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The future of mining in the Adria region: current status, SWOT and Gap analysis of the mineral sector

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Abstract

The Adria region which includes the countries of: Albania, Bosnia and Herzegovina, Croatia, Montenegro, North Macedonia, and Serbia, and corresponds to the Dinarides, northwesternmost Hellenides, and the Vardar zone, has a long history of mining. Here, the main strengths and challenges of the mineral sector of the Adria region were assessed using the following methodology: (1) presentation of the current status of mineral exploration and exploitation, (2) SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis on parameters including geological potential, economic environment, legal and regulatory framework, innovation and technology framework, environmental protection and land use planning, governmental and social potential, human resources and educational potential, (3) Gap analysis, and (4) integration of the results obtained in the development of a roadmap for the actions required to promote investments in the mineral sector in the Adria region. The main strengths of the regional mineral sector include the significant mineral potential due to a favourable geological setting, significant reserves, a long mining tradition, and active exploration areas, as well as a significant number of active and abundant mines and the availability of secondary raw materials. Nevertheless, there are many challenges that the mineral sector faces, such as difficulties in ensuring social acceptance, a lack of new exploration campaigns in many areas, estimation of resources or reserves that do not follow international codes and standards, regulations related to environmental issues in the mineral sector of Adria countries that do not comply with European legislation, and the limited availability of qualified technical, scientific and managerial personnel involved in the whole mineral cycle. Therefore, actions and measures such as awareness campaigns to highlight the significance of Raw Materials in the sustainable development of the region, further exploration, reserves calculation in alignment with internationally recognized codes, harmonization with spatial plans, and reforms to attract investors and capacity building programs should be taken for further development of the Adria region's mineral sector in a sustainable manner.

Keywords: raw materials potential, exploration and exploitation status, SWOT analysis, Gap analysis, Adria region

1. INTRODUCTION AND BACKGROUND

Geographically and politically, the Adria region includes the area of the Western Balkans, i.e., Albania (ALB), Bosnia and Herzegovina (BiH), Croatia (HRV), Montenegro (MNE), North Macedonia (MKD), and Serbia (SRB). In the Early Neolithic period, the Adria region was a centre of mining and metallurgical activities due to its richness in copper ore minerals such as malachite and azurite (RADIVOJEVIĆ et al. 2010). Mining and smelting activities in the Roman period included base metals such as copper, gold, silver, lead, and zinc, while today numerous metallic and non-metallic raw materials are mined and processed in the region (REICHL & SCHATZ, 2021).

1.1. Raw material potential

The Adria region mainly comprises the Dinarides, the northwesternmost Hellenides, and the Vardar zone, which host Palaeozoic to Neogene External and Internal units (the High Karst and Pre-Karst units, Variscan basement units with the surrounding Bosnian flysch, the Western Vardar ophiolite unit, and the Sava suture zone) and ore deposits associated with various stages of the Alpine Wilson cycle (PALINKAŠ et al., 2008; PAMIĆ et al., 1998). The predominant ore-productive phases are the following:

(1) Permian units related to early intracontinental rifting hosting hydrothermal siderite-baryte polysulfide deposits, epigenetic sedimentary uranium deposits, red bed-type, sabkha-type copper and barite deposits and evaporites (PALINKAŠ et al., 2008), that are widespread mainly in the northern part of the Dinarides (Croatia, Bosnia and Herzegovina, and partly Albania). Ongoing exploitation in the region is related to (a) evaporites (Croatia, Bosnia and Herzegovina, and Albania) and (b) gossans developed over primary siderite-polysulfide deposits (Bosnia and Herzegovina).

(2) Advanced Triassic rifting with Mn-Fe-SEDEX and hydrothermal iron-polysulfide-barite-mercury deposits with ongoing production/project activities in manganese and antimony deposits in Bosnia and Herzegovina.

(3) Jurassic oceanization associated with chromite, titanomagnetite, the platinum group elements (PGEs), Cu hydrothermal and magnesite deposits in the upper part of the ophiolite sequences in the ophiolite zone of the inner Dinarides - Hellenides and coeval bauxites on the High Karst and Pre-Karst units. Ongoing geological prospecting and exploitation are focused on (a) copper, sometimes associated with Pb, Zn, Au, Ag, Se (Albania; MILUSHI, 2015; HORN et al., 2021), (b) bauxite, occasionally enriched with titanium and rare earth elements (REEs) (Croatia, Bosnia and Herzegovina, Montenegro, Albania; TOMAŠIĆ et al,

2019; RADUSINOVIĆ & PAPADOPOLOULOS, 2021), (c) chromite- and titanomagnetite-bearing vanadium mineralization and PGEs, talc deposits (Albania; MILUSHI, 2015), and (c) magnesite (Albania, Bosnia and Herzegovina, Serbia).

(4) Late Jurassic to Cretaceous subduction and obduction of ophiolites with associated banatite magmatism hosting porphyry-type Cu-Mo-Au deposits associated with Pt, Pa, and Se in eastern Serbia (VLAD and BERZA, 2003), which have been mined for more than a hundred years in the Bor and Majdanpek areas. At the same time, most of the external Dinaric bauxite deposits formed on the High Karst and Pre-Karst units and are currently in operation in Croatia, Bosnia and Herzegovina, Montenegro, and Albania, while syngenetic phosphorite-bearing limestones of Upper Cretaceous age are mined in Albania (SERJANI, 1990; BRUNETT & RIGGS, 1992). Obducted ophiolite crust hosts Late Cretaceous (Fe)Ni-Co laterites in southern Serbia, Kosovo, North Macedonia, and Albania, where several mines with ferronickel production but without cobalt extraction are in operation (HORN et al., 2021; ECONOMOU-ELIOPOULOS et al., 2021).

(5) Extremely fertile are Paleogene collision and (6) Neogene post-collision and extension related magmatic and volcanic rocks hosting numerous working Pb-Zn (Ag, Au, Sb) mining fields and highly successful Li-B exploration projects in the Sava suture zone in Bosnia and Herzegovina, Serbia, Kosovo, and North Macedonia. The rich North Adriatic Late Paleogene bauxite deposits (Croatia) are contemporaneous (KOVAČEVIĆ GALOVIĆ et al., 2012). Most of the bentonite and salt deposits are related to the Miocene Dinaride Lake system (GVERIĆ et al., 2020).

After a century of modern exploitation of traditional metals (Fe, Al, Mn, Cr, Cu, Pb, Zn, Au, Ag, Sb…), the Adria region also hosts numerous secondary raw materials sites with potential for supplying critical raw materials (CRMs). ŠAJN et al. (2022) provides insight on the structure and value of such secondary deposits, analysing 1650 mining and metallurgical waste sites, with approximately 2.6 Gt of waste. These authors concluded that 42 sites with 270 Mt of waste with increased quantities of Au, Ag, Bi, Cu, In, Mo, Rh, Sb, W and Zn corresponding to a profit of 18,100 Mt could be selected for recovery with high economic benefit. Within this special issue, several papers deal with critical minerals in Adria and secondary raw materials sites (RADUSINOVIĆ et al., 2022; STEINER et al, 2022; SERAFIMOVSKI et al., 2022).

Undoubtedly, the raw material potential of the Adria region is great, both in metallic and industrial minerals. Therefore, the aim of this article is to assess the main strengths and challenges of the mineral sector in the Adria region using the following methodology: (1) presentation of the current status of mineral exploration and exploitation; (2) SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of the Adria region, including geological potential, economic environment, legal and regulatory framework, innovation and technological framework, environmental protection, and spatial planning, governmental and social potential, human resources, and educational potential; (3) Gap analysis of the Adria region; and (4) integration of the obtained results in order to present the roadmap, i.e., a strategic plan that defines a goal or desired outcome and includes the key steps or milestones needed to increase investment in the mineral sector of the Adria region.

2. REGIONAL GEOLOGICAL SETTING

The Dinarides are a 650 km long, folded, thrusted, and imbricated belt located between the Southern Alps to the northwest and the Hellenides to the south and southeast, with a northwest-southeast vergence (PAMIĆ et al. 1998). The Dinarides consist of several major tectonostratigraphic and lithostratigraphic units of different origin related to the Alpine-Carpathian orogenic process dating from the Palaeozoic to the Neogene (PAMIĆ et al. 1998; SCHMID et al. 2020). The predominant structures are large thrusts with SW vergence at a regional scale resulting in knappes and local klippes thrusted onto the Adria plate in its present position. The tectonic units include external and internal sectors from the Adriatic units toward the northeast to the adjoining Tisia mega-tectonic unit (zonation follows the overviews of PAMIĆ et al. (1998) and SCHMID (2020; Fig. 1): (1) High Karst and Pre-karst units, (2) Bosnian flysch units, (3) Palaeozoic basement units, (4) Western Vardar Ophiolitic Unit and (5) the Sava suture zone.

The High Karst and Pre-Karst units and their correlatives, together with the East Bosnian-Durmitor zone constitute the External Dinarides, while the Western Vardar Ophiolite unit and the Sava Suture Zone represent units of the Internal Dinarides. The High Karst and Pre-Karst units of the Upper Palaeozoic basement are overlain by Upper Permian to Norian clastics and platform carbonates with penecontemporaneous rift-related igneous rocks, a Norian-Lutetian carbonate platform, and Eocene overstep flysch sequences. Similarly, the Internal and External units of the Dinarides contain exposed Variscan basement units with various degrees of metamorphism (mainly up to greenschist, in some cases up to epidote-amphibolite facies). They are composed of Ordovician to Carboniferous (Permian) metasediments and metavolcanics overlain by a mainly Triassic carbonate clastic cover. The Bosnian Flysch is a 4000-5000 m thick passive continental margin carbonate-clastic tectonostratigraphic unit of Jurassic to Late Cretaceous age. The Western Vardar Ophiolite zone consists of an ophiolite mélange, while Mesozoic radiolarite sequences are associated with basalt, greywacke and shale, and large ultramafic thrust sheets. These formations are overlain by Late Jurassic-Early Cretaceous and Late Cretaceous overstep sequences, whereas the Sava Suture zone contains Late Cretaceous to Palaeogene flysch associated with volcanics, tectonized ophiolite melange, regionally metamorphosed sequences derived from the surrounding Late Cretaceous-Palaeogene rocks and synkinematic granitoids.

The geodynamic evolution of the Dinarides began with the Early Permian rifting of the Variscan basement (BOROJEVIĆ ŠOŠTARIĆ et al. 2009; BOROJEVIĆ ŠOŠTARIĆ et al. 2012), the opening of the Tethyan Ocean in the Late Triassic, followed by the Late Jurassic-Early Cretaceous subduction and emplacement of the Dinaric ophiolites (PAMIĆ et al., 1998). Parts of the Sava Suture zone remained open until the Early Paleogene (SCHMID et al., 2020).

