3.3 Sedimentary Rocks

Reading Focus

Key Concepts
- Describe the major processes involved in the formation of sedimentary rocks.
- What are clastic sedimentary rocks?
- What are chemical sedimentary rocks?
- What features are unique to some sedimentary rocks?

Vocabulary
- erosion
- deposition
- compaction
- cementation
- clastic sedimentary rock
- chemical sedimentary rock

Reading Strategy
Outlining Copy this outline beneath the outline you made for Section 3.2. Complete this outline as you read. Include points about how each of these rocks form, some of the characteristics of each rock type, and some examples of each.

II. Sedimentary Rocks
A. Clastic Rocks
1. ?
2. ?
B. Chemical Rocks
1. ?
2. ?

Build Vocabulary
LINCS Have students List the parts of the vocabulary words that they know. For example, cement is part of cementation. Next, they should Imagine a mental picture of the term’s meaning and describe the image in their own words. Sediments held together by cement might be an image for cementation. Students should then make a Note of a familiar “sound-alike” word. They can Connect the terms by making up a short story about the meaning of the term that incorporates the sound-alike word. Lastly, students should conduct a Self-test by quizzing themselves on the vocabulary terms.

Reading Strategy
A. 1. rock made up of weathered bits of rocks and minerals
A.2. Common example of clastic sedimentary rock is shale.
B. 1. rock that forms when dissolved minerals precipitate from water
B.2. Common example of chemical sedimentary rock is limestone.

All sedimentary rocks begin to form when existing rocks are broken down into sediments. Sediments, which consist mainly of weathered rock debris, are often transported to other places. When sediments are dropped, they eventually become compacted and cemented to form sedimentary rocks. The structures shown in Figure 9 are made of the sedimentary rock called sandstone. It is only one of many types of sedimentary rocks.

Figure 9 Sedimentary Rocks in Canyonlands National Park, Utah The rocks shown here formed when sand and other sediments were deposited and cemented. Weathering processes created this arch.
**Section 3.3 (continued)**

### INSTRUCT

#### Build Reading Literacy

Refer to p. 64D in Chapter 3, which provides the guidelines for directed reading/thinking activity (DRTA).

**DRTA** Before students read this section, have them preview the key concepts, vocabulary terms, and headings. Ask: What do you think you will learn in this section? (Sample answer: about sedimentary rock formation, clastic sedimentary rocks, and chemical sedimentary rock formation.) What type of questions might a teacher ask about this topic? (Sample answer: How do sedimentary rocks form? How are sedimentary rocks classified?) List these questions on the board. As students read the section, pause to discuss the answers to the questions.

**Verbal**

### Formation of Sedimentary Rocks

**Address Misconceptions**

Some students may think that rocks are stronger than the agents of mechanical and chemical weathering. To help dispel this misconception, place a few drops of vinegar on a sample of limestone. Have students observe the resulting chemical reaction. Ask: What would happen if the acid continued to drip on the rock over a long period? (The rock would eventually break down or be chemically weathered.)

**Visual, Logical**

### Build Science Skills

**Observing** Provide small groups of students with 250-mL beakers, stirrers, sand, water, gravel, and soil. Tell students to half-fill the beakers with water. They should then pour about a handful of each material into the water. Have them stir the mixture, then observe what happens to the materials. Ask: Which materials settled on the bottom? Which settled on the top? (The heavier materials settled on the bottom; the smaller, lighter materials settled on the top.) What does this activity model? (the settling out of sediments from a fluid, such as water or air)

**Kinesthetic, Visual**

### Formation of Sedimentary Rocks

The word *sedimentary* comes from the Latin word *sedimentum*, which means "settling." Sedimentary rocks form when solids settle out of a fluid such as water or air. The rocks shown in Figure 10 formed when sediments were dropped by moving water. The sediments eventually became cemented to form rocks. Several major processes contribute to the formation of sedimentary rocks.

#### Weathering, Erosion, and Deposition

Recall that weathering is any process that breaks rocks into sediments. Weathering is often the first step in the formation of sedimentary rocks. Chemical weathering takes place when the minerals in rocks change into new substances. Weathering also takes place when physical forces break rocks into smaller pieces. Living things, too, can cause chemical and physical weathering.

