Experiments with polyurethane foam toward simulating tube pumice

MASATOSHI OHASHI[1*], MIE ICHIHARA[1], ATSUSHI TORAMARU[2] AND OSAMU KUWANO[3]

[1]Earthquake Research Institute, The University of Tokyo, (*correspondence: m-ohashi@eri.u-tokyo.ac.jp)

[2]Department of Earth and Planetary Sciences, Faculty of Sciences, Kyushu University

[3]Japan Marine Science and Technology Center (JAMSTEC)

Tube pumice including elongated bubbles is a common product of explosive silicic eruptions forming calderas. Such bubble deformation is considered to occur in the processes of magma ascending in a conduit, which include vesiculation, flow, and fragmentation. Polyurethane foam is a candidate of analogue materials to be used to simulate the formation processes of pumice because it undergoes vesiculation, flow, and solidification at ordinary temperature and pressure. Here we present the bubble textures of the polyurethane foam and the time-dependent rheological properties during its formation, and discuss the factors controlling the bubble structures.

Polyurethane foam is a polymeric solid and produced by mixing two polymeric liquids (polyisocyanate and polyol). In this study, we use two polyurethane foams: one includes a foam stabilizer and the other not. According to X-ray tomographic imaging, the former has a homogeneous cellular structure while the latter includes elliptical bubbles. Bubbles in the former are smaller in size and larger in number density than those in the latter. This result is consistent with the function of a foam stabilizer that it stabilizes the interfaces of bubbles and prevents bubbles from coalescing.

We examine the temporal change of the rheology of the polyurethane foam from inflation to solidification. In order to measure viscoelasticity of polyurethane foam of which volume and rheology vary with time, we develop a method using a rheometer with a specifically designed concentric cylinder. Under oscillatory rotation, the temporal change of viscoelasticity and the time scale in which the material transits from solid to liquid are quantified.

Finally, a large strain is applied to each sample while it is solidifying. The relationship among bubble deformations, rheological properties, and straining condition is examined.