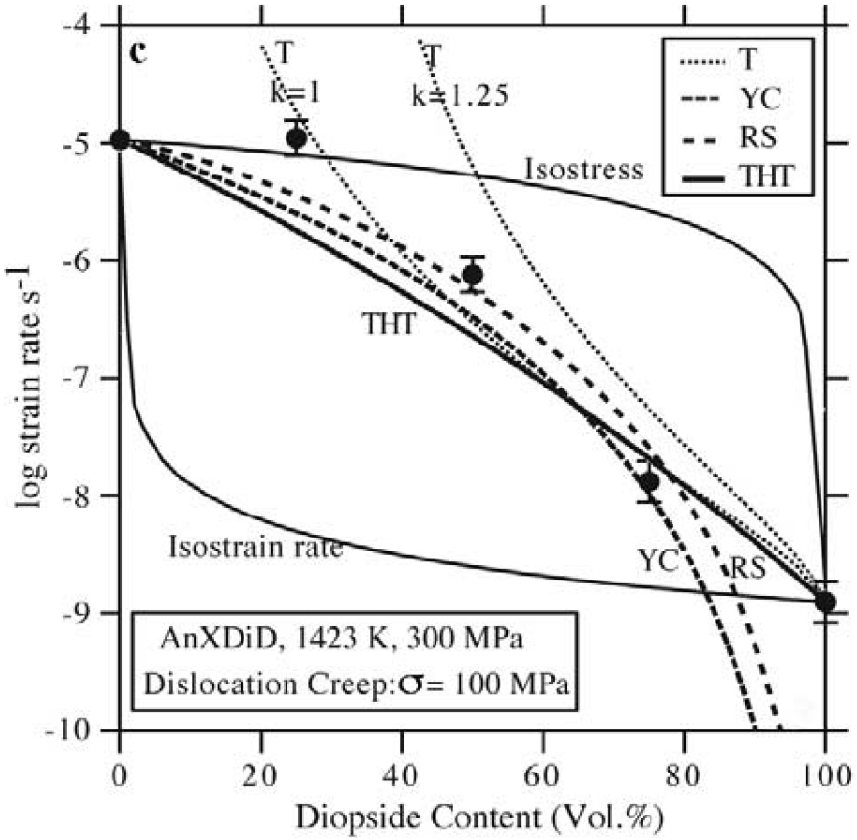
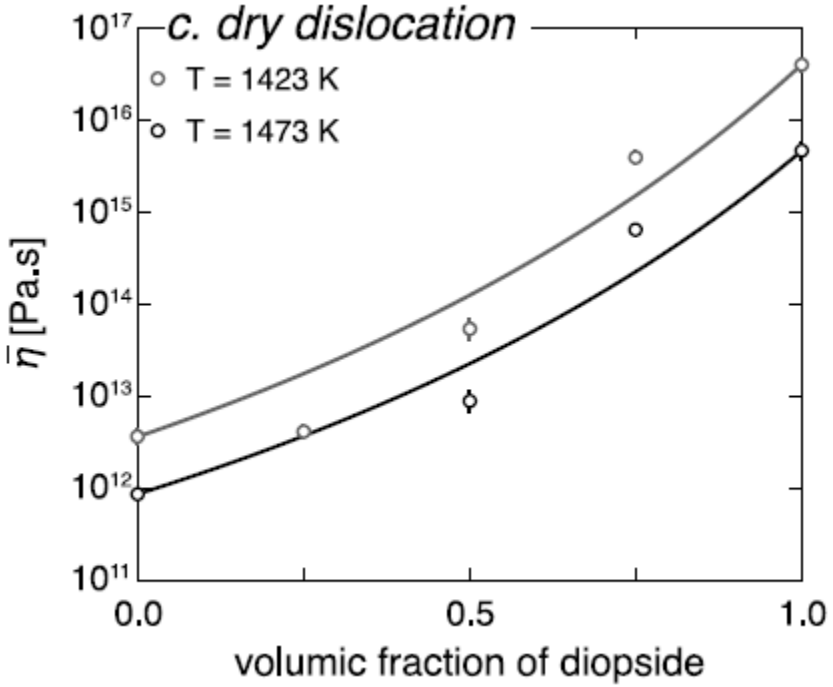
A road map to incorporating rheology into CRM

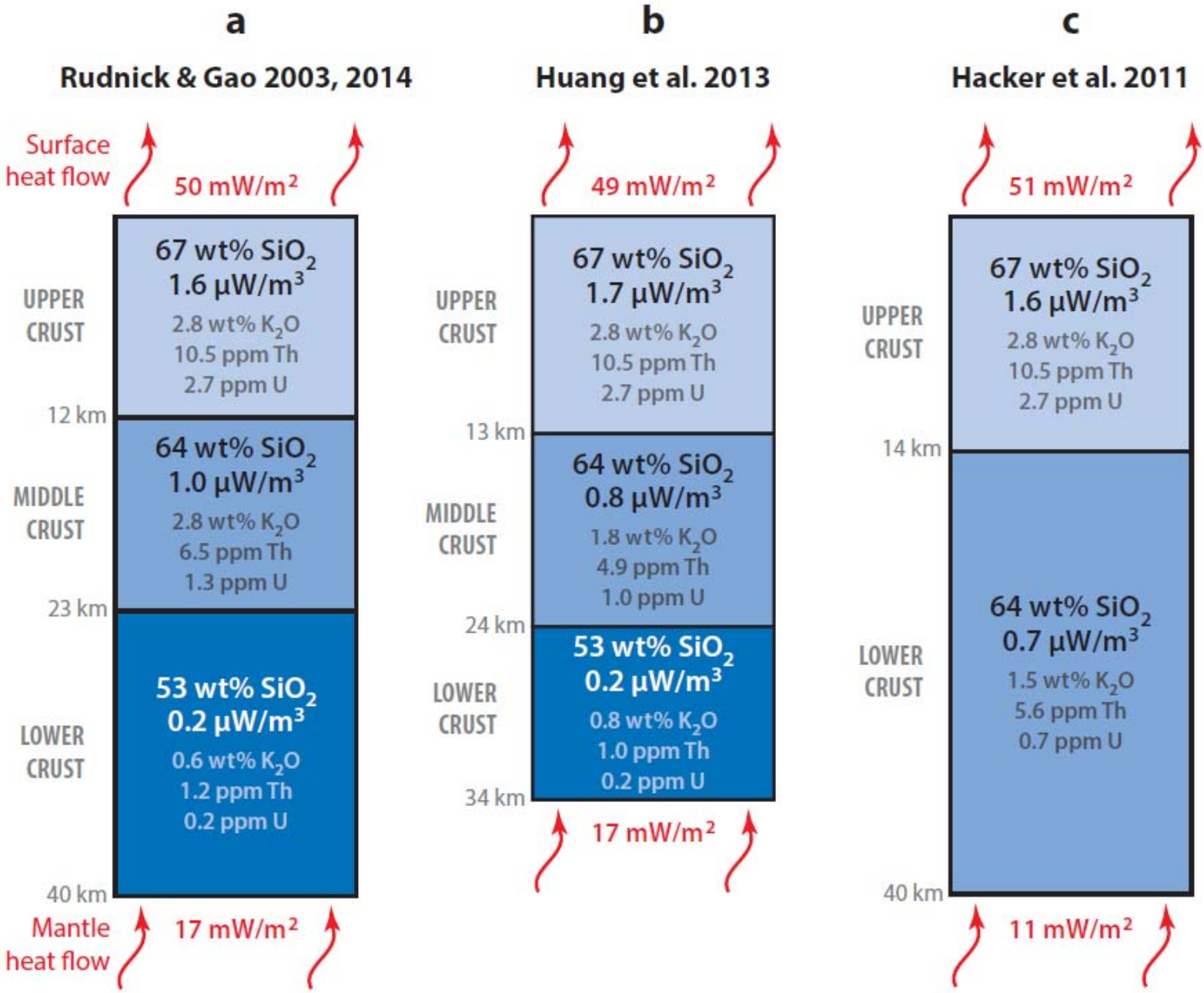
FIRST STEP
Rocks are not single phase aggregates
Need to use mixing models



