Temporal and spatial evolution of fluids related to hydrothermal alteration and porphyry copper mineralization at Red Mountain, AZ

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Alteration and mineralization characteristics of porphyry copper deposits (PCDs) have been the focus of numerous field based, laboratory and theoretical studies, and it is widely recognized that fluids play a significant role in the genesis of PCDs. In this study, a three dimensional representation of mineralization, alteration and fluid inclusion characteristics of the porphyry copper system at Red Mountain, AZ, is being developed to evaluate the role of fluids in the temporal and spatial evolution of alteration and mineralization.

In most PCDs in the SW US, the shallow lithocap region has been removed by erosion. As a consequence, the thermal and chemical evolution in the upper part of the system has not been well characterized. In that context, the Red Mountain deposit, and its preserved lithocap, is an ideal location to study the evolution in space and time of alteration and mineralization in the upper part of a PCD.

At Red Mountain a low-grade (0.2 % Cu) enargite zone related to quartz-pyrite alteration overlies a higher grade chalcopyrite zone associated mainly with the deeper potassic alteration zone. The enargite-rich zone is frequently absent from porphyry copper deposits due to erosion, although it has been preserved in some other deposits with characteristics similar to those of Red Mountain (e.g. Sunnyside, El Salvador, Lepanto-Far Southeast, and Recsk). A near-surface chalcocite enrichment zone with grades between 0.4-1.1 % Cu lies above the main deep mineralization. The deep zone shows grades between 0.4- 0.8% in the copper ore shell, with grades of 1 to 1.2 % Cu at the margins of a breccia pipe located within the potassic alteration zone.

The occurrence of a high-sulfidation zone overlying more typical PCD mineralization represents the transition between the epithermal and porphyry environment. Fluid inclusions from the deeper parts of the system are characterized by coexisting halite-bearing and vapor-rich inclusions, whereas halite-bearing inclusions are less common in the more shallow parts of the system, consistent with the transition from the epithermal to porphyry environment.

Petrochronologic constraints on partial melting in the Leo Pargil Dome, NW India

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Evaluation of tectonic models for the Himalaya involving ductile extrusion of mid-crustal material requires a thorough understanding of the processes of partial melting as a function of time. The Leo Pargil dome (LPD) in the northwestern Himalaya provides an ideal setting within which to study the systematics of melt generation, transport, and emplacement. The LPD consists of a high-grade metamorphic and anatectic core structurally separated from low-grade Tibetan metasedimentary rocks by the Leo Pargil shear zone (LPSZ), a complex low-angle, normal-sense detachment system. Understanding the metamorphic and exhumational history of the LPD within the context of competing geodynamic models depends upon detailed knowledge of the petrochronologic history of leucogranites preserved in the footwall and hanging wall of the LPSZ. Field observations and bulk rock isotopic data, supported by detailed U-Th-Pb and trace element analysis of accessory phase minerals from >30 leucogranite bodies, provide new data critical for a detailed understanding of the magmatic history of the LPD. Variably deformed dikes cross-cut and exhibit foliation, indicating syn-kinematic emplacement of leucogranite during top-to-the-northwest ductile deformation. Melting and emplacement of multiple generations of chemically and isotopically distinct intrusions occurred at the sub-million year time-scale at temperatures in excess of 700 °C between ~ 26 and 16 Ma. Phase equilibria modeling and geochronologic data from metamorphic rocks [1] support a model in which leucogranites are derived locally by minimum-temperature partial melting of Greater Himalayan Series rocks, rather than being derived distally and transported, as advocated by previous workers (e.g. [2]). Thus, geochemical and isotopic studies of LPD leucogranites place important constraints on the timing, duration, and source of melting within the NW Indian Himalaya.

[1] Langille *et al*. (2010) *Geochimica et Cosmochimica Acta*, this volume. [2] Leech (2008) *Earth & Planetary Science Letters* **276**, 314–322.