Noble gas signature on the Mid-Atlantic Ridge (24-30 °N): A unique window into volatile cycling and a heterogenous mantle

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The heavy noble gases provide important constraints on the chemical evolution of the mantle and mantle dynamics. However, the pattern of variability in Ne, Ar and Xe isotopic compositions in basalts erupted along mid-ocean ridges is largely unknown. Here we present new high-precision Ne, Ar, and Xe data in suite of normal MORBs from the Mid Atlantic Ridge between the Kane (24°N) and Atlantis (30°N) fracture zones. This region is devoid of known geochemical or geophysical anomalies and hence, represents an ideal place to investigate processes governing the composition of noble gases in the MORB mantle.

The high-precision neon data, along with previously published helium data, show a gradient with more radiogenic compositions in the south and less radiogenic compositions in the northern part of the study area. Superimposed on this trend is a sharply defined anomaly in He-Ne compositions centered at 29^{o} N that requires the presence of a less degassed, more primitive mantle component. Ar and Xe isotopic compositions, measured on a subset of the samples and corrected for shallow-level atmospheric contamination, show extreme variability compared to the He and Ne isotopic data. Moreover, the spatial pattern of Ar and Xe isotopic variability appears to be distinct from that of He and Ne. These observations hint at an additional process that drive Ar and Xe isotopic variability in the convecting mantle, most likely subduction of atmosphere-derived Ar and Xe associated with seawater-derived fluids. While the lithophile isotopic data in this section of the Mid Atlantic Ridge show minimal variability, the anomalous spike and the strong gradients in noble gas data point to utility of the noble gases in elucidating processes and mixing relations that are sometimes not easily visible in other isotopic systems.