

## RECENT DEVELOPMENTS IN RAW MATERIALS POLICY IN THE EUROPEAN UNION: PERSPECTIVE OF EUROGEOSURVEYS AS A DATA SUPPLIER

### NAJNOWSZE TRENDY W POLITYCE SUROWCOWEJ UNII EUROPEJSKIEJ Z PERSPEKTYWY EUROGEOSURVEYS JAKO DOSTAWCY DANYCH

JELENA VIDOVIC<sup>1</sup>, SLAVKO SOLAR<sup>1</sup>

**Abstract.** Mineral Raw Materials are of strategic importance for Europe's economic growth and societal development. The European Commission addressed this challenge through the Raw Materials Initiative (RMI), stakeholders' platform, the European Innovation Platform on Raw Materials (EIP-RM), and Horizon 2020 funding. The aim is to ensure security and sustainability of mineral raw materials supply from EU domestic and other primary and secondary sources and management of competing uses of the European surface and sub-surface. The sustainable supply of raw materials from European sources requires an improved knowledge base of raw materials within the EU, namely the European Union Raw Materials Knowledge Base (EURMKB), where EuroGeoSurveys, the Geological Surveys of Europe, is one of the key data providers. Current European Commission policies have the same objectives that will be fully implemented in near future. The Mobility Package and its implementation activities (such as European Battery Alliance) and tools (including Horizon Europe) will strengthen the raw materials position in an overall EU policy setting.

**Key words:** raw materials, Raw Materials Initiative, European Innovation Partnership, EU Research and Innovation programme Horizon 2020, Geological Surveys of Europe, European Union Raw Materials Knowledge Base.

**Abstrakt.** Naturalne surowce mineralne mają strategiczne znaczenie dla europejskiego wzrostu gospodarczego i rozwoju społecznego. Komisja Europejska podjęła takie wyzwanie poprzez Inicjatywę dla Surowców (RMI), platformę zainteresowanych stron, Europejską Platformę Innowacji w Zakresie Surowców Naturalnych (EIP-RM) i fundusz Horyzont 2020. Celem jest zapewnienie bezpieczeństwa i zrównoważonych dostaw surowców z krajowych i innych źródeł Unii Europejskiej oraz zarządzanie konkurencyjnym wykorzystaniem powierzchni ziemi i stref wglębnych Europy. Zrównoważone dostawy surowców ze źródeł europejskich wymagają udoskonalonej bazy wiedzy o surowcach UE, tzw. Bazy Wiedzy o Surowcach w Unii Europejskiej (EURMKB), w której EuroGeoSurveys, służby geologiczne Europy, są jednym z kluczowych dostawców danych. Obecna polityka Komisji Europejskiej ma te same cele, które zostaną w pełni wdrażane w najbliższej przyszłości. Pakiet Mobilności i jego działania wdrożeniowe (takie jak European Battery Alliance) i narzędzia (w tym Horizon Europe) wzmocnią pozycję surowców naturalnych w ogólnym kontekście polityki UE.

**Słowa kluczowe:** surowce naturalne, Inicjatywa na Rzecz Surowców, Europejskie Partnerstwo dla Innowacyjności, Unijny Program Badawczo Innowacyjny Horizon 2020, Służby Geologiczne Europy, Unijna Baza Wiedzy o Surowcach.

## INTRODUCTION

Raw materials are essential for the sustainable functioning of the EU's economy. Securing reliable, sustainable and undistorted access to raw materials and their circular use in

the economy is becoming a growing concern within the EU (EC, 2011, 2014a; Blengini *et al.*, 2017).

The EU has many raw material deposits (Bertrand *et al.*, 2016). This fact does not mean their availability. Their exploration and extraction are facing increased competition for

<sup>1</sup> EuroGeoSurveys, Rue Joseph II 36-38, 1000 Brussels, Belgium; e-mail: jelena.vidovic@eurogeosurveys.org, slavko.solar@eurogeosurveys.org.

different land uses and a highly regulated environment, as well as technological limitations in access to mineral deposits. The EU is highly dependent on imports of strategically important raw materials which are increasingly affected by market distortions. In the case of high-tech metals, this dependence can even be considered critical in terms of their high economic importance to the EU, combined with a high risk associated with their supply (EC, 2014a, Blengini *et al.*, 2017).

Securing reliable and unhindered access to certain raw materials has been a growing concern for the EU. To address this challenge, in 2008, the European Commission launched the EU Raw Materials Initiative, an integrated strategy related to the supply of raw materials, with a priority action to define critical raw materials (CRMs) for the EU (EC, 2008). Moreover, in 2011, the Commission committed to review and update the list of critical raw materials for the EU at least every 3 years to reflect production, market and technological developments (EC, 2011). This list of critical raw materials (CRM) is one of the key instruments in the context of the EU raw materials policy (Blengini *et al.*, 2017).

The EU Raw Materials Initiative is based on the following three pillars: 1. ensuring access to raw materials on world markets at undistorted conditions, 2. fostering sustainable supply of raw materials from European sources, 3. reducing the EU's consumption of primary raw materials by boosting resource efficiency and promote recycling (EC, 2008). The umbrella framework for the RMI implementation is the European Innovation Partnership (EIP) on Raw Materials (EC, 2012a), a stakeholders' platform that defined specific objectives and targets through the Strategic Implementation Plan (SIP), translated the strategic policy framework into concrete actions and mobilized the stakeholder community to implement them (EC, 2012a, 2013a).

