Preliminary Pb and Pb isotopes from the US GEOTRACES North Atlantic Transect

ABIGAIL E. NOBLE[1*], YOLANDA ECHEGOYEN-SANZ[2], AND ED BOYLE[3]

[1]Massachusetts Institute of Technology, Cambridge, USA anoble@mit.edu (* presenting author)
[2]Universidad de Zaragoza, Zaragoza, Spain, yolandaechegoyen@gmail.com
[3] Massachusetts Institute of Technology, Cambridge, USA, eaboyle@mit.edu

This study presents preliminary Pb and Pb isotope data from the US GEOTRACES North Atlantic Transect which was sampled during two cruises that took place during the Fall of 2011 and 2012. Almost all of the Pb found in the modern ocean is derived from anthropogenic sources, and the North Atlantic has received significant Pb inputs from the United States and Europe due to emissions from leaded gasoline and high temperature industrial processes. During the past three decades, Pb fluxes to the North Atlantic have decreased following the phasing out of leaded gasoline in the United States and Europe. Following the concentrations and isotope ratios of Pb in this basin over time reveals the temporal evolution of Pb in this highly- affected basin. This cruise included a re-occupation of the Bermuda Atlantic Time Series station (BATS) that was one of 8 occupations since 1979 for Pb and one of 6 for Pb isotopes at approximately 5-year intervals,. Two stations in the Eastern North Atlantic were previously occupied in 1989, 1999, and the data from this expedition provide some comparison of the temporal evolution of Pb in this region. The Pb isotope signatures reflect the relative importance of inputs from the United States and Europe as leaded gasoline was phased out faster in the United States relative to Europe. This is observed in a surface trend towards slightly lower ^{206}Pb / ^{207}Pb ratios in the last decade. Pb concentrations decrease with time in the upper water column (<2000m) with higher concentrations observed in mid-latitude northern stations decreasing southward at the eastern end of the basin. Concentrations and isotopes converge in deep waters with longer residence times. Further results from the section will be presented as data become available.

Isotopic Variability of the Ninetyeast Ridge – Implications for its Mantle Sources

INÊS G. NOBRE SILVA[1]*, DOMINIQUE WEIS[1], JAMES S. SCOATES[1], MALCOLM S. PRINGLE[2] AND FRED A. FREY[2]

[1]Pacific Centre for Isotopic and Geochemical Research, Earth & Ocean Sciences, Univ. of British Columbia, Vancouver, BC V6T 1Z4, Canada, inobre@eos.ubc.ca (* presenting author)
[2]EAPS, MIT, Cambridge MA 02139 USA.

The ~5000 km long north-south oriented Ninetyeast Ridge in the eastern Indian Ocean Basin represents the age progressive, ~80 to ~40 Ma products of the 120 Ma old Kerguelen mantle plume. Basaltic basement samples recovered during DSDP and ODP drilling campaigns are however scarce and debate concerning the nature and number of components in the mantle source of the Ninetyeast Ridge persists. Dredging during a National Science Foundation-funded 2007 cruise recovered basaltic basement from 21 locations along ~3200 km of the ridge. New high-precision isotopic compositions by MC-ICP-MS (Pb, Hf, and Nd) and TIMS (Sr) were obtained on 59 basaltic samples from 21 dredges. Sample choice was based on the lowest degree of alteration (lowest LOI), high Mg#, and variable trace element ratios (e.g., Zr/Nb, Y/Nb, La/Sm). Altogether these samples cover a greater range of Pb-Sr-Nd-Hf isotopic compositions and wider within-site isotopic variability than that covered by the drilled samples recovered during ODP Leg 121, and are generally intermediate between those of the volcanic products of the Kerguelen and Amsterdam-St. Paul mantle plumes. This attests to a compositionally heterogeneous mantle source, and at least three, possibly four, distinct source components with relatively enriched and depleted signatures are required to explain the observed isotopic variability along the Ninetyeast Ridge. Mixing with shallow level Indian MORB does not account for the lower $^{87}Sr/^{86}Sr$ and higher Nd and Hf isotopic ratios of basalts from some of the dredges (i.e., $^{87}Sr/^{86}Sr$ 0.70369-0.70428, $^{143}Nd/^{144}Nd$ > 0.51300 and $^{176}Hf/^{177}Hf$ > 0.28322 for 5 samples from 2 dredges). These depleted signatures are instead consistent with the presence of a previously depleted, garnet-enriched component intrinsic to their deep mantle source that had been identified based on incompatible trace element abundances alone. Together with other Indian Ocean island basalts of typical EM-1-like compositions, the Pb-Hf-Sr-Nd isotopic compositions of the Ninetyeast Ridge basalts are consistent with provenance from a deep mantle source that has incorporated a mixture of recycled sediments and lower continental crust together with altered oceanic crust. This supports a deep origin for the EM-1-like Dupal signatures encountered in ocean island basalts.