4

Soil: It's Not Dirt

Dirt, soil, what's the difference? Good question. Let's think about this before delving into our soil content primer. We'll start with simply gathering a sample of each one. Sweep the floor in your home and you'll have what most of us refer to as dirt, or just get a sample from the vacuum cleaner if you dare. What you'll discover is that dirt is composed of crumbs, hair, lint, skin cells, and the unfortunate arthropod (e.g., an ant). Okay, so what is soil? Dig up a sample of earth from your backyard or obtain some potting soil and you'll basically have three components: sand, silt, and clay. Not very exciting—but it can be with some basic information and investigative inquiry techniques.

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Topic: What Is Soil?
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A Content Primer

Learning about soil and soil composition is an essential part of environmental science education and connects the land-water and land-air interface in a number of significant ways. For example, soil structure and chemical composition are clear indicators of the usefulness of soil to grow plants, which is important for a healthy ecosystem. By learning about important aspects of soil and its significance in the environment, a better understanding of watersheds, nutrient cycles, water quality, and overall quality of the system can be attained.

4 Soil: It's Not Dirt

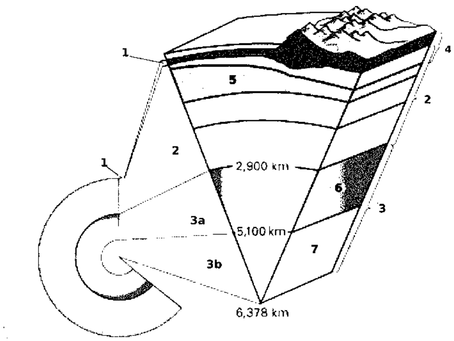
What Is Soil?

By definition soil is composed of both *abiotic* components, such as sand, silt, and clay from the weathering and erosion of geological sources, and *biotic* material, organic matter from the decay of plants, animals, and other organisms. Soil is a thin layer atop the portion of the Earth known as the crust, which together with the uppermost mantle makes up the Earth's lithosphere (see Figure 4.1). This layer extends into the aquatic and marine environment (typically termed *sediment*) as well and can vary widely in its thickness and composition.

Topic: Soil Layers
Go to: *www.scilinks.org*
Code: IO020

Topic: Microorganisms in Soil
Go to: *www.scilinks.org*
Code: IO021

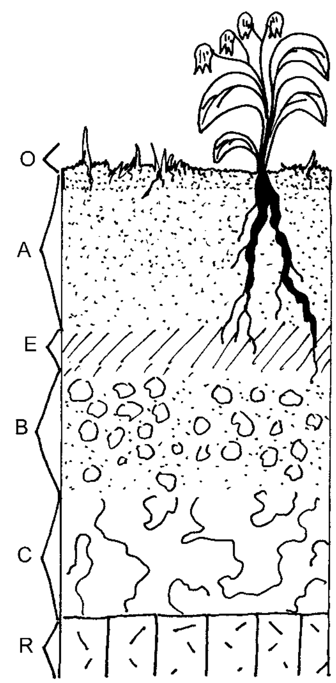
FIGURE 4.1
Earth Cross-Section



Key
1 = crust (oceanic and continental crust 0–80 km)
2 = mantle (upper mantle, including asthenosphere, and lower mantle)
3 = core (3a = outer core, 3b = inner core)
4 = lithosphere (crust and uppermost solid mantle)
5 = asthenosphere
6 = outer core liquid
7 = inner core solid
Source: *http://pubs.usgs.gov/gip/dynamic/inside.html*

Soil can be divided into *soil horizons*, defined as "relatively uniform *soil* layer[s] which lies at any depth in the soil profile, which is parallel, or nearly so, with the soil surface, and which is differentiated from adjacent horizons above and below by contrasts in mineral or organic properties" (Allaby and Allaby 1999). Soil horizons can then be categorized by the layer's composition. The typical horizon layers are O, A, E, B, C, and R; the R horizon is the underlying bedrock (see Figure 4.2). There can be significant variations in soil composition, and the composition is helpful to

FIGURE 4.2
Soil Cross-Section Illustrating Some of the Horizons Found in Soil



O is the top layer of soil and contains high levels of organic material (litter). A is the start of mineral soil components and mixes with organic materials. E is the layer where leaching is dominant and removes organic material, inorganic material, and clay from the soil; this process is driven by the movement of water through the soil. B is the layer where minerals and fine sediments start to become compacted. C is the layer where the soil parent material is found. R is the layer of bedrock.

indicate the environment of origin (e.g., loamy temperate forest soil compared with sandy soil from the coastal plain).

Soil Morphology

Color

All soils can be classified using three basic categories: *color*, *structure*, and *texture* (Lal 2002). One of the first things you will observe about soil is the color. Soil color is influenced by sedimentation from sources that carry minerals, primarily iron as well as organic matter (Lal 2002). Iron in soil creates a reddish-orange color in dry material and becomes increasingly more yellow as the moisture increases. Decomposed organic matter (dead plants and animals), known as *humus*, is black. The variety of sources will result in color variations that can be interpreted with practice and knowledge of the surrounding environment (see Table 4.1).

