

The Rock Cycle

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What is a rock?
- How are rocks classified?
- What does the texture of a rock reveal about how it was formed?

**National Science
Education Standards**
ES 1c, 1d

Why Are Rocks Important?

You know that you can recycle paper, aluminum, and plastic. Did you know that the Earth also recycles? One thing the Earth recycles is rock. A **rock** is a naturally occurring solid mixture of one or more minerals. Some rocks also contain the remains of living things.

Rock is an important resource for human beings. Early humans used rocks as hammers and other tools. They shaped rocks like chert and obsidian into spear points, knives, and scrapers. Rock is also used in buildings, monuments, and roads. The figure below shows how rock has been used as a building material in ancient and modern civilizations.



The ancient Egyptians used a rock called **limestone** to build the pyramids at Giza (left-hand figure). The Texas state capitol building in Austin is constructed of a rock called **granite** (right-hand figure).

It may seem like rocks never change, but this is not true. In fact, rocks are changing all the time. Most of these changes are slow, which is why it seems like rocks do not change. The processes by which new rocks form from older rock material is called the **rock cycle**.



Describe As you read this section, make a chart describing the processes of weathering, erosion, and deposition.

TAKE A LOOK

1. Identify What are two kinds of rocks that people have used for constructing buildings?

SECTION 1 The Rock Cycle *continued*

What Processes Shape the Earth’s Surface?

Many different processes are part of the rock cycle. These processes shape the features of our planet. They form the mountains and valleys that we see around us. They also affect the types of rock found on the Earth’s surface.

STANDARDS CHECK

ES 1c Land forms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.

2. Explain How does weathering shape the Earth’s surface?

WEATHERING, EROSION, AND DEPOSITION

Weathering happens when water, wind, ice, and heat break down rock into smaller fragments. These fragments are called *sediment*. Sediment can move over the Earth’s surface through erosion and deposition.

Erosion happens when water, wind, ice, or gravity move sediment over the Earth’s surface. Over time, sediment that has been eroded stops moving and is deposited. When sediment stops moving, it is called **deposition**. Sediment can be deposited in bodies of water and other low-lying areas.

TAKE A LOOK

3. Identify Give two things that may have caused the weathering and erosion in Bryce Canyon.



The rocks in Bryce Canyon, Utah, have been shaped by weathering and erosion. Although these processes can be slow, they can cause large changes in the Earth’s surface.

HEAT AND PRESSURE

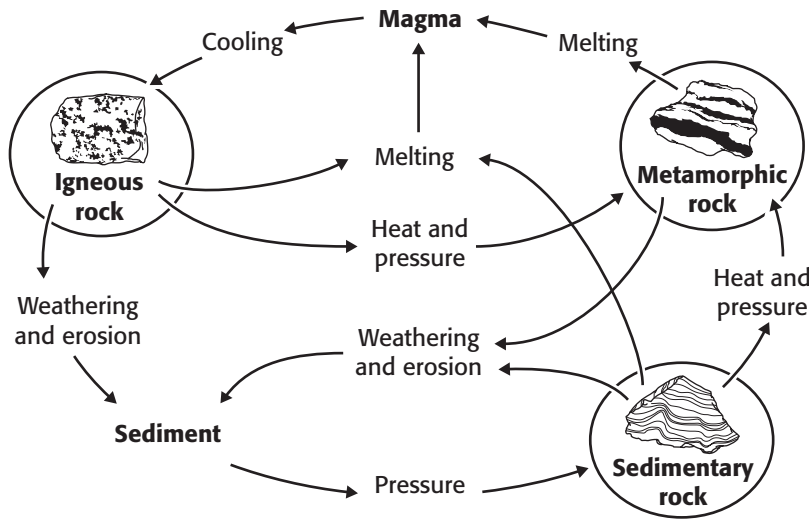
Rock can also form when buried sediment is squeezed by the weight of the layers above it. In addition, temperature and pressure can change the minerals in the rocks. In some cases, the rock gets hot enough to melt. This melting produces liquid rock, or *magma*. When the magma cools, it hardens to form new rock. The new rock contains different minerals than the rock that melted.

SECTION 1 The Rock Cycle *continued*

THE ROCK CYCLE

Geologists put rocks into three main groups based on how they form. These groups are igneous rock, sedimentary rock, and metamorphic rock. *Igneous rock* forms when melted rock cools and hardens. *Sedimentary rock* is made of pieces of other rock (sediment). *Metamorphic rock* forms when heat and pressure change the chemical composition of a rock.

