

Unit A: Principles of Soil

Lesson 4: Formation of Soil

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

1. Identify 5 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. Explain how time and weathering affect properties of soil
6. Explain how climate affects development of soil

Recommended Teaching Time: 3 Hours

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

- A PowerPoint has been provided

List of Equipment, Tools, Supplies, and Facilities:

Writing surface
Writing surface
PowerPoint Projector
PowerPoint Slides
Dried fruits and nuts enough for all students
Soil Formation Worksheet

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.

Have a sample of dried fruits and nuts that you have mixed together to eat as a snack. Ask the students how this snack is made. Ask what factors are incorporated into making this snack. Divide the class into groups of four. Give each group a variety of the ingredients to make the snack. Make sure there are enough ingredients for all students in each group. Have the students make the snack. Before they can eat it they have to brainstorm how this might relate to learning about soil. Use questions to guide them in the right directions. Use questions like “how do the different ingredients mixed together to form a snack relate to the development of soil?” Once they get to the conclusion that soil formation is the new lesson, they will be allowed to eat their snack.

Summary of Content and Teaching Strategies

Objective 1: Identify five factors involved in soil formation.

(PowerPoint Slide 3)

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

- A. Parent material—type of rock material the soil is formed from.
- B. Climate—temperature and moisture characteristics of the area in which the soil was formed.
- C. Living organisms—the organisms, including plant material, that live within the soil.
- D. Topography—slope characteristics of the soil.
- E. Time or weathering—age of the soil and its climate.

Discuss with the students how the five factors listed on the PowerPoint and TM: A4-1 are involved in soil formation. Explain to them that it is important to know all five of these. Ask them how each factor would affect soil formation. Be sure to explain that these factors may take hundreds of years or longer to impact the formation of soil.

Objective 2: Describe different types of parent material.

(PowerPoint Slide 4)

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:

(PowerPoint Slide 5)

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.

(PowerPoint Slide 6)

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.

(PowerPoint Slide 7)

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.

(PowerPoint Slide 8)

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 9)

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

(PowerPoint Slide 10)

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.

Explain how soils around the world are developed differently due to what is available to make the soil. For example, the mountains and rock help develop the soil here where as in other places they have a lot of water where glaciers affected the soil. In other places of this country, there is very little water, with a lot of sun and heat, developing deserts.

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

(PowerPoint Slide 11 and 12)

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

Make sure students understand the concept of Topography and how the slope of the land can impact the type of soil that may be used for agricultural purposes. To make sure students grasp the concept of Topography show them the picture on PowerPoint Slide 13 or TM: C4-2 and have them explain the concept of Topography from the picture on the slide. Ask them what they think the drainage of the top of the mountain would be, the middle, and the bottom, and see if they can explain why each drainage would occur at that specific location on the mountain.

Objective 4: Explain how organisms affect soil development.

(PowerPoint Slide 14)

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. 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.

(PowerPoint Slide 15)

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 16)

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.

(PowerPoint Slide 17)

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.

Ask the students to explain how living matter affects organic matter in the soil. Ask them to provide examples of how living matter becomes organic matter (examples could be: peelings from vegetables that may be composted, when an animal eats and then defecates, that is added to the soil as organic matter, or when an animal or a plant dies, the dead decaying matter is added to the soil as organic matter.) You may need to provide an example from above to help prompt student discussion.

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

(PowerPoint Slide 18)

- V. A. There are two types of weathering:
1. **Physical weathering**—the effects of climatic factors such as temperature, water, and wind. Freezing and thawing is a major contributor to physical weathering.
 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 19)

- 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.
 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 different students read each section out loud. When they are finished, use a demonstration to further explain physical and chemical weathering. Take a soft rock and put it on the table. Then take a hammer and smash the rock. Explain to them that is physical weathering. Then take a rusted piece of metal and show them that the rust happens when you leave the metal outside in the rain overtime. That can also occur to the iron in the soil overtime when the water flows through the soil.

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

(PowerPoint Slide 20)

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.

(PowerPoint Slide 21)

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.

Ask the students what the climate is at home? Then ask them how that would be different from Australia or Northern Russia. Explain how that affects soil development and formation dramatically.

Review/Summary:

Use the picture on PowerPoint Slide 22 or TM: 4-3 to review the student learning objectives and to summarize the lesson. Have students explain the content associated with each objective from the picture they are observing. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions on PowerPoint Slide 23 can also be used to help review the content of the lesson.

Application:

Application can involve the following student activity using the attached lab sheet:

Soil Formation Worksheet—**LS: A4-1**

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 A Lesson: 4: Formation of Soil

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.

TM: A4 –1

SOIL FORMATION

Factors affecting process of soil formation:

- a. Parent material**
- b. Climate**
- c. Living organisms**
- d. Topography**
- e. Time**

TM: A4 -2



TM: A4 -3



Lab Sheet

Soil Formation Worksheet

Purpose:

Enhance your understanding of soil formation.

Procedure:

Using the appropriate information from your notes, 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.

LS KEY: A4-1

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