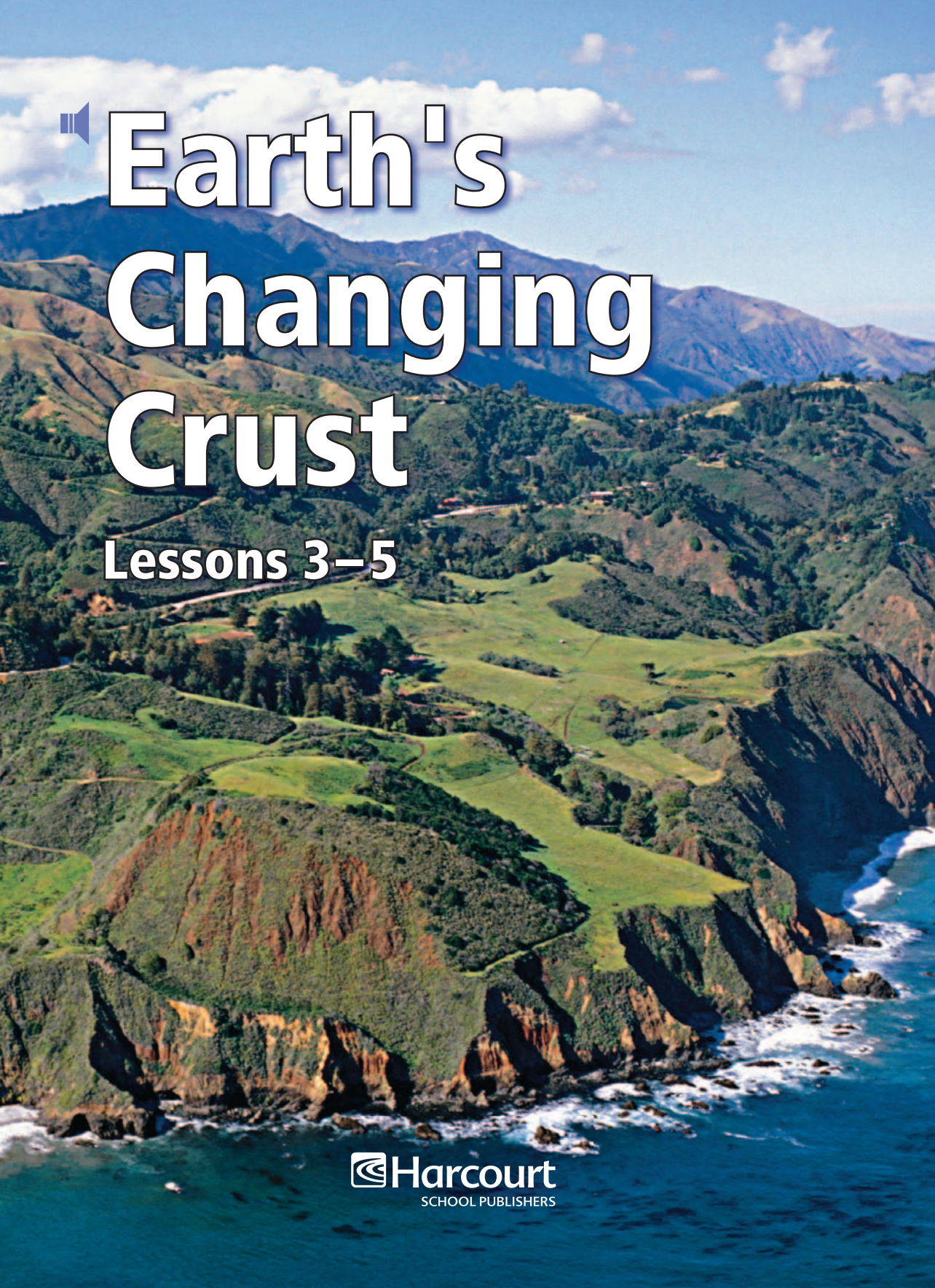

Earth's Changing Crust
Lessons 3–5
Harcourt
SCHOOL PUBLISHERS

Printed in the United States of America

ISBN-13: 978-0-15-349203-7
ISBN-10: 0-15-349203-1

1 2 3 4 5 6 7 8 9 10 179 15 14 13 12 11 10 09 08 07 06

Earth's Changing Crust

Lessons 3–5

Harcourt
SCHOOL PUBLISHERS

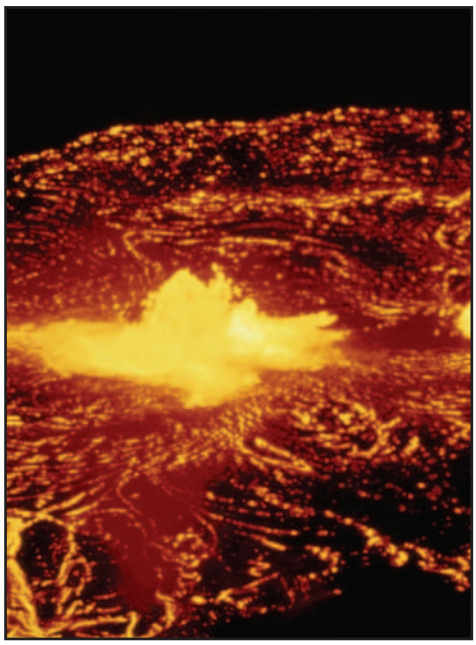
Lesson 3

What Are the Effects of Plate Motion?

