

**CONFERENCE REPORT: raw materials diplomacy
event 'Exchange of best practices on mining
policies and technologies: challenges in the
current state of the global economy'**

28-29 June 2016

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1. Executive summary

The conference 'Exchange of best practices on mining policies and technologies: challenges in the current state of the global economy' took place on 28 and 29 June 2016 at the Metropole Hotel in Brussels.

The conference was attended by close to 130 high-level participants representing mining ministries and geological surveys in the EU, Australia, Canada, Chile, Mexico, Peru and South Africa, as well as delegates from DG DEVCO, DG ENV, DG GROW, the JRC, research institutions, industry and other interested organisations.

The audience discussed the requirements for pursuing sustained and inclusive growth while addressing the mining industry's **cost and productivity challenges** in view of low commodity prices. Because of falling raw material prices, mining companies have cut operating costs and **withheld investments**. However, raw materials remain of prime importance for the economy. In order to avoid future raw material supply shortages and price peaks it is important to keep investing in mining projects. A collection of best practices addressing investment shortages were presented and discussed.

Mining waste management embraces environmental, safety, economic and regulatory issues. Both industry and society face substantial challenges in this area. Participants discussed how **international cooperation** would benefit global resource efficiency and the recovery of resources, from social acceptance, legal, and research and innovation points of view. The economic factors most influencing the transformation of mining waste from the past into valuable resources today were also discussed.

It was acknowledged that worldwide sustainability standards for resources that ensure a level playing field are needed. An economic level playing field that allows for the development of efficient resource production and use is also necessary. So that mining activities remain economically viable, **legislation** must be consistent and practicable. Permitting delays are holding up investment projects in the mining industry. Prolonged permitting processes often jeopardise the value of mines.

Delegates also discussed how to ensure **environmental protection** and to contribute to the **circular economy** by both promoting the recycling of raw materials and treating mining waste as a **secondary resource of raw materials**. Relevant European and international legislation was presented. Various presentations demonstrated that technology-wise, **re-use and recycling of mining waste** is possible. The question is more whether the process is economically viable. Tailings present not only environmental but also severe economic risks. Best practices in **tailing management** were shared and discussed. International best practices in **mine rehabilitation** were also shared. When carried out correctly they can reverse environmental problems and the impacts of centuries of mining activity.

Resource policy issues must be integrated into international dialogues and policies and must be effectively communicated to relevant stakeholders. Without **social acceptance** of mining it will not be possible to have long term sustainability. Industry needs raw materials and the question is how this can be communicated. The general public needs to understand the paramount importance that raw

materials have for industry. Some best practices in mediating social conflict and inciting **citizen engagement** were presented and discussed.

Innovation is needed along the whole value chain to optimise the use of the world's resources to the benefit of its entire population. Technology transfer and **scientific collaboration across the entire value chain** of raw materials was promoted. International research projects were presented. The audience was invited to make full use of future project opportunities and to provide DG GROW with ideas and suggestions for future research projects.

2. Welcome

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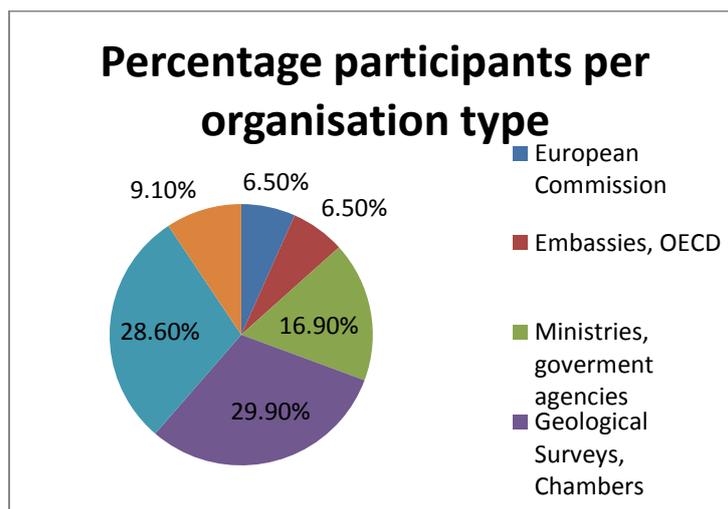


Figure 1: 'Exchange of best practices on mining policies and technologies: challenges in the current state of the global economy'

The conference was opened by the Director General of DG GROW, Ms **Lowri Evans**. She invited the audience to dialogue on best practices among mining policies and technologies in the context of the economic slowdown and decreasing commodity prices. The mining sector has cut exploration expenditure and is launching fewer projects. But to avoid supply shortages in the future, now is the time to innovate and to invest. Ms Evans reaffirmed the EU's continued commitment to the Raw Materials Initiative, which has led to the creation of the European Innovation Partnership (EIP) on Raw Materials, a stakeholder platform with over 900 partners that engage on a voluntary basis on 123 joint undertakings (so-called "commitments") with a total value of € 3 billion.

The Critical Raw Materials list provided by the Raw Materials Initiative is a foresight tool to help identify and address challenges related to security of supply. Ms Evans announced the European Minerals Raw Materials and Recycling Investment Platform under the European Fund for Strategic Investments (EFSI), intended to help address the investment deficit in Europe that is affecting – inter alia – the mining industry. She presented the new Circular Economy Package adopted in December 2015 that is designed to help European businesses and consumers make the transition to a stronger and more circular economy, where resources are used in a more sustainable way across the entire production cycle. Care needs to be taken to use technology as a source of competitive advantage, and at the same time as a tool to respect high environment and health and safety standards. Horizon 2020 has so far yielded excellent results and continues to be open to global cooperation with € 600 million having been earmarked for projects on raw materials until 2020.

3. Challenges for the mining sector in the current state of the global economy and commodity prices: Part I

The session was chaired by Director General of DG GROW, Ms **Lowri Evans**. In Part I, high-level speakers from mining ministries and councils in Australia, Peru and South Africa, and from Europe's Geological Survey's umbrella organisation, - the EGS - shared information on mineral policy frameworks and on activities and challenges in their respective countries' mining sectors. Without social acceptance of mining it will not be possible to have long-term sustainability. Industry needs raw materials, but the question is how this can be communicated in order to obtain social acceptance. The general public needs to understand the paramount importance raw materials have for industry. A good practice was shared: in Peru, round tables in cities near to mining sites have been established by the government. Mutually beneficial agreements between producer and consumer countries are also needed to attain sustainable development in African. The Minerals Council of Australia shared insights into how the Australian mining industry was able to increase efficiency. The EGS gave an overview of how the European Geological Surveys encourage mineral exploitation by providing information on the availability of resources.

