GEOTRACES Zonal Atlantic Section: Arsenic and phosphorus biogeochemistry

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Intellectual Merit: Arsenic and phosphorus are chemically and biochemically very similar, so much so that arsenate (AsV) is toxic to phytoplankton due to its substitution in ATP, effectively decoupling energy metabolism. This toxicity is therefore a function of arsenic's chemical speciation, but also the arsenate:phosphate ratio; in oligotrophic waters where phosphate concentrations drop below 10 nmol/L , arsenate is > 10 nmol/L and toxicity is a problem. However, many phytoplankton are able to ameliorate As toxicity by reducing arsenate to arsenite (AsIII) and/or methylating it to mono (MMAs) and dimethyl As (DMAs); these compounds are non-toxic to phytoplankton. Interestingly, in these same conditions of low phosphate phytoplankton are already experiencing P stress or even limitation, so it is possible that reduced and methylated As could function as markers/tracers of P stress. This proposal seeks funding to examine the coupled biogeochemical cycling of As and P during the US GEOTRACES North Atlantic Zonal Section cruise in 2010. The specific research objectives are:

1. **To establish the correlations between measured dissolved arsenate:phosphate ratios and the concentrations of arsenite, MMAs, and DMAs.**
2. **To quantify the surface water residence times of arsenite, MMAs, and DMAs with respect to photo-oxidation and demethylation.**
3. **To evaluate the efficacy of using the concentrations of arsenite, MMAs, and/or DMAs as proxies for phosphate stress.**
4. **To construct a biogeochemical budget for dissolved As in the North Atlantic that will allow the effect of P on As cycling to be quantified.**

Broader Impacts: This research will contribute directly to the emerging paradigm of co-limitation, but with a toxic orientation. Moreover, the measurements proposed here of As concentrations and speciation over much of the North Atlantic and its water masses directly contributes to two of the three overriding GEOTRACES goals:

1. **To determine global ocean distributions of selected trace elements and isotopes – including their concentration, chemical speciation and physical form – and to evaluate the sources, sinks, and internal cycling of these species to characterize more completely the physical, chemical and biological processes regulating their distributions.**
2. **To understand the processes involved in oceanic trace element cycles sufficiently well that the response of these cycles to global change can be predicted, and their impact on the carbon cycle and climate understood.**

At least one postdoctoral researcher and one undergraduate will be directly participating in this research. In addition, Cutter is a co-PI in the NSF-funded "Hall-Bonner Minority Doctoral Scholars in Ocean Sciences" initiative (http://www.hamptonu.edu/science/marine/hallbonner.htm) that is a collaborative program between Hampton University, Virginia Institute of Marine Sciences, and Old Dominion University for minority PhD students. The H-B Program is currently up for renewal, and if

funded Cutter will endeavor to get some of these students involved in GEOTRACES in general, and more specifically, this research.