

IMP@CT

Integrated Modular Plant and Containerised Tools for Selective,
Low-impact Mining of Small High-grade Deposits

Deliverable D2.2

Update of existing platform

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Summary

The present document reports on the improvements brought to the existing EU-Minerals Knowledge Data Platform including both the database and the web-based portal for the benefit of the community of end users. These facilitate the identification and location of small-scale high-grade complex deposits through selection functionalities in a dedicated data layer of documented mineral occurrences.

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Disclaimer

Data presented in the present document originate from databases that have a continental scale coverage (scales in the order of 1/1,000,000). The degree of precision of points and polygons may lead to erroneous localisations or associations at higher (i.e. national, regional, local) scales that do not reflect the reality. The information provided here are meant to assist identifying pertinent deposits for a SO-SO approach, but should anyway be carefully checked before engaging any further costly works.

Abbreviations

ERML – Earth Resource Modelling Language

EU – European Union

EU-MKDP – European Union Minerals Knowledge Data Platform

EU-MKDB – European Union Minerals Knowledge Data Base

GIS – Geographic information system

ID - Identifier

MD – Mineral deposits

MO – Mineral occurrences

NGO – Non-governmental organization

OGC – Open Geospatial Consortium

SO-SO – Switch on-switch off

T – Task

WFS – Web feature service

WP – Work package

Note also that chemical elements are named using either their full name (e.g., antimony) or their symbol in the Mendeleev's periodic table (e.g., Sb).



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1. Introduction

According to the IMP@CT Work programme, the activity of Task 2.1 is two-fold: (1) to identify appropriate criteria to define small-scale high-grade complex deposits and properly query existing raw materials databases in order to set up a methodology; (2) update a dedicated web portal to facilitate the multi-criteria selection and location of such deposits potentially mineable with the SO-SO approach. The end users are the society at large including the European Commission, national authorities, NGOs, academic bodies, professional and industrial organisations, and general public.

These improvements build on a spatial data infrastructure dedicated to primary and secondary mineral resources, i.e. EU-Minerals Knowledge Data Platform (EU-MKDP) designed and implemented over the last decade through EU-co-financed projects such as ProMine¹, Minerals4EU², EURare³, ORAMA⁴.

Earlier works in Task 2.1 as reported in D2.1 “Baseline database for switch on – switch off extraction” focused on how the database was queried using different approaches, and which the final extraction criteria were. Then, the way how the data subset was “augmented” with other sources of data was explained. The purpose of the dataset produced using this methodology was to demonstrate how it could be applied to facilitate the identification of small-scale high-grade complex deposits possibly appropriate for a SO-SO approach.

As for any mining project, the approach must be adapted on a case by case basis and each project has to be carefully analysed in its own particular context (in terms of geology, metallogeny, ore processing, land use, socio-economy, etc.). A series of possible criteria was proposed as a way forward to guide the selection of deposits that each end user will have to adapt according to his/her own objectives: Country, Latitude and longitude, Deposit type, Morphology of mineralisation, Type of exploitation, Status of deposit, Value of past production, Values of reserves, Resources and grades, All contained commodities, Criticality of commodity, and Type of land cover.

The present document reports on the improvements brought to the existing EU-Minerals Knowledge Data Platform including both the database and the web-based portal for the benefit of the community of end users. These facilitate the identification and location of small-scale high-grade complex deposits through selection functionalities in a dedicated data layer of documented mineral occurrences.

¹ ProMine: <http://promine.gtk.fi/>

² Minerals4EU: <http://www.minerals4eu.eu/>

³ EURare: <http://www.eurare.eu/>

⁴ ORAMA: <https://orama-h2020.eu/>



2. EU-Minerals Knowledge Data Platform (EU-MKDP)

Data related to raw materials, either metallic, industrial or construction materials, primary or from wastes (mining and industrial) are available in Europe but scattered amongst a variety of institutions, including governmental agencies, universities, NGOs and industries. Through a series of EU-co-financed projects, the EU-MKDP has been developed as part of the larger EU-Raw Materials Knowledge Base (EU-RMKB). Its role is to provide the end user with a seamless access to data related to the whole value chain from deposit exploration, mining and extraction of ore, exploitation technologies to treatment of end-of-life products and the generation of "new" materials, consumption and demand, with the ability to combine all spatial and non-spatial pertinent information in a single reference system.

The principles of the EU-MKDP architecture follow the Implementing rules of the European INSPIRE Directive (2007, "Establishing an Infrastructure for Spatial Information in the European Community") to make data and services interoperable across Europe over a distributed infrastructure (Cassard et al., 2015).

The open architecture includes several components connected together to build the EU-MKDP, taking into account state-of-the-art developments to enhance the performance, stability, sustainability and user friendliness of the system. The connections between the components are specified by standardised interfaces.

2.1. EU-MKDP Contents

The system is designed to accommodate:

- Structured data from national databases (mineral occurrences, deposits, mines, reserves, production, trade...),
- Semi- and non-structured information: syntheses and statistics (graph charts and time-series) related to primary and secondary resources, from exploration, production, reserves and resources evaluations to waste characterisation in various formats (text files, PDF files, images...).

The main data sets capitalised and managed in the EU-MKDP are the following:

- Data on primary and secondary resources from databases provided and updated by Geological surveys and previous EU-co-financed projects such as ProMine, EuroGeoSource, Minerals4EU, EURare and OARAMA. These data are semantically harmonised using common terminology (Schubert et al., 2014). They are delivered through INSPIRE/OGC compliant web services and according to the common data model that extends the INSPIRE core data model (INSPIRE Data specification on MR - INSPIRE Thematic Working Group Mineral Resources, 2013) which is based on the ERML v.2 data model (EarthResourceML, 2013; Vuollo et al., 2010, 2012; Cassard et al., 2012; Raymond et al., 2012).



- Data and information concerning statistics analyses, analyses of supply and demand in the EU, stocks, flows, including trends in what products are put on the market and their composition, analyses of the composition of waste products and wastes arising from pre-processing and their geographic location in EU.

In addition, the semi- or non-structured information are enriched by the provider with a metadata record, then processed and indexed, first extracting relevant information from the documents (e.g., named-entity recognition on atomic elements such as location names, expressions of time, thematic specific terms, etc.), then classifying this information according to three facets (spatial, temporal and thematic). Relevant indexes are then created and presented to the end user through dedicated sub-menus (facets).

2.2. EU-MKDP system components

This system (Figure 1) is not centralised in a unique location but distributed over collaborating European partners. It comprises several components interacting with each other through standardised interfaces:

- collection/harvesting mechanism,
- harvesting database,
- diffusion database,
- database synchronisation mechanisms,
- metadata catalogue,
- search engine on structured and semi- and non-structured data sets,
- web services,
- web portal with a map viewer and time series/statistics data visualisation.

The participating data providers (e.g. Geological Surveys) set up their databases and populate them with national data. Each database contains the data of the geological survey, transformed from their own original format to the INSPIRE data model and semantically harmonised using commonly agreed terminology resulting in 50+ code lists (see INSPIRE Thematic Working Group Mineral Resources, 2013; EarthResourceML, 2013; Schubert et al., 2014; GEUS, 2015). The data are then transformed into an INSPIRE compliant WFS format.

The harvesting system consists in a harvesting application and a database. The harvesting application retrieves formatted data from each provider through Web Feature Services (WFS), harvests data from it, transforms it into a proper form and then stores it in the Central Harvesting database. It was developed and is presently operated by the Geological Survey of Slovenia (GeoZS).

The Diffusion Database is a copy, dedicated to data delivery and computations based on the data stored in the Harvesting Database. This database is kept updated with the Harvesting Database using a database synchronisation mechanism. The specialisation of this database aims to optimise the response time of the services proposed to the users through the web-based interface. The Diffusion Database was developed and is presently operated by the French Geological Survey (BRGM).



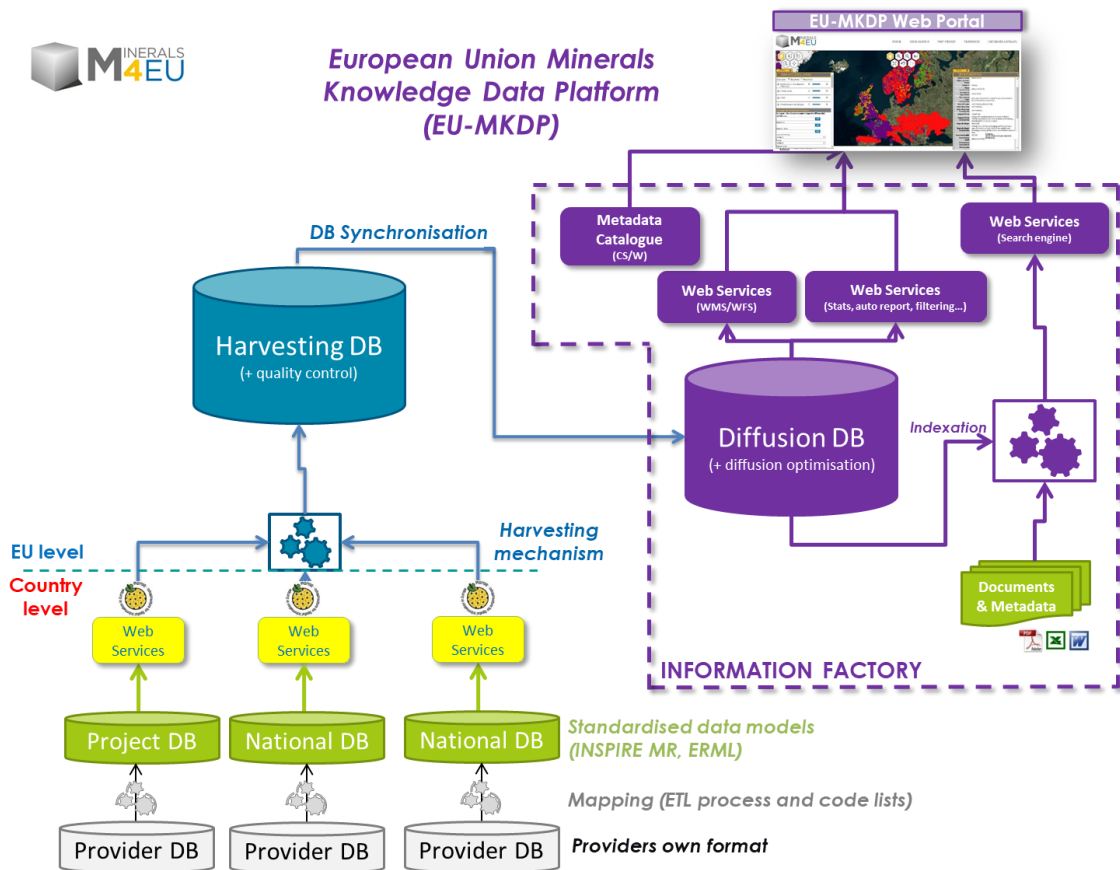


Figure 1 - Distributed components of the EU-Minerals Knowledge Data Platform.

