Geophysical Research Abstracts
Vol. 14, EGU2012-1206, 2012
EGU General Assembly 2012

Fragmentation mechanism transition of multiphase magma analogues.

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The properties of multiphase flow in volcanic conduits affect the way magma is transported, fragmented and erupted. We performed shock-tube experiments to investigate the ductile–brittle response of analogue suspensions to diffusion-driven bubble expansion. Magma analogues employed in these experiments are suspensions of micron-sized particles in a transparent Newtonian liquid. Suspension rheology as function of the total solid content has been previously characterized by means of high-precision rotational rheometry measurements.
In our experiments the suspensions are charged into a transparent autoclave and pressurized by an inert gas for several hours at constant pressure. The gas diffuses into the sample from top to bottom saturating it. Upon rupture of a diaphragm system, the sample undergoes instantaneous decompression that we record by high-speed camera system and a set of pressure sensors positioned at different heights of the shock tube and at contact with the sample.
At decompression we observe exsolution-driven bubble nucleation. Bubbles grow and coalesce, expanding the liquid and the particles around them eventually leading to fragmentation.
Experimental variables include the amount of solid volume fraction (0 to 60 vol%), the viscosity of the Newtonian liquid (10 and 100 Pa s), and the time of gas diffusion in the sample (0 to 72 hours). During the diffusion gas pressure is kept constant at 10 MPa for all experiments. For this set of experiments decompression rate has also been kept constant. We observe a variation in the time scale over which the suspensions expand, as a function of solid concentration. Expansion velocity varies between 0.1 and 10 m/s for diluted and concentrated suspensions, respectively. This corresponds to different styles of sample response to decompression: foaming and outgassing is observed for dilute suspensions, while layer-by-layer fragmentation of discrete sample portions is observed in suspensions with highest solid volume fraction.