxy-hydroxides concentrically precipitated around a nucleus. The polymetallic nodules are formed by metals precipitation either from ambient seawater (hydrogenetic formation), from pore-waters in the sediments (diagenetic formation), from hydrothermaly derived fluids (Bonatti and Nayudu, 1965; Bau et al., 2014; Kuhn et al., 2017) and the formation processes that represent a mix of these different end-member processes. The formation mechanisms control the general chemical composition of the nodules, e.g. the hydrogenetic precipitation leads to an enrichment of Co and REE while the diagenetic precipitation favours enrichment of Ni and Cu.

Nodules exploration has taken place since more than 30 years, e.g. in the Clarion-Clipperton Zone (CCZ) of the northeast equatorial Pacific, in the Central Indian Ocean Basin, and the Cook Islands area (Sharma, 2017). These areas have been targeted for nodule exploration and exploitation and are therefore subject of detailed investigation for several decades. There are however many other locations in the Atlantic and in European waters where nodules also occur, some of these occurrences are poorly characterized but some show clear indicators of promising deposits.

In the Baltic Sea, fast growing (0.013–1 mm year−1) diagenetic Mn nodules have been described at several locations and some with high metals content. High nodule abundances, between 10 and 40 kg/m2, occur in the Gulfs of Riga, Finland, and Bothnia, covering areas of a few hundred square kilometres. In the Russian sector of the Gulf of Finland, nodules have already been commercially mined between 2004 and 2007 (Kuhn et al., 2017). Mn nodules and other ferromanganese precipitates of special formation and metal content have been reported from the Gulf of Cadiz and in the Galicia Bank offshore Iberia. The nodules from the Gulf of Cadiz show unusual metal compositions that are related to the special local conditions, such as the migration and seepage of hydrocarbons and their occurrence associated with fault systems which may tap deeper fluids that control the chemical composition of these nodules (Gonzalez et al., 2009; Gonzalez et al., 2012; González et al., 2016). In the NE Atlantic, on seamounts, abyssal plains and plateaus, Fe-Mn deposits of hydrogenetic origin (crusts and nodules) are found to be distributed over water depths comprising the present-day depths of the Mediterranean Outflow Water and the North East Atlantic Deep Water, exhibiting enrichment of trace metals of economic interest. Studies indicate that these Atlantic deposits are, in places, comparable to the ones of the CCZ and that may therefore be an important future resource (Muinos et al., 2013; Muinos, 2015; Marino et al., 2017; Warwas & Kuhn, 2017).

The WP6 includes the following tasks:

T6.1 Definition of the parameters that will be employed for a polymetallic nodules prospect identification and evaluation. These parameters will be employed to fill the polymetallic nodules occurrences database that will incorporate the geophysics and samples geochemistry (GSO) datasets, their respective EU´s Critical Raw materials concentrations and the geological settings of the occurrences;

T6.2 Characterize the polymetallic nodules occurrences in European waters and their deposit types by compiling relevant data on the classification, geological setting, terrain, age, mineralogical and chemical composition, morphology, textural types, and other controlling parameters defined in T6.1. The compiled data will be re-formatted, following the parameters defined in the previous task and will be included in the European mineral resource portals;

T6.3 Characterize the trace elements content of the several polymetallic nodules deposit types including the Critical Raw Materials (CRM) for base, noble and technological metals. Controlling factors on the occurrence of CRM will also be characterized;

T6.4 Review all collected and compiled data in terms of genetic models for their polymetallic nodules prospect evaluation, and if needed, improve with critical analytical work in specific targets, to evaluate these targets prospects;

T6.5 Analysis of the compilation and identification of areas of high likelihood of unknown occurrences;

T6.6 Present an assessment of the mineral potential for European polymetallic nodules deposits and demonstrate how the results can be used in mineral exploration.

Deliverables

- D6.1: WP6 Polymetallic Nodules Task Guide, to outline the work schedule, specific deliverables and provide detailed instructions to project partners. M3

- D6.2: Report of the polymetallic nodules prospect evaluation parameters that will be employed as a road map for the creation of the polymetallic nodules occurrence database. M24

- D6.3: INSPIRE-compliant harmonised data for polymetallic nodules occurrences database, including their classification and potential for critical elements prospect evaluation. Data to be integrated into the European resource databases and information systems, including the EURMKB (RM1), EmMODnet Geology and EGDI. M1-36

- D6.4: Identification of areas of high likelihood occurrence of polymetallic nodules. M36

- D6.5: Report of the polymetallic nodules prospect evaluation for European waters based on data generated by this study. M36

The WP6 includes the following milestones:

- M6.1: Database and metallogenetic map on Polymetallic Nodules in European Seas. M30
- M6.2: Report summarizing the metallogenic settings for Polymetallic Nodules in European Seas. M30
- M6.3: Polymetallic Nodules predictive and mineral exploration potential map. M34

Work package number	7	Lead beneficiary	IGME-Sp (Spain)				
Work package title	**Exploration in the Atlantic, Mediterranean, Baltic and Black Sea**						
Participant number	50	17	26	29	43	45	52	53
Short name of participant	**IGME-Sp**	**BGR**	**IGME-Gr**	**GSI**	**NGU**	**LNEG**	**SGU**	**GIU**
Person months per participant	8	2	0.5	2	1	1	1	0.5
Start month	1		End month	36				

Objectives

- Devise a delineated baseline study to integrate geological, mineralogical and geochemical data from pan-European sources in order to create a new dataset on the distribution of the areas explored for submarine mineral resources in Europe.

- Propose recommendations for new unexplored marine areas, based on known geological environments where mineral accumulations are most likely. These areas will be published as recommendations for future exploration of base metals and CRM.

- Recommending pilot areas with high potential for discovery of new submarine mineral resources.

- Communicate the potential to alleviate dependence on European imports of these metals, as well as social and ethical benefits.

- New data will be included in the GeoERA information platform and integrated and harmonized with applicable European databases.

Description of work

The Atlantic Ocean and seas around Europe have been intensely explored during the last decades. The geographical scope of the work proposal includes the European Atlantic Ocean, Mediterranean Sea, Baltic Sea and Black Sea (within EU and International waters). Fragmented marine data on submarine mineral resources are available from the Geological Surveys and Internet platforms-databases including publicly-available information (published scientific papers etc.). Many submarine deposits like ferromanganese crusts, polymetallic Mn-nodules or volcanogenic massive sulphides have been discovered and studied during the last years in continental margins, oceanic ridges and deep-sea basins around Europe. They contain base metals and strategic and critical elements such as cooper (Cu), cobalt (Co), vanadium (V), nickel (Ni), titanium (Ti), platinum group elements (PGEs) or rare earth elements (REEs) plus yttrium (REY) that are being considered for future mining. The European economies are highly dependent on imports of many of these strategic metals from political and/or economical unstable countries, being necessary a deeper knowledge of our resources including the marine environment. A better understanding of the distribution, abundance and geological characteristics of these deposits, is essential for the selection of viable mine sites and the design of environmentally sound and efficient mining systems for the future.

The proposal is to compile fragmented marine data products and metadata from areas where exploration and investigated for mineral resources has taken place. These will be made available through an information platform. The portal will provide access to data and metadata held by each organisation based on standards developed in the Geo-Seas and EMODnet-Geology project and data products compiled at a scale of 1:250,000.

A complimentary action is to identify potential areas and sources of strategic and rare metals within the EU and associated countries waters. Co, Te, Pt and REEs are typically associated with ferromanganese crust deposits. P and also REEs and Y are present in phosphorites. Cu and Ni are abundant in polymetallic Mn-nodules; and Cu and noble metals are usually associated with massive sulphide deposits.

The WP can be seen as a pilot study on the pan-European distribution of the areas explored for submarine mineral resources, identifying sources of base metals and CRM, detecting the areas no or scarcely explored and proposing zones with high potential for discovery of new mineral resources.

The WP7 includes the following tasks:

T7.1 Compilation of existing data on seafloor minerals exploration in European waters. Existing relevant databases, such as those maintained by EMODnet, ISA and InterRidge Programs will be consulted.

T7.2 Literature and projects will be scrutinised to identify potential areas and sources of strategic and rare metals within the EU and associated countries waters.

T7.3	Perform a review of all collected and compiled data in terms of exploration methods, data and samples acquired and areas explored or yet unexplored for each mineral resource.
T7.4	Present an assessment of the mineral potential for discovery of new mineral resources.

Deliverables

- D7.1: WP7 Exploration in the Atlantic, Mediterranean, Baltic and Black Sea Task Guide, to outline the work schedule, specific deliverables and provide detailed instructions to project partners. M3

- D7.2: INSPIRE-compliant harmonised datasets and maps of marine areas explored for different mineral resources and unexplored regions in the European seas. M1-36

- D7.3: Mineral-potential and prospectivity maps, where such information is available. Proposal of pilot areas for discovery of new resources. M36

- D7.4: Literature review report on present-day status of exploration for submarine mineral deposits around Europe. M36

The WP7 includes the following milestones:

- M7.1: Database and maps of marine minerals explored in European Seas. M30
- M7.2: Report summarizing the present-day status of exploration for submarine mineral deposits in European Seas. M30
- M7.3: Proposal of prospectivity areas for discovery of new resources. M34

Work package number	8	Lead beneficiary		**GSI (Ireland)**
Work package title	**Link to Information Platform**			
Participant number	29	50		
Short name of participant	**GSI**	**IGME-Sp**		
Person months per participant	9	4		
Start month	1	End month		36

Objectives

Knowledge of metallogenic mineral occurrences on the seabed, their distribution, quality and quantity variable throughout Europe. Yet demands for this information increase with the worlds growing dependency on metalogenic and CRM to sustain green energy and the diversification of the technological market.

This project WP aims to establish best approach for refining information for metallogenic seabed mineral deposits and their economic potential in the pan-European setting. Once refined, information will be made available via GeoERA websites, data and information will be harmonised and standardised according to INSPIRE, EMODnet Geology, Open Geospatial Consortium (OGC) and EGDI standards, infrastructures and frameworks.

Once data has been aggregated by all project partners, the following objectives will be carried out, products will be produced and publicised.

- Characterise deposit types
- Characterise the trace element content of the deposit type including CRM;
- Identify the principal metallogenic provinces
- Develop harmonized mineral maps and datasets of seabed deposits incorporating available datasets, along with mineral-potential and prospectivity maps
- Demonstrate how the cases study results can be used in off-shore mineral exploration
- Analyse present-day exploration and exploitation status in terms of regulation, legislation, environmental impacts, exploitation and future directions
- Demonstrate efficiency of a pan-European research approach to understanding seabed minerals and modes of exploration.

Information pertinent to the following projects will to be shared-European Union Raw Materials Knowledge Base (EURMKB), EGDI and EMODnet Geology WP7 minerals.All project results will be published on the project portal and the generally made available through the GeoERA Information Platform (GIP).

- The main objective is to be a reliable data and information broker between the project participants and the Information Platform (IP), thus facilitating the identification of requirements. Ongoing discussion will be maintained with the IP team.
- Ensure principles and guidelines provided by the IP-project team are followed and implemented.
- Facilitate the integration and updating of ongoing projects to improve the European Union Raw Materials Knowledge Base (EURMKB).
- This project will develop harmonised databases and maps of ore deposit types, along with mineral-potential maps and prospectively maps.

Other objectives related to IP are: proof of concepts for exploration targeting, interoperability, standards and harmonisation.

Description of work

The marine environment poses well known challenges to marine mappers and geoscientists, with less the 5% of the deep-sea mapped to high resolution. Some geological features and marine mineral deposits have already been mapped, yet many others wait to be discovered. Technical difficulties associated mapping the marine realm include high acquisition costs and challenging conditions and are the main reasons we do not have a comprehensive knowledge of seabed and subsurface raw materials. Another contributing factor we cannot underestimate is the fragmented nature of information and data relating to methodology, standards, results and knowledge gathered to date.

Geological Surveys and researchers across Europe have specialised knowledge in seabed mapping techniques; resource estimation and sampling methodologies. Having compiled literature, complex marine geological and environmental information and detailed resource information; this project will create user friendly information packages, data products, metadata and graphics designed with our stakeholders in mind. All of these products will be communicated with the IP. Data, services and requirements will be communicated with the common IP, ensuring the value of our projects results. During the course of the project we will ensure that policy makers, industry researchers and the general public will be able to access and easily interpret the projects results.

Close communication and cooperation will be continued throughout the project to facilitate learning the principals and guidelines devised by the GeoERA Information Platform team. This WP will ensure communication with the IP on all relevant topics for the project, such as: Establishing standards and methodologies; prototyping; testing and implementation of fully functional data services; communication.

T8.1 Develop a project portal with project details and information on data products and useful links

T 8.2 Establish database standards with IP and develop a facility for thir production

T8.3 Establish standards with the IP & project WP leaders for characterisation of: each mineral type; the controlling factors of formation; WP defined, relevant data on the classifications associated with each mineral type - established to index the varying sub-types in accumulations; genetic models; prospectivity maps including CRM & strategic mineral evaluation, identification of datagaps and prospective evaluation maps.

T8.4 Define IP standards for mapping to the correct EGDI extension

T8.5 Establish strategy for communication, dissemination material and user analytics with IP and WP leaders.

Deliverables

During the project we will create a communication flow between the projects co-proponents and GeoERA IP.

- D8.1: Concise overview report with explanatory notes relating to the standards for databases, data, information and communication that will be created by the WP's (see each WP for detailed information). This will be agreed with the GeoERA IP and will adhere to European standards such as those devised by INSPIRE, EMODnet Geology and EGDI, where relevant. M3

- D8.2: Project metrics will be reported on the accessibility and use of data, data products and outreach material, for the IP and general public. M1-36

- D8.3: Best practice manual with practical guidelines and workflows for data, to include examples of mapping and resource assessment tools and procedures of offshore CRM, base and strategic minerals. M18

- D8.4: Completion of project databases & fully functional portal with published maps relating to each of the WP deliverables. These will adhere to INSPIRE principles and formats according to the EGDI standards. M1-36

Reports will be produced on user statistics that will guide our understanding for the demands for marine minerals information in comparison with other uses of maritime space where strategic marine minerals occur.

The WP8 includes the following milestones:

- M8.1: The establishment contact with the GeoERA Information Platform team, learn planned approaches to: website set; principals and guidelines; standards and methodologies; prototyping; testing and implementation of fully functional data services; communication. (this will be ongoing throughout the project lifespan) M1-36
- M8.2: Report on WP progress. To include update on the establishment of structures for disseminating and communicating: classification, standards and database for the IP platform. (6 monthly reporting)
- M8.3: Initial publication of products to include: WP resource information and sub type-classification summary; CRM and strategic resource maps (iterations 24, 36 months)
- M8.4: Fully functional web layers of all WP deliverables. Publication of databases, information, communication materials and map products from each of the WP’s M36
- M8.5: Completion of recommendations on resource, research and exploration practices. M36

Table 3.1b) List of work packages

Work package No.	Work Package Title	Lead Participant No.	Lead Participant Short Name	Person - Months	Start Month	End month
1	Management & Coordination	50	IGME-Sp	12	1	36
2	Communication, Dissemination & Exploitation	50	IGME-Sp	12.3	1	36
3	Seafloor Massive Sulphide Deposits	43	NGU	15.5	1	36
4	Ferromanganese Crusts, Phosphorites and CRM	50	IGME-Sp	21	1	36
5	Marine Placer Deposits	26	IGME-Gr	10	1	36
6	Polymetallic Nodules	45	LNEG	24	1	36
7	Exploration in the Atlantic, Baltic, Mediterranean and Black Sea	50	IGME-Sp	16	1	36
8	Link to Information Platform	29	GSI	13	1	36
				Total person - months	123.8	

Table 3.1c) List of deliverables

Deliverable number	Deliverable name	Work package number	Short name of lead participant	Type	Dissemination level	Delivery date (in months)
D1.1	Internal Progress Report	1	IGME-Sp	Report	Theme Coordinator	M6, M12, M18, M24, M30, M36
D1.2	Project Progress Report	1	IGME-Sp	Report	GeoERA Stakeholder Council	M18
D1.3	Final Project Progress Report	1	IGME-Sp	Report	GeoERA Stakeholder Council	M36
D1.4	Cumulative expenditure reports	1	IGME-Sp	Report	GeoERA	M6, M18
D2.1	WP2 Task guide	2	IGME-Sp	Task guide	GeoERA and Partners	M3
D2.2	Dissemination products	2	IGME-Sp	Digital products	Public	M1-36
D2.3	Workshops	2	IGME-Sp	Workshop	GeoERA and Public	M8, M15, M21, M28, M36
D2.4	Report WP2	2	IGME-Sp	Report	Public	M36
D3.1	WP3 Task guide	3	NGU	Task guide	GeoERA and Partners	M3
D3.2	Database and maps on SMS	3	NGU	Dataset	Public	M1-36
D3.3	SMS metallogenic models	3	NGU	Report (modelization)	Public	M28
D3.4	SMS potential assessment	3	NGU	Report	Public (decision makers)	M36
D4.1	WP4 Task guide	4	IGME-Sp	Task guide	GeoERA and Partners	M3
D4.2	Database and maps on Fe-Mn crusts and phosporites	4	IGME-Sp	Dataset	Public	M1-36
D4.3	Mineral-potential and prospectivity maps	4	IGME-Sp	Maps	Public	M36
D4.4	Fe-Mn crusts and phosphorites metallogenic models	4	IGME-Sp	Report (modelization)	Public	M28

D4.5	Exploration potential of CRM	4	IGME-Sp	Report	Public (decision makers)	M30
D4.6	Status of regulation, legislation and exploitation	4	IGME-Sp	Report	Public	M36
D4.7	Case study	4	IGME-Sp	Report (modelization)	Public (decision makers)	M36
D5.1	WP5 Task guide	5	IGME-Gr	Task guide	GeoERA and Partners	M3
D5.2	Database and maps on marine placers	5	IGME-Gr	Dataset	Public	M1-36
D5.3	Mineral-potential and prospectivity maps	5	IGME-Gr	Maps	Public	M36
D5.4	Placers metallogenic models	5	IGME-Gr	Report (modelization)	Public	M28
D5.5	Status of regulation, legislation and exploitation	5	IGME-Gr	Report	Public (decision makers)	M36
D6.1	WP6 Task guide	6	LNEG	Task guide	GeoERA and Partners	M3
D6.2	Polymetallic nodules prospect evaluation parameters	6	LNEG	Report	Public	M24
D6.3	Database and maps on polymetallic nodules	6	LNEG	Dataset	Public	M1-36
D6.4	Mineral-potential and prospectivity maps	6	LNEG	Maps	Public	M36
D6.5	Polymetallic nodules prospect evaluation	6	LNEG	Report	Public	M36
D7.1	WP7 Task guide	7	IGME-Sp	Task guide	GeoERA and Partners	M3
D7.2	Database and maps on Exploration	7	IGME-Sp	Dataset and Maps	Public	M1-36

D7.3	Mineral-potential and prospectivity maps	7	IGME-Sp	Maps	Public	M36
D7.4	Present-day status of exploration	7	IGME-Sp	Report	Public (decision makers)	M36
D8.1	WP8 Task guide	8	GSI	Task guide	GeoERA and Partners	M3
D8.2	Project metrics	8	GSI	Report	Public	M1-36
D8.3	Best practice manual with practical guidelines and workflows for data	8	GSI	Manual	Public	M18
D8.4	Completion of project databases & fully functional portal	8	GSI	Dataset	Public	M1-36

Tables for section 3.2

Table 3.2a) List of milestones

Milestone number	Milestone name	Related work package(s)	Due date (in months)	Means of verification
M1.1	Kick-off meeting	WP1	1	Event ocurrence
M1.2	Project Progress Report	WP1	18	Delivery of report
M1.3	Final Project Progress Report	WP1	36	Delivery of report
M1.4	Final meeting	WP1	36	Event ocurrence
M2.1	Dissemination on the website and apps	WP2	6-36	Digital platforms
M2.2	Report on Communication strategy	WP2	34	Delivery of report
M3.1	Database and metallogenic map on SMS	WP3	30	Delivery of database and maps
M3.2	Metallogenic settings and CRM potential on SMS	WP3	30	Delivery of report
M3.3	Predictive and mineral exploration potential map	WP3	34	Delivery of maps
M4.1	Database and metallogenic map on Fe-Mn crusts and phosphorites	WP4	30	Delivery of database and maps
M4.2	Metallogenic settings and CRM potential on Fe-Mn crusts and phosphorites	WP4	30	Delivery of report
M4.3	Predictive and mineral exploration potential map	WP4	34	Delivery of maps
M4.4	Case study	WP4	36	Delivery of maps
M5.1	Database and metallogenic map on marine placers	WP5	30	Delivery of database and maps
M5.2	Metallogenic settings for marine placer deposits	WP5	30	Delivery of report
M5.3	Predictive and mineral exploration potential map	WP5	34	Delivery of maps
M6.1	Database and metallogenic map on polymetallic nodules	WP6	30	Delivery of database and maps
M6.2	Metallogenic settings for polymetallic nodules	WP6	30	Delivery of report
M6.3	Predictive and mineral exploration potential map	WP6	34	Delivery of maps
M7.1	Database and maps of marine minerals explored in Europe	WP7	30	Delivery of database and maps
M7.2	Present-day status of exploration	WP7	30	Delivery of report
M7.3	New prospectivity areas	WP7	34	Delivery of report and maps
M8.1	Data normative and format requirements	WP8	18	Delivery of report
M8.2	Publication and fully functional web layers of products	WP8	24, 36	Acceptance by IP coordinator
M8.3	Recommendations on resource, research and exploration practices	WP8	36	Delivery of report

Table 3.2b) List of critical risks for implementation

Description of risk (indicate level of likelihood: Low/Medium/High)	Work package(s) involved	Proposed risk-mitigation measures
Loss of key staff / Low	WP1	Senior scientists with experience of managing major international projects
Data access restrictions/ Low-Medium	WP´s 3-7	Many of the data have been harmonised in the frame of EMODnet – Geology project
Delays in task execution	All WP´s	Apply guidelines for organising and running events will prevent any delays regarding process-design
Insufficient physical presence of Partners in physical meetings	WP´s 3-7	Possibility to attend the meetings virtually through online tools·

Table 3.3a) Summary of Staff Effort

	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	Total Person- Months per Participant
17/ BGR		1		6		5	2		14
26/ IGME-Gr		0.5			5		0.5		6
29/ GSI		1	1				2	9	13
43/ NGU		0.5	3				1		4.5
45/ LNEG		0.5	1	1	0.5	5	1		9
50/ IGME-Sp	12	4.5	3	8	3	3	8	4	45.5
52/ SGU		0.5				2.5	1		4
53/ GIU		0.8		0.5	0.5	0.5	0.5		2.8
IPMA (Non-funded)		0.5	0.5	0.5	1	4			6.5
USGS (Non-funded)		1	2	2		2			7
VNIIOkeangeologia (Non-funded)		1	3	1		1			6
IGEO (Non-funded)		0.5	2	2		1			5.5
Total Person Months	12	12.3	15.5	21	10	24	16	13	123.8

Table 3.3b) 'Other direct cost' items (travel, equipment, other goods and services)

17/ BGR	Cost (€)	Justification
Travel	€6,000	Attending 4 meetings, €800 per person per meeting; field work/laboratory work.
Equipment	€0	None anticipated.
Other goods and services	€2,000	Analysis of CRM in 20 samples (sub-contracting).
Total	€8,000	

26/ IGME-Gr	Cost (€)	Justification
Travel	€4,000	Attending 4 meetings €1000 per person per meeting
Equipment	€0	None anticipated.
Other goods and services	€200	Consumables
Total	€4,200	

29/ GSI	Cost (€)	Justification
Travel	€4,800	Attending 4 meetings, €800 per person per meeting; and field work/laboratory work.
Equipment	€0	None anticipated.
Other goods and services	€1,500	Miscellaneous (software)
Total	€6,300	

43/ NGU	Cost (€)	Justification
Travel	€4,000	Attending 4 meetings €1000 per person per meeting
Equipment	€0	None anticipated.
Other goods and services	€0	None anticipated.
Total	€4,000	

45/ LNEG	Cost (€)	Justification
Travel	€4,000	Attending 4 meetings €1000 per person per meeting
Equipment	€0	None anticipated.
Other goods and services	€6,000	Analysis of CRM in 20 samples (sub-contracting); consumables.
Total	€10,000	

50/ IGME-Sp	Cost (€)	Justification
Travel	€36,000	Attending kick-off and progress meetings for all partners (2 persons*1000 eur/person*8 EuroGeoSurveys*2 Meetings); attending field work/laboratory work.
Equipment	€0	None anticipated.
Other goods and services	€16,000	Analysis of CRM, isotopes and dating in 40 samples (nodules, crusts and phosphorites) (sub-contracting)
Other goods and Services	€36,000	Web page and apps creation; photographic catalogue of mineralisations and videos of marine exploration activities (sub-contracting)
Total	€88,000	

52/ SGU	Cost (€)	Justification
Travel	€4,000	Attending 4 meetings €1000 per person per meeting
Equipment	€0	None anticipated.
Other goods and services	€3,000	Consumables; analysis of CRM in samples (sub-contracting).
Total	€7,000	

53/ GIU	Cost (€)	Justification
Travel	€4,000	Attending 4 meetings €1000 per person per meeting
Equipment	€0	None anticipated.
Other goods and services	€200	Consumables
Total	€4,200	

Table 3.3c) Financial table with requested budget

Participant	(A) Direct personnel costs (EUR)	(B) Other direct costs; travel, equipment, infrastructure, other (EUR)	(C) Direct costs of sub-contracting (EUR)	(D) Indirect costs (= (A + B) *0,25) (EUR)	(E) Total estimated eligible costs (=A+B+C+D) (EUR)	(F) Reimbursement Rate (29,7%)[1]	(G) Requested EU contribution (=E*F)	(H) Surveys in-kind contribution = (E – G)
IGME-Sp	€227,500	€36,000	€52,000	€65,875	€381,375	29.7	€113,269	€268,107
BGR	€90,044	€6,000	€2,000	€24,011	€122,055	29.7	€36,250	€85,805
IGME-Gr	€18,600	€4,200	€0	€5,700	€28,500	29.7	€8,464.5	€20,036
GSI	€65,000	€6,300	€0	€20,313	€81,250	29.7	€24,131	€57,119
NGU	€33,750	€4,000	€0	€9,438	€47,188	29.7	€14,015	€33,173
LNEG	€45,000	€5,000	€5,000	€12,500	€67,500	29.7	€20,048	€47,453
SGU	€20,000	€5,000	€2,000	€6,250	€33,250	29.7	€9,875	€23,375
GIU	€13,531	€4,200	€0	€4,433	€22,163	29.7	€6,583	€15,581
IPMA	€32,500	€0	€0	€8,125	€40,625	Non-funded	€0	€40,625
USGS	€35,000	€0	€0	€8,750	€43,750	Non-funded	€0	€43,750
VNIIOkeangeologia	€30,000	€0	€0	€7,500	€37,500	Non-funded	€0	€37,500
IGEO	€27,500	€0	€0	€6,875	€34,375	Non-funded	€0	€34,375

IPMA, USGS, VNIIOkeangeologia and IGEO are Non-funded Partners. They will contribute with own funds towards MINDeSEA.

[1] The EC Reimbursement rate for ERA-NETs is 33%. 10% of this Reimbursement rate is reserved for the Coordination Costs of GeoERA as agreed in the Grant Agreement. Therefore, the Reimbursement rate for GeoERA is these calculations results in 29,7%.

4 Members of the consortium

4.1 Participants (applicants)

GEOLOGICAL SURVEY OF SPAIN/ INSTITUTO GEOLÓGICO Y MINERO DE ESPAÑA (IGME)

Ríos Rosas, 23
28003 Madrid (Spain)
Phone: + 34 913 495 700
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www.igme.es

- **Description of the legal entity and its main tasks**

The **Geological Survey of Spain (IGME)** is a Public Research Institution created in 1849 attached to the Ministry of Economy and Competitiveness. The main mission of IGME is to provide the State Administration, the Autonomous Regions Administrations and the general society, with precise knowledge and information regarding the Earth Sciences and related technologies for any development on the Spanish territory.

The functions of the Geological Survey of Spain are: a) Studies, analysis and research in the field of Earth Sciences and Technologies; b) Generation of basic scientific knowledge; c) Information, technical-scientific assistance and advice to public administrations, economic agents and society in general, concerning geology, hydrogeology, geoenvironmental sciences, geological resources and minerals; d) Interdisciplinary relations with other areas of knowledge, contributing to the best understanding of the territory and of the processes that form and modify it, to the sustainable use of its resources and the conservation of the geological and hydrogeological heritage; e) Preparing and implementing budgets of R&D&I and knowledge infrastructures in national and international programmes, within the scope of its competences.

The activities of the Geological Survey of Spain are related to the following strategic lines: a) Geoscientific National Mapping, b) Geoscientific Information Systems, c) Subsurface Geology and CO_2 Geological Storage d) Mineral Resources and Environmental Impact of Mining e) Geodiversity, Geological and Mining Heritage and Scientific Culture, f) Geological Hazards, Active Processes and Global Change g) Hydrogeology and Environmental Quality. More than 12.000 technical reports covering all IGME's research activities are readily available at IGME`s Document Information System. Some 9.000 are digitized and can be downloaded on the internet. The number of staff employed is 450.

- **Short CV of key researchers / staff**

Dr. Javier González (Male), Marine Geologist. He is currently a member of the research staff in the Marine Geological Mapping Division at the Geological Survey of Spain (IGME). He is graduated in 1999 from Department of Geology, Salamanca University (USAL). His obtained Doctor of Science Degree in seafloor manganese deposits in 2008 at Department of Crystallography and Mineralogy of the "Complutense University of Madrid" (UCM). He has mainly worked on the Iberian continental margins, Canary Islands and Scotia Sea (Antarctica), where he has been involved in several national and international oceanographic cruises and research projects related to marine mineral deposits since 2004. He is an expertise on ferromanganese deposits, phosphorites and associated Critical Raw Materials along the continental margins of Iberia and the Canary Archipelago.

Dr. Luis Somoza (Male), Marine Geologist. He is currently the head of the Marine Geological Mapping Division at the Geological Survey of Spain (IGME). His obtained Doctor of Science Degree in 1989 at the Department of Geodynamic of the "Complutense University of Madrid" (UCM). He has also been researcher at the Spanish Oceanographic Institute (IEO). He has mainly worked on the Iberian continental margins, Canary Islands and Scotia Sea (Antarctica), where he has been involved in several national and international oceanographic cruises and research projects since 1999. He has representative for Spain in the Council and Assembly of the International Seabed Authority (ISA). Presently, he leads the Project for Extension of the Continental Shelf of Spain according the United Nations Convention for the Law of the Sea (UNCLOS). He has published up to 85 papers in SCI-ranked international journals concerning marine geology.

Dr. Teresa Medialdea (Female), Marine Geologist. She is currently a member of the research staff in the Marine Geological Mapping Division at the Geological Survey of Spain (IGME), where she has been working since 1984. She has participated in several research projects and geological mapping projects in the Spanish Continental margin and Antarctica and has been involved in numerous oceanographic cruises related to these projects. At present she represents the Geological Survey of Spain in the Marine Geology Expert Group of Eurogeosurveys and in the EMODnet- Geology project, where she is responsible of the Geological maps of the Spanish Continental margin.

Mr. Jesús Reyes (Male), Chemist. He is currently the head of the Geochemistry Laboratory at the Geological Survey of Spain (IGME). He is graduated in Chemistry (Specialty: Analytical Chemistry) in the Universidad Complutense de Madrid (UCM) in 1983. The main line of scientific investigation he is dedicated is development of procedures (design/checking/ assessment) of instrumental technics applied to the geological sample analysis. Among them may be mentioned the determinations of major and traces (including strategic and critical elements) in mineralisations of iron-manganese (crusts and nodules) or the determinations major and traces in acid mine drainages.

Dr. Eva Bellido (Female), B.Sc in Chemistry- Geochemistry (1996) from the University Autónoma of Madrid (UAM) Spain, and Ph.D in Chemistry (2004) from UAM. Researcher at the Geological Survey of Spain (IGME). She is the responsible of the X-Ray Fluorescence Spectrometry laboratory. She has more than 20 years of experience in analytical technics of geochemical research, included implementation and validations of analytical methods related to geological samples, included marine samples as manganese nodules, cobalt-rich crusts and sediments. Another work lines are the participation in Certification of Reference Materials with International Institutions, or contaminated soils and phyto-remediations.

Mrs. Sandra Mink (Female), Degree in Environmental Sciences. Her work centers on Geographic Information Systems (GIS) applied to geological, geomorphological and active processes mapping since 2003. She started working at the Geological Survey of Spain (IGME) in 2007. Currently, her main responsibilities are map production, data validation of spatial databases, data model mapping and geoprocessing tasks using spatial ETL tools.

- **A list of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content.**

1. **González, F.J.**, **Somoza, L.**, Hein, J. R., **Medialdea, T.**, León, R., Urgorri, V., **Reyes, J.**, Martín- Rubí, J. A. (2016). Phosphorites, Co-rich Mn nodules, and Fe-Mn crusts from Galicia Bank, NE Atlantic:

Reflections of Cenozoic tectonics and paleoceanography. ***Geochemistry, Geophysics, Geosystems*** 17-2, 346-374. Q1 GEOCHEMISTRY AND GEOPHYSICS

2. Marino, E., **González, F.J.**, **Somoza, L.**, Lunar, R., Ortega, L., Vázquez, J.T., **Reyes, J., Bellido, E.** (2017). Strategic and rare elements in Cretaceous-Cenozoic cobalt-rich ferromanganese crusts from seamounts in the Canary Island Seamount Province (northeastern tropical Atlantic). ***Ore Geology Reviews,*** 87, 41-61. Q1 GEOSCIENCES

3. **González, F.J.**, **Somoza, L.**, León, R., **Medialdea, T.**, Torres, T., Ortiz, J.E., Lunar, R., Martínez-Frías, J. Merinero, R. (2012) Ferromanganese nodules and micro-hardgrounds associated with the Cadiz Contourite Channel (NE Atlantic): palaeoenvironmental records of fluid venting and bottom currents. ***Chemical Geology*** 310-311, 56-78. Q1 GEOCHEMISTRY AND GEOPHYSICS

4. EMODnet Geology Team (where are included **Medialdea, T., Somoza, L.,** and **González, F.J.),** maps and metadata catalogue, including mineral resources: http://www.emodnet-geology.eu/

5. **González, F.J.**, **Medialdea, T.**, Gómez-Ramos, G., Blasco, I., Blanco, L., **Somoza, L.**, Marino, E., León, R. (2017) First map and catalogue of submarine mineral deposits from Spain: EMODnet-Geology project. ***Economical, Technological and Environmental Aspects: Cooperative Solutions for Future Deep-sea Mining***, ***46th Underwater Mining Conference 2017***, Berlin (Germany), 24-29 September, 2017.

- **A list of up to 5 relevant previous projects or activities, connected to the subject of this proposal.**

1. ***European Marine Observation and Data NETwork-geology EMODNET-Geology*** (Phase 2: 2012/S 96 -158476 and Phase 3: EASME/EMFF/2016/1.31.2-Lot 1/SI2.750862)
Agency: European Commission (Calls 2012 and 2016)
From: 2013 until: 2018
Participation: Partner (**Teresa Medialdea**, Spanish Representative)

2. ***Submarine fluid venting on the continental margins of the Canary Islands and the Gulf of Cadiz: Geological processes and related mineral deposits-SUBVENT*** (CGL2012-39524-C02-02)
Agency: I+D+I Spanish Agency (Call 2012)
From: 2013 until: 2016
Principal Investigator: **Luis Somoza** (IGME)

3. ***Project for Extension of the Continental Shelf of Spain according the United Nations Convention for the Law of the Sea (UNCLOS)*** (CTM2010-09496-E, subprograma MAR)
Agency: I+D+I Spanish Agency (Call 2010)
From: 2010 until: 2013
Principal Investigator: **Luis Somoza** (IGME)

4. ***Development of new technologies and protocols in studies of energy resources and marine minerals*** (PEJ-2014-A-57173)
Agency: I+D+I Spanish Agency -European Commission (Call 2015)
From: 2016 until: 2018
Principal Investigator: **Javier González** (IGME)

5. ***Exploration of submarine emissions of hydrothermal fluids, mineralisations and associated geobio-systems-EXPLOSEA*** (CTM2016-75947-R)
Agency: I+D+I Spanish Agency (Call 2016)
From: 2017 until: 2020
Principal Investigator: **Luis Somoza** (IGME)

- **Previous experience and capacity relevant to the main tasks in the project**

The IGME Marine Geological Mapping Division has a broad experience in the field of the marine geology (tectonic, sedimentary and mineralisation processes in continental margins and oceanic basins) and in the natural resources, especially in ferromanganese deposits and marine mineral deposits derived from hydrocarbon and hydrothermal emissions, both recent and fossils. The group has also a proved experience backed up by the planning and development of numerous national scientific projects of the Plan Estatal I+D+I (TASYO, GADES, ERGAP, CONTOURIBER, SUBVENT, EXPLOSEA), CONSOLIDER INGENIO projects (TOPO-IBERIA), European projects of EUROCORE-EUROMARGINS program (MOUNDFORCE, MVSEIS), COST Actions (PERGAMON), EMODnet-Geology, scientific projects in collaboration with the Foreign Office (Project for Extension of the Continental Shelf of Spain according the United Nations Convention for the Law of the Sea, UNCLOS) and seafloor cartographic projects of IGME. In this sense, the scientific group combine the experience in methods of marine geophysical prospection in deep environment (Marine Geology, IGME) with experts in mineralogical and geochemical analysis (Lab. IGME), methods of hydrocarbon analysis (Biomolecular Stratigraphy Laboratory -ETSIM) and analytic techniques and study of mineral deposits derived of hydrothermalism or sedimentary processes (IGME, UCM and CSIC). The scientific group has organized and done numerous oceanographic cruises in Antarctica, Canary Island, Gulf of Cádiz, Galicia margin, Bay of Biscay and Mediterranean Sea onboard R/V Sarmiento de Gamboa, R/V Miguel Oliver, R/V Hespérides, R/V Cornide de Saavedra, R/V Paula Navarro, R/V Odón de Buen, R/V Prof. Logachev, R/V Urania, R/V Le Suroit, R/V L'Atalante and R/V James Cook. The group of Marine Geology of IGME is part of the Expert Group of Marine Geology of EUROGEOSURVEYS. Finally, IGME is, now, the representation of Spain in the International Seabed Authority (ISA) in the United Nations seated in Jamaica, organization that regulates the submarine mining in the Area.

- **Significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.**

IGME Central Laboratory offers modern installations and specialized technical services to provide the experimental technical data needed for research projects. It is an important point of reference for the analytical needs of Earth Sciences in Spain. IGME Laboratory provides facilities in two basic technical areas: Chemical Analysis and Technological and Mineralogical Testing. The following functions are carried out:

- Service provision for physical/chemical analysis and testing of waters, soils, rocks, minerals, industrial residues and effluents.
- R&D projects on treatment processes for mineral resources, industrial residues, contaminated soils, etc.
- Expert reports and assessments of mineralogical, petrographical or chemical classification and composition of mineral resources.
- Reports required for projects to install or modify mineral processing plants.
- Geotechnical tests to determine working or safety conditions.

FEDERAL INSTITUTE FOR GEOSCIENCES AND NATURAL RESOURCES (BGR)

- **Description of the legal entity and its main tasks**

The **Federal Institute for Geosciences and Natural Resources** (BGR) is the central geoscientific authority providing advice to the German Federal Government in all geo-relevant questions. It advises the Federal Ministry of Economics on deep-sea mining and represents Germany at the International Seabed Authority (ISA). The BGR carries out exploration research for manganese nodules in the equatorial NE Pacific, after signing a 15 years exploration contract with the ISA in July 2006. Furthermore, BGR signed another 15-years exploration contract for polymetallic sulphides in the Central Indian Ocean in 2015.

- **Short CV of key researchers / staff**

Dr. Thomas Kuhn (Male) is a senior researcher at the BGR with about 20 years of experience in relevant topics. He is currently responsible for exploration work in the German Mn nodules license area, with special emphasis on resource modelling. Furthermore he has 15 years' experience in marine technology with respect to ROVs and autonomous drilling devices**.**

Dr. Annemiek Vink (Female) is a senior researcher at the BGR with about 20 years of experience in relevant topics. She is currently responsible for the environmental work in the German Mn nodules license area, with special emphasis on near-bottom current analysis and modelling.

Mr. Robert Sommerfeldt (Male) is a database and ArcGIS specialist at the BGR with about 6 years of experience in the field of geoscientific work.

Ms. Petra Meloh (Female) is a lab technician working in the field of marine minerals for 10 years.

- **List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content**

Knobloch, A., **Kuhn, T.**, Rühlemann, C., Hertweg, T., Zeissler, K.-O., Noack, S. 2017. Predictive mapping of the nodule abundance and mineral resource estimation in the Clarion-Clipperton Zone using artificial neural networks and classical geostatistical methods. In: R. Sharma (Ed.): Deep-Sea Mining: Resource Potential, Technical and Environmental Considerations. *Springer International*, Cham, pp. 189 – 212.

Kuhn, T., Rathke, M., 2016. Visual data acquisition in the field and interpretation for seafloor manganese nodules. EU Project Blue Mining (GA No. 604500) Delivery D1.31. http//:www.bluemining.eu/downloads, 34 pp.

Kuhn, T., Wegorzewski, A., Rühlemann, C., **Vink., A.**, 2017. Composition, Formation, and Occurrence of Polymetallic Nodules. In: R. Sharma (Ed.): Deep-Sea Mining: Resource Potential, Technical and Environmental Considerations. *Springer International*, Cham, pp. 23 – 64.

Kuhn T., Versteegh G.J.M., Villinger H., Dohrmann I., Heller C., Koschinsky A., Kaul N., Ritter S., Wegorzewski A.V. and Kasten S. 2017. Widespread seawater circulation in 18–22 Ma oceanic crust: Impact on heat flow and sediment geochemistry. Geology, 45(9), 799-802. doi: https://doi.org/10.1130/G39091.1.

Schoening, T., **T. Kuhn**, D.O.B. Jones, E.Simon-Lledo, T.W. Nattkemper, 2016. Fully automated image segmentation for benthic resource assessment of polymetallic nodules. *Methods in Oceanography* 15-16: 78-89.

Wiedicke-Hombach, M., **T. Kuhn**, C. Rühlemann, **A. Vink**, U. Schwarz-Schampera, 2015. Deep-sea mining - a future source of raw materials? *Mining Report* 151, No. 4, 318 – 329.

Aleynik, D., M.E. Inall, A. Dale, **A. Vink**, 2017. Impact of remotely generated eddies on plume dispersion at abyssal mining sites in the Pacific. *Scientific Reports 7,* 16959. DOI: 10.1038/s41598-017-16912-2.

- **List of up to 5 relevant previous projects or activities, connected to the subject of this proposal**

- Blue Mining - EU
- Managing Impacts of Deep-SeA ReSource Exploitation (MIDAS) - EU
- MiningImpact - Joint Programming Initiative - Oceans (JPI-O)
- EcoMine: Two sides of a coin – balancing ecological risks and economic benefits of deep-sea mining: lessons to be learned from Germany and New Zealand – DE/NZ
- 15-years license contract for the exploration of Manganese nodules in the Area (NE Pacific) – ISA/DE
- 15-years license contract for the exploration of massive sulphides in the Area (Central Indian Ocean) – ISA/DE

- **Previous experience and capacity relevant to the main tasks in the project**

BGR's deep-sea mining group consists of 20 scientists and technicians with more than 20 years of experience in relevant areas. The group is equipped with a TV grab, sidescan-sonar, video-multi-functional sledge, and diverse sampling tools such as box corer and piston corer. The BGR is well equipped with analytical laboraties for the investigation of geological and environmental samples as well as different software packages for the modelling of resources (e.g., ArcGIS, Gocad, MLA, Surfer, analySIS, and methods of artificial intelligence).

LABORATÓRIO NACIONAL DE ENERGIA E GEOLOGIA, I.P. (LNEG)

- **Description of the legal entity and its main tasks**

LNEG is an R&D institution oriented to respond to the needs of society and enterprises. Betting on a sustainable research and for sustainability through the generation of knowledge of our territory. Side by side with what´s best done internationally, LNEG guarantees to have in its areas of competence an adequate response to the needs of the business sector. We do Science in energy and geology with a view to its application in advanced solutions for leveraging our economy. The Portuguese National Laboratory for Energy and Geology (LNEG) is a State laboratory of the Ministry of Economy that makes R&D oriented to the needs of society and enterprises, investing in a sustainable research, along with the international best practices, ensures that its areas of expertise allow an adequate response to the needs of the business sector. LNEG is aware that cooperative work and networking can optimize skills and that knowledge sharing is a tool for success, so it is an active partner of the major networks and collaborative platforms in the areas of energy and geology. LNEG´s mission is to promote technological innovation science and technology oriented for economic development contributing to increase competitiveness of economic agents in the context of sustainable progress of the Portuguese economy.

The Department of Mineral Resources and Geophysics (URMG) of LNEG, which participates in the project, is one of the largest of the institution and includes the areas of Geophysics, Geology, Metallic Resources, Ornamental Rocks, Aggregates, Heavy Mineral studies and Metallogeny, Mineralogy, Geochemistry, Remote Sensing, etc.

- **List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content**

Current, Geoportal, http://geoportal.lneg.pt/

Carta Radiométrica de Portugal, à escala de 1:500.000 (2013); ISBN (Digital Edition): 978-989-675-027-5; ISBN (Paper Edition): 978-989-675-028-2

Carta de Ocorrências Mineiras do Alentejo e Algarve, à escala 1:400.000 (2013); ISBN (Digital Edition): 978-989-675-029-9; ISBN (Paper Edition): 978-989-675-030-5

Carta de Depósitos Minerais de Portugal (Região Norte) à escala 1:200.000 (2014); ISBN (Digital Edition): 978-989-675-035-0; ISBN (Paper Edition): 978-989-675-034-3

Carta Geoquímica de Cobre em Solos, Zona Sul Portuguesa, Faixa Piritosa Ibérica, à escala 1:400.000 (2016); ISBN (Paper Edition): 978-989-675-044-2

Carta Radiométrica (Contagem Total), Zona Sul Portuguesa, Faixa Piritosa Ibérica, à escala 1:400.000 (2016); ISBN (Paper Edition): 978-989-675-045-9

Carta Gravimétrica (Anomalia de Bouguer), Zona Sul Portuguesa, Faixa Piritosa Ibérica, à escala 1:400.000 (2016); ISBN (Paper Edition): 978-989-675-046-6

Carta Magnética (Campo Total Reduzido do IGRF), Zona Sul Portuguesa, Faixa Piritosa Ibérica, à escala 1:400.000 (2016); ISBN (Paper Edition): 978-989-675-047-3

- **List of up to 5 relevant previous projects or activities, connected to the subject of this proposal**

Promine: Nano-particle products from new mineral resources in Europe. The philosophy behind ProMine is to stimulate the extractive industry to deliver new products to manufacturing industry.

EuroGeoSource: EuroGeoSource is a data portal, which allows access by Internet to the aggregated geographical information on geo-energy (oil, gas, coal etc.) and mineral resources (metallic and non-metallic minerals, industrial minerals and construction materials: gravel, sand, ornamental stone etc.), coming from a wide range of sources in a significant coverage area of Europe (ten countries). The project was funded by the Competitiveness and Innovation Framework Programme (CIP), under the Policy Support Programme (PSP), Geographic Information Theme.

Minerals4EU: The Minerals4EU project is designed to meet the recommendations of the Raw Materials Initiative and will develop an EU Mineral intelligence network structure delivering a web portal, a European Minerals Yearbook and foresight studies. The network provides data, information and knowledge on mineral resources around Europe, based on an accepted business model, making a fundamental contribution to the European Innovation Partnership on Raw Materials (EIP RM), seen by the Competitiveness Council as key for the successful implementation of the major EU2020 policies.

MICA: The MICA project contributes to on-going efforts towards the establishment of a stakeholder tailored product, namely the "European Union Raw Materials Intelligence Capacity Platform" (EU-RMICP).

PROSUM: The ProSUM Project aims to provide an inventory of secondary raw materials, particularly critical raw materials, arising in WEEE, ELVs, waste batteries and mining wastes. This inventory will support the EU European Innovation Partnership's Strategic Implementation Plan to build an EU raw materials knowledge base.

GEOLOGICAL SURVEY OF IRELAND (GSI)

- **Description of the legal entity and its main tasks**

The **Geological Survey of Ireland (GSI)** is a division of the Department of Communications, Energy & Natural Resources (DCENR). GSI is responsible for providing geological advice and information, and for the acquisition of data for this purpose. GSI produces a range of products including maps, reports and databases and acts as a knowledge centre and project partner in all aspects of Irish geoscience. It is also active in geoscience research as a funder, partner and research performer.

A member of Euro Geo Surveys (EGS) and actively involved in EGS expert groups, including minerals and marine, GSI has involvement in a number of European and international collaborative projects and research initiatives. In one such EC funded project, EMODnet, GSI are WP leader for the marine minerals component of EMODnet Geology.

GSI serves its customer needs through a range of operational programmes and support services:

- The Information Management Programme underpins all of our activities in the delivery of geological information to our customers, and is recognised as the most important corporate priority.

- The Surveying Programmes (Bedrock Geology, Quaternary Geology, Marine Geology and Geophysics) are long-term, and feed information to the Applied Programmes, as well as producing maps and reports used directly by a wide range of external customers.

- The Applied Programmes (Groundwater, Minerals, Geotechnical, Geological Heritage) are largely project-oriented, and provide solutions to specific customer needs, their various activities helping to build their respective databases.

- The Research Programme is an overarching programme providing funding and research support for geosciences in Ireland

The GSI owns and manages several key programmes relevant to GEO ERA. The Research Programme is the only funding mechanism dedicated to geoscience research in Ireland. Elements of this programme are also formally connected to external, national research funding programmes through joint funded calls (e.g. Science Foundation Ireland, Irish Research Council etc.).

The GSI Information Management, Surveying and Applied programmes (listed above) include data acquisition, data management, and provision of derived products and data services as well as research components.

The GSI has considerable experience in large EU networks and collaborative projects in recent Framework Programmes across all topics of interest to this ERA NET. GSI has participated in ERA NETs, Interreg programmes, COST, EU Infrastructure Projects (e.g. EPOS) etc. It also manages a national programme for research in geoscience with over €12m awarded to Irish researchers since 2007.

- **Short CV of key researchers / staff**

Mr Koen Verbruggen: Director, GSI. (Male). 16 years with GSI in including a period as manager of INFOMAR the national marine mapping programme, 15 years in private industry in mineral and petroleum exploration worldwide. Currently President of EuroGeoSurveys (2015-2017).

Mr. Gerry Stanley: Head, GSI Minerals Programme. (Male). BSc Geology, MSc Geology, MSc Mining Engineering. Gerry represents GSI on EuroGeoSurveys' Mineral Resources Expert Group and is Deputy Chair of the Group.

Mary Carter; Senior Geologist, (Female) B.A. (Mod) in Geology. Mary has worked on many EU projects including OneGeology-Europe, as well as the EGDI project. Nationally she has managed the Digital Map Production System, which delivered the first series of Digital Bedrock maps at a scale of 1:100,000.

Aoife Braiden: Reserach Manager. (Female). BSc (Hons) Earth Sciences, PhD Palaeobiology, Dip. Business Studies. Aoife has 10 years' experience managing national and international research funding including developing projects, securing funding, managing the research programme and financial management of projects of all scales.

Mr James Trench (Male) BEng, Dip. Env. Eng., Dip. Project Management. He has been working in the GSI for 16 years both on a hardware and software level involving the development and support of its' network infrastructure, corporate systems and applications.

Ms. Maria Judge, Marine Geologist. (Female). BSc Earth and Ocean Science. Experience: mineral exploration; marine geophysical and geological acquisition, data interpretation, data product production. Member of the EuroGeoSurveys, Marine Geology Expert Group; steering group member of the European Commission funded EMODnet Geology project; Work Package leader for Marine Minerals. Mr James Trench (Male) BEng, Dip. Env. Eng., Dip. Project Management. He has been working in the GSI for 16 years both on a hardware and software level involving the development and support of its' network infrastructure, corporate systems and applications.

- **List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content**

- EMODnet Geology WP7 Marine Minerals. Work package, technical guidance document. Editions available 2013-2017. European Marine minerals data download service providers, viewable.

- **Judge, M.** Verbruggen, K. (2016) Mapping marine minerals in Europe (2016). 35th International Geological Congress, Cape Town, South Africa.

- **Judge, M.** (2015). European Marine Observation and Data Network (EMODnet): Making Fragmented Marine Data Relevant and Accessible. Earthzine, IEEE.

- Wheeler AJ, Murton B, Copley J, **Judge M,** et.al. (2013). Moytirra: discovery of the first known deep-sea hydrothermal vent field on the slow-spreading Mid-Atlantic Ridge north of the Azores. G cubed. 14(10): 4170-4183.

- Connelly DP, Copley J.T, Murton B.J, **Judge, et.** al. (2012). Hydrothermal vent fields and chemosynthetic biota on the world's deepest seafloor spreading centre. Nature Communications. 3. DOI: 10.1038/ncomms1636

- **List of up to 5 relevant previous projects or activities, connected to the subject of this proposal**

- Have been an active member of Minerals4EU

- Project group and steering group member, WP leader of EMODnet Geology since its inception. An EC funded project collecting marine data, metadata and data products across all European seas.

- Irish National Seabed Mapping Programme, INFOMAR. National marine data acquisition project, interprets data and provides informative marine products for stakeholders.

- NAGTEC- Research project. Compiled data across NE Atlantic, created a new atlas detailing the evolution of the NE Atlantic, with a focus on seafloor spreading and conjugate margin comparison.

- Continue to explore the deepsea, mapping features, environments and processes that form seabed minerals. Next expedition: Tectonic Ocean Spreading at the Charlie Gibbs Fracture Zone (TOSCA) May-June 2018

INSTITUTE OF GEOLOGY & MINERAL EXPLORATION (IGME) / INSTITOUTO GEOLOGIKON KAI METALLEFTIKON EREVNON (IGME)

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- **Description of the legal entity and its main tasks**

The **Greek Institute of Geology and Mineral Exploration (IGME)** – *"Institouto Geologikon kai Metalleftikon Erevnon"* – founded in 1952, is supervised by the Ministry of Environment and Energy and is by legislation the State's technical adviser in geoscientific matters. Its fundamental aim is the geological study of the country and the exploration – evaluation of the mineral raw materials and ground water resources. Emphasis is also given to projects related to the protection of the environment and strong participation is demonstrated in competitive E.C. projects.

The number of staff employed on a permanent basis is 216 (geoscientists, technical and administrative personnel), complemented by contract/fixed-term personnel in the frame of various projects.

During 40 years of marine geological work a vast amount of data has been collected, including marine sediment samples and cores, shallow and medium penetration seismic profiling, bathymetry and side scan sonar data. The IGME marine geology team has carried out many research studies, mainly in the Aegean Sea (e.g. mapping of the continental shelf, distribution and nature of seabed substrate, research for placer deposits) and participated in numerous European projects related to marine geological subjects and open-data infrastructures (e.g. EUMARSIN, EU-SEASED, EUROSEISMIC, ANAXIMANDER, Geo-Seas, EMODnet-Geology). In these projects IGME role has varied from coordinator to associate contractor, and thus a lot of experience in project management and implementation has been gained. The Institute's marine geology team is complemented by IGME experts in analytical techniques, mineralogical and geochemical analyses (various IGME laboratories); a member of the team is the Greek representative in the EuroGeoSurveys Marine Geology Expert Group, while IGME is also participating in the Hellenic Committee for Authorization of Marine Research.

- **Short CV of key researchers / staff**

- **Dr. Irene Zananiri** (Female), Geologist – Geophysicist. Graduated from the Aristotle University of Thessaloniki in 1998, obtained a MSc (2000) and a PhD (2004) in Geology. Employed by IGME since 2006, involved in GIS, data harmonization/standardization according to EU directives, applied geophysics and marine geology research. Scientific responsible of several projects (Geo-Seas, EMODnet-Geology 2&3), and team member of numerous others (e.g. One Geology Europe Plus, GEOCHART) involved in COST action and Greek representative in the EGS Marine Geology Expert Group. Since 2012 responsible for the design and maintenance of the IGME Marine Geology geodatabase (partly INSPIRE-compliant), and the digital publication of marine sediment/geology maps. Deputy Manager of YPOTHER project. Author of reports, surficial sediment maps and peer-reviewed publications.

- **Vaggelis Zimianitis** (Male), Geologist. Graduate of the Department of Geology of the University of Palermo, Italy; working for IGME since 1985. He has participated in many national and international projects related to the study of the marine sediments in the Greek seas and co-authored a number of marine sediment maps and related publications. Deputy scientific responsible of EU funded projects (e.g. EMODnet-Geology).

- **Dr. Alexandra Zervakou** (Female), Geologist – GIS specialist. Graduated in 2001 from the Kapodistrian University of Athens, specialized in GIS (MSc). Working at IGME, since 2006, responsible for the Digital Cartography – GIS and Geological Maps Publication Laboratory. She has been involved in CSF 2000-2006 and NSRF 2007 -2013 projects and has experience in INSPIRE-compliant GIS datasets. Greek representative in the EGS Spatial Information Expert Group.

- **Dr. Adonis Photiadis** (Male), Geologist. BSc in Geology (1983), MSc (1984) and PhD (1986) in Applied Geology of “Universite des Sciences et des Techniques, Franche-Comte, Besancon”, France. Between 1983 up to mid-1987 worked as tutor in the Laboratory of Mineralogy and Petrography of the previous University. Since 1987 employed by IGME, is author or co-author of more than thirty geological maps in scale 1:50.000 and scientific responsible of several geology projects (e.g. GEOCHART-One Geology), with a total peer-reviewed 70 publications and 110 conference participations.

It is also planned that a young scientist (sedimentologist) experienced in marine sediment studies will be employed –in the frame of other projects– and will be part of the IGME team.

- **List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content**

Interactive surface lithology/age map of Greece 1:1 000 000 (INSPIRE) (Fotiadis, A. & Zananiri, I., 2015)
http://www.europe-geology.eu/onshore-geology/geological-map/onegeologyeurope/

Minerals4EU. Data portal linked to Greek resources
http://minerals4eu.brgm-rec.fr/

EMODnet-Geology. Data portal incorporating Greek marine resources
http://www.emodnet-geology.eu/

Perissoratis, C., Angelopoulos, I. & Mitropoulos, D., 1987. *Exploring the offshore area of NE Greece for placer deposits: geological framework and preliminary results.* In: Teleki P.G., Dobson M.R., Moore J.R., von Stackelberg U. (eds) Marine Minerals. NATO ASI Series, Vol 194, 57-70, Springer, Dordrecht.

Ioakim, Chr., **Zananiri, I**., **Zimianitis, E.**, Efthymiou, G., Vakalas, I., Giamali, Chr., Valaouris, A., Drosopoulou, E., Gkintoni, E., Economou, G., Papatrechas, Chr., Tarenidis, D., Koutsovitis, P., Xirokostas, N., Sakalis, M., Spiropoulos, V., Patsis, P., Tsapara, E., Karagiorgis, A., Roussakis, G. & NCMR research team (2016). *Final report of marine geological and sedimentary research in the Aegean Sea: Deliverables of YPOTHER project.* IGME, NSRF 2007-2013/ Operational Programme Competitiveness & Entrepreneurship/ Project MARINE GEOLOGY AND MINERAL RESEARCH STUDY ALONG THE COASTLINE BETWEEN CHALKIDIKI AND KAVALA, AND THE CALDERA OF SANTORINI, Athens, pp. 339 (in Greek).
http://www.igme.gr/

- **List of up to 5 relevant previous projects or activities, connected to the subject of this proposal**

- ✓ EMODnet – Geology project (Phase 2: 2013-2016 & Phase 3: 2017-2018): Geology portal which assembles marine data, including mineral resources (EU funding).
- ✓ YPOTHER project (2011-2015): “Marine Geology and mineral research study on the continental shelf and other areas of the Aegean Sea” (NSRF funding).
- ✓ Minerals 4EU (2013-2015): Pan-European data portal on mineral resources.
- ✓ Geo-Seas project (2009-2013): Pan-European marine data and metadata catalogue (EU funding).
- ✓ National program for compiling the Surficial Sediment Map of the Hellenic Seas in scale 1:200000: Mapping the bathymetry, seafloor conditions, sediment distribution, geodiversity and tectonics along the Hellenic coast and sea areas.

GEOLOGICAL SURVEY OF NORWAY (NGU)

- **Description of the legal entity and its main tasks**

The **Geological Survey of Norway (NGU)** was founded in 1858 and is a government agency under the Ministry of Trade, Industry and Fisheries (NFD). NGU shall actively contribute to ensuring that geoscientific knowledge is utilized for the effective and sustainable management of the nation's natural resources and environment. NGU provide services and information within a large range of geoscience subjects, such as mineral resources (metals, industrial minerals, natural stone and aggregate), geological hazards, environmental issues, marine geology, regional geophysics and land use planning. NGU provides databases on mineral and aggregate resources to Norway's national information infrastructure and to the European mineral resource data platforms. NGU has participated in several European projects aimed at harmonizing data sets across borders, to the benefit of national and international land use planning, and industrial development and innovation. NGU has 200 employees, of which approximately 65% are scientists.

NGU works to identify and evaluate potential deposits of metals and industrial minerals which may be of future economic significance. The user target is industry, public administration, and other stakeholders. Information is gathered and stored in NGUs mineral resource databases which are accessible through www.ngu.no and www.prospecting.no. NGU uses mineralogical and geochemical techniques for the characterization of mineral resources and has a well-equipped laboratory for both mineral and rock characterization. NGU will contribute with maps, knowledge and data on the distribution and composition of known resources.

- **Short CV of key researchers / staff**

Dr. Henrik Schiellerup (Male) is heading the Mineral Resources team at the Geological Survey of Norway. He is an economic geologist with specialty in igneous petrology. Dr Schiellerup obtained his PhD from the Norwegian University of Science and Technology in Trondheim, Norway, in 2001, and his MSc from the University of Aarhus, Denmark, in 1991. From 1991 to 1993 he received a research fellowship from the Nordic Volcanological Institute in Reykjavik, Iceland, working with Pleistocene volcanology.

Dr. Terje Bjerkgård (Male) has long-standing experience in economic geology with a special interest in sulphide deposits. He has participated in two ODP projects, both related to hydrothermal activity and seafloor massive sulphides. He earned his PhD from the University of Oslo in 1995 and his MSc from the same place in 1989. Both thesis works are dealing with the genesis of volcanogenic massive sulphides.

Mr. Terje Thorsnes (Male) is a senior geologist working in the marine geology group. His specialties are seabed mapping, autonomous vehicles, geo-bio interactions and geomorphology. He was the project leader the Norwegian seabed mapping programme MAREANO from 2005 to 2013. He earned his MSc from the University of Bergen with a thesis dealing with tectono-stratigraphic relationships of obducted ophiolites.

- **List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content**

Mineral resources in Norway. Publicly accessible databases at:

http://geo.ngu.no/kart/mineralressurser_mobil/

Minerals4EU. Data portal linked to Norwegian resources:
http://minerals4eu.brgm-rec.fr/

Mineral Resources in The Arctic. Map service at:
http://geo.ngu.no/kart/circumarctic_mobil/?lang=eng

Boyd, R., Bjerkgård, T., Nordahl, B., Schiellerup, H. (editors) 2016. Mineral resources in the Arctic, Geological Survey of Norway 483 p.
http://www.ngu.no/upload/Aktuelt/CircumArtic/Mineral_Resources_Arctic_Mainbook.pdf

Buhl-Mortensen, L., Hodnesdal, H. & Thorsnes, T. (eds.) The Norwegian Sea Floor, New Knowledge from MAREANO for Ecosystem-Based Management, 192 pp. Published by MAREANO.

Pedersen, R.B., Bjerkgård, T. 2016. Sea-floor massive sulphides in arctic waters. In R. Boyd et al. (eds.): Mineral Resources in the Arctic, NGU, Trondheim. p 209-216.
http://www.ngu.no/upload/Aktuelt/CircumArtic/5_SMS.pdf

- **List of up to 5 relevant previous projects or activities, connected to the subject of this proposal**

Mineral Resources in The Arctic (8 Arctic countries): Products include a database, maps and map services, as well as books on the most important mineral resources north of 60°N.

Minerals4EU (EU): Pan-European data portal on mineral resources.

MARMINE (Norway): Deep marine resources program, headed by the Norwegian University of Science and Technology and funded by the Research Council of Norway (NGU partner).

EMODNET (EU): Geology portal which assembles marine data, including mineral resources.

MAREANO (Norway): Mapping the bathymetry, seafloor conditions, biodiversity, geodiversity and sedimentary contamination along the Norwegian coast and sea areas.

- **Significant infrastructure and/or any major items of technical equipment, relevant to the proposed work**

NGU Laboratories: Advanced rock and mineral analyses, including LA-ICP-MS, SEM, XRF, XRD, and noble gas mass spectrometry.

NGU Geomatics: Database development

GEOLOGICAL SURVEY OF SWEDEN (SGU)

- **Description of the legal entity and its main tasks**

The **Geological Survey of Sweden (SGU)** is the central governmental agency under the Ministry of Enterprise, Energy and Communications for matters relating to the geology of Sweden and the management of mineral resources. SGU's main task is to meet the national need of geological information, for example with respect to sustainable supplies of natural resources, spatial planning, the environment, and the total defense and national vulnerability. Information from SGU is used by exploration companies in their search for mineral resources and for the purposes of local authority planning, protection of groundwater resources, remediation of industrially contaminated soil, environmental monitoring, and locating buildings, plants, roads, bridges and railways.

The Mining Inspectorate of Sweden, which is part of SGU, is responsible for issuing permits for minerals exploration and extraction. SGU also grants licences for prospecting of sand, gravel, or pebbles within public waters of the Swedish continental shelf at the same time as it must ensure compliance with the legal regulations and conditions for such licences.

- **Short CV of key researchers / staff**

Dr. Johan Nyberg (Male), state and senior geologist, with basic background in Marine Geology (MsC in 1996 and PhD in 2001) from Göteborg University. He is experienced in marine geological mapping and research, field works as well as analyses and dissemination. He has been leading investigations regarding aggregate deposits, is working in the EU-project EMODNet with e.g. marine minerals, and is one of two National Delegates from Sweden in the Marine Geology Expert Group of the EuroGeoSurveys. He is also the scientific advisor regarding submitted applications to SGU within the Continental Shelf Act.

Dr. Lovisa Zillén (Female) is Head of the Department of Marine Environment and Planning at the Geological Survey of Sweden (SGU) and has worked as a researcher and project leader for almost two decades. She has a MsC (1999) and a PhD (2003) in Quaternary Geology from Lund University, Sweden, She has a broad broad and in depth experience in research about the Baltic Sea environment and its sensitivity to multiple stressors, such as climate change and human impact over both short and long time-scales. At a national level, she manages several projects on marine spatial planning in collaboration with other Swedish government agencies and county administrative boards, including developing the marine management tool "Symphony". She has experience of scientific communication with stakeholders, end-users and reference group.

- **List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content**

Interactive map of marine geology of Sweden (in Swedish)
https://apps.sgu.se/kartvisare/kartvisare-maringeologi.html

Interactive map of marine mineral occurrences in Sweden
http://www.emodnet-geology.eu/map-viewer/

Report and GIS-products on aggregate deposits in Sweden (Abstract in English)
http://resource.sgu.se/produkter/sgurapp/s1705-rapport.pdf

Marine Spatial Planning
https://www.havochvatten.se/en/swam/eu--international/marine-spatial-planning.html

- **List of up to 5 relevant previous projects or activities, connected to the subject of this proposal**

Investigation of sustainable extractions on marine aggregate deposits in Sweden
EMODnet-Geology
Symphony
Minerals4EU - EU
ERA-Min

STATE INFORMATIONAL GEOLOGICAL FUND OF UKRAINE (GEOINFORM - GIU)

- **Description of the legal entity and its main tasks**

The **State Research and Development Enterprise "State Informational Geological Fund of Ukraine" – SRDE "GeoInform of Ukraine"**, or GeoInform, is the specialized research and development unit of the State Geological and Subsurface Survey of Ukraine which collects, stores, analyzes and provides information received from geological study and use of subsurface.

GIU conducts research work on monitoring of mineral resources of Ukraine on the basis of geological and mining activities during the year, recording deposits and making public the balance of mineral resources management of the State fund of deposits and occurrences (more than 10,000 objects recorded), synthesis and analysis of exploration for oil and gas, creating a system of state accounting of oil and gas wells, completion and maintenance of the State cadastre of mineral deposits and occurrences as well as State cadastre of groundwater deposits of Ukraine.

- **Short CV of key researchers / staff**

Dr. hab. Boris Malyuk (Male), Director for International Cooperation, graduated in 1981 from Department of Geology, Lviv University, Ukraine, and in 1999 from Centre of Geostatistics, Ecole des Mines de Paris, France. Obtained Candidate of Science (PhD) Degree in Geotectonics in 1984, and extended Doctor of Science Degree in Petrology in 1991. National Delegate of Ukraine to the EuroGeoSurveys.

Dr. Igor Melnyk (Male), Sector Chief, with basic background in geology, has an experience in field works and research in geochemistry, hydrogeology and ecology (PhD in 1996), as well as geoinformatics and GIS applications.

Ms. Tetiana Biloshapska (Female), Chief Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1980. She is experienced in field works. She had studied mineral-resource base of Ukraine for more than 30 years, took part and led projects on prospecting and exploration of mineral deposits, conducted regional geological studies.

Ms. Natalia Korpan (Female). Chief, Division of mineral deposits and reserves inventory. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1986. She had studied geology of coal and peat deposits and their reserves inventory for 30 years.

Ms. Ganna Sankina (Female). I-category Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology'. She is working in the field of geology for more than 15 years, is experienced in field works in the course of geological mapping in the scale 1:200 000. She is managing the State inventory of oil and gas wells as well as compilation and analysis of these data.

- **List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content**

Interactive map of mineral deposits of Ukraine (in Ukrainian)

http://geoinf.kiev.ua/wp/interaktyvna-karta-rodovyshch-korysnykh-kopalyn.htm

Interactive map of mineral licenses (in Ukrainian)

http://geoinf.kiev.ua/wp/interaktyvni-karty-spetsdozvoliv.htm

Interactive geological map of Ukraine 1:1 000 000 (in Ukrainian)

http://geoinf.kiev.ua/wp/Interaktyvna-heolohichna-karta-Ukrayiny.htm

Interactive geological map of Ukraine 1:1 000 000 (in English)
http://geoinf.kiev.ua/wp/Interactive-Geological-Map-of-Ukraine.htm
Interactive State Geological Map of Ukraine 1:200 000 (in Ukrainian with English entries)
http://geoinf.kiev.ua/wp/kartograma.htm

- **List of up to 5 relevant previous projects or activities, connected to the subject of this proposal**

- Minerals4EU - EU
- ProSUM - EU
- NUMIRE – Norway-Ukraine (NGU/SGSSU)
- EIMIDA – Norway-Ukraine (NGU/Geoinform)

INSTITUTO PORTUGUÊS DO MAR E DA ATMOSFERA (IPMA)

- **Description of the legal entity and its main tasks**

IPMA is a public research institute that aims to promote research, technological development and innovation, to provide highly skilled services to the economic sector and the citizens, operating and maintaining state-owned scientific infrastructures, acquiring data, processing and maintaining the national scientific databases on its areas of competence, and promoting and coordinating scientific research and technological development. It operates the Portuguese meteorological, climate and seismological networks; possesses a strong cluster of competences on Resource and Fisheries related research: stock management, production methods, biology, ecology, water and sediment contaminants, geochemistry, toxicology, and most of the scientific fields related to the marine environment and biodiversity management and control. IPMA has a vast range of expertise and national competences in marine geosciences, as in the fields of Marine Minerals resources and non-conventional energy resources, marine natural hazards such as risks associated to earthquakes, tsunamis and submarine mass movements and in the fields of palaeoceanography and paleoclimate. IPMA is a member of EU-COST actions FLOWS, MIGRATE, MEDSALT. IPMA participates on The European Marine Observation and Data Network (EMODnet) and is the responsible for gathering the data on the Portuguese Exclusive Economic Zone for several of the data portals. IPMA is also involved in several PT and EU research projects in the fields of marine geology and marine geo-resources. IPMA is the responsible for the National Biological Sampling Program in Portuguese and international waters of the Atlantic and Indian Oceans. It has a strong experience in conducting observations at sea and deploying of oceanographic moorings, in phyto and zooplankton, in chemical analysis of living organisms and in the study of physical-biological interactions in the ocean. It has been coordinator or major partner in many international and national projects.

