



UNIT C

Earth and Its Resources

**Flowing water can change
the shape of land.**

waterfall at Point Lobos State Reserve, California



Literature

National Wildlife Federation

Ranger
Rick

Magazine Article

Lichen

Life on the Rocks

Lichen (LIH•kuhn) is not one thing but two.

It is a team effort. Half the team is an alga. Algae are tiny green protists. They use sunlight to make their own food. The other team member is a fungus. Fungi are living things that often grow and feed on dead things. They help to break down dead things and recycle them. Mushrooms are one type of fungus.

Some lichen are crusty and flat and grow on a rock's surface. Others are leafy and often grow on tree bark. Still other lichens are thick branching ones, such as reindeer moss, that grow in clumps on the ground.

In a lichen, each partner helps out the other. The alga makes food for both of them. The fungus provides a "house" that protects the alga from drying out in sunlight. Lichens are able to live in places where few other living things can. Lichens, for example, are often the first things to grow on bare rock.

The lichen forms a crust on the rock. It grows very slowly and begins to break down the rock. Acids it gives off form tiny cracks in the rock. Water fills the tiny cracks and, when the water freezes, causes the cracks to widen. Over time, blowing bits of soil get caught in the lichen. Plant seeds may take root. After many years, the rock is covered with soil and plants. This all starts with fungi and algae!



Write About It

Response to Literature This article tells you that lichen is not one thing but two. What are the two parts of a lichen? How can a lichen change rocks? Write a summary. Use your own words to explain what this article is about.



-Journal Write about it online
at www.macmillanmh.com

CHAPTER 5

Shaping Earth



What causes Earth's surface to change?

Essential Questions

Lesson 1

What are Earth's features above the ground and below the ground?

Lesson 2

How can Earth's crust change?

Lesson 3

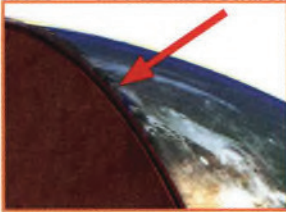
What forces shape and change Earth's landforms?

Lesson 4

How does weather shape and change the land?



Big Idea Vocabulary



crust rock that makes up the Moon's and Earth's outermost layers (p. 208)



earthquake a sudden shaking of the rock that makes up Earth's crust (p. 216)



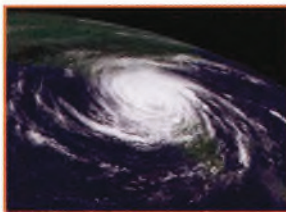
seismograph a tool that graphs seismic waves as wavy lines and helps scientists detect earthquakes (p. 218)



weathering a process that breaks rocks into smaller pieces (p. 226)



erosion the weathering and removing of rock or soil (p. 228)



hurricane a violent, swirling storm with strong winds and heavy rains (p. 240)



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The background of the page is a photograph of the Bisti Badlands in New Mexico. The landscape is a dry, arid desert with sand dunes and numerous unique rock formations. Some rocks are tall and thin, while others are flat and layered. The ground is a mix of sand and small rocks. The sky is a pale, hazy blue.

Lesson 1

Earth

Look and Wonder

In the Bisti Badlands of New Mexico, the ground is dry and coarse. Odd features cover the landscape. How would you describe these features?

Explore

Inquiry Activity

What shapes can the land take?

Purpose

Explore some of the features on Earth's surface.

Procedure

- 1 Observe** Draw some different shapes that you have seen on Earth's surface. Think about places you have visited. Recall places you have seen in magazines, movies, on television, or the Internet. You can also look for pictures in this chapter.
- 2 Make a Model** Choose one of these land shapes. Shape some modeling clay to show how the land looks. Add as many details as you can.
- 3 Communicate** Discuss your model with a partner. How are your models alike? How are they different?

Draw Conclusions

- 4 Classify** Do you recognize any of the land shapes? Name them if you can.
- 5** Do you think the land always had these shapes? If not, how did they come about?

Explore More

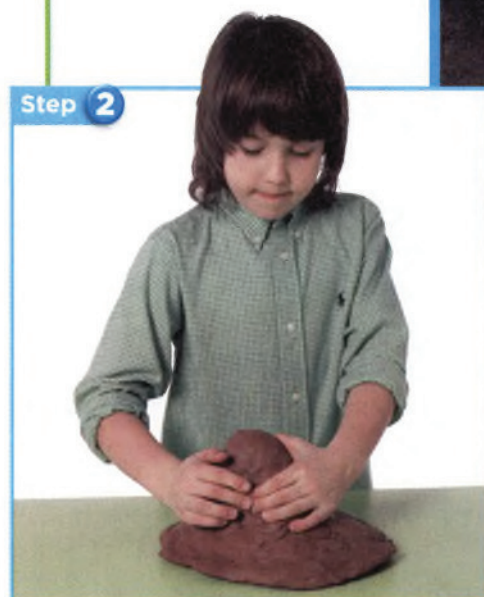
Describe the shape of the land where you live. Are any of the models like that land? If not, make a new model to show what the land looks like near you.

Materials



- modeling clay

Step 2



Step 2



Read and Learn

Essential Question

What are Earth's features above the ground and below the ground?

Vocabulary

crust, p. 208

mantle, p. 208

outer core, p. 208

inner core, p. 208

Reading Skill



Draw Conclusions

Text Clues	Conclusions

Technology



e-Glossary and e-Review online at www.macmillanmh.com

What does Earth's land look like?

Viewed from space, Earth's land might seem flat. From close up, you can see many natural features on Earth's surface. These features are called *landforms*.

Tallest and Flattest

The tallest and most visible landforms are *mountains*. Most rise steeply to a peak at the top. Others have a gentle slope. Some are *volcanoes* formed by melted rock.

A *plain* is the flattest kind of landform. Plains are vast areas of land without hills or mountains.

Landforms Shaped by Water

Flowing water can shape the land. Streams and rivers can cut small *channels* or larger *gullies* where they flow. Strong flows can create deep *valleys*. In some places, rivers form narrow, steep sided valleys called *canyons*. The Grand Canyon is more than 1 kilometer deep!

Waves wear away land too. Waves can make a beach flat and smooth or sharp and rocky.

Landforms Shaped by Wind

Gusts of wind can pile sand into large mounds in deserts and on beaches. These mounds are called *sand dunes*. Wind can also combine with water to make mountains steeper and valleys deeper.



The Continental United States



Quick Check

Draw Conclusions What can landforms teach us about Earth's history?

Critical Thinking Compare how wind and water shape the land.

Read a Map

Describe landforms you might see on a trip across the United States.

Clue: Match the numbers on the map to the numbers on the pictures.

What does it look like where water meets land?

Water always flows downhill. What happens when it gets to the bottom of a landform?

River Deltas

As the land gets flatter, the flow of water in a river begins to slow. If the river empties into an ocean, the water moves even slower. It drops off bits of sand and soil it carried. The bits form a *delta*—a landform that is sometimes shaped like a triangle.

Drainage Basins

Small rivers empty into bigger rivers. A *drainage* (DRAY•nij) *basin* is the area of land drained by flowing water. Much of central North America, for example, is a drainage basin for the Mississippi River.

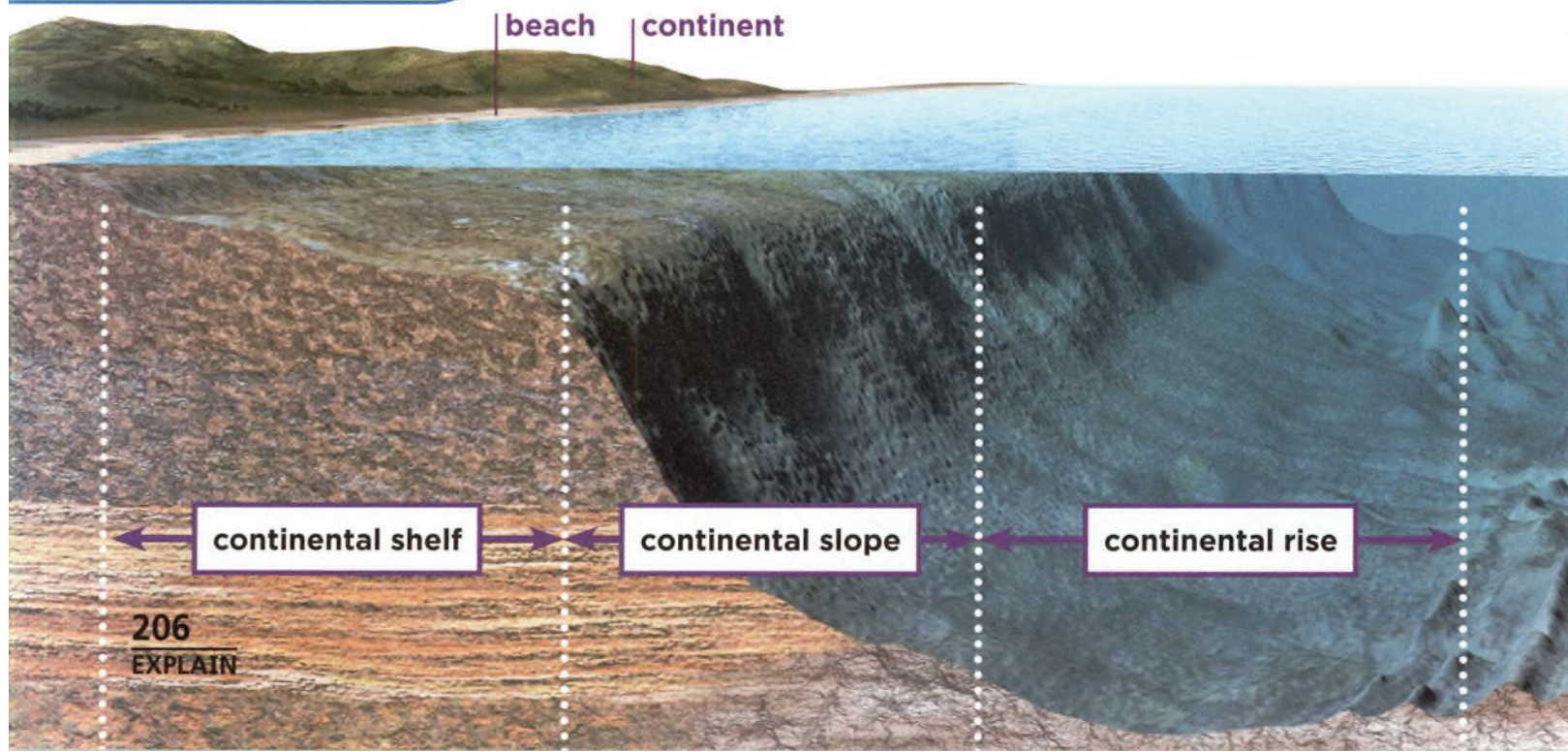


This delta formed where the Copper River meets Prince William Sound in Alaska.

