Geophysical Research Abstracts
Vol. 18, EGU2016-9298, 2016
EGU General Assembly 2016

Brittle and semibrittle creep in a low porosity carbonate rock

Aurélien Nicolas (1), Jérôme Fortin (2), Jean-Baptiste Regnet (3), Alexandre Dimanov (4), and Yves Guéguen (5)

(1) Laboratoire de géologie, ENS, Paris, France (nicolas@geologie.ens.fr), (2) Laboratoire de géologie, ENS, Paris, France (jerome.fortin@ens.fr), (3) Laboratoire de géologie, ENS, Paris, France (regnet@geologie.ens.fr), (4) Laboratoire de Mécanique des Solides, Ecole Polytechnique, Palaiseau (dimanov@lms.polytechnique.fr), (5) Laboratoire de géologie, ENS, Paris, France (gueguen@geologie.ens.fr)

The mechanical behavior of limestones at room temperature is brittle at low confining pressure and becomes semi-brittle with the increase of the confining pressure. The brittle behavior is characterized by a macroscopic dilatancy due to crack propagation, leading to a stress drop when cracks coalesce at failure. The semi-brittle behavior is characterized by diffuse deformation due to intra-crystalline plasticity (dislocation movements and twinning) and microcracking. The aim of this work is to examine the influence of pore fluid and time on the mechanical behavior. Constant strain rate triaxial deformation experiments and stress-stepping creep experiments were performed on white Tavel limestone (porosity 14.7%). Elastic wave velocity evolutions were recorded during each experiment and inverted to crack densities.

Constant strain rate triaxial experiments were performed for confining pressure in the range of 5-90 MPa. For Pc$\leq$55 MPa our results show that the behavior is brittle. In this regime, water-saturation decreases the differential stress at the onset of crack propagation and enhances macroscopic dilatancy. For Pc$\geq$70 MPa, the behavior is semi-brittle. Inelastic compaction is due to intra-crystalline plasticity and micro-cracking. However, in this regime, our results show that water-saturation has no clear effect at the onset of inelastic compaction.

Stress stepping creep experiments were performed in a range of confining pressures crossing the brittle-ductile transition. In the brittle regime, the time-dependent axial deformation is coupled with dilatancy and a decrease of elastic wave velocities, which is characteristic of crack propagation and/or nucleation. In the semi-brittle regime, the first steps are inelastic compactant because of plastic pore collapse. But, following stress steps are dilatant because of crack nucleation and/or propagation. However, our results show that the axial strain rate is always controlled by plastic phenomena, until the last step, during which the axial strain rate increases significantly because of crack interactions leading to the macroscopic failure

Our results show the complex interplay between confining pressure, pore fluid and strain rate (i.e. time), which has an influence on the micromechanisms of deformation and thus on the macroscopic behavior.