Reassessing the role of organic matter on metal transport and deposition in Chilean stratabound Cu deposits

ANDREA P. HERAZO[1*], MARTIN REICH[1], FERNANDO BARRA[1], DIEGO MORATA[1]

[1]Department of Geology and Andean Geothermal Center of Excellence (CEGA), Universidad de Chile, Plaza Ercilla 803, Santiago, Chile; *aherazo@ing.uchile.cl

In the last few decades, several studies have recognized the significance of organic matter in mineralizing processes, in particular, for carbonate-hosted, metal-rich shales and uranium deposits, among others. Recent experimental and analytical studies have shown that liquid hydrocarbons have the capacity to transport and deposit significant quantities of metals, and hence could constitute ore fluids. Despite these advances, the close spatial association between ore mineralization and, e.g., bitumen, is commonly interpreted to be either coincidental or to provide evidence for redox-induced mineral deposition by the organic matter.

In this study we re-evaluate, on a metallotect scale, the role of fluid and solid (bitumen) hydrocarbons on metal transport and deposition in stratabound Cu deposits from northern Chile. This belt extends for ~1000 km and hosts Jurassic to Lower Cretaceous, high-grade Cu (± Ag) sulfide mineralization that is intimately associated with bitumen and pyrobitumen. The sulfide-bitumen mineralization at El Soldado, La Culebra/Manto Cobrizo and Lorena/Las Luces deposits is hosted in volcanic rocks and occurs in fractures, veins and/or filling vesicles. Textural relationships in these deposits point to multiple pulses of Cu-rich hydrothermal fluids and liquid hydrocarbon introduction. Furthermore, sulfur isotope data for the belt show a wide range of $\delta^{34}S$ values ranging from -50.0 to +28.0‰, indicating multiple sources for sulfur and/or significant redox fractionation. Despite these advances, the role of organic matter on metal transport and deposition in these deposits remains highly controversial, and it is still unclear whether petroleum had played a role in the ore deposit formation.

We are currently performing a comprehensive study of sulfide-bitumen mineralization along the Jurassic-Cretaceous belt of northern Chile. Field observations are combined with detailed petrographic imaging of bitumen using scanning and transmission electron microscopy, EMPA and LA-ICP-MS microanalyses, and synchrotron XRF and XANES. Results point to significant concentrations of metals and halogens (e.g., Cu, Ag, S, Cl, I) in variable mineralogical occurrences within bitumen, which suggest an unforeseen role of hydrocarbons as active agents for metallic mineralization.