Linking the redox state of magmas to that of their mantle source

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Arc magmas are more oxidized than mid-ocean ridge magmas [1], likely because the mantle source region of arc magmas has been modified by a release of oxidized and volatile-rich fluids from the subducting slab [2]. In particular, the migration of Fe-bearing fluids released during serpentine devolatilization [3] to the mantle wedge is likely to result in the oxidation of mantle Fe^{2+} to Fe^{3+}. However, it is still up to debate whether the variations in $Fe^{3+}/\Sigma Fe$ of magmas from various environments arise due to differences in mantle fO_2 or to differentiation processes in the arc crust such as partial crystallization and degassing [4]. In addition, variations in mantle potential temperature generate changes in relative fO_2 [5], which further complicates the calculation of mantle fO_2 from glasses. Here our aim is to combine different fO_2 proxies in order to carefully reconstruct mantle source fO_2 from the compositions of melt inclusions and erupted glasses from mid-ocean ridge, hot spot and arc settings. These fO_2 proxies include $Fe^{3+}/\Sigma Fe$ measured by micro-X-ray absorption near-edge structure (μ-XANES) spectroscopy and trace element proxies that were calibrated experimentally such as V/Sc and V/Yb ratios, Cu and Zn/Fe*.

Our results show that melt inclusions and glasses from mid-ocean ridges display $Fe^{3+}/\Sigma Fe$ ratios (0.11-0.18) that are consistent with previously published values for MORBs [6]. Melt inclusions from Reunion island display similar $Fe^{3+}/\Sigma Fe$ (0.12-0.17), while melt inclusions from 3 arc regions (Antilles, Southern Italy and Vanuatu) display a much larger range of $Fe^{3+}/\Sigma Fe$ values (0.17-0.45), suggesting variable and more oxidized redox conditions. As previously observed [1], $Fe^{3+}/\Sigma Fe$ ratios correlate with the H_2O contents in the melts, and with incompatible trace element ratios such as K/Ti and La/Sm. A careful evaluation of the differentiation and melting processes and their effects on the various fO_2 proxies is being carried out in order to better constrain the link between the redox state of iron in melts and that of their mantle sources.

[1] Kelley & Cottrell (2009), *Science* 325, 605–607. [2] Brounce et al. (2015), *Geology* 43, 775-778. [3] Debret et al. (2016), *Geology* 44, 215-218. [4] Gaillard et al. (2015), *Chem. Geol.* 418, 217-233. [5] Gaetani (2016), *GCA* 185, 64-77. [6] Cottrell & Kelley (2011), *Earth Planet. Sci. Lett.* 305, 270–282.