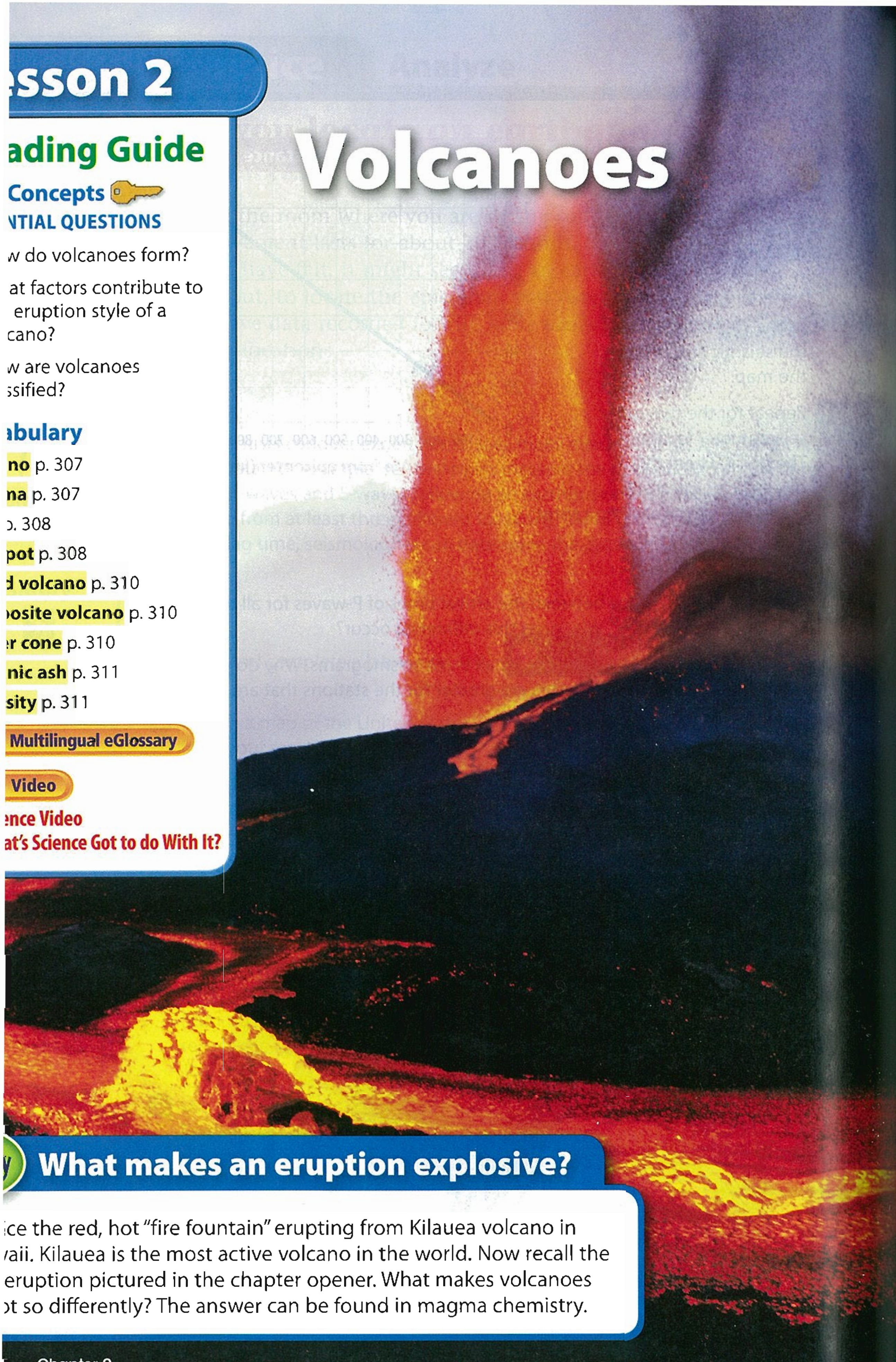
## ·sson 2

# Volcanoes



### ·ading Guide

**Concepts**
**·NTIAL QUESTIONS**

·w do volcanoes form?

·at factors contribute to ·eruption style of a ·cano?

·w are volcanoes ·ssified?

**·abulary**

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**·at's Science Got to do With It?**

## What makes an eruption explosive?

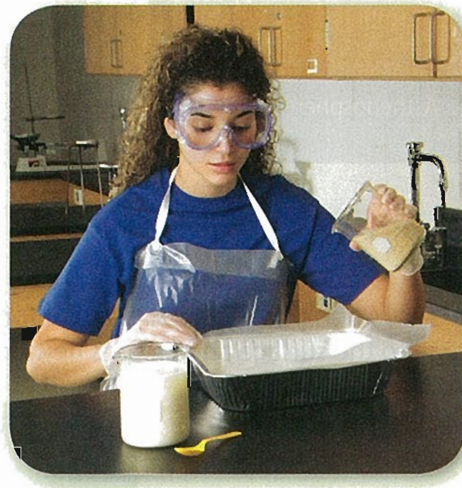
·ce the red, hot "fire fountain" erupting from Kilauea volcano in ·aii. Kilauea is the most active volcano in the world. Now recall the eruption pictured in the chapter opener. What makes volcanoes ·t so differently? The answer can be found in magma chemistry.

