chapter 12 Earth's Internal Processes

section ● Evolution of Earth's Crust

What You'll Learn

- evidence for the continental drift hypothesis
- failings of the continental drift hypothesis

Before You Read

If you look at a map of the world, you will notice that the continents look like pieces of a puzzle. Why do you think they look that way?

____

____

Study Coach

Discussion After reading this section, use an index card to write down the two most important things you learned. Put one idea on each side of the card. Form a group of four students to discuss the things you learned.

Read to Learn

Continental Drift

At the start of the twentieth century, geologists only studied the land that was close to them. They developed theories about erosion and mountain-building processes. There was no theory to explain that the geologic processes on Earth were related.

What was Pangaea?

In 1915, Alfred Wegener (VEG nur) proposed a hypothesis that suggested Earth's continents once were part of a super-continent called Pangaea (pan GEE uh). He thought that Pangaea broke into pieces that drifted over Earth's surface to their current locations.

Wegener hypothesized that Pangaea probably started to break apart around 200 million years ago. Unfortunately, he was unable to find a force strong enough to move continents.

Puzzle pieces Compare the eastern coastline of South America and to the western coastline of Africa. Do they match? When South America and Africa are joined together, their southern tips fit very well into the Weddell Sea of Antarctica. The coastlines of these continents are like puzzle pieces that fit together.

How are continents like a torn newspaper?

Wegener needed to prove that the continents once actually were joined. He compared the continents to a torn newspaper. To repair a torn newspaper, you need to make sure the words connect as well as the edges. In other words, the lines of print had to match in terms of their content, not just their shapes.

Wegener argued that rock types, fossils, erosion features, and mountain ranges on different continents could be matched. He said that continents could have been joined if there were similar structures and formations on them.

How are fossils evidence of Pangaea?

Wegener thought that he could prove Pangaea existed by using fossils. If fossils of large land animals that could not swim or fly across oceans were found on different continents, it would suggest that the continents once had been joined.

The fossils of large land animals, such as *Lystrosaurus* and *Cynognathus*, supported Wegener's hypothesis. The fossils of *Glossopteris*, a large fern with large, heavy spores, also supported the idea.

How are mountains evidence of Pangaea?

When Pangaea broke apart, some mountain ranges were split. For decades, geologists had studied these mountain ranges as if they were separate ranges that had no connections. Wegener showed that they were once joined because they shared specific rocks and minerals.

Why didn't people believe Wegener?

Other scientists did not accept Wegener's hypothesis because he could not describe a force strong enough to move the continents apart. He thought that Earth's rotation, the gravitational pull of the Sun and the Moon, and centrifugal force could move continents. Physicists quickly proved that even when these forces were combined, they weren't strong enough to move continents.

Picture This

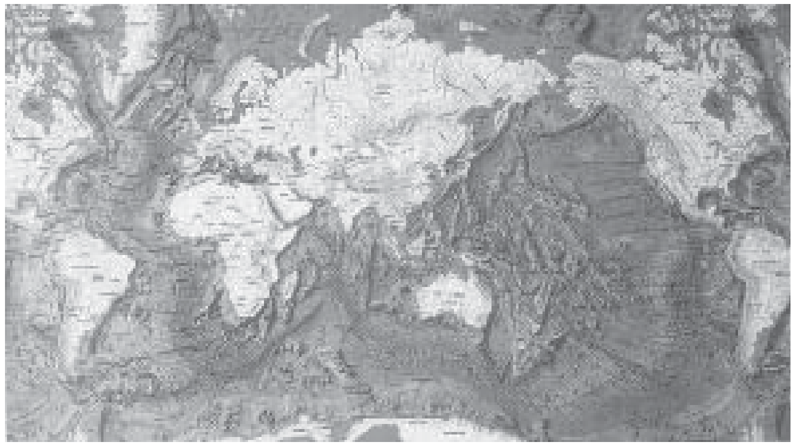
1. **Highlight** the coastlines of South America and Africa where they meet.

Think it Over

2. **Explain** What was the main reason Wegener's hypothesis was not accepted?

Seafloor Spreading Hypothesis

After World War II, Dr. Harry Hess studied Wegener's ideas. Hess used sonar to map the seafloor. Three-dimensional models of the seafloor were created from sonar data. Look at the figure below. The **mid-ocean ridge** system is a continuous underwater ridge on the seafloor that wraps around Earth.



Picture This

3. **Identify** Using a highlighter, trace the MOR.

What is seafloor spreading?

