Miner Econ (2017) 30:7–13
DOI 10.1007/s13563-017-0104-0

EDITORIAL

Introduction

Magnus Ericsson[1] · **Kristiina Jokelainen**[2]

Published online: 7 March 2017

The unprecedented mineral and metal boom beginning in 2004/5 and peaking in 2011 exposed European economic vulnerability and the continent's high dependence on imported raw materials. The almost limitless Chinese appetite for metals and minerals together with Chinese control over certain metals of strategic importance (nowadays called critical metals), such as the rare earths, further exacerbated the situation. European politicians and bureaucrats were caught unaware of the seemingly low security of supply for European industry. Not surprising, as during the two last decades of the twentieth century, the European Commission had been trying to limit damages caused by the crumbling European mining sector, primarily coal but also other minerals and metals, and had not been thinking about future supply issues at all. But since then the Commission has slowly but steadily revved its mineral raw material policies into action. The European actions are carried out under a range of acronyms, and for the non-European reader, it might be useful to present these in some detail, with a focus on R&I (research & innovation) aspects, as a background to this issue of Mineral Economics.

EU initiatives

The boom years clearly demonstrated the importance to the EU economy and its industry of a reliable and unhindered supply of raw materials. In the member countries, there are at least 30 million jobs depending on a steady flow of raw materials at reasonable prices. The European Commission's actions to ensure a sustainable supply of metals and minerals evolve from two main initiatives:

- The Raw Material Initiative (RMI)
- The European Innovation Partnership on Raw Materials (EIP RM)

These are specific for the raw material sectors but are generic to the EU in that there are other sectors of the economy and society in Europe which are targeted with Innovation Partnerships and Initiatives using similar methods and approaches. All initiatives further have as a common denominator to create new networks and increase cooperation among all EU's member countries and also other neighbouring and associated countries including non-European ones.

The Raw Material Initiative

The RMI was adopted in 2008. It sets out a strategy for tackling the issue of access to raw materials for the EU. As discussed in the foreword above, the EU strategy has three pillars. The strategy covers all raw materials used by European industry excluding agricultural materials and energy materials. Focus is on minerals although also for example rubber and forestry products are included. The Commission considers that ensuring sustainable access to these raw materials is crucial to the competitiveness and growth of the EU economy and to the objectives of the Europe 2020 strategy. A list of particularly important or critical raw materials has been published and is regularly updated. An expert group, the Raw Material Supply Group, which has representatives from EU countries, European Economic Area countries, EU candidate countries, and their stakeholders—industry, research,

✉ Magnus Ericsson
magnus@gladtjarnen.se

[1] Luleå University of Technology, Luleå, Sweden

[2] Regional Council of Lapland, Rovaniemi, Finland

and civil society—advises the Commission and oversees the initiative's implementation.

The European Innovation Partnership (EIP) on Raw Materials

The EIP Raw Materials is the main EU initiative implementing the RMI and brings together EU countries, companies, researchers, and NGOs to promote innovation in the raw material sector.

The European Commission wants the EIPs to be challenge driven, focusing on societal benefits and a rapid modernisation of the associated sectors and markets. EIPs should act across the whole research and innovation chain, and aims at bringing together all relevant actors at EU, national and regional levels in order to:

(i) step up research and development efforts;
(ii) coordinate investments in demonstration and pilots;
(iii) anticipate and fast-track any necessary regulation and standards; and
(iv) mobilise 'demand' in particular through better coordinated public procurement to ensure that any breakthroughs are quickly brought to market.

Rather than each member country taking the above steps independently, as was earlier the case, the aim of the EIPs is concentrate efforts across the member countries and to design and implement them in parallel to cut lead times.

The overall objective of the EIP on raw materials is to contribute to the 2020 objectives of the EU's Industrial Policy—increasing the share of industry to 20% of GDP—and the objectives of the flagship initiatives 'Innovation Union' and 'Resource Efficient Europe', by ensuring the sustainable supply of raw materials to the European economy while increasing benefits for society as a whole.

The Commission hopes to achieve these goals by:

- Reducing import dependency and promoting production and exports by improving supply conditions from EU, diversifying raw material sourcing and improving resource efficiency (including recycling) and finding alternative raw materials.
- Putting Europe at the forefront in raw material sectors and mitigating the related negative environmental, social and health impacts.

