Section 6.2

Objectives

- **Describe** the types of clastic sedimentary rocks.
- **Explain** how chemical sedimentary rocks form.
- **Describe** biochemical sedimentary rocks.

Review Vocabulary

saturated: the maximum possible content of dissolved minerals in solution

New Vocabulary

clastic sedimentary rock
clastic
porosity
evaporite

Types of Sedimentary Rocks

MAIN Idea Sedimentary rocks are classified by their mode of formation.

Real-World Reading Link If you have ever walked along the beach or along a riverbank, you might have noticed different sizes of sediments. The grain size of the sediment determines what type of sedimentary rock it can become.

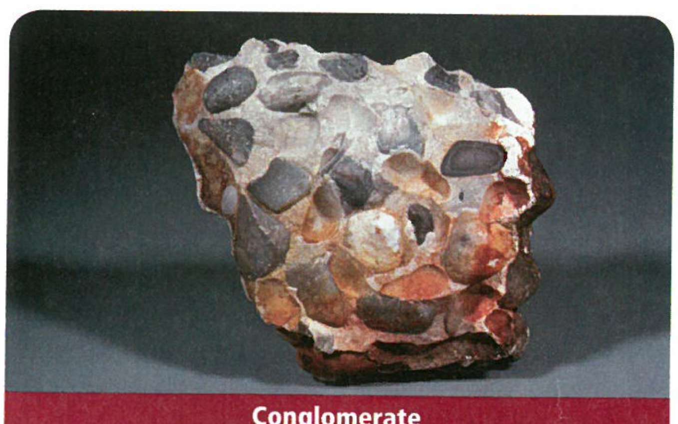
Clastic Sedimentary Rocks

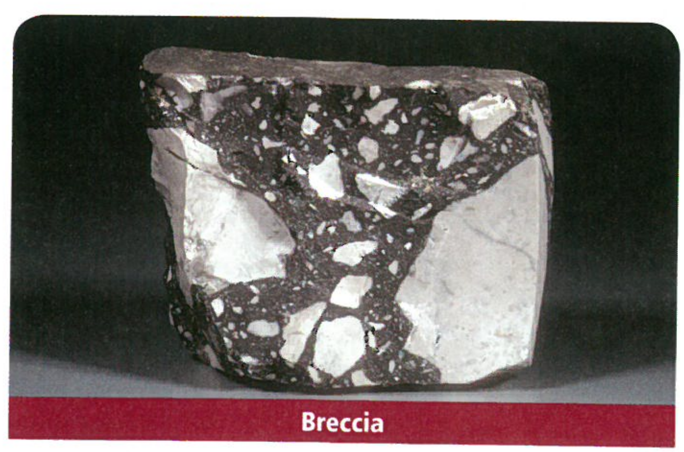
The most common sedimentary rocks, **clastic sedimentary rocks,** are formed from the abundant deposits of loose sediments that accumulate on Earth's surface. The word **clastic** comes from the Greek word *klastos,* meaning *broken.* These rocks are further classified according to the sizes of their particles. As you read about each rock type, refer to **Table 6.1** on the next page, which summarizes the classification of sedimentary rocks based on grain size, mode of formation, and mineral content.

Coarse-grained rocks Sedimentary rocks consisting of gravel-sized rock and mineral fragments are classified as coarse-grained rocks, samples of which are shown in **Figure 6.10.** Conglomerates have rounded, gravel-sized particles. Because of its relatively large mass, gravel is transported by high-energy flows of water, such as those generated by mountain streams, flooding rivers, some ocean waves, and glacial meltwater. During transport, gravel becomes abraded and rounded as the particles scrape against one another. This is why beach and river gravels are often well rounded. Lithification turns these sediments into conglomerates.

In contrast, breccias are composed of angular, gravel-sized particles. The angularity indicates that the sediments from which they formed did not have time to become rounded. This suggests that the particles were transported only a short distance and deposited close to their source. Refer to **Table 6.1** to see how these rocks are named.

Figure 6.10 Conglomerates and breccias are made of coarse sediments that have been transported by high-energy water.
Infer *the circumstances that might cause the types of transport necessary for each to form.*





Concepts In Motion
Interactive Table To explore more about sedimentary rock formation, visit glencoe.com.

