Ref. Ares(2023)1471992 - 28/02/2023

REFLECT DELIVERABLE D3.3

The REFLECT European Fluid Atlas

Summary:
This deliverable summarises the features of the European Fluid Atlas developed by University of Miskolc.

Authors:
Károly Kovács, Researcher, University of Miskolc
Anna Seres, Researcher, University of Miskolc
Éva Hartai, Honorary Professor, University of Miskolc

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement nº 850626

Title:	The REFLECT European Fluid Atlas
Lead beneficiary:	University of Miskolc
Other beneficiaries:	GFZ, IzTech, BRGM, ISOR, UKRI, EFG, EFG's LTPs
Due date:	28 February 2023
Nature:	Public
Diffusion:	All Partners
Status:	Submitted Version
Document code:	REFLECT_D3.3
DOI:	https://doi.org/10.48440/gfz.4.8.2023.002
License information:	CC-BY-4.0
Recommended citation:	Kovács, K., Seres, A., Hartai,É., The H2020 REFLECT project: Deliverable 3.3 – The REFLECT European Fluid Atlas, *GFZ* German Research Centre for Geosciences, DOI: https://doi.org/10.48440/
ORCID:	

Revision history	Author	Delivery date	Summary of changes and comments
Version 01	Károly Kovács et al.	08 Feb 2023	Draft version
Final version		28 Feb 2023	Included minor changes from Project Manager KK

	Name	Function	Date
Deliverable responsible	Károly Kovács	Project participant	28.02.2023
WP leader	Tamás Madarász	WP leader	
Reviewer	Katrin Kieling	Project manager	28.02.2023
Project Coordinator	Simona Regenspurg	Project coordinator	28.02.2023

Table of Contents

List of Figures

1 EXECUTIVE SUMMARY

The recent deliverable describes the development and the characteristics of the European Fluid Atlas (EFA) created in the frame of the REFLECT project by University of Miskolc. In the Atlas, formerly existing and newly measured data of geothermal fluids are visualised. Fluid data were collected from 21 European countries. The layers provide point feature information presented on a base map, including geography, geology, and depth range, as well as physical, chemical and microbial properties of fluids. Data of wells, rocks and reservoirs are also available. The focus is on fluids used for electricity generation (> 100 °C), but data from heat projects are also included.

A free and open-source cross-platform is used for the visualisation, in which the geographic information system provides the environment to view, edit and analyse geospatial data. The interface includes query and filtering tools to explore the database with a map-based visualization. The query results can be downloaded as an excel worksheet. By selecting the entire dataset, the downloaded report contains all the data published on EFA.

2 INTRODUCTION

The chemical and physical nature of produced fluids have a major impact on the geothermal power industry and influence the feasibility of site development, exploration approaches, plant design and operating practices. That is why the REFLECT project focuses on clarifying and re-defining geothermal fluid properties. Knowing these properties is very important for geothermal power plant operators because they determine the potential precipitation or corrosion processes, which can highly reduce project economics. Enhanced understanding of the fluid properties allows optimising plant developments and operation.

The REFLECT project redefines fluid properties by generating new analytical, thermodynamic and kinetic reaction data. Using these data, predictive models have been developed to determine fluid reactions at extreme conditions. During the project implementation, not only new data were achieved by field observations, lab measurements and modelling, but formerly existing data of the geothermal fluids, as well as the related rocks, wells and reservoirs were also collected and re-evaluated from 21 European countries. The focus was on fluids that are used for electricity generation (> 100 °C) but lower temperature fluids (down to 50°C) were also considered.

All these data served as input for the European Fluid Atlas, a user-friendly visualisation tool developed in the frame of the project. The systematization and accessibility of large amounts of data in the Atlas can greatly facilitate academic research work. On the other side, from the practical point of view, it allows the optimisation of the geothermal reservoir management and power and heat production. Using the data from the Atlas, investors or operators can have access to information about fluid, rock and reservoir properties at a certain location, which help them in assessing the associated risks when planning and designing new geothermal installations.

3 DATA SOURCES FOR THE FLUID ATLAS

The Fluid Atlas comprises two main groups of data compiled within the project lifetime:

1) Formerly existing data collected from freely accessible sources (scientific publications, reports, datasets, and documents in national archives).
2) Data from field measurements and laboratory experiments generated by the project partners.

3.1 Formerly existing data

Data by the linked third parties (LTPs)

The national member geological associations of the European Federation of Geologists (EFG), which acted in the project as linked third parties (LTPs), played a major role in compiling these datasets. They collected publicly available data at national level from 20 European countries: Belgium, Bulgaria, Croatia, Czech Republic, Denmark, France, Germany, Greece, Hungary, Italy, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovenia, Spain, Turkey, UK and Ukraine. Details of this process are described in Deliverable 3.1 – Report on the collection of data on geothermal fluids at a European level (Sanchez Miravalles & Hartai 2021).

Data by the project partners

In the REFLECT fluid sampling six project partners were involved: BRGM, GFZ, HI, ISOR, IzTech, TNO, and UKRI. These partners also collected formerly existing data from literature, mostly limited to the sampling sites, but also from other geothermal sites in their countries. Six countries overlapped with those that were represented by the LTPs (Austria, France, Germany, Netherlands, Turkey, and UK). As ISOR provided data from Iceland, which was not covered by LTPs, the number of countries covered by data collection was extended to 21 (Figure 1). The data collected by the six project partners are detailed in Deliverable 3.2 – Data compilation by REFLECT partners (Hartai et al. 2021).