VOCABULARY

- magma
- lava
- fault
- eruption
- hot spot

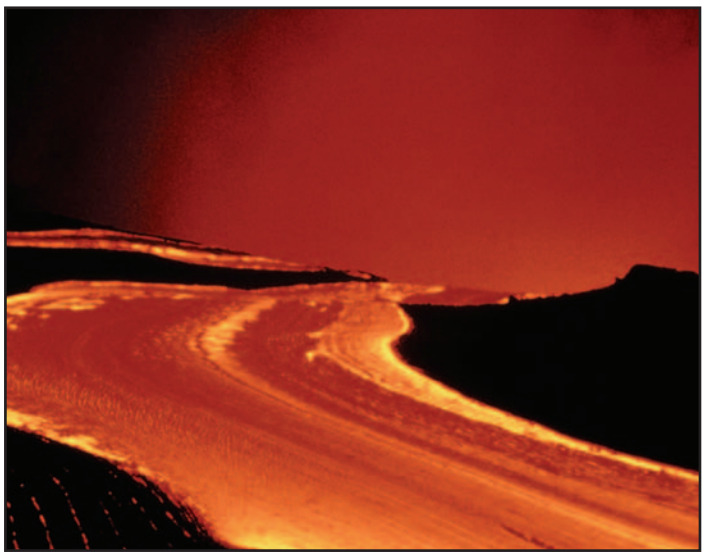
Just before a volcano erupts, **magma** rises through Earth's crust.



Lava erupts from a volcano.

The San Andreas **fault** runs through California.

Live volcanoes have **eruptions**.



Volcanoes in the Hawaiian islands formed over a **hot spot** under the ocean.

Focus Skill

READING FOCUS SKILL

CAUSE AND EFFECT

A **cause** is something that makes another thing happen. An **effect** is the thing that happens.

Reading this text will help you learn how plate movements can **cause** changes in land features.

Building Mountains

Mountain ranges were formed because the plates that make up Earth's surface are always moving. When two continental plates hit each other, or collide, the plate edges get crumpled and folded. *Fold mountains* form. Because of the constant pressure, the mountains continue to rise.

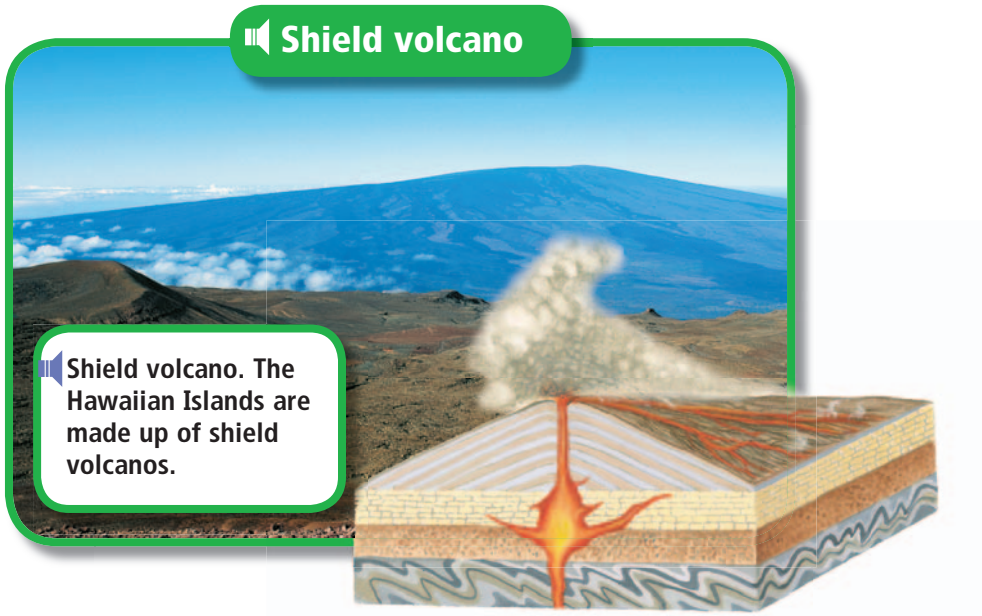
Mountains can also form where one plate is pushed under another plate. As the edge of one plate is pushed down, it causes rock to melt. **Magma** is melted rock beneath Earth's surface.

The magma can rise and burst through the crust. **Lava** is melted rock at Earth's surface. Over a long period, the lava can build up. The lava will become a chain of volcanic mountains.

Mountains can also form when a plate is pulled apart. The crust may stretch. This will cause a fault to form. A **fault** is a break in Earth's crust. Large blocks of crust can be pushed up along these faults.

Focus Skill

What happens when the edge of an oceanic plate is pushed down?



