More to Learn

Soil

In *Learning Set 3* of *Digging In*, you spent a lot of time working with *soil*. You read how *weathering* is a natural process. It breaks down rock into smaller pieces. Weathering can be *physical* and *chemical*. You observed how *erosion* moves soil and other particles from one place to another. You saw that there is a relationship between particle size and erosion as well as slope and erosion.

Your challenge was to build a basketball court and prevent the soil in the area from eroding. Soil is a very important factor to consider in any kind of construction. Engineers and soil scientists must work together. They examine the soil at a construction site. They have to decide if the soil can support a structure.

You also need to know if the soil can support you. As you walked across what looked like solid ground, have you ever sunk down into mud? Have you ever had a wheelchair stuck in mud? If you have, you can understand one reason why you need to know about the soil under you.

However, soil is so much more than just the "dirt" under your feet. It is important for more reasons than just construction. What is soil? Why else is soil important? You probably already have many ideas about soil.

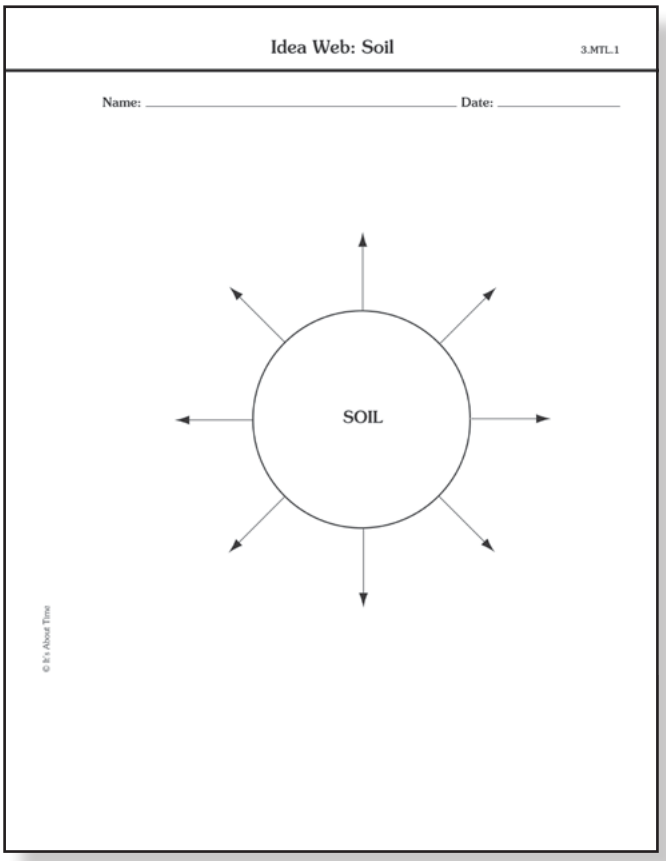
It is important for engineers to know if the type of soil in an area will support the structure they plan to build. It is also important for you to know if the soil you are walking or driving on will support you.

Conference

Work as a group. Think about the following questions. Discuss your answers with others in your group.

- What is soil? What are the components of soil?
- Are there different types of soil? If so, what are they?
- Is soil living or nonliving?
- How is soil formed? What affects the formation of soil?
- Why is soil important? What does soil provide you with?

Begin an idea web similar to the one shown below. Use the idea web to record what you and your group think you know about soil. Use the questions above as a guide.


Idea Web: Soil 3.MTL.1

Name: _____ Date: _____

SOIL

Communicate

Share your group's ideas about soil with the class. As a class, begin a class idea web about soil.

While working on your class idea web, you may have found that there were some things that you did not agree on. You may also have found that there were some things that you were unsure of. You will now have a chance to complete some investigations and readings. They may help you clear up some of the things that you are not sure of.

Explore

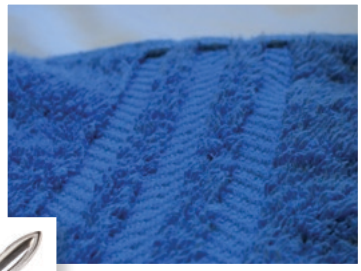
One of the questions you were asked to think about was, "Why is soil important?" When you were planning the basketball court, it was important to keep the soil off the court. You needed to know a little bit about soil to be able control soil erosion. Why would you need to learn more about soil? Why should you care about soil?