Weathered sediments don’t usually remain in place. Instead, water, wind, ice, or gravity carries them away. **Erosion involves weathering and the removal of rock.** When an agent of erosion—water, wind, ice, or gravity—loses energy, it drops the sediments. This process is called deposition.

Sediments are deposited according to size. The largest sediments, such as the rounded pebbles in the conglomerate in Figure 10A, are deposited first. Smaller sediments, like the pieces of sand that make up the sandstone in Figure 10B, are dropped later. Some sediments are so small that they are carried great distances before being deposited.

#### Compaction and Cementation

After sediments are deposited, they often become lithified, or turned to rock. **Compaction** and **cementation** change sediments into sedimentary rock. **Compaction is a process that squeezes, or compacts, sediments.** Compaction is caused by the weight of sediments. During compaction, much of the water in the sediments is driven out.

**Cementation** takes place when dissolved minerals are deposited in the tiny spaces among the sediments. Much of the cement in the conglomerate shown in Figure 10A can be seen with the unaided eye. The cement holding the sand grains together in the sandstone in Figure 10B, however, is microscopic.

![Figure 10](image)

**Figure 10** Although these two rocks appear quite different, both formed when sediments were dropped by moving water. A conglomerate is made of rounded pebbles cemented together. B Sandstone is made of sand grains cemented together.

#### Customized for English Language Learners

Compile a classroom library using up-to-date magazines and newspaper articles. Select reading materials that correspond to chapter content. For example, try to find articles that discuss different types of rocks. Avoid academic journals and reference materials with high reading levels. Provide opportunities for ELL students to read the articles in class. This will give them a broader context in which to place this chapter’s vocabulary terms and key concepts.
Classification of Sedimentary Rocks

Just like igneous rocks, sedimentary rocks can be classified into two main groups according to the way they form. The first group includes rocks that are made of weathered bits of rocks and minerals. These rocks are called clastic sedimentary rocks. The second group forms when dissolved minerals precipitate from water solutions. These rocks are called chemical sedimentary rocks.

Clastic Sedimentary Rocks

Many different minerals are found in clastic rocks. The most common are the clay minerals and quartz. This is because clay minerals, like those that make up much of the shale in Figure 11A, are the most abundant products of chemical weathering. Quartz, which is a major mineral in the breccia shown in Figure 11B, is a common sedimentary mineral for a different reason. It is very durable and resistant to chemical weathering.

Clastic sedimentary rocks can be grouped according to the size of the sediments in the rocks. When rounded, gravel-size or larger particles make up most of the rock, the rock is called conglomerate. If the particles are angular, the rock is called breccia. Sandstone is the name given to rocks when most of the sediments are sand-size grains. Shale, the most common sedimentary rock, is made of very fine-grained sediment. Siltstone is another fine-grained rock.

Describe the major types of clastic sedimentary rocks.

Chemical and Biochemical Sedimentary Rocks

Chemical sedimentary rocks form when dissolved substances precipitate, or separate, from water solution. This precipitation generally occurs when the water evaporates or boils off leaving a solid product. Examples of this type of chemical rock are some limestones, rock salt, chert, flint, and rock gypsum.

Chemical Weathering

Purpose
Students will observe how chemical weathering can change the minerals in rocks.

Materials
calcium tablet, 250-mL beaker, vinegar

Procedure
Half-fill the beaker with vinegar. Place the calcium tablet into the vinegar. Allow students to observe the reaction.

Expected Outcome
Students will observe that the calcium fizzes, foams, and eventually dissolves in the vinegar. Explain that chemical weathering breaks down rocks in a similar, though slower, fashion.

Visual

Download a worksheet on sedimentary rocks for students to complete, and find additional teacher support from NSTA SciLinks.
Section 3.3 (continued)

Build Science Skills

Designing Experiments

Have students work in small groups to design an experiment to show how sedimentary rocks form when dissolved minerals precipitate from water. Students should develop a hypothesis and procedure, listing controls, safety measures, and materials to be used. A sample experiment might involve placing table salt in water, then heating the water until it evaporates. If time permits, allow students to carry out their experiments. 

