Isotopic fingerprinting of U recycling

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The mobility of uranium (U) under oxic conditions and its enrichment in the oceanic crust has long led to speculations about the importance of this low-tempeature process on the distribution of U in the mantle. Notably, the return flux of U from surface to mantle, via subduction, is potentially sufficient to perturb the mantle U abundance. This mechanism has been used as a mean to explain the distinctive U-Th-Pb systematics of mid-ocean ridge basalt (MORB) (e.g. [1]).

Advances in MC-ICPMS have allowed high-precision measurements of the $^{238}U/^{235}U$ ratio providing new constraints on this cycle. Recent work has shown that the U in the near surface environment can be fractionated at the permil-level (e.g. [2] [3]). Therefore, recyling of significant amounts of isotopically fractionated U from the surface to the mantle has the potential to perturb not only its U abundance but also its isotope ratio. We have obtained precisions of ~0.02‰ on $^{238}U/^{235}U$ of mantle-derived samples, a sufficient resolution to detect the influence of recyled U in the mantle [4].

We have determined that the net effects of alteration and subduction leave the deep recycled slab with isotopically heavy U. The preferential return of this U into the upper mantle has driven the MORB mantle isotopically heavy [4], consistent with the anomalously low Th/U of MORB (e.g. [1]). In constrast, we find the $^{238}U/^{235}U$ signature of a range of ocean island basalts (OIB) to be similar to the chondritic reference. These differences are interpreted to reflect the age of the U addition from surface to mantle and different low-temperature U isotope fractionation processes in the altered oceanic crust. We will discuss the importance of these changing surface-processses in relation to the $^{238}U/^{235}U$ signatures in OIB and MORB and their implication for the time-scales of mantle convection and geochemical heterogeneity.

[1] Elliott at al. (1999) *EPSL* **169** p129-145 [2] Stirling *et al*. (2007) *EPSL* **264** p208-225 [3] Weyer *et al* (2008) *GCA* **72** p345-359 [4] Andersen *et al*. (2015) *Nature* **517** p356-359