

Lesson 4

Metamorphic Rocks

Look and Wonder

This rock is different from the rocks you have learned about. Are there any clues in this rock that tell you how it may have formed?

170
ENGAGE



4 ES 4.a. Students know how to differentiate among igneous, sedimentary, and metamorphic rocks by referring to their properties and methods of formation (the rock cycle).

Read and Learn

Main Idea 4 ES 4.a

Extreme heat and pressure can cause any kind of rock to change to a metamorphic rock. The rock cycle shows how rocks are constantly changing.

Vocabulary

pressure, p. 172

metamorphic rock, p. 172

geologist, p. 178

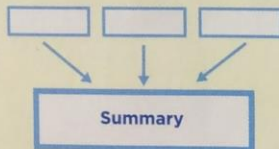
rock cycle, p. 180

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Reading Skill

Summarize



Reading Diagrams

Why do you think metamorphic rocks are formed on the bottom layers, beneath Earth's surface?

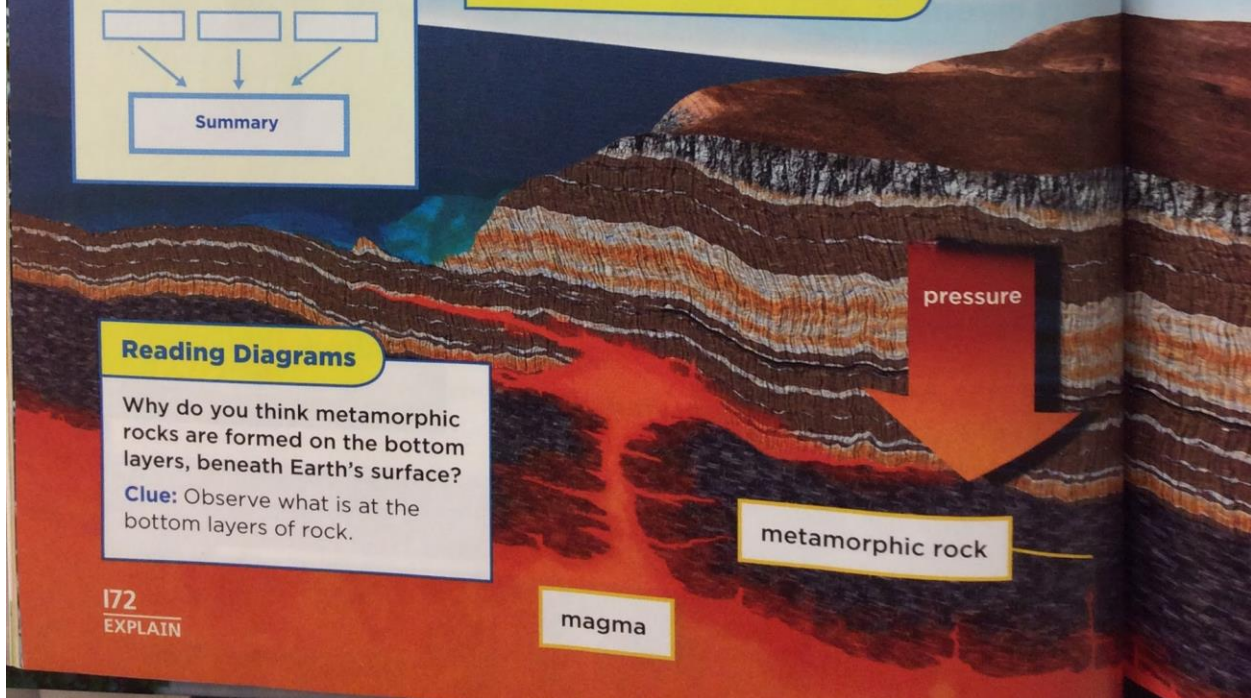
Clue: Observe what is at the bottom layers of rock.

How are metamorphic rocks formed?

Think about the rock under your feet. Layers of rock sit on top of layers of rock. This causes a force called **pressure** (PRESH•uhr) to build deep in Earth. This pressure squeezes rocks together.

Temperatures under Earth's surface can be very high. What happens to rocks under so much heat and pressure? Their physical properties change. The mineral makeup of the rocks may change, too. Rocks formed from other rocks by extreme heat and pressure deep inside Earth are called **metamorphic** (met•uh•MAWR•fik) **rocks**. They can be formed from igneous, sedimentary, or even from other metamorphic rocks.

Metamorphic Rock Formation



Rocks That Are Made Over

One type of metamorphic rock is called gneiss (NIGHS). The colorful bands in gneiss are formed when the igneous rock, granite, is heated under great pressure.

