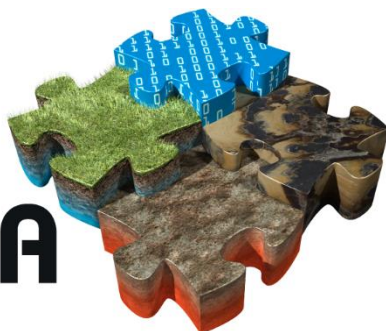


# GeoERA



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

## JOINT CALL DOCUMENT NO.4

### SCIENTIFIC SCOPE

#### Stage One - Project Ideas

Joint Call on applied geoscience in the fields of:

- Geo-energy
- Groundwater
- Raw materials
- Information platform

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## 1 Background to the Joint Call

Under the EC Horizon 2020 Work Programme 48 national and regional Geological Survey Organisations (GSOs) from 33 European countries have joined forces to develop the ERA-NET COFUND action “**Establishing the European Geological Surveys Research Area to deliver a Geological Service for Europe (GeoERA)**”. The overall goal of GeoERA is to integrate the GSOs information and knowledge on subsurface energy, water and raw material resources to support sustainable use of the subsurface in addressing Europe’s societal challenges.

The “Joint Call for Project Ideas” is Stage One of a two stage process that enables GeoERA to focus on specifically identified questions and needs related to geological research in Europe.

The Joint Call has a planned budget of 30.3 M €, of which 10 M € will be contributed by the EC. The Joint Research Projects selected in the Joint Call will be implemented by the GeoERA participants themselves, who provide their co-funding in-kind. The Joint Call will address four GeoERA themes: **A) GeoEnergy, B) Groundwater, C) Raw Materials, and D) Information Platform**. The Information Platform theme is crosscutting in nature, and is designed to provide a sustainable framework to disseminate the findings and data from the other themes. The Joint Call will also address crosscutting issues between GeoERA Themes A to C.

The GeoERA Partners are listed in <http://geoera.eu/parties/>. The Joint Call is coordinated centrally by the GeoERA Secretariat.

## 2 GeoERA aim and objectives

GeoERA aims to integrate European GSOs information and knowledge on subsurface energy, water and raw material resources to support sustainable use of the subsurface in addressing Europe’s societal challenges. With the Horizon2020 Work Programme<sup>1</sup> in mind GeoERA launches this Joint Call for transnational research projects (Joint Research Project), to which all stakeholders may submit Project Ideas in Stage One and GeoERA Partners may submit Project Proposals in Stage Two.

Resulting Joint Research Projects should address the development of:

- Interoperable, pan-European data and information services on the distribution of geo-energy, groundwater and raw material resources and harmonized methods to assess them;

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<sup>1</sup> Horizon 2020 Work Programme 2016 – 2017, 10. ‘Secure, Clean and Efficient Energy’, pp. 114-118; [http://ec.europa.eu/research/participants/data/ref/h2020/wp/2016\\_2017/main/h2020-wp1617-energy\\_en.pdf](http://ec.europa.eu/research/participants/data/ref/h2020/wp/2016_2017/main/h2020-wp1617-energy_en.pdf)



- Common assessment frameworks and methodologies supporting a better understanding and management of the water-energy-raw materials nexus and potential impacts and risks of subsurface use;
- Knowledge and services aimed at European, national and regional policy makers, industry and other stakeholders.

The objectives of the selected Joint Research Projects are to:

- Integrate national and regional research resources;
- Develop, improve, optimize and harmonize pan-European geological data and information at a scale and resolution that is useful for national and regional geological mapping programmes;
- Contribute to the establishment of a common European Geological Knowledge Base, and to the provision of a Geological Service for Europe.

The European Geological Knowledge Base will provide European stakeholders with access to objective and seamless data, information, knowledge and expertise on subsurface resources. This will contribute to the following goals:

- Facilitate the optimal use and sustainable management of the subsurface; maximising its added value for energy, groundwater and raw material resources; while minimising environmental impacts and footprints;
- Support the reaching of good environmental status for subterranean and seabed resources.

### 3 Scientific scope of the Joint Call

Proposals for *Project Ideas* should address one or more of the **four GeoERA Themes** identified in Section 3.1.

