EART290Q 2020

WEEK #3 – RHEOLOGY

Topics/Concepts

Newtonian vs. non-newtonian rheology

Grain-boundary sliding, diffusion creep, basal slip

Maxwell viscoelasticity, phase lag, dissipation

Correspondence principle, Laplace transforms

Equations

$$\eta = \frac{\sigma}{\dot{\varepsilon}} \qquad \dot{\varepsilon} = A\sigma^n d^{-p} \exp\left(-\frac{Q+PV}{RT}\right)$$

$$\text{Maxwell: } \dot{\varepsilon} = \frac{\sigma}{\eta} + \frac{\dot{\sigma}}{\mu} \qquad t_{\max} = \frac{\eta}{\mu}$$

$$\text{Complex rigidity : } \mu^* = \frac{\mu}{1+\frac{\mu}{i\eta\omega}}$$

Numbers

η_{ice}~10^{13}-10^{15} Pa s (near the melting point) Q_{ice}~50 kJ mol^{-1} μ_{ice}~3 GPa

References

Turcotte, D.L, G. Schubert, *Geodynamics*, 2nd ed., CUP 2002, Chapter 7.

Findley, Lai, Onaran, *Creep and relaxation of nonlinear viscoelastic materials*, Dover, 2011.

Goldsby, D.L., D.L. Kohlstedt, Superplastic deformation of ice: Experimental observations, *J. Geophys. Res.* 106, 11017-11030, 2001.

Ross, M.N., G. Schubert, Tidal dissipation in a viscoelastic planet, *J. Geophys. Res*. 91, B4, suppl., D447-D452, 1986.

Segatz, M. et al., Tidal dissipation, surface heat flow and figure of viscoelastic models of Io, *Icarus* 75, 187-206, 1988.