Uranium isotope fractionation during slab dehydration beneath the Izu arc

HEYE FREYMUTH[1], MORTEN B. ANDERSEN[2], TIM ELLIOTT[3]

[1]School of Earth and Environmental Science, University of Manchester, heye.freymuth@manchester.ac.uk
[2]School of Earth and Ocean Sciences, Cardiff University, AndersenM1@cardiff.ac.uk
[3]Bristol Isotope Group, University of Bristol, Tim.Elliott@bristol.ac.uk

Differences in $^{238}U/^{235}U$ between the bulk Earth, mid-ocean ridge and island arc basalts have recently been reported implying recycling of surface-processed U within subduction zones and to the upper mantle [1]. The previously studied Mariana arc lavas are distinctly isotopically light, with the most extreme compositions in the most sediment poor samples. Thus a low $\delta^{238}U$ (the parts per thousand difference in $^{238}U/^{235}U$ from the NIST SRM 112a/145 standard) has been inferred for the slab-derived fluid. To further explore the release of U from the slab, possible associated isotope fractionation, and its consequences for the recycling of U into the mantle we have measured $^{238}U/^{235}U$ ratios in lavas from the Izu volcanic arc. The Izu arc has a more variable and more fluid-dominated slab input than the Mariana arc (Freymuth et al. 2016) and thus allows a more detailed assessment of the release of U from the slab via fluids.

The Izu arc lavas extend to lower $\delta^{238}U$ and lower Th/U than the Mariana arc lavas. Their U isotope data are consistent with a model that suggests U contributions to the sub-arc mantle via slab melts comprised dominantly of altered oceanic crust (AOC) with a minor sediment component, and U-enriched fluids which sequester elements from the lower mafic crust [2]. The slab components present in the Izu arc lavas require the slab contributions to be variable along the arc. The Izu arc data, combined with previous observations from the Mariana arc, suggest that while generally isotopically light, slab fluids vary in their $\delta^{238}U$ within and between different arcs. The data suggests that U isotope fractionation is associated with mobilisation of U from deeper levels of the mafic crust, thus generating the light U isotopic composition of the fluid.

The exact $\delta^{238}U$ of slab-derived fluids is likely controlled by the degree of interaction between relatively oxidised fluids with the mafic oceanic crust. The extraction of isotopically light U from the lower mafic crust together with the upper AOC that is isotopically heavy from low-temperature U alteration results in an isotopically heavy residual slab that is recycled into the deeper mantle beyond subduction zones.

[1] Andersen, Elliott, Freymuth, Sims, Niu & Kelley (2015), *Nature* 517, 356-359 [2] Freymuth, Ivko, Gill, Tamura & Elliott (2016) *GCA* 186, 49-70