Asymmetry of Rate and State Friction

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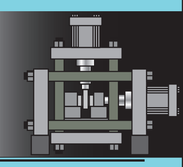
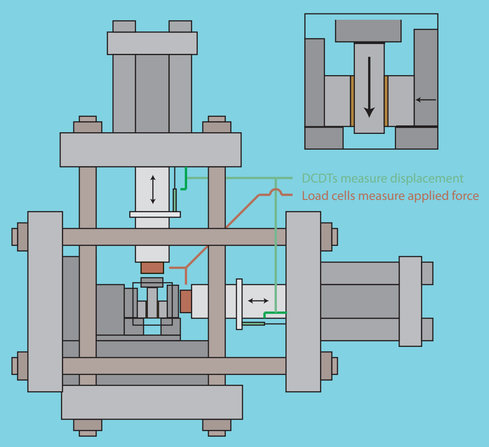
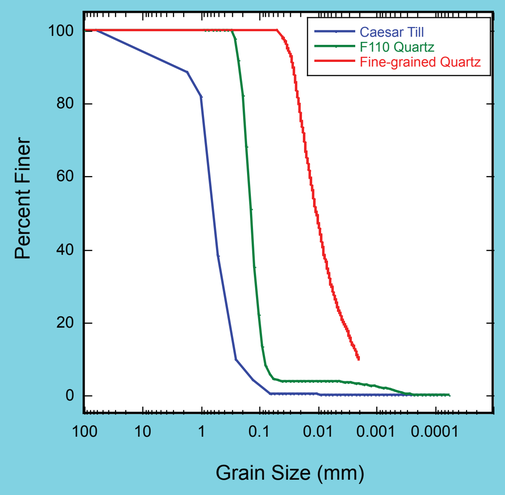
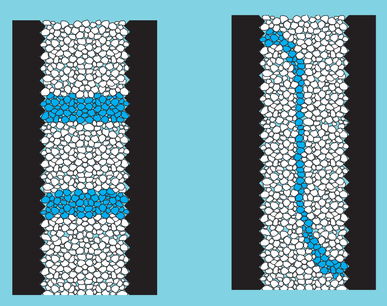


Introduction

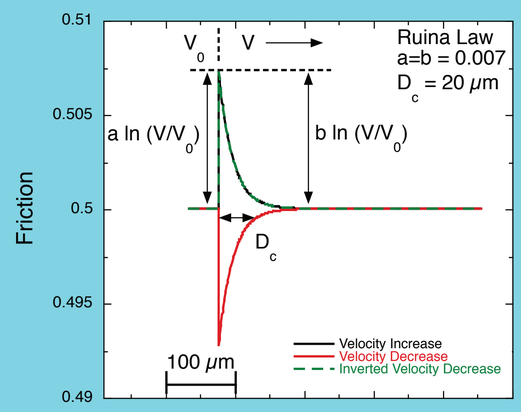


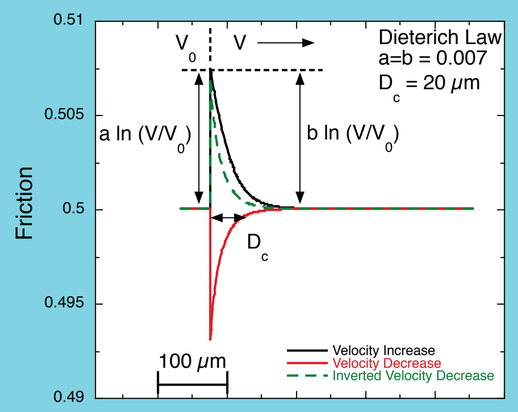




Double-direct shear experiments
3 materials; velocity strengthening (C.Till), weakening (Fine-grained Quartz), transitional (F110 Quartz)
Localizes into a boundary parallel zone
[Rathbun & Marone, in review]

