Geophysical Research Abstracts
Vol. 14, EGU2012-9888, 2012
EGU General Assembly 2012


# Effects of gravity and the state of pore-fluid pressure in the bedrock surrounding an idealised magma chamber, compared to the "Mogi" approach.

M. Gerbault, F. Cappa, and R. Hassani
Geoazur,UNS-IRD-CNRS, France, Sophia-Antipolis, France (gerbault@geoazur.unice.fr)

Surface displacements solutions of elastic deformation around an inflating magma chamber generally assume that the associated internal overpressure is limited by the bedrock tensile strength. However this assumption is valid when the bedrock is fluid-saturated with a state of near lithostatic pore-fluid pressure. When considering stress balance in a relatively intact bedrock adjacent to a spherical or infinitely long cylinder, the gravity body force actually resists tensile failure, thus leading to a much larger pressure threshold for failure, which actually occurs by shear instead of tension. Here we explore with analytical and numerical models such conditions for shear or tensile failure, with and without pore fluid pressure in the surrounding bedrock. We compare elasto-plastic solutions of surface displacements and patterns of failure in plane-strain at fixed internal overpressure. Shear failure propagates independently from the surface downwards, from the chamber walls upwards, and finally the two plasticised domains connect. In case of lithostatic fluid pore pressure in the bedrock, gravity cancels out, and tensile failure is enabled for an overpressure close to the tensile strength. In the most common state of hydrostatic fluid pore pressure in the bedrock, shear failure still occurs at the chamber wall. Coupled hydromechanical models in undrained conditions show how the initial bedrock porosity controls the evolution of fluid pressure, volumetric strain and effective normal stress, and consequently also the pressure threshold for the onset of failure. A bedrock of low porosity is more prone to fail than a bedrock of high porosity. In summary, our elasto-plastic and hydromechanical models illustrate the contexts for either tensile or shear failure around magmatic bodies. We believe that these factors modify to a first order (around 30 %) estimates of magmatic source geometries deduced from geodetic measurements at the ground surface. They should thus become more systematically tested in standard methods for estimating depth and size of magmatic sources.