After studying the MOR, Hess proposed a hypothesis of seafloor spreading. He said that liquid rock, or magma, from Earth's mantle is forced upward through the MOR because magma has lower density than the surrounding rock. This causes the crust to crack (fault) and move apart. Twin mountain ranges are formed with a valley in between. A **rift valley** is a down-dropped valley between twin mountain ranges caused by faulting. ☑

Reading Check

4. **Explain** What allows magma to travel upward through the MOR?

____

____

What are the ages of seafloor sediments and rocks?

In the 1960s, scientists drilled into the ocean floor and took out samples, or cores, of the rock layers. Sediments near the continents are thick, but thin near the MOR. Continental rocks are billions of years old, but seafloor rocks are less than 200 million years old. Rocks of the oceanic crust increase in age as their location extends from the MOR.

What is magnetic polarity of rocks?

Recall that Earth's magnetic field can reverse, causing the magnetic poles to reverse. The seafloor also has bands of reversed magnetic polarity. Geologists discovered bands of reversed polarity in the seafloor rocks similar to those on the continents. The bands are parallel and equally distant from the MOR. As crystals form in magma pushing out at the MOR, they take on the polarity of Earth when they form.

Theory of Plate Tectonics

The theory of plate tectonics originated in the 1960s. It describes how many moving, crustal plates cover Earth's surface. Seafloor spreading showed that Earth's crust moves sideways. Scientists wanted to understand the motion of all Earth's plates.

Plates are made of a rigid layer of uppermost mantle and a layer of either oceanic or continental crust above. Some plates are made only of oceanic crust. Others are made of part oceanic and part continental crust. There are about 12 major plates and many minor ones.

There are three main kinds of plate motions. At their boundaries, plates can move apart, together, or slide past each other.

What are divergent plate boundaries?

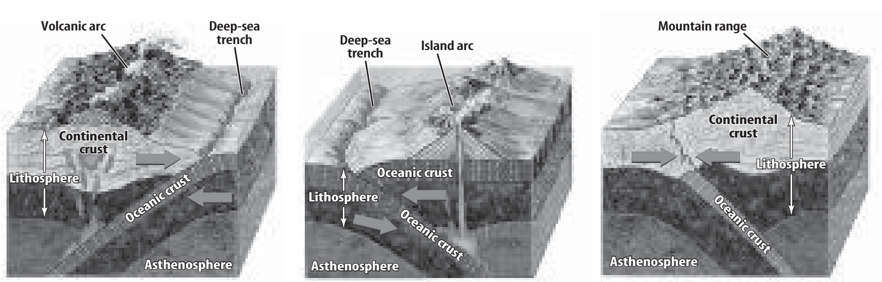
Divergent boundaries are places where plates are pulling apart. You learned that magma is pushed up through faults in a rift valley at a mid-ocean ridge (MOR). The magma spreads, cools and hardens to form new oceanic crust at this divergent boundary.

What are convergent plate boundaries?

Convergent boundaries are areas where plates collide. Several things can happen at these boundaries depending on the types of plates that collide.

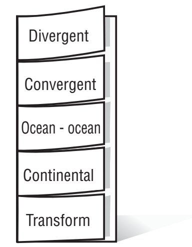
Continental lithosphere is less dense and thicker than oceanic lithosphere. When a continental plate meets an oceanic plate, the oceanic plate bends and is forced under the continental plate. **Subduction** is the process of one plate being forced under another plate.

When heat along a subduction zone partially melts rock, magma forms and rises to the surface. It travels into a volcanic arc that runs along side the subduction zone. A deep sea trench also runs parallel to a subduction zone. The Andes mountain range in South America is a subduction zone.



FOLDABLES

Organize Information Make the following Foldable to help you organize information about the type of plates boundaries.



Picture This

5. **Identify** At plate boundaries, what kind of motion can occur?

____

____

____

Ocean-Ocean Convergent Boundaries Convergent plate boundaries also exist between two slabs of oceanic lithosphere. The colder, denser plate subducts. Magma that erupts there creates chains of volcanic islands called island arcs. Japan is an example of an ocean-ocean convergent boundary.

Continental Convergent Boundaries Along some convergent plate boundaries, two continental slabs of low density collide but do not subduct. Since both are low in density, they both buckle upward to form a high range of folded mountains. The Himalaya of Asia are an example.

What are transform plate boundaries?

At **transform boundaries** two plates slide by each other. No new lithosphere is created. No old lithosphere is being destroyed, or recycled. The main result of transform boundaries is horizontal plate movement.

