

# **Boron, Lithium, and Nitrogen Cycling through Subduction Zones**

GRAY E. BEBOUT<sup>1</sup>

<sup>1</sup>Dept. Earth and Environmental Sciences, Lehigh University,  
Bethlehem, PA, 18015, USA. [geb0@lehigh.edu]

The initial incorporation of B, Li, and N into seafloor sedimentary lithologies eventually to be subducted is rather disconnected, involving both organic and inorganic fractions. Diagenetic reactions involving clay minerals, accompanied by breakdown of the organic N source, dominate the initial cycling of these elements in sediments. Boron, Li, and N are mobilized in fluids in shallow accretionary settings, for at least B producing some isotopic shift (with loss of adsorbed B). However, it appears that this flux represents only small amounts of loss distributed over large volumes of sediment, and forearc metasedimentary rocks (e.g., Franciscan) contain a large fraction of their seafloor B-Li-N inventories.

At deep forearc and greater depths, the mineral residency of B, Li, and N is strongly influenced by the stability of micas, particularly phengite. Boron mobility can be controlled by the presence of and reactions involving tourmaline, and factors dictating whether or not tourmaline growth occurs in such rocks are not well understood. Tourmaline can stabilize B to great depths, once it is transferred from micas into tourmaline during prograde devolatilization reactions. At lower grades, Li is strongly partitioned into chlorite, but with chlorite breakdown at greater depths, Li is largely transferred into micas (and amphiboles). Varying partitioning of the LILE (particularly Cs), B, and Li between micas and various “fluids” beneath arcs could lead to across-arc chemical trends and differing retention into the deeper mantle. In warmer forearcs, B and N are released to greater extents from devolatilizing metasedimentary rocks, whereas Li appears to be largely retained in micas during devolatilization of such rocks. In mafic rocks (altered oceanic crust), N and B are likely largely sited in the micas, whereas Li is strongly partitioned into clinopyroxene and amphibole (in addition to the micas, where present). In such rocks, B and, to a lesser extent, N contents correlate with K (and other LILE) concentrations reflecting intensities of seafloor alteration.

Isotopic fractionation of B, N, and Li in forearcs and beneath arcs likely depends on thermal evolution of the margin and related fractions of devolatilization losses. Some margins show across-arc B isotope variation consistent with distillation from micas in subducting sedimentary and mafic lithologies. Study of metamorphic cycling of B, Li, and N is limited to suites peak-metamorphosed at depths of less than 100 km, limiting considerations of loss profiles beneath arcs.