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

\[ F = -k \frac{dT}{dz} \]
\[ \frac{DT}{Dt} = \frac{\partial T}{\partial t} + u \cdot \nabla T = k \nabla^2 T + \frac{H}{\rho C_p} \]

Numbers

\( k \approx 3 \text{ W m}^{-1} \text{K}^{-1} \quad \kappa \approx 10^{-6} \text{ m}^2 \text{s}^{-1} \quad H \approx 3 \times 10^{-12} \text{ W kg}^{-1} \) (Earth, present-day)

\(^{26}\text{Al}\) decay: 3 MeV per atom, \( t_{1/2} \approx 0.7 \) Myr

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

References