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Potential Benefits and Constraints of Development of Critical Raw Materials' Production in the EU: Analysis of Selected Case Studies

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Abstract: Major benefits and constraints related to mineral extraction within the EU have been identified on the examples of selected critical raw materials' deposits. Analyzed case studies include the following ore deposits: Myszków Mo-W-Cu (Poland), Juomasuo Au-Co (Finland), S. Pedro das Águias W-Sn (Portugal), Penouta Nb-Ta-Sn (Spain), Norra Kärr REEs (Sweden) and Trælen graphite (Norway). They represent different stages of development, from the early/grassroot exploration stage, through advanced exploration and active mining, up to reopening of abandoned mines, and refer to different problems and constraints related to the possibility of exploitation commencement. The multi-criteria analysis of the cases has included geological and economic factors as well as environmental, land use, social acceptance and infrastructure factors. These factors, in terms of cost and benefit analysis, have been considered at three levels: local, country and EU levels. The analyzed cases indicated the major obstacles that occur in different stages of deposit development and need to be overcome in order to enable a new deposit exploitation commencement. These are environmental (Juomasuo and Myszków), spatial (Juomasuo) as well as social constraints (Norra Kärr, Juomasuo). In the analyzed cases, the most important constraints related to future deposit extraction occur primarily at a local level, while some important benefits are identified mainly at the country and the EU levels. These major benefits are related to securing long-term supplies for the national industries and strategically important EU industry sectors.

Keywords: critical raw materials; minerals' security; mineral resources; mining; environmental impact; social license to operate; case studies

1. Introduction

Securing the access to the mineral deposits in the European Union (EU) is one of the key factors and actions enabling to diminish the EU's dependency on external supplies. Availability of minerals is of great importance for the development of the innovative and competitive industry of the EU, the integration of sustainable growth and the implementation of numerous objectives of the Europe 2020 strategy [1–3], such as challenging growth and employment opportunities, research and innovation actions, as well as climate change and energy transition goals. Moreover, there are new strategies and policies re-setting the scenery and raising the importance of minerals at the EU level, such as the European Green Deal [4], Industrial Strategy for Europe [5], EU Regulation on the establishment of a framework to facilitate sustainable investment [6] and the EU Recovery plan for Europe [7], but also at a global level, such as the United Nations (UN) Sustainable Development Goals [8,9]. They are applied to minerals' management, being an all-inclusive set of policy initiatives, addressing energy transition, circular economy and resource efficiency, to enable climate neutrality by 2050. In particular, the new Industrial Strategy for Europe [5] is aiming to strengthen strategic value chains for a future-ready EU industry and to form industrial alliances as an appropriate tool for steering work and helping finance large-scale mineral projects with positive spillover effects across Europe. The European Battery Alliance [10] and the European Raw Materials Alliance [11] are also good examples of activity towards that direction.

The global metal and mineral use has been strongly increasing due to advanced technological progress and fast-growing demand in the emerging countries. It is estimated that between 2010 and 2030, the volume of the world's raw materials' consumption could even double [12]. Securing supplies of raw materials, particularly those determined as critical, is essential for development of the strategic industrial sector in the EU [13–15]. The forecasted increase of demand for many of the critical raw materials (CRMs), accompanied with rising competition of other consumers on the global market, causes concerns of whether the future supplies will be sufficient to meet the future needs of the EU's downstream manufacturing sectors. The new, updated 2020 list of Critical Raw Materials [14] reports that for electric vehicle batteries and energy storage, the EU would need up to 18 times more lithium and 5 times more cobalt in 2030, and almost 60 times more lithium and 15 times more cobalt in 2050. Demand for rare earth elements used in permanent magnets, e.g., for electric vehicles, digital technologies or wind generators, could increase ten-fold by 2050. The World Bank projects that demand for metals and minerals increases rapidly with climate ambition [14,16]. The OECD (Organization for Economic Co-operation and Development) forecasts that global minerals' use will more than double, from 79 billion tons in 2011 to 167 billion tons in 2060 [14,17]. Improved recycling, resource efficiency, better product design and new materials will reduce mineral and metal consumption per capita, but mining of primary resources will continue to play an important role in the future in building sustainable societies.

A growing concern about the potential limitation of mineral supplies for the EU economy resulted in launching the Raw Materials Initiative in 2008 [18] and the strategic implementation plan (SIP) of the European Innovation Partnership (EIP) on raw materials in 2013 [19]. They have been followed by numerous research and innovation actions, especially funded under the Horizon 2020 Program, aiming at enabling access to minerals from primary resources as well as development of recycling and substitution options, as part of a circular and resource-efficient economy. As supplies of numerous CRMs from secondary resources are often very limited, their availability is strongly reliant on mining of minerals from primary resources (mineral deposits), which is strictly dependent on the access to land, that is fundamental for minerals' development. Numerous projects and expert groups related to these issues have been recently implementing such projects as, e.g., EO-MINERS, EU-RARE, FORAM, GeoERA, INTRAW, MICA, MINATURA2020, MINERALS4EU, MinGuide, MINLEX, MIREU, ORAMA, ProMine, ProSum, SARMa, SCRREEN and VERAM [20–36], as well as such expert activities and platforms as, e.g., Raw Materials Supply Group, Ad-Hoc Working Group on Defining Critical Raw Materials, European Technology Platform on Sustainable Mineral Resources, ERECON, Raw Materials Information System, etc. [37–41].

Among them, the recently completed MinLand project has been designed to meet challenges concerning competing land-use planning related to different land-use interests, including actual or potentially valuable mineral resources for exploration and extraction [42]. According to the project assumptions, this goal has to be achieved in an integrated and optimized process, taking into account land use policy and mineral policy in the EU member countries. Particular attention has been focused on the CRMs in cases where a strong reliability and dependency of the many important industry sectors on supplies from outside the EU has been noted. The crucial risks related to these raw materials are: strong concentration of the production in just a few non-European countries, and limited sourcing and import options from outside the EU, coupled with increasingly restrictive export policy in the countries exporting these raw materials [43–46]. Other important factors are the general lack of substitutes or limited possibilities of substitution of these raw materials [47].

There is no doubt that mining can bring positive benefits and new growth opportunities to the host countries, as well as to the regional economies and local communities concerned, but mining activities can also come at a cost to the environment, including biodiversity and conservation issues, if resources and operations are not managed properly and sustainably [48,49]. Conducting open, inclusive and continuing dialogue with local communities throughout the mining cycle is a precondition in order to create strong, transparent, trusting, collaborative and lasting relationships [50]. The fundamental aim must be equitable distribution of the benefits of development and minimization of the negative impact on people and the environment. Sustainable land use integrates and maximizes the multiple benefits related to economic, social, environmental and cultural values. Responsible navigation in this area requires a strong ethical compass [51,52].

The societal discourse on extractive activities has to be informed of the systemic costs and benefits of the respective development trajectories [53]. The discourse also has to be informed about potential risk displacement effects to more vulnerable societies if mineral raw materials are predominantly obtained from outside the EU, considering the societal and ethical issues involved when it comes to the conditions of producing operations in some extra-EU countries. Exploitation of domestic mineral raw materials for use and consumption within the EU can also help to stabilize economies by making them less dependent on international mineral markets' fluctuations and more resilient to any supply chain disruptions [5,18].

The initial hypothesis of this article has been an assumption that the EU has some resources of the most important CRMs that can potentially be developed with benefits at the EU, state and local level. Authors have concentrated on CRMs with high economic importance, high risks of supply and known potential resource base in the EU. After surveying in 9 European countries, a final in-depth analysis for 6 selected cases has been performed. With such assumptions, the main objective of this article was to detail the characteristics and analyses of those six case studies which have been recognized as potential sources of selected critical raw materials according to the actual list of CRMs [14]. The list of analyzed raw materials was determined during the MinLand project [54], supplemented with some updates [55]. The authors placed a lot of emphasis on benefits analysis in cases of starting extraction of selected deposits. Potential benefits were considered at the local, country and the European Union levels, highlighting the added value and related potential benefits for the EU downstream industry, such as battery and permanent magnet manufacturing, as well as the e-mobility industry. Potential constraints in the development of these deposits were also indicated, especially taking into account environmental, social and land use factors. Conclusions from such benefits and constraints analyses for each of the studied cases, as well as the subsequent comparative analysis in this regard for the set of 6 cases, are the main novelty of the presented work, also confirming the initial research hypothesis.

2. Materials and Methods

The work concentrated on the critical raw materials that were thoroughly analyzed in the MinLand project [54] and for which the three following conditions were simultaneously met:

- They were important for EU economy and their supply risk is high (according to the EU criticality assessment published in 2017) [43].

- They were recognized as important for at least one strategic value chain identified in JRC's Institute for Energy and Transport report (JRC—The Joint Research Centre is the science and knowledge service of the European Commission, and it employs scientists to carry out research in order to provide independent scientific advice and support to European Union policy), including renewable energy (wind and photovoltaics), grids, Li-ion batteries, electric vehicles, robotics and defense value chain [13].
- There were some prospects of their deposits' development within the EU.

Within the MinLand project, this approach allowed to select eight critical raw materials, i.e., cobalt, natural graphite, niobium, platinum group metals (PGMs), light rare earths elements (LREEs), heavy rare earths elements (HREEs), tantalum, tungsten and vanadium [54].

However, it is worth mentioning that the updated list of critical raw materials was published in 2020 [14], and as a result, the methodology applied by the authors has been recently adopted to these new assessments in the study of Lewicka et al. [55]. This approach has also been modified in terms of technologies and sectors identified as strategic by the European Commission [15]. As a result, nine critical raw materials have been recognized as important for at least two EU strategic industrial sectors within the main value chains. In comparison to the list provided in the MinLand project [54], lithium and titanium have been added (not being classified as critical in the 2017 assessment), while tantalum and vanadium have been removed [55].

The choice of cases for detailed description has been made on the basis of a preliminary questionnaire, which included the following information: data on available resources and reserves of mineral raw materials, type of constraints related to social, environmental and land use conditions, as well as any other barriers that can influence possible future mining activity. It has been assumed that the selected cases should represent different stages of deposits' development, from the early/grassroot exploration stage, through the advanced exploration stage and even active mines, up to closed mines for possible reopening, referring to different problems related to the possibility of mining commencement. Conditions related to planned land use were also very important analyzed factors. However, even if these land use conditions do not restrict mining and it is possible that under favorable economic conditions some deposits can be developed, becoming sources of CRMs, it cannot be excluded that some other obstacles (e.g., reaction of the local community, anti-mining activism) will appear at any moment and stage during respective deposit development. The choice of cases also depended on the availability of an appropriate set of data on these mineral projects.

Participants of the survey were partners of the MinLand project, who delivered some information of potential sources of CRMs in six European countries for in-depth analysis (Figure 1):

1. Myszków molybdenum-tungsten-copper ore deposit in Poland,
2. Juomasuo gold-cobalt ore deposit in Finland,
3. S. Pedro das Águias tungsten-tin ore deposit in Portugal,
4. Penouta niobium-tantalum-tin ore deposit in Spain,
5. Norra Kärr REEs deposit in Sweden,
6. Trælen graphite deposit in Norway.

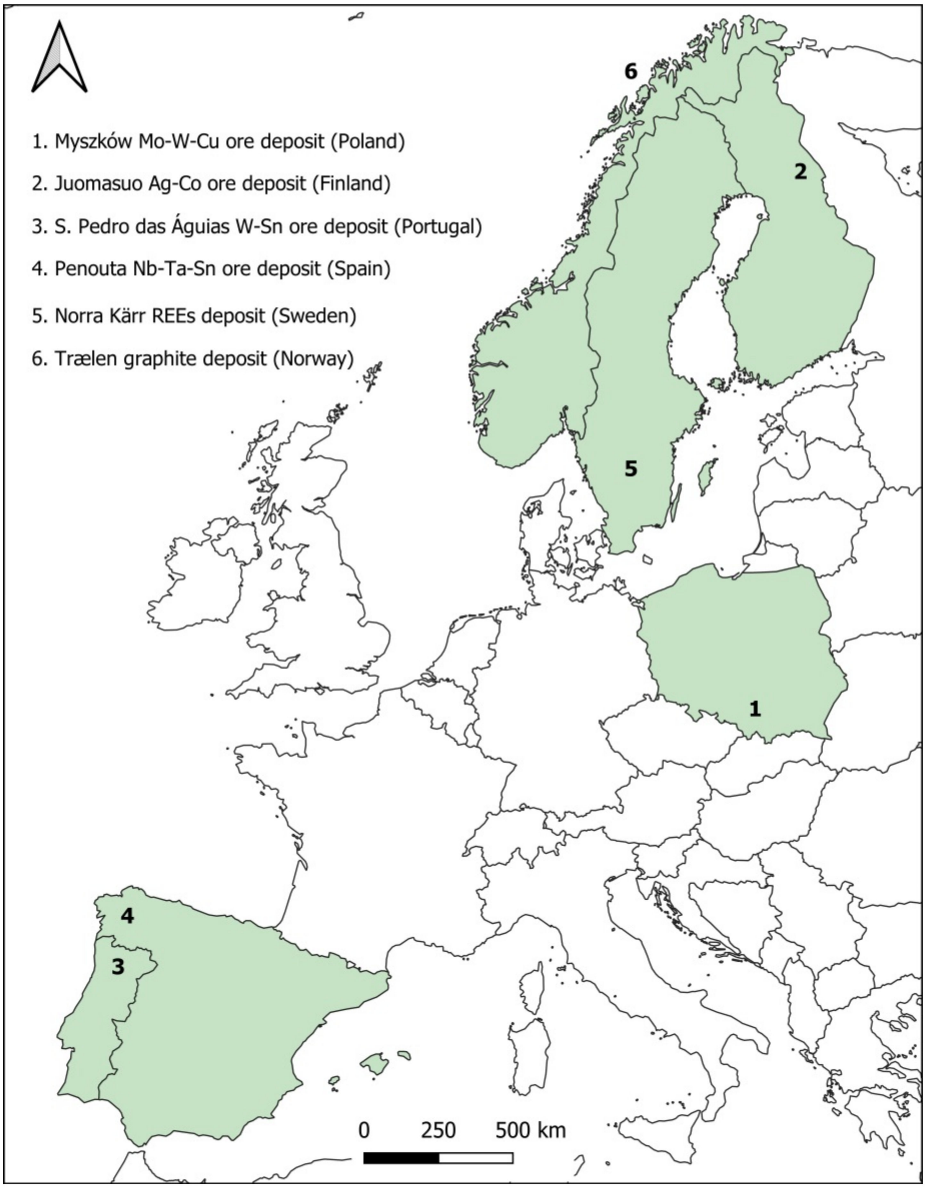

Figure 1. Location of selected case studies.

For these 6 cases, expected main benefits, as well as expected main costs and risks of the potential extraction, have been analyzed by the authors at three levels: local, country and EU, explained further in the Discussion Section. This has allowed for the preparation of some general conclusions in regard of both potential benefits as well as potential costs and risks of such activity on these three levels of perception and influence.

The work is based on thorough, multi-criteria analysis of selected cases of possible commencement of extraction of the most crucial critical raw materials, taking into account not only geological, but also economic, environmental, land use, social acceptance and infrastructure factors. Such a wide approach to the case analysis requires the use of various sources of information. These are: scientific publications related to the mineral deposits, reports of companies involved in mineral exploration and development (e.g., resources and environmental reports, opportunity and pre-feasibility studies), reports stored in archives of the state geological surveys, as well as official documents and decisions, and even press releases related also to social acceptance of these projects. With respect to land use, some important data have been collected from maps (e.g., land use planning maps, geo-environmental and environmental maps) and online portals.

3. Results

3.1. Myszków Deposit (Poland)—Potential Source of Tungsten and Molybdenum

3.1.1. Basic Information about the Deposit

The Myszków Mo-W-Cu ore deposit is located in Southern Poland (Figure 1), Śląskie Province, in the nearest neighborhood of the Myszków and Żarki towns, 80 km northwest of Kraków.

This polymetallic ore deposit [56,57] can be recognized as an early/grassroot exploration stage project. An intensive drilling program (over 30 km of drilling) was carried out in the years 1975–1992 on the basis of State funds to document the Myszków deposit in an area of 0.54 km^2 and down to the depth of 1300 m in 1993 [58]. In 2006, an exploration license was issued for Śląsko-Krakowska Kompania Górnictwa Metali—a Polish geological exploration company, owned by The Electrum Group, New York, Denver, US (55%) and Strzelecki Metals Ltd., Perth Western, Australia (45%). Exploration works in the years 2007–2009 (3 drillholes, about 3 km) were carried out by Strzelecki Metals Ltd., together with preparation of a new deposit model [59].

