

Trace element partitioning between silicate and sulphate melts at high pressure and temperature

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Current genetic models for magmatic-hydrothermal ore deposits require the transport of both economically important metals and volatile elements (particularly water, sulphur and chlorine) through the crust in arc magmas. Large amounts of sulphur in many of these deposits (often >1Gt) implies very sulphur rich magmas, and recent work has shown that arc magmas may be regularly sulphate saturated during ascent. Sulphate is commonly present as anhydrite at magmatic conditions, however previous experimental work on basalts found immiscible sulphate melts were stable at ~1GPa and 1300°C. As a natural analogue Chambefort et al. (2008) have also described “wormy anhydrite” inclusions in amphiboles from Yanacocha, Peru.

Despite this there has been no systematic study of the stability or composition of these sulphate melts in equilibrium with silicate melts. Our preliminary work has found them to be stable at a range of mid to lower crustal P-T conditions (200-1000MPa and 1000-1300°C) in a range of hydrous (~4-7wt% H₂O) silicate melts (54-65wt% SiO₂). Sulphate melts are notoriously difficult to analyse due to both quench heterogeneities and complications with polishing soft, soluble materials. Here we present compositional data based on LA-ICP-MS and EPMA analyses as well as mass balance calculations. The major element make up is CaO, Na₂O, K₂O (~10:3:2.5 by weight) and SO₃ as well as significant amounts (>1wt%) of FeO, MgO and Cl. A number of trace elements also partition strongly into the sulphate melt including Sr, Y, Ba, REE, Re and possibly Cu.

Sulphate melts behave differently both physically (density, viscosity etc.) and chemically (major and trace element partitioning) from crystalline anhydrite and their presence may have widespread implications for the geochemical evolution of ore forming magmas.