28*th* IUGG Conference on Mathematical Geophysics, June 7-11, 2010, Pisa, Italy
Session 1: Geophysical fluid dynamics I - Volcanoes

Visco-elastic magma - Fragmentation criteria revisited

Ittai Kurzon[1,2], Vladimir Lyakhovsky[2], Oded Navon[1]

[1] *Institute of Earth Science, The Hebrew University, Jerusalem, Israel*
[2] *The Geological Survey of Israel, Jerusalem, Israel*

Keywords: *magma fragmentation, failure criteria, bubbly magma, visco-elasticity, elastic deformation*

We present a visco-elastic bubble growth model, accounting for viscous and elastic deformations and for volatile mass transfer between bubbles and melt. We define the borders between previous bubble growth models accounting for incompressible viscous melt, and our new model that also accounts for melt compressibility and elastic deformation. Elastic deformation is most prominent for magma of small vesicularities, where the growth regime depends on the shear modulus. Following an instantaneous pressure drop, elastic deformation of melt with high shear modulus is negligibly small; high gas pressure is preserved in the bubbles and their growth follows an exponential viscous growth regime. For magma of low shear modulus bubbles initially expand due to elastic deformation of the surrounding melt; gas pressure falls quickly and growth follows a square-root diffusive solution. Our model provides all the elastic components (stresses, strains and strain rates) required for defining criteria for failure and magma fragmentation. We examine two failure criteria, a stress related criteria based on the internal friction and the Mohr-Coulomb failure theory, and a strain related criteria based on fibre elongation experiments. We argue that both criteria are equivalent if we consider their dependence on the shear modulus and effect of the modulus on magma rheology.