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## International collaboration on raw materials

# Contents



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# Foreword

*EurGeol. Vítor Correia, EFG President*

*"The peace we seek, founded upon decent trust and cooperation among nations, can be fortified not by weapons of war but by wheat and cotton, by milk and wool, by meat and timber, and by rice. These are words that translate into every language."*
Dwight D. Eisenhower

The trade of mineral resources has been with mankind since our ancestors started developing tools. There is evidence of the exchange of obsidian and flint during the Stone Age. Obsidian use shows this material was increasingly the preferred choice rather than chert for cutting tools from the late Mesolithic to Neolithic. And because deposits of obsidian were rare in the Mediterranean area, obsidian was traded at distances of 900 km[1]. Gold, silver, precious stones (for jewellery and coins), copper, tin (for bronze tools), iron ore and many other minerals were traded in all major civilizations, including Mesopotamia, Greece, Egypt, China, India and the Roman empire. Later, coal became the fuel of the industrial revolution, and the trade of coal (and soon oil and natural gas) and iron had a huge impact on transport infrastructures (ports, canals and railways), facilitating the movement of goods, people and ideas.

Trade of raw materials hasn't always been peaceful, and many wars have been fought to ensure access to energy and minerals. World War I (access to raw materials exploited in African and Asian colonies) and the invasion of Manchuria by Japan before WWII were both directly linked to raw materials' supply.

But peace can also be linked to raw materials. The Schuman Declaration, presented by the French foreign minister Robert Schuman on 9 May 1950, highlighted the importance of sharing natural resources (coal and iron) in order to *make war not only unthinkable but materially impossible*, and laid down the foundations for the creation of the European Coal and Steel Community. This was the predecessor of the European Union, awarded the 2012 Nobel Peace Prize for its contribution over six decades to *the advancement of peace and reconciliation, democracy and human rights in Europe*.

Technology has enlarged the range of raw materials used in industry applications since the birth of the European Coal and Steel Community. Nowadays, the list of raw materials used in industry encompasses a bigger share of the elements in the periodic table, and criticality assessments overlooking 54 different elements are regularly carried by the European Commission. This means that international cooperation and free trade of raw materials are paramount in tackling the expectations of a growing population. And politicians need to be aware that building national walls to protect domestic industrial production will have reverse and multiple impacts, because no country in the world has all the raw materials needed for its economic, social and environmental development in order to meet its citizens' desires for a high quality of life and enhanced well-being.

This number of the *European Geologist Journal* is about international cooperation on raw materials. Geologists are used to international cooperation, because geoscientific knowledge (like geological structures) is not limited by political borders. And we also know that beneficiation and transformation of ores into concentrates, of concentrates into metals and other semi-finished products, and of these into goods is possible through and facilitated by international trade and cooperation.

The timing of this issue couldn't be better, since the battle between those who defend greater openness to the world and those who stand for more protectionism and nationalism has reached a milestone, already with political consequences in the UK and the USA, and with increasing uncertainty in the elections to take place in France, Italy and Germany in 2017 (thus affecting 5 countries of the G7). I quoted Eisenhower at the beginning of this foreword because as an experienced military officer, he was aware that peace needs to be fortified by trade between nations. I will only dare to add that, in today's world, the agents of international trade and transformation of raw materials have the responsibility of ensuring that the natural resources being traded are exploited and transformed in a responsible and sustainable way. That is the European standard. That is the contribution of geoscientists to sustainable development and long-lasting peace.

1 Williams-Thorpe, O. (1995), Obsidian in the Mediterranean and the Near East: A Provenancing Success Story. Archaeometry, 37: 217–248. doi:10.1111/j.1475-4754.1995.tb00740.x

# Fostering International Cooperation on Raw Materials – the INTRAW Project and the European International Observatory for Raw Materials

*Diego Murguía*, Fathela Brovko, Matt Wenham, Vítor Correia and Balázs Bodo*

*In the last decade there has been a structural change in the world's mineral markets and an increase in the global demand for raw materials. Securing the domestic minerals supply in a sustainable way will be challenging to most countries. The International Cooperation on Raw Materials (INTRAW) project was launched in 2015, with the focus of mapping the national best practices and policies of five technologically advanced partner countries: Australia, Canada, Japan, South Africa, and the United States of America. Several key drivers of research, development and innovation in raw material exploration and exploitation were identified. The outcome of the ongoing mapping and knowledge transfer activities will be used as a baseline to set up and launch the European Union's International Observatory for Raw Materials as a critical new component in the EU's raw materials knowledge management infrastructure.*

*Ces dix dernières années, s'est produit un changement structurel des marchés mondiaux de substances minérales ainsi qu'une augmentation de la demande mondiale en matières premières. Garantir l'approvisionnement national en substances minérales, de manière durable, représentera un défi pour la grande majorité des pays. Le projet de Coopération Internationale pour les matières premières (INTRAW) fut lancé en 2015 avec l'objectif de dégager les meilleures méthodes nationales de mises en œuvre et d'ordre politique, propres à un groupe de cinq pays, en pointe du point de vue technologique : Australie, Canada, Japon, Afrique du Sud et Etats Unis d'Amérique. Ils ont identifié différents paramètres clés de la recherche, du développement et de l'innovation pour l'exploration et l'exploitation des matières premières. Le résultat des activités actuelles de cartographie et de transfert de connaissances sera utilisé comme point de départ pour établir et faire fonctionner l'Observatoire International des Matières Premières de l'Union Européenne en tant que composant essentiel de l'infrastructure de gestion des connaissances concernant les matières premières de l'Union Européenne.*

*En la última década ha habido un cambio estructural en el mercado de minerales a nivel globaly un aumento en la demanda mundial de materias primas. Garantizar el suministro nacional de minerales de manera sostenible será un desafío para la mayoría de los países. El proyecto de Cooperación Internacional sobre las Materias Primas (INTRAW) fue lanzado en 2015 con el objetivo de trazar las mejores prácticas y políticas nacionales de cinco países socios tecnológicamente avanzados: Australia, Canadá, Japón, Sudáfrica y Estados Unidos de América. Se identificaron varios impulsores clave de la investigación, el desarrollo y la innovación en la exploración y explotación de materias primas. El resultado de las actividades actuales de cartografía y transferencia de conocimientos se utilizará como punto de partida para establecer y poner en marcha el Observatorio Internacional de las Materias Primas de la Unión Europea como un componente crítico en la infraestructura de gestión de conocimientos sobre las materias primas de la UE.*

In the last decade a structural change has taken place in global mineral markets. The old rule of thumb – 20 percent of the world population in Europe, United States of America (USA) and Japan consuming more than 80 percent of the total minerals production – is no longer valid. With the integration of India, the People's Republic of China and other populous emerging countries such as Brazil and Russia into the world economy, today more than half of the world's population claims an increasing share in raw materials. Thus the global demand for raw materials stands at the bottom of a new growth curve. It is estimated that, under a business-as-usual scenario, by 2030 the worldwide need for raw materials will have doubled from that of 2010 (Bringezu, 2015).

Access to raw materials on global markets is one of the European Commission's priorities. Over the last decade the European Union (EU) has become increasingly aware that securing a reliable, fair and sustainable supply of raw materials is important for sustaining its industrial base, an essential building block of the EU's growth and competitiveness. This awareness was triggered by the increasing demand for unprocessed minerals and metals.

The Horizon 2020 funded project "International Cooperation on Raw Materials" (INTRAW, ***www.intraw.eu***), runs during the period 2015–2018 with the objective of mapping best practices (***Figure 1***) and boosting cooperation opportunities in raw materials with technologically advanced non-EU reference countries (Australia, Canada, Japan, South Africa, and the United States) responding to similar global challenges. The ultimate goal of the project is to set up and launch the European Union's International Observatory for Raw Materials.

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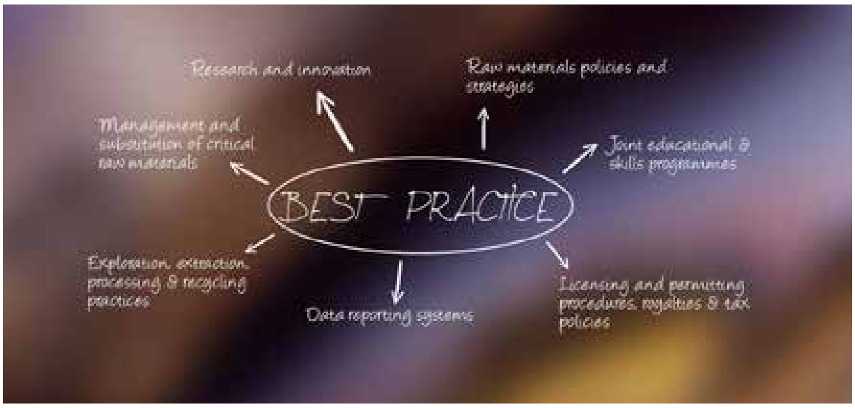


*Figure 1: Aims of INTRAW.*

The creation of the EU's International Observatory for Raw Materials will address current shortcomings in the EU's raw materials knowledge infrastructure by providing a link to the knowledge infrastructure in technologically advanced countries. It will enable better alignment of the research and innovation (R&I) activities among the individual EU members, and will leverage cooperation with third countries by boosting synergies with international research and innovation programmes.

The INTRAW project started with an integrated and holistic bottom-up approach to benchmarking the contextual environment of the reference countries with regards to the evolution of their raw materials industry and raw materials supply policies. This article presents findings from the benchmarking, crossing historical, cultural, social, legal and economical factors from the 19th century onward, and highlights factors that explain how Australia, Canada, Japan, South Africa and the USA built a competitively superior position in raw materials supply.

**Contextual analysis and key enablers of a successful mining industry: lessons from five countries**

***Research and innovation***

Since the steel-based industrial revolution of the late 1890s, the USA has joined the ranks of world leaders in innovation. Government and industry-funded institutions in the USA developed throughout the 20th century, resulting in solid research and development (R&D) infrastructure, including government-funded laboratories, high-tech profile innovation clusters like Silicon Valley, and many others. Econometric studies from the USA strongly suggest that R&D spending has a positive influence on productivity (Blanco *et al.*, 2013), with a rate of return that is likely to exceed that on conventional investments (Congressional Budget Office, 2005). After the USA, Japan ranks 2nd in the world in absolute terms of total expenditure on R&D with Canada and Australia in the 8th and 9th position; in relative terms (expenditure on R&D as a percentage of GDP in 2012), Japan ranked 5th in the world with 3.3% (after Korea, Israel, Finland and Sweden), USA 11th, Australia 15th, Canada 25th and South Africa 43th (Institute for Management Development, 2014) . The knowledge and resource base (infrastructure) in the USA and Japan has been of high importance in their transition towards a knowledge-based economy. Canada and Australia have well-established science, technology and industry systems. South Africa also has a well-developed science system, which has been developed in relative isolation due to sanctions and has been reconnected to the world's developments only since the end of apartheid.

The USA, Japan and South Africa have strong R&D cultures. USA companies are highly sophisticated and innovative, supported by an excellent university system that collaborates admirably with the business sector in R&D. Japan´s R&D culture developed during the 20th century and was led by technology transfer process from the West to Japan during the catch-up period and afterwards, when Japan took the lead in innovation. R&D in Japan is mostly (over 70%) financed by the private sector (OECD, 2015). Despite South Africa's strong R&D tradition, its gross expenditure on research and development (GERD) of 0.8% is below that of other emerging economies (HSRC, 2014), with much of the research being business driven.

The USA has an excellent track record at continuously investing in geoscientific data and related research, as these are considered critical factors enabling the development and growth of the mining industry. The information acquired and published by the US Geological Survey (USGS) is internationally considered reliable and their data and publications are amongst the most widely used around the world for mineral statistics.

Raw materials-related R&D is conducted in South Africa by public and private partners. Mintek is one of the world's leading technology organisations specialised in mineral processing, extractive metallurgy and related areas. One of the mandates of the Council for Geoscience (***http://www.geoscience.org.za/***) is to develop and publish world-class geoscience knowledge products and to render geoscience-related services to the South African public and industry.

Canada is also heavily invested in geoscientific data, but unlike the USGS, the data acquisition and related research are done by provincial geological surveys, with the data made publicly available. The mining industry has continuously invested in R&I and it has become a driving force in Canada´s new knowledge-based economy. New technologies in mining have created a circle of growth and innovation that circulates through two-way linkages between mining and the rest of the economy. A large part of the innovations in the mining industry take place in the exploration sector, with some 1,200 exploration companies located in British Columbia (the greater Vancouver area) (Marshall, 2014).

Australia has traditionally maintained a high level of investment in R&I in the mining sector. One of the most significant Australian innovations was the development of flotation, widely used in the international metal mining industry. Australia keeps pioneering R&I to increase productivity and cost control and the Pilbara region acts as the main mining innovation ecosystem. This includes testing and running automation technologies such as driverless haul trucks, automated wheel changers for haul trucks, remote train and ship loading, remotely operated drill and smart blast activities, as well as the development of a new class of tunnelling machines for underground mines.

***Education and Outreach***

During the last decade, skills shortages have been arguably the mining industry's most significant problem. Mining is undertaken in over 100 countries and it is estimated that on a global basis the formal mining sector employs more than 3.7 million workers (Zeballos & Garry, 2010). The organisational structure of a mining company generally includes senior corporate staff, managers, university-educated specialists, supervisors, and operational staff overseeing a range of skilled and semi-skilled staff and associated contractors.

Today's mining industry relies on highly skilled workers with a diverse skill set, the ability to use sophisticated technology and operate in challenging environments. It typically seeks skilled operators, graduates and technical specialists with not just mining knowledge but also digital literacy, problem solving ability and good interpersonal skills, who can work safely in both a team and individual capacity.

Mining education encompasses a wide range of education and training options that can be accessed by students seeking to enter the industry, mature entrants reskilling, in-work employees' upskilling and even those taking courses purely for interest. Universities offer a range of mining-focused undergraduate degree options around applied geology, mining engineering, mineral processing and metallurgy, as well as a raft of generic but relevant subjects in engineering, business, environment, etc.

Training for technician and administrator levels in mining related areas are usually delivered by technical colleges and training centres. These usually involve a combination of conventional teaching with placements and work-based learning, and include technical, commercial and clerical provision. Mining investment in efficiency, mechanisation and automation will push up the required skills levels and reduce the opportunities for low-skill jobs.

Volatility in the industry and increased resource nationalism, as well as demand of producer countries for local staff to take over the more senior roles, is leading to a need for rapid upskilling and loss of experienced international staff. The cyclical nature of the industry has caused endemic skills shortages followed by oversupply, which lag behind the industry cycles and result in elevated costs and loss of experience from the industry (Hagan, 2015). Employers need to consider funding, retaining and upskilling staff through the downturns, and this may require new models of employment. The MINAD project in Australia is an example of an initiative to tackle such challenges, moving beyond reactionary initiatives to counter cyclical industry requirements. In aiming to address educational issues in the mining industry, the analysis has produced a list of possible metrics to benchmark and compare EU countries against and to form the basis for action plans:

- Number of universities teaching mining/minerals geoscience
- Length of programs and quality of curriculum (including staff-student ratio)
- Number of students and demographics
- Amount of mining/minerals geoscience in secondary school curriculum
- Number of mining education organisations and their membership
- Training data and workforce shortages
- Qualification requirements
- Other metrics identified in reports by the Mining Industry Human Resources Council - Canada (MiHR), the Society of Mining Professors (SOMP) and national workforce planning exercises.

Real-time skills and employment data are not easily accessible and new methods are needed if prediction through the cycle is to be realistic. Training needs to be better aligned with industry cycles – evidence of good practice is available but there is a need for more creative solutions to in-work education and industry-education partnership arrangements.

### *Industry and Trade*

During the second half of the 20th century the international trade of raw materials – especially of metals and minerals – expanded remarkably, and consolidated as a principal driver behind the economic growth of industrial economies such as the USA and Japan. Dramatic decreases in transport and communication costs coupled with reductions in trade barriers have been the driving forces behind today's global trading system. Special mineral trade bilateral partnerships during the 20th century that still today remain very important were those of the USA-Canada and Japan-Australia.

The **USA-Canada partnership** was due to geographic proximity and similar historical cultural characteristics; the USA and Canada share a history of economic development based on the domestic use and bilateral trade of mineral resources. In 2015 U.S. exports to Canada accounted for roughly 19% of overall U.S. exports (Office of the U.S. Trade Representative, 2016); in turn, Canada's (merchandise) exports to the U.S. accounted for 77% of all exports in 2014 (Minister of Public Works and Government Services Canada, 2015).

The main enablers of the **Japan-Australia partnership** were the creation of bulk transport vessels (lowering transportation costs), the adaptation of port facilities, and the bilateral agreements on commerce and business, with the Commerce Agreement signed between both countries in 1957 (the first trade agreement of Japan after WWII). Notably since the 1960s Japan has traditionally imported strategic resources (iron ore, coal, manganese) while Australia has imported vehicles and machinery from Japan (Siddique, 2011).

In a globalised market economy, countries tend to base their minerals supply and demand on multiple partners with smaller but significant shares. The USA is a good example of changing and multiple sources for supply, combining domestic extraction and imports. The domestic endowment of natural and mineral resources was highly important in the early phases of industrialisation, but then the economy began a transformation process towards a knowledge- and services-based economy in which the availability of domestic resources became less important. Currently the USA is the world´s largest economy and consumer of natural resources, using roughly 20% of the global primary energy supply and 15% of all extracted materials (Gierlinger & Krausmann, 2012).

In Japan, the government and the mining industry have been historically closely interrelated. Japan's post-WWII high growth era and its sustained economic and industrial development were enabled by a dynamic mineral resources policy which ensured that the Japanese industry secured a stable supply of raw materials to overcome its extreme import dependency of minerals. The latter encompassed not only securing the supply of primary raw materials via agreements with countries but also direct investment by private capital in overseas mines and in exploration of Japanese offshore resources.

Nowadays the government administrative agency Japanese Oil, Gas and Metals National Cooperation (JOGMEC) is a key actor in the Japanese resources policy. With a worldwide network of 13 offices, JOGMEC leads a multi-faceted strategy and permanently supports the domestic and overseas development of the minerals industry, both primary and secondary, fostering innovation and cooperation. Such a strategy encompasses joint operations, training for experts, providing equity capital and loans and liability guarantees for metal exploration and development by Japanese companies, and conducting overseas geological surveys to help Japanese companies secure mineral interests and support their exploration projects, among others.

South Africa has also been closely related in minerals trade with Japan as a supplier of essential minerals such as chromium, manganese, cobalt, vanadium, and PGMs, of which South Africa hosts 95% of world reserves (USGS, 2016). Japan is, in fact, South Africa's sixth largest trading partner and over 100 Japanese companies have a presence there (ADB, 2016).

The *key drivers* behind the success of the domestic non-energy extractive industry in all mineral resource-rich countries were analysed. While the historical circumstances of each country differ and the mining industry evolved adapting to internal and external situations, the INTRAW project was able to identify a series of common drivers. The most important are listed below:

***Exploration phase:***

- Availability of public and reliable geoscience data
- Well-developed and dynamic exploration cluster

***Exploitation phase:***

- Politically and institutionally stable framework
- Access to land, energy and water
- Efficient permitting procedures
- Granting of the social licence
- Skilled workforce

**The role of the EU International Observatory for Raw Materials**

The Observatory will be launched before 2018, aiming at the establishment and maintenance of strong long-term relationships with world key players in raw materials technology and scientific developments. It will be part of the EC raw materials infrastructure that will remain operational after the project completion. In terms of functions the Observatory is relatively broadly defined in the INTRAW Grant Agreement as a permanent body that will ensure improved co-ordination of effective research and innovation programmes, funded research activities, and synergies with international research and innovation programmes for the EU raw materials sector

This relatively broad definition provides sufficient room to fine-tune the Observatory concept to match present and expected future requirements. The immediate support of "small-scale" cooperation, exchanges, networking and scholarships would likely generate substantial interest, whilst it will probably not result in resistance from any of the global key players. Risks to be aware of include adding to bureaucracy instead of making things easier and the possible birth of a new type of resource colonialism, with the EU taking the lead; these situations must be consciously avoided as they would result in resistance from other global players.

In the longer timeframe the Observatory is seen as an important catalyst in aggregating international research, resulting in wider availability of data, including data for basic/academic research. Industry participation in the work of the Observatory is seen as beneficial as it could lead to investment in applied research and raw materials exploration, extraction and recycling.

In terms of the project vision it has been agreed that the Observatory will not only continuously monitor cooperation possibilities but will also actively promote these through facilitating the establishment of dedicated bilateral and multilateral incentives for raw materials cooperation between the EU and technologically advanced countries outside the EU.

**Conclusions**

The global challenges being faced by the non-energy minerals industry such as skill shortages, price volatility, market distortions and supply risks, lack of social licence to operate, and others need to be approached by means of international cooperation, and not only via competition mechanisms. The historical analysis of the five reference countries has shown that bilateral trade partnerships can be a long-term source of mutual benefits for countries or regions, allowing stable economic growth and a politically and institutional stable environment attractive for investments. The key drivers of mining success have shown that countries face similar challenges but resolve these in different ways, and they can learn from each other. Results have shown that cooperation should not only be among governments, but also between governments and the industry. The close relationship of the government, its agencies and the industry in Japan is a good example. Another example is given by the constant support of the Canadian and Australian governments to the exploration sector by financing the public availability of digital data on exploration or by assigning case managers to projects in order to ensure the smooth approval of necessary permits. Further results and conclusions are available in the Country Reports of the five reference countries (see ***http://intraw.eu/publications/***).

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# Fostering the mining potential of the European Union

*Mattia Pellegrini**

*Raw materials are decisive for the growth and competitiveness of the European economy. Only looking at the metals value chain, more than 40% of the jobs and added value from the EU's manufacturing sector depend on raw materials. Therefore, in the second pillar of Raw Material Initiative, the European Commission proposed responding to the various challenges posed to extracting raw materials with the aim of reducing import-dependence while increasing resource efficiency and mitigating negative environmental and social impacts from extraction. In this context, the article presents priority activities concerning: the improvement of the EU's minerals policy framework; fostering access to mineral potential; developing public awareness, acceptance and trust (PAAT), as well as research and innovation within the EU's Horizon 2020 Research and Innovation Programme.*

*Les matières premières sont incontournables au niveau croissance et compétitivité de l'économie européenne. En considérant la seule échelle de valeur des métaux, plus de 40% des emplois et de la valeur ajoutée liée au secteur manufacturier européen dépendent des matières premières. En conséquence, pour le second volet de l'Initiative sur les Matières Premières, la Commission Européenne a proposé de répondre aux différents défis posés par l'extraction des matières premières dans le but de réduire la dépendance vis à vis des importations en augmentant l'efficacité dans la disponibilité des ressources et en réduisant le côté négatif des impacts environnementaux et sociaux générés par leur extraction. Dans ce contexte, l'article présente les activités prioritaires concernant: l'amélioration du cadre de la politique européenne pour les ressources minérales; l'accès potentiel à ces ressources qui doit être favorisé; le développement de la perception du public, de l'acceptation et de la confiance (PAAT) tout autant que la recherche et l'innovation à l'intérieur du programme européen de recherche et d'innovation Horizon 2020.*

*Las materias primas son decisivas para el crecimiento y la competitividad de la economía europea. Sólo con respecto a la cadena de valor de los metales, más del 40% de los puestos de trabajo y del valor añadido del sector manufacturero de la UE dependen de las materias primas. Por lo tanto, en el segundo pilar de la Iniciativa de Materias Primas, la Comisión Europea propuso responder a los diversos desafíos para la extracción de materias primas con el objetivo de reducir la dependencia de las importaciones y aumentar la eficiencia de los recursos y mitigar los impactos ambientales y sociales negativos de la extracción. En este contexto, el artículo presenta actividades prioritarias relativas a: la mejora del marco de la política de minerales de la UE; fomentar el acceso al potencial mineral; desarrollar la sensibilización, la aceptación y la confianza del público (PAAT), así como la investigación y la innovación dentro del Programa de Investigación e Innovación Horizonte 2020 de la UE.*

The entire progress of human civilisation is based on raw materials. Since the first industrial revolution, the use of raw materials has increased exponentially, both in quantity and type (***Figure 1***). Only in the last century, material extraction grew from 7 billion tonnes to 68 billion tonnes and projections of future trends indicate that developing regions will drive up global resource demand in the coming decades (EC, 2016). The European Union is highly dependent on raw material imports and so quite exposed to supply risk. At the global level, some European countries are at the top of the ranking of the Investment Attractiveness Index (based on the Fraser Institute's Annual Survey of Mining Companies for mining and exploration companies) (Ferguson *et al.*, 2015). Examples are Ireland (4th) and Finland (5th). As shown in ***Figure 2***, a significant number of mineral deposits have been identified within the EU surface: base metals, precious metals and critical raw materials. However, the number of exploration projects is significantly lower (***Figure 3***), indicating that that the European potential is under-explored and therefore under-exploited (EC, 2016). Furthermore, there is a consistent dependence on imports of the metals necessary in the high-tech and manufacturing sectors (for instance cobalt, platinum, rare earths and titanium) that are crucial for current and future growth (EC, 2008).

Although new mining activities are emerging, such as in Sweden and Finland, all Member States face restrictions on their domestic supplies, both in the framework of policies and as regards potential access. For instance, projects can encounter increased competition from other land uses and a highly regulated environment, as well as technological limitations in gaining access to mineral deposits. As a response, the European Commission adopted the Raw Material Initiative, an integrated strategy that since 2008 has dedicated special attention to mining's framework conditions and, since 2014, is the framework programme for R&D Horizon 2020, which finances specific projects in the European raw material sector.

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**Improving the minerals policy framework**

In order to facilitate a sustainable supply of raw materials from European deposits, it is important to have the right policy framework conditions in place. In the current sit-

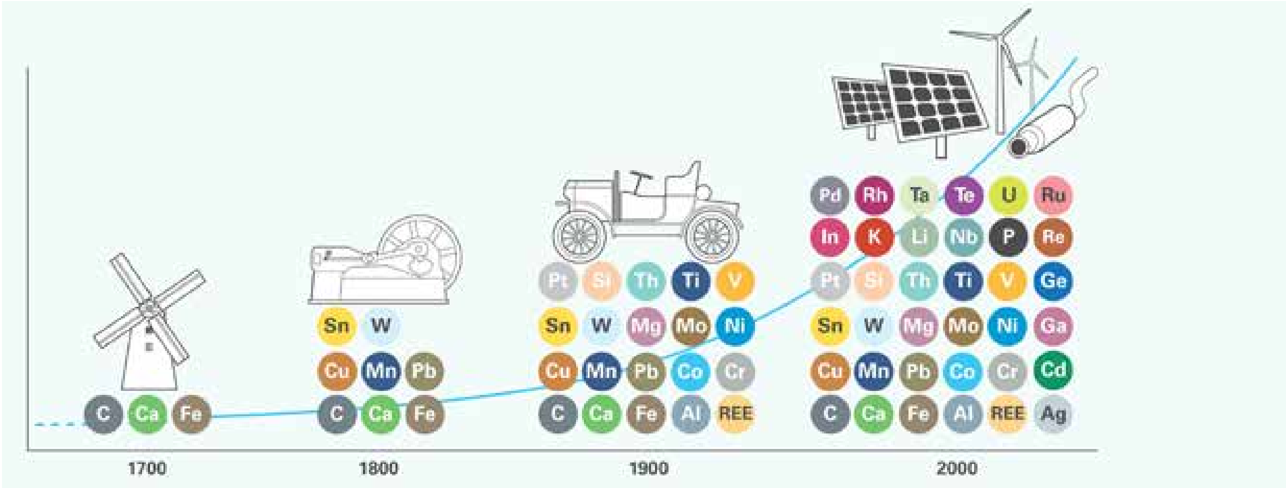


*Figure 1: Materials widely used in energy technologies (from Volker* et al.*, 2014).*

uation, there is a need for all Member States to streamline administrative conditions and smooth the permit process for exploration and extraction activities. Whilst Member States vary in their success in policy perception and investment attractiveness, as shown in ***Figure 4***, their responsibilities for minerals policies are frequently dispersed horizontally and vertically, endangering their enforcement. The permitting procedure, for instance, involves many authorities and requirements at local, regional and national levels that could overlap or enter into conflict (EIP, 2013).

For these reasons, the EU is funding research projects that indicate policy pathways to increase European competitiveness. One example is the study that has been commissioned with the title "Legal framework for mineral extraction and permitting procedures for exploration and extraction in the EU", under the acronym "MINLEX". The overall objective of this study is to provide the European Commission with a clear and detailed understanding of the legal framework, highlighting challenges and opportunities framing the Non-Energy Extractive Industries (NEEI) permitting procedures across the EU and its Member States. This information can induce further improvements in framework conditions and in the functioning of the Single Market, in order to make the investment climate more attractive to domestic as well as foreign investments. In detail, the study will provide: the screening of the European, national and regional legislation of highest relevance for the NEEI's permitting; a search for incompatibilities, inconsistencies, infringements, violations, contradictions, inconsistencies or unnecessary duplications between them, and the review of exemplary court cases which indicates reasons for delays and success rates in each Member State.

A further aspect constraining exploration and extraction activities in the EU is the complexity of their impact on the environment. Mineral activities may strongly affect wildlife and nature. This is one of the reasons that the European Union established the network Natura 2000. Stretching over 18% of the EU's land area and almost 6% of its marine territory, it is the largest co-ordinated network of protected areas in the world, designed to ensure the long-term survival of Europe's most valuable and threatened species and habitats. Natura 2000 is not a system of strict nature reserves from which all human activities are excluded but, within these areas, limited activities can be carried out, subject to certain conditions.

