Midterm exam GEO3-4301 Soil and Water Pollution

11 January 2005 9:00 – 11:00 h

1. Give a definition of the following environmental terms
   a. Octanol-water partition coefficient
   b. Diffuse double layer
   c. Colloids
   d. Phosphate fixation
   e. Aliphatic chlorinated hydrocarbons
   f. Non-point source
   g. Dispersion
   h. LNAPL
   i. Beta radiation
   j. PZC

(20 points)

2. Discuss in brief the importance of the redox potential and pH for the environmental behaviour of :
   a. heavy metals.
   b. aluminium
   c. nitrogen

(15 points)

3. Give three examples of natural radionuclides that do not belong to the three radioactive decay series (Uranium-238, Uranium-235, and Thorium-232 series).

(10 points)

5. In turbulent flowing waters the bottom shear stress is given by:

$$\tau_b = \rho_w \, g \, H \, S$$

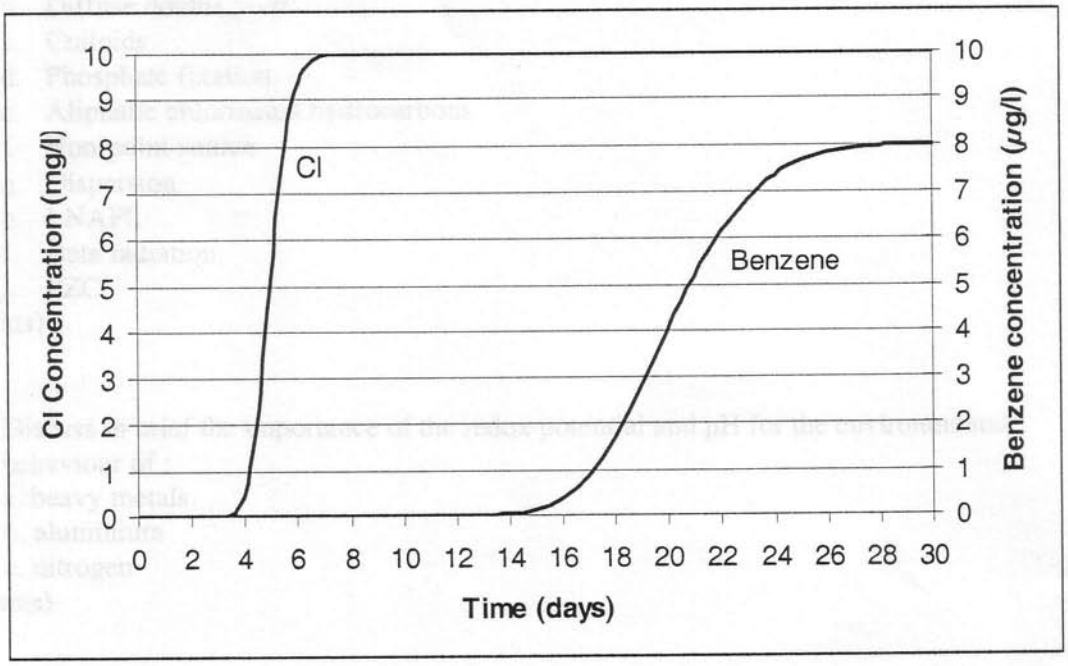
and the vertical sediment deposition flux by

$$J_s = \left(1 - \frac{\tau_b}{\tau_{b,d}}\right) w_s \, C$$

The vertical settling velocity of sediment in stagnant water was determined at $4.0\ 10^{-6}$ m s^{-1}. In river water entering a floodplain section, the sediment concentration amounts to 80.0 mg l^{-1}. Calculate the sediment concentration at 4 km downstream from this location given the following information: slope of the water table = 0.0000025, water depth = 1.8 m, water flow velocity = 0.25 m s^{-1}, gravitational acceleration constant = 9.8 m s^{-1}, density of water = 1000 kg m^{-3}, critical shear stress for sedimentation = 0.8 N m^{-2}. Assume that the sediment remains mixed over the water column.

(20 points)

6. A column experiment is carried out to determine the benzene adsorption characteristics of a sediment. For this purpose, a 1 m long cylinder (diameter = 0.45 m) of inert material is filled with sediment (porosity = 0.3 and bulk density = 1500 kg m^{-3}), through which a solution of NaCl and benzene is percolated. The initial concentration of the percolate is 10 mg l^{-1} for chloride and 8 μg l^{-1} for benzene. The cylinder is and. The following graph shows the breakthrough curves of chloride and benzene.



a. Calculate the flow velocity through the column in m^3 day^{-1}.
b. Explain the form of the breakthrough curves of both chloride and benzene
c. Calculate the distribution coefficient for benzene given the formula:

$$R_f = 1 + \frac{\rho_b}{n} K_d$$

(25 points)