## Inquiry Launch Lab

**15 minutes**

### What determines the shape of a volcano?

Not all volcanoes look the same. The location of a volcano and the magma chemistry play an important part in determining the shape of a volcano.



1. Read and complete a lab safety form.
2. Obtain a **tray, a beaker of sand, a beaker with a mixture of flour and water, waxed paper,** and a **plastic spoon.**
3. Lay the waxed paper inside the tray.
4. Hold the beaker of sand about 30 cm above the tray. Slowly pour the sand onto the waxed paper and observe how it piles up.
5. Fold the paper in half and use it to carefully pour the sand back into the beaker.
6. Stir the flour and water mixture. It should be about the consistency of oatmeal. Add water if necessary.
7. Repeat steps 4 and 5 with the flour and water mixture. Record your observations for each trial in your Science Journal.

#### Think About This

1. What do the sand and the flour and water mixture represent?
2. **Key Concept** How do you think volcanoes get their shape?

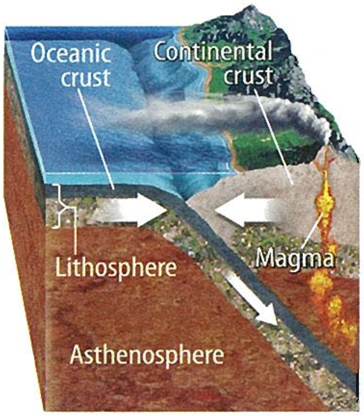
## What is a volcano?

Perhaps you have 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. 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.** Volcanoes are in many places worldwide. Some places have more volcanoes than others. In this lesson, you will learn about how volcanoes form, where they form, and about their structure and eruption style.

**Reading Check** What is magma?

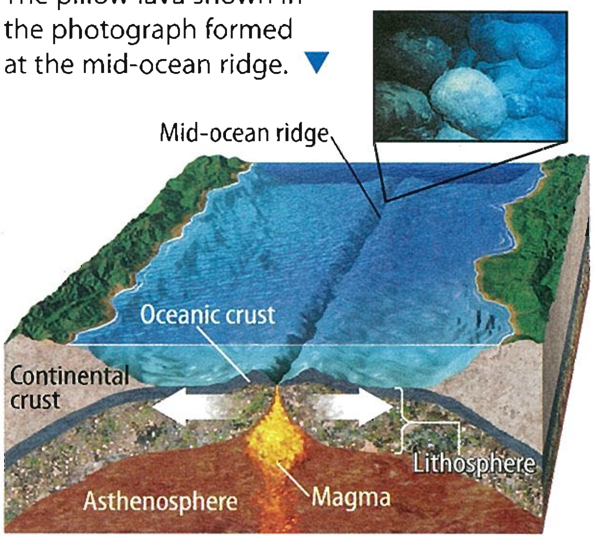
## How do volcanoes form?

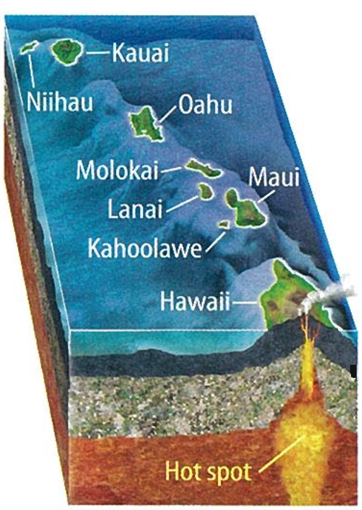
Volcanic eruptions constantly shape Earth's surface. They can form large mountains, create new crust, and leave a path of destruction behind. Scientists have learned that the movement of Earth's tectonic plates causes the formation of volcanoes and the eruptions that result.




◀ **Figure 8** During subduction, magma forms when one plate sinks beneath another plate.

**Figure 9** When plates spread apart, it forces magma to the surface and creates new crust. The pillow lava shown in the photograph formed at the mid-ocean ridge. ▼




◀ **Figure 10** The farther each of the Hawaiian Islands is from the hot spot, the older the island is.

## Convergent Boundaries

Volcanoes can form along convergent plate boundaries. Recall that when two plates collide, the denser plate sinks, or subducts, into the mantle, as shown in **Figure 8.** 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 surrounding mantle and rises through cracks in the crust. This forms a volcano. *Molten rock that erupts onto Earth's surface is called* **lava.**

## Divergent Boundaries

Lava erupts along divergent plate boundaries too. Recall that two plates spread apart along a divergent plate boundary. As the plates separate, magma rises through the vent or opening in Earth's crust that forms between them. This process commonly occurs at a mid-ocean ridge and forms new oceanic crust, as shown in **Figure 9.** More than 60 percent of all volcanic activity on Earth occurs along mid-ocean ridges.