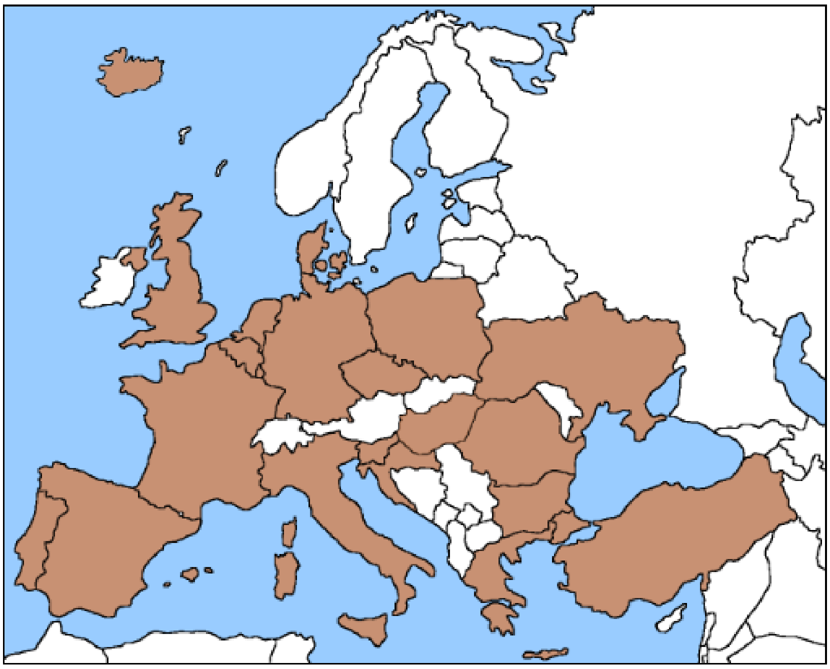


Figure 1: Countries covered by the data collection

3.2 New data generated during the project implementation

The six project partners, which were involved in the fluid sampling, carried out also on-site measurements. The collected fluid samples were analysed in GFZ laboratory, at Hydroisotop GmbH, in IzTech laboratory and in BRGM laboratory. 11 fluid sampling sites were identified from 7 countries. Sampling was carried out at the following sites:

- Bad Blumau (Austria)
- Bouillante (France)
- Groß Schönebeck, Insheim, Neustadt-Glewe (Germany)
- Krafla, Theistareykir (Iceland)
- Heemskerk (The Netherlands)
- Aydin, Tuzla (Turkey)
- United Downs (UK)

The newly generated data were added to the formerly existing ones in the database. Details of the compilation of new data are described in Deliverable 3.2 – Data compilation by REFLECT partners (Hartai et al. 2021).

3.3 Data types

University of Miskolc, as work package leader, developed a template for data collection in order to harmonise the work by the different project entities and make the data assessable for the Fluid Atlas. This template was used both by the LTPs for collecting data on national level and by the project partners for collecting formerly existing and newly generated data.

The template is an excel file including four working sheets. Detailed guidelines for the correct use of IDs, units, coordinates, references, and the interpretation of the comments at the cells were also provided. The requested data types are indicated in the headlines of columns on each sheet. Explanatory notes are provided in most of the cells in the headlines and the selection from drop-down menus make the harmonisation of the data easier. Wells are listed vertically, and the data to the relevant wells are filled in horizontally. References to the data are requested on each sheet.

The four working sheets include the following data types:

- Well data (location, geographical and physical characteristics),
- Fluid sample data (identification, physical and chemical properties),
- Rock sample data (identification, geological information, physical properties)
- Reservoir data (location, position, extent, and physical properties)

The methodology for developing the data collection template and its exact content are detailed in Deliverable 3.1 – Report on the collection of data on geothermal fluids at a European level (Sanchez Miravalles & Hartai 2021).

4 PROCESS OF DEVELOPMENT OF THE FLUID ATLAS

The European Fluid Atlas (EFA) is an on-line query and visualization toolset for the Pan-European geothermal well-fluid-rock-reservoir dataset, which was collected throughout the REFLECT project. The database (DB) handeling, query and web visualization is developed using open-source JavaScripts, Postgre and GeoServer APIs and frameworks.

The work-flow of the development has four main stages (Figure 2.):

1. Data collection and processing
2. Database development
3. Setting up the back end
4. Developing the front end

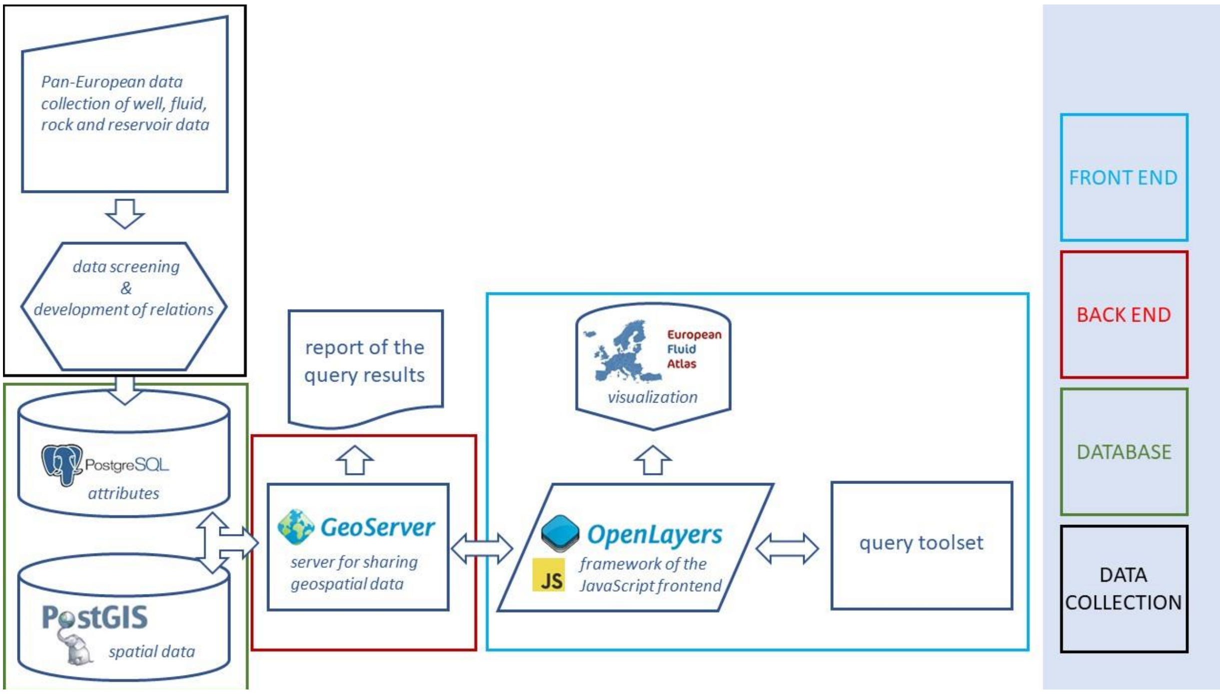


Figure 2: The complete flowchart of the European Fluid Atlas

4.1 Data collection and processing

The Pan-European dataset, collected by twenty-one organizations and the project partners, was expected to be laden with errors, or at least, harmonization problems. The national datasets, submitted one by one throughout the data collection, was checked for errors before incorporating in the final database.

The main failures of the dataset were:

- coordinate errors for wells;
- incorrect identifiers for fluid and rock samples, and reservoir properties;
- non-numeric entries for numeric attributes;
- entries out of the listed options;
- entries with units other than required;
- typos.