Peru

The Peruvian Vice minister of Mines, Mr **Guillermo Shinno**, presented the challenges for the Peruvian mining sector in the new global economic environment. Peru is competitive cost-wise due to favourable energy prices, and it has many deposits still worth exploring. It is also streamlining mining permits legislation and it facilitates mining investment. Over three years the Peruvian ministry of mines has also been developing social management strategies that focus on early relationship-building between companies and neighbouring communities, and on monitoring social commitments. The Peruvian government promotes regional and local development through round tables in cities near mining sites. The round tables address the lack of investment in local communities and draw up development plans to improve living conditions in local communities.

South Africa

Ms **Zarina Kellerman**, special mineral resources advisor, conveyed greetings from the South African minister of mineral resources, Mr Mosebenzi J. Zwane. Mining is the economic heartbeat of the South African economy. In 2013 it accounted for around 10% of GDP and 40–50 % of exports. The country was impacted by decreasing raw materials prices, leading to a \$ 17 billion drop in export earnings between 2011 and 2014 and a substantial decline in receipts from royalties. The African Mining Vision, endorsed by the African Union (AU), aims to attain sustainable development and transformation of the continent's vast mineral endowment. To reach this goal, both a transparent regulatory framework and diversification of the sector through minerals beneficiation and value addition are necessary. African countries need significant investments and processing technology to explore their potential. Mutually beneficial agreements between producer and consumer countries are needed to foster sustainable partnerships. Delegates acknowledged that relationships are good but could be further improved.

Australia

Mr **Brendan Pearson**, Chief Executive of the Minerals Council of Australia, gave an Australian perspective on the fluctuations and tribulations within the commodity cycle. The Australian mining sector is growing in spite of decreasing commodity prices. This can be explained by an investment boom within the country that stemmed from demand driven by increasing industrialisation in Asia. The price and investment boom have been accompanied by a cost boom. When prices began to fall in 2012 industry reduced production costs through more efficient use of equipment and staff. On the policy side, Australia's elevated mining and carbon taxes have been revoked.

Europe

The president of EuroGeoSurveys (EGS), Mr **Koen Verbruggen**, gave his view on how the EU and its Geological Surveys are rising to the minerals and assessment challenges. The world increasingly needs greater varieties of raw materials and minerals, thereby putting more pressure on the mining industry and increasing the EU's mineral dependency. The national governments and geological surveys encourage mineral exploration. Geological Surveys contribute to projects such as ProMine and Tellus to provide information on the availability of resources.

4. Challenges for the mining sector in the current state of the global economy and commodity prices: Part II

The session was chaired by Industrial Minerals Association (IMA) scientific advisor Ms **Aurea Shitzia**. In Part II, government agents and agencies from Australia, Chile and Mexico, together with EIT Raw Materials, described and discussed how they pursue sustained and inclusive economic growth, social development and environmental protection. The government of Western Australia reduces mining red tape to improve industry productivity and encourage investment. The Chilean mining industry is reducing costs and is following the national mining roadmap to improve technological, social and environmental mining processes. A good practice addressing the investment gap faced by the mining industry was presented: the provision of loans by the Mexican government agency FIFOMI. EIT Raw Materials promotes public-private partnerships in the European mining sector.

Australia

Government of Western Australia agent Mr **John Atkins** gave an overview of challenges and opportunities for his region's mineral sector. According to the Frazer Institute, Western Australia is ranked the world's most attractive mining investment destination. He discussed the division between Government levels, as well as the roles of the State and of the Federal Government with regard to ownership, taxes and royalties of mineral resources. In 2015, Western Australia achieved a large increase in the volume of mineral resources produced that has partially offset decreases in the value of commodities. Strong demand and higher prices for lithium and rare earth, both needed as battery raw materials, are driving investment into new and niche areas. Mr Atkins gave an overview of the Government's endeavours to reduce mining red tape to help improve productivity and competitiveness in the industry, to mitigate the effects of the commodity price downturn on junior miners, and to encourage exploration expenditure. He underlined that now is the time to invest – to take advantage of low costs across the resource sector. This is needed to avoid future price peaks as experienced in the past.

Chile

The Director of Research and Policy Planning at the Chilean Copper Commission (COCHILCO), Mr **Jorge I. Cantallops**, dwelt on the effect of lower copper prices on Chile. Between 2006 and 2015 mining, and predominantly copper, accounted for 14.3 % of Chile's GDP on average. The decreasing copper prices led to reduced tax revenues and to raising unemployment. Also it had a negative impact on the mining investment portfolio. Mining remains the main economic activity in Chile despite the fall in commodity prices. The mining sector is striving to reduce costs. A national mining roadmap has been developed to increase productivity and improve technological, social and environmental mining processes in the next two decades.

Mexico

The Director-General of Fideicomiso de Fomento Minero (FIFOMI), Mr **Armando Pérez Gea**, gave an overview of Mexico's mining opportunities despite the current unfavourable climate. He provided insight into FIFOMI's financing of mining-related activities. Mexico is the world's 15th largest economy

in terms of GDP, and the mining industry contributes 4 % to the GDP. Mexico is a major mining producer, and hosts many Canadian mining companies. For 80 years it has supported mining activities with loans, technical assistance and training. Before 2012 there had been more equity financing available, while commercial and Development Banks' loans to Mexico's mining industry have been limited in recent years. FIFOMI's support was an important bridge, helping to close the investment gap. Beneficiaries are ore producers, service providers, primary mineral processors, distributors and traders. Mr Perez Gea provided an overview of the governance of mineral resources in Mexico with regard to ownership, the granting of mining concessions and fiscal regime. 80 % of the resources from mining taxes are spent on social, environmental and development projects. The Fund for Sustainable Regional Development distributes 62.5 % of resources to the municipalities where the exploitation of minerals takes place, and 37.5 % to the local state.

