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The dependence on pressure of the plastic flow of rocksalt in the temperature range 25-250˚C: implications for the rate controlling mechanism

Nawaz Muhammad, Chris Spiers, Hans De Bresser, and Colin Peach
High Pressure and Temperature Laboratory, Faculty of Earth Sciences, Utrecht University, Utrecht, the Netherlands (n.muhammad@uu.nl)

Despite the large body of data that already exists, the question what microphysical mechanisms govern plastic flow of natural rocksalt at *in situ* conditions has not yet been answered to full satisfaction. In particular, the exact mechanism controlling dislocation motion at relatively low temperature is still insufficiently understood. As a result, uncertainties exist regarding the appropriate mechanism-based flow-law for low temperature, hampering reliable extrapolation of lab creep data to *in situ* strain rates. Such extrapolation is required for the modelling of the long term behaviour of salt for geomechanical purposes (e.g. subsidence prognosis).

Several dislocation models have been proposed to control plastic flow of rocksalt, such as dislocation climb, cross-slip and (impurity-controlled) glide, but none of these have been rigorously verified. One way to test which model is appropriate is by investigating the pressure dependence of flow of rocksalt. Dislocation glide is expected to be hardly affected by pressure, cross slip (controlled by constriction of partial dislocations) will become easier with increasing pressure, and dislocation climb will become more difficult.

We performed conventional axi-symmetric compression tests on synthetic polycrystalline salt samples with an average grain size of 300 μm. The samples were dry, in order to eliminate the possible influence of pressure solution creep. The experiments were carried out at temperatures in the range 25-250˚C, i.e. 0.28-0.48T_m, and at pressure ranging 50-600 MPa, which is a range not previously covered for polycrystalline rocksalt. Argon gas was used as the pressure medium.

With confining pressure increasing from 50 to 600 MPa, the rocksalt remained of the same strength at RT, but became about 60% stronger at 125^{o}C and about 80% stronger at 250^{o}C at strain rate 10^{-6} s^{-1} (at 15% strain). Using a conventional (Dorn-type) power law to describe the mechanical behaviour, stress exponents (n) were found that varied from 10.3 at 125˚C to 7.1 at 250˚C. The data suggest that dislocation glide may control the behaviour of rocksalt at room temperature, but the absolute values found for n and the decrease in n with increasing Tindicate that a single dislocation climb controlled model is not sufficient to describe the flow at 125-250˚C. We evaluated the experimental data against various models of dislocation glide, cross slip and glide, and combinations of these, in order to come to a (composite) flow law that can be applied in the modelling of the long term behaviour of salt at relatively low temperature.