The dataset, containing well, fluid, rock and reservoir data obtains spatiality from the well's coordinates. The first check of the incoming data was for the correct geotagging. The screening, correction and transformation of the well coordinates could be done semi-automated. The typical errors could be detected and corrected using scripting, but there were specific mistakes, which had to be corrected one by one. The coordinates were requested in the WGS84 coordinate system, decimal degree format. Frequently occurring errors were switching the latitude and longitude values, providing the coordinates in degree-minute-second format, or using inappropriate characters for marking degrees or providing coordinates in undefined coordinate system.

The well dataset published in the EFA is varying in spatial distribution and accuracy, due to the provided coordinate accuracy and uneven distribution of wells by countries. Also, data availability was different throughout the European countries.

After screening the incoming datasets, the final DB contains 2989 wells, which have correct coordinates. This set provides a European wide geographical coverage for the Atlas (Figure 3.).

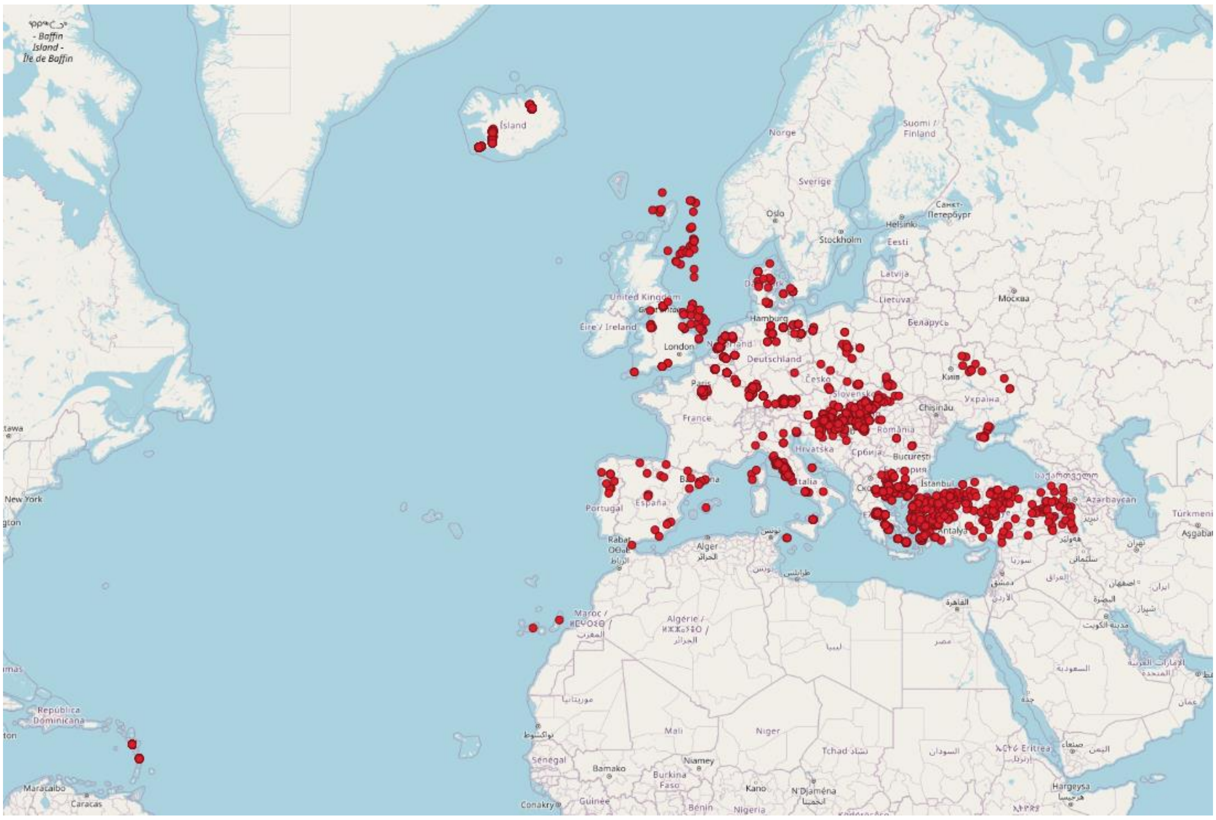


Figure 3: The European wide geographical coverage of the Atlas

The geotagged wells providing the spatial data for the DB had to be related to the attributes. The data collection template requested from data providers to create IDs for all fluid, rock and reservoir entries by a given protocol. This required extra work from the data providers and the protocol itself was understood differently. The errors in the IDs were corrected by human work; no automation was possible for that.

The values of the well-fluid-rock-reservoir properties were joined the well point spatial dataset by the IDs as the attributes of the spatial point data.

The broad scope and wide geographical coverage of the data collection showed how different the national datasets are. The purpose of measurements, the analytical methods, the applied units, and data series are different region by region. The template was developed for broad data collection, but the entries show, that experts working on the database development wanted to include more detailed information. This resulted in an unharmonised database, and unfitting entries: many string entries at numeric attributes (marks for remarks; complementary explanations; listing; uncertainty indicated).

To run statistical analysis on the database, and to make it applicable for query and visualization, the primary task was to transform string entries into numeric format. During the transformation, certain amount of extra information was lost. Where the extra information could be extracted, it appears in the "remark" column.

Due to the different geochemical setups of reservoirs, fluid chemical properties alter widely. This results in high variance within the dataset, and not normally distributed values. The reservoir dataset was incomplete to classify the entire DB and study the data by reservoir, and even the set of values were too small to run statistical analysis. Therefore, incorrect data entries were hidden by the variance of the data. For the same reason, Z-scores could not be used to detect outliers. Interquartile range seemed a robust, distribution independent method to calculate outlier ranges, and was applied for the DB, but the detected outliers mostly turned out to be correct data. However, for values where the unit is in %, the method permitted to determine incorrect values.

The most reliable quality check method will be implemented to the end of the project. As EFA is published and on-line available, partners and data providers are asked to explore the published DB and report errors. This way, local experts will note errors that may occur in the DB and can report even the reason of the mistake.

4.2 The database, web-server, and front end

The database consists of two parts: the spatial dataset (wells) and its attributes (well, fluid, rock and reservoir properties). The DB is managed by PostgreSQL, spatial data is handled by PostGIS which is a spatial database extender for PostgreSQL. The database and backend are installed on a server of the University of Miskolc.

The frontend was developed within the framework of OpenLayers API. OpenLayers is an Open Source JavaScript, developed for on-line map visualization. The query toolset was developed in JavaScript.

The frontend has been installed on the REFLECT Project's website.

4.3 The query tools, data download and visualisation

The European Fluid Atlas is an on-line toolset for exploring the European wide database of well, fluid, rock, and reservoir properties. It is available on the REFLECT Project's domain: https://www.reflect-h2020.eu/efa/.

