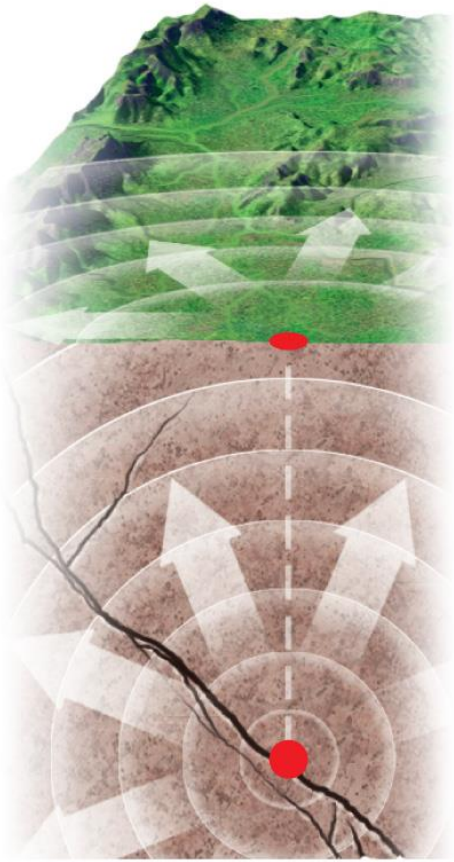
Chapter Menu

Chapter Introduction

Lesson 1 Earthquakes

Lesson 2 Volcanoes

Chapter Wrap-Up



What causes earthquakes and volcanic eruptions?

Get Ready

What do you think?

Before you begin, decide if you agree or disagree with each of these statements. As you view this presentation, see if you change your mind about any of the statements.

Get Ready

Do you agree or disagree?

1. Earth's crust is broken into rigid slabs of rock that move, causing earthquakes and volcanic eruptions.
2. Earthquakes cause energy waves that travel through Earth.
3. Earthquakes can be predicted.

Get Ready

Do you agree or disagree?

4. Volcanoes can erupt anywhere on Earth.

5. Volcanic eruptions are rare.

6. Volcanic eruptions only affect people and places located close to the volcano.

Lesson 1

Earthquakes

Key Concepts

- What is an earthquake?
- Where do earthquakes occur?
- How do scientists monitor earthquake activity?

Lesson 1

Earthquakes

Vocabulary

- earthquake
- fault
- seismic wave
- focus
- epicenter
- primary wave
- secondary wave
- surface wave
- seismologist
- seismometer
- seismogram

What are earthquakes?

- **Earthquakes** are the vibrations in the ground that result from movement along breaks in Earth's lithosphere, called faults.
- The forces that move tectonic plates also push and pull on rocks along the fault.
- The greater the force applied to a fault, the greater the chance of a large and destructive earthquake.

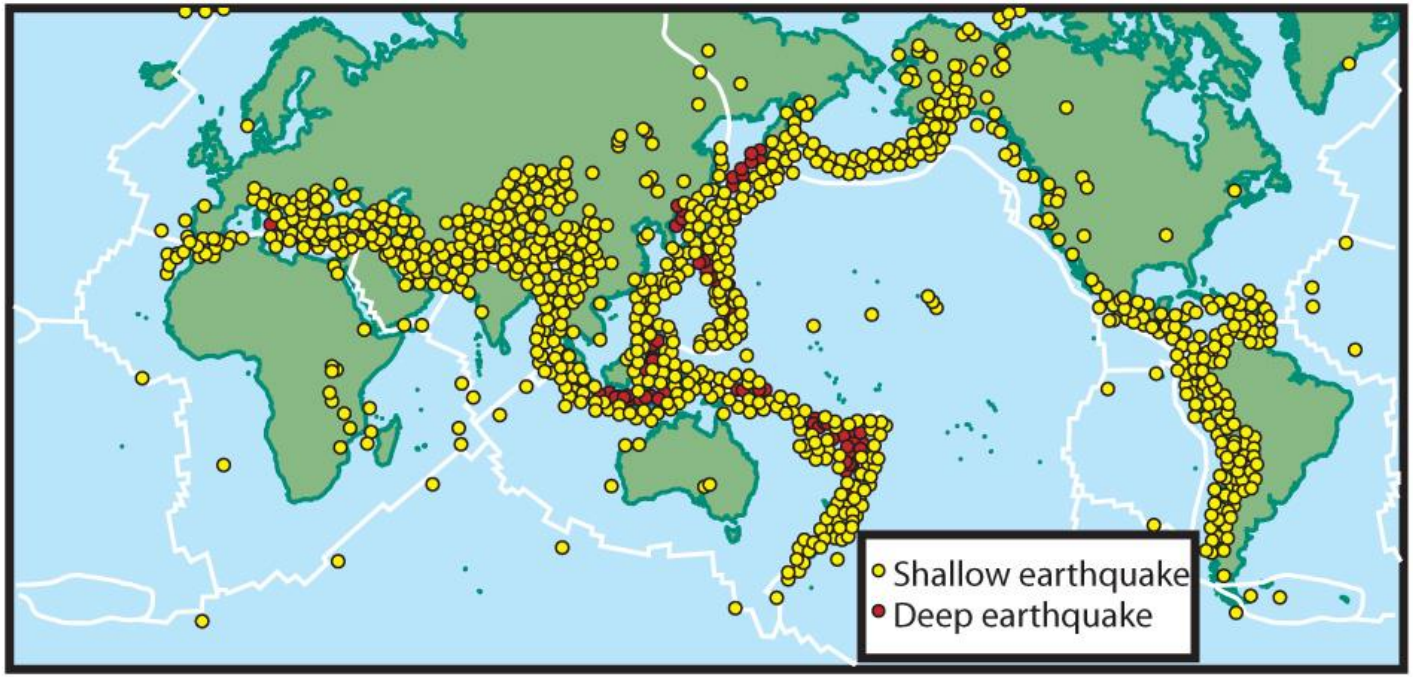
What are earthquakes? (cont.)

KEY CONCEPT CHECK

What is an earthquake?

Where do earthquakes occur?

Records show that most earthquakes occur in the oceans and along the edges of continents.



Where do earthquakes occur? (cont.)

- Earthquakes result from the buildup and release of stress along active plate boundaries.
- The deepest earthquakes occur where plates collide along a convergent plate boundary.
- Here, the denser oceanic plate subducts into the mantle.

Where do earthquakes occur? (cont.)

Science Use v. Common Use

mantle

Science Use the area in Earth's interior below the crust and above the core

Common Use something that covers, enfolds, or envelops like a hood

Where do earthquakes occur? (cont.)

Shallow earthquakes are common where plates separate along a divergent plate boundary.

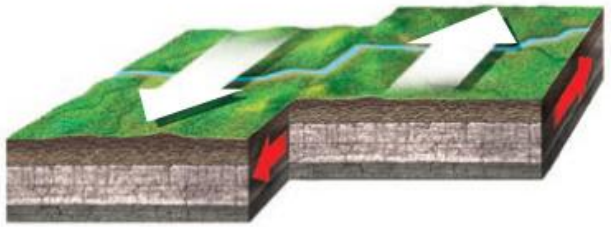
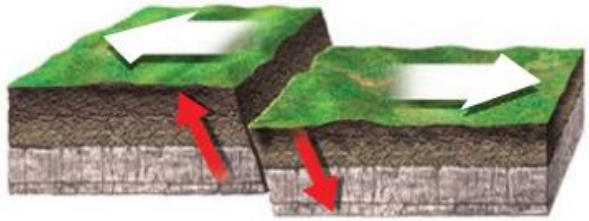
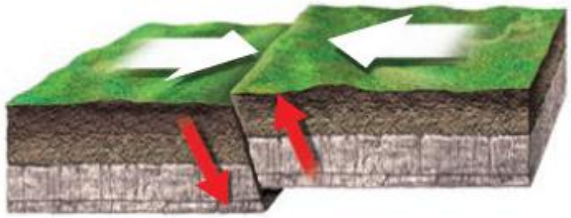
KEY CONCEPT CHECK

Where do most earthquakes occur?

Where do earthquakes occur? (cont.)

- Rock deformation can result in ground displacement.
- A **fault** is a break in Earth's lithosphere where one block of rock moves toward, away from, or past another.
- When rocks move in any direction along a fault, an earthquake occurs.

