

**STUDY QUESTIONS  
FOR  
GEOLOGY 408U/508**

These questions should be used as a guide to your study of the course material for exam preparation. A significant portion of exam questions will be taken from these study questions and the questions at the end of each chapter.

CHAPTER 1: The Soils Around Us

1. Define and distinguish between microelement and micronutrient. Give two examples of each.
2. What factors affect the amounts and types of elements that will be removed from a soil by ground and surface waters and plant uptake.
3. What are the effects of soil pH on plant growth and ion uptake by plants?
4. Why is "Total chemical analysis" of sediments and soils of little use when conducting environmental or agricultural studies?
5. What is the most ideal balance of air, water, and mineral matter in a soil?
6. What is the meaning of the term "active absorption" or "active uptake" by plants. Why or why not is this process of importance or concern?
7. If a toxic metal is present in relatively low concentrations in the groundwater supply and you are growing garden vegetables in the soil through which this water is moving, is there any cause for concern about eating the vegetables? Explain.
11. Why is agricultural pollution from nitrogen sources generally far greater than for the other fertilizer elements? That is, what reactions, behavior, and forms of nitrogen are unique to this element and causes it to often be a major water pollutant?
9. Describe the major components of soils and what percentage each usually comprises.
10. Explain the term "dynamic component." Which of the soil components is the dynamic component?
12. Discuss how forms of elements in the soil are important in governing their behavior using phosphorous, nitrogen, and calcium as examples.

## CHAPTER 2: Formation of Soils From Parent Materials

Define, describe, or explain:

parent material  
loess

alluvium  
disintegration

colluvial material  
decomposition

1. In relation to the phenomena of the weathering of parent material or rock to soils, compare and contrast the processes of physical disintegration and chemical decomposition.
2. Discuss and give examples of the types of chemical weathering.
3. Discuss and give examples of the types of mechanical weathering.
4. Discuss how the most important factors affect the weathering of minerals.
5. What are the major groups of parent materials and what kinds of materials comprise each group?
6. What are some of the major characteristics of marine sediment parent materials? Explain.
7. How can alluvium be recognized? That is, what are its most distinguishing characteristics?

## CHAPTER 3: Soil Classification

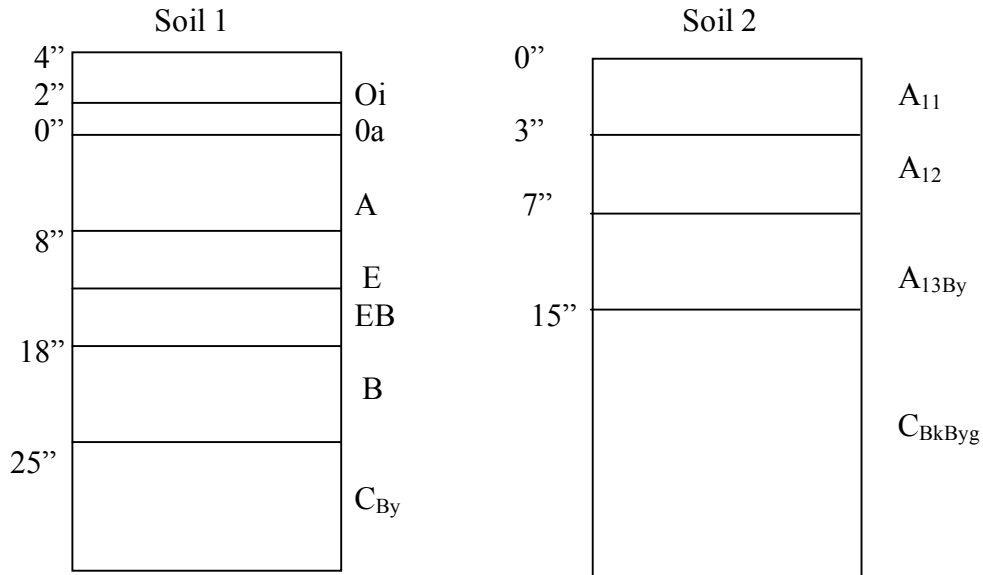
1. How may "topographic age" influence soil formation and differentiation of soils in a given general area?
2. Discuss nutrient recycling in: a) deciduous versus conifer forests and, b) tropical rainforest vegetation and soils.
3. Rank the following soil orders in order of increased weathering (from least to most weathered): Alfisols, Inceptisols, Mollisols, Oxisols, and Ultisols.
4. Are most soils in Tidewater what you would expect from the general climate of the area? Why or why not?
5. Name and briefly explain (describe) the five major factors influencing soil formation.
6. What are the major characteristics of: a) Mollisols and b) Entisols?
7. Discuss the importance and influence of parent material and climate on soil formation.
8. Explain the concept of climatic age on soil development.

