GEOL 695: Geophysical Geodesy - Day 8

Preliminaries

- Homework due dates
- Questions on Reading

New Reading:

Findley, Lai and Onaran, Creep and Relaxation of non-linear viscoelastic materials, with and Introduction to Linear Viscoelasticity, sections 5.1 to 5.6.

optional:
Jackson, D.D., 1972, The interpretation of inaccurate, insufficient and inconsistent data, Geophys. J. R. astr. Soc., 28, 97-109.

Viscosity and Viscoelasticity

Viscous materials flow, and hence the amount of deformation is proportional to the amount of time that has elapsed. Thus *time* is an essential ingredient to constitutive equations that describe the response of a viscous material to stress.

The math describing this relationship is otherwise similar to an elastic medium where there is no compressibility allowed.

Fluids respond to pressure gradients and body forces.

Elasticity

single spring: $\boldsymbol{F} = -k\,\boldsymbol{x}$

3d tensor $\sigma_{ij} = c_{ijpq}\,\varepsilon_{pq}$

Viscosity

dashpot: $\boldsymbol{F} = -k\,\dfrac{d\,\boldsymbol{x}}{dt}$

3d tensor $\sigma_{ij} = \eta\,\dot{\varepsilon}_{pq}$ when i j

η is the proportionality constant between shear stress and shear strain rate. It has units of Pascal-seconds (= 10 poise). Viscosity is diffusion of momentum.

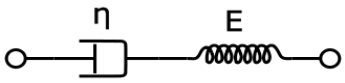
Typically only the shear component of deformation is allowed to flow over time, and the bulk (volumetric) component is not, though it is possible to write the equations in such a way as to allow this.

Viscoelasticity

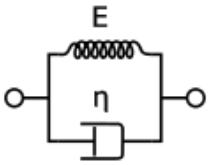
This describes materials that exhibit characteristics of both elastic solids and viscous fluids. Can anyone think of an example?

Silly Putty.

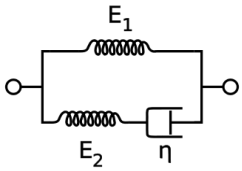
Maxwell Model: spring and dashpot in series



Kelvin Model: spring and dashpot in parallel



Standard Linear Solid



Burghers Model: is a Maxwell and a Kelvin in series.

Note: Graphics are from Wikipedia (http://en.wikipedia.org/wiki/Viscoelasticity). E is the spring constant that I often wrote as μ in class.

equations, graphs and examples.

Rate/frequency dependence of response.

Connection to seismology: Makes the medium *dispersive*, i.e.
- energy is lost to heat
- wave speed is frequency dependent