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Noble gas isotope composition in Pannonian Basin mantle xenoliths

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Noble gases are sensitive geochemical tracers of mantle processes as their isotopic signature is different in deep mantle plumes, the shallow mantle, subcontinental lithospheric mantle and the crust. We present high-precision helium, neon and argon isotope data on ultramafic xenoliths from alkali basalts from the Pannonian Basin (Hungary). ⁴He/³He ratios are in the range between 102,000 and 114,000 which is in agreement with previous helium isotope analyses of subcontinental ultramafic rocks [1]. Neon isotope data indicate mixing between atmospheric and mantle neon. A line fit through all data is significantly steeper than the MORB line which can only be achieved by admixing of a solar-like mantle plume component as it is observed in deep mantle plume-derived volcanics from Loihi (Hawaii), Iceland or Reunion [2,3,4]. The apparently contradictory variation in neon isotopic composition without discernible variation in helium isotopic ratios can be explained in terms of hyperbolic mixing between SCLM and deep mantle plume reservoirs: while Ne is ranging between a relatively pure SCLM signature and a less nucleogenic composition, He is largely dominated by SCLM He, resulting in a relatively uniform composition. We could also infer the argon isotopic composition of the xenoliths' mantle source more reliably than hitherto for any other mantle source [2,5]. The ⁴⁰Ar/³⁶Ar ratio of 15000±1200 is much closer to the Loihi mantle source estimate of 8000 [2] than to the MORB source estimate of 30000-40000 [5]. The uniform Ar isotopic composition evaluated for different xenoliths indicates that plume type argon dominates these samples. This observation fits the overall result that in these mantle xenoliths we have two distinct mantle components: a Hawaii- or Réunion-like deep mantle noble gas component dominating Ar, and a SCLM component dominating helium. Neon is influenced by both components to varying degrees.

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He, Hf, Nd and double spike Pb isotope geochemistry of the Canary Islands Archipelago

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³He/⁴He ratios measured in basalts from the Canary Islands archipelago exhibit spatial variability. The eastern islands (Lanzarote, Fuerteventura, Gran Canaria and Tenerife) have ³He/⁴He ratios < 7Ra, similar to the 'classic' HIMU ³He/⁴He range (5 – 7Ra) [1]. The western islands (La Gomera, La Palma and El Hierro), however, have maximum ratios more similar to those of MORB (8.75 ± 2.14Ra) [2]. We have carried out a high precision Pb, Hf and Nd isotope study of basalts from five islands of the Canary Island Archipelago. Pb isotopes show a considerable range (²⁰⁶Pb/²⁰⁴Pb = 19.10 – 20.04, ²⁰⁷Pb/²⁰⁴Pb = 15.54 – 15.65 and ²⁰⁸Pb/²⁰⁴Pb = 39.08 – 39.85), comparable to previous studies but with generally reduced scatter in ²⁰⁷Pb/²⁰⁴Pb ratios. Hf and Nd isotope ratios vary from εHf = +4.3 – +9.1 and εNd = +3.1 – +6.3. These values are distinct from MORB, but overlap with the HIMU field. Spatial variability is evident in these isotope systems, from east to west. The eastern islands (Fuerteventura and Gran Canaria) have positive Δ8/4 and relatively low ¹⁴³Nd/¹⁴⁴Nd signature compared to that of the western islands, indicating that the eastern islands have a more enriched source. The western islands have negative Δ8/4, with the ¹⁴³Nd/¹⁴⁴Nd ratios trending off towards more depleted ratios. It is also clear that some lavas have an enriched signature which may be consistent with assimilation of sediment located below the volcanic construct.

Two possible models may account for the spatial heterogeneities within the Canary Islands: (a) regional east to west heterogeneity within the mantle source, (b) late stage crustal contamination of the magmas governed by the changing lithospheric structure from east to west.

References

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