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Mechanical energy consumed during magmatic fragmentation: New insights from rapid decompression experiments on natural volcanic samples

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Magmatic fragmentation during explosive eruptions consumes a significant amount of mechanical energy in the generation of new surface area. This leads to a reduction in the energy that can be converted into kinetic energy driving the ejection of the pyroclasts. Models of fragmentation to date have largely neglected the energy balance involved in the magmatic fragmentation. This is understandable as the mechanical energy consumed during magma fragmentation is not known and it is not possible to measure it directly during volcanic explosions. New insights may however be achieved from experiments using natural samples in the fragmentation bomb (Alidibirov and Dingwell, 1996). We have adapted the low-pressure section of the fragmentation bomb by fitting it with four copper wires conducting an electric signal. When the particles reach the wires, the signals drop, and, knowing the distances between the wires, we can calculate the maximum speed of the particles. We performed a number of experiments of fragmentation of natural samples by rapid decompression at high temperature (850˚C) at different pressures and measured the maximum ejection speed of the resulting particles. The potential energy before fragmentation is calculated from the applied pressure and the porosity of the sample. The maximum kinetic energy is calculated from the mass and the measured speed. In this manner we can estimate the efficiency of the transformation of the potential energy into kinetic energy after the fragmentation. Further, we analyzed the grain-size distribution of the particles produced by the fragmentation and measured the created new surface by Argon adsorption using the BET method. We compared the results with the prod-

ucts of experiments performed with pre-fragmented magma with a known grain-size distribution and with theoretical models based on shock tube theory. In this way we have estimated the mechanical energy that is consumed by fragmentation produced by rapid decompression.