N-isotopes in hot spot hydrothermal gases: Preliminary results

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The isotopic composition of terrestrial rare gases provides a powerful argument in favor of a two-layered mantle – the lower mantle is the primary repository of primordial rare gases, and is sampled by OI volcanism. The upper mantle, sampled at MOR, also contains primordial rare gases – a substantial proportion of which is likely transferred from the lower mantle. Growth of radiogenic rare gases contributes to the volatile inventory in both parts of the mantle and their influence is greater in the upper mantle due to enhanced loss of the primordial component. Geophysical and geochemical studies challenge layered mantle models and suggest that convection occurs on a mantle-wide scale and that subducting slabs sink past the 670-km seismic discontinuity. Nitrogen isotopes offer an independent test of the scale of mantle convection and extent of recycling of surface material into the lower mantle. N is particularly suitable to trace the evolution of, and interactions between, different terrestrial reservoirs given its wide range in isotopic compositions. $\delta^{15}N$ of the upper mantle (MORB) is estimated to be ~ -4‰ (vs AIR $\delta^{15}N$= 0 ‰). Organic sediments on the ocean floors have $\delta^{15}N$ from + 5 to + 7 ‰. N data on plume related lavas indicate that ^{15}N is enriched – up to +8‰, which results from recycling of surface N into the lower mantle [1]. We report the first data on the N-isotope composition of hydrothermal gases from Kilauea, Yellowstone and Valles Caldera. Kilauea and Yellowstone have $^3He/^4He$ ratios up to 15.9 and 15.5 Ra, characteristic of plume volatiles. Valles gases have N_2/He (51-175) and He/Ar (0.04-1.09) that resemble hot spot volatiles, but $^3He/^4He$ ratios are 6 Ra. $\delta^{15}N$ values for all samples are negative: Kilauea (-4.4 to - 2.1‰), Yellowstone (-2.7 to - 1.2‰) and Valles (-3.5 to - 1.9‰) in contrast to data from plume related lavas [1]. This apparent discrepancy in N-isotopes between fluid and solid (glass) hot spot samples has important implications: 1) isotopic fractionation may occur during magma degassing; 2) plume sources are heterogeneous so that recycled N (^{15}N enriched) characterizes only some localities; 3) contamination of plume N with upper mantle N during magma ascent and degassing changes its isotopic composition. Future work on plume related volatiles is required to resolve the isotopic heterogeneity of the N signature of the mantle.

References

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Dissecting the nitrogen cycle in a tropical mangrove ecosystem

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On a small mangrove island in Belize, we have measured extremes in $\delta^{15}N$ values within red and black mangrove tissues and lichens growing on these trees (range = +2 to –18 ‰). Our measurements include N isotopic compositions of porewater, rainwater, and atmospheric ammonia, along with their concentrations, leaves, roots, stems, and wood, senescent leaves, leaf fragments from 8,500 years old core, and lichens, in addition to compound specific isotopic measurements (N and C) of amino acids. Several hypotheses were tested to determine which process was most important in controlling these isotopic ratios. 1) Porewater ammonium concentrations had no relationship to increased N isotopic fractionation. 2) Supply and demand for N had some relationship to $\delta^{15}N$ values, but these processes were not the major drivers. 3) Mangroves growing under P sufficient conditions had more positive $\delta^{15}N$ owing to the active transport of ammonium into roots rather than passive uptake. 4) A pool of isotopically-negative ammonia measured in the atmosphere ($\delta^{15}N$ = -18 ‰) was a source of available N for stressed mangrove trees. 5) Isotopic compositions of P-limited mangrove leaves were related to concentrations and isotopic compositions of ammonia in the air. This work links $\delta^{15}N$ of mangrove tissues with sedimentary P cycles, including GIS mapping of different P pools as they relate to N concentrations, reactivity, and isotopic distributions in the geosphere, biosphere, and atmosphere.