Another influence on soil color is the amount of aeration or oxygen available in soil, which then dictates biological activity. Oxygen makes

TABLE 4.1
Sources of Soil Color

Soil Color	Source of Color
Reddish-orange	Presence of iron oxides
Black	Presence of organic matter, manganese oxides, or iron sulfides. Organic matter can indicate that the soil is nutrient rich and fertile. Iron sulfides occur in wetlands and are often associated with the rotten egg odor found in wetlands; this odor is produced via sulfide gas from iron sulfide formation.
Gray	Presence of elevated water tables and reduced iron.

SCILINKS THE WORLD'S A CLICK AWAY
Topic: Soil Types
Go to: *www.scilinks.org*
Code: IO022

TABLE 4.2
Influences of Soil Condition on Color

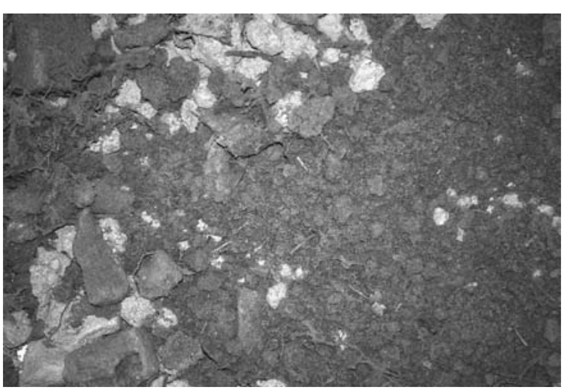
Condition	Dark (dark grayish-black)	Moderately Dark (brown to yellow brown)	Light (pale brown, yellow)
Organic matter	High	Medium	Low
Erosion factor	Low	Medium	High
Aeration	High	Medium	Low
Available nitrogen	High	Medium	Low
Fertility	High	Medium	Low
Soil Condition		**Subsurface Soil Color**	
Water-logged soils, poor aeration		Grayish-black (if in low-rainfall soils 0–20 inches)	
Well-drained soils		Yellow, red-brown, black (if in forest soils)	
Somewhat poorly drained soils		Mottled gray (if in humid soils)	

Source: Adapted from BioWorld Products, *www.adbio.com/science/soil/color.htm* soil either *aerobic* (oxygen rich) or *anaerobic* (oxygen poor). Moisture also plays a role in soil conditions (the amount of rainfall; the proximity to a stream or a source of groundwater such as a natural spring) and further impacts the striking variations in color of similar soil samples under different conditions (see Table 4.2, p. 71).

Structure

Soil structure is simply the organization of soil clumps, or aggregates, into an arrangement that determines how well water will drain through the soil. For example, soil in a temperate forest generally has a spongy consistency, composed of organic matter that disaggregates easily (falls apart) and is porous, which provides filtration and good drainage. The photo in Figure 4.3 shows the soil from a forest floor and the overall structure, including bits of leaves, woody materials, and decomposed organic matter.

FIGURE 4.3
Soil From a Forest in Frederick County, MD, Illustrating the Overall Structure of the Uppermost Soil Horizon

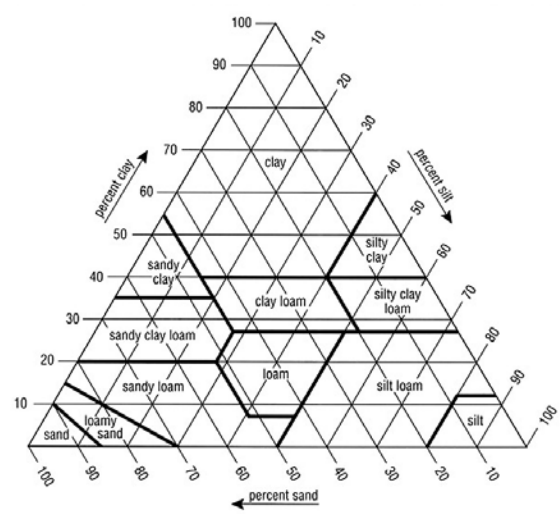


Drainage is one factor that makes forest cover on land so valuable to water quality because instead of water runoff, the soil acts to filter, or "percolate," water, thus replenishing groundwater sources and helping the water remain clear. In contrast, highly compacted soil or impervious surfaces (think of a parking lot) will result in poor percolation and more runoff, leading to more sedimentation and contaminants in streams and other water bodies.