Proposed Project Ideas shall have a transnational scope and are expected to address:

- The establishment of harmonized science-based information on the distribution, accessibility and availability for exploitation of subsurface resources that is interoperable at a European level, and/or
- The development of new concepts, harmonized methods or tools for the concrete benefit to multiple stakeholders and end-users.

Cross-cutting aspects of the **GeoEnergy**, **Groundwater** and **Raw Materials** themes could address e.g. methodologies, intelligence and sustainability issues.

The fourth GeoERA Theme addresses the development of a common **Information Platform**. Proposed Project Ideas and Project Proposals in Stage Two of the Call from any of the three GeoERA Themes shall address the development of spatial information services, and their integration into the Information Platform.



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## 3.1 Description of GeoERA Themes

### 3.1.1 Theme A: GeoEnergy

The scientific scope for Project Ideas focused on the **GeoEnergy** Theme should consider hydrocarbons, energy derived from solid resources such as coal, geothermal energy from hydrothermal and petro-thermal resources, capacities for temporary storage of energy carriers and capacities for permanent storage of CO<sub>2</sub> and other energy effluents. Project Ideas should deliver harmonized pan-European information on one or more of the following:

- Potential energy resources and storage capacities;
- Potential risks and environmental impacts associated with subsurface development of energy resources or storage applications (e.g. seismic hazards);
- Potential competition and interference, as well as opportunities for synergies, between different uses of subsurface space, including interactions with surface infrastructures and near surface resources.

The energy resources and storage capacities targeted are broadly defined. Their development should be proven or at least considered technically viable in the foreseeable future. Resources may either have a pan-European or regional to local distribution but the level of information is based on regional to national mapping and assessment scales. Local assessment of resources directed to specific assets and industry projects is therefore excluded. In accordance with the Work Programme, the following resource categories are considered part of the scientific scope:

- Hydrocarbons including conventional/unconventional oil and gas, gas hydrates;
- Solid subsurface resources such as coal (including coal bed methane (CBM) and underground coal gasification), lignite, peat, uranium;
- Geothermal energy from hydrothermal and petro-thermal resources, both shallow and deep;
- Capacities for subsurface storage of energy carriers (including natural gas, hydrogen, compressed air and heat);
- Capacities for permanent storage of CO<sub>2</sub> and other effluents resulting from energy production.

Proposed research objectives should be aligned with the core competences, data sources and geoscientific evaluation principles presented at and exercised by the national and regional GSOs. Envisioned outcomes should be compatible with the overall concept of harmonizing and integrating knowledge and information through application of regionally consistent cross-border geological framework data and methodologies (i.e. on the basis of spatial distribution and essential properties of geological intervals containing relevant geo-energy resources and storage capacities. Common methodologies should be developed and applied with the aim to assess and quantify technically recoverable resources across borders in a comparative manner. Development and demonstration of advanced modelling and assessment activities may be proposed for specific cross-border regions characterized by complex geological configurations. Such activities should however support the



integration and harmonization of information at European level, and thus be linked to the objectives of developing a common European spatial information platform.

Project ideas should address the investigation of potential physical effects or interactions resulting from the exploitation of geo-energy resources. For example:

- Identification and analysis of potential overlaps and interactions between geo-energy resources and areas prone to seismic activity or subsidence;
- Determination and analysis of potential connections to groundwater and surface water systems;
- Identification and analysis of potential interferences as well as synergies/pooling between various geo-energy resources and other subsurface uses (including groundwater and minerals).

In this context, the Project Ideas may be aimed at developing and demonstrating methodologies in specific cross-border areas, with the purpose to test their applicability in future transnational and pan-European assessments. Site-specific risk assessments are excluded from the scientific scope.

- In general, the envisaged contributions, which should facilitate or allow for future maintenance and updates.

To reach progress beyond state-of-the-art the Project Ideas should consider that, as of now, there are no comprehensive Pan-European decision support systems that integrate all relevant geo-energy information. Although several individual compilations of potential geo-energy resources and capacities have been or are being developed (e.g. related to CO<sub>2</sub> storage, shale gas, energy storage), these products are not yet based on a common geological assessment framework and still incorporate unresolved cross-border inconsistencies. Furthermore, most assessments resulted in static maps and databases, which do not incorporate update and maintenance options. As a consequence, these products are not suitable for sustainable and integrated planning of resources and evaluations of potential competitive interests.

