Compression experiments of foamed rhyolite

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Degassing mechanism is one of the most important issues to understand dynamics of the volcanic eruption. A model for foam collapse leading to the non-explosive lava effusion, in which foamed magma is compacted and permeable degassing occurs has been proposed (e.g. Eichelberger et al., 1984). The detail mechanisms of the foam collapse, however, are not well understood. It is pointed out that fragmentation, which has been widely known as the critical condition for the explosive eruption, enhances the progressive degassing (e.g. Gonnermann and Manga, 2003). Rheological properties of the foam are thus crucial to understand the eruption styles.

In order to examine the compression behavior of rhyolitic foam, we have carried out uniaxial-compression experiments using tubular siliconit furnace at atmospheric pressure. Obsidians with ca.0.7wt% H2O (from Wada Pass, Nagano Pref.) were used as starting materials. The basic design for bubble growth experiments is Heat and Quench Technique (e.g. Liu and Zhang, 2000). Firstly, cubic obsidian pieces with a side of ca.1cm were put into alumina cylinder, then heated in the muffle furnace. The temperature was kept at 900-1000 oC for 5-7 minutes and quenched. Secondly, the foamed sample in a compression vessel was heated using the siliconit furnace for 5-10 minutes. Afterwards, the melted sample was compressed by loading via sintered pyrophyrite piston.

In the run with pre-heating of 5 minutes in the siliconit furnace, and load of 0.07Mpa, we were able to observe the compaction of the foamed sample and obtained the stress-strain relationship. The sample was compressed for 3-4mm rapidly during the first 5 minutes, then for 2-3mm slowly in the next 10 minutes. This might show that the rheological property of the foam was changed with their strain. The color of the foam changed from white to gray by compression, which is consistent with the relation between color and vesicularity of natural pumices. The bubbles of the compressed part were deformed perpendicular to the compression axis. On the other hand, the bubbles far from the piston retained the original shape which was slightly elongated along the alumina cylinder.

The foams produced by heating for 10 minutes in the muffle furnace were fragmented by compression experiment with the same load, forming volcanic ash-like fragments by the brittle fracture of the foam. This indicates that the volcanic ash can be produced compression at ascending magma head as well as by the internal stresses of bubbles due to vesiculation.

Localized deformation of bubbles near the piston suggests that foam has viscoelasticity. In our experiments, successive dehydration of melt occurs during heating. Change of meltfilm property should be considered for farther analysis of the experimental results.