HS Weathering and Formation of Soil

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CHAPTER 1 HS Weathering and Formation of Soil

CHAPTER OUTLINE

The solid granite rocks of Yosemite Valley appear to have been there forever and look as if they will be there forever. Yet this photo holds clues to the amazing changes that have taken place in the geologic history of Yosemite Valley and clues to what will lead to the Valley's eventual demise. The rounded domes are the way granitic rock breaks as pressure is released as it rises through the crust. Fractures seen in the granite expose weaknesses in the rock that can lead to boulders breaking off. Those boulders lie in the bottom of the valley.

Bridalveil Creek flows through a notch in the granite before plunging over a cliff as Bridalveil Falls. The creek has eroded a V-shaped valley for itself within the U-shaped valley that was once filled with a glacier. The falls plunge into another larger valley, Yosemite Valley, which also has a U-shape from the glacier that once flowed through it.

On the far left side of the photo is what's left of a granite dome that split in half. What will be left when the other half of Half Dome is gone?

1.1 Weathering

Lesson Objectives

- Define mechanical and chemical weathering.
- Discuss agents of weathering.
- Give examples of each type of weathering.

Vocabulary

- abrasion
- chemical weathering
- climate
- hydrolysis
- ice wedging
- leaching
- mechanical weathering
- oxidation

Introduction

The footprints that astronauts left on the Moon will be there forever. Why? This is because the Moon has no atmosphere and, as a result, has no weathering. Weathering is one of the forces on Earth that destroy rocks and landforms. Without weathering, geologic features would build up but would be less likely to break down.

What is Weathering?

Weathering is the process that changes solid rock into sediments. Sediments were described in the Rocks chapter. With weathering, rock is disintegrated. It breaks into pieces.

Once these sediments are separated from the rocks, erosion is the process that moves the sediments. Erosion is the next chapter's topic. The four forces of erosion are water, wind, glaciers, and gravity.

- Water is responsible for most erosion. Water can move most sizes of sediments, depending on the strength of the force.
- Wind moves sand-sized and smaller pieces of rock through the air.
- Glaciers move all sizes of sediments, from extremely large boulders to the tiniest fragments.
- Gravity moves broken pieces of rock, large or small, downslope.

While plate tectonics forces work to build huge mountains and other landscapes, the forces of weathering gradually wear those rocks and landscapes away. Together with erosion, tall mountains turn into hills and even plains. The Appalachian Mountains along the east coast of North America were once as tall as the Himalayas.

No human being can watch for millions of years as mountains are built, nor can anyone watch as those same mountains gradually are worn away. But imagine a new sidewalk or road. The new road is smooth and even. Over hundreds of years, it will completely disappear, but what happens over one year? What changes would you see? (**Figure** 1.1). What forces of weathering wear down that road, or rocks or mountains over time?

- Animations of different types of weathering processes can be found here: http://www.geography.ndo.co.uk/animationsweathering.htm#.

FIGURE 1.1
A once smooth road surface has cracks and fractures, plus a large pothole.

Mechanical Weathering

Mechanical weathering (also called physical weathering) breaks rock into smaller pieces. These smaller pieces are just like the bigger rock, just smaller. That means the rock has changed physically without changing its composition. The smaller pieces have the same minerals, in just the same proportions as the original rock.

There are many ways that rocks can be broken apart into smaller pieces. **Ice wedging** is the main form of mechanical weathering in any climate that regularly cycles above and below the freezing point (**Figure** 1.2). Ice wedging works quickly, breaking apart rocks in areas with temperatures that cycle above and below freezing in the day and night, and also that cycle above and below freezing with the seasons.

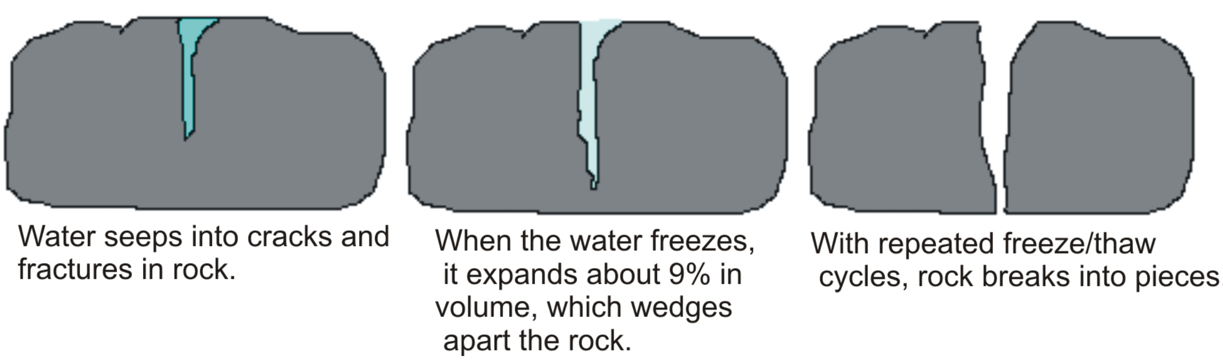

FIGURE 1.2
Ice wedging.

