

Focus

Overview


This section explores how sedimentary rock forms and how it accumulates in layers, or strata. Students distinguish between clastic, chemical, and organic sedimentary rocks and learn how each rock type forms.

Bellringer

Ask students to write about how layers in sedimentary rock are like the rings in a tree. How are they different? What information can geologists infer by examining sedimentary layers?

Motivate

Demonstration — GENERAL

Dissolution of Minerals Limestone forms when calcium carbonate crystallizes out of ocean water. Students may not believe that water contains the chemical components of dissolved minerals. If you live in an area with hard water, have students observe ice melting in warm water. After the ice melts, there is a layer of fluffy calcium carbonate that forms at the bottom of the glass. If you live in an area with soft water, make hard water by dissolving a little baking soda and calcium chloride in water. Then, freeze the water into ice cubes. Use these ice cubes for the demonstration.  Visual

READING WARM-UP

Objectives

- Describe the origin of sedimentary rock.
- Describe the three main categories of sedimentary rock.
- Describe three types of sedimentary structures.

Terms to Learn

strata
stratification

READING STRATEGY

Reading Organizer As you read this section, create an outline of this section. Use the headings from the section in your outline.

Figure 1 The red sandstone "monuments" for which Monument Valley in Arizona has been named are the products of millions of years of erosion.



Sedimentary Rock

Have you ever tried to build a sand castle at the beach? Did you ever wonder where the sand came from?

Sand is a product of weathering, which breaks rock into pieces. Over time, sand grains may be compacted, or compressed, and then cemented together to form a rock called *sandstone*. Sandstone is just one of many types of sedimentary rock.

Origins of Sedimentary Rock

Wind, water, ice, sunlight, and gravity all cause rock to physically weather into fragments. Through the process of erosion, these rock and mineral fragments, called *sediment*, are moved from one place to another. Eventually, the sediment is deposited in layers. As new layers of sediment are deposited, they cover older layers. Older layers become compacted. Dissolved minerals, such as calcite and quartz, separate from water that passes through the sediment to form a natural cement that binds the rock and mineral fragments together into sedimentary rock.

Sedimentary rock forms at or near the Earth's surface. It forms without the heat and pressure that are involved in the formation of igneous and metamorphic rocks.

The most noticeable feature of sedimentary rock is its layers, or **strata**. A single, horizontal layer of rock is sometimes visible for many miles. Road cuts are good places to observe strata. **Figure 1** shows the spectacular views that sedimentary rock formations carved by erosion can provide.

CHAPTER RESOURCES

Chapter Resource File

- Lesson Plan
- Directed Reading A **BASIC**
- Directed Reading B **SPECIAL NEEDS**

Technology

- Transparencies
- Bellringer

WEIRD SCIENCE

The Bonneville Salt Flats, in Utah, are the remnants of a vast lake called Lake Bonneville. After the last ice age, most of the lake drained quickly, but much of the remaining water slowly evaporated, which left behind the salt flats. The Great Salt Lake is the largest of the lakes left after Lake Bonneville evaporated.

Figure 2 Classification of Clastic Sedimentary Rock



Composition of Sedimentary Rock

Sedimentary rock is classified by the way it forms. *Clastic sedimentary rock* forms when rock or mineral fragments, called *clasts*, are cemented together. *Chemical sedimentary rock* forms when minerals crystallize out of a solution, such as sea water, to become rock. *Organic sedimentary rock* forms from the remains of once-living plants and animals.

Clastic Sedimentary Rock

Clastic sedimentary rock is made of fragments of rocks cemented together by a mineral such as calcite or quartz. **Figure 2** shows how clastic sedimentary rock is classified according to the size of the fragments from which the rock is made. Clastic sedimentary rocks can have coarse-grained, medium-grained, or fine-grained textures.

Chemical Sedimentary Rock

Chemical sedimentary rock forms from solutions of dissolved minerals and water. As rainwater slowly makes its way to the ocean, it dissolves some of the rock material it passes through. Some of this dissolved material eventually crystallizes and forms the minerals that make up chemical sedimentary rock. Halite, one type of chemical sedimentary rock, is made of sodium chloride, NaCl, or table salt. Halite forms when sodium ions and chlorine ions in shallow bodies of water become so concentrated that halite crystallizes from solution.

Reading Check How does a chemical sedimentary rock such as halite form? (See the Appendix for answers to Reading Checks.)

strata layers of rock (singular, *stratum*)

CONNECTION TO Language Arts

WRITING SKILL **Salty Expressions**

The word salt is used in many expressions in the English language. Some common examples include "the salt of the earth," "taken with a grain of salt," "not worth his salt," "the salt of truth," "rubbing salt into a wound," and "old salt." Use the Internet or another source to research one these expressions. In your research, attempt to find the origin of the expression. Write a short paragraph that summarizes what you found.

Answer to Reading Check

Halite forms when sodium ions and chlorine ions in shallow bodies of water become so concentrated that halite crystallizes from solution.

