

Impact Objectives

- Develop a new switch on-switch off (SOSO) mining paradigm to improve the viability of many critical metal and other small complex deposits, in response to rapid market fluctuations
- Demonstrate the technical conditions under which SOSO mining will operate to minimise environmental impacts and enhance social sustainability using case studies
- Determine the step-changes that will be necessary for the technology to be applied globally

New concepts for small mining operations

Dr Kathryn Moore explains the challenges the European mining industry faces and the innovative plan she and her colleagues have developed that aims to redesign how Europe thinks about mining



What are some of the current challenges facing the raw materials market that you are hoping to address through this work?

Modern technological innovations require the use of an ever increasing array of raw materials with specialist properties, in addition to those commodities that have traditionally been used in manufacturing. For many of the latter, the raw material market is facing an over-production crisis in which companies continue producing even at very low prices. This has arisen from the need to maximise throughput from large mines, which has driven past innovations in mining practice to reduce operating costs and lower specific production costs. High investment in operations is no longer available in the current economic climate, the raw materials market has stagnated, many small companies have ceased to trade and only those companies that hold the largest ore deposits are secure. Europe is facing the fact that it has been largely mined out of world-class deposits, compared to the 'big' mining nations and that it is dependent on imports of technology metals.

A reduction in the number of smaller operators on the market will concentrate global production even further, potentially increasing risks to the security of supply. Consequently, the raw materials market has an increasingly limited ability to respond to increased demand for raw materials

or shortages in raw material supply. The problem is most extreme for critical raw materials that may have a high market price but are produced in small quantities relative to traditional metal commodities, so that the potential return on investment is too low to attract large mining companies. The IMP@CT project was developed following consultation with end users whose concerns relate to the rate of response of mining operations to changes in demand, and consultation with raw materials producers whose concerns relate to the lack of financial support for new mine start-up.

Your project proposes a new switch on-switch off (SOSO) method. Can you talk briefly about how this will work and the benefits the method has?

The new switch on-switch off (SOSO) mining paradigm will lower the barriers to market entry for new operators by reducing capital start-up costs and using production to support early operational costs. The project will develop an integrated solution that combines selective underground mining with ore sorting and adaptable designs for processing of ores. A portable, modular and adaptable processing plant could be utilised as either a low capital start-up approach or hired by a mining company such that the processing plant becomes a part of the operating costs. This would enable income generated by initial mining of the highest grade ore to offset the early operational costs and to develop greater geological and metallurgical certainty as mining progresses. The flexibility and modularity of plant design

means that it can be reconfigured to different ore deposits in response to market demands for different commodities. Transport of the modular plant between multiple small deposits, linked as part of a larger mining programme, would reduce haulage of ore and associated environmental impacts.

How will these ideas improve the feasibility of mining operations in European countries?

The plant design, selective mining and rock sorting methods together reduce the amount of rock extracted and fed through minerals processing technologies. The development of new innovative tools, coupled with identification of the most appropriate available technologies currently on the market, will reduce the energy, land, water and chemicals required for mining and processing. These factors should improve the economic feasibility of small-scale industrial mines enough for small companies to operate in competition with large companies that mine world-class ore deposits using significant economies of scale. There are deposits across Europe that are near to economic feasibility, a significant number of which are viable using a SOSO method. It could potentially increase European production of raw materials for European manufacturing, securing supplies, boosting and reinforcing economic resilience across the value chain. It will hopefully smooth possible future over-production crises and facilitate the mining of metals that are consumed in relatively small quantities. ►



Europe's future in switch on-switch off mining

A change is needed for Europe to diversify its mining sector and ensure supply security for technological manufacturing. The IMP@CT project proposes a focus towards smaller, more agile operations, poised to maximise small European deposits and rapidly address market fluctuations

The geological resources exist to supply raw materials globally. However, access to these supplies is not always guaranteed and Europe's world-class deposits are largely mined out. The economic downturn of the last decade, challenges being made to assumptions of free trade and successful economic and industrial strategies in 'big mining' nations like China have resulted in the search for alternatives to very low cost overproduction. The situation is now that mining operations no longer attract high levels of investment, small companies are squeezed out and only those companies with the largest ore deposits are able to keep operations going. European manufacturing is therefore heavily dependent upon imported raw materials.

'It can be argued that small-scale mining in Europe is an ethical approach to mining because it must involve cooperation with environmentally and socially aware individuals who have a collective community expectation for their quality of life, and rigorous monitoring of environmental and social sustainability,' says Coordinator for the IMP@CT project Dr Kathryn Moore, geologist and lecturer at the Camborne School of Mines, University of Exeter. The aim of the IMP@CT (Integrated Modular Plant and Containerised Tools for Selective,

Low-impact Mining of Small High-grade Deposits) project is to 'develop mechanisms to enhance the response of raw material supply to rapid fluctuations in market forces, utilising high grade or small complex deposits in Europe'.

FLEXIBILITY IS KEY

The IMP@CT consortium would like to develop methods to take advantage of and sustainably exploit the valuable deposits that are not amenable to large scale mining operations. In order to do so operations need to have low start-up costs and the flexibility to move locations and start production quickly. These nimble operations could utilise the high value small deposits in a cost effective manner and rapidly shift to meet changes in market demands. For the team the solution is their proposed switch on-switch off method.