Ice wedging breaks apart so much rock that large piles of broken rock are seen at the base of a hillside, as rock fragments separate and tumble down. Ice wedging is common in Earth's polar regions and mid latitudes, and also at higher elevations, such as in the mountains. **Abrasion** is another form of mechanical weathering. In abrasion, one rock bumps against another rock.

- Gravity causes abrasion as a rock tumbles down a mountainside or cliff.
- Moving water causes abrasion as particles in the water collide and bump against one another.
- Strong winds carrying pieces of sand can sandblast surfaces.
- Ice in glaciers carries many bits and pieces of rock. Rocks embedded at the bottom of the glacier scrape against the rocks below.

Abrasion makes rocks with sharp or jagged edges smooth and round. If you have ever collected beach glass or cobbles from a stream, you have witnessed the work of abrasion (**Figure** 1.3).

FIGURE 1.3
Rocks on a beach are worn down by abrasion as passing waves cause them to strike each other.

Now that you know what mechanical weathering is, can you think of other ways it could happen? Plants and animals can do the work of mechanical weathering (**Figure** 1.4). This could happen slowly as a plant's roots grow into a crack or fracture in rock and gradually grow larger, wedging open the crack. Burrowing animals can also break apart rock as they dig for food or to make living spaces for themselves.

Mechanical weathering increases the rate of chemical weathering. As rock breaks into smaller pieces, the surface area of the pieces increases **Figure** 1.5. With more surfaces exposed, there are more surfaces on which chemical weathering can occur.

Chemical Weathering

Chemical weathering is the other important type of weathering. Chemical weathering is different from mechanical weathering because the rock changes, not just in size of pieces, but in composition. That is, one type of mineral changes into a different mineral. Chemical weathering works through chemical reactions that cause changes in the minerals.

Most minerals form at high pressure or high temperatures deep in the crust, or sometimes in the mantle. When these rocks reach the Earth's surface, they are now at very low temperatures and pressures. This is a very different

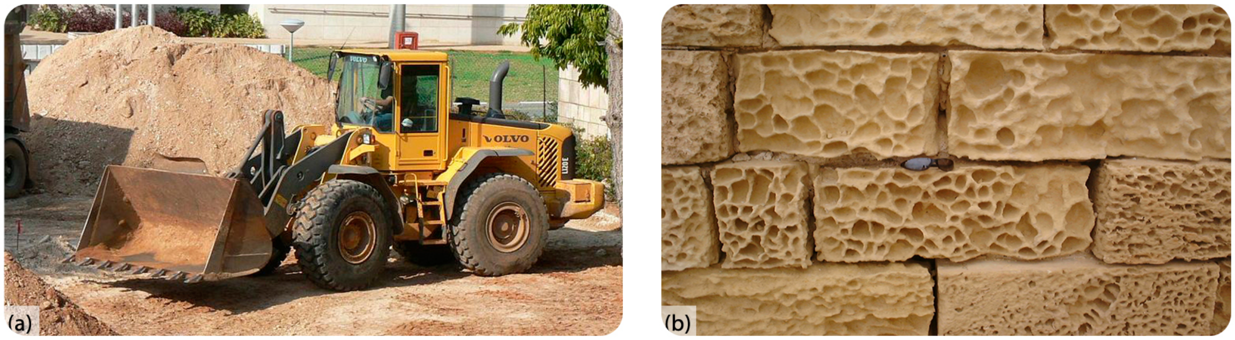

FIGURE 1.4

(a) Human activities are responsible for enormous amounts of mechanical weathering, by digging or blasting into rock to build homes, roads, subways, or to quarry stone. (b) Salt weathering of building stone on the island of Gozo, Malta.

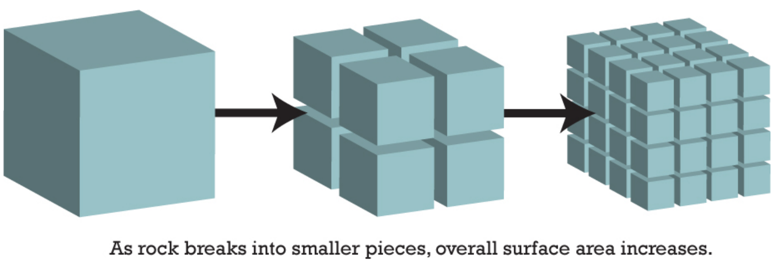

FIGURE 1.5

Mechanical weathering may increase the rate of chemical weathering.

environment from the one in which they formed and the minerals are no longer stable. In chemical weathering, minerals that were stable inside the crust must change to minerals that are stable at Earth's surface.

