# Magma plumbing system and eruption triggering process of the lava dome forming eruptions from 45ka to 10ka in Haruna Volcano—Comparison with two eruptions at Futatsudake in the 5th to 7th century—

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Haruna volcano is located in the southern end of the NE Japan arc. Recently, Geshi and Takeuchi (2012) divided its whole activity into older activity (500-240ka) and newer activity(45ka-). There have been many whole rock data for whole activity of Haruna volcano (Geshi and Takeuchi, 2012; Takahashi et al., 2016). However, limited study has provided detailed petrological data including mineralogical ones. One exception is Suzuki and Nakada (2007, J. Petrology) which examined latest eruption in Haruna volcano, Futatsudake-Ikaho eruption (late 6th century to early 7th century). This study focuses on four lava dome eruptions that took place from 45ka to 10ka. We compare data from older lava domes with those of the Futatsudake-Ikaho eruption. The stratigraphic relation between the lava domes and tephra constrains the approximate ages for the four lava domes; 45-29ka for both Haruna-Fuji and Jyagadake, 20-15ka for Somayama, 10ka for Mizusawayama (Geshi and Takeuchi, 2012). The total volumes of ejecta for the four lava domes vary between 0.06-0.3km$^3$ (total value for Haruna-Fuji and Jyagadake), while that for Futatsudake-Ikaho eruption is ca. 1.0km$^3$. Most samples of four lava domes were directly from lava domes. As to Mizusawayama eruption, we also used lava blocks in deposit of either pyroclastic flow or talus accumulation. Some lava samples include dark inclusions. Therefore, we define parts other than dark inclusions as host part. The total number of samples for the host was 24 (5 for Haruna-Fuji; 4 for Jyagadake; 8 for Somayama; 7 for Mizusawayama), while the total for the dark inclusion was 4 (3 for Haruna-Fuji; 1 for Mizusawayama).
Suzuki and Nakada (2007) proposed for Futatsudake-Ikaho eruption that mush-like felsic magma ($SiO_2$ 60.5-61.5 wt.%; 820-850C) was remobilized through heating by and mixing with mafic magma, resulting in the eruption. This time, we have found for older four lava dome eruptions that similar two endmember magmas and similar eruption triggering process are involved. The host parts ($SiO_2$ 59.5-64.5 wt.%) contain phenocrysts of Pl+ Opx + Hb + Fe-Ti oxides +Qtz. One host sample of Somayama (59.5 wt.%; minimum of all) include also Ol phenocrysts. Phenocrysts phases other than Ol were all derived from felsic magma. EPMA analyses were conducted for Pl, Opx and Hb (Fe-Ti oxides are exsolved). Core compositions of three phases are similar among four lava domes; An50-85, 0.2-0.35 wt.% FeO, -0.03 wt.% MgO for Pl; Mg# 63.5-67.5, Wo 0.8-1.9 for Opx; Si 6.42-7.16, Mg# 0.73-0.84 for Hb. Also, these compositionally resemble those in Futatsudake-Ikaho eruption. The application of Putirka (2016) to cores of Hb yield <850C and SiO2=68-72 wt.% for the melt that crystallized Hb. The temperature is consistent with the value estimated by Suzuki and Nakada (2007) for low-temperature endmember magma using Fe-Ti oxide thermometer. Rim data are available for Pl and Opx (Hb has break down rims). The lower the bulk SiO2 contents of the host part, the higher the Mg # and Wo values (Opx) and the higher FeO and MgO values (Pl) at the rims. These rises are rarely seen in the host samples with more than 63 wt.% in bulk SiO2. In the four lava dome eruptions, the low-temperature magma (mush) was common, but depending on the degree of the influence of the high-temperature magma immediately before the eruption, the difference of whole rock composition of the final product (host part of the lava) was generated. Also, it can be noted that host samples with more than 63 wt.% in SiO2 are hardly affected by magma mixing and heating. The bulk composition of the low-temperature endmember magma appears to be slightly different between the

 

older four lava dome eruptions and the Futatsutake Ikaho eruption. The bulk composition for Futatsutake Ikaho eruption is SiO2 60.5-61.5 wt.% based on the analyses of white pumices. The facts previously mentioned indicate that the bulk composition for the older four lava dome eruptions are SiO2 = 63 wt.% or higher.
Similarities between the older four lava dome eruptions and the Futatsudake-Ikaho eruption were confirmed even for high-temperature endmember magma. Dark inclusions (50.9-55.1 wt.% in SiO2) are also mixing products of the same two endmember magmas that produced the host part. Among the dark inclusions, those less affected by the low-temperature magma has close SiO2 contents to those of high temperature magmas in Futatsutake Ikaho eruption (about 52 wt.%). Compositions of Ol phenocrysts that were derived from high temperature magmas (78-80.5 in Mg#) also support this idea.

Keywords: Haruna volcano, Lava dome, Mush-like felsic magma, Magma mixing, Heating from hotter magma, Eruption trigger

 