Geophysical Research Abstracts
Vol. 14, EGU2012-7603, 2012
EGU General Assembly 2012

Quantitative experimental modelling of fragmentation during explosive volcanism

Ø. Thordén Haug, O. Galland, and G. Gisler
Physics of Geological Processes (PGP), University of Oslo, Oslo, Norway, (o.t.haug@fys.uio.no)

Phreatomagmatic eruptions results from the violent interaction between magma and an external source of water, such as ground water or a lake. This interaction causes fragmentation of the magma and/or the host rock, resulting in coarse-grained (lapilli) to very fine-grained (ash) material.
The products of phreatomagmatic explosions are classically described by their fragment size distribution, which commonly follows power laws of exponent D. Such descriptive approach, however, considers the final products only and do not provide information on the dynamics of fragmentation. The aim of this contribution is thus to address the following fundamental questions. What are the physics that govern fragmentation processes? How fragmentation occurs through time? What are the mechanisms that produce power law fragment size distributions? And what are the scaling laws that control the exponent D?
To address these questions, we performed a quantitative experimental study. The setup consists of a Hele-Shaw cell filled with a layer of cohesive silica flour, at the base of which a pulse of pressurized air is injected, leading to fragmentation of the layer of flour. The fragmentation process is monitored through time using a high-speed camera. By varying systematically the air pressure (P) and the thickness of the flour layer (h) we observed two morphologies of fragmentation: "lift off" where the silica flour above the injection inlet is ejected upwards, and "channeling" where the air pierces through the layer along sub-vertical conduit. By building a phase diagram, we show that the morphology is controlled by P/dgh, where d is the density of the flour and g is the gravitational acceleration.
To quantify the fragmentation process, we developed a Matlab image analysis program, which calculates the number and sizes of the fragments, and so the fragment size distribution, during the experiments.
The fragment size distributions are in general described by power law distributions of exponents D. This procedure allows, for the first time, to determine the scaling laws that govern the number of fragments (N), the average size of the fragments (A) and D. We show that (1) N scales with P(1/2), (2) A scales with P(-2/3), (3) D scales with P(1/5). Our experimental procedure thus appears as a unique tool to unravel the complex physics of fragmentation during phreatomagmatic explosions.