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海洋性島弧における沈み込み開始プロセスとそのタイムスケール

Processes and timescale of subduction initiation and subsequent evolution of oceanic island arc

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The Bonin Ridge is an unusually prominent forearc massif in the Izu-Bonin arc that exposes early arc volcanic rocks on Bonin Islands. Submarine parts of the ridge, which could complement the record of volcanism preserved on the islands, had not been extensively investigated.
Diving and dredging expedition to investigate the submarine section of Bonin Ridge revealed the forearc stratigraphy exposed on the landward slope of the Izu-Ogasawara trench. The members of forearc crustal section are from bottom to top: 1) gabbroic rocks, 2) a sheeted dyke complex, 3) basaltic lava flows, 4) volcanic breccia and conglomerate with boninitic clasts, 5) boninite and tholeiitic andesite lava flows and dykes (on the Bonin Islands).
In addition to the crustal section, dredge sampling and ROV Kaiko dives recovered mantle peridotite below the gabbro. These observations indicate that almost all of the forearc crust down to Moho has been preserved in this forearc area. The obtained forearc stratigraphy shows remarkable similarity to supra-subduction zone ophiolite section.
Then the question is what the nature of this basaltic crust is? Basaltic section recognised in forearc stratigraphy show tholeiitic trend and shares many geochemical features with Philippine Sea back-arc basin basalt (Philippine Sea MORB), such as lack of significant input of slab component, while these basalts are distinct from other Eocene volcanics exposed on Bonin Islands. However there are some significant differences between the two. For example, the forearc basalts show significantly lower Ti/Yb, Ti and Yb content compared to Philippine Sea MORB. This implies that the forearc basalts were produced from more depleted source. Another noticeable difference is that the basalts from forearc have low LREE, and LREE/HREE compared to Philippine Sea MORB. This could indicate that forearc basalts have more depleted source or produced at larger degree melting. Isotopic characteristics also indicate some difference in source between Philippine Sea MORB and forearc basalts. They seem to have common characteristics in having relatively high delta8/4 of Pb isotopic ratio compared to Pacific MORB. i.e., Indian Ocean MORB character. However, they have distinctly higher $^{87}Sr/^{86}Sr$ and $^{206}Pb/^{204}Pb$ than Philippine Sea MORB. The difference in isotopic characteristics as well as trace element characteristics between the forearc basalts and Philippine Sea MORB strongly implies that the forearc basalts are not the basement of the arc, that is, preexisting ocean crust of West Philippine Basin prior to the subduction initiation. We propose that the forearc basalt formed as a consequence of seafloor spreading associated with subduction initiation at the site of the modern forearc.
Primary magma composition and condition of melting estimated by analysis of glass samples imply that condition of melting or segregation of melt from mantle is estimated to have occurred at 1320

-1370℃ and 0.9-1.1GPa. This result implies that at the initiation of subduction, decompression melting of MORB-type source had been achieved, and also P-T condition which melting of depleted source at hot and shallow condition required for boninite magma production was present. Age determination of basalt and gabbro by $^{40}Ar/^{39}Ar$ and U-Pb methods has confirmed that these rocks predate boninite on Bonin Isalnds and could be older than 50 Ma. $^{40}Ar/^{39}Ar$ dating of basalts gave ages between 50-53 Ma and U-Pb age of zircon from a gabbro is 51.6 Ma, indicating that the basaltic magmatism might predate boninite by 2-3 m.y. Combined with ages from boninitic rocks and later arc tholeiites and calcalkaline rocks, change from first basaltic magmatism at subduction initiation to 'normal' arc magmatism appears to have taken 7-8 m.y.

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