

# End Semester Exam for Environmental Geoscience (ID4111)

28<sup>th</sup> November, 2018

Total Marks: 60

Time: 3 hrs

Answer all questions.

- A) Explain in detail what factors contribute to the net charge in both 2:1 and 1:1 clays? (4)

B) Why some 2:1 clay minerals have high shrink swell capacity over 1:1 clay minerals? (3)

C) In the natural soil processes, does both cation and anions are exchangeable? Justify your answer. (3)
- A) What factors influence the sorption capacity of clays. (4)

B) Write the order of sorption capacity of metal ions of 1<sup>st</sup> column and 2<sup>nd</sup> column of periodic table towards clays. Which of the series have high sorption capacity towards bentonite clay over Ferrihydrite (Fh) and why? (3)

C) What is the concept of point of zero charge of a clay particle (3)
- A) Name some examples of natural/anthropogenic waters that are essentially regulated by carbonate system (5)

B) Describe in detail the various steps involved in wastewater treatment process including the overall schematic plot (5)
- A) Explain the various engineering properties of soils that draws conclusions on choosing appropriate soils for constructions. (4)

B) How contaminants are accumulated in sediments/soils? Explain using schematic diagram. (3)

C) Explain briefly the principal transport processes for contaminant transport in the environment? (3)
- A site X in India is contaminated with cadmium (Cd). Iron-modified-clays that have high adsorption capacity towards Cd adsorption and were applied for the removal of Cd from the site. Batch sorption studies were performed in the laboratory and following adsorption data was obtained using the modified-clay and soil leachate containing Cd (note that a blank experiment was also conducted without the addition of modified-clay):

| Mass of modified-clay (mg) | Volume of flask (mL) | C <sub>e</sub><br>Equilibrium Cd in solution, mg Cd/L |
|----------------------------|----------------------|---|
| 120                        | 100                  | 13.6  |
| 110                        | 100                  | 14.3  |
| 100                        | 100                  | 15  |
| 80                         | 100                  | 17  |
| 50                         | 100                  | 21  |
| 30                         | 100                  | 25  |
| 0                          | 100                  | 37  |

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- A) Assuming that the sorption follows linear isotherm, calculate the adsorption coefficient ( $K_d$ ) (4)
- B) Under the above conditions, where modified-clay is applied in the contaminated soil, calculate the migration distance during 1 year for Cd in m/year. Following are the given parameters: hydraulic conductivity is  $10^{-3}$  m/s, hydraulic gradient is 0.003, effective porosity is 0.28, bulk density of solid phase is  $1.5 \text{ kg/dm}^3$ , total porosity is 0.32. (6)
6. A) How organic matter contributes to maintain the fertility of soils (5)
- B) An annual soil loss of 8.67 tons/acre/year was reported for a village in West Bengal. The main reason for erosion was due to the adapted tillage method (spring plow of factor 0.29) on a cross slope landscape (P factor 0.39). The values for other factors are given follows: slope length gradient factor of the region is 1.96, rainfall and runoff factor is 112, soil erodibility factor is 0.36. Based on the above, taking into consideration the tolerable soil loss value as 6 tons/acre/year, which crop(s) will you direct for cultivation (crop type factors are given below) to reduce the soil erosion? (5)

| Crop type                    | Factor |
|------------------------------|--------|
| Silage corn, beans & canola  | 0.3    |
| Cereals (spring & winter)    | 0.2    |
| Seasonal horticultural crops | 0.14   |
| Fruit trees                  | 0.12   |
| Hay and pasture              | 0.02   |
| Grain corn                   | 0.6    |