Continental Shelves

It is a sunny day at the beach. You want to swim with your friends. You move farther from shore, but the water is still too shallow. Where are you? You are on a continental shelf. The *continental shelf* is part of the land that is covered by the sea. It can stretch seaward for miles.

From Land to Sea



Beyond the Continent

Beyond the continental shelf is an area of land called the *continental slope*. This land is the steeper part of the continent that slopes down toward the ocean floor. Underwater canyons can form on the slope.

At the base of the slope lies the *continental rise*. The rise connects the continent and ocean floor.

Most of the ocean floor is flat and without features. However, long mountain ranges stretch along the bottom of the oceans. These are *ocean ridges*. The ocean floor is spotted with undersea volcanoes too. The ocean floor also has deep trenches; some are more than 8 kilometers (5 miles) deep.

Read a Diagram

How does Earth's surface change between the continent and ocean floor?

Clue: Trace a line from the beach to the ocean ridge.

ocean ridge

Quick Lab

Drain Away

- 1 Make a Model** Place some modeling clay in a plastic or metal container. Shape it into landforms. Include at least one mountain, valley, and plain. Draw a map of your model.
- 2** Spray water onto the top of the model mountain and along its sides. Repeat until you see water collecting in the container.
- 3 Observe** How did the water flow over the model? Where did the water collect?
- 4** Use your map to describe the drainage basin in your model.



Quick Check

Draw Conclusions Are oceans drainage basins? Explain.

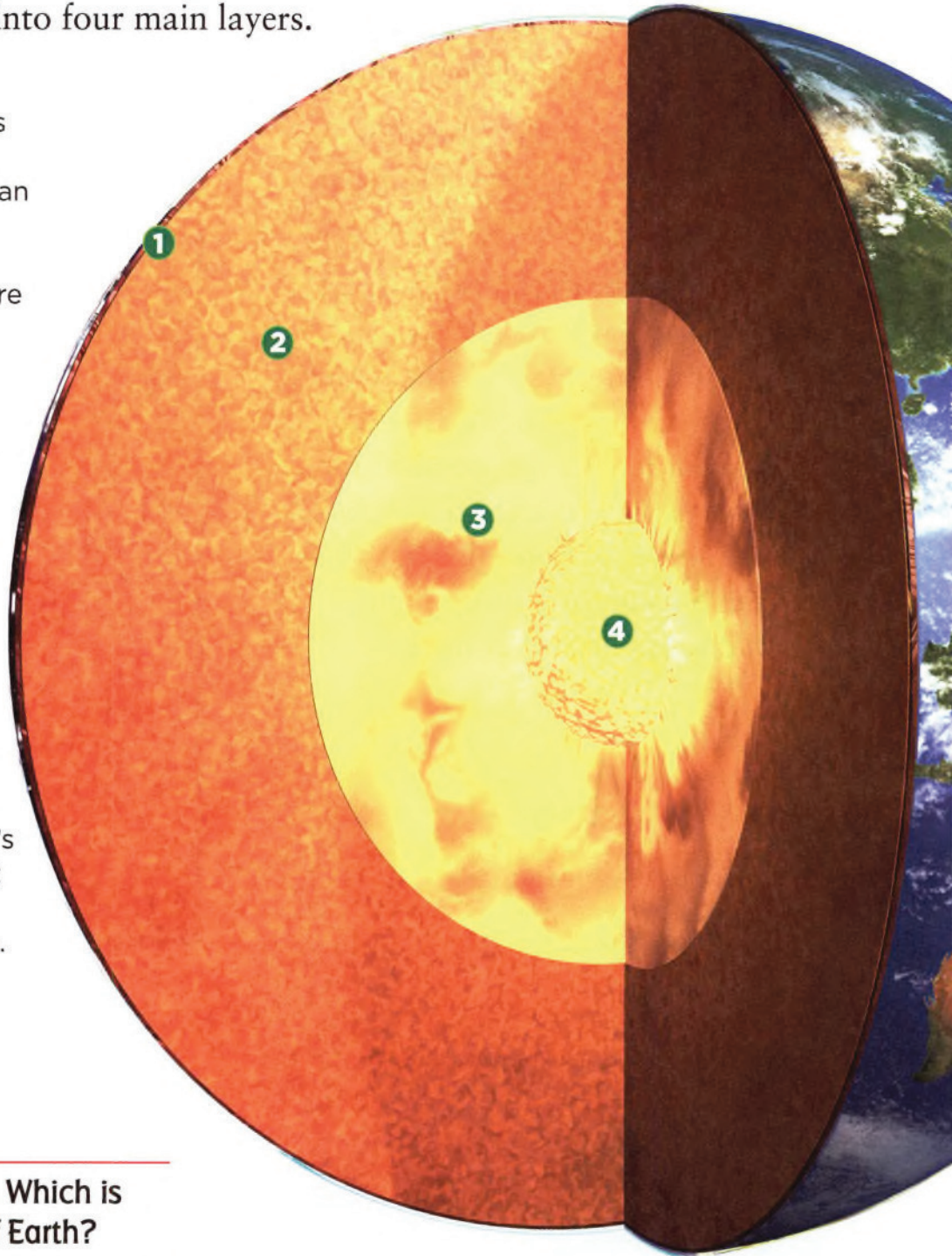
Critical Thinking How do features of the ocean floor compare to those on land?

What is below Earth's surface?

You have read about some of the features on Earth's surface. What is Earth like beneath those features?

Look at the diagram. It shows the interior of Earth. Scientists divide Earth into four main layers.

- 1 Crust** Rock that makes up Earth's outermost layer. It is brittle and can crack easily. Earth's landforms and underwater features are found on the crust.
- 2 Mantle** Layer of rock below the crust. It is solid, but some of the rock can move or change shape at high pressures and temperatures.
- 3 Outer Core** Liquid layer below the mantle. It is made mostly of melted iron.
- 4 Inner Core** Sphere of solid material at Earth's center. It is the hottest part of Earth. It is probably made of iron.



Quick Check

Draw Conclusions Which is the thinnest layer of Earth?

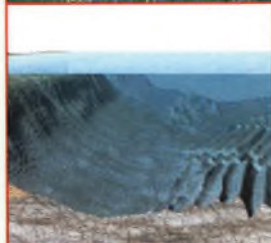
Critical Thinking How can scientists study Earth's core?

Lesson Review

Visual Summary



Earth's landforms include mountains, plains, canyons, and other features formed by water and wind.



Earth's water drains into rivers, channels, drainage basins, and oceans. The ocean has features similar to land.



Earth's layers are the crust, mantle, outer core, and inner core.

Make a **FOLDABLES** Study Guide

Make a three-tab book. Use it to summarize what you read about Earth's features.



Think, Talk, and Write

- Vocabulary** The first layer of Earth beneath the crust is the _____.
- Draw Conclusions** Where would you go to find a delta?

Text Clues	Conclusions

- Critical Thinking** How could you use an apple to model Earth's interior?
- Test Prep** A wide, flat landform is called a
 - A plain.
 - B valley.
 - C canyon.
 - D trench.
- Test Prep** What is Earth's outermost layer?
 - A inner core
 - B outer core
 - C mantle
 - D crust
- Essential Question** What are Earth's features above the ground and below the ground?



Writing Link

Write an Essay

Write an essay about the different landforms that you would visit on a trip across the United States. You can also research and write about specific places, such as the Great Lakes or the Grand Canyon.



Math Link

Writing Fractions

Oceans cover about 70 percent of Earth's surface. How can you show 70 percent as a fraction? Express the fraction in simplest form. How could you model this fraction?



Focus on Skills

Inquiry Skill: **Experiment**

A mountain takes thousands of years to form. Yet it can change in a day. Landslides are one way a mountain changes quickly. Soil and rocks suddenly slide downhill. Houses and trees may be carried away. To study landslides, scientists do **experiments**. Then they draw conclusions from their results.

► Learn It

When you **experiment**, you make and follow a procedure to test a hypothesis. A procedure is a set of numbered steps that tell what to do first, next, and last. It is important to record your observations while you follow your procedure. Your observations can help you draw a conclusion from your results. It is always good to run your test several times. That way, you know whether your results are true.

► Try It

Do you think there is a way to lessen the damage from landslides? Write your idea in the form of a hypothesis. Then **experiment** to test your hypothesis.

Materials soil, planter box, rocks, twigs, wooden blocks, water, watering can, plastic tablecloth, 2 or 3 books, cookie tray

- 1 Spread dry soil in the bottom of a long planter box. Push rocks and twigs into the soil. Place small, wooden blocks as houses. Sprinkle the soil with water until it is damp.
- 2 Cover a table with a plastic tablecloth. Set the box on it. Prop up one end of the box with two or three large books. Place a cookie tray under the other end of the box.



- 3 Predict what would happen to the soil in a heavy rainstorm. Record your prediction in a chart like the one below.

Step	Predictions	What I Observed
step 3 no wall or barrier		
step 5 wall near top		
step 6 barrier near bottom		

- 4 Use a watering can to pour water at the high end of the box. Record what happens.
- 5 Repeat steps 1 and 2. This time, bury a block in the soil near the top of the box to make a wall. Then repeat steps 3 and 4.
- 6 Repeat steps 1 and 2. This time, make a fence or barrier. Put a piece of wood as wide as the box into the low end of the box. Then repeat steps 3 and 4. If you have time, rerun the entire experiment from step 1 through step 5.
- 7 Review your results. Do they support your hypothesis? Explain.
- 8 Can anything be done to prevent or ease the damage caused by landslides? Use your results to explain your answer.

► Apply It

- 1 What do you think would happen if you placed the barrier near the top of the hill? What if one barrier were at the top and one were at the bottom? What if every house had a fence around it? Write a hypothesis for one of these ideas or form your own.
- 2 Design an **experiment** to test your hypothesis. Remember to record your observations, run several tests, and draw conclusions from your results.



Lesson 2

The Moving Crust

Look and Wonder


These mountains in Grand Teton National Park probably began as flat layers of rock. What made them rise and tilt? Did something happen to Earth's crust?

How can Earth's crust change shape?

Make a Prediction

Predict how flat rock layers will react to pressure.

Test Your Prediction

- 1 Flatten three pieces of colored clay into thin layers. Press the layers on top of each other, like a sandwich.
- 2 **Make a Model**  **Be Careful.** Use the plastic knife to cut the stack of clay into two squares. These are your models of rock layers.
- 3 Press two wooden blocks flat against opposite sides of one clay square. Move the blocks slowly and firmly toward each other. Record your observations.
- 4 Cut a slice at an angle from the top to the bottom of the second clay square. Repeat step 3 on this new model. Record your observations.

Draw Conclusions

- 5 How did squeezing change the clay layers? What landforms do the models now resemble?
- 6 **Interpret Data** Did slicing the layers make a difference in how the clay reacted to squeezing? Explain.
- 7 **Infer** Using your model, explain how rock layers can be folded or lifted.

