Section 6.1

Objectives

- **Sequence** the formation of sedimentary rocks.
- **Explain** the process of lithification.
- **Describe** features of sedimentary rocks.

Review Vocabulary

texture: the physical appearance or feel of a rock

New Vocabulary

sediment
lithification
cementation
bedding
graded bedding
cross-bedding

Formation of Sedimentary Rocks

MAIN Idea **Sediments produced by weathering and erosion form sedimentary rocks through the process of lithification.**

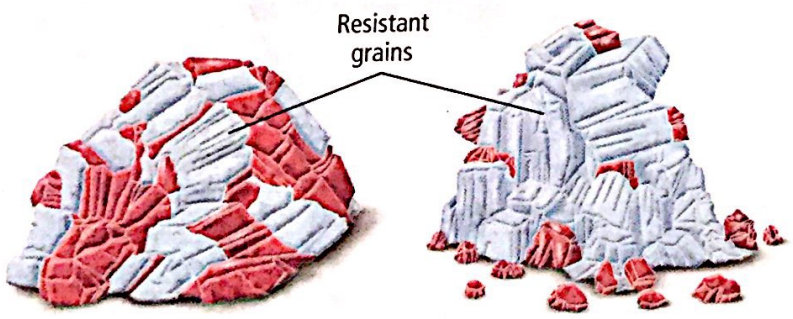
Real-World Reading Link Whenever you are outside, you might see pieces of broken rock, sand, and soil on the ground. What happens to this material? With one heavy rain, these pieces of broken rock, sand, and soil could be on their way to becoming part of a sedimentary rock.

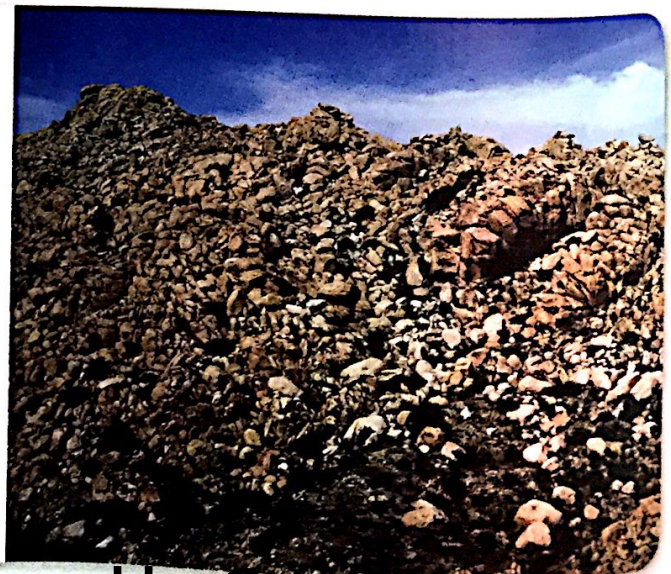
Weathering and Erosion

Wherever rock is exposed at Earth's surface, it is continuously being broken down by weathering—a set of physical and chemical processes that breaks rock into smaller pieces. **Sediments** are small pieces of rock that are moved and deposited by water, wind, glaciers, and gravity. When sediments become glued together, they form sedimentary rocks. The formation of sedimentary rocks begins when weathering and erosion produce sediments.

Weathering Weathering produces rock and mineral fragments known as sediments. These sediments range in size from huge boulders to microscopic particles. Chemical weathering occurs when the minerals in a rock are dissolved or otherwise chemically changed. What happens to more-resistant minerals during weathering? While the less-stable minerals are chemically broken down, the more-resistant grains are broken off of the rock as smaller grains. During physical weathering, however, minerals remain chemically unchanged. Rock fragments break off of the solid rock along fractures or grain boundaries. The rock in **Figure 6.1** has been chemically and physically weathered.

■ **Figure 6.1** When exposed to both chemical and physical weathering, granite eventually breaks apart and might look like the decomposed granite shown here.
Explain *which of the three common minerals —quartz, feldspar and mica—will be most resistant to weathering.*

