Welcome to the first annual newsletter of the IMP@CT project. It has been a busy 12 months since we commenced our research and innovation activities. A great deal of progress has been made towards development of a prototype selective mining tool: a cutting head has been designed, built and tested and a powerpack is now under development. Read the interview with Gareth Thomas of Metal Innovations on page 4 for more details. Rados International have constructed a small-scale X-Ray Fluorescence (XRF) Ore-Sorter which has arrived in the Camborne School of Mines (CSM) for commissioning and the start of test work, as shown in the photos on page 8. Collaboration between CSM and Mineco to develop best practice sampling techniques to constrain geological uncertainty in highly variable and complex ore deposits is described on page 4. The consortium partners working on Minerals Processing and metallurgy, led by Imperial College, have significantly progressed work to constrain the flowsheet parameters needed for design of adaptable and transportable processing modules suitable for small deposit mining. Meanwhile BRGM have addressed the question of what small deposit mining means in a European context and the methods of gathering data on how extensively small deposit mining could be rolled out, for a select number of commodities in the first instance. Read the interview with Richard Roethe of Mineco on page 5 for an industrial view of opportunities relating to small deposit mining.

The advances described have been facilitate by a programme of meetings, and knowledge transfer events, starting in January with a Kick-off meeting in Orléans at the BRGM headquarters. This was followed by a two-day stakeholder meeting in March (described on page 2) with one day devoted to ethics in mining and a second day devoted to mining and minerals processing technologies. In order to develop a full understanding of all the issues that would surround the issue of small deposit mining, most of the consortium attended a project workshop at Olovo in Bosnia (pictured here and described on page 3). Olovo is the first of two case studies where new technologies will be tested in the field and several partners have also visited the mine site individually for more directed fact-finding and research. Informal workshops have also been convened at Extracthive headquarters in Avignon, to focus on minerals processing, and in Bristol, to focus on mine planning. Great communication has facilitated timely completion of all Year One Deliverables.

So, what will year 2 hold for the IMP@CT consortium? We can expect to see further technical advances in the development of mining tools and integration with modularised plant ahead of deployment to site and field testing in the summer of 2018 at Olovo. The University of East Finland, in collaboration with BRGM and Mineco, has recently established research into the social sustainability of small deposit mining. We aim to tease out and illustrate the interplay of many facets of small deposit mining in a whole systems context at the IMP@CT session of the AIMS conference: Mines of the Future. Please read pages 6-7 to learn more about the conference and for information to submit an abstract or register your attendance.

A website www.impactmine.eu has been launched for the IMP@CT project, where more information about the project and its partners can be found, and I would like to take this opportunity to thank Dana Finch (the Project Manager) for designing and maintaining the website, and putting together this newsletter.

Kate Moore (Project Lead)
Whole systems research within the IMP@CT project encompasses concerns relating to society and environmental impacts as well as technological innovation. The IMP@CT Stakeholder meeting was held over two days, 27 and 28 March, 2017, with the aim of capturing knowledge related to mining of small, complex deposits in a sustainable and ethical framework. The first day of the meeting was devoted to the ethics of mining and the second to technological aspects of mining as they relate to the Switch-on:Switch-off (SOSO) concept.

Experts from academia, industry and non-profit organisation were invited to present their work within the context of ‘ethical considerations in mining and related industries’ or the ‘ethics of conducting research in post conflict zones’. The speakers were Gavin Hilson, Bridget Storrie, Emilia Skrzypek, Edvard Glücksman, Marcello Veiga, Nic Bilham, Edmund Nickless, and Dylan McFarlane. One of the main themes to emerge from the discussion groups was the need to understand the local communities where SOSO mining may be introduced, such that the usual Social Licence to Operate (SLO) investigations can be too brief to truly understand the complex make up of many communities in terms of languages spoken, religious or cultural beliefs and practices, and the differences in urban and rural communities. Communities world-wide do not perceive a mine in the same way, nor do they necessarily want the benefits which are offered by mining companies. To preserve their way of life is sometimes seen as more important, and although some companies may offer educational opportunities or other incentives, these are not always understood or appreciated. In addition, the promise of economic gains from mining at the exploration stage may generate unrealistic expectations in communities, leading to disillusionment. A conflict was recognised between the time needed for full community understanding and the financial support allocated to the development of SLO. For future small-scale mining in Europe the need to reduce risk of social misunderstandings and conflict is extremely important, and effective community relations throughout the timeframe of a SOSO project will be needed to manage expectations and to simultaneously develop longevity of community benefits from short-term industry.