9. Refer to the two soil profiles below and answer the questions:

SOIL 1

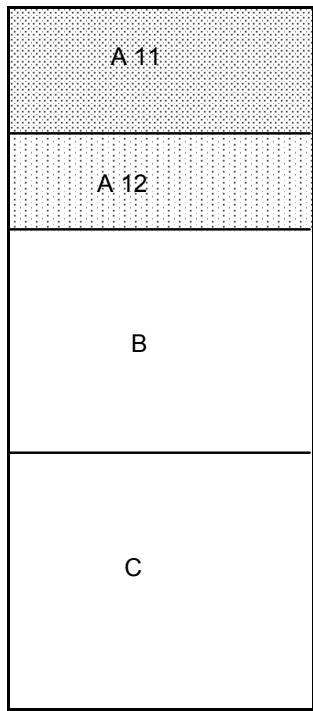
SOIL 2

- a. relative age
- b. predominate vegetation
- c. direction of predominate water movement
- d. climate (rainfall)

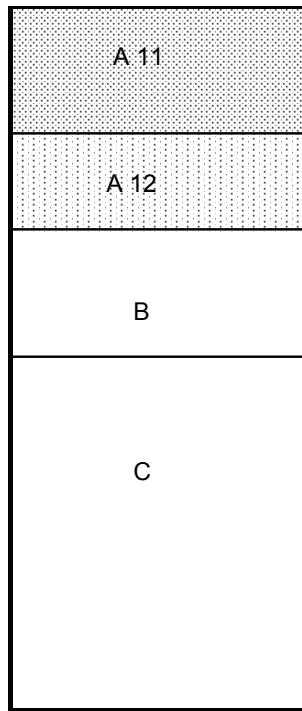


10. Support (explain) each of your answers in a-d in Question 9.

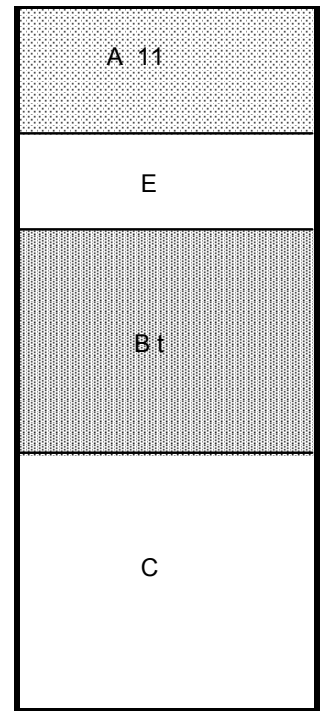
11. Refer to Figure 1 below and (a) rank the soil profiles from youngest (list first) to oldest (list last) based on their relative age. (b) Give (briefly discuss) the criteria used in making your choices. (c) What is the most probable soil order for each profile? Note: shading indicated relative amounts of OM or clay accumulation.



