POSSIBLE ANALOGOUS LONG-TERM HISTORIES OF THE TERRESTRIAL GEOID AND THE MARTIAN AEROID. K. C. Burke[1], T. H. Torsvik[2], M. A. Smethurst[2], B. Steinberger[2], and S. C. Werner[2]
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Introduction: Terrestrial Large Igneous Province (LIP) eruption sites of the past 250 My are located close to the +14 m contour of the geoid except in regions affected by subduction over the past ~150 Ma. Those LIP eruption sites vertically overlie the margins of two Large Low Slow Velocity Provinces (LLSVPs) at the Core Mantle Boundary [1-3].

Our observations indicate that:

(1) The positively elevated residual geoid dominantly reflects the masses of the two iron-rich, Large Low Slow Velocity Provinces (LLSVPs) [4], each representing about 1% of the total mantle mass, that are antipodally disposed just above the Core/Mantle boundary and very close to the equator (Figs.1&2, Table 1).

	African LLSVP	**Pacific LLSVP**	**total**
Mass % of mantle	1.13%	0.79%	1.91%
Center of mass	15.6°S, 13.0ºE	11.0°S, 162.9°W	

Table 1: Size and location of LLSVPs [1]

(2) The residual geoid which is the part of the geoid unrelated to slabs of subducted lithosphere [5] has been fixed in its present position wrt the spin axis for all of 250 My, because LIPs of a full range of ages back to 250 Ma were erupted close to the + 14m geoid elevation.

We have argued [1] from the stability of the LLSVPs that those bodies have been chemically and mechanically isolated from material which has been involved in through-going mantle flow for the past 250 Ma and possibly for the whole of Earth history since the moon forming event. Long-term stability is consistent with the two LLSVPs having "centers of mass" in dynamically stable positions antipodally disposed very close to the equator (Fig.2, Table 1). An implication is that the residual geoid has possibly also been in its present position since recovery from the moon-forming event.

One possible scenario is that during recovery from the moon-forming impact most of the Earth's mantle mass soon came to occupy a volume described by the hydrostatic figure of the Earth. A remnant 2% of mantle mass was not accommodated in that way and it is that material which, also in a short time, came to form the two LLSVPs as isolated dense, iron-rich and stable bodies at the base of the mantle antipodally disposed very close to the equator.

Mars: The Martian aeroid resembles the terrestrial residual geoid in being dominated by two roughly antipodal elevated regions centered close to the equator (Fig.3). We speculate that, as on the Earth, that distribution may reflect the isolation early in Martian history of remnant masses not accommodated within the bulk mantle. Closer spacing of aeroid contours in the Tharsis region perhaps indicates that (in contrast to conditions on the Earth) part of the aeroid to be influenced by material lying near to the surface, possibly having been catastrophically transferred vertically from close to the Core/Mantle Boundary in Tharsis igneous events at some time relatively early in Martian history.

References: [6] Becker, T.W. and Boschi, L. (2002) *Geochem. Geophys. Geosys*., 3, 2001GC000168. [3] Burke, K. and Torsvik, T.H. (2004) *EPSL* 227, 531-538. [1] Burke, K et al. (2008) *EPSL* 265, 49-60, doi:10.1016/j.epsl.2007.09.042. [4] Garnero, E.J. et al. (2007) *Geol. Soc. Am. Spec. Pap.* 430. [5] Hager, B.H., (1984) *JGR* 89, 6003-6015. [2] Torsvik, T.H. et al. (2006) GJI 167, 1447-1460.

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Figure 1 Eruption sites of 20 LIPs of the past 150 Ma reconstructed in the global moving hotspot reference frame (pink circles) and hotspots (crosses) plotted on top of the geoid relative to hydrostatic equilibrium shape. Because subducted slabs in the mantle influence the shape of the geoid and partly obscure the dominant influence of the LLSVPs subduction locations over the past 110 Ma are shown. From [1].

Figure 2 Original LIP eruption sites [palaeomagnetic and global moving/fixed hotspot (for the Pacific)] and hotspots (crosses) on the SMEAN [6] shear wave velocity anomaly model for 2800 km. From [2].

Figure 3 Mars Laser Altimeter Topographic data (shaded relief) with a superimposed areoid (red is high, blue low; map provided by http://jules.unavco.org). Volcanic regions are marked.

Figure 1:

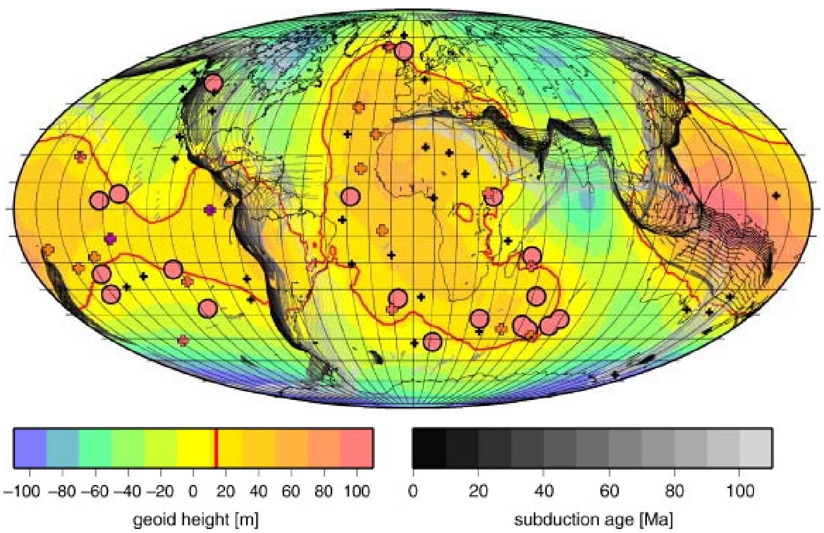

Figure 2:

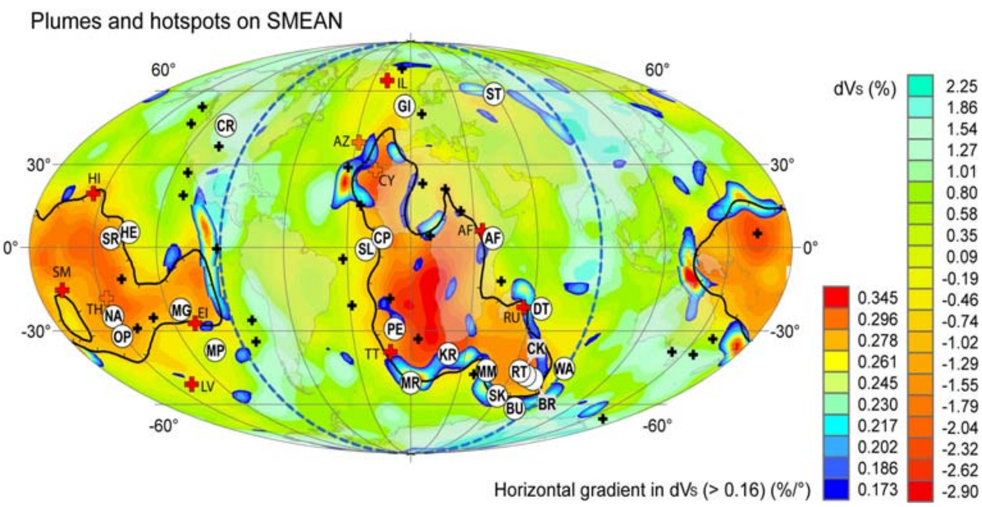

Figure 3: