

研究題目：島弧火山岩の地球化学

Geochemistry of the island arc volcanic rocks

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Recent our studies on the isotope systematics from Izu (B and Pb) and northeastern Japan (Pb, Sr and Nd) arcs have elucidated the chemical evolution of source mantle of island arc magmas as follows; 1) the original mantle wedge is MORB-type mantle, 2) the subduction component is added to the mantle wedge by the fluid derived from dehydration of subducting slab, and 3) the dehydration continues to a depth of at least 180 km, implying a continuous release of elements from the descending slab.^{[1],[2]} For better understanding of fluid-related processes in subduction zones, we investigated B isotopic compositions of Quaternary volcanics from northeastern Japan in addition to Sr, Nd and Pb isotopic compositions. Because boron is highly concentrated in subducting oceanic sediments and altered MORB relative to the overlying mantle wedge, and is extremely mobile during both partial melting and dehydration, thereby the B isotope is utilized as an excellent tracer of crust recycling at subduction zones.

The $\delta^{11}\text{B}$ of northeastern Japan decreases from +5 to -5 ‰ with increasing depth to the slab from 130 to 180 km, and then increases up to -2 ‰ at 300 km (Fig. 1). This across arc variation is basically consistent with those of Pb, Sr and Nd isotopic compositions.^[2] However, the lowest $\delta^{11}\text{B}$ value of -5 ‰ at 180 km in depth is significantly lower than that of MORB ($\delta^{11}\text{B} \approx 0$).^[3] The relationship between Nb/B and $\delta^{11}\text{B}$ is presented in Fig. 2. In the B isotopic study from Izu arc,^[1] $\delta^{11}\text{B}$ simply decreases with increasing Nb/B ratio (Fig. 2), indicating that the across arc variation of B isotopic composition was simply caused by the two-component mixing of slab derived fluid and mantle wedge. In northeastern Japan, however, the $\delta^{11}\text{B}$ decreases with decreasing Nb/B ratio at the depth range of 150 to 180 km (Trend B), although the $\delta^{11}\text{B}$ -Nb/B systematics from the other depth is essentially same as observed in Izu arc (Trend A). Only crustal materials have such lower values of $\delta^{11}\text{B}$ than MORB,^[3] but Trend B cannot be explained by crustal contamination as shown by the arrow in Fig. 2. It is, therefore, inferred that the Trend B must be incorporated with a peculiar component derived from subducting oceanic sediment and this component should contain extremely lower amounts of Pb, Sr and Nd compared to B because such a component was not observed in Pb-Sr-Nd isotope systematics. To satisfy these constraints, tourmaline which contains ≈ 3 wt % of B, is most suitable candidate for the source of peculiar component at the depth range of 150 to 180 km. Tourmaline is stable in the wide ranges of pressure (>3 GPa) and temperature (<1000°C),^[5] and often occurs in metasedimentary rocks.^[4] When tourmaline in subducting oceanic sediments breaks down, huge amounts of B with lower $\delta^{11}\text{B}$ will be released and transferred to mantle wedge by fluid with extremely small Nb/B ratio.^[1] According to numerical study,^[6] temperature of subducting slab at the depth from 150 to 180 km is 900 to 1100°C that is nearly consistent with the condition at which tourmaline dissociates. From these observations, it may be concluded that tourmaline in the subducted oceanic sediments breaks down at 150 to 180 km in depth and this process releases a peculiar subduction component with extremely lower $\delta^{11}\text{B}$ and Nb/B to the mantle wedge. The reason why no effect of tourmaline is observed from Izu arc can be explained by the extremely small involvement of oceanic sediments which contain tourmaline to subduction component (<1%)^[1] compared to the case of northeastern Japan (15 %).^[2]

References: [1] Ishikawa and Nakamura (1995), [2] Shibata and Nakamura (1997), [3] Ishikawa and Nakamura (1993), [4] Henry and Dutrow (1996), [5] Krosse (1995), [6] Peacock (1990)

