Geophysical Research Abstracts
Vol. 20, EGU2018-7413, 2018
EGU General Assembly 2018

Micromechanisms of deformation in shales

Audrey Bonnelye (1), Hakim Gharbi (1), Simon Hallais (1), Alexandre Dimanov (1), Michel Bornert (2), Manel Mezni (1), and Nathalie Conil (3)

(1) Ecole Polytechnique, Palaiseau, France , (2) Laboratoire Navier, ENPC, France, (3) ANDRA

One of the envisaged solutions for nuclear wastes disposal is underground repository in shales. For this purpose, the Callovo Oxfordian (Cox) argillaceous formation is extensively studied. The hydro-mechanical behavior of the argillaceous rock is complex, like the multiphase and multi-scale structured material itself. The argilaceous matrix is composed of interstratified illite-smectite particles, it contains detritic quartz and calcite, accessory pyrite, and the rock porosity ranges from micrometre to nanometre scales. Besides the bedding anisotropy, structural variabilities exist at all scales, from the decametric-metric scales of the geological formation to the respectively millimetric and micrometric scales of the aggregates of particles and clay particles

Our study aims at understanding the complex mechanisms which are activated at the micro-scale and are involved in the macroscopic inelastic deformation of such a complex material. Two sets of experiments were performed, at two scales on three bedding orientations (90°, 45° and 0°).

The first set was dedicated to uniaxial deformation followed with an optical set-up with a pixel resolution of 0.55μm. These experiments allowed us to see the fracture propagation with different patterns depending on the bedding orientation.

For the second set of experiments, an experimental protocol was developed in order to perform uniaxial deformation experiment at controlled displacement rate, inside an environmental scanning electron microscope (ESEM), under controlled relative humidity, in order to preserve as much as possible the natural state of saturation of shales. We aimed at characterizing the mechanical anisotropy and the mechanisms involved in the deformation, with an image resolution below the micormeter. The observed sample surfaces were polished by broad ion beam in order to reveal the fine microstructures of the argillaceous matrix.

In both cases, digital images were acquired at different loading stages during the deformation process and Digital Image Correlation Technique (DIC) was applied in order to retrieve full strain fields at various scales from sample scale to microstructure scale. The analysis allows for identification of the active mechanisms, their relationships to the microstructure and their interactions.