Explore More

Compare how the clay model reacts to slow steady pressure and strong sudden pressure. Make new models and test them.

Materials



- modeling clay (3 colors)
- plastic knife
- 2 wooden blocks

Step 1



Read and Learn

Essential Question

How can Earth's crust change?

Vocabulary

fault, p. 215

plateau, p. 215

fold, p. 215

mountain, p. 215

earthquake, p. 216

seismic wave, p. 218

seismograph, p. 218

volcano, p. 220

Reading Skill ✓

Cause and Effect

Cause	→	Effect
	→	
	→	
	→	
	→	

Technology



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How does Earth's crust move?

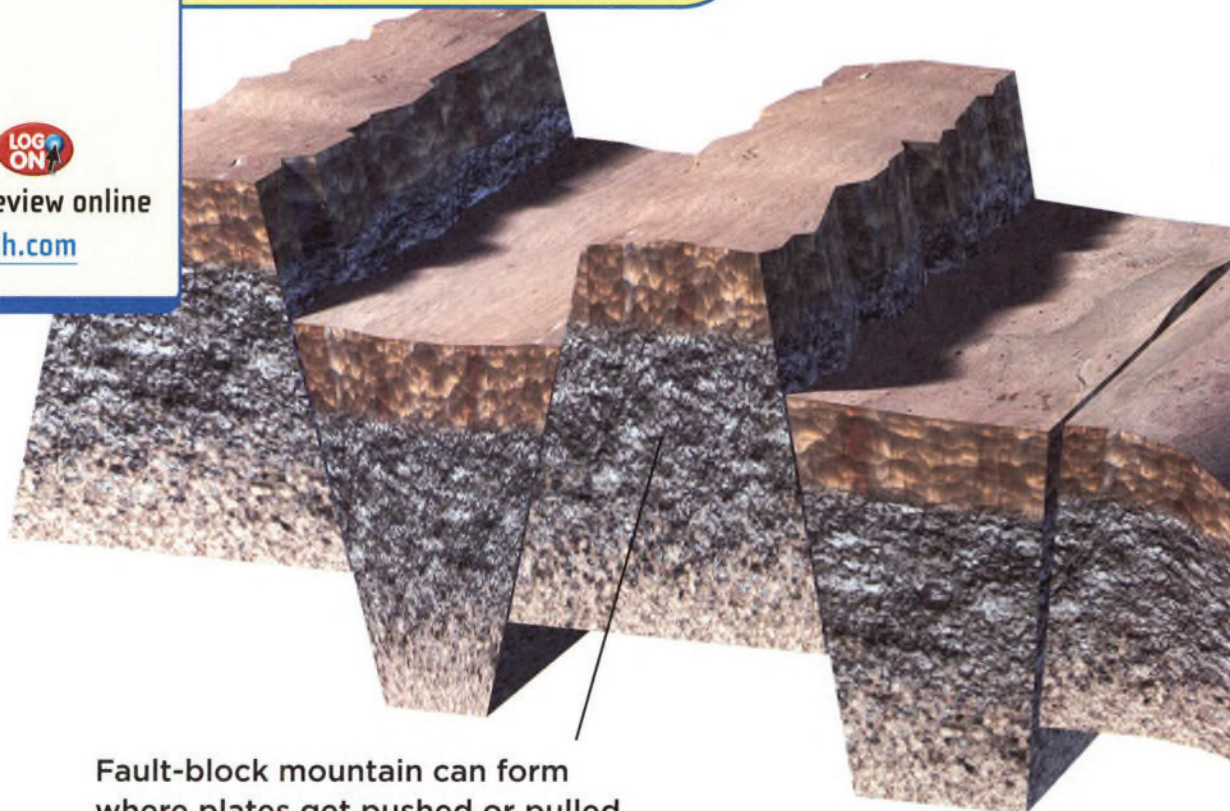
You have learned that Earth is made up of layers. The crust is the thinnest, outer layer. The mantle lies beneath the crust.

Plates

Earth's surface is broken into several huge plates of rock. *Plates* are made of crust and the upper part of Earth's mantle. The crust and mantle are solid but the upper mantle can flow. When the mantle flows, Earth's plates move.

Earth's plates move about as slowly as your fingernails grow. The moving plates get pushed and pulled, changing the crust. You cannot see or feel most of the changes. Others you cannot miss!

Mountains in the Making



Fault-block mountain can form where plates get pushed or pulled.

Faults

As plates get pushed and pulled, cracks called faults form in the crust. A **fault** is a crack in the crust along which movement takes place.

Rocks on either side of a fault can slide up or down compared to the other side. Faults can sometimes form *fault-block mountains*. If the lifting is spread over a wide area, a plateau (pla•TOH) may form. A **plateau** is a high landform.

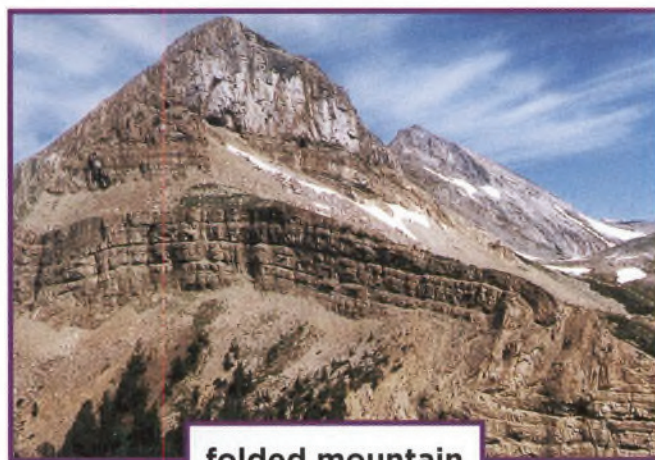
Folds

Some plates meet at the edges of continents. If the land scrunches up between them, a fold forms. A **fold** is a bend in the rock layers.

If the land keeps scrunching, folds become mountains. A **mountain** is a tall landform. As time passes, wind and rain can break off pieces and change the shape of the mountain.



fault-block mountain



folded mountain



Quick Check

Cause and Effect What are two ways that mountains can form?

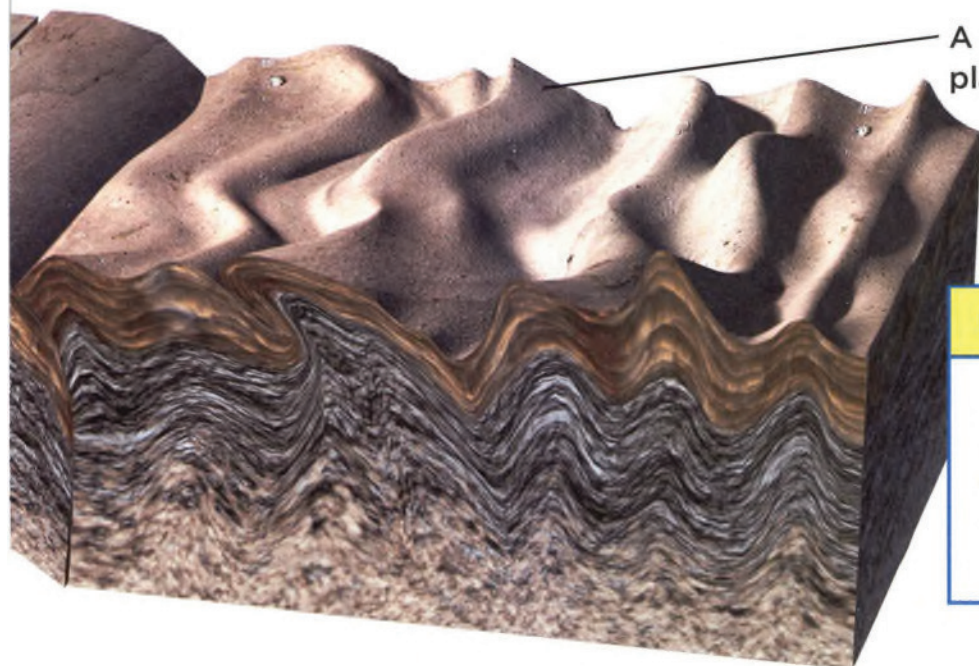
Critical Thinking Why do mountains form at only some places on Earth?

A folded mountain can form where plates slide toward each other.

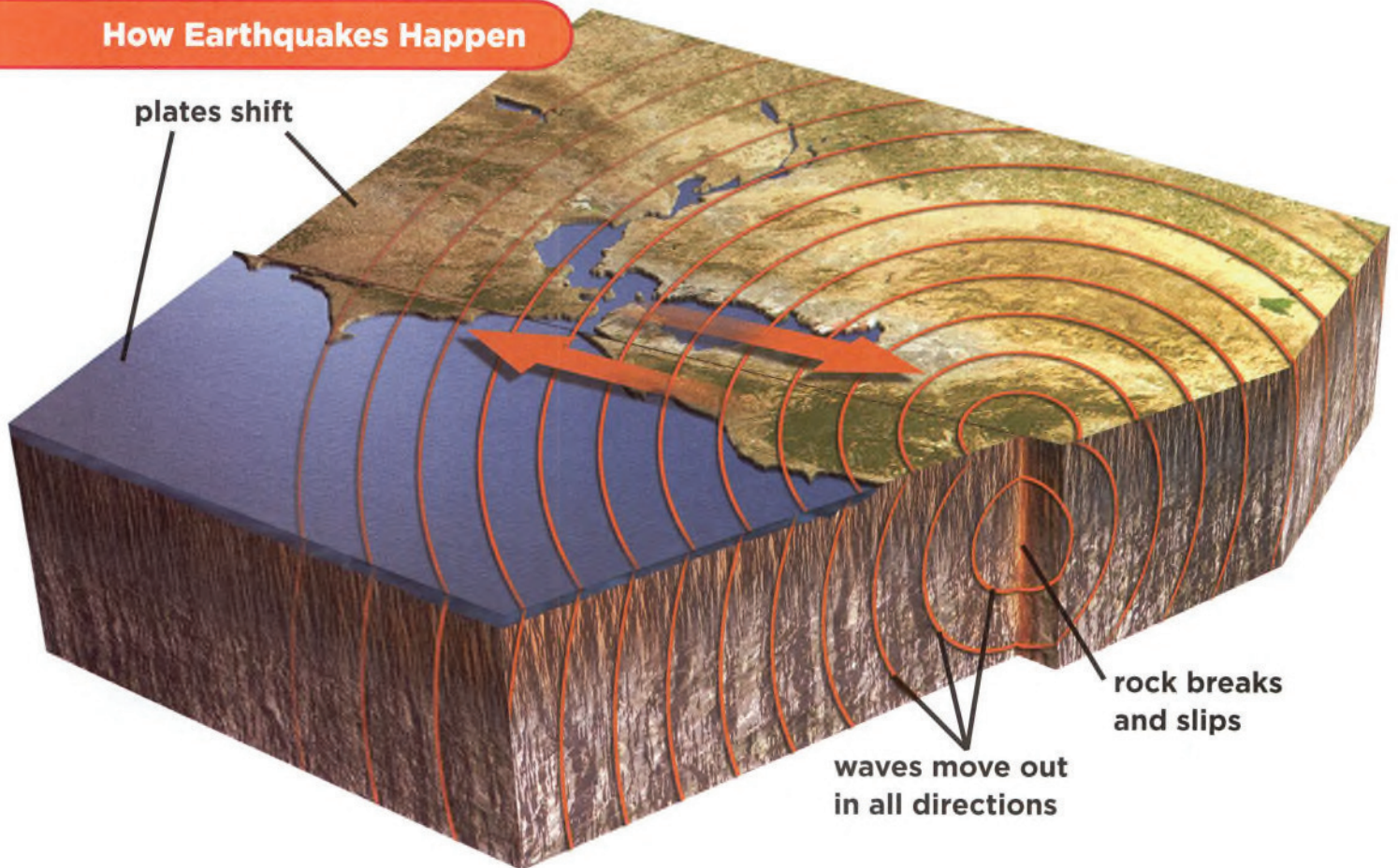
Read a Diagram

Compare how fold mountains and fault-block mountains form.

