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Specific dehydration process in heating experiments of hydrated basaltic glass: 3-D vesicle textures and their time developments.

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3-D structures of vesicles in hydrated basaltic glass by heating and their time development (4-D structures) were examined using x-ray microtomography to understand dehydration process of basaltic magma.

Powder of AIST standard sample of basalt (JB-2) added by 1.01 wt.% water was sealed in a Pt capsule of 8 mm in diameter, heated in an internally-heated pressure vessel of TITECH at 2400 atm and 1300^{o}C for 1 hr, and quenched. The synthesized hydrated basaltic glass was cut into a cylinder (1.94 mm in diameter and 2 mm in height) and set in an alumina tube (2 and 3 mm in inner and outer diameter, respectively), which was placed on a stainless steel sample holder, which was set on a sample stage for tomography. The experiments were made by repeating the following cycle: the sample was heated in a box furnace at a constant temperature, cooled in an air, and then imaged by tomography. To avoid oxidation of the sample Ar gas flow of 2000 cc/min was applied in the furnace. Four sets of experiments were carried out (run-B1 at 675^{o}C for 0,5,10,30,40,60,80, and 100 min.; run-B2 at 675^{o}C for 0,5,15,20,25,35,45,55,65,75,95,115, and 135 min.; run-B3 at 700^{o}C for 0,5,15,30, and 60 min.; run-B at 700^{o}C for 0,5,10,15,20,25,30,40,45,50,55,60,70, and 80 min.). Tomographic imaging was made at BL20B2 of SPring-8 at 25 keV with the voxel size of 3.14 micron.

Vesiculation took place in two stages. Vesicles were formed first by heterogeneous nucleation on the sample walls as well as on small inclusions in the glass after 5 to a few tens min. heating, and grew into large bubbles of less than a few hundreds microns. These bubbles were not integrated with each other. After the first stage vesiculation, a large numbers of very fine vesicles of submicron to a few microns were formed at a location near the wall, and the fine vesicle-rich region (about 35 vol.% in porosity) grew inward at a constant rate of about 0.1 mm/min. When the fine vesicle-rich region covered the whole sample area, the vesiculation stopped. The sample volume was expanded finally about 1.3 to 2 times. The present vesiculation process has remarkable contrast with hydrated rhyolitic glass (obsidian), where vesicles are formed by homogeneous nucleation and grow to form a very porous and largely expanded foam structure.

Working hypothesis for the second stage vesiculation mechanism is follows: (1) the hydrated glass is disintegrated into anhydrous glass and water vapor without new nucleation, (2) fine vesicles of the vapor form 3-D network from the sample surface and the front of the vesicle network grows inward, and (3) water is transferred to the front by diffusion in the glass, to the surface through the network by a vapor pressure gradient, and finally escaped to the outside. This can explain the linear rate growth of the front. The presence of the vesicle network should be confirmed for further study, and more reliable kinetics and dynamics should be discussed.

If the second stage vesiculation mode in the present experiments is common in basaltic magmas, less violent eruptions of basaltic magmas can be attributed to this vesiculation mode, where water is easily escaped from the system. However, we do not know whether or not this mode occurs at high temperatures by pressure decrease. It is critical to search textures due to this vesiculation mode in natural basalts.