The research values of the geo-energy theme in particular concern the development and demonstration of:

- Advanced mapping and 3D modelling strategies that allow for regional to pan-European cross-border consistency and integration;
- Advanced and harmonized resource estimation workflows addressing uncertainty and sensitivity;
- State-of-the-art assessment workflows for analysis of potential geologically related surficial and subsurface effects induced by resource exploitation (e.g. subsidence, tremors, etc.);
- Methodologies to objectively weigh interacting or mutually exclusive potential uses of space within the geo-energy theme and across the other themes on groundwater and minerals.



**Expected impacts** include:

- Improved ability to predict potential subsurface contributions to secure future energy supply based on a transnational harmonized and unbiased inventory of hydrocarbon, solid fuel and geothermal resources and energy storage capacities;
- Improved evaluation of potential measures to limit further human-caused climate change, through improved and more comprehensive understanding of existing subsurface storage capacities for CO<sub>2</sub>;
- Improved detection and anticipation of potential bottle-necks with respect to exploitation of geo-energy resources and storage capacities, based on an objective, science-based understanding of potential consequences from such exploitations (e.g. hazards, environmental impacts, conflicts and competitions);
- Improved basis for formulating and developing future research and innovation programmes through newly identified information and knowledge gaps and/or uncovered potential for technological developments;
- More comprehensive and scientifically supported basis for societal and economic cost-benefit analyses, subsurface spatial planning decisions and strategic environmental assessments;
- Increased opportunities for improving the dialogue with public and societal organizations, by providing transparent, unbiased, science- and evidence-based arguments for discussions on geo-energy uses.

### **3.1.2 Theme B: Groundwater**

The objective for the Project Ideas under the groundwater theme is to provide groundwater data, information and decision support tools for the long-term protection, sustainable management and improvement in groundwater resources across Europe, taking into account societal challenges and EU policies, based on innovative methodologies to tackle diversity of hydrogeological settings and scales (regional to pan-European). Jointly developing harmonized and effective tools and methodologies for monitoring, modelling, data management and visualization will improve the understanding of groundwater systems at regional to pan-European scales.

The scientific scope for Project Ideas on **Groundwater** should address one of the following eight societal issues:

- Groundwater, Drinking Water and Human Health, sustaining Europe's drinking water supply, including methods to prevent the further need for extensive purification measures;
- Groundwater and Agriculture, including aspects of water demand for irrigation or the leaching of contaminants from diffuse sources to groundwater;
- Groundwater and Climate, including projected changes in groundwater recharge, extreme events (flooding and droughts) and adaptation of resource management under likely Climate Change scenarios;
- Groundwater, Energy and Mining, including the interplay between the extraction of fossil fuels and groundwater, the storage of cold and heat and the use of geothermal systems, the abstraction of groundwater for mining purposes and the potentials for contamination by mining waste;



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- Groundwater and Ecology, including the environmental objectives of the EU Water Framework Directive (WFD) for aquatic and terrestrial ecosystems in rivers and seas that are influenced by groundwater;
  - Groundwater and Hazards, including sea water intrusion, landslides, induced and natural seismicity and land subsidence;
  - Groundwater and Urbanized areas, including high-resolution characterization of the subsurface to support infrastructure, water and energy systems;
  - Groundwater and Subsurface Spatial Planning as a management tools to promote sustainable use of the subsurface by different stakeholders, supporting future groundwater use, ecological and human wellbeing.

The Call requests Project Ideas relevant to at least one of these societal issues, which aim to deliver innovative harmonized groundwater information products and tools at one or more of three different scales:

- Pan-European products such as maps and/or dedicated monitoring programs that create a form of harmonization between EU member states;
- Cross-border or multiple-country demonstration projects addressing issues or methodologies with high promise for deliverables relevant to harmonised future characterization and assessment tools;
- A smaller number of regional methodological studies, provided that they generate innovative, widely applicable information products or methodologies and tools for the assessment and/or characterization of groundwater or groundwater bodies across GeoERA partner countries and potentially extendable to all European countries.

