Magnesium isotope fractionation in arc lavas caused by magmatic differentiation

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Magnesium is a major constituent of Earth and its isotope system can provide unique insights on Earth evolution. However, there still remain questions about magnesium isotopic fractionation, in particular during subduction. Isotopically heavy magnesium in arc lavas from the Lesser Antilles was reported by Teng *et al.* [1]. This was unexpected since depleted mantle and MORB have indistinguishable magnesium isotope compositions [2] and subduction is unlikely to modify magnesium isotope ratios of arc basalts significantly because of the overwhelming magnesium abundance in the mantle (~40 wt.% MgO) and less than 1 wt.% MgO in subduction dehydration fluids [3].

Here, we present new magnesium isotope data of a further suite of arc basalts from the Lesser Antilles and a comparison set from the Mariana arc system. These samples have been measured by critical mixture double spiking [4] which enables high-precision (2 se of 0.01 to 0.02 ‰) and comparable accuracy. Arc basalts from the Lesser Antilles have variable $\delta^{25}Mg_{DSM\text{-}3}$ from typical mantle-like values, ~ 0.125 ‰, to values ~ 0.05 ‰ higher. Importantly, the most primitive magmas have normal mantle $\delta^{25}Mg_{DSM\text{-}3}$ values and, in general, $\delta^{25}Mg_{DSM\text{-}3}$ is negatively correlated with MgO and Mg#. All Mariana arc basalts have $\delta^{25}Mg_{DSM\text{-}3}$ higher than depleted mantle, up to a value of -0.055 ‰.

We argue that these data are best explained by magnesium isotopic fractionation during arc lava differentiation. A previous study of basaltic magma differentiation in Hawaii Kilauea Iki showed there was no isotopic fractionation of magnesium isotopes [2]. We speculate that the hydrous nature of the arc lavas or more complex processes of differentiation lead to different results for arc lavas.

[1] Teng *et al.* (2016) *Proceedings of the National Academy of Sciences of the United States of America* **113**, 7082-7087. [2] Teng *et al.* (2010) *Geochim. Cosmochim. Acta* **74**, 4150–4166. [3] Kessel *et al.* (2005) *Nature* **437**, 724-727. [4] Coath *et al.* (2017) *Chemical Geology* **451**, 78-89.