Launch Lab

15 minutes

How do rocks change?

Weathering is any natural process that changes a rock. The processes can be physical or chemical. How can you tell the difference between physical and chemical weathering?

1. Read and complete a lab safety form.
2. Use a **graduated cylinder** to pour 100 mL of water into a **beaker.** Use a **wax pencil** to mark this beaker with a *W.*
3. Pour 100 mL of **vinegar** into a second beaker. Mark this beaker with a *V.*
4. Break a piece of **chalk** into two equal pieces. Use a **mortar and pestle** to crush one half. Put the crushed chalk on a piece of **paper.** Repeat for the other piece of chalk.
5. At the same time, add the crushed chalk to each beaker. In your Science Journal, describe what happens.

Think About This

1. When did physical weathering take place? When did chemical weathering take place? Explain.
2. **Key Concept** What do you think is the difference between physical and chemical weathering?

Breaking Down Earth Materials

Tall mountains form as a result of movement along faults near plate boundaries. But mountains don't get taller forever. Other processes wear away and break down mountains. These processes often are so slow that it is difficult to see changes in the mountains during a human's lifetime.

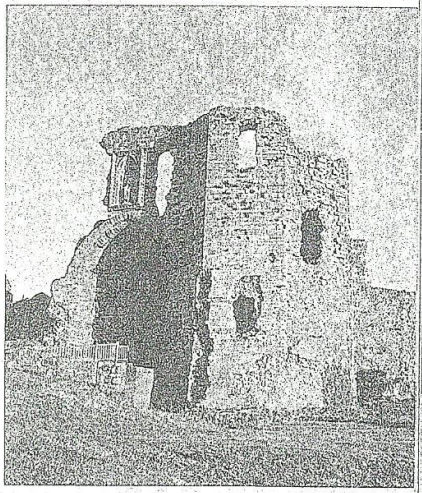
Think of an old castle made of stone, such as the one shown in Figure 16. The stones might be round or broken. Some walls might have collapsed. Over time, many processes acted together and broke down the stones. The effects of rain and wind have gradually made the stones more rounded. Perhaps an earthquake knocked down some of the castle. Mountains are similar. Over time, the same processes that changed the stones of the castle can change the rocks that make up mountains.

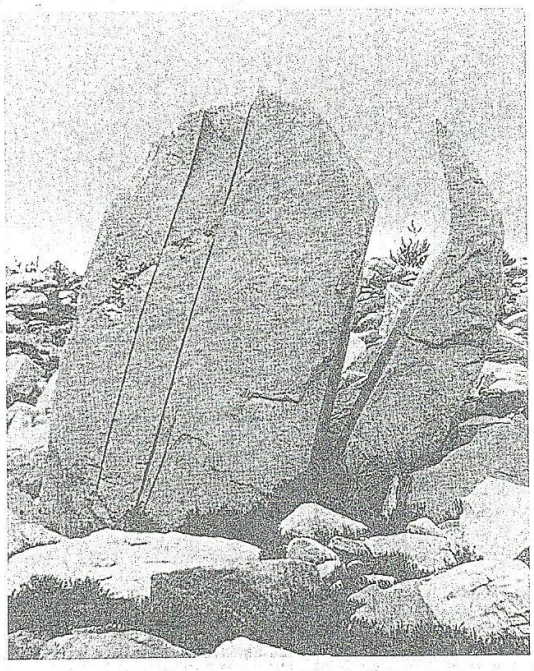
Weathering *refers to the mechanical and chemical processes that change Earth's surface over time.* Weathering can affect rocks in different ways. The processes of weathering can break, scrape, smooth, or chemically change rock. **Sediment** *is the material formed from rocks broken down by weathering.* Weathering can produce sediment of different sizes. Sediment can be rock fragments, sand, silt, or clay.

Reading Check How is weathering related to sediment?

Figure 16 Over time, some of the same processes that changed the stone walls of this building also can wear away and break down mountains.

Visual Check What changes have occurred to the stone walls of this castle?





▲ **Figure 17** The repeated freezing and thawing of water broke this rock.

Physical Weathering

The first step in making sediment is to make smaller pieces of rock from larger ones. **Physical weathering** *is the process of breaking down rock without changing the composition of the rock.* Several natural processes cause physical weathering. For example, if a boulder rolls off a cliff and breaks apart, it experiences physical weathering. Forces from plate motion, such as when faults rupture, also can cause rock to break.

Physical weathering also can occur because of changes in weather. Water can seep into rocks. If the temperature is cold enough, the water can freeze. Unlike most liquids, water expands when it freezes. The force from the expanding ice pushes outward and, over time, can shatter rocks, as shown in **Figure 17.**

Plants and animals also can break rocks. The roots of plants can grow into cracks in rocks. The force from the growing roots can pry the rock open, as shown in **Figure 18.** Even the roots of lichen, the small flat plants that grow on rock surfaces, can cause small cracks to form.

