

Petrological and geochemical constraints on the origin of Cenozoic basalt from the Fukuoka district, SW Japan

Hidemi Ishibashi[1]; Yasushi Mori[2]; Takeru Yanagi[3]

[1] Earth and Planetary Sci., Kyushu Univ; [2] Kitakyushu Mus. Nat. Hist. Hum. Hist; [3] Earth and Planetary Sci., Kyushu Univ

Petrological and geochemical investigations of Cenozoic basalts from the Fukuoka district, SW Japan, are performed. The basalts have phenocrysts of olivine, magnetite, and sometimes clinopyroxene and hornblende, and lack plagioclase phenocryst. Magnetite was observed not only as a phenocryst but also as inclusions in olivine phenocrysts. The basalts show compositional ranges of SiO₂ and (Na₂O+K₂O) contents from 42.4 to 48.7wt% and from 3.8 to 5.4 wt%, respectively, and are classified into an olivine alkali basalt defined by Cox et al.(1979). With the increase of SiO₂ content, Fe₂O₃* (=Fe₂O₃+FeO/0.9) content significantly decreases from 18 to 11wt%. MgO content, however, is almost constant around 7wt% independently of SiO₂ content. TiO₂, CaO, and Sc content decreases from 4 to 2wt%, from 9.5 to 8wt%, and from 30 to 20ppm, and Al₂O₃ content increases from 14 to 17wt% with the decrease of Fe₂O₃* content. LILE (Large Ion Lithophile Elements)/Nb, La/Nb, and La/Ce ratios increase, and HFSE (High Field Strength Elements) ratios, such as Nb/Zr, Y/Zr, and Ti/Zr, decrease with the decrease of Fe₂O₃* content. Y/Zr ratio vary in the range from ca.0.17 to 0.09. Rb/Sr ratio is lower than 0.03 and almost constant independently of SiO₂ content. The value is similar to that of N-MORB. Rb/Ba, Ba/La, Ce/Sr, and Nd/Zr ratios are almost constant independently of Fe₂O₃* content. Ce/Sr ratio is ca. 0.11 and Nd/Zr ratio is ca. 0.25, both ratios are higher than those of N-MORB and primitive mantle.

The variations of incompatible element ratios with Fe₂O₃* content indicate that the variation of Fe₂O₃* content of the basalts cannot be explained by fractional crystallization and/or addition of mineral components, and the basalts may be derived from chemically varied parental melts. The chemical variation of their parental melts cannot be explained by a difference in degree of partial melting from the source rock with the same composition because the highly incompatible element ratios, which are almost constant through partial melting and fractional crystallization processes, vary significantly with Fe₂O₃* contents. The positive relation between Nb/Zr and Ti/Zr ratios indicates that the source rock of the basalts is chemically varied not only for LILE and LREE (Light Rare Earth Elements) but also for HFSE. Hence, the chemical variation of the source rock cannot be explained only by a difference in the degree of addition of subduction-related aqueous fluid to the same source rock.

Some samples in the basalts show Fe₂O₃* content higher than partial melts of normal peridotite, which represents primitive and depleted mantle, even at high pressure. The Fe-enriched basalts may be derived from a source rock enriched in Fe. Several recent high pressure melting experiments indicate that Fe content in partial melt increases with the increase of Fe content in the source rock. Another possibility is a fractionation of Fe-poor minerals such as plagioclase and clinopyroxene from partial melts of normal mantle. Plagioclase phenocryst, however, was not crystallized and fractionated from the basalts because of the lack of plagioclase phenocryst and the almost constant Ce/Sr ratio. Fractionation of clinopyroxene also cannot explain the Fe enrichment because the Fe-enriched basalts show higher CaO and Sc contents than the relatively Fe-poor basalts.

The melting residue was thought to contain garnet and lack plagioclase because of the high Zr/Y ratio and the almost constant Ce/Sr ratio. One possible source rock of the high-Fe basalts may be a cumulative garnet-pyroxenite enriched in Fe and Ti, which can explain the major element characteristics such as relatively low SiO₂ and Al₂O₃ contents, high Fe₂O₃* and TiO₂ content and some trace element characteristics.