The occurrence and petrology of the block and ash flow deposit from the Futatsudake-Shibukawa eruption, Haruna volcano

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Haruna volcano is located in the southern end of the NE Japan arc. The latest two eruptions occurred at Futatsudake; Shibukawa eruption in late 5th to early 6th century (0.4 DRE km^3), and Ikaho eruption in late 6th to early 7th century (0.99 DRE km^3)(ages from Geshi and Oishi, 2011; volumes from Yamamoto, 2013). Suzuki and Nakada (2007) conducted petrological study of Ikaho eruption to reveal eruption triggering process. First, injection of mafic magma into the mush-like felsic magma generated mixed magma and heated felsic magma. Then, these low viscosity magmas opened the conduit and vent, resulting in the decompression of whole reservoir. It is indispensable to study two eruptions from a continuous view point, because two eruptions occurred from the same place at an interval of only several decades.

The outcrops of the Shibukawa eruption are categorized into those consisting of block-and-ash-flow (BAF) deposit (this presentation) and those consisting of fine pyroclasts derived from pyroclastic surge and phreatic explosion (Maruyama and Suzuki, 2019; this conference). Outcrops of BAF deposit locate in the vicinity of river valleys, while outcrops of fine pyroclasts locate away from the valleys. The BAF deposit includes relatively large (up to 30cm) juvenile pumiceous blocks, allowing more precise determination of bulk composition of erupted magma than the fine pyroclastic deposit. We investigated four outcrops, two of which locate along Owagawa and Noborisawagawa in the NE flank of the volcano, and two of which locate along Haruna-Shirakawa in the SE flank. Geshi and Oishi (2011) recently clarified the BAF deposit in the SE flank is the product of the Shibukawa eruption by the carbon dating. At some outcrops, BAF deposit could be divided into subunits by the existence of intercalated ash deposit. In any outcrop/subunit, juvenile blocks were classified into white, gray and dark gray. In some blocks, parts with different colors are in stripes or irregularly mixed.

The pumice blocks are homogeneous felsic andesite with 60.6-61.7 wt.% SiO_2(N=21). There is no systematic difference in the composition between the NE and SE flanks. In Unzen 1991-1995 eruption, the composition of the erupted magma changed with time, and there was a temporal change in the flow direction of the pyroclastic flow (Nakada and Motomura, 1999). The present data of Shibukawa eruption show no tendency like that. In the representative six samples covering the pumice color variation, Hb, Opx, Pl, Qtz and Fe-Ti oxides present as phenocryst phase. But, Qtz is quite rare, as we observed only one crystal in 8 thin sections. Phenocryst phases other than Qtz form aggregate, indicating they crystallized in equilibrium. Dusty zone was observed in the plagioclase rim, showing that the melt became undifferentiated just prior to the eruption, due to 1) mixing with hotter magma, or 2) heating by hotter magma. There is no change in whole rock composition and phenocryst assemblage with pumice block color. The different color is likely to be caused by different amount of groundmass crystal (Gardner*et al.*, 1998). The breakdown of Hb was observed only in dark gray blocks.

The felsic endmember magma of the Ikaho eruption erupted as white pumice (60 to 62 wt.% SiO_2). The white pumices contain phenocrysts of Hb, Opx, Pl and Fe-Ti oxides. Therefore, it is highly probable that the felsic magma similar to that in Ikaho eruption was active in the Shibukawa eruption. In the Ikaho eruption, ejecta with obvious characteristics of magma mixing (gray pumice and lava, down to 57.5 wt.% SiO_2) have been confirmed. It means that the mixing ratio of the high-temperature magma in the Shibukawa eruption (even if it happened) was very small. In the future, as well as exploring the eruption

triggering process of the Shibukawa eruption in detail, we need to investigate phenocrysts derived from the felsic magma for the Ikaho eruption. They might record the effects of heating and mixing by high-temperature magma, which occurred several decades before the eruption.

Keywords: Haruna volcano, Block and ash flow deposit, Mush-like felsic magma , Eruption trigger, Magma mixing, Heating from hotter magma