Texture

There are 12 soil texture classes identified in the *Soil Survey Manual* of the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (see Figure 4.4). These classes are primarily determined by biotic material and

FIGURE 4.4
Soil Texture Triangle for Soil Composition Determination



Source: U.S. Department of Agriculture, Natural Resources Conservation Service. 2007. *Soil survey manual,* Chapter 3: Examination and description of soils. *http://soils.usda.gov/technical/manual/contents/chapter3e.html*

by three primary abiotic components: sand, silt, and clay. The smaller-sized particles are called *fine earth* and are distinct from *rock fragments* (pebbles, cobbles, stones, and boulders) by size (USDA 2007). Fine earth particles are generally

TABLE 4.3
Fine Earth Particle Size Comparison

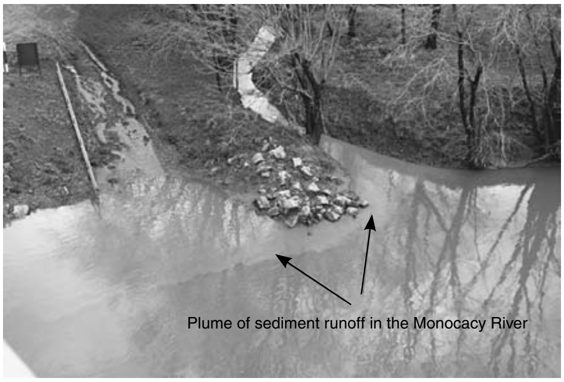
Name	Size (mm)
Very coarse sand	2.0–1.0
Coarse sand	1.0–0.5
Medium sand	0.5–0.25
Fine sand	0.25–0.10
Very fine sand	0.10–0.05
Silt	0.05–0.002
Clay	< 0.002

Source: U.S. Department of Agriculture, Natural Resources Conservation Service, *http://soils.usda.gov/technical/manual/contents/chapter3e.html#50*

less than 2 mm in diameter (see Table 4.3) and are determined in the field by feel. Although classifying soil type can be somewhat complicated, the texture triangle in Figure 4.4 makes this process easier, yet goes beyond simply calling a soil sample clay, silt, or sand.

What does texture tell us? Soils that have a certain composition will have specific characteristics that determine their texture classification and in part their function. For example, a predominance of sand would create a soil with very little ability to retain moisture, whereas a predominance of clay would create a soil that is very "sticky" or compact when wet, providing very little, if any, drainage. Soils that are considered optimal for plant growth are known as loam or sandy loam and are medium-textured soils with relatively good drainage. A medium texture provides more pore space that allows for water percolation/filtration and gas exchange—crucial processes for soil-dwelling organisms. Soil components such as sand and silt are a result of physical weathering, and clay is a result of chemical weathering. Clay becomes significant in the land-water interface because it will carry nutrients and other minerals that become bound to its structure chemically to sources of water through erosion and runoff, thus contributing negatively to water clarity. Too much clay from runoff, as depicted in Figure 4.5, can result in too many nutrients in a system.

FIGURE 4.5
Monocacy River (MD) Runoff



Soil as a Habitat

Although most of us may think of soil as consisting of only abiotic components, it is closely tied to a myriad of organisms (see, e.g., Figure 4.6) that make it their home. Think of the interactions and processes of organisms that alter the soil makeup. For example, digestive processing by earthworms and their addition of organic material (poop) to soil and the many varieties of bacteria that inhabit soil can change the soil's composition of nutrients (Discovery Education). Bacteria, in particular, are very closely integrated to soil types (and sediment in the aquatic environment) and are the subject of continuing research and study by scientists, leading to new findings about the importance of these microscopic soil inhabitants.

FIGURE 4.6
Centipede and Fungus

4 Soil: It's Not Dirt

It is helpful to understand soil basics when considering environmental science education and outdoor activities, because the type of soil can provide clues to the health of the surrounding habitat and an essential link to the land-water and land-air interfaces.

Soil Activities

4

Soil studies are easy for many teachers to ignore because unless a school site has construction going on, soil is typically covered with grass or pavement and therefore "invisible" to students. Because we don't see much soil, it is convenient to think of it as simple, uniform, and unimportant. Studying soil or "dirt," however, is an excellent inquiry project that integrates science process skills, mainly observing, classifying, comparing/contrasting, and inferring. A soil system plays an integral role in environmental studies because (1) most living organisms either live or make their living from a relationship with soil, and (2) soil is a vital component of nutrient cycles.

The activities that follow will investigate the general soil characteristics of color, structure, and texture and will link the soil environment to biology by showcasing a variety of soil-dwelling bacteria that can be seen with the naked eye through the construction of a Winogradsky column.

Activity 1. Soil Color: Wetland Versus Nonwetland Soils[1]

We begin with a soil color activity," Do You Dig Wetland Soil?" from *WOW! The Wonders of Wetlands* (Kesselheim et al. 1995), an activity book published by Environmental Concern. Although Environmental Concern focuses mainly on the study of wetlands, this is the simplest and most inexpensive (and therefore the best) activity we have found that engages students directly in handling soil as they investigate soil color.

Wetland soils, called *hydric,* can be identified by their grayish-black color; this color can be attributed to the prolonged saturation of these soils, resulting in little aerobic activity.

