

Section 1

Minerals and Rocks

CALIFORNIA

Standards Focus

5 6.6.b Students know different natural energy and material resources, including air, soil, rocks, minerals, petroleum, fresh water, wildlife, and forests, and know how to classify them as renewable or nonrenewable.

c. Students know the natural origin of materials used to make common objects.

- What is a mineral?
- What are the three major groups of rock, and how do they form through the rock cycle?
- How are minerals and rocks used and processed?

Key Terms

- mineral
- crystal
- rock cycle
- igneous rock
- sedimentary rock
- sediment
- metamorphic rock
- nonrenewable resource
- ore
- smelting

Lab zone

Standards Warm-Up

What's a Rock?

1. Your teacher will give you three different rocks.
2. Observe each rock under a hand lens. In your notebook, describe the color or colors that you see in the rocks. Also describe any shapes or patterns in the rocks.
3. Make a sketch of each of your rocks.
4. Are your rocks made up of one material or several materials? How can you tell?
5. How are the rocks similar? How are they different?

Forming Operational Definitions Based on your observations, how would you define the word *rock*?

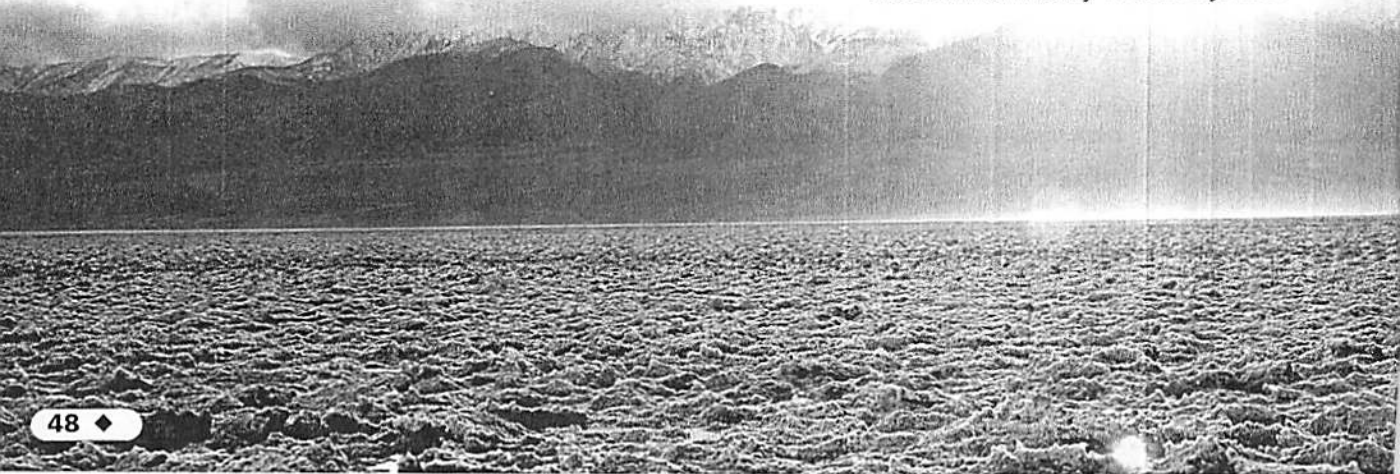
You may think of a golf course as a place covered by smooth, green grass. But that's not true of the Devil's Golf Course in Death Valley National Park. Instead of grass, a jagged crust of salt covers this "golf course." The salt forms lacy sheets, spikes, and other strange shapes.

Where did the salt that forms the Devil's Golf Course come from? About 3,000 years ago, a large lake filled the area. The lake's water contained dissolved salt. Over time, the climate became drier and the lake slowly dried up. As the water evaporated, the salt was left behind. This salt, the same as ordinary table salt, is also called halite. To a geologist, halite is a mineral.

FIGURE 1

Devil's Golf Course

The fantastic shapes on this dry lake bed in Death Valley National Park, California, are formed mostly of salt crystals.



What Is a Mineral?

Minerals can be as rare as a precious diamond. Or they can be as common as the halite that makes up the Devil's Golf Course. Geologists have identified more than 3,000 different minerals. But all of these minerals share certain characteristics.