In 2011/12, the EIP RM developed its Strategic Implementation Plan (SIP) through a long process with broad participation from all types of stakeholders from most member countries. This process resulted in 95 actions to foster innovative solutions. These may be technological or non-technological. Specific actions include research and development, addressing policy framework conditions, disseminating best practices, building a knowledge base, and fostering international cooperation.

EIT raw materials

In December 2014, the European Institute of Innovation and Technology (EIT, an independent body of the EU based in Budapest) launched a Knowledge and Innovation Community (KIC) Raw Materials. This is considered a milestone in achieving the objectives of the European Innovation Partnership (EIP) on Raw Materials. One of the key targets of the EIP is indeed to set up a network of research, education, and training centres on sustainable raw material management organised as a KIC, another generic EU organisation to promote R&D across the Union. The KICs are intended to overcome the fragmented European innovation landscape and have three general goals:

- Develop innovative products and services;
- Start new companies; and
- Train a new generation of entrepreneurs.

The KIC Raw Materials will address sustainable exploration, extraction, processing, and also recycling and substitution and the impact these activities will generate.

EIT Raw Materials was set up as the legal entity of the KIC Raw Materials. This KIC has the very ambitious vision of turning the challenge of raw material dependence into a strategic strength for Europe. Its mission is to boost the competitiveness, growth and attractiveness of the European raw material sector via radical innovation and entrepreneurship. The KIC aims at integrating multiple disciplines, diversity, and complementarity including business, education and research across the whole raw material value chain.

EIT Raw Materials is said to become the strongest consortium ever created in the world in the raw material field. The approach will pay particular attention to systemic thinking and de-siloing across the value chain. Focus will be on growth and job creation by boosting start-ups, SMEs, radical innovation and education. The EIT Raw Materials is organised as 6 Co-location Centres (CLC) and a main coordination centre in Berlin. One of the CLCs is located in Luleå in the middle of the Nordic mining and smelting cluster. This is the first CLC outside the major European cities ever.

EIT Raw Materials hopes to generate significant impact on European competitiveness and employment. This is planned to be realised through the introduction of innovative and sustainable products, processes and services and well-educated people that will deliver increased economic, environmental and social sustainability to European society. This might all sound a bit vague but there are concrete goals set as well: By 2022, the KIC is aiming to create, among others, 64 start-ups and 5 new primary/secondary sources of critical raw materials (CRM).

EIT Raw Materials contributes to EU's research and innovation program Horizon 2020, which runs for 7 years and begun in 2014. The budget is 80 billion EUR, not including the private funding these investments will attract. One important area of contribution by the EIT Raw Materials will be to address the societal challenges in a manner complementary to the other initiatives in these areas.

Horizon 2020

In the raw material areas, there are so far 42 projects within Horizon 2020 with a total funding of 223 million EUR from the Commission. There are over 400 partners cooperating from more than 40 countries from all parts of the world. Half of them are private companies. The projects are divided into three pillars as outlined in the SIP: technology, international cooperation and non-technology. Of particular interest for readers of Mineral Economics are the projects in the International cooperation pillar. So far, four projects have been started:

STRADE: strategic dialogue on sustainable raw materials for Europe.
MinFuture: global material flows and demand—supply forecasting for mineral strategies.
INTRAW: international co-operation on raw materials.
FORAM: towards a world forum on raw materials.

We hope to be able to report on and from these projects in future issues of Mineral Economics.

Role of regions

In all these programs and actions, the mining regions of Europe are expected to play an important role. Naturally, mining can only take place in regions where there are mineral resources and hence regional initiatives are encouraged and supported. The regions in this sense have an important strategic role. Collaboration between the Commission in Brussels and regional policy makers is needed to develop complementary approaches. The level of activity naturally varies across Europe but the Nordic mining regions are active with Finland in the lead. Also, regions where mining has stopped, at least for the time being, are engaged in these projects. Examples of regionally led initiatives with active participation from Finland, Sweden and Norway are MIREU and REMIX.

MIREU or Mining regions of Europe is an EIP Raw Material *commitment* by 25 mining regions in 12 countries. A commitment is an undertaking by a group of stakeholders to jointly finance and carry out a project which is officially recognised and listed as fitting into the SIP (see above).

Smart and Green Mining Regions of EU (REMIX) encourages resource-efficient raw material production in an environmentally and socially acceptable way, including critical raw materials. REMIX brings together 10 partners from nine countries.

