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Extreme compositional variability of melts preserved in olivine-hosted melt inclusions from a ridge-transform intersection in Central Indian Ridge (16.5°S)

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Ridge-transform intersections (RTIs) have a great potential to preserve compositional heterogeneity of mid-ocean ridge basalts (MORBs), thereby serving as optimal site to investigate the detailed magmatic processes on MORB formation. We present major and trace element composition, volatile contents and Pb isotopes of 37 olivine-hosted melt inclusions in a porphyritic MORB collected near a RTI in the Central Indian Ridge (CIR; 16.5°S) to investigate the role of melting and melt-rock reaction processes and mantle heterogeneity on chemical variability of the melt inclusions.

The melt inclusions exhibit a diverse range of enrichment ($[La/Sm]_N$=0.29-3.85, K_2O/TiO_2=0.05-0.70), comparable to those observed within ~1,000 km of the CIR ($[La/Sm]_N$=0.38-3.20, K_2O/TiO_2=0.02-0.74). They can be categorized into anomalous, N-MORB and E-MORB inclusions. The anomalous inclusions showing positive Sr anomalies with increasing Al_2O_3, CaO and decreasing Na_2O, TiO_2 are attributed to dissolution of gabbroic assemblages, while those without major element changes can be explained by ghost plagioclase or disequilibrium mineral-melt reactions. The N-MORB and E-MORB inclusions exhibit limited evidence of such reactions, whose Sr anomalies are within the extent of the CIR MORBs within 7.5-20.6°S. Rather, fractional crystallization model confirms their geochemistry was controlled by primary magma composition and subsequent crystallization.

E-MORB inclusions display trace element patterns, Pb isotopes, F/Nd and Cl/K ratios similar to those of basalts from Réunion hotspot trails. It reflects a notable contribution of Réunion plume component to the mantle source. The N-MORB inclusions exhibit a broad variation in Pb isotopic ratios ($^{207}Pb/^{206}Pb$=0.806-0.857, $^{208}Pb/^{206}Pb$=1.99-2.11) with a limited range of La/Sm, indicating involvement of an additional mantle component characterized by low $^{208}Pb/^{206}Pb$ and $^{207}Pb/^{206}Pb$ ratios and depletion in incompatible trace elements.

The relative standard deviation of the melt inclusion compositions in this study calculated at various ranges of forsterite contents are higher compared to high magma-supply regions with similar spreading rate. Considering the deeper CO_2 saturation depth of the melt inclusions (5-13 km) than the global intermediate- to slow-spreading ridge reflects thick lithosphere in this region, it can be inferred that the preservation of variable compositions of melt inclusions is likely due to the low magma supply resulted from the cooling effect of fracture zone.