Teach

ACTIVITY

BASIC



Sedimentary Rock

Organize students into three groups to investigate sandstone, shale, and limestone. The first group should work together to learn how the rocks form. The second group should investigate how the rocks are used in industry, architecture, or the arts. The third group should investigate rock formations that have become tourist attractions. Members of each group should prepare exhibits, posters, or models to demonstrate what they have learned.

Logical/Visual Co-op Learning

CONNECTION to Life Science

BASIC

Calcium Carbonate Critters

Calcium carbonate is an important compound for many different animals. Many mollusks remove calcium and carbonate from sea water and combine them in special tissues that then harden to form a calcium carbonate shell. When the mollusk dies, its shell either dissolves back into the water or becomes part of the sediment on the bottom of the ocean. If the shell is part of deposited sediment, it may become a fossil. Have students research a fossil locality in their state (for example, the Mazon Creek deposits, in Illinois) to learn more about fossils. **Logical**

Close

Reteaching

BASIC

Creating a Diagram Have students select one of the three types of sedimentary rock. Ask students to create a diagram that illustrates all of the processes that occur in the formation of the rock type they have selected. **LS Visual**

Quiz

GENERAL

1. How does halite form?
(It forms when sodium ions and chlorine ions become so concentrated in ocean water that halite crystallizes out of the water.)
2. What is stratification, and why is it important to Earth scientists? (Stratification is the layering of rock. It is important because it records many events in Earth's history, as well as erosion and deposition rates.)

Alternative

Assessment

GENERAL

Depositional Environments

To review sedimentary rock formation, have students draw a picture of an environment that shows where the sediments come from and where they are deposited. A second drawing should show what the environment might look like millions of years later after sedimentary rock has formed. **LS Visual**



Figure 3 Ocean animals called coral create huge deposits of limestone. As they die, their skeletons collect on the ocean floor.

Organic Sedimentary Rock

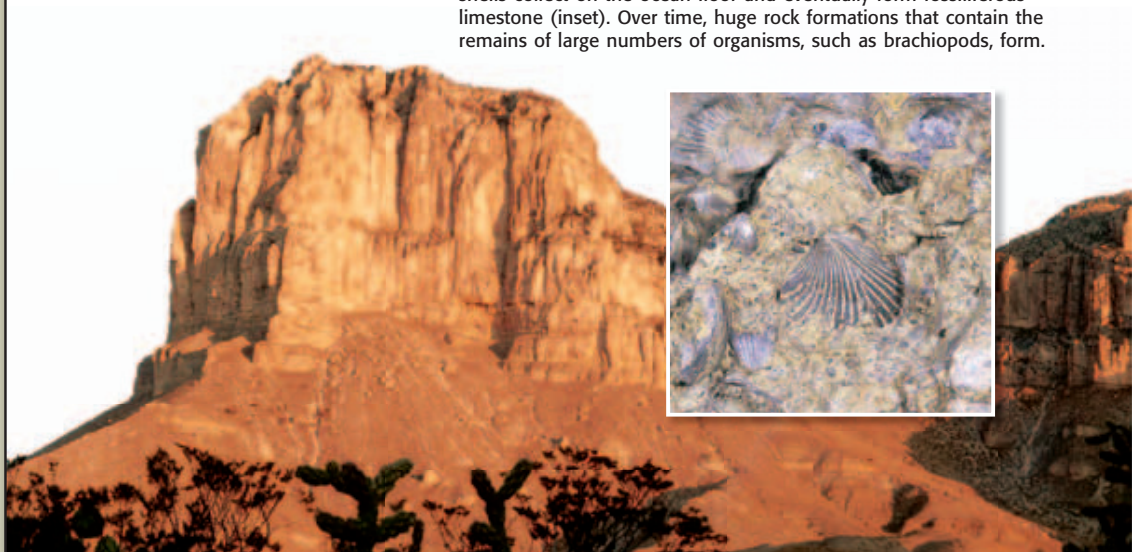
Most limestone forms from the remains, or *fossils*, of animals that once lived in the ocean. For example, some limestone is made of the skeletons of tiny organisms called *coral*. Coral are very small, but they live in huge colonies called *reefs*, shown in **Figure 3**. Over time, the skeletons of these sea animals, which are made of calcium carbonate, collect on the ocean floor. These animal remains eventually become cemented together to form *fossiliferous limestone* (FAH suhl IF uhr uhs LIEM STOHN).

Corals are not the only animals whose remains are found in fossiliferous limestone. The shells of mollusks, such as clams and oysters, commonly form fossiliferous limestone. An example of fossiliferous limestone that contains mollusks is shown in **Figure 4**.

Another type of organic sedimentary rock is *coal*. Coal forms underground when partially decomposed plant material is buried beneath sediment and is changed into coal by increasing heat and pressure. This process occurs over millions of years.

Figure 4 The Formation of Organic Sedimentary Rock

Marine organisms, such as brachiopods, get the calcium carbonate for their shells from ocean water. When these organisms die, their shells collect on the ocean floor and eventually form fossiliferous limestone (inset). Over time, huge rock formations that contain the remains of large numbers of organisms, such as brachiopods, form.



