## Distinguishing primary versus hydrothermal alteration assemblages at the Chuquicamata porphyry copper system, Chile

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One of the major problems facing a new geologist at a mine is learning how to distinguish in the workings and in drillcore the various fresh, generally unmineralized rock units, their hydrothermally altered equivalents, and those altered by weathering, which are often intermingled due to complex structural deformation. It is also tricky to distinguish between magmatic biotite and K-feldspar from that formed by potassic alteration. Previous review of previous work is essential, and classical mineralogy and petrographic techniques, such as slabbing and staining of feldspars can help, but often thin section microscopy, x-ray diffraction and other modern mineralogical tools (e.g., electron microprobe) are necessary to unravel the alteration record. At the Chuquicamata porphyry copper deposit, Chile, mineralogical and geochemical evidence suggest a multiphase history of intrusion and alteration/mineralization complicated due to structural complexity. A strike-slip structure, the West Fault, truncates the Chuquicamata Intrusive Complex (CIC), which consists of the calcalkaline granodioritic Este, Oeste, and Banco porphyries. The CIC is overprinted by multiple phases of alteration (e.g., potassic, quartz-sericite, argillic) and mineralization. Inside the open pit and juxtaposed across the West Fault is the relatively unaltered and unmineralized Fortuna Intrusive Complex (FIC). Macroscopically, the fresh and the potassically altered Este Porphyry are nearly identical, making pit and core mapping very difficult. However, a closer examination of the potassically altered rocks reveals a lack of Ca-bearing silicate minerals. The potassic alteration affecting the Este Porphyry is the result of a late hydrous phase of the same magma with high halogen contents that preferentially partitioned Ca into the melt and the escaping fluid phase. The Banco Porphyry is unaffected by the potassic Ca-leaching event giving a firm relative age of intrusion, but altered by the phyllic event which obliterated feldspars and biotite, but introduced sericite and anhydrite. The upper levels of the mine and structurally shattered zones are deeply weathered and dominated by low temperature clay minerals, sulfates and other secondary minerals that make the rocks textures unrecognizable.