

# Ask the experts

Dr Will Goodall explains how a better understanding of ore mineralogy can increase process efficiency and reduce operating costs in mining

The mining industry is constantly looking for ways in which to drive process efficiency in operations, reduce operating costs and maximise output. For managers and process metallurgists there is often an expectation for continual process improvement and tools are required to achieve this.

The smart use of mineralogical analysis can provide a beneficial tool for increasing the effectiveness of process improvement initiatives and overall process efficiency. Understanding the composition of feed material and how valuable minerals are associated with waste gives an advantage in any bid to increase efficiency by allowing operations to target the areas of greatest potential value.

In many mineral processing operations, waste represents over 99% of the material that passes through the process. Mineralogical evaluation allows us to understand the association of waste with the valuable minerals so we do not end

up paying to process material that provides no value.

The imperative to reduce costs wherever possible, while maintaining best practice for environmental emissions, places responsibility on operators to generate a deep understanding of their process.

The expectation from management, shareholders and community stakeholders is that best practice in all aspects of process operation is maintained, while minimising the costs associated with undertaking these initiatives. This is only possible if we become smarter about generating and using information relevant to the process.

## CASE STUDY

A typical example of using mineralogy to improve efficiency would be a gold operation that is experiencing pressure to increase total production to make the most of high gold prices.

While this example is hypothetical, the problems encountered and operating expenditure values are based on my experience at a number of real mine sites.

In this scenario, the operation is already operating at design capacity and any increase in throughput would require major capital expenditure and a long lead time before any real benefits were seen.

This leaves the option of improving process efficiency to obtain greater gold recovery from the existing process.

The team has been diligent with attempts at process improvement and regularly undertake process audits, but is unsure where the greatest benefit can be found.

The example operation processes 1Mt/y of material to produce 65,000oz/y

of gold at an average recovery of 85% and cost of US\$900/oz. The process includes a comminution circuit, followed by gravity recovery of coarse gold and flotation of the gravity tailing, as demonstrated in figure 1. Gold is recovered from the flotation concentrate by cyanide leaching, and gold doré bars are produced on-site.

The process team has attempted to examine the various process units with inconsistent results, and finally the project metallurgist calls in a consultant to help build a systematic mineralogical programme.

The consultant would immediately focus on the feed material to the process, organising for a composite sample of mill feed to be collected. They then build a comprehensive characterisation programme for this sample, as capturing this information early in the process will identify unit operations that can be targeted to provide the greatest benefit.

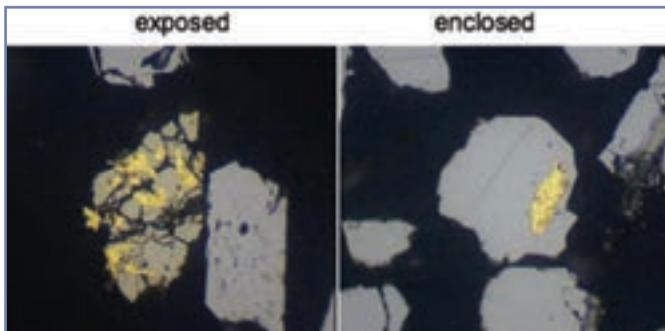
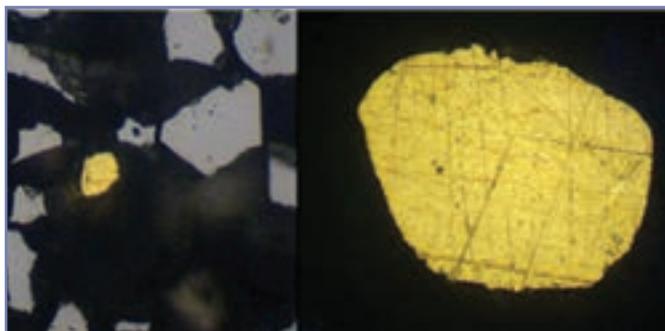
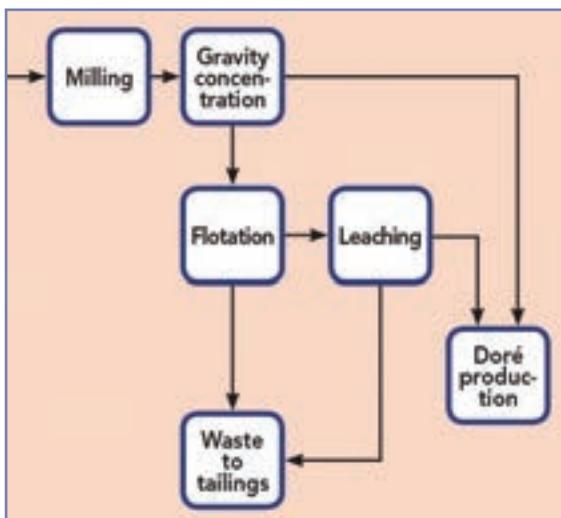
The programme includes investigation of characteristics of the gold minerals, along with detailed evaluation of the gangue mineralogy. By focusing on both gold and gangue mineralogy, the programme can provide flexible data applicable to both efficiency improvement and cost reduction.

