**Min Assist**

A Better Understanding of your Minerals

WHAT IS PROCESS MINERALOGY?

INTRODUCTION

Process Mineralogy can be considered as the practical application of mineralogical knowledge to aid mineral exploration, and to predict and optimise how an ore can best be mined and processed. It bridges mineral *process*ing and traditional *mineralogy,* and is a specialisation within the field of applied mineralogy. Process Mineralogy is being applied in areas such as geometallurgy, ore characterisation, process design and optimisation, driven by today's increasingly complex ore bodies and the rising pressure to reduce operational cost. Responsible environmental management also demands a greater understanding of the minerals and their textures in order to reduce risk.

The aim of process mineralogy is to identify, diagnose and predict processing characteristics of an ore that are mineralogically controlled or influenced, and to understand either the benefits of these that can be harnessed, or the limitations that need to be catered for. The *mineralogy* and, most critically the *texture* (Figure 1), of an ore dictates how the ore can be mined and processed optimally, as well as highlighting potential environmental ramifications in doing so.
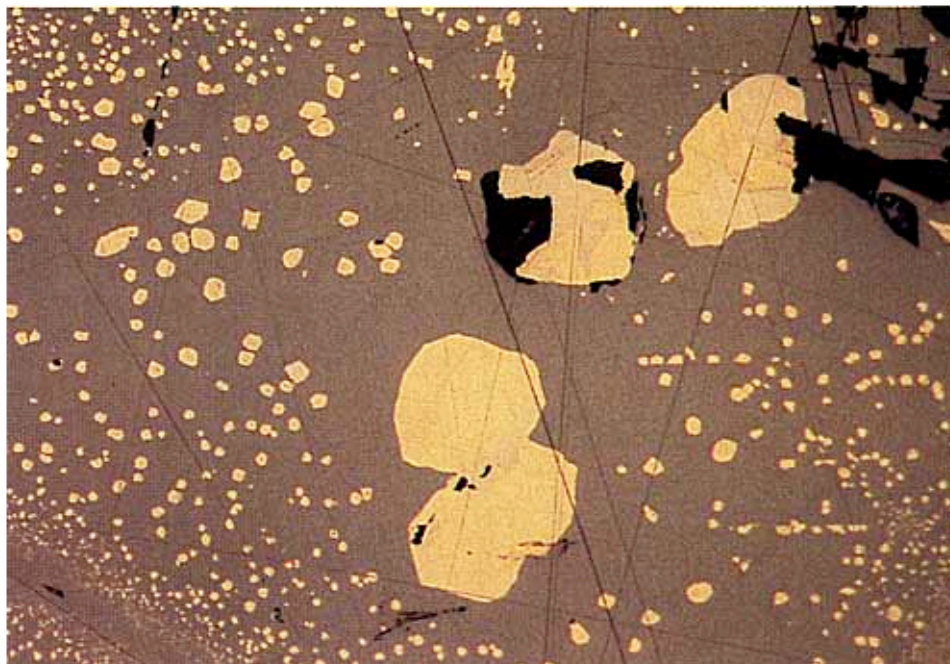
250μm

Figure 1. Sphalerite (blue-grey) containing abundant chalcopyrite (yellow) ranging from several hundred microns to only a few microns. Grade alone is not enough to characterise an ore – the texture is paramount. www.smenet.org.

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WHERE IS PROCESS MINERALOGY USED IN MINING?

Process mineralogy is utilised in all stages of the mining cycle, including; exploration, mine planning, mineral processing, tailings management, and metallurgy. It is closely linked to geometallurgy, being fed directly in to a geometallurgical predictive model, which spans the whole process.

Rock and mineral properties that can be identified through process mineralogy techniques include; gangue and target mineralogy, key element deportment, grain size and shape, deleterious minerals and elements (for example swelling clays, refractory minerals, arsenic…) and mineral associations.

EXPLORATION:

In mineral exploration, process mineralogy is used to identify the ore minerals, and make an early assessment of potentially problematic minerals. In early stages, knowledge of the mineralogy can be used to provide indicators and vectors guiding location of the ore body(ies). Knowledge of the mineralogical and textural characteristics of the rock and ore increases as a resource moves from an exploration target through to a known resource and reserve. This includes expanding on the recovery potential for certain minerals / elements, and making predictions on how the ore may behave during processing.

MINE PLANNING

During mine planning, the process mineralogical knowledge from exploration is further expanded and refined for input to the mine model, and the operational plan. This will include process mineralogy and geometallurgical analysis to identify units of ore with similar processing responses, and potentially the identification of units that could be blended.

Process mineralogy can also help predict the rock breakage during blasting and other handling characteristics, as optimising this can be considered the first stage in efficient comminution.

