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Biogeochemical processes controlling the marine Ba cycle: dissolved and particulate barium distributions along the US GEOTRACES North Atlantic and South Pacific Zonal Transects (GA03 and GP16)

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The geochemical behavior of Ba was investigated along the US GEOTRACES GP16 South Pacific (EPZT) and GA03 North Atlantic (NAZT) zonal transects, which navigated similar oceanic biogeochemical and physical features. Dissolved Ba (dBa) was usually lowest in surface waters (~35-50 nmol/kg), increasing with depth to 70-80 nmol/kg and 140-150 nmol/kg in deep waters of the NAZT and EPZT, respectively. Radium and silicic acid concentrations are well-correlated with those of dBa (r^2>0.90) in the water column. Inputs of dBa are considerable from broad continental margins and have not been accounted for in conceptual models of the marine Ba cycle. Inputs from hydrothermal vents have a minor impact on Ba distributions in both transects. Much of the water column below 2000 m in the EPZT can be described by dBa depletions from conservative mixing, whereas in the NAZT most of the water column is characterized by dBa enrichment over water mass mixing. In both basins, conservative mixing of water masses with varying pre-formed dBa values can account for ~70% of differences in dBa concentrations. Nevertheless, non-conservative geochemical processes substantially impact dBa distributions.

Most of measured particulate Ba forms in the mesopelagic as barite ($BaSO_4$), also called particulate excess Ba (pBa_{xs}). Concentrations of pBa_{xs} are lower in the NAZT and distributions are less extensive in the water column than in the EPZT. Excess ^{230}Th activities were used to track barite formation and dissolution rates. Precipitation of barite in the water column depletes dBa within Oxygen Minimum Zones (OMZs) from concentrations derived by conservative water mass mixing, whereas particle dissolution, benthic diffusive flux, and inputs from continental margins raises dBa from predicted values. Between both basins, burial efficiencies are variable, ranging from ~17–100%. We reassess global river dBa inputs as 6.8 ± 3.9 Gmol/y, or <50% of estimated Ba marine sinks. Taking into account dBa inputs from continental margins and a revised global river dBa flux may help balance the marine Ba isotope budget.