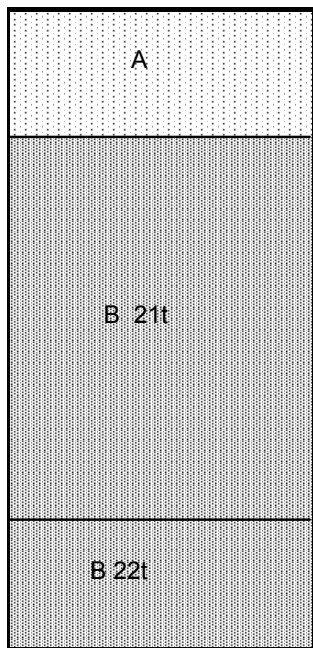
PROFILE A



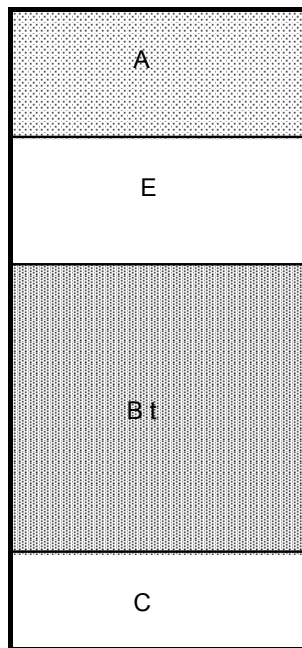
PROFILE B



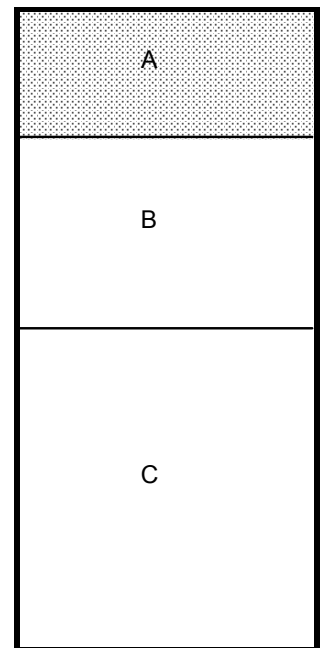
PROFILE C



PROFILE D



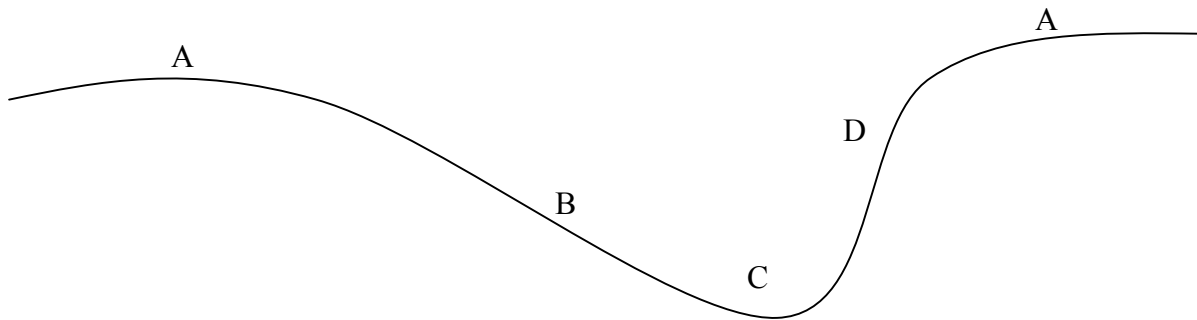
PROFILE E



PROFILE F

FIGURE 1

12. Answer the following questions from the slides that you will see:
- Slide 1:
- How many horizons present?
  - What horizons are they? (Assume no transition horizons.)
- Slide 2:
- How many layers or horizons?
  - What horizons?
  - What is the climate of the area, specifically temperature and rainfall?
- Slide 3:
- What horizons are present? How many and give horizon designations.
  - What type or texture of parent material (and soil)?
  - What is the general climate?
  - What is the predominant vegetation?
  - In what area of the U.S. is this soil located?
13. Using the diagram below explain the concept of topographic age on soil development.



14. What is the general importance of nutrient recycling on soil development?
15. What is the soil development age? Give an example to explain your answer.

16. Write each of the seven soil orders listed on the appropriate area of occurrence in Figure 4-10. Explain your reasons for choosing the locations.

Alfisol, Aridisol, Inceptisol, Mollisol, Oxisol, Spodosol, Ultisol.

