Section 1

# Changing Earth's Surface

## Reading Preview

### Key Concepts

- What processes wear down and build up Earth's surface?
- What causes the different types of mass movement?

### Key Terms

- erosion
- sediment
- deposition
- gravity
- mass movement

### Target Reading Skill

**Comparing and Contrasting** As you read, compare and contrast the different types of mass movement by completing a table like the one below.

Mass Movement

| Type of Mass Movement | Speed | Slope |
|---|---|---|
| Landslide | | |
| | | |

## Lab zone Discover Activity

### How Does Gravity Affect Materials on a Slope?

1. Place a small board flat on your desk. Place a marble on the board and slowly tip one end of the board up slightly. Observe what happens.
2. Place a block of wood on the board. Slowly lift one end of the board and observe the result.
3. Next, cover the board and the wood block with sandpaper and repeat Step 2.

**Think It Over**

Developing Hypotheses How do the results of each step compare? Develop a hypothesis to explain the differences in your observations.

The ground you stand on is solid. But under certain conditions, solid earth can quickly change to thick, soupy mud. For example, high rains soaked into the soil and triggered the devastating mudflow in Figure 1. A river of mud raced down the mountainside, burying homes and cars. Several lives were lost. In moments, the mudflow moved a huge volume of soil mixed with water and rock downhill.

## Wearing Down and Building Up

A mudflow is a spectacular example of erosion. **Erosion** is the process by which natural forces move weathered rock and soil from one place to another. You may have seen water carrying soil and gravel down a driveway after it rains. That's an example of erosion. A mudflow is a very rapid type of erosion. Other types of erosion move soil and rock more slowly. Gravity, running water, glaciers, waves, and wind are all causes, or agents, of erosion. In geology, an agent is a force or material that causes a change in Earth's surface.

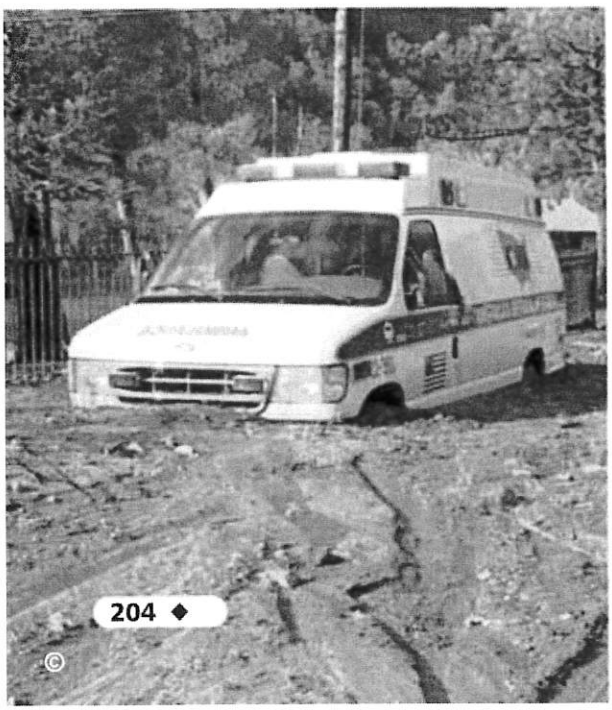


FIGURE 1
**Mudflow**
A mudflow caused by heavy rains in San Bernardino, California, brought this ambulance to a stop.

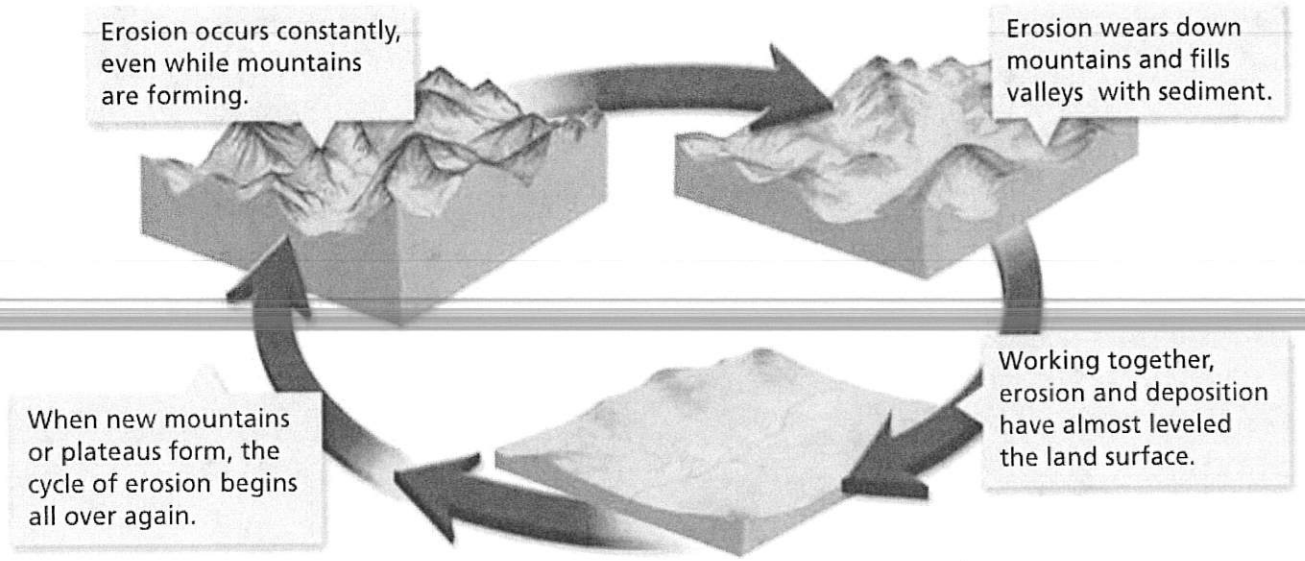



FIGURE 2
**Cycle of Erosion and Deposition**
Over millions of years, erosion gradually wears away mountains while deposition fills in valleys with sediment.
Predicting *What would happen to the surface of the land if uplift did not occur?*

The material moved by erosion is **sediment.** Sediment may consist of pieces of rock or soil or the remains of plants and animals. Both weathering and erosion produce sediment. **Deposition** occurs where the agents of erosion, deposit, or lay down, sediment. Deposition changes the shape of the land. You may have watched a playing child who picked up several toys, carried them across a room, and then put them down. This child was acting something like an agent of erosion and deposition.

**Weathering, erosion, and deposition act together in a cycle that wears down and builds up Earth's surface.** Erosion and deposition are at work everywhere on Earth. As a mountain wears down in one place, new landforms build up in other places. The cycle of erosion and deposition is never-ending.

Reading Checkpoint **What is sediment?**

## Mass Movement

Imagine that you are sitting on a bicycle at the top of a hill. With only a slight push, you can coast down the hill. If the slope of the hill is very steep, you will reach a high speed before reaching the bottom. The force that pulls you and your bicycle downward is gravity. Gravity pulls everything toward the center of Earth.

**Gravity** is the force that moves rock and other materials downhill. Gravity causes **mass movement**, any one of several processes that move sediment downhill. **The different types of mass movement include landslides, mudflows, slump, and creep.** Mass movement can be rapid or slow.

Lab zone Skills Activity

### Making Models

You can make a model of mass movement. Design a plan to model one of the types of mass movement using sand, pebbles, and water. With your teacher's approval, make and test your model.

How well did your model represent the type of mass movement you chose? How could you improve your model?

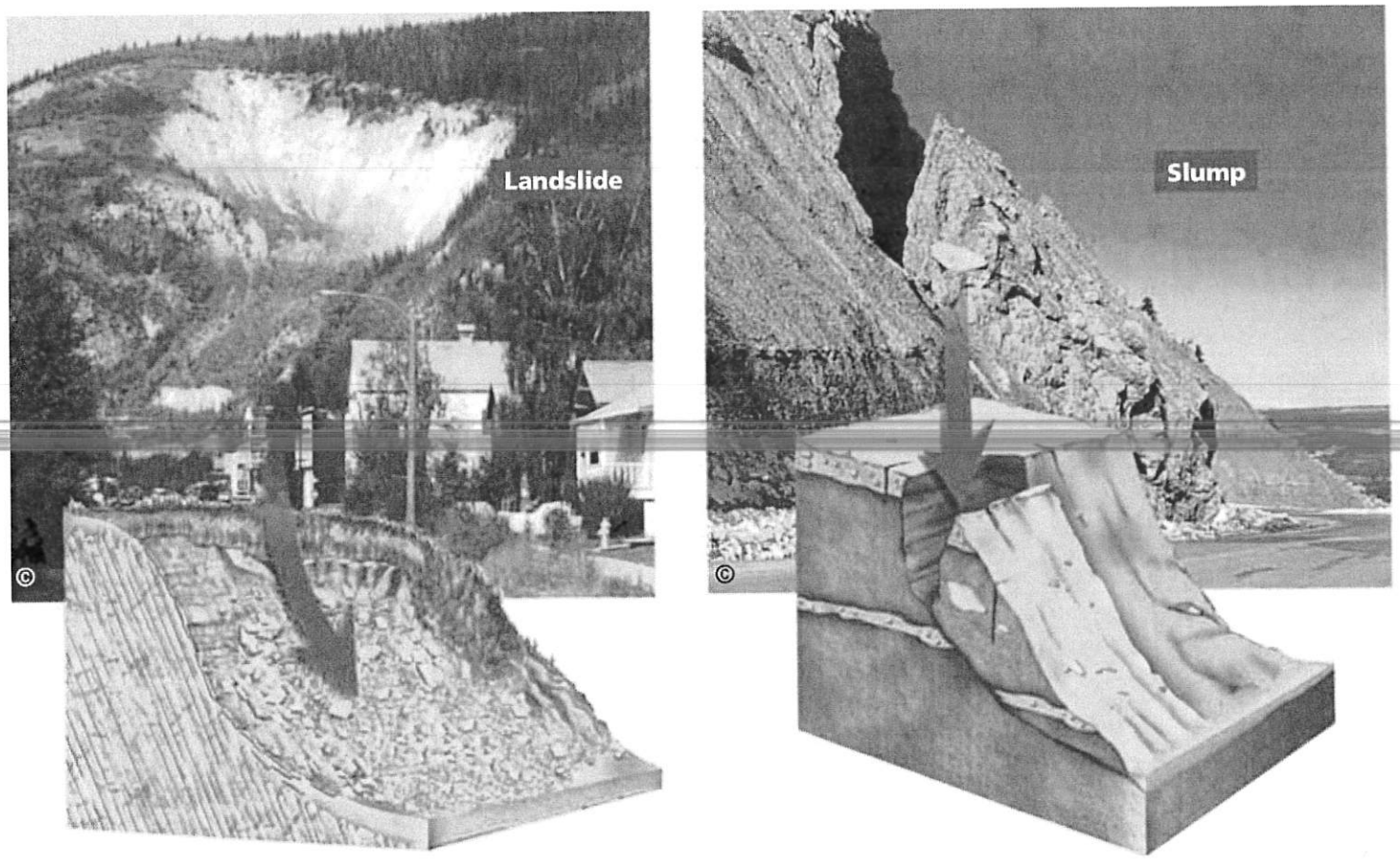
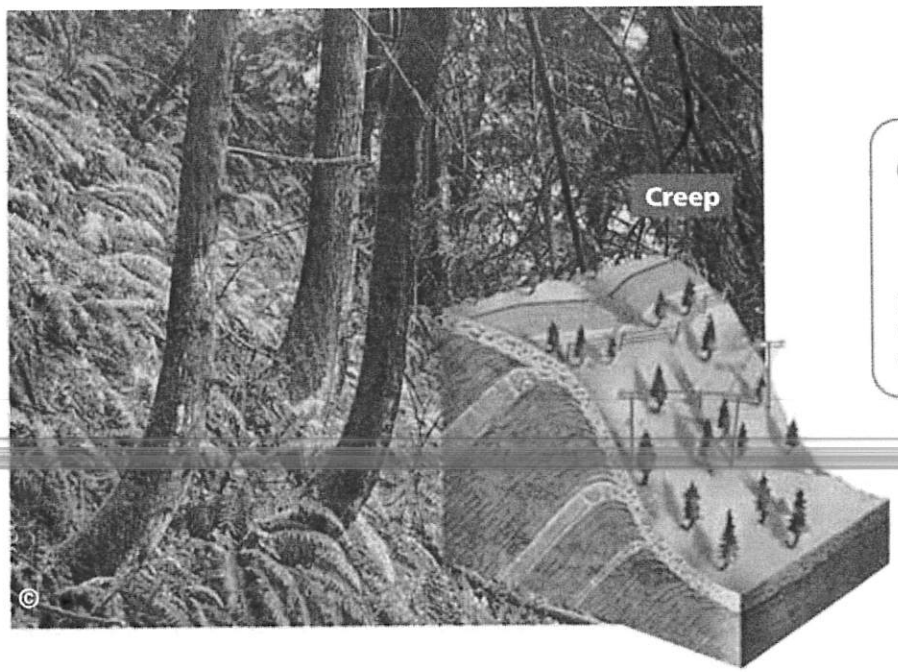



FIGURE 3
**Mass Movement**
In addition to mudflows, types of mass movement include landslides, slump, and creep.
Making Judgments *Which form of mass movement produces the most drastic change in the surface?*

**Landslides** The most destructive kind of mass movement is a landslide, which occurs when rock and soil slide quickly down a steep slope. Some landslides contain huge masses of rock. But many landslides contain only a small amount of rock and soil. Some landslides occur where road builders have cut highways through hills or mountains. Figure 3 shows an example of a landslide.

**Mudflows** A mudflow is the rapid downhill movement of a mixture of water, rock, and soil. The amount of water in a mudflow can be as high as 60 percent. Mudflows often occur after heavy rains in a normally dry area. In clay soils with a high water content, mudflows may occur even on very gentle slopes. Under certain conditions, clay soils suddenly turn to liquid and begin to flow. An earthquake can trigger both mudflows and landslides. Mudflows can be very dangerous.

**Slump** If you slump your shoulders, the entire upper part of your body drops down. In the type of mass movement known as slump, a mass of rock and soil suddenly slips down a slope. Unlike a landslide, the material in a slump moves down in one large mass. It looks as if someone pulled the bottom out from under part of the slope. A slump often occurs when water soaks the bottom of soil that is rich in clay.

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**Creep** Creep is the very slow downhill movement of rock and soil. It can even occur on gentle slopes. Creep often results from the freezing and thawing of water in cracked layers of rock beneath the soil. Like the movement of an hour hand on a clock, creep is so slow you can barely notice it. But you can see the effects of creep in objects such as telephone poles, gravestones, and fenceposts. Creep may tilt these objects at spooky angles. Landscapes affected by creep may have the eerie, out-of-kilter look of a funhouse in an amusement park.

Reading Checkpoint **What is the main difference between a slump and a landslide?**

## Section 1 Assessment

**Vocabulary Skill** Latin Word Origins Review the Latin words *de-* and *positus*. Use what you've learned to explain the meaning of *deposition*.

### Reviewing Key Concepts

HINT HINT HINT HINT HINT HINT

1. a. Listing What are five agents of erosion?
   b. Defining In your own words, write a definition of *deposition*.
   c. Predicting Over time, how will erosion and deposition affect a mountain range? Explain.
2. a. Listing What are the four types of mass movement?
   b. Relating Cause and Effect What force causes all types of mass movement?
   c. Inferring A fence runs across a steep hillside. The fence is tilted downhill and forms a curve rather than a straight line. What can you infer happened to the fence? Explain.

Lab zone **At-Home Activity**

Evidence of Erosion After a rainstorm, take a walk with an adult family member around your neighborhood. Look for evidence of erosion. Try to find areas where there is loose soil, sand, gravel, or rock. **CAUTION:** *Stay away from any large pile of loose sand or soil—it may slide without warning.* Which areas have the most erosion? The least erosion? How does the slope of the ground affect the amount of erosion? Sketch or take photographs of the areas showing evidence of erosion.

Lab zone **Skills Lab**

# Sand Hills

## Problem

What is the relationship between the height and width of a sand hill?