Tungsten (W), molybdenum (Mo) and copper (Cu) occur in Myszków deposit as major valuable metals, whereas silver (Ag), gold (Au) and rhenium (Rh) occur as main accompanying elements [60]. Ore mineralization is associated with stockwork that forms a quartz veins system containing disseminated mineralization of sulfides and oxides of metals, and is related to Variscan igneous activities (Figure 2) [57,61]. The Myszków deposit shows quite high homogeneity and continuity, with a high-grade central part. Deposit has been recognized to the depth of 1300 m, but the largest concentrations of tungsten and molybdenum are recognized at a depth of about 700 m. An average overburden thickness is about 170 m. Mineralization comprises mainly scheelite ($CaWO_4$) as a major tungsten mineral, and molybdenite (MoS_2) as a major molybdenum mineral, as well as chalcopyrite, pyrite, magnetite, etc. [62,63]. The quality of Mo-W-Cu ore in the Myszków deposit is quite variable, with Mo content in the range of 1–22,300 ppm (average: 617 ppm), W content 1–11,686 ppm (average: 404 ppm) and Cu content 1–47,000 ppm (average: 1210 ppm) [60].

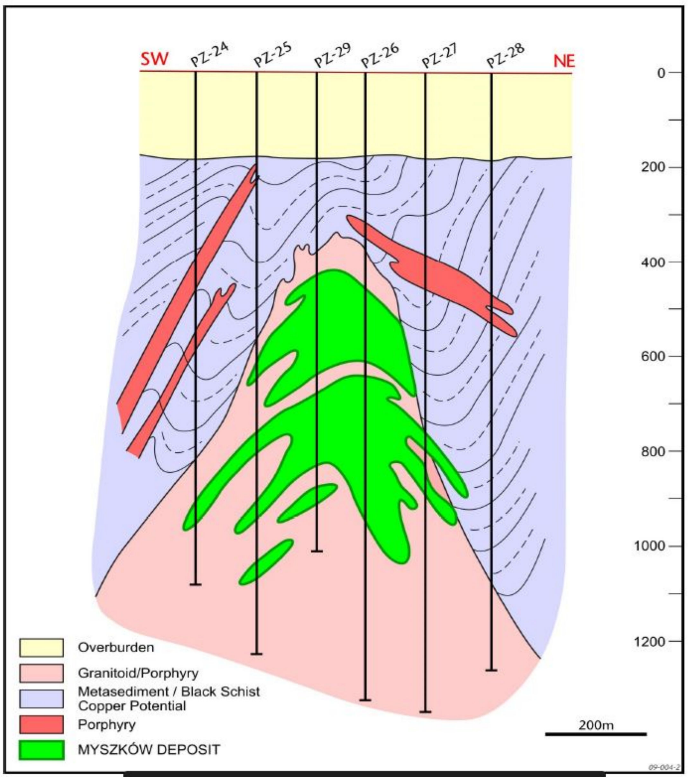

Figure 2. Schematic cross-section through the central portion of the Myszków deposit [60].

Inferred mineral resources of the Myszków deposit were first estimated in the Polish C2 resources category in 1993 [59]. In 2007, the so-called economic resources of the Myszków deposit, documented according to the Geological and Mining Law of Poland category [61], were re-evaluated, and it was found that they are markedly larger than previously estimated in 1993 (Table 1). In 2009, resource estimation was performed by SMG consultants for Strzelecki Metals Ltd., according to the JORC template (A JORC code is the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves) [60,64]. They defined a mineralized body of 1.3 billion tons of Mo-W-Cu ore (at a cut-off grade of 500 ppm eMo—molybdenum equivalent content of molybdenum, tungsten and copper), within which 726 million tons of Mo-W-Cu ore is described as Inferred Resources, averaging 1187 ppm eMo (1518 ppm eW—tungsten equivalent content of tungsten, molybdenum and copper) at a cut-off grade of 850 ppm eMo (Table 1). At a cut-off grade of 1500 ppm, these resources were much smaller (Table 1).

Table 1. Mineral resources of the of the Myszków Mo-W-Cu deposit [59,60].

Resources	Ore (Mt)	Tungsten (kt)	Molybdenum (kt)	Copper (kt)	Silver (Million tr oz)
Resources according to the Polish resources' classification					
So-called anticipated economic resources C2	551	238	295	800	-
So-called anticipated subeconomic resources C2	750	212	298	771	-
Resources according to the JORC Code					
Inferred resources at a cut-off grade of 850 ppm eMo	726	293	448	878	52
Inferred resources at a cut-off grade of 1500 ppm eMo	102	64	79	206	7

It is worth noting that the Myszków deposit is believed to be one of the ten largest molybdenum deposits in the world in terms of tonnage. It has the potential to be the first molybdenum-producing deposit in Europe [64]. Moreover, with the resources of about 293,000 tons W, the Myszków deposit constitutes at least 3% of the world's tungsten resources, being estimated at around 7 million tons W [65], so it could possibly be a supplementary source of primary tungsten production for the EU needs, as at the moment it is carried out, e.g., in Austria (Mittersill) and in Portugal (Panasqueira) [27,65]. The average EU production of W metal contained in ores and concentrates in recent years is estimated at about 2 ktpy, in comparison to the EU primary tungsten demand of about 10 ktpy [15]. Opportunities of launching the new production will depend on future tungsten prices that strongly influence the profitability of the mining operations. However, in case of the Myszków deposit, issues related to demand and prices of molybdenum (metal occurring in the largest quantities) will probably be decisive.

The Myszków Mo-W-Cu deposit can be extracted by underground methods only. In accordance with the preliminary deposit development plan, a pillar–chamber mining system (with underground backfilling) is recommended. A concept study was prepared for Strzelecki Metals Ltd. by Coffey Mining of Perth in 2009 [64]. Preliminary metallurgical testing of the molybdenum, tungsten and copper concentrates on the basis of the Myszków Mo-W-Cu ore were performed at laboratory scale production in 2006 and 2009. Their results initially suggested that four metals (Mo, W, Cu and Ag) could be recovered through the proper mining and processing operation, with use of flotation and recoveries of 94% of molybdenum, 85% of copper (silver probably at a similar level), but only 41% of tungsten [56]. Processing tailings were planned to be stored underground. The richest part of the deposit was planned to be extracted at the rate of 5 Mtpy for at least 17 years, with investment costs estimated at 427 million USD [60,64].

3.1.2. Possible Restrictions and Opportunities of Deposit Development

Preliminary analyses show that the potential development of the Myszków Mo-W-Cu ore deposit has no important or more crucial land use restrictions. The surface above the deposit, within 80 ha of the potential investment (mining and processing plant), is occupied mostly by agricultural areas (soil of low quality), with a small share of meadows and wasteland, and a very low share of built-up area (Figure 3). The deposit area is properly marked in the local (commune) land use documents [66]. Considering the depth of deposit and strength parameters of surrounding rocks, it can be initially assumed that exploitation would not cause deformation of the surface.

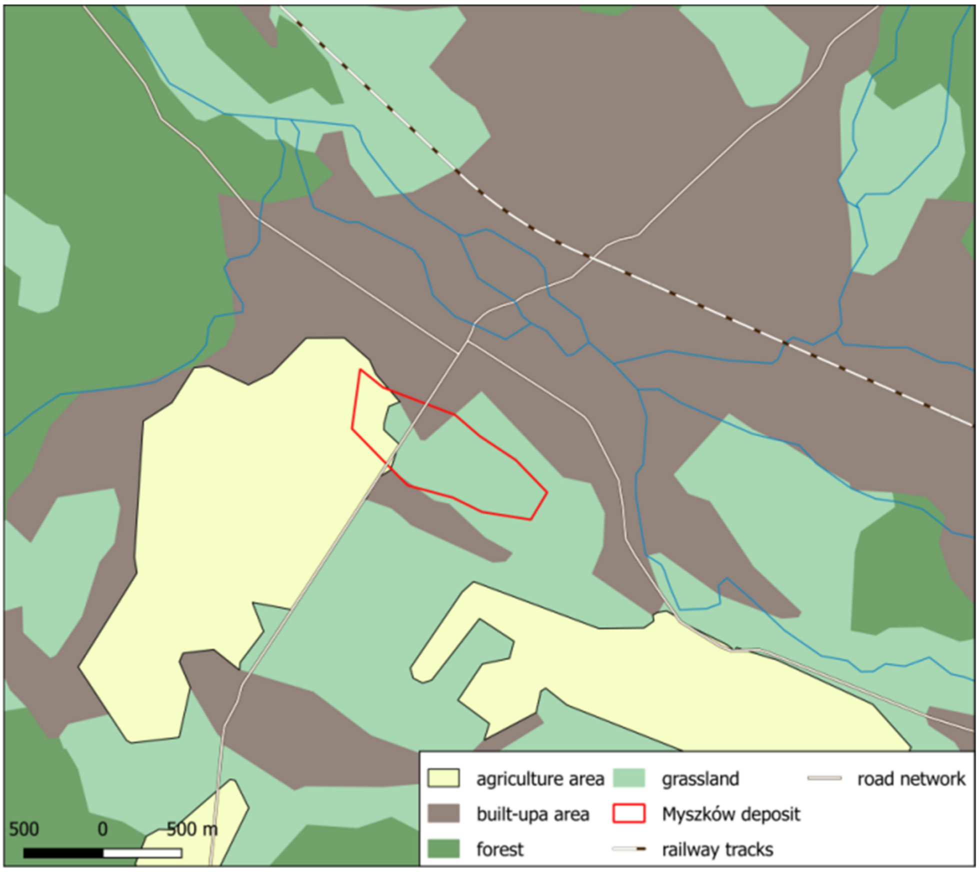

Figure 3. Land use in vicinity of the Myszków deposit, based on [67,68].

Regarding available technical infrastructure, the location of deposit is very favorable (sealed roads, a major railway line only 1.3 km away and 2 high-voltage power lines crossing the property and good trunk roads on site). Communal land is potentially available for the ground part of the mine (including processing plant and tailings pond). Moreover, in the region, there is a high availability of skilled workforce.

Preliminary analyses also show that the potential development of the Myszków Mo-W-Cu ore deposit has no crucial environmental restrictions, but two important environmental limitations have to be regarded. The first one is the occurrence of the Triassic underground water reservoir (Figure 4), that is a source of high-quality drinking water. Other important factor is high waste production related to this possible future mining and processing activity, as the total content of components recovered in the concentrated form will constitute less than 1% of the mass of potential mining output, and the preferable processing method is flotation [59,64].

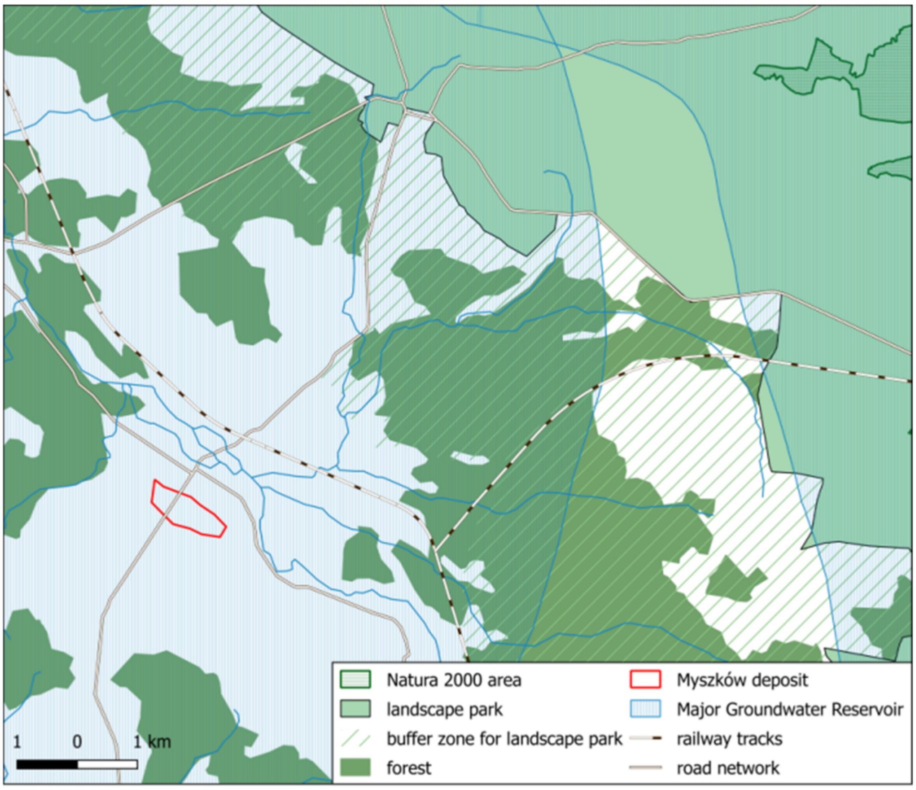

Figure 4. Environmental conditions in the vicinity of the Myszków deposit, based on [68,69].

At the current stage of the Myszków Mo-W-Cu ore deposit development, it can be said that the social license to operate this deposit is positive, with initial acceptance or even endorsement of the local self-government and local community (based on a survey from the local community).

Regarding economic and technological conditions, it needs to be highlighted that the results of initial laboratory flotation tests, performed at the current stage of the project, show that obtaining concentrates with high selectivity in the analyzed metals may be difficult. This is due to the technological properties of ore and losses of metal caused by the complex character of multi-stage hydrothermal mineralization (ore minerals form aggregates) [56]. Therefore, it can be a decisive factor in making the Myszków project unprofitable at the current market conditions (especially molybdenum and tungsten raw materials' prices). Project profitability may change significantly, with a marked increase in the prices of these raw materials.

3.2. Juomasuo Deposit (Finland)—Potential Source of Gold and Cobalt

3.2.1. Basic Information about the Deposit

The Juomasuo Au-Co deposit is located in the Kuusamo region, northeastern Finland (Figure 1). The deposit is related to the Paleoproterozoic Kuusamo Schist Belt (Figure 5). The region has been an area of intense mineral exploration for decades. It is a highly prospective area for gold and cobalt, and to some extent also for copper, rare earth elements, uranium and diamonds [70,71].

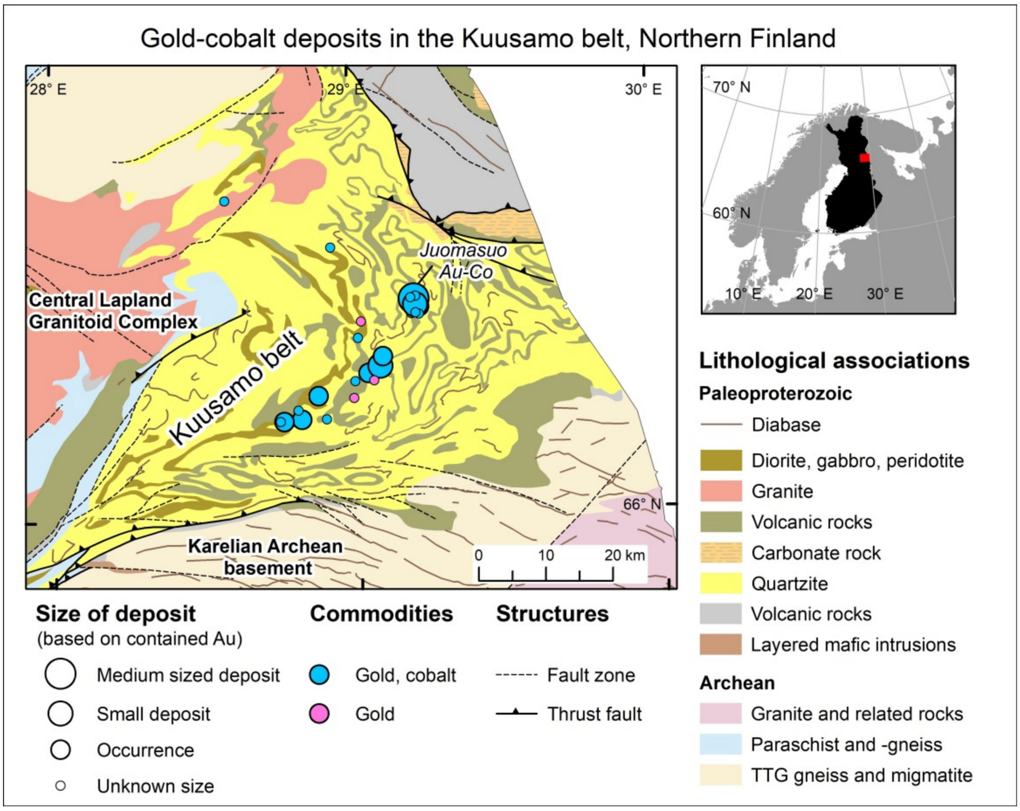

Figure 5. The Kuusamo Schist Belt and its gold-cobalt deposits, including the Juomasuo deposit. Modified after [72]. © Geological Survey of Finland 2020.

The Juomasuo gold-cobalt deposit was discovered by the Geological Survey of Finland (GTK) in 1985 on the basis of aero-radiometric anomalies. It has been subsequently explored and developed by the GTK, Outokumpu Oy, Polar Mining Oy, Dragon Mining Oy, Kuusamo Gold Oy and Latitude 66 Cobalt Oy since the 1980s [73–75]. At the moment, the deposit is at the advanced exploration stage and part of it is a mining concession area.

