

PROJECT SUMMARY

Criterion 1, Intellectual Merit

This proposal seeks funding to collect aerosol and rainfall samples on the GEOTRACES North Atlantic section cruise in 2010. Three high-volume aerosol samplers and two automated rain samplers have already been acquired using previous NSF funding. They are used to collect aerosols on acid-cleaned Whatman-41 (cellulosic) filters (for inorganic trace elements and isotopes – TEIs) and pre-combusted quartz microfiber (QMA) filters (for organic species, Hg, and nitrogen compounds). One sampler is equipped with a 5-stage Sierra-style slotted cascade impactor to collect size fractionated aerosols (from $>7 \mu\text{m}$ to $<0.49 \mu\text{m}$). With collaboration from researchers around the world, the 24-hour integrated aerosol samples, and event-based rain samples, will be analyzed for a large suite of TEIs. We will analyze all aerosol samples for ultra-pure water soluble, seawater soluble, and total (residual) TEIs. Rain samples will be analyzed, both filtered and unfiltered, to quantify the soluble and particulate TEI concentrations. Air mass back-trajectories for all sampling days will be modeled using the NOAA HySplit program. We also request some funding for the analysis of seawater samples from the towed-fish and GEOTRACES Trace Metal rosette samplers. Those samples, and the seawater aerosol solubility samples, will be analyzed in our lab for Mn, Fe, Co, Ni, Cu, Zn, Cd, and Pb using a shore-based column extraction method utilizing isotope dilution and high-resolution magnetic sector ICPMS.

The overall goal of the GEOTRACES program is to improve our understanding of the sources, distributions, and sinks of geochemically significant trace elements and their isotopes (TEIs) in the world's oceans. After several years of coordination and planning, and as we near the conclusion of the 2008 and 2009 intercalibration efforts, US GEOTRACES is ready to move forward with the North Atlantic Ocean Section in 2010. The importance of measuring trace element and isotope (TEI) concentrations and deposition to the oceans for aerosols and rainfall is described in the GEOTRACES Science Plan (2006). Aerosol and rainfall deposition can be a significant source of TEIs in the North Atlantic, and will be strongly affected by anthropogenic emissions from North America and Europe and dust emission from northern Africa ("Saharan dust"). Desert dust will be a significant source of Fe despite the relatively lower solubility compared to Fe in anthropogenic aerosols. Significant enrichment in surface waters of the North Atlantic from atmospheric deposition can be seen in the distributions of dissolved Al and Fe, as well as Mn and Co (two other important bioactive TEIs), while dissolved Pb is elevated throughout the upper ocean in the North Atlantic. Pb isotopes can be used to distinguish North American and European air masses, while Nd isotopes can be used to constrain the ages of aerosol source rocks. Atmospheric deposition of nitrate and ammonia may also be significant across the North Atlantic, and the isotopic N and O composition of nitrate can be used to evaluate anthropogenic source contributions. We recognize that atmospheric deposition has very strong seasonality, such that ship-board sampling cannot be expected to reflect the average annual aerosol concentration. However, the proposed cruise track and timing should enable us to chemically characterize relatively distinct samples of North American aerosols, European aerosols, and Saharan dust from the beginning, middle, and end of the cruise, respectively. The atmospheric deposition research will also compliment the water column TEI research, where TEIs with widely different residence times in the upper ocean (such as $\text{Mn} > \text{Al} > \text{Fe} = \text{Nd} > \text{Th}$) will be studied.

Criterion 2, Broader Impacts

Education and training of graduate students are essential components of this research. The PI regularly teaches undergraduate and graduate classes and incorporates the results of his fieldwork into lecture materials to motivate the next generation of Earth scientists. The researchers (PI and graduate student) will benefit from participation in large projects that will create multiple collaborations. Undergraduate FSU chemistry and/or biology majors (males, females, minorities) are involved in the research via annual requests for REU supplements. Our results will be presented at national/international scientific meetings, and published in peer-reviewed journals. The data will be submitted in a timely manner according to the requirements of NSF/OCE and the GEOTRACES Intercalibration program.