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Report on creating a West Balkan Mineral Register of PMR data (D4.3.)

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List of Content

1. Introduction

The RESEERVE project maps the primary and secondary mineral resources of West Balkan countries: Albania, Bosnia and Herzegovina, Croatia, North Macedonia, Montenegro, and Serbia. The main project outcome is the "Mineral Register" for the region. The aim of the register is to integrate the region into the "pan-European Minerals Intelligence Network" and bring it closer to the common mineral market. Establishing the West Balkan Mineral Register supports mineral exploration in the region and opens it up to the European mineral market.

The RESEERVE project's activities are in line with all three pillars of the "Raw Materials Initiative - meeting our critical needs for growth and jobs in Europe (Brussels, COM(2008/699))":

1. To ensure access to raw materials,
2. To foster a sustainable supply of raw materials from European sources,
3. To boost resource efficiency.

The project's objectives are also aligned with the "Europe 2020 Flagship Initiative on Resource Efficiency" and the "Roadmap to a Resource Efficient Europe", as well as with the "INSPIRE Directive (2007/2/EC) - establishing an infrastructure for spatial information". It contributes to EU resource efficiency aligned with Goal 12, and subsequently to EU economic growth (Goal 8). Since the region is less developed regarding the EU average, the project contributes to diminishing inequality among nations following Goal 10.

According to the EU, with its mineral resources demands and strategic tendencies, the West Balkan Mineral Register provides a basis for the region's entry into the common European data infrastructure. Publicly available data in this Register represent crucial information and a starting point for interested stakeholders: potential investors, other mining/mineral related businesses, as well as research and education institutions.

Before the creation of the Register, relevant national data providers were identified. Data were collected from West Balkan task partners, mostly national geological surveys. After data collection, the data quantity, quality, and format were examined.

Beneficiaries of the Mineral Register are:

- West Balkan countries and their mining/mineral community: authorities responsible for mining/minerals, which increase their capacity for national mineral management, national geological surveys, junior mining companies, SMEs, start-ups, and other mining/mineral companies.
- Potential investors in the region, for whom the Mining Registry represents a better opportunity to decide about their potential investment options.
- Other projects developed from the results of this project.

The Register will increase West Balkan countries' knowledge about their mineral endowment and improve local mineral management. Through the Register promising deposits become accessible for potential investors to explore these and determine their economic value. Positive exploration results will be followed by mining activities that have a positive effect on job creation and other economic effects. Mining activities will also have a positive effect on all mineral-related sectors.

2. Definition of PRM attributes

National meetings with the most important data providers were organised at the task partners' premises. The framework for the common set of attributes, which provide the most important information about natural mining/mineral resources at a national level, were determined at these workshops. The attributes of the PRM table definition present a starting point for the creation of the Primary Mineral Register.

The activities for creating common mineral resource datasets can be divided into three steps:

1. Studying existing primary raw materials data,
2. Selection of attributes according to analysis,
3. Creating common primary raw materials dataset.

The most interesting attributes for each country were selected according to their informational value for potential beneficiaries. According to the informational value for national stakeholders, some attributes were added, although they are not available in a comprehensive INSPIRE-aligned set. In the next step, a set of attributes was determined and a set of attributes which are common to the whole region were selected. Most of the attributes are based on INSPIRE code lists (listed in brackets in the following text). The PRM attributes were divided, according to their type, into three major data groups.

1. **General data**, providing basic deposit information
2. **Technical data,** related to the technical description of the deposit
3. **Geological data**, describing the basic geology of the deposit

Further **General data** were divided into:

- Mineral deposit name (active or greenfield), (INSPIRE)
- Municipality of the mineral deposit
- X and Y WGS84 (World Geodetic System) coordinates, (INSPIRE)
- Country in which the deposit is located, (INSPIRE)

Technical data were divided into:

- The site's current status (operating, closed, abandoned, feasibility etc), (INSPIRE)
- Mining method (open pit, underground, quarrying etc), (INSPIRE)
- Concessionaire's name, (INSPIRE)
- Mineral reserves (calculated in tonnes), (INSPIRE)
- Reserve type (proven, probable etc.), (INSPIRE)
- Concentration of useful components in ore

Geological data were divided into:

- Basic geological map with a scale of 1:100.000
- Type of mineral deposit, (INSPIRE)

- Size of mineral deposit, (INSPIRE)
- Age of mineral deposit, (INSPIRE)
- Hosting rock type,
- Major (INSPIRE), minor and trace minerals (according to their quantity),
- Final product (produced or could be produced from raw materials, (INSPIRE).

