

Course	Agricultural Science II
Unit	Soil Science
Lesson	Soil Formation
Estimated Time	Three 50-minute blocks
Student Outcome	

Describe how soils are formed.

Learning Objectives

1. Describe how climate, organisms, parent materials, topography, and time affect soil formation.
2. Describe how the soil-forming processes affect soil development.
3. Describe how the soil-forming processes work together to form soil.
4. Explain why soils are different.

Grade Level Expectations

SC/ME/1/B/09-11/c

SC/ES/1/B/09-11/a

SC/ES/2/A/09-11/a

SC/ES/2/A/09-11/b

Resources, Supplies & Equipment, and Supplemental Information

Resources

1. PowerPoint Slides
 - PPt 1 - How Climate Affects Development of Organic Matter
 - PPt 2 - Why Soils are Different
2. Activity Sheet
 -  AS 1 - Life in the Soil
3. Minor, Paul E. *Soil Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1995.
4. *Soil Science Curriculum Enhancement*. University of Missouri-Columbia: Instructional Materials Laboratory, 2003.

Supplies & Equipment

- See AS 1 for materials and equipment needed to complete the Activity Sheet.

Supplemental Information

1. Internet Sites
 - Soil Formation and Classification. USDA Natural Resources Conservation Service. Accessed May 14, 2008, from <http://soils.usda.gov/education/facts/formation.html>.
 - Soil Geology. Seafriends Marine Conservation and Education Centre, New Zealand. Accessed May 14, 2008, from <http://www.seafriends.org.nz/enviro/Soil/geosoil.htm>.
2. Print
 - Ashman, Mark R., and Geeta Puri. *Essential Soil Science: A Clear and Concise Introduction to Soil Science*. Malden, MA: Blackwell Publishing, 2002.



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- ❑ Brady, Nyle C., and Ray R. Weil. *The Nature and Properties of Soils*. 14th ed. Upper Saddle River, NJ: Prentice Hall, Inc., 2007.
 - ❑ Coyne, Mark S., and James A. Thompson. *Fundamental Soil Science*. Clifton Park, NY: Delmar CENGAGE Learning, 2005.
 - ❑ Donahue, Roy L., and Roy Hunter Follett. *Our Soils and Their Management*. Danville, IL: Interstate Publishers, Inc. 1990.
 - ❑ Plaster, J. Edward. *Soil Science and Management*. 2nd ed. Albany, NY: Delmar Publishers, Inc., 1992.
 - ❑ White, Robert E. *Principles and Practice of Soil Science: The Soil as a Natural Resource*. 4th ed. Malden, MA: Blackwell Publishing, 2005.
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Interest Approach

After reviewing similarities and differences in their soils from home, have the students list what forces might have influenced the formation of their particular soil. Let the students know that although time is an important factor in soil formation, the “age” of a soil is usually measured in development, not in years.

Communicate the Learning Objectives

1. Describe how climate, organisms, parent materials, topography, and time affect soil formation.
2. Describe how the soil-forming processes affect soil development.
3. Describe how the soil-forming processes work together to form soil.
4. Explain why soils are different.

Instructor Directions	Content Outline
<p>Objective 1</p> <p><i>Discuss how the five soil-forming factors influence soil formation. Discuss the difference between active and passive factors. Of the five soil-forming factors, climate and organisms are active factors. They are catalysts that cause soil to form. The other three factors (parent material, topography, and time) are passive factors. They respond to the forces exerted by climate and organisms. All five factors are closely interrelated and few generalizations can be made about the effect of any factor unless conditions are specified for the other four factors. Display Ppt 1 when discussing climate. Have students complete AS 1 after discussing organisms.</i></p> <p> PPT 1 – How Climate Affects Development of Organic Matter</p> <p> AS 1 – Life in the Soil</p>	<p>Describe how climate, organisms, parent materials, topography, and time affect soil formation.</p> <p>Climate</p> <ol style="list-style-type: none">1. Temperature<ol style="list-style-type: none">a. Rate of chemical activityb. Type of vegetation and biological activity2. Rainfall<ol style="list-style-type: none">a. Leachingb. Movement of clay particles <p>Organisms (Refer to Figure 2.1 in Student Reference.)</p> <ol style="list-style-type: none">1. Macroorganisms: living and dead<ol style="list-style-type: none">a. Source of all organic matterb. Include large plants and animalsc. Plants being the largest contributor of organic matterd. Large trees<ol style="list-style-type: none">- Decay slowly- Break up soil and leave channelse. Soil animals<ol style="list-style-type: none">- Contribute organic matter- Mix the soil and leave channels2. Microorganisms (microbes)<ol style="list-style-type: none">a. Microscopic plants and animalsb. Primary decomposers of organic materialc. Humus, produced by microbes, acts as glue for soil aggregatesd. Without microbes, inert soil