The services on top of the Diffusion Database are:

- Simple visualisation of georeferenced data sets on maps,
- Search facilities in the whole database (structured) and documents (semi- and non-structured),
- Minerals4EU's dedicated services (e.g., the e-Minerals Yearbook).
- Data download: in some cases (and depending on the access rights to the data) data sets are available for download for user processing in other applications (e.g., desktop GIS...). As the EU-MKDP database structure is extremely complex, only selected parts of the structure (called "portrayals") are made available for download.

The Minerals4EU Metadata Catalogue (for structured data) is the central access point to metadata concerning European mineral resources and related topics. Based on MiCKA system, it was developed and is presently operated by the Czech Geological Survey (CGS). These metadata are based on Standard Dublin Core (<http://dublincore.org/>). The Dublin Core Metadata Element Set has 15 so-called "mandatory" elements covering the most important properties to describe a document (title, creator, subject, coverage – temporal or geographical, etc.). These metadata are then used in the search facilities to retrieve the documents (<http://m4eu.geology.cz>).



The search facilities are based on a search engine indexing the Central Diffusion Database, the documents corpus (non-structured data) and some external databases (if any). The user interface allows the end users to retrieve data from the whole EU-MKDP using a simple input (single search field; a simple sentence searches in the whole EU-MKDP), or using specialised interfaces (e.g. search specific concepts using their main attributes). Almost all the indexed concepts have a geographic and temporal extent (coming from INSPIRE MR/ERML for the Diffusion database or from the Dublin Core metadata for the documents). These extents allow the user to receive the most accurate response for his/her search.

These interconnected components are made accessible to the user community through the EU-MKDP Web portal (Figure 2, Figure 3, <http://minerals4eu.brgm-rec.fr/>). It includes functionalities to represent and use the data (representation, single/multiple selection, getFeature info [information obtained when clicking on a site], download capabilities, etc.).



Figure 2 -EU-Minerals Knowledge Data Platform home page.



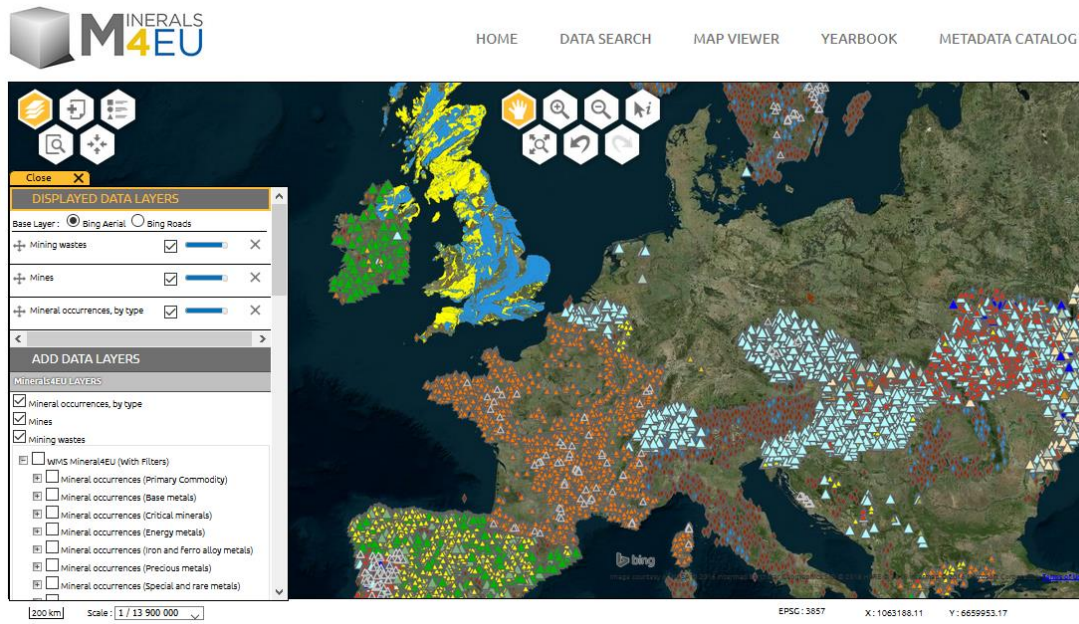


Figure 3 - Interactive visualisation of georeferenced data sets on the EU-MKDP Platform.

3. Integration of a new data set in the EU-MK Database

In order to propose a new data layer dedicated to identify suitable mining sites for a SO-SO approach, the mineral deposit location and description capitalised in the existing database system had to be prepared accordingly. The IMP@CT deliverable D2.1 “Baseline database for switch on – switch off extraction” presented a methodology and recommended guides and selection criteria. Then, it was to generate an updated data set in the European Mineral Resources database and make it available through the web-based portal (EU-MKDP – Figure 1) in form of a filterable layer.

Therefore, several preparatory stages were carried out. At first, it was to identify the mandatory data and locate them in the database structure. Then, a series of pre-processing steps (add, update, creation, calculation, correction, aggregation...) were applied in view to publish them for display, interrogation and selection on the web-based portal.



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3.1. Project data identification

As exposed here above, the necessary data were identified in the earlier activity of Task 2.1 and presented in D2.1. The items identified in ProMine Mineral Deposit (MD) database are the following (Table 1):

| Field names | Comments |
|-------------------------------|--|
| ID | Unique identifier |
| Name of deposit | Name of the deposit (first, if several) |
| Country | Country name |
| Province | Province name |
| Longitude | Longitude (decimal degrees, WGS84) |
| Latitude | Latitude (decimal degrees, WGS84) |
| Main commodity | Main commodity (most produced commodity in the mine) |
| Deposit type | Deposit type (concatenation id code + label) |
| Status of deposit | In fact, Mine status (id code + label) |
| Morphology of mineralisation | Morphology of mineralisation |
| Type of exploitation | Type of exploitation |
| Targeted commodity | Targeted commodity |
| Past Production value | Past Production value |
| Past Production average grade | Past Production average grade |
| Reserve value | Reserve value |
| Reserve average grade | Reserve average grade |
| Resource value | Resource value |
| Resource average grade | Resource average grade |
| Grade unit | Grade unit |
| All contained commodities | All contained commodities |

Table 1 - Selected fields from the ProMine Mineral Deposit (MD) database

This database is not any longer the reference database for the European mineral deposits. Presently, the authoritative database is the so-called Minerals4EU Diffusion Database (Figure 1) which centralises all the data coming from all Europeans data providers' partners through the Harvesting Database. This reference data set is formalised to facilitate its publication on the EU Minerals Knowledge Data Platform web portal.

Consequently, it was necessary to identify the relevant database items in the ProMine MD database and design a multi-stage process to compute them while taking into account:

- the difference of structure between the ProMine MD and Minerals4EU Diffusion databases, and;
- the heterogeneity of data management by a wide panel of European data providers.



3.2. Project data in Minerals4EU Database

3.2.1. Project data identification in Minerals4EU DB

The mapping through the EU-MKDP information system (Figure 1) allowed to find all fields identified in ProMine Mineral Deposit DB in the Minerals4EU DB. A dedicated view has been created also including several other relevant fields. These are shown in bold characters in Table 2 here after. They are used to represent the data and/or to anticipate layer interrogation (improvement of the user experience and shorter response time).

3.2.2. Data quality control

At a certain point of the pre-processing work, the structure of this new view was satisfactory but the content in terms of data was not. Indeed, despite of a common structure, the European providers do not manage the data in the same way. Consequently, this generates a large number of inconsistencies and duplicates in the database records. In those conditions, data not respond to the IMP@CT project objectives and therefore cannot be displayed and filtered as expected in the web portal. To respond to this problematic and make the data consistent, certain actions on the data were necessary: improvement, correction and aggregation.

3.3. Data computation/Data management rules

3.3.1. Data linked to the Mineral Occurrence (blue lines in Table 2)

In the Minerals4EU database, most of data directly linked to the mineral occurrences did not require adaptation.

However, it was observed that several countries had several name for the same mineral occurrence. In this case, two fields are proposed:

- *deposit_name*: corresponds to the first deposit name saved in the database for the mineral occurrence;
- *other_deposit_name*: other deposit names grouped by mineral occurrence.