Europe

Mr **Ernst Lutz**, the CEO of EIT RawMaterials gave a presentation on the role of the organisation as a success factor in the raw materials industry, academia and research partnerships. EIT RawMaterials, initiated by the EIT (European Institute of Innovation and Technology) and funded by the European Commission, is the largest and strongest consortium in the raw materials sector worldwide. EIT RawMaterials unites more than 100 partners – academic and research institutions as well as businesses – from more than 20 EU countries. They collaborate on finding new, innovative solutions to secure the supplies and improve the raw materials sector all along its value chain – from extraction to processing, from recycling to reuse. There are six regional hubs in Belgium, Finland, France, Italy, Poland and Sweden, called Co-location Centers (CLC) that represent different regional ecosystems bridging between business, research and education. EIT Raw Materials provides services in matchmaking and networking, in validation and acceleration, in business creation and support and in learning and education. A total of over 80 projects with a budget of more than € 20 million are being run. EIT RawMaterials aims to significantly enhance innovation in the raw materials sector by sharing of knowledge, information and expertise: Entrepreneurs, Start-ups and SMEs receive funding and support through our partner network and collaboration activities.

5. Challenges for the mining sector in the current state of the global economy and commodity prices: Part III

The session was chaired by Ms **Corina Hebestreit**, Director of Euromines, an association representing the European metals and minerals mining industry. Ministry, Geological Survey, research centre and company representatives from the Czech Republic, Mexico, Poland and the UK, as well as the Industrial Minerals Association (IMA), shared experiences of the importance of international collaboration in addressing economic and environmental challenges. Base metal prices fell consistently from February 2011 to mid-January 2016. Because of these falling prices, mining companies have been reducing operating costs and cutting investments. Prolonged permitting processes also lead to higher costs and increased risks that can jeopardise a mine's value. The Czech Republic's ministry representative highlighted the importance of international missions for maintaining mining know-how. The Polish research centre underlined the importance of joint European research for contributing to the circular economy. The Mexican representative explained that the Geological Survey suggests exploration areas to government, and engages in international collaboration for remediation works in contaminated sites and the recovery of mines. IMA presented case studies showing how European industry addresses challenges by shifting from bulk commodities provision to niche specialities. An OECD representative presented a visual trade policies tool.

Czech Republic

The Head of Unit of State Minerals Policy at the Czech Ministry of Industry and Trade, Mr **Martin Vlastnik**, presented the challenges facing the raw materials sector in the Czech Republic, and opportunities for cooperation. The country's raw materials policy aims to strengthen national raw materials supply security. The Czech Republic is an ancient mining region and continues to mine brown coal, industrial minerals and construction materials. Czech companies also spend some time work abroad to keep abreast of know-how on prospecting in green-fields. The country is beginning geological exploration of some minerals listed as critical on the EU's Critical Raw Minerals list, such as lithium, that may be retrieved in pit heaps or tailing ponds. The speaker noted that environmental protection is taken very seriously in the Czech Republic.

Europe

The Europe Director-General of the Industrial Minerals Association (IMA), Mr **Didier Jans**, gave an overview of challenges for the industrial minerals industry in the current global economic context. He provided three examples of how the sector is addressing these challenges by shifting from provision of bulk commodities to niche specialities. He requested that policy makers reduce unnecessary regulatory burdens and improve business conditions. Predictability in time and costs, competitive taxation and energy prices, and stability are key for investors and companies. For this reason he called for sustained political focus on visionary policies enforceable beyond election cycles, and for better regulation within and between frameworks.

Poland

Mr **Wiktoria Kowalczyk** from the KGHM research and development centre gave an overview of the Polish raw materials policy. KGHM is a major international copper and silver producer born of the former Polish State Mining and Metallurgical Combine. At present, Poland is defining its raw materials policy. Many decisions of strategic importance for the nation – on deposits, for example – are taken by

the municipal authorities. An official document defining directions for the development of raw materials was called for. It was considered crucial to take geological, technological, economical aspects as well as risk investment into consideration. Participants also considered it important to dialogue with the population, whether via participation in H2020 projects or via awareness-rising on the importance of raw materials in schools. To address waste, which is currently exported rather than recycled, the exchange of knowledge and joint research and innovation projects are considered vital. These would also address legal, technological and economic issues that make it difficult to create a circular economy.

Mexico

Mr **Enrique Gustavo Espinosa Arámburu**, Deputy Director of Mexico's Geological Survey, presented the organisation's range of activities and exploration technology and methods used. Geosciences are indispensable to development in Mexico, where exploration is focusing on shale gas. Geological information is important in deciding where to invest. Some 36 % of the entire country, and 53 % of prospective areas have been mapped. Between 2007 and 2015 the Mexican Geological Survey suggested 700 locations as prospective mining areas, of which 80 became a government exploration target and, eventually, an allotment. Remediation works on contaminated sites have become a priority goal for authorities such as SEMARNAT (the Secretariat of Environmental and Natural Resources). Also, the Mexican Geological Survey has collaborated with the Association of Ibero American Geology and Mining Services (ASGMI) within a working group for the evaluation and recovery of abandoned mines. Participants called for the creation of a federal fund for remediation measures and the reinforcement of the law on preventing and managing waste.

UK

Mr **Chris Hinde**, Reports Director, SNL Metals & Mining, gave an overview of the general mining environment. Demand for base metals is cyclical, and closely follows changes in industrial production. Base metal prices fell consistently from February 2011 to mid-January 2016, before generally recovering. SNL predicts the downward trend could continue until the end of this year, at which point SNL also anticipates a bottoming-out in capital expenditure. There is a correlation between metal prices and exploration budgets, which are now at the level of 2006. Because of falling metals prices, mining companies have been reducing operating costs. Chris Hinde examined three US mines that have struggled with permitting delays. The higher costs and increased risk that often arise from a prolonged permitting process can cut the expected value of a mine in half before production even begins. He presented a model of combined impact of additional risks, costs and delays that may lead to mining projects becoming financially unviable. For a major mining project on federal lands, 30 or more federal, state and local regulatory programmes may apply in the US. He suggested that some aspects, such as timelines (which must be clearly defined) or agency roles need reform.

Chris Hinde also gave an overview of the Horizon 2020 project STRADE, which addresses the long-term security and sustainability of the European raw materials supply from both European and non-European countries. Using a dialogue-based approach, the project brings together governments, industry and civil society to deliver policy recommendations for an innovative European strategy on future EU mineral raw material supplies. The project has established an international dialogue which the audience was invited to join.