The above-mentioned attributes were selected to provide complete information on mineral deposit and raw materials.

3. Collecting PRM data from TP countries

Project task partners from the West Balkan region are experts on raw materials in their local environment. They have gathered comprehensive mineral data about metals, industrial minerals, and rocks at a national level. Publicly accessible data were selected and gaps in the information on minerals were identified. Although in most countries all mineral commodities are a property of the state, some data are not public. Considering the differences in mineral endowment, exploration level, level of data details and the technical (IT) tools in use, datasets differ from country to country. Therefore, a comparison of datasets from different TP countries was performed and the mineral data validated. A common dataset was established to ensure comparability of the data provided. A broad set of mineral data for different sites has been included - from active, abandoned, and closed mines to sites where no previous mining activities took place – “greenfield sites”.

4. PRM data quality

After gathering data from national TPs, a data quality checking process began. Through an iterative process between the project coordinator and task partners the data quality is getting better and consequently the information value for beneficiaries has risen. Physical and online, common, project bilateral meetings and workshops have been taking place, where data issues have been discussed. According to the task partners’ expert knowledge, the most promising metal, industrial minerals, and rock sites were targeted.

4.1. Challenges addressed

In the process of data quality improvement different challenges needed to be addressed. Data were gathered from different sources. First, shortcomings in collected data had to be identified. Some mineral data needed to be refreshed and updated, because they were derived from old geological reports and assets. During the political and economic transition taking place in the region in the 1990s, many data on deposit status and ownership were unclear and had to be examined once again. Some regional specifics also need to be addressed – e.g. the collected data were in the Gauss-Krüger coordinate system instead of in WGS 84 (World Geodetic System), so they had to be converted.

Some shortcomings of the INSPIRE vocabulary were also raised e.g. there is no option for simultaneous subsurface and surface mining. The difference between the terms “under development” and “construction“

in the INSPIRE vocabulary is not made sufficiently clear etc. Therefore, initial ambiguity was eliminated with the assistance of the project partners.

5. PRM data analysis/statistical processing

The PRM data from the Mineral Register were analysed according to different attributes. Some elementary statistics were performed by the Register's PRM attributes. These analyses provided some interesting information. 473 PRM sites, described with 27 attributes, are included in the Mineral Register. Among these, there are 248 metal sites and 225 sites of industrial minerals and construction materials.

