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Viscoplastic behavior of synthetic salt : In-situ SEM full field measurement, a micromechanical approach.

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Halite has been extensively studied both as a natural material (storage, diapirs, ...) and an analog material (tectonics, pressure solution, ...). In this work, we study the deformation of halite at room temperature, under uniaxial loadings in order to identify the different mechanisms of plastic deformation at the local scale. Halite is a ionic polycrystal formed by single crystals of NaCl with a face-centered cubic structure. We elaborate the material in the laboratory by HIP (Hot Isostactic Pressure) at 100 MPa and 150°C and annealing at 750°C. We thus achieve a rather homogeneous and compact structure with grain sizes ranging from 250 to 500 micrometers. Work on a synthetic material allows us to control the micro-structure (grain size and distribution) and the composition of the material as well as to limit initial porosity and damage.

We perform 2D and 3D observations of the sample under load. In a first series of experiments, the samples of synthetic halite are deformed under uniaxial compression inside a scanning electron microscope (SEM). The sample are polished and micro droplets of gold are deposited on the surface in order to provide very fine markers at the micrometer scale for the Digital Image Correlation technique used to evaluate the surface displacement field at several steps of the loading process.The Digital Image Correlation method allows to compute the strain field and to evaluate quantitatively the heterogeneity of the local deformation which can be related to local mechanisms such as intracrystalline slip and/or grain boundary sliding. Evidence of intracrystalline slip is also provided by the direct observation of slip bands on the surface of the sample. The measure of local crystalline orientations by EBSD (in the undeformed and deformed states) and the orientation of the slip bands serve to identify the active slip plane . Additional assumptions on the local stress state, coupled with FEM computations may provide the identification of the slip systems. Those microscopic tests have been supplemented by with macroscopic triaxial and uniaxial tests in order to characterize the global macroscopic behavior of our synthetic salt. The results show us that it is comparable to typical natural rocksalt studied in the literature.

In a second set of experiments, we measure the strain field in 3D during uniaxial compression under X-Ray microtomography or using the synchrotron radiation. These tests have been done with another synthetic salt containing a small fraction (5 volume percent) of a second phase (fine copper particles) used as a volumetric marker. One of the objective of these experiments is to check whether mechanisms, such as grain sliding, observed on the surface are also present in the bulk.

It appears that more than one deformation mechanism is involved in the plastic deformation of halite. A constitutive model for halite should account for more than intracrystalline plasticity.