☉ A mineral is a naturally occurring, inorganic solid that forms on or beneath Earth's surface. Almost all minerals have a crystal shape. Each mineral also has a definite chemical composition. For a substance to be a mineral, it must have all five of these characteristics.

Inorganic Solid Halite occurs naturally in areas once occupied by lakes or seas. Halite is inorganic. This means that the mineral did not form from materials that were once part of a living thing. If you pour some halite into your hand, you can see that it is made up of small, solid particles.

Crystal Shape Halite also has a crystal shape. In Figure 2, you can see that halite crystals are shaped like cubes. A crystal is a solid made up of particles that line up in a pattern that repeats over and over again.

Definite Chemical Composition Halite has a definite chemical composition. This means that it is made up of certain elements in definite proportions. Halite is made up of one atom of sodium for every atom of chlorine. Many other minerals are made up of several elements. A few minerals are made up of only one element. Copper, silver, gold, and sulfur sometimes occur naturally in this form.

Each mineral has different properties depending on its chemical composition. For example, minerals differ in color, hardness, and crystal shape.



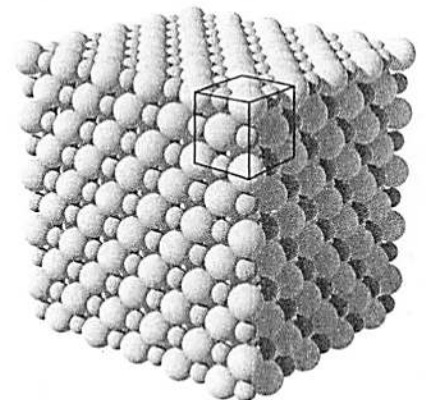
Reading
Checkpoint

What is a crystal?

FIGURE 2

Mineral Crystals

Crystals of the mineral halite—which you know as table salt—are shaped like cubes.



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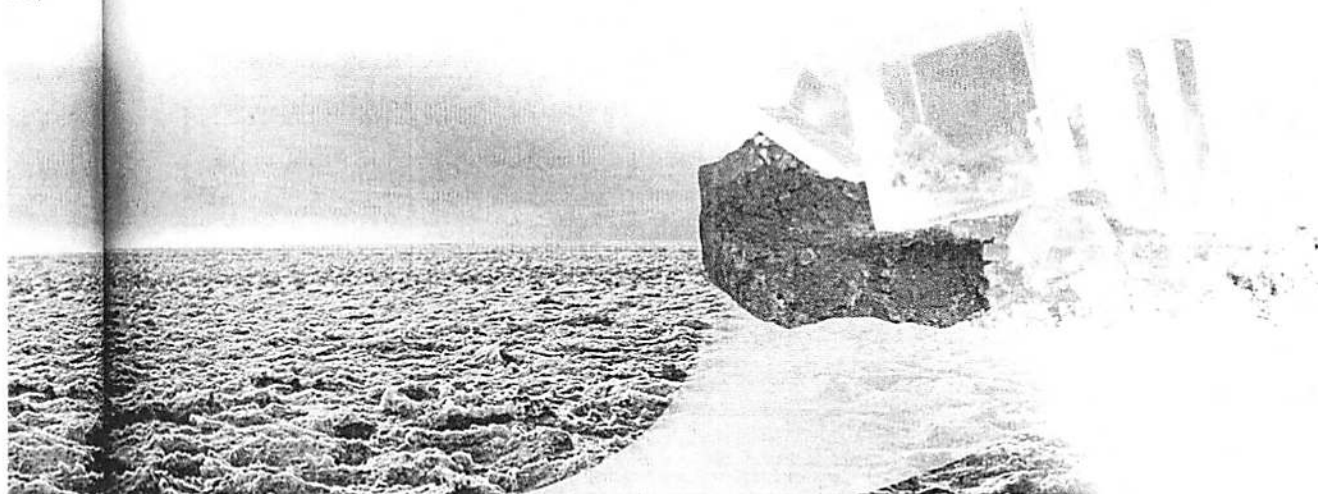
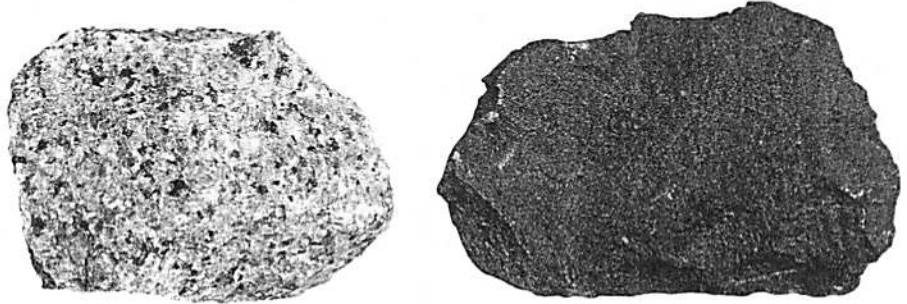