5.1. Current Status of Sites

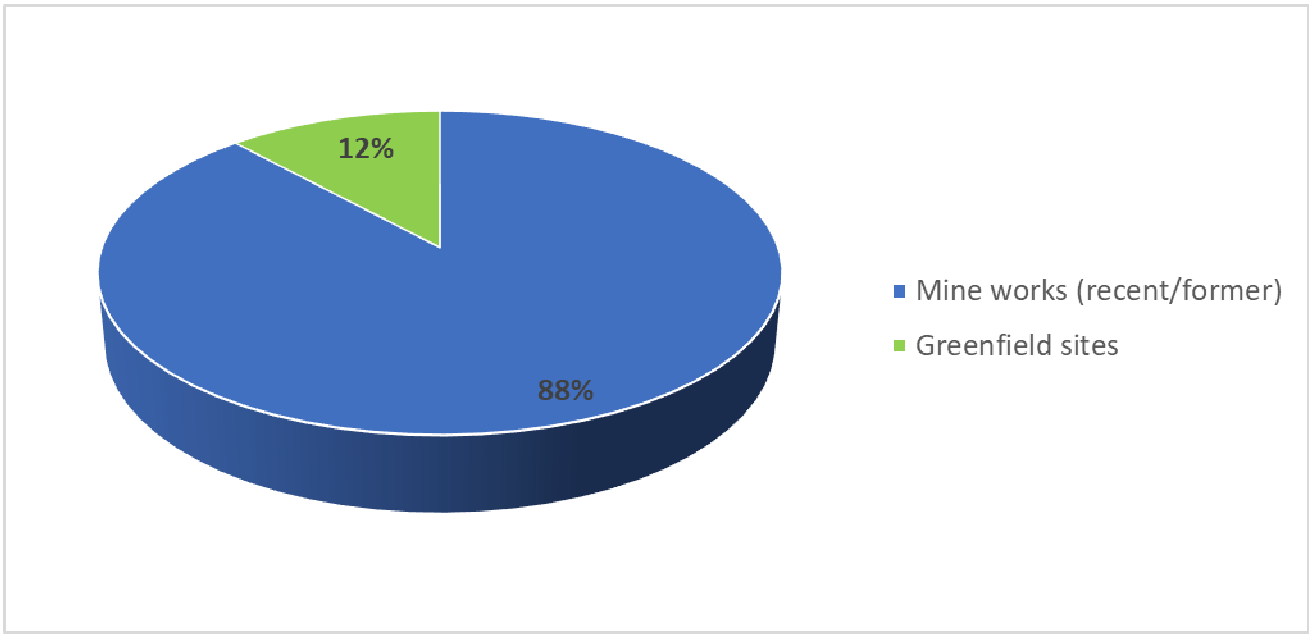


Figure 1. Share of greenfield sites in the Mining Register

56 sites, or 12% of all sites, are intact ie. greenfield sites. Some mining activities have already been realised in the rest of these sites (88%).

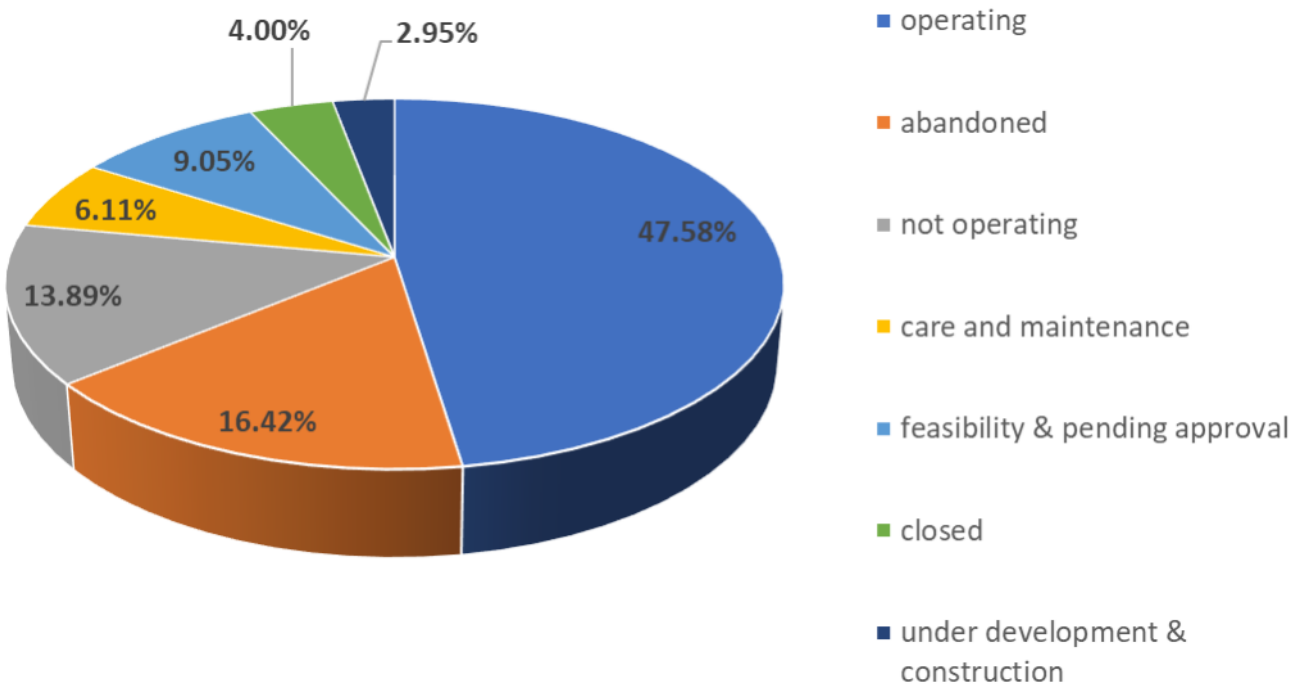


Figure 2. Current status of sites

A site's current status describes a phase in a site's "lifetime". Almost half the selected sites are in operation. This is the result of economic transition and regional wars, as well as a lack of proper legislation. which meant that a lot of mines are abandoned nowadays. There are very few sites with the status of closed, where some closing procedure has been applied. 9% of the selected sites are at the beginning of a "lifetime" cycle, with their status feasibility and pending approval.