The boundary between the Dinarides and the Hellenides is considered to be the Skutari-Peć line, where units continue into Albania following the Dinaride zonation: (1) the External Albanides consisting of a pre-Apulian carbonate platform and flysch deposits in Early Oligocene- Middle Miocene fold- and thrust knappes of sedimentary rocks derived from the proximal facies of the continental margin of Adria (KILIAS et al., 2001); (2) the Pindos Zone with Jurassic ophiolitic massifs and Jurassic-Cretaceous ophiolites and sedimentary cover units, underlain with continental and oceanic thrust slices of both (ROBERTSON & SHALLO, 2000); and (3) the Korabi-Palegonian Zone composed of the Hercynian basement of Ordovician to Devonian low-grade metamorphic rocks unconformably overlain by Permian- Lower

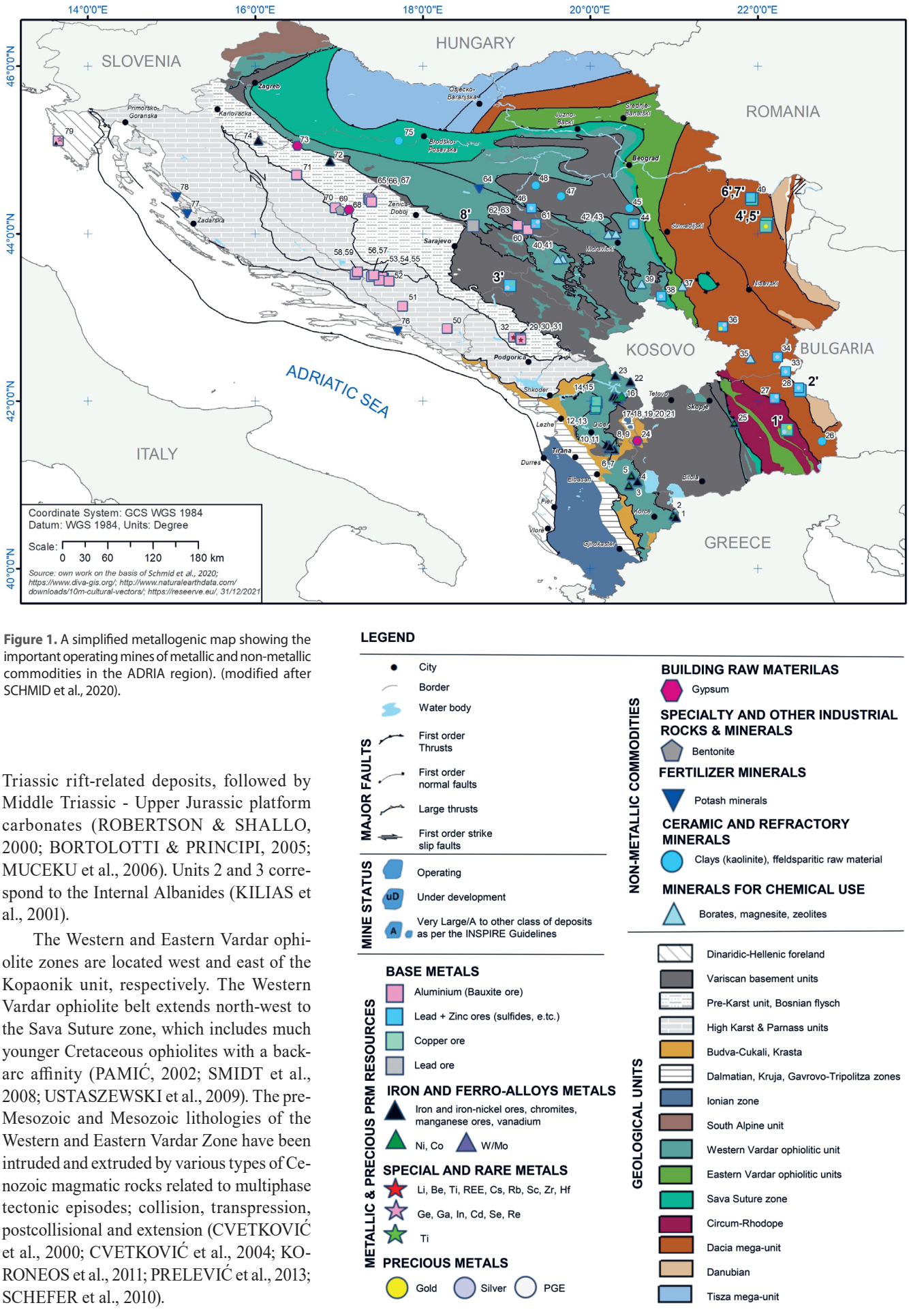

Figure 1. A simplified metallogenic map showing the important operating mines of metallic and non-metallic commodities in the ADRIA region). (modified after SCHMID et al., 2020).

Triassic rift-related deposits, followed by Middle Triassic - Upper Jurassic platform carbonates (ROBERTSON & SHALLO, 2000; BORTOLOTTI & PRINCIPI, 2005; MUCEKU et al., 2006). Units 2 and 3 correspond to the Internal Albanides (KILIAS et al., 2001).

The Western and Eastern Vardar ophiolite zones are located west and east of the Kopaonik unit, respectively. The Western Vardar ophiolite belt extends north-west to the Sava Suture zone, which includes much younger Cretaceous ophiolites with a back-arc affinity (PAMIĆ, 2002; SMIDT et al., 2008; USTASZEWSKI et al., 2009). The pre-Mesozoic and Mesozoic lithologies of the Western and Eastern Vardar Zone have been intruded and extruded by various types of Cenozoic magmatic rocks related to multiphase tectonic episodes; collision, transpression, postcollisional and extension (CVETKOVIĆ et al., 2000; CVETKOVIĆ et al., 2004; KORONEOS et al., 2011; PRELEVIĆ et al., 2013; SCHEFER et al., 2010).

3. RAW MATERIAL EXPLORATION AND EXPLOITATION STATUS

The exploration and exploitation status is described using the classification of mineral commodities, i.e. materials of economic interest in the Earth Resource into the following groups, according to the World Mining Data categories: (i) iron and ferro-alloy metals; (ii) non-ferrous metals; (iii) precious metals; and (iv) industrial minerals. Mineral fuels are excluded from consideration. In the Western Balkan Register of the rESEErve project, individual deposits are classified according to the INSPIRE Directive (INSPIRE DIRECTIVE, 2007/2/EC). Based on the D2.8.III.21 Data Specification on Mineral Resources –Technical Guidelines related to INSPIRE, a statistical comparison with a large number of deposits worldwide allows classification of the deposits as A (very large), B (large), C (medium), or D (small) according to the tonnage of the examined commodity (see Annex F of the aforementioned Guidelines). Commodity rank is based on the endowment, i.e. (cumulated) past production + reserves (not including past production) + resources, or (if the deposit has never been exploited), reserves + resources. As an example, in the case of lead deposits of the A / B / C / D categories, these correspond to 5,000,000 / 500,000 / 50,000 / 5,000 t of lead (metal) content, respectively. Alternatively, for industrial minerals such as borates, the A / B / C / D categories correspond to tonnage of commodities of 25,000,000 / 2,000,000 / 500,000 / 100,000 t of borates (B_2O_3) content, respectively. In the case of a deposit containing several commodities, this classification is expressed for each, and every commodity and the ranking follows the order of importance taking into account the tonnages, scarcity, and price of the commodity.

3.1. Exploration status

As logged in the WEST BALKAN MINERAL REGISTER (2021), and shown in Fig. 2 and Appendix 1, exploration activities in the Adria region, are associated with

(i) Iron and ferro-alloy metals in Albania and North Macedonia (iron, manganese, molybdenum, nickel, and titanium).

Albanian feasibility stage projects are the Butmi and Sukaxhi titanium magnetite projects (Class B) in Lezhë Municipality and the Liqeni I Kuq iron-nickel project (Class C). The key strength for the country's development is related to the Large Ti magnetite deposits, with Ti included in the List of critical raw materials for the EU (EUROPEAN COMMISSION, 2020). Feasibility-stage projects in North Macedonia, ranging in size from small to very large (Class D to A), include the Pehčevo and Iberli iron projects, the Rakle and Studena Voda iron-nickel projects, the Mitrašinci titanium-iron project, the Stogovo manganese project, the Strelci molybdenum project, and the Petrošnica molybdenum-copper-gold project. The iron ore project at Tajmište is under development.

(ii) Non-ferrous metals in Montenegro, Bosnia and Herzegovina, Serbia, North Macedonia, and Albania (aluminium, copper, lead, lithium, zinc).

Exploration activities for bauxite in Montenegro are focused on eight greenfield sites within the Nikšić bauxite field, all of which are at the feasibility study stage. Total reserves and probable reserves are 5,466,000 t and 4,318,000 t, respectively. Four greenfield bauxite deposits in Oštrelj, Bosnia and Herzegovina, are pending approval. In Bosnia and Herzegovina, the Rupice and Veovača lead-zinc deposits (Class B and C, respectively) have exploration status, while the Vitlovac and Kazani lead deposits near the border with Serbia (Class B) are under construction. In addition, the Montenegro lead-zinc deposits (Classes C to B) Đurđeve vode, Paljevine, Ribnik, Igrišta, Brskovo and Strmošne bare (Sjekrica) and the Varine copper project (Class B) are at the feasibility stage. The Serbian Babe lead deposit is currently in the exploration phase. The North Macedonian Konjsko, Borov Dol, Ilovica, Kadiica, Kazan Dol, Plavica and Crn Vrv copper deposits and the Bašibos, Jamište and Blizanci lead-zinc deposits are at the feasibility study stage. Albanian copper deposits in the municipality of Fushë Arrëz, in the municipality of Korce, Cifij, and in the municipality of Has, Nikoliq 2, as well as in the municipality of Mirdite, Perlati Jugor, are also under construction.

(iii) Precious metals in Albania, Bosnia and Herzegovina, North Macedonia and Serbia (gold and platinum group metals - palladium, platinum, rhodium).

The Albanian Babje gold project (unknown size) and the PGE Bregu Bibes project (Class D) are under exploration, as are the Bakovići gold project in Bosnia and Herzegovina and the Korkan and Bigar Hill gold projects in Serbia. The North Macedonian Ilovica, Borov dol and Plavica Pb-Zn projects and Crn Vrv contain significant quantities of gold and/or silver.

(iv) Industrial minerals in Bosnia and Herzegovina, Serbia and Kosovo (boron minerals, kaolinite).

Li-B mineralization in the Adria region is associated with Miocene volcanic/pyroclastic activity in the Sava suture zone in Bosnia and Herzegovina, Serbia and Kosovo. Several lithium and borate projects are currently being developed in the region. The Jadar project in Serbia is at a mature stage and aims to produce battery-grade lithium and borates (feasibility study developed). The project began with the discovery of the unique lithium sodium borosilicate mineral jadarite ($LiNaSiB_3O_7(OH)$) in 2004. After a decade of exploration, RIO TINTO (2020) reported measured reserves in 2020 of 16.6 million t at 1.81% Li_2O and 13.4% B_2O_3, indicated resources of 55.2 million t at 1.68% Li_2O and 17.9% B_2O_3, and inferred resources of 84.1 million t at 1.84% Li_2O and 12.6% B_2O_3. The Valjevo lithium-borate project, currently in the exploration phase, is located 60-70 km east of Jadar in Serbia and is a world-class deposit containing at least 10 Mt of lithium and 40 Mt of boron. In addition, several other lithium-borate exploration projects are located further south (Rekovec, Piskanja and Jarandol projects, central Serbia), the Viti project in Kosovo and the Vranje project on the border between Serbia and North Macedonia. Ongoing exploration is reported from the Lopare Basin in Bosnia and Herzegovina.

