Geophysical Research Abstracts, Vol. 7, 05578, 2005
SRef-ID: 1607-7962/gra/EGU05-A-05578

Acoustic emissions and velocities associated with the formation of compactions band in sandstone

J. Fortin (1), S. Stanchits (2), G. Dresen (2), A. Schubnel (3) and Y. Guéguen

(1) Laboratoire de Geologie, Ecole Normale Superieure, Paris, France - (2)GeoForschungsZentrum, Potsdam, Germany - (3) Lassonde Institute, University of Toronto, Canada (Contact Email fortin@geologie.ens.fr)

Since dilatancy is generally observed as precursor to brittle faulting and the development of shear localization, attention has focused on how localized failure develops in a dilatant rock. However, recent geologic observations and reassessment of bifurcation theory have indicated that strain localization may be pervasive in compactant porous rock, a mode of localized deformation that has received little previous attention in the geosciences. Compaction bands are narrow planar zones of material that has been compacted without apparent shear. Compaction localization can be observed in the laboratory, at room temperature, under high confining pressure and deviatoric stress. These localizations are observed in high porosity and as they display significantly reduced porosity, they are potentially important permeability barriers in reservoir rocks and aquifers.

To investigate localized compaction and changes in physical properties of porous sandstone, we performed triaxial tests on Bleurswiller sandstone, (50% quartz 30% feldspars and 20% clay, 25% porosity), and on Flechtingen sandstone ($65-75\%$ quartz, calcite and illite 15%, porosity $5.5-7\%$). Thirteen experiments were performed at the Laboratoire de Géologie (Ecole Normale Superieure - Paris) and at GeoForschungsZentrum Potsdam. Evolution of volumetric strain, elastic wave velocities and permeability were recorded at confining pressures of 12 and 180 MPa. Acoustic Emission (AE) characteristics during deformation were studied at GeoForschungsZentrum Potsdam. To monitor velocity change and microcracking of sandstone, 10 P-wave sensors and 8 polarized S-wave piezoelectric sensors were glued to the cylindrical surface of the samples. To monitor fracture-induced anisotropy, two additional P sensors were installed in axial direction. Fully digitized waveforms were

recorded by 10 MHz/16bit Data Acquisition System with an accuracy of AE hypocenters determination of about 2.5 mm.

Microstructural observations of samples after loading show that discrete compaction bands appear in Bleurswiller sandstone for confining pressure more than 40 MPa. Location of acoustic emission events reveal the evolution of localized compaction bands in sandstone subjected to axial compression, and confirm the microstructural observations.

Samples were first subjected to increasing confining pressure and subsequently loaded axially. During hydrostatic compression, elastic wave velocities first increased up to 10% due to crack closure and compaction. During axial loading, after beginning of localization, axial and transverse velocities decreased by $10\% - 20\%$: compaction localizations should increase the velocities, microstuctural observations show inside the band grains crushing and pore collapse, and in this case, velocities are more sensitive to the cracks inside the band than the porosity reduction. We observed no velocity anisotropy during the axial loading, that suggests randomly distributed cracks inside compaction band