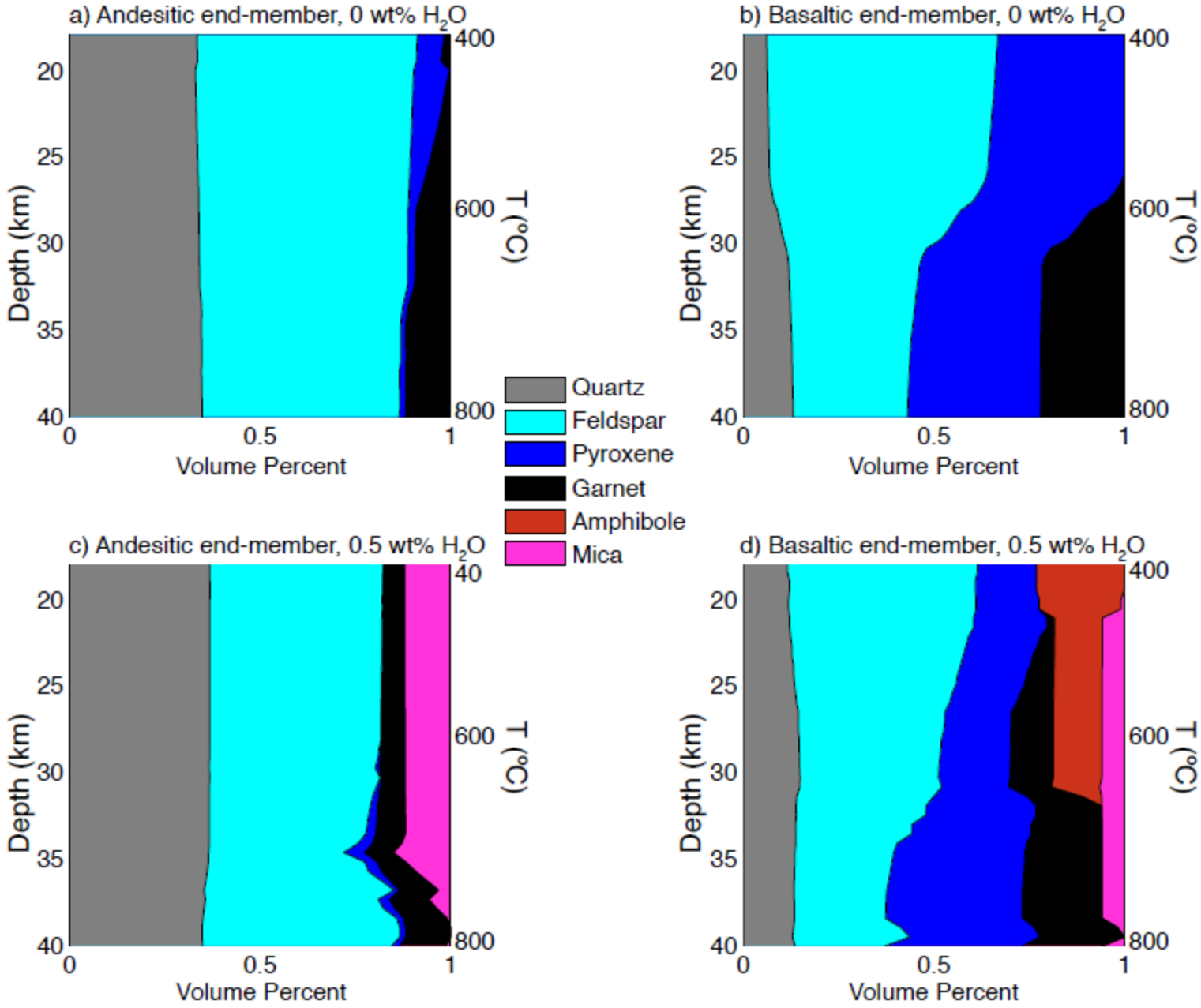
Dimanov and Dresen, 2005



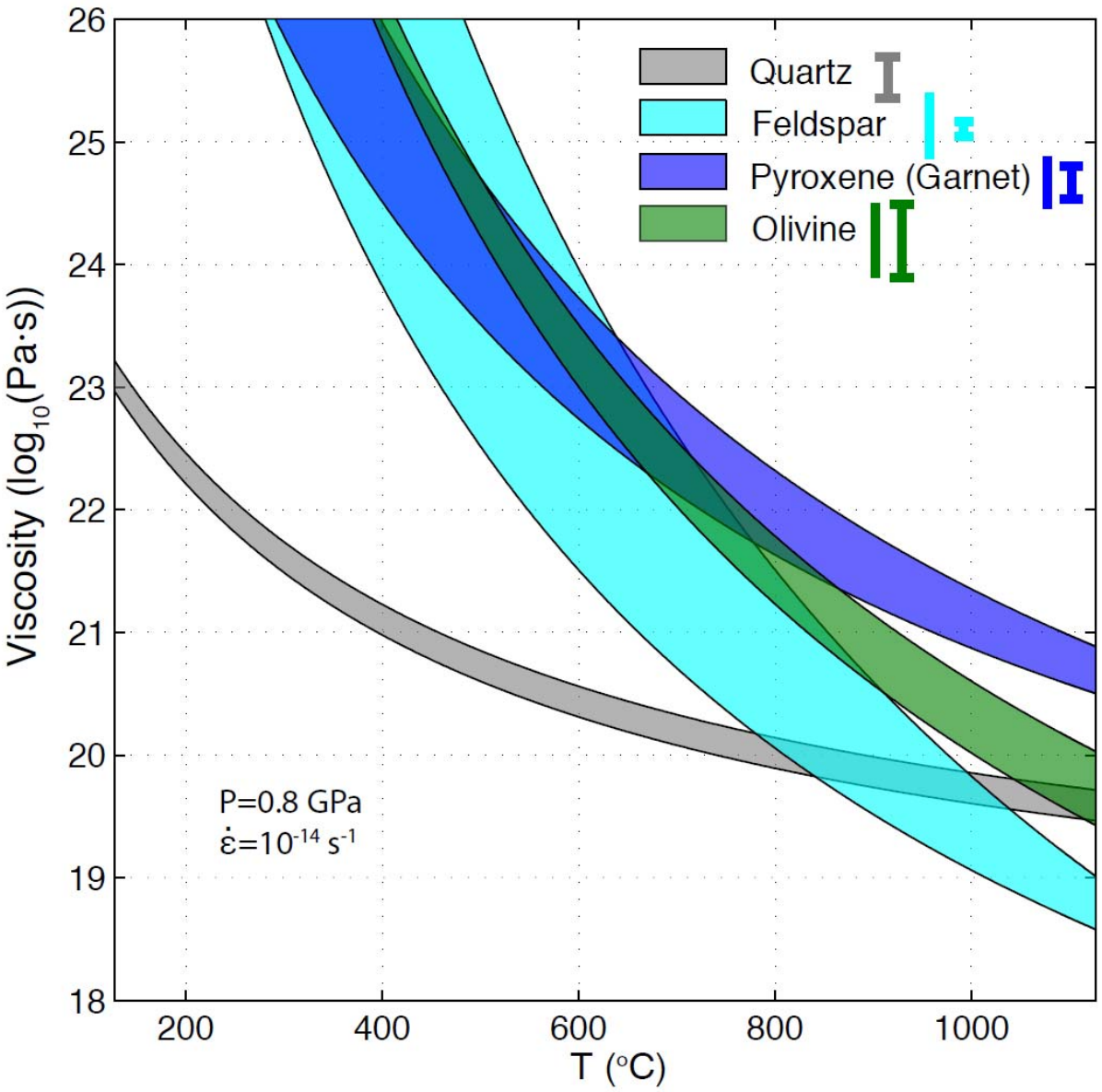
Huet et al., 2014



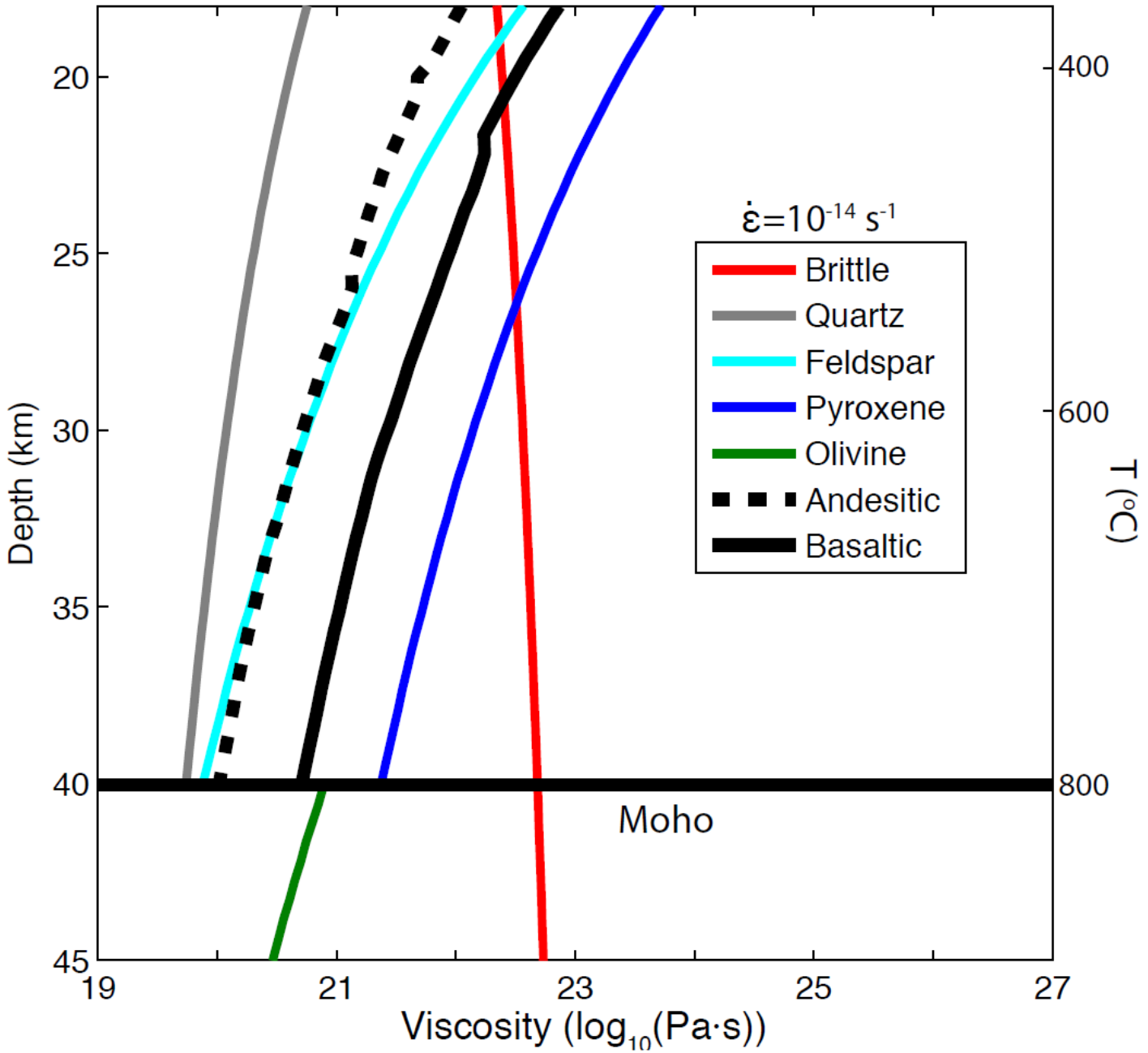
Hacker et al., 2015



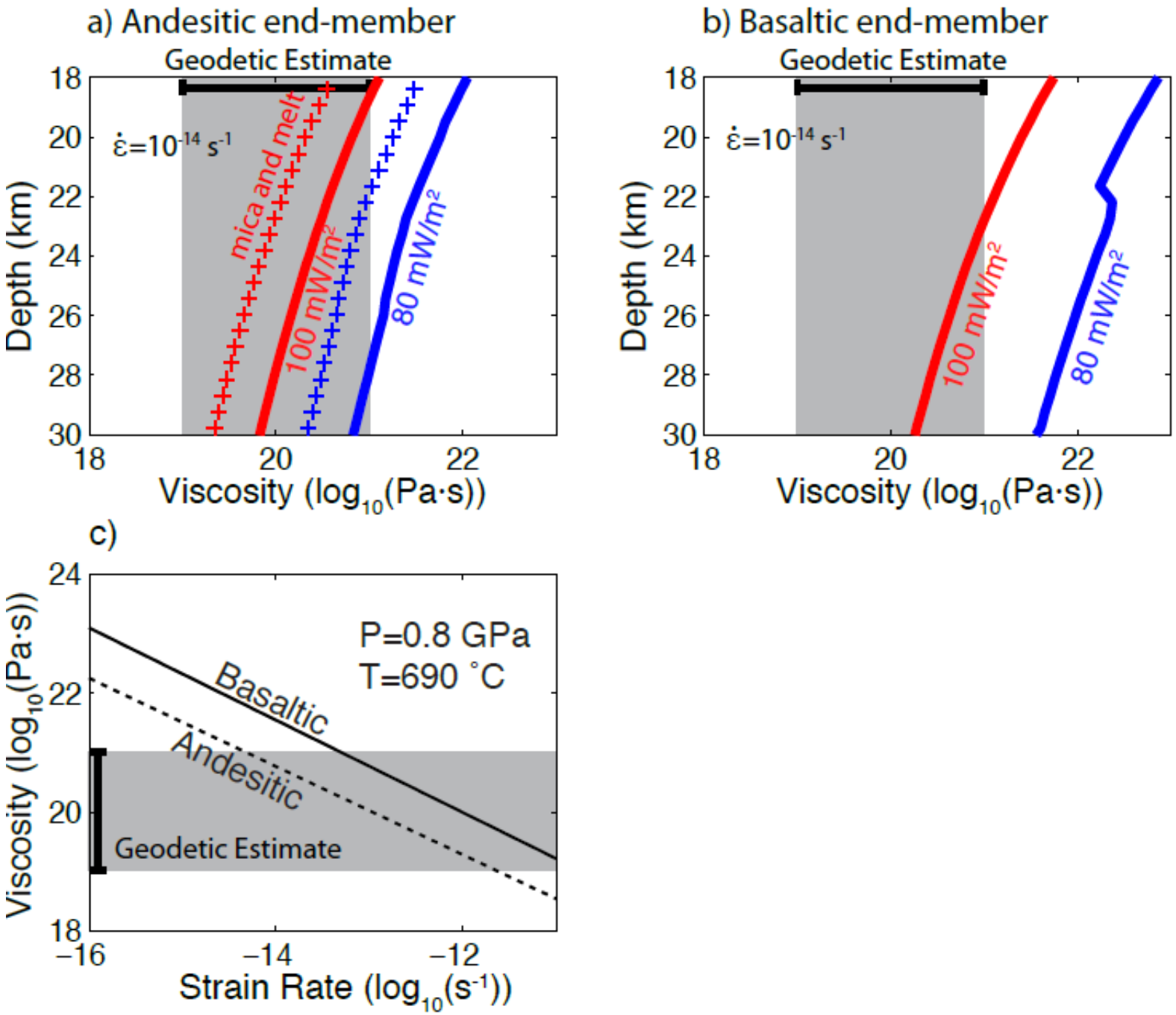
Shinevar, Behn and Hirth, GRL, provisionally accepted



Shinevar, Behn and Hirth, GRL provisionally accepted



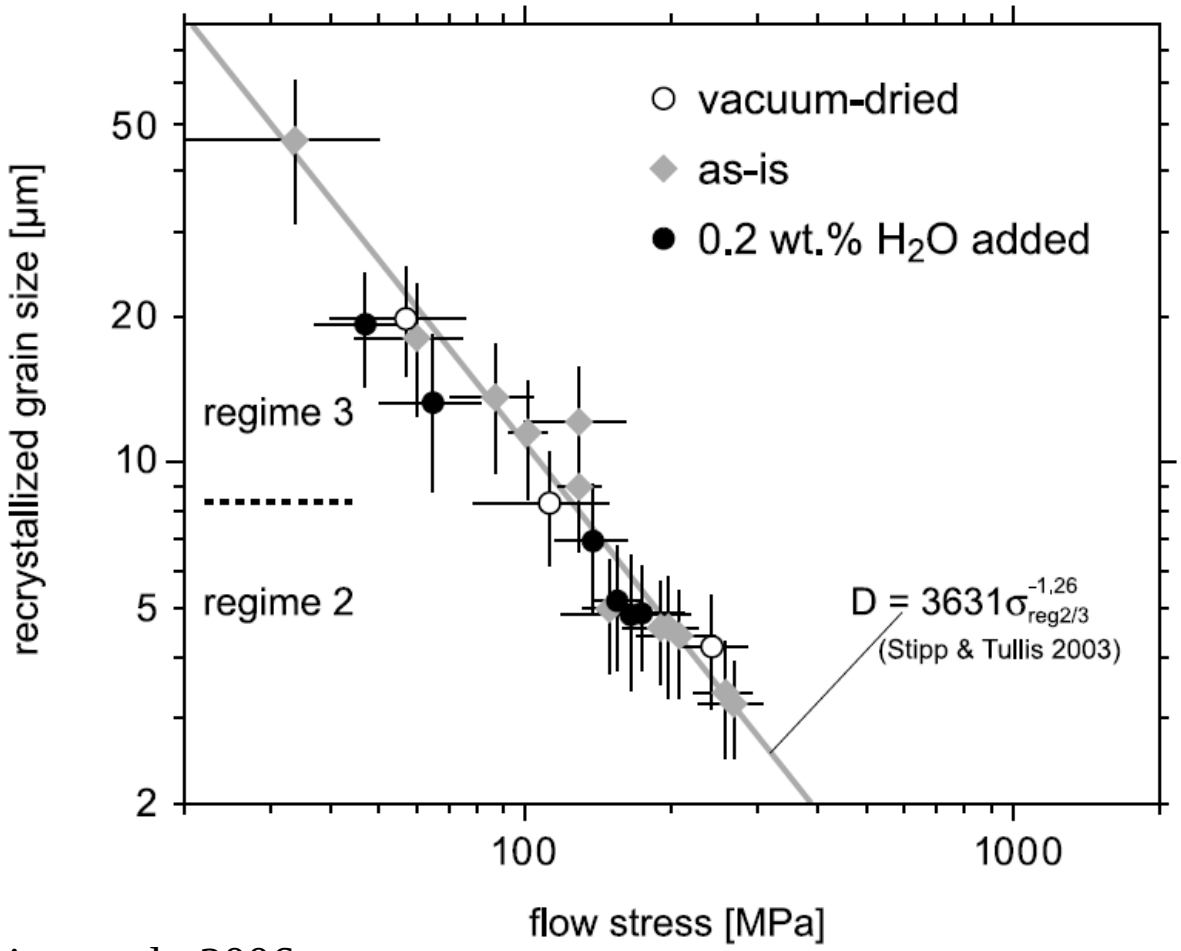
Shinevar, Behn and Hirth, GRL, provisionally accepted



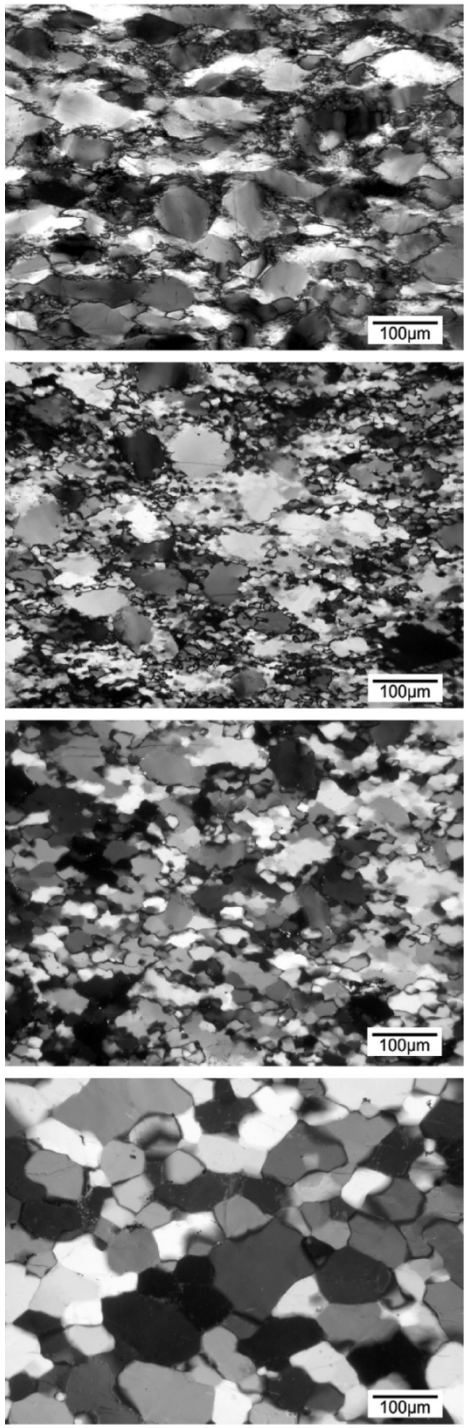
Shinevar, Behn and Hirth, GRL, provisionally accepted

