Mantle thermo-chemical plumes, the DUPAL anomaly and a compositional anomaly at the Earth's core-mantle boundary

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The South Atlantic and Indian Oceans have a large number of hotspots and many impressive island chains and aseismic ridges, that are thought to be the tracks left by the passage of surface plates over major hotspots. For example, the Tristan hotspot is thought to have created the Walvis Ridge on the African plate and the Rio Grande Rise on the South American plate. The Kerguelen hotspot is proposed to have created the Ninetyeast Ridge on rapidly northward-moving Indian plate until at about 45 Ma when the Southeast Indian Ridge migrated over the hotspot, and then left trace entirely on the Antarctic plate. The Marion hotspot is suggested to have generated the widespread Cretaceous flood basalts on the Madagascar Island and subsequently created the submarine Madagascar Plateau. The Réunion hotspot is thought to have progressed along the Laccadive, Maldive, and Chagos Islands, and then after the Carlsberg Rise migrated over the hotspot, made the southern part of the Mascarene Plateau, the individual islands of Mauritius and the Réunion Island

Basalts from the ocean floor in the South Atlantic Ocean and the Indian Ocean have also been noted to have high $^{87}Sr/^{86}Sr$ ratios and anomalously high $^{207}Pb/^{204}Pb$ and $^{208}Pb/^{204}Pb$ ratios for a given $^{206}Pb/^{204}Pb$ ratio. This unique isotope signature and its geographical distribution were termed the "DUPAL anomaly". It has been suggested that the mantle entity for the DUPAL signature has probably existed for billions of years, as the positive values of isotope anomaly require high time-integrated values for the parent-daughter ratios in the source, and some isotopic ratios such as $^{207}Pb/^{204}Pb$ must date back to early in the Earth's history.

Analyses of the relative motion using hotspot tracks, age progressions and plate circuits, and of the absolute motion using plaeolatitude data indicate that, three major long-lived surface hotspots geographically within a very low velocity province (VLVP) at the base of the Earth's mantle, Tristan, Marion and Kerguelen, exhibit small relative motions (<9 mm/yr) in the past 80 Ma. The geochemical DUPAL anomaly maximum in the South Atlantic and Indian Oceans is also shown to geographically coincide with the VLVP boundary when the past plate motions are taken into account. These observations can be explained and related by invoking a mechanism that the VLVP, a compositional anomaly at the core-mantle boundary, serves as an anchor to thermo-chemical mantle plumes that give rise to these three long-lived and relatively-slowly moving surface hotspots with the DUPAL signature, and as source to the DUPAL anomaly in the South Atlantic and Indian Oceans.