5.2. Mining Methods

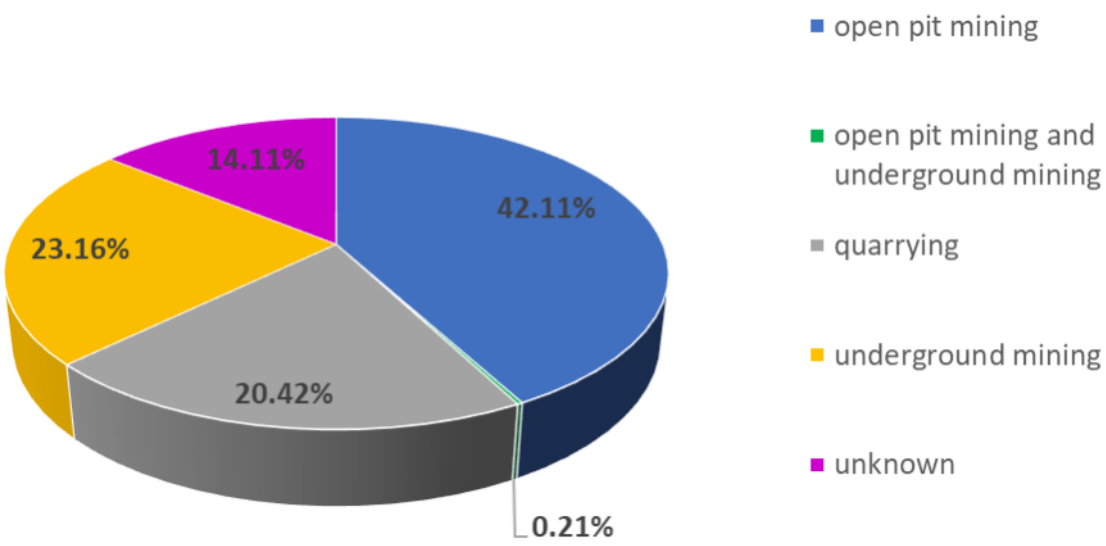
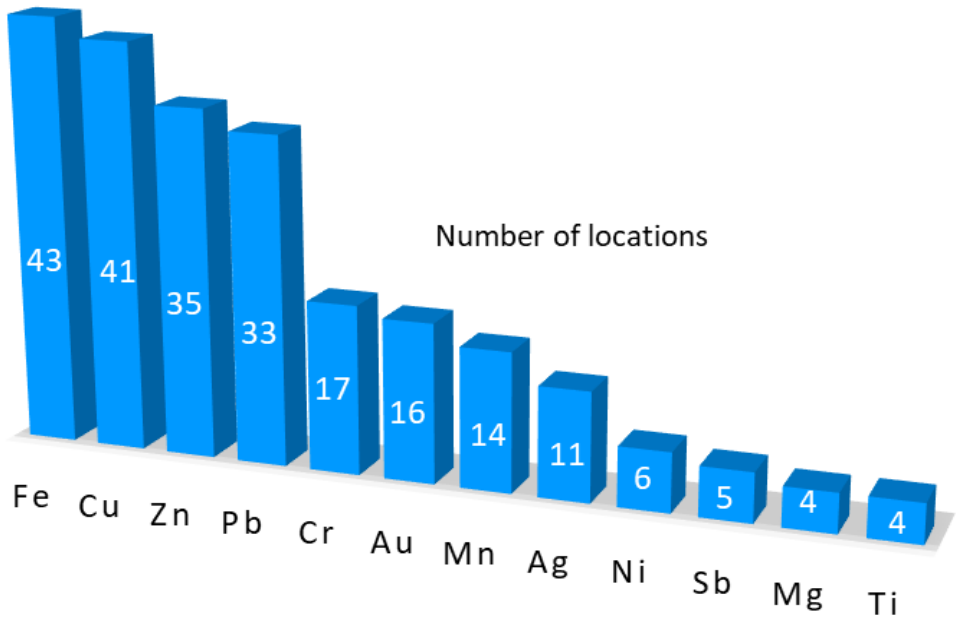


Figure 3. Mining Methods used

The mining method is defined by the type of minerals mined, the geological structure, and the depth of the ore body. Open pit mining is/was the predominant mining method in the region, followed by underground mining and quarrying at selected sites. Quarrying is used for aggregate-crushed stone. Sometimes mining methods are used as a combination of all three methods.

5.3. Major ore metals



*Polymetal sites are counted a few times for each individual metal.

Figure 4. Metal sites

The most frequent metals on the detected sites are: iron, copper, zinc, and lead.

There are several major mineral metallogenic provinces in the West Balkans, from west to east: Dinaric, Vardar, the Serbian-Macedonian and Carpatho-Balkan zone.

The largest geotectonic unit on the West Balkan peninsula (ex-Yugoslavia territory) is Dinarides, divided into: External Dinarides (along the Adriatic coast) and Inner Dinarides (towards the Pannonian basin).