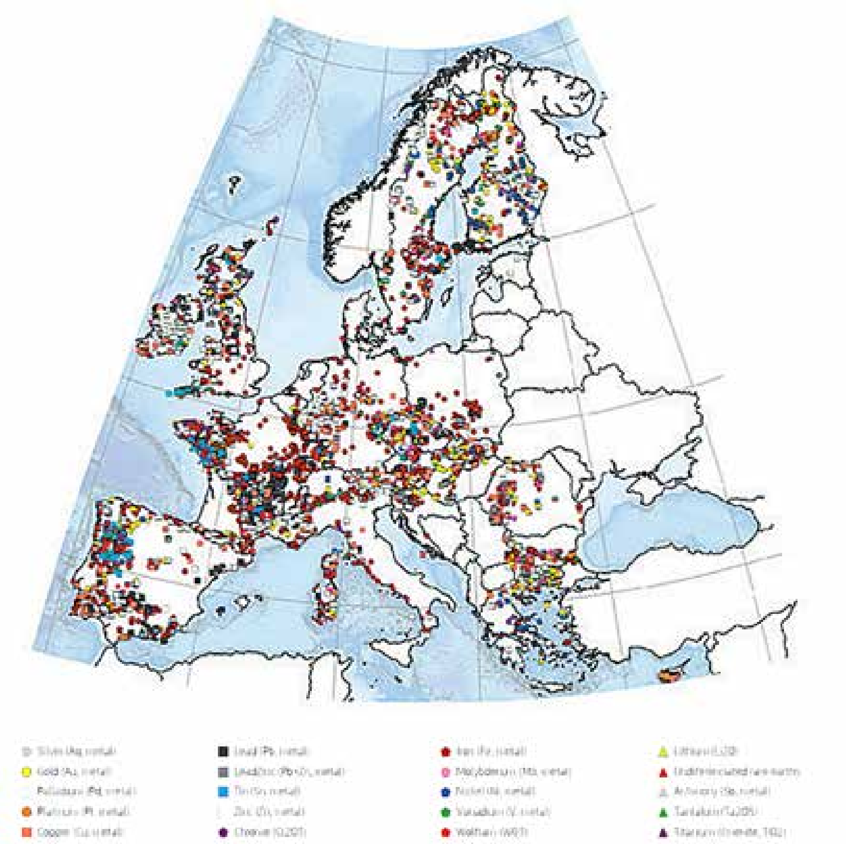

*Figure 2: Mineral deposits, occurrences and showings in the EU-28, 2010 (Source: © BRGM 2016; G. Bertrand, D. Cassard, ProMine project,* ***http://promine.gtk.fi/****, retrieved January 2016).*

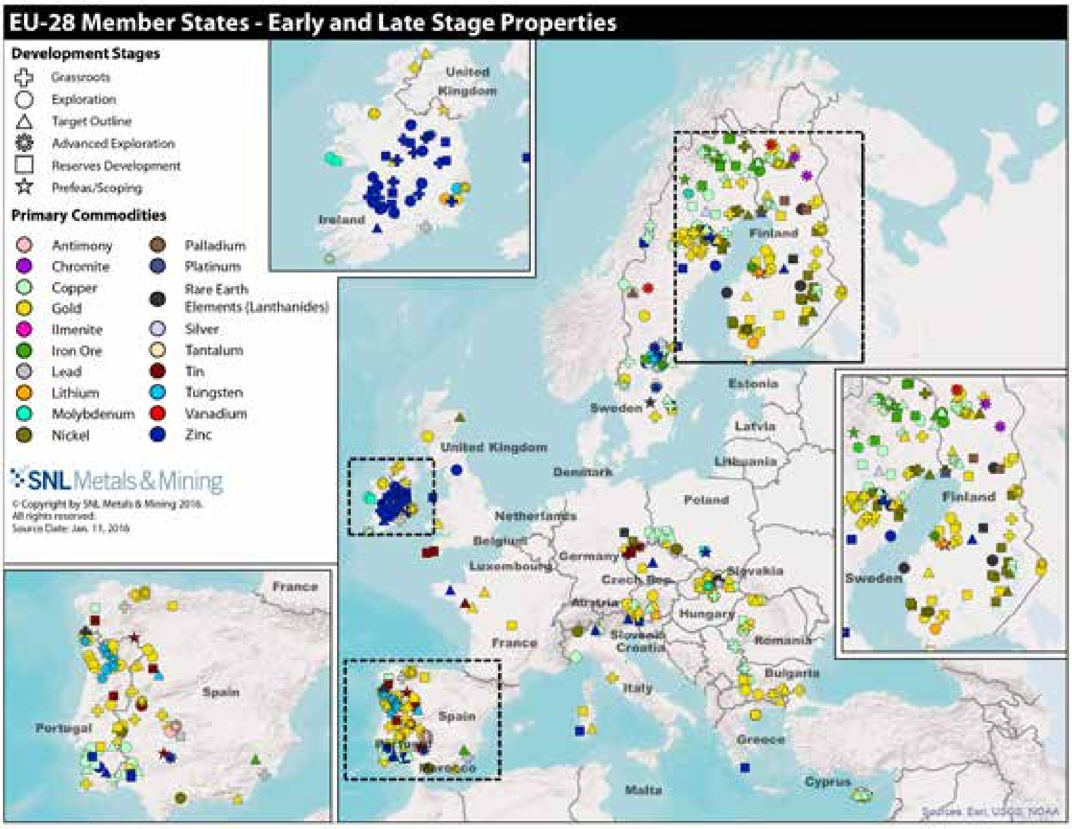


*Figure 3: Metallic mineral exploration in the EU (2014) per development stage (Source: © SNL Metals & Mining 2016).*

Accordingly, in order to clarify how to reconcile extractive activities in or near selected sites, a specific guidance document was provided for the NEEI. The "EC Guidance on undertaking new non-energy extractive activities in accordance with Natura 2000 requirements" (EC, 2010) was delivered in 2010 and encapsulates the provisions of the two EU Directives, on Habitats and on Birds. It is designed principally for use by competent authorities and developers, as well as by consultants and site managers, particularly for the implementation of Article 6 of the Habitats Directive, which determines the relationship between conservation and land use. Paragraphs (3) and (4) of Article 6 set out a series of procedural and substantive safeguards that must be applied to plans and projects that are likely to significantly affect a Natura 2000 site.

The guidance document dedicates two chapters to demonstrating how the stages of the procedure are applied and how decisions are reached on the authorisation or rejection of a plan or project, in order to avoid common causes of delay in decision-making processes, such as a lack of information or poor-quality assessments. Furthermore, the practical aim of the guidance is to promote cooperation between diverse stakeholders from within the mining sector and outside it. Although it is not legally binding, it offers the NEEI all the tools to contribute positively to the environment, including mitigation measures and the rehabilitation of extraction sites.

Each Member State has to deal with its own national minerals policy but, as part of the European Union, there are advantages such as the possibility to improve practices in the above-mentioned issues. In this context, the Commission established the ad-hoc Expert Group "Exchange of best practices on minerals policy and legal framework, information framework, land-use planning and permitting" to compare the existing Member States' raw materials policies and share their good practices, to identify gaps, make recommendations and improve these policies where needed . From the last report (AHWG, 2014), it became clear that some EU Member States do not have national minerals policies in place yet; even where they exist, these policies are not always aligned with the other policies affecting the industries. There are Member States with traditional, single, all-material inclusive specific codes for extractive activities (Germany, Austria, Hungary, France, and Spain). Elsewhere, hydrocarbons are treated separately (Romania), or geological research has a distinct law. In some Member States, aggregates are regulated by land-use planning laws (United Kingdom, the Netherlands). In a few new Member States, mining codes have no "mining" in the title, but the term "sub-surface resources" or "sub-soil" is used instead, and their content covers geo-space utilisation as well (Bulgaria, Estonia, Latvia). Finland is mentioned for interesting good-practice examples on the policy and legal frameworks, as its original definition of a national strategy has been extended to encompass an action plan. This has been developed and, based on it, both government and the NEEI will implement an agreed upon programme in order to meet ambitious national objectives by 2019, and long-term objectives up to 2030.

**Fostering access to mineral potential**

A precondition for the use of domestic sources is access to deposits. As mentioned above, European potential is underexploited and areas with a high potential could be hindered by competition from other land uses, such as agriculture, forestry, housing or industrial zones. Thus, the area available for extraction in the EU is constantly decreasing and the biggest competitors in land use, like building, can dissipate potential deposits for future use for mining activities. Therefore, with regard to land use planning and marine spatial

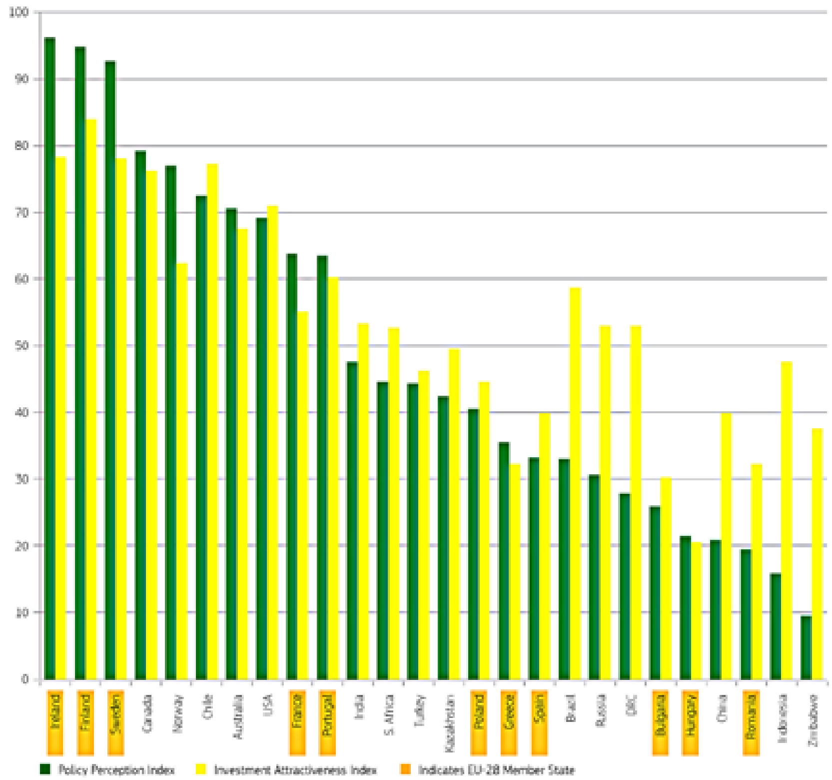


*Figure 4: Policy Perception Index and Investment Attractiveness Index (based on Fraser Institute Annual Survey of Mining Companies, 2014) (from Ferguson* et al.*, 2015) [Both indices are normalised to a maximum score of 100 (highest level of attractiveness to mining)].*

plans, the EU aims to ensure that the NEEI is considered on equal terms with all other competing sectors. This would guarantee an appropriate time frame for long-term investments in minerals extraction, processing and refining.

To this end, the importance of certain mineral deposits at each of the different levels (local, regional, national, EU) should be confirmed. Land use plans at different levels (local, regional, national) should be better co-ordinated and linked to the general rules and guidelines for minerals land use plans, and cover potential as well as current and past extractive areas. These rules and guidelines should include tools and mechanisms for forecasting the long-term supply of raw materials that are important at local, regional, national and EU levels in view of their foreseen demands.

Land-use planning procedures are long term and NEEI activities are frequently considered as a hazard for the environment, rather than as an economic activity that is only temporarily using land. Mining for non-energy minerals tends to receive a relatively low ranking compared to other land uses, such as urbanisation, agriculture, recreation, etc. (EIP, 2013). So, in 2014 the Commission proposed developing an appropriate mapping framework with the detailed definition and qualifying conditions for the concept of Mineral Deposits of Public Importance (MDoPI), covering all minerals but with stress on the occurrence of critical minerals, defining deposits of local, regional, national or EU interest and considering how to safeguard them. MINATURA 2020 is the project that answered to the proposal, with a partnership of 24 organisations from 19 countries (including three non-member states: Bosnia and Herzegovina, Montenegro and Serbia). In 2018, it will provide an agreed upon definition for MDoPI with a guidance document on how to incorporate it into mineral and land-use policies, as well as a set of qualifying conditions for a Harmonised Mapping Framework (HMF) for each type of mineral and a report on testing results in selected case-study countries. A bottom-up approach has been adopted to find the best compromise from amongst different existing protocols and standards.

**Developing public awareness, acceptance and trust**

Public acceptance is a precondition for the development of any economic activity. It is even more important for the extractive industry, given the evident environmental and social concerns at both European and global levels. Public acceptance of extractive industries in the EU compared with other economic sectors is low, meaning that much can still be done. According to surveys amongst the European general public on their trust in the commitment towards society by companies from various sectors, mining and oil & gas companies are perceived as making the least effort to behave responsibly towards society: 55% of respondents stated that companies working in mining and oil & gas do not make sufficient efforts to behave responsibly. Initiatives for corporate social responsibility (CSR) are already becoming more common and the EU has emerged as an international leader on sustainability reporting (EC, 2016).

The EU, on its side, includes in the second pillar strategies on Public Awareness, Acceptance and Trust (PAAT), designating campaigns on information and education, and promoting best-practice examples of communication for stakeholders that are particularly tailored for European conditions (such as social and cultural backgrounds and landscape integration).

Public perception can be distorted by prejudices, so preventive measures are helpful in gaining trust. Transparency and communication boost local awareness about the role of raw materials in the economy and for employment. Through reports and commitments to voluntary codes, the development of modern mining and good governance models can be explained and proved, thus increasing public acceptance (EIP, 2013). A good example is the Finnish Network for Sustainable Mining, with members from various sectors such as agriculture, forestry and nature conservation aiming to develop an open and continuous dialogue between the mining industry and its stakeholder constituency. Based on voluntary action and self-regulation, the network provides tools for planning mining activities in specific regions, issues corporate social responsibility reports and is working to develop a new sustainability standard for ore exploration.

Public acceptance is strongly linked to both the above-mentioned policy framework conditions and access to minerals potential. Open project proposals under Horizon 2020 for raw materials policy support actions including the creation of an "EU network of mining and metallurgy regions", a network aiming at improving related framework conditions, industrial competitiveness and also social aspects of mining activities. More specifically, the project should focus on the definition of guidelines for a Social Licence to Operate (i.e. the level of acceptance or approval by local communities and stakeholders of mining companies) to combine with governmental licences, communication activities and the involvement of the entire stakeholder community, including regional authorities (EC, 2016).

**Conclusions**

The three main axes presented here are included in the Raw Materials Initiative and comprise one of the three pillars on which the Raw Materials Initiative is based. In fact, actions to foster the sustainable supply of raw materials inside the European Union are included in the Second Pillar and are promoted, alongside actions of the Third Pillar, to improve resource efficiency and recycling. Similarly, they are profiled together with actions of the First Pillar to ensure a fair and sustainable global market, such as through international dialogues and diplomacy with key countries producing raw materials. The three pillars together form the basis for achieving competitiveness and growth, not only for the raw materials sector, but also for the whole EU economy.

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# The participation of the company GET s.r.o. in Czech international development cooperation projects

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*This article reports on the prospecting results and on the evaluation of the industrial mineral sources that comprise the Programme of Development Cooperation financed by the Czech government. Individual projects have been implemented in Vietnam (silica sand, limestone and feldspar for the glass industry), in Mali (dimension and crushed stone, cement raw materials, sand and gravel), in Jamaica (high-grade limestone, cement raw materials, ceramic materials and construction materials), in Belize (ceramic clay, bentonite and feldspar), in Guyana (kaolin, dimension and crushed stone) and in Afghanistan (gypsum, marble, cement raw materials, coal). The work was carried out in cooperation with the local geologists and usually it also included specialised training and workshops. Projects of this type undoubtedly are important and should be supported in the future.*

*Cet article rend compte des résultats de la prospection et de l'évaluation des sources des minéraux industriels qui font partie du Programme de Coopération pour le Développement, financé par le gouvernement tchèque. Des projets individuels ont été réalisés au Vietnam (sable siliceux, calcaire et feldspath pour l'industrie du verre), au Mali (calibration et concassage de la roche, pierres à ciment, sable et graviers) en Jamaïque (calcaire de qualité, pierres à ciment, matériaux de céramique et de construction), à Belize (argiles à céramique, bentonite et feldspath), en Guyane (kaolin, roche calibrée et concassée) et en Afghanistan (gypse, marbre, pierre à ciment, charbon). Le travail fut réalisé en coopération avec les géologues locaux et d'habitude, il s'est aussi accompagné de formation spécialisée et d'ateliers. Les projets de ce type sont indubitablement importants et devraient faire l'objet d'un soutien dans le futur.*

*Este artículo presenta los resultados de la prospección y la evaluación de fuentes minerales industriales que componen el Programa de Cooperación para el Desarrollo financiado por el Gobierno checo. Proyectos individuales se han ejecutado en Vietnam (arena de sílice, caliza y feldespato para la industria del vidrio), en Malí (piedras ornamentales y trituradas, materias primas de cemento, arena y grava), en Jamaica (caliza de alto grado, materias primas de cemento, materiales de cerámica y de construcción), en Belice (arcilla cerámica, bentonita y feldespato), en Guyana (caolín, piedras ornamentales trituradas) y en Afganistán (yeso, mármol, cemento, carbón). El trabajo se llevó a cabo en cooperación con los geólogos locales y usualmente también incluyó formación y talleres especializados. Los proyectos de este tipo son, sin duda, importantes y deberían ser apoyados en el futuro.*

The firm GET s.r.o.[1] was founded in 1993 as one of the successor companies to the Geoindustria State Enterprise. From simply carrying out geological work the company gradually expanded its activities to also include mining design, surveying, designing remediation and reclamation projects and land use planning.

Since its inception the geologists who worked within the company had made use of experience based on joint projects that had been carried out in the former Council for Mutual Economic Assistance of the socialist countries. In addition to private foreign geological projects, this experience constituted the basis for the company's subsequent activities in the area of international development cooperation.

From the onset of the new millennium, the company's geologists have been participating in projects related to international development cooperation that have been financed by the Czech Government (GET, 2016). Generally these projects are focused on:

- the evaluation of selected raw materials that are of significance for the development of the local infrastructure and industry;
- specific projects for the rehabilitation and the reclamation of sites that have been affected by mining;
- the training of state administration employees;
- the organising of lectures and courses;
- providing specialised equipment, including software, GPS, digital cameras, etc.

1 Společnost s ručením omezeným is the Czech Republic legal structure for a private limited liability company. The commercial name of a limited liability company must include the designation "společnost s ručením omezeným" ("limited liability company"), or its abbreviated form "spol. s r.o.", or "s.r.o." Approximate equivalents in the company law of some other countries are e.g. Ltd., GmbH, or SARL (from Wikipedia).

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**Afghanistan (2005-2007)**

In Afghanistan, GET s.r.o. was the principal member of the project entitled *Development aid to Afghanistan for restoring the functioning of geological institutions focusing on the utilisation of mineral resources*. Also closely involved in this project were the Faculty of Science of Charles University in Prague and the Czech Geological Survey. On the Afghan side, the project was coordinated by the Afghanistan Geological Survey, Kabul Polytechnic University and the University of Kabul.

The individual activities that were carried out during the methodological section of the project were focused on the preparation of modern manuals for the design, implementation and interpretation of the results of geological work and additionally mining and geological documentation, mine surveying work, the methodology of the EIA studies, and programmes for reducing the impacts of mining and of mineral resources. All of these procedures were applied in the field (Knésl *et al.*, 2006; Pechar, 2007).

In Chesht-i-Sharif in Herat Province, both white and grey marble of high quality was evaluated. Apart from its use as a dimension stone, it was also verified that it is suitable for the production of lime and, to a lesser extent, also of micronised limestone. In total 24 million $m^3$ of prognostic resources were estimated to be present at the site.

At the Suah Ab deposit, located in the same area, a 4,900 m long and 150 m wide body of gypsum was identified. It was estimated that there was a total quantity of 36 million $m^3$ of gypsum of varying quality to be found there.

Figure 1: On an outcrop of blue-grey marbles. Ghazag, Afghanistan.

Figure 2: An exploratory gallery on the Calaw coal seam. Kabul, Afghanistan.

Also several limestone occurrences were investigated in the surroundings of Kabul (***Figure 1***) and in the vicinity of the Jebel Seraj Cement Plant in Parwan. The methodology of the environmental impact assessment was prepared for the purpose of extracting the raw cement material. In 2016, the plant was reopened after having been closed for 20 years.

The mine surveying work, the technological surveying of the coal and the assessment of its suitability for energy production were carried out at the Calaw coal seam, which is located approximately 30 km southeast of the capital city, Kabul (***Figure 2***).

The educational section included the organising of specialised workshops and of field excursions. The main topics covered were petrology, tectonics, microscopy and geographic information systems. Several educational manuals and posters were printed, both in Persian and in Pashto. As part of this programme, Afghan experts visited the Czech Republic several times, where they trained at the Faculty of Science of Charles University in Prague.

The entire project was concluded in October 2007 with the organising of an international conference entitled *The Geology and the Mineral Deposits of Afghanistan – The first meeting concerning the rehabilitation of geological research in Afghanistan*.

**Jamaica (2001-2011)**

During its initial stage, a development assistance programme was implemented in accordance with projects that were entitled *The Development and the Industrial Application of Non-Metallic Mineral Resources in Jamaica* (2001-2005) and *The Exploitation and Processing of Industrial Minerals in Jamaica and in additionally selected CARICOM countries* (2006-2011). The work that was carried out was consistent with the priorities of the Jamaican party, which was represented by the Mines and Geology Division of the Ministry of Mines and Energy (Pechar and Štefek, 2006; Pechar *et al.*, 2011).

Of particular interest were the high-percentage limestones that are suitable for the production of white cement, lime or micro-fillers; the volcanic rocks for the production of crushed stone with skid-resistant properties; the marbles suitable for producing decorative stone; the carbonate rocks for the production of Portland cement; and clay minerals as potential raw materials for producing ceramics or as additives for cement production. At the request of the Jamaican party, testing was also carried out at selected sites of clay minerals for the production of expanded aggregate, on the properties of the red sludge that emanates from the treatment of bauxite for its potential use in industry, while evidence concerning barite and rare earths was evaluated in regard to their potential danger to the environment. In total, during the period from 2001to 2011, 43 final reports were elaborated and submitted to the Jamaican party, representing a possible basis for future exploration (***Figure 3***).

Figure 3: A field trip of Czech and Jamaican geologists in the Rio Grande area, Portland, Jamaica.

Figure 4: The presentation of the cooperation project's results in the Mines and Geology Division, Kingston, Jamaica.

Because in some instances mining and mineral processing in Jamaica is poorly planned and can have a negative impact on the environment, another important part of the programme was the introduction of a variety of methods that can be utilised for development, extraction, treatment, rehabilitation and/or reclamation. Czech geologists contributed significantly to the establishment of a geological and mineralogical-petrological exhibition at the museum of the Mines and Geology Division in Kingston, which currently is accessed primarily by the local schools and by The University of the West Indies (***Figure 4***).

**Belize (2007–2010)**

The work carried out in Belize was conducted in accordance with the development

*Figure 5: Granite outcrops in the stream of Rio On, Pine Ridge Mts., Belize.*

*Figure 6: Exploratory drilling using a hand-held Eijkelkamp auger-set in Swasey Bladen, Belize. Note the pine trees that have been bent by hurricanes.*

aid project entitled *The Exploitation and Processing of Industrial Minerals in Jamaica and in additionally selected CARICOM countries* (Pechar, 2006–2011). The Belizean party was represented both by the Ministry of Natural Resources and the Environment and the Geology and Petroleum Department (GPD).

A large area of Belize is covered by tropical forests and rainforest. Limestone, dolomite and gravel are mined to a limited extent; in recent years it is petroleum that has become the great hope. Our work was focused specifically on industrial minerals.

*Figure 8: White bentonite from Spanish Lookout, Belize, the drilling core placed on plastic foil.*

*Figure 9: Pure bentonite clay from Spanish Lookout, Belize.*

Prospecting work for feldspar was carried out in the central and western parts of Belize, focusing specifically on the granite massif of the Mountain Pine Ridge (***Figure 5***). Evaluated were the white-burning ceramic clay resources located in Swasey Bladen, materials that are suitable for tiles and colour-ware clays that are suitable for the manufacture of stoneware and of coarse pottery (***Figures 6 and 7***). The applicability of raw materials for foundry and, more recently also for other uses, such as for the production of mineral litter, was verified at the bentonite deposits located in Spanish Lookout (***Figures 8, 9***). The dolomite deposits located in the Stann Creek District were investigated for their main features in regard to quality and quantity (Tvrdý and Pechar, 2014).

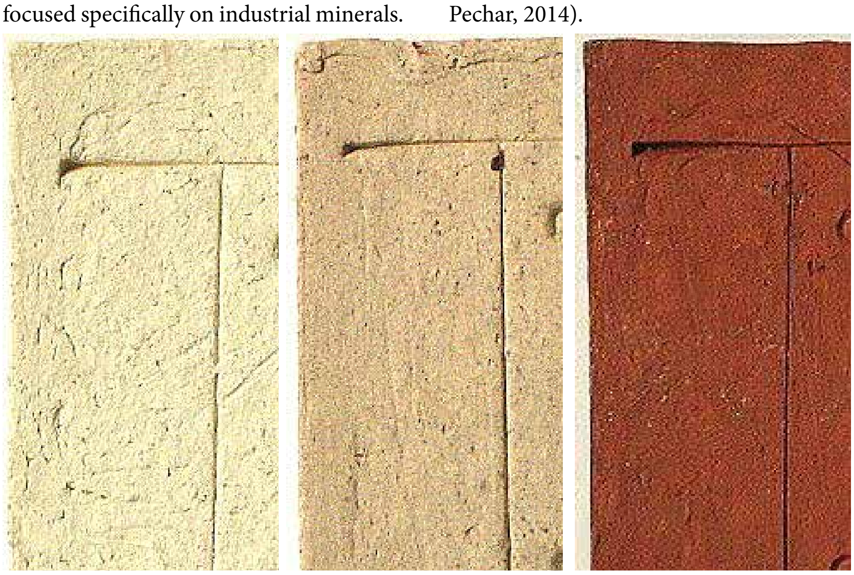

*Figure 7: Laboratory-fired samples of ceramic clays from Swasey Bladen, Belize.*

**Guyana (2006–2008)**

Work in Guyana was implemented in accordance with the same development aid project as that which was in operation in Belize (Pechar, 2006–2011). The scope of this work was based on the development objectives and priorities of the partners from the Guyana Geology and Mines Commission (GGMC).

Guyana is the largest of the CARICOM States; the majority of its land surface is covered by tropical forest. Primarily mined there are bauxite and gold, while hopes are also placed in the exploration for oil that is taking place along the coast. The main objective of our work was to carry out a geological and technological evaluation of potential sources of selected non-metallic raw materials: kaolin, silica sand, dimension stone, aggregates and feldspar sands.

Deposits of kaolin are found in areas in which bauxite was formerly mined and also those in which, in their excavated areas, the heads of kaolinitic eluvia of Precambrian granites or of fluvial relocated kaolinitic clays were exposed. The raw material is suitable for conventional methods of use (paper and ceramic industries), and also for such new applications as the production of metakaolin or of white refractories.

**Mali (2008–2012)**

The project entitled *Evaluation of the resource potential of the building materials of Mali for material support for the development of the local infrastructure* was focused on a comprehensive assessment of basic building materials from selected areas of the country (Lhotský *et al.*, 2012). An integral feature of the project was the capacity building of the partner organisation DNGM (Direction Nationale de la Géologie et des Mines).

The results of the project —which mainly operated in Bamako, the urban capital – were highly positive. The thoroughly verified Kirina deposit of sand and gravel, with an area of more than 2 km$^2$ and more than 6.4 million m$^3$ of indicated resources of high quality raw materials suitable for the production of concrete or mortar, represents a very important deposit, the lifetime of which is estimated to be approximately 25–30 years (***Figure 10***).

The survey that was carried out verified the industrial importance of the identified deposits of the building stone (dolerite) in the Sokolombougou area (***Figure 11***). The assessed resources of over 70 million m$^3$ are usable in full, given favourable deposit and hydrogeological conditions, the small

*Figure 10: Hand-held drilling taking place on the banks of Niger. Kirina, Mali.*

*Figure 11: On the dolerite outcrop. Sokolombougou. Mali.*

thickness of the overburden, the favourable technological quality of the raw material and its suitability for use and the absence of any conflicts of interest.

**Vietnam (2006-2014)**

The first development aid project that was implemented by our company under the auspices of the Czech Ministry of Industry and Trade was approved for the period of 2006–2010 under the title *Acquisition of a raw material base for industrial use in the glass industry in the southern area of central Vietnam*. Its main objective was to verify and to evaluate the resources of silica sands and of other minerals (feldspar, kaolin) and, additionally, to carry out pilot studies regarding any necessary adjustment(s) to the raw materials, to make plans for the development of a mining process, including proposals for the redevelopment and the revitalisation of the already excavated areas and for the evaluation of the impact of the anticipated mining projects on the environment.

The geological work led to the discovery of a commercially significant deposit (more

*Figure 12: Sampling of silica sand. Phong Dién, Vietnam.*

than 50 million tons of explored reserves) of silica sand located in the Phong Dién district in the province of Thua Tien Hué and several other potentially significant deposits of kaolin located in the Phu Tho province (***Figure 12***).

In 2011, the GET Company won a grant from the Czech Development Agency (CDA) for the provision of professional training for Vietnamese Geological Survey GDGMV's specialists in Hanoi and for students attending the Technical University in Hué City. The main objective was to familiarise the Vietnamese participants with the application of modern methods of deposit exploration, mine design, mine surveying and EIA.

In 2012–2014, on behalf of the CDA, the GET Company implemented the project entitled *The Development of the Glass Industry in Central Vietnam*. The main objective of this project, in addition to the assessment of the economic potential of the local raw materials, was to strengthen the technical and professional skills of the partner organisations (Tvrdý *et al.*, 2014). The principal result was defining three raw materials that are suitable for use in the glass industry in the province of Thua Tien Hué: i.e. feldspar in Bot Do, limestone in Thuong Quang, and dolomitic limestone in Phong Xuan (***Figures 13–15***).

**Conclusions**

In this article the authors would like to point out the benefits of geological topics in regard to developing international cooperation. The examples shared above clearly demonstrate that these topics:

- contribute significantly to the development of the infrastructure;
- enable the starting up of new localised production fields;
- support sustainable economic growth;
- enhance the "capacity building" of government authorities in the use of the mineral resources sector;
- significantly improve the manner of management of natural resources.

In our opinion the management and evaluation of mineral resources have a rightful place in such programmes (Pechar and Tvrdý, 2016). Unfortunately, the current Czech development strategy pushes this topic into the background; thus, valuable opportunities for aiding development may be lost.

*Figure 13: Fieldwork in the Phong Xuan limestone deposit, Vietnam.*

*Figure 14: Checking the chemistry of limestones using a XRF-spectrometer. Phong Xuan, Vietnam.*

*Figure 15: Evaluation of the field works. The Phong Dién District, Vietnam.*

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# Internationalisation in Mining Engineering at Clausthal University of Technology

*Dr.-Ing. Elisabeth Clausen* and Univ.-Prof. Dr.-Ing. Oliver Langefeld*

*Securing the supply of raw materials in an efficient, economically-feasible, environmentally-friendly and socially-accepted manner is a global concern and challenge. For coping with these challenges in such a global economy, internationalisation in teaching and research plays an increasingly important role. For several years, the Institute of Mining at Clausthal University of Technology (Germany) has pushed forward internationalisation in the field of Mining Engineerinag, for example by establishing an international, English-speaking study programme "M.Sc. in Mining Engineering" and by building up cooperation structures with renowned universities in Europe, Africa, the USA, South America and Asia, as well as by fostering international research collaborations. The article gives an overview of successfully implemented structures, programmes and initiatives as well as current activities for fostering internationalisation in the field of Mining Engineering at Clausthal University of Technology.*

*Sécuriser l'approvisionnement des matières premières de manière efficace, et économiquement viable, en préservant l'environnement et l'adhésion sociale nous concerne globalement et représente un défi. Pour faire face à ces défis dans un tel environnement économique global, l'internationalisation de l'enseignement et de la recherche joue un rôle d'importance croissante. Depuis plusieurs années, l'Institut des Mines de l'Université de Technologie de Clausthal (Allemagne) à fait avancer l'internationalisation dans le domaine de l'Ingénierie minière, par exemple, en établissant un programme d'étude en langue anglaise "M.Sc. en Ingénierie Minière" et en développant des structures de coopération avec les meilleures Universités en Europe, Afrique, aux USA, en Amérique du Sud et en Asie, sans oublier d'encourager les collaborations internationales au niveau de la recherche. L'article présente à la fois un panorama des structures, programmes et initiatives mises en place avec succès et les activités actuelles pour encourager l'internationalisation dans le domaine de l'ingénierie minière à l'Université de Technologie de Clausthal.*

*Garantizar el suministro de materias primas de manera eficiente, económicamente factible, respetuoso con el medio ambiente y socialmente aceptable es una preocupación y un reto mundial. Para hacer frente a estos retos en una economía global, la internacionalización de la enseñanza y la investigación juegan un papel cada vez más importante. Durante varios años, el Instituto de Minería de la Universidad de Tecnología de Clausthal (Alemania) ha impulsado la internacionalización en el campo de la Ingeniería de Minas, por ejemplo mediante el establecimiento de un programa de estudio internacional en ingles "M.Sc. en Ingeniería de Minas" y mediante la construcción de estructuras de cooperación con universidades de renombre en Europa, África, Estados Unidos, América del Sur y Asia, así como mediante el fomento de colaboraciones internacionales en investigación. El artículo ofrece una visión general de las estructuras, programas e iniciativas implementados con éxito, así como las actividades actuales para fomentar la internacionalización en el campo de la Ingeniería de Minas en la Universidad de Tecnología de Clausthal.*

Due to the high dependency of the European industry on the international market, the secure accessibility and availability as well as sustainable supply and use of raw materials is one of the EU`s central societal challenges for the next centuries. The raw material sector is inherently international as a result of economic, social, geological and geopolitical factors. In combination with the increased importance of knowledge and information, the internationalisation of higher education has also become increasingly important in recent years. Europe, Germany and Clausthal University of Technology have a long mining tradition and long-term experience in the development of mining engineering education systems in an international environment. For several years, the Institute of Mining at Clausthal University of Technology has pushed forward internationalisation in the field of Mining Engineering.

