Depths of two magma chambers of the Fuji 1707 eruption

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Fuji volcano dominantly consists of basalt; however, several lines of evidence indicate existence of differentiated SiO_2-rich magma beneath. The olivine-hosted melt inclusions clearly show the existence of andesitic liquid. Phenocrystic plagioclase generally show bimodal distributions in compositional frequency, while most olivine phenocrysts show unimodal distribution with reverse zoning and frequently contain andesitic melt inclusion. These suggest that erupted magmas of Fuji are generated through mixing between basalt and more SiO_2-rich magmas. It has been argued that the SiO_2-rich magmas evolved within a shallow magma chamber is mixed with the newly ascended basalt magma which have differentiated in a deep magma chamber (e.g. Kaneko, et al., 2010).

The depth of the deep magma chamber has been estimated to be deeper than 20 km based on the compositional variation of basalt magmas (Fujii, 2007) and to be 25 km by high pressure melting experiments on the basalt scoria of the 1707 eruption (Ushioda et al., 2012).

The depths of the shallow chambers, however, have not been well constrained because the SiO_2-rich end member magma has been usually dissolved in the mixed basalt magma and is obtained only as a melt inclusion in phenocryst.

Among the eruption history of Fuji volcano, the 1707 eruption was peculiar because the SiO_2-rich end member magma was extremely differentiated to dacite composition and resulted in unmixing with the basalt magma. This is a rare case we can obtain the composition of the SiO_2-rich magma as dacite pumice erupted at the beginning.

Recent finding of hornblende phenocryst in the dacite pumice of the 1707 eruption gives constraint on the depth estimation of the evolved magma chamber. The pressure estimated is below 200 MPa and is almost 100 MPa. The melt inclusions hosted in hypersthene phenocryst in dacite contain around 4 wt% of H_2O, indicating a crystallization pressure around 100-150 MPa. These suggest the shallow magma chamber is around 4-6 km in depth. This estimation is consistent with the volatile concentration of olivine-hosted melt inclusions in basalt scoria of 1707 eruption. The most volatile-rich melt inclusion in olivine shows basaltic composition which indicates unmixing nature and contains 3wt% H_2O and 300 ppm CO_2, suggesting the depth of crystallization of 6km or deeper.

The evidence described above indicates that a shallow and a deep reservoir are involved in the 1707 eruption. The first is shallow as well as 4-6 km, and the deeper is around 25km. As most basalts of Fuji volcano show evidence of mixing between a SiO_2-rich melt such as andesite, and a basalt magma, the magma plumbing system derived from the analysis of the 1707 eruption might be applied to the usual eruptions through the development of Fuji volcano.

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