

Volcanic Eruptions

Reading Preview

Key Concepts

- What happens when a volcano erupts?
- What are the two types of volcanic eruptions?
- What are a volcano's stages of activity?

Key Terms

- magma chamber • pipe
- vent • lava flow • crater
- pyroclastic flow • dormant
- extinct

Target Reading Skill

Using Prior Knowledge Before you read, look at the section headings to see what the section is about. Then write what you know about how a volcano erupts in a graphic organizer like the one below. As you read, write what you learn.

What You Know

1. Lava flows out of a volcano.
- 2.

What You Learned

- 1.
- 2.

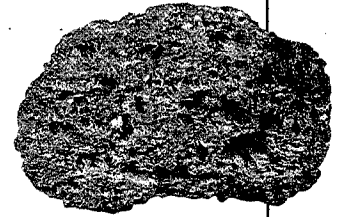
Lab
zone

Discover Activity

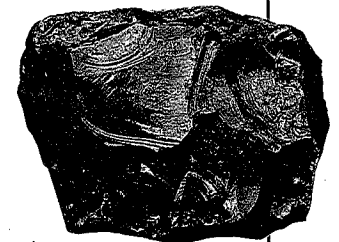
What Are Volcanic Rocks Like?

Volcanoes produce lava, which hardens into rock. Two of these rocks are pumice and obsidian.

1. Observe samples of pumice and obsidian with a hand lens.
2. How would you describe the texture of the pumice? What could have caused this texture?
3. Observe the surface of the obsidian. How does the surface of the obsidian differ from pumice?



Pumice



Obsidian

Think It Over

Developing Hypotheses What could have produced the difference in texture between the two rocks? Explain your answer.

In Hawaii, there are many myths about Pele (PAY lay), the fire goddess of volcanoes. Pele lives in the depths of Hawaii's erupting volcanoes. According to legend, when Pele is angry, she causes a volcanic eruption. One result of an eruption is "Pele's hair," a fine, threadlike rock formed by lava. Pele's hair forms when lava sprays out of the ground like water from a fountain. As it cools, the lava stretches and hardens into thin strands, as shown in Figure 8.

Where does this lava come from? Lava begins as magma, which usually forms in the asthenosphere. The materials of the asthenosphere are under great pressure. Liquid magma is less dense than the solid material around it. Therefore, magma flows upward into any cracks in the rock above. As magma rises, it sometimes becomes trapped beneath layers of rock. But if an opening in weak rock allows the magma to reach the surface, a volcano forms.

FIGURE 8

Pele's Hair

Pele's hair is a type of rock formed from lava. Each strand is as fine as spun glass.

Magma Reaches Earth's Surface

A volcano is more than a large, cone-shaped mountain. Inside a volcano is a system of passageways through which magma moves.

