

Evolution of magma plumbing system of Miyakejima volcano

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Miyakejima is an active tholeiitic volcanic island located at about 200 km south of Tokyo in Izu-Mariana arc. Miyakejima is a typical volcano in immature arc crust. Tsukui et al. (2001) divided the volcanic activity of the last 10,000 years into four stages: 10-7ka (Ofunato Stage), 4-2.5ka (Tsubota Stage), 2.5ka to AD1154 (Oyama Stage) since AD1469 (Shinmio Stage). According to Niihori et al.(2003), products of the Ofunato Stage were basalts and they were relatively primitive basalts. On the other hand, products in Tsubota Stage were andesites and those in the latter two stages were mixed products of basalt and andesite. Precise knowledge of depth, temperature, water content and fO_2 of magma chamber are essentially important in discussing evolution of magma plumbing system. The purpose of this study is to investigate the evolution of the magma plumbing system in Miyakejima in the last 10ka based on high-pressure experiments and petrology. We show that a simple system in the Ofunato Stage developed into a complex one and this accounts for the change in chemical and petrological features in the subsequent stages of Miyakejima volcano.

To understand the evolution of the magma plumbing system, first we studied the magma chamber in Ofunato Stage by high-pressure experiments. Experiments were performed at 1.0-2.5kbar with various H₂O content using IHPVs at the Magma Factory, Tokyo Tech. Based on the experimental results and petrology of products in Ofunato Stage, magma chamber in Ofunato Stage was reconstructed. The magma chamber was located at 5-6km depth (about 1.5kbar) and water-rich (about 3wt.%) basalt magma crystallized olivine and calcic plagioclase (which is the typical phenocryst assemblage throughout Ofunato Stage). Volatile content (H₂O, CO₂, S and Cl) of melt inclusions were analyzed by FTIR and EPMA. Maximum H₂O and CO₂ content of a melt inclusion in olivine are 3.3wt.% and 160wt.ppm, respectively. The gas saturation pressure of magma indicates that the pressure of magma chamber in Ofunato Stage should be at least 1.5kbar.

Whole rock compositions in Ofunato and Tsubota stage was analysed by XRF. A series of crystallization trends were calculated using MELTS program (Ghiorso and Sack, 1995), and it is found that andesites erupted in Tsubota Stage can be formed by fractional crystallization of OFS basalt at pressure less than 1.5kbar which corresponds with that of shallow level chamber in the two-layered magma chamber after Sinmio stage (e.g. Amma-Miyasaka and Nakagawa, 2003). Postulated water content in magma (about 0.6 wt.%; water-saturated pressure of basalt for this water content is less than 1.0kbar), however, is much lower than in Ofunato Stage (about 3 wt.