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Microstructural variation in natural mylonites and their consequences for rheological extrapolations from laboratory to nature

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At first glance, the characteristics of natural microfabrics of calcite mylonites formed at mid-crustal levels almost invariably suggest grain size insensitive creep (GSI) to be the predominant deformation mechanism. This inference contradicts extrapolations of laboratory experiments, which predict grain size sensitive (GSS) flow to be dominant under a wide range of natural deformation conditions (e.g. de Bresser et al., 2001). This extrapolation problem between nature and experiment can be solved if quantified grain size distributions of natural microfabrics are used. These distributions act as input parameters for the rheological modeling of composite GSS+GSI flow (ter Heege et al., 2004) using constraints from nature on temperature and strain rate or stress. Results for selected natural calcite mylonites indicate predominance of grain size insensitive creep at low temperatures but with an increase of the contribution of grain size sensitive creep to the bulk flow with increasing T (Herwegh et al., 2005). This elegantly corroborates the inferences made from the natural microfabrics.

In nature, however, not only the deformation conditions (stress, temperature, strain rate), but also the composition of calcite mylonites (chemistry, second phase content, fluids) and the geodynamic evolution can vary substantially between individual large-scale shear zones. This variability, of course, directly affects the resulting deformation microstructures, which again has implications for the extrapolation of rheological lab data to nature. Based on a series of different large-scale shear zones, we will demonstrate microstructural variations in calcite mylonites from the Alps and discuss what their consequences for rheological predictions are.

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