

Iron isotope fractionation in olivine-hosted melt inclusions as an indicator of mantle oxygen fugacity

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Many studies have demonstrated that arc basalts are more oxidized (QFM -0.5 to +4) than MORBs (QFM-1.2 to ~ QFM; [1-6]). However, the oxidation state of the sub-arc mantle is still debated. On the one hand Kelley and Cottrell [2, 3] suggest that variations in the $\text{Fe}^{3+}/\text{Fe}_{\text{Tot}}$ ratio measured in basaltic glasses and olivine-hosted melt inclusions from mid-ocean ridges and arcs could be explained by the sub-arc mantle being more oxidized than the mantle beneath ridges. On the other hand, Mallmann and O'Neill [7] and Lee et al. [8] proposed the use of other $f\text{O}_2$ proxies, namely V/Sc and Zn/ Fe_{Tot} ratios in lavas and suggested that the oxidation state of the MORB mantle could not be distinguished from that of the mantle wedge. In a study of synthetic glasses ranging from basaltic to rhyolitic compositions, Dauphas et al. [9] have demonstrated that iron isotope fractionation is mainly controlled by redox ($\text{Fe}^{3+}/\text{Fe}_{\text{Tot}}$) and polymerization of silicate melts. In the present study and for the first time, iron isotopic compositions ($^{56}\text{Fe}/^{54}\text{Fe}$) were measured by SIMS in olivine-hosted melt inclusions from various arc, OIB and MORB localities. The results obtained with this technique, along with $\text{Fe}^{3+}/\text{Fe}_{\text{Tot}}$ ratios obtained by Raman spectroscopy and XANES on the same set of melt inclusions, are used to constrain the oxidation state of primary magmas formed in these different geological settings. A careful evaluation of the magmatic processes and their effects on the various $f\text{O}_2$ proxies will be presented in order to better constrain the link between the redox state of iron in melts and that of their mantle-source regions.

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