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Bifurcation condition of the eruption explosivity in the Asama-Maekake volcano inferred from the lithic fragments

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Abundant dense, angular lithic fragments are contained in the pumice fall deposit of Asama 1108 eruption. The lithic fragments have the same chemical composition with the pumices of the same deposits. Because the erupted materials of the three historical and pre-historical eruptions of the Asama volcano have different bulk-chemical compositions with each other, the accordance of the bulk-rock chemistry clearly shows that most of the lithic fragments are juvenile. The abundance of the lithic fragments varies from 5 to 40 % among the subunits of the fall deposit, and their average volume is 0.01 m^3in each subunit. Since the lithic fragments are voluminously and continuously contained in the pumice fall deposit, they were not formed by the Vulcanian eruption but effused during the Plinian eruption. The lithic fragments were not coated with vesicular matrix, showing that the fragments were taken into the mist flow regime, i.e., after the magma fragmentation that produced the pumice clasts. Density of the juvenile material shows clear bimodal distribution with 1.0-1.4 and 1.4-2.7 g/cm^3. Here we distinguished between the lithic fragment and the pumice at 1.4 g/cm^3.
The An content of plagioclase microlites in the lithic fragments ranges from An 55 to 75. This range and frequency distribution of the An content are quite similar to those of the microlites in the pumices. This shows that the lithic fragments and the pumices have similar decompression history from magma chamber to the shallow conduit. The groundmass of the pumices has a porosity ranging from 40% to 60%, and have a positive correlation with groundmass crystallinity. The highest crystallinity of the pumice, which has a groundmass porosity of 60%, coincides with the lowest of the lithic fragments. The groundmass porosity of 60% is also the critical porosity at which pore connectivity steeply increases. These petrographical observations strongly suggest that the lithic fragments are the collapsed material of the vesiculated magmas just before they fragmented to form the pumices. The lithic fragments often contain mosaic texture and healed cracks, showing that they were formed by repeated shear-induced fragmentation and annealing. The average water contents of the glasses in the groundmass of the lithic fragments and the pumices are 0.35 and 0.54%, respectively; this shows that they were quenched at depths <200 and < 300 m, respectively. The average volume of the lithic fragments in each sub-unit is equivalent to a magma plug with diameter of 200 m and depth of 200 m, which is almost equal to the present crater size of the Asama-Maekake volcano. These lines of evidences indicate that the magma ascent condition was just near the bifurcation between formation of lava plug via foam compaction and magma fragmentation as a Plinian eruption. Namely, the following sequence was repeated in the 1108 eruption: 1)formation of the dense lava plug via foam collapse, accompanied by the shear -induced fragmentation of the welded lava 2)excess pressure accumulation of the magma column in the conduit 3)pumice eruption with entrainment of the cracked lava plug as lithic fragments, resulting in the erosion of the vent lava plug and collapse of the eruption column, producing the Oiwake pyroclastic flow. The magma ascent rate of the 1108 eruption could therefore be a rough indication to predict the eruption explosivity in the future eruption of Asama volcano, as long as the boundary conditions such as magma compositions, excess pressure of magma chamber and

conduit geometry are similar to those of the 1108 eruption.

Keywords: Asama volcano, Plinian eruption, Vulcanian eruption, explosive eruption, Lithic fragments