Geophysical Research Abstracts
Vol. 12, EGU2010-7098, 2010
EGU General Assembly 2010

Elastic moduli evolution and accompanying stress changes with increasing crack damage during the cyclic stressing of rocks

Dan Faulkner (1), Michael Heap (2,3), and Philip Meredith (2)

(1) Rock Deformation Laboratory, Department of Earth and Ocean Sciences, University of Liverpool, Brownlow Street, Liverpool, L69 3GP, UK, (2) Rock & Ice Physics Laboratory, Department of Earth Sciences, University College London, Gower Street, London WC1E 6BT, UK, (3) Ludwig-Maximilians-University Munich, Department of Earth and Environmental Sciences, Section for Mineralogy, Petrology and Geochemistry, Theresienstr. 41, 80333 München, Germany (heap@min.uni-muenchen.de)

The elastic moduli of rock present in areas susceptible to crack damage, such as within fault zones or volcanic edifices, can be subject to large modifications. Knowledge of how elastic moduli may vary in such situations is important for both the reliable modelling of volcano deformation and stability, and for linear and non-linear elastic crack models for earthquake rupture. It has previously been shown that changes in elastic moduli can induce changes in the stress field surrounding faults (Faulkner et al., 2006).

Here therefore we report both uniaxial experimental measurements of changes in elastic moduli during increasing-amplitude cyclic stressing experiments on a range of different rock types (basalts, sandstones and granite), and the results of modelled stress modifications. The trend in elastic moduli evolution with increasing damage was remarkably similar for each rock type, with the exception of an essentially crack-free intrusive basalt that exhibited negligible changes. In general, Young's modulus decreased by between 11 and 32% and Poisson's ratio increased by between 72 and 600% over the total sequence of loading cycles. Our results also demonstrate that acoustic emission (AE) output during any loading cycle only commenced when new crack damage was generated. This corresponded to the level of stress where AE ceased during the unloading portion of the previous cycle.

Using the multi-layer elastic model of Faulkner et al. (2006) we demonstrate that the damage-induced changes in elastic moduli also result in significant decreases in differential stress, increases in mean stress and rotation of the applied greatest principal stress relative to the orientation of the mechanical layering. The similar trend in the evolution of the elastic moduli of all the rocks tested suggests that stress modification in the damage zone of faults might take the same form, regardless of the lithology through which the fault runs. These observations are discussed in terms of their applicability to both fault zones and volcanic environments.