Reading Check What processes can break down rock into smaller pieces?

Figure 18 As roots grow, they push pieces of rock apart. ▽

Chemical Weathering

Some minerals can react with water, air, or substances in water and air, such as carbon dioxide (CO_2). **Chemical weathering** *is the process that changes the composition of rocks.*

Some minerals can dissolve in slightly acidic water, such as rainwater. Limestone contains calcite, a mineral that dissolves in slightly acidic water, as shown in **Figure 19.**

Other minerals react with air and water to form new minerals. CO_2 in the atmosphere and in water can react with minerals, such as feldspar, to form clay. Some minerals contain iron, which can react with oxygen in the atmosphere to form iron oxide, or rust. The red color of many rocks is caused by iron oxide, as shown in **Figure 19.**

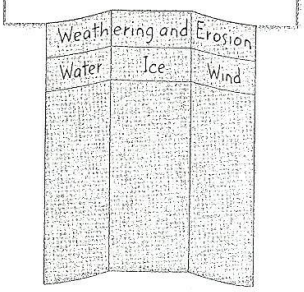
Chemical weathering happens faster where water is abundant. It also happens faster where it is warm because chemical reactions happen faster at higher temperatures.

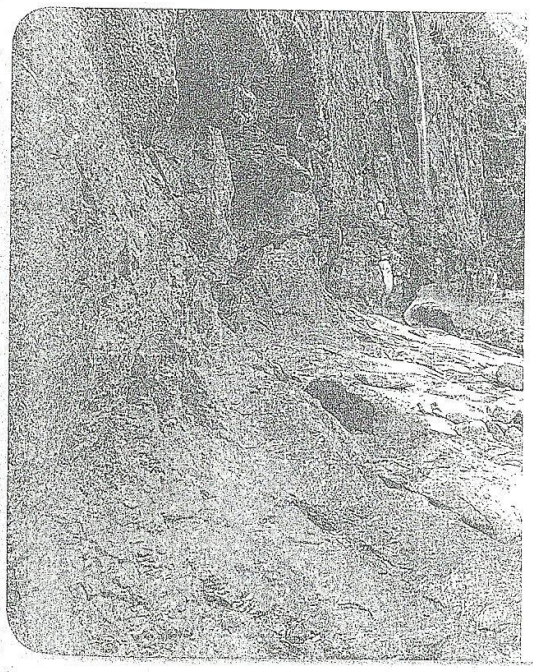
Chemical weathering and physical weathering affect each other. For example, physical weathering makes smaller pieces of rock. When rocks break, chemical weathering can occur on the newly exposed surfaces. Chemical weathering can make rocks weaker, making the rocks break more easily. The rounded hill pictured at the beginning of this chapter formed from the interaction between physical and chemical weathering.

Key Concept Check What is the difference between physical and chemical weathering?

FOLDABLES®

Make a vertical three-column chart book. Label it as shown. Use it to organize your notes on weathering and erosion.





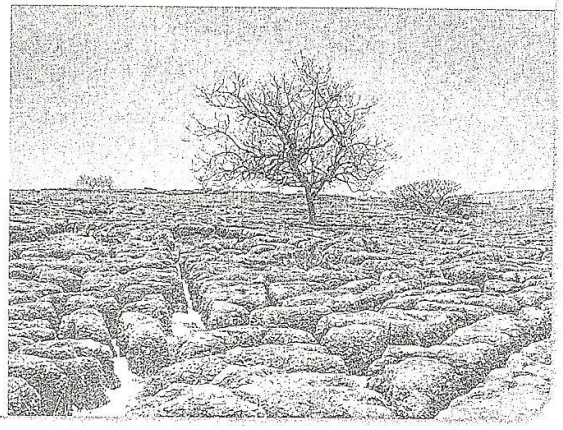


Figure 19 Chemical weathering can change rocks. Water and oxygen weathered the iron in this rock on the left, forming red-colored iron oxide. Limestone, shown on the right, can dissolve easily in rainwater.

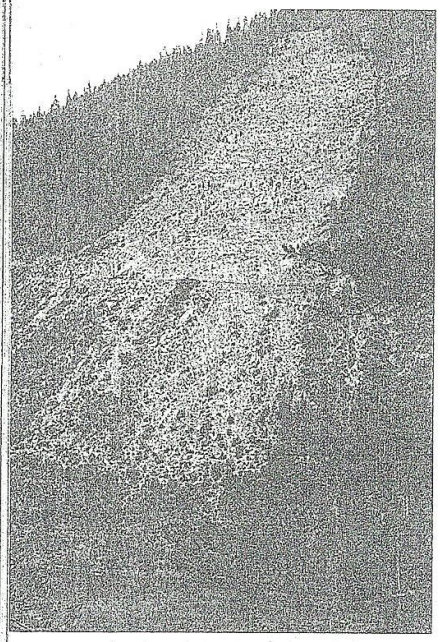


Figure 20 Mass wasting can cause quick and drastic changes to landscapes. This landslide, in Emerald Bay, California, occurred in weathered granite.