Technical experts on the use of containerised plant, small-scale mining of waste heaps, and innovative technologies for minerals processing were drawn together with the experts in sustainability on Day two of the meeting. The speakers were Ludo Ferranti, Colin Collino, Gregor Borg, Felix Scharfe, Mike Battersby, Paul Ainsworth, Gawen Jenkin, Andrew Batchelor and Tim Sambrook. The presentations reinforced that large-scale mining is not fit-for-purpose to provide a secure supply of a wide diversity of raw materials in small quantities and described the bespoke and design build challenges of SOSO mining. The availability and suitability of process flowsheets, the ability to design and build in-house, and a workforce with a wide skillset across mining and processing were considered to be critical issues in reducing the scale of operations. The wrap-up discussions reinforced that industrial stakeholders recognise a need for change and are ready to innovate and develop the technologies necessary for conventional small-scale mining to be developed more extensively in a suitable economic climate. Additional points discussed included materials handling, hard rock narrow vein mining, tailings and ore sorting, batch processing, water usage, processing of waste heaps as environmental remediation, mine closure plans and co-creation of opportunities. A Stakeholder Panel has subsequently been established, and can be found here www.impactmine.eu/stakeholderpanel. If you would like to become a member of the panel and keep in touch with IMP@CT please email info@impactmine.eu and you will receive updates and invitations to key events.
The first IMP@CT Project Workshop was held on 15-18 May, 2017, in Olovo, near Sarajevo. Most of the project participants were able to attend. To ensure everyone was able to experience every aspect of the mine, we were split into six groups, and were taken from the accommodation, just outside Olovo, to various parts of the mining site. Workshops were arranged at each station. Starting at the highest level, the 720, we were given hard hats, lamps and boots. Following a safety briefing we were then led through the mine down to the 580 level, where more Mineco staff were on hand to explain the geology of the region and the mine, and to take us to a barbecued lunch on the riverbank. The presentations included mining methods, led by Mario Nunic, geology led by Dragan Djordevic, processing and metallurgy, led by Dominic Roberts, and Infrastructure, led by Richard Roethe. There was also a session at the Town Hall in Olovo, where Ismar Sabovic gave an enlightening presentation on the social and economic situation of the region, and later we had the opportunity to meet local community representatives.

In addition to the mine visit and workshops, IMP@CT members held project meetings, and were invited to the British Ambassador’s Residence in Sarajevo for a reception with many of the region’s mining experts and ministers. The following day a guided tour of the city was arranged, and we spent the morning learning about the often violent and pivotal history of this intriguing city.
INTERVIEW

Developing a continuous mining tool: in conversation with Gareth Thomas, of Metal Innovations

How did the idea for the “continuous miner” arise?

The concept of the continuous miner was conceived by me in 2000 after researching how to develop a machine that could bridge the different requirements posed by different sorts of mining eg coal, gold, lead and civil engineering.

What are/were the main challenges in the design?

Designing a cutting head that would be compact yet powerful was the real challenge. After visiting the mine site in Bosnia my years of experience told me the challenge was not cutting the ore but cutting the host rock to maintain access for the machine and men to pass. We looked at a remote control machine but in the end decided that in order to maintain clear visibility and keep galleries and stopes as productive as possible we needed to maintain the smallest possible footprint in order to work thin veins as productively as possible.

How will it be used in the IMP@CT project?