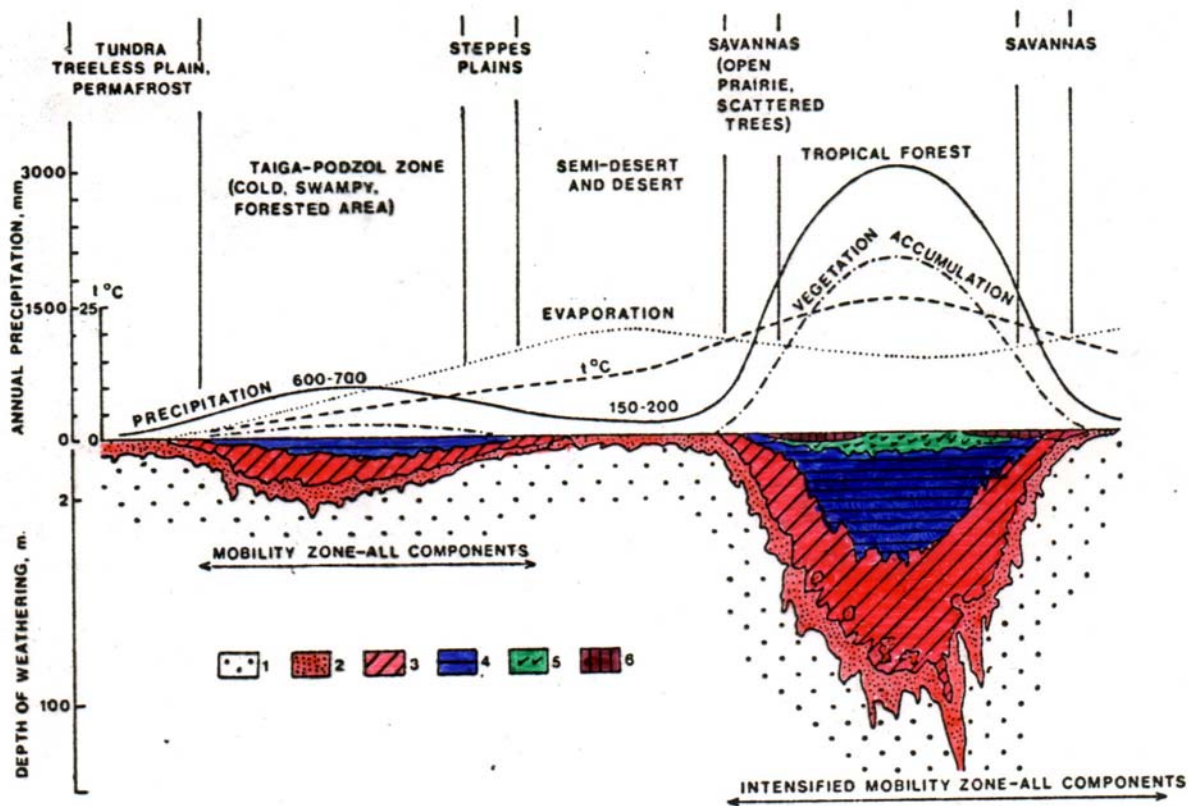


Figure 4-10. Formation of a leached, decomposed weathered crust in tectonically inactive areas: (1) new crust; (2) grus zone, little modified chemically; (3) hydromica-montmorillonite-beidellite zone; (4) kaolinite zone; (5) ochers,  $Al_2P_3$ ; (6) hard layer  $Fe_2O_3-Al_2O_3$ . (Reproduced from Strakhov, 1967, Principles of Lithogenesis, Oliver & Boyd Ltd, and Consultants Bureau Enterprises, Inc.)

FIGURE 4.10. Formation of a leached, decomposed weathered crust in tectonically inactive areas: (1) new crust, (2) grus zone, little modified chemically, (3) hydromica-montmorillonite-beidellite zone; (5) ochers,  $Al_2P_3$ , (6) hard layer  $Fe_2O_3-Al_2O_3$ . (Reproduced from Strakhov, 1967, Principles of Lithogenesis, Oliver & Boyd Ltd, and Consultants Bureau Enterprises, Inc.)

## CHAPTER 4: Soil Architecture &amp; Physical Properties

Define, describe, or explain:

soil structure	macro-pore space	porosity
soil texture	permeability	soil structure
bulk density	soil consistence	

1. Define and distinguish between particle density and bulk density.
2. What are the factors important in maintaining aggregate stability in soils? Which are important in the short term and which for the long term?
3. How does bulk density vary with depth in the soil? Explain, using the influencing factors.
4. Compare and contrast a sandy surface soil and a fine textured surface soil in terms of bulk density, particle density, pore space, structure, and aggregation. (Make a table if you wish.)
5. Discuss the role of organic matter during (a) formation and (b) stabilization of soil aggregates.

## CHAPTER 5: Soil Water: Characteristics and Behavior

1. What are the components of the matrix force (potential) of soil water? How do these component forces affect the free energy of soil water? Use a diagram if it will help.
2. How does the polarity of the water molecule influence its properties and behavior in the soil?
3. Starting with a soil completely saturated with water during a rain, give the four levels or categories of moisture content which will be present as the soil dries to near the point of complete water removal. Where appropriate, give the suction associated with each category. Don't hesitate to use a diagram if you desire.
4. What is the major effect of the osmotic potential with respect to soil water?
5. Discuss capillary rise of soil water and compare it to the capillary rise in a glass capillary.
6. Name and explain (or describe) the forces affecting the free energy of soil water. Be sure to state whether each force is positive or negative.
7. What is the general effect of a stratified layer on water movement (of any type of material) in soils?

