Evolution of magma ascent during the climactic phase of 2011 eruption of Shinmoe-dake, Japan, in view of groundmass microlite textures

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The climactic phase of the Shinmoe-dake 2011 eruption is characterized by three sub-Plinian events (Jan 26PM, 27AM, 27PM) and a lava accumulation stage in the crater (Jan 27-29), both of which were accompanied by vulcanian events. This study aimed at reconstructing magma ascent in conduit for this phase by using groundmass microlite textures. We then related the changes of magma ascent conditions with those of eruption intensity and style.
The analyzed samples include pumiceous clasts (gray and brown) and denser lava-like juvenile clasts from sub-Plinian (Layer 2-5, each with lower and upper subunits) and Jan 28 vulcanian deposits, and a lava block ejected from the crater on the Feb 1 vulcanian event. These are from magmas of the same chemical and storage conditions just prior to ascent from the reservoir. Representative samples for the textural analyses were selected based on bulk density that reflects syneruptive ascent rate and resultant degree of degassing. Subunits of Layer 2 to Layer 4 resemble one another in bulk density distribution (0.8~1.7 g/cm^3), except Layer3-up with extension to higher density (0.8~2.1 g/cm^3). Also, subunits of Layer 5 to Jan 28 resemble one another (0.8~2.8 g/cm^3) in having extension to much higher density than Layer3-up. The bulk density of Feb 1 lava (2.1g/cm^3) corresponds to high value observed in Layer 5 to Jan 28. The textural analyses were carried out for samples with maximum and minimum bulk densities in representative units (Layer2-up, 3-up, 4-up, 5-low, 5-up, Jan28, Feb 1 Lava).
The crystal size distributions (CSD) of plagioclase microlites are almost the same for all samples over the larger size (40-100 micrometer length in 3D). CSDs over smaller size change depending on the bulk density; dense samples from Layer 5-low, Layer 5-up, Jan 28 and Feb1 lava have steeper CSD than low density samples. These lines of evidence show magma ascent conditions at deeper part of conduit were constant throughout the climactic phase, but condition at shallow part was changing. The higher crystal numbers in dense samples can be explained by either a) higher ascent rate (when undercooling is relatively small, as a whole) or b) lower ascent rate (when undercooling is relatively large). Model b) is more likely in the present case, if decreasing trend of eruption intensity is considered. The bulk density distribution and correlation between bulk density and ascent rate show that the decrease of magma ascent rate at shallow part occurred gradually. The ascent rate variation widened in the third sub-Plinian event (Layer 5), by a little appearance of slowly ascended magmas. Only slowly ascended magmas came to occupy the conduit in the lava accumulation stage.
Suzuki *et al*. (2014 JPGU meeting) proposed that Layer3-up corresponds to the start of the second sub-Plinian event, based on that the bulk density distribution of Layer3-up has an extension to higher density, and degassed magma could have been formed in conduit during the resting phase (Jan 26, 19:00 –Jan 27, 2:00; between the first and second sub-Plinian events) due to decreased eruption rate. The textural study this time newly revealed CSD of plagioclase microlites of high density sample (ca. 2.0 g/cm^3) from Layer3-up resembles those of other pumiceous clasts from the first and second sub-Plinian events, implying conduit residence time of the degassed magma was not extremely long. This interpretation is consistent with the infrasound data indicating quasi-steady state magma flow for the resting phase.

Keywords: Shinmoe-dake, Bulk density, Groundmass microlite, Magma ascent, Degassing, Infrasound