The implementation of the SIP is supported by different financial instruments, mainly by the EU Research and Innovation Programme Horizon 2020 (H2020), with calls dedicated exclusively to primary and secondary raw materials. In addition, within H2020, the European Institute on Innovation and Technology (EIT) for raw materials has been established.

A sustainable supply of raw materials from European sources requires an improved knowledge base of raw materials within the EU, namely the European Union Raw Materials Knowledge Base (EURMKB), as highlighted in the EIP SIP from 2013, particularly in the Action area no. II.8. EuroGeoSurveys, the Geological Surveys of Europe (EGS), is one of the key data providers to the European Union Raw Materials Knowledge Base.

One of the major aims of EuroGeoSurveys is to improve the geological data collections (including raw materials) at the national and regional level and to facilitate subsequent access to data. In this way, EGS is addressing the recommendations of the second pillar of the RMI. These activities are carried out in the first place through participation of EGS' members in the H2020 projects.

The aim of this paper is to provide an overview of raw materials policy developments since 2008. It is focused on to present the policy development and trends, and to discuss the role of geological surveys as a data provider in the context of the EU Raw Materials Initiative and its implementation actions.

## EU RAW MATERIALS POLICY DEVELOPMENTS SINCE 2008

In 2008, the Commission adopted “The Raw Materials Initiative (RMI) — meeting our critical needs for growth and jobs in Europe” communication, which set out a strategy for addressing the issue of supply of raw materials in the EU. This strategy has three pillars which aim to ensure:

- Fair and sustainable supply of raw materials from global markets,
- A sustainable supply of raw materials within the EU,
- Resource efficiency and supply of “secondary raw materials” through recycling (EC, 2008).

Within the 1<sup>st</sup> pillar of the RMI, the EU committed to actively pursue raw materials diplomacy with a view to secure access to raw materials. This included better and more effective coordination and coherence among EU external policies (external relations, trade, and development). Another objective of the 1<sup>st</sup> pillar was to promote enhanced international cooperation, including dialogues on the security of international trade routes for raw materials.

In order to facilitate the sustainable supply of raw materials from European deposits (2<sup>nd</sup> pillar), the EU required the improvement of the knowledge base of mineral deposits within the EU and long-term access to these deposits within land use planning. Therefore, the Commission recommended better networking between the national geological surveys to facilitate the exchange of information and improve the interoperability of data and their dissemination. To tackle the technological challenges related to sustainable mineral production, the Commission committed to promoting research projects that focus on the extraction and processing of raw materials in its 7<sup>th</sup> Framework Programme (FP7). Resource efficiency, recycling, substitution and the increased use of renewable raw materials are promoted within the 3<sup>rd</sup> pillar, aiming to ease the critical dependence of the EU on primary raw materials, reduce import dependency, and improve the environmental balance, as well as meeting industrial needs for raw materials. The Commission committed to promoting research projects that focus on resource-efficient products and production under FP7.

The RMI brings together all relevant policy areas into a coherent whole, including external trade. The Directorate General for Trade of the European Commission (DG Trade) pledged to regularly report on its implementation. This first activity report was published in 2009 and covered the actions in the domain from the end of 2008 through 2009. During this period the inventory of trade barriers in the field of raw materials was completed and their economic impact was

assessed, showing in particular the global nature of the issue; there were several ongoing bilateral or multilateral negotiations on export restraints; the European Commission organized the workshop with the OECD that brought together over 100 government representatives, academics and business representatives, enhancing the understanding of the economic effects of export restraints and facilitating an exchange of experience on policy aims; DG Trade took actions aimed at ensuring the coherence of EU trade policy on raw materials with other EU policies, such as environment and development priorities (EC, 2009, Solar *et al.*, 2012, Chapman *et al.*, 2013).

In 2011, the Commission published the communication “Tackling the Challenges in Commodity Markets and on Raw Materials”, reporting the increase in financial activity across all classes of commodities and raw materials and emphasizing that the integrity and transparency of commodity derivative markets need to be enhanced. For this reason, the Commission has launched several initiatives in the field of financial services, aiming to examine the extent to which further improvements are necessary on the transparency and accessibility of information on physical commodity markets. This increased transparency of financial and physical trading activities should allow regulators and market participants to better understand the interaction between financial and physical commodity markets and help to prevent abusive practices (EC, 2011). In turn, in 2013, the European Commission published the report on the implementation of the Raw Materials Initiative (EC, 2013a), giving an overview of the ongoing initiatives and highlighting the joint interest for the EU and third countries rich in raw materials to work in partnership.

The review of the implementation of the Raw Materials Initiative was done in 2014 (EC, 2014b), noting that there has been a significant progress in the first and third pillars of the RMI. Further development of the second pillar became a key priority, especially regarding framework conditions for mining and improving the raw materials knowledge base, that may include setting up a pan-European knowledge base of non-energy, non-agricultural raw materials by 2020.