OECD

OECD economist and trade policy analyst Ms **Jane Korinek** reminded her audience that no one country is self-sufficient in every raw material. Moreover, virtually all countries are vulnerable to any attempt to restrict the export of at least some commodities. Notwithstanding that resource nationalism

is increasingly at odds with the interdependency of economies in the 21st century, the use of export restrictions to regulate the supply and trade in these materials has increased. Export restrictions have contributed to episodes of global supply shortages and strong swings in prices; they have affected trading partners and are a source of friction and open trade dispute between governments. The OECD has inventoried export restricting measures placed on 66 metals and minerals by all major exporters. The inventory includes export bans, quotas, taxes, non-automatic licences and any other export restricting measures. A hierarchy has been established based on the trade distorting potential of each measure. The inventory has been combined with production and reserves data collected by the US Geological Survey, and trade data from UN COMTRADE, to provide a more comprehensive picture of global metals and mineral markets. Jane Korinek presented how to use the visual tool on mining trade and trade policies <https://www.compareyourcountry.org/>. She underlined that the tool looks at both import and export trade restrictions.

6. High level discussion panel - Challenges for the mining sector in the current state of the global economy and commodity prices

The high level discussion panel 'Challenges for the mining sector in the current state of the global economy and commodity prices' was chaired by its director, Mr **Gwenole Cozigou**, DG GROW Dir C 'Industrial Transformation and Advanced Value Chains'. In view of decreasing prices, companies are tending to decrease investment in mining and exploration projects. However, raw materials remain of prime importance for the economy. In a few years, raw material shortages are likely as a result. For this reason, Mr Cozigou advised remaining ambitious with regard to mining activities. Delegates from government agencies and ministries in Chile, the Czech Republic, Peru, Mexico, South Africa and Western Australia, together with the EIT Raw Materials, IMA and Euromines, provided their views on how to secure a reliable and sustainable supply of raw materials. They shared experiences on how they beat the industry's cost, investment and innovation challenges by mediating social conflict, by addressing investment shortages, regulatory and environmental issues, and by maintaining the skill base and innovating along the entire raw materials value chain. Recognition of the mining sector is fostered by citizen engagement and public awareness.

Guillermo Shinno, Peruvian Vice minister of Mines

Peru remains a reliable producer country of raw materials. As operational costs are quite low in Peru, no mine has had to be closed. The round tables established in Peru have also helped mediate risk stemming from social conflict.

Mosa Mazuba, Deputy Director Mineral Mining, representing Mosebengi J. Zwane, South African Minister of Mines

Given the current challenges facing the South African mining sector, the country is putting emphasis on research and development, and on investment in diversification and new applications – from commodities to specialities. Concerns over policy and regulatory environment are fully understood and are being addressed. South Africa has now regulated the time it takes to obtain a licence, making it a maximum of 300 days. In any event a balance must be found between supply and demand, the latter of which will hopefully grow.

Brendan Pearson, Chief Executive of the Minerals Council of Australia

Mr Brendan Pearson reminded the audience that due to an unprecedented investment boom in Australia, the mining industry – today worth \$ 641 billion – is four times bigger than it was before the boom in 2000/2001. Australia has also undertaken cost cutting and employment in the mining sector has decreased from 260 000 to 225 000 employees. Care must be taken not to lose the industrial skill base. Mr Pearson noted a new wave of anti-mining activism that tends to try to block mining projects, e.g. by delaying licences, thus reducing mine projects' Net Present Value (NPV).

Armando Pérez Gea, Director-General of Fideicomiso de Fomento Minero (FIFOMI)

Mr Armando Pérez Gea confirmed the trend of new projects being put on hold in Mexico. However the Mexican government has addressed the lack of private equity that most SMEs and junior miners were facing by providing loans. As a temporary measure, Mexico has also started to charge companies royalties to address social, health and infrastructure needs in small communities in a transparent and accountable way.

Jorge I. Cantallopts, Director of Research and Policy Planning of the Chilean Copper Commission (COCHILCO)

Chile remains a stable mining country. Mr Jorge Cantallopts underlined how Chile has increased mining productivity, and how public policy promotes exploration. Enhanced mining performance is yielded by observing environmental standards. Problems with regard to mining impact are mediated at an early stage by honestly communicating with local communities. Local providers are also an effective way in which to involve local communities into the value chain.

John Atkins, Government of Western Australia agent

Mr John Atkins told the audience that the mining industry is addressing its cost and innovation challenges, connecting mining ecosystem across the entire value chain in the process. This is not yet finished and offers enormous opportunities.

Ernst Lutz, CEO EIT Raw Material

Mr Ernst Lutz reminded the audience that the mining sector is not only about mining. By driving and fostering innovation all along the raw materials value chain EIT RawMaterials empowers various stakeholders to bring change to the way primary and secondary resources are being used and substituted.

Martin Vlastnisk, Head of Unit of State Minerals Policy, Czech Ministry of Industry and Trade

Mr Martin Vlastnisk pointed out that his traditional raw materials producer country has not issued any exploration licences in the past 15 years. He stated that European Commission and European mining association raw material initiatives are vital to strengthening EU Member States' national raw material policies. The Czech Republic is organising round tables with companies and citizens, and competitions on the rehabilitation of mines as habitats for wildlife, thereby promoting biodiversity. Media interest in the competition was not particularly high.

Didier Jans, Industrial Minerals Association (IMA) Europe's Director-General

Mr Didier Jans underlined the huge trust gap between the mining industry, institutions and the public that has led to a plethora of mining legislation that stifles investment. Of course impact assessments do make a lot of sense. However, legislation must be practicable. Also, mining is not an end in itself but serves growth, production and employment along all phases of the value chain. IMA seeks to raise the visibility of the mining sector, e.g. by organising the European Mineral Day at international level, to which he invited the audience.

Corina Hebestreit, Director of Euromines

Ms Corina Hebestreit suggested making the public aware of the mines from which raw materials come, and how they are used.

7. Mining waste management: Part I

The session was chaired by the Deputy Head of Unit B3 Waste Management and Secondary Materials within the European Commission's DG ENV – Mr **Julius Willem Langendorff**. With Directive 2006/32/EC on the management of waste from the extractive industries (mining waste directive) the EU has introduced measures to prevent or minimise any adverse effects on health and the environment arising from the management of waste from extractive industries. Within the Circular Economy Action Plan, the European Commission will issue guidance and promote best practices on mining waste to improve the recovery of raw materials. It will also take action to encourage recovery of Critical Raw Materials (CRMs), and prepare a report on best practices and options for further action at the EU level. Tailings are recognized as a business risk. Not only do they present huge potential for environmental, social and economic damage. Failures cost money. The direct costs caused by tailing dam failures are often above € 50 million. The resulting overall costs to the company and shareholders caused by tailing dam failures can be many times greater than the direct costs. Delegates from Australia, Canada, Finland, Peru, Portugal and the US shared good practices in tailings management and mine rehabilitation.