- **Short CV of key researchers / staff**

Dr. Pedro António Gancedo Terrinha (Male) Marine Geologist, head of the Marine Geology and Georesources Division of IPMA. PhD in Geology, in 1998, Thesis title: Structural Geology and Tectonic Evolution of the Algarve Basin, Portugal. Imperial College, Univ. of London, U.K.; Master (1990) in Structural Geology and Rock Mechanics. Imperial College, Univ. of London, U.K.; Graduation in Geology. University of Lisbon, Portugal, in 1987. Principal areas of research: Marine Geology: Neotectonics of the Eurasia-Africa plate boundary in the North Atlantic and Mediterranean. Sedimentary basins analysis and modelling. Habitat mapping, seafloor mapping, sedimentary processes in estuary and continental shelf, deep sea sedimentary processes. Mineral deposits in the continental shelf and deep ocean.

Participation in relevant projects: FLOWS - Impact of Fluid circulation in old oceanic Lithosphere on the seismicity of transfOrm-type plate boundaries: neW solutions for early seismic monitoring of major European Seismogenic zones. E-COST Action oc-2012-2-13444. MINEPLAT - Determinação do potencial em recursos minerais na plataforma continental do Alentejo e as condicionantes naturais impostas pelo soerguimento da margem continental no Plio-Quaternário (Assessment of Mineral resources on the continental shelf of Alentejo and their environmental conditions). ALT20-03-0145-FEDER-000013. PRINCIPAL INVESTIGATOR of IPMA. ASTARTE: “Assessment, STrategy And Risk Reduction for Tsunamis in Europe"; alternate coordinator of WP2: Long term recurrence of tsunamis. EU FP7, Grant Agreement no: 603839, ENV.2013.6.4-3. COORDINATOR of WP2. TAGUSDELTA: 3D high-resolution seismic stratigraphy of the Tagus Delta – imaging of tsunami and earthquake evidence for natural hazards assessment PTDC/MAR/113888/2009. PRINCIPAL INVESTIGATOR.

At present he represents the Portugal and IPMA in the EMODnet- Geology and EMODnet-Bathymetry and in the Marine Geology Expert Group (MGEG) of the EuroGeoSurveys. He has published more than 50 papers in SCI-ranked international journals, mainly in the field of marine geology.

Dr. Vitor Hugo da Silva Magalhães (Male) Marine Geologist. He is Auxiliary Researcher at the Portuguese Sea and Atmosphere Institute (IPMA), Marine Geology and Georesources Division. PhD in Geosciences (2007) at the University of Aveiro, Thesis title: Authigenic Carbonates and Fluid Escape Structures in the Gulf of Cadiz. Geology Diploma in 1995 at the University of Porto. Main scientific areas of research: Marine Geology - Mud volcanism and fluid escape structures; Gas hydrates, occurrence and stability fields modelling; Methane-derived authigenic carbonates; Tectonic and stratigraphic control of fluid escape structures; Marine Geophysics: Processing and interpretation of seismics, SSS and multibeam; GIS. Petrophysics: MSCL (participation at the IODP Exp 366 as physical properties expert) and XRF core scanner. Habitat and Seafloor mapping, sedimentary processes in estuary and continental shelf, deep sea sedimentary processes. Participation in 7 research projects and PI of the PES project (PTDC/GEOFIQ/5162/2014) Pockmarks and fluid seepage in the Estremadura Spur: implications for regional geology, biology, and petroleum systems. Author and co-author of 23 ISI publications.

Dr. Sónia Silva (Female) Marine Geologist/Geophysicist. Post-doc of EMODnet Geology 3 project at Portuguese Sea and Atmosphere Institute (IPMA), Marine Geology and Georesources Division. PhD in Geodynamics (2017) at the Faculty of Sciences, University of Lisboa. Thesis title: "Strain partitioning and the seismicity distribution within a transpressive plate boundary: SW Iberia-NW Nubia", Master (2007) in Geodynamics at the Faculty of Science, University of Lisboa. Thesis title "*O cruzamento de falhas activas: o exemplo das falhas Odemira- Ávila e Vidigueira- Moura*" ("Active faults interference: the Vidigueira-Moura and the Odemira- Ávila faults case study"). Geology Diploma in 2001 at Faculty of Science, University of Lisboa. Principal domain of specialization: Geology. Second domains of specialization: Seismotectonics, Seismology, Neotectonics. Research interests: Seismotectonics in the SW Iberia margin, dynamic earthquake rupture; aseismic and seismic slip transition, slow and transient slip in faults, micro-seismicity and high magnitude earthquakes relation. Other skills: Processing seismological data, Multichannel seismic reflection profiles and GIS. Participation in relevant projects: project EMODnet-Geology3 (Knowledge base for growth and innovation in ocean economy: assembly and dissemination of marine data for seabed mapping and for the dissemination of research results) FLOWS - Impact of Fluid circulation in old oceanic Lithosphere on the seismicity of transfOrm-type plate boundaries: neW solutions for early seismic monitoring of major European Seismogenic zones. E-COST Action oc-2012-2-13444. Research grant at Portuguese Institute for Sea and Atmosphere, as part of the project EMODnet-Geology2. TOPOMED- plate re-organization in the western Mediterranean: Lithospheric causes and topographic consequences (*TopoMed*); SHARE- IBERIA Workshop on Seismogenic sources "do FP7 Project SHARE Seismic Hazard Harmonization in Europe, 2010; NEAREST (Integrated Observations From Near Shore Sources Of Tsunamis: Towards An Early Warning System), GOCE contract n. 037110. Author and co-author of 5 ISI publications.

Dr. Luis Batista (Male) Marine Geologist. PhD student in Geology at the University of Lisbon. Dissertation topic: Morpho-tectonics and geophysics of the Gloria Fault in the context of the Africa-Eurasia plate boundary. Master degree (2009) in Environmental Geology, Geological Hazard and Land Management at Sciences Faculty of University of Lisbon. Degree in Geology and Natural Resources (2007) at Sciences

Faculty of University of Lisbon, Portugal. Principal areas of research: Marine Geology – Structure and composition of ocean crust in the Eurasia-Africa plate boundary; Sedimentary Processes; seismic reflection and refraction processing and interpretation. Seismic processing and interpretation with: Landmark; Fledermaus; ArcGis; Zelt; SPW; RADEX. Participation in relevant projects: TECTAP – Structure, Stratigraphy and Tectono-Thermal Evolution of the Tagus Abyssal Plain – PTDC/CTE-GIN/68462/2006; MODELINK project - Modeling the tectonic missing link between the active Gloria and SWIM fault systems along the (Atlantic) Eurasia-Nubia plate boundary – MODELINK EXPL/GEO-GEO/0714/2013; FLOWS project - Impact of Fluid circulation in old oceanic Lithosphere on the seismicity of transfOrm-type plate boundaries: neW solutions for early seismic monitoring of major european Seismogenic zones, E-COST Action oc-2012-2-13444. At present he holds a Scholarship at the Portuguese Sea and Atmosphere Institute (IPMA) to work in the EMODnet- Geology 3 project.

- **List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content**

Duarte, D., **Magalhães, V.H., Terrinha, P.**, Ribeiro, C., Madureira, P., Pinheiro, L.M., Benazzouz, O., Kim, J.H., Duarte, H., 2017. Identification and characterization of fluid escape structures (pockmarks) in the Estremadura Spur, West Iberian Margin. Marine and Petroleum Geology 82, 414-423.

Hensen, C., Scholz, F., Nuzzo, M., Valadares, V., Gràcia, E., Terrinha, P., Liebetrau, V., Kaul, N., **Silva, S.,** Martínez-Loriente, S., Bartolome, R., Piñero, E., **Magalhães, V.H.**, Schmidt, M., Weise, S.M., Cunha, M., Hilario, A., Perea, H., Rovelli, L., Lackschewitz, K., 2015. Strike-slip faults mediate the rise of crustal-derived fluids and mud volcanism in the deep sea. Geology 43, 339-342.

Muinos, S.B., Hein, J.R., Frank, M., Monteiro, J.H., Gaspar, L., Conrad, T., Pereira, H.G., Abrantes, F., 2013. Deep-sea Fe-Mn Crusts from the Northeast Atlantic Ocean: Composition and Resource Considerations. Mar. Georesour. Geotechnol. 31, 40-70.10.1080/1064119X.2012.661215

o **List of up to 5 relevant previous projects or activities, connected to the subject of this proposal**

EMODnet, Ongoing. EMODnet Geology; EMODnet Bathymetry;

MINEPLAT, Ongoing. Determinação do potencial em recursos minerais na plataforma continental do Alentejo e as condicionantes naturais impostas pelo soerguimento da margem continental no Plio-Quaternário (Assessment of Mineral resources on the continental shelf of Alentejo and their environmental conditions). ALT20-03-0145-FEDER-000013.

PES, Ongoing. PES project (PTDC/GEO-FIQ/5162/2014) Pockmarks and fluid seepage in the Estremadura Spur: implications for regional geology, biology, and petroleum systems

ASTARTE, Assessment, STrategy And Risk Reduction for Tsunamis in Europe"; alternate coordinator of WP2: Long term recurrence of tsunamis. EU FP7, Grant Agreement no: 603839.

TAGUSDELTA , 3D high-resolution seismic stratigraphy of the Tagus Delta – imaging of tsunami and earthquake evidence for natural hazards assessment PTDC/MAR/113888/2009.

UNITED STATES GEOLOGICAL SURVEY (USGS)

- **Description of the legal entity and its main tasks**

The **United States Geological Survey (USGS)** is a Bureau of the Department of the Interior (DOI) and Dr. Hein is part of the Coastal and Marine Geology Program (CMGP) within the USGS. The CMGP has the responsibility for conducting a wide range of geological, geophysical, and oceanographic investigations along the continental margins and within the adjacent oceans of the United States, its protectorates, cooperating nations, and globally. Some of the centers scientific programs focus on minerals and energy resources in the US Exclusive Economic Zone and globally. Dr. Hein's Marine Minerals Program does research on the genesis, distribution, and deposit models for marine minerals including ferromanganese crusts and nodules, seafloor massive sulfides, phosphorite, barite, rare earth element-rich muds, and others. The project collects samples and data throughout the global ocean using appropriate operations, processes the data and samples, and analyzes those processed samples and data for publication.

- **Short CV of key researchers / staff**

Dr. James Hein (Male) received a Ph.D. in Earth Sciences from the University of California at Santa Cruz in 1973 and has been a marine geologist with the USGS since 1974. He started working on marine mineral deposits two years later as a member of the DOMES team, a large interdisciplinary group studying Ni- and Cu-rich Fe-Mn nodules from the Clarion-Clipperton zone. In 1982, Hein became Project Chief of Co-Rich Fe-Mn Crust Program. That project produced cooperative funding agreements and cooperative research with a wide-range of collaborators globally. Those efforts evolved into studies of the full range of mineral deposit types that occur in modern ocean basins and comparisons with potential analogs in the geologic record. He has been investigating hydrothermal deposits that occur at oceanic fracture zones, island arcs, and spreading centers. Those studies include rare-metal-rich sulfide, sulfate, and silica deposits and rifted continental-margin barites. Also, he is studying the oceanographic conditions conducive to formation of seamount and continental margin phosphorite deposits. Hein has authored or co-authored over 570 papers and abstracts, including co-editing six books and three special issues of Ore Geology Reviews and Economic Geology. He is a Fellow of the Society of Economic Geologists and the Geological Society of America, Past President and currently on the Executive Board of the International Marine Minerals Society (IMMS), scientific advisor to the DOS delegation to the ISA, and recipient of the prestigious Distinguished Service Award, the highest honor bestowed by the US DOI, and the Moore Medal, the highest honor of the IMMS.

Kira Mizell (Female) is a PhD Student at the University of California at Santa Cruz and member of the USGS Marine Minerals Program. Dr. Hein and Dr. Phoebe Lam are her Ph.D. advisors. Her thesis involves the acquisition of halogens and rare metals from seawater by ferromanganese crusts.

Dr. Amy Gartman (Female) is a term research oceanographer at the USGS and member of the Marine Minerals Program. She completed a doctorate in Oceanography from the University of Delaware in 2013 and a post-doctoral research program at Harvard University, where she researched the contribution of microbial activity to sulfide mineral formation and accumulation. She has conducted shipboard research at mid-ocean ridge and back-arc basin seafloor massive sulfide deposits. She is an advisor to the US Department of State.

- **List up to 5 current and 5 recent relevant publications to the call content of the proposal**

1. **Hein, J.R.**, Conrad, T.A., and Staudigel, H., 2010. Seamount mineral deposits, a source of rare-metals for high technology industries. Oceanography, v. 23(1), p. 184-189.

2. Muiños, S.B., **Hein, J.R.,** Frank, M., Monteiro, J.H., Gaspar, L., Conrad, T., Garcia Pereira, H., and Abrantes, F., 2013. Deep-sea Fe-Mn crusts from the northeast Atlantic Ocean: Composition and resource considerations. Marine Georesources and Geotechnology, v. 31 (1), p. 40-70.

3. **Hein, J.R., Mizell, K.,** Koschinsky, A., and Conrad, T.A., 2013. Deep-ocean mineral deposits as a source of critical metals for high- and green-technology applications: Comparison with land-based resources. Ore Geology Reviews, v. 51, p. 1-14.

4. **Hein, J.R.** and Koschinsky, A., 2014. Deep-ocean ferromanganese crusts and nodules. In Holland, H.D. and Turekian, K.K. (eds.), Treatise on Geochemistry, Second Edition, v. 13, Chapter 11, p. 273-291, Oxford, Elsevier

5. **Hein, J.R.**, de Ronde, C.E.J., Koski, R.A., Ditchburn, R.G., **Mizell, K.**, Tamura, Y., Stern, R.J., Conrad, T.A., Ishizuka, O., Leybourne, M.I., 2014. Layered hydrothermal barite-sulfide mound field, East Diamante caldera, Mariana volcanic arc. Economic Geology, v. 109, p. 2179-2206.

6. **Gartman A.**, A.J. Findlay, and G.W. Luther, III. 2014. Nanoparticulate pyrite and other nanoparticles are a widespread component of hydrothermal vent black smoker emissions. *Chem. Geol.* **366**, 32-41.

7. **Hein, J.R.,** Spinardi, F., Okamoto, N., **Mizell, K.,** Thorburn, D. and Tawake, A., 2015. Critical metals in manganese nodules from the Cook Islands EEZ, abundances and distributions. Ore Geology Reviews, v. 68, p. 97-116.

8. **Hein, J.R.,** Koschinsky, A., Mikesell, M., **Mizell, K.,** Glenn, C., and Wood, R., 2016. Marine phosphorite deposits as a potential resource for heavy rare earth elements and yttrium. Minerals 2016, 6(3), 88, p. 1-22.

9. **Gartman, A**., Hannington, M., Jamieson, J.W., Peterkin, B., Garbe-Schönberg, D., Findlay, A.J., Fuchs, S., and Kwasnitschka, 2017. T. Boiling-induced formation of colloidal gold in black smoker hydrothermal fluids. Geology v. 46, p. 39-42 https://doi.org/10.1130/G39492.1

10. **Hein, J.R.**, Konstantinova, N., Mikesell, M., **Mizell, K.,** Fitzsimmons, J.N., Lam, P.J., Jensen, L.T., Xiang, Y., Gartman, A., Cherkashov, G., Hutchinson, D.R., and Till, C.P., 2017. Arctic deep water ferromanganese-oxide deposits reflect the unique characteristics of the Arctic Ocean. Geochemistry, Geophysics, Geosystems, 18 (11), https://doi.org/10.1002/2017GC007186.

- **List of up to 5 relevant previous projects or activities, connected to the subject of this proposal**

1 ***Law of the Sea and Extension of the Continental Shelf of the USA Project***; USGS Program, task on Marine Minerals in the US Potential ECS (2015-2019), Task Chief, **James Hein**.

2 ***Formation of hydrothermal iron and manganese oxides at spreading centers, fracture zone, and volcanic arcs***; USGS, NOAA, and MBARI program, **James Hein** Chief, 2004-2020.

3 ***Resource assessment of ferromanganese crusts on seamounts***; USGS, SIO, **James Hein** Chief, 1990-2020.

4 ***Seafloor massive sulfide alteration*** USGS Program task on Marine Minerals (2015-2018), Task Leader **Amy Gartman**

- **Previous experience and capacity relevant to the main tasks in the project**

All aspects of marine minerals have been undertaken by the USGS participants including numerous research cruises and many ships using all operations related to geophysics, geology, geochemistry, environmental, and oceanography applied to better understanding these mineral deposits and their resource potential.

- **Significant infrastructure and/or any major items of technical equipment, relevant to the proposed work.**

USGS laboratories include modern analytical techniques including X-ray diffraction, Fourier Transform Infrared Spectrophotometry, Scanning Electron Microscopy, Microprobe, ICP-MS, petrography, and others.

THE ALL-RUSSIA SCIENTIFIC RESEARCH INSTITUTE FOR GEOLOGY AND MINERAL RESOURCES OF THE OCEAN (VNIIO)

- **Description of the legal entity and its main tasks**

VNIIOkeangeologia (VNIIO) is a leading Institute for marine geological survey in the Ministry of Natural Resources of Russia. VNIIO is responsible for scientific supervising of marine mineral resources exploration and evaluation within EEZ and in the Area beyond the national jurisdiction.

VNIIO will contribute to GeoERA proposal in the field of deep-sea mineral deposits (seafloor massive sulphides at the Mid Atlantic Ridge) as well as of shallow water minerals (nodules in the Baltic Sea) investigation.

VNIIO is planning to share experience in study of marine minerals distribution, composition, geological control and estimation of their resources.

- **Short CV of key researchers / staff**

Dr. Georgy Cherkashov (Male) is Deputy director of the Institute for Geology and Mineral Resources of the Ocean (VNIIOkeangeologia, St. Petersburg, Russia) of the Ministry of Natural Resources (since 1996). He holds a Dr. Sci. for research of seafloor massive sulfide (SMS) deposits of the Mid-Atlantic Ridge. Chief scientist of 13 ocean-going Russian and international expeditions for prospecting of SMS deposits in the Pacific, Atlantic and Indian Oceans (1983-2007). President of International Marine Minerals Society (2011-2012). Member of the Legal and Technical Commission of the International Seabed Authority (since 2012). Professor of St. Petersburg State University (Marine Geology), part time (since 2005). He is currently supervising exploration works in the Russian contract areas in the Atlantic and Pacific.

Dr. Sergei Petukhov (Male), marine geologist. PhD, 1997 (Moscow State Mining Institute, Russia). He is currently the head of group for study and resource evaluation of deep-sea mineral deposits in VNIIOkeangeologia (St Petersburg, Russia). Participated in several cruises in Atlantic and Indian oceans. Field of research includes geodynamical modeling of SMS deposits, application of GIS-technology (ArcGis, MapInfo), DataBase (Access), Maple and Micromine software for modeling and resource estimation. Certificates ESRI ArcGis1,2 (2008) & DataBase (2016), Micromine (2014).

Natalia Konstantinova (Female), marine geologist. PhD student of the Earth Science Institute of Saint-Petersburg State University. Since 2008 she has been working at the Institute for Geology and Mineral Resources of the Ocean (VNIIOkeangeologia) in St.Petersburg (Russia). In 2016-2017 she was a Fulbright Fellow at the USGS in Santa Cruz, CA working with James R. Hein. She participated in several cruises to the Arctic, Atlantic and Pacific oceans. The primary focus of research is study of ferromanganese crusts from different oceanic areas and geological settings.

Anna Firstova (Female), marine geologist. PhD student of the Earth Science Institute of Saint-Petersburg State University. Since 2008, she has been working at VNIIOkeangeologia (Department of geology and mineral resources of the Ocean). She was involved in cruise to the Atlantic. The primary focus of her research is study of mineral and chemical compositions of seafloor massive sulfides. Participated in several international conferences (UMI 2015-2017, Goldschmidt 2015-2017) and workshops (2015, 2017 – Nautilus Minerals; 2017 - Joint Modular Course on Hydrothermal Ore Deposits, University of Ottawa).

- **List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content**

Cherkashev G.A., V.N. Ivanov, V. Bel'tenev, L.I. Lazareva, I.I. Rozhdestvenskaya, M.L. Samovarov. Massive sulfide ores of the northern equatorial Mid-Atlantic Ridge, Oceanology 53 (2013) 607–619, http://dx.doi.org/10.1134/S0001437013050032.

Cherkashov G., Smyslov A., Soreide F. Fe-Mn nodules from the Finnish Bay (Baltic Sea). Underwater Mining Institute. 2013. Abstract volume. 3 p.

Cherkashov G. Seafloor Massive Sulfide deposits: distribution and prospecting. In: Deep-Sea Mining. Resource Potential, Technical and Environmental Considerations. R. Sharma (ed.) Springer International Publishing AG. 2017. P.143-165. DOI 10.1007/978-3-319-52557-0_4

Cherkashov G., V.Kuznetsov, K.Kuksa, E.Tabuns, F.Maksimov, V.Bel'tenev. Sulfide geochronology along the Northern Equatorial Mid Atlantic Ridge. Ore Geology Reviews. 2017. P. 147-154. DOI: 10.1016/j.oregeorev.2016.10.015

Cherkashov G.. Mining for Marine Minerals. In: The regulation of continental shelf development: rethinking international standards. 2013. Eds. M. Nordquist, J. Moore, A. Chircop and R. Long.Center for oceans law and policy.Martinus Nijhoff Publishers.Leiden-Boston.V. 17 p. 71-79

- **List of up to 5 relevant previous projects or activities, connected to the subject of this proposal**

Study of rare elements in seafloor massive sulfides for their resource assessment

Interpretation of multibeam data and resource potential assessment at the Norwegian EEZ.

Study of rare earth elements in oceanic ferromanganese nodules and crusts

GEOSCIENCES INSTITUTE/ INSTITUTO DE GEOCIENCIAS (IGEO-CSIC-UCM)

- **Description of the legal entity and its main tasks**

IGEO was established on January 18th, 2011 following the CSIC 2006-2009 renewal plan proposing unification of research groups in Earth Sciences at a single institution in Madrid. Thus, IGEO brings together research groups that have been withdrawn from other joint institutes, such as the Institute of Economic Geology (IGE) and the Institute of Astronomy and Geodesy (IAG), and other groups from the Department of Geology and Volcanology of the National Museum of Natural Sciences (CSIC), together with Faculty staff from the schools of Geological Sciences, Physics and Mathematics at the Complutense University of Madrid (UCM).

We believe that working together with this concentration of expertise we can improve our understanding of the Earth system and interactions between the processes that have shaped, and continue to shape, its evolution. IGEO will carry out cutting-edge research from a multi- and interdisciplinary viewpoint in different lines of research related to Geology, Geodesy and Geophysics, with special emphasis on applied aspects aimed at solving current socio-economic problems such as Natural Hazards, Global Change and Geological Resources.

- **Short CV of key researchers / staff**

Prof. Dr. Rosario Lunar (Female) Geologist. Graduated at the Complutense University of Madrid in 1973, where she also obtained her PhD degree in Economic Geology in 1976. She is director of the Geosciences Institute (IGEO) since 2012. She is the head of a cooperative interdisciplinary research group investigating hydrothermal and magmatic deposits and metallogenetic processes in Spain and Chile. Those studies include rare-metal-rich sulfide, platinum group elements, methane-derived carbonates and ferromanganese deposits. She has authored or co-authored numerous papers and abstracts, including co-editing books and special issues in mineral resources. She has directed 18 PhD Thesis and 20 student Masters. She is the Spanish Coordinator for the InterRidge Program; Academic Member of the Spanish Doctors Academy and past Vice-president of the European Mineralogical Union.

Dr. Jesús Martínez Frías (Male) Geologist. Graduated at the Complutense University of Madrid in 1982, where he also obtained his PhD degree in 1986. He has developed several stays of research in UK (University of Leeds), Canada (University of Toronto), Germany (University of Heidelberg) and the USA (University of California). He is Scientific Researcher at the Geosciences Institute, IGEO (CSIC-UCM), Head of the Research Group of Meteorites and Planetary Geosciences and founder and Director of the Spanish Planetology and Astrobiology Network. He has participated in more than 40 projects and scientific campaigns (e.g. Antarctica, Mauritania, Iceland, Costa Rica). In 2002, he participated in the NASA flight to study the Leonid Meteor Shower. He is co-I in NASA-MSL (rover Curiosity), ESA-ExoMars and NASA-Mars2020 and in 2016 and 2017 heas was instructor of ESA astronauts in the PANGAEA program (Lanzarote and Chinijo Islands UNESCO Global Geopark). He has supervised 14 PhD and Master theses and published 8 books and more than 200 articles (Science, Nature, Geology, etc). He was Former Member of the UN ECOSOC Committee on Natural Resources, Ex-ViceChair of the UNCSTD and Ex-Chair of IUGS-COGE. He is co-founder and President of the International Association for Geoethics (IAGETH) and President of the Geoethics Commission of the Spanish Association of Geologists (ICOG). He is Editor-in-Chief of the journal Geosciences (MDPI) and co-editor of the Springer Book Series: Geoheritage, Geoparks and Geotourism. He has received several awards and recognitions (i.e. NASA, ESA, GSAf, ArabGU, Spanish Association of Scientists).

- **List of up to 5 relevant publications, and/or products, services (including widely use datasets or software), or other achievements relevant to the call content**

Marino, E., González, F.J., Somoza, L., **Lunar, R.**, Ortega, L., Vázquez, J.T., Reyes, J., Bellido, E., 2017. Strategic and rare elements in Cretaceous-Cenozoic cobalt-rich ferromanganese crusts from seamounts

in the Canary Island Seamount Province (northeastern tropical Atlantic). ***Ore Geology Reviews,*** 87, 41-61.

Rubin, D. M., Fairén, A. G**., Martínez-Frías, J.**, Frydenvang, J., Gasnault, O., Gelfenbaum, G., Wiens, R. C., 2016. Fluidized-sediment pipes in Gale crater, Mars, and possible Earth analogs. ***Geology***, G38339.1. doi:10.1130/G38339.1

González, F.J., Somoza, L., León, R., Medialdea, T., Torres, T., Ortiz, J.E., **Lunar, R., Martínez-Frías, J.** Merinero, R., 2012. Ferromanganese nodules and micro-hardgrounds associated with the Cadiz Contourite Channel (NE Atlantic): palaeoenvironmental records of fluid venting and bottom currents. ***Chemical Geology*** 310-311, 56-78.

Piña, R., Gervilla, F., Barnes, S.-J., Ortega, l., **Lunar, R.**, 2012. Distribution of platinum-group and chalcophile elements in the Aguablanca Ni-Cu sulfide deposit (SW Spain): evidence from a LA-ICP-MS study**. Chemical Geology,** 302-303, 61-75.

Merinero, R., **Lunar, R.**, Somoza, l., Díaz-del-Río, v., **Martínez-Frías, J.**, 2009. Nucleation, growth and oxidation of framboidal pyrite associated with hydrocarbon-derived submarine chimneys: lessons learned from the Gulf of Cadiz. ***European Journal of Mineralogy***, 21 (5), 947-961.

- **List of up to 5 relevant previous projects or activities, connected to the subject of this proposal**

INTRAW project, International Raw Materials Observatory

Study of mineralisation systems and rare elements in fossil seafloor massive sulphides (Iberian Pyritic Belt; Almeria volcanic area) for their resource assessment

Study of methane-derived carbonate chimneys in the Gulf of Cadiz (NE Atlantic)

Study of rare earth elements in oceanic ferromanganese nodules and crusts from the Atlantic Iberian margins

Study of magmatic platinum group elements in Ni-Cu sulphide deposits from the SW of Spain

5 Ethics and Security

5.1 Ethics

Have you completed an ethics self-assessment? (See "How to complete your ethics self-assessment")

NO

(If YES, upload this as an additional document in ISAAC under the tab *Attachments* – Other)

5.2 Security

Please indicate if your project will involve:

- Activities or results raising security issues: (**NO**)
- 'EU-classified information' as background or results: (**NO**)

(See for guidance this document)

REFERENCES

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- Hein, J.R., Koschinsky, A., Bau, M., Manheim, F.T., Kang, J.K., Roberts, L., 2000. Co-rich ferromanganese crusts in the Pacific. In: Cronan, D.S. (Ed.), Handbook of Marine Mineral Deposits. CRC Marine Science Series. CRC Press, Boca Raton, Florida, pp. 239–279.
- Hein, J.R., Koschinsky, A., Halliday, A.N., 2003. Global occurrence of tellurium-rich ferromanganese crusts and a model for the enrichment of tellurium. Geochim. Cosmochim. Acta 67 (6):1117–1127. http://dx.doi.org/10.1016/S0016-7037(02)01279-6.
- Hein, J.R., Mizell, K., Koschinsky, A., Conrad, T.A., 2013. Deep-ocean mineral deposits as a
- source of critical metals for high- and green-technology applications: comparison with land-based resources. Ore Geol. Rev. 51:1–14. http://dx.doi.org/10.1016/j.oregeorev.2012.12.001.
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- Marino, E., González, F.J., Somoza, L., Lunar, R., Ortega, L., Vázquez, J.T., Reyes, J., Bellido, E., 2017. Strategic and rare elements in Cretaceous-Cenozoic cobalt rich ferromanganese crusts from seamounts in

the Canary Island Seamount Province (northeastern tropical Atlantic). Ore Geol. Rev. 87, 41-61. https://doi.org/10.1016/j.oregeorev.2016.10.005.

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	Month																																		
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	2018						2019												2020												2021					
WP1	Project Management continues throughout the duration of the programme																																		
WP2	Communication, Dissemination and Exploitation activities throughout the project																																		
	Construction of the products												Consolidation of data products												Convergence phase											
WP3																																			
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Biannual Internal Report																																			
Project Progress Report	Project Progress Report (by 29.2.2020)																																		
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GeoERA Meetings	1																				2															3
Final Project Progress Report	Final Project Progress Report (by 31.8.2021)																																		
Cumulative Expenditure						1st												2nd												3rd						

1: Kick-off Meeting (June 2018)
2: Review Meeting (March 2020)
3: Final Review Meeting (September 2021)

5.14 Mintell4EU

Mintell4EU

HISTORY OF CHANGES	
Date	**Amendment to Project Plan**
31-05-2018	Changes below arises from a) adding two new partners and b) updating of budgets for three partners which discovered that fals wage rates were used in the submitted versions of the proposal (BGS: far too high; BRGM and SGL: sligtly too low).
-	Updating partner name of NERC/BGS to UKRI/BGS (United Kingdom Research and Innovation)
-	Adding two new partners: Regione Umbria and GBA
-	Update of table 3.1a by changing person months for • WP1: GEUS from 25 to 26 PM • WP2: GEUS from 1 to 1.2 PM • WP3: Adding Regione Umbria with 5.4 PM • WP4: Adding GBA with 5 PM • WP5: GEUS from 10 to 13 PM • WP5: UKRI/BGS from 1 to 0.5 PM
-	Update of table 3.1b, increasing PM: • WP1: from 41 to 42 PM • WP3: from 188 to 193 • WP4: from 38 to 43 • WP5: from 54 to 57 • Total from 456 to 470
-	Update of table 3.3a, changing total PM per participant: • GEUS: from 43 to 47 • UKRI/BGS: from 49.5 to 49 • Adding RU with 5.4 • Adding GBA with 5
-	Update of table 3.3b, adding a travel budget for the two new partners: • RU: €4,589 • GBA: €3,000
-	Updated Table 3.3d consistent with the formulas resulting: • Increasing total budget for GEUS with €39,998 • Increasing total budget for BRGM with €4,498 • Decreasing total budget for UKRI/BGS with € 112,798 • Increasing total budget for SGL with €4,617 • Adding RU with a total budget of €28,686 • Adding GBA with a total budget of €35,000 • Decreasing budget for (A) Direct personal costs with €7,588 • Increasing budget for (B) Other costs with €7,588
-	Adding partners description of RU and GBA to chapter 4: Members of the consortium

Title of project proposal

Mineral Intelligence for Europe (Mintell4EU)

The European Union has identified security of supply, improvement in environmental management and resource efficiency as key challenges for the raw materials sector. Data regarding the location and spatial distribution of primary and secondary raw materials, with respect to exploration, exploitation, production and trade activities, underpin decision making in government and industry. Given the dynamic character of such data, regular updates of comprehensive, reliable and harmonized information across borders are required. The overall aim of this proposal is to improve the European Knowledge Base on raw materials by updating the electronic Minerals Yearbook produced in the Minerals4EU project and to extend the spatial coverage and quality of data currently in the Minerals Inventory. The project will, furthermore, aim to increase the degree of harmonization, communication and interaction between existing data platforms, with the ambition of reaching a fully operational and reliable data knowledge management system, fulfilling the European needs and taking into account the Raw Materials Information System (RMIS) of the European Union. Importantly, the project will also integrate the electronic Minerals Yearbook into the Minerals4EU database, ensuring future sustainability as part of the EuroGeoSurveys-governed European Geological Data Infrastructure (EGDI). All results will be integrated in the GeoERA Information Platform that will, by end of the project, disseminate European raw materials intelligence in a uniform way to end users through a common web portal interface. Finally, the applicability of the UNFC classification system for obtaining more accurate Pan-European mineral inventories will be tested.

SRT

Raw Materials – RM1–Improving and sustaining the Raw Materials Knowledge Base by periodically delivering a Minerals Yearbook and Inventory Information System

List of participants

#	Participant Legal Name	Institution	Country
1	Geological Survey of Denmark and Greenland [Project Coordinator]	GEUS	Denmark
2	Bureau de Recherches Géologiques et Minières	BRGM	France
3	Instituto Geológico y Minero de España	IGME (Sp)	Spain
4	Cyprus Geological Survey Department	GSD	Cyprus
5	Geological Survey of Italy	ISPRA	Italy
6	Geological Survey of Norway	NGU	Norway
7	Geological Survey of Slovenia	GeoZS	Slovenia
8.	Geological Survey of Sweden	SGU	Sweden
9.	State Informational Geological Fund of Ukraine	GeoInform - GIU	Ukraine
10.	Statny Geologicky Ustav Dionyza Stura	SGIDS	Slovak Republic
11.	Laboratório Nacional de Energia e Geologia, I.P.	LNEG	Portugal
12.	Institute of Geology and Mineral Exploration	IGME (Gr)	Greece

13.	Hrvatski geološki institut - Croatian Geological Survey	HGI-CGS	Croatia
14.	Geological Survey of Finland	GTK	Finland
15.	Natural Environment Research Council (British Geological Survey)	UKRI/BGS	United Kingdom
16.	Regierungspräsidium Freiburg (Landesamt für Geologie, Rohstoffe und Bergbau Baden-Württemberg)	LGRB	Germany
17.	Bundesanstalt für Geowissenschaften und Rohstoffe (The Federal Institute for Geosciences and Natural Resources)	BGR	Germany
18.	Geological Survey of Ireland	GSI	Ireland
19.	Geological Survey of Belgium	GSB-RBINS	Belgium
20.	Mining and Geological Survey of Hungary	MBFSZ	Hungary
21.	Service géologique du Luxembourg - Geological Survey of Luxembourg	SGL	Luxembourg
22.	GEOLOGICAL SURVEY OF SERBIA	GSS	Serbia
23.	Albanian Geological Survey	AGS	Albania
24.	Czech Geological Survey	CGS	Czech Republic
25.	Geological Survey of Federation of Bosnia and Herzegovina	FZZG	Federation of Bosnia and Herzegovina
26.	Regione Umbria, Geological Survey	RU	Italy
27.	Geologische Bundesanstalt	GBA	Austria

1 Excellence

Mintell4EU is a proposal related to the GeoERA Specific Research Topic on Raw Materials “RM1 – Improving and sustaining the Raw Materials Knowledge Base by periodically delivering a Minerals Yearbook and inventory information system”. The overall aim of the proposal is to improve the European Knowledge Base on raw materials by updating the electronic Minerals Yearbook produced in the Minerals4EU project and to extend the spatial coverage and quality of data from past and ongoing European projects that currently reside in the Minerals Inventory. Furthermore, the project will aim to increase the degree of harmonization, communication and interaction between existing knowledge data platforms, with the ambition of reaching a fully operational data knowledge management system, fulfilling the European needs. All results will be integrated in the GeoERA Information Platform (EGDI) through which up-to-date, comprensive, reliable and harmonised raw materials intelligence from Europe will be disseminated in a uniform way to relevant stakeholders, both through a dedicated web portal, but also taking into account the interoperability with the Raw Materials Information System (RMIS) of the European Union. This will substantially add to the usability, robustness and sustainability of the overall EU Raw Materials Knowledge Base (EURMKB).

Aims and objectives

The European Union has identified security of supply, improvement in environmental management and resource efficiency as key challenges for the raw materials sector. Data regarding the location and spatial distribution of primary and secondary raw materials, with respect to exploration, exploitation, production and trade activities, underpin decision making in government and industry. Given the dynamic character of such data, regular updates of comprehensive, reliable and harmonized information across borders are required.

The overall aim of this proposal is to improve the overall EURMKB and more specifically to deliver:

- Updating of the European Minerals Yearbook with production and trade data (2014-2017), and resource and reserve data as well as exploration information (reference year 2019);
- Integration of the European Minerals Yearbook in the INSPIRE-compliant Minerals4EU database;
- Improving the quality and spatial coverage of the Minerals Inventory, addressing harmonization issues and facilitating interoperability with other ongoing European mineral intelligence project;
- Testing the application of the UNFC classification system as a tool to obtain more accurate pan-European mineral inventories;
- Recommendations of communication and interaction between already existing databases and data portals, and the Raw Materials Information System (RMIS);
- Integration of the European Minerals Yearbook and Minerals Inventory in the GeoERA Information Platform and provide user-oriented search and visualisation facilities, thereby de-facto establishing a dedicated EURMKB portal, but also enabling interoperability of raw materials data with data on groundwater and geoenergy resources to support spatial planning and management of competing landuses.

Relation to existing EU programmes and projects

During the past decade, the European Commission has strongly supported projects and initiatives, aimed to generate reliable and comprehensive raw materials datasets, supporting safe, informed and knowledgeable decisions from political bodies and the industry. The initiatives stimulate both investment in the EU and job growth on the continent (a major concern, see https://ec.europa.eu/growth/sectors/raw-materials/policy-strategy_en).

Among the previous initiatives and projects is the **ProMine** project which collected and collated a great amount of data related to both primary and secondary mineral resources across Europe. ProMine contributed to define the INSPIRE Mineral Resources data model and the improvement of the Earth Resource data model (ERML). Similarly, the **EuroGeoSource** project collected and collated numerous energy and mineral resources data from several European countries and implemented (for the first time) an INSPIRE compliant distributed architecture. These two projects were thus strongly linked with the development and the implementation of the INSPIRE Directive, whose fundamental aim is the

interoperability of data and their sharing. Several other projects also contributed to reaching this objective, most notably the **Minerals4EU** project, which set up the foundations for a fully operational, INSPIRE compliant, distributed architecture, allowing the serving of continuously updated data related to both primary (onshore and offshore) and secondary resources (mining wastes). Projects like **EURare** (REE in Europe), **ProSUM** (the urban mine) and **SCRREEN** (CRM in Europe) made progress on the management of non-structured data, with the next real step coming from ProSUM, with the development of an unified data model for the urban mine (for WEEE (Waste electric electronic equipment), ELV (end-of-life vehicles) and BATT (spent batteries)) and the improvement of the INSPIRE MR data model, notably for mining wastes. Connected to these knowledge data platforms (KDPs), the **MICA** ontology-based Expert system provides answers to most of the questions an end user may have on the raw materials domain.
See table 1.1 for an overview of related past and existing project etc. and their contribution/interaction with Mintell4EU.

<u>Some important concepts explained</u>

Many past and current projects have contributed to the European Union Raw Materials Knowledge Base (**EURMKB** – see the Strategic Implementation Plan of the European Innovation Partnership on Raw Materials - EIP-SIP) – a common data and information "repository" for raw materials information underpinning policy making in Europe. On top of the EURMKB, each project has delivered a so-called Knowledge Data Platform (**KDP**) with user-oriented applications targeted to the specific objectives of the project (rare earth elements, critical raw materials, urban mining etc.). One part of the EURMKB is the **e-Minerals Yearbook** containing statistical data on e.g. production and trade and another one is the **Minerals Inventory** – an INSPIRE compliant relational database (the **Minerals4EU database**) containing among other things information about primary mineral resources. To meet the challenges relating to sustainability of data products from European geoscience projects (raw materials as well as other themes) the EuroGeoSurveys (**EGS**) members have established the European Geological Data Infrastructure (**EGDI**), which comprises a network of web service-enabled (distributed and centralised) data sources, a central hub with harvesting databases etc., a web portal and, very importantly, agreed operational as well as governance structures defining roles and responsibilities. The Minerals4EU database is already considered part of the EGDI whilst the e-Minerals Yearbook is not (but will be a result of this project). The **GeoERA information platform (GIP)** will basically be an extension to the EGDI and by the end of GeoERA, the results from all projects will be disseminated through the EGDI portal (equal to the GeoERA information platform). The current project will deliver a **"EURMKB portal**" as required by the call, which will be a dedicated corner of the EGDI portal. The Raw Materials Information System (**RMIS**) is another web portal that was launched by the European Commission JRC with the aim of being a one-stop information gateway and knowledge service centre for primary and secondary raw materials in Europe. This portal – like the EGDI-portal – will need access to data in the EURMKB and therefore the integration of data in the EGDI-portal will be coordinated tightly with the development of web interfaces towards the RMIS through WP5 of this project.

Despite significant progress through these projects, some essential functionalities have not yet been achieved. Gaps in the spatial coverage is a major issue, as they prevent the development of other fundamental applications, such as Pan-European statistical studies useful for decision making support. Data quality issues cover several aspects from completeness, accuracy, attached references and metadata. Generally, the economic part (production, reserves and resources) of spatial records is challenging because:

- Links between the available spatial and statistical data are frequently absent, and the national datasets are therefore not reflecting the national resource/reserve base;
- Quality of the data is often not described (attached references or metadata describing the data, how it was produced, from where it comes, etc.);
- The absence of mandatory national resource reporting codes in many countries, (e.g., JORC, PERC, NI43-101) prevents consistent resource records for the EC for statistical data on resources and reserves;
- National discrepancies occur with respect to the classification of "sensitive", commodities, preventing comprehensive EC-resource records (e.g. uranium).

The H2020 ORAMA project that will start at the beginning of 2018 will address some of these issues (e.g. review of the INSPIRE Mineral Resources (MR) data model implementation, national aggregated datasets harvesting…). Given the fact that ORAMA will not cover all issues, Mintell4EU is designed to go a step further, aiming to make the full system operational.

1.1 Concept and methodology

This proposal should be considered as a follow up of a series of projects, which all brought their contribution to the 'edifice'. For various reasons, the implementation of these projects did not totally succeed in completing and implementing a sustainable system providing high-quality data for the whole of Europe. Retrospectively, these shortcomings are related to e.g. (i) budget constrains for certain actions not allowing the work to be completed (e.g. the e-Minerals Yearbook in Minerals4EU); (ii) inadequate time to engage in dialogues with certain potential data providers (e.g. the German Länder); (iii) inadequate time and budget to provide technical assistance to some of the partner countries (e.g. Baltic and Former Yugoslavia countries). In addition, due to the resource dynamics over the past decade, new data requirements have surfaced, making a revision of the initial version of the INSPIRE MR data model necessary, including updates to the harvesting system and updating of the web services (ongoing action). New stakeholders also appear on the scene, with specific needs (e.g., the JRC with the RMIS), which require new developments from the data provider side (i.e. the Geological Surveys).
Such developments have a bearing on (i) the improvement of datasets in terms of quality and completeness (and Mintell4EU will build on the advances made by ORAMA in terms of data optimization), and (ii) the improvement related to the architecture of the systems. The latter with a view to introduce additional capabilities / functionalities, related primarily to search and discovery of dedicated knowledge, to the retrieval and download of specific data via APIs, and to intelligent integration of e.g. the e-Minerals Yearbook or the ProSUM Stats' module in external systems. All these requests are legitimate, as they contribute to the overwhelming goal of making data available to the larger community.
To address these challenges, Mintell4EU will focus specifically on the following issues:

- Ensuring future sustainability of the e-Minerals Yearbook (initially developed in Minerals4EU), making it INSPIRE compliant, and ensure a set-up that can keep maintenance costs at a low level, thus improving the likelihood for a sustainable maintenance. This proposal includes tasks that are designed to address these challenges looking for (i) data availability and gathering, (ii) automation – as much as possible – of the process of data collation, and (iii) for integration into the European Geological Data Infrastructure (EGDI) for long-term sustainability;
- Improving the Mineral Inventory (coverage, quality, completeness etc.), addressing also harmonization issues, in order to make it applicable for various purposes, and for a wide range of stakeholders (private and public);
- Investigating whether UNFC, as a tool to obtain more accurate Pan-European mineral inventories, will provide better harmonization of minerals resource data in Europe;
- Exploring the role of data providers in making data available by elaborating the rules of communication/interaction between the existing KDPs and their applications, and the Raw Materials Information System (RMIS). RMIS was launched by the European Commission DG JRC, and the ambition of the RMIS 2.0 is to become 'the one-stop information gateway and knowledge service centre for non-energy, non-food primary and secondary raw materials and materials/commodities' in Europe.
- Enabling integration with EGDI through the GeoERA Information Platform, and make sure that all common standards and guidelines are respected, and that relevant user-oriented functionality for searching and inspecting data will be available in the Information Platform portal.

Figure 1 illustrates the expected infrastructure of the databases

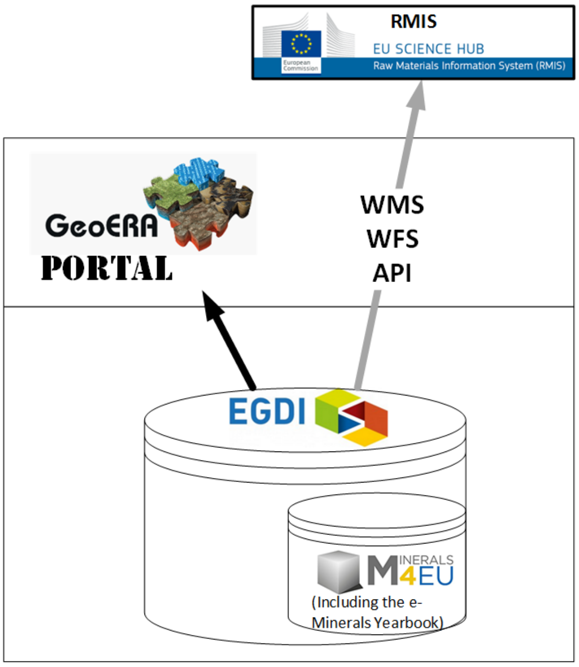

Figure 1. The current project will integrate the e-Minerals Yearbook into the Minerals4EU database that currently hosts an up-to-date Minerals Inventory. The Minerals4EU database is already considered part of the EGDI platform that forms the basis for the GeoERA Information Platform. Appropriate web services and APIs will be integrated into the environment to allow external systems such as RMIS to perform queries and access data as much as needed.

1.2 Ambition

Building on the ORAMA project, which partly runs at the same time with participation of several members of the Mintell4EU consortium, the overall ambition of this proposal is to get as close as possible to a fully operational and reliable data knowledge management system fulfilling the European needs.

When building the overall GeoERA proposal in 2015-2016, the GeoERA consortium identified several key-tasks on which the effort should be based:

- Alimentation and automation of the e-Minerals Yearbook and its incorporation in the Minerals4EU database and further integration into the GeoERA Information Platform through the EGDI
- harvesting and harmonization of the minerals inventory
- reporting standards and UNFC
- data and knowledge delivery while keeping the existing platforms operational

This proposal covers most of the problems identified these last years and thus ensures that the work foreseen will contribute to the efficiency and the sustainability of the systems patiently developed throughout these last years.

Finally, it is noteworthy that most – if not all – members of the present consortium have been involved since the very beginning in the development of the INSPIRE MR datamodel as well as the ProMine and EuroGeoSource projects, and that they have the deepest available knowledge of the weaknesses of these systems and how to remedy them.

Table 1.1: Related past or existing projects.

Project/ initiative name	Project type	Description	Type of interaction
IKMS	EU FP7	Integrated Knowledge Management System for REE developed in the EU-FP7 **EURare** project. Based on a distributed architecture, serves up-dated data, whatever their format (from databases or from reports, monographs, statistics…).	Part of the EURMKB, and thus contributing to the data, information and knowledge feeding of the RMIS 2.0
EU-MKDP	EU FP7	European Union Minerals Knowledge Data Plat-form developed in the EU-FP7 **Minerals4EU** project. Same technical characteristics as the IKMS but covering all commodities, primary or secondary, from continental surface and deep sources, as well as resources of marine origin. Connected to the e-Minerals Yearbook, it also provides foresight studies.	Part of the EURMKB, and thus contributing to the data, information and knowledge feeding of the RMIS 2.0
EU-UMKDP	H2020	The European Union Urban Mining Knowledge Data Platform is a replica of the EU-MKDP, but prepared for the Urban mine (WEEE, ELVs and BATT). Connected to the EU-MKDP and provides data related to mining waste. Developed within the H2020 **ProSUM** project it also provides a service related to statistics on stocks and flows.	Part of the EURMKB, and thus contributing to the data, information and knowledge feeding of the RMIS 2.0
EU-RMICP	H2020	The European Union Raw Materials Intelligence Capacity Platform developed in the H2020 **MICA** project. Based on an original database containing a description of METHODS & TOOLS, it will facilitate the answering of any end user question related to mineral resources. It is supported by utilization of a Dynamic Decision Graph (DDG) based on a multidimensional ontology representing the Domain of end user's questions. Connected to the different KDPs, including the RMIS 2.0, it will represent the core of a future EU Expert System on RM.	In practice, the linkages between the KDPs (including the RMIS) and the EU-RMICP work in two complementary ways **for the mutual benefit of the two systems**: (1) the KDPs will appear as referenced data sources in the DDG; (2) the EU-RMICP may improve its ability to provide answers if it is provided with dedicated fact- and docSheets, and if the boundaries and the granularity of the Main Ontology are augmented.
EU-CRMKDP	H2020	The European Union Critical Raw Materials Knowledge Data Platform is developed in the H2020 **SCRREEN** project. It has the same technical characteristics as the IKMS and the EU-MKDP, but is dedicated to CRM. It will be connected to the EU-RMICP, which will be completed/ improved (boundary and granularity of the Main Ontology for CRM) to perform the role of a Decision Support System.	Part of the EURMKB, and thus contributing to the data, information and knowledge feeding of the RMIS 2.0. The EU-CRMKDP will improve the EU-RMICP with the development of the Main Ontology towards CRM, and use it as a decision support system.

EC RMIS 2.0	In-house EC develop-ment	The Raw Materials Information System, launched in 2015, will be further developed to act as a bridge between knowledge needs and providers in the context of raw materials. This will include support for the EC's Critical Raw Materials analysis as well as the Raw Materials Scoreboard and the Circular Economy.	
EGDI	EuroGeo-Surveys	The European Geological Data Infrastructure (EGDI) is developed and owned by the EuroGeoSurveys community. The EGDI is the platform through which the results of past, present and future European geoscience projects will be sustained and made available. In GeoERA, the EGDI forms the basis for the Information Platform.	The Minerals4EU database can already be considered part of the EGDI, but the e-Minerals Yearbook will be integrated as part of the project.
ORAMA	H2020	One of the main goals of the project is optimisation of collection of primary and secondary raw materials information within EU member states.	Recommendations, common user support workshops
RESE-ERVE	EIT Raw-Materials	RESEERVE - Mineral potential of the ESEE region - the overall goal of this project is to provide a truly comprehensive and useful inventory for primary and secondary mineral resources in West Balkan, in order to efficiently provide all necessary data for potentially interested investors, through the ESEE mineral register.	West Balkan countries are not data providers for EURMKB. One of the objectives is to demon-strate of harmonisation of existing PRM data into INSPIRE-compliant data. We are planning to organise common user support workshops.

2 Impact

2.1 Expected impact

A comprehensive mineral resource data platform for the European primary and secondary mineral resources, including a user friendly portal, will provide vital information to governmental and private stakeholders, for planning and investment purposes. This proposal addresses a system, provided by the GeoERA Information Platform, aimed to provide data in a seamless way, using fully parametrizable applications for download and thus facilitating their use/integration in client in-house applications.

2.2 Measures to maximize impact

2.2.1 Dissemination and exploitation of results

Given the importance of the regional and local component in the project, Mintell4EU activities and results will be promoted both at EU and at local levels. Efforts will be directed towards coordination of actions across the EU Member States to ensure the widest possible geographic coverage, especially in those areas that are sensitive for the project purposes.

The dissemination activities will also liaise with ongoing initiatives relevant to Mintell4EU. In this regard, online and offline channels will be exploited to make mutual benefits of projects responding to similar challenges visible (i.e. attending events organized by related projects, promotion online of initiatives or events, creating opportunities for visibility on connected projects platforms, etc.)

Mintell4EU will produce a Communication and Dissemination Plan defining objectives, targets, messages and tools. The focus of the plan will be on disseminating information on the project progress and results, promoting its benefits, as well as fostering the connections with past and ongoing initiatives related to Mintell4EU. In order to reach these goals, stakeholders will be identified among the wider community operating in the field of Raw Materials policies, including national, regional and local public authorities, and other interested third parties and the general public. In particular, the actors addressed by the project are Raw Materials Knowledge Base practitioners - local, regional and national - with responsibility for Raw Materials Management; specialists and experts in related industry; civil society (NGOs, category associations, etc.).

Dissemination will focus on:

- Informing stakeholders on Mintell4EU main objectives and expected impacts, as well as on seeking the most fruitful collaboration where needed;
- Attending (giving presentations) conferences, debates, events etc. to promote Mintell4EU and meet stakeholders;
- Use of the consortium members´ wide network to disseminate information, both at EU and National level;
- Informing policymakers in charge of Raw Materials Management, industry, general public, aiming at higher awareness about the specific project's deliverables and importance of improving and sustaining the Raw Materials Knowledge Base;
- Dedicated training workshops for new contributors to the Minerals Inventory;
- Highlighting project progress and results, when ready, to illustrate the challenges and importance of improving and sustaining the Raw Materials Knowledge Base to interested stakeholders, primarily policy makers at local, regional and national level;
- A dissemination event will be organised halfway of the project (in connection to the overall GeoERA mid-term meeting) to ensure that current results are made available and to stimulate interest in the view of the final outcomes;
- Production of presentation summing up the key outcomes of Mintell4EU targeting governmental officers and policy makers.

Instead of traditional exploitation activities great focus will be given to the long term sustainability of the Minerals4EU and e-Minerals Yearbook as compoments of EGDI. This will be included as a separate task in WP1.

2.2.2 Communication activities

The communications activities to be implemented will be thoroughly described in a Communication and Dissemination Plan. These activities will be designed to target the main Mintell4EU stakeholders in particular, but communications will be open to all interested parties, respecting a principle of full transparency of the actions.

Communication will focus on:

- Organisation of events: meetings and workshops will be organized along the complete project lifetime. In particular, there will be two users support workshops organized together with ORAMA and RESEERVE projects.
- Attendance of events: the project team will seek to disseminate the results by giving presentations and speeches at key events (conferences, meetings, etc.), networking and meeting stakeholders. The scope will be to engage with policy makers, civil society and scientists.

2.3 Contribution of Project Proposal to the Information Platform or vice versa

Mintell4EU will cooperate closely with the GeoERA Information Platform, and has designated a specific tasks within a WP5 for this. As described earlier (see fig. 1) the infrastructure of the data (bases) elaborated in this project, will be interlinked. All the applications to be developed in Mintell4EU will directly contribute to the development of the Information Platform/EGDI and notably to enhance its capabilities to deliver data, information and knowledge to the other platforms such as the RMIS 2.0. An mportant contribution of Mintell4EU to the Information Platform is to ensure it is 'INSPIRE compliant'.

The Mintell4EU project will be very much dependent upon the Information Platform project as described in WP5. As interlinked ICT development activities will take place between the two projects it is of utmost importance that a very close coordination and cooperation is maintained throughout the whole duration of the GeoERA between the two projects. A review of the relevant deliverables (both in the IP project and in Mintell4EU) and the timing of those must be undertaken approximately in Month 6 in order to ensure that the related activities and results are available when they are needed.

3 Implementation

3.1 Work Plan – Work packages, deliverables

The work in Mintell4EU will be organized in five work packages (WP). WP1 will responsible for the overall coordination and project management, but will also be is in charge of communication and dissemination activities through dedicated tasks. An important aspect of WP1 will, furthermore, be to deal with issues related to the sustainability of the entire system after the end of GeoERA. WP2 and WP3 deals with updates and improvement to the content of the EURMKB in terms of the e-Minerals Yearbook and the Minerals Inventory respectively taking into account related activities in the currently running complementary ORAMA project and in close dialogue with national data providers. WP4 will explore if and how the application of UNFC can in the long run contribute to better harmonization of mineral resource data across Europe through a number number case strudies. Finally, WP5 will liaise with the GeoERA Information Platform and ensure that the project results are properly integrated in this platform according to the overall GeoERA requirements. The WP will, furthermore, explore improved ways to facilitate interoperability between the EURMKB and RMIS and a task will also be dedicated to the integration of the e-Minerals Yearbook into the Mineral4EU database. Figure 2 illustrates the interaction between the tasks, between platforms, and relation to other projects and dataproviders. Figure 3 shows the timeline related to deliverables and milestones.

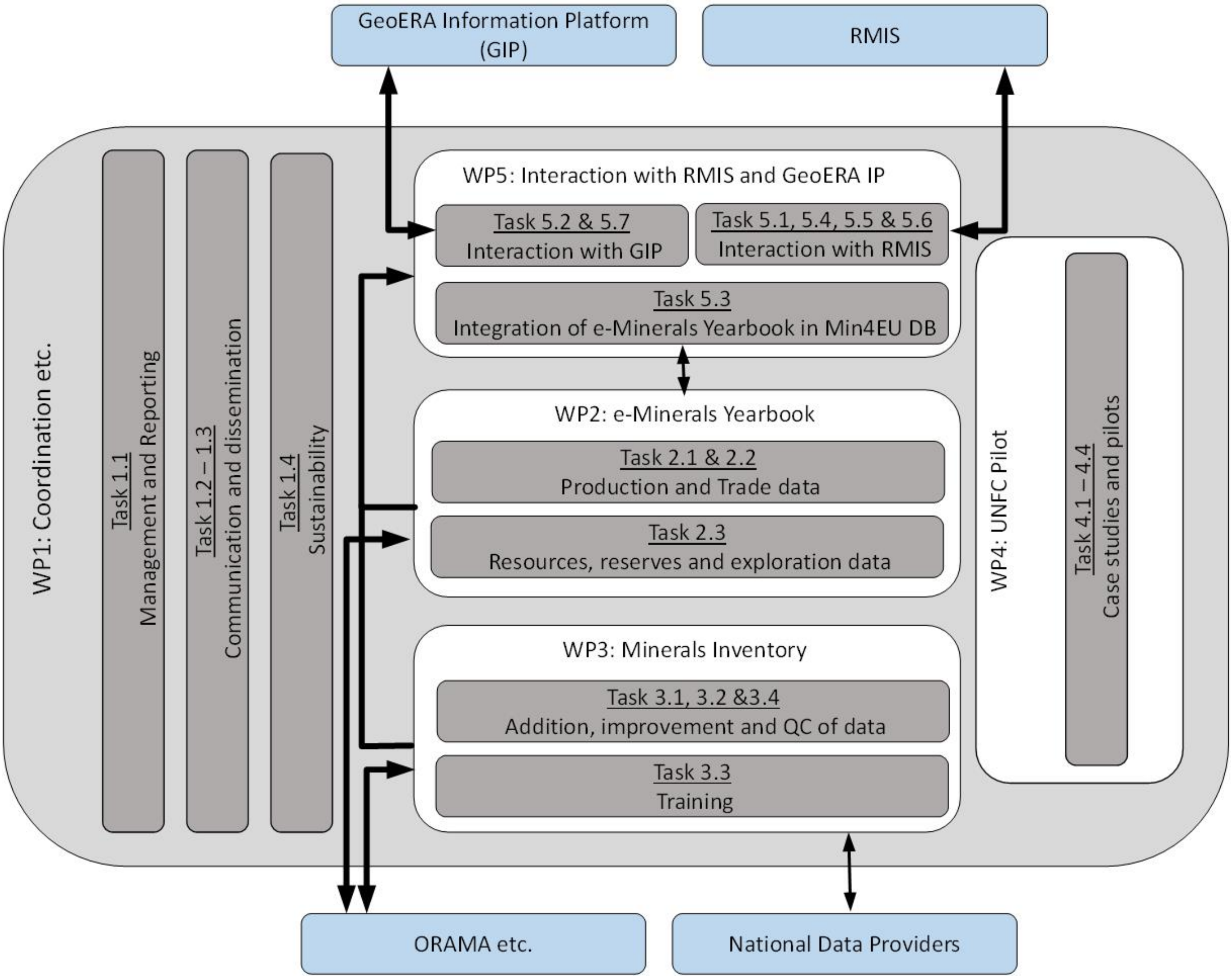

Figure 2. Relationship between work packages and tasks in the Mintell4EU project.

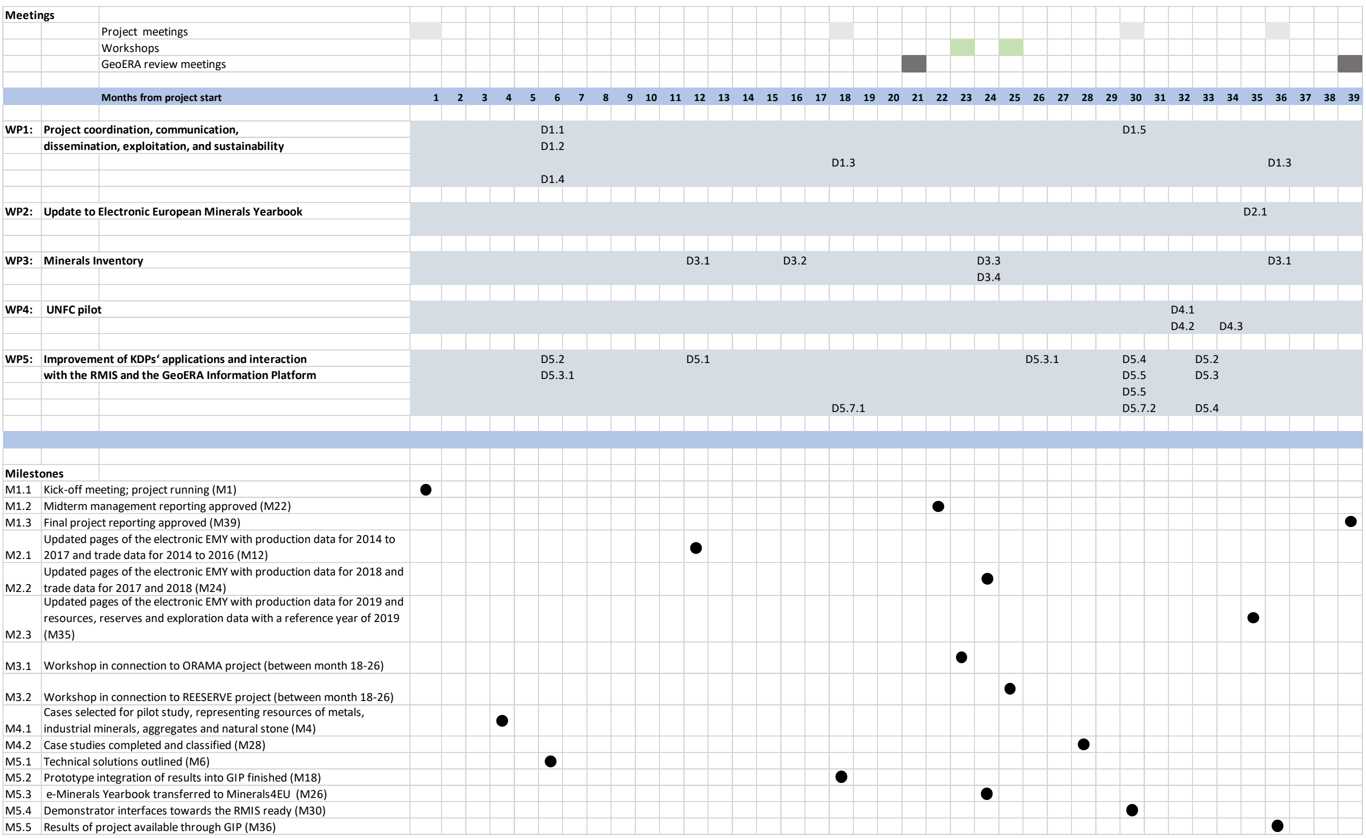

Figure 3: A Gantt diagram illustration timeline of deliverables and milestones.

Table 3.1a) Work package description (This table is **included** in the page limit!)

Work package number	1	Lead beneficiary			GEUS	
Work package title	**Management, communication, dissemination, and sustainability**					
Participant number	1	7	11	19	24	
Short name of participant	GEUS	GeoZS	LNEG	GSB-RBINS	CGS	
Person months per participant	26	12	0.4	3	0.2	
Start month	1			End month	36	

Objectives

The main purpose of work package 1 (WP1) is to manage, coordinate and monitor the overall progress of the project, and ensure that the project meets the objectives stated for the work described in the Project Agreement. WP1 must ensure proper coordination acroos Work Packages (WPs) and that WP leaders and partners respect the timeline and deliverables.

Furthermore, WP1 will focus on dissemination of the project results during the project life-span as well as maximizing the impacts after the end of the project. WP1 will focus on developing and implementing a data management plan as well as a comprehensive communication plan addressing the multiple stakeholders of the project. In terms of communication and dissemination activities, WP1 will:

(i) Disseminate information on the project, its progress and results to the wider community operating in the field of Raw Materials Knowledge Base in the EU and beyond, including national, local, regional public authorities, other interested third parties and the general public;
(ii) Ensure that the project benefits are clearly and systematically promoted, and foster a two-way dialogue with stakeholders;
(iii) Raising awareness and visibility on the importance of improving Europe's framework conditions for Raw Materials Knowledge Base;
(iv) Fostering the connection with existing EU and Member States initiatives and projects relevant to the project outcomes.
Lastly, WP1 will have a dedicated task to guide activities in different work packages towards more consolidated and sustainable solutions taking into account technical sustainability (through integration with the EGDI), but also exploring possible sources of future funding to keep the e-Minerals Yearbook and Minerals Inventory updated. The task will, furthermore, liaise with other related raw materials projects like ORAMA to make sure that related activities are coordinated across projects.

Description of work

A) Management

This work package is in the first place in charge of the coordination and project management tasks, including organizing project meetings and coordinating the reporting. All participants are required to adhere to the project management procedures that will be elaborated, consolidated and described in an Inception Report following a dedicated project workshop at the first project meeting.

Task 1.1 Management and reporting (Lead GEUS, contribution from all partners) (Month 1-36)

- Organize project meetings, kick-off meeting, other full consortiums meetings, and a closing meeting.
- Keep track of progress and costs against budgeted expenditure.
- Manage the WP leaders and monitor the project progress against tasks, deliverables, milestones, and use of resources.
- Coordinate actions across work packages
- Report on progress and expenditure; process claims and validation that the project expenditure is in accordance with the eligibility criteria and the project agreement.
- Producing and continuously updating a Data Management Plan for the project supplementing the overall GeoERA Data Management Plan (D1.1)
- Producing a detailed project management plan, a so-called Inception Report resulting from a dedicated workshop at the first project meeting (D1.2).

The reporting part will run for the entire duration of the project and will consist of:

- Management reports (D1.3) including expenditure against the profile.

B) Communication and dissemination

Task 1.2 Communication Plan (Lead: GeoZS, contribution from all partners) (Month 1-36)
In addition to management of the project, WP1 will produce a detailed Communication and Dissemination Plan (D1.4) defining goals, audience and appropriate channels. The plan will define resources to be allocated, media to be used, messages and sources. This will take into account the complexity of actors addressed by the project. The focus will be on the major audiences: policy makers dealing with Raw Materials resources challenges; national, regional and local administrators and public institutions responsible for Raw Materials management; civil society, industry and the general public.

Task 1.3 Dissemination and communication of project results (Lead: GeoZS, contribution from all partners) (Month 1-36)
In accordance with its main objectives, WP1 will coordinate communication with the rest of GeoERA and the outside world. Furthermore, WP1 willdisseminate the project results to target stakeholders by

implementing tailored activities that will follow the project progress and deliverables according to the Communication and Dissemination Plan produced by task T1.2.
Specific attention will be given to the promotion of the project results produced by other WPs to better illustrate the concrete challenges of improving and sustaining the Raw Materials Knowledge Base by periodically delivering a Minerals Yearbook and Inventory Information System. The project outcomes will be presented in an understandable way for no-scientific audiences, in order to facilitate their adoption as a *tool* for policy makers and interested parties.
Dissemination material will be produced according to identified needs.

C) Sustainability

Task 1.4 Sustainability (Lead: GEUS, contribution from all partners) (Month 1-30)
The European Raw Materials (RM) challenges have led to numerous EU funded RM projects that have each added to the complexity of the Knowledge Data Platform (KDP) landscape. The actions carried out by the Mintell4EU project all contribute to a consolidation of this and the close coordination with the EGDI initiative through the GeoERA information platform project further facilitates long-term sustainability. The current task is responsible for coordinating and guiding all activities in the project towards sustainable solutions and liaise with other running EU projects such as ORAMA to make sure that they target the same goals. The task will, furthermore, explore possible funding mechanisms that could contribute to the setting up more permanent governance structures to secure continuous updates and maintenance of the e-Minerals Yearbook, Minerals Inventory and other systems that contribute to the EU Raw Materials Knowledge Base, which to a high degree will be an integral part of the GeoERA information platform after the end of the project. The task will produce a roadmap with recommendations of activities to be conducted after the end of the project to further work towards a long-term sustainable EURMKB.

Deliverables
D1.1 Data management Plan (M6) R (GEUS)
D1.2 Project Management plan/Inception report (M6) R (GEUS)
D1.3 Management Reports (M18, M36) R (GEUS)
D1.4 Communication and Dissemination Plan (M6) R (GeoZS)
D1.5 Roadmap for future actions towards full sustainability (M30) R (GEUS)

Milestones
M1.1 Kick-off meeting; project running (M1)
M1.2 Midterm management reporting approved (M22)
M1.3 Final project reporting approved (M39)

Work package number	2		Lead beneficiary			UKRI/BGS		
Work package title	**Update to Electronic European Minerals Yearbook**							
Participant number	15	7	2	10	3	20	1	12
Short name of participant	UKRI/ BGS	GeoZS	BRGM	SGIDS	IGME-Sp	MBFSZ	GEUS	IGME-Gr
Person months per participant	48.5	13	1.1	15	12	1.5	1.2	3
Participant number	18	9	19	8	21	4	5	24
Short name of participant	GSI	GIU	GSB-RBINS	SGU	SGL	GSD	ISPRA	CGS

Person months per participant	1	15	8	2	0.5	4	4	5
Start month	1			End month		36		

Objectives

The objective of the work package is to update the data contained within the electronic European Minerals Yearbook, produced by the Minerals4EU project (September 2013 to August 2015).