Clue: Look for the differences between the two kinds of mountains in the diagram.



How Earthquakes Happen



What causes earthquakes?

An **earthquake** is a sudden shaking of Earth's crust. It is caused by sudden movement along a fault. When forces push and pull a plate, energy builds up. Earth's crust may store this energy for many years. Then suddenly, the energy is released. The rock breaks apart and moves along the fault! Earthquakes are common in places with active faults, like parts of Alaska and California.

How Earthquakes Travel

An earthquake begins below the ground. The energy released by a sudden movement shakes the crust. Vibrations, or waves, move through Earth in all directions.

Did you ever drop a pebble in water? The waves of an earthquake travel like the ripples of water. As they move away from the center of the earthquake, the waves weaken. Even so, you may feel them at the surface hundreds of miles away from the center!

Earthquake Safety

Most earthquakes are too weak to notice. Others can cause extreme damage. During a major earthquake, buildings and roads may break apart. Bridges might collapse.

Do you know what to do if the ground below you starts to shake? You can stay safe in an earthquake by following a few simple rules. If you are indoors, duck under a table or doorway. Keep away from walls and windows. If you are outdoors, stay away from trees, power lines, and anything that might fall down.

Earthquakes in the Ocean

Some earthquakes strike below the ocean. If an earthquake is strong enough, it can cause the ocean crust to lift suddenly. When this happens, look out! A giant wave, called a *tsunami* (soo•NAH•mee), might hit the shore. Tsunamis cause great damage along coastlines. They can destroy everything in their path.



Quick Check

Cause and Effect How can an earthquake cause a tsunami?

Critical Thinking How can you stay safe if a tsunami is coming?

▼ Modern buildings can stand up to most earthquakes. This older building in San Francisco was damaged by an earthquake.



How do scientists study earthquakes?

Any movement can cause a vibration. **Seismic waves** are the vibrations caused by earthquakes.

When an earthquake strikes, seismic waves travel out from the source in all directions. The waves move at different speeds. Some of the waves travel along or near Earth's surface. Others travel through Earth's interior.

Measuring Seismic Waves

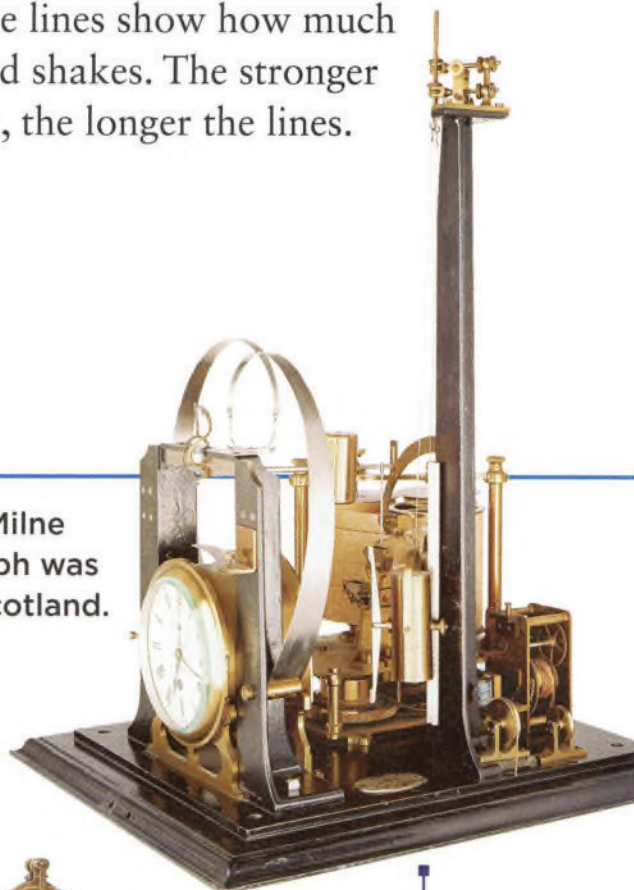
Scientists measure seismic waves with an instrument called a seismograph (SIZE•muh•graf). A **seismograph** detects and records earthquakes. It shows seismic waves as jagged lines along a graph. The lines show how much the ground shakes. The stronger the quake, the longer the lines.

Time Line of Seismic Study

Chang Hêng's seismoscope was invented in China.



The Gray-Milne seismograph was made in Scotland.



This seismoscope was invented in Italy.



A.D. 132

1856

1885

Seismic Networks

When an earthquake hits, one of the first questions is “Where was it?” Earthquake scientists have a network of seismographs around the world. They collect data from each seismic station. Then they calculate the location and depth of the quake.

✓ Quick Check

Cause and Effect

What causes seismic waves?

Critical Thinking Why do the seismic wave readings shown below have different heights?

Quick Lab

Hearing Clues

- 1 Your teacher will give you containers. Make a plan to find out what they hold without opening the containers.
- 2 **Observe** Carry out your plan. Be sure not to damage the containers. Record your observations.
- 3 **Interpret Data** Study your data. What clues do they provide?
- 4 What do you think is inside each container? Make a diagram to help explain your ideas.



Ocean Bottom Seismographs were invented in the United States.



Wiechert's seismograph was invented in Germany.



1899

1937

Read a Diagram

How have seismographs changed over time?

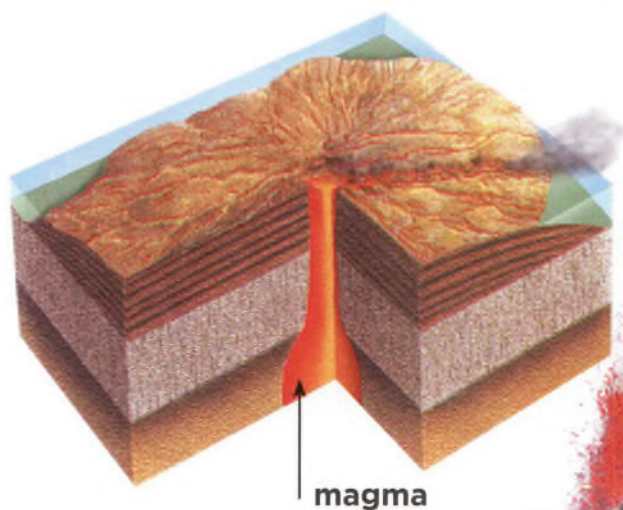
Clue: Follow the time line from left to right.

What is a volcano?

A **volcano** is a mountain that builds up around an opening in Earth's crust. Sometimes a volcano will force materials from Earth's interior out of its opening. Scientists call this event an *eruption*.

A volcanic eruption can send out melted rock, gases, ash, or rocks into the air. Melted rock is called *magma*. Once magma reaches Earth's surface, it is called *lava*. By erupting often, a volcano can build a large mountain. Each eruption can add layers of lava and ash. The lava cools and hardens into rock.

Some volcanoes rest quietly for many years until they erupt suddenly. Others erupted often in the past but will never erupt again.



Where Volcanoes Form

Most volcanoes occur at the edges of plates. When two plates meet, one can sink below the other. As it sinks, the plate gets hotter. The rock melts into magma. The magma rises and forms a volcano.

Volcanoes also form where Earth's plates move apart. The space between the moving plates allows magma to rise to the surface.

Some volcanoes form far away from plate edges. These *hot spots* are places where Earth's crust is very thin. Magma can easily break through to the surface. The islands of Hawaii formed over a hot spot in the Pacific Ocean. The islands are the tops of huge volcanoes that rose from the ocean floor.

✓ Quick Check

Cause and Effect How can volcanic eruptions build mountains?

Critical Thinking When should you stay a safe distance away from a volcano?

Volcanoes still build the Island of Hawaii.

Lesson Review

Visual Summary



Earth's crust and upper mantle are divided into slow-moving plates. **Mountains** may form where plates meet.



An **earthquake** is a sudden shaking of Earth's crust. It begins along a fault, releasing seismic waves.



A **volcano** is an opening in Earth's crust to the magma below. Volcanoes can build mountains.

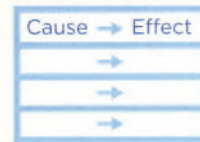
Make a **FOLDABLES** Study Guide

Make a trifold book. Use it to summarize what you read about Earth's moving crust.



Think, Talk, and Write

- Vocabulary** What do we call the vibrations from an earthquake?
- Cause and Effect** What are three ways that mountains are built?



- Critical Thinking** Earth's plates move slowly. Why do earthquakes happen suddenly?
- Test Prep** Which instrument measures earthquakes?
 - A scientist
 - B seismic wave
 - C seismology
 - D seismograph
- Essential Question** How can Earth's crust change?



Math Link

Measuring Distance

One kind of seismic wave moves through rock at 7 km per second. How long would it take such a wave to travel from San Francisco to New York—a distance of 4,100 km?



Social Studies Link

Research and Report

In the year A.D. 79, Mount Vesuvius erupted in Italy. Ash quickly covered the city of Pompeii. Research and report on this event. Describe the effect of the eruption.






Meet Ro Kinzler

Ro Kinzler is fascinated by volcanoes and volcanic rocks. She would go just about anywhere to find out more about them. Ro is a scientist at the American Museum of Natural History.

Ro travels to the Cascades in Northern California to collect lava samples from active volcanoes like Mount Shasta and Medicine Lake. She wants to study how magma moves through Earth. Back in the lab, Ro does experiments. She heats and squeezes the lava samples to find out how they formed deep in Earth.



Ro's favorite place to collect lava samples is Kilauea volcano in Hawaii.



