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Magma genesis of Miocene basalts from Ootsu district, Yamaguchi Prefecture, SW Japan arc

HIGASHIYAMA, Yoji[1] ; HASENAKA, Toshiaki[1*] ; SHIBATA, Tomoyuki[2] ; YOSHIKAWA, Masako[2] ; NAGAO, Takashi[3]

[1]Grad School Sci. & Tech., Kumamoto Univ., [2]Beppu Geothermal Res. Lab., Kyoto Univ., [3]Grad School Sci. & Eng., Yamaguchi Univ.

The geological, petrological and geochemical studies of Miocene Ootsu basalts, distributed in Tsunoshima and Yuyashima islands along the coast of the Japan Sea, revealed the temporal and vertical changes in mantle melting processes. Based on their volcanic stratigraphy and petrological data, Ootsu basalts were grouped into; (1) clinopyroxene-olivine basalt (COB), (2) olivine basalt, magnetite-rich type 1 (MRB1), (3) olivine basalt, magnetite-rich type 2 (MRB2), and (4) olivine basalt, magnetite-poor type (MPB). MRB1 and MRB2 are rich in FeO$*$ and TiO_2 contents, and MPB is rich in SiO_2 and Al_2O_3 contents. MRB1, MRB2 and COB are alkalic and MPB is tholeiitic.

Phase diagram and mass balance calculations indicate that these four groups were derived from different primary magmas, and had experienced polybaric crystallization. The compositions of primary magmas for these four groups suggest that MRB1 and MPB were generated at the deepest and shallowest depths, by the lowest and the highest degrees of melting, respectively. Multi trace element plots (normalized by the primitive mantle values) of Ootsu basalts show the strong enrichment of LILE (Rb, Ba, and K), and distinct negative anomaly of Nb and Sm. The compositions of coexisting olivine and spinel (OSMA) suggest that MPB's mantle source is the most fertile among four groups. The different ratios of LREE/HREE among four groups suggest different mantle source and different degree of partial melting. B/Nb ratio of four groups is getting higher with decreasing segregation depth. These systematic differences in B/Nb ratio indicate that the upper mantle beneath Ootsu district is characterized by an increased degree of metasomatism at shallow level.

We concluded that the diversities of chemical composition in Ootsu basalts attribute largely to different segregation depth and heterogeneous mantle source.

Keywords: alkaline rock, tholeiite, boron, rare earth element, mantle