

## KEY CONCEPT

# 15.2

# Igneous rocks form from molten rock.

### BEFORE, you learned

- Earth's interior is very hot
- Most minerals in Earth's crust are silicates

### NOW, you will learn

- Why igneous rocks formed at Earth's surface are different from those formed within Earth
- Why silica content is important in classifying igneous rocks
- Why igneous rocks can make long-lasting landforms

## VOCABULARY

intrusive igneous rock  
p. 511

extrusive igneous rock  
p. 511

## THINK ABOUT

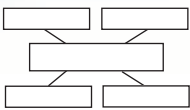
### *Why do two rocks made of the same minerals look very different?*

Look at a sample of granite and a sample of rhyolite (RY-uh-IYT). These two igneous rocks contain the same minerals, so their chemical compositions are very similar. Yet granite and rhyolite look very different. What do you think might cause this difference?



## MAIN IDEA WEB

Remember to make a web for each main idea.



## Magma and lava form different types of igneous rocks.

Igneous rocks form from molten rock, but where does molten rock come from? The temperature inside Earth increases with depth. That is, the farther down you go, the hotter it gets. Deep within Earth, temperatures are hot enough—750°C to 1250°C (about 1400°F to 2300°F)—to melt rock. This molten rock is called magma. Molten rock that reaches Earth's surface is called lava.

An igneous rock is classified on the basis of its mineral composition and the size of its mineral crystals. A rock formed from magma can have the same composition as a rock formed from lava. The rocks, though, will have different names, because the sizes of their crystals will be very different. You will read why later in this section.

People's decisions about how to use igneous rocks are based in part on the rocks' crystal sizes. For example, rocks with large mineral crystals are often used as building stones because they are attractive.

## Origin of Igneous Rocks

Depending on where they form, igneous rocks are classified as intrusive (ihn-TROO-sihv) or extrusive (ihk-STROO-sihv).

An **intrusive igneous rock** is one that forms when magma cools within Earth. An **extrusive igneous rock** is one that forms when lava cools on Earth's surface.

Granite is a common intrusive rock in continents. If magma with the same composition reaches the surface, it forms extrusive rocks such as rhyolite and pumice (PUHM-ihs). Basalt (buh-SAWLT) is an extrusive igneous rock that forms the ocean floor. Gabbro is an intrusive rock that has the same composition as basalt.

### VOCABULARY

Add magnet word diagrams for *intrusive igneous rock* and *extrusive igneous rock* to your notebook.