In your group, look at the pictures on the following page.

a) milk

b) antibiotics

c) cotton towel



e) cereal

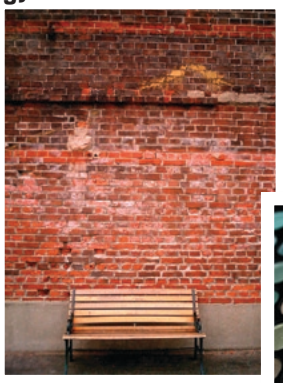
f) water from a tap

d) china

h) wooden house

i) clean air

g) bricks and concrete



j) makeup

k) meat

1. Record how each of the items in the photographs relates to you or is important to you.

2. Decide how each item is related to soil. Use arrows and words to illustrate the connections between the item and soil. See the example shown.

$$\text{milk} \xrightarrow{\text{comes from}} \text{cows} \xrightarrow{\text{eat}} \text{grass} \xrightarrow{\text{grows in}} \text{soil}$$

3. Name three other things that are important to you that you can connect to soil. Use arrows and words to show the connection.

Communicate

Share your soil connections with the class. How were the connections others made different or similar to yours? Which things that could be traced to soil were important to them? Which things were the same as those on your list? Which ones were different? Record anything that surprised you or that you had not thought about that relates to the importance of soil.

Why Is Soil Important?

In *Learning Set 3* of *Digging In*, you explored how soil was important in construction. Soil is the foundation upon which building are constructed. The soil must be able to support a structure. Engineers must also take into account soil erosion. Roads and houses must be built so that they are not affected by erosion.

The soil under this house has been eroded away.

As you explored the connections between different items and soil, you probably discovered that soil is also used in and connected to many construction materials. The wood used to build houses comes from trees that grow in the soil. Brick and cement are also made from materials found in soil.

Plants live in soil. Humans use plants in many different ways. Plants provide a lot of the food you eat. Plants also provide food for the animals that some people eat. Some plants provide material from which clothing is made. For example, cotton comes from cotton plants. Silk is also a fabric that is used for clothes. It comes from the cocoons of silkworms that feed on mulberry bushes. Plants are also the source of different types of fuel that can be used to provide energy.

Cotton fabric is made from fiber that grows in a boll around the seed of the plant.

Plants can also help to keep the air clean. They use carbon dioxide and give off oxygen as part of their life processes. Soil also absorbs and emits different gases that help to keep the air clean.

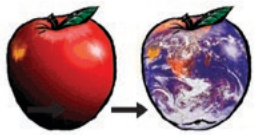
As well, soil absorbs, holds, and releases water. You can see how important this is if you watch what happens to water that lands and runs off paved areas. Soil also purifies water. Water is filtered as it passes through the soil to aquifers. (Aquifers are areas underground where water is stored. Many areas in United States use water from aquifers as their source of drinking water.)

Pavement cannot absorb or hold water the way that soil can.

Soil is also "home" to many animals. Some animals, such as groundhogs and mice, burrow into soil. Other organisms, such as bacteria and fungi, also live in the soil. A cup of soil can contain as many bacteria as there are people on Earth. Many of the soil bacteria are the source of antibiotics. These are a type of medicine that you may take if you are sick.

If you live in the country, you probably see acres of soil around you. If you live inside a big city, you may be aware of the fact that there is very little soil there. However, you have probably seen pictures of large areas of soil in many other parts of the United States. Would it surprise you

to know that the amount of soil on Earth is very small compared to the size of Earth? Look at the series of drawings below. They compare the amount of soil on Earth to a very small, thin strip of peel from an apple. The amount of soil on Earth is very small compared to how much plants and animals, including you, rely on it.



Imagine Earth as an apple. The layer of soil on Earth is like the peel of an apple. About 75 percent of Earth is covered by water.

The remaining 25 percent represents dry land. About 50 percent of that dry land is desert, polar, or mountainous regions where food production is limited.

