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

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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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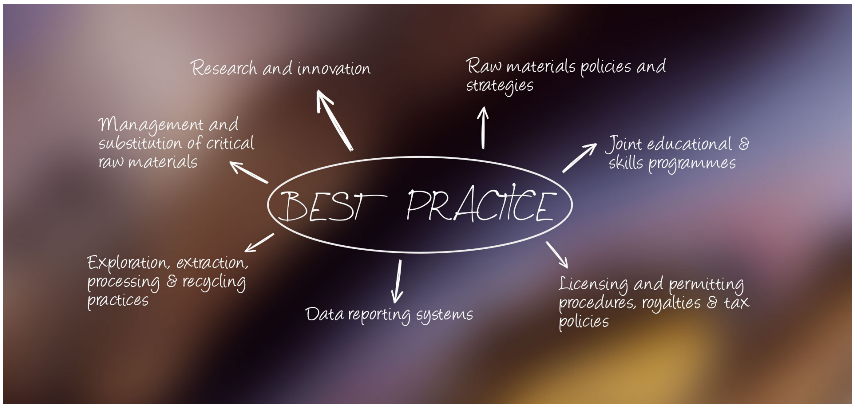

Figure 1: Aims of INTRAW.

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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