Fragmentation of vesicular magma with non-uniform distribution of bubbles

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Brittle fragmentation is a key process in explosive eruption. Estimation of the decompression time in real explosive events indicates that the style of fragmentation is to be “brittle-like fragmentation” [1], which was defined as the solid-like fracture of the material whose bulk rheological properties was close to fluid state. We present our recent laboratory experiments and numerical simulatation, which clearly indicate the fact that the internal non-uniform structure of bubbles is a major source of crack development that may lead to brittle-like fragmentation.

In laboratory experiment, syrup containing bubbles as a magma analogue because syrup has large rigidity close to magma, and can have wide range of viscosity like magma. A rapid decompression apparatus was used to simulate the fragmentation. We conducted X-ray CT imaging at SPring-8/JASRI to observe the internal structure of the specimen (bubbly syrup) before decompression. Then we observed its dynamic response during decompression by high speed photography. In numerical simulation, we conducted finite element analysis of the specimen under the rapid decompression. We computed stress field of a simplified 3D model of the specimen in which we extracted just around a primary large bubble with a satellite small bubble. The specimen was assumed to be a Maxwell fluid.

We found that the surface crack propagates along the line of computed stress concentration. The maximum stress concentration, which is the trigger of fragmentation, occurred on the surface of satellite bubble, at which the local brittleness [2] is large enough when the stress reaches the critical value of fracture.

[1] Kameda et al. (2013) *J. Volcanol. Geotherm. Res.* **258**, 113-125. [2] Ichihara & Rubin (2010) *J. Geophys. Res.* **115**, B12202.