CONNECTION ACTIVITY

Real World

GENERAL

Uses of Organic Sedimentary Rock

Chalk is a sedimentary rock formed from the shells of tiny marine creatures, including diatoms. The shells of diatoms contain silica, which can be used as an abrasive to clean teeth. Have students divide into groups and research other uses of organic sedimentary rock. Have each group prepare a class presentation in which they discuss the benefits and ingredients of a product made from sedimentary rock. **LS Logical**

Is That a Fact!

The Great Barrier Reef, a long coral reef that lies off the northeastern coast of Australia, is the most massive structure ever built by living creatures. It is more than 2,000 km long and covers an area of 207,000 km².

Sedimentary Rock Structures

Many features can tell you about the way sedimentary rock formed. The most important feature of sedimentary rock is stratification. **Stratification** is the process in which sedimentary rocks are arranged in layers. Strata differ from one another depending on the kind, size, and color of their sediment.

Sedimentary rocks sometimes record the motion of wind and water waves on lakes, oceans, rivers, and sand dunes in features called *ripple marks*, as shown in **Figure 5**. Structures called *mud cracks* form when fine-grained sediments at the bottom of a shallow body of water are exposed to the air and dry out. Mud cracks indicate the location of an ancient lake, stream, or ocean shoreline. Even raindrop impressions can be preserved in fine-grained sediments, as small pits with raised rims.

Reading Check What are ripple marks?

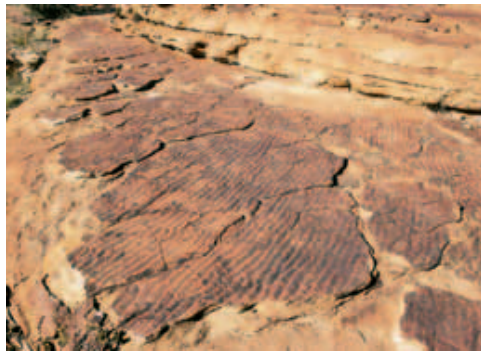


Figure 5 These ripple marks were made by flowing water and were preserved when the sediments became sedimentary rock. Ripple marks can also form from the action of wind.

stratification the process in which sedimentary rocks are arranged in layers

Answers to Section Review

1. Sample answer: Strata are layers in sedimentary rock. Stratification is the process in which layers are arranged into sedimentary rock.
2. c
3. Clastic sedimentary rock is formed by the processes of weathering, erosion, deposition, compaction, and cementation. Rocks are physically weathered into fragments called sediment. Sediment is transported by erosion and is deposited in layers. Older layers of sediments are compacted by younger layers of sediments. Sediments in layers that have been compacted are cemented together by minerals that are dissolved in water, such as calcite and quartz, forming clastic sedimentary rock.
4. Clastic sedimentary rock forms when sediments are compacted and cemented together. Chemical sedimentary rock forms when dissolved minerals separate out of solution and crystallize. Organic sedimentary rock is made from the remains of animals that once lived in the ocean.
5. $2 \text{ m} = 2,000 \text{ mm}$;
 $2,000 \text{ mm} \div 4 \text{ mm/year} = 500 \text{ years}$
6. Texture is more useful in classifying clastic sedimentary rock because the size of the grain can provide clues to where and how the rock was formed.
7. Answers may vary. Sample answer: The finer the grains of sediment are, the more likely delicate structures such as raindrop impressions will be preserved in them.

SECTION Review

Summary

- Sedimentary rock forms at or near the Earth's surface.
- Clastic sedimentary rock forms when rock or mineral fragments are cemented together.
- Chemical sedimentary rock forms from solutions of dissolved minerals and water.
- Organic limestone forms from the remains of plants and animals.
- Sedimentary structures include ripple marks, mud cracks, and raindrop impressions.

Using Key Terms

1. In your own words, write a definition for each of the following terms: *strata* and *stratification*.

Understanding Key Ideas

2. Which of the following is an organic sedimentary rock?
 - a. chemical limestone
 - b. shale
 - c. fossiliferous limestone
 - d. conglomerate
3. Explain the process by which clastic sedimentary rock forms.
4. Describe the three main categories of sedimentary rock.

Math Skills

5. A layer of a sedimentary rock is 2 m thick. How many years did it take for this layer to form if an average of 4 mm of sediment accumulated per year?

Critical Thinking

6. **Identifying Relationships** Rocks are classified based on texture and composition. Which of these two properties would be more important for classifying clastic sedimentary rock?
7. **Analyzing Processes** Why do you think raindrop impressions are more likely to be preserved in fine-grained sedimentary rock rather than in coarse-grained sedimentary rock?

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Topic: Sedimentary Rock
SciLinks code: HSM1365

Answer to Reading Check

Ripple marks are the marks left by wind and water waves on lakes, seas, rivers, and sand dunes.

CHAPTER RESOURCES

Chapter Resource File

- Section Quiz **GENERAL**
- Section Review **GENERAL**
- Vocabulary and Section Summary **GENERAL**