

section 1 The Rock Cycle

Before You Read

Think about all the different rocks you have seen. Some may have been shiny, others dull. Describe how the rocks you have seen are different.

What You'll Learn

- what the rock cycle is
- how rocks change

Read to Learn

What is a rock?

Different rocks have different characteristics. Some are smooth, some are rough, some are striped, and some are spotted.

What are common rocks?

Most buildings and public monuments are made from common rock. Rock used for building stone often contains one or more common materials, called rock-forming minerals. Two rock-forming minerals are quartz and calcite. A **rock** is a mixture of rock-forming minerals and other materials such as volcanic glass, organic material, or other natural materials.

The Rock Cycle

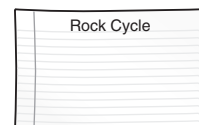
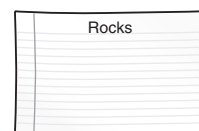
Scientists have created a model to show how rocks slowly change over time. The **rock cycle** shows the processes that create and change rocks. The three types of rocks shown in the rock cycle are igneous, metamorphic, and sedimentary. The rock cycle shows how rocks can change from one type of rock to another.

Mark the Text

Underline As you read, underline key words and definitions. Underline ideas and explanations that help you understand the text.

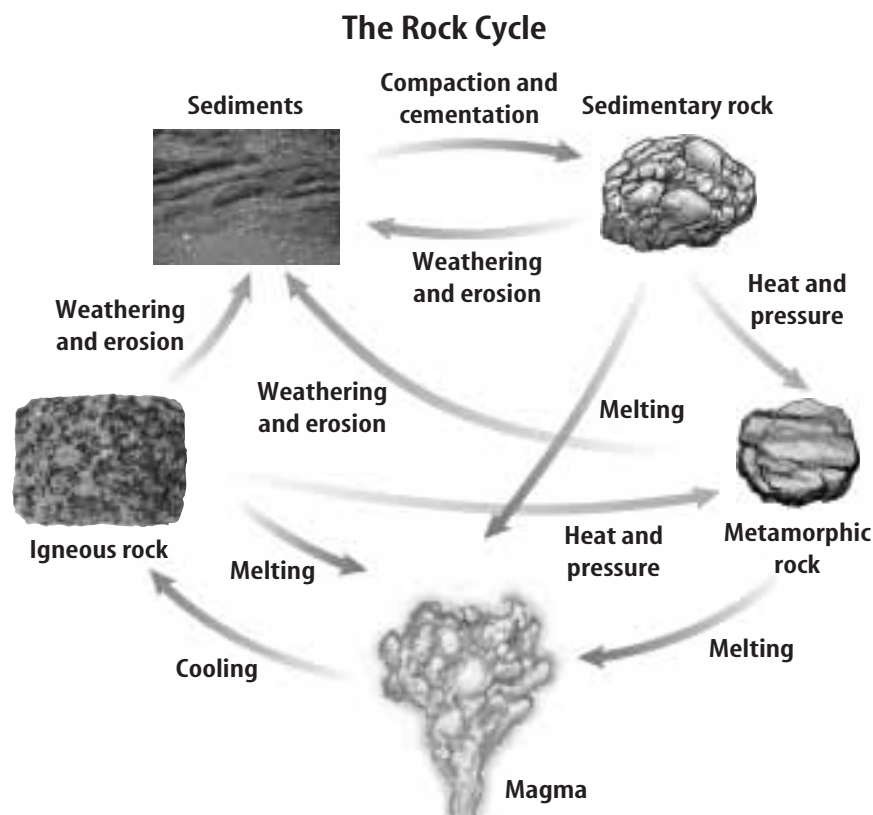
FOLDABLES™

A Draw and Label Make a Foldable from two half sheets of notebook paper to list facts about rocks and to describe the rock cycle.



Picture This

- 1. Identify** Use colored pencils to add information to the rock cycle. Color arrows that involve heat red, weathering and erosion green, cooling blue, and compaction brown.



How do rocks change?

The rock cycle in the figure above shows there are several processes that change rocks. Weathering breaks down rocks into tiny mineral grains, or sediments. Erosion moves the sediments by wind or water. Layers of sediments pile up. They are compacted, or packed down, by more layers of sediment piling on top of them. Over time, the pressure of compaction turns the sediment into sedimentary rock.

Heat and pressure deep inside Earth may change sedimentary rock into metamorphic rock. The metamorphic rock can then melt and later cool to form igneous rock. The igneous rock may then be weathered into mineral grains. The grains eventually form new sedimentary rock. Any rock can change into any of the three major types of rock. A rock can even change into another rock of the same type. No matter what happens, the mineral material is never lost or destroyed. It is conserved, or used in other forms. ✓

✓ Reading Check

- 2. Determine** Is mineral material in rocks destroyed or conserved during the changes?

