MINERAL INTELLIGENCE
FOR EUROPE

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Minerals Inventory Report

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GENERAL INTRODUCTION

The European Union has identified security of supply, improvement in environmental management and resource efficiency as key challenges for the raw materials sector. Data regarding the location and spatial distribution of primary and secondary raw materials, with respect to exploration, exploitation, production, and trade activities, underpin decision making in government and industry. Given the dynamic character of such data, regular updates of comprehensive, reliable, and harmonized information across borders are required. The overall aim of MINTELL4EU is to improve the European Knowledge Base on raw materials as there are several sources of non-harmonized data with different coverages developed for different purposes during national and international projects over recent decades. All data are shared at the European Geological Data Infrastructure, EGDI.

Tasks include updating the electronic Minerals Yearbook produced in the Minerals4EU project as well as extending the spatial coverage and quality of data currently in the Minerals Inventory. Furthermore, MINTELL4EU aims to increase the degree of harmonization, communication, and interaction between existing data platforms, with the ambition of reaching a fully operational and reliable data knowledge management system, fulfilling the European needs, and taking into account the Raw Materials Information System (RMIS) of the European Union. Finally, the applicability of the UNFC classification system for obtaining more accurate Pan-European mineral inventories is tested through a large number of case studies on different commodities across Europe.

MINTELL4EU has 27 partners, each representing a national or regional geological survey organisation, from 25 European countries.

EXECUTIVE REPORT SUMMARY

This report describes a Europe-wide effort to update, supplement, and harmonize data from many data providers that are contributing to the Minerals Inventory.

The report describes the MIN4EU data model and how the data were collected from national data providers, the status of the data by the end of October 2021, how they are integrated and displayed in EGDI, and what challenges remain for the future.

As a major update of the data by the data providers is expected in November 2021, an update of the report is expected at the end of November.

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1 OVERVIEW

The main objectives of WP3 were to extend the spatial coverage and quality of Minerals Inventory data currently stored in the MIN4EU database (developed from the former Minerals4EU M4EU database) in order to have sustainable access to up-to-date and harmonized information on primary raw materials across borders.

The focus was on overcoming data quality issues by continuously:

- Building a transparent and understandable data collection and review process tailored to the needs of users.
- Develop of new training materials.
- Training data providers through workshops so that they become capable and reliable data providers.
- Improving the harvesting system and its quality assurance.
- Consolidating the strong network and communication between data providers.

At the end of October 2021, the MIN4EU database still does not cover the whole geographical coverage of Europe and the level of data coverage varies from country to country. Data are regularly harvested (at least once a month) and eventually stored in the central MIN4EU database. However, it is important to remember that the contents of the database depend on the input from the data providers. The quality and content of national data sets transferred to MIN4EU are the sole responsibility of each individual data provider.

The data on mineral occurrences and mines stored in MIN4EU DB until the end of October 2021 cover 31 countries, hereof 22 of the 27 EU Member States (Bulgaria, Estonia, Latvia, Lithuania, and Malta are still missing, as are 15 of 16 German states). The spatial coverage has been successfully extended to the countries of the Western Balkans (Bosnia and Herzegovina - Republic of Srpska, Federation of Bosnia and Herzegovina, Montenegro, Northern Macedonia, and Serbia), Luxembourg and at regional level to Germany (Baden-Württemberg as one German State).

Harmonization is well advanced, all code lists in the database have been extended or new added (e.g., for UNFC classification). The data model has also been extended and we are currently talking about v2020.08.02 (see chapter 2 of this report for more details).

In close connection with the MINTELL4EU WP5 and the GIP-P project, the harvesting reporting system, including quality assurance procedures to ensure that data harvesting is done correctly, has been updated and improved according to the new data model to make it easier for existing and new data providers to map their national data to MIN4EU DB (see also MINTELL4EU deliverable *D3.3 Quality control system for harvesting report* and GIP-P Deliverable *D7.3 Final version of Central database / harvesting*).

2 MIN4EU DATA MODEL

The current MIN4EU DB model v2020.8.x builds on the version v1.1.2 (Minerals4EU DB) from the ProSUM project (2015 – 2017), which again build on the Minerals4EU project (2013 - 2015) and euRARE project (2013 – 2017) version v07.0.2 (Minerals4EU DB).

The evolution from M4EU database to what is now called MIN4EU database goes via different versions:

- DB version v07.0.2 for Primary Raw Materials including indicating Secondary Raw Materials in one related table.
- DB version v1.1.2 extended the DB model with the mining waste extension:
    - the whole DB Model including code list was described in the ProSUM project (http://www.prosumproject.eu/) deliverable 'Deliverable 5.5 Data models and code lists, 1162 pp' (Heijboer et al., 2017).
- DB model v2020.8.x improvement of the INSPIRE MR / ERML data model with focus on the UNFC Classification:
    - The ORAMA project (2018-2019, https://orama-h2020.eu) recommended improvement of the INSPIRE MR / ERML data model.

2.1 MIN4EU DB model v2020.8

In the MINTELL4EU project, the MIN4EU DB model has been extended with three tables (Figure 1) by the recommendation from the ORAMA project and an inquiry from the RESEERVE project (https://reseerve.eu/) about adding the attribute 'prosumMiningWasteName' in the ProSUMMiningWaste table. This has been done in MIN4EU DB model v2020.8 including review and update of all code lists.

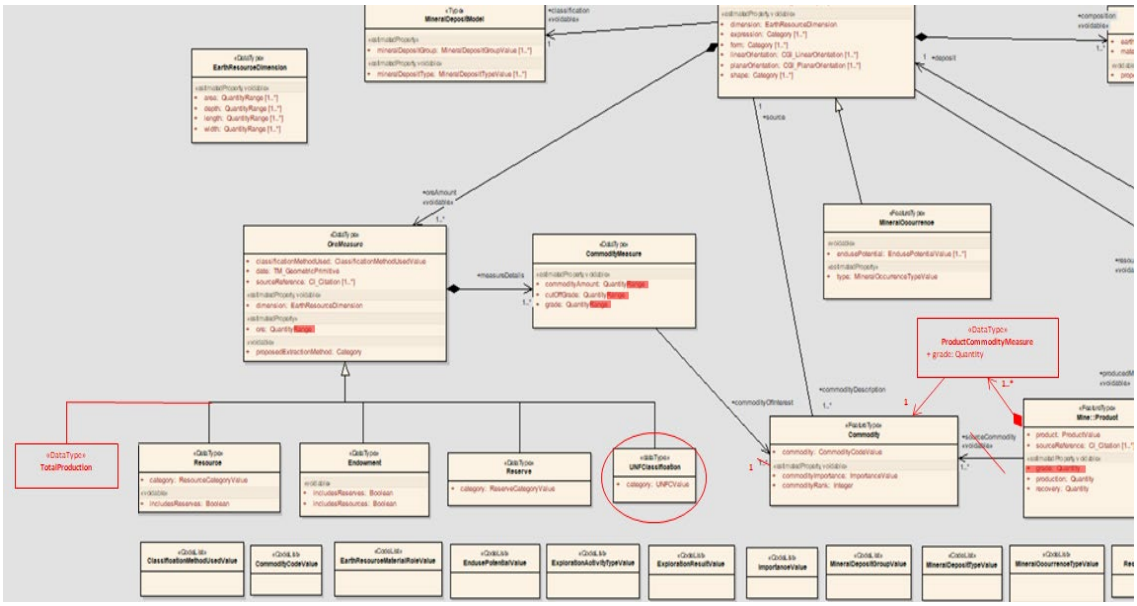

Figure 1. *Modifications in MIN4EU data model v2020.8*

Figure 1 shows, how the DataType ‘ProductCommodityMeasure’ has been added for managing grades,‘cardinalities’ in Products corrected and ‘range’ removed from Quantity. Also, a new specialization of ‘OreMeasure’, ‘TotalProduction’ was added. UNFC is managed through a dedicated DataType and three related code lists with separate E, F and G values.

2.2 Documentation and material for the DB available

All the documentation and materials from previous and the current project are found on GEUS Gitlab Server (https://geusgitlab.geus.dk/m4eu) (Figure 2): the Minerals4EU, ProSUM, ORAMA and Mintell4EU (2020 M4EU v2020.8) projects for the development of the database, toolstack, guidelines for system setup of softwares and insert of data in the DB, etc. (Figure 3).

