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Large vesicles record pathways of degassing at basaltic volcanoes

M. Polacci

Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Catania, Piazza Roma 2, 95123 Catania, Italy (polacci@ct.ingv.it)

At basaltic explosive volcanoes degassing controls magma dynamics and affects the style of eruptive activity. Gas is recorded in erupted products as vesicles. To better understand how gas is transported within basaltic magmas we performed the first 3D investigation of vesicles preserved in basaltic scoria via synchrotron X-ray computed microtomography, the only high-resolution, non-destructive technique available to reconstruct the internal structure of these porous materials. We chose products from the 2005 and 2006 explosive activity of Stromboli, a well-studied volcano of the Aeolian Islands, Southern Italy, famous for its persistent quiescent degassing and intermittent, mild to moderate, Strombolian explosive activity. The ultimate goal was to use vesicle analysis to investigate pathways of gas flow and the shallow conduit dynamics of the volcano. Vesicle volume distributions of scoria clasts are comparable among different samples, span many orders of magnitude in size and are characterized by a power-law with an exponent near 1. Interestingly, these distributions show the ubiquitous occurrence of one to a few large (volume $>$ 0.5 mmˆ3) vesicles, exhibiting mostly irregular, tortuous, channel-like textures, orders of magnitude greater in volume than all other vesicles in the sample. We compare observations on natural samples with results from numerical simulations and experimental investigations of vesicle size distributions in Stromboli basalt melts and demonstrate that this type of vesicle invariably forms in magmas with vesicularity $>$ 0.30. We suggest that large vesicles represent preferential pathways of degassing through which gas flows non-explosively along the conduit and is passively lost from the magma at the surface. Finally, we propose that this type of vesicle plays an important role in sustaining the daily, persistent activity of Stromboli as well as of other active, basaltic volcanoes.