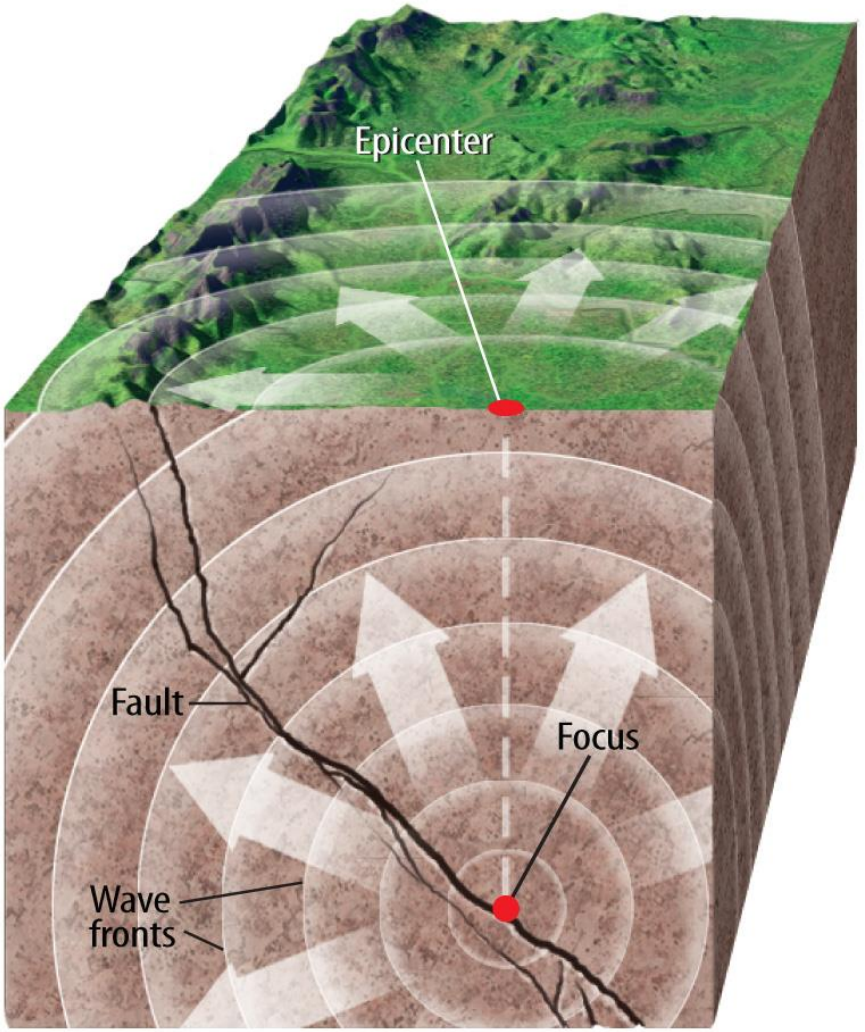
Types of Faults

Types of Faults		
Strike-slip	• Two blocks of rock slide horizontally past each other in opposite directions. • Location: transform plate boundaries	
Normal	• Forces pull two blocks of rock apart. One block moves down along the fault relative to the other. • Location: divergent plate boundaries	
Reverse	• Forces push two blocks of rock together. One block moves up along the fault relative to the other. • Location: convergent plate boundaries	

Where do earthquakes occur? (cont.)

- When rocks move along a fault, they release energy that travels as vibrations on and in Earth called **seismic waves**.
- These waves originate where rocks first move along the fault, at a location inside Earth called the **focus**.

The **epicenter** is the location on Earth's surface directly above the earthquake's focus.



Get Animated

Seismic Waves

- Scientists use wave motion, wave speed, and the type of material that the waves travel through to classify seismic waves.
- The three types of seismic waves are primary waves, secondary waves, and surface waves.

Seismic Waves (cont.)

Primary waves, also called P-waves, cause particles in the ground to move in a push-pull motion similar to a coiled spring.

WORD ORIGIN

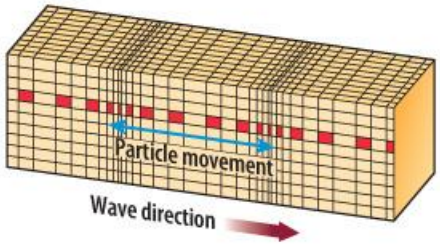
primary

from Latin *primus*, means “first”

Seismic Waves (cont.)

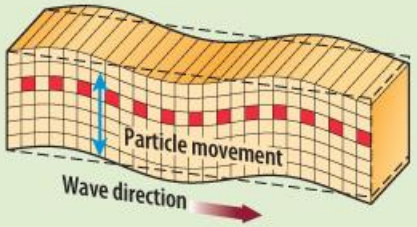
- **Secondary waves**, also called S-waves, cause particles to move at right angles relative to the direction the wave travels.
- **Surface waves** cause particles in the ground to move up and down in a rolling motion.

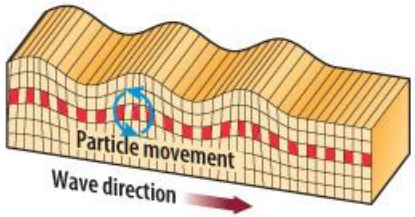
Properties of Seismic Waves



Primary wave
- Cause rock particles to vibrate in same direction waves travel
- Fastest seismic waves
- First to be detected and recorded
- Travel through solids and liquids

Secondary wave
- Cause rock particles to vibrate perpendicular to direction that waves travel
- Slower than P-waves, faster than surface waves
- Detected and recorded after P-waves
- Only travel through solids



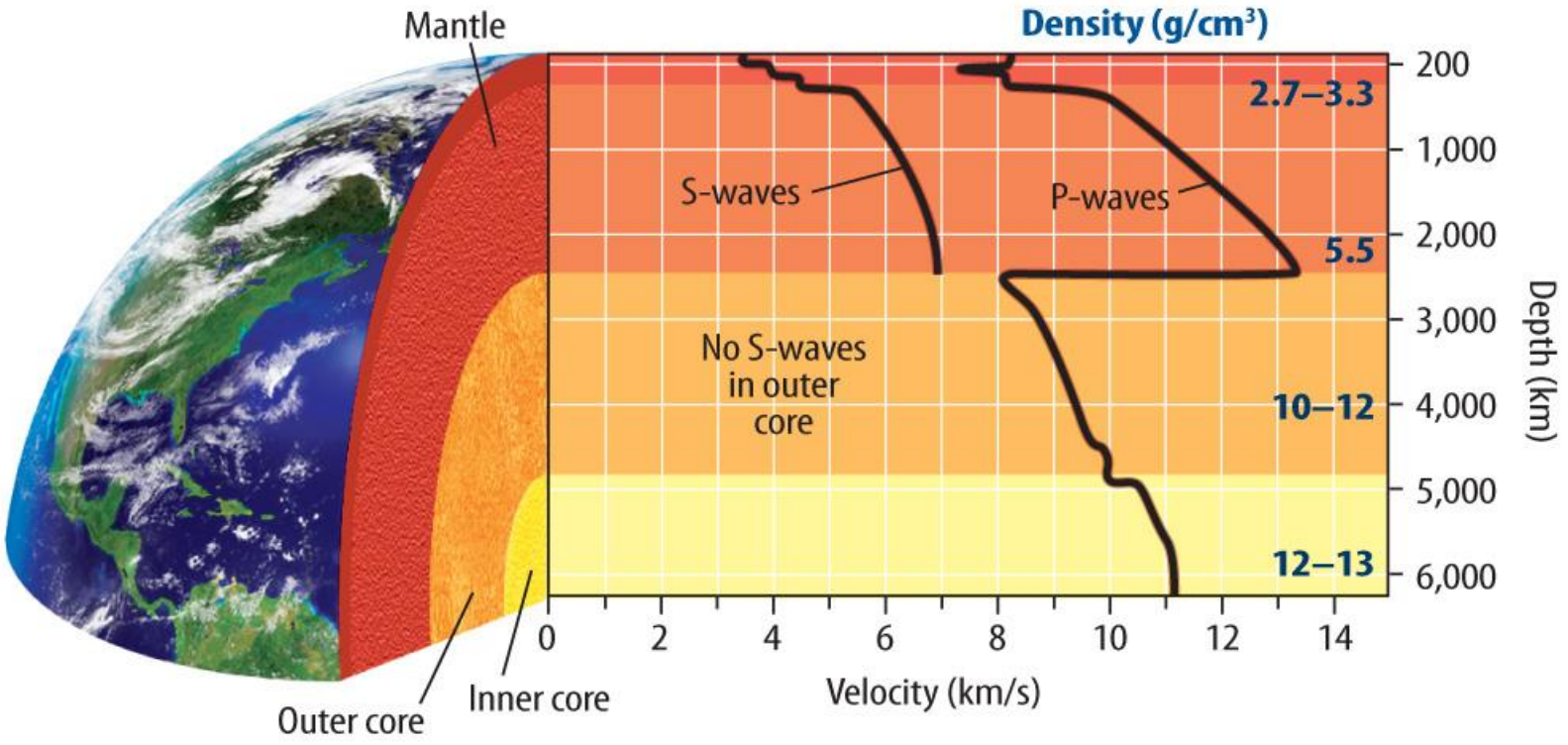


Surface wave
- Cause rock particles to move in a rolling or elliptical motion in the same direction as waves travel
- Slowest seismic wave
- Generally cause the most damage at Earth's surface

Mapping Earth's Interior

- Scientists that study earthquakes are called **seismologists**.
- They use the properties of seismic waves to map Earth's interior.

P-waves and S-waves at different depths within Earth's interior travel at different speeds.

