

Geophysics 150: Home set due Oct. 16, 2002

1. We are interested in whether and where springs may be found on Mars. The problem is basically similar to springs in the Arctic and Antarctic. A spring would be an excellent place to look for life on Mars as no drilling would be required. An inactive spring might have recent fossils.

a. We can guess the heat flow on Mars scales with gravity and it about 40% of that of the Earth. We will take it to be 32 mW m^{-2} . The conductivity of somewhat porous rock is $1.6 \text{ W m}^{-1} \text{ K}^{-1}$. The mean annual temperature at the site is -30°C . How deep to we need to go to get 0°C water?

b. Say that "geothermal" water at 5°C upwells over a broad region. The topographic roughness is such that if it ascends to within 100 m from the nominal model surface -30°C and its still at least 0°C there may be springs. Use the exponential expression from for temperature in uniformly ascending flow to get the flow rate. The specific heat of water is $4 \times 10^6 \text{ J m}^{-3} \text{ K}^{-1}$. You may use graph to estimate if it helps.

c. Instead assume that most of the water freezes. Estimate an effective specific heat from the water that starts at -30°C and obtain an estimate for the necessary flow rate. The latent heat of water is $320 \times 10^6 \text{ J m}^{-3}$. The rate that water can escape over broad areas on Mars is unknown but the velocity should be less than 1 mm yr^{-1} because there is little atmospheric transport of water. Do you expect broad areas of springs on Mars?