## Skills

developing hypotheses, interpreting data, predicting

## Materials

- dry sand, 500 mL
- cardboard tube
- tray (about 15 cm × 45 cm × 60 cm)
- wooden barbecue skewer
- masking tape
- spoon
- ruler
- pencil or crayon
- several sheets of white paper

## Procedure

1. Begin by observing how gravity causes mass movement. To start, place the cardboard tube vertically in the center of the tray.
2. Using the spoon, fill the cardboard tube with the dry sand. Take care not to spill the sand around the outside of the tube.
3. Carefully lift the sand-filled tube straight up so that all the sand flows out. As you lift the tube, observe the sand's movement.
4. Develop a hypothesis explaining how you think the width of the sand pile is related to its height for different amounts of sand.
5. Empty the sand in the tray back into a container. Then set up your system for measuring the sand hill.
6. Copy the data table into your lab notebook.
7. Following Steps 1 through 3, make a new sand hill.

Data Table

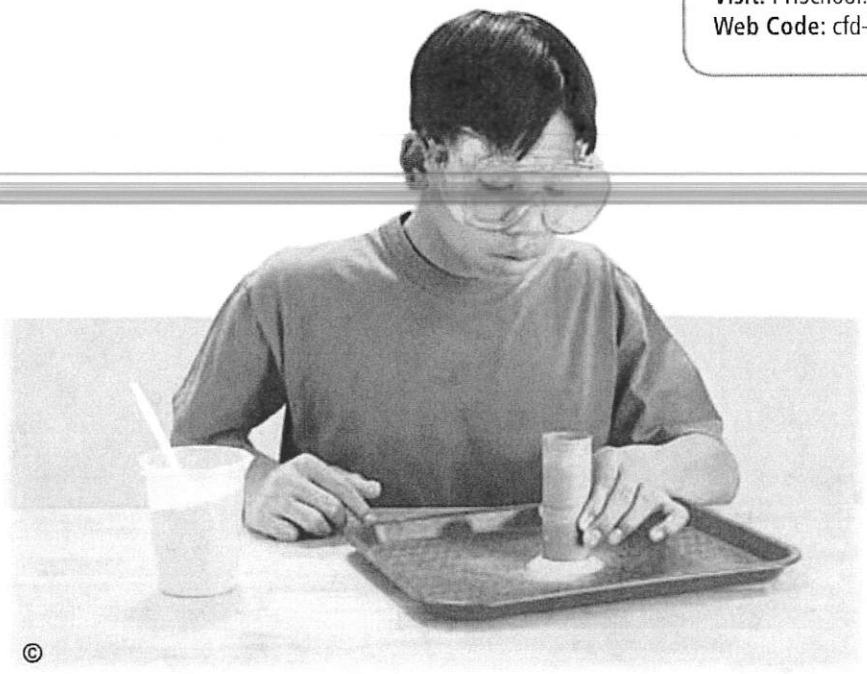
| Test | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Width | | | | | |
| Height | | | | | |

8. Measure and record the sand hill's height and width for Test 1. (See the instructions on the bottom of the page to help you accurately measure the height and width.)

5. Measure the sand hill's height by inserting a barbecue skewer through its center. Make a mark on the skewer at the top of the hill.
6. Remove the skewer and use the ruler to measure how much of the skewer was buried in the hill. Try not to disturb the sand.

## How to Measure a Sand Hill

1. Cover the bottom of the tray with unlined white paper and tape it firmly in place.
2. Mark off points 0.5 cm apart along one side of the paper in the tray.
3. Carefully draw the sand hill's outline on the paper. The line should go completely around the base of the hill.
4. Now measure the width of the hill against the marks you made along the edge of the paper.



9. Now test what happens when you add more sand to the sand hill. Place your cardboard tube vertically at the center of the sand hill. Be careful not to push the tube down into the sand hill! Using the spoon, fill the tube with sand as before.
10. Carefully raise the tube and observe the sand's movement.
11. Measure and record the sand hill's height and width for Test 2.
12. Repeat Steps 9 through 11 at least three more times. After each test, record your results. Be sure to number each test.

## Analyze and Conclude

1. Graphing Make a graph showing how the sand hill's height and width changed with each test. (*Hint*: Use the *x*-axis of the graph for height. Use the *y*-axis of the graph for width.)
2. Interpreting Data What does your graph show about the relationship between the sand hill's height and width?
3. Drawing Conclusions Does your graph support your hypothesis about the sand hill's height and width? Why or why not?
4. Developing Hypotheses How would you revise your original hypothesis after examining your data? Give reasons for your answer.
5. Predicting Predict what would happen if you continued the experiment for five more tests. Extend your graph with a dashed line to show your prediction. How could you test your prediction?
6. Communicating Write a paragraph in which you discuss how you measured your sand hill. Did any problems you had in making your measurements affect your results? How did you adjust your measurement technique to solve these problems?

## Design an Experiment

Do you think the use of different materials, such as wet sand or gravel, would produce different results from those using dry sand? Make a new hypothesis about the relationship between slope and width in hills made of materials other than dry sand. Design an experiment in which you test how these different materials form hills. *Obtain your teacher's approval before you try the experiment.*

Section 2

# Water Erosion

## Reading Preview

### Key Concepts

- What process is mainly responsible for shaping the surface of the land?
- What features are formed by water erosion and deposition?
- What causes groundwater erosion?

### Key Terms

- runoff • rill • gully • stream
- tributary • flood plain
- meander • oxbow lake
- alluvial fan • delta
- groundwater • stalactite
- stalagmite • karst topography

### Target Reading Skill

**Previewing Visuals** Before you read, preview Figure 10. Then write two questions that you have about the illustration in a graphic organizer like the one below. As you read, answer your questions.

**The Course of a River**

| |
|---|
| Q. What features does a river produce by erosion? |
| A. |
| Q. |

### Lab zone Discover Activity

**How Does Moving Water Wear Away Rocks?**

1. Obtain two bars of soap that are the same size and brand.
2. Open a faucet just enough to let the water drip out very slowly. How many drops of water does the faucet release per minute?
3. Place one bar of soap in a dry place. Place the other bar of soap under the faucet. Predict the effect of the dripping water droplets on the soap.
4. Let the faucet drip for 10 minutes.
5. Turn off the faucet and observe both bars of soap. What difference do you observe between them?

**Think It Over**

Predicting What would the bar of soap under the dripping faucet look like if you left it there for another 10 minutes? For an hour? How could you speed up the process? Slow it down?

Walking in the woods in summer, you can hear the racing water of a stream before you see the stream itself. The water roars as it foams over rock ledges and boulders. When you reach the stream, you see water rushing by. Sand and pebbles tumble along the bottom of the stream. As it swirls downstream, the water also carries twigs, leaves, and bits of soil. In sheltered pools, insects such as water striders skim the water's calm surface. Beneath the surface, a rainbow trout swims in the clear water.

In winter, the stream freezes. Chunks of ice scrape and grind away at the stream's bed and banks. In spring, the stream floods. Then the flow of water may be strong enough to move large rocks. But throughout the year, the stream continues to erode its small part of Earth's surface.

▼ A stream in summer

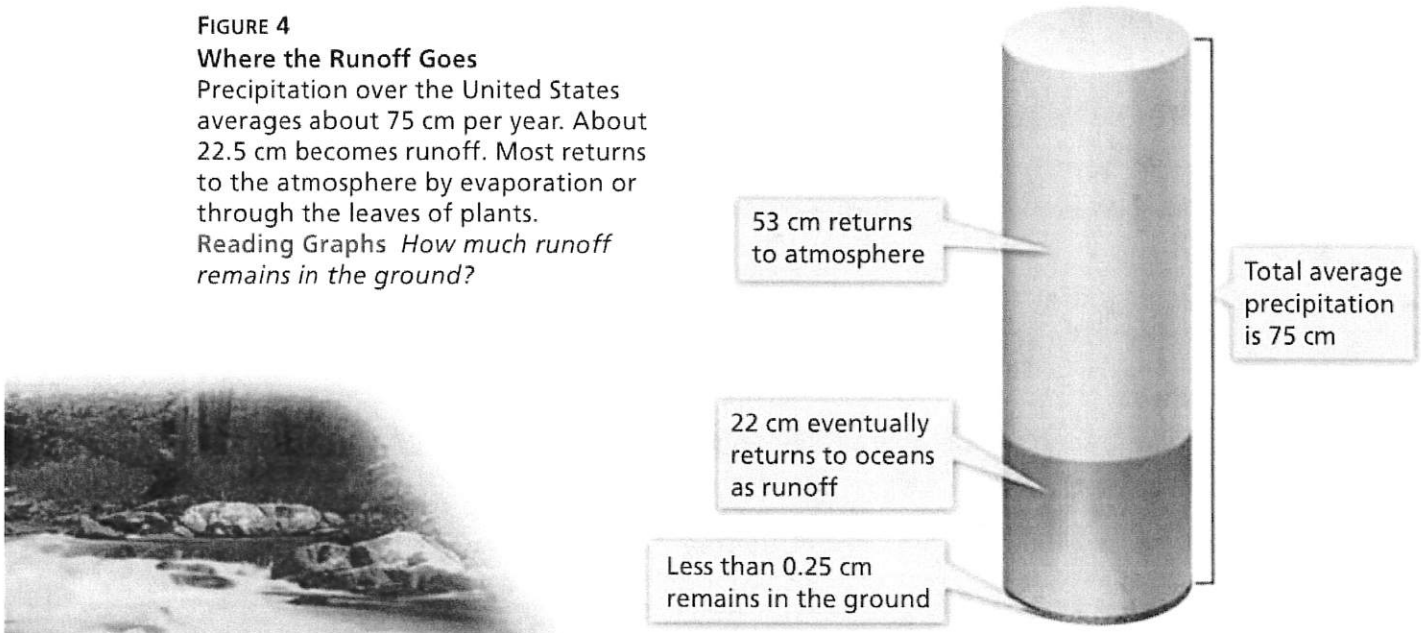
## Runoff and Erosion

**Moving water is the major agent of the erosion that has shaped Earth's land surface.** Erosion by water begins with the splash of rain. Some rainfall sinks into the ground. Some evaporates or is taken up by plants. The force of a falling raindrop can loosen and pick up soil particles. As water moves over the land, it carries these particles with it. This moving water is called runoff. Runoff is water that moves over Earth's surface. When runoff flows in a thin layer over the land, it may cause a type of erosion called sheet erosion.

**Amount of Runoff** The amount of runoff in an area depends on five main factors. The first factor is the amount of rain an area receives. A second factor is vegetation. Grasses, shrubs, and trees reduce runoff by absorbing water and holding soil in place. A third factor is the type of soil. Some types of soils absorb more water than others. A fourth factor is the shape of the land. Land that is steeply sloped has more runoff than flatter land. Finally, a fifth factor is how people use the land. For instance, a paved parking lot absorbs no water, so all the rain that falls on it becomes runoff. Runoff also increases when a farmer cuts down crops, since this removes vegetation from the land.

Generally, more runoff means more erosion. In contrast, factors that reduce runoff will reduce erosion. Even though deserts have little rainfall, they often have high runoff and erosion because they have few plants. In wet areas, runoff and erosion may be low because there are more plants to protect the soil.

FIGURE 4
**Where the Runoff Goes**
Precipitation over the United States averages about 75 cm per year. About 22.5 cm becomes runoff. Most returns to the atmosphere by evaporation or through the leaves of plants.
Reading Graphs *How much runoff remains in the ground?*



Lab zone **Try This Activity**

## Raindrops Falling

Find out how the force of falling raindrops affects soil.

1. Fill a petri dish with fine-textured soil to a depth of about 1 cm. Make sure the soil has a smooth, flat surface, but do not pack it firmly in the dish.
2. Place the dish in the center of a newspaper.
3. Fill a dropper with water. Squeeze a large water drop from a height of 1 m onto the surface of the soil. Repeat 4 times.
4. Use a meter stick to measure the distance the soil splashed from the dish. Record your observations.
5. Repeat Steps 1 through 4, this time from a height of 2 m.

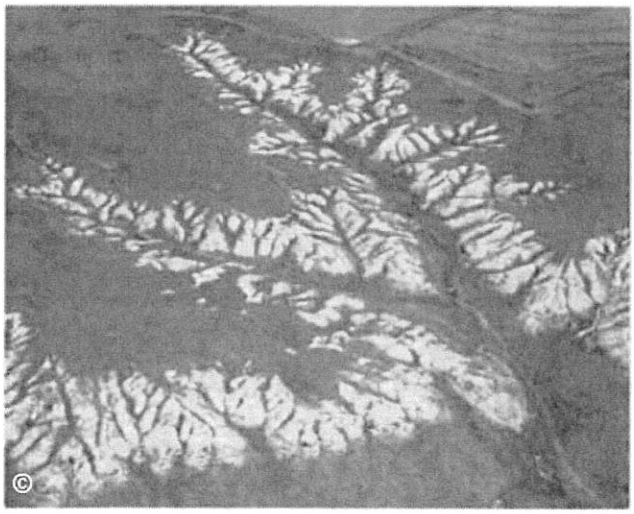
Drawing Conclusions Which test produced the greater amount of erosion? Why?

**Rills and Gullies** Because of gravity, runoff and the material it contains move downhill. As runoff travels, it forms tiny grooves in the soil called **rills**. As many rills flow into one another, they grow larger, forming gullies. A **gully** is a large groove, or channel, in the soil that carries runoff after a rainstorm. As water flows through gullies, it moves soil and rocks with it, thus enlarging the gullies through erosion. Gullies contain water only after it rains.

**Streams and Rivers** Gullies join together to form a larger channel called a stream. A **stream** is a channel along which water is continually flowing down a slope. Unlike gullies, streams rarely dry up. Small streams are also called creeks or brooks. As streams flow together, they form larger and larger bodies of flowing water. A large stream is often called a river.

**Tributaries** A stream grows into a larger stream or river by receiving water from tributaries. A **tributary** is a stream or river that flows into a larger river. For example, the Missouri and Ohio rivers are tributaries of the Mississippi River. A drainage basin, or watershed, is the area from which a river and its tributaries collect their water.

Reading Checkpoint **What is a tributary?**



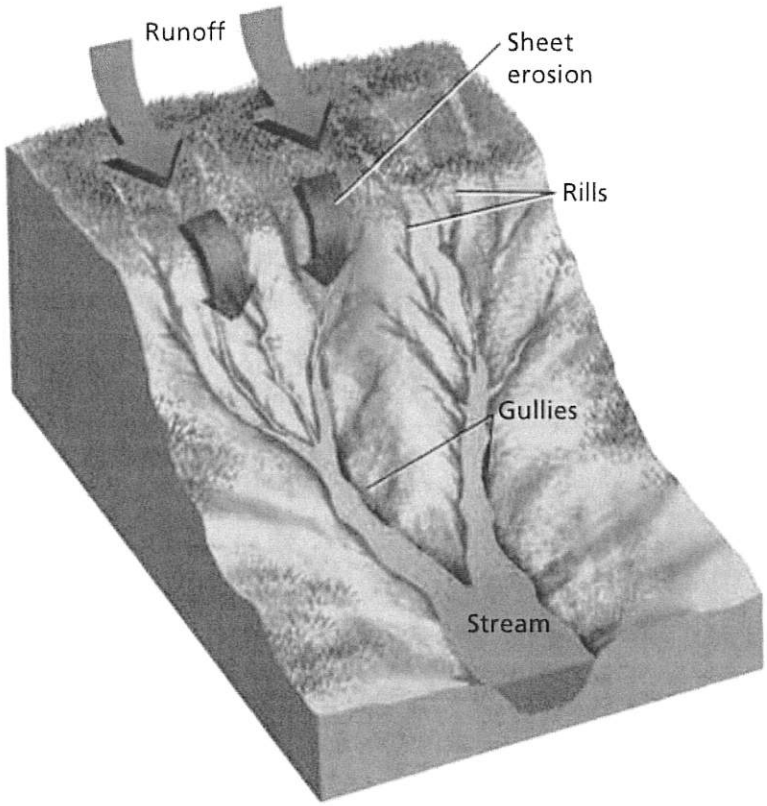



FIGURE 5
**Runoff, Rills, and Gullies**
Water flowing across the land runs together to form rills, gullies, and streams.
Predicting *What will happen to the land between the gullies as they grow wider?*

## Erosion by Rivers



As a river flows from the mountains to the sea, the river forms a variety of features. **Through erosion, a river creates valleys, waterfalls, flood plains, meanders, and oxbow lakes.**

Rivers often form on steep mountain slopes. Near its source, a river is often fast flowing and generally follows a straight, narrow course. The steep slopes along the river erode rapidly. The result is a deep, V-shaped valley.

