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Second Report (M35) wrapping-up the synergies and overlaps highlighted between the projects in terms of geoinformation.

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GENERAL INTRODUCTION

The GeoERA Information Platform project (GIP-P) supports the 14 geoscientific projects (GSPs) of GeoERA in organising and disseminating the geoinformation generated in their frameworks. The GIP-P is entitled to manage the data produced by each GeoERA project by archiving and making them available to citizens, researches and/or stakeholders. This will be achieved by extending the current European Geological Data Infrastructure (EGDI).

The different geoscientific projects deal with multiple aspects of geosciences in the fields of groundwater, raw materials, and geo-energy. These projects will thus generate a variety of products, which will require specific functionalities to be developed to store, display, and share them appropriately. Hence, the GIP-P must have a good understanding of the products that each project will generate, and the functionalities required to display them correctly. That is assured by Work Package 2 (WP2), which coordinates the interactions between the various GeoERA projects and the GIP-P.

EXECUTIVE REPORT SUMMARY

The present report is the third and final deliverable from Task 2.1. The objectives of this task are to facilitate the communication between the GSPs and the GIP-P, and to follow up of the data production (harmonisation, standardization, etc.) and data delivery.

Deliverable D2.1.3 provides an overview of the synergies in terms of geoinformation that have been established among the various GSPs in the framework of GeoERA. Most of those synergies have been described in previous WP2 deliverables; notably, in D2.1.1, D2.2.2 and D2.1.2. Most of the information provided in this report is therefore a summary of the information provided in previous deliverables, which have been updated/completed with the latest information shared by the GSPs.

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DEFINITIONS

Attributes: information stored in the spatial data.

Functionality: Refers to the ability of the (GIS) software/application to provide a set of functions to users for consulting, visualizing, archiving, downloading, and searching data.

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

3D (Geological) model: A digital representation of portions of the earth's crust based on geophysical and geological observations.

Geoinformation: In the present report, the term geoinformation refers to any spatial data (vector, raster graphics, georeferenced documents, etc.), as well as to any information related to those data (e.g., documents, spreadsheets, pictures, vocabularies, metadata, etc.).

Product: any deliverable generated by a GeoERA project that will be available via EGDI. Projects will deliver 4 types of products:

1. **Spatial data:** data concerning phenomena implicitly or explicitly associated with a location within Earth. These typically are:

   - **2D, 2.5D and 3D GIS data:** shapefiles, GeoPackages, GeoTiffs, ASCII grids, etc.

   - **Geographically localized 3D (Geological) models**

   - **Open Geospatial Consortium (OGC) Web services**: services defined by the OGC, allowing all kinds of geospatial functionality, e.g., WMS, WFS, ATOM. They include services for data access, data display and data processing.

2. **Non-spatial data**: documents (PDFs, text files, etc.), photos/images (JPGs, PDFs, etc.), data sets (TXT, CVS, etc.), URL (DOI, etc.), etc. These data can or cannot be linked to spatial data.

3. **Metadata:** data that provides information about the spatial and/or non-spatial data, e.g., the purpose of the data, time of creation, authors, etc.

4. **Project vocabularies:** collections of terms with short descriptions, bibliographic citations and links to unstructured web contents used to define scientific parameters and concepts.

ABBREVIATIONS

3DGEO-EU: 3D geomodelling for Europe.

GARAH: Geological Analysis and Resource Assessment of selected Hydrocarbon systems.

GeoConnect³d: Cross-border, cross-thematic multiscale framework for combining geological models and data for resource appraisal and policy support.

CSW: Catalogue Service for the Web

DOI: Digital Object identifier

FDB: (HIKE) Fault Database

EGDI: European Geological Data Infrastructure

EuroLithos: European Ornamental stone resources

FRAME: Forecasting and Assessing Europe's Strategic Raw Materials needs

GIP-P: GeoERA Information Platform Project

GIS: Geographic Information System

GSPs: Geoscientific projects within GeoERA

HIKE: Hazard and Impact Knowledge for Europe.

