Geophysical Research Abstracts, Vol. 8, 05398, 2006
SRef-ID: 1607-7962/gra/EGU06-A-05398

Pattern and structure of basaltic reticulite: foam formation in lava fountains

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Two types of magmatic foams are generated in basaltic lava fountain eruptions: 1) scoria with predominantly spherical, closed vesicles and 2) reticulite consisting of a polygonal network of glass struts. Reticulite is less abundant than scoria but is a ubiquitous product of high fountaining events and forms as a consequence of expansion of gas bubbles to >95% by volume of the magma as it ascends in the hot core of fountains hundreds of meters high. The silicate melt rapidly quenches to glass while falling through cool air, thus preserving the delicate textures of the polygonal foams.

We examine the structures of reticulite samples from 1984-1986 fountain episodes of Kilauea volcano, Hawai'i. Cell shapes and sizes are characterized in 3-D using x-ray tomography and in 2-D from optical and SEM imaging of planar sections cut from samples. The structures are defined by trigonal glass struts (plateau borders) formed at the intersection of three faces (usually open because films are not preserved), which delimit cell boundaries. Reticulite generally consists of 12- to 14-sided cells, 1-4 mm in size, with hexagonal, pentagonal and quadrilateral faces. We compare the reticulite structures to those of other foams (e.g., soaps and popcorn) and to theoretical structures proposed by Kelvin (Phil. Mag., 1887) and Weaire and Phelan (Phil. Mag. Lett., 1994) that aim to minimize the surface area of cells that partition 3-D space into cells of equal volume. Finally we use basalt foam structures to constrain the kinetics of bubble nucleation and growth during eruptions as well as the physical mechanism of magma fragmentation in lava fountains (Mangan and Cashman, JVGR, 1996).