Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SVC46-P08 Room:Convention Hall Time:May 25 18:15-19:30

X-ray CT observation of fragmentation of vesicular magma analogue

AOKI, Yamato[1*] ; KAMEDA, Masaharu[1] ; TSUGO, Mitsuaki[1] ; YAMADA, Akihumi[1] ; ICHIHARA, Mie[2] ; OKUMURA, Satoshi[3] ; UESUGI, Kentaro[4]

[1]Mech. Systems Eng.,TUAT, [2]ERI, Univ. of Tokyo, [3]Earth Sci., Tohoku Univ., [4]JASRI

”Explosive eruption” of volcano adversely affects to our lives. The explosive eruption may be triggered by the rapid discharge of gas in vesicular magma due to its brittle fragmentation. We focused our attention to the ”brittle-like fragmentation” (Kameda et al. JVGR 2013) which was defined as the solid-like fracture of the material whose bulk rheological properties was close to fluid state. We tackle to elucidate the mechanism of the brittle-like fragmentation by laboratory experiment.

Recent our laboratory experiment (Shida et al. IAVCEI 2013) showed that the onset of brittle-like fragmentation depended on the size of specimen even if the bulk rheological properties and void fraction remained constant. The probability of the fragmentation decreases as the size decreases. In our experiments, the heterogeneity of spatial and size distribution of the bubbles was more remarkable in larger specimen than in smaller one. We guess that this heterogeneous distribution of the bubble in the specimen is a main source of the brittle-like fracture.

On observing the behavior of the fracture, we use the syrup as magma analogue. The syrup is suitable for the magma analogue because its rigidity is close to the rigidity of magma, and its viscosity is varied widely by hydration or dehydration. Furthermore, we add H_2O_2 and MnO_2 into the syrup and generate O_2 gas bubbles to mimic the vesicular magma. We use the rapid decompression equipment to observe the fracture of the specimen. It consists of the pressure container whose top is sealed by plastic (Lumirror) film. A thin nichrome wire is bonded to the film. We set the specimen in the pressure container, and pressurize the container by filling nitrogen gas up to our desired value. After pressurization is completed, we energize the nichrome wire by rapid current discharge from capacitor. The film is abruptly ruptured by the heat of the nichrome wire, then rapid decompression attacks the specimen. The specimen has a hemispherical shape whose diameter is about 20mm. We choose the viscosity of each specimen in the range from 10 MPa s to 200 MPa s. The initial pressure before decompression is 2 MPa. The characteristic time of decompression (the time when the pressure in the container reach 1/e of the initial value) is about 5 - 7 ms.

We conducted the X-ray micro CT imaging at BL20B2 in SPring-8 (JASRI) to observe the internal structure of the specimen. We took the transmission images of the specimen whose viewing angle was varied from 0 to 180 degrees every 0.1 degree. Each captured image has 2048 pixels in width and 1400 pixels in height. We conducted the CT imaging before compression, after compression, and after rapid decompression (at atmospheric pressure). We also captured the dynamic behavior of the specimen during decompression by high-speed radiography (100 fps).

From these experiments, we found that the fracture occurred at the parts where the large bubbles were accumulated. In contrast, the fracture did not occur at the parts where a large bubble independently existed. Furthermore, we found that the fracture may occur when the inter-distance of neighboring bubbles is close to the order of the bubble radius, even if the rheological bulk properties of the specimen is close to the fluid state (the brittleness is not near unity).

Keywords: Magma, Fragmentation, Rapid decompression, Brittleness, X-ray CT, Non-uniform distribution of bubbles