The slug buster: an analogue experiment for the study of Strombolian explosions

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Strombolian explosive activity is often described as the simple bursting of individual, large gas bubbles (slugs) at the surface of a stagnant magma column. However, individual explosions may often last up to several tens of seconds and produce complex geophysical signals. High-speed imaging revealed complex patterns within individual explosions, with large velocity and mass fluctuations in the ejected pyroclasts flux, and the presence of multiple ejection pulses characterized by exponential decay of pyroclast velocity throughout each pulse (Taddeucci et al., 2012a). Shock-tube experiments successfully reproduced such pulses by the impulsive release of pressurized gas-particles mixtures, allowing modeling the maximum velocity and velocity decay in the jets as a function of pressure, volume, and depth of the pressurized mixture (Taddeucci 2012b). However, these shock-tube experiments that used solid particles and gas could not investigate the dynamic response of slugs in magma to rapid decompression.

Here we present a new experimental setup specifically designed to investigate the response of slugs in a liquid when subjected to rapid decompression. Gas and liquid are provided by air and water, respectively. A pressurized gas slug is attained by suddenly releasing a controlled volume of pressurized air into a 3m long pressurized water column. The water column plus slug system is kept pressurized until the slug reaches a given burst distance (typically a few cm) from the top of the water column. Then the top of the column is suddenly exposed to ambient pressure and the slug expands explosively, ejecting a mixture of air and water droplets into the atmosphere. Monitored parameters currently include slug volume, pressure, and burst distance, with the possibility also to investigate the effect of liquid rheology, conduit diameter, and vent geometry. Mixture ejection velocity and mass histories are recorded by two high-speed cameras. Also, acoustic to infrasonic signals generated by the experiment are recorded by two microphones.

Preliminary experiments yield the same trend of ejection velocity decay observed in shock-tube experiments, as well as during Strombolian explosions. Specific features in this trend are related to slug volume and pressure, also controlling the resulting signal recorded by the microphones.

References

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