FIGURE 3

Granite and Basalt

Granite is made up of large crystals of several minerals, including quartz, mica, and feldspar. The crystals in basalt are too small to be seen without a hand lens.



Granite

Basalt

Rocks and the Rock Cycle

Minerals are one of the main building blocks of rock. Rock is the solid material made up of one or more minerals or other substances. Rock makes up Earth's hard crust. How do the different kinds of rocks form? Forces deep inside Earth and at the surface produce a slow cycle that builds, destroys, and changes rocks. The **rock cycle** is a series of processes on and beneath Earth's surface that slowly change rocks from one kind to another. ➡ **Geologists classify rocks into three major groups: igneous rock, sedimentary rock, and metamorphic rock.** The rocks in each group form through different steps in the rock cycle.

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Try This Activity

Rock Absorber

Here's how to find out if water can soak into rock.

1. Using a hand lens, compare samples of sandstone and shale.
2. Use a balance to measure the mass of each rock.
3. Place the rocks in a pan of water and watch closely. Which sample has bubbles escaping? Predict which sample will gain mass.
4. Leave the rocks submerged in the pan overnight.
5. The next day, remove the rocks from the pan and find the mass of each rock.

Drawing Conclusions How did the masses of the two rocks change after soaking? What can you conclude about each rock?

Forming Igneous Rock The rock cycle begins when molten material forms inside Earth. Then, this material slowly cools and hardens at or beneath the surface. The result is **igneous rock** (IG nee us). The granite in Figure 3 formed when molten material cooled slowly beneath the surface. Because it cools slowly, granite is made up of large crystals.

Other igneous rocks form when molten material erupts onto Earth's surface. Basalt forms when molten material cools and hardens on the surface. Because it cools quickly, basalt is made up of very small crystals.

Forming Sedimentary Rock The rock cycle continues as **sedimentary rock** (sed uh MEN tur ee) forms. Water and weather cause rocks on Earth's surface to break down, forming sediment. **Sediment** is small, solid pieces of material that come from rocks or living things.

Water and wind carry sediment and deposit it in layers. Layers of sediment build up and are squeezed together by their own weight. At the same time, minerals in the rock slowly dissolve in water. These minerals harden and glue the sediment together. Over millions of years, the sediment slowly changes to sedimentary rock.