Volcanoes

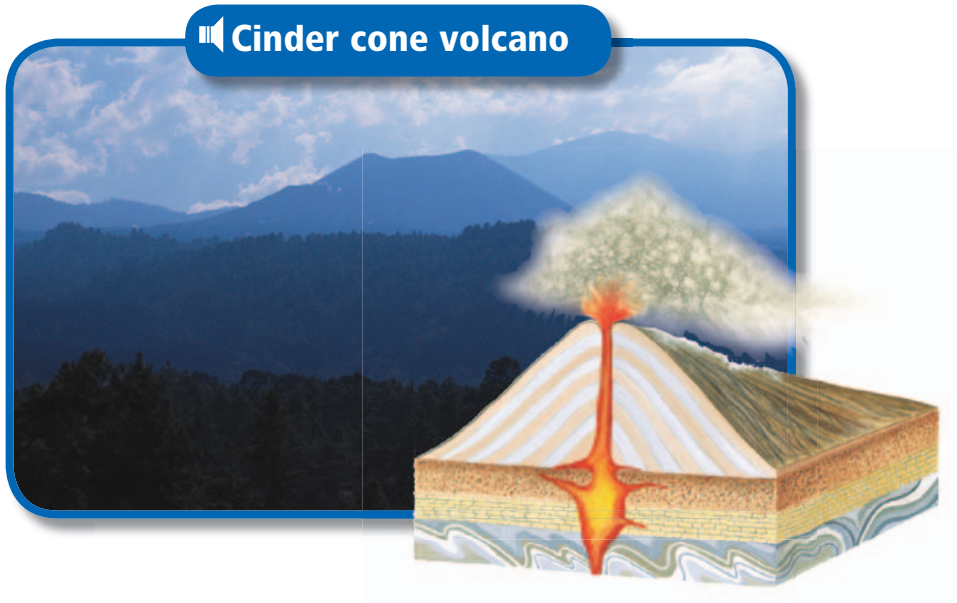
Most of the world's volcanoes form at plate boundaries. As the plates separate, hot rock from the upper mantle moves up. The hot rock begins to melt. Magma rises to the surface and can erupt through *fissures*. Fissures are cracks in Earth's surface.

Volcanoes can also form when plates collide. One plate is pushed down into the mantle. This causes melting of the rock. Magma is less dense than solid rock, so the magma moves upward. It can flow through an opening called a *vent*.

A volcanic **eruption** is the release of material from a vent. Volcanoes can erupt with a great explosion, or they can erupt very quietly.

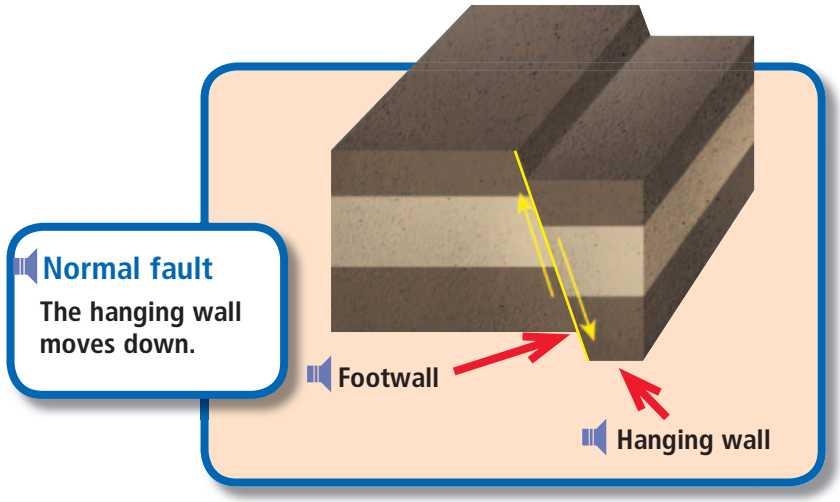
A quiet eruption happens when lava is thin. Thin lava flows slowly out of a vent. The gases inside the volcano can escape easily. A quiet eruption often forms a shield volcano. The Hawaiian Islands are made up of shield volcanoes.

A violent eruption happens when lava is thick. The thicker lava traps pockets of gas. The gas bursts out with great force. Violent eruptions often form cinder cone volcanoes.



A **hot spot** is a place in the middle of a plate where magma rises toward Earth's surface. A hot spot can be under the ocean's crust. As the plate moves, a chain of volcanoes may form. In time, the volcanoes may become islands. The Hawaiian Islands are one example of hot spot volcanoes.

Focus Skill **What type of eruption does thick lava cause?**

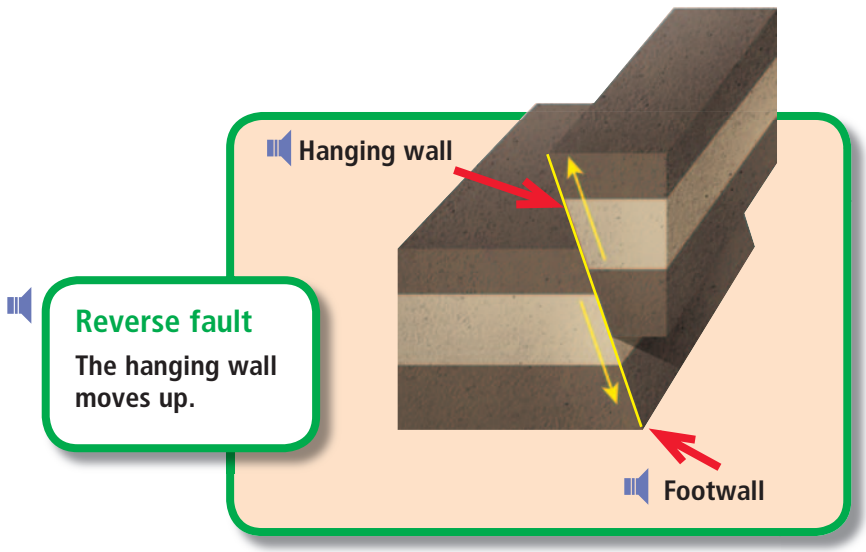


Types of Faults

A fault is a break in Earth's crust. Rock moves apart or presses together to make a fault. Most faults form near plate boundaries. Some faults can also form within a plate.

A *normal fault* has a hanging wall that moves down. Normal faults form where Earth's crust is stretched. They can be found at divergent boundaries, near mid-ocean ridges.

A *reverse fault* has a hanging wall that moves up. It forms where the crust is being pushed together and folded.

