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Laboratory Studies of Volcanic Explosion Earthquakes

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Rapid decompression of magma during ascent leads to fragmentation of the magma and gas propelled ejection of the fragments. These volcanic explosions generate distinctive earthquakes, whilst propelling hazardous ash particles into the atmosphere. The fragmentation process can be studied in the laboratory through pressurisation of magma samples in a shock-tube apparatus, which are then rapidly depressurised to atmospheric pressure. The initial applied pressure required to induce fragmentation of different magmas during this rapid depressurisation reveals the pressure drop required to fragment different magmas. The size distribution of the fragmented particles, which is analysed after these experiments, is related to the surface energy required to generate these fragments.

Here, we conduct rapid depressurisation experiments on magmas at room temperature whilst recording acoustic emissions (AE). AE are elastic waves transmitted through solid media; a laboratory analogue to earthquakes. In this set-up, AE were transmitted directly from the sample to piezoelectric transducers via metal waveguides. Complete waveforms of the whole fragmentation process were recorded on an array of transducers, which allowed us to locate the initiation of the fragmentation process. With this novel set-up, we also relate the size and frequency content of the AE emitted during fragmentation to the energy inferred from applied pressures and particle size distributions. These results are compared to volcanic explosion earthquakes to infer how earthquake characteristics relate to the fragmentation process.