Experimental investigations on degassing behavior and related seismo-acoustic markers: the effect of complex conduit geometries

Spina L.*[1], Morgavi D.[2], Cannata A.[3-4] & Perugini D. [2]

[1] Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Roma1, Rome, Italy.
[2] Department of Physics and Geology, University of Perugia, Italy.
[3] Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Etneo, Sezione di Catania, Italy.
[4] Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Catania, Italy.

Corresponding email: laura.spina@ingv.it

Keywords: analogue experiments, fractal conduits, seismic tremor.

One of the main challenge in monitoring active volcanoes is understanding gas-magma dynamics in volcanic conduits and relating them with their geophysical markers at the surface. Accordingly, we combine here two main approaches used to investigate conduit dynamics via indirect observations, i.e. analogue laboratory experiments and seismo-acoustic measurements, and address a crucial, yet unexplored, subject: the irregularity (i.e. the departure from an ideal smooth cylindrical shape) of the conduit surface. To this aim, we developed a protocol to assemble epoxy conduits with different fractal dimensions (D_c; i.e. irregularity) of the internal surface, and used silicone oil as a proxy for magma. We investigated different degassing patterns, from bubbly to slug and churn-annular flow, by varying systematically: 1) injected gas flux (5 to 180x10^{-3} l/s); 2) analogue magma viscosity (10 to 1000 Pas); 3) fractal dimension (D_c) of the conduit surface (i.e. D_c=2, D_c=2.18 and D_c=2.99). The experiments were monitored by tracking the temporal evolution of sample expansion and outgassing periodicity through a video-camera and investigating the relative seismo-acoustic fingerprint by means of a set of dedicated sensors (i.e. microphone, piezo-films, accelerometer). Results show that viscosity strongly influences the transition among degassing patterns and the frequency of slug bursts at the surface. Furthermore, we noticed an increase of the exponent of the power law equation linking squared seismic amplitude to gas flow rate with conduit roughness; whereas the opposite trend was observed increasing the viscosity of the liquid phase. These results have fundamental implications for linking eruption source parameters such as the volume discharge rate to seismic data (i.e. volcanic tremor) at different volcanoes or for investigating their temporal evolution at a single vent.