In the IMP@CT project it would be used to prove the viability of selective mining taking mainly high grade ore. These deposits appear to be concentrated in thin veins even though these veins are at times dispersed in larger loads.

Will it benefit mining in Europe in the longer term?

I believe that this concept could benefit Europe by allowing small-scale mining and investigations to proceed at a lower cost. It’s true that there are many ore deposits throughout Europe and the U.K and Ireland that are too small for large scale mining.

What is the history of Metal Innovations, and why were you attracted to get involved in IMP@CT?

Metal Innovations was formed in 2004 by myself with a very small amount of funds. Working with the rest of the team we have moved the company forward so it has been active in many countries around the world; we are a very innovative company that pushes the boundaries of what is accepted in order to get the most out of every opportunity. This grant will allow that innovative spirit to deliver greater machines that will help all.

Bosnia and Serbia Field Trips

In July 2017, Luke Palmer (pictured) from CSM and Richard Roethe from Mineco flew to Bosnia to take part in a geological field trip. This was an initial fact-finding mission, and as such was a success. They describe the trip:

Over the first seven days at the Olovo mine, active and historic underground workings were visited daily, allowing the external participants to get a good overview of the different geological properties of the ore zones and the host rock across different levels. Following this, for several days, the observed mineralisation styles were documented at the 580 level through detailed mapping, photography and sampling. We concentrated on methods to capture the close spaced variability that is commonly associated with narrow vein complex deposits. As an immediate result, we are working on the production of a profile panoramic photography to complement the detailed mappings of an outcrop at the 580 level. At this outcrop, the drive intersects a ‘typical’ high grade vein with different mineralisation styles and alterations, over a 17m long exposure at almost 90° angle to the drive. In addition to the already available MINECO sampling...
data from this drive, geochemical samples from different mineralisation styles were taken. A close spaced sampling of 21 points along a previous 1m channel-sample were taken to investigate the shortest range variability. Further, we worked with Geomet’s geologists and trained them in the use of the Schmidt Hammer to assess rock strength parameters of the rock. We were also very glad to be able to rely on the assistance of the recently established Olovo minesite XRF geochemical laboratory, with two highly capable chemical engineers. This allowed us to analyse the first samples immediately and conduct other measurements like bulk density as well as sampling tree experiments. We are processing and analysing all of this data.

Most of our results are directly relevant to focussing on best practice approaches to sampling and estimation methods of complex deposits. Furthermore, as the underlying assumptions of geological conditions are pivotal to the down-stream engineering aspects, so these results are very relevant to all partners and work packages of the project.

Towards the end of the trip, a visit to the MINECO database geologist, Mr. Milan Milasinovic gave a significant insight to the commonly encountered resource estimation issues on deposits with complex geology and low data. On the final day, the team visited historic workings of Austro Hungarian (1720s) and Roman origin at Mineco’s Rudnik Mine in Serbia. This will contribute to investigating the issues of historic and ancient mining, and what practices could be relevant to this project. We also were able to visit a recently opened narrow vein, which is being mined in a shrinkage stoping method at the Rudnik Mine. In essence, this trip was a crucial first step to get started on the research topic, giving us a better overview and ideas about the general conditions encountered in a complex deposit such as Olovo.

INTERVIEW

Richard Roethe of Mineco talks about some of the challenges of introducing a new mining concept to a post-conflict mining region

What motivated you to host the field testing of the IMP@CT project?

Mineco has several projects that operate on small, high grade and complex deposits, which are precisely the target of the IMPaCT project. Therefore we are very interested, not only in new technologies for this kind of mining, but also in new business models and ways to make small mining projects socially and environmentally sustainable. With our Olovo project, we have the perfect ‘sandbox’ in which we can run the first round of equipment testing, whilst still having access to infrastructure such as workshops etc. A follow up field test in one of our project areas located in the south of Bosnia will then fully verify the technological approach for greenfield situations. We are seeing a high potential for several small but high grade near-surface deposits in the Balkans, which has been classically our preferred operating territory.