The query tool of EFA is what makes it unique. The calculator-like interface makes it possible for users to create complex queries, have comparisons, and a selection can also be made through the map.

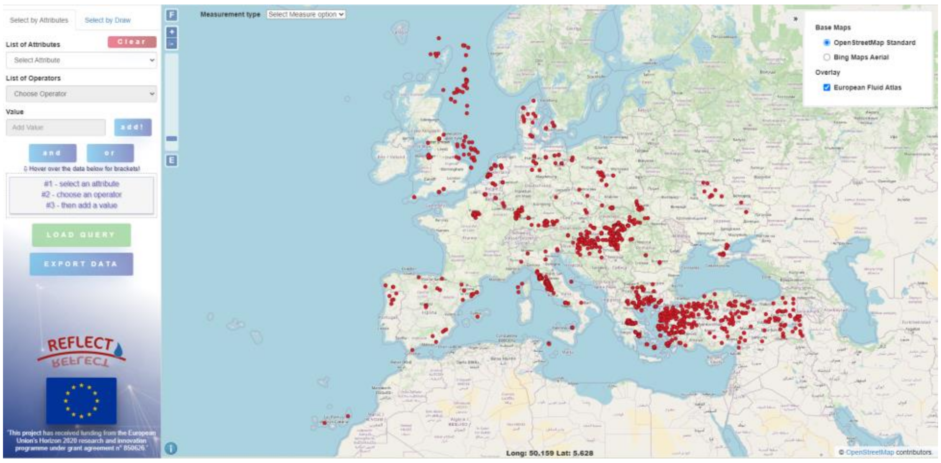
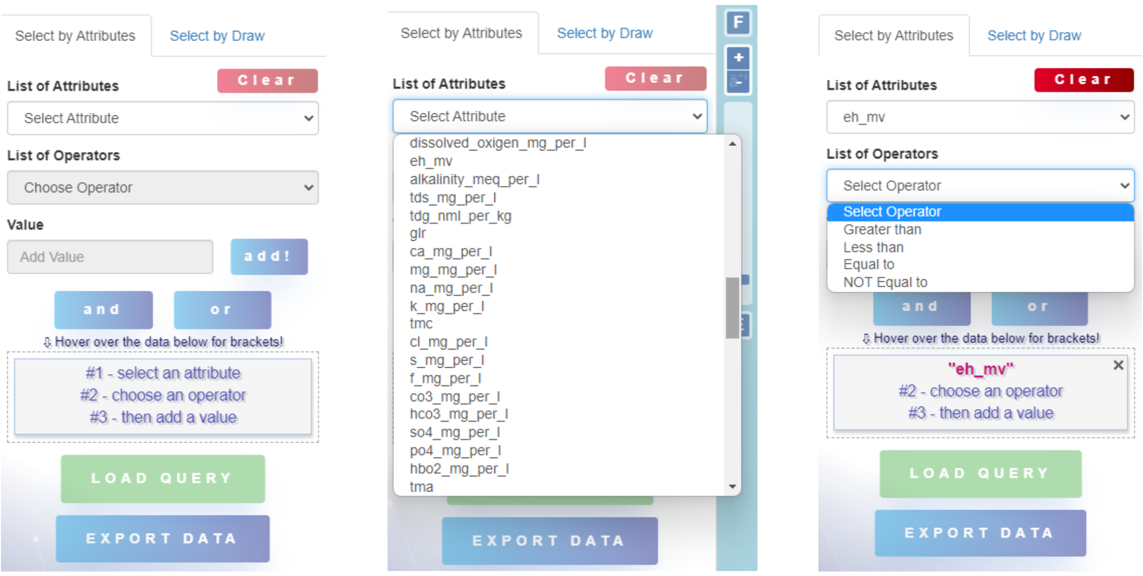


Figure 4: The on-line interface of the European Fluid Atlas (https://www.reflect-h2020.eu/efa/)

The query was developed to serve different end-user needs. The calculator like interface of the "Select by attributes" toolset (Figure 5.) can be used to build complex queries. All attributes from the database are listed and can be selected. Then, depending on the data type, Boolean or relational operators can be selected, and the value added to build up the query. By using brackets a complex query of AND/OR logical operators can be built.



2. Figure: The "Select by attributes" toolset

When loading the query, wells of fluids of the indicated properties are selected on the map and the attribute table appears (Figure 6.).

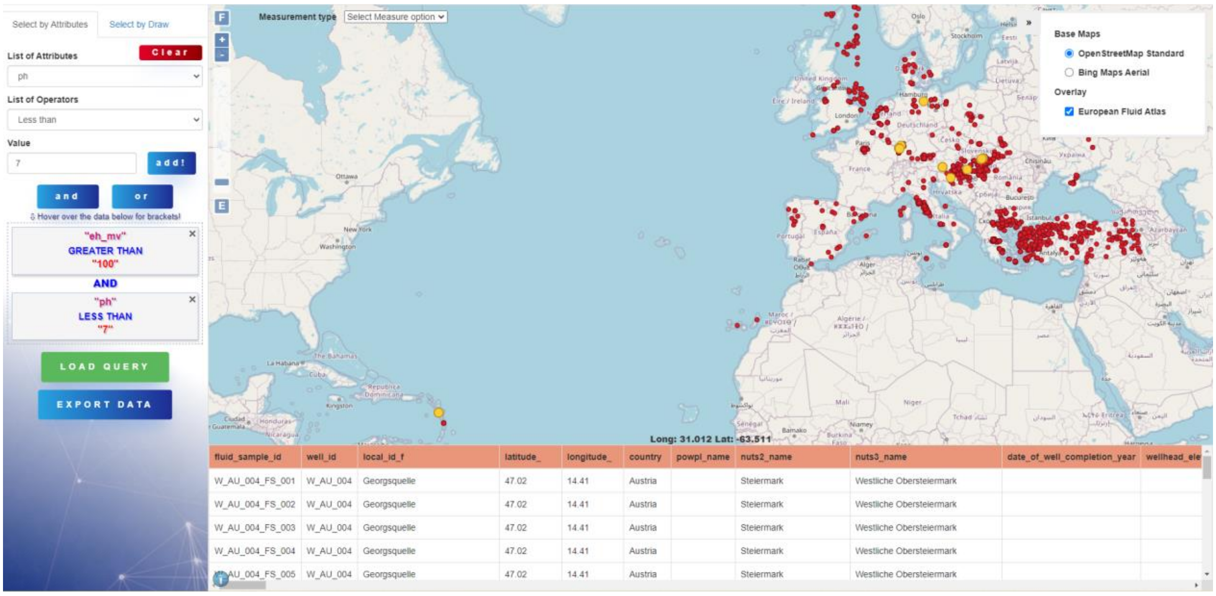


Figure 6: Selection visualized on the map, and the attributes listed

By selecting the well on the map or the data row within the table the sub-selection appears highlighted and the map zooms on the highlighted element (Figure 7.). Elements of the query results can be highlighted by clicking the row of the table or the well on the map.