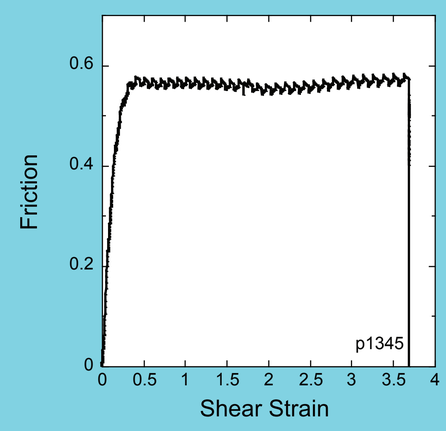
Rate and State Friction



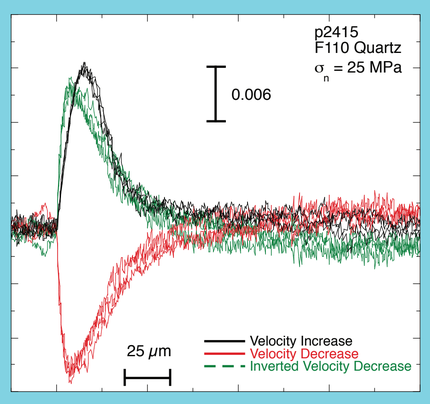


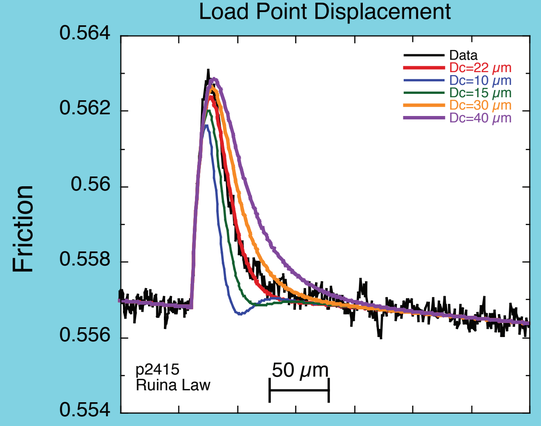
$$\frac{d\theta}{dt} = \frac{V\theta}{D_c}\ln\left(\frac{V\theta}{D_c}\right) \qquad \mu \equiv f(V,\theta) = \mu_0 + a\ln\frac{V}{V_0} + b\ln\frac{V_0\theta}{D_c} \qquad \frac{d\theta}{dt} = 1 - \frac{V\theta}{D_c}$$

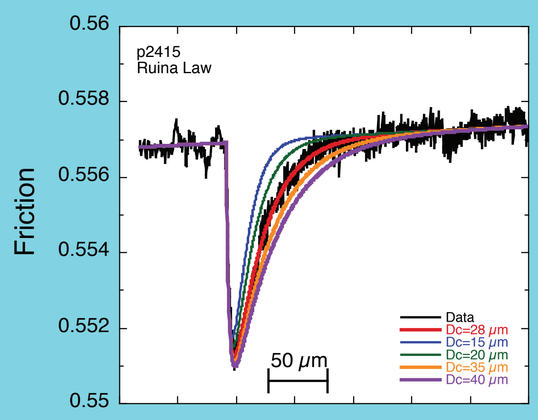
Velocity stepping experiments are conducted to look which evolution law best fits and any symmetry or asymmetry of rate and state friction



