EPSc 413 Homework #3
Due March 8, 2017

Write all answers on separate sheets of paper. Please only write on one side of the page. Answers may also be typed.

1. *This question asks you to explore the differences among major soil minerals and their chemical properties.*

a. Describe the major properties of the following soil minerals or mineral groups: Kaolinite, Smectites, and Iron Oxides. **(9 pts)**

b. Considering the differences in their structures, explain why smectites typically have CEC values of 80-150 $cmol_c$/kg and kaolinite 3-15 $cmol_c$/kg. **(5 pts)**

2. *This question is designed to familiarize you with CEC and related soil parameters.*
Consider the following soil samples:

	Exchangeable cation concentrations (cmol cation/kg dry soil)				
Soil	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Al^{3+}
A	1.9	3.7	0.1	0.1	5.6
B	7.4	3.6	1.3	0.3	0.6
C	0.6	0.4	0.3	0.2	1.2
D	3.9	2.0	6.9	0.9	0.9

For soils A-D:

a. Calculate the CEC in $cmol_c$/kg soil. **(8 pts)**

b. Calculate the % base saturation and % acid saturation. **(8 pts)**

Then answer the following questions about soils A-D:

c. Which soil likely contains a mollic epipedon? Explain your answer. **(2 pts)**

d. Which soil likely contains a natric horizon? Explain your answer. **(2 pts)**

Hint: For parts c & d, make sure to read the definition of these horizons in the textbook. Also, consider the more complete definition of a mollic epipedon:

> A surface horizon of mineral soil that is dark colored and relatively thick, contains at least 5.8 g/kg organic carbon, is not massive and hard or very hard when dry, has a base saturation of >50% when measured at pH 7, has <110 mg P/kg soluble in 0.05 M citric acid, and is dominantly saturated (>80%) with divalent cations.

3. *This question asks you to become more familiar with adsorption processes.*

a. Explain the difference between cation exchange and surface complexation. (**8 pts**)

b. List two examples of elements whose behavior in soils is primarily controlled by cation exchange. (**4 pts**)

c. List two examples of elements whose behavior is soils is primarily controlled by surface complexation. (**4 pts**)

4. *This questions asks you to review the importance of aluminum is soil acidity.*

a. Explain why 1 cmol of Al^{3+} produces three times the acidity of 1 cmol of H^{+}. (**6 pts**)

b. Describe how aluminum causes the CEC of soils to be lower under acidic pH conditions (for example, pH 4) than under neutral conditions (pH 7). (**6 pts**)

c. Consider a silt loam soil used to grow corn. This soil has a cation exchange capacity of 17 $cmol_c$/kg and has an 80% acid saturation, all of which originates from exchangeable aluminum (Al^{3+}). Corn yields are greatly reduced above an acid saturation of 20%. If you want to decrease the acid saturation to 20%, how many $cmol_c$ of calcium would it take to replace the exchangeable acid cations per kg of soil? Assume that the exchange of calcium for aluminum is complete (do not worry about the effects of cation preferences). (**8 pts**)

5. *This question asks you to explore the role of key organisms in soil ecosystems.*

a. Describe two important roles of earthworms in soils. (**8 pts**)

b. Describe two important roles of fungi in soils. (**8 pts**)

c. Describe two important roles of bacteria in soils. (**8 pts**)