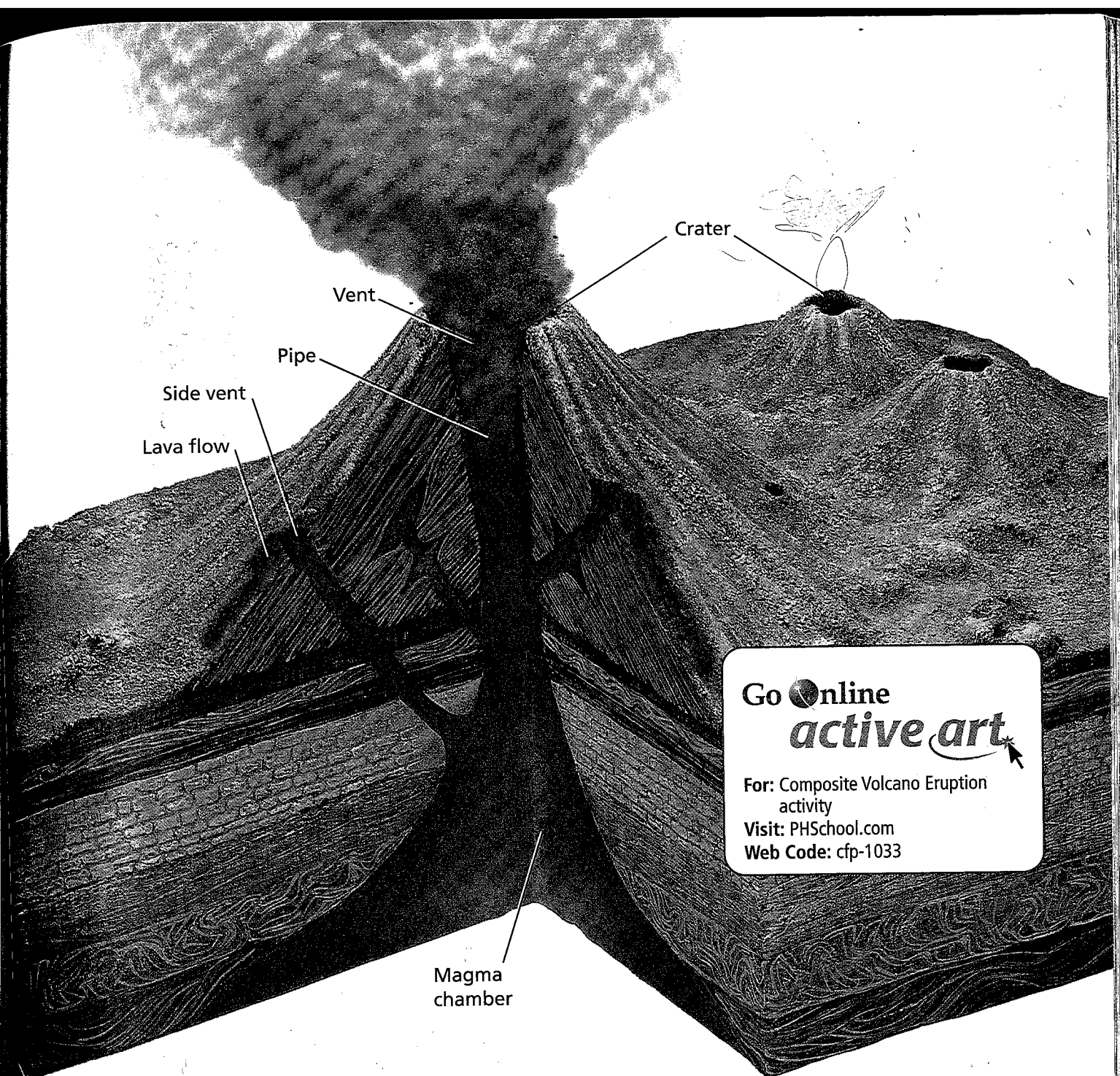
Inside a Volcano All volcanoes have a pocket of magma beneath the surface and one or more cracks through which the magma forces its way. Beneath a volcano, magma collects in a pocket called a **magma chamber**. The magma moves upward through a **pipe**, a long tube in the ground that connects the magma chamber to Earth's surface. You can see these features in Figure 10.

Molten rock and gas leave the volcano through an opening called a **vent**. Often, there is one central vent at the top of a volcano. However, many volcanoes also have other vents that open on the volcano's sides. A **lava flow** is the area covered by lava as it pours out of a vent. A **crater** is a bowl-shaped area that may form at the top of a volcano around the central vent.

A Volcanic Eruption What pushes magma to the surface? The explosion of a volcano is similar to the soda water bubbling out of a warm bottle of soda pop. You cannot see the carbon dioxide gas in a bottle of soda pop because it is dissolved in the liquid. But when you open the bottle, the pressure is released. The carbon dioxide expands and forms bubbles, which rush to the surface. Like the carbon dioxide in soda pop, dissolved gases are trapped in magma. These dissolved gases are under tremendous pressure.

FIGURE 9
Lava Burp
During an eruption on Mount Kilauea, the force of a bursting gas bubble pushes up a sheet of red-hot lava.





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As magma rises toward the surface, the pressure of the surrounding rock on the magma decreases. The dissolved gases begin to expand, forming bubbles. As pressure falls within the magma, the size of the gas bubbles increases greatly. These expanding gases exert an enormous force. **When a volcano erupts, the force of the expanding gases pushes magma from the magma chamber through the pipe until it flows or explodes out of the vent.** Once magma escapes from the volcano and becomes lava, the remaining gases bubble out.

FIGURE 10

A Volcano Erupts

A volcano forms where magma breaks through Earth's crust and lava flows over the surface.