3.2 Exploitation status

Ongoing mining activities in the Adria region, shown in Fig. 1 and Appendix 2, are related to the WEST BALKAN MINERAL REGISTER (2021):

(i) Iron and ferro-alloy metals in Albania and Bosnia and Herzegovina (iron, chromium, nickel, manganese).

Chromium mining activities in Albania are concentrated in several small to medium size deposits (Batër (Class D), Bulqizë (D), Vlahën (Class D), Krastë (Class D), Thekën (Class D), Kalimash 2 Tr 1 (Class C), Qafë Bulli (Class C), Kalimash 1 TR 7 (Class C), Kalimash 3 Tr. 6, 6A,A (Class D), Zogaj 3 (Class D), Katjel (Class D), Batër (Class D), which contributed to > 40% of the

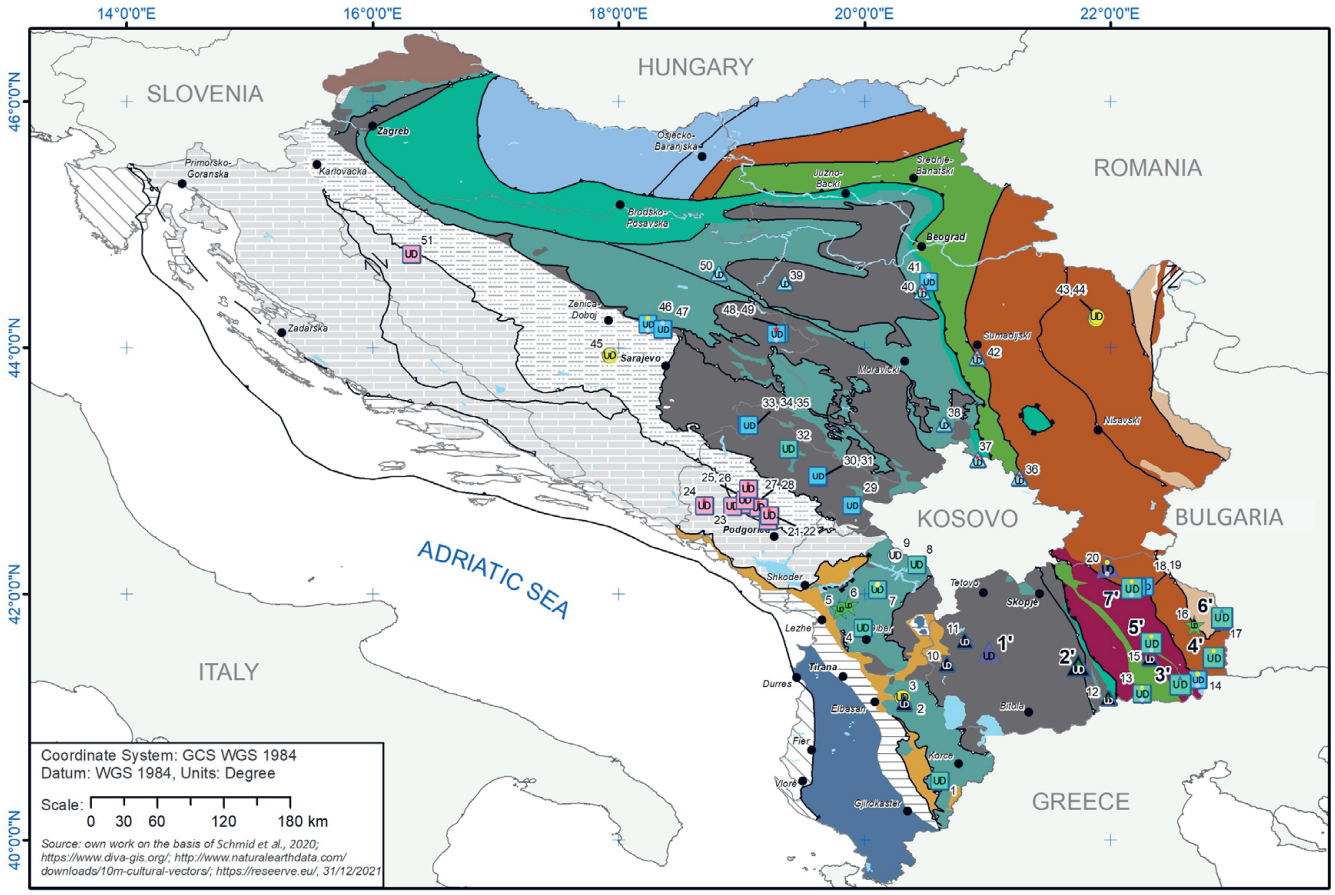

Figure 2. Simplified metallogenic map showing important mines under development (modified after SCHMID et al., 2020).

country's chromium production in 2019 (REICHL & SCHATZ, 2021). Albania hosts one nickel and several small- to medium-sized iron-nickel deposits that are currently exploited (Bitinckë (Class C), Skroskë (Class C), Trull (Class D), Kodra e Trullit (Class D), Debrovë (Class D), Kapshticë (Class D), and the Mamëz nickel ore mine (Class C)), resulting in annual nickel production of 2,960 t for 2019 (REICHL & SCHATZ, 2021). A small iron-nickel ore deposit (Groot; class D) is operating in Nort Macedonia. The Ljubija iron ore deposit in Bosnia and Herzegovina (Class B) is mined with a total production of 739,600 t of iron per year (REICHL & SCHATZ, 2021; Appendix 2). Bosnia and Herzegovina hosts a single Adria manganese mine from a medium-sized Popović Polje deposit (Class C).

(ii) Non-ferrous metals in the Adria region (Albania, Bosnia and Herzegovina, Montenegro, North Macedonia, Serbia) (bauxite (aluminium), copper, lead, selenium, zinc).

Currently, several Albanian underground copper mines are operating in the municipalities of Mirditë: Munellë (Class B); Spaç (Class B); Gurth (Plakez) (Class C); Qafë Bari (Class C), with an annual production of 5,900 tonnes of copper (REICHL & SCHATZ, 2021). A very large copper ore deposit (Bučim; Class A) is exploited in North Macedonia. The annual copper production in Serbia is 43,550 t. Operating copper mines in the Bor district (Bor - Jama, Class A; Veliki Krivelj, Class A) and in the municipality of Majdanpek (very large deposits of Majdanpek North and South Revir) are sporadically enriched in selenium. The copper-gold deposit Čukaru Peki (Velojić et al., 2020, 2022; Banješević et al, 2019; Class A) started initial production in 2021.

Mining of bauxite is mainly carried out in Bosnia and Herzegovina, which has a long record in aluminium production. The bauxite mines operating in the Federation of Bosnia and Herzegovina, range in size from small to large (Cerovi Doci, Sobač - Tribistovo, Bojište, Jasenjani, Vučipolje - Tribistovo, Volujak - Kadim, Bešpelj, Crne Lokve - Gnjat, Crvene Stijene, Mratnjača, Poljane, Studena - Vrila - Zagorje and Široki Brijeg) and large mines in the Republic of Srpska (such as Gradina, Braćan, Crvene stijene and Kosturi) result in a national production of 67.690 t of aluminium extracted from 1,043,343 t of mined bauxite (Appendix 2). Montenegro is also an aluminium-producing country. In the municipalities of Niksic and Jablanica, 36,552 t of aluminium are produced from the small mines (class D) of Zagrad, Durakov do I, Biočki stan, and Štitovo II (REICHL & SCHATZ, 2021).

Bosnia and Herzegovina exploits large to very large lead deposits at Očekalj - Prgoševo (Class A) and Srebrenica - Sase (Class B), while Montenegro exploits the large Šuplja Stijena lead-zinc deposit (Class A), which produces 3,480 t of lead and 9,520 t of zinc annually (REICHL & SCHATZ, 2021). North Macedonia hosts very large and large lead-zinc ore deposits (Toranica (Class A), Sasa (Class A), Zletovo (Class B)). The current lead and zinc production of the country is quite significant and amounts to approximately 43,490 t of lead and 31,040 t of zinc, while the total annual production of non-ferrous metals reaches 81,761 t (REICHL & SCHATZ, 2021). The annual production of Serbian lead-zinc deposits is 13,930 t of lead and 10,560 t of zinc. Seven operating copper mines are medium to very large (Tenka 1,2 - North Revir, Rudnik, Belo Brdo, Veliki Majdan, Lece, Podvirovi, and Grot - Blagodat).

(iii) Precious metals in North Macedonia and Serbia (gold, platinum group metals (palladium, platinum), silver).

In North Macedonia, gold concentrations are mined from the operating Bučim porphyry copper mine, contributing to the country's annual production of 593 kg Au (REICHL & SCHATZ, 2021). Annual production of silver from large to very large lead and zinc deposits (Toranica, Sasa, Zletovo) and copper deposit (Bučim) is 17,880 kg. Serbian precious metal production in 2019 was equivalent to 1,452 kg of gold, 10 kg of palladium, 10 kg of platinum, and 14,502 kg of silver (REICHL & SCHATZ, 2021). Some examples of precious metal bearing deposits are the very large copper deposits North and South Revir of Majdanpek (Au, PGEs), Bor-Jama of Bor (Au), medium to large lead-zinc deposits of Rudnik (Class B), Belo Brdo (Class B), Veliki Majdan (Class C), Podvirovi (Class C), Grot - Blagodat (Class C) containing Ag and Lece (Class B) containing Au and Ag, whereas copper-gold deposits Čukaru Peki host significant quantities of gold (Velojić et al., 2020, 2022; Banješević et al, 2019; Class A).

(iv) Industrial minerals of Albania, Bosnia and Herzegovina, Croatia, North Macedonia and Serbia (bentonite, feldspar, gypsum and anhydrite, kaolin, magnesite, salt, talc, zeolite).

A single large bentonite mine is located in Bosnia and Herzegovina (Sokolac, B) and a single feldspar mine in North Macedonia (Hamzali, Class C). Evaporite (gypsum and anhydrite) exploitation includes large gypsum mines in Albania, Bosnia and Herzegovina (Dočići, B, Petkovac, B), Croatia with several deposits (the largest is Kosovo polje) that contributed to production of 199,255 t in 2019 (REICHL & SCHATZ, 2021), and North Macedonia (Kosovrasti deposit, Class C). Significant kaolinite deposits exist in Bosnia and Herzegovina (Kobaš, class B), while several Serbian deposits are under exploitation. Magnesite production in Serbia includes several class A magnesite deposits at Krive Strane i Torine, wider locality of Čačak, and Ribnica, as well as deposits with undetermined reserves, such as Brezak. There is significant salt exploitation in Croatia (Pag, Nin, Ston) and Bosnia and Herzegovina (Tuzla). Talc is mined in Bosnia and Herzegovina, while zeolites are extracted from several Serbian deposits (Korminjoš, Igroš - Vidojevići with unknown deposit size). Several deposits with ongoing exploitation of industrial minerals with undetermined reserves of kaolinite in Serbia are located at Kranjani, Beli Majdan and Garas, and borates in the Pobrde.