**Waterfalls** Waterfalls may occur where a river meets an area of rock that is very hard and erodes slowly. The river flows over this rock and then flows over softer rock downstream. As you can see in Figure 6, the softer rock wears away faster than the harder rock. Eventually a waterfall develops where the softer rock was removed. Areas of rough water called rapids also occur where a river tumbles over hard rock.

**Flood Plain** Lower down on its course, a river usually flows over more gently sloping land. The river spreads out and erodes the land, forming a wide river valley. The flat, wide area of land along a river is a **flood plain.** A river often covers its flood plain when it overflows its banks during floods. On a wide flood plain, the valley walls may be kilometers away from the river itself.

FIGURE 6
**How a Waterfall Forms**
A waterfall forms where a flat layer of tough rock lies over a layer of softer rock that erodes easily. When the softer rock erodes, pieces of the harder rock above break off, creating the waterfall's sharp drop.

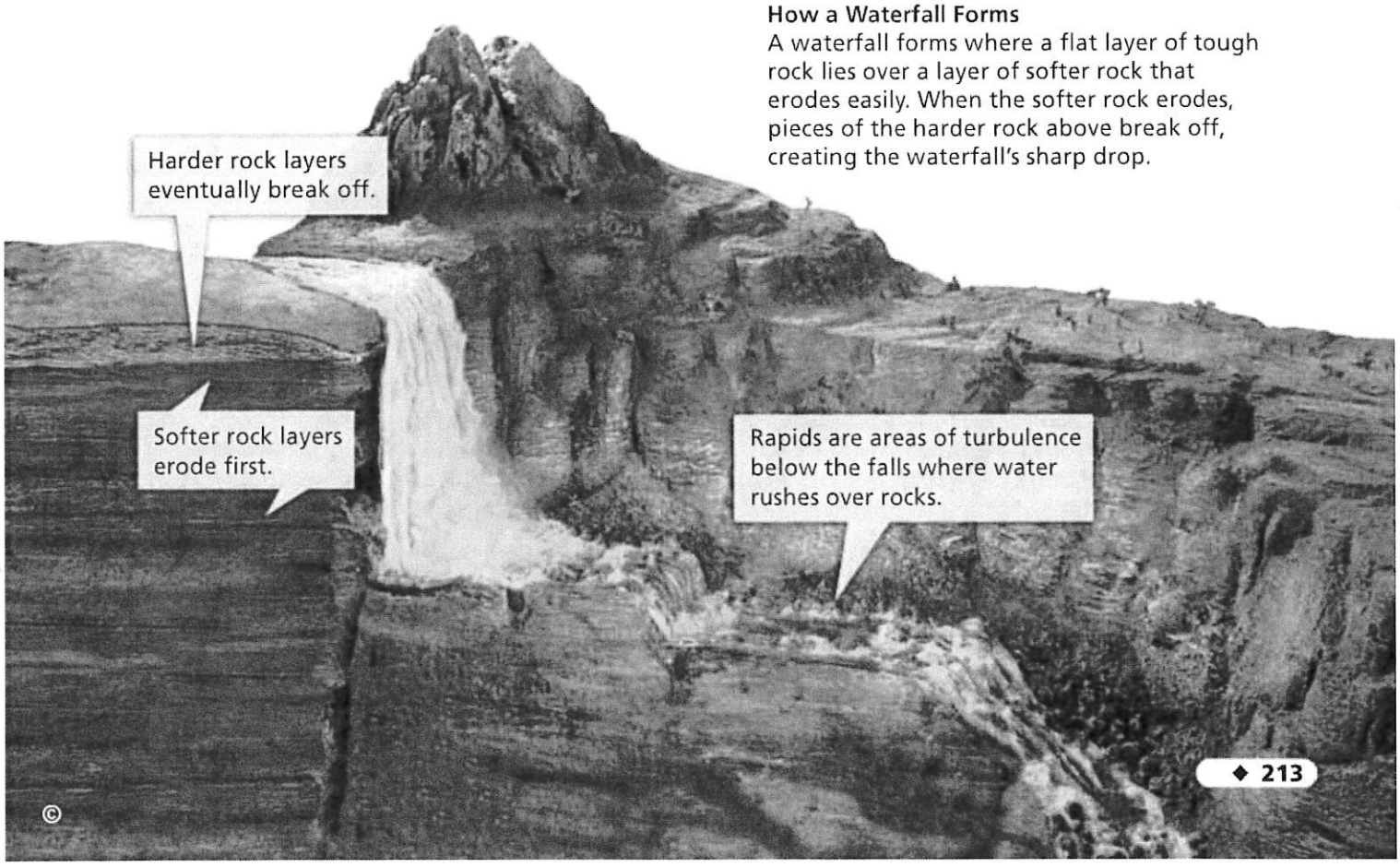
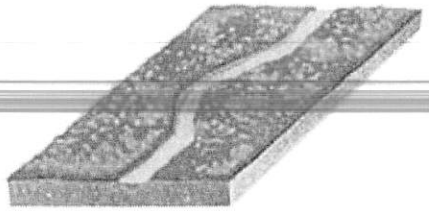
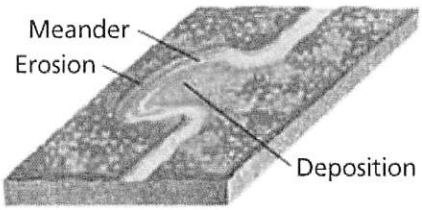


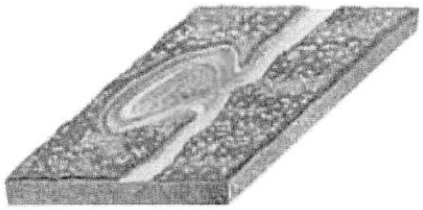
FIGURE 7
**Meanders and Oxbow Lakes**
Erosion often forms meanders and oxbow lakes where a river winds across its floodplain.



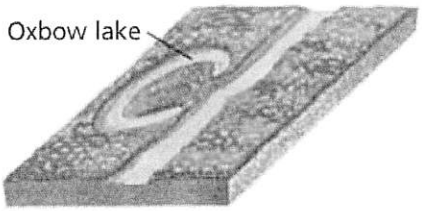
1 A small obstacle creates a slight bend in the river.




2 As water erodes the outer edge of a meander, the bend becomes bigger. Deposition occurs along the inner edge.



3 Gradually, the meander becomes more curved. The river breaks through and takes a new course.




4 An oxbow lake remains.

**Meanders** A river often develops meanders where it flows through easily eroded rock or sediment. A **meander** is a loop-like bend in the course of a river. As the river winds from side to side, it tends to erode the outer bank and deposit sediment on the inner bank of a bend. Over time, the meander becomes more and more curved.

Because of the sediment a river carries, it can erode a very wide flood plain. Along this part of a river's course, its channel is deep and wide. Meanders are common. The southern stretch of the Mississippi River is one example of a river that meanders on a wide, gently sloping flood plain.

**Oxbow Lakes** Sometimes a meandering river forms a feature called an oxbow lake. As Figure 7 shows, an **oxbow lake** is a meander that has been cut off from the river. An oxbow lake may form when a river floods. During the flood, high water finds a straighter route downstream. As the flood waters fall, sediments dam up the ends of a meander. The meander has become an oxbow lake.

Reading Checkpoint **How does an oxbow lake form?**

## Deposits by Rivers

As water moves, it carries sediments with it. Any time moving water slows down, it drops, or deposits, some of the sediment. As the water slows down, fine particles fall to the river's bed. Larger stones quit rolling and sliding. **Deposition creates landforms such as alluvial fans and deltas. It can also add soil to a river's flood plain.** In Figure 10, you can see these and other features shaped by rivers and streams.

**Alluvial Fans** Where a stream flows out of a steep, narrow mountain valley, the stream suddenly becomes wider and shallower. The water slows down. Here sediments are deposited in an alluvial fan. An **alluvial fan** is a wide, sloping deposit of sediment formed where a stream leaves a mountain range. As its name suggests, this deposit is shaped like a fan. You can see an alluvial fan in Figure 8.

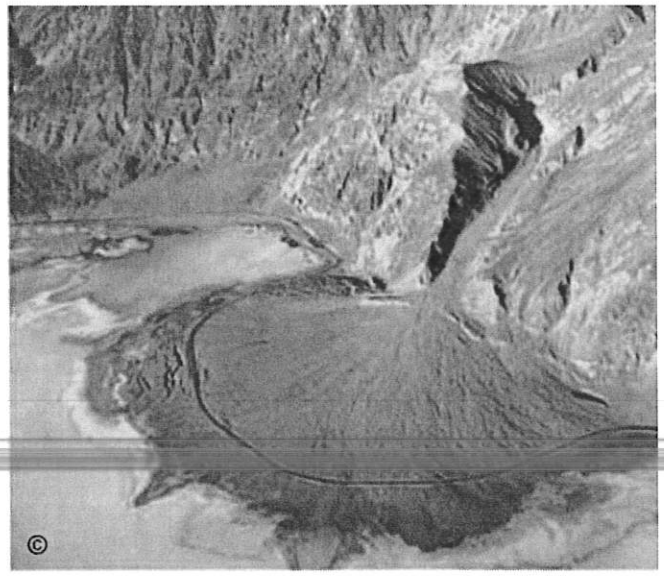


FIGURE 8
**Alluvial Fan**
This alluvial fan in Death Valley, California, was formed from deposits by streams from the mountains.

**Deltas** A river ends its journey when it flows into a still body of water, such as an ocean or a lake. Because the river water is no longer flowing downhill, the water slows down. At this point, the sediment in the water drops to the bottom. Sediment deposited where a river flows into an ocean or lake builds up a landform called a **delta**. Deltas can be a variety of shapes. Some are arc shaped, others are triangle shaped. The delta of the Mississippi River, shown in Figure 9, is an example of a type of delta called a "bird's foot" delta.

**Soil on Flood Plains** Deposition can also occur during floods. Then heavy rains or melting snow cause a river to rise above its banks and spread out over its flood plain. When the flood water finally retreats, it deposits sediment as new soil. Deposition of new soil over a flood plain is what makes a river valley fertile. Dense forests can grow in the rich soil of a flood plain. The soil is also perfect for growing crops.

Reading Checkpoint **How can a flood be beneficial?**

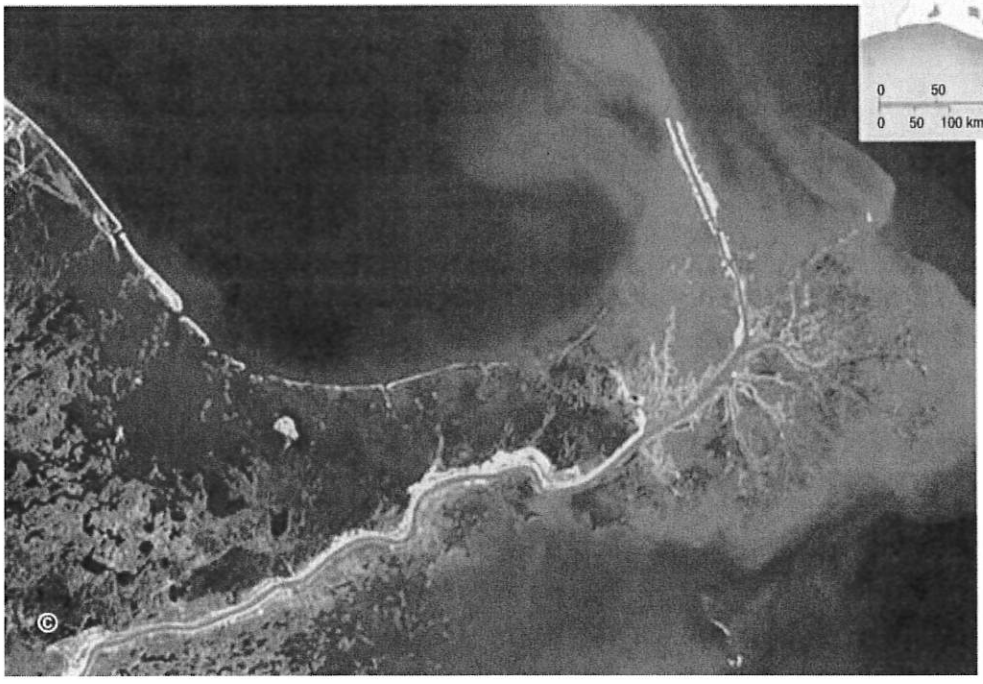



FIGURE 9
**Mississippi Delta**
This satellite image shows the part of the Mississippi River delta where the river empties into the Gulf of Mexico.
Observing *What happens to the Mississippi River as it flows through its delta? Can you find the river's main channel?*

