Cenozoic Seawater Uranium Isotopic Composition Recorded in Mn-Fe Crusts

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Previous attempts to track ocean oxygen levels during recent (Cenozoic) climatic shifts have been predominantly model-based or have utilized geochemical proxies that are inherently regional in scope. The uranium (U) isotope system ($^{238}U/^{235}U$) has emerged as a proxy that can track changes in ocean redox on a global scale. We provide a U isotope record throughtout the Cenozoic archived in hydrogeneous Mn-Fe crusts dredged from the Pacific, Atlantic, and Indian oceans.

Uranium is scavengaged and incorporated into the crusts through adsorption by hydrogeneous Mn-Fe phases, which are formed by direct precipitation of Mn-Fe oxyhydroxides from seawater. Therefore, Mn-Fe crusts can track the U isotope composition of seawater. We analyzed five hydrogeneous Mn-Fe crusts formed at different locations and different depths in the ocean. Although U concentration varied between and within the studied crusts, $^{238}U/^{235}U$ did not show analytically resolvable variation. Crusts from all three oceans have a consistent, time-independent $^{238}U/^{235}U$ value that is ~0.2‰ lower than the ratio of modern seawater. This isotopic shift agrees with modern Mn-Fe crust values and laboratory adsorption experiments. We monitored ^{234}U to ensure that we are not recording diffusional profiles.

The consistency in our U isotope record indicates remarkable secular stability of the marine redox landscape throughout the Cenozoic. We acknowledge that shorter perturbations to ocean redox may have been superimposed upon this pattern, because the sampling resolution was not high enough to cover short durations. However, the data imply that stabilizing feedbacks have somehow prevented major long-term oxygen shifts despite secular changes in surface temperature, atmospheric pCO_2, and tectonic events.