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$\delta^{238}U$ variation in ancient altered mafic oceanic crust

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Uranium (U) is enriched in the upper portions (~500 m) of the altered mafic oceanic crust (AMOC), as a consequence of seawater alteration [e.g. 1, 2]. The processes that lead to U enrichment have also recently been shown to be associated with isotopic fractionation of U [3]. Namely, in the upper AMOC U^{6+} can be absorbed onto secondary mineral surfaces, leading to low $\delta^{238}U$, while partial reduction of U^{6+} from deep circulating fluid results in high $\delta^{238}U$ [3].

In both cases, such U isotopic fractionation requires the presence of U^{6+} in seawater and so reflects oxygenated deep ocean water. Determining when AMOC first acquired variable U isotopic compositions therefore constrains the timing of deep ocean oxygenation, providing an independent proxy to compare with other methods, such as $Fe^{3+}/\sum Fe$ ratios [e.g. 4]. It also records when isotopically distinct U started to be recycled into the mantle [3].

Here we present $\delta^{238}U$ data for ophiolite samples (ancient AMOC) from the Phanerozoic to investigate past U alteration processes. Our results document significant U isotope fractionation in samples at 540 and 480 Ma, suggesting alteration conditions similar to modern deep oxygenated oceans. Low Th/U ratios and alteration mineralogy also reflect U uptake similar to modern conditions. Given these results imply an oxygenated deep ocean back to 540 Ma, we plan to target older samples (750 Ma) to better define the end of ocean anoxia. These results allow us to estimate timescales for the generation of chemical heterogeneity in the upper mantle by the recycling and mixing in of isotopically distinct U [3].

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