Volatile evolution of magma plumbing system of the 2000 eruption at Miyakejima volcano deduced from melt inclusion analyses

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The 2000 eruption of Miyakejima volcano, Japan, is characterized by intrusion of a dyke and a submarine eruption in June, subsidence of the summit area with phreatic and phreatomagmatic explosions in July to August, and intense and continuous degassing from the summit after the major eruptions (e.g., Nakada et al., 2005). Geophysical and petrological observations suggested that shallow andesitic and deeper basaltic magma chambers existed beneath the volcano before the 2000 eruption (e.g., Amma-Miyasaka et al., 2005). In this study, petrological and melt inclusion studies were carried out in order to know volatile evolution of the magma plumbing system. We can consider three component magmas, "A" magma in the shallow magma chamber erupted at the submarine eruption, and "B" and "C" magmas erupted at the summit eruptions. The C magma represents the deeper-sourced basaltic magma and the B magma was produced by 40 wt% fractional crystallization of the C magma. The bimodal olivine core composition and diffusion profiles of the olivines in the ejecta of the summit eruptions indicate the mixing of B and C magmas in two months before the eruption. The melt inclusions in Mg-rich olivines derived from the C magma have slightly higher H_2O (1.9-3.5 wt%) and S (0.06-0.21 wt%) contents, and a lower Cl (0.04-0.07 wt%) content than the inclusions in Mg-poor olivines from the B magma, while they have similar CO_2 (0.003-0.025 wt%) contents. The wide range of CO_2 contents can be explained by magma degassing with a decrease in pressure. The initial CO_2 content of the deep basaltic magma (0.15 wt%) was estimated from the H_2O and S contents of the inclusion in the Mg-rich olivine and the volcanic gas composition. Based on the variation in the chemical composition of the melt inclusions, we propose volatile evolution of the magma plumbing system as follows, In the deep magma chamber at depth of about 10 km, 40 wt% fractional crystallization of C magma having initial volatile content of 3 wt% H_2O and 0.15 wt% CO_2 made B magma having bulk volatile content of 5 wt% H_2O and 0.25 wt% CO_2. This B magma ascended from the deep magma chamber to the shallow magma chamber (3-5 km depth), causing degassing of the B magma with pressure decrease. The decompression degassing decreased the volatile content of the B magma to 3.9 wt% H_2O and 0.008 wt% CO_2. Before the 2000 eruption, the addition of CO_2-rich gas to the B magma occurred in the shallow magma chamber and caused a change in the volatile content of the melt to 2.8 wt% H_2O and 0.035 wt% CO_2. In addition, the C magma ascended from the deep magma chamber and was injected into the B magma. The mixture of the B and C magmas ascended to a depth shallower than 3 km, accompanied by magma degassing with the pressure decrease.