Geophysical Research Abstracts, Vol. 8, 06594, 2006
SRef-ID: 1607-7962/gra/EGU06-A-06594

Acoustic emission during formation of compaction bands in sandstone

S. Stanchits (1), J. Fortin (2), Y. Gueguen (2) and G. Dresen (1)

(1) GeoForschungsZentrum Potsdam, Telegrafenberg D423, 14473 Potsdam, Germany (stanch@gfz-potsdam.de), (2) Laboratoire de Geologie, Ecole Normale Superieure, 24 rue Lhomond, 75005, Paris, France (fortin@geologie.ens.fr)

Localized compaction bands in high porosity rocks are narrow zones with significantly reduced local porosity. Compaction bands could significantly change physical properties of rocks, forming permeability barriers in reservoirs and aquifers, and affect fluid circulation and extraction of oil and gas from reservoirs.

To investigate the influence of compaction bands on physical properties of porous rocks we performed 3 triaxial tests on Bleurswiller sandstone (BS) samples at 60, 80 and 100 MPa confining and at 10 MPa pore pressure. Grain size and porosity of BS are $\approx$ 100 μm and 25% respectively. BS contains 50% quartz, 30 % feldspars, and 20% oxides-micas. Twelve P-wave sensors, eight S-wave sensors and two pairs of orthogonally oriented strain-gages were glued to the surface of rock samples to monitor acoustic emission (AE), velocities and local strain during the loading. Fully digitized AE waveforms were recorded by 10 MHz/16bit Data Acquisition System. About 40% of total AEs were used to locate hypocenters with location error of 2.5 mm. Analysis of first motion polarity of AE events allowed discriminating between tensile (T-type), shear (S-type) and pore collapse (C-type) source types.

P and S ultrasonic velocities and amplitudes increased during hydrostatic loading, and during the initial stage of axial loading. After onset of shear-enhanced compaction velocities decreased progressively, indicating accumulation of stress-induced crack damage. AE events were initially localized in clusters, indicating progressive coalescence and growth of compaction bands perpendicular to the loading direction. Structural analyses of deformed specimens indicate excellent agreement between location of AE clusters and compaction bands. First motion polarity analysis of AEs shows dominantly C-type events. Shear-type sources contribute 5-10% during initial loading, and increase up to 25-30% during propagation of the bands. Nucleation of compaction bands could be clearly demonstrated by the appearance of AE clusters inside samples. Formation of a nucleation patch was also indicated by maximum of the spatial correlation coefficient for S- and C-type AE events. During progressive spreading of the bands the spatial correlation coefficient continuously decreased indicating distributed cracking. With increasing load after nucleation of compaction bands, fractal dimension coefficient (d-value) increased progressively suggesting a transition from compaction localized in planar bands towards cracking distributed in the entire sample volume.