

CHAPTER 11

SOIL AS A RESOURCE

Important Concepts

1. *Soil* is an unconsolidated mixture of weathered rocks, minerals, and organic matter produced by the weathering of rocks. Its characteristics are determined by climate, topography, composition of parent material, and time (duration of weathering).
2. Soil is an essential resource because agriculture depends on soil. Soil degradation is a worldwide concern.
3. *Weathering* encompasses three types of processes:

Mechanical weathering is the physical breakup of rock with no change in the rock's chemical composition; however, mechanical weathering increases the surface area exposed to chemical attack, thereby enhancing chemical weathering. Mechanical weathering is usually the dominant type of weathering in cold or dry climates.

Chemical weathering is the decomposition of the minerals in a rock by chemical reactions with other substances in the environment, mainly water. Chemical weathering proceeds rapidly in warm, wet climates and more slowly in cold, arid climates.

Biological weathering is the breakdown of rock through the activities of living organisms. This type of weathering can be either mechanical or chemical.

4. A *soil profile* comprises the weathered material that occurs in layers or horizons between the bedrock and the atmosphere. The typical soil profile has three layers: an uppermost *A horizon* (also called the zone of leaching), an intermediate *B horizon* (also called the zone of accumulation or the zone of deposition), and a lower *C horizon* (zone of partly broken-up parent rock).
5. Soils can be characterized on the basis of color, texture (size distribution of fragments in the soil), and structure (the tendency of soil particles to form lumps).
6. *Pedalfers* are typically acidic soils that develop in regions having abundant rainfall and are rich in aluminum and iron. *Pedocals* are alkaline soils that develop in drier climates and retain soluble compounds such as calcium carbonate. *Laterites* are severely leached, nutrient-poor soils that develop in tropical climates. The classification scheme used by soil scientists is much more elaborate.
7. The United States is losing soil due to erosion at the rate of several billion tons per year. The causes of soil erosion include agricultural activities, highway and building construction, mining activities, and the use of off-road recreational vehicles (ORVs).
8. In addition to soil loss, soil erosion contributes to chemical pollution of rivers and lakes, because the resulting sediments contain residues of toxic chemicals from pesticides and herbicides.
9. Strategies for reducing erosion include the planting of cover crops, the establishment of windbreaks, strip cropping, contour plowing, terracing, and minimum-tillage farming.

Key Terms

A horizon	pedalfer
B horizon	pedocal
chemical weathering	soil
C horizon	zone of accumulation
laterite	zone of deposition
leaching	zone of leaching
mechanical weathering	

Multiple Choice

1. Soil scientists distinguish soil from regolith on the basis of the soil's
 - a. chemical composition.
 - b. ability to support plant life.
 - c. depth below the surface.
 - d. physical texture.
2. The effects of chemical weathering would be most evident
 - a. in polar regions.
 - b. in deserts.
 - c. in tropical climates.
 - d. at high altitudes.
3. The soil horizon consisting of the most intensively weathered rock material is the
 - a. A horizon.
 - b. B horizon.
 - c. C horizon.
 - d. R horizon.
4. The soil horizon known as the zone of leaching is the
 - a. A horizon.
 - b. B horizon.
 - c. C horizon.
 - d. O horizon.
5. A clay-rich soil may hold a great deal of water; however, such a soil may not necessarily be desirable in an agricultural setting because clay soils
 - a. are nutrient-poor.
 - b. are often slow to drain due to their low permeability.
 - c. are often too acidic for most crops.
 - d. release toxic heavy metals, which are incorporated into plant tissues.
6. Pedalfer soils are
 - a. typically alkaline.
 - b. characteristic of humid climates.
 - c. rich in calcium carbonate.
 - d. common soils of the western and southwestern United States.

7. Lateritic soils
- contain a high percentage of soluble nutrients.
 - are an extreme type of pedocal.
 - are severely leached soils.
 - are best developed in cool, dry regions.
8. Histosols are
- soils of deserts and semiarid regions.
 - bog-type soils.
 - grassland soils.
 - soils that contain expandable clay.
9. In North America, the single greatest cause of soil degradation is from
- deforestation.
 - overgrazing.
 - industrialization.
 - agricultural activities.
10. The Dust Bowl of the 1930s resulted from
- clearing and/or close grazing of natural vegetation.
 - sustained drought.
 - poor farming practices.
 - All of the above choices are correct.
11. Dust storms have greatly increased worldwide over the past two centuries primarily because of
- worldwide drought.
 - deforestation and increasing cultivation.
 - increasing urbanization.
 - intense winds.
12. All of the following can be used to reduce wind erosion on farmland except
- planting hedges or trees along field borders.
 - planting cover crops.
 - leaving stubble in the fields.
 - contour plowing.
13. One of the disadvantages of terracing is
- increased surface runoff.
 - decreased infiltration.
 - leaching of soil nutrients.
 - its cost.
14. A method of reducing soil erosion in which the land is not plowed before or after planting but at the time of planting is called
- contour plowing.
 - single-step tillage.
 - minimum tillage.
 - nonrotational farming.