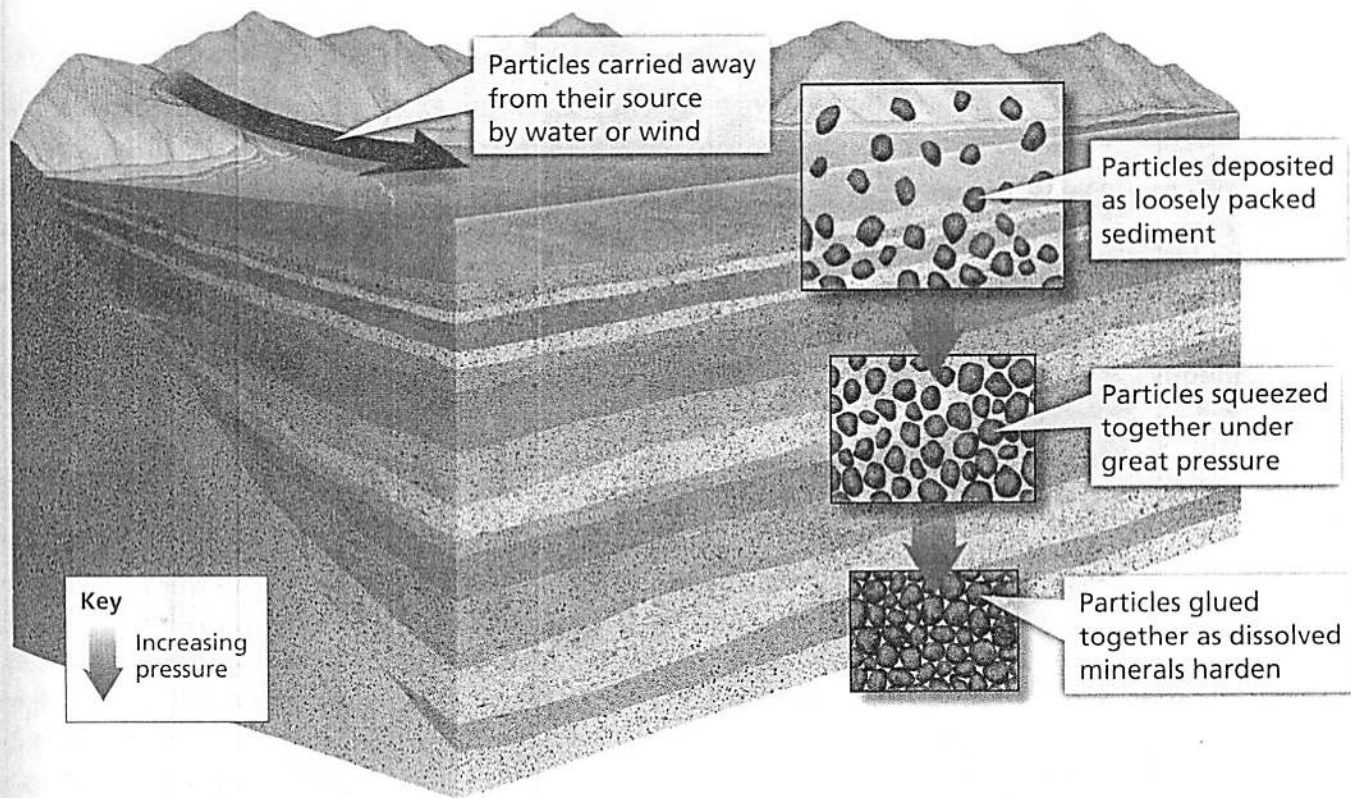



FIGURE 4
How Sedimentary Rocks Form
 Sedimentary rocks form over millions of years as particles of sediment are deposited and then squeezed and glued together.
Relating Cause and Effect What conditions are necessary for sedimentary rocks to form?

Some sedimentary rocks, such as sandstone, are made up of particles of other rocks. The remains of plants and animals can also form sedimentary rock. For example, limestone forms in the oceans from the shells and skeletons of coral and other animals. Another type of sedimentary rock forms when minerals dissolved in water form crystals. That's how rock salt, made of the mineral halite, is formed.

Forming Metamorphic Rock As the rock cycle continues, any rock can change into **metamorphic rock** (met uh MAWR fik). Forces inside Earth can push rocks down toward the heat of Earth's interior. The deeper a rock is buried, the greater the pressure on that rock. Under great heat and pressure, the minerals in a rock can be changed into other minerals. The rock has become metamorphic rock. For example, heat and pressure can change granite into gneiss, as shown in Figure 5.

