3DGEO-EU
GEO-ENERGY

3D Geomodelling for Europe
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Deliverable 7.1

Technical requirements for project data and results

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1 INTRODUCTION

1.1 Document Background and Scope

This document presents the 3DGEO-EU-Workpackage 7 ”Technical requirements for project data and results” report. It provides an overview of the project goals and results, which will be transfered and published via the GeoERA-Information Platform (GIP) project. With respect to the particular and various data sets comprising 3D geomodels, new compilations and derived data sheets as well as project reports, guidelines and manuals, the report focuses on a clarification of project deliverables, associated data and requirements to efficiently ensure the maintenance, dissemination and sustainablity of project results. This report represents the status in June 2019 after the first project year.

1.2 Abbreviations

3DGEO-EU	Project ”3D geomodelling for Europe”
EGDI	European Geological Data Infrastructure
GIP	Project ”Geo-Information Platform”
WP	Workpackage

2 AMBITIONS AND EXPECTED IMPACTS

2.1 Ambitions

The main ambition of 3DGEO-EU is the harmonization of geological data across geological, topographical, but especially across national borders to allow reliable assessments of resource potentials and possible use conflicts on a pan-European scale. Due to a variety of thematic challenges associated with geological and geophysical parameters and characteristics (e.g. stratigraphy, geophysical models, structural interpretation) specific workflows for harmonization of geological information across borders need to be establishe and proofed. In the 3DGEO-EU project such methods will be developed, described and prooved to ensure the availability of validated workflows for the geoscientific community in Europe. This work will be done in three workpackages (WPs), which focus on the integration of geophysical potential field data, cross-border harmonization of fault data and the estimation and visualisation of uncertainties. Developed and established workflows were further applied in three WPs focusing on cross-border pilot areas. The methodologic advantages and the gain in experience on cross-border 3D harmonization work will be a keystone for further transnational harmonization efforts.

2.2 Expected impacts

The aim of 3DGEO-EU is to establish methods and workflows for cross-border harmonization of 3D geomodels and geodata, which will become applicable to other border regions in Europe. The expected impacts are:

- The development of methods for semantic and geometric harmonization of geodata and geomodels.
- The establishment of advanced mapping and 3D geomodeling strategies for regional to pan-European data and model harmonization, improvement of consistency and model integration.
- The development of improved visualization methods for uncertainties and optimized reconstruction and restoration workflows to reduce uncertainty of geomodels.
- The establishment of consistent data and geomodels in cross-border regions, which can become the nucleus for further transnational harmonization projects.
- The harmonization of stratigraphic and structural modeling workflows to enhance the comparability of results in a pan-European scale.

3 PROJECT OVERVIEW AND DELIVERABLES

The 3DGEO-EU project is subdivided into eigth WPs (Figure 1) with various deliverables comprising manuals, reports, harmonized data as well as 3D geomodels, which will be produced during the project duration. Three WPs (WP1, WP2 and WP3) dominantly will produce geodata and geomodels from pilot areas while WP4, WP5 and WP6 will focus on method development and example data. Two WPs (WP7 and WP8) will take care of the dissemination of results and project management. The following chapters will give a detailed overview of the WPs and associated deliverables.