Remember that the rock cycle is made of all of the processes that make new rock out of older rock material. Weathering, erosion, deposition, heat, and pressure are some of the processes that are part of the rock cycle. The figure below shows how the processes in the rock cycle can change rocks from one kind to another.



As you can see, rocks do not have to follow a single path through the rock cycle. An igneous rock may be weathered to form sediment, which then forms sedimentary rock. The igneous rock could also melt and cool to form a new igneous rock.

The path that a rock takes through the rock cycle depends on the forces that act on the rock. These forces change depending on where the rock is located. For example, high pressures and temperatures below the Earth's surface can cause metamorphic rock to form.

Critical Thinking

4. Compare How are igneous rocks different from metamorphic rocks?

TAKE A LOOK

5. Use a Model Find two paths through the rock cycle that lead from sedimentary rock to igneous rock. Use a colored pen or marker to trace both paths on the figure.

SECTION 1 The Rock Cycle *continued*

How Do Geologists Classify Rocks?

Remember that rocks can be divided into three groups based on how they form. Each main group of rock can be divided into smaller groups. These divisions are also based on the ways rocks form. For example, all igneous rock forms when magma cools and hardens. However, different kinds of igneous rock form when magma cools above the ground and when it cools underground.

Each kind of rock has specific features that make it different from other kinds of rock. Geologists can learn how a rock formed by studying its features. Two features that are especially helpful for classifying rocks are composition and texture

READING CHECK

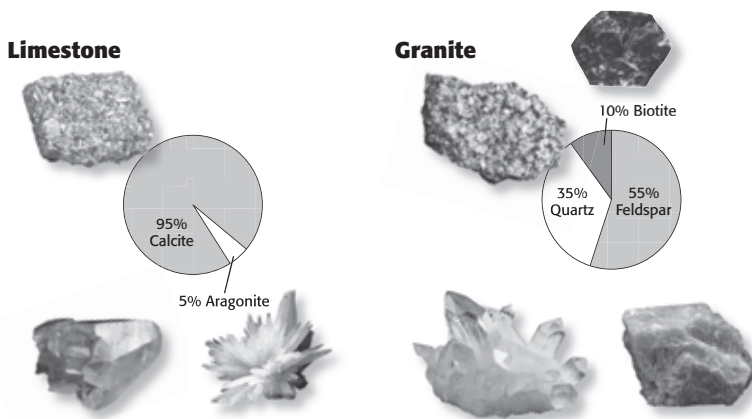
6. Explain How do geologists learn how a rock formed?

COMPOSITION

The combination of elements or compounds that make up a rock is the rock's **composition**. The minerals in a rock determine the rock's composition. For example, the sedimentary rock limestone is made mainly of the minerals calcite and aragonite. In contrast, the igneous rock granite contains the minerals feldspar, quartz, and biotite. These two rocks contain different minerals and have different compositions.

Math Focus

7. Calculate Rock A contains 10% quartz and 45% calcite. The rest of the rock is mica. What percentage of the rock is mica?



Limestone, a sedimentary rock, contains the minerals calcite and aragonite.

Granite, an igneous rock, contains the minerals biotite, feldspar, and quartz.

Composition can help geologists classify rocks. This is because different minerals form under different conditions. For example, remember that the mineral garnet forms under high temperatures and pressures. Therefore, a rock with garnet in it probably formed under high temperature and pressure. Such a rock is probably a metamorphic rock.

SECTION 1 The Rock Cycle *continued*

TEXTURE

The sizes, shapes, and positions of the grains that make up a rock are the rock's **texture**. The texture of a rock can be affected by different things. The texture of a sedimentary rock is mainly affected by the sediment that formed it. For example, a sedimentary rock that forms from small sediment pieces will have a fine-grained texture. The figures below show some examples of sedimentary rock textures.

Fine-grained



Siltstone

Siltstone is made of tiny pieces of sediment, such as silt and clay. Therefore, it has a fine-grained texture. It feels smooth when you touch it.

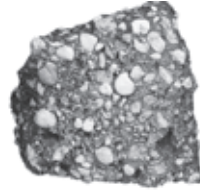
Medium-grained



Sandstone

Sandstone is made of pieces of sand. It has a medium-grained texture. It feels a bit rough, like sandpaper.