## Hot spots

Not all volcanoes form on or near plate boundaries. Volcanoes in the Hawaiian Island-Emperor Seamount chain are far from plate boundaries. *Volcanoes that are not associated with plate boundaries are called* **hot spots.** Geologists hypothesize that hot spots originate above a rising convection current from deep within Earth's mantle. They use the word *plume* to describe these rising currents of hot mantle material.

**Figure 10** illustrates how a new volcano forms as a tectonic plate moves over a plume. When the plate moves away from the plume, the volcano becomes dormant, or inactive. Over time, a chain of volcanoes forms as the plate moves. The oldest volcano will be farthest away from the hot spot. The youngest volcano will be directly above the hot spot.

**Key Concept Check** How do volcanoes form?

## Volcano Distribution

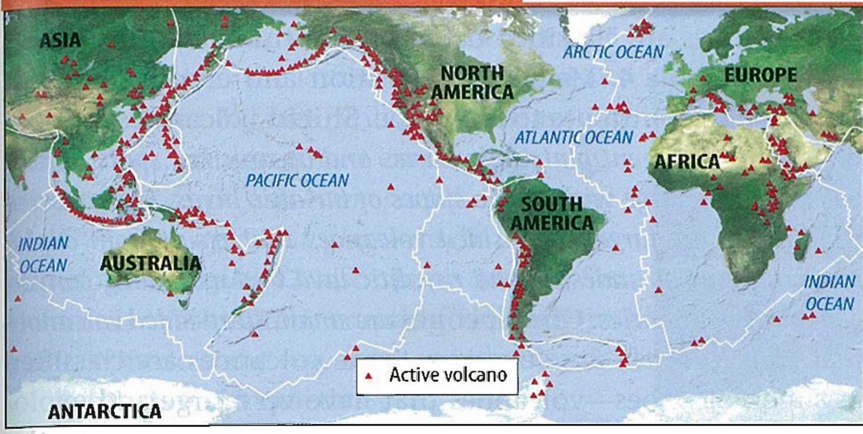



**Figure 11** Most of the world's active volcanoes are located along convergent and divergent plate boundaries and hot spots.

# Where do volcanoes form?

The world's active volcanoes are shown in **Figure 11.** The volcanoes all erupted within the last 100,000 years. Notice that most volcanoes are close to plate boundaries.

## Ring of Fire

The Ring of Fire represents an area of earthquake and volcanic activity that surrounds the Pacific Ocean. When you compare the locations of active volcanoes and plate boundaries in **Figure 11,** you can see that volcanoes are mostly along convergent plate boundaries where plates collide. They also are located along divergent plate boundaries where plates separate. Volcanoes also can occur over hot spots, like Hawaii, the Galapagos Islands, and Yellowstone National Park in Wyoming.

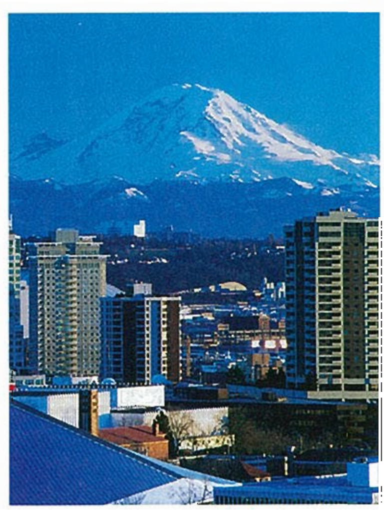
**Reading Check** Where is the Ring of Fire?

## Volcanoes in the United States

There are 60 potentially active volcanoes in the United States. Most of these volcanoes are part of the Ring of Fire. Alaska, Hawaii, Washington, Oregon, and northern California all have active volcanoes, such as Mount Redoubt in Alaska. A few of these volcanoes have produced violent eruptions, like the explosive eruption of Mount St. Helens in 1980.

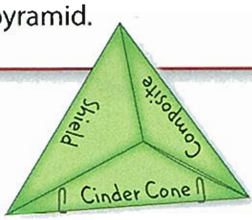
The United States Geological Survey (USGS) has established three volcano observatories to monitor the potential for future volcanic eruptions in the United States. Because large populations of people live near volcanoes such as Mount Rainier in Washington, shown in **Figure 12,** the USGS has developed a hazard assessment program. Scientists monitor earthquake activity, changes in the shape of the volcano, gas emissions, and the past eruptive history of a volcano to evaluate the possibility of future eruptions.

**Figure 12** Mount Rainier is an active volcano in the Cascade Mountains of the Pacific Northwest. Many people live in close proximity to the volcano.



**FOLDABLES®**

Fold a sheet of paper to make a pyramid book. Use it to illustrate the three main types of volcanoes. Organize your notes inside the pyramid.