Table 6.1 Classification of Sedimentary Rocks

Classification	Texture/Grain Size	Composition	Rock Name
Clastic	coarse (> 2 mm)	Fragments of any rock type—quartz, chert and quartzite common } rounded / angular	conglomerate / breccia
	medium (1/16 mm to 2 mm)	quartz and rock fragments quartz, potassium feldspar and rock fragments	sandstone arkose
	fine (1/256 mm–1/16 mm)	quartz and clay	siltstone
	very fine (< 1/256 mm)	quartz and clay	shale
Biochemical	microcrystalline with conchoidal fracture	calcite ($CaCO_3$)	micrite
	abundant fossils in micrite matrix	calcite ($CaCO_3$)	fossiliferous limestone
	oolites (small spheres of calcium carbonate)	calcite ($CaCO_3$)	oolitic limestone
	shells and shell fragments loosely cemented	calcite ($CaCO_3$)	coquina
	microscopic shells and clay	calcite ($CaCO_3$)	chalk
	variously sized fragments	highly altered plant remains, some plant fossils	coal
Chemical	fine to coarsely crystalline	calcite ($CaCO_3$)	crystalline limestone
	fine to coarsely crystalline	dolomite $(Ca,Mg)CO_3$ (will effervesce if powdered)	dolostone
	very finely crystalline	quartz (SiO_2)—light colored —dark colored	chert flint
	fine to coarsely crystalline	gypsum ($CaSO_4 \bullet 2H_2O$)	rock gypsum
	fine to coarsely crystalline	halite (NaCl)	rock salt

Medium-grained rocks Stream and river channels, beaches, and deserts often contain abundant sand-sized sediments. Sedimentary rocks that contain sand-sized rock and mineral fragments are classified as medium-grained clastic rocks. Refer to **Table 6.1** for a listing of rocks with sand-sized particles. Sandstone usually contains several features of interest to scientists. For example, because ripple marks and cross-bedding indicate the direction of current flow, geologists use sandstone layers to map ancient stream and river channels.

Another important feature of sandstone is its relatively high porosity. **Porosity** is the percentage of open spaces between grains in a rock. Loose sand can have a porosity of up to 40 percent. Some of these open spaces are maintained during the formation of sandstone, often resulting in porosities as high as 30 percent. When pore spaces are connected to one another, fluids can move through sandstone. This feature makes sandstone layers valuable as underground reservoirs of oil, natural gas, and groundwater.

VOCABULARY
ACADEMIC VOCABULARY
Reservoir
a subsurface area of rock that has enough porosity to allow for the accumulation of oil, natural gas, or water
The newly discovered reservoir contained large amounts of natural gas and oil.

Fine-grained rocks Sedimentary rocks consisting of silt- and clay-sized particles are called fine-grained rocks. Siltstone and shale are fine-grained clastic rocks. These rocks represent environments such as swamps and ponds which have still or slow-moving waters. In the absence of strong currents and wave action, these sediments settle to the bottom where they accumulate in thin horizontal layers. Shale often breaks along thin layers, as shown in **Figure 6.11.** Unlike sandstone, fine-grained sedimentary rock has low porosity and often forms barriers that hinder the movement of groundwater and oil. **Table 6.1** shows how these rocks are named.

Reading Check **Identify** the types of environments in which fine-grained rocks form.

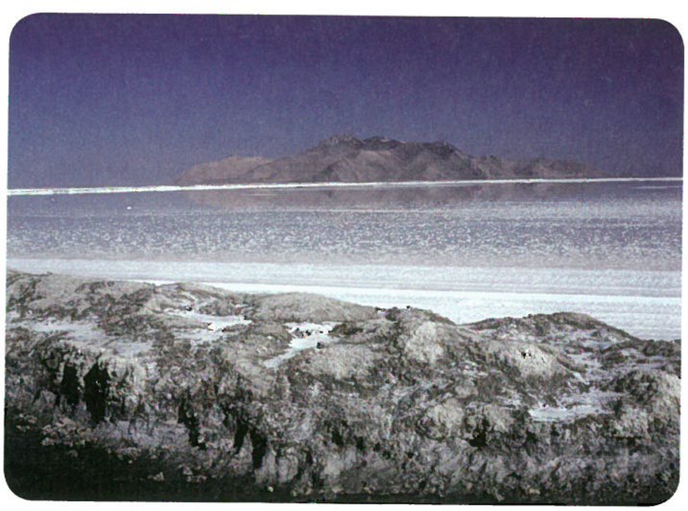
Figure 6.11 The very fine-grained sediment that formed this shale was deposited in thin layers in still waters.

