EART290Q 2020

WEEK #1 – HEAT TRANSFER

Topics

Fourier's law and applications (temperature-dependent thermal conductivity, shear heating)

Steady-state spherical heat conduction (in a shell, with advection, with heat production)

Time-dependent heat conduction (Stefan problem, thermal inertia)

Heating during accretion

Numerical approaches

Equations

$$F = -k\frac{dT}{dz} \qquad \frac{DT}{Dt} = \frac{\partial T}{\partial t} + u \cdot \nabla T = \kappa \nabla^2 T + \frac{H}{\rho C_p} \qquad t \sim d^2/\kappa$$

Numbers

k~3 $Wm^{-1}K^{-1}$ κ~10^{-6} m^2s^{-1} H~$3x10^{-12}$ W kg^{-1} (Earth, present-day)

^{26}Al decay: 3 MeV per atom, $t_{1/2}$~0.7 Myr

C_p~1 kJ kg^{-1} K^{-1} (rock) ~2 kJ kg^{-1} K^{-1} (ice), L~0.3 MJ kg^{-1} (rock/ice)

References

Turcotte, D.L, G. Schubert, *Geodynamics*, 2nd ed., CUP 2002, Chapter 4.

Carslaw, H.S., J.C. Jaeger, *Conduction of Heat in Solids*, 2nd ed., OUP 1959, all of it esp. Ch 9.

O'Reilly, T.C., G.F. Davies, Magma transport of heat on Io – a mechanism allowing a thick lithosphere, *Geophys. Res. Lett.* 8, 313-316, 1981.