Mineral production of the 6 Adria countries is taken from the World Mining Data annual report for 2019 (REICHL & SCHATZ, 2021). It is given in metric tonnes and in millions of USD (Tab. 1). The ranking of exploitation (in tonnes of mined ore) of the 6 Adria countries for 2019 is as follows: BiH > ALB > MKD > MNE > HRV. The ranking of revenues from exploitation is as follows: ALB > SRB > BiH > HRV > SRB > MNE.

Tab. 1. Total mineral production in 2019 by country in metric T and in million USD (REICHL & SCHATZ, 2021)

3.3. Abandoned mines' locations

Based on the WEST BALKAN MINERAL REGISTER (2021), cases of abandoned mines of interest for the growth of the mineral sector are associated with (https://reseerve.eu/results):

(i) Iron and ferro-alloy metals of Bosnia and Herzegovina and Serbia (cobalt, molybdenum).

Abandoned cobalt mines (lateritic crusts) could be an opportunity for further exploration in Albania, as could the abandoned porphyry molybdenum deposits in Serbia.

(ii) Non-ferrous metals in Albania, Bosnia and Herzegovina, Croatia and North Macedonia, Serbia) (antimony, arsenic, bauxite (aluminium), lead, zinc).

In Albania, there are numerous abandoned hydrothermal antimony mines. In Bosnia and Herzegovina, antimony is associated with abandoned lead and zinc deposits, whereas within North Macedonia it is associated with arsenic ores.

In Croatia, a number of abandoned bauxite deposits with unidentified reserves containing titanium, vanadium, and gallium are of interest for further exploration.

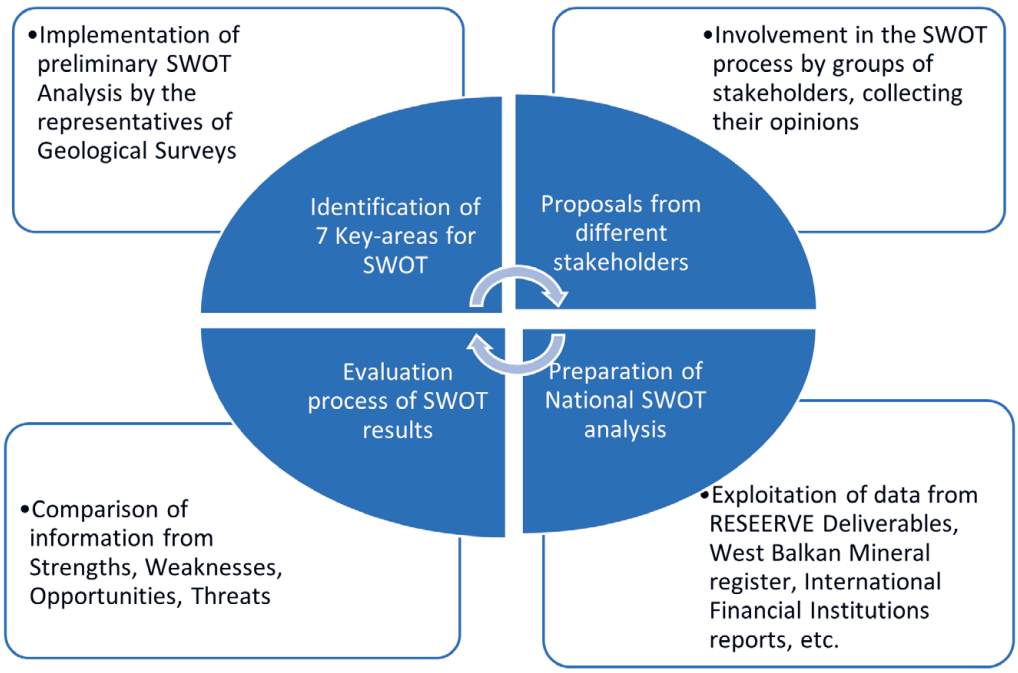

Figure 3. A diagram illustrating the preparation process of the mineral sector SWOT analysis.

(iii) Industrial minerals of Albania (phosphates)

The abandoned phosphate deposits of Albania are unique commodities in the Adria region and are of great interest for further explorationwith the phosphate rocks ranked as CAMs (EUROPEAN COMMISSION, 2020).

4. METHODOLOGY FOR THE DEVELOPMENT OF ROAD MAPS

4.1. SWOT analysis

A SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis is a method used for identifying and analysing internal strengths and weaknesses, as well as external opportunities and threats, that determine current and future operations and help develop strategic objectives (NAMUGENYA, 2019). SWOT is one of the many strategic tools used in the fields of strategic planning and management. It is characterised by its simplicity, and it is widely applied in many sectors (KONG, 2008). In order to map and assess the current position of the mineral sector in the Adria countries, a SWOT analysis was conducted within the framework of the present study. The results provided the basis for the development of new strategic plans by combining the key strengths (the advantages over other competitors), weaknesses (the areas that need improvement compared to competitors), opportunities (trends and market gaps to exploit), and threats (external factors that may threaten the businesses) (see Fig. 3).

Initially the 7 key areas for SWOT analysis were identified followed by the preparation of a SWOT analysis draft by the representatives of the geological service surveys of each country. These drafts were presented at the National thematic workshops organised in each country, within the framework of the EIT Raw Material project rESEErve - Mineral Potential of the ESEE Region.

The second step included the involvement of stakeholders from industry, research institutions, academia as well as policy makers from each country, who participated in the National thematic workshops and actively discussed the above prepared SWOTs. These discussions were organised in the form of teamwork where the teams consisted of members representing different types of stakeholders. Such discussions were organised in person at the National thematic workshops in Bosnia and Herzegovina, Croatia and Montenegro. Due to the Covid 19 pandemic, in the remaining countries (Albania, North Macedonia and Serbia), the National thematic workshops were organised online, and the opinions of different stakeholders were collected in advance in the form of questionnaires and discussed at the National thematic workshops.

For the finalisation of the SWOT analysis for each country and for the consistent assessment of the available data from the National thematic workshops, the rESEErve project deliverables, the reports of the international financial institutions and other published data were reviewed (Step 3). Within this framework the following seven key areas that have a positive or adverse impact on the development of the mineral sector were examined with a set of parameters and key performance indicators:

1. Geological potential: ores, industrial minerals, CRMs (EUROPEAN COMMISSION, 2020), secondary raw materials (SRMs), size of reserves, type of reserves (probable, proven), unknown reserves, exploration activities, greenfield areas and mines in feasibility stage, mines under development, research to produce added value materials, mainly from industrial minerals and rocks.

2. Economic environment: current and projected mineral production of the country, global demand for raw materials, economic stability of the country, GDP, GDP per capita, tax system, ease of doing business, infrastructure, financial product of mining, investment in the mining sector, state aid to the mining sector.

3. Legal and regulatory framework: state mineral policy and mining regulations; licencing procedures; exploration, mining, environmental and ownership regulations; control mechanisms; adoption of EU environmental legislation.

4. Innovation and technological framework: mining development status, innovation funding opportunities, technological status of processing plants, research and development (R&D) status.

5. Environmental protection and land use planning: protected areas, waste management, contaminated brownfield sites, reclamation of old sites, land use planning, alternative use of previously mined areas.

6. Government and societal potential: resource planning / sustainable management of resources, accessibility to resources, administrative drawback permitting/concessions, spatial planning, state R&D strategy.

7. Human resources and educational potential: stakeholder involvement, education level and status of research and development, personnel qualified for mining activities, capacity building, and demographics.

As a final step (Step 4), the national SWOT analyses was unified into an integrated analysis for the Adria region.

The geological potential is unique for each country, however, the legal, regulatory, land use planning and educational potential for the former Yugoslavian counties stems from the same legis-

Figure 4. A schematic diagram illustrating the generic methodology of the gap analysis to determine the key steps for sustainable development of the extractive sector.

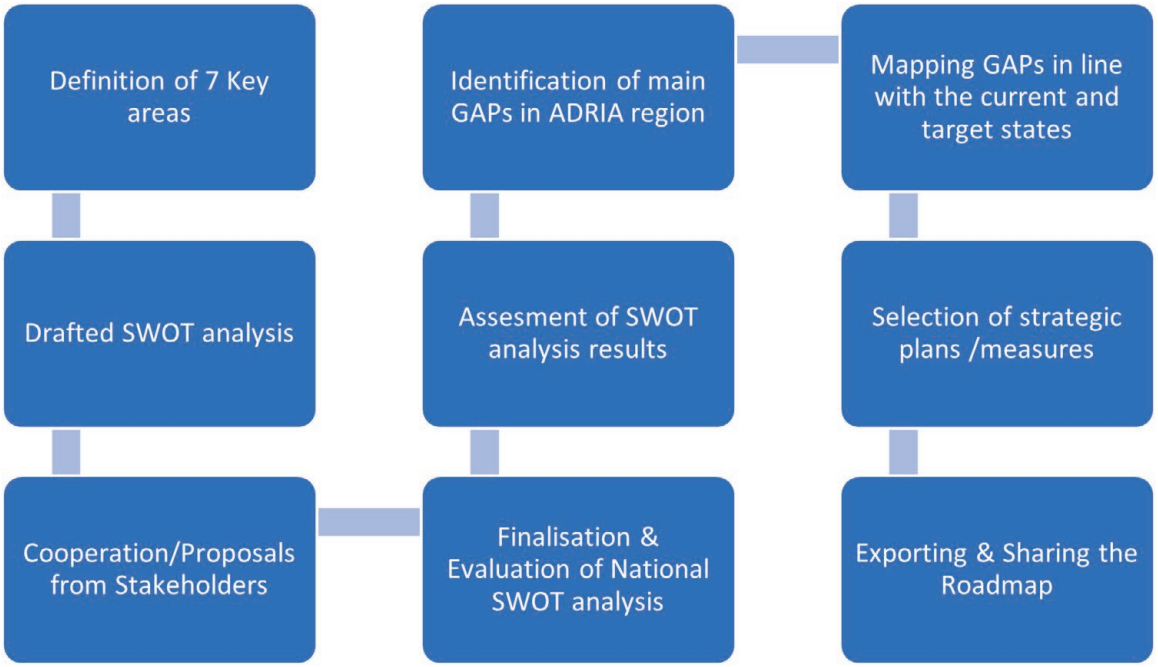

Figure 5. Diagram illustrating the overall methodology.

lative processes, so they are comparable. Croatia, as a member of the European Union (EU), has already implemented the EU legal framework.

4.2. Gap analysis

Gap analysis was used to identify the main gaps/barriers/obstacles in performing businesses requirements. To determine those gaps, it is essential to refer to where the entity/sector is today, and where it may go in the near future, setting the initial situation, the target situation, and the measures to be taken towards this direction (Fig. 4). To assess the existing status of the sector, the available information, as derived from the components of SWOT analysis were used. The evaluation included the identification of factors significantly affecting mineral sector growth, considering the specific characteristics of each Adria country. Following that, the major limitations preventing the Adria region's mineral sector boost were recorded and ranked, demonstrating the priority areas where countries present the same needs/gaps or contrasting ones. Limitations were recorded taking into consideration the seven, key-areas of SWOT analysis.

SWOT and Gap analyses were used in the present study as the basis for the strategic plans to guide development in the raw materials business and strategic initiatives.