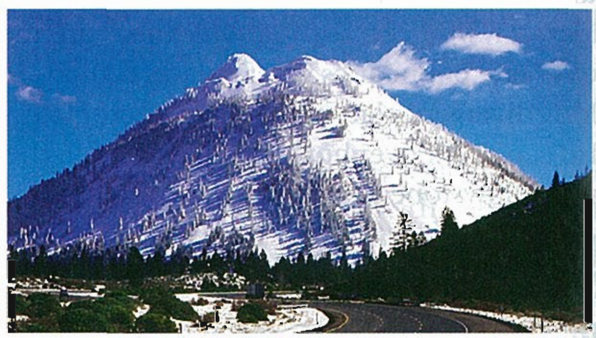

## Types of Volcanoes

Volcanoes are classified based on their shapes and sizes, as shown in **Table 4.** Magma composition and eruptive style of the volcano contribute to the shape. **Shield volcanoes** *are common along divergent plate boundaries and oceanic hot spots. Shield volcanoes are large with gentle slopes of basaltic lavas.* **Composite volcanoes** *are large, steep-sided volcanoes that result from explosive eruptions of andesitic and rhyolitic lava and ash along convergent plate boundaries.* **Cinder cones** *are small, steep-sided volcanoes that erupt gas-rich, basaltic lavas.* Some volcanoes are classified as supervolcanoes—volcanoes that have very large and explosive eruptions. Approximately 630,000 years ago, the Yellowstone Caldera in Wyoming ejected more than 1,000 $km^3$ of rhyolitic ash and rock in one eruption. This eruption produced nearly 2,500 times the volume of material erupted from Mount St. Helens in 1980.

**Key Concept Check** What determines the shape of a volcano?

**Table 4** Geologists classify volcanoes based on their size, shape, and eruptive style.

**Table 4 Volcanic Features** — Concepts in Motion Interactive Table

| Shield volcano | Composite volcano |
| --- | --- |
|  Large, shield-shaped volcano with gentle slopes made from basaltic lavas. |  Large, steep-sided volcano made from a mixture of andesitic and rhyolitic lava and ash. |
| **Cinder cone volcano** | **Caldera** |
|  Small, steep-sided volcano; made from moderately explosive eruptions of basaltic lavas. |  Large volcanic depression formed when a volcano's summit collapses or is blown away by explosive activity. |

## Volcanic Eruptions

When magma surfaces, it might erupt as a lava flow, such as the lava shown in **Figure 13** erupting from Kilauea volcano in Hawaii. Other times, magma might erupt explosively, sending **volcanic ash**—*tiny particles of pulverized volcanic rock and glass*—high into the atmosphere. **Figure 13** also shows Mount St. Helens in Washington, erupting violently in 1980. Why do some volcanoes erupt violently while others erupt quietly?

### Eruption Style

Magma chemistry determines a volcano's eruptive style. The explosive behavior of a volcano is affected by the amount of dissolved gases, specifically the amount of water vapor, a magma contains. It is also affected by the silica, $SiO_2$, content of magma.

**Magma Chemistry** Magmas that form in different volcanic environments have unique chemical compositions. Silica is the main chemical compound in all magmas. Differences in the amount of silica affect magma thickness and its **viscosity**—*a liquid's resistance to flow.*

Magma that has a low silica content also has a low viscosity and flows easily like warm maple syrup. When the magma erupts, it flows as fluid lava that 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 that has a high silica content has a high viscosity and flows like sticky toothpaste. This type of magma forms when rocks rich in silica melt or when magma from the mantle mixes with continental crust. The volcanic rocks andesite and rhyolite form when intermediate and high silica magmas erupt from subduction zone volcanoes and continental hot spots.

**Key Concept Check** What factors affect eruption style?

**Quiet Eruption**

**Violent Eruption**

**Figure 13** Lavas that are low in silica and the amount of dissolved gases erupt quietly. Explosive eruptions result from lava and ash that are high in silica and dissolved gases.

**ACADEMIC VOCABULARY**

**dissolve**

***(verb)*** to cause to disperse or disappear

**Figure 14** The holes in this pumice were caused by gas bubbles that escaped during a volcanic eruption.

**Dissolved Gases** The presence of **dissolved** gases in magma contributes to how explosive a volcano can be. This is similar to what happens when you shake a can of soda and then open it. The bubbles come from the carbon dioxide that is dissolved in the soda. The pressure inside the can decreases rapidly when you open it. Trapped bubbles increase in size rapidly and escape as the soda erupts from the can.

All magmas contain dissolved gases. These gases include water vapor and small amounts of carbon dioxide and sulfur dioxide. As magma moves toward the surface, the pressure from the weight of the rock above decreases. As pressure decreases, the ability of gases to stay dissolved in the magma also decreases. Eventually, gases can no longer remain dissolved in the magma and bubbles begin to form. As the magma continues to rise to the surface, the bubbles increase in size and the gas begins to escape. Because gases cannot easily escape from high-viscosity lavas, this combination often results in explosive eruptions. When gases escape above ground, the lava, ash, or volcanic glass that cools and crystallizes has holes. These holes, shown in **Figure 14,** are a common feature in the volcanic rock pumice.

## Inquiry MiniLab

**20 minutes**

### Can you model the movement of magma?

Magma erupts because it is less dense than Earth's crust. Similarly, oil is less dense than water and can be used to model magma.