Reading Check

6. **Explain** What are transform boundaries?

____

____

What drives the plates?

Research shows that plates are driven by a combination of forces. One force is ridge push at the MOR. Because divergent boundaries are higher at the center of the ridge, gravity forces material down the slopes of the MOR.

What is a slab pull?

Slab pull is a process that occurs when a plate subducts back into Earth at some convergent boundaries. You probably have experienced an analogy to slab pull. When you wake up and your bed covers are on the floor, something like slab pull has occurred. Here's what happens. While you tossed and turned at night, your covers began to move off the bed. Eventually, enough of the covers were over the side that gravity pulled the rest of them to the floor. Subducting plates act in much the same way. Portions of descending plates pull the rest of the plate down with them.

How does friction act as a force?

Friction is another force between a plate and the mantle material below the plate. Plates that drag continental material along with them move slower than plates that are purely oceanic. Scientists think that continental plates have deep roots that cause more frictional force.

Internal convection of mantle material is the driving force for all plate motion. The main source for the heat in Earth's mantle is the decay of radioactive elements.

Think it Over

7. **Determine** What causes the movement of all plates?

____

____

After You Read

Mini Glossary

convergent boundary: where tectonic plates collide

divergent boundary: where tectonic plates are pulling apart

mid-ocean ridge: an underwater mountain ridge on the seafloor of the Atlantic Ocean that wraps around Earth

rift valley: a down-dropped valley between twin mountain ranges caused by faulting.

subduction: when one tectonic plate is forced under another tectonic plate

transform boundary: where two tectonic plates slide by each other

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that explains how subduction occurs.

____

____

2. Complete the chart below. List three arguments Wegener used to prove that the continents were once joined:

Pangaea
1.
2.
3.

3. Review the ideas your group wrote on the index cards. Write one idea that you all agreed was important. How did this idea help you to understand the evolution of Earth's crust?

____

____

____

Science Online Visit **gpescience.com** to access your textbook, interactive games, and projects to help you learn more about the evolution of Earth's crust.

End of Section

chapter 12 Earth's Internal Processes

section ● Earthquakes

What You'll Learn

- causes of earthquakes
- characteristics of earthquakes
- how seismic waves affect Earth's surface
- seismic waves and Earth's internal structure

Before You Read

Have you ever felt the ground shake? What do you think caused it to shake? How did you feel when it shook?

____

____

Mark the Text

Organize Information
As you read this section, use a highlighter to mark the most important ideas in each paragraph.

Read to Learn

Global Earthquake Distribution

For decades, scientists have known that earthquakes are not distributed randomly. Earthquakes occur in particular places. These zones are along the boundaries of Earth's lithospheric plates. Earthquakes occur near the edges of the plates. Seismic data gathered from an earthquake gives scientists information about the structure of the ocean floor and the structure and motion of Earth's plates.

Depth of Focus Scientists who plot data about depths of earthquakes on a world map have seen patterns develop. Transform faulting of divergent boundaries lets plates move in opposite directions. This creates a narrow band of shallow earthquakes. In an opposite way, convergent boundaries have wide earthquake zones. The shallowest focal points in these zones are near the surface at the point the boundaries converge. The deepest focal points lie under volcanoes or mountains that are created in the area where boundaries collide.

Causes of Earthquakes

An earthquake is any seismic vibration of Earth caused by a rapid release of energy. Earthquakes can be either natural or caused by humans.

What is deformation?

Earth's crust is made of rigid, rocky material and can be considered brittle. When a stress is put on a brittle material, it shows little sign of strain or deformation. However, it might suddenly break. A strain is the manner or deformation in response to a stress. Stress is the force per unit area that acts on a material.

What are the four types of stress?

There are four types of stress:

1. Compressive stress occurs when a material is squeezed or shortened.
2. Tension stress occurs when a material is stretched or lengthened.
3. Shear stress occurs when different parts of a material are moved in opposite directions along a plane.
4. Torsion stress occurs when a material is twisted.

What are the kinds of deformation?

Elastic deformation occurs when a material deforms from stress and then snaps back when the stress is removed. A rubber ball that changes shape as it hits the ground and then returns to its original shape is an example of elastic deformation.

Plastic deformation occurs when a material deforms from stress and stays in a new shape when stress is released. For example, modeling clay behaves plastically. Rocks at great depth, where temperatures are high enough, also show plastic behavior.

