Collaborative Research: U.S. GEOTRACES North Atlantic Section: Analysis of ^{230}Th, ^{232}Th and ^{231}Pa

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Project Summary

This proposal requests support for four collaborating labs (Woods Hole Oceanographic Institution, University of Rhode Island, University of Minnesota and Lamont-Doherty) to undertake measurements on the US GEOTRACES North Atlantic section of the dissolved and particulate concentrations of ^{230}Th and ^{231}Pa, two isotopes designated as "key" or critical to the success of the GEOTRACES program. In addition, we propose to measure ^{232}Th concentrations and to provide supporting analyses of particle composition. The proposed work fulfills scientific objectives defined in the U.S. GEOTRACES North Atlantic Implementation Plan.

All PIs will collaborate in interpreting the results, with leadership in pursuit of specific scientific objectives divided as follows:

1) Moran and Edwards will take the lead in interpreting the impact of overturning circulation and lateral mixing on the distributions of dissolved ^{230}Th and ^{231}Pa.

2) Anderson will lead the interpretation of chemical scavenging (removal) of, and fractionation between, Th and Pa, focusing on the role of particle composition and particle concentration.

3) Robinson will lead the interpretation of the distributions of dissolved and particulate ^{232}Th. ^{232}Th was identified in GEOTRACES North Atlantic Implementation as a potential tracer for mineral aerosol (dust) sources of TEIs, but it has never been investigated systematically in this context.

4) Mixing, fractionation during scavenging and particle flux all affect the interpretation of sedimentary ^{231}Pa/^{230}Th ratios as a tracer of boundary scavenging. The PIs will work together on this topic.

Intellectual Merit The proposed new ^{231}Pa, ^{230}Th and ^{232}Th data will lead to improved models of material exchange between the boundaries and interior Atlantic on a basin-wide scale. This project will permit us to test hypotheses regarding the relative importance of regional variations in circulation, particle composition, and particle flux that influence the redistribution of particle-associated elements, including carbon, trace metals and contaminants, between the continental shelf/slope regions and interior basins in the Atlantic. Furthermore, obtaining new water column ^{231}Pa and ^{230}Th data will allow us to test a key hypothesis: that ^{230}Th is largely removed within the North Atlantic, whereas nearly half of the ^{231}Pa produced in-situ is exported with North Atlantic Deep Water. Sedimentary ^{231}Pa/^{230}Th ratios have become the principal proxy used to evaluate past changes in Atlantic Meridional Overturning Circulation (AMOC). Completing the proposed work will characterize the importance of particle composition for ^{231}Pa/^{230}Th fractionation, and thereby constrain the potential bias in using ^{231}Pa/^{230}Th as a kinematic proxy for AMOC. These results, in turn, will lead to a more reliable assessment of the role of AMOC variability in past climate change.

Broader Impacts The hypotheses and objectives outlined in this proposal are central to the International GEOTRACES program, whose focus is on the global-ocean distribution of trace elements and isotopes (TEI's) in seawater. ^{231}Pa and ^{230}Th are designated key parameters in

the GEOTRACES Science Plan as their measurement on all sections is deemed to be critical to the success of this international ocean science program. The proposed research will provide new opportunities for graduate student (LDEO) and post doc (UMinn) research experience, enhance ocean science interactions between several US institutions (LDEO, URI, UMinn, WHOI), foster collaboration with international GEOTRACES colleagues, and contribute to existing science education programs designed for teachers and the public.