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# Soil: A Living System

Soils 201

Midterm #1

September 24, 2001

Total Number of Points: 88

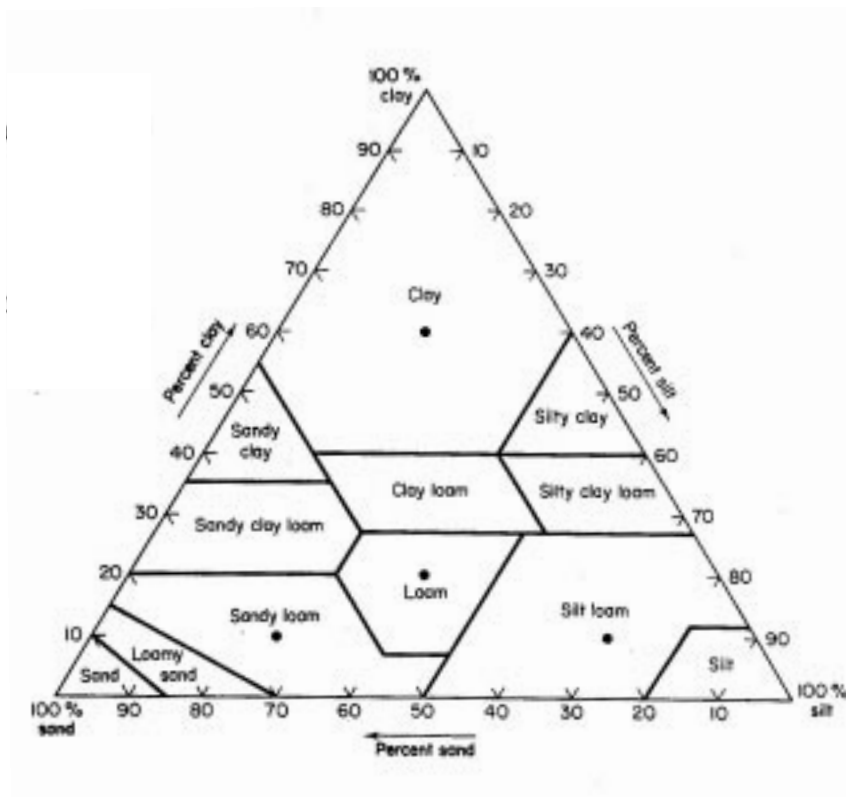
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## 1 Single-Answer Multiple Choice

2 points each. Circle the one solution that answers each question or completes the sentence.

- Which of the following is not a soil forming factor?
  - time
  - biota
  - space ♣
  - topography
  - climate
- The parent material of the soils of the Palouse region has been deposited by
  - wind, and is called loess ♣
  - wind, and is called alluvium
  - water, and is called loess
  - water, and is called alluvium
  - glaciers, and is called till
- Travelling south to north in the United States, a person would observe that
  - the content of organic matter in the soil decreases
  - the content of organic matter stays constant
  - the content of organic matter in the soil increases ♣
- Which of the following reactions is a dissolution reaction?
  - $\text{Al}_2\text{O}_3 + 3 \text{H}_2\text{O} \rightarrow \text{Al}_2\text{O}_3 \cdot 3 \text{H}_2\text{O}$
  - $\text{KAlSi}_3\text{O}_8 + \text{H}_2\text{O} \rightarrow \text{HAlSi}_3\text{O}_8 + \text{K}^+ + \text{OH}^-$
  - $\text{CaCO}_3 + \text{H}_2\text{O} \rightarrow \text{Ca}^{2+} + \text{HCO}_3^- + \text{OH}^-$  ♣
- Hydration is
  - the addition of water to a mineral ♣
  - the addition of hydrogen to a mineral
  - the dissolution of limestone

