Geophysical Research Abstracts
Vol. 18, EGU2016-8910, 2016
EGU General Assembly 2016

Imaging the shallow volcanic conduit from magma analogue decompression experiments: their implication for volcanic eruptions and applications to numerical models

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Experimental volcanology is a powerful tool to reconstruct the dynamics of magmatic fluids within the conduit. More specifically analogue models, allow constraining the conduit dynamics by independently examine physical variables and their reciprocal relationships. Accurate scaling of the experiments to the natural systems is necessary to derive quantitative information on the studied processes.

Here we present a suite of experiments investigating the decompressive response of magma analogues with different properties (i.e. fluid viscosity, suspended particle shape and/or content) and their scaling to the natural basaltic systems. In the experiments Ar-saturated silicone oils with different viscosities are used as proxies for volatile-bearing mafic magmas. Varying percentages of micrometric particles are added to the fluid to investigate the role of crystals content as well as crystal shape on the dynamics of the expanding flow. Through decompression, the degassing mixture is characterized by a regime of periodical oscillations of the bubbly front determined by phases of foam collapse and renewal. We find that time-scale of these oscillations has important implications for understanding the cyclical eruptive behaviour observed at basaltic volcanoes. Applicability of the experimental results to natural mafic systems has been verified in the scaling by using a set of a-dimensional numbers.

The experimental dataset has been finally used to validate a numerical code implemented in the Openfoam framework. The original compressible multiphase solver twoPhaseEulerFoam was implemented to take into account the multicomponent nature of the fluid mixtures (liquid and gas) and their phase transition, as also reproduced in the experiments.

Decompression experiments and their scaling to volcanic system provided fundamental information on the dynamics of volatiles within the shallow conduit. Furthermore, they are an invaluable tool to validate complex numerical codes for multiphase multicomponent mixtures.