(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?

$t_{half} := 28.5 \cdot yr$ $\lambda := \frac{ln(2)}{t_{half}}$ $Ci := 3.7 \cdot 10^{10} \cdot sec^{-1}$ $Bq := 1 \cdot sec^{-1}$ $R_0 := 10 \cdot Ci$

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

$\varepsilon := 0.05$ Typical range: 0.01 to 0.05, p. 667 The assumptions made here correspond to the worst case!

$\delta := 1500 \cdot \frac{kg}{m^3}$ Typical range: 1500 to 2500, p. 667

$vn := \frac{vw}{1 + k_d \cdot \delta \cdot \frac{1 + \varepsilon}{\varepsilon}}$ from eqn.(22.13) $t := \frac{dist}{vn}$ $t = 473.5 \cdot yr$

$R_t := R_0 \cdot exp(-\lambda \cdot t)$ $R_t = 3.689 \cdot 10^6 \cdot Bq$

$ALI := 6 \cdot 10^5 \cdot Bq$ $n_{ALI} := \frac{R_t}{ALI}$ $n_{ALI} = 6.148$

(a) The total amount reaching the well after about 474 years is at most 3.7 MBq, i.e. about 6 ALI.

(b) If the miner is still alive, the water might be harmful if the miner drinks > 16% of the water in the well rapidly at the time when the ^{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.