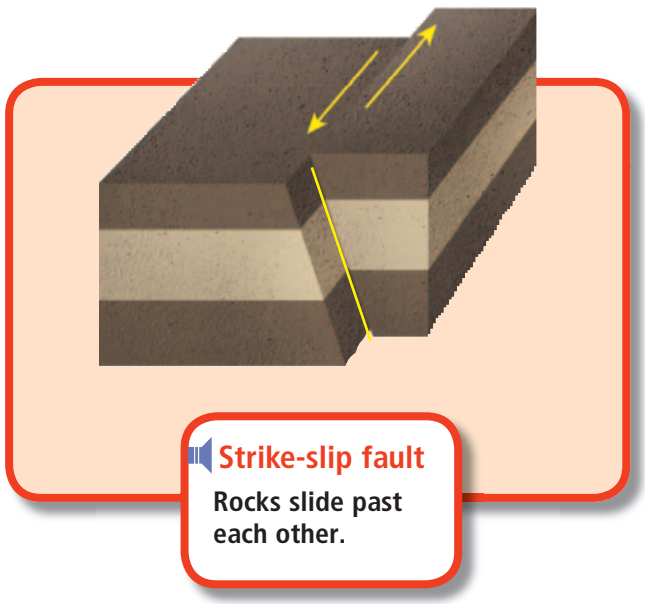


In a *strike-slip fault*, rocks slide past each other. The rocks do not move upward or downward. Strike-slip faults are similar to transform fault boundaries.

Most earthquakes occur at plate boundaries or at faults near boundaries.

Focus Skill

What will form as a result of Earth's crust being stretched and cracked?



Strike-slip fault
Rocks slide past each other.

Review

Focus Skill

Complete these cause and effect statements.

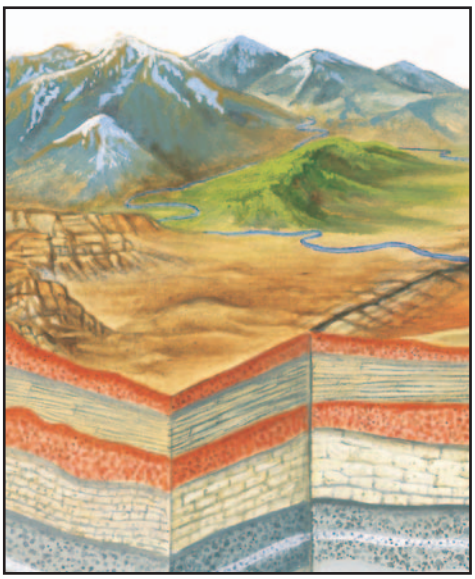
1. Fold mountains form when two continental plates _____ .
2. Large blocks of crust can be pushed up along faults to form _____ mountains.
3. Violent eruptions often cause _____ volcanoes to form.
4. If the hot spot lies under oceanic crust, a chain of volcanoes may form and then become _____ .

Lesson

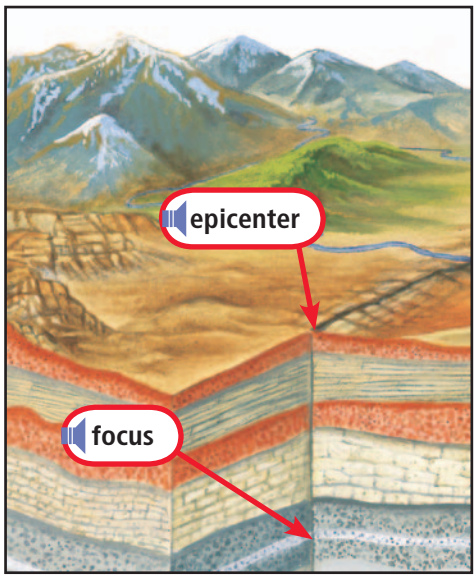
How Do Earthquakes Affect Earth's Surface?

VOCABULARY

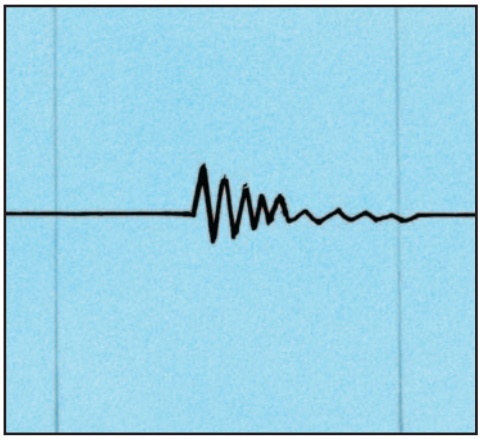
- focus
- epicenter
- P wave
- S wave
- surface wave
- magnitude



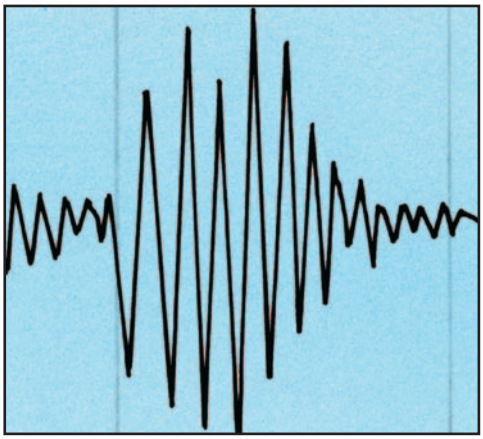
An earthquake begins at the **focus** deep inside Earth.



