Arc magmatism at the incipient stage of formation of subduction zone: geochemistry of the Bonin Islands

Kyoko Kanayama[1]; Susumu Umino[2]; Osamu Ishizuka[3]

[1] Geosciences, Shizuoka Univ.; [2] Earth Sci., Kanazawa Univ.; [3] GSJ/AIST

Bonin Islands are known for the occurrence of boninite series and high-Mg arc tholeiite and calk-alkaline rock series generated at the incipient stage of formation of subduction zone. We present new analysis of major and trace elements and petrogenetic processes of volcanic rocks of the Bonin Islands.

Boninite series rocks in Chichijima and Mukojima Island Group represent the primitive arc magmatism in middle Eocene time, which gave way to arc tholeiite and calk-alkaline rocks are in Hahajima Island Groups. Boninite series of the Maruberiwan and Asahiyama Formations indicates a differentiation trend that sharply increases in $FeO*/MgO$ with increasing SiO_2 contents. $FeO*/MgO$ ratios of arc tholeiite and calk-alkaline rocks of the Hahajima Island Group are slightly lower than those of the Izu-Bonin Quaternary volcanic front lavas. Boninite series samples of the Mikazukiyama Formation show a similar trend to the Maruberiwan-Asahiyama boninite series samples. However, the former has lower SiO_2 contents and higher $FeO*/MgO$ ratios than the latter. Most of the Maruberiwan and Mikazukiyama boninites belong to low-Ca type, while only a small number of Maruberiwan boninite samples belong to high-Ca type.

Maruberiwan boninites are the most depleted in REEs, which is only about 1/10 of N-MORBs, and the most enriched in LILEs in the Bonin Islands. Maruberiwan Low-Ca boninites indicate a distinct positive anomaly of Zr and negative anomalies of Sm and Ti, while Maruberiwan high-Ca boninites, Mikazukiyama boinites and Hahajima basalts indicate moderate anomalies of these elements. Basalts of the Hahajima Island Group are the most enriched in REEs and HFSEs in the Bonin Islands. Compared to the Hahajima basalts, the present Izu-Bonin front lavas are more depleted in LREEs and HFSE, and enriched in LILEs.

Estimated conditions of magma generation show that the primary magmas in the Hahajima Island Group can coexist with lherzolite residue at 1-1.3 GPa under dry or wet (water content˜0.5 %) condition. .

Boninites are characterized by low Sm/Zr and Ti/Zr ratios. Results of model calculations strongly suggests that the source mantle changed from highly depleted to fertile compositions together with slab-derived components that changed from amphibolite melt through garnet amphibolite melt to aqueous fluid as the generated magma changed from boninite in shallow (˜0.8 GPa) mantle 48Ma to basalt in deeper (1-1.3 GPa) mantle 44Ma. The differences in trace element compositions between low- and high-Ca boninites originated from the slab component, but not the source depletion.