Iron stable isotopes, magmatic differentiation and the oxidation state of Mariana Arc magmas

H. M. WILLIAMS[1*], J. PRYTULAK[2], T. PLANK[3], K. A. KELLEY[4], M. N. BROUNCE[5] AND J. WOODHEAD[6]

[1]Durham University, UK, *h.m.williams2@durham.ac.uk
[2]Imperial College London
[3]Columbia University
[4]University of Rhode Island
[5]California Institute of Technology
[6]University of Melbourne

Arc magmas are widely considered to be oxidized, with elevated ferric iron contents relative to mid-ocean ridge lavas [1]. However, it is unclear whether the oxidized nature of arc basalts is a primary feature, inherited from the sub-arc mantle, or the product of magmatic differentiation and/or post eruptive alteration processes [2].

Iron stable isotopes can be used to trace the distribution of Fe during melting and magmatic differentiation (e.g. [3-7]). Here we present Fe isotope data for well-characterized samples [8-10] from islands of the Central Volcanic Zone (CVZ) of the intra-oceanic Mariana Arc to explore the effect of magmatic differentiation processes on Fe isotope systematics.

The Fe isotope compositions (δ^{57}Fe) of samples from the CVZ islands range from -0.10 ± 0.04 permil (Anatahan; 3.85 wt% MgO) to 0.29 ± 0.01 permil (Guguan; 3.47 wt% MgO). Lavas from Anatahan have Fe isotope compositions that are displaced to lower overall values than the other CVZ samples and which are positively correlated with SiO_2 and negatively correlated with Ca, Fe_2O_3(t), Cr and V. These correlations are interpreted in terms of clinopyroxene and magnetite fractionation, with magnetite saturation throughout the differentiation sequence. Magnetite saturation is further supported by negative correlations between V, Fe_2O_3(t), Cr and MgO (for MgO <3.5 wt%). The early saturation of magnetite in the Anatahan and CVZ lavas is likely to be a function of melt water content [11] [12] and potentially oxidation state. The overall lower δ^{57}Fe values of lavas and inferred primitive melts from Anatahan relative to those from other islands (e.g. Uracas, Guguan), may reflect derivation from distinct sub-arc mantle source regions with variable δ^{57}Fe, water and ferric iron contents.

[1] Kelley, *Science* (2009); [2] Lee, *J. Pet.* (2005); [3] Schuessler, *Chem. Geol.* (2009); [4] Sossi, *CMP* (2012); [5] Williams, *EPSL* (2005); [6] Dauphas., *EPSL* (2014); [7] Elliott, *JGR* (1997); [8] Wade, *JVGR* (2005); [9] Woodhead, *Chem. Geol.* (1989); [10] Brounce, *J. Pet* (2014); [11] K. A. Kelley, *J. Pet.* (2010); [12] Sisson et al., *CMP* (1993).