Based on the definition of Knight (1994), internationalisation in this context is addressed as the "process of integrating an international/intercultural dimension into the teaching, research and service functions of the institutions." International and intercultural aspects and elements form an integral part in the continuous development of our academic programmes, research and scholarly collaborations, as well as in extracurricular activities. After an introduction to Clausthal University of Technology, this article will give an overview of examples of successfully implemented structures and programmes as well as current activities for fostering internationalisation at the Institute of Mining at Clausthal University of Technology. The activities described will mainly focus on the area of education; additionally specific emphasis will be put on the description of recently running DAAD-International Study and Apprenticeship (ISAP) programmes with Namibia University of Science and Technology, the University of Pretoria, South Africa, and Pontificia Universidad Catolica del Peru in Lima before the article concludes with a summary and outlook.

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**Clausthal University of Technology**

Today's Clausthal University of Technology (CUT) was founded in 1775 as a mining academy. During its history, the Royal School of Mines (1864) broadened its focus and covers today within the framework of research and study programmes the whole range from Raw Materials to Material Sciences, through Mechanical and Process Engineering to Economics, Computer Science and Advanced Electronic Waste Recycling. CUT's main interdisciplinary research areas are "Sustainable Energy Systems", "Raw Materials Supply and Resource Efficiency", "Innovative Materials and Processes for Competitive Products", and "Open Cyber-Physical Systems and Simulation"; more than 50% of the faculty are acting in raw materials related research areas. The university has a well-established network of regional, nationwide and international industrial and academic partners along the whole value chain of raw materials. Currently, approximately 5,000 students are enrolled at Clausthal University of Technology in 13 B.Sc. and 18 M.Sc. Programmes. With about 1,400 international students (30%) and around 20% of its faculty coming from abroad, CUT is considered as one of the most international universities in Germany. The university has around 150 co-operation agreements with universities and research facilities worldwide and ranks number 2 in terms of incoming students among all German universities within the IAESTE (International Association for the Exchange of Students for Technical Experience) programme. A variety of activities regarding international and intercultural aspects, for example language courses, certification on intercultural competence or administrative support for student exchange and staff mobility, are offered by the International Center Clausthal. The University runs several student laboratories and a Research and Teaching Mine in cooperation with the World Cultural Heritage Rammelsberg, a former ore mine with more than 1,000 years of production. Good teaching in an international and intercultural environment with the integration of competence-oriented, student-centred innovative teaching and learning approaches is important for CUT (Clausen, 2015). To this end, the Centre for Higher Education offers a Professional Certificate in Teaching and Learning in Higher Education as well as a variety of different courses in higher education and personal coaching.

**Integration of the International Dimension in Academic Programmes and Activities**

For integrating the international dimension in Mining Engineering related activities and programmes at the Institute of Mining at Clausthal University of Technology, a process-oriented approach has been strategically performed during recent years. In the process-oriented approach "emphasis is placed on the concept of enhancing and sustaining the international dimensions of research, teaching and service. Integration is key to the process and strategies which focus on both academic activities as well as organisational factors are central to achieving a successful and sustainable integration of the international dimension." (Knight, 1999, p. 23). The following overview and description will focus on international[1] programme strategies including three major categories: academic programmes, research and scholarly activities and extra-curricular activities.

***Academic Programmes***

To integrate an international and intercultural dimension into curriculum development and the teaching and learning process, Clausthal University of Technology switched completely in 2014 from a German-speaking to a fully English-speaking course in Mining Engineering, thus attracting more international students. This study programme – with currently about 90% of students from outside Germany – is highly international and intercultural. In addition, the overall curricula as well as course content and teaching/learning concepts were geared towards these changing requirements and expected working areas of the future graduates. Moreover, the Institute of Mining fosters student and staff mobility through the implementation of exchange programmes, for example the ISAP Programme, by offering summer research internships, by inviting and including visiting lecturers from industry and other universities into the courses and by developing cooperation with mining universities from leading mining countries as well as emerging countries. Examples of recently signed agreements are those with the Indian School of Mines (Dhanbad, India), China University of Mining and Technology (Beijing, China), the University of Dar-es-Salaam (Dar-es-Salaam, Tanzania) and the National Technical University of Kazakhstan (Almaty, Kazakhstan). Alongside with agreements on the general exchange of students and credit transfer, the establishment of double degrees is intended. Through the programmes of the International Centre Clausthal, i.e. language courses or courses on intercultural competence, the students are well prepared for studying or working in an international and intercultural environment. Academic programmes are linked with current research activities through final-year thesis work.

***Research and Scholarly Activities***

This category comprises all international activities related to research, research collaborations and the dissemination of research results. In accordance with this issue, Clausthal University of Technology (CUT) has been developing strategic partnerships along the whole value chain of raw materials with regional, national and international partners. For instance CUT is a partner in the German Resource Research Centre (GERRI) as well as a core partner in the EIT KIC Raw Materials allocated to Co-location Centre CLC West. CUT is contributing so far to the objectives of the KIC with activities in Up-Scaling, Network of Infrastructure, Wider Society Learning and PhD/Master Education related to primary and secondary resources as well as substitution of critical raw materials in products. Through these strategic partnerships, international research as well as education cooperation and collaboration are fostered and significantly enhanced. In addition, research results are regularly published in international journals and presented at international conferences and seminars. What is more, through the worldwide professional network SOMP – Society of Mining Professors - members have the opportunity of exchanging ideas and developing fields of collaboration annually.

***Extra-Curricular Activities***

"Extracurricular activities can be an effective way to internationalise the total educational experience of both domestic and international students and help to bring a comparative perspective to the classroom" (Knight, 1999, p. 25). Therefore, the Institute of Mining has been supporting student activities, clubs and associations through various ways. An example is the newly founded association Minex-Clausthal e.V., which was founded by Mining Engineering students of the Institute of Mining. Minex is the first SME (Society for Mining, Metallurgy & Exploration) Student Chapter in Germany. Their main objective is to enhance the educational experience of the students by:

- ***Encouraging*** the improvement of their technical and soft skills through the presentation of their research

1 *International* in this context means *non-European countries* or *non-EU partner*.

work in international seminars and conferences;

- ***Creating*** opportunities for effective relations between the students and raw material industry, attending on-site tours and solving real study case projects;
- ***Shaping*** the future together with the faculty, industry and alumni by building a strong professional network.

Intended activities are, among others:

- Development of industrial contacts and field trips;
- Establishment of study groups and tutoring;
- Participation in international mining games;
- Participation in the SME international student mine design competition.

**International Study and Apprenticeship Programmes (ISAP)**

Since 2011 the Institute of Mining has run different "International Study and Apprenticeship Partnerships" (ISAP), which is a programme of the German Academic Exchange Service (DAAD) and funded by the Federal Ministry of Education and Research. The objective of this programme is the development of long term and sustainable institutional cooperation structures between partner universities. During the programme, sustainable structures related to credit and grade transfer, curricula and course enhancement as well as additional activities for fostering student and staff mobility are to be developed. Partners in these programmes have been and are leading mining universities from Namibia (Namibia University of Science and Technology), South Africa (University of Pretoria) and Peru (Pontificia Universidad Católica del Peru). In addition to featuring different cultural backgrounds and languages, each of the partner university countries is famous for its mining industry, culture and special characteristics. For example, South-Africa is famous for the deepest ore mines of the world (around -4,000 m) and its related challenges, while Peru is famous for the highest mines in the world (+4,000 m) and a variety of minerals and mining activities. Germany, on the other hand, is famous for its deepest and high-performing hard-coal mining operations as well as for high standards in Mine Health and Safety and environmental protection.

The programmes comprise both student and staff exchange. During the exchange students from both partner universities usually spend one semester studying at the partner university. Alongside with intercultural experiences, the specific objectives for the students are the enhancement of their professional competence in an international environment and the development of sustainable networks, as well as improvement in their language proficiency and personal competences. During staff exchange, lecturers are invited to both partner universities to give courses with country- and research-specific topics. This means that students not participating in the student exchange also have the opportunity to strengthen their professional knowledge. In addition, lecturers thus have the opportunity to meet in person on a regular basis and discuss potential future activities. An overview of the programmes and key figures are given in ***Table 1***.

***Statements from students studying abroad:***

Jason Henriquez, M.Sc. Mining Engineering, spent one semester at the University of Pretoria (UoP) in 2016:

*"(…) what I learned with all my experiences in different countries and continents is that living and studying abroad helps me to open my mind to new concepts and cultures, giving me the opportunity to test my perceptions and habits that until then I did not know that I had. This experience of studying abroad for one semester in Africa helped me to understand and absorb different approaches on how to see things and issues and how to solve them in ways that I never thought was possible. Moreover, I think that one of the most important personal developments that a person can have is the enhancement of their soft skills, their social skills, and the only way to improve them is to involve yourself in different social scenarios where you learn to identify, behave and react with the people that surround you, and studying and living abroad in another country and continent gave me a unique opportunity to improve this skill."*

Raoul Schmitt, B.Sc. Energy and Raw Materials, spent one semester at Pontificia Universidad Católica del Peru (PUCP):

*"In 2014 the ISAP Programme gave me the opportunity to spend a semester at the Pontifical Catholic University of Peru (PUCP) in Lima. Studying at one of South America's top universities was a great experience for me, since there is a big number of interesting courses and plenty of cultural activities to choose from. I studied in the mining engineering faculty and really enjoyed the courses I had chosen, not only due to their interesting practical content, but also because of the great support given by the experienced lecturers. Although Spanish as the main teaching language was sometimes challenging, with the help of my fellow students I was able to improve my speaking skills and managed to receive all the credits I needed for my German university. In addition, Peru is a very diverse country, rich in nature and culture and therefore offers exciting opportunities for travelling, apart from university life. I would recommend the ISAP Programme to anyone who is interested in intercultural learning experiences and willing to put some personal effort into expanding one's horizon."*

*Table 1: CUT's International Study and Apprenticeship Partnerships.*

| *Partner* | *Financial Support* | *Period* | *Main activities* |
|---|---|---|---|
| *Namibia University of Science and Technology (formerly: Polytechnic of Namibia (PoN)), (Windhoek, Namibia)* | *DAAD, Federal Ministry for Economic Cooperation and Development* | *2011–2013* | • *PoN => CUT: 3 students per year*<br>• *CUT => PoN: 3 students per year;*<br>• *10-week lecture per year from CUT => PoN* |
| *University of Pretoria, (Pretoria, South Africa)* | *DAAD, Federal Ministry of Education and Research* | *2012–2016* | • *UoP=> CUT: 7 students in total*<br>• *CUT => UoP: 12 students in total*<br>• *2 visiting lecturers per year* |
| *Pontificia Universidad Católica del Peru (Lima, Peru)* | *DAAD, Federal Ministry of Education and Research* | *2013–2015* | • *PUCP => CUT: 3 students per year*<br>• *CUT => PUCP: 3 students per year;*<br>• *2 visiting lecturers per year* |

**Summary and Outlook**

For securing the supply of raw materials in an efficient, economically feasible, environmentally friendly and socially accepted manner, internationalisation in Mining Engineering higher education is becoming increasingly important. Clausthal University of Technology, with its long term tradition in mining engineering education, is pushing forward with a strategical process of integrating an international and intercultural dimension into teaching, research and service functions. The current article highlights examples of successfully implemented structures and programmes as well as current activities for fostering internationalisation at the Institute of Mining related to academic programmes, research and scholarly work and extra-curricular activities. As internationalisation is a dynamic process, emphasis will be placed on the further enhancement and improvement of existing programmes and activities as well as the development of new innovative approaches.

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# European Geological Surveys cooperating on Raw Materials

*EurGeol Gerard A. Stanley PGeo**

*The Geological Surveys of Europe under their umbrella organisation EuroGeoSurveys (or EGS) have being cooperating in addressing the challenges facing Europe with respect to raw materials. Since the publication of the Raw Materials Initiative by the European Commission in 2008 and the inclusion of Societal Challenge 5 (Climate action, environment, resource efficiency and raw materials) in the European Union's programme for research and innovation to create new growth and jobs in Europe (Horizon2020), EGS has participated in a number of projects which aim to address the European Union Raw Materials Knowledge Base (EURMKB). The main projects in which EGS has been involved include Minerals4EU (Minerals Intelligence Network for Europe), ProSUM (Prospecting Secondary raw materials in the Urban mine and Mining wastes) and now MICA (Mineral Intelligence Capacity Analysis). This article will summarise the work and achievements of these important projects and the international cooperation which facilitated their realisation.*

*Les Services géologiques européens, sous la bannière de l'Organisation EuroGeoSurveys (ou EGS) coopèrent en répondant aux défis qu'affronte l'Europe dans le domaine des matières premières. Depuis la publication, en 2008, de l'Initiative "Matières Premières" par la Commission européenne et l'inclusion du Défi Sociétal 5 (impact climatique, environnement, sécurisation de la ressource et matières premières) au sein du programme de l'Union européenne pour la recherche et l'innovation, pour créer de la croissance et de l'emploi en Europe (à l'Horizon 2020), EGS a participé à un nombre de projets dont l'objectif est d'élargir le niveau de connaissance des matières premières pour l'Union européenne (EURMKB); Les projets principaux pour lesquels EGS a été impliquée incluent les projets Minerals4EU (le réseau européen d'information sur les ressources minérales), ProSUM (recherche de matières premières secondaires sur site urbain et déblais miniers) et aujourd'hui MICA (Analyse discriminatoire de l'information en matière de substances minérales). Cet article a pour but de résumer le travail et les acquis issus de ces projets importants ainsi que la coopération internationale qui a facilité leur réalisation.*

*Los Servicios Geológicos de Europa bajo su organización paraguas EuroGeoSurveys (o EGS) han estado cooperando para abordar los desafíos que enfrenta Europa con respecto a las materias primas. Desde la publicación de la Iniciativa Materias Primas por la Comisión Europea en 2008 y la inclusión del Desafío Social 5 (Acción climática, medio ambiente, eficiencia de los recursos y materias primas) en el programa de investigación e innovación de la Unión Europea para crear nuevo crecimiento y empleos en Europa (Horizon2020), EGS ha participado en una serie de proyectos destinados a abordar la Base de Conocimiento de Materias Primas de la Unión Europea (EURMKB). Los principales proyectos en los que ha participado EGS son Minerals4EU (Minerals Intelligence Network para Europa), ProSUM (Prospección de materias primas secundarias en la mina urbana y en los residuos mineros) y ahora MICA (Mineral Intelligence Capacity Analysis). Este artículo resumirá el trabajo y los logros de estos importantes proyectos y la cooperación internacional que facilitó su realización.*

During the early part of this century the European Union (EU) and its industry faced challenges in the sourcing of raw materials, which are an essential building block for the EU's growth and competitiveness. Sectors depending on access to raw materials, such as the construction, chemicals, automotive, aerospace, machinery, equipment, and renewable energy industries, have a combined added value in excess of €1,000 billion and provide employment for some 30 million people across Europe.

The European Commission responded by developing **'The raw materials initiative (RMI) — meeting our critical needs for growth and jobs in Europe'** as a Communication from the Commission to the European Parliament and the Council (EC, 2008). This forms the basis of European Strategy on Raw Materials. The strategy covers all raw materials used by European industry except materials from agricultural production and materials used as fuel. In addition, a Commission expert group — the Raw Materials Supply Group (RMSG), with representatives from EU countries, European Economic Area countries, EU candidate countries, and organisations representing stakeholders – industry, research and civil society – advises the Commission and oversees the implementation of the RMI.

The Commission also regularly publishes a list of **critical raw materials (CRM)** for the EU which are deemed to be important to European industry and threatened by supply considerations. The most recent iteration of this was published in 2014 and included 20 raw materials. The next iteration of the CRM list is due to be published in 2017.

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**European Innovation Platform on Raw Materials**

An overarching initiative to meeting the challenges which Europe faces is the inclusion of the stakeholders in a sector to address the challenges which it faces. This is achieved through the European Innovation Partnership (EIP) Scheme. EIPs operate across the whole research and innovation chain, bringing together all relevant stakeholders at EU, national and regional levels in order to:

1. foster research and development efforts;
2. coordinate investment in demonstration and pilot activities;
3. anticipate and accelerate any necessary regulation and standard development; and
4. facilitate the rapid commercialisation of innovations or developments.

*Table 1: Summary of the Strategic Implementation Plan of the European Innovation Platform on Raw Materials: Pillars, Priority Areas, Action areas and No. of Actions.*

| Pillar | Priority Area | Action Area | No. of actions |
|---|---|---|---|
| ***TECHNOLOGY*** | ***I.A. Research and innovation coordination*** | *I.1. Improving research and innovation coordination* | 4 |
| | ***I.B. Technologies for primary and secondary raw material production*** | *I.2. Exploration* | 2 |
| | | *I.3. Innovative extraction of raw materials* | 5 |
| | | *I.4. Processing and refining of raw materials* | 3 |
| | | *I.5. Recycling of raw materials from products, buildings and infrastructure* | 3 |
| | ***I.C. Substitution of raw materials*** | *I.6. Materials for green energy technologies* | 4 |
| | | *I.7. Materials for electronic devices* | 2 |
| | | *I.8. Materials under extreme conditions* | 2 |
| | | *I.9. Applications using materials in large quantities* | 2 |
| ***NON-TECHNOLOGY*** | ***II.A. Improving Europe's raw materials framework conditions*** | *II.1. Minerals policy framework* | 12 |
| | | *Ii.2. Access to minerals potential in the EU* | 7 |
| | | *II.3. Public awareness, acceptance and trust* | 4 |
| | ***II.B. Improving Europe's waste management framework conditions and excellence*** | *II.4. Product design for optimised use of (critical) raw materials and increased quality recycling* | 3 |
| | | *II.5. Optimised waste flows for increased recycling* | 4 |
| | | *II.6. Prevention of illegal waste shipments* | 2 |
| | | *II.7. Optimised material recovery* | 2 |
| | ***II.C. Knowledge, skills and raw materials flows*** | *II.8. EU raw materials knowledge base* | 6 |
| | | *II.9. Possible EIT knowledge and innovation community* | 3 |
| | | *II.10. Optimised raw material flows along value chains* | 3 |
| ***INTERNATIONAL*** | ***III. International cooperation*** | *III.1. Technology* | 6 |
| | | *III.2. Global raw materials governance and dialogues* | 5 |
| | | *III.3. Health, safety and environment* | 1 |
| | | *III.4. Skills, education and knowledge* | 4 |
| | | *III.5. Investment activities* | 6 |

The **European Innovation Partnership on Raw Materials (EIP-RM)** is a stakeholder platform that brings together representatives from industry, public services, academia and NGOs. Its mission is to provide high-level guidance to the European Commission, Member States and private sector on innovative approaches to the challenges related to raw materials.

The EIP-RM played a key role in the development of Europe's response to the challenges faced by the raw materials sector by developing its **Strategic Implementation Plan (SIP)** (EIP-RM, 2013). This plan identified specific objectives and targets as well as priority areas and actions. The SIP included 95 concrete actions organised into 7 Priority Areas and 24 Action Areas (***Table 1***).

Within the Non-technology pillar of the SIP, Priority Area IIC lists three Action Areas, of which **Priority Area II.10 EU raw materials knowledge base (EURMKB)** is the most pertinent to the present discussion. In summary, these actions envisage the development of a minerals database and infrastructure for Europe to include:

1. Structured data from databases; an
2. Non-structured data (reports, theses, articles, statistics, maps, images, video and other materials).

All of these actions are amenable to international cooperation between the various stakeholders, including Geological Surveys. Especially relevant to European Geological Surveys, however, is the collection and collation, homogenisation and amalgamation of data and then the dissemination of information on Europe's geology and mineral deposits.

### Raw Materials in Horizon 2020

**Horizon 2020 (H2020)** is one of the European Union's funding mechanisms 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 which 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).

### EuroGeoSurveys

**EuroGeoSurveys (EGS)** is the representative organisation of the Geological Surveys of Europe. It comprises 34 national Geological Surveys working across the continent of Europe. Its mission is:

*To provide public Earth science knowl-*

*edge to support the EU's competitiveness, social well-being, environmental management and international commitments.*

EGS pursues activities that lie exclusively in the public interest or in the interest of public administration, that will benefit from the combined and coordinated expertise of its members and that are in the direct interest of the European Union and/or of the European Free Trade Association.

The EGS vision is to establish a common European Geological Knowledge Base and to provide a Geological Service for Europe. The EGS vision corresponds with the aims of the SIP of the EIP-RM – research and innovation, knowledge sharing and international cooperation – which makes EGS an eminently suitable organisation for contributing to the realisation of the SIP.

EGS carries out its work through the operation of eight Expert Groups, one of which is the Mineral Resources Expert Group (MREG). The MREG competes on an equal basis with other organisations responding to Calls from the EU, such as those of the Framework and H2020 Programmes. EGS 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 will compete on 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 sector. In this article I will cover three of these projects, namely **Minerals4EU, ProSUM** and **MICA**.

**Minerals4EU**

The Minerals4EU project, coordinated by the **Geological Survey of Finland (GTK)** and comprising 32 partners, was funded through FP7 with a European Union contribution of approximately €2 million. The project ran for two years and was completed in August 2015. Within the project a web portal, 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 minerals information.

The results of the study are accessible through the project website – ***http://www.minerals4eu.eu/index.php#*** with the results displayed in four distinct areas of the website: Data repository on minerals in Europe; Map viewer; Minerals Yearbook; and the Foresight Studies (***Figure 1***). 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 twelve mineral waste flows and eight commodity case studies for metals in secondary raw materials (aluminium, copper, dysprosium, indium, iron and steel, palladium, platinum, yttrium) – see the 'data search' part of the Minerals Yearbook for these reports. An example of the type of data available for waste flows is given in ***Figure 2***.


*Figure 1: Minerals4EU portal (http://minerals4eu.brgm-rec.fr/) showing the four areas of entry to the EUMKDP – Date search, Map viewer, Minerals Yearbook and Foresight studies.*

A feature of Minerals4EU is the **harvesting system**. The harvesting system is an automated system whereby individual geological surveys dedicated Minerals4EU databases are 'contacted' every month to supply updated information to the Minerals4EU Knowledge Data Platform. In this way the system continues to live past the end of the project. In addition, a **permanent body** has been set up (incorporated in Belgium) which will oversee the continuation of the minerals intelligence system into the future.

**Prospecting Secondary raw materials from the Urban Mine (ProSUM)**

ProSUM is Latin for 'I am useful'. The project is funded under H2020, commenced in 2015 and is due to be completed in 2017. The project is coordinated by the **WEEE Forum** and comprises 17 partners of whom 5 are individual geological surveys as wells as EGS. In addition, 12 geological surveys under the umbrella of EGS will contribute data as linked third parties. The EU is contributing some €3 million to the project. The urban mine in this context consists of raw materials contained in four waste streams: waste electrical and electronic equipment (WEEE); end-of-life vehicles (ELVs); spent batteries; and mining wastes. The project website is ***http://www.prosum-project.eu/***

The objectives of ProSUM are:

1. To deliver the first **Urban Mine Knowledge Data Platform (EU-UMKDP)**, complementing the EURMKB, whose development began in Minerals4EU (***Figure 3***). The EU-UMKDP will develop:

a. dedicated 'Urban Mine' database of

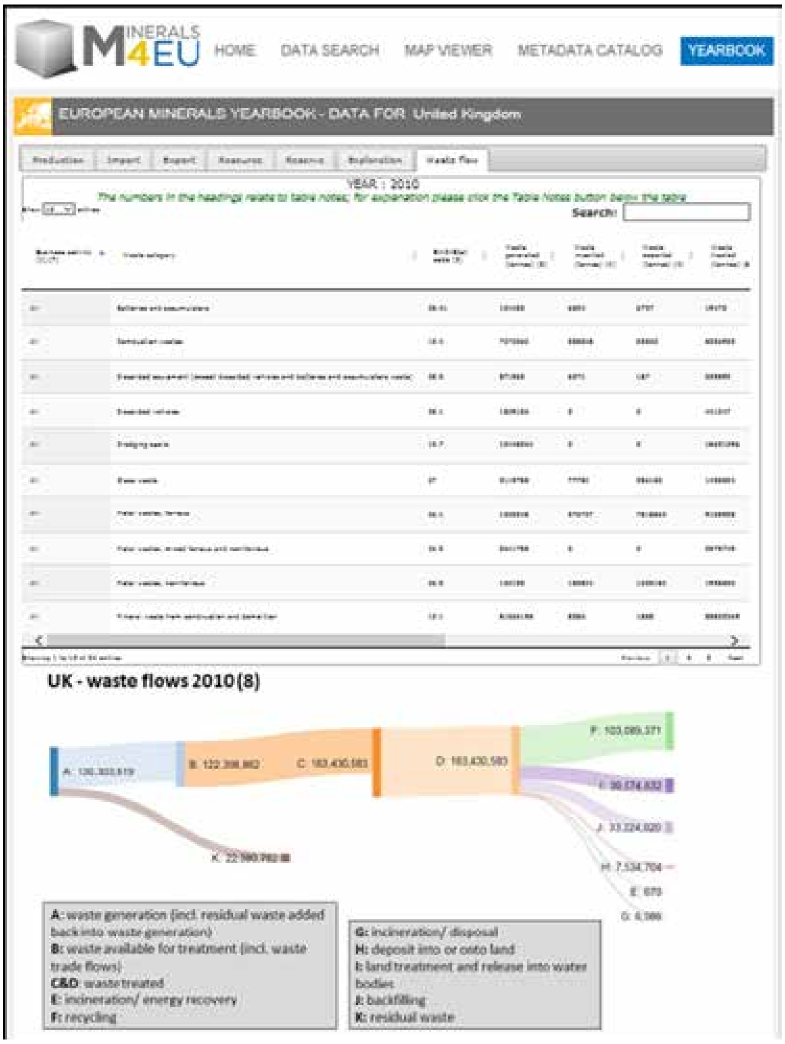


*Figure 2: An image from the Minerals4EU portal showing waste flows for the United Kingdom for different waste streams.*

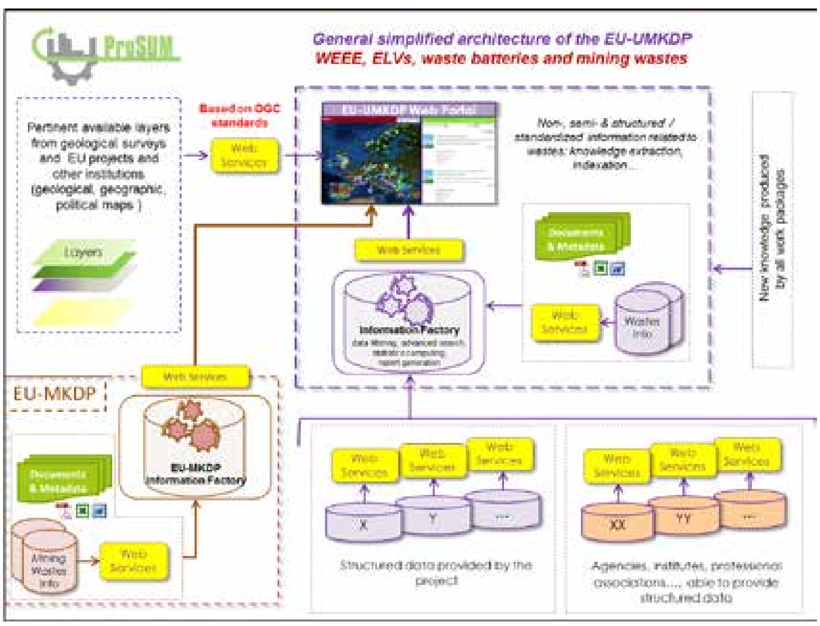


*Figure 3: The generalised simplified architecture for the ProSUM EU-UMKDP (Figure 2.1 in Technical annex to the ProSUM proposal).*

all available data and information on products and composition, and stocks and flows, including the characterization of related wastes;

b. a primary and secondary raw materials database, accessible through the Minerals4EU Knowledge Data Platform;

c. the basis for improving Europe's raw material supply, with the ability to accommodate more wastes in future; and

d. a user friendly interface providing access to data and intelligence on mineral resources from extraction to end of life products, with the ability to reference all spatial and non-spatial data.

2. To provide **harmonised data** to allow stakeholders to improve the management of these wastes and enhance the resource efficiency of collection, treatment and recycling, thus providing:

a. interoperable data on products and waste in stock, waste flows, the nature of the waste and the materials and elements which they contain; and

b. protocols and methodologies to update the EU-UMKDP and to make future data comparable and interoperable.

3. To create an Information Network that will:

a. address a wide range of end users, including the recycling industry, producers and producer compliance schemes, and policy makers;

b. allow partners to provide and use data and to create an inventory of waste streams with a high potential to serve as a source of CRMs; and

c. identify how data should be presented and organised for the wide range of stakeholders to ensure it meets their needs.

**Minerals Intelligence Capacity Analysis (MICA)**

The project is funded under H2020, commenced in December 2015 and is due to be completed in January 2018. The project is coordinated by the Geological Survey of Denmark and Greenland and comprises 15 partners, of whom 6 are individual geological surveys and EGS. In addition, 15 geological surveys under the umbrella of EGS will contribute data as linked third parties. The EU is contributing some €2 million to the project. The project website is ***http://mica.eurogeosurveys.org/***

The MICA project brings together experts from a wide range of disciplines in order to ensure that Raw Materials Information is collected, collated, stored and made accessible. The overall aim is to develop a system which is capable of answering mineral raw material queries. The project will develop the **European Union Raw Materials Intelligence Capacity Platform (EU-RMICP)** to address this goal.

The project will develop an Expert system based on "fact sheets" and "flow sheets" on topics related to raw materials. Fact sheets are domain-specific descriptions of methods (or tools), models they are implementing and the data they need (along with their sources), whereas "flow sheets" can be considered to be "recipes" that describe what fact sheets should be used for, as well as how they should be combined and in what sequence to obtain answers to specific/complex questions. The EU-RMICP will be a stand-alone product that will be plugged into the EU-MKDP (from Minerals4EU). In this regard, the MICA project will complement Minerals4EU. The main objectives of MICA are:

1. identification and definition of stakeholder groups and their Raw Material Intelligence (RMI) needs;
2. determination of appropriate methods and tools to satisfy stakeholder Raw Material Intelligence needs;
3. consolidation of relevant data on primary and secondary raw materials;
4. investigation of (Raw Material Intelligence) options for European mineral policy development;
5. development of the EU-RMICP integrating information on data and methods/tools with a user interface capable of answering stakeholder questions; and
6. linking the derived intelligence to the EU-MKDP developed by Minerals4EU.

Domains and concepts will be defined for

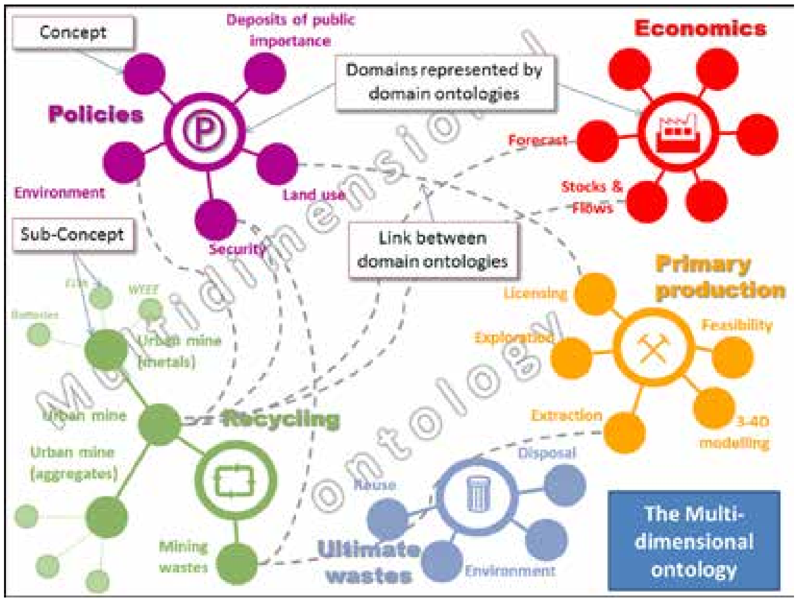


*Figure 4: The generalised simplified architecture for the ProSUM EU-UMKDP (Figure 2.1 in Technical annex to the ProSUM proposal).*

the major issues related to mineral exploration and development, such as mineral deposits, environmental impact, social impact, land use planning etc. These will be linked through an ontology (a formal naming and definition of the types, properties, and interrelationships of the entities covering a particular topic – in this case mineral raw materials).