Remember that the most common minerals in Earth's crust are the silicate minerals. Many silicate minerals form in igneous or metamorphic rocks. The minerals that form at the highest temperatures and pressures are the least stable at the surface. Clay is stable at the surface and chemical weathering converts many minerals to clay (**Figure** 1.6).

There are many types of chemical weathering because there are many agents of chemical weathering. Water is the most important agent of chemical weathering. Two other important agents of chemical weathering are carbon dioxide and oxygen.

Chemical Weathering by Water

A water molecule has a very simple chemical formula, H_2O, two hydrogen atoms bonded to one oxygen atom. But water is pretty remarkable in terms of all the things it can do. Remember from the Earth's Minerals chapter that water is a polar molecule. The positive side of the molecule attracts negative ions and the negative side attracts positive ions. So water molecules separate the ions from their compounds and surround them. Water can completely dissolve some minerals, such as salt.

- Check out this animation of how water dissolves salt:

FIGURE 1.6
Deforestation in Brazil reveals the underlying clay-rich soil.

http://www.northland.cc.mn.us/biology/Biology1111/animations/dissolve.html

Hydrolysis is the name of the chemical reaction between a chemical compound and water. When this reaction takes place, water dissolves ions from the mineral and carries them away. These elements have been **leached**. Through hydrolysis, a mineral such as potassium feldspar is leached of potassium and changed into a clay mineral. Clay minerals are more stable at the Earth's surface.

Chemical Weathering by Carbon Dioxide

Carbon dioxide (CO_2) combines with water as raindrops fall through the atmosphere. This makes a weak acid, called carbonic acid. Carbonic acid is a very common in nature where it works to dissolve rock. Pollutants, such as sulfur and nitrogen, from fossil fuel burning, create sulfuric and nitric acid. Sulfuric and nitric acids are the two main components of acid rain, which accelerate chemical weathering (**Figure** 1.7). Acid rain is discussed in the Human Actions and the Atmosphere chapter.

FIGURE 1.7
This statue has been damaged by acid rain.

Chemical Weathering by Oxygen

Oxidation is a chemical reaction that takes place when oxygen reacts with another element. Oxygen is very strongly chemically reactive. The most familiar type of oxidation is when iron reacts with oxygen to create rust (**Figure** 1.8). Minerals that are rich in iron break down as the iron oxidizes and forms new compounds. Iron oxide produces the red color in soils.

FIGURE 1.8
When iron rich minerals oxidize, they produce the familiar red color found in rust.

Now that you know what chemical weathering is, can you think of some other ways chemical weathering might occur? Chemical weathering can also be contributed to by plants and animals. As plant roots take in soluble ions as nutrients, certain elements are exchanged. Plant roots and bacterial decay use carbon dioxide in the process of respiration.

Influences on Weathering

Weathering rates depend on several factors. These include the composition of the rock and the minerals it contains as well as the climate of a region.

Rock and Mineral Type

Different rock types weather at different rates. Certain types of rock are very resistant to weathering. Igneous rocks, especially intrusive igneous rocks such as granite, weather slowly because it is hard for water to penetrate them. Other types of rock, such as limestone, are easily weathered because they dissolve in weak acids.

Rocks that resist weathering remain at the surface and form ridges or hills. Devil's Tower in Wyoming is an igneous rock from beneath a volcano (**Figure** 1.9). As the surrounding less resistant rocks were worn away, the resistant center of the volcano remained behind.

Different minerals also weather at different rates. Some minerals in a rock might completely dissolve in water but the more resistant minerals remain. In this case, the rock's surface becomes pitted and rough. When a less resistant mineral dissolves, more resistant mineral grains are released from the rock.

FIGURE 1.9
Devil

Climate

A region's **climate** strongly influences weathering. Climate is determined by the temperature of a region plus the amount of precipitation it receives. Climate is weather averaged over a long period of time. Chemical weathering increases as:

- Temperature increases: Chemical reactions proceed more rapidly at higher temperatures. For each $10^{o}C$ increase in average temperature, the rate of chemical reactions doubles.
- Precipitation increases: More water allows more chemical reactions. Since water participates in both mechanical and chemical weathering, more water strongly increases weathering.

