Trends in Metal Limitation of Phytoplankton and Coccolithophores Along the "Great Calcite Belt" in the Southern Ocean

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Introduction – High resolution vertical profiles of dissolved bioactive trace metals

Satellite observations have shown particulate inorganic carbon (PIC) concentrations to be elevated in a "Great Calcite Belt" that encircles the Southern Ocean between approximately 40°S and 60°S. We participated in cruises to the Atlantic and Indian Ocean sectors of this belt to investigate the potential control of phytoplankton—and coccolithophores, in particular—by trace metal availability.

Experimental – Metal additions to trace nutrient-limited phytoplankton and coccoliths

Water samples from several regimes in the southern Atlantic and Indian Oceans were amended with trace metals. The samples were incubated and monitored to measure the biological response (based on PIC and chlorophyll *a* ("Chl") concentrations).

Dissolved samples collected three times over the course of incubation were subsampled into quartz tubes and spiked with a mixture of enriched stable isotope standards (Fe, Cd, Cu, Ni, Zn and Pb) and monoisotope standards (Mn and Co). The samples were UV-irradiated to release the metals from organic ligands, then the metals were extracted from the seawater matrix by passing them over a chelating resin column containing the Nobias Chelate PA-1 resin[1]. The metals were eluted from the column into a small volume of 1.0 M HNO_3 at a preconcentration factor of ~20. Eluted samples were analyzed with calibration standards using the Thermo ELEMENT 2 HR-ICP-MS, housed in the Geochemistry division of the NHMFL.

Results and Discussion

Iron limitation of the bulk phytoplankton community (assessed by increases in Chl after Fe addition) was observed in the Indian sector but not the Atlantic sector of the belt, nor was iron limitation found north of the sub-tropical front (**Fig. 1**). This zonal trend matches modeled dust deposition to the Southern Ocean and broad regional trends in surface dissolved iron. Iron stimulated coccolithophore growth (assessed by increases in PIC) 40% more than it stimulated growth of the bulk phytoplankton community at one station, and additions of zinc or cobalt resulted in approximately 2-fold higher PIC/Chl ratios, relative to controls, at the same station. It appears that coccolithophores in some parts of the belt are poised to preferentially respond to added metals (**Fig. 2**).

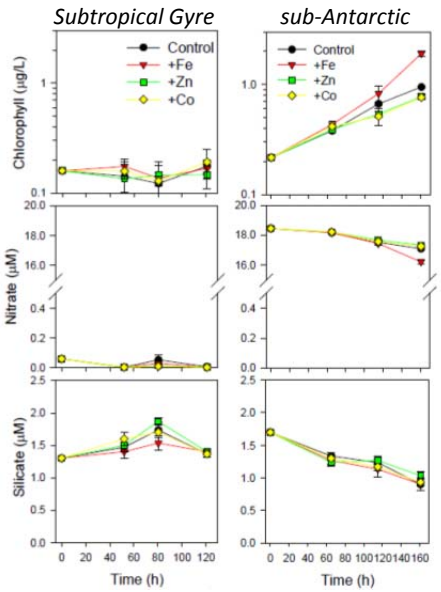

Fig.1: Biological response (Chl production, nutrient uptake) in incubations from waters of the Indian Ocean subtropical gyre and sub-Antarctic waters.

Conclusions

Spatial trends in metal limitation of phytoplankton community broadly match modeled dust deposition to the Southern Ocean and broad regional gradients in surface dissolved Fe. Zinc or Co additions resulted in ≈ 2-fold higher PIC/Chl ratios, relative to controls, at the Crozet station (6). Coccolithophores in parts of the Great Belt appear poised to preferentially respond to added metals.

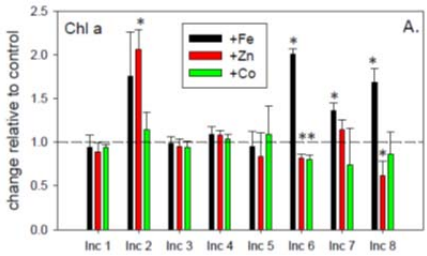

Fig.2: Chl changes due to different trace metal amendments (relative to control incubation).

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References

[1] Milne, A., *et al*., Analytica Chimica Acta, **665**, 200-207 (2010).