Logical, Interpersonal

Features of Some Sedimentary Rocks

Use Visuals

Figure 13 Ask: Based on its appearance, what can you infer about the rock labeled A? (It may have formed along a beach or stream bed.) What can you infer about the rock labeled B? (It may have formed when wet mud or clay dried and shrank.) 

Visual

Facts and Figures

Unlike other chemical sedimentary rocks, which are rich in calcite or silica, coal is made mostly of organic matter. When coal is viewed under a magnifying glass, chemically altered leaves, bark, and wood are visible. The materials provide evidence that coal is the end product of the burial of large amounts of plant materials over long periods of time. The initial stage of coal formation is the accumulation of large quantities of plant remains in a swampy environment. Coal then undergoes successive stages of formation. With each stage, higher temperatures and pressures drive off impurities and volatiles.

About 90 percent of limestones are formed from biochemical sediments. Such sediments are the shells and skeletal remains of organisms that settle to the ocean floor. The coquina in Figure 12 is one obvious example. You can actually see the shells cemented together. Another biochemical rock is chalk, the material used to write on a chalkboard.

Features of Some Sedimentary Rocks

Sedimentary rocks, like other types of rocks, are used to unravel what may have happened in Earth’s long history. The many unique features of sedimentary rocks are clues to how, when, and where the rocks formed. Each layer of a sedimentary rock, for example, records a period of sediment deposition. In undisturbed rocks, the oldest layers are found at the bottom. The youngest layers are found at the top of the rocks. Ripple marks like the ones shown in Figure 13A may indicate that the rock formed along a beach or stream bed. The mud cracks in Figure 13B formed when wet mud or clay dried and shrank, leaving a rock record of a dry environment.

Fossils, which are the traces or remains of ancient life, are unique to some sedimentary rocks. Fossils can be used to help answer many questions about the rocks that contain them. For example, did the rock form on land or in the ocean? Was the climate hot or cold, rainy or dry? Did the rock form hundreds, thousands, millions, or billions of years ago? Fossils also play a key role in matching up rocks from different places that are the same age.

To summarize, sedimentary rocks are rocks that form as the result of four major processes. Weathering produces particles called sediments. Wind, water, ice, and gravity erode and deposit these sediments. Over time, the sediments are compacted and cemented to form rocks. Sedimentary rocks can be classified according to how they form. A general classification scheme based on a rock’s formation, texture, and composition is shown in Table 2.
Section 3.3 Assessment

Reviewing Concepts
1. Contrast weathering, erosion, and deposition.
2. Name four clastic sedimentary rocks and explain how these rocks form.
3. Name four chemical sedimentary rocks and explain how these rocks form.
4. Explain how three different features of sedimentary rocks can be used to determine how, where, or when the rocks formed.
5. What is compaction?
6. Where do the cements that hold sediments together come from?

Critical Thinking
7. Applying Concepts Briefly describe how the rock shown in Figure 12 may have formed.
8. Predicting Which type of sediments do you think would undergo more compaction—grains of sand or grains of clay? Explain your choice.
9. Formulating Conclusions Suppose you found a sedimentary rock in which ripple marks were pointing toward the ground. What could you conclude about the rock?

Use Visuals
Table 2 Ask: How does the texture of gravel compare with that of sand? (Gravel has a coarse texture; grain size is more than 2 mm. Sand has a medium texture; grain size is 1/16 to 2 mm.) What type of detrital sedimentary rock has a very fine texture? (shale) What is the chemical composition of chalk? (calcite) Which chemical sedimentary rock is made up of halite? (rock salt)

Evaluate Understanding
Give students samples of sandstone, siltstone, shale, breccia, and conglomerate. Have them use magnifying glasses to classify the rocks according to grain size.

Reteach
Review Table 2. As you discuss the different types of textures and chemical compositions, explain how each sedimentary rock likely formed.

Sample answer: Shale is used in construction. Coal is used as an energy resource.

Connecting Concepts
Sedimentary Rocks Choose one of the sedimentary rocks pictured in this section. Find out how the rock is useful to people.