Lava is melted rock that cools at Earth's surface.

You don't find volcanoes only on land. There are lots of them on the ocean floor. Ro and other scientists have gone to the bottom of the ocean to study volcanoes. They use small underwater vehicles called submersibles.

The scientists visited the Mid-Atlantic Ridge, part of the longest volcano chain in the world. Ro is one of the few people to have ever seen it. She peered out the portholes of the submersible *Alvin* with other scientists. They made careful observations. They used these observations to make maps of the ocean floor.



▲ *Alvin* is a submersible that can take scientists to the ocean floor.

Cause and Effect

- ▶ The cause answers the question "Why did something happen?"
- ▶ The effect answers the question "What happened as a result?"



Write About It

Cause and Effect Read the article with a partner. Fill out a cause-and-effect chart to record why Ro visits volcanoes and collects lava samples. Tell what happens as a result of her work.



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Lesson 3

Weathering and Erosion

Look and Wonder

Once this sea arch was a continuous piece of rock. Now you can see through it. How did this arch form in the limestone cliffs of Normandy, France?

How can rain shape the land?

Make a Prediction

Water always moves down a slope. What happens when it rains? Make a prediction that tells how rainfall shapes the land.

Test Your Prediction

- 1 **Make a Model** Pile a mixture of potting soil, sand, and pebbles at one end of a pan. Shape the mixture into a sloping hillside.
- 2 Use a spray bottle to simulate rain. Spray at an even rate until the hillside is soaked.
- 3 **Observe** Continue the rain at the same rate. Observe what happens to the hillside. Record your observations.

Draw Conclusions

- 4 **Communicate** Did your results match your prediction? Explain what happened to the model land.
- 5 **Infer** How is your model like the real world? Use evidence from your observations.

Explore More

Does the rate of rainfall affect the amount of land that moves downhill? What variables must you control to test a hypothesis? What variable would you change? Try it. Report your results.

Materials



- potting soil
- sand
- pebbles
- shallow pan
- spray bottle with water

Step 2



Read and Learn

Essential Question

What forces shape and change Earth's landforms?

Vocabulary

weathering, p. 226

erosion, p. 228

deposition, p. 229

terminus, p. 231

moraine, p. 231

Reading Skill ✓

Classify

Technology



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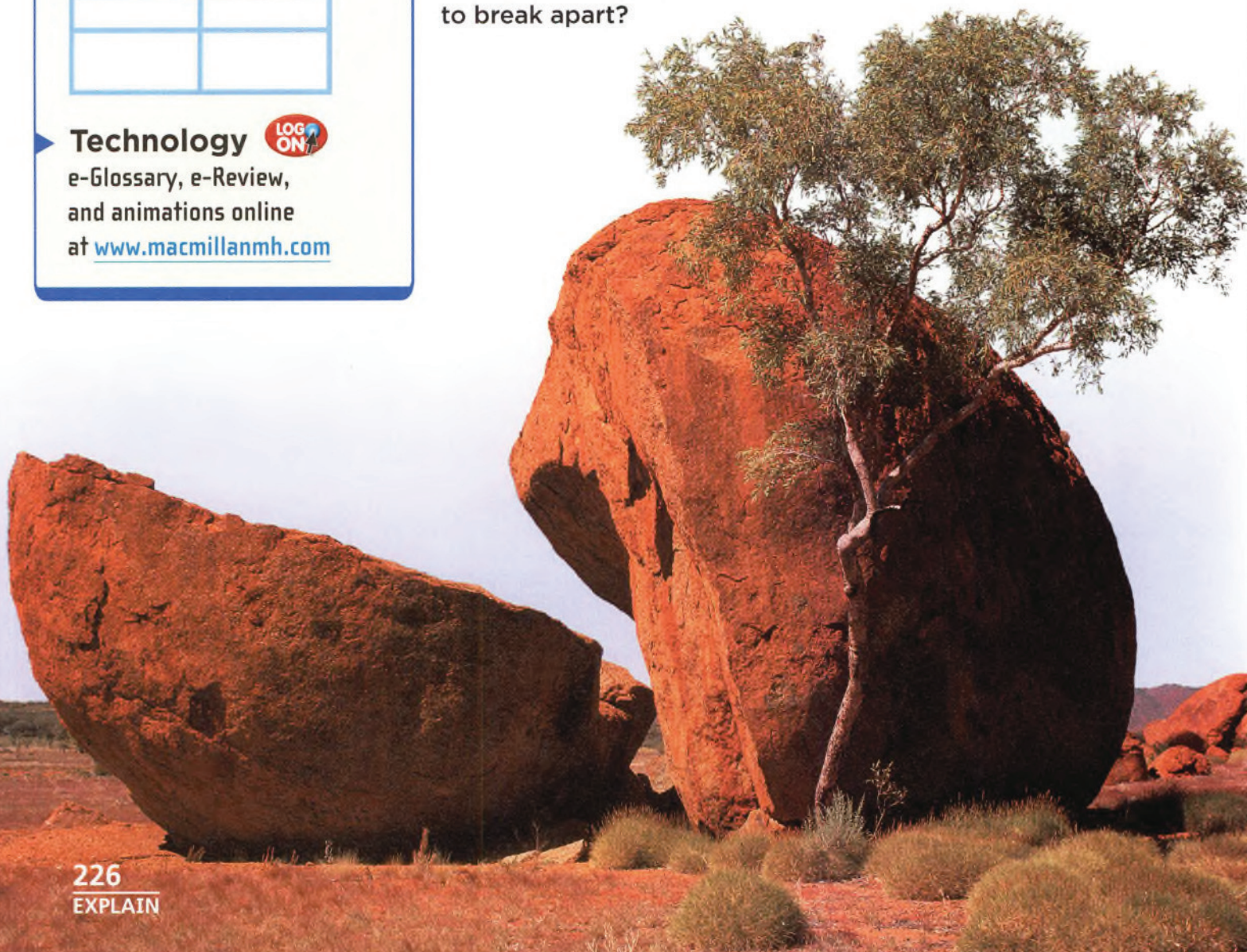
What is weathering?

Every day, rocks move and change shape as the wind blows and rain falls. Look at the rock below. What happened to it?

Even the largest boulder can break apart over time. **Weathering** is the slow process that breaks rocks down into smaller pieces. Flowing water, rain, and wind are some causes of weathering.

In the distant future, the rock below will probably look very different. It may break into pieces the size of pebbles or even smaller!

What caused this boulder to break apart?





▲ Chemical weathering can form limestone caves like this one in Brazil.

Physical Weathering

Rocks can change size and shape without changing their chemical makeup. This process is called *physical weathering*.

Flowing water from streams and rivers can make sharp rocks smooth. Waves crashing onto a cliff can break off small pieces of land. Rainfall may seep through small cracks in a rock. Cycles of freezing and melting can widen the cracks.

Living things also cause physical weathering. Plant roots can force their way through cracks in a rock. As the plant grows, its roots get stronger. The strong roots can break the rock apart.

Chemical Weathering

Chemical weathering changes the minerals that make up rocks. Oxygen, acids, and carbon dioxide all cause chemical weathering. They change minerals into new substances.

Have you ever seen an iron chain get rusty? Water and air change iron into rust. Rocks that have iron in them can rust too. Water and carbon dioxide can form limestone caves. Even living things, such as lichens, can soften the rocks they grow on.



Quick Check

Classify What are the two kinds of weathering?

Critical Thinking Where might you find examples of weathering?

What is erosion?

Have you ever built a sand castle at the beach? Did waves wash it away? Waves crash against the shores of oceans and lakes all the time. They pick up beach sand and small rocks. Then they carry the pieces away.


The weathering and removal of rock or soil is called **erosion**. Weathering and erosion shape the land.

Causes of Erosion

Flowing water is one cause of erosion. Rainwater carries particles into streams and rivers. The moving water then flows downhill and carries them along. The particles in water can carve valleys into rock.

Waves and wind also pick up small pieces of rock and put them somewhere else. Gravity moves rocks downhill. Glaciers carve through land as they slide over it.

Evidence of erosion is all around you. You can find grooves carved into ancient rocks by erosion. Or look closely at a handful of sand. Over time, weathering and erosion can turn a sharp, rocky peak into a smooth, round one.

A hiker with a backpack is standing on the peak of a tall, narrow rock column. The rock is reddish-brown and has a jagged, weathered appearance. The background is a clear blue sky.

These tall columns of rock are called *hoodoos*. They were shaped by frost and sudden rain.

Rivers Erode the Land

The Grand Canyon in Arizona shows how powerful a river can be. The canyon is 446 km (277 mi) long. It has an average depth of 1.6 km (1 mi). This huge space was carved over millions of years by the Colorado River.

Rivers and streams pick up bits of rock and soil as they flow over land. Some of the pieces get deposited, or dropped off, on riverbanks. Others get carried to the mouth of the river.

Deposition

Deposition is the dropping off of weathered rock. Deposition by water builds up deltas, riverbanks, and beaches. Deposition by wind forms sand dunes.



Quick Check

Classify What processes erode land? What processes deposit it?

Critical Thinking How do rivers cause weathering and erosion?

Rivers Shape the Land

Read a Photo

In your own words, describe how this canyon in Utah probably formed.

Clue: Observe the sides of the canyon. Look where the water is located.



Science in Motion Watch how a river shapes the land at www.macmillanmh.com

How do glaciers shape the land?

In very cold places, thick sheets of ice called *glaciers* (GLAY•shurz) creep over the land. Over one million years ago, glaciers began to cover much of Earth. Few places are cold enough for glaciers today.

Glaciers form where snow collects quickly and melts slowly. Year after year, the snow builds higher. The weight on top of the mound puts pressure on the snow below. The bottom of the glacier slowly turns to ice. Near the ground, some ice melts.

Carving the Land

As the weight of the ice increases, the glacier begins to flow. The bottom and sides freeze onto rocks. As the glacier continues to move, it tears rocks from the ground. It scratches, flattens, breaks, or carries away the things in its path. A glacier can make a valley wider and steeper.

A glacier carved this valley in Alaska. ▼



A Glacier Deposits Land

moraine

moraine

What Glaciers Leave Behind

You have read how glaciers erode the land. Glaciers also deposit eroded rock. As glaciers melt, they leave behind the rocks they carried. The leftover rocks are called *glacial debris* (GLAY•shul duh•BREE).

Glacial debris can be made of large boulders or small particles. It can have bits of gravel, sand, and clay. The glacier drops most of this debris at its downhill end, or **terminus**.

Have you ever seen a giant boulder all by itself in a field? It was probably glacial debris. More often, glacial debris is a mix of small rocks, gravel, sand, and clay. The mixture is called *glacial till*.

Materials that a glacier picks up or pushes can form mounds. These mounds are called **moraines**. Today, you can find glacial till and moraines across Canada and northern parts of the United States.

Read a Diagram

How does a glacier change the land as it melts?

