Mineralogy Informed Flowsheet Modelling

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Project Highlights:

- Model the impact of mineralogy on circuit performance
- Predict liberation distributions from breakage behaviour
- Directly coupled comminution and separation predictions

Overview:

In minerals processing the mineralogy and texture of an ore plays a key role in the link between comminution and subsequent separation. In current circuit simulation software this link is usually lost, with comminution simulations usually only predicting the size distribution of the resultant particles, with important considerations for the subsequent separation, such as volumetric and surface liberation not directly being predicted. In this work we propose to develop a methodology for using SEM-EDX and/or microCT images of unbroken ore particles as an input to the flowsheet modelling. These will then be virtually broken, with mass balances based on populations of these virtual particles. In order to do this efficiently, a balance will need to be struck between the number of particles being tracked and the accuracy of the resultant distributions. As the size of the particles can change by orders of magnitude over a comminution circuit, which particles are being tracked will need to automatically evolve over the flowsheet. Other than the unit specific models, the key algorithms that will need to be developed are those for virtually breaking particles and those for deciding which are key particle types to include in the mass balance and which to discard, as well as how to ensure that the macroscopic mass balances remain accurate as particles are discarded. The discarding of particles from the simulations will need to be based on a number factors, including their importance to mass balance for the various minerals and particle size classes, as well as their uniqueness. The ultimate aim of the simulator will be to allow comminution and separation to be jointly optimised based on the actual ore textures and mineralogy. It will also allow circuits where separation and comminution are directly integrated with one another, such as flash flotation cells in the milling circuit or regrinding within the flotation circuit, to be far more accurately simulated than is currently possible.

