Recycled and Solar Nitrogen Contributions to the Central Indian Ridge (CIR) Réunion-plume system

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The principal mechanism by which chemical and isotopic heterogeneities are introduced into the mantle is by subduction of sediments and oceanic crust [1]; however, the fate of volatile species (e.g., N and noble gases) is not well-constrained. Isotopically-enriched N is metabolically concentrated in Mesoproterozoic ocean sediments, which following subduction, is variably reincorporated back to surface reservoirs in volcanic arcs [2-3], while the remaining (unknown) fraction is transported into the deep mantle [4-6].

Here, we present N-Ne isotope and abundance results of plume-influenced oceanic basalts dredged along the Central Indian Ridge (CIR) and adjacent (off-axis) seamounts. $\delta^{15}N$ ranges from +1.8 ‰ to -3.8 ‰ (n=15) vs. air, whereas $^{20}Ne/^{22}Ne$ values extend from 9.84-11.32 and $^{21}Ne/^{22}Ne$ values range from 0.0290-0.0401 (n=20). Using a coupled N-Ne approach, we combine air-corrected (i.e., extrapolated) Ne-isotope values ($^{21}Ne/^{22}Ne_{EX}$) with $^{15}N/^{14}N$, and show that data conform to binary-mixing between postulated solar and mantle endmembers. On-axis CIR samples (~ 8 ± 1 R_A; [7]) trend to $\delta^{15}N$ values ~ -2 ‰, whereas off-axis seamounts (characterised by $^3He/^4He > 8R_A$) have higher values ($\delta^{15}N$ ~ +2 ‰). Thus, the isotopically-enriched N is preferentially recycled into the high $^3He/^4He$ mantle source of the CIR-Réunion system. We calculate that the ubiquitous sediment-derived contribution lies between 30 and 65% in the on- and off-axis samples, respectively. Furthermore, there is also a small (0.2%) but detectable solar nitrogen component is all samples. Large N-isotope variations have previously been linked to the oxygenation of Earth's atmosphere throughout the Pre-Cambrian [8]. As such, these results help constrain the timing of subduction, as plume-derived N-isotope values closely-resemble Mesoproterozoic sediment signatures.

[1] Hoffman and White, 1982 [2] Elkins *et al* 2006 [3] Mitchell *et al* 2010 [4] Marty and Dauphas, 2003 [5] Holland and Ballentine, 2006 [6] Kendrick *et al* 2011 [7] Füri *et al* 2011 [8] Thomazo and Papineau, 2013