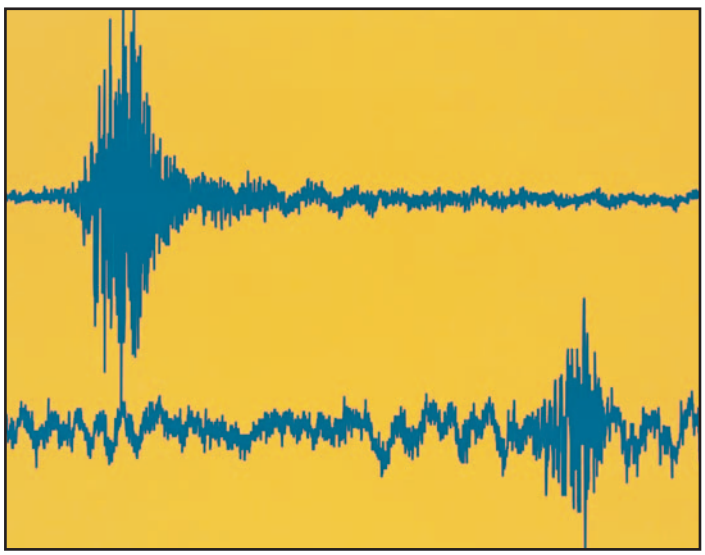
The farther you are from an earhquake's **epicenter**, the safer you will be.



The first wave recorded from an earthquake is the **P wave**. The second wave recorded is the **S wave**.



Damage from an earthquake is usually caused by a **surface wave**.



An earthquake with a high **magnitude** can cause a great deal of damage.

Focus Skill

READING FOCUS SKILL

MAIN IDEA AND DETAILS

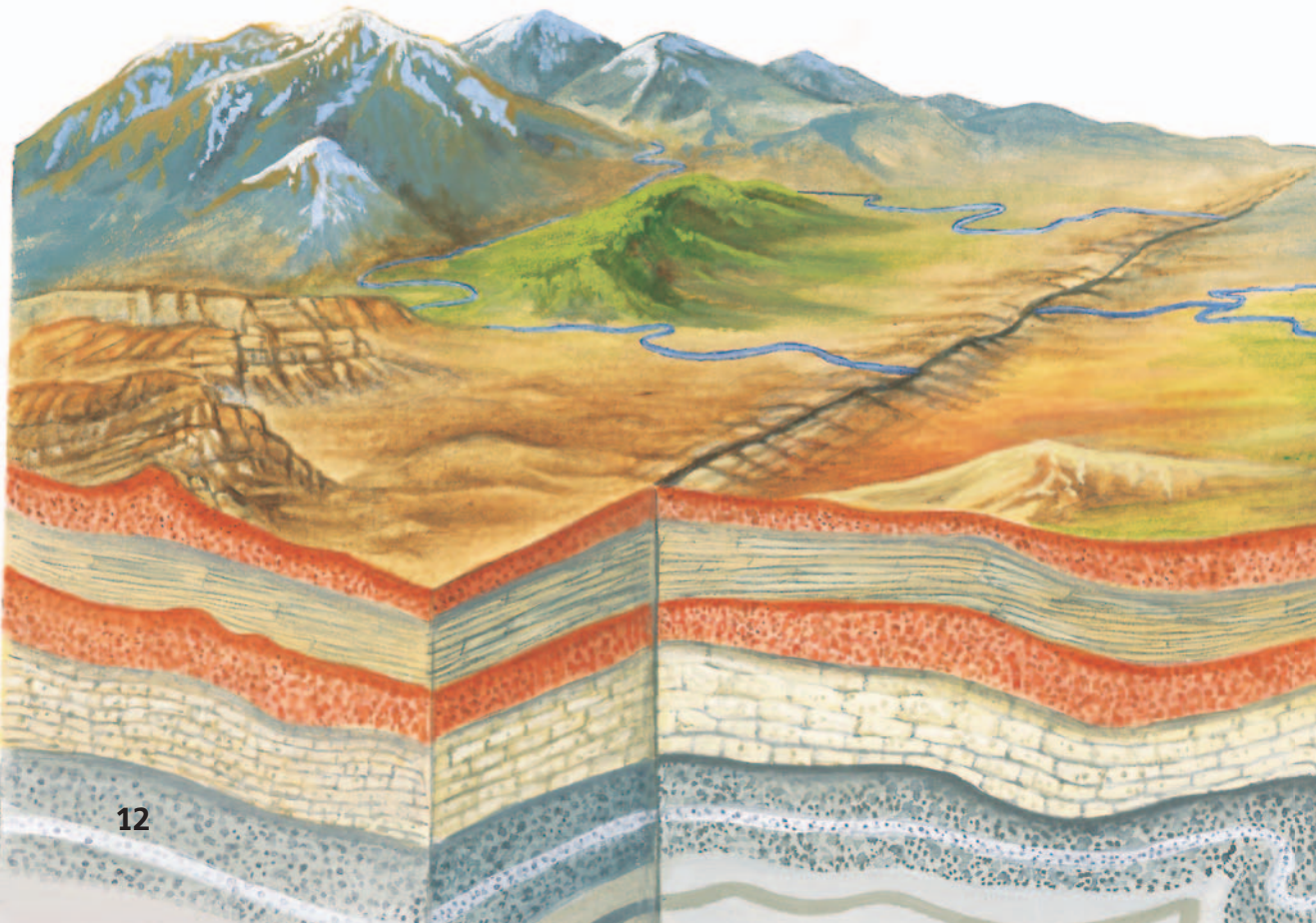
The **main idea** is what the text is mostly about. The **details** tell more about the main idea.

The **main idea** is about the kinds of energy waves earthquakes produce. Look for **details** about the ways to measure earthquake waves.s.

