

Vesicular magma attachment and shock tube: A model for vulcanian eruptions at Sakurajima volcano

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BL-Swarms is the phenomenon of numerous BL-type earthquakes occurring within a few days, prior to explosive event. The attachment of vesicular magma beneath degassed magma cap occurs during BL-Swarms (Miwa and Toramaru, 2009). The present study clarifies the relation between structure of shallow conduit magma and the amplitude of pressure wave, and proposes a model for the vulcanian eruptions with BL-Swarms at Sakurajima volcano. We performed the textural analysis of vesicle and particle shape, and measured the water content in groundmass glass using infrared spectroscopy. The VNDDs (vesicle number density distributions) were made from textural data. The median of VNDDs, which is inverse measure of degassing, has positive correlation with the amplitude of pressure wave (A_{pw}) and ranges from 10 to 158 (number/mm²). The average water content reflecting the pressure of magma has positive correlation with A_{pw} . These comparisons show that large amount of the attachment of less degassed magma beneath dense magma results in a larger A_{pw} . Next, we model the eruptions using shock tube theory. If magma fragmentation occurs from vesicle, the fai_{obs} (vesicularity of vesicles preserved in ash) should be different from fai_{dr} (vesicularity of bubble driving the eruption). Because upper limit of irregularity (perimeter / equivalent circle of particle) of particle shape increases with increasing the VND, we assume that the V_{obs} (volume of vesicles preserved in ash) is proportional to V_{dr} (volume of bubble driving the eruption) with proportional constant of x and derived following relation between fai_{dr} and fai_{obs} .

$$fai_{dr} = x fai_{obs} / (1 + fai_{obs})$$

Using the water content, VND and particle vesicularity data from the ash, the empirical relation between magma pressure and the fai_{obs} is derived and used for shock tube calculation. The result of calculation shows that the range of corrected A_{pw} (0.15-1.2MPa) can be explained by fai_{obs} (vesicularity of 0.01-0.60) observed in the ash. Therefore, we conclude that the vulcanian eruption with BL-Swarms at Sakurajima volcano can be explained by 1) attachment of vesicular magma beneath dense magma cap and 2) shock tube nature of conduit system (conduit + shallow conduit magma).

Keywords: Volcanic ash, Pressure wave, Shallow conduit magma, Shock tube, Vulcanian eruption, Sakurajima volcano