Application of Flow Laws to the Rheology of Shear Zones

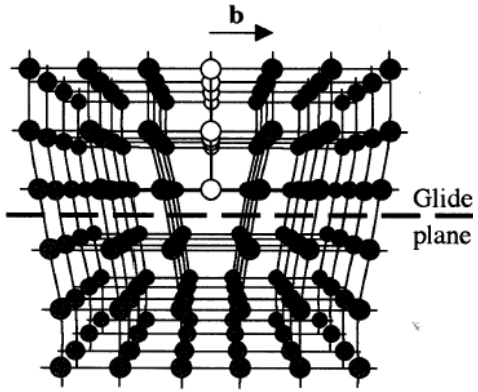
FIRST STEP: Stress Estimates

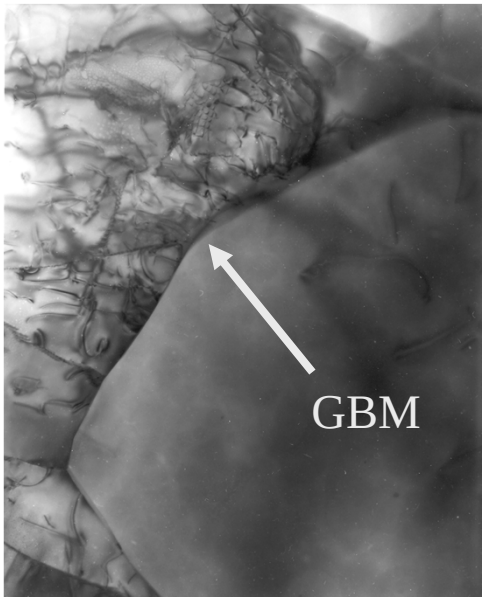


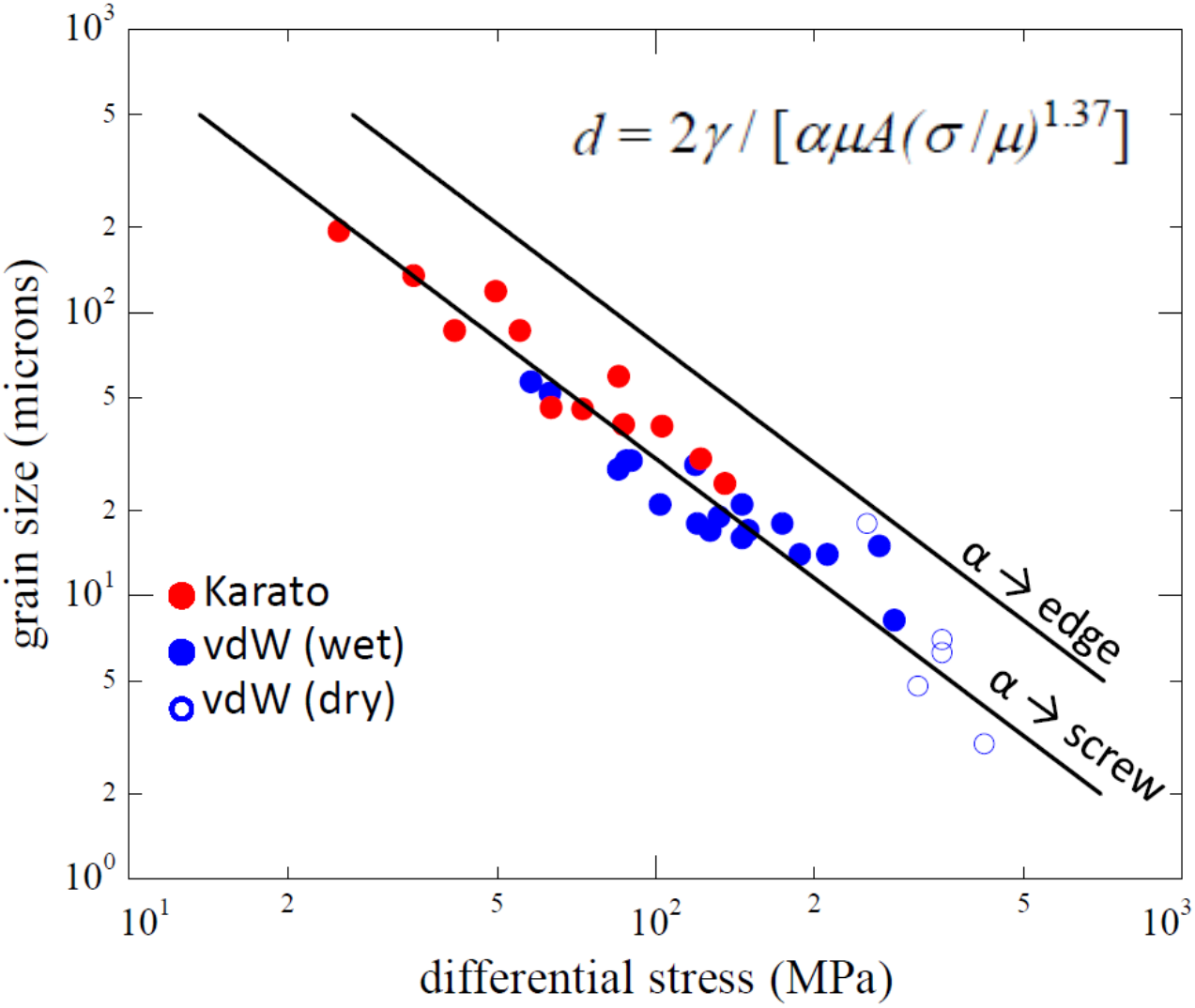
Stipp et al., 2006



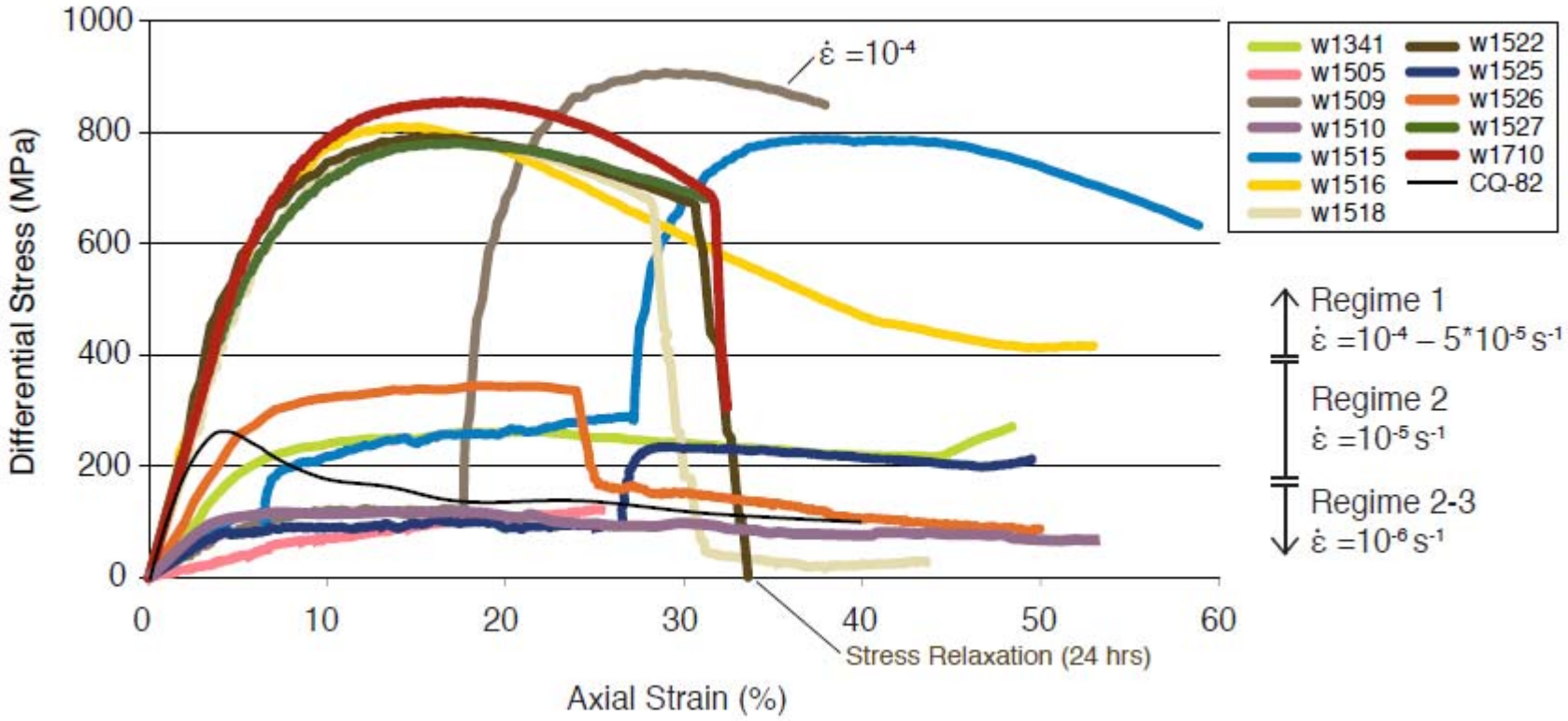
$$\alpha\rho\mu b^2 = 2\gamma/d$$



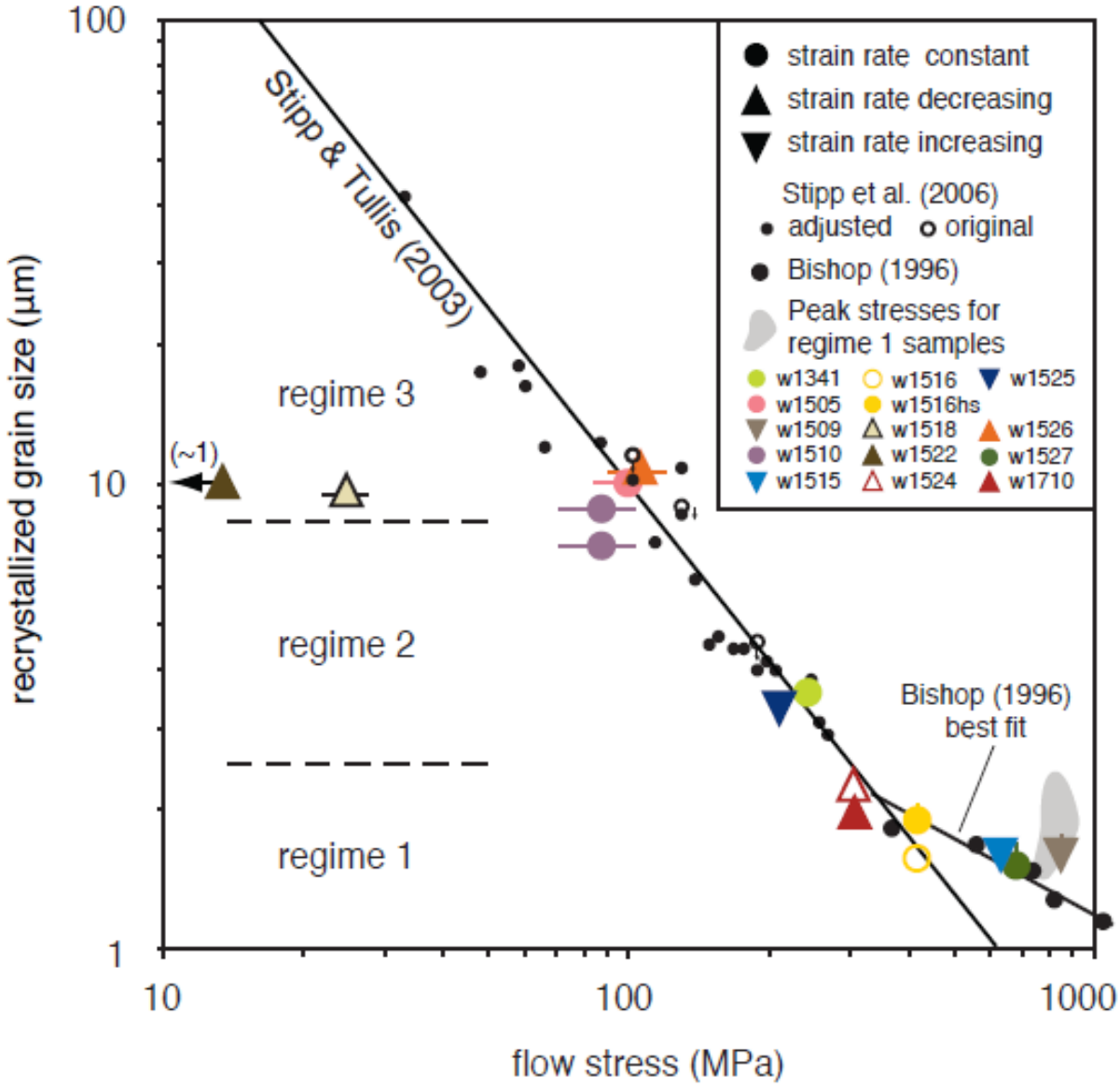




