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Deformation mechanisms in synthetic halite samples : observations and full field measurements in a scanning electron microscope and comparison with crystalline plasticity computations

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Halite is an important analog material as well as a geological material of choice for underground storage cavities. We present the initial part of an extensive study which aims at characterizing the deformation mechanisms of halite with surface and volume observations and to model them with special attention to the mechanisms of grain boundary sliding which complements or acts in parallel with the more classic crystalline plasticity. In this first part, we limit ourselves to surface observations of samples of synthetic halite deformed in uniaxial compression inside a scanning electron microscope (SEM). The sample are prepared by HIP (Hot Isostactic Pressure) and after annealing, a rather homogeneous and compact structure is achieved with grain sizes ranging from 250 to 500 micrometers. Digital image correlation (DIC) is used in order to record the local deformation and compute the components of the strain tensor. Electron back scattering diffraction (EBSD) provides the local crystal orientations (local textures) at an initial stage and intermediate steps of the mechanical test. Traces of slip planes and DIC computed local strains are markers of intra-crystalline plasticity but also for the latter of potential grain boundary sliding.

The first computations use a 3D finite element scheme, which considers a few grains of known geometry and orientation. Applying proper boundary conditions to reproduce the local ones, one computes through a crystal plasticity based model which slip systems are active and how do the different parts of the grains reorient themselves. Comparisons are made between experimental data et computations in order to test the validity of the model. First attempts are made to account for grain boundary sliding in the computations.

Computations are an important complement to experiments, since they can provide estimates of local stress magnitudes, while the experiments are limited to the kinematics of the deformation. In the next stage of the project, we shall attempt to integrate 3D experimental data into our approach and to have a better physically based model of grain boundary sliding.