Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35081

Calcium isotope variability in São Miguel lavas (Azores) and implications for mantle source heterogeneity and the deep carbon cycle

GRANT A. DEKOEKKOEK[1], MICHAEL A. ANTONELLI[1], CHRIS YAKYMCHUK[2], ALEKSANDR E. MARFIN[1] AND PROF. JAMES M.D. DAY[3]

[1]University of Houston
[2]University of Waterloo
[3]University of California at San Diego, Scripps Institution of Oceanography

Ocean Island Basalts provide a window into the heterogeneity of the deep Earth. Radiogenic isotopes play key roles in identifying mantle sources, which may include recycled oceanic crust, metasomatized mantle, and recycled sediments (± marine carbonates). Debate continues, however, regarding the nature of subducted materials. Calcium is linked to the carbon cycle through the precipitation of carbonate minerals (i.e., $CaCO_3$) in the oceans. Phanerozoic carbonates have average $\delta^{44}Ca_{BSE}$ (-0.35‰) [1] that are distinguishable from the mantle (≈ 0‰) and MORB (~ -0.10‰). Calcium isotopes may therefore be used to understand the influence of carbonates on the deep carbon cycle. Identifying the true $\delta^{44}Ca$ of mantle sources, however, is complicated by process-based effects (e.g., partial melting, magmatic differentiation) that obfuscate the original $\delta^{44}Ca$ signatures.

The Azores mantle source exhibits distinct heterogeneity in Sr-Nd-Hf-Pb isotope space, attributed to recycled oceanic crust [2] and/or metasomatism by basaltic melts [3]. Calcium isotopes have been measured in three Azores samples [4]. These samples have low $\delta^{44}Ca_{BSE}$ values (-0.24 to -0.20‰) that inversely correlate with Th/Yb (Fig. 1) and Na_2O+K_2O, but not with $^{87}Sr/^{86}Sr$, consistent with a partial-melting control. Previous work suggests that these compositions still require a low-$\delta^{44}Ca$ mantle source ≈ MORB [4], but did not analyze the full range of São Miguel compositions (e.g., Th/Yb values up to 3.2, $^{87}Sr/^{86}Sr$ up to 0.7056, $^{206}Pb/^{204}Pb$ up to 20.1, and $^{143}Nd/^{144}Nd$ down to 0.51267 [5]). We present $\delta^{44}Ca$ data for twelve additional samples that represent the compositional diversity observed on São Miguel and evaluate whether $\delta^{44}Ca$ variability in the Azores reflects magmatic processes and/or mantle source heterogeneity. Calcium isotope data will be discussed alongside major/trace element data and location-specific phase equilibrium models (used to correct for isotopic fractionations during magmatic processes) to determine the nature of subducted materials and their possible influence on the $\delta^{44}Ca$ of the Azores mantle source.

[1] Fantle et al., (2014) Earth-Science Reviews 129, 148–177.
[2] Beier et al., (2007) EPSL 259, 186–199.
[3] Elliott et al., (2007) GCA 71, 219–240.
[4] Eriksen & Jacobsen (2022) EPSL 593.
[5] Waters et al., (2020) GCA 268, 422–445.