The deposit's mineralization is hosted by sericite quartzite, and volcanic and hypabyssal mafic and ultramafic rocks (Figures 5 and 6) [74]. This volcano–sedimentary sequence was intensely altered, deformed and metamorphosed to greenschist facies during the 1.93–1.76 Ga Svecofennian orogeny. Native gold is chiefly associated with Bi and Te minerals as inclusions in pyrite, cobaltite and uraninite, between silicates, and tiny Au-Bi-Te mineral veinlets oriented parallel with foliation and enveloped by silicates [73]. All the mineralized rocks have, apparently, the same ore-mineral assemblage. According to [71], the metal association in the Juomasuo deposit was formed by spatially coincident, multiple hydrothermal processes. These type of deposits have been classified by, e.g., the authors of [75] as 'orogenic gold deposits with an atypical metal association'. This metallogenic subtype shares several similarities with classic orogenic Au deposits, with the most significant difference being the enrichment in base metals in addition to gold.

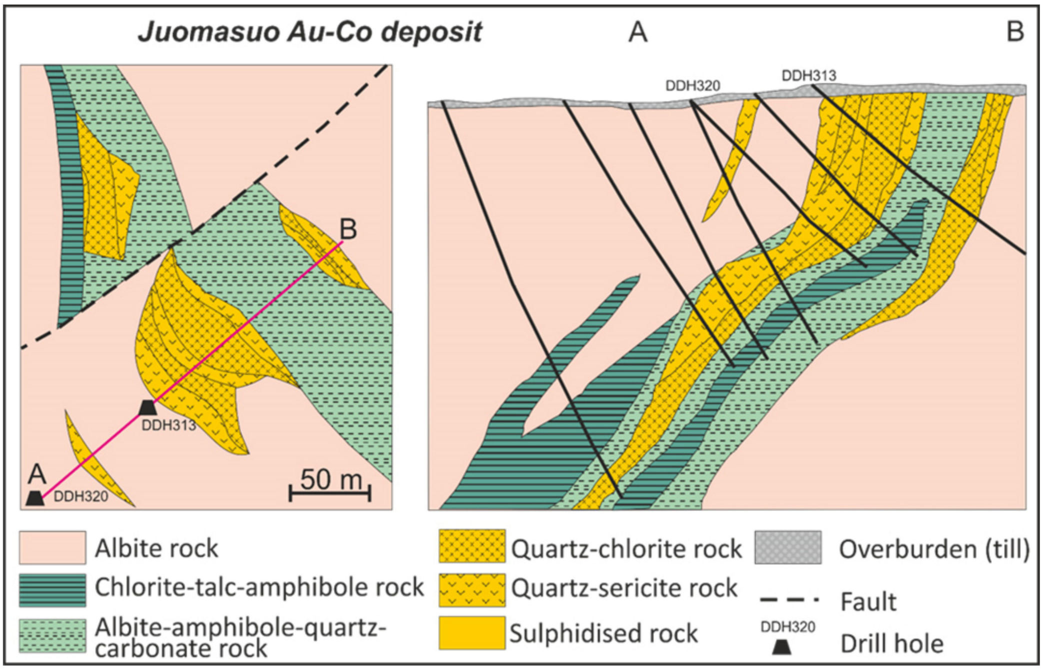

Figure 6. Cross-sections of the Juomasuo gold-cobalt deposit. Modified after [72,74,76]. © Geological Survey of Finland 2020.

Juomasuo is the largest known epigenetic-hydrothermal Au–Co deposit in the Kuusamo belt. Apart from Au and Co, the most commonly associated trace metals in the deposit are Cu, Mo and REE, together with a minor enrichment of U [76]. Its mineral resources are partially known, as the deposit is open at a depth of 300–350 m [77]. The current estimated CRIRSCO-compliant (Committee for Mineral Reserves International Reporting Standards) resources are presented in Table 2. If developed, Juomasuo deposit could be another important source of cobalt in Finland, which is currently the only mining cobalt producer in the EU. According to [78], mining is planned to be performed as an underground mine. The choice of the processing methods will depend on the drilling results, the beneficiation tests of the ore, as well as the environmental impact assessment results.

Table 2. Estimated resources of the Juomasuo gold-cobalt deposit in Kuusamo [77].

Commodity	Total Metal Resources (t)	Indicated	Inferred
Au	18.8	1.6 ppm	0.22 ppm
Co	16,454	0.081%	0.052%

3.2.2. Possible Restrictions and Opportunities of Deposit Development

Kuusamo has a history of environmental struggles over diverse natural resources (forests, fishery, hydropower, reindeers, minerals) [79]. The case of Juomasuo is among the oldest ongoing mining disputes in Finland [80], and has been covered well by the local and national press. The dispute started when foreign companies were exploring for uranium in 2006–2010 [81]. Anti-uranium activists also focused their attention on projects of other commodities in which uranium is associated, including Juomasuo [79,82]. Juomasuo's association with uranium has incited opposition towards the project since its former ownership by Australian Dragon Mining. Dragon Mining also applied for mineral exploration permits close to the Ruka ski resort (Figure 7), which caused local tourism entrepreneurs to oppose the company and its projects [83]. Those unfavorable towards the project also included some local environmental non-governmental organizations.

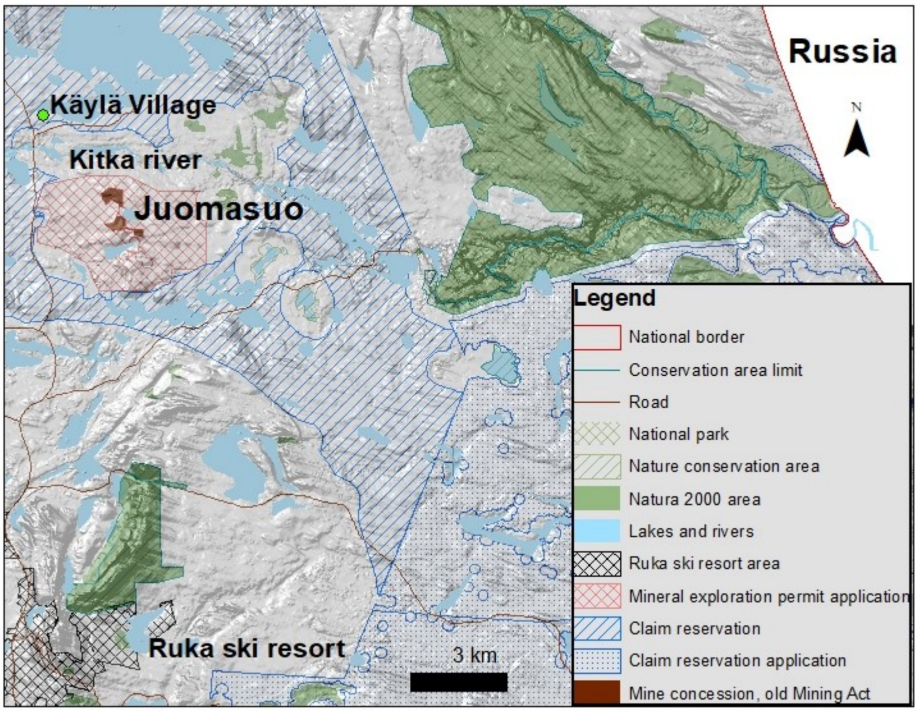

Figure 7. Location of the Juomasuo mine concession and its land use in Kuusamo [84,85]. © Geological Survey of Finland 2020.

When the environmental permit application was not successful, Dragon Mining Oy sold the prospect to another Australian company, Latitude 66 Cobalt, in 2016. Despite the efforts of the current concession holder (e.g., sharing benefits by supporting local teen athletes, openness to communication), opposition has continued. This is a typical situation where a new concession holder inherits a dispute from a former one. According to a poll in February 2018, almost half of the local people opposed the Juomasuo mine development in Kuusamo [86]. In addition, the Municipality of Kuusamo tried to exclude mining from its area through urban planning, but this strategy to exclude mining was considered illegal in a High Court ruling [87].

The planned mine area is inhabited, there is the village of Käylä nearby and the mine would be close to the Kitka River, national parks, protected natural areas and leisure centers (Figure 7). The Juomasuo dispute relates mainly to associated uranium and conflicting interests of land use, i.e., nature tourism vs. mining. Eerola [79,82] referred to such disputes between mining and tourism as the 'Not in My Leisure Area' (NIMLA) phenomenon. However, concessions for mineral exploration and mining have been given by the Mining Authority (Tukes) for the Kuusamo region. The Latitude 66 Cobalt Oy has a valid mining license from its former holder, for which it has applied for five additional years and is preparing environmental impact assessment (EIA) for the purpose of an environmental permit for mining [88]. According to the company, it performs additional mineral exploration in the vicinity of the planned mine, and beyond, by employing new low-impact technologies such as drones. It also takes the tourism into account, wishing to conciliate mining and tourism in the region [89].

3.3. São Pedro das Aguias Deposit (Portugal)—Potential Source of Tungsten and Tin

3.3.1. Basic Information about the Deposit

The São Pedro das Águias W-Sn deposit is located in northern Portugal, in the Tabuaço Municipality, south of Douro River, 300 km NNE of Lisbon and 100 km to the east of Porto (Figure 8).

Currently, the São Pedro das Águias deposit corresponds to a very advanced exploration project. Prospecting between 2007 and 2013 was carried out over mineral occurrences exploited during World War II. A preliminary economic assessment was completed in September 2013, indicating potential for economically viable project options for the deposit and suggesting that further studies and field work for this project are justified. A concession for experimental extraction was granted in 2013 and ended in 2017. Mining did not initiate due to a lack of funding [90].

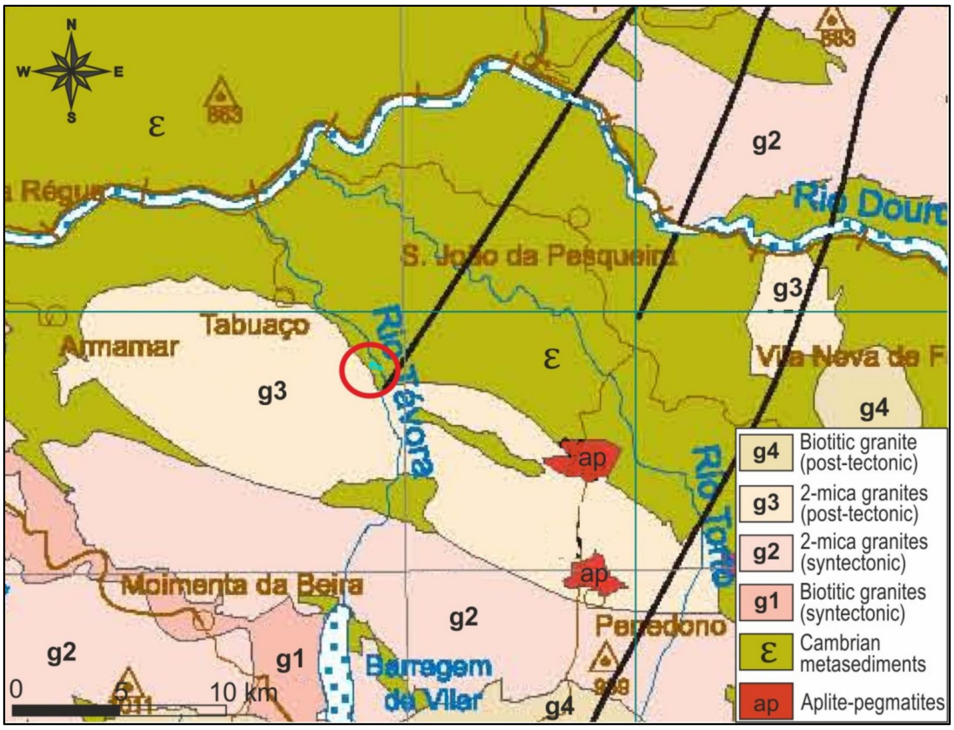

Figure 8. Geology of the area of the São Pedro das Águias W-Sn deposit: location marked with a red circle (extract adapted from the Geological Map of Portugal, 1:1,000,000) [91].

Geologically, the São Pedro das Águias deposit is located in the Central Iberian Zone of the Variscides, which is known by abundant W-Sn mineralization associated with granitic rocks (Figure 8). It is a skarn-type tungsten deposit without molybdenum, also rich in tin and with possibilities for the recovery of fluorite as a by-product. The major ore minerals are scheelite ($CaWO_4$) and cassiterite (SnO_2) [92]. Exploration works between 2007 and 2013 encompassed: detail geologic mapping, stream sediments survey, including geochemical and pan-concentrate sampling, mineral prospecting and soil geochemical traversing, structural geology studies, sampling of outcropping mineralization and a diamond drilling program (82 exploration and evaluation holes of about 10 km total). The achieved results indicate: very thick (5 to 20 m) mineralized bodies (skarns), with some hundred meters of extension, and deepening gently, metasedimentary sequence, including the skarns, continuing under the granitic intrusion (Figure 9), good-quality ore, essentially silicates, practically without sulfides or heavy metal contaminants, and high scheelite contents, with high scheelite purity and without molybdenum [93,94].

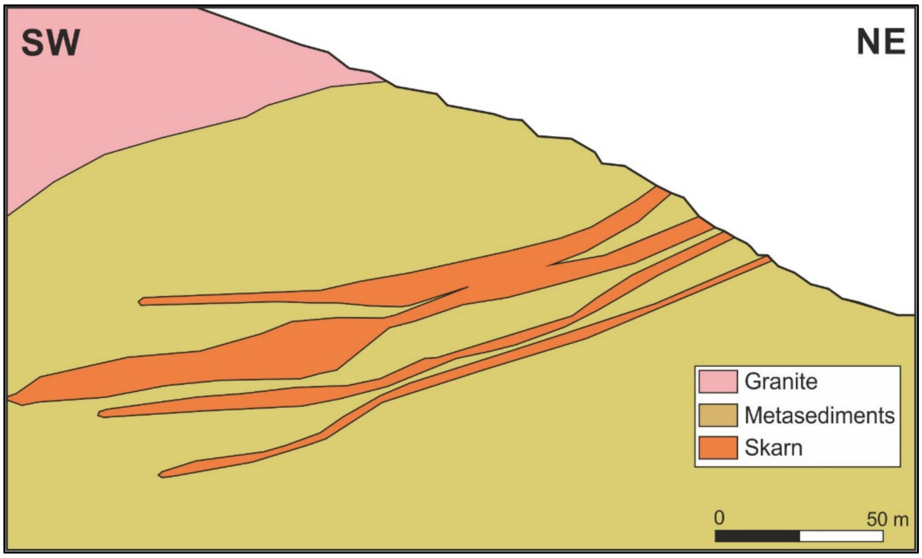

Figure 9. Cross-section of the São Pedro das Águias W-Sn deposit. Modified from [94].

Resource estimations were performed in 2012, in accordance with the Canadian regulation NI 43–101 (Table 3). These include resources evaluated for a smaller deposit occurring 600 m to the north of the S. Pedro das Águias deposit. In addition, it is worth noting that the extension of these deposits remains open towards SW, and there is promising evidence for other orebodies in the immediate vicinity. Therefore, further exploration works may lead to a substantial increase in the values presented in Table 3.

Table 3. Estimated resources of the São Pedro das Águias W-Sn deposit [94].

Resource Category	Ore Resources (kt)	Grade (% WO_3)	Metal Resources (t WO_3)
Indicated	1495	0.55	8150
Inferred	1230	0.59	7200
Total	2725	0.56	15,350

If developed, São Pedro das Águias deposit could be another important source of tungsten in the EU, in addition to the currently active Mittersill mine in Austria and the Panasqueira mine in Portugal.

Mining development was projected to be underground (drift and fill, backfilling), and processing would involve several crushing, milling and concentration steps before flotation and magnetic separation [93]. Metallurgical test work indicated the possibility of obtaining high-grade (70%) WO_3 concentrates through the application of a combination of gravity and flotation methods [93,94].

3.3.2. Possible Restrictions and Opportunities of Deposit Development

The mineral deposit of S. Pedro das Águias is located in a rural vineyard area for Porto Wine production. More specifically, it is located right below the Convent of S. Pedro das Águias, which was acquired by the promoters of the mining project for rural tourism and Porto Wine production. The planned mining operations were made compatible with these activities [93].

As can be seen in Figure 10, there are no land use planning issues regarding the implementation of the project because municipal authorities foresaw the need to delimit a potential area for the development of mining works. This was triggered by the engagement of the mining company to take appropriate awareness-raising actions near local politicians during the land use planning review phase. In addition, according to the land use planning regulations, the surrounding agricultural spaces are compatible with the exploitation of geological resources, as this kind of activity is temporary and spatially restricted. Nature protection areas are already integrated in the land use planning scheme of the municipality of Tabuaço, and no such kind of areas exist within the range of the mining project [93].