An original feature of the MICA project will be the development of a Dynamic Decision Graph (DDG). The DDG will be an ontology-based graphical user interface which will be specially developed to answer queries from any user (***Figure 4***). Navigating within the DDG will allow the end user to select the concepts of interest; during the selection process concepts not of interest will be removed, leading to a natural selection of fact and flow sheets ranked by relevance.

## Concluding remarks

In conclusion, this paper has attempted to illustrate the cooperation achieved through the use of EU funds, and specifically FP7 and H2020 funds, which have enable cooperation to take place between national geological surveys and other partners across Europe and beyond. The results could not have been achieved without international cooperation. The information contained in the EURMKB could not have been accumulated by a single country on its own. This knowledge base will be added to in the coming years by the incorporation of data on secondary raw materials, thus extending the knowledge base to the entire value chain, through the international cooperation of partners in the ProSUM project. Finally, a new way of looking at minerals intelligence is being developed by the collaboration of experts from many countries which will enhance the experience of the user in arriving at solutions to questions in a novel and user friendly manner through the MICA project. No one organisation or country has a monopoly on expertise related to mineral raw material and it is only through collaboration and teamwork that we will be able to enhance the lives of our citizens.

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# Dimension Stones, a unique and attractive sector for international institutions and private investors

## Outcomes from the *International Conference STONECHANGE 2016* as a first step for the necessary future international cooperation

*Marco Cosi* and Piero Primavori*

*The dimension stones industry represents a very unique sector and a key asset for most Western and developing countries, with well-known historical sources and new and potential sources in high demand for the international market. However, most international cooperation programmes and initiatives do not often consider dimension stones in their interventions, mainly because the industry and its characteristics are not well known.*
*This contribution points out the main issues regarding the dimension stone industry and its absolute need to:*

- *to undergo a fast and modern process of sustainable development;*
- *to begin a necessary awareness action toward international institutions, in order to be in a position to develop cooperation programmes.*

*It also reports on the outcomes of the STONECHANGE 2016 International Conference, which tried to create discussions on these two issues.*

*L'industrie de la pierre de taille représente un secteur très particulier et un avantage clé pour la majorité des pays développés, en tenant compte des sites historiques bien connus et de la forte demande du marché international à partir de nouveaux sites potentiels. Cependant la plupart des programmes de coopération et d'initiatives internationales considèrent rarement la pierre de taille comme un sujet d'intervention, principalement parce que l'industrie et ses caractéristiques ne sont pas bien connues.*
*L'article souligne ici les questions principales concernant l'industrie de la pierre de taille et son apport incontournable pour:*

- *se conformer à un processus rapide et moderne de développement durable;*
- *initier une démarche de prise de conscience nécessaire, en faveur des institutions internationales, pour être capable de mettre en œuvre des programmes de coopération.*

*L'article fait également le point sur les résultats de la Conférence internationale STONECHANGE 2016 qui a essayé de lancer le débat sur les deux questions précédentes.*

*La industria de piedras ornamentales representa un sector muy singular y un activo clave para la mayoría de los países occidentales y en desarrollo, con yacimientos históricos y nuevos, y con alto potencial de demanda en el mercado internacional. Sin embargo, la mayoría de los programas e iniciativas de cooperación internacional no suelen considerar las piedras de ornamentales en sus injerencias, principalmente porque la industria y sus características no son bien conocidas.*
*Esta contribución señala las principales cuestiones relativas a la industria de la piedra ornamental y su absoluta necesidad de:*

- *someterse a un proceso rápido y moderno de desarrollo sostenible;*
- *iniciar una acción de sensibilización necesaria hacia las instituciones internacionales, a fin de estar en condiciones de desarrollar programas de cooperación.*

*También informa sobre los resultados de la Conferencia Internacional STONECHANGE 2016, que trató de crear debates sobre estas dos cuestiones.*

In general, international conferences and workshops are mainly organised to bring together experts and stakeholders of different industries or sub-sectors, to discuss new ideas or theories or to exchange information, data and views on new aspects and trends of that industry or area.

In the case of STONECHANGE 2016 (***www.stonechange2016.com***), the first international dimension stone conference about the future trends of the industry and the absolute need to find a path towards its necessary sustainable development, the objective of the event was much wider and ambitious: sustainable development and international cooperation.

STONECHANGE 2016 took place in the famous marble hub of Carrara (Italy) on the 16-17th June 2016 with 100 participants from 18 different countries of all continents; it was organised by IMM Carrara, AlpiConsult Stones, the Pan European Resources and Reserves Reporting Committee (PERC) and the European Federation of Geologists (EFG), with the patronage of the European Federation of Stone Association (Euroroc) and the National Council of Italian Geologists.

STONECHANGE 2016, among other objectives, had the main aim to attract the interest of international institutions and the private sector on some key issues for the future "survival" and development of the sector:

- sustainable development: a must!!
- international cooperation: private-private and private-institutional
- sectoral modernisation
- sustainability
- standardisation
- international standard reporting and the figure of the Competent Person in the construction materials industry
- ethical conduct issues: in mining, processing and trading
- awareness action toward policy

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makers, sectoral governance actors and private and institutional stakeholders
- "sowing seeds" for an EU coordinated legislative framework to govern a modern sustainable sector, with very particular and unique features
- EU financial tools to support the mining industry
- new opportunities to develop historical stone districts, some of them still producing stone products very much in demand in the international market, but also stone sectors in developing countries; this by mutual international collaboration.

Dimension stones (DS), although not included in the category of "Strategic Minerals" as defined by the European Union Programmes and Initiatives (e.g. RMI, EIP, etc.), belong, to the target group of Raw Materials considered officially by the European Commission, together with industrial minerals and construction materials. Dimension stones are supported by several initiatives and programmes supporting the development of the EU mining sector and international cooperation (see the ***EU Raw Material Initiative webpage***).

The stone industry has represented and still represents a key asset for most European countries and societies, with well-known historical source districts and famous attractive material that are in increasing demand in the international market (***Figure 1***). Moreover, the same is true for other world regions, including developing and in-transition countries, which, although far behind in relation to western countries – have the opportunity to take the right direction for successful sustainable development of the industry. This will certainly bring medium and long-term benefits to the local economy, environment and society.

DS represents a very unique sector in the mining scenario, with its own particular rules, approaches and evaluation, that needs

*Figure 1: Open pit marble mine in Carrara – Good management: controlled environmental impact and successful marketing (photo G. Milazzo)*

to improve its innovation in exploration, evaluation and mining for its necessary long term sustainable development (see ***EFG Magazine N. 39 , May 2015***).

The uniqueness of the sector is well explained by the following examples:

- Although seriously affected by the crisis, the DS sector has been continuously growing, on a worldwide scale, for 60 years.
- Unlike gold, or silver, or copper or some industrial minerals, each granite or each marble is different from the others; this makes their individual evaluation (technical, economic, social) necessary, case by case. Moreover DS evaluation and consequently DS resources-reserves estimation cannot be made starting from chemical analysis, but mainly by considering the market quality and related value, which is often subjective.
- DS materials appear not to be indispensable (not strategic!), but, with few exceptions, they are (after all, we are surrounded by walls, floors, stairs, squares, etc.). As matter of fact, they convert into indispensable goods when the lifestyle of a country starts to improve.
- Primary raw resource may be almost everywhere. Unlike metallic and base minerals, which are mainly connected to specific geologic settings, a "common" limestone or an "ordinary" granite may really be everywhere.

Anybody who intends to work in, govern and support this particular industry, at any level, must know the very specific characteristics of the sector and the rules driving it. International cooperation institutions must also be aware of the sector's features and regulations.

The world is changing, and thus its priorities, market rules and living practices; new key issues have entered into our everyday life such as environmental sustainability and ethical conduct, both more and more demanded by Western markets and societies and probably soon to be demanded in other countries, too. Any industry must have these trends in mind and find ways to meet them.

Moreover, international co-operation programmes and projects, both institutional and private, need to take into consideration this quick change, by supporting also developing countries and making the local industries aware of these changes in international societies and markets. If the local stakeholders want to export, they have to know that it is not enough to have an attractive material consistently produced, but they must also begin to comply with social, ethical and environmental requirements of the importing markets.

STONECHANGE 2016, had, and we hope will still have in future editions, the ambitious goal to contribute to the "rescue" of the dimension stone Industry in the EU and in general all over the world, mainly based on a short-to-medium-term strategy for the sustainable development, modernisation and conscious involvement of governance institutions both in Western and developing countries.

Furthermore, the organisers hope that this type of event could begin a new trend of international cooperation among institutions, companies and associations of both sides (developed and developing countries). In particular, following the present crisis of most of the "classic" mining industry (mainly base metals, coal, uranium, etc.) arising from the global economic-industrial crisis and for other environmental and social reasons, the STONECHANGE 2016 Conference focused on the development of the so- called *"low value minerals"* (or, as named by UN institutions "neglected minerals"): construction materials, "low value" industrial minerals and dimension stones, although the third group does certainly not include real low value materials! (***Figure 2***).

These materials and minerals should also represent a perfect "instrument" to build up the local regional markets in developing and in transition countries (e.g. the African, Caribbean and Pacific Group of States (ACP), Middle East and Latin American countries); this can be done through the creation and development of the local private sector and rural communities and through meeting local domestic regional market demand, driven by the high improvement and growth of the construction sectors in these countries.

In July 2015, a €13.1 million capacity building programme named the *ACP-EU Development Minerals Programme* (ACP-EU DMP) was launched, considering exactly these goals. The programme supporting the development of the so-called "neglected minerals and materials" is co-financed by the EU and UNDP, and implemented by the UN Programme (see ***webpage in the references***).

The ACP-EU DMP is in line with the 17 Sustainable Development Goals (SDGs), "otherwise known as the Global Goals, which represent a universal call to action to


*Figure 2: UNDP -* ACP-EU Development Minerals Programme *website – Particular focus on construction materials and dimension stones.*

end poverty, protect the planet and ensure that all people enjoy peace and prosperity (***Figure 3***). These 17 goals build on the successes of the Millennium Development Goals, while including new areas such as climate change, economic inequality, innovation, sustainable consumption, peace and justice, among other priorities. The goals are interconnected – often the key to success on one will involve tackling issues more commonly associated with another" (from UNDP website).

The programme supports the small-scale mining and quarrying private sector, public institutions and communities in the Africa, Caribbean and Pacific Group of States in the "neglected" minerals and materials mentioned above. It will provide assistance in promoting knowledge exchange to increase the sector's productivity, improve mining, processing and market management, adhere to national and international environmental, ethical and health standards, and prevent conflict through effective community relations.

The UNDP EU-ACP Programme was present at STONECHANGE 2016 with a group of 20 participants representing 10 ACP countries. The group also participated in the other two international cooperation capacity building events organised during the "Stone Week" in Carrara between 15 and 20st June 2015:

- a training course organised by PERC, AlpiConsult Stones and IMM Carrara on Mineral Standard Reporting titled *"Best practice for Assessment and Reporting of Exploration Results, Mineral resources and Minerals Reserves"* (15 June 2016) and
- a second training course on *"Dimension Stones and other Construction Materials Quarry Management"* (18-20 June 2016).

It is possible to affirm that STONECHANGE 2016, in addition to the main objective to keep alive the Western quarry industry through modern and innovative sustainable development, has also really started a new phase of international cooperation North-South, based on the necessary new vision that the only way to develop the small-mining/quarrying sector is to aim towards sustainable development together with the innovation and development of local-regional markets in developing countries, too.

During the conference a one-and-a-half-day plenary session took place devoted to presentations; six main sessions included 29 presentations, introduced by international key-speakers from 11 different countries.

The six sessions covered the following issues:

**SESSION I: Institutional Programmes and Initiatives to support the necessary sustainable development of the quarrying industry.**

**SESSION II: International Reporting Standards in the Mining Industries – Standards for public reporting of exploration results, mineral resources, and mineral reserves - A new entry: the Natural Stones Industry.**

This session in particular regarded the key issue of Mining Project Evaluation and Resources/Reserves Reporting Standards, very commonly used in the "Classic" Mining Industry, but not yet used much in Dimension Stones Quarrying projects, for various reasons (e.g. the cultural background of DS players, small size of DS companies, low investment for exploration and official valuations, etc.).

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**SESSION III: Governance and Policymaking for a new sustainable natural stone sector in the EU and worldwide. Seeking a coordinated and harmonized way to manage, regulate, and support the sector, taking into consideration the different mining, environmental and social characteristics of various countries and districts.**

The session, open to local and central institutions, administrators and policymakers as well as to private sectoral stakeholders, included case histories, experiences and new plans to govern and support the NS industry in some of the main EU historical districts. The session was open also to experiences outside of the EU.

**SESSION IV: Technical Innovation – Innovative technologies for a more sustainable modern DS industry. Key support to increase its sustainability and performance.**

The session aimed to introduce experiences in the design and use of new modern technologies, in the exploration, mining and processing areas (***Figure 4***), addressed to more sustainable (financial and environmental) production of natural stone products. It also introduced new mining and processing technologies, methods and equipment, new methodologies for field data collection, exploration and selective low-impact mining and processing.

**SESSION V: Sustainability - Selective Mining, Ethical Conduct and Waste Management are the next future priorities for a new sustainable Dimension Stone industry.**

The financial and socio-environmental sustainability of natural stone projects is the key to future operation of the NS industry. In current economic and social conditions, this is vital and also urgent for the developed countries, although also the developing countries and those in transition must work towards the same goal as soon as possible.


*Figure 3: The 17 sustainable development goals (Source: UNDP website).*

*Figure 4: Innovation and technology: left - Multiwire block cutter (photo P. Primavori); right - underground marble mining (photo G. Milazzo).*

In this section all issues to reach this desirable necessary goal were discussed and related case histories, lessons learned, and new proposals were presented:

- Quarry and processing waste management and re-use;
- Pilot projects concerning the "environmental & social and ethical conduct mark" to be officially accepted in the very near future in developed markets;
- New methodologies and other tools to assist NS project sustainability concerning the environment, society and economy;
- Any other issue that will be considered interesting to reach this critical goal for the future world society.

**SESSION VI: Attractive Materials and Quarries in EU and in the world: an opportunity of investment and development both for EU and overseas companies.**

The development of a new modern DS sector also depends on the availability of high class materials, to attract the interest and finance of investors and final end users.

In this final session particular new material and product investment opportunities from the most important EU stone districts and all over the world were introduced and discussed. New and unfamiliar grass-roots and operating quarry projects were described by various local companies, sponsors and consultants, as well. New materials and quarries from EU and all over the world were also described that are looking for international support, partners and or investors willing to establish sustainable business.

The event certainly highlighted some critical problems affecting the small mining and quarrying sector with particular regards to the dimension stones sector, justifying the efforts made to organise such a particular and unique conference.

In particular, the very low participation of EU dimension stones companies (only three!), confirmed that most of them are not interested in or not fully aware about the present situation of the industry in Europe or about the absolute need for a quick drastic turn to sustainable development and that the conference was organised at the right time. This is needed to avoid a short-term collapse of the small mining and quarrying sector in the EU and in other Western developed countries.

On the other hand, not surprisingly, international institutions and related programmes and initiatives were present (e.g. the EU, UN and others). This certainly is a good sign for future international cooperation in the Industry.

Another group that was not well represented was local (country and regional) governance institutions and policy makers, who should be the main drivers and regulators of this new development trend. Finally, we also regret the low participation of central and country-level regulators and policy makers, who should be the first to understand the characteristics and rules of the quarry industry in order to be in a position to regulate and manage the sector with a new modern view.

It is to be hoped that this type of event, as well most other international and national institutions and related initiatives regarding the small mining and quarrying sectors – and especially those concerning dimension stones and other construction materials – will be focused on this key issue, with the main aim being to help these industries to survive and modernise. This will contribute to the necessary future sustainable development of the mining industry in all its areas and aspects.

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# Stepping up the international cooperation for the sustainable supply of raw materials

*Dina Carrilho**

*ERA-MIN is a pan-European network of R&I funding programmes in the non-energy and non-agricultural raw materials sector that has established cooperation with Argentina and South Africa. Analysis of the transnational cooperation between the 12 countries involved in the 13 R&I projects funded under two ERA-MIN joint calls shows significant cooperation across the EU and with non-EU countries, covering the different value chain areas for the sustainable supply of raw materials in Europe. Moreover, significant participation of companies from most of the countries is observed, although it is not equally distributed by the thematic areas. Future joint calls aim to mobilise more companies to cover the whole raw materials value chain and to promote the shift to a circular economy.*

*ERA-MIN constitue un réseau de financement de programmes en Recherche et Innovation (R&I), dans le secteur des matières premières non énergétiques et non agricoles, réseau qui a établi une coopération avec l'Argentine et l'Afrique du Sud. L'analyse de la coopération transnationale entre les 12 pays impliqués dans les 13 projets de R&I financés à partir de deux invitations collectives d'ERA-MIN est le signe d'une coopération significative vis-à-vis des pays européens et non européens, recouvrant les différents niveaux de l'échelle de compétences pour l'approvisionnement durable des matières premières en Europe. De plus, une importante participation de compagnies provenant de la majorité des pays est remarquée, bien que non répartie de façon égale en fonction de la thématique.*
*De futures invitations vont mobiliser davantage de compagnies pour intéresser l'ensemble de la chaine de valeur applicable aux matières premières et pour la promotion du décalage vers une économie circulaire.*

*ERA-MIN es una red paneuropea de programas de financiación de I + I (Investigación e Innovación) en el sector de las materias primas no energéticas y no agrícolas y que a su vez ha establecido una cooperación con Argentina y Sudáfrica. El análisis de la cooperación transnacional entre los 12 países que participan en los 13 proyectos de I + I financiados en el marco de dos convocatorias conjuntas, ERA-MIN muestra una cooperación significativa en toda la UE y con países no pertenecientes a la UE, que abarca las diferentes áreas de la cadena de valor para un suministro sostenible de materias primas en Europa. Además, se observa una participación significativa de empresas de la mayoría de los países, aunque no se distribuye equitativamente por las áreas temáticas. Las convocatorias conjuntas futuras tienen como objetivo de movilizar más empresas para cubrir toda la cadena de valor de las materias primas y promover el cambio hacia una economía circular.*

**The EU raw materials policy context**

The technologies and systems that support the current lifestyle of the developed economies are based on products that require a wide range of raw material inputs. Many sectors of the economy, such as construction, machinery, chemicals, automotive, aerospace, information technologies and conventional and renewable energy would be constrained if raw material supplies were interrupted. Securing access to a sustainable supply of raw materials, such as minerals, is of utmost importance and crucial for the economy, competiveness and growth of European industry and for society as a whole, in line with the objectives of the Europe 2020 strategy for developing the EU into a smart, sustainable and inclusive economy (European Commission, 2010).

The "Raw Materials Initiative" (European Commission, 2008) is the medium- to long-term integrated EU strategy covering non-energy and non-agricultural raw materials and is based on the 'three pillars':

1. Ensure access to raw materials from international markets under the same conditions as other industrial competitors;
2. Set the right framework conditions within the EU in order to foster the sustainable supply of raw materials from European sources;
3. Boost overall resource efficiency and promote recycling to reduce the EU's consumption of primary raw materials and decrease the relative import dependence.

The first pillar is being implemented through Raw Materials Diplomacy (strategic partnerships and policy dialogues) with non-EU countries. So far, political agreements and letters of intent for raw materials (mostly during the Missions for Growth) have been signed with Latin American countries (Brazil, Chile, Uruguay, Argentina, Colombia, Mexico and Peru), the EuroMed countries (Morocco, Tunisia, and Egypt) and Greenland. The Commission maintains policy dialogues with China, Russia, the US, Japan, Canada, Australia, and the countries of the African Union (For more information: ***http://ec.europa.eu/growth/sectors/raw-materials/specific-interest/international-aspects/index_en.htm***).

The European Innovation Partnership on Raw Materials (EIP on Raw Materials) was launched in 2012 to promote innovation in the raw materials sector under three pillars: technology, non-technology and international cooperation (European Commission, 2012a). For the sustainable access of the European industry to non-energy, non-agricultural raw materials, its action plan – the Strategic Implementation Plan (SIP) (***https://ec.europa.eu/growth/tools-databases/eip-raw-materials/en/content/strategic-implementation-plan-sip-0***) – was launched in 2013. The main objective of the EIP on Raw Materials is to contribute to the 2020 objectives of the EU's Industrial Policy – raising industry's contribution to the EU's GDP to around 20% – and the objectives of the flagship initiatives 'Innovation Union' and 'Resource Efficient Europe'.

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A Knowledge and Innovation Community (KIC) that brings together academia and business organisations of all the European Member States has been established to boost the EU's innovation capacity across the whole value chain for mineral resources. The strategic objectives of the European Institute of Innovation and Technology on Raw Materials (EIT Raw-Materials) are to: secure raw materials supply, design solutions, and close material loops. It will focus on four strategically relevant markets for Europe with significant potential for job creation and export to international markets: mobility, machinery & equipment, information & communication technology and energy.

**European Research Area-Networks (ERA-NETs)**

The European Research Area-Networks (ERA-NETs) are public-public (P2P) partnerships and are one of the instruments of the EU RTD Programme to accomplish the objectives of the European Research Area (European Commission, 2012b). Seventy one ERA-NET actions, either thematic or targeting a region or a country in the globe, were funded for the first time under the 6th Framework RTD Programme (2002-2006) (***http://cordis.europa.eu/fp7/coordination/about-era_en.html***). In the 7th Framework RTD Programme (2007-2013), besides ERA-NETs, a new instrument was created, the ERA-NET Plus actions. This kind of P2P partnership is being supported in the Horizon 2020 programme (2014-2020) through the new ERA-NET Cofund actions (ERA-LEARN 2020: ***https://www.era-learn.eu/manuals-tools/p2p-in-h202***0). The only eligible partners for these ERA-NET Cofund actions are organisations that define strategies and priorities and fund national collaborative projects (e.g. ministries, funding agencies).

The main objective of the ERA-NET Cofund actions is to promote the cooperation and co-ordination of research and innovation funding programmes; not only across European Union Member States but also with non-EU countries and regions (e.g. Associated countries and Third countries), thus mitigating ongoing duplication and fragmentation of scientific research and public funding and fostering transnational collaboration among academic and industrial researchers in common global challenges and priorities.

Cooperation between funding organisations within ERA-NETs usually includes joint activities such as mapping, strategies alignment, dissemination, monitoring, and international cooperation, with the ultimate goal to implement joint transnational 'calls for proposals' based on agreed research topics and procedures. Under the joint calls organised by ERA-NETs, small transnational R&I consortia (ranging between 3–5 partners from 2–4 countries) are supported, where each research partner is funded by the respective participating funding organisation of their country following national rules and procedures. Since the support is provided for coordinated and focused projects run by small consortia, this scheme provides the framework to promote the internationalisation of national and regional research and innovation communities, complementing national and regional scientific programmes. The ERA-NET Cofund scheme could be attractive to newcomers from academia, SMEs and industry within both EU and non-EU countries. The expansion of existing partnerships or the development of new partnerships in funded R&I consortia under the ERA-NET programme could facilitate future applications to larger R&I projects (e.g. Horizon 2020).

**ERA-MIN - the pan-European network on Raw Materials**

In November 2011, ERA-MIN, the ERA-NET on the *"Industrial Handling of Raw Materials for European industries"*, was one of the ERA-NET projects funded under the 7th Framework Programme. For the first time, 11 funding organisations (e.g., ministries and funding agencies) of nine European countries gathered in a network aiming at cooperation and co-ordination of research and innovation funding programmes in the three segments of non-energy, non-agricultural raw materials: metallic, construction and industrial minerals.

After four years, funding organisations from EU and non-EU countries with common priorities and challenges were invited to join the network and as a result ERA-MIN was successfully enlarged to 15 full partners and 6 associate partners from 15 EU countries and from two non-EU countries, Argentina and South Africa.

The research and innovation gaps and major challenges were identified through the mapping of the European Non-Energy Raw Materials Community, the Stakeholders Forum and the annual Stakeholders Conferences. Almost 150 experts from academia and industry drafted a Roadmap for Research Priorities for the next five to ten years in the non-energy non-agricultural raw materials sector, which has been used as a background document of the SIP of the EIP on Raw Materials. The topics of the ERA-MIN Research Agenda cover the entire mineral raw materials value chain, from primary to secondary resource to the substitution of critical materials, as well as cross-cutting issues such as public policy support, environmental and social impacts, public perception, international cooperation, education and outreach (Vidal *et al.*, 2013).

**ERA-MIN joint calls analysis**

Based on common challenges and priorities as described in the ERA-MIN Research Agenda (Vidal *et al.*, 2013), ERA-MIN launched three joint calls for transnational research proposals in 2013, 2014 and 2015, to which 5, 11 and 12 countries, respectively, committed national funds to support a total of 17 transnational projects corresponding to a total of €13 million of public funding. Italy and UK were associate partners and Slovakia was a full member that did not participate in any of the joint calls because they could not commit national funds at that time.

Whereas the pilot joint call for transnational research projects in 2013 addressed only the "Sustainable and Responsible Supply of Primary Resources in Europe", the 2014 and 2015 joint calls focused on the "Sustainable Supply of Raw Materials in Europe" by addressing the entire value chain of mineral raw materials: from primary resources to secondary resources (recycling) and the substitution of critical materials. So far, 'needs-driven' research has always been the joint call's scope but areas of Public Policy Support and Minerals Intelligence or Education and International Cooperation could also be addressed. In addition to the five countries (Finland, Poland, Portugal, Romania and Sweden) that participated in the pilot joint call 2013, other EU and non-EU countries joined the second joint call 2014, namely Argentina, France, Hungary, South Africa, Spain and Turkey. In the third joint call 2015, two new countries joined (Germany and Ireland) but Spain did not participate.

The results reported here will not take into consideration the pilot joint call since it only addressed primary resources and only five countries were involved. More information on the funded projects' summaries, consortia and call statistics under the first two joint calls, 2013 and 2014, are summarised in the ERA-MIN Project Catalogue (2015) available at the ERA-MIN website, which will be updated with the results of the joint call 2015.

The 13 funded transnational projects under the two ERA-MIN joint calls 2014 and 2015 were analysed to identify the partnerships established between the par-

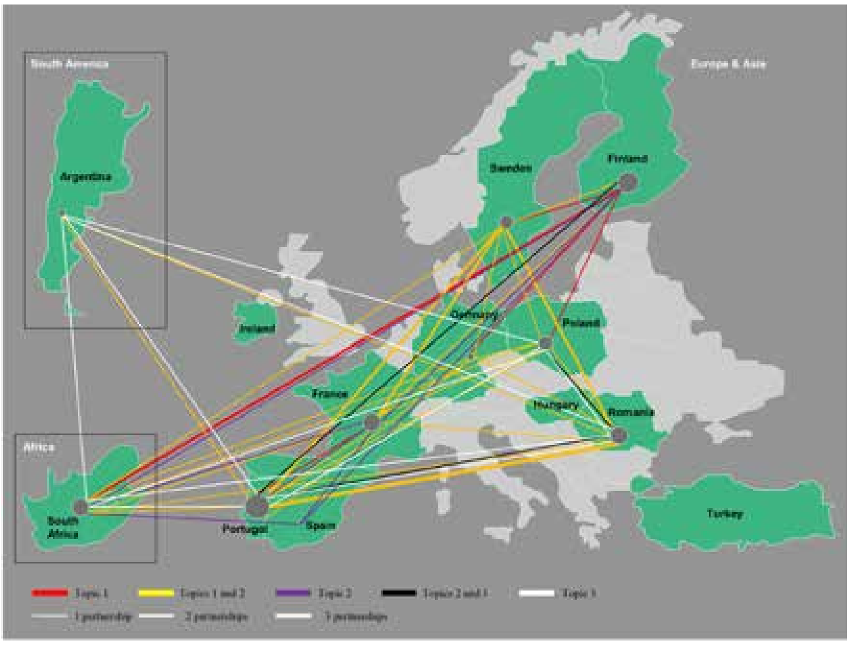


*Figure 1: Partnerships established between countries in the projects funded under ERA-MIN joint calls 2014 and 2015. The size of the circles in each country reflects the total number of projects with partners from that country. The thickness of the connecting lines reflects the number of partnerships.*

ticipating countries as well as the research topics addressed in those partnerships. Considering the funded project consortia, the number of partners ranged from three to eleven, coming from a range of two to seven countries. Each of the funded projects could address more than one of the three main topics, namely: Topic 1 - Primary resources; Topic 2- Secondary resources and Topic 3 - Substitution of critical materials. For that reason, five different combinations of topics were identified in the funded projects: five on Topic 1, four on Topics 1 and 2; two on Topic 2, one on Topics 2 and 3 and one on Topic 3.

Portugal, Finland, Romania, France, South Africa, Poland and Sweden have participated in both joint calls and were the countries with the highest number of funded projects: Portugal has supported seven joint projects and Sweden four projects. On the contrary, Germany and Spain have participated in only one joint call and have supported one project each. It is worth noting that a Norwegian company and a German research institute have joined a funded project with own funding in the ERA-MIN joint call 2014, in which Germany did not commit national funds and the Norwegian funding organisation did not participate.

There are several reasons that can justify why a country did not support any project, such as, no significant engagement of their institutions in establishing consortia, not being recommended for funding by the independent scientific peer-review of submitted projects, or the non-availability of funding from a country. It should be noted that in the case of Turkey, the funding programme could only support Turkish companies which did not apply.

***Figure 1*** displays the established partnerships between countries for the 13 funded projects and their distribution by the three main topics. When considering the funded projects addressing both Topics 1 and 2, Portugal and Romania established partnerships in three projects whereas France and Sweden were partners in two projects as well as Portugal and Sweden; and Romania and Sweden. Finland and South Africa participated in two projects addressing only Topic 1. The other countries have only established one partnership in the different combination of topics.

It is worth to note that both South Africa and Argentina have participated in consortia covering all three topics; however, while South Africa established a partnership with all participating countries, Argentina partnered with just Poland, Portugal, Romania and South Africa. On the contrary, France and Sweden addressed only Topics 1 and 2.

No cooperation was established between Portugal and Finland despite the high number of funded projects in each country. The lack of partnerships between Spain and other countries (Argentina, Poland, Portugal, Romania and Sweden) could be just a reflection of the low number of funded projects by Spain (only one) and does not necessarily reflect the potential cooperation between those countries.

Companies corresponded to 22 % of the total participants in joint call 2014 and are partners in a high number of funded projects in all call topics. Almost 80% of the Finnish participants are companies, of which more than 60% addressed Topic 1. In other countries, less than 50% of the participants are companies (***Figure 2(A)***). Finland and Portugal have the highest company participation, especially covering Topic 1, when compared to the total number of participants (***Figure 2(B)***). Interestingly, there is no cooperation between companies of these two countries, as depicted in F***igure 1***, eventually pinpointing the existence of two clear hubs.

Companies from all countries except France, Romania and Spain are cooperating in projects covering Topic 1. Companies from Finland, France, Poland, Portugal and Romania have participated in consortia that covered Topic 2, Topics 1 and 2, and Topics 2 and 3 while only companies from Poland, Portugal and Romania are cooperating in Topic 3 and Topics 2 and 3 (***Figure 2***).

**Future perspectives**

Building on the experience and lessons learnt from the ERA-MIN programme, an ERA-NET Cofund on Raw Materials has been selected for funding under Horizon 2020, to implement a European-wide coordination of research and innovation programs on Raw Materials through (1) a joint call for proposals with EU co-funding in 2017 and (2) additional joint calls. The international cooperation will be further strengthened in the raw materials sector in Europe through the enlargement to almost all EU countries relevant to the raw materials sector, as well as to other countries outside Europe that are global leaders in mining, which will guarantee the global dimension of the R&I transnational projects to be publically funded.

Thematic areas of future joint calls will address the three segments of the non-energy mineral raw materials: metallic, construction and industrial minerals, from exploration to recycling and substitution, based on the ERA-MIN Research Agenda and national and regional priorities under a circular economy perspective (European Commission, 2015).

