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Particulate excess Ba as a proxy for biological productivity along the North Atlantic and South Pacific GEOTRACES transects

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Through the formation of particulate organic carbon (POC), marine primary production consumes >50% of atmospheric CO_2 and plays a major role in controlling atmospheric CO_2 over glacial/interglacial timescales. Of the ~4200 Tmol/y of POC that is produced in the surface ocean, <1% arrives to the seafloor, much of it being respired in the mesopelagic zone (100-1000m). Particulate excess barite (pBa_{xs}) is thought to form in the water column within decaying organic matter and has preservation efficiencies higher than POC. Using pBa_{xs} concentrations and ^{230}Th-normalized fluxes in the water column and sediment, the accuracy of pBa_{xs} as a productivity proxy was tested along the US GEOTRACES GA03 North Atlantic (NAZT) and GP16 Eastern Tropical Pacific (EPZT) transects, which traversed both near-shore and open-ocean gyre stations. Depth weighted averages of pBa_{xs} were determined for two mesopelagic depth intervals and compared to the attenuation of ^{230}Th-normalized POC flux estimates. Averages were typically higher in the EPZT (~230-410 pM/l) than the NAZT (~100-330 pM/l), and corresponded with respiration estimates derived from POC flux. For example, in 100-500 m of the EPZT water column, pBa_{xs}-based POC respiration rates ranged from 0.6-5.7 mmol-C/m^2/d, whereas rates based on POC attenuation were 1.2-6.2 mmol-C/m^2/d.

Available pBa_{xs} mass accumulation rates (MAR) at EPZT stations were used to calculate export production in the water column using two well-known algorithms [1, 2]. Export production (EP) was also calculated by applying Martin (power-law fit) and 1st-order kinetic (exponential fit) models to ^{230}Th-normalized POC flux curves using several estimates of euphotic zone depth (e.g., deep chlorophyll maximum or particle production zone). Sedimentary pBa_{xs} -based EP estimates were poorly correlated (r^2 ~ 0.0-0.4) to EP estimates based on water column POC flux. Correlations in gyre stations were often negative. However, excess barite appears to be a reasonable proxy for POC respiration in the water column. We suggest that pBa_{xs} MARs at stations underlying the EPZT are not a good proxy for EP due to sediment movement or benthic dissolution of pBa_{xs} post-deposition.

[1] Dymond et al. (1992) Paleoceanography 7, 163-181. [2] Francois et al. (1995) GBC 9, 289-303.