Earthquakes

Suppose you are holding a plastic ruler by both ends. If you press on both ends, the ruler will bend. If you press too hard, the ruler may snap.

Earth's plates behave in a similar way. Under pressure, the plates can bend. When the pressure is great, huge rocks can break. The break is the fault.



Rock along a fault will bend or stretch. If the rock stretches too far, it will snap. The rocks on either side of the fault will suddenly slide against each other. This releases energy. An earthquake is the release of energy when Earth's crust moves along a fault. The **focus** is where the movement occurs and the earthquake starts. The point on Earth's surface above the focus is called the **epicenter**.

When an earthquake begins, energy is released. The energy travels in waves. The fastest waves are **P waves**, or *primary waves*. The P waves push and pull the rock deep inside Earth.

The next waves are called **S waves**, or *secondary waves*. S waves move up and down or from side to side.

A third type of wave is called a **surface wave**. It travels along Earth's surface. Waves of this type shake the ground in an earthquake. Surface waves cause most of the damage to buildings.

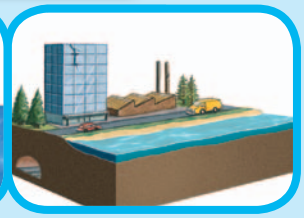
Focus Skill

What happens when rock at Earth's crust suddenly moves along a fault?

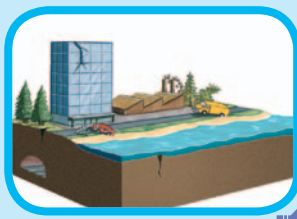
The Modified Mercalli Scale

II A few persons at rest may feel earthquake vibrations, especially on upper floors.

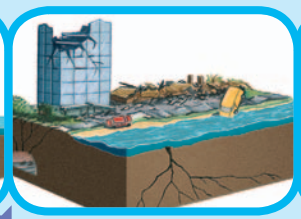
IV Indoors many will feel vibrations; dishes may fall and break; cars will rock



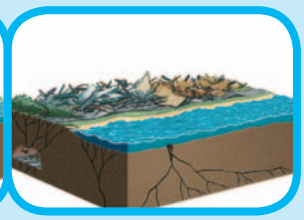
VI Quake felt by all; heavy furniture moves; books knocked off shelves, pictures fall; other damage slight



VIII Quake-proof buildings okay, normal buildings partly collapse; heavy furniture overturned



X Many wood, block, and brick buildings destroyed; ground badly cracked; landslides from steep slopes



XII Destruction nearly total; fires; roads, rail lines, runways made crooked; no public services

Measuring Earthquakes

In the early 1900s, Giuseppe Mercalli developed a scale. The scale could show the *intensity* of an earthquake. Intensity measures the shaking an earthquake causes. Mercalli based his scale on the amount of damage caused by earthquakes.

The scale uses Roman numerals from I to XII (1 to 12). Very minor damage is rated I to III. A rating of XII means that most buildings in the area were destroyed.

Damage is not the most precise way to measure how strong an earthquake is. Other things besides intensity affect the amount of damage from an earthquake.

Focus Skill **What feature of an earthquake doesMercalli's scale measures?**

The Richter Scale

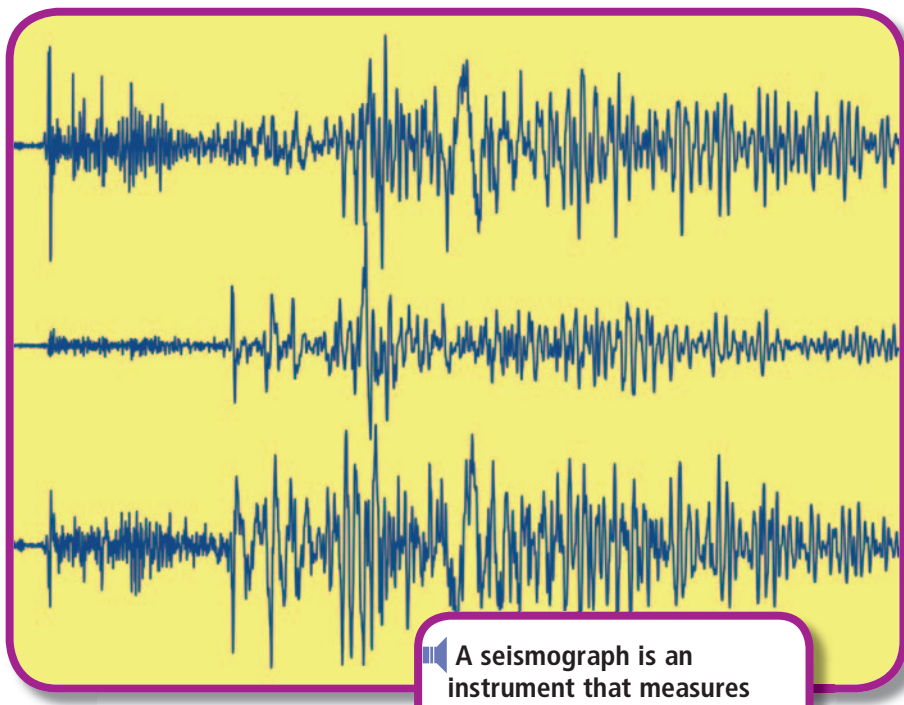
In 1935, Charles Richter developed a new earthquake scale. The scale measures the heights of earthquake waves. The waves are recorded on a *seismograph*. It measures the motion of waves. The amount of energy an earthquake releases is its **magnitude**.