- (8. A water column that is 500 cm high will exert a suction of how many bars (atm)?
9. Why and how is the height of rise of water through soil capillaries different than predicted from calculations based on the average pore size?

CHAPTER 6: Soil & the Hydrologic Cycle

Define, describe, or explain:

percolation                      SPAC                      evapotranspiration                      leaching

1. What are some of the important factors in determining whether to use open or closed drainage systems in a given area?
2. Discuss the concept of the soil-plant-atmosphere continuum (SPAC).
3. Name and discuss the factors that influence water loss as a function of the vapor pressure gradient.
4. How may percolation losses over relatively large areas be determined? Why is this important?
5. What factors affect leaching losses of nutrients or other elements from soils?
6. Define and differentiate between percolation and leaching. List three or more factors that affect each process.
7. How may upward movement of water occur in soils? What are some results of this type of water movement?
8. What can be done to reduce soil moisture losses from evaporation processes?
9. What can be done to reduce percolation losses of soil water?
10. How may leaching losses of plant nutrients be reduced?

CHAPTER 7: Soil Aeration & Temperature

CHAPTER 8: Soil Colloids: The Seat of Soil Chemical & Physical Activity

Define, describe, or explain:

CEC                                      clay particle                                      base exchange clay mineral  
 cation                                      colloidal particle                                      micelle



1. Write and balance an exchange reaction between a calcium saturated clay and sodium sulfate.
2. Give five cations that are naturally predominate in soils of humid areas; of arid areas.
3. Name a clay mineral that has: a) little ionic substitution in its layers and b) a high amount of ionic substitution in its layers.
4. What property is effected by ionic substitution in clay mineral layers (No.3) and how?
5. Give four properties or characteristics of hydrous iron oxides.
6. (a) What is dispersion and (b) what could one do to disperse or aid in dispersion of soil particles?
7. (a) Distinguish between flocculation and precipitation.  
(b) How can one promote flocculation of colloids?
8. Write (and balance) an exchange reaction between a magnesium saturated clay after an addition of sodium ions.
9. What are the major sources of negative charges on clay particles?
10. What are the major types of charges on silicate clays? Briefly discuss each.
11. Rank the following materials as to CEC; arrange from highest to lowest: Hydrous oxides, vermiculite, kaolinite montmorillonite, humus, illite.
12. Write a balanced exchange reaction between potassium saturated clay and zinc sulfate.
13. Compare and contrast the (relative) properties of kaolinite, illite, and montmorillonite with respect to: CEC, plasticity, cohesion, shrink-swell properties, and internal surface area. Suggestion: make a table.

14. How may hydrous oxides affect the CEC and reactivity of the silicate clays in soils and sediments?
15. What is base saturation (%B.S.) in soils?
16. Why is % B.S. important in soils?

CHAPTER 9: Soil Acidity

Define, describe, or explain:

buffering  
neutralizing power  
slaked lime

buffer capacity  
quicklime

bound hydrogen  
dolomitic limestone

1. Define and distinguish between active, exchangeable and residual acidity.
2. What effect does Al have on soil pH?
3. What is buffering and buffering capacity in soils?
4. What is the importance of buffering in soils?
5. What soil property is most important in determining the buffering capacity of a given soil?
6. How does the effect of Al on pH vary with soil pH?
7. What are the major acidity-forming factors in soils?
8. Why is the particle size distribution of ground limestone important?
9. What are the major effects of lime on the soil?

CHAPTER 11: Organisms & Ecology of the Soil

Define, describe, or explain:

primary consumer  
heterotrophic  
mycorrhizae

autotrophic  
detritivores  
herbivores

secondary consumer  
rhizosphere

1. Which group of soil organisms is responsible for the majority of plant diseases? What management practices can be used to control plant diseases?
2. Compare and contrast the activities and influence of soil fungi and soil bacteria.