Who discovered the rock cycle?

Scottish scientist James Hutton noticed that some rocks have straight layers, while others are tilted. He saw that some rocks are weathered, while others are not. Hutton observed that rocks change constantly over time.

● After You Read

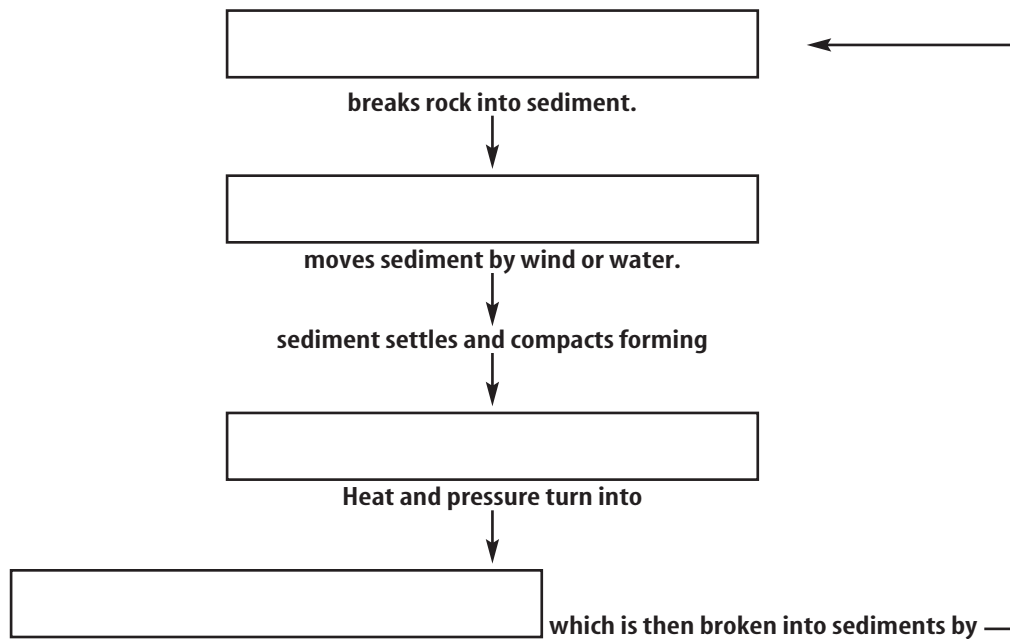
Mini Glossary

rock: mixture of rock-forming minerals and other materials

rock cycle: model that shows how rocks slowly change over time

1. Review the terms and their definitions in the Mini Glossary. Then write a sentence about the rock cycle that explains how rocks change.

2. Fill in the blanks in the boxes below.



3. You underlined the main words, facts, and ideas in this section. How did underlining help you learn about and remember the different types of rocks?

section 2 Igneous Rocks

What You'll Learn

- how igneous rocks form
- how igneous rocks are grouped

Before You Read

Think about an erupting volcano you may have seen on TV or in the movies. On the lines below, describe what comes out of an erupting volcano.

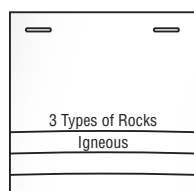
Study Coach

Map Complete

Definitions Create a definition map. Write each vocabulary word, its definition, and ideas that tell about each word. Your map should answer the questions: "What is it?" "What is it like?" and "What are some examples?"

FOLDABLES™

B Identification Make a layered book with two sheets of notebook paper. Write about igneous rock as you read this section. You can complete your Foldable as you read Sections 3 and 4.



Read to Learn

Formation of Igneous Rocks

When a volcano erupts, red-hot material may flow out of it. The extremely hot material is melted rock, called magma. Magma flows like a liquid. When magma flows near or onto Earth's surface, it cools and hardens. **Igneous rock** forms from the cooled and hardened magma.

How does magma become lava?

Inside Earth, the temperature and pressure in certain places are just right to melt rocks. As a result, magma forms. Magma can be found at depths ranging from near Earth's surface to about 150 km below the surface. The temperature of magmas range from about 650°C to 1,200°C.