On the Richter scale, an earthquake with a magnitude of 2.0 is minor. A magnitude of 4.0 can be felt, but it causes little damage. A large earthquake has a magnitude of 6.0. It can cause major damage.

Scientists can also measure the time between P waves and S waves. The amount of time can tell us how far away the epicenter is. The more time between the P and S waves, the farther away the epicenter is.

Focus Skill

What instrument measures the motion of an earthquake's waves?



A seismograph is an instrument that measures waves from an earthquake.

Earthquake Effects

We know that earthquakes can cause damage. The amount of damage depends on these things:

- the magnitude of the earthquake
- the distance from the epicenter
- local geology
- the type of building construction

The greater the magnitude, the more damage an earthquake will cause. Also, places closer to the epicenter will have more damage than places farther away.

Local geology will affect the amount of damage. Ground that is loose, soft, or wet can be *unstable*. Unstable ground shakes and rolls more than ground that is hard and stable.

An earthquake in 1989 caused great damage in San Francisco.

Buildings that are made of *brittle* materials can crack during an earthquake. Buildings made of *flexible* materials will bend. Buildings made of stone may crack. Wood is more flexible than stone. Some buildings have been built to sway with earthquake motion. This helps prevent damage to the buiilding.

The focus of a powerful earthquake can be under the sea. This can cause a tsunami. A *tsunami* (tsoo•NAH•mee) is a large wave. A tsunami can travel a great distance through an ocean. The giant wall of water can slam into a coast.

Many people are killed by tsunami waves. Often people do not know the warning signs. Before a tsunami hits, water suddenly moves away from the shore. This unusual sight is a warning. People should move to higher ground, where they will be safer.

Focus Skill **What factors influence earthquake damage?**

Review

Focus Skill **Complete the main idea and detail statements.**

1. An earthquake is the release of energy when Earth's crust moves, or slips along a _____ .
2. The first waves detected in an earthquake are called _____ .
3. _____ waves can move up and down or side to side.
4. _____ waves cause most of the damage to buildings in an earthquake.

Lesson 5

How Did Plate Movement Shape California?

VOCABULARY

- terrane
- basin
- basin and range

California is made up of many different kinds of rock. Each kind of rock can be a different **terrane**.

Compression made this **basin** start to form.

When you drive across a **basin and range** region, you go up and down. You do this again and again.

Focus Skill

READING FOCUS SKILL

CAUSE AND EFFECT

A **cause** is something that makes another thing happen. An **effect** is the thing that happens.

While you read, try to discover how plate boundaries **cause** changes to California's landforms.

Building California

Earth's plates move. The landforms of California were formed by this movement. A **terrane** (tuh•RAYN) is a piece of lithosphere. The terrane forms when a piece of one plate becomes attached to another plate. The west coast of North America is formed of terranes.

Millions of years ago, the North American plate moved west. The plate collided with ocean plates. There were islands on the ocean plates. The edge of the ocean plate sank under the North American plate. The islands were slowly added to the western edge of North America. These collisions slowly built California.

The San Andreas fault marks the place where the Pacific plate is grinding past the North American plate.

Focus Skill

What caused the building of California's landforms?

The Klamath Mountains were once volcanic Islands and ocean floor. Plate collisions added the Klamaths to North America more than 100 million years ago.

Ventura Basin

Mountains and Basins

Mountains and basins are common landforms around Los Angeles. A **basin** is a low place on Earth, shaped like a bowl. Movement at the San Andreas fault produced mountains and basins. The San Andreas fault runs through the western part of California.

Where the plates collide, they fold and cause mountains to rise. The land between the folds is pushed down to form basins. Basins become deep bowls that fill with sediment. The sediment comes from erosion of the mountains. The Santa Ynez, San Gabriel, and Santa Monica Mountains are fold mountains.

Focus Skill **What causes fold mountains to form?**

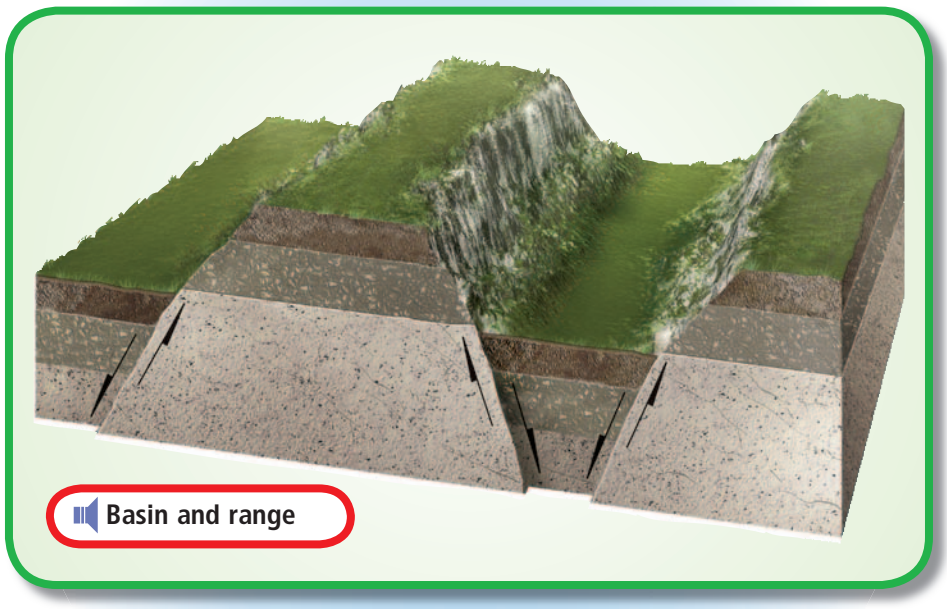
Basin and Range

East of the Sierra Nevada, is a series of hills and valleys. This is a **basin and range** area. It is a region of long, parallel ridges. Each ridge has a narrow valley between it and the next ridge. The ridges and valleys were formed when the lithosphere was stretched 30 million years ago.

