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Ductile shear zone development in the pressure solution regime in dense aggregates of very soluble brittle salt: an in situ experimental investigation.

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A series of in-situ deformation experiments were carried out to study (micro-scale) ductile shear zone development under conditions where dissolution-precipitation processes and water-assisted subcritical microcracking are the dominant deformation processes. Sodium chlorate ($NaClO_3$) was used as a rock analogue material. This is a *brittle* salt, with a solubility and a dissolution/growth rate comparable to rock salt (NaCl). $NaClO_3$ cannot be deformed plastically to any significant amount, at least at room temperature and atmospheric pressure (strain resolution <0.1%).

Dense polycrystalline aggregates of $NaClO_3$ were prepared by hotpressing analytical grade $NaClO_3$ grain aggregates for 48 hours at 40°C and an applied pressure of 40 MPa with 40 vol.-% of added water. Samples thus prepared measured 20 x 6 x 0.5 mm in size, had an average grain size of 500 µm and a porosity of 1%. They were slid into a transparent vessel between two 1.5 mm thick glass slides 50 x 50 cm in size, held 0.6 mm apart by brass spacers that closed-off the vessel from all sides except from above where a brass piston was slid in. The sample was held on its outer left and right side (like a bridge) and indented in the middle by a 6 mm wide and 0.5mm thick piston. Empty space was filled up with loose $NaClO_3$ grains of 500 µm in size and with saturated $NaClO_3$ solution. The piston was loaded with a dead weight of 1204g corresponding to a calculated stress under the piston of 4 MPa (friction neglected).

Left and right of the piston two opposite shear zones developed of about 7 mm wide. Average shear strain rate was 10^{-7}/s. Average finite shear strains of 0.7 were obtained. Shear zone development was monitored continuously under the optical microscope. First results show that shear zones mainly form by solution precipitation processes, probably associated with sliding of grains and local grain scale microcracking, as well as the opening of relatively large scale tension gashes (typically 4 - 6 mm long and 500 µm wide). The tension gashes were partly filled in with newly precipitated $NaClO_3$ during the shearing. Some of them also mechanically closed up during later stages of shear zone development and developed into small scale brittle shear zones.