1. Read and complete a lab safety form.
2. Half-fill a **clear plastic cup** with **pebbles.**
3. Fill the cup with **water** to a level just above the top of the pebbles.
4. Fill a **syringe** with 5 mL of **olive oil.**

5. Insert the syringe between the pebbles and the side of the cup until it touches the bottom.
6. Inject the oil slowly, 1 mL at a time.
7. Observe and record your results in your Science Journal.
8. Repeat the procedures using **motor oil.**

#### Analyze and Conclude

1. **Observe** What happens to the oil when you inject it into the water?
2. **Compare** How did the movement of the two oils differ?
3. **Key Concept** Which oil behaves like magma that will become basalt? Which behaves like magma that will become rhyolite? Explain.

## Effects of Volcanic Eruptions

On average, about 60 different volcanoes erupt each year. The effects of lava flows, ash fall, pyroclastic flows, and mudflows can affect all life on Earth. Volcanoes enrich rock and soil with valuable nutrients and help to regulate climate. Unfortunately, they also can be destructive and sometimes even deadly.

**Lava Flows** Because lava flows are relatively slow moving, they are rarely deadly. But lava flows can be damaging. Mount Etna in Sicily, Italy, is Europe's most active volcano. **Figure 15** shows a fountain of fluid, hot lava erupting from one of the volcano's many vents. In May 2008, the volcano began spewing lava and ash in an eruption lasting over six months. Although lavas tend to be slow moving, they threaten communities nearby. People who live on Mount Etna's slopes are used to evacuations due to frequent eruptions.

▲ **Figure 15** Mount Etna is one of the world's most active volcanoes. People that live near the volcano are accustomed to frequent eruptions of both lava and ash.

**Ash Fall** During an explosive eruption, volcanoes can erupt large volumes of volcanic ash. Ash columns can reach heights of more than 40 km. Recall that ash is a mixture of particles of pulverized rock and glass. Ash can disrupt air traffic and cause engines to stop mid-flight as shards of rock and ash fuse onto hot engine blades. Ash can also affect air quality and can cause serious breathing problems. Large quantities of ash erupted into the atmosphere can also affect climate by blocking out sunlight and cooling Earth's atmosphere.

**Mudflows** The thermal energy a volcano produces during an eruption can melt snow and ice on the summit. This meltwater can then mix with mud and ash on the mountain to form mudflows. Mudflows are also called lahars. Mount Redoubt in Alaska erupted on March 23, 2009. Snow and meltwater mixed to form the mudflows shown in **Figure 16**.

◀ **Figure 16** Many of the steep-sided composite volcanoes are covered with seasonal snow. When a volcano becomes active, the snow can melt and mix with mud and ash to form a mudflow like the one shown here in the Cook Inlet, Alaska.

▲ **Figure 17** A pyroclastic flow travels down the side of Mount Mayon in the Philippines. Pyroclastic flows are made of hot (*pyro*) volcanic particles (*clast*).

**Pyroclastic Flow** Explosive volcanoes can produce fast-moving avalanches of hot gas, ash, and rock called pyroclastic (pi roh KLAS tihk) flows. Pyroclastic flows travel at speeds of more than 100 km/hr and with temperatures greater than 1000°C. In 1980, Mount St. Helens produced a pyroclastic flow that killed 58 people and destroyed 1 billion $km^3$ of forest. Mount Mayon in the Phillippines erupts frequently producing pyroclastic flows like the one shown in **Figure 17.**

### Predicting Volcanic Eruptions

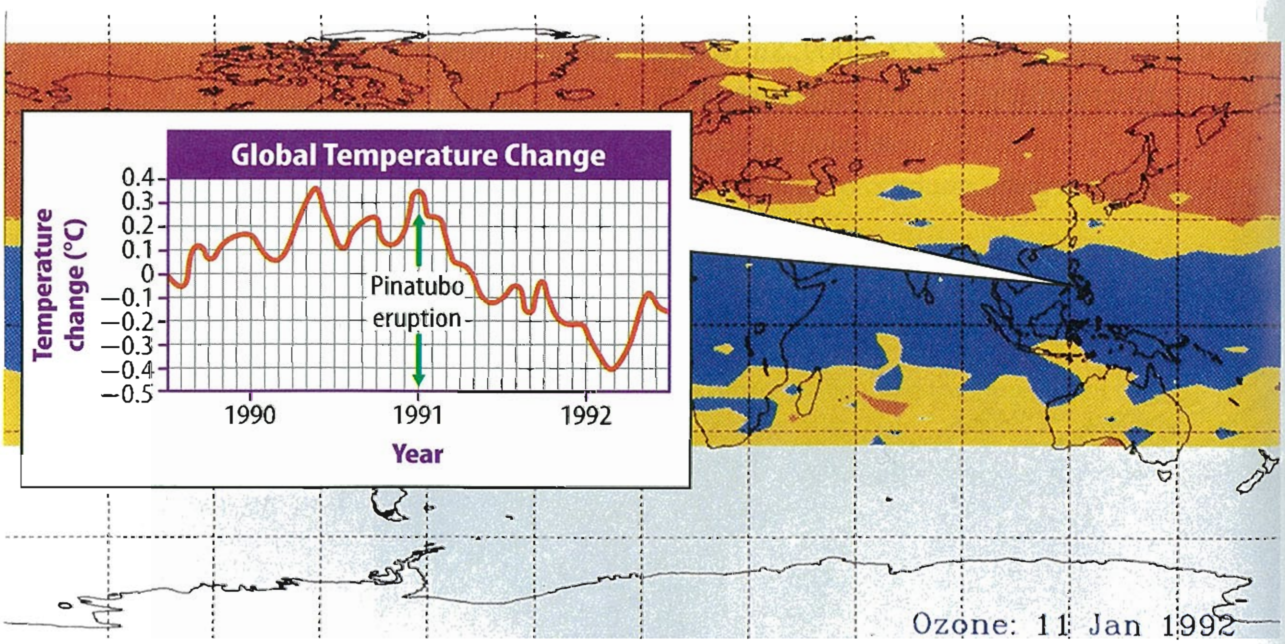
Unlike earthquakes, volcanic eruptions can be predicted. Moving magma can cause ground deformation, a change in shape of the volcano, and a series of earthquakes called an earthquake swarm. Volcanic gas emissions can increase. Ground and surface water near the volcano can become more acidic. Geologists study these events, in addition to satellite and aerial photographs, to assess volcanic hazards.