6. Hot magma rises in the earth's crust, is slowly cooled, and solidifies before it reaches the surface. The rock that is formed is a granite. Suppose the same magma reaches the earth's surface and cools quickly. What is the rock that is formed?
- (a) Basalt
  - (b) Rhyolite ♣
  - (c) Gabbro
  - (d) Gneiss
  - (e) Marble
7. The Bt-Horizon is a horizon where
- (a) clay minerals have been leached out
  - (b) sesquioxides dominate the mineral fraction of the soil
  - (c) clay minerals have been accumulated by either weathering processes or illuviation from other soil horizons ♣
  - (d) organic material is mixed with mineralic material
8. The E-Horizon is characterized by
- (a) eluviation ♣
  - (b) illuviation
  - (c) accumulation of organic matter
  - (d) accumulation of oxides and hydroxides of Fe
9. According to the USDA classification, the fine earth is classified as follows
- (a) clay:  $< 0.005$  mm; silt:  $0.005$  mm –  $0.05$  mm; sand:  $0.05$  mm –  $<2$  mm
  - (b) clay:  $< 0.02$  mm; silt:  $0.02$  mm –  $0.05$  mm; sand:  $0.05$  mm –  $<2$  cm
  - (c) clay:  $< 0.0002$  mm; silt:  $0.0002$  mm –  $0.05$  mm; sand:  $0.05$  mm –  $<2$  mm
  - (d) clay:  $< 0.002$  mm; silt:  $0.002$  mm –  $0.05$  mm; sand:  $0.05$  mm –  $<2$  mm ♣
  - (e) none of the above
10. Using the texture triangle, a soil sample with 10% sand, 45% silt, and 45% clay is a:
- (a) silty clay ♣
  - (b) silty clay loam
  - (c) silt
  - (d) silt loam
  - (e) none of the above
11. A soil sample of 225 g weight consists of 82 g sand, 67 g silt, and 76 g clay. Using the texture triangle, this soil is a
- (a) loam
  - (b) clay loam ♣
  - (c) silt loam
  - (d) sandy loam
  - (e) sandy clay loam



12. The term “clay” can mean

- (a) a soil mineral
- (b) a certain size fraction of soil minerals
- (c) a soil textural class
- (d) all of the above ♣

13. Which soil structure do you usually find in the very top of an agricultural soil?

- (a) granular ♣
- (b) columnar
- (c) blocky
- (d) platy

14. What are the binding agents that can hold soil particles together

- (a) organic compounds
- (b) sesquioxides
- (c) water
- (d) clay minerals
- (e) all of the above ♣

15. Soil usually consists of three phases: soil, water, and air. The porosity  $\epsilon$  of soil is usually defined as
- the mass of soil divided by the total volume of the soil sample
  - the mass of water divided by the mass of the dry soil
  - the mass of the soil divided by the volume of the solid phase
  - the volume of the soil divided by the mass of the dry soil
  - the volume of the pore space divided by the volume of the total soil ♣
16. A soil sample is taken with a cylindrical device with a volume of  $1200 \text{ cm}^3$ . After complete drying in the oven, the soil sample weighs  $1400 \text{ g}$ . What is the bulk density of the soil sample?
- $0.857 \text{ g cm}^{-3}$
  - $1.167 \text{ g cm}^{-3}$  ♣
  - $1.2 \text{ g cm}^{-3}$
  - $1.4 \text{ g cm}^{-3}$
  - none of the above
17. Assuming a specific density of  $2.65 \text{ g cm}^{-3}$ , what is the porosity of the above soil?
- $55.96 \text{ cm}^3 \text{ cm}^{-3}$
  - $0.6432 \text{ cm}^3 \text{ cm}^{-3}$
  - $0.5596 \text{ cm}^3 \text{ cm}^{-3}$  ♣
  - $0.4596 \text{ cm}^3 \text{ cm}^{-3}$
  - none of the above
18. The gravimetric water content of a soil sample is  $0.4 \text{ g g}^{-1}$ . Assuming a bulk density of  $1.1 \text{ g cm}^{-3}$  and that the density of water is  $1 \text{ g cm}^{-3}$ , what is the volumetric water content of the sample?
- $0.33 \text{ cm}^3 \text{ cm}^{-3}$
  - $0.44 \text{ cm}^3 \text{ cm}^{-3}$  ♣
  - $0.5 \text{ cm}^3 \text{ cm}^{-3}$
  - $0.54 \text{ cm}^3 \text{ cm}^{-3}$
  - none of the above
19. How much of the soil volume in the soil sample in the previous question is filled with air (assume that the specific density is  $2.65 \text{ g cm}^{-3}$ )?
- $0.0 \text{ g cm}^{-3}$
  - $0.07 \text{ cm}^3 \text{ cm}^{-3}$
  - $0.14 \text{ cm}^3 \text{ cm}^{-3}$  ♣
  - $0.28 \text{ cm}^3 \text{ cm}^{-3}$
20. Topsoil material is usually darker than subsoil material because
- there is more organic material present in the topsoil than in the subsoil ♣
  - there are more Fe oxides and hydroxides present in the topsoil than in the subsoil
  - because sunlight causes dark discoloration of soil minerals
  - a and b

21. The CO<sub>2</sub> content of the soil air is usually higher than the CO<sub>2</sub> content of the atmosphere because
- (a) photosynthetic activity of plant roots produces CO<sub>2</sub>
  - (b) soil always contains water and CO<sub>2</sub> is much more soluble in water than O<sub>2</sub>
  - (c) respiration of soil organisms and plant roots produces CO<sub>2</sub> ♣
22. What do you expect the relative humidity to be in soil air in summer in a desert area like central Washington?
- (a) 0-10%
  - (b) 10-50%
  - (c) 50-80%
  - (d) 90%-100% ♣

## 2 Multiple-Answer Multiple Choice

4 points for each problem set. Each problem set below consists of one problem with four possible answers. Each has at least one of the answers listed, but may have two, three or four of the answers listed. Mark "T" for true for each answer that is correct and "F" for each answer that is incorrect.