3. A high population of earthworms is indicative of high soil \_\_\_\_\_.
4. The group of soil microanimals that are most injurious to higher plants are \_\_\_\_\_.
5. The group of soil organisms responsible for most of the soil borne diseases of crop plants is the \_\_\_\_\_.
6. How may earthworms influence soil properties?
7. What is the primary (major) source of organic matter in soils?
8. Discuss the importance of soil bacteria. What are the major conditions that affect their growth?

### CHAPTER 12: Soil Organic Matter

Define, describe, or explain:

biocycle                      humic acid      mineralization                      fulvic acid  
nitrification

1. How does the C/N ratio of organic matter affect the rate or amount of organic matter breakdown in soils?
2. Discuss some of the properties and characteristics of humus.
3. Explain the influence of organic matter on soil aggregation.
4. What are the two general (major) sources of organic matter in soils?
5. Give some examples of the simple decomposition products of organic matter.
6. Briefly explain the "life cycle."
7. What factors affect the amount of organic matter in soils? Explain.

### CHAPTER 15: Micronutrient Elements & Other Trace Elements

1. What are the most common chemical forms of the micronutrient elements in soils?
2. Discuss the factors that influence the availability of the micro- nutrient cations.
3. What are chelates? How are they useful in relation to soils?
4. What problems (and potential problems) are unique to the micro- nutrients when compared to the macronutrients?

5. What are the major natural forms (sources) of micronutrients?
6. Discuss the factors that influence the availability of the micro- nutrient anions.
7. Which micronutrient(s) is(are) most likely to be deficient in coastal plain soils in Virginia? in Florida? in Colorado?
8. What is antagonism? Explain and give two examples involving micronutrients.

#### CHAPTER 16: Practical Nutrient Management

1. What are some of the major benefits of recycling (or applying) organic wastes to soils?
2. Discuss the possible problems with applying the various types of organic wastes to soils?
3. What are some problems associated with applying very high levels of farm manure wastes to soils?

#### CHAPTER 17: Soil Erosion and Its Control

Define, describe, or explain:

infiltration    contour tillage    sheet erosion    conservation tillage

1. How does the infiltration capacity of a soil affect its erodability?
2. Are soil erosion problems decreased or increased in urbanized areas? Explain.
3. What are the components of the rainfall effects that influence soil erosion? Which of these components is most important?
4. Discuss the effect of vegetative cover on soil erosion.
5. What is accelerated soil erosion?
6. What are the factors that affect soil erosion?
7. What can urban homeowners do to reduce soil erosion?

#### CHAPTER 18: Soils and Chemical Pollution

Define, describe, or explain:

fumigant                      pesticide                      herbicide

## REFER TO FIGURE 1

An abandoned landfill (LF) was found to contain a variety of substances including old auto batteries, sewage sludge, old agricultural fertilizer, and used auto tires.

1. Assume a somewhat clayey but permeable soil just under and around the landfill (about to the water table in the figure).
2. Assume a deep silt-loam soil as the material which underlays the general landscape.
3. Assume a humid climate.
4. Remember that the leachate shown in Figure 1 is generalized and may or may not have any relation to the substances in this question.

1. A. Indicate the (general) position in the landscape/profile that you would expect to find each of the 10 substances listed below at the end of two years. The position indicated should be point of maximum expected movement.

B. Give one reason for each substance that will help explain its movement (or lack thereof).

- |              |                                              |
|--------------|----------------------------------------------|
| a. DDT       | f. Diquat (organic cation) pesticide         |
| b. Boron     | g. Pb (from batteries)                       |
| c. Phosphate | h. Dieldrin (non-ionic, non-polar) pesticide |
| d. Arsenic   | i. Zn                                        |
| e. Cu        | j. Zn                                        |