#### CRITICAL RAW MATERIALS

Within the framework of the EU Raw Materials Initiative, it was decided to identify a list of critical raw materials (CRM) at EU level, in close cooperation with the Member States and stakeholders. Therefore, the European Commission’s Ad-hoc Working Group on Defining Critical Raw Materials was established, which was active between April 2009 and June 2010 under the umbrella of the Raw Materials Supply Group. Report of the Ad-hoc Working Group on Defining Critical Raw Materials was published in 2010 (EC, 2010a), where a selection of 41 minerals and metals were analyzed, and a relative concept of criticality was developed. The raw material is labelled “critical” when the risks of supply shortage and their impacts on the economy are higher compared with most of the other raw materials. Two types of

risks are considered: a) the “supply risk” taking into account the political-economic stability of the producing countries, the level of concentration of production, the potential for substitution and the recycling rate; and b) the “environmental country risk” assessing the risks that measures might be taken by countries with weak environmental performance in order to protect the environment and, in doing so, endanger the supply of raw materials to the EU. The EC criticality methodology was used to create a list of 14 CRMs at EU level in 2010: antimony, indium, beryllium, magnesium, cobalt, niobium, fluorspar, platinum group metals, gallium rare earths, germanium, tantalum, graphite and tungsten (EC, 2010a).

Following the Commission’s commitment to review and update the list of critical raw materials for the EU at least every 3 years (EC, 2011), after the first list published in 2011, a second revised list of 20 CRMs was adopted in 2014: antimony, beryllium, borates, chromium, cobalt, coking coal, fluorspar, gallium, germanium, indium, magnesite, magnesium, natural graphite, niobium, PGMs, phosphate rock, HREEs (heavy), LREEs (light), silicon metal, tungsten (EC, 2014a).

Finally, in 2017, the Commission presented an updated list of 27 critical raw materials for the EU as a result of a third assessment (EC, 2017a): antimony, baryte, beryllium, bismuth, borate, cobalt, coking coal, fluorspar, gallium, germanium, hafnium, helium, indium, magnesium, natural graphite, natural rubber, niobium, phosphate rock, phosphorus, scandium, silicon metal, tantalum, tungsten, vanadium, platinum group metals, heavy rare earth elements, light rare earth elements. The list of critical raw materials for the EU is subject to regular update at least every three years, in order to reflect production, market and technology developments, and the number of raw materials assessed has increased with each update (EC, 2017a).

In 2016, Pavel and Tzimas published the study on raw materials in the European defense industry, identifying the importance of raw materials and evaluates the potential risks associated with their supply in terms of import dependency (Pavel, Tzimas, 2016). An analysis of import dependency showed that the EU is almost 100% dependent on import of 19 raw materials (beryllium, boron, dysprosium, germanium, gold, indium, magnesium, molybdenum, neodymium, niobium, praseodymium and other REEs, samarium, tantalum, thorium, titanium, vanadium, zirconium and yttrium) and is more than 50% reliant on imports for over three-quarters of them. China is the major producer for one-third of the raw materials identified in defense applications (Pavel, Tzimas, 2016).

#### EUROPEAN INNOVATION PARTNERSHIPS

The role of Europe as a supplier of raw materials has been progressively reduced, which emerged a new paradigm pointing to innovation as a driving force. In 2010, the Commission set out the appropriate framework of European Innovation Partnerships (EIPs), as part of the Innovation

Union flagship initiative (EC, 2010b). In 2012, a proposal for the European Innovation Partnership (EIP) on Raw Materials was launched, targeting non-energy, non-agricultural raw materials, including but not limited to the EU's list of critical raw materials (EC, 2012a). The EIP is the major EU initiative implementing the Raw Materials Initiative stakeholder platform that brings together EU countries, companies, researchers, and NGOs to promote innovation in the raw materials sector. The main objective of the Partnership is to help raise industry's contribution to the EU's GDP to around 20% by 2020 by securing its access to raw materials. It also plays an important role in meeting the objectives of the Commission's flagship initiatives Innovation Union and Resource Efficient Europe, by accelerating innovations that ensure secure, sustainable supplies of both primary and secondary raw materials, preventing wastage of key raw materials during all their life cycle and in this way ensuring the sustainable supply of raw materials to the European economy whilst also increasing benefits for society as a whole (EC, 2012a).

In 2013, following the objective of the EIP on Raw Materials, the Strategic Implementation Plan (SIP) was developed, promoting international cooperation, sustainable and secure supply, circularity and expansion of secondary RM market (EC, 2013b). The work under the EIP is structured under three pillars reflecting the nature of the actions: I) Technology Pillar, II) Non-technology Pillar, and III) International cooperation Pillar. Technology Pillar has three priority areas: I.1) Raw materials research and innovation coordination, I.II) Technologies for primary and secondary raw materials production, and I.3) Substitution of raw materials. The priority areas of Non-technology Pillar are: II.1) Improving Europe's raw materials framework conditions, II.2) Improving Europe's waste management framework conditions and excellence, and II.3) Knowledge and skills and optimized raw materials flows. International cooperation Pillar has five action areas: III.1) Technology, III.2) Global Raw Materials Governance and Dialogues, III.3) Health, Safety and Environment, III.4) Skills, Education and Knowledge, and III.5) Investment activities.

