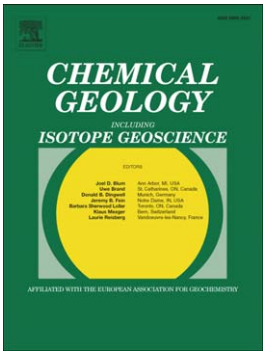

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Geochemistry of lavas from the Caroline hotspot, Micronesia: Evidence for primitive and recycled components in the mantle sources of lavas with moderately elevated $^{3}He/^{4}He$.

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Abstract

A suite of lavas from Kosrae, Ponape and Chuuk islands, which are related to the Caroline hotspot, are characterized for Sr, Nd, Pb, Hf and He isotopic compositions and major and trace element concentrations. The observed radiogenic isotopic variability spans a relatively narrow range for $^{87}Sr/^{86}Sr$ (0.703171 to 0.703491), $^{143}Nd/^{144}Nd$ (0.512923 to 0.512991), $^{176}Hf/^{177}Hf$ (0.283075 to 0.283123), $^{206}Pb/^{204}Pb$ (18.36 to 18.84), $^{207}Pb/^{204}Pb$ (15.48 to 15.55), and $^{208}Pb/^{204}Pb$ (38.21 to 38.70). The $^{3}He/^{4}He$ data, produced by vacuum crushing of olivine, vary from 7.6 to 12.8 Ra, and are 7.8 Ra and 10.4 Ra in two peridotite xenoliths from Kosrae and Ponape, respectively. The three highest $^{3}He/^{4}He$ values (12.8, 11.5 and 11.3 Ra) were obtained from Kosrae lavas, and $^{3}He/^{4}He$ exhibits positive covariation with $^{87}Sr/^{86}Sr$. This observation, together with low $^{3}He/^{4}He$ in a single fusion measurement of crushed olivine powder from the highest $^{3}He/^{4}He$ lava, supports a magmatic origin for the highest $^{3}He/^{4}He$ value of 12.8 Ra. As the high $^{3}He/^{4}He$ mantle domain is thought to reside in the deep mantle, the discovery of moderately high $^{3}He/^{4}He$ (i.e., $^{3}He/^{4}He$ greater than the mean MORB value of 8.8 ± 2.1 Ra) in Caroline lavas complements a recent report of a seismically-resolved mantle plume conduit beneath the Caroline hotspot.

Lavas with moderately elevated $^{3}He/^{4}He$ (up to 12.8 Ra) from Kosrae, as well as lavas from other high-$^{3}He/^{4}He$ localities globally, exhibit evidence for a recycled oceanic crust signature, including elevated Ti concentrations and moderately radiogenic Pb isotopic compositions. This observation suggests that primitive high-$^{3}He/^{4}He$ and recycled reservoirs are intimately associated, and mix, in the deep mantle sources of plumes. Hybrid mantle domains generated in this way serve as the melt source for lavas with elevated $^{3}He/^{4}He$ from many