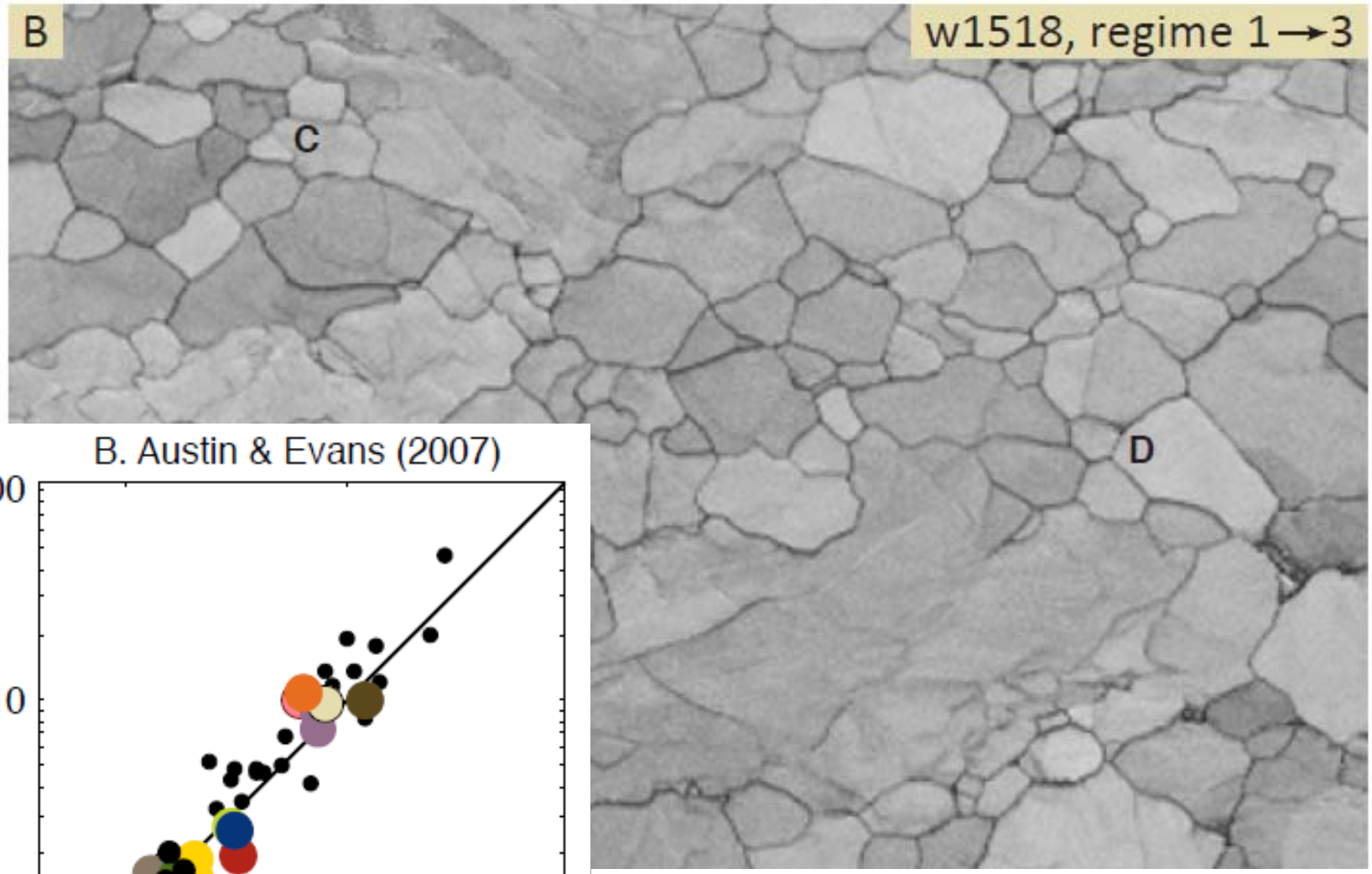
Hirth & Kohlstedt, 2015



Kidder, Hirth, Avouac & Behr, JSG, in revision



Kidder, Hirth, Avouac & Behr, JSG, in revision



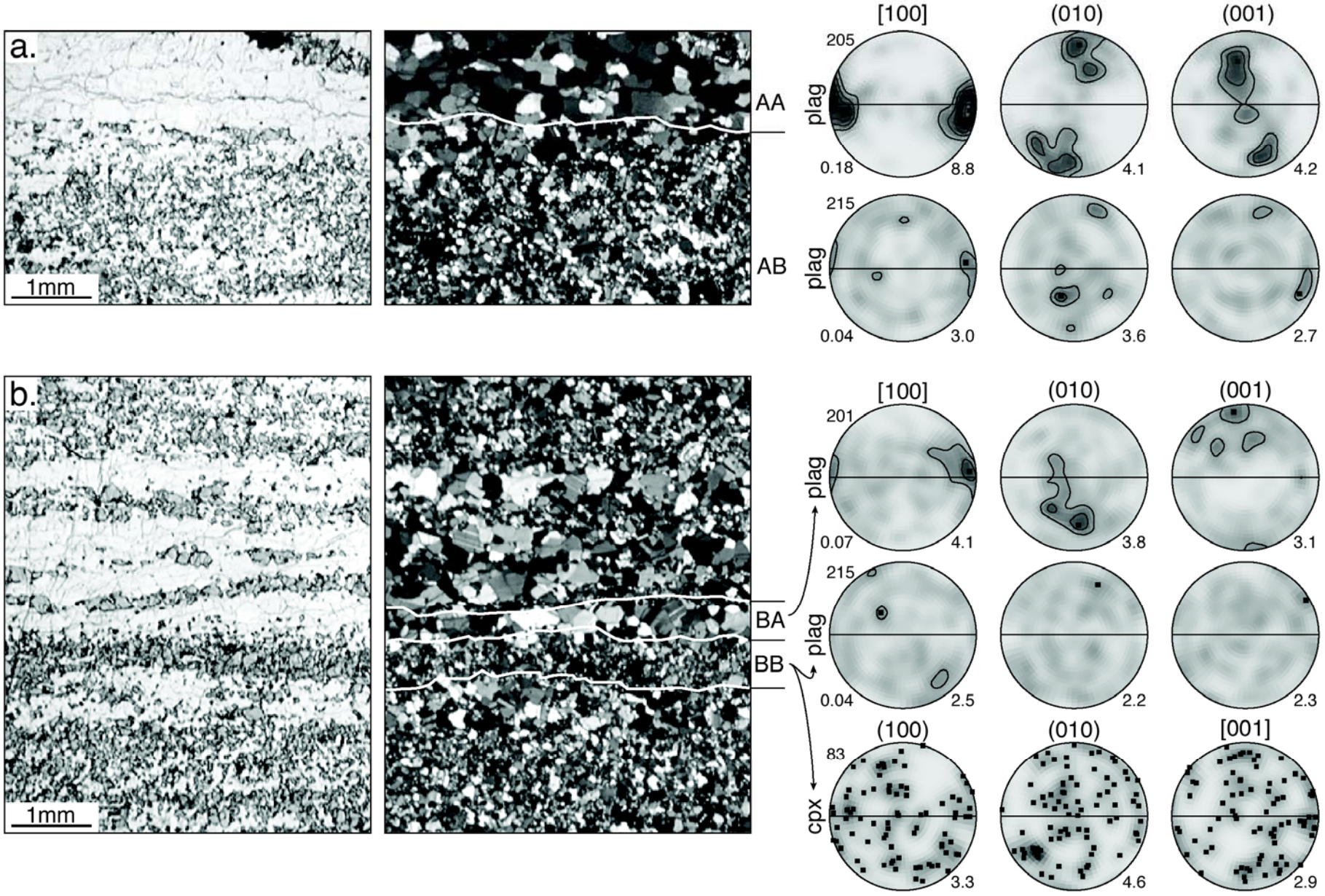
$$\dot{d}_{tot} = -\frac{\beta\lambda\sigma\dot{\varepsilon}d^2}{c\gamma} + K_g \exp\left(\frac{-Q_g}{RT}\right) p^{-1} d^{1-p}$$