 **Reading Checkpoint** What is sediment?

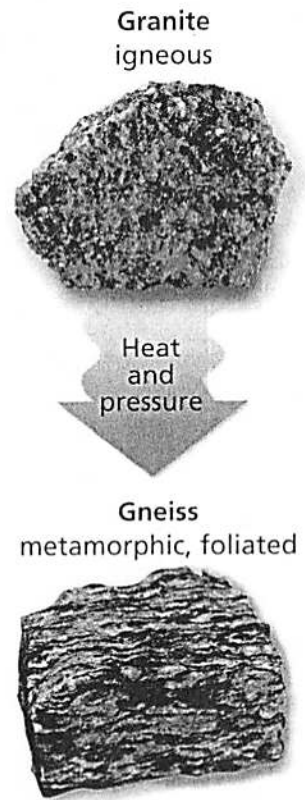
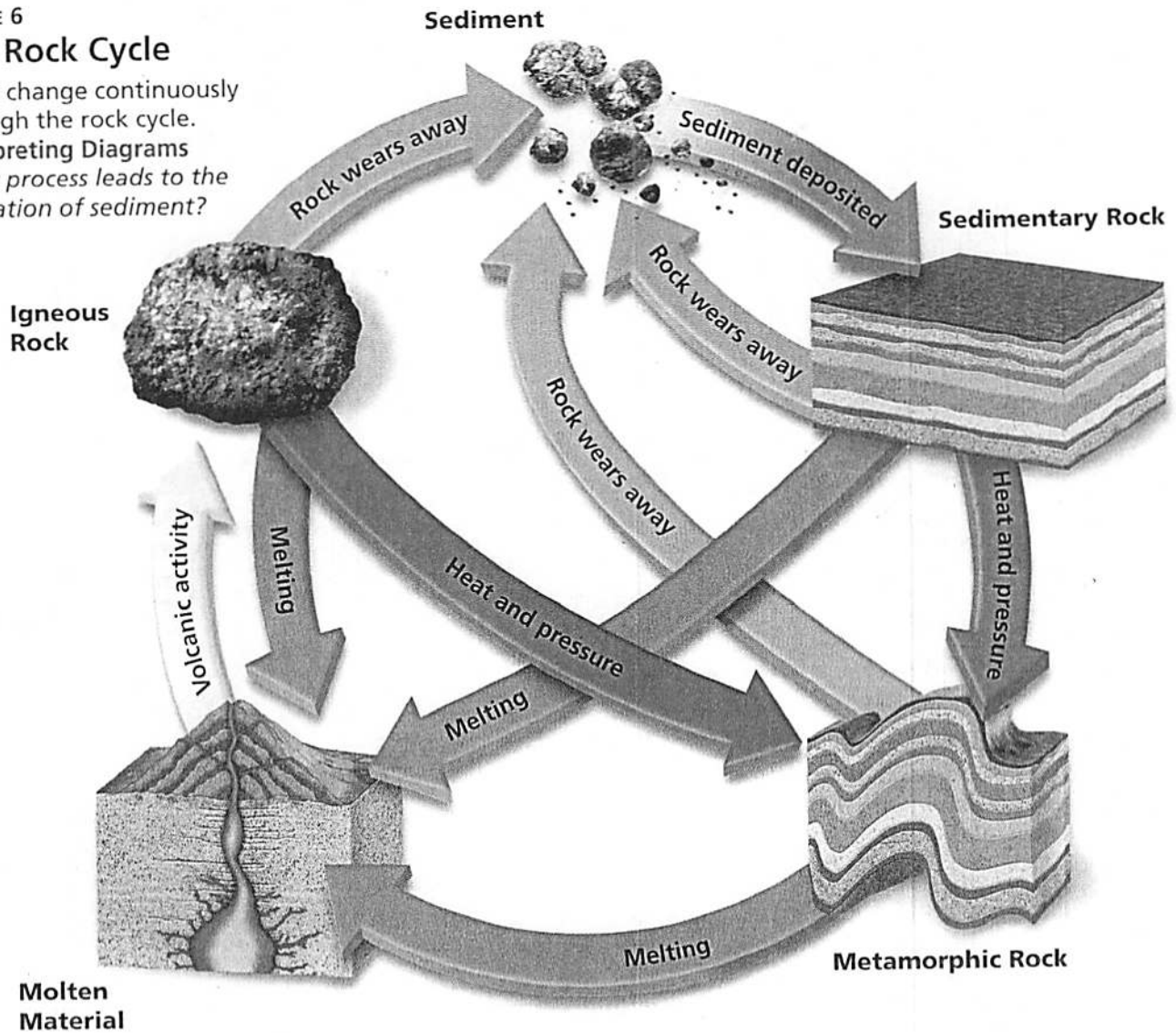


FIGURE 5
Forming Metamorphic Rock
 Heat and pressure change granite to a metamorphic rock, gneiss.

FIGURE 6

The Rock Cycle

Rocks change continuously through the rock cycle. Interpreting Diagrams
What process leads to the formation of sediment?



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Pathways of the Rock Cycle As you can see in Figure 6, there are many pathways through the rock cycle. Here is one possible pathway: The igneous rock granite formed beneath the surface millions of years ago. Then, the forces of mountain building slowly pushed the granite upward, forming a mountain. Slowly, water and weather wore away the granite, forming sand. Streams carried the sand to the ocean.