HotLime: Mapping and Assessment of Geothermal Plays in Deep Carbonate Rocks – Cross-domain Implications and Impacts

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.

KSP: (HIKE) Knowledge SharePoint

MiCKA: EGDI software for (spatial data/services) metadata management.

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

MINTELL4EU: Mineral Intelligence for Europe.

MUSE: Managing Urban Shallow Geothermal Energy.

RESOURCE: Resources of groundwater harmonized at cross-border and pan- European scale.

TACTIC: Tools for Assessment of Climate change Impact on groundwater and adaptation Strategies.

UNFC: United Nations Framework Classification for Resources

VoGERA: Vulnerability of Shallow Groundwater Resources to Deep Subsurface Energy-Related Activities.

WCS: Web Coverage Service

WFS: Web Feature Service

WMS: Web Map Service

WP: work package

1 INTRODUCTION

The GeoERA program consists of 14 geoscientific projects (GSPs), which are grouped in 3 different geological themes (Groundwater, Raw Materials and Geo-energy). The outputs produced by the geoscientific projects are managed by the information platform project (GIP-P). The GIP-P is entitled to extend the European Geological Data Infrastructure (EGDI) to adapt it to the special needs of the products generated by the various GSPs to share them with the scientific community and the public. The GIP-P also provides support on how to produce harmonised and standardized data following European regulations.

The present deliverable provides a summary of the synergies identified among the different GSPs in terms of geoinformation. The information presented in this manuscript comes from:

- Deliverables D2.1.1, D2.1.2, D2.3.1, D2.3.2 and D2.2.2. Notably, potential overlaps and synergies among GeoERA projects were discussed in detail in deliverable D2.1.1. These deliverables can be consulted/downloaded at https://geoera.eu/projects/gip-p/.

- Feedbacks from the different GIP-P/WPs on previous WP2 deliverables.

- Information exchanged between the GSPs and the GIP-P's liaison officers by email or during project meetings.

This manuscript is divided in three main sections, exposing: 1) correlations among the data formats chosen by the different projects to furnish their data; 2) correlations among the different functionalities requires by the various projects to show and share their data; and 3) collaborations/synergies among different projects to create joint datasets, vocabularies, etc.

2   DATA FORMATS

Table 1: correlations among the data formats and delivery methods chosen to deliver spatial data by the various GeoERA projects. RE: RESOURCE; Vo: VoGERA; HO: HOVER; TA: TACTIC; Eur: EuroLithos; FR: FRAME; MIND: MINDeSEA; Min: MINTELL4EU; Geo: GeoConnect³d; HI: HIKE; 3DGEO: 3DGEO-EU; MU: MUSE; Hot: HotLime; GA: GARAH.

Requirements		Groundwater				Raw materials				Geo-energy					
Product types, formats and delivery methods		RE	Vo	HO	TA	Eur	FR	MIND	Min	Geo	HI	3DGEO	MU	Hot	GA
th	Shapefiles	X	X	X	X	X				X		X		X	
	GeoPackages			X	X	X	X	X	X	X	X	X	X	X	X
	NetCDF	X		X	X										
	WMS					X	X								
	WFS					X	X		X						
	REST services				X										
	PostgreSQL database								X						
	GeoTIFF			X	X							X		X	X
	2.5D ESRI Grids (ASCII)			X								X			X[1]
	XYZ datasets in Access format														
	XYZ datasets in Excel format														
	3D Shapefile														
	3D - OBJ format														
	2.5D & 3D Gocad ASCII (Tsurf, PLine, VSet, Solid, Voxet, SGrid)				X					X	X[2]	X		X	X[1]
	CPS3 ASCII											X			X[1]
	VTK ASCII											X			
Delivery method (data)	Direct upload into EGDI database	X	X	X	X	X	X	X		X	X	X	X	X	X
	direct access via web services				X	X	X		X						
Delivery method (metadata)	Direct editing in MiCKA metadatabase	X	X	X	X	X			X	X	X	X	X	X	X
	harvesting from CSW				X	X	X								X

Requirements	Groundwater				Raw materials				Geo-energy					
Product types, formats and delivery methods	RE	Vo	HO	TA	Eur	FR	MIND	Min	Geo	HI	3DGEO	MU	Hot	GA
Project vocabulary			X		X				X	X	X[3]	X	X	

(1) GARAH will produce their 3D data in collaboration with 3DGEO-EU; hence, they both will provide 3D data in the same formats.

