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Increasing Efficiency Through Understanding Geological Controls on Grade Engineering

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CRC ORE (Cooperative Research Centre for Optimising Resource Extraction, www.crcore.org.au) works to improve the productivity, energy, and water signatures of mining operations and has developed Grade Engineering®, which is a range of technologies to reject nonvaluable material at a coarse particle size (~10–100 mm) early in the mining value chain. This reduces the amount of material sent for further size reduction and in doing so significantly reduces the amount of energy and water use per unit of metal produced.

Grade Engineering® is based on combinations of screening, sensor-based sorting, and heavy media separation related to five rock-based levers: preferential grade deportment by size, differential blasting for grade by size, sensor-based bulk and stream sorting, and coarse gravity separation. CRC ORE, in collaboration with CODES (Centre for Ore Deposit and Earth Sciences, www.utas.edu.au/codes), is working to identify relationships between geologic parameters (e.g., mineralogy, texture, hardness) and Grade Engineering®, particularly preferential grade deportment by size.

Preferential grade deportment by size is the propensity for some ores to exhibit preferential breakage leading to concentration of minerals in specific size fractions. This typically involves an increase of valuable mineral phases in finer size fractions. For example, at an Australian gold deposit ore screened into +50, 50 to 19, and -19 mm size fractions showed that >85% of the gold is in the -19-mm particles, and this size fraction makes up only ~25 to 35% of the total mass. Screening of subeconomic ores at a South American Zn-Pb-Ag operation into +70, 70 to 19, and -19 mm size fractions demonstrated that most of the value is in the -19-mm size fractions, which make up only ~25% of the mass.

Anecdotal information suggests that preferential grade deportment by size response is related to geologic textural parameters—for example, mineralization styles dominated by veins are likely to have a higher preferential grade deportment by size response than disseminated mineralization styles. Early research results indicate this is true for at least some ores. Vein and disseminated ore from a porphyry copper deposit shows clear differences in Response Ranking (RR), a measure of preferential grade deportment by size developed by CRC ORE (Fig. 1 a, b). Where veins are important, vein abundance, paragenesis, and alteration can be significant with respect to RR, as illustrated by samples from a gold porphyry deposit (Fig. 1c, d). The aim is to use various techniques (detailed logging, hyperspectral mineralogy, high resolution images, etc.) to identify geologic parameters that can be linked to RR. Ideally these will be measured (semi)-automatically in drill core. The parameters will be used to predict RR and allow it to be mapped and included in 3D models.

Fig. 1. Porphyry copper ore – a) vein-hosted (1.2% Cu), b) disseminated sulphides (0.7% Cu); Gold porphyry ore – c) multiple veins and significant potassic alteration (0.5 ppm Au); d) single vein and minor potassic alteration (0.3 ppm Au). Drill core is ~50 mm across. RR = response ranking.