1. The **Dinaric Metallogenic Zone** occupies the western part of Central Serbia, most of the BiH territory, southwest Croatia, and Montenegro along the coast and part of Albania. Endogenic ore mineralisation is caused by two metallogenic epochs: late Hercynian and early Alpine.

   The Bosnia and Hercegovina Dinarides zone is well known for Pb/Zn ore (Veovača, Olovo deposits etc.); in addition, some other metal ore deposits are present, such as Fe (eg. Radovan) and Cu (eg. Mackara); even antimonite occurs in the Čemernica district. Dinarides in western Central Serbia characterises the Zlatibor ore district, bearing Fe, as well as the Priboj-Tutin cone and the Polimlje ore district with its copper deposits.

In the same geologic-geotectonic unit there are hydrothermal massive Fe-Cr-Ni sulphides; the most significant occur in Albanian basalts from the vulcano-sedimentary period.

The most representative mineralisation for the karstic External Dinarides are Fe-bauxite deposits, spread parallel to the Adriatic coast in Croatia and Montenegro.

2. **The Vardar Zone** is a belt east of the Dinaric Alps and west of the Serbo-Macedonian Massif. It consists of three parts: the Srem, Jadar and Kopaonik blocks, separated by ophiolitics fractures (Dimitrijević, 1997). The geological succession of the Vardar Zone consists of small blocks of crystalline schists, Carboniferous Veles beds, Jurassic ultramafics, Triassic sediments, diabase-chert formations, Jurassic granitoids, Lower and Upper Cretaceous flysch and Tertiary calc-alkaline volcano-intrusive complexes (Jelenković et al, 2008). The ophiolites of the Vardar Zone consist mainly of Mg-rich peridotite and dunite. Their metallogeny is characterised by major chromite and significant pyritic cupriferous deposits, as well as the major magnesite and chrysotile asbestos deposits, local nickel silicate, and nickeliferous iron deposits.

   The main ore mineralisation is linked to the Jurassic ophiolites complex (peridotite-pyroxene deposits bearing Cr, Ti, Fe). Endogenous ore deposits related to these ophiolitic complexes are mostly Ni-Co-Cu-Fe sulphides, pyritic cupriferous deposits, sporadically magnetite deposits, and minor gold mineralisation, but without major chromite deposits.

   In the same geo-tectonic unit there are also deposits of hydrothermal massive sulphides with pyrite and copper (particularly significant in Albanian basalts). Sporadically, Ni-Cu mineralisation could be found in Jurassic ultramafic units, as well as the origin of Cr and Ti during magmatic differentiation.

3. **The Serbian-Macedonian Massif** is a belt stretching in the north-south direction along the Great and South Morava valleys in Serbia, into western North Macedonia (continuing into northern Greece).

   Metal deposits are linked to Ol-Mi volcanic intrusive containing Pb and Zn, subordinated Cu and Sb, accompanied by Au, Ag, As, Ta, Bi and Fe. The Kopaonik ore region is characterised by hydro-thermal and metasomatic vein type ore deposits, bearing Pb and Zn and other metals (Ag). The copper porphyry type of deposits are also important.

4. **The Carpatho-Balkan Arc** runs across eastern Serbia, in the shape of an arc. Its northern part, the Serbian Carpathians, is an extension of the Carpathian Range, and it joins the western parts of the Balkan Mountains, whose main massif is in Bulgaria.

   Many deposits in the Carpatho-Balkanian metallogenic province (eastern Serbia) are associated with horst-graben structures formed above subducted oceanic lithosphere under the Eurasian plate, following the closure of a Tethyan branch during the Early Cretaceous period (Janković 1990). The most important deposits (Cu, Au, and rare Pb-Zn) related to subduction-related settings are of the porphyry copper, skarn type and volcano-hydrothermal (massive-sulphide): the Bor deposit, Majdanpek deposit, Veliki Krivelj deposit (Bor metallogenic zone) and the Ridanj-Krepoljin Zone (Reškovica, Antina Čuka etc).