Moving Earth Materials

Mountains wear away for many reasons. Weathering produces smaller rocks, which can be moved more easily. Chemical weathering dissolves minerals that make up these smaller rocks. But this slow weathering is not the only way mountains wear down. Rock also can be removed from the tops of mountains. Geologists use the term ***erosion*** to describe *the moving of weathered material, or sediment, from one location to another.* **Deposition** *is the laying down or settling of eroded material.* Together, erosion and deposition change the surface of Earth.

Gravity's Influence

Gravity causes material to move downhill. **Mass wasting** *is the downhill movement of a large mass of rocks or soil due to gravity.* If mountains are tall enough or slopes are too steep, the force of gravity can create landslides, a type of mass wasting. In just a few moments, large amounts of rock and soil can come crashing downhill. Some landslides start from the tops of mountains and end at valley floors, as shown in **Figure 20.**

Erosion requires energy. During a landslide, gravity provides this energy. But, flowing water, wind, and moving ice also can have enough energy to move rocks and soil.

Reading Check What provides the forces that can cause rock to move downhill?

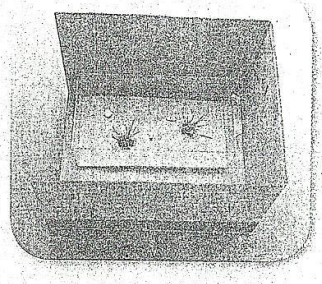
MiniLab

15 minutes

How can wind change Earth's surface?

Wind changes Earth's surface in different ways. How can you demonstrate how wind can change the land?

1. Read and complete a lab safety form.
2. Pour dry **sand** into a **clear plastic box.** Place two or three **large pebbles** and **small clumps of grass** on the surface of the sand.
3. Place the box into a **cardboard box** that is open on one side.
4. Plug in the **hair dryer.** Hold the hair dryer about 10 cm from the edge of the box at a 45° angle relative to the plastic box.
5. Turn the dryer on low. Hold it in the same position for 2–3 min. Record your observations in your Science Journal.



Analyze and Conclude

1. **Observe** How did the hair dryer—the wind model—change the sand? Be specific in your answer.
2. **Key Concept** How does wind change Earth's surface?

Water

Most erosion and transport of sediment occurs by flowing water. Water flows fastest where the land is steep. Water also flows faster in larger rivers than in smaller ones. Large rivers cause the most erosion. The faster water flows, the larger the pieces of sediment it can carry. Rivers can even wear away solid rock, such as Niagara Falls, shown in **Figure 21.**

Water often slows as it flows downstream. Slowly flowing water has less energy and can carry less sediment. As water slows, the sediment in the water is deposited on the sides of the river. Sediment also is deposited when rivers enter oceans or lakes, creating land features called deltas.

REVIEW VOCABULARY

delta
triangular deposit of sediment that forms where a stream enters a large body of water.

Wind

Sometimes, wind is strong enough to cause erosion. In deserts, erosion by wind can be the most important process that changes landforms. Wind can slowly weather and erode solid rock, as pictured in **Figure 22.** Wind also can pick up sand grains and carry them from one place to another. Sand dunes and ripples, such as those shown in **Figure 23,** are examples of landforms made by wind.

Reading Check What causes most erosion on Earth?

Figure 21 Flowing water can erode solid rock and make land features such as waterfalls.

Review Personal Tutor

Figure 23 Blowing wind can carry sand, forming ripples on sandy surfaces.

Figure 22 Strong wind can carve rocks into unusual shapes that rise above the surroundings.

