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Bulk density change of juvenile clasts during the climactic phase of the 2011 Shinmoe-dake eruption

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In the 2011 eruption of Shinmoe-dake, three sub-Plinian events occurred intermittently between Jan 26 PM and Jan 27 PM (1/26PM, 1/27AM and 1/27PM). This was followed by lava accumulation in the crater (Nakada et al. 2013, EPS). Based on Suzuki et al. (2013a, JVGR) that clarified characteristics and plumbing system of the erupted magmas, we reveal evolution of conduit magma flow during the climactic phase as above, by using groundmass textures. The questions we would like to address are, 1) mechanisms that led to the intermittent sub-Plinian events, including triggering process of each event, 2) timing and condition of syneruptive magma ascent that were responsible for the shifting eruption intensity and style.

As a preliminary result, we here present bulk density data for samples (gray and brown pumices and lava) of the same chemical and storage conditions just prior to ascent from the reservoir. If lithic fragments in sub-Plinian deposit can be judged juvenile (i.e. from the 2011 magma) based on whole rock composition and appearance under the microscopy, they were included in the sample set for the bulk density analysis. Generally, the bulk density data reflect syneruptive ascent condition and resultant degree of syneruptive outgassing. This time, the data allowed us to select representative samples for further textural analyses. The bulk density data also helped us newly define the horizon corresponding to the start of the second sub-Plinian event.

Following the results in Maeno et al. (revised) and Nakada et al. (2013, EPS), the sub-Plinian deposit was collected at locations on dispersal axes and 2-3km from the crater. The following unit numbers are after Nakada et al. (2013). We had no difficulty in identifying the deposit of the third sub-Plinian event (Layer5), because the field survey was in progress at the time of occurrence. The lower units (Layer2, 3 and 4) exhibit reverse grading from layer2 to layer3 and normal grading from layer3 to layer4, as if it was generated in a single event. This occurrence had prevented us from identifying the boundary between the first and second sub-Plinian events. As far as area of the sampling is considered, we believe no deposition during the resting phase between the first and second sub-Plinian events (Jan 26, 19:00 - Jan 27, 2:00) . The most likely deposit for the resting phase is ash, if plume height of 3.5km and lower (Shimbori and Fukui, 2012; lower than 6-7km during the sub-Plinian events) is considered. We did not find ash layers between the two of the three layers (layer2, 3 and 4).

The bulk densities of the samples change systematically with the subunits; 1.0-1.7 g/cm^3 from Layer2-low to Layer3-low, 1.0-2.0 g/cm^3 in Layer3-up, and 0.8-1.4 g/cm^3 from Layer4-low to Layer4-up. The average densities for the subunits are 1.25 g/cm^3, 1.28 g/cm^3, 1.27 g/cm^3, 1.44 g/cm^3, 1.14 g/cm^3, 1.17 g/cm^3 in order from Layer2-low.

We propose that Layer3-up corresponds to the start of the second sub-Plinian event, based on a judgment that high-density pumices in Layer3-up are from upper-conduit degassed magma that was generated during the resting phase (Jan 26, 19:00 - Jan 27, 2:00). The infrasound and seismic data (Ichihara et al., submitted) recorded no explosion for the resting phase. Therefore, we infer the degassed magma did not block the conduit completely.

We could not know exact time of the Layer4 deposition. However, the lower bulk densities in Layer4, in comparison with those of layer3-up, is consistent with the temporal increase of plume height (e.g. ca. 5km at AM2 of Jan 27 $<$ca. 7km at AM4 of Jan 27) and mass eruption rate (Ueda et al., 2013) during the second sub-Plinian event. In this model, we however must explain smaller pumice sizes in Layer4 in comparison with those of Layer3-up.

Keywords: Shinmoe-dake, Sub-Plinian eruption, Bulk density, Outgassing, Infrasound, Plume height