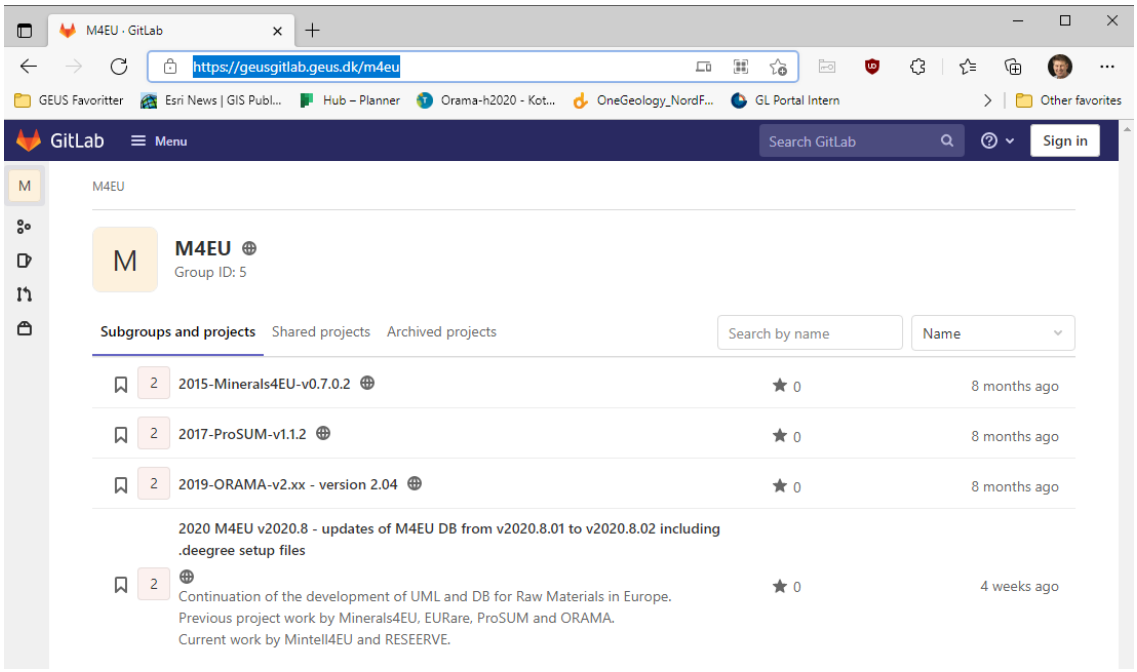

Figure 2. *GEUS Gitlab Server (https://geusgitlab.geus.dk/m4eu).*

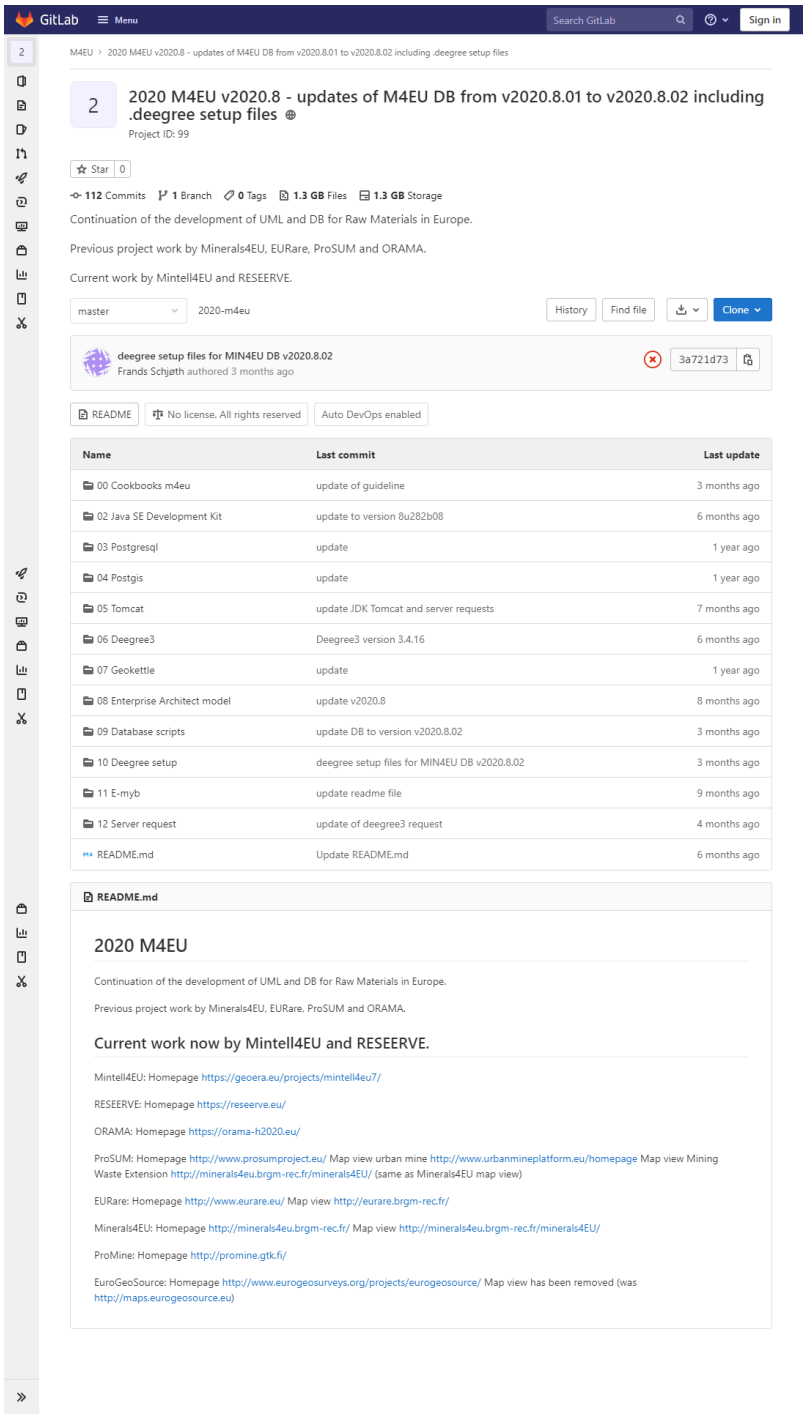

Figure 3. *MIN4EU DB v2020.8 (https://geusgitlab.geus.dk/m4eu/2020-m4eu).*

3 STATUS OF DATA IN MINERALS INVENTORY

The following analysis of the data stored in the MIN4EU Minerals Inventory shows the status of the data as of the end of October 2021. A significant contribution from several data providers is expected in November 2021, which will lead to a new publication of the data on the EGDI viewer and an updated version of this report.

3.1 Spatial coverage

Compared to 2013, the spatial data coverage of the Minerals Inventory has, in cooperation with the RESEERVE project, been extended with data from Western Balkan countries, from Luxembourg, and from one German State (Baden-Württemberg). Besides (Figure 4), contact has recently been established with Kosovo that would also like to add their data to MIN4EU. This work will continue after the end of the project.

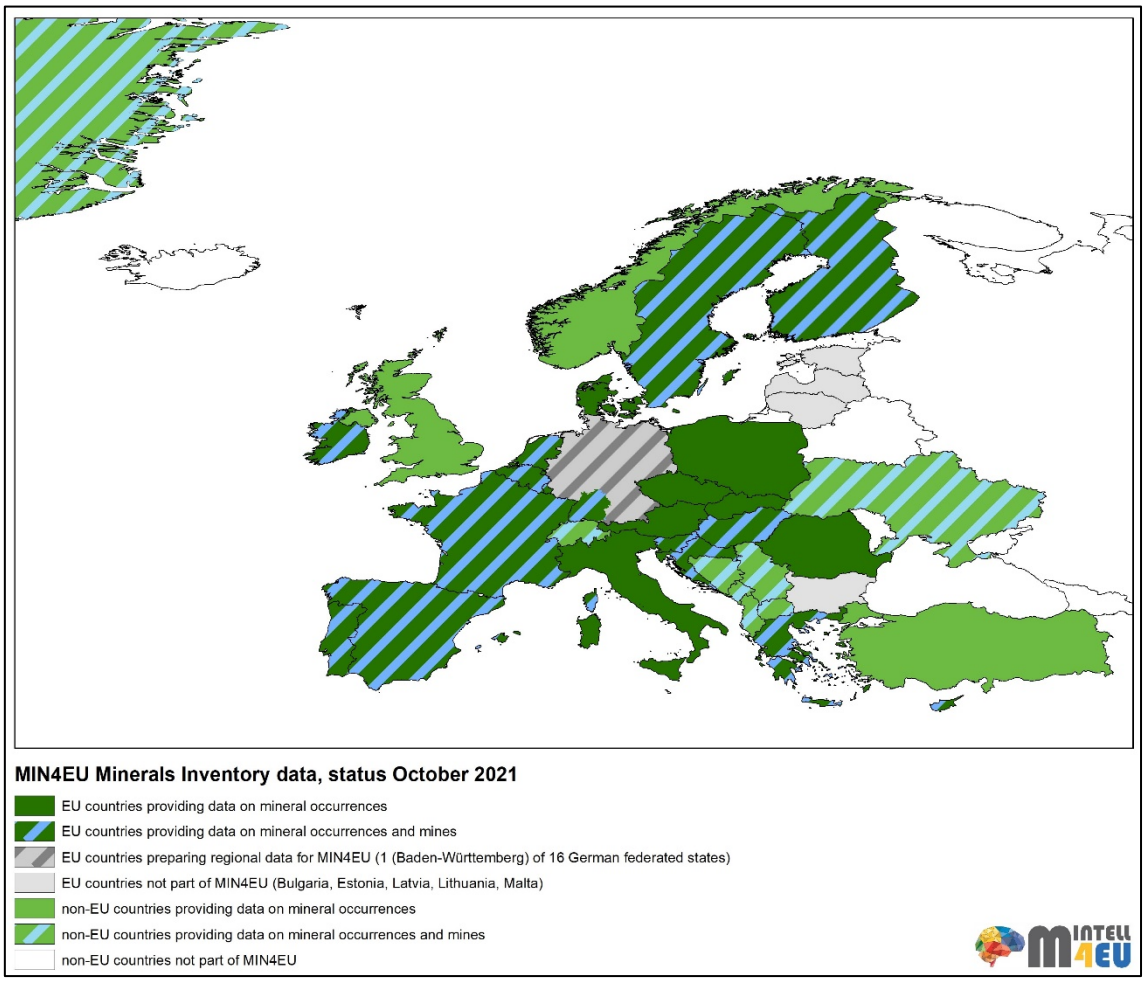

Figure 4. *Spatial coverage of Minerals Inventory data at the end of October 2021*