Since the beginning of the exploration works, the promoter of the mining project also had a strong engagement with local populations. For this reason, it was found through an environmental scoping study [95] that there are no special social concerns about a mining development in the region.

This general picture about political willingness, no land use planning restrictions (including those directly related to nature protection, e.g., natural parks) and no social concerns for the development of the mining project was an exception in the central and northern parts of Portugal. In fact, taking into account the national strategic guidelines for land use planning, when dealing with the zoning of rural land, the local authorities give precedence to areas for some kind of nature protection, which account for more than 50% of the rural land. In addition, rural land tenure in the northern and central parts of Portugal is characterized by small parcels, each with its owner, which usually gives rise to NIMBY (Not In My Back Yard) issues.

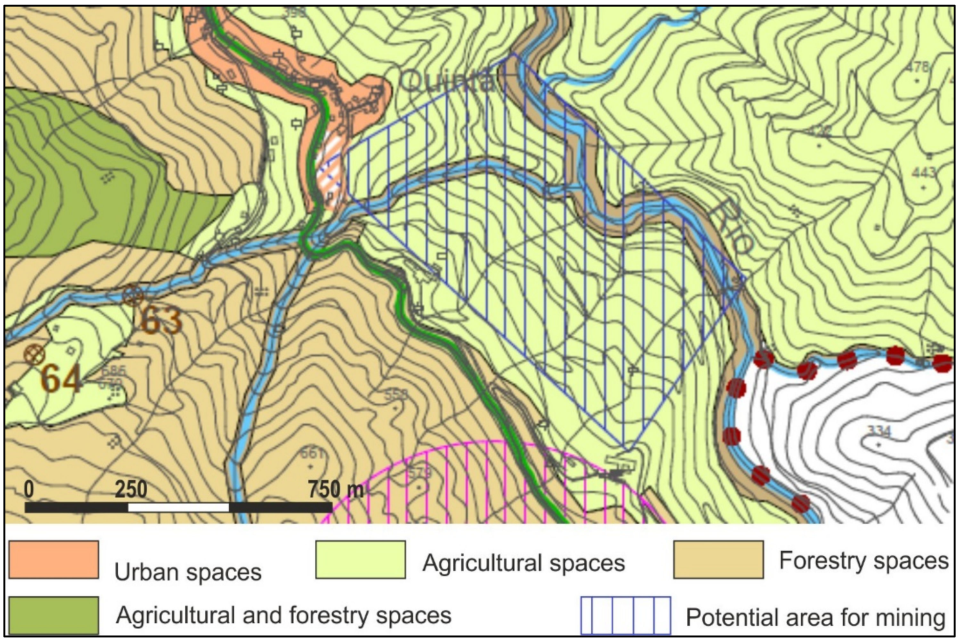

Figure 10. Extract from the land use planning map of the Tabuaço municipality regarding the location of the S. Pedro das Águias tungsten deposit (adapted from [96]).

If the project proceeds, an environmental impact assessment study would be required. This would assess positive compliance with the spatial planning instrument, but would also assess the environmental impacts that the project's implementation will cause, for example, impacts on surface and groundwater that could eventually compromise the implementation of the project or would require special minimization actions.

3.4. Penouta Deposit (Spain)—Potential Source of Niobium, Tantalum and Tin

3.4.1. Basic Information about the Deposit

The Sn-Ta-Nb Penouta Mine is located to the north of the town of Penouta, in Concello de Viana do Bolo, on the west-central border of the Ourense province of Spain (see Figure 1).

The Penouta project may be considered partly an active mine and partly an attempt of abandoned mine reactivation. Two mining permits have been conferred in this regard, according to the Spanish mining law: Section B (exploitation permit focused on waste/secondary deposit, which is currently under exploitation) and Section C (research project focused on primary mineralization). During the mining activities developed in previous decades, large amounts of Sn- and Ta-bearing materials were deposited in the tailing ponds, due to deficient mineral processing. Due to economic and technological changes developed in recent years, exploitation of these sources seems to be potentially viable nowadays. Therefore, the Resource Exploitation Concession for Section B "Penouta" is intended to reprocess those materials that were considered mining waste until now [97].

From a geological point of view, the Penouta Sn-Ta-Nb ore deposit is located in the eastern side of an anticlinorium called "A Mezquita", composed of various granite intrusions in the axial region of the anticlinorium, whereas the western side is constituted by the so-called "Viana series", a metamorphic complex that lies under an extensive formation of glandular gneisses, named "Ollo de Sapo". The deposit is composed of diverse rocks: leucogranite, aplite-pegmatite dikes, greisen and quartz veins, hosted by metamorphic rocks formed before the main Hercynian deformational phase: gneisses in the "Ollo de Sapo" formation, as well as orthogneisses and Schists (Figure 11). Mineralization of cassiterite, Nb and Ta oxides is disseminated throughout the alkaline granite, being concentrated in the cupola zone. Towards the contact with the "Ollo de Sapo" gneiss, a cassiterite-rich greisen zone is developed. Cassiterite is also present in the upwards quartz veins, where they can reach centimeter-sized crystals [98].

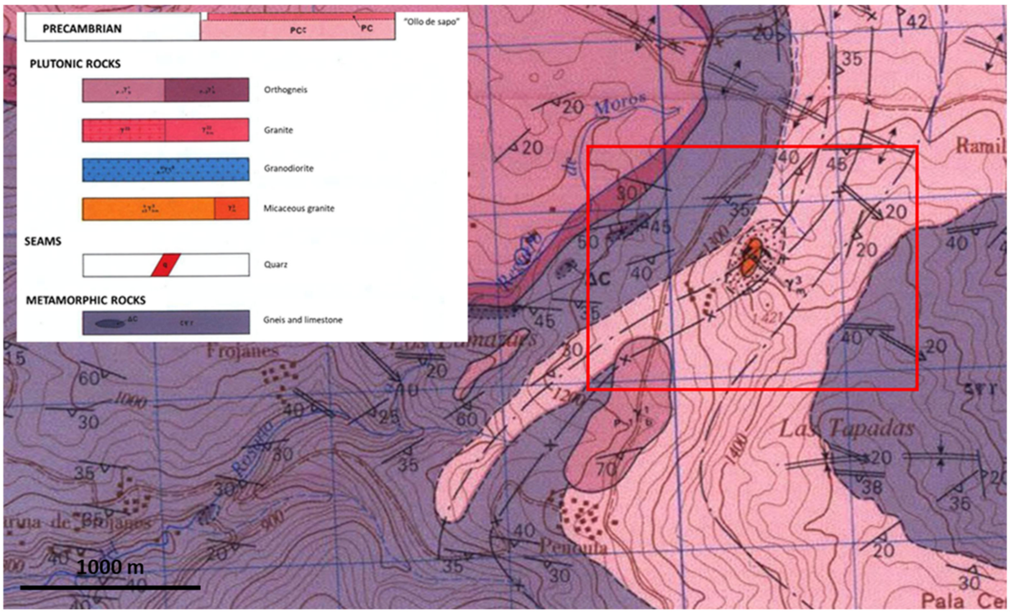

Figure 11. Geology of the area of Penouta Mine [99].

A detailed estimation of resources (Table 4) has shown 4.82 million tons of wastes (secondary source) as an indicated source of Sn (av. 387 ppm) and Ta (av. 48 ppm), as well as 10.97 million tons of primary ore in an open-pit project with high contents of Sn (av. 461 ppm), Ta (av. 79 ppm) and Nb (av. 64 ppm) [97]. If developed, Penouta deposit could become the first own primary source of niobium and tantalum within the EU.

Table 4. Estimated resources of the Penouta deposit [97].

Resource Category	Ore Resources (kt)	Sn Resources (t)	Ta Resources (t)	Nb Resources (t)
Open-pit project	10,970	37,224	6514	5330
Wastes	4820	1863	231	-
Total	15,790	39,087	6745	5330

The assumed type of extraction is open-pit mining for Section C (primary deposit), while in the case of Section B (wastes), only direct extraction and charge are required. The main planned stages of beneficiation of primary ore are: milling, gravity enrichment (spirals and shaking tables) and magnetic separation (of low and high intensity). Some of these stages will probably not be necessary to apply to the treatment of wastes [97].

3.4.2. Possible Restrictions and Opportunities of Deposit Development

There are no remarkable problems regarding land uses in the case of the Penouta deposit. Bushes and grassland areas dominate the main land uses in the vicinity, as well as rain-fed agriculture (Figure 12). In addition, there are a couple of adjacent Natura2000 areas, e.g., Pena Trevinca (SCI—Site of Community Importance + SPA—Special Protection Areas ES1130007). However, planned mining activities will not have an influence on these sites [100,101].

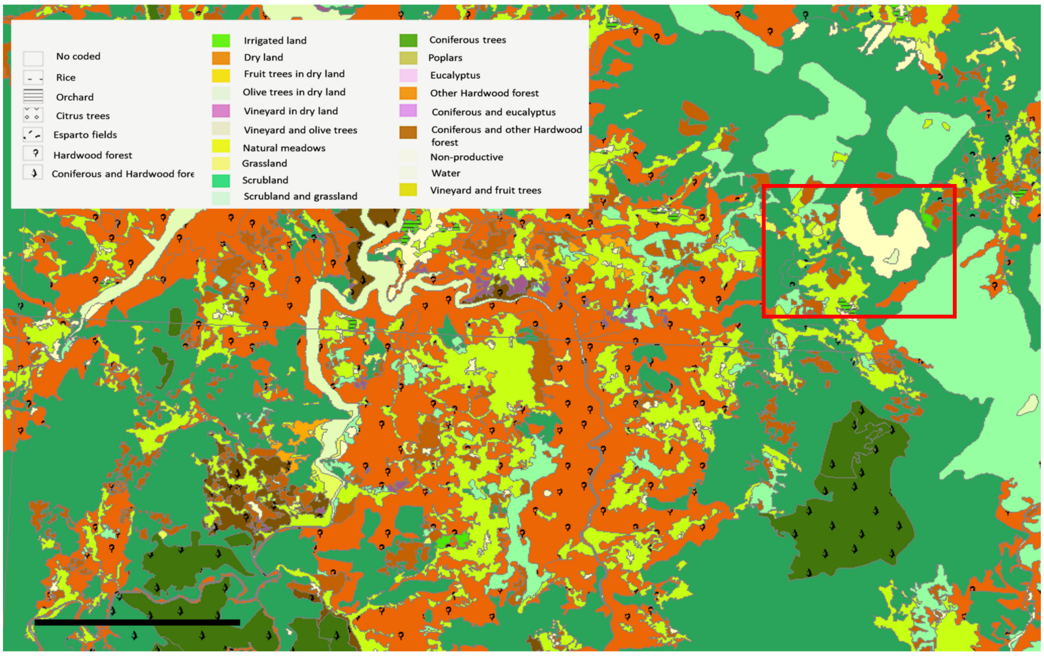

Figure 12. Land use planning map of Penouta Mine [102].

Local society appears to agree with the development of the project. Complaints regarding the Penouta mine activities have not been reported to date (no NIMBY effect). There are no issues regarding activity of any environmental NGO. Currently, there is an environmental permit and exploitation license for Section B, while for Section C, this process is in progress, but there is no evidence of problems regarding municipal permits.

Strategic Minerals Spain is currently working to evaluate possibilities of waste reprocessing to minimize the environmental impact generated by tailing ponds. The company is also improving water recycling processes in order to reduce the inputs and losses of water. Furthermore, chemical reagents are not used in the processing, and the water leaked during the process is appropriate to return it to the process (recirculation rate 75%). Based on previous studies of environmental aspects susceptible to being affected by mining activities, the company is also going to apply a rigorous environmental control and surveillance program, ensuring that all environmental effects are adequately controlled and meet the expected requirements. In addition, given the initial state of the mine site (abandoned mine-affected area), the company is going to initiate restorative works before the beginning of the extraction activities in the area [97].

3.5. Norra Kärr Deposit (Sweden)—Potential Source of Rare Earth Elements

3.5.1. Basic Information about the Deposit

As one of the largest REE deposit in the European Union and one of the most significant heavy REE resources in the world [103], the Norra Kärr deposit, situated in south central Sweden (Figure 1), is significant for the security of future REE, zirconium and hafnium supply [40,104,105].

The Norra Kärr deposit was initially discovered in 1906, and further recognized and assessed by the Boliden mining company for extraction of nepheline syenite and zirconium in the mid-20th century [106]. The deposit was recently explored by Tasman Metals, later Leading-Edge Materials, for extraction of REEs, hafnium, zirconium, as well as by-product nepheline syenite host rock [107]. The company was granted a mining license in 2013, making it stronger to build-up risk capital for a final EIA application to the environmental court. This was, however, appealed to the Supreme Administrative Court, and as a result reverted to an exploration license. A more detailed environmental study, including sites for industrial facilities such as tailing dams, was recognized to be necessary, moving the application for a mining license closer to the final environmental application [108]. At the moment, the deposit is at the advanced exploration stage with a NI43-101 assessment of the HREEs.

The Norra Kärr deposit consists of a peralkaline nepheline-syenite intrusive complex covering an area of 450 × 1500 m and extending at least to the depth of 350 m [106]. Below this depth, the deposit is open. The Norra Kärr intrusion is enriched in zirconium (Zr), HREEs, yttrium (Y), niobium (Nb) and hafnium (Hf), resulting in the presence of minerals that are uncommon on a global scale [109,110]. The deposit is unusual as nearly all REE are found in one mineral, and not distributed through multiple phases. The complex zircono-silicate mineral eudialyte hosts over 95% of REE, with lesser amounts in a secondary Ca-LREE-F-silicate mineral, tentatively identified as britholite, with trace mosandrite and cerite [106]. The TREO (total rare earth oxides) content in eudialyte varies between 6% and 10% [111].

The Norra Kärr deposit has recognized substantial resources unusually rich in HREEs, with probable mineral reserves of 23.6 million tons of ore (NI 43-101), containing on average 0.59% REE oxides (Table 5) [106]. The quality is very high, with an unusually high share of HREEs (it has the highest HREEs share among all known large REE deposits around the world). The ore quality is, in general, stable across the deposit. As a result, the Norra Kärr deposit seems to be the most important HREE source for potential extraction in the EU, as well as one of the richest HREE deposit in the world. It is currently one of two REE projects in Sweden that has the possibility to be developed into extraction within the next ten years (the second one is the apatite waste/rock from the LKAB Kiruna and Malmberget apatite-iron ore mines). Leading Edge, which is developing the Norra Kärr project, is today aiming to include within the mining license application also extraction and production—as a by-product—of nepheline syenite (host rock for HREEs), which is believed to be suitable for European ceramic and glass markets. Such a solution would be beneficial for making mining economically sustainable in the long term and would enable to avoid market fluctuations of REEs. The company is aiming at production of about 5000 tpy of separated HREE oxides for at least 20 years, taking into account currently recognized resources [109].

Table 5. Indicated mineral resources and probable mineral resources in the Norra Kärr deposit [106].

Ore (Mt)	TREO (%)	HREO/TREO Ratio (%)	Dy_2O_3 (%)	Y_2O_3 (%)	Eu_2O_3 (%)	La_2O_3 (%)	Nd_2O_3 (%)	Ce_2O_3 (%)	Gd_2O_3 (%)	Tb_2O_3 (%)	Pr_2O_3 (%)	Sm_2O_3 (%)	Lu_2O_3 (%)
Indicated Mineral Resource Estimate, 0.4% cut-off													
31.1	0.61	52.6	0.027	0.218	0.002	0.057	0.067	0.128	0.020	0.004	0.017	0.018	0.003
Probable Mineral Reserve Estimate													
23.6	0.59	53.1	0.027	0.215	0.002	0.055	0.065	0.124	0.020	0.004	0.016	0.018	0.002

TREO—total rare earth oxides, HREO—heavy rare earth oxides.

Under the model assumed by [112], Norra Kärr could be exploited by open-pit mining with conventional hydraulic shovels and rigid body trucks, a support loader for clean-ups, oversized transport and muck pile construction [109]. The deposit crops out or lies under only a thin soil cover [106].

Although until now a simple process flowsheet has been proposed and high REE recoveries in metallurgical testing have been achieved [103], significant roadblocks have been identified in processing such obtained REE concentrates within Europe. The proposal of conventional and innovative metallurgical treatment, starting from beneficiation, leaching and REE separation, and ending in metal production, developed in EURARE, have proven the technical feasibility but would require significant investments in order to set up the respective REE processing plants [21].

3.5.2. Possible Restrictions and Opportunities of Deposit Development

The project is well-serviced by power and other infrastructure that will allow year-round mining and processing. It is close to a major road (very close to an important highway), and also has good access to the railroad. The skill-rich cities of Linköping and Jönköping lie within daily commuting distances from Norra Kärr [106]. Its location close to operating ports with rapid access to the European market [103] is also very important, as well as the high level of reliance on local equipment, reagents and labor [113].