Australia

Mr **Reg Howard-Smith, CEO, Chamber of Minerals and Energy Western Australia**, gave an overview of effective regulation and innovative uses for mining waste. Mining industry is a dominant contributor to the Western Australian economy, and 0.2 % of the land is used for mining. Mining activities incur mining and non-mining waste. A lot of mineral waste in Western Australia is relatively inert. As Western Australia is a dry and geologically stable environment, tailings management is not complicated. All tenements that have an approved mining proposal must also have an approved mine closure plan. The Mine Rehabilitation Fund is a pooled fund contributed to by Western Australian mining operators. The fund is used for rehabilitation when the tenement holder/operator fails to meet rehabilitation obligations. The generated interest is used to fund rehabilitation works on legacy abandoned mine sites throughout the state. Sodium cyanide plays a key role in extracting gold and other metals such as silver, copper and zinc. A series of devastating global incidents shone a spotlight on the management of cyanide. A leading practice guide 'cyanide management' has been developed by industry and government. It addresses implementation of International Cyanide Management Code ICMI 2006. The focus lies on minimising on-site consumption and impacts, and maximising cyanide recycling and gold recovery. The Upper Fortescue region has become a major iron ore producing area since mining commenced in the 1960s. Many mines extract ore from below the water-table and must dewater. The disposal of excess dewaterers needs to be carefully managed. Some 730 gegalitres (GL) of water is licensed to be abstracted annually in the Pilbara.

Canada

Vice President of the Mining Association in Canada (MAC), Mr **Charles Dumaresq**, presented progressive approaches to mine tailings management in Canada. In 2004 the TSM (Towards Sustainable Mining) Programme was established. TSM improves environmental and social performance in the critical areas of environmental footprint, energy efficiency, and community and people. Performance is measured at facility-level, and results are externally verified. TSM is monitored by the external Community of Interest (COI) Advisory Panel and it encourages continuous improvement. TSM is mandatory for all MAC members for their operations in Canada and there is growing interest in adoption around the world. Effective tailings management is an industry imperative as serious tailings dam's failures in recent decades have led to loss of life, severe environmental impacts, significant financial costs to mining companies, governments, and society as a whole. They

impact on the mining industry's reputation and social licence to operate. TSM contains five performance indicators designed to confirm whether a facility has implemented a system for responsible tailings management. It refers to three guides that provide more detailed requirements. Facilities must conduct annual reviews of their management system and report results to the responsible executive officer. TSM uses a 5 level rating scheme: C, B, A, AA and AAA. The number of mines operating at A level and above has increased since 2006. The Protocol and the Tailings Guide is underway. The revised tailings guide is expected to require rigorous, transparent process to select tailings management technologies and tailings facility locations. Tailings management is particularly challenging in Canada due to the complex regulatory environment, with 14 different sets of rules across the country, due to geographic diversity, and due to a wide range of mine types. With such variability across the industry, there is no one-size fits all solution for tailings management.

Finland

Executive Director of the Finnish Mining Industry, Mr **Pekka Suomela**, presented Finland's framework for sustainable mining. In Finland an entire mineral value chain is in place. The government has streamlined mining legislation, and it contributed to the Best Available Techniques Reference document (BREF) for mining waste. The Finnish mining industry and steel and metal producers strongly support the goal of reducing emissions worldwide. An equal level playing field is needed globally to avoid the EU exporting jobs while importing CO₂. Finland has run a Green Mining Programme (2011-2016) with a budget of € 115 million from 2011 to 2016. Tailings are recognised as a major business risk that must be managed. A working group representing the mining sector and its key stakeholders is seeking to identify a new standard for mining in Finland. The self-regulated Finnish network for sustainable mining established in May 2014 has already adopted the new sustainability standard for mining operations based on the Canadian TSM initiative. So far 14 mining companies and two auditing companies have participated in training courses on implementing the Finnish TSM.

Peru

Institute of Geological Mining and Metallurgy (INGEMMET) geological research advisor Ms **Mirian Mamani** presented the section of the Peruvian National Programme dealing with geochemistry of environmental mining liabilities. With over 8 500 passive mines, Peru has a record number of environmental mining liabilities. Soil composition is particularly complex in Peru. INGEMMET is examining the geochemistry of 100 sites in hydrographic basins affected by mining liabilities and the local community is actively participating in the exercise. At INGEMMET, laboratory water, tailings, sediments and rocks are analysed. INGEMMET promotes its findings in a series of publications and it shares geological information on the web platform Geocatmin, which can be accessed for free and is visited around 800 000 times from over 100 countries every day.

USA

American Institute of Mining, Metallurgical and Petroleum Engineers technical expert Ms **Carol Cox Russell** presented US mining policies and innovations in waste reduction. Over time, the grade in mined ores declines. Technological advances are helping operations to extract lower grade ores than was possible a few decades ago (i.e. copper grades from 4 % in 1900 to 1.07% in 2010). However lower ore grades mean more mine waste.

Ms Russell provided an overview on the laws and agencies that govern hard rock mining operations on both public and private lands in the country's western states. In most states, the Clean Water Act, the Clean Air Act, the Toxic Substances Control Act, the Resource Conservation and Recovery Act, and the Safe Drinking Water Act, are administered by state environmental agencies with oversight by the US Environmental Protection Agency (EPA). Hard rock mining operations are also subject to

regulatory programmes for the protection of plants and wildlife, including the Endangered Species Act. Furthermore, the modern hard rock mining industry is extensively regulated by the federal government on US Bureau of Land Management and US Forest Service administered lands. The western states' regulations also ensure that, at closure, mined lands are returned to a safe, stable condition for productive post-mining use.

Although metal recovery may not be economically attractive by itself, metal removal and recovery can be used to offset treatment or disposal costs and reduce long-term environmental liability. Ms Russell gave four examples of innovative waste reduction in the US: sewage wastewater treatment facilities for gold, silver and copper; sulphide precipitation technologies for selective metal recovery at Wellington-Oro Treatment Plant; In situ leaching (ISL) in-situ uranium recovery; and the Rio Tinto Kennecott pilot dewatering project to accelerate stabilisation of its south tailings facility.