Through research and innovation coordination and coherence between regional, national and EU funding in the mineral raw materials sector, transnational collaboration and targeted international collaboration are expected to strengthen the industry competitiveness in line with the objectives of the EIP on Raw Materials.

Participation of researchers from academia, SMEs and industry will be encouraged in future joint calls to address their

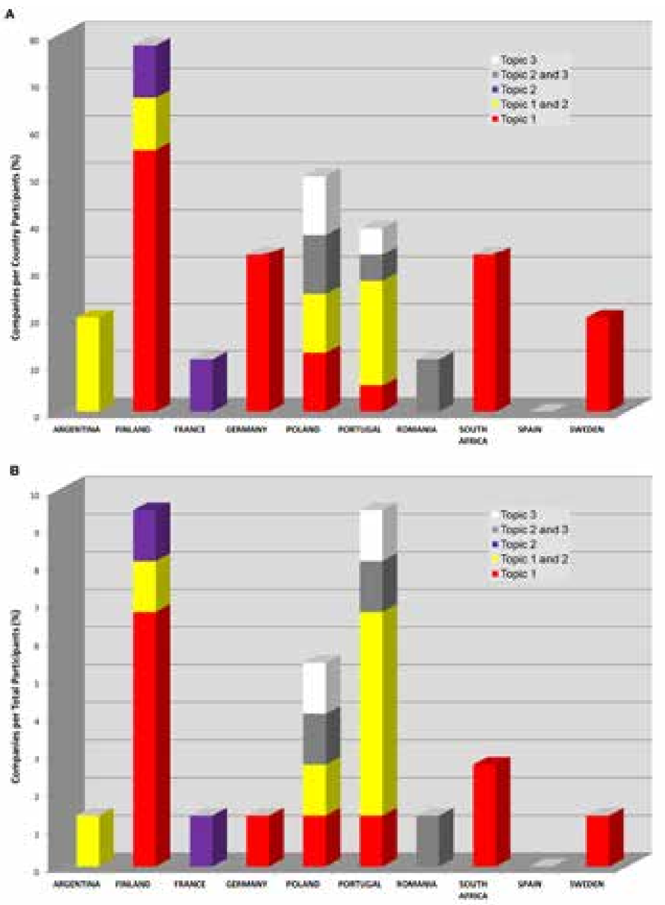


*Figure 2: Company distribution per country and per topic in the funded projects under ERA-MIN joint calls 2014 and 2015. (A) Number of companies in relation to the total participants of each country. (B) Number of companies in relation to the total participants in the joint calls.*

research needs, stronger links will be developed and knowledge transfer and access to know-how and markets will be promoted. Engagement with social scientists working in the area of public awareness, acceptance and trust will also be encouraged.

**Conclusions**

In general, the countries that have participated in the two ERA-MIN joint calls and have a higher number of funded projects, established cooperation across Europe and outside Europe. Since the analysis was based on only 13 transnational funded projects, conclusions should be drawn with caution, especially when considering only one or two funded projects in a country.

This analysis shows significant cooperation within EU countries and also with Argentina and South Africa in the non-energy and non-agricultural raw materials sectors, from exploration, extraction, mineral processing and metallurgy to recycling of mining and smelting residues and substitution of critical materials for green energy technologies. Moreover, the companies in the mining sector and in the recycling sector are cooperating mainly through academia-industry partnerships.

None of the funded projects covered the whole raw materials value chain, which could be due to the fact that usually only small consortia with small budgets are supported under an ERA-NET joint call.

It is worth underlining the pioneering role that ERA-MIN has played in boosting the dynamics of collaboration across national programmes in the raw materials sector. Given the aims of the EU Raw Materials Initiative and the global nature of the raw material supply chain, the engagement of two non-EU funding organisations in the ERA-MIN joint calls is a significant success.

**Acknowledgements**

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# The Sustainable Aggregates Management and Planning Initiative in South East Europe

*Gorazd Žibret**

*Between 2009 and 2015 The South East Europe Transnational Cooperation Programme co-funded two international projects – the SARMa and SNAP-SEE projects. Both deal with international cooperation related to mining – more specifically, to the planning of aggregates supply. Their territorial domain was the South East Europe area. The topic of the SARMa project was sustainable aggregates resource management on three levels: at extraction site level, at national level and at transnational level. The SNAP-SEE project's main goal was to initiate and improve aggregate planning process in South East Europe. International cooperation was among the key components within both projects. Both projects promoted international harmonisation of legislation, standards and cross-border exchange of information in order to improve planning processes and consequently improve overall resource efficiency.*

*Entre 2009 et 2015, Le Programme de Coopération Transnationale pour le Sud-est de l'Europe cofinança deux Projets internationaux - le SARMa et le SNAP-SEE. Les deux projets traitent de coopération internationale sur le secteur minier - plus précisément pour la planification de l'approvisionnement en agrégats. Leur domaine géographique correspondait à la région sud-est de l'Europe. Le thème du projet SARMa consistait en la gestion de la ressource durable en agrégats avec trois volets : le volet site d'extraction et les volets national et transnational. L'objectif principal du projet SNAP-SEE consistait en l'initiation et l'amélioration du processus de planification pour le Sud-est de l'Europe. La coopération internationale faisait partie des paramètres clés des deux projets. Les deux faisaient aussi la promotion de l'harmonisation législative internationale, des échanges d'information standards et transfrontaliers pour optimiser le processus de planification et en conséquence améliorer le volet ressource dans tous ses aspects.*

*Entre 2009 y 2015 el Programa de Cooperación Transnacional del Sureste de Europa cofinanció dos proyectos internacionales: SARMa y SNAP-SEE. Ambos tratan con la cooperación internacional relacionada con la minería - más específicamente, con la planificación del suministro dearidos. Su dominio territorial era el sureste de Europa. El tema del proyecto SARMa fue la gestión sostenible de los recursos de agregados en tres niveles: nivel de extracción local, nivel nacional y transnacional. El objetivo principal del proyecto SNAP-SEE era iniciar y mejorar el proceso de planificación de los agregados en el sureste de Europa. La cooperación internacional fue uno de los componentes claves de ambos proyectos. Ambos proyectos promovieron la armonización internacional de la legislación, las normas y el intercambio transfronterizo de informaciones con el fin de mejorar los procesos de planificación y, en consecuencia, mejorar la eficiencia general de los recursos.*

Aggregates (crushed rocks, sand and gravel) are crucial for infrastructure development and construction. Aggregates are the second most needed natural resource for humankind, just after water (UNEP, 2014). They can be produced from natural sources, like extraction from gravel and sand pits, extracted from suitable geological units in quarries, or extracted below sea level. They can be also manufactured by recycling different wastes. However, the majority of aggregates we are using today come from natural sources. Within the EU only 8% of aggregates come from secondary sources, like from recycling of construction and demolition waste or from different industrial wastes (manufactured aggregates). Aggregates are used for preparing foundations for buildings and infrastructure, to produce concrete, to build roads, harbours, airports, houses, community buildings, etc. According to the UEPG estimates, the EU consumes 2.51 billion tons of aggregates annually, or almost 5 tons per year per capita. The aggregate sector directly employs over 200,000 people. Aggregates are extracted from 23,955 extraction sites, operated by 13,263 companies. In general - the more developed a country is, the more aggregates it consumes (UEPG, 2015).

Aggregates are, however, a specific commodity. They are bulky and heavy, we need them in large quantities, and long transportation of aggregates from the production site to the end-user not only drastically increases their price but is also not very environmental friendly. So aggregates must be extracted locally, and transportation routes of aggregates are usually not longer than 50 km by road. By using railways or ships, economically viable distances for the transportation of aggregates can be extended. Moreover, the EU faces greater and greater competition for the use of land, where many different sectors compete, like transportation, housing, farming, energy, industry and different protected areas (i.e. water protected areas, Natura 2000 sites, etc.).

South East Europe (SEE) is rich in suitable geological formations from which aggregates can be extracted. This area will also need to develop its infrastructure in the future. This means that aggregate consumption in the SEE area will be drastically increased in the future. However, the SEE area is characterised by having different approaches to aggregates planning, if it exists at all. Aggregates planning documents are scattered among many different legal documents, there is lack of capacity for appropriate aggregates planning at all levels, some countries are also dealing with a large share of illegal quarrying, best practices are not always followed during the extraction and land remediation stages, and there is almost no trans-border or transnational cooperation in aggregates planning in the

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*Figure 1: The SARMa and the SNAP-SEE logos, and the logo of the co-funding authority.*

area. All of these hinder the efficient use of resources, cause unnecessary environmental and social burdens that can lead to public opposition to quarrying, and could cause aggregates supply bottlenecks in the future.

**Addressing aggregates planning issues in the SEE area**

To cope with the aforementioned challenges two projects (***Figure 1***) were co-funded by the South East Europe Transnational Cooperation Programme between 2009 and 2015. The first one was the SARMa project – Sustainable Aggregates Resource Management (***www.sarmaproject.eu***), coordinated by Dr. Slavko V. Šolar from the Geological Survey of Slovenia, and the second was the SNAP-SEE project – Sustainable Aggregates Planning in South East Europe (***www.snapsee.eu***), coordinated by Dr. Günter Tiess from Montanuniversität Leoben (Austria) at the time of the project (now with MinPol GmbH). While the SARMa project addressed sustainable aggregates resource management and sustainable aggregates supply mix concepts and tried to promote and implement them within local, regional and national practices within the SEE area, the SNAP-SEE project aimed primarily at the implementation of the Sustainable Aggregates Planning concept. The SARMa project geographically covers 10 countries in the SEE area - Slovenia, Greece, Austria, Hungary, Italy, Romania, Bosnia and Herzegovina, Serbia, Albania and Croatia, while the SNAP-SEE project added Montenegro, Bulgaria, Slovakia and Turkey for a total of 14 countries. Project partnerships were composed of different types of organisations, from local, regional and national minerals planning authorities, research organisations, universities, industrial associations and non-governmental organisations. The SARMa and the SNAP-SEE project topics covered a variety of themes: efficient and low socio-environmental impact quarrying and waste management, construction and demolition waste and industrial by-products recycling, illegal quarrying, identifying best practices in the area, capacity building, improving policies and regulations affecting aggregates, implementing EU guidelines in the area, as well as promoting transnational cooperation in sustainable aggregates supply and the need for stakeholder consultations within the aggregates planning process. The transnational approach taken in both projects was to develop a common SEE approach to aggregates management and to develop a joint vision concerning best practices in aggregates planning, while promoting the need for stakeholder consultations in this process.

**The SARMa project - international cooperation and joint recommendations for aggregates management**

The research methods used in the SARMa project were legislation analysis, identifying best practices in the region and studies on the similarities and differences in aggregates planning in the SEE area. Each partner responded to a series of extensive questionnaires, targeting mining legislation, waste management, spatial planning procedures, the current state of mining, illegal mining in the country, etc. Synthesis reports were created, showing similarities and specifics for each country, and joint recommendations for aggregates planning in SEE were produced as one among many results of this international cooperation activity. These recommendations can be summarised as (Hámor, 2011):

1. Addressing needs for aggregates planning in SEE, with aggregate plans being harmonised with spatial and local plans and available within a single document.
2. The ownership of the minerals should remain unchanged; however, the central state shall always have the right of delegating licencing and supervision to lower administrative levels, and shall make it clear that that mining right is distinct and independent from the land ownership right where minerals are located.
3. It does not matter whether the country applies a one-stop shop or parallel assessment in granting mining rights; however, a consultation process is needed when creating minerals planning policy, clear responsibilities should be defined and each country's geological and mining services should be maintained.
4. Legal exclusions from the mining licencing scheme should be kept at a minimum, because they cause disturbances on the aggregates market.
5. A smoother and faster permitting process is required, with precise and strict definition of the intervening stakeholders, their competences and deadlines, because shorter permitting procedures discourage speculative players in the aggregates sector. Combined with time-wise progressive financial regulatory tools, this can improve accessibility to aggregates and direct unwanted land occupation towards actual production.
6. Strategic Environmental Impact Assessment for the aggregates sector is suggested for aggregates planning, to ease the process of obtaining Environmental Impact Assessment by quarry operators, or to replace it completely.
7. Competent authorities should learn how aggregate extraction and biodiversity goals can be achieved simultaneously, because too large a number of "no-go" zones for aggregates extraction exist in the SEE area due to biodiversity issues.
8. If too many (more than a dozen) co-authorities are involved in the aggregates planning process, it is suggested that their role should be revised, for example, to define their legally binding consent as providers of expert opinions, and that the existence of a central, independent regular body authorised to coordinate permitting procedures must be assured.
9. Although public participation within the aggregates planning process is set up according to the EU standards, opposing NGOs still do their job better than the typical aggregate producer. This is why it is recommended to involve local communities in a more enhanced and sophisticated way, beyond the regulatory minimum.
10. An on-line public aggregates information centre covering primary and

*Figure 2: The SARMa conference, held in Ljubljana, Slovenia, September 2011.*

secondary aggregates in SEE is badly needed.

11. There are great differences in mineral taxation and royalties in different countries, which can lead to distorted competition in cross-border regions.
12. National, regional and local minerals plans should include secondary aggregates, to move towards a more recycling-friendly society.
13. The availability of data related to secondary aggregates in SEE area is disappointing, and should be improved in the future.
14. All countries should adopt a minerals policy and a common process for long-term planning.

The SARMa project was concluded with the international Sustainable Aggregates Resource Management Conference, held in September 2011 in Ljubljana, Slovenia (***Figure 2***; Žibret and Šolar, 2011), where participants discussed the results of the project and how they could be used to improve minerals planning policy on the EU level.

**The SNAP-SEE project - a joint SEE vision for better aggregates planning**

Within the SARMa project it became obvious that the aggregates planning process in the SEE area needs improvement. Based on the outcomes of the SARMa project, with the inclusion of new countries and partners, a new project named the Sustainable Aggregates Planning in South East Europe (SNAP-SEE) project was submitted and accepted for co-funding. Four main challenges were addressed:

- the lack of coordinated aggregates planning in the SEE area;
- the lack of integrated planning for primary and secondary aggregates;
- the lack of capacity and competences to address the preceding two problems;
- very low stakeholder engagement.

The methodology within the SNAP-SEE project was similar to that in the SARMa project, with the addition that SNAP-SEE project partners tried to initiate the aggregates planning process by organising two stakeholder consultation events in their own countries. As a result, more than 800 participants – representatives of different stakeholders in the aggregates planning process – participated in 20 organised events (***Figure 3***) in 11 SEE countries. The general impression from these events was that they are extremely useful and necessary, and that it is important that different stakeholders sit around the same table and discuss issues of land use and the state of the aggregates industry and quarrying, because each one views the same problem from its own perspective.

*Figure 3: Selected snapshots from stakeholders consultation events in Slovenia (upper left), Italy (upper right), Montenegro (bottom left) and Greece (bottom right).*

Beside stakeholder consultations, project partners also provided data and information to carry out policy analysis for the SEE area. This is needed to properly address gaps and to construct a common vision for sustainable aggregates planning in the SEE area. This vision, as a direct result of cooperation among partners, focuses on minerals planning policy practices, mineral resources ownership, assessment type (parallel, one-stop shop), inclusion of secondary aggregates within aggregates planning policy, and other relevant aspects (Horváth *et al.*, 2014). It was found that not all countries in the region had adopted a minerals planning policy (***Figure 4***), and only a few included secondary aggregates within it. There is also the lack of an appropriate recycling policy in most countries in the area (***Figure 5***).

Based on the policy and multi-sectoral analysis of aggregate planning in the SEE area, and according to the results from the stakeholder consultation process, a joint vision for aggregates planning in the SEE area was prepared (Horváth *et al.*, 2014). Snapshots from the joint vision related to national and transnational levels policies are:

- primary and secondary aggregates are managed together;
- planning authorities cooperate with other sectors;
- public consultation procedure is conducted before adoption of mineral plans;
- plans are updated regularly (every 5–10 years);
- plans include the optimisation of transport routes according to life-cycle analysis;
- illegal quarrying is prevented and sanctioned;
- aggregate safeguarding areas are defined;
- land is reclaimed after quarrying is finished;
- aggregates planning policy is monitored regularly;
- all SEE countries have aggregates related policies developed on a similar level;
- aggregates are considered equal to

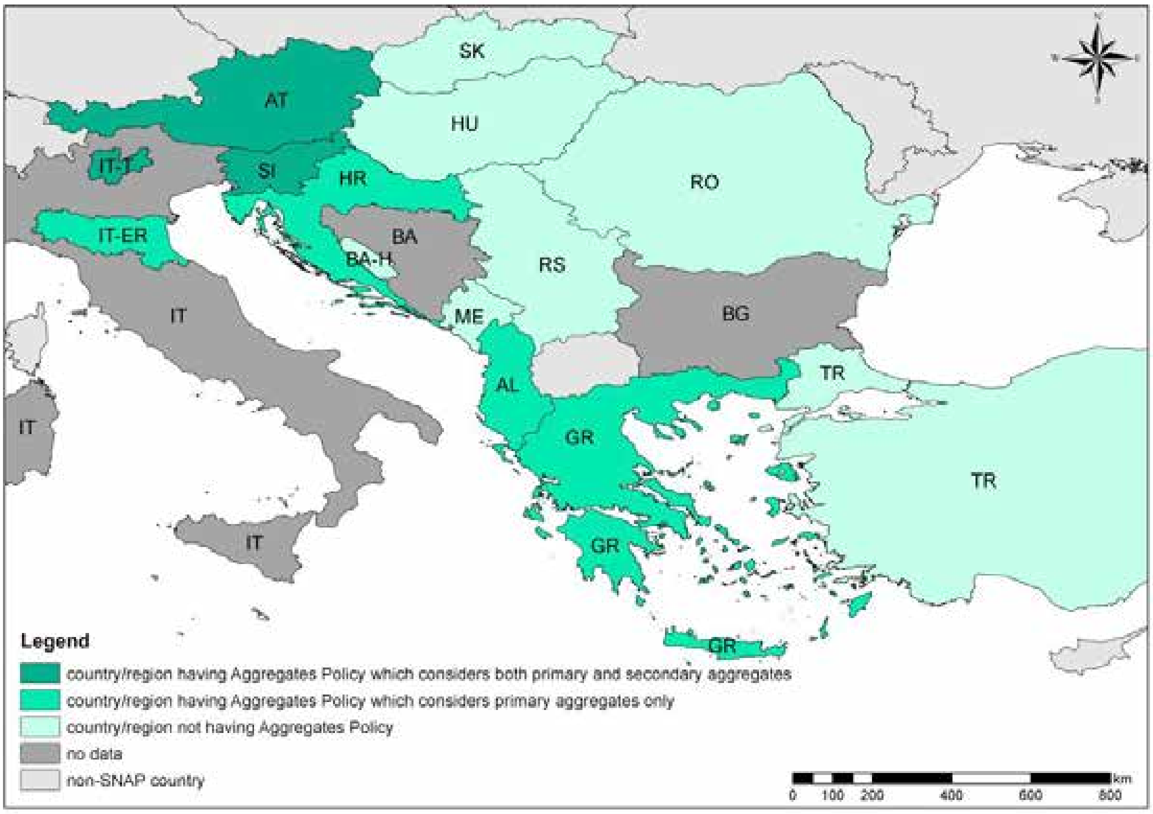


*Figure 4: Aggregates planning policy in the SEE area (from Horváth* et al.*, 2014). Because some countries in the SEE area have aggregate planning policy defined on regional levels, data for Italy and BA represent only the information valid for indicated regions (IT-ER - Emilia Romagna region; IT-T - Trento region; BA-H - Herzeg Bosnia canton).*

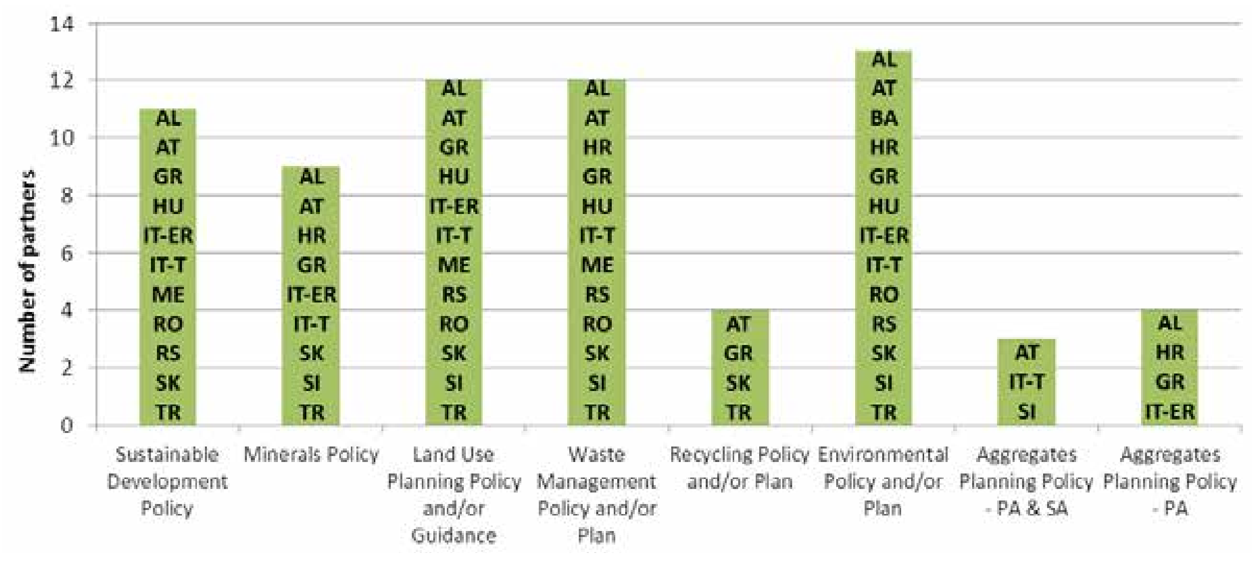


*Figure 5: Sustainable Development Policy, Minerals Policy, Land Use Planning Policy, Waste Management Policy, Recycling Policy, Environmental Policy and Aggregates Planning Policy in SEE area. PA: primary aggregates; SA: secondary aggregates (from Horváth* et al.*, 2014). Regional data only: IT-ER - Italy, Emilia Romagna region; IT-T - Italy, Trento region; BA-H - Bosnia and Herzegovina, Herzeg Bosnia canton.*

other natural resources;

- land use plans contains designated areas for extraction and for safeguarding the resources;
- sustainability assessment screening is obligatory;
- waste management policies support aggregates recycling;
- there are simple, fast and efficient permitting processes with clearly defined deadlines with the encouragement to adopt e-government;
- stakeholders are involved in the permitting process;
- landscape strategy and restoration plans are developed before mining operations begin;
- joint legal terminology is adopted for

aggregates;
- governments use green public procurement procedures;
- past and present aggregates extraction sites contribute to biodiversity;
- cross-border aggregate market analysis is taken into account in the aggregates planning process;
- financial instruments are harmonised within the SEE area;
- there is data and aggregates planning knowledge exchange between SEE countries;
- landfill taxation and aggregate levies are established;
- a comprehensive and easily accessible transnational primary and secondary aggregates inventory is available, where data is standardised and harmonised;
- joint maps of aggregate potentials are compiled in the SEE area;
- maximum transport efficiency is targeted, including cross-border transport routes.

More information can be found within the "Aggregates planning toolbox", containing 4 booklets describing project results and outcomes in greater detail, and a booklet containing general information about the SNAP-SEE project. The aggregate planning toolbox can be downloaded from the SNAP-SEE web page (***www.snap-see.eu***).

**Conclusions**

Both the SARMa and the SNAP-SEE projects demonstrated the stakeholders' willingness to participate in such an international initiative related to mineral resources. Both projects helped to present the concepts of aggregates planning and supply to the relevant public authorities, the private sector and the public within the SEE area. Especially within the SNAP-SEE project, partners not only prepared reports and recommendations but also took real actions to bring SARM and SSM concepts into practice by organising stakeholder consultations. The impressions gained from these events were that they were badly needed, and such initiatives were welcomed by the majority of participants. Both project consortiums wished to continue promoting good aggregates planning practices in their national regulations, as well as beyond the SEE area. The new, on-going continuation of the SNAP-SEE project is the MINATURA 2020 project (***www.minatura2020.eu***), funded by the Horizon 2020 programme, which addresses the importance of safeguarding mineral deposits on the EU level.

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# Future challenges in international cooperation for the exploration and exploitation of mineral resources with high added value in Europe

*Rubén Esteban Pérez**

*For the last decade, mining has been experiencing the effects of a major change relating to the mining business itself and the conditions of the professionals involved in exploration and exploitation of geological deposits. The lack of a European mining policy and development constraints (including NIMBY) on the European continent have led to heavy reliance on third countries for supply of the metal ores needed for European manufacturing. The EU has defined a policy to explain to the European countries that mineral resources must be properly studied and exploited in an economically viable way. Therefore, the EU is developing an international cooperation plan with a geological basis to reduce dependence on imports from countries outside Europe.*

*Durant les dix dernières années, le secteur minier a subi les effets d'un changement radical lié aux affaires sectorielles elles-mêmes et aux conditions d'exercice des professionnels que ce soit pour l'exploration ou l'exploitation des gisements géologiques. Le manque de politique minière européenne et de contraintes (y compris pas dans mon arrière-cour ou NIMBY), en matière de développement sur le Continent européen ont conduit à une dépendance aigüe des pays en voie de développement pour l'approvisionnement en minerais métalliques, nécessaires à l'Industrie européenne. L'UE a défini une politique pour expliquer aux pays européens que les ressources minérales doivent être étudiées de façon pertinente et exploitées de manière viable, du point de vue économique. C'est pourquoi l'UE met en place un plan de coopération internationale basé sur la géologie pour réduire la dépendance matérialisée par les importations provenant de pays à l'extérieur de l'Europe.*

*Durante la última década, la minería ha estado experimentando los efectos de un importante cambio relacionado con el propio negocio minero y con las condiciones de los profesionales involucrados en la exploración y la explotación de yacimientos geológicos. La falta de una política minera europea y las limitaciones de a su desarrollo (incluido el efecto NIMBY) en el continente europeo han llevado a una fuerte dependencia de terceros países para el suministro de minerales metálicos necesarios para la empresa manufacturera europea. La UE ha definido una política para explicar a los países europeos que sus recursos minerales deben ser adecuadamente estudiados y explotados de una manera económicamente viable. Es por esto que está desarrollando un plan de cooperación internacional con fuerte base geológica para reducir la dependencia de las importaciones procedentes de países fuera de Europa.*

Several challenges face the mining industry both now and in the decades to come. Important initiatives are underway that aim to address these challenges, such as creating systems for sharing geological knowledge and forming and implementing strategies to reduce dependence on mineral raw materials from non-European Union countries. Other areas also deserve attention; suggestions are given for more comprehensive EU mining legislation, for shared R&D and classification systems, and for greater standardisation of curricula in mining and geological education.

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**Creating a database of European and international cooperation in geological knowledge**

Long gone are the days when the policies of individual countries in Europe were predominantly directed towards the exploration and exploitation of mineral resources in their own territories alone. The implementation of major geological mapping campaigns (such as the MAGNA Plan in Spain) were encouraged, which laid down the foundations for the geological knowledge of the wider territory in many aspects such as mining and other geoscientific information.

Today we can say that at the European level, knowledge on the location and distribution of geological resources of the EU28 territory is well advanced. Two projects of the 7th Framework Programme for Research and Technological Development (2007-2013) are good examples: ProMine (Jalovaara, 2013) and EuroGeoSource (Fortes *et al.*, 2013).

After these projects and within the framework of the new European program of R&D Horizon 2020, the Minerals4EU project developed between 2013 and 2015 was designed to meet the recommendations of the European Raw Materials Initiative (RMI) (Solar, 2015).

In parallel to all these activities, international bodies based in Europe such as the UNECE (United Nations Economic Commission for Europe) have been developing the so-called UNFC-2009 (United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources) (UNECE, 2015). The document aims to become the single classification system for conducting inventories of mineral resources at the country level, using a unified set of definitions and intergovernmental comparable terms.

The UNFC is something that affects European geologists directly. The European Union (EU) has promoted the use of this classification system at least for evaluation by the member states. After the meeting of the Competitiveness Council of the EU in March 2011, the Council of the Union encouraged the European Commission to act as facilitator to promote the use of the system created by UNECE.

In this sense, one of the most important projects was EuroGeoSource, previously mentioned, which during the period of its execution promoted the use of the UNFC to harmonise data concerning energy and mineral resources (Blystad, 2012).

In relation to this, it is fundamental not to confuse the UNFC classification system with the classification system of PERC (Pan European Reserves and Resources Reporting Committee), developed in Europe by various international organisations within the CRIRSCO template (Committee for Mineral Reserves International Reporting Standards), which allows to generate reports (Reporting Code) on research results and of mineral resources and reserves of economically viable deposits. The CRIRSCO template reporting codes such as PERC allow data on mineral resources and reserves data to be gathered, understood and compared by investors, investment advisers, Stock Exchanges or Global Financial Markets (PERC, 2013). In addition to the above, there are other classification systems included in the CRIRSCO template, such as the Australasian JORC, NI 43-101 for North America and more. These Reporting Codes generate positive synergies that allow easy comparison and understanding by the various stakeholders involved in the mining process for the purpose of gaining relevant and reliable data, based on the principles of transparency and competition, when researching and exploiting of mineral resources had been done.

It is important that there is a worldwide system of inventory and classification of mineral resources and reserves at the country level, regardless of the viability of mining operations, but it is also necessary that this system coexist with others employed by enterprises for exploitable economically viable deposits. While international systems such as the UNFC are designed and developed to facilitate communication between Member States and the exchange of information relating to exploration and exploitation of mineral resources among many stakeholders (governmental, academic and industrial), the Reporting Code has a strictly business purpose, valuing in detail the technical and economic viability of the exploitation of the deposit in order to secure funding to undertake the different phases of the mining project. We must keep in mind that today shared or coexisting systems are still lacking, and while some countries have adopted the UNFC as a classification system for their mineral resources, others use their own system or even none at all.

**The European Strategy for Raw Materials (RMI) and dependence on third countries in metal and strategic mining**

Mineral raw materials, and especially the so-called critical minerals or Critical Raw Materials (CRM), are vital to the economy of the EU and are equally necessary and, for now, irreplaceable for the development of modern technologies friendly to the environment.

Today, the mining industry is part of a globalised market. Decisions on studying new mineral deposits and whether or not to open or reopen a mine depend on the global prices of raw materials.

Other aspects are the cost differences due to geographical and geological conditions, the standards of employability for different professionals involved in the mining work, and the regulations on environmental impact, disposal of waste generated from the extractive activity, increased pollution, and potential geological risk in soil and/or changes in local water quality.

The high-value-added global metallic and non-metallic mining industry sector is characterised by a relatively small number of international industrial groups operating across continents. Many of the products resulting from the activity of this sector are traded globally and prices are set in global financial markets.

While the EU is self-sufficient in the production of construction materials, it has high levels of net imports of metal ores, and mainly of CRM, the strategic and technological minerals.

However, minerals and metals global financial markets are increasingly distorted due to excessively protectionist policies, increasingly meagre market output quotas from producing countries, great price variability, lack of exploration for new deposits, and price controls for the global markets. These factors ultimately produce insecurity in the supply chain of these minerals to European manufacturing companies.

Minerals such as antimony, beryllium, cobalt, fluorspar, gallium, germanium, graphite, indium, magnesium, niobium, platinum, rare earths, tantalum and tungsten are considered strategic by the EU. The supply of rare earth, niobium and indium is from third countries, with up to 90% from countries like China or Brazil (Rachovides, 2015).

Besides the above, it must take into account that there are supplies such as tantalum and niobium (also called coltan) from countries such as the Democratic Republic of Congo, with a risk of influence by war and on guerrilla factions. This has led the EU to restrict the market of so-called "conflict minerals" and replace these export routes with other alternatives, but always outside European borders.