By the end of October 2021, 36 data providers covering 31 European countries provide data to MIN4EU (Table 1 and Table 2). Of these 36, 18 have implemented a data service while 13 have filled in an Access template developed for this purpose, and a data service was created and hosted by GeoZS or GEUS to allow these data to be collected (harvested) together with the other data services. The remaining five data providers are represented by datasets collected in the Minerals4EU project, which have been transferred to the MIN4EU database. These are datasets from three countries that were partners in Minerals4EU but not in MINTELL4EU (The Netherlands (TNO), Romania (GIR), Switzerland (SWISSTOPO)) as well as datasets from two MINTELL4EU partners (HSMGE Greece (HSMGE), and France (BRGM)) that failed in updating and upgrading their national datasets to MIN4EU as expected, see chapter 4.4. For these five countries, a dedicated 'services' was created for version 1.1.2. of the database and data from these services had been transferred to 'countries referential databases'. This allows their old data to be included in the MIN4EU DB (so no data services are available for v.2020.08 for these countries) via harvesting. After October 2021 only the v 2020.08 will be harvested continuously.

Table 1*: Data providers for Min4EU Minerals Inventory, data provides marked with yellow are expected to update their data in November 2021.*

No. of data providers	Providers Short Name	Country Name
1	HSGME	Greece
2	TNO	Netherland
3	GSB-RBINS	Belgium
4	BRGM	France
5	IGME	Spain
6	MBFSZ	Hungary
7	ISPRA	Italy
8	RU	Italy
9	IGR	Romania
10	SWISSTOPO	Swiss
11	GBA	Austria
12	UKRI/BGS	United Kingdom
13	GEUS	Denmark
14	GEUS	Greenland
15	SGU	Sweden
16	NGU	Norway
17	PGI	Poland
18	GSI	Ireland
19	LNEG	Portugal
20	FMG_Res	Albania
21	AGS_Min	Albania
22	GSD	Cyprus
23	GTK	Finland
24	GeoInform-GU	Ukraine
25	FMG	Serbia

26	GSS	Serbia
27	GSM	Montenegro
28	HGI-CGS	Croatia
29	GeoZS	Slovenia
30	BIH_FZZG	Bosnia
31	BIH_GSRS	Bosnia
32	CGS	Czech
33	SGIDS	Slovakia
34	LGRB	Germany
35	BGR	Germany
36	SGL	Luxembourg

Table 2*: Status of data for Min4EU Minerals Inventory*

No. of countries covered	Status of data
5	2017 (from DB version 1.1.2)
5	preparing data for 2021 (till then data are dated to year 2017, from DB version 1.1.2)
21	year 2021
SUM: 31	

3.2 Count comparison

Below are some comparisons between the data collected in MIN4EU DB in the period between December 2018 and October 2021. Most comparisons show a positive trend in terms of increase in the number of records. In some countries, this trend is negative, due to improved data quality and more correct input into the same database.

It must also be stressed that the content of the database depends on the inputs of the data providers. The quality and content of the national datasets submitted to MIN4EU are the sole responsibility of each individual data provider.

Figure 5 shows comparison between the number of records in the Mineral Occurrences table per country, with red indicating the number of records in December 2018 and blue indicating the number of records in October 2021. If the blue and the red part of the column is equally 50%, there are no increase in number of records. If the column for a country is more blue than red this means that the number of records has increased; if more red than blue, the number has decreased. Table 3 shows the exact numbers for each country.

Mineral occurrences were recorded as points or polygons and can be displayed on EGDI as shown in Figure 6 and Figure 8.

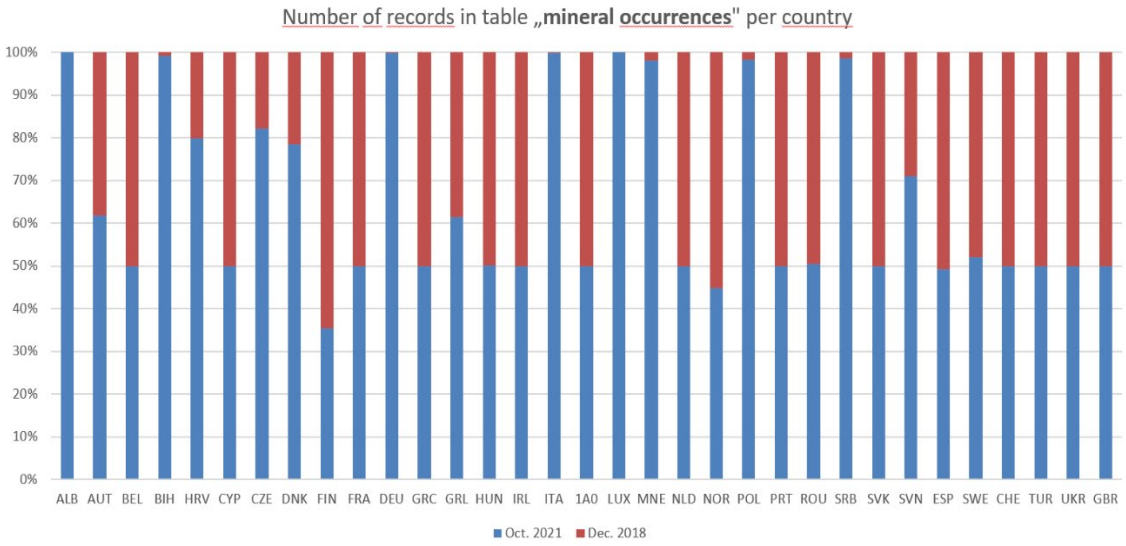

Figure 5. *Comparison between number of "mineral occurrence" records from December 2018 to October 2021.*

Table 3: *MIN4EU data in table "mineral occurrence" – difference between number of records from December 2018 to October 2021*

mineral occurrence	M4EU 2018 12 27	MIN4EU 2021 10 28	
county	count	count	difference
Albania	0	680	680
Austria	3474	5622	2148
Belgium	574	574	0
Bosnia and Herzegovina	1	136	135
Croatia	46	183	137
Cyprus	172	172	0
Czech Republic	708	3263	2555
Denmark	230	837	607
Finland	1908	1049	-859
France	4214	4215	1
Germany	2	2171	2169
Greece	236	236	0
Greenland	663	1058	395
Hungary	1271	1281	10
Ireland	282	282	0
Italy	3	2343	2340
Kosovo	1	1	0
Luxembourg	0	552	552
Montenegro	1	52	51
Netherlands	5	5	0
Norway	18862	15351	-3511
Poland	303	16782	16479
Portugal	2278	2278	0
Romania	388	396	8
Serbia	1	69	68
Slovakia	624	624	0
Slovenia	206	504	298
Spain	31133	30302	-831
Sweden	18279	19813	1534
Switzerland	1290	1290	0
Turkey	4	4	0
Ukraine	6309	6309	0
United Kingdom	22545	22545	0

As mentioned, due to modifications in the data model as well as extensions of code lists, today we have a better quality of data. This are reflected in the lower number of records in the DB (which is the case for mineral occurrence data in Finland, Norway and Spain). However, in total, the number of records in the DB has increased significantly.

