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Influence of shear friction on fragmentation processes

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Fragmentation processes are thought to drive explosive volcanic eruptions, hence it is essential to understand the underlying physical processes involved. Despite recent progress in terms of modelling and experiments, the type of activity and the duration of an eruption are still extremely hard to predict.

Here we focus on the magmatic part of fragmentation (leaving out the phreatomagmatic behaviour), caused solely by gas dissolved in the magma and produced either by a rapid acceleration of a two phase flow, a rapid decompression of an edifice or a combination of both.

In order to realistically simulate volcanic fragmentation processes, we performed rapid decompression experiments with an apparatus based on the shock tube principle (modified fragmentation bomb). Sample sets from Krakatau, Lipari, Montserrat and Bezymianny were investigated. We hereby covered a range in open porosity from over 60 down to 16%, resulting in fragmentation threshold values of up to 15 MPa.

In comparison to recent studies, we analyzed samples that were bigger in diameter (60mm $\leftrightarrow$25mm) and we held the sample back from the top, using a massive steel ring with a reduced orifice. Such changes in experimental setup allowed us to test the influence of sample size and increased shear friction on fragmentation threshold, speed and particle size of the ejecta.

The remnants of the fragmented sample on the wall of the sample holder show extensive shear fractures, pointing at a downward angle of 45˚ (V-shaped) from the center to the rim of the sample holder. These fractures are similar to the shear bands and fracture surfaces observed in the tube pumices described by J. Marti et al. (1999).

Even though we introduced a higher shear friction in the experiments, the results are

in good agreement with former data, especially in terms of fragmentation speed and energy density (fragmentation energy standardized to a unit volume). We will however further investigate the presence of the shear fractures. This work is part of the BMBF project SUNDAARC, which aims to quantify the potential risk of selected highly-explosive volcanoes

by combining field and laboratory investigations.