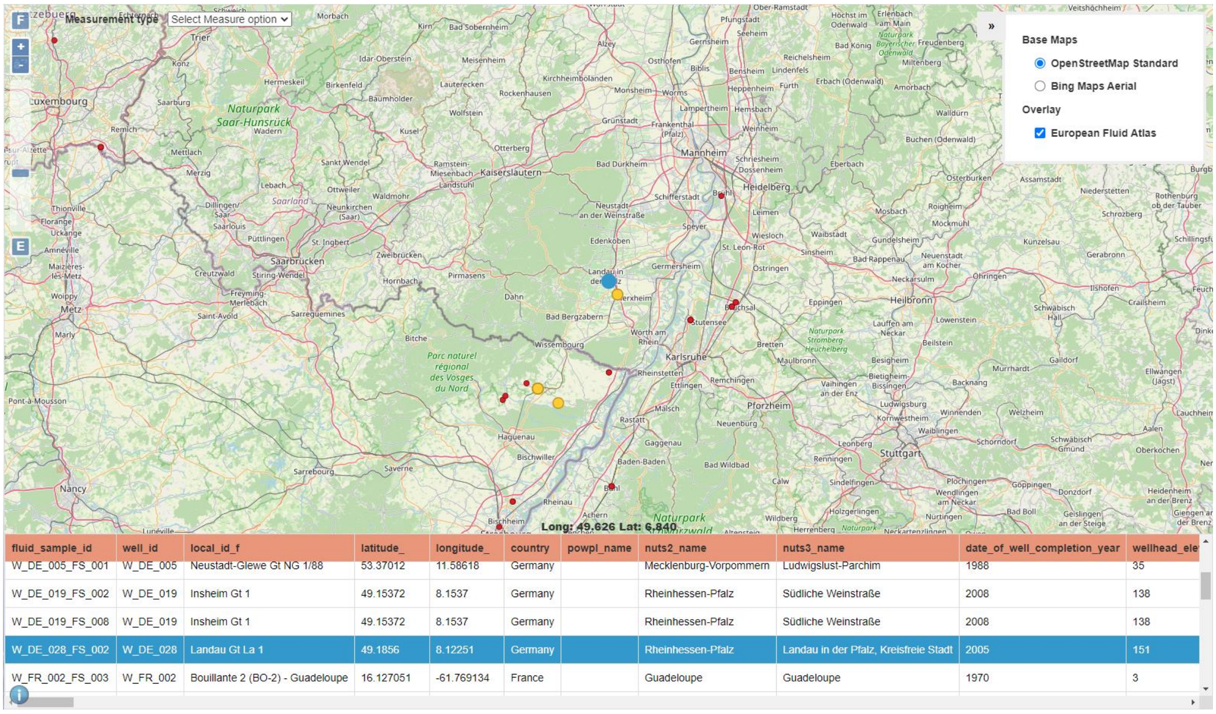


Figure 7: Highlighted element of the query results

The “Select by draw” tool (Figure 8.) is built to select wells on the map by their geographical location. Drawing a polygon on the map (Figure 9.) the wells are selected within the area

(Figure 10.) and their properties are called from the database. Highlighting a sub-selection works the same, like in the "Select by Attributes" toolset.