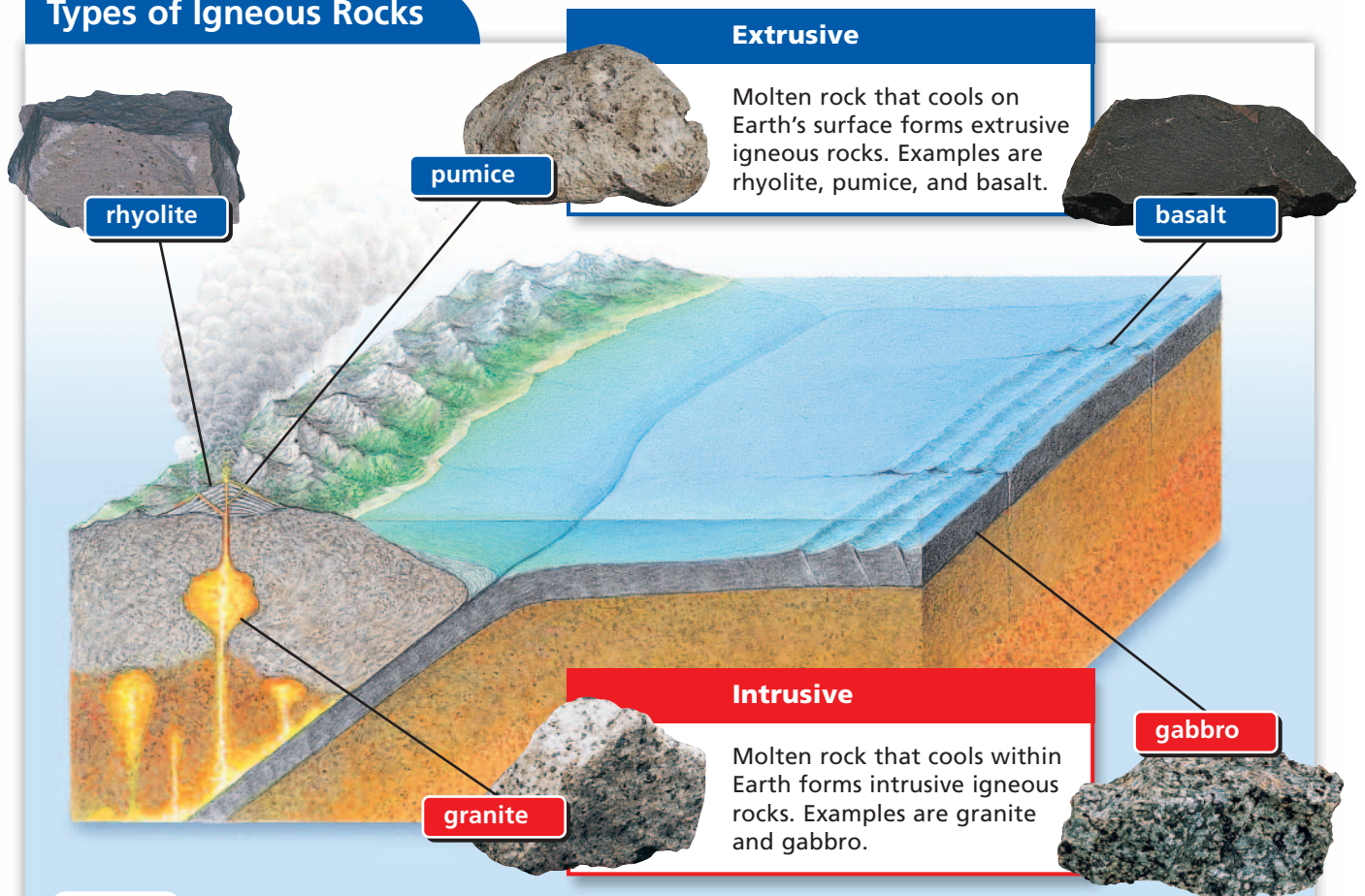


### CHECK YOUR READING

How are gabbro and basalt similar? How are they different?

You can see extrusive igneous rocks at Earth's surface. But intrusive igneous rocks form within Earth. How do they reach the surface? Forces inside Earth can push rocks up, as when mountains form. Also, water and wind break apart and carry away surface rocks. Then deeper rocks are uncovered at the surface.

## Types of Igneous Rocks



### READING VISUALS

Is the volcano in the illustration built of layers of intrusive or extrusive igneous rock? Explain your answer.

## Textures of Igneous Rocks



Explore an animation showing how crystals form as molten rock cools.

The texture of an igneous rock—that is, the size of its mineral crystals—depends on how quickly magma or lava cooled to form it. In an icemaker, crystals form as water freezes into ice. In a similar way, mineral crystals form as molten rock freezes into solid rock.

The magma that forms intrusive igneous rocks stays below the surface of Earth. Large crystals can form in intrusive rocks because

- the interior of Earth is very hot
- the high temperatures allow magma to cool slowly
- slow cooling allows time for large mineral crystals to form

The lava that forms extrusive igneous rocks reaches Earth's surface. Very small crystals form in extrusive rocks because

- the surface of Earth is cooler than Earth's interior
- the lower temperatures cause the lava to cool quickly
- there is no time for large mineral crystals to form