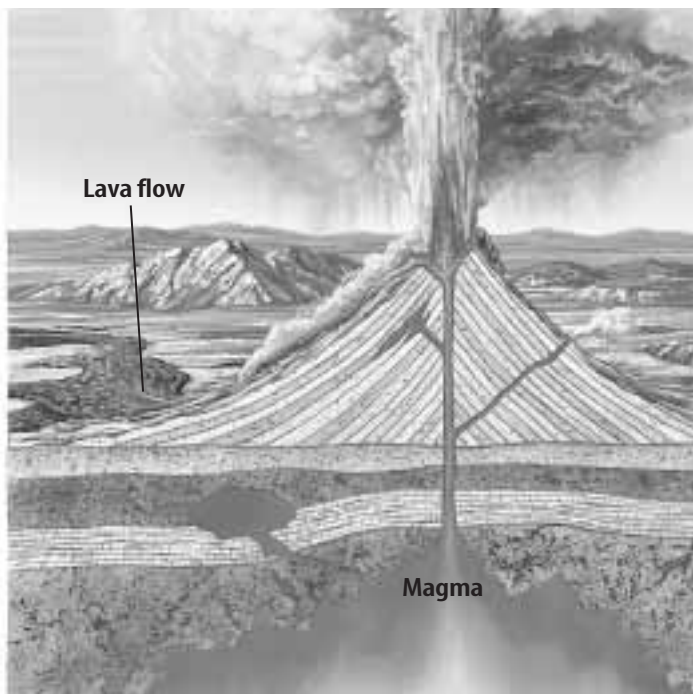
Where does the heat come from that melts rock inside Earth? Some heat comes from the decay of radioactive elements in rocks. Some heat is left from when Earth was formed. At first, Earth was very hot, molten material.

Magma is less dense than the solid rock around it. Because it is less dense, it is forced up toward Earth's surface. When magma reaches Earth's surface and flows from volcanoes, it is called **lava**.

What are intrusive igneous rocks?

Magma is melted rock made up of common elements and liquids. Magma cools as it rises toward Earth's surface. As magma cools, the atoms and compounds in the liquid rearrange themselves into new crystals called mineral grains. As cooling continues, mineral grains grow together to form rocks. Sometimes this process takes place beneath the surface. **Intrusive** igneous rocks form from cooling magma beneath Earth's surface, as shown in the figure below. It takes a long time for magma beneath Earth's surface to cool. Cooling is so slow, mineral grains grow quite large. Intrusive igneous rock has large mineral grains.

Intrusive igneous rocks can be found on Earth's surface. After many years, the layers of rock and soil that once covered them are removed by erosion. Erosion occurs when the rocks are pushed up by forces inside Earth.



What are extrusive igneous rocks?

Extrusive igneous rocks form as lava cools on the surface of Earth, as shown in the figure above. When lava reaches the surface, it is exposed to air and water, which cools it quickly. The atoms in the liquid do not have time to arrange into large crystals. Therefore, the mineral grains in extrusive igneous rock are quite small.



Think it Over

1. Make Connections

The prefix "in" means "inside." Where do intrusive rocks form?

Picture This

2. **Label** Write *intrusive rock* where this rock forms. Write *extrusive rock* where this rock forms.



Think it Over

3. Make Connections

The prefix "ex" means "outside." Where do extrusive rocks form?



Think it Over

4. **Infer** The word “igneous” comes from the Latin word *ignis*, which means “fire.” Why is igneous a good word for this type of rock?

✓ Reading Check

5. **Determine** What is one way basaltic and granitic igneous rocks differ?

What is volcanic glass?

Sometimes, lava that comes out of a volcano cools so quickly that few or no mineral grains form. A rock that forms from this quickly cooling lava is called volcanic glass. Volcanic glass has few or no crystals because the atoms are not arranged in an orderly pattern.

Obsidian is a volcanic glass that looks like shiny black glass. Pumice and scoria are also volcanic glasses, but they do not look like glass. They have lots of holes, or pores. These materials form from a gooey liquid that contains pockets of gases. Some of these gases escape and holes are left where the rock formed around the gas pocket.

Classifying Igneous Rocks

Igneous rocks can be grouped as either intrusive or extrusive depending on how they are formed. Igneous rocks can also be grouped according to the type of magma they come from. An igneous rock can form from basaltic, andesitic, or granitic magma. The type of magma that cools to form an igneous rock affects the properties of that rock. Some of the chemical and physical properties of a rock are its mineral composition, density, color, and melting temperature.

What are basaltic rocks?

Igneous rocks that are dense and dark-colored are **basaltic** (buh SAWL tihk). They form from magma containing a lot of iron and magnesium, but little silica, which is made of silicon and oxygen. Basalt gets its dark color from the iron and magnesium it contains. Basaltic lava is fluid and flows freely.

What are granitic rocks?

Granitic igneous rocks are light-colored and not as dense as basalt. They form from thick, stiff magma that contains lots of silica, but smaller amounts of iron or magnesium. Stiff granitic magma can build up lots of gas pressure. This pressure is released in violent volcanic eruptions. ✓

What are andesitic rocks?

