GEOTHERMAL ENERGY LOSS DUE TO HEAT CONDUCTION

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Reference: Daniel V. Schroeder, *An Introduction to Thermal Physics*, (Addison-Wesley, 2000) - Problem 1.61.

The temperature of the Earth increases as we go further underground so, given that the rock that makes up the Earth's crust has a thermal conductivity and there is a temperature difference between a point underground and the Earth's surface, the Earth is actually losing energy by heat conduction. Using the values given by Schroeder, we have $\Delta T=0.02\text{ K m}^{-1}$ and $k_t=2.5\text{ W m}^{-1}\text{K}^{-1}$. The rate of heat conduction in an area of 1 m^2 is therefore

$$\begin{aligned}\frac{Q}{\Delta t} &= -k_tA\frac{T_2-T_1}{\Delta x} &(0.1)\\ &= (2.5)(1)\frac{0.02}{1} &(0.2)\\ &= 0.05\text{ W} &(0.3)\end{aligned}$$

Although the rate of heat loss is quite small for a square metre, if we assume this value applies over the entire Earth (radius 6400 km), the total heat loss is

$$\frac{Q_{tot}}{\Delta t}=4\pi\left(6.4\times10^{6}\right)^{2}(0.05)=2.57\times10^{13}\text{ W} \tag{0.4}$$

Although this sounds like a lot, to put it in perspective, the sun's luminosity is 3.839×10^{26} W, and the peak energy received on Earth from the Sun is around 1365 W m^{-2}, which is around 27,000 times the rate at which the geothermal energy is being lost.