# *Earthquakes and Volcanoes*

## Volcanoes

### Before You Read

**What do you think?** Read the three statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statement or a D if you disagree. After you've read this lesson, reread the statements to see if you have changed your mind.

| Before | Statement | After |
|---|---|---|
| | **4.** Volcanoes can erupt anywhere on Earth. | |
| | **5.** Volcanic eruptions are rare. | |
| | **6.** Volcanic eruptions only affect people and places close to the volcano. | |

### Read to Learn

## What is a volcano?

*A* **volcano** *is a vent in Earth's crust through which melted—or molten—rock flows. Molten rock below Earth's surface is called* **magma.** Have you heard of some famous volcanoes such as Mount St. Helens, Kilauea, or Mount Pinatubo? All of these volcanoes have erupted within the last 30 years. Volcanoes exist in many places around the world. Some places have more volcanoes than others.

## How do volcanoes form?

Volcanic eruptions constantly shape Earth's surface. They can form large mountains, create new crust, and destroy anything in their path. Scientists have learned that the movement of Earth's tectonic plates causes volcanoes to form and to erupt.

### Convergent Boundaries

Volcanoes can form along convergent plate boundaries. When two plates collide, the denser plate sinks, or subducts, into the hot mantle. The thermal energy below the surface and fluids driven off the subducting plate melt the mantle and form magma. Magma is less dense than the mantle and rises through cracks in the crust. This forms a volcano. *Molten rock that erupts onto Earth's surface is called* **lava.**

**Key Concepts**

- How do volcanoes form?
- What factors contribute to the eruption style of a volcano?
- How are volcanoes classified?

**Study Coach**

**Make Flash Cards** Think of a quiz question for each paragraph. Write the question on one side of a flash card. Write the answer on the other side. Work with a partner to quiz each other using the flash cards.

**Reading Check**

**1. Define** What is magma?

## Divergent Boundaries

Lava also erupts along divergent plate boundaries. As the plates spread apart, magma rises through the vent or opening between them. More than 60 percent of all eruptions occur at divergent plate boundaries along mid-ocean ridges. There, the lava forms new oceanic crust.

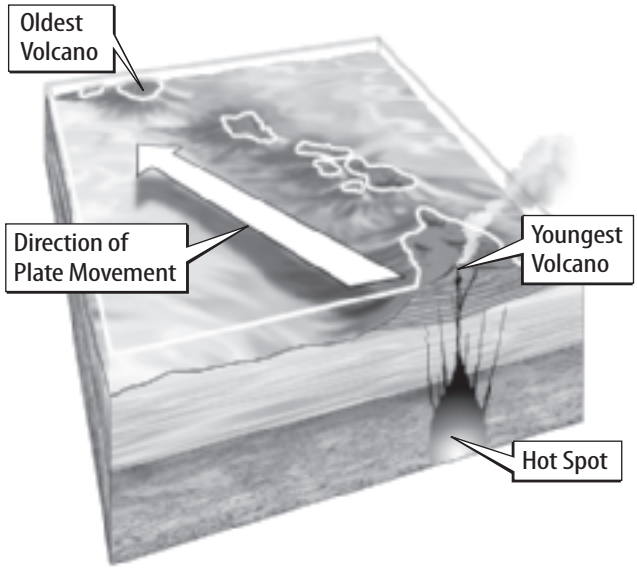
## Hot Spots

Not all volcanoes form on or near plate boundaries. *Volcanoes that are not associated with plate boundaries are called* **hot spots.** Geologists hypothesize that hot spots form above a rising current of hot mantle materials, called a plume.

Plumes do not move. As shown in the figure below, a volcano forms as a tectonic plate moves over the plume. As the moving plate carries a volcano away from the hot spot, the volcano becomes dormant, or inactive. As the plate continues to move, a chain of volcanoes forms. The oldest volcano will be the farthest away from the hot spot. The youngest volcano will be directly above the hot spot.

**Key Concept Check**

**2. Explain** How do volcanoes form?




**Visual Check**

**3. Interpret** As a hot spot forms a chain of volcanoes, what moves and what does not move?

# Where do volcanoes form?

The figure on the next page shows the world's active volcanoes. Notice that most volcanoes are close to plate boundaries.