Land use issues were judged both in the mining license decision and in the environmental court decision. Due to opposition of anti-mine activists, this issue is not yet resolved, even though the company was initially granted a mining license, which was appealed to the high administrative court. The court decided that the mining license was rejected and transferred back to the status of an exploration license. The impact of the decision, demanding an outline of the industrial facilities and a deeper environmental investigation, puts pressure on the project to be more heavily developed for an application for a mining license than previous practices for applications for a mining license in Sweden. The consequence may be that it will be more difficult to find financing for the project development, as a previously possessed mining license was an important force attracting investors for the final step towards mine construction. After the present verdict, the situation became more complicated.

The project has faced opposition from anti-mining activists, with false claims that Lake Vättern will be polluted, e.g., by uranium. In fact, the Norra Kärr deposit has no significant contents of uranium [112] and the direction of watercourses from the area is not towards Lake Vättern. The company responded in their stakeholder dialogues and by making polls regarding the view of mining among the local population. In the local perspective within the county, the recent polls have shown that there is a majority in favor of mining, even though closer to the mine site there have been more negative opinions [111]. This is in line with a current investigation made by the SOM-Institute for the SGU Geological Survey of Sweden, that has shown that a majority is in favor of mining, a large minority is undecided, and a small minority is against mining [114]. However, in this case, due to existing opposition of anti-mining activists, the social license to operate is not yet resolved.

As with all mining operations where there is a strong mineral supply monopoly, as China controls the lion-share of all REEs produced globally, in practice, the guarantee for an economic prize of the product can be difficult unless buyers will sign long-term contracts for buying the Norra Kärr products. Otherwise, there is a risk that such mining operation will not be economically viable, though other products such as the nepheline syenite can positively change this viability. This is one of the very important aspects of the possible development of the Norra Kärr project.

3.6. Trælen Deposit (Norway)—A Reliable Source of Graphite

3.6.1. Basic Information on the Deposit

The Trælen natural graphite deposit is located in the northernmost part of Norway (Figures 1 and 13), in Senja municipality, Troms and Finnmark counties. The closest major town is Tromsø, approximately 70 km by air, with a population of approximately 41,000. It is in an area of relatively good infrastructure, next to the shore with roads and high-voltage power lines nearby.

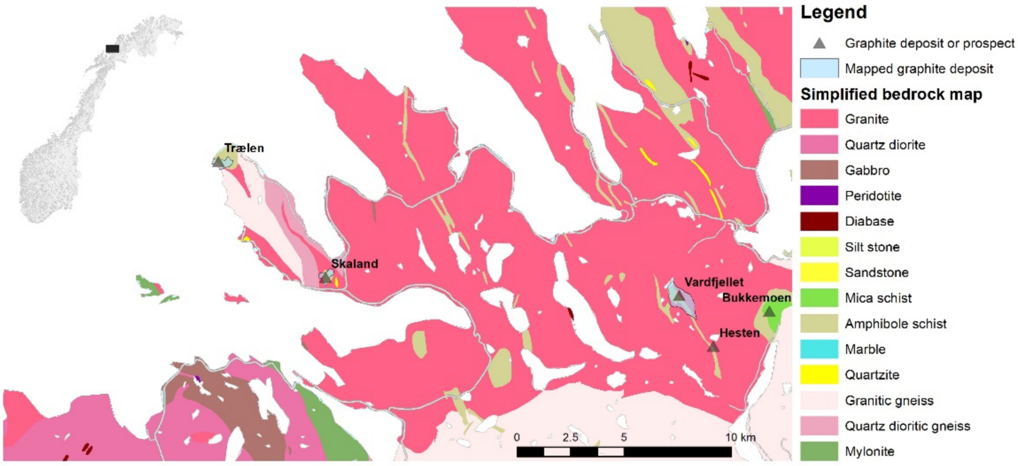

Figure 13. Location of Trælen and Skaland graphite mines, and the nearby Vardfjellet, Hesten and Bukken/Bukkemoen graphite prospects on the background of simplified bedrock geology [115,116].

There are two graphite deposits in Trælen-Skaland area (Figure 13), both developed as underground mines (Skaland and Trælen), owned by the same company. The Skaland mine had been operating since 1918, but the mining activity ceased in 2006. The currently active Trælen mine was opened in 2007, but the company remained named Skaland Graphite AS and the processing plant is located at Skaland. The Skaland Graphite AS company was acquired by Mineral Commodities Ltd., Belmont, WA, Australia in 2019.

The Trælen deposit is hosted by hornblende gneisses with graphite horizons, possibly metamorphic greywacke and calciferous rocks, and granitic orthogneisses. Quartz diorites and pegmatites form discontinuous intrusions. The rocks have been exposed to at least three phases of folding and deformation. As a result, the mineralized horizon is isoclinally folded and thick, with most continuous mineralization occurring as lens-shaped bodies oriented parallel to the main fold axis. Mining is currently being conducted by long-hole open-stoping in a bottom-up sequence. Future mining is assumed to be long-hole open-stoping in a top–bottom sequence [117,118]. A simplified geological map is presented in Figure 13.

As of March 2020, maiden JORC resource estimation for the Trælen graphite mine (Table 6) has been estimated at 1.78 million tons, at 22% total graphitic carbon (TGC) for 397 kt of contained graphite, using a 10% cut-off [119].

Table 6. Total mineral resources of the Trælen natural graphite deposit at a 10% cut-off grade [119].

Resource Category	Ore Resources (kt)	Total Graphitic Carbon (% TGC)	Graphite Resources (kt)
Indicated	409	26%	106
Inferred	1376	21%	291
Total	1785	22%	397

In the Norwegian valorization system of mineral resources, the Trælen deposit has been classified as a deposit of international importance [116]. It is the highest-grade flake graphite operation in the world and the largest graphite-producing mine in Europe, which provides 8% of the consumption of natural graphite in the EU [120]. It currently produces 12,000 tons/year of flake and powder grade graphite, containing 85–95% carbon [121]. The Trælen deposit has also been a case study in classifying mineral deposits in the UNFC system [122] and was classified as E1 F1 G1 + 2 + 3 [123].

3.6.2. Possible Restrictions and Opportunities of Development

As the deposit has been mined for several decades, the risks often related with opening new mines, such as opposition to mining activity in general and possible negative impacts on tourism, landscape and environment, are less protruding. The company states that estimation of mineral resources in Trælen deposit is not materially affected by any known environmental, permitting, legal, title, taxation, socio-economic, marketing, political or other relevant issues (according to an announcement on 12 March 2020) [118].

The surface areas that are affected by the mining of the Trælen deposit are well-regulated in the municipality land use plans (Figure 14), but subsurface structures and the extent of the deposit are currently not marked in the current land use plans [124].

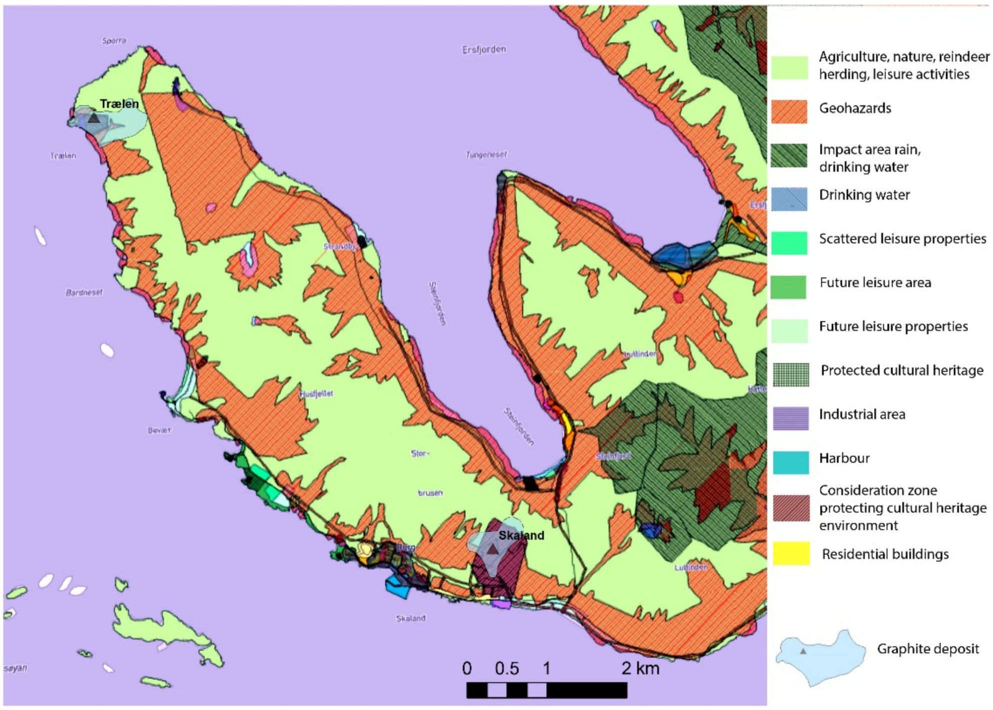

Figure 14. Land use planning map of Trælen and Skaland graphite deposits [116,124].

If the additional prospects become targets of future mining operations, restrictions may appear, as these areas are currently subject to reindeer grazing during spring and summer. It is possible that some conflicts between the mining company and the indigenous people may occur. Unless a new nearby harbor is established or the graphite is transported on existing roads (approximately 70 km), new infrastructure to the current processing plant at Skaland must be established. The shortest route to Skaland may conflict with protected nature areas and local water supplies, as well as passing through areas of high risk of geohazards (landslides, rockfalls and avalanches). If the old Skaland mine is considered to be reopened both to investigate and possibly extract the nearby potential resources [119], it might be restricted to conservation of cultural heritage [124].

4. Discussion

During the past decades, numerous mines in the EU have been closed due to economic, environmental or other reasons (e.g., exhaustion of reserves). At the same time, demand for mineral raw materials remains at a constantly high level, resulting in growth of the EU's dependency on imports from extra-EU countries third-world [20]. On the other hand, there are still significant possibilities of raw materials' production from primary sources [125–127]. It also concerns critical raw materials, supplies of which are increasingly under pressure. The mineral resources' potential in this regard has been recognized in the framework of many EU-funded projects [27,32,35], however, due to limited availability of data and various levels of the geological knowledge for many countries, this information is incomplete. Nevertheless, some primary sources (occurrences/deposits/resource/reserves) have been identified within the EU for almost all critical raw materials, with the exception of borates [55]. Therefore, it is clear that there are some other constraints that limit the production development. The area of land available for exploration and extraction purposes in the EU becomes more and more limited due to intensive infrastructure development and urbanization (road and housing investments), as well as environment protection (e.g., extensive network of the Natura 2020 areas). Additionally, a lack of the social acceptance of the mining activity is becoming a serious and urgent to solve problem. According to [50], the opposition to mining refers mostly to new and expansion projects, and rarely to operating mines. It mostly concerns conflicts between mining companies and local communities rather than protests on the regional or country level (anti-mining activism). A social license to operate, although it is not a formal agreement, is necessary and is intended to mitigate the negative impact of mining on the local community [128].

Together with the development of the above-mentioned limitations to the development of mining, intensive technological progress based on raw materials is observed. Technological advancement results in decreasing amounts of raw materials required in some technologies (i.e., miniaturization of electronic equipment), however the range of the utilized elements has been extended. For example, in the modern energy technologies, demand for raw materials has been significantly increasing, together with development of wind and solar energy. This sector currently consumes about 40 different raw materials, including numerous base metals and critical raw materials (e.g., REEs, PGMs, Co, Si, Nb, Li, Ti, V, Ge, Ga, W) [129]. The list of the raw materials required for digital technologies' development is also long, with a particularly high share in consumption of Cu, PGMs, Ge, In, Ga, Au, REEs and Ta. As a result, some technologies compete with each other for raw material supplies [14]. The EU's negative trade balance in high-technology components has increased to 23 billion Euros as the Union falls behind on the production of key digital technologies. It contributes to an overall deficit in trade for the whole group of non-food and non-energy mineral commodities [130]. A significant dependence on supplies from outside the EU particularly relates to critical raw materials, which have a strong production concentration in a few regions of the world. Limited availability of these raw materials relates to numerous economic conditions (growth of the mining extraction), environmental conditions (increased social awareness and sensitivity to environmental protection issues also outside the EU), as well as political conditions (trade restrictions introduced by countries participating in the international trade in raw materials). Simultaneously, the growing costs of production of these raw materials (depletion of high-grade ores and increase in the depth of exploitation), as well as their transportation costs, mean that their purchase becomes more expensive. Regardless of the economic factors, the significant problems related to imports of raw materials from outside the EU concern political issues (political instability in some mining regions which can interrupt continuity of supplies), ethical issues (human rights violations, child labor) [131,132], as well as environmental degradation.

The demand for mineral raw materials has been increasing on the global scale by 3% to 6% per year [133]. Henckens et al. [133] forecast that at this rate, in the next 100 years (calculated from 2015 as a base year), recoverable resources of gold, antimony, copper, chromium and zinc will be depleted. In a situation when new deposits will not be recognized and developed, a growth of demand may lead to arising problems with the raw materials' availability on the market, as in the perspective of the nearest future, both volume and quality of resources are expected to be reduced. This, in turn, will result in an increase of the costs of mineral extraction (the rising amounts of mine rocks necessary to obtain the same volume of metal), and an increasing impact of mining activities on the natural environment, resulting from growing consumption of water and energy, greenhouse gas emissions, waste production and landscape transformation [133].

From this perspective, development of own resource base and extraction from primary sources would be important contributions to mitigate the EU's dependency on CRMs from outside EU countries whenever it would be possible. It particularly concerns raw materials of significant potential of future production commencement in the EU, such as lithium, cobalt and REEs [55]. It is important to be aware that exploration and recognition of mineral deposits as well as following processes of development of a new mine is a process extended over time.

Case study analyses of six selected deposits that constitute a potential source of critical raw materials in the EU included: Myszków Mo-W-Cu deposit, Juomasuo Au-Co deposit, S. Pedro das Águias W-Sn deposit, Penouta Nb-Ta-Sn deposit, Norra Kärr REEs ore deposit and Trælen graphite deposit (Table 7).

Table 7. General characteristics of case studies of potential primary sources of CRMs production within the EU.

Deposit	Country	CRMs	Resources of CRM	Other Minerals	State of Deposit Development
Myszków	Poland	W	inferred 293,000 t W	Mo, Cu	early/grassroot exploration stage
Juomasuo	Finland	Co	indicated + inferred 16,454 t Co	Au	advanced exploration stage
São Pedro das Aguias	Portugal	W	indicated 8150 t WO_3 inferred 7200 t WO_3	Sn, fluorite	advanced exploration stage
Penouta	Spain	Nb-Ta	6745 t Ta 5330 t Nb	Sn	partly an active mine/ partly an abandoned mine
Norra Kärr	Sweden	REEs	indicated 189,700 t REEs	Zr, Hf	advanced exploration stage
Trælen	Norway	graphite	indicated + inferred 397,000 t contained natural graphite	-	active mine

4.1. Benefits from Development of New Primary Sources of Selected CRM

Benefits from each domestic mining project should be considered at local, country and the European Union levels, according to the guidelines and indications, including, among others, in the Raw Materials Initiative [18] and Strategy Europe 2020 [1]. Both documents emphasized that access to mineral resources from primary sources and their affordability are factors decisive for proper functioning of the European Union economy. However, detailed benefits, especially at local as well as country levels, depend on domestic law, mainly in the field of taxes and royalties. Local environmental, agriculture, urbanization and other land use conditions are also crucial. Nevertheless, the analysis of above case studies allowed to indicate major and common benefits regardless of location (Table 8). If the mining project is ever developed, it will lead to a considerable number of local benefits [93]. First of all, there are monetary ones, as part of the royalties and taxes would go directly to the municipality budget, ensuring welfare improvement of the local community (social services, infrastructure improvements, pro-environmental actions, etc.). Besides the direct monetary benefits, others are expected to trigger an increase in the local development, namely:

- Creation of new workplaces of high to low technical level, leading to an increase in the population—especially in the young population (key factor, especially in a very aging and low population density region, e.g., Penouta, S. Pedro das Águias and Senja regions). A mine is often a stable and important cornerstone employer, as it is in the case of the Trælen mine, located in a remote part of Norway with limited possibilities of local employment and income for the local community.
- Creation of new business opportunities with regard to social and economic services to support a growing population.
- Corporate social responsibility company actions, e.g., supporting activities for the benefit of local population and activities.

In the Portuguese case, it was indicated that underground exploitation would allow the maintenance of vineyards and touristic activities at the surface, which will also be triggered by the existence of a mine. In case of Penouta mine in Spain (partly abandoned), it will also encourage restoration/dismantling of structures which affect landscape, management of existing tailings ponds (secondary deposits), improvement of environmental control measures (environmental health control), as well as dismantling of existing dangerous abandoned facilities.