#### EUROPEAN UNION RAW MATERIALS KNOWLEDGE BASE

The European Union Raw Materials Knowledge Base (EURMKB) is a part of the European Innovation Partnership's Strategic Implementation Plan (EC, 2014b) aiming to provide all information on raw materials in the EU and serving industry and policymakers as a valuable source of data. With the help of EU countries, the service is collecting, storing, maintaining, upgrading, analyzing and disseminating information on the raw materials. In 2015, the Joint Research Centre (JRC), European Commission's science and knowledge service launched the Raw Materials Information System (RMIS 1.0), Commission's reference knowledge platform on non-fuel, non-agriculture raw materials from primary (extraction/harvesting) and secondary (recycled/re-

covered) sources. The RMIS contributes to consolidating the EU Raw Materials Knowledge Base (EURMKB) and aims at strengthening the visibility and competitiveness of the EU raw materials sector while promoting green and sustainable growth. In the communication from 2015, the European Commission presented measures needed to be taken forward in line with the better regulation principles, focusing among other on the key role of the RMIS and its further development (EC, 2015). The assessment of potential bottlenecks along the materials supply chain for the future deployment of low-carbon energy and transport technologies in the EU was done in 2016, with an aim to give a quantitative indication of the EU's resilience regarding the supply of materials relevant for the deployment of low-carbon energy and transport technologies. The report focused on wind, photovoltaic and electric vehicles, considering the complete materials supply chain – from raw materials to final components production (Blagoeva *et al.*, 2016). In 2017, the Commission published the interim progress report and roadmap towards advanced Raw Materials Information System (RMIS) and officially launched the advanced RMIS (RMIS 2.0) during the Raw materials week (EC, 2017b).

In parallel to the studies aiming at identifying key materials for Europe's economy, the European Commission launched in 2012 the Study on Data Needs for a Full Raw Materials Flow Analysis (EC, 2012b). The objective of this study was to support the European Commission in identifying the information and data needed for a complete raw materials flow analysis at the European level. The aims of the study were to assess available data with reference to material flows, to examine data gaps and bottlenecks and to make recommendations for a future data strategy covering the improvement of both data availability and quality. As a follow up the study on data for a raw material system analysis was carried out and published (BIO by Deloitte, 2015), with the aim to respond to the needs of information on non-energy material flows and to assist the European Commission on the development of a full Material System Analysis (MSA) for several key raw materials in the European Union.

Projects based on the EIP Strategic Implementation Plan related to European Union Raw Materials Knowledge Base were carried out within the Societal Challenge 5: Climate Action, Environment, Resource Efficiency and Raw Materials of Horizon 2020 Programme, from 2014 on. Detail description of the project is given below.

#### RAW MATERIALS IN FRAMEWORK PROGRAMMES (FP7, HORIZON 2020)

Since their launch in 1984, the Framework Programmes have played a lead role in multidisciplinary research and cooperative activities in Europe and beyond. The Seventh Framework Programme for research and technological development (FP7) was the European Union's main instrument for funding research in Europe from 2007 to 2013. It is the result of years of consultation with the scientific community, research and policy-making institutions, and other interested

parties. Since 2010, FP7 was contributing to finding solutions to the challenge of raw materials, mainly in the Nanotechnologies, Materials and New Production (NMP) and Environment Themes.

Horizon 2020 (H2020) is the current (2014–2020) European Union's funding mechanism supporting research and innovation and follows on from the Framework Programmes. Horizon 2020 is the financial instrument implementing the Innovation Union, a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness. In order to reflect the policy priorities and address the major concerns expressed by European citizens, H2020 has adopted a challenge-based approach that brings together resources and knowledge across different fields, technologies and disciplines, including social sciences and the humanities.

Seven "Societal Challenges" (SC) have been identified by the Commission, including SC5 – Climate action, environment, resource efficiency and raw materials. SC5 aims to tap the full potential of primary and secondary raw materials along the entire raw materials value chain and to boost the innovation capacity of the EU raw materials sector. It focuses on non-energy and non-agricultural raw materials used in industry (metallic minerals, industrial minerals, construction materials, wood and natural rubber).

## POLICY TRENDS AND DEVELOPMENTS

On 25 September 2015, the United Nations adopted 17 Sustainable Development Goals (SDGs) to end poverty, protect the planet, and ensure prosperity for all as part of a new sustainable development agenda. Each goal has specific targets to be achieved over the next 15 years. The EU is committed to these goals. In its 2016 communication on steps for a sustainable European future, the Commission pledged to apply the principles of sustainable development to all EU policies and initiatives (EC, 2016). A report on mining and the SDGs was published the same year, illustrating how mining can contribute to the achievement of every SDG (Soneson *et al.*, 2016).

In September 2017, the Commission presented renewed EU Industrial Policy "Investing in a smart, innovative and sustainable Industry", showing the ambition to help European industries stay or become the world leader in innovation, digitization and decarbonization. The Commission emphasized the need to strengthen European industry's ability to adapt and innovate by facilitating investment in new technologies and embracing changes brought on by increased digitization and the transition to a low-carbon and more circular economy (EC, 2017c). This renewed EU Industrial Policy has three "Mobility Packages".

The 1<sup>st</sup> Mobility Package, "Europe on the Move", was presented in May 2017, focusing on the key contribution that must be made by road transport. It is accompanied by a series of proposals targeting this sector, whose aims include supporting the rollout of infrastructure for road charging, alternative fuels and connectivity, better information for con-

sumers, a stronger internal market and improved working conditions for the road haulage sector, as well as steps to lay the ground for cooperative, connected and automated mobility (EC, 2017d).