Clue: Trace the glacier's path from the top of the hill to the terminus.

terminus

glacial till

Quick Lab

Scratch, Scratch

- 1 Compare two ice cubes—a plain one and one with sand or gravel.
- 2 Rub each cube over a material, such as waxed paper or aluminum foil. Compare the effects of each material on each ice cube.
- 3 **Observe** Place the ice cubes in separate dishes. Allow them to melt. Observe what happens.
- 4 **Infer** How do the two ice cubes act like glaciers?



Quick Check

Classify Which landforms do glaciers erode? Which do they deposit?

Critical Thinking How do glaciers compare to other causes of weathering and erosion?

How do people shape the land?

Most processes in nature change Earth's land very slowly. People can make faster changes.

Mining

One way people change the land is by mining it. *Mining* is digging into the land for useful resources like minerals, metals, or fuel.

Landfills

Landfills are places where people pile trash. Some form large mounds or hills. Some are covered with soil and plants to blend in with the land.

Forests

People need land to build farms, and homes. Often people cut down or burn forests to clear the land. The trees are used to make products. Without the trees, erosion easily washes away the soil.



▲ You can help the land by planting and caring for trees.



Quick Check

Classify List some of the ways people shape the land. Are these helpful or harmful to the land?

Critical Thinking Think of other helpful ways that people shape the land.

Part of this evergreen forest has been cut down. ▼



Lesson Review

Visual Summary



Weathering is the breaking down of rock into smaller pieces. Two kinds of weathering are physical and chemical.



Erosion is the removal of weathered rock. Deposition is the dropping off of eroded rock.



People change the land in many ways. These changes can be helpful and harmful to the land.

Make a FOLDABLE[®] Study Guide

Make a three-tab book. Use it to summarize what you read about weathering and erosion.



Think, Talk, and Write

- Vocabulary** Glacial debris collects at the _____ of a glacier.
- Classify** List examples of physical weathering and examples of chemical weathering.

- Critical Thinking** Compare natural weathering and erosion to changes that people make to the land.
- Test Prep** Which of the following is most likely to carve a canyon into Earth's crust?
 - A chemical weathering
 - B wind
 - C moving water
 - D waves
- Test Prep** Which is made of deposited materials?
 - A a moraine
 - B a mountain
 - C a valley
 - D a river

- Essential Question** What forces shape and change Earth's landforms?



Math Link

Measuring Distances

A glacier advances 6 meters every year. How long will it take for the glacier to move a distance of 1,000 m?



Social Studies Link

Study a Map

Study a road map of Colorado, Utah, Montana, or another state that has mountains. Compare the roads and cities to the paths of rivers.



Land over Time

Mountains may seem like mighty giants. But are they? Weathering can break down even the strongest mountains. How does this happen?

Wind carries the seeds of plants from place to place. A seed can land on a patch of soil on rock. There the seed sprouts. The roots find small cracks in the rock.

As the roots grow, rainwater fills the cracks in the rock. If it gets cold enough, the water freezes into ice. The ice expands. The cracks widen. All this time, the roots grow bigger.

At some point, the cracks widen so much that pieces of rock break off. In time, these pieces get smaller. Over millions of years, weathering can break down an entire mountain!



Write About It

Expository Writing Write a paragraph that summarizes “Land over Time.” Include the main idea and the most important details.

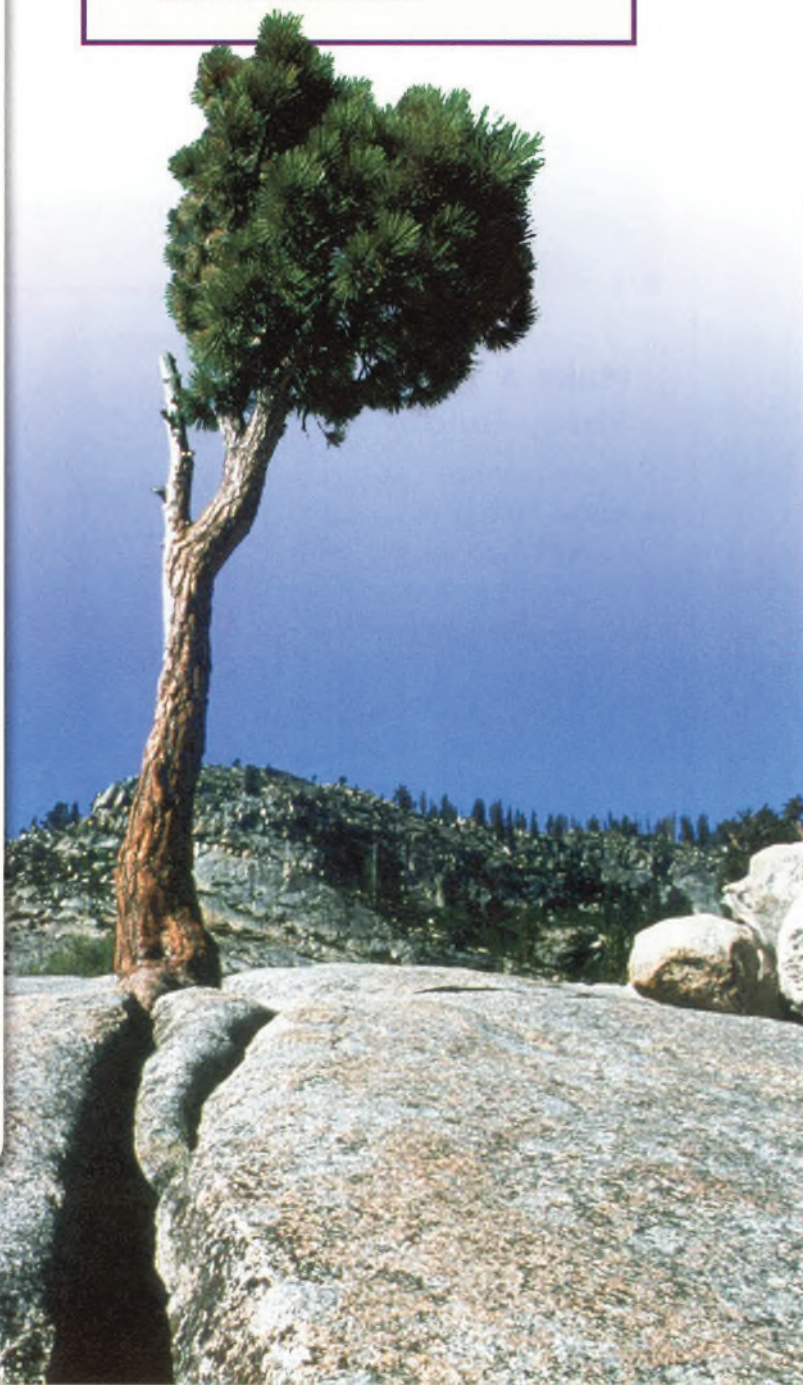


-Journal Research and write about it online at www.macmillanmh.com

Expository Writing

Good expository writing

- ▶ presents the main idea in a topic sentence;
- ▶ supports the main idea with facts and details.



DISAPPEARING MOUNTAINS



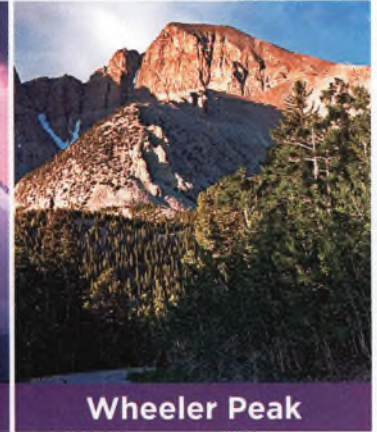
Mount McKinley



Mount Whitney



Mount Shasta



Wheeler Peak

This table shows the heights of some mountain peaks in the United States.

Heights of Mountain Peaks			
Mountain	State	Height in Meters	Height in Feet
Mount McKinley	Alaska	6,194	20,320
Mount Whitney	California	4,417	14,491
Mount Shasta	California	4,317	14,162
Wheeler Peak	Nevada	3,982	13,065

Mountains erode by small amounts. Suppose Mount McKinley erodes 2 m each year. How many years would it take for the mountain to be 6,174 m tall?



Solve It

If the erosion rate is 1 m each year, what will be the height of:

1. Mount Shasta in 20 years?
2. Mount Whitney in 15 years?
3. Wheeler Peak in 80 years?

Problem Solving

- To find the number of years, you can count backward by 2 from 6,194 m to 6,174 m.

6,192 6,190
6,188 6,186
6,184 6,182
6,180 6,178
6,176 6,174

It would take 10 years.

- Another way is to find the number of meters lost. Then you can divide the difference of meters by 2.
 $6,194 \text{ m} - 6,174 \text{ m} = 20 \text{ m}$
 $20 \div 2 = 10$
 It would take 10 years.

Lesson 4

Changes Caused by the Weather

Look and Wonder

This house in Washington state is in a strange position. How did it get that way? What caused the damage?

How does steepness of slope affect the movement of Earth's materials?

Form a Hypothesis

We sometimes see evidence of sliding rocks and soil at the bottom of a hill. How does the steepness of a slope affect the downhill movement of rocks and soil? Write a hypothesis.

Test Your Hypothesis

- 1 Stir equal amounts of soil, gravel, and sand in the pan. Pat the mixture into a flat layer.
- 2 **Predict** What will happen when you raise one end of the pan? Record your prediction.
- 3 **Observe** Raise one end of the pan 4 centimeters. Record what happens. Continue raising that end by 4 cm at a time until the pan is nearly upright. Record your observations each time.

Draw Conclusions

- 4 **Interpret Data** How did raising the end of the pan affect your results?
- 5 What is the relationship between steepness of slope and the movement of soil and rocks?

Explore More

How do sudden downpours of rain affect very steep slopes? How could you test this? What variable would you control? What variable would you change? Try it. Report your results.

Materials



- deep aluminum pan
- measuring cup
- potting soil
- gravel
- sand
- metric ruler

Step 1



Step 3



Read and Learn

Essential Question

How does weather shape and change the land?

Vocabulary

flood, p. 238

tornado, p. 240

hurricane, p. 240

landslide, p. 242

avalanche, p. 242

Reading Skill



Infer

Clues	What I Know	What I Infer

Technology



e-Glossary and e-Review online at www.macmillanmh.com

How do floods and fires change the land?

You have learned how erosion and deposition change the land slowly. What causes Earth's surface to change quickly?

Floods

Heavy rain or quickly melting snow can cause water to flow over the land. The water may not soak into the ground completely. It runs on top of the land. It flows into streams and rivers. The extra water may spill over the sides, or banks, of streams and rivers. Then it floods (FLUDZ) the nearby land. A **flood** is an overflow of water onto land that is normally dry.

Cities flood when water drains cannot carry water away fast enough. The drains overflow. The streets become flooded.

