Manganese: a key trace metal in the Southern Ocean?

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The role of iron (Fe) as a limiting nutrient for phytoplankton growth has been widely described in the Southern Ocean, the largest High Nutrient Low Chlorophyll (HNLC) area. However, other micronutrients, with essential physiological role have also been suggested to limit phytoplankton productivity in these regions.

Manganese (Mn) is an essential micronutrient for phytoplankton. It is used for photosynthesis and in the intracellular defence against reactive oxygen species. Manganese has been suggested to be a co-limiting element with Fe in the Southern Ocean, where its distribution has been poorly described.

Here we present the first Mn concentrations measured along a full-depth transect (WOCE-SR3 line), sampled at 35 stations between Tasmania (Australia) and Antarctica in Jan-Feb 2018, and test the hypothesis that Mn can co-limit phytoplankton growth in this region.

Low Mn concentrations (average: 0.37 ± 0.16 nM) were observed along the transect, with several higher concentration plumes originating from sources such as sediments, aerosols and sea-ice melting. Our results are the first to show evidence of hydrothermal input above the Southeast Indian ridge, with a plume of enriched dissolved and particulate Fe and Mn at 2500m depth, extending to more than 500 km to the north.

Correlations of Mn with macronutrients and fluorescence suggest Fe/Mn co-limitation in the Antarctic zone, with the strongest correlations above the continent shelf. Surprisingly, a high Mn/P ratio cannot be linked with diatom requirements, species usually observed in this region. Furthermore, flow cytometry analysis reveals variability in phytoplankton communities present along the transect and suggests a species succession, potentially due to Fe and Mn co-limitation. These preliminary results highlight the need to better understand the limiting role of Mn and other secondary trace metals in order to better prevent the variability of the marine biological carbon pump.