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The effects of chlorine and melt aluminosity on ore-forming potential in arc-related magmatic-hydrothermal systems

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The exsolution of magmatic-hydrothermal fluids from silicate melts is a fundamental ore-forming process by which economic metals may be transferred to the fluid phase and transported through the crust. The fluid-melt partitioning of these metals is dependent on a variety of factors including pressure (*P*), temperature (*T*), the availability of ligands, and melt composition (X). Nevertheless, no comprehensive models have yet been established to predict the fluid/melt partition coefficients of porphyry ore metals in *P*-*T*-X space. The aim of this study is to understand the influence of the fluid Cl content and melt aluminum saturation index (ASI) on the fluid-melt partitioning of Au, Cu, Ag, and Mo with the goal of constructing an accurate model of fluid-melt partitioning applicable to porphyry deposits and arc-magmatic systems. For this purpose, a series of experiments were conducted at 800 °C and 1750 bar in René 41 alloy cold-seal pressure vessels. Au-Ag-Cu alloy capsules were filled with a synthetic, rhyolitic glass and aqueous fluids expected to be in equilibrium with the melt at run conditions. Natural quartz cylinders were used to trap synthetic fluid inclusions. Experiments were conducted with four different fluid Cl concentrations (1, 3, 9, and 27 molal) and a melt ASI range spanning 0.8–1.2. Experimental results show a partitioning dependence of all metals on both fluid Cl content and melt ASI. Cu, Ag, and Mo partition coefficients all strongly increase with increasing Cl concentration in the fluid and decrease slightly with increasing melt ASI. Mo shows the lowest fluid-melt partition coefficients (up to ~60), while Au displays the highest (up to ~1300), being about 3–5 times higher than those of Cu and Ag. These results suggest an efficiency of metal extraction from a crystallizing and degassing magma reservoir in the following sequence: Au > Cu≈Ag > Mo; and that strongly peraluminous melts and low Cl systems provide the least favourable conditions for porphyry ore-fluid generation.