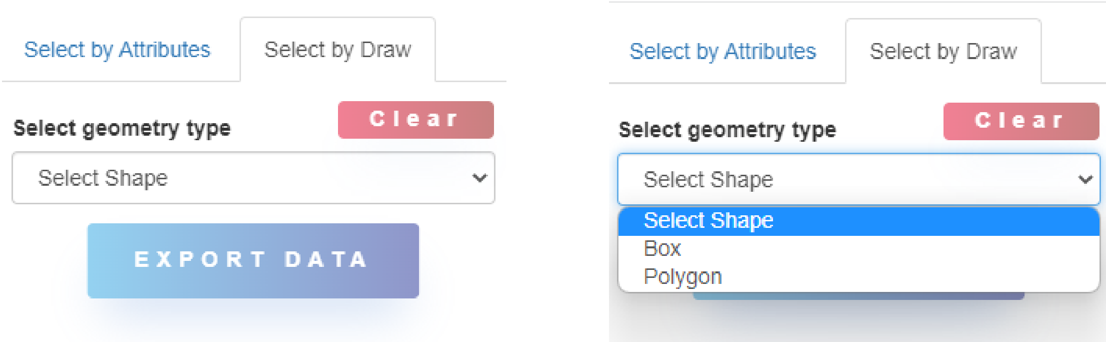


Figure 8: The "Select by Draw" toolset

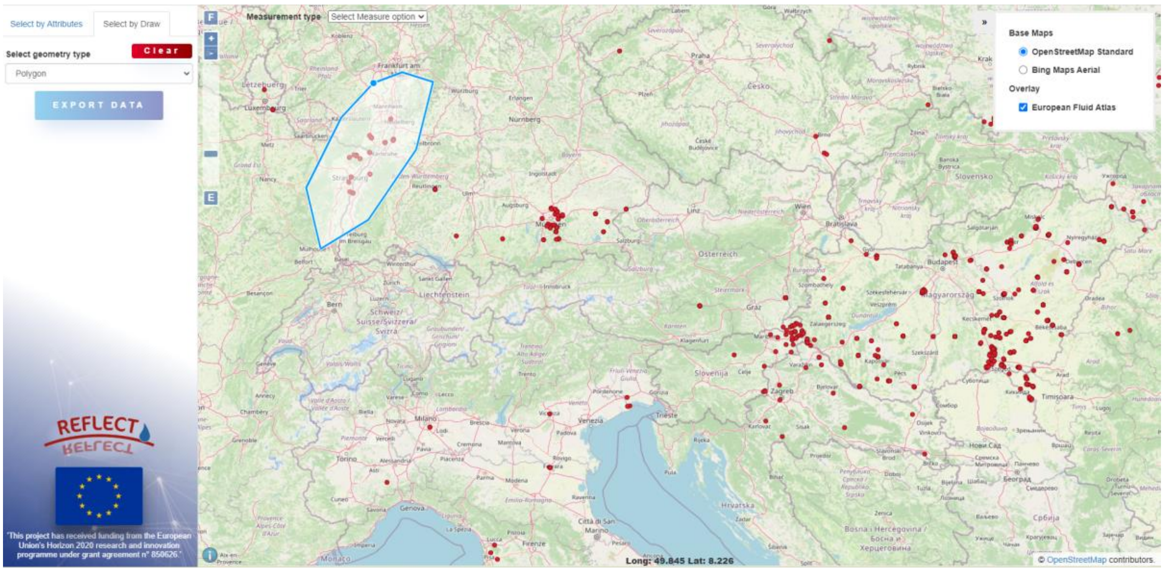
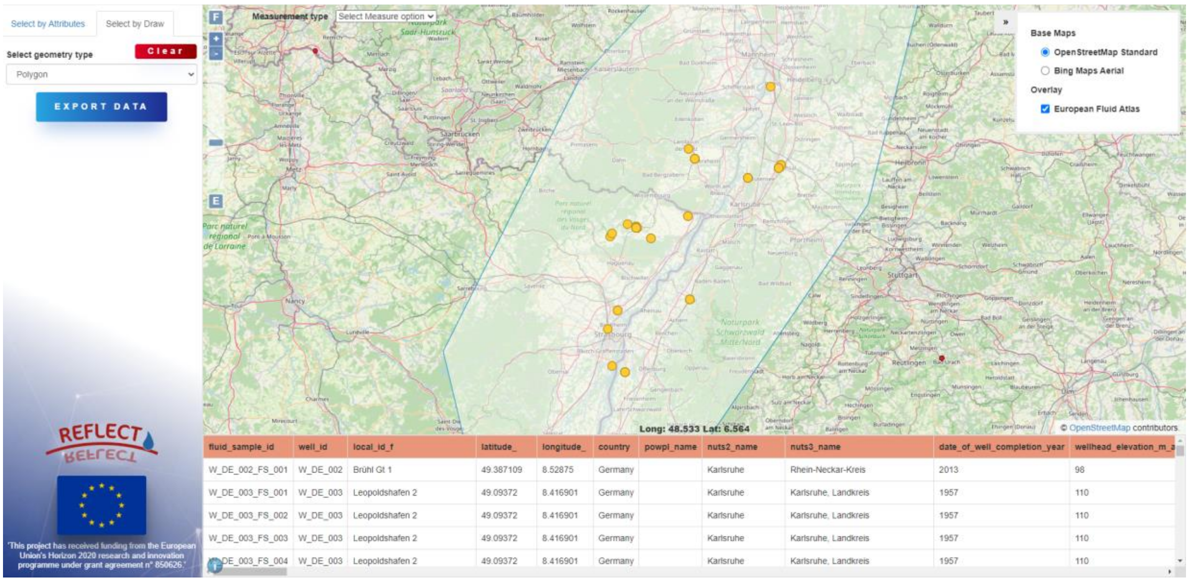


Figure 9: Selecting the wells within a polygon



fluid_sample_id	well_id	local_id_f	latitude_	longitude_	country	powpl_name	nuts2_name	nuts3_name	date_of_well_completion_year	wellhead_elevation_m_a
W_DE_002_FS_001	W_DE_002	Brühl Gt 1	49.387109	8.52875	Germany		Karlsruhe	Rhein-Neckar-Kreis	2013	98
W_DE_003_FS_001	W_DE_003	Leopoldshafen 2	49.09372	8.416901	Germany		Karlsruhe	Karlsruhe, Landkreis	1957	110
W_DE_003_FS_002	W_DE_003	Leopoldshafen 2	49.09372	8.416901	Germany		Karlsruhe	Karlsruhe, Landkreis	1957	110
W_DE_003_FS_003	W_DE_003	Leopoldshafen 2	49.09372	8.416901	Germany		Karlsruhe	Karlsruhe, Landkreis	1957	110
W_DE_003_FS_004	W_DE_003	Leopoldshafen 2	49.09372	8.416901	Germany		Karlsruhe	Karlsruhe, Landkreis	1957	110