So how do different climates influence weathering? A cold, dry climate will produce the lowest rate of weathering. A warm, wet climate will produce the highest rate of weathering. The warmer a climate is, the more types of vegetation it will have and the greater the rate of biological weathering (**Figure** 1.10). This happens because plants and bacteria grow and multiply faster in warmer temperatures.

Some resources are concentrated by weathering processes. In tropical climates, intense chemical weathering carries away all soluble minerals, leaving behind just the least soluble components. The aluminum oxide, bauxite, forms this way and is our main source of aluminum ore.

Lesson Summary

- Mechanical weathering breaks rocks into smaller pieces without changing their composition.
- Ice wedging and abrasion are two important processes of mechanical weathering.
- Chemical weathering breaks down rocks by forming new minerals that are stable at the Earth's surface.
- Water, carbon dioxide, and oxygen are important agents of chemical weathering.
- Different types of rocks weather at different rates. More resistant types of rocks will remain longer.

FIGURE 1.10
Wet, warm tropical areas have the most weathering.

Review Questions

1. What are the four forces of erosion and which is responsible for the most erosion?
2. Name two types of mechanical weathering. Explain how each works to break apart rock.
3. What are three agents of chemical weathering? Give an example of each.
4. What type of climate would likely produce the greatest degree of weathering? Explain.
5. What causes differential weathering in a rock?
6. Would a smooth even surface weather faster than an uneven, broken surface?
7. What type of rocks would be best suited to making monuments?

Points to Consider

- What other types of surfaces are affected by weathering other than rock?
- What might the surface of the Earth look like if there was no weathering? Think about the Moon or other planets.
- Do you think that you would be alive today if water did not dissolve elements?
- Would the same composition of rock weather the same way in three very different climates?

1.2 Soils

Lesson Objectives

- Discuss why soil is an important resource.
- Describe how soil forms from existing rocks.
- Describe the different textures and components of soil.
- Draw and describe a soil profile.
- Define three climate related soils: pedalfer, pedocal and laterite.

Vocabulary

- B horizon
- C horizon
- humus
- inorganic
- laterite
- loam
- pedalfer
- pedocal
- permeable
- residual soil
- soil
- soil horizon
- soil profile
- subsoil
- topsoil
- transported soil

Introduction

Without mechanical and chemical weathering working to break down rock, there would not be any soil on Earth. It is unlikely that humans or most other creatures would be able to live on Earth without soil. Wood, paper, cotton, medicines, and even pure water need soil. So soil is a precious resource that must be carefully managed and cared for. Although soil is a renewable resource, its renewal takes a lot of time.

Characteristics of Soil

Even though soil is only a very thin layer on Earth's surface over the solid rocks below, it is the where the atmosphere, hydrosphere, biosphere, and lithosphere meet. Within the soil layer, important reactions between solid rock, liquid water, air, and living things take place. **Soil** is a complex mixture of different materials.

- About half of most soils are **inorganic** materials, such as the products of weathered rock, including pebbles, sand, silt, and clay particles.

- About half of all soils are organic materials, formed from the partial breakdown and decomposition of plants and animals. The organic materials are necessary for a soil to be fertile. The organic portion provides the nutrients, such as nitrogen, needed for strong plant growth.
- In between the solid pieces, there are tiny spaces filled with air and water.

In some soils, the organic portion could be missing, as in desert sand. Or a soil could be completely organic, such as the materials that make up peat in a bog or swamp (**Figure** 1.11).

FIGURE 1.11
Peat is so rich in organic material, it can be burned for energy.

Soil is an ecosystem unto itself. In the spaces of soil, there are thousands or even millions of living organisms. Those organisms could be anything from earthworms, ants, bacteria, or fungi (**Figure** 1.12).

FIGURE 1.12
Earthworms and insects are important residents of soils.

Climate

Scientists know that climate is the most important factor determining soil type because given enough time, different rock types in a given climate will produce a similar soil (**Figure** 1.13). Even the same rock type in different climates will not produce the same type of soil. This is true because most rocks on Earth are made of the same eight elements and when the rock breaks down to become soil, those elements dominate.