In this case, the outcomes of mineralogical evaluation show two key results; gold is present in two distinct populations. The first is coarse gold grains that are greater than 100 microns in size and are already well liberated in the mill feed. The second refractory component is very fine gold grains, less than 20 microns in size, which are always associated with cracks and fractures within sulphide minerals (see figures 2 and 3).

Figure 1 (below): example flowsheet for a typical gold operation

Figure 2 (bottom left): coarse liberated gold grain typical of gravity recoverable gold

Figure 3 (bottom right): sulphide-hosted gold grains typical of floatable gold population



With this information the consultant could quickly identify some changes that would have major benefits to gold recovery and process operating cost.

The presence of well-liberated coarse gold would allow the gravity concentration circuit to be moved into the milling circuit for recovery of gold earlier in the process.

This has the added benefit of reducing over-grinding of the coarse gold grains and eliminating the build-up of circulating gold in the milling circuit. The mineralogy also showed that once coarse gold was removed, the material in screen fractions, representing 10% of the total mass, was barren of gold and could be rejected.

Having reduced the circulating load of the mill, it is possible to reduce the target grind size of the flotation feed to provide better liberation of sulphide minerals and gold.

This in turn results in a lower mass in the flotation concentrate and a higher gold grade, which reduces throughput in the leaching circuit and leads to increased gold recovery – a total cost saving of 5%. A summary of the upgraded flowsheet can be seen in figure 4.

### THE BENEFITS

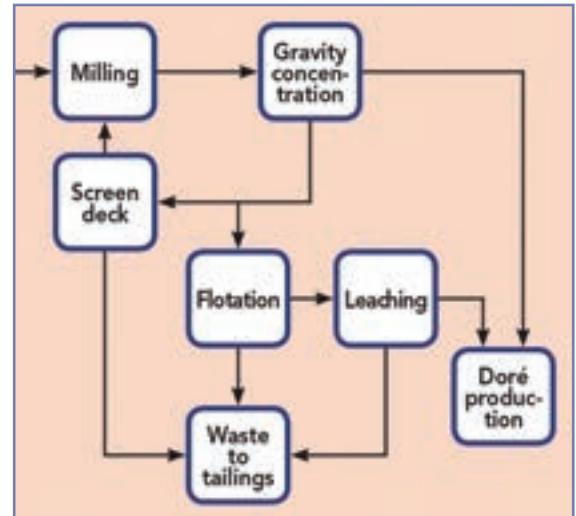
Overall, through building a better understanding of the mineralogy of the feed material the example operation could increase gold recovery to 90%, gaining an extra 5,000oz/y of gold production.

More importantly, the reduction in throughput to the flotation and leaching circuits would lead to a reduction in reagent consumption and power for these circuits. This results in a worthwhile reduction in operating costs to US\$850/oz of gold.

The cost of the mineralogy programme to achieve these benefits would be between US\$50,000 and US\$100,000. In this example, assuming a gold price of US\$1,600/oz, the total benefit to the operation would be around US\$5 million per year for the life of the project, representing a 100-fold return on investment in the first year alone.

This advantage could be achieved simply by gaining a better understanding of the mineralogy of the feed to the operation.

The example presented highlights the potential benefits that building an



understanding of the process mineralogy can bring to an operation. While it does not replace the need for systematic metallurgical test work in process improvement, the use of smart mineralogical programmes can greatly increase efficiency, leading to faster return on investment and greater cost reductions. ▼

*Figure 4: upgraded flowsheet reflecting the knowledge gained from the mineralogical evaluation programme*

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