Now there is only 12.5 percent of the Earth remaining. On about 40 percent of this land, food production is limited by terrain, fertility, or excessive rainfall.

About 10 percent of the surface remains.

The skin of this 10 percent represents the amount of soil that the world depends on for food production.

To help protect the fragile amount of soil that is on Earth, you should know what makes up soil. You should also know how soil is formed. This will make you be better prepared to make correct decisions about the use and protection of soil. After all, in so many ways, your life depends on soil.

Stop and Think

1. Describe four important functions of soil.
2. Why is it important to protect soil from misuse?

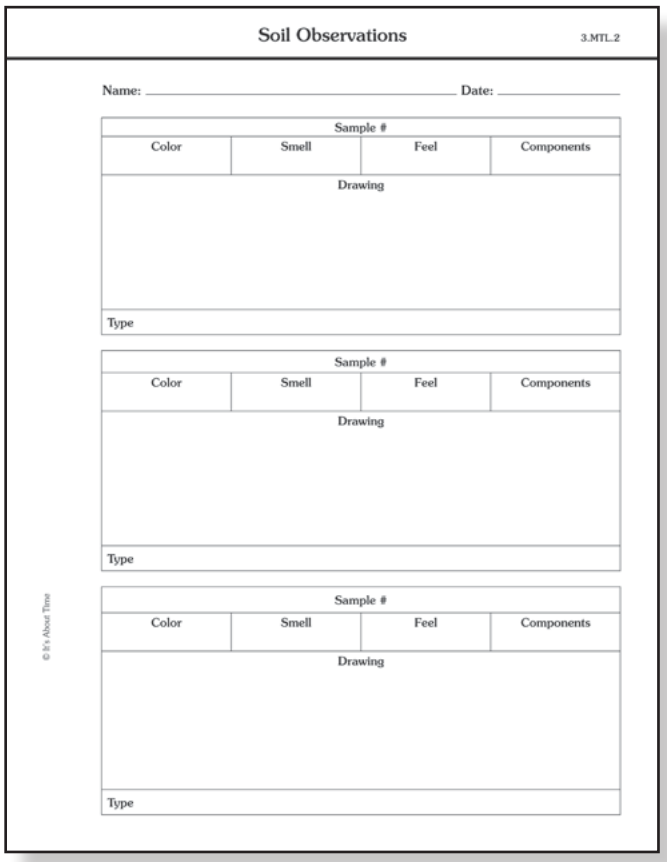
Reflect

1. Name one item that you did not realize was connected to soil. Why do you think you did not realize that that item had any connection to soil?
2. How do you think people sometimes misuse soil? Think back to what you read about in *Learning Set 3* of *Digging In*. Recall any information that you may have read or heard about in the news. Think about how the soil around you is used.
3. Return to your class idea web about soil. Add any new information that you found out about the importance of soil.

Investigate

What Makes up Soil?

In this investigation, you will observe several different soil samples. You will record your observations on a *Soil Observations* sheet. For this part of the investigation, you do not need to record anything in the *Type* row.


Soil Observations 3.MTL.2

Name: _____ Date: _____

Sample #

Color	Smell	Feel	Components

Drawing

Type

Sample #

Color	Smell	Feel	Components

Drawing

Type

Sample #

Color	Smell	Feel	Components

Drawing

Type

© It's About Time

Soil Observations

Procedure

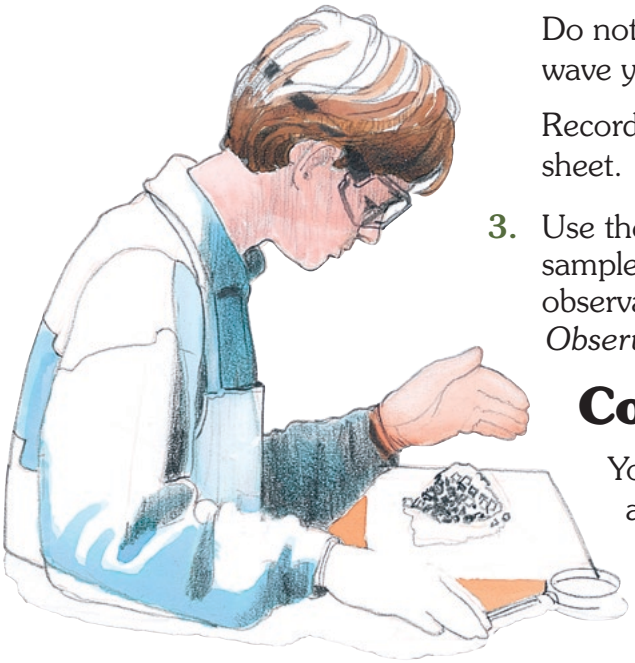
1. Cover a large, flat area with newspaper. Place the soil sample on the paper.
2. Use your senses of sight, smell, and touch to examine the soil sample.

