The oxidation state of iron in silicate melts as a function of pressure

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During accretion the $Fe^{3+}/\sum Fe$ ratio of a magma ocean was likely to have been governed by metal-silicate equilibration occurring near its base [1]. Magmas in equilibrium with iron at low pressures have very low $Fe^{3+}/\sum Fe$ ratios. It is possible, however, that melt $Fe^{3+}/\sum Fe$ ratios increase with pressure at a constant oxygen fugacity, as observed for some silicate minerals [2]. A deep magma ocean may then contain higher levels of Fe^{3+} than would be expected for a magma ocean that has equilibrated with iron metal. This would have important implications for the early oxidation state of the mantle. Existing experimental results on melts equilibrated at the Ru-RuO_2 oxygen buffer, however, show $Fe^{3+}/\sum Fe$ ratios to decrease with pressure [3]. We report results of further experiments where this trend appears to at least flatten at high pressure (Figure 1). This leaves open the possibility that at even higher pressures the $Fe^{3+}/\sum Fe$ ratio of a silicate melt at a fixed fo_2 may start to increase.

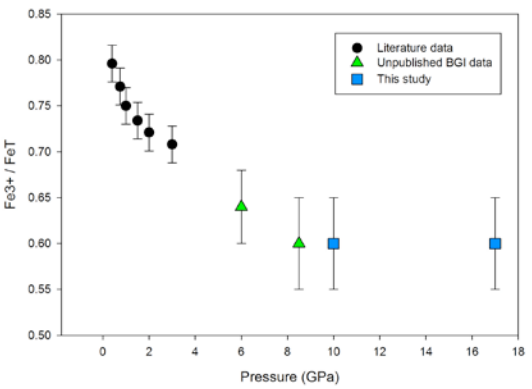

Figure 1: The $Fe^{3+}/\sum Fe$ ratio of andesitic melts equilibrated at the Ru-RuO_2 oxygen buffer as a function of pressure. Mossbauer $Fe^{3+}/\sum Fe$ measurements were performed on glasses up 9 GPa but on quenched crystallised mineral assemblages at higher pressures.

[1] Hirschmann M.M. (2012) *Earth Planet Sci. Letters*, 341-344, 48-57. [2] Frost D. J. & McCammon C.M. (2008) *Annu. Rev. Earth Planet Sci.* **36**, 389-420 [3] O'Neill H. St. C. *et al.* (2006) *Am Mineral.* **91**,404-412