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The volcano in a gravel pit: Volcano monitoring meets experimental volcanology

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Volcanic eruptions are an inevitable natural threat. During explosive eruptions, gas and pyroclasts are ejected at high speed over variable time spans and at variable intensity. As magma fragmentation inside a volcanic edifice defies direct observation, our mechanistic and quantitative understanding of the syn-eruptive processes is still incomplete.

In an attempt to bridge this gap, we used a supra-disciplinary approach and combined experimental volcanology and volcano monitoring devices. We performed 34 field-based fragmentation experiments using cylindrical samples, drilled from natural volcanic rock samples. Decompression and particle ejection were monitored with (1) Doppler Radar (DR), (2) high-speed and high-definition cameras, (3) high-speed thermal camera, (4) acoustic and infrasound sensors and (5) pressure transducers. The experiments were performed at controlled sample porosity (25 to 75 vol.%) and size (60 mm height and 25 mm and 60 mm diameter, respectively), confinement geometry, applied pressure (4 to 18 MPa) and temperature (25 and 850 °C).

We present how the velocity of the ejected pyroclasts was measured by and evaluated for the different approaches and how it was affected by the experimental conditions and sample characteristics. We show that all deployed instruments successfully measured the pyroclast ejection, giving coherent results of up to 130 m/s. Close and high-resolution volcano monitoring, spiced with results from our experiments, will allow for "calibrating volcanoes". An enhanced understanding of the pressurisation state of a volcano is an essential factor in ballistic hazard evaluation and eruption energy estimation and will contribute to adequate risk mitigation.