Lesson 07: Soil

Lesson Objectives:

- Students will understand the processes of soil development
- Students will understand the role of water in soil development including chemical weathering and soil ecology
- Students will identify the types of soil characteristic of different biomes of the Earth
- Students will plan and conduct scientific investigations

Soil

A gardener may think of soil mainly as something to grow plants in. A farmer knows that crops could not be grown easily without soil. To the earth scientist, soil is a product of the weathering of rock and the decay of living matter. There are many different kinds of soil composed of different kinds of particles. Some types of soils are more suitable for growing and planting than others.

Pedology is the study of the soil. Though you may not realize it, the creation of soil can take thousands of years. The **pedosphere** is the part of our Earth that is made of soil.

There are five factors to consider in the way soil forms: Parent material, climate, organisms, topography, and time. The most well known parent material of soil is rock, but it can be old soil or deposits left by ocean waves, glaciers, or volcanoes. This parent material is then affected by climate; physical and chemical weathering wear down the parent material, breaking it into smaller pieces. Plants grow and break up parent material with their roots, or die and add a decomposition component to the area; animals burrow through the soil or carry it around on their paws, or even drop waste onto it for more decomposition. The topography can effect whether soil or sediment builds up or is easily eroded away. Each of these will happen in a different period of time depending on all the other factors.

Soil Layers

The mixture that we call soil is made of many kinds of particles. These particles can be divided into two large groups. One group is made up of organic materials. Organic means coming from living things. Most of the organic

material in soil comes from plants. Some organic material also comes from animal remains and the many microscopic living things present in soil. In time, all the organic material is changed by the action of bacteria into a dark-colored substance called **humus**. Humus is a very important part of the soil. It is the main source of the nutrients needed for the growth of new plants. Without a plentiful supply of the nutrients supplied by humus, soil is not fertile. Soils in different places may have large differences in the amount of humus and other organic matter that they contain. In swamps or bogs, for example, the soil may be made almost entirely of organic matter. In deserts, on the other hand, the soil usually has only a small amount of humus.

The second group of particles in soil includes pieces of weathered rock. These particles vary in size. Large particles are called **gravel**. Smaller particles, from microscopic size up to 2 mm, are called sand. Silt and clay particles are even smaller. They are extremely fine particles like flour or dust.

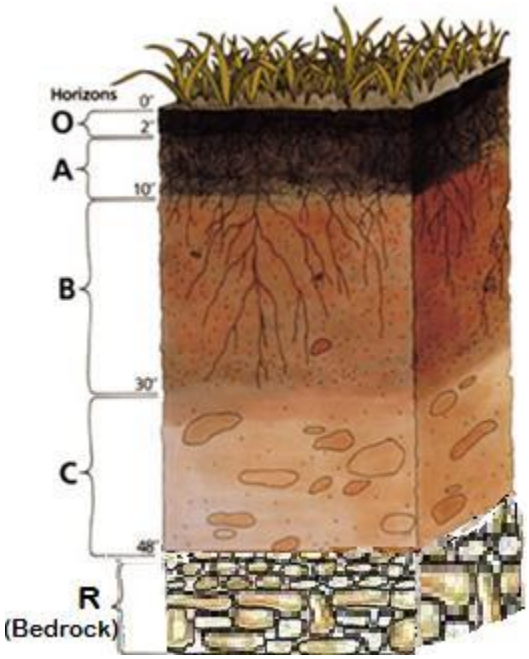
Quartz is released from granite by the weathering processes. Quartz is not easily changed by chemical weathering. It is the most abundant mineral in sand and is also found in many other soils. The second most common kind of rock particle found in soil is clay. Clay is made from many different minerals.

Soil formation is a very slow process. The process begins as soon as rock is exposed to air and water. Large pieces of rock are weathered, forming smaller ones. These pieces of soil material are usually removed by wind or water from where they are formed and deposited in valleys or plains. Particles moved in this way called **transported soils**. Some soil is not eroded, but sits on the rock from which it was formed. This soil is called residual soil. Residual soil sits on its parent rock.

