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Multi-type ultra-depleted mantle components beneath a single 80-km-long segment at 53°E, Southwest Indian Ridge

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Mantle heterogeneities based on Hf-Nd isotope variations in mid-ocean ridge basalts (MORB) from the Indian and Pacific oceans reveal that Indian MORB have more radiogenic Hf than Pacific MORB, providing strong evidence for the presence of highly depleted and highly radiogenic Hf components in the Indian MORB mantle[1].

In contrast to the correlated Hf and Nd isotopes found on a ridge segment scale in MORB, abyssal peridotites exhibit decoupling, with clinopyroxenes showing extremely radiogenic εHf in association with less radiogenic εNd[2].

We present Hf and Nd isotope ratios of abyssal peridotite clinopyroxenes from the Dragon Bone segment (both on axis and on the off-axis ridge flanks) located at 53°E on the Southwest Indian Ridge[3]. Our analysis reveals significant variations in Hf and Nd isotopes that span the range observed in global oceanic basalts and published abyssal peridotite clinopyroxenes. We identified three mantle components beneath the Dragon Bone ridge segment:

1) A normal depleted mantle that has undergone ancient mantle melting or ridge melting within the last tens of millions of years and has since experienced recent melt-rock reactions, resulting in MORB-range εNd but higher εHf isotopes.

2) A metasomatized ultra-depleted mantle, characterized by extremely high εHf and distinctly low εNd values (with εHf up to 256.8 and εNd from -4.5 to 4.7). These values are similar to those observed in clinopyroxenes from Hawaiian peridotites (εNd from 2.77 to 9.03 and εHf up to 114.5) and garnets from the South African continental lithosphere, which also exhibit negative εNd values and high εHf values up to 470.

3) A mantle infiltrated by ultra-depleted melt, as evidenced by the pervasively developed symplectites in the peridotites and extremely high εNd values up to 100.5 and εHf values up to 451.5.

The significant variations in Hf and Nd isotopes in peridotite clinopyroxenes in this 80-km-long segment illustrate the presence of multi-type ultra-depleted mantle components.

References

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