Project Summary

GEOTRACES Atlantic Section: Characterization of phytoplankton trace metal quotas and their contribution to the particulate metal pool in the upper ocean

Intellectual Merit

Incorporation of the trace elements Mn, Fe, Co, Ni, Cu and Zn into phytoplankton, and the chemical, biological and biochemical mechanisms which regulate this process, are of central importance to our understanding of the biogeochemical functioning of the oceans. These trace elements (TE) have the potential to control ocean productivity, ecosystem structure and the utilization of macronutrients in large regions of the global ocean. Significant effort has been expended to study the response of cellular trace element quotas to environmental conditions in laboratory cultures, but measurements of cellular trace element quotas and stoichiometries in natural biogenic particulate material are rare and sorely needed to constrain and evaluate biogeochemical models. The international GEOTRACES program was initiated to advance our knowledge of the concentrations and physical and chemical speciation of trace elements in the global ocean. Here I propose to measure the Al, Si, P, Mn, Fe, Co, Ni, Cu, Zn and Cd contents of individual phytoplankton function groups and bulk particulate matter across biogeochemical gradients in the surface waters of the Atlantic Ocean using a combination of bulk and microanalytical elemental techniques. Samples will be collected from the surface mixed layer and deep chlorophyll maximum layer during the GEOTRACES North Atlantic Survey Section cruise using a combination of GoFlo bottles, *in situ* pumping and a towed 'fish'. Individual phytoplankton cells representing major functional groups (diatoms, autotrophic flagellates, cyanobacteria, coccolithophores) will be analyzed with synchrotron x-ray fluorescence analysis (SXRF). Particulate matter collected on 0.45-µm polyethersulfone membranes will be digested and analyzed with high resolution inductively coupled plasma mass spectrometry (ICP-MS). In this way, the response of phytoplankton trace element composition to natural gradients in dissolved and particulate macro- and micronutrient supply can be resolved. Additionally, three methods commonly used to better characterize bulk particulate matter (oxalate/EDTA rinse, weak acetic acid digestion, correction for lithogenic material with TE:Al ratios) will be applied and their effectiveness evaluated through comparisons with direct SXRF measurements of cellular trace elements. Single-cell analyses of diatoms and their frustules will enable evaluation of Zn and Ni as potential paleoceanographic proxies, as well as determination of synergistic and antagonistic relationships among macronutrients and micronutrients and taxa-dependent preferences for specific micronutrients, addressing several core GEOTRACES objectives.

Broader Impacts

The broader impacts of this study include a strong commitment to providing research experiences and mentorship to high school and undergraduate students in an EPSCoR state. This will be accomplished through existing educational programs at the Bigelow Laboratory for Ocean Sciences (Keller-BLOOM, REU) and through individualized research internships for one or two undergraduate students to work directly on this project, culminating in a presentation at a scientific meeting. Outreach to the general public will be accomplished through presentations at local organizations (e.g., libraries, churches, civic groups) and via the *Café Scientifique* program at Bigelow. The proposed work will provide essential information on the trace element composition of phytoplankton functional groups and biogenic particulate material in the surface waters of the Atlantic Ocean. This data is needed for parameterization and testing of biogeochemical models which inform our understanding of the potential response of the oceans to global climate change.