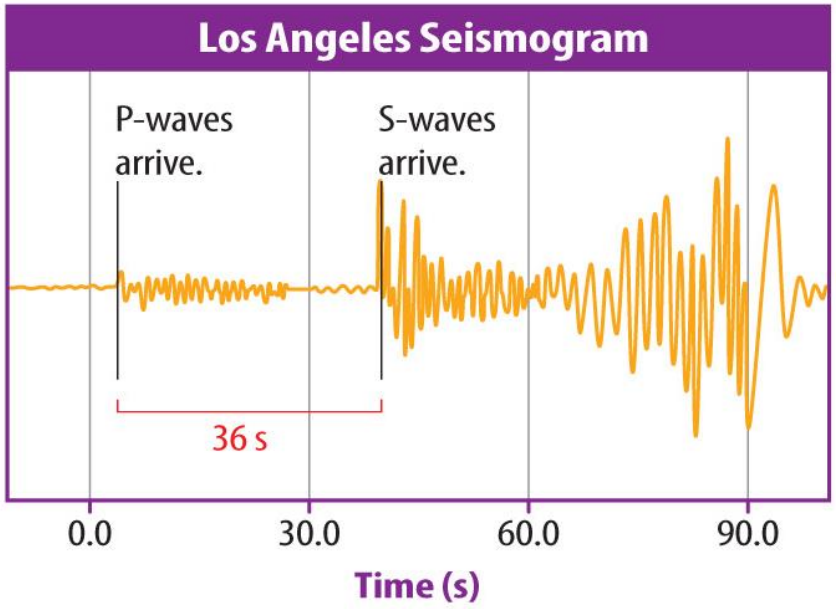


Mapping Earth's Interior (cont.)

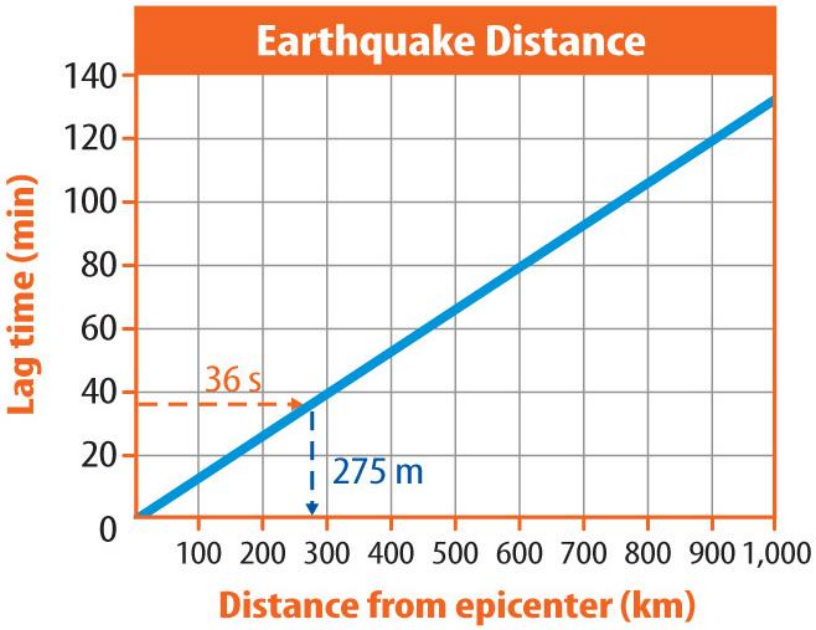
- An instrument called a **seismometer** measures and records ground motion and the distance and direction that seismic waves travel.
- Ground motion is recorded as a **seismogram**, a graphical illustration of earthquake waves.

Seismologists use a method called triangulation to locate an earthquake's epicenter.

1 Find the arrival time difference.



2 Find the distance to the epicenter.



3 Plot the distance on the map.

Determining Earthquake Magnitude

- Scientists can use three different scales to measure and describe earthquakes.
- The Richter magnitude scale uses the amount of ground motion at a given distance from an earthquake to determine magnitude.
- The moment magnitude scale measures the total amount of energy released by the earthquake.

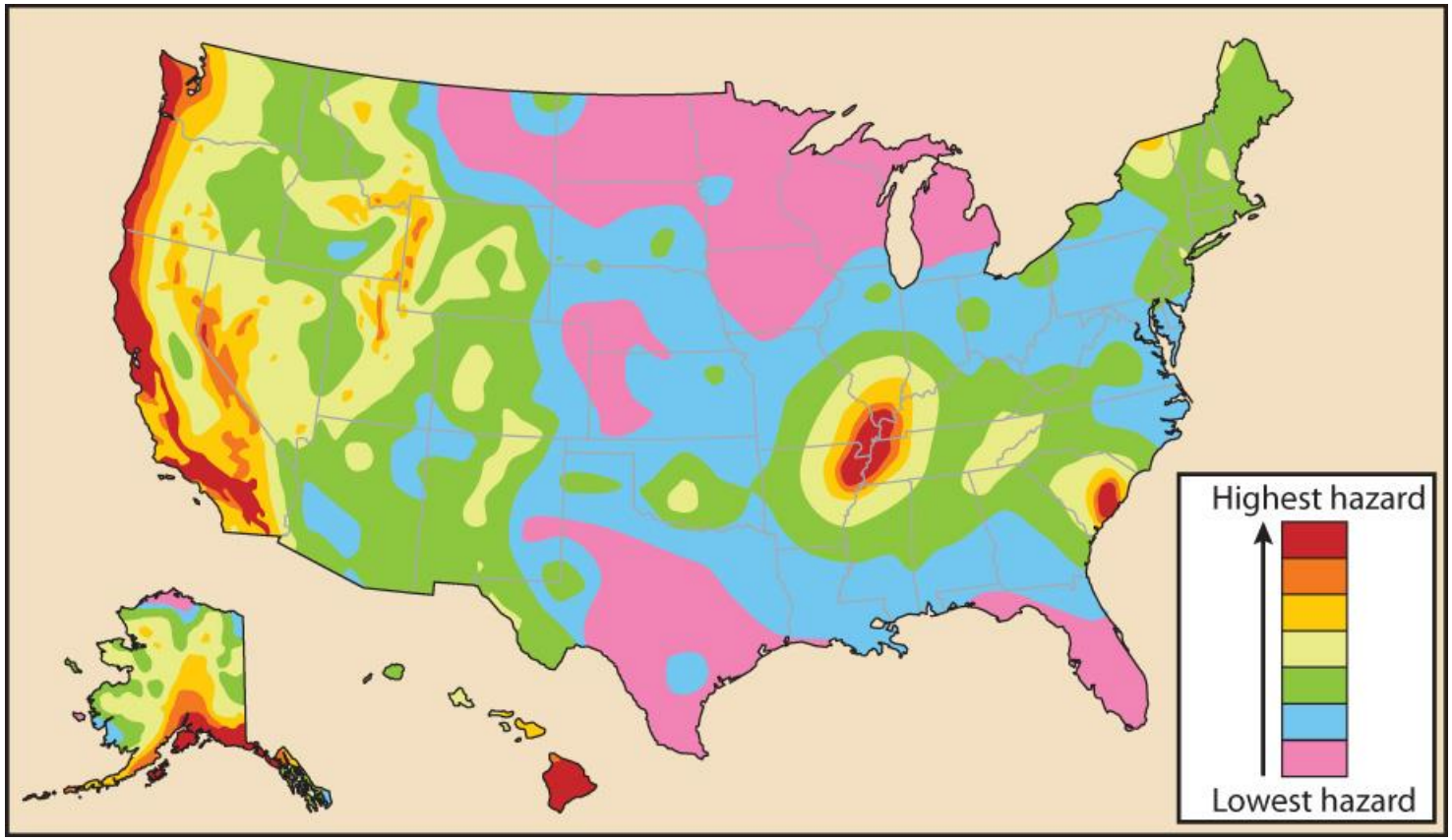
The Modified Mercalli scale measures earthquake intensity based on descriptions of the earthquake's effects on people and structures.

Modified Mercalli Scale	
I	Not felt except under unusual conditions.
II	Felt by few people; suspended objects might swing.
III	Most noticeable indoors; vibrations are like the passing of a truck.
IV	Felt by many people indoors but by few people outdoors; dishes and windows rattle; standing cars rock noticeably.
V	Felt by nearly everyone; some dishes and windows break and some walls crack.
VI	Felt by all; furniture moves; some plaster falls from walls and some chimneys are damaged.
VII	Everybody runs outdoors; some chimneys break; damage is light in well-built structures but considerable in weak structures.
VIII	Chimneys, smokestacks, and walls fall; heavy furniture is overturned; partial collapse of ordinary buildings occurs.
IX	Great general damage occurs; buildings shift off foundations; ground cracks; underground pipes break.
X	Most ordinary structures are destroyed; rails are bent; landslides are common.
XI	Few structures remain standing; bridges are destroyed; railroad rails are greatly bent; broad fissures form in the ground.
XII	Total destruction; objects are thrown upward into the air.

Determining Earthquake Magnitude (cont.)

- Probability is one of several factors that contribute to earthquake risk assessment.
- Seismologists also study past earthquake activity, the geology around a fault, the population density, and the building design in an area to evaluate risk.

Areas that experienced earthquakes in the past will likely experience earthquakes again.