The sharp increase in commodity prices up to 2008 has led the European Commission to adopt a new strategy to address the challenges for raw materials supplies to the European markets, named the Raw Materials Initiative or RMI, with the following key points and time limit until 2020 (EC, 2008) :

- Definition of a national policy for every European State to ensure that mineral resources are exploited in an economically viable way in harmony with other national policies.
- Establishment of a territorial planning mining policy that includes an important basis of geological knowledge as result of exploration for new mineral deposits and transparent and comprehensive methodology inventory of mineral resources.
- Setting up an authorisation process for exploration and extraction of minerals that is clear, understandable and provides certainty to the citizen that complies with environmental protocols.

However, even fully implementing the above points will not ensure change in the current situation of exploration and exploitation of mineral deposits in Europe.

From a minerals resources point of view, Europe has remained a highly decentralised and fragmented continent. The policies developed in the Member States in order to give the regions increasingly important legislative and executive independence have led Europe to be a continent of regions where policies emanating from the European Directives are transposed the legislative *acquis* of the countries with multiple changes. These changes are often influenced by the political colour of the party holding the majority or by the needs of certain parties to achieve approval of legislation. Subsequently, these laws, which are generally not basic or primary laws, almost always lead to more restrictive regional laws for the mining sector. These laws are nothing more than the legislative achievement of a NIMBY (not in my back yard) trend that has come to stay in Europe.

No politician, regardless of political colour, in a 4- or 5-year legislative timeframe wants to get involved in mining projects with life cycles of decades, when society in general is demanding the establishment of other industries in their territory. Almost nobody stops to think about where the minerals that allow manufacturing in their welfare state come from, or under what conditions they arrive.

In addition to this, each country now has very different legislation and there is no mining regulation at European level that is of direct and mandatory application in the territory of the EU-28 that can replace obsolete mining laws not very consistent with the globalisation of raw materials currently existing on the planet. Without this common regulatory framework for all countries of the EU-28 it will be very difficult, if not impossible, to implement national policies that comply with the principles of the RMI.

Similarly, in the order of administrative competences, there are still cases of national mining laws which reserve different activities for certain professionals to the detriment of others. One example is the Mining Law of Spain, in force since its adoption in the bygone era of the dictatorship. A unified European criterion regarding the professional activity does not exist. Although professional titles, such as EurGeol, are valid at the European level for various tasks, to practice as a geologist in a foreign country as a resident, you still need to have the academic title of geologist achieved in the country of origin recognised through some bureaucratic process. This is usually complex and not always rewarding in many European countries.

The answer to these problems requires a global response and cooperative sense among the member countries of the Union. There are also notable differences between the European countries' classifications of mineral resources, laws on ownership of subsurface resources, types of licenses for exploration and exploitation, and many other aspects.

**Vision for the future**

That is why, in conclusion, we can say that in order to provide Europe with a genuine common policy on research and sustainable exploitation of our geological resources it is necessary to create a common legislative framework for the countries of the EU-28, with important intergovernmental and intersectoral collaboration in the development of a European raw materials policy.

Thus, the creation of a European Regulation that brings together all aspects that make up the mining process and creates a single and direct legislative framework and of full implementation at the European level is essential. A regulation that promotes a new legal framework at European level and the adequacy of national mining laws and development decrees would ensure that mining in Europe started from common rules for the entire EU territory.

This would cover not only the administrative issue of permits and licenses, but also would include the process of preliminary investigation, investment in exploitation, environmental control during operation and decommissioning and closure once the deposit has been fully exploited. It would also facilitate the creation of a truly European geological service (similar to the USGS) that would boost the exchange of competences and specialisation throughout the European countries.

Previous research could be based in a research and development program created to elaborate a map of mineral resources in Europe using a global classification system, comparable and of easy information exchange between the stakeholders involved. This classification system could be the UNFC-2009 or even the PERC code if additional categories for mineralisations beyond inferred resources were created.

From there, once the probable and proven mineral reserves are defined at country level, as well as the potential economic resources (with the help of the National Geological Services or "ad hoc" working groups), there could be open tenders for the detailed investigation of the known mineral resources where information could be shared and understood by all stakeholders through a mining Reporting Code, such as PERC.

For certain strategic minerals it may be worthwhile to map, assess and measure the mineral resources for an economically viable deposit and then to set up public tenders for exploitation as a useful tool for mining companies that could participate on equal terms. If the resources of the European subsoil were all in public ownership, even though the surface land could be private property, this would facilitate this process, as undesirable attitudes that sometimes occur if ownership of subsoil mineral resource is in private hands would then be avoided in mining project management.

Another point of importance which is currently not implemented in Europe is the homogenisation of curricula for training professionals involved in the mining process, so that a true free movement of professionals across borders of the different European countries and third countries would be generated, treating all on an equal footing, eliminating existing barriers – similar to those existing the 19th century – to the freedom to provide professional services and reserves of activity. The Bologna Process has created the framework for an engineer, geologist or technician of any country in Europe to carry out his/her activity in another country on equal footing with their nationals, but there is still much work to ensure that competence is given to the competent professional in mining operations. In this issue, international collaboration within the territory of the EU-28 is essential, both at the level of governments and of the professional associations of the different sectors involved in the research and extraction of mineral raw materials.

A possible solution would be for the EurGeol title to serve as a passport to freedom to provide services across Europe to all geologists who possess it. This would eliminate the need to validate the academic title in the administration of another country in order to work there as a geologist.

Finally, the NIMBY trend on the European continent for everything related to mining is a problem that can destroy environmentally safe and viable projects before they start. This trend is fed by certain political sectors, by certain social actors who reject outright any mining activities, and by some economic sectors that move at the bidding of global financial markets. This situation is a handicap for mining activity in Europe and worldwide. Nor has it helped that some accidents in mines in operation draw national and international media attention, which can make the population more likely to reject the extraction of the resources needed for the future development of their own societies.

Mining Professionals must give guarantees to society that mining projects, like any economic activity of an industrial nature, comply with the highest technical and environmental requirements before starting extraction, throughout the whole useful life cycle and during the closure and restoration time. The Environmental Impact

Assessment should be completed with geological studies, supervised by a Competent Person. They should be mandatory for all mining projects regardless of its magnitude or its characteristics.

A European Regulation for mining with an inventory of best practices could be a tool to improve technical exploitation, pushing the industry towards adopting the highest safety standards. Then, pedagogy and information should do the rest to convert mining into an option for many communities without a strong economy, despite having sufficient geological resources to face their future.

Only by developing all of the above aspects, expending work and time and working towards consensus, can we talk of a real European policy on raw materials. This would lead to rationalisation in the exploitation of our geological resources in an environmentally sustainable manner, drastically reducing Europe's import dependence on third countries in CRM, and a clear rejection of "conflict minerals" or minerals from countries where international standards on environment and human rights are not respected.

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# Resourcing Future Generations: A global effort to meet the world's future needs head-on

*Edmund Nickless**

*The last fifty years saw a dramatic increase in living standards and improvement in the quality of life for many of the world's poorest. Mortality rates fell, life expectancy rose, and per capita incomes swelled.*
*That improvement has been underpinned by technological development and the ubiquitous use of metal and mineral resources. To maintain this trajectory while addressing climate change and rising world population, sustainable sources of raw materials are required, in both developed and developing countries.*
*Of the 200 or so countries in the world, 60 are open to large-scale mining but 140 are not. International agreement and a new form of Social Contract are needed to more fairly share the wealth generated by mining. Working with others such as the International Resources Panel of the United Nations Environment Programme and the International Council for Metals and Mining could develop and promote such arrangements.*

*Les cinquante dernières années ont vu, pour la majorité des pauvres de ce monde, une augmentation incroyable des conditions de vie et une amélioration de la qualité de vie. Les taux de mortalité ont diminué, l'espérance de vie a crû et les revenus par habitant ont bien augmenté.*
*Cette amélioration a été étayée par un développement technologique et l'utilisation omniprésente des métaux et ressources minérales. Pour maintenir ce cap tout en affrontant le changement climatique et l'accroissement de la population mondiale, les sources durables de matières premières sont nécessaires à la fois pour les pays développés et pour ceux, en voie de développement.*
*Sur un groupe d'environ 200 pays dans le monde, 60 sont favorables à une industrie minière mais 140, pas. Un accord international et une nouvelle mouture de Contrat Social sont nécessaires pour une plus juste répartition des richesses générées par la Mine. Travailler avec d'autres partenaires comme le Comité International des Ressources du Programme Environnemental des Nations Unies et avec le Conseil International pour les Métaux et la Mine pourraient développer et promouvoir de tels accords.*

*Los últimos cincuenta años muestran un aumento dramático de los niveles de vida y la mejora de la calidad de vida de muchos de los más pobres en el mundo. Las tasas de mortalidad disminuyeron, la esperanza de vida aumentó y los ingresos per cápita aumentaron.*
*Esta mejora ha estado respaldada por el desarrollo tecnológico y el uso omnipresente de recursos minerales y metálicos. Para mantener esta trayectoria mientras se abordan el cambio climático y el aumento de la población mundial, se requieren fuentes sostenibles de materias primas, tanto en los países desarrollados como en los países en desarrollo.*
*De los cerca de 200 países del mundo, 60 están abiertos a la minería, pero 140 no lo son. Acuerdos internacionales y una nueva forma de contrato social son necesarios para compartir más equitativamente la riqueza generada por la minería. Trabajar con otros, como el Panel de Recursos Internacionales del Programa de las Naciones Unidas para el Medio Ambiente y el Consejo Internacional de Metales y Minería, podría desarrollar y promover este tipo de acuerdos.*

With few exceptions, what we do not grow, farm or fish comes out of the Earth: the clay to make bricks; the aggregate to mix with cement to make concrete; the limestone dust which acts as a mild abrasive in toothpaste.

The improvement in the standard of living of many of the world's poorest over the last half century has been driven in large measure by technological development. That development has depended on the use of an increasingly wide range of metallic elements to the extent that, by way of example, up to 75 elements, almost all the Periodic Table, are used in mobile phones, albeit in small quantities.

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Demand for all metals and raw materials is rising (***Figure 1***), consumption is increasing (***Figure 2***), surface mines are going deeper, consuming more energy (***Figure 3***)

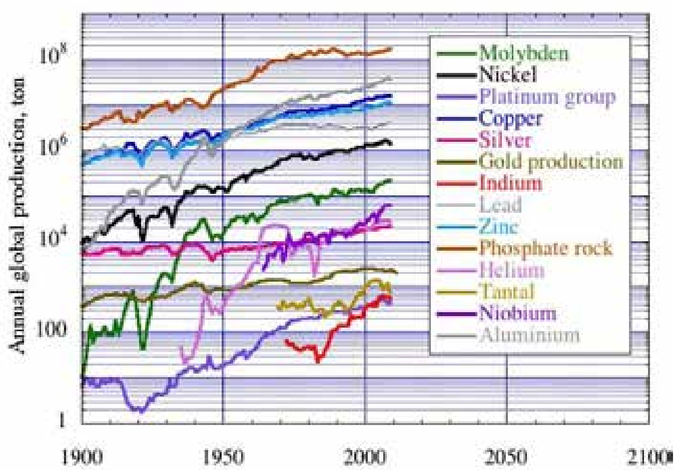


*Figure 1: Output from global mining for selected metals and elements (Sverdrup et al., 2013).*

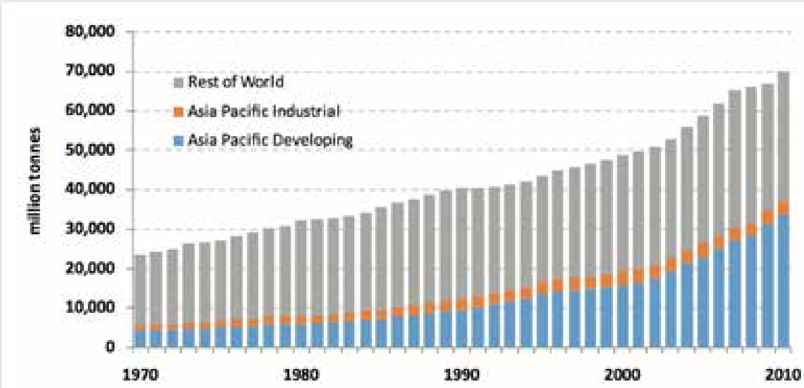


*Figure 2: Domestic material consumption, Asia-Pacific region and rest of world (1970-2010) (UNEP, 2015, Fig. 2).*

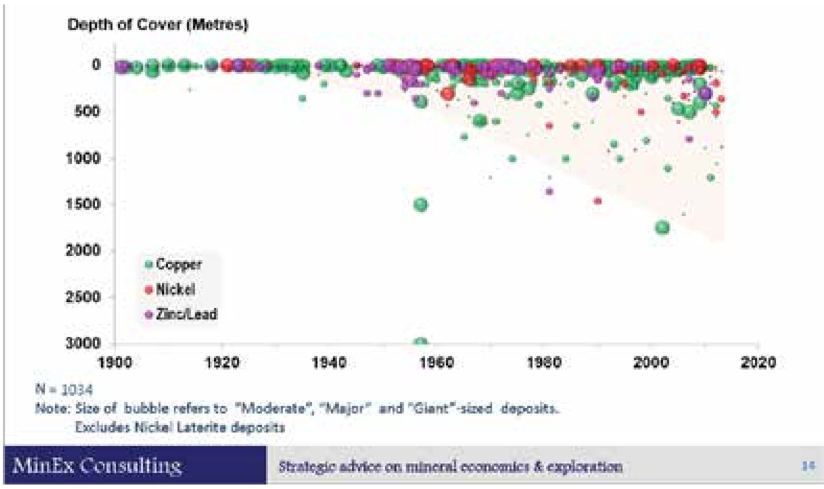


*Figure 3: Base metal deposits found in the World between 1900-2013 by progressively exploring under deep cover (Schodde, 2014).*

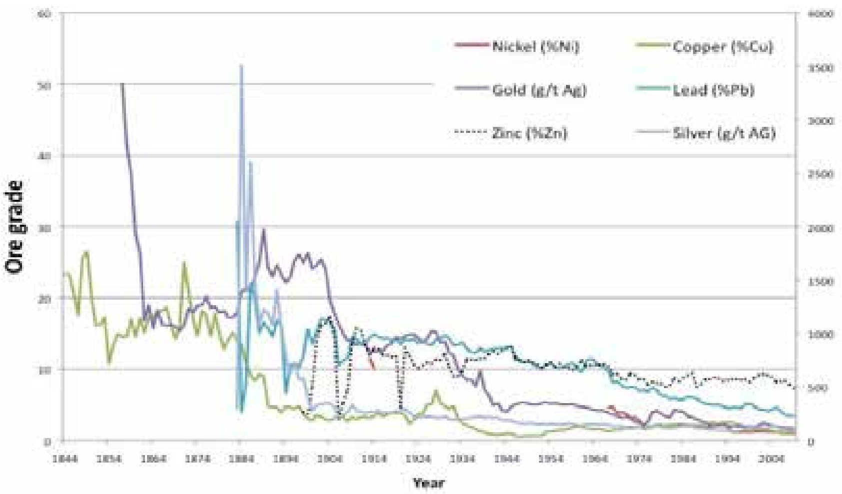


*Figure 4: Ore grades are steadily declining for a variety of base and precious metals in Australia. (Prior et al., 2012, Fig. 3).*

and lower grades are being worked using more energy and water (***Figure 4***). Arguably the most easily found deposits are already known. Discovery of new deposits is failing to keep pace with the rate of exhaustion and costs of exploration and development are rising (***Figure 5***) and there is increasing opposition at local, regional and national level to opening new mines. Mining and people do not always mix well, with the result that there is public reaction – push back – perhaps because of a lack of awareness of where metals and raw materials come from.

Mining competes with other land uses with the result that there is increase in community conflict, operations are delayed or prevented by problems in receiving permits and licences or social conflicts. In many jurisdictions, community and legal barriers add many years' delay to the issuing of licences, resulting in many millions of tonnes per year loss in supply.

In October 2015 world leaders agreed to 17 UN Sustainable Development Goals with delivery within 15 years (***Figure 6***). Two of the 17 Sustainable Development Goals touch on resource extraction and use (***Table 1***).

And in December 2015, with the adoption of the Paris Accord, there was international agreement to move towards a global, less intensive carbon economy which if implemented will impose additional demands for metals and minerals. From where will future supplies come?

Recognising that rapid growth in demand could lead to problems in continuity of supply, in February 2013 the International Union of Geological Sciences (IUGS) launched a new initiative – Resourcing Future Generations – overseen by a New Activities Strategic Implementation Committee. The original intention was to consider future mineral, energy and water supply, all of which are interlinked, but for now the initiative is focussed on metals and minerals.

Some background on IUGS together with documents published by NASIC and other references are at ***Table 2***. Of these, the most recent is the report (***Table 2***, item 8) of a group of 17 geoscientists and social scientists who met in Namibia in July 2015 to consider three themes:

1. The evolution of demand over the next few decades and consideration of the issues this raises for supply, and how energy security and climate change are altering the demand for metals and minerals;
2. The specific issues in meeting future demand for minerals and metals that primarily come from non-renewable sources in the ground, together with a summary of developments in the technology for finding, understanding and extracting mineral and metal resources from the ground and, using Namibia as a case study, how geological expertise can positively contribute to economic development;
3. The potential contribution of resource development in nation building, if handled effectively, and using Brazil

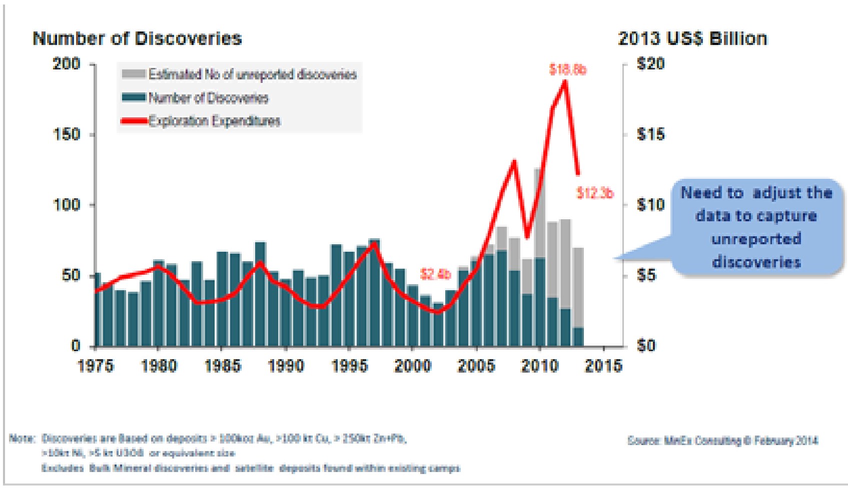


*Figure 5: Western world exploration spending and discovery (Schodde , 2014).*


*Figure 6: UN Sustainable Development Goals: 17 goals to transform our world (**http://www.un.org/sustainabledevelopment/sustainable-development-goals/**).*

*Table 1: United Nations Sustainable Development Goals directly related to resource extraction and use.*

| *Goal/Subgoal* | |
|---|---|
| *Goal 8* | *Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all* |
| *8.4* | *improve progressively through 2030 global resource efficiency in consumption and production, and endeavour to decouple economic growth from environmental degradation…* |
| *Goal 12* | *Ensure sustainable consumption and production patterns* |
| *12.2* | *by 2030 achieve sustainable management and efficient use of natural resources* |

as an example, how channelling revenues from resources into economic and social development, including health and education, drives development.

The group recommends a series of actions:

1. **Develop international guidelines for planetary mineral consumption:** Articulate at global and regional levels a vision for future mineral and metal demand;
2. **Raise awareness of the impacts of mineral consumption from source to product:** Investigate a system for tracking mineral use from source to product, incorporating as a global chain-of-custody programme similar to the concept of "food miles" or sustainable forestry marking;
3. **Support industry investment and research into new mineral exploration and extraction technologies:** New mineral exploration techniques are needed to find remote or deeply buried deposits. Major investment at a scale only realisable through private-public cooperation is needed to develop these techniques;
4. **Develop global best practice for responsible mineral resource development:** Technological evolution needs to be reinforced by the development of global practices for responsible resource development that balance the long term value of any mineral assets against alternative land-uses, such as biodiversity protection, agriculture and urbanisation.

How do we make this happen? Although the timing is uncertain, despite the present low price of many commodities future shortages in supply are inevitable. The current global downturn in the commodities sector is restricting investment in exploration, which will have a longer term effect, given that it can take 20 or more years from discovery of a deposit to bring a mine into production. ***Figure 7*** models the future requirement for copper – but might equally be for iron or similar materials in high demand for infrastructural development – and forecasts a shortfall in supply from about 2035, which at 2050 peaks at 30 Mt.

Increased recycling and substitution has the potential to reduce the level of future demand but continuing urbanisation and redevelopment of existing cities will lock away huge quantities of materials in infrastructure for many decades, possibly 120 years or more, and there will be a continuing need for primary production for the foreseeable future. Even under the most efficient recycling processes the need for primary production will continue, albeit potentially at a lower level.

***Figure 8*** shows work by Kleijn, 2011, but there are other studies, for example by the European Commission (***Table 2***, item 10), which tell essentially the same story. The estimated metals demand of new energy generating and transmission technologies is shown to the right; the traditional energy generating technologies lie to the left.

The transition to a low-carbon energy system required to tackle climate change implies a steep increase of the metals intensity of the energy system, which in turn will cause a substantial increase in the demand for metals (by a factor 2 to 100). Specifically, the introduction of Carbon Capture and Storage in fossil-based power production would increase the metals intensity of power generation by 30% for iron and 75% for nickel at coal-fired plants, and by 40% for iron and 150% for nickel at gas-fired plants.

In switching to renewable energy

*Table 2: Background on IUGS and further reading on RFG.*

| No. | Source document(s), website(s) |
|---|---|
| 1 | The International Union of Geological Sciences (IUGS) is one of five geosciences-related scientific unions within the International Council for Science (ICSU). With 121 national members, the IUGS aims to promote development of the Earth sciences through the support of broad-based scientific studies relevant to the entire Earth system; to apply the results of these and other studies to preserving Earth's natural environment, using all natural resources wisely and improving the prosperity of nations and the quality of human life; and to strengthen public awareness of geology and advance geological education in the widest sense. Further information on IUGS is at http://www.iugs.org/. The International Council for Science (ICSU) is a non-governmental organisation with a global membership of national scientific bodies (122 Members, representing 142 countries) and International Scientific Unions (31 Members). See http://www.icsu.org/ |
| 2 | Resourcing Future Generations (RFG), an IUGS initiative, was launched in February 2013. Background is at http://iugs.org/index.php?page=resourcing-thefuture-initiative and http://www.geolsoc.org.uk/RFG |
| 3 | Membership of IUGS comprises Adhering members and Affiliated organisations. Adhering members are listed at http://iugs.org/index.php?page=adhering-members; Affiliated organisations are listed at http://iugs.org/index.php?page=directory#AO |
| 4 | Membership of the RFG Core Group is at http://iugs.org/index.php?page=resourcing-the-future-initiative |
| 5 | Lambert, I., Durrheim, R., Godoy, M., Kota, M., Leahy, P., Ludden, J., Nickless, E., Oberhaensli, R., Anjian, W., Williams, N. 2013. Resourcing future generations: A proposed new IUGS initiative. Episodes 36(2). 82-86. http://www.episodes.org/index.php/epi/article/view/57474/44844 |
| 6 | RFG brochure (8 pp.) http://www.geolsoc.org.uk/~/media/shared/documents/RFG/ResourcingFutureGenerations%20%20%20FINAL.pdf?la=en |
| 7 | Nickless, E., Bloodworth, A., Meinert, L., Giurco, D., Mohr, S., Littleboy, A. 2014. Resourcing Future Generations White Paper: Mineral Resources and Future Supply. International Union of Geological Sciences. (30pp.) http://iugs.org/uploads/Consultation%20Paper%202014_Oct_12_AL_EN_DG%20FINAL.swf |
| 8 | Nickless, E., Ali, S., Arndt, N., Brown, G., Demetriades, A., Durrheim, R., Enriquez M.A., Giurco, D., Kinnaird, J., Littleboy, A., Masotti, F., Meinert, L., Nyanganyura, D., Oberhänsli, R., Salem, J., Schneider, G., Yakovleva., N. Resourcing Future Generations: A Global Effort to Meet The World's Future Needs Head-on. International Union of Geological Sciences. 2015, 78pp. http://iugs.org/uploads/RFG%20Report-sm.pdf |
| 9 | RFG policy statement http://www.geolsoc.org.uk/~/media/Files/RFG%20Policy%20Statement.pdf?la=en |
| 10 | Report on critical raw materials for the EU. Report of the Ad hoc Working Group on defining critical raw materials. May 2014 |

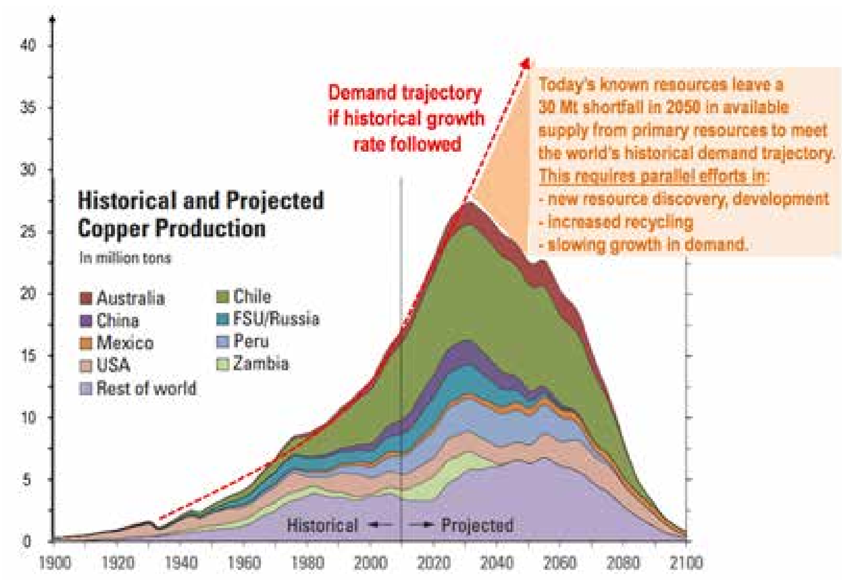


*Figure 7: Historical and projected primary copper production (modified from Kerr, 2014 and Northey et al., 2014).*

generation:

- Wind turbines require rare earth elements for magnets, copper for the generator, and steel and cement for the tower and base;
- PV solar cells require silver for silicon based cells, and cadmium, tellurium, indium, gallium, germanium and ruthenium;
- Energy crops require steel for agricultural machines and mineral inputs for fertilisers.

And finally, the transmission of more renewable energy would require more copper and steel for the electricity power lines and pipelines, and platinum and other specialty metals for catalysts and storage.

Regardless of whether known supplies are enough to cover demand in the near term, efforts must be made now to forestall unpredictable yet inevitable supply shortages in the decades to come – shortages that will dramatically impact deployment of low-carbon technology and whose effect will fall disproportionately on the developing world. Can market forces alone ensure continuity of supply?

The Sustainability Development Goals refer to sharing the wealth generated by mining more equitably and to socio-cultural consequences of geological activities, including nation building. How are such objectives to be delivered? In many countries there is an antithesis to mining. Many countries fear 'resource colonialism' and wish to retain more of the wealth from mining by adding value in-country.

Responsible resource development has the proven potential to alleviate poverty and empower communities and nations, particularly in developing nations, but of the world's 200 or so countries, large-scale mining is focussed on fewer than 60, partly because of geology but also for reasons as diverse as the absence of modern mining law, baseline geological information, transport and communications infrastructure, skilled indigenous workforces and stable

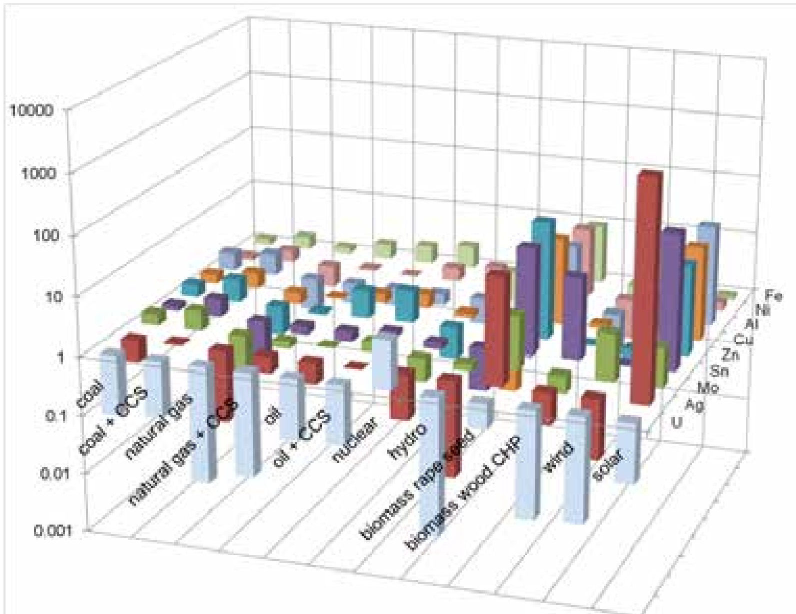


*Figure 8: Requirements of selected metals in different power generation technologies relative to the metal demand of the current mix (Kleijn et al., 2011).*

governance.

New, highly transparent arrangements are needed that recognise the interests of mining companies and populations at local, regional and national level, balancing the use of land for mining against the claims of other industries, agriculture, urban development and ecological demands including water protection, forestry and recreation.

Mining is just one of many uses of land and social acceptance – social licence – cannot be assumed given the legacy of past mining, when natural resource development was often accompanied by undesirable impacts on landscapes, on air and water quality, and on human and wildlife health.

As part of the push toward sustainability – globally, regionally and locally – mining efforts must be pursued responsibly and efficiently to minimise damage to ecosystems and ensure accessible supplies for future generations.

More inclusive arrangements are needed to embrace individual applicant companies, national, regional and local government, local communities and other stakeholder groups, and aimed at delivering Sustainable Development Goals. But who would broker such new arrangements? There are already many actors and arguably no need for new institutional arrangements. So the challenge is to use existing organizations and structures. But how do you encourage dialogue and cooperation?

Much is already going on. The International Resource Panel of the United Nations Environment Programme with the International Council for Metals and Mining could develop and promote such arrangements as best practice. Within Europe, there is a considerable body of work being done under the EU Horizon 2020 programme. And the IUGS RFG initiative is an attempt by the geological community to reach out to others, to recognise the roles of academia, in all its hues, and of industry.

Delivery of the Sustainable Development Goals within the agreed 15-year timetable, with improvement in the quality of life of many of the world's poorest, together with creation of new power generation and transmission technologies to implement the Paris Accord, will increase demand for metals and minerals. To ensure continuity of supply concerted action and agreement at an international level is necessary. The way to achieve that is far from clear, but perhaps by beginning to discuss these matters a pathway will emerge.

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# International Cooperation in Development of Mexican Raw Materials

*Barney Paul Popkin**

*Foreign capital, technology and know-how have long played a role in the development of raw materials in Mexico. Sweeping government reforms in 2015 now allow for private and international investment in its energy sector, encouraging more international cooperation. International partners in cooperation include its northern, wealthy entrepreneurial U.S. and Canadian neighbors, its former Spanish colonial masters, and more recently, more modest cooperation with European, Japanese and Chinese organizations. Prospects for beneficial cooperation could be improved by minimizing some of the weaknesses currently found.*

*Les capitaux étrangers, la technologie et le savoir-faire ont longtemps joué un rôle dans le développement des matières premières au Mexique. Les réformes radicales gouvernementales de 2015 permettent maintenant un investissement privé et international dans ce secteur de l'énergie, en encourageant une coopération internationale accrue. Les partenaires internationaux pour la coopération comprennent ses voisins du Nord, les riches entrepreneurs américains et canadiens, ses anciens maitres de l'Espagne coloniale et plus récemment, une coopération plus modeste avec les Organisations européennes, japonaises et chinoises. Les perspectives pour une coopération profitable pourraient être améliorées par la réduction de quelques unes des faiblesses couramment rencontrées.*

*El capital extranjero, la tecnología y el know-how han jugado un papel importante en el desarrollo de las materias primas en México. Las amplias reformas del gobierno en 2015 permiten ahora inversiones privadas e internacionales en su sector energético, fomentando una mayor cooperación internacional. Los socios internacionales en cooperación incluyen a sus vecinos norteamericanos, ricos y emprendedores de los EEUU y de Canada, sus antiguos amos coloniales españoles y, más recientemente, una cooperación más modesta con organizaciones europeas, japonesas y chinas. Se podrían mejorar las perspectivas de cooperación beneficiosa minimizando algunas de las debilidades que se constatan actualmente.*

The United Mexican States is located south of the USA (***Figure 1***) and covers nearly 2 million km$^2$. It is rich in oil and gas, coal, silver, gold, copper, lead, zinc, minerals and gems, sand and gravel, salt, timber, and seawater. Its varied, largely mountainous terrain, multiple climate zones, and coastal waters provide home to an extraordinarily large biogenetic pool.