The mine sites are in post-conflict areas of the Balkans. How has this affected the opening up of a mine? Could you say a few words about governance?

Unfortunately mine sites are often located along historical fracture lines. This is certainly the case in the Balkans, both Olovo and Gorazde were fought over during the civil war and both bear the social and physical scars of conflict. Mineco’s extensive post-conflict experience at our largest mine in Srebrenica has helped us develop a set of tools specifically for use in such scenarios. As a further consequence of the conflict there is still much improvement needed of the legislative regime in all of the affected Balkan’s states. Industry, working with government, is starting to make a difference but we need to work harder to ensure that all levels of government understand that to create wealth in the population it needs to be generated by the private sector first.

Ethics plays a big part in IMP@CT, particularly as it relates to social impacts in the region. How is Mineco dealing with these complex considerations?

As well as the directly employed staff, mining generates a large number of indirect and spin-off employment opportunities. It is general accepted that for each employed miner a further four employment positions are created. The social impact of mining, invariably on smaller, remote communities is huge. One of the key stakeholders in any mining operation is the community within which it works and accordingly we must coordinate very closely with the local authorities. One of the interesting aspects of the project will be to assess the potential impact of SOSO mining on such communities, and whether they are prepared to support mining operations without the potential for generational security.

Does the SOSO concept present any particular technical challenges? How widely would the IMP@CT technology be useful for Mineco’s operations in the Balkans?

As mine operators, we are currently operating in a very risk averse environment, meaning that only the largest and geologically persistent deposits are actually exploited. The reality is the world is running out of deposits of this kind and we must be creative to find new solutions for our ever increasing resource demand. Smaller, high grade deposits do exist in surprising numbers throughout Europe, however their exploration and the assessment of resource potential is much more difficult. One approach of the IMPaCT project is to change the business model of mining, reducing the required capital expense and utilise mobile and modular equipment. This approach holds higher risk but the capital exposure of the operating company is much lower, as they could just halt the mining and move to the next project. The technical difficulty lies in finding a mining and processing solution which would work with the most small and high grade deposits.
Why “Mines of the Future”? How do you see mining developing in the near future?

Today’s mining has changed considerably from previous generations. Technological developments have improved exploration and mining operations. Also, today’s mining operations have come to be more sensitive to the communities in which they are situated and the environment in which they operate. Thus, while modern mining needs to be profitable, it should operate with environmental integrity, be considerate of social concerns and be supported by effective government systems. At the same time, mining companies face operational challenges. For example, the ore content of mineral resources decreases, the ore mineralogy becomes more complex, the depth and size of mining operations increase, the amount of energy needed to extract the valued commodity increases, and the amount of waste spirals. Nowadays, the concept of “sustainable mining”, to be able to provide resources for future generations economically and using environmentally sound and socially accepted practices, has become a major global challenge. At the same time, the world’s population is forecasted to surge from currently 7500 million to 11000 million people by the end of the century. With the growth of both global population and prosperity, especially in developing countries, the prospect of much higher resource consumption levels is far beyond what is likely sustainable. According to the report by UNEP’s International Resource Panel, by the year 2050, human beings could devour an estimated 140 billion tonnes of minerals, ores, fossil fuels and biomass per year – three times the current consumption rate. The question then arises as to how to provide mineral and energy resources for a growing world population. Such a global challenge will only be solved through very important changes, in the way the mining sector engages with society, uses energy, protects the environment, educates professionals and pursues innovations. And in our global business of resources, we will also need greater exchange of technical information and knowledge. Thus, the conference “AIMS 2018 – Mines of the future” will be such a platform.

What kind of technological advances will be presented at the conference?

The main topics of the conference will be:
Technological advances and innovation
Best practices and benchmarking
Responsible and sustainable mining
Do you think mining in Europe has a positive future or will it die out? How important is environmental and social sustainability in the future of mining?

