Uranium isotope in ferromanganese crusts: Implications for the marine $^{238}U/^{235}U$ isotope system

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Variations of $^{238}U/^{235}U$ ($\delta^{238}U$) in sedimentary rocks have been proposed as a proxy for paleo-oceanic redox conditions [1, 2]. To better understand the marine $\delta^{238}U$ system, we investigated spatial and temporal variation of $\delta^{238}U$ in ferromanganese crusts from the Pacific Ocean.

In the surface layers (0-3 mm depth) from 6 seamounts, $\delta^{238}U$ shows little variation, ranging from –0.59 to -0.65‰. This uniformity is consistent with the long residence time of U in modern seawater. $\delta^{238}U$ in these sediments is lighter than that of present-day seawater by ~0.24‰ [1, 2], consistent with fractionation experiments [3]. These results suggest that removal of U from seawater to Fe-Mn crusts is responsible for the second largest U isotopic fractionation in the modern marine system, and helps explain the heavy $\delta^{238}U$ of seawater.

Depth profiles of $\delta^{238}U$ in two ferromanganese crusts were also investigated. $\delta^{238}U$ shows no resolvable variation over a depth corresponding to 40 Myr. One interpretation of these data is, that the relative proportions of oxic and reducing U sinks have not varied significantly over this time. However, $\delta^{234}U$ depth profiles in the same sediments suggest U redistribution after deposition. Therefore, $\delta^{238}U$ may have been overprinted by secondary mobilization.

To assess the potential effect of U removal by Mn oxides on seawater $\delta^{238}U$, we calculated the seawater $\delta^{238}U$ under different fractions of U removal by Mn oxides using a simple isotope balance model. This calculation suggests that seawater $\delta^{238}U$ could have varied significantly throughout Earth's history along with the changes of the Mn oxides accumulation rate.

[1] Stirling *et al* 2007 *EPSL* **264**, 208–225. [2] Weyer *et al* 2008 *GCA* **72**, 345–359. [3] Brennecka *et al* 2011 *ES&T* **45**, 1370-1375.