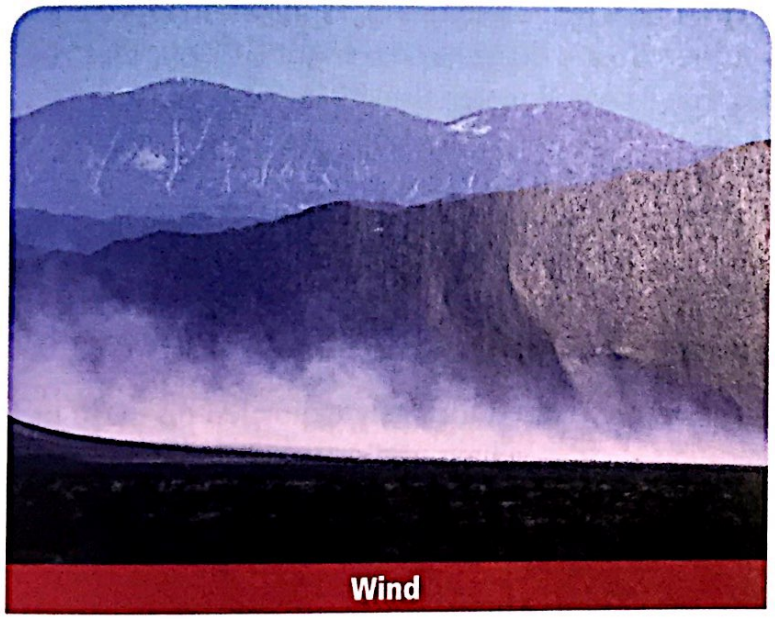


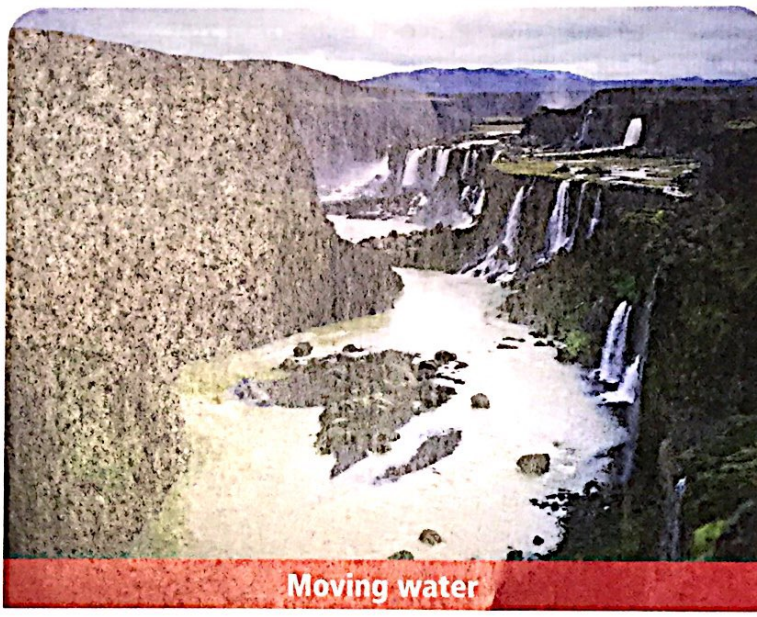


Erosion The removal and transport of sediment is called erosion. **Figure 6.2** shows the four main agents of erosion: wind, moving water, gravity, and glaciers. Glaciers are large masses of ice that move across land. Visible signs of erosion are all around you. For example, water in streams becomes muddy after a storm because eroded silt and clay-sized particles have been mixed in it. You can observe erosion in action when a gust of wind blows soil across the infield at a baseball park. The force of the wind removes the soil and carries it away.

After rock fragments and sediments have been weathered out of the rock, they often are transported to new locations through the process of erosion. Eroded material is almost always carried downhill. Although wind can sometimes carry fine sand and dust to higher elevations, particles transported by water are almost always moved downhill. Eventually, even windblown dust and fine sand are pulled downhill by gravity. You will learn more about weathering and erosion in Chapter 7.

Reading Check **Summarize** what occurs during erosion.





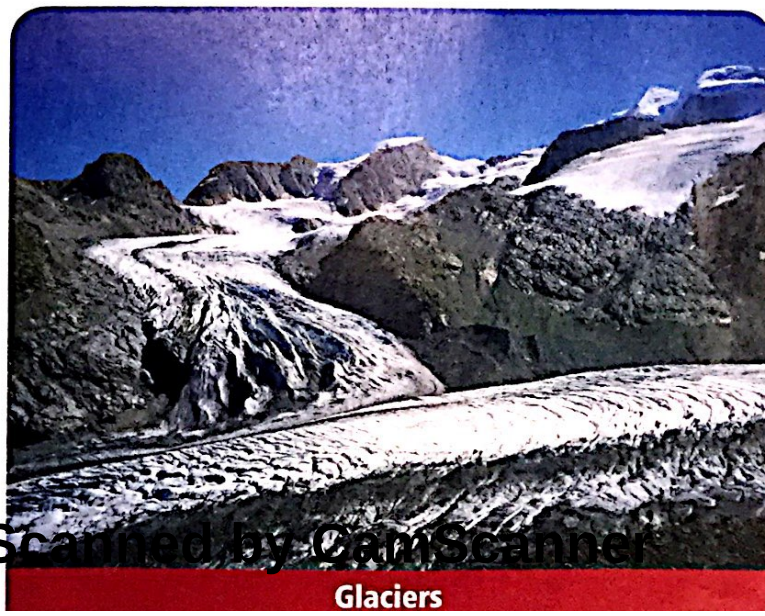


Figure 6.2 Rocks and sediment are eroded and transported by the main agents of erosion—wind, moving water, gravity, and glaciers.