Mineral occurrence geometry can be recorded with different shapes (point, multipoint, polygon, multipolygon). In order to keep a logic in the data representation and to delete duplicates, it was decided to propose two fields for computing data in order to have either a point or a polygon (e.g. *geom_mo_4258_point* and *geom_mo_4258_poly*). For the polygon geometry, mining feature occurrences were also taking into account to determine the polygon area. For example, this is shown on Figure 4 in case of the *Twente-Rijn Zout* (Deposit_id, Netherlands).



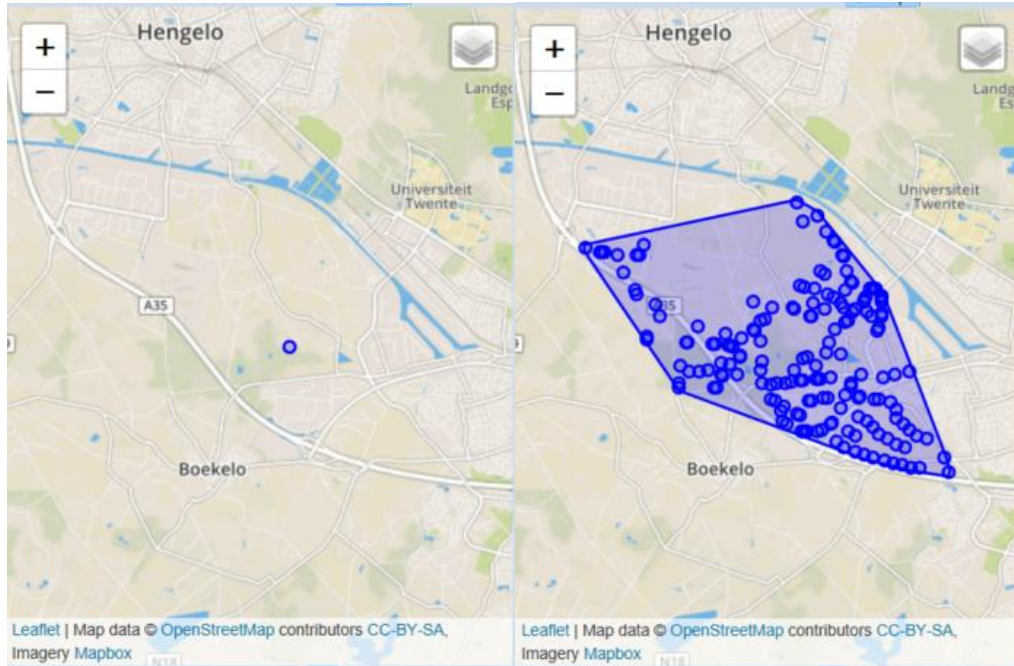


Figure 4 - Geometry point (left) versus geometry polygon (right) surrounding all mining feature occurrence of one Mineral Occurrence (Twente-Rijn Zout, Netherlands).

The field *all_commodities* groups all the commodities exploited in the mineral occurrence (all mines included when several).

3.3.2. Data concerning the commodities (green lines in Table 2)

In the ProMine Mineral Deposit (MD) database subset, data were organised differently. For one deposit (one mineral occurrence), there was only one mine. It is no longer the case in the Minerals4EU Database where it is possible to have several mines associated to a mineral occurrence (Figure 4).

The commodity production data (*production*, *uom_production*, *prod_grade*) are linked to the mine and mining activities whereas the commodity resource (*sum_min_resource*, *uom_resource*, *resource_grade*, *commodity_resourcedetails*) and the commodity reserve data (*sum_min_reserve*, *uom_reserve*, *reserve_grade*, *commodity_reservedetails*) are linked to the *oremeasure* of the mineral occurrence. It is not possible to associate resource and reserve data to the mine. Therefore, we grouped all the data by commodity and by mineral occurrence.

The previous stage allows determining the main commodity (*mo_main_commodity*) exploited in the mineral occurrence. It corresponds to the commodity with the maximum production. When there is no production data (null or zero):

- if there is only one commodity, this commodity is the main commodity by default;
- if there are several commodities, then there is no main commodity.



The measurement unit of the grade (*uomgrade*) exists only in the “product table”. Then, it was decided to use this *uom* as the *uomgrade* for all measured grades (production, resource, reserve).

3.3.3. Data about the mine status and activity (yellow lines in Table 2)

As all the data are grouped by mineral occurrence, then the *status*, *descr_status*, *miningactivitytype* and *descr_miningactivity* fields were grouped as well. That consisted in grouping and counting each different value for all the mines associated to the same mineral occurrence. For example, in case of the Twente-Rijn Zout (Deposit_id, Netherlands) deposit, there are the following status:

- 65 abandoned mines,
- 13 mines in retention,
- 20 mines under development,
- 75 mines in operation.

3.4. Stored procedures and automation

All the data computations were done on intermediate database tables.

The procedure already designed and used by the previous projects as listed above have been updated to add fields linked to the mineral occurrence (shape, form). Another was also created to:

- do all the computation and calculation described here above (refer to “Action on data” column in the Table 2) to feed or update intermediates database tables;
- feed or update the final table from all the others.

Consequently, with such an automated process using recorded procedures and temporary tables, the Minerals4EU Diffusion Database is easily updated from the Harvesting database as shown in Figure 1.



| Promine DB Fields/Columns names | M4Eu DB Fields/Columns names | Definitions | Action on data | Filterable Fields | Data type | Nullable |
|---------------------------------|------------------------------|--|-------------------------|--|-----------|----------|
| | unique_id | Unique ID | Next value | Use to represent data on the cartographic viewer (Web portal). | int4 | NO |
| | mineraloccurrenceidbk | Mineral Occurrence Identifiant | Original | No | int8 | NO |
| | inspire | Inspire Code | Original | Yes : INSPIRE code | varchar | NO |
| id | deposit_id | Deposit Id (Alpha-numeric field) | Original | Yes : Deposit id | varchar | YES |
| Name of deposit | deposit_name | Deposit Name (first name if several) | Computation/Calculation | Yes : Deposit name | varchar | YES |
| | other_deposit_name | Other possible deposit name(s) | Computation/Calculation | No | text | YES |
| | country | Country id | Original | No | text | NO |
| Country | countryname | Country label | Original | Yes: Country | varchar | NO |
| | geom_mo_4258_poly | Geometry Polygon calculated (if not available) or encompassing all the mines belonging the mineral occurrence (if several). EPSG 4258. | Computation/Calculation | Use to represent data on the cartographic viewer (Web portal). | geometry | NO |
| | geom_mo_4258_point | Geometry point (if available), centroid of the mineral occurrence Polygon (if not available or if several mines). EPSG 4258. | Computation/Calculation | Use to represent data on the cartographic viewer (Web portal). | geometry | NO |
| Longitude | mo_4258_x | Longitude of the mineraloccurrence (from geom_mo_4258_point). EPSG 4258. | Original | No | float8 | NO |
| Latitude | mo_4258_y | Latitude of the mineraloccurrence (from geom_mo_4258_point). EPSG 4258. | Original | No | float8 | NO |
| | occurrencetype | Mineral occurrence status id | Original | No | varchar | NO |
| | occurrencetypename | Mineral occurrence status | Original | Yes : Status | text | NO |



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|------------------------------|----------------------------------|---|-------------------------|---------------------------|---------|-----|
| | occurrencetypedescription | Mineral occurrence description | Original | No | text | NO |
| Deposit type | deposittype | Deposit type id | Original | No | varchar | YES |
| Deposit type | deposittypename | Deposit type label | Original | Yes : Deposit type | text | YES |
| | depositgroup | Deposit group id | Original | No | varchar | YES |
| | depositgroupname | Deposit group label | Original | No | text | YES |
| | depositgroupdescription | Deposit group description | Original | No | text | YES |
| | form | Deposit form id | Original | No | varchar | YES |
| Morphology of mineralization | formname | Deposit form label | Original | Yes : Deposit form | varchar | YES |
| | descr_form | Deposit form description | Original | No | text | YES |
| | shape | Deposit shape id | Original | No | varchar | YES |
| | shapename | Deposit shape label | Original | Yes: Deposit shape | varchar | YES |
| | descr_shape | Deposit shape description | Original | No | text | YES |
| | commoditydbk | All Commodities dbk | Original | No | text | NO |
| | commodity | Commodity id | Original | No | varchar | NO |
| Targeted commodity | commodity_name | Commodity name | Original | Yes : Commodity | varchar | NO |
| All contained commodities | all_commodities | All commodities of the mineral occurrence | Computation/Calculation | No | text | NO |
| | importance | Id of the Deposit importance (by commodity) | Original | No | varchar | YES |
| | deposit_importance | Deposit importance (by commodity) | Original | Yes: Commodity Importance | varchar | YES |



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|-------------------------------|---------------------------|--|-------------------------|----------------------|---------|-----|
| Past Production value | production | Total commodity production for the mineral occurrence (all mines belongig to the same mineral occurrence if several) | Computation/Calculation | No | float4 | YES |
| | mo_main_commodity | Id of the main commodity of the mineral occurrence | Computation/Calculation | No | varchar | YES |
| Main commodity | mo_main_commodity_name | Main commodity of the mineral occurrence | Computation/Calculation | Yes : Main Commodity | varchar | YES |
| | uom_production | Unit of measure of the production | Original | No | varchar | YES |
| Reserve value | sum_min_reserve | Total commodity reserve for the mineral occurrence (all mines belongig to the same mineral occurrence if several) | Computation/Calculation | No | float4 | YES |
| | uom_reserve | Unit of measure of the reserve | Original | No | varchar | YES |
| | commodity_reservedetails | Reserve type details | Original | No | text | YES |
| Resource value | sum_min_resource | Total commodity resource for the mineral occurrence (all mines belongig to the same mineral occurrence if several) | Computation/Calculation | No | float4 | YES |
| | uom_resource | Unit of measure of the resource | Original | No | varchar | YES |
| | commodity_resourcedetails | Resource type details | Original | No | text | YES |
| Grade unit | uomgrade | Unit of measure of the grade | Original | No | varchar | YES |
| Past Production average grade | prod_grade | Production grade | Original | No | float4 | YES |
| Resource average grade | resource_grade | Resource grade | Original | No | float4 | YES |