Instructor Directions	Content Outline
	<p>3. Finely divided nonliving material</p> <ol style="list-style-type: none"> a. Humus <ul style="list-style-type: none"> - Amorphous (formless) - Dark brown or black <p>Parent material</p> <ol style="list-style-type: none"> 1. Original geologic material 2. Passive 3. Residuum: formed in place from bedrock 4. Transported: deposits of sediments <ol style="list-style-type: none"> a. Colluvium b. Alluvium c. Loes d. Glacial till <p>Topography</p> <ol style="list-style-type: none"> 1. Relief or landscape 2. Influences soil formation: drainage, runoff, erosion, sunlight, and wind <p>Time</p> <ol style="list-style-type: none"> 1. "Young" soils more closely resemble their parent materials. 2. Some parent materials weather faster than others. 3. Climates may change with the passage of time.
<p>Objective 2</p> <p><i>Discuss the four major processes that change parent material into life-sustaining soil. These processes are a result of catalytic influences of the active factors (organisms and climate).</i></p>	<p>Describe how the soil-forming processes affect soil development.</p> <ol style="list-style-type: none"> 1. Additions <ol style="list-style-type: none"> a. Organic matter gives black or dark brown color to the surface layer. b. Rainfall adds nitrogen. c. Acid rain may change the rate soil processes. d. Flooding adds new sediment. 2. Losses <ol style="list-style-type: none"> a. Leaching <ul style="list-style-type: none"> - Free lime or salts - Fertilizers (especially nitrogen) b. Slowly dissolving minerals: residual effects of weathering

Instructor Directions	Content Outline
	<ul style="list-style-type: none"> c. Gases <ul style="list-style-type: none"> - Oxygen from organic decay - Water vapor from organic decay - Nitrogen changed to gas by wetness d. Solids (mineral and organic): solids lost by erosion are the most serious loss. <ol style="list-style-type: none"> 3. Translocations <ul style="list-style-type: none"> a. Movement of particles from the surface soil to subsoil b. Caused by water <ul style="list-style-type: none"> - This movement carries clay particles - Incomplete leaching leaves mineral deposits 4. Transformations <ul style="list-style-type: none"> a. Changes that take place within the soil <ul style="list-style-type: none"> - Microorganisms - Chemical weathering b. Changes of elements <ul style="list-style-type: none"> - Reduction of iron oxide - Mottling caused by repeated cycles of wetting and drying
<p>Objective 3</p> <p><i>Obtain samples of common soil-forming rocks and minerals. Discuss what processes must happen to change these parent materials to soil. Discuss how the different layers in a soil profile might have been formed.</i></p>	<p>Describe how the soil-forming processes work together to form soil.</p> <ol style="list-style-type: none"> 1. Climate acts immediately. 2. Physical weathering decreases size of parent material. 3. Weathering changes minerals. 4. Leaching removes salts and limes. 5. Plants add organic matter. 6. Biological activity increases (humus is formed). 7. Increased porosity allows more leaching and weathering. 8. Chemical weathering and leaching continue to change and remove minerals. 9. More horizons develop beneath the surface. 10. The soil becomes more acid. 11. Clay minerals begin to form. 12. Clay is translocated and clay films become visible. 13. Rate of water movement through the soil decreases. 14. Weathering continues, but leaching is not as rapid. 15. Changes continue at a very slow rate.

Instructor Directions	Content Outline
<p>Objective 4</p> <p><i>Observe differences in Missouri soil. Discuss why soils are different. Discuss what might have caused the differences. Display PPT 2 and discuss how these causes may have interacted.</i></p> <p>☐ PPT 2 – Why Soils are Different</p>	<p>Explain why soils are different.</p> <ol style="list-style-type: none"> 1. Factors are closely interrelated in the effects on soil. The five factors interact with each other and the four major soil-forming processes. 2. Soil-forming processes are also closely interrelated in the effects on soil. The four major soil-forming processes interact with each other and the five factors.
<p>Application</p> <p>📄 AS 1 – Life in the Soil</p>	<p>Answers to AS 1:</p> <ol style="list-style-type: none"> 1. To be determined by the student. 2. Yes 3. Earthworms feed on fresh organic matter, making the nutrients available to plants. Earthworms bring soil from lower levels to the surface, thus mixing the soil. Earthworms improve aeration and internal drainage of the soil. <p>Other activities:</p> <ol style="list-style-type: none"> 1. Take a field trip and study the history of local soils to see how different soils are formed. 2. Demonstrate the effects of heat in the soil-forming process. Explain what will be done and ask students for predictions. Heat a rock and drop it into ice water (in a non-glass container). Observe the results. Draw conclusions. USE EXTREME CAUTION. 3. Demonstrate the effects of cold in the soil-forming process. Explain what will be done and ask students for predictions. Put wet clay in a jar or plastic bag so it is full and is a tight fit. Freeze it and observe the results. Draw conclusions. 4. Demonstrate the effects of wetting and drying in the soil-forming process. Explain what will be done and ask students for predictions. Take a moist clod of clay. Cut it square. Put two pins in it and measure the distance between them. Put the clay (with the pins) in the oven to dry. Take it out of the oven and measure the distance between the pins. Compare the two measurements. Draw conclusions.

Instructor Directions	Content Outline
<p>Closure/Summary</p>	<p>The active factors of soil formation (climate and organisms), together with the passive factors (parent material, topography, and time) are so closely interrelated in their effects on the soil that few generalizations can be made unless conditions are known for all of them. The soil-forming processes (additions, losses, translocations, and transformations) may add further variability.</p>
<p>Evaluation: Quiz</p>	<p>Answers:</p> <ol style="list-style-type: none"> 1. b 2. e 3. c 4. d 5. f 6. a 7. i 8. h 9. g 10. j