Description of work

The Minerals Intelligence Network for Europe project (Minerals4EU), which received funding from the European Union's Seventh Framework Programme (grant agreement number: 608921), produced as one of its key deliverables an electronic European Minerals Yearbook containing mineral statistical data for six data types relating to primary raw materials, alongside data for waste flows. The datasets for primary raw materials included:

- Production data for 2004 to 2013
- Import data for 2004 to 2013
- Export data for 2004 to 2013
- Resource data as at 31 December 2013
- Reserve data as at 31 December 2013
- Exploration data with a reference year of 2013

In each case, the project attempted to collect data for a total of 40 European countries and more than 60 mineral commodities.

However, with the completion of the Minerals4EU project, these datasets have remained static. This work package proposes to update these datasets according to the schedule outlined in the following three tasks:

<u>**Task 2.1:**</u> **Production data updates for 2014 to 2017 and trade data updates for 2014 to 2016** (Month 1-12)

Task Leader: UKRI**/BGS**
Data Providers: **all European geological surveys** along with national statistical offices, government departments and other sources as required.
Contributors: **GeoZS** and **BRGM** (for digital transfer of data and to update the user interface)

T.2.1.1: Production data for 2014, 2015 and 2016 will be provided from the UKRI/BGS World Mineral Statistics database and will be available from the start of the project. This sub-task involves the development of a digital method for reliably transfering these production data to the database that sits behind the electronic European Minerals Yearbook. It will take into account the work that will be ongoing within the ORAMA project and will include quality assurance procedures to ensure the transfer happens correctly. During this task UKRI/BGS will also collect production data relating to 2017 and these will be made available by month 12 for the digital transfer to the Yearbook.

T.2.1.2: Trade data for 2014 already exists within the UKRI/BGS World Mineral Statistics database but trade data for 2015 and 2016 will need to be compiled. For these latter two years the raw trade data will be purchased from a supplying agency, checked for consistency with prior years by experienced UKRI/BGS staff and cross-checked with other data sources such as Eurostat and the United Nations Commodity Trade database. This process will endeavour to fill gaps in the data and ensure consistency across all countries. The compiled dataset will then be subjected to the usual UKRI/BGS quality assurance procedures. Once these steps have been completed the three years of data will be transferred by the same digital method as sub-task 2.1.1 into the database that sits behind the electronic European Minerals Yearbook.

T.2.1.3: Once the transfer of data has taken place under sub-tasks 2.1.1 and 2.1.2, the user interface for the electronic European Minerals Yearbook will be updated.

Task 2.2: Production data updates for 2018 and 2019 together with trade data updates for 2017 and 2018 (Month 13-36)

Task Leader: **UKRI/BGS**
Data Providers: **all European geological surveys** along with national statistical offices, government departments and other sources as required.
Contributors: **GeoZS** and **BRGM** (for digital transfer of data and to update the user interface)

T.2.2.1: Production data for 2018 will be collected by UKRI/BGS during months 13 to 24, in accordance to its existing methods and subjected to the usual UKRI/BGS quality assurance procedures which ensure the data are consistent across all countries and with prior years. The data will then be made available by month 24 for the digital transfer to the database that sits behind the electronic European Minerals Yearbook as developed under task 2.1. This sub-task will then be repeated for 2019 production data and made available for the digital transfer by month 36.

T.2.2.2: Trade data for 2017 and 2018 will be collected in a similar manner to that described under sub-task 2.1.2 during months 13 to 24 and made available by month 24 for the digital transfer to the database that sits behind the electronic European Minerals Yearbook by the digital method developed under task 2.1.

T.2.2.3: Once the transfer of data has taken place under sub-tasks 2.2.1 and 2.2.2, the user interface for the electronic European Minerals Yearbook will be updated.

Task 2.3: Resources, reserves and exploration data updates with a reference year of 2019 (Month 25-36)

Task Leader: **GeoZS** and **IGME-Sp**
Data providers: **all European geological surveys** along with other sources as required.
Contributors: **UKRI/BGS, MBFSZ, SGUDS, GSI, GIU, GSB-RBINS, SGU, SGL, GEUS, IGME-Gr, ISPRA, GSD, CGS and BRGM**

T.2.3.1: Data related to mineral resources and reserves in Europe was collected for the Minerals4EU project using a questionnaire. This sub-task will first review the survey forms and utilise the lessons learned from the Minerals4EU project to make small revisions to the forms to improve their ease of completion. These revised questionnaire forms will then be used to conduct a new survey of mineral resources and reserves across Europe with a reference year of 2019.

During the Minerals4EU project it was recognised that each country of Europe has its own methods and procedures for collecting and/or recording resources and reserves data which means that the data are not harmonised across the continent and the figures for different countries cannot be directly and reliably compared. An amalgamated total for Europe is also not possible as a consequence. A separate project, Optimising Quality of Information in Raw Materials Data Collection Across Europe (ORAMA), is seeking to begin the process of addressing this issue by identifying a single system of reporting that all countries should endeavour to use when reporting mineral resources and reserves data for purposes such as the electronic European Minerals Yearbook (even if each country continues to use its own systems internally or for other purposes, such as reporting to stock exchanges, etc). The ORAMA project is scheduled to end in November 2019 and hence this task is deliberately delayed until after that project has completed.

Whilst it is anticipated that the harmonisation process for resources and reserves data is unlikely to be completely resolved by the end of the ORAMA project, mainly because the training element is likely to be significant and ongoing, it is ***expected*** that progress towards harmonisation will have been made by this time. Additional workshops are also proposed under WP3 of this proposal which will assist with this process. Consequently it is ***hoped*** that the data collected during this proposed survey will be more harmonised and consistent than those collected during the previous survey carried out under the Minerals4EU project during 2014/15. However, this expected improvement is ***reliant*** on the ORAMA project and ongoing training sessions, and is beyond the control of this task. Therefore, if significant progress is not made towards harmonisation by the time this task is due to start, the new survey will collect non-harmonised resources and reserves data because ***undertaking any form of harmonisation process for this data type is outside the scope of this work package***. It is also possible that data collected under this task are only partially harmonised.

The method for transferring the resources and reserves data to the electronic European Minerals Yearbook during the Minerals4EU project will be reviewed and new procedures will be written to ensure the collected data are transferred to the Yearbook in a reliable and efficient manner.

T.2.3.2: Exploration data was collected during the Minerals4EU project using five metrics (expenditure, total number of active licences, total number of new licences issued, area under exploration and number of companies involved) but data for all these metrics were not available from all countries. First this sub-task will review the data collected by the previous survey to identify which of these metrics are most commonly available and/or most valuable. The survey questionnaire will be modified accordingly before a new survey is conducted with a reference year of 2019.

The method for transferring the exploration data to the electronic European Minerals Yearbook will also be reviewed and new procedures will be written to ensure the collected data are transferred to the Yearbook in a reliable and efficient manner.

T.2.3.3: Once the transfer of data has taken place under sub-tasks 2.3.1 and 2.3.2, the user interface for the electronic European Minerals Yearbook will be updated.

Deliverables

D.2.1 Report describing the processes developed for updating the electronic European Minerals Yearbook (M35) R (UKRI/BGS)

Milestones

M.2.1 Updated pages of the electronic European Minerals Yearbook with production data for 2014 to 2017 and trade data for 2014 to 2016 (M12).

M.2.2 Updated pages of the electronic European Minerals Yearbook with production data for 2018 and trade data for 2017 and 2018 (M24).

M.2.3 Updated pages of the electronic European Minerals Yearbook with production data for 2019 and resources, reserves and exploration data with a reference year of 2019 (M35).

Work package number	3		Lead beneficiary			GeoZS	
Work package title	**Minerals Inventory**							
Participant number	7	3	8	9	11	12	13	5
Short name of participant	GeoZS	IGME (Spain)	SGU	(GIU)	LNEG	IGME (Gr)	HGI-CGS	ISPRA
Person months per participant	25	6	2	8	1.2	3	11.7	4
Participant number	17	1	4	18	19	20	21	22
Short name of participant	BGR	GEUS	GSD	GSI	GSB-RBINS	MBFSZ	SGL	GSS

Person months per participant	6.5	2	2	5.5	7	1.5	0.25	24
Participant number	24	23	16	25	26			
Short name of participant	CGS	AGS	LGRB	FZZG	RU			
Person months per participant	4.5	24	24	21.6	5.4			
Start month	1			End month		36		

Objectives

The objective of the work package is to extend the spatial coverage and quality of data currently in the Minerals4EU system to have access to up-to-date harmonized information across borders on primary raw materials by using the existing systems developed within the project Minerals4EU. Currently, the Minerals4EU system is not covering all Europe and it is not fully harmonise, and a different degree of data is available from country to country.

WP3 will refine the Minerals Inventory (current Minerals4EU database) by identifying and fiiling data gaps, and low-quality or completely missing data. Solutions, addressing in particular problems of data quality, will be given through workshops, tailored upon users' needs.

WP3 will:
(i) identify and fill data gaps in spatial coverage;
(ii) outline data harmonization;
(iii) update mineral resource assessment information for the Minerals Inventory
(iv) educate project partners to become capable and reliable data providers
(v) facilitate interoperability between relevant on-going projects (i.e. ORAMA, RESEERVE)

There will be a strong connection with WP2 (Task 2.3: Resources, reserves and exploration updates), WP5 (updates of harvesting system) and GeoERA Information Platform project.

Description of work

Task 3.1 Minerals Inventory Improvements (Month 1 to 36)
Lead: **GeoZS**
Partners: GEUS, MBFSZ, IGME (Spain), SGU, (GIU), LNEG, IGME (Greece), HGI-CGS, ISPRA, BGR, GSD, GSI, GSB-RBINS, MBFSZ, AGS, FZZG, GSS, CGS, RU - plus all other European Geological Surveys
T 3.1.1 Identification and filling data gaps in spatial coverage
The existing Minerals Inventory spatial coverage will be extended with data from countries that were participant of Minerals4EU project but did not deliver data as well as countries from SE Europe that were not partners of Mineral4EU (in coordination to RESEERVE project).

T 3.1.2 Data harmonization
In coordination with Task 2.3 and ORAMA project and the GeoERA Information Platform project we will address problems of data quality with tehnical guidelines and workshops.

Task 3.2. Quality control of harvesting (Month 13 to 34)
Lead: **GeoZS**
Partners: GEUS
Establishing of harvesting reporting system including quality assurance procedures will ensure that data harvesting happens correctly, in coordination with WP5.

Task 3.3 Training Workshops (Month 18-26)
Lead: **GeoZS**
Partners: GEUS, MBFSZ
Other data providers: IGME (Spain), SGU, (GIU), LNEG, IGME (Gr), HGI-CGS, ISPRA, BGR, GSD, GSI, GSB-RBINS, AGS, FZZG, GSS, RU

Minerals inventory improvements will be supported through workshops, tailored upon users' needs, directed in particular at data providers. For that purpose, technical guidelineswill be elaborated and freely available to all data providers.

Two workshops will be targeted towards:

1. achieving up-to-date, comprehensive, reliable and harmonized information, its quality and efficiency of data reporting. The workshop will be tailored to existing data providers and their needs (with connection to ORAMA project).
2. the education of new project partners (mainly form SE Europe) to become capable and reliable data providers (with connection to RESEERVE project).

Constantly, WP3 will be providing technical help to data providers via via teleconferenes, web seminar e-mails, phone, etc.

Task 3.4 Historical mine sites (Months 13-24)
Lead: GSI
Partners: GeoZS, RBINS, CGS, ISPRA, NGU, PGI-NRI, LNEG, IGME-Sp, GIU

Europe has a long mining history dating back to the Bronze Age (3300 - 1200 BC). Early mining activity was a carried out in a primitive manner and only relatively high grade mineralization was worked. Many developments have taken place since then up to the present day. In addition, the range of commodities mined has greatly expanded over this time period and include ornamental stone, industrial minerals, fuel minerals as well as metal mines. Several of these sites have had over 1,000 years of continuous mining activity while others measure their life in decades or less. The mining activity has altered the landscape and many mining regions have a unique environment and built heritage.
This Task aims to document those mining areas which have developed tourist attractions or amenities following the closure of the mines, in partner countries. Only sites that have active attractions at the site will be documented. This will be achieved by developing a template for the recording of relevant features and attributes of each site. Specifically, information will be collected which will:

1. Provide a brief overview of the mine – commodities worked, period of operation, type of mining, mining activities that were carried out at the site (extraction, processing, smelting, products, etc.).
2. Describe the current condition of the site including any remediation. This will include the built heritage and any remains at the site.
3. Describe the current attractions at the site (preserved built heritage, interpretative centre, walks, etc.).
4. Describe the management of the site (who looks after the site, visitor attractions, numbers annual visitor numbers, any income generation – direct and indirect).

RM4 (Critical Raw Materials) will also be examining historic mine sites (WP7 led by BGR). The WP will examine the critical raw material content and resource potential of both the waste materials and any undeveloped or in-situ mineralization. The present WP will liaise with the RM4 so that any synergies or potential conflicts can be taken into account.

Deliverables
D3.1 Minerals Inventory Report (M12 and M36) R (GeoZS)
D3.2 Technical guidelines (M16) R (GeoZS)

D3.3	Quality control system for harvesting report (M24) Others (GeoZS)
D3.4	GIS database layer illustrating relevant historic mine features (M24) Other (GSI)

Milestones

M3.1	Workshop in connection to ORAMA project (between M18-26)
M3.2	Workshop in connection to REESERVE project (between M18-26)

Work package number	4	Lead beneficiary			NGU					
Work package title	**UNFC pilot**									
Participant number	6	1	9	14	13	20	19	8	7	27
Short name of participant	NGU	GEUS	GIU	GTK	HGI-CGS	MBFSZ	GSB-RBINS	SGU	GeoZS	GBA
Person months per participant	6	5	5	8	4.5	1.5	3.5	2	3	5
Start month	1				End month		36			

Objectives

The current work package aims to show how the application of UNFC will provide better harmonization of mineral resource data in Europe, and to demonstrate the strength of UNFC as a tool for more accurate Pan-European mineral inventories. Full European implementation of UNFC has the potential to provide more accurate forecasts, and improve policy formulation and government resource management. Through the harmonization of data from known prospects to fully assessed deposits, UNFC may be implemented as a standard land use management tool, able to enhance the visibility of mineral resources of public importance, and observing the UN System of Environmental/Economic Accounting, SEEA.

The work will be case study based, but aimed to be Pan-European in nature; it will cover the range of solid mineral resource types, including CRM's. An eventual implementation of UNFC as a standard tool will thus provide better insights into the European stocks "in the ground" and potential for critical raw materials, and the possibility for future supply from European sources.

Harmonized aggregated data will highlight prospectivity and development issues to be addressed through strategies and policies. Successful implementation, demonstrated through case studies, is expected to increase the accuracy and usability of the existing Pan-European databases on mineral resources. High accuracy harmonized data will provide industry with a better basis for effective mineral development and financing.

Description of work

Miners and developers usually have to comply with one of a number of public standards for the reporting of exploration results, resources and reserves. For companies and activities not required to report their resources and reserves, compliant figures are unlikely to be available. Similarly, known resources which have not been subjected to a modern detailed investigation will lack standardized figures for tonnages and qualities. The conventional reporting codes are therefore not suitable tools for comparing and aggregating resource, and potential resource, inventories.
The United Nations Framework Classification for Resources (UNFC) aims to make harmonized inventories by classifying and quantifying projects based on (1) their social and economic favourability, (2) the uncertainty of geological knowledge, and (3) the project maturity. UNFC may therefore be applied

across projects from uncertain, reconnaissance stage, and under-explored prospects to well characterized and well assessed resources and reserves. Classification may include both primary and secondary resources.
The current work package aims to explore the perspective for better and more transparent resource management by applying UNFC to solid mineral resources in Europe. Case studies will demonstrate the applicability across the European resource and policy field and provide guidelines for ease and accuracy of application, thus ensuring that harmonized data are available for future aggregation.

T4.1: Selection of relevant cases to cover metals, industrial minerals, natural stone, and on- and off-shore aggregates across Europe (M1-M4)
Task leader: **HGI-CGS**
Contributors: All partners
Case studies will cover the range of solid mineral resource types, including CRM's, and different levels of project scale and development, in order to produce an overview of strengths and weaknesses, data availability and gaps.

T4.2: Case study pilots; application of UNFC to European resources across resource types, level of development and policy fields (M4-M28)
Task leader: **NGU**
Contributors: All partners
The application of UNFC will be explored and evaluated along all three system axes, and eventually applied systematically and coherently to the complete case study portfolio. The pilot will reveal strengths and weaknesses across the targeted systems and environments, and all cases should be carefully documented and systematized for further reference and analysis. Task T4.2 will progress in close cooperation with T4.3 in order to optimize procedures for harmonization and aggregation. A suggested work flow with practical guidelines illustrated by relevant case studies will be produced (D4.1).

T4.3: Review of harmonization issues, data gaps and challenges (M12-M32)
Task leader: **GTK**
Contributors: NGU, SGU, GEUS, GIU, HGI-CGS, GeoZS
Task4.3 will assist T4.2 in developing a harmonized procedure, for the project, on which the UNFC classification will be based. T4.3 will investigate the case study portfolio on a broader scale in terms of co-alignment, lack of necessary data and other challenges. The findings will be reported in D4.2.

T4.4: Pan-European aggregation pilot (selected resources) (M24-M36)
Task leader: **GEUS**
Contributors: NGU, GTK, SGU, GeoZS, GIU, HGI-CGS, MBFSZ, GBA
T4.4 will aim to generate aggregated UNFC classified data to be included in the European mineral resources inventory. Aggregation should be performed and evaluated for the different resource types and selected commodities. The aggregated figures will be compared with existing resource/reserve based estimates, and the added value investigated. A recommendation on if and how to implement the UNFC classification across from national to Pan-European inventories will be issued. T4.4 will ensure the migration of project data to WP3 (D4.3).

Deliverables

D4.1	Case study review with practical guidelines/work flows and examples for applying UNFC to European mineral resources (M32) R (NGU)
D4.2	Report on harmonization issues, data gaps and challenges, reviewing also the quality of Pan-European aggregated inventories for selected commodities (M32) R (GTK)
D4.3	Supply data to WP 2, 3 and 5, for inclusion in the European yearbook, resource databases and information systems (M34) Others (GEUS)

Milestones

MS4.1	Cases selected for pilot study, representing resources of metals, industrial minerals, aggregates and natural stone (M4)
MS4.2	Case studies completed and classified. (M28)

Interconnection with other projects and work packages
RM1-WP4 aims to test the UNFC classification scheme as a resource management tool, and demonstrate the practical use of the system. UNFC is potentially able to provide better harmonized, easier aggregated, and more reliable and broadly understandable resource inventory data. WP4 will therefore generate new input to RM1-WP3 on the European resource inventory, and possibly recommend UNFC as a preferred tool. RM1-WP4 relies on commodity and deposit/prospect/occurrence data for the complete range of resource types. In terms of on- and off-shore aggregates the work package will collaborate extensively with RM2A.

Work package number	**5**	**Lead beneficiary**		BRGM			
Work package title	**Improvement of KDPs' applications and interaction with the RMIS and the GeoERA Information Platform**						
Participant number	2	1	18	8	7	19	12
Short name of participant	BRGM	GEUS	GSI	SGU	GeoZS	GSB-RBINS	IGME (Gr)
Person months per participant	8	13	0.5	1	15	3.5	3
Participant number	13	9	20	15	11	5	22
Short name of participant	HGI-CGS	GIU	MBFSZ	UKRI/BGS	LNEG	ISPRA	CGS
Person months per participant	4.5	4	3	0.5	0.4	4	0.3
Start month	**1**			End month	**36**		

Objectives
The earlier mentioned Raw Materials Knowledge Data Platforms (KDP) constitute the European Union Raw Materials Knowledge Base (EURMKB – see the EIP-SIP) that will be 'exploited' by 'Super' platforms such as the Raw Materials Information System (RMIS) by the European Commission DG JRC whose ambition is to become the one-stop information gateway and knowledge service centre for primary (e.g., extracted through mining) and secondary (e.g., recycled, recovered from mining waste) raw materials and materials/commodities. Many of these KDPs are based on the INSPIRE MR data model as implemented in the Minerals4EU database. This database currently includes the Minerals Inventory (information about primary mineral resources in Europe) and is forming an important part of the European Geological Data Infrastructure (EGDI) through which its long-term sustainability is ensured. An important part of this project is to transfer the e-Minerals Yearbook into the same database to allow automation and sustainability, but also to be able to implement appropriate and streamlined interfaces towards end users through e.g. the GeoERA Information Platform and external system such as the RMIS.

The main aim of WP5 is to;

- set up the rules of communication/interaction between KDPs) and their applications (e.g., the e-Minerals Yearbook), and the RMIS.
- define how structured data and information and non-structured information and knowledge can be delivered to, and be exploited by the RMIS 2.0 via its thematic interface(s), using either web services such as WMS and WFS, or more sophisticated and dedicated Application Programming Interfaces (APIs) and design the prototypes of such applications, having in mind key-functions of the RMIS such as providing information for the Raw Materials Scoreboard.
- transfer the e-Minerals Yearbook into the Minerals4EU database and set up appropriate systems for harvesting and automation.
- set up web services and APIs for exchange of data.
- communicate with the allocated liaison person in the GeoERA Information Platform project about requirements and guidelines and coordinate the integration of data from the e-Minerals Yearbook and the Minerals Inventory into the GIP.

Description of work

Task 5.1: Comparative analysis of KDPs resources versus RMIS 2.0 needs (Month 1-12)
Task leader: **BRGM**

Main contributors: GSI, GIU, SGU

Most of the KDPs recently developed (e.g., the IKMS for REE (EURare), the EU-MKDP for all deposit types (Minerals4EU), the EU-UMKDP for the urban mine (ProSUM), the EU-CRMKDP for CRMs (SCRREEN) are providing data and information and generally store and manage thematic unstructured Knowledge. Some of them have sophisticated applications to exploit their contained data e.g., the e-Minerals Yearbook and the e-Stat ProSUM module. All these ‘services’ are of interest to the RMIS, knowing that (i) the RMIS cannot maintain this data and the harvesting systems or compilation processes that are behind them and (ii) the platforms need to be autonomous in order to ensure their survival. This task will thus examine how KDPs can/should deliver their resources to the RMIS.

T5.1.1: Data (all platforms): Two types of data are considered, those related to primary resources and those related to secondary resources. The latter include mine waste on one side and the urban mine (WEEE, ELV and spent batteries) on the other. This task will examine how these data can be utilised by the RMIS and what are the implications for this in terms of selection, format, and conveyor.

T5.1.2: Applications - with a focus on the e-Minerals Yearbook and the ProSUM e-Stat module: what are the needs of the RMIS in terms of pre-computed views?

T5.1.3: Knowledge (all platforms): the idea is to facilitate the RMIS to carry out powerful thematic searches within non-structured knowledge related to REE, CRM, mineral deposits, the urban mine, etc. which is managed by the KDPs, in addition to more generic web-related searches.

Task 5.2: Identification of architectural requirements and user needs (Month 1-18)
Task leader: **GEUS**

Main contributors: BRGM, GeoZS

This task will examine the functionality currently available on the Minerals4EU platform and – together with the entire consortium – identify needs for new functionality to be provided by the GeoERA Information Platform. Finally, the principles and guidelines coming out of the GeoERA Information Platform project will be analysed (and influenced). The main deliverable of the task (D5.2) will be a report containing functional requirements and recommendations for integration activities – both within the current project and within the relevant work packages of the GeoERA Information Platform project. The prototype described in Task 5.7 will initially be based on this deliverable and it will, furthermore, feed into the inception report (D1.3). The task will last until M18 to continuously liaise with the GeoERA Information Platform project and update the list of requirements, which will feed into Task 5.7.

Task 5.3: Integration of e-Minerals Yearbook in Minerals4EU database (Month 1-26)

Task leader: **GeoZS**

Main Contributors: UKRI/BGS, BRGM, GEUS

This task will explore the current structure of the e-Minerals Yearbook and the Minerals4EU database and any extensions to these datasets as they may be planned by WP2 and WP3. Furthermore, the task will explore the data- and workflow that is part of the production of the various statistical data for the Yearbook (Production and Trade) in will deliver a report by M6 recommending steps to be undertaken to integrate the e-Minerals Yearbook in the Minerals4EU database and assessing the possibilities and technical solutions relating to setting up harvesting systems and automation routines (D5.3.1). The second phase of the task will do the actual integration of the e-Minerals Yearbook in the Minerals4EU database and develop the necessary systems for harvesting etc. as recommended by D5.3.1. The integration will be finished in time to allow the second transfer of statistical data by WP2 to be delivered in the new structure. The integration will be described in a report delivered by M26 (D5.3.2).

Task 5.4: Data exchange with RMIS (Month 10-30)
Task leader: **GeoZS**
Main Contributors: GIU, GEUS, BRGM
Several situations can be considered. Web Map Services (WMS) or Web Feature Services (WFS) are efficient means to expose structured data and feed GIS applications. However, for complex structured data, the development of a dedicated Application Programming Interface (API) e.g., permitting a user to identify which fields/data are to be retrieved and their format so that they can be incorporated directly into a client application, is a real bonus. For example, a specific Scoreboard indicator for the RMIS may be directly generated from one or more KDP. Data can also be available in the form of tables within unstructured documents (e.g., periodical reports, monographs…) or via semi-structured supports like spreadsheets, and in such a case the development of an Extraction, Transformation and Loading (ETL) process may be beneficial, especially for large datasets. This task will examine these different situations and notably the possible development of APIs for some Scoreboard indicators related to exploration and mining in the EU.

T5.4.1: Review of the different situations with the development of adapted use cases. The interest of an ETL process will be reviewed, but no further development is envisaged here as the setup of this process is too much data (structure) dependant.
T5.4.2: Development of prototype(s) (WFS, WMS, and/or dedicated API(s)).

Task 5.5: KDP's applications delivery to RMIS (Month 10-30)
Task leader: **BRGM**
Main Contributors: GIU, GEUS, GSI
If a diagram or a view provided by an application running on the top of an existing Knowledge Data Platform is totally satisfying, then it can be directly integrated within the RMIS via its Thematic Interface. However, if the diagram or the view does not exist or is not compatible with the RMIS, it could be an action of common interest both for Knowledge Data Platform operator and the JRC, that the operator develops either a specific view (possibly necessitating the development of a dedicated application) or adapt the existing view and link it to the RMIS as in the first situation above. An example of such collaboration could be the ProSUM H2020 project and its EU-UMKDP, and the production of foresight studies and diagrams (not foreseen in the frame of the project).

T5.5.1: Review of the different situations with the development of adapted use cases.
T5.5.2: Development of prototype(s).

Task 5.6: Dedicated search in KDPs from RMIS (Month 10-30)
Task leader: **BRGM**
Main Contributors: GIU, GEUS, GSI
The RMIS 2.0 should be able to connect to the different Search capabilities of the existing Knowledge Data Platforms. In addition to its own search facilities, this would allow the RMIS performing more targeted searches (e.g., on CRM, on secondary resources like WEEE, BATT or ELV…) and benefiting from already constituted corpus of information and knowledge.

A dedicated ‘Search’ interface will be developed, allowing the end user to perform generic and/or more targeted searches. The idea is for the end user to be able to perform the search directly through the RMIS 2.0 interface, the results being presented within this same interface. This solution relies on the search capabilities of the existing KDPs that are part of the EURMKB.

Technically, this supposes for the existing KDPs to propose a search interface (API) that can be requested from the RMIS. These search interfaces need to be standardized and the use of OpenSearch[1] might be considered. Then the RMIS would have to implement an OpenSearch client to be able to interrogate these KDPs.

T5.6.1: Review of the different situations with the development of use cases.
T5.6.2: Development of prototype(s).

Task 5.7: Integration of data, search and other functionalities in GeoERA Information Platform (Month 6-36)
Task leader: **GEUS**
Main Contributors: BRGM, GeoZS, UKRI/BGS, CGS

Based on communication with the GeoERA Information Platform project during the first six months of the project (Task 5.2), the GeoERA Information Platform team will set up a prototype portal for the project. The purpose of this will be to start integrating information and develop functionality already during the course of the projects to ensure a high degree of matureness when the final project results are delivered. The current task is based on the requirements mapped in Task 5.2 and will liaise with the relevant partners of the GeoERA Information Platform project in order to 1) setup an appropriate prototype, 2) integrate the current Minerals4EU database in the prototype, 3) work with the GeoERA Information Platform project to have the necessary functionality developed in the protoptype for later integration in the GeoERA Information Platform, assess together with Tasks 5.4, 5.5 and 5.6 which of the components developed in these tasks should be integrated in the GeoERA Information Platform and 4) provide any relevant feed-back from the GeoERA Information Platform project to the other tasks and WPs in the present project to ensure that any requirements for datasets, formats etc. that are discovered in the process of developing the prototype are taken into account. This result of this task will be a prototype containing preliminary data and functionality as the consortium agrees are suitable. This prototype will be described in deliverable D5.7.1.

Based on the prototype, the task will in the second phase ensure that the final data, information (including metadata) and developments resulting from the project (T5.4, 5.5 and 5.6) and the prototype are properly integrated in the final GeoERA Information Platform. The task will also ensure that all other relevant resources from the project (documents, descriptions, metadata etc.) are made available on the GeoERA Information platform according to the general principles and based on the recommendations of the consortium in the current project. The final deliverable of this task (D5.7.2) will be a report describing how data, information and developments from the project are integrated with the GeoERA Information Platform and guidelines for future maintenance.

Deliverables

D5.1 Comparative analysis of KDPs resources versus RMIS 2.0 needs (M12) R (BRGM)
D5.2 Recommendations for integration of results into the GeoERA Information Platform (M6) R (GEUS)
D5.3.1 Specification of steps needed to integration the e-Minerals Yearbook in the Minerals4EU database (M6) R (GeoZS)
D5.3.2 Report on the integration of the e-Minerals Yearbook into the Minerals4EU database (26) R (GeoZS)
D5.4 Review and data exchange prototype(s) (M30) DEM (GeoZS)

[1] http://www.opensearch.org/Home

D5.5 Review and application delivery prototype(s) (M30) DEM (BRGM)
D5.6 Review and dedicated search prototype (M30) DEM (BRGM)
D5.7.1 Description of how data and information from the project are integrated into the GeoERA Information Platform (including a specification of the technical interface of the prototypes to be developed in tasks 5.4, 5.5 and 5.6) and guidelines for future maintenance (M18) R (GEUS)
D5.7.2 Report on testing of integration into the Information Platform (M30) R (GEUS)

Milestones

M5.1 Technical solutions outlined (M6)
M5.2 Prototype integration of results in the GeoERA Information Platform finished (M18)
M5.3 e-Minerals Yearbook transferred to Minerals4EU database (M24)
M5.4 Demonstrator interfaces towards the RMIS ready (M30)
M5.5 Results of project available through GeoERA Information Platform (M36)

3.2 Management structure, milestones and procedures

This project will be carried out by a consortium of 25 partners from EU Member States, and from Albania, Norway, Serbia, and Ukraine – all associated to H2020. All partners have signed the overall GeoERA Consortium Agreement and will sign the a Mintell4EU project agreement in case this proposal is approved.This section describes the resources and processes necessary for the project to be implemented efficiently and in a timely manner.
The project will be coordinated by the project lead (PL) and supported by the work package (WP) leaders; these individuals comprise the project board (PB).
The PL is responsible for delivering against the project agreement and the Inception Report. The management structure, shown below, will guarantee execution of the project to the given timescale, to the highest quality results, and within budget.
The management strategy of Mintell4EU will be based on clear responsibilities, professional planning, communication and progress monitoring throughout the project lifetime.
The PL (GEUS) is responsible for project management including monitoring progress of the project, controlling the quality of partners' contributions, ensuring that deadlines are met, and strict financial management. The PL is responsible for maintaining contacts with the GeoERA Secretariat, the PB and all partners, ensuring a smooth and transparent running of the project.
Partners will undertake the execution of 5 inter-related WPs with coordination and dissemination activities over a period of three years. The number of partners involved in the project, calls for a strong and well-defined management structure necessary, coupled with an efficient decision-making mechanism. The availability of solid management tools as well as a structured process of project revision and monitoring is the necessary basis on which to build to the achievement of the objectives.
At the start of the project, the PB will be established, composed of one representative from each WP – though, WP5 will be represented by two partners (BRGM and GEUS). This group will be responsible for decision making and monitoring progress. It will have regular conference calls and meet at least once a year to review progress and discuss management issues, such as project status and progress, review of expenditure profiles, partners' performance, and dissemination. Decisions will be taken on a majority vote basis and be binding on all project partners. Each member will have one vote with the PL having a casting vote in the event of a draw.

Table 3.2.1: Project Management

Project Board	Chairperson	Project Lead
	Members	Work Package Leaders (two from WP5)
	Tasks	High-level steering of the project in terms of scientific goals, progress, finance, quality, and dissemination to meet EC terms: • Communication of project information • Report against project deliverables • Receipt of grant and distribution to Members • Preparation of annual accounts • Monitor and report on progress with activities
	Meetings	Monthly Conference Calls, one physical meeting per year
Work Package Team	Chairperson	Work Package Leader assisted by Task Leaders
	Members	Work Package Leader, Task Leaders, other WP Task Partners
	Tasks	Provision of input for monitoring and reporting purposes. Delivery of the tasks, milestones and deliverables. Coordination of the Work Package. Contribution to the progress report.
	Meetings	Physical meetings at Project Assembly and monthly conference calls oras required.
Project Assembly	Meetings	Physical meetings at Project Assembly and conference calls as required.
	Chairperson	Project Lead
	Members	One representative for each Partner

Project Lead: GEUS has the role as project manager and is the responsible project lead. The project lead will be the main interface between the project and the GeoERA Secretariat and will:

- Monitor the compliance of partners against their obligations under the project agreement;
- Report to the GeoERA Secretariat;
- Be responsible for overall legal, contractual, financial and administrative management;
- Have the overall responsibility for the achievement of project goals:
- Manage the project to:
    - Keep records and accounts for verification of payments;
    - Achieve overall project planning, milestone scheduling, controlling;
    - Report and monitor progress;
    - Organise project meetings.

Work package leaders and teams: The work package leaders are responsible for the successful completion of their work packages under time, cost and quality constraints. They support the project lead to achieve the overall project goal. They are responsible for:

- Accomplishment of the technical objectives of the work package;
- Monitoring work package progress;
- Progress reporting to the project lead;
- Coordination of tasks between WPs;
- Following up milestones and deliverables;
- Ensuring high-quality results;
- Planning and charing work package meetings;
- Risk management;
- Work package documentation and information management.

The work package teams consist of the task leaders within the work package. The work package team is responsible for the successful execution of all tasks within the work package.

Management Procedures

Meetings The project will have a physical kick-off meeting including all partners in M1. Full consortia meetings, including Project Board and WP meetings, will be held once a year. The final and closing event will be organized in M36.

Instead of establishing another management body – e.g. an Advisory Board – the Project Board will contact a few selected relevant stakeholders to inform and discuss the project outcomes and future opportunities.

List of meetings

Kick-off meeting (M1), Brussels.

Monthly video conference project meetings.

Project meeting end of year 1 and of year 2 (M18 and 30)

Final project meeting (M36)

(EuroGeoSurveys Board of Directors Meetings (twice per year, spring and autumn))

Project Assembly

The Project Assembly (PA) consist of one representative of each partner. Each PA member shall be deemed to be duly authorised to deliberate, negotiate and decide on all matters listed below. The PL shall chair all PA meetings. Partners agree to abide by all decisions of the PA. This does not prevent the partners to submit a dispute to resolution in accordance with the provisions of the settlement of disputes by the PA.

Decisions of the PA: The PA are free to act on its own initiative to formulate proposals and take decisions in accordance with the procedures set out in the project agreement. The following decisions shall be taken by the PA:

- Changes to the project agreement;
- Decisions related to Intellectual Property;
- Withdrawal of a partner from or entry of a new partner to the project and approval of the settlement on the conditions of the withdrawal/accession of such a partner;
- Identification of a breach by a partner of its obligations under the project agreement or the overall GeoERA grant agreement;
- Declaration of a partner to be a Defaulting Partner;
- Remedies to be performed by such a partner as well as termination of a defaulting partners's participation in the project;
- Proposal to the GeoERA Secretariat for a change of the PL;
- Suspension of all or part of the project;
- Termination of the project and the project agreement.

Conflict resolution: Any conflicts concerning technical issues will be resolved by the PL. If the PL is unable to develop consensus, an independent referee (e.g. member of the EGS Board of Directors) will be appointed whose judgment will be considered conclusive. All other conflicts between partners will be handled and resolved by the PB, convened within 15 working days from the identification of a conflict to attempt a final resolution. In such case, the PL is responsible for arranging a PB meeting. In the first instance, disputes will be resolved by negotiation. Should consensus not be achieved, a majority vote will be used: each partner will hold one vote and the PL, if necessary, will hold a casting vote. If the dispute persists, the PrB will inform the PL, solicit the advice of reviewers, and call for an additional meeting with EGS Board of Directors members.

E-mails E-mail will be used for regular contact between all partners.

Online collaboration: Information management software (e.g. the GeoERA Intranet) will be used to store documents, work on documents, store and retrieve contact information, follow project progress, identify and assign issues and collaborate on work using the discussion tool. Since the tool is secured using a secure server, it is suitable to place information that should be only accessible to partners.

Videoconference: Online video conferencing such as Skype, GoToMeeting (used in the drafting stages of this proposal) or Webex, will be used for a monthly meeting between the PL and the WP leaders. WP leaders may set up their own schedule of conference call meetings for their own WPs. The video conferencing tool will be web-based to ensure that all partners with a computer and access to the internet can participate, regardless of their location.

Project reporting and Progress Management Plan/Inception report: A detailed management plan in terms of an Inception report following a dedicated workshop at the kick-off meeting will be written detailing

the schedule of milestones and deliverables necessary to deliver the project. This plan will be written by the PL and approved by the PA.
Work Package work plan: Each WP will have its own work plan detailing how the WP will be delivered. This plan will be written by the WP leader and approved by the PL.
Data Management Plan: This deliverable (D1.1) specifies provisions data management in accordance with the overall GeoERA Data Management Plan
Voting rules: All partner will have one vote in the PA. In case of a draw the organisation of the Coordinator will have the decisive vote.

Risk management
Mintell4EU is a large and all-encompassing project with limited funding and high expectations. Such a project can only be undertaken if there is a clear understanding of potential risks and contingency plans must be ready to deal with risks if they occur. There are three main risks:

- Internal within the project partners;
- External problems or stakeholder challenges;
- Technical failure affecting the quality of work.

In all cases, Mintell4EU recognises that resolution relates to management. Therefore, a strong management structure and decision-making process have been put in place. See table 3.2b for an elaborated list of risk and the management of these.

3.3 Consortium as a whole

The 25 partners of the Mintell4EU consortium represent both national and regional Geological Surveys with expertise on primary resources and mining waste. This combination will ensure sufficient expertise to cover the scope of the proposal, which is wide both in area and types of resources. As all of the partners are or recently have been, engaged in projects related to developing various aspects of the raw material sector, they have widespread networks that can be used to ensure dissemination of the project's results. Participation of several organizations will facilitate the data collection and improve the required coverage of the Member States.

3.4 Resources to be committed:
The project duration required to achieve the set objectives is 36 months. The total budget required to carry out all tasks described in section 3 of this document is 2,86 M€, sum. The person months of this proposal totals 456 PM which reflects the amount of effort necessary to complete the project’s objectives to the high standards required. Especially in WP3, *Minerals Inventory*, a substantial amount of MM are necessary for new Member States to contribute data.

Table 3.1b) List of work packages *(This table is not covered by the page limit)*

Work Package No.	Work Package Title	Lead Participant No.	Lead Participant Short Name	Person-Months	Start Month	End month
1	Management, communication, dissemination, and sustainability	1	GEUS	42	1	36
2	Update to Electronic European Minerals Yearbook	15	UKRI/BGS	135	1	36
3	Minerals Inventory	7	GeoZS	193	1	36
4	UNFC pilot	6	NGU	43	1	36
5	Improvement of KDPs' applications and interaction with the RMIS and the GeoERA Information Platform	2	BRGM	57	1	36
				Total person–months: **470**		

Table 3.1c) List of deliverables *(This table is not covered by the page limit)*

Deliverable number	Deliverable name	WP number	Short name of lead participant	Type	Dissemination level	Delivery date (in months)
D1.1	Data management Plan	1	GEUS	R	PU	3
D1.2	Project Management plan/Inception report	1	GEUS	R	PU	6
D1.3	Management Reports	1	GEUS	R	PU	18, 36
D1.4	Communication and Dissemination Plan	1	GeoZS	R	PU	6
D1.5	Roadmap for future actions towards full sustainability	1	GEUS	R	PU	30
D2.1	Report describing the processes devel-oped for updating the electronic European Minerals Yearbook	2	UKRI/BGS	R	PU	35
D3.1	Minerals Inventory Report	3	GeoZS	R	PU	12 and 36
D3.2	Technical guidelines	3	GeoZS	R	PU	16
D3.3	Quality control system for harvesting report	3	GeoZS	Other	PU	24
D3.4	GIS database layer illustrating relevant historic mine features	3	GSI	Other	PU	24
D4.1	Case study review with practical guide-lines/work flows and examples for apply-ing UNFC to Europe-an mineral resources	4	NGU	R	PU	32
D4.2	Report on harmo-nization issues, data gaps and challenges, reviewing also the quality of Pan-Euro-pean aggregated in-ventories for selec-ted commodities	4	GTK	R	PU	32
D4.3	Supply data to WP2, 3 and 5 for inclusion in the European yearbook, resource databases and information systems	4	GEUS	Others	PU	34
D5.1	Comparative analysis of KDPs resources versus	5	BRGM	R	PU	12

	RMIS 2.0 needs					
D5.2	Recommendations for integration of results into GeoERA Information Platform	5	GEUS	R	PU	6
D5.3.1	Specification of steps needed to integration the e-Minerals Year-book in the Minerals-4EU database	5	GeoZS	R	PU	6
D5.3.2	Report on the integration of the e-Minerals Yearbook into the Minerals4EU database	5	GeoZS	R	PU	26
D5.4	Review and data exchange prototype(s)	5	GeoZS	DEM	PU	30
D5.5	Review and application delivery prototype(s)	5	BRGM	DEM	PU	30
D5.6	Review and dedica-ted search prototype	5	BRGM	DEM	PU	30
D5.7.1	Description of how data and information from the project are integrated into the Information Platform and guidelines for future maintenance	5	GEUS	R	PU	18
D5.7.2	Report on testing of integration into the Information Platform	5	GEUS	R	PU	30

Type: R=Report; DEM=demonstrator; Others=software, technical diagrams, etc.
Dissemination level: PU=public

Table 3.2a) List of milestones *(This table is not covered by the page limit)*

Milestone number	Milestone name	Related work pac-kage(s)	Due date (in months)	Means of verification
M 1.1	Kick-off meeting	All	M1	Project is running
M 1.2	Midterm management reporting approved	WP1	M22	Letter of approval of the midterm report recieved
M 1.3	Final project reporting approved	WP1	M39	Letter of approval of the final project report recieved
M 2.1	Updated pages of the electronic European Minerals Yearbook with production data for 2014 to 2017 and trade data for 2014 to 2016.	WP2	M12	Updated data is visible through the electronic European Minerals Yearbook
M 2.2	Updated pages of the electronic European Minerals Yearbook with production data for 2018 and trade data for 2017 and 2018.	WP2	M24	Updated data is visible through the electronic European Minerals Yearbook
M 2.3	Updated pages of the electronic European Minerals Yearbook with production data for 2019 and resources, reserves and exploration data with a reference year of 2019.	WP2	35	Updated data is visible through the electronic European Minerals Yearbook
M 3.1	Workshop with connection to ORAMA project	WP2, WP3, WP5, WP6	M18-26 (coordina-ted with ORAMA)	Number of participants; quality of data
M 3.2	Workshop with connection to RESEERVE project	WP2, WP3, WP5, WP6	M18-26 (coordina-ted with RESEER VE)	Number of participants; quality of data
M 4.1	Cases for pilot study	WP4	4	Cases representing resoruces of metals, industrial minerals, aggregates and natural stones are identified and selected
M 4.2	Case studies completed and classified	WP4	28	Conclusions reported
M 5.1	Technical solutions outlined	WP5	6	The integration of project results in the GeoERA Information Platform, the merge between the e-Minerals Yearbook and the Minerals4EU data-base specified and reported
M 5.2	Prototype integration of results into GeoERA Information Platform	WP5	18	A prototype portal with existing data from Mineralas4EU established.
M 5.3	e-Minerals Yearbook transferred to Minerals4EU	WP5	24	Data from the first two updates to the Minerals Yearbook have been transferred to the Minerals4EU data structure.
M 5.4	Demonstrator interfaces towards the RMIS ready	WP5	30	Prototype services targeted RMIS have been set up and the integration to RMIS has been tested.
M 5.5	Results of project available through GeoERA Information Platform	WP5	36	All data from the e-Minerals Year-book and Minerals Inventory avai-lable for search and display on the GeoERA Information Platform portal

Table 3.2b) List of critical risks for implementation *(This table is not covered by the page limit)*

Description of risk	WP(s) involved	Proposed risk-mitigation measures
Delays in task execution, particularly event organisation (medium)	All WPs	Apply guidelines for organising and running events will prevent any delays regarding process-design. In-built project design (i.e. inter-linked WPs still allow for most of the tasks to be conducted to some extent independently) Elaborate a contingency plan and appropriately reflect it in the changes in the project budget, GANTT chart, etc.
Non-consistent technical approach (medium)	WP2, WP3, WP5	WP1 will coordinate the writing of an inception report to ensure consistency and common understanding of system architecture and data flows across tasks and work packages.
Inter-partner conflicts (medium)	ANY	Open and regular communications, timely clarification of expectations, quick response to possible problems, material availability, involvement of members in management, management structure of disputes.
Delay in the expected results and recommendations from the ORAMA project (medium).	WP2, WP3	The Mintell4EU project is complementary to ORAMA project. In case of delays in ORAMA, the consortium will provide their own solutions. Good communication and collaboration between the projects
Incomplete harmonisation of resources/reserves data, despite the best efforts of the ORAMA project, at the time the new survey needs to commence (medium)	WP2, WP3	Conduct survey to collect non-harmonised data and be clear in their publication what system(s) of reporting is/are used. Ongoing discussions, training sessions, provision of guidance so that all countries can progress towards reporting resources/reserves data according to the agreed harmonised system
New data providers will not provide data or quality of the data will be poor (medium)	WP2, WP3	Repeated communication Training workshops for data providers Technical guidelines made available to data providers. Technical help to data providers via tele-conferences, web seminar, e-mails, etc.
Corruption of data caused by malfunctions in the transfer process between the Yearbook's database and the relational Minerals4EU database (low)	WP2, WP5	Clear and unambiguous description of how the transfer process will be carried out (D5.3.1). Clear communication between all the experts involved such that agreement is reached by all parties that the proposed steps will achieve the desired end. Capturing of screenshots or archiving of the Yearbook webpages before the transfer so that a direct 'before' and 'after' comparison can be made. Testing of the Yearbook after the transfer has taken place to ensure the same level of quality and functionality is maintained.
Defaulting bankruptcy or non-performance of a partner (low)	ANY	Sharing competence and functions among the Members, withhold of payment of non-performing Member, exclusion of the defaulting Member, transfer of tasks and funding to another partner
Quality of deliverables not satisfactory (low)	ANY	Deliverables reviewed in good time by WP leaders and coordinator.

Table 3.3a) Summary of Staff Effort *(This table is not covered by the page limit)*

Participant Number	Participant Short Name	WP1	WP2	WP3	WP4	WP5	Total Person- Months per Participant
1	GEUS	26	1,2	2	5	13	47.2
2	BRGM		1.1			8	9.1
3	IGME (Sp)		12	6			18
4	GSD		4	2			6
5	ISPRA		4	8			12
6	NGU				6		6
7	GeoZS	12	13	25	3	15	68
8	SGU		2	2	2	1	7
9	GIU		15	8	5	4	32
10	SGIDS		15				15
11	LNEG	0.4		1.2		0.4	2
12	IGME (Gr)		3	3		3	9
13	HGI-CGS			11.7	4.5	4.5	20.7
14	GTK				8		8
15	UKRI/BGS		48.5			0.5	48
16	LGRB			24			24
17	BGR			6.5			6.5
18	GSI		1	5.5		0.5	7
19	GSB-RBINS	3	8	7	3.5	3.5	25
20	MBFSZ		1.5	1.5	1.5	3	7.5
21	SGL		0.5	0.25			0.75
22	GSS			24			24
23	AGS			24			24
24	CGS	0.2	5	4.5		0.3	10
25	FZZG			21.6			21.6
26	RU			5.4			5.4
27	GBA				5		5
Total Person Months							**469.75**

Table 3.3b) ‘Other direct cost’ items (travel, equipment, other goods and services)
(This table is not covered by the page limit)

Please complete the table below for each participant.

1. GEUS	Cost (€)	Justification
Travel	21 000	Travel for project meetings, workshops, representative duties as project coordinator and any necessary field work. Includes costs of travel and subsistence.
Equipment		
Other goods and services	21 000	Organisation of project meetings, including kick-off meeting, progress meetings, workshops and final meeting. Includes costs for meeting venues and catering and material production (printing documents, poster, banner, etc.).
Total	42 000	

2. BRGM	Cost (€)	Justification
Travel	8 480	Project kick-off, progress and final meetings + meetings with EC DG JRC
Equipment		
Other goods and services		
Total	8 480	

4. GSD	Cost (€)	Justification
Travel	3 870	Travel to participate in meetings (3-4 meetings)
Equipment		
Other goods and services		
Total	3 870	

5. ISPRA	Cost (€)	Justification
Travel	13 420	Attending kick-off, progress and final meetings, missions aimed at reaching the objectives and technical meetings.
Equipment		
Other goods and services		
Total	13 420	

6. NGU	Cost (€)	Justification
Travel	4 000	Progress and management meetings
Equipment		
Other goods and services		
Total	4 000	

7. GeoZS	Cost (€)	Justification
Travel	20 000	Project kick-off, progress and final meetings Organization of two (2) workshops
Equipment		
Other goods and services		
Total	20 000	

8. SGU	Cost (€)	Justification
Travel	3 000	Travel costs for progress and management meetings
Equipment		
Other goods and services		
Total	3 000	

9. GeoInform - GIU	Cost (€)	Justification
Travel	16 913	10% of total direct personnel costs, travels to project meetings (kick-off, mid-term, final), and WP meetings, EUR 1000 each
Equipment		
Other goods and services		
Total	16 913	

10. SGIDS	Cost (€)	Justification
Travel	3 000	Attending kick-off, progress and final meetings.
Equipment		
Other goods and services	3 300	Printing Minerals Yearbook.
Total	6 300	

11. LNEG	Cost (€)	Justification
Travel	4 500	Travels to project meetings for 3 persons
Equipment		
Other goods and services	2 500	Analyses and field work
Total	7 000	

12. IGME (Gr)	Cost (€)	Justification
Travel	6 000	Attending kick-off, progress and final meetings
Equipment		
Other goods and services		
Total	6 000	

13. HGI-CGS	Cost (€)	Justification
Travel	2 000	Travel costs to meetings; 4 meetings (4X 500€)
Equipment		
Other goods and services		
Total	2 000	

14. GTK	Cost (€)	Justification
Travel	6 000	Progress and management meetings
Equipment		
Other goods and services		
Total	6 000	

15. BGS	Cost (€)	Justification
Travel	6 737	Attending kick-off, progress and final meetings.
Equipment	0	None anticipated.
Other goods and services	6 737	Purchase of raw trade data
Total	13 474	

16. LGRB	Cost (€)	Justification
Travel	12 000	Attending project meetings and workshops
Equipment		
Other goods and services		
Total	12 000	

17. BGR	Cost (€)	Justification
Travel	2 036	Attending project meetings, workshops and missions aimed at reaching the objectives and technical requirements.
Equipment		
Other goods and services		
Total	2 036	

18. GSI	Cost (€)	Justification
Travel	4 500	Attending project meetings
Equipment		
Other goods and services		
Total	4 500	

19. GSB-RBINS	Cost (€)	Justification
Travel	8 616	Attending project meetings
Equipment		
Other goods and services		
Total	8 616	

20. MBFSZ	Cost (€)	Justification
Travel	1 100	Attending kick-off, progress and final meetings and field work.
Equipment		
Other goods and services		
Total	1 100	

21. SGL	Cost (€)	Justification
Travel	750	Attending project meetings
Equipment		
Other goods and services		
Total	750	

22. GSS	Cost (€)	Justification
Travel	4 000	Attending project meetings
Equipment		
Other goods and services		
Total	4 000	

23. AGS	Cost (€)	Justification
Travel	9 000	Attending project meetings
Equipment		
Other goods and services		
Total	9 000	

24. CGS	Cost (€)	Justification
Travel	3 209	Attending project meetings
Equipment		
Other goods and services		
Total	3 209	

25. FZZG	Cost (€)	Justification
Travel	4 269	Attending project meetings
Equipment		
Other goods and services		
Total	4 269	

26.	Cost (€)	Justification
Travel	4 589	Attending project meetings
Equipment		
Other goods and services		
Total	4 589	

27. GBA	Cost (€)	Justification
Travel	3 000	Attending project meetings
Equipment		
Other goods and services		
Total	3 000	

Table 3.3c) Financial table with requested budget (€) *(This table is not covered by the page limit)*

Participant	(A) Direct personnel costs	(B) Other direct costs; travel, equipment, infrastructure, other	(C) Direct costs of subcontracting	(D) Indirect costs (= (A + B) *0,25)	(E) Total estimated eligible costs (=A+B+C+D)	(F) Reimbursement rate (29,7%)	(G) Requested EU contribution (=E*F)	(H) Surveys in-kind contribution = (E-G)
GEUS	358,986	42,000	0	100,247	501,233	29.70	148,866	352,367
BRGM	70,174	8,480	0	19,664	98,318	29.70	29,200	69,117
IGME (Sp)	82,206	0	0	20,552	102,758	29.70	30,519	72,239
GSD	25,806	3,870	0	7,419	37,095	29.70	11,017	26,078
ISPRA	66,000	13,420	0	19,855	99,275	29.70	29,485	69,790
NGU	45,000	4,000	0	12,250	61,250	29.70	18,191	43,059
GeoZS	238,000	20,000	0	64,500	322,500	29.70	95,783	226,718
SGU	52,150	3,000	0	13,788	68,938	29.70	20,474	48,463
GIU	154,635	16,913	0	42,887	214,435	29.70	63,687	150,748
SGIDS	43,500	6,300	0	12,450	62,250	29.70	18,488	43,762
LNEG	10,000	7,000	0	4,250	21,250	29.70	6,311	14,939
IGME (Gr)	27,900	6,000	0	8,475	42,375	29.70	12,585	29,790
HGI-CGS	49,680	2,000	0	12,920	64,600	29.70	19,186	45,414
GTK	56,000	6,000	0	15,500	77,500	29.70	23,018	54,483
NERC/ BGS	185,724	13,474	0	49,800	248,998	29.70	73,952	175,045
LBRG	136,008	12,000	0	37,002	185,010	29.70	54,948	130,062
BGR	39,975	2,036	0	10,503	52,513	29.70	15,596	36,917
GSI	45,500	4,500	0	12,500	62,500	29.70	18,563	43,938
GSB-RBINS	205,141	8,616	0	53,439	267,196	29.70	79,357	187,838
MBFSZ	11,813	1,100	0	3,228	16,141	29.70	4,794	11,347
SGL	4,875	750	0	1,406	7,031	29.70	2,088	4,943
GSS	37,800	4,000	0	10,450	52,250	29.70	15,518	36,732
AGS	37,800	9,000	0	11,700	58,500	29.70	17,375	41,126
CGS	15,750	3,209	0	4,740	23,699	29.70	7,039	16,660
FZZG	34,020	4,269	0	9,572	47,862	29.70	14,215	33,647
RU	18,360	4,589	0	5,737	28,686	29.70	8,520	20,166
GBA	25,000	3,000	0	7,000	35,000	29.70	10,395	24,605
Total	**2,077,802**	**209,526**		**571,832**	**2,859,160**		**849,171**	**2,009,990**

4 Members of the consortium

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4.1 Participants (applicants)

1. GEOLOGICAL SURVEY OF DENMARK AND GREENLAND (GEUS)

The Geological Survey of Denmark and Greenland (GEUS) (www.geus.dk) is a research and advisory institute in the Danish Ministry of Energy, Utilities and Climate. GEUS was founded in 1888 and works in the fields of geoscientific studies, research, consultancy and geological mapping. GEUS covers the disciplines groundwater, energy resources, mineral resources, climate and information management.
GEUS has contributed intensively to the development and operation of databases and exchange-formats for geological and geophysical data related to geoenergy, mineral resources and groundwater for more than 25 years. The institution runs nationwide databases for boreholes, geochemistry, geophysics, geological samples, digital reports, digital maps and geological models. In addition to the databases a large number of web-services have been developed for query and update of the data.
GEUS has contributed to the EU co-funded minerals intelligence projects Minerals4EU, EURARE, ProSum and MICA and is furthermore a partner in the recently started project ORAMA. GEUS has also gained experience with data harmonisation and data exchange on a European scale from participation in numerous other EU co-funded projects including EUMARSIN, EUROSEISMICS, GeoSeas, eWater, GEOMIND, OneGeologyEurope, EPOS-IP, EuroGeoSource, EUOGA, EMODnet-geology, EGDI-Scope and InGeoCloudS. GEUS is member of the INSPIRE Thematic Working Group on Geology and Mineral Resources and has coordinated the development of EGDI
In the GeoERA RM1 project, GEUS will be responsible for the coordination with the Information Platform by leading WP6. GEUS will also contribute significantly to the communication part of WP1 and to some degree to the other WPs.

Special relevant skills

- Experts in raw material mapping and resource evaluation
- Detailed knowledge about offshore aggregates classification
- 3D geomodelling
- Integrated interpretation of marine geological and geophysical data
- Building databases and web services for subsurface data

Products and services

EGDI: http://www.europe-geology.eu
Greenland portal http://www.greenmin.gl/
GEUS' interactive maps: http://www.geus.dk/UK/data-maps/Pages/default.aspx

Profiles of key staff members

Per Kalvig (male): PhD in Industrial minerals potential in Greenland. Chief Advisor, Head of Center for Minerals and Raw Materials (MiMa). Per has gained experience from the private mining and exploration sector both as a mine geologist and exploration consultant, as well as from his time with geological survey organisations involved in a wide range of research projects related to economic geology subjects. Over the past years the focus has diverted into global mineral assessments, critical rawmaterials, secondary resources, and circular economy.

Mikael Pedersen (male): PhD in ore geology. Head of Department at Department of Data & IT. Responsible for GEUS' databanks, GIS and IT. Mikael has been working with establishing databases for geological data for more 15 years and has been participating in several EU funded data harmonisation and –dissemination projects including Geomind, Geo-seas, InGeoCloudS, EGDI-Scope, EPOS-IP, Minerals4EU, MICA, EUOGA and EMODnet.

Jørgen Tulstrup (male): M.Sc. in Geology/Geophysics. Chief Consultant. For 15 years responsible for GEUS' databanks and GIS. Jørgen has been working with establishing databases for geological and other geodata data for more 30 years and has been a participant in several EU funded projects including OneGeologyEurope, EuroGeoSource, EUMARSIN, InGeoCloudS, EGDI-Scope, Minerals4EU and EPOS.

Jørn Bo Jensen (male). M.Sc. in Geology, PhD in Marine Geology. Head of Marine geological Department and experienced in all aspects of raw material exploration. 30 years professional experience as geologist, concentrating mainly on marine geological interpretation in Danish and International waters. Experienced in project management of large marine geological multidisciplinary studies, involving management, planning, implementation of fieldwork, interpretation and reporting.

Niels Nørgaard-Pedersen (male): M.Sc. in Geology, PhD in Marine Geology. Senior Researcher and specialist in shallow seismic interpretation and mapping of marine raw materials, foundations for offshore windmill farms, cable corridors, and Natura-2000 habitat areas. Since 2008, Niels has been working on mapping and classification of marine raw material resources in Danish waters. In addition he works as advisor on new and existing raw material areas for private stakeholders and the Danish Environmental Agency. In the framework of several EU research projects, he has earlier worked on reconstructing historical and geological time scale proxy records of climate and environmental change, both in the Arctic region, along the coast of Greenland and in the UK and Danish offshore sectors.

Lisbeth Flindt Jørgensen (female): M.Sc. in sediment geology. Senior consultant, scientific coordinator. Lisbeth has several years of experience as project coordinator and contributor, mainly in the groundwater area, from both international and national projects. In the recent years, she has mainly worked with coordination of research activitites within all working fields of the Geological Survey of Denmark and Greenland.

Frands Schjøth (male): M.Sc. in Geology/Geophysics. Computer Geoscientist and GIS specialist. Since 1995 Frands has been working with digital exploration and mineral resource data both in Oracle and PostgreSQL databases and in advanced ArcGIS for Desktop and ArcGIS-server environment. Frands has lately worked with making mineral and energy resource data from Denmark and Greenland available for external use through the Greenland portal, EuroGeoSource system, Minerals4EU, EURARE and ProSUM.

Tjerk Heijboer (male): Geologist with 5 years' experience in database and IT web development. Has been involved in the European projects: Minerals4EU, EURARE, PROSUM and EPOS. Participation in these projects includes creating database models implementing them in databases and setting up INSPIRE compliant web services and coordination with other participants in these projects.

Publications

Krogt, R.v.d, Hughes, R., Pedersen, M., Serrano J.-J., Lee K. A., Tulstrup, J. & Robida F. 2013: Working towards a European Geological Data Infrastructure. Geophysical Research Abstracts Vol. 15.

Krogt, R.v.d., Pedersen, M., Tulstrup, J., Robida, F., Serrano, J.-J., Grellet, S., Lee, K., Harrsion, M., Demicheli, L., Delfini, C., Hugelier, S. & Daalen, T.v. 2014: Design and Implementation Aspects of the Geological Data Infrastructure for European Society. Geophysical Research Abstracts Vol. 16.

Keiding J, Kalvig P, Ditlefsen C et al. (2015) Assessment og mineral raw material potential in Denmark – methods and major findings. Geological Survey of Denmark and Greenland Bulletin 33, 37-40.
Kallesøe AJ, Clausen RJ, Skar S, von Platen-Hallermund F, Ditlefsen C, Kalvig P (2016): Indvinding af danske mineralske råstoffer - en geografisk sammenstilling, MiMa publication (Videncenter for mineralske råstoffer og materialer)
Ditlefsen C, Lomholt S, Skar S, Jakobsen PR, Kallesøe AJ, Keiding JK, Kalvig P (2015): Danske mineralske råstofressourcer, MiMa publication (Videncenter for mineralske råstoffer og materialer)

Involvement in other relevant European and national projects

- MiMa project (2015-2016): Evaluation of the extration of mineral raw materials (sand, gravel, clay, chalk/limestone) in Denmark.

- Participated in EU projects such as BALANCE, EUSeaMap, EMODNET Geology, BONUS.
- Conducted numerous seabed mapping programmes and 3D geological modelling studies.
- Minerals4EU: http://www.minerals4eu.eu
- EuRare: http://www.eurare.eu/
- ProSum: http://www.prosumproject.eu/
- EGDI: http://www.europe-geology.eu
- EUOGA: https://openecho.jrc.ec.europa.eu/
- EPOS-IP: https://www.epos-ip.org/

Significant infrastructures

- National Jupiter database on borehole information (lithology, groundwater heads and groundwater quality).
- National Martha database on Offshore Aggregates resources

2. Bureau de Recherches Géologiques et Minières - French geological survey (BRGM)

BRGM is the French Geological Survey and France's leading public institution in the field of Earth Science for the sustainable management of natural resources (including mineral resources) and surface and subsurface risks. This activity is carried out through research activities, support to public policies, and international cooperation with companies and foreign research institutions. BRGM employs over 1,100 people, including more than 700 researchers and engineers. The GeoResources Division activity covers the whole spectrum of the management of mineral resources, from fundamental research (e.g., ore forming processes, metallogenic syntheses, predictive mapping, etc.), including exploration, expertise, development of geological and mining infrastructures, management of after mine problems, to raw materials economy.The IT Division activity focuses on diffusion of GeoScientific Information, from collection, collation, harmonization and diffusion, directly to user or through added-value services. First French public body to join Open Geospatial Consortium, the IT Division was also very active on the set up of the INSPIRE directive.

BRGM is a main contributor of (i) the EU- project **OneGeology-Europe** to make available metadata and map services of the national geological maps to build on-line the geological map of Europe, (ii) the pan-European Geological Data Infrastructure (**EGDI-Scope, EGDI**), an action which will provide the backbone for serving interoperable, pan-European geological data currently held by Geological Surveys, and data from past (notably the flagship EU-FP7 **ProMine** project – BRGM leader of 2 WPs), ongoing and future European projects and (iii) the INspired GEOdata CLOUD Services project (**InGeoCloudS**) which aims at demonstrating the feasibility of employing a cloud-based infrastructure coupled with the necessary services to provide seamless access to geospatial public sector information, especially targeting the geological, geophysical and other geoscientific information. BRGM is also WP5 Leader in the EU-FP7 **Minerals4EU** project (dealing notably with Critical Raw Materials (CRM) in Europe), a key-partner of the **EURARE** EU-FP7 project (REE in Europe), WP5 Leader in the H2020 **ProSUM** project (CRM and the urban mine), WP6 Leader in the H2020 **MICA** project (Mineral Resources Expert System), WP9 Leader in the H2020 **SCRREEN** project (CRM dedicated platform linked to an expert system), WP3 leader in the H2020 **ORAMA** project dedicated to EU datasets optimization and Task Leader in the **REFRAM** (Refractory Metals) and **IMP@CT** (Low-impact Mining of Small High-grade Deposits) projects...

The BRGM teams from the GeoResource and IT Divisions involved in **GeoERA – RM1** have thus a strong experience in European projects and our expertise cover all the value chain from data production and management, to data models conception, and to Knowledge Data Platforms development.

Website: http://www.brgm.fr/

Role in Project

- WP5 Leader: BRGM's role is **to set up the rules of communication / interaction** between the existing Knowledge Data Platforms (KDPs) and their applications, developed within EU-FP7 and H2020 projects, and the Raw Materials Information System (RMIS) version 2.0 launched in November 2017 by the European Commission DG JRC;
- BRGM will also bring experience and technical know-how to other WPs, and notably WP2 related to the improvement (automation) of the e-Minerals Yearbook.

Profiles of key staff members

Dr. D. CASSARD (M)	**Daniel Cassard** (PhD), Scientific Program Coordinator, Minerals4EU WP5 Leader, ProSUM WP5 Leader, MICA WP6 Leader, SCRREEN WP9 Leader, INSPIRE TWG 'Mineral Resources' Expert, IUGS/CGI/ Interoperability Working Group member. Member of the EuroGeoSurveys Mineral Resources Expert Group (EGS/MREG), Executive Secretary of the ETP-SMR.
F. TERTRE (M)	**François Tertre** (MSc), Project leader in Information and Numerical Services, managing IT projects at national and European levels. Project leader in the ENVISION EU-FP7 project, also involved in the Initial Operating Capabilities task force for INSPIRE. Deputy WP Leader of EURare, Minerals4EU, ProSUM, MICA, SCRREEN and ORAMA EU-FP7 and H2020 projects.

<u>First and second contacts for the scientific and technical matters:</u>

First contact names:	Daniel CASSARD
Email address:	d.cassard@brgm.fr

Second contact names:	François TERTRE
Email address:	f.tertre@brgm.fr

<u>Contact for the administrative and financial matters:</u>

First contact names:	Amélie VAGNER
Email address:	a.vagner@brgm.fr

Publications

- <u>Cassard D.</u>, <u>Bertrand G.</u>, Billa M., Serrano J.J., Tourlière B., Angel J.M. and ✞Gaàl G. (2015). ProMine mineral databases: new tools to assess primary and secondary mineral resources in Europe. In: Weihed P. (ed.), 3D, 4D and Predictive Modelling of Major Mineral Belts in Europe, Mineral Resource Reviews (Springer publ.), DOI 10.1007/978-3-319-17428-0_2.
- <u>Cassard D.</u>, Serrano J.-J., Vuollo J. (2012). The use of the standard exchange EarthResourceML in the ProMine project. 34th International Geological Congress, Brisbane, August 2012, Abstracts on CD-ROM.

- Cassard D., Tertre F., Bertrand G., Schjøth F. & Podboj M. (2017). Insights on the EURare Integrated Knowledge Management System (IKMS) on European REE data. Presentation at ERES 2017, the 2nd conference on European Rare Earth Resources, 28-31 May 2017, Santorini, Greece.
- Serrano J.-J., Kauniskangas E., Cassard D. (2010). ProMine: architecture, portal and web services to provide a European mineral resources information system. 4th INSPIRE Conference. Krakow, Poland, 22-25 June.
- Tourlière B., Pakyuz-Charrier E., Cassard D., Barbanson L., Gumiaux C. (2015). Cell-Based Associations: A procedure for considering scarce and mixed mineral occurrences in predictive mapping. Computers and Geosciences 78, 53-62.

Involvement in other relevant European and national projects

- EU FP7 EURare: Task Leader, in charge of the development of the Integrated Knowledge Management System (IKMS);
- EU FP7Minerals4EU: WP Leader, in charge of the development of the EU-Minerals Knowledge Data Platform (EU-MKDP);
- H2020 ProSUM: WP Leader, in charge of the development of the EU-Urban Mining Knowledge Data Platform (EU-UMKDP);
- H2020 MICA: WP Leader, in charge of the development of the ontology-based Dynamic Decision Graph (expert system);
- H2020 SCRREEN: WP Leader, in charge of the development of EU-Critical Raw Materials Knowledge Data Platform (EU-CRMKDP);
- H2020 MSP REFRAM: Task Leader on primary resources mapping;
- H2020 ORAMA: WP Leader, in charge of demonstrating the applicability of the recommendations made in terms of improvement/optimization of European datasets related to Raw Materials;
- MINVENTORY EU tender: WP leader, in charge of the data gap analysis and the development of the web portal.

All these platforms/portals are linked and are contributing to set up the EURMKB (see the EIP-SIP)

- H2020 CSA MSP-REFRAM Network on refractory metals;
- H2020 RIA IMP@CT Integrated Modular Plant and Containerised Tools for Selective, Low-impact Mining of Small High-grade Deposits.

Significant infrastructures

Knowledge data platforms developed by BRGM in the frame of European projects:
- http://ptrarc.gtk.fi/promine/default.aspx
- http://eurare.brgm-rec.fr/
- http://minerals4eu.brgm-rec.fr/
- http://prosum.brgm-rec.fr/
- http://micaontology.brgm-rec.fr/MICAOntology/Home.action

3. INSTITUTO GEOLÓGICO Y MINERO DE ESPAÑA (IGME)

The Instituto Geológico y Minero de España (IGME) is a Public Research Institution created in 1849 attached to the Ministry of Economy and Competitiveness. The main mission of IGME is to provide the State Administration, the Autonomous Regions Administrations and the general society, with precise knowledge and information regarding the Earth Sciences and related technologies for any development on the Spanish territory.
The functions of the Geological Survey of Spain are: a) Studies, analysis and research in the field of Earth Sciences and Technologies; b) Generation of basic scientific knowledge; c) Information, technical-scientific assistance and advice to public administrations, economic agents and society in general, concerning geology, hydrogeology, geoenvironmental sciences, geological resources and minerals; d) Interdisciplinary relations with other areas of knowledge, contributing to the best understanding of the

territory and of the processes that form and modify it, to the sustainable use of its resources and the conservation of the geological and hydrogeological heritage; e) Preparing and implementing budgets of R&D&I and knowledge infrastructures in national and international programmes, within the scope of its competences.
The activities of the Geological Survey of Spain are related to the following strategic lines: a) Geoscientific National Mapping, b) Geoscientific Information Systems, c) Subsurface Geology and CO2 Geological Storage d) Mineral Resources and Environmental Impact of Mining e) Geodiversity, Geological and Mining Heritage and Scientific Culture, f) Geological Hazards, Active Processes and Global Change g) Hydrogeology and Environmental Quality. More than 12.000 technical reports covering all IGME's research activities are readily available at IGME`s Document Information System. Some 9.000 are digitized and can be downloaded on the internet.
The number of staff employed is around 400.