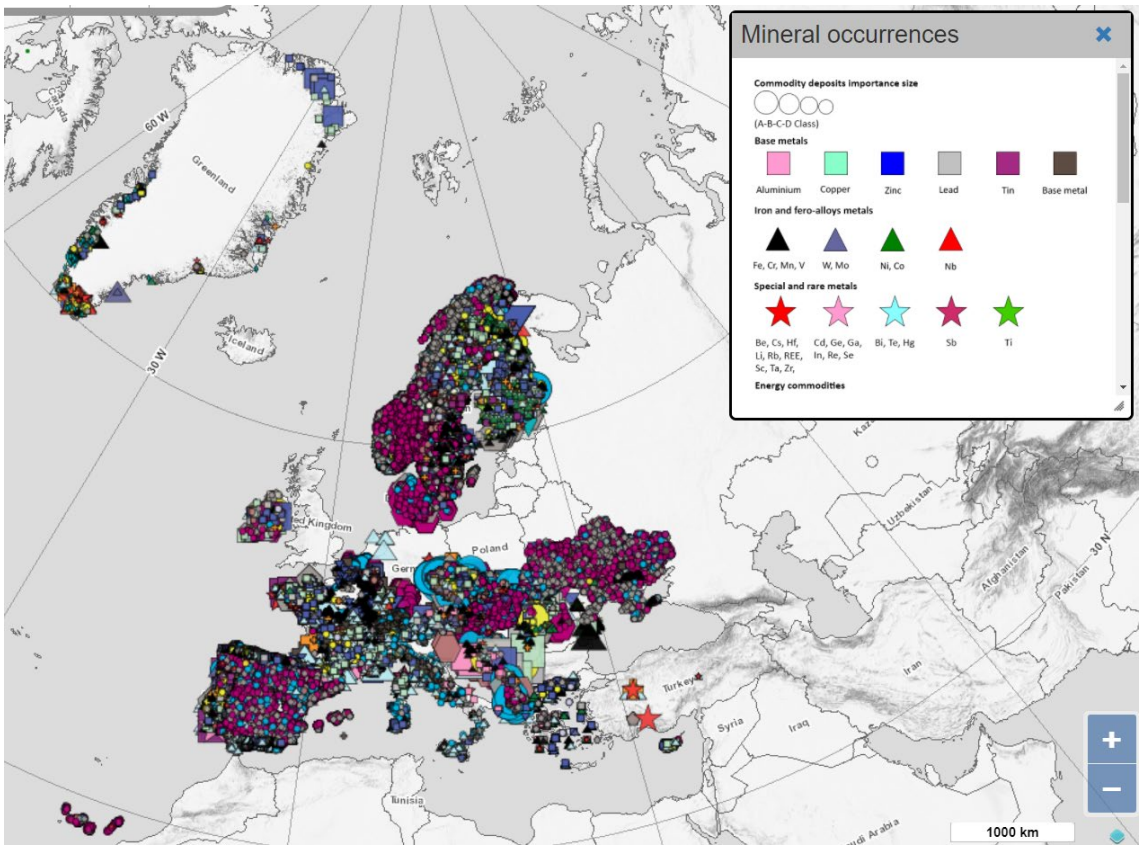

Figure 6. *"Mineral occurrence" in the MIN4EU DB end of October 2021*

Figure 6 shows location of all mineral occurrences according to commodity deposit importance.

Ideally, the data providers categorise the 'importance' of mineral occurrences. However, Figure 7 indicates that more than 90% of mineral occurrences are identified simply as occurrence or their importance is not specified.

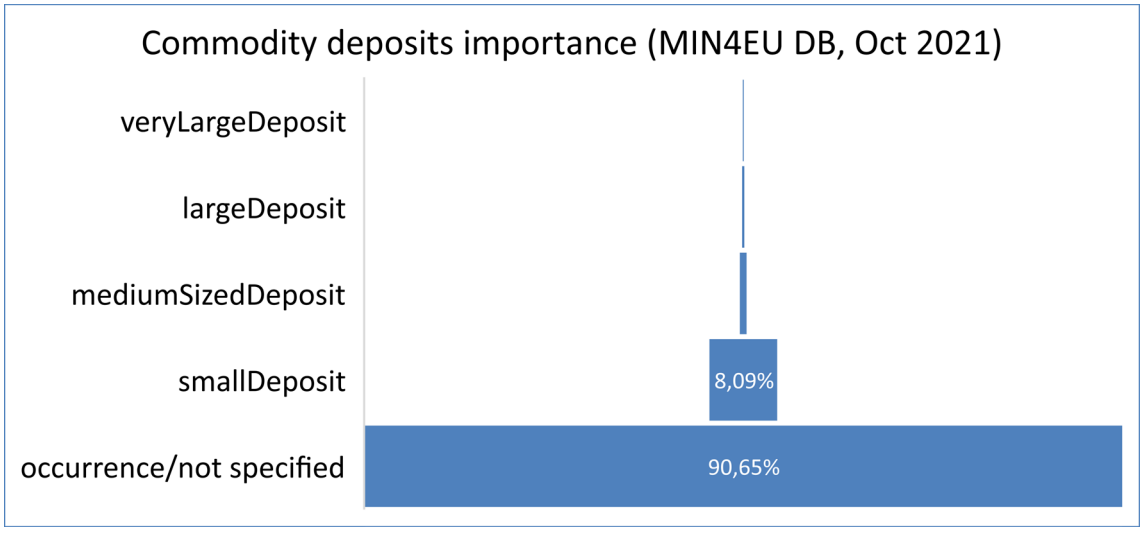

Figure 7. *Percentage of "mineral occurrence" according to commodity deposits importance*

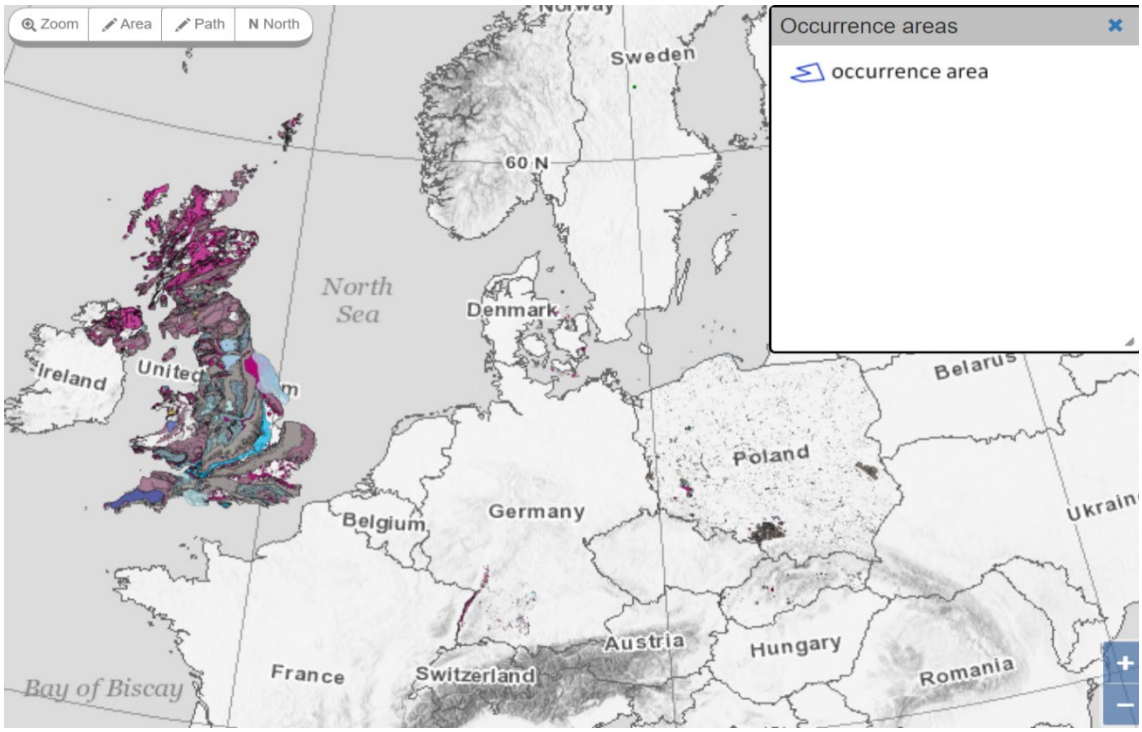

Figure 8. *"Mineral occurrence" areas in the MIN4EU DB end of October 2021*

Some data providers have chosen to deliver their data as mineral occurrence areas, illustrated in figure 8.

Figure 9 shows the ratio between number of records in the "mine" table per country, red indicating number of records in December 2018 and blue indicating number of records in October 2021. Table 4 shows the exact numbers of mines per each country.

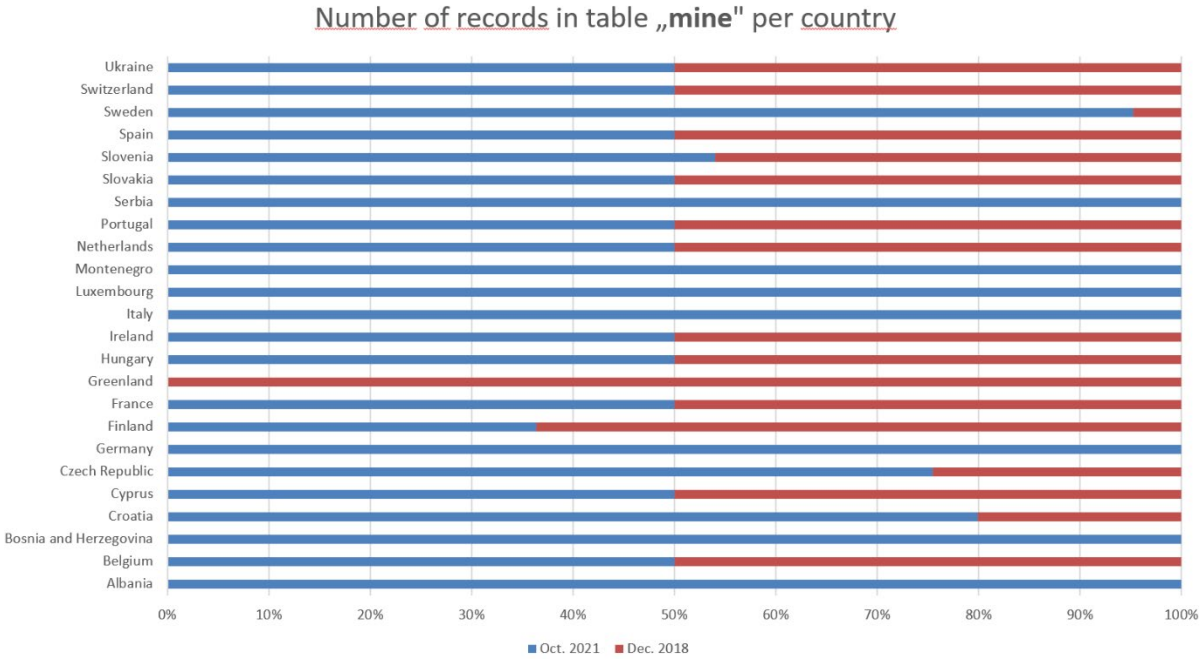

Figure 9. *Comparison between number of "mines" records from December 2018 to October 2021*