Over millions of years, layers of sandy sediment piled up on the ocean floor. Slowly the sediments were pressed together and cemented to form sandstone, a sedimentary rock. Over time, the sandstone became deeply buried. Heat and pressure changed the rock's texture from gritty to smooth. Over millions of years, the sandstone changed into the metamorphic rock quartzite.

Metamorphic rock does not end the rock cycle. For example, the heat of Earth's interior could melt the rock. This molten material could then form new igneous rock.

Using Minerals and Rocks

People use minerals and rocks in thousands of ways. But because minerals and rocks can take millions of years to form, they are considered nonrenewable resources. A **nonrenewable resource** is one that is not replaced in a useful time frame.

Uses of Minerals You might be surprised at how many common products contain minerals. **Minerals are the source of gemstones, metals, and other materials used to make many products.**

Gemstones such as rubies and sapphires have amazed people throughout the ages. Usually, a gemstone is a hard, colorful mineral. Gemstones are used mainly for jewelry. They are also used for mechanical parts and for grinding and polishing.

Minerals are also the source of metals such as iron, copper, and silver. Metal tools, aluminum foil, and the steel used to make cars all began as minerals. Many other minerals are used in foods, medicines, fertilizers, and building materials. Quartz, a mineral found in sand, is used in making glass. Gypsum, a soft, white mineral, is used to make wallboard and cement.



Reading
Checkpoint

What are gemstones?

Uses of Rocks Throughout history, people have found many uses for rocks. For thousands of years, people made arrowheads out of flint, a sedimentary rock. **Today, people use rocks for building materials and in industrial processes.** Hard, durable granite is used in curbstones, floors, and kitchen counters. Limestone can be cut easily into blocks or slabs for use in buildings. Limestone is also used in making cement and steel. Slate splits easily into flat pieces. These pieces can be used for flooring and roofing.