## Volcanic Eruptions and Climate Change

Volcanic eruptions affect climate when volcanic ash in the atmosphere blocks sunlight. High-altitude wind can move ash around the world. In addition, sulfur dioxide gases released from a volcano form sulfuric acid droplets in the upper atmosphere. These droplets reflect sunlight into space, resulting in lower temperatures as less sunlight reaches Earth's surface. **Figure 18** shows the result of sulfur dioxide gas in the atmosphere from the 1991 eruption of Mt. Pinatubo.

**Key Concept Check** How do volcanoes affect climate?

**Figure 18** In 1991, Mount Pinatubo erupted more than 20 million tons of gas and volcanic ash into the atmosphere. The greatest concentration of sulfur dioxide gas from the eruption is shown below in blue. The eruption caused temperatures to decrease by almost one degree Celsius in one year. ▼



# Types of Volcanoes

A **volcano** is the mountain or hill formed by the accumulation of materials erupted through one or more openings in the Earth's surface. The pipe-like openings that connect the volcano's **crater** (depression at the top) to the **magma chamber** (pool of molten rock deep within the Earth) are called **volcanic vents.** Volcanoes form because heat and pressure within Earth cause rock to melt. This molten rock, called **magma,** is less dense than the solid rock around it, so it is slowly forced toward the surface of Earth. Magma that reaches Earth's surface through vents is called **lava**. A **volcanic eruption** is when lava, ash, debris, and/or gas is thrown out of a volcano. Some eruptions are very explosive while others are relatively quiet outpouring of bubbling lava or even gas.

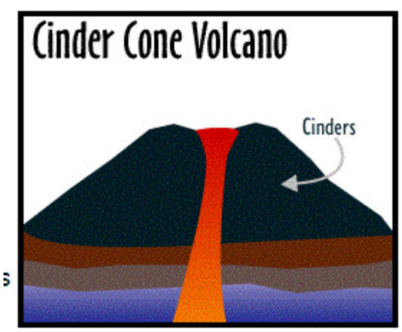
Photo of a 1946 eruption of Paricutin.

Some volcanoes on Earth are **active** (erupted within the last century), but most of them are **dormant** (inactive). Dormant volcanoes have not erupted in hundreds of years, but they could. Volcanoes that have not erupted in thousands of years are considered **extinct** and most likely will never again become active. There are more than 5,000 active underwater volcanoes and more than 800 active above-sea volcanoes currently in existence around the world.

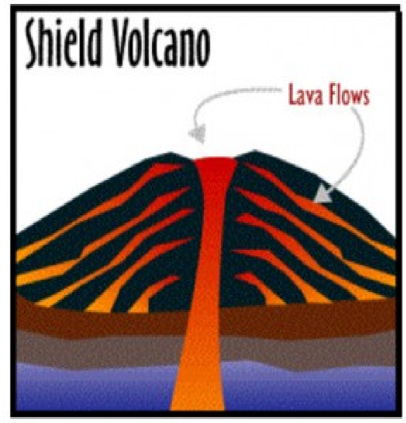
Different types of eruptions produce different kinds of volcanoes. Following are three different types of volcanoes.

### 1. Cinder Cone Volcanoes

**Explosive eruptions** throw lava high into the air. The lava cools and hardens into different volcanic material called **tephra** (lava blasted into the air by a violent volcanic eruption that solidifies as it falls to the ground). Tephra comes in different sizes, including ash, cinders, and large rocks called volcanic bombs. A **cinder cone volcano** is formed by an explosive eruption in which tephra piles up into a steep-sided loosely packed cone. As the tephra fall back down around the vent, the heavier materials fall near the vent and the lighter weight materials are thrown farther away. This type of volcano usually has a rounded top with a small bowl-shaped crater (hollowed-out area at the top of a volcano). The upper parts of the volcano are steep with a more gently sloping base. There are many cinder cone volcanoes in the western United States, such as Sunset Crater in Arizona. These volcanoes are also found in many other parts of Earth, including the island of Java, in Indonesia.

