WHAT IS GEOMETALLURGY?

By Al Cropp and Dr Will Goodall

INTRODUCTION

Rather than reacting to a spike in losses to tails, imagine a situation where plant operators know exactly how to process the next 24hrs of feed ore that is sitting on the conveyor belt ahead of time. How much risk would this remove from an operation? Now imagine plant operators being able to walk along this 'virtual' conveyor belt and see exactly what will be coming in tomorrow, how it will behave and be able to plan for it. Continue to extend the vision, where the plant operator can continue to walk along the side of the conveyor and stop at any point representing next week, next month, next year… through to the end of the life of the mine: and at any given point in time, know exactly what the ore will be, how it will process, how to operate the plant to maximize recovery and efficiency, and how to effectively manage the environmental impact. This knowledge will also help drive mine planning, blending strategy and tailings management (Figure 1). This is ***Geometallurgy***.

Figure 1. Geometallurgy is applied from exploration, through mine planning, blending strategy, flowsheet design, plant optimisation and tailings management.

METALLURGICAL ORE TYPING AND MODELLING

The traditional evaluation approach focuses on in situ tonnes and grade of the economic commodities, however with more complex and refractory ore bodies being exploited the emphasis is increasing with regards to risk management and cost efficiency. The geometallurgical approach directly addresses this by resulting in block models that display the distribution of key metallurgical parameters through the orebody that support metallurgical process modeling and add value to the planning and optimization process (Dominy, 2011). This includes:

1. Unlocking the characteristics of how a rock will behave, right from drilling and blasting through to metal recovery and tailings management.

2. Building this knowledge block by block in to a 4D geometallurgical predictive model, with each block orientated spatially and ready to be laid out over time on a “virtual conveyor belt”, for mine planning, flowsheet design optimisation, blending and process optimisation

3. Integrating this with operational reality, including financial, environmental and risk management variables

4. Reducing operational risk through variability, minimizing unnecessary metal losses, and effectively managing environmental issues.

Geometallurgy can be thought of as ***Metallurgical Ore Typing*** – identifying the ore to be processed not just based on different mineralogy and rock types (traditional "Ore Types"), but based on relevant metallurgical characteristics that directly control the way an ore will behave in the processing plant. These geometallurgically defined units may comprise an ore type, or several ore types, that possess a unique set of textural and compositional properties from which it can be predicted they will have similar metallurgical performance (Lotter et al., 2011).

These meaningful metallurgical ore types must be designed to reflect characteristics that plant operators can realistically react to within the operating philosophy and set-up of the plant. Too many ore types can reduce effectiveness, as the plant simply cannot be expected to be changed and react in time to maximise recovery of each one. Too few ore types may result in variable ore running through the plant, resulting in variable recovery. Both these scenarios will increase risk, and increase operational costs; geometallurgy is designed to find the balance.

WHERE GEOMETALLURGY FITS?

Consider 3 primary influences on the efficiency and recovery from a processing plant – a trilogy of plant operation if you like (MacDonald, M. et al., 2011). 1) operational philosophy, 2) ore type and 3) day to day operation (Figure 2).

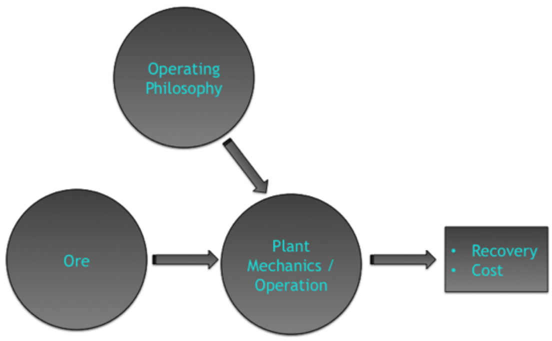

Figure 2. The trilogy of plant operation.

Operating philosophy is often defined during the design phase, at which point the degree to which it can be altered (without major investment) is also often constrained. To a large degree, the ore and the way the plant is operated can therefore be considered the primary variables for improvement during day-to-day operation. The greater the geometallurgical understanding of the ore, the lower a variable the ore becomes and the lower the risk. The focus can then be placed on operating the plant at maximum efficiency within the confines of the operating philosophy for each geometallurgical unit.

If the properties of the ore are not fully understood, the ore will vary, metallurgical response will change, and losses and concentrate dilution will occur. An even bigger challenge and expense may then arise from chasing the problem because the same response may arise from poor plant operation or performance; so which is it? Do you ignore the problem and accept variable recovery, or spend more time and money chasing the issue down without knowing where to look?

THE ROLE OF PROCESS MINERALOGY

A key tool in understanding the distribution and behaviour of ore types can be found in the use of process mineralogy. The field of ***Process Mineralogy*** is essentially the integration of process diagnosis, flowsheet design and optimisation through metallurgical test work based on sound mineralogical characterisation. It involves understanding the characteristics of the rocks and minerals at all scales, from the macro (m or kms scale) across the deposit, to the micro (mm to µm) for processing or tailings management (Figure 3).

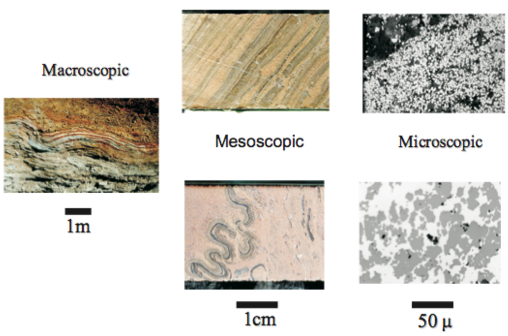

Figure 3. Process mineralogy quantifying the rocks and minerals across different scales. From (Shaw, 2009)

CASE STUDIES IN GEOMETALLURGY

Schouwstra et al, (2010) highlight the importance of the multi-disciplinary approach that geometallurgy takes to ore assessment, drawing a clear link between mineralogy, flotation response and downstream refining. They add that mining and processing based on grade alone would not in some cases be sufficient, pointing to a seemingly "inferior" ore (based on grade) which would actually result in a better quality concentrate if handled correctly. In this case study, careful mining and blending is likely to be required to meet target grades and recoveries, making carefully integrated geometallurgical testing and analysis vital.

Hunt et al, (2011) recognise the criticality of mineralogy and texture (i.e. process mineralogy) to geometallurgy, and the importance of having this information right from the planning stages of mining and mineral processing. They cite an example where there could be increased potential for liberation of target phases in low grade ores, which traditionally have been highly variable, but which with good geometallurgical understanding may become a mineable resource with predictable recovery.

CONCLUSIONS

Geometallurgy is about reducing the risks in an operation by understanding and managing one of the greatest potential variables – the ore. This is done through sound understanding of the geology, mineralogy and processing implications of the ore. In the end it is all about man taking apart what nature put together, and a proper understanding these will allow this to happen in the most environmentally responsible, cost effective and optimal manner.

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