

Secular variation of bulk rock and mineral chemistry of Late Cenozoic mafic volcanic rocks in Oki-Dogo Island, SW Japan

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Oki-Dogo Island is 17-18km in diameter and is situated in the Japan Sea, about 60km from Shimane Peninsula. Volcanic activity in Oki-Dogo began in the Oligocene, and continued intermittently through to the Pleistocene, with a hiatus in Middle to Late Miocene. Studies of geochronology, magnetostratigraphy, geology, petrography and geochemistry have been carried out (Kano & Nakano, 1985; Fujimaki et al., 1989; Uto et al., 1994; Kobayashi & Sawada, 1998; Kojima et al., 2001; Kobayashi et al., 2002; Kimura et al., 2003; Yamauchi et al., 2005; Tayama, 2005MS; Sawada et al., 2006). Based on these data, the history of volcanic activity is summarized thus: (1) Late Oligocene to Early Miocene Tokibariyama Formation (Fm) (26-18Ma): subalkaline volcanic rocks ranging from basalt to rhyolite; (2) Early Miocene Kori Fm (21-18Ma): subalkaline basalt to basaltic andesite; (3) Latest Miocene (Omosu Fm (Oki Alkaline Volcanic Rocks) (5.7-5.4Ma): alkaline volcanic rocks consisting mainly of rhyolite and trachyte and associated hoshonite, basaltic trachyte and trachyandesite; (4) Pliocene to Pleistocene: consisting of alkaline olivine basalt, and subdivided into 5 stages; I: 4.7-4.1Ma; II: 3.6-3.3Ma; III: 2.8-2.4Ma; IV: 1.3Ma; V: 0.8-0.4Ma.

Clear secular geochemical variation is recognized among the Late Cenozoic mafic volcanic rocks, which are divided into three main groups based on geochemical characteristics: group-1: Oligocene and Early Miocene group, group-2: early Pliocene group and group-3 late Pliocene and Pleistocene. SiO₂ contents of group-1 basalts and basaltic andesites are greater than those of group-2 and 3 basalt at given FeO*/MgO ratio. TiO₂, P₂O₅ and K₂O contents at given FeO*/MgO ratio decrease progressively from group-1 through to group-3. Mafic volcanic rocks of the Omosu Fm and its equivalents are extremely enriched in TiO₂, Fe₂O₃ and P₂O₅, and depleted in Al₂O₃ at given SiO₂ content, compared with the mafic volcanic rocks in the other stages. Zr/Nb ratios in group-1 are more than 13, in sharp contrast to the lower values (ca. 5) seen in groups -1 and -3, indicating that the source mantle materials of the mafic magmas differed between group-1 and groups-2 and -3. Contents of HFS elements increase from group-1 through to group-3. The degree of partial melting increased from group-2 to 3, based on FeO*/MgO - HFS element variation diagrams.

Fo contents of olivine phenocrysts having NiO=0.4wt%, which generally represents the NiO content in mantle olivine (Sato, 1977), are higher in the early Miocene than in the Pliocene and Pleistocene (Fo90 in the Kori Fm; Fo83 in Stages I and III, Fo87-86 in Stages IV and V). Bulk chemistry and Cr number (Cr#) [Cr/(Cr+Al)] of spinel composition*) from the mafic volcanic rocks of the Oligocene to Lower Miocene Tokibariyama and Kori are 0.77 and 0.86-0.51, respectively. Cr# of spinel in Pliocene and Pleistocene basalt are: Stage I: 0.41-0.28; Stage III: 0.31-0.21; Stage IV: 0.29-0.26; Stage V: 0.54-0.36, and 0.24-0.12. Bulk chemistry and Cr# of spinel from the Pliocene and Pleistocene basalts show oceanic island alkaline character. Cr#s of spinel from the Pleistocene Stage V basalts plot in a similar area to spinel lherzolites xenoliths in the Pliocene basalts (Abe et al., 2003), suggesting source mantle peridotite.

Mafic volcanic rocks in the Oligocene and Lower Miocene show depleted in incompatible elements suggesting that the activity was related to opening of the Japan Sea and injection of hot asthenosphere. After the hiatus in Middle to Late Miocene, a new mantle plume injected and replaced previous upper mantle material.

*) Here we adopted spinels of $Fe^{3+}/(Cr+Al+Fe^{3+})$ less than 0.15, and in olivine phenocrysts of Fo more than 80].