Application of Flow Laws to the Rheology of Shear Zones

Localization promoted by diffusion creep of fine-grained matrix

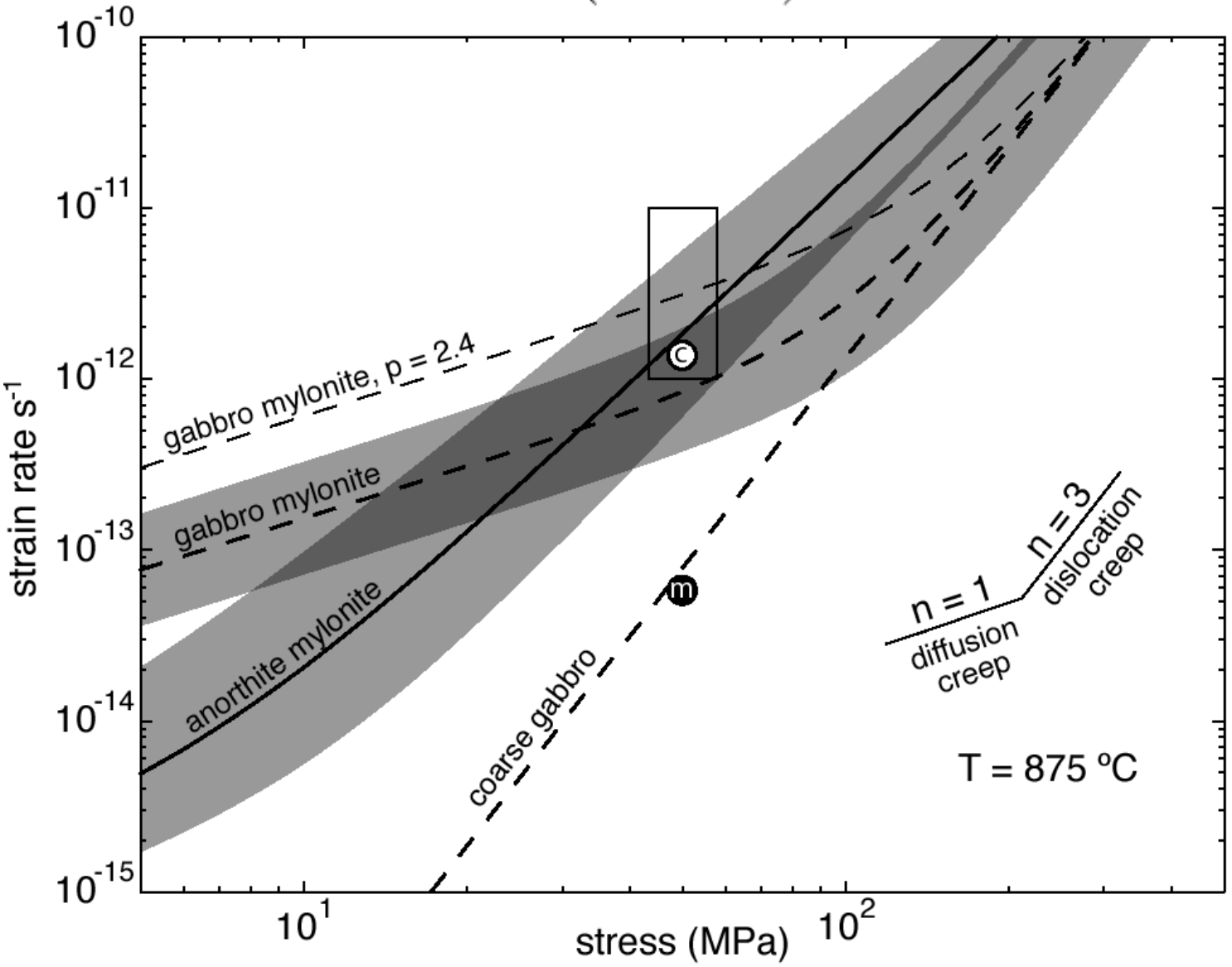
AND

Shear zone strain rate consistent with dislocation creep flow law for weak phase (lower bound model)

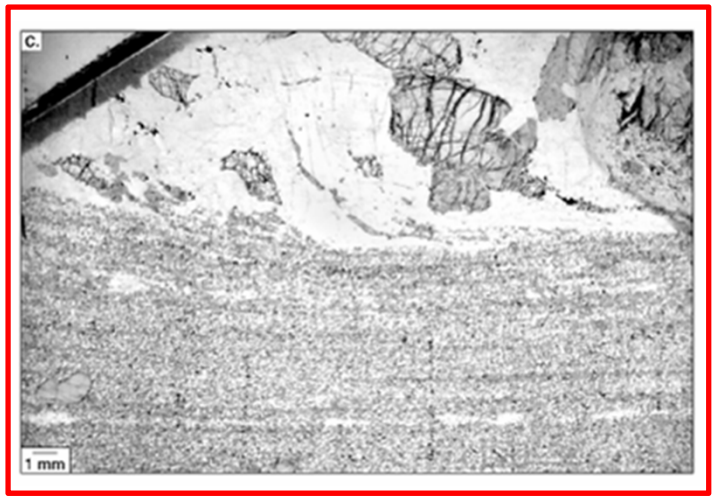


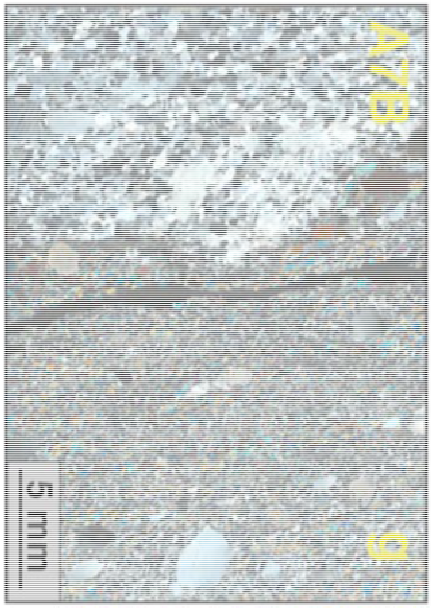
Mehl and Hirth, JGR 2008

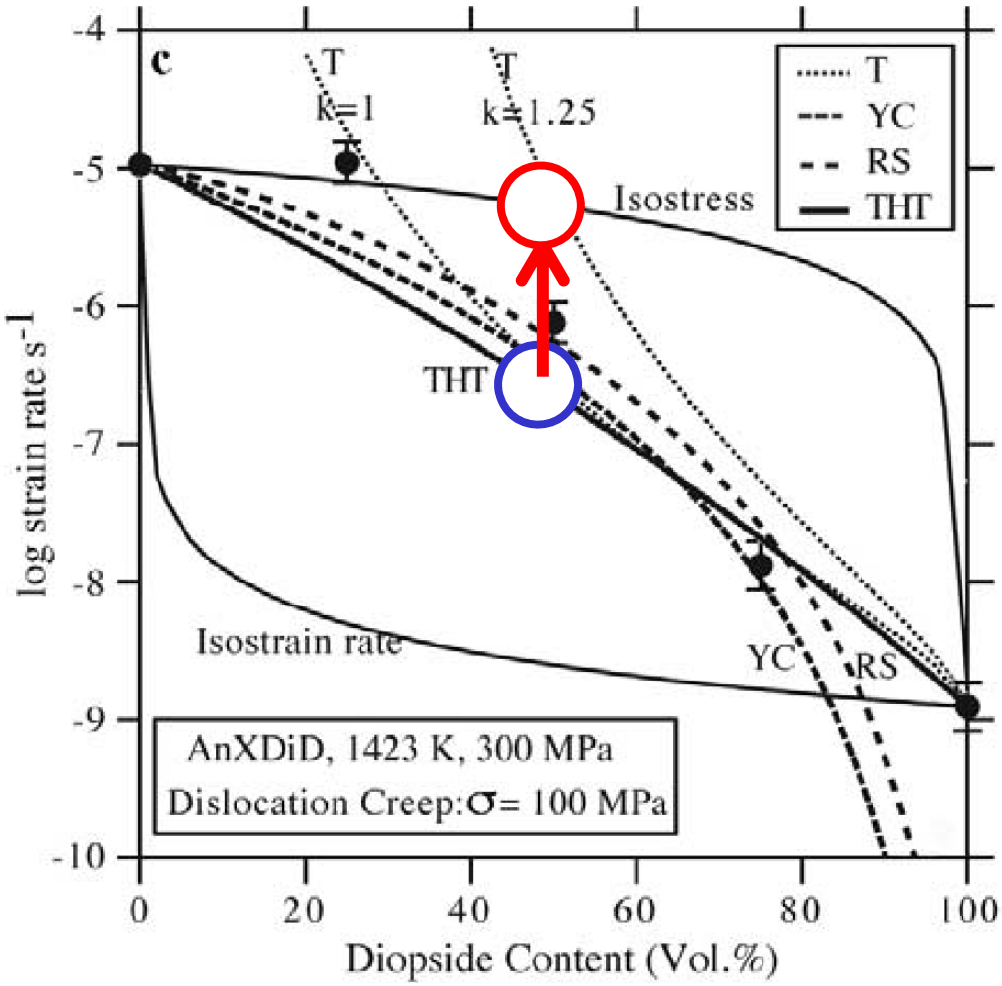
$$\dot{\varepsilon} = A\frac{\sigma^n}{d^m} f(\phi,\ C_{OH}) \exp\left(-\frac{Q + PV^*}{RT}\right)$$