Driving Questions

1. What are the characteristics of wetland soil?
2. How can we distinguish wetland soil from nonwetland soil?

Materials

- Soil color chart (Figure 4.7, p. 76; see the Wetland Soils Color Chart in the "Do You Dig Wetland Soils?" activity [Kesselheim et al. 1995] for the color representations)
- 64-count box of Crayola crayons
- Trowel, shovel, or soil corer (available at lawn and garden stores)
- Bucket or container for soil
- Meterstick or tape measure to measure depth of soil sample
- Safety glasses or goggles

Procedure

1. Create field identification charts using crayons.
2. Collect a soil sample and use the Wetland Soils Color Chart to make a general determination if soil is upland or wetland in origin.
3. Use the Wetland Soils Color Chart to make a specific color identification.

Think About

1. What soil characteristics did you observe?
2. How did soil from the bottom of the hole differ from soil near the surface in color and texture?
3. Compare wetland soil with soil you have observed at home and around the schoolyard. How do the soils differ, and what makes them different?

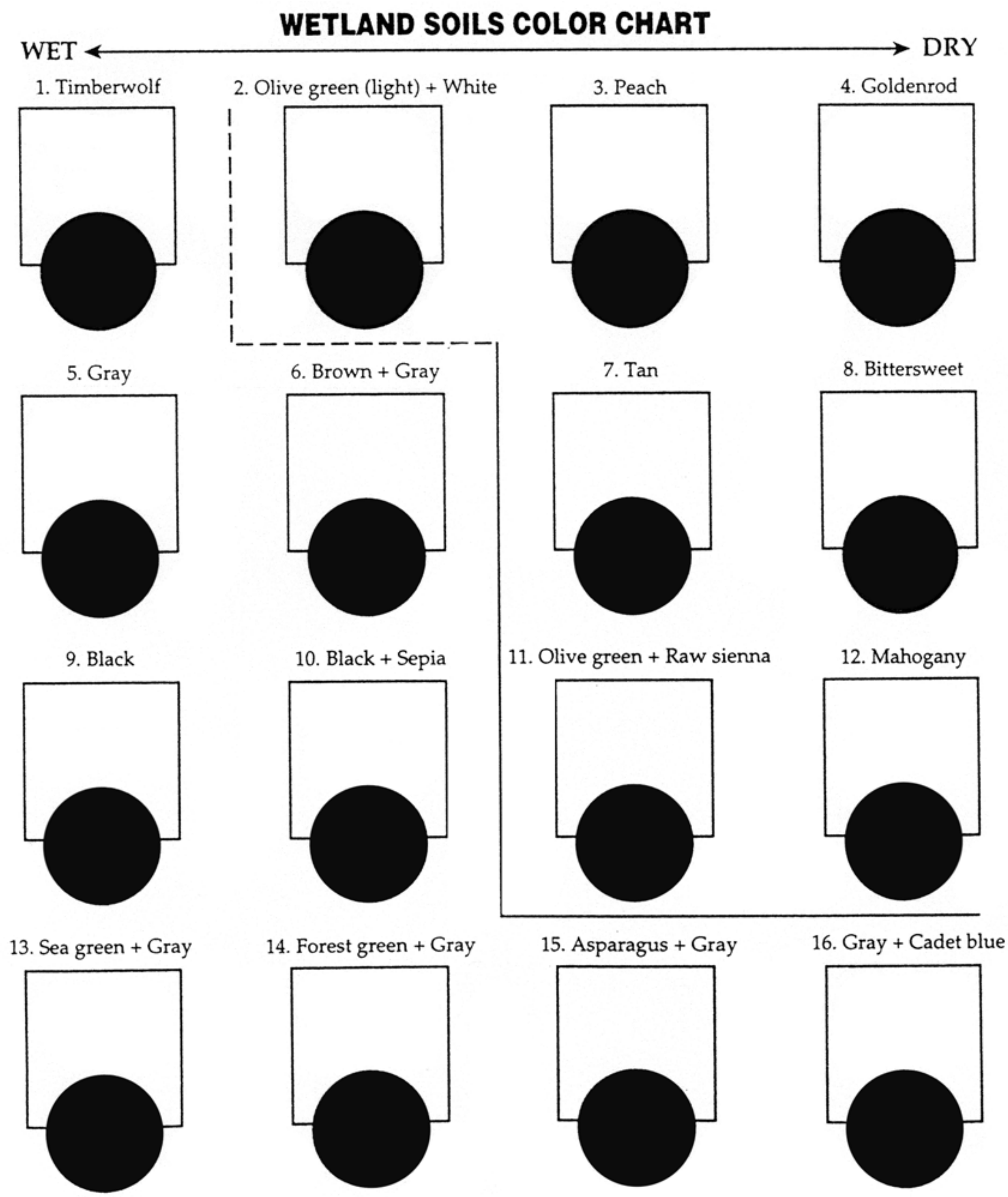
SCILINKS THE WORLD'S A CLICK AWAY

Topic: Soil and Climate
Go to: *www.scilinks.org*
Code: IO023

Topic: Wetlands
Go to: *www.scilinks.org*
Code: IO024

1 "Do You Dig Wetland Soil?" activity (p. 76) from *WOW! The Wonders of Wetlands* is used with permission from Environmental Concern Inc. For further information contact Environmental Concern Inc. at PO Box P, 201 Boundary Lane, St. Michaels, MD 21663. Ph: 410-745-9620, or visit *www.wetland.org.*