The final step was the selection of the actions to be taken for the sustainable development of raw materials in the Adria region via roadmaps for the implementation in practise. Those actions are incorporated into the Adria region's roadmap, focusing on the areas of geological, economic and business framework where the main constraints were recorded (Fig. 5).

5. RESULTS AND DISCUSSION

5.1. SWOT analysis of the Adria region

5.1.1. Geological potential

The Strength of the Adria countries regarding Geological Potential relates to their significant reserves of primary metallic (Cr, Sb, Pb, Zn, Mo, Au, Li) and industrial minerals (bauxites, borates). These deposits are included in the WEST BALKAN MINERAL REGISTER (2021) following the t D2.8.III.21 Data Specification on Mineral Resources –Technical Guidelines related to INSPIRE Directive (INSPIRE DIRECTIVE, 2007/2/EC). Moreover, these countries have active exploration areas, as well as a large number of developed mines (see Fig. 1).

However, there is a lack of recent systematic exploration and corresponding databases for new CRMs for emerging technologies (Li, B, REE) which is reported as a main Weakness. Another weakness regarding further exploration of the geological potential of these countries focuses on the peculiarities of karst bauxites, which are found in numerous small deposits (class D).

Opportunities lie in the potential and current greenfield exploration and brownfield operations (SCHODDE, 2021). Significant greenfield exploration in CRMs such as Li, B, Sb, and REEs in bauxites are recorded (GIANNAKOPOULOU et al., 2021). Brownfield operations facilitate geological research and increase the existing reserves of primary and secondary (mining waste, tailings and metallurgical waste) metallic and industrial minerals.

5.1.2. Economic environment

The total mineral production (excluding fossil fuels) of the Adria region in 2020 was 2,644 million USD (REICHL & SCHATZ, 2022). Hence, it contributed 1.65% of the sum of their nominal GDPs (based on REICHL and SCHATZ, (2022)), with Albanian mineral production being the highest contributor (1550 million USD, contributing more than 10% of the Albanian nominal GDP) and Croatia the lowest (15 million USD). The ease of doing businesses in the Adria countries ranged approximately from 65% to 80%, with Bosnia and Herzegovina ranked in the lowest position among the 6 Adria countries examined (GIANNAKOPOULOU et al., (2021)). In calculating the overall ease of doing business, indicators such as starting a business, obtaining construction permits, electricity supply, registering property, obtaining credit, protecting minority investors, paying taxes, trading across borders, enforcing contracts, and resolving insolvency were considered. Four of the six economies under study were ranked as high as 51st

out of 190 economies, indicating that there is a framework in place to support future investment in the mineral sector (DOING BUSINESS, 2021). However, economic instabilities in non-EU countries and underdeveloped local infrastructure (e.g., transportation infrastructure, energy infrastructure) are seen as weaknesses for the sector's growth (WORLD BANK 2021).

The general increase in demand for raw material (REICHL & SCHATZ, 2021) and the interest of international mining companies in exploration and exploitation represents an opportunity for the mineral sector in Adria countries (EBRD, 2017; SCHODDE, 2021). However, the volatility of commodity prices on the world market and the underdeveloped downstream industry for certain raw materials are seen as a threat

5.1.3. Legal and regulatory framework

In all the Adria countries, mineral resources are protected by the Constitution and the existing legal framework includes regulations for exploration, mining and mine waste treatment. However, methods for estimating reserves are not aligned with international standards, such as PERC/JORC/UNFC (GIANNAKOPOULOU et al., 2021). Moreover, concession/exploration licencing procedures are reported as lengthy and in need of significant simplification, with institutional quality affecting investment activities (ESTRIN & UVALIC, 2014). In Bosnia and Herzegovina, further difficulties are faced due to the fact that the country consists of two entities, the Republic of Srpska and the Federation of Bosnia and Herzegovina, with each entity having its own legislative, executive, and judicial procedures. In the Federation of Bosnia and Herzegovina, a large part of the entity's authorities has been transferred to the regional governments.

A great opportunity for the Adria countries is that a large number of concessions for exploration and mining were issued by the local governments in the last 20 years. However, there is a threat of the application of more stringent environmental laws that could lead to additional restrictions on the permitting and implementation of mining operations.

5.1.4. Innovation and technological framework

Among the Adria candidate and potential EU candidate countries for which data are available, gross domestic expenditure on R&D as a percentage of GDP in 2018 and 2019 ranged approximately from 0.2% in Bosnia and Herzegovina to 1% in Serbia, compared with an average of 2.2% in the EU (EUROPEAN COMMISION, 2022). Industry stakeholders report a lack of investment in green technology and research infrastructure for mining and processing. External funding for innovation and technological development are expected from regional, national and EU sources.

5.1.5. Environmental protection and land use planning

There are positive examples the rehabilitation of old mining sites (WILLIAMS & MASLAĆ, 2010) however, the lack of harmonisation of spatial planning documents in regions with potential for mining activities is considered as a weakness.

Consideration of protected areas in spatial planning documents is an opportunity, however, enforcement of environmental legislation will impose additional restrictions on mining in non-EU countries that are in the process of implementing Natura 2000.

5.1.6. Government and social potential

All Adria countries have national strategies to promote the sustainable development of mineral resources. However, the wider society is not sufficiently informed about the importance of raw materials in every-day life.

Low social acceptance of mining and processing by local communities and non-governmental organizations poses a serious threat to the further development of the mineral sector.

5.1.7. Human resources and educational potential

The strength of the Adria region in terms of human resources and educational potential lies in the existing higher education institutions that cover the entire commodity value chain. Moreover, the active presence of the national organizations that promote the R&D of science and technology, as well as technological innovation activities considers another strength, towards this aim combined with various Research & Innovation programs for scientists and professionals that are currently underway. However, higher education raw materials related programs often need to be updated, and students' interest in enrolling in these programs is low. In addition, there is an inadequate supply of lifelong learning courses for existing raw material professionals.

Current activities in the Adria Region to develop new higher education programs that produce T-shaped professionals (collaborative, empathetic, enthusiastic, open-minded, and visionary) and lifelong learning courses are seen as a great opportunity for the mineral sector in the future. However, declining demographics and a brain drain pose a serious threat (MURPHYA and PACHERB, 2021);

5.2. Gap analysis of the Adria region

Following the SWOT analysis, a Gap analysis was performed to determine barriers and obstacles for the further exploitation of the mineral sector in the Adria region. The barriers and obstacles were identified, emphasizing a countries' current economic and business environment, mineral production, as well as geological potential, infrastructure, mining legal framework, support of the local communities and mineral state policies. Regarding policies adversely impacting the Raw Materials sector, the emphasis is placed on permit issues and the cooperation of competent authorities. Gaps regarding mining in protected areas, spatial planning and its harmonization with mining legislation are also highlighted. Regarding social aspects, a region's needs for skilled human resources and capacity building, are also recorded in the Adria region. A challenging obstacle is the acceptance of mining activities by local communities. General problems are: (1) the low level of confidence in the government and public administrations of Adria countries (often perceived by impacted local community to be driven by particular interest groups or as corrupt) to properly regulate the mining industry; (2) misinterpretation of the environmental risks of the project, usually by publicly exposed non experts, leading the local community to believe that economic benefits of the project are negligible compared to the overall risks for water, soil and air, and (3) infrequent, inadequate or delayed communication of the mining companies toward the local community leaving the impression of non-transparencies. Very often, the initial conflict between local communities and the mining companies are recognised by various political parties, activists, or NGO as an ideal setting for popularity-raising, free media space or self-promotion, usually prior to approaching local or national elections.

Even though in the rESEErve project, the construction of the WEST BALKAN MINERAL REGISTER (2021) database as per the INSPIRE guidelines (INSPIRE DIRECTIVE, 2007/2/EC) covered areas where improvements are needed, gaps such as the lack of harmonisation of reserves estimation with international standards (GIANNAKOPOULOU et al., 2021), and the absence

of systematic exploration in some of the new areas presenting geological potential, are considered as constraints for the sector's development. The economic environment for investments in the Adria countries is characterized by a rather low cooperation among the public and private sectors, with the need for more advanced techniques/tools being considered as "a must" for investment enhancement, as reported by the relevant stakeholders.

The need to strengthen/reform/update the current legal and regulatory framework is a common conclusion among the 6 Adrian countries examined in this study. Areas to be improved are summarized below and include; the importance of simplification of the current raw materials legislation, given that the procedures for obtaining concessions and exploration licenses was consistently considered as relatively time-consuming and complicated, there is an urgent need to implement reforms in line with the EU legislation, and Raw Materials strategies, as well as the implementation of activities for the long-term mineral resources' policies (GIANNAKOPOULOU et al., 2021).

Despite the fact that the 6 examined countries have recently upgraded their national legal framework in relation to the mineral sector and to business environment regulatory areas, it is also recognized that mineral policy, land planning, mineral laws and regulations for exploration and mining, need further reforms to integrate spatial planning legislation and provide a clear mineral policy and strategy regarding access to resources and safeguarding of reserves (e.g., MATI, 2017). Concerning spatial planning, one of the gaps recorded is the absence of its harmonization with mineral plans. Moreover, alignment of spatial planning with other land-uses, e.g., spatial mineral plans, at different levels of state, county, municipality, are required for enhancing the internal investments (GIANNAKOPOULOU et al., 2021).

Furthermore, as reported by the stakeholders, active in the Adria region, human resources, and capacity building are areas for improvements needed to support the sector's potential growth. A low level or absence of cooperation between universities, industry, research institutions, and the state authorities represent a major gap to be covered in future steps. At the same time, the reduced number of skilled professionals and technical staff due to the "brain drain" (MURPHYA and PACHERB, 2021) and the low interest for studies in the raw materials fields such as geology, results in the generation of a rather low number of professionals to cover the sector's needs. The reducing number of skilled raw materials professionals combined with the lack of knowledge of new technologies, mainly for the exploitation of CRM deposits are constraints to be mitigated (GIANNAKOPOULOU et al., 2021; MELCHER & REICHL, 2017).

5.3. Roadmap for the raw materials investment in the Adria countries

As already described, SWOT/Gap Analysis for the development of the Raw Materials sector in the Adrian countries examined was performed in the present study. This followed a comprehensive literature review, and active consultation with the stakeholders, with the emphasis placed in the 7 National Thematic Workshops conducted in the countries under study.

Subsequently, assessment and evaluation of the above SWOT/Gap analysis results, provided the basis for the development of a General Strategy roadmap presenting the relevant actions required for the sustainable development of the mineral sector of the Adria region.

With this aim, the general strategy roadmap included the following actions, related to 5 key areas linked with the SWOT/Gap analysis components:

Stakeholders' consent and awareness. Local communities/ public authorities/ professional associations are key stakeholders for the implementation of the different stages of a mining project, however public consultation and permit issue is a process often delayed in Adria countries. Given that social acceptance and stakeholders' consent is required during the whole life cycle of a mining project, starting from permits, to operation, closure and post-closure stages, agreement and active cooperation among authorities and stakeholders is considered a necessity.

