

Marine Chemistry

Winter dissolved and particulate zinc in the Indian Sector of the Southern Ocean: Distribution and relation to major nutrients (GEOTRACES G1pr07 transect)

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Abstract

First winter measurements of dissolved zinc (dZn) and particulate zinc (pZn) are presented from seven stations, between 41 and 58°S, occupied in July 2017 along the 30°E longitude in the Indian Sector of the Southern Ocean. This unique spatial and seasonal dataset provided the opportunity to investigate Zn biogeochemical cycling in a region which is extremely data scarce and during a period when conditions are unfavourable for phytoplankton growth. Surface comparisons of our winter dZn and pZn to previous measurements during spring and summer revealed that Zn seasonality is most pronounced at the higher latitudes where higher dZn (and higher ratios of dZn to phosphate; dZn:PO₄) and lower pZn in winter reflect decreased biological uptake and preferential dZn resupply (relative to PO₄) to surface waters through deep winter mixing. The composition of pZn was majorly biogenic however localised lithogenic inputs were attributed to potential hydrothermal activity and transport of continental sediment via Agulhas waters. Calculated vertical attenuation factors (b values) for pZn (0.31) and phosphorus (P; 0.41) suggest that Zn has a longer remineralisation length scale than P, providing a mechanism as to why dZn appears to be remineralised deeper in the water column than PO₄. Ratios of pZn to P (pZn:P) in surface waters increased with latitude from 1.12 to 8.28 mmol mol⁻¹ due to increased dZn availability and the dominance of diatoms (with high cellular Zn quotas) in the high latitude Antarctic Zone (AAZ). Interestingly, the high surface pZn:P ratios in the AAZ did not change significantly with depth (in contrast to

the northern stations where pZn:P increased with depth) suggesting the export of diatom cells below the winter mixed layer where remineralisation and rigorous mixing may resolve the linear dZn to silicic acid (dZn:Si(OH)₄) correlation (dZn (nmol kg⁻¹) = 0.064 Si(OH)₄ (μmol kg⁻¹) + 0.690; r² = 0.93; n = 120) despite these elements being located in separate components of the diatom cell. Additionally, elevated concentrations of dZn and Si(OH)₄ below 3000 m in the AAZ may reflect nutrient accumulation in bottom waters where northward flow is inhibited by the Indian mid-Ocean ridge.