FIGURE 7

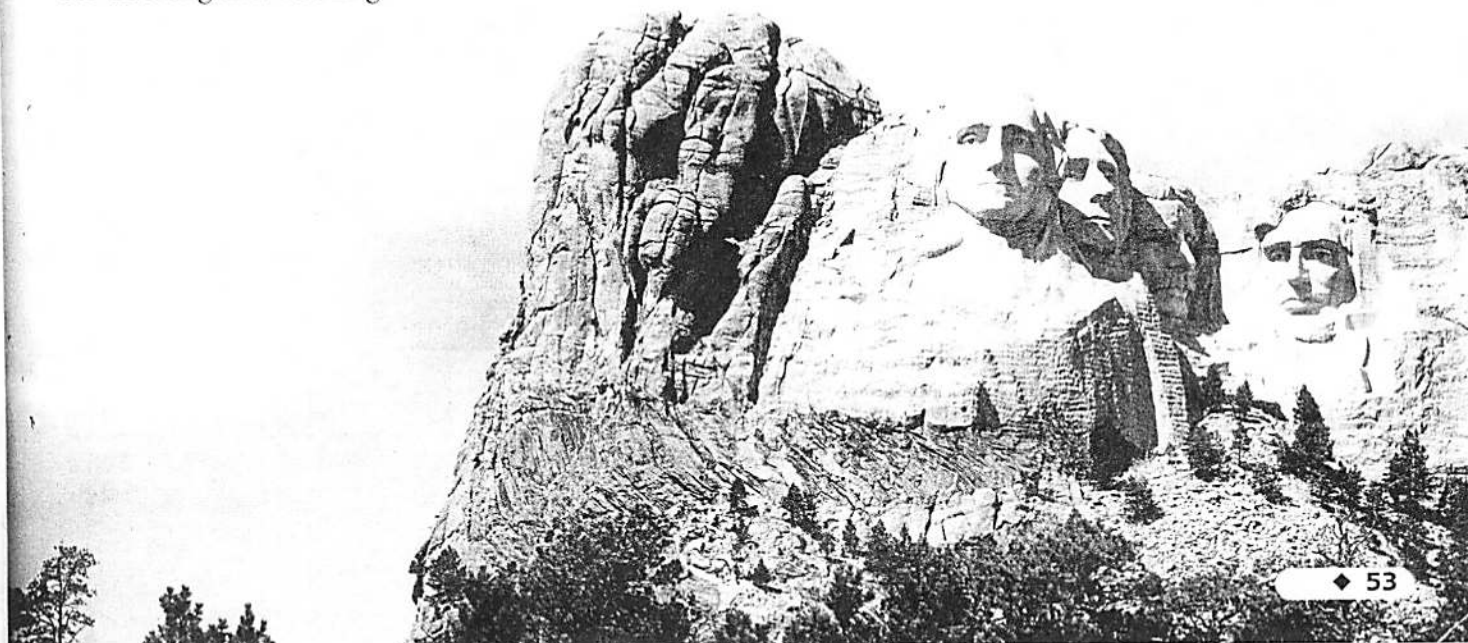
Gemstones

Minerals have many uses. Precious gems like the rubies and emeralds in this necklace are used in jewelry.

FIGURE 8

Durable Granite

The faces of four presidents were carved in granite on Mount Rushmore, South Dakota.



Products From Minerals

To understand how minerals must be processed before they are used, compare bauxite and an aluminum can.


1. Examine a piece of the mineral bauxite carefully. Describe its properties, such as color, texture, and hardness.
2. Examine an aluminum can. (The metal aluminum comes from bauxite.) Compare the properties of the aluminum can with the properties of bauxite.

Posing Questions

To understand how bauxite is made into a useful material, what questions would you need to ask?

Producing Metals From Ores

A rock that contains a metal or other useful mineral that can be mined and sold at a profit is called an **ore**. Most metals do not occur in a pure form. A metal usually occurs as a mineral that is a combination of that metal and other elements. Copper often comes from ores containing iron and sulfur as well as copper.

How is an ore made into a finished product?  To produce metal from an ore, the ore must be mined, or removed from the ground. Then the ore must be processed to extract the metal.

Mining Once geologists locate an ore deposit, miners decide how to remove the ore from the ground. There are three types of mines: strip mines, open-pit mines, and shaft mines. In strip mining, earthmovers scrape away soil to expose ore. In open-pit mining, miners use giant earthmoving equipment to dig a huge pit. Then they remove the ore deposits. For ore deposits that occur in veins, miners dig shaft mines. Shaft mines often have a network of tunnels that extend deep into the ground.

Each type of mining has environmental effects. For example, strip mines expose the soil, which can then be blown or washed away. Plants may not be able to grow in a strip-mined area for many years. To restore the land, mine operators replace soil removed during mining. Then they plant grass and trees.

Smelting Ores must be smelted before the metals they contain can be used. In the process of **smelting**, an ore is mixed with other substances and then melted to separate the useful metal from other elements the ore contains. For example, iron ores must be smelted to separate the iron from the oxygen and other substances in the ores.

Smelting releases gases and particles of metals into the air and water. Some of these substances can be harmful to living things. Smelters often have devices called “scrubbers” located on exhaust vents to reduce the release of harmful substances.



Reading
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What is smelting?

FIGURE 9

Processing Ore

Once an ore has been processed in a smelter, the molten metal can be poured into a mold and formed into bars called ingots.

FIGURE 10
Smelting

Iron ore must be smelted to separate the iron from the oxygen and other substances in the ore. Interpreting Which step is the other step?



