Geophysical Research Abstracts
Vol. 15, EGU2013-11844, 2013
EGU General Assembly 2013

Fracture mode analysis and related surface deformation during dyke intrusion: Results from 2D experimental modelling

Mohamed Mansour Abdelmalak (1), Regis Mourgues (2), and Olivier Galland (3)

(1) Department of geosciences, University of Oslo, Po Box 1047 Blindern, 0316 Oslo, Norway(m.m.abdelmalak@geo.uio.no), (2) L.P.G.N. CNRS UMR 6112, University of Maine, Faculty of Science, 72085 Le Mans, France, (3) Physics of Geological Processes (PGP), University of Oslo, Norway

The complex mechanics occurring at tips of dykes during their propagation are very challenging to address in volcanic systems. Direct observation of dyke propagation is impossible, and only indirect geophysical monitoring, such ground deformation induced by dyke emplacement, are available. Interpreting ground deformation in terms of dynamics of dyke emplacement thus requires a full understanding of the fracture mode at dyke tips. To achieve this, we performed 2D laboratory experiments that simulate the emplacement of shallow dykes. Our experimental setup consists of a Hele-Shaw cell, in which model magma is injected into a cohesive model crust. The morphology of the dyke was photographed through time. Using an optical image correlation technique (Particle Imaging Velocimetry), we also measured the surface deformation, the displacements and the strain field induced by the emplacement of the dykes within the country rock.

We identify two types of intrusion morphologies (Types A and B), which exhibit two evolutional stages. During the first stage, both types resulted in a vertical dyke at depth; its propagation was controlled by both shear deformation and tensile opening. The model surface lifted up to form a smooth symmetrical dome, resulting in tensile cracks. During the second stage, Types A and B experiments differ when the dyke reaches a critical depth. In Type A, the intrusion gradually rotates, forming an inclined sheet dipping between 45 to 65°. This rotation results in asymmetrical surface uplift and shear failure upon the tip of the dyke. In Type B, the dyke tip interacts with tensile cracks formed during the first stage. This fracture controls the subsequent propagation of the dyke toward the surface. In both types of experiments, intrusions result in surface uplift, which can be accommodated by reverse faults. Our study provides important understanding on the mode of propagation of dyke tips and suggests that they propagate as viscous indenters, rather than linear elastic fracturing.