- According to Van't Hoff's rule

23.  chemical weathering is usually more pronounced in warmer climates  T
24.  increasing temperature increases the speed of chemical reactions  T
25.  respiration slows down and photosynthesis speeds up when temperature increases  F
26.  respiration and photosynthesis slow down when the temperature increases  F

- Basalt

27.  is a metamorphic rock  F
28.  is an igneous rock  T
29.  contains smaller mineral sizes than gabbro  T
30.  is lighter colored than granite  F

- What is the potential effect of climate on soil formation?

31.  Climate determines the rate of chemical reactions that take place  T
32.  Climate determines whether there is much leaching of ions through the soil profile  T
33.  Climate affects the type of vegetation that establishes on the soil surface  T
34.  Climate determines the type of rainfall (snow, rain) that falls on the soil  T

- Natural soils consist of different layers, called horizons. What is the reason that such layers are formed?

35.  The soil forming processes change with depth  T
36.  Organic matter accumulates predominantly at the soil surface and changes the chemical and physical properties of the topsoil, as well as the chemical composition of the percolation water  T
37.  Percolation water leaches chemicals out of the topsoil and these chemical may accumulate in the subsoil  T
38.  The layering is entirely due layered deposits of material from rivers and wind  F

- Different soils have different characteristic horizons. These horizons follow a certain sequence from top to bottom in a soil profile. Which of the following sequences (from top to bottom in the soil profile) are reasonable (mark true) or are unreasonable (mark false)?

39.  A-Bt-E-C  F
40.  A-E-Bt-C-R  T
41.  A-Bt-Ab-C  T
42.  E-A-Bs-E-C-R  F

- According to the USDA classification,

43.  sand is material larger than 2mm  F
44.  silt is material between 0.002 and 0.05 mm  T
45.  clay is smaller than 0.002 mm  T
46.  clay is is material between 0.02 and 0.05 mm  F

- A colloidal particle is a particle

47.  in the sand fraction of the soil  F
48.  a particle that does not sediment in a suspension  T
49.  belonging likely to the clay fraction of the soil  T
50.  likely composed of quartz  F

- The air in soil contains

51.  less oxygen than the air in the atmosphere  T
52.  less carbon dioxide than the air in the atmosphere  F
53.  more water vapor than the air in the atmosphere  T
54.  only half of the amount of nitrogen than the atmosphere  F

- Which of the following statements are true and false?

55.  cohesion is the attraction between water molecules themselves  T
56.  cohesion is the attraction between water molecules and the soil particles  F
57.  adhesion is the attraction between water molecules and the soil particles  T
58.  adhesion is the attachment of cations to soil particles  F

- Consider two soils that have been formed on granitic parent material. All soil forming factors, with the exception of the vegetation, are the same. On one soil, there is a grassland vegetation, the other soil carries a coniferous forest.

59.  The horizon sequence of the soil under grassland is likely A-Bt-Ck-C  T
60.  The horizon sequence of the soil under forest is likely O-A-E-Bt-C  T
61.  The A horizon under grassland is thicker than the A horizon under forest  T
62.  The pH in the A horizon under grassland is lower than the pH in the A horizon under forest  F
- Chemical weathering comes in different forms. Which of the following statements are true or false?
63.   $\text{CaSO}_4 + \text{H}_2\text{O} \rightarrow \text{Ca}^{2+} + \text{SO}_4^{-2} + \text{H}_2\text{O}$  is a dissolution reaction  T
64.   $\text{Fe}_2\text{O}_3 + 3 \text{H}_2\text{O} \rightarrow 2 \text{Fe}(\text{OH})_3$  is a reduction-oxidation reaction  F
65.   $\text{AlOOH} + \text{H}_2\text{O} \rightarrow \text{Al}(\text{OH})_3$  is a hydration reaction  T
66.   $\text{NaAlSi}_3\text{O}_8 + \text{H}_2\text{O} \rightarrow \text{HAlSi}_3\text{O}_8 + \text{Na}^+ + \text{OH}^-$  is a complexation  F