Andesitic igneous rocks have mineral compositions between those of basalt and granite. Like granitic magma, andesitic magma can produce violent volcanic eruptions.

● After You Read

Mini Glossary

basaltic: dense, dark igneous rock that forms from magma containing a lot of iron and magnesium, but little silica

extrusive: igneous rocks that form when lava cools on the surface of Earth

granitic: light-colored igneous rock that forms from thick magma containing lots of silica, but little iron or magnesium

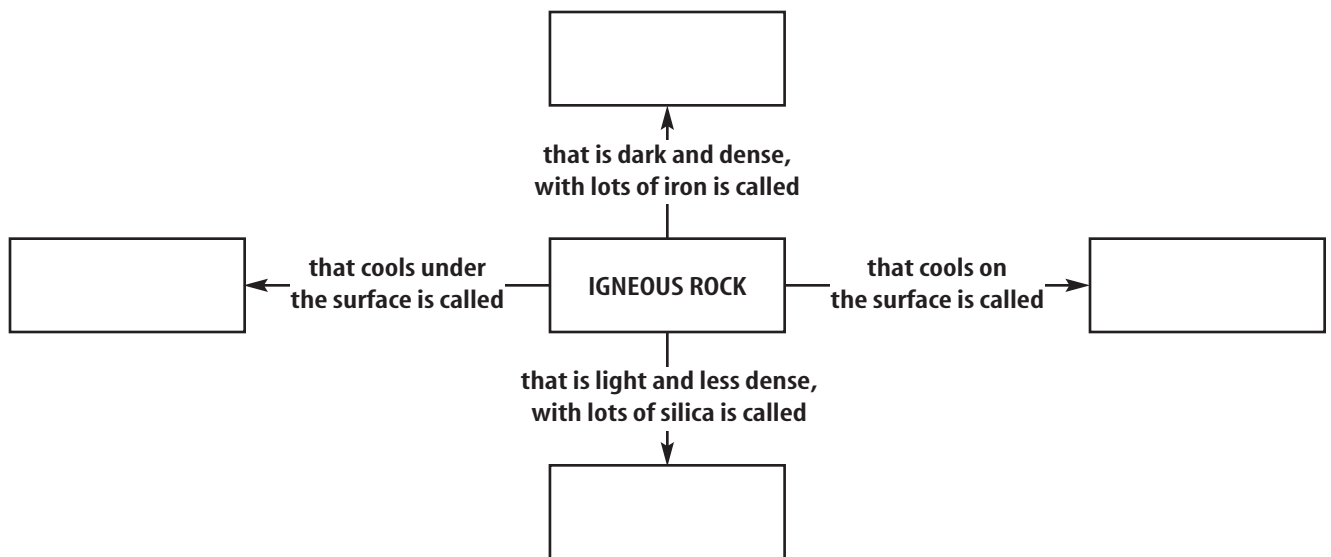
igneous rock: rock that forms as magma or lava cools and hardens

intrusive: igneous rocks that form beneath the surface of Earth

lava: molten rock that flows from volcanoes onto Earth's surface

1. Review the terms and their definitions in the Mini Glossary. Then write one sentence that explains how igneous rock forms.

2. Fill in the blank boxes with words from this section.



3. How did using your definition map help you learn and remember the vocabulary words in this section?

section ③ Metamorphic Rocks

What You'll Learn

- how metamorphic rock forms
- how metamorphic rock is classified

● Before You Read

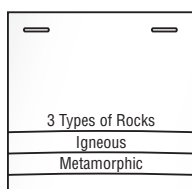
Think about a time you packed a sandwich for lunch and placed a can of juice or soda on top of it. Describe how the sandwich looked at lunchtime and why it looked that way.

Study Coach

Main Ideas As you read, write one sentence to summarize the main idea in each paragraph. Use vocabulary words in your sentences.

FOLDABLES™

B List and Identify As you read this section, use your layered Foldable to list types of metamorphic rock and to describe each type.



● Read to Learn

Formation of Metamorphic Rocks

Like a sandwich that has been flattened by a can of soda, rocks can be affected by changes in pressure. Changes in temperature also can affect rocks. **Metamorphic rock** is rock that has been changed because of changes in temperature and pressure, or the presence of hot, watery fluids. These conditions may change the rock's form, the material it contains, or both.

Metamorphic rock may form from sedimentary rocks, igneous rocks, and even other metamorphic rocks.

How do heat and pressure change rock?

Rocks deep beneath Earth's surface are under great pressure from the layers of rock above them. Temperature also increases with depth. In some areas, the pressure and the temperature are just right to melt rock. The melted rock forms magma. Different types of metamorphic rock may form from the magma.