SusMinNor

Within this complex framework, a range of local, regional and international projects to implement the overarching goals have been started in many of Europe's mining regions. Funded and supported not only by the European Commission but also by local and regional authorities responsible for development, R&I, training, environment etc. One of these projects is 'Sustainable mining in northernmost Europe—Lesson learned and practices developed'. As usual in the EU, an acronym is set up in this case SusMinNor! The project aims at improving the understanding of mining's potential contribution to local economies and the implications of mining for sustainable development in the region. It is a fairly typical project funded partly by the European Regional Development Fund (ERDF) 65% and partly by other interested parties 35%. It runs for 15 months and is hence a bit shorter than most projects. It aims not only to create new knowledge and publish this but perhaps more importantly in the long run to foster cooperation and forge links between in this case researchers in northern Finland and Sweden for the future. The study 'Sustainable extractive industries—competence and know how' will collect and condense experiences from mines and mining projects in the region during the past 5–7 years. Finally the project intends to establish a meeting place for mining regions and mining universities. The Regional Council of Lapland (Finland) has taken a leading role in the project and its partners are the University of Lapland (Rovaniemi, Finland) and Luleå University of Technology (Sweden).

SusMinNor is funded by the Interreg Nord, which is an EU-program supporting cross-border cooperation in order to strengthen the economic and social development in the northernmost area of the EU: north Norway, north Finland, north Sweden including Sápmi (the area inhabited by the Sami people, which spreads over all three countries). The region differs from other European regions due to its Arctic features with cold climate, long, dark polar nights, midnight sun, vast natural areas and abundance of natural resources.

Social sciences research on mining and sustainability in the North

One of these many meetings and seminars reporting project progress and research results held over Europe in many projects within this framework took place on April 11th and 12th in Haparanda in northern Sweden right on the border to Finland. It is also the city in Sweden located furthest to the east, on the

same longitude as Athens or Sofia. Some 20 researchers from the Universities of Oulo (Finland) and Lapland and Luleå University of Technology together with Lapland University of Applied Sciences, Natural Resources Institute and Geological Survey (all three in Finland) presented their findings. There is still some work to be done, but most of the project has already been completed.

Twelve presentations were given of which four are presented in this issue of Mineral Economics. The ones not included covered a diverse range of topics:

1. Current state of the metal markets and some thoughts on the outlook for mining in the European North.
2. The political economy of industrial pollution control: Lessons from the Swedish mining industry.
3. Defining mineral deposits of national interest.
4. Socio-economic challenges in the mining industry—Four cases from the Barents region.
5. 'They might do whatever': The planning process of mining projects from reindeer herders' point of view.
6. Nature-based tourism meets mining industry: Win-win situation or unhappy arranged marriage?
7. Adaptive governance of mining—Is it possible?
8. Arctic Smart Mining Cluster (AMIC)—Promoting sustainable mining industry in northern and eastern Finland.

A synthesis of the entire project is available as a separate publication.[1]

Mining in northern Finland, Norway and Sweden

The Interreg Nord regions cover an area of some 590 km^2, approximately the same size as Spain, Belgium and the Netherlands taken together. The number of inhabitants is however less than three million inhabitants roughly the same as in Wales (Fig. 1). Mining in these areas has a long tradition and has been one of the most important drivers of economic and social developments over the past 100 years. The Malmberget and Kiruna iron ore mines in Norrbotten Sweden had been known for centuries but only in the late 19th century did exploitation start when a railway line was built with British capital first to Malmberget and later to Kiruna and Narvik in Norway. The Boliden district in Västerbotten in Sweden was opened during the late 1920s. New geophysical exploration methods made it possible to find metal deposits also under a thick cover of moraine. The iron ore deposits in Sydvaranger were developed in the early twentieth century and in operation all through the cold war as a way to keep the Norwegian border areas with Soviet Union populated. Nickel deposits on the Barents Sea, in what was at the time part of Finland, were opened with North American financial support between the wars. These areas were ceded to the Soviet Union in the peace treaty after the war.

During the past 25 years, exploration has increased and new mines have been developed in particular in Sweden and Finland, while activities in Norway have been on a much lower scale. A number of new mines such as Kittilä and Kevitsa, in Finland and Björkdal in Sweden have been started. The difficulties when opening a new mine became obvious from the poor experiences of the Northland iron ore project in Sweden and the Talvivaara nickel operation in Finland. Nevertheless exploration expenditures in Sweden and Finland have been running around 120–140 million EUR in the past boom years and even if there is a decline at present the level is still above 100 MEUR. The two mining companies Boliden and LKAB are most active in Sweden while in Finland international companies based out of Canada, Australia and the UK are in the lead after Outokumpu exited mining some 10 years ago and decided to sell out its deposits and exploration targets.