At the country level, a considerable number of benefits may also be considered. Part (e.g., Portugal, Poland) or all of the royalties would contribute to the general country's budget, which, for example, in Portugal, supports the national program for the environmental rehabilitation of old abandoned mines. The opening of the mine will also improve the country's attractiveness for mining activities, including new foreign investments. In addition, the growth of the population in a low-density region and the economic diversification of rural areas would contribute to minimization of the existing imbalance between coastal and inland regions, which was emphasized in Portuguese and Spanish cases. Countrys' benefits must also be considered in the field of domestic raw materials' security, including diversification of supply sources (Table 8). Potential development of analyzed mining projects would establish sources of important critical raw materials for national industries. For example, in Finland, it could be production of cobalt for the growing battery industry, likewise producing natural graphite for battery anodes in Norway, while in Sweden, the analyzed project would provide support to national industries depending upon REE supplies, such as the high-tech industry, defense industry and renewable energy industry (e.g., wind mills, hydropower plants, etc.). Another benefit identified at the country level is the growth of the national competence in mining and building tunnels (e.g., Norwegian case of the Trælen mine).

Table 8. Major benefits of CRMs production development for selected case studies.

No.	I	II	III	IV	V	VI
Case Study	**Myszków Deposit (Poland)**	**Juomasuo Deposit (Finland)**	**São Pedro das Aguias Deposit (Portugal)**	**Penouta Deposit (Spain)**	**Norra Kärr Deposit (Sweden)**	**Trælen Deposit (Norway)**
Raw materials *	Mo-**W**-Cu	Au-**Co**	**W**-Sn, fluorite	**Nb**-**Ta**-Sn	**REEs**, Zr, Hf	**natural graphite**
CRMs importance for the EU strategic value chains	defense	batteries, e-mobility, robotics, defense	Defense	renewable energy (wind energy), defense	renewable energy (PV), e-mobility, robotics, defense	batteries
BENEFITS OF THE CRMs PRODUCTION DEVELOPMENT						
EU level	*Securing long term supplies for the strategically important EU industry sectors, mitigating the supply risk and potential trade restrictions, reduction of the EU's dependency on critical raw material imports, diversification of supply sources of CRMs, mitigating the effects of metal prices' volatility*					
	• diversification of the W (and Mo) supplies for the EU industry • securing of W supplies for defense value chain (also Mo supplies for defense, robotics, electric vehicles and renewable energy value chains) • improvement of the negative trade balance and price volatility of Mo and W	• improvement of raw materials' value chains for realization of the EU's priority actions, such as the Green Deal Program • increasing volume of the European Co production for the batteries value chain • contribute to the EU's actions for climate change mitigation	• contribute to increase of W supplies for the European industry, • reduction of dependency on W non-European supplies	• mitigation of scarcity of Nb and Ta for the EU countries' industries	• long-term independence of the EU Member States in terms of REE supplies	• securing supplies for the batteries, steel, foundries industries, friction products and lubricants, flame-retardants, electrical applications, etc.
Country level	*Revenue for the budget from royalties and taxes, securing supplies of CRMs for national industries, increase of the foreign investment and attracting foreign investors*					
		• increase of the cobalt production for the growing battery industry • strengthening the Finnish position as the only Co supplier in Europe	• potential support for the environmental rehabilitation • the growth of population in a low-density region • economic diversification of the rural areas	• potential support for the environmental rehabilitation • the growth of population in a low-density region	• REE supplies for the national high-tech industry, defense industry and renewable • energy industry	• graphite supplies for the growing battery industry
Local level	*Economic growth of region, increase in economic activities, royalties and taxes to the municipality budget, creation of new workplaces, improvement of the local community welfare, corporate social responsibility company actions, e.g., supporting activities for the benefit of local population, donations from mining companies*					
			• maintenance of the current land use above the deposit due to underground methods of exploitation • creation of new business opportunities to support growing population in the area	• management of tailing ponds • restoration of landscape and abandoned facilities after previous mining activity		

* Critical raw materials are in bold, *italics*—common factors identified for all case studies.

Benefits at the EU level are connected mainly with communities' raw materials' security. The largest benefits of the Myszków deposit (Poland) development are expected to be at the EU level, as such development would limit the negative EU trade balance for molybdenum and tungsten raw materials, securing a large part of supplies of these metals for the EU economy (as, collectively, the EU accounts for at least 20% of the world consumption of these metals). It would be the first EU own source of molybdenum, supplying it for EU strategic defense, robotics, electric vehicles and renewable energy value chains. It would also, together with the Portuguese São Pedro das Aguias mine, assure a significant part of supplies of tungsten for the EU strategic defense value chain. Indirectly, the Myszków mine could also enable to develop EU tungsten-based and molybdenum-based industry sectors, hardly diversifying sources of their supplies for the EU industry. From this point of view, projects such as the Polish, Portuguese and Swedish ones would also significantly lower the risk of supplies and mitigate the potential effect of trade restrictions imposed by the outside EU countries (currently, e.g., tax on tungsten raw materials exports from China and Vietnam, REE export quotas from China).

The Juomasuo mine (Finland) and the Trælen mine (Norway) would increase European production of cobalt and graphite respectively, for the European battery industry, also contributing to the traffic electrification and climate change mitigation. If accomplished, the Juomasuo mine will be the fourth cobalt mine in Finland, the only country in the EU producing primary cobalt [134]. The project would also contribute to the reduction of the EU's dependency on imported battery minerals according to the EU's Green Deal Program. An important aspect regarding the production of graphite at Skaland Graphite AS is combining the high-grade ores with Norway's low-cost renewable energy (hydropower) and proximity to market. As a result, the Skaland graphite operations at Senja ensure a lower carbon footprint in comparison to non-European graphite producers.

Potential development of the Penouta Mine implies the mitigation of the scarcity of niobium and tantalum, as it can be an important source of these critical metals for the industry of other EU countries. Similarly, the Norra Kärr project in Sweden would enable long-term supplies of REE, especially HREE, allowing survival of the strategic and economically important industry for the long-term independence of the EU member states.

To sum up, important benefits resulting from the development of the mineral extraction from the EU's internal deposits to be sources of CRMs supplies have been visible at the EU level as well as at the individual countries level, as diversification of supply sources would allow to increase their resource security. It is worth emphasizing that access to raw material supplies strictly determines an increase of the competitiveness of the EU economy and its development. It is also essential for the possibility of implementation of the EU priorities in terms of transformation towards climate neutrality and digital leadership (A European Green Deal and A Europe fit for the digital age). A growing demand for the critical raw materials in technologically advanced industry sectors means that the list of these raw materials has been systematically extended every time it has been updating (every three years since it was published for the first time in 2011). The first list included 14 raw materials, the following two respectively 20 and 27, while according to the latest 2020 criticality assessment, 30 raw materials have been classified as critical. In the case of nearly half of them, the EU has been totally dependent on external supplies, while only for a few of them is the import reliance index (IR) lower than 50% [44]. Production of these raw materials from the primary sources within the EU would reduce the EU's dependence on the imports of these raw materials. It would also reduce the risk of raw material supplies' interruption in the future, particularly those important for the EU's strategic value chains.

4.2. Constraints of Development of New Primary Sources of Selected CRMs

Most mining projects face a number of constraints, regardless of the economic and social benefits associated with them. Such constraints have also been identified for the analyzed case studies (Table 9). Generally speaking, they can be divided into environmental, spatial (land use) and social constraints. All of them are strictly dependent on local conditions, and they are very often specific to an individual region (e.g., reindeer herding in Scandinavian countries). At the current stage of development of these mining projects, no restrictions have been identified at the EU level. At the national level, a general dislike of mining projects is becoming a crucial problem in Finland, but to some extent also in Sweden, Norway and other analyzed countries.

The Myszków project, without doubt, would result in significant generation of the processing (flotation) waste, constituting at least 99% of extracted ore, though there were initial plans to locate them underground as backfilling paste. From the environmental point of view, such investment could potentially cause problems related to: discharge of mine water, surface and underground water pollution (related to Major Groundwater Reservoir), negative influence on local fauna and flora and waste storage. Similar issues were also highlighted in case of the S. Pedro das Águias case in Portugal and the Penouta case in Spain (Table 9). At the moment, it is difficult to assess the scale of these environmental threats as the full environmental impact assessments of the mentioned mines have not yet been prepared. Moreover, though until now the social license to operate is positive in general (in Poland, Spain and Portugal), potential protests of the local community and social conflicts may occur at the stage of mine construction, as well as during mining and processing activity in each location. Technical constraints can be a decisive factor, e.g., making the Myszków project in Poland unprofitable at the current market conditions. Among the major factors influencing the economy of the mining activity, there are also raw material price fluctuations on the global market.

Table 9. Major potential constraints of CRMs production development for selected case studies.

	Myszków Deposit (Poland)	**Juomasuo Deposit (Finland)**	**São Pedro das Aguias Deposit (Portugal)**	**Penouta Deposit (Spain)**	**Norra Kärr Deposit (Sweden)**	**Trælen Deposit (Norway)**
Raw materials *	Mo-**W**-Cu	Au-**Co**	**W**-Sn, fluorite	**Nb**-**Ta**-Sn	**REEs**, Zr, Hf	**Graphite**
CRMs importance for the EU strategic value chains	defense	batteries, e-mobility, robotics, defense	Defense	renewable energy (wind energy), defense	renewable energy (PV), e-mobility, robotics, defense	batteries
CONSTRAINTS OF THE CRMs PRODUCTION DEVELOPMENT						
EU level	None	None	None	None	None	None
Country level	None	• opposition to mining activity in general • operation in sensitive areas (protection of environment, tourist area) • possible negative impact on tourism • expected protests if the mining project advances	• risk of protest against mining • infrastructure investment costs	Not identified	Not identified	Not identified
Local level	• processing waste generation (flotation) • underground and surface waters' pollution • negative influence on fauna and flora • social conflicts and anti-mining activism in region • technical (proper mining and processing solutions)	• threat to local society (touristic area, reindeer herding and hunting area) • negative impact on landscape (the vicinity of protected areas, including national parks) • emission of dust and noise, water pollution, increase of radiation and contamination by uranium and its decay products • anti-mining activism in region	• mining and processing waste generation • negative impact on landscape • negative influence on fauna and flora	• generation of tailings and waste material • surface and underground water pollution • negative influence on local fauna and flora • decrease in local economic dynamics after the mine closure	Not yet identified	• operational hazards • changes in global economy affecting market and prices

* Critical raw materials are in bold.

The main risks of the analyzed Finnish project are typical for northern Scandinavia. They are related to potential mining activity in a nature-based touristic region, which can be a threat to this industry, as well as for reindeer herding. It would also restrict hunting within the mine area. From the environmental point of view, the risks are related to possible impacts of the mine construction on the landscape. At the production stage, the mine can impact the environment in several ways if not responsibly managed, including: leakages with emission of dust, noise, acid mine drainage and even increase of radiation and contamination by uranium and its decay products. As a social risk, the social impact of the project has already been seen by raised resistance and anti-mining activism in the region. However, if those issues would not be able to stop the project, their requests may influence it positively towards more sustainable practices. Another challenge for the project is the ongoing Finnish Mining Act review, which may cause additional problems for any mine permitting process. At a national level, general opposition to mining in Finland should be underlined. It is related to a foreign origin of a company (resource nationalism), uranium threat, operation in sensitive areas (nature conservation, Sámi homeland, reindeer herding, tourism destinations) and poor corporate conduct [79,82,83,135,136]. Most of these issues have been present in the history of the Juomasuo dispute case. As the planning and construction of mines is the stage of the mining lifecycle in which most of the conflicts happen globally, increased opposition and protests may also be expected regarding Juomasuo if the project advances. A similar opposition may also be present in Norway when opening new mining areas, such as the new discoveries close to the Trælen mine.

In case of the Swedish Norra Kärr project, the most important expected costs and risks are more or less at the same level as for typical mines also possessing a processing plant, what will add extra costs in terms of securing the environment. All remediation costs for the mine once closed have to be covered by the operating company, according to the current best practices in Sweden. Moreover, no mining license and environmental permit will be issued unless environmental financial security will be assured to cover unexpected environmental and remediation costs, when, e.g., if mining company goes bankrupt.

5. Conclusions

The mineral deposits analyzed as cases in this paper are potential future sources of tungsten, cobalt, niobium, tantalum, as well as of rare earth elements and graphite. These metals and minerals are of significant importance for the EU strategic value chains, such as: renewable energy (niobium, REEs), batteries (cobalt, graphite), e-mobility (cobalt, REEs), robotics (cobalt, REEs) and defense (cobalt, niobium, REEs, tantalum and tungsten) value chains.

The analyzed cases have shown the major obstacles at different stages of the deposit development cycle (from the early/grassroot exploration stage, through the advanced exploration stage and active mines, up to reopening of abandoned mines) that need to be overcome to make it possible to commence a new deposit exploitation. These are environmental (Juomasuo and Myszków deposit), spatial (Juomasuo deposit) as well as social constraints (Norra Kärr, Juomasuo deposit).

Analyses of benefits and constraints for selected mining projects in each case require an individual approach and consideration of numerous geological, technical, economic, social and environmental conditions. In particular, in the case of critical raw materials, a broader view is necessary, not only limited to the impact of mining activity on local society. Therefore, the cost and benefits identified in this work for the six selected case studies refer to three levels: local, country and the EU levels. In the analyzed cases, the most important constraints related to future deposit extraction occur primarily at a local level, while some important benefits are identified primarily at the country and the EU levels.

The major benefits identified in the course of the conducted analyses at the EU and state levels were:

- Securing long-term CRMs supplies in order to enable development of the national industries as well as strategically important EU industry sectors along all value chains.

It particularly concerns most valuable raw materials, supplies of which are crucial for more than one of these key sectors, such as REEs (renewable energy, e-mobility, robotics and defense value chain), cobalt (batteries, e-mobility, robotics and defense value chains), natural graphite (batteries) and niobium (renewable energy and defense value chain) [13].

- Mitigating the supply risk and potential effect of trade restrictions. The range of these restriction, imposed in the past by outside EU countries, include, e.g., taxes on export of tungsten, cobalt, niobium, tantalum and REEs, licensing requirements on exports of tungsten, cobalt, tantalum and REEs, export prohibition on cobalt and REEs, as well as export quotas on REEs and tungsten [46]. A rising concern on security of the analyzed raw material supplies results from the fact that the number of export restrictions imposed by producers on minerals and metals is increasing, and once introduced, measures are rarely lifted [45].
- Reduction of dependency on critical raw material imports (in particular, those of the highest IR (import reliance) reported by the EC, such as niobium and REEs—100%, tantalum—99% and cobalt—86%) [44].
- Diversification of supply sources of CRMs, enabling to mitigate the effects of minerals' and metals' price volatility.

Other significant benefits at the country and local levels were primarily social and monetary ones, including:

- Revenue for the municipality and national budget from royalties and taxes.
- Corporate social responsibility and other actions of mining companies for the benefit of the local community.
- Economic growth of the regions in general related to new workplaces, migration of population to low-density areas and enhancement of foreign investors.

Among the identified constraints, a negative impact of the mining activity on landscape, environment, local fauna and flora, as well as a threat to business activities of local society in cases where the location of deposits is in agricultural or touristic areas, were the most common. The issues of mining and processing waste generation as well as hazards of surface and underground water pollution were also often highlighted. In case of three out of six analyzed cases, some social constraints were identified either at the local or country levels (anti-mining activism).

As the locations of deposit cannot be changed to be logistically, socially, environmentally or politically optimal, mining companies have to deal with circumstances that could pose challenges in terms of relationship with local communities, local and national governments, relation to landscape/environment values, etc. It arose from the case studies that, when it comes to mineral land use planning issues, it is necessary to deal with these challenges in a responsible way and with sustainable management practices. It needs to be clear at an early stage of the land use planning process that mining can bring positive benefits to the host communities, but these can come at some cost to the environment and local communities, especially if relationships, resources and operations are not managed properly. The fundamental aim in the course of promoting mineral land use as a prime exploitation option must be convincing in terms of managing to enable an equitable distribution of the benefits of development, along with minimization of the negative impacts on people and the environment.

To sum up, mining and subsequent processing of the CRMs analyzed in this work are crucial for development of the EU and state industry sectors, particularly those of strategic importance. Taking this into account, it can be concluded that access to mineral deposits determines the future technological advancement and level of modern life. The analyses of the six case studies exhibited numerous constraints related to possible future commencement of mining in the examined EU countries. However, the society needs to be aware that some of the CRMs are imported to the EU from countries where ethical standards are not respected, and environmental issues are not taken into consideration. Among the analyzed raw materials, tantalum and tungsten are listed as so-called Conflict Minerals, while most of the cobalt supplies originate from the Democratic Republic of Congo, where artisanal production occurs in unacceptable working and environmental conditions, and is not the only exceptional case [14,131,137]. It is worth emphasizing that we can take advantage of the location and development of raw material deposits within the EU, where we can have an influence on mining companies to ensure they operate in a responsible way while maintaining sustainable mining standards.

