The emerging niche for ethical small-scale mining

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Whole systems research within the IMP@CT project encompasses concerns relating to society and environmental impacts as well as technological innovation. Since large high-grade deposits are becoming depleted, the economies of scale and the need to prolong mining for investment security promote mining of large low-grade deposits with increased energy consumption and waste generation. It has been argued (Siegel, 2013) that a sane mining ethic would establish limits on prolonging extraction once the grade reaches an unsustainable level. Such a sound ideological principal might fail to make headway while expensive surveys are needed to secure investment and while financiers manage environmental and social risks (through the IFC's Equator Principles). However, the centralisation of large-scale mining activities in few geographical locations requires vast global transport networks, and the energy constraints on the scale of crushing technologies combined with new regulations on shipping fuels may drive up the price of metals from a dominant global supplier. A climate of increasing costs from large deposits at decreasing grade may create space in the market for small-scale conventional mining with technological solutions that increase competitiveness. It can be argued that small-scale mining, particularly in Europe, is more ethical because it must involve cooperation with environmentally and socially aware individuals who have a collective community expectation for their quality of life. However, small-scale mining is unlikely to realise an extended life of mine and an accelerated transition from pre-mining to post-mining community must be designed to protect the ethical right of the individual to live well and prosper in both a healthy environment and a sustainable community.

Siegel, S., 2013. The missing ethics of mining. *Ethics and International Affairs*, 14 February 2013.

Definition of Mineral Resources during Exploration and Exploitation in a Switch-On-Switch-Off Mining context

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Switch-On-Switch-Off (SOSO) mining requires a new approach of defining mineral deposits during exploration and exploitation, focusing on maximising the value of sampling and providing adequate information for subsequent planning. The large budgets and time-frames available for the appraisal of large projects are unavailable for SOSO mining projects, where only small time-frames and budgets are practical. To meet this challenge, a two-phase geometallurgical sampling strategy is presented.

The exploration phase requires initial characterisation of the deposit to produce an adequate picture with minimal information at the maximum acceptable risk. Relevant mining, processing and environmental variables (such as, rock mass strength, grade, metallurgical recovery and presence of deleterious elements) must be investigated from the start to reduce costs, enable early extraction and generate cash-flow. Rather than attempt whole-deposit characterisation, a small zone is studied in detail, resulting in a short Life-Of-Mine (LOM) with acceptable prospects for expanding this zone using further data collected during production.

The exploitation phase consists of using production data (such as grade control, production drilling, reconciliation and short-term mine planning) and further orebody definition through sampling to permit continued extraction and increase LOM. Using current industry best-practice, there should be, in theory, sufficient knowledge of the project at start-up to ensure a financial return without production data. Whereas, for SOSO projects, the information obtained from production data is an integral part of the financial success of the project; minimal data are initially acquired, resulting in a higher chance of project failure.

IMP@CT baseline database for 'switch-on switch-off' extraction

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The mineral supply chain cannot respond rapidly to demand or supply shocks, creating price volatility and potentially supply shortage. This risk can be reduced by increasing the readiness of new capacity. Europe has a large number of small complex mineral deposits, particularly of critical raw materials, that are not currently viable because their size would result in a short life-of-mine that cannot justify large capital investment. However, small complex deposits in Europe have the potential to diversify and extend the resource base, to provide supply safety to European industry and end users, thus reducing material criticality.

The IMP@CT project proposes a new approach to increasing supply capacity readiness that alleviates the need for major capital expenditure and facilitates 'smaller' operators, including the entrance of new suppliers to the market. Its main objective is to develop an innovative 'switch on-switch off' (SOSO) approach, using modularised mobile plants that can be adapted to variable geological and metallurgical conditions, transported between sites, and safely deployed within the cost-constraints of such small mining operations. The SOSO mining model would minimise expenditure on exploration and pre-feasibility drilling and focus on the identification of high-grade ore to support rapid production and income generation. The research project also has a special focus on environmental and social aspects that are associated with small mining operations and short mine-life.

In order to test this approach, the project needs to select small-scale high-grade complex deposits that may be used as case studies. This contribution describes the IMP@CT baseline database of deposits for a SOSO approach and how it was constructed during the first year of the project. It presents the ProMine Mineral Deposit database that was used as the main source of data. Then it describes how this database was queried, testing different approaches, and how the extraction was 'augmented' with other complementary sources of data. Finally, it describes the resulting dataset, and how it will be used for the SOSO approach.