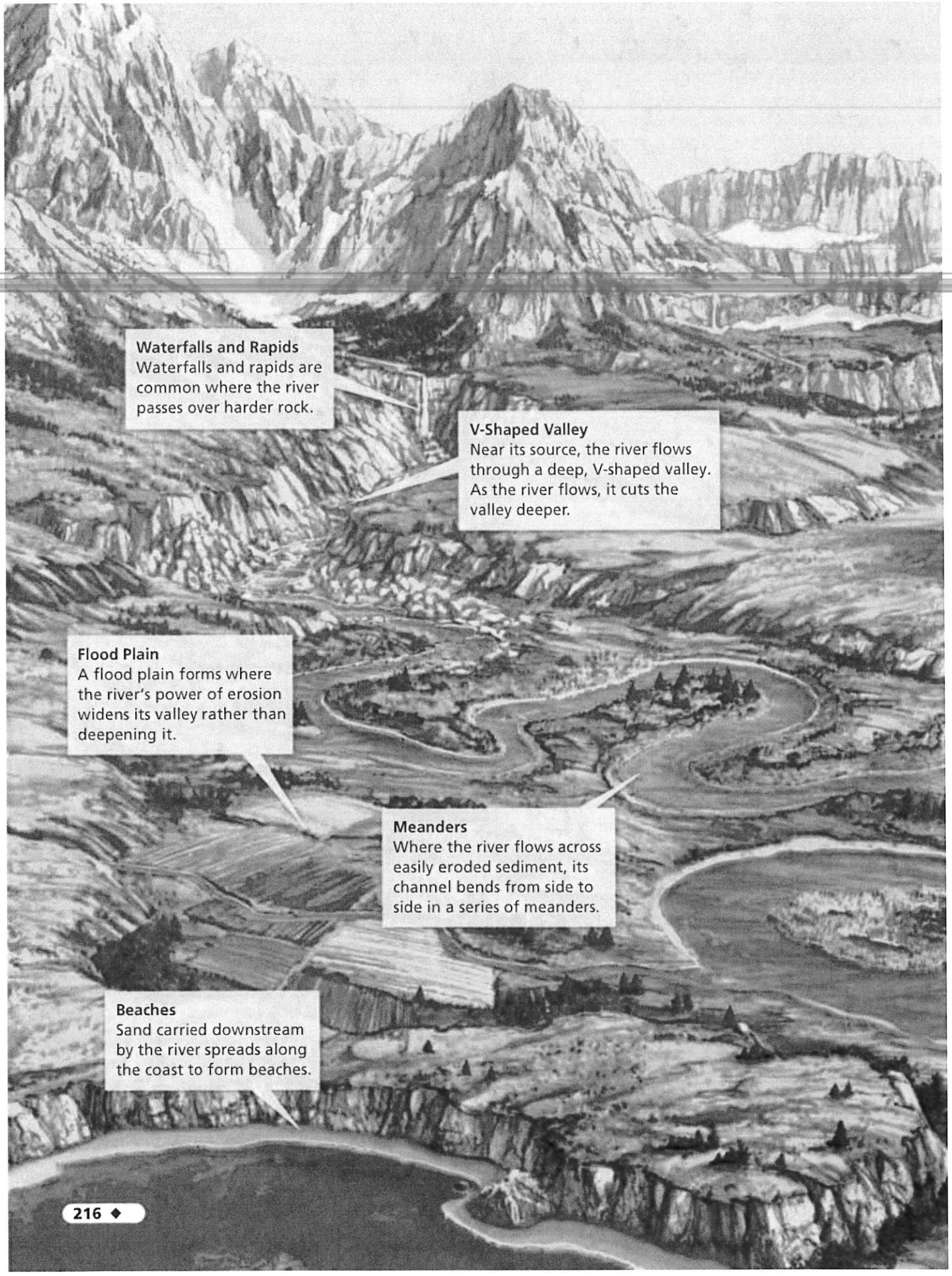
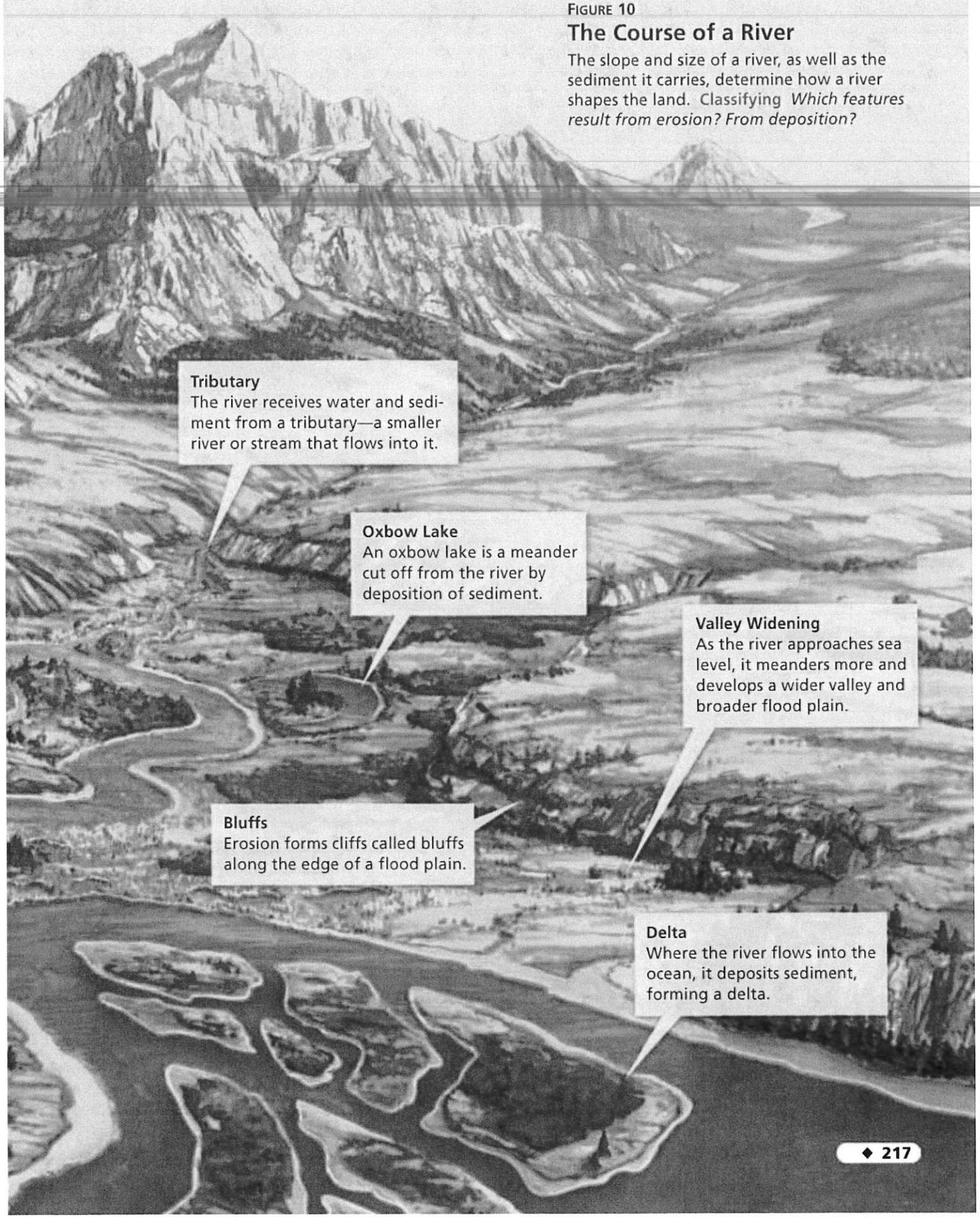
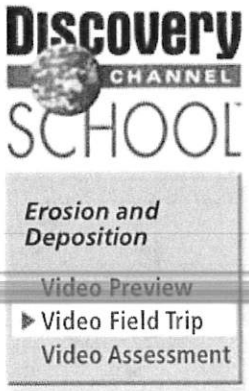

Waterfalls and Rapids
Waterfalls and rapids are common where the river passes over harder rock.
V-Shaped Valley
Near its source, the river flows through a deep, V-shaped valley. As the river flows, it cuts the valley deeper.
Flood Plain
A flood plain forms where the river's power of erosion widens its valley rather than deepening it.
Meanders
Where the river flows across easily eroded sediment, its channel bends from side to side in a series of meanders.
Beaches
Sand carried downstream by the river spreads along the coast to form beaches.

FIGURE 10

## The Course of a River

The slope and size of a river, as well as the sediment it carries, determine how a river shapes the land. Classifying *Which features result from erosion? From deposition?*






## Groundwater Erosion

When rain falls and snow melts, not all of the water evaporates or becomes runoff. Some water soaks into the ground. There it fills the openings in the soil and trickles into cracks and spaces in layers of rock. **Groundwater** is the term geologists use for this underground water. Like running water on the surface, groundwater affects the shape of the land.

**Groundwater can cause erosion through a process of chemical weathering.** When water sinks into the ground, it combines with carbon dioxide to form a weak acid, called carbonic acid. Carbonic acid can break down limestone. Groundwater containing carbonic acid flows into any cracks in the limestone. Then some of the limestone changes chemically and is carried away in a solution of water. This process gradually hollows out pockets in the rock. Over time, these pockets develop into large holes underground, called caves or caverns.

**Cave Formations** The action of carbonic acid on limestone can also result in deposition. Inside limestone caves, deposits called stalactites and stalagmites often form. Water containing carbonic acid and calcium from limestone drips from a cave's roof. Carbon dioxide is released from the solution, leaving behind a deposit of calcite. A deposit that hangs like an icicle from the roof of a cave is known as a **stalactite** (stuh LAK tyt). Slow dripping builds up a cone-shaped **stalagmite** (stuh LAG myt) from the cave floor.

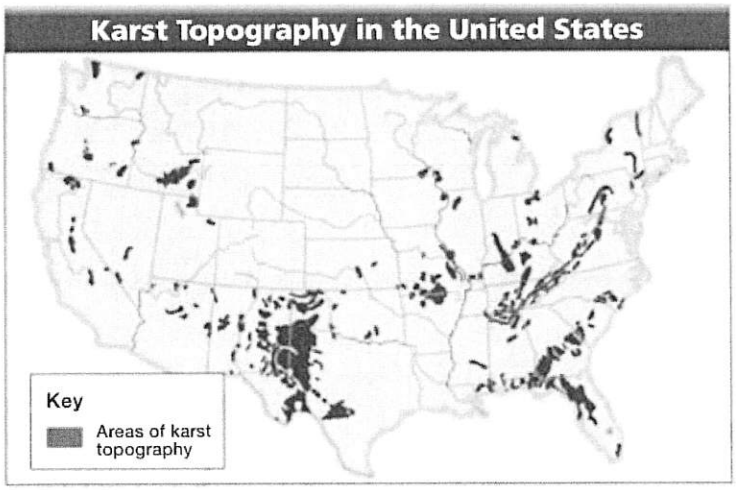



FIGURE 11
Karst topography is found in many parts of the United States where the bedrock is made up of thick layers of limestone.

**Karst Topography** In rainy regions where there is a layer of limestone near the surface, groundwater erosion can significantly change the shape of the land. Streams are rare, because water easily sinks down into the weathered limestone. Deep valleys and caverns are common. If the roof of a cave collapses because of the erosion of the underlying limestone, the result is a depression called a sinkhole. This type of landscape is called **karst topography** after a region in Eastern Europe. In the United States, regions of karst topography are found in Florida, Texas, and many other states.

Reading Checkpoint **How does deposition occur in a limestone cave?**

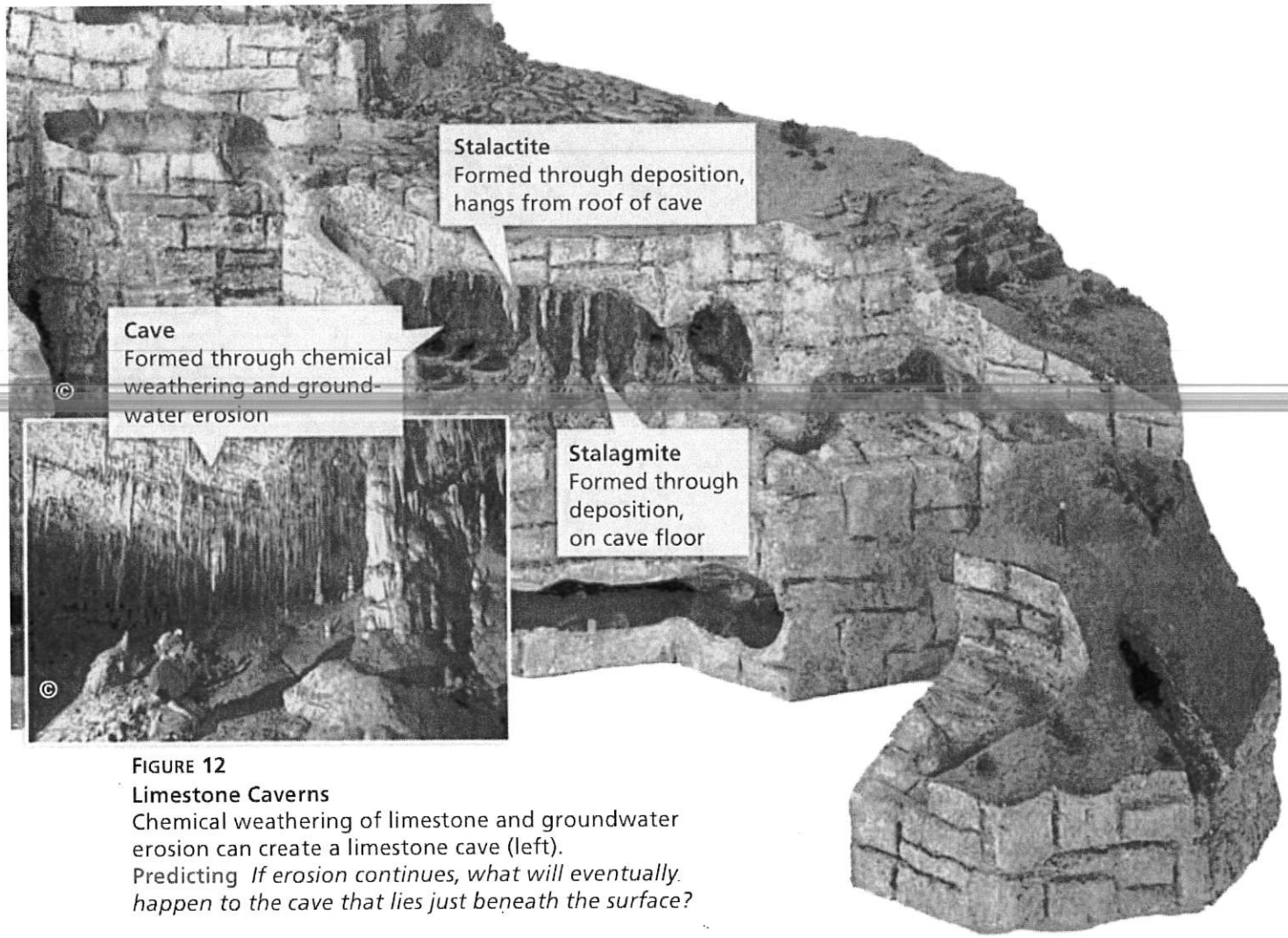



FIGURE 12
**Limestone Caverns**
Chemical weathering of limestone and groundwater erosion can create a limestone cave (left).
Predicting *If erosion continues, what will eventually happen to the cave that lies just beneath the surface?*

## Section 2 Assessment

**Target Reading Skill** Previewing Visuals Refer to your questions and answers about Figure 10 to help you answer Question 2 below.

### Reviewing Key Concepts

HINT 1. a. Reviewing What is the major agent of erosion on Earth's surface?
HINT b. Sequencing List these in order of size: tributary, stream, rill, gully, runoff, river.
HINT c. Predicting Where would gullies be more likely to form: a field with plowed soil and no plants, or a field covered with thick grass? Explain.
HINT 2. a. Listing What are five features that erosion forms along a river?
HINT b. Listing What are three features that result from deposition along a river?
HINT c. Relating Cause and Effect Why does a delta often form where a river empties into the ocean?

HINT 3. a. Identifying What process is the cause of groundwater erosion?
HINT b. Explaining How do groundwater erosion and deposition produce a limestone cave?

### Lab zone At-Home Activity

**Erosion Cube** In a small dish, build a cube out of 27 small sugar cubes. Your cube should be three sugar cubes on a side. Fold a square piece of paper towel to fit the top of the cube. Wet the paper towel, place it on the cube, and let it stand for 15 or 20 minutes. Every few minutes, sprinkle a few drops of water on the paper towel to keep it wet. Then remove the paper towel. What happened to your cube? How is the effect of water on a sugar cube similar to groundwater eroding limestone? How is it different?

Lab zone Skills Lab

# Streams in Action

## Problem

How do rivers and streams erode the land?

## Skills Focus

making models, observing

## Materials

- diatomaceous earth
- plastic measuring cup
- spray bottle
- hand lens
- watch or clock
- water
- 1 metal spoon
- plastic foam cup
- blue food coloring
- liquid detergent
- scissors
- 2 wood blocks about 2.5 cm thick
- bucket to hold 2–3 L of water or a source of tap water
- plastic stirrers, 10–12 cm long, with two small holes each
- wire, 13–15 cm long, 20 gauge

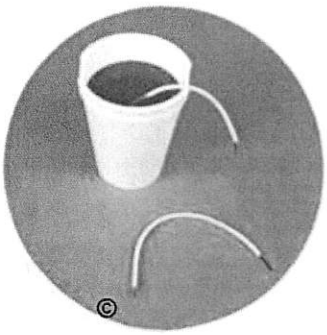
## Procedure

### PART 1 Creating Streams Over Time

1. Your teacher will give you a plastic tub containing diatomaceous earth that has been soaked with water. Place the tub on a level surface. **CAUTION:** *Dry diatomaceous earth produces dust that may be irritating if inhaled.* To keep the diatomaceous earth from drying out, spray it lightly with water.
2. One end of the tub will contain more diatomaceous earth. Use a block of wood to raise this end of the tub 2.5 cm.
3. Place the cup at the upper end of the slope with the notches pointing to the left and right.
4. Press the cup firmly down into the earth to secure its position.
5. Start the dripper (see Step 6 in the box below). Allow the water to drip to the right onto the diatomaceous earth.
6. Allow the dripper to drip for 5 minutes. (*Hint:* When you need to add more water, be careful not to disturb the dripper.)

## Making the Dripper

1. Insert the wire into one of the two holes in a plastic stirrer. The ends of the wire should protrude from the stirrer.
2. Gently bend the stirrer into a U shape. Be careful not to make any sharp bends. This is the dripper.
3. With scissors, carefully cut two small notches on opposite sides of the top of the foam cup.
4. Fill the cup to just below the notches with water colored with two drops of blue food coloring. Add more food coloring later as you add more water to the cup.



