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Olivine and pyroxene-hosted fluid inclusions record high arc nitrogen fluxes and multiple slab sources

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Nitrogen is the most abundant gas in Earth's atmosphere (78% N_2), but occurs as a trace element in rocks, making it a potentially sensitive tracer of recycled surface materials in the mantle. Constraining the factors that control nitrogen (N) mobility from subducted slab lithologies, and ultimately the fluxes of N from volcanic arcs, is essential for modeling the evolution of the atmospheric and mantle N budgets through geologic time. We present new nitrogen and noble gas concentration and isotope data from fluid inclusions in mineral separates from mafic arc lavas to evaluate the source(s) of nitrogen and the effect of slab parameters on N mobility from subducting slabs. Most samples have sediment-like $\delta^{15}N$ (~+5‰) and mantle-like $^3He/^4He$ (7 ± 1 R_a) signatures, although some record lower $\delta^{15}N$ values, which we attribute to altered oceanic crust (AOC) or mantle contributions. There is no correlation between $\delta^{15}N$ and subarc slab depth, suggesting no discernable fractionation associated with progressive breakdown of N-bearing phases in the slab in inter-arc comparisons. We observe a possible negative correlation between $\delta^{15}N$ and the slab thermal parameter (ϕ/100; km), that may indicate warmer slab thermal regimes facilitate greater N mobility. Notably, fluid inclusion $N_2/^3He$ values are uniformly greater than the median values reported from volcanic gas measurements [1], regardless of the primary fluid source (mantle, AOC or sediment). These new data imply that global arc N fluxes are likely underestimated, which highlights the need for more systematic along and across arcs studies that pair nitrogen with other volatiles.

[1] Hilton, Fischer, & Marty (2002), *Reviews in Mineralogy and Geochemistry*, 47(1), 319-370.