Profiles of key staff members

Montserrat Trío (female): Ph. D.in Mining Engineering. Between 1984 and 1986 worked for the company Promotora de Minas de Carbón in mineral research. In 1986 appointed to the Instituto Geológico y Minero de España (IGME), in Madrid, "Ministerio de Industria y Energía" in Spain, with activity in field work for the Geology Department, and in planning within the Computers Department. In 1990-91 she was appointed to the Jefatura de Minas in Santander, Cantabria. In 1992 returned to the private sector, working mainly in international trade in Africa and Asia. In February 2015 she returned to IGME, becoming responsible of the publication of "Panorama Minero" and the development of the mining heritage data bases in the Geological and Mining Heritage Area.

Juana Vegas (female): PhD in Geology. Since 2006 she works at the Instituto Geológico y Minero de España (IGME), where she has a full position in the Geological and Mining Heritage Area. For 20 years, she has been working in geoheritage and mining heritage inventories at different scales and initiatives for sustainable tourism in geological and mining sites of interest. Nowadays, she has been a participant in PanAfGEO EU funded project.

Bruno Martínez (male): Ph. D. in Mining Engineering. Since 1990 he has worked on mineral deposits and other geological resources of all sections of the Spanish Mining Law, especially in the preparation of projects on environmental, restoration and management issues, as well as in the study and evaluation of projects related to land development plans. Restoration, protection perimeters in mines, exploitation concessions and research permits by the Spanish administration. Currently it is dedicated exclusively to the mining heritage at IGME.

Luis Jordá Bordehore (male): PhD mining engineer from Polytechnic University of Madrid with a master`s degree in Ecole Superieure du Petrole in France (2000) and an Exchange Erasmus scholarship in Mons Belgium (1998-1999). He has worked as senior geotechnical engineer in drilling, tunnel and underground mine design. He has university experience teaching geological hazards, slope stability and rock engineering in Spain and South America. The last 4 years he has been living in Peru, Bolivia and Ecuador, where he has developed and intense networking in geoengineering in universities and private companies and institutions.

Pedro Delgado (male): holds a BSc Geology from the Complutense University of Madrid (1988). Since 2014 is a raw materials specialist in the Minerals Resources Department of the Geological Survey of Spain. He has over 30 years of experience related to Geological Resources such as oil and gas exploration, groundwater urban supply and open pit mining operations. He has been involved in several European projects as Minerals4EU, MICA, MinLex, FORAM, ORAMA, MINLAND. He is also a member of EuroGeoSurveys Minerals Resources Expert Group.

Publications

Alberruche del Campo, Esther, Marchán Sanz, C., Sánchez Rodríguez, A., Ponce de León Gil, D. y García de Domingo, A. (D.L. 2013). Guía metodológica para la integración del Patrimonio Minero en la Evaluación de Impacto Ambiental: Encomienda de gestión de trabajos en materia de impacto ambiental y de producción y consumo sostenible. [Madrid]: Ministerio de Agricultura, Alimentación y Medio Ambiente; Instituto Geológico y Minero de España.

Florido, P. y Rábano, I. (Eds.). (2010). Una Visión multidisciplinar del patrimonio geológico y minero. Madrid: Instituto Geológico y Minero de España.

Marchán Sanz, C. y Sánchez Rodríguez, A. (2013). Consideraciones sobre el patrimonio minero desde la perspectiva de un servicio geológico nacional: Mining heritage considerations from the standpoint of a national geological survey. Boletim Paranaense de Geociencias, 70, 77–86. Recuperado de http://dx.doi.org/10.5380/geo.v70i0.31502

Rábano, I., Mata-Perelló, J. M. y Moreno-Eiris, E. (Eds.). (2006). Publicaciones del Instituto Geológico y Minero de España: Vol. 6. Patrimonio geológico y minero: Su caracterización y puesta en valor. Madrid: Instituto Geológico y Minero de España.

Ferrero Arias, Á., Rodríguez Sánchez, A., Marchán, C., Díaz Martínez, E. y García Cortés, Á. (2012). Mapa de Patrimonio Minero de Galicia. Publicaciones del Instituto Geológico y Minero de España, Madrid, 1 mapa a dos caras, carpeta contenedora. NIPO: 728-13-018-6.

Involvement in other relevant European and national projects

- Partner in PanAfGEO http://www.panafgeo.org
- Partner in M4ShaleGas - Measuring, Monitoring, Mitigating & Managing the environmental impact of shale gas (2015−2017), H2020 Research and Innovation Programme
- Partner in Minerals4EU - Minerals Intelligence Network for Europe (2013−2015), FP7-CSA-NMP.2013.4.1
- Partner in CGS Europe - the Pan-European coordination action on CO2 Geological Storage (2011−2013), 7th Framework Programme
- Partner in ProMine - Nano-particle products from new mineral resources in Europe (2009−2013), FP7-NMP-2008-LARGE-2

Significant infrastructures

IGME Central Laboratory offers modern installations and specialized technical services to provide the experimental technical data needed for research projects. It is an important point of reference for the analytical needs of Earth Sciences in Spain. IGME Laboratory provides facilities in two basic technical areas: Chemical Analysis and Technological and Mineralogical Testing. The following functions are carried out:

- Service provision for physical/chemical analysis and testing of waters, soils, rocks, minerals, industrial residues and effluents.
- R&D projects on treatment processes for mineral resources, industrial residues, contaminated soils, etc.
- Expert reports and assessments of mineralogical, petrographical or chemical classification and composition of mineral resources.
- Reports required for projects to install or modify mineral processing plants.
- Geotechnical tests to determine working or safety conditions.

4. CYPRUS GEOLOGICAL SURVEY DEPARTMENT (GSD)

The Cyprus Geological Survey Department (G.S.D.) was established in 1950 with a mandate to consult the state on geological matters. It is a state-funded public institution under the Ministry of Agriculture, Rural Development and Environment and its mission is to safeguard the public interest through the identification, the exploitation and protection of mineral and groundwater resources, the investigation and assessment of the geological environment and geohazards, the monitoring and assessment of seismicity, the investigation of foundation conditions, the protection and promotion of sites of geological and mining heritage and the production and dissemination of unbiased geological information to society.

Roles / tasks in the project
RM 1 Knowledge Base
WP3 – Minerals Yearbook
WP4 – Minerals Inventory

Profiles of key staff members

Christodoulos Hadjigeorgiou (Male): He holds an MSc in Geology from the SUNY at Stony Brook, New York, USA. He specializes in Geology and Industrial Minerals (e.g. mineralogy, petrography, quality control of industrial minerals, rehabilitation of abandoned mines and quarries, sustainable development of natural resources). Since 2010, he is a Senior Geological Officer and is the Head of the Economic Geology Section at GSD. Apart from involvement in public organization, he has longstanding experience as a Geologist in private quarrying companies. He serves as an expert Member of the Mirror Committee in the field of Civil Engineering of the Cyprus Standards Organization covering issues concerning mineral raw materials.

George Hadjigeorgiou (Male): He holds an MSc degree in neotectonics from the National and Kapodistrian University of Athens in Greece and Post Graduate Diploma in Public Sector and MBA from the Mediterranean Institute of Management in Cyprus. He is currently employed as a Geological Officer at the Economic Geology Section of the Geological Survey Department of Cyprus. His current research activities involve: exploration for mineral resources including, mapping, drilling, characterization and reserve calculation of mineral recourses. The mineral resources that are explored for the local needs are currently aggregates, armourstones, and umbers.

Ioulia Georgiadou (Female): She holds a Bachelor in Geology and MBA. Since 2011, she is employed as a Geological Officer at the Economic Geology Section of the Geological Survey Department of Cyprus. Her current research activities involve: exploration for mineral resources including, mapping, drilling, characterization and reserve calculation of mineral recourses. The mineral resources that are explored for the local needs are currently aggregates.

Iosifina Iosif Stylianou (Female): She is working at the Cyprus Geological Survey Department since 2001. From the position of Senior Technician, she specialized in Information Technology (IT), Geographical Information Systems (GIS) and Digital Cartography.

Publications

Economic Geology Section of GSD holds a database of historic and current information of the mineral resources of Cyprus. GSD operates several drilling rigs that are used among others for the exploration of mineral resources. Also, the chemical and the Engineering Geology and Industrial Minerals Laboratories are used for the characterization of the mineral resources.

- *Mineral Resources Map of Cyprus, (Greek), Nicosia 2007*
- *Mineral Resources Map of Cyprus, (English), Nicosia 2007*

Crushed limestone as an aggregate in concrete production: the Cyprus caseI. Ioannou, M. F. Petrou, R. Fournari, A. Andreou, C. Hadjigeorgiou, B. Tsikouras and K. Hatzipanagiotou, Geological Society, London, Special Publications, 331, 127-135, 29 March 2010

Involvement in other relevant European and national projects
- Minerals4EU
- ProSum
- MICA

Special relevant skills

- Exploration for mineral resources including aggregates
- Market surveillance for aggregates
- Active involvement in the process for licensing new quarries or mines

5. GEOLOGICAL SURVEY OF ITALY (ISPRA)

The Geological Survey of Italy is a Department of the National Institute for Environmental Protection and Research (ISPRA).
The Geological Survey of Italy was established in 1873 and its main task was the creation and the publication of the Geological Map of Italy. It is today composed of a team of 140 people working with enthusiasm to protect and preserve our territory and to promote its geological knowledge.
The main goal is a constant activity of research and data production, collection and analysis, aiming at promoting a rational, fair and sustainable use of resources, at reducing risks due to natural and anthropogenic causes and at supporting Public Administrations (e.g. Ministry of the Environment). In particularly, next to the activity of geological mapping, the Geological Survey of Italy (GSI) monitors the state of soil and subsoil, develops geological, stratigraphic, geophysical, geomorphological and hydrogeological analyses to better understand the geological structure of the territory and the dynamics that modify it. It also contribute to natural risks mitigation, with particular care to hydrogeological risks, through data production, collection, analysis and development of specific databases.
Despite the strong contraction of production in recent years, the mining industry of solid mineral resources remains an important sector of the Italian economy. Italy, since last decade, is trying to address national legislation, in line with the European directives, towards environmental sustainability, raw materials' recycling and territorial planning.
The ownership of national mining policies is headed by the Ministry of Economic Development (MISE) and the collection of statistical data is carried on by ISTAT and MISE, but the transversality of the subject and the strong environmental impacts of the active and abandoned extractive sites, make the Geological Survey of Italy (and ISPRA), the backbone and necessary element of any future sustainable development policy of the sector, even with regard to the reconversion of the abandoned mining areas for cultural purposes.
The Geological Survey of Italy is currently carrying on activities concerning the standardization of statistical information on raw materials, primary and secondary, environmental studies of quarries and mines (restoration of extractive sites, mine waste deposits) and cultural exploitation (for tourism) of mining parks and museums.

Profiles of key staff members

Main persons involved: Marco Di Leginio, Fiorenzo Fumanti, Mauro Lucarini, Lucio Martarelli

Mauro Lucarini (male). Position: Geologist (Scientific Researcher III)

Relevant experience:

- Coordination and support of actions related to extraction activities from national level to international level (Member of the Mineral Resources Expert Group of Eurogeosurveys, point of contact of EU Projects);
- Knowledge of extractive industry sector (and legal framework), from extraction to production of non-energy mineral raw materials with the related by-products and the subsequent restoration of the mine/quarry sites.
- Geological and Groundwater Expertise for Environmental Impact Assessment concerning Gasducts, Geothermal Exploration and Oil and Gas Exploration;
- Geological and Geomorphological Expertise on Hydrogeological Hazards;
- Geoarchaeologist researcher (studies on pedo-stratigraphic units, archaeological remains, ornamental stones and lithics).

Selected works

- **Lucarini M.**, 2014. *Feldspar*. In: “Minerals in your life”, Eurogeosurveys, Brussels (Belgium), ISBN 9789090281476, P. 40-43.
- **Lucarini M.**, Fumanti F., Di Leginio M., Martarelli L., 2017. “Mining methods”, MICA Factsheet, EU MICA Project, www.mica-project.eu.

Lucio Martarelli (male). Geologist (senior Researcher Technologist)

Relevant experience:

- research activities in the frame of projects in the field of groundwater resources and hydrogeology (e.g., hydrogeological survey, hydrogeological information management, hydrogeological mapping)
- research activities in the frame of projects in the field of Mineral Deposits and Applied Geochemistry, mainly concerning mineralizations of the western Mediterranean Area

Selected works

- Ferrini V., **Martarelli L.**, Masi U. (1993) - Geochemical features of the massive pyrrhotite deposit of El-Kettara (Jebilet Mts., central Morocco) and genetic implications. Miner. Petrogr. Acta XXXVI, 307-320.
- **Martarelli L.**, Ferrini V., Masi U. (1995) - Geochemical features of the stratabound metamorphosed barite-pyrite (Pb-Ag) deposit of Pollone (Apuan Alps, Tuscany) and genetic implications. Mineral. Petrog. Acta XXXVIII, 51-64.
- **Martarelli L.**, Ferrini V., Masi U. (1997) - Geochemistry of the polymetallic skarn-vein deposit of Fenice Capanne (southern Tuscany, Italy) and genetic implications. Mineral. Petrogr. Acta XL, 271-285.
- Ferrini V., **Martarelli L.**, De Vito C., Çina A., Deda T. (2003) – The Koman Dawsonite and realgar-orpiment deposit, Northern Albania: inferences on processes of formation. Can. Mineral. 41, 413-427.

Marco Di Leginio (male). Geologist (Scientific Researcher III)

Relevant experience:

- Member of the EGS (EuroGeoSurveys) Mineral Resources Expert Group.
- ISPRA-ISTAT working group to support the project: “Human pressure and natural hazards”
- Environmental reporting specifically to soil themes (Coordinator of “Geosfera” chapter in the Environmental data yearbook);

Selected works

- **Lucarini M.**, Fumanti F., Di Leginio M., Martarelli L., 2017. “Mining methods”, MICA Factsheet, EU MICA Project, www.mica-project.eu.
- **Di Leginio M., Fumanti F. -** Environmental Data Yearbook. “Section on “Quarries Mines Data and Information” Editions from 2004 to 2016.

Fiorenzo Fumanti (male). Geologist (Scientific Researcher)
Relevant experience:
•Geological survey and facies analysis of volcanic and sedimentary rocks
•Modelling of debris flow
•Activities on Italian and European soil policies
•National data collection and management on active and ceased quarries and mines.

Selected works
•Centamore E., Fumanti F. & Nisio S. (2002) - The Central-Northern Apennines geological evolution from Triassic to Neogene time. Boll. Soc. Geol. It., Volume speciale n. 1.
•Fumanti F. (2016) – Le attività estrattive di minerali solidi. Relazione sullo Stato dell'Ambiente. Ministero dell'Ambiente e delle Tutela del Territorio e del Mare .
•Fumanti F. and Di Leginio M. (2003-2017) – Quarries and Mines. In: Italian Environmental Yearbook, ISPRA, Rome, from 2003 to 2017 editions.

Publications

Partner	Type	Reference
ISPRA (GSI)	Product	Geoportal and Thematic Maps of Italian territory http://sgi.isprambiente.it/geoportal/catalog/main/home.page
ISPRA (GSI)	Product	Environmental Data Yearbook – Section on Extractive Activities (Mines and Quarries Production) http://annuario.isprambiente.it/
ISPRA (GSI)	Product	Quality of Urban Environment – Annual Report on Urban Mine Sites http://www.areeurbane.isprambiente.it/it
ISPRA (GSI)	Service	Mineral Wastes Inventory (Legislative Decree n.117/2008) http://www.isprambiente.gov.it/files/miniere/Inventario_Aggiornamento_2017.pdf

Involvement in other relevant European and national projects

Partner	Type of project/activity	Description
ISPRA (GSI)	Project 1	Re.Mi. (National Network of Mining Parks and Museums)- aimed both at connecting all the sites involved in the recovery of abandoned mining areas as industrial heritage tourism resource, and also at strengthening the regulatory framework.
ISPRA (GSI)	Project 2	Minerals4EU – aimed at developing an EU Minerals Intelligence Network (2013-2015), containing data and metadata on mineral resources.
ISPRA (GSI)	Project 3	MICA – aimed at building up a Minerals Intelligence Capacity Analysis, defining the Ontology of EU mineral resources (2015-2017).
ISPRA (GSI)	Project 4	FORAM – aimed at developing an European platform of international experts and stakeholders for the creation of a World Raw Materials Forum (WFRM), supporting a better international cooperation on raw materials policies and investments (2016-2018).

6. GEOLOGICAL SURVEY OF NORWAY (NGU)

GEOLOGICAL SURVEY OF NORWAY, founded in 1858, is a government agency under the Ministry of Trade, Industry and Fisheries (NFD). NGU shall actively contribute to ensuring that geoscientific knowledge is utilized for the effective and sustainable management of the nation's natural resources and environment. NGU provide services and information within a large range of geoscience subjects, such as mineral resources (metals, industrial minerals, natural stone and aggregate), geological hazards, environmental issues, marine geology, regional geophysics and land use planning. NGU provides databases on mineral and aggregate resources to Norway's national information infrastructure and to the European mineral resource data platforms. NGU has participated in several European projects aimed at harmonizing data sets across borders, to the benefit of national and international land use planning, and industrial development and innovation. NGU has 200 employees, of which approximately 65% are scientists.

NGU works to identify and evaluate potential deposits of industrial minerals and ores which may be of future economic significance. The user target is industry, public administration, and other stakeholders. Information is gathered and stored in NGUs mineral resource databases which are accessible through www.ngu.no and www.prospecting.no. NGU uses mineralogical and geochemical techniques for the characterization of mineral resources and has a well-equipped laboratory for both mineral and rock characterization. NGU will contribute with maps, knowledge and data on the distribution and composition of known resources.

Profiles of key staff members

Dr Henrik Schiellerup (male) is heading the Mineral Resources team at the Geological Survey of Norway. He is an economic geologist specialized in igneous petrology. Schiellerup obtained his PhD from the Norwegian University of Science and Technology in Trondheim, Norway, in 2001, and his MSc from the University of Aarhus, Denmark, in 1991. From 1991 to 1993 he received a research fellowship from the Nordic Volcanological Institute in Reykjavik, Iceland, working with Pleistocene volcanology.

Kari Aslaksen Aasly (female) is heading the Natural Construction Materials team at the Geological Survey of Norway. She is an economic geologist, educated (MSc) from the Norwegian University of Science and Technology in Trondheim in 2000. Aasly has been working with different issues related to natural construction materials, both hard rock aggregates and natural stone. She has been involved in the Nordic UNFC working group.

Tom Heldal (male) is the Director of the Georesources and Environment division at the Geological Survey of Norway. He is a geologist, educated (MSc) from the University of Bergen in 1987. Heldal has been working with different issues related to mineral resources for many years, particularly natural stone. He has more than 40 peer-reviewed papers on the subject. Heldal has been coordinating an FP6 project and has been involved in UNFC working groups on both national and Nordic scale.

Publications

Partner	Type	Reference
NGU	Service	2017, Metals, industrial minerals and natural stone database http://geo.ngu.no/kart/mineralressurser_mobil/?lang=eng
NGU	Service	2017, Gravel and hard rock aggregates database http://geo.ngu.no/kart/grus_pukk_mobil/?lang=eng
EuroGeoSurvey	Service	2015, Minerals4EU, http://minerals4eu.brgm-rec.fr/

Involvement in other relevant European and national projects

Partner	Type of project/activity	Description
Pan-European	FP7 project	Minerals4EU; Pan-European data portal on mineral resources (2013-2015)
Petronavit, Nordic geological surveys, mining inspectorates, and branch organizations	Project	Nordic UNFC project, stage I (pilot) 2015-2016. Applying UNFC to mineral resources in Norway, Sweden and Finland. Relevance and applicability.
Petronavit, Nordic geological surveys, mining	Project	Nordic UNFC project, stage II (main), ongoing. Applying UNFC to mineral resources in Norway, Sweden and Finland.

inspectorates, and branch organizations		
MinFuture	H2020 project	Ongoing; Global material flows and demand-supply forecasting for mineral strategies
Pan-European	H2020 project	MINLAND, ongoing. Mineral resources in sustainable land-use planning

Significant infrastructures

Partner	Type	Description
	NGU Geomatics	Resource databases – data and development

7. GEOLOGICAL SURVEY OF SLOVENIA (GeoZS)

Geological Survey of Slovenia (GeoZS) is a public research institute with app. 90 95 employees and established by the Government of the Republic of Slovenia. It carries out fundamental and applied research in regional geology, hydrogeology, geochemistry, sedimentology, paleontology, petrology, tectonics, geophysics, mineral resources and fossil energy, geothermal energy, geohazards, GIS and education. It provides a public service through scientific research programs and cooperation with universities. GeoZS is tightly involved in national and international research and professional communities worldwide. Activities are supported by Geological Information Centre, responsible for the collection, processing, storage and dissemination of geological data. We support national authorities and agencies in the process of concession granting for mining, and mineral and thermal water use. Our laboratories do petrological, mineralogical, geochemical and geothermal analyses.

GeoZS role in the project:
GeoZS operates and manages the Slovenian national mineral database and related knowledge and intelligence and part of legal tasks of GeoZS is also to perform national Public Mining Service. GeoZS experts are members of National Commission for determining mineral reserves, a commission that oversees reviews and acknowledge the reserve elaborates and according to the national legislation GeoZS prepare “National Balance Sheet for Mineral Reserves” annually / and in a period of 5-years.
The GeoZS teams from the Geological Information Centre department have a strong experience in European projects and our expertise cover from data production and management, to data models conception, and to Knowledge Data Platforms development. Team from minerals department is involved in the project ORAMA and in the EIT RawMaterial project RESEERVE.

Profiles of key staff members

Špela Kumelj (female), B.Sc. in Geography, leading expert associate at Geological Information Centre. As a geographer with master degree of first level in digital cartography and GIS, she is specialized in spatial analysis, modelling in GIS, databases, GIS standards and protocols. She has been actively involved in researches within geologically induced hazards, susceptibility mapping, civil protection and management of national and international projects. Currently she is a GeoZS coordinator for GIS activities within three internatiuonal projects (DARLINGe, PanAfGeo and EMODnet3-Geology)
Matija Krivic (male), B.Sc. in Geography, is an Expert in GIS in geological sciences – Geological Information Center. As a geographer he is specialized in spatial analysis, modelling in GIS, databases, GIS standards and protocols. He is experienced in design and implementation of geological information system and spatial data infrastructure at Geological survey of Slovenia, Digital cartography, Spatial Analysis. He is involved in the project National information system of mineral resources of the Republic of Slovenia. He has participated in tasks related to landslide hazards in terms of warning, predictions, susceptibility analysis, risk, remote sensing imagery. He has participated in many past international projects, funded by different EU and other international funding schemes (eWater, OneGeology, OneGeology-Europe, eENVplus, Minerals4EU, “Support to formulate an artisanal and small-scale mining

– a pilot study using satellite remote sensing & GIS in Nigeria” as well participating in national projects (GH-14, MASPREM).

Ana Burger (female) B.Sc. in Geology. She works at Mineral resources and environmental geochemistry department. She is involved in different tasks, relating management of mineral resources, mining waste and aggregate recycling. She also works for ministry, responsible for mining in a frame of Public Mining Service. That includes different activities and tasks as: managing database, producing different statistics for the needs of the government. One of the tasks of Public Mining service is also establishment, keeping and maintaining of the Mining registry book. She was involved in projects SARMa and EO-MINERS.

Marko Mehle (male), has a master's degree in geotechnology, mining and environment from Faculty of Natural Sciences and Engineering. Since 2017 he works at the Geological Survey of Slovenia in department of mineral resources. Between 2006 and 2017 he has worked as project, process manager, geotechnical and mining engineer in drilling, tunnel and underground mine construction and designing on construction sites across Europe. Also has an experience in chemistry, mechanical process engineering in the field of mineral resources, waste management and renewable energy sources. As seen he has a lot of working experiences, expertise and knowledge in many areas such as nature, ecology and environment.

Dr. Duška Rokavec (female), Ph.D., senior geologist, is the head of the Department of Economic Geology. She has 26-year experiences as research assistant for evaluation and assessment of non-metal mineral deposits, economic geology with classification and categorization of reserves and resources, spatial planning of open pits etc. She is qualified as a court expert for mineral deposits and surface mining and she has gained the designation of European Engineer. She has contributed to creating and competing national Mining Act and Statutory Acts, as well as in estimating MR values for the purpose of imposing taxes. She co-operated in establishing and maintaining the MR database, including mining cataster. She is a president of national Republic Commission for determining mineral reserves and resources. Some EU funded projects she is/was involved in: ORAMA, Minerals4EU, Snap-SEE, EuroGeoSource, Minventory, Minatura2020.

Publications

ROKAVEC, Duška, ŠINIGOJ, Jasna. Minerals4EU - minerals intelligence network for Europe (Mreža obveščanja o mineralnih surovinah Evrope). Mineralne surovine v letu ..., ISSN 1854-3995, 2015, leto 2014, str. 119-120. [COBISS.SI-ID 2464853]
ŠINIGOJ, Jasna, HRIBERNIK, Katarina, PODBOJ, Martin, KRIVIC, Matija. Informacijski sistem okoljskih podatkov. V: KLADNIK, Drago (ur.), et al. Skrb za pitno vodo, (Geografija Slovenije, ISSN 1580-1594, 31). Ljubljana: Založba ZRC, 2014, str. 27-36, ilustr., zvd. [COBISS.SI-ID 37867309]
GOSAR, Mateja, ŠINIGOJ, Jasna. Projekt ProSUM. Mineralne surovine v letu ..., ISSN 1854-3995, 2015, leto 12, št. 1, str. 170-171, ilustr. [COBISS.SI-ID 2584661].
BURGER, Ana, TUKIĆ, Marko. Spletna aplikacija Rudarska knjiga. Mineralne surovine v letu ... ISSN: 1854-3995.- Leto 13, št. 1 (2016), str. 120-123. [COBISS.SI-ID 2677077].
ŠOLAR, Slavko V., BURGER, Ana. Projekt SARMa : Trajnostno gospodarjenje z mineralnimi surovinami za gradbeništvo = Sustainable aggregates resource management – SARMa. Mineralne surovine v letu ... ISSN: 1854-3995.- l. 2009 (2010), str. 115-118. [COBISS.SI-ID 1803349].

Involvement in other relevant European and national projects

GeoZS is involved in ongoing project

- H2020 SCRREEN: partner, co-development of EU-Critical Raw Materials Knowledge Data Platform (EU-CRMKDP);
- H2020- ORAMA: partner;
- H2020 ProSUM: partner, development of the harvesting system for the EU-Urban Mining Knowledge Data Platform (EU-UMKDP);
- H2020 MICA: partner;
- EIT RawMaterials – RESEERVE: project coordinator;

- EIT RawMaterials – Mineservice: project coordinator;
- INTRAW: partner;
- MINATURA 2020: WP leader;
- EGDI - co-development of the European Geological Data Infrastructure;
- eGeologija - National portal on inventory and collection of datasets in the field of geology;
- PanAfGeo: technical partner in the project;
- EMODNet: partner;

and in finished project as

- Minerals4EU: partner, development of the harvesting system for EU-Minerals Knowledge Data Platform (EU-MKDP);
- SARM:, project coordinator;
- Snap-SEE: WP leader;
- EO-MINERS: partner;
- EuroGeoSource: WP leader;
- InGeoCloudS: partner;
- PanGeo: partner;
- OneGeology – Europe: partner.

Significant infrastructures

Knowledge data platforms co-developed by GeoZS in the frame of European projects

- http://eurare.brgm-rec.fr/
- http://minerals4eu.brgm-rec.fr/
- http://prosum.brgm-rec.fr/
- http://akvamarin.geo-zs.si/t-jam_boreholes/Default.aspx
- http://akvamarin.geo-zs.si/incomepregledovalnik/Default.aspx

eGeologija: national portal on inventory and collection of datasets in the field of geology

Mining registry book:
https://ms.geo-zs.si/

8. GEOLOGICAL SURVEY OF SWEDEN (SGU)

The Geological Survey of Sweden (SGU) is the national agency for issues relating to bedrock, soil and groundwater in Sweden. SGU is a governmental body governed by The Ministry of Enterprise and Innovation. At present SGU has about 240 employees and an annual turnover that totals c. 43 M€. SGU has extensive expertise in geology, geophysics, geochemistry and economic geology relevant to the current project proposal.
SGU is part of EIT KIC on Raw Materials consortium and participates in the EURARE, ProSUM, X-Mine, SCRREEN, MINLAND and FORAM projects, and has contributed to Minerals4EU. SGU has been active in building the Fennoscandian Ore Deposit Database FODD, together with Norwegian, Finnish and Russian counterparts. SGU is currently working on projects in the Bergslagen mining district in south central Sweden. SGU´s recently finished Barents project has included work on mineralisation systems in northernmost Sweden in order to guide future exploration.
SGU is a member of ETP-SMR High Level Group and participates in the Raw Materials Supply Groups, the ad hoc working group on criticality. SGU is also involved in EGS Mineral Resource Expert Group and in DG Growth’s operational groups in terms of the strategic implementation of the actions included in the European Innovation Partnership on Raw Materials.

Profiles of key staff members

Erika Ingvald (female) is Head of Division for Mineral Information and Mining Industry at the Geological Survey of Sweden, including the Malå Mineral Information office. The division develops statistics on the

Swedish exploration and mining industry, international projects, mining and environment information, and areas of national interests. Erika is a project member of the Nordic UNFC project, aiming at developing guidance to the UNFC for Finland, Norway and Sweden. Erika is a geologist with a backgrund as a researcher in sedimentary petrology, with twenty years experience as a science journalist and communications officer. She is also a co-author of the books Where gold glints blue: Scientists on the nano revolution, and The High Coast - A World Heritage.

Torbjörn Bergman (male) is educated at Stockholm University and has a Ph. Lic. degree in Ore Geology (1994). He has been employed at the Geological survey of Sweden since 1995 and has been working with bedrock mapping, documentation of Swedish mineral deposits and is responsible for the Swedish mineral resources database. He has also been working as a consultant for the Swedish Nuclear Waste Management Company (SKB) and is author and co-author of more than 20 reports. He is currently involved in the international project, Fennoscandian Ore Deposit Database (FODD) and EURARE.

Anders Hallberg (male) received his PhD at Uppsala University in 1993. After his dissertation he was employed by the Geological Survey of Sweden (SGU) and stationed at the Mineral Resources Information Office in Malå, Northern Sweden, where the main task was to provide relevant geological information to the rapidly growing exploration industry. Data for the first national mineral resources database and for the Fennoscandian Ore Deposit Database was gathered, compiled and published with his active participation. Recently his work has expanded into information and statistics on mining waste, both in national and international projects including the ProSUM project.

Helge Reginiussen (male) PhD in metamorphic and igneous petrology. He has been employed at SGU since 2002 working as a geologist and senior geologist. He held a position at SGUs Mineral Resources Information office in Malå for ten years working with mineral resources information activities towards exploration companies and researchers. He was the project leader for SGUs recently finished hyperspectral drillcore imaging project. Helge is now at the division of mineral information and mining industry at SGU Uppsala where he is involved in a project related to critical raw materials from both primary and secondary sources. He is currently SGUs member of EuroGeoSurveys Mineral Resources Expert Group (MREG).

Publications

Partner	Type	Reference
SGU	Service	Mineral resources database. Ores and minerals map viewer. https://apps.sgu.se/kartvisare/kartvisare-malm-mineral.html
SGU	Service	Aggregates map viewer. https://apps.sgu.se/kartvisare/kartvisare-ballast.html
EGS	Service	Minerals4EU. http://minerals4eu.brgm-rec.fr/

Involvement in other relevant European and national projects

Partner	Type of project/activity	Description
SGU	Minerals4EU	The Minerals4EU project delivered a web portal, a European Minerals Yearbook and foresight study on mineral resources around Europe.
SGU	SCRREEN	The SCRREEN project will establish an **EU Expert Network that covers the whole value chain for present and future critical raw materials.**
SGU	MINLAND	The MINLAND project will meet the challenges of competing land use and will produce guidelines for securing access to land for exploration and extraction of minerals, including critical raw materials.

SGU	Nordic UNFC project	A Guidance for the Application of the UNFC-2009 for Mineral Resources in Finland, Norway and Sweden.

9. STATE INFORMATIONAL GEOLOGICAL FUND OF UKRAINE (GeoInform – GIU)

The State Research and Development Enterprise "State Informational Geological Fund of Ukraine" – SRDE "GeoInform of Ukraine", or GeoInform, is the specialized research and development unit of the State Geological and Subsurface Survey of Ukraine which collects, stores, analyzes and provides information received from geological study and use of subsurface.
GIU conducts research work on monitoring of mineral resources of Ukraine on the basis of geological and mining activities during the year, recording deposits and making public the balance of mineral resources management of the State fund of deposits and occurrences (more than 10,000 objects recorded), synthesis and analysis of exploration for oil and gas, creating a system of state accounting of oil and gas wells, completion and maintenance of the State cadastre of mineral deposits and occurrences as well as State cadastre of groundwater deposits of Ukraine.

Profiles of key staff members

Dr. hab. Boris Malyuk (Male), Director for International Cooperation, graduated in 1981 from Department of Geology, Lviv University, Ukraine, and in 1999 from Centre of Geostatistics, Ecole des Mines de Paris, France. Obtained Candidate of Science (PhD) Degree in Geotectonics in 1984, and extended Doctor of Science Degree in Petrology in 1991. National Delegate of Ukraine to the EuroGeoSurveys.

Sergii Prymushko (Male), Director, with basic IT-background, has more than 30 years experience in management of geological information, including partitioned database systems.

Volodymyr Velychko (Male), Chief Engineer, at his position is responsible for hardware and software facilities and database development having basic IT-background. In the Project he will contribute to geoscientific data systems.

Dr. Igor Melnyk (Male), Deputy Director, Center for International Cooperation, with basic background in geology, has an experience in field works and research in geochemistry, hydrogeology and ecology (PhD in 1996), as well as geoinformatics and GIS applications.

Tetiana Biloshapska (Female), Chief Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1980. She is experienced in field works. She had studied mineral-resource base of Ukraine for more than 30 years, took part and led projects on prospecting and exploration of mineral deposits, conducted regional geological studies.

Natalia Korpan (Female). Chief, Division of mineral deposits and reserves inventory. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology' in 1986. She had studied geology of coal and peat deposits and their reserves inventory for 30 years.

Ganna Sankina (Female). I-category Geologist. Graduated from Kyiv State University under specialty 'Hydrogeology, engineering geology'. She is working in the field of geology for more than 15 years, is experienced in field works in the course of geological mapping in the scale 1:200 000. She is managing the State inventory of oil and gas wells as well as compilation and analysis of these data.

Iryna Mykhaylyk (Female), Leading Geologist, Division of Information Technologies. Graduated from Department of Geology, Taras Shevchenko Kyiv National University in 2010, under specialty "Geology".

Natalia Kovalenko (Female), Leading Engineer, Division of Information Technologies. Graduated from Department of Transport Construction, Kyiv Autoroad Institute (nowadays – Transport University) in 1985, under specialty "Bridges and Tunnels", in 1989 graduated from special courses "Programming C++", education center "Uspikh", Kyiv, and in 2002 graduated from special courses "WEB-programming PHP, HTML, CSS", education center "Perspektiva", Kyiv

Tamara Bardygola (Female). Interpreter, Center for International Cooperation. Graduated from Department of Mechanics and Mathematics, Kyiv University in 1988, under specialty "Mechanics of solid medium".

Publications

Interactive map of mineral deposits of Ukraine (in Ukrainian)
http://geoinf.kiev.ua/wp/interaktyvna-karta-rodovyshch-korysnykh-kopalyn.htm
Interactive map of mineral licenses (in Ukrainian)
http://geoinf.kiev.ua/wp/interaktyvni-karty-spetsdozvoliv.htm
Interactive geological map of Ukraine 1:1 000 000 (in Ukrainian)
http://geoinf.kiev.ua/wp/Interaktyvna-heolohichna-karta-Ukrayiny.htm
Interactive geological map of Ukraine 1:1 000 000 (in English)
http://geoinf.kiev.ua/wp/Interactive-Geological-Map-of-Ukraine.htm
Interactive State Geological Map of Ukraine 1:200 000 (in Ukrainian with English entries)
http://geoinf.kiev.ua/wp/kartograma.htm

Involvement in other relevant European and national projects

- Minerals4EU - EU
- ProSUM - EU
- NUMIRE – Norway-Ukraine (NGU/SGSSU)
- EIMIDA – Norway-Ukraine (NGU/Geoinform)

10. STATE GEOLOGICAL SURVEY OF THE SLOVAK REPUBLIC (SGIDS)

Statny Geologicky Ustav Dionyza Stura (SGUDS) performs the tasks of the State Geological Survey of the Slovak Republic.
The SGUDS activity is focused in the solutions of the geological research and exploration projects, creation and application of the information system in geology, registration, collection, evidence and making accessible the results of geological works carried out at the territory of the Slovak Republic. SGUDS provides independent expertise, lecturing, consulting and advisory activity and compiles the input documents for the state administration. The State Statny Geologicky Ustav Dionyza Stura is a state contributory organization supervised by the Ministry of Environment of the Slovak Republic.
The Institute was established in 1940. The SGUDS headquarters are in Bratislava with regional centres in Spišská Nová Ves, Banská Bystrica and Košice.
The State Statny Geologicky Ustav Dionyza Stura is a member of the international organization of geological surveys EuroGeoSurveys and GeoHealth.
SGUDS has many years long (more than 50 years) experience in gathering, processing and publishing Minerals Yearbooks in Slovakia.

Profiles of key staff members

Stanislav Šoltés (male): PhD. in Deposit Geology. Senior geologist. For 10 years responsible for SGUDS' databanks for mineral deposits and old mining works. Stanislav has been a participant in EU funded project Minerals4EU. Organizer of several minerals related conferences (Forum pre nerudy – 2013, 2016).

Dušan Kúšik (male): PhD. in Economic Geology. He is an Economic Geologist of the State Geological Institute of Dionýz Štúr in Bratislava and he is a Head of department of Raw Minerals and Geophysics. His team works on regional studies of critical raw materials and raw material potential as a general rule. He deals with the compilation of national raw material databases and raw material base assesment. He is a member of the Slovak Economic Geologists Association (SALG). He has been a participant in several EU funded projects including OPIS, MINATURA, ENOS.

Jozef Mižák (male): Head of the Geofond department. For 12 years responsible for SGUDS' databanks and GIS.

Products and services

http://www.geology.sk/new/
http://apl.geology.sk/mapportal/

Publications

1. Sentpetery M., Šoltés S., Španek P., Kúšik D., Mižák J. (Eds.), 2015: Evidencia ložísk nevyhradených nerastov Slovenskej republiky k 1. januáru 2015. ŠGÚDŠ, Bratislava, 28 s.
2. Sentpetery M., Šoltés S., Španek P., Kúšik D., Mižák J. (Eds.), 2015: Bilancia zásob výhradných ložísk Slovenskej republiky k 1. januáru 2015. ŠGÚDŠ, Bratislava, 233 s.
3. Sentpetery M., Šoltés S., Španek P., Kúšik D., Mižák J. (Eds.), 2016: Evidencia ložísk nevyhradených nerastov Slovenskej republiky k 1. januáru 2016. ŠGÚDŠ, Bratislava, 28 s.
4. Sentpetery M., Šoltés S., Španek P., Kúšik D., Mižák J. (Eds.), 2016: Bilancia zásob výhradných ložísk Slovenskej republiky k 1. januáru 2016. ŠGÚDŠ, Bratislava, 225 s.

Involvement in other relevant European and national projects

Minerals4EU: http://www.minerals4eu.eu

11. LABORATÓRIO NACIONAL DE ENERGIA E GEOLOGIA, I.P. (LNEG)

Laboratório Nacional de Energia e Geologia is an R&D institution oriented to respond to the needs of society and enterprises. Betting on a sustainable research and for sustainability through the generation of knowledge of our territory. Side by side with what´s best done internationally, LNEG guarantees to have in its areas of competence an adequate response to the needs of the business sector. We do Science in energy and geology with a view to its application in advanced solutions for leveraging our economy. The Portuguese National Laboratory for Energy and Geology (LNEG) is a State laboratory of the Ministry of Economy that makes R&D oriented to the needs of society and enterprises, investing in a sustainable research, along with the international best practices, ensures that its areas of expertise allow an adequate response to the needs of the business sector. LNEG is aware that cooperative work and networking can optimize skills and that knowledge sharing is a tool for success, so it is an active partner of the major networks and collaborative platforms in the areas of energy and geology. LNEG´s mission is to promote technological innovation science and technology oriented for economic development contributing to increase competitiveness of economic agents in the context of sustainable progress of the Portuguese economy. The Department of Mineral Resources and Geophysics (URMG) of LNEG, which participates in the project, is one of the largest of the institution and includes the areas of Geophysics, Geology, Metallic Resources, Ornamental Rocks, Aggregates, Heavy Mineral studies and Metallogeny, Mineralogy, Geochemistry, Remote Sensing, etc.

Profiles of key staff members

João Xavier Matos, is a Senior Geologist at the LNEG's Mineral Resources and Geophysics Research Unit, since 1990. Currently is PhD student in Metallogeny and Master in Economic and Applied Geology, by the Faculty of Sciences, University of Lisbon. He is currently responsible for LNEG Aljustrel Drill Core Store, collaborating with ID projects related to Mineral Exploration, Geological and Mining Mapping and Stratigraphy in the southern of Portugal, especially in the Iberian Pyrite Belt massive sulphide European Mining province and Ossa Morena Zone. Presently is research He is currently responsible for the Alentejo2020 EXPLORA and ZOM 3D projects and for the LNEG activities of the GEO-FPI Interreg POCTEP project.

Zélia Pereira holds a Ph.D. in Stratigraphy from the University of Porto (Portugal). Her area of specialty and research is Palynostratigraphy. Additionally she works in supporting data for geological mapping, biostratigraphic detailed age control and correlations on sedimentary basins, high resolution stratigraphy applied to exploration on economic resources in the mining and energy sector (coal, oil and gas) and geological heritage. She has participated in a number of national and international projects. She is currently the General Secretary of the CIMP (Commission Internationale de la Microflore du Paléozoique).

Teresa P. Silva is graduated in Technologic Chemistry from the Faculty of Sciences of the University of Lisbon (Portugal) and presented a dissertation equivalent to PhD to the Tropical Research Institute, in Minerochemistry. She is currently working as a researcher in LNEG-Laboratório Nacional de Energia e Geologia, mainly within the fields of mineralogy, geochemistry, X-ray analytical techniques including synchrotron radiation, spectroscopy (XANES, EXAFS). She has participated in several national and international projects and is co-author of more than 50 publications in national and international scientific journals with revision, in addition to numerous communications in conferences.

Publications

Partner	Type	Reference
LNEG	Publication	Authors, year, title, publication, pp, URL
	Service	Current, Geoportal, http://geoportal.lneg.pt/
	Product	Carta Radiométrica de Portugal, à escala de 1:500.000 (2013); ISBN (Digital Edition): 978-989-675-027-5; ISBN (Paper Edition): 978-989-675-028-2 Carta de Ocorrências Mineiras do Alentejo e Algarve, à escala 1:400.000 (2013); ISBN (Digital Edition): 978-989-675-029-9; ISBN (Paper Edition): 978-989-675-030-5 Carta de Depósitos Minerais de Portugal (Região Norte) à escala 1:200.000 (2014); ISBN (Digital Edition): 978-989-675-035-0; ISBN (Paper Edition): 978-989-675-034-3 Carta Geoquímica de Cobre em Solos, Zona Sul Portuguesa, Faixa Piritosa Ibérica, à escala 1:400.000 (2016); ISBN (Paper Edition): 978-989-675-044-2 Carta Radiométrica (Contagem Total), Zona Sul Portuguesa, Faixa Piritosa Ibérica, à escala 1:400.000 (2016); ISBN (Paper Edition): 978-989-675-045-9 Carta Gravimétrica (Anomalia de Bouguer), Zona Sul Portuguesa, Faixa Piritosa Ibérica, à escala 1:400.000 (2016); ISBN (Paper Edition): 978-989-675-046-6 Carta Magnética (Campo Total Reduzido do IGRF), Zona Sul Portuguesa, Faixa Piritosa Ibérica, à escala 1:400.000 (2016); ISBN (Paper Edition): 978-989-675-047-3

Involvement in other relevant European and national projects

Partner	Type of project/activity	Description
LNEG	Promine	Nano-particle products from new mineral resources in Europe. The philosophy behind ProMine is to stimulate the extractive industry to deliver new products to manufacturing industry.
	EuroGeoSource	EuroGeoSource is a data portal, which allows access by Internet to the aggregated geographical information on geo-energy (oil, gas, coal etc.) and mineral resources (metallic and non-metallic minerals, industrial minerals and construction materials: gravel, sand, ornamental stone etc.), coming from a wide range of sources in a significant coverage area of Europe (ten countries). The project was funded by the Competitiveness and Innovation Framework Programme (CIP), under the Policy Support Programme (PSP), Geographic Information Theme.
	Minerals4EU	The Minerals4EU project is designed to meet the recommendations of the Raw Materials Initiative and will develop

		an EU Mineral intelligence network structure delivering a web portal, a European Minerals Yearbook and foresight studies. The network provides data, information and knowledge on mineral resources around Europe, based on an accepted business model, making a fundamental contribution to the European Innovation Partnership on Raw Materials (EIP RM), seen by the Competitiveness Council as key for the successful implementation of the major EU2020 policies.
	MICA	The MICA project contributes to on-going efforts towards the establishment of a stakeholder tailored product, namely the “European Union Raw Materials Intelligence Capacity Platform” (EU-RMICP).
	PROSUM	The ProSUM Project aims to provide an inventory of secondary raw materials, particularly critical raw materials, arising in WEEE, ELVs, waste batteries and mining wastes. This inventory will support the EU European Innovation Partnership's Strategic Implementation Plan to build an EU raw materials knowledge base.

Significant infrastructures

Partner	Type	Description
LNEG	Infrastructure	Geoportal
	item 1	SIORMINP – Mineral deposit database of Portugal
	Archive	Archive of all mineral occurrences reports, both historic and current

12. Institute of Geology and Mineral Exploration (IGME Greece)

IGME is the major geological research organization in Greece, authorized by the Ministry of Environment and Energy. For more than 40 years IGME contributes to the country’s growth and social welfare in terms of evaluating and securing the sustainable use of natural resources (water, geothermal energy, soils and minerals). IGME participates in European Research and Development programs and in Regional projects co-funded by the Structural Funds, covering all fields of earth and environmental sciences. It conducts public and contract-based services in basic geological research, exploration and evaluation of mineral deposits, geothermal fields, hydrogeological surveys, geochemical and geotechnical studies, environmental control and monitoring and special studies on safe disposal sites for industrial and domestic solid wastes. The number of staff employed on a permanent basis is 216 (geoscientists, technical and administrative personnel), complemented by contract/fixed-term personnel in the frame of various projects.

Profiles of key staff members

Varvara Pefani (Female) Responsible for RM1 Position: Senior Mining Engineer, Director of Mineral Research and Feasibility Studies Department
Relevant experience:

- Knowledge of Greek minerals resources.
- Database experience.
- Participant in several EC funded and collaborative projects.

Selected works

1. Aggelatou V., Aggelopoulos K., Eliopoulos D., Laskaridis K., Malliaris D., Marantos I., Michael K., **Pefani V.**, Chalkiopoulou F., Hatzilazaridou K., Hatzipanagis J., Christidis C., Michaleou F., 2011: New Development Opportunities for Sustainable and Competitive Growth. *Greek Mineral Wealth.*
2. Drougas J., **Pefani V**., Panteli Z., 2009: Innovative Technologies - Monitoring – and Development of wastes of abandoned public mines. *IGME, Greece*.
3. Kaklamanis N., Theodoroudis A., Arvanitidis N., Filippou S., Tarenidis D., **Pefani V**., Aggelatou V. 2008: Quartz- Industrial Minerals – Innovative Technologies- New Products. *IGME, Greece*.
4. Drougas J., **Pefani V**., 2006: Critical Minerals – Innovative Technologies – Evaluation and Development of Metallic Minerals. *IGME, Greece.*
5. **Pefani V**., 1987: Statistics of Mining Activity in Greece. *IGME, Greece.*

Kostas Laskaridis (Male) Position: Director of Economic Geology Department, Technical responsible of LITHOS Laboratory

Selected works

1. “Greek Marble through the Ages: An Overview of the Greek Marble Producing Areas and the Stone Sector of Today”, **Kostas Laskaridis**, “V Global Stone Congress 2014”, 22nd-25th October 2014, Antalya Turkey**2.** “Inter-Laboratory Characterization of Building and Decorative Limestones from Cyprus”, Ioannou Ioannis, Modestou Sevasti, Fournari Revekka, **Laskaridis Kostas**, Patronis Michael, Kousseris Ioannis, 6th International Congress “Science and Technology for the Safeguard of Cultural Heritage in the Mediterranean Basin”, Athens, Greece, 22nd-25th October 2013**3.** “Relationship between Breaking Moments at the Dowel Hole and at Flexure under Concentrated Load of Ornamental Stones”, Michael Patronis, **Kostas Laskaridis** and Maria Niaou, “Global Stone Congress 2012”, 16-20/7/2012, Alentejo (Borba), Portugal**4.**“Rapid Prototyping techniques for use in conjunction with natural stone powders and aggregates”, S. Theodoridou, K. Savidis, **K. Laskaridis** and M. Founti, “Global Stone Congress 2010”, 2-5/3/2010, Alicante, Spain**5.**"Characterisation of the timeless white marble and quarrying activity in Thassos", **K. Laskaridis** and V. Perdikatsis, 2009, in Y. Maniatis (ed.), ASMOSIA VII, The Study of Marble and Other Stones in Antiquity – Proceedings of the 7th International Conference of the Association for the Study of Marble and Other Stones in Antiquity, BCH Suppl., 51, pp. 309-317.

Demetrios Eliopoulos (Male) Position: Senior Geologist, Economic Geology Department , Head of Metallic Minerals

ELIOPOULOS DEMETRIOS, Dr., entered service with IGME in 1985. He received his H.B.Sc in Natural Sciences from the Athens University, his M.Sc in Economic Geology from the University of Western Ontario, Canada, and his Ph.D in Economic Geology at the University of Southampton, United Kingdom. His research interests are focussed on the metallogenesis of precious and base metal sulphide deposits, PGE in hydrothermal systems, Ni-laterites and Cu-porphyry systems, databases for handling and processing large geological data, and expert systems. He has 30 years of experience in co-ordinating and leading R&D EU, national and international mineral exploration projects. Also, he has working experience from Canada, Ontario Geological Survey and Private Companies for precious metals exploration. The Greek Academy of Science and Letters awarded him in 1991 for his contribution to the science of Economic Geology. He is member of several geological organisations, Fellow member of the Society of Economic Geologists and currently representative for the Students Chapter in Greece. He participated as Council member of the Society for Geology Applied to Mineral Deposits (SGA) for 8 years.

Selected works

1. **Eliopoulos, D.G.**, and Kilias, S.P., 2011: Marble–Hosted Submicroscopic Gold Mineralization at Asimotrypes Area, Mount Pangeon, Southern Rhodope Core Complex, Greece. *Economic Geology*, v. 106, p.751-780.

2. **Eliopoulos, D .G.**, Economou-Eliopoulos M., Apostolikas, A., Golightly, J.P., 2012: Geochemical features of nickel-laterite deposits from the Balkan Peninsula and Gordes, Turkey: The genetic and environmental significance of arsenic. *Ore Geology Reviews*, v. 48, p. 413-427.
3. **Eliopoulos, D.G.**, and Economou-Eliopoulos, M., 2013: Palladium and Platinum in hydrothermal systems: The case of porphyry-Cu systems and sulfides associated with ophiolite complexes. In: Proceedings of the 13th International Congress, Chania, *Bulletin of the Geological Society of Greece*, vol. XLVII 2013
4. **Eliopoulos, D.G.**, Economou-Eliopoulos, M., and Zhelyaskova-Panayiotova, M., 2014: Critical factors controlling Pd and Pt potential in porphyry-Cu-Au deposits; Evidence from the Balkan Peninsula. *Geosciences*, 4, 31-49: doi: 10.3390/geosciences 4010031.
5. K.M. Goodenough, J. Schilling, P. Kalvig, N. Charles, J. Tuduri, E.A.Deady, M. Sadeghi, H.Schiellerup, A. Muller, G. Bertrand, N. Arvanitidis, **D.G. Eliopoulos,** R.A. Shaw, K. Thrane, N. Keulen, 2016.Europe's rare earth element resource potential: An overview of REE metallogenetic provincesand their geodynamic setting. *Ore Geology Reviews*, 72, 838-856

Nikolaos Androulakakis (Male) Position: Director of ICT Department

ANDROULAKAKIS NIKOLAOS: He received his HBSc in Electrical Engineering, MSc and PhD in GeoInformatics from the National Technical University of Athens. He is a Member of: Member of Technical Chamber of Greece (TEE-TCG) since 1980, Member of Hellenic Society of Geographic Information Systems (HellasGI), Member of Hellenic Association of Computer Engineers (HACE**).**
He has an excellent knowledge of information systems and Geoinformatics and is proficient in the use of latest technology software, both commercial and open-source, such as ArcGIS, QGIS, Geoserver, ArcGIS Server, POSTGRESQL, POSTGIS, Open Layers, etc.

Relational Databases: PostgreSQL/POSTGIS
GIS: ArcGIS , QGIS
Programming Languages: Javascripts, Python, Visual Basic
WEB GIS : ArcGIS server, Geoserver, Geonetwork
Web Technology: XML, GML, KML, various API's (google, openlayers, GeoExt, etc)
CMS : Joomla, WordPress
LMS : Moodle, Udemy

His key qualifications include
· Ability to organize, prioritize and work under extreme work pressure, heavy work load and deadlines.
· Strong verbal and personal communication skills.
· Decision making, critical thinking Self-motivated, initiative, maintains a high level of energy.
· Accuracy and Attention to details
· Tolerant and flexible, adjusts to different situations.
· Problem analysis, use of judgment and ability to solve problems efficiently

He has participated as a coordinator or research associate in many projects funded by the 2nd CSF, 3rd CSF and the NSRF, and also in numerous EU programs.He has authored several books and also worked as an educator in the field of Geoinformatics and e-learning. He has taught at the Technological Educational Institutes (TEI) of Halkida (1990-2000) and Athens (2000-2010) as a research associate, at the School of Rural and Surveying Engineering of NTUA, when writing his PhD thesis and at the Training Institute of the Greek National School of Public Administration.He has served as a board member (2000-2008) and Vice President (2004-2006) of the Hellenic Society of Geographic Information Systems (HellasGI) and has recently been appointed as a Board Member of the Vocational Training Centre of the Region of Attica and Board Member of the Greek National Centre for Public Administration and Local Government (EKKDA).

Professional Experience Record

1984-210: IGME, ICT Dept, Geothermal Energy Dep, General Director Office. System Analyst, GIS consultant
2011-2014: Region Of Attica (Athens): Vice Governor for E-government and Transparency

2014-2015: National Centre of Public Administration, Deputy Director of National School of Public Administration
2015 – Present: IGME, ICT Manager
Demetrios Sgouros (Male) Position: ICT Officer, Thessaloniki

DEMETRIOS SGOUROS is an ICT officer at IGME's Branch in Thessaloniki, northern Greece. He entered service with IGME in 1984.He is highly qualified and experienced in Geographical Information Systems (**ArcGIS, QGIS, GRASS GIS, gvSIG, SAGA-GIS, uDig**), Geoserver, Mapserver, Degree, Mapnik, Databases (**MySQL, PostgreSQL, PostGIS, MsSQL, Oracle, Access e.t.c**) , Geonetwork, Development of Web-GIS.
He has participated in several EU funded projects, namely **NuPulse, Nemisref, Promine, InGeoClouds, OneGeology, Minerals4EU, EuRare .**

Publications

Partner	Type	Reference
IGME Gr	Product	Map of Metallic Minerals of Greece (Promine)
IGME Gr	Product	Map of Metallogenic Districs of Greece (Promine)
IGME Gr	Product	Datasets of Metallic Minerals of Greece (Mn4Eu)
IGME Gr	Product	Datasets of Rare Earth elements of Greece

Involvement in other relevant European and national projects

Partner	Type of project/activity	Description
IGME Gr	Project 1	Promine
IGME Gr	Project 2	Minerals4EU – EU Mineral intelligence network structure providing data, information and knowledge on mineral resources around Europe.
IGME Gr	Project 3	Eurare – Development of a Sustainable Exploitation Scheme for Europe's Rare Earth Element Deposits
IGME Gr	Project 4	Geonickel – Integrated Technologies for the Exploration, Exploitation and Evaluation of Nickel Laterite Deposits Of Europe

13. CROATIAN GEOLOGICAL SURVEY (HGI-CGS)

The Croatian Geological Survey (HGI-CGS) is the principal public research institute in Croatia in the field of geosciences and geological engineering. It undertakes fundamental and applied geoscience research for the benefit of the society and economy of Croatia. Major science disciplines within The Croatian Geological Survey (HGI-CGS) include geological surveying and mapping, hydrogeology, engineering geology, mineral resources, and geochemistry. The Croatian Geological Survey (HGI-CGS) acquires and publishes geological data over the entire territory of the Republic of Croatia.

The Croatian Geological Survey (HGI-CGS) organizes this information into a form that provides substantive guidance to both the national and regional planning processes in Croatia. The Croatian Mining Act (2013) places HGI-CGS as the main authority for collecting, storing and distributing all geological data related to exploration of all types of mineral resources (energy and non-energy).
The Department for Mineral Resources is the coordinate of the national project the Mineral Resource Map of Croatia which integrates both geological, mining and policy data related to mineral resources. The mineral resource research staff of HGI-CGS investigate the potential of mineral resources and develop policy plans and advice for both the Mining directorate as well as local authorities in order to enhance the rational and sustainable management of mineral resources.

The Department for mineral resources in the near future will establish MS-MKDP (*Mineralne sirovine-Minerals Knowledge Data Platform*). MS-MKDP will develop an operational data management distributed system based on high-level interoperability standards in terms of database structure, harvesting systems, web services, metadata management, and integration of non-structured information. MS-MKDP will also contribute to implement the standards developed jointly by Member States (MS) and the European Commission (EC) in the framework of the INSPIRE Directive. The objective is to develop a MS-MKDP allowing to easily combine information related to primary and secondary mineral resources and to provide end-users with all the available information from primary sources to waste streams, from exploration to production and trade, from estimates of resource availability to foresight studies on raw materials supply and demand in the RC. The MS-MKDP will also represent one of the first bricks of the future Geology information System (GEOLIS). The proposed technical solutions assure an effective and sustainable system designed for facilitating data updates and maintenance. It is designed to allow a full access to information related to the whole mineral resources value chain. The Department for mineral resources will participate in four work packages which are connected with Minerals Knowledge Data Platform of Croatian mineral resources in the sense of the reporting systems mineral yearbook, mineral inventory, UNFC classifications and tourism.

Profiles of key staff members

Željko Dedić, male, zdedic@hgi-cgs.hr; +385 1 61 60 743; +385 98 543 535
Engineer of Geology, Expert Advisor, Croatian Geological Survey, Department for mineral resources, with more than 10 years of experience in mineral resources (studies of raw materials; spatial planning, gypsum, cement raw materials, aggregates, GIS and database specialist, geochemistry and tectonics of gypsum deposits, economic geology and spatial planning). Author and co-author in more than 30 reports and papers. Actively participates in mineral resources related projects KMS (Map of Mineral Resources of Croatia), SARMa, SNAP-SEE, Minerals4EU, MICA, PROSUM, GEO-ERA, FORAM and GEO-CRADLE. on behalf of Croatian Geological Survey. Member of the Mineral Resources Expert Group EGS.

Dr. Slobodan Miko; smiko@hgi-cgs.hr, +385 1 6160 788.
Dr. Slobodan Miko, Senior research scientist, Director General of Croatian Geological Survey, adjunct Ass. Prof. at RGNF (Zagreb Uni.) Geology of Ore Deposits, member of EGS Mineral resources expert group (MREG). Croatian partner Coordinator for mineral resources related projects SARMa, SNAP-SEE,

Minerals4EU, MICA, PROSUM, GEO-ERA, EMODnet Geology II (marine resources). Areas of mineral research are: aggregates, bauxite, gypsum and clays, economic geology, mineral resource availability and spatial planning related to mineral extraction.

Mr. Boris Kruk, male, bkruk@hgi-cgs.hr; +385 1 61 60 747;
Engineer of Geology, Expert Advisor, Croatian Geological Survey, Department for mineral resources, with more than 30 years of experience in mineral resources (studies of raw materials; spatial planning, gypsum, cement raw materials, aggregates, geochemistry and tectonics of gypsum deposits, economic geology and spatial planning). Author and co-author in more than 100 reports and papers. Actively participates in mineral resources related projects KMS (Map of Mineral Resources of Croatia), SARMa, SNAP-SEE on behalf of Croatian Geological Survey.

Erli Kovačević Galović, female, ekovacevic@hgi-cgs.hr, +385 1 61 60 743
Engineer of Geology, Expert associate at Croatian Geological Survey, Department for mineral resources. Has 13 years of experience in the area of mineral resources, mostly as field, GIS and database specialist with a specific interest in bauxites. Active participant in a number of mineral resources related projects, national (Map of Mineral Resources of Croatia) and international (SARMa, SNAP-SEE, MICA, PROSUM, FORAM).

Dr. Nikolina Ilijanić, female, nilijanic@hgi-cgs.hr; +385 1 6160 745
Dr. Nikolina Ilijanić, Research Associate, Head of Department for Mineral Resources, Croatian Geological Survey, specialized in the mineralogical analysis of raw materials, sediments and soils during the work in Croatia Geological Survey on XRD analysis, environmental magnetism and geochemistry of Quaternary sediments and soils. Author of 1 CC paper, 4 papers in other journals, 4 papers in conference proceedings, 1 chapter in book/exscursion guide and 59 scientific abstracts in conference proceedings from domestic and international conferences, and at the moment, 1 CC paper and 1 paper in other journals is accepted for publication, while 3 are under revision. Actively participated in mineral resources related projects KMS (Map of Mineral Resources of Croatia), SARMa, SNAP-SEE, MICA.

Dr. Ozren Hasan, male, ohasan@hgi-cgs.hr; +385 1 6160 746
Dr. Ozren Hasan, Research Associate, Department for Mineral Resources, Croatian Geological Survey. Areas of mineral research are: aggregates, gypsum and clays, economic geology, mineral resource availability and spatial planning related to mineral extraction. Author and co-author in 4 CC paper, 4 papers in other journals, 6 papers in conference proceedings, 73 scientific abstracts in conference proceedings from domestic and international conferences. Author and co-author in more than 30 reports. Actively participated in mineral resources related projects Map of Mineral Resources of Croatia, SARMa, SNAP-SEE.

Publications

1. Dedić, Ž., Ilijanić, N., Miko, S.; Mineralogical-petrographical study of evaporites from Mali Kukor, Vranjkovići and Slane Stine quarry (Upper Permian evaporites from Dalmatia, Croatia), Geologia Croatica, article in press. 2017.
2. Miko, S., Dedić, Ž.,: MINLEX - Study on the legal framework for mineral extraction and permitting procedures for exploration and exploitation in the EU, str.41-42, Dreistetten, Austria, August 2016
3. Dedić, Ž., Miko, S.: Foresight Study: Thematic Report II, Societal Challenges of mineral raw materials accessibility; Aggregates plans and their future: a view from South East Europe (SEE) countries Topic: Access to European Mineral Raw Material (MRM) deposits, 2015.
4. Horváth, Z., Miko, S., Sári, K. and Dedić, Ž.: A Vision of Best Practices for Aggregates Planning in South East Europe, SNAP-SEE Project, www.snapsee.eu. doi: 10.5474/snapsee-WP5-EN, Publisher: ©SNAP-SEE project 2014.
5. Kovačević, E., Miko, S., Dedić, Ž., Hasan, O., Lukšić, B., Zoran P.: Past mining and present quarrying impacts on the Dalmatian karst environment, Croatia, // 15th Meeting of the Association of European Geological Societies, Georesources and public policy: research, management, environment, 16-20 September 2007, Tallinn, Estonia //

Involvement in other relevant European and national projects

1. **The Mineral Resources Map of Croatia.** 1993-2013. Funding: Ministry of Science and Education (MZOŠ) http://www.hgi-cgs.hr/karta-mineralnih-sirovina-RH.htm
2. **Sustainable Aggregate Resource Management**-SARMa. SEE cooperation program. 2009-2011, SARMa had established a common approach for sustainable aggregate resources management in the countries of project members, including updated data infrastructure and competence strengthening, (2012-2014), http://www.sarmaproject.eu/
3. **Minventory**: DG Growth 2013, Statistical Information on EU Raw Materials Deposits, which will allows to implement an action plan for harmonization of EU mineral resources data (2013-2014), https://ec.europa.eu/growth/tools-databases/minventory/content/minventory
4. **Sustainable Aggregates Planning in South East Europe** SNAP-SEEproject, SEE cooperation program. 2012-2014, Sustainable Aggregates Resource Management, developing a toolkit to support national / regional planning of primary and secondary aggregates in Eastern European Area' countries, http://www.snapsee.eu/
5. **Minerals Intelligence network for Europe** Minerals4EU Funding Scheme: FP7-NMP-2013-CSA. 2013-2015, EU Mineral intelligence network structure providing data, information and knowledge on mineral resources around Europe, http://www.minerals4eu.eu/

Significant infrastructures

- *GIS data base of the Croatian mineral deposits (aggregates either as sand & gravel or as crushed rock)*
- *Smear slides*
- *Magnetic susceptibility measurements*
- *Mineralogical and clay mineral analysis*
- *Grain size analysis*
- *Geochemical analysis-AAS*
- *SEM-EDS*

Special relevant skills
Experts in raw material mapping and resource evaluation

14. GEOLOGICAL SURVEY OF FINLAND (GTK)

Geological Survey of Finland (GTK) is national geological research centre operating under the Ministry of Employment and Economy. GTK is an internationally known and recognized expert organization in applied earth sciences. The geological earth resources of strategic and economic importance are in the core of GTK's research mission and GTK has long history and extensive knowledge in all areas of data management from definition of database structures to building services based on these databases. As a result of this work Finland constantly ranks in top positions in Fraser Institute's annual surveys to mining companies in respect to quality and coverage of available data.
GTK contributes to a wide range of international geosciences, mapping, mineral resources and environmental monitoring projects as well as projects concerning eco-efficient mining and mineral processing. International references of GTK cover a wide spectrum of undertakings in about 40 countries on all continents. GTK is active in the European Innovation Partnership on Raw Materials and one of the core partners in EIT Knowledge and Innovation Community Raw MatTERS. The total staff of GTK is about 435, annual turnover totals about 44 million €, of which 8 million € is invoicing. Web-site: www.gtk.fi

Profiles of key staff members

Janne Hokka (MSc, male) is Geologist at the Ore and Industrial Minerals Unit of GTK. Janne holds MSc in economic geology from University of Helsinki (2011) and he has over 8 years of experience in different exploration and mining projects. His research areas include mineral exploration and evaluation of Mineral Resources from early-stage exploration through to production. Janne is Project leader in GTK's bedrock mapping and ore potential estimation project (2016-). He has been part of the Nordic Group preparing the Guidance for the Application of the UNFC-2009 for Mineral Resources in Finland, Norway and Sweden and he is the UNFC contact person in Geological Survey of Finland.

Mari Kivinen (PhD, female) is a senior scientist at Ore Geology and Mineral Economics unit of GTK. She is specialized on foresight in mineral exploration and mining including the industry´s effect to the environment, society and economy. Lately she has focused on conflict of interest related to mineral exploration and mining projects. In addition, she works with following subjects: minerals on circular economy and sustainable development, production chains and minerals policy. Mari Kivinen studied geology at the University of Helsinki and received her PhD on 2014. Her thesis considered sustainability of the Finnish mining sector in the context of global supply chains of metals. She has worked as a visiting scientist at the Institute for Sustainable Futures (Sydney) and Luleå Technical University (Sweden).

Sami Lepistö (MSc, male) is Geologist at the Ore and Industrial Minerals Unit of GTK. Sami graduated in geology and mineralogy from University of Turku in 2003. His career has focused on base metal, Cu-Ni-PGE, and gold projects. He has over 15 years of working experience and has worked as a Geologist and Senior Geologist for several international mining companies that have carried out large scale ore exploration, near mine exploration, and mine feasibility study projects in Finland. Last five years he has worked at GTK, focusing on regional ore potential estimation, geological 3D modeling and resource estimations.

Publications/Services

Partner	Type	Reference
GTK	Service	Mineral Deposits and Exploration – MDaE. Public webservice. Espoo: Geological Survey of Finland [referred 20.01.2017]. Online at: http://gtkdata.gtk.fi/mdae/
	Service	Eilu, P., Hallberg, A., Bergman, T., Bjerkgård, T., Feoktistov, V., Korsakova, M., Krasotkin, S., Lampio, E., Lauri, L., Litvinenko, V., Philippov, N., Sandstad, J.S., Shchiptsov, V. (2016). Fennoscandian Ore Deposit Database. Annual update. Online at http://en.gtk.fi/informationservices/databases/fodd/index.html
	Service	Cassard, D., Bertrand, G., Angel, J.-M., Aatos, S., Eilu, P., Pelleter, E., Tornos, F., Arvanitidis, N., Ballas, D., Billa, M., Christidis, C., Dimitrova, D., Filipe, A., Gloaguen, E., Gouin, J., Gazea, E., Eliopoulos, D., Inverno, C., Karinen, T., Lintinen, P., Mäki, T., Marantos, I., Matos, J., Michael, C., Mladenova, V., Navas, J., Neidbal, M., Perantonis, G., Picot, J.-C., Pyra, J., Santana, H., Serafimovski, T., Strzelecki, M., Tasev, G., Tudor, G., Kauniskangas, E., Meliani, M., Serrano, J.-J., Strengell, J. & Maldan, F. (2013). Europe-wide mineral deposit database. ProMine project. Online at: http://ptrarc.gtk.fi/ProMine/default.aspx
	Publication	Eilu, P. (ed.) (2012). Mineral deposits and metallogeny of Fennoscandia. Geological Survey of Finland, Special Paper 53, 401 p

Involvement in other relevant European and national projects

Partner	Type of project/activity	Description
Pan-European	FP7 project	Coordinator of Minerals4EU - Minerals Intelligence Network for Europe (2013−2015), FP7-CSANMP.2013.4.1-3
Petronavit, Nordic geological surveys, mining inspectorates, and branch organizations	Project	Nordic UNFC project, stage I (pilot) 2015-2016 and stage II, ongoing. Applying UNFC to mineral resources in Norway, Sweden and Finland.
Pan-European	H2020 project	MICA, ongoing. Mineral Intelligence Capacity Analysis
Pan-European	H2020 project	MINLAND, ongoing. Mineral resources in sustainable land-use planning
Pan-European	H2020 project	ORAMA, ongoing. Optimising quality of information in RAw MAterials data collection across Europe

Significant infrastructures

Partner	Type	Description
	GTK DigiKP2000, MDaE,	Resource databases, internal map user interfaces and services

15. British Geological Survey (UKRI(BGS)

The United Kingdom Research and Innovation (UKRI) is the UK's leading body for basic, strategic and applied research and monitoring in the environmental sciences. The British Geological Survey (BGS) is a component organisation of the UKRI and was founded in 1835, making it the world's longest established national geological survey. BGS seeks to advance the understanding of the structure, properties and processes of the solid Earth system through interdisciplinary surveys, monitoring and research for the benefit of society. BGS is responsible for advising the United Kingdom government on all aspects of the geosciences, as well as providing impartial geological advice to industry, academia and the public. It is the UK's premier provider of objective and authoritative geoscientific data, information and knowledge for sustainable use of natural resources.