MiniLab

Model Sediment Layering

How do layers form in sedimentary rocks? Sedimentary rocks are usually found in layers. In this activity, you will investigate how layers form from particles that settle in water.

Procedure

1. Read and complete the lab safety form.
2. Obtain 100 mL of **sediment** from a location specified by your teacher.
3. Place the sediment in a **200 mL jar with a lid.**
4. Add **water** to the jar until it is three-fourths full.
5. Place the lid on the jar securely.
6. Pick up the jar with both hands and turn it upside down several times to mix the water and sediment. Hesitate briefly with the jar upside down before tipping it up for the last time. Place the jar on a flat surface.
7. Let the jar sit for about 5 min.
8. Observe the settling process.

Analysis

1. **Illustrate** what you observed in a diagram.
2. **Describe** what type of particles settle out first.
3. **Describe** what type of particles form the topmost layers.

Deposition When transported sediments are deposited on the ground or sink to the bottom of a body of water, deposition occurs. During the MiniLab, what happened when you stopped turning the jar full of sediment and water? The sediment sank to the bottom and was deposited in layers with the largest grains at the bottom and the smallest grains at the top. Similarly, sediments in nature are deposited when transport stops. Perhaps the wind stops blowing or a river enters a quiet lake or an ocean. In each case, the particles being carried will settle out, forming layers of sediment with the largest grains at the bottom.

Energy of transporting agents Fast-moving water can transport larger particles better than slow-moving water. As water slows down, the largest particles settle out first, then the next largest, and so on, so that different-sized particles are sorted into layers. Such deposits are characteristic of sediment transported by water and wind. Wind, however, can move only small grains. For this reason, sand dunes are commonly made of fine, well-sorted sand, as shown in **Figure 6.3.** Not all sediment deposits are sorted. Glaciers, for example, move all materials with equal ease. Large boulders, sand, and mud are all carried along by the ice and dumped in an unsorted pile as the glacier melts. Landslides create similar deposits when sediment moves downhill in a jumbled mass.

Lithification

Most sediments are ultimately deposited on Earth in low areas such as valleys and ocean basins. As more sediment is deposited in an area, the bottom layers are subjected to increasing pressure and temperature. These conditions cause **lithification,** the physical and chemical processes that transform sediments into sedimentary rocks. *Lithify* comes from the Greek word *lithos*, which means *stone.*

