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Source mechanisms of acoustic emissions in triaxially loaded granite.

C. Graham (1), S. Stanchits (2), G. Dresen (2), I. Main (1)

(1) School of GeoSciences, University of Edinburgh, UK, (2) GeoForschungsZentrum, Potsdam, Germany. (c.c.graham@sms.ed.ac.uk / Phone: +44 131 6505919)

The process of brittle deformation and failure of rock is highly relevant to many aspects of Geoscience, such as seismology, tectonics and hydrofracture in hydrocarbons reservoirs. One possible approach in the study of this process is the application of damage mechanics, where time-dependent failure models involve the estimation of average internal damage as it varies with time. The growth of microcracks within a deforming rock can produce high frequency acoustic emissions (AE), which are suitable as an indicator of damage during laboratory experiments, but current models consistently overestimate the peak stress required to fail a rock sample. This project is concerned with the role of damage localisation in this overestimation, employing AE laboratory data and microstructural analysis, in combination with mechanical observations, with the aim of incorporating such effects into a predictive model of rock failure. Here, we present results relating to the triaxial compression of red Aue granite.

Our current analysis of the observed acoustic emissions involves investigating the microscale source mechanisms that lead to their production. Source characterisation from AE waveforms is complicated by significant reflection and ringing effects within a small laboratory sample. Here, we use a technique requiring only P-wave amplitudes, to invert for the full moment tensor, for over 16,000 AEs recorded during the compressive loading of a cylindrical sample of red Aue granite. The resulting tensor elements were then decomposed into Double-Couple (DC), Compensated Linear Vector Dipole (CLVD) and Isotropic (ISO) parts, and events were then classified into predominantly shear, tensile and mixed-mode sources. Temporal variation in source-type dominance could then be observed. A clear shift in the dominant mechanism of cracking is visible between tensile sources, in the early stages of loading, and shear sources, during the later stages. The results are encouragingly similar to those of a simpler polarity study

carried out with the same data set. We conclude that this technique has great potential as a method for characterising damage in laboratory rock fracture tests.