BGS is also a world leader in the compilation of mineral statistical information and analysis, with one of the largest databases in the world on the production and trade of minerals. It is the custodian of an historical dataset containing mineral production and trade data, by commodity and country, from 1913 to present. It also publishes a highly-respected Mineral Profile series includes detailed reviews and analysis of the market dynamics and end-uses for number of raw materials and these are available on our dedicated minerals web portal (www.mineralsUK.com). BGS has published a risk index, which provides an indication of the relative risk to supply of chemical elements we need to maintain our economy and lifestyle.
BGS has contributed to and led work packages on a number of relevant EU-funded projects including Minventory (statistical information on EU raw materials deposits), Minerals4EU (EU minerals intelligence network), EURare (development of a basis for an EU rare earth elements industry) and MICA (minerals intelligence capacity analysis). It is also involved with ongoing EU-funded projects including MinFuture (global material flows and demand-supply forecasting for mineral strategies), SCRREEN (solution for critical raw materials – a European expert network) and ORAMA (optimising quality of information in raw materials data collection across Europe). BGS has been represented on the European Ad-hoc Working

Group on defining critical raw materials since its inception in 2009. As a global leader in the provision of raw materials data BGS was part of the consortium that undertook the DG Grow Study on the review of the EU list of Critical Raw Materials, published in 2017. These and other projects have resulted in diverse range of relevant collaborations and an expanding network of contacts in the European raw materials arena.

BGS is accredited to ISO 9001:2008 at its Keyworth, Edinburgh, Wallingford and Cardiff sites. The British Standards Institute has provided BGS with independent third party certification of its Management System and the interacting business processes across all its activities.

Profiles of key staff members

Teresa Brown (female) is a Mineral Commodity Geologist working for the Ore Deposits and Commodities team at the British Geological Survey (BGS). She has amassed considerable experience in the geology, production and global trade of a wide range of mineral commodities and she is the Project Leader for the BGS's long-running work relating to Minerals Information and Analysis, which produces the World Mineral Production publication on an annual basis. Teresa is a co-author of two chapters of the Critical Metals Handbook and she has been extensively involved in the BGS Mineral Profile Series, authoring profiles on lithium, tungsten and uranium. Teresa was the BGS lead for the EU-funded Minerals4EU project with specific responsibilities for the Mineral Statistics work-package and the development of the digital European Minerals Yearbook. Teresa will be leading WP2 of this proposed project with responsibility for co-ordinating the update to this Yearbook.

Tom Bide (male) is an experienced minerals geologist specialising in economic minerals and has excellent research and analytical skills. Tom focuses on the mapping of and spatial distribution of mineral resources and is a specialist in Marine Minerals leading a BGS national project with the Crown Estate. He has experience with mineral resource assessments and has complied mineral resource maps for the UK continental Shelf, the central belt of Scotland, and Wales. He has also managed projects undertaking more focused regional studies to map mineral resources, such as assessments of sand and gravel resources of Milton Keynes and North Yorkshire. He has experience undertaking international mineral resources assessments and has worked in UAE as part of a project to define dimension stone resources. He has expertise in compilation of mineral commodity statistics and derived products for the UK, Europe and the World.

Richard Shaw (male) is an Economic Geologist contributing to mineral resource related projects in the UK. In 2010 he completed a M.Sc. in Mining Geology, at the Camborne School of Mines, achieving a distinction in his thesis - 'The Potential for Indigenous Rare Earth Element Resources in South West England: a Reconnaissance Study'. He is lead author of the BGS Niobium-Tantalum Mineral Profile which encompasses all aspects of the industry including mineral occurrences, extraction and processing, world production and trade, global resources and consumption, uses and application, and recycling and substitution. He is the lead author of the BGS Risk List 2015. His current research is focussed on the niobium-tantalum potential of granitic pegmatites in the North West Highlands of Scotland. Mr Shaw also has over five years' experience of quality system and environmental auditing to a number of international standards including, BS EN ISO/IEC 17025:2005, 14001:2004, and 9001:2000.

Publications

Type	Reference
Service	World Mineral Statistics Data Download tool. (ongoing). http://www.bgs.ac.uk/mineralsuk/statistics/wms.cfc?method=searchWMS
Publication	Brown, T J; Idoine, N E; Raycraft, E R; Shaw, R A; Deady, E A; Hobbs, S F and Bide, T. (2017). World Mineral Production. British Geological Survey. http://www.bgs.ac.uk/mineralsuk/statistics/worldStatistics.html
Service	European Minerals Yearbook (electronic). (2015). Minerals4EU. http://minerals4eu.brgm-rec.fr/m4eu-yearbook/theme_selection.html

Publication series	Mineral Profiles. (2007-2016). British Geological Survey. http://www.bgs.ac.uk/mineralsuk/statistics/mineralProfiles.html
Publication	Risk List 2015. (2015). British Geological Survey http://www.bgs.ac.uk/mineralsuk/statistics/riskList.html

Involvement in other relevant European and national projects

Type of project/activity	Description
Project: Minerals4EU	BGS was a work package leader for this Europe wide project, with the specific responsibility for delivering the electronic European Minerals Yearbook
Project: MICA	BGS is a work package leader for this Europe wide project, with the specific responsibility for the development of an inventory of raw materials data and information
Project: ORAMA	BGS is a work package leader for this newly-started European wide project, with the specific responsibility for optimising data collection for primary raw materials.
Project: World Mineral Statistics	BGS is a world leader in the collection, collation and analysis of data relating to mineral production and trade. It is the custodian of a dataset containing data from 1913 to present.

16. Landesamt für Geologie, Rohstoffe und Bergbau Baden-Württemberg - Department of the Regierungspräsidium Freiburg - regional council of administrative region of Freiburg (LGRB)

Within the institutional setup of the State of Baden-Wuerttemberg, the Regierungspraesidium Freiburg is an authority located between the state's ministries and the local district authorities and municipalities. Its principal task is to pool and coordinate manifold tasks in nearly all spheres of life, as diverse as building and construction industries, agriculture, environmental protection, water management, geology and mining and transboundary cooperation with France and Switzerland. Department 9 (Landesamt für Geologie, Rohstoffe und Bergbau) acts as Regional Geological Survey and Mining Authority in the State of Baden-Württemberg. The Regional Geological Survey collects, keeps record of and evaluates data about the substratum incl. groundwater, geothermal energy, geo-hazards and mineral resources. The public, e.g. government and administration bodies, companies, scientific institutions and citizens, has access to the survey´s geo-data and information. The survey´s geological data and information are applied in the fields of

- regional and national planning: urban land-use planning, regional planning;
- securing the supply of resources: raw materials and mining, drinking, mineral and thermal water; geothermal energy
- environmental impact studies and inspections
- environmental protection, especially groundwater and soil.

The surveys core skills include integrated, cross-disciplinary and transboundary geological mapping and modelling and data management in 2 and 3 dimensions. It provides data bases, information and knowledge for state-wide geoscientific data, e.g. the state-wide borehole database. The surveys products primarily targeted at administration, raw material industry and science in the water and geothermal energy sector.

Profiles of key staff members

Dr. Wolfgang WERNER (male): Since 1998: Head of Division of Economic Geology at the State Geological Survey of Baden-Wuerttemberg. 1989 – 1998: project manager for mineral planning at the State Geological Survey of Baden-Wuerttemberg. 1985–1989: research contract at the University of Goettingen, thesis on the genesis of Devonian SEDEX deposits. 1980–1985: Project geologist with BP

Minerals, key activities were tungsten and base-metal exploration. 1974–1980: studies of geology at the University of Munich with key activities on economic and structural geology

Dr. Jens WITTENBRINK (male): He is expert for economic geology, regional planning and maintenance of the raw-material-data base at LGRB. He studied geology and earned a diploma and PhD degree at the University of Clausthal-Zellerfeld. After working in Chile for a gold-exploration project he came 2008 to the LGRB. The main task of his work at the LGRB is the mapping of raw materials and the compilation of the “Map of Raw Materials of Baden-Wuerttemberg 1 : 50 000” and all corresponding database works.

Publications

WERNER, W., KIMMIG, B., TSCHERNAY, P., WITTENBRINK, J., BOCK, H. & KLEINSCHNITZ, M. (2013): Rohstoffbericht Baden-Württemberg 2012/2013. Bedarf, Gewinnung und Sicherung von mineralischen Rohstoffen – Dritter Landesrohstoffbericht. – LGRB-Informationen, **27**: 204 S., 228 Abb., 7 Tab.; Freiburg i. Br. (L.-Amt Geol., Rohst. Bergb. Baden-Württ., Hrsg.).

WERNER, W., WITTENBRINK, J., BOCK, H. & KIMMIG, B. (2013), unter Mitarbeit von GRÜNER, F., STEIN, K. J., KOCH, R., HILDEBRANDT, L. & REIFF, W.: Naturwerksteine aus Baden-Württemberg – Vorkommen, Beschaffenheit und Nutzung. – 765 S., 1248 Abb., 45 Tab.; Freiburg i. Br. (L.-Amt. Geol., Rohst. Bergbau, Hrsg.). – ISBN 978-3-00-041100-7.

WERNER, W., KIMMIG, B., LIEDTKE, M., KESTEN, D. & KLEINSCHNITZ, M. (2006): Rohstoffbericht Baden-Württemberg 2006. – LGRB-Informationen, **18**: 202 S., 21 Abb., 15 Tab., 1 Kt.; Freiburg i. Br. – [Landesamt f. Geologie, Rohstoffe und Bergbau, Hrsg.].

WERNER, W., KIMMIG, B., BRASSE, A., BOCK, W. D., FINGER, P., TRAPP, C., SCHLOZ, W., WEINZIERL, W., DENNERT, V., FROMM, F., BOCK, H., KÖBERLE, G., KÜCK, J. & ANDRÄ, H. (2002): Rohstoffbericht Baden-Württemberg 2002. Gewinnung, Verbrauch und Sicherung von mineralischen Rohstoffen. – L. Amt Geol., Rohst. u. Bergb. Baden-Württ., Informationen, **14**: 92 S., 58 Abb., 12 Tab., 1 Anh.; Freiburg i. Br.

WERNER W. (2000 a): Regional-planning-related exploration for non-metallic minerals - a case history from southwestern Germany. – Z. angew. Geol., **46**: 3–14, 11 Abb.; Hannover.

DASEN, E. & WERNER, W. (1985): Exploration for strata-bound base-metal deposits in the Rhenish Massif (FRG) – The application of combined lithogeochemical and palaeogeographical exploration methods for Meggen-Rammelsberg-type deposits.- 39 S., 25 Abb.; Commission of the European Communities, no. MSM 014 D [unpublished final report]; Kassel.

WITTENBRINK, J. & WERNER, W. (2010) mit einem Beitrag von SELG, M.: Erläuterungen zu den Blättern KMR 50 L 7910/L 7912 Breisach a. R./Freiburg i. Br.-Nord. – 258 S., 35 Abb., 10 Tab., 2 Anh., 2 Kt. . – Freiburg i. Br. (Landesamt f. Geol., Rohst. u. Bergbau, Hrsg.).

WITTENBRINK, J. (2015) mit Beiträgen von W. WERNER: Erläuterungen zu den Blättern L 7126/L 7128 Aalen/Nördlichen (Südteil) und L 7326/L 7328 Heidenheim a. d. Brenz/Höchstädt a. d. Donau.– 207 S., 41 Abb., 10 Tab., 2 Kt. – Freiburg i. Br. (Regierungspräsidium Freiburg, Landesamt f. Geol., Rohst. u. Bergbau, Hrsg.).

Involvement in other relevant European and national projects

- State Mineral Report, data acquisition and ascertainment (2002, 2006, 2013, 2019): mining activities, raw material production, assessment of relevant mineral deposits in the state of Baden-Wuerttemberg
- Interreg project Regio Mineralia, INTERREG V Oberrhein (2014-2020)

Relevant infrastructures

- LGRB Map Viewer:
  http://maps.lgrb-bw.de/?view=lgrb_kmr,
  http://maps.lgrb-bw.de/?view=lgrb_rohstoffabbau,
  http://maps.lgrb-bw.de/?view=lgrb_uek350_rohstoffe
- LGRB economic mineral statistics:
  http://www.lgrb-bw.de/rohstoffgeologie/rohstoffgewinnung

17. Federal Institute for Geosciences and Natural Resources (BGR)

The Federal Institute for Geosciences and Natural Resources (BGR) is the central geo-scientific authority providing advice to the German Federal Government in all georelevant questions. The BGR is a federal institute accountable to the Federal Ministry for Economic Affairs and Energy (BMWi) of Germany. BGR provides neutral and independent advice and information about all geoscientific and natural resource issues.

The BGR's work is supported by a modern scientific-technical infrastructure. Laboratories, collections, equipment and technical expertise are developed and provided as required for executing specific projects. In addition, central technical services such as the library, public relations work and information technology guarantee documentation and target-group oriented provision of data, information and publications.

Concerning related GeoERA raw materials topics the BGR is working in the fields of the economic geology, ore geology and mineralogy, the availability of mineral resources, development cooperation and the exploration of marine raw materials. As consultants to the German Federal Government and the German Industry the BGR continuously analyses and evaluates global mineral resource potentials and markets for metals, industrial minerals and non-metals. The BGR researches and develops new exploration methods and strategies in the run-up to industrial activities, in particular for high-tech metals, critical raw materials and specific industrial minerals. The BGR develops resource and development policy instruments and concepts for utilising mineral resources based on ecological, social and economic criteria. With the DERA (German Mineral Resources Agency) the BGR hosts the central platform for information and consulting services on non-renewable resources (metals, industrial minerals, rocks, and energy resources). This includes expert knowledge of resource efficiency and secondary raw materials.

Within GeoERA RM4 the BGR will lead the WP “Historic mine sites/regions revisited”. The BGR expertise is based on broad in-house expert knowledge on raw materials and experience from a variety of national and international research projects.

Profiles of key staff members

PD Dr. Torsten Graupner (Male): Torsten Graupner holds a PhD in geology with more than 20 years of experience in the fields of mineral resources and leads the BGR research topic “World-wide raw material potentials of metals of strategic economic importance”.
His graduate and post-graduate research at universities in Germany and the University of Toronto (Canada) focused on the genesis of gold and tungsten deposits in Central Asia. Key aspects of his research at the BGR include the characterization of complex non-conventional deposit types in order to identify new potentials of high-tech metal supply. His current research activities focus on the development of innovative concepts for exploration activities for mineral deposits, mining and ore processing.
Role in the project: Torsten Graupner will contribute data on carbonate-hosted ore deposits to RM3B WP5.

Doris Homberg-Heumann (Female): Doris Homberg-Heumann with more than 20 yrs of work experienced is a very qualified member of BGR´s Mineral Economics: Ms Homberg-Heumann is member of the German delegation at the International Study Groups on Lead-Zinc, Nickel, and Copper and holds a vice chair in the Environmental and Economics Committee of the International Nickel Study Group. Moreover, she coordinates BGR's work with regard to the International Study Groups on raw materials.
Role in the project: Doris Homberg-Heumann will support BGR's contribution by compiling data on raw materials supply in particular to RM1 WP2 and WP3.

Dr. Dieter Huy (male): Dieter Huy is a geologist and holds a doctoral degree in natural sciences. He is member of the BGR Mineral Economics team since 1997 and is responsible for BGR's raw material databases.
Role in the project: Dieter Huy will contribute data on commodities to RM1 WP2 and WP3.

Dr. Henrike Sievers (Female): Henrike Sievers is a geologist and holds a doctoral degree in natural sciences from the RWTH Aachen University. She has more than 15 years professional experience in the field of metallic raw materials and joined the BGR Mineral Economics team in 2009. Prior to that, she was working for the copper industry in the field of environment and sustainability and she was a research scientist on metallic raw material flows at the RWTH Aachen University (2000-2005)
Within the BGR Henrike was engaged in several projects and studies on resource availability and criticality, including international working groups. She is member of the Mineral Resources Expert Group of EuroGeoSurveys and the EU SC05 Advisory Group. Henrike was leading work packages in the EU-funded projects Polinares and Minerals4EU and is involved in other EU-funded projects like MICA, SCRREEN or FORAM.
Role in the project: As Leader of RM4, WP7 "Historic mine sites/regions revisited" Henrike Sievers will ensure data migration from RM4 Wp7 to RM1 WP3.

Dr. Michael Szurlies (Male): Michael Szurlies holds a PhD in geology with more than 15 years experience in the fields of energy and mineral resources and leads the unit "Availability of Mineral Resources" at BGR. His unit advises the Federal Government, the German industry and the public on issues related to worldwide exploration and mining activities as well as the availability of mineral resources. Moreover M. Szurlies is key contact person between BGR and the National Geological Surveys of the Federal States of Germany (Bundesländer). M. Szurlies is member of the German delegation at the International Study Groups on Lead-Zinc, Nickel, and Copper and holds a vice chair in the Standing Committee of the Lead and Zinc Study Group and is a member of the Mineral Resources Expert Group of EuroGeoSurveys. His current activities focus on exploration and mining activities on base metals.
Role in the project: As head of unit, M. Szurlies is coordinating the activities of the staff involved in the project and keeps contact to the Federal States of Germany.

Dr. Antje Wittenberg (Female): Antje Wittenberg is a postgraduate natural scientist (Diploma degree in Mineralogy 1993, Doctor degree in natural sciences 1997, both Leibniz University Hannover) and senior scientist with over 20 years of experience on research in raw materials and materials sciences, more than 7 years on academic lecturing as well as 11 years on governmental bodies concerning geological resources. She' s the BGR representative on Raw Materials Supply Group of EU and member of the ad-hoc working group on critical raw materials as well as further European working groups and networks.
In 2008 A. Wittenberg was seconded to BMZ followed by a secondment to the European Commission from 2009 to 2011. As Seconded National Expert she was heavily involved in all aspects on the Raw Materials Imitative, in the development of the European Innovation Partnership on Raw Materials, and the development of the EIT KIC on Raw Materials.

Since 2013 she is also a scientific member of the BGR research group on marine massive sulphides and member of the scientific cruise team of the exploration license Germany holds in the Indic Ocean.
Role in the project: Antje Wittenberg will work in RM4, WP7 and linked WPs.

Involvement in other relevant European and national projects

Type of project/activity	Description
Minerals4EU project	H2020 project www.minerals4eu.eu
MICA project	H2020 project www.mica-project.eu
SCRREEN project	H2020 project www.scrreen.eu
FORAM project	H2020 project www.foramproject.eu
POLINARIS project	FP7 project

Significant infrastructures

Partner	Type	Description
BGR	Laboratories and large equipment's	Geochemical, mineralogical, petrological analytical facilities, incl. XRF, XRD, SEM, EMP
BGR	BLA-GEO	Cooperation and Networking infrastructure of the Federal Authorities and State Geological Services of Germany

18. Geological Survey of Ireland (GSI)

The **Geological Survey of Ireland** (**GSI**) is a division of the **Department of Communications, Climate Action and Environment** (DCCAE). **GSI** is responsible for providing geological advice and information, and for the acquisition of data for this purpose. **GSI** produces a range of products including maps, reports and databases and acts as a knowledge centre and project partner in all aspects of Irish geoscience. It is also active in geoscience research as a funder, partner and research performer. **GSI** serves its customer needs through a range of operational programmes and support services: The Information Management Programme underpins all of our activities in the delivery of geological information to our customers. The Surveying Programmes (Bedrock Geology, Quaternary Geology, Marine Geology and Geophysics) are on-going and provide information to the Applied Programmes, as well as producing maps and reports used directly by a wide range of external customers. The Applied Programmes (Groundwater, Minerals, Geotechnical, and Geological Heritage) are largely project oriented and provide solutions to specific customer needs. The activities of these Programmes help to build their respective databases. The Research Programme is an overarching programme providing funding and research support for geosciences in Ireland.

Profiles of key staff members

EurGeol **Gerry Stanley** PGeo holds degrees in geology (BSc Hons and MSc from University College Dublin and Acadia University Canada, respectively) and in mining engineering (MSc from the Camborne School of Mines). He has worked in the private sector in mineral exploration and development and for government both as a minerals regulator and researcher. He is currently Head of the Mineral Section in Geological Survey Ireland. His interests are in carbonate hosted zinc-lead deposits, mineral construction materials, minerals data management and minerals potential mapping. He is Deputy Chair of the Mineral

Resources Expert Group at EuroGeoSurveys and has served as President (and other roles) in the Irish Association for Economic Geology and the Institute of Geologists of Ireland.

Publications

Type	Reference
Service	Ongoing. Mineral localities in Ireland. https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228
Service	Ongoing. Aggregate Potential Mapping. https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228

GSI contribution

WP2 – data provision over three years. WP3 – participate in workshops on data harmonisation; lead Task 3.4 – Historic Mine Sites; update Irish input to Minerals Inventory. WP5 – input to programme of work and review documentation.

GSI will also provide commentary to WP4 and WP6 without specifying a time input, if requested. In addition GSI will contribute to C + D + E activities, if requested. The latter will primarily be by way of review of documentation and promotional materials (brochures etc.).

Selected publications

Author (sole or joint)

Boni M., G. Balassone, H.A. Gilg and **G.A. Stanley**, 2007. Non-sulphide Zn-Pb mineralization in the Irish Midlands (Tynagh. Silvermines and Galmoy), p. 377 – 380; in Digging Deeper, Proceedings of the Ninth Biennial SGA Meeting, Dublin 2007. Published by IAEG. 1633pp.

Cox, W. and **Stanley, G.** 2004. Gold in Ireland. CD publication.

Doyle E., A.A. Bowden, G.V. Jones and **G.A. Stanley**, 1992. The Geology of the Galmoy zinc-lead deposits, Co. Kilkenny, p. 211 – 225; in The Irish Minerals Industry 1980 – 1990. Published by IAEG, Dublin. 436pp

O'Connor, P.J. and **Stanley, G.A.** 1997. Ireland: a world class Zn-Pb province. Notes et Mémoires du Service Géologique Maroc. No. 388, p. 75-84.

Stanley G.A., 1990. Mineral Exploration of the Limerick Basin, including 12 maps. GSI Report Series 90/1 (Mineral Resources). 109pp.

Stanley G.A., V. Gallagher, F. Ní Mhairtín, , P. Lally, E. Doyle and L.P.C. Farrell, 2010. Historic Mine Sites: Inventory and Risk Classification, Volume 1; including CD with data and 6 Appendices. Geological Survey of Ireland and Environmental Protection Agency. 160pp.

Stanley G.A. and G. Earls, 2011. Mineral Deposits Map of Ireland.

Editor or joint editor

North Atlantic Minerals Symposium, Extended Abstracts, 1999. Edited by **G.A. Stanley**. 194pp.

Europe's Major Base Metal Deposits, 2003. Edited by J.G. Kelly, C.J. Andrew, J.H. Ashton, M.B. Boland, G. Earls, L. Fusciardi and **G.A. Stanley**. Published by IAEG, Dublin. 552pp.

North Atlantic Minerals Symposium and International Exploration Geochemical Symposium, 2003. Abstracts volume. Edited by **G.A. Stanley**. 140pp.

Digging Deeper, Proceedings of the Ninth Biennial SGA Meeting, Dublin 2007. Published by IAEG. 1633pp. Forty-eight editors including **G.A. Stanley**.

Involvement in other relevant European and national projects

Type of project/activity	Description
Project: Minerals4EU	GSI was a partner to this Europe wide project which delivered the EU-Minerals Knowledge Data Platform.
Project: ProSUM	GSI was a third party to this Europe wide project which delivered the EU-Urban Mine Knowledge Data Platform. GSI's contribution centred on CRM in mine waste.
Project: Characterisation of Mining Waste	A preliminary study on the content of mine waste in Ireland with special reference to CRM. A research project funded by GSI and carried out by Aurum Exploration Services Ltd.

19. Geological Survey of Belgium GSB-RBINS

The Geological Survey of Belgium (GSB) is a research and service department of the Royal Belgian Institute for Natural Sciences (RBINS). The GSB-RBINS raw material group has developed an expertise in metallogeny and applied mineralogy. Its expertise covers a wide range of mineral resources, including phosphate deposits (Belgium, Burundi, South Africa), Iron, Zinc and Lead deposits (Belgium) and copper, cobalt and manganese (DR-Congo, New Caledonia, Burkina Faso and South Africa). Applied research at GSB-RBINS also includes advancing spectrometric techniques (Raman, infrared absorption, LIBS) combined with geochemical analyses for the characterisation of critical minerals, with an emphasis on their application on complex and heterogeneous ores.

The GSB-RBINS raw material group has been involved in numerous joint projects, financed both by European and national institutions (including EuroGeoSource, AEGOS, GECO, One Geology Europe, GESTCO, PSSCCS projects I and II, Minerals4EU, MICA, FORAM). The RBINS-GSB-RBINS also maintain several raw materials related public web services (http://gisel.naturalsciences.be/gisel/gisel.html; www.gecoproject.org, http://www.minerals4eu.eu), and is managing the most active communication platform for Geoscientists in Belgium and Luxembourg (http://www.blugublg.be). GSB-RBINS is also currently the national data provider for Minerals4EU knowledge data platform.

Profiles of key staff members

Yves Vanbrabant (Male) is a geologist with 19 years of experience mainly focusing on the Belgian subsurface. His PhD topic was related to the Geodynamics evolution of the Variscan fold-and-thrust belt in Belgium by combining field structural observations with finite-element modelling of sedimentary basin deformation. He joined the Geological Survey of Belgium in 2004 where he acted as a project officers. Amongst the most relevant projects for the MEET proposals, two studies were conducted for the Walloon Government on: 1) the evaluation of the deep geothermal potential of the Walloon subsurface; 2) the risk evaluation and their mitigation of deep geothermal projects. He was also a member of the technical follow-up committee for the reconversion of the Havelange borehole. Currently, Yves Vanbrabant is a member of the BruGeo FEDER team at GSB in charge of the exploration and the evaluation of the geothermal potential of the Brussels Capital Region. Yves Vanbrabant has been promoted as the 'Acting Director of the Geological Survey of Belgium' in 2015.

Christian Burlet (male): obtained his Master in Geology in 2002 from the University of Liège (Belgium). He started his career at the Geological Survey of Belgium in 2007 in applied Mineralogy (DRC oxidized ores), followed by FP7 and H2020 CSA projects on raw materials (Minerals4EU, MICA, FORAM). He is a member of the EuroGeoSurveys Minerals and Raw Materials Expert Group and the DG-Grow Raw Materials Supply Group. He is currently working on the Brugeo FEDER project (geothermie.brussels) that aims to develop geothermal energy in Brussels.

Thierry Leduc (male): PhD in Sciences (Mineralogy) (2013, University of Liège, Belgium). Since 2001, he has been working as mineralogist at the RBINS, managing collections and related databases. He is also in charge of the laboratories at the GSB.

Thomas Goovaerts (male): M.Sc. in Geology (2012, University of Leuven, Belgium). He is working as geologist technician since 2014

Marleen De Ceukelaire (female) : Msc in Sciences (University of Gent , 1985) is conservator of the collections geology at the Royal Institute of Natural Sciences – section Heritage.

Publications

Type	Reference
Product	Digital geological map of Belgium (1:40000) https://www.naturalsciences.be/en/science/do/94/page/2453
Product	GISel : Belgium geological information system (GSB samples and core data) http://gisel.naturalsciences.be/gisel/gisel.html
Publication	Burlet, C, Vanbrabant, Y (2015). Study of the spectro-chemical signatures of cobalt-manganese layered oxides (asbolane–lithiophorite and their intermediates) by Raman spectroscopy. Journal of Raman Spectroscopy 46:941–952
Publication	Decrée, S., Ihlen, P.M., Schiellerup, H., Hallberg, A., Demetriades, A., Raha, M., Soesoo, A., 2017. Phosphate and associated strategic elements: a European perspective. SEG 2017: Ore Deposits of Asia: China and Beyond, Beijing, China.

Involvement in other relevant European and national projects

Type of project/activity	Description
Activity 1	MICA H2020 project
Activity 2	FORAM H2020 Project
Activity 3	Mineral4EU FP7 project
Activity 4	Eurogeosource FP7 project

20. Mining and Geological Survey of Hungary (MBFSZ)

The **Mining and Geological Survey of Hungary** (MBFSZ) was established on July 1st, 2017 by the merger of the Mining and Geological Office of Hungary (MBFH) and the Geological and Geophysical Institute of Hungary (MFGI). The Survey is a central governmental body supervised by the Ministry of National Development. It is supporting all state activities related to mining and geology and its mission is to support Hungary's economic competitiveness, the effectiveness of public services and policy by providing up-to-date geoscientific information for the government and the society relying on nearly 150 years traditions of geological-geophysical research and of mining administration. As a national geological survey MBFSZ is responsible to advance geoscientific knowledge of Hungary's landmass by systematic acquisition, interpretation, management and dissemination of geoscientific data. The current number of employees is 241, most of them highly qualified researchers in various fields of geology, geophysics, environmental sciences, mining administration and IT technology.

MBFSZ's core skills include geoscientific data management and integrated 3D geological-geophysical modelling, as well as national potential assessments for various mineral resources and preparation of concessions, especially geo-energy (hydrocarbon, geothermal, coal), study of geohazards, environmental geology and hydrogeology. The survey also maintains and operates several national geoscientific observatory and monitoring systems, e.g. magnetic, gravimetric, groundwater, etc. MBFSZ is a designated state advisor of geoscientific matters related to the Mining Act (1993 XLVIII) and the Governmental Decree 267/2006 (XII. 20.) defining state geological tasks.

Profiles of key staff members

Zoltán Horváth (M) Head of the Department of Mineral Resource Management and Concession Affairs

Zoltán Horváth (Phd) Dr. is a geologist, expert of general geology and soil-engineer and soil expert. Previous researches were classical geological type ones including quaternary sedimentological and paleo-environmental researches. Sedimentological and paleopedological, humus conservation researches on archeological sites brought him closer to the study of the land use aspects. He worked 2 years on Environmental Impact Assessments related to domestic hydrocarbon concessions as a project leader. This work allowed him to have deeper insight into the conflict management of different aspects such as scientific purposes (geology, geography, groundwater, mineral resources), interest of different authorities (mining, environmental, land administration, etc.) and interest of other stakeholders. Later on he had many experience on the potential assessment of the non-metallic solid mineral resources including aggregates primarily from the methodological, supply evaluation and legal-regulatory point of view. The SNAP SEE project was an excellent field for developing the analysis of the multi-sectoral analysis (mineral resources-, water- and waste-management), preparation of guidance for aggregates planning in co-operation of project partners. As a project leader of the harmonization of national mineral resources classification and inventories with international standards he has experiences in the classification of solid mineral resources in the CRIRSCO family (CRIRSCO, JORC, PERC) and in the UNECE framework (UNFC-2009) and regarding the possible harmonization steps. As a EuroGeoSurveys MREG UNECE-mineral classification Task Team leader coordinating a questionnaire survey and the evaluation of data and the regular participation on classification meetings he has experiences on this field on EU and global level as well.

Role in the project: Z. Horváth will bring all his experience about a number of national projects related the mineral resources and two EU-projects on the sustainable management of aggregates and the related mineral policies. He will mainly contribute to the benchmark analysis of existing national minerals legislation and policies as well as international standards (CRIRSCO system and UNECE framework). The contribution to the stakeholder consultations and the dissemination activity of the results will be also important. Experience in potential assessment of mineral resources will also be applied.

List of publications, and/or products, services, patents or achievements

1. HORVÁTH, Z., MIKO, S., SÁRI, K., DEDIĆ, Ž. 2014: A Vision of Best Practices for Aggregates Planning in South East Europe, SNAP-SEE project, www.snapsee.eu. DOI: 10.5474/snapsee-WP5-EN, Ljubljana, 56 p
2. HORVÁTH, Z., SÁRI, K. 2014: Joint vision on the optimal contents of aggregates plans. – International Conference on Sustainable Aggregates Planning in South East Europe, Conference Proceedings, 54–60.
3. HORVÁTH, Z., SÁRI, K., MIKO, S., DEDIĆ, Ž. 2014: Aggregates planning in SEE countries based on multi-sectoral analysis and a guidance. – International Conference on Sustainable Aggregates Planning in South East Europe, Conference Proceedings, 60–67.
4. Zoltán Horváth, Katalin Sári, Zsolt Kovács, Anita Jobbik, László Zilahi-Sebess, Annamária Nádor, Ágnes Gulyás, György Falus, Zoltán Püspöki, Gábor Szepessy, Mrs. Gombár Gizella Forgács, Kálmán Török, Zoltán Lantos, Daniella Tolmács (2013): Overview of international mineral resources classification systems – foundation of the domestic harmonization. Assessments of the Hungarian mineral resources, research isseues and mining and exploitation possibilities, Renewel of mining Hungary, Anket series, Special issue, 5-24., Pécs.
5. HORVÁTH Z., SÁRI K. (2014): The progress of the harmonization of the national mineral resources classification system by the international standards – based on the experiences of the SNAP SEE project. HUNGEO Conference proceedings, 66–69., Debrecen.

List of projects/activities (organisational level)

1. SNAP-SEE: Sustainable Aggregates Planning in South East Europe. Multi-sectoral analysis of the state of the aggregates planning in 13 countries. MFGI was WP leader regarding the

national/regional planning. The joint vision of the aggregates planning and the guidance document for the SEE region was prepared. It was done in co-operation with partners from 13 countries. Two national stakeholder consultations were organized and the results were built in the handbook about the joint vision (www.snapsee.eu).
2. Mine4EU: Minerals4EU (Minerals Intelligence Network) is a EU-wide project with the purposes of networking, foundation of a knowledge platform, setup of a permanent body. In co-operation with the Hungarian office for Mining and Geology MFGI serves data on mineral resources and the regulatory framework. Case study was prepared regarding the secondary aggregates (mining waste).
3. National project. Since 2013 the MFGI Team in co-operation with the Hungarian Office for Mining and Geology has benn working on the mineral potential assessment of the non-metallic soild raw materials including construction aggregates. The project metholodology incolves the analysis of the mineral deposits access considering the limitation factors.
4. T-JAM (2009-2011) helped to enhance the cooperation between the strategic thermal water resources managers and to recognize the future perspectives for the use of geothermal energy in the transboundary area of north-east Slovenia and west Hungary. MFGI was a partner and took part in the critical evaluation of the existent legislations, construction of databases, models and joint documents including suggestions for the sustainable use of this type of mineral resource.
5. Minatura: The overall objective of MINATURA 2020 is to develop a concept and methodology (i.e. aharmonised European regulatory/guidance/policy framework) for the definition and subsequent protection of “mineral deposits of public importance” in order to ensure their “best use” in the future. Providing a policy planning framework that comprises the “sustainability principle” for mining is the key driving force behind MINATURA. MFGI is a WP leader, multisectoral analysis, guidance and a joint vision will be done (2015-2017).

Kovács Gábor Dr. (M) Deputy head of division, Mining and Geology Survey of Hungary

2017: deputy head of division, Mining and Geology Survey of Hungary, Division of Geological and Geophysical Data Center. 2013 to 30 June 2017 deputy head of division, Hungarian Office for Mining and Geology, Division for Geology and Data Management. 2010-2013 head of department, Hungarian Office for Mining and Geology, Dept. of Data Management. 2007-2010 GIS expert, Hungarian Office for Mining and Geology, Dept. of Data Management. 1995-2006 head of department, Hungarian Geological Survey, Dept. of Computing Services (activity: geoinformatics, GIS, geological databanks, data processing). 1994-1995 geologist, Hungarian Geological Survey, Dept. of National Geological Databank (activity: GIS, geological databanks, data processing). 1991-1993 research fellow (geomathematics, data processing), Geological Institute of Hungary. 1987-1990 consultant, head of geochemical team (geological mapping, geochemical exploration), 3rd Hungarian-Cuban Geological Expedition, Cuba. 1984-1987 research associate (geological mapping, petrology), Geological Institute of Hungary.

Role in the project: Information for mineral resources concerning exploration areas and mining leases.

List of publications, and/or products, services, patents or achievements

1. MAROS GY., KATONA G., Ó.KOVÁCS L., KOVÁCS G., SZENTPÉTERY I., OROSZ L., VARGA A., MEZEI É. 2014: Renewal of the state core sample collections in Hungary (in Hungarian, with English abstract). Geol. Geoph. Inst. Hung. Ann. Rep. of 2012-2013: pp. 177-182.
2. Ó.KOVÁCS L., SZEBÉNYI G., KOVÁCS P.G. 2008: Common and extreme concentrations of ore-forming chemical elements in the Recsk complex. – In: FÖLDESSY J., HARTAI É. (eds): Recsk and Lahóca. Geology of the Paleogene Ore Complex. Publications of the University of Miskolc, Series A, Mining, vol. 73, pp. 167-191.
3. SZEBÉNYI G., KOVÁCS P.G., Ó.KOVÁCS L. 2008: Exploration methodology as a factor of geological uncertainty in evaluation of Recsk Deep’s ore mineralizations. – In: FÖLDESSY J., HARTAI É. (eds): Recsk and Lahóca. Geology of the Paleogene Ore Complex. Publications of the University of Miskolc, Series A, Mining, vol. 73, pp. 145-166.
4. THIÓ-HENESTROSA S., EGOZCUE J.J., PAWLOWSKY-GLAHN V., Ó.KOVÁCS L., KOVÁCS P.G. 2008: Balance-dendrogram. A new routine of CoDaPack. Computers and Geosciences, vol. 34, no. 12, pp. 1682-1696. doi:10.1016/j.cageo.2007.06.011

5. Ó.KOVÁCS L., SZEBÉNYI G., KOVÁCS P.G., FÖLDESSY J. 2007: Statistical distributions of ore elements in the Recsk ore field, Hungary. Acta Mineralogica-Petrographica, Szeged, vol. 47, pp. 1-16.

List of projects/activities (organisational level)

1. Participation in the GEIXS (Geological Electronic Information Exchange System) project aimed at increasing the use of European geological information.
2. Participation in the SARMa project aimed at developing a common approach to Sustainable Aggregates Resource Management across South East Europe

Gizella Gombárné Forgács (F) Professional Coordinator of Mineral Resource Management

Gizella Gombárné Forgács received MSc. degree in geology on Mining Faculty of Miskolc University (NME) in 1981. She started to work as classical geologist on different departments of Hungarian State Geological Institute (MÁFI), like Budapest Local Geological Survey and Hydrocarbon Geology Department. Since foundation of Hungarian Geological Survey (MGSZ) in 2000 she had been working at Mineral Resources Inventory Department of MGSZ dealing with preparation of the annual resource inventory of non-metallic solid minerals of Hungary. Since 2007 from the foundation of Hungarian Office for Mining and Geology she has been working as a Head of Mineral Resources Inventory Department, managing the State Mineral Resources database, which is updated yearly for the annual mineral resources inventory. Between 2007-2009 she took part on several meetings of UN UNECE expert team dealing with terminology harmonization of fossil energy- and mineral resources in Geneva. /UNECE Ad Hoc Group of experts on Fossil Energy and Mineral Resources Terminology/ From 2017 she is working as responsible coordinator on preparation of annual inventory of mineral resources, according to the tasks described in the referring laws in the frame of the new organization: Mining and Geological Survey of Hungary.

Role in the project: Data production (from available data) for national mineral resources according to the national legislation.

List of publications, and/or products, services, patents or achievements:

1. Fodor B., Gombárné Forgács G., Kontsek T., et all. 2002: Mineral resources of Hungary. Information on mineral resources of Hungary according to status of January 01, 2002.
2. Balogh Z., Drazsdik L., Forgó Z., Gombárné Forgács G., et all. 2002: Non-metallic mineral resources of Hungary January 01, 2002.
3. Fodor B., Gombárné Forgács G., Kontsek T., et all. 2003: Mineral resources of Hungary. Information on mineral resources of Hungary according to status of January 01 2003.
4. Gombárné Forgács G., Kontsek T. 2004.: Changes of known and registered mineral resources of Hungary during the past 10 years. /Bányászati és Kohászati Lapok 2004 2.-3. 25-28/
5. Fodor B., Gombárné Forgács G., Kontsek T., et all. 2004: Mineral resources of Hungary. Information on mineral resources of Hungary according to status of January 01, 2004.

Katalin Sári (F) Concession Desk Officer

Katalin Sári is an earth scientist and English-Hungarian special translator in natural sciences working for the Mining and Geological Survey of Hungary at the Department of Mineral Resource Management and Concession Affairs. She is involved in several projects assessing the mineral potential of Hungary e.g. non-metallic mineral, coal, secondary raw material and soil amendment minerals potential. In case of the latter one she is the project leader. She investigates the classification of mineral resources and the alignment possibilities of national and international classification systems in a national project and participates in international fora with similar aims (UNECE-EGRC, EGS MREG). Katalin took part in SNAP-SEE and Minerals4EU projects and is currently participating in MINATURA, FORAM, COST Minea, MICA and MINLAND projects, in case of the latter two as national leader.

Role in the project: Katalin Sári will bring all her experience about a number of national projects related the mineral resources and two EU-projects on the sustainable management of aggregates and the related mineral policies. She will mainly contribute to the benchmark analysis of existing national minerals legislation and policies as well as international standards (CRIRSCO system and UNECE framework). The contribution to the stakeholder consultations and the dissemination activity of the results will be also important. Experience in potential assessment of mineral resources will also be applied.

List of publications, and/or products, services, patents or achievements:

1. SARI, K. 2017: Multisectoral analysis of the relevant legislations – Introduction to the work package 3 of MINATURA2020 project. Conference Book of the 10th Annual Meeting of Aggregate Quarry Operators, pp. 34–35
2. HORVATH, Z., SARI, K., FODOR, B. 2016: Overview of the international mineral resource classification framework and the reporting standards for solid minerals. Bulletin of the Hungarian Geological Society 146/2, pp. 107–120
3. HORVATH, Z., SARI, K. 2016: The modernisation of the Hungarian non-metallic mineral resource inventory based on the international mineral classification framework and reporting standards. Bulletin of the Hungarian Geological Society 146/2, pp. 147–154
4. PUSPOKI, Z., HAMOR-VIDO, M., SARI, K., SZEILER, R., FANCSIK, T. 2016: The modernisation of the Hungarian non-metallic mineral resource inventory based on the international mineral classification framework and reporting standards. Bulletin of the Hungarian Geological Society 146/2, pp. 155–162
5. HORVÁTH, Z., MIKO, S., SÁRI, K., DEDIĆ, Ž. 2014: A Vision of Best Practices for Aggregates Planning in South East Europe, SNAP-SEE project, www.snapsee.eu. DOI: 10.5474/snapsee-WP5-EN, Ljubljana, 56 p.

List of projects/activities (organisational level)

1. SNAP-SEE: Sustainable Aggregates Planning in South East Europe. Multi-sectoral analysis of the state of the aggregates planning in 13 countries. MFGI was WP leader regarding the national/regional planning. The joint vision of the aggregates planning and the guidance document for the SEE region was prepared. It was done in co-operation with partners from 13 countries. Two national stakeholder consultations were organized and the results were built in the handbook about the joint vision (www.snapsee.eu).
2. MEU: Minerals4EU (Minerals Intelligence Network) is a EU-wide project with the purposes of networking, foundation of a knowledge platform, setup of a permanent body. In co-operation with the Hungarian office for Mining and Geology MFGI serves data on mineral resources and the regulatory framework. Case study was prepared regarding the secondary aggregates (mining waste).
3. National project. Since 2013 the MFGI Team in co-operation with the Hungarian Office for Mining and Geology has benn working on the mineral potential assessment of the non-metallic soild raw materials including construction aggregates. The project metholodology incolves the analysis of the mineral deposits access considering the limitation factors.
4. T-JAM (2009-2011) helped to enhance the cooperation between the strategic thermal water resources managers and to recognize the future perspectives for the use of geothermal energy in the transboundary area of north-east Slovenia and west Hungary. MFGI was a partner and took part in the critical evaluation of the existent legislations, construction of databases, models and joint documents including suggestions for the sustainable use of this type of mineral resource.
5. Minatura2020: The overall objective of MINATURA 2020 is to develop a concept and methodology (i.e. a harmonised European regulatory/guidance/policy framework) for the definition and subsequent protection of “mineral deposits of public importance” in order to ensure their “best use” in the future. Providing a policy planning framework that comprises the “sustainability principle” for mining is the key driving force behind MINATURA. MFGI is a WP leader, multisectoral analysis, guidance and a joint vision will be done (2015-2017).

Publications

1. Zoltán Horváth, Katalin Sári, Zsolt Kovács, Anita Jobbik, László Zilahi-Sebess, Annamária Nádor, Ágnes Gulyás, György Falus, Zoltán Püspöki, Gábor Szepessy, Mrs. Gombár Gizella Forgács, Kálmán Török, Zoltán Lantos, Daniella Tolmács (2013): Overview of international mineral resources classification systems – foundation of the domestic harmonization. Assessments of the Hungarian mineral resources, research isseues and mining and exploitation possibilities, Renewel of mining Hungary, Anket series, Special issue, 5-24., Pécs.
2. HORVÁTH Z., SÁRI K. (2014): The progress of the harmonization of the national mineral resources classification system by the international standards – based on the experiences of the SNAP SEE project. HUNGEO Conference proceedings, 66–69., Debrecen.
3. HORVÁTH, Z., MIKO, S., SÁRI, K., DEDIĆ, Ž. 2014: A Vision of Best Practices for Aggregates Planning in South East Europe, SNAP-SEE project, www.snapsee.eu. DOI: 10.5474/snapsee-WP5-EN, Ljubljana, 56 p.
4. HORVÁTH, Z., SÁRI, K., MIKO, S., DEDIĆ, Ž. 2014: Aggregates planning in SEE countries based on multi-sectoral analysis and a guidance. – International Conference on Sustainable Aggregates Planning in South East Europe, Conference Proceedings, 60–67.
5. Z. HORVÁTH, K. SÁRI: The modernisation of the Hungarian non-metallic mineral resource inventory based on the international mineral classification framework and reporting standards. Bulletin of Hungarian Geological Society. http://epa.oszk.hu/01600/01635/00452/pdf/

Involvement in other relevant European and national projects

Type of project/activity	Description
SNAP SEE/WP Leader	Sustainable Aggregates Planning in South East Europe – contribution to the preparation of Tool Box including data and methodology, stakeholder consultations, planning scheme and guidance with joint vision (FP7, www.snapsee.eu)
MINATURA2020/WP Leader	Concept on Mineral Deposits of Public Importance with preparation and contribution to guidance, joint vision and stakeholder consultation (H2020, www.minatura2020.eu)
MINERALS4EU/Partner	Minerals Intelligence Network with data service, knowledge base, good practices (FP7 - www.minerals4Eu.eu)
Mineral potential assessment of non-metallic solid mineral resources	National project from 2013 with the development of methodology and survey on access to minerals. Reports (2013, 2014, 2015, 2016) are available in the MBFSz Data Repository, Hungary.
Modernization of national inventory harmonized by international systems	National project from 2013 with the development of methodology (bridging for energy and non-energy resources). Reports (2013, 2014, 2015, 2016) are available in the MBFSz Data Repository, Hungary.

Significant infrastructures

Type	Description
digital database	GeoBank: national borehole database with more than 270 000 records http://www.mfgi.hu/hu/node/79
web-map services (WMS, WFS)	various geological (surface and subsurface), geophysical and applied geological maps of Hungary https://map.mbfsz.gov.hu/

21. Service géologique du Luxembourg - Geological Survey of Luxembourg (SGL)

The Service géologique du Luxembourg (SGL) ('Geological Survey of Luxembourg') is a department of the 'Administration des ponts et chaussées' (National roads authority), and hereby under the competence of the Ministry for sustainable development and infrastructures.

Founded in 1936, its main tasks are studies, advisory and research, primarily in the fields of geology, geotechnics, hydrogeology, geomorphology and mineral resources.
These include:

- engineering geology and geotechnical studies for various public works projects;
- geological hazards evaluations;
- geothermal energy investigations;
- mineral resources surveys;
- geological and other geoscientific mapping and related database management;
- geoscientific information management and supply to the public.

The SGL acts as a public service for various national governmental bodies and local communities and has the status of a national survey organization. It is founding member of Eurogeosurveys and national representation of the IUGS.

During GeoERA, the Ministry for sustainable development and infrastructures will act as the research programme owner to which the SGL gives account to, by the intermediate of the directorate of the 'Administration des ponts et chaussées' (National roads authority).

Profiles of key staff members

Robert Colbach (male):
Head of geological survey since 2015. M.Sc. in geology and hydrogeology from the University of Montpellier and Avignon (F) in 1997. Joined SGL im 1997, responsible for general geology, geotechnical investigations, geological mapping as well as geographical information systems, database development and maintenance.
SGL's main administrative and technical responsible during the research projects OneGeology, Terrafirma and PanGeo.

Romain Meyer (male):
Ph.D. in geology from the KU Leuven (B). Romain has a wide expertise in geology ranging from mineralogy, geochemistry to geophysics. He has been associated as researcher to the Massachusetts Institute of Technology MIT, the Norwegian Centre of Excellence for Geobiology, the GeoForschungsZentrum Potsdam, and has lectured general geology and geophysics as professor at the Washington and Lee University prior to joining the SGL in Mai 2017. In the last years, he contributed in numerous international cooperation projects like ESF EuroMARGINS, NSF MARGINS and NSF GeoPRISMS, and participated on different research expeditions e.g. IODP.

Petra Münzberger (female):
Ph.D. in geology and palaeontology. Educated from the Technical University 'Bergakademie' Freiberg (D) in 2002. From 2002 to 2005 she had a research fellowship on geology, geomorphology and settlement history from the University of Regensburg. Worked since 2005 for the SGL as a contractual employee for geological exploration of roads and bridges, hydrogeological exploration, sedimentological and paleontological studies, geological cartography. Joined as permanent staff member in 2017.

Publications

Dejonghe, L., **Colbach, R.**; Goemaere, E. (2017): The lithostratigraphy of the lower Devonian formations of the Eisleck region (northern Luxembourg). Comparison with their Belgian lateral equivalents, Geologica Belgica: 20/1-2.

Kummerow, J., Raab, S., **Meyer, R.** (2017): Understanding physical rock properties and their relation to fluid-rock interactions under supercritical conditions. Geophysical Research Abstracts, Vol. 19., EGU2017-14819-1.

Nozaka, T., Wintsch, R.P., **Meyer, R.** (2017): Serpentinization of olivine in troctolites and olivine gabbros from the Hess Deep Rift. – Lithos, 282-283, 201-214.

Nozaka, T., **Meyer, R.**, Wintsch, R.P., Wathen, B. (2016): Hydrothermal spinel, corundum and diaspore in lower oceanic crustal troctolites from the Hess Deep Rift. – Contributions to Mineralogy and Petrology, 171:53, 1-14.

Meyer, R., van Wijk, J. (2015): The Interdisciplinary Earth: A Volume in Honor of Don L. Anderson*.* The Geological Society of America*, Special Paper 514 and American Geophysical Union, Special Publication 71, 65-85. (INVITED)*

Gillis, K. M., Snow, J. E., **Meyer, R.**, et al. (2014): Primitive Layered Gabbros from Fast-Spreading Lower Oceanic Crust – Nature 505, 204-207.

Involvement in other relevant European and national projects

The SGL also has contributed to the following EU co-funded projects:
Terrafirma, OneGeology, PanGeo

22. GEOLOGICAL SURVEY OF SERBIA (GSS)

Geological Survey of Serbia was formed based on the Mining and Geological Investigations Law („Official Gazette RS“, no. 88/2011) On 29. 06. 2012. Geological Survey of Serbia was formed from Geological Institute of Serbia, organization with a long history. First organization was the Geological Institute of the Kingdom of Yugoslavia, formed in 1930. Geological Survey of Serbia has three geological departments: Fundamental Geology, Mineral Resources, Geotechnic and Hydrogeology, as well as Groups for Geophysical investigation and Laboratory for rocks, ores, and soil and water analysis. Our mission is to create geological, geomorphological, geochemical, hydrogeological and engineering geological maps, geodiversity and geoheritage protection, protection and promotion of the environment, investigation of mineral resource deposits.

<u>GSS role in the project:</u>

Participation in WP3 and involved in the EIT RawMaterial project RESEERVE.

Profiles of key staff members

Jovan Kovačević (male), PhD in Geology, assistant director at the Department of Mineral Resources. Leader and Senior research expert in numerous projects. Researcher of different metallic mineral raw materials in the Eastern Serbia region, particularly: uranium, gold, lead-zinc, copper, bauxite, etc and non metallic mineral raw materials, particularly: corundum, limestone, gabbros and basalt. Member of the Technical Commission for evaluation of the environmental impact studies, since 2009. The Committee member at the Faculty of Physical Chemistry, University of Belgrade for a PhD thesis research in the field of nuclear mineral raw material. Author of more than 70 published scientific and professional papers.

Mihajlo Pandurov (male), B.Sc. in Geology, at the Department of Mineral Resources – group for geophysics. He participated in many projects regarding Mineral Raw Material Research in Libya, Iraq and Serbia. He is experienced in refractive seismic testing for oil exploration, geomagnetic and geoelectric tests for mineral resource exploration and geophysical investigations for hydrogeology and engineering geology including the geophysical borehole and well logging.

Vuk Kasalica (male) B.Sc. in Geology, works at the Department of Mineral Resources. He is involved in different tasks, relating the management of mineral resources, project management and basic geological research of energy mineral resources (Coal, uranium, thorium, petroleum and natural gas). He participates in the preparation of reports and information for the Government in the field of energy mineral resources and also involved in the production of other specialist maps.

Jasmina Beljić (female) M.Sc. in Geology, works at the department of Department of Mineral Resources. She is involved in different tasks and projects such as basic geological research of metallic mineral resources. She is experienced in creating the mineral resource database and maps in ArcGIS. Also, performs mineral resource and ore reserves evaluation and estimation, and modeling of mineral deposits by GDM software. She participates in preparation of technical reports and studies.

Publications

- Tereesh M.B., Radenković M.B., Kovačević J., Miljanić S.S., 2013: Terrestrial Radioactivity of the Jabal Eghei Area in Southern Libya and Assessment of the Associated Environmental Risks. *Radiation Protection Dosimetry,* 153, 4, 475-484.
- Kovačević J., Tereesh M.B., Radenković M.B., Miljanić Š.S., 2013: Discovery of uranium mineralizations in the rhyilite-granite complex in the Jabal Eghei area of southern Libya. *Journal of the Serbian Chemical Society,* 78, 5, 741-78.
- Komarnicki S., Dalub H.S., Marović M., Vasić N., Kovačević J.,. Grubić A., Tasić Z., Stejić P., Komatina M., 2007: Explanatory booklet for the Geological map of Libya 1:250 000 Sheet: JABAL ATTI NF 33-2 , str. 180, Beograd-Tripoli.
- Komarnicki S.,. Menem A.T., Marović M., Vasić N., Kovačević J., Grubić A., Tasić Z., Stejić P., Komatina M., 2007: Explanatory booklet for the Geological map of Libya 1:250 000 Sheet: JABALI TUMMU NF 33-6, str. 107, Beograd-Tripoli.
- Toljić M., Marović M., Vasić N., Rončević G., Kovačević J., Grubić A., Štrumberger V., Petković P., Komatina M. 2007: Explanatory booklet for the Geological map of Libya 1:250 000 Sheet: MOURIIZIDE NF 33-3, str. 326, Beograd-Tripoli.

Relevant previous projects or activities, connected to the subject of this proposal

- Creating the Geological Map of Libya
- Basic and detailed research of metallic, non metallic and energetic mineral raw materials
- Creating the geological and radiometric maps of different scales and purposes
- Creating the National database of metallic, non metallic and energetic mineral raw materials
- Preparation of instructions and standards for creating and production of metalogenetic, mineragenetic and energetic maps for different purposes

23. Albanian Geological Survey (AGS)

Albanian Geological Survey is a government organization, which perform its activity in the field of geosciences, according to law 111/2015, which defines the role of AGS, as scientific and technical adviser of Albanian government. According to the medium term strategy, the AGS aims to perform the rational land-use and comprehensive environmental management of the urban areas, to carry out accurate mineral resource assessments, to monitoring the exploration permits, to supply and protect the water resources, to respond to the engineering geology services. AGS is focused on sustainable management of mineral

resources, assessment of geohazards, exploitation of minerals in relation to water quality, modelling and elaboration of digital geological data. Its main activities encompass the stability of the riverbed, coastal erosion, sedimentation, preventive measures.
The new law approved on 2011, extends and enlarge the competences of AGS on monitoring of explorations permits.
In the framework of EGS strategy for mineral resources the Albanian Geological Survey AGS maintain a fruitful collaboration with several institutions that have in their focus mining activity such National Agency of Natural Resources, Institute of Geo Sciences, Polytechnic of Tirana- Geology and Mining Faculty and foreign Institutions as well.

The staff of Albanian Geological Survey is composed by specialist qualified in Albania and cross border countries, in short and long trainings. They are active participants in national and international congresses, conferences and workshops. They have numerous publications on scientific journals, bulletins, annuals and different presentations/ articles or posters in international scientific events, related with project objectives. Members of staff have experience as lectures in the Faculty of Geology and Mine, Polytechnic University of Tirana.

AGS role in project
AGS as one of the partners in project, will work to be in line with objectives and duties written down on this proposal. By low the AGS is authority for assessments of the natural resources, monitoring and licensing of raw materials deposits. This way AGS will be involved in (i) gathering the raw mineral data (ii) harmonization of raw material data (iii) provide to leader the accurate data (iv) update the raw mineral data in actual mining database. AGS performance is guaranteed by the expertise of its own trained staff and facilities created on the AGS.

Profiles of key staff members

Dr. Lavdie Moisiu(female) : PhD at Earth Sciences. Her master is in GIS field near University of Lecce Italy. She is working on Geoinformatization Directorate since 1998 and has accumulated a large experience as GIS expert. The main activities are related to mapping, development and implementations of GIS on different field's of geology as mineral resources, hydrogeology, geo environmental etc. Provide assistance on elaboration and established of different database; Expert on METADATA preparation. She has been coordinator for many international projects. She is involved in different tasks related to the sustainable management of raw materials, environmental issues and geoheritage.

Dr. Sirelda Bele(female). She has PhD in Mineral modelling. He is graduated as GeoInformaticien (GIS expert) near the Faculty of Mining and Geology in Polytechnic University of Tirana She works on the elaboration of data sector. Has a experience as GIS expert and her expertise is related with fata mining.

Msc. Dashamir Gega (male) Expert Msc in Geology. He is graduated as Geologist near the Faculty of Mining and Geology in Polytechnic University of Tirana Actually works as geologist in Raw Materials sector. Has participate in international projects: The Minerals4EU; Mineral Intelligence Capacity Analysis (MICA). His fields of expertise are: the studies in the field of metal and non-metallic minerals; exploration and exploration projects in the Field of Minerals and their Implementation; Assessments of metal and non-metal mineral reserves

Eng. Bilal Koçi. (male) Senior. He is graduated as Geologist near the Faculty of Mining and Geology in Polytechnic University of Tirana; He has worked for 15 years on mineral resource directorate. Actually he is chief of permitting sector. On its activity are included tasks such assessment of mineral resources, monitoring the mining companies activities, He is contact person for AHS to the ministry of Energy and he has to report all the development on mineral resources.

Eng. Xhevdet Fero (male) Mining engineer. He has large experience on mining works,. Actually he wprks near the monitoring sector of permits neat Mineral resources Directorate.

Eng. Aurora Senior (female) Young Geologist . She works in Mineral resources Department. She is young geologist. Her duties are related to extracting the mining data by old geological reports and inserting those to database of mineral resources. She has worked inpreparation of different mineral resources map as part of teamwork.

Publications

1. Industrial Minerals and Rocks of Albania.Mineralet Industriale te Shqiperise. Author: L.Hoxha,P.W .Scott, J .M. Eyre, D.Gega (Geological Society of London 2003)
2. M.Sc.Eng Lavdie Moisiu; Prof. Sokol MATI; Math. Albert AVXHIU *"Sustainability development of aggregates supply in cross border areas based on the National, Regional and EU Policies''* Ljubljana, Slovenia, 19-23 September 2011
3. Moisiu L, Lekaj Gj and Mati. S. "Planning – "A need for sustainable use of aggregates" Tirana Albania XX Congress of Geolgoy . October 2014
4. Lavdie Moisiu, Sokol Mati, Gjovalin Lekaj, Xhevdet Fero "The debate with the stakeholders and its importance in the planning process of aggregate supply" (pg 36-40)
5. Lavdie Moisiu; Albert Avxhi; Edlira Plaku. "Digital Data And Their Storage In Albanian Geological Survey" International conference on Geology in Digital Age" 14-16 september, Belgrad, Serbi.

1. ***Involvement in other relevant European and national projects***On-going project
    - H2020 MICA: partner;
    - EIT RawMaterials – RESEERVE: partner;
    - The Minerals4EU Project
    - Mineral Intelligence Capacity Analysis (MICA)
    - European Marine Observation and Data Network (EMODnet)
2. Finished project
    - Sarma project: partner
    - Snap - See project: partner

Significant infrastructures

AGS is almost well-equipped with software and hardware. Te department of Data Processing (DGIS)is established since 1997. The staff is well trained and directorate of GeoInformatization is responsible for maintance of digital data and intranet platform (Digital archive, GIS data,etc

Capable to work on web application
Archive digital platform
Mining permits database
Mineral database.

24. Czech Geological Survey (CGS)

Czech Geological Survey (CGS) (Česká geologická služba) is a research institute of the Ministry of Environment of the Czech Republic. The mission of the CGS, the history of which has started in1919, is the performance of the state geological survey in the Czech Republic and research in geosciences. CGS leads and participates in basic and interdisciplinary research projects.
The main fields of expertise include:

- Geological research and mapping (regional geological research, geological and thematic mapping, paleontologic and biostratigraphic studies, geological heritage)
- Geochemistry and environmental studies (interaction atmosphere – biosphere –hydrosphere – geosphere, monitoring of element budgets, acidification of forest soils, organic pollutants, radon risk)
- Mineral resources and mining impact assessment (identification and assessment of resources, regional raw material policies, mitigation of mining impacts)
- Applied geology and natural risks (hydrogeological mapping and research, geological hazards, radioactive waste disposal, support of development planning)

The system of CGS district geologists and associated specialists assists in acquisition and assessment of data on the geological composition of the state territory and the CGS provides expert information to the authorities for the political, economic and environmental decision-making.
Research of the mineral resources is focused on sources of critical and national strategic raw materials. The research is supported by national raw materials knowledge base (large geological archive – Geofond, spatial databases from which most of them support INSPIRE) and laboratory with wide spectrum of chemical and mineralogical analysis. Main solved project “CEEMIR” Centre for Economic and Ecological Mining of CRM fits all solved topics associated with CRM mineral deposits and their indicators, include geoinformatics, metallogeny, mineralogical and geochemical properties, ore body modelling, mineral processing and economy of CRM.

Profiles of key staff members

Ivo Sitenský (male), holds RNDr. degree (1976) in Economic Geology from Faculty of Sciences, Charles University, Prague, Czech Republic, CSc. degree (1985) in Economic Geology and Mineral Economics from Faculty of Sciences, Charles University, Prague and Master-CAAE diploma (2003) in business administration from the Institut d'Administration des Entreprises de Lyon, Université Jean Moulin, Lyon 3, France. His professional work is focused to mineral economics and statistics. Among others he estimated economic potential of Czech shale gas possible occurences and critically reviewed Czech mineral and energy policy. During his career he was sworn expert in economy specialised on evaluation and prices of mineral deposits and 6 years to his retirement he acted as the head of the mineral policy department of the Czech Geological Survey - Geofond. He will participate in RM1/WP2.

Dalibor Mašek (male), received diploma in Economic Geology and Geochemistry at Faculty of Sciences, Charles University in Prague, Czech Republic (1989).He is a member of the Raw Material Department of the Division GEOFOND of the Czech Geological Survey. His professional work is focused on the regional Raw Material Policy and documents for the Spatial Planning, minerals statistic and the Minerals Information System of the CGS; editor of the Mineral Commodity Summaries of the Czech Republic. Participation in the project PECOMINES and MINEO. He will participate in RM1/WP2.

Jaromír Starý (male), holds a PhD. in Economic Geology from VŠB - Technical University of Ostrava - Faculty of Mining and Geology, Geological Engineering and M.Sc. diploma (1986) in Economic Geology and Geochemistry in Faculty of Sciences, Charles University in Prague, Czech Republic. His professional work is focused to minerals statistic and creating of the Minerals Information System of the CGS (SurIS). He is an expert for the Czech mineral base, especially for kaolin, feldspar, tungsten and lithium. His professional career is connected with the Geofond, former central information institution for geology, since 2012 department of CGS. During his career he was expert worker and last 7 years director of the Geofond until its dissolution in the end 2011. Since 2012 he is the Head of Mineral Deposits Department. He will participate in RM1/WP3.

Helena Skarková (female), holds a Ing. diploma in Mining Survey from VŠB - University of Mine Technology of Ostrava, Czech Republic - Faculty of Mining and Geology. She works as an IT specialist focused on programming, analysis and databases. She will participate in RM1/WP3.

Otmar Petyniak (male), holds M.Sc. degree in Geoinformatics from Faculty of Science, Palacký University Olomouc, Czech Republic (2014). Since completing studies he works as a GIS specialist in CGS. His work is focused on GIS processing of geological maps, python scripting, urban geology and 3d geological modelling. He will participate in RM1/WP6.

Tereza Peterková (female), holds M.Sc. in Geology (Petrology, Ore geology, Geochemistry) from Charles University in Prague, Czech Republic and she spent exchange semester (M.Sc.) in Technical University of Clausthal, Germany (in German). She is currently studying Ph.D. in Ore geology and petrology, Charles University in Prague, Czech Republic, focused on Sn-W-Li-Mo greisen systems in Erzgebirge. She has practical experience with exploration from Gold exploration internship, Mineral Exploration Network (Finland) Ltd., one season in Spain. She participated in EU projects Minerals4EU and ProSUM. Her present position is geologist, junior scientist. She will participate in RM1/WP3.

Petr Rambousek (male), received M.Sc. (RNDr.), diploma in Economic Geology and Geochemistry at Faculty of Sciences, Charles University in Prague, Czech Republic. The second diploma in Geoinformatics and Environmental Geology received in retraining study on Technical University Ostrava, faculty of Mining and Geology, Czech Republic. The main area of his activity is mineralogy, geochemistry and metallogeny of mineral deposits, including prospecting and geological mapping. He worked also in geoinformatic (GIS) and environmental geology (mining impacts mapping, mining waste). He has been leader of many national projects, now he is solving mineralogical and geochemical properties of CRM sources (CEEMIR project). He participated in EU projects PECOMINES, EO MINERS, MINERALS4EU and ProSUM. He participated in international project of CGS in Zambia, Vietnam and Iran. He is currently the head of Department of Mineral Resources Research and Mineral Policy, he is member of MREG. He is coordinator of RM theme in proposed GeoERA project in CGS. He will participate in RM1/WP1 and WP3.

Publications

Starý, J. – Sitenský, I. – Mašek, D. – Hodková, T. – Novák, J. – Vaněček, M. – Kavina, P. (2010-16): Mineral commodity summaries of the Czech Republic 2015. 420 s. – Ministerstvo životního prostředí. Praha. ISBN 978-80-7075-921-9

Janíková, P. – Starý, J. – Klika, R. – Kavina, P. – Jirásek, J. – Sivek, M. (2015): Gold deposits of the Czech Republic from a mineral policy perspective. – Gospodarka surowcami mineralnymi – Mineral Resources Management 31, 4, 35-50. ISSN 0860-0953

Starý, J. – Pticen, F. – Jirásek, J. – Sivek, M. (2017): Development of kaolin production, reserves and processing in the Czech Republic in 1999–2015. – Gospodarka surowcami mineralnymi – Mineral Resources Management 33, 3, 5-30. ISSN 0860-0953

Starý, J. – Baláž, P. – Kolroser, V. – Osvald, W. – Zoltay, Á. – Sochorová, V. (2013c): Central Europe: Rising to the challenge. – Mining Journal 2013, May 17, 16-25. ISSN 0026-5225

Sivek, M. – Jirásek, J. – Kavina, P. – Starý, J. (2016): Czech Republic: Mineral and Energy Policy. In Tiess, G. - Majumder, T. - Cameron, P: Encyclopedia of Mineral and Energy Policy, s. 1-9. – Springer-Verlag. Berlin. ISBN 978-3-642-40871

Involvement in other relevant European and national projects

Partner	Type of project/activity	Description
CGS	Project 1	**Minerals4EU**
	Funded by FP7, 2012-2014	CGS as a member of consortium support work in the field geoinformatics (metadata catalogue, INSPIRE transposition minerals data), case studies- mining waste usage etc.

Partner	Type of project/activity	Description
CGS	Project 2	**ProSUM**
	Funded by H2020, 2015-2017	CGS also a member of consortium. Main task solved in metadata calalogue building,

		characterization of mining waste features, dissemination of results.

Partner	Type of project/activity	Description
CGS	Project 3	**CEEMIR - Centre for Economic and Ecological Mining of CRM**
	Funded by Czech Technology Agency, 2014-2019	CGS is a member of consortium, which of is leading by Mining University of Ostrava. CGS is directly responsible for archive studies of CRM, mineralogical and geochemical investigations for prospecting, metallogeny, ore quality and environmental aspects.

Partner	Type of project/activity	Description
CGS	Project 4	**Rare metals**
	Funded by Czech Technology Agency, 2015-2016	Geochemical, mineralogical and technology characteristic of important mineral rare metals resource in the Czech Republic territory. Technology tests on selected localities. Proposals for changes of important related legal rules. Commodities: W, Li, Nb, Ta, Rb, Ag, Au, Mn

Significant infrastructures

SurIS – State information raw material system:
http://mapy.geology.cz/GISViewer/?mapProjectId=13&cultureInfo=en

Mining Waste Inventory – Inventory of Mining Waste Facilities:
http://mapy.geology.cz/GISViewer/?mapProjectId=13&cultureInfo=en

Abandoned Mining Sites
http://mapy.geology.cz/GISViewer/?mapProjectId=13&cultureInfo=en

Old Mining maps – mining maps from archives of CR:
http://mapy.geology.cz/GISViewer/?mapProjectId=13&cultureInfo=en

CGS Metadata Cataloque
https://micka.geology.cz/index.php?language=eng

25. Geological Survey of Federation of Bosnia and Herzegovina (FZZG)

Geological Survey of Federation of Bosnia and Herzegovina (FZZG) is independent department under jurisdiction of Government. Geological Survey has 29 permanent staff, of which 20 are geologists.
According to law, main tasks of the Geological Survey are: Exploration of mineral resources; Development of geological, engineering geological, hydrogeological, seismotectonic, metallogenic and other geological maps; Development of Federal mineral resources management program; Identify and recommends to the Government a list of strategic mineral resources with a proposal for their use and recommending politics of geological research.
The main strategic objectives Geological Survey are: Support to Government and Ministries; Scientific research; Support to public and industry and International cooperation.

The realization of these strategic objectives will be performed through: Development of a unified database of all deposits and occurrences of minerals, waters and landslides; Analysis of the reserves of mineral resources; Giving the suggestions Government and ministries of the potential areas for exploration of mineral resources; Development of geological maps and map of mineral resources; Exploration of mineral resources; Attracting foreign direct investment in geological exploration of mineral resources; Improving conditions for exploration, use and protection of mineral resources and groundwater; Improving standards and norms in the field of geological research; Improve cooperation with other research insititutions and the economy.
FZZG also has contribution to he EU co-founded projects OneGeoloogy Europe, GEMAS, APOPSBAL, ANTHROPOLPROT, HARMONIZATIOIN SEISMIC DATA (NATO project), VAMOS and DARLING.

