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Plume-ridge interaction unravels the origin of $^{3}He/^{4}He$ peak offset from plume center

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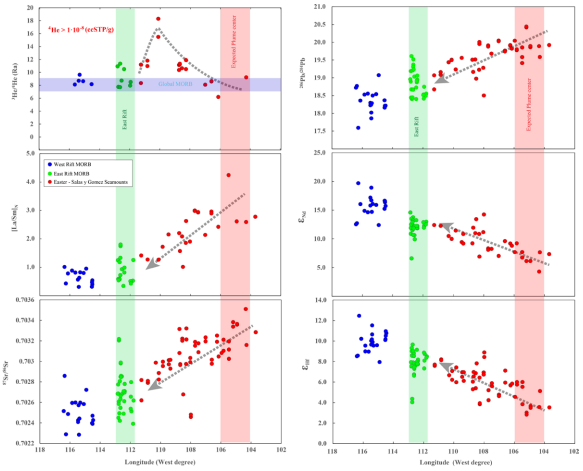
The Easter-Salas y Gomez Ridge (ESGR) has been generated/generating by the long-lived Easter mantle plume (EMP). The plume center is inferred to be located near Salas y Gómez Island (~106°W) [1]. Basalts with high $^{3}He/^{4}He$ (11.7 R_a) are reported for East Pacific Rise (EPR) at 112°W [2], but no $^{3}He/^{4}He$ data exist on ESGR seamounts. An extensive study of basaltic glasses from seamounts along the ESGR reveals a peak $^{3}He/^{4}He$ (18-19 R_a) that is present in seamounts around Easter Island (Rapa Nui) around 110°W. The $^{3}He/^{4}He$ peak is offset by 300-400 km from the trace element and radiogenic isotope expression of the Easter plume [3] (Fig. 1). The melts produced close to the plume center were generated beneath thick lithosphere and exhibit MORB-like $^{3}He/^{4}He$ values and enriched trace element/isotopic composition, while the high-$^{3}He/^{4}He$ near-EPR basalts are compositional similar to ambient depleted mantle and were generated beneath thinner lithosphere. It seems likely that the high-$^{3}He/^{4}He$ component is present in compositionally depleted and physically refractory mantle that possesses a higher solidus than the enriched mantle components in the upwelling plume. The observed along-ESGR geochemical variation can be readily explained by ridge-ward flow of the heterogeneous Easter plume mantle towards the EPR in response to ridge suction and decompression melting [4]. Early melting of the enriched mantle domains in the upwelling plume is followed by progressively greater contributions from depleted, high-$^{3}He/^{4}He$ mantle that possesses a higher solidus, resulting in gradually lower $[La/Sm]_N$, $^{87}Sr/^{86}Sr$ and $^{206}Pb/^{204}Pb$ and higher $^{143}Nd/^{144}Nd$ and $^{176}Hf/^{177}Hf$ (Fig. 1). This plume-ridge interaction process explains why deep mantle He isotope signatures are often spatially decoupled from the enriched signature in mantle plumes interact with mid-ocean ridges.

Fig. 1



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