Shale is a soft sedimentary rock. With heat and pressure, shale can change into slate. Slate has a different mineral makeup than shale. Some of its physical properties are different, too. Slate is much harder

than shale, for example, but both break apart easily into layers.

The chart below shows some metamorphic rocks with the rocks they formed from.

✓ Quick Check

Summarize How is metamorphic rock formed?

Critical Thinking Why can you think of a metamorphic rock as a rock that has been made over?



What are the properties of some metamorphic rocks?

Just like igneous and sedimentary rocks, metamorphic rocks have different physical properties. They have different properties because they are each made from different minerals. The amount of heat and pressure a metamorphic rock undergoes also determines its properties.

Properties of Gneiss

In some metamorphic rocks, such as gneiss, minerals get rearranged and pressed into thin layers. The layers are called *bands*. The bands can be straight across. They can also be wavy.

The crystals in gneiss are large and easily seen. This gives gneiss its coarse texture. It feels rough.

Properties of Quartzite

Quartzite is a metamorphic rock without layers. It looks a lot like sandstone from far away. It has a similar color and is made of small mineral crystals. It has a medium texture.



▲ Quartzite is very hard and can have a glassy appearance.



▲ This sample of gneiss shows distinct bands, or layers.





▲ Marble is usually white, but may be found in other colors too.

Properties of Marble

Marble is another metamorphic rock without layers. The crystals in marble can vary in size. Where crystal size is small, marble has a fine texture. Where crystal size is large, marble has a coarse texture.

Properties of Slate

Slate is another metamorphic rock whose minerals settle into layers. The crystals in slate are very small. They are packed together and are not easily seen. The small crystals give slate its fine texture. It feels smooth.



◀ Slate has very thin, flat layers.

Quick Lab

A Model Metamorphic Rock

- 1 Make a Model** Put three pieces of clay on top of each other to form three layers.
- 2** Squeeze the layers together from top to bottom. Then squeeze from side to side.

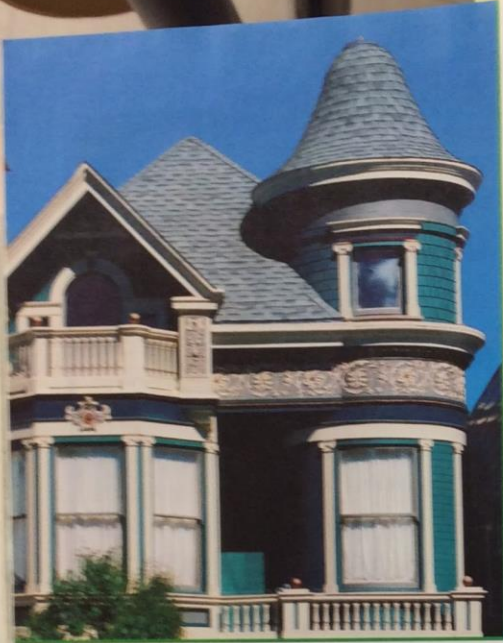


- 3 Observe** Use a plastic knife to cut through your model. How have the layers in your model changed?
- 4 Draw Conclusions** How is your model like some kinds of metamorphic rock?

Quick Check

Summarize Why do metamorphic rocks have different properties?

Critical Thinking Two metamorphic rocks contain the same exact mineral content. How can they be classified as two different rocks?



▲ The shingles on this roof are made of slate.

What are some uses of metamorphic rock?

You see examples of metamorphic rock all around you. Metamorphic rocks are used in buildings, sidewalks, statues, jewelry, and many other items.

Slate is used to make tiles for walkways. Because slate is waterproof, it is also used for roofs.

Marble, which forms from limestone, is used for buildings and for statues. That's because marble does not break apart in layers when you carve it.

A rock called *lapis lazuli* (LAP•is LAZ•uh•lee) is another type of metamorphic rock formed from limestone. The rock is used to make jewelry and other objects.



◀ This guardian lion in Bangkok is made of marble.

These items are made of lapis lazuli.

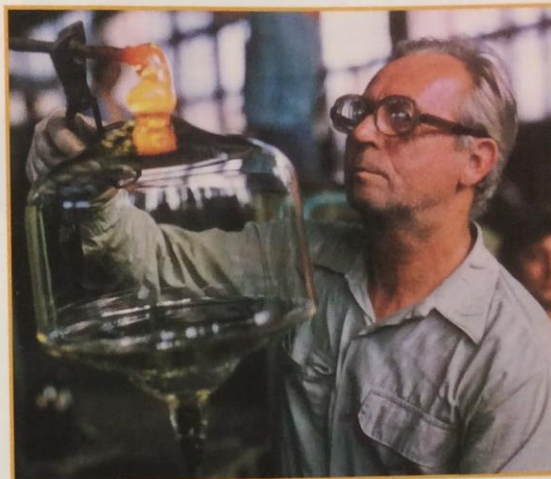


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Quartzite is used in glassmaking and ceramics. Tile floors, stone walls, and swimming pools may also be made from quartzite.