FIGURE 4.7
"Do You Dig Wetland Soil?" Identification Chart and Color Schemes From Wonders of Wetland Program



Activity 2. Soil Texture Investigation

An important part of studying soil is learning what soil is composed of, how these components differ, and the compositional parts of a sample. If you recall in Chapter 3, Activity 9, we used a jar of soil and water (the sedimentator) to determine the relative turbidity of water. In this activity we return to the sedimentator and ask students to describe what they see. To refresh their memories, it may be useful to prepare another sample so they can view the remixing of the particles (Figure 4.8). During the initial mixing phase (immediately after shaking) students can make observations of the settling process and begin to develop hypotheses about the particles, their size, and their behavior in water, which could then lead back to the concept of turbidity.

Driving Question

How does soil particle size affect turbidity?

Materials

- Sedimentator (see Chapter 3, Activity 9, and Figure 4.8)
- Copy of Soil Texture Triangle for Soil Composition Determination (see Figure 4.4, p. 72)

Procedure

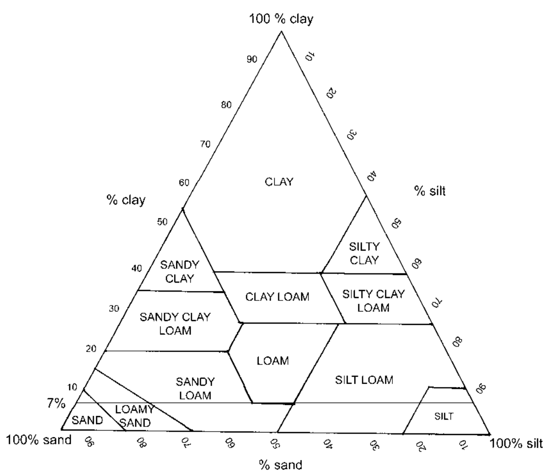
1. Using the initial jar, which should be completely settled and ready for measurement, have students begin by diagramming and describing what they see. For example, at the top of the tube should be a clear layer of water followed by the soil separated into three distinct layers. The top layer, consisting of clay, is the finest of the three particles and takes the longest to settle. The remaining two layers, in order, are silt and sand.
2. Have students determine the percentage of clay, sand, and silt relative to the whole sample; this percentage is determined as shown in Table 4.4 (divide the value of each individual layer by the total value of all soil layers and multiply by 100). Have students locate the individual percentages on the texture chart (Figures 4.9, 4.10, and 4.11, p. 78); the point where all three intersect indicates the soil type of the sample.

FIGURE 4.8
Sedimentator

TABLE 4.4
Sample Measurement and Calculation of Soil Layers in a Sedimentator

Measurement of Soil Layers (total of all soil layers = 7.0 cm)	Calculation of Percentage of Each Soil Layer
Clay layer = 0.5 cm	Clay layer: 0.5/7.0 = 0.07 × 100 = 7%
Silt layer = 4.5 cm	Silt layer: 4.5/7.0 = 0.64 × 100 = 64%
Sand layer = 2.0 cm	Sand layer: 2.0/7.0 = 0.29 × 100 = 29%

FIGURE 4.9
Soil Texture Triangle—Clay



- Find the percentage of clay on the left side and draw a line to the right that is parallel to the triangle base. From Table 4.4 (p. 77) the amount of clay is 7%.
- Find the percentage of sand on the base and draw a line from the bottom up to the left, parallel to the right side. From Table 4.4 the amount of sand is 29%.
- Find the percentage of silt on the right side and draw a line from this side down toward the base, parallel to the left side. From Table 4.4 the amount of silt is 64%.

The resulting texture is *silt loam.*

3. This sample can then be compared with other samples being investigated. For each sample the type of soil can be determined using the process illustrated in steps 1 and 2.
4. Once the soil texture is identified for each sample, other types of investigation can be performed that relate to the overall properties of the soil. One of these properties, percolation of water through soil, will be the subject of Activity 3.