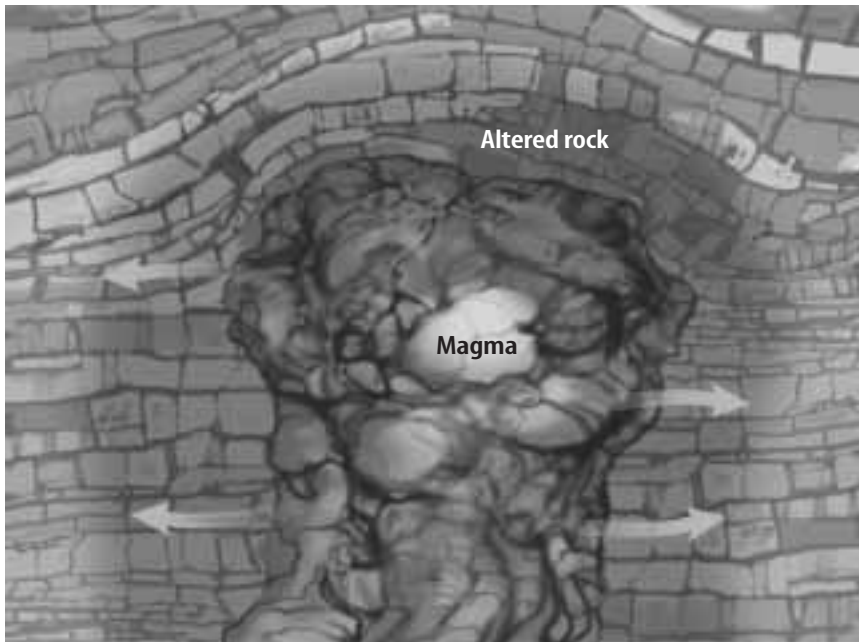
In other places deep inside Earth where there is a lot of liquid, rocks do not melt. Instead, some mineral grains dissolve in the liquid and then form new crystals. Under these conditions, minerals sometimes exchange atoms with surrounding minerals and new minerals form.

How does shale change to gneiss?

Depending on the amount of pressure and the temperature under Earth, one type of rock can change into several different types of metamorphic rock. For example, shale, a sedimentary rock, will change into slate, a metamorphic rock. As the temperature and pressure on it increase, the slate can change into phyllite, then into schist, and finally into gneiss (NISE).

How do hot fluids change rock?

Hot fluids from magma flow through spaces in and between underground rocks. The hot fluids are mostly water, but they also contain dissolved elements and compounds. These fluids can react with the rock they flow through and change its composition. As shown in the figure below, the hot fluid flows into the rock and chemically changes it into a type of metamorphic rock.



Classifying Metamorphic Rocks

Metamorphic rocks form from igneous, sedimentary, or other metamorphic rocks. Heat, pressure, and hot fluids cause these rocks to change. The types of metamorphic rocks that form can be classified based on their composition and texture. 

Picture This

- 1. Highlight** Use a colored marker or pencil to highlight the rocks in the figure that are being changed by the hot fluid from magma.

Reading Check

- 2. Identify** Name three things that cause rocks to change into metamorphic rock.

Reading Check

3. **Describe** How do the layers look in a foliated metamorphic rock?
-

Reading Check

4. **Determine** What is the name of metamorphic rocks that form without layers?
-

What are foliated rocks?

As some metamorphic rocks form, their mineral grains line up in parallel layers. Metamorphic rocks with a **foliated** texture have parallel layers of mineral grains. For example, slate is a metamorphic rock that forms from shale, a sedimentary rock. When shale is exposed to heat and pressure, it changes. Its mineral grains line up in parallel layers to form slate, a foliated metamorphic rock. 

Slate Slate's parallel layers of mineral grains are pressed so tightly together that water cannot pass between them easily. Slate also breaks into smooth, flat pieces. Because it sheds water and splits smoothly, slate is often used for paving stones and roofing tiles.

Gneiss Gneiss is a foliated rock that forms when granite and other rocks are changed by heat and pressure. The foliated texture of gneiss is easily seen in its light and dark bands. As gneiss forms, the movement of atoms separates the dark minerals in the rock from the light-colored minerals in the rock.

What are nonfoliated rocks?

Some metamorphic rocks are formed without layers. In these rocks, the mineral grains grow and rearrange, but do not form layers. **Nonfoliated** rocks are metamorphic rocks that form without a layered texture. 

Sandstone Sandstone is a sedimentary rock made mostly of quartz grains. When it is heated under a lot of pressure, sandstone is changed into quartzite. Heat and pressure cause the sandstone's quartz grains to grow larger and lock together like pieces of a jigsaw puzzle. The quartz grains in quartzite are not in layers, so quartzite is a nonfoliated rock.

