Origin and evolution of mantle heterogeneities

R.J. O'CONNELL[1]*, S.B. JACOBSEN[2] AND J.B. KELLOGG[3]

[1]Dept EPS, Harvard Univ, Cambridge MA 02138, USA (*correspondence: oconnell@geophysics.harvard.edu)
[2]Dept EPS, Harvard Univ, Cambridge MA 02138, USA (jacobsen@geochemistry.harvard.edu)
[3]J.B. Kellogg, Cate School, Carpinteria CA 93014, USA (jamesbkellogg@gmail.com)

Mantle heterogeneities arise from differentiation at mid-ocean ridges, subduction zones, and melting associated with hotspots. The residues from of these processes, as well as the recycled products, are circulated in the mantle where they evolve isotopically, mechanically and spatially. We model the evolution of heterogeneities in a statistical model in which the isotopic composition, length scale and depth of heterogeneities evolve. The change in length scale of heterogeneities depends on their effective viscosity (dehydrated melting residues are strong, recycled crust and unerupted plume material is weak) as well as their location in the mantle; deformation rates are high in the upper mantle, and lower in the higher viscosity deeper mantle. Melting residues and recycled material mixes to varying depths depending on the details of mantle flow, and heterogeneities may follow a range of paths. Melting at ridges samples the upper mantle on a time scale of ~300 My; processing the volume of the mantle takes ~10 times longer. This leads to a preferential processing of the upper mantle. Exchange with the deeper mantle is from deep subduction, and from plume conduits that rise from depth, as well as convective stirring. The rates of deformation in the mantle and of vertical transport of heterogeneities are estimated from geographically realistic mantle circulation models with plates.

A statistical assemblage of mantle heterogeneities is constructed based on these processes. The assemblage is sampled to produce MOR basalts and continental crust, which reflect averages of the component heterogeneities. The model successfully reproduces observations of Pb, Nd and Sr isotopes [1]. A feature of the model is a ubiquitous component similar in composition to FOZO or C that is made up of heterogeneities with small length scales (<15 km). This mixes with residues of melting (which are larger) to produce observed data arrays. The model allows the effects of heterogeneity properties, deformation rates, sampling rates and material transport rates to be assessed, and it captures the essentially statistical nature of mantle evolution and sampling.

[1] Kellogg *et al*. (2007) *EPSL* **262**, 328-342.

Productivity and sediment supply from the E-O boundary in Tanzania

A. O'HALLORAN, C.J. NICHOLAS AND R. GOODHUE

Department of Geology, Trinity College, University of Dublin, Dublin 2, Ireland

The Eocene-Oligocene transition was one of intense global climate change, including global cooling, ice-growth, attendant sea-level fall, and accelerated extinction occuring across the boundary.

We use nitrogen isotopes and mineralogical data gathered from Tanzanian passive margin, organic-rich, hemipelagic marine clays, cored by the Tanzania Drilling Project (Sites 12 and 17). Recent data [1] has recorded extinctions in the foraminifera and nannoplankton, as well as the two-step onset of the delta^{18}O maximum, recorded in deep-sea cores [2, 3] due to early Oligocene glaciation. We show that terrigenous input to the coastal zone increased in the early Oligocene (Fig. 1). This increase may be due to eustatic sea-level fall and/or to enhanced terrestrial run-off.

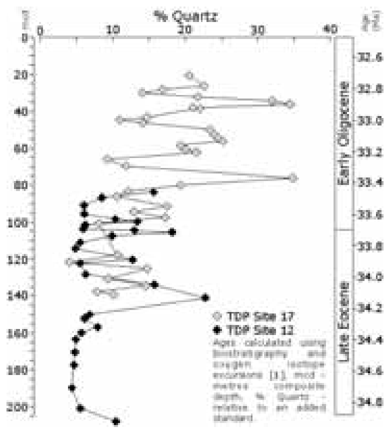

Figure 1: Quartz increases, indicating increased terrigenous input.

Our initial data suggest an increase in productivity during the early Oligocene. Further nitrogen isotopic data may ascertain whether this signals a boom in ocean ecology or if, in fact, it marks a recovery from the late-Eocene extinctions.

[1] Pearson *et al*. (2008) *Geology* **36,** 179-182. [2] Coxall *et al*. (2005) *Nature* **433,** 53-57. [3] Zachos *et al.* (1996) *Paleoceanography* **11,** 251-266.