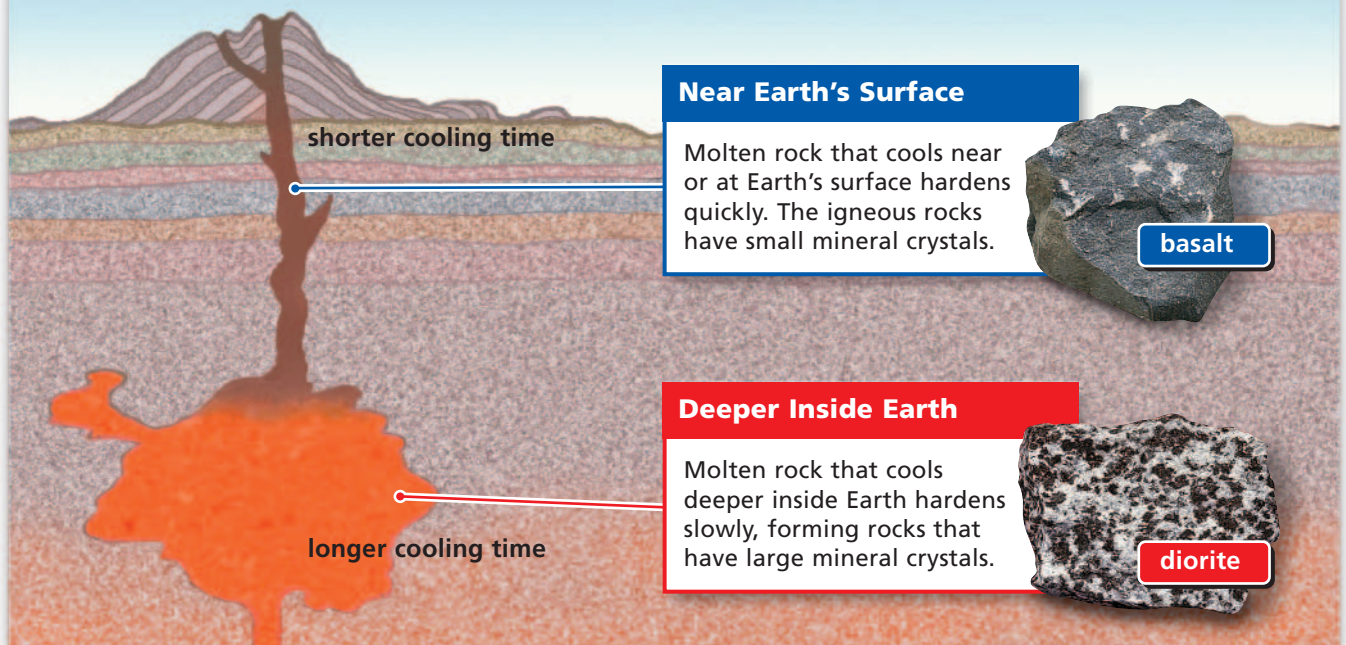
Some igneous rocks contain crystals of very different sizes. These rocks formed from magma that started cooling within Earth and then erupted onto the surface. The large crystals grew as the magma cooled slowly. The small crystals grew as the lava cooled quickly.



How does an igneous rock that has both large and small mineral crystals form?

### Crystal Size and Cooling Time

The more slowly molten rock cools within Earth, the larger the igneous rocks' mineral crystals will be.



# INVESTIGATE Crystal Size

## How does cooling time affect crystal size?

### PROCEDURE

- 1 Look at the Mineral Crystal Diagrams datasheet.
- 2 Describe your observations of the crystals in each of the igneous-rock diagrams A–C on the lines provided.
- 3 Describe what is shown in each of graphs 1–3 on the lines provided.
- 4 Match each igneous-rock diagram with its corresponding graph.
- 5 On the back of the paper, explain why you matched each crystal diagram with a particular graph.

### WHAT DO YOU THINK?

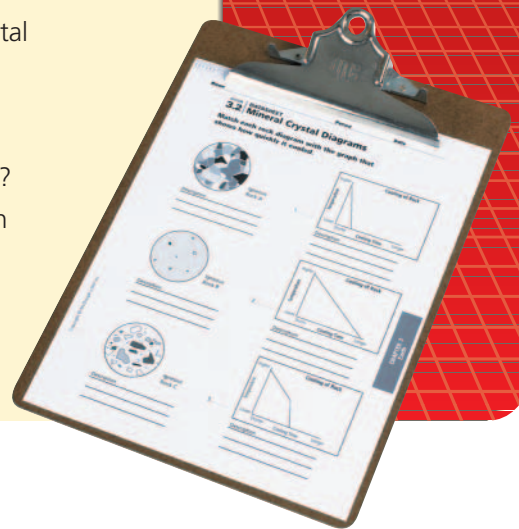
- Which diagram shows an intrusive igneous rock, such as gabbro?
- Where do you think the rock shown in diagram B formed? Explain your answer.

