Section 5

Metamorphic Rocks

Reading Preview

Key Concepts

- Under what conditions do metamorphic rocks form?
- How do geologists classify metamorphic rocks?
- How are metamorphic rocks used?

Key Term

- foliated

Target Reading Skill

Previewing Visuals Before you read, preview Figure 17. Then write two questions that you have about metamorphic rocks in a graphic organizer like the one below. As you read, answer your questions.

Metamorphic Rocks

Q. Why do the crystals in gneiss line up in bands?
A.
Q.

Go Online
NSTA SCILINKS
For: Links on metamorphic rocks
Visit: www.SciLinks.org
Web Code: scn-1055

Lab zone **Discover Activity**

How Do Grain Patterns Compare?

1. Using a hand lens, observe samples of gneiss and granite. Look carefully at the grains or crystals in both rocks.
2. Observe how the grains or crystals are arranged in both rocks. Draw a sketch of both rocks and describe their textures.

Think It Over

Inferring Within the crust, some granite becomes gneiss. What do you think must happen to cause this change?

Every metamorphic rock is a rock that has changed its form. In fact, the word *metamorphic* comes from the Greek words *meta*, meaning "change," and *morphosis*, meaning "form." But what causes a rock to change into metamorphic rock? The answer lies inside Earth.

Heat and pressure deep beneath Earth's surface can change any rock into metamorphic rock. When rock changes into metamorphic rock, its appearance, texture, crystal structure, and mineral content change. Metamorphic rock can form out of igneous, sedimentary, or other metamorphic rock.

Collisions between Earth's plates can push the rock down toward the heat of the mantle. Pockets of magma rising through the crust also provide heat that can produce metamorphic rocks. The deeper a rock is buried in the crust, the greater the pressure on that rock. Under high temperature and pressure many times greater than at Earth's surface, the minerals in a rock can be changed into other minerals. The rock has become a metamorphic rock.

Types of Metamorphic Rocks

While metamorphic rocks are forming, high temperatures change the size and shape of the grains, or mineral crystals, in the rock. Extreme pressure squeezes rock so tightly that the mineral grains may line up in flat, parallel layers. **Geologists classify metamorphic rocks according to the arrangement of the grains that make up the rocks.**

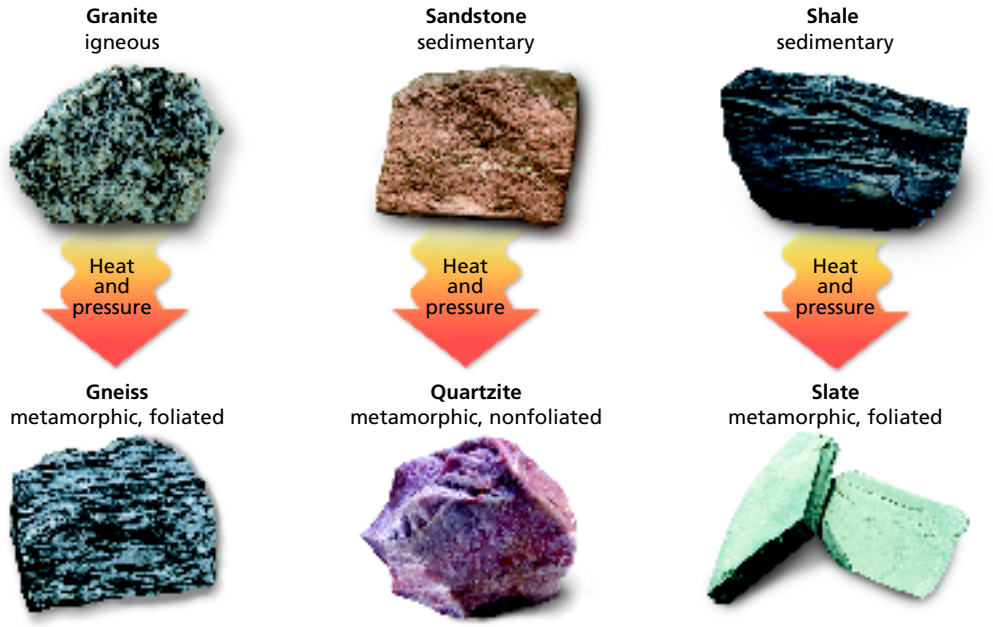
Foliated Rocks Metamorphic rocks that have their grains arranged in parallel layers or bands are said to be **foliated.** The term *foliated* comes from the Latin word for "leaf." It describes the thin, flat layering found in most metamorphic rocks. Foliated rocks—including slate, schist, and gneiss—may split apart along these bands. In Figure 17, notice how the crystals in granite have been flattened to create the foliated texture of gneiss.

One common foliated rock is slate. Heat and pressure change the sedimentary rock shale into slate. Slate is basically a denser, more compact version of shale. During the change, new minerals such as mica form in the slate.