5. Add one drop of detergent to keep air bubbles out of the dripper and increase flow.
6. To start the dripper, fill it with water. Then quickly tip it and place it in one of the notches in the cup, as shown at left.
7. Adjust the flow rate of the dripper to about 2 drips per 1 second. (*Hint:* Bend the dripper into more of a U shape to increase flow. Lessen the curve to reduce flow.)

7. Observe the flow of water and the changes it makes. Use the hand lens to look closely at the stream bed.
8. After 5 minutes, remove the dripper.
9. In your lab notebook, draw a picture of the resulting stream and label it "5 minutes."
10. Now switch the dripper to the left side of the cup. Restart the dripper and allow it to drip for 10 minutes. Then remove the dripper.
11. Draw a picture and label it "10 minutes."

## PART 2 Changing the Angle of Slope

1. Remove the cup from the stream table.
2. Save the stream bed on the right side of the tub. Using the bowl of the spoon, smooth out the diatomaceous earth on the left side.
3. To increase the angle of slope of your stream table, raise the end of the tub another 2.5 cm.
4. In your lab notebook, predict the effects of increasing the angle of slope.
5. Replace the cup and restart the dripper, placing it in the notch on the left side of the cup. Allow the dripper to drip for 5 minutes. Notice any changes in the new stream bed.
6. At the end of 5 minutes, remove the dripper.
7. Draw the new stream bed in your lab notebook. Label it "Increased Angle."
8. Follow your teacher's instructions for clean-up after this activity. Wash your hands when you have finished.

## Analyze and Conclude

1. **Observing** Compare the 5-minute stream with the 10-minute stream. How did the length of time that the water flowed affect erosion along the stream bed?
2. **Drawing Conclusions** Were your predictions about the effects of increasing the angle of slope correct? Explain your answer.
3. **Observing** What happened to the eroded material that was carried downstream?
4. **Making Models** What features of streams were you able to observe using your model? How could you modify the model to observe additional features?
5. **Controlling Variables** What other variables besides time and angle of slope might affect the way rivers and streams erode the land?
6. **Communicating** Describe an example of water erosion that you have seen, such as water flowing down a hillside or street after a heavy rain. Include in your answer details such as the slope of the land, the color of the water, and the effects of the erosion.

## Design an Experiment

Design an experiment in which you use your model to measure how the amount of sediment carried by a river changes as the volume of flow of the river increases. *Obtain your teacher's approval before you try the experiment.*

Section 3

# Glaciers

## Reading Preview

### Key Concepts

- What are the two kinds of glaciers?
- How do glaciers cause erosion and deposition?

### Key Terms

- glacier • continental glacier
- ice age • valley glacier
- plucking • abrasion • till
- moraine • kettle

### Target Reading Skill

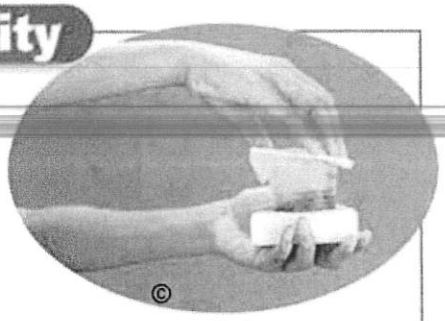
**Asking Questions** Before you read, preview the red headings. In a graphic organizer like the one below, ask a *what, how,* or *where* question for each heading. As you read, answer your questions.

Glaciers

| Question | Answer |
| --- | --- |
| What kinds of glaciers are there? | Valley glaciers and . . . |
| | |

## Lab zone Discover Activity

### How Do Glaciers Change the Land?



1. Put some sand in a small plastic container. Fill the container with water and place it in a freezer until the water turns to ice.
2. Remove the block of ice from the container. Hold the ice with a paper towel.
3. Rub the ice, sand side down, over a bar of soap. Observe what happens to the surface of the soap.

**Think It Over**

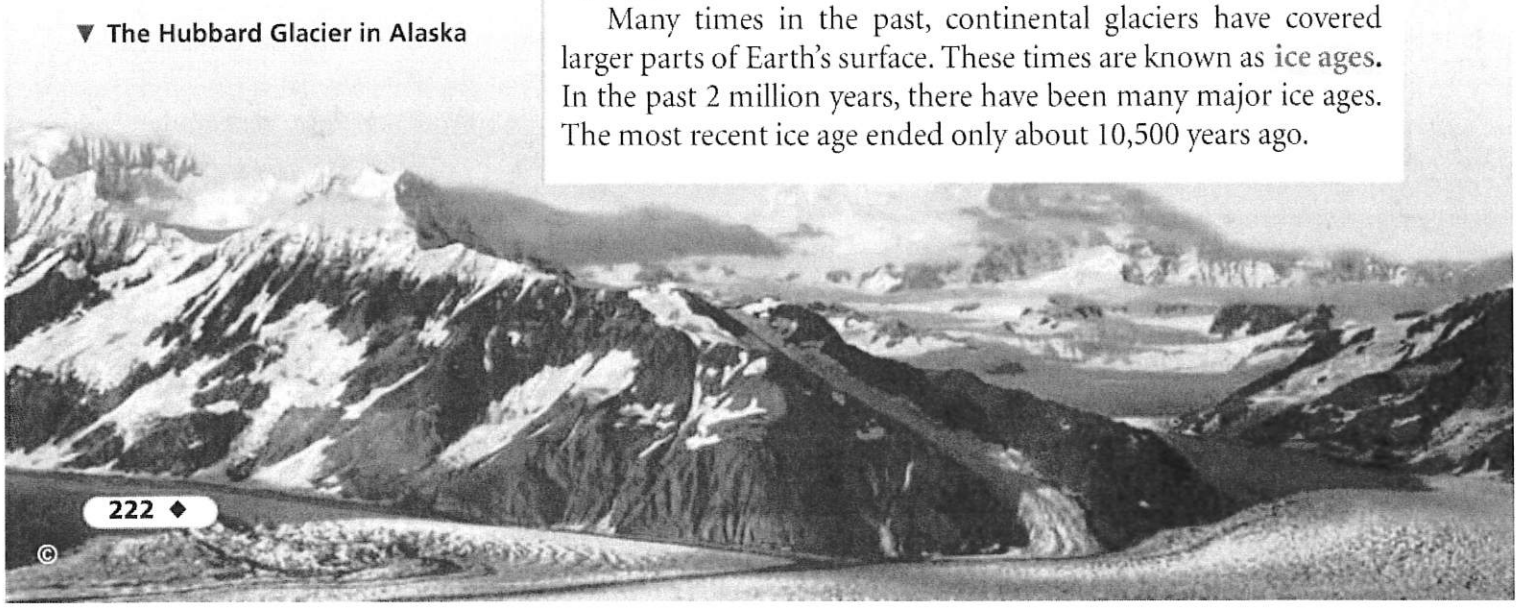
Inferring Based on your observations, how do you think moving ice could change the surface of the land?

Geologists define a **glacier** as any large mass of ice that moves slowly over land. **There are two kinds of glaciers—continental glaciers and valley glaciers.**

**Continental Glaciers** A **continental glacier** is a glacier that covers much of a continent or large island. They can spread out over millions of square kilometers. Today, continental glaciers cover about 10 percent of Earth's land. They cover Antarctica and most of Greenland. Continental glaciers can flow in all directions, spreading out much as pancake batter spreads out in a frying pan.

Many times in the past, continental glaciers have covered larger parts of Earth's surface. These times are known as **ice ages.** In the past 2 million years, there have been many major ice ages. The most recent ice age ended only about 10,500 years ago.

▼ The Hubbard Glacier in Alaska



**Valley Glaciers** A valley glacier is a long, narrow glacier that forms when snow and ice build up high in a mountain valley. The sides of mountains keep these glaciers from spreading out in all directions. Instead, they usually move down valleys that have already been cut by rivers. Valley glaciers are much smaller than continental glaciers, but can still be tens of kilometers long.

High in mountain valleys, snow builds up year after year. The weight of more and more snow compacts the snow at the bottom into ice. Glaciers can form only in an area where more snow falls than melts. Once the depth of snow and ice reaches more than 30 to 40 meters, gravity begins to pull the glacier downhill.

Reading Checkpoint **On what type of landform are valley glaciers found?**

## How Glaciers Shape the Land

The movement of a glacier changes the land beneath it. Although glaciers work slowly, they are a major force of erosion. **The two processes by which glaciers erode the land are plucking and abrasion.**

**Glacial Erosion** As a glacier flows over the land, it picks up rocks in a process called plucking. Beneath a glacier, the weight of the ice can break rocks apart. These rock fragments freeze to the bottom of the glacier. When the glacier moves, it carries the rocks with it.

Many rocks remain on the bottom of the glacier, and the glacier drags them across the land. This process, called abrasion, gouges and scratches the bedrock. You can see the results of erosion by glaciers in Figure 13.

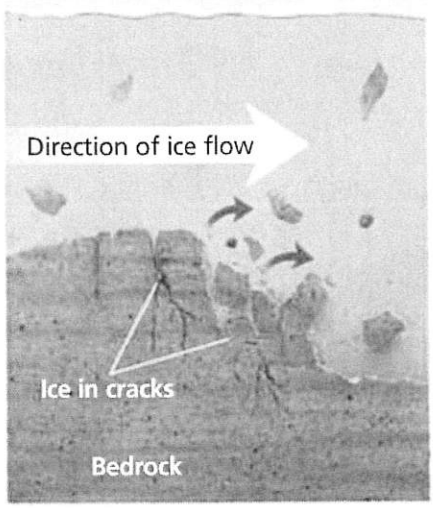
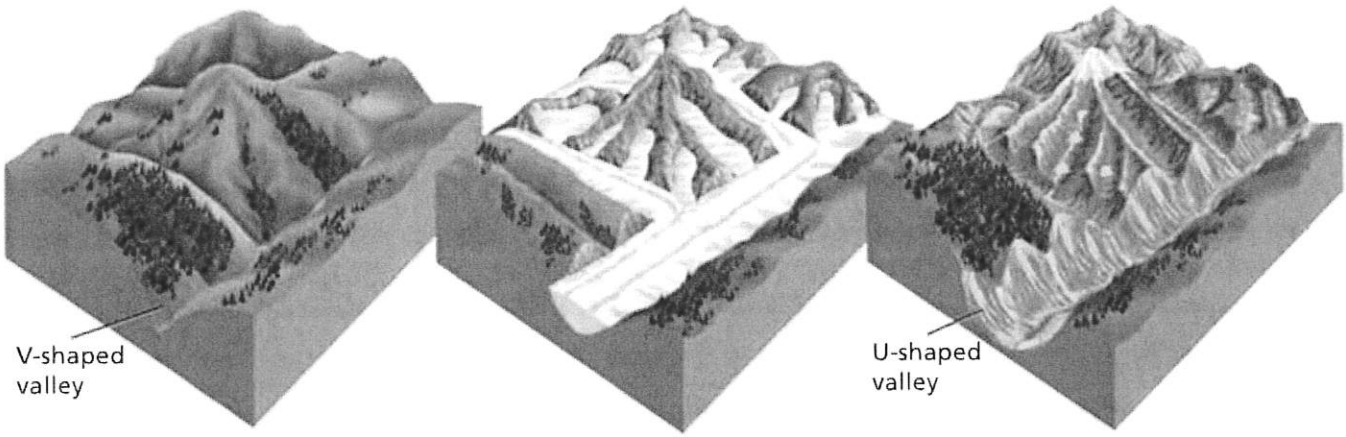



FIGURE 13
**Glacial Erosion**
As a glacier moves (above), plucking breaks pieces of bedrock from the ground. Erosion by glaciers (below) can carve a mountain peak into a sharp horn and grind out a V-shaped valley to form a U-shaped valley.
Observing *What other changes did the glacier produce in this landscape?*



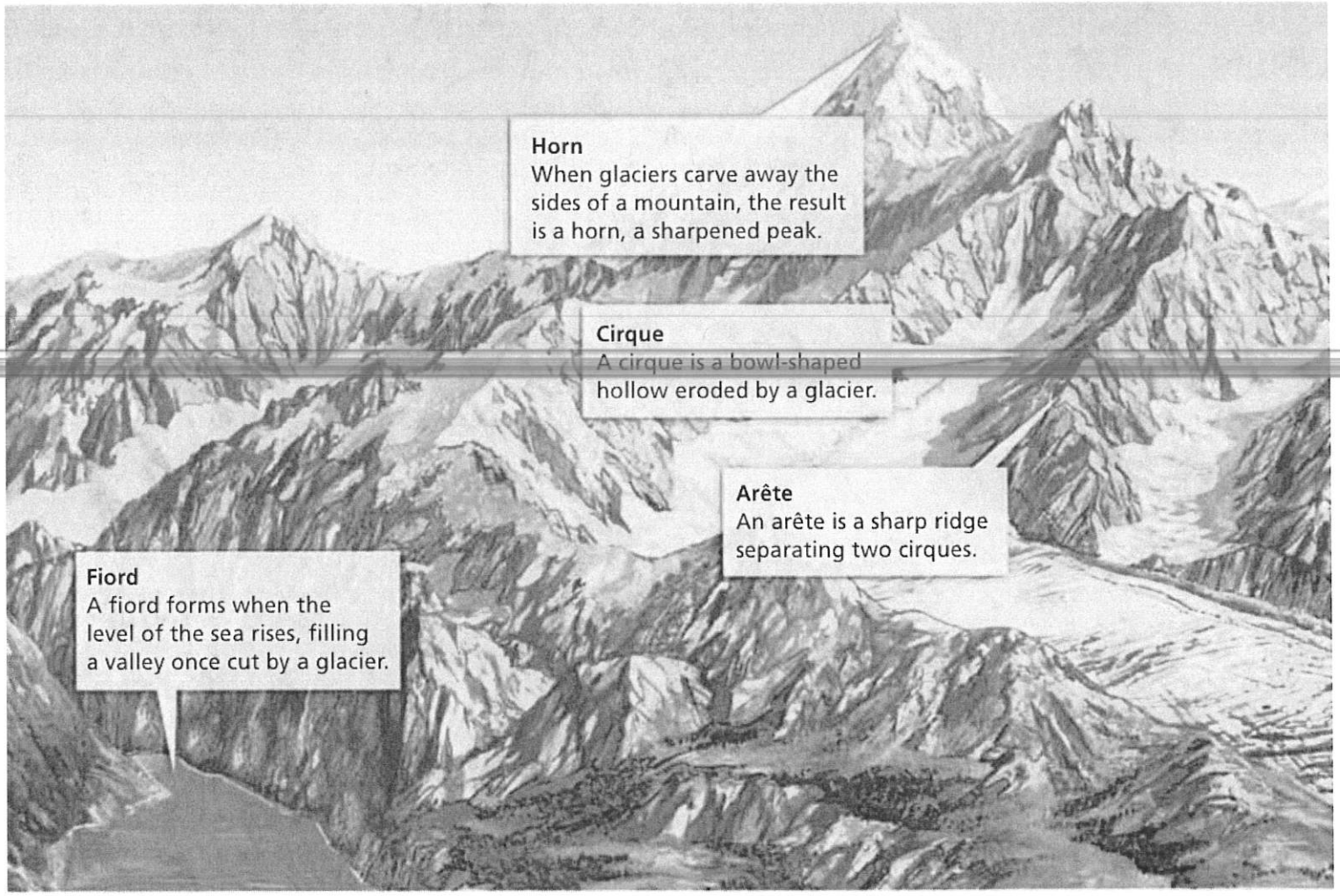



**FIGURE 14**
**Glacial Landforms**
As glaciers advance and retreat, they sculpt the landscape by erosion and deposition.
Classifying *Classify these glacial features according to whether they result from erosion or deposition: drumlin, horn, cirque, moraine, U-shaped valley.*

