How are critical elements distributed in a world-class porphyry Cu deposit?

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Porphyry Cu-Mo deposits (PCD) are the world's most important source of Cu, Mo and Re, and are also major sources of Au and Ag. Previous studies have reported that some PCD can have sub-economic to economic grades of critical elements, which are both essential for modern societies and subject to the risk of supply restriction (e.g., Co, In, Bi, platinum group elements (PGE) and rare earth elements (REE), among others). Reconnaissance studies have focused predominantly on porphyry Cu-Au deposits, and few studies have reported critical element concentration data for PCD. Hence, their occurrence, distribution and mineralogical form remain poorly constrained.

Here we focus on the world-class Río Blanco PCD in Central Chile, where Ag is extracted as a sub-product from Cu sulfide ores. Statistical examination of an extensive drill hole ICP-MS dataset (~10,000 data points) pointed to major elemental trends at the deposit scale, including Cu-Ag, Ag-In, Ag-Sb and Ag-As correlations. Based on these results, drill core samples of all major hydrothermal events were selected for in-situ mineral analysis. To ensure representativeness, sample selection took into consideration the spatial distribution of alteration and mineralization events, as well as sulfide parageneses.

FESEM, EMPA and LA-ICP-MS analyses of major sulfides and sulfosalts at Río Blanco show complex distribution patterns. Besides Ag, which is dominantly concentrated in bornite and sulfosalts, significant concentrations of Ag, In, Co, Au, Bi and PGEs were detected in pyrite and chalcopyrite. Overall, the data shed new light on fluid/metal partitioning in sulfides from PCD, and provide relevant information about critical element resources at the deposit scale.