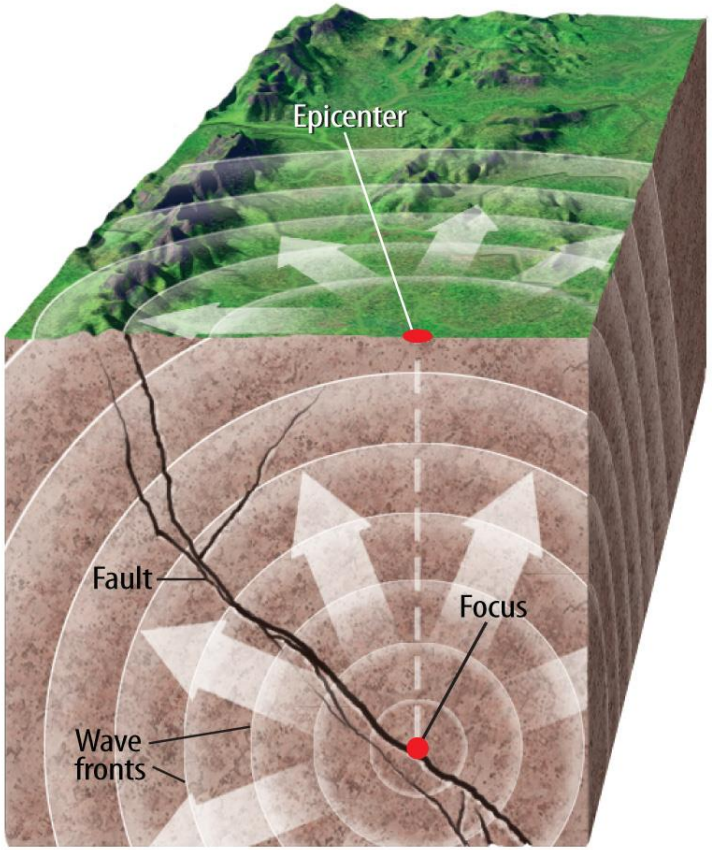
Determining Earthquake Magnitude (cont.)

KEY CONCEPT CHECK

How do seismologists evaluate risk?

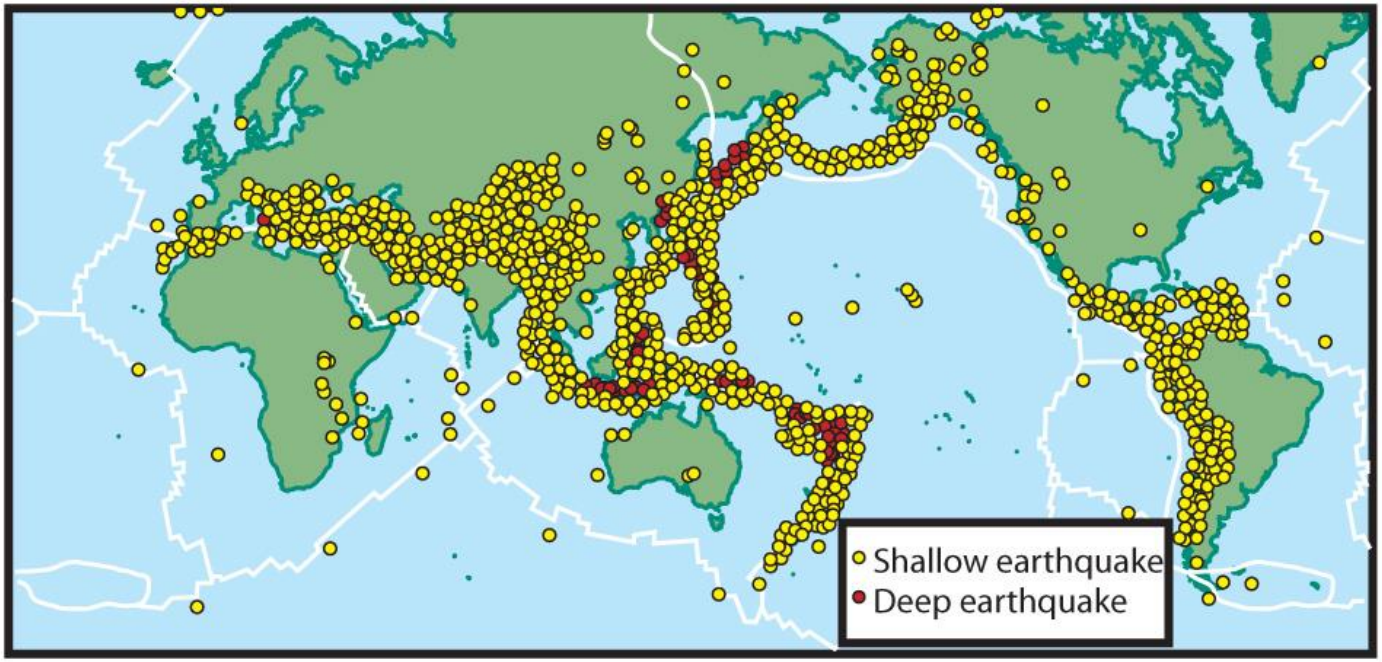
Summary

- The focus is the area on a fault where an earthquake begins.



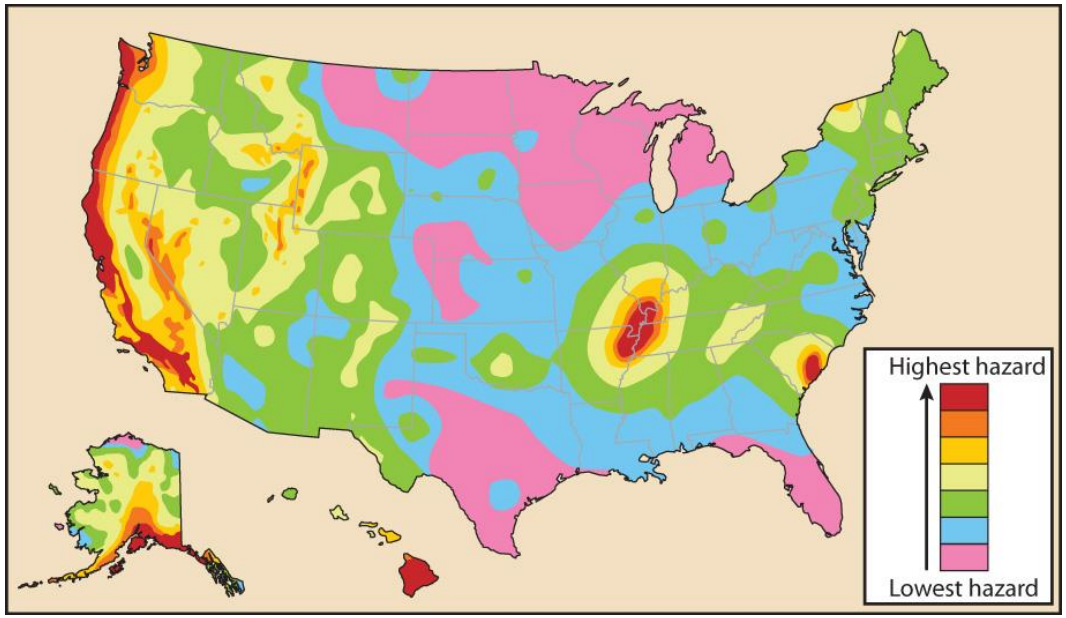
Summary

- Earthquakes occur along plate boundaries.



Summary

- Seismologists assess earthquake risk by studying past earthquake activity and local geology.



Lesson Review

Which term refers to the location on Earth's surface directly above an earthquake's focus?

A. fault

B. seismic wave

C. epicenter

D. seismogram

Lesson Review

Which of these uses the amount of ground motion at a given distance from an earthquake to determine magnitude?

A. the Richter magnitude scale

B. the moment magnitude scale

C. the Modified Mercalli scale

D. seismogram

Lesson Review

Which of these cause particles to move at right angles relative to the direction the wave travels?

A. primary waves

B. secondary waves

C. surface waves

D. epicenter

Lesson Review

What do you think NOW?

Do you agree or disagree?

1. Earth's crust is broken into rigid slabs of rock that move, causing earthquakes and volcanic eruptions.
2. Earthquakes cause energy waves that travel through Earth.
3. Earthquakes can be predicted.