   When you use your sense of sight, look at the color of the soil. Identify any large pieces that you can.

   When you touch the soil, how does it feel? You may want to use terms such as gritty, smooth, or sticky. Mix some of the soil with a little bit of water. Squeeze it. Observe what happens. Try to squeeze a bit of the soil out of your fist through your thumb and forefinger. Observe what happens.

Materials

- soil samples on white paper plates
- rubber gloves
- water
- newspaper
- hand lens
- tools for separating soil (plastic knife, tweezers)



Do not smell the sample directly. To smell the sample, wave your hand over the soil toward your nose.

Record all your observations on the *Soil Observations* sheet.

3. Use the tools to separate the soil sample. Examine the sample more closely using the hand lens. Record your observations. Make a sketch of what you saw on the *Soil Observations* sheet.

Communicate Your Results

You will now communicate what each group observed about their soil samples. Each group will have an opportunity to present their observations. When it is your turn to present, use your group's *Soil Observations* sheet to help you describe what you observed. As each group presents, listen to how their observations are different or similar to yours. As a class, decide which observations best describe each soil sample. Develop a class *Soil Observations* sheet that everyone agrees on.

Reflect

Answer the following questions. Be prepared to share and discuss your answers with the class.

1. In *Learning Set 3* of *Digging In*, you made plans to build a basketball court at the bottom of a hill. In the *Investigate*, you observed several different types of soil. Which type of soil would you not want on the hill? Which type do you think would be the best on the hill to prevent erosion? Provide reasons for your answers.
2. Which soil do you think would hold water the best? Why?
3. Which soil do you think would let water pass through it the easiest? Why?
4. Suggest a test you could perform to more accurately answer *Questions 2* and *3*.
5. Which soil do you think would be the most fertile? That is, which soil would be the best for growing crops? Why do you think so?
6. What else would you need to know about the soil to determine if it is fertile?

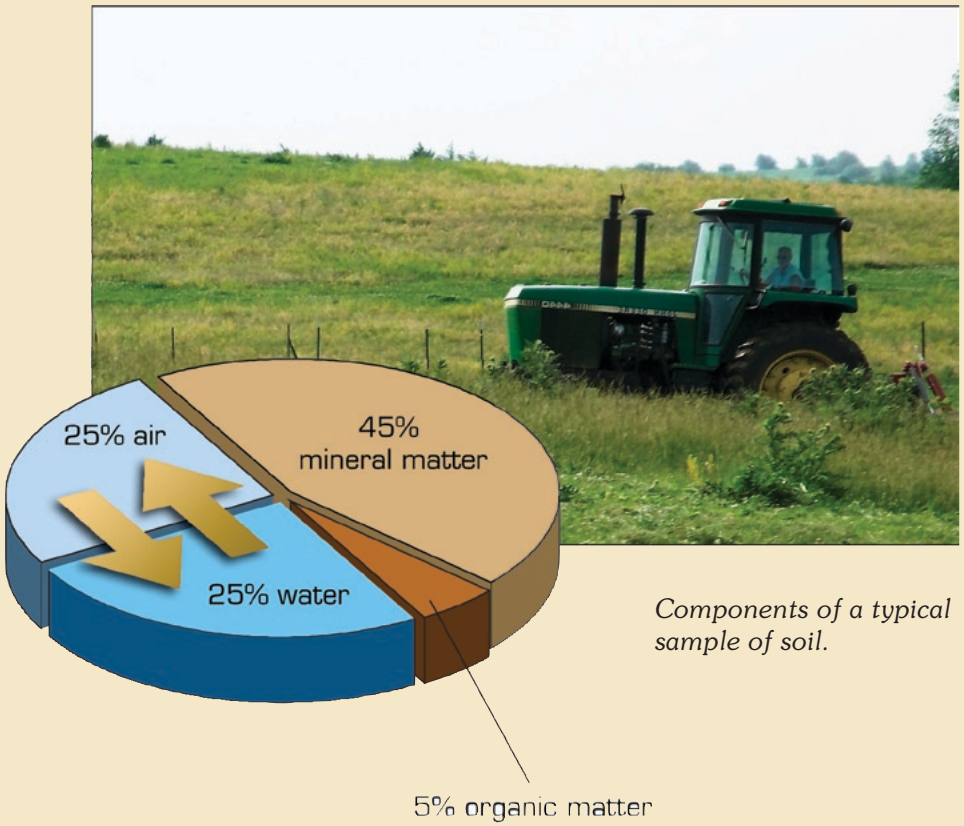
What Is Soil and How Is It Formed?

