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Sedimentary signatures of Cu-(Fe) sulfides from the bitumen-bearing El Soldado stratabound Cu(-Ag) deposit, central Chile

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Bitumen-bearing stratabound Cu(-Ag) deposits of Cretaceous age are distributed in a belt of more than 1,000 km within the Coastal Cordillera of central and northern Chile [1]. Within this belt, the El Soldado deposit stands out as the largest known stratabound Cu deposit, and a key example of Cu mineralization associated with bitumen. Despite its economic relevance, the geochemistry and origin of the Cu-(Fe) sulfide remain unconstrained. Here, we use a combination of petrographic and microanalytical techniques to examine the distribution and concentration of trace elements in sulfides (pyrite, chalcopyrite and bornite), and to determine the source of metals at El Soldado.

Our results indicate that Cu(-Fe) sulfides host a wide variety of trace elements, ranging from ppm to wt% levels. Combined EPMA and LA-ICP-MS data show that pyrite has relatively high concentrations of Co, Ni, As, Mn, Mo and Tl (up to 285, 1000, 7900, 3100, 61.9, 678 ppm respectively). Chalcopyrite can incorporate Se, Ag, Mn and In (up to 14000, 23, 2540, 9.8 ppm, respectively), while bornite accommodate Pb, Se, Te, Bi, Ag, Mn, Mo and Tl (up to 322, 6800, 2100, 530, 460, 1610, 388, 13.4 ppm, respectively). In addition, EPMA analysis of bitumen show significant concentrations of S, Cl, Mn, Fe, Cu and Ag up to 1000-ppm levels, and μ-XRF maps show homogeneous (e.g., Cl, S) and irregular distribution (e.g., Tl, Cu, V) of these elements.

Elemental ratios including Co/Ni and Mn/Fe/Mo in pyrite, and In/Se and Ag/Bi in chalcopyrite and bornite respectively, were used to fingerprint the source of metals, indicating a sedimentary source for the Cu(-Fe) sulfides, showing notable differences when compared with other deposit types such as IOCG and IOA deposits occurring within the Coastal Cordillera belt.

In summary, our preliminary results point to a significant basinal contribution in the ore-forming processes, primarily attributed to the presence of elements such as V, Mn, Mo and Tl in ore sulfides and pyrite, and the ubiquitous presence of organic matter in close association with the sulfide assemblages.

References

[1] Maksaev & Zentilli (2002), H*ydrothermal Iron Oxide Copper-Gold & Related Deposits: A Global Perspective* 2, 185-205.