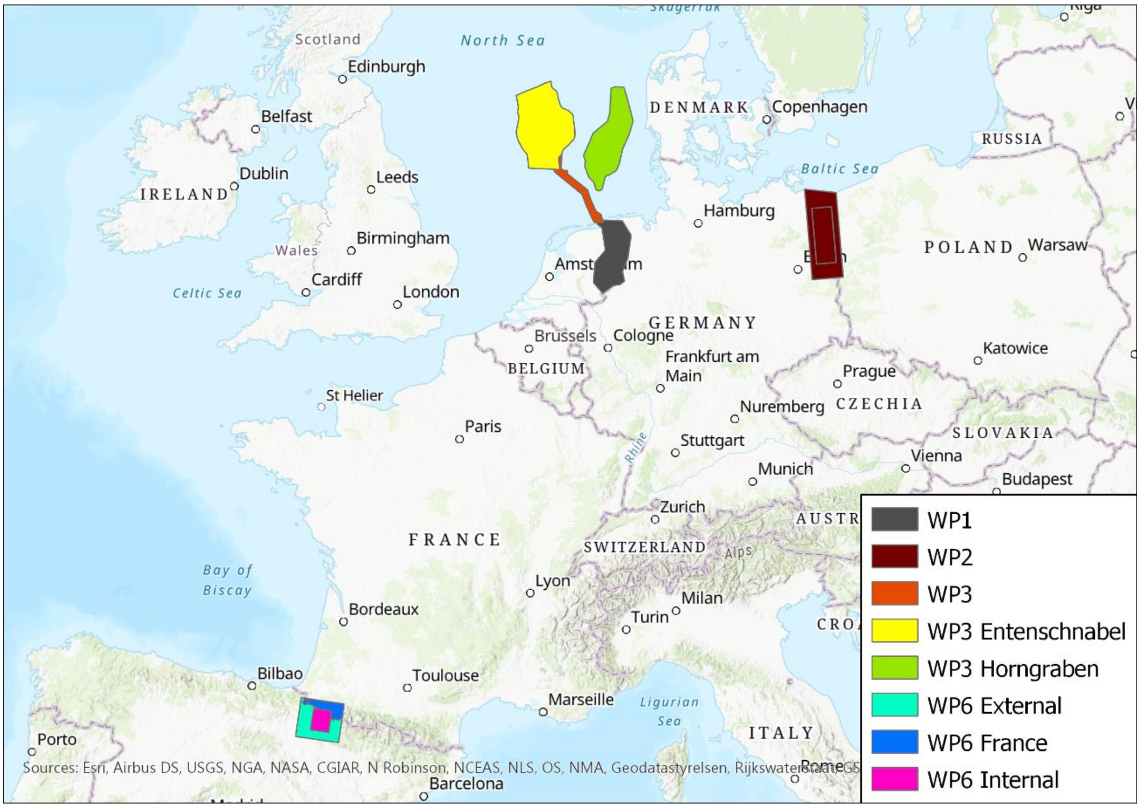

Figure 1: Location of the different work areas of the work packages.

3.1 Cross-border pilot areas

3.1.1 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 barriers 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.

Deliverable number	Deliverable name	Deliverable data (in month)	Type of deliverable	Data formats
D1.1	Inventory report	M6	Report	PDF
D1.2	Harmonized 3D model	M24	3D model	Gocad TSurf
D1.3	Maps of Cenozoic geothermal reservoirs	M30	Digital data	CPS3, GeoPackage
D1.4	Database of geothermal properties	M30	Digital data	not specified yet
D1.5	Geothermal property maps	M36	Digital data	CPS3, GeoPackage
D1.6	Map of hydraulic barrier	M34	Digital data	CPS3, GeoPackage

3.1.2 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)

Deliverable number	Deliverable name	Deliverable data (in month)	Type of deliverable	Data formats
D2.1	State of the Art	M9	Report	PDF
D2.2	Documentation methods, workflows and results	M33	Report	PDF
D2.3a	Harmonized 3D geomodel pilot area 1)	M18	3D model	Gocad TSurf
D2.3b	Harmonized 3D geomodel pilot area 2)	M33	3D model	Gocad TSurf

D2.4	Final report incl. lessons learned	M36	Report	PDF

3.1.3 *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 stratigraphic boundaries, seismic interpreted lithostratigraphic horizons, 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.

Deliverable number	Deliverable name	Deliverable data (in month)	Type of deliverable	Data formats
D3.1	State of the art report	M6	Report	PDF
D3.2	Generalized cross-border 3D depth model of (a part of) the Entenschnabel region	M6	3D model	TVDgrids (Zmap, CPS3) Supporting document (PDF)
D3.3	Harmonized stratigraphic chart for the North Sea area NL-DE-DK	M18	Report	PDF
D3.4	Lithostratigraphic/ chronostratigra-phic correlation profiles through the study area	M18	Report	PDF
D3.5	Harmonized seismostratigra-phic concepts and structural interpretations	M24	Report	PDF
D3.6	Summary of the harmonization work on time model for seismic interpreted main horizons incl. main fault planes	M24	3D model	not specified yet

Deliverable number	Deliverable name	Deliverable data (in month)	Type of deliverable	Data formats
D3.7	Harmonized cross-border velocity model	M24	3D model	not specified yet
D3.8	Harmonized structural 3D models	M30	3D model	not specified yet
D3.9	Final report incl. lessons learned	M36	Report	PDF

3.2 Method development

3.2.1 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.