Portugal

Empresa de Desenvolvimento Mineiro (EDM) project director Mr **Edgar Carvalho** presented best practices and challenges in mining waste management through environmental reclamation of old mining areas in Portugal. The Portuguese State granted EDM the concession for the environmental remediation of abandoned mining areas.

Mr Carvalho presented the technical objectives, environmental concerns encountered, and solutions in mining waste management. There are 175 abandoned legacy mines in Portugal. Work on 95 of these has been finalized, with € 96.6 million having been spent. Remediation work is ongoing on 10 abandoned mines, costing € 24.1 million; 50 remaining mining areas will be remediated by 2022, for which a budget of € 89 million has been planned.

With the conclusion of the Environmental Remediation of Old Mining Areas Plan, Portugal seeks to reverse environmental liabilities and impacts caused by centuries of mining activity. This leads to improvements in public health and safety issues, soil, water and air quality, mining heritage preservation and reclamation of these degraded areas for further uses. Mining wastes could be seen not only as an environmental liability, but as potential secondary source of raw materials.

8. Mining waste management: Part II

The session was chaired by the Acting Head of Unit C2 'Clean technologies and products' of the European Commission's DG GROW, Ms **Flavia Raffaelli**.

Speakers from Brazilian, Chilean, South African and Swedish associations, technology institutes and companies, and from DG GROW shared a wealth of knowledge and experiences on how to retrieve value out of residues. The presentations reflected the complexity of the subject matter. They showed that technology-wise, the re-use and recycling of almost any waste is possible. The barriers are more often economic than technological.

South Africa

Mr **Peter Craven**, General Manager of South Africa's state owned technology institute Mintek, quoted Agricola: "there is greater detriment from mining than the value of the metals which mining produces". He wondered if one can prove Agricola wrong and if South African mining waste is a resource or a curse.

South Africa produces around 400 million tonnes (Mt) of mineral waste every year that potentially offers value if various metals can be recovered. Residues from 150 years of gold mining with around 250 tailings dams in the Witwatersrand Basin cover approximately 400 km² in surface area and embrace gold, uranium and sulphuric acid. Phosphor-gypsum residue from phosphoric acid production with 50 Mt stockpile contain around 250 000 tonnes of rare earth oxides (REO). Magnetite and vermiculite from copper and phosphate mining contain 240 Mt stockpiled magnetite with 56 % Fe and 2 % Ti accumulated over 50 years of mining. Heavy mineral sand mining tailings provide rare earth and thorium potential. And platinum and chrome residues bear platinum and chrome potential.

Mr Craven stated that economy of scale is of particular importance in low grade situations. He gave the example of Anglo American's ERGO tailings re-treatment plant that treated up to 130 000 tonnes of old gold mine tailings a day. Over 28 years of operation the plant cleared 4 500 hectares of land, thereby producing 262 tonnes of gold.

South Africa is home to around 90 % of the world's platinum and over 70 % of chrome resources. Large quantities of cheap chromite have been recovered from platinum tailings. However, after 1995, platinum companies sold the so-called UG2 seam on international markets. China developed its smelting industry on imported UG2 seam to the disadvantage of South Africa.

In South Africa there are 6 000 abandoned mines, of which 250 are asbestos mines. They are the legacy of the State. Peter Craven predicted that the rehabilitation costs of these mines will be higher than their output value.

Brazil

Mr **Claudio Schneider** shared 20 years of experience working as Mineral Processing Coordinator with CETEM. For 38 years, CETEM has been widely recognised for its mineral technology, research, development, innovation and sustainability and sociological assessments in Brazil. With 100 staff (90 % of whom hold PhD degrees), 22 laboratories and 5 industrial areas for pilot-scale experiments, CETEM provides fundamental research expertise in mineral analysis characterisation, ore, minerals and metallurgical processing.

Mr Schneider presented five examples of tailing processes in Brazil that maximise resource usage efficiency whilst minimising the generation of residues. CETEM is currently investigating the flotation of all minerals of interest. By applying Wealz Kiln technology, metals such as lead, arsenic, cadmium and indium are recovered from tailings dams while residues for cement manufacturing are co-produced. By using column flotation, fine hematite is recovered from iron ore tailings. CETEM has

been active in the characterisation and mineralogy of RE carriers, mineral processing operations (mostly flotation) and leaching of RE elements. CETEM uses mini plants for solvent extraction (SX) of RE. Light RE elements are retrieved from flotation tailings incurred in CBBM's niobium production. Heavy RE elements are retrievable from tailings from columbite flotation incurred in Taboca's tin production. The REE retrieved are likewise currently priced higher than by Chinese suppliers. However, having the technology ready will prevent the industry from possible future supply shortages and price peaks.

Chile

Mr **Armando Valenzuela**, Director, AI Prospecta, presented advances in mining waste management in Chile and offered cooperation opportunities.

Today, Chile is the largest producer of copper in the world and a globally significant supplier of molybdenum, rhenium, silver, gold, and industrial minerals such as nitrate, lithium and iodine.

Mr Valenzuela gave an overview on regulations affecting mining operations and copper smelters. A new mine closure legislation was implemented in 2012, where mining companies must submit mine closure plans and provide financial guarantees. Industry must also comply with new arsenic and sulphur dioxide (SO₂) emission standards by 2018. The majority of forecasted copper projects (2016 to 2025) will utilise concentrator plants, and some will use leaching, solvent extraction and electro winning technologies. The mined ores will be lower-grade, and mining will use more water (mainly sea water), thereby resulting in higher flotation tailings generation. Mr Valenzuela gave an overview of a technology roadmap offering solutions to future challenges. He presented four waste management and metals recovery projects dealing with anodic slimes, copper smelter slags, flotation tailings, and complex copper concentrates containing arsenic. The technological roadmap is a good tool for identifying opportunities in R&D cooperation.

Sweden

Mr **Lars-Åke Lindahl**, Director Environment and Coordinator EU Affairs at the Swedish Association of Mines, Mineral and Metal Producers (SveMin), presented the potential and the limitations of mine waste as a resource. Mineral extraction waste, both waste rock and tailings, present the lion's share of Sweden's waste volume.