Constitutional acts of the Adria countries are defining mineral resources to be of primary national interest, however proper education on the importance of the Raw Materials sector in everyday life ("we grow it, or we mine it = agriculture and raw materials") is left to be promoted by professional organisations with limited capacities and knowledge. Geology is the only natural science outside secondary school curricula, and often erroneous/ unreviewed information on mineral resources appears in textbooks, influencing an early negative perception of the mining and metallurgical community by the wider society. The authors suggest including important elements on raw materials exploration, mining, processing and recycling in the primary and secondary schools' curricula as well as creating relevant life-long learning courses for high-school teachers. Wider society learning courses should bring basic understanding to the broader public.

Timely awareness-raising campaigns starting prior to the first geological prospection is proposed as one of the tools, aiming to inform different types of stakeholders on employment opportunities in the Raw Materials sector, its contribution to local infrastructure development, the regional and national economies, and the need to jointly mitigate the obstacles that adversely impact the development of the region, and the steps required to achieve the Social License to Operate. Thus, wider society learning and awareness - raising will contribute to avoid misconceptions and build a trustworthy relationship between the Mining Industry –and local stakeholders setting the basis for the required social acceptance.

Quality of geological potential data. In the Adria region, geological potential data are available in the countries' digital databases. However, in order to attract investors' interest and financing, in addition to the identification of the type of resources, i.e., inferred, indicated, measured, or the classification of the reserves of a deposit for the commodities of interest into probable and proved, it is also essential that domestic or foreign companies report the results of their exploration activities and classify mineral resources, and ore reserves according to internationally accepted standards. As noted in the Gap analysis, the above classification is proposed to be conducted in line with the international codes for public reporting of exploration results, mineral resources and ore reserves, including JORC (Australian Joint Ore Reserves Committee Code), PERC (Pan European Reserves and Resources Reporting Committee Code), CIM (Canadian Institute of Mining, Metallurgy and Petroleum), UNFC (United Nation Framework Classification for Resources) etc. (GIANNAKOPOULOU et al., 2021).

Moreover, and in order to improve the level of confidence of the available geological data and reserves estimation per commodity, further exploration work for certain primary raw materials is proposed as an action to support the development of the RMs sector. In summary, further exploration to enhance the qual-

ity control of available Minerals Register's data, and alignment with internationally acceptable codes, are considered as actions leading to the sector's development.

Reforms/updates of legislation and codification of regulations: based on the SWOT and Gap analysis results, interventions in the following five areas were identified as a priority in order to circumvent legal constraints: (1) Mineral policy and strategy of the state; (2) Licensing and permit procedures for exploration and exploitation activities; (3) Royalties / fees and compensatory benefits; (4) Harmonization of Spatial Plans, and Alignment with the EU environmental legislation to delineate and manage nature protected areas and restore historic and/or abandoned sites, (5) Codification and Simplification of the mining regulations and legislation, is also necessary, while the mapping of additional areas of legal constraints is recommended (GIANNAKOPOULOU et al., 2021). The Adria countries examined, take steps for upgrading mining legislation, focusing on the direction of mining activities to become an essential pillar for the economy (SOHOL, 2017).

Even though the national legal framework related to the Minerals sector and the business environment regulatory areas has been recently upgraded, issues such as protection of the sustainable development of mineral resources of public importance, in line with the EU legislation are not considered in the currently prevailing legislation. Moreover, simplification of the permit procedures is essential, regulating the competencies and the responsibilities of the related authorities, and enhancing the cooperation among different levels of state government. The lack of harmonisation among the different levels of spatial planning, and the non- alignment with EU directives needs to be mitigated with a special spatial mineral plan per country. Royalties / fees need to be re-assessed taking into consideration the value of the commodity mined, while the need for benefits for local communities was also noted.

Competitiveness and financing dimension: Stakeholders consider that the competitiveness of the sector is a multi - faceted task covering areas such as enhancing research and development activities, technology transfer for upgrading and increasing the capacity of existing mines and plants, and vertical integration of the mineral sector. Funded research programs, funding development and reconstruction are common practices to attract EU and international financial resources for enhancing exploration and other research activities of the sector and supporting growth in investments.

It is thus concluded that reforms are needed for attracting investors and creating a favourable business environment. Indicators such as starting a business, dealing with construction permits and enforcing contracts were determined as significant aspects that need improvement in order to further enhance Adria region's business environment (GIANNAKOPOULOU et al., 2021; https://www.doingbusiness.org).

With this aim, scoping technical studies per country are proposed for identifying the special needs to promote countries' potential in raw materials. Technology transfer, application of innovative methods for exploration, exploitation, or processing, increase of the processing plants' capacity, modernizing facilities, reprocessing SRMs, etc., will result in the reduction of operating costs, and overall improvement of economic performance, the vertical integration of the Raw Materials sector, the production of new added value products and the opening of new markets. Actions for the reduction of the environmental footprint of the sector including extraction waste management and reclamation of mined out areas should also be included.

Moreover, focused funded research projects in cooperation with the industry are proposed, in order to solve specific technical problems. With this aim, comprehensive review studies may be needed on the state-of-the art techniques for the overall treatment of selected mineral raw materials including CRMs. Market research and feasibility studies covering the overall spectrum of the products of interest are required in order to document the sustainability of the proposed changes and/or upgrades in mines and plants.

Human resources and capacity building. The need to enhance the skills of the technical, scientific and managerial personnel involved in the whole cycle of raw materials activities is a common conclusion. Reduction of skilled professionals and technical staff linked to a "brain drain" (MURPHYA & PACHERB, 2021) or for other reasons (e.g. limited interest in the raw materials sector in general) and limited expertise in new technologies for exploration, mining and processing of ores and wastes, are some of the issues reported by the stakeholders in the countries examined. Gaps have been also noticed between the existing educational programs and the present and future needs of the raw materials sector. A need to enhance the cooperation in the knowledge – triangle of universities, research and technology organizations, and industry in different areas was also noted (GIANNAKOPOULOU et al., 2021). Capacity building programs for training of scientists and technical staff, given the increased emerging needs in the mineral sector of the region (SCHODDE, 2021), are considered as necessary, with Croatia having already made steps as an active partner in the regional inovation scheeme (RIS) projects founded by the European Institute for Inovation and Technology (EIT) projects. Strengthening innovation, entrepreneurship, and cooperation with the participation in EIT Raw Materials RIS or other types of EU funded projects, as well involvement of the specific target groups in thematic training, and lifelong learning programs are proposed as key measures for technology transfer and capacity building.

6. CONCLUSIONS

The Adria region has a long history of mining, however the mineral sector currently faces a variety of challenges that prevent its sustainable development.

The SWOT analyses performed for the ESEE countries examined, Albania, Bosnia and Herzegovina, Croatia, Montenegro, North Macedonia and Serbia covered parameters such as geological potential, economic environment, legal and regulatory framework, innovation and technological framework, environmental protection and land use planning, governmental and societal potential, human resources, and education potential.

SWOT Analyses results served as the basis for the Gap analysis, and the integration of the results obtained into regional strengths and challenges in order to create a roadmap for investment in the mining sector.

Adria countries have significant reserves of primary metallic and industrial minerals and active exploration areas, as well as a large number of operating mines. The total mineral production versus the current GDP for the Adria countries was calculated as close to 4%, whereas in all countries examined, mineral resources are protected by the constitution and there is a legal framework regulating exploration, mining and treatment of mine waste. Moreover, the presence of national higher education institutions that cover the entire raw materials value chain, as well as

national organizations that facilitate R&D activities are considered as factors supporting the development of the Mineral sector.

Despite these strengths, the mineral sector in the Adria region faces a number of challenges related to reduced social acceptance, the lack of new exploration campaigns in many areas, estimation of resources or reserves not aligned with international codes and standards, and lack of skilled technical, scientific and managerial personnel involved in the whole cycle of mineral activities.

The Adria countries have uneven potential in terms of mineral resources. However, apart from Albania, they all emerged from the disintegration of the same state (Yugoslavia) and present many similar weaknesses regarding the prevailing business environment and business opportunities. Croatia stands out from the other Adria countries in terms of opportunities, as it is the only EU member state.

Actions proposed for the sustainable development of the mineral sector in the Adria region include:

Awareness raising campaigns to obtain the required social license to operate and gain stakeholders' knowledge of the sector and consent;

Further exploration activities to increase the level of confidence and reserves, quality control of the West Balkan Mineral Register's data (WEST BALKAN MINERAL REGISTER, 2021) and alignment with internationally recognized codes, such as JORC, PERC, CIM, UNFC;

Harmonization with spatial planning and alignment with relevant EU environmental EU legislation;

Reforms to attract investors and create a favourable business environment focusing on areas such as opening business/dealing with construction permits/enforcing contracts;

Capacity building programs.

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Appendix 1.

Primary mineral deposits of the ADRIA region in the exploration phase (based on the WEST BALKAN MINERAL REGISTER, 2021).
UD: Under Development, F: Feasibility, PA: Pending Approval, Constr.: Construction; *No records at the West Balkan Mineral Register - location is not accurate.