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|-----------------------|----------------------|--|-------------------------|----|--------|-----|
| Reserve average grade | reserve_grade | Reserve grade | Original | No | float4 | YES |
| Status of deposit | status | Grouping and counting of the status for the whole mines belonging to the same mineral occurrence | Computation/Calculation | No | text | YES |
| | descr_status | Grouping and counting of the status description for the whole mines belonging to the same mineral occurrence | Computation/Calculation | No | text | YES |
| Type of exploitation | miningactivitytype | Grouping and counting of the mining activity type for the whole mines belonging to the same mineral occurrence | Computation/Calculation | No | text | YES |
| | descr_miningactivity | Grouping and counting of the mining activity type description for the whole mines belonging to the same mineral occurrence | Computation/Calculation | No | text | YES |
| | last_maj | Last data update date | Computation/Calculation | | date | NO |

Table 2 - Fields extracted from the Minerals4EU Database and directly linked to the Mineral Occurrence (see explanation of colored cells in the “data computation/data management rules” chapter).



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3.5. Web Services feeding

The final table is used to feed the corresponding web service so the expected data set is made available to the end user through the web portal.

- Several fields are used to represent the data: *unique_id*, geometries (it is possible to use point or polygon; in the present project, the geometry “point” was chosen as the most representative), Occurrence type name (or status) define the type of the point (Figure 5).

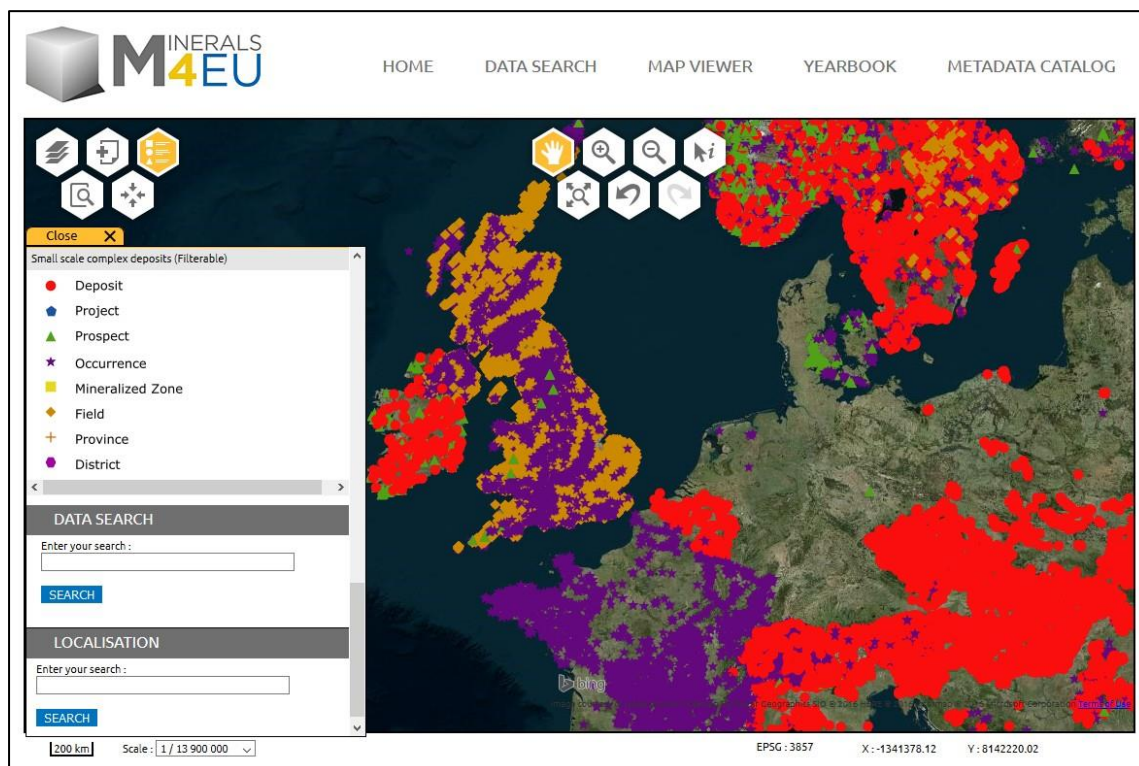


Figure 5 - Result of the loading of the “Small-scale complex deposits” layer without filter. All Occurrence types are represented (legend on the left corner).



- Several fields (“Filterable Fields” in Table 2) are used to select data (Figure 6).

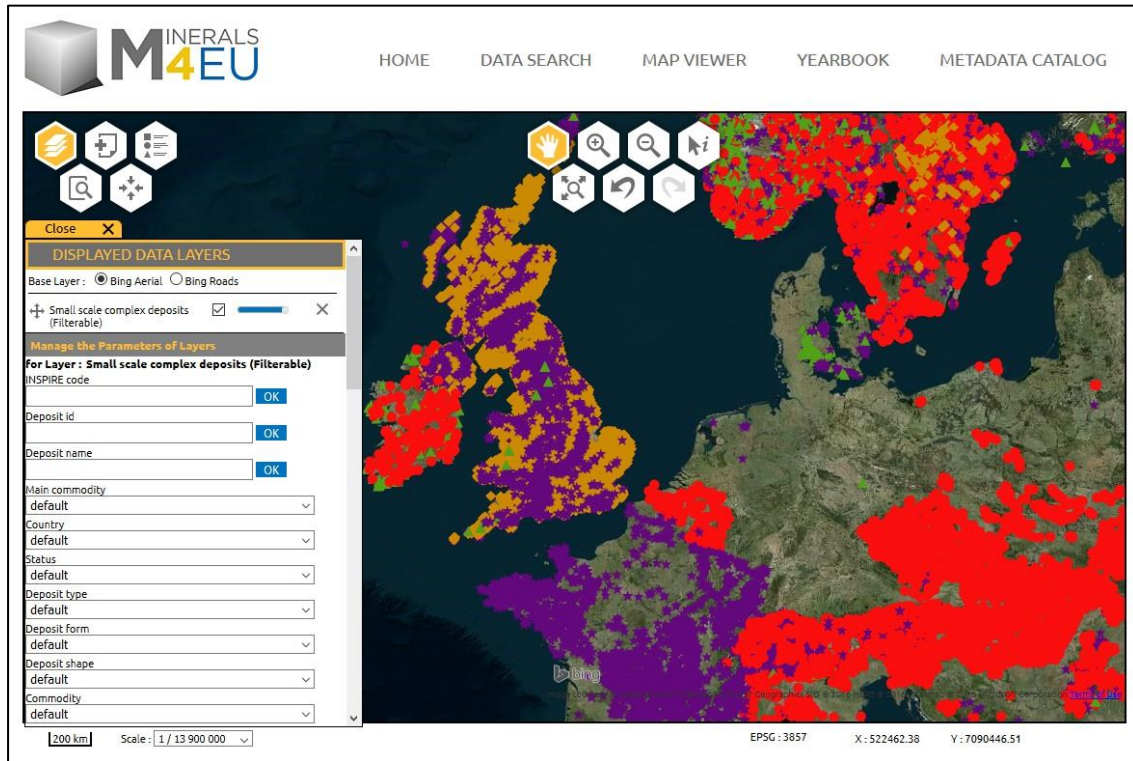


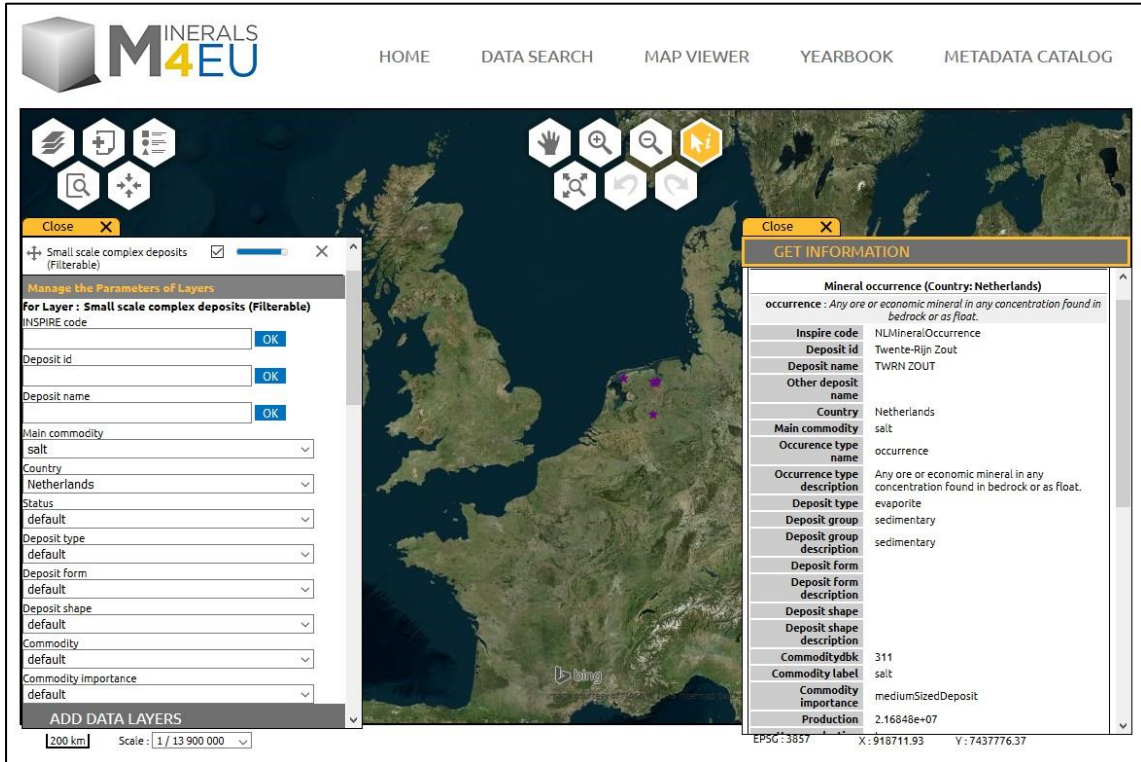
Figure 6 - Available querying filters (left corner) for the “Small-scale complex deposits” layer.



