Asthenospheric contribution to magmatism at the active rift zone in the northern Izu-Bonin arc

*Yasuhiro Hirai[1], Takanori Yoshida[1,5], Satoshi Okamura[1], Izumi Sakamoto[2], Ryuichi Shinjo[3], Keiji Wada[4]

1. Sapporo Campus, Hokkaido Educ. Univ., Japan, 2. Dept. Marine & Earth Sci., Tokai Univ., Japan, 3. Dept. Physics & Earth Sci., Univ. Ryukyus, Japan, 4. Asahikawa Campus, Hokkaido Educ. Univ., Japan, 5. Niki Junior High School, Hokkaido, Japan

The active rift zone lies just behind the Quaternary volcanic front in the northern Izu-Bonin arc. Volcanism at the active rift zone has been active since ca. 2 Ma, and late Quaternary basaltic lavas (< 0.1 Ma) and hydrothermal activity occur along the central axis of the rifts (Taylor, 1992; Ishizuka et al., 2003). The southern part of the active rift zone has greater subsidence of the basement than the northern part (Ishizukda et al. 2002). In this paper we present new Sr, Nd, and Hf isotope and trace element data for the basalts erupted in the active rift zone, composed of northern Aogashima rift, Myojin rift, and southern Sumisu rift. Three geochemical groups can be identified within the active rift basalts: Low-Zr basalts (LZB), Mid-Zr basalts (MZB) and High-Zr basalts (HZB). The MZB and LZB occur at all rifts, whereas the HZB only at the Sumisu rift. The MZB has higher Zr/Yb and Nb/Yb, lower Ba/Nb than the LZB. The HZB has the highest Zr/Yb, and exhibits a similar Nb/Yb and Ba/Nb to the LZB. The MZB from the Aogashima rift has higher Ba/Th and lower Th/Nb than the HZB and MZB from the Sumisu rift. The HZB and MZB from the Sumisu rift show a similar Ba/Th and Th/Nb to the western back-arc seamount chains. Depletion of Zr-Hf in the N-MORB-normalized spiderdiagram characterizes the MZB and LZB. The $^{176}Hf/^{177}Hf$ values are slightly lower in the HZB than in the MZB and LZB, decoupling of $^{176}Hf/^{177}Hf$ and $^{143}Nd/^{144}Nd$ values. ODP Leg126 site 788, 790, and 791 reached the basaltic basement of the Sumisu rift (Gill et al., 1992). The geochemical data and stratigraphic relations of the basement indicate that the HZB is younger than the MZB. Estimated primary magma compositions suggest that segregation depth of primary magma for the basalts at the Sumisu rift exhibits 30 km (~ 1.0 GPa), whereas that at the Aogashima and Myojin rifts more than 45 km (~ 1.5 GPa). The correlation between Zr/Yb, Nb/Yb and Ba/Nb indicate that the MZB and LZB were produced by different degree of partial melting of a common source mantle. The MZB and LZB volcanism at the early stage of the back-arc rifting is best explained by a partial melting of subducted slab saturated with trace quantities of zircon under low-temperature condition in the mantle wedge. On the other hand, the HZB requires a partial melt of subducted slab accompanied by full dissolution of zircon under high-temperature condition in the mantle wedge. Spatial geochemical variation of the active rift zone basalts indicates that contribution of a slab melt component (high Th/Nb relative to Ba/Th) dominates in the Sumisu rift, whereas that of an aqueous fluid component dominates in the Aogashima rift. We propose that the back-arc rifting could have been caused by asthenospheric injection with high-temperature in the south during the syn stage.

References

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