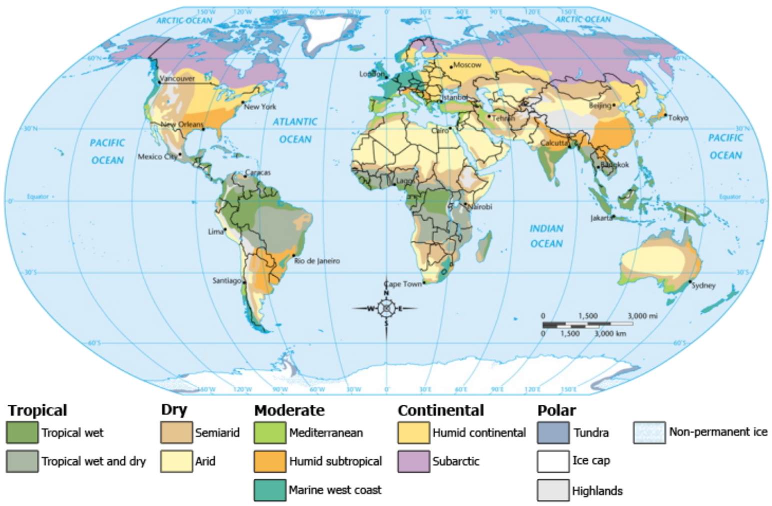

FIGURE 1.13
Climate is the most important factor in determining the type of soil that will form in a particular area.

The same factors that lead to increased weathering also lead to greater soil formation.

- More rain equals more chemical reactions to weather minerals and rocks. Those reactions are most efficient in the top layers of the soil where the water is fresh and has not yet reacted with other materials.
- Increased rainfall increases the amount of rock that is dissolved as well as the amount of material that is carried away by moving water. As materials are carried away, new surfaces are exposed, which also increases the rate of weathering.
- Increased temperature increases the rate of chemical reactions, which also increases soil formation.
- In warmer regions, plants and bacteria grow faster, which helps to weather material and produce soils. In tropical regions, where temperature and precipitation are consistently high, thick soils form. Arid regions have thin soils.

Soil type also influences the type of vegetation that can grow in the region. We can identify climate types by the types of plants that grow there.

Rock Type

The original rock is the source of the inorganic portion of the soil. The minerals that are present in the rock determine the composition of the material that is available to make soil. Soils may form in place or from material that has been moved.

- **Residual soils** form in place. The underlying rock breaks down to form the layers of soil that reside above it. Only about one-third of the soils in the United States are residual.
- **Transported soils** have been transported in from somewhere else. Sediments can be transported into an area by glaciers, wind, water, or gravity. Soils form from the loose particles that have been transported to a new location and deposited.

Slope

The steeper the slope, the less likely material will be able to stay in place to form soil. Material on a steep slope is likely to go downhill. Materials will accumulate and soil will form where land areas are flat or gently undulating.

Time

Soils thicken as the amount of time available for weathering increases. The longer the amount of time that soil remains in a particular area, the greater the degree of alteration.

Biological Activity

The partial decay of plant material and animal remains produces the organic material and nutrients in soil. In soil, decomposing organisms breakdown the complex organic molecules of plant matter and animal remains to form simpler inorganic molecules that are soluble in water. Decomposing organisms also create organic acids that increase the rate of weathering and soil formation. Bacteria in the soil change atmospheric nitrogen into nitrates.

The decayed remains of plant and animal life are called **humus**, which is an extremely important part of the soil. Humus coats the mineral grains. It binds them together into clumps that then hold the soil together, creating its structure. Humus increases the soil's porosity and water holding capacity and helps to buffer rapid changes in soil acidity. Humus also helps the soil to hold its nutrients, increasing its fertility. Fertile soils are rich in nitrogen, contain a high percentage of organic materials, and are usually black or dark brown in color. Soils that are nitrogen poor and low in organic material might be gray or yellow or even red in color. Fertile soils are more easily cultivated.

Soil Texture and Composition

The inorganic portion of soil is made of many different size particles, and these different size particles are present in different proportions. The combination of these two factors determines some of the properties of the soil.

- A **permeable** soil allows water to flow through it easily because the spaces between the inorganic particles are large and well connected. Sandy or silty soils are considered 'light' soils because they are permeable, water-draining types of soils.
- Soils that have lots of very small spaces are water-holding soils. For example, when clay is present in a soil, the soil is heavier, holds together more tightly, and holds water.
- When a soil contains a mixture of grain sizes, the soil is called a **loam** (**Figure** 1.14).

FIGURE 1.14
A loam field.

When soil scientists want to precisely determine soil type, they measure the percentage of sand, silt, and clay. They plot this information on a triangular diagram, with each size particle at one corner (**Figure** 1.15). The soil type can then be determined from the location on the diagram. At the top, a soil would be clay; at the left corner, it would be sand, and at the right corner it would be silt. Soils in the lower middle with less than 50% clay are loams.