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- All the fields (except those used to represent data) are returned when the user interrogates (click on) a point. For example, as shown in Figure 7, two filters are used to select the *Twente-Rijn Zout* deposit (Netherlands): “Main commodity = “salt” and Country = “Netherlands”. The detailed information about the selected point is visible in the “GET INFORMATION” pop-up window on the right side of the web page.



The screenshot shows the Minerals4EU web application interface. The top navigation bar includes 'HOME', 'DATA SEARCH', 'MAP VIEWER', 'YEARBOOK', and 'METADATA CATALOG'. The main area shows a map of Europe with a pop-up window on the left titled 'Manage the Parameters of Layers' and another on the right titled 'GET INFORMATION'. The 'GET INFORMATION' window displays detailed data for the Twente-Rijn Zout deposit in the Netherlands.

| Mineral occurrence (Country: Netherlands) | |
|---|--|
| occurrence | - Any ore or economic mineral in any concentration found in bedrock or as float. |
| Inspire code | NLMIneralOccurrence |
| Deposit id | Twente-Rijn Zout |
| Deposit name | TWRN ZOUT |
| Other deposit name | |
| Country | Netherlands |
| Main commodity | salt |
| Occurrence type name | occurrence |
| Occurrence type description | Any ore or economic mineral in any concentration found in bedrock or as float. |
| Deposit type | evaporite |
| Deposit group | sedimentary |
| Deposit group description | sedimentary |
| Deposit form | |
| Deposit form description | |
| Deposit shape | |
| Deposit shape description | |
| Commoditydbk | 311 |
| Commodity label | salt |
| Commodity importance | mediumSizedDeposit |
| Production | 2.16848e+07 |

Figure 7 - Two filters activated (left menu) and information requested on one point occurrence (info yellow button): detailed information for the Twente-Rijn Zout displayed in a pop-up window (on the right).

4. Integration of a new data layer in the Minerals4EU map viewer

In direct connection with the Minerals4EU database update, which lead to generate a data set dedicated to explore the “small-scale high-grade deposits”, the same was to be made available to the user community through a new layer accessible on the EU-MKDP web portal. As described previously in chapter 2 “EU-Minerals Knowledge Data Platform”, the map viewer proposes a series of data layers for interactive discovery and display.

The project working group so decided that the new layer should be “filterable” for an in-depth exploration of the data set. In addition, and as far as possible, the guides and selection criteria recommended in the D2.1 project report were also taken into account and their equivalence are now proposed in the dropdown menus.



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As shown on Figure 8, the new map layer is now proposed in the layer catalogue used by the Minerals4EU map viewer (<http://minerals4eu.brgm-rec.fr/minerals4EU/>). It is accessible by its full name: **“Small scale complex deposits”**.

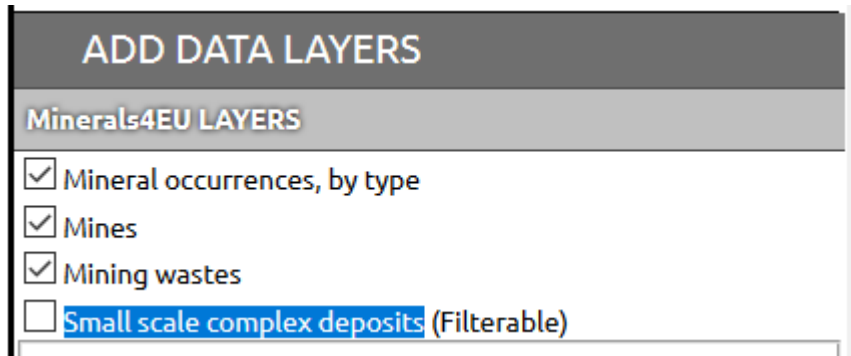
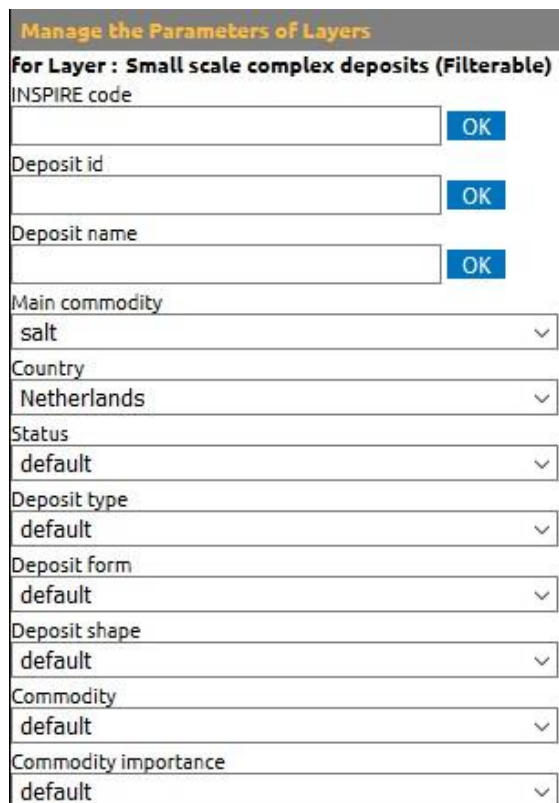


Figure 8 - Catalogue of data layers with the new layer “Small scale complex deposits”.

This layer is marked as “Filterable” whereby the user can manage the data set presented by the map service. The data can be filtered by a series of eight criteria (Figure 9). They can be chosen through code lists such as: Main Commodity (Figure 10), Deposit Type, Depository shape, or simply by text input (Deposit Name and/or Deposit id, and/or INSPIRE identification code).



| Manage the Parameters of Layers | |
|--|--|
| For Layer : Small scale complex deposits (Filterable) | |
| INSPIRE code | <input type="text"/> <input type="button" value="OK"/> |
| Deposit id | <input type="text"/> <input type="button" value="OK"/> |
| Deposit name | <input type="text"/> <input type="button" value="OK"/> |
| Main commodity | salt <input type="button" value="v"/> |
| Country | Netherlands <input type="button" value="v"/> |
| Status | default <input type="button" value="v"/> |
| Deposit type | default <input type="button" value="v"/> |
| Deposit form | default <input type="button" value="v"/> |
| Deposit shape | default <input type="button" value="v"/> |
| Commodity | default <input type="button" value="v"/> |
| Commodity importance | default <input type="button" value="v"/> |

Figure 9 - List of possible filters (mineral occurrence selection criteria).



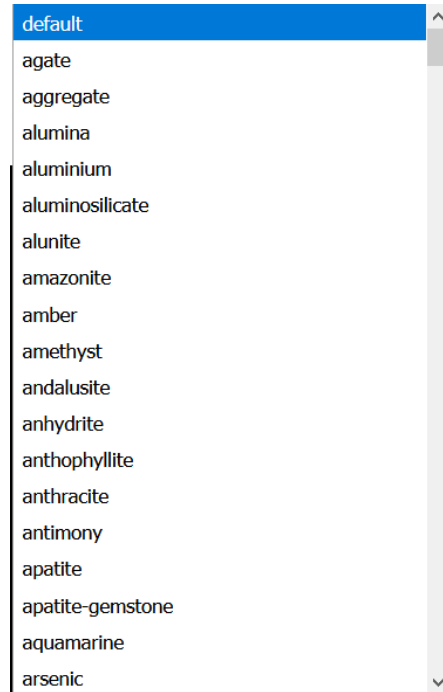


Figure 10 - Extract of the list of commodities (“Main commodity” selection criteria).

The layer is also query enabled. When a mineral occurrence is queried using the “Information” button (functionalities top menu), the result is displayed in a pop-up window on the right side of the web page (Figure 11).

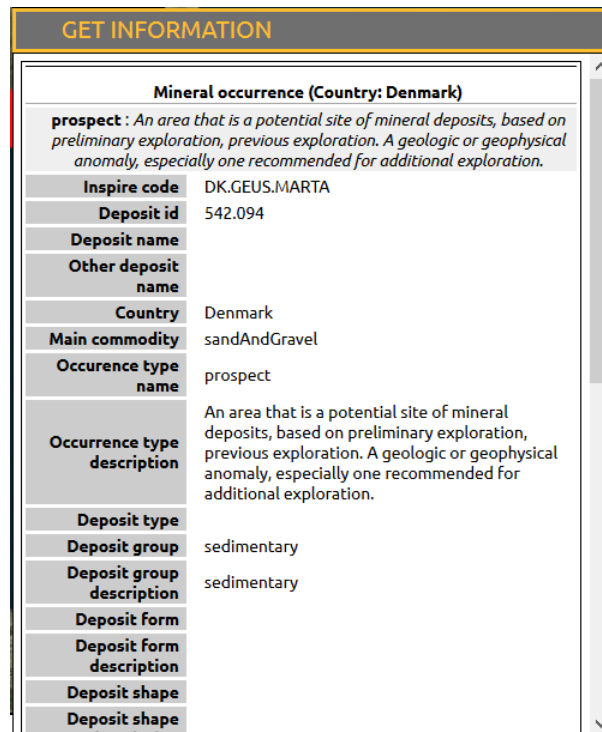


Figure 11 - Detailed information resulting from a point interrogation



5. Example case study

This chapter describes an example case study, in order to illustrate a possible usage of the tool described hereabove. The scenario of this case study is the following: a mining company is searching for Sb-bearing vein-type deposits in Greece that could be possible candidates for a SO-SO exploitation. Based on this simple scenario, the search criteria are the followings:

- Contained commodity is antimony (note that we are not searching here for Sb as “main commodity” but only as “contained commodity”, although both options are possible);
- Country is Greece;
- Status is deposit;
- Type is vein or low sulphidation.

