Isotopic perspectives on uranium uptake in altered oceanic crust: lessons from ODP hole 1256D

MORTEN B. ANDERSEN[1], TIM ELLIOTT[2], HEYE FREYMUTH[3], DAMON TEAGLE[4], KARI COOPER[5]

[1]School of Earth & Ocean Sciences, Cardiff University, UK, andersenm1@cardiff.ac.uk
[2]Bristol Isotope Group, University of Bristol, UK
[3]SEES, University of Manchester, UK
[4]National Oceanographic Centre Southampton, UK
[5]EPS, University of California, Davies, USA

Seafloor weathering, and resulting alteration of oceanic crust (AOC), plays a major role in heat exchange and elemental redistribution between the deep and surface Earth. This process shapes the chemical evolution of the oceans and elemental recycling into subduction zones and the mantle. During this seafloor weathering, uranium is one of the elements that is removed from seawater and added to the AOC. The fractionation between the long-lived isotopes ^{238}U and ^{235}U during this process allows new perspectives on the global U cycle [1].

Oxic U uptake has been observed in the upper 600 m of 6 Ma AOC drill core 504B [2]. In contrast, much older (>100 My) drill cores 417/418 and 801 are associated with higher total U uptake (400 ppb), with net isotopically heavy U measured in core 801 [1]. We measured U isotope ratios in samples from 16 Ma AOC of ODP hole 1256D and show that the upper 600 m are characterised by moderate U enrichments (100-200 ppb) and isotopically light U compared to seawater, the latter suggesting a dominantly oxic U uptake. Deeper in a breccia zone of 1256D, ppm-level U uptake is associated with isotopically heavier U, likely from U uptake in a more reducing environment. Furthermore, these deeper zones are associated with $^{234}U/^{238}U$ compositions out of secular equilibrium, showing the uptake occurred during the last million years. Significant U uptake is likely occurring during off-axis alteration; thus, the relatively young cores 1256D and 504B primarily record the first, dominantly oxic, stage of U uptake and do not represent the full U budget of AOC.

[1] Andersen et al. (2015) Nature, 517, 356-359
[2] Bach et al. (2003) G-cubed, 4, 3