Oral | Symbol S (Solid Earth Sciences) | S-VC Volcanology

[S-VC50_2AM2]Dynamics of volcanic eruptions and igneous activities

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Fri. May 2, 2014 11:00 AM - 12:45 PM 315 (3F)

This session discusses the dynamics of volcanic and igneous activities such as magma accumulation, magma ascent in volcanic conduits, and dispersion of volcanic products. In order to understand such multi-scale phenomena, the researches of microscopic and macroscopic scales and the techniques that combine the different scales are required. We aim to discuss the latest approaches as well as the recent observations, laboratory experiments and analyses numerical simulations from the viewpoint of cross-cutting research.

12:30 PM - 12:45 PM

[SVC50-P07_PG]X-ray CT observation of delayed fragmentation of vesicular magma analog

3-min talk in an oral session

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A laboratory experiment was performed to understand the mechanism of fragmentation of vesicular magma, which is a trigger of explosive volcanic eruption. From the observation of Shinmoe-dake 2011 eruption, the viscosity of magma is not so high as its response is in solid manner. Thus, we aim to reveal the mechanism of brittle-like fragmentation of the magma which behaves in fluid manner. Rapid decompression test was conducted using syrup containing oxygen bubbles as a magma analogue. The decompression facility consists of a high-pressure chamber in which the specimen can be placed, and an electromagnetic valve. The pore structure of interior of the specimen was observed by X-ray microscopic tomography. The X-ray tomographic microscopy was performed at the BL20B2 beamline of the Japan Synchrotron Radiation Research Institute (JASRI, Hyogo, Japan). Initial structure of the specimen was observed by three-dimensional tomographic imaging. A digital charge-coupled device (CCD) camera was used as the detector whose imaging area is about 2048 pixels (horizontal) by 644 pixels (height) with spatial resolution of 8 μ m/pixel. We took 1800 projections over 180 degrees of rotation for tomographic imaging. High-speed radiography was performed during the decompression. The framing rate of radiography is 200 frames per second. The specimen has a semi-spherical shape whose diameter was 20 mm. The initial pressure (p_0) was 1.5 MPa, the characteristic time of decompression (t_{dec}) was 50 ms, the viscosity of syrup was about 1×10^8 Pa s, the initial averaged void fraction φ_0 was about 10%. We tested nine samples whose pore structure was different to each other. The fragmentation occurred with two samples in which a 10-mm-diameter bubble was contained, while the fragmentation did not occur using the seven samples whose pore structure was relatively uniform. The onset of fragmentation is 960 ms after the decompression was started. The onset was substantially delayed not only from the characteristic decompression time but also from the relaxation time of Maxwellian viscoelastic material (viscosity/rigidity = 150 ms). Referring to the radiographic images, we found that the fracture was initiated from a chain of small gas bubbles and a notch in the vicinity of the 10-mm (large) bubble. The internal crack may grow in ductile manner when the hoop stress around the large bubble increased due to

decompression. At a certain instance the stress concentration and the brittleness at crack tip may exceed the critical level, which leads to brittle failure of the crack. The experimental result indicates that brittle-like fragmentation can occur in the non-uniform vesicular magma even if the response of magma is in fluid manner.