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Sao Miguel, Revisited: New Perspectives on the Mantle Source and Melting Processes beneath the Azores

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It has long been recognised that the island of Sao Miguel, Azores shows extremely large isotopic variability over a length scale of some 40 km (e.g. Hawkesworth et al, 1979). We have re-examined these variations by obtaining Hf, high precision Pb and U-Th isotopic data to examine further a suite of samples that span the entire range of compositions (e.g. ε_{Nd} 5.2-0.9). These new data give rise to some striking observations that place important constraints on the source and melting processes occurring beneath Sao Miguel. The arrays of all plots of isotopic systems are remarkably linear. The linearity is most plausibly explained by mixing of melts (or sources) with a highly restricted range of compositions (e.g. two end-members only) which have very similar key elemental ratios (e.g. Pb/Hf, Hf/Nd). The latter constraint strongly argues against the enriched compositions resulting from a recycled continental component. This is further substantiated by the slope of the lavas on a Nd vs Hf isotope array. The enriched end-member of Sao Miguel plots on the opposite side of the mantle array from the field of pelagic sediments and manganese nodules (Blichert-Toft et al., 1999), with a highly unusual composition of sub-chondritic Hf at slightly super-chondritic Nd. The apparent absence of recycled crustal material adds further interest to the high Th/U (~4.1) and steep trend of the lavas in $^{207}Pb/^{204}Pb$ vs $^{206}Pb/^{204}Pb$ space away from the Northern Hemisphere reference line. The latter implies ancient U/Pb enrichment in the mantle, but the Th/U, like the Nd and Hf isotopic compositions, are strikingly close to chondritic values. In the absence of continental additions, this suggests limited modification of the Sao Miguel enriched component through earth history. The effectively zero-aged lavas show modest ($^{230}Th/^{238}U$) excesses of 12-15%. The very small variations in the degree of disequilibrium are not related to the long-lived isotopic variations, and in some cases can clearly be attributed to crustal contamination processes. Thus despite the very significantly different degrees of enrichment, in terms of Nd isotope ratio for example, the melting process appears fairly uniform beneath the island. The well dated lavas span a ~20 ka time period, over which there are no obvious deviations from the well defined linear long-lived radiogenic isotope arrays. This holds for even for elements with a significant contrast in incompatibility (e.g. Nd relative to Hf). Yet differential element transport rates must be occurring as witnessed by Th excesses. The combination of these observations suggests a near steady state melting regime has operated beneath Sao Miguel over the last ~20 ka, which is most easily reconciled with a large dimension (at least 2 km deep) for the enriched mantle source.

Hawkesworth CJ, Norry MJ, Roddick JC & Vollmer R, *Nature*, **280**, 28-31, (1979).

Blichert-Toft J, Frey FA & Albarède F, *Science*, **285**, 879-882, (1999).