The Southern Ocean: a trace metal pauper

Speaker: JC Loock[1]
R Cloete[1], TM Mtshali[2], S. Fiets[1], AN Roychoudhury[1]
[1] Department of Earth Sciences, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa
[2]CSIR, P.O. Box 320, Stellenbosch 7600, South Africa
16041399@sun.ac.za

Abstract

The sequestration and fixation of carbon in marine systems as exacted by photosynthetic microorganisms, may be governed by the availability of micronutrients (e.g., Co, Fe, Cu, Mn among others). Trace concentrations (<0.1µM) of essential elements limit bio-availability, in turn inhibiting their availability for enzymatic and protein functioning. In the Southern Ocean, this manifests as the High Nutrient Low Chlorophyll (HNLC) paradox; a condition where low bio-available micronutrient (trace metal) concentrations limit growth resulting in the sub-optimal utilization of the macronutrient source pool. This study reports on an investigation into the distribution and controls of "dissolved" (<0.2µm filtrate) trace metals in the Southern Ocean along the zero meridian GEOTRACES transect. A multi-element dataset was established using a novel pre-concentration (sea*FAST* pico trace*)* and ICP-MS coupled technique. The method proved highly precise (≤10%RSD) in the repeat analysis of an in-house control (TM4A), and accurate in the analysis of the SAFe (D2) community reference material. Here we report the concentrations of labile Co (LCo; 5-40 pmol/kg), dissolved Mn (DMn; 0.034-0.67nmol/kg), Zn (DZn; 0.61-12nmol/kg) and Cd (10-900 pmol/kg). Owing to strong biological depletion, the lowest concentrations were typically observed in the surface waters and may be capable of variably co-limiting the growth of marine phytoplankton. Common scavenging below the sub-surface was implicated in the linear correlation (R^2≈0.8) observed between LCo and DMn and resulted in a "hybrid type" distribution. DCd and DZn exemplified the "nutrient type" oceanic distribution correlating strongly with phosphate (PO_4) and silicate (SiO_4) respectively. The first seasonal re-occupation (summer-winter) of the zero meridian exposed significant increases in the surface mixed layer trace metal concentrations. These elevated concentrations were the culmination of several factors acting concurrently: entrainment through deep mixing; decreased bio-utilization; source flux (atmospheric and hydrothermal); and hydrographic shifts.