

Unit E: Basic Principles of Soil Science

Lesson 2: Understanding Soil Formation

Student Learning Objectives: Instruction in this lesson should result in students achieving the following objectives:

1. Identify five factors involved in soil formation.
2. Describe different types of parent material.
3. Explain topography and how it affects soil formation.
4. Explain how organisms affect soil development.
5. Describe how time and weathering affect properties of soil.
6. Explain how climate affects the development of soil.

Recommended Teaching Time: 3 hours

Recommended Resources: The following resources may be useful in teaching this lesson:

- A PowerPoint has also been developed for use with this lesson plan

List of Equipment, Tools, Supplies, and Facilities:

Writing surface
PowerPoint Projector
PowerPoint Slides
Transparency Masters
Sample of soil
Copies of Student Lab Sheet
Magnifying glasses
Plastic or metal sieves

Terms: The following terms are presented in this lesson (shown in bold italics and on PowerPoint Slide 2):

- Alluvium
- Bedrock
- Chemical weathering
- Climate
- Glacial till
- Loess
- Native vegetation
- Organic matter
- Outwash
- Parent material
- Physical weathering
- Prairie soils
- Timber soils
- Topography

Interest Approach: Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Ask two students to sit or stand in front of the class. Ask the class if the students are exactly the same. Responses should be a resounding “No!” Ask the class what makes the students different from each other. One of the first responses should be that they have different parents. Relate this to different parent materials of soils. An additional answer should be that students have grown up in different environments and have different experiences. Relate this to different environments in which soils develop. You may even wish to ask students to think about identical twins that may have been separated as youngsters. As adults, there will be differences between them. Explain that even though the twins have the same genetic makeup, they have experienced different environments and situations. Relate the same concept to soil development.

Summary of Content and Teaching Strategies

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Objective 1: Identify five factors involved in soil formation.

I. There are five primary factors that affect the process of soil formation and development.

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A. Parent material—type of rock material the soil is formed from.

(PowerPoint Slide 5)

B. Climate—temperature and moisture characteristics of the area in which the soil was formed.

(PowerPoint Slide 6)

C. Living organisms—the organisms, including plant material, that live within the soil.

(PowerPoint Slide 7)

D. Topography—slope characteristics of the soil.

(PowerPoint Slide 8)

E. Time or weathering—age of the soil and its climate.

****Before introducing the content, ask students to identify factors in nature they think would affect the formation of soil.**

Objective 2: Describe different types of parent material.

(PowerPoint Slide 9)

II. **Parent materials** are formed by the disintegration and decomposition of rock. They are classified according to the way they were moved and scattered.

- A. Many soils have been formed from material originally moved by glaciers.
Soils of glacial origin are classified as follows:

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1. **Loess**—occurred from the blowing of the soil after the glaciers melted and dried. Loess is the most desirable single soil parent material. This is due to its well-balanced mineral content, medium texture, and excellent water-holding capacity.

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2. **Outwash**—occurred when the glaciers melted. The melt waters carried the gravelly materials away to be deposited below the glacial ridges. Sandy outwash was carried further downstream and the finer materials, silt and clay, were deposited in lakebeds or slow moving water along streams.

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3. **Glacial till**—have not been layered from the effects of wind or water as the other two types of glacial soils. It often contains a variety of sizes of soil particles. Pebbles and various sizes of boulders are common in till.

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- B. Some soils are formed as a result of recent sediments deposited by streams as they flood. It is referred to as alluvium. **Alluvium** is generally a water-borne material deposited on bottomlands.

(PowerPoint Slide 14)

- C. **Bedrock**—shale, sandstone, or limestone bedrock; weathered bedrock can provide soil parent material.

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- D. **Organic matter**—occur where formerly shallow ponds supported swamp vegetation. The wet conditions slowed decay of the dead plants so that organic matter could accumulate. The two types of organic soils are referred to as peat and muck. Muck is more decomposed than peat.

****Use notes provided above to outline important points to students. Have students locate their local area to identify the predominate parent material found there. Ask students to describe it.**

Objective 3: Explain topography and how it affects soil formation.

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III. **Topography** refers to the slope characteristics of a soil. It includes the degree or steepness, length, shape, and direction of a slope.

