Magma generation process of the Quaternary Yufu Volcano, Northeast Kyushu, Japan: Approach from petrological features of amphibole

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Yufu-dake and Tsurumi-dake are located in northeastern Kyushu, Japan, and are part of the volcanic front of Southwest Japan. These volcanoes composed of amphibole-bearing andesites. These andesites show disequilibrium mineral assemblages and contain basaltic inclusions. The major and trace element contents, Sr isotopic compositions and disequilibrium mineral assemblages show that andesitic magma of Yufu-dake and Tsurumi-dake was produced by magma mixing and that mixing endmembers are represented by basaltic inclusions and dacite of Jissoji volcano which is older volcano than Yufu-dake and Tsurumi-dake (Ohta and Aoki, 1991). In the investigation for Sr-Nd isotopic and trace element compositions (Yoshikawa et al., 2017), it is reported that andesite of Yufu-dake have systematically different trend from that of Tsurumi-dake. From this difference of trend, it is pointed out that formation of magma of Yufu-dake due to the larger contribution of adakite melt compared to Tsurumi-dake. This indicates the possibility that magma generation process and the magma plumbing system of Yufu-dake may be different from those of Tsurumi-dake. The magma plumbing system of Tsurumi-dake was reported by Nagasaki et al. (2017) from major elements of amphiboles in andesite of Tsurumi-dake, but those of amphiboles in andesite of Yufu-dake has not reported. In this study, we analyzed major element composition of amphiboles in andesite from Yufu-dake, basaltic inclusion and dacite of Jissoji volcano to estimate temperature, pressure, SiO_2 (SiO_2^{melt}) content and FeO*/MgO ratio (FeO^*/MgO^{melt}) of coexisting silicate melts and to discuss the magma plumbing system of Yufu-dake.

Based on the chemical composition of amphiboles, two distinct groups of amphiboles are identified as follows; group I: Si-poor (Si = 5.9 - 6.3 apfu) amphiboles and group II: Si-rich (Si = 6.5 - 6.9 apfu) amphiboles. The SiO_2^{melt} and FeO^*/MgO^{melt} of group I in andesite of Yufu-dake were 56.0 - 64.5 wt.% and 2.11 - 4.00, respectively, and those of group II were 73.5 - 75.0 wt.% and 2.67 - 3.03, respectively. These results show that group I and II were crystallized in andesitic-dacitic magma and dacitic-rhyolitic magma, respectively, and these were to be coexisted by magma mixing. Although the SiO_2^{melt} of group I is similar to SiO_2 content of the whole rock of andesite of Yufu-dake, FeO^*/MgO^{melt} of group I is higher than FeO*/MgO of the whole rock of andesite of Yufu-dake. These results suggest that basaltic magma represented by basaltic inclusion, which had lower SiO_2 content and FeO*/MgO than group I, is required to explain the bulk composition. Therefore, we suggest that andesite of Yufu-dake was produced by mixing of andesitic-dacitic magma, dacitic-rhyolitic magma and basaltic magma. The temperature and pressure of group I in andesite of Yufu-dake were estimated as 937 - 998 ℃ and 356 - 654 MPa (13.5 - 24.7 km in depth), respectively, and those of group II were estimated as 807 - 836 ℃ and 131 - 188 MPa (5.0 - 7.1 km in depth), respectively. These results show that magma chamber coexisting with group I exists at a depth of 14 −25 km, and magma chamber coexisting with group II exists at a depth of 5 −7 km. The chemical composition of amphiboles in basaltic inclusion and the melt composition estimated from

amphiboles in basaltic inclusion are similar to those of Yufu-dake. These results suggest that amphiboles in basaltic inclusion were crystallized in same magma which amphiboles in andesite of Yufu-dake were crystallized and were incorporated into basaltic inclusion when magma mixing occurred.

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