The lack of broad societal acceptance of mining in Europe will shift mining operations to resource-rich developing nations, but with the environmental impacts also being shifted from Europe to other continents and to government systems that are ill-equipped to deal with resource extraction. In future, Europe will have to provide mining expertise to resource-rich developing nations. For example, training will have to be extended to resource-rich developing nations that will require capacity building of local professionals.

Conflicts between the mining industry and other stakeholders, in particular local communities, will continue, unless the social revolution of mining will continue to pursue initiatives like the Extractive Industries Transparency Initiative (EITI), Global Reporting Initiative (GRI), or Fairtrade. These initiatives could ensure that companies establish and maintain a social license to operate. The mine of the future will have to be increasingly quiet, out of sight and hardly visible, green and clean. It has to have an insignificant environmental footprint, and it will only bring to the surface the primary resources required by an increasingly circular economy. Mining will have to be like keyhole surgery – getting the same resource with a much smaller footprint. Also, the rehabilitation of mine sites will need to become more innovative and considered of the long-term needs and expectations of all stakeholders.

The mine of the future will be different to that of today. There is reason for optimism that the required revolutions in mining are possible. Such optimism is based on the fact that the mining sector has a phenomenal ability to achieve progress and change. However, only a combined effort by all stakeholders (education and training organisations, government agencies, mining companies, mining contractors, equipment suppliers, community groups, media) will result in a bright future of mining in the 21st century.

IMP@CT at Aachen

Europe is not self-sufficient in critical raw materials and is currently dependent on raw material supplies from world class deposits across the globe. The IMP@CT Project, funded by the EU Horizon 2020 research and innovation programme is looking at developing an adaptable method of Switch-On, Switch-Off mining which would enable small and high-grade or complex ore deposits across Europe to be opened up in an economic and environmentally and socially sustainable way. IMP@CT is hosting a session on small-scale mining at the AIMS Conference in May, 2018, where project results and work in progress will be presented. The conveners invite abstracts that cover a wide range of topics related to the potential for small-scale mining. These can include, but are not limited to, ore deposit geology, the economics of mining, geometallurgy and minerals processing, and social and environmental sustainability.

Dates: Abstract submission from 1st December 2017 - 1st March 2018
Registration for authors from 1st December 2017 - 1st March 2018
Registration for participants from 1st December 2017- 30 April 2018
To register and submit abstracts please go to http://www.aims.rwth-aachen.de/
The RADOS ore sorter has arrived at CSM. After a lot of clever manoeuvring the crate was finally unloaded (above) and is now installed in the lab. Nashlen Odiar from Rados International has arrived to train CSM and IMP@CT staff in the use of the equipment, which will hopefully be a valuable addition to the IMP@CT project.

There have been many opportunities to disseminate the IMP@CT project throughout 2017, including MINEX Europe and the AIMS Second International Conference, Mining in Europe, Aachen. IMP@CT members also had the opportunity to meet mining experts and ministers from the region at the British Ambassador’s reception in Sarajevo.

In November Amela Imamovic, from Bosnia, arrived at CSM to undertake lab work and training for a 6 week period. Amela is pictured here with Saeid Moradi from CSM (centre) and Rob Davies of South West Metallurgical Services on a recent visit to discuss spiral requirements.

Members of IMP@CT visited Extracthive in Avignon in July 2017 for a site visit and workshop, seen here, above, examining the Extracthive facilities.

2018 upcoming dates to note

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<tr>
<td>Project meeting</td>
<td>February 22-23</td>
<td>Bristol, UK</td>
<td>Internal</td>
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<tr>
<td>AIMS “Mines of the Future” Conference, Aachen</td>
<td>May 23-24</td>
<td>Aachen, Germany</td>
<td>Registration/abstract submission</td>
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<td>MMP deployment</td>
<td>May 2018</td>
<td>Olovo, Bosnia</td>
<td>Project Milestone</td>
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<td>Project workshop</td>
<td>July (TBC)</td>
<td>Olovo, Bosnia</td>
<td>Internal</td>
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