

COUPLED DISSOLUTION-PRECIPITATION PROCESSES DURING CHALCOPYRITE HEAP LEACHING

By

Eric O. Ansah, ¹Apoorv Jyoti, Jay R. Black and Ralf R. Haese

School of Geography, Earth and Atmospheric Sciences, The University of Melbourne, Australia

Presenter and Corresponding Author

Eric O. Ansah

ABSTRACT

Coupled dissolution and precipitation mechanisms govern the process of sulphide ore leaching. In this study, correlative microscopy is combined with continuum scale reactive transport modelling to better understand the role of precipitation during low grade (1-3%) chalcopyrite dissolution in a chloride-rich acid.

Initially, a continuum scale reactive transport model was designed using iCP (interface COMSOL-Phreeqc) to inform column experiments being run over 7 days and 30 days. The model domain had the same dimensions as planned experiments, with a width of 10 mm and height of 120 mm. The top and bottom of 100 mm were filled with unreactive quartz mineral and the middle layer filled with low grade chalcopyrite ore. A particle size of 1 mm was considered for both the unreactive quartz and low chalcopyrite ore.

Various model scenarios highlighted that a flow velocity of 1E-7 m/s led to the highest copper recovery, more FeOOH precipitation and low jarosite precipitation relative to flow velocities of 1E-6 m/s and 1E-5 m/s, respectively. Correlative microscopy, utilizing 2D electron microscopy in tandem with 3D micro-CT scans, highlighted physical observations of coupled dissolution (pitting) – precipitation (overgrowth, intergrowth, and passivation) as well as changes in chemical maps for specific regions of interest. This study highlights two main precipitation fronts: (i) Siliclastic, sulphur and oxide precipitates – which occur on all mineral surfaces, be it gangue or sulphide minerals and (ii) copper and iron sulphides/hydroxysulphate – which only occur on sulphide mineral surfaces. These precipitates may influence petrophysical properties (such as porosity and permeability) to limit fluid-ore mineral contact and hinder dissolution through surface passivation of the copper sulphide ore minerals.

This was also evident in the fluid chemistry; wherein copper dissolution reached a steady state after 8 hours of leaching. The concentration of aluminium and silicon ions in the fluid chemistry were minimal after 8 hours, hinting at possible siliclastic mineral precipitation. Also, a drop in the total iron concentration shows possible formation of various iron oxide, and iron hydroxysulphate precipitates. This decreased the required iron (Fe) concentration for chalcopyrite dissolution.

Results from this study are aiming to find optimal conditions for sulphide mineral leaching during heap leach processing, in particular copper bearing sulphides given the current resource demand.

Keywords: leaching, reactive transport, correlative microscopy, chalcopyrite, precipitation