Geophysical Research Abstracts, Vol. 7, 03052, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03052

The D" Zone and the origin of LIPS

T.H. Torsvik(1), K. Burke(2), B. Steinberger(1) and M.A. Smethurst(1)

(1) Center for Geodynamics, Geological Survey of Norway, Leiv Eirikssons vei 39, 7491 Trondheim, Norway

(2) Department of Geosciences, University of Houston, 312 S&R1 Houston Tx 77204-5007 and GL and DTM, Carnegie Institution of Washington, 5241 Broad Branch Road, Washington DC 20015, USA

Since its recognition as a distinct region more than 50 years ago the D" zone (the lowest 300-400 km of the mantle, Bullen 1949) has attracted interest as the basal unit of the convecting mantle. Wilson's (Wilson 1963) hypothesis that deep mantle plumes persisted for intervals of tens of millions of years and were fixed with respect to other deep mantle plumes, and Morgan's (Morgan 1971) suggestions that those same deep mantle plumes are derived from the core-mantle-boundary (CMB) served to greatly enhance interest in the D" zone. Current understanding of the geodynamic relations among long-lived hot spots, deep mantle plumes, the D" zone and plate tectonics therefore results from a huge amount of observational, theoretical and experimental work. The mantle exhibits a diverse range of structures within the D" zone: Fast velocities in tomographic models have been detected in regions where geodynamic modelling predicts the graveyard of ancient subduction (e.g. Lithgow-Bertelloni & Richards 1998) whereas slow velocity regions have been associated with hot(?) and rising mantle plumes.

The deep plume model is controversial and alternative models associate some or all hotspot volcanism with superficial processes, especially within-plate extensional stresses. We have recently shown, however, that Large Igneous Provinces (LIPs) of the past 200 My when restored to their position with respect to the spin-axis at the time of their eruption become concentrated radially above areas of the CMB occupied by the slower (hotter?) parts of the D" zone (Burke & Torsvik 2004). Here we: (1) confirm and refine our previous results, mainly by using improved plate-circuits and upgraded paleomagnetic data-sets, (2) compare and discuss differences between a new palaeomagnetic reference frame, a revised fixed hotspot frame, and a mantle frame where the motion of hotspots in a convecting mantle is considered (Steinberger et al. 2004), and (3) consider the implications of our findings for the understanding of the structure of the D” zone and the origin of LIPs, especially the significance of our recognition that nearly all of the LIPs of the past 200 My were emplaced vertically above the 1% slow δVs contour of the D” zone. We will also elaborate on the idea that CMB heterogeneities have remained fairly stationary relative to the spin-axis for the past 200 My with its implications that we can reconstruct the continents while keeping the present-day tomography of the deep mantle fixed. Using this approach and extending our analysis back to the Late Palaeozoic (250 Ma), we can demonstrate that Pangea overlies the heterogeneities near the CMB, observed today under parts of Africa, and that the Siberian Traps were underlain by a low shear wave velocity anomaly when erupted at $\sim$ 251 Ma.

Burke, K. & Torsvik, T.H. 2004: Derivation of large igneous provinces of the past 200 million years from long-term heterogeneities in the deep mantle. *Earth Planet Sci. Lett. 227, 531-538*.

Bullen, K.E 1949: Compressibility-pressure hypothesis and the Earth’s interior. *Month. Not. R. astr. Soc., Geophys. Suppl.* 5, 355-368.

Lithgow-Bertelloni, C. & Richards, M.A. 1998: The dynamics of cenozoic and mesozoic plate motions. *Rev. Geophys.* 36, 27-78.

Morgan, W. 1971: Convection plumes in the lower mantle. *Nature 230*, 42-43.

Steinberger, B., Sutherland, R. & O’Connell, R.J. 2004: Prediction of Emperor-Hawaii seamount locations from a revised model of plate motion and mantle flow. *Nature 430*, 167-173,

Wilson, J.T. 1963: Evidence from islands on the spreading of ocean floors. *Nature 197*, 536-538.