The second Mobility Package of proposals under the "Europe on the Move" initiative seeks to ensure that the best low- and zero-emission, connected and automated mobility solutions, equipment and vehicles are developed, offered and manufactured in Europe, and that we have the most modern support infrastructure in place. At the same time, it contributes to cleaning up the environment for citizens and improving their quality of life, notably through better air quality in cities and by reducing congestion. Measures proposed under this package also contribute to restoring consumers trust. This package thus includes a combination of supply- and demand-oriented measures to put Europe on a path towards low-emission mobility and strengthen the competitiveness of the European automotive and mobility eco-system (EC, 2017e).

With the third "Europe on the Move" Package, the Commission is completing its broad range of legislative proposals and enabling measures, which form a comprehensive, integrated and forward-looking approach to achieving clean, connected and competitive mobility for EU citizens (EC, 2018a). The advantage should be taken of the possibilities of new technology to pursue several goals at the same time – to make European mobility safer and more accessible, European industry more competitive, European jobs more secure, and to be cleaner and better adapted to the imperative of tackling climate change (EC, 2018a).

In October 2017, the Commission launched a "European Battery Alliance" with key industry stakeholders, active Member States and the European Investment Bank. This cooperative platform aims to facilitate the emergence of well-integrated and industry-led battery cell manufacturing projects bringing together EU strengths and supporting cooperation among the various players along the value chain, unlocking synergies and gaining in competitiveness and economies of scale. As part of the "Europe on the Move" package and following the consultation of and close cooperation with industry stakeholders under the "European Battery Alliance", the Commission is putting forward a comprehensive Strategic Action Plan for Batteries (EC, 2018b), setting out a set of concrete measures that will contribute to creating this innovative, sustainable and competitive battery "ecosystem" in Europe. Through this action plan, the Commission is not only promoting a cross-border and integrated European approach, but also putting a focus on sustainable batteries manufacturing throughout the value chain, starting with the extraction and processing of (primary and secondary) raw materials, the design and manufacturing phase of battery cells and battery packs, and their use, second use, recycling and disposal in a circular economy context. Such an approach will promote the production and use of high performing batteries and set sustainability benchmarks throughout the EU value chain. The action plan combines targeted measures at EU level including raw materials'

research and innovation, financing/investment, standardization/regulatory, and trade and skills development in order to make Europe the global leader in sustainable battery production and use, in the context of the circular economy. More specifically, it aims to secure access to raw materials from resource-rich countries outside the EU, facilitate access to European sources of raw materials, as well as accessing secondary raw materials through recycling in a circular economy of batteries (EC, 2018a, b).

In May 2018, the Commission published the Report on Raw Materials for Battery Applications, with the purpose to launch an informed discussion with the Member States and other stakeholders and to inform about the implementation of the Battery Action Plan, in particular the strategic action area “Securing the supply of raw materials” (EC, 2018c). The report focuses on four essential raw materials for batteries production namely: cobalt, lithium, graphite and nickel, whose supply chain is potentially vulnerable to disruption. In view of the large quantities needed in the future, the sustained extraction and exploitation of these resources is fundamental, and recycling of materials will increasingly become important for reducing the EU’s dependency on third country markets and should be encouraged in the framework of the transition to a circular economy. The report confirms that the EU is sourcing primary battery raw materials mostly from third countries such as Democratic Republic of Congo, Russia, Chile and Brazil, and that there is a potential for boosting primary and secondary battery materials production in the EU. It also shows that there are few obstacles to using the EU potential, such as: the lack of geological data necessary to discover deeper deposits; the difficulty to access to known deposits; a weak integration of land use planning and mining and finally diverse regulatory conditions across the EU, and low public awareness of raw materials and acceptance of production operations (EC, 2018c).

#### RAW MATERIALS IN THE NEXT FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION: HORIZON EUROPE

Building on the success of the EU’s past flagship research and innovation programmes, the Commission proposes the biggest ever research and innovation funding programme “Horizon Europe” (EC, 2018d). It is designed around three pillars:

- I. Open Science,
- II. Global Challenges and Industrial Competitiveness,
- III. Innovation.

The proposal will be discussed with the Member States in the Council and the European Parliament until its adoption expected in 2020. **Pillar I.** Open Science builds on the success of the European Research Council, the Maria Skłodowska-Curie Actions and the Research Infrastructures component in the current framework programme H2020. **Pillar II.** Global Challenges and Industrial Competitiveness pillar includes five thematic clusters that address the full spectrum of global challenges through top-down collabora-

tive R&I activities: Health, Inclusive and Secure Society, Digital and Industry, Climate, Energy and Mobility, Food and Natural Resources. These clusters, supported by areas of intervention, cut across typical boundaries between disciplines, sectors and policy areas and will lead to more collaboration and increased impact in what concerns the Union and global policy priorities. **Pillar III.** Open Innovation will essentially focus on scaling up breakthrough and market-creating innovation through a new European Innovation Council and activities aiming at enhancing and developing the overall European innovation landscape, including support to the European Institute of Innovation and Technology (EIT). A sustainable supply of raw materials is covered in the area of intervention called “Circular Industries” under the Cluster “Digital and Industry” of Pillar II “Global Challenges and Industrial Competitiveness” (EC, 2018d). The Commission advocates for an integrated value chain approach covering, under the same cluster “Digital and Industry”, very closely related aspects such as the sustainable supply and substitution of raw materials, industrial symbiosis, improved resource and energy-efficiency in industry, or the decarbonisation of energy-intensive industries (the latter under the Area called “Low carbon and clean Industries”).