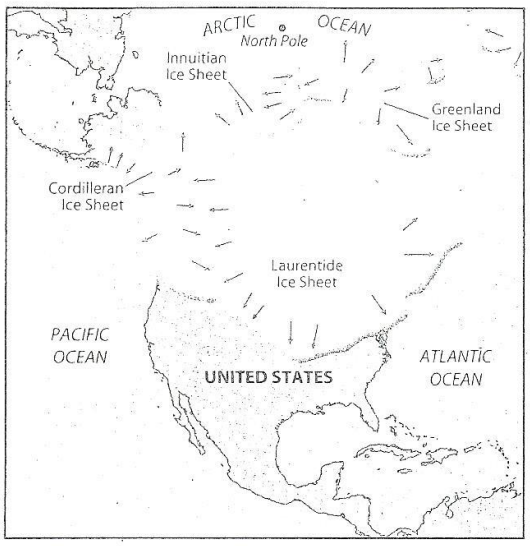
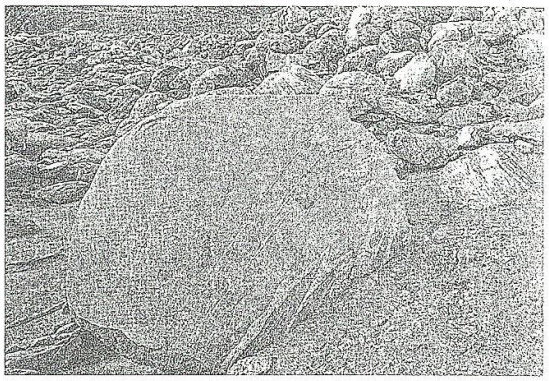


Figure 24 Large glaciers flowed from Northern Canada into the United States 20,000 years ago. These ice sheets brought sediment with them. When the ice melted, sediment, such as these large boulders, was left behind.



Ice

In cold climates, such as high mountains or near the North Pole and the South Pole, *large masses of ice, formed by snow accumulation on land, that move slowly across Earth's surface are called* **glaciers.** The force of gravity causes this ice to flow downhill.

WORD ORIGIN
glacier
from Greek *glacies*, means "ice"

Sliding and flowing ice can weather the rocks over which the ice moves. This process creates sediment that glaciers carry away. Over time, glaciers can carve deep valleys.

When a glacier melts, it deposits the sediment it carried. Much of North America was covered by ice 20,000 years ago, as shown in **Figure 24.** When this ice sheet melted, it left behind sediment. Rocks and smaller sediment were carried from northern Canada and deposited in the United States.

Earth's Changing Surface

ACADEMIC VOCABULARY
processes
(noun) a series of actions or operations that lead to an end result

Many of Earth's surface features and the processes that occur on it can be related and explained by plate tectonics. The **processes** that move Earth material depend on climate, or the average weather in a region over a long period of time. Temperature, amount of precipitation, the pattern of winds, and circulation of the ocean affect climate. The location of continents affects ocean circulation. The locations of mountains affect wind patterns and precipitation. The processes that change the features made by plate movement are affected by plate movement itself.

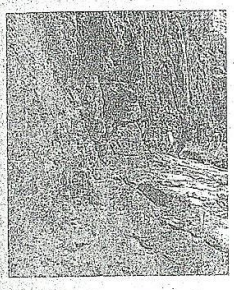
Key Concept Check How do water, ice, and wind change Earth's surface?

Lesson 3 Review

Assessment Online Quiz

Visual Summary

Physical weathering breaks down rocks into smaller pieces but does not change the mineral composition.



Chemical weathering changes a rock's mineral composition. This makes rocks weaker and helps break down rocks into smaller pieces.

Gravity, wind, water, and ice can cause physical and chemical weathering. They break down, erode, transport, and deposit rocks and sediment.

FOLDABLES

Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end of the chapter.

What do you think NOW?

You first read the statements below at the beginning of the chapter.

5. Wind erosion only occurs in the desert.

6. Rivers are the only cause of erosion.

Did you change your mind about whether you agree or disagree with the statements? Rewrite any false statements to make them true.

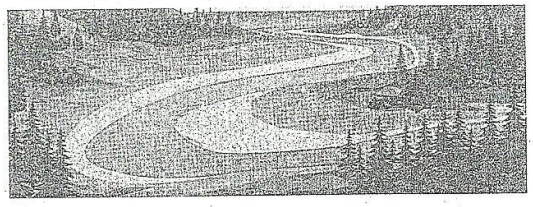
Use Vocabulary

1. **Define** *weathering* in your own words.
2. Material transported by water, wind, and ice is called _____.
3. The opposite of deposition is _____.

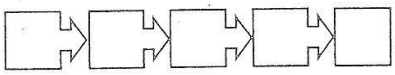
Understand Key Concepts

4. **Explain** why large boulders are present in steep mountain streams.
5. On steep slopes, gravity causes
   - A. chemical weathering.
   - B. mass wasting.
   - C. physical weathering.
   - D. strong winds.
6. **Contrast** chemical and physical weathering.

Interpret Graphics



7. **Analyze** What happened to the speed of the water as it rounded this bend in the river? Explain.
8. **Sequence** Put these terms in the correct sequence as they relate to the breakdown and movement of Earth materials: *rock, sediment, deposition, erosion, weathering.*



Critical Thinking

9. **Predict** how increased temperature and precipitation would affect a mountain.
10. **Reconstruct** the ways physical and chemical weathering rounded the rocks in the lesson opener photo. Explain how the two types of weathering interact.