1 FOCUS

Section Objectives

3.1 **Define** the term *rock*.
3.2 **Identify** the three major types of rocks and **explain** how they differ.
3.3 **Describe** the rock cycle.
3.4 **List** the forces that power Earth's rock cycle.

Reading Focus

Build Vocabulary

L2

Cycle Diagram Have students construct a cycle diagram of the rock cycle. Students should use the terms *igneous rock, sedimentary rock, metamorphic rock, sediment, magma,* and *lava* to indicate the materials involved in the rock cycle. The processes of the rock cycle are shown in Figure 2 on p. 67. Tell students to place the terms in ovals and use labeled arrows to indicate how one process leads to another.

Reading Strategy

L2

a. a solid mixture of one or more minerals
b. rock that forms when magma or lava cools and hardens
c. rock that forms when sediment is compacted and cemented
d. weathered pieces of earth materials

2 INSTRUCT

Rocks

Use Visuals

L1

Figure 1 Ask: **How does the texture of obsidian compare with that of pumice?** *(Obsidian is smooth; pumice is rough.)* **What other differences do you see?** *(Sample answer: The color and shape of the samples are different.)*
Visual

3.1 The Rock Cycle

Reading Focus

Key Concepts

- What is a rock?
- What are the three major types of rocks?
- How do igneous, sedimentary, and metamorphic rocks differ?
- What is the rock cycle?
- What powers Earth's rock cycle?

Vocabulary

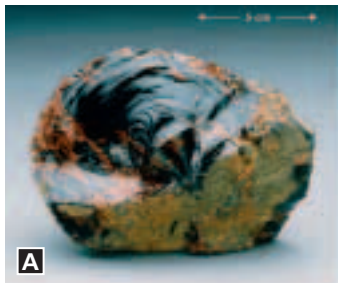
- rock
- igneous rock
- sedimentary rock
- metamorphic rock
- rock cycle
- magma
- lava
- weathering
- sediments

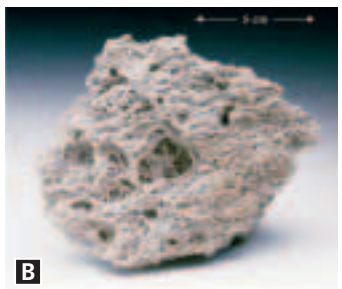
Reading Strategy

Building Vocabulary Copy and expand the table to include each vocabulary term. As you read, write down the definition for each term.

Term	Definition
rock	a. ?
igneous rock	b. ?
sedimentary rock	c. ?
sediments	d. ?

Figure 1 **A** Obsidian and **B** pumice are two examples of rocks that do not have a crystalline structure.





Why do we study rocks? All Earth processes such as volcanic eruptions, mountain building, weathering, erosion, and even earthquakes involve rocks and minerals. Rocks contain clues about the environments in which they were formed. For example, if a rock contains shell fragments, it was probably formed in a shallow ocean environment. The locations of volcanic rocks tell a story of volcanic activity on Earth through time. Thus, you can see that a basic knowledge of rocks is essential to understanding the Earth.

Rocks

A rock is any solid mass of mineral or mineral-like matter that occurs naturally as part of our planet. A few rocks are composed of just one mineral. However, most rocks, like granite, occur as solid mixtures of minerals. A characteristic of rock is that each of the component minerals retains their properties in the mixture. A few rocks are composed of nonmineral matter. Coal is considered a rock even though it consists of organic material. Obsidian and pumice, shown in Figure 1, are volcanic rocks that do not have a crystalline structure.

Rocks are classified into three groups based on how they were formed. **The three major types of rocks are igneous rocks, sedimentary rocks, and metamorphic rocks.** Before examining each group, you will look at a model for the rock cycle, which is the process that shows the relationships between the rock groups.