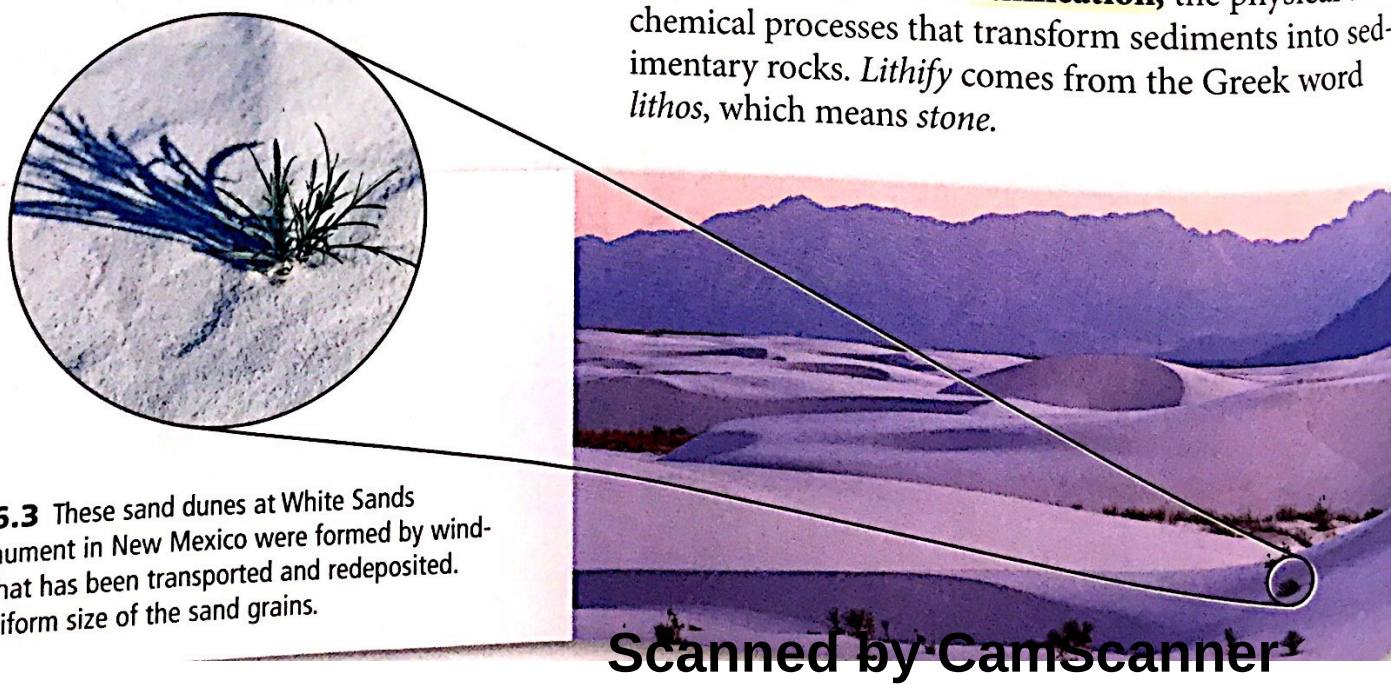


Figure 6.3 These sand dunes at White Sands National Monument in New Mexico were formed by wind-blown sand that has been transported and redeposited. Notice the uniform size of the sand grains.

Compaction Lithification begins with compaction. The weight of overlying sediments forces the sediment grains closer together, causing the physical changes shown in **Figure 6.4.** Layers of mud can contain up to 60 percent water, and these shrink as excess water is squeezed out. Sand does not compact as much as mud during burial. One reason is that individual sand grains, usually composed of quartz, do not deform under normal burial conditions. Grain-to-grain contacts in sand form a supporting framework that helps maintain open spaces between the grains. Groundwater, oil, and natural gas are commonly found in these spaces in sedimentary rocks.

Cementation Compaction is not the only force that binds the grains together. **Cementation** occurs when mineral growth glues sediment grains together into solid rock. This occurs when a new mineral, such as calcite ($CaCO_3$) or iron oxide (Fe_2O_3), grows between sediment grains as dissolved minerals precipitate out of groundwater. This process is illustrated in **Figure 6.5.**

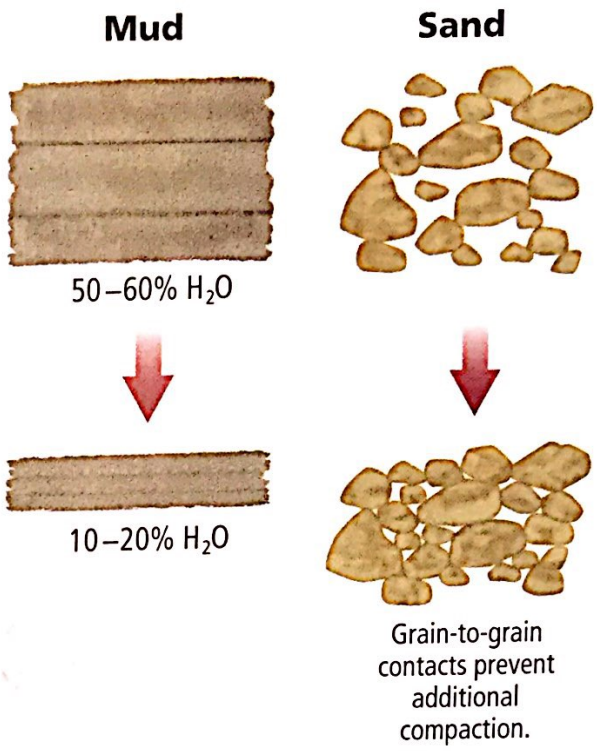


Figure 6.4 The high water content and flat shape of particles in mud cause it to compact greatly when subjected to the weight of overlying sediments.

Sedimentary Features

Just as igneous rocks contain information about the history of their formation, sedimentary rocks also have features and characteristics that help geologists interpret how they formed and the history of the area in which they formed.

Bedding The primary feature of sedimentary rocks is horizontal layering called **bedding.** This feature results from the way sediment settles out of water or wind. Individual beds can range in thickness from a few millimeters to several meters. There are two different types of bedding, each dependent upon the method of transport. However, the size of the grains and the material within the bedding depend upon many other factors.

FOLDABLES
Incorporate information from this section into your Foldable.

Figure 6.5 Minerals precipitate out of water as it flows through pore spaces in the sediment. These minerals form the cement that glues the sediments together.