Soil is formed by weathering of rock. As time passes and weathering continues, soil begins to develop separate layers. The layers in the soil are called **horizons**. Each horizon has its own properties and is different from the other layers. Humus in the top layer gives it a dark color. This dark-colored top layer is called the A horizon. The A horizon is also called **topsoil**. It is the layer best able to support the growth of plants. Humus and other organic matter that supplies the plants with nutrients are found in the topsoil layers.

In young or immature soil there are only two horizons. These two layers are the A horizon and the C horizon. The C horizon is partly weathered rock. If erosion

does not remove the topsoil of an immature soil, a third layer will develop. Water from rain or runoff moving through the A horizon dissolves some minerals. Small particles, the size of clay or silt, are carried downward into the soil by the water. These particles are deposited below the A horizon. The new layer is called the B horizon, or **subsoil**. It takes about 100,000 years for this third layer to form.

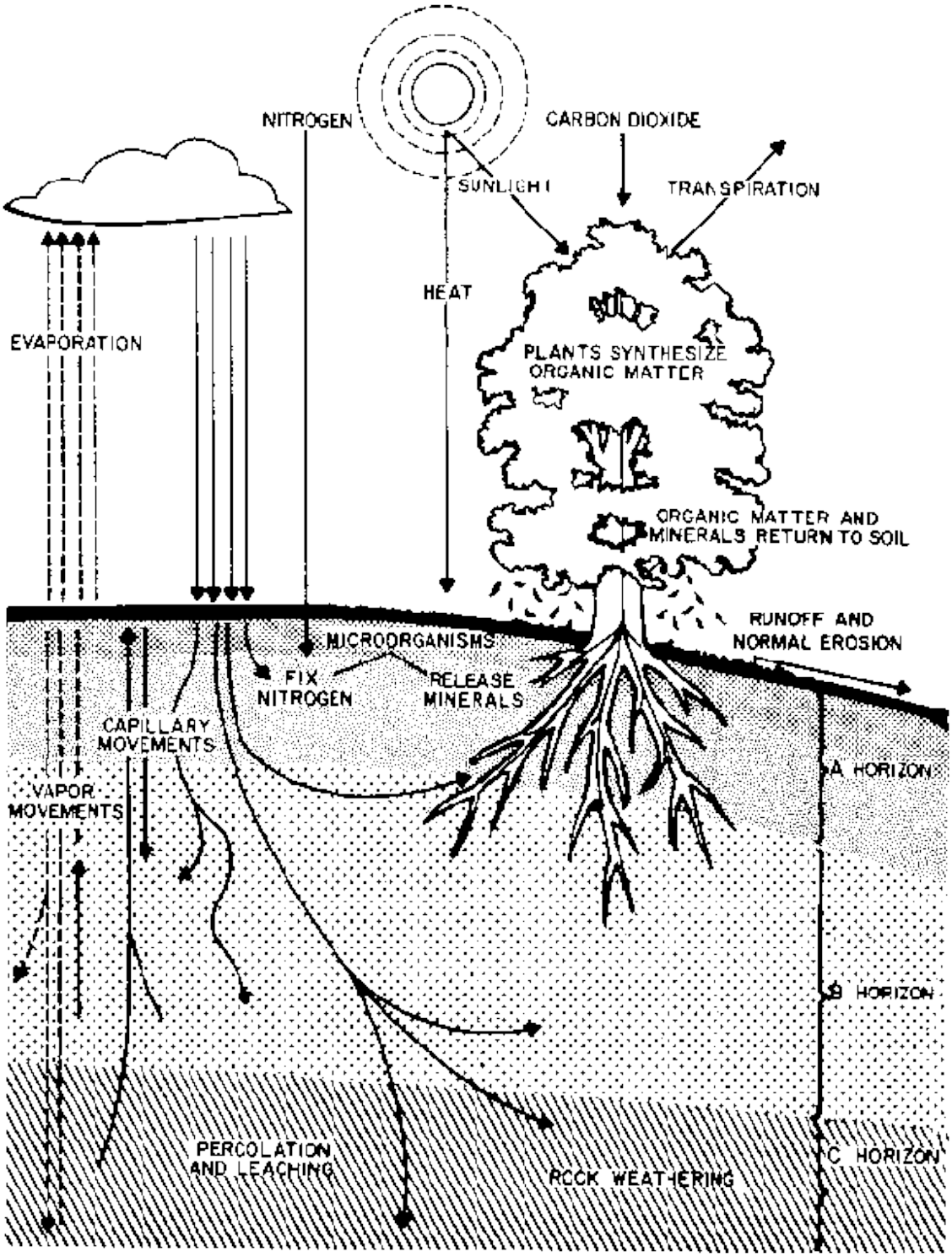


The clay particles in the B horizon are smaller than the particles in the A horizon. Material in the B horizon is packed together more closely than in the A horizon. The B horizon is a hard soil and is difficult to plow or dig. Only large, strong plant roots can enter it. Water moves slowly through this horizon.

Types of Soil

A soil with well developed A,B, and C horizons is called mature. Mature soils develop best in warm, moist climates. Water and high temperatures help to weather rock rapidly. Plant life is abundant in such a climate. Lush plant life protects the soil from erosion. It also provides the materials from which humus is formed.

Mature soils are not formed in dry regions. The moisture needed for the chemical weathering processes is absent in dry areas. There are few plants. Erosion is rapid. Mature soils are also rare on land that is often flooded because the soil is washed away before layers can form. Soil on the steep slopes of mountains also is immature soil. Wind, water, and gravity erode topsoil on slopes.



Soil structure and processes. From Mathews et al. 1980.

Thousands of different soil types exist. Parent material (the type of rocks and minerals present), climate, organisms (such as plant cover, soil microbes, etc.), topography (such as how sloped the land is), and time are the factors that

