

Effect of differentiation on Fe oxidation in arc basalts

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The role of crustal differentiation processes in creating or modifying the relatively oxidized condition of arc basalts relative to mid ocean ridge basalts (MORB) is not well constrained. We present the first combined data set for major elements, dissolved volatile concentrations and $\text{Fe}^{3+}/\Sigma\text{Fe}$ ratios (determined by μ -XANES) in olivine-hosted basaltic glass inclusions from four Mariana arc volcanoes in order to examine how Fe oxidation varies with extent of fractional crystallization, degassing and contributions from the slab to the arc mantle source.

Glass inclusions span a variety of compositions and are consistent with multi-phase crystallization and degassing. A strong trend in Fe reduction accompanies magmatic degassing and inclusions with the highest MgO (>6.5 wt%) are consistently the most oxidized ($\text{Fe}^{3+}/\Sigma\text{Fe}>0.235$). The reduction trend suggests that redox exchange may occur during SO_2 degassing that redistributes e^- in the residual magma ($\text{S}^{2-}_{\text{melt}} \rightarrow \text{S}^{4+}_{\text{vapor}} + 6e^-$). We show that the high $\text{Fe}^{3+}/\Sigma\text{Fe}$ observed here cannot be created through extensive multi-phase fractionation (olv \pm cpx \pm plag) of a MORB-like primary melt ($\text{Fe}^{3+}/\Sigma\text{Fe}=0.16$ [1]). These observations support the hypothesis that the elevated $\text{Fe}^{3+}/\Sigma\text{Fe}$ of arc and back-arc basalts are due to differences in the source mantle. Primary melt compositions were reconstructed by restoring the most mafic inclusion compositions to equilibrium with Fo_{90} . A strong positive correlation exists between $\text{Fe}^{3+}/\Sigma\text{Fe}_{\text{Fo90}}$ and $\text{H}_2\text{O}_{\text{Fo90}}$, suggesting that slab derived fluids may contain an oxidized signature that contributes significantly to the oxidation state of basalts erupted at the Mariana arc.

[1] Cottrell and Kelley, *EPSL*, (2011).

Simultaneous reaction and creep in the KCl-KBr-H₂O system

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As early as 1983 [1] it has been suggested that dissolution-precipitation creep rates may be affected by chemical reaction. However, for a long time research has focused mainly on creep of single phase mineral aggregates in order to understand the physics of stress-driven dissolution-precipitation creep [2,3,4]. More recent research has shown that background ions in solution may significantly effect surface kinetics and solubility both negatively and positively [5]. We present experiments on simultaneous reaction and dissolution precipitation creep in the system KBr, KCl, K(Br,Cl), H₂O.

When KBr and KCl are reacted in the presence of an aqueous fluid at room temperature a solid solution $\text{K}(\text{Br}_x, \text{Cl}_{1-x})$ will form. Creep rates of KBr and KCl in their respective aqueous solutions are compared with those of KBr and KCl in the solution of the other endmember, and with creep rates of mixtures of KBr and KCl in an aqueous solution that is in equilibrium with the solid solution that will form when reaction has gone to completion. These results provide insight the complex combination of effects that reaction has on deformation, including changes in solid volume due to solubility differences between parent and product phases, changes in grain size and material properties, and changes in kinetics.

[1] Rutter (1983) *J. Geol. Soc.* **140**, 725-740. [2] Raj (1982) *JGR* **87**, 4731-4739. [3] Spiers and Schutjens (1990) in *Deformation Processes in Minerals, Ceramics and Rocks*, ed. Barber and Meredith, London, 334-353. [4] Gratier *et al.* (2009) *JGR – Solid Earth* **114**, B03403. [5] Zhang *et al.* (2011) *Geofluids* **11**, 108-122.