Project Ideas should optimise transnational to pan-European consistency, and be intended to improve the tools and protocols available for improved future pan-European assessments.

The following specific research deliverables are foreseen to result from Project Ideas:

- Improved subsurface characterisation tools and models for assessing the impacts of climate change, human activities and competing uses of the subsurface on groundwater resources and dependent terrestrial ecosystems;
- Delineated cross-border aquifers, aquitards and groundwater bodies, tuned transnational groundwater monitoring systems, common groundwater and integrated ground-surface-water modelling protocols, and widely applicable methods for the qualitative / quantitative assessment of groundwater resources;
- 3D maps of main characteristics of groundwater resources (volumes, ages, water quality, resilience towards overexploitation and pollution, sustainable yields);
- Harmonized methodologies to assess spatiotemporal trends in or related to groundwater, including:
  - Groundwater levels, depletion and associated land subsidence;
  - Diffuse pollution by nutrients and pesticides from agriculture;





- Fate, behaviour and degradation of emerging pollutants from industry, households and agriculture;
- Common tools to evaluate the impacts of groundwater use and contamination on dependent terrestrial and aquatic ecosystems, including nutrient loadings and environmental flows;
- Innovative and harmonized methods for risk assessment of groundwater and surface water in relation to extreme events (droughts and flooding), salt water intrusion and land subsidence;
- New models and support systems for balancing water demands for water supply and irrigation with environmental objectives of dependent terrestrial ecosystems, surface waters, and groundwater-associated (aquatic) ecosystems.

To reach progress beyond state-of-the-art Project Ideas should consider that to date there has been no attempt to make pan-European harmonized compilations of available groundwater and hydrogeology data. Key aim of this theme will be 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.

Cross-border, regional and pan-European examples of the most important and widely applicable data should be showcased on the Geoscience Information Platform, and may be visualized and downloaded together with e.g. data on competing interests for geo-energy and raw materials in a specific region. Importantly, GeoERA aims at providing the possibility of compiling and analysing geo-energy, groundwater and raw materials data in the advanced 3D geological and geophysical modelling, interpretation and visualisation software used in the petroleum industry, which is generally not available to the groundwater community.

**Expected impacts** include:

- Improved support for the implementation of EU water policies such as the Water Framework and Groundwater directives and the Blueprint to Safeguard Europe's Water Resources taking into account the exploitation of other subsurface resources (geo-energy and raw materials);
- Improved decision support for climate change adaptation by improved coupled climate and groundwater-surface water models;
- State-of-the-art resource mapping and assessment that will set the basis for an integrated Europe-wide monitoring system of groundwater in line with the Water Framework Directive;
- Improved insight in the potential consequences, hazards (e.g. land subsidence) and interactions of subsurface activities, climate change and groundwater abstraction 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 and protection of freshwater resources, globally;
- Improved access to downloadable hydraulic and (hydro)chemical parameters of main European aquifers and aquitards (or groundwater bodies) needed for e.g. model development, and 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;
- 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.

### 3.1.3 Theme C: Raw Materials

The primary concerns for **Raw Materials** are

- a) Security and sustainability of supply of primary and secondary mineral raw materials from EU domestic sources; and
- b) Managing competing uses of the European surface and subsurface, both on-shore and offshore.

The scientific scope for Project Ideas on Raw Materials includes four main goals:

- Extending, deepening, upgrading the quality of the pan-European primary and secondary continental and marine resources inventory;
- Updating contributions to and augmenting the coverage of the Annual Minerals Yearbook published by the Minerals4EU project;
- Performing pilot studies supporting exploration and development of mineral raw materials; and
- Implementation of innovative and efficient approaches throughout the mineral raw materials value chain, with the aim of optimizing the use and management of the resources, while minimizing negative environmental, health and societal impacts.

With respect to the main challenges in the area of raw materials Project Ideas should focus on the development and application of new technologies, models and actions to both highlight the attractiveness of the mineral endowment of Member State jurisdictions, and address any possible negative aspects so that they are carefully managed.

