Neon and plume – MORB mixing along the Galapagos Spreading Center

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Characterizing noble gas composition variations along plume-influenced ridges can help reveal mantle processes such as mantle flow, source mixing, degassing, fractionation and mantle heterogeneities. Lavas from Western and Southern Galapagos islands have very high ^{3}He/^{4}He, up to 30 Ra, but the Northern Galapagos islands and Wolf-Darwin lineament have relatively low ^{3}He/^{4}He, between ~6 and 8 Ra. Along the Galapagos Spreading Center (GSC), ^{3}He/^{4}He ratios are from 5,9 to 8,5. No high ^{3}He/^{4}He ratios resembling those of Western and Southern islands are observed along the GSC, despite many indicators of the involvement of plume-derived material [1]. Here, we use Ne isotopes to detect plume involvement in the generation of GSC basalts.

New basaltic glasses were sampled in the ridge axis of GSC between 86 and 98°W. The samples were analysed by crushing of one fragment of sample in order to release volatiles trapped in vesicules. The abundance of CO_2 was measured with a capacitance manometer and the isotopes of Ne were analysed on a Helix MC noble gas multi-collection mass spectrometer.

Preliminary results from two samples so far analysed have very low abundances of mantle Ne, with ^{4}He/^{21}Ne* (where * denotes corrected for atmospheric contamination) significantly higher than the mantle production ratio. Fractionation of He from Ne may result from late stage degassing (during emplacement of the lavas, for example) or could be due to contamination of the plume-derived melts by asthenospheric He (but no Ne). Analysis of more samples, as well as analysis of Ar isotopes and abundances, will allow two cases to be distinguished.

References

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Significance of the mantle Fe isotope variations

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The Fe isotopic variability found among mantle xenoliths [1] is in sharp contrast with the homogeneous isotopic composition of mantle-derived rocks [2,3]. To address this issue, we have undertaken a comprehensive petrological and geochemical study of different suites of mantle xenoliths. They sample continental and oceanic lithospheric mantles of different ages, in the spinel facies and the garnet facies.

The $\delta^{57}Fe_{IRMM14}$ range measured at the bulk rock scale (0.99‰) is even larger than previously found. None of the xenolith suites studied display a homogeneous isotopic composition. Bulk-rock Fe isotope signatures were compared to bulk-rock and mineral major and trace element contents. In some cases, the observed correlations can be interpreted as resulting from the effect of different types of metasomatism whereas for other examples, they seem to reflect melt extraction. Although both of these processes affected the bulk-rock Mg#, it was possible for three of the studied xenolith suites to infer the “starting” isotopic composition of the mantle area studied. Two intracontinental suites (Cameroon and South Africa) yielded a $\delta^{57}Fe_{IRMM14}$ of 0.1‰, whereas one intraoceanic suite (Kerguelen) led to a value of 0‰ for a highly melt-depleted mantle.

These results point to an “initial” lithospheric mantle, prior to multiple episodes of metasomatism and melt extraction, having a mean $\delta^{57}Fe_{IRMM14}$ indistinguishable from that of mantle-derived basalt. This inference is consistent with [4].

These findings also illustrate that Fe isotopes are a sensitive tracer of mantle metasomatic processes despite the high temperatures involved and the usually small Fe isotopic variations observed in igneous rocks. The mechanisms responsible for this peculiar behaviour of Fe isotopes has yet to be fully understood.

References

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