#### GEOLOGICAL SURVEYS OF EUROPE AS A DATA PROVIDER

EuroGeoSurveys (EGS), The Geological Surveys of Europe, is a not-for-profit organization representing 37 National Geological Surveys and some regional Geological Surveys in Europe, with an overall workforce of several thousand geoscientists, engineers and other experts. EGS Members are public sector institutions carrying out operations and research in the field of geosciences within their respective jurisdictions, depending on their mandate. These organizations have a long tradition and experience, in many cases more than 100 years, in the collection of data, preparation of information, and in conducting research focused on their national subsurface.

EGS provides the European Institutions with expert, independent, balanced and practical pan-European advice and information as an aid to problem-solving, policy, regulatory and programme formulation in areas such as: use and management of on-shore and off-shore natural resources (energy, including renewable geothermal energy; minerals; water; soils; underground space; and land), identification of natural hazards of geological origin, their monitoring and the mitigation of their impacts (deficit or excess of trace elements in soils and waters; earthquakes; natural emissions of hazardous gases; landslides and rockfalls; land heave; subsidence; shrinking and swelling clays), environmental management, waste management and disposal, land-use planning, sustainable development and safe construction, e-government and access to geoscientific data and metadata, and development of interoperable and harmonized geoscientific data at the European scale.

EGS carries out its expert work through the operation of the Expert Groups, one of which is the Mineral Resources Expert Group (MREG). The MREG members compete on an equal basis with other organizations responding to Calls from the EU, such as those of the Framework and H2020 Programmes (Regueiro y González-Barros, 2015). EGS and its members may submit proposals to Calls either as an entire EGS community with individual surveys as partners or third parties, or as individual surveys as part of consortia, depending on the subject matter of the call. Typically, where a Call is for the compilation of data or information on a Europe-wide basis where individual surveys have national data, EGS is trying to respond to the Call as a European-wide consortium.

EuroGeoSurveys and its constituent members have been successful in obtaining funding to deliver several EU-funded projects in the raw materials call, particularly related to EURMKB. These projects are Minerals4EU, ProSUM, MICA and ORAMA.

The Minerals4EU project was funded through the FP7 Framework Programme. Within the project, a web portal (<http://www.minerals4eu.eu/>), a European Minerals Yearbook, and foresight studies were delivered, and an EU Minerals Intelligence Network structure was developed. The Minerals4EU project is built around an INSPIRE compliant infrastructure that enables EU geological surveys and other partners to share mineral deposit data and knowledge, and stakeholders to find, view and acquire standardized and harmonized information on minerals. Minerals4EU delivered one of the initial building blocks of the EURMKB, covering primary raw materials in detail, as well as some information on secondary raw materials, for 12 mineral waste flows and eight commodity case studies for metals in secondary raw materials (aluminum, copper, dysprosium, indium, iron and steel, palladium, platinum and yttrium).

The ProSUM Project, Prospecting Secondary raw materials from the Urban Mine is funded under H2020 Framework Programme. The urban mine in this context consists of raw materials contained in waste electrical and electronic equipment (WEEE), end-of-life vehicles (ELVs), spent batteries, and mining wastes. The objective of ProSUM was to deliver the first Urban Mine Knowledge Data Platform (EU-UMKDP), complementing the EURMKB, whose development began in Minerals4EU.

The MICA project, Minerals Intelligence Capacity Analysis, was funded under H2020 Framework Programme. The project aimed to develop the European Union Raw Materials Intelligence Capacity Platform (EU-RMICP). This platform is a stand-alone product that will be plugged into the EU-MKDP (from Minerals4EU).

The two-year ORAMA project (Optimizing quality of information in Raw Materials data collection across Europe) started at the end of 2017. The project supports the further development of the system containing the information on the resources and production of mineral raw materials. The objective is to create a system to transfer information stored at a national level to the Raw Materials Information System

(RMIS) by DG JRC. This public service will support EU raw materials policy through the Scoreboard and Critical Raw Materials updates and background data and information.

## FUTURE GEOLOGICAL SERVICE FOR EUROPE

The EGS vision is to establish a European Geological Service (EGS, 2014). The EGS vision corresponds in its raw materials part with the aims of the Strategic Implementation Plan (SIP) of the European Innovation Partnership (EIP) on Raw Materials (EC, 2012a) – research and innovation, knowledge sharing, and international cooperation – which makes EGS an eminently suitable organization for contributing to implement the SIP.

The European Geological Service is based on three pillars: 1. Joint Research with Impact on EU Policy Level, 2. Harmonizing and sharing pan-European Geological Data (EGDI), and 3. Sharing Knowledge, Capacities and Infrastructure.

