(22.8) A miner has a deep well 160 km away from a waste repository. During an earthquake, the rock fractures and a groundwater stream opens between the repository and the well so that 10 Ci ^{90}Sr momentarily dissolves and moves toward the well at v_w 160 km y^{-1}. (a) What will be the amount of ^{90}Sr (in Bq) reaching the well (assume plug flow)? (b) Will that water be harmful to the miner?

$Ci := 3.7 \cdot 10^{10} \cdot sec^{-1}$ $Bq := 1 \cdot sec^{-1}$ $kBq := 1000 \cdot Bq$ $MBq := 1000 \cdot kBq$

$t_{half} := 28.5 \cdot yr$ $\lambda := \frac{ln(2)}{t_{half}}$ $R_0 := 10 \cdot Ci$ $R_0 = 3.7 \cdot 10^5 \cdot MBq$

$dist := 160 \cdot km$ $vw := 160 \cdot \frac{km}{yr}$ $k_d := 0.015 \cdot \frac{m^3}{kg}$ From Table 22.11

$\varepsilon := 0.05$ Typical range: 0.01 to 0.05, §22.10.4 The assumptions made here correspond to the worst case!

$\delta := 1500 \cdot \frac{kg}{m^3}$ Typical range: 1500 to 2500, §22.10.4

$vn := \frac{vw}{1 + k_d \cdot \delta \cdot \frac{1 - \varepsilon}{\varepsilon}}$ from eqn.(22.12) $t := \frac{dist}{vn}$ $t = 428.5 \cdot yr$

$R_t := R_0 \cdot exp(-\lambda \cdot t)$ $R_t = 11 \cdot MBq$

$ALI := 6 \cdot 10^5 \cdot Bq$ $n_{ALI} := \frac{R_t}{ALI}$ $n_{ALI} = 18.4$

(a) The total amount reaching the well after about 429 years is at most 11 MBq, i.e. about 18 ALI.

(b) If the miner is still alive, the water might be harmful if the miner drinks > 5% of the water in the well rapidly at the time when the peak concentration of ^{90}Sr arrives. For more average data on rock porosity and density, the water might never be harmful to drink in any quantity at any time.