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# Phreatic and Hydrothermal Explosions - a Lab Approach

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Phreatic eruptions are amongst the most common and most diverse eruption types on earth. They might be precursory to another type of volcanic eruption but often they stand on their one. Despite being the most common eruption type, they also are one of the most diverse eruptions, in appearance as well as on trigger mechanism. Yet the almost instantaneous evaporation of water to steam is the common fuel behind all phreatic or hydrothermal eruptions. The steam-driven explosions occur when subsurface water or water on the surface is heated by magma, lava, hot rocks, or fresh volcanic deposits (such as ignimbrites, tephra and pyroclastic-flow deposits) and result in craters, tuff rings and debris avalanches.
Another wide and important field affected by steam explosions are hydrothermal areas; here hydrothermal explosions might occur every few months creating explosion craters and resemble a significant hazard to hydrothermal power plants as well as visitor parks.
Despite of their hazard potential, phreatic explosions have so far been overlooked by the field of experimental volcanology. A part of their hazard potential in owned by the fact that phreatic explosions are hardly predictable in occurrence time and size as they have manifold triggers (variances in groundwater and heat systems, earthquakes, material fatigue, water level, etc..)

A new set of experiments has been designed to focus on steam explosions, based on the shock-tube experiments to analyse magmatic fragmentation due to gas overpressure in vesicles (e.g. Alidibirov & Dingwell 1996, Spieler et al. 2004) whereas classical phreatomagmatic experiments use molten fuel-coolant interaction (e.g., Zimanowski, et al. 1991). The setup can be operated with gas overpressure (argon) and to varying degree water saturated samples, so far in a temperature range from room temperature up to 400°C. Sensors monitor the pressure evolution over the experiment and allow obtaining the fragmentation speed of the sample. The resulting particles are recovered and changes in their grain size distribution are analysed. In these experiments two energy sources have to be considered: (1) rapid decompression of gas overpressure in vesicles, (2) steam flashing of water in vesicles. The violent transition of the superheated water to vapour adds another degree of explosivity to the dry magmatic fragmentation, driven mostly by vesicle bursting due to internal gas overpressure. At low or moderately water saturated samples water the fragmentation is strongly enforced by the mixture of these two effects and a large fraction of fine pyroclasts are produced, whereas at high water fraction in the sample the fragmentation is less violent.
Volcanoclastic sandstone served as sample material for this case study. The experimental conditions used hereby (varying degree of water saturation, moderate overpressure, 200- 300°C, rapid decompression) apply e.g. to volcanic rocks as well as country rocks at depth of about 100-800 m in a conduit or dome bearing a fraction of ground water and being heated from magma rising beneath (150-400°C). The diversity of phreatic eruptions at a volcanic system (vent) arises from the variety of host rocks, ways to seal the conduit, and to alter this material depending on the composition of volcanic gases.
Here, we assess the influence of rapid decompression of the supercritical water phase in the pore space of samples, on the fragmentation behaviour. This will enable us to elucidate the characteristics of the different “fuels” for explosive fragmentation (gas overpressure, steam flashing), as well as their interplay.