The first pillar is being implemented by 48 national and regional Geological Survey Organisations (GSOs) from 33 European countries that joined forces to develop an ERA-NET Co-Fund Action: Establishing the European Geological Surveys Research Area to deliver a Geological Service for Europe (GeoERA). GeoERA aims to optimize the use and management of the raw materials while minimizing potential negative environmental, health and societal impacts. GeoERA will:

- Address both on-shore and off-shore resources;
- Consider all mineral raw materials – metals, industrial minerals, construction materials and in particular critical raw materials; and
- Consider all parts of the value chain in the context of the Circular Economy.

Specifically, the Raw Materials Theme will contribute to the development of minerals intelligence (Minerals Yearbook and Minerals Inventory) and to innovation through the development of specific Pilot Studies, such as:

- Commodities for challenging environments and new frontiers, such as energy critical elements, energy storage, telecommunications, transport, societal well-being;
- Improving European regional geological and metallogenic knowledge;
- Improving existing genetic and exploration models; and
- Creating 3D/4D modelling and 3D predictive targeting systems;

all with a view to developing more efficient and effective exploration tools and technologies leading to the sourcing of indigenous raw materials and the development of European industry and quality of life for all citizens.

There are four projects within GeoERA Raw Materials Theme:

- Mineral Intelligence for Europe – Mintell4EU project, aims to improve the European Knowledge Base on raw materials by updating the electronic Minerals Yearbook produced in the Minerals4EU project and to extend the spatial coverage and quality of data currently in the

Minerals Inventory. The project will increase the degree of harmonization, communication and interaction between existing data platforms, with the ambition of reaching a fully operational and reliable data knowledge management system, fulfilling the European needs and taking into account the Raw Materials Information System (RMIS) of the European Union. The project will also integrate the electronic Minerals Yearbook into the Minerals4EU database, ensuring future sustainability as part of the EuroGeoSurveys-governed European Geological Data Infrastructure (EGDI), the second pillar of EGS vision. All results will be integrated into the GeoERA Information Platform.

- Forecasting and Assessing Europe’s Strategic and Raw Materials Needs – FRAME project, will build on previously and currently developed pan-European and national databases, and expand the strategic and CRM knowledge through a compilation of mineral potential and metallogenic areas of critical raw materials resources in Europe, focused on related metal associations on land and the marine environment. Secondary resources, in terms of historical mining wastes and potential by-products, will also be considered. The mineral resources will extend beyond the current EU CRM list and include also minerals and metals (e.g., lithium, copper and manganese) that are strategic for the European downstream industry in the mid- and long-term perspective.
- European Ornamental stone resources – EuroLithos project, is founded on the idea that increased knowledge of the geology, quality and history of use of natural stone in Europe will stimulate both more sustainable use of stone resources in Europe for the benefit of SME’s and our cultural heritage, and a sound land use management for the safeguarding of ornamental stone deposits. EuroLithos will result in an ornamental stone knowledge base under the umbrella of EGDI, covering harmonized spatial data on European stone resources, the atlas of resources and use, a directory of ornamental stone properties, and guidelines for valorizing ornamental stone heritage.
- Seabed Mineral Deposits in European Seas; Metallogeny and Geological Potential for Strategic and Critical Raw Materials – MINDeSEA project, addresses an integrative metallogenetic study of principal types of seabed mineral resources (hydrothermal sulphides, ferromanganese crusts, phosphorites, marine placers and polymetallic nodules) in the European Seas. The importance of submarine mineralization systems is related to the abundance and exploitation-potential of many strategic metals and Critical Raw Materials (CRM) that are necessary for the modern society development.

## CONCLUSIONS

Mineral Raw Materials underpin the societal development and Europe’s ambition for economic growth and well-being. The European Commission recognized the impor-

tance of raw materials through its Raw Materials Initiative (RMI) / EU raw materials policy in 2008. After 2008, it established a stakeholders’ platform, the European Innovation Platform on Raw Materials (EIP-RM), and provided Horizon 2020 funding, specifically through Societal Challenge 5 – Climate Action, Environment, Resource Efficiency and Raw Materials. The main objectives of the initiatives are: the security and sustainability of mineral raw materials supply from EU domestic sources and other sources (primary and secondary); and management of competing uses of the European surface and subsurface. These objectives are also included in the current European Commission policies that would be fully implemented in near future. The Mobility Package and its implementation activities (such as European Battery Alliance) and tools (including Horizon Europe) will, next to existing policies and activities, strengthen the raw materials position in an overall EU policy setting.