Profiles of key staff members

Ismir Hajdarević (male): M.Sc. in Geology. Adviser for non-metallic mineral resources in Sector of Mineral resources in Federal institute of geology, Sarajevo. Ismir working on the cadastre of deposits and occurrences of mineral resources of the Federation of Bosnia and Herzegovina. He also performs processing of geological data and creates thematic geological maps in the GIS software. Ismir has been participant in EU project VAMOS.

Emina Brkić (female): M.Sc. in Geology. Adviser for coals in Sector of Mineral resources in Federal institute of geology, Sarajevo. Emina working on the cadastre of deposites and occurrences mineral resources, espetially on cadastre of coals Federation of Bosnia and Herzegovina. She has expirience in GIS.

Involment in other relevant EUROPEAN and national projects

Cadastre mineral resources of Federation of Bosnia and Herzegovina

Products and services

FZZG portal http:// fzzg.gov.ba

26. Regione Umbria (RU) – Servizio geologico

Brief description of the legal entity
RU (Geological Survey) is a technical entity of Regione Umbria (public body). Its missions and activities are: increasing knowledge and understanding of geology, groundwater resources, raw materials and geothermal issues) performing regional studies even through Geological Data Base and GIS to support policy makers and local governments providing them with essential information and technical assistance needed to regulate with uniform laws geological activities and manage natural resources even through long-term planning and legislation; Evaluation of geologic and earthquake hazard even through geology, seismic and geomorphology mapping of the territory in Umbria and the dissemination of geological data and information to the general public; Hydrogeological risk assessment, pursuing landslide investigations and forecasts, providing technical assistance to respond to landslide emergencies and strategic approaches for the mitigation of hydrogeological risk in terms of economic cost and of environmental safety, including procedures for the protection of infrastructures with relevant environmental impact; Management of regional seismographic network and geotechnical control stations.

Description of persons designated for Mintell4EU implementation:
Dr. Andrea Motti (male): senior geologist. He works for RU since 1992, expert in geology, structural geology, seismic hazard. Author of 65 publications (geological mapping, geological survey, seismic hazard, geological engineering, web mapping). Public works inspector.

Dr. Norman Natali (male): senior geologist. He works for RU since 1998, expert in ICT and GIS analysis and modeling, database management, and development of cartographic web applications.

Publications

- Study for Umbria regional assessment of geothermal resources, (2015) Regione Umbria Ed.
- 1:10.000 regional geological map (276 sheets),
- 1:10.000 regional seismic hazard maps (276 sheets).
- 1:100.000 regional hydrogeological map and 1:25.000/1:10.000 regional hydrogeological maps.

Projects and research programme(s)

- SISMA (EU project on System Integration for Security Management Activities) as Lead Partner.
- CARG (1:25.000 geological and geothematic map of Italy)
- IFFI (Inventory of landslide phenomena in Italy)

Infrastructure

RU has license and works with GIS software ArcGIS by ESRI, QGIS.

27. Geologische Bundesanstalt (GBA)

The Geological Survey of Austria (GBA) (www.geologie.ac.at) is a federal institution and is subject to the Federal Ministry of Science, Research and Economy. It serves the federal government as a central information and advice centre in the field of earth sciences and has to consider the developments in science, economy and social needs in their work. The tasks of the survey include studies and research in the fields of geosciences and geotechnical engineering, the geoscientific land survey and (as basic information for sustainable land use), collecting and evaluating geogenously related natural hazards, collecting and evaluating occurrences of mineral resources and raw materials, hydrogeological collection and evaluation of drinking and industrial water resources, preparation of expert reports and planning documents, collection, processing and up-to-date keeping of results and documentations using modern information technologies in cooperation with the governments crisis management.
The Department of Mineral Resources employs 15 geoscientists. Core missions include the Austrian Mineral Resources Plan, the geoscientific data and knowledge base of Austrian mining sites and storage and maintenance of nation-wide data sets on raw materials (industrial minerals, aggregates, dimensional stone) as well as chemical analyses of rocks, sediments, soils and groundwater (in cooperation with the Departments of Geochemistry and Hydrogeology). Among the department's main activities and research programmes are surveying of Austrian mineral occurrences, fundamental research on raw materials characteristics, consultancy for legal proceedings on mining operations, risk assessment of abandoned mine sites, geochemical prospection surveys, online-service of the Austrian Resource Information System, and geoinformation for environmental studies, nature conservation and land use planning.

Sebastian Pfleiderer (male, Sebastian.Pfleiderer@geologie.ac.at) is senior researcher at the Department of Mineral Resources of the Geological Survey of Austria (GBA) and vice-chairperson of the EGS Minerals Resources Expert Group. His current research interests include aggregate resources, hydrogeology, environmental geochemistry and 3D geological modelling. He holds two Master's degrees (University of Grenoble and RWTH Aachen University - hydrogeology) and a PhD (University of Toronto – rock physics). He worked as a postdoctoral research fellow at Atomic Energy of Canada (AECL) and at the French National Centre for Scientific Research (CNRS). He has been working at GBA since 1994. In 2000 he spent a sabbatical at the Geological Survey of Canada (GSC). He has been project / work package leader of several national / EU projects: (a) Computer-based characterisation of renewable aggregate deposits in Austria with respect to quantity, quality and potential use as construction material (2016-2019, ÜLG-65F); (b) Quantitative description of the region's hydrogeological characteristics and assessment of the regional potential for sustainable water supply and of groundwater vulnerability (2016-2019, NA-45_BUWE); (c) GeoMol - Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources (2012-2015; EU-AlpineSpace). He also participated in national / EU projects: Minerals4EU - Minerals Intelligence Network for Europe (2013-2015, EU-FP7); (e) Austrian Mineral Resources Plan (2001-2011).

Publications, infrastructure/technical equipment:
Weber, L. (Ed.) (2012): Der Österreichische Rohstoffplan. – Archiv für Lagerstättenforschung, 26, 264 pp., Geol. B.-A., Wien.

Multi-thematic Geological Map:
http://geolba.maps.arcgis.com/apps/webappviewer/index.html?id=0e19d373a13d4eb19da3544ce15f35ec

Interactive Raw Material Information System:
http://www.arcgis.com/home/webmap/viewer.html?webmap=c1255d236ac84cd68fc02fd037a5ed8d&extent=9.5714,46.0148,17.1246,49.3562

3D Geology Viewer:
https://gisgba.geologie.ac.at/3dviewer/

Geological cross sections and borehole logs:
https://gisgba.geologie.ac.at/gbaviewer/?url=https://gisgba.geologie.ac.at/ArcGIS/rest/services/AT_GBA_PROFILE/MapServer

GBA Thesaurus − a controlled vocabulary for geosciences:
http://resource.geolba.ac.at/

Related projects and activities:
CarVin, CGS-Europe, CO2StoP, PANGEO, EUOGA

5 Ethics and Security *(This section is not covered by the page limit)*

5.1 Ethics

The project proposal has been checked against the ethics sections in “H2020 Guidance — How to complete your ethics self-assessment: V5.2 – 12.07.2016”. This check did not raise any issues.

5.2 Security

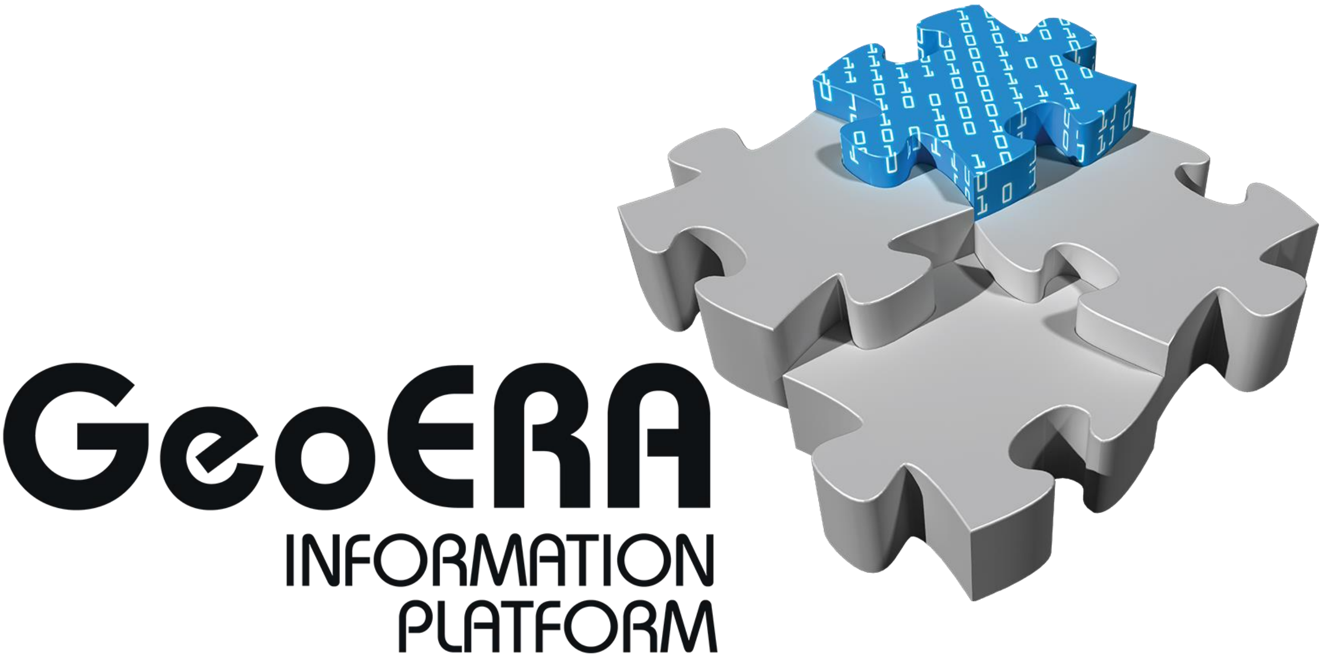
Please indicate if your project will involve:

- Activities or results raising security issues: NO
- 'EU-classified information' as background or results: NO (countries’classified information will be used)

5.15 GIP-P

GeoERA Information Platform project – GIP-P

A proposal for the Information Platform Specific Research Topic "IP1 - Development of an Information Platform to support management and provision of data for the three other themes"



Abstract

It is the overall aim of GeoERA to integrate information and knowledge to support sustainable use of the subsurface. The geoscientific projects (GSPs) on subsurface energy, water and raw material resources will produce large amounts of geological data and information and the GeoERA Information Platform Project (GIP-P) will establish a common platform for organising, disseminating and sustaining the digital results of those projects.

The platform will include a central database, a metadatabase, a user friendly web-portal and a digital archive for organising reports and unstructured data. The portal will include facilities for visualising complex information like 3D/4D geological models.

In order to ensure that the needs of the GSPs are fully identified and understood by the experts who will implement the platform, a specific organisation will be set up to liaise between those projects and the GIP-P.

Great effort will be put into adhering to European and international standards in order for the results to be as useful as possible for the whole of GeoERA and its external users thereby maximising the overall impact of the project. Techniques like Linked Open Data and multilingual thesauri will be implemented to ensure maximum interoperability of the data and services.

The platform will be based on a coherent architecture which will take into account experiences gained in previous EU funded data harmonisation projects and be built as an extension to the European Geological Data Infrastructure (EGDI).

The project will explore how the sustainability of the platform is ensured after the end of GeoERA.

List of participants

#	Participant Name	Institution	Country
1 (Coor.)	GEUS	Geological Survey of Denmark and Greenland	Denmark
2	BGR	Bundesanstalt Für Geowissenschaften und Rohstoffe	Germany
3	TNO	Nederlandse Organistie voor Toegepast Natuurwetenschappelijk Onderzoek	The Netherlands
4	SGU	Sveriges Geologiska Undersökning	Sweden
5	GeoZS	Geoloski Zavod Slovenije	Slovenia
6	CGS	Ceska Geologicka Sluzba	Czech Republic
7	BRGM	Bureau de Recherches Geologiques et Minieres	France
8	NERC	Natural Environment Research Council	United Kingdom
9	ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale	Italy
10	GTK	Geologian Tutkimuskeskus	Finland
11	NGU	Geological Survey of Norway	Norway
12	RBINS	Institut Royal des Sciences Naturelles de Belgique	Belgium
13	GSI	Department of Communications, Energy and Natural resources	Ireland
14	IGME-ES	Instituto Geológico y Minero de Espana	Spain
15	GeoInform	State Research and Development Enterprise State Information Geological of Ukraine	Ukraine
16	GIR	Institutul Geologic al Romaniei	Romania
17	GBA	Geologische Bundesanstalt	Austria
18	SGSS	Servizio Geologico, Sismico e dei Suoli della Regione Emilia-Romagna	Italy
19	MBFSZ	MAGYAR BÁNYÁSZATI ÉS FÖLDTANI SZOLGÁLAT	Hungary
20	LfU	Bayerisches Landesamt fur Umwelt	Germany
21	LNEG	Laboratorio Nacional de Energia e Geologia I.P.	Portugal
22	PGI	Panstwowy Instytut Geologiczny – Panstwowy Instytut Badawczy	Poland
23	HGI-CGS	Hrvatski Geološki Institut	Croatia
24	ISOR	Íslenskar orkurannsóknir	Iceland

Abbreviations used in the following text:
EGDI: European Geological Data Infrastructure.
EGS: EuroGeoSurveys.
GSP: Geoscientific Project. The GeoERA projects except for the Information Platform Project. They are sometimes in GeoERA material referred to as “transnational projects”.
GIP: GeoERA Information Platform.

GIP-P: The GeoERA Information Platform Project (this project).

1 Excellence

Sustainable use and management of the subsurface has a truly multidisciplinary character and the need for uniform access to multi-domain data is drastically increasing. Numerous previous European projects have produced valuable data and information related to raw materials, groundwater, geoenergy and other themes. Such projects, however, have typically focussed on issues associated with individual geoscientific domains and the results have been disseminated through dedicated web portals that often have been abandoned shortly after the end of the projects. To meet the increasing needs of European stakeholders for sustainable, usable and easy findable data, the EuroGeoSurveys community has initiated the establishment of the European Geological Data Infrastructure – EGDI (www.europe-geology.eu), where results from previous European projects relating to different geoscientific domains have been made available in a homogeneous but not entirely harmonised way. The overall GeoERA programme is a unique opportunity to bring this a big step further by extending the EGDI and integrating the results from the research-oriented GeoERA projects from the groundwater, geoenergy and raw materials themes.
The GeoERA Information Platform Project (GIP-P) is a proposal related to the GeoERA Information Platform Specific Research Topic “IP1 - Development of an Information Platform to support management and provision of data for the three other themes”. By setting up shared rules, guidelines and standards the project will act as a catalyst for the successful and interoperable integration of the results coming from the other GeoERA projects into one single information platform with user-friendly as well as machine-oriented interfaces that are targeted at all relevant categories of end users and fitting into the broader European e-infrastructure landscape.

Aims and objectives

The overall aim of the GIP-P is to support the GeoERA Geoscientific Projects (GSPs) in organising, disseminating and sustaining their results in terms of digital data, interpretations, reports and services thereby indirectly supporting the sustainable use and management of the subsurface. For this to happen, the GSPs’ results must be FAIR meaning Findable, Accessible, Interoperable and Reusable thereby making them as valuable as possible for the stakeholders.
The GIP-P will aim at doing this with higher quality and more cost efficient than would have been possible if the GSPs had to manage their digital results individually. This will be made possible by taking advantage of the large group of experts from the GeoERA partners who will be developing the GIP. These experts have been involved in building information systems for geoscientific data for many years, both at national and at European level. It will furthermore be possible due to the fact that the GIP-P will ensure that data and information will be organised and disseminated in a coherent and standardised way based on state-of-the art database and web technologies. Finally the development of the platform will be given a jump start as it will be built as an extension to the already existing EGDI platform, thereby saving a very large amount of of work.
The project will also aim at making the platform and thereby the results of the GSPs sustainable for a long period of time after the end of the GeoERA programme. This will be achieved by building on the EGDI, which is supported by EuroGeoSurveys (EGS) and by adhering to European and international standards to as high degree as possible.
The project will furthermore aim at supporting the establishment of the spatial data infrastructure for Europe by using the existing standards for data exchange like INSPIRE and extending those following the INSPIRE recommendations where necessary. This will be to the benefit of a broad range of stakeholders in the public as well as in the private sector who will be in a better position to get value out of the geological data and information.
Finally, the project will aim at contributing to the establishment of a single access point for European geological information by combining the access to pan-European and cross-border data from GeoERA and earlier projects originating from the huge amount of national and regional data generated and gathered by the Geological Survey Organisations.

Relation to existing programmes and projects

The GeoERA Information Platform (GIP) will be built by extending the European Geological Data Infrastructure (EGDI) to support the work in the GSPs. In the version 1, EGDI was developed in 2016 based on the needs of EuroGeoSurveys (EGS) to provide the technology and know-how to sustainable access to the specific geological data, information and knowledge of the EGS members, and in particular to secure results of already finished European geoscience-related projects performed by the members of EGS (OneGeology-Europe, EuroGeoSource, Minerals4EU, EMODnet, and others). GIP will significantly contribute to the development of the EGDI platform with new data and functionality based on the requirements from GSPs (see Figure 1). The basic operation of EGDI is financed by EGS and is closely connected to the existing organisational set-up of EGS, including the Spatial Information Expert Group (SIEG). The primary responsibilities of SIEG involve the coordination of the INSPIRE Maintenance and Implementation Framework and participation in EU projects.

Figure 1 GeoERA as an extension to the EGDI

EGDI is proposed to serve as the source of geological information to a wide range of users and other platforms, in particular to the European Plate Observing System (EPOS), created as an integrated European research infrastructure for solid Earth sciences, to The European Commission's Raw Materials Information System (RMIS 2), to the European Union Programme Copernicus for satellite and in situ Earth Observations, etc.

The GIP will implement common standards (OGC, INSPIRE, ISO, …) as well as define community standards based on the requirements from GSPs. As several members of the consortium are also participating in relevant panels and working groups like the SIEG, OGC GeoScience Domain Working Group, INSPIRE Thematic Clusters, etc. close contact will be maintained with those during the course of the project in order to ensure the highest possible level of interoperability and accessibility of the results from the GSPs.

1.1 Concept and methodology

The overall concept behind the proposed information platform project is to support the overarching GeoERA aim to provide integrated access to data, information, interpretations and models derived from projects within the three GeoERA themes (geo-energy, groundwater and raw materials) in a standards-based and interoperable manner. We would endeavour to build a platform that supports innovation and research across scientific disciplines (within and beyond the themes of GeoERA), societal challenges (energy, raw materials, environment, food, security, health, transport) and sectors (academia, industry, policy) in need of geological data and information. GeoERA Themes share the objective to provide and disseminate spatial information relating to their respective resources and underpinning geological data. Our proposal will create a common geoscience information platform capable of integrating up-to-date data, interpretations and models from different and distributed sources, both within and across GeoERA

Themes. We will utilise sound data management planning and FAIR data management principals to help ensure data assets within the GIP are Findable, Accessible, Interoperable and Reusable.

Our methodology will address the key stated requirements for GIP by including a central database, a web-portal and a digital archive and basing the content and functionality on the requirements from the GSPs. Collaboration will be core to our project ensuring we engage fully across all GeoERA themes to extract their requirements for the proposed platform. We will ensure cross-domain integration and provide facilities for making information available in a user-friendly way for all stakeholders by providing metadata-driven systems for discovering data and data access services. We will ensure future sustainability by aligning with wider EU funded research infrastructure projects (such as EPOS and the European Open Science Cloud) and building on the work of previous projects regarding harmonisation, organisation, exchange and dissemination of geoscientific data. To that end, central to our proposal will be expanding the existing infrastructure provided by the European Geological Data Infrastructure (EGDI). We will provide a better integration of the MICKA metadatabase into EGDI; advance semantic harmonisation through extending vocabularies and linked open data publishing; utilise central storage in combination with access to national/regional data sources; implement a digital archive for holding and publishing unstructured data.

We will demonstrate how information access can be augmented beyond dissemination by providing exemplar research infrastructure functionality that facilitates tailor-made processing and analytical tools to enable science to be undertaken and knowledge derived. The resulting platform will facilitate an improved ability of GSOs to effectively define future actions with regards to improving key knowledge on geo-energy, groundwater and mineral resources, through provision of a sustainable and expandable spatial information framework. It will enable end-users to combine geospatial (2D and 3D) databases, developed in GeoERA or at national/regional level, with other environmental data and information sources. We will establish pan-European and more local (cross-border) databases with a coordinated structure to store raw data, interpretations, and models and enable integration and consolidation. We will develop standards for interoperable cross-border and pan-European scale geological base maps and datasets (including stratigraphic correlation schemes and structural geological definitions) that are valid across different data scales and resolutions. We will register and disseminate metadata including uncertainty about maps, databases, products and services in a user-friendly way facilitating access to data and assess its relevance for particular uses. We will set up services to make data available according to INSPIRE and other standards facilitating the use of data from different sources and thematic areas in combination. This will enable users to address real-world questions such as those concerning competing interests in certain geospatial areas or geological formations. We will build portals with user-friendly functions for search, visualization, analysis and download of data for management as well as research purposes in a regional to Pan European context. Importantly, we will provide training and technical support to both data providers and users.

Our methodology for ensuring the success of cross-thematic integration will be to ensure data providers and end-users alike:

1. have full knowledge of the GIP capability and functionality
2. understand how it can help their science
3. know how to utilise/exploit that capability
4. appreciate and value the benefits it provides
5. have awareness of stepping stones to wider E-Infrastructures

By creating an information platform that aligns and integrates with wider e-infrastructures across Europe and beyond (such as EPOS, EMODnet, Copernicus, European Open Science Cloud, GEOSS) we will open up data from the European geological surveys to be integrated with a wider range of earth science data. Our approach will be to build the information platform in a modular way to produce core components that can be plugged in to other interfaces, initiatives and infrastructures. For example, functionality based on GeoSciML that allows users to query varied geological models and databases to discover what information is held about the Lower Carboniferous might be integrated into EPOS as an ICS-D provided by the European Geological Survey community. We will provide a reusable research infrastructure for geology that can be used in isolation or plugged in to other initiatives helping to secure sustainability in to the future and providing a modern data architecture for European geological surveys. Building on the good work already undertaken by the European Geological Surveys on initiatives such as GeoSciML, OneGeologyEurope, and focussing on metadata, standardisation and harmonisation,

functionality will be provided that enables cross querying of multiple information sources including geological databases and 3D models and integrating the results into research software on a geologist's desk such as a 3D modelling package. By building on what has gone before in projects such as Minerals4EU, EMODNet, GeoMol and European Geological Data Infrastructure (EGDI), and by aligning with wider European research infrastructures such as EPOS, we will extend current capabilities to support advanced use cases for handling 3D/4D models, parameterized models and uncertainty data and develop and extend 3D-modelling strategies in GeoERA. Our project will conform to data models and standards from INSPIRE, Open Geospatial Consortium (OGC) and the IUGS Commission for the Management and Application of Geoscience Information (CGI).
Our proposal will employ a collaborative approach to ensure the effective integration of spatial information from the other three GeoERA Themes. Our methodology will rely on community building and networking to ensure a successful outcome. GIP will be developed in *cooperation with* users and *for* users. We already have a good network of contacts with many of the GeoERA Theme SRTs who create a pool of users from many science domains represented by the research organisations that will take an active part within GeoERA.
Furthermore, the successful results of the project will be widely disseminated among the interested stakeholders and the geological community as a whole by the project Communication and Dissemination plan.

1.2 Ambition

The GIP will provide the tools and infrastructure for the GSPs enabling them to disseminate their results on the platform that will serve as the long-term sustainable geological information system for Europe. This is ambitious but also realistic based on the fact that the GIP will be built as an extension to the existing EGDI platform that has already proved to be robust and well functioning.
The GIP will, moreover, position itself in the new European landscape of scientific information platforms, ambitioned by the EU through EOSC (European Open Science Cloud) which will help science, industry and public authorities in Europe access world-class data infrastructures and cloud-based services. By design, the GIP will contribute to EOSC by providing access to a wide range of geoscientific data to a large community of users. Based on the vast experience in data management and stewardship collectively held by the partners in this consortium, the GIP will provide FAIR data to a wide range of users (scientists, industry and the public sector).
With the contribution to the project of lead experts in the development of international standards for geoscience (including new developed standards for 3D geology in OGC IUGS/CGI, or cooperation between OGC and W3C), the GIP will guarantee the highest level of semantic interoperability with other disciplines in Europe, as well as with geoscientists from all over the globe. Being positioned as an advanced infrastructure in EOSC, the GIP will facilitate the reuse of geological information in multidisciplinary areas such as climate change.
Through the participation of a large number of European geological survey organisations in the project consortium, best practices and technologies will be shared across Europe, facilitating their implementation at the national as well as regional scale.
The connection with the ESFRIs will be developed in particular through the partnership between EPOS and EGS.
At the international scale, the partners are already cooperating with the most advanced projects of the domain such as Auscope in Australia and EarthCube in the USA.
This open and generic platform will also be made available to integrate data from other domains of the geological surveys not covered by GeoERA such as geohazards, geochemistry, earth observations, etc..

2 Impact

2.1 Expected impact

The primary impact of the GIP-P will be indirect as the project's primary goal is to support the GSPs and thereby the scientific and sociatal impacts that will result from those. The GSPs' impacts are expected to be considerably higher than they would have been without the GIP-P because the GIP will ensure a common access point to the GeoERA results and a much higher degree of harmonisation of the data and information making this much more useful for users working cross thematic and cross border or even pan-European.

In the past, user-friendly access to geological data and information from across Europe has been very limited. A number of European data harmonisation projects successfully developed web portals, but these were never maintained after the end of the project. With the establishment of version 1 of the EGDI in 2016 by the EuroGeoSurveys members, the foundation for a long-term sustainable infrastructure was made. The first version was basic, but well functioning, and basing the GIP-P on the EGDI will be an valuable and cost efficient instrument for advancing the developments and ensure that a number of different stakeholders in Europe will not only get user-friendly access to the results of the GSPs through a common access point, but that they will also be able to combine these results with data from numerous previous European and regional projects. By building on EGDI the GIP will furthermore bring additional value for scientists, decision makers and other stakeholders by giving access to the GeoERA results through the same portal as a wide range of other data and information about geology and related topics from the European Geological Surveys, including geohazards, geochemistry, geophysics and basic geology. This will significantly increase the value of the GeoERA results for the mentioned stakeholders.
As EGDI, and the extensions to this through the GIP, adheres to established European and international standards, the GeoERA results will also be interoperable with data and information from other domains than geology like biology, land use, physical infrastructure and others. This will greatly increase the impact of the GSPs' results for a broad range of stakeholders.
In addition to the support of the GSPs, the GIP/EGDI will however also in itself have great impact by enabling SMEs like software companies, consultants and similar to develop advanced services on top of the platform as the project will establish new or extend existing standards for data exchange of geoscientific data. An important example of this will be 3D/4D geological models where no standard exist today miking it difficult to build sustainable software for this kind of information. As EGDI originates from the EGS and is backed by this organisation, the platform can be considered sustainable also beyond the lifetime of the GeoERA programme itself. This will make it much more valuable for the SMEs as they can develop their services with a long time frame.

2.2 Measures to maximise impact

The GIP-P has a special role regarding dissemination of results for the whole of GeoERA in that it shall

- contribute to the dissemination of results from all the GSPs (the digital products like data, maps, models, etc.), and
- carry out dissemination and communication activities related to the GIP-P itself.

Furthermore the communication and dissemination activities must be aligned with the overall initiatives by the GeoERA Secretariat in these areas. This implies for instance that the GIP-P will use the GeoERA website (geoera.eu) for giving access to the GIP in addition to giving access through the EGDI website. The following two sections deals with the communication and dissemination activities related specifically to the GIP-P itself.

2.2.1 Dissemination and exploitation of results

The first task will be to carry out and build on the GeoERA Dissemination Plan and to create a multiplatform approach to communicate GeoERAs outputs and benefits to stakeholders. A database of stakeholders will also be built. The Dissemination plan will be targeted to the GeoERA participants involved in the projects, and to stakeholders outside GeoERA, such as private and industrial stakeholders, academia and all potential users involved in the geological and earth science data. The use of the results relies heavily on the information platform for the long-term provision of high quality and easy to use information, which can be used at local, regional, national, and EU level. The Plan will need to be updated throughout the evolution of the project. Sustainability of the benefits of the project should continue to benefit stakeholders after the end of the project. The exploitation of the results will be in accordance with the general GeoERA Dissemination and Exploitation Plan.

2.2.2 Communication activities

Communication efforts will be through relevant activities such as brochures, press releases, posters, multimedia, website and social media content. Internal communication will be fostered with regular virtual meetings and teleconferences to facilitate sharing of information. Communications guidelines for partners will be developed to ensure consistency. External communications will take place by feeding into the overall GeoERA Communication and Dissemination plan. Common tools and guidelines will be used as well as providing content for the newsletter and the website.

2.3 Contribution of Project Proposal to the Information Platform or vice versa

As the primary purpose of the GIP-P is to support the GSPs, the GIP-P has very high focus on these projects' needs and this is reflected in the organisation of the work. First of all a Work Package about User Requirements (WP2) will be dedicated to facilitating the dialogue with the GSPs throughout the whole life cycle of the projects. This will ensure that the GIP-P will build the GIP in accordance with, not only the state of the art technologies and legal frameworks such as the INSPIRE Directive, but very importantly also very much with the requested functionalities defined by the GSPs. The WP2 is subdivided into three tasks of which two are related to the bi-directional expertise exchanges between the GIP-P and the GSPs. A first task consists in establishing and maintaining a close contact with GSPs by assigning three liaison officers, one for each theme. Similarly, each GSP is requested to establish a Work Packages (GIP interface WP) dedicated to the liaison with the WP2 of the GIP-P (see Figure 3 below). A second task will organise workshops with the leaders of all these Work Packages in order to compile and harmonise their requirements. The GIP-P will then be able to construct the first prototype of the platform by extending the EGDI.

But there are also other Work Packages that will have close contact with the GSPs. WP4 will design and test the development of vocabularies, thereby supporting harmonisation and multilingualism. WP6 will be responsible for the development of the GSPs' interfaces in a user-friendly way and as requested by the users' requirements of the WP2. Therefore the GSPs will have direct influence on the design and the functionalities of the GIP. Among the foreseen technical developments, the IP will have a particular emphasis on supporting the display of 3D geological models as this is an important aspect of several of the GeoERA calls. WP8 is exclusively oriented toward the GSPs and will provide support to the users in order to prepare their datasets and the different web services to delivers the produced data to the central EGDI database of the GIP. WP8 will write cookbooks, use e-learning systems and set up a helpdesk with buddy system for direct user support. Finally, WP10 will deal with the IPR and the data policy issues for all the data that are delivered or stored in the central EGDI database by the GSPs.

3 Implementation

3.1 Work Plan – Work packages, deliverables

3.1.1 General Work Plan

The following sections explain the main elements and concepts of the Project Implementation Plan (PIP). During the first two months of the project the Project Coordinator and Project Board will together establish a detailed PIP. This plan will be approved by all partners represented in the Project Assembly. The main purpose of the GIP is to support the GSPs. A big challenge will be that at the time of writing this proposal it is not known which GSPs will be awarded and their detailed requirements can therefore not be taken into account.

Another challenge will be that the results, that the GIP must support, will be produced within the same time frame as the GIP-P, which will result in a very busy time in the last months of GeoERA in order to incorporate all results in the platform. The work will therefore be conducted in the following phases (Figure 2):

- Start-up (M1 – 6): Here focus will be on three activities:
    - The identification and description of the requirements from the other GSPs.
    - The draw up of a first version of an overall architecture.
    - Establishment of the PIP and consolidation of the project tema and ways of cooperating.

- Prototyping (M7 – 18): A first version of the GIP will be developed including prototype functionality in EGDI to demonstrate how all data types of GeoERA will be accessible. This prototype will be used in renewed dialogs with the GSPs. The architecture may be updated based on the knowledge gained in the development of the prototype.

- Full Development (M19 – 30): Version 2 of the GIP will be developed with full functionality and including all the data that are available from the GSPs at that time. The goal is that all functionality can be tested by the users on real data although not all results from the GSPs will be available. First versions of documentation and guidelines will also be developed in this phase. Furthermore a data delivery plan for all data to be supported from the GSPs will be made and agreed with the GSPs.

- Wrap-up (M31 – 36): The last data will be included in the GIP and final testing will be carried out. In case this testing results in shortcomings/errors in the functionality of the platform these will be eliminated, but no new functionality will be developed. Final versions of documentations and guidelines will be completed and arrangements for the operational phase after GeoERA will be designed and impemented.

Figure 2 GANTT diagram the phases of the project, milestones, duration of the different WP tasks and deadlines for deliverables.

3.2 Management structure, milestones and procedures

The management structure and strategy of the GIP-P is established with the aim to ensure clear responsabilities, professional planning, communication and progress monitoring throughout the lifetime of the project.

The project is organised in 11 Work Packages, most of them dealing with a specific aspect of the development of the platform. As the GIP-P has a very strong focus on providing ICT and other facilities for the other GeoERA projects a special Work Package (WP2) has been dedicated to the liaison with those. Similarly, all geoscientific projects are supposed to have one IP Information Work Package (IIWP) dedicated to the liaison with the GIP-P (see Figure 3).

All WP leaders will be members of the Project Board (PB), which will have teleconferences at regular intervals (approx. monthly). The PB shall monitor the implementation of the project. The PB will have a very central role as many of the WPs are closely interrelated.

The Project Assembly (PA) shall consist of one representative from each project partner. The PA will decide on matters that affect the entire project. This includes changes that affect the entire project including composition of the consortium, partner roles, timing of main deliverables and milestones, assignment of resources, partner contributions and budgets. The PA will also approve the PIP. The PA will meet face-to-face at least 4 times during the project and by teleconference when needed.

The Project Coordinator (PC) will be the contact person to the GeoERA Executive Board and be chairman the PB. He will be responsible for the day-to-day managemtn of the whole project. The PC is Jørgen Tulstrup of GEUS. Jørgen has more than 30 years of exerience in the developemnt and management of information systems supporting geosciences and has been head of the department for the Geological Datacentre of GEUS for more than 15 years and through that responsibel for all aspects of geodata management and GIS. He has participated in numerous European projects about data harmonisation and dissemination including EUMarsin, OneGeologyEurope, EuroGeoSource, Minerals4EU, GeoSeas, EGDI-Scope and EPOS-IP. He is currently coordinating the development and operations of EGDI and is Executive Secretary to Geoscience Information Consortium (g-i-c.org) and Deputy Chair of EGS' Spatial Information Expert Group (SIEG).
Jørgen has been Theme Coordinator for the Information platform Theme during the first phase of GeoERA and also member of the GeoERA Secretariat and Executive Board as Work Package Leaders for Communication. Jørgen has not taken part in any Executive Board decision concerning the evaluation and selection of the Information Platform project ideas and proposals.

Each WP will have a leader who will be resposible for the day-to-day management and technical coordination of the WP and for the cross-WP coordination through the PB. Task leaders within each WP coordinate the execution of technical project activities by the project partners. The task leaders and WP leaders be in contact (probably teleconference) at least once pr. month. During these meetings the progress of the work in the individual tasks will be discussed and solutions will be sought to any problems. Issus that cannot be solved straight away will be escalated to the PB.

Figure 3 shows the organisational structure of the GIP-P.

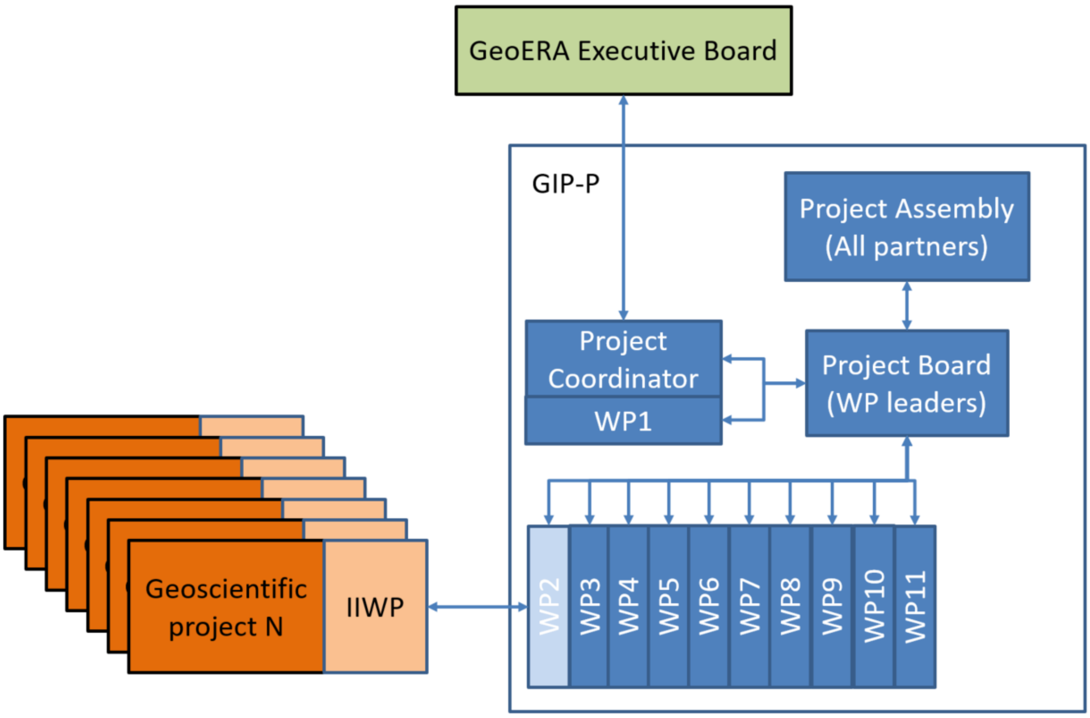


Figure 3. Organisational structure of the GIP-P

The different WPs are:

- WP1, Coordination. The WP will take care of the overall coordination of the work in the other WPs and the technical and financial reporting. It will also establish the methodologies to be used in the development, Quality Assurance and Documentation of the GIP as well as write guidelines for the reporting.

- WP2, User Requirements. The WP will ensure that the requirements of the other projects are fully understood, common elements across more GSPs are identified and appropriate extensions to EGDI are defined. It will work closely with the IIWPs of the GSPs.
- WP3, Standards and interoperability issues. The WP will analyse which data models and services can be used for the exchange and storage of the data identified in WP2. Existing data models will be used to the highest degree possible, but these may have to be extended in some cases. The WP will furthermore develop a validation system to help aligning the data and services with the chosen data models.
- WP4, Semantic harmonisation. The WP will establish technologies that will better enable users of the data and services generated in the GSPs to find what they are looking for and to combine information across borders and from scientists using different terms and languages. The technologies include vocabularies, Linked Open Data and SKOS/RDF. The WP will also assist participants in the GSPs in making their data and services more useful through these technologies.
- WP5, Architecture. The WP will define a clear architecture for the GIP both in terms of data/services and system. The architecture will build on the current architecture of EGDI and recently developed Best Practices from W3C and OGC.
- WP6, Developments, User oriented. The WP will develop all interactive components of the GIP as an extension to the EGDI portal. It will use an iterative process including prototyping in the form of demonstrators for each GSP. The WP will also handle the addition of data from the GSPs including validation and registration of metadata.
- WP7, Developments, Central. The WP will develop central components of the GIP including the central database, the metadatabase and harvesting systems to collect data from national and regional levels. Which data will be stored in the central database and which will be accessed directly from more local levels by the portal will depend on the requirements from the GSPs (analysed by WP2) and the needs by WP3, WP4 and WP7.
- WP8, Data provider support. The WP will support the data providers from the GSPs in integrating and disseminating their data, information, interpretations and models in a standards-based and interoperable manner through the GIP. This will happen by providing a suite of support tools, channels and activities, including cookbooks, buddy systems, mentoring networks, eLearning and training workshops.
- WP9, Sustainability issues. The WP will analyse how the GIP can be sustained in the long term (after the end of GeoERA). It will try to identify one or more funding mechanisms and describe a governance model.
- WP10, IPR and data policy issues. The WP will examine the current limitations around open access for geodata, creating reports on existing licencing legislation, legal risk and surveys to identify areas for improvement. This work package will attempt to provide solutions to the current issues, with the development of standard user and supplier licence forms. A Data Management Plan will also be produced under this work package.
- WP11, Communication and Dissemination This WP will ensure that the results of the Information Platform (IP) are transparent and that many organisations can use them directly or built upon them. The tasks of the WP are designed to plan and carry out effective communication and dissemination activities that reach targeted audiences and aim to facilitate communication and a transparent interaction with the consortium members, the projects running in parallel with this one and all relevant platforms and stakeholders, during and beyond the GeoERA.

Figure 4 shows how the WPs relate to each other and the GSPs.

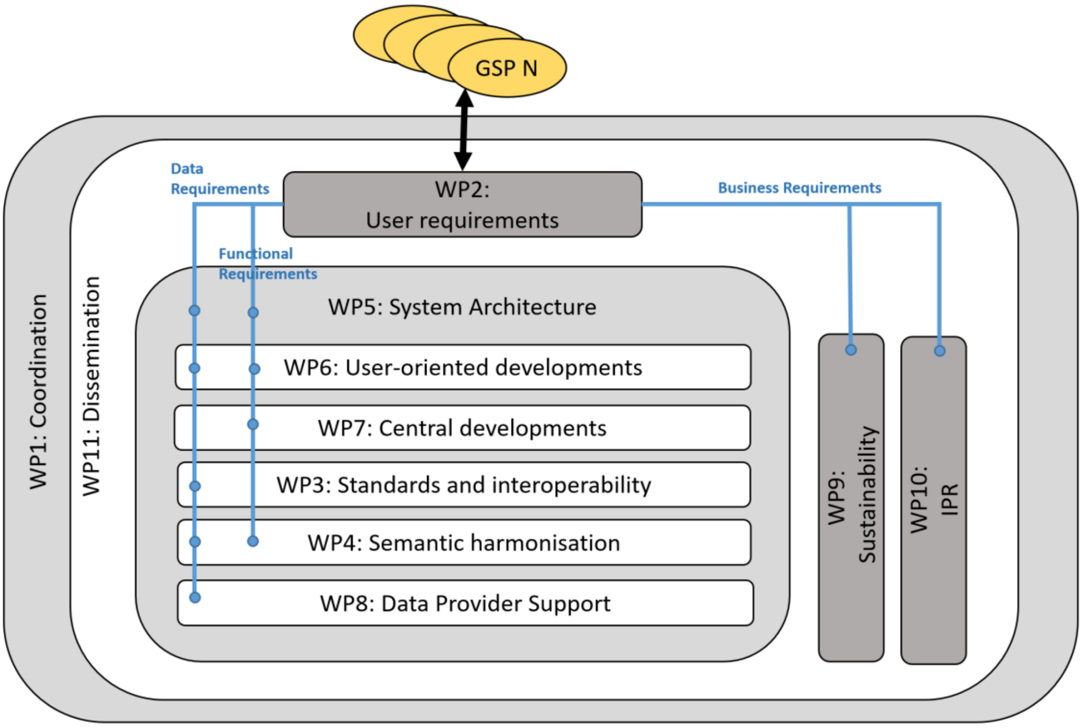


Figure 4. Work Packages and their relationships

Four milestones are defined for the GIP-P, each of them at the end of one of the major phases of the project (see section 3.1.1). The milestones are described in detail in table 3.2a below.

Reporting will follow a procedure including verifications at different levels including among partners, task leaders, WP leaders, The PC and the PB. The aim is to ensure delivery of high quality reports providing a accurate insight on the state of the project. Deliverables and milestones will follow an internal quality control procedure defined by WP1 and carried out by all partners represented in the project. All deliverables and milestones are subject to final approval by the PA.

The PB will closely follow up and control the progress of the project and the work done by each partner. Check lists (action database), will follow day-by-day partner contribution and interaction within the WPs in order to ensure project quality. Risk assessment will aim at identifying, analysing and prioritizing risks inherent in the project and then determining the appropriate actions to eliminate or mitigate them. This will be an on-going process and a standard item on the agenda for all meetings of the PB. Some likely critical risks have already been identified in the preparation of this proposal. These are listed in table 3.2b, together with proposed risk mitigation measures.

3.3 Consortium as a whole

The Consortium consists of experts in geoinformation management from Geological Surveys who have been heavily involved in previous EU funded projects on data harmonisation and dissemination of geological information. At the same time many of them are developing databases, digital archives, web-GIS and digital services to safeguard and dissemination geological information at the national and regional level. Many of the experts have a very useful mixed educational and professional background covering ICT as well as geoscience. Expertice regarding legal aspects of the dissemination of geodata is also in the group.

The community has for many years been working together in EGS' Spatial Information Expert Group (SIEG) which formed the basis for developing the EGDI platform. The SIEG has also a long experience in contributing to the development of standards for the exchange of geological data and has been actively supporting the INSPIRE specification process and the work in the Commission for the Management and Application of Geosciences Information under the International Union of Geological Sciences (IUGS) and in Open Geospatial Consortium.

The consortium also includes experts from the whole European Continent therefore also with a background in very different geological settings in Europe. This will be a big advantage in the dialogue with the GSPs and in understanding their needs.

3.4 Resources to be committed

Table 3.1a) Work package descriptions

Work Package No: 1, Coordination, Lead beneficiary: GEUS
Start month; 1, End Month 36.
Participants:

Partner No:	Partner:	Man Months:		Partner No:	Partner:	Man Months:
Part 01	GEUS	18,00		**Part 13**	GSI	1,00
Part 02	BGR	0,67		**Part 14**	IGME-ES	1,00
Part 03	TNO	0,67		**Part 15**	GeoInform	1,00
Part 04	SGU	0,33		**Part 16**	GIR	0,33
Part 05	GeoZS	1,00		**Part 17**	GBA	0,50
Part 06	CGS	3,00		**Part 18**	SGSS	0,40
Part 07	BRGM	1,00		**Part 19**	MBFSZ	0,33
Part 08	NERC	1,00		**Part 20**	LfU	0,58
Part 09	ISPRA	1,00		**Part 21**	LNEG	0,67
Part 10	GTK	1,00		**Part 22**	PGI	0,33
Part 11	NGU	0,67		**Part 23**	HGI-CGS	0,67
Part 12	RBINS	1,00		**Part 24**	ISOR	0,33

Objectives
This work package is concerned with the overall financial, administrative and operational management of the project as well as coordinating activities (data management and trust) across work packages. Specific objectives are to:

- Perform daily management of the project (monitoring of progress; communication between partners and with the GeoERA Executive Board; financial management; reporting; decision making; conflict management).
- Define methods and guidelines for quality assurance, technical methods, configuration management, …
- Organise meetings of the Project Board and the Project Assembly and produce minutes of those meetings. The Project Assembly will meet at least four times back to back with the Kick-off meeting of the whole of GeoERA, at the end of Year 1 and Year 2 and with the Final meeting.

Description of work
Task 1.1 Project management. (GEUS, BGR, TNO, SGU, GeoZS, CGS, BRGM, NERC, ISPRA, GTK, NGU, RBINS, GSI, IGME-ES, GeoInform, GIR, GBA, SGSS, MBFSZ, LfU, LNEG, PGI, HGI-CGS, ISOR).
This task covers daily management and reporting of the project and consortium including financial, administrative and operational management and monitoring of progress, risk management, arrangement of regular teleconference with the Project Board, arrangement of meetings with the Project Assembly as well as coordination of dependencies across WPs.
During the course of the project four full consortium meetings (face-to-face) will be arranged. Travel expensed for up to three participants from each partner will be funded by WP1.
It will also establish the Project Implementation Plan.
Task 1.2 QA, methods, guidelines, etc. (GEUS, CGS).
This task deals with establishing standards for quality assurance, modelling and development principles and methods, technical documentation, reporting (scientific and financial), risk management, etc.

Deliverables
D1.1: Project guidelines including procedures for QA, reporting and risk management (M5)
D1.2: Internal progress reports (M7, M13, M19, M25, M31)
D1.3: Project progress meeting minutes (M2, M8, M14, M20, M26, M32)
D1.4: Final conference report (M36)

Work Package No: 2, User Requirements, Lead beneficiary: RBINS
Start month; 1, End Month 36.
Participants:

Partner No:	Partner:	Man Months:		Partner No:	Partner:	Man Months:
Part 01	GEUS	3,00		**Part 12**	RBINS	17,00
Part 02	BGR	6,00		**Part 13**	GSI	8,00
Part 03	TNO	4,00		**Part 14**	IGME-ES	10,00
Part 04	SGU	2,00		**Part 16**	GIR	3,00
Part 05	GeoZS	6,00		**Part 18**	SGSS	2,00
Part 06	CGS	3,00		**Part 19**	MBFSZ	2,00
Part 07	BRGM	6,00		**Part 21**	LNEG	4,00
Part 09	ISPRA	5,00		**Part 22**	PGI	2,00
Part 11	NGU	2,00		**Part 24**	ISOR	3,00

Objectives

- WP2 will coordinate the interactions between the GSPs and the GIP-P
- It will list, describe and harmonize the requirements in terms of data infrastructure and display of the geoinformation produced as the scientific output of the themes GSPs.
- It will assist the GSPs in writing their project specific Data Management Plans.
- It will ensure that the scientific products use up to date technologies, appropriate standards and whenever necessary compile the needed extension to the European Geological Data Infrastructure (EGDI).

Description of work

Task 2.1 Liaison with other projects: (RBINS, IGME-ES BRGM, NGU, GSI, MBFSZ, LNEG)

A liaison officer for each research theme will be assigned for the entire duration of the project in order to facilitate the communication and the homogenisation of the produced datasets and to assist the GSPs in writing their project specific Data Management Plans. This team will be reinforced by a group of experts in 3D modelling, database management, metadata, etc. to resolve specific issues. The liaison will continue throughout the whole duration of the project, in the later phases also following up on the delivery of data to the GIP from the GSPs.

Task 2.2 Extract and homogenise requirements from the other projects (RBINS, TNO SGU, GEOZS, BRGM, ISPRA, NGU, GSI, IGME-ES, GIR, SGSS, MBFSZ, LNEG, PGI, ISOR**)**

This task is to ensure that the generalities and the particularities of the diverse research products will be systematically identified and listed. It will require a permanent coordination between the GSPs and the GIP-P (see task 2.1). This is the first step toward an implementation of the digital scientific output of GeoERA which will share a common technological and architectural approach. A first workshop will be organised at an early stage of the projects (M5). A second workshop will take place at the end of the Prototyping phase (M18) of the GIP-P.

Task 2.3 Describe extensions to EGDI (GEUS, BRGM, GEUS, BGR, TNO, GEOZS, CGS, BRGM, ISPRA, RBINS, IGME-ES, GIR, SGSS**)**

From the compiled list of homogenized requirements of Task 2.2, this task will describe the needed extension such as the 3D and 4D by taking into consideration the current state of development of the EGDI.

Deliverables

D 2.1.1. First report (M12) highlighting the potential synergies and overlaps between the projects in terms of geoinformation.

D 2.1.2. A data delivery plan (M27) describing which data sets the different GSPs plan to finally deliver to the GIP.

D 2.1.3.Second Report (M35) wrapping-up the synergies and overlaps highlighted between the projects in terms of geoinformation.

D 2.2.1. First report (M6) describing the requirements to the Information Platform by the GeoEnergy, Groundwater and Raw Materials themes. It will also contain lists of attributes for the data, expected semantics and a description of required functionalities related to the prototype display interface that will be built during the Prototyping phase. D 2.2.2. A second report (M18) refining the requirements after feedback exchanges related to the prototypes of the EGDI database and the display interface. D 2.3.1 A first report (M9) mapping and describing the needed extensions to EGDI directly related to the task 2.2.. D 2.3.2 A second report (M21) filling the gap between the first extensions to EGDI and the actual geoinformation produce by the projects.

Work Package No: 3, Standards and interoperability issues, Lead beneficiary: ISPRA
Start month; 1, End Month 15.
Participants:

Partner No:	Partner:	Man Months:		Partner No:	Partner:	Man Months:
Part 01	GEUS	1,00		**Part 11**	NGU	3,00
Part 02	BGR	6,00		**Part 15**	GeoInform	1,00
Part 03	TNO	1,50		**Part 17**	GBA	1,50
Part 04	SGU	5,00		**Part 18**	SGSS	3,00
Part 05	GeoZS	3,00		**Part 19**	MBFSZ	2,00
Part 06	CGS	2,00		**Part 21**	LNEG	3,00
Part 07	BRGM	5,00		**Part 22**	PGI	1,00
Part 08	NERC	4,00		**Part 23**	HGI-CGS	2,00
Part 09	ISPRA	7,00		**Part 24**	ISOR	3,00

Objectives

The main objectives of this work package will be to explore in detail the requirements and needs stemming from the other GSPs (mapped by WP2) in order to identify shortcomings in the data models. This will lead to the development of a set of data models taking into account existing standards and specific needs for extensions. In order to help the data and service producing GSPs, the task will identify the rules to evaluate whether a given dataset is conformant with the relevant data model (a “conformance class”) and develop a data and service validation system to embed in the Information Platform in the Prototyping and Development phases. The technical requirements and documents produced by this package are essential for WP 5/6/7 to develop a system able to manage different types of data and formats.

Description of work

Task 3.1 Standardisation and interoperability analysis. (NERC, GEUS, BGR, TNO, SGU, GeoZS, CGS, BRGM, ISPRA, NGU, Geoinform, GBA, SGSS, MBFSZ, LNEG, PGI, HGI-CGS, ISOR**)**

The task will analyse in the Start-up phase the existing standards and Technical Guidelines (TGs) based on the common international standards: INSPIRE, ISO, IUGS CGI, OGC (GeoSciML, GWML, O&M, etc.), RDF, W3C (DCAT, semantic web best practices).
It will be based on the data requirements of each of the GSPs and will produce an overview of existing standards and provide some guidelines how to use these UMLs. A number of such data types have been identified through the “pre-defined” use cases mentioned in other GSPs (i.e. geological models). Driven by these use cases, the task will produce a set of rules that will be transformed in WP8 as a toolkit, enabling the data providers to transform their datasets according to the appropriate standards. The main set of tools will be for the remodelling of the dataset elements from the source to the standardised target schemas.
Building on the identified international interoperability standards, this will produce the reference data structures to be used within the Information Platform (D3.1).

Task 3.2 Data model gap analysis and technical requirements. (BRGM, GEUS, BGR, TNO, SGU, GeoZS, CGS, NERC, ISPRA, NGU, GBA, SGSS, MBFSZ, LNEG, HGI-CGS, ISOR**)**

Based on the analysis of existing standards and models (UML) of task 3.1, this task will evaluate possible gaps and produce a roadmap for the extension of the data models and standard (D3.2.1). When a completely new view and data models and standard will be developed, the task should target technical interoperability. It will identify and describe the minimum technical requirements (functional as well as non-functional) for the development of components needed to data integration and access, serving as core functionalities for the infrastructure. Technical requirements will be calibrated in the Prototyping phase on the needs identified by the analysis of existing and missing standards, producing also a set of recommendations for other the GSPs (D3.2.2). All the requirements and recommendations will be treated in parallel by the validation (task 3.3) and WP 6 and 7, to produce validation procedures and services and to develop the technical components of Information Platform.

Task 3.3: Standards validation procedures. (ISPRA, GEUS, SGU, BRGM, NERC, SGSS**)**
Based on the UML models defined in task 3.1 and on the vocabularies and ontologies identified and archived in WP4, this task will develop the Abstract Test Suites (ATS - a set of technical rules to implement in a real case the data model) that must take the sematic content into consideration.

Based on the ATS, the task will produce the schematron and the Executable Test Suite (ETS) needed to realise a Validation service for each data type provision. The documents in the Prototyping phase will provide to WP7 that should be implemented the schematron documents and the ETS transforming in a specific web services based on these information, requirements and recommendations for each. The task will also provide in the Prototyping and Full Development phases the "Validation service specification and requirements" document some example how to perform the validation against the requirements identified in ATS.
The task will be marked by two important internal milestones, moreover all the implementation procedure description and the list schematron documents will be described in a deliverable (D.3.3).

Deliverables
D 3.1 – Data models standards guidelines and toolkits [M9].
The document contains the analysis on the existing reference standard that can be used in the different project and that can be implemented in the Information Platform, at the same time it will provide Tool, guidelines and examples for datasets and metadata harmonisation.

D 3.2.1 – Gap analysis and path extension [M12].
The document list the gaps between the existing standards and the needs as mapped by WP2 as well as some general workflows describing how to extend the existing model to improve the knowledge.

D 3.2.2 – Technical requirements [M15].
The document contains all the technical requirements to integrate these reference data model and how to target the technical interoperability.

D 3.3 - Validation service specification and requirements [M18].
The documents contains some examples on how to perform the validation against the ATS requirements, the ATS identified for each data model that could be managed in the Information platform as identified in the previous deliverables and the basic schematron that will be implemented as service in the Information Platform.

Work Package No: 4, Semantic harmonisation issues, Lead beneficiary: GBA
Start month; 1, End Month 36.
Participants:

Partner No:	Partner:	Man Months:		Partner No:	Partner:	Man Months:
Part 01	GEUS	1,00		**Part 10**	GTK	1,00
Part 02	BGR	3,00		**Part 14**	IGME-ES	4,00
Part 03	TNO	4,00		**Part 15**	GeoInform	1,00
Part 04	SGU	4,00		**Part 17**	GBA	5,00
Part 05	GeoZS	4,00		**Part 19**	MBFSZ	4,00
Part 06	CGS	4,00		**Part 20**	LfU	8,00
Part 07	BRGM	3,00		**Part 21**	LNEG	2,00
Part 09	ISPRA	4,00		**Part 23**	HGI-CGS	3,00

Objectives

- Establishing technologies to support better search capabilities (semantic, multilingual, …) on the data sets and services generated in the GSPs
- Evaluation of existing standard terminology - to compile a new multilingual keyword thesaurus
- Semantic text search functionality for metadata - to improve the search capabilities in EGDI metadata catalogue (user platform development in WP6 and data base development WP7).
- Enable project specific vocabularies (knowledge representations as Linked Open Data) publishing scientific terms and names - to harmonize the use of terms where a Europe wide nomenclature is not applicable (overall architectural design to integrate vocabulary data in WP5, data base development in WP7)
- Draft guidelines for working with Linked Data - to support "GeoERA project vocabularies"

Description of work

The WP4 initiates, designs and tests the development of vocabulary data within the framework of the whole GeoERA program. This includes suggestions for a technical infrastructure for sustainable data storage, the organization of the editing and maintenance of the vocabularies, as well as the technical possibilities of coding data sets with vocabulary. The supported use cases are **"Multilingual semantic text search"** and **"GeoERA project vocabularies"** for coding GSP datasets with Linked Data (SKOS/RDF) concepts.

T4.1 Multilingual semantic text search (GBA, IGME, ISPRA, SGU, TNO, CGS, GIU, GeoZS, MBFSZ, LfU, BGRM, GTK, GEUS, BGR, HGI-CGS, LNEG**)**

Evaluation of existing vocabularies applicable for subject headings (IGME, GBA, ISPRA, SGU, TNO, CGS, GIU, GeoZS, MBFSZ, LfU, BGRM, GTK, GEUS, BGR, HGI-CGS, LNEG**)**
To integrate a semantic text search we investigate existing vocabularies for geosciences applicable for subject headings (evaluation). This task includes a survey of vocabularies suitable for keywords and evaluates the covered geoscientific domains, the scope, granularity, and other criteria. It selects which existing terminology is suitable for a new GeoERA/EGDI subject heading system.

Compilation of a keyword thesaurus (GeoZS, GBA, ISPRA, SGU, TNO, CGS, GIU, MBFSZ, LfU, BGRM, IGME, GTK, GEUS, BGR, HGI-CGS, LNEG**)**
A following task building on the previous is for modelling the subject heading system, from selected and tested vocabularies, to create a new keyword thesaurus and also to complete and translate missing keywords.

Governance plan, workflows around keyword thesaurus (CGS, GBA, GeoZS, BGR, LfU**)**
For a multilingual semantic text search it designs a governance plan for a keyword thesaurus including workflows for application, crosslinking to other Linked Data resources, and thesaurus maintenance - in order to establish a multilingual and semantic subject heading system for the GeoERA platform.

T4.2 GeoERA project vocabularies (GBA, IGME, ISPRA, SGU, TNO, CGS, GeoZS, MBFSZ, LfU, BGRM, GEUS, BGR**)**

URI Design, strategy (GBA, GEUS, TNO, IGME, BRGM, LfU**)**
A common agreed URI design and a strategy to assign for keywords and project vocabularies.

What is a "project vocabulary"? (MBFSZ, ISPRA, GBA, TNO, BGR, GeoZS, LfU**)**
It describes how to use project vocabularies suitable for semantic harmonization purposes. It evaluates Linked Data resources, the SKOS ontology, SKOS examples and best practices, define entity and relationship types, with restriction to a scientific use. Finally yet important, to find the differences between knowledge representations and standardized code lists like INSPIRE/GeoSciML.

Methods, models and workflows around "project vocabularies" (SGU, GBA, IGME, MBFSZ, BGR, ISPRA, GeoZS, CGS, LfU**)**

To develop methods, models and workflows around project vocabularies - which is about knowledge modelling, generation of vocabularies, connection to metadata catalogue, linked data showcases. This task applies the principles of lexical semantic modelling. It also designs a workflow of data transformation and -integration for project vocabularies and ideas of using RDF data format and O&M standard to describe geological, geophysical features.

Support the issue of "project vocabularies" (TNO, GBA, LfU, ISPRA**)**
A support part is to advise and assist project teams in the building of project vocabularies and to interact with projects where the harmonization will be done. It is mainly about knowledge modelling, transformation, validation, and implementation of project vocabularies. The support team working on project vocabularies uses guidelines drafted under T4.2 and finalized under WP8 professional data provider support. In addition, a test of a project vocabulary use case (workflow, frontend, and implementation) is planned.

Deliverables
D4.1 Keyword Thesaurus (RDF file) (T4.1 Compilation of a keyword thesaurus) [M14]
D4.2 Report - Keyword Thesaurus (T4.1 Evaluation of existing vocabularies applicable for subject headings, Compilation of a keyword thesaurus, Governance plan, workflows) [M16]
D4.3 Report - GeoERA project vocabulary (T4.2 URI Design, strategy, Scope of vocabulary concepts, Guideline - Methods, models and workflows, Testing and support "GeoERA project vocabularies") [M16]
D4.4 final report - experiences and status of the work (T4.1 and T4.2) [M34]

Work Package No: 5, Architecture, Lead beneficiary: BRGM
Start month; 1, End Month 30.
Participants:

Partner No:	Partner:	Man Months:
Part 01	GEUS	4,00
Part 05	GeoZS	9,00
Part 06	CGS	3,00
Part 07	BRGM	9,00
Part 08	NERC	3,00
Part 09	ISPRA	1,00
Part 14	IGME-ES	1,00
Part 17	GBA	1,00

Objectives
In order for the GIP to organise, disseminate and produce useful content for the GSPs a clear architecture must be defined both on the data and system aspect.

Building on pre-existing projects experience (OneGeology, EGDI, EPOS, and others) and recent international achievements (ex: W3C/OGC collaboration) WP5 will define the IIT guidelines to be applied for the platform.

- Define the blueprint of the GIP according to WP2 use-cases.
- Share the results of the GSPs according to interoperability and web-GIS best-practices.
- Organize the deployment/application of semantic and technical interoperability throughout the Information Platform.
- Data discoverability according to traditional OGC/INSPIRE practices, but also aligned with W3C guidelines.
- Define information flows from data providers to the GIP for each GSP.
- Articulate in a seamless system the GIP, EGDI and ultimately EPOS Geological Information and Modelling Thematic Core Service if practically feasible.

Description of work

Task 5.1 Overall system (Lead: BRGM, GEUS, GeoZS, CGS, NERC, ISPRA, IGME-ES, GBA**)**

The GIP must provide the GSPs with:

- Structured, interoperable and up-to-date reference datasets, GSP results and semantic references
- Served by a well defined service architecture in line with current best practices.

Thus, the overall system architecture will tackle two intertwined aspects: data and associated services.

"Data" architecture:

The recent collaboration between W3C and OGC has produced important best practices that adds the missing piece to the puzzle of interoperability as it was designed more than 15 years ago.

Recent W3C "Data on the Web Best Practices" and W3C/OGC "Spatial Data on the Web Best Practices" provide the way to go when it comes to data sharing.

The "data" part of the architecture will clarify the reference datasets to be used, their accessibility through the web (URI), their visibility (indexing), the way they should be linked together (linked data), and be structured (semantic interoperability).

It will also define how new data types and instances will have to be provided through the Information Platform. Clarify how several scientific projects concerning the same data type should connect together to ensure data augmentation instead of data duplication.

"Services" architecture:

The service architecture will be defined to meet the data architecture requirements along with required interaction and processing stemming from the requirements analysis.

The various services necessary to provide data in a rationalized manner will be defined in a coherent blueprint.

For each information type required by GSPs it has to be defined what service will be deployed where (data provider VS Information Platform level), how those services will be fed and, in turn, feed the GIP.

Task 5.2 Central System (Lead BRGM, GEUS, GeoZS, CGS, NERC, ISPRA, IGME-ES, GBA**):**

Other elements have to be deployed apart from the ones defined to support data provision. All those components are necessary for the system as whole to be coherent; such as:

- the reference metadata catalogue (datasets and services metadata), vocabulary registry underlying triple stores, URI resolver.
- the OGC webservice stack (WMS, WFS, …) and underlying database to expose and query datasets from the GIP itself.
- the validation services required to validate data compliancy.
- the various front-ends (GUI) required (portal, web-GIS, 3D/4D viewers, …).
- the harvesting system with its potential notification service and the system management tools.
- the various elements deployed to ensure the scalability of the architecture.

All those bricks have to have their roles and deployment strategies clarified for each of the needs arising from the scientific projects.

Deliverables

D 5.1: Report. GIP blueprint: data and service architecture of the overall system will be defined early on and regularly updated. Building on previous projects a first version will be made available at M6 then updated at the end of each phase (M6, M18, M34).

D 5.2: Report. GeoERA Central System specification. Building on previous project experience a first version will be produced for M6 then updated at the end of each phase (M6, M18, M34).

Work Package No: 6, Developments (user oriented), Lead beneficiary: GEUS
Start month; 3, End Month 36.
Participants:

Partner No:	Partner:	Man Months:		Partner No:	Partner:	Man Months:
Part 01	GEUS	24,00		**Part 09**	ISPRA	1,00
Part 02	BGR	5,00		**Part 10**	GTK	4,00
Part 03	TNO	8,00		**Part 14**	IGME-ES	2,00
Part 04	SGU	5,00		**Part 15**	GeoInform	1,00
Part 05	GeoZS	10,00		**Part 16**	GIR	4,00
Part 06	CGS	5,00		**Part 17**	GBA	4,00
Part 07	BRGM	5,00		**Part 19**	MBFSZ	2,67

Objectives

This work package will carry out the development of all user-oriented interfaces and ascertain that information generated in the GSPs are made available in a user-friendly way as clearly as required by the call. User-friendliness is a combination of usability (intuitiveness) of the interfaces and the degree to which these interfaces fulfil the needs of the end users. The nature of the information to be provided through the GIP will be decided in the GSPs and accordingly, these projects will be the main source of information regarding relevant end user groups and their needs.

To ensure the highest level of success, an agile approach will be applied through which persistent interactions with the other GSPs and WP2 will facilitate continuous gathering of requirements and use cases as well as feedback on mock-ups and prototypes.

The main objectives of WP6 will be;

- Implement requirements from the GSPs for optimal data representation on the portal.
- Give users an efficient state-of-the-art access to GeoERA data sets and products
- Extending the EGDI portal, including;
  - A more advanced content management system (CMS) that integrates to the GeoERA web-site GeoERA.eu.
  - GeoERA landing pages for each GSP including self-management.
  - An extended Web-GIS application with a new 3D viewer.
  - New applications for providing access to data as required by the thematic projects.
  - Seamless integration of the EGDI metadata database for optimal portal usability

Description of work

T6.1: Development of the Information Platform Portal (Participants: GEUS, BRGM, TNO, CGS, GBA, MBFSZ, BGR, SGU, GeoZS, ISPRA):

A first version of the GIP Portal will be developed based on the EGDI portal (http://www.europe-geology.eu) and launched early in the project.

Portal and Web-GIS functionality will gradually be improved by introducing Web-GIS best practices and the possibility to view 3D models when users click a feature with 3D content in the Web-GIS. The 3D viewer will have state-of-the-art capabilities and will run within any modern browser (PC or a handheld) without the use of plugins. The viewer will use open standards and free tools to generate, manage, store and view 3D data. To strengthen the capabilities, we will collect tools and functionality from GeoERA partners and integrate these into the viewer. As a first version, the 3D viewer will target two data types; geological models and faults. The latter will be connected to a service-enabled architecture with direct access to a fault database.

A dedicated demonstrator version of the relevant parts of the portal will be setup for each of the GSPs that will deliver information to the portal. The demonstrator will be a fully functional area in the portal complete with CMS, Web-GIS and data viewing functionality, but accessible only to that specific GSP.

The idea is to facilitate continuous interaction with these projects based on the demonstrators. Dialogue will become concrete and solution-oriented when issues can be tested and prototyped in real-time. For each data-delivering project, the demonstrator will be carefully populated with existing or new datasets by T6.2 in close cooperation with WP2 and the data-delivering projects. Furthermore, specific functionality as required by the data-delivering projects – like for instance support for 3D geological models - will be developed by T6.1 and integrated in the demonstrators, where they can be tested by key persons in the different GSPs. All relevant information and functionality will eventually be merged into the portal – and consequently into EGDI. The portal will have seamless integration of INSPIRE-compliant metadata functionality using the existing metadata catalogue of MICKA developed and maintained by Czech Geological Survey.

The portal will include components that are considered current best practice for portals, including:

- A shared file management system for having relevant project files in one central location.
- Intranet areas for publishing internal information and documents within working groups
- User registration related to feedback, support and download of data products.
- Logging of user activity by installing Piwik or connecting to existing analytical software.
- Digital archive for georeferenced documents.

The Validation Service prototype developed by WP3 available M12 when the first package of ETS implementation that verifies the conformance of GML datasets based on the ATS (Abstract Test Suite) included in the INSPIRE Data Specifications will be defined for the existing standard. This service will be based on the open source component OGC free testing facility GML 3.2 (ISO 19136:2007). The prototype will be added to the information platform thereafter.
The final validation Service system that will be included as toolkit in the platform will be developed in the second phase and it will be based on the ETSs implementation and “schematron” documents developed by WP3 in the second year for all the data models.

T6.2: Adding new data sets to the web-GIS (Participants: GEUS, BRGM,TNO, IGME-ES, ISPRA, MBFSZ, GeoZS, GeoInform, GTK)
This task will work actively with WP2 and contact persons from each of the other GSPs to determine use cases and ensure that data generated in the projects conform to the requirements that allow them to be integrated with the GIP. We will introduce standardized validation routines for new data sets (outcome from WP3) and multilingual semantic search/SKOS (outcome from WP4). Conformance analysis will include quality control, INSPIRE evaluation and feedback to data owners. Furthermore, existing datasets are located and their conformance level evaluated. This could for example be data generated by past European geoscience projects or data generated by projects outside of the geological community (geography, hydrography etc.). In case that some technical or legal issues prevent these data from being visualized in the Web-GIS, task T6.2 will work on solving these issues together with relevant contact persons from the respective data providers. All identified datasets will be continuously integrated with the demonstrator versions of the portal to be evaluated by the data-delivering projects. New functionality needed will be identified and prioritized. To best facilitate the development, a web-based administration module will be developed for efficient management of data product and their visual representation in the Web-GIS. Best practices will be developed for managing data products within GSPs related to dissemination and conformance. Finally, a cookbook for GSPs on creating and using the "Demonstrator" developed in T6.1 will be created.