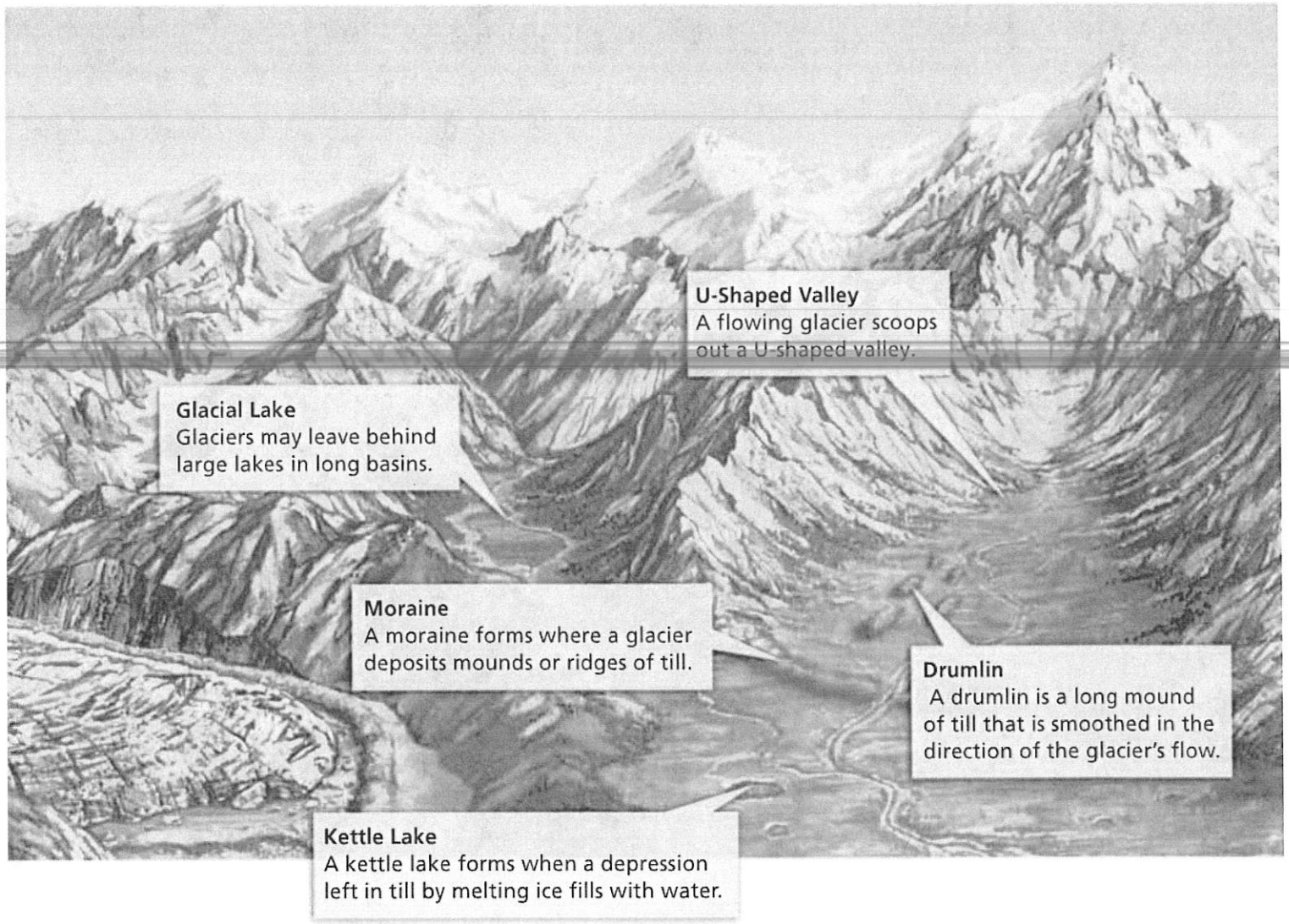
**Glacial Deposition** A glacier gathers a huge amount of rock and soil as it erodes the land in its path. **When a glacier melts, it deposits the sediment it eroded from the land, creating various landforms.** These landforms remain for thousands of years after the glacier has melted. The mixture of sediments that a glacier deposits directly on the surface is called **till.** Till is made up of particles of many different sizes. Clay, silt, sand, gravel, and boulders can all be found in till.

The till deposited at the edges of a glacier forms a ridge called a **moraine.** A terminal moraine is the ridge of till at the farthest point reached by a glacier. Long Island in New York is a terminal moraine from the continental glaciers of the last ice age.

Retreating glaciers also create features called kettles. A **kettle** is a small depression that forms when a chunk of ice is left in glacial till. When the ice melts, the kettle remains. The continental glacier of the last ice age left behind many kettles. Kettles often fill with water, forming small ponds or lakes called kettle lakes. Such lakes are common in areas, such as Minnesota, that were covered with ice.

Reading Checkpoint **What is a terminal moraine?**

Go Online
SCILINKS NSTA
**For:** Links on glaciers
**Visit:** www.SciLinks.org
**Web Code:** scn-0734




## Section 3 Assessment

**Target Reading Skill** Asking Questions Use the answers to the questions you wrote about the headings to help you answer the questions below.

### Reviewing Key Concepts

HINT HINT HINT

1. a. Defining What is a continental glacier?
   b Defining What is a valley glacier?
   c. Comparing and Contrasting How are the two types of glaciers similar? How are they different?

HINT

2. a. Reviewing What condition is necessary for a glacier to form?

HINT HINT

   b. Explaining How does a glacier move?
   c. Relating Cause and Effect Why does the snow that forms a glacier change to ice?

HINT HINT

3. a. Identifying What are two ways in which glaciers erode Earth's surface?
   b. Describing How does glacial deposition occur?

### Writing in Science

**Travel Brochure** A travel agency wants people to go on a tour of a mountain region with many glaciers. Write a paragraph for a travel brochure describing what people will see on the tour. In your answer, include features formed by glacial erosion and deposition.

Section 4

# Waves

## Reading Preview

### Key Concepts

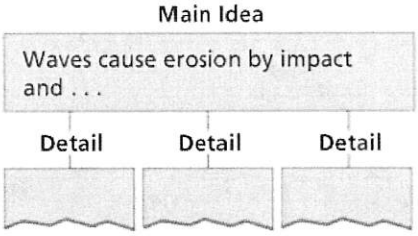
- What gives waves their energy?
- How do waves erode a coast?
- What features result from deposition by waves?

### Key Terms

- headland • beach
- longshore drift • spit

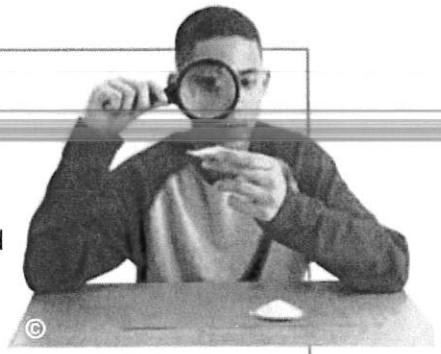
### Target Reading Skill

**Identifying Main Ideas** As you read Erosion by Waves, write the main idea in a graphic organizer like the one below. Then write three supporting details that further explain the main idea.




### Lab zone Discover Activity

#### What Is Sand Made Of?



1. Collect a spoonful of sand from each of two different beaches.
2. Examine the first sample of beach sand with a hand lens.
3. Record the properties of the sand grains, for example, color and shape. Are the grains smooth and rounded or angular and rough?
4. Examine the second sample and repeat Step 3. How do the two samples compare?

**Think It Over**

Posing Questions What questions do you need to answer to understand beach sand? Use what you know about erosion and deposition to help you think of questions.

Ocean waves contain energy—sometimes a great deal of energy. Created by ocean winds, they carry energy vast distances across the Pacific Ocean. Acting like drills or buzz saws, the waves erode the solid rock of the coast into cliffs and caves. Waves also carry sediment that forms features such as beaches.

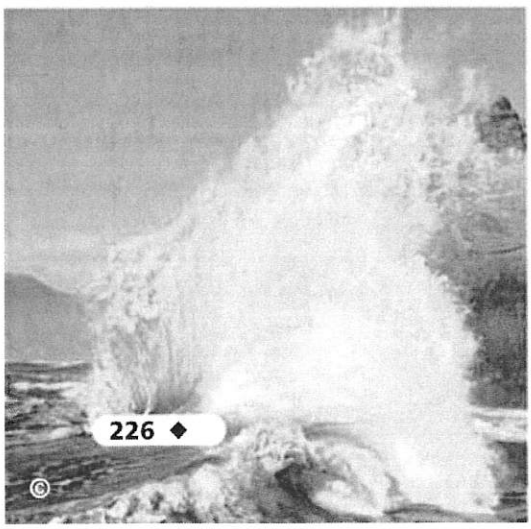
## How Waves Form

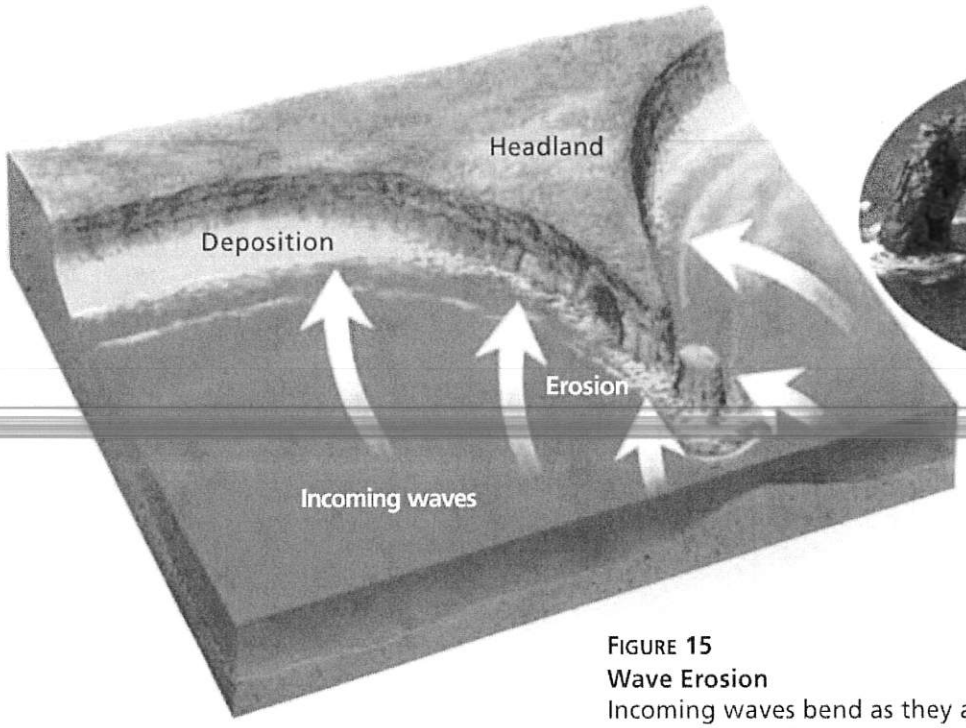
**The energy in waves comes from wind that blows across the water's surface.** As the wind makes contact with the water, some of its energy transfers to the water. Large ocean waves are the result of powerful storms far out at sea. But ordinary breezes can produce waves in lakes or small ponds.

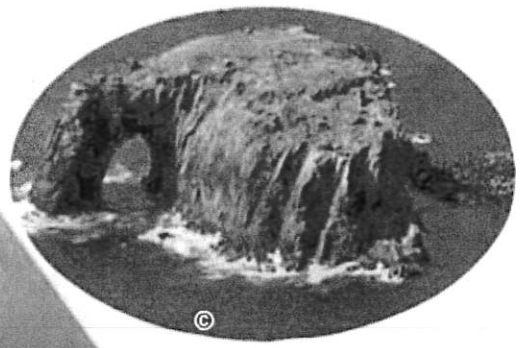
The energy that water picks up from the wind causes water particles to move up and down as the wave goes by. But the water particles themselves don't move forward.

A wave changes as it approaches land. In deep water, a wave only affects the water near the surface. But as it approaches shallow water, the wave begins to drag on the bottom. The friction between the wave and the bottom causes the wave to slow down. Now the water actually does move forward with the wave. This forward-moving water provides the force that shapes the land along the shoreline.

▼ Waves on the Oregon coast





▲ Sea arch

**FIGURE 15**
**Wave Erosion**
Incoming waves bend as they approach the shore, concentrating their energy on headlands. Waves have shaped these spectacular cliffs (right) along the coast of Cornwall in England.
Relating Cause and Effect *What will eventually happen to the headlands?*

## Erosion by Waves

Waves are the major force of erosion along coasts. **Waves shape the coast through erosion by breaking down rock and transporting sand and other sediment.**

**How Waves Erode** One way waves erode the land is by impact. Large waves can hit rocks along the shore with great force. This energy in waves can break apart rocks. Over time, waves can make small cracks larger. Eventually, the waves cause pieces of rock to break off.

Waves also erode by abrasion. As a wave approaches shallow water, it picks up sediment, including sand and gravel. This sediment is carried forward by the wave. When the wave hits land, the sediment wears away rock like sandpaper wearing away wood.

Waves coming to shore gradually change direction. The change in direction occurs as different parts of a wave begin to drag on the bottom. Notice how the waves in Figure 15 change direction as they approach the shore. The energy of these waves is concentrated on headlands. A **headland** is a part of the shore that sticks out into the ocean. Headlands stand out from the coast because they are made of harder rock that resists erosion by the waves. But, over time, waves erode the headlands and even out the shoreline.