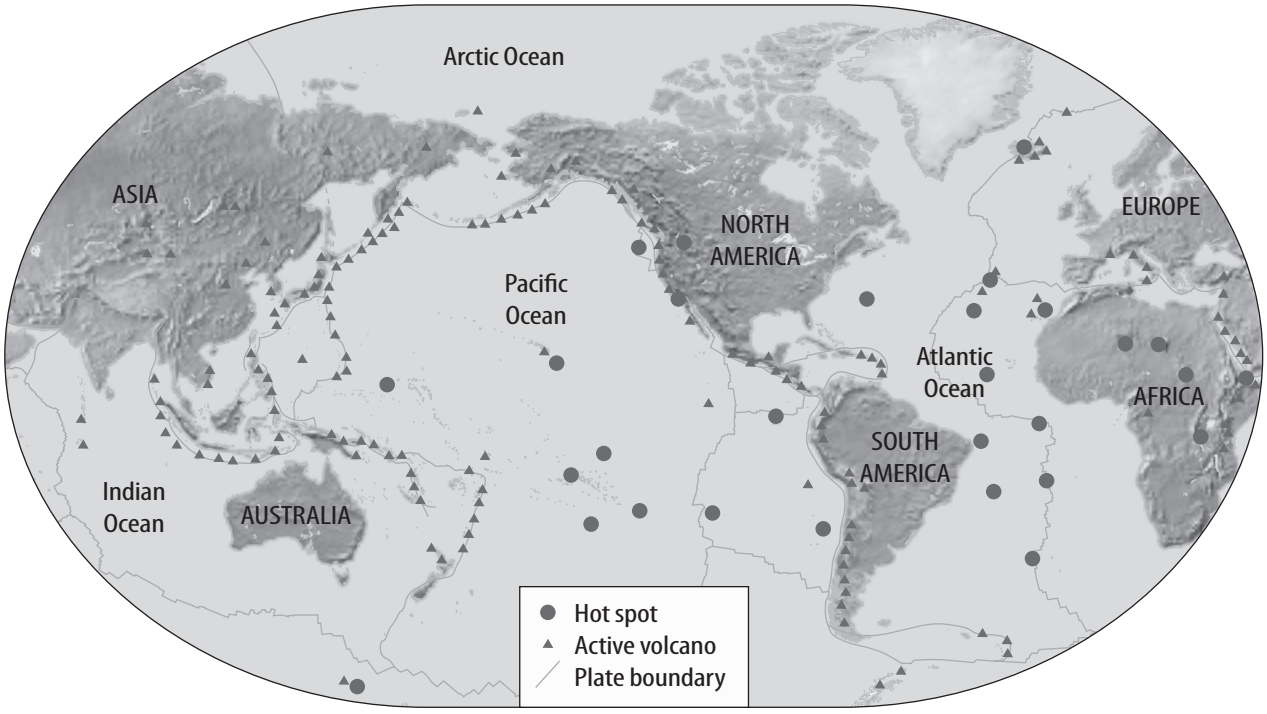
## Ring of Fire

In the figure, notice that volcanoes form a ring around most of the Pacific Ocean. Because of its earthquake and volcanic activity, the area surrounding the Pacific Ocean has earned the name Ring of Fire.

**Reading Check**

**4. Locate** Where is the Ring of Fire?

**Volcanoes, Hot Spots, and Plate Boundaries**




## Volcanoes in the United States

The United States has 60 active volcanoes. Most are part of the Ring of Fire. Alaska, Hawaii, Washington, Oregon, and northern California all have active volcanoes. Mount Redoubt in Alaska is an active volcano. Mount St. Helens in Washington is also an active volcano. It exploded with a violent eruption in 1980.

The United States Geological Survey (USGS) operates volcano observatories. Because many people live near volcanoes, scientists monitor earthquake activity, changes in the shape of volcanoes, and gas emissions. Scientists also study the history of past eruptions to determine the possibility of future eruptions.

# Types of Volcanoes

Scientists classify volcanoes based on the shape and size of the volcano. The magma composition and eruption style of a volcano contribute to its shape.

**Shield Volcanoes** *The* **shield volcanoes** *are common along divergent plate boundaries and oceanic hot spots. They are large, with gentle slopes of basaltic lavas.*

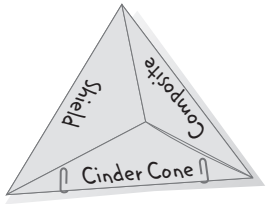
**Composite Volcanoes** *The* **composite volcanoes** *are large, steep-sided volcanoes. They result from explosive eruptions of andesitic and rhyolitic lava and ash along convergent plate boundaries.*

**Visual Check**

**5. Locate** the Ring of Fire on the map. Highlight it.

FOLDABLES®

Make a pyramid book. Inside the pyramid, organize your notes about the three main types of volcanoes.