Interpreting Diagrams *What part of a volcano connects the vent with the magma chamber?*



Reading
Checkpoint

What happens to the pressure in magma as the magma rises toward the surface?

Gases in Magma

This activity models the gas bubbles in a volcanic eruption.

1. In a 1- or 2-liter plastic bottle, mix 10 g of baking soda into 65 mL of water.
2. Put about six raisins in the water.
3. While swirling the water and raisins, add 65 mL of vinegar and stir vigorously.
4. Once the liquid stops moving, observe the raisins.

Making Models What happens after you add the vinegar? What do the raisins and bubbles represent? How is this model similar to the way magma behaves in a volcano?

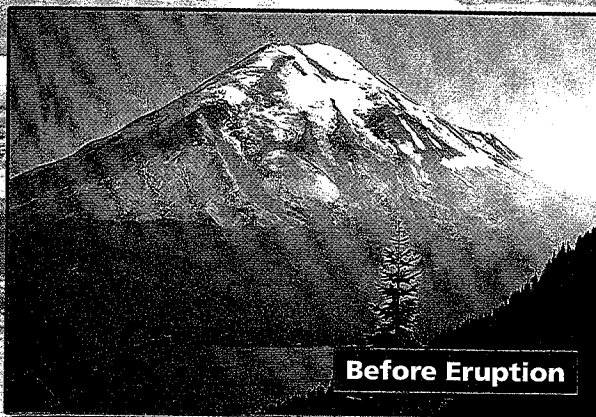
Kinds of Volcanic Eruptions

Some volcanic eruptions occur gradually. Others are dramatic explosions. Geologists classify volcanic eruptions as **quiet** or **explosive**. The physical properties of its magma determine how a volcano erupts. Whether an eruption is quiet or explosive depends on the magma's silica content and viscosity.

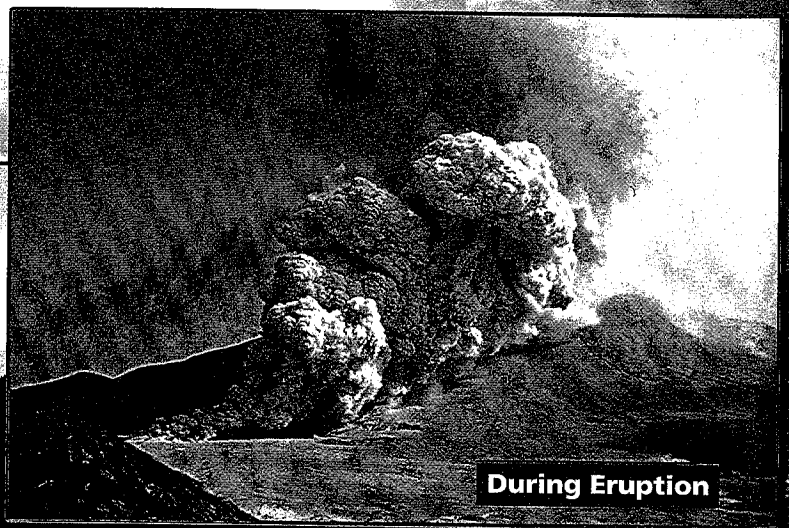
Quiet Eruptions A volcano erupts quietly if its magma is low in silica. Low-silica magma has low viscosity and flows easily. The gases in the magma bubble out gently. Lava with low viscosity oozes quietly from the vent and can flow for many kilometers. Quiet eruptions can produce both pahoehoe and aa.

The Hawaiian Islands were formed from quiet eruptions. On the Big Island of Hawaii, lava pours out of the crater near the top of Mount Kilauea. But lava also flows out of long cracks on the volcano's sides. Quiet eruptions have built up the Big Island over hundreds of thousands of years.

Explosive Eruptions A volcano erupts explosively if its magma is high in silica. High-silica magma has high viscosity, making it thick and sticky. The high-viscosity magma does not always flow out of the crater. Instead, it builds up in the volcano's pipe, plugging it like a cork in a bottle. Dissolved gases, including water vapor, cannot escape from the thick magma. The trapped gases build up pressure until they explode. The erupting gases and steam push the magma out of the volcano with incredible force. That's what happened during the eruption of Mount St. Helens, shown in Figure 11.



