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Potassium isotope evidence for subducted upper and lower oceanic crust in ocean island basalt sources

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The Madeira mantle plume is proposed to contain a complete package of recycled oceanic lithosphere. It has not been possible, however, to establish if lower oceanic crust is present within the magma source of Madeira. This study reports potassium and oxygen isotope data of lavas from the Madeira Archipelago, which show that $\delta^{41}K$ (-0.50‰ to -0.31‰) correlates with radiogenic (Sr-Nd-Pb-Hf) isotopic compositions and $\delta^{18}O$ (4.90‰ to 5.21‰), confirming the incorporation of recycled crustal material. The increase in $\delta^{41}K$ from Madeira's early shield stage lavas (-0.50‰ to -0.40‰) to the subsequent post-erosional stage lavas (-0.34‰ to -0.31‰) is consistent with the mantle source (plume) becoming progressively depleted in low $\delta^{41}K$ recycled upper oceanic crust (converted to eclogite/pyroxenite) through melt extraction with decreasing age. The post-erosional lavas, however, require a source with higher $\delta^{41}K$ values than in the lithospheric mantle and thus point to the presence of lower oceanic crust in the Madeira plume sources. Consequently, potassium and oxygen isotopes provide the strongest evidence to date that ocean island sources can contain both upper and lower recycled oceanic crust. This study provides important constraints for the origin of mantle heterogeneities, as well as the recycling of K through subduction zones and the deep mantle.