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Generation processes of mafic inclusions of Fujiyama volcano in northern part of Takahara volcano, northeast Japan

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Takahara volcano is a Quaternary stratovolcano located on volcanic front in the southern part of northeast Japan arc. This study focused on Fujiyama volcano formed in northern part of Takahara volcano. It is a small lava dome composed of dacites. Takahara volcano was presumed to have finished its volcanic activity ca. 100 ka (Inoue et al., 1994), but Fujiyama volcano was clarified to have been formed at 6.5 ka (Okuno et al., 1997; Takashima, 1999).

Magma mixing is accepted as one of the important processes leading to the formation of mafic inclusions (e.g., Eichelberger, 1975; Koyaguchi, 1986). The presence of mafic inclusions was already reported in Fujiyama volcano (Ikeshima and Aoki, 1962). However, there are no investigations for the mafic inclusions in Fujiyama volcano, and petrogenesis of the inclusions is not yet fully investigated. Therefore, we carried out the detailed microscopic observations and chemical analysis of minerals and whole-rocks for understanding genetic processes of these mafic inclusions and host dacites, and for presuming magma mixing mechanisms in Fujiyama volcano.

The mafic inclusions in Fujiyama dacites (SiO2=67.4-70.4 wt.%) have andesitic composition (SiO2=60.7 wt.%). They are dark in color and most inclusions have spherical to oblate in shape. In the boundary between host rock and inclusion, a few phenocrysts straddle the boundary. All inclusions have abundant vesicles. These features are similar to the mafic inclusions reported from other volcanoes, and clearly indicate that the inclusions were liquid when they were entrained by the silicic magma (e.g., Heiken and Eichelberger, 1980; Bacon, 1986). The host rocks (dacite) contain phenocrysts of plagioclase, quartz, orthopyroxene, hornblende, Fe-Ti oxides and rarely augite. The inclusions contain phenocrysts of plagioclase, orthopyroxene, augite, Fe-Ti oxides and rarely include hornblende and quartz. Groundmass of the inclusions contains acicular grains that are coarse compared to those of the host rocks, which indicates that they were formed by rapid growth (Lofgren, 1980).

Whole-rock major and trace element composition of the inclusions have composition between host dacites and basalts erupted during the earliest activity in Takahara volcano. In outline, chemical compositions have liner data trend in element variation diagrams which may be evidence of magma mixing between dacitic and basaltic magma. Plagioclase and orthopyroxene phenocryst cores in the host rocks and inclusions have a large variation in composition. Both rocks contain Ab-rich plagioclase, An-rich plagioclase, Fe-rich orthopyroxene and Mg-rich orthopyroxene. Reversely zoned textures are often seen in most Ab-rich plagioclase and Fe-rich orthopyroxene in the inclusions. Sr isotopic ratio (87Sr/86Sr) of the inclusion is slightly lower than that of the host dacite, which is also consistent with mixing of magma with two end-members.

From these results, it is presumed that magma mixing occurred between silicic magma and mafic magma in Fujiyama. Silicic end-member might have been close to in composition to the host Fujiyama dacitic magma, and mafic end-member might have been basaltic magma having similar composition to the products erupted during the earliest stage in activity of Takahara volcano. Therefore, it is suggested that the mafic inclusions were formed from resultant andesitic magma by the magma mixing.

Keywords: Takahara volcano, Fujiyama lava dome, Mafic inclusion, Magma mixing