determine the kind of soil formed. The soils in North America are often divided into five types. These five types are forest, grassland, prairie, desert, and tundra.

Forest soils cover most of the eastern part of North America. This area receives a large amount of rain. Minerals have been dissolved out of the topsoil. Trees plant their roots in the firm subsoil. Some of the leaves of forest trees resist decay. As a result, there is not much humus. Minerals have been dissolved out of the topsoil. Trees plant their roots in the firm subsoil. Some of the leaves of forest trees resist decay. As a result, there is not much humus. The topsoil, therefore, is thin and not very fertile. In the northeast, the subsoil is gray or brown. Higher temperatures in the south cause the iron in the subsoil to turn a red or yellow color.

Grassland soils occupy most of the region from the eastern forests to the Rocky Mountains. The topsoil is thick and rich in humus. There is less rainfall in the grasslands than in the eastern forests. The topsoil holds many vital minerals needed by plants. Grassland soils are very fertile.

Prairie soils are found in the corn belt (Iowa, Illinois, Minnesota, and some neighboring states). Prairie topsoils are dark with humus. These areas get more rainfall than the grasslands. The combination of rich soil and generous rain makes the prairie soils very fertile.

Desert soils are found in the dry regions of the west. Lacking rain, the desert soils are rich in minerals. Only a few kinds of plants can grow there. The desert soil is low in humus. With irrigation, desert soils are being made fertile.

Tundra soil is found in northern parts of Alaska. Temperatures there are low, and there is little rainfall. The deep layers of tundra soil are permanently frozen. The upper layers are rich in humus. During the summer months these top layers are filled with water. Plant life here grows low to the ground and has shallow roots.

Farmers and earth scientists may look at soil in different ways. But both know that the thin covering of weathered rock is needed to produce almost all of our food supply. To scientists, soil is made up of particles of rock and humus, which are slowly developing into separate layers. The kind of soil found in a particular place is the result of special conditions that affect the way rock weathers. In the United States there are five major kinds of soil.

Grading Rubric:

To get a 10: All answers are correct the first time, or within first revision. You can have no grammatical or structural errors, within the first revision. Answer in complete sentences; all lesson requirements have been met.