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These factors influence the amount of rainwater runoff, or the amount that enters the soil or collects in small depressions on the soil surface. Soils on steep slopes have higher amounts of runoff and erosion than those on level topography. The amount of moisture in the soil during its development affects the rate of weathering and the development of subsoil colors. Soils in

depressions and on nearly level topography are likely to have poor or very poor natural drainage. Soils on moderately sloping to steep topography are usually well drained.

****Help students to understand that slope influences moisture relationships with the soil. This in turn affects the development of soil. If you have a variety of topographies in your area, ask students to relate their experiences on how the soils may differ from one area to another.**

Objective 4: Explain how organisms affect soil development.

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IV. Organisms that live in soil—like plants, insects, and microbes—actively affect soil formation. The greatest affect on the development of soil is from plants that once grew in it. This is referred to as ***native vegetation***. It determines the kind and amount of organic matter in the soil.

(PowerPoint Slide 19)

For example, two common types of native vegetation in the Midwest are tall prairie grass and deciduous-hardwood forests. Soils in these areas are referred to as prairie soils and timber soils.

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- A. ***Prairie soils*** have a dark and deep surface layer. This is because roots from the prairie grass filled the top of the soil to a depth of 1 to 2 feet or more. Partial decay of these roots over a long period of time gave these soils a high organic matter content.

(PowerPoint Slide 21)

- B. ***Timber soils*** tend to have a thin, moderately dark layer. This is due to organic matter accumulating on the surface where decay occurs more rapidly. When tilled, this dark material is mixed with the soil below to produce a lighter color.

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- C. Other living matter that influences the development of soil includes various kinds of animal life. Earthworms, crawfish, ground squirrels and other burrowing animals, and various insects which incorporate organic matter into the soil are examples.

****Divide the class into groups of 2 or 3 and have them gather about a two liter sample of soil. Soil should be collected to a depth of at least 15-20 centimeters. Bring the sample into the lab area and use the magnifying lens to locate any form of living material. Have students share their findings with the entire class. One of the findings should be plant material. Outline the major types of native vegetation found in your region. Explain how the resulting soil differs. Which is preferred?**

Objective 5: Describe how time and weathering affect properties of soil.

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V. Timing and Weathering

A. There are two types of weathering:

(PowerPoint Slide 24)

1. **Physical weathering**—the effects of climatic factors such as temperature, water, and wind. Freezing and thawing is a major contributor to physical weathering.

(PowerPoint Slide 25)

2. **Chemical weathering**—changes the chemical makeup of rock and breaks it down. Rainwater is mildly acidic, and can slowly dissolve many soil minerals. Some minerals react with oxygen in the atmosphere. Oxidation further acts to decompose rock.

(PowerPoint Slide 26)

B. Weathering causes soil to:

1. Develop—occurs rapidly, plant nutrients are released, and organic matter accumulates. Soils will develop faster in humid regions than in arid regions.

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2. Mature—soil is at peak productivity with a high amount of organic matter. Water begins leaching away nutrients and plant growth starts to decline. This results in less organic matter.
3. Age—minerals continue to break down and clay is leached into the subsoil. The soil becomes lighter in color from less organic matter.

**** Have students identify the various stages of life in people. They should mention childhood, early adulthood, and late adulthood. Have students relate how the productivity of people changes as they progress through life. Compare the development of soil to the development of people. Help students identify what is happening in the soil during each of the three stages of development. Compare it with the human life cycle. Major points should include the amount of organic matter, soil productivity, and amount of clay or fine soil particles found.**

Objective 6: Explain how climate affects the development of soil.

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VI. **Climate** refers to rainfall, freezing, thawing, wind, and sunlight.

- A. These factors are either directly or indirectly responsible for the breakdown of rocks and minerals, the release of plant nutrients, and many other processes affecting the development of soils.
- B. In areas characterized by hot summers and cold winters, the climate enhances the weathering process through freezing and thawing. Soils in humid regions are subject to more leaching than soils in dry regions.
- C. Rainfall wears the rock away a little at a time. Wind also wears the rock away.

****Have students describe the type of climate they live in. Is it cold or hot or both? Wet or dry? Windy, etc.? Using the notes above, describe how these factors affect soil development. Refer students to experiences from the suggested labs completed under Objective 1. This will reinforce the concept of weathering as it relates to climate.**

Review/Summary: Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions on PowerPoint Slide 29 can also be used as well.