What Are the Components of Soil?

In the investigation, you observed some different types of **soil**. There are many kinds of soil. A group of soil scientists made up a way of grouping soils. This grouping has hundreds of named soil types. You could spend a lifetime studying soil. However, there are some things that you can begin to understand about soil now.

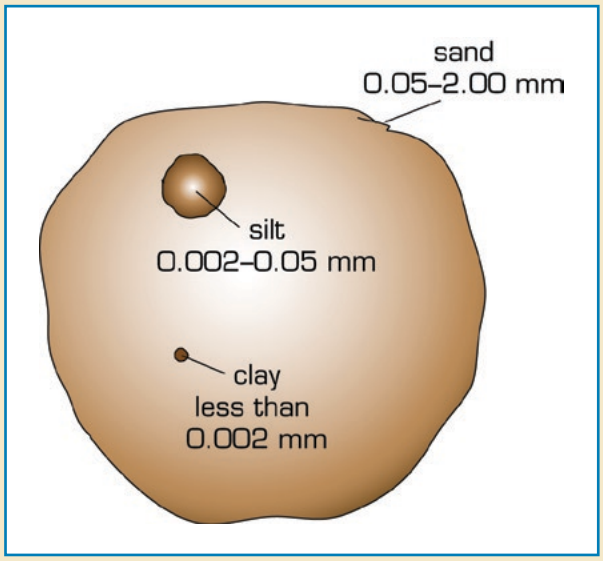
soil: the mineral and organic material on the surface of Earth. Soil supports plant growth.

All soils are made of just a few main components. Soil consists of fine particles of minerals and rocks. It also contains organic matter. This consists of decaying as well as living plants and animals. You can easily see the larger plants and animals. There are even more tiny plants and animals that you can only see with a microscope. Soil also contains water and air.