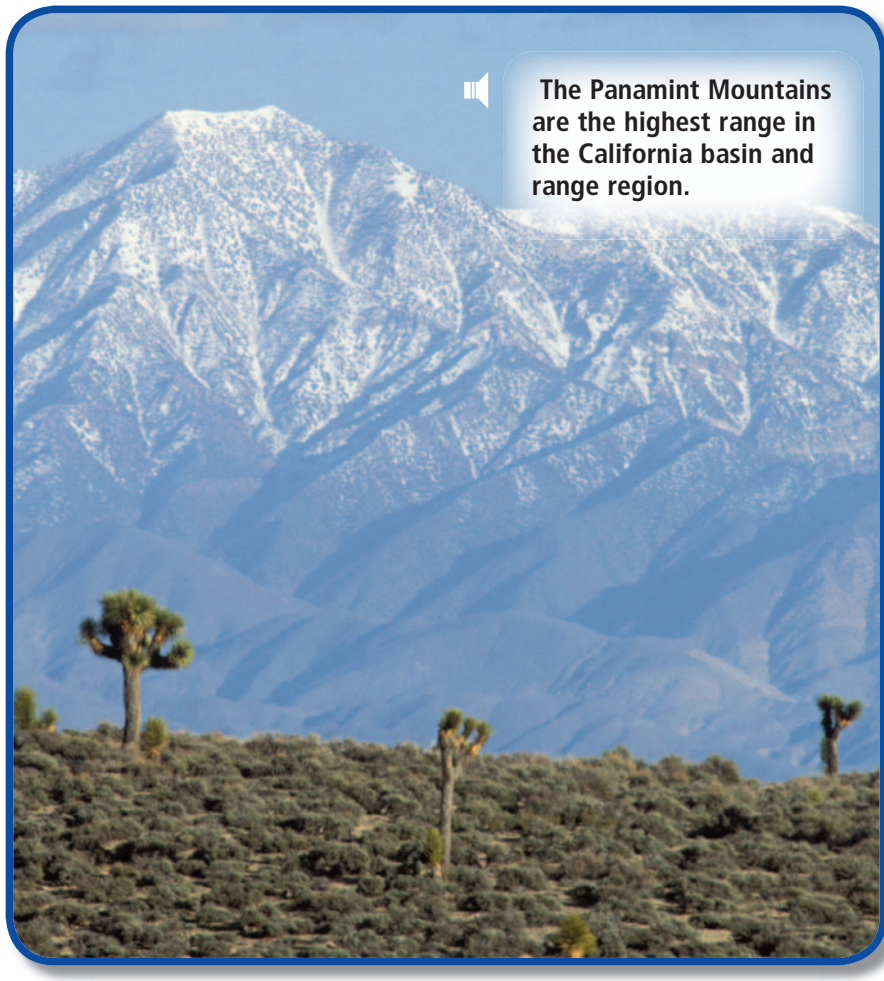
The stretching of the crust and the movement of the faults continues in California today. This is why earthquakes are common in California.

Focus Skill

What type of movement causes ridges and valleys to form?



Basin and range



The Panamint Mountains are the highest range in the California basin and range region.

Review

Focus Skill

Complete these cause and effect statements.

1. When a piece of one of Earth's plates joins another plate, a _____ forms.
2. Mountains and _____ form as a result of plate collisions.
3. Stretching of Earth's crust is one cause of _____ .
4. The North American plate is grinding past the Pacific plate. This movement causes the _____ _____ fault to form.

GLOSSARY

basin [BAY•sin] A small, low area on Earth shaped like a bowl.

basin and range [BAY•sin AND RAYNJ] An area of parallel ridges with narrow valleys between.

epicenter [EP•ih•sent•er] The spot on Earth's surface above the focus of an earthquake.

eruption [ee•RUP•shuhn] The flow of lava or ash from a volcano.

fault [FAWLT] A crack in Earth's crust.

focus [FOH•kuhs] The place inside Earth where rock moves and an earthquake occurs.

hot spot [HAHT SPAHT] A place away from plate boundaries where molten rock is being forced toward Earth's surface.

lava [LAH•vuh] Molten rock that is exposed at Earth's surface.

magma [MAG•muh] Molten rock beneath Earth's surface.

magnitude [MAG•nuh•tood] A measure of the energy released by an earthquake.

P wave [PEE WAYV] The first wave to arrive at a station after an earthquake.

S wave [ESS WAYV] The second wave to arrive at a station after an earthquake.

surface wave [SER•fis WAYV] The last wave to arrive at a station after an earthquake.

terrane [tuh•RAYN] A small piece of lithosphere from one plate that is attached to another plate.

Think About the Reading

1. How are the measurements different between the Mercalli scale and the Richter scale? Which section should you read again to learn more about these scales?
2. How would you contrast the pictures on pages 6–7? How are these volcanoes different?

Hands-On Activity

Make a three-dimensional map of California that includes landforms such as mountain ranges, basins, and faults. Draw your map on a piece of cardboard or the inside of a box. Use construction paper to make your landforms.

1. Do you live close to a mountain range or in a basin?
2. Have you seen the San Andreas fault line?

School-Home Connection

Take your three-dimensional map home and show it to a family member. Together, add features to your map. Draw cities, special places you have visited, lakes, rivers, and reservoirs.