Many metamorphic rocks are ground up into small chunks. The chunks are often used in the gravel you see in driveways and on the side of the road.

Another metamorphic rock is called anthracite (AN•thruh•sight) coal. Coal is mined from Earth and burned as fuel. Most coal is used in its softer, sedimentary rock form, bituminous coal. However, anthracite coal is found deeper in Earth's layers. Because of the intense pressure on it, anthracite coal is a much harder coal than its sedimentary form. It burns cleaner and longer than soft coal.



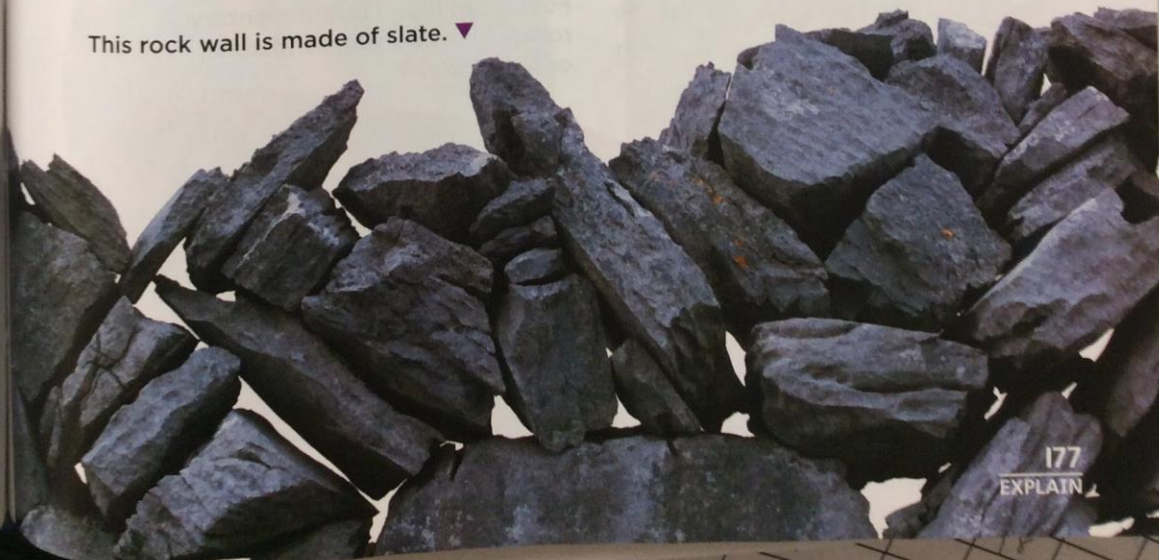
▲ Quartzite is used to make glass.

