Evaluating lithium isotopes as a tracer for subducting slab components in Aleutian arc lavas

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The presence of altered oceanic crust and/or sediment components from the subducting slab are credited with producing the distinct geochemical signatures of island arc lavas, which cannot be explained by mantle melting alone. Li isotopes are of interest as a slab component tracer, however, previous studies yield mixed results when using Li isotopes to decipher slab signals in island arc lavas. This study examines the potential for Li as a tracer of slab components in the Aleutian island arc using Li concentration ([Li]) and δ^7Li values in a well-studied suite of 36 geographically (165 to 184°W), compositionally (SiO_2 = 46 to 70 wt.%), and temporally (0 to 11 Ma) diverse lavas. The δ^7Li in these rocks range from -0.7‰ to +14.2‰, with 32 of the 36 samples falling within the depleted mantle range (δ^7Li +1.6 to +5.6‰). δ^7Li values in Aleutian lavas do not exhibit the spatial trends, nor do δ^7Li values correlate with radiogenic isotopes, oxygen isotopes, or traditional trace element ratio indicators of slab components. Aleutian trench sediment, which has been identified in Aleutian samples by other slab component indicators, spans a range of δ^7Li values comparable to that of the depleted mantle [1]. This makes discerning a slab signature through Li isotopes difficult, though not necessarily impossible. Of the 26 samples with published δ^{18}O values, 23 fall beyond the range of mantle-derived basalts (5.2 ± 0.2‰), suggesting that small extents of alteration could have impacted δ^7Li values and [Li]. Water-rock alteration modeling suggests that the majority of Aleutian samples exchanged Li with isotopically heavy hydrothermal fluids at relatively low water/rock ratios, thus obscuring an already difficult-to-detect slab signature. Thus, Li may be most useful as a slab component tracer when 1) the isotopic signatures of the slab components differ significantly from mantle range; and 2) potential incipient alteration has not obscured the signal.

[1] Chan et al. (2006), Geochem. Geophys. Geosyst. 7, 1-25.