Marble Another nonfoliated metamorphic rock is marble. Marble forms from limestone that is under great heat and pressure. Limestone contains the mineral calcite. Heat and pressure change the calcite into marble, which does not have a layered texture. In fact, marble's fine, smooth texture makes it the perfect material for sculptures and buildings.

● After You Read

Mini Glossary

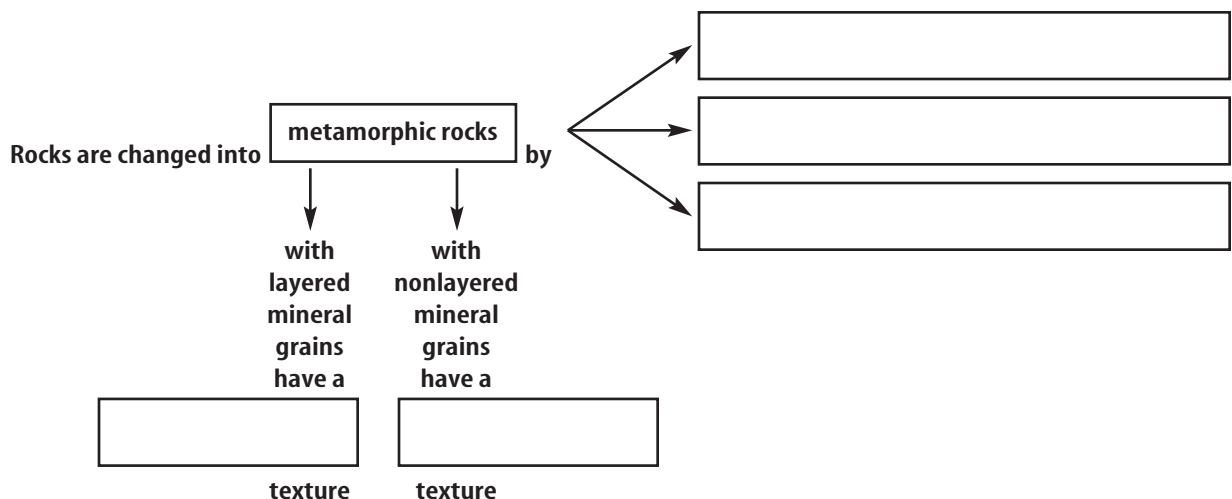
foliated: metamorphic rock whose mineral grains are lined up in parallel layers

metamorphic rock: rock that has been changed by heat, pressure, or the presence of hot fluids

nonfoliated: metamorphic rock whose minerals grow and rearrange themselves in a nonlayered texture

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that describes the difference between foliated metamorphic rock and nonfoliated metamorphic rock.

2. Fill in the blanks in the boxes below to organize the information from this section.



3. In this section you were asked to write sentences using the vocabulary words to summarize the main ideas. How did this help you understand what you read?

section 4 Sedimentary Rocks

What You'll Learn

- how sedimentary rocks form
- how sedimentary rocks are classified

Before You Read

Imagine you are stacking slices of bread, one on top of the other. Then you put a heavy book on top of the stack and leave it there overnight. Describe how the slices of bread might look the next day.

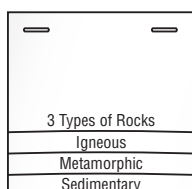
Study Coach

Sticky-note Discussion

Use sticky notes to mark places in the text that you find interesting or that you have a question about. Write your comment or question on the sticky note and stick it to the page.

FOLDABLES™

B Organize Use your Foldable to help you organize sedimentary rocks into groups based on their characteristics.



Read to Learn

Formation of Sedimentary Rocks

Weathering breaks down rocks into sediment. **Sediment** is the loose material, such as tiny pieces of rock, mineral grains, and bits of shell, that are moved by wind, water, ice, or gravity. Sediments come from already-existing rocks that are weathered and eroded.

Sedimentary rock forms when sediments are pressed and cemented together, or when minerals form from solutions. About 75 percent of the rocks you see on Earth's surface are sedimentary rocks.

What do sedimentary rocks look like?

Sedimentary rocks often form as layers, like a stack of papers. The older layers are at the bottom because they were deposited first. The newer layers are at the top because they were deposited later. If sedimentary rock is not disturbed, the layers will remain in place, with the oldest at the bottom and youngest at the top.

Sometimes, though, forces within Earth overturn layers of sedimentary rock. Then, the oldest layers are no longer on the bottom. The order of the layers is changed.

Classifying Sedimentary Rocks

Sedimentary rocks can be made of just about any material in nature. Sediments come from weathered and eroded sedimentary, metamorphic, and igneous rock. Sediments also can come from the remains of some organisms. The composition of a sedimentary rock depends on what types of sediments formed it.

