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Reappraising the U isotope composition of seawater and deep-sea corals: Implications for paleo-environmental reconstructions

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Uranium isotope ratios are widely utilized in paleoceanography. The $^{238}U/^{235}U$ ratio (expressed as $\delta^{238}U$) is leveraged as a proxy for the areal extent of seafloor anoxia, and the $^{234}U/^{238}U$ ratio (expressed as $\delta^{234}U_{Sec}$) tracks riverine and estuarine inputs to the ocean, in addition to featuring prominently in U-series geochronology. Both of these ratios are thought to be recorded by biological carbonates precipitating from seawater, with corals serving as one of the most commonly-used archives of seawater U isotope ratios in the past. The utility of the U isotope proxy in biological carbonate archives relies not only on this faithful recording of ambient seawater signatures, but also on the homogeneity of the seawater U isotope composition, which enables samples to be leveraged as proxy for the entire ocean.

In this work [1], we revisit the foundational assumption of homogeneity of the marine U reservoir, and the capacity of deep-sea corals to record the U isotopic composition of ambient seawater. To this end, we first reevaluated the analytical limits of precision and accuracy achievable for both $\delta^{238}U$ and $\delta^{234}U_{Sec}$ analysis by MC-ICP- MS. We then measured the U isotopic composition of 26 deep-sea coral and 45 seawater samples from multiple sites around the world (*i.e.*, North and South Atlantic, and South Pacific localities). Seawater samples were obtained from GEOTRACES stations in close proximity to the deep-sea coral specimens studied. We find subtle $\delta^{238}U$ and $\delta^{234}U_{Sec}$ heterogeneity that correlates with U concentrations, which allows us to calculate new salinity-normalized global mean seawater values for $\delta^{238}U$ (-0.379 ± 0.023 ‰) and $\delta^{234}U_{Sec}$ (+145.55 ± 0.28 ‰). At each site, biological carbonates act as precise archives of the seawater $\delta^{238}U$ value. The same is true for $\delta^{234}U_{Sec}$, with a few exceptions where samples appear to show vital effects that cause intra-sample $^{234}U/^{238}U$ repartitioning. In sum, these observations support deep-sea corals as a robust archive of seawater U isotope ratios, but highlight the importance of utilizing multiple sample sites and replicate analyses to overcome coral vital effects (for $\delta^{234}U_{Sec}$) and subtle marine U isotopic heterogeneity.

[1] Kipp et al. (2022) *GCA* **336**, 231-248.