Coarse-grained



Conglomerate

Conglomerate is made of sediment pieces that are large, such as pebbles. Therefore, it has a coarse-grained texture. It feels bumpy.

TAKE A LOOK

8. Explain What determines the texture of a sedimentary rock?

The texture of an igneous rock depends on how fast the melted rock cools. As melted rock cools, mineral crystals form. When melted rock cools quickly, only very small mineral crystals can form. Therefore, igneous rocks that cool quickly tend to have a fine-grained texture. When melted rock cools slowly, large crystals can form, which make a coarse-grained igneous rock.

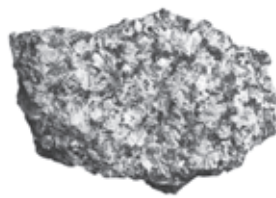
Fine-grained



Basalt

Basalt forms when melted rock cools quickly on the Earth's surface. It has a fine-grained texture because the mineral crystals in it are very small.

Coarse-grained



Granite

Granite forms when melted rock cools slowly underground. It has a coarse-grained texture because the mineral crystals in it are large.

TAKE A LOOK

9. Describe How does granite form?

Section 1 Review

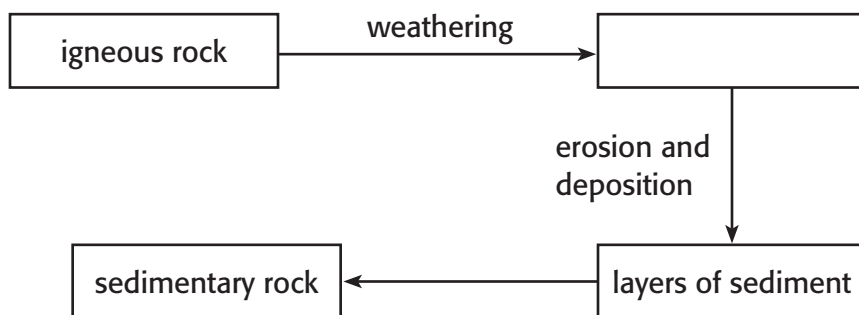
NSES ES 1c, 1d

SECTION VOCABULARY

<p>composition the chemical makeup of a rock; describes either the minerals or other materials in the rock</p> <p>deposition the process in which material is laid down</p> <p>erosion the process by which wind, water, ice, or gravity transports soil and sediment from one location to another</p>	<p>rock a naturally occurring solid mixture of one or more minerals or organic matter</p> <p>rock cycle the series of processes in which rock forms, changes from one type to another, is destroyed, and forms again by geologic processes</p> <p>texture the quality of a rock that is based on the sizes, shapes, and positions of the rock's grains</p>
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1. Compare What is the difference between weathering and erosion?

2. Identify Complete the diagram to show how igneous rock can turn into sedimentary rock.



3. List What are two features that geologists use to classify rocks?

4. Describe What determines the texture of an igneous rock?

5. Explain How can a rock's composition help geologists to classify the rock?

- The crystal's shape is determined by the arrangement of atoms or molecules in the crystal.
- Water is not a solid.
- Silicate minerals contain compounds of silicon and oxygen. Nonsilicate minerals do not contain compounds of silicon and oxygen.
- native elements, oxides, sulfides, sulfates, halides, carbonates

SECTION 2 IDENTIFYING MINERALS

- It can react with air or water.
- A mineral's color may change, but its streak is always the same.
- conchoidal
- 19 times
- the resistance of a mineral to being scratched
- No, because orthoclase is harder than apatite.
- They glow.

Review

- Minerals with cleavage break along smooth, flat surfaces. Minerals with fracture break along curved or irregular surfaces.
- The same mineral can have many different colors.
- hardness, streak, cleavage or fracture, luster, density
- The mineral's hardness is probably about 4. Calcite has a hardness of 3. Apatite has a hardness of 5. Since apatite scratches the mineral but calcite doesn't, the mineral's hardness must be somewhere between 3 and 5.
- 2.6

SECTION 3 THE FORMATION, MINING, AND USE OF MINERALS

- Metamorphism: garnet, graphite, talc
Reaction: gold, copper, pyrite
- gold, copper
- iron, coal, salt
- horizontal, vertical, angled
- pollution and habitat destruction
- When mineral materials are recycled, less of the minerals have to be mined from the Earth.
- Silver: electronics, jewelry
Bauxite: aluminum cans, utensils
- ilmenite, magnetite, bauxite, beryl

- These appliances run on electricity. If electricity couldn't move through them easily, they might not work correctly.
- calcite, quartz
- impurities

Review

- An ore is a rock or mineral that has enough useful material in it to be mined at a profit.

