

Study Questions: Soil Chemistry - Soil Colloids (Clay minerals and organic matter)

Note: This list is meant to help you learn the main points. They are not necessarily the exact topics or questions that will be asked on quizzes or exams. You'll see that there are more topics here than could possibly be on a single exam. But, by learning/understanding this material, you should be a long way toward doing well on the exams and final.

- 1) What is a colloid?
- 2) List and briefly describe the different types of soil colloids.
- 3) Explain why soil colloids contribute so much to soil properties.
- 4) *Tetrahedrons* and *octahedrons* are the building blocks of layer silicate clays.
 - a) what is the central element in each of these?
 - b) Explain how the tetrahedrons and octahedrons arrange to form sheets, and how the sheets arrange to form 1:1, 2:1, 2:1:1 minerals
- 5) Sketch and give an example of each of the following types of clay minerals:
 - a) 1:1 layer silicate
 - b) 2:1 expanding-type layer silicate
 - c) 2:1 slightly expanding-type, high CEC layer silicate
 - d) 2:1 nonexpanding layer silicate
 - e) 2:1:1 layer silicate
 - f) oxide clay (know at least on Fe and one Al type)
- 6) What is *isomorphic substitution*? What types of colloids does it occur in (layer silicates, non-crystalline silicates, sesquioxides, organic matter)?
- 7) Why does isomorphic substitution result in a net negative charge?
- 8) What balances the negative charge on colloids?
- 9) In what environment and type of soil are each of the following clay minerals most prevalent? (In other words: where would you expect to find soils dominated by each of the following minerals? Think about the extent of weathering and the five soil forming factors.)
 - a) oxides and hydrous oxides
 - b) 2:1 clays
- 10) What is 'permanent charge'? How do clay minerals get 'permanent charge'?
- 11) What is pH-dependent charge? Where does it form?
- 12) Which types of colloids are dominated by 'permanent charge'?
- 13) Which types of minerals are dominated by pH-dependent charge?

14) What type of charge does organic matter have, permanent or pH-dependent?

Study Questions: Soil Chemical Properties (cont.)**– Cation & Anion Exchange, Non-acid Cation Saturation (Base Saturation)**

- 1) Explain what is *cation exchange* is.
- 2) What is *cation exchange capacity (CEC)*?
- 3) What is *anion exchange capacity (AEC)*?
- 4) Explain how a soil can have both *cation* and *anion* exchange capacity at the same time.
- 5) Which is usually greater in the mineral soils of Washington, *cation* or *anion* exchange capacity?
- 6) Describe at least one application for understanding the terms and processes of cation and anion exchange (that is, at least one scenario where it would be useful to know).
- 7) Which of the following are considered ‘non-acid cations’ (formerly called ‘base-forming’ cations)?
 Al^{3+} Ca^{2+} Mg^{2+} K^+ NH_4^+ H^+
- 8) What does the term ‘non-acid cation saturation’ (formerly *base saturation*) mean?
- 9) If a soil sample is tested and found to contain the following % of exchange sites occupied by the following cations, what is its non-acid cation saturation?

a)	Al^{3+}	10%
	K^+	45%
	NH_4^+	25%
	H^+	20%
b)	Al^{3+}	10%
	Ca^{2+}	5%
	Mg^{2+}	15%
	K^+	35%
	NH_4^+	25%
	H^+	10%
- 10) A soil in the Palouse has 5% organic matter content, is close to pH=7.0, and a clay content (with average CEC = 85 cmolc/kg) of 15%

Study Questions: Soil Chemical Properties (cont.)

- Soil pH, acidity, and alkalinity

- 1a) What is the pH of a solution containing $[H^+] = 10^{-6}$ moles/L? *Note: the [] indicates 'concentration'.*
- b) What is the pH of a solution containing $[H^+] = 10^{-8}$ moles/L?
- c) What is the pH of a solution containing $[OH^-] = 10^{-8}$ moles/L?

- 2) What is the range in soil pH we can find around the world?

- 3) Why does soil pH affect the charge on some colloids?

- 4) Does increasing the soil pH generally *increase* or *decrease* cation exchange capacity?

- 5) Would an increase in soil pH generally *increase* or *decrease* a soil's non-acid cation saturation?

- 6) What are the various ways that soil pH affects plant growth?

- 7) Why does soil pH affect the mobility of some pollutants (and mobility of cations in general)?

- 8) Is the availability of plant nutrients affected by soil pH? Explain.

- 9) Explain the soil forming factors and human factors that cause soils to be acidic.

- 10) What factors cause soils to be alkaline?

- 11) Explain why two soils that initially have the same soil pH may require very different amounts of lime to increase that pH to a given level.

- 12) What kinds of materials can be used to *decrease* the acidity of alkaline materials?

- 13) Why does addition of certain calcium salts (such as calcium carbonate, $CaCO_3$, or calcium hydroxide, $Ca(OH)_2$) increase the pH of acidic soils, while the addition of others (such as gypsum ($CaSO_4$)) does not?