

## Sulfur and Chalcophile Metal Mobility During Magma Mixing

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Mass balance calculations, using experimental partitioning data at geologically relevant P-T-X-fO<sub>2</sub> conditions, for the origin of sulfur (S) and chalcophile metals (e.g., Cu) in arc-related magmatic-hydrothermal porphyry-type ore deposits are not consistent with derivation of these (and other) ore metals from the intermediate (dacitic) to felsic (rhyolitic) rocks that host porphyry deposits. There is a growing body of evidence from natural systems that the S and chalcophile metals in porphyry deposits are sourced from mafic magma(s) that either underplates (without physical mixing or mingling) or intrudes into and physicochemically mixes with overlying intermediate to felsic magma [1,2]. This model suggests that S and chalcophile metals are originally dissolved in the mafic melt, and mass transfer is facilitated by aqueous fluid that exsolves from the mafic melt, scavenges S and ore metals, and ascends into the overlying porphyry environment. This process plausibly explains the observed excess of S (i.e., high S/Cu) in porphyry systems [3].

Here, we test this model directly by using new experimental data that constrain the mobility of S and chalcophile metals (as well as H<sub>2</sub>O, Cl, etc.) during mixing of andesite and dacite. Natural samples from Quizapu Volcano, Chile, were used to synthesize, at 150 MPa and fO<sub>2</sub>~FMQ+3, two initial glass compositions: 1) andesite with ~2.0 wt. % H<sub>2</sub>O, ~700 ppm S, ~300 ppm Cl at 1030°C; and 2) dacite with ~2.3 wt. % H<sub>2</sub>O, ~100 ppm S, ~4700 ppm Cl at 900°C. The glasses were equilibrated as a diffusion-couple at 950°C, 150 MPa, fO<sub>2</sub>~FMQ+3 for durations ranging from 0.1 to 100 h.

Analysis of the quenched run products revealed that the andesite became fluid saturated, and that the S concentration of the andesitic melt decreased from the initial ~700 ppm to ~300 ppm in 1 h, and to <80 ppm in 10 h. Notably, the S content of the dacite remained unchanged at ~100 ppm S, and there was no measurable S diffusion profile across the andesite-dacite interface. These data demonstrate unequivocally that magma mixing, and crystallization-induced degassing of the more mafic melt, resulted in significant mass transfer of S to the aqueous fluid. The implications of these data for ore forming systems will be discussed.

[1] Hattori, K, *Geology*, 1993, 1083-1086. [2] Halter *et al Mineralium Deposita*, 2005, 845-863. [3] Hunt, *JP, Econ. Geol.*, 1991, 192-206.