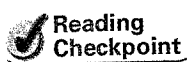
Before Eruption



During Eruption

An explosive eruption breaks lava into fragments that quickly cool and harden into pieces of different sizes. The smallest pieces are volcanic ash—fine, rocky particles as small as a speck of dust. Pebble-sized particles are called cinders. Larger pieces, called bombs, may range from the size of a baseball to the size of a car. A **pyroclastic flow** (py roh KLAS tik) occurs when an explosive eruption hurls out a mixture of hot gases, ash, cinders, and bombs.

Pumice and obsidian, which you observed if you did the Discover Activity, form from high-silica lava. Obsidian forms when lava cools very quickly, giving it a smooth, glossy surface like glass. Pumice forms when gas bubbles are trapped in fast-cooling lava, leaving spaces in the rock.



Reading
Checkpoint

What is a pyroclastic flow?

FIGURE 11

An Explosive Eruption

Mount St. Helens in Washington State erupted at 8:30 A.M. on May 18, 1980. The explosion blew off the top of the mountain, leaving a huge crater and causing great destruction.

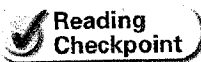


After Eruption

Volcano Hazards Although quiet eruptions and explosive eruptions produce different hazards, both types of eruption can cause damage far from the crater's rim.

During a quiet eruption, lava flows from vents, setting fire to, and then burying, everything in its path. A quiet eruption can cover large areas with a thick layer of lava.

During an explosive eruption, a volcano can belch out hot clouds of deadly gases as well as ash, cinders, and bombs. Volcanic ash can bury entire towns. If it becomes wet, the heavy ash can cause roofs to collapse. If a jet plane sucks ash into its engine, the engine may stall. Eruptions can cause landslides and avalanches of mud, melted snow, and rock. The Science and History timeline shows the effects of several explosive eruptions.



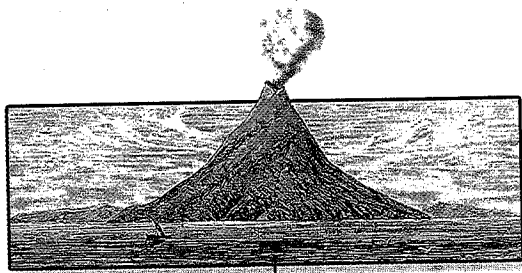
Reading
Checkpoint

How does volcanic ash cause damage?

Science and History

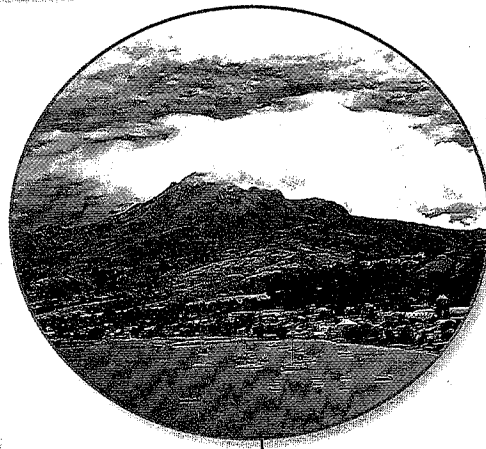
The Power of Volcanoes

Within the last 150 years, major volcanic eruptions have greatly affected the land and people around them.



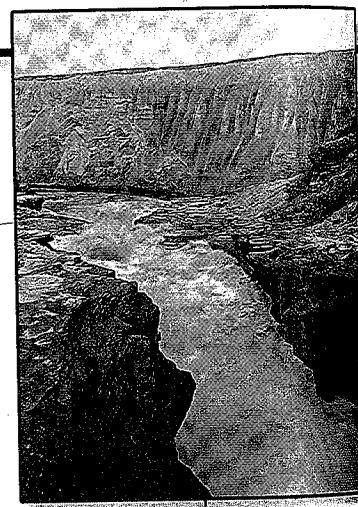
1883 Krakatau

The violent eruption of Krakatau volcano in Indonesia threw 18 cubic kilometers of ash skyward. The blast was heard 5,000 kilometers away.



1902 Mount Pelée

Mount Pelée, a Caribbean volcano, spewed out a burning cloud of hot gas and pyroclastic flows. The cloud killed 29,000 residents of St. Pierre, a city on the volcano's flank. Only two people survived.