(2) HIKE will produce 3D data, but these are not to be shown in EGDI webGIS portal. The 3D data (or the contact information from where to get them) will be accessible through the 2D fault geometries and/or their metadata.

(3) 3DGEO-EU will use HIKE's vocabulary, which might be extended with 3DGEO-EU specific terms in a later stage of the project.

Table 2: correlations among the data formats and delivery methods chosen by the various GeoERA projects to submit documents and other non-spatial data to EGDI. The meaning of the abbreviations is explained in the caption of Table 1.

Requirements		Groundwater				Raw materials				Geo-energy					
Product types, formats and delivery methods		RE	Vo	HO	TA	Eur	FR	MIND	Min	Geo	HI[1]	3DGEO	MU	Hot	GA
Data formats	PDF	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	JPG, TIFF, PNG			X	X	X				X	X				
	EXEL files[2]		X[2]												
	CSV				X	X		X			X				
	DOIs							X		X	X		X		
	URLs									X	X				
Documents linked to spatial data or to a location		X	X	X	X	X	X	X		X	X	X	X	X	X

(1) HIKE may provide documents, tables, etc. in other formats, but they will not be stored in EGDI document repository, although they will be accessible through it from documents and/or URLs archived in there (see HIKE D5.1b for more information).

(2) TXT and Excel files are not allowed in EGDI. Projects delivering tabular data must do so in CSV or PDF. However, an exception has been made for the VoGERA project, as their spreadsheets contain formulas that will not work in CSV format.

3. FUNCTIONALITIES

Table 3: Functionalities required by the various GSPs according to deliverables D2.2.2 and D2.1.2. Note that, even though versions of most of the functionalities listed in this table will be available in EGDI, the timeframe of GeoERA is limited and has not permitted to implement all of them. The meaning of the abbreviations is explained in the caption of Table 1.

Requirements		Groundwater				Raw materials				Geo-energy					
	Functionality	RE	Vo	HO	TA	Eur	FR	MIND	Min	Geo	HI	3DGEO	MU	Hot	GA
2D viewer & docs	Search based on location			X	X	X	X	X	X	X			X		
	Search through attributes					X	X				X	X			
	Search Documents	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Searching for maps	X		X											
	Interface to upload and thematize Shapefiles, GeoPackages and/or GeoTIFFs	X	X	X	X	X	X	X	X	X	X			X	X	X
	Possibility of uploading and thematizing NetCDF			X	X										
	(1)Interface to knowledge base and related documents									X	X			X	X
	Web page with all services	X	X	X	X	X	X	X	X	X	X			X		X
	Overview panel	X	X	X	X	X	X	X	X			X			X
	Legend with tree view/hierarchical on/off switching	X	X	X	X		X			X	X	X	X		
	Export map	X		X	X	X	X	X	X	X		X	X		X
	Download data with or without access control	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Identify + follow link	X		X	X	X	X	X	X	X	X			X	X	X
	Specific projection	X										X			
	Handling Time component			X						X					
	Display a graph with time series data				X										
	Multiscaling			X	X	X	X			X	X	X	X	X	
	Transparency			X	X					X			X		