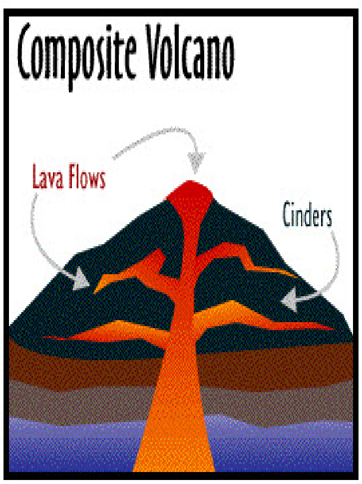


## 2. Shield Volcanoes




A **shield volcano** (a volcano composed of layers of solidified lava, a wide base, and a large, bowl-shaped opening at the top) is generally less steep and shorter than other types of volcanoes. It is made by repeated eruptions producing lava flows. The lava forming this volcano is relatively thin and flows away from the vent. As the lava cools, it becomes thicker, flows more slowly and finally becomes solid. Mauna Loa in Hawaii is one of the largest shield volcanoes.

## 3. Composite Volcano




A **composite volcano** (cone-shaped volcano formed by alternating layers of solidified lava and rock particles) is a combination of a cinder cone and shield volcano that results from alternating eruptions of volcanic debris and lava. This type of volcano is likely to be the tallest and steepest volcano. Mount Rainier, in the state of Washington, is an example of a composite volcano.

http://scienceprojectideasforkids.com/2010/types-of-volcanoes/

**Cinder Cone Volcano:** Sunset Crater - Arizona

**Cinder Cone Volcano:** Volcano Paricutin - Mexico

**Shield Volcano:** Mona Loa - Hawaii

**Shield Volcano:** Kilauea - Hawaii

**Composite Volcano:** Mount Rainer - Washington

**Composite Volcano:** Mount St. Helen’s – Washington

# ON SITE: HAWAIIAN VOLCANO OBSERVATORY

Volcanologists often wear helmets, climbing gear, heat-resistant clothing, gas masks, and other gear to protect themselves from dangerous conditions in and around active volcanoes. Once this volcanologist climbs down to the test site, he will put on heat-resistant gloves.

**Kilauea, a shield volcano on the island of Hawaii, is one of the world's most active volcanoes and the most dangerous volcano in the United States, according to the United States Geological Survey (USGS). Scientists monitor the conditions of Kilauea at the nearby Hawaiian Volcano Observatory (HVO). The observatory also serves as a laboratory where samples gathered in and around Kilauea can be studied.**

**Lava collection** Imagine standing next to moving lava that is 1170°C. To get a direct measurement of the temperature or to collect a sample, scientists must withstand high temperatures and watch where they step. Samples are collected with heat-resistant materials and immediately cooled in a container with water to prevent contamination from the surrounding air. To protect themselves, volcanologists wear some of the gear shown in the photo.

**Seismic activity** Earthquake activity beneath a volcano is an indicator of impending eruptions. One way to monitor earthquakes is to check seismic activity. Scientists place seismometers in and around the vents of volcanoes to monitor seismic activity.

**Gas samples** Volcanologists collect samples of gases released at vents that they will analyze for sulfur dioxide and carbon dioxide in the HVO laboratory. An increase in sulfur-dioxide or carbon-dioxide emission can indicate a potential eruption.

**Ground monitoring** An instrument called an electronic distance meter (EDM) helps scientists monitor the ground around volcanoes and predict an eruption. As magma rises toward Earth's surface, the ground might tilt, sink, or bulge from pressure.

Volcanologists at HVO are constantly recording data, running tests, and making advances around the world. Without their research, we might not understand volcanoes as well as we do today.

### WRITING in Earth Science

**Research** the methods scientists use to predict time, size, and type of eruption. Visit glencoe.com for more information. Summarize your findings and share your research with your classmates.

# Hot Spots

Volcanoes are some of the hottest places on Earth. They are also some of the coolest.

Joanne Green carefully put her foot down as if it were her last step. It could have been. The hardened lava underfoot was blazing hot. A nearby river of glowing lava splashed melted rock.

"The heat on your face is very, very intense," said Green. "If you aren't careful," she went on, "you'll melt your boots on the hot rock. Or worse!"

Green, you see, is a volcanologist. She's a scientist who studies volcanoes. To learn about the hot spots, she gets as close to them as she can.

## TOWERING INFERNOS

Green was studying Kilauea. It's a volcano in Hawaii. It's just one of nearly 600 volcanoes on Earth's land. Many more rise from the ocean floor. All together, there are 1,500 active volcanoes worldwide.

Active volcanoes, however, make up only a small fraction of all mountains of fire. Many others are dormant, or "sleeping." These volcanoes haven't erupted in a long time. Some may never erupt again. Then there are extinct volcanoes. They fizzled out thousands or even millions of years ago.

All kinds of volcanoes—active, dormant, or extinct—are important. Volcanoes made 80 percent of Earth's surface. Most of our fertile soils came from volcanoes. And much of the air we breathe was erupted by them.