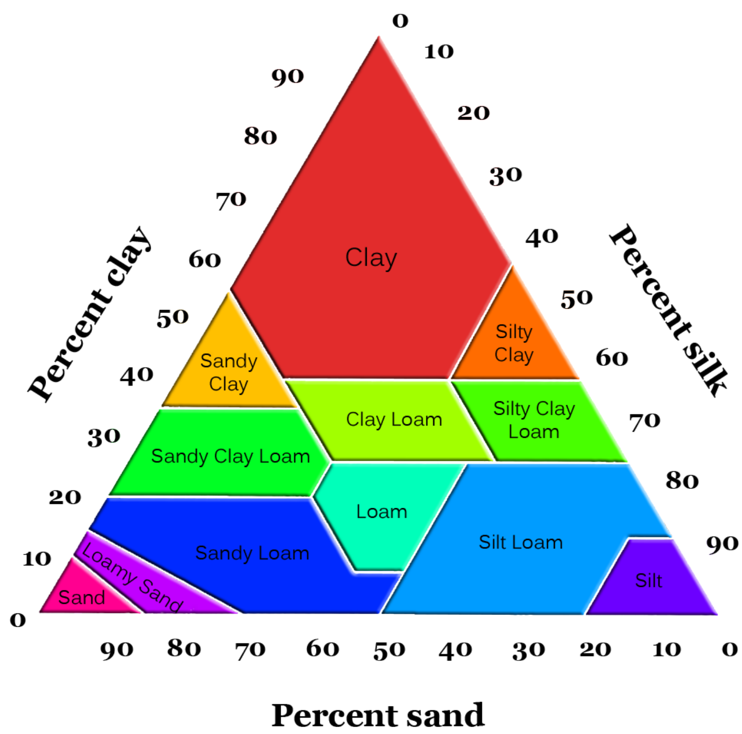

FIGURE 1.15
Soil types by particle size.

Using the chart as a guide, what is the composition of a sandy clay loam? If you would like to determine soil type by feel, here's a chart from the USDA to help you: http://soils.usda.gov/education/resources/lessons/texture/.

Soil Horizons and Profiles

A residual soil forms over many years, as mechanical and chemical weathering slowly change solid rock into soil. The development of a residual soil may go something like this.

1. The bedrock fractures because of weathering from ice wedging or another physical process.
2. Water, oxygen, and carbon dioxide seep into the cracks to cause chemical weathering.
3. Plants, such as lichens or grasses, become established and produce biological weathering.
4. Weathered material collects until there is soil.
5. The soil develops **soil horizons**, as each layer becomes progressively altered. The greatest degree of weathering is in the top layer. Each successive, lower layer is altered just a little bit less. This is because the first place where water and air come in contact with the soil is at the top.

A cut in the side of a hillside shows each of the different layers of soil. All together, these are called a **soil profile**. (**Figure** 1.16).

The simplest soils have three horizons.

Topsoil

Called the A horizon, the **topsoil** is usually the darkest layer of the soil because it has the highest proportion of organic material. The topsoil is the region of most intense biological activity: insects, worms, and other animals

FIGURE 1.16
Soil is an important resource. Each soil horizon is distinctly visible in this photograph.

burrow through it and plants stretch their roots down into it. Plant roots help to hold this layer of soil in place. In the topsoil, minerals may dissolve in the fresh water that moves through it to be carried to lower layers of the soil. Very small particles, such as clay, may also get carried to lower layers as water seeps down into the ground.

Subsoil

The **B horizon** or **subsoil** is where soluble minerals and clays accumulate. This layer is lighter brown and holds more water than the topsoil because of the presence of iron and clay minerals. There is less organic material. **Figure** 1.17.

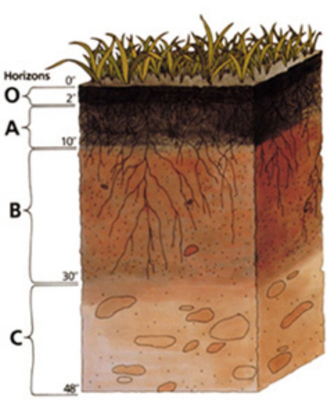

FIGURE 1.17
A soil profile is the complete set of soil layers. Each layer is called a horizon.

C horizon

The **C horizon** is a layer of partially altered bedrock. There is some evidence of weathering in this layer, but pieces of the original rock are seen and can be identified.

Not all climate regions develop soils, and not all regions develop the same horizons. Some areas develop as many as five or six distinct layers, while others develop only very thin soils or perhaps no soils at all.

Types of Soils

Although soil scientists recognize thousands of types of soil – each with its own specific characteristics and name - let's consider just three soil types. This will help you to understand some of the basic ideas about how climate produces a certain type of soil, but there are many exceptions to what we will learn right now (**Figure** 1.18).