Lesson 2

Volcanoes

Key Concepts

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

Lesson 2

Volcanoes

Vocabulary

- volcano
- magma
- lava
- hotspot
- shield volcano
- composite volcano
- cinder cone
- volcanic ash
- viscosity

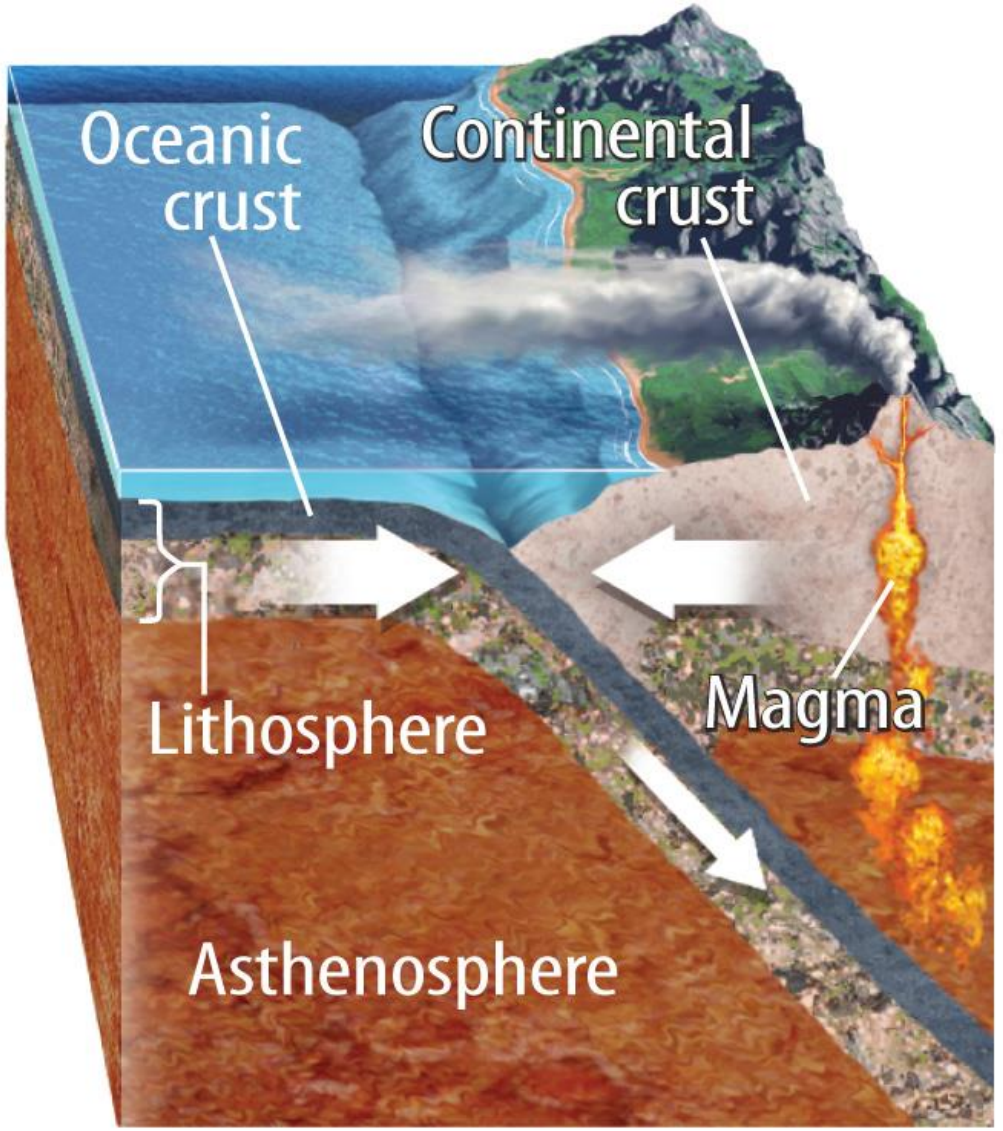
What is a volcano?

- A **volcano** is a vent in Earth's crust through which melted—or molten—rock flows.
- This molten rock is called **magma**.

How do volcanoes form?

- The movement of Earth's tectonic plates causes the formation of volcanoes and the eruptions that result.
- Volcanoes can form along convergent plate boundaries.

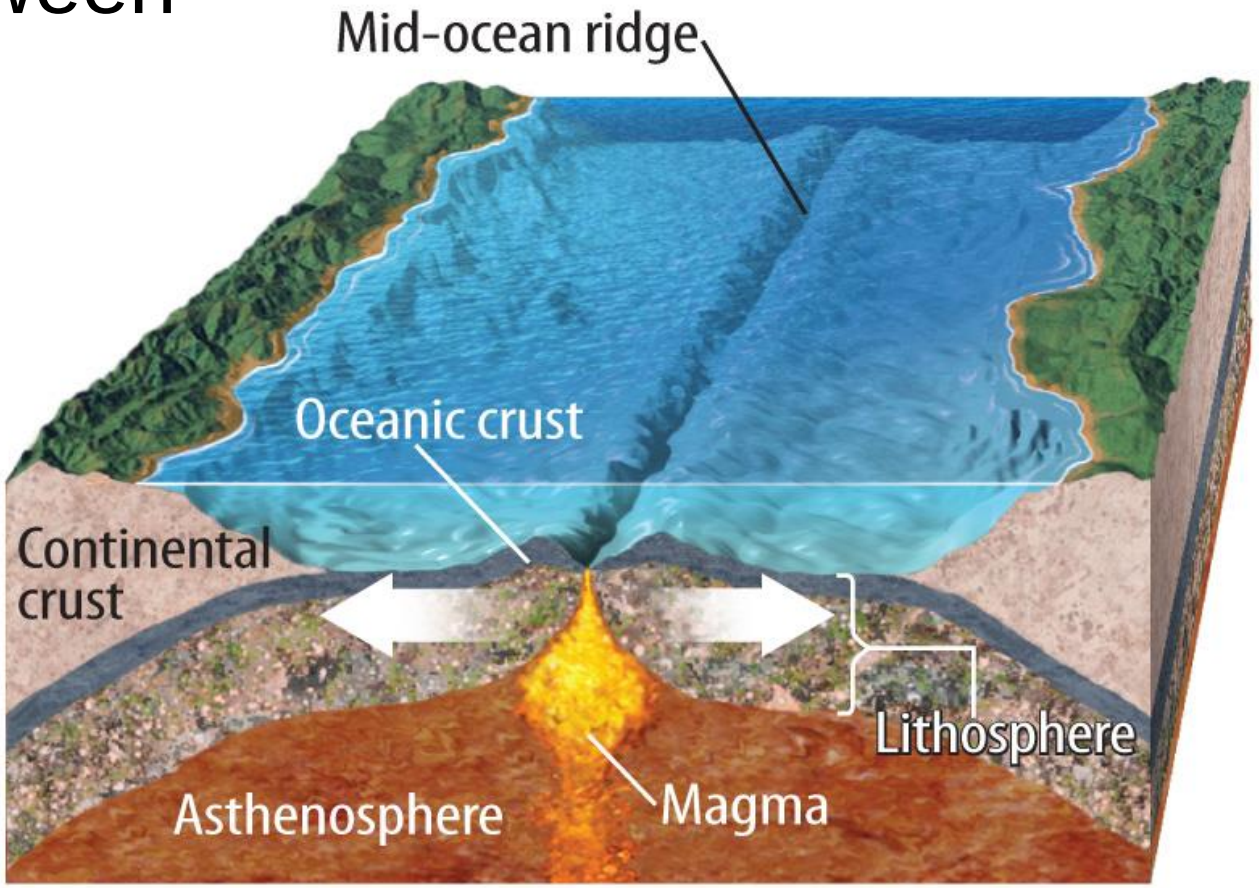
When two plates collide, the denser plate sinks, or subducts, into the mantle.



How do volcanoes form? (cont.)

- Magma that erupts onto Earth's surface is called **lava**.
- Lava erupts along divergent plate boundaries.

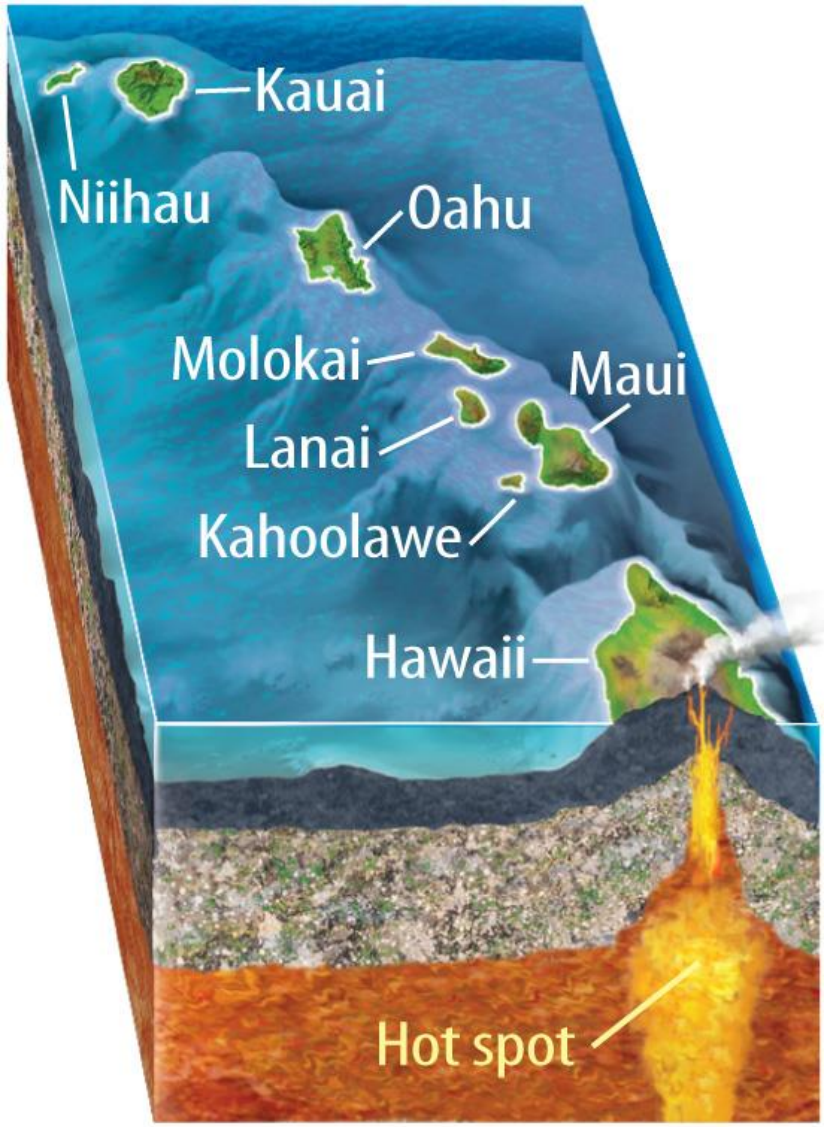
As plates separate, magma rises through the vent or opening in Earth's crust that forms between them.



