Potential REE deposits along the Red Sea coast of Egypt

JAMES ROBERTS[1]* AND TAREK IBRAHIM[2]

[1]University of Pretoria, Pretoria, South Africa (*correspondence: james.roberts@up.ac.za)
[2]El Mansoura University, Cairo, Egypt, (elsahabi@yahoo.com)

In Egypt, exploration for heavy mineral deposits with their associated REE minerals has traditionally concentrated on the Mediterranean coast, and large garnetiferous heavy mineral sands have been identified at localities near Alexandria. However, the Red Sea coast is also an ideal environment for the formation of such deposits [1].The Red Sea Coast in the southernmost portion of Egypt has a long geological history of erosion and sediment transportation, and several alluvial deposits rich in economic heavy minerals have been identified in the coastal strip between Ras Banas and the border with Sudan. Accumulations of heavy minerals have been observed along Red Sea beaches at Ras Manazel, Khudaa, Shalateen, Wadi Diit, and along the coastal stretches between these locations. These deposits have formed not only by transport processes related to offshore currents in the Red Sea, but also by drainage networks operating in the Eastern Desert of Egypt. Satellite imagery of the drainage networks indicates that the granites of the Sudanese highlands are the source of the heavy minerals, with minor input from granites in the southern Egyptian highlands. Deposits inland from the current Red Sea coastline may have been formed before the opening of the Red Sea, and subsequent erosion and reworking through flash flooding and other catastrophic transport mechanisms has created more recent deposits along the current coastline. The deposits contain not only illmenite, rutile, magnetite, and garnet, but also large concentrations of radioactive minerals such as thorite, zircon and monazite. Preliminary studies have shown that some of the deposits are extremely rich in REE minerals (1-2% zircon by weight, 0.5% monazite by weight). The mineralogical composition of the deposits matches those of the granites in Sudan and southern Egypt, which have been explored extensively for uranium for the last 10 years. These deposits are thus a viable target for further exploration, with the intent to extract the REE minerals as well as the titaniferous ilmenite.

[1] Dawood, El-Naby (2007) *Mineralogical Magazine* **71**, 389–406. [2] Balestrieri, Abbate, Bigazzi , Ali (2009) *Earth Surf. Process. Landforms* **34**, 1279–1290.

Rare earth element association with foraminifera

N.L. ROBERTS[1]*, A.M. PIOTROWSKI[1], T.I. EGLINTON[2] AND M.L. LOMAS[3]

[1]Department of Earth Sciences, Downing Street, Cambridge, UK (*correspondence: nr297@cam.ac.uk)
[2]Geological Institute, Sonneggstasse 5, Zürich, Switzerland
[3]Bermuda Institute of Ocean Sciences, St George's, Bermuda

Nd isotopes are becoming widely used as a paleoceanographic tool for reconstructing past changes in water mass source [1]. Recent analysis of Nd isotopes on sedimentary planktonic foraminifera at the Bermuda Rise has proven to be a robust alternative to bulk sediment leachates, for reconstructing bottom water circulation [2]. However, in order to use foraminiferal Nd isotopes as a proxy for bottom water composition, we need to establish how, where and when rare earth elements (REEs) become associated with foraminifera.

We have measured REE concentrations and Nd isotopes on plankton tow and sediment trap foraminifera from the NW Atlantic, and compared with sedimentary foraminifera from marine cores in the same region. This allowed an evaluation of REE association with planktonic foraminifera at various stages of settling through the water column, and diagenesis near the sediment-water interface.

We find approximately 80% of plankton tow and sediment trap Nd is scavenged by particulate organic carbon and metal oxides. These phases are remineralised as particles fall through the water column allowing partial equilibration of foraminiferal Nd isotopes with ambient dissolved sea water. Once at the sediment-water interface, respiration of organic matter between foraminiferal primary calcite layers provides a reducing micro-environment within which diagenetic phases precipitate. These phases increase foraminiferal REE concentrations by ~10 fold through inorganic partitioning from bottom and pore waters.

Calculated partition coefficients suggest manganese carbonate is the predominant diagenetic host for REEs in planktonic foraminifera at the Bermuda Rise. This carbonate phase is difficult to remove during reductive cleaning, and is also resistant to down core REDOX changes, allowing reconstruction of robust bottom water Nd isotope records by measuring mixed planktonic foraminfera. Our findings have important implications for the use of planktonic foraminifera, both for surface and bottom water Nd isotope reconstruction.

[1] Piotrowski *et al*. (2005) *Science* **307**, 1933–1938. [2] Roberts *et al*. (2009) *Science* **327**, 75–78.