Rocks in different temperatures can be compared to wax candles. If you put stress on a candle when it is cold, it will break. But a candle will bend easily under stress when the wax is warm.

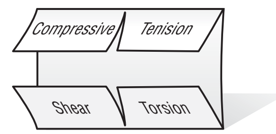
How is energy released?

Stress creates strain energy along cracks in Earth's crust. When this strain energy is released suddenly, it causes the rock to lurch, or move suddenly, to new position. A **fault** is a crack along which movement has taken place. If no movement takes place, the crack is called a fracture. You can see a diagram of a long fault in the figure on the next page.

Earthquakes occurs when the rocks lurch and break because they are brittle. The sudden energy release that goes with the fault movement is **elastic rebound**. Elastic rebound causes seismic vibrations, or earthquakes. ☑

FOLDABLES™

Understand Cause and Effect Make the following Foldable to help you understand the causes and effects of the four types of stress.



Reading Check

1. **Describe** elastic rebound.

Earthquake Waves

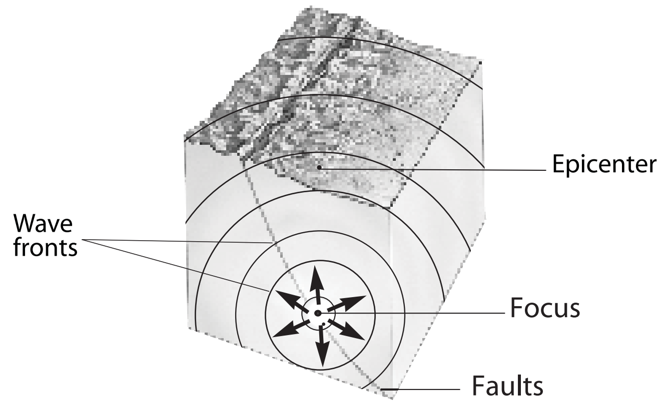
Earthquake waves travel out in all directions from a point where strain energy is released. This point is the **focus**, or point of origin, of an earthquake. The focus is usually deep inside Earth. The **epicenter** is the point on Earth's surface directly above the focus. This is demonstrated in the figure below.

Picture This

2. **Describe** what happens to the waves in the figure as they travel farther from the focus?

____

____



When you throw a rock into still water, you see rings of waves. The center of these rings, where the rock hit, is similar to the focus of an earthquake. The difference is that the rings of waves in an earthquake move in spheres, not circles.

There are two main types of earthquake waves. Body waves are waves that travel through Earth. Surface waves are waves that travel across Earth's surface.

What are two types of body waves?

Primary waves travel through all kinds of matter. Secondary waves only can travel move though solids.

Think it Over

3. **Infer** three types of matter through which P-waves can travel.

____

____

____

Primary Waves Primary waves or P-waves cause particles in a material to undergo a push-pull motion. Because this motion is in the direction of wave travel, the wave energy is transferred very quickly. The particles move, but they do not permanently change position. Primary waves can travel through all kinds of matter.

Secondary Waves Secondary waves, or S-waves, also are called shear waves because they make particles move at right angles to the direction of wave travel. S-waves travel only through solid matter.

Wave Speed S-waves travel more slowly than P-waves. As the body waves move away from the focus of an earthquake, S-waves fall farther and farther behind the P-waves. The time between the P-wave and the S-wave can be measured. Scientists use this time difference to find the epicenters of earthquakes.

What is a surface wave?

Surface waves roll, much like ocean waves. When surface waves travel through material on Earth's surface, they move in an up and down rolling motion and also a side-to-side motion. The side-to-side rocking is the motion that destroys the foundations of buildings.

Earthquake Measurement

The Modified Mercalli Intensity scale ranks earthquakes in a range from I-XII. XII describes the worst, most serious earthquakes. The Modified Mercalli scale describes earthquakes by intensity and uses eyewitness obervations to assign intensity value.

The Richter magnitude scale is often called the Richter scale. It uses the amplitude of the largest earthquake wave as a comparison. The Richter scale describes how much energy was released during an earthquake. A seismograph is an instrument used to measure earthquake waves and determind a Richter value. A seismogram is the tracing of the seismograph's pen. ☑

What determines earthquake damage?

Research has shown that poorly built buildings increase earthquake damage and loss of life. Poorly constructed buildings can cause tens of thousands of people to die in an earthquake. Buildings can be made earthquake resistant, but they cannot be made earthquake proof.