How do volcanoes form? (cont.)

- Volcanoes that are not associated with plate boundaries are called **hotspots**.
- Geologists hypothesize that hotspots originate above a plume—a rising convection current deep within Earth's mantle.

Over time, a chain of volcanoes form as a tectonic plate moves. The oldest volcano will be farthest away from the hotspot. The youngest volcano will be directly above the hotspot.



How do volcanoes form? (cont.)

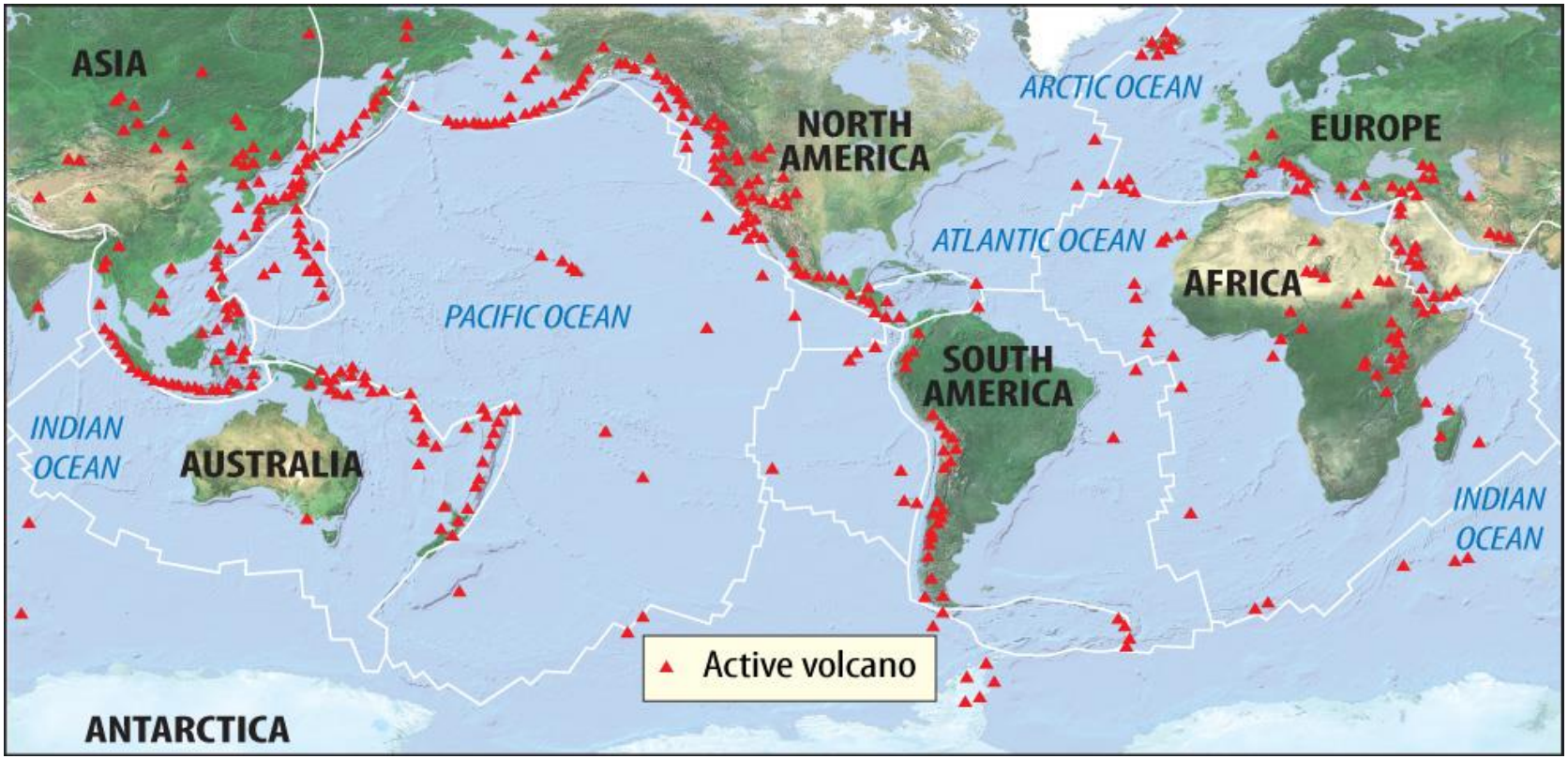
Key Concept Check

How do volcanoes form?

Where do volcanoes form?

- The Ring of Fire represents an area of earthquake and volcanic activity that surrounds the Pacific Ocean.
- By comparing the locations of active volcanoes and plate boundaries, you can see that volcanoes are mostly along convergent plate boundaries where plates collide.

The world's active volcanoes are along convergent and divergent plate boundaries and hotspots.

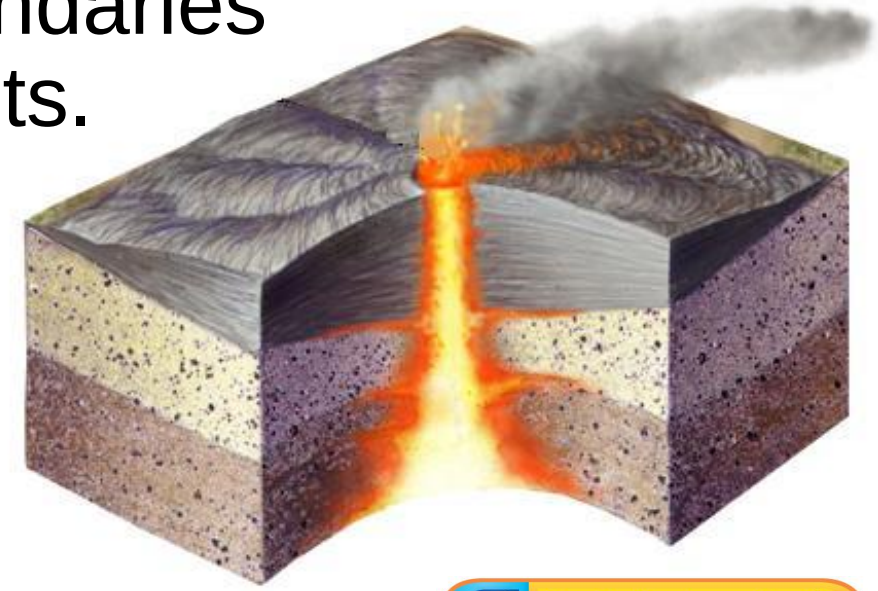


Where do volcanoes form? (cont.)

- 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, the USGS has developed a hazard assessment program.

Types of Volcanoes

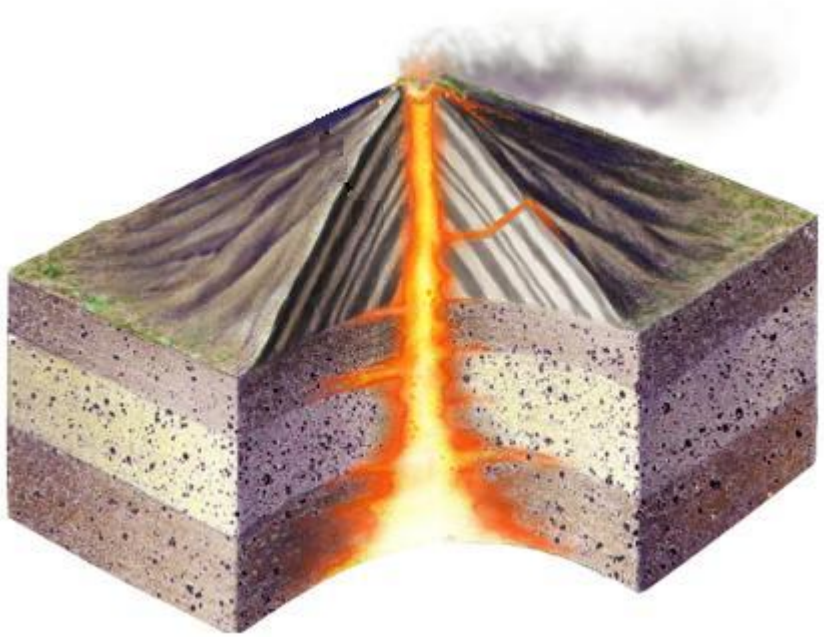
- Volcanoes are classified based on their shape and size.
- **Shield volcanoes** are common along divergent plate boundaries and oceanic hotspots.
- Shield volcanoes are large with gentle slopes of basaltic lavas.