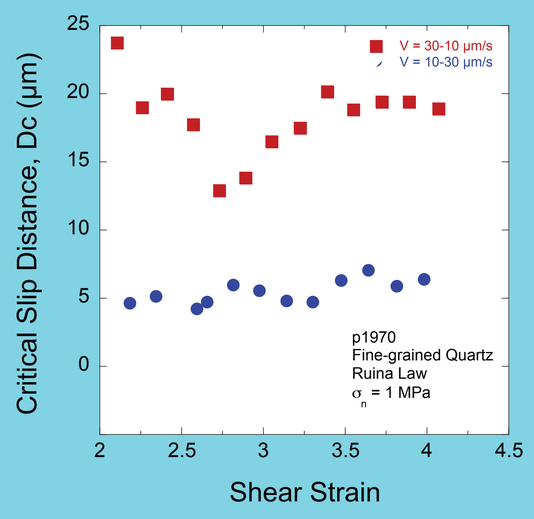
Modeling







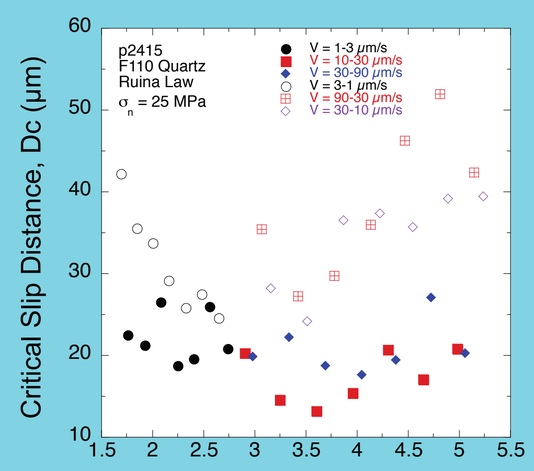
Results

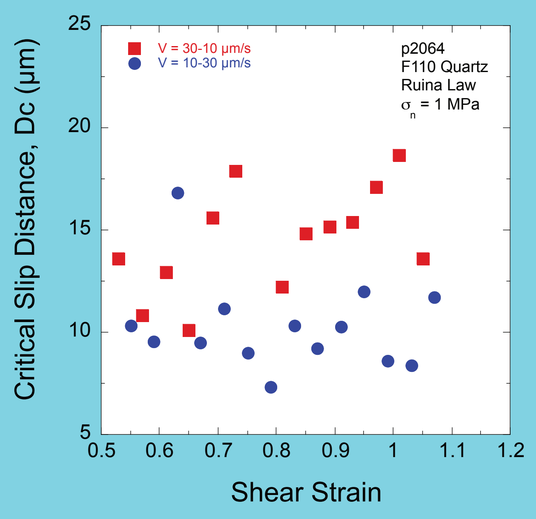


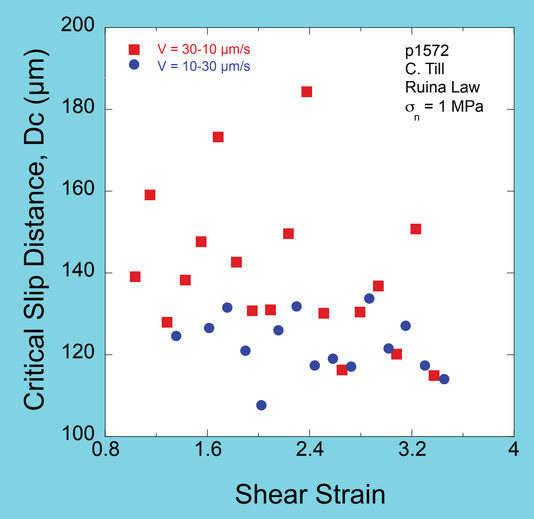
Critical slip distance is larger for velocity decreases relative to increases

Occurs over a range of normal stresses and velocities

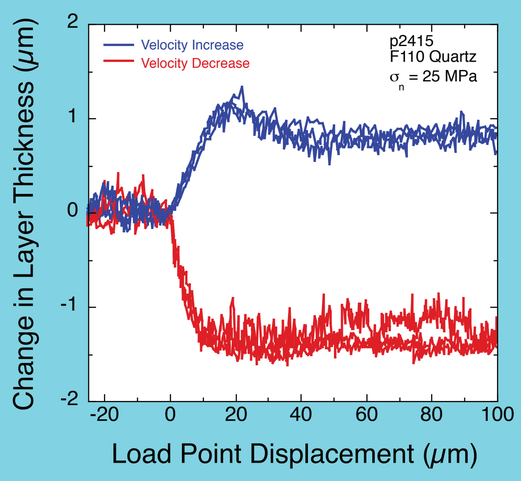
Opposite of the commonly used Dieterich Law

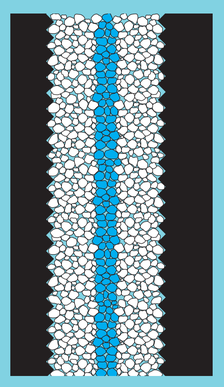


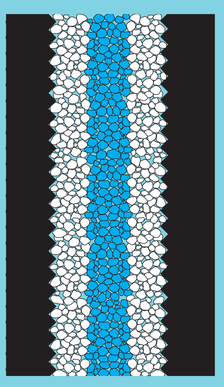




Mechanism?







Variations in shear zone width may override the rate and state friction laws. Unstable shear zone thickness or changing thickness during steps may lead to the lengthening of the critical slip distance.