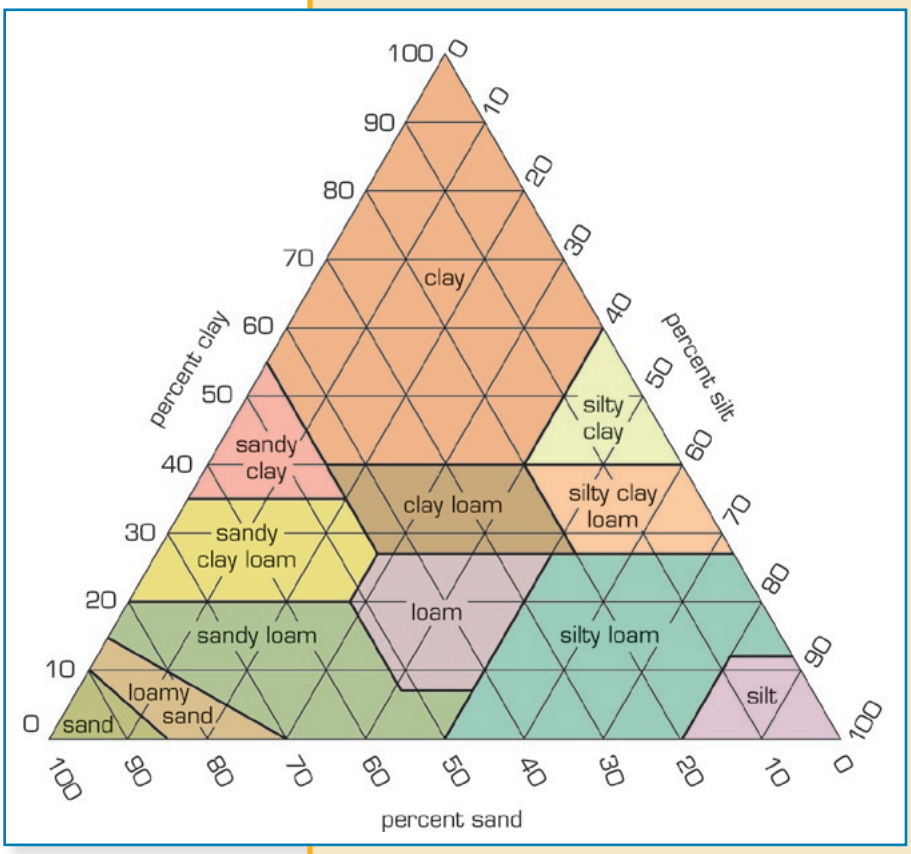


Components of a typical sample of soil.

The mineral component of soil is made up of gravel, sand, silt, and clay. The diagram shows the relative sizes of some of these materials. The amount of each of these materials varies with different kinds of soils. It determines the texture of the soil. It also determines the ability of the soil to hold water and provide nutrients. The water and nutrients are needed for plants to grow.



Relative sizes of the mineral components of soil.



Soil triangle.

After gravel, sand particles are the largest mineral materials found in soil. Soil that contains a large amount of sand holds less water. It also dries out quickly. Silt particles are smaller than sand. Silt soil can hold more water and nutrients than sand. Clay particles are the smallest. Clay soil can hold more water than sand and silt. However, it is very slow to dry out.

Most soils are a mixture of all three mineral materials. Look at the diagram showing the soil triangle. It shows how soils are classified and named on the basis of the various percentages of grain sizes contained. Loam is

made up of equal parts of sand, silt, and clay. It is very good for growing plants. It does not drain water too quickly or too slowly.

The amount of organic matter in soil also varies with different kinds of soil. The organic matter is made up of both living and dead plants and animals. Plants make up a large part of the organic matter. However, many other organisms can also be found in soil. Animals as large as rabbits and moles can be found living in soil. You can also see earthworms, centipedes, beetles, ants, and other animals in soil. There are also organisms in soil that you can only see with a microscope. Bacteria, yeast, and other tiny fungi are examples of these organisms.

Earthworms, ants, and prairie dogs are just some examples of the many organisms that live in soil.

When the living organisms in soil die, they decay. They are broken down into simpler substances. The decaying materials return nutrients to the soil. When the organic matter is broken down as much as it can be, it is called **humus**. Soils that have a lot of humus are dark in color. These soils are very fertile.

humus: organic matter in soil that cannot be broken down any further.

The solid particles in soil, either mineral or organic, have spaces among them. These spaces are very important. They allow water and air to move among the solid particles. Both water and air are important for the plants and animals that live in the soil. As water soaks into soil, it replaces the air in the spaces. Then, as the soil dries, air returns to the spaces.

Stop and Think

1. What are the four main components of soil?
2. Name the mineral materials found in soil in order of size from largest to smallest.
4. What makes up the organic matter in soil?
5. What is humus?
6. Where are the air and water in soil found?

What Affects Soil Formation?

Soil formation is a slow process. It can take from about one hundred to several hundred years to form just 1 cm of soil. There are several factors involved in soil formation. They are parent material (bedrock type), climate, living organisms, topography, and time.