Numbering	Mines (INSPIRE)	Greenfields (INSPIRE)	Municipality	Lat. WGS 84 (INSPIRE)	Lon. WGS 84 (INSPIRE)	Commodity Group (INSPIRE)	Metal (INSPIRE)	Minor Metal (symbol)	Deposit Class (INSPIRE)	Current Status (INSPIRE)	Type of Deposit (INSPIRE)
1'	Strelci		Kičevo	41.5280	21.0136	Molybdenum ore, Iron and ferro-alloys metals	Mo	Cu, Fe, Mn	A	F	graniticIgneousRocksAndPegmatites
2'	Rakle		Prilep	41.4180	21.7426	Iron-nickel ore, Iron and ferro-alloys metals	Fe, Ni	Co, Cr	A	F	laterite
3'	Kazan Dol		Valandovo, Bogdanci, Dojran	41.2607	22.5725	Copper ore, Base metals	Cu	Pb, Zn, Cd, As, Sb, Se, Te, W, Mo, Bi, Sn	A	Constr.	veinPolymetallic
4'	Ilovica		Bosilovo, Novo Selo	41.4825	22.8427	Copper ore, Base metals	Cu, Au	Ag, Mo	A	PA, Constr.	porphyry
5'	Borov Dol		Konče, Štip	41.6009	22.3354	Copper ore, Base metals	Cu, Au, Ag	Fe, Mn, Mo	A	Constr.	porphyry
6'	Kadiica		Pehčevo	41.8073	22.9084	Copper ore, Base metals	Cu	Fe, Mn, Mo	A	Constr.	porphyry
7'	Plavica and Crn Vrv		Kratovo, Probištip	42.0449	22.1761	Copper ore, Base metals	Cu, Ag, Au	Pb, Zn	A	PA, Constr.	porphyry
1		Çiflig	Korçë	40.4815	20.6138	Copper ore, Base metals	Cu		C	F	maficToUltramaficEffusiveVolcanism
2		Liqeni I Kuq	Librazhd	41.1142	20.3270	Iron-nickel ore, Iron and ferro-alloys metals	Fe		C	F	laterite
3		Babe	Barajevo, Sopot, Voždovac	44.5356	20.5248	Lead-zinc ore, Base metals	Pb, Zn, Ag	Fe, Cu, As	unknown	UD	polymetallicManto
4		Perlati Jugor	Mirditë	41.7243	19.9915	Copper ore, Base metals	Cu		B	F	maficToUltramaficEffusiveVolcanism
5		Butmi	Lezhë	41.8733	19.8034	Titanium-magnetite ore, Special and rare metals	Ti		B	F	nonOrganic
6		Sukaxhi	Lezhë	41.9061	19.8712	Titanium-magnetite ore, Special and rare metals	Ti		B	F	nonOrganic
7		Tuçi Lindor	Fushë Arrëz	42.0335	20.1070	Copper ore, Base metals	Cu	Au	B	F	maficToUltramaficEffusiveVolcanism
8		Nikoliq 2	Has	42.2347	20.4264	Copper ore, Base metals	Cu		C	F	maficToUltramaficEffusiveVolcanism
9		Bregu Bibes	Tropojë	42.3115	20.2528	PGE, Precious metals	Pt	Pt	D	F	ophiolite
10		Stogovo	Debar, Centar Župa, Kičevo, Struga, Debarca	41.4301	20.6722	Mangenese ore, Iron and ferro-alloys metals	Mn	Ni, Co, Cr, Fe, Mn	C	F	sedimentaryManganese
11		Tajmište	Kičevo, Mavrovo and Rostuše	41.6192	20.8178	Iron ore (carbonate), Iron and ferro-alloys metals	Fe		D	UD	bandedIronFormation
12		Studena Voda	Kavadarci	41.1562	21.9861	Iron-nickel ore, Iron and ferro-alloys metals	Fe, Ni	Co, Cr	D	F	laterite
13		Konjsko (Javorak)	Nikšić	42.5942	19.2174	Aluminium (Bauxite ore), Base metals	Al		D-	F	bauxite
14		Bašibos	Valandovo	41.3028	22.7137	Lead-zinc ore, Base metals	Pb, Zn	Cu, Ag, Bi, Au	B	F	veinPolymetallic
15		Iberli	Demir Kapija	41.4770	22.3251	Iron ore, Iron and ferro-alloys metals	Fe, Zn, Cu	Mn, Ag, W, Be, Bi, Cd, Sr	D	F	skarnAndCarbonateReplacement
16		Mitrašinci	Berovo	41.7408	22.6862	Titanium-iron ore, Special and rare metals	Ti, Fe	Ni, V	unknown	F	maficToUltramaficIntrusion
17		Pehčevo	Pehčevo	41.7705	22.9178	Iron ore, Iron and ferro-alloys metals	Fe	Mn, Cu, Pb, Zn, Al, Ti	D	F	shorelineOrMarinePlacer
18		Jamište	Probištip	42.0600	22.2796	Lead-zinc ore, Base metals	Pb, Zn	Cu, Au, Cd	B	F	polymetallicManto
19		Blizanci	Probištip	42.0529	22.2172	Lead-zinc ore, Base metals	Pb, Zn	Cu, Mn	B	F	veinPolymetallic
20		Petrošnica	Staro Nagoričane	42.2195	21.9759	Molybdenum copper gold ore, Iron and ferro-alloys metals	Mo, Cu, AU, Ag	Sb, Zn, Pb, Ba, Sn	unknown	F	

Appendix 1. continued.

Numbering	Mines (INSPIRE)	Greenfields (INSPIRE)	Municipality	Lat. WGS 84 (INSPIRE)	Lon. WGS 84 (INSPIRE)	Commodity Group (INSPIRE)	Metal (INSPIRE)	Minor Metal (symbol)	Deposit Class (INSPIRE)	Current Status (INSPIRE)	Type of Deposit (INSPIRE)
21		Konjsko	Gevgelija, Kavadarci	41.1905	22.2609	Copper ore, Base metals	Cu, Au, Ag	Zn, As, Sb	unknown	F	polymetallicMan-to
22		Međugorje	Nikšić	42.6365	19.2278	Aluminium (Bauxite ore), Base metals	Al		D-	F	bauxite
23		Međeđe	Nikšić	42.7140	18.9296	Aluminium (Bauxite ore), Base metals	Al	Fe	D	F	bauxite
24		Đelov do	Nikšić	42.7143	18.6999	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti, Si	D	F	bauxite
25		Laz	Nikšić	42.7608	19.0303	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti, Si	D-	F	bauxite
26		Strašnica	Nikšić	42.8525	19.0557	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti, Si	D-	F	bauxite
27		Bršno (Raline)	Niksic	42.7258	19.0244	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti, Si	D	F	bauxite
28		Crvenjaci	Niksic	42.7004	19.1399	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti, Si	D	F	bauxite
29		Strmošne bare (Sjekrica)	Berane	42.7203	19.8976	Lead-zinc ore, Base metals	Pb,Zn	Cu	C	F	polymetallicMan-to
30	Brskovo		Mojkovac	42.9500	19.6258	Lead-zinc ore, Base metals	Pb,Zn	Cu	B	UD	polymetallicMan-to
31		Igrišta	Mojkovac	42.9598	19.6227	Lead-zinc ore, Base metals	Pb, Zn	Cu	B	F	polymetallicMan-to
32		Varine	Pljevlja	43.1775	19.3832	Copper ore, Base metals	Cu	Cu	B	F	maficVolcanism-MassiveSulphide
33		Đurđeve vode	Pljevlja	43.3747	19.0440	Lead-zinc ore, Base metals	Pb, Zn	Cu	B	F	polymetallicMan-to
34		Paljevine	Pljevlja	43.3710	19.0500	Lead-zinc ore, Base metals	Pb,Zn	Cu	C	F	polymetallicMan-to
35		Ribnik	Pljevlja	43.3691	19.0598	Lead-zinc ore, Base metals	Pb,Zn	Cu	C	F	polymetallicMan-to
36		Vranje*	Vranje	42.9400	21.2627	Borates-lithium ore, Minerals for chemical use			unknown	UD	
37		Viti*	Viti	43.0887	20.9237	Borates-lithium ore, Minerals for chemical use			unknown	UD	
38		Piskanja	Raška	43.3793	20.6474	Borates, Minerals for chemical use			unknown	UD	nonOrganic
39		Jadar	Loznica	44.5268	19.3541	Borates-lithium ore, Minerals for chemical use	Li		unknown	UD	nonOrganic
40		Valjevo*	Valjevo	44.4557	20.4716	Borates-lithium ore, Minerals for chemical use			unknown	UD	
41		Babje	Librazhd	41.1591	20.3098	Gold ore, Precious metals	Au		unknown	F	orogenicGold
42		Rekovac*	Rekovac	43.9180	20.9202	Borates-lithium ore, Minerals for chemical use			unknown	UD	
43		Bigar Hill	Žagubica and Majdanpek	44.2354	21.8816	Gold ore, Precious metals	Au		unknown	UD	CarlinTypeCar-bonateHosted
44		Korkan	Bor and Žagubica	44.2543	21.8894	Gold ore, Precious metals	Au		unknown	UD	CarlinTypeCar-bonateHosted
45		Bakovici	Fojnica	43.9398	17.9296	Gold ore, Precious metals	Au	Ag	C	UD	orogenicGold
46		Rupice	Vareš	44.1927	18.2393	Lead-zinc ore, Base metals	Pb, Zn, Ag, Au	Cu, Sb, Hg	B	UD	shaleHosted
47		Veovaca	Vareš	44.1509	18.3625	Lead-zinc ore, Base metals	Pb,Zn	Ag, Hg	C	UD	shaleHosted
48		Vitlovac	Srebrenica	44.1170	19.3080	Lead ore, Base metals	Pb, Zn	Cd, Ag, Sn, Sb, S, Mn	B	Constr.	polymetallicMan-to
49		Kazani	Srebrenica	44.1130	19.2870	Lead ore, Base metals	Pb, Zn	Cd, Ag, Sn, Sb, S, Mn	B	Constr.	polymetallicMan-to
50		Lopare*	Lopare	44.6024	18.8159	Borates, Minerals for chemical use			unknown	UD	
51	Oštrelj		Sanski Most	44.7591	16.3149	Aluminium (Bauxite ore), Base metals	Al		D-	PA	bauxite

Appendix 2.

Primary mineral deposits of the ADRIA region in the exploitation phase (based on the WEST BALKAN MINERAL REGISTER, 2021). Legend: O: Operating, OI: Operating Intermittently, OC: Operating Continuously.

Numbering	Mines (INSPIRE)	Greenfields (INSPIRE)	Municipality	Lat. WGS 84 (INSPIRE)	Lon. WGS 84 (INSPIRE)	Commodity Group (INSPIRE)	Metal (INSPIRE)	Minor Metal (symbol)	Deposit Class (INSPIRE)	Current Status (INSPIRE)	Type of Deposit (INSPIRE)
1'	Bučim		Radoviš, Štip	41.6617	22.3506	Copper ore, Base metals	Cu, Au, Ag	Fe, Mn, Mo, Bi, Se, Pd, Ti	A	OC	porphyry
2'	Sasa		Makedonska Kamenica	42.1267	22.5066	Lead-zinc ore, Base metals	Pb, Zn, Ag	Ag, Cd, In, Co, Bi, Cu, Sb	A	OC	skarnAndCarbonateReplacement
3'	Šuplja Stijena		Pljevlja	43.3801	19.0440	Lead-zinc ore, Base metals	Pb, Zn	Cu	A	O	polymetallicManto
4'	Veliki Krivelj		Bor	44.1236	22.1139	Copper ore, Base metals	Cu, Fe	Cu	A	O	porphyry
5'	Bor - Jama		Bor	44.0894	22.1006	Copper ore, Base metals	Cu, Au	Fe, Au	A	O	highSulphidation
6'	Majdanpek - S. Revir		Majdanpek	44.4254	21.9239	Copper ore, Base metals	Cu, Au	Se, PGE, Ag, Cd (recoverable)	A	O	porphyry
7'	Majdanpek - N. Revir		Majdanpek	44.4107	21.9319	Copper ore, Base metals	Cu, Au	Se, PGE, Ag, Cd (recoverable)	A	O	porphyry
8'	Očekalj - Prgoševo		Olovo	44.0953	18.6036	Lead ore, Base metals	Pb		A	OC	carbonateHosted
1	Kapshticë		Devoll	40.6098	21.0218	Iron-nickel ore, Iron and ferro-alloys metals	Fe		D	O	laterite
2	Bitinckë		Devoll	40.6372	20.9913	Iron-nickel ore, Iron and ferro-alloys metals	Fe	Co	C	O	laterite
3	Debrovë		Pogradec	40.9916	20.4644	Iron-nickel ore, Iron and ferro-alloys metals	Fe	Co	D	O	laterite
4	Katjel		Prenjas	41.0376	20.5668	Chrome ore, Iron and ferro-alloys metals	Cr2O3		D	O	ophiolite
5	Skroskë		Prrenjas	41.1073	20.4944	Iron-nickel ore, Iron and ferro-alloys metals	Fe	Co	C	O	laterite
6	Batër		Bulqizë	41.4586	20.2369	Chrome ore, Iron and ferro-alloys metals	Cr2O3		D	O	ophiolite
7	Bulqizë		Bulqizë	41.4786	20.2247	Chrome ore, Iron and ferro-alloys metals	Cr2O3		D	O	ophiolite
8	Krastë		Bulqizë	41.4301	20.2203	Chrome ore, Iron and ferro-alloys metals	Cr2O3		D	O	ophiolite
9	Thekën		Bulqizë	41.4202	20.2902	Chrome ore, Iron and ferro-alloys metals	Cr2O3		D	O	ophiolite
11	Batër		Bulqizë	41.4539	20.2347	Chrome ore, Iron and ferro-alloys metals	Cr2O3		D	O	ophiolite
11	Qafë Bulli		Peshkopi	41.4771	20.1988	Chrome ore, Iron and ferro-alloys metals	Cr2O3		C	O	ophiolite
12	Spaç		Mirditë	41.9010	20.0554	Copper ore, Base metals	Cu	Au	B	O	maficToUltramaficEffusiveVolcanism
13	Gurth - (Plakez)		Mirditë	41.9182	20.0690	Copper ore, Base metals	Cu		C	O	maficToUltramaficIntrusion
14	Munellë		Fushë Arrëz	41.9737	20.0815	Copper ore, Base metals	Cu	Zn, Pb, Au, Ag	B	O	maficToUltramaficEffusiveVolcanism
15	Qafë Bari		Fushë Arrëz	41.9972	20.0753	Copper ore, Base metals	Cu	Au	C	O	maficToUltramaficEffusiveVolcanism
16	Mamëz		Kukës	42.0550	20.3777	Nickel ore, Iron and ferro-alloys metals	Ni		C	O	laterite
17	Kalimash 1 TR 7		Kukës	42.0524	20.2741	Chrome ore, Iron and ferro-alloys metals	Cr2O3		C	O	ophiolite
18	Kalimash 2 Tr 1		Kukës	42.0562	20.2995	Chrome ore, Iron and ferro-alloys metals	Cr2O3		C	O	ophiolite

Appendix 2. continued.

