Geometallurgy

Abstracts

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Using particle-based separation models to evaluate the selectivity of different collectors in chalcopyrite flotation.

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Abstract

Particle-based separation models are a powerful tool for modelling and understanding mineral separation processes at the level of single particles. Latest developments in this field have enabled the incorporation of complete particle datasets from image-analysis based techniques, thus allowing for the full integration of material complexity into process models. So far, these models have mostly been applied to static processes, without variations in operating conditions. In this contribution, we used particle-based separation models to understand variations in the flotation behavior of a fine-grained and low-grade chalcopyrite-dominated copper ore using different collectors: PAX and kerosene. This approach highlights the influence of particle size and shape on the flotation of chalcopyrite-bearing particles. Moreover, it demonstrates that detailed information on mineral associations is critical to achieve a full description of the process behavior of single particles. Full association data should therefore be used instead of simplified ore mineral liberation data whenever possible. Finally, results indicate that higher selectivity against pyrite can be achieved when kerosene is used as a collector instead of PAX. In addition, ideas for improving separation (e.g., higher grade and recovery) are discussed based on detailed particle information.

Sample characterization in leach kinetics studies: current status and opportunities.

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Abstract

Sulfide leach kinetics depend on resistivity, crystal defects, catalyzing impurity elements, and galvanically active gangue in samples. These properties vary over orders of magnitude in chalcopyrite ores due to the wide range of physicochemical conditions in which they form and stabilize. However, a review of recent research articles on the leaching kinetics of chalcopyrite shows that variation in these properties is not usually accounted for in experiments. In a review of published articles on the kinetics of chalcopyrite leaching, 23% did not report any quantitative chemical assay of the sample; 42% did not report any sample mineralogy; and 56% did not report quantitative mineral proportions. In several studies, the sample leached contained Cu mineral(s) other than chalcopyrite. No study accounted for the presence of galvanically active gangue or employed an analysis capable of detecting catalyzing or inhibiting trace metals in the chalcopyrite itself. These uncertainties contribute to variability in published kinetic data even in well-studied leaching systems.

Improved characterization can enable more consistency and certainty in kinetic analysis of leach results. Best practices include WDS or LA-ICP-MS analysis of trace elements; resistivity measurements; optical or electron imaging of textures such as fine-grained intergrowths; and characterization of any metallic gangue that may form a galvanic couple with chalcopyrite. Residues should be analyzed by the same methods.

Tracking ore property using a 3D dynamic stockpile model for advancing the geometallurgical modelling

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Abstract

Mining companies invest a vast amount of effort and resources into populating geometallurgical information (e.g., hardness, grade, mineralogy, elemental assay, etc.) to their resource block models with the aim to pass that information to production. Then the data from block models could drive the operational strategies to optimise the process. Significant technological progress over the past decades enables the tracking of the in-situ ore as it undergoes blasting, loading and hauling in mining operations. Nonetheless, much of the temporal resolution of this valuable geometallurgical information is then lost as the ore is fed into big stockpiles. Size segregation, live/dead volumes, limited instrumentation and long delays hinder the ability to do proper ore tracking in stockpiles. However, dynamic simulation can help fill this gap in linking the mine data to processing. Researchers at the Julius Kruttschnitt Mineral Research Centre (JKMRC) have developed and validated a 3D dynamic stockpile model that allows tracking the ore as it enters, moves through, and leaves the stockpile depending on its operation. The model calibrates using a combination of lab-scale test and industrial data, making it possible to predict the ore properties drawn from each feeder. This model can provide the opportunity to link the geometallurgical data which are available from ore tracking technologies to the operational data, which can advance geometallurgical modelling with more granular data.

Future Challenges in Geometallurgy and Operations at Minera Centinela

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Abstract

Minera Centinela currently produces copper concentrates and cathodes at a rate of 250 Kt Cu per year, 90 Kt Cu are obtained by hydrometallurgical processes and 160 Kt Cu by concentration of sulfide ores. The ores that feed the current processes come from the deposits Tesoro, Encuentro Óxidos, Mirador, Tesoro Sur and Esperanza.

The development of Minera Centinela contemplates soon building a new concentrator plant, this new facility will process ores from two new deposits called Esperanza Sur and Encuentro Sulfuros. Additionally, the current plant will add minerals from the Esperanza Sur deposit to its process, these mixtures and variety in the feed will generate an important challenge for production planning, which will have to be based on geometallurgy.

The first major challenge will be to define in which plant each type of ore will perform optimally and, consequently, where it will provide the greatest value to the company. Of the materials, the Esperanza and Esperanza Sur deposits have similar geological characteristics (lithology, alteration), however, the Encuentro Sulfuros deposit has differences that show, through its hardness indicators (Axb, Wi), that it is more competent to the milling process. It is for this reason that the design of the new concentrator plant considers HPGR technology in its comminution circuit, unlike the current SAG circuit, which makes it less sensitive to changes in hardness and grain size of the ore.

In relation to the recovery of products and by-products of interest, these minerals for the current and future plant, present differences in the intermediate products of flotation, but not in the recovery potential, so these considerations should be added to those associated with hardness, as well as others related to the thickening processes, in order to have a robust support from the geosciences and process models that allow to correctly guide the operation and thus achieve the optimal result.