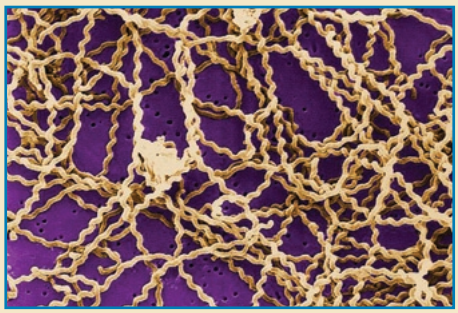
Soil is formed when rock is weathered. The rock from which the mineral matter of soil is weathered is called **parent material**. The type of parent material affects the rate of weathering. Therefore, it affects the rate of soil formation. The type of minerals present in the parent material is also important. It affects the fertility of the soil.

parent material: the source of the material from which soil is formed.

Climate is also a factor that affects soil formation. Temperature and precipitation determine the type of weathering that takes place. If also affects the rate and depth of weathering. A hot, wet climate may produce a thick layer of soil. During the same time, a cold, dry climate may produce only a thin layer of soil. Climate also controls the amount and type of organisms that are present.

Tundra has cold temperatures and little precipitation. The soil is thin and not very fertile.

Plants and animals are a very important factor in soil formation. Plants and animals are the source of the organic matter in soil. Organic matter, in part, determines the fertility of a soil. Some organisms play a role in the decay of dead plants and animals. These include organisms such as fungi, bacteria, and other microscopic organisms. Earthworms and other burrowing animals also play an active role in soil formation. They help to mix the mineral and organic parts of soil. Other microscopic organisms help to increase the fertility of soil in another important way. They can convert the nitrogen in air into a form that plants can use.



Bacteria and fungi found in soil. A gram of soil can contain billions of bacteria and millions of fungi along with other tiny organisms.

Topography also plays a role in soil formation. Usually, there is little or no soil on mountain slopes. Gravity and water transport the sediments down the slope. You saw this when you investigated erosion earlier. On the other hand, valleys usually have thick deposits of soil. The materials have been carried there from steeper slopes.

All of these factors affecting soil formation take place over *time*. They all need time to act. However, no single factor acts on its own. All the factors together interact to form soil. This can take place over a hundred to several thousand years.

Large, flat areas like this often have thick, fertile soil.

Stop and Think

1. Name five factors that affect soil formation.
2. In what two ways does parent material affect soil formation?
3. Describe how climate affects soil formation.
4. How do plants and animals contribute to the formation of soil?
5. Why is soil on sloping mountain sides thinner than soil on broad, flat areas?

Reflect

Answer the following questions. Be prepared to discuss your answers with the class.

1. Return to your *Soil Observations* sheet. Use what you learned from the readings to complete the *Type* row.
2. How would you now answer the question, "Is soil living or nonliving?" Use evidence from your reading to support your answer.
3. You read about five factors that affect the formation of soil. Which factor do you think is most important? Provide reasons for your answer.
4. What do you think is the difference between dirt and soil?
5. Return to the class idea web about soil. Add any new links that you think are needed. Correct or improve any links and ideas that were inaccurate or not complete.

Investigate

What Does Soil Look Like When You Dig Down?

If you have ever dug down into the soil, you may have noticed how the soil changes the deeper you dig. You may have also dug down and hit your shovel on large stones. In this investigation, you will look at some *soil profiles*. A soil profile is a vertical cross section of soil.

Procedure

1. Prepare your area to analyze the soil core sample assigned to you. Gather the materials you need. Spread a sheet of paper on your table.
2. Lay the soil core on your covered work surface. Unwrap it carefully without breaking it.
3. Use your eyes to observe the core. Note any differences in the core from the top to the bottom. Look for color changes, different types of material, and any living things. Record your observations. Make a drawing of your core. Use colored pencils to make the drawing as realistic as possible. Label the parts of the core you observed.
4. Use a plastic knife to make a long cut down the center of the core. Look inside. Record any interesting materials or items you see. Add them to your diagram.
5. With the plastic knife, spread the core material apart sideways until it is about 5 cm wide. Now you can study the materials in the core in more detail.
6. Use a hand lens to observe the different kinds of materials. Use the knowledge you gained from the previous investigation and your reading to help you identify the materials.

Materials

- **soil core sample**
- **large sheet of paper to cover work area**
- **rubber gloves**
- **colored pencils**
- **plastic knife**
- **hand lens**
- **tweezers or tongue depressor**

7. Observe the photographs of the soil profiles shown below. Make a drawing of each profile. On your drawing, indicate the layers that you can observe. The markings on the tape measure are given in inches. Record the depths of each layer that you can observe. Also record what you see as being the differences among the layers.