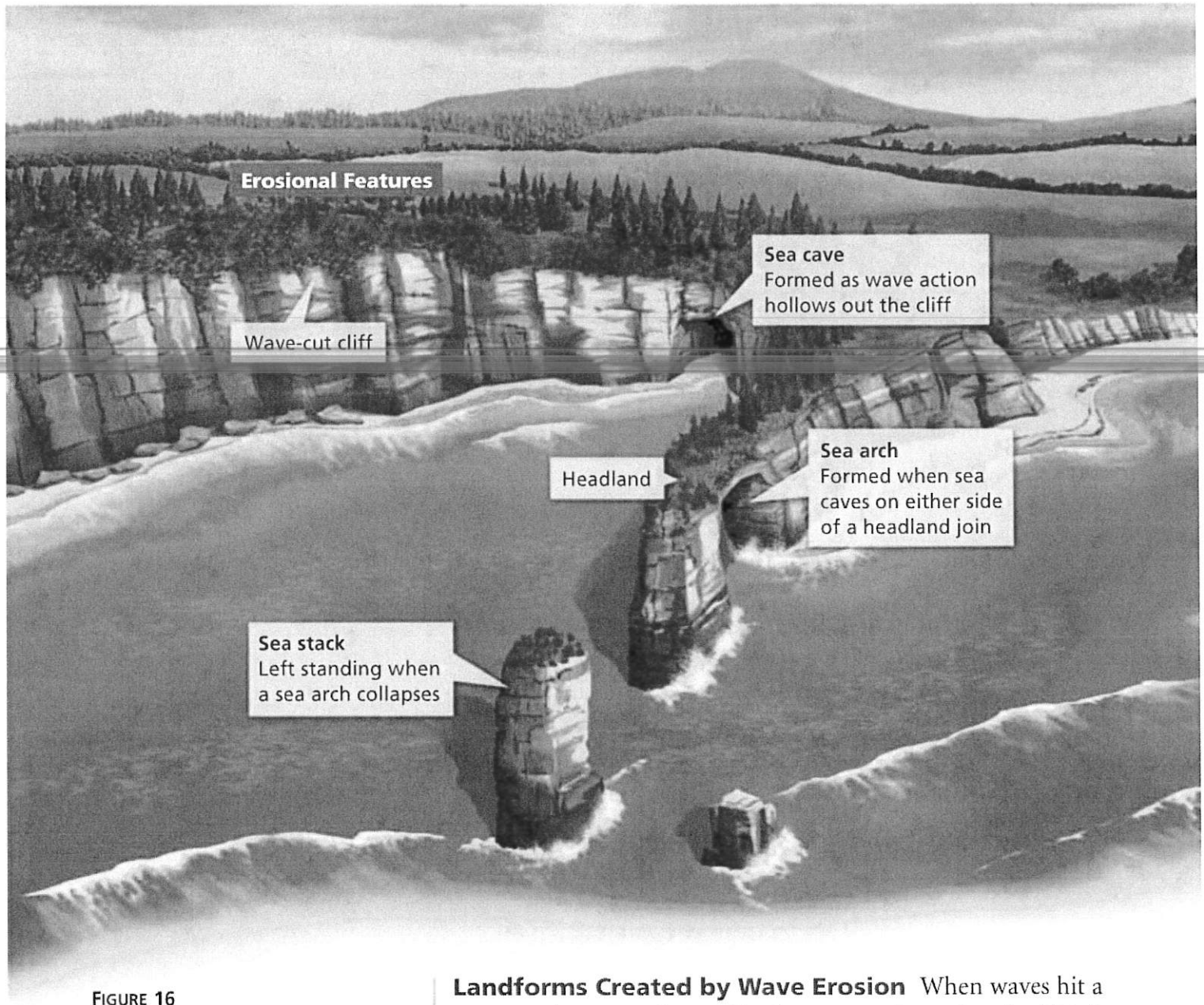



FIGURE 16

## The Changing Coast

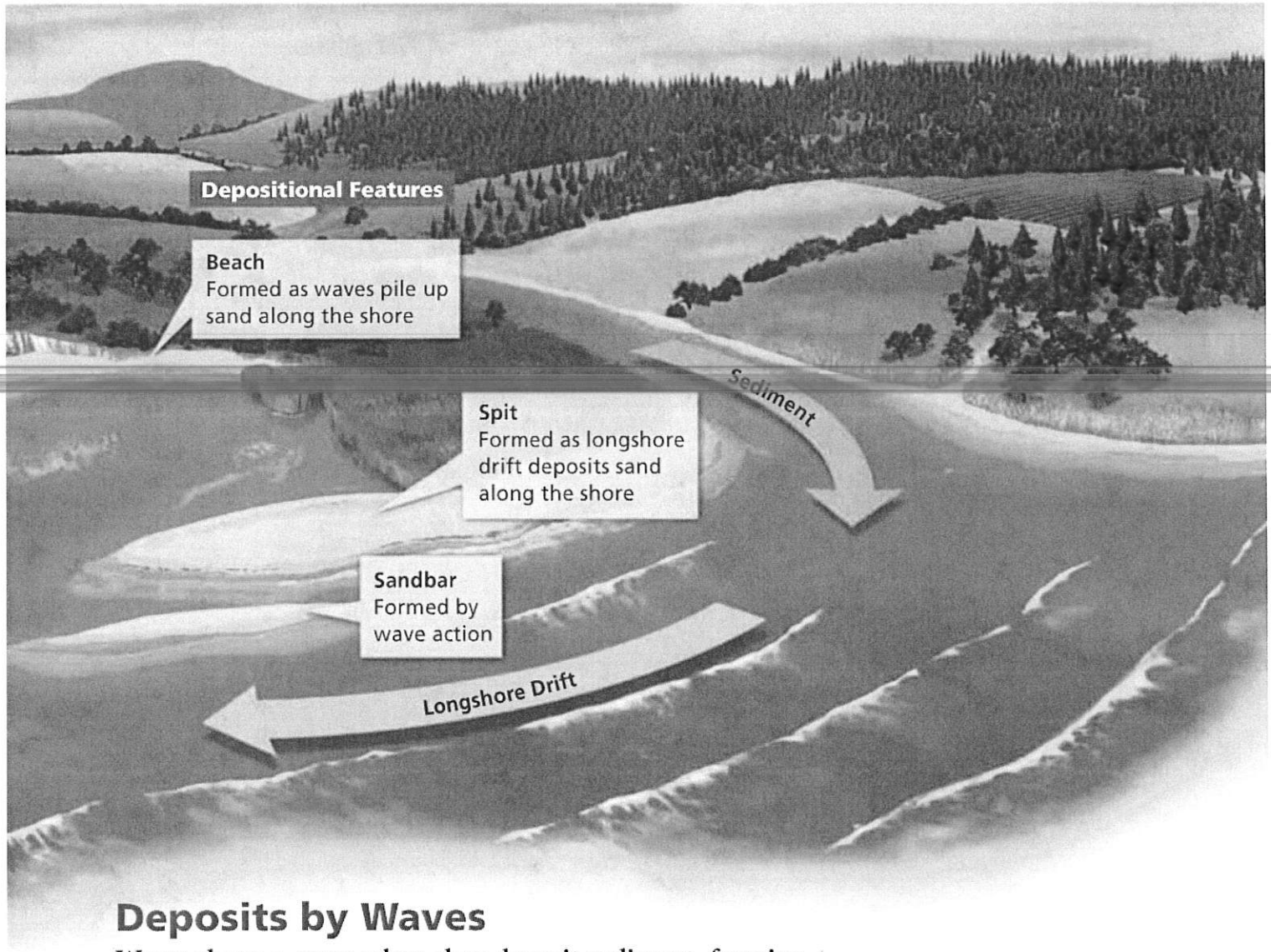
Erosion and deposition create a variety of features along a coast. Predicting *What will eventually happen to the sea arch?*

**Landforms Created by Wave Erosion** When waves hit a steep, rocky coast, they strike the area again and again. Think of an ax striking the trunk of a tree. The cut gets bigger and deeper with each strike of the blade. Finally the tree falls. In a similar way, ocean waves erode the base of the land along a steep coast. Where the rock is softer, the waves erode the land faster. Over time the waves may erode a hollow area in the rock called a sea cave.

Eventually, waves may erode the base of a cliff so much that the rock above collapses. The result is a wave-cut cliff. You can see an example of such a cliff in Figure 16.

Another feature created by wave erosion is a sea arch. A sea arch forms when waves erode a layer of softer rock that underlies a layer of harder rock. If an arch collapses, the result might be a sea stack, a pillar of rock rising above the water.

Reading Checkpoint **Over a long period of time, what effect do waves have on a steep, rocky coast?**




## Deposits by Waves

**Waves shape a coast when they deposit sediment, forming coastal features such as beaches, spits, and barrier beaches.** Deposition occurs when waves slow down, causing the water to drop its sediment. This process is similar to the deposition that occurs on a river delta when the river slows down and drops its sediment load.

**Beaches** As waves reach the shore, they drop the sediment they carry, forming a beach. A **beach** is an area of wave-washed sediment along a coast. The sediment deposited on beaches is usually sand. Most sand comes from rivers that carry eroded particles of rock into the ocean. But not all beaches are made of sand. Some beaches are made of small fragments of coral or sea shells piled up by wave action. Florida has many such beaches.

The sediment on a beach usually moves down the beach after it has been deposited. Waves usually hit the beach at an angle instead of straight on. These angled waves create a current that runs parallel to the coastline. As waves repeatedly hit the beach, some of the beach sediment moves down the beach with the current, in a process called **longshore drift.**

**Lab zone Skills Activity**

Calculating A sandy coast erodes at a rate of 1.25 m per year. But a severe storm can erode an additional 3.75 m from the shore. If 12 severe storms occur during a 50-year period, how much will the coast erode? If you wish, you may use an electronic calculator to find the answer.

FIGURE 17
**Spits**
This aerial photograph shows how longshore drift can carry sand and deposit it to form a spit.
Observing *How many spits can you find in this image?*

**Spits** One result of longshore drift is the formation of a spit. A spit is a beach that projects like a finger out into the water. Spits form as a result of deposition by longshore drift. Spits occur where a headland or other obstacle interrupts longshore drift, or where the coast turns abruptly.

**Sandbars and Barrier Beaches** Incoming waves carrying sand may build up sandbars, long ridges of sand parallel to the shore. A barrier beach is similar to a sandbar. A barrier beach forms when storm waves pile up large amounts of sand above sea level forming a long, narrow island parallel to the coast. Barrier beaches are found in many places along the Atlantic coast of the United States, such as the Outer Banks of North Carolina. People have built homes on many of these barrier beaches. But the storm waves that build up the beaches can also wash them away. Barrier beach communities must be prepared for the damage that hurricanes and other storms can bring.

Reading Checkpoint **How does a barrier beach form?**

## Section 4 Assessment

**Target Reading Skill** Identifying Main Ideas Use your graphic organizer to help you answer Question 2 below.

### Reviewing Key Concepts

HINT 1. a. Explaining What is the source of the energy in ocean waves?

HINT b. Describing How does an ocean wave change when it reaches shallow water?

HINT c. Inferring Does an ocean wave possess potential energy or kinetic energy? Explain.

HINT 2. a. Identifying What are two results of wave erosion along a coast?

HINT b. Describing What are two ways in which waves erode rock?

HINT c. Sequencing Place these features in the order in which they would probably form: sea stack, sea cave, headland, cliff, sea arch.

3. a. Listing What are three features formed by wave deposition? HINT

b. Relating Cause and Effect Beginning with the source of sand, explain the process by which a spit forms. HINT

### Writing in Science

**Explaining a Process** Suppose that you live in a coastal area that has a barrier beach. Write a paragraph in which you explain the processes that formed the barrier beach. Also describe how the forces might change it over time.

Section 5

# Wind

## Reading Preview

### Key Concepts

- How does wind cause erosion?
- What features result from deposition by wind?

### Key Terms

- sand dune
- deflation
- loess

### Target Reading Skill

**Sequencing** As you read, make a flowchart like the one below that shows the process of wind erosion and deposition. Write each step of the process in a separate box in the flowchart in the order in which it occurs.

Wind Erosion

Wind picks up smallest particles of sediment.

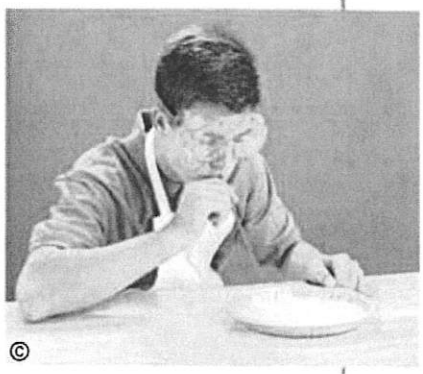
▼

▼

## Lab zone Discover Activity

### How Does Moving Air Affect Sediment?

1. Cover the bottom of a pan with a flat layer of cornmeal 1–2 cm deep.
2. Gently blow over the layer of cornmeal using a straw to direct your breath. Observe what happens. **CAUTION:** *Do not blow the cornmeal in the direction of another student.*



**Think It Over**

Observing What changes did the wind you created make in the flat layer of cornmeal?

Imagine a landscape made almost entirely of sand. One such place is the Namib Desert. The desert stretches 1,900 kilometers along the coast of Namibia in Africa. In the southern half of the Namib are rows of giant sand dunes. A **sand dune** is a deposit of wind-blown sand. Some sand dunes in the Namib are more than 200 meters high and 15 kilometers long. Much of the sand in the dunes originally came from the nearby Orange River. Over thousands of years, wind has swept the sand across the desert, piling up huge, ever-changing dunes.

## How Wind Causes Erosion

Wind by itself is the weakest agent of erosion. Water, waves, moving ice, and even mass movement have more effect on the land. Yet wind can be a powerful force in shaping the land in areas where there are few plants to hold the soil in place. For example, few plants grow in deserts, so wind can easily move the grains of dry sand. **Wind causes erosion by deflation and abrasion.**

**Wind erosion constantly shapes the giant sand dunes in the Namib Desert of southwestern Africa. ▼**

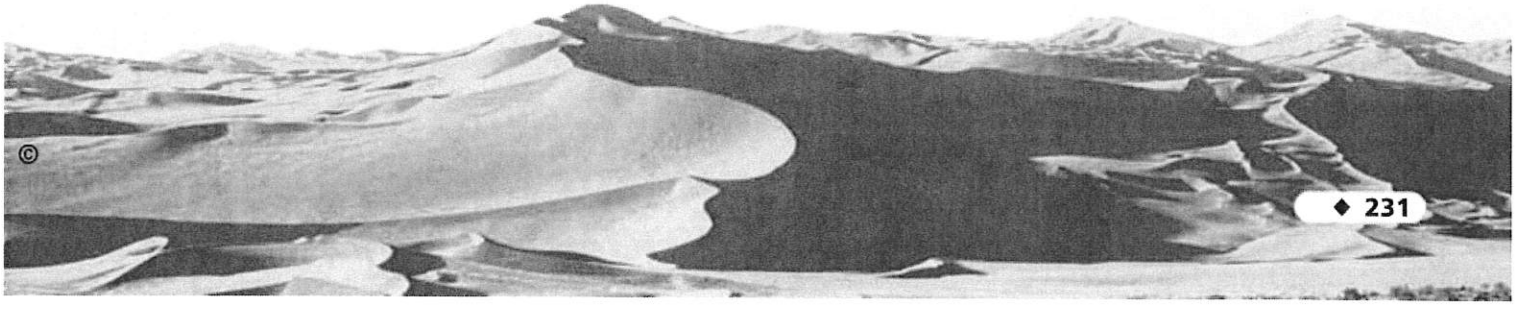
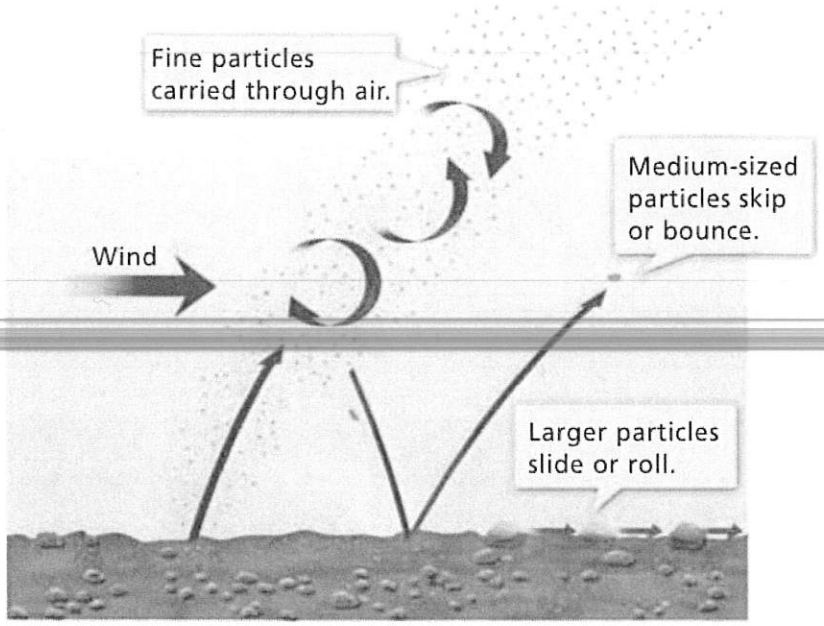


FIGURE 18
**Wind Erosion**
Wind erosion moves sediment particles of different sizes in the three ways shown at right.
Comparing and Contrasting
*Compare the movement of sediment by wind with the movement of sediment by water in Figure 14 earlier in the chapter. How are the processes similar? How are they different?*




**Deflation** The main way that wind causes erosion is by deflation. Geologists define **deflation** as the process by which wind removes surface materials. When wind blows over the land, it picks up the smallest particles of sediment. This sediment is made of bits of clay and silt. The stronger the wind, the larger the particles that it can pick up. Slightly heavier particles, such as sand, might skip or bounce for a short distance. But sand soon falls back to the ground. Strong winds can even roll heavier sediment particles over the ground. Figure 18 shows how wind erodes by deflation.

Deflation does not usually have a great effect on land. However, in parts of the Great Plains in the 1930s, deflation caused the loss of about 1 meter of topsoil in just a few years. In deserts, deflation can sometimes create an area of rock fragments called desert pavement. You can see an area of desert pavement in Figure 19. There, wind has blown away the smaller sediment. All that remains are rocky materials that are too heavy to be moved. Where there is already a slight depression in the ground, deflation can produce a bowl-shaped hollow called a blowout.

