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Cerium -Hf-Nd-Sr-Pb isotope constraints on the Azores source composition and plume-rift interaction.

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We present $^{138}Ce/^{136}Ce$ isotope data on previously well characterized [1] subaerial and submarine lavas from the Central Azores islands of São Jorge, Pico, Faial, Terceira and Graciosa, and for the João de Castro (JdC) seamount. All these eruptive centers are located on or close to the ultraslow E-W striking Terceira Rift, which straddles the Azores platform perpendicular to the Mid-Atlantic ridge.

Each eruptive center forms an individual binary mixing trend in multi-isotope space, between a local enriched component and a common depleted Azores component ($\varepsilon_{Nd} \sim 6$), with no mixing between the enriched components [1]. The proportion of the enriched component in a given eruptive center typically decreases from east to west. This is consistent with the progressive exhaustion of fertile components through melting during westward asthenospheric flow along the Terceira Rift, as the asthenosphere/lithosphere boundary shallows from east to west towards the Mid-Atlantic Ridge. This feature allows sampling the heterogeneity of the Azores mantle below the Terceira Rift with a horizontal resolution of ~70 km, and to constrain the isotope composition of individual source components in the mantle plume.

The existing global MORB – OIB data form well-defined linear arrays in $\varepsilon_{Ce} - \varepsilon_{Nd}$ and $\varepsilon_{Ce} - \varepsilon_{Hf}$ space [2] (slopes: -8 and -15). The Central Azores data extend from ε_{Ce} = -1.00 to -0.25 and overlap with other OIB data. JdC seamount, on the other hand, shows a shallower trend (slopes: -2 and -3) at an angle to the global MORB – OIB arrays. The most Ce-isotope depleted JdC lava has ε_{Ce} = -1.5, similar to MORBs with the lowest Ce isotopes values [2], but with ε_{Nd}(=4) and ε_{Hf} (=2) that are considerably lower than MORB. These compositions are consistent with recycling and aging of depleted MORB (D-MORB) type oceanic crust with low La/Ce that approaches that of the DMM source as both La and Ce are highly incompatible during melting. In contrast, Sm/Nd and Lu/Hf ratios are more fractionated during MORB melting than La/Ce, causing recycled D-MORB to deviate from DMM over time.

In contrast, the isotopically enriched Hf-Nd-Sr-Pb isotope compositions of the eastern island of São Miguel (Eastern Azores) are consistent with recycled E-MORB. The combined JdC and São Miguel data can be explained by magmatic sampling of recycled 2.5 – 3.0 Ga oceanic crust with variable composition, from D-MORB to E-MORB [1]. Given sufficiently long storage in the mantle (> 2 Ga), the variability of parent-daughter ratios in global MORB lavas (e.g. La/Ce = 0.25 – 0.52 [3]) is large enough to generate a range of isotope compositions comparable (albeit not identical) to the global OIB dataset. Overall, the new Ce-Nd-Hf isotope data of the Azores lavas confirm that cerium isotope ratios are a sensitive tracer of recycled oceanic crust and the type and proportion of depleted mantle involved in MORB-OIB generation.

[1] Béguelin et al. (2017) *Geochimica et Cosmochimica Acta*, 218, 132-152.

[2] Willig and Stracke (2019) *EPSL*, in press.

[3] Gale et al. (2013) G^3, 14(3), 489-518.