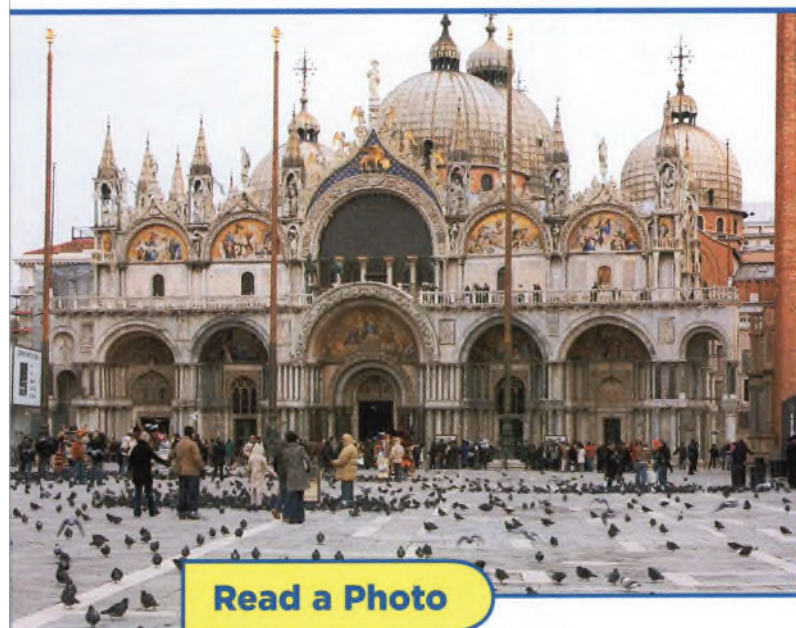
Floods can carry mud into homes and streets. The mud and water cause damage. Floodwaters erode the soil quickly. They can wash away trees and anything else in their path.

Floods also serve a purpose in nature. After a flood, new soil is deposited on the land. The nutrients in this soil help plants grow.

Fires

When there is too little rain, fires are likely. Many are caused by lightning. A fire can quickly change a forest into a field of charred tree trunks. Forest animals lose their habitats. Grassland fires are fueled by dry plants and spread by winds. Most places recover from natural fires.

Before and After



Read a Photo

How can floods and fires change the land?

Clue: Compare the photo of a flood and the photo of a fire.

Fire Safety

Carelessness also causes fires. People can prevent wildfires by being safe around campfires and cookouts. Do not light fires in dry areas. Never play with matches.



Quick Check

Infer What kinds of weather cause floods and fires?

Critical Thinking How can people prevent forest fires?

How do storms change the land?

Have you ever heard the saying “When it rains, it pours”? A light shower might form a few puddles here and there. A severe storm can change the land.

Tornadoes

A thunderstorm can spin off a violent storm called a tornado (tor•NAY•doh). **Tornadoes** are columns of spinning wind. They move across the ground in a narrow path. As they move, tornadoes whip up or destroy everything in their path.

Tornadoes are common in the Great Plains region of the United States. In fact, a certain path through that region is known as “Tornado Alley.”

Hurricanes

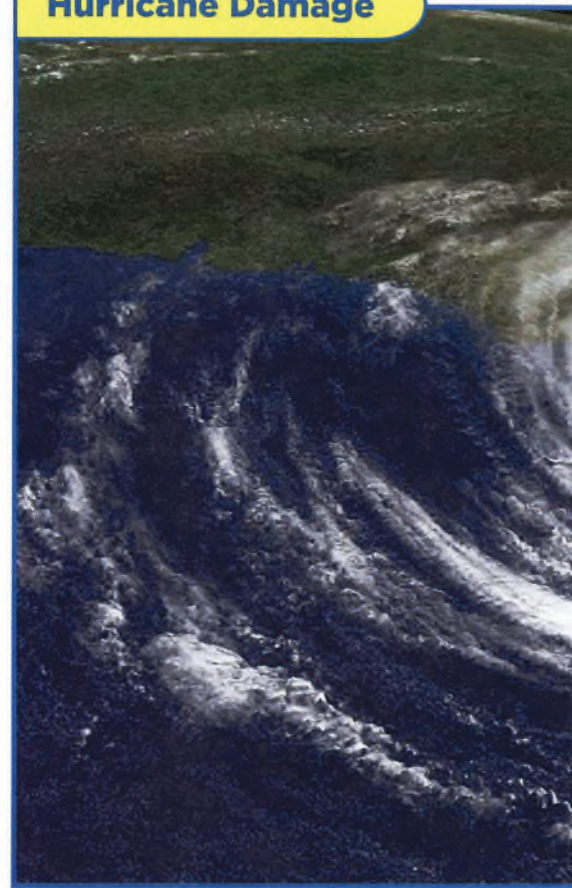
If you live near an ocean or the Gulf Coast, you may have experienced a hurricane. A **hurricane** is a very large, swirling storm. At its center, or eye, is an area of very low pressure. Strong winds, walls of clouds, and pounding rains surround the eye.

A hurricane is much bigger than a tornado. It can span hundreds of kilometers. It also lasts longer.

Hurricanes form over warm oceans near the equator. They whip up large waves as they travel. When a hurricane moves toward a coast, winds and waves can force water onshore. Massive floods can occur. Heavy rains add to the flooding. The damage does not stop there. When it is over land, a hurricane can uproot trees and flatten buildings. It can change an entire ecosystem in one day.

Hurricanes are becoming more common in some places. Scientists are finding that higher temperatures are a factor.

Hurricane Damage



Quick Lab

Storms at the Beach

- 1 Make a Model** Pour and press sand into one end of a long pan. This is your beach. Add water to the other end. The water should come up to the lower edge of the beach.
- 2** Make waves by moving a ruler back and forth in the water. Observe how the beach changes. Continue observing as you move the ruler more quickly, making taller waves.
- 3 Infer** Storms bring taller, stronger waves. How do storms and waves affect beach erosion?



Read a Photo

How can a hurricane change people's lives?

Clue: Think about the people who live or work in the place shown below.



Quick Check

Infer Why is it useful to predict storms?

Critical Thinking How are tornadoes similar to hurricanes? How are they different?

How do landslides change the land?

Have you ever seen a pile of rocks at the bottom of a slope? How did they get there? Part of the answer is gravity. *Gravity* pulls rocks and other objects from high places to low places.

Heavy rains can cause loose rock and soil to move quickly down a slope. A **landslide** is the sudden downhill movement of these materials in large amounts.

An avalanche (A•vuh•lanch) is similar to a landslide. In an **avalanche**, tons of ice and snow rush down a mountain.

Scientists work to predict when and where landslides and avalanches happen. They never know when one will strike. It pays to be extra careful when you are near mountains.

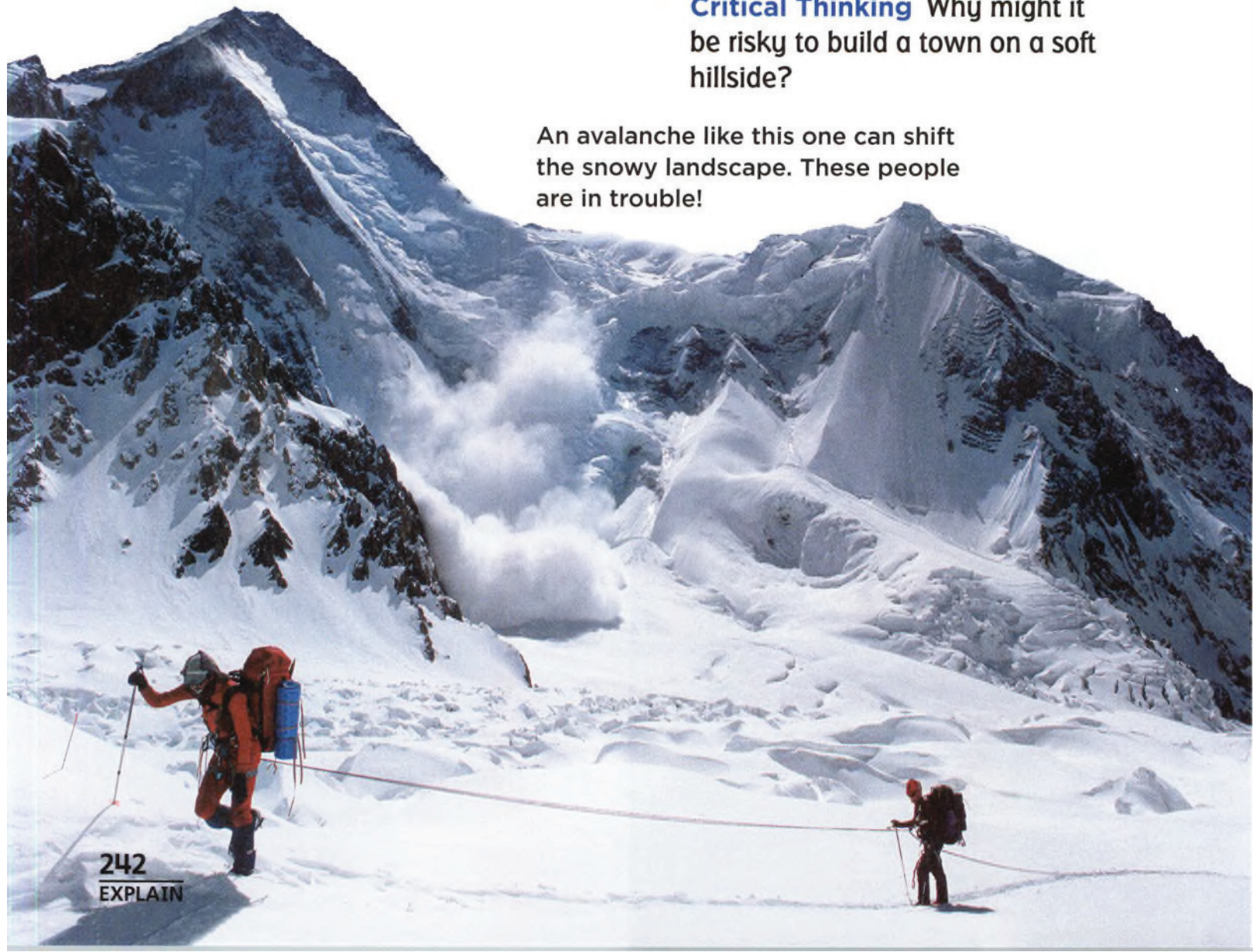


Quick Check

Infer Near which landforms would landslides likely take place?

Critical Thinking Why might it be risky to build a town on a soft hillside?

An avalanche like this one can shift the snowy landscape. These people are in trouble!

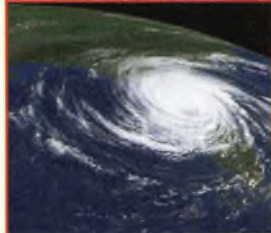


Lesson Review

Visual Summary



Too much rain can cause **floods**. Too little rain can lead to fires. Both can change the land quickly.