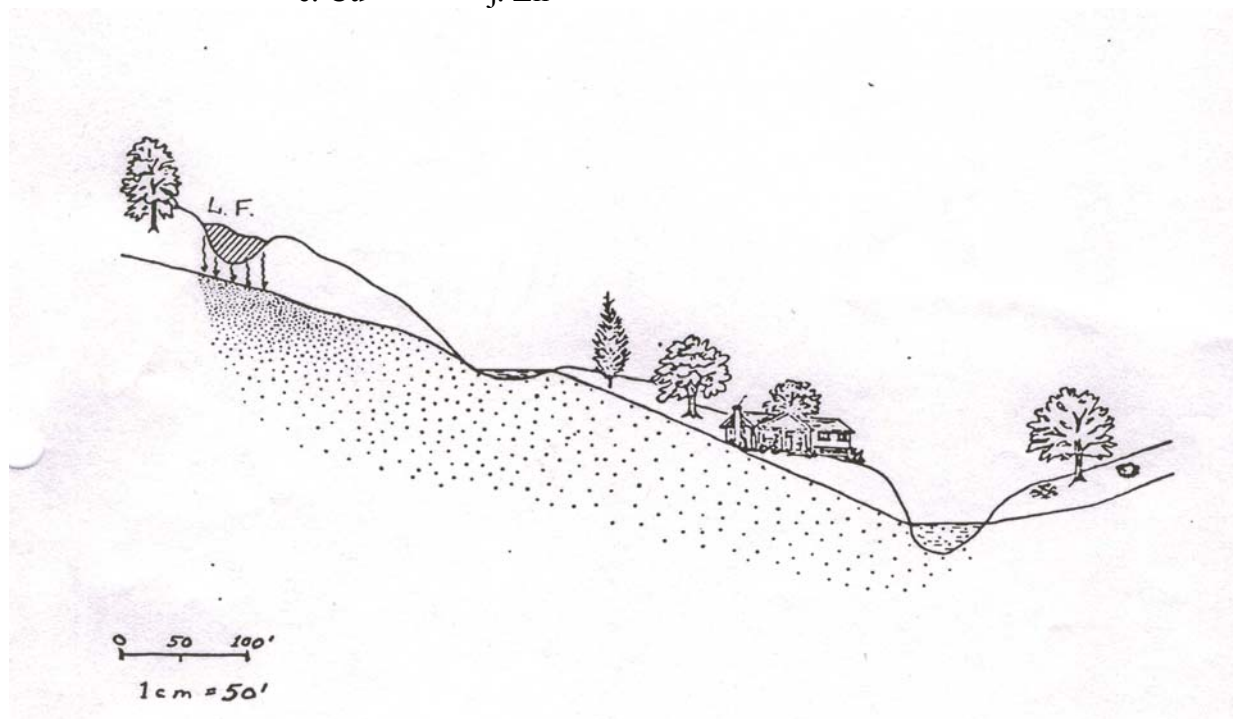


FIGURE 1. Generalized movement of leachate through the land phase of the hydrologic cycle.

2. What are the possible fates of pesticides after application to the soil?
3. For inorganic elements, give two examples for each class:
  - a. extremely toxic; b. moderately toxic; c. relatively low in toxicity
4. Describe the properties for the "ideal" soil to be used in a landfill or disposal site. How would you obtain such a soil if one were not available in a desirable location?
5. What are the three major types of pesticides?
6. How can the adsorption of non-ionic polar molecules onto silicate clays be increased?
7. Nitrate pollution was found at the mouth of a stream. How could one determine if the source of the pollution was agricultural or industrial? Include the type of sampling program necessary and the reasons.
8. You are asked to evaluate the potential of a given soil to remove an inorganic, ionic pollutant from an effluent water. List five important factors (or assumptions) which you would have to consider in your evaluation.
9. You are asked to evaluate the potential of two soils to remove an inorganic, ionic pollutant from an effluent water. One soil is a sandy loam and the other is a silty loam.
  - a) List eight important soil properties and eight important pollutant properties which will be of importance in considering either soil.
  - b) Give advantages and disadvantages of each soil type.
  - c) After all considerations, which soil should be used?
10. How may various organic pesticides interact with inorganic soil clays?
11. Discuss some of the benefits from the use of chemical pesticides.
12. Discuss some of the problems and dangers from pesticide use.
13. What are the major sources of soil contamination by toxic inorganic compounds?
14. What soil management practices should be considered for soils found to be contaminated by: a) organic pesticides, or b) toxic inorganics?
15. What are the major problems associated with the disposal of sewage sludge on agricultural lands?
16. Discuss the advantages and disadvantages of using various soils as organic waste disposal sites.
13. How does acid precipitation affect the soil system?

CHAPTER 20 Global Soil Quality as Affected by Human Activities

1. What are some advantages and disadvantages to slash and burn farming methods?
2. Discuss the possibilities of addressing human nutrient deficiencies through crop fertilization. What are some of the greatest challenges to this idea?
3. What are some of the greatest challenges facing agricultural food production in the next few decades?