Earthquake damage can also cause other disasters, such as landslides, fires, and tsunamis. Scientists know where earthquakes are likely to occur. These places are called active earthquake zones. But no one can yet predict when exactly an earthquake will hit.

Think it Over

4. **Discuss** why side-to-side rocking can destory a building foundation.

____

____

____

Reading Check

5. **Identify** three types of natural disasters caused by earthquakes

____

____

____

After You Read

Mini Glossary

elastic rebound: the sudden energy release that goes with the fault movement

fault: a crack along which movement takes place

focus: the point of origin of an earthquake

epicenter: the point on Earth's surface directly above the focus

1. Review the vocabulary words and their definitions in the Mini Glossary. Write a sentence that uses the terms *fault* and *elastic rebound* to describe an earthquake.

2. Complete the chart by filling in the corresponding scale:

	Measures Intensity	Measures Energy Released
Name of scale		

3. Look at the parts of the text that you highlighted. How did this help you to learn about earthquakes?

Science Online Visit **gpescience.com** to access your textbook, interactive games, and projects to help you learn more about earthquakes.

End of Section

chapter 12

Earth's Internal Processes

section ● Earth's Interior

Before You Read

Knock on a piece of wood, a brick wall, and a window. Listen to the sounds they make. Why do you think these materials sound different?

____

____

____

What You'll Learn

- how geologists study Earth's inner structure
- about the internal structure and composition of Earth

Read to Learn

What's inside?

How do scientists learn about Earth's interior? In 1961 scientists drilled a hole 200 m into the oceanic crust. They hoped to reach the Mohorovicic (moh huh ROH vee chihch) discontinuity. Unfortunately, the project was canceled after Phase I. Earth's center is 6,371 km below the surface.

Seismologists are geologists who study seismic waves to learn about Earth. Studying the behavior of earthquake waves to gather data about Earth's interior is similar to using sound waves to see inside the human body. Observing seismic waves allows scientist to infer images of Earth's interior.

Is Earth's interior the same throughout?

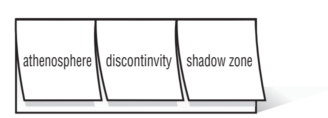
Suppose Earth had the same structure and composition throughout its interior. If you knew how fast earthquake waves traveled through it, you would know exactly when the earthquake waves would reach the opposite side. But scientists have observed that earthquake waves arrive at different times than expected. This tells scientists that Earth's interior is not uniform.

Study Coach

Sticky Notes Discussion
Write questions about the section on the sticky notes. At the end of the section, meet with two or three students to exchange questions and come up with answers as a group.

FOLDABLES™

● **Build Vocabulary** As you read this section, make a three-tab vocabulary Foldable to show that you understand the vocabulary terms.



Earthquake Observations

Seismic wave recording stations across Earth record seismic wave data. From this data, scientists make discoveries. Data has shown that refracted waves bend when they encounter sharp changes in density. A **discontinuity** is a boundary that marks a density change between layers. The Mohorovicic discontinuity separates the crust from uppermost mantle.

Shadow Zones Observations show that P- and S-waves spread out in a pattern from a given epicenter. They travel through Earth for 105 degrees of arc in all directions. The **shadow zone** is a "dead zone" between 105 and 140 degrees from the epicenter where nothing is recorded. From 140 degrees to 180 degrees (directly opposite the epicenter) only P-waves are recorded.

Think it Over

1. **Explain** Why do scientists think the outer core is a liquid?

____

____

____

Earth's Core Shadow zones reveal interesting facts about Earth's interior. Scientists think that there is a layer in Earth that is absorbing waves. The S-waves may turn into P-like waves in the outer core. Recall that S-waves only travel through solids. This suggests that the outer core is a liquid.

Does Earth have a solid inner core?

When P-waves pass through the core, they are refracted, or bent. This proves that the inner core is denser than the outer core and soil. The pressure from the material outside the inner core keeps the inner core solid. The high temperatures cause the outer core to remain liquid even under great pressure.

Composition of Earth's Layers

Earth's internal layers become denser with depth. The crust and uppermost mantle together form the lithosphere. They are made of rocky materials – mostly silicates. The **asthenosphere** is a weaker, plastic-like layer under the lithosphere. Earth's lithospheric plates move on the asthenosphere. ☑

Reading Check

2. **Compare and Contrast** the lithosphere and the asthenosphere.

____

____

Under the asthenosphere is more mantle. Like the upper mantle in the lithosphere, this layer is made of silicates. However, the minerals present have different structures because they are under higher pressure. Earth's cores are made mostly of metallic materials, such as nickel and iron.

