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Hafnium Isotopic Variations in East Atlantic Intraplate Volcanism

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Based on age determinations, plate tectonic reconstructions and systematically different Pb and Nd isotope ratios, two individual hotspot tracks (Madeira and Canary track) are proposed to explain the broad belt of intraplate volcanism in the East Atlantic between 25ºN and 36ºN (e.g., Geldmacher et al., 2005, EPSL 237). This study presents, for the first time, 176Hf/177Hf ratios from seamounts and islands of both provinces, encompassing the full range of different evolutionary stages and isotopic endmembers. The majority of samples have mafic, mainly basaltic compositions with Mg-numbers within or near the range of magmas in equilibrium with mantle olivine (68-75).

In comparison to published Nd isotope variations (6 epsilon Nd units), 176Hf/177Hf ratios span a much larger range (14 epsilon Hf units). Samples from the Madeira archipelago have the most radiogenic compositions (176Hf/177Hfm= 0.283132-0.283335), widely overlapping the field for central Atlantic N-MORB. They form a relatively narrow, elongated trend (stretching over >6 epsilon Hf units) between a radiogenic MORB-like end-member and a composition located on the Nd-Hf mantle array. Although samples of Seine and Unicorn seamounts, attributed to the Madeira hotspot track, show less radiogenic Hf and Nd isotope ratios than Madeira, their isotopic compositions lie along an extension of the Madeira trend in plots of Hf versus Sr, Nd, Pb isotopes. In contrast, all samples from the Canary hotspot track plot below the mantle array (176Hf/177Hfm = 0.282943-0.283067) and, despite being from a larger geographic area, form a much denser cluster with less compositional variation (4 epsilon Hf units). The cluster largely overlaps the composition of the proposed common mantle endmember “C” (Hanan and Graham, 1996, Science 272) but spans a space between “C”, a more depleted composition and a HIMU-type endmember. The new Hf isotope ratios confirm the existence of at least two geochemically distinct volcanic provinces (Canary and Madeira) in the East Atlantic as previously proposed. Their different isotopic composition is best explained by different recycling ages of their respective enriched mantle source endmembers, which are believed to represent subducted oceanic lithosphere that is preserved in the mantle.