The default display of the Minerals4EU map viewer is shown in the Figure 12 below.

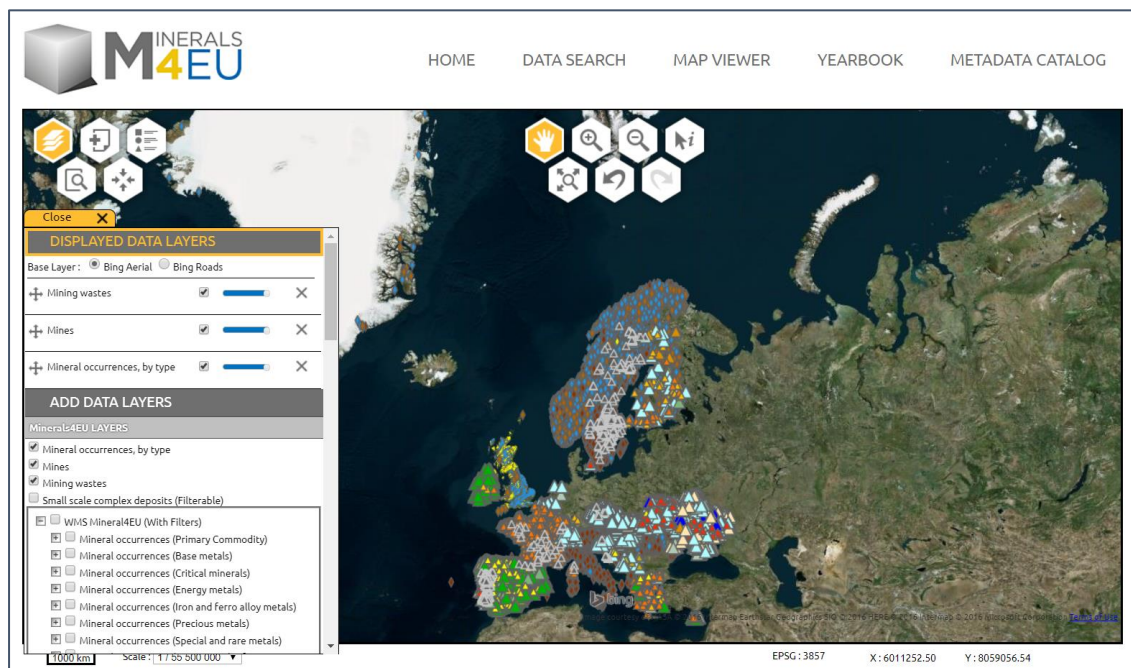


Figure 12 - Default view of the Minerals4EU EU-MKDP map viewer.



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The goal is to search for SO-SO candidate deposits with the dedicated tool, so the first action is to uncheck the “Mineral occurrences, by type”, “Mines” and “Mining wastes” layers, in the “Add data layers” section of the left-hand side box, and to check the “Small scale complex deposits (Filterable)” layer (Figure 13). After a few seconds, the display is refreshed, as shown in Figure 14. The left-hand side box is also refreshed and proposes a new section (“Manage the parameters of layers”) with several criteria to select records in the “Small scale complex deposits (Filterable)” layer (Figure 15).

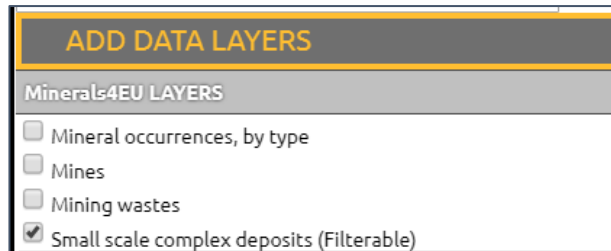


Figure 13 - detail of the “Add data layer” section to select the “Small scale complex deposits (Filterable)” layer.

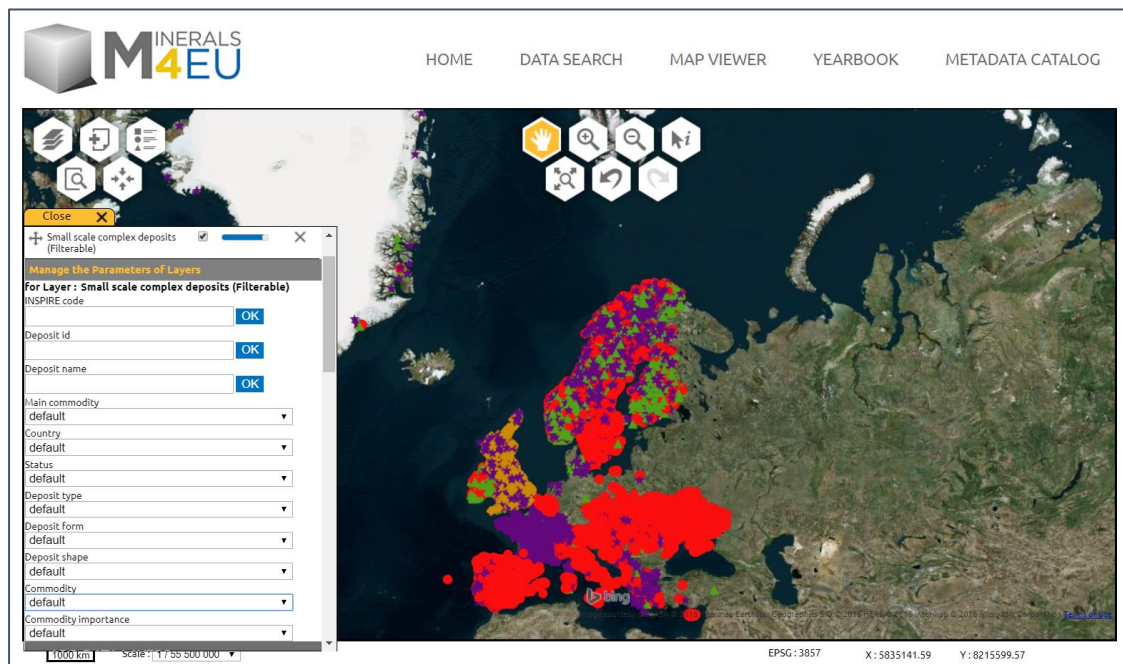


Figure 14 - View of all records in the “Small scale complex deposits (Filterable)” layer.



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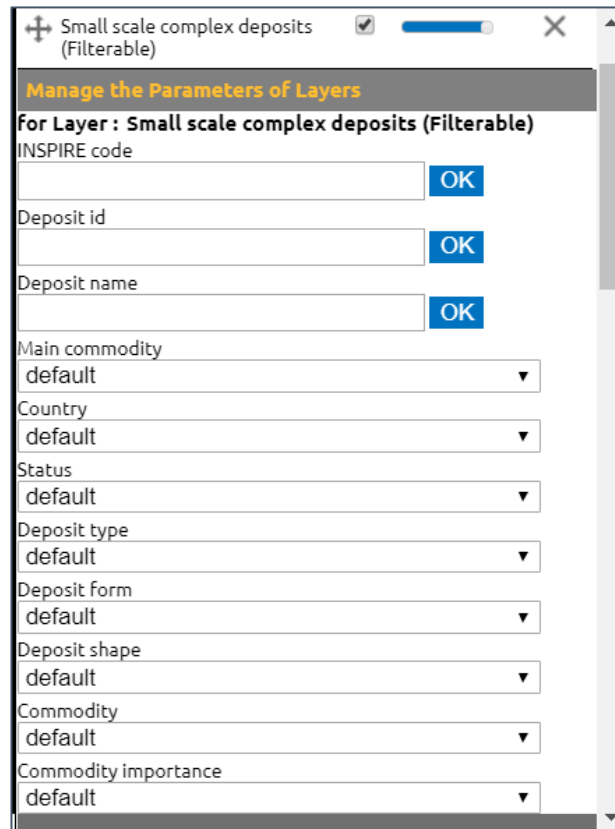


Figure 15 - detailed view of the search tool that allows to query the “Small scale complex deposits (Filterable)” layer using either free text fields (“INSPIRE code”, “Deposit ID”, or “Deposit name”) or lexicon-guided fields (all others, with drop-down lists of values).

In the drop-down list of the “Status” field, we select “deposit”. The display is then refreshed, showing only records with “deposit” status (Figure 16).