## IT'S ABOUT THE LAVA

A volcano is an opening, or vent, into Earth's hot interior. Molten rock, ormagma, rises through the vent. When the magma blasts onto Earth's surface, it's called lava.

Not all lava is the same. Some volcanoes make runny lava. It flows very fast, like pancake batter. Runny lava forms a gentle slope called a shield volcano.

Other volcanoes erupt thick, sticky lava. It flows slowly, like toothpaste. This kind of lava cannot flow very far. It forms a mountain with steep slopes. It's called a composite volcano.

Composite volcanoes can erupt violently. A blast can hurl ash and lava at more than 600 miles per hour. Sometimes an eruption blows away large chunks of the volcano itself. All that's left is a steaming caldera.

## THE RING OF FIRE

Three-quarters of all volcanoes rise near the rim of the Pacific Ocean. This circle of hot spots is called the Ring of Fire.

It's no accident that so many volcanoes are located there. The Ring of Fire is an area where some of the plates that form Earth's surface meet.

Sometimes when plates meet, one of them moves under the other. The lower one melts, forming magma. This magma squeezes through cracks in the surrounding rock. The magma can then burst through Earth's surface to build a new volcano or erupt from an old one.

## LIVING WITH A VOLCANO

All active volcanoes affect the plants and animals that live around them. They make rich soils for plants to grow in. The plants attract all kinds of animals. Volcanoes even change the way people live. Farmers grow crops on rich volcanic soils. Tourists vacation near the beautiful mountains. Cities grow in the valleys beneath the peaks.

But life near an active volcano isn't easy. Sometimes the peaks turn into dangerous mountains of fire. When that happens, you don't want to be anywhere nearby.

## A SLEEPING GIANT AWAKENS

One of the most scenic U.S. volcanoes was Mount St. Helens. It's about 95 miles south of Seattle, Washington. The mighty mountain had last erupted in 1857.

Over the years, millions of people moved to the area around Mount St. Helens. Thousands more visited each year.

After all, the snowcapped volcano seemed peaceful and calm. But that all changed on the morning of May 18, 1980. At 8:32 a.m. a powerful earthquake rattled the area. Suddenly the north side of the volcano exploded.

Hot ash and steam surged down the volcanic slopes at 200 miles per hour. When the smoke cleared, it looked like the top of the mountain had been chopped off. More than 1,000 feet was gone. A swath of land stretching 15 miles from the volcano was destroyed.

Today the volcano continues to erupt. But now it is slowly rebuilding itself. One day in the distant future, it will look much like it used to. But it is destined to repeat its violent past and destroy itself again.

Article by Beth Geiger.
"Hot Spots" appears on pages 10-15 of our May 2004 issue.
http://magma.nationalgeographic.com/ngexplorer/0405/articles/mainarticle.html

# Predicting Eruptions

INSTANT EXPERT

Popular Science Magazine
http://www.popsci.com/scitech/article/2007-03/predicting-eruptions

Earlier this week, lava flows put the volcanic Italian island of Stromboli on high alert. Here, we show you how scientists are using tech to better forecast when volcanoes worldwide are likely to blow.

Located 30 miles off the coast of Sicily, Stromboli (the three-mile-wide island, not the tasty pizza roll) is home to several hundred people and one of Europe´s most active volcanoes. On February 27, all dough-and-tomato-sauce jokes were suspended when two new craters opened up on the volcano´s summit, sending streams of lava pouring down into the sea. A similar incident in 2002 triggered a massive landslide and a 33-foot tidal wave, damaging local villages and closing the island to visitors for months. Although this week´s eruptions caused little damage, authorities ordered residents to move away from the coast, all the while assuring them that the chance of any serious damage was minimal.

The official word may sound dangerously nonchalant, but the Italians are practiced in these matters. The volcanoes that dot the landscape are folded deeply into the country´s history, their eruptions resulting in the same intensive cultural shifts caused by wars or pandemics elsewhere (not that Italy hasn´t had its share of those, too). In fact, the Stromboli eruption occurred just days after scientists at the National Geophysical and Vulcanology Institute in Pisa revealed the first four-dimensional simulation of what would occur if Vesuvius erupted again. (As many as 300,000 people living near the volcano could perish, mirroring the total destruction of Pompeii after its most catastrophic eruption in 79 A.D.)

And several weeks ago, scientists from the National Geophysical and Vesuvian Vulcanology Institute Observatory in Naples published a paper noting how the ground near Naples is slowly undergoing a volcanic uplift. The area, Campi Flegrei, is an ancient collapsed volcano about four miles across. It´s part of the volcanic arc that encompasses Mount Vesuvius, and when it last erupted five centuries ago, it expelled enough lava to create an entirely new mountain.

If all this sounds pretty bleak, take heart: Knowing when to expect the next big one is a coup for Italians living among dozens of volcanoes. The modeling of Vesuvius demonstrates how dangerous the next eruption will be, but it also shows how the lava will flow, when evacuation should start, and where evacuees will safely be able to go. The data on the Campi Flegrei was collected with little more than GPS measurements, but it can be used to forecast the magnitude of hazard at any site of potential volcanic activity.