

Constraining the Equatorial Pacific barium cycle with stable barium isotopes

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The oceanic barium (Ba) cycle has been linked to biological activity and the marine carbon cycle as barite (BaSO_4) precipitates during the oxidation of sinking organic matter. The stable Ba isotope composition ($\delta^{138}\text{Ba}$) is a valuable tracer for the Ba cycle due to isotopic fractionation during BaSO_4 precipitation. This study aims to gain a better understanding of conservative versus nonconservative Ba behavior, the depth range of organic matter and BaSO_4 remineralization, and conservative mixing in the Equatorial Pacific.

We present combined dissolved Ba concentration ($[\text{Ba}]$) and $\delta^{138}\text{Ba}$ data obtained from GEOTRACES Equatorial Pacific cruise GP11 (RV Sonne cruise SO298, April to June 2023) between Ecuador and Papua New Guinea. The Equatorial Pacific is characterized by a significant E-W contrast in surface ocean productivity and the marked equatorial current. The sampling period coincided with the transition between La Niña and El Niño states, which led to warmer than usual near surface waters and a shoaling of the Equatorial Undercurrent, the most important source of nutrients to the surface waters flowing from West to East.

$[\text{Ba}]$ and $\delta^{138}\text{Ba}$ in the study area ranged from 31.8 to 142.5 nmol/kg and 0.24 to 0.74‰, respectively. Despite differences in productivity along the transect, the water column profiles for $[\text{Ba}]$ and $\delta^{138}\text{Ba}$ are surprisingly similar and only show significant vertical variations. The Ba distribution has a nutrient-like gradient with low $[\text{Ba}]$ in surface waters, but without reaching near complete depletion, and high $[\text{Ba}]$ in deep waters. The $\delta^{138}\text{Ba}$ profiles have the opposite pattern, related to precipitation of BaSO_4 in the mesopelagic zone, which preferentially incorporates light Ba isotopes and causes the waters to be enriched in heavy isotopes. The data show a close correlation between seawater $[\text{Ba}]$ and $\delta^{138}\text{Ba}$ where heavier values of $\delta^{138}\text{Ba}$ are observed in surface waters in our study compared to previous studies in the Atlantic, Pacific and Southern Oceans. Overall, our data indicate the importance of processes other than primary production such as water mass mixing/ocean circulation on the Ba cycle in the Equatorial Pacific.