

Magma segregation suite beneath the NE Japan arc: mantle processes

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The mantle processes that control the chemical diversity of the Quaternary basalts in the NE-Japan arc are (1) addition of contemporaneous slab derived AOC fluids, (2) melting of a common depleted MORB source asthenosphere, with (3) different melting parameters between frontal and rear arcs.

Frontal arc basalts in this arc are low- to medium-K, but display significant isotopic variation, ranging from DM to EM II compositions. The isotopic diversity broadly corresponds to that of the basement granitoids that were emplaced during the Cretaceous and Tertiary periods. This suggests involvement of lithospheric mantle or lower crustal materials in the genesis of the Quaternary basaltic lavas. Mixing calculations using rare earth elements (REEs) or high field strength elements (HFSEs) with Sr-Nd-Pb isotopes require a depleted mantle end-member.

The depleted source should have MORB-like isotopic signatures with depleted MORB source trace element abundances. Although rear-arc high-K basalts represent the melts from such a source, a similar depleted source is required to explain the chemical diversity found along the frontal arc. The depleted MORB source must thus exist beneath the entire volcanic arc and, therefore, is thought to form the mantle wedge asthenosphere. Large ion lithophile elements (LILEs: Rb, Ba, Pb, and Li) are relatively enriched compared to REEs in the frontal arc basalts. The LILEs do not behave in the same way as the REEs or HFSEs, suggesting an independent origin other than from lithosphere or asthenosphere. The LILEs were likely added to the mantle sources via fluids derived from dehydration of sediments or altered MORB of the subducting Pacific Plate.

Open system melting calculations for incompatible elements suggest that addition of a 0.5 % contemporaneous altered oceanic crust (AOC) fluid with 20 % partial melting of depleted MORB source is required to produce the frontal arc basalts. In contrast, a 0.5 % fluid addition with 3 % partial melting of the same depleted source mantle can reproduce the trace element and isotopic compositions of the rear arc basalts. In these models, necessary sources for the basalts are simply the depleted MORB source mantle and altered oceanic crust fluids. Fluid flux rate can also be constant for both rear and frontal arcs, with different melting parameters.