Overview

1. Laboratory flow laws have physical background.
2. Laboratory flow laws can be linked to field observations in certain instances.

Examples: similarity of fabrics across a mantle shear zone with lab-produced fabrics field observations confirm fabric diagram with switch of pattern as a function of water content.

Gabbro deformation inferred temperature, strain rates and deformation mechanism fall on correct point of lab generated deformation mechanism map.

3. Conclusion for lower crust: use plagioclase flow law.

4. Strength difference between shear zone and outside of a factor of 100 means strain rate is different (strain localization) (stress inside and outside is the same).
Inside shear zone: diffusion creep, outside: dislocation creep.

5. Importance of stress pulse relative background stress (if pulse is small relative to background stress can use lab flow laws).

6. Anastomosing shear zones at scale from mm to 25 km
gammas are different -> strain rates differ from mylonites to ultramylonites.

7. Cavity formation and failure at stresses much smaller than confining pressure, in the Earth this could lead to episodic slip acceleration.

8. If there are shear zones in lower crust, lower crust is weak, with linear post seismic creep.

9. Transient creep can produce strain rates higher than steady state strain rates. Evolution of transients with time may explain far field GPS observations that can not be modeled with steady state flow laws. Physical model links transients to steady state creep.

10. Texture gives rocks a ‘memory’ from past deformation. This can result in significant strength variations and can require significant strain to ‘erase’.

11. It is necessary to consider energy input into a system by deformation, in addition to evolution of state variables. With development of shear zones energy dissipation is concentrated in shear zone with their fine grain size.

Synthesis/further points:

1. Flow laws provide reasonable fit to a wide range of geologic observations, indicating that extrapolation is warranted – BUT need to be incorporated into models to investigate feedbacks. "Weak phase" power laws are a good place to start, but additional weakening effects caused by grain size reduction and LPO need to be accounted for.

2. Transient creep relates to evolution of state variables: grain size, dislocation density, phase distribution, LPO etc… Evolution laws can be used in conjunction with flow laws to study these feedbacks

The overall goals require incorporating these data in models – some processes are not amenable to direct experimental observation.

Experimental data: We can always refine flow laws; while we have a lot of data now, still need refining feedbacks with grains size, phase distribution and LPO.

Data for small strain transient creep are lacking for "lithospheric" conditions.

Data for role of fluids and "flow laws" for semi-brittle deformation are lacking – as well as their role of strain localization.

Realization of disGBS (power law in stress and grain size) as important mechanism needs to be further explored.

Compilation of stress/temperature/composition as well as shear zone width data from mylonites – starting with Burgmann and Dresen – MAP onto appropriate depth/seismic velocity/geotherm in SoCal