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# Revisiting creep of calcite

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A fundamental concept in deformation experiments is the idea that steady state flow laws can be theoretically derived and matched to experimental observations. These flow laws link physical properties like stress and temperature to allow the extrapolation of a material's rheology towards natural deformation conditions. Importantly, theoretical constitutive laws try to describe the rate of deformation of a material for one microscopic process during a deformation. However, it is clear that within the window of an experiment's conditions more than one process can be active at given strain rate and flow stress. Ideally, the bulk deformation of a material can be described by adding together different laws for different specific deformation processes expected to be active at given physical deformation conditions. This additive procedure allows for the fitting and transition of low stress diffusion creep behaviour to high stress dislocation creep behaviour.

We revisited the diffusion creep experiments of Herwegh et al. (2003) and the dislocation creep experiments of Xu et al. (2008) for calcite and found that both the activation energy and pre-exponential factor evolve as a function of stress. These dependencies are attributed to the coeval activity of some dislocation glide process with grain boundary diffusion. It is shown that even in domains classically interpreted to be grain size sensitive and creeping by diffusion creep ($n \approx 1$), some dislocation migration process may make significant contributions to the accommodation of strain. We find that all data revisited can be fitted but the resultant flow law must contain knowledge of the stress dependencies because they exist even when $n \approx 1$. We also fitted the low stress data for the classical diffusion creep flow law but found that when this was added to a dislocation creep flow law the data could not be matched. This may mean that at least for these experiments it is harder to assign end member deformation mechanisms with clear domain boundaries. Our work provides a constitutive equation with mixed characteristics that could define the transitional properties for plots like deformation maps. However this moves away from the ideal flow law, which describes only one process and may be more generally useful. In future it would be needed to properly decompose the contribution of the underlying processes with detailed microstructural characterisation.

Herwegh, M., Xiao, X., Evans, B. Earth and Planetary Science Letters (2003) 212:3, 457–470. doi:10.1016/S0012-821X(03)00284-X

Xu, L., Renner, J., Herwegh, M., Evans, B. Contrib Mineral Petrol (2009) 157: 339. doi:10.1007/s00410-008-0338-5