MINERAL PROCESSING

Sound process mineralogy data will allow the generation of theoretical grade-recovery curves for feed material, indicating how much of the target mineral(s) / element(s) can be recovered at a given concentrate grade. Recoverable vs non-recoverable material can also be identified. These data can be used to guide metallurgical testwork and to create theoretical flowsheets for testing – potentially saving significant time and money (Figure 2).
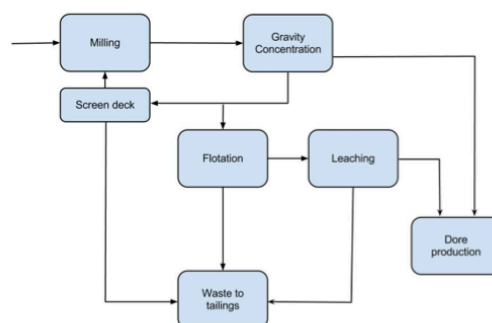

Figure 2. Theoretical flowsheet development is possible based on sound process mineralogical knowledge of an ore, saving time and money.

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Typical applications include targeting recovery improvements, lowering energy costs, optimising liberation and characterising losses to tailings.

Process mineralogy most commonly examines composite samples collected from critical points within the processing circuit in order to understand the efficiency of each circuit, and identify improvements. Samples are typically split in to a number of size fractions to improve statistical representivity and data accuracy, from which data on each population can be gathered using a range of techniques.

Common key mineralogical attributes include quantifying target mineralogy, gangue mineralogy, deleterious mineral or element distribution, grain size and shape, mineral-mineral association, surface coatings, degree of liberation (Figure 3) and free surface area.
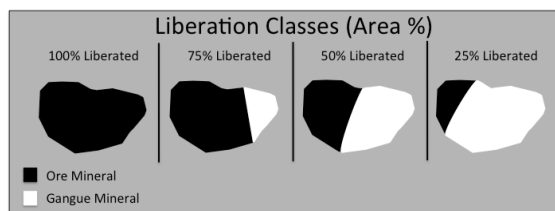

Figure 3. Example of liberation classes for a simulated particle with ore and gangue.

Sample points may include for example:

-   Grinding discharge, to establish the degree of liberation and free surface area of target minerals, and the association of the target minerals with other phases
-   Tailings, to identify and diagnose losses. This may include identifying what size fraction they report to, their degree of free surface area (and

therefore ability to be collected during flotation for example), and their locking characteristics.

-   Concentrate, to examine dilution, with particular focus on deleterious minerals or elements which may impact further processing, refining or final product value

The knowledge gained from undertaking a well defined and focused process mineralogy study on an operation can have a significant impact on reducing operational costs, improving recovery and lowering risk. Further, establishing a regular and on-going process mineralogy program on a daily, weekly or at least monthly basis will lead to much greater long-term benefits through deeper understanding of an ore and an operation over time.   Process mineralogy studies can also be used to guide, interpret and optimise bench and pilot projects, and to audit plant performance with confidence using mineralogy.

TAILINGS MANAGEMENT

Responsible mining and processing operations utilise process mineralogy as one of the primary tools to ensure that tailings that can be disposed of in an environmentally safe manner (Figure 4). This includes examining, for example, the elemental distribution of say sulphur and arsenic, as well as the texture of the minerals containing them, in order to quantify whether these are locked or not and therefore the likelihood of their being released in to the environment.

Figure 4. Comprehensive process mineralogy can be used in tailings management.

METALLURGY

Hydrometallurgical operations involve leaching materials to provide a leach concentrate containing the element(s) of interest and a residue, whilst pyrometallurgical operations involve smelting of concentrates to produce metals and slags. Process mineralogy is used to characterise these concentrates, residues and slags to understand the behaviour and response of the ore and minerals to these processes.

RECCOMENDED READING

Bradshaw, D.J., Triffett, B., Kashuba, D., 2011. The role of process mineralogy in identifying the cause of low recovery of chalcopyrite at KUCC. Presented at the 10th International Congress for Applied Mineralogy, 1-5 August 2011, ICAM, Trondheim, Norway, pp. 73–80.

Evans, C.L., Wightman, E.M., Manlapig, E.V., Coulter, B.L., 2011. Application of process mineralogy as a tool in sustainable processing. Miner. Eng.

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Petruk, W., 2000. Applied Mineralogy in the Mining Industry. Elsevier Science B.V.

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ABOUT MINASSIST

MinAssist is a boutique consulting group specialising in Process Mineralogy, developing programs to assist the minerals industry to optimize value and reduce technical risks. MinAssist brings value to clients in unifying process mineralogy and metallurgy.

Process Mineralogy Blog:

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