Figure 10: The selection and attributes

Using the "Export data" button the result of the queries of both selecting tools can be downloaded. The downloaded report's format is an Excel worksheet which contains the fluid, the rock and reservoir data linked to the wells on different tabs (Figure 11.). Explanatory worksheets (Figure 12.) explain all attributes (units and technical explanations) in detail. The downloaded report sheet can be used for further data processing.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1	fluid_sam	well_id	local_id_f	latitude_	longitude	country	powpl_na	nuts2_nar	nuts3_nar	date_of_v	wellhead_	surface_e	well_dept	top_of_sc	bottom_o	reservoir_	hydraulic_	pz_data_p	bottomho	outflow_t	well_yielc	scaling_e›	inhibitor_	geotherm
2	W_DE_002	W_DE_002	Brühl Gt 1	49.387109	8.52875	Germany	N/D	Karlsruhe	Rhein-Ne	2013	98	N/D	3423	N/D	N/D	N/D	N/D	N/D	153	N/D	252	N/D	N/D	N/D
3	W_DE_003	W_DE_003	Leopoldsh	49.09372	8.416901	Germany	N/D	Karlsruhe	Karlsruhe,	1957	110	N/D	1300	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
4	W_DE_003	W_DE_003	Leopoldsh	49.09372	8.416901	Germany	N/D	Karlsruhe	Karlsruhe,	1957	110	N/D	1300	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
5	W_DE_003	W_DE_003	Leopoldsh	49.09372	8.416901	Germany	N/D	Karlsruhe	Karlsruhe,	1957	110	N/D	1300	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
6	W_DE_003	W_DE_003	Leopoldsh	49.09372	8.416901	Germany	N/D	Karlsruhe	Karlsruhe,	1957	110	N/D	1300	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
7	W_DE_003	W_DE_003	Leopoldsh	49.09372	8.416901	Germany	N/D	Karlsruhe	Karlsruhe,	1957	110	N/D	1300	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
8	W_DE_004	W_DE_004	Offenburg	48.460854	7.809558	Germany	N/D	Freiburg	Ortenauk	N/D	146	N/D	1501	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
9	W_DE_004	W_DE_004	Offenburg	48.460854	7.809558	Germany	N/D	Freiburg	Ortenauk	N/D	146	N/D	1501	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
10	W_DE_004	W_DE_004	Offenburg	48.460854	7.809558	Germany	N/D	Freiburg	Ortenauk	N/D	146	N/D	1501	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
11	W_DE_004	W_DE_004	Offenburg	48.460854	7.809558	Germany	N/D	Freiburg	Ortenauk	N/D	146	N/D	1501	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
12	W_DE_004	W_DE_004	Offenburg	48.460854	7.809558	Germany	N/D	Freiburg	Ortenauk	N/D	146	N/D	1501	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
13	W_DE_004	W_DE_004	Offenburg	48.460854	7.809558	Germany	N/D	Freiburg	Ortenauk	N/D	146	N/D	1501	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
14	W_DE_004	W_DE_004	Offenburg	48.460854	7.809558	Germany	N/D	Freiburg	Ortenauk	N/D	146	N/D	1501	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
15	W_DE_019	W_DE_019	Insheim G	49.15372	8.1537	Germany	N/D	Rheinhess	Südliche \	2008	138	N/D	3650	N/D	N/D	N/D	N/D	N/D	N/D	N/D	306	N/D	N/D	N/D
16	W_DE_019	W_DE_019	Insheim G	49.15372	8.1537	Germany	N/D	Rheinhess	Südliche \	2008	138	N/D	3650	N/D	N/D	N/D	N/D	N/D	N/D	N/D	306	N/D	N/D	N/D
17	W_DE_019	W_DE_019	Insheim G	49.15372	8.1537	Germany	N/D	Rheinhess	Südliche \	2008	138	N/D	3650	N/D	N/D	N/D	N/D	N/D	N/D	N/D	306	N/D	N/D	N/D
18	W_DE_019	W_DE_019	Insheim G	49.15372	8.1537	Germany	N/D	Rheinhess	Südliche \	2008	138	N/D	3650	N/D	N/D	N/D	N/D	N/D	N/D	N/D	306	N/D	N/D	N/D
19	W_DE_019	W_DE_019	Insheim G	49.15372	8.1537	Germany	N/D	Rheinhess	Südliche \	2008	138	N/D	3650	N/D	N/D	N/D	N/D	N/D	N/D	N/D	306	N/D	N/D	N/D
20	W_DE_019	W_DE_019	Insheim G	49.15372	8.1537	Germany	N/D	Rheinhess	Südliche \	2008	138	N/D	3650	N/D	N/D	N/D	N/D	N/D	N/D	N/D	306	N/D	N/D	N/D
21	W_DE_019	W_DE_019	Insheim G	49.15372	8.1537	Germany	N/D	Rheinhess	Südliche \	2008	138	N/D	3650	N/D	N/D	N/D	N/D	N/D	N/D	N/D	306	N/D	N/D	N/D
22	W_DE_019	W_DE_019	Insheim G	49.15372	8.1537	Germany	N/D	Rheinhess	Südliche \	2008	138	N/D	3650	N/D	N/D	N/D	N/D	N/D	N/D	N/D	306	N/D	N/D	N/D
23	W_DE_028	W_DE_028	Landau Gt	49.1856	8.12251	Germany	N/D	Rheinhess	Landau in	2005	151	N/D	3300	N/D	N/D	N/D	N/D	N/D	159	N/D	144	Y	Y	0.1
24	W_DE_028	W_DE_028	Landau Gt	49.1856	8.12251	Germany	N/D	Rheinhess	Landau in	2005	151	N/D	3300	N/D	N/D	N/D	N/D	N/D	159	N/D	144	Y	Y	0.1
25	W_DE_034	W_DE_034	Bühl	48.698401	8.131255	Germany	N/D	Karlsruhe	Rastatt	1980	137	N/D	2655	N/D	N/D	N/D	N/D	N/D	N/D	N/D	0.612	N/D	N/D	0.044
26	W_DE_034	W_DE_034	Bühl	48.698401	8.131255	Germany	N/D	Karlsruhe	Rastatt	1980	137	N/D	2655	N/D	N/D	N/D	N/D	N/D	N/D	N/D	0.612	N/D	N/D	0.044
27	W_DE_034	W_DE_034	Bühl	48.698401	8.131255	Germany	N/D	Karlsruhe	Rastatt	1980	137	N/D	2655	N/D	N/D	N/D	N/D	N/D	N/D	N/D	0.612	N/D	N/D	0.044
28	W_DE_034	W_DE_034	Bühl	48.698401	8.131255	Germany	N/D	Karlsruhe	Rastatt	1980	137	N/D	2655	N/D	N/D	N/D	N/D	N/D	N/D	N/D	0.612	N/D	N/D	0.044
29	W_DE_039	W_DE_039	Bruchsal G	49.135625	8.581102	Germany	N/D	Karlsruhe	Karlsruhe,	1983	110	N/D	1918	N/D	N/D	N/D	60	N/D	119	N/D	N/D	Y	Y	0.055
30	W_DE_039	W_DE_039	Bruchsal G	49.135625	8.581102	Germany	N/D	Karlsruhe	Karlsruhe,	1983	110	N/D	1918	N/D	N/D	N/D	60	N/D	119	N/D	N/D	Y	Y	0.055
31	W_DE_039	W_DE_039	Bruchsal G	49.135625	8.581102	Germany	N/D	Karlsruhe	Karlsruhe,	1983	110	N/D	1918	N/D	N/D	N/D	60	N/D	119	N/D	N/D	Y	Y	0.055
32	W_DE_040	W_DE_040	Bruchsal G	49.12554	8.567514	Germany	N/D	Karlsruhe	Karlsruhe,	1985	110	N/D	2532	N/D	N/D	N/D	60	N/D	133	N/D	86.4	Y	N/D	0.048
33	W_DE_040	W_DE_040	Bruchsal G	49.12554	8.567514	Germany	N/D	Karlsruhe	Karlsruhe,	1985	110	N/D	2532	N/D	N/D	N/D	60	N/D	133	N/D	86.4	Y	N/D	0.048
34	W_DE_040	W_DE_040	Bruchsal G	49.12554	8.567514	Germany	N/D	Karlsruhe	Karlsruhe,	1985	110	N/D	2532	N/D	N/D	N/D	60	N/D	133	N/D	86.4	Y	N/D	0.048
35	W_DE_040	W_DE_040	Bruchsal G	49.12554	8.567514	Germany	N/D	Karlsruhe	Karlsruhe,	1985	110	N/D	2532	N/D	N/D	N/D	60	N/D	133	N/D	86.4	Y	N/D	0.048
36	W_DE_040	W_DE_040	Bruchsal G	49.12554	8.567514	Germany	N/D	Karlsruhe	Karlsruhe,	1985	110	N/D	2532	N/D	N/D	N/D	60	N/D	133	N/D	86.4	Y	N/D	0.048
37	W_DE_040	W_DE_040	Bruchsal G	49.12554	8.567514	Germany	N/D	Karlsruhe	Karlsruhe,	1985	110	N/D	2532	N/D	N/D	N/D	60	N/D	133	N/D	86.4	Y	N/D	0.048
38	W_DE_040	W_DE_040	Bruchsal G	49.12554	8.567514	Germany	N/D	Karlsruhe	Karlsruhe,	1985	110	N/D	2532	N/D	N/D	N/D	60	N/D	133	N/D	86.4	Y	N/D	0.048
39	W_FR_040	W_FR_040	Cronenbo	48.6011	7.72451	France	N/D	Alsace	Bas-Rhin	1980	144	N/D	2870	N/D	N/D	W_FR_040	N/D	N/D	160	N/D	N/D	N/D	N	N/D
40	W_FR_041	W_FR_041	Soultz-sou	48.935251	7.865344	France	N/D	Alsace	Bas-Rhin	N/D	N/D	N/D	1403	N/D	N/D	W_FR_041	N/D	N/D	116	N/D	N/D	N/D	N	N/D
41	W_FR_042	W_FR_042	Soultz-sou	48.931164	7.867635	France	N/D	Alsace	Bas-Rhin	1991	N/D	N/D	2227	N/D	N/D	W_FR_042	N/D	N/D	146	N/D	N/D	N/D	N	N/D
42	W_FR_043	W_FR_043	Soultz-sou	48.935251	7.865344	France	N/D	Alsace	Bas-Rhin	1992	N/D	N/D	3590	N/D	N/D	W_FR_043	N/D	N/D	160	N/D	N/D	N/D	Y	N/D
43	W_FR_043	W_FR_043	Soultz-sou	48.935251	7.865344	France	N/D	Alsace	Bas-Rhin	1992	N/D	N/D	3590	N/D	N/D	W_FR_043	N/D	N/D	160	N/D	N/D	N/D	Y	N/D

