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# Soil: A Living System

Soils 201

Midterm #1

September 20, 2002

Total Number of Points: 87

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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 are the five soil forming factors?
  - time, space, parent material, biota, topography
  - time, parent material, biota, topography, humans
  - parent material, biota, topography, climate, humans
  - time, parent material, biota, topography, climate ♣
- Igneous, sedimentary, and metamorphic are three \_\_\_\_\_.
  - types of rocks ♣
  - classes of soils
  - master horizon names
  - forms of minerals
  - processes of weathering
- If you wanted to find a soil where physical weathering dominated over chemical weathering you would be most apt to find it in \_\_\_\_\_.
  - a humid region in Brazil
  - the hill lands of Georgia
  - a desert region of Arizona ♣
  - the coastal plain area of Delaware
- The element most often involved in oxidation reactions as mineral weather is \_\_\_\_\_.
  - copper
  - silicon
  - aluminum
  - magnesium
  - iron ♣

5. In which of the following horizons has the process of illuviation most likely occurred?
- (a) O horizon
  - (b) C Horizon
  - (c) A horizon
  - (d) E horizon
  - (e) B horizon ♣
6. Organic matter accumulation is most pronounced in the \_\_\_\_\_.
- (a) O horizon ♣
  - (b) C Horizon
  - (c) R horizon
  - (d) E horizon
  - (e) B horizon
7. Silicate clay accumulation is most pronounced in the \_\_\_\_\_.
- (a) O horizon
  - (b) C Horizon
  - (c) A horizon
  - (d) E horizon
  - (e) B horizon ♣
8. Granite is an example of a(n) \_\_\_\_\_.
- (a) sedimentary rock
  - (b) igneous rock ♣
  - (c) metamorphic rock
  - (d) soil mineral
9. Which of the following statements is correct?
- (a) Soils on hillsides tend to be deeper than those on level lands.
  - (b) Limestone parent materials enhance the process of acidification
  - (c) Calcium carbonate accumulation is more prominent in arid than in humid regions ♣
  - (d) Uncultivated prairie soils have less organic matter than cultivated soils.
10. Textures describes the \_\_\_\_\_ of particles in a soil.
- (a) sizes ♣
  - (b) colors
  - (c) arrangement
  - (d) mineralogical makeup
  - (e) roughness

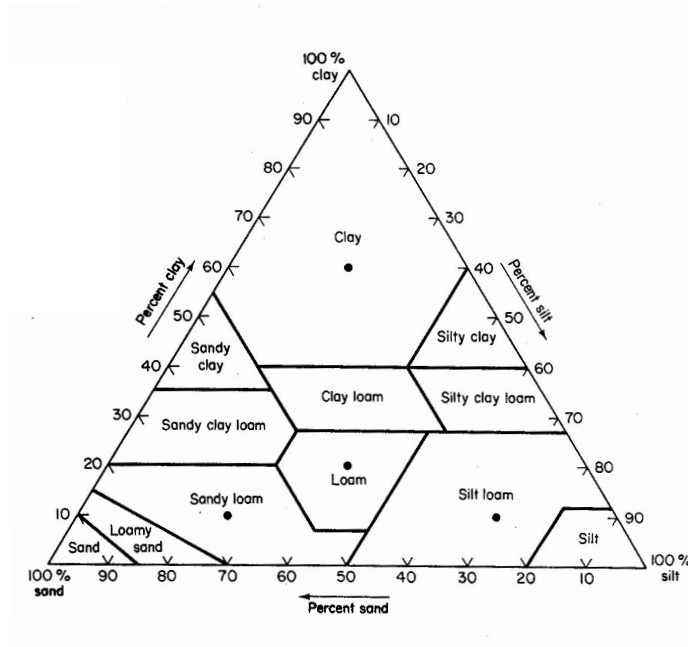
11. Colloidal properties are exhibited by the \_\_\_\_\_ fraction of soils.
- (a) gravel
  - (b) sand
  - (c) silt
  - (d) clay ♣
12. Because of their greater surface area per unit soil mass, a silty soil has generally a greater capacity than a sandy soil to \_\_\_\_\_.
- (a) adsorb water
  - (b) release nutrients by mineral weathering
  - (c) adsorb gases and nutrients
  - (d) support bacterial growth
  - (e) all of the above ♣
13. A soil with a platy or flaky soil structure contains plenty of which minerals?
- (a) quartz
  - (b) sesquioxides
  - (c) aluminosilicate clays ♣
  - (d) feldspars
14. Granular structure is common in which horizon
- (a) A-Horizon ♣
  - (b) B-Horizon
  - (c) C-Horizon
  - (d) all of the above
15. Soil structure
- (a) is relatively resistant towards deterioration
  - (b) depends on the water content of the soil ♣
  - (c) can easily be recovered when destroyed
  - (d) all of the above
16. Soil usually consists of three phases: soil, water, and air. The bulk density ( $\rho_b$ ) of soil material is usually defined as
- (a) the mass of soil divided by the total volume of the soil sample ♣
  - (b) the mass of water divided by the mass of the soil
  - (c) the mass of the soil divided by the volume of the solid phase
  - (d) the volume of the soil divided by the mass of the soil
  - (e) the mass of soil plus the mass of water divided by the volume of the soil

17. Using the texture triangle, a soil sample with 40% sand, 40% silt, and 20% clay is a:

- (a) clay loam
- (b) sandy clay loam
- (c) loam ♣
- (d) silt loam
- (e) none of the above

18. A soil sample of 125 g weight consists of 42 g sand, 58 g silt, and 25 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



19. A soil sample is taken with a cylindrical device with a volume of 1000 cm<sup>3</sup>. After complete drying in the oven, the soil sample weighs 1200 g. What is the bulk density of the soil sample?