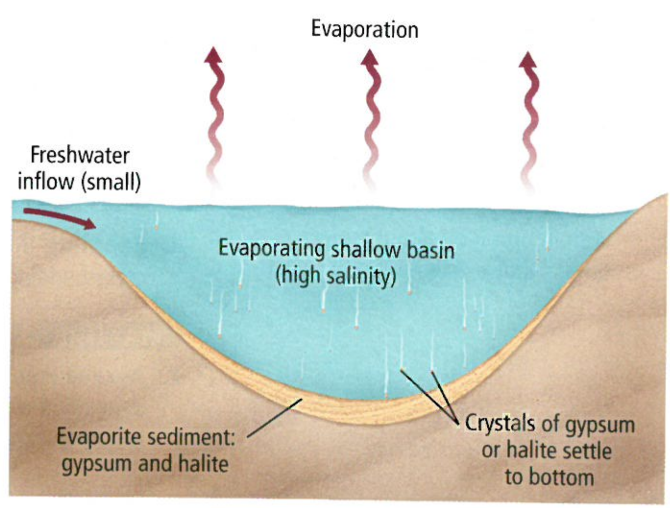
Chemical and Biochemical Sedimentary Rocks

The formation of chemical and biochemical rocks involves the processes of evaporation and precipitation of minerals. During weathering, minerals can be dissolved and carried into lakes and oceans. As water evaporates from the lakes and oceans, the dissolved minerals are left behind. In arid regions, high evaporation rates can increase the concentration of dissolved minerals in bodies of water. The Great Salt Lake, shown in **Figure 6.12,** is an example of a lake that has high concentrations of dissolved minerals.

Chemical sedimentary rocks When the concentration of dissolved minerals in a body of water reaches saturation, crystal grains precipitate out of solution and settle to the bottom. As a result, layers of chemical sedimentary rocks form, most of which are called **evaporites.** Evaporites most commonly form in arid regions and in drainage basins on continents that have low water flow. Because little freshwater flows into these areas, the concentration of dissolved minerals remains high. Even as more dissolved minerals are carried into the basins, evaporation continues to remove freshwater and maintain high mineral concentrations. Over time, thick layers of evaporite minerals can accumulate on the basin floor, as illustrated in **Figure 6.12.**

Figure 6.12 The constant evaporation from a body of salt water results in precipitation of large amounts of salt. This process has been occurring in the Great Salt Lake in Utah for approximately 18,000 years.





■ **Figure 6.13** Limestone can contain many different fossil organisms. Geologists can interpret where and when the limestone formed by studying the fossils within the rock.

Biochemical sedimentary rocks Biochemical sedimentary rocks are formed from the remains of once-living organisms. The most abundant of these rocks is limestone, which is composed primarily of calcite. Some organisms that live in the ocean use the calcium carbonate that is dissolved in seawater to make their shells. When these organisms die, their shells settle to the bottom of the ocean and can form thick layers of carbonate sediment. During burial and lithification, calcium carbonate precipitates out of the water, crystallizes between the grains of carbonate sediment, and forms limestone.

Limestone is common in shallow water environments, such as those in the Bahamas, where coral reefs thrive in 15 to 20 m of water just offshore. The skeletal and shell materials that are currently accumulating there will someday become limestone as well. Many types of limestone contain evidence of their biological origin in the form of abundant fossils. As shown in **Figure 6.13,** these fossils can range from large-shelled organisms to microscopic, unicellular organisms. Not all limestone contains fossils. Some limestone has a crystalline texture, some consists of tiny spheres of carbonate sand, and some is composed of fine-grained carbonate mud. These are listed in **Table 6.1.**

Other organisms use silica to make their shells. These shells form sediment that is often referred to as siliceous ooze because it is rich in silica. Siliceous ooze becomes lithified into the sedimentary rock chert, which is also listed in **Table 6.1.**

Section 6.2 Assessment

Section Summary

- Sedimentary rocks can be clastic, chemical, or biochemical.
- Clastic rocks form from sediments and are classified by particle size and shape.
- Chemical rocks form primarily from minerals precipitated from water.
- Biochemical rocks form from the remains of once-living organisms.
- Sedimentary rocks provide geologists with information about surface conditions that existed in Earth's past.

Understand Main Ideas

1. MAIN Idea **State** the type of sedimentary rock that is formed from the erosion and transport of rocks and sediments.
2. **Explain** why coal is a biochemical sedimentary rock.
3. **Calculate** the factor by which grain size increases with each texture category.
4. **Analyze** the environmental conditions to explain why most chemical sedimentary rocks form mainly in areas that have high rates of evaporation.

Think Critically

5. **Propose** a scenario to explain how it is possible to form additional layers of evaporites in a body of seawater when the original amount of dissolved minerals in the water was enough to form only a thin evaporite.
6. **Examine** the layers of shale in **Figure 6.11** and explain why shale contains no cross-bedding or ripple marks.

MATH in Earth Science

7. Assume that the volume of a layer of mud will decrease by 35 percent during deposition and compaction. If the original sediment layer is 30 cm thick, what will be the thickness of the shale layer after compaction?

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