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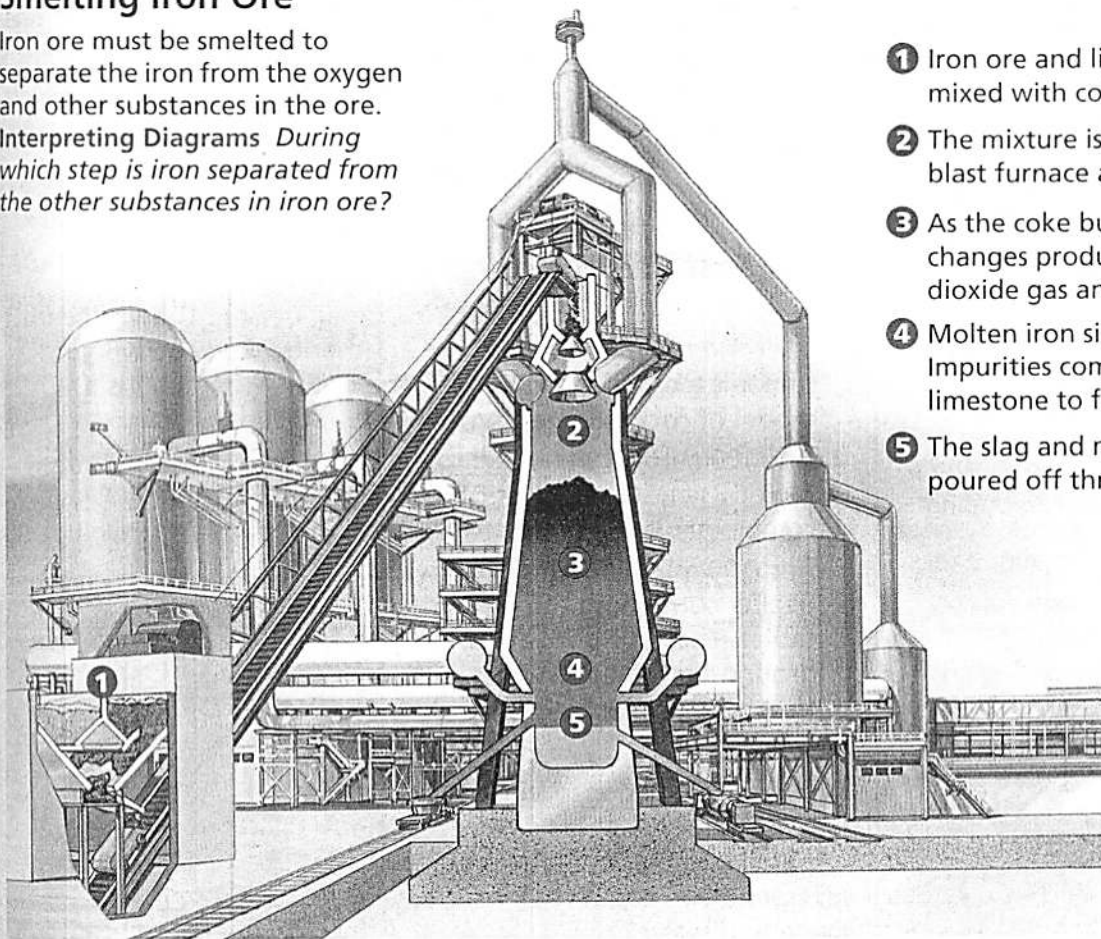
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FIGURE 10

Smelting Iron Ore

Iron ore must be smelted to separate the iron from the oxygen and other substances in the ore.

Interpreting Diagrams During which step is iron separated from the other substances in iron ore?



- 1 Iron ore and limestone are mixed with coke (baked coal).
- 2 The mixture is placed in the blast furnace and heated.
- 3 As the coke burns, chemical changes produce carbon dioxide gas and molten iron.
- 4 Molten iron sinks to the bottom. Impurities combine with the limestone to form slag.
- 5 The slag and molten iron are poured off through taps.

Section 1 Assessment

S 6.6.b, S 6.6.c
E-LA: Reading 6.2.0

Target Reading Skill Preview Visuals Review your questions and answers about the rock cycle. What are two processes that occur during the rock cycle?

Reviewing Key Concepts

1. a. **Listing** List the five characteristics of a mineral.
b. **Explaining** What does it mean to say that a mineral is inorganic?
c. **Classifying** Coal is a solid, naturally occurring substance. Coal forms from the remains of plants and animals. Is coal a mineral? Explain.
2. a. **Defining** Write a definition of the rock cycle.
b. **Explaining** What must happen for any rock in the rock cycle to form sedimentary rock?
c. **Sequencing** Begin with an igneous rock and explain how it could change through two more steps in the rock cycle.

3. a. **Listing** List three main uses of minerals and two main uses of rocks.
b. **Identifying** What is an ore?
c. **Summarizing** Explain the steps that must take place before an ore can be made into a product.

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At-Home Activity

The Rocks Around Us Many common household products contain minerals found in igneous rock. For example, glass contains quartz, which is found in granite. Research one of the following materials and the products in which it is used: garnet, granite, perlite, pumice, or vermiculite. Explain to family members how the rock or mineral formed and how it is used.