Quantifying non-conservative behavior of the rare earth elements in the South Atlantic

PETER M. SCOTT[1,2], XINYUAN ZHENG[2], YVES PLANCHEREL[2], DEBORAH J. HEMBURY, MATTHEW POINTING, MALCOLM S. WOODWARD[3] AND GIDEON M. HENDERSON[2]

[1]Department of Earth Sciences, University of Cambridge, Downing Street, CB2 3EQ, UK pms65@cam.ac.uk
[2]Department of Earth Sciences, University of Oxford, South Parks Road, OX1 3AN, UK
[3]Plymouth Marine Laboratory, Prospect Place, The Hoe, Plymouth, UK.

The rare earth elements (REE) have potential as tracers of process and provenance in the ocean. They show similar characteristics to micronutrients but are not biologically utilised, so offer insight into the abiogenic cycling of these elements. Patterns within the relative concentration of the REE can fingerprint sources of metals to the oceans. Although REEs can now be routinely measured on small volumes of water, their potential has not been widely explored, largely because of a lack of quantitative understanding of their chemical cycling in the ocean.

In this study we use a deconvolution approach (OMP) to assess the extent of non-conservative behaviour of the REEs and to quantify their removal/addition. We pursue this approach using full-water-column dissolved-REE measurements from two UK-GEOTRACES cruises (JC068 and D357). This data provides a zonal section across the South Atlantic at 40°S, sampling all the major deep-water masses of the Atlantic.

We separate the extent to which the distribution of REE concentrations is due to preformed versus non-conservative behaviour. Monte-Carlo simulations indicate the level of uncertainty in these fractions, and their spatial patterns. Because scavenging intensity is relatively stronger for light REE (LREE) than for heavy REE (HREE), the preformed contribution is relatively greater for the HREE than for LREE. The distribution of the HREE is thus more closely associated with the hydrography than that of the LREE. Overall, roughly 80-90% of the REE concentration in the deep South Atlantic is preformed.

We also contrast the REE patterns of these new 40°S analyses with results from the CoFeMUG section (10°S), which allows investigation of changes in REE concentration along water mass flow paths.