Table 4: *MIN4EU data in table "mine" – difference between data count from December 2018 to October 2021*

	M4EU 2018 12 27	M4EU 2021 10 28	
county	count	count	difference
Albania	0	261	261
Belgium	314	314	0
Bosnia and Herzegovina	0	95	95
Croatia	46	183	137
Cyprus	408	408	0
Czech Republic	707	2176	1469
Germany	0	941	941
Finland	346	198	-148
France	4214	4215	1
Greenland	1	0	-1
Hungary	1268	1268	0
Ireland	166	166	0
Italy	0	2341	2341
Luxembourg	0	548	548
Montenegro	0	35	35
Netherlands	205	205	0
Portugal	455	455	0
Serbia	0	50	50
Slovakia	562	562	0
Slovenia	206	242	36
Spain	23293	23293	0
Sweden	676	13467	12791
Switzerland	154	154	0
Ukraine	5119	5119	0

Again, due to modifications in the data model as well as extensions of code lists, today we have better quality of data, which in some cases results in a lower number of records in the DB (which is the case for mineral occurrence data in Finland, while the negative number for Greenland indicates a mistake in the data entry). Mines can be viewed on MINTELL4EU map viewer hosted by EGDI as shown on Figure 10 and Figure 11.

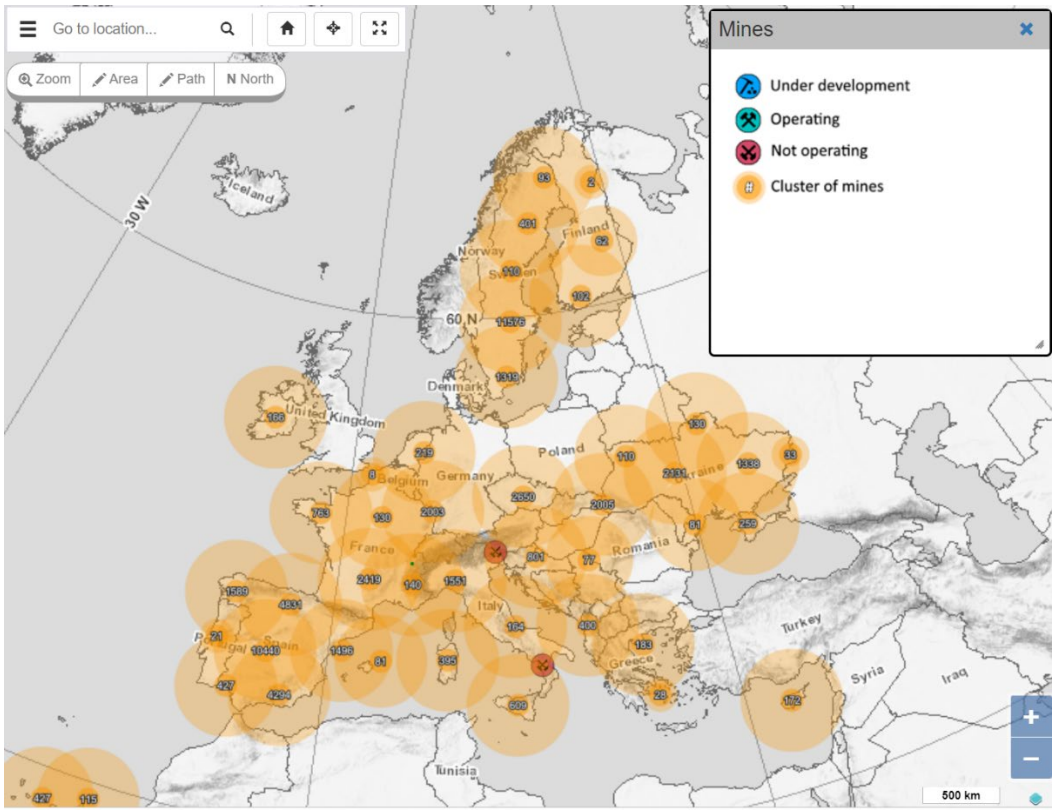

Figure 10. *"Mines" in the MIN4EU DB end of October 2021, showed as clusters*

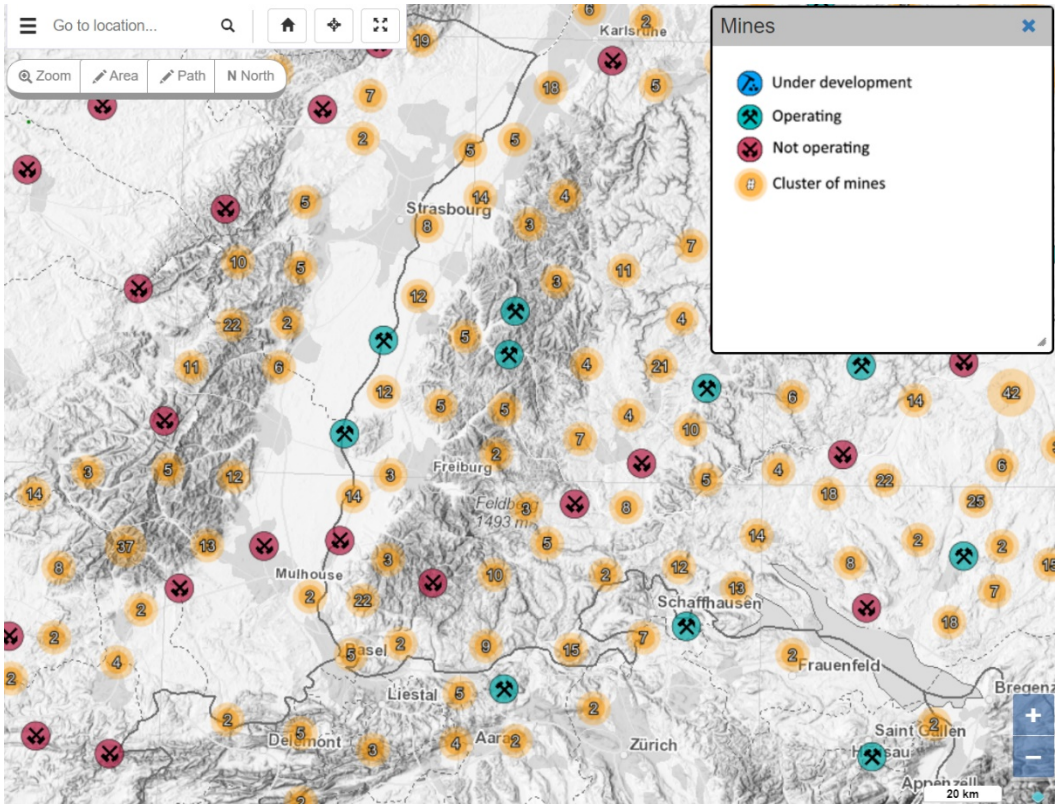

Figure 11. *"Mines" in the MIN4EU DB end of October 2021in more detailed zoom.*

Some additional comparison on mines can be made on their status and mining activity. Figure 12 shows percentage of ”mines” in different categories, describing status of mine, and Figure 13 shows percentage according to their type of mining activity. In both cases figures are showing the status of data end of October 2021).

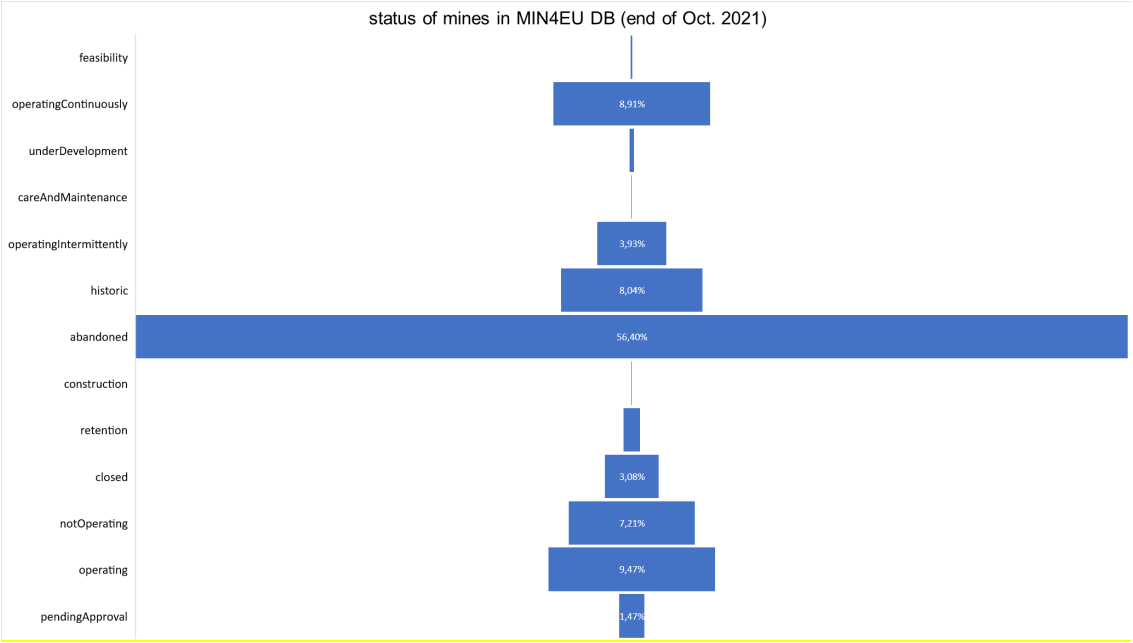

Figure 12. *Percentage of ”mines” according to status of mine (status end of October 2021)*