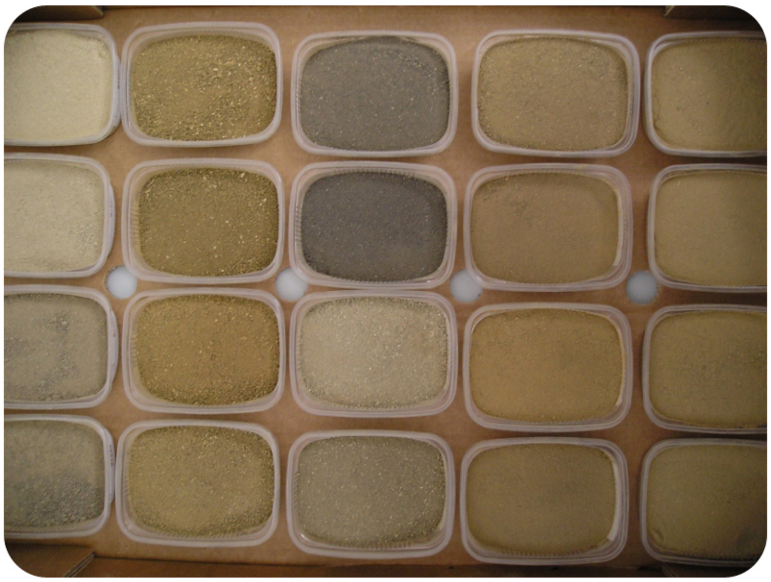

FIGURE 1.18
Just some of the thousands of soil types.

Pedalfer

Deciduous trees, the trees that lose their leaves each winter, need at least 65 cm of rain per year. These forests produce soils called **pedalfers**, which are common in many areas of the temperate, eastern part of the United States (**Figure** 1.19). The word pedalfer comes from some of the elements that are commonly found in the soil. The *Al* in ped**al**fer is the chemical symbol of the element aluminum, and the *Fe* in pedal**fe**r is the chemical symbol for iron. Pedalfers are usually a very fertile, dark brown or black soil. Not surprising, they are rich in aluminum clays and iron oxides. Because a great deal of rainfall is common in this climate, most of the soluble minerals dissolve and are carried away, leaving the less soluble clays and iron oxides behind.

Pedocal

Pedocal soils form in drier, temperate areas where grasslands and brush are the usual types of vegetation (**Figure** 1.20). The climates that form pedocals have less than 65 cm rainfall per year, so compared to pedalfers, there is less chemical weathering and less water to dissolve away soluble minerals so more soluble minerals are present and fewer clay minerals are produced. It is a drier region with less vegetation, so the soils have lower amounts of organic material and are less fertile.

A pedocal is named for the calcite enriched layer that forms. Water begins to move down through the soil layers, but before it gets very far, it begins to evaporate. Soluble minerals, like calcium carbonate, concentrate in a layer that marks the lowest place that water was able to reach. This layer is called caliche.

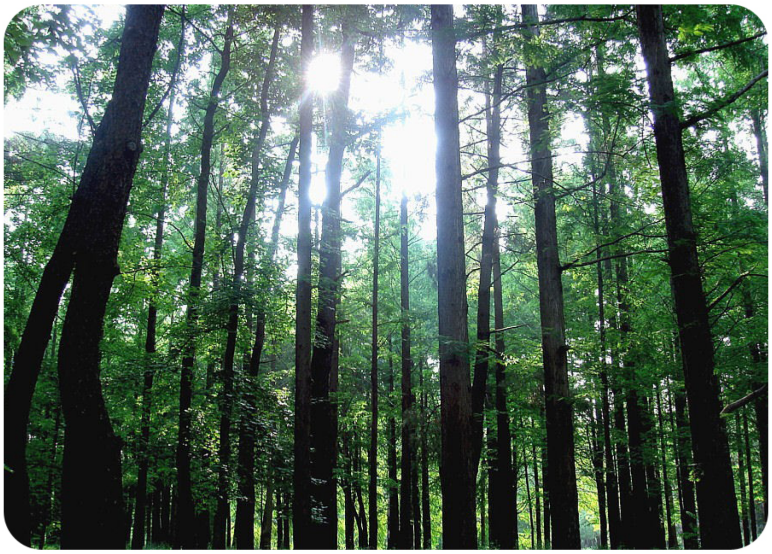

FIGURE 1.19
A pedalfer is the dark, fertile type of soil that will form in a forested region.

FIGURE 1.20
A pedocal is the alkaline type of soil that forms in grassland regions.

Laterite

In tropical rainforests where it rains literally every day, **laterite** soils form (**Figure** 1.21). In these hot, wet, tropical regions, intense chemical weathering strips the soils of their nutrients. There is practically no humus. All soluble minerals are removed from the soil and all plant nutrients are carried away. All that is left behind are the least soluble materials, like aluminum and iron oxides. These soils are often red in color from the iron oxides. Laterite soils bake as hard as a brick if they are exposed to the sun.