Nonfoliated Rocks Some metamorphic rocks are nonfoliated. The mineral grains in these rocks are arranged randomly. Metamorphic rocks that are nonfoliated do not split into layers. Marble and quartzite are two metamorphic rocks that have a nonfoliated texture. Quartzite forms out of sandstone. The weakly cemented quartz particles in the sandstone recrystallize to form quartzite, which is extremely hard. Notice in Figure 17 how much smoother quartzite looks than sandstone.

Reading Checkpoint **What is a foliated rock?**

FIGURE 17
Forming Metamorphic Rocks
Great heat and pressure can change one type of rock into another. **Observing** *How does slate differ from shale?*



Lab zone **Try This Activity**

A Sequined Rock

1. Make three balls of clay about 3 cm in diameter. Gently mix about 25 sequins into one ball.
2. Use a 30-cm piece of string to cut the ball in half. How are the sequins arranged?
3. Roll the clay with the sequins back into a ball. Stack the three balls with the sequin ball in the middle. Set these on a block of wood. With another block of wood, press slowly down until the stack is about 3 cm high.
4. Use the string to cut the stack in half. How are the sequins arranged?

Making Models What do the sequins in your model rock represent? Is this rock foliated or nonfoliated?

FIGURE 18
The Lincoln Memorial
The statue of Abraham Lincoln in the Lincoln Memorial in Washington, D.C., is made of gleaming white marble.

Uses of Metamorphic Rock

Certain metamorphic rocks are important materials for building and sculpture. Marble and slate are two of the most useful metamorphic rocks. Marble usually forms when limestone is subjected to heat and pressure deep beneath the surface. Because marble has a fine, even grain, it can be cut into thin slabs or carved into many shapes. And marble is easy to polish. These qualities have led architects and sculptors to use marble for many buildings and statues. For example, one of America's most famous sculptures is in the Lincoln Memorial in Washington, D.C. Sculptor Daniel Chester French carved this portrait of Abraham Lincoln in gleaming white marble.

Like marble, slate comes in a variety of colors, including gray, black, red, and purple. Because it is foliated, slate splits easily into flat pieces. These pieces can be used for flooring, roofing, outdoor walkways, chalkboards, and as trim for stone buildings.

Reading Checkpoint **What characteristics of slate make it useful?**

Section 5 Assessment

Target Reading Skill **Previewing Visuals** Compare your questions and answers about Figure 17 with those of a partner.

Reviewing Key Concepts

1. **a.** **Explaining** What does *metamorphic* mean?
   b. **Relating Cause and Effect** Where and under what conditions are metamorphic rocks formed?
2. **a.** **Identifying** What characteristic of metamorphic rocks do geologists use to classify them?
   b. **Explaining** How does a foliated metamorphic rock form?
   c. **Classifying** Which of the rocks in Figure 17 is foliated? How can you tell?
3. **a.** **Identifying** What is the main use of metamorphic rocks?
   b. **Making Judgments** Which might be more useful for carving chess pieces—marble or slate? Explain your answer.

Lab zone **At-Home Activity**

Rocks Around the Block How are rocks used in your neighborhood? Take a walk with your family to see how many uses you can observe. Identify statues, walls, and buildings made from rocks. Can you identify which type of rock was used? Look for limestone, sandstone, granite, and marble. Share a list of the rocks you found with your class. For each rock, include a description of its color and texture, where you observed the rock, and how it was used.

Mystery Rocks

Problem

What properties can be used to classify rocks?

Skills Focus

inferring, classifying

Materials

- 1 "mystery rock"
- 2 unknown igneous rocks
- 2 unknown sedimentary rocks
- 2 unknown metamorphic rocks
- hand lens

Procedure

1. For this activity, you will be given six rocks and one sample that is not a rock. They are labeled A through G.
2. Copy the data table into your notebook.
3. Using the hand lens, examine each rock for clues that show the rock formed from molten material. Record the rock's color and texture. Observe if there are any crystals or grains in the rock.
4. Use the hand lens to look for clues that show the rock formed from particles of other rocks. Observe the texture of the rock to see if it has any tiny, well-rounded grains.
5. Use the hand lens to look for clues that show the rock formed under heat and pressure. Observe if the rock has a flat layer of crystals or shows colored bands.
6. Record your observations in the data table.

Data Table

Sample	Color	Texture (fine, medium, or coarse-grained)	Foliated or Banded	Rock Group (igneous, metamorphic, sedimentary)
A				
B				

Analyze and Conclude

1. **Inferring** Infer from your observations the group in which each rock belongs.
2. **Classifying** Which of the samples could be classified as igneous rocks? What physical properties do these rock share with the other samples? How are they different?
3. **Classifying** Which of the samples could be classified as sedimentary rocks? How do you think these rocks formed? What are the physical properties of these rocks?
4. **Classifying** Which of the samples could be classified as metamorphic rocks? What are their physical properties?
5. **Drawing Conclusions** Decide which sample is not a rock. How did you determine that the sample you chose is not a rock? What do you think the "mystery rock" is? Explain.
6. **Communicating** What physical property was most useful in classifying rocks? Which physical property was least useful? Explain your answer.

More to Explore

Can you name each rock? Use a field guide to rocks and minerals to find the specific name of each rock sample.