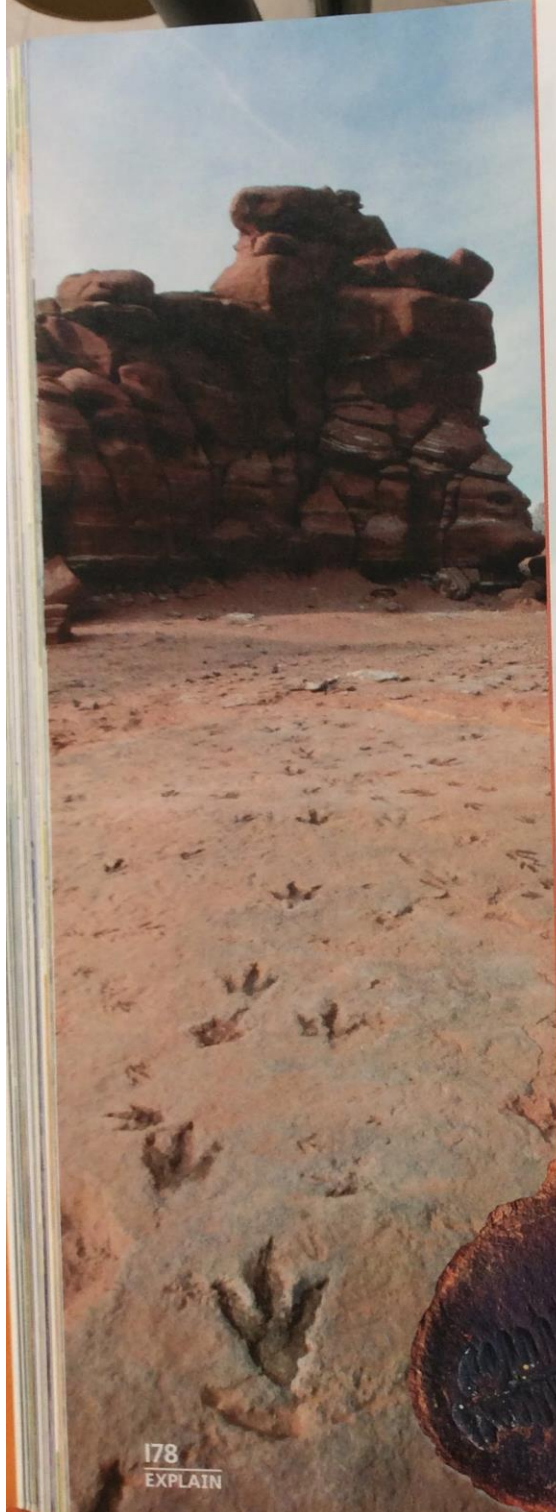
✓ **Quick Check**

Summarize Tell some uses of metamorphic rock.

Critical Thinking Do you think that metamorphic rocks are more useful than sedimentary or igneous rocks? Explain your answer.

▼ This rock wall is made of slate.





How can you be a rock detective?

Identifying rocks is the work of scientists called **geologists** (jee•AHL•uh•jists). A geologist studies Earth's history by examining rocks. A geologist's work is much like detective work. Suppose someone handed you an unknown rock. Like a geologist, you would use the rock's physical properties to classify it. Texture, crystal shape and size, and layers are just some of the clues that a good rock detective uses to identify a rock.

Sedimentary Rocks

Rocks that contain fossils of once-living things are most likely sedimentary. Most sedimentary rocks have layers. If you can easily break apart a rock like mudstone or clay, it is most likely sedimentary rock.

Fossils are found in sedimentary rocks, such as shale, sandstone, or limestone. ▼

Ign

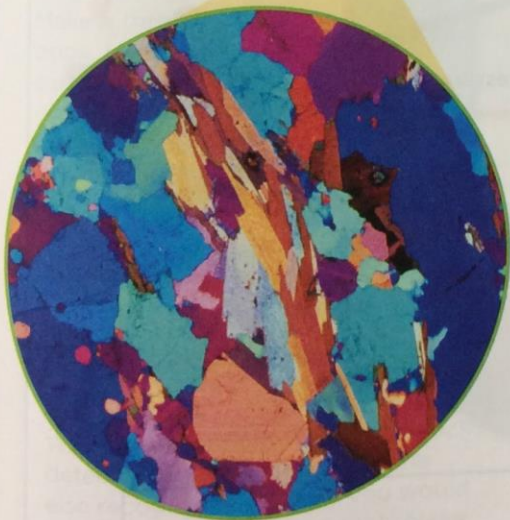
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Igneous Rocks

The texture of a rock is also a clue to its identity. When you touch a rock, does it have a smooth, glassy texture? Then you might be looking at an igneous rock. Many of the minerals in igneous rock are also shiny and twinkle when held in the light. Igneous rocks are also hard and show no layering.



▲ Obsidian is black and sometimes has brown streaks. It has a glassy texture.



▲ This is what gneiss crystals look like under a special microscope.

Metamorphic Rocks

Colored bands in a rock are clues to identifying metamorphic rock. Many of these rocks have mineral crystals that line up in the same direction. Certain minerals are only found in metamorphic rocks. For example, if you find a rock that has talc or graphite in it, you can be sure it is metamorphic. Even though metamorphic rocks are formed under intense heat and pressure, some of the minerals they contain may be soft.

✓ Quick Check

Summarize Which properties help to identify a rock?

Critical Thinking Do you think that you could find a fossil in a metamorphic rock? Explain.

