KEY CONCEPT

5.1 Forces wear down and build up Earth's surface.

BEFORE, you learned

- Weathering breaks rocks apart
- Weathering forms soil

NOW, you will learn

- How erosion moves and deposits rock and soil
- How gravity causes movement of large amounts of rock and soil

VOCABULARY

erosion p. 145
deposition p. 145
mass wasting p. 147

THINK ABOUT

How did natural forces shape this landform?

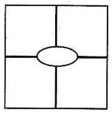
This valley in Iceland was formed by the action of water. How long might it have taken to form? Where did the material that once filled the valley go?

Natural forces move and deposit sediments.

The valley in the photograph was formed by the movement of water. The water flowed over the land and carried away weathered rock and soil, shaping a valley where the water flows. In this section you will learn about the processes that shape landscapes.

The process in which weathered particles are picked up and moved from one place to another is called **erosion** (ih-ROH-zhuhn). Erosion has a constant impact on Earth's surface. Over millions of years, it wears down mountains by removing byproducts of weathering and depositing them elsewhere. The part of the erosion process in which sediment is placed in a new location, or deposited, is called **deposition** (DEHP-uh-ZIHSH-uhn).

VOCABULARY
Use four square diagrams to take notes about the terms *erosion* and *deposition*.



The force of gravity is an important part of erosion and deposition. Gravity causes water to move downward, carrying and depositing sediment as it flows. Gravity can pull huge masses of ice slowly down mountain valleys. And gravity causes dust carried by the wind to fall to Earth.

Erosion of weathered rock by the movement of water, wind, and ice occurs in three major ways:

- **Water** Rainwater and water from melting snow flow down sloping land, carrying rock and soil particles. The water makes its way to a river, which then carries the sediment along. The sediment gets deposited on the river's bottom, banks, or floodplain, or near its mouth. Waves in oceans and lakes also carry sediment and deposit it to form beaches and other features.
- **Wind** Strong winds lift tiny particles of dust and carry them long distances. When the wind dies down, the particles drop to the ground. Wind can also push larger particles of sand along the ground.
- **Ice** As ice moves slowly downhill, it transports rock and soil particles that are embedded in it.

CHECK YOUR READING What are the three major ways in which erosion moves sediment?

INVESTIGATE Erosion

How does the effect of rainwater on sloping land differ from its effect on flat land?

DESIGN YOUR OWN EXPERIMENT

Streams are one of the main agents of erosion on Earth. Design an experiment to show the effect that rainwater has on sloping land.

SKILL FOCUS
Designing experiments

MATERIALS
- soil
- 2 large trays
- pitcher of water

TIME
25 minutes

PROCEDURE

1. Figure out how to use the soil, water, and trays to test the effects of rainwater on sloping land and on flat land.
2. Write up your procedure.
3. Carry out your experiment.

WHAT DO YOU THINK?

- What were the results of your experiment? Did it work? Why or why not?
- What were the variables in your experiment?
- What does your experiment demonstrate about erosion and running water?

CHALLENGE How would you design an experiment to demonstrate the relationship between floods and erosion?

Gravity can move large amounts of rock and soil.

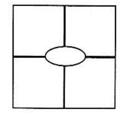
Along the California coast many homes are built atop beautiful cliffs, backed by mountains and looking out to the sea. These homes may seem like great places to live. They are, however, in a risky location.

The California coast region and other mountainous areas have many landslides. A landslide is one type of **mass wasting**—the downhill movements of masses of rock and soil.

In mass wasting, gravity pulls material downward. A triggering event, such as heavy rain or an earthquake, might loosen the rock and soil. As the material becomes looser, it gives way to the pull of gravity and moves downward.

Mass wasting can occur suddenly or gradually. It can involve tons of rock sliding down a steep mountain slope or moving little by little down a gentle hillside. One way to classify an occurrence of mass wasting is by the type of material that is moved and the speed of the movement. A sudden, fast movement of rock and soil is called a landslide. Movements of rock are described as slides or falls. Movement of mud or soil is described as a mudflow.

VOCABULARY
Be sure to make a four square diagram for *mass wasting* in your notebook.



