Geophysical Research Abstracts
Vol. 20, EGU2018-15352, 2018
EGU General Assembly 2018

Plaster and Magnets: An experimental study tracking fluid flow and surface deformation during magma intrusion in the crust

Simon Martin (1), Janine Kavanagh (1), Prokop Závada (2), Olivier Galland (3), and Andrew Biggin (1)

(1) University of Liverpool, Earth Ocean and Ecological Sciences, 4 Brownlow Street, Liverpool, United Kingdom (smartin@liverpool.ac.uk), (2) Institute of Geophysics, Academy of Sciences of Czech Republic, Boční II/1401, 14131, Czech Republic, (3) Physics of Geological Processes, Department of Geosciences, University of Oslo, Oslo, Norway

Understanding magma behaviour during emplacement within the lithosphere is vital for determining the dynamic processes occurring in volcanic systems. Here we present results from laboratory experiments that study the fluid flow and surface deformation occurring during magma intrusion in the crust. Multi-coloured plaster of Paris seeded with magnetite particles (the magma analogue) was loaded sequentially or annularly into a piston, and this was injected through a central port in the base of a 1.2 x 1.2 x 0.5 m box filled with fine grained wheat flour (the crust analogue). During injection, timelapse photographs of the flour surface were captured for post-experiment reconstruction of the surface deformation using the photogrammetry software MicMac. Surface deformation initiated after 7 minutes with a series of radial fractures originating from the center of the surface. Pulsatory inflation caused further centralised fracturing and uplift, leading to the development of a ring fault structure along which pistoning up of the central region of flour occurred. Eruption occurred along a section of the ring fracture almost directly above the inlet at which point injection was halted.

Once solidified, the experimental plumbing systems were excavated, photographed and their morphologies characterised. Cup structures, radial dyke systems, en echelon dyke segments, lobes, surface ridges and lineations, and conduits propagating to the surface were identified. The plaster colour enabled the order of formation and internal fabrics of the modelled plumbing system to be constrained. One intrusion was sliced both perpendicular and parallel to the dyke planes so that the internal fabrics could be analysed. Concentric colour patterns were observed which show flow localisation through conduits. Closely-spaced sampling across the length, breadth and thickness of this intrusion permitted the detailed three-dimensional mapping of magnetic fabrics. Anisotropy of magnetic susceptibility results show both prolate and oblate fabrics with the ellipsoid long axes sub-parallel to the dyke plane. Prolate fabrics are suggestive of sub-horizontal flow along the dyke plane, producing a slight inwards dip towards the dyke tip. Oblate fabrics suggest more complex processes originating from compression and shear within the flowing plaster. These observed fabrics indicate that a series of complex processes are occurring during emplacement, which are preserved by the orientation of magnetic particles. The experimental results have important implications for the interpretation of surface changes associated with magma intrusion in the crust and the analysis of magma flow fabrics measured in natural samples.