Geophysical Research Abstracts
Vol. 16, EGU2014-12962, 2014
EGU General Assembly 2014


# Flow-permeability feedbacks and the development of segregation pipes in volcanic materials

Alison Rust
University of Bristol, Earth Sciences, Bristol, United Kingdom (alison.rust@bristol.ac.uk)

Flow and transformation in volcanic porous media is important for the segregation of melts and aqueous fluids from magmas as well as elutriation of fine ash from pyroclastic flows and vents. The general topic will be discussed in the framework of understanding sets of vertical pipes found in two very different types of volcanic deposits: 1) vesicular (bubbly) cylinders in basalt lava flows and 2) gas escape pipes in pyroclastic flow deposits. In both cases the cylinders can be explained by a flow-permeability feedback where perturbations in porosity and thus permeability cause locally higher flow speeds that in turn locally increase the permeability.

For vesicular cylinders in lava flows, the porous medium is a framework of crystals within the magma. Above a critical crystallinity, which depends on the shape and size distribution of the crystals, the crystals form a touching framework. As the water-saturated magma continues to cool, it crystallizes anhydrous minerals, resulting in the exsolution of water vapour bubbles that can drive flow of bubbly melt through the crystal network. It is common to find sets of vertical cylinders of bubby melt in solidified lava flows, with compositions that match the residual melt from 35-50% crystallization of the host basalt. These cylinders resemble chimneys in experiments of crystallising ammonium chloride solution that are explained by reactive flow with porous medium convection. The Rayleigh number for the magmatic case is too low for convection but the growth of steam bubbles as the magma crystallizes induces pore fluid flow up through the permeable crystal pile even if there is no convective instability. This bubble-growth-driven upward flow is reactive and can lead to channelization because of a feedback between velocity and permeability.

For the gas escape pipes in pyroclastic flows, the porous medium is a very poorly sorted granular material composed of fragments of solid magma with a huge range of grain sizes from ash (microns to 2 mm) to clasts of decimeters or greater. The vertical gas escape pipes are distinguished from the surrounding pyroclastic flow deposit by the lack of fine ash in the pipes; this missing ash was transported up out of the pyroclastic flow by gas flow, a process called elutriation. Laboratory experiments with beds of binary mixtures of spheres aerated through a porous plate at the base, demonstrate that the size ratio, density ratio, and proportions of the two populations of spheres all affect the pattern and efficiency of segregation. Decompaction of the upper portion of the bed separates the grains and thus facilitated the elutriation of the finer particles, which must be transported up through the spaces between the larger particles. A variety of segregation feature are found including pipes lacking fines that grow down from the top of the bed. These could be explained by channelizing of gas flow due to a feedback between local reduction in fines increasing the local permeability and gas velocity.