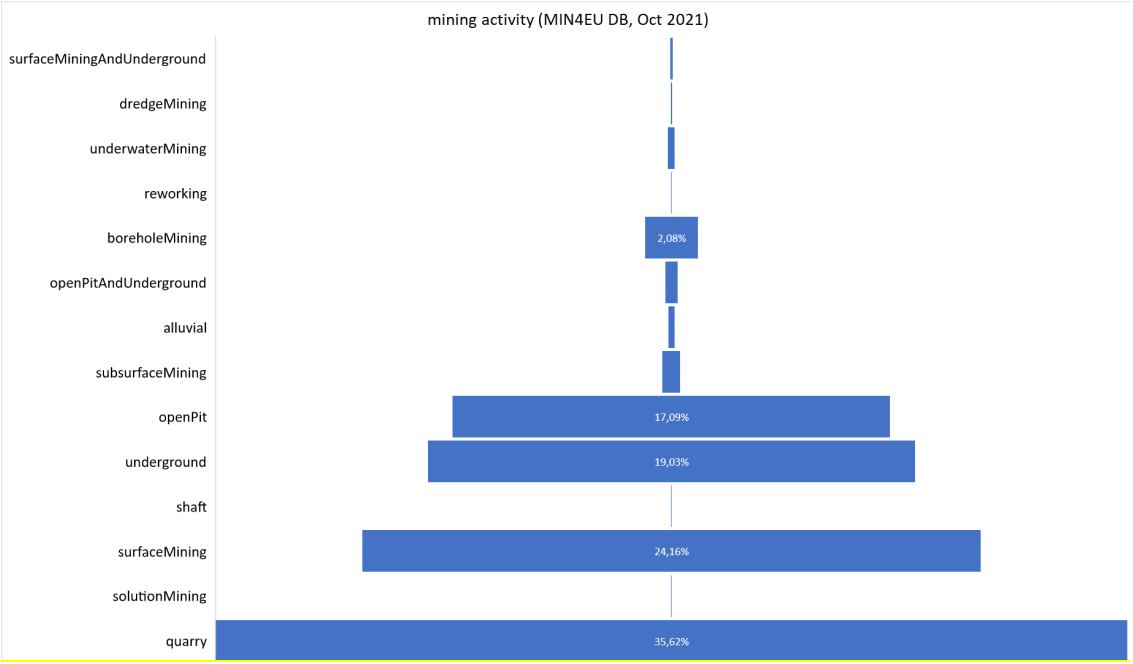

Figure 13. *Percentage of ”mines” according to mining activity (status end of October 2021)*

3.3 Metadata

Data from the central MIN4EU database are visualised on the MINTELL4EU map viewer hosted by EGDI (described in Chapter 4: “Accessibility of the data on EGDI viewer” of this report), and a metadataset *MIN4EU harmonized dataset - "Minerals Inventory”* has been created at the EGDI metadata base. The Minerals Inventory data are downloadable and covered by a CC-BY license, however, with one exception as the Polish data are covered by a CC-BY-NC-ND license.

There are two metadata descriptions available for each data provider:

- Description of national data, that are part of MIN4EU (Slovenian example: *MIN4EU harmonized dataset - "Minerals Inventory" - national data for Slovenia:* https://egdi.geology.cz/record/basic/615c102c-5128-441c-a1a4-6f590a010855) (Figure 14).

- Description of download service (Slovenian example: *MIN4EU harmonized dataset - "Minerals Inventory" - download service for Slovenia:* https://egdi.geology.cz/record/basic/61655323-ac04-472e-af8d-78010a010855) (Figure 15).

Both are coupled with so called ‘parent dataset’: MIN4EU harmonized dataset - "Minerals Inventory”: https://egdi.geology.cz/record/basic/5f8008e9-7928-4ef3-a0d2-42e70a010833 (Figure 16).