Numbering	Mines (INSPIRE)	Greenfields (INSPIRE)	Municipality	Lat. WGS 84 (INSPIRE)	Lon. WGS 84 (INSPIRE)	Commodity Group (INSPIRE)	Metal (INSPIRE)	Minor Metal (symbol)	Deposit Class (INSPIRE)	Current Status (INSPIRE)	Type of Deposit (INSPIRE)
19	Kalimash 3 Tr. 6, 6A,A		Kukës	42.0469	20.3069	Chrome ore, Iron and ferro-alloys metals	Cr2O3		D	O	ophiolite
20	Trull		Kukës	42.0215	20.3381	Iron-nickel ore, Iron and ferro-alloys metals	Fe	Co	D	O	laterite
21	Kodra e Trullit		Kukës	42.0165	20.3230	Iron-nickel ore, Iron and ferro-alloys metals	Fe	Co	D	O	laterite
22	Vlahën		Has	42.2320	20.4782	Chrome ore, Iron and ferro-alloys metals	Cr2O3		D	O	ophiolite
23	Zogaj 3		Tropojë	42.3040	20.3005	Chrome ore, Iron and ferro-alloys metals	Cr2O3		D	O	ophiolite
24	Kosovrasti		Debar	41.5255	20.5635	Gypsum, Building raw materials			C	OC	evaporite
25	Groot		Veles	41.7374	21.7231	Iron-nickel ore, Iron and ferro-alloys metals	Fe, Ni	Co	D	OC	laterite
26	Hamzali		Bosilovo	41.5199	22.7696	Feldspathic raw material (ceramics), Ceramic and refractory minerals			C	OC	graniticIgneousRocksAndPegmatites
27	Zletovo		Probištip, Kratovo	42.0332	22.2052	Lead zinc ore, Base metals	Pb, Zn, Ag	Ag, Cd, Cu, In, Ga, Au	B	OC	veinPolymetallic
28	Toranica		Kriva Palanka, Makedonska Kamenica	42.1593	22.4915	Lead-zinc ore, Base metals	Pb, Zn, Ag	Fe, Cu, As, Bi, Mn	B	OC	skarnAndCarbonateReplacement
29	Durakov do I		Niksic	42.7623	19.1618	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti, Si	D	O	bauxite
30	Biočki stan		Niksic	42.7532	19.1678	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti, Si	D	O	bauxite
31	Štitovo II		Niksic	42.7352	19.1735	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti, Si	D	O	bauxite
32	Zagrad		Niksic	42.7631	19.0861	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti, Si	D	O	bauxite
33	Podvirovi		Bosilegrad	42.3509	22.3360	Lead-zinc ore, Base metals	Pb, Zn	Fe, Mn, Au, As	C	O	polymetallicManto
34	Grot - Blagodat		Vranje	42.5294	22.2387	Lead-zinc ore, Base metals	Zn, Pb, Ag	Cd, Cu, Au, As	C	O	skarnAndCarbonateReplacement
35	Korminjoš		Vranje	42.5056	21.9150	Zeolites, Minerals for chemical use			Unknown	O	nonOrganic
36	Lece		Medveđa	42.8876	21.5832	Lead-zinc ore, Base metals	Pb, Zn	Fe, Au	B	O	polymetallicManto
37	Igroš - Vidojevići		Brus	43.3691	21.1026	Zeolites, Minerals for chemical use			Unknown	O	nonOrganic
38	Belo Brdo		Leposavić	43.2526	20.8493	Lead-zinc ore, Base metals	Pb, Zn, Fe	As, Cu	B	O	skarnAndCarbonateReplacement
39	Pobrđe		Raška	43.3950	20.6149	Borates, Minerals for chemical use			Unknown	O	nonOrganic
40	Krive Strane i Torine		Čajetina	43.6982	19.6700	Magnesite, Minerals for chemical use	Mg		Unknown	O	ophiolite
41	Ribnica		Čajetina	43.6924	19.6136	Magnesite, Minerals for chemical use	Mg		Unknown	O	ophiolite
42	Brezak		Čačak	43.9903	20.2152	Magnesite, Minerals for chemical use	Mg		Unknown	O	ophiolite
43	wider locality of Čačak		Čačak	43.9933	20.3059	Magnesite, Minerals for chemical use	Mg		Unknown	O	ophiolite
44	Rudnik		Gornji Milanovac	44.1176	20.5198	Lead-zinc ore, Base metals	Pb, Zn	Fe, Cu, As	B	O	skarnAndCarbonateReplacement
45	Garasi		Aranđelovac	44.3058	20.4720	Clays (kaolinite), Ceramic and refractory minerals			Unknown	O	laterite
46	Veliki Majdan		Ljubovija	44.3040	19.3001	Lead-zinc ore, Base metals	Pb, Zn	Fe, Cu, As	C	O	polymetallicManto
47	Kranjani		Valjevo	44.4467	19.6513	Clays (kaolinite), Ceramic and refractory minerals			Unknown	O	shorelineOrMarinePlacer

Appendix 2. continued.

Num-bering	Mines (INSPIRE)	Greenfields (INSPIRE)	Municipality	Lat. WGS 84 (INSPIRE)	Lon. WGS 84 (INSPIRE)	Commodity Group (INSPIRE)	Metal (INSPIRE)	Minor Metal (symbol)	Deposit Class (INSPIRE)	Current Status (INSPIRE)	Type of Deposit (INSPIRE)
48	Beli Majdan		Loznica	44.5764	19.3516	Clays (kaolinite), Ceramic and refractory minerals			Unknown	O	laterite
49	Tenka 1,2 - North Revir		Majdanpek	44.4314	21.9175	Lead-zinc ore, Base metals	Zn, Cu	Fe, Pb, Au, Ag	B	O	polymetallicManto
50	Crveni pijesci-Pleće		Trebinje	42.8670	18.2910	Aluminium (Bauxite ore), Base metals	Al	Al	D	O	laterite
51	Jasenjani		Mostar	43.1322	17.7585	Aluminium (Bauxite ore), Base metals	Al		D-	OI	bauxite
52	Široki Brijeg		Široki Brijeg	43.4334	17.5961	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti, Si	D-	OC	bauxite
53	Cerovi Doci		Posušje	43.4701	17.5268	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti	D-	OI	bauxite
54	Vučipolje-Tribistovo		Posušje	43.4790	17.5133	Aluminium (Bauxite ore), Base metals	Al		D-	OI	bauxite
55	Crne Lokve - Gnjat		Široki Brijeg	43.4402	17.4803	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti	D-	OC	bauxite
56	Sobač - Tribistovo		Posušje	43.4889	17.3881	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti, Si	D-	OI	bauxite
57	Mratnjača		Posušje	43.5054	17.4132	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti	D-	OC	bauxite
58	Volujak-Kad-im		Posušje	43.5142	17.1950	Aluminium (Bauxite ore), Base metals	Al		Unknown	OI	bauxite
59	Studena - Vrila - Za-gorje		Posušje	43.5438	17.2188	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti, Si	D-	OC	bauxite
60	Kosturi		Srebrenica	44.0480	19.2570	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti	B	O	laterite
61	Srebrenica-Sase		Srebrenica	44.1180	19.3530	Lead ore, Base metals	Pb, Zn	Cd, Ag, Sn, Sb, S, Mn	B	O	polymetallicManto
62	Braćan		Milići	44.0890	19.1520	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti, Si	B	O	laterite
63	Crvene stijene		Milići	44.1000	19.1310	Aluminium (Bauxite ore), Base metals	Al	Al	B	O	laterite
64	Tuzla*		Tuzla	44.537	18.6732	Salt, Fertilizer Minerals			Uknown	O	unkown
65	Bešpelj		Jablanica	44.4231	17.3531	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti	D-	OC	bauxite
66	Crvene Stijene		Jajce	44.4040	17.3690	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti	D-	OC	bauxite
67	Poljane		Jajce	44.3802	17.3883	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti, Si	D-	OC	bauxite
68	Dočići		Šipovo	44.2920	17.1180	Gypsum, Building raw materials	CaSO4		B	OI	unkown
69	Sokolac		Šipovo	44.2860	17.0160	Clays (Bentonite), Specialty and other industrial rocks and minerals			B	O	layeredComplex
70	Gradina		Baraći	44.3100	16.9540	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti, Si	B	O	laterite
71	Bojište		Sanski Most	44.7026	16.4938	Aluminium (Bauxite ore), Base metals	Al		D-	OI	bauxite
72	Ljubija		Prijedor	44.8670	16.8940	Iron ore, Iron and ferro-alloys metals	Fe	Si, Ba, Pb, Zn, Ca, Mn	B	O	bandedIronForma-tion
73	Petkovac		Novi Grad	45.0520	16.5020	Gypsum, Building raw materials	CaSO4		B	O	unkown
74	Popović Polje		Bužim	45.1143	16.0375	Mangenese ore, Iron and ferro-alloys metals	Mn		C	OI	sedimentaryMan-ganese
75	Kobaš		Srbac	45.1080	17.7170	Clays (Kaolinite), Ceramic and refractory minerals			B	O	layeredComplex
76	Ston*		Ston	42.8383	17.6963	Salt, Fertilizer Minerals			Uknown	O	unkown
77	Nin*		Nin	44.2423	15.1834	Salt, Fertilizer Minerals			Uknown	O	unkown
78	Pag*		Stara Novalja	44.4434	15.0553	Salt, Fertilizer Minerals			Uknown	O	unkown
79	Rovinj		Rovinj	45.1080	13.6440	Aluminium (Bauxite ore), Base metals	Al	Fe, Ti	Unknown	O	bauxite