Conductive Geotherm

The 1D temperature distribution $T(z,t)$ at shallow depths in the crust resp. lithosphere can be modeled as the solution of the one-dimensional, time-dependent heat conduction equation:

$$\rho c_p \frac{\partial T}{\partial t} = k \frac{\partial^2 T}{\partial z^2} + H \tag{1}$$

In this equation, density ρ, specific heat c_p, thermal conductivity k, and heat production per unit volume H (from radioactive decay) are considered to remain constant throughout the lithosphere.
For a given $T(z,t)$, the outward heat flux $q_0(t)$ at the Earth's surface follows from the geothermal gradient $\partial T / \partial z$ with

$$q_0 = -k \left(\frac{\partial T}{\partial z} \right)_{z=z_0} \quad . \tag{2}$$

(1) Calculate the steady-state geotherm of a simple (1-layer) crust using the following boundary conditions:

(i) on top $z = z_0$, there is $T(z_0) = T_{surf}$

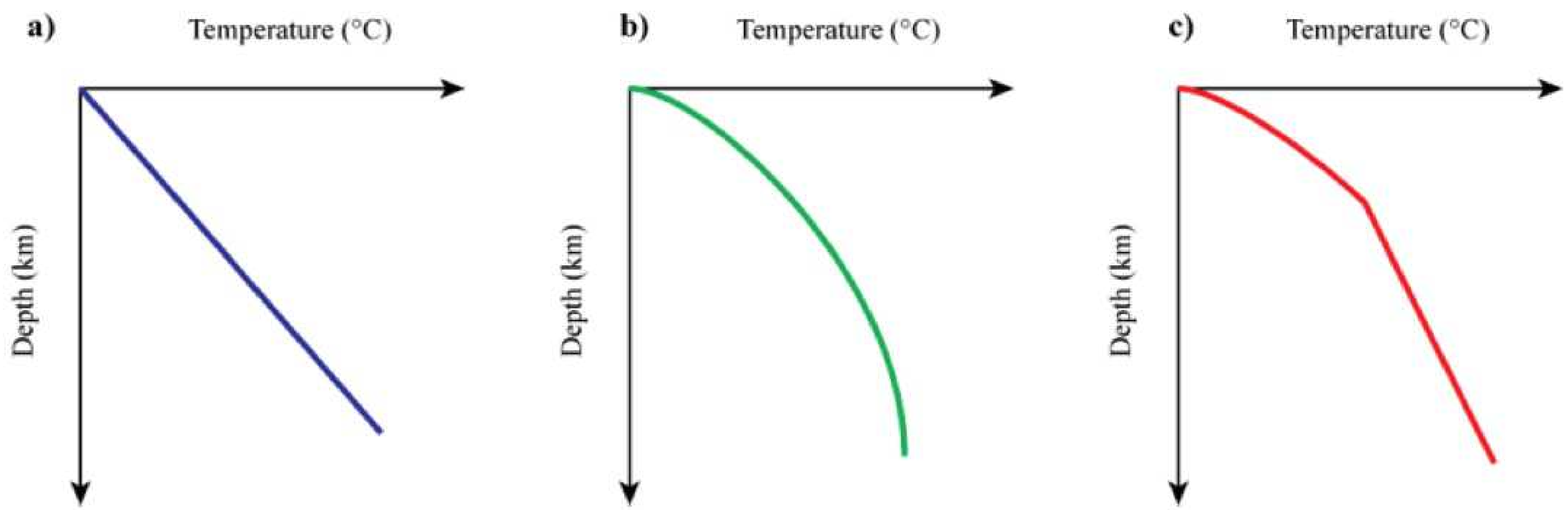
(ii) at bottom $z = z_1$, there is $q(z_1) = q_m$ (mantle heat flow)

(2) Given the following numbers, what is the resulting heat flux at the surface q_0 ?

$$H = 2{\cdot}10^{-6}\,\frac{W}{m^3}, \quad k = 2.5\,\frac{W}{mK}, \quad q_m = -0.01\,\frac{W}{m^2}, \quad z_1 = 3.0{\cdot}10^4\ m$$

Shape of Lithospheric Geotherms

In textbooks one can find the following three geotherm types



Explain their possible geological meaning !