

## The partitioning of iron species between garnet and melt in subduction zones

MEGAN HOLYCROSS<sup>1</sup> AND ELIZABETH COTTRELL<sup>2</sup>

<sup>1</sup>Cornell University

<sup>2</sup>National Museum of Natural History, Smithsonian Institution

Presenting Author: holycross@cornell.edu

Arc magmas are depleted in total iron (Fe), have higher ratios of oxidized Fe to total Fe ( $\text{Fe}^{3+}/\Sigma\text{Fe}$ ) and record higher oxygen fugacities ( $f\text{O}_2$ ) compared to magmas erupted at mid-ocean ridges. The oxidized nature of arc magmas may result from the melting of mantle oxidized by material liberated from subducted lithosphere. Conversely (or in addition), magmatic differentiation in the crust may drive the oxidation of arc magmas. In the latter scenario, high pressure fractional crystallization of garnet-bearing cumulates may act to remove more ferrous than ferric iron from melts, such that a ‘crustal redox filter’ oxidizes arc magmas after they have separated from their mantle sources. This hypothesis requires that the compatibility of  $\text{Fe}^{2+}$  in garnet be much greater than the compatibility of  $\text{Fe}^{3+}$  in garnet as it crystallizes from primitive arc magmas in the crust, yet this model for magmatic differentiation has never been tested experimentally. We measured the partitioning of ferric and ferrous iron between garnet and melt in twelve piston-cylinder experiments at  $T=950\text{-}1230$  °C,  $P=1.5\text{-}3$  GPa and  $\log f\text{O}_2 = \text{QFM}-1$  to  $\text{QFM}+6$ . X-ray absorption near edge structure spectroscopy of Fe in garnets and melts show the compatibilities of  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  in garnet are of similar magnitudes in experiments conducted at temperatures  $>1100$  °C and  $f\text{O}_2$ s within three log units of the QFM buffer. Following ref. [1], we modeled changes in the total Fe content,  $\text{Fe}^{3+}/\Sigma\text{Fe}$  ratio and  $f\text{O}_2$  of a hydrous primitive magma during fractionation of garnet pyroxenite using our new measured partition coefficients. We find the formation of garnet-bearing cumulates at high temperature and pressure will remove 20% of total Fe from primary arc basalts but will negligibly impact the  $\text{Fe}^{3+}/\Sigma\text{Fe}$  ratio and  $f\text{O}_2$  of the melt. Garnet crystallization is unlikely to be responsible for the relatively oxidized nature of arc basalts.

[1] Tang, Erdman, Eldridge & Lee (2018) *Science Advances* 4, 1-7.