Type of material	Main features	Common objects made from it
Metal	has shiny surfaces, does not transmit light, transmits heat and electricity easily, can be rolled into sheets or stretched into wires	wires, cars, electronics
Nonmetal	has shiny or dull surfaces, does not transmit heat or electricity easily, transmits light	cement, computer chips, glass

- evaporation, metamorphism, deposition
- Open-pit mines: gold
Quarries: gravel
Strip mines: coal

Chapter 4 Rocks: Mineral Mixtures

SECTION 1 THE ROCK CYCLE

- limestone, granite
- Weathering causes rock to break down into smaller pieces.
- water, wind, ice, gravity
- Igneous rocks form when melted rock cools. Metamorphic rocks form when rock is heated (but does not melt) and its composition changes.
- One possible path: Sedimentary rocks melt and cool to form igneous rocks.
- by studying its features
- 45%
- the sizes of the sediment particles it is formed from
- when melted rock cools slowly underground

Review

- Weathering is the process by which water, wind, ice, and heat break down rock. Erosion is the process by which sediment is transported from its source.

- In the box: sediment
Above the arrow: pressure
- texture, composition
- how fast the magma cools
- Different minerals form under different conditions. The minerals in a rock determine its composition.

SECTION 2 IGNEOUS ROCK

- increasing temperature, decreasing pressure, addition of fluids
- Magma contains many minerals that solidify at different temperatures.
- Most felsic rocks are light-colored and rich in Na, K, and Al. Most mafic rocks are dark-colored and rich in Fe, Mg, and Ca.
- rhyolite
- gabbro
- rock that forms when melted rock cools slowly underground
- dike, stock, sill, batholith
- The lava cools very quickly.

Review

- Intrusive rock forms below the surface and has a coarse-grained texture. Extrusive rock forms above the surface and has a fine-grained texture.
- basalt, rhyolite
- A stock or dike forms. Then, the rock around it erodes away. The igneous rock is left over as a volcanic neck.
- A dike cuts across rock layers, but a sill is parallel to other, previous layers.
- It probably has a coarse-grained texture because it cooled slowly (or because it is an intrusive rock).
- extrusive, intrusive, intrusive, extrusive

SECTION 3 SEDIMENTARY ROCK

- at or near the Earth's surface
- calcite, quartz
- coarse-grained
- Minerals crystallize from water.
- Rock made from the shells of sea creatures.
- Sediment is deposited in layers.

Review

- the arrangement of rocks in layers

- sandstone, shale, siltstone, conglomerate
- Clastic sedimentary rock forms when rock or mineral fragments are cemented together. Organic sedimentary rock forms from the remains of once-living organisms.
- Evaporite forms when halite and gypsum crystallize as water evaporates.
- Fossiliferous limestone forms from the fossils of animals in the ocean. Skeletons of sea animals collect on the ocean floor. These animal remains become cemented together to form limestone.
- The sediment was probably deposited in an area with steady winds or running water. Wind and water produce ripples in sediment. These ripples can be preserved as ripple marks in sedimentary rock.

SECTION 4 METAMORPHIC ROCK

- Minerals react to produce new minerals.
- Mineral molecules moved together during metamorphism.
- metamorphism that happens when rock is heated by nearby magma
- where rock is deeply buried or where pieces of crust collide
- squeezing
- Sillimanite is more likely to be found in a metamorphic rock because it forms under high temperatures and pressures.
- Minerals like quartz form under a range of temperatures and pressures.
- chlorite
- a metamorphic rock in which the minerals are arranged in bands
- gneiss
- They can change.

Type of metamorphic rock	Description	Example
Foliated	Minerals are arranged in bands or stripes.	gneiss
Nonfoliated	Minerals are not arranged in bands or stripes.	quartzite

Review

- Foliated rocks have minerals arranged in bands. Nonfoliated rocks do not.
- Regional metamorphism happens when high temperatures and pressures cause rock in a large area to change.