Uranium Dynamics in Amazon Estuary Revealed by Isotopic Analysis

E.C. BORDER[1], J. KAMM[1], A. KOSCHINSKY[2], F. MARTIN[3], N. FRANK[1]

[1]Institute of Environmental Physics, Heidelberg University, 69120 Heidelberg, Germany
(correspondence: eborder@iup.uni-heidelberg.de)
[2]Jacobs University, Campus Ring 1, 28759, Bremen, Germany
[3]GEOMAR Helmholtz Centre for Ocean Research, 24148 Kiel, Germany

A high precision isotopic analysis of water samples from across the Amazon Estuary taken during the M147 cruise provides insight into the complex system of uranium addition and removal present. While traditionally thought of as the embodiment of a conservative ocean tracer, recent findings have shown surprising temporal variability in oceanic uranium isotopic makeup taking place on relatively short time scales when compared with its typical ocean residence time [1]. This has placed a renewed onus on better understanding the global inputs and outputs.

The new results show uranium concentrations ranging from 0.04 to 3.26 ppb and $\delta^{234}U$ values from 145.7 to 247.6‰ with pronounced geographical differences in estuarine behaviors. The southeastern portion of the Amazon Estuary displays strictly conservative mixing in both concentration and isotopic makeup across the ocean-river salinity gradient, while the northwestern section (at salinities of 1-15 PSU) shows up to 87% uranium depletion and $\delta^{234}U$ values elevated by up to 80‰. This points towards the northwestern region functioning simultaneously as both an overall uranium sink and a high-$\delta^{234}U$ source, likely due to the accumulation of 'removed' uranium in sediments and the corresponding increase in the strength of alpha-recoil effects.

That there are two separate regimes on display in the estuary leads to the possibility that, if changing environmental conditions could alter the balance between the two regimes, this could also shift the Amazon Estuary's impact on global ocean uranium content. A shift towards more conservative behavior of uranium in the estuary would 'uncover' sediments rich in uranium and with a high $\delta^{234}U$ output, while the opposite shift would result in less river-sourced high-$\delta^{234}U$ uranium reaching the ocean, as well as enhanced removal of oceanic uranium. Due to the immensity of the Amazon River, this could have a sizable impact on global oceanic $\delta^{234}U$ and merits further study.

[1] Chen et al. (2016) *Science* 354, 626-629.