



## **Plume Generation Zones On The Core Mantle Boundary: their origin and what they tell about how the Earth works - and how it has worked (Arthur Holmes Medal Lecture)**

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It is more than 50 years since Wilson (1963) suggested that a fixed plume of deep origin from the convecting mantle is generating the Hotspots of the Hawaiian chain on the overlying moving rigid lithosphere and nearly 45 years since Morgan (1972) followed by suggesting that the plumes which generate Hotspots rise only from the Core/Mantle Boundary (CMB). During the past  $\sim 15$  years testing has begun of a refinement of Morgan's idea based on the observation that Plumes responsible for Hotspots, Large Igneous Provinces (LIPs) and a significant fraction of other igneous rocks (including kimberlites) originate only in Plume Generation Zones (PGZs) at the edges on the CMB of one or other of TUZO and JASON the 2 antipodal, equatorial, Large Low Shear Wave Velocity Provinces (LLSVPs) of the deep mantle (Garnero et al. 2007) or from similar PGZs at the edges on the CMB of  $\sim 8$  smaller Low Shear Wave Velocity Provinces.

Today I will: (i) demonstrate using dated Hotspot, Large Igneous Province and Kimberlite occurrence history and paleomagnetic rotations (e.g. Torsvik et al. 2010, Burke et al. 2008) the stability throughout the past 0.55 Ga of the LLSVPs and LSVPs (ii) show from the history of the Earth and Mars how the LLSVPs and LSVPs are likely to have formed early in Earth history and to have been stable since  $\sim 4.4$  Ga (Burke et al. 2012) (iii) show, following an analogy suggested by Jack Whitehead of similarity to atmospheric fronts, why plumes are generated only from PGZs on the CMB at the margins of LLSVPs and LSVPs. (iv) show from results of recent seismological studies of Iceland, Jan Mayen, Hawaii, Yellowstone, the Afar and Ontong Java, that although plumes rise vertically in the deep mantle from the CMB their fate in the top  $\sim 1,000$  km of the mantle is proving to be varied and to depend largely, as Wilson suggested, on how they interact with the plates above them.

Properties of the Plume Generation Zones (PGZs) on the CMB and of the plumes that rise from them are proving useful in the interpretation of mantle behaviour (For example: TPW, Steinberger and Torsvik 2008) and represent an as yet not fully utilized opportunity for improving understanding of the solid Earth.

SUCCINCT REFERENCES: Burke et al. EPSL v.265, 2008, Burke et al. GRL v.39.2012, Garnero et al. GSA Mem.430, 2007, Morgan 1972 GSA Mem.132, Steinberger and Torsvik, Nature v.452, 2008, Torsvik et al Nature v.466, 2010, Wilson Can. J. Physics 1963.