Interreg Nord area is one of the most important mining regions of the European Union. All production of the critical metals palladium and platinum originates here. Kemi in Finland hosts the only chromite mine in EU. Over 90% of all iron ore production in the EU is mined in the region as well as 36% of the nickel mine production and around 10% of zinc and copper. See Table 1. It is also worth noticing that in spite of the high cost of labour, energy and strict regulations in the Nordic countries, mines are highly effective and generally low cost producers.

The ores produced are to a large extent also smelted and refined in the Nordic countries. There is copper smelter and refinery in Rönnskär in Sweden. In Kokkola lies a zinc smelter and refinery. The steel works of SSAB in Luleå as well as all other blast furnaces in the Nordic countries are fed by LKAB pellets. The Outokumpu stainless steel works in Tornio, one of the largest plants in the world, is the only unit which has its own chromite mine and ferrochrome smelter just nearby.

Into the future, there are several interesting new projects which could become major new mining operations in the all three countries. Some of these are shown in (Fig. 2). In Norway, the Nussir copper project is the most advanced. In Sweden, Laver is a new copper project which is similar to the giant Aitik mine opened in the 1960. The most fascinating project, so far, has however been found in Finland: the nickel/copper/platinum group metals (PGM including both platinum and palladium) project Sakatti which is an entirely new, grass root project found by the UK-based Anglo American one of the most powerful mining companies in the world. This is a true world class deposit, i.e. a deposit which is unique in the world with high grades and large size and a potential to secure metals for the demand of the growing world population and to give local communities an economic boost.

[1] Lesser P., Ejdemo T., Suopajärvi L. and Petrétei A. SusMinNor, Sustaiable mining in the Northernmost Europe—lessons learned and practices developed, Synthesis report, 2016. Avaialble from thomas.ejdemo@ltu.se.