A key action concerns the improvement of the pan-European 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.

The proposed Project Ideas should build on previously developed databases such as EURare, Minerals4EU and ProSUM that represent the building blocks of the EU Raw Materials Knowledge Base (EURMKB), which is a major deliverable of the Strategic Implementation Plan (SIP) of the European Innovation Partnership on Raw Materials (EIP-RM).

An overview of minerals statistics on an annual basis is important to inform policy makers and other stakeholders on Europe's capabilities to meet its overall mineral resources demands. Project Ideas



should maintain and expand the content and scope of the Minerals Yearbook first developed within the EU-FP7 funded Minerals4EU project (see <http://www.minerals4eu.eu/>). The Annual Minerals Yearbook will provide statistics in a standardized format. The current (Minerals4EU) and expanded (GeoERA) coverage for the Minerals Yearbook can be seen in the following table.

	<b>Minerals4EU</b>	<b>GeoERA</b>
<b>Coverage</b>	Most European countries	Expand coverage to include more Eastern and South-eastern European countries
<b>No. of commodities</b>	66 commodities	66 + additional commodities such as: andalusite, kyanite, sillimanite; calcite; corundum; dimension stone; dolomite; gallium; slate
<b>Waste flows</b>	12 categories	12 + additional categories or subcategories such as: WEEE waste; end-of-life aircraft; end-of-life shipping

Project Ideas should address the development and application of new technologies, models and actions to both highlight the attractiveness of the mineral endowment of Member State jurisdictions, and ensure that any possible negative aspects are carefully managed. This could include:

- Critical Raw Materials needs as identified and regularly updated by the Commission at European level;
- Commodities for challenging environments and new frontiers, such as energy critical elements, energy storage, telecommunications, transport, societal well-being including health;
- Improving European regional geological and metallogenic knowledge regarding:
  - Well-known and understood mineral deposit types in specific European geological domains;
  - future potential of existing mines, given emerging technologies and economics;
  - Underexplored mineral deposit types in Europe and related co- and by-products of existing and past mining operations;
  - Small high-grade deposits that may be put into production rapidly without necessitating significant investment;
- Improving existing genetic and exploration models, and thus developing more efficient and effective exploration tools and technologies, e.g., Data Mining and Knowledge Discovery in Databases (KDD) techniques using the EU-RMKB as a key data source;
- Enhancing 2D predictive methods and creating 3D/4D modelling and 3D predictive targeting systems:
  - to improve exploration efficiency;
  - to identify and safeguard areas of high mineral resource prospectivity and areas with development potential taking into account competing land uses,
  - to facilitate the identification of mineral resources at depth;
- Constraining the undiscovered resources of specified commodities within Europe using appropriate methodologies, as an essential input for driving Mineral Resources policies;
- Producing harmonized transnational metallogenic, mineral potential and mineral prediction maps based on common methodologies;



- Developing appropriate methods for the reporting of reserves and resources of waste rock, mine waste and tailings;
- Improving newly developed data models and populating the related databases (composition, products, stocks and flows) of secondary raw materials.

To reach progress beyond state of the art Project Ideas should consider to build upon previous achievements funded in the context of the EU Raw Materials Initiative (RMI), address identified knowledge and information gaps, and encourage future project coordinators to be innovative and inventive in addressing these challenges by:

- Optimising the standardisation and harmonisation of minerals data for all of Europe efficiently and providing services to exploit data (linked with the IT theme of this proposal);
- Improving mineral deposit models for under-explored or poorly explored deposit types in Europe;
- Using modern geological concepts such as Mineral Systems to better understand and thus predict the location and distribution of mineral deposits;
- Providing volume estimates of resources (discovered and undiscovered) for specific commodities;
- Developing the downstream end of the value chain by improving the collection, collation and harmonization of secondary resource data.

**Expected impacts** include:

- 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;
- 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);
- 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 optimise their investment;
- Data and tools to facilitate the re-use and recycling of mineral based waste;
- Reduction of the import dependency of Europe's industries for critical raw materials.

