Pore-scale modelling to infer hydrodynamic behaviors for In-Place Recovery of critical minerals

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# ABSTRACT

In-place recovery by underground stope leaching (USL) has increased in recent years due to its low cost and low environmental footprint in extracting minerals from hard rock formations. USL leaches packed ore fragments after blasting with no further crushing, grinding, or agglomeration required, and thus results in a particle size distribution (PSD) of a much greater range. Due to the large PSD range, the inter-fragment void size distribution and the spatial distribution are highly heterogeneous, with the scale of inter-fragment voids spanning several orders of magnitude. As with SHL, a lixiviant is introduced through a drip/sprinkler irrigator to create an unsaturated condition. The result is strong heterogeneity of the hydraulic properties of the stope, making the validity of many flow models for SHL questionable for USL. In the work presented here, we attempt to infer the hydrodynamic behaviours of fluid flow in the stope by simulating fluid that drips into columns packed with ore fragments that have sizes and shapes that are typical of run-of-mine ores after blasting. Direct flow simulations are conducted in these inter-fragment voids to assess the flow channelling behaviours considering different fragment geometries, void structures, and irrigation patterns. This study provides a further understanding of channelling flow in a strongly heterogeneous packed structure. The findings of this work also highlight the main limitations of the commonly used approach of solving Richard’s equation with uniform hydraulic properties for the unsaturated flow process in heap leaching.