**CHALLENGE** Write a hypothesis to explain why the rock shown in diagram C might be found at a shallow depth in Earth's crust.

**SKILL FOCUS**  
Analyzing

**MATERIALS**  
Mineral Crystal  
Diagrams datasheet

**TIME**  
20 Minutes



## Composition of Igneous Rocks

Texture is not enough to identify an igneous rock. Think about substances that have similar textures, such as sugar and salt. A spoonful of sugar and a spoonful of salt both consist of small white grains. However, sugar and salt are different materials—that is, they have different compositions. Likewise, different igneous rocks might have similar textures. To identify them, you must also consider their compositions.

Most igneous rocks are mainly made up of silicate minerals, which you read about in the last chapter. The silicate mineral group is the most common group in Earth's crust. Silicate minerals contain varying amounts of silica, a compound of silicon and oxygen. After identifying the texture of an igneous rock, geologists classify the rock on the basis of how rich it is in silica.

Special equipment must be used to determine a rock's exact composition, but you can estimate the level of silica in an igneous rock by looking at its color. Igneous rocks with high levels of silica, such as granite and rhyolite, are typically light in color. Those with low levels of silica, such as gabbro and basalt, are dark in color.

### CHECK YOUR READING

Would you expect a light gray igneous rock to be rich or poor in silica? Why?

## Igneous rocks make long-lasting landforms.

In northwestern New Mexico, a great peak rises out of a flat, barren desert. The Navajo call the peak Tsé Bit'a'í (tseh biht-ah-ih), meaning “rock with wings.” In English, it’s called Ship Rock, because it looks something like a sailing ship. Ship Rock is an example of the kinds of landforms that are made of igneous rocks. A landform is a natural feature on Earth’s land surface.

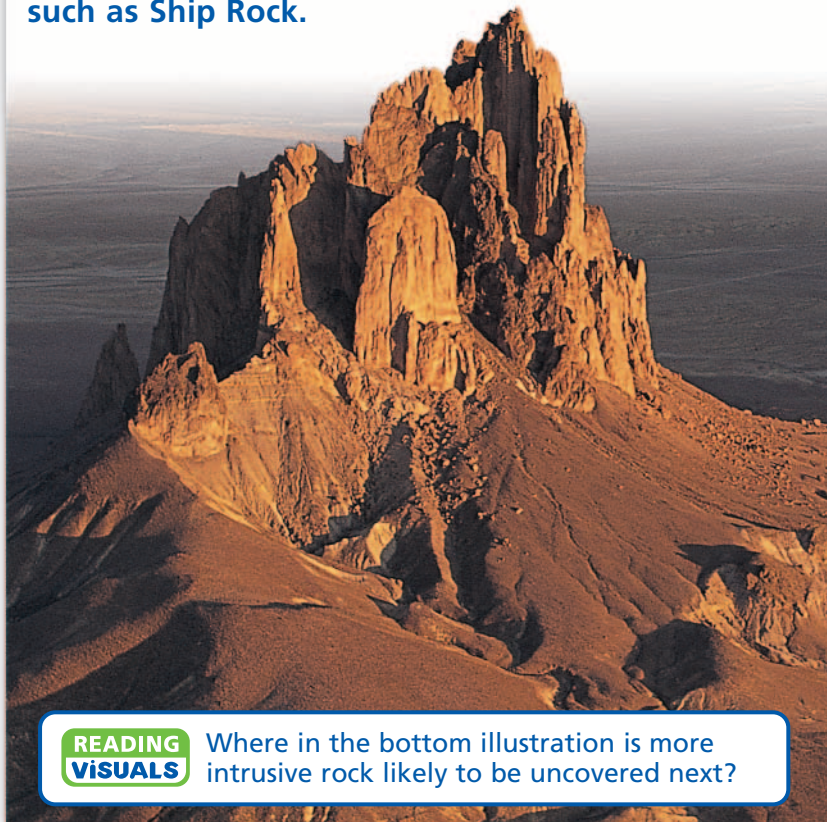
### Intrusive Rock Formations

Ship Rock actually formed about one kilometer below the surface of Earth 30 million years ago. It is all that remains of magma that once fed a volcano. The magma cooled slowly and formed intrusive igneous rock.