Mass Wasting of Rock

Mass wasting of rock includes rockfalls and rockslides:

- In a rockfall, individual blocks of rock drop suddenly and fall freely down a cliff or steep mountainside. Weathering can break a block of rock from a cliff or mountainside. The expansion of water that freezes in a crack, for example, can loosen a block of rock.
- In a rockslide, a large mass of rock slides as a unit down a slope. A rockslide can reach a speed of a hundred kilometers per hour. Rockslides can be triggered by earthquakes.

Mass wasting of rock often takes place in high mountains. In some places, rocks can fall or slide onto roads. You might also see evidence of rockfalls and rockslides at the base of steep cliffs, where piles of rock slope outward.

Rockslides, such as this one in California, can drop huge amounts of rock onto highways.

Mudflows in 1999 in Venezuela happened very quickly and took as many as 30,000 lives.

Mudflow

Sometimes a mountain slope collapses. Then a mixture of rock, soil, and plants—called debris (duh-BREE)—falls or slides down. Like mass wasting of rock, mass movements of debris are common in high mountains with steep slopes.

A major type of mass wasting of debris is a mudflow. A mudflow consists of debris with a large amount of water. Mudflows often happen in mountain canyons and valleys after heavy rains. The soil becomes so heavy with water that the slope can no longer hold it in place. The mixture of soil, water, and debris flows downward, picking up sediment as it rushes down. When it reaches a valley, it spreads in a thin sheet over the land.

Mudflows also occur on active volcanoes. In 1985, a huge mudflow destroyed the town of Armero, Colombia, and killed more than 20,000 people. When a volcano erupted there, the heat caused ice and snow near the top of the volcano to melt, releasing a large amount of water that mixed with ash from the volcano. The mixture of ash and water rushed down the volcano and picked up debris. It formed gigantic mudflows that poured into all the surrounding valleys.

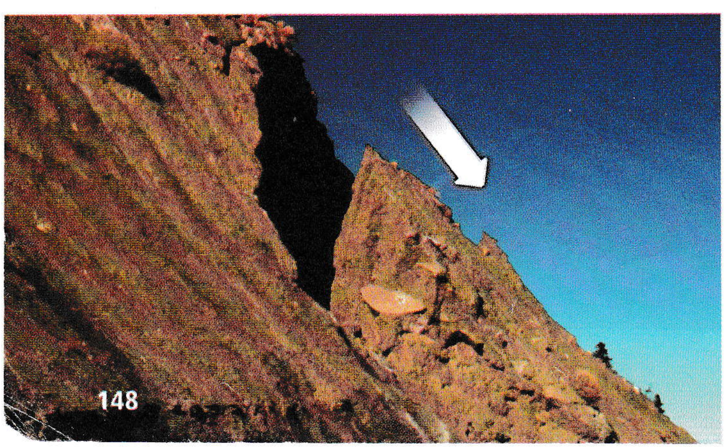
Mount St. Helens, a volcanic mountain in the state of Washington, is a place where large mudflows have occurred. During an eruption in 1980, some mudflows from the volcano traveled more than 90 kilometers (56 mi) from the mountain.

RESOURCE CENTER
CLASSZONE.COM

Learn more about mudflows.

CHECK YOUR READING What causes a mudflow to occur?

In this example of slump, at Mesa Verde National Park in Colorado, a huge mass of rock and soil moved downward.

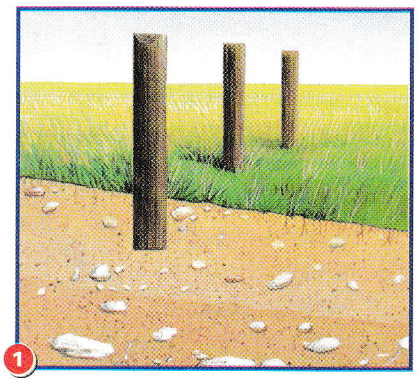


Slumps and Creep

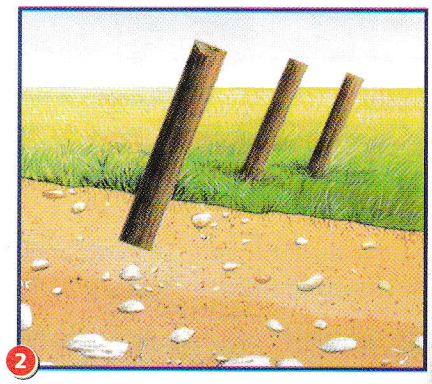
Slumps and creep are two other main types of mass wasting on hilly land. These forms of mass wasting can be much less dramatic than rockslides or mudflows. But they are the types of mass movement that you are most likely to see evidence of.