Reading Checkpoint *What are the three types of rocks?*

The Rock Cycle

Earth is a system. It consists of many interacting parts that form a complex whole. **Interactions among Earth's water, air, and land can cause rocks to change from one type to another. The continuous processes that cause rocks to change make up the rock cycle.** Most changes in the rock cycle take place over long periods of time.

Figure 2 shows some key events in the rock cycle. Refer to the figure throughout this section as you examine how rock might change over time. Look at Figures 2A and 2B. **Magma** is molten material that forms deep beneath Earth's surface. **When magma cools and hardens beneath the surface or as the result of a volcanic eruption, igneous rock forms.** Magma that reaches the surface is called **lava.**

Go Online active art

For: Rock Cycle activity
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Rock Cycle

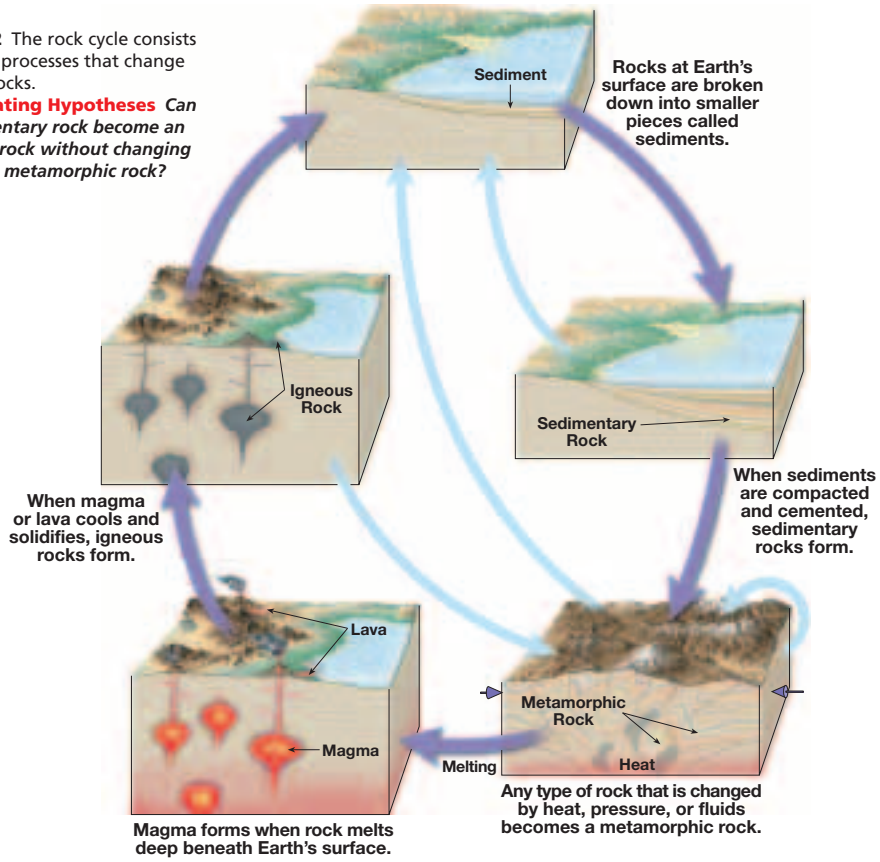

Figure 2 The rock cycle consists of many processes that change Earth's rocks.
Formulating Hypotheses ***Can a sedimentary rock become an igneous rock without changing first to a metamorphic rock? Explain.***

Customize for English Language Learners

Encourage students to compile vocabulary terms into a science glossary. Have students consult dictionaries to obtain the pronunciation and definition of each term and then write these items in their glossaries. Model how to use the dictionary to determine the proper pronunciation of difficult words, such as *igneous* or *metamorphic*. Students may also want to draw simple diagrams next to the terms to further help them to remember each word's meaning. To reinforce language skills, have students arrange the terms in alphabetical order.