**Cinder Cones** *The* **cinder cones** *are small, steep-sided volcanoes that erupt gas-rich, basaltic lavas.* Cinder cones are made from mildly explosive eruptions.

Some volcanoes are classified as supervolcanoes. The Yellowstone Caldera in Wyoming is the result of a supervolcano. A large volcanic depression formed approximately 630,000 years ago when the summit was blown away during an explosive eruption.

**Key Concept Check**

**6. Summarize** What determines the shape of a volcano?

# Volcanic Eruptions

Sometimes magma surfaces and erupts as a lava flow. Other times, magma erupts explosively. Explosive eruptions send **volcanic ash**—*tiny particles of pulverized volcanic rock and glass*—high into the atmosphere. An example of an explosive eruption is the violent Mount St. Helens eruption in 1980.

## Eruption Style

**ACADEMIC VOCABULARY**
**dissolve**
***(verb)*** to cause to disperse or disappear

The chemical composition of the magma and the amount of dissolved gases in it contribute to the eruption style. The most abundant gas dissolved in magma is water vapor.

**Magma Chemistry** All magmas are made mainly of silica. The amount of silica in magma affects magma thickness and viscosity. **Viscosity** *is a liquid's ability to flow.*

Magma with a low silica content has low viscosity. It flows easily, like warm syrup. When this type of magma erupts, it flows as fluid lava. The lava cools, crystallizes, and forms the volcanic rock basalt. This type of lava commonly erupts along mid-ocean ridges and at oceanic hot spots, such as Hawaii.

Magma with a high silica content has high viscosity. It flows like sticky toothpaste. This type of magma forms when rocks high in silica content melt. The volcanic rocks andesite and rhyolite form when high silica magma erupts from subduction zones and continental hot spots.

**Key Concept Check**

**7. Specify** What factors affect the eruption style of a volcano?

**Dissolved Gases** All magmas contain dissolved gases—mainly water vapor and small amounts of carbon dioxide and sulfur dioxide. As magma moves toward the surface, pressure from the weight of the rock above decreases. As the pressure decreases, the gases can no longer stay dissolved in the magma. Bubbles begin to form. As the magma continues to rise, the bubbles get larger and the gas begins to escape. But gases cannot easily escape from lava with high viscosity. The combination of high-viscosity lava and large gas bubbles often results in explosive eruptions.

## Effects of Volcanic Eruptions

Lava flows, ash fall, mudflows, and pyroclastic flows from volcanic eruptions can affect all life on Earth. Erupted materials enrich rock and soil with nutrients and help regulate climate. However, eruptions also destroy and kill.

**Lava Flows** Lava flows move so slowly that they are rarely deadly. But lava flows do cause damage. People living near Mount Etna in Sicily, Italy, flee its frequent eruptions.

**Ash Fall** Explosive eruptions can spew volcanic ash high into the air. Recall that ash is a mixture of particles of pulverized rock and glass. Ash can cause airplane engines to stop in mid-flight. Ash in the air can cause breathing problems. Large quantities of ash can affect climate by blocking sunlight and cooling Earth's atmosphere.

**Mudflows** The thermal energy produced during an eruption can melt snow and ice on a volcano's summit. This meltwater can then mix with mud and ash on the mountain to form mudflows. Mudflows, also called lahars, can sweep down the mountainside and bury everything below.

**Pyroclastic Flow** Explosive volcanoes can produce pyroclastic (pi roh KLAS tihk) flows—avalanches of hot gas, ash, and rock. These flows can travel at speeds of more than 100 km/h and reach temperatures above 1,000°C. A pyroclastic flow from Mount St. Helens killed 58 people.

## Predicting Volcanic Eruptions

Volcanic eruptions can be predicted. Geologists study changes that could signal a brewing eruption. Moving magma can deform ground features, change a volcano's shape, or set off a series of earthquakes called an earthquake swarm. A volcano might emit more gas before it erupts. Ground and surface water near the volcano can become more acidic. Geologists study these events and photographs from airplanes and satellites to assess the danger.

# Volcanic Eruptions and Climate Change

Volcanic eruptions can affect climate. Ash in the atmosphere blocks sunlight. High-altitude winds can move ash around the world. Also, sulfur-dioxide gas released from a volcano forms sulfuric acid droplets in the atmosphere. These droplets reflect sunlight back into space. Global temperatures decrease as less sunlight reaches Earth's surface.

**Think it Over**

**8. Define** What are lahars?

**Think it Over**

**9. Analyze** Why are pyroclastic flows so dangerous?

**Key Concept Check**

**10. Determine** How do volcanic eruptions affect climate?