

Subduction processes associated with back-arc opening; Hf isotope study of Tertiary NE Japan arc

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Back-arc opening is one of the major tectonic features in island arc formation. In order to document the geochemical evolution of a subduction zone during back-arc opening, Hf isotope compositions were determined for Tertiary and Quaternary volcanic rocks from NE Japan. The samples selected are from volcanoes along the volcanic front. The ages of the Tertiary samples range from 22 to 8 Ma, which overlaps with the period of opening of the Japan Sea back-arc basin (22-15 Ma).

Hf isotope data demonstrate a secular variation. Among the samples, the 22 Ma high magnesian andesites (HMA) have the lowest ϵ_{Hf} (+9). The 8 Ma tholeiitic basalts and andesites show the highest ϵ_{Hf} (+14). Calc-alkaline basalts and andesites between 22 and 16 Ma have intermediate ϵ_{Hf} from +10 to +13. Consequently, ϵ_{Hf} was low (enriched) in the early stages of back-arc opening but became high (depleted) after back-arc opening ceased.

The observed secular variation in Hf isotope ratios may be attributed to a change in magma source composition. (1) Injection of depleted asthenospheric mantle into previously enriched mantle wedge during back-arc opening is one possible process for such a secular variation. This occurred on the back-arc side of NE Japan, as indicated by a coupled decrease and increase of Sr and Nd isotope ratios, respectively, during and after back-arc opening[1]. On the trench side, however, Sr and Nd isotope ratios were almost constant, suggesting that material flux was minimal on the trench side of the NE Japan arc[2]. (2) A hot asthenospheric injection into the mantle wedge, even if restricted to the back-arc side, should induce a high temperature gradient in the whole mantle wedge, which could affect the slab surface temperature, resulting in changing dehydration/melting conditions of the subducted slab. Melt from the subducted slab transports Hf more effectively into the mantle wedge than dehydrated fluid. The secular change in ϵ_{Hf} is consistent with a model whereby slab melt was added to the mantle wedge during the early stage of back-arc opening, and slab dehydration was dominant after cooling of the mantle wedge.

[1] Nohda S., Tatsumi Y., Otofujii Y., Matsuda T., and Ishizaka K. (1988) *Chem. Geol.* 68, 317-327.

[2] Tatsumi Y., Nohda S., and Ishizaka K. (1988) *Chem. Geol.* 68, 309-316.