PROJECT SUMMARY

Intellectual Merit

Funding is requested for participation in the GEOTRACES North Atlantic Zonal Section for the purpose of collecting samples for Pb and Pb isotopes and for the analysis of these properties and for their interpretation. Pb is a reactive trace element with four stable isotopes whose ratios vary with a signal-to-noise level of

Pb in the present North Atlantic is dominated by anthropogenic lead, emitted into the atmosphere, carried on the surface of fine particles by the atmosphere and deposited into the sea surface, and then transported within the ocean by currents and by sinking biogenic particles. Indeed, the anthropogenic signal is so strong that no one has clearly identified "natural" lead in North Atlantic ocean waters. Because this "experiment" is time-dependent, with emissions rising from the mid-19th century to a peak ~1975 followed by a decrease to levels ~25% of their peak, and because different sources of lead have different isotopic ratios, it is possible to trace many aspects of Pb transport through the ocean. Previous data have demonstrated that the decrease in emissions due to the phasing out of leaded gasoline have resulted in a significant decrease of Pb in the upper 1000 m of the North Atlantic Ocean. Decadal- and century-scale changes in the Pb isotope ratio of sources allows us to determine transit times for Pb from the surface to the deep ocean. Existing data for the radioisotope ^{210}Pb further enhances our ability to constrain rates on a decadal scale. Because Pb shares many features of other Trace Elements and Isotopes (TEIs) – atmospheric deposition, biological uptake and abiotic "scavenging" – information derived from the study of Pb helps illuminate the behavior of other TEIs. Conversely, studying lead in the context of a detailed data set for other TEIs illuminates the behavior of Pb.

We will address the following questions in this research: How have the oceanic Pb and Pb isotope profiles evolved in the western and eastern subtropical Atlantic evolved since 1999? Are the North Atlantic Pb and Pb isotope distribution mostly consistent with advective transport or can we find evidence of exchange with sinking particles? Are Pb isotopes generally the same in the dissolved phase and suspended particulate matter? Is there evidence for exchange with the seafloor or nepheloid layers? Are significant Pb or Pb isotope signals from hydrothermal vents transported a significant distance beyond the source? How do upper and lower NADW differ in their Pb and Pb isotopic compostion, and how are these differences expressed laterally over the western boundary? Has the Pb and Pb isotopic signature of Mediterranean Outflow Water evolved with time since 1999? Can we model the evolving distribution of Pb in the North Atlantic Ocean?

In this effort we will collect approximately 600 2-liter samples, all of which will be analyzed for lead, and ~1/3 of which will be analyzed for Pb isotopes.

Broader Impacts

It is widely agreed that the ocean biogeochemical research community needs a global picture of the key and ancillary GEOTRACES properties; the major impact of this project will be in its service to that community. This service will enable the development of better ocean biogeochemical models so that we can assess the likely impact of future climate change and anthropogenic pollution, and provide a basis for understanding changes observed in past oceans. In particular, Pb studies on GEOTRACES will take advantage of the "Global Experiment" of Pb pollution to help constrain processes that move metals through the ocean. The development of teams that understand the proper sampling and measurement techniques, many of whom will be graduate students and postdocs, will supply the community with a pool of skills necessary to achieve the goals of the next generation of ocean research programs.