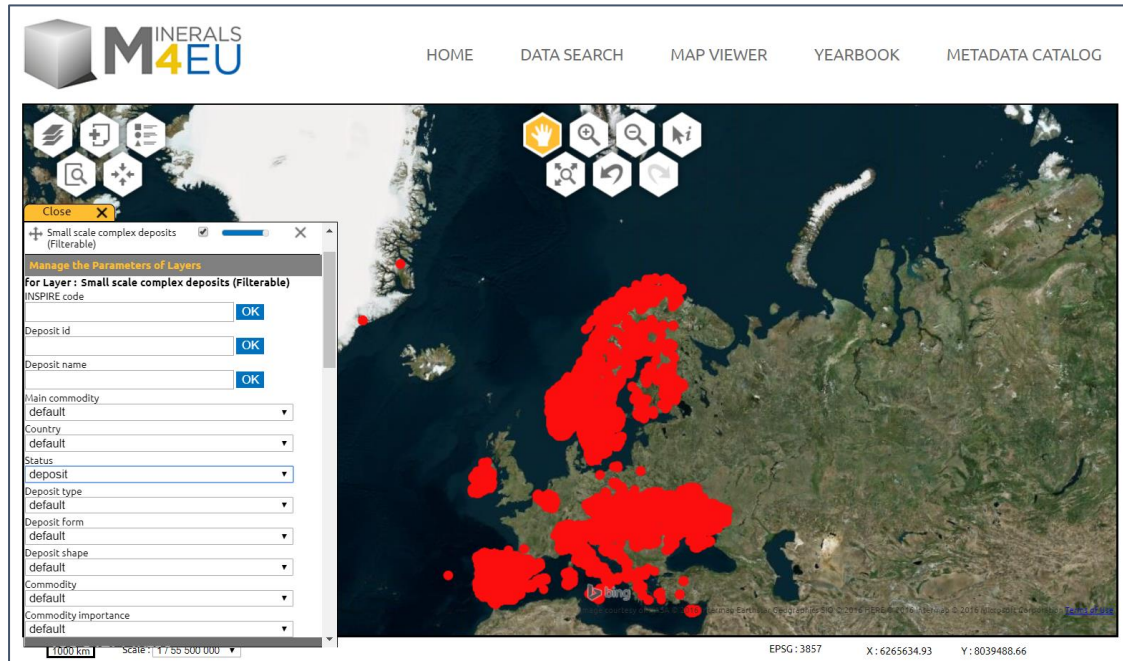


Figure 16 - view of all records in the “Small scale complex deposits (Filterable)” layer that have the status “deposit”.

In the drop-down list of the “Commodity” field, we then select “Antimony”. As pointed out above, we could have used here the “Main commodity” field, but we are looking for all deposits containing antimony, and not only those where antimony is the main commodity. The display is refreshed, showing only deposits containing antimony (Figure 17). We end-up with a limited number of records in Iberia, central Europe and Greece.



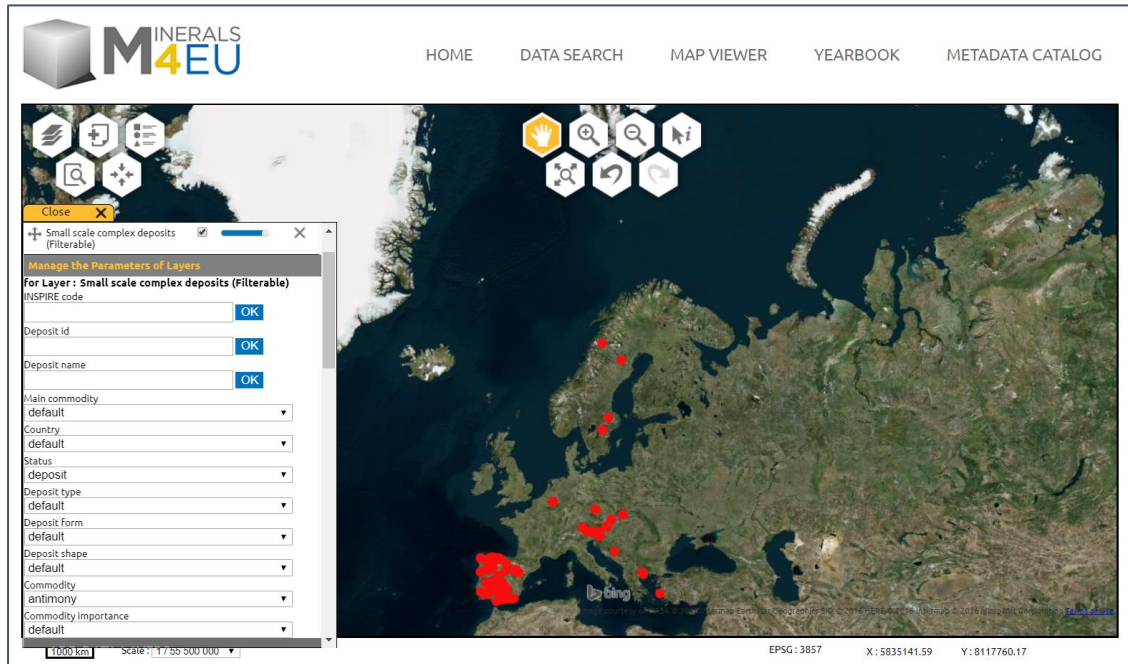


Figure 17 - view of all records in the “Small scale complex deposits (Filterable)” layer that have the status “deposit” and contain the commodity “antimony”.

To focus our search on Greek deposits, we select “Greece” in the drop-down list of the “Country” field. The display is refreshed, to show only Greek deposits containing antimony (Figure 18).

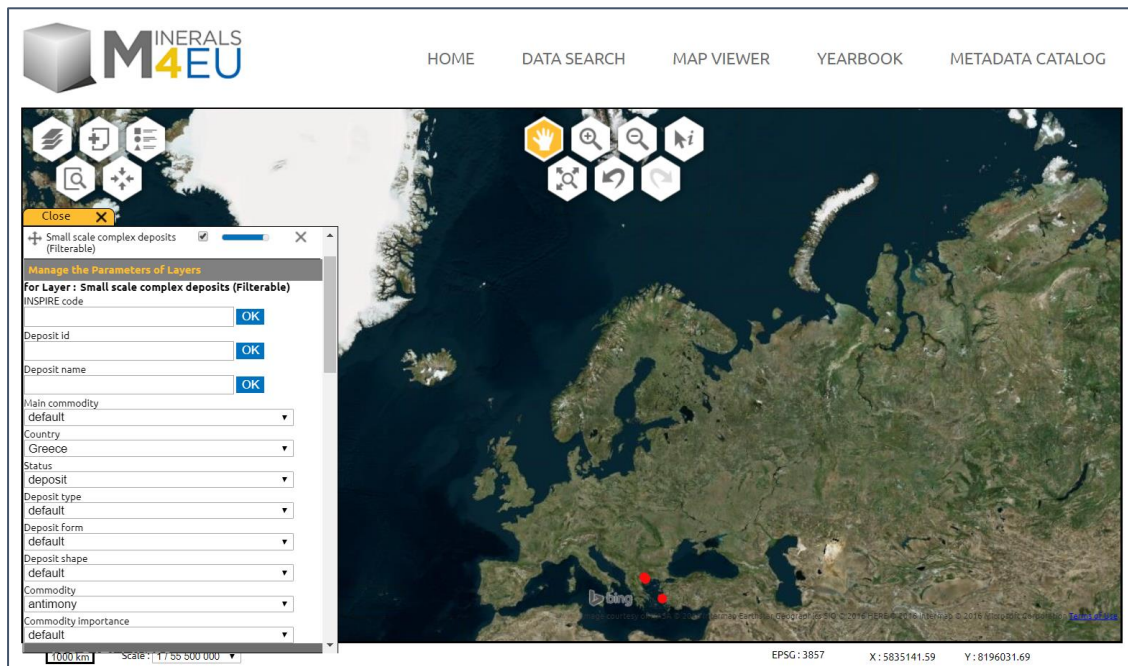


Figure 18 - view of all records in the “Small scale complex deposits (Filterable)” layer that have the status “deposit”, contain the commodity “antimony” and are located in Greece.



In order to ease the visualization of the results, we use the “zoom in” tool in the upper central group of buttons (yellow button in Figure 19). The display is refreshed and zoomed on Greece.

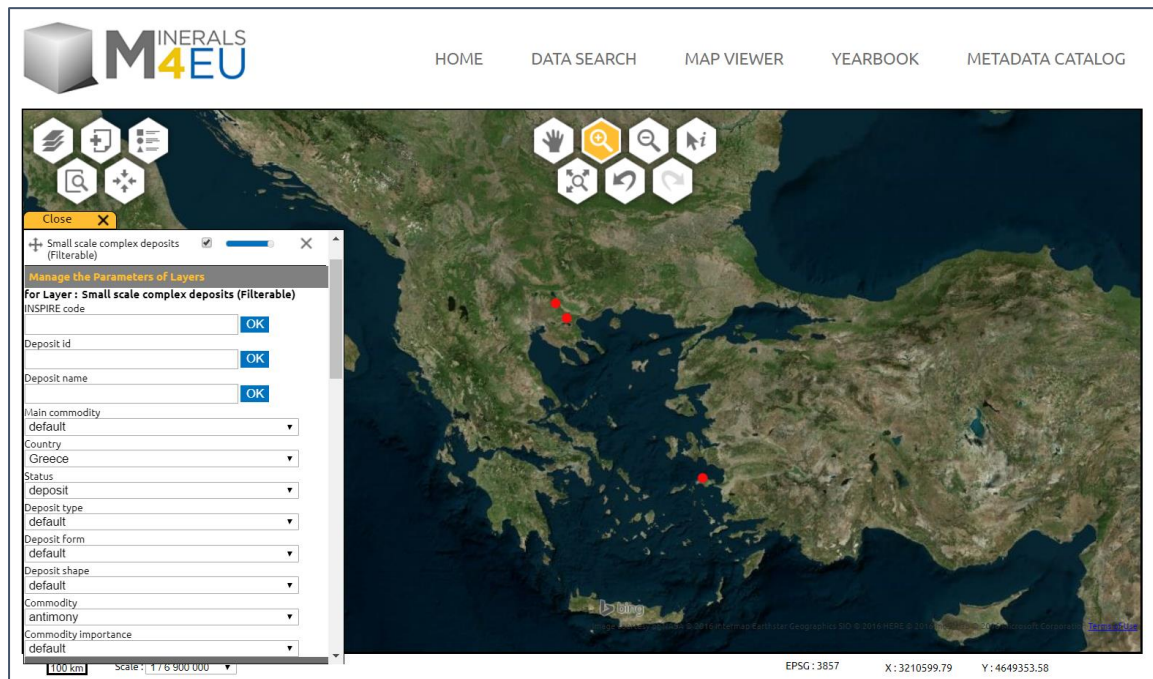


Figure 19 - zoomed view of all records in the “Small scale complex deposits (Filterable)” layer that have the status “deposit”, contain the commodity “antimony” and are located in Greece.