Deliverable number	Deliverable name	Deliverable data (in month)	Type of deliverable	Data formats
D4.1	State of the art in uncertainty visualization	M12	Report	PDF
D4.2	Sources of uncertainties in geomodels	M18	Report	PDF
D4.3	Uncertainty visualization requirements for EGDI	M18	Report	PDF
D4.4	Example data sets/geo-models containing uncertainty information	M36	Digital data, 3D models	VTK, Gocad TSurf

3.2.2 *WP5 Method development – Faults*

This work package is closely connected to the GeoERA 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 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.

Deliverable number	Deliverable name	Deliverable data (in month)	Type of deliverable	Data formats
D5.1	3D fault objects with metadata and attributes	M30	Map series, 3D models	not specified yet
D5.2	Reporting	M36	Report	PDF

3.2.3 *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.

Deliverable number	Deliverable name	Deliverable data (in month)	Type of deliverable	Data formats
D6.1	Report on a 3D model of the South western Pyrenees	M36	Report	PDF
D6.2a	3D model of the South western Pyrenees	M30	Digital data	not specified yet
D6.2b	Major faults in the South western Pyrenees model	M35	Digital Data	not specified yet

D6.3	Report on harmonization procedure with gravmag in East GER/ West Poland border	M36	Report	PDF
D6.4	Report on case study North Sea	M36	Report	PDF
D6.5	Optimized 3D reconstructions workflows	M36	Report	PDF

3.3 Project management and result dissemination

3.3.1 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.

Deliverable number	Deliverable name	Deliverable data (in month)	Type of deliverable	Data formats
D7.1	Technical requirements for project data and results	M12	Report	PDF
D7.2	Data exchange report	M36	Report	PDF

3.3.2 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.

Deliverable number	Deliverable name	Deliverable data (in month)	Type of deliverable	Data formats
D8.1	Minutes of meetings	M1 – M36	Document	PDF
D8.2	Project Data Management Plan	M6	Document	PDF
D8.3	Project Progress and Monitoring Report	M18	Report	PDF
D8.4	Final Project Progress Report	M36	Report	PDF
D8.5	Synthesis Report on final results	M36	Report	PDF

4 REQUIREMENTS FOR TECHNICAL IMPLEMENTATION OF RESULTS

The requirements for the technical implementation substantially comprise three main topics, which evolved from the different needs of the two different partners (GIP & 3DGEO-EU):

- spatial reference,
- data exchange formats,
- EGDI functionalities

However these topics will represent questions and needs which result on the current status of the project work. It is certainly possible that some of the points mentioned below may change during project runtime.

4.1 Spatial Reference

Since GeoERA is a pan-European project dealing with transnational projects the necessity of using proper spatial reference systems becomes evident. Following the technical guidlines prescribed by *INSPIRE Thematic Working Group Coordinate Reference Systems & Geographical Grid Systems (2014)* two spatial reference systems would be suitable for this purpose: On the one hand Lambert Conformal Conic (ETRS89-LCC) for conformal mapping at scales smaller or equal to 1:500,000 (EPSG 3034) and on the other hand Lambert Azimuthal Equal Area (ETRS89-LAEA) for spatial analysis and displaying information (EPSG 3035). However, only ETRS89-LCC is supported by the EGDI-platform. Using this reference system is still under discussion within the 3DGEO-EU project as it turns out that ETRS89-LAEA is more suitable because true area projection is required: WP1 analyzed the result of the projection of a 3D-model from ETRS89-LAEA into ETRS89-LCC. The distortion of the resulting data led to the decision that it is not recommendable to use ETRS89-LCC.

