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Abstract

Miyakejima volcano, which is an active basaltic volcano, was chosen to understand evolution of arc volcano. In order to reveal the evolution of magma plumbing system of Miyakejima volcano, it is inevitable to understand its long-term evolution (Chapter 1).

In Chapter 2, conditions of magma chamber in Ofunato Stage (4000-10000 yBP) was studied based on high-pressure experimental study and petrologic study on melt inclusions. Basalts in Ofunato Stage seem to be parental to rocks in later stages and the basalts in Ofunato Stage shows only limited compositional variation having no signs of magma mixing. It is the most suitable rocks in order to estimate the crystallization conditions in a magma chamber. Melting experiments on OFS (Ofunato scoria), one of the least fractionated Miyakejima basalt in the last 10,000 years, were carried out. Melt inclusions of phenocrysts in OFS scoria were also analyzed. In order to crystallize phenocrysts of OFS in the magma chamber, optimum *P*, *T* conditions and H_2O content in melt were ~150 MPa and ~1100°C and ~3wt.% of H_2O content in melt. From melt inclusion analyses, maximum H_2O and CO_2 content were 3.4 wt.% and 165 wt.ppm, respectively, and the saturated pressure of this melt was estimated to be ~150MPa (depth of ~6km). Magma plumbing system of Miyakejima volcano was simple in Ofunato Stage having a single magma chamber at around 6 km depth.

In Chapter 3, variation of whole-rock composition in the last 10000 years and conditions of crystal differentiation were discussed, in order to understand evolution of magma plumbing system in Miyakejima volcano. Possibility of crystal fractionation from Ofunato basalts to andesites is Tsubota Stage was examined by MELTS calculation. It is found that Tsubota andesites can be derived from Ofunato basalts provided that H_2O content in magma is small (0.6wt.%). This result is consistent with estimated H_2O contents for products of Ofunato and Tsubota Stage using our new hygrometer (Chapter 3). Judging from the low water content, depth of the magma chamber for Tsubota andesites may be very shallow (<1 kbar).

Whole-rock compositions of some eruptive products were analyzed and it is found that Togahama scoria may represent newly injected basalt magma and possibly is a parental magma in Oyama Stage and Shinmio Stage. Togahama scoria was erupted just before Hatchodaira eruption from stratigraphy, and it is the least differentiated basalt in from Tsubota Stage. Injection of basalt magma (represented by Togahama scoria) may possibly triggered Hatchodaira plinian eruption by vesiculating partially solidified shallower magma chamber (Tsubota andesite) and deeper magma (Ofunato basalt). Compositional gaps exist between older rocks (Ofunato and Tsubota stage; 10000 to 2500 yBP) and younger rock (Oyama and Shinmio Stage: 2500 yBP to present) for incompatible element (K, P, Ba, La and Zr). It is suggested that preexisting material in the Miyakejima magma plumbing system was evacuated during the Hatchodaira eruption. During Oyama and Shinmio Stage, Miyakejima volcano erupted basalt and basaltic andesite which are mixtures of andesite in shallow magma chamber and basalt in deeper magma chamber.

In chapter 4, a plagioclase phenocryst hygrometer was constructed, in order to estimate water content in arc basalts. In order to analyze water content in small experimental run products, FTIR apparatus was calibrated (based on additional experiments) for reflectance measurement. From the experiments on OFS (Chapter 2) most suitable runs to construct hygrometer were selected. As a result of the experiments, we found that the Ca/Na partition coefficient between plagioclase and hydrous basaltic melt increases linearly with increasing H_2O content of melts. Based on these experiments we proposed a simple plagioclase hygrometer, which is expressed as a function of only H_2O in melt without regard to *P* and *T*. Our hygrometer is useful to estimate water content in arc basaltic magma where precise conditions of crystallization (pressure, temperature, etc) are not known.

Water content in pre-eruptive basaltic magma in Northeast Japan arc and Izu-Mariana arc were estimated using a simple hygrometer developed. From literatures, we chose geochemical data sets of relatively primitive basaltic rocks (with no evidence of magma

mixing) and most frequent Ca-rich plagioclase phenocrysts from 16 basaltic arc volcanoes, which includes both frontal-arc volcanoes and rear-arc volcanoes. In the 16 volcanoes studied, plagioclase phenocrysts of high anorthite content (An>90) are commonly observed, whereas plagioclase phenocrysts in rear arc volcanoes usually have lower anorthite content (90>An>80). In all volcanoes studied, the estimated H_2O content of basaltic magma is at least 3 wt.% H_2O or higher. Many volcanoes located on the volcanic front show about 5 wt.% H_2O in magma whereas those from a rear-arc side are slightly lower in H_2O content.