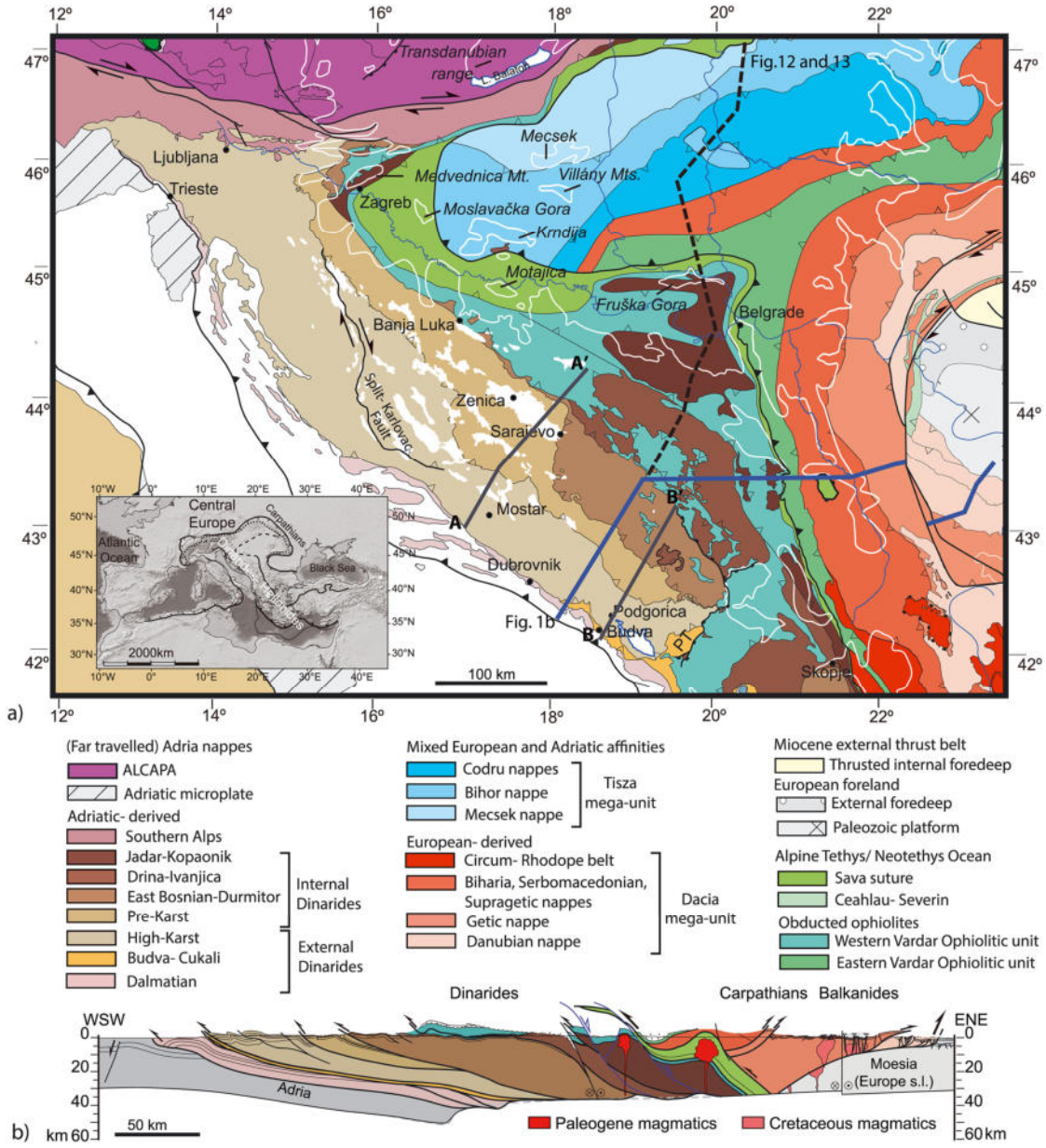


Figure 5: Geotectonic units in the West Balkans

(https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2018TC005066)

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Dimitrijević M.D. 1997: Geology of Yugoslavia. Geological Institute – GEMINI, Belgrade, Spec. Publ., Monograph, 1—197

Jelenković R. et al, Mineral resources of Serbia , Geologica Carpathica, 2008, 59, 4, 345—361