FIGURE 4.10
Soil Texture Triangle—Clay and Sand

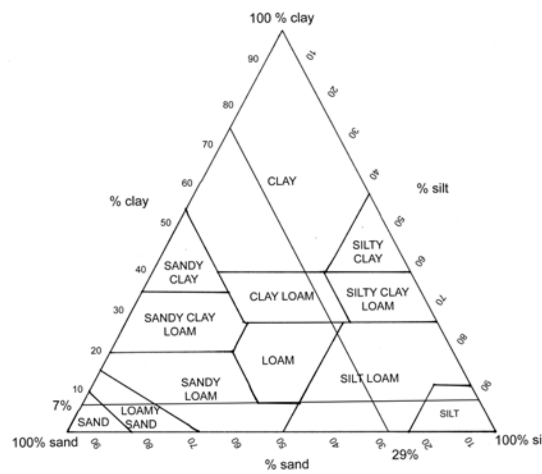
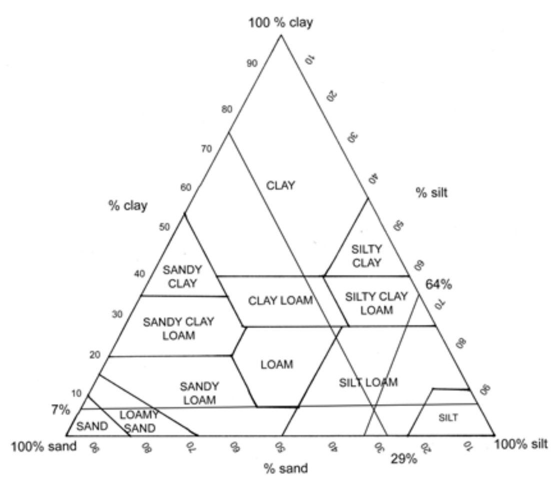


FIGURE 4.11
Soil Texture Triangle—Clay, Sand, and Silt



Think About

1. Which soil type settled first, and which settled last?
2. What accounts for these differences?

Activity 3. Percolation of Soil

In this activity we have students investigate the relationship between soil characteristics and two factors: the rate at which water moves through the soil (percolation rate) and the ability of soil to "hold" water (holding capacity). *Percolation* is defined as the movement of water through soil and is dependent on soil particle size and the space between particles. The activity involves testing a variety of soil samples, measuring the amount of water that drains through the soil, and determining the amount of water that is retained by the soil. In general the size of the spaces in the soil depends on the soil's texture; smaller spaces are found in soils with smaller particles, and larger spaces are found in soils with larger particles. Table 4.5 summarizes the relationship between soil texture and percolation and holding capacity of soil.

TABLE 4.5
Relationship Between Soil Texture and Percolation and Holding Capacity

Texture	Percolation	Water-Holding Capacity
Sand	Good	Poor
Silt	Medium	Medium
Clay	Poor	Good
Loam	Medium	Medium

Driving Question

How does soil type affect percolation rate?

Materials

(per group)

- Five damp (*not wet*) soil samples (damp soil better represents natural conditions): one sand, one clay (finely ground, nonclumping cat litter), one loam (top soil and/or potting soil), two others
- Five pie plates or paper plates
- Soil porosity and permeability tubes (Carolina Biological) or five plastic soda or water bottles; 20 oz. minimum for each bottle (remove labels)
- Percolation and Holding Capacity Data Sheet (p. 80)
- Cheesecloth, netting, and/or coffee filter (cheesecloth and netting are available at drugstores)
- Five 500 ml beakers (available from any science education supplier)
- Permanent marker (use low- or non-VOC marker)
- Ring stand (available from any science education supplier)
- Measuring cup or extra 500 ml beaker
- Stopwatch or wall clock with second hand
- Two 500 ml graduated cylinders (available from any science education supplier)
- Tap water or other source of water
- Scissors (Use caution, as scissors can cut skin.)
- Tape, rubber bands, or cable ties (enough to secure the cheesecloth to the container)
- Indirectly vented chemical splash goggles, aprons, and gloves

Procedure

1. Prepare percolation tubes by cutting the bottom out of each of the plastic bottles.
2. Wrap a piece of cheesecloth, netting, or coffee filter at the other end of the bottle.

Secure with tape, rubber band, and/or cable tie. Label each tube with soil type.

3. Secure the percolation tubes upside down so that the screen end faces into a beaker. Use ring stands or some other mechanism to keep the tube supported.
4. Label each beaker with the types of soil to be tested.
5. Place 1 cup (about 200–250 ml) of each soil in the appropriate tube. Be sure that each tube gets the same amount of soil.
6. Lightly shake the tube back and forth to settle soil to resemble natural conditions.
7. Slowly pour 100 ml of water, wait 30 seconds, and pour another 100 ml of water. Repeat until all 500 ml of water have been poured. Begin recording time when first 100 ml sample is poured.
8. Record the amount of time it takes for the first drip to occur.
9. Record the total amount of water collected in the beaker after five minutes on the data sheet in the "Volume Collected From Percolation" column.

Soil Percolation
Water moving through columns containing soil samples to test percolation. From left: sand, topsoil, and cat litter (clay). Upper-right inset: After 5 minutes the amount of water (100 ml) that has drained from each sample can be seen.