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References

1. European Commission. *Europe 2020. A Strategy for Smart, Sustainable and Inclusive Growth, Communication from the Commission*; COM (2010) 2020 Final; European Commission: Brussels, Belgium, 2010.
2. European Commission. *Europe 2020 Flagship Initiative Innovation Union. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions*; SEC (2010) 1161; European Commission: Brussels, Belgium, 2011.
3. European Commission. *Roadmap to a Resource Efficient Europe. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions*; COM (2011) 571 Final; European Commission: Brussels, Belgium, 2011.
4. European Commission. *The European Green Deal. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions*; COM (2019) 640 Final; European Commission: Brussels, Belgium, 2019.
5. European Commission. *A New Industrial Strategy for Europe. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions*; COM (2020) 102 Final; European Commission: Brussels, Belgium, 2020.
6. European Commission. Regulation of the European Parliament and of the Council of 18 June 2020 on the Establishment of a Framework to Facilitate Sustainable Investment, and Amending Regulation (EU) 2019/2088. O.J.E.U. L 198/13. 2020. Available online: http://data.europa.eu/eli/reg/2020/852/oj (accessed on 20 June 2021).
7. European Commission. *Proposal for a Regulation of the European Parliament and of the Council Establishing a Recovery and Resilience Facility*; COM (2020) 408 Final; European Commission: Brussels, Belgium, 2020.
8. United Nations (UN). Transforming Our World. The 2030 Agenda for Sustainable Development. United Nations. A/RES/70/1. 2015. Available online: https://sustainabledevelopment.un.org/ (accessed on 10 April 2021).
9. Mancini, L.; Vidal Legaz, B.; Vizzarri, M.; Wittmer, D.; Grassi, G.; Pennington, D. *Mapping the Role of Raw Materials in Sustainable Development Goals. A Preliminary Analysis of Links, Monitoring Indicators and Related Policy Initiatives*; Publications Office of the European Union: Luxembourg, 2019. [CrossRef]
10. European Battery Alliance. Available online: https://www.eba250.com/ (accessed on 10 April 2021).
11. European Raw Materials Alliance. Available online: https://erma.eu/ (accessed on 10 April 2021).
12. European Commission. *Report on Critical Raw Materials and the Circular Economy*; Publications Office of the European Union: Luxembourg, 2018. [CrossRef]
13. Blagoeva, D.; Pavel, C.; Dias, P.A. Critical Raw Materials in Strategic Value Chains 2018. Available online: http://scrreen.eu/wp-content/uploads/2018/11/03.-CRM-in-Strategic-Value-Chains-Blagoeva.pdf (accessed on 10 April 2021).
14. European Commission. *Critical Raw Materials Resilience: Charting a Path Towards Greater Security and Sustainability. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions*; COM (2020) 474 Final; European Commission: Brussels, Belgium, 2020.

15. European Commision. *Critical Materials for Strategic Technologies and Sectors in the EU—A Foresight Study*; Publications Office of the European Union: Luxembourg, 2020. [CrossRef]
16. Hund, K.; La Porta, D.; Fabregas, T.P.; Laing, T.; Drexhage, J. *Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition: Climate-Smart Mining Facility*; World Bank Group: Washington, DC, USA, 2020; Available online: https://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf (accessed on 10 April 2021).
17. European Commision. *Strategic Research Agenda for Batteries: European Technology and Innovation Platform on Batteries—Batteries Europe*; European Commission: Brussels, Belgium, 2020; Available online: https://ec.europa.eu/energy/sites/ener/files/documents/batteries_europe_strategic_research_agenda_december_2020__1.pdf (accessed on 23 March 2021).
18. European Commission. *The Raw Materials Initiative: Meeting Our Critical Needs for Growth and Jobs in Europe. Communication from the Commission to the European Parliament and the Council*; COM (2008) 699 Final; European Commission: Brussels, Belgium, 2008.
19. European Commission. *Strategic Implementation Plan (SIP) of the European Innovation Partnership (EIP) on Raw Materials: Part II—Priority Areas, Action Areas and Actions*; Final Version-18/09/2013; European Commission: Brussels, Belgium, 2013.
20. EO-MINERS Project. Available online: http://www.eo-miners.eu/ (accessed on 12 April 2021).
21. EU-RARE Project. Available online: http://www.eurare.org/ (accessed on 12 April 2021).
22. FORAM Project. Available online: http://www.foramproject.net/ (accessed on 12 April 2021).
23. GeoERA/FRAME Project (Forecasting and Assessing Europe's Strategic Raw Materials Needs). Available online: https://geoera.eu/projects/frame2/ (accessed on 12 April 2021).
24. INTRAW Project. Available online: https://intraw.eu/ (accessed on 12 April 2021).
25. MICA Project. Available online: http://www.mica-project.eu/ (accessed on 12 April 2021).
26. MINATURA2020 Project. Available online: https://minatura2020.eu/ (accessed on 12 April 2021).
27. MINERALS4EU. Knowledge Data Platform. Available online: http://www.minerals4eu.eu/ (accessed on 12 April 2021).
28. MINGUIDE Project. Available online: https://www.interregeurope.eu/policylearning/good-practices/item/2178/min-guide-key-innovations-in-exploration-extraction/ (accessed on 12 April 2021).
29. MINLEX Project. Available online: http://www.minlex.eu/eu_legislation.html (accessed on 12 April 2021).
30. MIREU Project. Available online: https://mireu.eu/ (accessed on 12 April 2021).
31. ORAMA Project. Available online: https://orama-h2020.eu/ (accessed on 12 April 2021).
32. ProMINE Project. Available online: http://promine.gtk.fi/index.php/about (accessed on 12 April 2021).
33. ProSUM Project (Prospecting Secondary Raw Materials in the Urban Mine and Mining Wastes). Available online: http://www.prosumproject.eu/ (accessed on 12 April 2021).
34. SARMa Project (Sustainable Aggregates Resource Management). Available online: http://www.sarmaproject.net/ (accessed on 12 April 2021).
35. SCRREEN Project. Available online: http://scrreen.eu (accessed on 12 April 2021).
36. VERAM Project. Available online: http://veram2050.eu/ (accessed on 12 April 2021).
37. RMSG (Raw Materials Supply Group). Available online: https://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetail&groupID=1353 (accessed on 14 April 2021).
38. Ad-Hoc Working Group on Defining Critical Raw Materials. Available online: https://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetailPDF&groupID=1353 (accessed on 14 April 2021).
39. ETRP SMR (European Technology Platform on Sustainable Mineral Resource). Available online: https://www.etpsmr.org/?page_id=6 (accessed on 14 April 2021).
40. ERECON (European Rare Earths Competency Network). Available online: https://ec.europa.eu/growth/sectors/raw-materials/specific-interest/erecon_en (accessed on 12 April 2021).
41. RMIS (Raw Materials Information System). Available online: https://rmis.jrc.ec.europa.eu/ (accessed on 14 April 2021).
42. MINLAND Project. Available online: https://www.minland.eu/ (accessed on 14 April 2021).
43. European Commission. *On the 2017 List of Critical Raw Materials for the EU. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions*; COM (2017) 490 Final; European Commission: Brussels, Belgium, 2017.
44. European Commission. *Study on the EU's List of Critical Raw Materials (2020). Critical Raw Materials Factsheets*; Final Report; European Commission: Brussels, Belgium, 2020.
45. Korinek, J. Trade restrictions on minerals and metals. *Min. Econ.* **2019**, *32*, 171–185. [CrossRef]
46. OECD. Inventory of Export Restrictions on Industrial Raw Materials. 2019. Available online: https://qdd.oecd.org/subject.aspx?Subject=ExportRestrictions_IndustrialRawMaterials (accessed on 22 March 2021).
47. Pavel, C.C.; Marmier, A.; Alves Dias, P.; Blagoeva, D.; Tzimas, E.; Schüler, D.; Schleicher, T.; Jenseit, W.; Degreif, S.; Buchert, M. *Substitution of Critical Raw Materials in Low-Carbon Technologies: Lighting, Wind Turbines and Electric Vehicles*; EUR 28152 EN; Publications Office of the European Union: Luxembourg, 2016. [CrossRef]
48. Ruokonen, E. Preconditions for successful implementation of the Finnish standard for sustainable mining. *Extr. Ind. Soc.* **2020**, *7*, 611–620. [CrossRef]
49. Haikola, S.; Anshelm, J. Mineral policy at a crossroads? Critical reflections on the challenges with expanding Sweden's mining sector. *Extr. Ind. Soc.* **2016**, *3*, 508–516. [CrossRef]

50. Lesser, P.; Gugerell, K.; Poelzer, G.; Hitch, M.; Tost, M. European mining and the social licence to operate. *Extr. Ind. Soc.* **2020**, *8*, 100787. [CrossRef]
51. International Association for Promoting Geoethics. Available online: https://www.geoethics.org/publications/wp-responsible-mining (accessed on 14 April 2021).
52. Organisation for Economic Co-operation and Development (OECD). *OECD Due Diligence Guidance for Responsible Business Conduct*; OECD: Paris, France, 2018; Available online: OECD-Due-Diligence-Guidance-for-Responsible-Business-Conduct.pdf (accessed on 14 April 2021).
53. Kamal, A.; Al-Ghamdi, S.; Koc, M. Revaluing the costs and benefits of Energy efficiency: A systemic review. *Energy Res. Soc. Sci.* **2019**, *54*, 68–84. [CrossRef]
54. Guzik, K.; Burkowicz, A.; Galos, K.; Kot-Niewiadomska, A.; Lewicka, E.; Szlugaj, J.; Kamyk, J.; Wertichova, B.; Luodes, N.; Carvalho, J.; et al. Mineral Resources in Sustainable Land-Use Planning: MINLAND Project. Deliverable 5.3. Promoting a Common Framework as Tool for Societal Risk Management and Risk Displacement Tool. 2019. Available online: https://www.minland.eu/project/ (accessed on 14 April 2021).
55. Lewicka, E.; Guzik, K.; Galos, K. On the Possibilities of the Critical Raw Materials Production from the EU's Primary Sources. *Resources* **2021**, *10*, 50. [CrossRef]
56. Mączka, W.; Ociepa, Z.; Pieczonka, J.; Piestrzyński, A. Problemy wzbogacania polimetalicznych rud Mo-W-Cu ze złoża Myszków. *Górnictwo i Geoinżynieria* **2006**, *30*, 213–228.
57. Badera, J.; Markowiak, M. Mineralizacja kruszcowa na tle wieloetapowych intruzji porfirowych w rejonie Myszkowa. *Biuletyn Państwowego Instytutu Geologicznego* **2008**, *429*, 7–12.
58. State Geological Institute, National Geological Archive. *Geological Report on Myszków Mo-W-Cu Ores Deposit, in C2 Category in Myszków, Myszków Commune, Częstochowa Province (Dokumentacja geologiczna złoża rud molibdenowo-wolframowo-miedziowych Myszków, w kat. C2. w Myszkowie, gmina Myszków, województwo częstochowskie)*; State Geological Institute, National Geological Archive: Warsaw, Poland, 1993.
59. National Geological Archive/ PRGW Ltd. *Geological Report on Myszków Mo-W-Cu Ores Deposit, in C2 Category in Myszków (Dokumentacja Geologiczna Złoża Rud Molibdenowo-wolfra Mowo-Miedziowych w Myszkowie w Kat. c2 w Miejsc. Myszków)*; National Geological Archive/ PRGW Ltd: Sosnowiec, Poland, 2007.
60. Strzelecki Metals Ltd. ASX Release. Myszkow Molybdenum-Copper Project, Poland. 2009. Available online: https://hotcopper.com.au/threads/ann-myszkow-project-progress-report.889789/ (accessed on 14 April 2021).
61. Stein, H.J.; Markowiak, M.; Mikulski, S.Z. Metamorphic to magmatic transition captured at the Myszków Mo-W deposit, southern Poland. In *Mineral Deposit Research: Meeting the Global Challenge, Proceedings of the Eight Biennial SGA Meeting, Beijing, China, 18–21 August 2005*; Mao, J., Bierlein, F.P., Eds.; Springer: Berlin/Heidelberg, Germany, 2005; pp. 833–836.
62. Podemski, M. (Ed.) Paleozoic Porphyry Molybdenum-Tungsten Deposit in the Myszków Area, Southern Poland. In *Polish Geological Institute Special Papers*; Polish Geological Institute: Warsaw, Poland, 2001; Volume 6, pp. 1–88.
63. Oszczepalski, S.; Speczik, S.; Małecka, K.; Chmielewski, A. Prospective copper resources in Poland. *Miner. Resour. Manag.* **2016**, *32*, 5–30. [CrossRef]
64. Strzelecki Metals Ltd. ASX Media Release. Bright Outlook for Strzelecki's Myszkow Molybdenum Deposit. 2009. Available online: www.asx.com.au/asxpdf/20091104/pdf/31lvj0jzfrf46v.pdf (accessed on 14 April 2021).
65. European Commision. Study on the Review of the List of Critical Raw Materials. In *Critical Raw Materials Factsheets*; European Commision: Brussels, Belgium, 2017. [CrossRef]
66. Supreme Audit Office, Regional Branch in Katowice. *Post-Audit Speech*; Supreme Audit Office, Regional Branch in Katowice: Warsaw, Poland, 2017.
67. Main Office of Geodesy and Cartography. Available online: http://www.gugik.gov.pl/ (accessed on 12 April 2021).
68. CGD Central Geological Database—PORTAL. Polish Geological Institute-National Research Institute. Available online: https://www.pgi.gov.pl/ (accessed on 14 April 2021).
69. GDOS Geoservice. Available online: http://www.gdos.gov.pl/ (accessed on 14 April 2021).
70. Pankka, H.S.; Vanhanen, E.J. Early Proterozoic Au-Co-U Mineralization in the Kuusamo District, Northeastern Finland. *Precambrian Res.* **1992**, *58*, 387–400. [CrossRef]
71. Vasilopoulos, M.; Molnár, F.; O'Brien, H.; Lahaye, Y.; Lefèbvre, M.; Richard, A.; André-Mayer, A.-S.; Ranta, J.-P.; Talikka, M. Geochemical signatures of mineralizing events in the Juomasuo Au–Co deposit, Kuusamo belt, northeastern Finland. *Miner. Depos.* **2021**, 1–28. [CrossRef]
72. Geological Survey of Finland. Juomasuo, Paleoproterozoic Kuusamo Belt. Mineral Systems of Finland. 2020. Available online: https://minsysfin.gtk.fi/index.php/juomasuo-paleoproterozoic-kuusamo-belt/ (accessed on 14 April 2021).
73. Pankka, H.; Puustinen, K.; Vanhanen, E. *The Cobalt-Gold Deposits of the Kuusamo Schist Belt*; Geologian tutkimuskeskus, Tutkimusraportti: Espoo, Finland, 1991; Volume 101, p. 53.
74. Vanhanen, E. Geology, mineralogy and geochemistry of the Fe-Co-Au-(U) deposits in the Paleo-proterozoic Kuusamo Schist Belt, northeastern Finland. *Geol. Surv. Finl. Bull.* **2001**, *399*, 283.
75. Eilu, P. Overview on Gold Deposits in Finland. In *Mineral Deposits of Finland*; Maier, W.D., O'Brien, H., Lahtinen, R., Eds.; Elsevier: Amsterdam, The Netherlands, 2015; pp. 377–403.