Astronomers hypothesize that Earth may have formed from meteorite-like material. This material was forced together by gravity and melted. The densest materials settled toward the core and lower-density ones floated the Earth's surface.

After You Read

Mini Glossary

asthenosphere: the layer of Earth under the lithosphere

discontinuity: the boundary that marks a density charge between layers

shadow zone: a "dead zone" between 105 and 140 degrees from epicenter where no seismic waves are recorded

1. Review the definitions of the vocabulary words in the Mini Glossary. Choose one of the words and write what it means in your own words.

____

____

____

2. Draw a cross section of Earth with the layers you learned about in this section. Place the layers in the correct order. Shade the layer that contains the crust and uppermost mantle. Draw stripes on the layer on which plates move.

3. Think about the question you wrote on. Write one question and the anser you and your group decided on. How did these notes help you learn?

____

____

____

Science Online Visit **gpescience.com** to access your textbook, interactive games, and projects to help you learn more about Earth's interior.

End of Section

Earth's Internal Processes

chapter 12

section ● Volcanoes

What You'll Learn

- types and causes of different types of volcanoe eruptions
- the link between volcanoes and plate tectonics

Before You Read

Have you ever pumped air into a bicycle tire? What would happen if the tire had many small cracks? What would happen if the tire had no cracks and you kept pumping in air after it was full?

____

____

Study Coach

Make Flash Cards Make a flash card for each important idea or term in this section. Use these cards to help you review after reading this section.

Read to Learn

Origin of Magma

Faults are weaknesses in Earth's crust along which movement takes place. This movement causes a decrease in pressure, called decompression. When pressure decreases, the melting point of rock also descreases, even though the temperature does not change.

Magma comes from Earth's asthenosphere. This nearly molten rock can change to liquid by decompression melting. As magma rises to Earth's surface, it becomes even more fluid as it decompresses, especially if it contains a lot of gas.

Why does magma rise?

Any molten rock material has a lower density than solid rock. A buoyant force caused by the difference in density between molten rock and solid rock causes magma to rise. The rising magma may reach Earth's surface if pressure conditions allow and there are paths for it to flow through.

Imagine hot magma rising through the crust creating brittle deformation near the surface in the form of fractures and faults. The cracks cause a drop in pressure and more paths are available for magma to flow through. Deformation continues until the magma reaches Earth's surface as a volcanic eruption. When magma erupts at the surface, it is called lava.

FOLDABLES™

● **Find Main Ideas** As you read this section, use a half sheet of paper to make the following Foldable to show that you understand the volcanoes.

Where does lava flow?

Most surface lava flows or eruptions occur on or near boundaries between Earth's plates, above hot spots, or mantle plumes, on continents, or in the ocean basins.

Eruptive Products

Volcanoes throw out, or expel, a variety of different materials. These materials occur in different states of matter. Volcanoes erupt lava, gases, and chunks of solid material, as shown in the figure of Mt. St. Helen's below. ☑

What solids erupt from volcanoes?

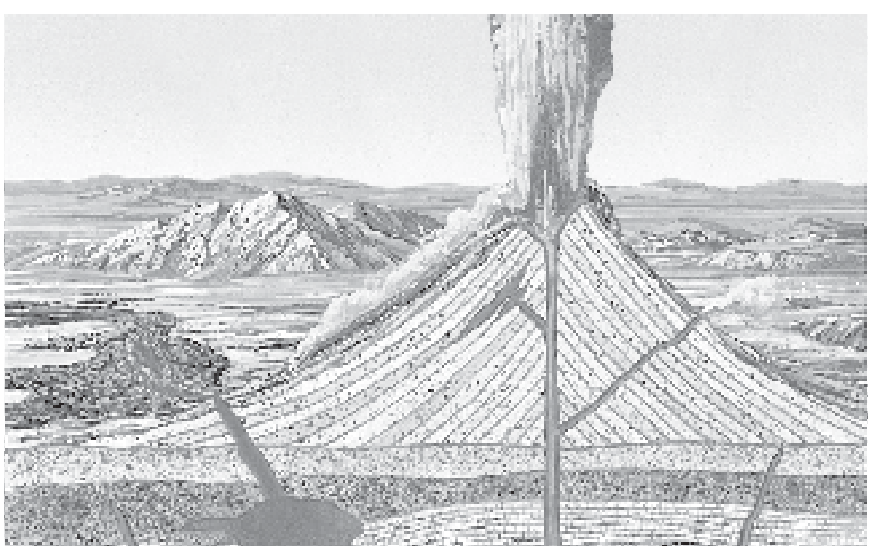
All solid materials expelled by a volcano are called pyroclasts. Often lava is thrown into the air as globules, or small globs. These globules cool and turn into solids as they fall toward Earth.