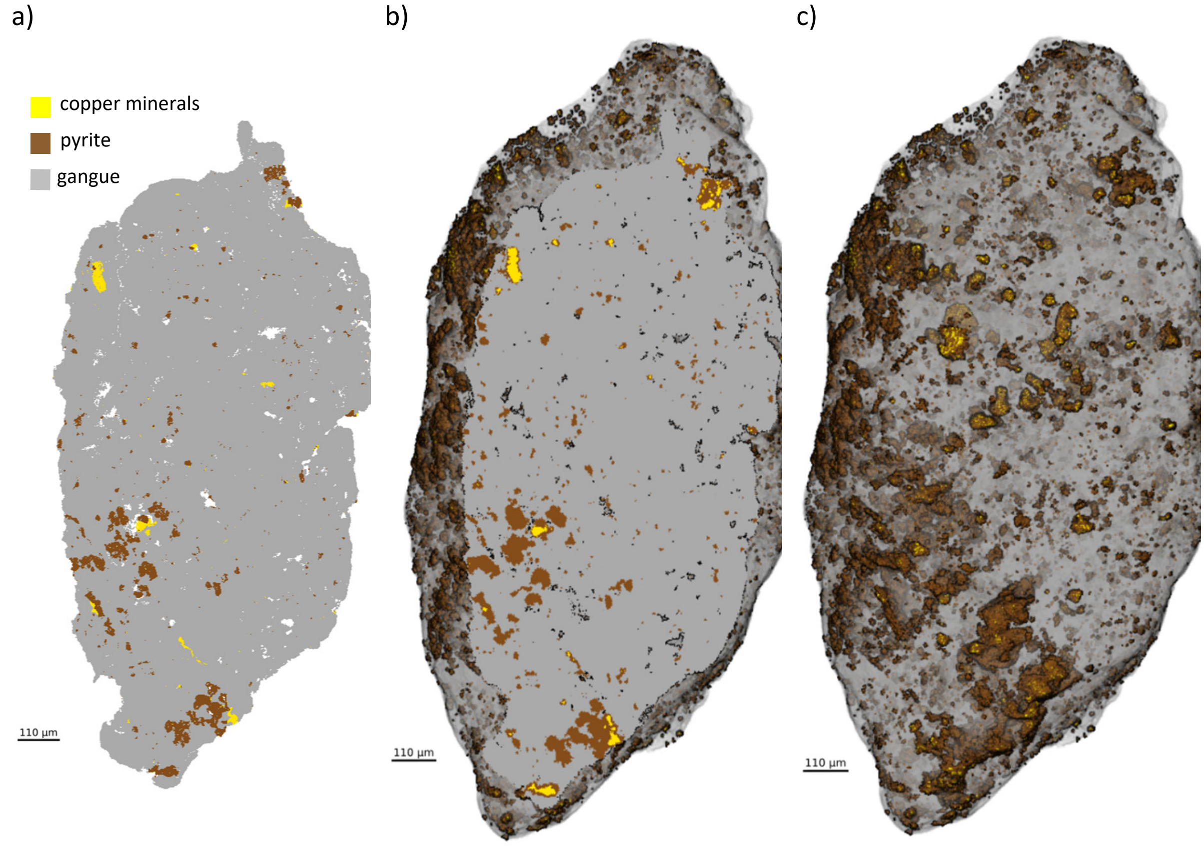

Figure 1 A calibrated XMT based mineral map, with calibration based on a 2D EDS mineral classification. These sorts of 3D images will be used as the initial input for the flowsheet simulations. a) EDS based classification, b) same slice using the threshold found and c) the resulting 3D mineral map

Methodology:

The PI has already developed a framework into which these algorithms can be inserted. The key task of this project will therefore be to develop the algorithms for virtually breaking microCT or SEM-EDX images of ores. This will then need to be coupled with additional algorithms for determining the representative particles to carry forward at each point in the simulation and how to redistribute those that are rejected. To test these algorithms some lab based experiments will need to be carried out in which a piece of ore is milled and separated, with both the intact ore and the resultant particles at each stage of the separation imaged. This will also require the adaption and improvement of our existed imaging algorithms to allow comparisons to be made between the actual and virtual particle distributions.

Possible Timeline

Year 1: Develop initial algorithms together with simple unit models. Obtain initial 3D and 2D images of ore particles to use in algorithm development

Year 2: Obtain images of processed ores to compare with the virtual particles predicted by the simulator with the actual ore particles produced. This will be coupled to algorithm improvement and the development of initial unit models. These will be based on literature models, but adapted to this new framework.

Year 3: As well as continued improvement of the simulator, in this year it will be used to investigate different comminution and separation configurations and their impact on the overall circuit performance.

Training and skills:

TARGET researchers will participate in a minimum of 40 days training over the 3.5 years of study composed of:

- an annual one-week workshop dedicated to their year group, and tailored to that cohort's needs in terms of skills development – *for the first three years of their study*;
- an annual all-TARGET workshop with cross-year interactions, advanced training and opportunities to specialise in particular areas – *all years of study*;
- a number of one-day workshops;
- additional online events and in-person workshops attached to relevant conferences.

Partners and collaboration (including CASE):

The student will be co-supervised by academics from Imperial College and the Natural History Museum. This supervisory team has a strong track record of successful collaboration on multidisciplinary projects in mining. The student will receive guidance across the technical, geological, and environmental aspects of mineral resource exploitation.

Industry collaborators, both mining companies and equipment manufacturers that implement minerals processing circuits for their clients, will have a strong interest in the resultant flowsheet simulation framework. They will also have case studies that could be used as the basis for the testing of the simulator and the evaluation of different circuit designs.

Further reading:

Reyes, F., Lin, Q., Cilliers, J.J., Neethling, S.J. (2018) Quantifying mineral liberation by particle grade and surface exposure using X-ray microCT. Minerals Engineering 125, 75-82.

Neethling, S.J., Brito-Parada, P.R. (2018). Predicting flotation behaviour–The interaction between froth stability and performance. Minerals Engineering 120, 60-65.

Lin, Q., Neethling, S.J., Dobson, K.J., Courtois, L., Lee, P.D. Quantifying and minimising systematic and random errors in X-ray micro-tomography based volume measurements. Computers & Geosciences 77, 1-7.

Further details:

Please get in contact with Prof. Stephen Neethling (s.neethling@imperial.ac.uk) to discuss a potential application.

Visit https://target.le.ac.uk/ for additional details on how to apply.