76. Pankka, H. Geology and Mineralogy of Au-Co-U Deposits in the Proterozoic Kuusamo Volcano-Sedimentary Belt, Northeastern Finland. Ph.D. Thesis, Michigan Technological University, Houghton, MI, USA, 1992; p. 233.
77. Latitude 66 Cobalt. Latitude 66 Cobalt's Resource Estimation: Juomasuo is the Europe's Fourth Largest Known Cobalt Deposit. 2021. Available online: https://lat66.com/ajankohtaista/latitude-66-cobaltin-varantoarvio-juomasuo-euroopan-neljanneksi-suurin-tunnettu-kobolttiesiintyma/ (accessed on 14 April 2021). (In Finnish).
78. Latitude 66 Cobalt. Application to Postpone Mining Permit's Lapse and to Secure Public and Private Interests Because of Review of Needed Determinations. 2019. Available online: https://lat66.com/wp-content/uploads/2019/05/Latitude66Cobalt_asiakirja-kaivosviranomaiselle_30_04_2018_julkinen-osuus.pdf (accessed on 14 April 2021). (In Finnish).
79. Eerola, T. Corporate social responsibility in mineral exploration—The importance of communication and stakeholder engagement in earning and maintaining the social license to operate. *Geol. Surv. Finl. Res. Rep.* **2017**, *233*, 69.
80. Eerola, T. SLO good practices and recent disputes. In *Illustrative Examples across Europe*; Lesser, P., Ed.; Finland. Mining and Metallurgical Regions of Europe (MIREU) Project: Brussels, Belgium, 2021; (forthcoming).
81. Eerola, T. Uranium exploration, non-governmental organizations, and local communities. The origin, anatomy, and consequences of a new challenge in Finland. *Est. J. Earth Sci.* **2008**, *57*, 112–122. [CrossRef]
82. Eerola, T. The development of the civic activism and its impact on the mining company performance in Finland. In *Mining and Mineral Exploration in Finland: From the Supporting Pillar of the Industrial Value-Chain for Part of the Global Network-Society*; Kivinen, M., Aumo, R., Eds.; Report of Investigation; Geological Survey of Finland: Espoo, Finland, 2015; Volume 221, pp. 39–52. (In Finnish)
83. Lyytimäki, J.; Peltonen, L. Mining through controversies: Public perceptions and the legitimacy of a planned gold mine near a touristic destination. *Land Use Policy* **2016**, *54*, 479–486. [CrossRef]
84. Mining Register Map Service Tukes. Available online: http://gtkdata.gtk.fi/kaivosrekisteri (accessed on 14 April 2021).
85. National Land Survey of Finland. Available online: https://www.maanmittauslaitos.fi/en (accessed on 14 April 2021).
86. Pirttikoski, R. *A Query by a Mining Company: Mining Projects Are Rejected in Kuusamo, There Are Clearly More Favorable Attitudes Towards Them in Posio*; Kaleva, 03.04.2018: Oulu, Finland, 2018. (In Finnish)
87. Purunen, R. The Urban Plan Banning Mining in Kuusamo Rejected by the High Court—A Mining Company Satisfied with the Decision; Kaleva, 23.5.2019. 2019. Available online: https://www.kaleva.fi/kuusamon-kaivoshankkeen-kieltava-kaava-nurin-korke/1711409 (accessed on 14 April 2021).
88. Latitude 66 Cobalt Oy 2019b. Latitude 66 Cobalt Prepares Changes to the Permit Applications for Areas Surrounding the Juomasuo Mine Concession. Available online: https://lat66.com/ajankohtaista/latitude-66-cobalt-valmistelee-muutoksia-juomasuon-kaivospiiria-ymparoivien-alueiden-lupahakemuksiin/ (accessed on 14 April 2021). (In Finnish).
89. Latitude 66 Cobalt Oy 2021b. Mining Projects. Available online: https://lat66.com/_kaivoshankkeet/ (accessed on 14 April 2021). (In Finnish).
90. Colt Resources Inc. Personal Comments of Former Company's Director. 2019.
91. LNEG-LGM. *Carta Geológica de Portugal à escala 1:1 000 000, Edição 2010*; LNEG-LGM: Lisboa, Portugal, 2010; ISBN 978-989-675-005-3.
92. Gomes, G.L.; Almeida, J.; Chichorro, M.; Matias, F. The simulation of W-Sn grades of the São Pedro das Águias skarn ore deposit (Tabuaço, northern Portugal). In Proceedings of the 17th Annual Conference of the International Association for Mathematical Geosciences, Freiberg, Germany, 2–9 September 2015. [CrossRef]
93. Colt Resources Inc. Tungsten mineralization in Portugal—The case of the São Pedro das Águias Deposit. In *Mineral Resource Assessment Workshop: Assessment of the Tungsten Potential in Greenland, Copenhagen*; Colt Resources Inc.: Montreal, QC, Canada, 2013.
94. Faria, A.F. Skarn-type tungsten deposits of Tabuaço Area, Northern Portugal. *Eur. Geol.* **2014**, *37*, 29–33.
95. DHV SA. *Proposta de Definição de Âmbito do EIA do Projeto Mineiro de S. Pedro das Águias, Tabuaço*; DHV SA: Amadora, Portugal; Colt Resources Inc.: Montreal, QC, Canada, 2012; p. 178. Available online: https://siaia.apambiente.pt/AIADOC/DA178/pda1782016222172352.pdf (accessed on 14 April 2021).
96. Tabuaço, C.M. Plano Director Municipal—Planta de Ordenamento. Câmara Municipal de Tabuaço. 2013. Available online: https://www.cm-tabuaco.pt/download.php?info=YTozOntzOjU6ImFjY2FvIjtzOjg6ImRvd25sb2FkIjtzOjg6ImZpY2hlaXJvIjtzOjM4OiJtZWRpYS9maWNoZWlyb3Mvb2JqZWN0b19vbmxpbmUvMzYzLnBkZiI7czo2OiJ0aXR1bG8iO3M6MjQ6IjAxK1BsYW50YStkZStPcmRlbmFtZW50byI7fQ (accessed on 14 April 2021).
97. Strategic Minerals—Mina de Penouta. Available online: https://www.strategicminerals.com/en/our-job/penouta/ (accessed on 14 April 2021).
98. Llorens González, T.; García Polonio, F.; López Moro, F.J.; Fernández Fernández, A.; Sanz Contrera, J.L.; Moro Benito, M.C. Tin-tantalum-niobium mineralization in the Penouta deposit (NW Spain): Textural features and mineral chemistry to unravel the genesis and evolution of cassiterite and columbite group minerals in a peraluminous system. *Ore Geol. Rev.* **2017**, *81*, 79–95. [CrossRef]
99. Mapa Geologico de Espana. Viana Del Bollo. Available online: http://info.igme.es/cartografiadigital/datos/magna50/jpgs/d2_G50/Editado_MAGNA50_228.jpg (accessed on 14 April 2021).
100. El Progreso. 2020. Available online: https://www.elprogreso.es/articulo/economia/viana-do-bolo-tiene-unica-mina-europa-oro-negro-fabricar-moviles/202002061223121421693.html (accessed on 14 April 2021).
101. Xataka. 2020. Available online: https://www.xataka.com/empresas-y-economia/primera-unica-mina-coltan-europa-esta-pueblo-ourense-1 (accessed on 14 April 2021).

102. Mapa de Cultivos y Aprovechamientos de 1:50.000 (2000–2010) Ministerio de Agricultura, Alimentación y Medio Ambiente (MAGRAMA). Available online: https://sig.mapama.gob.es/geoportal/ (accessed on 14 April 2021).
103. The Norra Kärr REE-Zr Project 2013. *Excursion Guidebook SWE3, SWE6 & SWE7. The Norra Kärr REE-Zr Project and the Birthplace of Light REEs. The Historic Sala Silver Deposit*; Geological Survey of Sweden: Utö, Sweden, 2013; pp. 36–48. Available online: https://www.researchgate.net/publication/348805986_The_Norra_Karr_REE-Zr_project (accessed on 20 April 2021).
104. Goodenough, K.M.; Schilling, J.; Jonsson, E.; Kalvig, P.; Charles, N.; Tuduri, J.; Deady, E.A.; Sadeghi, M.; Schiellerup, H.; Müller, A.; et al. Europe's rare earth element resource potential: An overview of REEmetallogenetic provinces and their geodynamic setting. *Ore Geol. Rev.* **2016**, *72*, 838–856. [CrossRef]
105. Jonsson, E.; Nysten, P.; Bergman, T.; Sadeghi, M.; Söderhielm, J.; Claeson, D. REE Mineralisations in Sweden. In *Rare Earth Elements Distribution, Mineralisation and Exploration Potential in Sweden*; SGU Report 146; Sadeghi, M., Ed.; The Geological Survey of Sweden: Uppsala, Sweden, 2019; pp. 20–111.
106. Saxon, M.; Leijd, M.; Forrester, K.; Berg, J. Geology, mineralogy, and metallurgical processing of the Norra Kärr heavy REE deposit, Sweden. In Proceedings of the Symposium on Strategic and Critical Materials Proceedings, Victoria, BC, Canada, 13–14 November 2015; Simandl, G.J., Neetz, M., Eds.; British Columbia Geological Survey Paper; British Columbia Ministry of Energy and Mines: Vancouver, BC, Canada, 2015; Volume 3, pp. 97–107.
107. The Geological Survey of Sweden. *Exploration Newsletter*; The Geological Survey of Sweden: Uppsala, Sweden, 2020; Available online: https://www.sgu.se/globalassets/mineralnaring/mineralstatistik/exploration-newsletter/exploration-newsletter-2020-10.pdf (accessed on 14 April 2021).
108. The Geological Survey of Sweden. *Exploration Newsletter*; The Geological Survey of Sweden: Uppsala, Sweden, 2019; Available online: https://www.sgu.se/globalassets/engelska/om-sgu-news/exploration-newsletter-2019-09.pdf (accessed on 14 April 2021).
109. Leading Edge Minerals—Norra Karr Project. Available online: www.leadingedgematerials.com/norra-karr (accessed on 14 April 2021).
110. Bluemel, B.; Leijd, M.; Dunn, C.; Hart, C.J.R.; Saxon, M.; Sadeghi, M. Biogeochemical expression of rare earth element and zirconium mineralization at Norra Kärr, Southern Sweden. *J. Geochem. Explor.* **2013**, *133*, 15–24. [CrossRef]
111. Sjöqvist, A.S.L.; Cornell, D.H.; Andersen, T.; Erambert, M.; Ek, M.; Leijd, M. Three compositional varieties of rare-earth element ore: Eudialyte-group minerals from the Norra Kärr alkaline complex, southern Sweden. *Minerals* **2013**, *3*, 94–120. [CrossRef]
112. Short, M.; Apelt, T.; Moseley, G.; Mounde, M.; Digges La Touch, G. *Norra Kärr Project PFS, Gränna, Sweden, Amended & Restated Prefeasibility Study—NI 43-101—Technical Report for the Norra Kärr Rare Earth Element Deposit*; GBM Minerals Engineering Consultants Ltd.: London, UK; Wardell Armstrong International Ltd.: Truro, UK; Golder Associates Ltd.: Toronto, ON, Canada; Tasman Metals Ltd.: Vancouver, BC, Canada, 2015.
113. Tasman Announces Results of Pre-Feasibility Study for the Norra Karr Heavy Rare Earth Element Project in Sweden. 2015. Available online: https://www.newswire.ca/news-releases/tasman-announces-results-of-pre-feasibility-study-for-the-norra-karr-heavy-rare-earth-element-project-in-sweden-516489861.html (accessed on 14 April 2021).
114. SOM-Institute. 2020. Available online: https://www.gu.se/sites/default/files/2020-06/22.%20Sveriges%20geologiska%20unders%C3%B6kning%202019.pdf (accessed on 14 April 2021).
115. Geological Survey of Norway—NGU. Harmonized Bedrock Map. 2021. Available online: https://geo.ngu.no/kart/common_mobil/?_/kart/berggrunn_mobil/__lang=nor::extent=580855.5075481472,7701983.946445978,613351.5075481472,7715016.196445978::map=5 (accessed on 5 March 2021).
116. Geological Survey of Norway—NGU. Mineral Resource Database Fact Sheet for Trælen Graphite Deposit. 2021. Available online: https://geo.ngu.no/api/faktaark/mineralressurser/visIndustrimineraler.php?objid=7179&lang=eng (accessed on 5 March 2021).
117. Gautneb, H.; Rønning, J.S.; Engvik, A.K.; Henderson, I.H.C.; Larsen, B.E.; Solberg, J.K.; Ofstad, F.; Gellein, J.; Elvebakk, H.; Davidsen, B. The Graphite Occurrences of Northern Norway, a Review of Geology, Geophysics, and Resources. *Minerals* **2020**, *10*, 626. [CrossRef]
118. Mineral Commodities Ltd. Maiden JORC Estimation for the Skaland Graphite Project ASX: MRC 15 July 2020. 2020. Available online: https://www.mineralcommodities.com/wp-content/uploads/2020/10/15-July-2020-Highly-Prospective-Graphite-Project-20km-From-Skaland.pdf (accessed on 5 March 2021).
119. Mineral Commodities Ltd. ASX: MRC 12 March 2020. Highly prospective graphite exploration project secured 20 km from Skaland. Available online: https://www.mineralcommodities.com/wp-content/uploads/2020/03/Maiden-JORC-Estimation-Skaland.pdf (accessed on 31 May 2021).
120. European Commission. Study on the EU's List of Critical Raw Materials, Factsheets on Critical Raw Materials. 2020. Available online: https://ec.europa.eu/docsroom/documents/42883/attachments/2/translations/en/renditions/native (accessed on 10 April 2021).
121. MRC Skaland Graphite, AS. 2021. Available online: https://graphite.no/ (accessed on 31 May 2021).
122. UNECEF. United Nations Framework Classification for Resources Update 2019 ECE Energy Series No 61 ISBN. 2019. Available online: https://unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/publ/UNFC_ES61_Update_2019.pdf (accessed on 5 March 2021).
123. Knežević Solberg, J.; Gautneb, H. A Case Study on Graphite. Presented at UNFC Europe Ensuring Sustainable Raw Materiale Management to Support the European Green Deal, Virtual Workshop. 19 November 2020. Online event hosted by EuroGeoSurveys.
124. Senja Kommune. Arealdelplan for Senja Kommune (Area and Zoning Maps for Senja Municipality. In Norwegian Only). 2021. Available online: https://kommunekart.com/?urlid=728ab708-751b-49e6-a132-e69f6d7ec400 (accessed on 31 May 2021).

125. Bertrand, G.; Cassard, D.; Arvanitidis, N.; Stanley, G.; EuroGeoSurvey Mineral Resources Expert Group. Map of Critical raw material deposits of Europe. *Energy Procedia* **2016**, *97*, 44–50. [CrossRef]
126. Pro Mine Mineral Database Partners; EuroGeoSurveys Mineral Resources Expert Group. *A Note on the Map of Critical Raw Material Deposits of Europe*; Version 3; Arvanitidis, N., Stanley, G., Eds.; The Geological Surveys of Europe: Brussels, Belgium, 2015; Available online: https://www.eurogeosurveys.org/wp-content/uploads/2016/04/CRM-MAP-FINAL_HQ-F.pdf (accessed on 31 May 2021).
127. Cassard, D.; Bertrand, G.; Billa, M.; Serrano, J.-J.; Tourlière, B.; Angel, J.-M.; Gaál, G. ProMine Mineral Databases: New tools to assess primary and secondary mineral resources in Europe. In *3D, 4D and Predictive Modelling of Major Mineral Belts in Europe. Mineral Resource Reviews*; Weihed, P., Ed.; Springer: Cham, Switzerland, 2015; pp. 9–58. [CrossRef]
128. Matebesi, L.; Marais, L. Social licensing and mining in South Africa: Reflections from community protests at a mining site. *Resour. Policy* **2018**, *59*, 371–378. [CrossRef]
129. Zepf, V.; Simons, J.; Reller, A.; Ashfield, M.; Rennie, C. *Materials Critical to the Energy Industry—An Introduction*, 2nd ed.; BP p.l.c.: London, UK, 2014; Available online: https://www.drvolkerzepf.de/app/download/11633904993/2014+ESC_Materials_handbook_BP+2nd+edition.pdf?t=1607953267 (accessed on 31 May 2021).
130. Nita, V.; Garbossa, E.; Ciuta, T. *European Union's Trade Flows on Non-Food and Non-Energy Raw Material Commodities. Basic Facts and Figures, EUR 29110 NE*; Publications Office of the European Union: Luxembourg, 2018; ISBN 978-92-79-79380-6. [CrossRef]
131. Benton, D.; Ethics in Mining. Challenging, But Necessary. Available online: https://www.miningglobal.com/supply-chain-and-operations/ethics-mining-challenging-necessary (accessed on 18 April 2021).
132. Siegel, S. The Missing Ethics of Mining. February 2013. Available online: https://www.ethicsandinternationalaffairs.org/2013/the-missing-ethics-of-mining-full-text/ (accessed on 18 April 2021).
133. Heckens, M.L.C.M.; Ryngaert, C.M.J.; Driessen, P.P.J.; Worrell, E. Normative principles and the sustainable use of geologically scarce mineral. *Resour. Policy* **2018**, *59*, 351–359. [CrossRef]
134. Horn, S.; Gunn, A.G.; Petavratzi, E.; Shaw, R.A.; Eilu, P.; Törmänen, T.; Bjerkgård, T.; Sandstad, J.S.; Jonsson, E.; Kountourelis, S.; et al. Cobalt resources in Europe and the potential for new discoveries. *Ore Geol. Rev.* **2021**, *130*, 1–25. [CrossRef]
135. Lassila, M.M. Mapping mineral resources in a living land: Sami mining resistance in Ohcejohka, northern Finland. *Geoforum* **2018**, *96*, 1–9. [CrossRef]
136. Jartti, T.; Litmanen, T.; Lacey, J.; Moffat, K. National level paths to the mining industry's Social Licence to Operate (SLO) in Northern Europe: The case of Finland. *Extr. Ind. Soc.* **2020**, *7*, 97–109. [CrossRef]
137. Mancini, L.; Eslava, N.A.; Traverso, M.; Mathieux, F. *Responsible and sustainable sourcing of battery raw materials, EUR 30174 EN*; Publications Office of the European Union: Luxembourg, 2020; ISBN 978-92-76-17950-4. [CrossRef]