The Rock Cycle

Use Visuals

L1

Figure 2 Point out that the arrows represent the processes that link each group to the others. Ask: **What processes form sedimentary rocks?** *(compaction and cementation)* **What possible changes might a sedimentary rock undergo?** *(A sedimentary rock might be broken back down into sediment. Heat and pressure could change it into a metamorphic rock.)* **What type of rock is formed by cooling magma or lava?** *(igneous rock)* **What happens to igneous rock that is weathered?** *(It is broken down into sediment.)*
Visual

Build Reading Literacy

L1

Refer to **p. 186D** in **Chapter 7**, which provides the guidelines for relating text and visuals.

Relate Text and Visuals Tell students to read the text on pp. 67–68. Have them list parts of the rock cycle that are difficult to understand. Write a few of these concepts on the board. Then have students carefully study Figure 2. Using the list on the board, have volunteers explain how the visual helped them understand the rock cycle.
Verbal, Visual

Go Online active art

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Visit: PHSchool.com
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Students interact with the rock cycle diagram online.

Answer to . . .

Figure 2 *No, because any change in temperature and/or pressure will cause the sedimentary rock to become a metamorphic rock. If the temperatures and/or pressures are great enough, the metamorphic rock will melt to form magma, which will crystallize to form an igneous rock.*

Reading Checkpoint *Igneous rocks, sedimentary rocks, and metamorphic rocks are the three major types of rocks. Igneous rocks form when magma or lava cools. Sedimentary rocks form when sediment is compacted and cemented. Metamorphic rocks form when existing rocks are changed by heat, pressure, or solutions.*

Teacher Demo

Weathering

L2

Purpose Students will observe how ice can be an agent of weathering.

Materials 2-L plastic bottle with cap, water

Procedure Fill the plastic bottle nearly full with water and put on the cap. Have students note the level of the water. Place the bottle in the freezer for several hours, then have students observe the frozen water.

Expected Outcome Students will observe how the ice expanded and distorted the bottle. Tell them that in a similar way, water can seep through cracks and pores in rocks, then freeze and expand to break apart the rocks.
Visual

Build Science Skills

L2

Activity

Using Models Have students work with a partner to design simple models that show how pressure affects rocks. For example, students can place a heavy textbook on a sandwich or squeeze a piece of modeling clay between their hands.
Kinesthetic, Interpersonal

Figure 3 El Capitan in Yosemite National Park This granite was once buried deep beneath Earth's surface. Now that it is exposed, it will eventually weather and form sediments.

What will happen if an igneous rock that formed deep within Earth is exposed at the surface? Any rock at Earth's surface, including the granite shown in Figure 3, will undergo weathering. **Weathering** is a process in which rocks are physically and chemically broken down by water, air, and living things to produce sediment. **Sediment** is made up of weathered pieces of earth materials**.** Sediment is moved and deposited by water, gravity, glaciers, or wind. **Eventually, sediment is compacted and cemented to form sedimentary rock, as shown in Figure 2C and 2D.**

If the sedimentary rocks become buried deep within Earth, they will be subjected to increases in pressure and/or temperature. **Under extreme pressure and temperature conditions, sedimentary rock will change into metamorphic rock, as shown in Figure 2E.** If the metamorphic rocks are subjected to additional pressure changes or to still higher temperatures, they may melt to form magma. The magma will eventually crystallize to form igneous rock once again.

Facts and Figures

Some of the most important accumulations of metals, such as gold, silver, copper, mercury, lead, platinum, and nickel, are produced by igneous and metamorphic processes. For example, as a large magma body cools, the heavy minerals that crystallize early tend to settle to the lower portion of the magma chamber. This type of process is particularly active in large basaltic magmas where chromite, magnetite, and platinum are occasionally generated. Layers of chromite, an ore of chromium, are mined from such deposits in the Bushveld Complex in South Africa, which contains more than 70 percent of the world's known platinum reserves.