The smallest particles cool quickly and turn into volcanic ash. Ash can be picked up by wind and blown hundreds or even thousands of kilometers away. The larger, heavier globules cool, harden and fall closer to the volcano.

Often chunks of solid material are ripped away from the conduit of the volcano. These solid chunks of rock are called blocks. Blocks fall close to the volcano.

What gases erupt from volcanoes?

Volcanoes release many superheated gases. The most common one is water vapor. In addition, carbon dioxide and gases that contain sulfur compounds are released into the atmosphere. There is strong evidence that volcanoes contribute greenhouse gases that have an affect on the climate long after an eruption is over.



Reading Check

1. **Explain** What three kinds of materials do volcanoes expel?

____

____

____

Picture This

2. **Label** the places where the following materials would be found after a volcano erupts like the one show here.

   a. Ash
   b. Gases
   c. Globules
   d. Blocks

What liquids erupt from volcanoes?

Recall that when magma flows to Earth's surface, it is known as lava. Because the composition of lava can vary, lava's physical properties can vary.

Reading Check

3. **Explain** What is viscosity?

____

____

____

Viscosity is a measure of the resistance of a fluid to flow. The temperature of molten rock influences its viscosity. For example, have you ever tried to pour cold pancake syrup? It has high viscosity when it first comes out of the refrigerator. But if you let the syrup warm, it flows more easily because its viscosity decreases. Other factors that affect viscosity and flow are gas content and composition.

What are basaltic lavas?

Low-viscosity lavas are mostly basaltic. Basaltic lavas are low in silica (SiO_2) content. They are high in some chemical elements such as calcium, magnesium, and iron.

Basaltic lavas flow from fissure cracks, such as along the mid-ocean ridge (MOR) and from hot spot volcanoes. They tend to flow easily and form huge volcanic forms that cover large areas on Earth's surface. Shield volcanoes and flood basalts are basaltic lava flows.

How does gas affect lava?

If lavas have large amounts of gas dissolved in them, then the viscosity is lowered. High gas quantities help magma force its way through rock. Sometimes it spews out explosively as a lava fountain that behaves much like a geyser.

Eruptive Styles

Volcanoes can erupt in many different ways. The viscosity of magma affects the kind of eruption that occurs. Thick, high-viscosity magmas do not erupt. Instead, they cause the pressure inside a volcano. When Earth's crust fails from the high pressure to rise, a violent, explosive eruption occurs. This type of eruption contains large quantities of solid material, or pyroclasts. In contrast, runny, low-silica, high-temperature basaltic lavas erupt easily. These eruptions are quiet and have freely flowing lava. Other factors that affect eruptions are temperature, composition, and the type of plate boundary.

Think it Over

4. **Apply** List two fluids with different viscosity. Which one pours more easily?

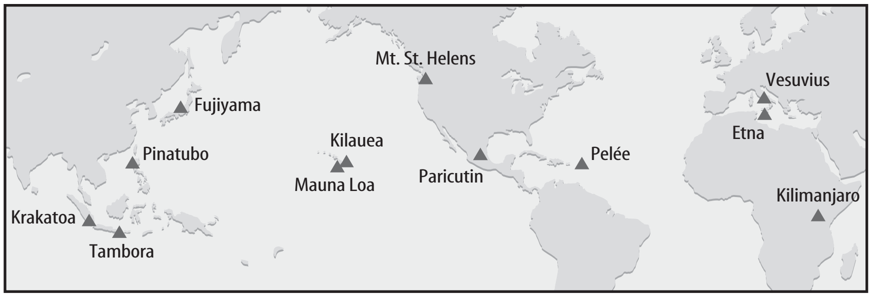
____

____

____

What comes from convergent boundaries?

Most of Earth's volcanoes are located along the Ring of Fire that runs along the edges of the Pacific Ocean. In the Ring of Fire, volcanoes lie in subduction zones. There, an oceanic and a continent material are being mixed and partially melted.



The motion of the plates and melting create a wide variety of magma types. Large earthquakes and violent volcanic eruptions often occur in ocean-continent and ocean-ocean boundaries.