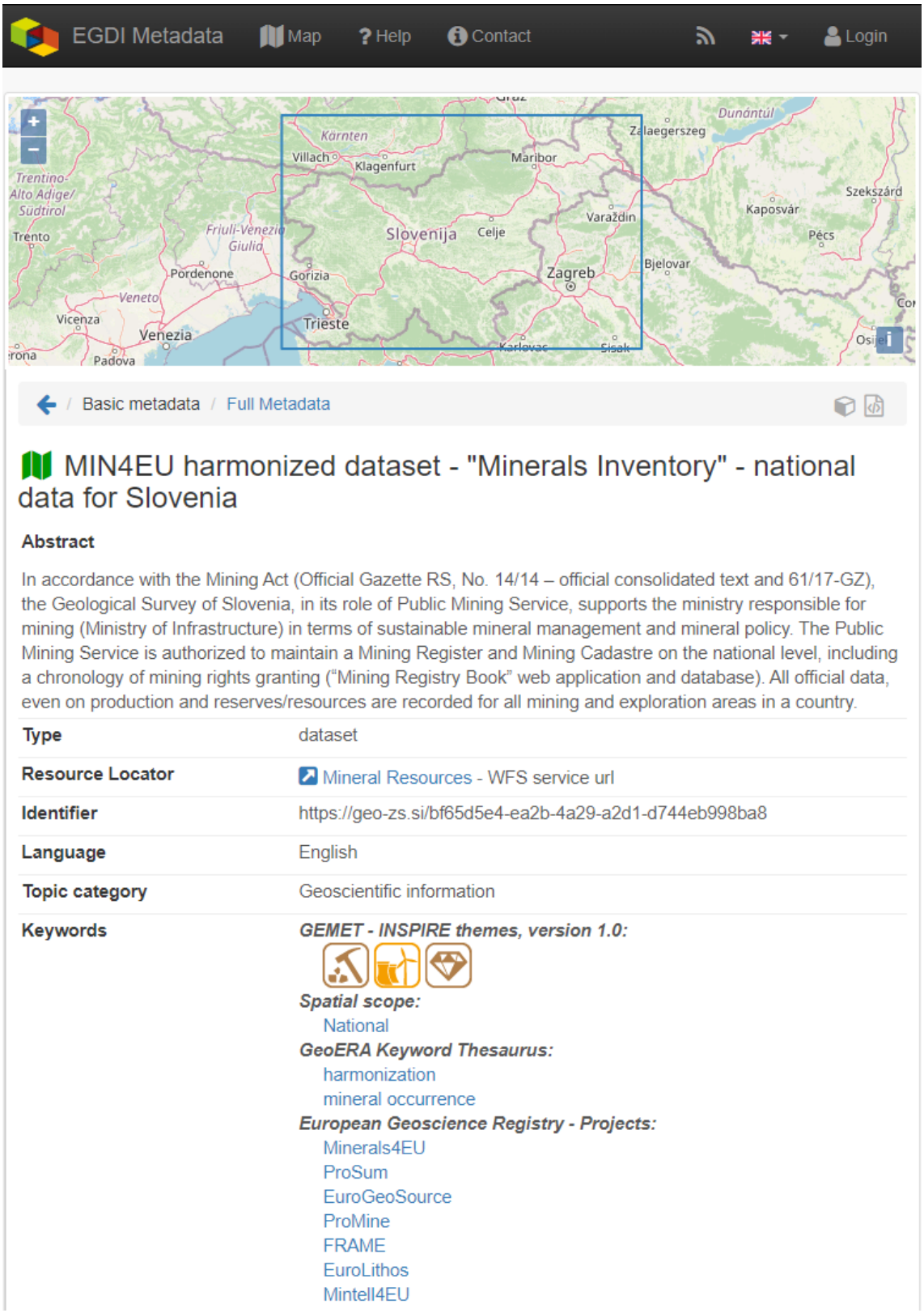

Figure 14. *Screenshot from national metadata description (example Slovenia).*

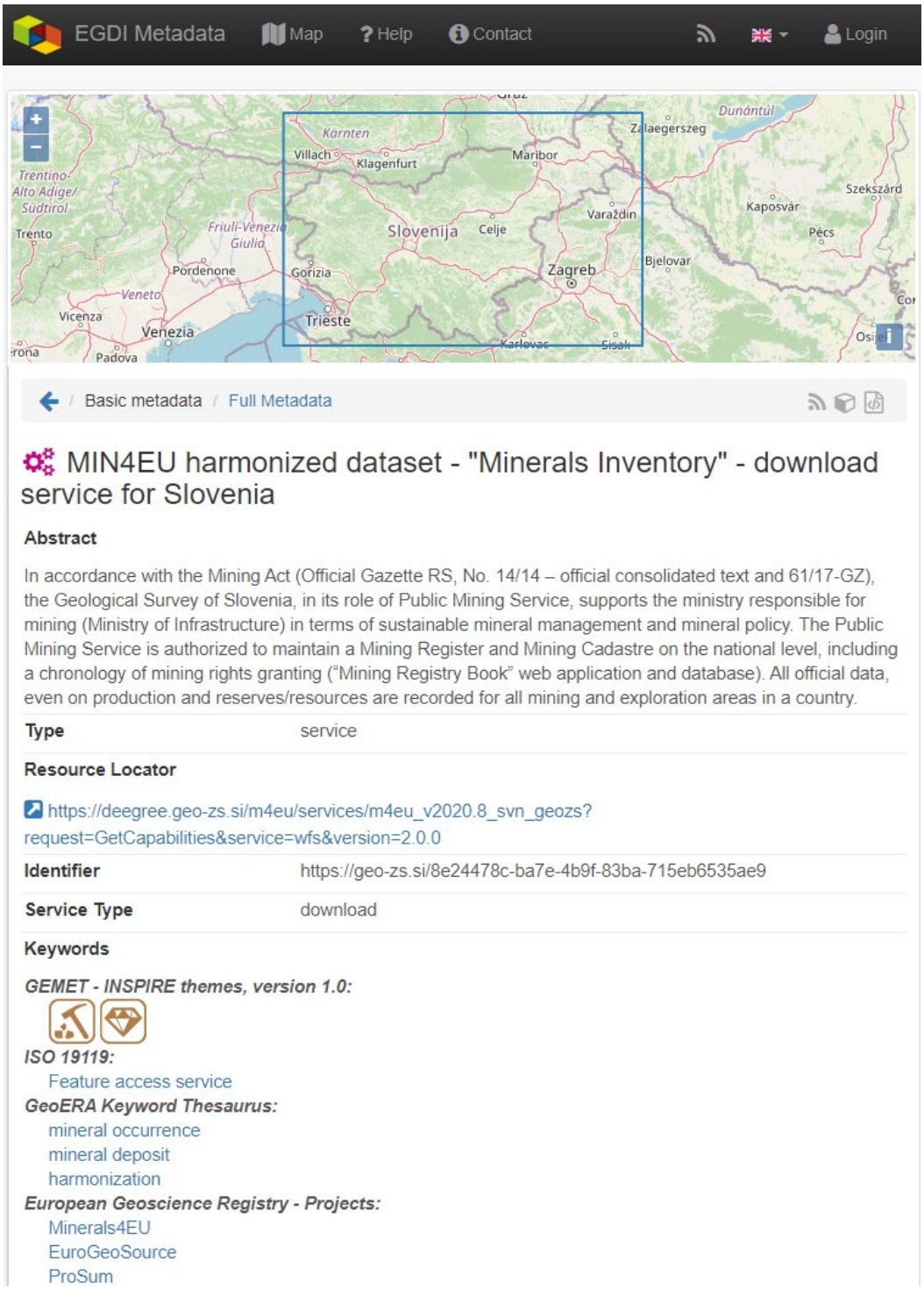

Figure 15. *Screenshot from download service metadata description (example Slovenia).*

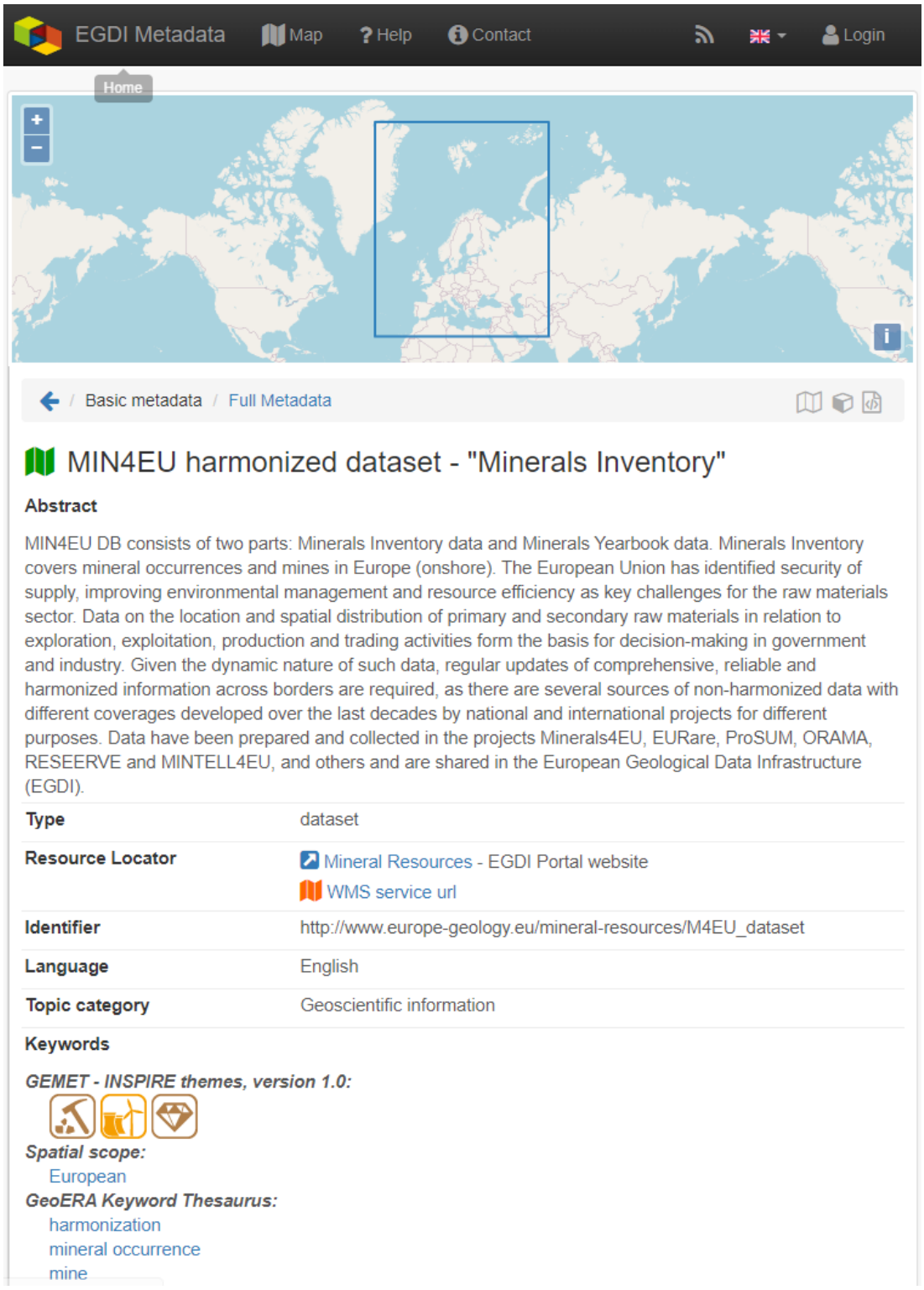

Figure 16. *Screenshot from MIN4EU harmonized dataset – 'Minerals Inventory' metadata description.*

4 ACCESSIBILITY OF THE DATA ON THE EGDI VIEWER

This chapter summarizes the content of the Deliverable D5.7.2 “Report on testing of integration into the European Geological Data Infrastructure (EGDI)”, in the part relating to the Minerals Inventory.

The MINTELL4EU viewer allows users to see the location of mineral resources and mines within Europe and Greenland. Information is stored under the mineral resources theme, showing layers on critical raw materials, mineral occurrences, occurrence areas, mines and tourist mine sites. The three first mentioned layers displays the different commodity groups by deposit size, and it is possible to select data to be displayed by deposit size, commodity group or by commodity. The mines layer displays the location of open and closed mines as well as mines under development. Users can display mines based on commodity, operational status or type of mining activity. The tourist mine site layer shows the location of historical mines that have been developed into tourist attractions.

4.1 Integration of mineral resources theme on the EGDI platform

Tabular and spatial data are harvested from national databases of 36 European data providers covering 31 countries.

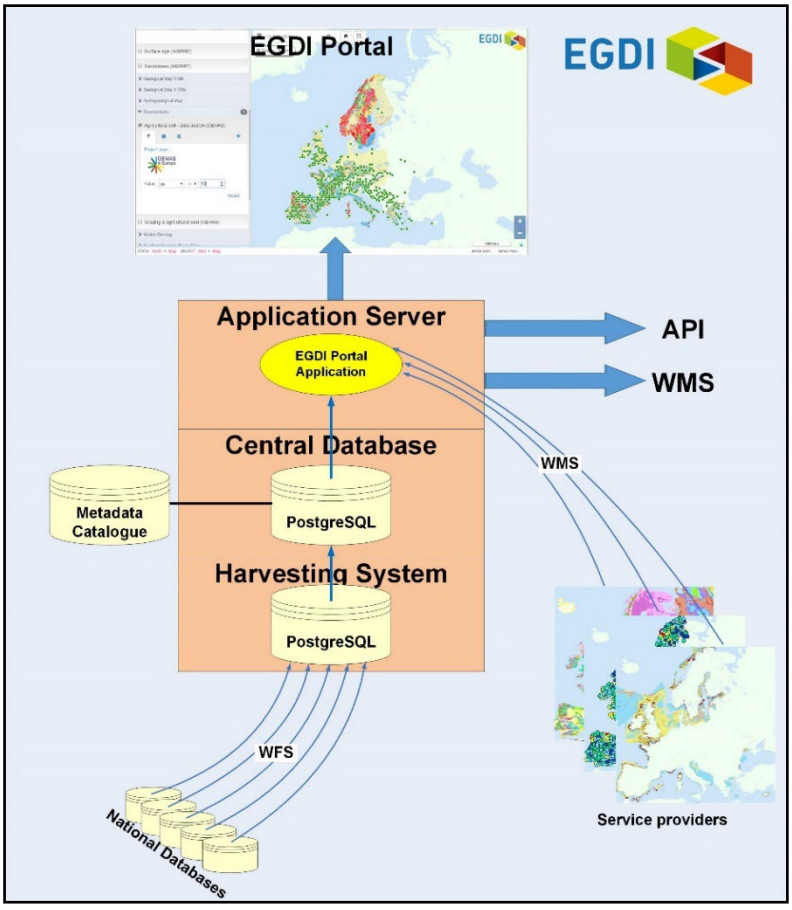

Figure 17: *Overview of EGDI architecture showing central and distributed components.*