5.4. Industrial Minerals and Rocks (including some aggregates)

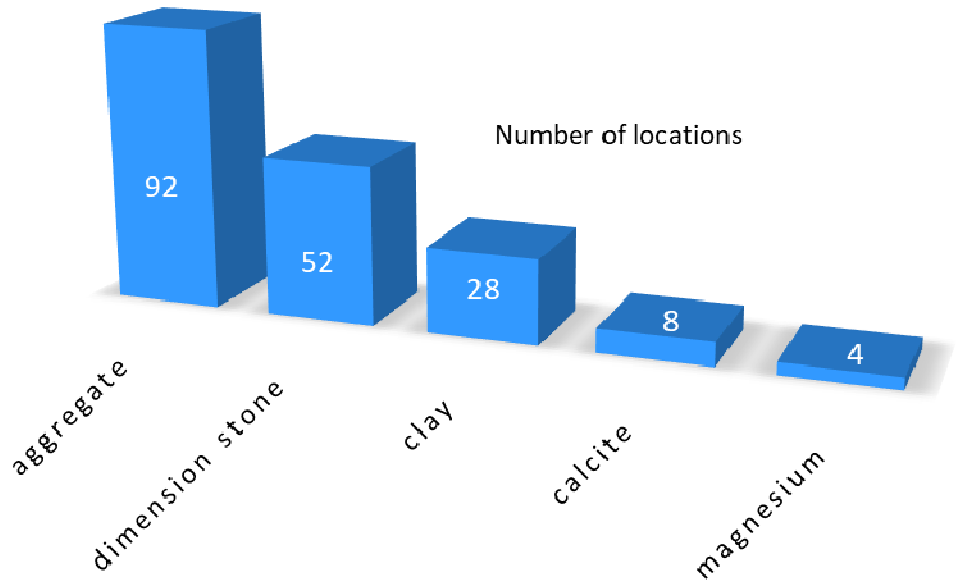

Figure 6. Industrial Minerals and Rocks (including aggregates)

Aggregates (crushed stones, sand, and gravel) are reported from Croatia and Montenegro, although they are frequent in the whole region. Bauxite is abundant in carbonate host rocks throughout the Dinarides, and has been reported from Croatia, Montenegro, BIH, and Albania. Amongst industrial rocks there is pure calcite reported from the whole region and magnesite reported from BIH and Serbia. Particular dimension stone sites and different types of clay, some of them also with a high economic value, are also of interest in the region.

5.5. CRM (Critical Raw Materials)

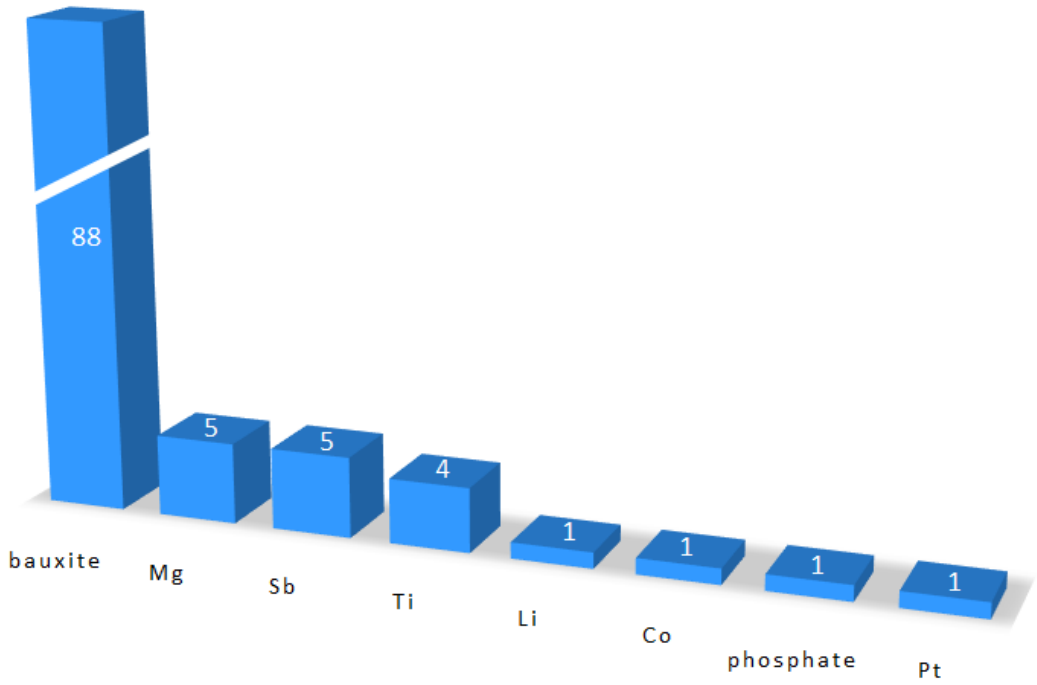

Figure 7. Critical Raw Materials

The European Commission has defined a list of critical raw materials (CRMs) for the EU. These are raw materials of great importance for the EU economy and with high risk associated with their supply. The predominant CRM in the region is bauxite, due to its specifics. Among other CRMs, magnesium, antimony, and titanium are the most commonly reported.