What comes from divergent boundaries?

Divergent plate boundaries are where plates pull apart. They are also volcanically active. However, most of the activity is underwater along the MOR. It goes unnoticed by most people. Where divergences take place on land, volcanic activity can be seen. Iceland and the East African Rift Valley are land areas that are part of divergent boundaries. Lava that erupts in these places is mostly low-viscosity and basaltic in make-up. ☑

What kind of volcano comes from hot spots?

Hot spots are volcanically active sites caused by large quantities of magma that move to the surface in large, column-like plumes. Scientists think that plumes are caused by heat in Earth's mantle. When a hot spot occurs under an oceanic plate, volcanic island chains form. Other hot spots occur under continental plates. Hawaiian volcanoes and the Yellowstone region in North America are examples of hot spots.

What lava comes from a hot spot volcano?

The lava that erupts from hot spot volcanoes contains alkali metals, such as potassium and sodium. Like divergent boundary or MOR lavas, hot spot lavas tend to have fluid, basaltic lavas. The composition of lava can change. It depends on the make-up of the rock material it forces through, such as the rock in continental crust.

Picture This

5. **Highlight** the regions of the world where most of the active volcanoes exist.

Reading Check

6. **Identify** Where does most of the volcanic activity at divergent plates take place on Earth?

____

____

Types of Volcanoes

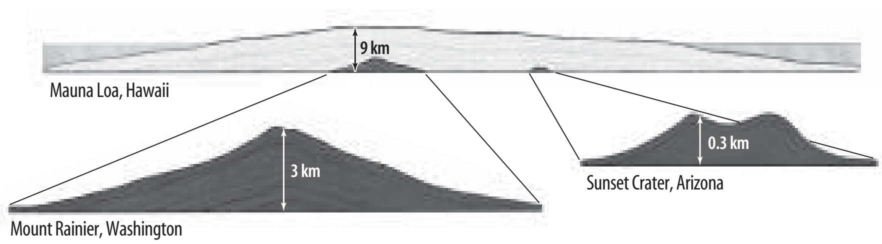
Volcanoes are classified by their size, shape, and the materials that compose them. Recall that the magma source helps to determine the kind of materials that erupt from a volcano. The physical properties of magma include temperature, make-up, and gas content of magma.

What is a cinder cone volcano?

A **Cinder cone volcano** forms when large pieces of solid material erupt from a volcano. When gas-rich magma erupts, large chunks of solid materials are spewed into the air. Materials pile up near the vent. These volcanoes are small, usually hundreds of meters tall. The figure below shows the size of cinder cones are compared to other volcanoes.

Picture This

7. Identify In the figure, circle the cinder cone volcano.



What are shield volcanoes?

Shield volcanoes, which form from high-temperature, fluid, basaltic lava, are broad and flat with many layers of lava. Think of pancake batter. If the batter is cold and thick, it piles up and you get thick pancakes. If you add more milk and make a runny batter, it flows easily across the pan and makes thin pancakes. Shield volcanoes are found in Hawaii.

Reading Check

8. Determine What shape are shield volcanoes?

____

____

What are composite volcanoes?

Composite volcanoes are large and composed of alternating layers of lava flows and chunks of solids. They are often thousands of meters high and tens of kilometers wide.

They occur on convergent plate boundaries and have magmas with high silica content. When subduction happens in convergent boundaries, water and sediment are forced downward. They are pushed into places with higher temperatures. When the materials begin to melt, the silica-rich part of the rock and sediment melts first. It produces viscous magma. This thick magma causes explosive eruptions followed by lava flows.

After You Read

Mini Glossary

cinder cone volcano: forms when the majority of materials erupting from a volcano are large pieces of solid material

composite volcano: tall and wide, composed of alternating layers of lava and pieces of solid material

shield volcano: broad and flat, formed by high-temperature, fluid, basaltic lava

viscosity: is a measure of the resistance of a fluid to flow

1. Review the definitions of the vocabulary words in the Mini Glossary. Describe why viscosity changes.

2. Complete the chart below to organize information you have learned about volcanoes.

Volcanoes			
Type	Shield Volcano	Composite Volcano	Cider Cone Volcano
Type of Magma			
Type of Eruption			
Boundary where volcano forms			

3. Think about what you have learned in this section. Pick a partner. Quiz each other with the flash cards you made. How did these cards help you learn?

Science Online Visit **gpescience.com** to access your textbook, interactive games, and projects to help you learn more about volcanoes.

End of Section