Bioavailability of Cadmium: Stable Isotope Uptake and Toxicity of Cd to Marine Phytoplankton in the Costa Rica Upwelling Dome

A.D. COX[1] A.E. NOBLE, AND M.A. SAITO[3]

[1] MIT/WHOI Joint Program in Chemical Oceanography, Woods Hole, MA 02543; alysia@mit.edu
[2] Department of MC&G, Woods Hole Oceanographic Institution, Woods Hole, MA 02543; anoble@whoi.edu
[3] Department of MC&G, Woods Hole Oceanographic Institution, Woods Hole, MA 02543; msaito@whoi.edu

Cadmium can function as either a nutrient or toxin in the marine environment. This duality has been demonstrated in phytoplankton cultures where cadmium has been shown to have toxic effects to cyanobacteria, but acts as a nutrient in the marine diatom *T. weissflogii*, by biochemically replacing zinc. Whether or not Cd functions as a nutrient or toxin is likely to be controlled by its bioavailabilty. Like many other trace metals in surface waters, Cd is complexed by strong organic ligands, which are thought to be produced by marine phytoplankton, particularly the cyanobacteria. In the summer of 2005, the bioavailability of Cd in the Costa Rica Upwelling Dome was examined using incubation and uptake experiments. The Costa Rica Dome is a tropical thermocline dome in the Eastern Pacific fed uniquely by a coastal wind jet that produces a habitat with high phytoplankton biomass relative to surrounding waters. This dome supports some of the highest cell densities of the cyanobacterium, *Synechococcus*, reported anywhere in nature, making it an ideal place to observe cyanobacterially-dominated processes.

We hypothesized that higher cadmium ligand production in the dome prevented toxicity of upwelled Cd in this region, relative to the oligotrophic waters. Bottle incubation experiments with Cd additions ranging from 0.5 to 5 nM reduced chlorophyll *a* outside of the dome, but showed no toxic effects within the dome, consistent with this hypothesis. Moreover, tracer uptake experiments were conducted with the low-abundance stable isotope ^{110}Cd at stations within and outside the dome, in which variations with depth and time were examined. Biomass from the tracer incubations were harvested on a 0.2 μm filter then frozen until acid digestion and ICP-MS analysis in the lab. Cd speciation and totals were measured shipboard and in the lab using anodic stripping voltammetry, showing depletion of total Cd in the surface waters and increased concentrations with depth. Cd uptake was greatest within the upper 40 m of water inside the dome, decreased with depth, and increased with time. Uptake correlated positively with chlorophyll *a* concentrations. Together, these experiments demonstrate uptake of Cd into the microbial loop in the upper water column both in and out of the Costa Rica Dome, but show that Cd toxicity was not induced within the dome presumably due to a greater degree of complexation of Cd by natural organic ligands in that region.