15. Which one of the following is an environmental cost associated with increased crop productivity?
- increased reliance on irrigation and the resultant increase in the “mining” of ground water
 - increased use of pesticides and fertilizers
 - a six-fold increase in energy use for agricultural activities since 1950
 - All of the above are correct.

Fill In the Blanks

- _____ is a mixture of disintegrated rocks and organic matter that will support the growth of plants.
- _____ _____ is the physical breakup of rock without changes occurring in the rock's chemical composition.
- _____ _____ is the disintegration of rock due to reactions with chemicals in the environment.
- _____ is the process of removal of soluble minerals from the soil by dissolution.
- The _____ _____ of a typical soil profile consists mainly of broken-up rock.
- The _____ _____ of a typical soil profile is also called the zone of accumulation or the zone of deposition.
- Soil _____ relates to the sizes of fragments in the soil, whereas soil _____ relates to the soil's tendency to form lumps of soil particles.
- _____ soil contains an abundance of aluminum and iron hydroxides and oxides, is typically acidic, and is characteristically developed in humid climates.
- _____ soil develops in acid climates and is characterized by the presence of calcium carbonate.
- _____ soil is severely leached, nutrient-poor soil of tropical climates.

True or False

Indicate whether the following statements are true or false. If false, correct the statement to make it true.

- _____ 1. The fracturing of rock due to the repeated freezing and thawing of water in cracks in the rock would be a type of mechanical weathering.
- _____ 2. Given several silicates that have crystallized from the same magma, those that formed at the highest temperatures tend to be the most resistant to chemical weathering.
- _____ 3. The A horizon of a typical soil profile contains most of the organic matter.
- _____ 4. Mechanical weathering tends to involve a net loss of elements from rock or soil.

- _____ 5. Soils are named on the basis of their color.
- _____ 6. One problem with lateritic soils is that they tend to harden to a solid, bricklike consistency when exposed to the tropical sun.
- _____ 7. A negative consequence of soil erosion in some areas is the buildup of toxic residues in the soil.
- _____ 8. The United States Soil Conservation Service was established in response to the disastrous Dust Bowl conditions of the 1930s.
- _____ 9. Despite the problems of soil erosion, world production of cereal crops has increased faster than population for the past thirty years.
- _____ 10. Because of improved soil conservation practices, energy use in agriculture worldwide has decreased six-fold since 1950.

Review Questions

1. Discuss the different processes of weathering that produce soil from rocks. What are the factors that control the effectiveness of weathering?
2. Sketch a generalized soil profile and label the following: A, B, and C soil horizons; zone of leaching, and zone of accumulation. Does every soil profile look like your sketch?
3. Explain the difference among pedocals, pedalfers, and laterites. Why is lateritic soil not good for cultivation?
4. Why is soil erosion a major global concern? What strategies should we adopt to address this concern?

Surfing the Net

Numerous Internet links concerning soil science (NSCSS Soil Science Links Home Page):

<<http://www.wolfe.net/~psmall/soil.html>>

Photographic examples of weathering (Duke University):

<<http://www.geo.duke.edu/geo41/wea.htm>>

World Soil Resources Office of the U.S. Department of Agriculture and Conservation Service:

<<http://www.nhq.nrcs.usda.gov/WSR/>>

Information about wetlands (The National Wetlands Research Center):

<<http://www.nwrc.gov/>>

CHAPTER 11 ANSWER KEY

Multiple Choice

- | | | | |
|------|-------------------|-------|-------|
| 1. b | 5. b | 9. d | 13. d |
| 2. c | 6. b | 10. b | 14. c |
| 3. a | 7. c | 11. b | 15. d |
| 4. a | 8. b (table 11.2) | 12. d | |

Fill In the Blanks

- | | |
|--------------------------|-----------------------|
| 1. Soil | 6. B horizon |
| 2. Mechanical weathering | 7. texture, structure |
| 3. Chemical weathering | 8. Pedalfer |
| 4. Leaching | 9. Pedocal |
| 5. C horizon | 10. Lateritic |

True or False

1. True
2. False. Given several silicates that have crystallized from the same magma, those that solidified at the lowest temperatures tend to be the most stable and the most resistant to chemical weathering.
3. True
4. False. Chemical weathering tends to involve a net loss of elements from rock or soil.
5. False. Soils are named on the basis of their texture.
6. True
7. True
8. True
9. True
10. False. Energy use in agriculture worldwide has increased sixfold since 1950.