Sedimentary rocks are classified by what they are made of. They are also classified by the way in which they formed. Sedimentary rocks are classified as detrital, chemical, or organic. 

Detrital Sedimentary Rocks

The word *detrital* (dih TRI tul) comes from the Latin word *detritus*, which means “to wear away.” Detrital sedimentary rocks are made from the broken pieces of other rocks. The tiny pieces are compacted and cemented together to form solid sedimentary rock.

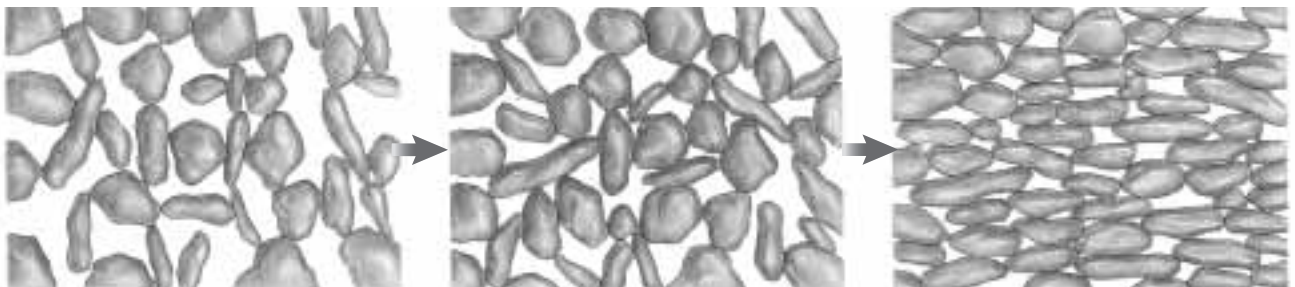
What are weathering and erosion?

Weathering is the process in which air, water, or ice breaks down rocks into smaller and smaller pieces. The movement of weathered material is called erosion.

What is compaction?

Erosion moves sediments to a new place, where they are deposited in a thin layer. Over time, layer upon layer of sediment builds up. The weight of the top layers pushes down on the lower layers. Downward pressure causes small sediments to stick together and form solid rock. The process in which layers of sediments are pressed together to form rock is called **compaction**. The figure below shows how rock pieces are compacted to form sedimentary rock.

Compaction of Sediments



Reading Check

1. **Identify** the three classes of sedimentary rock.

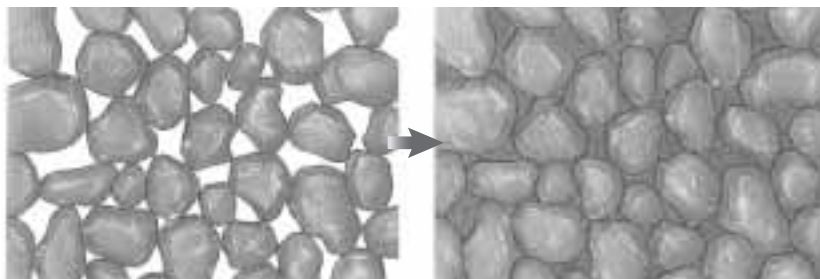
Picture This

2. **Describe** Use a colored pencil to color in the spaces between the sediments in each figure. What happens to the spaces as the sediments form rock?

Picture This

3. **Outline** with your pencil the spaces between sediments where water and dissolved minerals move.

Cementation



What is cementation?

Large sediments, like sand grains and pebbles, cannot form rock from pressure alone. These large sediments form rock only if something helps them stick together.

As water moves through rock and soil, it picks up materials released by the weathering of minerals. The resulting solution of water and dissolved minerals moves through open spaces between larger sediments. The solution acts as a kind of glue that holds the large sediments together. **Cementation** is the process in which sediments are held together by dissolved minerals produced when water moves through rock. Minerals such as quartz, calcite, and hematite make the best cement for holding large sediments together. ✓

What are the shapes and sizes of sediments?

Detrital rocks have a grainy texture, like grains of sugar. They are named according to the shapes and sizes of the sediments that form them. For example, conglomerate and breccia (BRECH uh) are detrital rocks that form from large sediments. If the sediments are rounded, the rock is called conglomerate. If the sediments have sharp angles, the rock is called breccia. The farther sediments are carried by wind, water, or ice, the more rounded they become.

What materials are found in sedimentary rocks?

Conglomerate and breccia are formed from gravel-sized sediments that are cemented together by quartz or calcite. These sediments may come from the minerals quartz or feldspar, or may contain chunks of other rocks, such as gneiss, granite, or limestone.

