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DUCTILE FLOW BY WATER-ASSISTED CATACLASIS

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In the presence of water otherwise brittle materials may deform macroscopically ductile by water-assisted cataclastic creep. This is possible as long as (i) solubility is high enough, so that stress-corrosion can occur, and (ii) local stress is low enough, to that fracturing remains subcritical.

Water-assisted cataclastic creep (WACC) may play an important role in the middle and lower continental crust where mineral solubilities are high and stresses low. WACC is a poorly understood deformation process. Experiments were performed on very soluble brittle salts (Na-chlorate; K-alum) to study microstructure development by WACC. The experiments were carried out at room temperature and atmospheric pressure in a small see-through vessel. In this way the cataclastic deformation process could be studied "in-situ" under the microscope.

Crystals were loaded in the presence of saturated salt solution. It appeared that originally straight mineral surfaces were instable when kept under stress. Grooves (or channels) slowly developed in the surface by local dissolution. These grooves behave like so-called Grinfeld instabilities. They develop because the energy of a grooved surface under stress is lower than the energy of a straight surface under stress.

The grooves may deepen and turn into subcritical cracks when local stress further increases. These cracks propagate slowly. They propagate parallel to sigma1 but also at an angle and even perpendicular to sigma1, often following crystallographically controlled directions. The fractures mostly change direction while propagating, locally making turns of more than 180 degrees. Irregular fracture fragments thus develop.

The fractures may migrate sideways (as with grain bounday migration) probably by solution-redeposition driven by differences in stress between both sides of the fracture. Thus the shape of the fragments changes. The size of the fracture fragments seems to be controlled by the distance of the grooves, which decreases with increasing stress.