Alternate Paths

The purple arrows in Figure 2 show only one way in which an igneous rock might form and change. Other paths are just as likely to be taken as an igneous rock goes through the rock cycle. The blue arrows show a few of these alternate paths.

Suppose, for example, that an igneous rock remained deeply buried. Eventually, the rock could be subjected to strong forces and high temperatures such as those associated with mountain building. Then, the igneous rock could change into one or more kinds of metamorphic rock. If the temperatures and pressures were high enough, the igneous rock could melt and recrystallize to form new igneous rock.

Metamorphic and sedimentary rocks, as well as sediment, do not always remain buried. Often, overlying rocks are stripped away, exposing the rock that was once buried. When this happens, the rocks weather to form sediments that eventually become sedimentary rocks. However, if the sedimentary rocks become buried again, metamorphic rocks, like those used for the roof tiles in Figure 4, will form.

Where does the energy that drives Earth's rock cycle come from?

Processes driven by heat from Earth's interior are responsible for forming both igneous and metamorphic rocks. Weathering and the movement of weathered materials are external processes powered by energy from the sun and by gravity. Processes on and near Earth's surface produce sedimentary rocks.

Figure 4 The roof on this house is made of slate. Slate is a metamorphic rock that forms from the sedimentary rock shale. **Explaining** ***How can shale become slate?***

Section 3.1 Assessment

Reviewing Concepts

1. What is a rock?
2. What are the three major types of rocks?
3. How do igneous, sedimentary, and metamorphic rocks differ?
4. What is the rock cycle?
5. What powers Earth's rock cycle?

Critical Thinking

6. **Comparing and Contrasting** Compare and contrast igneous and metamorphic rocks.
7. **Applying Concepts** How might a sedimentary rock become an igneous rock?
8. **Applying Concepts** List in order the processes that could change one sedimentary rock into another sedimentary rock.

Writing in Science

Writing to Persuade Coral reefs are made of calcium carbonate that is secreted by the corals and algae that make up the reefs. Over time, this calcium carbonate accumulates to form limestone. Use what you know about minerals and rocks to write a paragraph explaining whether or not you think that this limestone is a rock.

Alternate Paths

Use Community Resources L2

Invite a construction contractor to discuss with the class how various rocks are used as building materials. Ask the contractor to bring in sample supplies for students to examine. Have students prepare by brainstorming questions to ask the contractor about the different qualities of rocks, such as durability and strength.

Verbal

3 ASSESS

Evaluate Understanding L2

Have students draw sketches illustrating the source of the energy that drives the rock cycle. For example, to represent the interior processes that form igneous rocks, a sketch might show molten material deep inside Earth.

Reteach L1

Use Figure 2 to draw a diagram of the rock cycle that does not include arrows. Make copies of the diagram and distribute it to students. Have students add arrows showing the relationships among the processes of the rock cycle.

Writing in Science

Students should recall that most limestones are made from organic sediments such as shells and the secretions of corals. This limestone is a biochemical sedimentary rock.

Answer to . . .

Figure 4 *If shale is subjected to an increase in pressure and/or temperature, it can become the metamorphic rock called slate.*

Section 3.1 Assessment

1. Most rocks are mixtures of one or more minerals. Some rocks, however, are not made of minerals.
2. igneous rocks, sedimentary rocks, and metamorphic rocks
3. Rocks differ in the way they form. Igneous rocks form when magma or lava cools and solidifies. Sedimentary rocks form when sediment is compacted and cemented. Metamorphic rocks form when existing rocks are changed by heat, pressure, or solutions.
4. interactions among Earth's water, air, and land which cause rocks to change
5. processes deep within Earth and energy from the sun
6. Both form as the result of increases in pressure or temperature. Igneous rock formation involves melting, while the formation of metamorphic rocks does not.
7. The sedimentary rock could become buried at depths where temperatures and pressures were great enough to cause melting. When the melted material (magma) cooled and hardened, an igneous rock would form.
8. weathering, transportation, deposition, compaction, and cementation