Application: Application can involve the following student activity using the attached lab sheet: Soil Formation Worksheet—LS: E2-1

Evaluation: Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is attached.

Answers to Sample Test:

Part One: Matching

1=b, 2=f, 3=h, 4=e, 5=a, 6=d, 7=c, 8=g

Part Two: Completion

1. weathering
2. glaciers
3. organic matter, subsoil
4. organic matter

Part Three: Short Answer

1. a. Development occurs rapidly with organic matter and productivity increasing.
b. Soils reach peak productivity and amount of organic matter.
c. Slow process where the amount of organic matter and productivity decline. Clay accumulates in the subsoil.
2. Students can list any three of the following: rainfall, freezing, thawing, wind, and sunlight
3. Students can list any three of the following: parent material, climate, living organisms, topography, and time.

Test

Unit E Lesson 2: Understanding Soil Formation

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

- | | | |
|-----------------|------------------------|----------------------|
| a. Glacial till | d. Prairie soils | g. Loess |
| b. Alluvium | e. Physical weathering | h. Native vegetation |
| c. Topography | f. Timber soils | |

- _____ 1. Water-borne parent material deposited on bottomlands.
- _____ 2. Soils with less organic matter accumulation and lighter in color.
- _____ 3. Plants that originally grew on the land and contributed to the development of the soil.
- _____ 4. The effects of climatic factors that act to break down mineral matter.
- _____ 5. Parent material that was physically moved and deposited by the glacier itself.
- _____ 6. Soils with a dark and deep surface layer.
- _____ 7. Refers to the slope characteristics of a soil.
- _____ 8. Parent material of the glacial origin that was deposited by wind.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

- 1. Changes that affect the chemical makeup of rock and helps to break it down is referred to as chemical _____.
- 2. Many soils have been formed from material originally moved by _____.
- 3. When the soil is young, _____ accumulates, but as soils get older, this substance as well as production decline and clay accumulates in the _____.
- 4. _____ gives soils it is dark color and is found primarily in the surface layer of the soil.

Part Three: Short Answer

Instructions. Use the space provided to answer the following questions.

1. Weathering causes soils to develop, mature, and age. Describe what is taking place in soil and/or how the soil is changing during each of the following:
 - a. develop—

 - b. mature—

 - c. age—

2. What are three factors of climate that act to break down the rock and minerals during the development of soils?
 - a.

 - b.

 - c.

3. Soil formation and development can be attributed to five primary factors. Name three of those factors.
 - a.

 - b.

 - c.

Lab Sheet

Soil Formation Worksheet

Purpose:

Enhance your understanding of soil formation.

Procedure:

Using the appropriate text materials, fill in the blanks in the following questions as they relate to the formation of soil.

Questions:

1. Soil parent materials are classified according to the way in which they were _____.
2. Soils from water-deposited origins that are usually found as sediments in floodplains are known as _____.
3. Topography refers to _____.
4. Soils on steep topography are subject to more severe _____.
5. Native vegetation determines the _____ and _____ of organic matter in the soil.
6. Under forest cover, organic matter is in the form of _____. Since the material is on the surface, it decays _____ and leaves only a small residue. Total organic matter, therefore, is quite _____.
7. Most prairie soils have a _____ surface layer that is fairly _____. Wild prairie grasses and other plants have abundant _____ which filled the top of the soil 1 to 2 feet down. Partial decay of these roots over a long period of time gave us the high _____ content of prairie soils, and along with it, the _____ color.
8. Soils at various stages in the _____ process will differ widely.
9. When the soil is young, _____ accumulates. As it gets older, organic matter and production decline, and clay accumulates in the _____.
10. Weathering depends on _____.

11. As a rule, the surface of the soil is darker than the subsoil because it contains more _____.

12. The darker the surface soil, the _____ the organic matter.

13. Climate refers to:

a.

b.

c.

d.

e.

Lab Sheet Key

Soil Formation Worksheet

1. moved and scattered
2. alluvium
3. slope characteristics of a soil
4. erosion
5. kind, amount
6. duff, rapidly, low
7. dark, deep, roots, organic matter, black
8. weathering
9. organic matter, subsoil
10. climate
11. organic matter
12. higher
13. a. Rainfall
- b. Freezing
- c. Thawing
- d. Wind
- e. Sunlight