5.6. Raw Materials for Electric Vehicle Batteries

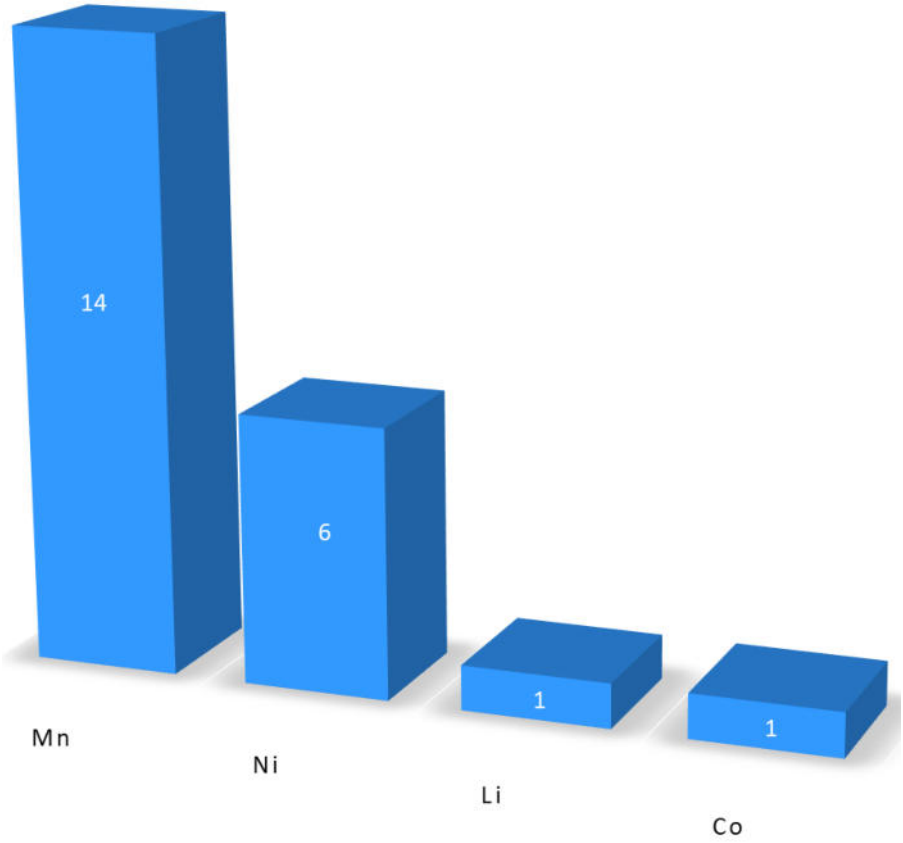

Figure 8. Raw materials for Electric Vehicle Batteries

Mineral deposits with RM for electric vehicle batteries were also represented in the Register. With the exception of graphite, all other primary minerals for batteries are defined/found. Providing these to EU producers of e-vehicle components, the West Balkans also provide great support for the EU's transformation in relation to e-mobility and, consequently, a more sustainable and green society, because there is a high potential in this region for RM supply for the battery industry.

6. Integrating the West Balkans into the EGDI infrastructure

One of the most important of the RESEERVE project's objectives was to demonstrate the harmonisation of existing data in the INSPIRE-compliant EU mineral intelligence network. The project's initial goal - "for the duration of the project up to two countries will be connected to the INSPIRE-aligned network" was exceeded by including mineral data provided by all TP countries.

The PRM data from the RESEERVE project have been gathered in the European Union Minerals Knowledge Data Platform (EU-MKDP), developed in the framework of the "Minerals4EU" project. The most interesting sites, according to the task partner's selection, are therefore also visible on the EGDI portal. West Balkan mineral information is accessible and easily shared across Europe and the world.

7. Conclusions

The project is committed to the West Balkan region, which recently still represented a gap in the “pan-European Minerals Intelligence Network”. The RESEERVE project represents an excellent case study for providing methodology on how to obtain and organise data from different sources and countries and prepare these for harvesting into the INSPIRE-aligned “pan-European Minerals Intelligence Network”. During the RESEERVE project, the “Mineral Register for the West Balkans” has been created. The mineral data became accessible and attractive for potential investments in the raw materials sector in the West Balkan region. Data captured in the West Balkan Mineral Register will increase the visibility of the most promising primary raw material sites in the region and lead to an increase in investments in existing mining areas. The Mineral Register will provide the necessary information to enhance national mineral management and to increase European mineral self-supply, which is crucial for European industry. The positive effects will contribute to raising the innovation level in the West Balkan region, the transfer of new technologies, job creation, and prevention of a brain drain.