The distribution and controls of bioactive trace elements (Cu and Zn) in the Atlantic Sector of the Southern Ocean

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An improved method for the contamination free collection of seawater and subsequent trace element analysis is presented. A vertical profile sampling method was employed for the collection of seawater samples along the Bonus Goodhope Line (BGL) during the 2014/2015 austral summer. Validation through intercalibration with the University of Plymouth (UK) proved the implementation of this technique successful. Samples from two locations, 46°S, Polar Frontal Zone (PFZ) and 65°S, Weddell Gyre (WG), were analysed for their total and dissolved fractions in a land based trace clean laboratory approximately 6 months later. An offline preconcentration step was successfully employed to extract the trace elements from their seawater matrix and ensure quantitative recovery by Inductively Coupled Plasma Mass Spectrometry (ICP-MS). This method allowed the simultaneous quantification of 10 trace elements (Al, V, Mn, Fe, Ni, Cu, Zn, Mo, Co, Cd, Pb). Validation of the offline pre-concentration and ICP-MS analysis was performed by analysis of external SAFe standards as well as internally by analysis of Multi-Element Standards (MES).

Furthermore this study reports on the distribution and controls of dissolved copper (DCu) and dissolved zinc (DZn) in the Southern Ocean. In the PFZ, DCu and DZn displayed typical nutrient like behaviour with concentrations increasing with depth. This is consistent with surface water trace element uptake by marine phytoplankton and remineralization of organic biomass by bacteria in the deeper waters. DCu and DZn had similar surface concentrations of 1.00 ± 0.04 nmol/kg and 1.46 ± 0.61 nmol/kg respectively while at the greatest depth sampled (4300 m), DZn exhibited a higher maximum concentration of 6.96 ± 0.35 nmol/kg compared to 3.15 ± 0.01 nmol/kg for DCu. In the WG, both DCu and DZn showed higher surface concentrations compared to the PFZ, most likely the result of ice melt. DZn concentrations decreased rapidly from 5.78 ± 0.01 nmol/kg at 100 metres depth to 1.02 ± 0.03 nmol/kg at the surface and similarly from 1.89 ± 0.09 nmol/kg to 1.29 ± 0.01 nmol/kg for DCu. This rapid depletion in the WG can be attributed to increased biological uptake by marine phytoplankton compared to the PFZ which is in agreement with chl-a data collected during occupation of the sample stations. Deepwater (>1000m) DZn and DCu concentrations remained relatively constant at approximately 5.5 nmol/kg and 2.4 nmol/kg respectively. This suggests that the cold deepwaters in the WG, characterised by Weddell Sea Deep Water (WSDW), inhibited the bacteria's ability to remineralize sinking organic matter. Analysis of macronutrient data revealed that the Antarctic Polar Front (APF) exerted an important control whereby macronutrients were limiting primary productivity North of the APF and trace elements were limiting primary productivity to the South. Currently we are analysing the rest of the Austral Summer seawater samples as well as samples collected during the Austral Winter. We hope to make conclusions on the seasonal cycling of trace elements based on three overlapping stations at 46°S, 50°S and 54°S.