For over 500 years, Mexico depended on foreign capital for its raw materials development. Mexico still depends on international cooperation from foreign investors, managers, technologies, and markets. Raw materials were developed for local use, export, political and social reasons, resource independence, as well as investment for profit. For the past 90 years, political and social reasons led Mexico to vacillate between resource nationalization and privatization.

The oil and gas industry and the mining industry are major contributors to the nation's economy. The industries have tended to be under the control of a limited number of major players, either national companies or a select group of landowners; however, the involvement of international partners is becoming more common. ***Table 1*** compares the two sectors and ***Figure 2*** gives information on July 2016 market prices of some major commodities.

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**Oil and Gas Industry**

The oil and gas industry operates through its national monopoly Pemex. Since its founding in 1933 and its quick expatriation of foreign oil company facilities, Pemex was and continues to be heavily subsidized by the Mexican government. Pemex lost money until 1962, when a financial breakthrough occurred after Pemex obtained international credits from the British Board of Petroleum Equipment (GBP 10M) and US financial institutions (USD 50M), including Chase Manhattan Bank, to modernize and stimulate the sector. Over its long history, Pemex has depended heavily on foreign subcontractors to provide technology and service expertise.

The Mexican government has begun to reform its monopoly of its oil and gas sector with a PRI-PAN political alliance which


*Figure 1: Location map of Mexico (CIA, 2016).*

Table 1: Comparison between the Mexican petroleum and mining sectors.

| Oil and Gas Sector | Mining Sector |
|---|---|
| *Mexico is the world's 11th largest oil producer, 13th largest oil exporter, with the 17th largest oil reserves, and 4th largest producer in the Western Hemisphere behind the USA, Canada and Venezuela (CIA, 2014). Oil generates 10% of Mexico's export income and about 33% of collected taxes.*<br>*Ending a 76-year largely unprofitable monopoly, Mexico kept 83% of its petroleum reserves within its Pemex bureaucracy, but in an effort to boost declining income and dwindling productivity, government auctions for foreign firms were announced for new shale gas and offshore oil and gas exploration and development. This unknown reserve is estimated at 20% of future production (Parker, 2014). Exxon-Mobil, Shell, Chevron, Petrobas, BP, Russia's Lukoil, Japan's Mitsui, Toronto's Pacific Rubiales, Dallas' Talos, London's Premier, Italy's Eni are among the over 30 firms chasing this market.*<br>*The Pemex monopoly also runs Mexico's retail gas stations either directly or through small but growing private concessionaires like Groupo Hidrosina, La Gas, and more recently, U.S.-based Gulf Oil.* | *Gold, silver and copper dominate the Mexican mining sector with over 60% of annual production value (Deloitte, 2012).*<br>*Much of Mexico's mining sector is controlled by oligopolies, wealthy families and associations. Grupo Mexico of Cananea, Sonora, holds vast mining interests in Mexico, as well as having interests in Minera Mexico, Ferrocarril Mexicano, Condumex, Southern Copper Corporation, Mexican Railway Group and Ferrosur, Asarco, and International Copper Association Banamex.*<br>*Main foreign investment countries include the USA, Spain, Canada, Netherlands, Germany, Japan, Belgium, and France, with about 8.8% invested in the sector in 2014 (Secretariat, 2016); Canada represents 75% of the total foreign investment related to the mining sector in Mexico (Deloitte, 2012).* |
| ***As crude oil prices dropped** to almost one third of their previous price over the past several years, Pemex has been under pressure to cut its costs and increase foreign investors.*<br>*Pemex seeks a sustained price of USD 25/bbl to at least cover its heavily subsidized costs (Domm, 2016), compared to a 2008 peak of USD 120/bbl.* | ***As copper prices slump**, dipping below USD 2.00/lb in January 2016, or less than half its 2000 high, it traded at a spot price of USD 2.30 most of 2016. Copper prices were on an upswing during autumn and early summer 2016 on signs of more demand from China, but fell to USD 2.11 on news of Britain's vote to leave the EU on June 23, which also adversely impacted copper firms' share price by more than 10 percent on the New York Stock Exchange.*<br>*Copper miners seek a sustained price of USD 2.15 to consider making future expansions (POT, 2016).* |


*Figure 2: Recent commodity post-Brexit prices of selected materials (Metals, Mexico Mining Center and Crude Oil, West Texas Intermediate Crude Oil Spot Price, 9 July 2016).*

enabled the December 2013 approval of constitutional reforms on energy, constitutional reforms in December 2013, and secondary laws approved in August 2014 (Seelke *et al.*, 2015).

Offshore drilling is the main area of expansion, with new discoveries reported recently by Pemex (OET, 2016). Other developments include some financial difficulties for Pemex, hurt by low oil prices. The need to cut costs may thus stimulate further international partnerships and cooperation, as may the push to open up to competition. It was recently reported that the oil industry regulator of Mexico has for the first time approved drilling in Mexico's waters by a firm other than Pemex (Scully, 2016).

## Mining

Mining has been taking place in Mexico since at least the 1500s. Technology introduced from Europe after the Spanish conquest led to expansion in the mining, especially of gold and silver, and metals made up the majority of the exports of "New Spain" for centuries afterwards (MMR, 2013). Couturier (2003) notes the high cost of new mining technologies, the extent of capital transferred to fixed mining works, the improved silver refining methods, the policies of the Spanish crown and its constant need for money, and the foreign control over the mines in the 18th century. The government favored large enterprises and monopolies in the hands of wealthy Spanish merchants.

Taylor (2001) discusses how the silver boom energized Mexican-U.S. trade, the economic development of Southern California, and the Mexican government's attempts to control the mines and their foreign investors in the 19th century. Hart (2008) notes the pre-Mexican Revolution period's silver bonanza. American investors began purchasing mines and expanding their hold on natural resources outside in the mid-19th century and 1910. Technology, industrialization and politics tied Mexican mining communities to the U.S. and China. This led to development which relied on foreign investments, managers and technology.

Shepherd (2000) writes on the silver mining challenges faced by an American silver mining company from 1880 to the early 20th century, while Calderón (2000) discusses the complex mining-driven ideology, economic growth and social disruption in both Mexico and the western U.S. from the late 19th century to 1930. And finally, Lowell (2014) recounts his experience as an American mineral exploration geologist working in Mexico from the mid-20th to the early 21st century.

In May 2008, building on a 100-year legacy of Cornish miners in Mexico, the mining industry issued an Initial Public Offering on the London Stock Exchange as Fresnillo, the world's largest producer of silver. The enterprise raised some USD 2 billion, but London dominates international mining finance. Today, Mexico ranks as one of the world's top metals producers (Deloitte, 2012). Money collected from mining royalties is to go to the Fund for Sustainable Regional Development in Mining Municipalities. A variety of metals are mined in Mexico, including copper (***Figure 3***).

However, metals are not the only products mined in Mexico: other minerals are also abundant (***Figure 4***). Salt, for instance, is also important. In 2014, Mexico exported slightly over 9 million tons of salt from its Exportadora de Sal facility in Baja California Sur (***Figure 5***) – jointly owned by the Mexican Government and Japan's Mitsubishi and worth USD 164M – making it the world's seventh largest world producer and fifth largest salt exporter, after the Netherlands, Canada, Germany and Chile (GeoMexico, 2015).

**Investments and international cooperation**

Investment in Mexico's raw materials is funded by wealthy, traditional landowning and property-rich families, as well as consortia and concessionaires, and of course by foreign investors, donors and the federal government. ***Table 2*** provides some insights into Mexico's mining industry and shows the sectors' importance and trade agreements.

*Figure 3: Grupo Mexico's Cananea mine in Mexico holds the seacond biggest copper reserve in the world. Image courtesy of Lokomen123.*

U.S.-Mexico cooperation includes (Seelke *et al.*, 2015): Bilateral Framework on Clean Energy and Climate Change (2009); North American Development Bank loan of over USD 577M since 2011 for wind and solar energy development; USAID's Mexico Global Climate Change program, a 5-yr, USD 70M greenhouse gas reduction and low emissions program (2011-2014); U.S.-Mexico Trans-boundary Hydrocarbons Agreement, a Gulf of Mexico energy partnership (2012). A USAID pre-2000 "Partnership to promote Clean Technology in the Mining Sector in Latin America and the Caribbean" included pollution prevention in Mexican mining.

Additionally, EU-Mexico cooperation includes: EU-MEX INNOVA (2013-2016) for clean energy development; EU-Mexico Global Agreement (2015) for renewable energies; and the EU-Mexico GEMex (2016-2020) 3-year renewable for geothermal energy, where each party is contributing EUR 20M.

**Potential barriers to international cooperation**

The mining industry faces certain challenges. In 2014, there were more than 37 disputes over land, water, environmental and social issues related to the mining industry. For instance, Gómez (2013) discusses confrontation between the Mexican National Miners' Union and transnational corporations in 2006. Many of the weaknesses listed in the SWOT analysis (***Table 3***) pose major problems for both smooth operation and close international cooperation. Corruption appears to be one such issue, not only on an industrial scale but in terms of daily life, as well (see ***Box 1***). In addition, personal accounts from international experts working in the Mexican mining industry give evidence of working conditions and customs that sometimes hinder safe and efficient operations (see ***Box 2***). Such problems in the mining industry


*Figure 4: USGS Mexican minerals map (January 13, 2013).*

*Figure 5: Loading a salt barge at Exportadora de Sal facility in Baja California Sur, a joint venture of the Mexican government and Mitsubishi of Japan.*

*Table 2: Mexican Secretariat of the Economy mining insights.*

| *Mining in Mexico and the World (Secretariat, 2016)* | *Foreign Trade/Countries with Treaties and Agreements signed by Mexico (Secretariat, 2015)* |
|---|---|
| ***Mexico in the world***<br>• *Ranked first place in silver production worldwide. It ranks among the top 10 world producers in: bismuth, fluorite, celestite, wollastonite, cadmium, molybdenum, lead, zinc, diatomite, salt, barite, graphite, gypsum, gold and copper.*<br>• *It is the first destination in investment in mineral exploration in Latin America and the 4th in the world (SNL Metals & Mining, 2015).*<br>• *It is the 5th country in terms of being the best environment for mining businesses, according to a report by consultancy Behre Dolbear published in August 2015.*<br>• *As of July 2015, the mining-metallurgical sector generated 352,666 direct jobs and 1.6M indirect jobs, according to a report by the Mexican Social Security Institute. The mining-metallurgical sector in Mexico contributes 4% of national GDP.* | • *Mexico has signed bilateral investment treaties with over 30 countries.*<br>• *Mexico has a network of 12 Free Trade Agreements with 46 countries, 32 Agreements for the Promotion and Reciprocal Protection of Investments with 33 countries and 9 agreements of limited scope (Economic Complementation Agreements and Partial Scope Agreements partial) within the framework of the Latin American Integration Association.*<br>• *Mexico is actively involved in multilateral and regional organizations and forums such as the World Trade Organization, the Asia-Pacific Mechanism Economic Cooperation, and the Organization for Economic and Cooperation and Development.* |

*Table 3: SWOT Analysis of international cooperation in Mexican raw materials.*

| SWOT | Analysis |
|---|---|
| *Strengths* | • *Extensive natural resources for development at competitive costs*<br>• *Rising middle class wanting to invest and demanding better and more goods and services*<br>• *Growing economy*<br>• *Favorable labor laws*<br>• *Basic education, training and literacy in Spanish and English*<br>• *Vibrant, young, educated and skilled labor force*<br>• *Awareness of challenges among public sector operators, generous North American donors; well-informed academics, researchers and private sector advisors, consultants, and engineering firms; successful non-governmental organizations*<br>• *Strong maquiladoras (free-trade zones along the U.S.-Mexican border with special privileges for owners, operators and laborers) and shelter companies*<br>• *Good infrastructure: highways, roads, bridges, rail, trucking and shipping*<br>• *Liberalized and favorable US/Mexico trade policies*<br>• *Expedited USA/Mexico customs services; expanding and new ports of entry*<br>• *Favorable regulations and enforcement* |
| *Weaknesses* | • *Corruption, poor governance and public management, institutional and political constraints, threatened press and media, criminality, heavily centralized decision making, embezzlement, bribery, corruption, nepotism/cronyism/favoritism, and lack of trained and motivated personnel*<br>• *Labor shortages and rising labor costs*<br>• *Non-transparent contracting, procurement, bidding regulations and processes*<br>• *Inadequate ports of entry*<br>• *High bank interest rates*<br>• *Economy is highly tied to the U.S. economy*<br>• *Socioeconomic and class stratification*<br>• *Violence involving criminal organizations that presents a risk in parts of Mexico (particularly some areas along the U.S.-Mexico border)*<br>• *Some sectors are reserved exclusively for the Mexican State or for Mexican nationals*<br>• *Logistical, distribution and supply chain challenges*<br>• *Government restrictions on certain foreign investment; red tape, corruption, arbitrary licensing decisions; high mining taxes, tariffs, and fees; archaic legislation; weak intellectual property rights.*<br>• *Claims of government reform may be oversold.* |
| *Opportunities* | • *Growing demand for low-cost, high-quality raw materials*<br>• *Labor costs comparable to Asia-based manufacturing, extensive trade agreements and a strategic location between North and South America*<br>• *Government is positively oriented to foreign investment with efforts to carry out economic reform and new investment opportunities* |
| *Threats* | *Growing national and local movements in environmental protection; threats by indigenous peoples and labor rights movement; materials reduction, reuse, recycling and substitutions; phasing out of fossil fuels; competition; fluctuations in demands and exchange rates* |

may pose barriers to extensive international cooperation.

In order for Mexico to capitalize on its strengths and take advantage of its opportunities (see ***Table 3***) and mineral resources (see ***Figure 4***), some progress in tackling these issues would be highly beneficial.

**Box 1: Personal account of recent Mexican petrol station bribery**

In July 2016, a Mexican-American neighbor planned a sightseeing and shopping visit to Puerto Peňasco, Sonora, Mexico, taking her estranged former husband along with her as his Spanish is better and he is better equipped to bribe the Pemex petrol station operators for a lower fuel price. Bribery is common at border, customs, police and other stations and public facilities in Mexico.

## Conclusion

Mexico has gone through different stages in the development of its raw materials resources – exporting to Spain as a colony for centuries, moving later to nationalization of industries – and seems to be entering a new phase in which international partnerships and cooperation will be more welcome. International investments and projects are in place, especially with its

**Box 2: Personal account of recent Mexican mining inefficiencies by a mining geologist**

On the basis of my year spent at Compania Minera Dolores, State of Chihuahua:

a) Need for expatriates to be given extra protection (i.e. flying between Chihuahua City and the mine site) to avoid possible kidnap by drug runners.

b) Inability of senior Mexican mine management to show an example to their subordinates by adhering to normal work/leave rotation rosters. The general manager (and his assistant) at the Dolores mine worked from Monday morning to Friday morning each week, flying in and out from/to Chihuahua City and spending three days every weekend with their families at home. Everyone else working at the mine was required to work two weeks continuously at the mine, followed by a one-week leave.

c) Inadequacies and unhelpfulness of the Mexican police in upholding the rule of law. There was an incident where the vehicle that brought in food was stopped from progressing to the mine. Certain villagers put up barricades which they refused to pull down unless the mine paid them USD 100,000. The mine manager tried to call in the police but they said that they didn't want to get involved! The matter was finally resolved by involving local politicians, who insisted that the barriers be pulled down.

North American neighbors, but the circle of partners from other areas of the world is expanding. While there are issues to be addressed (corruption, security, bureaucratic red tape, etc.), the opportunities for international cooperation are promising.

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# The firewater trail

*Manuel Regueiro y González-Barros**

*Old Spanish saying:* Una gota de aguardiente deja el estómago caliente y hace al hombre fuerte y valiente *(A drop of firewater warms the buck and makes a man courageous and tough).*

*Firewater has accompanied society since early times. This paper is one small section of a yet-to-be-written book titled* The Spirits of Europe*, which aims to correlate the very varied production of this type of alcoholic drinks in Europe with the geology of the lands where they are produced. The text includes a history of firewater, their types and production modes and presents a representative case in Spain: the geology of the firewater trail.*

*L'eau –de-vie a accompagné la société depuis le début des temps. Cet article est une première ébauche d'un travail plus grand et jamais écrit intitulé* «Les eaux-de-vie de l'Europe» *qui a l'intention de mettre en corrélation la production très variée de ce type de liqueurs en Europe avec la géologie des terroirs où ils sont produits. Le texte comprend une histoire des eaux-de vie, leurs types et modes de production et présente un cas représentatif en Espagne: la géologie de la route de l'eau-de-vie.*

*El aguardiente ha acompañado a la sociedad desde sus tiempos más remotos. Este artículo es un primer borrador de un libro más extenso y nunca escrito titulado* "Los licores y aguardientes de Europa" *que pretende relacionar la producción de este tipo de bebidas en Europa con la geología de los territorios donde se producen. El texto incluye una historia de los aguardientes, sus tipos y métodos de producción y presenta un caso representativo en España: la geología de la ruta del aguardiente.*

**Brief history of firewater**

Although most authors agree that the history of firewater starts with the invention of distillation by Muslims, Berthelot (1885) cites the existence of small alembics or distillation apparatus in the house of "chemists" in Egyptian Alexandria (3rd century B.C.).

The alchemist, pharmacist, philosopher, astronomer, and physicist Jabir ibn Hayyan (died ca. 808 or 815) is considered the father of chemistry. His works – *Book of Chemistry, The Balances and others* – were translated by Robert of Chester (ca. 1144) and Gerard of Cremona (ca. 1187) in Toledo. Jabir described how boiling wine released a flammable vapour, or spirit. *Al-Razi* is credited with identifying ethanol, or grain alcohol. In fact the word alcohol derives from the name *al-ghawl* given to this substance by Muslim chemists, meaning spirit or intoxicant (Qur'an 37:47), incidentially also the source of the English word *ghoul* (an evil spirit or phantom).

*De aqua vitae simplici et compositae* of the French physician and alchemist Perarnau de Vilanova, printed in 1332 (Rodríguez Guerrero, 2010-2013), is considered the first work that mentions firewater by its Latin name of *aqua vitae*, which is still used in Sweden and Norway as a*quavit*, in Denmark as *akuavit* and in Italy as *acqua vitis* or *acqua de vite*. He thought that alcohol was the universal panacea, the "elixir of eternal life" or the dream of alchemists, sought for centuries, as it was considered a fantastic medicine for use against bubonic plague and other infections, although it had a nasty taste and burnt the throat when drinking it. To mask its bad taste, plants and fruit were added, which also had medicinal properties.

The habit of drinking firewater extended to Germany in the 15th century, where it was considered a refinement more than a medicine; at this time the manufacture of firewater from cereals was discovered. Miguel Savonarola wrote a comprehensive manuscript on firewater and made public a procedure to determine the quantity of alcohol contained in the liquor (Valsecchi, 2010). In 1543 Bavaria imposed a tax on firewater consumption. At the end of the 16th century it had become a very common drink in Sweden, and in Russia its consumption then was already as important as it is today.

Potato firewater was first cited in 1682 in a book edited by Backer (Delgado 2007). The first potato distillery was established in 1759 in Monsheim in the Rhineland-Palatinate (Germany).

The 18th century saw the advent of firewater produced from fruit, berries and cereals, and also its prohibition in some places on the grounds of it being a poison. It was then considered the cause of most crimes and vices, a drink of hell and an invention of the devil; it was fought against by societies, ecclesiastic organisations, religions, etc. In fact this is something that still endures…

**Firewater production**

Firewater is a drink of high (40 to 65%) *alcoholic volumetric content* (avc) obtained by the distillation of other liquids and mixtures with a low avc, which are separated using heat, based on the fact that alcohol evaporates at lower temperature than water. At atmospheric pressure both alcohol (ethanol) and water evaporate, but while water boils at 100 ºC, alcohol starts boiling at 78 ºC. Thus, when a mixture of alcohol and water is boiled, alcohol will separate while water will still preserve its liquid state. If alcohol vapours are passed by a coolant an almost pure alcohol will be recovered by condensation.

The time firewater ages in the barrel, in close contact with wood, determines its final properties. Firewater from wine reaches its maximum quality after 15 to 20 years, but gin and other firewater of high avc need very little aging, since after one year they stop improving. The quality of barrels has a great impact on the aging of firewater. Cognac ages in Limousine oak barrels, which improves its quality. Fire-treated white oak provides a special taste to whisky due to tannic substances. In general water evaporates little by little through the wood, so after a certain time the avc rises proportionally to the reduction in the amount of liquid.

**Classification of firewater**

Firewater can be classified in several ways; here we include a classification based on the source material[1]:

1 A more detailed classification at the European level can be found in Council Regulation (EEC) No 1576/89 of 29 May 1989, laying down general rules on the definition, description and presentation of spirit drinks.

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1. **Firewater from wine or grape pomace**
- **Brandy** (i.e. sherry brandy). Minimum avc 36%Vol. The name comes from Holland, where in order to stock the surplus of the wine harvest, Dutch dealers started to distil and store it in small barrels, calling it brandewinj (burnt wine), a name that was later shortened to brandy.
- **Cognac**
- **Armagnac**
- **Orujo** (from grape marc)
- **Liquors.** Hydroalcoholic sweet drinks aromatised with several substances. Avc over 15%.
- **Pisco** (a grape brandy from wine)

2. **Firewater from other sources**
- **Tequila & Mescal.** From agave
- **Kirschwasser.** From cherries
- **Shōchū.** Typically distilled from barley, sweet potatoes, buckwheat, or rice, though it is sometimes produced from other ingredients such as brown sugar, chestnut, sesame seeds, or even carrots. Japanese.
- **Patxaran, pflaumenwasser.** From plum
- **Vodka.** A spirit produced by either rectifying ethyl alcohol from fermented cereal grains or potatoes or filtering it through activated charcoal, possibly followed by straightforward distillation or an equivalent treatment. The product may be given special organoleptic characteristics by the addition of flavouring.
- **Cider, mead, palm wine**
- **Anisette: anise and badian.** Aromatization of ethylic alcohol with aniseed-flavoured essences. Minimum avc 35%.

3. **Firewater from other sugar-containing substances**
- **Rum.** Obtained from alcoholic fermentation and distillation of molasses or syrup from the manufacture of cane sugar. Minimum avc 37.5%, maximum 96%.

4. **Firewater from grain**
- **Gin.** Distilled from fermented grain mash (malt wine) of barley and or other grains. Owes its characteristic taste to the addition of juniper berries. The name comes from the world geneva, a corruption of the French word *genièvre* or Dutch *junever*, both meaning *juniper*. Dutch gin (Geneva, Genever, Ginebra, Schiedam or Hollands) is produced by adding a third of fermented crushed and rectified malt to low avc alcohol, distilling the mixture and adding flavouring and taste agents and then rectifying it again to produce a final product with an avc 43° to 44°. British gin is produced by rectifying a high avc mixture of whiskeys or other alcoholic mixtures so that they lose flavour and taste. Flavouring is done by adding strawberries as well as orris roots, the herb angelica, almonds, coriander, caraway, cardamom, anise, cassia, lemon peel, orange, etc.
- **Whiskey.** Produced by distillation of a mash of cereals and matured for at least three years in wooden casks. Various grains (which may be malted) are used for different varieties, including barley, corn (maize), rye, and wheat, which give the various whisky types: corn whiskey or single malt from one grain, usually barley. A good description of the relation to the important malt whisky producing districts to the geology of Scotland and Northern Ireland and its influences on the taste of a single malt can be read in Cribb and Cribb (1998).

**FIREWATER IN SPAIN**

The alembic tradition was introduced in Spain by Muslims with a simple instrument called *alquitara*, from the Arabic term *al-gattara*, meaning *"that which distils"*. It had three connected pieces: a base or support usually made of cast iron, a pot or boiler, and a top condenser, a semi-spherical expansion chamber with a drain or pipe to extract the liquor. The top case has two holes for the water that cools the condenser.

The alembic was the technical evolution of the *alquitara*, the name comes from *al-ambiq* which in turn comes from the Greek word *ambicos*, meaning vase. The main difference is that the alembic separates the vaporisation and condensation sections of the process. An alembic has a copper boiling pot of variable capacity and a top condenser which is prolonged in a long goose neck (or elephant trunk) that ends in cylindrical cooling condenser which contains a copper cooling coil.

Spain has a long tradition in the manufacture of firewater, as it was considered the "drink of the underprivileged" par excellence. There is evidence of the first *alquitaras* in the year 900 being used to distill wine in the region of Jerez de la Frontera (Fernandez de Bobadilla, 1990).

In Andalusia, the consumption of firewater was traditionally related to hard physical work, such as mining, as it was a custom to drink it before entering the mine, but

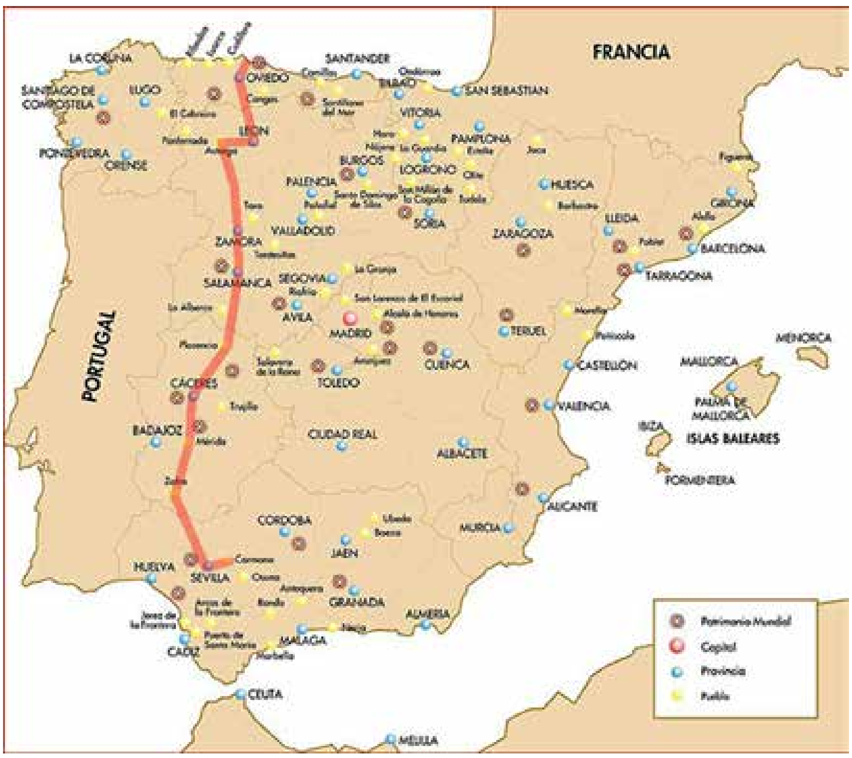

*Figure 1: The Silver Trail.*

is also an after-meal drink. Firewater production was originally much diversified in Andalusia, with several cities with a very relevant production, such as Cazalla de la Sierra (Seville) where very strong local firewater was produced, the famous *cazalla*, or Zalamea la Real, close to the mines of Riotinto and Rute south of Cordoba.

In the northwest, firewater production is typical in Galicia. Galician firewater is produced from the pomace of grapes, from which it takes its traditional name *orujo*. The European Union recognised the Galician tradition of firewater production in its regulation 1576/89, and authorises in Annex II the name *Orujo Gallego* for these types of distilled products. Galicia is the sole Spanish firewater producing region mentioned in this EU norm.

## GEOLOGY OF THE FIREWATER TRAIL

The main firewater production centres in Spain can be linked by a line that follows a well-known ancient Spanish trail: The *Silver Trail* (***Figure 1***) which has also a geological linkage: the Iberian Massif.

### The Silver Trail

The Silver Trail is an old Roman route that crossed Spain south to north, from Merida to Astorga, and today is one of the main north-south bound routes in Spain from Seville to Gijón. The name Silver Trail does not really have to do with the existence of a metal trade, but actually derives from the Arabic word *al-balat*, which means paved route, and described the road engineered by the Romans. The sound of this word in Spanish resembles that of the word *plata* (silver), so probably this confusion was the reason why this name was finally adopted.

The Roman route was built during Augustan times (late 1st century B.C.) to link Emérita Augusta (today Mérida), the capital of the then new province of Lusitania, with the northern territories recently incorporated into the Empire after their conquest. The route was later employed for access to the West during the re-conquest of Spain from the Muslims and finally as a pilgrimage route to Santiago de Compostela, a use that is still maintained today. The radial communication system built in Spain from the 18th century reduced its relevance.

Firewater has been produced and traded along the Silver Trail since its first appearance in Andalusia in the Cordoba sultanate of the Muslim Spain. From the famous brandies of Jerez de la Frontera and Puerto de Santa Maria (Cádiz), the firewaters of Valverde del Camino (Huelva), Rute and Montilla (Córdoba), Ronda (Málaga), Atarfe (Granada) and the cazallas of Cazalla de la Sierra in Seville, to the Galician orujos of Orense, Lugo and A Coruña, passing by the firewaters of Extremadura in the Jerte Valley (Cáceres) and in Almendralejo (Badajoz), the trail can be traced by the different and varied types of spirits that today help the pilgrims in their quest for Santiago.

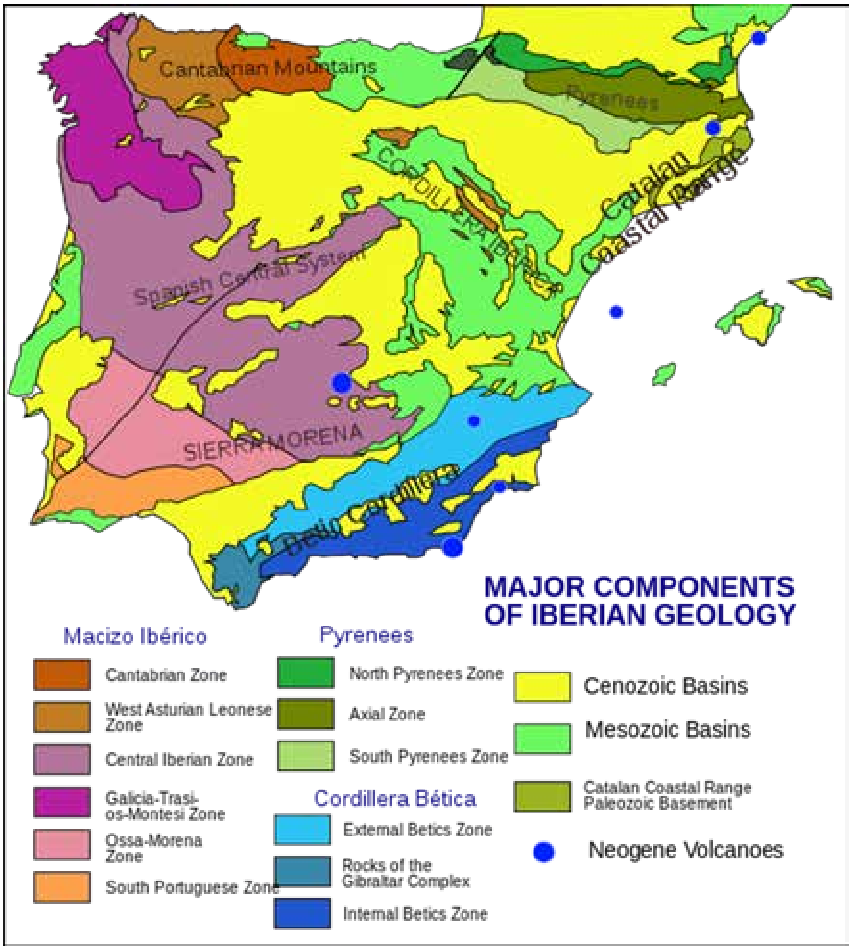


*Figure 2: The Iberian Massif.*

### Geology of the Silver Trail

The geological substrate of the main western Spanish firewater production zones is almost entirely included in the Iberia Massif (***Figure 2***).

