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The Deep Mantle and Ocean Island Basalts: Views from Two Major Mantle EM-I Plumes – Kerguelen and Hawai'i

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Fred Frey was a pioneer in the study of ocean island basalts and the unique opportunity they represent for geochemists to study the Earth's deep mantle. The Kerguelen mantle plume has been active for >115 Myr, producing a very large volume of volcanic products, and has the longest associated linear hotspot track. The Hawaiian mantle plume has been active for >85 Myr and, today, it has the highest magma production of all OIB settings. Kerguelen has erupted basalts in various tectonic settings, from continental break-up in the early stages, to ridge-centered at ~40-35 Ma, and to oceanic intraplate environment ever since, in a setting comparable to Hawai'i. When projected to the core-mantle boundary (CMB), Kerguelen is located at the eastern edge of the African LLSVP and Hawai'i, on the northwestern edge of the Pacific LLSVP. In isotope plots, Kerguelen and Tristan define sub-parallel trends to those of Hawai'i and Pitcairn, but with more radiogenic Sr isotopic ratios (towards the EM-I component). The “enriched” Kerguelen component dominates the chemistry of the younger mildly alkalic basalts (25-24 Ma) and a depleted Southeast Indian Ridge component is present in older (28-26 Ma) tholeiitic-transitional basalts when the hotspot was located closer to the ridge. This “enriched” Kerguelen end-member is present in all magmatic products resulting from the activity of the plume, including Broken Ridge and Ninetyeast Ridge, in proportions that correlate directly to proximity to continental crust for the Cretaceous Kerguelen Plateau or to the SEIR at 40 Ma. When compared to Hawai'i, the isotopic variations of the Kerguelen Archipelago (<28 Ma) cover a similar range and do not show evidence of continental contamination. The “enriched” Kerguelen signature is linked to the African LLSVP at the CMB, as the enriched Loa component on Hawai'i is linked to the Pacific LLSVP. The compositions of the African and Pacific LLSVPs are different. These seismological anomalies above the CMB are long-lived features in the deep mantle that represent the repositories of recycled material, potentially older under Africa. In this keynote, some of Fred Frey's contributions to understand these two fascinating EM-I mantle plumes will also be reviewed.