Soil profile 1

Soil profile 2

Analyze Your Data

In your group, examine your data. Think about and discuss the following questions. Be prepared to share your answers with the class.

1. Which materials in your core sample contained living (or once living) things? Which materials in your core sample have probably not come from living things? How can you tell? Which materials are you uncertain about?
2. Which materials tend to be near the top of the soil sample? Which tend to be near the bottom?
3. Which materials seem to be all through the core sample?
4. How could measurements help you to describe your sample? What could you do to make these measurements?

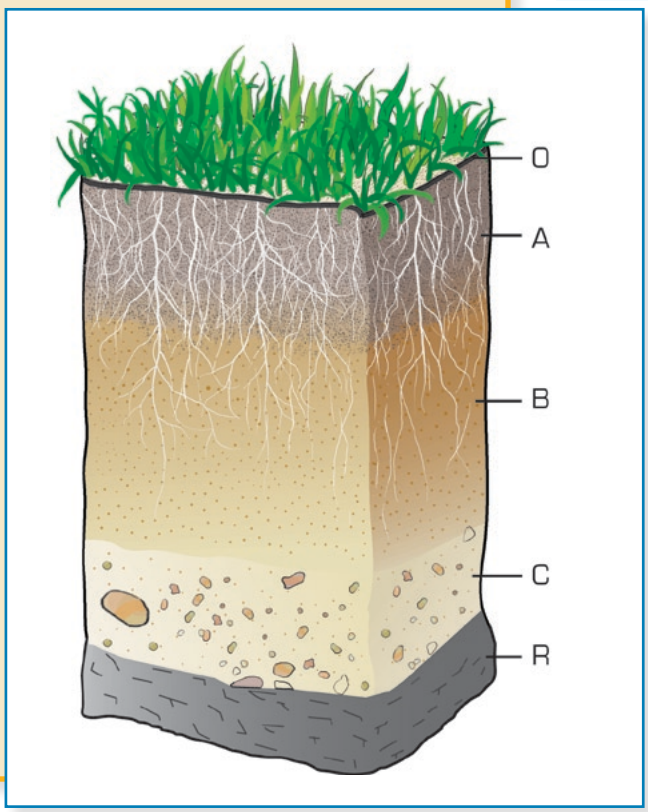
Communicate Your Results

You will now communicate what each group observed about their soil sample core. Each group will have an opportunity to present their observations. When it is your turn to present, use your drawing and describe what you observed. As each group presents, listen to how their observations are different or similar to yours. Did other groups find more or less layers than your group? How did the color of the layers in other core samples differ from yours?

What is Below the Surface of the Soil?

In the *Investigate*, you observed a **soil profile**. You noticed that the soil was formed in layers. These layers are called **soil horizons**. The formation of these horizons takes place over long periods of time. It is the result of the soil-forming processes that you read about earlier.

Although soils differ greatly from one another, some soils typically have the horizons shown in the diagram. The top layer covering the soil is the O horizon. This horizon is mainly organic. It consists of leaves, limbs, and decaying matter. The A horizon contains some mineral material mixed with plant roots, insects, microorganisms, earthworms, and humus. These two horizons are what make up topsoil. In many soils they are darker than the layers below. The B horizon is the subsoil. It contains some nutrients. Materials from above build up in this horizon. However, this horizon has much less organic material than the horizons above it. The next layer is the C horizon. It consists of partly broken-up bedrock. The R horizon is the underlying solid rock. All horizons are not always present in all soils.



An ideal soil profile.

soil profile: a vertical cross section of soil.

soil horizon: a layer of soil that differs from the layers above and beneath it.

Stop and Think

1. Describe what an ideal soil profile would look like.
2. Describe each soil horizon.

Reflect

1. Return to the class idea web about soil. Add any new links that you think are needed. Correct or improve any links and ideas that were inaccurate or not complete.
2. Based on what you now know, what new questions about soil do you think would be useful to investigate?
3. How could you use what you learned about soil in a practical way?