

PROJECT SUMMARY

Collaborative Research: US GEOTRACES North Atlantic Section – Nd isotope distribution: sources, sinks, and internal cycling

Intellectual Merit: Neodymium (Nd) isotopes are a versatile tracer in the oceans and paleoceans. Predominantly supplied to the oceans by continental weathering, they reveal source and transport pathways for water masses and particles and can be used to calculate mass flux between reservoirs representing trace element sources and sinks (e.g., sediment-seawater exchange). As such, they are also instrumental in tracing the origin of other trace elements and isotopes (TEIs) that play critical roles as biolimiting nutrients, tracers and contaminants in the ocean. For these reasons Nd isotopes have been targeted as part of the suite of key TEIs that will be analyzed in every GEOTRACES section. However, there is a dearth of seawater Nd isotope data and hence a gap in the knowledge of the Nd isotope distribution in the ocean and the processes controlling it. As a result there is a lack of consensus on the degree that Nd should be considered as a conservative tracer or an open system, and the answer is fundamental for determining how the Nd tracer should be applied. Until the sources, sinks, and internal cycling of Nd in the oceans are better constrained, Nd isotopes will not realize their full potential as a tracer of provenance and process in the oceans. This shortcoming also limits the use of Nd isotopes as water mass tracer and hence their use to test climate models against past changes, which in turn reduces our ability to project future changes.

The proposed collaborative study is designed to conduct a rigorous survey of the distribution of dissolved Nd isotopes and concentrations along the US GEOTRACES North Atlantic zonal section. Some Sr isotopes and REE patterns are also planned. Four key objectives will be addressed: 1) identify regions where a 'Nd isotope anomaly' relative to the value expected from water mass distributions, which would indicate and quantify Nd addition/exchange in the water column, 2) compare Nd isotopes and concentrations in seawater to particulates, along with radium isotopes, to assess the potential for Nd addition/exchange to water masses via the processes of boundary exchange and submarine groundwater discharge, 3) compare Nd isotopes and concentrations in aerosol, particulate, and seawater samples at open ocean and near-margin stations to constrain particulate and dust provenance, the process of reversible scavenging, and 4) compare REE patterns and Nd isotopes at stations inside and outside of the low oxygen zone near Africa to evaluate the impact of redox conditions on the seawater Ce anomaly and REE release from sediment.

Broader Impacts: The resulting data from this study will contribute to the global GEOTRACES effort aimed at characterizing and understanding the distributions, sources, sinks and internal cycling of TEIs in the ocean. They will add to an improved understanding of biogeochemical cycles in the ocean and reinforce the application of Nd as tracer for present and past changes in ocean circulation and mixing. The proposed study will therefore yield eminent results that will be of high interest to a wide range of ocean and climate scientists as well as policy makers that are urged to understand and project global warming and its impact on the ocean.

Graduate student and postdoc training is a significant part of the proposed project. It will therefore directly integrate research and education. The proposed study will further offer ample opportunities for small and self-contained research projects for undergraduate students, that we plan to engage in the various aspects of the project. This will provide an opportunity for the students to gain profound hands-on insight into analytical and scientific work. Moreover, each PI is committed to outreach activities at his/her institution and/or community.

The PIs will comply with the International GEOTRACES data policy and submit all resulting data to the Biological and Chemical Oceanography Data Management Office (BCO-DMO) as soon as they become available. The data will therefore be immediately accessible to all PIs of the US GEOTRACES North Atlantic zonal section cruise, and when finalized, will be distributed internationally and made available to the public. Of course, the data will further be communicated to the scientific community through publications in peer-reviewed journals.