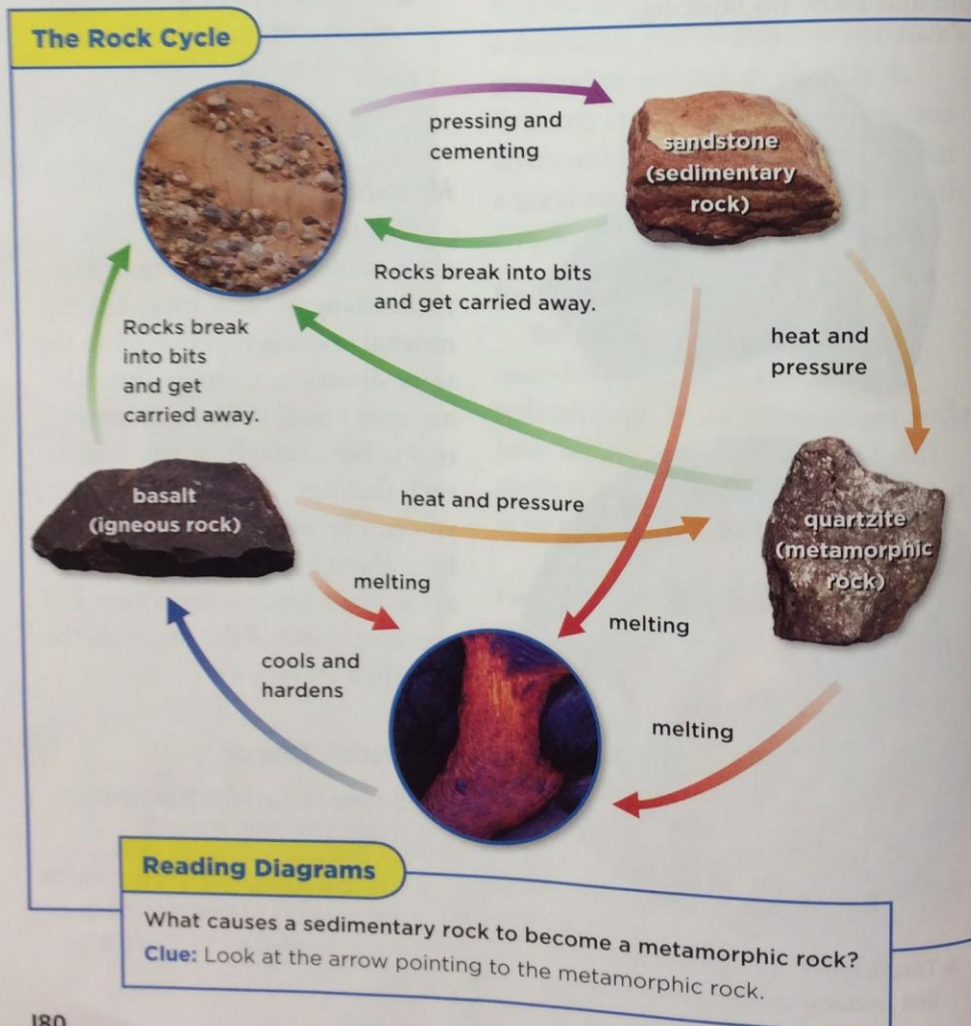
What is the rock cycle?

You learned how the three kinds of rocks form. Did you know that, over time, all rocks can change from one kind to another? The cycle by which rocks change from one form to another is called the **rock cycle**.

Quick Check

Summarize What is the rock cycle?

Critical Thinking Do you think the rock cycle can happen quickly? Explain your answer.



Lesson Review

Summarize the Main Idea



Metamorphic rocks form deep inside Earth from great heat and pressure. (pp. 172–173)



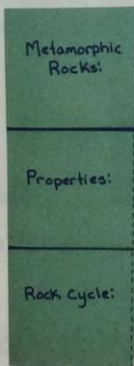
Metamorphic rocks are identified by their **properties** and minerals. (pp. 174–179)



The **rock cycle** is a never-ending cycle by which rocks change from one type to another. (p. 180)

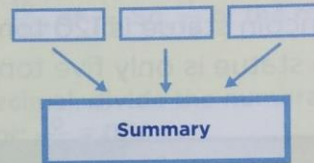
Make a **FOLDABLES™** Study Guide

Make a three-tab book. Use it to summarize what you read about metamorphic rocks.



Think, Talk, and Write

- 1 Main Idea** Does a rock stay the same forever? Explain your answer.
- 2 Vocabulary** What are metamorphic rocks?
- 3 Summarize** How can you tell a sedimentary rock apart from a metamorphic rock?



- 4 Critical Thinking** How is the rock cycle a lot like recycling?
- 5 Test Practice** Which phrase describes how a metamorphic rock changes into another kind of metamorphic rock?
 - A sediments form
 - B minerals dissolve
 - C heat and pressure change the rock
 - D magma cools



Writing Link

Write a Story

Write a story about how you, a rock detective, identify a rock no one else recognizes. Tell how you would go about classifying the rock. Make up a name for the new rock.



Art Link

Make a Poster

Cut out pictures that show different ways we use rocks. Organize the pictures on a poster. Then, share your poster with the class.