The effect of volatile sulfur on metal partitioning at magmatic conditions

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We have quantified the effect of volatile sulfur on the partitioning of Cu and Au by performing experiments in both a sulfur-free and sulfur -bearing, silicate melt – vapor - brine ± pyrrhotite ± magnetite system at PVTX conditions attending the evoluton of porphyry-type ore deposits. These data are a first step toward a thermodynamically-constrained understanding of the effect of volatile sulfur on the the mass transfer of ore metals from silicate melts to exsolved aqueous fluid(s). Experiments to elucidate Au and Cu partitioning were done at 800 degrees C, 145 MPa, oxygen fugacity buffered at Ni-NiO, and vapor and brine salinities of 19 and 35 wt. % NaCl eq., respectively. Sulfur was added as pyrrhotite which breaks down at PT to yield H_2S ($3FeS + 4H_2O = Fe_3O_4 + H_2S + H_2$) and SO_2 ($6FeS + 5O_2 = 2Fe_3O_4 + SO_2$). Calculated log fS_2 = -3.5 and the $H_2S:SO_2$ = 9 at run conditions. Concentrations of Na, K, Fe Cu, and Au in immiscible aqueous fluids trapped as fluid inclusions in quartz microfractures were quantified by LA-ICPMS. The presence of volatile sulfur at constant total salinity of the aqueous fluids increases the v/b partition coefficient for Cu from 0.1 to 0.7. The Cu v/m and b/m partition coefficients increase from 13 to 300 and 100 to 500, respectively, with the addition of volatile sulfur. The Au v/b partition coefficient is ~ 0.65 with/without volatile sulfur. The v/m and v/b partition coefficients for Au increase from 72 to 1800 and 100 to 2200, respectively, with addition of volatile sulfur. Data from this study evince the effect that volatile sulfur can have on the mass transfer of metals between silicate melt and saline, aqueous fluids. More experiments at variable sulfur fugacity are in progress to constrain fully the effect of volatile sulfur across the spectrum of PVTX conditions attending the evoluton of porphyry-type ore deposits.

The island arc magmatic system

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There is perhaps no other magmatic system where the tectonic, thermal, petrologic, and temporal evolution is better constrained than that of island arcs. Yet the overall dynamics of the system is relatively little appreciated. The dynamic and petrologic beauty of the system offers compelling evidence of the system-wide operation of magma generation, extraction, ascension, high level ponding, emplacement and eruption. Yet, specific and often poorly understood, in terms of actual implications, petrologic characteristics are interpreted to have implications reaching far beyond their veracity. I review here the thermal and volatile regime of the down-going plate, the characteristics of plate melting, wedge flow, magma transfer, and the fundemental implications of primitive high alumina basalt as the primary work fluid of island arcs.