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Strain localization from deformation experiments in torsion: results from the working group of ETH

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The first high temperature (up to 1600K), high pressure (up to 500 MPa) deformation apparatus developed for torsion-testing of geologic materials was installed in 1995 at the Rock Deformation Laboratory, ETH. Since then, experiments performed on this machine to shear strains of up to 50 allowed measuring the textural and rheological evolution of artificial and natural rocks during progressive deformation by plastic and cataclastic flow and to highlight the mechanisms of strain localization and of maintenance of deformation into high strain zones.

Most of monomineralic aggregates (i.e. calcite, dolomite, olivine, anhydrite, gypsum etc.) deformed homogeneously, and reached a mechanical steady-state flow stress only after shear strain > 5, i.e. after hardening followed by weakening phases. Even if weakening was sometime important (up to 50% in anhydrite, probably induced by a switch from dislocation to diffusion creep), was not sufficient to lead to strain localization.

On the other hand, most of the two phase aggregates (e.g. calcite and anhydrite, calcite and mica, or melt and a solid phase) displayed a more complex deformation pattern, leading to localization of the deformation.

From our experimental experience we can conclude that strain localization in torsion is facilitated by microstructural heterogeneities (e.g. different phases) and that maintenance of deformation in a localized zones depends upon the degree of weakening of the deformed versus less deformed portion of the rock.