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Seamount Nitrogen and Noble Gas Evidence for Subduction-Derived Volatiles in the East Pacific Rise Mantle

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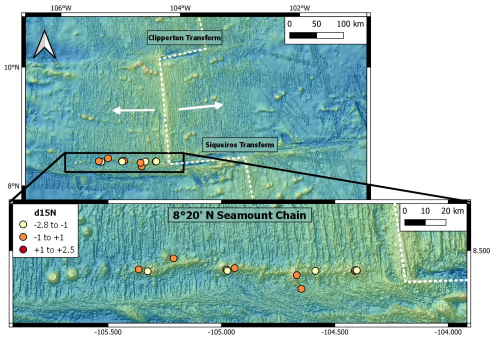

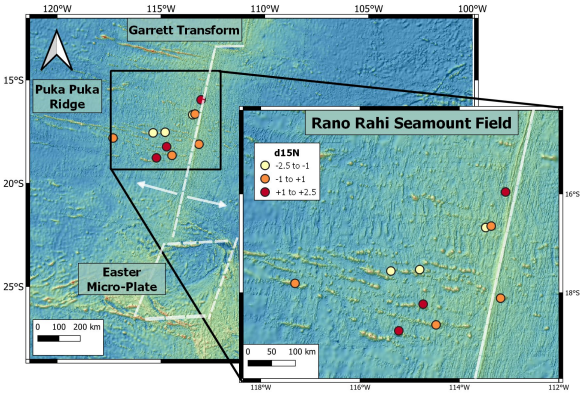

The East Pacific Rise (EPR), the fastest spreading mid-ocean ridge (MOR) on Earth, is responsible for creating much of Earth’s crust today. Although the EPR is well studied, the isotopic composition and origin of volatiles in the sub-EPR mantle remain enigmatic. Seamounts flanking the EPR capture a wider range of compositions than on-axis lavas, because off-axis melts bypass mixing processes occurring beneath the ridge. This study examines the origin of volatiles in the EPR mantle by pairing nitrogen and noble gas abundances with isotope ratios of well-characterized basalt glasses from two geochemically heterogeneous, near-EPR seamount regions (8°20’N and the Rano Rahi region between 15°-19°S). Nitrogen and noble gas isotopes are sensitive tracers of the volatile history of geochemical reservoirs, largely because of their distinct compositions and predictable behaviors during exchanges between Earth’s surface and interior.

To characterize mantle sources beneath the EPR, we compare new N and noble gas abundances and isotopic ratios with Pb, Sr, and Nd isotopic ratios, and major and trace element compositions. $^{3}He/^{4}He$ ratios from 8°20’N seamount lavas alone span the entire range of MOR basalts away from plumes (6.4 - 9.2 times atmospheric (R_A)). Significant $\delta^{15}N$ variability also exists in these locations; the 8°20’ N seamounts range from -2.8 (±0.2) to +1 (±0.4)‰, and Rano Rahi seamounts range from -2.5 (±0.2) to +2.5 (±1.7)‰. Most incompatible element enriched basalts (EMORB) possess higher $\delta^{15}N$ values (> -1‰) than other lava types, often corresponding with high $^{87}Sr/^{86}Sr$, implicating subduction-related input into the mantle as a key mechanism responsible for forming EPR EMORB. $\delta^{15}N$ values of all lavas at 8°20’N and Rano Rahi are higher than average MOR mantle (-5 ± 2‰; [1]), indicating that all of the seamount lavas derive from subduction-influenced mantle. These findings support a model whereby subduction has contributed to the development of widespread mantle heterogeneity beneath the EPR. For each lava type, the $\delta^{15}N$ values for Rano Rahi seamounts are higher than the same lava types at 8°20’N, potentially reflecting different proportions or compositions of subducted material entrained in the northern versus southern EPR mantle.

[1] Marty & Dauphas (2003), *EPSL* 206, 397-410