The four-year EU-funded ProSUM project aims to systemise present knowledge and data on four different but important waste categories in EU: electronics waste (WEEE), batteries (BAT), used cars (ELV, end of life vehicles) and mining waste (MIN). For WEEE, BAT and ELV there is already EU-legislation on recycling of waste in place; no legislation is however in place for recycling mining waste. A 150-year history of mining means that Sweden possesses good statistics on the amount and location of waste rock and tailings. The potential, challenges and limitations of utilising waste as a resource depend on what waste to use and for which purpose. Waste may inter alia be used for backfilling or other on-site purposes, such as off-site construction material, for reprocessing to recover 'more of the same', for new substances such as REE or phosphates, or for processing downstream waste (slag). There is potential, but unrealistic expectations should be avoided. A lot of extractive wastes have already been reprocessed. Economy and technology are generally the main limiting factors to mine waste recovery, and the extractive industry is actively developing technologies.

Mr **Paul Kruger**, Senior Project Manager, Boliden, provided a company perspective on reuse and reprocessing of mining waste.

Boliden's value chain comprises both mining operations from rock to metal and smelter operations from secondary materials of externally or internally supplied concentrates to metal. Half of Boliden's R&D efforts go to reprocessing and reuse of waste as today's waste is considered to be tomorrow's resource.

Mr Kruger presented opportunities for mining waste recovery. The examples provided are recovery back-filling sand from tailings used in underground mines; rehabilitation from old tailings that may contain high metal concentrations and whose metal values can help pay for rehabilitation costs; reprocessing waste dumps; and recovery of metals from waste water that is mostly inhibited by economic factors or recovery of metals from sludge. Mr Kruger also presented synergies with other organisations. Boliden reuses municipality and industry sludge in reclamation. It employs green liquor from paper industries as a substitute for sodium hydroxide and sodium sulphide in water treatment, and it reprocesses copper from slag. Boliden Rönnskär smelter is the world's largest recycler of electronic scrap. Boliden recycles electronic scrap from Europe, North America and other areas, to recover copper and gold. The smelter also refines metals from copper scrap, Cu/Zn residues, Electric Arc Furnace dust and lead scrap. Furthermore, Boliden is developing a process for reprocessing furnace dust.

Europe

Mr **Magnus Gislev**, Policy Officer within the European Commission's DG GROW, provided an overview of circular economy and mining waste management in the EU.

He explained the EU policy context of the circular economy, whereby the value of products, materials and resources is maintained in the economy for as long as possible, thereby minimising the generation of waste. The objectives are to promote innovative and resource-efficient production processes and to provide incentives for the design of products that are easier to repair, recycle and disassemble so that valuable materials may be recovered. Key actions include: promoting sustainable production and sourcing; promoting best practices for waste management and resource efficiency in industrial sectors and mining; facilitating industrial symbiosis; and promoting durability, reparability and recyclability in eco-design.

Mining and quarrying waste makes up around 30 % of all waste generated in the EU, second only to construction and demolition waste. The circular economy action plan foresees two actions dedicated to mining waste. These are exchanges of best practices on mining waste management plans (required under the Mining Waste Directive 2006/21/EC) and the recovery of critical raw materials from mining waste.

Mr Gislev recalled the conclusions of the October 2015 best practice workshop on mining policies and technologies, and in particular the session dealing with mine waste management and mine rehabilitation. It had been concluded that reclamation of value from mining waste had strong potential to create jobs. The importance of integration in planning operations, and of a multidisciplinary approach, had also been highlighted, and it was acknowledged that international guidelines for good practices should be used alongside national and regional regulations. The lack of information on the values of mining waste was considered one of the key obstacles. He also referred to the outcome of the international conference on exchange of good practices on metal by-products recovery of November 2015. A Joint International Study Groups project on mine waste had been proposed to cover a wide range of issues, including the technological aspects involved in disposing of mine waste, possibilities for recovery of valuable elements including critical raw materials (CRMs), environmental aspects, the current regulatory aspects of mine waste, and trends for the future, data on global quantities as well as mineralogical content and metal content.

Mr Gislev also spoke of three finalised FP7 and four ongoing Horizon 2020 projects addressing mining waste.

9. High-level discussion panel – Mining waste management (environmental, safety, economic and regulatory issues)

The session was chaired by the President of Belgium-based Euromines, Mr **Mark Rachovides**.

Mining waste management embraces environmental, safety, economic and regulatory issues. Both industry and society face substantial challenges in this area. First and foremost, extraction and processing of resources must be safe. Therefore worldwide sustainability standards for resources that ensure a level playing field are essential. An economic level playing field that allows for the development of efficient resource production and use is necessary. Innovation is needed along the whole value chain to optimise the use of global resources to the benefit of the entire population. Resource policy issues must be integrated into international dialogues and policies, and must be effectively communicated to relevant stakeholders.

The high-level panel discussed in which ways international cooperation would most benefit global resource efficiency and recovery of resources, from a legal, research and innovation or social acceptance point of view. The panel also discussed which economic factors will most determine the turning of mining waste from the past into valuable resources today.

Pekka Suomela, Executive Director, Finnish Mining Association, remarked that both Finnish and Swedish mining companies foster international sustainable mining through close collaboration and the exchange of experience and information. The Finnish mining industry also cooperates with the Canadian Mining Association, which resulted in the adoption of the tailings management TSM programme to improve environmental and social performance in the critical areas of environmental footprint, energy efficiency and community and people.

Reg Howard-Smith, CEO of the Chamber of Minerals and Energy Western Australia, pointed out that Australia's mining ecosystem offers strong support for collaborative research and innovation through research, industry and government partnerships. Large Australian companies undertake international research.

Armando Valenzuela, Director of the Chilean AI Prospecta consultancy company underlined that mining is a long process and that it can easily take more than 10 years from exploration to metal production. For this reason, investor protection must be guaranteed by a legal framework. He reminded the audience of the new recycling standard in Chile that focuses on extended producer responsibility (EPR) and that also applies to international procurement (imports).

Paul Kruger from Sweden's Boliden mining company stressed that technology-wise, re-use and recycling of almost any waste is possible. The question is more whether the process is economically viable. To exploit resources optimally, new innovative strategies are required. Care must be taken to make legislation consistent. For instance, legislation banning cadmium and mercury from products is not compatible with legislation promoting zero waste due to the fact that in zero waste scenarios, all elements of the periodic table are retrieved.

Peter Craven, General Manager of the South African Mintek technology institute, pointed out that today's best mining closure practices may not be acceptable at the time of mine closure. As it is impossible to predict the next 50 years, having dynamic mining closure and rehabilitation plans to cater for advancing technologies should be considered. One must recognise the interest of communities in developing countries in waste processing. While waste processing operations may be only of marginal economic value, more should be applied. International standards may be needed to improve processing operations. Tax incentives may also be considered for companies applying waste processing operations.

