Systematics of Au and Cu in magmatic-hydrothermal fluids

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Transportation and Precipitation of Cu and Au

Cu and Au in porphyry-type systems are derived from a crystallizing magma and transported by a magmatic volatile phase (MVP). The MVP can be a high-salinity brine, low-salinity vapor, or supercritical fluid with its composition exercising a major control over the quantity of metals carried. The role of the MVP is well established, but there are few data on metals in the MVP over a large range of compositions (e.g., S_2 and HCl). Experiments were performed at 500-700 °C and 50-100 MPa to determine the equilibrium concentrations of Cu, Au, Fe, Pb, and Zn in vapors, brines, and supercritical fluids. A synthetic MVP was equilibrated with chalcopyrite, bornite, and gold over a wide range of total chloride (Cl), HCl concentration, and oxygen (O_2) and sulfur (S_2) fugacities. The equilibrium MVPs were trapped in synthetic fluid inclusions within quartz and analyzed by using LA-ICP-MS.

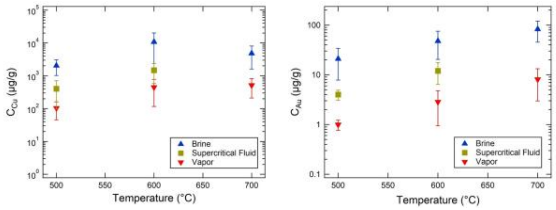

Figure 1: Cu and Au concentrations in high-salinity brines, low-salinity vapors, and moderate salinity supercritical fluids.

Results and Discussion

Cu concentrations in the MVP were strongly influenced by total Cl and were always greater in coexisting brine than vapor. Cu concentrations in supercritical fluids were, on average, greater than lower salinity vapors at the same temperature. Au behaved similarly to Cu as concentrations increased with increasing Cl, HCl and temperature. Gold in the MVP appeared to be more affected by changes in temperature, O_2/S_2, and HCl than Cu. The data indicate that chloride is the major control on metal solubility in the MVP whereas preliminary data on HCl indicate that it also has a direct relationship to metal solubility. Variations in O_2, S_2, H_2S, and SO_2 had little observable impact on Cu, Au, Fe, Pb, and Zn concentrations.