The Iberian Massif represents the Precambrian and Palaeozoic rocks cropping in the western half of the peninsula and is sharply limited to the south by the Guadalquivir Valley with Cainozoic sediments. The Massif shows the most complete European outcrops of the Variscan (or Hercynian) orogeny (Middle Devonian and Carboniferous), the result of the collision of two mega-continents: Laurasia and Gondwana, including also small continental masses such as Armorica and Avalonia, and represents the main part of the Pangea supercontinent.

The Iberian Massif was subdivided by Lotze (1945) into six zones according to their stratigraphic, structural, metamorphic and magmatic characteristics: the Cantabrian Zone, Western Asturian-Leonese Zone, Central Iberian Zone, Galicia-Tras-Os–Montes Zone, Ossa-Morena Zone and South Portuguese Zone. These correspond to their position in the old orogeny, thus the Cantabrian and South Portuguese zones are the most external zones, with sediments formed during the orogeny (sin-orogenic) and folds and thrusts tilted to the outside of the chain, whilst the rest of the zones are internal regions with very important deformations, metamorphism and magmatism.

The main firewater production zones in the Silver Trail are geologically located south to north in the Guadalquivir Tertiary basin and three zones of the Iberian Massif.

- **Guadalquivir Tertiary Basin:** The Guadalquivir Basin is an ENE-WSW elongated depression filled with Neogene sediments where the famous brandies of Jerez de la Frontera and Puerto de Santa Maria (Cádiz) are produced. It is a foreland basin located between the Betic Range at the south (active border) and the Iberian Massif (passive border). The substrate of most white firewater white wine producing regions of Burdigalian–Langian–Serravalian age are formed by *moronite* or *albarizas* facies ("whitish) mainly composed by white marls rich in foraminifera, cocolites and diatoms from deep marine environments.

- **Ossa-Morena Zone:** The firewaters of Valverde del Camino (Huelva), Rute and Montilla (Córdoba) and the *cazallas* of Cazalla de la Sierra (Seville), are produced in areas with rocks from Precambrian to the Palaeozoic of a continental block merged during the Variscan Orogeny, generally characterised by low to medium metamorphism and a tectonic foliation related to metamorphic phases. The limits of the zone are marked by rocks of oceanic affinity (ophiolites), which indicates the closure of oceanic zones and suture of continental blocks.
- **Central Iberian Zone:** This is the widest and largest part of the Massif. It corresponds to the central parts of the Variscan orogeny and presents an important amount of granitic batholiths. The firewaters of Extremadura in the Jerte Valley (Cáceres) and in Almendralejo (Badajoz) are produced in this geological zone, which is limited to the north by the Vivero fault and to the south by the Central Unit of the share zone of Badajoz-Cordoba. Stratigraphically it stands out for the transgressive character of the Lower Ordovician, for the preeminence of the pre-Ordovician materials and for the uniformity of the Ordovician and Silurian materials in almost all the zone. The Variscan orogeny magmatism is very well developed in the zone, with alochtonous granites from in-situ melting of pre-orogenic materials.
- **Galicia-Trás-os-Montes Zone:** The northwest of the Massif corresponds to a complex group of alochtonous sheets thrusting 300 km over the Central Iberian Zone. The terrains have a varied source as fragments of oceanic crust or of a volcanic arc and are the source of most Galician *orujos* of Orense, Lugo and A Coruña. This zone has two superimposed thrusting sub-domains, genetically independent. The lower Palaeozoic dominium shows siliciclastic sediments and metavulcanites, and the upper dominium was formed by accretion of materials from very different sources, ophiolitic materials from oceanic crust in several units of the Ordenes and Cabo Ortegal complexes and mixed materials from continental or potential island arch sources, which all together seem to point to the suture of the closure of the Rethic Ocean.

## CONCLUSIONS

Firewater has a deep geological connection, be it for the waters used in the manufacture of the different varieties, or because of the geological subsurface under the soils where the awesome variety of plants employed in its production are grown. The taste of firewater is also the result of the fantastic combination of original plants, waters, soil and subsoil types (from igneous to sedimentary or metamorphic rocks) and the elaborating process.

Firewater has been produced and traded along the Spanish Silver Trail since its first appearance in Andalusia in the Cordoba sultanate of the Muslim Spain. The Silver Trail follows a well-known N-S Precambrian and Palaeozoic geological structure: the Iberian Massif. From the famous brandies of Jerez de la Frontera and Puerto de Santa Maria (Cádiz), the firewaters of Valverde del Camino (Huelva), Rute and Montilla (Córdoba), Ronda (Málaga), Atarfe (Granada) and the cazallas of Cazalla de la Sierra in Seville, to the Galician orujos of Orense, Lugo and A Coruña, passing by the firewaters of Extremadura in the Jerte Valley (Cáceres) and in Almendralejo (Badajoz), the trail can be traced by the different and varied types of spirits that today help the pilgrims in their quest for Santiago.

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*News corner:*
*Compiled by Isabel Fernández Fuentes and Anita Stein, EFG Office*

## Horizon 2020 projects

Horizon 2020 is the biggest EU research and Innovation programme ever, with nearly 80 billion euros of funding available to secure Europe's global competitiveness in the period 2014–2020. Beginning in 2015 the Federation was already involved in four Horizon 2020 projects: INTRAW, KINDRA, MINATURA2020 and ¡VAMOS!. Three new projects started at the beginning of 2016 (UNEXMIN, CHPM2030 and MICA) and another new project began in November 2016 (FORAM). Below you will find descriptions of the topics and aims of the current projects.

### INTRAW

*642130 - INTRAW*
*International cooperation on Raw materials*
*START DATE: 1 February 2015*
*DURATION: 36 MONTHS*

INTRAW, which started in February 2015, aims to map best practices and develop new cooperation opportunities related to raw materials between the EU and technologically advanced countries (Australia, Canada, Japan, South Africa and the United States) in response to similar global challenges. The outcome of the mapping and knowledge transfer activities conducted in the first two years of the project will be used as a baseline to set up and launch the European Union's International Observatory for Raw Materials as a permanent raw materials knowledge management body.

The European Federation of Geologists (EFG) is the coordinator of a consortium of 15 partners from different countries including Australia, the United States and South Africa. Most of EFG's members are also part of the consortium as EFG Linked Third Parties.

EFG reported on the first 18-month period, both technically and financially, including the reports from Linked Third Parties (LTPs) on 30 September 2016. As a project coordinator, EFG collected the activities of the INTRAW partners and submitted the interim report to the European Commission. The project evaluation by the European Commission took place in October 2016. The project received a very positive evaluation for the work done until now.

The representatives of INTRAW's Joint Panels of Experts met in Falmouth, Cornwall (UK), from 5 to 7 October 2016 in order to validate the reports prepared by the project consortium that focus on raw materials related research & innovation, education & outreach and industry & trade in the five reference countries (Australia, Canada, Japan, South Africa and the United States). These three reports underpin the development of a better understanding of the achievements made in the five countries in relation to the entire raw materials value chain and will be presented to the public in 2017. Moreover, the experts also provided precious input on the development of the business model for the International Observatory for Raw Materials. The workshop closed with a visit to the Geevor and Botallack tin mines, which are UNESCO World Heritage sites.

In the framework of the Raw Materials Week (Brussels, 28 November–2 December 2016 organised by the European Commission, DG Growth) the INTRAW Consortium co-organised a workshop. Participants were invited to comment on and elaborate three different possible future scenarios for global raw materials provisioning in 2050. This attempt to look into the long-term future of the mineral raw materials world will be used to explore two pathways: 1) how to prepare for the three scenarios; and 2) which is the desired scenario and how to safeguard against the others.
For more information: ***www.intraw.eu***

### MINATURA2020

*642139 - MINATURA 2020*
*Developing a concept for a European minerals deposit framework*
*START DATE: 1 February 2015*
*DURATION: 36 MONTHS*

MINATURA2020 was launched in February 2015 as a response to social needs to safeguard mineral deposits of public importance for the future. The overall objective of this three-year project is to develop a concept and methodology for the definition and subsequent protection of "Mineral Deposits of Public Importance" (MDoPI) in order to ensure their best use in the future.

EFG is involved in the establishment of the Council of Stakeholders and leads the Work Package on Dissemination (WP6).

Since the project launch EFG has:

- Created the project website and the national pages on the website, collected information from 24 partners in their own languages for the pages.
- Prepared the communication and dissemination plan for MINATURA2020.
- Prepared a poster, two brochures, two press releases and a leaflet about the project,
- Created and maintains the "MINATURA Outreach Table" with all dissemination events,
- Co-organised with APG the international workshop "The importance of geological knowledge for sustainable land use" held on 19-20 May, 2016 in Lisbon.

EFG reported on the 18-month period, both technically and financially on target The project evaluation took place in Dreistetten, Austria, on 27 October 2016. EFG presented the WP6 progress. The completion of the first half of the project was accepted.
More information: ***www.minatura2020.eu***

## KINDRA

*642047 - KINDRA*
*Knowledge Inventory for Hydrogeology Research*
*START DATE: 1 January 2015*
*DURATION: 36 MONTHS*

Groundwater and hydrogeology-related research activities cover a wide spectrum of research areas at EU and national levels. However, groundwater issues are quite often either ignored or considered only in insufficient detail and separated from the associated surface water bodies, despite groundwater's critical importance as a renewable, high-quality, naturally protected (but still vulnerable) resource that has significant impacts on both surface water bodies and ecosystems. The EU-funded KINDRA project seeks to take stock of our current knowledge of hydrogeology through an inventory of research results, activities, projects and programmes.

The European Federation of Geologists (EFG) is the leader on data collection and processing to carry out an EU-wide assessment of existing practical and scientific knowledge (using the developed HRC-SYS) focussing on EU, national, regional, international and EU-third party scientific activities. This assessment will be implemented with the help of the national members of EFG. EFG is also involved in the dissemination activity. Most of EFG's members are also part of the consortium as EFG third parties.

An amendment to the KINDRA Grant Agreement was presented on 28 September 2016 for the termination of the Linked Third Party (LTP) French Geological Society and assignment of its tasks and budget to EFG. The work of the French LTP will be carried out by an expert employed by EFG (Marina Alazard) with the support of the French national chapter of the International Association of Hydrogeologists. The EFG Office assists with technical support. The French national workshop was organised as a KINDRA session within the 43rd annual congress of IAH, Montpellier (France) on 27 September 2016. The session was coordinated by EFG in collaboration with the KINDRA Coordinator and Partners.

EFG reported on the first 18-month period, both technically and financially, including the reports from LTPs on 30 September 2016. The project evaluation by the European Commission took place in Brussels on 24 October 2016. The project received a very positive evaluation for the work done until now.

National workshops have been organised in the countries covered by the LTPs. A full calendar with the dates of all national workshops is available on the KINDRA website. The deadline for this action was October 2016; however, some national workshops have been organised after this date due to links with other national events.

The national experts from each Linked Third Party (LTPs) are providing national data to the European Inventory on Groundwater Research (EIGR). In addition to adding data to the KINDRA inventory, the national experts will provide a Country report. In this report the LTPs need to supply "qualitative" information concerning procedures for uploading research/knowledge to the EIGR in the particular country.
More information: ***www.kindraproject.eu***

## ¡VAMOS!

*642477 - VAMOS*
*¡Viable and Alternative Mine Operating System!*
*START DATE: 1 February 2015*
*DURATION: 42 MONTHS*

The aim of the EU-funded ¡VAMOS! (Viable Alternative Mine Operating System) project is to design and build a robotic underwater mining prototype with associated launch and recovery equipment, which will be used to perform field tests at four EU mine sites. The project consortium passed a major milestone in September 2015 with the successful delivery of conceptual design plans of the prototype and all associated equipment.

EFG supports the project through stakeholder engagement and dissemination activities.

EFG reported on the first 18-month period, both technically and financially, on 30 August 2016. The project evaluation by the European Commission took place in Brussels on 4 October 2016.

Within Work Package 1, EFG presented the outcomes from the two stakeholder workshops organised within the project. The project received a very positive evaluation for the work done until now.

After 18 months the ¡VAMOS! Consortium has reached the "design freeze" stage of the prototypes to be built. More info on this: http://vamos-project.eu/vamos-reaches-design-freeze-milestone/

EFG will stay active in project dissemination via the EFG news section and communication tools.
More information: ***http://vamos-project.eu***

## UNEXMIN

*690008 - UNEXMIN*
*Autonomous Underwater Explorer for Flooded Mines*
*START DATE: 1 February 2016*
*DURATION: 45 MONTHS*

Thirteen organisations from seven countries across Europe are collaborating in this ambitious project to develop a submersible robotic system for surveying and exploring flooded mines. The €5M project, funded by the European Union's Horizon 2020 research programme, will include the development of a Robotic Explorer (UX-1) for autonomous 3D mine mapping to gather valuable geological information that cannot be obtained in any other way: in general the mines are too deep and dangerous for access by human divers.

Some of EFG's national associations participate in this project as Linked Third Parties and support the consortium through data collection for the inventory of flooded mines. EFG also supports the Work Package on dissemination and EFG's Third Parties will disseminate the project results at national level in web portals, newsletters, conferences, workshops, educational activities, exhibitions or by any other relevant means.

The UNEXMIN consortium had a meeting in Madrid in October 2016 to discuss advancements on software and hardware decisions related to the UX-1 robot development. The post-processing data analysis and database were also discussed. This second follow-up UNEXMIN workshop, organized on 25 and 26 October 2016, served to get the project team together in order to discuss very important aspects of the project and the UX-1 developments.

More information: ***www.unexmin.eu***

## CHPM2030

*654100 - CHPM*
*Combined Heat, Power and Metal extraction from ultra-deep ore bodies*
*START DATE: 1 January 2016*
*DURATION: 42 MONTHS*

The CHPM2030 project aims to develop a novel, pilot level technology that combines geothermal resource development, minerals extraction and electro-metallurgy in a single interlinked process. In order to improve the economics of geothermal energy production, the project will investigate possible technologies for manipulating metal-bearing geological formations with high geothermal potential at a depth of 3–4 km in order to make the co-production of energy and metals possible; potentially this could be optimised according to market demands in the future. Led by the University of Miskolc (Hungary), the project will be implemented through the cooperation of 12 partners from 10 European countries.

EFG supports the activities for the CHPM2030 methodology framework definition (WP1), particularly European data integration and evaluation: during the first months of the project, EFG's Linked Third Parties (LTP) collected publicly available data at a national level on deep drilling programmes, geophysical and geochemical explorations and any kind of geo-scientific data related to the potential deep metal enrichments. They also collected data on the national geothermal potential. Guidelines and templates for data collection were provided by EFG.

During the second year, EFG will support the road mapping and preparation for Pilots (WP6), European Outlook. EFG's Linked Third Parties will assess the geological data on suitable ore-bearing formations and geothermal projects collected in WP1, in relation with the potential application of the CHPM technology. This work will combine these data with the outcomes of the most recent predictive metallogenic models. Only existing datasets will be utilised; no new surveys will be carried out.

EFG also leads the Work Package on dissemination and has produced so far the following deliverables: Final project web site; Project image and stylebook; Communication and dissemination plan; Brochure (1st edition); Newsletter 1 and Press release and media kits.

The 2nd Consortium Meeting and the first meeting with the CHPM2030 Advisory Board members were heldon 12– 14 October 2016 in Älvkarleby (Sweden). The project partners evaluated the work done so far and made a detailed plan for the following year. The Advisory Board provided valuable input for the further development of the project.

More information: ***http://chpm2030.eu***

## MICA

*689648 - MICA*
*Mineral Intelligence Capacity Analysis*
*START DATE: 1 December 2015*
*DURATION: 26 MONTHS*

The MICA project brings together experts from a wide range of disciplines in order to ensure that Raw Materials Information is collected, collated, stored and made accessible in the most useful way in order to correspond to stakeholder needs. Hence, the goal for MICA is to provide stakeholders with the best possible information in a seamless and flexible way using an ontology-based platform, the European Union Raw Materials Intelligence Capacity Platform (EU-RMICP). To accomplish this goal, MICA will assess sources of relevant data and information and conduct analyses of appropriate methods and tools in order to provide guidelines and recommendations.

EFG supports the Work Package on communication, outreach and linkages. In collaboration with EuroGeoSurveys, EFG will be involved in the development of the communication strategy, the engagement with geosciences data providers, and professionals and public outreach.

EFG participated in the MICA meeting in Brussels from 27 to 29 September 2016 where the WPs were presented and progress so far was discussed. EFG also prepared and distributed a questionnaire and collected data through an online survey within WP2 and conducted two interviews with major stakeholders (Initiative for responsible mining and Industry All Global Union) in order to find out their needs for and expectations of the MICA platform.

More information: ***http://mica-project.eu***

## FORAM

*730127 – FORAM*
*Towards a World Forum on Raw Materials*
*START DATE: 1 November 2016*
*DURATION: 24 MONTHS*

The project Towards a World Forum on Raw Materials (FORAM) will develop and set up an EU-based platform of international experts and stakeholders that will advance the idea of a World Forum on Raw Materials and enhance the international cooperation on raw material policies and investments. This platform will work on making the current complex maze of existing raw material related initiatives more effective. As such, the FORAM project will be the largest collaborative effort for raw materials strategy cooperation on a global level so far. Synergies with relevant EU Member State initiatives will be explored and fostered. Particularly, the project will seek to engage the participation of G20 member countries and other countries active in the mining and other raw materials sectors, so that experiences will be shared and understanding of all aspects of trade in raw materials will be increased.

The FORAM project is coordinated by the World Resources Forum Association (WRFA) and supported by eleven additional leading organisations (EuroGeoSurveys, European Federation of Geologists, United Nations University, Leiden University, University of Kassel, Clausthal University of Technology, ESM/Matsearch, Gondwana Empreendimentos e Consultorias, Servicio Geológico Colombiano, MinPol GmbH and La Palma Research Centre for Future Studies SL), which compose the FORAM consortium.

EFG leads Work Package 3 on "Strategic Planning" which will set the stage for the World Forum on Raw Materials (WFRM) using a highly participative process. WP3 will define and present a long-term vision and its strategic positioning, as well as an appropriate framework to measure performance and to respond to geo-political, technological and economic changes.

The FORAM project was officially launched on 30 November 2016 in Brussels, during the first Raw Materials Week organised by the European Commission. More information: ***http://foramproject.net/***

## EFG/UNFC workshop: International cooperation on natural resources: geoscientists' contribution to enhanced governance, policy making and attainment of the Sustainable Development Goals

*Royal Belgium Institute of Natural Sciences, Brussels, Belgium, 9 (afternoon) and 10 (full day) February 2017*

**Co-organisers:** EFG, UNECE

**Aim:** This conference will foster the convergence of terminology and the comparability/compatibility of data, thus contributing to the creation of a solid European Knowledge Database on mineral and energy resources. Such harmonisation is equally important to government policymakers and to companies and regulators within the energy and minerals industries, including the users and providers of data on energy and minerals reserves and resources and renewable energy. The UNFC will be reviewed, including its potential for application in Europe and beyond and its relationship with other classification and public reporting systems.

**Audience – who should attend?** The conference provides a unique opportunity to discuss a transparent and harmonised classification framework for fossil and renewable energy sources and minerals in a cross-disciplinary environment, including EU policymakers, UN representatives, international energy experts, national government officials, academics, energy and minerals company executives, as well as finance, industry and environment experts. Pre-register now by sending an email to ***info.efg@eurogeologists.eu***

**More information:** ***http://eurogeologists.eu/event/international-cooperation-on-natural-resources-geoscientists-contribution-to-enhanced-governance-policy-making-and-attainment-of-the-sustainable-development-goals/***

## News from the 72nd EFG Council Meeting, 19– 20 November 2016, Brussels

**Board members elected:**

During the meeting two Board members were elected. Vitor Correia was re-elected for a third term as EFG President.

Marko Komac has been elected to the position of External Relations Officer. Marko is currently an independent consultant and researcher, an occasional lecturer at two Slovenian universities as an associate professor and an ardent sportsman. He has been involved in several international organisations in the past, more precisely from 2006 on and during that time he has gained excellent networking, facilitating and diplomatic skills, excellent managing and organisational skills in the field of research institutions and teams (also at the international level). In the period 2006–2014 he was a director of the Geological Survey of Slovenia and from 2013 to 2016 he was a Managing Director of the OneGeology Consortium. In 2011 and 2012 he was President of EuroGeoSurveys and in the period 2012– 2016 the Vice-President of the IUGS. From 2015 on he has been the officially appointed delegate of the Slovenian Geological Society (SGD) at EFG. Marko holds a PhD in geology and is specialised in GIS applications in geological sciences, spatial analyses, remote sensing, satellite imagery and graphical analysis, geohazard analysis and assessment, landslide susceptibility analysis, and spatial modelling. He speaks Slovenian, English, less advanced French, Croatian, Serbian, and has just started to learn Russian.

**New EFG member: Bulgarian Geological Society (BGS)**

EFG is glad to welcome a new full member, the Bulgarian Geological Society (BGS). BGS was founded in 1925 and is presently headquartered in Sofia. The BGS mission is contributing to geological knowledge and the active protection of the geological heritage of Bulgaria, promoting achievements of the BGS' members and the national geology, advancing cooperation with similar organisations in Bulgaria and abroad, supporting the development of geological education and raising the qualifications of workers in the field of earth sciences and geological practice, raising the prestige of the geological profession and protection of the interests of Bulgarian geologists, as well as being the public corrective of state policy in the field of geology.

With the addition of the Bulgarian Geological Society, EFG now counts 25 national membership associations in 26 European countries.

**EFG speaks out against sexual harassment in sciences**

An update to the EFG Code of Ethics (Regulation C1) related to the working environment was unanimously approved by the EFG Council at the 72nd EFG Council meeting held in Brussels on 19 and 20 November 2016. This is particularly pertinent as geoethics and professionalism are core objectives of the EFG. Through consultation with and much appreciated cooperation and contributions from Silvia Peppoloni (IAPG – International Association for Promoting Geoethics) and Jesús Martínez-Frías (IAGETH – International Association for Geoethics), the following addition has been made to the EFG's Code of Ethics:

*'A respectful and fruitful working environment is fundamental for maintaining a high level of professionalism. Therefore, discrimination or harassment, either sexual or of any other kind, is unacceptable because it offends the dignity of persons and seriously undermines the atmosphere of trust essential to the work of all geologists'.*
For more information, the EFG Statutes and Regulations are available at the following link: ***http://eurogeologists.eu/statutesregulations***

The approach adopted by EFG is fully in line with recent initiatives by several scientific societies speaking out against sexual harassment. Amongst others, leaders from scientific and professional societies, government agencies, and academia gathered in Washington DC in September 2016 to discuss the challenge of sexual and gender-based harassment in the sciences. This meeting was convened by the American Geophysical Union (AGU) following several recent cases of harassment in the field of sciences. As an outcome, AGU recently published the "Draft Organizational Principles for Addressing Harassment", a set of guidelines for organisations willing to affirm their opposition against harassment.

**EFG Medal of Merit**

During its 72nd meeting, the EFG Council decided unanimously to award the EFG Medal of Merit for 2016 to Professor Iain Steward. The award ceremony is scheduled for the next EFG Spring Council meeting, in Santorini, Greece, on 20–21 May 2017.

Iain Simpson Stewart is a Scottish geologist and is currently Professor of Geoscience Communication at the University of Plymouth. Internationally known both for his academic expertise and charismatic ability to communicate with the general public (he was a child actor on TV at the age of 14), Professor Stewart's expertise is in the area of Earth hazards and natural disasters, particularly in identifying past major earthquakes, tsunamis and volcanic eruptions in the Mediterranean region. Through his television programmes he has brought the reality of geology to everyone in showing globally how geology has generated the environment in which we live, the catastrophic forces that have affected mankind and the climate change issues that shape our future.

The award of the EFG Medal of Merit recognises his outstanding contribution in elevating the profile of geology around the world.

## EAGE/EFG Photo Contest 2016

EFG and the European Association of GeEFG and the European Association of Geoscientists and Engineers (EAGE) again jointly organised their photo contest 'Geoscientists at work'. Members of EFG and EAGE were invited to submit their photos in the following sub-categories: 1) Education & training, 2) Landscapes & environment, 3) Fieldwork and 4) Energy.

An impressive number of photos was submitted by the deadline for participation (March 2016) and a vote determined the 12 most popular photos, which were shown during the 78th EAGE Annual Conference & Exhibition 2016 (30 May – 2 June 2016 in Vienna, Austria) and at the EAGE Near Surface Geoscience Annual Meeting 2016 (4-8 September 2016 in Barcelona, Spain).

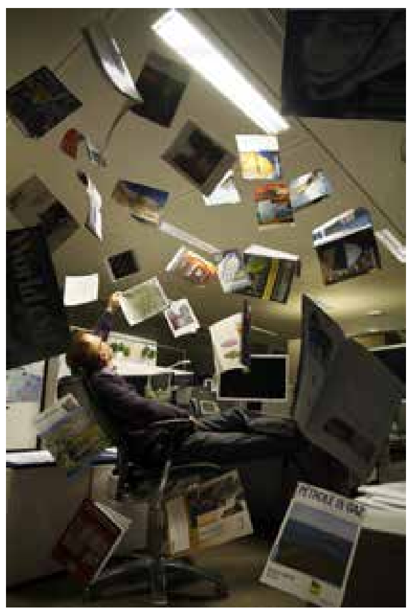
Voting for the best three photos by EAGE and EFG members closed on 9 September. This year's competition winner is Mahmoud Hamdy for his photograph 'Tough Work' taken in August 2015 at Meliha Field, Western Desert, in Egypt. Second place went to Catalina Llano Ocampo for her 'Inside Out' (January 2014, Haukadalur Valley, Iceland) and third place to Nicolas Nosjean's 'Flying Publications' (December 2015, Engie Paris La Defense Head Office, France). The first prize was a tablet, the second prize a book and an EAGE bookshop voucher of €100, and the third prize a book plus an EAGE bookshop voucher of €50.

The top 12 photos show the great diversity of 'Geoscientists at work' with pictures portraying different geological structures and activities. For those who missed the photos or want to see them again, you can enjoy them throughout next year by ordering the 2017 calendar containing the best 12 'Geoscientists at Work' photographs. You may order the calendar through the EAGE bookshop at ***http://bookshop.eage.org/Webshop/product_details.aspx?prod_code=ZA0036&cat_code***. Photos for next year's Photo Contest can be submitted from 1 January 2017.

More information: ***http://houseofgeoscience.org/photocontest***

*Mahmoud Hamdy 'Tough Work'*

*Catalina Llano Ocampo 'Inside Out'*



*Nicolas Nosjean 'Flying Publications'*

# Submission of articles to European Geologist Journal

## Notes for contributors

The Editorial Board of the European Geologist journal welcomes article proposals in line with the specific topic agreed on by the EFG Council. The call for articles is published twice a year in December and June along with the publication of the previous issue.
The European Geologist journal publishes feature articles covering all branches of geosciences. EGJ furthermore publishes book reviews, interviews carried out with geoscientists for the section 'Professional profiles' and news relevant to the geological profession. The articles are peer reviewed and also reviewed by a native English speaker.
All articles for publication in the journal should be submitted electronically to the EFG Office at ***info.efg@eurogeologists*** according to the following deadlines:

- Deadlines for submitting article proposals (title and content in a few sentences) to the EFG Office (***info.efg@eurogeologists.eu***) are respectively 15 July and 15 January. The proposals are then evaluated by the Editorial Board and notification is given shortly to successful contributors.
- Deadlines for receipt of full articles are 15 March and 15 September.

## Formal requirements

*Layout*

- Title followed by the author(s) name(s), place of work and email address,
- Abstract in English, French and Spanish,
- Main text without figures,
- Acknowledgements (optional),
- References.

*Abstract*

- Translation of the abstracts to French and Spanish can be provided by EFG.
- The abstract should summarise the essential information provided by the article in not more than 120 words.
- It should be intelligible without reference to the article and should include information on scope and objectives of the work described, methodology, results obtained and conclusions.

*Main text*

- The main text should be no longer than 2500 words, provided in doc or docx format.
- Figures should be referred in the text in italic.
- Citation of references in the main text should be as follows: 'Vidas and Cooper (2009) calculated…' or 'Possible reservoirs include depleted oil and gas fields… (Holloway *et al.*, 2005)'. When reference is made to a work by three or more authors, the first name followed by '*et al.*' should be used.
- Please limit the use of footnotes and number them in the text via superscripts. Instead of using footnotes, it is preferable to suggest further reading.

*Figure captions*

- Figure captions should be sent in a separate doc or docx file.

*References*

- References should be listed alphabetically at the end of the manuscript and must be laid out in the following manner:
- Journal articles: Author surname, initial(s). Date of publication. Title of article. Journal name, Volume number. First page - last page.
- Books: Author surname, initial(s). Date of publication. Title. Place of publication.
- Measurements and units
- Measurements and units: Geoscientists use Système International (SI) units. If the measurement (for example, if it was taken in 1850) was not in SI, please convert it (in parentheses). If the industry standard is not SI, exceptions are permitted.

*Illustrations*

- Figures should be submitted as separate files in JPEG or TIFF format with at least 300dpi.
- Authors are invited to suggest optimum positions for figures and tables even though lay-out considerations may require some changes.

## Correspondence

All correspondence regarding publication should be addressed to:
EFG Office
Rue Jenner 13, B-1000 Brussels, Belgium.
E-mail: ***info.efg@eurogeologists.eu***

## Note

All information published in the journal remains the responsibility of individual contributors. The Editorial Board is not liable for any views or opinions expressed by these authors.

## Subscription

Subscription to the journal:

15 Euro per issue

## Contact

EFG Office
Rue Jenner 13, B-1000 Brussels, Belgium.
E-mail: ***info.efg@eurogeologists.eu***

# Advertisements

EFG broadly disseminates geology-related information among geologists, geoscientific organisations and the private sector which is an important employer for our professional members, but also to the general public.

Our different communication tools are the:

- EFG website, ***www.eurogeologists.eu***
- GeoNews, a monthly newsletter with information relevant to the geosciences community.
- European Geologist, EFG's biannual journal. Since 2010, the European Geologist journal is published online and distributed electronically. Some copies are printed for our members associations and the EFG Office which distributes them to the EU Institutions and companies.

By means of these tools, EFG reaches approximately 50,000 European geologists as well as the international geology community.

With a view to improving the collaboration with companies, EFG proposes different advertisement options. For the individual prices of these different advertisement options please refer to the table.

## Prices for advertisements

| **EGJ** | **One Insertion** | **Two Insertions** |
|---|---|---|
| Full page (colour) | 820 Euro | 1320 Euro |
| Half page (colour) | 420 Euro | 670 Euro |
| Quarter page (colour) | 220 Euro | 350 Euro |
| Full page (black and white) | 420 Euro | 670 Euro |
| Half page (black and white) | 220 Euro | 350 Euro |
| Quarter page (black and white) | 120 Euro | 200 Euro |
| Business card size | 90 Euro | 150 Euro |
| Preferential location | 25% plus | |
| Price for special pages: | | |
| Outside back cover (colour) | 1200 Euro | 1900 Euro |
| Second page (colour) | 1000 Euro | 1600 Euro |
| Second last page (colour) | 1000 Euro | 1600 Euro |

| **Geonews** | **Annual Price** |
|---|---|
| Ad and regular newsfeed | 1500 Euro |
| **EFG Homepage** | |
| Ad and regular newsfeed | 1500 Euro |
| **University ad** | |
| Ad for training opportunities in the job area of the homepage | 500 Euro |
| **Annual package** | |
| Business card size ad in EGJ, GeoNews and homepage. | 3000 Euro |