Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.23565

Geochemical simulation of supergene copper enrichment using reactive transport models

ANTONIA B. CLERICUS CASTILLO[1], MARTIN REICH[1], ALIDA PEREZ-FODICH[1], FERNANDO BARRA[1] AND IRENE DEL REAL[2]

[1]Department of Geology, University of Chile
[2]Institute of Earth Sciences, Faculty of Sciences, Austral University of Chile

Presenting Author: antonia.clericus@ug.uchile.cl

Different styles of supergene profiles are observed associated with the oxidation of diverse copper (Cu) deposits such as Iron oxide-copper-gold (IOCG), porphyry Cu and stratabound Cu(-Ag), located in the Coastal Cordillera of northern and central Chile. The formation of Cu oxides and secondary sulfides may contribute to an increase of 2 to 3 times hypogene Cu grades. Hence, understanding the processes involved in the formation of supergene Cu is a critical topic in mineral exploration programs. Supergene profiles are formed as a result of exhumation of sulfide-bearing rocks and chemical weathering. The oxidation of hypogene sulfides releases low-pH solutions which leads the hydrolysis of aluminosilicates, leaching of metals, and precipitation of secondary Cu-bearing minerals over periods ranging from ~0.5 to 9 Ma[1]. These processes produce a vertically zoned profile, which usually includes an upper leached cap followed downwards by an oxidation horizon and a secondary (Cu) sulfides zone.

Numerical simulations can be a fundamental tool to understand the geochemical evolution of supergene upgrading. This approach allows evaluating the interaction of various geological, geomorphological, and climatic factors. Here we use the reactive transport modelling code CrunchFlow[2] to simulate the advective flow of solutes and water-rock chemical reactions during the development of supergene enrichment profiles. Our modeling strategy seeks to evaluate the main factors controlling the development of supergene profiles contrasting real settings in two mineral deposit types: IOCG and porphyry Cu. These factors include: (1) host rock mineralogy, (2) hypogene alteration, and (3) sulfide mineralization. In this study, field observations will be used to establish the different geological scenarios that constrain the boundary conditions in terms of mineralogy.

Our preliminary results allow us to constrain the intrinsic deposit factors—such as the pyrite/Cu-sulfide ratio, hydrothermal alteration mineralogy, and porosity variation—controlling the evolution of supergene enrichment profiles developed in Cu deposits in the Coastal Cordillera of northern and central Chile.

The authors acknowledge support from ANID through FONDECYT grant #1230161.

References

[1] Sillitoe, R.H. (2005) Econ. Geol. 100th Anniversary Volume SEG, 723–768.

[2] Steefel et al. (2015) Reactive transport codes for subsurface environmental simulation: Computational Geosciences, 19(3), 445–478.