- (a) 0.833 g cm<sup>-3</sup>
- (b) 1.2 g cm<sup>-3</sup> ♣
- (c) 1.25 g cm<sup>-3</sup>
- (d) 1.32 g cm<sup>-3</sup>
- (e) none of the above

20. Assuming a specific density of  $2.65 \text{ g cm}^{-3}$ , what is the porosity of the above soil?
- (a)  $54.7 \text{ cm}^3 \text{ cm}^{-3}$
  - (b)  $0.547 \text{ cm}^3 \text{ cm}^{-3}$  ♣
  - (c)  $43.2 \text{ cm}^3 \text{ cm}^{-3}$
  - (d)  $0.432 \text{ cm}^3 \text{ cm}^{-3}$
  - (e) none of the above
21. The gravimetric water content of a soil sample is  $0.3 \text{ g g}^{-1}$ . 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?
- (a)  $0.33 \text{ g cm}^{-3}$
  - (b)  $0.33 \text{ cm}^3 \text{ cm}^{-3}$  ♣
  - (c)  $0.273 \text{ g cm}^{-3}$
  - (d)  $0.273 \text{ cm}^3 \text{ cm}^{-3}$
  - (e) none of the above
22. Brown and red colors in subsurface horizons are caused by \_\_\_\_\_ in the soil.
- (a) manganese
  - (b) organic matter
  - (c) iron oxides ♣
  - (d) clay minerals
23. The range of the relative humidity in the soil air is usually
- (a) 0-10%
  - (b) 50-60%
  - (c) 60-80%
  - (d) 98%-100% ♣
24. The content of  $\text{CO}_2$  in the soil air is usually \_\_\_\_\_ than in the atmosphere.
- (a) higher ♣
  - (b) lower
  - (c) the same
25. The bulk of gaseous exchange in soils takes place by \_\_\_\_\_.
- (a) mass flow
  - (b) dissolution in water
  - (c) diffusion ♣
  - (d) respiration

## 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.

- Rhyolite

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

- Basalt

30.  is a metamorphic rock  F
31.  is an igneous rock  T
32.  contains smaller mineral sizes than gabbro  T
33.  is lighter colored than granite  F

- What is the effect of intensive physical and chemical weathering under warm, humid conditions?

34.  The soil becomes more and more alkaline  F
35.  The soil becomes more and more acidic  T
36.  Soil fertility decreases because nutrients are leached out  T
37.  There is an accumulation of oxides and sesquioxides in the soil profile  T

- What is the reason that soil that has been destroyed cannot be regenerated easily anymore?

38.  The soil forming processes are slow compared to the span of human life  T
39.  During soil formation, complex chemical and physical processes change the original parent material in such a way that the soil cannot be reproduced artificially  T
40.  Soil structure is often very unstable and is formed slowly by physical, chemical, and biological processes  T
41.  Soil microorganisms can only survive in the native soil  F

- Which of the following statements regarding weathering are true or false?

42.  In limestone, the dominant process of weathering is hydrolysis  F
43.  Granite weathers more easily than basalt  T  F
44.  The horizon where there is pronounced weathering of minerals in situ is called a B-Horizon  T
45.  Depending on the parent material of the soil, very intensive chemical weathering leads to an increase of quartz and sesquioxides  T

- The word “clay” can mean

46.  a soil mineral  T
47.  a particle size  T
48.  a textural class of soils  T
49.  a soil horizon  F

- Which of the following statements are true or false?

50.  Clay formation is favored under high precipitation  T
51.  organic matter accumulation occurs dominantly in low and high temperature regions  F
52.  high soil pH is often associated with high precipitation  F
53.  physical weathering occurs **only** in presence of water  F

### 3 Essay Question

9 points. 3 points for each subquestion.

- 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. Describe the soil that is formed on the two sites, by considering the following aspects:

1. What is the sequence of soil horizons of the two soils? Give the master horizons, and if applicable also the subhorizons.
2. Explain the specific sequences based on your knowledge of weathering and other soil forming processes.
3. Which of the soils would be better suited for agricultural crop production, and why?

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1. Grassland: A1-A2-Bt-Ck-C (A-Bt-C); Forest: O-A-E-Bh-Bs-Bt-C (O-A-E-Bt-C) (give full points if major sequence is correct as indicated in parentheses)
  2. Grassland: roots well developed, add organic matter to topsoil, bioturbation, deep A horizon. Forest: accumulation of organic material at soil surface, slow breakdown, acids from organic matter leach through soil and weather granitic minerals chemically until most resistant material remains, quartz sand. Organics and clays will accumulate in the B horizon, little bioturbation.
  3. Grassland soil, has more organic material, better mixing, higher pH.
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