Do dissolved barium isotopes in seawater trace water mass mixing and nutrient cycling?

Z. CAO[1]*, C. SIEBERT[1], E. C. HATHORNE[1], M. DAI[2] AND M. FRANK[1]

[1]GEOMAR Helmholtz Center for Ocean Research Kiel, Wischhofstrasse 1-3, Kiel 24148, Germany (*correspondence: zcao@geomar.de, csiebert@geomar.de, ehathorne@geomar.de, mfrank@geomar.de)

[2]State Key Laboratory of Marine Environmental Science, Xiamen University, Xiang'an District, Xiamen 361102, China (mdai@xmu.edu.cn)

Dissolved and particulate barium (Ba) concentrations are widely used for tracing oceanic processes such as riverine inputs or biological productivity. The stable isotopic composition of Ba has, however, until recently not been accessible as a biogeochemical tracer in seawater despite its potential to expand the applications of the Ba proxy. In this study, we present a first set of dissolved Ba isotope data ($\delta^{137/134}$DBa) collected in the East and South China Sea (measured by a double spike method with analytical errors generally <0.1‰, 2 standard deviations), which display distinct spatial variations.

A first set of analyses of global river waters suggests relatively light $\delta^{137/134}$DBa values of ~0.0 to +0.4‰. This is supported by analyses of surface waters influenced by the plume of the Changjiang (Yangtze River) in the East China Sea, which are enriched in dissolved Ba (DBa) and are isotopically light (~+0.4‰) compared with the corresponding near-bottom waters (~+0.6‰).

Beyond the area influenced by riverine inputs, $\delta^{137/134}$DBa signatures are significantly heavier in the upper 100 m (~+0.9‰) than in the deep waters (~+0.5‰), which is mirrored by a general increase of DBa concentrations with water depth. In contrast to silicon (Si) isotope fractionation during biological utilization clearly generating the heaviest signal in the surface mixed layer, both DBa and $\delta^{137/134}$DBa are efficiently homogenized by vertical mixing throughout the upper 100 m of the water column most likely implying that physical mixing of water masses exerts a significant influence on Ba dynamics. As a consequence of the distinct and measurable gradients of $\delta^{137/134}$DBa, it is suggested that stable Ba isotopes are a potentially useful tracer of water mass mixing and riverine freshwater inputs. Given the distinctly different processes controlling the distribution of dissolved Ba and Si isotopes in the surface waters, combination of these systems may provide valuable information on oceanic nutrient cycling in the photic zone.