Evolution of rheology and fabric with strain in torsion – experiments on synthetic rocksalt.

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Evaporitic rocks play an important role in localizing shear deformation in sedimentary sequences, implying that their strength is lower than that of most rocks. Salt tectonics commonly takes place in the uppermost 5 km of the Earth's crust. The temperatures under this conditions are generally <200°C and the lithostatic pressure is <120 MPa. In order to understand the role of evaporites, rheological data on steady-state flow of rocksalt and the associated deformation mechanisms under these P-T conditions form an important set of information. Since conventional tests in compression cannot produce shear strains large enough to attain steady-state, we performed torsion experiments up to a shear strain of $\gamma = 8$ using synthetic rocksalt.

We have studied the rheological, microstructural and textural evolution of wet synthetic rocksalt samples on a series of experiments in torsion at shear strain rates between 10^{-3}-10^{-5} s^{-1}, at confining pressure of 250 MPa and temperatures of 60, 100 and 200°C. The starting material was prepared from synthetic NaCl powder by uniaxial cold pressing at ~ 200 MPa and a nearly hydrostatic annealing at ~ 100 MPa. This yielded a dense material with a grain size of ~150 µm and polygonal grains with equilibrium structure.
Shear stress versus shear strain data for experiments conducted at 60 and 100°C show typical yielding at the beginning of the experiment. Beyond the yield point the shear stress continued to increase with increasing shear strain, indicating strain hardening. In the experiments conducted at a temperature of 200°C the shear stress vs shear strain curves show typical yielding in the beginning, like at lower temperatures. However, beyond the yield point, the salt either starts to weaken or shows a slight strain hardening that decays at large strain and finally steady state flow occurs. From strain rate stepping tests at large strains we observed a larger sensitivity of shear stress to the strain rate at 200°C than at lower temperature.

Microstructural analyses of a sample deformed to a shear strain of $\gamma \sim 4$ show a grain size zonation. Smaller grains are localized at the top and the bottom parts of the sample, whereas grain growth occurred in the middle part of the sample, reaching grain sizes up to 1 cm. This difference in size could be related to heterogeneities in water distribution. Further investigations on this size effect needs to be carried out under open conditions to consolidate this conclusion.

A first detailed micro-fabric analysis by electron backscatter diffraction (EBSD) mapping of a sample with maximal shear strain of $\gamma \sim 2$ revealed a crystallographic preferred orientation (CPO) of moderate strength around a {110} <110> component, i.e. a {110} plane parallel to the shear plane and a <110> direction towards the shear direction.