Fluid-well Data Export | Fluid-well Data Explanatory | Rock-well Data Export | Rock-well Data Explanatory | Reservoir-well Data Export | Reservoir-w ...

Figure 11: The query results worksheet

	A	B	C
1			
2		**fluid_sample_id**	Fluid sample ID
3		**well_id**	Well ID
4		**local_id_f**	Local ID for fluid sample
5		**latitude_**	Latitude/ Northing
6		**longitude_**	Longitude/ Easting
7		**country**	Country
8		**powpl_name**	Power plant's name
9		**nuts2_name**	Nomenclature of territorial units for statistics / Regions
10		**nuts3_name**	Nomenclature of territorial units for statistics / Counties
11		**date_of_well_completion_year**	Date of well completion (year)
12		**wellhead_elevation_m_amsl**	Wellhead elevation (m, amsl)
13		**surface_elevation_m_amsl**	Surface elevation (m, amsl)
14		**well_depth_m**	Well depth (m)
15		**top_of_screened_interval_m_below_wellhead**	Top of screened interval (m, below wellhead)
16		**bottom_of_screened_interval_m_below_wellhead**	Bottom of screened interval (m, below wellhead)
17		**reservoir_id_list_if_multiple**	Reservoir ID (list, if multiple)
18		**hydraulic_head_m_amsl**	Hydraulic head (m, amsl)
19		**pz_data_pa_per_m**	Pressure (P) change along a vertical axis (Z), given as the gradient of the pore pressure: how the
20		**bottomhole_temperature_c**	Bottomhole temperature (Â°C)
21		**outflow_temperature_c**	Outflow temperature (Â°C)
22		**well_yield_m3_per_hour**	Well yield (m3/hour)
23		**scaling_exists_y_or_n**	Scaling exists (Y/N)
24		**inhibitor_added_y_or_n**	Inhibitor added (Y/N)
25		**geothermal_gradient_in_well_c_per_m**	Geothermal gradient in well (Â°C/m)
26		**references_for_the_data**	References for the data (link/DOI/ISBN/ISSN/national archive identifier; list if multiple)
27		**remarks_well**	Remarks
28		**local_id_for_fluid_sample**	Local ID for fluid sample
29		**sampling_method**	Sampling method (Freeflow/Pumping/Pumping with packers/Pointwise (with bailer))
30		**sample_depth**	m below wellhead, interval if packers used
31		**sampling_date**	Sampling date and hour
32		**analysis_year**	Analysis date
33		**dominant_phase**	Dominant phase: Liquid/Gas/Supercritical
34		**temperature_c**	Temperature (Â°C)
35		**pressure_pa**	Pressure (Pa) - at the sampling depth
36		**hydraulic_head_m**	Hydraulic head (m) - At the sampling depth, given in m amsl as h0+p/(Ïg)
37		**density_kg_per_dm3**	Density (kg/dm3)
38		**kinematic_viscosity_m2_per_s**	Kinematic viscosity (m2/s)
39		**dynamic_viscosity_kg_per_m_per_s**	Dynamic viscosity (kg/m/s)
40		**specific_heat_capacity_j_per_k_per_kg**	Specific heat capacity (J/K/kg)
41		**electrical_conductivity_us_per_cm_ec25**	Electrical conductivity (ÂµS/cm, EC25)
42		**ph**	pH - on site measurement
43		**dissolved_oxigen_mg_per_l**	Dissolved oxigen (mg/L) - on site measurement

Fluid-well Data Export | Fluid-well Data Explanatory | Rock-well Data Export | Rock-well Data Explanatory | Reservoir-well Data Export

Figure 12: Explanatory worksheets

5 CONCLUSIONS

The aim of the European Fluid Atlas is to provide easy access to information on properties of geothermal fluids in different environments and potential geochemical risks prior to drilling to facilitate risk assessment and planning borehole and plant layout which suit fluid properties. The Fluid Atlas can be later integrated into other databases; thus, it can be an addition to already existing initiatives of geological data collection.

The on-line visualization and query tool of more than 4500 fluid samples database is the result of a European wide data collection campaign. The broad geothermal data collection from such a wide geographical coverage presents complications. Data harmonisation and correction toolsets need to be developed, to keep the Atlas useful and functional on the long run. The ongoing project CRM-geothermal - Raw materials from geothermal fluids: occurrence, enrichment, extraction (Project number: 101058163) - has the aim to extend the Fluid Atlas geographically and narrow the scope to CRM occurrences in geothermal fluids. For the data collection, WP lead University of Miskolc is developing an on-line data collection interface which automatically checks for errors, and data gaps. The interface connected to the new CRM Fluid Atlas will provide an updateable, quality checked geothermal database.

6 REFERENCES

Hartai, É., Madarász, T., Kovács, K., Seres, A., Fekete, Zs. (2021): The H2020 REFLECT project: Deliverable 3.2 - Data compilation by REFLECT partners, GFZ German Research Centre for Geosciences, DOI: 10.48440/gfz.4.8.2021.004

Sanchez Miravalles, A., Hartai, É. (2021): The H2020 REFLECT project: Deliverable 3.1 - Report on the collection of data on geothermal fluids at a European level, GFZ German Research Centre for Geosciences, DOI: 10.48440/gfz.4.8.2021.001