Geophysical Research Abstracts
Vol. 18, EGU2016-11171, 2016
EGU General Assembly 2016

Why do flow laws not predict sensible strain-rate distributions in the crust?

John Platt

Department of Earth Sciences, University of Southern California, Los Angeles, USA (jplatt@usc.edu)

The tensor strain rate *edot* in a ductile shear zone is directly related to its width w and the displacement rate V by *edot* = V/2w. If the strain-rate is related to stress via a constitutive relationship, or flow law, then we should be able to predict w as a function of temperature and depth by $w = V/2f$(*sigma*), where *sigma* is the second invariant of the deviatoric stress tensor, and f is the rheology. The rheology has the general form f(*sigma*) = A exp(-*Q*/*RT*) *sigma*$^n d^{-m}$, where Q is the activation energy, $R$is the gas constant, T is temperature, and d is grain-size. The prefactor A is a function of the properties of the mineral and its grain-boundaries, and may incorporate some dependency on water content.

If we have constraints on the variation of temperature and stress with depth, in a shear zone for which the slip rate is likely to have been constant with depth and time, we should be able to calculate *edot*, and hence w, as a function of depth. The Whipple Mountains metamorphic core complex provides an example of this, as the temperature and stress as a function of depth in the exhumed shear zone are known (Behr & Platt, EPSL, 2011), and the slip rate is well constrained over a 9 m.y. period. To calculate *edot*, I used a range of possible rheologies, including various published flow laws for quartz, and composite flow laws for granite or granitic gneiss based on several published approaches to the rheology of quartz-feldspar mixtures spanning the full range of physically viable solutions. These different rheologies give values for *edot* spanning many orders of magnitude, but more importantly, they all predict increasing strain-rate (and hence decreasing w) with depth and temperature. It is widely accepted that shear zones increase in width with temperature and depth, so this appears to be an example of a failed model. Some possible reasons for this, and approaches for the future, are discussed.