Geophysical Research Abstracts, Vol. 8, 05631, 2006
SRef-ID: 1607-7962/gra/EGU06-A-05631

The effect of crystal content on the fragmentation of explosively erupting basaltic magma

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To shed light on the genesis of ash during different styles of basaltic explosive activity, we performed experiments on the fragmentation of basaltic melts under different conditions and compared the experimental results with observations of eruptions and eruption products. The experiments, performed at the Universität Würzburg, Germany, investigate the role of groundmass crystallization on the modes and efficiency of magma fragmentation. Low- and high-crystallinity rocks from recent eruptions of Etna serve as a starting material representative of strombolian and ash fountain feeding magmas, respectively. After petrographic analysis, the starting material is heat-treated in cylindrical crucibles of 5 and 10 cm diameter and 10 cm depths at eruptive temperature to obtain a crystal-melt ratio similar to that of the natural products. Compressed air is released from below the partially molten plug to cause fragmentation, while force and pressure sensors record the process. We performed sets of experiments fragmenting variably crystallized melts and determining the texture and size distribution of particles as a function of starting conditions and energy input. Comparison of the morphology between natural and experimental particles validates the similarity of the fragmentation processes in the experiment and in nature, and the link between energy input and resulting grain size provides a quantification of the efficiency of fragmentation during eruptions. Another important outcome is the information about the size distribution of ash erupted by different styles of activity before any transport process acts to modify them, and the textures of experimental pyroclasts will constitute a standard to attribute particles from the stratigraphic record and from future eruptions to one or another style of eruption.