Get Animated

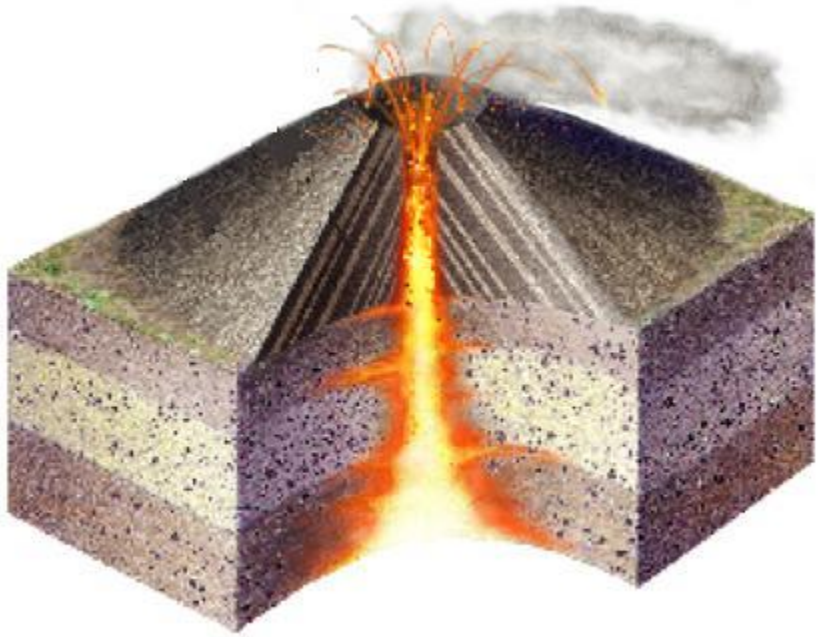
Types of Volcanoes (cont.)

Composite volcanoes are large, steep-sided volcanoes that result from explosive eruptions of andesitic and rhyolitic lava along convergent plate boundaries.



Types of Volcanoes (cont.)

Cinder cones are small, steep-sided volcanoes that erupt gas-rich, basaltic lavas.



Types of Volcanoes (cont.)

KEY CONCEPT CHECK

What determines the shape of a volcano?

Volcanic Eruptions

- When magma surfaces, it might erupt as a lava flow or erupt explosively, sending volcanic ash high into the atmosphere.
- **Volcanic ash** is tiny particles of pulverized volcanic rock and glass.
- Magma chemistry determines a volcano's eruptive style.

Volcanic Eruptions (cont.)

- Silica is the main chemical compound in all magmas.
- Differences in the amount of silica affect magma thickness and its **viscosity**—a liquid's ability to flow.

Volcanic Eruptions (cont.)

Key Concept Check

What factors affect eruption style?

Volcanic Eruptions (cont.)

- All magmas contain dissolved gases such as water vapor and small amounts of carbon dioxide and sulfur dioxide.
- When gases escape above ground, the lava, ash, or volcanic glass that cools and crystallizes has holes.

Volcanic Eruptions (cont.)

- The effects of lava flows, ash fall, pyroclastic flows, and mudflows can affect all life on Earth.
- Although lava flows tend to be slow moving, they threaten communities nearby.
- Volcanic ash can affect air quality and can cause serious breathing problems.

Volcanic Eruptions (cont.)

- The thermal energy a volcano produces during an eruption can melt snow and ice, creating meltwater that mixes with mud and ash on the mountain, forming mudflows.
- Explosive volcanoes can produce fast-moving avalanches of hot gas, ash, and rock called pyroclastic flows.

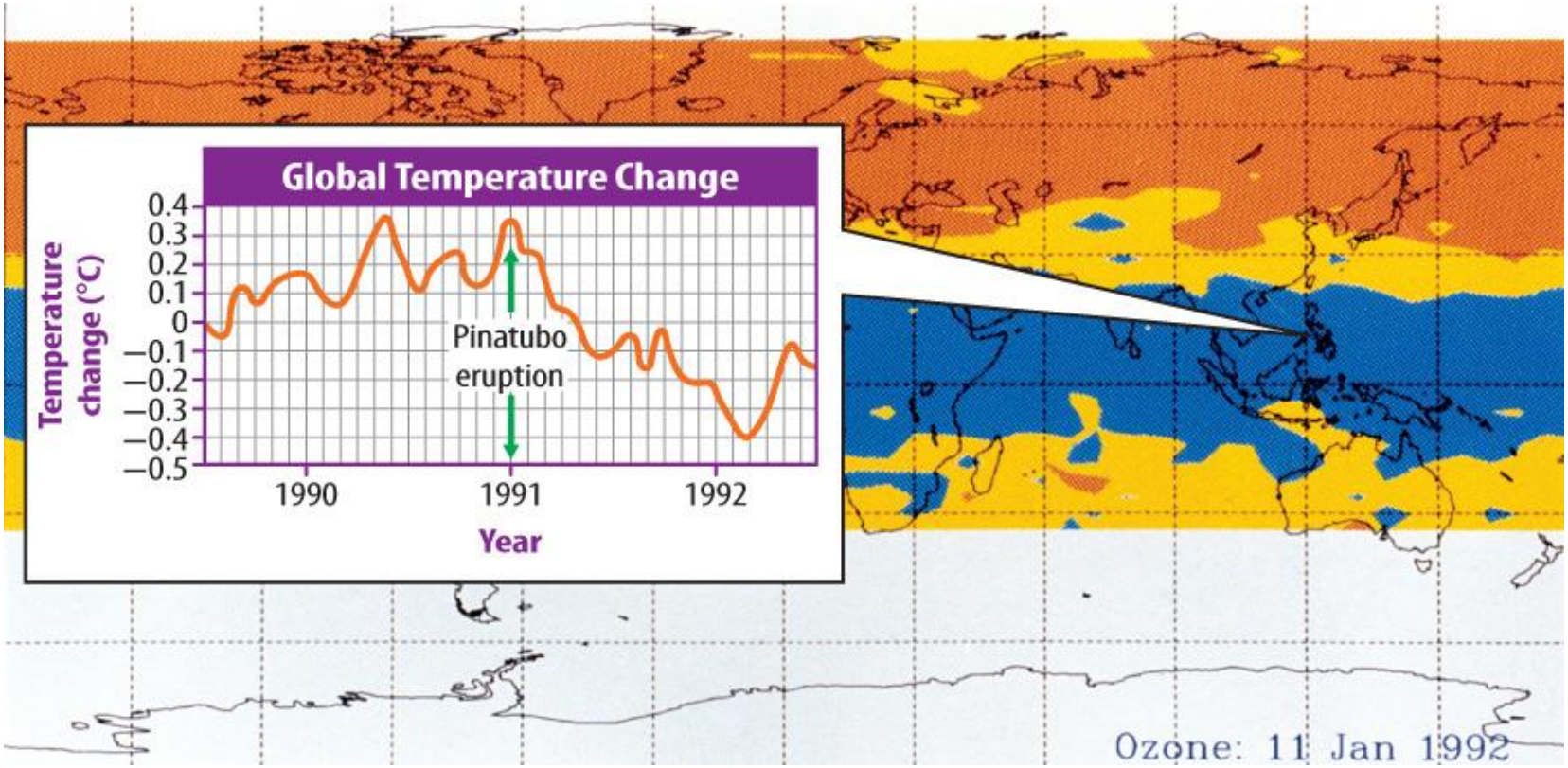
Volcanic Eruptions (cont.)

- Unlike earthquakes, volcanic eruptions can be predicted.
- Geologists study changes in the shapes of volcanoes, volcanic gas emissions, and 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.
- The average global temperature decreases as less sunlight reaches Earth's surface.

The 1991 Mount Pinatubo eruption caused temperatures to decrease by almost one degree Celsius in one year.



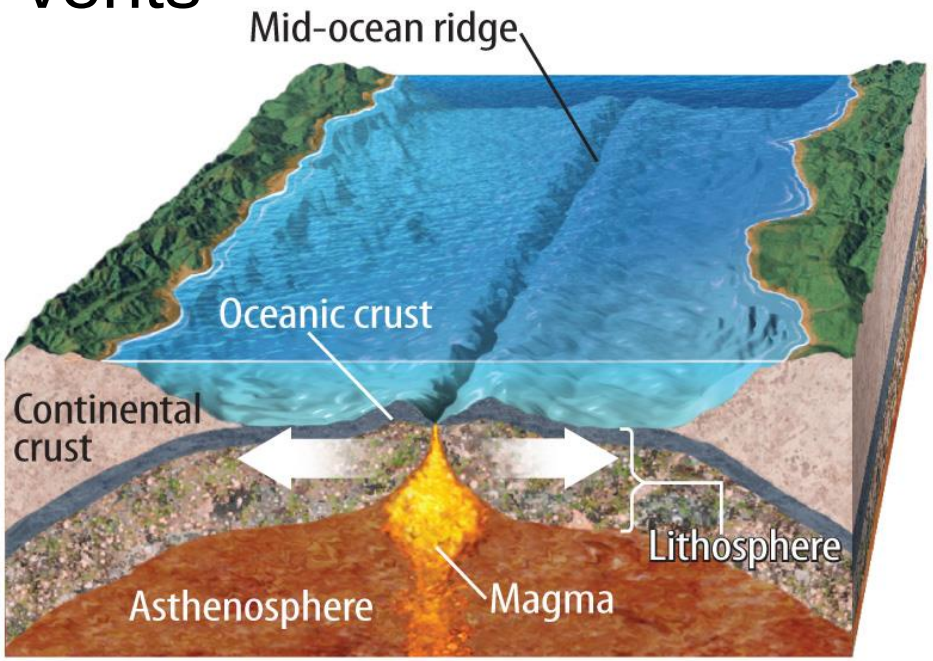
Volcanic Eruptions and Climate Change (cont.)