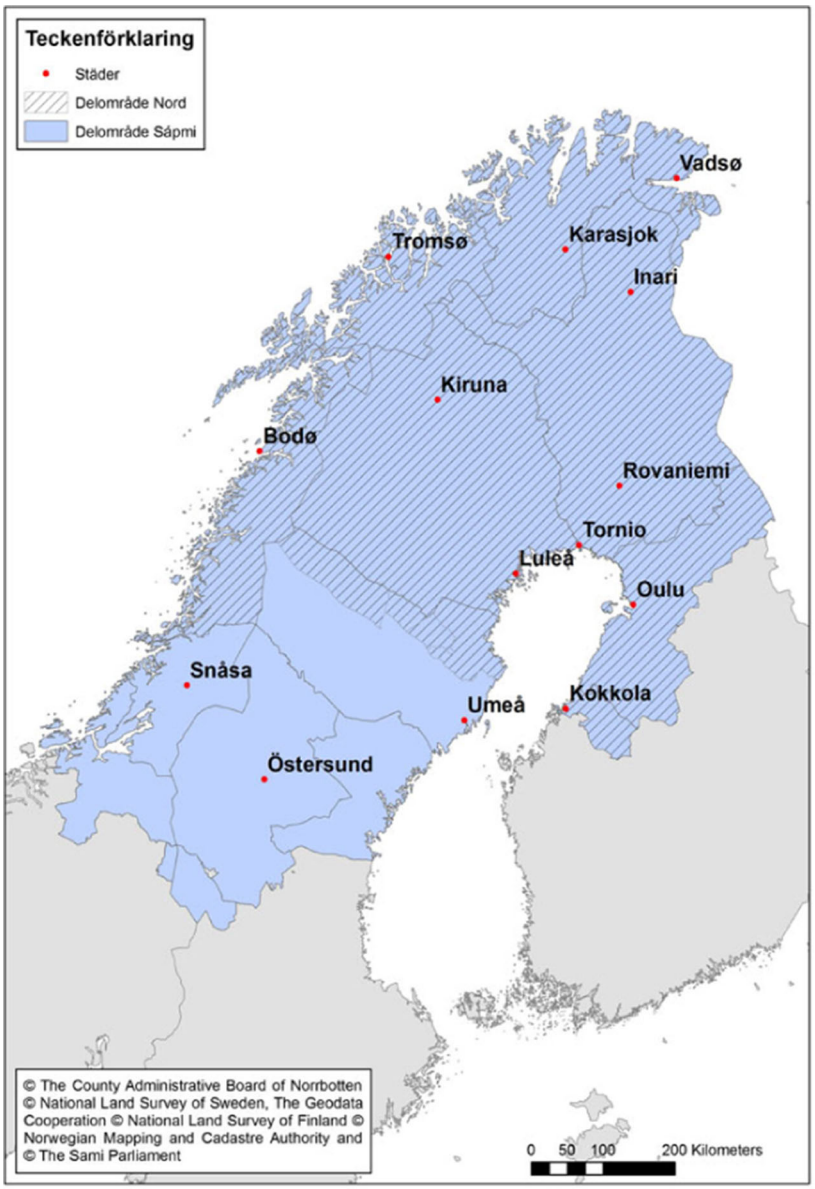

Fig. 1 Regions in SusMinNor

Notes: Städer=cities; Delområde Nord=Nord region; Delområde Sápmi=region Sápmi.
Source: Eurostat.

Discussion

The Fennoscandian Shield covers northern parts of Norway, Sweden and Finland, northwest Russia, northern Denmark and under the Baltic Sea. It contains the oldest rocks of the European continent and has several areas which are rich in ores in Finland, Sweden, Russia and Norway. Mining has historically over the centuries been undertaken in several areas: Bergslagen, the Skellefte district and Norrbotten in Sweden, Outokumpu district in Finland and Kola peninsula in Russia are the most important ones. Focus has gradually shifted northwards as infrastructure has been extended into the remote and dark northern parts of the Shield.

Traditionally, the colonialisation of the northernmost areas of Fennoscandia and the exploitation of its mineral deposits has taken place from the south northwards in each country. The national borders are still running south/north but east/west communications are becoming more important as these peripheral regions of each country understand and realise the potential of regional cooperation. It is both a matter of 'hard ware' infrastructure such as roads and railroads but perhaps more importantly an increasing flow and exchange of ideas and combining experiences from many years of separate development. In an historical parallel, it was the construction of the railroad from Kiruna in Sweden westwards to Narvik in Norway that made the large scale exploitation of the Norbotten iron ore deposits

Table 1 Interreg Nord share of EU mine production

Metal	2014		
	Production volume[a]	EU share of world (%)	Interreg Nord share of EU (%)
Chromite (Mt)	1.0 e	4	100
Platinum (t)	0.99	0.68	100
Palladium (t)	0.78	0.40	100
Iron ore (Mt)	32,3	1.6	93
Nickel (kt)	20.0	2.9	36
Copper (kt)	101	4.6	12
Zinc (kt)	77	5.9	9.7
Silver (t)	147	15.4	6.9

Share of EU are calculated on EU's + Norway's production, source: Raw Materials Data

[a] Production in InterregNord all regions in Sweden, Finland and Norway

e = estimate

possible. These mines became one of the cornerstones of the today's thriving societies in the region.

The common interests of these peripheral regions are more important than the traditional north/south links with respective capital in the south. Only by combining the voices of the regions across the borders will they have a chance of being listened to in Helsinki, Stockholm or Oslo and even less so in Brussels.

The mines in northern Fennoscandia have suffered from low metal prices and harsh competition from overseas low cost operations many times during the past 100 years, but have been able to survive by continuous technological and organisational developments and also be gradually having to adapt to tougher environmental demands (although initially grudgingly so). An early exposure to the world markets combined with a strong but realistic governance of the sector has made it possible to avoid the environmental disasters and ghost towns of many other mining regions in Europe. The Fennoscandian shield mines can serve as positive examples in many ways for other mineral rich regions inside (and outside) Europe where societal and economic conditions have been different preventing a gradual adaption to new conditions.