According to Charles Dumaresq, Vice President of the Canadian Mining Association, the permitting process takes regulators the time they need – which is not excessive. He said that companies have realistic expectations on the regulatory process. On one hand it adds to sustainability that tenements must get mine closure plans approved along with mining proposals prior to starting exploration. However, he agreed with Peter Craven that regulators cannot know today what technology will be available in four to five decades when mines will be closed. Having both certainty and flexibility at the same time is a challenge. It was suggested that examples of regulatory efficiency be looked into. For instance, the Peruvian government has managed to make the approval process faster with streamlined permitting legislation while still achieving sustainable mining. The audience agreed it is important to have mining closure plans that push for the best tailing management design and technology that is available at the time a mine is planned, but that caters for the possibility of improved technology over the following 50 years.

Lars-Åke Lindahl, Director Environment and Coordinator EU Affairs at Sweden's SveMin suggested broadening the discussion. It is important to fully understand both mining operators and stakeholders, he said. He observed that some initiatives do not focus on the real issues. The audience agreed that consumers are not aware of their mineral consumption and the waste thereby generated. Lars-Åke Lindahl advocated the importance of stakeholders talking to each other to obtain a clear picture of what concrete aims regulation should achieve. He advocated developing available resources in Europe as mining is done in a more sustainable way than in some other jurisdictions.

10. Closing remarks

The Head of the European Commission's DG GROW Unit C3 'Resource Efficiency and Raw Materials', Mr **Mattia Pellegrini**, closed the conference.

He acknowledged that the two days of debate had raised some important points.

It is vital to provide incentives to **invest** so that we do not again face supply shortages. The new European Minerals Raw Materials and Recycling Investment Platform under the European Fund for Strategic Investments will be an important tool for addressing the investment deficit in Europe applying inter alia to the mining industry. Continued investment is important to attain the African Mining Vision of sustainably developing and transforming the African continent and bettering the population's socioeconomic conditions. An initiative by the Mexican government financing entity, coordinated by the Ministry of Economy – FIFOMI – to support mining-related activities with loans was considered a best practice in terms of addressing the current investment deficit.

It remains important to innovate along the **whole value chain** so as to optimise the use of global resources to the benefit of the entire population. Driving and fostering innovation all along the raw materials value chain is changing the way primary and secondary resources are being used and substituted. It was acknowledged that African countries need significant investments and processing technology.

It also remains vital to engage local communities and to nurture a **dialogue with civil society**. The round tables established in Peruvian cities near to mining sites are considered a best practice in this respect. They address the lack of investment in local communities and provide development plans to improve living conditions there. Finland and Canada shared best practices in civil society engagement at all stages of the mining process.

International cooperation remains very important for addressing current mining sector challenges such as developing and sharing technologies for treating mining waste; exchanging experiences on successful practices in approval processes and gaining social acceptance; and in establishing geological cooperation. The Peruvian Institute of Geological Mining and Metallurgy INGEMMET is a good example. It is collaborating with Copernicus, the EU's earth observation and monitoring programme. INGEMMET is therefore able to provide international investors with comprehensive geological information obtained inter alia by its own satellites as well as those of Copernicus. And in Cape Town, a project to train African Geological Surveys in performing geoscientific mapping is about to launch.

Care must be taken to prevent **export restrictions** that, according to the OECD, increasingly impact the global raw materials trade.

Mattia Pellegrini promoted participation in **Horizon 2020** research and in Partnership Instrument (PI) projects, which offer a plethora of opportunities. He presented two Horizon 2020 projects that have already received funding: 'Strategic dialogue on sustainable raw materials for Europe' (STRADE) and 'International Raw Materials Observatory' (INTRAW). The Horizon 2020 work programme 2016–2017 has funding for Research and Innovation Actions (RIA) in new solutions for sustainable production of raw materials, raw materials Innovation Actions (IA), and raw materials international cooperation

Coordination and Support Actions (CSA). He also mentioned two ongoing evaluations of Partnership Instrument (PI) projects: a feasibility study for an EU-Canada mineral investment facility and an EU-Latin America Mineral Development Network Platform. Mr Pellegrini announced that the work programme for 2018 to 2020 is currently being drafted and that ideas and suggestions can be sent to his unit's general mailbox.

11. Acronyms

ASGMI	Association of Ibero American Geology and Mining Services
AU	African Union
BAT	Batteries
BREF	Best Available Techniques reference document
CBMM	Companhia Brasileira de Metalurgia e Mineração
CETEM	Centro de Tecnologia Mineral
CLC	Co-location Center
COCHILCO	Chilean Copper Commission
COI	Community of Interest Advisory Panel
CRM	Critical Raw Materials
CSA	Coordination and Support Actions
Cu	Copper
DG	Directorate-General
DG DEVCO	Directorate-General for development and cooperation
DG ENV	Directorate-General for the environment
DG GROW	Directorate-General for internal market, industry, entrepreneurship and SMEs
EDM	Empresa de Desenvolvimento Mineiro
EFSI	European Fund for Strategic Investments
EGS	EuroGeoSurveys
ELV	End of life vehicles
EIP	European Innovation Partnership
EIT	European Institute of Innovation and Technology
EPA	U.S. Environmental Protection Agency
EPR	Extended Producer Responsibility
EU	European Union
Fe	Iron
FIFOMI	Fideicomiso de Fomento Minero
GDP	Gross domestic product
GL	Giga litre
IA	Innovation Actions
IMA	Industrial Minerals Association
INGEMMET	Institute of Geological Mining and Metallurgy
INTRAW	International Raw Materials Observatory
JRC	Joint Research Centre
MAC	Mining Association in Canada
MIN	Mining waste
Mt	Million tonnes
NPV	Net Present Value
OAGS	Organisation of African Geological Surveys
OECD	Organisation for Economic Co-operation and Development
OTR	Off-the road
PI	Partnership Instrument
ProSUM	Prospecting Secondary raw materials in the Urban mine and Mining wastes
R&D	Research and development
REE	Rare earth element

REO	Rare earth oxides
RIA	Research and Innovation Action
SEMARNAT	Secretariat of Environmental and Natural Resources
SME	Small and medium-sized enterprise
STRADE	Strategic Dialogue on Sustainable Raw Materials for Europe
Ti	Titanium
TSM	Towards Sustainable Mining programme
UN COMTRADE	United Nations Commodity Trade Statistics Database
WEEE	Waste electronics
Zn	Zinc