| Requirements | Groundwater | | | | Raw materials | | | | Geo-energy | | | | | |
Functionality	RE	Vo	HO	TA	Eur	FR	MIND	Min	Geo	HI	3DGEO	MU	Hot	GA
Creation of statistical diagram, rose diagrams, histograms...			X			X		X		X				
Metadata compatible with other EU inventories				X	X	X								X
Create simple queries and filters from the webGIS interface	X		X		X	X	X	X	X	X		X	X	X
From getfeatureinfo creation of an automatic report querying a selection of layers.			X		X	X	X	X	X			X	X	
Visualization of reports in HTML						X								
Measurement tool						X								
Interactive GIS maps with online calculator						X								
(2)A common legend should be applied to all datasets based on attributes given in the fault attribute tables. The default colouring of subsurface faults will correspond to the colour coding of the International Chronostratigraphic Chart v2018/08.										X				
Functionality to show statistical data of the yearbook in EGDI								X						
(3)Visualizing the data according to UNFC classification								X						

	Requirements	Groundwater				Raw materials				Geo-energy					
	Functionality	RE	Vo	HO	TA	Eur	FR	MIND	Min	Geo	HI	3DGEO	MU	Hot	GA
	Linkage to Semantics/Project Vocabulary (link from the map to the project vocabulary and vice versa).					X	X	X		X	X	X	X	X	
	(2)Customizing classification and legend to certain purpose. For example, show proven faults in solid lines, assumed faults in dashed lines and/or a certain depth as line thickness.										X				
3D	(4)Create virtual logs from table data or 2.5D layers	X													
	(4)Create virtual cross section 2.5D layers from a user defined geometry	X										X			
	Handling and displaying 3D models			X	X					X		X		X	X
	Transparency of 3D models			X						X		X			
	Virtual borehole			X								X	X	X	
	Virtual cross section				X							X		X	
	Virtual (horizontal) slice											X		X	
	In 3D viewer: "getfeatureinfo" tool that displays information on each layer when the users click on them.													X	
	Handling and displaying uncertainty									X		X			

Requirements	Groundwater				Raw materials				Geo-energy					
Functionality	**RE**	**Vo**	**HO**	**TA**	**Eur**	**FR**	**MIND**	**Min**	**Geo**	**HI**	**3DGEO**	**MU**	**Hot**	**GA**
Visualization of data with scalar uncertainty, using 2D colour maps.											X			
Visualization of different representations of an object (e.g., a surface) showing different realizations; for example, the mean surface and additional 90% and 95% confidence envelopes as transparent surfaces.											X			
Storing data with uncertainty in 3D database											X			
Compass											X			
Colour / Alpha mapping functions to render attributes											X			
Glyphs for data representation											X			
Visualization of different models at the same time											X			
Possibility to display objects											X			
Grid lines											X			
Exploded views of detailed part of 3D model											X		X	
Show camera direction											X			

(1) The functionality "interface to knowledge base and related documents" is handled by the document repository and project vocabularies.

(2) Legends are defined by the GSPs when they upload the data into EGDI database. Hence, the projects can organise the legends as they wish by, for example, including multiple languages, applying harmonize colours, etc.

(3) The functionality "Visualizing the data according to UNFC classification" will only be created if the timeframe of GeoERA allows it.

(4) To create virtual logs/cross sections from tabular data or 2.5D layers, the layers must be uploaded to EGDI 3D database.

3 OTHER SYNERGIES AND/OR COLLABORATIONS AMONG PROJECTS IN TERMS OF GEOINFORMATION

3.1. GeoConnect³d – HIKE – HotLime

Synergies between HIKE, GeoConnect³D and HotLime are many and happened through meetings but also on a technical level; e.g., (HIKE) faults are referenced and used in several deliverables from the other projects.

There have been several cross-project meetings between HIKE and GeoConnect³D on where and how to use each-others project vocabularies and where to create specific ones. This has led to choices for both options and, thus, vocabularies that are closely related, but significantly different from the perspective of the projects.

The project vocabularies of HIKE and HotLime are also interrelated. Indeed, HIKE uses HotLime's project vocabulary to define some of the concepts associated with several of the faults included in HIKE's fault database. In addition, several entries of HotLime's project vocabulary are direct links to HIKE's project vocabulary.