Mistakes made during the years can of course also be learnt from and avoided. The balance between all three sustainability components: environment, social and economic aspects has not

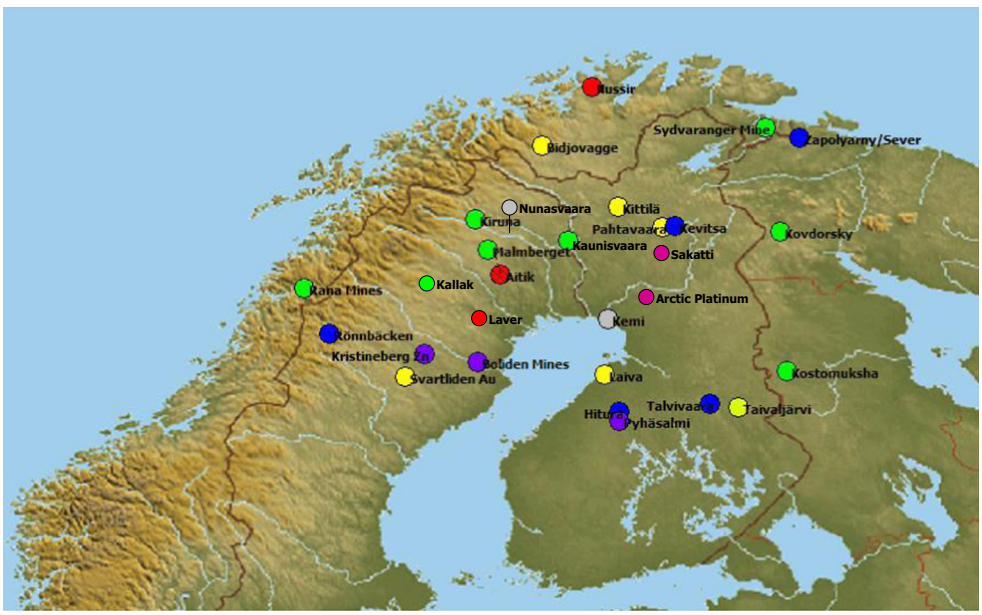

Fig. 2 Operating mines and major projects in SusMinNor regions

Source: Raw Materials Data.
Arctic Platinum (PGM), Bidjovagge (Au), Kallak (Fe), Laver (Cu), Nunasvaara (graphite), Nussir (Cu), Rönnbäcken (Ni), Sakatti (PGM) and Taivaljärvi (Ag) are selected projects. Kostomuksha (Fe), Kovdor (Fe) and Zapolyarny/Sever (Ni) are examples of Russian mines in the Fennoscandian Shield.

always been optimal in this region. Initially, the economic surplus and profits from mining were exported to the economic centres of Sweden and Finland and also to the mostly foreign investors who provided capital for the original expansions. It can still be debated how much of the economic surplus remains and which is mining's contribution to local societies. These issues continue to be of great importance but the balance and interdependence between local/regional/national and global aspects are much more intricate and deserve new approaches where the simple centre/periphery relation is developed and refined. There are important democratic aspects of deciding where a mine should be developed. In today's society economic linkages are direct, fast and mostly national but environmental threats are global. In these regions local, regional and national elections are held regularly and parliaments are elected which have the responsibility for all societal development issues. If additional procedures should be set up for mining, it must be carefully studied and evaluated how they interact with the overall democratic framework of each country.

Another problem, which is facing the mining sector, is the co-existence of all economic activities in the region: exploration/mining/smelting/tourism/reindeer herding/forestry/and others. The issue of land use planning is not a new one but it has recently come into focus. A starting point to discuss these issues is provided by the research presented in this issue. In addition to listen to all stakeholders and take their views seriously, it is important to realise that the areas available for economic activities of all types in the northern regions of Fennoscandia are vast, the population small and the climate harsh with long dark winters and short summers with midnight sun. The absolute size of the various economic activities must also be taken into account and the sustainability of each one separately and together carefully investigated before priorities are made.

To find this balance between various economic activities, between long-term and short-term goals, between local, national and regional democratic influence is particularly important in these times when several important new deposits have been localised in the Fennoscandian shield, some of them like Sakkatti in Finland even of global significance, while others are of at least national and sometimes of EU level importance. The two copper projects Laver in Sweden and Nussir in Norway are examples of the latter.

The present research can possibly contribute towards finding this balance or at least towards developing processes how to find it. Another goal for the SusMinNor, which is more easily within reach, is to raise the EU's awareness of the resource rich region of the Fennoscandian shield partly within its borders. A region, which could, by exploiting its mineral endowment to ensure its own sustainable regional development, also significantly contributes towards increasing the stable supply of metals to the European economy and society. The region can also, whatever its influence on the macro-economic level, make important contributions to academic and applied research across national borders in the fields of macro and micro economics, sociology, anthropology, technology, economic history, political science which will be necessary to develop new ideas for EU's mining strategy.