Sandstone forms from small sediments. The sand-sized sediments in sandstone can come from almost any mineral, though they usually come from quartz and feldspar. Shale is a detrital sedimentary rock that is made from the smallest clay sediments.

✓ Reading Check

4. **Identify** What is necessary for the process of cementation to take place—wind, water, or air?

💡 Think it Over

5. **Infer** Which has probably been carried farther by wind and water—the sediment in conglomerate rocks or breccia rocks?

Chemical Sedimentary Rocks

When water evaporates from a salt solution, salt grains remain. In a similar way, when the water in a lake evaporates, its minerals remain. The remaining mineral deposits form sediments which, in turn, form rocks. Chemical sedimentary rocks form when dissolved minerals come out of solution and form sediments that become rocks. 

How does limestone form?

Calcium carbonate is found dissolved in ocean water. Calcium carbonate comes out of solution as the mineral calcite. Calcite forms crystals, which bond to form limestone, usually on the bottom of lakes and shallow seas. Long ago, the central United States was covered with a shallow sea. Over time, the water evaporated. As a result, much of the central United States has limestone bedrock.

How does rock salt form?

Some bodies of water contain a lot of dissolved salts. When the water evaporates, it deposits the mineral halite, or rock salt. Rock salt is mined. It is used in manufacturing glass, paper, and soap. It is also made into table salt.

Organic Sedimentary Rocks

Rocks made of materials that were once living things are called organic sedimentary rocks. One of the most common organic sedimentary rocks is fossil-rich limestone. It is made of the remains of once-living ocean organisms. Ocean animals, such as clams and snails, make their shells out of calcium carbonate, which eventually becomes calcite. When the animals die, their shells pile up and become cemented together to form fossil-rich limestone. 

What are other organic sedimentary rocks?

Chalk Chalk is an organic sedimentary rock that is made up of extremely tiny bits of animal shells. When you write with chalk, you are crushing and smearing the calcite shell remains of once-living ocean animals.

Coal Coal is a useful organic sedimentary rock that forms when pieces of dead plants are buried under other sediments in swamps. The plant material is chemically changed. The resulting sediments are compacted to form coal. Today, coal is a fuel used in power plants to make electricity.

Reading Check

6. **Explain** What do chemical sedimentary rocks form from?

Reading Check

7. **Determine** What do all organic sedimentary rocks contain?

● After You Read

Mini Glossary

cementation: process in which sediments are held together by dissolved minerals produced when water moves through rock

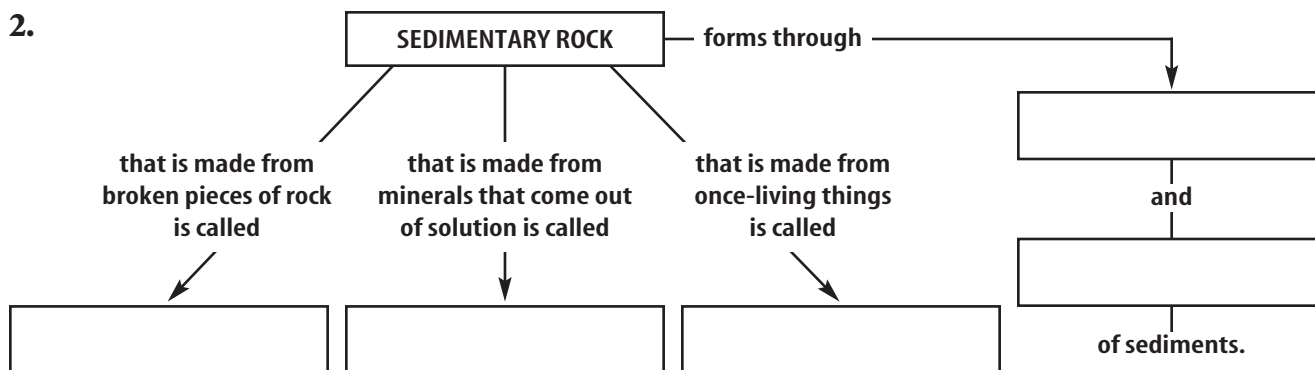
compaction: process in which layers of sediments are pressed together to form rock

sediment: loose material, such as tiny pieces of rock, mineral grains, and bits of shell, that are weathered from rocks and carried by wind or water

sedimentary rock: rock that forms when sediments are pressed and cemented together, or when minerals form from solutions

1. Review the terms and their definitions in the Mini Glossary. Then write one or two sentences that describe how sediments form sedimentary rocks. Use the terms in your answer.

2.



3. You used sticky notes to write comments or questions about this section. How did using sticky notes help you understand sedimentary rocks?

