# Temporal changes of magmas that caused lava dome forming eruptions in Haruna volcano in past 45,000 years

*Yuki Suzuki[1], Yurika Toeda[2], Shinya Kimura[2], Rei Tanaka[2]

1. Department of Earth Sciences, Faculty of Education and Integrated Arts of Sciences, Waseda University, 2. Department of Earth Sciences, School of Education , Waseda University

Haruna volcano is an active volcano which 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 (in the place of Futatsudake lava dome). They showed that mush-like felsic magma having Pl+ Opx + Hb + Fe-Ti oxides ($SiO_2$=60.5˜61.5 wt.%) was remobilized by injection of nearly aphyrik mafic magma. Along with the eruption triggering process, they also discussed storage depths of the endmember magmas. Such petrological information on past eruptions can be mandatory in future activity. First, it provides useful information for geophysical observation. Second, it helps us distinguish between juvenile and accessory material in ash which is the first sample to examine in most eruptions.

We are advancing petrological examination of newer volcanic activity (45ka˜) in Haruna volcano. The newer activity started with caldera forming eruption, followed by several lava dome forming activities in the area from the summit to the eastern flank. The lava domes include Haruna-Fuji, Jyagadake, Somayama, Mizusawayama and Futatsudake. The stratigraphic relation between the lava domes and tephra constrains the approximate ages; 45˜29ka for both Haruna-Fuji and Jyagadake, 20˜15ka for Somayama, 10ka for Mizusawayama (Geshi and Takeuchi, 2012). Two eruptions occurred in Futatsudake; the older activity (late 5th century˜early 6th century) is called Futatsudake-Shibukawa eruption, while the younger activity (late 6th century˜early 7th century) is called Futatsudake-Ikaho eruption (Soda, 1989). This time, we examined older four lava dome forming eruptions and compared their characteristics with those of lava and pyroclasts from two Futatsudake eruptions (Suzuki and Nakada, 2007; Suzuki's unpublished data). Most samples of older lava domes were directly samples from lava domes. As to Mizusawayama eruption, we also used lava blocks in deposit of either pyroclastic flow or talus accumulation.

Some lava samples of older four lava dome eruptions include dark inclusions. The host part (i.e. excluding the dark inclusion) has whole rock compositions ranging from 59.5˜64.5 wt. % in $SiO_2$. Most lava samples show phenocryst assemblages of Pl+ Opx + Hb + Fe-Ti oxides + Qtz. A lava sample with minimum whole rock $SiO_2$ content (from Somayama) exceptionally has olivine along with above phases. The clear petrological difference of older lava samples, in comparison with those of two Futatsudake eruptions, is the presence of quartz phenocryst. The petrological characteristics of older lava samples also show that older, four lava dome eruptions were also triggered by a similar process as the Futatsudake-Ikaho eruption studied in Suzuki and Nakada (2007); injection of mafic magma (with olivine) into the reservoir of mush-like felsic magma resulted in their mixing and/or hearing of felsic magma. The lava samples of older four lava dome forming eruptions show a systematic increase of phenocryst abundance with increase of whole rock $SiO_2$ contents, indicating that the crystal abundance of mafic endmember magma is low, as in the case of Futatsudake-Ikaho eruption.

We infer that mush-like felsic magma in the older four lava dome eruptions had 60.9˜64.5 wt. % in $SiO_2$, by excluding whole rock data of Somayama lava with olivine (clear evidence of mixing). These $SiO_2$

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contents are higher than those of felsic endmember magma in the two eruptions in Futatsudake ($SiO_2$ =60.5˜61.5 wt. %; from white pumices in the Futatsudake-Ikaho eruption and juvenile lava blocks in the block and ash flow deposits of Futatsudake-Shibukawa eruption). The higher bulk SiO2 contents may have stabilized Qtz in the older felsic magma. At the same time, we infer that felsic magmas erupted in different times (45ka˜10ka, and after 5th century) have common origin, although the final felsic magma had different crystal phase depending on the final storage condition. The phenocryst compositions support the common origin. For example, the lava samples from the older domes have plagioclases with cores of An50-80 and orthopyroxenes with cores Mg# ca. 65, both of which are similar to those of Futatsudake-Ikaho eruption (Suzuki and Nakada, 2007).

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

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