Experimental constraints on Re mobility in silicate magmas

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Re depletion in basalts from different tectonic regimes has been attributed to partitioning effects in their source regions (Righter and Hauri, 1993) or to degassing of magmas (Lassiter, 2003). To address the latter model, Re diffusion and volatility was measured in silicate liquids as a function of T, fO_2 and bulk composition (basalt, dacite). The volatility of ReO_x species from the interface of silicate liquids into O-bearing atmospheres was used to generate concentration profiles as functions of T, time and fO_2. Concentration profiles for Re in resultant silicate glasses were measured using LA-ICP-MS, and fitted to a semi-infinite diffusion model. The experiments showed decreasing diffusivity and volatility with increasing SiO_2 content. At 1300°C below $\log fO_2 = -2$ Re diffusivity decreases in a nonlinear a fashion with decreasing fO_2. In experiments performed in air at 1300°C, volatile release of ReO_x ($\log D_{vol} = -6.9$ cm^2/sec) outpaced Re diffusion ($\log D_{diff} = -7.8$ cm^2/sec) by an order of magnitude leading to a Re depletion front that extended from the melt/air interface into the melt. Chlorine doped experiments showed even higher volatility ($\log D_{vol}^{ReCl} = -6.5$). Increased Re loss in experiments under oxidizing conditions coupled with decreased Re loss under reducing conditions suggest an oxygen control on volatile release of ReO_x from basaltic magma.

References

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Similar V/Sc systematics in MORBs and arc basalts: Implications for the oxygen fugacities of their mantle source regions

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V/Sc systematics in peridotites, mid-ocean ridge basalts and arc basalts are investigated to constrain the variation of fO2 in the asthenospheric mantle. V/Sc ratios are used here to “see through” those processes that can modify barometric fO_2 determinations in mantle rocks and/or magmas: early fractional crystallization, degassing, crustal assimilation, and mantle metasomatism. Melting models are combined here with a literature database on peridotites, arc lavas (A), and mid-ocean ridge basalts along with new, more precise data on peridotites and selected arc lavas. V/Sc ratios in primitive arc lavas from the Cascades magmatic arc are subtly correlated with fluid mobile elements (e.g., Ba and K), indicating that fluids may subtly influence fO_2 during melting (B). These systematics cannot be explained by crustal contamination (curves in B). For the most part, the average V/Sc-inferred fO_2s of arc basalts, MORBs, and peridotites are remarkably similar (-1.25 to +0.5 log units f rom the FMQ buffer) and at odds with the observation that the barometric fO_2s of arc lavas are several orders of magnitude higher (A). These observations suggest that the upper part of the Earth’s mantle may be strongly buffered in terms of fO_2. The higher barometric fO_2s of arc lavas and some arc-related xenoliths may be respectively due to magmatic differentiation processes and to exposure to large time-integrated fluid fluxes incurred during the long term stability of lithospheric mantle.

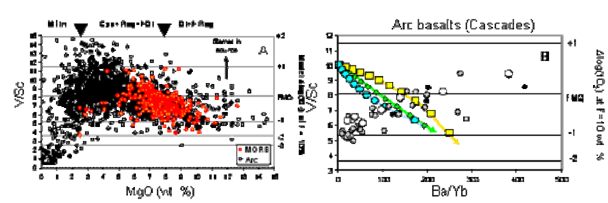

Figure 1. A. Global compilation of V/Sc of arc magmas (black) and MORBs (light). Horizontal lines represent V/Sc-fO2 isopleths at an assumed 10 % melting. B. V/Sc of primitive arc lavas from the Cascades versus Ba/Yb. Curved lines represent hypothetical mixing lines with continental crust lithologies.