Nitrogen cycling in subduction zones: Insights from eclogites of the Raspas Complex, Ecuador

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The significant flux of nitrogen (N) fixed in altered oceanic crust (AOC) into subduction zones (Busigny et al. 2005) has important implications for N cycling. However, it is not clear whether N is released from AOC and added to arcs, whether it is retained deeper into the mantle or whether it is incorporated into fluids along the slab-mantle interface. To better understand N cycling in subduction zones, we have analyzed high-pressure metamorphic rocks from the Raspas complex, Ecuador, for both N concentrations and N isotopic compositions.

Based on field associations and trace element geochemistry, the Raspas eclogites can be subdivided into two groups: The first group is LREE-depleted and has affinities to MORB, whereas the second group is spatially associated with zoisite veins and characterized by relative HFSE enrichments. The MORB-type eclogites have positive δ^{15}N values (+3 to +8) and elevated N concentrations (2-10 ppm) that are distinct from fresh MORB values (-4$\pm$2 and ˜1.1 ppm). They overlap the range for AOC, consistent with retention of a significant N proportion during prograde metamorphism. Trends on diagrams that can discriminate between seafloor alteration and metamorphic additions, such as Th/U vs Th (Bebout 2007), indicate that these elemental signatures could have been inherited from seafloor alteration processes. However, two features in the MORB-type eclogites indicate a high-pressure metasomatic alteration: Enrichments in Ba and Pb, elements that are typically not enriched on the seafloor, and the positive correlations of N with Ba, Pb, Rb and Cs, which suggests a small metasomatic N addition, probably via subduction-related fluids. The lack of enrichment in Cs, Rb and Ba combined with the high HFSE contents in the second group of eclogites is inconsistent with a magmatic origin, but indicates an additional metasomatic input. Transfer of N and HFSE from passing fluids into these eclogites is suggested by positive correlations of N with HFSE.

Relatively constant δ^{15}N values of all eclogites at variable Ce/Pb ratios can be interpreted as inherited from the AOC or as result of high-P fluid-rock interaction. In any case, N is not necessarily lost during metamorphism of the AOC. If these eclogites represent material that is eventually subducted into the deep mantle, our results imply addition of an isotopically heavy N component, which may be of significance for elevated δ^{15}N values in plume-derived magmas (Society Islands, Hawaii).

References

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