Many climates types have not been mentioned here. Each produces a distinctive soil type that forms in the particular circumstances found there. Where there is less weathering, soils are thinner but soluble minerals may be present. Where there is intense weathering, soils may be thick but nutrient poor. Soil development takes a very long time, it may take hundreds or even thousands of years for a good fertile topsoil to form. Soil scientists estimate that in the very best soil-forming conditions, soil forms at a rate of about 1mm/year. In poor conditions, soil formation may take thousands of years!

FIGURE 1.21
A laterite is the type of thick, nutrient poor soil that forms in the rainforest.

Soil Conservation

Soil is only a renewable resource if it is carefully managed. Drought, insect plagues, or outbreaks of disease are natural cycles of events that can negatively impact ecosystems and the soil, but there are also many ways in which humans neglect or abuse this important resource.

One harmful practice is removing the vegetation that helps to hold soil in place. Sometimes just walking or riding your bike over the same place will kill the grass that normally grows there. Land is also deliberately cleared or deforested for wood. The loose soils then may be carried away by wind or running water. In many areas of the world, the rate of soil erosion is many times greater than the rate at which it is forming. Soils can also be contaminated if too much salt accumulates in the soil or where pollutants sink into the ground. There are many practices that can protect and preserve soil resources. Adding organic material to the soil in the form of plant or animal waste, such as compost or manure, increases the fertility of the soil and improves its ability to hold onto water and nutrients (**Figure** 1.22). Inorganic fertilizer can also temporarily increase the fertility of a soil and may be less expensive or time consuming, but it does not provide the same long-term improvements as organic materials.

FIGURE 1.22
Organic material can be added to soil to help increase its fertility.

Agricultural practices such as rotating crops, alternating the types of crops planted in each row, and planting nutrient rich cover crops all help to keep soil more fertile as it is used season after season. Planting trees as windbreaks, plowing along contours of the field, or building terraces into steeper slopes will all help to hold soil in place (**Figure** 1.23). No-till or low-tillage farming helps to keep soil in place by disturbing the ground as little as possible when planting.

FIGURE 1.23
Steep slopes can be terraced to make level planting areas and decrease surface water runoff and erosion.

Lesson Summary

- Soil is an important resource. Life on Earth could not exist as it does today without soil.
- The type of soil that forms depends mostly on climate and, to a lesser extent, on the original parent rock material and other factors.
- Soil texture and composition, plus the amount of organic material in a soil, determine a soil's qualities and fertility.
- Given enough time, rock is weathered to produce a layered soil, called a soil profile.
- Each type of climate can ultimately produce a unique type of soil.

Review Questions

1. Why is soil sometimes described as a living resource?
2. Name two factors that influence soil formation and explain how they do so.
3. Which region of a soil profile reacts the most?
4. Is the soil in your backyard most likely a residual soil or a transported soil? How could you check?
5. Name several advantages to adding humus to the soil.
6. What are three soil horizons? Describe the characteristics of each.
7. Name three climate related soils. Describe the climate and vegetation that occurs in the area where each forms.
8. Where would you choose to buy land for a farm if you wanted fertile soil and did not want to have to irrigate your crops?

Further Reading / Supplemental Links

- The University of British Columbia has a collection of images that illustrate various aspects of soils: See here for more info.

Points to Consider

- Why is soil such an important resource?
- Would soil mature faster from unaltered bedrock or from transported materials?
- If soil erosion is happening at a greater rate than new soil can form, what will eventually happen to the soil in that region?
- Do you think there are pollutants that could not easily be removed from soil?

1.3 References

1. . Wea-0901-01.
2. . Wea-0901-02.
3. . HS-ES-09-03-Rocks-on-beach.jpg.
4. . Figure-09-04-Mechanical-weathering.
5. . Wea-0901-03.
6. . HS-ES-09-Deforestation-Brazil.JPG.
7. . Pollution - Damaged by acid rain.
8. . Wea-0901-04.
9. . Wea-0901-05.
10. . HS-ES-09-11-Tropical-areas.jpg.
11. . HS-ES-09-12-Peat-organic-material.jpg.
12. . HS-ES-09-13-Earthworms.jpg.
13. . ES climate map.
14. . HS-ES-09-15-Loam-Field.jpg.
15. . HS-ES-Rev-9-Soil types.png.
16. . Wea-0902-03.
17. . Wea-0902-04a.
18. . HS-ES-09-19-Soils.jpg.
19. . Wea-0902-05.
20. . Wea-0902-06.
21. . Wea-0902-07.
22. . Wea-0902-08.
23. . Wea-0902-09.