### **3.1.4 Theme D: Information Platform**

GeoERA Themes A to C share the objective to provide and disseminate spatial information on their respective resources and underpinning geological data. As the cross-thematic integration of information is an important aspect to be addressed, GeoERA introduces a specific Theme on Information Platform that effectively integrates all ICT-related and technical issues (database and dissemination) from the other Themes.



Theme D addresses the development of a common geoscience information platform capable of integrating up-to-date data, interpretations and models from different and distributed sources, both within and across Themes A to C.

The scientific scope for Project Ideas on the **Information Platform** should address collaborative approaches in the following research and innovation fields:

- Effective integration of spatial information and all ICT-related and technical issues (databases and dissemination) from the other three GeoERA Themes;
- Establish and promote a cross-cutting information system which enables the practical cross-thematic integration of GeoERA Themes data and information;
- Build systems for integrating and consolidating data from regional/national level to EU scale, thereby enabling easy access to data that is as complete and up-to-date as possible;
- Establish pan-European and more local (cross-border) databases with a coordinated structure to store raw data, interpretations, and models;
- Develop standards for interoperable cross-border and pan-European scale geological base maps and datasets, including stratigraphic correlation schemes, compatible model scales and resolutions, structural geological definitions, etc.;
- 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;
- 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 and for instance, address questions concerning competing of interests in certain areas and depths;
- 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 (e.g. cross-thematic analyses for spatial planning purposes);
- Provide training and technical support to data providers at regional and national level.

The Project Ideas should typically be aimed at delivering data models and extensions to common-agreed core databases and web-systems integrating new data as well as introducing extended functionality to service the new data. Other objectives should include extended generic functionality and adaptation of new relevant web and other technologies.

To reach progress beyond state of the art Project Ideas should consider that during previous research projects the GSOs collaboratively and through EGS have built several individual information platforms that incorporate some of the characteristics and functionalities requested in the Work Programme. Of particular relevance are projects like OneGeologyEurope, Minerals4EU and EMODNet. None of these projects have however been dealing with the comprehensive level of cross-domain data integration that is envisioned in GeoERA. Furthermore, the established information systems do not yet support advanced use cases for handling 3D/4D models and uncertainty data.

Recent efforts have resulted in the conceptual design of the European Geological Data Infrastructure (EGDI) which built on experiences gained during earlier collaborative projects. EGDI aims to deliver a more generic information framework capable of hosting data from all geo-scientific themes covered



by GSOs, and may as such provide the backbone for the GeoERA information and dissemination requirements. The development of the EGDI is also aligned with the development of the European Plate Observing System (EPOS). Furthermore, the EU-funded GeoMol project and several other local-funded transboundary projects have developed information systems and methodologies that are capable of handling and dissemination cross-border 3D model data. The outcomes of these projects provide an important basis for further developing and extending 3D-modelling strategies in GeoERA.

The objectives addressed in Themes A to C will provide the use cases that further guide the Information Platform development. In particular, the envisioned integration of 3D/4D geological and parameterized models and handling and documentation of quantitative data on uncertainties will require additional research and innovation on the existing concepts. The Information Platform will ensure that the direction of innovative design 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).

**Expected impacts** include:

- Better access to integrated information and knowledge on subsurface resources and potentials, including functionalities to investigate such data (e.g. maps, cross-sections, etc.), contributing to improving and structuring the dialogue between various policy domains and subsurface stakeholders in support of subsurface spatial planning and decision making;
- 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;
- Improved ability for end-users 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).

### **3.2 Cross-thematic integration**

Cross-thematic integration is an important objective for GeoERA as a whole. The joint call should facilitate Project Ideas that specifically address cross-thematic integration. Examples could include:

- Understand the interaction between the different natural resources (geo-energy, raw materials and groundwater);
- Develop common models and assessment frameworks that allow simultaneous appraisal of natural resources (geo-energy, raw materials and groundwater) exploitation;
- The use of the subsurface for climate change mitigation and adaptation options;
- Input to integrated surface and subsurface spatial planning including optimized location of different land uses and infrastructure (transport systems, new urban development etc.).



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- Identify the regional geo-hazards and geological impacts (floods, land subsidence, landslides, earthquakes etc.) related to deployment of geo-energy, groundwater and mineral resources.