Key Concept Check

How do volcanoes affect climate?

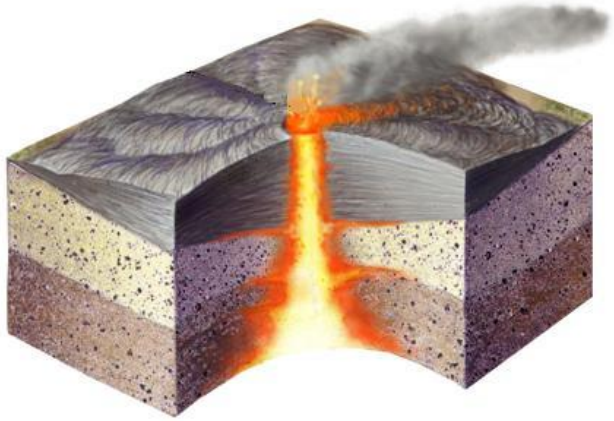
Summary

- Volcanoes form when magma rises through cracks in the crust and erupts from vents on Earth's surface.



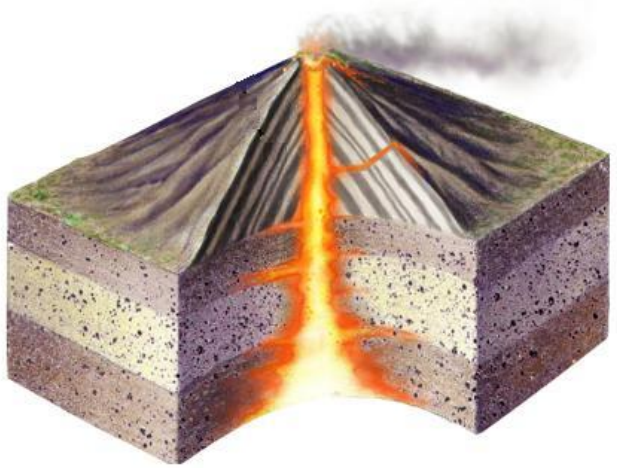
Summary

- Magma with low amounts of silica and low viscosity erupt to form shield volcanoes.



Summary

- Magma with high amounts of silica and high viscosity erupts explosively to form composite cones.



Lesson Review

What is the term to describe volcanoes not associated with plate boundaries?

A. cinder cones

B. shield volcanoes

C. hotspots

D. composite volcanoes

Lesson Review

Which of these refers to tiny particles of pulverized volcanic rock and glass?

A. magma

B. lava

C. silica

D. volcanic ash

Lesson Review

Which of these is a fast-moving avalanche of hot gas, ash, and rock?

A. pyroclastic flow

B. volcanic ash

C. lava flow

D. ash flow

Lesson Review

What do you think NOW?

Do you agree or disagree?

4. Volcanoes can erupt anywhere on Earth.
5. Volcanic eruptions are rare.
6. Volcanic eruptions only affect people and places located close to the volcano.

Menu

Key Concept Summary

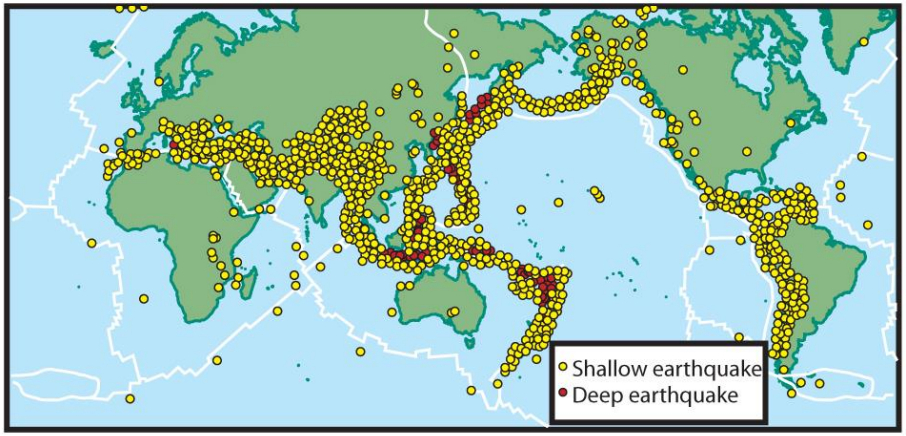
Interactive Concept Map

Chapter Review

Standardized Test Practice

Internal energy and movement of material within Earth causes both earthquakes along plate boundaries where plates slide past each other, collide, or separate and volcanoes at subduction zones, mid-ocean ridges, and hot spots

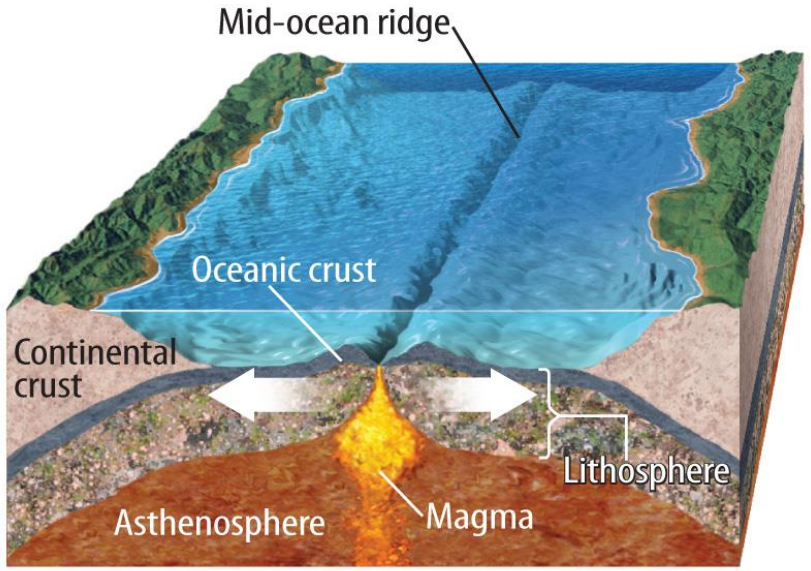
Lesson 1: Earthquakes



- Earthquakes commonly occur on or near tectonic plate boundaries.
- Earthquakes are used to study the composition and structure of Earth's interior and to identify the location of active faults.
- Earthquakes are monitored using seismometers and described using the Richter magnitude scale, the moment magnitude scale, and the Modified Mercalli scale.

Lesson 2: Volcanoes

- Molten magma is forced upward through cracks in the crust, erupting from volcanoes.
- The eruption style, size, and shape of a volcano depends on the composition of the magma, including the amount of dissolved gas.
- Volcanoes are classified as cinder cones, shield volcanoes, and composite cones.



Chapter Review

Which of these is a break in Earth's lithosphere where one block of rock moves toward, away from, or past another?

A. seismic wave

B. focus

C. epicenter

D. fault

Chapter Review

Where do seismic waves originate?

A. epicenter

B. hotspots

C. focus

D. ocean

Chapter Review

Earthquakes result from the buildup and release of stress along which of these?

A. P-waves

B. plate boundaries

C. seismic waves

D. epicenters

Chapter Review

What is the main chemical compound in all magmas?

A. ash

B. lava

C. silica

D. sulfur dioxide

Chapter Review

Which of these is magma that has erupted onto Earth's surface?

A. ash

B. lava

C. volcanic ash

D. silica

Standardized Test Practice

Which term refers to the vibrations in the ground that result from movement along breaks in Earth's lithosphere?

A. fault

B. earthquake

C. pyroclastic flow

D. epicenter

Standardized Test Practice

Which of these measures earthquake intensity based on descriptions of the earthquake's effects on people and structures?

A. seismometer

B. the Richter magnitude scale

C. the Modified Mercalli scale

D. the moment magnitude scale

Standardized Test Practice

Which term is used to describe a liquid's ability to flow?

A. eruptive style

B. ash fall

C. viscosity

D. pyroclastic flows

Standardized Test Practice

When meltwater from a volcanic eruption mixes with mud and ash, which of the following forms?

A. mudflows

B. ash fall

C. lava flows

D. pyroclastic flows

Standardized Test Practice

Which of these describes small, steep-sided volcanoes that erupt gas-rich, basaltic lavas?

A. cinder cones

B. composite volcanoes

C. shield volcanoes

D. pyroclastic flows