Harvesting routines, quality assurance and guidance are performed by the Geological Survey of Slovenia, GeoZS. Data are stored in a central MIN4EU database, which is integrated into the existing European Geological Data Infrastructure (EGDI) platform. The mineral resource data is visualized and made searchable on the portal through an integrated application server as shown in Figure 17. The figure also illustrates how data are disseminated through various channels such as WMS- and API interfaces. Detailed description of how data are integrated to the information platform is available in the Deliverable D5.7.2, Chapter 2.7

The MINTELL4EU viewer displays several datasets addressing raw materials and mines in Europe. The datasets have been prepared and collected in the projects Minerals4EU, EURare, ProSUM, MINTELL4EU, RESEERVE and others and are described in the EGDI metadata catalogue, formerly known as MICKA. (https://egdi.geology.cz/). – more info in previous chapter of this document. The datasets are represented by map layers on the portal (Figure 18).

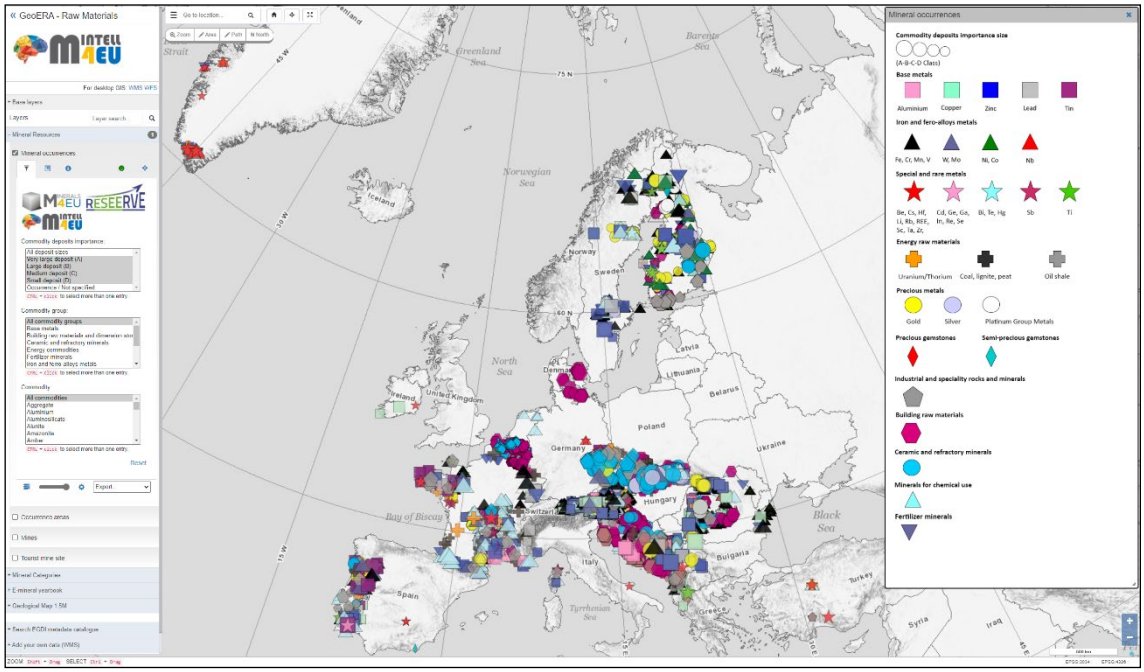

Figure 18. *MINTELL4EU Portal showing the mineral occurrence dataset according to the INSPIRE data specification on mineral resources.*

The legend of the mineral occurrence layer is based on the document D2.8.III.21 INSPIRE Data Specification on Mineral Resources –Technical Guidelines (https://inspire.ec.europa.eu/id/document/tg/mr), with additional information and corrections added from the MINTELL4EU workgroup. These additions include updated classifications on commodity groups and new symbology (Figure 19).

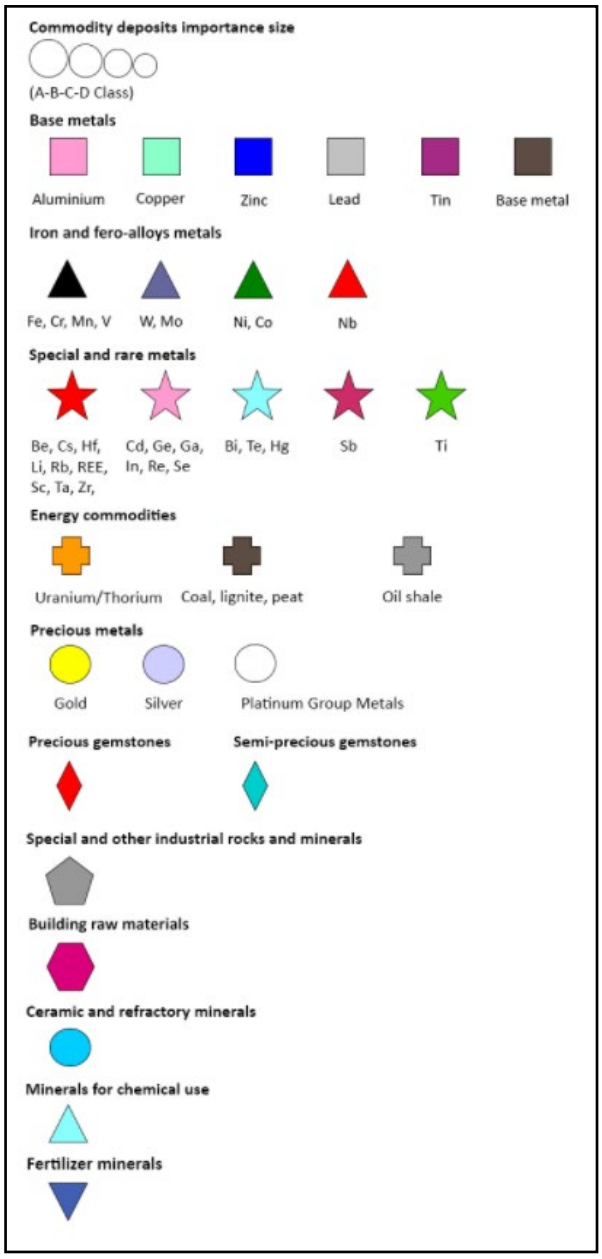

Figure 19: *Mineral occurrence legend*

5 STILL EXSISTING GAPS

Two MINTELL4EU partners failed to update their national datasets to MIN4EU as expected. These are HSMGE (Greece), which has not managed to find an external partner to support the in-house department IT in this task, and BRGM (France), which has indicated that the software required to publish the web services is not compatible with its new IT urbanization. Both partners have stressed that the datasets collected under Minerals4EU are to a large extent still valid. Therefore, these datasets have been transferred to MIN4EU.

In addition, for three countries that were partners of Minerals4EU but not of MINTELL4EU (Netherlands, Romania, Switzerland), their data services for version 1.1.2. were used and transferred to 'country reference databases' in v.2020.08. This allows their old data to be included via harvesting in MIN4EU DB, but the data itself has not been updated since the end of the Minerals4U project.

There are still some "white spots" on the EU map showing that some countries are not part of MIN4EU DB, e.g., the Baltic countries, Malta and Bulgaria. In addition, Germany is only covered by one federal state.

Although the whole consortium has been working to improve the harmonization of data from RM across Europe, there are still some challenges, e.g., a common understanding of the code lists. It is foreseen that work on this will continue in the CSA GSE.

6 MAINTENANCE

GeoZS and GEUS are in direct contact with the relevant data providers. However, it is important to keep in mind that the content of the database depends on the contributions of these data providers. The quality and content of the national datasets submitted to MIN4EU are the sole responsibility of each individual data provider.

The routines for harvesting are automated and will remain available and operational after the end of the project in October 2021. GeoZS and GEUS support will be provided to existing and potential new data providers. If an existing data provider wants to update their national data, they will need to send this information to the support email harvesting@geo-zs.si to allow GeoZS to perform the harvesting. The maps at EGDI will then automatically be updated with these new data.

Meanwhile, EGDI is maintained exclusively with the funds available for the EGDI infrastructure until the CSA GSE[1] is expected to start after summer 2022 as a follow up of GeoERA. As in GeoERA, EGDI has a central role in the CSA GSE.

[1] *Coordination and Support Action: Geological Service for Europe: a project proposal is being prepared under the leadership of EuroGeoSurveys, the Geological Surveys of Europe; call HORIZON-CL5-2021-D3-02-14: Support to the activities of the European Geological Services.*

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