4.2 Data Exchange Formats

As mentioned above the 3DGEO-EU-project produces harmonized cross-border three- as well as two-dimensional data, which will mainly consist of derived information based on existing primary data (e.g. well data) and national or regional 3D models. This leads to the necessity of finding appropriate data exchange formats for 2D, 2.5D and 3D data. The criteria for these data formats highly depend on the data type itself. Besides the georeferenced data a few different formats will be used: Excel or CSV for all kind of properties and PDF for reports.

4.2.1 2D- and 2.5-D Data

Inside the huge amount of possible 2D-data a distinction should be made between raster and vector data:

4.2.1.1 Raster Data

Two dimensional raster data will be stored and exchanged in three possible data formats: ZMapPlus, CPS-3 and GeoTiff. ZMapPlus is an ASCII format to store gridded data developed by Landmark Corp. In this case especially data created using the total variation distance method. The file extension is considered to be *.dat. CPS-3 is proprietary file format mostly used by Schlumberger's GeoSoftware. The usage of the last file type (GeoTiff) has not yet been finally clarified. But as a standard exchange format for raster or gridded data a possible application should be taken into account.

4.2.1.2 Vector Data

The project members usually use one of the standard GIS (e.g. ArcGIS, QGIS). The exchange format of vector data is limited to constraints given by the mentioned software. However the GIP will not be able to process ESRIs geodatabase and the outdated technical specifications and limitations (2 GB size) of their shape file format make it necessary to select a different format. As mentioned by the GIP the exchange format for all kind of vector data will be the OGC GeoPackage v1.2.1.

4.2.2 3D-Data

Most of the three dimensional data (3D-models) will be developed with the SKUA-Gocad Software Suite which generates the Gocad ASCII format (*.ts) by default. Some of the project members will produce more complex, parameterized 3D-data which will be stored in VTK ASCII and binary format suitable to be visualized with VTK and ParaView.

4.3 EGDI Functionalities

The functionalities needed by the 3DGEO-EU members include searching, data access and different visualization methods for 2D, 2.5D as well as 3D. However most of these functionalities are also desired by other projects but in the following the special 3DGEO-EU relevant ones are discussed.

4.3.1 Uncertain data

Uncertainties are a well known problem in modelling geological data due to the fact that different input data with an often widely varying spatial distribution is used within the modeling process. These uncertainties can be determined and then be used to parametrize the 3D model (e.g. scalar field).

4.3.2 Glyphs

Glyphs or some kind of 3D primitives (e.g. cubes, spheres) may be useful to visualize different parameters. As they are real 3D objects their vertices can be multiplied by matrix defined by the individual parameter: A tensor of second order (3x3 matrix) for each vertex can be used to transform a sphere into an ellipse in order to indicate a strain- stress- or permeability-tensor or to indicate the anisotropic uncertainty of a vertex position.

4.3.3 Option to display objects

These additional (textured) objects are similar to the glyphs mentioned above. However these objects don't need to be matrix manipulated during runtime (e.g. by a shader) depending on model parameters. The idea behind it is to represent buildings or drilling rigs for orientation purposes.

5 CONCLUSIONS

Altough 3DGEO-EU and its different WP's are very ambitious and highly sophisticated projects, most of the produced data follows the state of the art in 2D and 3D geological data processing. And so are the used data formats. All the 3D models developed in Gocad will be exchanged using the Gocad ASCII (*.ts) format. Even it is a proprietery file format it is easy to read and to process. VTK ASCII is similar but a lot more flexible. The different 2D and 2.5D raster formats depend on the software packages (e.g. GeoSoftware) employed in the particular workflows. However using only GeoTiff could ease up the data transfer as there would be no need for special interfaces. That's also why the OGC GeoPackage will be 2D vector data format of choice. Besides the mentioned data import interfaces some very 3D-related visualization functionalities are demanded by project members. Although visualization of three dimensional data is very common process, the very complex issue of visualizing parameters and hereof derived information adapted to different groups of users should be taken into account.

6 REFERENCES

INSPIRE Thematic Working Group Coordinate Reference Systems & Geographical Grid Systems (2014): D2.8.I.1 Data Specification on Coordinate Reference Systems – Technical Guidelines, 30 p.