3.2. GARAH – 3DGEO-EU – HIKE

GARAH and 3DGEO-EU work in synergy to create the 3D data that will be provided by the project GARAH in the framework of GeoERA. These projects interact through meetings and work sessions to discuss, produce, and exchange data.

The products created in the framework of the 3DGEO-EU project (and, by extension, of the GARAH project) are tightly related to HIKE's fault Database. Indeed, part of HIKE's fault database and its associated vocabularies is integrated in the 3DGEO-EU database.

3.3. MINTELL4EU

MINTELL4EU partners along with other data providers have been invited to add new data to the latest version of the MIN4EU database. This new database is a redevelopment of the former M4EU database structure and has involved the development of new and existing code lists/vocabularies.

The electronic Minerals Yearbook (eMYB), within the MINTELL4EU project, is being integrated into the MIN4EU database structure. As a result of this, existing code lists are being updated accordingly and are being developed with the addition of United Nations Framework Classification (UNFC) codes for all occurrences.

MINTELL4EU have worked with all the three other Raw Material projects and the GIP-P on data issues related to securing data for future use, which involves adding these to the MIN4EU database. There have been several meetings between MINTELL4EU, Eurolithos and GIP-P detailing with development of project vocabularies. Similarly, a webinar and one-to-one collaborative meetings were organised in

October 2020 to help data providers prepare their data accordingly to incorporate them in the MINTELL4EU repository.

3.4. Eurolithos

The Eurolithos project is to deliver an atlas and spatial data that will be harvested through the MIN4EU platform. This will likely require additional GeoPackages of a selection of unique stone resources with descriptions and there is a plan to enable the feature for providing "printed" country-atlases.

There is continued collaboration between MINTELL4EU, Eurolithos and the GIP-P to design harmonised procedures for spatial and non-spatial information about stone Resources. This includes enabling connections between data types and functionalities within the raw material projects.

Eurolithos vocabulary and uploading procedures of directory of stone types has been completed. Some issues still remain on particular code lists for harvesting of the Eurolithos spatial data for the MIN4EU. MINTELL4EU and GIP-P have been collaboratively assisting Eurolithos in resolving these issues.

3.5. FRAME – MINDeSEA

Project FRAME is designed to research the critical and strategic raw materials in Europe by employing sound strategies and a partner base spread amongst those that have some of these raw materials.

Through successful teamwork and collaboration, the FRAME Project has contributed towards knowing more about potential of primary deposits, prediction of new target areas/deposits and recognising the potential in secondary deposits. Through bi-lateral meetings with MINDeSEA functionality requirements were identified along with classifications and the resolution of technical issues. In terms of data, pan-European metallogenic maps for co-rich ferromanganese crusts and the cooperative compilation map (onshore-offshore) are results of the collaboration with MINDeSEA. Tools for metallogenic analysis and new genetic models were also developed on a collaborative basis.

4 CONCLUSION

Despite the many overlaps identified in deliverable D2.1.1 among the study areas and topics addressed by the different GeoERA projects, there have not been significant overlaps in terms of geoinformation. The topics addressed by the different projects are indeed rather specific. However, despite the specificity of each project, they all produced spatial and nonspatial data in similar formats, which were predetermined by the formats allowed by the platforms created by the the GIP-P to upload data into EGDI. The imposition of a limited number of data formats to deliver data to EGDI and the similarity of the geoinformation provided by the projects (i.e., 2D vector and raster data, 2.5D rasters, 3D geological models) have also conditioned the number/type of functionalities required by the different projects. As a result, the interfaces created in EGDI for each project (2D map viewers, 3D viewers, uploading modules, etc.) have the same functionalities available for each data format.

Several GeoERA projects have collaborated with one another to create data, vocabularies, etc. Notably, Geo-energy projects and Raw Material projects have established several collaborations and synergies centred around the projects HIKE and MINTELL4EU, respectively. Groundwater projects, on the other hand, have not established synergies among one another or with other GeoERA projects to create data and/or vocabularies. However, they meet regularly and keep each other informed on their progress.