10. If after five minutes no water has percolated, label that sample *impermeable*.
11. Determine and record the amount of water retained in the soil and record it on the data sheet. Repeat for each soil type. Wash hands with soap and water.

Percolation and Holding Capacity Data Sheet

Soil Type	Time First Drip Occurred (seconds)	Volume Collected From Percolation (ml)	Volume Retained in Soil After 5 Minutes	Soil Characteristics
1.				
2.				
3.				
4.				
5.				

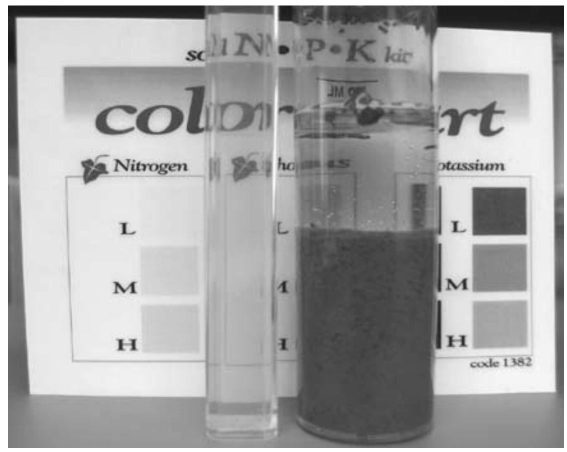
Think About

1. Which sample had the fastest percolation time? Explain why.
2. Which sample had the slowest percolation time? Explain why.
3. Which sample drained the most amount of water? Explain why.
4. Which sample drained the least amount of water? Explain why.
5. Which sample had the highest holding capacity? Explain why.
6. Which sample had the lowest holding capacity? Explain why.
7. Describe the relationship between particle size and the percolation of water through the soil.
8. Describe the relationship between particle size and holding capacity of soil.
9. How can you account for missing water if the total water retained plus the total water collected does not equal the original 500 ml sample?
10. Which soil would you use to maximize plant growth? Explain your reasoning.

Activity 4. Soil Chemistry

In this activity we measure the basic chemical elements in soil. The point is to emphasize that all living organisms need nutrients to live and, thus, these nutrients should be found in the soil habitat. As an activity, soil chemistry examination can be conducted along with biodiversity analysis, which demonstrates the integrated nature of these content areas. A more detailed presentation of the importance of essential nutrients is found in Chapter 5.

FIGURE 4.12
Soil Test Kits



Soil test kits are simple to use and can be a good visual for students learning about the soil environment. In the tube on the left the color of the solution is compared with the color chart. In the tube on the right the soil sample has settled, allowing for the liquid on top to be tested.

Driving Question

Which chemicals are present in soil?

Materials

- Soil test kit (see Figure 4.12; these kits can be found in most garden stores and generally test for nitrogen, potassium, and phosphorous; we use the LaMotte kit used by the GLOBE [Global Learning and Observations to Benefit the Environment] program)
- Soil Test Kit Results Data Sheet (p. 82)
- Distilled water
- Indirectly vented chemical splash goggles, gloves, and aprons

Soil Test Kit Results Data Sheet

Nitrogen		Phosphorous		Potassium	
Low		Low		Low	
Medium		Medium		Medium	
High		High		High	

Procedure

Provide students with the following instructions:

Preparation of Clear Solution

1. Fill the round tube to the 30 ml line with distilled water.
2. Add 2 Floc-Ex tablets. Cap the tube and mix until the tablets have disintegrated.
3. Remove the cap and add one heaping teaspoon of soil.
4. Cap the tube and shake for one minute.
5. Let the tube stand until the soil settles to the bottom. The clear solution above the soil is what you will use to test for nitrogen, phosphorous, and potassium.

Nitrogen Test

1. Use the pipet to transfer the clear solution above the soil to a square test tube until it is filled to the shoulder.
2. Add one Nitrate WR CTA tablet. Cap and mix until the tablet disintegrates.
3. Wait five minutes for the color to develop. Compare the pink color with the nitrogen color chart and mark the correct box on your data sheet.

Phosphorous Test

1. Use the pipet to transfer 25 drops of the clear solution above the soil to a square test tube.
2. Fill the tube to the shoulder with distilled water.
3. Add one phosphorous tablet. Cap and mix until the tablet disintegrates.
4. Wait five minutes for the color to develop. Compare the blue color to the phosphorous color chart and mark the correct box on your data sheet.

Potassium Test

1. Use the pipet to transfer the clear solution above the soil to a square test tube until it is filled to the shoulder.
2. Add one potassium tablet. Cap and mix until the tablet disintegrates.
3. Compare the cloudiness of the solution in the test tube with the potassium color chart. Hold the tube over the black boxes in the left column and compare it with the shaded boxes in the right column. Mark the correct box on your data sheet. Wash hands with soap and water after completing activities.

