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Small-scale Mantle Heterogeneities revealed by Mid Ocean Ridge cold spots

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Mid-Ocean-Ridge Basalts (MORB) have variable radiogenic isotope signatures ranging from time integrated trace element enriched ratios, mostly linked to the influence of hotspots, to depleted values, depicting ancient residual mantle components randomly distributed. However, the majority of MORB isotope ratios result from mixing of these various components and therefore hiding the extent of composition diversity of the mantle. Here we present major element compositions of 116 glasses and Sr, Nd, Pb and Hf isotope ratios of 59 of them from the Eastern Romanche Ridge Transform Intersection, in the Equatorial Mid-Atlantic Ridge region. They were collected mostly during the SMARTIES oceanographic expedition in 2019 along 25 dives or recovered from previous expeditions. This region is representative of a "normal" suboceanic mantle, far from any hotspot influence. An old and cold lithosphere is in contact with the warm axial segment tip of the southward MAR creating a progressively colder thermal regime along the ridge axis northward the transform domain (Ligi et al., 2005). There, MORBs show very heterogeneous compositions, some of them with very high alkali content similar to those observed in hot spot environments (Schilling et al., 1995). In our data ($^{87}Sr/^{86}Sr$ 0.702398 to 0.703758, $^{206}Pb/^{204}Pb$ 18.503 to 19.700, ε_{Nd} 2.26 to 11.5 and ε_{Hf} -2.88 to 23.7), we found four extreme mantle isotopic signatures: Depleted-MORB Mantle (DMM), Ultra-Depleted Mantle (UDM), HIMU and EMII. The mixing of these components covers most of the global isotopic variability documented in MORBs. The distribution of the isotopic compositions of the melts along the ridge axis correlates with mantle potential temperature. This reveals that in cold thermal regimes, mantle source signatures are not blended as well as elsewhere underneath MORs. This study demonstrates the importance of cold MOR environment, i.e., regions with colder-than-average mantle temperatures (Bonatti et al., 2001), to preserve individual components seen in melts so revealing hot spot-like heterogeneities at small-scale in the normal subridge mantle.

References

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