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Mantle heterogeneity and crustal processes preserved in olivine-hosted melt inclusions from the Central Indian Ridge at 16.5°S

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We present major and trace element compositions, volatile contents and in-situ Pb isotopic ratios of 37 olivine-hosted melt inclusions in an olivine-phyric mid-ocean ridge basalt (MORB) at Central Indian Ridge (CIR; 16.5°S) to discuss detailed magma evolution processes and mantle heterogeneity. The post-entrapment modification-corrected melt inclusions generally exhibit higher MgO and Mg# (100×Mg/[Mg+Fe] in mol) than the carrier basalt. They also show a diverse range of enrichment ($[La/Sm]_N$=0.29-3.85, K_2O/TiO_2=0.05-0.70), exceeding the intra- and inter-segment variations observed in the nearest CIR axis ($[La/Sm]_N$=0.38-3.20, K_2O/TiO_2=0.02-0.61). Some of the melt inclusions have extremely positive Sr anomalies, which indicates their composition has been severely modified by reaction with gabbroic rocks. However, this reaction was limited in the other melt inclusions whose Sr anomalies are within the extent of the nearest CIR basalts. Fractional crystallization modelling further confirms the Sr anomaly in those melt inclusions was controlled by primary magma composition and plagioclase fractionation, rather than contamination of the lower crust.

The melt inclusions were further divided into Enriched-MORB and Normal-MORB types. E-MORB melt inclusions display trace element patterns, Pb isotopes, F/Nd and Cl/K ratios that closely resemble those of basalts from Réunion Island. This similarity suggests a significant contribution of the fossil Réunion hotspot to the mantle source of the E-MORB melts. The N-MORB melt inclusions exhibit a wide variation of Pb isotopic ratios ($^{207}Pb/^{206}Pb$=0.806-0.857, $^{208}Pb/^{206}Pb$=1.99-2.11) over the narrow range of La/Sm. This feature cannot be explained by a binary mixing of depleted mantle and fossil Réunion hotspot components, but requires introduction of the third component that exhibits low $^{208}Pb/^{206}Pb$ and $^{207}Pb/^{206}Pb$ ratios and depletion in incompatible trace elements. The CO_2-H_2O saturation depth of the melt inclusions was calculated to be between 6-11 km, which is deeper than the average slow-spreading ridge. This is likely due to the cooler geotherm near the fracture zone compared to the center of the segment. The variability of melt inclusion compositions irrespective of Mg# indicates ineffective magma mixing and homogenization during differentiation.