Deliverables

D6.1. Portal, Version 1 (T6.1) [M3]

First version of portal with basic CMS and Web-GIS based on the existing EGDI functionality
Basic setup of CMS and web-GIS for each demonstrator portal

D6.2. Portal, Version 1.1 (T6.1) [M7]

File manager, intranet areas, user registration, user activity logging
Digital archive for georeferenced reports and articles etc.
3D viewer pilot

D6.3. Demonstrator portals, Version 1 (T6.2) [M16]

Administration module for managing data products and visual settings
Implementation of first datasets

Pilot implementation of validation routines
Ability to display geological models and faults in 3D

D6.4. Portal, Version 2 (T6.1) [M24]
Improved usability and design
Pilot implementation of advanced metadata searching
Final 3D viewer capable of viewing both geological models and data fetched directly from a 3D database

D6.5. Demonstrator portals, Version 2 (T6.2) [M35]
Final implementation of validation routines
Implementation of final version of datasets and functionality
Persist datasets and functionality in EGDI

Work Package No: 7, Developments (central), Lead beneficiary: GeoZS
Start month; 1, End Month 36.
Participants:

Partner No:	Partner:	Man Months:		Partner No:	Partner:	Man Months:
Part 01	GEUS	7,00		**Part 11**	NGU	1,50
Part 03	TNO	4,00		**Part 14**	IGME-ES	12,00
Part 05	GeoZS	36,00		**Part 19**	MBFSZ	1,00
Part 06	CGS	6,00		**Part 20**	LfU	4,00
Part 07	BRGM	5,00		**Part 23**	HGI-CGS	4,00
Part 09	ISPRA	2,00				

Objectives

The objective is to develop (upgrade / improve / optimize) various operational data management systems for the GSPs including harvesting systems, central databases, metadata system, system management tools, validation services, etc..
The platform will be based on and extend results obtained during the development of the EGDI and results from WP2 and WP5.

Description of work

The development will follow the rules and standards already used in previous projects as Minerals4EU, EURARE, ProSUM, EMODnet3, etc, and will be in-line with EGDI principles and recommendations.

The system will be developed upon outputs of different work packages: from requirements of WP2, from standards and interoperability in WP3, vocabularies from WP4 and it will be based on the architecture defined by WP5 and requirements from WP6 (data sets, data types and functionalities of the webGIS).

T7.1 Central database / harvesting (GeoZS, GEUS, BRGM, ISPRA, MBFSZ, HGI-CGS, Lfu, TNO**)**

- Extension of central EGDI database
- Futher development of existing EGDI harvesting system)
- Develop the central components of the digital archive to support GSPs (reports, unstructual data, etc.)

T7.2 Metadatabase (CGS, IGME-ES, GeoZS, HGI-CGS**)**

Further development of EGDI metadata system (MICKA) to include multilingual and semantic search functionality developed in WP4 to describe in the standardized form all identified data resources and other selected information delivered during projects by other work packages.

The Metadata Catalogue will be the central access point to metadata concerning data on geo-energy, groundwater and raw materials themes. It will provide tools for compilation of those metadata in a standardized format that will allow users to effectively search through the database. In order to make the data discoverable in the most efficient way, the catalogue will be fully compliant with international standards and will support the distributed system of metadata administration.

T7.3 Scalability issues (BRGM, GeoZS, Geus,LfU, TNO)
Development of various tests with different techniques for performance bottlenecks analysis.
T7.4 System management tools (IGME-ES, GeoZS, GEUS, NGU, ISPRA)

- A tool for measuring availability of web services (online, offline)
- A tool for monitoring the webGIS
- Central database monitoring tool (checking of data inserted regarding previous versions)
- A tool for validating dataseat and web services
- Other management tools based that will be defined in WP2 outputs if needed

Deliverables
D7.1 Working version Metadatabase (M18)
D7.2 Finished testing the system and identifying problems (M24)
D7.3 Final version of Central database / harvesting (M30)
D7.4 Final version of system management tools (M35)
D7.5 Final version of metadata catalogue and populated Metadatabase (M35)

Work Package No: 8, Data provider support, Lead beneficiary: NERC
Start month; 7, End Month 36.
Participants:

Partner No:	Partner:	Man Months:		Partner No:	Partner:	Man Months:
Part 01	GEUS	2,00		**Part 09**	ISPRA	4,00
Part 03	TNO	1,50		**Part 11**	NGU	4,00
Part 05	GeoZS	6,00		**Part 12**	RBINS	2,00
Part 06	CGS	4,00		**Part 15**	GeoInform	2,00
Part 07	BRGM	2,00		**Part 23**	HGI-CGS	4,00
Part 08	NERC	11,00				

Objectives
To empower the GSPs to disseminate and integrate data, information, interpretations and models resulting from their activities in a standards-based and interoperable manner through the GIP.
To provide a suite of support tools, channels and activities to facilitate data sharing through the GIP including the generation of cookbooks, provision of buddy systems and mentoring networks, creation of eLearning resources and delivery of training workshops.
To build on data provider support provided in previous data sharing and interoperability projects such as OneGeology and EGDI by extending with new, novel support functions.

Description of work
Task 8.1. Write a series of cookbooks to assist data providers in the utilisation of available standards to share GSP generated data. (NERC, ISPRA, GEUS, GEOZS, CGS, RBINS, GeoInform, NGU, HGI-CGS**)**
A cookbook can be considered a best practice manual 'containing a straightforward set of already tried and tested recipes or instructions for a specific activity'.
Building on the work done within OneGeology, this work package will provide a series of 'cookbooks' giving best practice on remodelling data to common agreed target schemas as identified in WP3 and using software to provide data in accordance with GIP standards e.g. on how to configure a WFS using GeoSciML from an institutions' internal digital databases. Such cookbooks will provide documented worked examples with workflows and sample code on how to deliver data to the GIP using commonly used industry software (both open source and proprietary as appropriate). Importantly, cookbooks will also be provided relating to the provision of metadata and metadata services as deemed necessary by the architecture of the GIP. They will also make the work of WP4 accessible to GeoERA data providers by supporting them in structuring their data so as to enhance semantic harmonisation across the GIP. These documents will provide specific work-flow guidance notes to enable full participation regardless of an organisation’s expertise.

This work will commence within the Prototyping phase and continue into the Full Development phase with finalisation being carried out in the Wrap-up phase. It is anticipated that most GSPs will add their data to the GIP towards the end of the Full Development phase and in the Wrap-up phase. The data support resources need to be available at that point though initial versions will be provided to encourage data providers to make early attempts at delivering via the GIP.

Task 8.2. Create of e-Learning resources. (ISPRA, NERC, HGI-CGS**).**

A series of e-Learning resources will be developed to make it easier to understand the guidance provided by the cookbooks written in task 8.1 and to increase the likelihood of projects being able to understand and implement the guidance provided in order to successfully provide data to the GIP. This task will be led by ISPRA through its partnership with the LINKVIT eLearning platform, the official Educational reference centre for JRC which has developed modules for INSPIRE.

This work will occur in the Full Development phase with finalisation being carried out in the Wrap-up phase.

Task 8.3. Create of a suite of data provider support systems. (NERC, CGS, ISPRA, GEUS, GEOZS, RBINS**).**

Support to data providers to help them implement the guidance provided by the cookbooks and e-Learning resources will take the form of a number of activities including:

- a buddy system and mentoring network that provides support from experienced organisations who have existing expertise in making data available following interoperable standards.
- An email help desk function providing a triage system to ensure users are put in contact with members of the GIP team who are best placed to help with any specific request.
- provision of training workshops with the purpose of further promoting the creation of data web services for inclusion in the GIP. These will take the form of webinars to reduce travel. Two such webinars are envisaged. There is the potential to consider one of these webinars to be conducted as face-to-face workshop to coincide with one of the coordination meetings.

This work will commence in the Prototyping phase, continue in to the Full Development phase with finalisation being carried out in the Wrap-up phase.

Task 8.4. Containerisation. (NERC, BRGM, NGU**).**

DevOps methodologies and technologies such as containerisation are designed to make it easier to create, deploy, and run applications. Containers allow a developer to package up an application with all of the parts it needs, such as libraries and other dependencies, and ship it all out as one package.

Utilising this technology will enable the provision of an off-the-shelf starter kit for providing data to the GIP. This will give data providers a quick start in implementing the guidance encapsulated within the cookbooks.

This work will be carried out during the Full Development phase with finalisation being carried out in the Wrap-up phase.

Deliverables

D8.1 A series of cookbooks (documents in PDF format or similar) assisting data providers delivering data to the GIP [released iteratively with final version month 32]
D8.2 A series of e-Learning resources providing interactive delivery of the content created in deliverable D8.1 [month 32]
D8.3.1 A support network incorporating buddy system, email-based helpdesk and issue triage system [initial version month 12; final version month 35]
D8.3.2 Two online training workshops for GIP data delivery [month 24; month 32]
D8.4 Series of example Docker containers supporting the delivery of data via the GIP [month 32]

Work Package No: 9, Sustainability issues. Lead beneficiary: GEUS

Start month; 1, End Month 36.
Participants:

Partner No:	Partner:	Man Months:
Part 01	GEUS	6,00
Part 05	GeoZS	3,00
Part 06	CGS	1,00
Part 07	BRGM	1,00
Part 09	ISPRA	0,50

Objectives

There has been numerous projects generating pan-European and more localised datasets that have been made accessible on the internet through projects funded by the EU and other sources over the last many years. Most of these have however seized to function a few years after implementation, as there has been no funding available to keep them alive.

One of the main goals of GeoERA is to make the resulting data and assessments sustainable in a long period after the end of the ERA-NET. This work package has the objective of proposing such a sustainable solution for GeoERA both in terms of funding and governance of the platform (operation, maintenance and further development).

Description of work

T9.1: Financial aspects of sustaining the IP (Participants: GEUS, BRGM**)**

This task will explore funding opportunities for the continued operation, maintenance and further development of the GIP. Potential sources include EuroGeoSurveys, a Geological Service for Europe (potential successor of GeoERA), Horizon 2020/FP9, European Open Science Cloud, JRC, etc.

T9.2: Governance aspects of sustaining the IP (Participants: GEUS, BRGM, GeoZS**)**

This task will analyse and describe one or more governance models(s) which could be established to support the long term sustainability of the IP.

Deliverables

D9.1: Report on the analysis of possible funding sources (M18).

D9.2: Report on financial models (M35).

D9.2: Report on governance models (M35).

Work Package No: 10, IPR and data policy issues, Lead beneficiary: NERC

Start month; 1, End Month 36.

Participants:

Partner No:	Partner:	Man Months:
Part 01	GEUS	2,00
Part 08	NERC	4,00
Part 09	ISPRA	0,50
Part 13	GSI	6,00

Objectives

In order for the GIP to perform both legally and efficiently it is essential that two requirements are met: (i) all information and knowledge used to make the GIP workable are free to use or licensed in such a way that makes use non-constrained, and (ii) geological information, results, models, etc created or derived as a result of the GSPs are free for reuse and preferably useable via Open Access. This is a common issue with Europe-wide projects, leaving it important to map any constraints on use of geological information and material and results: not to do so will leave participants open to potential legal action and stem the open use of results.

This work package will aim to:

- Gather information on the current issues surrounding open access data and existing blockages within the geodata geoscience marketplace in Europe and beyond
- Look at user and supplier requirements and work on a standard supplier licence to simplify and harmonise licensing for geodata.

- Examine issues around archiving and storage, legal risk and liability.

Description of work

Task 10.1 (NERC, GEUS, GSI, ISPRA**):** This task will look closely at the different forms of material to be used and disseminated by GeoERA: data, data products, software and models, services.
It will develop surveys for the three scientific areas already identified and look at existing blockages, permissions and legal concerns: why are there blockages – is this just specific to geodata?
The information gathered will be examined and common issues and areas for improvement will be highlighted.
The template for the H2020 FAIR management plan will be followed closely when creating the surveys, and the report on the results of these surveys will reference the FAIR data management guidelines and suggest improvements so that projects can better fulfil the requirements.

Task 10.2 (NERC, GEUS, GSI, ISPRA**):** The Work Package will then look at user/supplier requirements for geodata and study whether restricted access, embargoes, etc would help to alleviate supplier concerns. Regulations and licensing should enable the free flow of data while providing assurance that the value in the data will be protected for the owner.
This task will then look at licences in general: open access, restricted use, etc., leading on to the development of a standard supplier licence form - potentially in the form of a European Open Geoscience Licence.

Task 10.3 (GSI, GEUS, NERC**):** Issues around archiving and storage are another part of this work package as is a basic look at legal risk – understanding the risks and where any liability should fall. Archiving, storage and maintenance of geodata has a cost which is often not appreciated. When any geodata is released, there are always concerns about ownership and who should bear any risks associated. Are there ways of alleviating or reducing the risks? Minimising risks means increased and more confident dissemination of data.

Task 10.4 (GSI, GEUS, NERC**)** Although the GIP-P work packages will not in themselves generate large amounts of data, it is still important to assist with fulfilment of Horizon 2020 guidelines on FAIR data management. Certain aspects of the FAIR data management plan template are particularly relevant working towards the GIP-P; indeed, the information platform will be integral in ensuring the data is findable, accessible, interoperable and reusable. As a platform for the organisation and dissemination of the digital results of the projects in the three scientific areas, a data management plan must be created to ensure the FAIR principles apply to the data.

Deliverables

D 10.1 A Development of a questionnaire and interview with involved parties. An assessment of the information gathered from the surveys. This will be in the form of a report which highlights the common problems faced by the three science areas and identifies potential for improvement. (M4 and M11)

D 10.2 A report covering limitations on free movement of geodata. What are the constraints? Creation of basic user/ supplier forms- potentially in the form of a European Open Geoscience Licence. (M17)

D 10.3 Paper on new legislation covering access/open access, etc. Examining current approaches to licensing and copyright legislation and identifying areas for future development. (M24)

D 10.4 A study of the risks associated with geodata delivery in Europe (M35)

D 10.5 A data management plan(DMP), to ensure the GIP-P operates in a way which ensures data is findable, accessible, interoperable and reusable in line with H2020 guidelines. The FAIR DMP template will be followed and issues including open access, cohesive licensing rules and data security will be examined. (M9)

Work Package No: 11, Communication and dissemination, Lead beneficiary: IGME-ES
Start month; 1, End Month 36.

Participants:

Partner No:	Partner:	Man Months:
Part 01	GEUS	2,00
Part 04	SGU	1,00
Part 05	GeoZS	1,00
Part 07	BRGM	3,00
Part 09	ISPRA	4,00
Part 13	GSI	4,00
Part 14	IGME-ES	12,00

Overall objective:
The objective of this work package is to ensure that the results of the GIP are transparent and that many organisations can use them directly or built upon them. The tasks of the WP are designed to plan and carry out effective communication and dissemination activities that reach targeted audiences and aim to facilitate communication and a transparent interaction with the consortium members, the clustered projects and all relevant platforms and stakeholders, during and beyond the GeoERA.

Specific objectives:

- To carry out its own communication and dissemination plan on the basis of the dissemination part of the GeoERA Dissemination and Exploitation Master Plan (both during the Project Implementation Phase and during the Project Exploitation Phase) (GeoERA WP5, Communication, Exploitation and Dissemination of the results) in order to promote the GIP and the results of the GSPs in line with the GIP-P objectives;
- To collaborate with EuroGeoSurveys and its members in creating a multi-platform approach to communicating GeoERA's outputs and benefits to stakeholders (including tools, awareness activities, collaboration with stakeholder organisations);
- To identify and engage in new possible IP dissemination activities;
- To maximise the use of and transparent flow of information from the whole GeoERA;
- To measure the results of communication and dissemination activities, based on the established baseline targets set out in the GeoERA Dissemination and Exploitation Plan, and according to stakeholder groups and topics.

Communications functions:

Coordination and chairing of meetings and conference calls of transnational network partners – acting as central point of contact;

- Compilation of partner network input into communications guidelines, tools and activities;
- Primary responsibility for creation of communication products, including online content, print material, events, press releases, newsletters and stakeholder consultations;
- Compliance monitoring of project partners according to Communications Manual;
- Primary responsibility for measurement of results by creating a dashboard of indicators to monitor communication performance.
- Continuous stakeholder monitoring and horizon scanning to maintain communications approach relevance;
- Periodic progress updates to project team.

Description of work

Task 11.1. Developing a Communication Strategy. (IGME-ES, GEUS, GeoZS , BRGM, ISPRA, GSI)

A strategy for communication and dissemination in the GIP-P will be one of the first tasks to be undertaken. This will be in conjunction with the overall GeoERA Communications and Dissemination strategy. Communication and dissemination must take place both within the GIP-P between project partners but also to other projects, and to all relevant stakeholders.

The dissemination activities will start by defining a strategy for communication and dissemination in the GIP-P. This will be mirroring the overall Communications and Dissemination strategy in the GeoERA project overall. Communication and dissemination must take place both within the IP Project between project partners, but also to other projects, and to all relevant stakeholders.

With this objective in mind, the Communication Plan will identify the targets on three basic levels, experts connected with the project, stakeholders and decision makers and public, establishing different levels of communication for keeping them informed and updated. Therefore there will be an internal channel of communication with the partners and towards the main stakeholders, in order to ensure that the IP results are in line with their need, celebrating regular internal virtual meetings in order to foster frequent exchange of information between project partners.

The Dissemination plan will be targeted to the GEOERA participants involved in the projects, and to stakeholders outside GEOERA, such as private and industrial stakeholders in the market segments, academia and all potential users involved in the geological and earth science data. This approach will ensure the interoperability of data and of information and will allow an efficient information system to be set up for the duration of the GEOERA.

The strategy in the form of a **Communication Manual** (CM) will be shared with all the consortium members and will provide input for the main GeoERA Communications and Dissemination effort with relevant dissemination activities and products such as brochures, press releases, posters, multimedia, website and social media content using the established visual identity, and other pre-established GeoERA communication and dissemination products. Virtual training sessions on the use of the CM will be organised for all consortium partners. The plan will be reviewed and renewed every year after a gap analysis is made.

Target audience & messages:

The communication strategy will define specific communication and dissemination objectives, delineating key messages accordingly with the evolution of the results and outcomes of the IP and the corresponding communication target such as:

Geological Surveys: Creating a constant awareness, among the NGSOs on each of the GeoERA topics and its projects, sharing the information and the results delivered by them by using the most suitable dissemination tools to ensure that the information delivered will be easily reachable by the NGSOs in general and all its scientists and technicians in particular.

Policy makers: To contribute to improving and structuring the dialogue between various policy domains and subsurface stakeholders in support of subsurface spatial planning and decision making. Improved ability to combine geospatial (2D and 3D) databases, developed in GeoERA or at national/regional level, with other environmental data and information sources, to support e.g. environmental assessment, management of spatial planning, or evaluation and resolution of conflict of usage through implementation of standardised access (including INSPIRE compliant web services).

Industry: Better access to integrated information and knowledge on subsurface resources.
Consultants: Better access to integrated information on the subsurface in order for them to make value added products.

Scientist: Improved ability of scientists at GSOs and research institutions to effectively define future actions concerning improving key knowledge on geoenergy, groundwater and mineral resources, through provision of a sustainable expandable and reliable spatial information framework.

Public: To raise the awareness and knowledge about the subsurface resources available, other activities, the environment affected, etc.

Internal Communication and Dissemination

There will be regular virtual internal meetings in order to foster regular exchange of information between partners, with discussions on content as well as management matters. WP11 will monitor activities in all the other work packages as well as organise teleconferences to facilitate sharing of information. The project website will collate the latest available information and regular newsletters will keep the consortium duly informed.

External Communication and Dissemination

WP11 will feed into the GeoERA General Communications and Dissemination Plan, and will provide content for the website and social media tools. It will report on the common tools and guidelines for projects, such as templates, and will feed into newsletters and the website, as well as use of project specific logos. It will add project specific guidelines. Social media (Twitter and Linkedin) will be important tools to use. WP11 will collate reports from other workpackages in GIP-P and will report activities to the GeoERA Secretariat.

A stakeholder database will be developed in order to target messages appropriately. WP leaders will present their results at conferences events and workshops, and eventually to the public. Dissemination will have two phases

1. Raise awareness – to make sure that GIP-P, is well known within the community.
2. Promote and deepen understanding - by dissemination of results.

The stakeholder's database will be used by WP11 as a sort of advisory board sending them questionnaires and consults in order to adequately monitor the knowledge and use of the results of the project.

Task 11.2. Dissemination support services. (IGME-ES, GEUS, GSI, ISPRA, BRGM, GeoZS).
In order to maximize the value science projects obtain from disseminating data through the GIP, this task will focus on visualizing its benefits, by ensuring have full knowledge of the GIP capability and functionality of support services through the website. The aim is to assure that they understand how it can help their science, know how to utilise/exploit that capability and appreciate and value the benefits it provides. In addition, it will raise awareness of the stepping stones provided by GeoERA in terms of access to integration with wider science research E-Infrastructures incorporating EPOS, European Open Science Cloud and many other initiatives on a wider and interconnected network.

Task 11.3. Set of communication materials. (ISPRA, IGME-ES, GEUS, GSI, BRGM, GeoZS)
These materials will be adapted to the different targets detected on the first step for spreading the results transforming them into Information Platform users. In order to that there will be produced thematic materials, promoting the project results for experts, decision makers and general public.as videos, leaflets, posters, even other innovative practices like guerrilla marketing, depending on the different contexts and situations observed, giving some guidelines for national partners, relating with a common visual identity of the project.

WP11 will be responsible at developing the communication and dissemination materials for e.g. presentations, leaflet reports, deliverables, press releases, posters, website and social media content. The documents are intended to be available on-line or to be distributed during meetings, workshops or promotion activities and will be adapted to the target public.

Independently of the division into tasks above the GIP-P partners all will also have roles in:

- Development of guiding documents and communication guidelines;
- Collaboration on the development of activities, tools and resources;
- Acting as an on-the-ground stakeholder monitor and liaison in their respective region or country;
- Quality control and project monitoring;
- Ensure synchronisation of GeoERA communication initiatives on a national level;
- Regular participation in WP11 virtual meetings and conference calls.

Deliverables
D 11.1 Communication Manual (M6)
D 11.2 Website content determination (M7).
D 11.3 Information materials (leaflets, newsletter, video, brochures) (M35)
D 11.4 Performance Audit (M35)

Table 3.1b) List of work packages

Work package No.	Work Package Title	Lead Partici-pant No.	Lead Participant Short Name	Person - Months	Start Month	End month
1	Coordination	1	GEUS	36,5	1	36
2	User requirements	12	RBINS	88,0	2	36
3	Standards and interoperability issues	9	ISPRA	54,0	4	18
4	Semantic harmonisations issues	17	GBA	55,0	1	36
5	Architecture	7	BRGM	31,0	1	34
6	Developments (user oriented)	1	GEUS	80,7	3	36
7	Developments (central)	5	GeoZS	82,5	1	36
8	Data provider support	8	NERC	42,5	7	36
9	Sustainability issues	1	GEUS	11,5	1	36
10	IPR and data policy issues	8	NERC	12,5	1	36
11	Communication and Dissemination	14	IGME-ES	27,0	1	36
				521,2		

Table 3.1c) List of deliverables

Deliverable number	Deliverable name	WP No.	Lead participant	Type	Dissemination level	Delivery date (in months)
1.1	Project guidelines including procedures for QA, reporting and risk management (M5)	1	GEUS	R	CO	5
1.2	Internal progress reports	1	GEUS	R	CO	7, 13, 19, 25 and 31
1.3	Project progress meeting minutes	1	GEUS	R	CO	2, 8, 14, 20, 26, 32
1.4	Final confernece report	1	GEUS	R	PU	36
2.1.1	Highlights of the potential synergies and overlaps between the projects in terms of geoinformation.	2	RBINS	R	PU	12
2.1.2	Data delivery plan	2	RBINS	R	PU	27
2.1.3	Wrapping-up the synergies and overlaps highlighted between the projects in terms of geoinformation.	2	RBINS	R	PU	35
2.2.1	Description of the requirements to the Information Platform by the GeoEnergy, Groundwater and Raw Materials themes.	2	RBINS	R	PU	6
2.2.2	Refinements of the requirements after feedback exchanges related to the prototypes of the EGDI database and the display interface.	2	RBINS	R	PU	18
2.3.1	Mapping and description of the needed extensions to EGDI.	2	GEUS	R	PU	9
2.3.2	Fill-out of the gap between the first extensions to EGDI and the actual geoinformation produce by the projects.	2	GEUS	R	PU	21
3.1	Data models standards guidelines and toolkits	3	NERC	R	PU	9
3.2.1	Gap analysis and path extension	3	BRGM	R	PU	12

3.2.2	Technical requirements	3	BRGM	R	PU	15
3.3	Validation service specification and requirements	3	ISPRA	R	PU	18
4.1	Keyword Thesaurus (RDF file)	4	GBA	OTHER	PU	14
4.2	Keyword Thesaurus	4	GBA	R	PU	16
4.3	Report - GeoERA project vocabulary	4	GBA	R	PU	16
4.4	Final Report on semantic harmonisation	4	GBA	R	PU	34
5.1	GIP Blueprint	5	BRGM	R	PU	18, 30
5.2	GeoERA Central System specification	5	BRGM	R	PU	18, 30
6.1	Portal version 1	6	GEUS	DEC	PU	3
6.2	Portal version 1.1	6	GEUS	DEC	PU	7
6.3	Demonstrator portals, Version 1	6	GEUS	DEC	PU	16
6.4	Portal verison 2	6	GEUS	DEC	PU	24
6.5	Demonstrator portals, Version 2	6	GEUS	DEC	PU	35
7.1	Working version Metadatabase	7	CGS	DEM	PU	18
7.2	Report on testing	7	BRGM	R	PU	24
7.3	Final version of Central database / harvesting	7	GeoZS	OTHER	PU	30
7.4	Final version of system management tools	7	IGME-ES	OTHER	PU	35
7.5	Final version of metadata catalogue and populated Metadatabase	7	CGS	DEM	PU	35

8.1	A series of cookbooks	8	NERC	R	PU	32
8.2	A series of e-Learning resources	8	ISPRA	DEC	PU	32
8.3.1	A functioning support network	8	NERC	OTHER	PU	12, 35
8.3.2	Webinar training workshops	8	NERC	OTHER	PU	24, 35
8.4	A series of example Docker containers	8	NERC	OTHER	PU	32
9.1	Report on the analysis of possible funding sources	9	GEUS	R	PU	18
9.2	Report on financial models	9	GEUS	R	PU	35
9.3	Report on governance models	9	GEUS	R	PU	35
10.1	Report on queastionnaire and interviews	10	NERC	R	PU	4, 11
10.2	A report covering limitations on free movement of geodata	10	NERC	R	PU	17
10.3	Report on new legislation covering access/open access, etc.	10	NERC	R	PU	24
10.4	A study of the risks associated with geodata delivery in Europe	10	GSI	R	PU	35
10.5	Data Management Plan	10	GSI	R	PU	9
11.1	Communication Manual	11	IGME-ES	R	PU	6
11.2	Report on website content determination	11	IGME-ES	R	PU	7
11.3	Information content material	11	ISPRA	DEC	PU	35
11.4	Report on Performance Audit	11	IGME-ES	R	PU	35

Table 3.2a) List of milestones

Milestone number	Milestone name	Related work package(s)	Due date (in months)	Means of verification
1	Preparatory activities finished	2, 3, 4, 5, 6, 7	6	Final Project Implementation Plan approved; Project guidelines finalised; Requirements from GSPs described; Architecture blueprint finalised; Portal version 1 in place; Communication manual in place;
2	Prototyping finalised	2, 3, 4, 5, 6, 7	18	Requirements from GSPs refined through prototype; Data models and validation services specified; Demonstrator portals version 1 in place; Working version of Metadatabase in place; A functioning support network in place; Analysis of possible funding sources done; Data Managememt Plan in place;
3	Developments finalised	2, 4, 5, 6, 7, 8	30	Data delivery plan in place; Portal version 2 operational; Final verison of harvesting system and central database in place; e-Learning tools developed; First online training workshop conducted;

4	End of project	1, 2, 4, 5, 6, 7, 8, 9, 10, 11	36	All data and functionality required by the GSPs in place and operational; Demonstrator portals version 2 in place; System management tools in place; Final version of populated metadata database in place; All user training activities carried through; Financial and governance models described; All information materials peroduced and disseminated;

Table 3.2b) List of critical risks for implementation

Description of risk (indicate level of likelihood: Low/Medium/High)	Work package(s) involved	Proposed risk-mitigation measures
Requirements from GSPs higher or more complex than expected and what can be covered by the budget. Likelihood: Medium.	2, 3, 4, 5, 6, 7	Prioritization of development activities to support the main purpose of the GIP-P, namely the support of the individual GSPs. Could result in that other objectives like harmonisation across GSPs could suffer instead.
GSPs will not be ready to deliver their digital results to be disseminated through the GIP in a timely manner. Likelihood: Medium.	6, 7, 8	The GIP-P WP2 will be in contact with the GSPs throughout the whole duration of the project and the task 2.1 will have strong focus on any deviations from the data delivery plan D2.1.2
Poor engangement of contact persons from the GSPs. Likelihood: Low.	2, 3, 4, 5, 6, 7, 8, 9	Signs of low engagement will be in focus in task 2.1 and the Project Coordinator and the coordinator of the GSP will be notified.
Biased or inconsistent approach – partners not following standards and guidelines set. Likelihood: Low.	6, 7, 8	The organisational set-up, first of all the Project Board and the close contact between the WP leaders and task leaders will make it possible to detect this at an early stage and take corrective actions.
Loss of key project personnel, incomplete or bad performance, loss of direction/scope of project. Likelihood: Low.	All	The key participants originate in mature organisations with back-up resources. Also the shared responsibilities within the WPs and tasks provide resilience.

Deliverables and Milestones not realized on time leading to delays in project through domino effect. Likelihood: Low.	All	Frequent communication between the Project Coordinator and the WP and task leaders will ensure that potential delays are identified early. Corrective planning will take place as soon as possible.

Table 3.3a) Summary of Staff Effort

Partner	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9	WP10	WP11	Total MM
1 GEUS	18,00	3,00	1,00	1,00	4,00	24,00	7,00	2,00	6,00	2,00	2,00	**70,0**
2 BGR	0,67	6,00	6,00	3,00	0,00	5,00	0,00	0,00	0,00	0,00	0,00	**20,7**
3 TNO	0,67	4,00	1,50	4,00	0,00	8,00	4,00	1,50	0,00	0,00	0,00	**23,7**
4 SGU	0,33	2,00	5,00	4,00	0,00	5,00	0,00	0,00	0,00	0,00	1,00	**17,3**
5 GeoZS	1,00	6,00	3,00	4,00	9,00	10,00	36,00	6,00	3,00	0,00	1,00	**79,0**
6 CGS	3,00	3,00	2,00	4,00	3,00	5,00	6,00	4,00	1,00	0,00	0,00	**31,0**
7 BRGM	1,00	6,00	5,00	3,00	9,00	5,00	5,00	2,00	1,00	0,00	3,00	**40,0**
8 NERC	1,00	0,00	4,00	0,00	3,00	0,00	0,00	11,00	0,00	4,00	0,00	**23,0**
9 ISPRA	1,00	5,00	7,00	4,00	1,00	1,00	2,00	4,00	0,50	0,50	4,00	**30,0**
10 GTK	1,00	0,00	0,00	1,00	0,00	4,00	0,00	0,00	0,00	0,00	0,00	**6,0**
11 NGU	0,67	2,00	3,00	0,00	0,00	0,00	1,50	4,00	0,00	0,00	0,00	**11,2**
12 RBINS	1,00	17,00	0,00	0,00	0,00	0,00	0,00	2,00	0,00	0,00	0,00	**20,0**
13 GSI	1,00	8,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	6,00	4,00	**19,0**
14 IGME-ES	1,00	10,00	0,00	4,00	1,00	2,00	12,00	0,00	0,00	0,00	12,00	**42,0**
15 GeoInform	1,00	0,00	1,00	1,00	0,00	1,00	0,00	2,00	0,00	0,00	0,00	**6,0**
16 GIR	0,33	3,00	0,00	0,00	0,00	4,00	0,00	0,00	0,00	0,00	0,00	**7,3**
17 GBA	0,50	0,00	1,50	5,00	1,00	4,00	0,00	0,00	0,00	0,00	0,00	**12,0**
18 SGSS	0,40	2,00	3,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**5,4**
19 MBFSZ	0,33	2,00	2,00	4,00	0,00	2,67	1,00	0,00	0,00	0,00	0,00	**12,0**
20 LfU	0,58	0,00	0,00	8,00	0,00	0,00	4,00	0,00	0,00	0,00	0,00	**12,6**
21 LNEG	0,67	4,00	3,00	2,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**9,7**
22 PGI	0,33	2,00	1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**3,3**
23 HGI-CGS	0,67	0,00	2,00	3,00	0,00	0,00	4,00	4,00	0,00	0,00	0,00	**13,7**
24 ISOR	0,33	3,00	3,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**6,3**
Total person months	**36,48**	**88,00**	**54,00**	**55,00**	**31,00**	**80,67**	**82,50**	**42,50**	**11,50**	**12,50**	**27,00**	**521**

Table 3.3b) 'Other direct cost' items (travel, equipment, other goods and services). Only reported for particpants for whom other direct costs exceed 15% of direct personnel costs.

Partner: 06 – CGS	Cost (€)	Justification
Travel	18.000	Participation by three staff in all four Full Consortium meetings plus participation in specific meetings for WPs 2, 4, 7 and 8
Equipment	0	
Other goods and Services	0	
Total	18.000	

Partner: 10 – GTK	Cost (€)	Justification
Travel	13.000	Participation by three staff in all four Full Consortium meetings plus participation in specific meetings for WP 4
Equipment	0	
Other goods and Services	0	
Total	13.000	

Partner: 15 – Geoinform	Cost (€)	Justification
Travel	14.000	Participation by three staff in all four Full Consortium meetings plus participation in specific meetings for WP 4
Equipment	0	
Other goods and Services	0	
Total	14.000	

Partner: 16 – GIR	Cost (€)	Justification
Travel	6.000	Participation by one staff in all four Full Consortium meetings plus participation in specific meetings for WP 2
Equipment	0	
Other goods and Services	0	
Total	6.000	

Partner: 17 – GBA	Cost (€)	Justification
Travel	10.000	Participation by two staff in all four Full Consortium meetings plus participation in specific meetings for WPs 3, 4, 5, 6
Equipment	0	
Other goods and Services	0	
Total	10.000	

Partner: 18 – SGSS	Cost (€)	Justification
Travel	6.000	Participation by one staff in all four Full Consortium meetings plus participation in specific meetings for WP 2
Equipment	0	
Other goods and Services	0	

Total	6.000

Partner: 19 – MBFSZ	Cost (€)	Justification
Travel	3.000	Participation by one staff in all four Full Consortium meetings
Equipment	0	
Other goods and services	0	
Total	3.000	

Partner: 21 – LNEG	Cost (€)	Justification
Travel	10.000	Participation by two staff in all four Full Consortium meetings plus participation in specific meetings for WP 2
Equipment	0	
Other goods and Services	0	
Total	10.000	

Partner: 22 – PGI	Cost (€)	Justification
Travel	6.000	Participation by one staff in all four Full Consortium meetings plus participation in specific meetings for WP 2
Equipment	0	
Other goods and Services	0	
Total	6.000	

Partner: 23 – HGI-CGS	Cost (€)	Justification
Travel	9.000	Participation by two staff in all four Full Consortium meetings plus participation in specific meetings for WP 7
Equipment	0	
Other goods and Services	0	
Total	9.000	

Table 3.3c) Financial table with requested budget

Participant	(A) Direct personnel costs (EUR)	(B) Other direct costs; travel, equipment, infrastructure, other (EUR)	(C) Direct costs of sub-contrac-ting (EUR)	(D) Indirect costs (= (A + B) *0,25) (EUR)	(E) Total estimated eligible costs (=A+B+C+D) (EUR)	(F) Reimburse-ment Rate (29,7%)	(G) Requested EU contribution	(H) Surveys in-kind contribution
GEUS	507.500	35.000	0	135.625	678.125	29,7%	201.403	476.722
BGR	127.121	12.000	0	34.780	173.901	29,7%	51.648	122.252
TNO	139.156	13.000	0	38.039	190.195	29,7%	56.488	133.707
SGU	129.109	6.000	0	33.777	168.886	29,7%	50.159	118.727
GeoZS	276.500	32.000	0	77.125	385.625	29,7%	114.531	271.094
CGS	74.400	18.000	0	23.100	115.500	29,7%	34.304	81.197
BRGM	292.640	33.000	0	81.410	407.050	29,7%	120.894	286.156
NERC	139.610	13.000	0	38.153	190.763	29,7%	56.656	134.106
ISPRA	141.000	21.000	0	40.500	202.500	29,7%	60.143	142.358
GTK	41.400	13.000	0	13.600	68.000	29,7%	20.196	47.804
NGU	83.775	11.000	0	23.694	118.469	29,7%	35.185	83.284
RBINS	126.550	14.550	0	35.275	176.375	29,7%	52.383	123.992
GSI	114.000	14.000	0	32.000	160.000	29,7%	47.520	112.480
IGME-ES	191.814	27.500	0	54.829	274.143	29,7%	81.420	192.722
GeoInform	28.992	14.000	0	10.748	53.740	29,7%	15.961	37.779
GIR	21.257	6.000	0	6.814	34.071	29,7%	10.119	23.952
GBA	62.568	10.000	0	18.142	90.710	29,7%	26.941	63.769
SGSS	18.416	6.000	0	6.104	30.520	29,7%	9.065	21.456
MBFSZ	18.900	3.000	0	5.475	27.375	29,7%	8.130	19.245
LfU	79.275	10.000	0	22.319	111.594	29,7%	33.143	78.450
LNEG	48.350	10.000	0	14.588	72.938	29,7%	21.662	51.275
PGI	5.824	6.000	0	2.956	14.780	29,7%	4.390	10.390
HGI-CGS	25.631	9.000	0	8.658	43.289	29,7%	12.857	30.432
ISOR	53.805	4.000	0	14.451	72.256	29,7%	21.460	50.796
	2.747.593	**341.050**	**0**	**772.161**	**3.860.803**		**1.146.659**	**2.714.145**

4 Members of the consortium

4.1 Participants (applicants)

Participant No. 1, Geological Survey of Denmark and Greenland, GEUS, Denmark

Overall description of Survey Organisation
The Geological Survey of Denmark and Greenland (GEUS) (www.geus.dk) is a research and advisory institute in the Danish Ministry of Energy, Utilities and Climate. GEUS was founded in 1888 and works in the fields of geoscientific studies, research, consultancy and geological mapping. GEUS covers the disciplines groundwater, energy resources, mineral resources, climate and information management.

GEUS has contributed intensively to the development and operation of databases and exchange-formats for geological and geophysical data related to geoenergy, mineral resources and groundwater for more than 25 years. The institution runs nationwide databases for boreholes, geochemistry, geophysics, geological samples, digital reports, digital maps and geological models. In addition to the databases a

large number of web-services have been developed for query and update of the data. GEUS also has contributed to the EU co-funded projects EUMARSIN, EUROSEISMICS, GeoSeas, eWater, GEOMIND, OneGeologyEurope, EuroGeoSource, EMODnet-geology, EGDI-Scope and InGeoCloudS and through this gained experience with data exchange and formats. GEUS has furthermore a strong role in in the recently launched projects Minerals4EU and EURARE and is member of the INSPIRE Thematic Working Group on Geology and Mineral Resources.
GEUS has coordinated the development of EGDI

In the GeoERA Information Platform project GEUS will be the overall project coordinator and will hence lead WP1. GEUS will furthermore lead WP6 and WP9 and also contribute significantly to WPs 2, 7 and 11.

Products and services
EGDI
Greenland portal http://www.greenmin.gl/
Gerda

Publications
Rob van der Krogt, Richard Hughes, Mikael Pedersen, Jean-Jacques Serrano, Kathryn A. Lee, Jørgen Tulstrup, François Robida 2013: Working towards a European Geological Data Infrastructure. Geophysical Research Abstracts Vol. 15.
François Robida, J. Wächter, J. Tulstrup, H. Lorenz, M. Carter, et al.. Building geological services for the EPOS European Research Infrastructure. 35th International Geological Congress : IGC 2016, Aug 2016, Cape Town, South Africa. 2016.
J. Tulstrup, Agnès Tellez-Arenas, M. Pedersen, François Robida, B. Pjetursson, et al.. The European Geological Data Infrastructure EGDI. 35th International Geological Congress : IGC 2016, Aug 2016, Cape Town, South Africa. 2016.

Involvement in other relevant European and national projects
Minerals4EU: http://www.minerals4eu.eu
EGDI
EUOGA
EPOS-IP

Profiles of key staff members
Jørgen Tulstrup (male): M.Sc. in Geology/Geophysics. Chief Consultant. For 15 years responsible for GEUS' databanks and GIS. Jørgen has been working with establishing databases for geological and other geodata data for more 30 years and has been a participant in several EU funded projects including OneGeologyEurope, EuroGeoSource, EUMARSIN, InGeoCloudS, EGDI-Scope, Minerals4EU and EPOS.

Frands Schjøth (male): M.Sc. in Geology/Geophysics. Computer Geoscientist and GIS specialist. Remote sensing, Database manager and –administrator, IT-administrator, Digital exploration and mineral resource data. Since 1995 Frands has been working with digital exploration and mineral resource data both in Oracle and PostgreSQL databases and in advanced ArcGIS for Desktop and ArcGIS-server environment. Frands has lately worked with making mineral and energy resource data from Denmark and Greenland available for external use through the Greenland portal, EuroGeoSource system, Minerals4EU and EURARE.

Tjerk Heijboer (male): PhD in Geology. Geologist with 5 years' experience in database and IT web development. Has been involved in the European projects: Minerals4EU, EURARE, PROSUM and EPOS. Participation in these projects includes creating database models implementing them in databases and setting up INSPIRE compliant web services and coordination with other participants in these projects.

Christian Brogaard Pedersen (male): M.Sc. in Geology & Geoscience. GIS developer with background experience in 3D geological modelling for groundwater and energy storage. Working with advanced ArcGIS Desktop and ArcGIS Server as well as database modelling for both Oracle Spatial and

PostgreSQL. Christian has been working with 3D database storage facilities and been a participant in EU funded projects including EPOS-IP, EUOGA, Minerals4EU and NAG-TEC.

Participant No. 2, Bundesanstalt für Geowissenschaften und Rohstoffe, BGR, Germany

Overall description of Survey Organisation
BGR is the central scientific and technical institution which supports the German federal government and its ministries, the EU, and German industry in all geo-relevant matters. It is subordinate to the Federal Ministry of Economics and Technology (BMWi). BGR carries out projects of technical and scientific co-operation with developing countries and other European geological surveys. Among others, geo-technical security of (nuclear) waste deposits, research on energy resources, protection of resources and the geo-environment, and geo-risk assessment are BGR's tasks. BGR publishes its research results in form of reports, model data, maps, web services and operates several database applications (e.g. a lithostratigraphic encyclopaedia for Germany) as well as a digital product centre and a data viewer application.

Products and services
Data viewer application: https://geoviewer.bgr.de
Product centre: https://produktcenter.bgr.de
Lithostratigraphic encyclopaedia for Germany: https://litholex.bgr.de
Publication index application: https://zsn.bgr.de/biblioserver/

Publications
The 1:5 Million International Geological Map of Europe and Adjacent Areas (IGME5000)
Geological Map of Germany 1:1,000,000 (GK1000)
International Hydrogeological Map of Europe 1:1,500,000 (IHME1500)
Map of Groundwater Resources of the World (WHYMAP GWR)
Soil Regions of the European Union and Adjacent Countries 1:5,000,000 (EUSR5000)

Involvement in other relevant European and national projects
International: GIS of the International Quaternary Map of Europe, scale 1 : 2,5 Million (Review of the first edition of IQuaME 2500)
EU: European Marine Observation and Data Network (Emodnet 1-3, part Geology)
EU: 1:1 Million OneGeology pan-european Surface Geology (OneGeology-Europe)
EU: Tracing the Origin of Food (TRACE)

Profiles of key staff members
Tanja Wodtke
Head of Sub-Department Geoinformation, Stratigraphy
Current emphasis: spatial data infrastructure, INSPIRE, semantic web

Dr. Andreas-Alexander Maul
Scientific employee at Federal Institute for Geosciences and Natural Resources (BGR), collaboration within EU-Project GEIXS (Metadata Information System) in the years 1998-2000
Current emphasis: promotion of BGR's spatial data infrastructure, INSPIRE transformation of BGR's scientific data sets

Ulrike Andree
Technical employee at Federal Institute for Geosciences and Natural Resources (BGR)
Current emphasis: development and maintenance of BGR's Metadata Catalogue and Product Centre

Ralf Ziebarth
Technical employee at Federal Institute for Geosciences and Natural Resources (BGR)
Current emphasis: development and maintenance of BGR's Data Viewer and Web Services

Participant no. 3, Nederlandse Organistie voor Toegepast Natuurwetenschappelijk Onderzoek, TNO, The Netherlands

Overall description of Survey Organisation
TNO is a semi-independent Dutch research and technology organisation active in technical, earth, environmental, life, societal and behavioural sciences, focussing on healthy living, industrial innovation, energy, transport and mobility, built environment, the information society, and defence, safety and security.
TNO will be represented in Geo-ERA through the Geological Survey of the Netherlands, which provides geoscientific data, information and knowledge for:
 sustainable management of earth resources and the environment in general;
 safe living on subsiding lowlands;
 reduction of risks and costs in building and construction associated with ground conditions.
The survey's core skills include data management, geo-ICT and 3D-modelling. The organisation hosts the national repository for subsurface data and information and is the designated state advisor of all geological matters related to the Mining Act.

Products and services
Mention relevant portals, services etc. that your survey has developed.
- DINOLoket
- NLOG
- ThermoGIS

Publications
Mention relevant publications or major presentations.
- 3D geology in a 2D country : Perspectives for geological surveying in the Netherlands
- Opening up the subsurface for the cities of tomorrow. considering access to subsurface knowledge - Evaluation of practices and techniques
- Pressure information system of the onshore and offshore Netherlands
- Testing a simple and low-cost method for long-term (baseline) CO2 monitoring in the shallow subsurface

Involvement in other relevant European and national projects
- ESTMAP
- EuroGeoSource
- EGDI-Scope
- ODIP & ODIPII
- BRO

Profiles of key staff members
Drs. Rob van Ede: project manager and data analyst at TNO-GDN data & information group. Member of the EGS Spatial Information Expert Group & facilitator for the INSPIRE Energy Resources thematic cluster. 12 Years of experience in GIS and spatial data management

Drs. Frank Waardenburg: GIS software and database developer at TNO-GDN ICT department with many years experience in GIS services and software development in national and European projects like EuroGeoSource and OneGeology.

Participant no. 4, Sveriges Geologiska Undersökning, SGU, Sweden

Overall description Geological Survey of Sweden
SGU is an agency under the Ministry of Enterprise, Energy and Communication. The total staff of SGU is 249. The budget for 2017 is 42,5 million €. The Geological Survey of Sweden (SGU) is the national agency for issues relating to bedrock, soil and groundwater in Sweden.
SGU has extensive expertise in information management relevant to the current project proposal.
All IS/IT-related issues are handled within the operational support department by the IT and Geodata divisions which has a total staff of 25. Division of Geodata management is responsible for handling of geodata, record management and production of web services. Division of IT handles maintenance of the IT infrastructure, the internal helpdesk function and software development.

Products and services
Examples of SGU geospatial services
https://www.sgu.se/en/products/data/data-in-web-map-services-wms/
https://apps.sgu.se/kartvisare/index.html
https://apps.sgu.se/kartvisare/index-en.html
https://www.sgu.se/en/products/maps/map-generator/

Involvement in other relevant European and national projects
SGU is involved in the implementation of the Swedish national spatial infrastructure and its portal https://www.geodata.se/geodataportalen/
SGU is involved the implementation of INSPIRE for geology and Earth Resources
BALANCE, OneGeology Europe, Minerals4EU and EGDI are examples of European projects SGU has been involved.

Profiles of key staff members

Olov Johansson
Olov have been working with different aspects of information management for the past 10 years with focus on geographic information, models, standards, architecture and SDI (Spatial Data Infrastructure). His current position is information architect. Previous experience as specification coordinator and responsibility, model framework responsibility, architecture and infrastructure responsibility and thematic working group leader in Svensk Geoprocess a cooperation between the Swedish Land Survey (Lantmäteriet), the Swedish Association of Local Authorities and Regions as well as municipalities with the aim to create a national spatial data infrastructure and platform for cooperation with geographic information on a local, regional and national level.
Several years of participating in committees and working groups of the Swedish national ISO-body, reviewing ISO-standards, developing Swedish national standards and technical guidelines.

Daniel Sundberg
Daniel has a master's degree in Physical Geography. His main work is with Information and database modelling and management. He has extensive Project manager experience and knowledge of standardization work (GeoSciML, INSPIRE etc). Advanced GIS competence: Esri ArcGIS and ETL tools. Databases experience: SQL Server, PostgreSQL/PostGIS, Esri geodatabases

Karl Olsson
Karl is records- and information manager with experience from both public and private sector. He is part of ISO/TC 46/SC11:s mirror committee in Sweden - SIS TK546 "Management systems for records". In that group he works internationally with development of standards for records management and related. He is also involved in a national workgroup for developing national guidelines for archiving of geodata. His toolbox consists of information governance plans/schedules, information models (UML), specifications, terms and definitions and more.

Participant no. 5, Geoloski Zavod Slovenije, GeoZS, Slovenia

Overall description of the Geological Survey of Slovenia (GeoZS)
Geological Survey of Slovenia (GeoZS) is a public research institute with app. 95 employees and established by the Government of the Republic of Slovenia. It carries out fundamental and applied research in regional geology, hydrogeology, geochemistry, sedimentology, paleontology, petrology, tectonics, geophysics, mineral resources and fossil energy, geothermal energy, geohazards, GIS and education. It provides a public service through scientific research programs and cooperation with universities. GeoZS is tightly involved in national and international research and professional communities worldwide. Activities are supported by Geological Information Centre, responsible for the collection, processing, storage and dissemination of geological data. We support national authorities and agencies in the process of concession granting for mining, and mineral and thermal water use. Our laboratories do petrological, mineralogical, geochemical and geothermal analyses.
GeoZS role in the project:

The GeoZS teams from the Geological Information Centre department have a strong experience in European projects and our expertise cover from data production and management, to data models conception, and to Knowledge Data Platforms development.

The most relevant references are:

- ŠINIGOJ, Jasna, JEMEC AUFLIČ, Mateja, KRIVIC, Matija. Landslide prediction system in Slovenia (Masprem). Geophysical research abstracts, ISSN 1607-7962, 2017, vol. 19, no. EGU2017-12942, 1 str. http://meetingorganizer.copernicus.org/EGU2017/EGU2017-12942.pdf. [COBISS.SI-ID 2617173]

ROKAVEC, Duška, ŠINIGOJ, Jasna. Minerals4EU - minerals intelligence network for Europe (Mreža obveščanja o mineralnih surovinah Evrope). Mineralne surovine v letu ..., ISSN 1854-3995, 2015, leto 2014, str. 119-120. [COBISS.SI-ID 2464853]

- ŠINIGOJ, Jasna, HRIBERNIK, Katarina, PODBOJ, Martin, KRIVIC, Matija. Informacijski sistem okoljskih podatkov. V: KLADNIK, Drago (ur.), et al. Skrb za pitno vodo, (Geografija Slovenije, ISSN 1580-1594, 31). Ljubljana: Založba ZRC, 2014, str. 27-36, ilustr., zvd. [COBISS.SI-ID 37867309]
- ŠINIGOJ, Jasna, WAARDENBURG, Frank, TULSTRUP, Jørgen, REMMELTS, Gijs, PEN, Simon J., KERKENAAR, Edwin. EU information and policy support system for sustainable supply of Europe with energy and mineral resources. WP 4, Interoperability of the geo-resources attributes and the data exchange format : report. D4.2, Data exchange format for spatial object attributes. Ljubljana: Geological Survey of Slovenia, 2012. 62 str. [COBISS.SI-ID 2179925].

GeoZS is involved in ongoing project

- H2020 SCRREEN: partner, co-development of EU-Critical Raw Materials Knowledge Data Platform (EU-CRMKDP);
- H2020- ORAMA: partner; tasks leader
- H2020 ProSUM: partner, development of the harvesting system for the EU-Urban Mining Knowledge Data Platform (EU-UMKDP);
- H2020 MICA: partner;
- EIT RawMaterials – RESEERVE: project coordinator;
- EIT RawMaterials – Mineservice: project coordinator;
- EGDI - co-development of the European Geological Data Infrastructure;
- eGeologija - National portal on inventory and collection of datasets in the field of geology;
- PanAfGeo: technical partner in the project;
- EMODnet3-Geology: partner;

and in finished project as

- Minerals4EU: partner, development of the harvesting system for EU-Minerals Knowledge Data Platform (EU-MKDP);
- EuroGeoSource: WP leader;
- InGeoCloudS: partner;
- OneGeology – Europe: partner.

Knowledge data platforms co-developed by GeoZS in the frame of European projects:

- http://www.europe-geology.eu/ - EGDI
- http://eurare.brgm-rec.fr/,
- http://minerals4eu.brgm-rec.fr/,
- http://prosum.brgm-rec.fr/,
- http://akvamarin.geo-zs.si/t-jam_boreholes/Default.aspx,
- http://akvamarin.geo-zs.si/incomepregledovalnik/Default.aspx,

and national:

- eGeologija: national portal on inventory and collection of datasets in the field of geology
- Mining registry book: https://ms.geo-zs.si/

Key personnel

Matija Krivic (male), B.Sc. in Geography, is an Expert in GIS in geological sciences – Geological Information Center. As a geographer he is specialized in spatial analysis, modelling in GIS, databases, GIS standards and protocols. He is experienced in design and implementation of geological information system and spatial data infrastructure at Geological survey of Slovenia, Digital cartography and spatial analysis. He is involved in the project National information system of mineral resources of the Republic of Slovenia. He has participated in tasks related to landslide hazards in terms of warning, predictions, susceptibility analysis, risk, remote sensing imagery. He has participated in many past international projects, funded by different EU and other international funding schemes (eWater, OneGeology, OneGeology-Europe, eENVplus, Minerals4EU, DARLINGe, PanAfGeo, EMODnet3-Geology, "A pilot study using satellite remote sensing & GIS in Nigeria" as well participating in national projects (GH-14, MASPREM).
Špela Kumelj (female), B.Sc. in Geography, leading expert associate at Geological Information Centre. As a geographer with master degree of first level in digital cartography and GIS, she is specialized in spatial analysis, modelling in GIS, databases, GIS standards and protocols. She has been actively involved in researches within geologically induced hazards, susceptibility mapping, civil protection and management of national and international projects. Currently she is a GeoZS coordinator for GIS activities within three internatiuonal projects (DARLINGe, PanAfGeo and EMODnet3-Geology)
Andrej Vihtelič (male), M.Sc. in Civil engineering (construction) is an expert in object programming, relation databases and use of opensource solutions and in nonlinear and time dependent numerical analysis.His experience cover work at Hewlett Packard center in Böeblingen as employed at SoftLab and from 2013 he is participating in PRACE (Partnership for Advanced Computing in Europe) project in field of parallel programming and numerical simulations of physical processes on HPC (High Performing Computing). He is currently responsible for Minerals4EU and ProSUM harvesting.

Participant no. 6, Ceska Geologicka Sluzba, CGS, Czech Republic

Overall description of the Czech Geological Survey (CGS)
CGS is a state-funded organisation that compiles, stores, interprets and provides objective expert geological information. As a research institute it is supervised by the Ministry of the Environment and is responsible for providing the state geological service in the Czech Republic.
CGS Division of Informatics has developed a reputable national geoinformation system capable to meet the increasing public demand for relevant geoscientific information and effective provision of geodata. Modern information technologies, metadata and data management systems are routinely used to support all phases of projects, design of the web-portal architecture, development of the data models and an effective data processing and presentation. CGS has contributed to the EU-financed projects as a WP leader, responsible for the development of a multilingual thesaurus, creation and management of the metainformation system, proposal of the technical architecture, operational procedures for the data management, technical infrastructure and the technological workflow and also provision of the national data in standardized format.

Products and services
CGS portal: http://www.geology.cz/extranet-eng
CGS applications guidepost: http://applications.geology.cz/
Minerals4EU metadata catalogue: http://m4eu.geology.cz/metadata/, ProSUM metadata catalogue: http://prosum.geology.cz/
EGDI metadata catalogue http://egdi.geology.cz/?design=micka or http://www.europe-geology.eu/metadata/
Application to a boreholes e-shop http://www.geology.cz/app/gdo/?l=e
Public GIS services http://mapy.geology.cz/arcgis/rest/

Publications
Kramolišová, P. – Moravcová, O. – Kafka, Š. – Čápová, D. – Kondrová, L. – Šedinová, E. (2016): Prospecting Secondary raw materials in the Urban mine and Mining wastes Metadata catalogue. Praha. URL http://prosum.geology.cz/
Čápová, D. – Kramolišová, P. – Kondrová, L. – Moravcová, O. – Kafka, Š. (2016c): EGDI Metadata Catalogue - the European Geological Data Hub. 29.9. 2016. Barcelona, Spain

Čápová, D. – Kramolišová, P. – Moravcová, O. – Kondrová, L. – Kafka, Š. (2016d): European Geological Data Infrastructure ´EGDI´ Metadata Catalogue - Step to the Pan-European EPOS project. 16.11. 2016. Workshop CzechGeo/EPOS, Geophysical Institute AV ČR, Praha
Kramolišová, P. – Čápová, D. – Moravcová, O. (2016): ProSUM Metadata Catalogue. 28.1. 2016. Uppsala, Sweden
Kondrová, L. – Čápová, D. (2014): OneGeology-Europe Plus Initiative. European Geosciences Union (EGU) General Assembly 2014, Vienna
Kujal, R. - Binko, R. - Čápová, D. - Čoupek, P. - Gajdošová, Z. - Kondrová, L. - Kramolišová, P. - Krejčí, Z. - Moravcová, O. - Paleček, M. - Pospíšil, V. - Sedláček, J. - Šanderová, J. - Štrupl, V. (2013): Information system of old mine workings and old mine investigation documents. Czech Geological Survey, Prague.
Čápová, D. - Čoupek, P. - Ayele, S. - Urvois, M. - Tellez-Arenas, A. - Lyonnais, F. - Torchala, B. - Toloczyki, M. - Duffy, T. (2012): AEGOS - technical architecture for multilingual web access to georesources information in Africa. In Australian Geosciences Council: Proceedings of the 34th International Geological Congress 2012, s. 588. – Australian Geosciences Council. Brisbane. ISBN 978-0-646-57800-2
Čápová, D. (2012): Technical architecture for multilingual web access to georesources information in Africa. 7.8.2012. IGC 34, Brisbane, Australia.
Čápová, D. - Čoupek, P. (2011): AEGOS - D2.4 Protocol defining the functional design of the system, including dataflow concept and conceptual data model.
Čápová, D. (2011): AEGOS - D2.3 Hardware and software components and data flow specification related to required system functionality.

Involvement in other relevant European and national projects
eEarth (eContent) – WP leader
eWater (eContentPlus) – WP leader
OneGeology-Europe (eContentPlus) – WP leader
AEGOS (FP7) – WP leader
Minerals4EU (FP7) – task leader
ProSUM (H2020) – task leader
EGDI (EGS Initiative) – task leader
CzechGeo/EPOS (Distributed System of Permanent Observatory Measurements and Temporary Monitoring of Geophysical Fields - Large research infrastructure) – section leader
National Geological Mapping Database (MoE) – project leader

Profiles of key staff members
RNDr. Dana Čápová (female), M.Sc. in Geophysics, Team Leader, Deputy Director and Head of the Division of Informatics at the Czech Geological Survey. She has over 30 years experience in managing the compilation of geological databases and the creation of integrated geoinformation systems. She has been team leader or co-manager of a number of Czech grant projects, and also a workpackage leader on several EU funded international projects (eEarth, eWater, AEGOS, Minerals4EU, ProSUM), the coordinator of the OneGeology-Europe Plus Initiative and core member of EGDI Initiative.

Ing. Lucie Kondrová, Ph.D. (female), metadata and GIS specialist, Head of section of processing and management of applied data of the CGS Department of Geoinformation systems. She has been working as a key GIS specialist (mainly in the field of development and management of the enterprise GIS), she is responsible for the implementation of INSPIRE requirements at the Czech Geological Survey. She was a member of the core team for developing the geological metadata profile and catalogue for the OneGeology-Europe project.

Richard Binko (male), system administrator. He has been working in the Czech Geological Survey since 2000. He deals with the technological background of the information systems in the CGS, including technologies as Oracle, ESRI, VMware, Microsoft, Linux, Drupal, MySQL, PostgreSQL. He is the leader of the team for development and operation of technical infrastructure in CGS.

Ing. Radek Svítil (male): web administrator. He has been managing the web portal of the CGS since 2008. He has a long experience as the webmaster, system administrator and editor-in-chief of the environmental news server (European Network for Research in Geo-Energy etc.). He has compiled dozens portal websites on CGS projects and participates in development of CGS web applications. His expertise includes the Oracle portal and Drupal open-source publication systems, HTML, CSS and Javascript, jQuery and Dojo frameworks, XML technologies including XSL templates, ESRI Javascript API for web maps and Three.js javascript library for displaying 3D models on web.

Mgr. Petr Čoupek (male), data analyst, senior programmer and developer. He has been working in CGS since 1999 in the field of publishing and editing geo-scientific and spatial-related data. He deals with the technological solutions of information systems in the CGS, including the data availability, interoperability and security. He is responsible for advanced application development in the organization. He participated in the international projects related to data exchange and interoperability (OneGeology-Europe, AEGOS, Minerals4EU) as a technical expert for relational databases, OGC spatial web services and on-line map solutions.

Ing. Jan Sedláček (male), database administrator, data manager. He has more than 20 years of experience in the field of geoscientific information systems administration. He is a senior expert in geological data management, processing and provision with a good knowledge of data modelling, administration of relational databases and non-structured data repositories. He participated in several international projects (eEarth, eWater).

Otmar Petyniak (male): M.Sc. degree in Geoinformatics. Since completing studies he works as a GIS specialist in CGS. His work is focused on GIS processing of geological maps, Python scripting, urban geology and 3D geological modelling. As a key GIS specialist he is working on high priority projects as Impact of the extension Polish brown coal mine Turów, Urban geology of the City of Jablonec nad Nisou, Geophysical survey of potential locations of the deep radioactive waste depository.

Pavla Kramolisova (female): M.Sc. degree in Mathematics and Geography, B.C. in Geoinformatics. She works in CGS as metadata expert and GIS specialist in processing of geological maps. She participated in the international projects (eEarth, OneGeology-Europe Plus, Minerals4EU, ProSUM) and was a member of the core team for developing the geological metadata profile and EGDI catalogue, she leads maintenance of metadata and runs helpdesk to support sustainability of existing international metadata catalogues.

Participant no. 7, Bureau de Recherches Geologiques et Minieres, BRGM, France

Overall description of Survey Organisation
The Bureau de Recherches Géologiques et Minières (BRGM – French Geological Survey) is France's leading public institution for Earth Science applications applied in the management of surface/subsurface resources. BRGM is an interdisciplinary institution that delivers policy development support to public authorities and carries out research activities to bring innovative technologies and practical responses to major challenges such as climate change, new energy needs, and land degradation. BRGM is a major player in the collection and delivery of georeferenced data and has been a pioneering organisation in conceptual work on interoperability as a principle of distributed information systems. BRGM is deeply involved in interoperability standard development for geoscience through contributions and leadership positions in OGC and IUGS/CGI.
BRGM is coordinating and/or hosting European or international geoscientific data infrastructures such as OneGeology, EGDI, Minerals4EU, EPOS…
In the project, BRGM will lead WP6 on Architecture.

Products and services
OneGeology portal, Minerals4EU diffusion system
EGDI – EPOS: hosting of core EU infrastructures
French Inspire compliancy: BRGM hosts the French Inspire catalogue and code List repository.
Support to the French Ministry of Environment: BRGM ICT Division also hosts numerous platforms, decision support system for the French MoE especially for the Water and Risk department.

Publications

François Robida, J. Wächter, J. Tulstrup, H. Lorenz, M. Carter, et al.. Building geological services for the EPOS European Research Infrastructure. 35th International Geological Congress : IGC 2016, Aug 2016, Cape Town, South Africa. 2016.
J. Tulstrup, Agnès Tellez-Arenas, M. Pedersen, François Robida, B. Pjetursson, et al.. The European Geological Data Infrastructure EGDI. 35th International Geological Congress : IGC 2016, Aug 2016, Cape Town, South Africa. 2016.
Sylvain Grellet (1), Rainer Häner (2), Mikael Pedersen (3), Henning Lorenz (4), Mary Carter (5), Carlo Cipolloni (6), and François Robida (1), Setting up The Geological information and modelling Thematic Core Service for EPOS, EGU 2017, Vienna.
S. Grellet, F. Daffner and al. "Data Specification on Environmental monitoring Facilities -- Technical Guidelines"
Schleidt and al. (including S.Grellet): "Draft Guidelines for the use of Observations & Measurements and Sensor Web enablement--related standards in INSPIRE Annex II and III data specification development".

Involvement in other relevant European and national projects
EUROGEOSS (http://www.eurogeoss.eu/default.aspx *):* project coordinator.
ENERGIC OD (https://www.energic-od.eu/ : partner, host of French Virtual Hub
EGDI Scope (http://www.egdi-scope.eu/) : lead of work package on "Technical Design"
Minerals4EU (http://minerals4eu.gtk.fi/index.php/about): lead of work package on "Knowledge Data Platform"
EPOS implementation project (https://www.epos-ip.org/): lead of work package on "Geological Information and Modelling"

Profiles of key staff members
François Robida, male, deputy Director of Information Systems and Technologies division, BRGM. Mining engineer and geostatistician, 38 years of experience in computer science applications to earth sciences. Member of the Board of Directors of OGC (Open Geospatial Consortium), Chair of the EuroGeoSurveys Spatial Information Expert Group, Chair of the IUGS/CGI Council, member of the EOSC High Level Expert Group (for the European Commission).

Sylvain Grellet (male), IT Project Manager, Scientific Program Coordinator within BRGM IT department, 15 years of experience in data interoperability. Member of OGC (Open Geospatial Consortium) Domain Working Groups (Hydrology, Geoscience, SensorWebEnablement and related Standards Working Groups), co-chair of RDA (Research Data Alliance) Global Water Information Interest Group, INSPIRE specifications co-facilitator of "Environmental Monitoring Facilities" and "Guidelines on Observations & Measurements and Sensor Web Enablement" and various INSPIRE maintenance groups, Member of the EuroGeoSurveys Spatial Information Expert Group, IT contact point of EPOS-IP H2020 research infrastructure work package on 'Geological Information and Modelling'

Adrien Quentin, male, software architect, two Masters of science : Project management and IT network for internet service providers. He was involved in international projects at IBM as a software engineer and technical lead during 4 years. He is now actively contributing to EPOS European research infrastructure central component (ICS-C) work package on 'Geological Information and Modelling' to provide data flow and data dissemination automated solutions for geological data. He is also working with BRGM IT infrastructure department to enable new application hosting solutions, enhancing software factories CI/CD and development workflow for EPOS ICS-C and BRGM itself.

François Tertre (MSc, male), Project leader in Information and Numerical Services, managing IT projects at national and European levels. Project leader in the ENVISION EU-FP7 project, also involved in the Initial Operating Capabilities task force for INSPIRE. Deputy WP Leader of EURare, Minerals4EU, ProSUM, MICA and SCRREEN projects.

Sébastien Hameau, male, PhD in Geosciences, Project Manager in Information Systems since 2007. He is involved in the architecture and processes related to data banks and geological information dissemination services for the BRGM and other government services. He actively participates in the coordination of WP15 activities for the European Plate Observing System (EPOS) project.

Nicolas Mauroy, male, he is working as a project manager for OneGeology - International geoscience data portal. He is also involved in a 3D models project – SCUDDD – working on web services and a web portal for 3D models. As a software engineer, he is working on several web applications and scientific platforms. As well, he got involved in international projects taking place in Africa.

Participant no. 8, Natural Environment Research Council, BGS, United Kingdom

Overall description of Survey Organisation

The British Geological Survey (BGS) is a component organization of the Natural Environment Research Council, the UK's leading body for research and monitoring in the environmental sciences. Founded in 1835, BGS is the world's oldest national geological survey. BGS is a public sector organization and the UK's premier provider of objective, authoritative geoscientific data, information and knowledge for the benefit of society, tackling issues such as sustainable use of natural resources, reducing risk and living with the impacts of environmental change. BGS is the national UK repository for geoscience data derived from UK industry, international scientific collaboration and academic research. BGS has a range of experienced scientific and technical staff engaged with the collection of all types of geosciences data, its processing, interpretation, and archiving as well as the production of innovative data delivery systems and the creation of value-added digital information products.

Products and services

BGS has vast experience in developing data portals and have been making data publically available via the web for over 15 years.

• Our first application, released in July 2000, was GeoIndex (http://www.bgs.ac.uk/geoindex) – a map-based index to its data holdings.

• This was closely followed by commercial services such as GeoReports (http://shop.bgs.ac.uk/GeoReports/) which provides automated site specific geological assessment reports created from a number of underlying spatial datasets.

• In December 2009, BGS released OpenGeoscience (http://www.bgs.ac.uk/opengeoscience), an open access portal to BGS data. This included a web-based interactive viewer and WMS service for its 1:50,000 scale digital geology data for the whole of Great Britain – the first time in the world that national coverage, attributed, street-level scale geology data has been made available via the internet. OpenGeoscience received 20 million hits on its day of release.

• We have used the OpenGeoscience web services to deliver the data via the iGeology smartphone app (http://www.bgs.ac.uk/igeology) for both iPhone and Android phones. iGeology has had over 300,000 downloads and demonstrates our ability to provide user-focused interfaces to information to facilitate maximum access to the information made available.

• BGS are a lead party of the OneGeology project (http://www.onegeology.org) that, over the last ten years, has been creating a web-based geological map of the world at 1: 1 million scale through the provision of WMS and WFS services by geological surveys across the globe.

Publications

1. Harrison, M, Thomas, F, Barredo, J, Bojilov, V, Camia, A, Castella, RC, Cerba, O, Exadaktylos, G, Giovando, C, Isidro, ML, Pfeiffer, M, Tomas, R. 2013. D2.8.III.12 Data Specification on Natural Risk Zones--Technical Guidelines–INSPIRE Data Specification of Natural Risk Zones V3.0. Brussels, European Commission Joint Research Centre (http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/INSPIRE_Data Specification_PF_v3.0.pdf).

2. BGS partners the US National Geophysical Data Centre in producing the World Magnetic Model (WMM: www.ngdc.noaa.gov/geomag/WMM/DoDWMM.shtml). This proposal version was submitted by Massimo Cocco on 14/01/2015 16:27:00 CET. Issued by the Participant Portal Submission Service.

3. BGS operates a World Data Centre for Geomagnetism, affiliated to the ICSU World Data System (www.wdc.bgs.ac.uk) and also an INTERMAGNET Geomagnetic Information Node (www.intermagnet.org).

Involvement in other relevant European and national projects

1. BGS was an active project partner in the EPOS Preparatory Phase and participation in the Implementation phase will build on this.

2. BGS was also a partner (and WP leader) in in several complementary FP7 projects: • EGDI--Scope, which developed a roadmap for a European Geological Data Infrastructure development and integration. • SciDIP--ES which addressed issues relating to the long--term preservation of earth science data and developing user tool kits to assist with data preservation activities • EarthServer which establishing open access and ad--hoc analytics on extreme--size Earth Science data, based on and extending leading--edge Array Database technology. * EnvriPlus which is bringing together Environmental and Earth System Research Infrastructures, projects and networks together to create a more coherent, interdisciplinary and interoperable cluster of Environmental Research Infrastructures across Europe. * Ever-est creating a virtual research environment focussed on the earth sciences. * European Open Science Cloud (EOSC) supporting the first phase of its development.
3. BGS was a core member of the partnership creating OneGeology--Europe which aims to deliver harmonised maps of Europe via a single portal.

