Magma plumbing system and eruption mechanism in recent eruptions of Haruna volcano, central Japan

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In last tens of thousands of years, felsic magma activity in Haruna volcano has produced at least five lava domes along with fall and flow deposits (Oshima, 1986). As seen in geological records of two Futatsudake eruptions in 6th century (Soda, 1989), the activity can be highly explosive. However, we had no clear idea about structure of magma plumbing system because of no historical eruption and syneruptive geophysical observation. Thus, for future eruptions, this petrological study tried to reveal the magma plumbing system. This time, results from latest eruption are presented. The eruption in the middle of 6th century started with the Plinian phase (1.2 km^3; Arai, 1993), followed by the column-collapse type pyroclastic flow phase, and ended with lava dome emplacement. In fall and flow deposits, white pumice fragments are found in all eruptive units, while gray pumice and banded pumice (consisting of white and gray parts) are limited to the first eruptive unit of the Plinian phase.

Following magma involved in the eruption; phyric felsic magma (60-61wt % in bulk SiO2; with phenocrysts of orthopyroxene, amphibole, Fe-Ti oxides and plagioclase; 820-850C), aphyric mafic magma (52wt% in SiO2; 1100-1150C) and phyric mafic magma (with olivine and clinopyroxene; 1100-1150C). Gray part of pumice and dome lava are products of homogeneous mixing between the felsic and mafic magmas. The mafic endmember is aphyric in the gray part of pumice and is phyric in dome lava. The felsic magma appeared without mixing in middle of the eruption, but that erupted in the first eruptive unit of the Plinian phase has record of heating (-880C) started just prior to the eruption.

Following lines of evidence indicate two mafic magmas are from a storage system. Groundmass olivine crystals (-100micrometer) in gray part of pumice are from the aphyric mafic magma. Their core compositions are similar to rim compositions of olivine phenocrysts in dome lava, indicating that aphyric mafic magma is chemically equivalent to melt part of the phyric mafic magma. Olivine and clinopyroxene can coexist in mafic melt at relatively high pressure (7-10kb, e.g. Presnall and Hoover, 1987). Actually, Melts program yields more than 4kbar for olivine and clinopyroxene to be first liquidus phases in melt with 52wt% SiO2. This pressure can be consistent with depth of recent low-frequency earthquakes beneath Haruna volcano (33-44km; Ohara, 1993). On the other hand, storage pressure for the felsic magma can be around 4 kbar, assuming water saturation of magma. Thus, storage system of the felsic magma was probably separated from that of mafic magma, and located over shallower depth. As a result, following model explains the supply of two mafic magmas to the felsic magma reservoir; in ascent, melt was partly separated from a main phyric magma batch, and arrived to the felsic magma reservoir earlier.

The injection of the mafic magma into the felsic magma reservoir triggered the eruption as follows. The felsic magma was nearly rigid (with viscosity of 2.0 *10^7 Pa /s) even in reservoir due to high phenocryst abundance (-50 vol%). This means that the felsic magma had no ability to erupt for itself. The felsic magma and the aphyric mafic magma (7.0 *10^2 Pa /s in max.) formed a mixed magma with lower viscosity than that of the felsic magma. The mixed magma had ability to erupt for itself, and vent opening by this mixed magma made the high-viscosity felsic magma in reservoir erupt.