## REFERENCES

- BERTRAND G., CASSARD D., ARVANITIDIS N., STANLEY G. and the EuroGeoSurvey Mineral Resources Expert Group, 2016 – Map of critical raw material deposits in Europe. *Ener. Proc.*, **97**: 44–50.
- BIO by Deloitte, 2015 – Study on data for a raw material system analysis: roadmap and test of the fully operational MSA for raw materials. European Commission (EC), DG GROW, Brussels, Belgium.
- BLAGOEVA D., AVES DIAS P., MARMIER A., PAVEL C., 2016 – Assessment of potential bottlenecks along the materials supply chain for the future deployment of low-carbon energy and transport technologies in the EU. Wind power, photovoltaic and electric vehicles technologies, time frame: 2015–2030. European Commission (EC), DG Joint Research Centre, Petten, the Netherlands.
- BLENGINI G.A., NUSS P., DEWULF J., NITA V., TALENS PEIRÒ L., VIDAL-LEGAZ B., LATUNUSSA C., MANCINI L., BLAGOEVA D., PENNINGTON D., PELLEGRINI M., Van MAERCKE A., SOLAR S., GROHOL M., CIUPAGEA C., 2017 – EU methodology for critical raw materials assessment: Policy needs and proposed solutions for incremental improvements. *Resour. Pol.*, **53**: 12–19.
- CHAPMAN A., ARENDORF J., CASTELLA T., TERCERO ESPINOZA L., KLUG S., WICHMANN E., THOMPSON P., WILLIS P., 2013 – Study on Critical Raw Materials at EU Level: Final Report. Oakdene Hollins, Fraunhofer ISI, Brussels, Belgium.
- EC, 2008 – The Raw Materials Initiative – Meeting our Critical Needs for Growth and Jobs in Europe. European Commission (EC), Brussels, Belgium.
- EC, 2009 – Raw materials policy. European Commission (EC), DG Trade, Brussels, Belgium.
- EC, 2010a – Critical Raw Materials for the EU, Report of the Ad-hoc Working Group on Defining Critical Raw Materials. European Commission (EC), Brussels, Belgium.
- EC, 2010b – Europe 2020 Flagship Initiative Innovation Union. European Commission (EC), Brussels, Belgium.
- EC, 2011 – Tackling the Challenges in Commodity Markets and on Raw Materials. European Commission (EC), Brussels, Belgium.



- EC, 2012a – Making Raw Materials Available for Europe’s Future Wellbeing: Proposal for a European Innovation Partnership on Raw Materials. European Commission (EC), Brussels, Belgium.
- EC, 2012b – The Study on Data Needs for a Full Raw Materials Flow Analysis. European Commission (EC), Brussels, Belgium.
- EC, 2013a – Report from the Commission on the implementation of the Raw Materials Initiative on the implementation of the Raw Materials Initiative. European Commission (EC), Brussels, Belgium.
- EC, 2013b – Strategic Implementation Plan (SIP) of European Innovation Partnership (EIP) on Raw Materials. European Commission (EC), Brussels, Belgium.
- EC, 2014a – Report on Critical Raw Materials for the EU, Report of the Ad-hoc Working Group on Defining Critical Raw Materials. European Commission (EC), Brussels, Belgium.
- EC, 2014b – On the review of the list of critical raw materials for the EU and the implementation of the Raw Materials Initiative. European Commission (EC), Brussels, Belgium.
- EC, 2015 – Closing the Loop – An EU Action Plan for the Circular Economy. European Commission (EC), Brussels, Belgium.
- EC, 2016 – Next steps for a sustainable European future European action for sustainability. European Commission (EC), Brussels, Belgium.
- EC, 2017a – On the 2017 list of Critical Raw Materials for the EU. European Commission (EC), Brussels, Belgium.
- EC, 2017b – Raw Materials Information System (RMIS): towards v2.0 – An Interim Progress Report & Roadmap. European Commission (EC), DG Joint Research Centre, Ispra, Italy.
- EC, 2017c – Investing in a smart, innovative and sustainable Industry A renewed EU Industrial Policy Strategy. European Commission (EC), Brussels, Belgium.
- EC, 2017d – Europe on the Move: An agenda for a socially fair transition towards clean, competitive and connected mobility for all. European Commission (EC), Brussels, Belgium.
- EC, 2017e – Delivering on low-emission mobility: European Union that protects the planet, empowers its consumers and defends its industry and workers. European Commission (EC), Brussels, Belgium.
- EC, 2018a – Europe on the Move: Sustainable Mobility for Europe: safe, connected, and clean. European Commission (EC), Brussels, Belgium.
- EC, 2018b – Annex 2 to the Europe on the Move: Sustainable Mobility for Europe: safe, connected and clean. European Commission (EC), Brussels, Belgium.
- EC, 2018c – Report on Raw Materials for Battery Applications. European Commission (EC), Brussels, Belgium.
- EC, 2018d – Proposal for a decision of the European Parliament and of the Council on establishing the specific programme implementing Horizon Europe – the Framework Programme for Research and Innovation. European Commission (EC), Brussels, Belgium.
- EGS, 2014 – The Geological Surveys of Europe, for Europe - The EuroGeoSurveys vision towards a Geological Service for Europe. The publication of the EuroGeoSurveys (EGS) Strategy Task Force, Brussels, Belgium.
- PAVEL C., TZIMAS E., 2016 – Raw Materials in the European Defence Industry. European Commission, DG Joint Research Centre, Petten, Netherlands.
- REGUEIRO Y GONZÁLEZ-BARROS M., 2015 – Geological Surveys’ contribution to the EU minerals knowledge database. *Europ. Geol.*, **39**: 31–39.
- SOLAR S., DEMICHELI L., WALL P., 2012 – Raw Materials Initiative: A Contribution to the European Minerals Policy Framework. *In: Non-Renewable Resource Issues: Geoscientific and Societal Challenges* (eds. R. Sinding-Larsen, F. Wellmer). 1st ed. Netherlands: Springer Netherlands: 21–33.
- SONESSON C., DAVIDSON G., SACHS L., 2016 – Mapping Mining to the Sustainable Development Goals: An Atlas. World Economic Forum, Geneva, Switzerland.