In this concept of mining, technology is being developed to 'facilitate smaller operators to work small high grade or complex deposits by developing rescaled modularised plants,' explains Moore. These plants could then be switched on and switched off, rapidly deployed to the required deposits and minimise environmental impacts. 'This research is exciting because it has the potential to unlock many small deposits

globally, which would improve the security of supply of materials for manufacturers,' she continues. Ultimately manufacturers of intermediate or end products will benefit from a more stable supply chain but there are numerous potential beneficiaries outside of manufacturing. According to Moore, 'the IMP@CT project could potentially create a platform for a new workforce, in additions to the jobs related to mine sites, since consideration is given to the safety and longevity of workforces, as well as environmental and social sustainability.'

INDUSTRY INVOLVEMENT

Creating a paradigm shift in the European mining industry is not without significant challenges. One of the hurdles that switch on-switch off, small sized operators would face is that of legislative approval. Companies need to obtain appropriate licences within host countries in order to ensure that they operate responsibly, sustainably and transparently. The consortium recognises that a company will need to hold a portfolio of licenced ore deposits, to quickly shift operations from one deposit to another either within country or internationally, using the modularised technology. 'New mining paradigms will need to be communicated to legislative bodies, in order for licensing to support this new way of mining,' cautions Moore.

STAKEHOLDER GROUPS

As part of the social survey of the Olovo region, which is an intrinsic part of the project, the IMP@CT team hosts meetings with members of the community to exchange ideas about the expectations of local people, and the impact the mine may have in the region. One of the main challenges in the project is that the mine is situated in a post-conflict region, and therefore careful consideration has been given to the delicate social engagement needed to ensure smooth community relations across all ethnic groups. A strong ethical framework has been established within which the project operates. In addition to engagement with local communities the project has an extensive Stakeholder Group drawn from both industry and academia, with specialists in mining technologies, ethics and social sciences. This Stakeholder Group provides a platform for knowledge exchange and has held a two-day meeting in London at the beginning of the project, and continues to evolve. Participation is encouraged and readers can get involved by joining the Stakeholder Group, and a full list of participants is available on the website. To do so, send a request through the web portal (<http://www.impactmine.eu/>) or by contact the Project Manager, Dana Finch at info@impactmine.eu.

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Along with getting legislators on board, Moore says that the mining can only be rolled out where it is socially and environmentally responsible to do so. Mining must gain social acceptance in the communities that both rely on the industry for their livelihood and bear the largest environmental burdens of the industry. 'An ethical approach that respects the right of individuals to live, work and thrive in their environment and community will be necessary to ensure that social acceptance is granted,' she says. The life span of these types of mining projects will be short so innovative approaches will be needed to ensure the environmental protection and economic sustainability of communities and gain the social and legislative acceptance. The IMP@CT project is well positioned to address these concerns, because of the strong partnerships with end users and industry on which the project was developed. 'The project is founded upon industry involvement – it is essential to the project,' says Moore. Ten partner organisations are involved representing many countries in Europe, including France, Germany, the UK and Finland. This communication between academics and industry ensures that, while the new mining concepts are developed, the people who stand to gain or lose from these changes have a voice at the table.

PROOF-OF-CONCEPT

The solutions proposed by the IMP@CT project are ambitious and will require the hard work of all partners. Last year, the team completed their first mine visits and a workshop at the Olovo mine in eastern Bosnia and Herzegovina, including detailed mapping and sampling activities. 'We concentrated on methods to capture the close-spaced variability that is commonly associated with narrow vein complex deposits,' says Moore. At the same time, schemes for adapting mineral processing methods were built into the design of an adaptable test-scale processing plant. The testwork and design for a prototype selective mining tool were completed and a small-scale selective ore sorting tool was constructed. These activities were the first steps towards building the integrated switch on-switch off mining facility that will be used to demonstrate the proof-of-concept at viable, economic and fully-licensed mines in the West Balkans between July 2018 and November 2019. A survey of ore deposits in Europe has been initiated to examine where the mining approach may be viable in the future. The methods of gathering this data have been established and will inform research into the step-changes that would be required for the technology to be applied globally. ●

Project Insights

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- University of Exeter – Coordinator (UK)
- Bureau de Recherches Géologiques et Minières - BGRM (France)
- EPSE - Global EcoProcess Services Oy (Finland)
- EXTRACTHIVE (France)
- Institute of Mineral Resources Engineering – RWTH Aachen University (Germany)
- Imperial College of Science Technology and Medicine (UK)
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BIO

Dr Kathryn Moore is a geologist with qualifications (BSc, PhD, Dip) from the University of Edinburgh, University of Bristol and National University of Ireland, Galway (NUIG). She led the Magmatic Studies Group at NUIG from 1999 and became lecturer in Critical and Green Technology Metals at the Camborne School of Mines in 2012. She is Expert Council Leader in HiTech AlkCarb (new geomodels for exploration) and Project Lead for IMP@CT (low-impact mining of small, high-grade deposits). Moore serves on the Time and Tide working group to promote the natural, cultural and industrial heritage of the post-mining Perranzabuloe Community in Cornwall.