To get a 9: You can have 1 incorrect answer. You can have 1 grammatical errors (spelling, punctuation, capitalization, wrong word, etc.) Answer in complete sentences; all lesson requirements have been met.

To get an 8: You can have 2 incorrect answers. You can have 2 grammatical errors (spelling, punctuation, capitalization, wrong word, etc.). Answer in complete sentences; all lesson requirements have been met.

To get a 7: You can have 3 incorrect answers. You can have 3 minor grammatical errors (spelling, punctuation, capitalization, wrong word, etc.). Answer in complete sentences; all lesson requirements have been met.

To get a 6: This grade is reserved for administrative use

To get a 5: 6 or more incorrect answers. Plagiarism - purposeful or mistaken, which will lower your final grade for the course (so be very careful when posting your work!); lack of effort, disrespect, or attitude (we are here to communicate with you if you don't understand something); or 6 or more errors of any kind. Answer in complete sentences; lesson requirements have not been met.

Note: For this class it is necessary to post the questions over each answer. Failure to do so will result in asking for a revision.

No grade will be given for incomplete work.

Assignment:

Do not submit text that you have copied from sources, including websites. All of your work should be in your own words. Using copied text would be considered plagiarism. For more information, review our page on Plagiarism and Citation. Cite the complete web page source under each answer. Always put the question on top of the answer, and answer in complete grammatically correct sentences.

Many of these answers will require Internet research to answer. Make sure you rewrite all answers into your own words and be mindful of our page on Plagiarism and Citation. Answer all questions so that if I did not know what the answer was, I would know the answer from what you have written.

Reading:

1. In your own words, define the 7 terms that appear in bold in the lesson.
2. How is humus made?
3. What causes rock to turn into soil?
4. Where do mature soils develop best? What is essential for the process?

5. What characteristics distinguish fertile soil from infertile soil?

6. Rank the 5 soil types from most fertile to least fertile.

Research:

7. How does nitrogen from the air get into the soil?

8. Research "soil biology." Identify 4 different organisms that are essential to the production of humus and explain what role each organism plays.

9. Find out more about "soil erosion." In the lesson, we learned that soil erodes naturally on slopes due to gravity, water, and wind. What other man-made problems can lead to soil erosion? What are some practices that can prevent the loss of topsoil?

Activity:

Soil is made of different sized particles. The most familiar ones are sand, clay, silt, and gravel. These different particles can be separated for soil content analysis.
For this activity you will need the following materials:

- large clear glass or plastic jar with lid
- a sample of soil
- a ruler or tape measure
- water

Procedure:
Follow these instructions and keep a written record of precisely what you do and do not do. The record should be detailed enough that someone else could perform the same procedure just using what you have written.

- Pick a spot to get a soil sample. Keep notes on what sort of area you've chosen so you can talk about it in your report. You need enough soil to fill your container 1/4 full.
- Fill the container to 1/4 full with your soil sample.
- Fill the container with water.
- Put the lid on the jar and shake vigorously for 2 to 3 minutes or until the soil is totally loosened up (falls apart) and let it sit until all the particles (sediments) settle. Depending on your soil composition, this may take some time since the smallest particles will settle very slowly.
- There should be different layers of sediment in the jars. Measure the thickness of each layer and figure out the ratio of each layer. The thickness of the sediment layers and their ratio determines the soil composition.

Note: The particle size for gravel is between 10 to 2 mm in diameter, the particle size for sand is 2.00 mm 0.05 mm in diameter, 0.05 to 0.002 mm in

diameter is for silt, and clay's particle size is smaller than 0.002 mm in diameter.

Turn in the following for this activity:

1. A detailed report of what exactly you did. Submit this in the text box below.
2. A photograph of your jar with the layers settled. Upload Photograph HERE
3. A graph or chart that indicates the **percentage** of each type of particle. Use your logic to determine the best kind of chart or graph to make to communicate the information clearly. You can draw this by hand or use a computer program to make it. Upload Chart/Graph HERE.