In the “Deposit type” field, we select the type “vein, including polymetallic and 5 elements veins (Bi, Co, Ni, Ag, U)”. After refreshment, no record is displayed. There are no Sb-bearing vein-type deposits in Greece in the Minerals4EU database. In the “Deposit type” field, we then select the type “low sulphidation”. After refreshment, three Sb-bearing low-sulphidation-type deposits are displayed in Greece (Figure 19).

The “get information” tool in the upper central group of buttons (black arrow with a lower case “i”) allows to click on a record to get more information on it (“Get information” box on the right-hand side of the map viewer, Figure 20). The three deposits our search returned are Lachana-Rizana, Philadelphia-Sochos and Samos, all of which are closed mines of antimony. Mining was underground in Samos and at the surface at Lachana-Rizana and Philadelphia-Sochos.

In addition to data provided by the “get information” tool, we want to know the type of land cover at each of the three sites, to check whether they are still appropriate for a possible re-opening. In the “Add data layers” section of the left-hand side box of the map viewer, in the “OGC server” subsection, we enter the WMS (web map service) URL of



CORINE LAND COVER⁵, a database provided by the European Environmental Agency on types of land coverage. The WMS allows to fetch data on distant online servers and display it on our own visualizer (map viewer, GIS software, etc.).

After playing with the “zoom” and “pan” tools (upper central group of buttons) to adjust the zoom level and display on each deposit, we learn that Lachana-Rizana is on a forest or woodland area (Figure 21), Philadelphia-Sochos is on arable land, and Milos is at the junction between forest and cultivated land. Based on these information, we can sort the three deposits for their adequacy for SO-SO mining, according to the objectives of the project. For instance, Lachana-Rizana and Philadelphia-Sochos could be preferred as they were surface mined, which should involve less infrastructure work for their re-opening. Anyway, based on this first screening, additional information from external sources should be sought for each selected target in order to better assess its suitability for SO-SO mining.

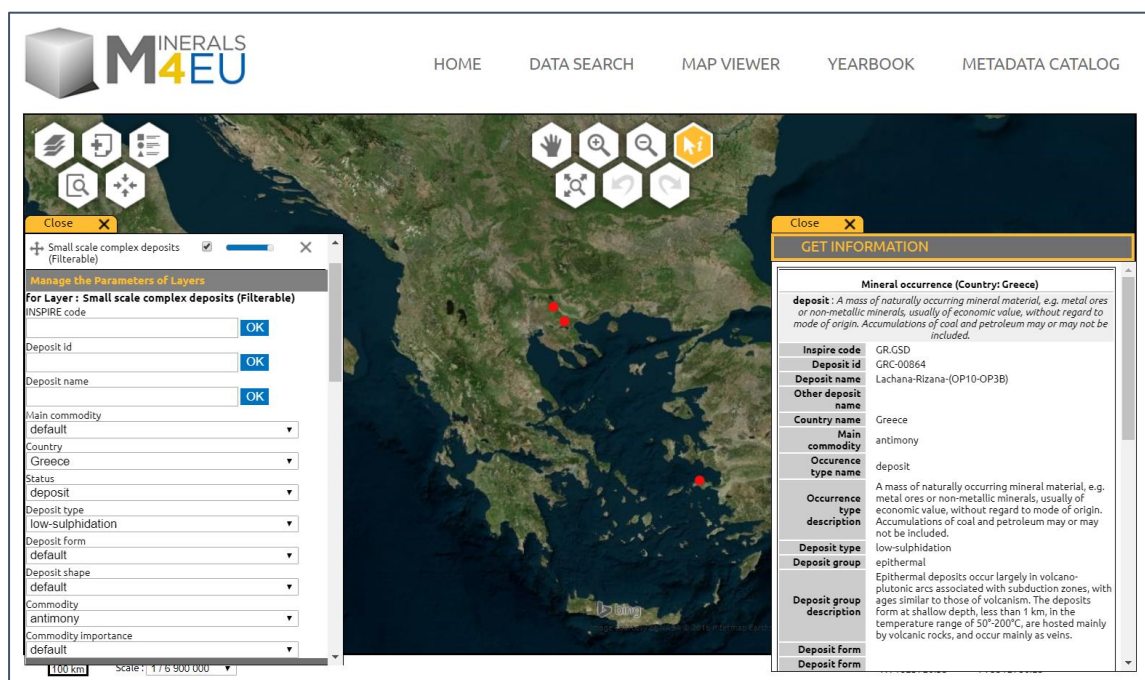


Figure 20 - view of the “get information” box, on the right-hand side of the screen that displays detailed information of a selected record (selection by mouse clicking in the map window).

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https://image.discomap.eea.europa.eu/arcgis/services/Corine/CLC2018_WM/MapServer/WmsServer? (2018 version)



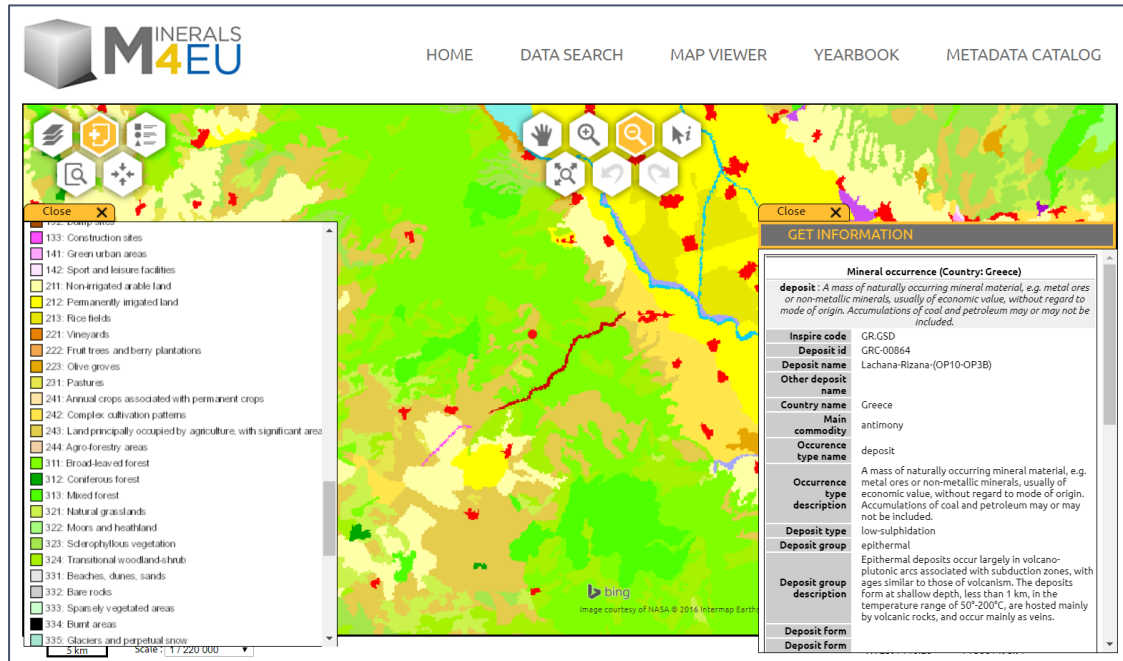


Figure 21 - view of the Lachana-Rizana deposit (red dot in the center of the picture) and its vicinity in the CORINE Land Cover data layer, to identify the type of land cover at the site of the deposit.

6. Conclusion

The present report describes a tool that has been implemented in the Minerals4EU EU Minerals knowledge data platform (EU-MKDP) to help identifying mineralization in Europe that could be pertinent candidates for SO-SO mining, as planned in task T2.1 of the IMP@CT project. This tool is openly and freely accessible on the Internet in the Minerals4EU EU-MKDP (<http://minerals4eu.brgm-rec.fr/>).

Note that this tool is not solely limited to searching candidate deposits for SO-SO mining but, as a multi-criteria query tool, could help select data for many other purposes. Note also that results returned by this tool strongly rely on the quality, accuracy, homogeneity and completeness of the Minerals4EU database, which is out of the scope of the IMP@CT project.

Still, the tool presented hereabove is a crucial help to quickly and easily identify potential deposits in Europe in one of the most complete and homogeneous database of mineral resources in Europe. It allows in a few minutes to screen the whole Minerals4EU database and identify a limited number of pertinent candidate deposits. Its user-readiness aims at being a milestone towards a case-by-case analysis for any mining project in Europe, and particularly emphasizes on SO-SO mining projects. Thus, each identified deposit could then be more thoroughly documented to confirm its adequacy for SO-SO mining, or any other mining paradigm. As such, it constitutes a valuable input that will help exploration and mining companies develop their own SO-SO mining projects upstream.



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