Pre-eruptive magmatic processes of "Hakone Tokyo Pumice eruption"

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Hakone volcano is an active volcano located at the closest from the Tokyo metropolitan area, and had repeated caldera-forming eruption several times. The largest-ever eruption of Hakone volcano is the latest caldera-forming eruption that occurred at ~60 ka (VEI 6), and formed caldera structure at Gora area. This eruption started with a plinian phase, and followed by a pyroclastic flow phase. The plinian fall pumice, called Hakone Tokyo Pumice (HTP), covered all over Kanto area, and the pyroclastic flow reached about 50 km away from the eruptive center (Kasama and Yamashita, 2008). It is very important to investigate the pre-eruptive magmatic processes of this eruption, hereafter called "Hakone Tokyo Pumice eruption", in detail to evaluate the risk that an eruption of the same magnitude will occur in the future. Therefore, in this study, we clarified the pre-eruptive processes of the Hakone Tokyo Pumice eruption.

Samples were collected at Ashinoyu, Kanagawa prefecture. Pumice and scoria were found as essential clasts, and pumice with mafic enclaves was also observed. We analyzed whole-rock compositions using XRF (National Museum of Nature and Science), carried out the petrographic structure analysis using polarization microscope and SEM (Kyoto Univ.), and analyzed the major element compositions using EPMA (Kyoto Univ.).

Pumice was rhyolite from dacite (SiO_2 = 64-71 wt.%) with plagioclase, clinopyroxene, orthopyroxene, magnetite, ilmenite, apatite and olivine phenocrysts. Scoria was andesite (SiO_2 = 58-60 wt.%) with plagioclase, clinopyroxene, orthopyroxene, magnetite, apatite and olivine phenocrysts. Mafic enclaves were basalt to basaltic andesite (SiO_2 ~52 wt.%) with plagioclase, magnetite and olivine phenocrysts. The chemical compositions of the glass and phenocryst minerals suggest that four types of melts coexisted, and it is considered that there were four types of chemically different magmas in the magma chamber before the eruption. Whole rock compositions of SiO_2 > ~67 wt.% and SiO_2 < ~67 wt.% show different trends. According to the whole rock compositional trends at SiO_2 > ~ 67 wt.% and chemical zoning of plagioclase phenocrysts, it is suggested that the crystal differentiation occurred in the most silicic magma. According to the whole rock compositional trends at SiO_2 < ~ 67 wt.% and chemical zoning of plagioclase and olivine phenocrysts, it is suggested that magma mixing occurred in the magma chamber. Pre-eruptive temperature are estimated by using Fe-Ti oxides geothermometer to be 820-880 ℃. Pre-eruptive melt water content is estimated by using melt-plagioclase geothermo-hygrometers to be 4.2-7.2wt.%. These estimations indicate that the magma chamber was located at the depth of 5.5-10.5 km assuming that silicic melt was saturated with water. Timescale from the last magma mixing to the eruption was estimated to be 30 days to 1 year on the basis of the Fe-Mg diffusion modeling of an olivine phenocryst.

These observations suggest that the pre-eruptive processes of the Hakone Tokyo Pumice eruption progressed as follows: first a differentiated silicic magma existed in the magma chamber existed at depth $\geq$5.5-10.5 km, there mafic magma intruded and mixed, and the eruption began after about 30 days to 1 year from the last magma mixing.

The depth of the magma chamber at the Hakone Tokyo Pumice eruption roughly agrees with the depth of the current magma chamber estimated based on geophysical observations (~10 km: Yukutake et al.,

2015). In order to accurately evaluate the risk of the future eruption, it is necessary to clarify the details of the pre-eruptive processes after Hakone Tokyo Pumice eruption.

Keywords: Hakone volcano, pre-eruptive magmatic process, caldera-forming eruption