Mehl and Hirth, JGR 2008







Dimanov and Dresen, 2005

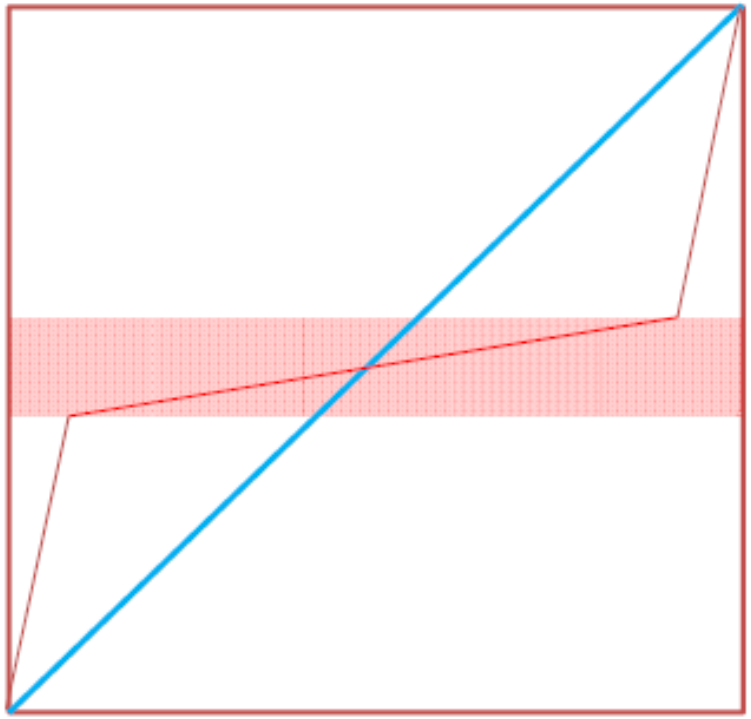
$$\dot{\varepsilon} = \dot{\varepsilon}_{sz}\chi + \dot{\varepsilon}_{cr}(1-\chi)$$

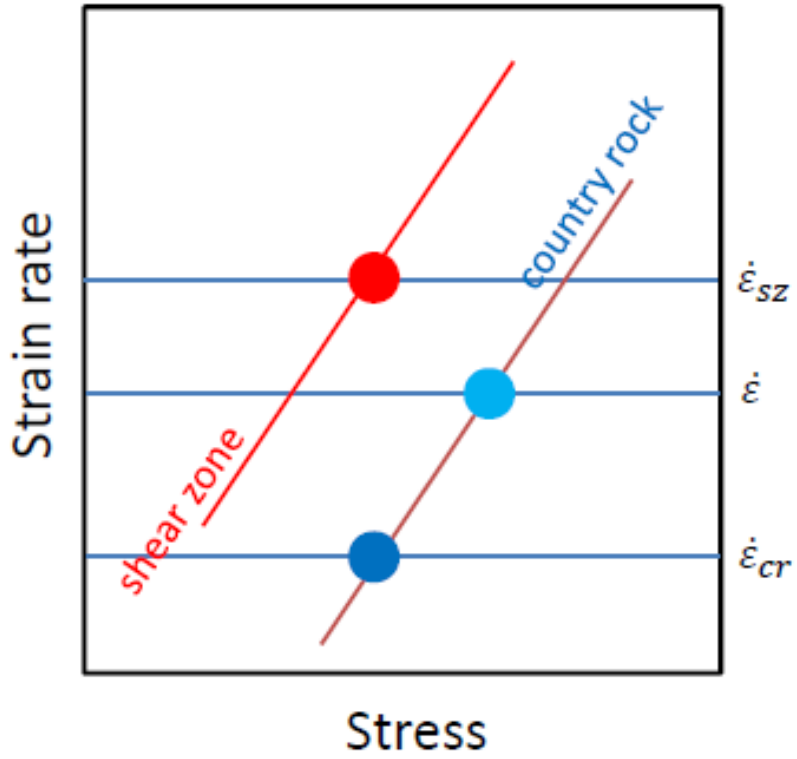
$$\chi = \frac{\dot{\varepsilon}/\dot{\varepsilon}_{sz} - F}{1-F}$$

χ = fraction of shear zone

$\dot{\varepsilon}_{sz} = \dot{\varepsilon}_{dislocation\ creep\ weak\ phase}$

$F = \frac{\dot{\varepsilon}_{cr}}{\dot{\varepsilon}_{sz}}$





$$\chi = \frac{\dot{\varepsilon}/\dot{\varepsilon}_{sz} - F}{1 - F}$$

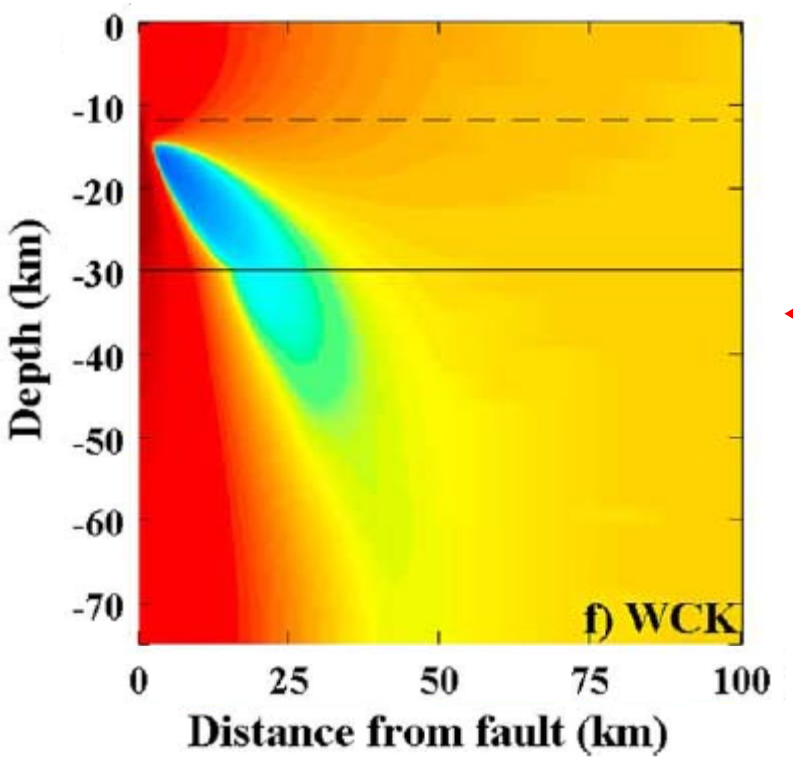
$\dot{\varepsilon} \rightarrow$ from large aperture GPS

$F \rightarrow$ from estimate of composition and flow laws

$\dot{\varepsilon}_{sz} \rightarrow$ modeling grain size

Compare with independent constraints for χ
Estimate for $\dot{\varepsilon}_{sz}$ provides constraint on effective viscosity

LOTS OF OTHER THINGS TO CONSIDER



Takeuchi and Fialko, 2012