

Project Summary

Intellectual Merit

The goal of GEOTRACES is to identify processes and quantify fluxes that control the distribution of trace elements and isotopes (TEIs) in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions. To this end we propose measurement of a suite of uranium/thorium series radionuclides on the first US GEOTRACES cruise in the North Atlantic that are well suited to study the sources and sinks of TEIs on time and space scales that are required to interpret lateral and vertical TEI distributions in this basin. Our measurements include the radium “quartet” (^{224}Ra , ^{223}Ra , ^{228}Ra and ^{226}Ra) to quantify horizontal and vertical transport of dissolved TEIs, as well as the shorter lived thorium isotopes, ^{234}Th and ^{228}Th , used to quantify particle scavenging, vertical fluxes and remineralization rates of bioactive and/or particle reactive TEIs.

A wide range of processes will be encountered along the proposed GEOTRACES N. Atlantic leg, and the short-lived U-Th series isotopes proposed herein will play a key role in the interpretation of observed TEI distributions. The utility of these tracers can be used to address two main key processes: boundary inputs of TEIs and TEI particle cycling including scavenging, vertical export and remineralization. Within boundary inputs, we intend to quantify TEI fluxes to the Atlantic Basin due to submarine groundwater discharge, cross-shelf mixing both surface and subsurface at the shelf break, and diffusion and vertical transport across the thermocline and benthic boundary layer (^{228}Ra). In terms of particle cycling, we can determine rate constants for transfer of reactive TEIs between dissolved and particulate phases, vertical export on sinking particles (upper ocean and benthic nepheloid layer), and remineralization of particle-bound TEIs in the ocean “twilight zone”.

Our proposed sampling plan includes: (1) detailed underway sampling of short-lived Ra isotopes (^{224}Ra , ^{223}Ra) at the western and eastern margins to quantify terrestrial inputs and off-shelf TEI transport; (2) upper ocean (0-1000 m) ^{234}Th and ^{228}Th profiling to capture export and remineralization patterns, (3) full water column ^{228}Ra and ^{226}Ra profiles to derive (a) submarine groundwater discharge, (b) midwater transport of TEIs from shelf/slope-basin interactions and (c) diapycnal mixing rates across the thermocline and benthic boundary layer, and (4) near bottom sampling to ascertain TEI sources and sinks associated with abyssal plain sediments and hydrothermal systems.

Broader Impacts

The PIs have actively involved undergraduate and high school students in their prior NSF-funded projects, with two having won awards at ASLO meetings in the past five years. This trend will continue with this effort through the participation of an undergraduate intern. In the past, WHOI PIs have mostly interacted with undergraduate students through the NSF-funded REU program. Recently, the WHOI Academic Programs Office has begun on a trial basis a semester-long internship program. We will participate in this exercise by hosting a student during the Fall Semester 2010. The anticipated timing of the GEOTRACES line is ideal for the student's participation in the cruise as well as a several weeks back in the laboratory analyzing samples.