Problem set #7 Fall 2014

**GEOL1370: Environmental Geochemistry**

**Rivers and Lakes (Due Tuesday, 11/25)**

1. A soil has a bulk density of 1.29 g/cm3 and an organic carbon content of 1 %. The porosity of the soil is 30 %, of which 50% is occupied by water and 50% by air. Using values given below, find the percentages of benzene and 2-butanone contained within the solid, liquid, and gas phases. Comment on the how water solubility, Henry’s constant and Kow (octanol-water partitioning coefficient) affect the distribution of these compounds in the three phases.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | BP  oC | Density  25oC | Water solubility  (mg/l)  25oC | Vapor pressure  mm Hg  10oC | Henry’s constant  (dimensionless)  25oC | Kow |
| Benzene | 80.1 | 0.88 | 1770 | 47.8 | 0.22 | 134.9 |
| 2-Butanone | 79.6 | 0.7994 | 26,800 | 314.3 | 0.001 | 1.82 |

Briefly explain the reasons for different partitions in the three phases for benzene and 2-butanone, and potential methods for cleaning up these compounds from a contaminated aquifer.

1. What are the key factors controlling the suspended sediment loads in rivers. Why does ~ ¾ suspended sediment transport by rivers into ocean around the world occur in Asia and Pacific Islands, when none of the three largest rivers in the world is in the region?
2. The following data were obtained for the dissolved chemical compositions of three rivers

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Concentration (mg L-1) | | | | | | | | | |
| River | Ca2+ | Mg2+ | Na+ | K+ | Cl- | SO42- | HCO3- | SiO2 | TDS |
| 1 | 207 | 55 | 310 | 15 | 401 | 544 | 409 | 69 | 2015 |
| 2 | 33 | 10.4 | 7.0 | 1.1 | 8.9 | 36.1 | 111 | 3.0 | 211 |
| 3 | 0.2 | 0.1 | 0.4 | 0.3 | 0.3 | 0.2 | 0.7 | 4.1 | 6.3 |

1. Plot the data for the three rivers on the Gibbs diagram, include this plot with your write up.
2. Classify these three rivers according to the Gibbs scheme, i.e., evaporation-crystallization, rock, or precipitation dominance
3. Water entering a lake contains 2.0 mg Ni L-1. The total inflow is 200 m3 s-1. The total outflow from the lake is 170 m3 s-1 and the outflow water contains 1.5 mg Ni L-1. The lake is located in an arid area and evaporation exceeds precipitation. Hence, water inflow is greater than water outflow. The lake is in steady state with respect to both its water volume and nickel content. Calculate the rate at which nickel is stored in the lake sediments.
4. Explain the seasonal cycle of water column stratification in a dimictic lake. What are the major differences in pH, nutrient concentration, redox potential between epilimnion and hypolimnion in a highly stratified lake during mid-summer.
5. a. List the natural conditions that favor the formation of saline lakes (instead of freshwater lakes).
6. Why do some saline lakes have exceptionally high pH (such as Mono Lake in California, with a pH of 10)?
7. How does the major ion chemistry in lakes with high pH differ from acidic fresh water lakes in terms of SO42-, Al3+, Na+, K+, Mg2+ and Ca2+? Briefly explain why this is the case for each ion.