Tornadoes and hurricanes are powerful storms that shape the land quickly.



In **landslides and avalanches**, large amounts of land, ice, or snow slide downhill suddenly.

Make a **FOLDABLES** Study Guide

Make a trifold book. Use it to summarize what you learned about changes caused by the weather.



Think, Talk, and Write

- Vocabulary** What word describes a large, sudden movement of ice or snow downhill?
- Infer** A photograph shows fallen palm trees along a beach. The beach is in the southeastern United States. What kind of event most likely caused this result? Fill in the graphic organizer to show your thinking.

Clues	What I Know	What I Infer

- Critical Thinking** Some radios are powered by batteries. How could such a radio help you prepare for a severe storm?
- Test Prep** Which of these events can help plants grow?
 - A hurricanes
 - B tornadoes
 - C forest fires
 - D landslides
- Essential Question** How does weather shape and change the land?



Writing Link

Write a Newspaper Report

Research a recent hurricane or tornado. Write a newspaper report describing the storm. Include facts and details. Support your report with comments from witnesses.



Social Studies Link

Research an Event

New Hampshire was once home to a rock formation called "Old Man of the Mountain." Find out what happened to the "Old Man." Describe the event that changed it.



Materials



aluminum pan



modeling clay



water



colored pencils



paper



soil and gravel



plastic cup

Structured Inquiry

What happens to the environment when a river floods?

Form a Hypothesis

Rivers can move large amounts of materials from one place to another. These materials include minerals and bits of rock. When a flood erodes the sides of a river, where do the materials go? Write your answer in the form "If a river floods, the materials in the water will be deposited..."

Test Your Hypothesis

- 1 Make a Model** Construct a model river and surrounding land. Mold clay inside an aluminum pan to form a flat river bottom. Flatten the land as well.
- 2** Pour just enough water into the river to fill it. Draw your model.
- 3** Make floodwater by mixing soil and gravel in a cup of water.
- 4** Pour the floodwater into the river. Where does the water go? Draw the flooded river area on a sheet of paper.
- 5 Observe** Let your flooded land dry overnight. Observe and record any changes the next day. Draw your river area again.
- 6 Communicate** Describe the materials that were deposited on the land.



Draw Conclusions

- 7 What happened to your landscape when the river overflowed?
- 8 **Infer** How might floods help plants, animals, or farmers on the land surrounding a river?

Guided Inquiry

How does the amount of water affect damage?

Form a Hypothesis

How can the amount of water in a flood affect the amount of damage to the land? Write your hypothesis in the form "As the amount of floodwater increases, the amount of material carried away by the water..."

Test Your Hypothesis

Design an investigation to test your hypothesis. Write out the materials you need and the steps you will follow. Record your observations and results.

Draw Conclusions

Did your results support your hypothesis? Why or why not? Explain how you set up the experiment to test for only one variable.

Open Inquiry

What can you learn about floods? For example, what types of soil are most likely to wash away during a flood? Design an investigation to answer your question. Test one variable at a time. Write your procedure so that another group can repeat the investigation by following your instructions.

Remember to follow the steps of the scientific process.

Ask a Question



Form a Hypothesis



Test Your Hypothesis



Draw Conclusions

CHAPTER 5 Review

Vocabulary

DOK I

Visual Summary



Lesson 1 Landforms such as mountains and valleys cover Earth's crust. Earth's interior is made of four layers.



Lesson 2 Earth's surface is broken into large plates. The plates move slowly. Many landforms form at the plate edges.



Lesson 3 Weathering, erosion, and deposition are slow processes that shape the land.



Lesson 4 Floods, fires, storms, avalanches, and landslides can change the land quickly.

Make a **FOLDABLES®** Study Guide

Tape your lesson study guides to a piece of paper as shown. Use your study guide to review what you have learned in this chapter.



Fill in each blank with the best term from the list.

crust, p. 208

hurricane, p. 240

deposition, p. 229

inner core, p. 208

erosion, p. 228

moraine, p. 231

fault, p. 215

volcano, p. 220

flood, p. 238

weathering, p. 226

1. A crack in Earth's crust along which movement occurred is called a(n) _____.
2. Physical _____ is a process that changes only the size of rock.
3. The sphere of solid material at the center of Earth is the _____.
4. A mound called a(n) _____ is formed by glaciers.
5. Heavy rainfall can cause a(n) _____.
6. Earth's landforms are found on the _____.
7. A large, swirling storm with strong winds and heavy rain is called a(n) _____.
8. The _____ of weathered rock particles by a river forms a delta.
9. When gravity, waves, wind, and glaciers weather and transport rock, _____ happens.
10. When a(n) _____ erupts, magma, ash, and gases are sent into the air.

Skills and Concepts

DOK 2-3

Answer each of the following.

11. **Infer** Why do volcanoes often appear near the edges of plates rather than at the center of plates?
12. **Make a Model** Design a way to show how wind causes erosion. Use a flat container, straw, and sand as your materials. How does wind move the different materials? Explain your results.
13. **Critical Thinking** How do scientists get information about Earth's layers?
14. **Expository Writing** Explain how snow can cause weathering and erosion.



15. **Cause and Effect** How do mountains form at faults?
16. **Predict** A field is plowed just before a heavy rainstorm. What effect will the rainstorm have on the recently plowed soil?
17. **True or False** *Canyons form by wind erosion.* Is this statement true or false? Explain.
18. **True or False** *The Grand Canyon reaches into Earth's mantle.* Is this statement true or false? Explain.

19. Which phrase best completes the following sentence? The Hawaiian Islands were formed by

A volcanoes. **C** folding.
B glaciers. **D** faulting.

20. What causes Earth's surface to change?



Performance Assessment

DOK 3

Make a Tornado

1. Place rock, soil, and other heavy materials in the bottom of a bucket. Fill the bucket with water.
2. Place a large spoon or stick in the bucket. Swirl it around rapidly to model a tornado in the water.
3. Describe what happens to the materials you placed in the bottom of the bucket.

Analyze Your Results

Explain how the objects in the water reacted to the model tornado. Were there any differences between the materials? How does the tornado you made compare to an actual tornado?



Test Preparation

- 1** The picture below shows rocks and sand along the side of a stream.

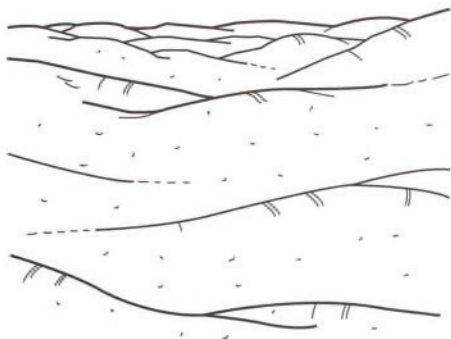


The settling of rocks and sand is an example of which process?

- A** deposition
- B** weathering
- C** eruption
- D** transport

DOK 1

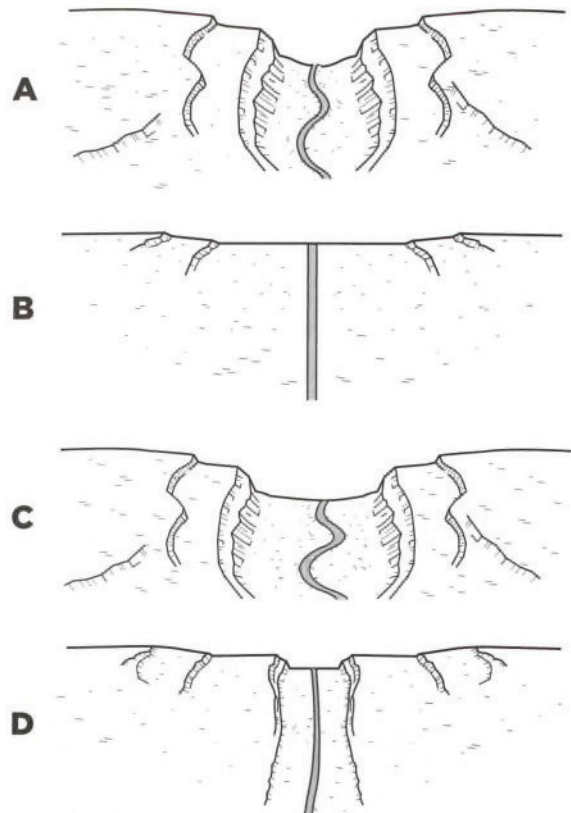
- 2** What most likely caused these desert landforms?



- A** rain
- B** wind
- C** flowing water
- D** freezing water

DOK 2

- 3** Which most likely shows the oldest river?



DOK 2

- 4** Over time, which of these can form over a hot spot?

- A** a delta
- B** a fault
- C** a fold
- D** an island

DOK 1

5 All of these are causes of erosion except

- A** gravity.
- B** moving water.
- C** wind.
- D** sunlight.

DOK 1

6 Each of the following causes rapid changes to Earth's surface except

- A** landslides.
- B** weathering.
- C** an earthquake.
- D** a volcanic eruption.

DOK 1

7 All of the following are a result of a glacier's movement across land except

- A** erosion of land.
- B** volcanic eruption.
- C** making a valley wider.
- D** deposition of large boulders and smaller rocks.

DOK 1

8 A tornado can cause all of the following except

- A** uprooted trees.
- B** flattened buildings.
- C** destroyed habitats.
- D** formation of moraines.

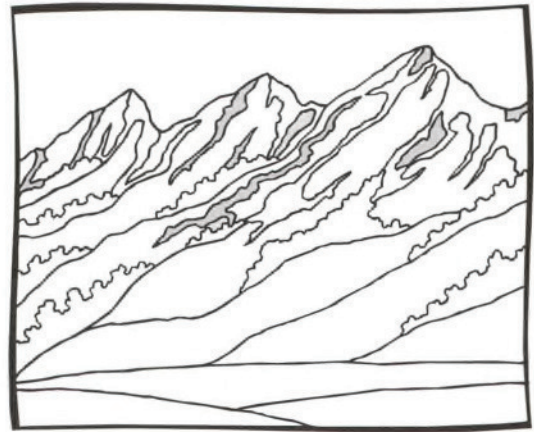
DOK 1

9 Which event would most likely cause a flood?

- A** volcano
- B** tornado
- C** hurricane
- D** forest fire

DOK 1

10 Look at the picture below.



Describe two different ways that mountains can form.

DOK 1

Describe two forces that can change the shape of a mountain.

DOK 2

Check Your Understanding

Question	Review	Question	Review
1	p. 229	6	pp. 216–220, 226–227, 238, 242
2	pp. 204, 226–229	7	pp. 230–231
3	pp. 228–229	8	p. 240
4	p. 220	9	pp. 220, 238, 240
5	pp. 228–229, 242	10	pp. 215, 220, 226–232