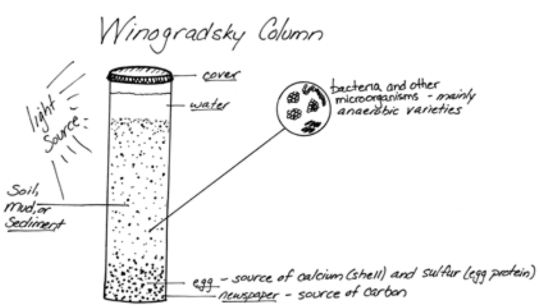
Think About

1. What nutrients were present in your soil sample?
2. Why might it be important for those nutrients to be found there?
3. Is there a link between nutrients found in soil and the biodiversity of that soil sample?

Activity 5. The Living Soil or Winogradsky Column

What does a Russian scientist named Sergei Winogradsky have to do with soil study? He was a microbiologist who specialized in the microorganisms that inhabit soil and found a simple way of getting them to display themselves so that they could be viewed with the naked eye. He used a clear cylinder of soil and other components to encourage the growth of unseen bacteria, resulting in a display of colors produced by the bacteria over a period of time under the right conditions; this cylinder is known today as a Winogradsky column (Figure 4.13). This activity makes an excellent long-term inquiry in the classroom and requires almost no maintenance

FIGURE 4.13
Winogradsky Column



to be successful. In addition, this is a good way to make connections to our chapter on biodiversity (Chapter 6). An interesting part of this is that students can be taught that plants are not the only things that photosynthesize—some microbes do so also.

The construction of a Winogradsky column is simple and will engage students in a variety of skills. It can also be a messy endeavor, so prepare properly.

Driving Question

How can you demonstrate that soil is an environment for microbial life?

Materials

(per group of two or three students)

- A clear plastic tube (column) at least 12–24 inches in height and at least 2 inches in diameter (a 2-liter soda bottle will work well)
- A sample of soil or sediment from a pond or other aquatic environment, enough to fill the tube about 2 inches from the top
- A hard-boiled egg yolk or a raw egg (a source of sulfur; see Figure 4.14), a tablespoon or two of chalk dust (a source of calcium), and a sheet of newspaper (a

FIGURE 4.14
Winogradsky Column Showing Eggs

source of carbon); the ingredients and amounts will vary depending on the size of the column and your experimental setup

- Spring water or de-chlorinated water for making mud from the soil sample

Figure 4.15 Winogradsky Column Nine Years After Construction

- A lamp for a light source that does not produce too much heat (40–60 W) (Caution: Do not touch lamp—heat can burn skin.)
- A location to place the columns where they can remain undisturbed
- Plastic wrap to cover the top of tube
- Indirectly vented chemical splash goggles and aprons

Procedure

(Add ingredients in order indicated.)

1. Mix soil and sediment with water to make the soil wet but not runny.
2. Drop the raw egg (make sure it breaks) or hard-boiled yolk into the bottom of the container.
3. Add chalk dust.
4. Shred and add newspaper (no larger than 3 cm × 3 cm in size).
5. Add soil and sediment to within 8–10 cm from the top.
6. Slowly add water to fill the tube to within 1–2 cm from the top.
7. Cover the top of the tube with plastic wrap.
8. Place in an undisturbed area and expose to a light source (keep light at least 45 cm from the tube).
9. Monitor changes in the color and appearance of the soil and sediment over time. Wash hands with soap and water.

In Figure 4.15 note how the newspaper is still intact and can be read even though it has been exposed to water, mud, high sulfur content, and microbial action. One reason could be the lack of oxygen in the bottom portion of the column and the slow degradation of materials by mainly anaerobic bacteria.

Think About

1. For a true experiment set up another cylinder with soil and sediment only.
2. Think about and research why changes in the test cylinder occur.
3. Think about and research how nutrients in the soil play a role in stimulating the growth of microbes in the soil ecosystem

Wrap-Up

As you can see, soil studies involve a variety of hands-on activities and necessitate going outside where the soil is located. Getting students to think of soil beyond the notion of "dirt" and helping them understand the integrated role that living and nonliving factors play in soil formation is important for an overall understanding of the environment.

Resource List

Printed Material

Allaby, A., and M. Allaby, eds. 1999. *A dictionary of Earth sciences.* London: Oxford University Press.

Kesselheim, A. S., B. E. Slattery, S. H. Higgins, and M. R. Schilling. 1995. *Wow! The wonders of wetlands: An educator's guide.* St. Michaels, MD: Environmental Concern.

Lal, R., ed. 2002. *Encyclopedia of soil science.* New York: Marcel Dekker.

Websites

Discovery Education
http://school.discoveryeducation.com

Environmental Concern
www.wetland.org

Project Wet
www.projectwet.org

Soil Color (BioWorld Products)
www.adbio.com/science/soil/color.htm

U.S. Department of Agriculture (USDA), Natural Resources Conservation Service. 2007. *Soil survey manual,* Chapter 3: Examination and description of soils.
http://soils.usda.gov/technical/manual/contents/chapter3e.html