1912 Mount Katmai

Today, a river in Alaska cuts through the thick layer of volcanic ash from the eruption of Mount Katmai.

1850

1875

1900

Stages of Volcanic Activity

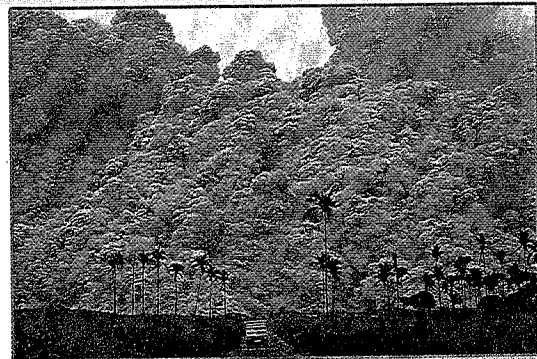
The activity of a volcano may last from less than a decade to more than 10 million years. Most long-lived volcanoes, however, do not erupt continuously. Geologists try to determine a volcano's past and whether the volcano will erupt again.

Life Cycle of a Volcano Geologists often use the terms *active*, *dormant*, or *extinct* to describe a volcano's stage of activity. An active, or live, volcano is one that is erupting or has shown signs that it may erupt in the near future. A dormant, or sleeping, volcano is like a sleeping bear. Scientists expect a **dormant** volcano to awaken in the future and become active. An **extinct**, or dead, volcano is unlikely to erupt again.

The time between volcanic eruptions may span hundreds to many thousands of years. People living near a dormant volcano may be unaware of the danger. But a dormant volcano can become active at any time.

Writing in Science

Research and Write People have written eyewitness accounts of famous volcanic eruptions. Research one of the eruptions in the timeline. Then write a letter describing what someone observing the eruption might have seen.



1991 Mount Pinatubo

Pinatubo in the Philippines spewed out huge quantities of ash that rose high into the atmosphere and buried nearby areas.

1980 Mount St. Helens

When Mount St. Helens in Washington exploded, it blasted one cubic kilometer of volcanic material skyward.

2002 Mount Etna

Bulldozers constructed a wall against a scalding river of lava creeping down the slopes of Mount Etna in Sicily.



1950

1975

2000



FIGURE 12
Volcano Watch
 Near Mount Kilauea in Hawaii, these geologists are testing instruments to monitor temperatures in and around a crater.

Monitoring Volcanoes Geologists have been more successful in predicting volcanic eruptions than in predicting earthquakes. Geologists use instruments to detect changes in and around a volcano. These changes may give warning a short time before a volcano erupts. But geologists cannot be certain about the type of eruption or how powerful it will be.

Geologists use tiltmeters and other instruments to detect slight surface changes in elevation and tilt caused by magma moving underground. They monitor any gases escaping from the volcano. A temperature increase in underground water may be a sign that magma is nearing the surface. Geologists also monitor the many small earthquakes that occur around a volcano before an eruption. The upward movement of magma triggers these quakes.



How do geologists monitor volcanoes?

Section 3 Assessment

Target Reading Skill Using Prior Knowledge
 Review your graphic organizer and revise it based on what you just learned in the section.

Reviewing Key Concepts

1. **a. Listing** What are the main parts of a volcano?
- b. Sequencing** Describe the order of parts through which magma travels as it moves to the surface.
- c. Relating Cause and Effect** As a volcano erupts, what force pushes magma out of a volcano onto the surface?
2. **a. Identifying** What are the two main kinds of volcanic eruptions?
- b. Explaining** What properties of magma help to determine the type of eruption?
- c. Inferring** What do lava flows made of pahoehoe and aa indicate about the type of volcanic eruption that occurred?

3. **a. Naming** What are the three stages of volcanic activity?
- b. Predicting** Which is more likely to be dangerous—a volcano that erupts frequently or a volcano that has been inactive for a hundred years? Why?

Writing in Science

Interview You are a television news reporter who will be interviewing a geologist. The geologist has just returned from studying a nearby volcano that may soon erupt. Write the questions that you would ask. Be sure to ask about the evidence that an eruption is coming, the type of eruption expected, and any hazards that will result. Write an answer for each question.