Profiles of key staff members
Mr. Matthew Harrison (male) is BGS's Director of Informatics. He leads a team organising UK and international geoscience information and making it accessible and usable. He led the EC INSPIRE thematic working group on Natural Risk Zones and has also been working on key deliverables for the e-Architecture for EPOS, the European geosciences Research Infrastructure. He co-chaired the cross-government Natural Hazards Partnership with an emphasis on providing products and services relating to natural hazards to Government and responder communities. He sits on the board of the One Geology Consortium representing BGS as the lead global contributor.

Mr Christopher Luton (male), head of IPR for BGS, is an intellectual property lawyer with specialism in management of commercialisation of, in particular, research outputs. With 10 years' work experience in the Far East managing a wide portfolio of intellectual property for leading companies such as Sony, Microsoft, TDK, etc., for the last 10 years he has worked specifically within the university sector in the UK. Prior to moving to BGS in 2007, Chris managed the University of Nottingham's legal, commercialisation and IP portfolio, including over 300 patents and 27 technology spin out companies. His legal specialism extends to contract negotiation and company set-up.

Mr Marcus Sen (male) is an informatics expert with 25 years' experience in IT systems design and application development. Marcus has knowledge of a very wide variety of technologies and underlying concepts in the areas of XML, programming, relational databases, GIS, web applications and geospatial web services. His experience includes setting up and customising Open Geospatial Consortium (OGC) compliant geospatial web services such as Web Mapping Service (WMS) and Web Feature Service (WFS). He is the author of a series of cookbooks explaining how to create compliant INSPIRE WFS download services. Marcus played a key role in the development of GeoSciML (GML Application schema and international standard for geoscientific data exchange) from conceptual model to XML Schema and in its validation using XML Schema and Schematron.

Ms Helen Glaves (female) is a Senior Data Scientist at BGS with responsibility for contributions to several EU-funded projects addressing data sharing both on the European and International scale. These including acting as project coordinator for the Ocean Data Interoperability Platform (ODIP II) and work package leader for ENVRIplus (http://www.envriplus.eu), the European Plate Observing System (EPOS) and EVER-EST projects. Helen also participates in the Belmont Forum's e-Infrastructure and Data Management initiative (http://www.bfe-inf.org/).

Mr Patrick Bell (male) is Information Systems Team Leader at the British Geological Survey. Patrick is a web systems and GIS specialist with over twenty years of experience. He leads web technology and application development at BGS and has been responsible for delivering award winning systems such as OpenGeoscience (www.bgs.ac.uk/opengeoscience) and UK Soil Observatory (www.ukso.org

Participant no. 9, Istituto Superiore per la Protezione e la Ricerca Ambientale, ISPRA, Italy

Overall description of Survey Organisation
ISPRA is the Institute for Environmental Protection and Research, has been established by Decree n°. 112 of 25 June 2008, converted into Law no. 133 (with amendments) on 21 August 2008, composed of

more than 1400 people. It carries out scientific and technical activities in the national interest to protect the environment, fields of energy, soil, geology, inland and marine waters, natural hazards, metrology, biodiversity, forests, agriculture, urban environment, waste and industrial risks. It's central hub of the SNPA System by the Law 132/2016 that defines the National System for Environmental Protection (SNPA), which is made up of ISPRA and 21 Territorial Environmental Protection Agencies (ARPA / APPA), established by Regional Laws. The Geological Survey of Italy represents a Department of ISPRA and has the role of Official National Cartographic body.
ISPRA is also reference Italian institutional technical organization for INSPIRE, responsible for the links with the Italian regional Authorities and for the support in the organization of training actions in Italy as established by the Legislative Degree n°. 32 of 27 January 2010 and it's the Technical INSPIRE Coordinator at national level and Member of INPIRE MIG-T. In according with L. 135/2012 ISPRA is also National Responsible to provide a catalogue and a platform to give access to all public geographical, environmental and territorial data produced or obtained by Italian Public Administration.
ISPRA is responsible for the links with the Italian regional Authorities and Local Public Administration and it is also available for the support in the organization of training actions in Italy on the INSPIRE themes as Land Cover, Geology, Environmental Monitoring Facility and Natural Risk Zones. Moreover, in its quality of institutional representatives of public stakeholders. ISPRA is also National responsible of Italian Copernicus User forum.

Products and services
Geoportal SGI: http://sgi.isprambiente.it/geoportal
GeoViewer 4D -cesiumJS
INSPIRE Monitoring and Validation Dashboard
OGC GeoSciML SWG

Publications

- Comerci V., Vittori E., Cipolloni C., Di Manna P., Guerrieri L., Nisio S., Succhiarelli C., Ciuffreda M., Bertoletti E. (2015) - Geohazards Monitoring in Roma from InSAR and In Situ Data: Outcomes of the PanGeo Project. Pure and Applied Geophysics, 03/2015. DOI: 10.13140/2.1.1486.5283
- C. Cipolloni, M. Krivic, M. Novak, M. Pantaloni, and J. Šinigoj (2014) - Harmonisation of geological data to support geohazard mapping: the case of eENVplus project. EGU European Geosciences Union General Assembly 27.04-02.05 2014, Vienna.
- M. P. Congi, V. Campo, C. Cipolloni, G. Delmonaco, L. Guerrieri, C. Iadanza, D. Spizzichino, A. Trigila (2014) – Landslide risk impact management and web services for improving resilience: the LIFE+IMAGINE project approach – EGU European Geosciences Union General Assembly 27.04-02.05 2014, Vienna.

Involvement in other relevant European and national projects
eENVplus, eEnvironmental services for advanced applications within INSPIRE, www.eenvplus.eu

PanGEO, geohazard information for many of the largest cities in Europe, www.pangeoproject.eu

LIFE+IMAGINE, Integrated Coastal Area Management Application Implementing GMES/Copernicus, INSPIRE and SEIS Data Policies: www.life-imagine.eu

SCIDIP-ES, Science Data Infrastructure for preservation-Earth Science: http://www.scidip-es.eu/

EPOS-IP, European Plate Observing System-Implementation Phase: https://www.epos-ip.org/

Profiles of key staff members
Dr. Carlo Cipolloni (Project Manager, male)

PhD in Geodynamic, Degree in Geological Sciences is senior researcher in ISPRA on SDI. Member of INSPIRE MIG-T and INSPIRE Committee. INSPIRE Contact Point to EC/JRC for ISPRA; he is leader of MIWP-5 Validation and conformity test group. He is also member of the Italian team on Cloud, Big data, open data Working Group (Working group 4 on ICT) in the framework of the Italy-USA. He was Project manager and WP leader for ISPRA in the INSPIRE Test Data Model, eENVplus, LINKVIT and LIFE+IMAGINE projects and still now is involved in giCASES project. He is responsible for IT sector in

PanGeo and EPOS-IP projects. He is member of IUGS-CGI group for OGC GeoSciML standard development. He's author or co-author of more than 70 scientific paper and technical reports.

Dr. Maria Pia Congi (female)
Senior researcher expert in geographic information systems and geological databases. Researcher since 2005, working as a technician in ISPRA; collaborates to the creation and maintenance of the Portal of the Geological Survey of Italy for the services and metadata production in compliance with the INSPIRE Directive. She has worked on the definition of a data infrastructure in Earth science and conservation policies and harmonized development of Semantics / Ontology / Metadata in support of services. Member of the Working Group INGV / Civil Protection Department biennium 2007/2009 for activities S1 "Three-dimensional geological modeling to support the evaluation of seismic hazard"; she is also supply member of Italian INSPIRE Directive Board. She is senior expert in the publication of standard services wcs wfs wms and Inspire services and has taken part in the following projects: Linkvit, eENVplus, LIFE+IMAGINE, Geomol.

Dr. Marco Pantaloni (Male)
Senior Researcher at the Geological Survey of Italy-ISPRA from 1995. His research activities focuses on geological mapping, stratigraphy and wells log elaboration. Coordinator for the national geological mapping (1:50,000 scale) for North-Eastern Italy and Sardinia and responsible for the Alpine chain geological Committee. Co-leader in the OneGeology-Europe project in the WP3 “1:1 million pan-European geological data specification, identification and sourcing”, responsible of a pilot application into eENVplus project to harmonise geological and geomorphological data, member of the EuroGeoSurvey Spatial Information WG.

Participant no. 10, Geologian Tutkimuskeskus, GTK, Finland

Overall description of Survey Organisation
Geological Survey of Finland (GTK) is national geological research centre operating under the Ministry of Employment and Economy. GTK is an internationally known and recognized expert organization in applied earth sciences. The geological earth resources of strategic and economic importance are in the core of GTK's research mission and GTK has long history and extensive knowledge in all areas of data management from definition of database structures to building services based on these databases. As a result of this work Finland constantly ranks in top positions in Fraser Institute’s annual surveys to mining companies in respect to quality and coverage of available data.

GTK contributes to a wide range of international geosciences, mapping, mineral resources and environmental monitoring projects as well as projects concerning eco-efficient mining and mineral processing. International references of GTK cover a wide spectrum of undertakings in about 40 countries on all continents. GTK is active in the European Innovation Partnership on Raw Materials, IUGS/CGI geostandard (GeoSciML and ERML) work and one of the core partners in EIT Knowledge and Innovation Community Raw Materials. The total staff of GTK is about 435, annual turnover totals about 44 million €, of which 8 million € is invoicing. Web-site: www.gtk.fi

Products and services
Promine: http://promine.gtk.fi/ and
GTK’s web map applications: http://en.gtk.fi/informationservices/map_services/
GTK’s interface services for spatial data: http://en.gtk.fi/informationservices/interface_services/
Data products, metadata and data management utilized in Hakku- search and downloading service https://hakku.gtk.fi/en

Publications

Nurmi, P., Eilu, P., Nykänen, V. and Vuollo, J. (2017) Long-term investment in geoscience has made Finland a top-ranking exploration target. Finland Proceedings of the 14th SGA Biennial Meeting, 20-23 August 2017, Québec City, Canada, 2017Society for Geology Applied to Mineral Deposits, p. 1407-1410.

Vuollo, J,, Cassard, D., Raymond, O., Simons, B., Rattenbury, M., Passmore J. and Fernette, G. (2016) EarthResourceML: the CGI-IUGS Data Standard to Deliver Mineral Resource Data. Abstract International Geological Congress 35th International Geological Congress: Abstracts. - American Geosciences Institute (AGI), 2016 Paper Number: 3517

Involvement in other relevant European and national projects
Coordinator of Minerals4EU - Minerals Intelligence Network for Europe (2013−2015), FP7-CSA-NMP.2013.4.1-3
Partner in SCRREEN - Solution for Critical Raw Materials – a European Expert Network, H2020 SC5-15a-2016-2017
Partner in EURARE - Development of a sustainable exploitation scheme for Europe's RareEarth ore deposits (2013-2018)
Coordinator of ProMine - Nano-particle products from new mineral resources in Europe (2009-2013); awarded as the best of all the projects launched under the EU Framework Programmes in the field of Industrial Technologies - FP7-NMP-2008-LARGE-2
Coordinator of: Fennoscandian Metallogeny Group (ongoing since 2004)

Profiles of key staff members
Ms Taina Eloranta, Geologist, M. Sc. in Geology (University of Helsinki). She is specialist in geoinformation management, GIS and geological data processing. Taina has over 10 years' experience of working with geological data management. She is responsible for GTK's mineral deposit database which was built according to the global geostandards (ERML and GeoSciML). She has been involved in Minerals4EU project providing the mineral deposit dataset to the M4EU map service.

Ms. Eira Kuosmanen, Research Scientist, M.Sc. in Geology and Mineralogy (University of Helsinki). She has strong work experience of data management, map production and developing of data products using GIS and FME.

Mr. Juha Strengell, System Specialist, M.Sc. in Computer science (University of Kuopio). His main tasks at GTK are developing and maintaining GIS-based solutions like web map applications and interface services including database designing, programming and implementation. He has involved in many international projects like ProMine, OneGeology and Minerals4EU. In those projects he has been developing web maps and implementing INSPIRE compatible data sources for sharing geological information.

Mr. Juha Köykkä, geologist, PhD in Geology & mineralogy (University of Oulu). He has more than ten years of experience (University researcher/post-doc and GTK) in Precambrian sedimentary rocks, stratigraphy, geochemistry, geological databases and GIS. Current and past works experience is related to the bedrock geology, stratigraphy, geochemistry, tectonics, sedimentology, geological vocabularies in Finland (national and INSPIRE, CGI etc.), geological databases and GIS.

Participant no. 11, Geological Survey of Norway, NGU, Norway

Overall description of Survey Organisation
The Geological Survey of Norway (NGU), founded in 1858, is a governmental agency under the Ministry of Trade and Fisheries and member of EuroGeoSurveys. NGU's overall mission is to provide, use and disseminate knowledge and data of geological materials, processes and relations that is important for the management of resources and environment in Norway.

NGU's main tasks are geological mapping, geodata collection and storage, to carry out applied research projects, to give advice, and to disseminate geoscientific knowledge. NGU maintains extensive archives and databanks, and runs highly specialized laboratories to support field activities and integrated services. NGU provides the National Spatial Data Infrastructure (Geonorway) with downloadable data sets, web services and technical expertise on mapping and programming. This NSDI is based upon national and international standards, and a technical architecture which follows INSPIRE. NGU co-operates with numerous governmental bodies and scientific institutions and at home and abroad.

Products and services

- Unstable mountain areas – URL
- National Area Information - URL
- 3D visualisation directly from map viewers - URL
- National database for ground investigations (NADAG) - URL
- Downloading services from NGU and Geonorway - URL

Publications

Elissar Khloussy and Yuming Jiang 2017: The Impact of Net Neutrality on Revenue and Quality of Service in Wireless Networks. Department of Information Security and Communication Technology Norwegian University of Science and Technology.

Ryghaug, P. & Wesche, J.G. 2009: Report evaluating existing metadata systems and profiles in the geological domain for national and applied map datasets relevant to the OneGeology-Europe project. Chapter 4, review of the INSPIRE metadata requirements, and the NGU contribution. ECP-2007-GEO-317001, D4.1.

Ryghaug, P. & Wesche, J.G. 2009: View service for access to high resolution national data, chapter 6.5 Norway. OneGeology-Europe, ECP-2007-GEO-317001. D9.1.

Tomas, R., Kondrova, L., Kafka, S., Serrano, J-J., Lindberg, T., Ryghaug, P., Wesche, J.G. 2010: Explanatory notes for creating multilingual metadata records of national geological and applied geological map data ECP-2007-GEO-317001, April 2010.

Involvement in other relevant European and national projects

- EMODnet
- GEMAS,
- Minerals4EU
- EURare
- INSPIRE Implementation Drafting Teams and Thematic Working Groups.

Profiles of key staff members

Frank Haugan (male): M.Sc. in Geography. ICT Director. Contribute to ensuring that geoscientific knowledge is utilized for the effective and sustainable management of the nation's natural resources and environment. Project manager in several national and international Spatial Data Infrastructure (SDI) projects since 2002.

Ane Bang-Kittilsen (female): M.Sc. in Geography. Senior Engineer, Team Geomatics and IT. PhD student in Geomatics, Faculty of Engineering, NTNU: The use of maps for communicating information about sub-urban geology to non-geologists. Project management and development open data, map services and download services.

Bobo Nordahl (male): M.Sc. in Geodesy, Photogrammetry and Cartography. Chief Engineer, Team Geomatics and IT, NGU. Manager and developer of NGU spatial databases, UML modelling, product specifications, national GI standardization. Participation in Minerals4EU project.

Bjørn Ove Grøtan (male): Senior Engineer, Team Geomatics and IT, NGU. Manager and developer of many Web Services (WMS, REST, SOAP). Integration (Java, Python, PHP) and systems monitoring and architecture. Representative in a reference group concerning the development of the new national geoportal.

Participant no. 12, Institut Royal des Sciences Naturelles de Belgique, RBINS, Belgium

Overall description of Survey Organisation

The Geological Survey of Belgium (GSB) is an autonomous subsection of the Royal Belgian Institute of Natural Sciences. Created in 1896, the GSB is a key geological and mineralogical research centre developing both applied and fundamental research approaches. It is also an independent, non-commercial provider of geoscientific services. These services are oriented towards local, regional, federal, European and international authorities, as well as researchers of institutions/universities, private companies, NGO's and citizens. The data collections are globally freely available for consultation. In order to do this, modern and historical data that become available through research and exploration, are digitally processed in geographical information systems, stored in databases and published online via web-services. In projects, this information is reworked into specific end-user products or advice, by combining it with the ad-hoc expertise of the geologists of the GSB.

Products and services
Geological maps of Belgium, boreholes database, fields observations are available online through the webGIS portal developed by GSB (www.belgiumgeology.net).

Involvement in other relevant European and national projects
Onegeology, EuroGeoSources, PanGeo, Thermomap, Min4EU.

Profiles of key staff members
Pierre-Yves Declercq: Geologist. 15 years of experience of Geo-Informatics support at the Geological Survey of Belgium including database and webGIS management. Is currently doing applied scientific research on earth ground motion using Radar Interferometry

Participant no. 13, Department of Communications, Energy and Natural resources, GSI, Ireland

Overall description of Survey Organisation
The Geological Survey of Ireland (GSI) has an Information Unit with four staff, one specialising in Communications. There are 90 staff in the GSI. As a line division of the Department of Communications Climate Change and the Environment (DCCAE), all services served by GSI are run by DCCAE staff and the GIS administrator, and Oracle administrator are also in DCCAE. Email, user accounts, servers, PC support and purchasing are handled by Department of Agriculture Food and the Marine (DAFM) for themselves, GSI and DCCAE. All our digital data is available at no cost under CC BY4.0 GSI publishes all of its metadata through the Irish Spatial Data Exchange (ISDE) to the INSPIRE portal and to the Irish Government Open Data portal data.gov.ie. GSI runs two large projects dealing with data collection. Tellus collects onshore data: aeromagnetic, gravity, soil sediment chemistry and stream sediment chemistry data. Offshore the INFOMAR project collects bathymetry data and does sea bottom classification.

Products and services
As well as having its own portal at www.gsi.ie, GSI has served services for the Minerals 4EU portal. Project websites are run for Tellus and Infomar. The EPOS project and EGDI and two more of the projects to which we supply services.

Involvement in other relevant European and national projects
We have been involved in the European Plate Observing System (EPOS) Project from the Preparatory Phase, and are now involved in the Implementation Phase and lead the Legal and Governance workpackage.
Minerals 4EU designed to meet the recommendations of the Raw Materials Initiative, we provided data and services for this portal
EGDI Scope
OneGeology Europe – GSI took part in OneGeology Europe Project. This portal is now closed and data can be found on the European Geological Data Infrastructure Project (EGDI)
Onegeology – GSI were involved in Onegeology World from the beginning, and we still serve data to that project.

Profiles of key staff members

Danielle Coombs is Communications Executive for GSI. She specialises in strategy, brand management, community engagement and outreach, and has completed projects for a variety of non-profit and government entities in both Canada and Ireland. Danielle earned an Arts degree from Memorial University of Newfoundland in 2007, and a Master of Business Administration from Trinity College Dublin in 2016. She is currently responsible for the rollout and enhancement of Geological Survey Ireland's communications function, including social media, internal communications, advertising and stakeholder relations.

Mary Carter is Senior Geologist and Head of Information at the GSI. Information management has been the focus of her activities since 1987. Having a degree in Geology from Trinity she also studies Information Technology there. She is currently runs the Information Management Programme with four staff. Responsibilities include the oracle database and the GSI Website, and communications. She has worked on all of the projects listed above.

Participant no. 14, Instituto Geológico y Minero de Espana, IGME-ES, Spain

Overall description of Survey Organisation
The Geological Survey of Spain (IGME) is a Public Research Institution belonging to the Spanish Ministry of Economy, Industry and Competitiveness. Since its creation in 1849, the main mission of IGME is to provide the State Administration, the Autonomous Regions Administrations and the general society, with precise knowledge and information regarding the Earth Sciences and related technologies for any development on the Spanish territory.
In the field of geoscientific information systems, IGME produces digital cartography and databases accessible through thematic applications, catalogues, viewers and interoperable services. Currently, a total of 50 databases, 2000 digital maps and 50 web map services are maintained. Most of these products are available through its WEB, accessed by about 2,000 different users every day. IGME's IT division, in charge of the maintenance and dissemination of the geoscientific information, has an extensive experience in database administration and gis-web development and participates in several national and European projects (EGDI, M4EU, OneGeology, etc).

Products and services
INFOIGME (http://info.igme.es/catalogo/default.aspx): IGME's basic catalogue that allows discovering all the geoscientific information available.

IGME's map viewer (http://info.igme.es/visorweb/): shows all the spatial information available through map services. Main functionalities: layers management (loading, order, visibility, etc.), load ARCGIS and WMS services, upload and display user points by a JSON file, search by place names., access to additional information (PDF files, photos, detailed reports) and query features by attributes and bounding box

Mapping Portal (http://info.igme.es/cartografiadigital/portada/default.aspx?mensaje=true&language=en): web application that provides access to IGME's geological and thematic maps.

SIGEOF (http://info.igme.es/SIGEOF/): web application to query and display geophysical information.

Map Services (http://mapas.igme.es/Servicios/default.aspx): web page that collects the links of the different web map services available.

Publications
Sanabria, M. P., Guardiola-Albert, C., Tomás, R., Herrera, G., Prieto, A., Sánchez, H., and Tessitore, S. (2014): Subsidence activity maps derived from DInSAR data: Orihuela case study, Nat. Hazards Earth Syst. Sci., 14, 1341-1360, doi: https://doi.org/10.5194/nhess-14-1341-2014.

Gómez Sánchez, M. (2012). Diseño y desarrollo de la metodología de intercambio y transferencia de información hidrogeológica. In Fernández Ruiz, L (Editor) *Las aguas subterráneas en la planificación hidrológica* (pp. 300-310). Madrid: IGME. NIPO 474-11-028-8.
http://libros.igme.es/product_info.php?products_id=49

Hernández, R., Arribas, A., Solano, J. G. Garrido G. Carroza, J. C. (2008). Sistema de Información Geográfica en el proyecto Fonelas. Cuadernos del Museo Geominero Nº 10, Instituto Geológico y Minero de España. ISBN 21-54 ISBN 978-84-7840-764-4. http://www.igme.es/epvrf/docs/FON-9.pdf

Prieto Martín, Á.; Pérez Cerdán, F.L.; Carroza García, J.A (2006). Portal de acceso a la cartografía digital del IGME. In *Ciencia, Investigación y Sociedad de la Información: IX Jornadas sobre Tecnologías de la Información para la modernización de las Administraciones Públicas* (340, Tecnimap 2006). Sevilla: Consejo Superior de Administración Electrónica, Ministro de Administraciones Públicas.

Involvement in other relevant European and national projects
Title: GEO_FPI (CROSS-BORDER OBSERVATORY FOR THE GEO-ECONOMIC EVALUATION OF THE IBERIAN PYRITE BELT http://www.igme.es/GeoFPI/default.htm). Grant Agreement No. 0052_GEO_FPI_5_E. Funding Entity: European Regional Development Fund (ERDF) through the territorial cooperation program - INTERREG V A Spain - Portugal (POCTEP) 2014-2020. IP: Mª Teresa López López (IGME). Duration: 01/06/2017-31/12/2018. Budget: 1,156,070.40 €. IGME Budget: 498,363.79 €. Participation: workpackage coordinator "Digital Platform"

Título: MINERALS4EU. Minerals Intelligence Network for Europe (http://www.minerals4eu.eu/). Grant Agreement No. 608921. Funding entity: European Union, Seventh Framework Programme. IP: Juha Kaija (GTK). Duration: 01/09/13-31/08/15. Budget: 2.784.588 €. IGME Budget: 56.710 €. Participation: IGME team member.

Title: LAMPRE. LAndslide Modelling and tools for vulnerability assessment Preparedness and REcovery management (http://www.lampre-project.eu/). Grant Agreement No. 312384. Funding entity: European Union, Seventh Framework Programme. IP: Fausto Guzzetti (IRPI, Italia). Duration: 01/03/13-28/02/15. Budget: 2.225.000 €. IGME Budget: 159.000 €. Participation: coordinator workpackage coordinator "Site characterization and production of geo-databases".

Title: PANGEO. Enabling free and open access to geohazard information in support of GMES (http://www.pangeoproject.eu/). Grant Agreement No. 262371. Funding entity: European Union, Seventh Framework Programme. IP: Ren Carpes (NPA Fugro, UK). Duration: From 01/02/11 to 31/01/14. Budget: 2.500.000 €. Budget IGME: 21.024 €. Participation: IGME team member.

Title: eWater (Multilingual cross-border Access to ground water databases). Grant Agreement No. ECP-2005-GEO-038214. Funding Entity: European Union eContentplus Programm (Decision No 456/2005/EC of the European Parliament and the Council, 9 March 2005 establishing a multiannual Community programme to make digital content in Europe more accessible, usable and exploitable). IP: Alexei Tchistiakov (TNO). Duration: 01/09/2006-01/09/2008. Budget: 1.197.202 €. IGME Budget: 100.847 €. Participation: workpackage coordinator "Interoperability of digital maps".

Profiles of key staff members
Román Hernández (male): Mine Engineer with extensive experience (more than 25 years) in design and implementation of relational database, development of web applications and direction of information systems projects at national and international level. Currently, he is the head of information systems and institutional databases division of the Geological Survey of Spain (IGME).

Margarita Gómez (female): She has a degree in Geological Sciences, with more than 25 years of professional experience in hydrogeology and hydrological tools, mathematical modelling, databases and geoscientific information systems. She has a large experience working in groundwater research projects at national and international level. Currently, she is involved in the working group that defines the Geological Survey of Spain (IGME) data policy.

Angel Prieto (male): Experienced IT professional. Having a GIS background with extensive experience (more than 20 years) in the development of web mapping applications and services, geoprocessing tools, relational database design and implementation and website design. Highly focused in Microsoft and ESRI technologies. Took a degree in Mathematics in 1996. After 7 years working in private sector, he joined the Geological Survey of Spain (IGME) in 2003.

Margarita Sanabria (female):Geologist with a Master degree in Environmental Research, Modelling and Risk Assessment with over 12 years of experience in the field of Geographic Information Systems (GIS). She joined the Geological Survey of Spain (IGME) in 2006 as a GIS technician. Her work focuses on quality control processes and production of digital mapping, database management and generation of OGC web map services.

Participant no. 15, State Research and Development Enterprise State Information Geological of Ukraine, GeoInform, Ukraine

Overall description of Survey Organisation
The State Research and Development Enterprise "State Informational Geological Fund of Ukraine" – SRDE “GeoInform of Ukraine”, or GeoInform, is the specialized research and development unit of the State Geological and Subsurface Survey of Ukraine which collects, stores, analyzes and provides information received from geological study and use of subsurface.
GIU conducts research work on monitoring of mineral resources of Ukraine on the basis of geological and mining activities during the year, recording deposits and making public the balance of mineral resources management of the State fund of deposits and occurrences (more than 10,000 objects recorded), synthesis and analysis of exploration for oil and gas, creating a system of state accounting of oil and gas wells, completion and maintenance of the State cadastre of mineral deposits and occurrences as well as State cadastre of groundwater deposits of Ukraine.

Products and services
Interactive map of mineral deposits of Ukraine (in Ukrainian)
http://geoinf.kiev.ua/wp/interaktyvna-karta-rodovyshch-korysnykh-kopalyn.htm
Interactive map of mineral licenses (in Ukrainian)
http://geoinf.kiev.ua/wp/interaktyvni-karty-spetsdozvoliv.htm
Interactive geological map of Ukraine 1:1 000 000 (in Ukrainian)
http://geoinf.kiev.ua/wp/Interaktyvna-heolohichna-karta-Ukrayiny.htm
Interactive geological map of Ukraine 1:1 000 000 (in English)
http://geoinf.kiev.ua/wp/Interactive-Geological-Map-of-Ukraine.htm
Interactive State Geological Map of Ukraine 1:200 000 (in Ukrainian with English entries)
http://geoinf.kiev.ua/wp/kartograma.htm

Involvement in other relevant European and national projects
Max. 5 projects.
Minerals4EU - EU
ProSUM - EU
NUMIRE – NGU/SGSSU
EIMIDA – NGU/Geoinform

Profiles of key staff members
Dr. hab. Boris Malyuk, Director for International Cooperation, graduated in 1981 from Department of Geology, Lviv University, Ukraine, and in 1999 from Centre of Geostatistics, Ecole des Mines de Paris, France. Obtained Candidate of Science (PhD) Degree in Geotectonics in 1984, and extended Doctor of Science Degree in Petrology in 1991. National Delegate of Ukraine to the EuroGeoSurveys.
Mr. Sergii Prymushko, Director, with basic IT-background, has more than 30 years experience in management of geological information, including partitioned database systems.
Mr. Volodymyr Velychko, Chief Engineer, at his position is responsible for hardware and software facilities and database development having basic IT-background.
Dr. Igor Melnyk, Sector Chief, with basic background in geology, has an experience in field works and research in geochemistry, hydrogeology and ecology (PhD in 1996), as well as geoinformatics and GIS applications.

Participant no. 16, Institutul Geologic al Romaniei, GIR, Romania

Overall description of Survey Organisation
Geological Institute of Romania (GIR) was created in 1906 with the mission and activities of a geological survey. Now it is a state-owned research institute involved in activities regarding mineral resources (geological conditions, chemistry, environmental impact of mining), hydrocarbon resources, geophysics, hydrogeology, geochemistry, environmental protection, geo-hazard, geological mapping. In the last years, activities related to the use of information technology for geological data (geological maps, mineral resources, geo-hazard) have been developed, represented by the development of GIS projects and the development of databases.

Products and services
1. WMS service for OneGeology – geological map of Romania at 1M scale
2. WMS and WFS service for Ongeology Europe – geological map of Romania at 1M scale
3. WFS service for Minerals4EU – mineral resources from Romania
4. WMS and WFS services for Pangeo – ground stability

Publications
1. Tudor G., Databases for Geological Maps with the Use of GIS Open Source Solutions, Scientific Annals of the University „AL. I. CUZA" IAŞI, Geology., LV, 2, p.113 – 124, 2009, (http://geology.uaic.ro/auig/article.php?id=44).
2. Tudor G., Gheuca I., GIS database model for geological maps, Romanian Journal of Mineralogy, vol. 84, p. 86-88, 2009.
3. Tudor G., WEBGIS – a framework for web presentation of the 1:1 million scale geological map, Scientific Annals of the University „AL. I. CUZA" IAŞI, Geology. ,LVI, 2, p.45 – 52, 2010, (http://geology.uaic.ro/auig/article.php?id=58).
4. Tudor G., Geomathematical characterisation of the mineralization indicators: a case study from Tincova magmatic intrusion (Romania),), Studia UBB Geologia 56 (2): 17-23, 2011 (http://scholarcommons.usf.edu/geologia/vol56/iss2/art2).
5. Tudor G., GIS database for mineral resources: case study – map of mineral resources from Romania at the 1: 500.000 scale (after Borcoș M., Udubașa G., Săndulescu M., Lupu M., Tudor G., Găbudeanu B.), Scientific Annals of the University "Al. I. Cuza" IAȘI Seria Geologie 58 (1) (2012) 53–58 (http://geology.uaic.ro/auig/articole/2012%20no1/1_L05-Tudor.pdf)

Involvement in other relevant European and national projects
1. PROMINE (http://promine.gtk.fi) - Nano-particle products from new mineral resources in Europe - The FP 7 project has developed a pan-European GIS database containing both metallic and non-metallic resources, including secondary resources.
2. MINERALS4EU (www.minerals4eu.eu) – Mineral Intelligence Network for Europe – co-financed under FP7 - NMP, is designed to meet the recommendations of the Raw Materials Initiative and will develop an EU Mineral intelligence network structure delivering a web portal, a European Minerals Yearbook and foresight studies.
3. Minventory (www.minventory.eu) – Statistical Information on EU Raw Materials Deposits, the aim of this DG Enterprise-commissioned project is to assess the possibility of implementing a pan-European statistical database on raw materials deposits.
4. GIS database applied to the geological information regarding the territory of Romania - the national project financed by the Research Ministry produced the GIS database project, the pilot implementation phases for the geological maps and mineral resources, software applications for managing or displaying data on the Internet, using ArcGIS Server to deploy map services (WMS, WFS, etc.).
5. Web presentation of geological spatial data using GIS software – national project financed by the Research Ministry, with aims to determine the GIS software technologies for web presentation of geological spatial data as well as the requirements for the implementation of a geoportal.

Profiles of key staff members
1. George Tudor (contact person), male (geologist with a PhD in metallogeny), senior researcher in Geological Institute of Romania, head of the GIS, database ant remote sensing team. The fields of interest are: Geoinformatics (GIS and databases) – last 20 years, mineral resources - 10 years in

mineral exploration. Participant or leader in national research projects involving GIS and databases for geological maps, mineral resources and participant in internationally-funded projects (PROMINE, SARMa, Mineral4EU, Minventory, OneGeology, OneGeology Europe Plus, Minatura2020, MICA). The applied skills are GIS (Geographic Information System) applications (design, data management, spatial analysis, 3D, cartography), database designing and development, software programming, web programming, geostatistics, mineral exploration.

2. Gabriel Preda, male (GIS technician), member of the tehchnical staff for GIS in Geological Institute of Romania. The fields of interest are: GIS in general and and especially GIS data creation – last 5 years. Participant in national research projects involving GIS and databases for geological maps, mineral resources and participant in internationally-funded projects (Eurogeosources, URMA, GEOSEE). The applied skills are GIS (Geographic Information System) applications (data management, cartography), geophysics.
3. Valentina Maria Cetean, female (geologist with a PhD in sedimentary geology), senior researcher at Geological Institute of Romania, geologist in geo-hazard team. Participant or leader in geological and environmental projects (mineral resources, risk assessment in natural and anthropic sites, identification, quantifying, monitoring, management of contaminated sites), applied and economical geology (landslide, raw materials, building materials), research (geology, environment, mineralogy, archaeometry, geo-chemistry, methodological standards and norms, etc.) (SUSMIN, TIMMAR, MONISENZ, ECO-USER, I-STONE, GREENET, MONRES etc.). The applied skills include GIS data management.

Participant no. 17, Geologische Bundesanstalt, GBA, Austria

Overall description of Survey Organisation

The Geological Survey of Austria, founded in November 1849, represents the geo-management of the public sector of Austria. It is a government organization affiliated to the Federal Ministry of Science, Research and Economy. Its activities are based on the National Law of Research of 2000. Presently their staffs comprise around 50 scientists with university degree, 30 non-scientists and a fluctuating number of non-government personnel (around 50).
According to its mandate, the Survey undertakes the following core programs:

- Geoscientific mapping of the Austrian territory at various scales
- Complementary mission-orientated basic research in biostratigraphy, geochronology and structural geology
- Collection and storage of unique types of rocks, minerals and fossils
- Monitoring the environment
- Administration and management of the most comprehensive geoscientific library of Austria
- Maintenance of related databases and voluminous archives of maps and unpublished reports collected over the past 150 years
- Source of advice and information in Earth Science to the government, local authorities, industry and the public in general

Traditional and applied tasks include such topics as:

- Assessment and sustainable development of raw materials and industrial minerals
- Water management
- Natural hazard mitigation in Alpine terrains
- Feasibility studies for major civil engineering projects
- Contamination and waste deposal studies
- Nature conservation and land use planning
- Geophysical measurements (including Aero- and ground geophysics) for assisting all related geoscientific investigations
- Networking in global change programs
- Membership in EuroGeoSurveys and other international organizations

One of its major concerns is promotion and presentation of all related geoscientific results and data. To achieve this as wide as possible an audience is addressed through media, maps, data services, periodical journals, popular scientific brochures, and other articles in the public interest.

Products and services

- GBA Thesaurus (Linked Data SKOS/RDF concepts) http://resource.geolba.ac.at/
- and DataViewer
- WMS Webservices https://www.geologie.ac.at/services/web-services/
- Web applications https://www.geologie.ac.at/services/webapplikationen/

Publications

Hörfarter, C. & Schiegl, M. (2016): Thesaurus and DataViewer application tool – knowledge representation to define concepts and visualize geoscientific data, Conference: 35TH INTERNATIONAL GEOLOGICAL CONGRESS, At Cape Town

Haider, V., Hörfarter, C. & Schiegl, M. (2016): GBA Thesaurus - more than a controlled vocabulary for GBA associates. - In: Ortner, Hugo: GeoTirol 2016: Annual Meeting DGGV: 25-28 September 2016, Innsbruck, Austria: Abstract Volume. - 97, Innsbruck.

Hörfarter, C., Schiegl, M., Mikula, C. & Stöckl, W. (2015): INSPIRE, GBA-Thesaurus and DataViewer at the Geological Survey of Austria – an approach to deal with lithostratigraphic issues. - In: Gülli, Elisabeth, Piller, Werner E.: 2nd International Congress on Stratigraphy STRATI 2015 19. - 23. July 2015, Graz, Austria: Abstracts. - 164, Graz.

Ebner, M., Schiegl, M., Stöckl, W. & Heger, H. (2012): From printed geological maps to web-based service oriented data products - strategies, foundations and problems.

Ebner, M., Schiegl, M., Stöckl, W., Schuster, R. & Janda, C. (2011): A SKOS based thesaurus of the Geological Survey of Austria exposed through an Open Linked Data Web-Service - In: GRA - Volume 13 (2011).

Involvement in other relevant European and national projects

- Minerals4EU: http://www.minerals4eu.eu
- EGDI-Scope: http://www.egdi-scope.eu
- TransEnergy: http://transenergy-eu.geologie.ac.at/
- OneGeology Europe http://www.onegeology-europe.org/
- OneGeology http://www.onegeology.org/ .

Profiles of key staff members

Mag. Martin Schiegl (male): Masters's degree in geography/landscape ecology. Head of the department of Geoinformation. Responsible for geodata management, geological maps, print publications and website. He has been working in data management for geology and town planning for more than 20 years and has been involved in several EU funded projects including OneGeologyEurope, EGDI-Scope and Minerals4EU.

Mag. Christine Hörfarter (female): Master's degree in petrology, project assistant in the field of hydrogeology, crystalline geology and geophysics and now responsible for the coordination and modelling of geoscientific data, co-editor of the GBA-Thesaurus and contact person in case of implementing INSPIRE due to content related harmonization.

Mag. Werner Stöckl (male): Masters's degree in geography/cartography. GIS expert in the IT departement. Responsible for geodata management, INSPIRE implementation and data products. He has been working in GIS, cartography and informatics for more than 20 years and has been involved in several EU funded projects including OneGeologyEurope, EGDI-Scope and Minerals4EU.

Participant no. 18, Servizio Geologico, Sismico e dei Suoli della Regione Emilia-Romagna, SGSS, Italy

Brief description

SGSS is a technical entity of Emilia-Romagna region (public body), the geological office is established to support the regional government policies dealing with the environment and land planning since 1976. The mission of the Survey is to provide the regional administration and society with basic up-to-date geological, pedological, geothematic information and maps. The remit of the Survey at present encompasses activities related to the monitoring of specific natural processes which affect the territory of Emilia-Romagna (subsidence, saltwater intrusion in groundwater, landslides, sea storms), the reduction of seismic risk and the identification and study of natural resources (water, soil, geothermal energy, mining and aggregates resources). The survey's core skills include data management, geo-ICT and 3D-modelling. The basic geological knowledge, provided by the Geological, seismic and soil survey, is crucial to a wide range of social issues, including resource security/sustainability (energy, minerals, water), environmental monitoring, safety of citizens, and the development of secure infrastructures (natural hazards).

Products and service

The SGSS is a data-rich organisation with over a hundred datasets in its care, organized in spatial databases, accompanied by the relative metadata (as established by the INSPIRE Directive). Many our datasets are of freely available to download. Data are delivered under the terms of the CC-BY License. A lot of dataset are made available also as OGC standards-based services (WMS, WFS, WCS).
Data can also be accessed by websites that use a map-based interface. Webgis and interactive cartography have been developed to publish data related to geology, geological heritage, seismic risk, land instabilities, costal system, soil and land planning and water resources.

Geological cartography and 3D geological modeling	Geological map at scale 1:50.000 (derived from the database of the CARG Project - Geological Map of Italy) and 1:10.000 scale: the portal contains geological, pedological and geothematic information, and include also landslides inventory data, geological sections and geognostic tests, piezometric level, groundwater quality of the plain, soil cartography, springs and aquifers, sea-cost data, geological heritage and cavities. Traditionally, 2D maps and cross-sections are used for geological data analysis, however, these are not ideal for fully understanding the complexity of the features, or for communicating the data to other stakeholders. SGSS implements geological model, displaying in 3D subsurface geology (thickness of geological formations, faults, folds ...) made in a territory to discover what lies underground and providing a new tool for communication and faster representation of what is below us. The creation of a model in three dimensions starts from the geological map of the surface, from the geognostic tests (boreholes, seismic lines, CPT Geologists have always represented the development of geology in three dimensions through the construction of geological-stratigraphic cross sections, which together with the geological surveys enable the reconstruction of surfaces and volumes of what lies beneath us. A great work of interpretation is always at the base of a good 3D model that despite being made today by dedicated software, needs the validation from the knowledge of the geologist. The case studies areas are: Po valley, southern margin of the Po Delta and coastal area in Emilia-Romagna.
Coastal cartography	The sea-coast information system is an interactive website offering access to the coastal and marine maps of Emilia-Romagna Region. This information constitutes a crucial asset

	for the monitoring and the analysis of coastal risks (sea storms, subsidence) and represents the starting point to develop more specific data applications.
Geological heritage and trail network	4.1.1 Geological heritage, geosites and cavities and Emilia-Romagna trail network: these websites have been realised to promote the knowledge of the geological heritage elements to both expert people (the webgis on geological heritage and caves) and non-geologist users (for promoting geology in a touristic idea), and is a collection of photos and further in-depth documents. The "REER" webgis publishes the database of about 7000 km of paths, that SGSS updates in collaboration with the CAI (Club Alpino Italiano).
Soil maps on Google Earth	4.1.2 The website provides data and information on the soils of Emilia-Romagna, availing on Google Earth and Google Earth plugin. A range of soil maps at various scales, derived thematic maps and maps of chemical and physical properties of soils.
Geographic Data Catalogue	SGSS Geographic Data Catalogue is a collection of vector, raster and alphanumeric data, accompanied by the relative metadata. Data is being published also in the Geoportal website, the distribution channel of geographical information provided by Emilia-Romagna region.

Dissemination
The SGSS is committed to an information campaign, for both public administration technicians and professionals, on the use of geological and soil maps, thematic maps derived from these and their applications. Furthermore, the SGSS strives to educate the public at large through its website http://ambiente.regione.emilia-romagna.it/geologia-en/divulgazione/geologia/geologia-sismica-suoli and several other media, including: maps of geological-environmental itineraries, documentary on the soil and landslides and the eBook called “Planet Earth”. Other projects include a census of the geological heritage, the creation of special trails aimed at educating the public on the most interesting geological aspects of Emilia-Romagna, and the publication of a series of publications on the main geo-environmental themes, plus a series of information leaflets on the main activities of the SGSS.
At the SGSS headquarters in Bologna, the Geological Garden Museum "Sandra Forni was set up to offer people, with special regard to schools, a space where they can meet but also further their understanding of the environment in which we live. The Museum houses a collection of minerals, rocks, soils and fossils from across the region and indeed from all over the world. Through the guided tour, the museum helps visitors grasp the fundamental notions of Earth Sciences; in the garden, visitors can enjoy a virtual stroll back in time thanks to the various stages illustrated in 14 rocks from the Emilia-Romagna Apennines, tasked with recounting the geological history of the region.

Publication
The publications in English language made by SGSS are listed in the web page http://ambiente.regione.emilia-romagna.it/geologia-en/divulgazione/pubblicazioni.
These are just a small part of the entire SGSS production that can be consulted in the Italian webpage http://ambiente.regione.emilia-romagna.it/geologia/divulgazione/pubblicazioni.
Technical reports on the various SGSS projects (groundwaters, soil consumption, heavy metals, land instabilities, seismic risk, coastal risk, subsurface 3D modeling, geothermal energy, geological heritage, seismic microzonation) are available, most in Italian, on the site as downloadable pdfs. The most recent publications made by SGSS are in Italian and are listed below:

- "A new Seismotectonic Map and neighboring areas "at scale 1: 250,000 and the final report" 3D Analysis of the Northern Apennine Seismic Hazard " - *Carta Sismotettonica della Regione Emilia-Romagna e aree limitrofe” alla scala 1:250.000 e il rapporto conclusivo “Analisi 3D della pericolosità sismica dell’Appennino settentrionale”* (2017);

- A guide book to a new exhibition of the Geological Garden Museum - *Rerbus. Guida all'esposizione "Il governo del territorio"* (2017);
- A summary of the knowledge acquired by SGSS on groundwater in the mountains through an interdisciplinary approach - *Acque dalle rocce una ricchezza della montagna* (2016);
- A book by SGSS, written after the earthquakes in 2012 that hit Emilia-Romagna, in collaboration with the Civil Protection Department and the National Council of Engineers - *Sisma Emilia 2012. Dall'evento alla gestione tecnica dell'emergenza* (2016).

Involvement in other relevant European and national projects
SGSS has always promoted exchange of knowledge, methodologies and approaches between the various players of the national and international geo-scientific community.
Since 1992 we have been working in tandem with the regional surveys of Bavaria and Catalonia, with EuroGeoSurveys and the European Commission to organize the European Congress on Regional Geo-Scientific Cartography and Information Systems (EUREGEO). This close working partnership led to the organization of nine editions of the EUREGEO in Bologna (1994, 2003, 2012), Munich (2000, 2009) and Barcelona (1997, 2006, 2015). Furthermore, SGSS has stipulated memorandums of agreement with the geological surveys of Hungary, Holland and Morocco for specific projects.
From January 2005 to November 2017, SGSS represented the regional geological services of Italy at EuroGeoSurveys. The work was done as a support to the National Geological Survey (ISPRA).
At European level, the SGSS has taken part in several projects such as ongoing project:

- Wi-GIM Life (2014-2017) - Wireless Sensor. Network for Ground Instability Monitoring;
- LIFE Helpsoil (2013-2017) - Helping enhanced soil functions and adaptation to climate change by sustainable agriculture techniques.

and projects already completed as:

- GeoMol (2012-2015) - "Assessing subsurface potentials in the Alpine foreland basins for sustainable planning and use of natural resources";
- SNAP-SEE (2012-2014) - Sustainable aggregate supply in South- East Europe;
- GEOPOWER (2010-2012) GEOthermal energy to address energy performance strategies in residential and industrial buildings.

At the national level, in addition to collaborating with several Regions and Institutions, SGSS participates in the National Committee for Geological Services convened in 2016 by ISPRA.

Profile of key members
- Alberto Martini (alberto.martini@regione.emilia-romagna.it)

Geology graduate, he is an expert GIS Technician and Analyst, spatial database and IT technical support officer. He has long experience with 3D modeling, reconstruction of surfaces and volumes from geognostic tests, CPT, seismic lines and spatial interpolation and interpretation of other geothematic parameters. He is accountable for geognostic tests database and natural caves database of Emilia-Romagna Region. He participated in the European GeoMol project, building 3D geological model, realizing layer information of thematic map about geothermal potential, for the Italian pilot area "Brescia-Mantova-Mirandola".

- Marica Landini (marica.landini@regione.emilia-romagna.it)

Graduated in computer science, she is a software developer and IT technical support officer. She has an extensive experience in Web GIS Application Development (js framework) and spatial database design, proficiency in Java (J2EE, JSF) and python language. She has experience with OCG standard and she participated at INSPIRE Directive Data Specification testing, about theme soil and geology. She is also an open source / open data enthusiast, and actively involved in association that promote these projects.

Participant no. 19, MAGYAR BÁNYÁSZATI ÉS FÖLDTANI SZOLGÁLAT, MBFSZ, Hungary

Overall description of Survey Organisation

The Mining and Geological Survey of Hungary (MBFSZ) was established on July 1st, 2017 by the merger of the Mining and Geological Office of Hungary (MBFH) and the Geological and Geophysical Institute of Hungary (MFGI). The Survey is a central governmental body supervised by the Ministry of National Development. It is supporting all state activities related to mining and geology and its mission is to support Hungary's economic competitiveness, the effectiveness of public services and policy by providing up-to-date geoscientific information for the government and the society relying on nearly 150 years traditions of geological-geophysical research and of mining administration. As a national geological survey MBFSZ is responsible to advance geoscientific knowledge of Hungary's landmass by systematic acquisition, interpretation, management and dissemination of geoscientific data. The current number of employees is 241, most of them highly qualified researchers in various fields of geology, geophysics, environmental sciences, mining administration and IT technology.

MBFSZ's core skills include geoscientific data management and integrated 3D geological-geophysical modelling, as well as national potential assessments for various mineral resources and preparation of concessions, especially geo-energy (hydrocarbon, geothermal, coal), study of geohazards, environmental geology and hydrogeology. The survey also maintains and operates several national geoscientific observatory and monitoring systems, e.g. magnetic, gravimetric, groundwater, etc. MBFSZ is a designated state advisor of geoscientific matters related to the Mining Act (1993 XLVIII) and the Governmental Decree 267/2006 (XII. 20.) defining state geological tasks.

The Survey is empowered by law to manage the mining, geological, hydrogeological and geophysical data centres of Hungary. It is also responsible for data provisioning, and the implementation of the INSPIRE directives in the related themes.

Products and services

INSPIRE discovery, view and download services for Geology, Geophysics, MineralOccurrences, Mines, Prospecting and Mining Permit Areas, Energy resources

Data layers for EGDI: OneGeologyEurope Geophysical measurements and models,

Publications

J. J. Serrano, J. Laxton, K. Ash, X. B. Batalla, S. Bergman, D. Cassard, B. Follestad, A. Hughes, U. Larsen, T. Nałęcz, S. Pen, L. Sőrés, J. Vuollo, R. Tomas [2013] D2.8.II.4 Data Specification on Geology – Technical Guidelines, INSPIRE Data Specification for the spatial data theme Geology

L. Sőrés, M. Pedersen [2016]: Geophysical Layers in European Geological Data Infrastructure (EGDI) INSPIRE Conference, Barcelona

Involvement in other relevant European and national projects

Minerals4EU, EGDI Pilot, EGIP, PANGEO, GEOMIND, eWater

Profiles of key staff members

László Sőrés is a geophysicist. He took part in geophysical explorations in Hungary and worldwide. He has a long time experience in computer programming and design of data processing and data management systems, data modelling, and implementation of web services. He took part in the INSPIRE Thematic Working Group for Geology and Mineral Resources as responsible for the specification of the geophysics data model. He has been working in the EGDI Bridge project to set up the Geophysical layers of the portal, designed and implemented download services for the MIN4EU harvesting system.

László Orosz is a cartographer and GIS expert with 10 years of work experience in geo-information projects. He is specialist in web-based cartography and webGIS. He has been the Head of Geo-information Department of the Hungarian Mining an Geological survey since 2012. He is also former developer, now project manager of the GeoBank, the unified Hungarian database of geological units and geological point objects (borehole, well, spring). He was the Hungarian project manager of two EU FP7 projects EuroGeoSource (2011-2013); and ThermoMap (2011-2013).

László Vértesy is a geologist, working mainly in geophysical exploration projects, for water, coal, hydrocarbon, geothermal energy and environmental protection since 1984 in Hungary and abroad

(Germany, Austria, Greece, Turkey, Oman et.). He started a project to set up the metadatabase of geological and geophysical datasets in Hungary. Besides that, he is working on projects like WEB visualisation of natural resources, magneto telluric exploration of geothermal targets, and geo-electric measurements to control subsurface pollution.

Benedek Simó is a WebGIS developer working for the Mining and Geological Survey of Hungary. He is responsible for most of the web related GIS data dissemination, such as GIS services (both proprietary and standardized services like WMS and WFS) and web mapping applications. He was involved in many geology related international project such as OneGeology and Thermomap.

Participant no. 20, Bayerisches Landesamt fur Umwelt, LfU, Germany

Brief description of the legal entity

Regional environment agency in charge for Bavaria, incorporating the legally mandated Geological Survey Organization with remits in geological and hydrogeological surveying, mapping and modelling, scientific advisor for geothermal issues and subsurface utilization, host of central archives/databases for all Bavarian subsurface information in line with the German Mining Law

Description of persons:

Dr. Gerold Diepolder (male), GeoERA project coordination: studied Geology at the University of Munich. After earning his PhD in 1990 he joined the Bavarian Geological Survey, GLA (now: Bavarian Environment Agency, LfU) as a research associate with remits on hydrogeology and the geopotentials of the deep subsurface. Overseas assignment for the Federal Institute for Geosciences and Natural Resources (Bundesanstalt für Geowissenschaften und Rohstoffe, BGR) in Namibia in 2001.
For 8 years until September 2016 head of the 3D study group of the German State Geological Surveys (Staatliche Geologische Dienste), lately realigned, now chief executive of the task force "3D geological models" focused on metadata and interoperability issues of structural 3D geomodels.
Initiator, coordinator and lead of the 2012–2015 transnational 3D modelling and geopotential assessment GeoMol project (www.geomol.eu), co-organizer of the informal European 3D Geological Modelling Community (www.3dgeology.org), active member of the OGC/CGI Geoscience Domain Working Group.
Gerold Diepolder is LEAR of the LfU and appointed GeoERA Programme Manager mandated by the Bavarian State Ministry of the Environment and Consumer Protection.

Dr. Carolin von Groote-Bidlingmaier (female) studied Geography with a minor in Geoinformatics at the University of Augsburg where she also completed her PhD on Geoinformatics. Since 11/2015 she is working for the Bavarian Environment Agency – Geological Survey as a geographical computer scientist in the project Infra3D. Her main tasks are the data harmonization and historization as well as the development of automated (geographical) data processing tools in the context with 3D subsurface modelling and a webGIS toolkit.

Elisabeth Lutterschmid (female), studied Physical Geography with a classes in Geophysics at the University of Regensburg. Since 2008 she is working for the Bavarian Environment Agency – Geological Survey as a geophysicist and in geophysical database maintenance, lately responsible for the registry of the geological general key of Bavaria including semantic harmonization and controlled vocabularies within the Infra3D project.

Publications:

- Diepolder, G.W. (2011): 3D modelling at the Bavarian State Geological Survey – examples for cooperation towards 3D standards. – Geological Survey of Canada, Open File 6998: Three-Dimensional Geological Mapping, Workshop Extended Abstracts, Minneapolis, Minnesota – October 8, 2011: 17-21, DOI: 10.4095/289609
- GEOMOL TEAM (2015): GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources. Project Report. 188 S. (Augsburg, LfU).

- Von Groote-Bidlingmaier, C., Jonietz, D. & Timpf, S. (2014): Calculating Route Probability from Uncertain Origins to a Destination, In: Gartner, G. & Huang, H. [eds.] Progress in Location-Based Services 2014, Lecture Notes in Geoinformation and Cartography 19 - 32. doi: https://doi.org/10.1007/978-3-319-11879-6_2
- Diepolder, G.W. (2016): From GeoMol to EGDI – towards the integration of regional 3D geological datasets into the European Geological Data Infrastructure (EGDI). http://www.americangeosciences.org/sites/default/files/igc/1691.pdf

Projects and research programme(s)

- 2009-2012: KLIP (Klimaprogramm Bayern 2020) - 3D-Untergrunderfassung des Alpenvorlands – Mehrwert für Erdwärmenutzung und Energiespeicherung (3D based capture of the pre-alpine subsurface – adding value to the use of geothermal energy and energy storage)
- 2012-2015:GeoMol – Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources
- Since 2016: Infra3D – development of data model and workflow for 3D subsurface potential assessment based on heterogeneous sources and a toolkit (webGIS) for the visualization of the 3D subsurface information from various domains exploiting the achievements of transnational 3D geo-energy assessment / distribution tools

Infrastructure developments

- LfU 3D Explorer: www.3dportal.lfu.bayern.de
- Standortauskunft Oberflächennahe Geothermie (Information system shallow geothermal energy) http://www.umweltatlas.bayern.de/mapapps/resources/apps/lfu_angewandte_geologie_ftz/index.html?lang=de&layers=service_ageo_18

Infra3D – development of data model and workflow for 3D subsurface potential assessment based on heterogeneous sources and a toolkit (webGIS) for the visualization of the 3D subsurface information from various domains exploiting the achievements of transnational 3D geo-energy assessment / distribution tools (under development)

Participant no. 21, Laboratorio Nacional de Energia e Geologia I.P., LNEG, Portugal

Overall description of Survey Organisation

The National Laboratory for Energy and Geology (LNEG) is an R&D institution oriented to respond to the needs of society and enterprises, betting on a sustainable research and for sustainability through the generation of knowledge of the Portuguese territory. We do Science in energy and geology with a view to its application in advanced solutions for leveraging our economy.

LNEG is aware that cooperative work and networking can optimize skills and that knowledge sharing is a tool for success, so it is an active partner of the major networks and collaborative platforms in the areas of energy and geology.

LNEG inherits competencies from the former geological survey and is the national repository for geological, geochemical, mineral resources, drill core, and water geodatabases. The Geoscientific Information Unit (UIG) is responsible for the integrated management and availability of geoscientific information, including new data and models, aiming to increase the dissemination and usage of digital information and respective metadata approaching to citizens and raising the support to decision-making actions.

Products and services

Geoportal, http://geoportal.lneg.pt/

Services:

Carta Geológica de Portugal à escala 1:1 000 000 - WMS – INSPIRE. Service URL: https://inspire.lneg.pt/arcgis/rest/services/CartografiaGeologica/CGP1M/MapServer/exts/InspireView/service

Sistema de Informação de Ocorrências e Recursos Minerais Portugueses - SIORMINP - WMS – INSPIRE. Service URL:
https://inspire.lneg.pt/arcgis/rest/services/RecursosMinerais/RecursosMinerais/MapServer/exts/InspireView/service
Carta Radiométrica de Portugal Continental à escala 1:500 000 - WMS – INSPIRE. Service URL:
https://inspire.lneg.pt/arcgis/rest/services/ZonasRisco/CartaRadiometrica/MapServer/exts/InspireView/service
Mapa do Atlas do Potencial Eólico Onshore de Portugal Continental - WMS – INSPIRE. Service URL:
https://inspire.lneg.pt/arcgis/rest/services/Energia/AtlasEolico/MapServer/exts/InspireView/service
Catálogo de Metadados do LNEG (CSW) http://geoportal.lneg.pt/metadados/csw

Publications

Lopes, C.; Quental, L, Oliveira, D., Filipe, A., Pereira, A. (2017) INSPIRE data harmonisation of mineral resources: contribution of MINERALS4EU project. Atas das JIIDE 2017 - VIII Jornadas Ibéricas de Infraestruturas de Dados Espaciais, 15–16 novembro, ISCTE, Lisboa. URL: http://www.dgterritorio.pt/jiide2017/docs/Artigos/JIIDE2017_C-I14-Inspire_data_harmonization_mineral_resources_Catarina_Lopes.pdf

Pereira, A., Mancebo, M., Patinha, P., Mink, S., Luís, G., Sanabria, M., Robador, A., Oliveira, J.T. & Hernandez, R. (2017). Aplicação da Diretiva INSPIRE à Cartografia Geológica: Entendimento entre Portugal e Espanha. Atas das JIIDE 2017 - VIII Jornadas Ibéricas de Infraestruturas de Dados Espaciais, 15 – 16 de novembro, ISCTE, Lisboa. URL:
http://www.dgterritorio.pt/jiide2017/docs/Artigos/JIIDE2017_C-P9_Aplicacao_diretiva_inspire_cartografia_geologica_Aurete_Pereira.pdf

Quental, L.; Oliveira, D.; Filipe, A.; Lopes, C.; Fortes, C. - Earth Observation Contribution as a Component for Mineral Resources Systems (2015) In: Inspire Geospatial World Forum, Lisbon, Portugal, 25-29 May 2015. URL: https://geospatialworldforum.org/speaker/bio-abstratct.asp?id=gwf2015A232 and presentation https://geospatialworldforum.org/speaker/SpeakersImages/Lidia%20Quental.pdf

Pereira, A.; Luís, G.; Cabral, P. (2013): Implementation of the INSPIRE Geology Data Model in Digital Geological Map Production in Portugal: A Preliminary Approach. In: *International Journal of Spatial Data Infrastructures Research*, Vol. 8

Involvement in other relevant European and national projects

OneGeology: http://portal.onegeology.org/OnegeologyGlobal/ (Portugal)
Promine*: http://promine.gtk.fi/*
EuroGeoSource: http://eurogeosource.eu/
Minerals4EU: http://www.minerals4eu.eu
C4G (Portuguese Collaboratory for Geosciences as national contribution for EPOS) http://www.c4g-pt.eu/

Profiles of key staff members

Lídia Quental (female) holds a Ph.D. in Engineering Science and M.Sc. in Georesources from the Technical University of Lisbon She is a remote sensing expert using multi-source data and methodologies to improve knowledge in thematic areas of geosciences. She participated in several EU and transnational R&D projects related to digital platforms, raw materials, geology, and environmental risk assessment. She is currently the Head of Geoscientific Information Unit.

Aurete Pereira (female) is a geologist with a MSc in Science & GIS. She was awarded with the international CEN/TC 287 AWARD for Excellence and Innovation in INSPIRE in 2013 with her work in implementing the INSPIRE Geology Data Model in Geological Map Production in Portugal. She has more than 15 years of experience in GIS, geological map production and spatial database management. Currently, she is responsible for the technical implementation of INSPIRE Directive in LNEG.

Gabriel Luís (male) holds a Ph.D. in Mining Engineering and a M.Sc. in Mineralurgia and Mining Planning from the Technical University of Lisbon. He is a Research Assistant at the Portuguese Laboratory for Energy and Geology (LNEG) where during 12 years headed the Geoscientific Information Research Unit. He was responsible for several projects in the area of management and provision of spatial data related to geology and geology

Pedro Patinha (male) is a mining engineer at the Portuguese Laboratory of Energy and Geology (LNEG). He graduated in Mining Engineering (1991) and holds a MSc in Mineralurgy and Mining Planning (1994) from the Technical University of Lisbon. He currently works at the "Geoscientific Information Unit" of LNEG and is expert in mapping and Geographical Information Systems.

Participant no. 22, Panstwowy Instytut Geologiczny – Panstwowy Instytut Badawczy, PGI, Poland

Overall description of Survey Organisation
The Polish Geological Institute (PGI) was founded on the 7th of May 1919. It is involved in comprehensive studies of geological structure of the country for practical use in national economy and environmental protection. In addition to scientific activities in all fields of modern geology the Institute was entrusted with the tasks of the Polish Geological Survey and the Polish Hydrogeological Survey. Moreover, it is responsible for the country's security in supply of mineral resources, the groundwater management, for monitoring of the geological environment and warning against natural hazards and risks. For over 20 years PGI maintains geological and hydrogeological databases, in which information on over 160 000 boreholes, 830 000 geological reports and 13 000 deposits has been collected. These information are shared by web applications to geological administration units and in thinner scope to society.
In February 2009, the Council of Ministers bestowed the Polish Geological Institute the status of National Research Institute.

Products and services
The Central Geological Database (CBDG)
http://baza.pgi.gov.pl

System of management and protection of mineral resources in Poland MIDAS
http://geoportal.pgi.gov.pl/midas-web
Central Hydrogeological Data Bank - The HYDRO Bank
http://spdpsh.pgi.gov.pl/PSHv7/

Involvement in other relevant European and national projects
- OneGeology - Europe sContentplus,
- European Marine Observation and Data Network (EMODnet),
- EU Information and Policy Support System for Sustainable Supply of Europe with Energy and Mineral Resources – EuroGeoSource,
- Minerals4EU - Minerals Intelligence Network for Europe,
- Implementation of the CSW service in accordance with the technical guidelines of the INSPIRE Directive and the metadata catalog (national project).

Profiles of key staff members
Paweł Lewandowski. Born in 1962 in Warsaw, Poland. Graduated from Warsaw University in 1987 (Faculty of Geology). Employed in PGI since 1987. 15 years of experience in GIS projects (analyst, project and database manager), 10 years of experience as an application analyst (databases design, IT systems design, process modelling, use cases creation), knowledge of UML and ArchiMate.

Participant no. 23, Hrvatski Geološki Institut, HGI-CGS, Croatia

Overall description of Survey Organisation

Croatian Geological Survey (HGI-CGS) is a public research institute in the field of Geosciences acting under the Ministry of Science of the Croatian Government. The main activities of HGI-CGS is scientific research in fields of Geology, Paleontology, Mineralogy and Petrology, Tectonics, Sedimentology, Geochemistry, Hydrogeology, Engineering Geology and Mineral resources and production of all kind of Geological and other maps. HGI-CGS is responsible for the collection and storage of geological data of the Republic of Croatia. The geological data are processed and stored in GIS databases, primarily in Geological Information System (GEOLIS). Data processing implies primarily to the standardization of all parts of relevant databases, data input, preparation and analysis, and generating various databases and maps. Geological information are available to economic entities, public administration, science community, and to the public in general through WebGIS services.

Products and services
Geoportal contains information on publications of the Croatian Geological Survey and the published works of its employees like:

1. Basic Geological Map of the Republic of Croatia 1:100,000
2. Basic Geological Map of the Republic of Croatia 1:300,000
3. Books published by CGS
4. Annual Reports CGS
5. Geologia Croatica magazine

Publications
1. Scientific Journal Geologia Croatica
2. Geothermal and mineral waters of the Republic of Croatia: geological monograph
3. Geochemical atlas of the Republic of Croatia
4. Evolution of the Adriatic Carbonate Platform: Palaeogeography, main events and depositional dynamics
5. Basic geological map of the Republic of Croatia 1:50,000

Involvement in other relevant European and national projects
1. Program of Basic Geological Maps of Croatia
2. Geological and seismological aspects of geodynamics in Kvarner area - unveiling of the Kvarner fault (GEOSEKVA)
3. Geophysical Surveys of the Koločep Channel Seafloor (LoLADRIA)
4. Cooperating towards Advanced MAnagement Routines for land use impacts on the water regime in the Danube river basin Basin Lake (CAMARO-D)
5. Efficient Practices of Land Use Management Integrating Water Resources Protection and Non-structural Flood Mitigation Experiences (PROLINE-CE)

Profiles of key staff members
1. Dr. Slobodan Miko, head of the HGI_CGS, research advisor, assistant professor at Faculty of Mining, Geology and Petroleum Geology, University of Zagreb, project leader for regional minerals plans and spatial plans, a leading scientist in environmental geochemistry.
2. Dr. Koraljka Bakrač, head of Department of Geology, senior research scientist, an expert in Neogene and Quaternary palynology.
3. Dr. Josip Terzić, head of Department of Hydrogeology and Engineering Geology, research advisor, an expert for karst hydrogeology and seawater intrusion related problems.
4. Dr. Nikolina Ilijanić, head of Department of Mineral Resources, research associate, an expert in mineralogy and clay mineral analysis.

Participant no. 24, Íslenskar orkurannsóknir, ISOR, Iceland

Overall description of Survey Organisation
ÍSOR is a governmental non-profit service, research and training institute under the Icelandic Ministry for the Environment and Natural Resources. ÍSOR is one of the world's leading geothermal consulting and research institutes and stands for over 70 years of continuous experience in geothermal research, encompassing all disciplines of geosciences, drilling engineering, utilisation technology and reservoir physics and management. ISOR has been the main scientific leader in the successful geothermal development in Iceland and collect maintains and manages earth science data used in geothermal

exploration. ÍSOR carries out geological mapping in Iceland as a part of overall service to the Icelandic geothermal sector. ÍSOR employees comprise about 80, most of which have academic degrees and long experience in geothermal research and training. Groups of specialisation include, geological mapping, borehole geology, geochemistry, hydrogeology, environmental sciences, well logging, geophysical exploration, borehole geophysics, marine geophysics, reservoir modelling, drilling engineering and geothermal utilisation.

Products and services

www.jardfraedikort.is

ISOR maintains a web service for the public where geological maps of Iceland, produced and published by ÍSOR, are accessible. GIS portal that runs on ArcGIS server.

vinnsla.isor.is

Internal data management system for e.g. borehole data, and logs.

Local earthquake monitoring

ÍSOR runs several local earthquake monitoring systems which all stream data to our servers where the automation is used to pick locations and to show results on the web. These sites are only available to the relevant stakeholders.

Publications

Kristján Sæmundsson, Magnús Á. Sigurgeirsson, Árni Hjartarson, Ingibjörg Kaldal and Sigurður Garðar Kristinsson. (2016). Geological Map of of Southweast Iceland, 1:100 000 (2nd ed.). Reykjavík: Iceland GeoSurvey.

Magnús Á. Sigurgeirsson, Árni Hjartarson, Ingibjörg Kaldal, Kristján Sæmundsson, Sigurður Garðar Kristinsson and Skúli Víkingsson. (2015). Geological Map of the Northern Volcanic Zone, Iceland. Southern Part. 1:100 000. Reykjavík: Iceland GeoSurvey.

Sæmundsson, K., Hjartarson, Á., Kaldal, I., Sigurgeirsson, M. Á., Kristinsson, S. G. and Víkingsson, S. (2012). Geological Map of Northern Volcanic Zone, Iceland. Northern Part. 1:100 000. Reykjavík: Iceland GeoSurvey and Landsvirkjun.

Hjartarson, Á. and Sæmundsson, K. (2014). Geological Map of Iceland. Bedrock. 1:600 000. Iceland GeoSurvey.

Involvement in other relevant European and national projects

IMAGE: Integrated Methods for Advanced Geothermal Exploration 2013-2017. The objective is to develop new methods to scrutinize and appraise geothermal systems in such a way that exploration wells can be sited with greater accuracy than before, thereby maximizing the success rate and reducing the cost of drilling associated with geothermal projects.

DEEPEGS: Deployment of deep enhanced geothermal systems for sustainable energy business 2016-2020. The aim of this project is to drill deeper into the geothermal areas, as far as 4-5 km and study the possibility for utilizing energy from lower depths than previously. Three sites will be examined; the Reykjanes geothermal area in Iceland and geothermal areas in Valence and Vistrenque in France.

THERMOMAP: Area Mapping of Superficial Geothermic Resources by Soil and Groundwater Data 2010-2013. The analysis of the geodata performed in a GIS environment with standardized methods, valid for the entire EU. These methods were intensely tested, verified and finally documented in a manual for geodata processing and analysis as future standards. The resulting geothermal potential as a georeferenced information value is intergrated in a WebGIS with a server side and a geovisualization and information front-end.

NAGTEC: (Northeast Atlantic Geoscience TECtonostratigraphic Atlas) 2011-2014. This collaborative project of the geological surveys of nine countries in Northern Europe involves a review of the geological structure of the Northeast Atlantic Atlas published in 2016 and the digital database will be on-line in 2019.

Profiles of key staff members

Gunnlaugur M. Einarsson (m): GIS Specialist, B.Sc. in Geography, M.Sc. in Geographic Information Management.

Spatial data management and analysis. Cartography, modelling and visualisation on in 2D and 3D. Part-time lecturer in Geographic information at the University of Iceland.

Albert Þorbergsson (m): GIS specialist, B.Sc. in Geography.
GIS data editing and analysis. Cartography and visualisation in 2D and 3D. ArcGIS database maintenance.
Steinunn Hauksdóttir (f): Director natural resources. B.Sc. in geology, M.Sc. in Geology, volcanology.
Supervision, marketing and project management of projects in the fields of geothermal research and utilization and natural resources. Geologist/Geochemist with experience in geothermal mapping, sampling of fluids and rocks. Supervision of various Information Technology projects and systems.
Kjartan Marteinsson (m): Programming Specialist. B.Sc. in Physics, B.Sc. in Computer Science, M.Sc. in Physics.
Development of internal tools for data processing and archiving. Development of software for data analysis. Maintenance of databases.

5 Ethics and Security (This section is not covered by the page limit)

5.1 Ethics

The project proposal has been checked against the ethics sections in “H2020 Guidance —How to complete your ethics self-assessment: V5.2 – 12.07.2016”. This check did not raise any issues.

5.2 Security

Please indicate if your project will involve:

- Activities or results raising security issues: NO
- 'EU-classified information' as background or results: NO