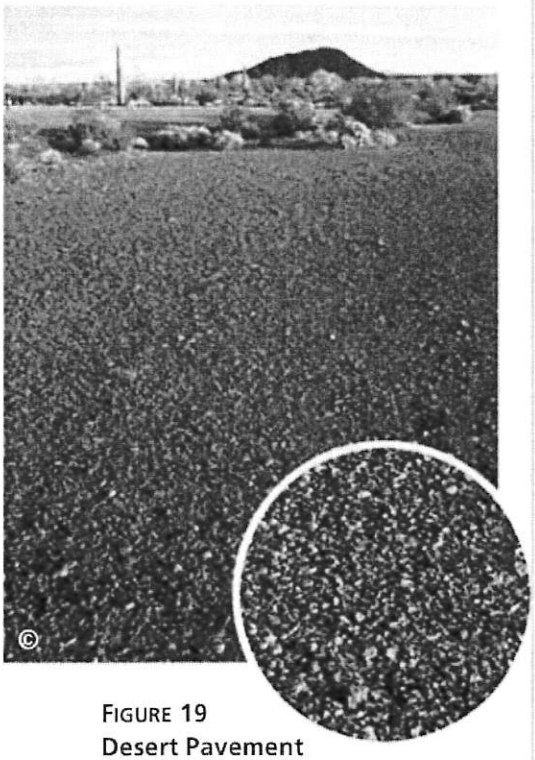


FIGURE 19
**Desert Pavement**
Wind erosion formed this desert pavement in the Arizona desert. Wind-driven sand may polish and shape individual stones.

**Abrasion** Abrasion by wind-carried sand can polish rock, but it causes little erosion. At one time, geologists thought that the sediment carried by wind cut the stone shapes seen in deserts. But now evidence shows that most desert landforms are the result of weathering and water erosion.

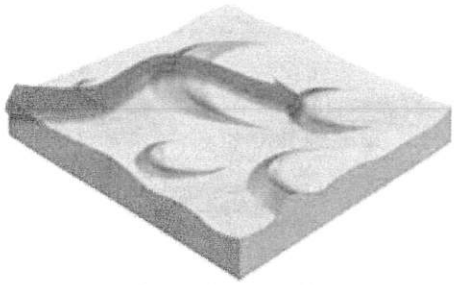
Reading Checkpoint **Where would you be most likely to see evidence of wind erosion?**

## Wind Deposition

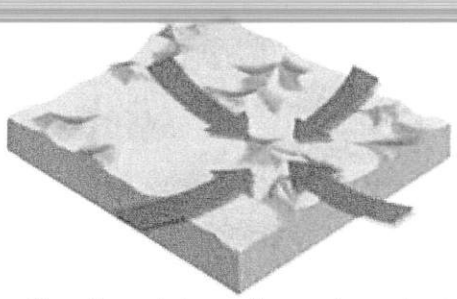
All the sediment picked up by wind eventually falls to the ground. This happens when the wind slows down or some obstacle, such as a boulder or a clump of grass, traps the windblown sand sediment. **Wind erosion and deposition may form sand dunes and loess deposits.** When the wind strikes an obstacle, the result is usually a sand dune. Sand dunes can be seen on beaches and in deserts where windblown sediment has built up.

**Sand Dunes** Sand dunes come in many shapes and sizes. Some are long, with parallel ridges, while others are U-shaped. They can also be very small or very large—some sand dunes in China have grown to heights of 500 meters. Sand dunes move over time. Little by little, the sand shifts with the wind from one side of the dune to the other. This process is shown in Figure 20. Sometimes plants begin growing on a dune. Plant roots can help to anchor the dune in one place.

**Loess Deposits** Sediment that is finer than sand, such as particles of clay and silt, is sometimes deposited in layers far from its source. This fine, wind-deposited sediment is loess (LES). Large loess deposits are found in central China and in such states as Nebraska, South Dakota, Iowa, Missouri, and Illinois. Loess helps to form fertile soil. Many areas with thick loess deposits are valuable farmlands.



Crescent-shaped dunes form where the wind usually blows in the same direction.



Star-shaped dunes form where the wind direction changes frequently.


FIGURE 20
**Movement of Sand Dunes**
Wind direction is one factor that helps determine the shape and size of sand dunes.

## Section 5 Assessment

**Vocabulary Skill** Latin Word Origins Use what you've learned to complete the following sentence. A process in which wind wears down surface materials is called _____.

### Reviewing Key Concepts

HINT
1. a. Reviewing What are two kinds of wind erosion?

HINT
b. Explaining Explain how sediment particles of different sizes move during wind erosion.

HINT
c. Predicting In a desert, soil containing a mixture of sand and small rocks is exposed to wind erosion. Over time, how would the land surface change? Explain.

HINT
2. a. Relating Cause and Effect What causes wind to deposit sand or other sediment?

HINT
b. Identifying What are two types of features that result from wind deposition?

HINT
c. Problem Solving How could sand dunes be held in place to keep them from drifting onto a parking lot?

### Lab zone At-Home Activity

Desert Pavement To model desert pavement, put a few coins in a shallow pan. Sprinkle enough flour over the coins to cover them. Then blow air gently through a straw across the surface of the flour. Be careful not to draw in any flour through the straw. Be certain the blown flour will not get in your or anyone else's eyes. Ask your family to predict what would happen if the "wind" blew for a long time.

# Chapter 7 Study Guide

**The BIG Idea** **Composition and structure of Earth** Moving water, wind, and ice erode Earth's surface and build new features.

## 1 Changing Earth's Surface

### Key Concepts

Weathering, erosion, and deposition act together in a cycle that wears down and builds up Earth's surface.

Gravity causes mass movement, including landslides, mudflows, slump, and creep.

### Key Terms

erosion
sediment
deposition
gravity
mass movement

## 2 Water Erosion

### Key Concepts

Moving water is the major agent of the erosion that has shaped Earth's land surface.

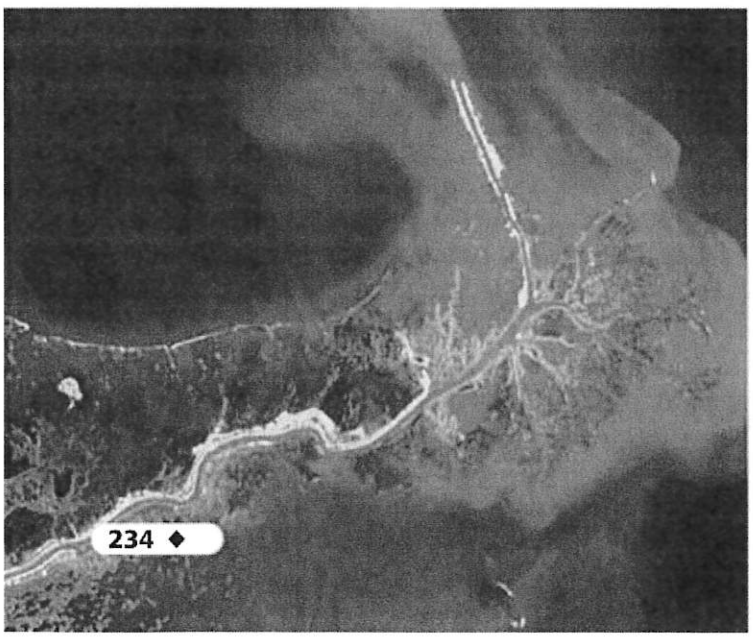
Through erosion, a river creates valleys, waterfalls, flood plains, meanders, and oxbow lakes.

Deposition creates alluvial fans and deltas. It can also add soil to a river's flood plain.

Groundwater can cause erosion through a process of chemical weathering.

### Key Terms

• runoff • rill • gully • stream • tributary
• flood plain • meander • oxbow lake
• alluvial fan • delta • groundwater
• stalactite • stalagmite • karst topography





## 3 Glaciers

### Key Concepts

There are two kinds of glaciers—continental glaciers and valley glaciers.

The two processes by which glaciers erode the land are plucking and abrasion.

When a glacier melts, it deposits the sediment it eroded from the land, creating various landforms.

### Key Terms

glacier
continental glacier
ice age
valley glacier
plucking
abrasion
till
moraine
kettle

## 4 Waves

### Key Concepts

The energy in waves comes from wind that blows across the water's surface.

Waves shape the coast through erosion by breaking down rock and transporting sand and other sediment.

Waves shape a coast when they deposit sediment, forming coastal features such as beaches, spits, and barrier beaches.

### Key Terms

headland
beach
longshore drift
spit

## 5 Wind

### Key Concepts

Wind causes erosion by deflation and abrasion.

Wind erosion and deposition may form sand dunes and loess deposits.

### Key Terms

sand dune
deflation
loess

# Review and Assessment

Go Online
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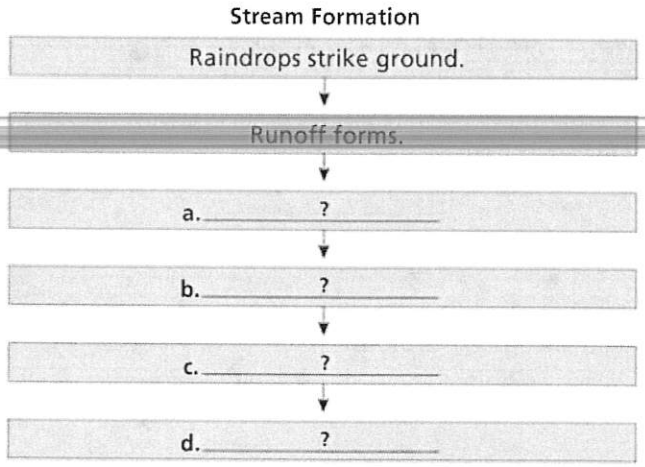
Visit: PHSchool.com
Web Code: cpa-0007

## Organizing Information

**Flowcharts** Copy the flowchart about stream formation onto a separate sheet of paper. Then complete it and add a title. (For more on flowcharts, see the Skills Handbook.)




## Reviewing Key Terms

**Choose the letter of the best answer.**

HINT
1. The eroded materials carried by water or wind are called
   a. stalactites.
   b. desert pavement.
   c. sediment.
   d. moraines.

HINT
2. The downhill movement of eroded materials is known as
   a. mass movement.
   b. abrasion.
   c. deposition.
   d. deflation.

HINT
3. As runoff flows over the surface, it forms tiny grooves in soil called
   a. gullies.
   b. deltas.
   c. rills.
   d. fans.

HINT
4. A mass of rock and soil deposited directly by a glacier is called
   a. bedrock.
   b. till.
   c. loess.
   d. a cirque.

HINT
5. The erosion of sediment by wind is
   a. deposition.
   b. deflation.
   c. plucking.
   d. glaciation.

**If the statement is true, write *true*. If it is false, change the underlined word or words to make the statement true.**

HINT
6. The process by which sediment in water settles in new locations is mass movement.

HINT
7. Groundwater that flows in a thin layer over the land causes sheet erosion.

HINT
8. A deposit that hangs from the roof of a cave is called a stalactite.

HINT
9. A looplike bend in a river is a meander.

HINT
10. The sediment deposited at the edge of a glacier forms a ridge called a kettle.

## Writing in Science

**Article** Suppose that you have just returned from a visit to a limestone cave, such as Mammoth Cave in Kentucky. Write an article describing your visit to the cave. Include how the cave formed, what you saw during your visit, and how features inside the cave developed.

Discovery Channel School
*Erosion and Deposition*
Video Preview
Video Field Trip
▶ Video Assessment

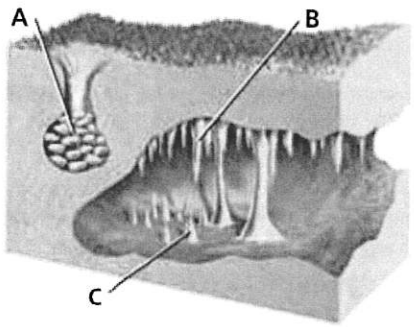
# Review and Assessment

## Checking Concepts

11. What agents of erosion are assisted by the force of gravity?
12. Beginning with rain hitting the land surface, describe the process by which a stream forms.
13. How does an alluvial fan form?
14. Describe the process by which groundwater can cause erosion and deposition in limestone beneath Earth's surface.
15. What are ice ages?
16. How does a kettle lake form?
17. How does a loess deposit form?

## Thinking Critically

18. **Comparing and Contrasting** Compare and contrast landslides and mudflows.
19. **Relating Cause and Effect** In a desert, you see an area that looks as if it were paved with rock fragments. Explain how this situation occurred naturally.
20. **Making Judgments** A salesperson offers to sell your family a new house right on a riverbank for very little money. Why might your family hesitate to buy this house?
21. **Relating Cause and Effect** What caused the features labeled A, B, and C in the diagram below to form? Explain.




22. **Problem Solving** Suppose you are a geologist studying a valley glacier. What method could you use to tell if it is advancing or retreating?
23. **Inferring** You see a sandy beach along a coastline. Where did the sand come from?

## Applying Skills

**Use the table below to answer Questions 24–26.**

*The table shows how a river's volume of flow and sediment load change over six months.*

| Month | Volume of Flow (cubic meters/second) | Sediment Load (metric tons/day) |
|---|---|---|
| January | 1.5 | 200 |
| February | 1.7 | 320 |
| March | 2.6 | 725 |
| April | 4.0 | 1,600 |
| May | 3.2 | 1,100 |
| June | 2.8 | 900 |

24. **Graphing** Make one graph with the month on the *x*-axis and the volume of flow on the *y*-axis. Make a second graph with the sediment load on the *y*-axis. Compare your two graphs. When were the river's volume of flow and load the greatest? The lowest?
25. **Developing Hypotheses** Use your graphs to develop a hypothesis about the relationship between volume of flow and sediment load.
26. **Relating Cause and Effect** What may have occurred in the river's drainage basin in April to cause the changes in volume of flow and sediment load? Explain.

## Lab zone Chapter Project

**Performance Assessment** Now you are ready to present to your class. Explain which types of soil you chose and why you chose them. Discuss the design of your dam, the tests you conducted, and the results. In your journal, write about the easiest and hardest parts of this project. How would you design your dam differently if you did the project again?

# GA Preparing for the CRCT

**Test-Taking Tip**

Eliminating Incorrect Answers

When answering a multiple-choice question, you can often eliminate some answer choices immediately because they are clearly incorrect. By doing this, you increase your odds of choosing the correct answer.

*Sample Question*

What is the slow, downhill mass movement of rock and soil, caused by gravity?

**A** a landslide
**B** creep
**C** runoff
**D** a glacier

*Answer*

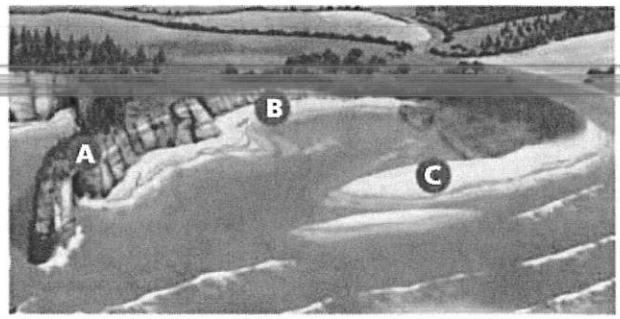
You can eliminate **C** and **D**, because neither are examples of mass movement due to gravity. Runoff is water moving over the land, and a glacier is a moving mass of ice. **A** is incorrect because a landslide is a rapid type of mass movement. The correct answer is **B**.

**Choose the letter of the best answer.**

1. Which statement best describes the process that forms a stream?
   **A** Sheet erosion digs a deep channel.
   **B** Tiny rills enlarge to form gullies, which join to form a stream.
   **C** Small gullies enlarge to form rills, which deepen to form a stream.
   **D** Water flows down a V-shaped valley. S6E5.e

2. How does wind carry sediment particles?
   **A** as fine particles carried through the air
   **B** as particles that bounce along the ground
   **C** as larger particles that slide or roll along the ground
   **D** all of the above S6E5.e

*Use the diagram below and your knowledge of science to answer Questions 3–4.*




3. What is the feature labeled *C* in the diagram?
   **A** a sandbar
   **B** a sea stack
   **C** a spit
   **D** a sand dune S6E5.e

4. Which of the labeled features was created by wave erosion?
   **A** feature A
   **B** feature B
   **C** feature C
   **D** all of the above S6E5.e

5. What is the process by which weathered rock, sediment, and soil is moved from place to place?
   **A** erosion
   **B** delta formation
   **C** running water
   **D** runoff S6E5.e

6. A meander that is cut off from the main course of a river becomes a(n)
   **A** kettle lake.
   **B** delta.
   **C** oxbow lake.
   **D** alluvial fan. S6E5.e

## Constructed Response

7. Describe how gravity is involved in the erosion of Earth's surface by mass movement, running water, and glaciers. Be sure to first explain what erosion is. S6E5.e