Signature of plume-ridge interaction on bathymetry and geochemistry along mid-ocean ridges: Insights from the Réunion Plume and Central Indian Ridge

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Plume-ridge interaction is an important thermal and geological process, which results in various physical and chemical anomalies along a significant length of the global mid-ocean ridges system. Despite numerous studies, some remaining questions to be solved are origin and mechanisms of geochemical variations and their possible influence on the morphology of mid-ocean ridges. The Central Indian Ridge, with a slow to intermediate spreading rate, provides an ideal opportunity to explore distant plume-ridge interactions. Presently, the ridge is moving away from the hotspot. The hotspot which started at the Deccan Traps (65 Ma) is presently 1000 km away from the Central Indian Ridge, at the Réunion Island. Paleogeographic reconstruction suggests that the hotspot crossed the middle part of the Central Indian Ridge (MCIR) between 8˚S and 17˚S at ~34 Ma. Studies suggest that the plume material that flows into the Central Indian Ridge is more or less concentrated around 19˚S, to the south of Marie Celeste Fracture Zone (MCFZ). In addition, recent geochemical study show southward-increasing gradient in Réunion mantle component between 14˚S and 18˚S north of MCFZ. The detailed mechanism of the plume interaction on the MCIR is in debate. In this study, we revisited the MCIR with additional Nd, Sr and Pb isotope analyses and ship-board high-resolution bathymetry data to constrain the influence of the Ré union plume on geochemistry and bathymetry of the MCIR. The results show that the geochemical anomaly observed between 14˚S and 18˚S are found only in the northern part of segments and subsegments, and these enrichments correlate with the shallow axial bathymetry. The localized geochemical and bathymetric anomalies can be ascribed to a hotspot leading edge effect where the hotspot leading segments are offset in the direction of the plume and are more influenced by the plume materials. It appears that discontinuities such as transform faults and the non-transform discontinuities influence the flow of mantle plume material into the ridge, and that the proximity of the ridge to the hotspot plays an important role in the plume-ridge interaction.

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