As magma pushes up toward Earth’s surface, it makes channels and other formations underground. Formations of intrusive igneous rock can be harder and more lasting than other types of rock. Notice in the illustration below how igneous rock has been left at the surface as other, weaker types of rock have been worn away.

#### Intrusive Rock Formation

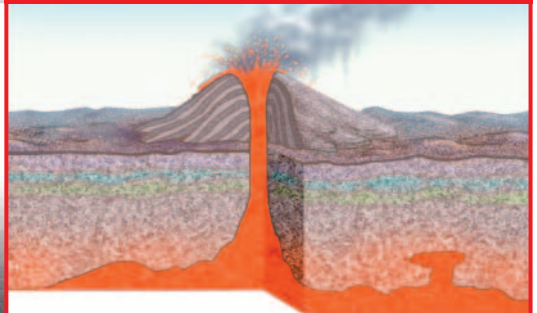
Wind and water wear away surrounding, weaker rock to reveal intrusive rock formations, such as Ship Rock.



**READING VISUALS**

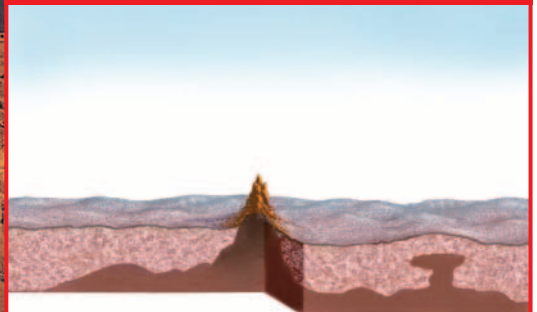
Where in the bottom illustration is more intrusive rock likely to be uncovered next?

#### Ancient Land Surface



Magma that remains below the surface will later become intrusive igneous rock.

#### Present-Day Land Surface



Surface rock has worn away to reveal some of the intrusive rock.

## Extrusive Rock Formations

When magma makes its way to Earth's surface through a volcano or crack, the lava may erupt in different ways. Some lava can build huge plateaus when it erupts from long cracks in Earth's surface. Lava that is low in silica, such as basalt lava, flows easily and spreads out in thin sheets over great distances. The Columbia Plateau in Oregon and Washington is made of basalt. When lava that is low in silica erupts at a single point, it can build up a huge volcano with gently sloping sides. The Hawaiian Islands are a chain of volcanoes that are built of basalt lava. The volcanoes started erupting on the sea floor and over a very long time grew tall enough to rise above the surface of the ocean as islands.

Lava that contains a greater amount of silica does not flow easily. Silica-rich lava tends to build cone-shaped volcanoes with steep sides. Volcanoes fed by silica-rich magma tend to erupt explosively. Because the magma is thick and sticky, pressure can build up in volcanoes until they explode. An example is Mount St. Helens in the state of Washington. Its 1980 eruption reduced the volcano's height by 400 meters (about 1300 ft). Lava flows are adding new extrusive igneous rock. At the current rate it will take more than 200 years for the volcano to reach its pre-1980 height.

### READING TIP

Notice what properties of basalt lava allow it to build large plateaus.



Basalt lava can flow long distances. Here it is spreading over a road in Hawaii.

### CHECK YOUR READING

Why does silica-rich lava tend to build steep volcanoes instead of spreading out?

## 15.2 Review

### KEY CONCEPTS

1. What is the main difference between intrusive and extrusive igneous rocks?
2. What are the two major properties used to classify igneous rocks?
3. Why can intrusive igneous rocks be left behind when surrounding rocks are worn away?

### CRITICAL THINKING

4. **Draw Conclusions** If granite within Earth melts and then erupts at the surface, what type of extrusive rock is likely to form?
5. **Analyze** Would you expect extrusive rocks produced by an explosive volcano to be light or dark in color? Why?

### CHALLENGE

6. **Synthesize** Why are the names *intrusive* and *extrusive* appropriate for the two types of igneous rocks?