Role of the Deep Mantle in Generating EM-I in Ocean Island Basalts

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Seismic studies indicate the presence of two large-low-shear-velocity-provinces (LLSVP) in the deep mantle [1]. When projected to the core-mantle boundary (CMB), Kerguelen and Tristan (Atlantic Ocean) are located on the eastern and western edges, respectively, of the tall steep-sided LLSVP African anomaly. The other two islands with enriched mantle "EM-I" signatures, Hawaii and Pitcairn, overlie the edges of the Pacific LLSVP. At Hawaii, the ultra-low velocity zone at the CMB is proposed to be the repository for enriched components in the mantle that are brought to the surface by strong mantle plumes [2]. For Kerguelen, new high-precision Pb-Sr-Nd-Hf isotopic compositions reveal that the archipelago flood basalts were derived from melting of an enriched component (=EM-I) in the plume source without trace of continental contamination. The enriched component dominates the chemistry of the alkalic basalts (25-24 Ma), whereas the older (28-26 Ma) tholeiitic-transitional basalts contain a higher proportion of a depleted-Southeast Indian Ridge component when the plume was close to the ridge. In binary isotope plots, Kerguelen compositions form sub-parallel trends that are distinctly more enriched than those from Hawaii. Kerguelen and Tristan carry the strongest enriched signature (DUPAL anomaly), whereas Pitcairn and Hawaii have a distinct, slightly less pronounced enriched signature. These differences indicate that some of the material constituting the LLSVP at the base of the mantle is distinct in the African and Pacific anomalies. The ambient deep mantle is also different beneath the Indian Ocean than the Pacific Ocean where it is sampled by volcanism on the Kea side of the trend in Hawaii [4]. In Hawaii, the EM-I signature has been traced back for at least 5 Ma and may be present as early as 45 Ma [3]. In Kerguelen, it can be traced back until 34 Ma on the archipelago and Northern Kerguelen Plateau, and until 82 Ma along the Ninetyeast Ridge [5]. These isotopic signals indicate that LLSVP are long-lived features of the deep mantle with the African anomaly present for the past ~100 million years.

[1] Ritsema *et al* (1999) *Science* **286**, 1925-8. [2] Weis *et al* (2011) *Nature Geosci*. **4**, 831-8. [3] Harrison *et al* (2014) *this meeting*. [4] Nobre Silva *et al* (2013) *G-Cubed* **14**, 659-76. [5] Nobre Silva *et al* (2013) *J. Pet*. **54**, 1177-1210.