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 Fe³⁺/Fe_total 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 fO₂ proxies, namely V/Sc and Zn/Fe_total 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 (Fe³⁺/Fe_total) and polymerization of silicate melts. In the present study and for the first time, iron isotopic compositions (56Fe/54Fe) were measured by SIMS in olivine-hosted melt inclusions from various arc, OIB and MORB localities. The results obtained with this technique, along with Fe³⁺/Fe_total 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 fO₂ 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.