

Tracing deep mantle component(s) in the near-rift Fjallgarðar Volcanic Ridge, Iceland: New constraints on lateral plume dispersion

NOËMI LÖW¹, SÆMUNDUR A. HALLDÓRSSON¹,
CHRISTOPH BEIER², JOSHUA CURTICE³, MARK D
KURZ³ AND PETER H BARRY³

¹Nordic Volcanological Center, Institute of Earth Sciences,
University of Iceland

²University of Helsinki

³Woods Hole Oceanographic Institution

High-³He domains in Iceland may originate from a deep, primordial mantle component in the Icelandic mantle plume. In the neovolcanic zones, the highest ³He/⁴He values (R_C/R_A , relative to air, R_A , and corrected for air-derived He) occur near the northwestern boundary of Vatnajökull, coinciding with the inferred location of the Icelandic mantle plume. This region is characterized by ³He/⁴He well above 18 R_A , reaching values as high as 26 R_A , reflecting its proximity to the mantle plume. In contrast, ³He/⁴He values of 8-11 R_A typify the Northern Rift Zone (NRZ).

The 200 km-long Fjallgarðar Volcanic Ridge (FVR), consisting of subglacially erupted tholeiitic basalt, was emplaced parallel and ~20-40 km to the east of the NRZ during the Brunhes geomagnetic polarity chron (<780 kyr). Previous studies suggest that the FVR erupted either during a temporary eastward jump or a widening of the NRZ, with magma input largely sourced from the NRZ, implying that the FVR should preserve NRZ source fingerprints.

Here, we present new He isotope data of glassy pillow rims (n=17), together with published major and trace element data on the same glasses from the FVR. Undegassed FVR glasses display some of the highest He isotope values (max ³He/⁴He = 22 R_A), comparable to ³He/⁴He values in the central Iceland region. Glasses with higher ³He/⁴He values correspond to lower incompatible minor and trace element ratios (e.g., K_2O/TiO_2 = 0.07-0.17, La/Yb = 2.0-3.8), similar to basalts from central Iceland, whereas lower ³He/⁴He values (~8 R_A) are observed in samples with higher ratios (K_2O/TiO_2 >0.18, La/Yb = 5.0-5.8), identical to basalts from Kverkfjöll, a volcano located adjacent to the southern tip of the FVR.

Our new dataset suggests that, rather than being linked to volcanic activity at the NRZ, a significant portion of the FVR magmas originates from a mantle source currently only evident beneath central Iceland, dominated by high-³He/⁴He plume component, thereby placing new constraints on lateral dispersion of plume material beneath Iceland over the past ca. 1 Ma.