A slump is a slide of loose debris that moves as a single unit. Slumps can occur along roads and highways where construction has made slopes unstable. They can cover sections of highway with debris. Like other types of mass movement, slumps can be triggered by heavy rain.

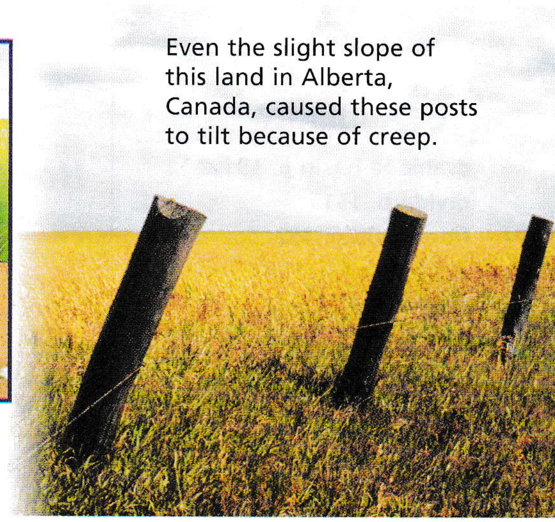
The slowest form of mass movement of soil or debris is creep. The soil or debris moves at a rate of about 1 to 10 millimeters a year—a rate too slow to actually be seen. But evidence of creep can be seen on hillsides that have old fences or telephone poles. The fences or poles may lean downward, or some may be out of line. They have been moved by the creeping soil. The soil closer to the surface moves faster than the soil farther down, which causes the fences or poles to lean.



Originally, the fence posts stand vertically in the ground.



Over many years, the soil holding the posts slowly shifts downhill, and the posts lean.



Even the slight slope of this land in Alberta, Canada, caused these posts to tilt because of creep.

Creep can affect buildings as well. The weight of a heavy mass of soil moving slowly downhill can be great enough to crack a building's walls. Creep affects all hillsides covered with soil, but its rate varies. The wetter the soil, the faster it will creep downhill.

5.1 Review

KEY CONCEPTS

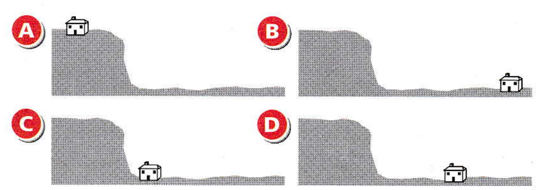
1. How does erosion change landscapes?
2. Describe why weathering is important in erosion.
3. How can gravity move large amounts of rock and soil?

CRITICAL THINKING

4. **Compare and Contrast** What is the main difference between erosion and mass wasting?
5. **Infer** What force and what cause can contribute to both erosion and mass wasting?

CHALLENGE

6. **Rank** Which of the four locations would be the best and worst places to build a house? Rank the four locations and explain your reasoning.



KEY CONCEPT

5.2 Moving water shapes land.

BEFORE, you learned

- Erosion is the movement of rock and soil
- Gravity causes mass movements of rock and soil

NOW, you will learn

- How moving water shapes Earth's surface
- How water moving underground forms caves and other features

VOCABULARY

drainage basin p. 151
divide p. 151
floodplain p. 152
alluvial fan p. 153
delta p. 153
sinkhole p. 155

EXPLORE Divides

How do divides work?

PROCEDURE

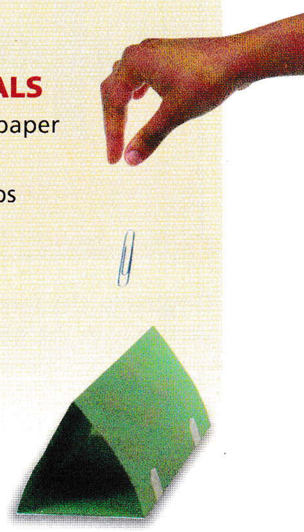
1. Fold the sheet of paper in thirds and tape it as shown to make a "ridge."
2. Drop the paper clips one at a time directly on top of the ridge from a height of about 30 cm. Observe what happens and record your observations.

WHAT DO YOU THINK?

How might the paper clips be similar to water falling on a ridge?

MATERIALS

- sheet of paper
- tape
- paper clips



Streams shape Earth's surface.

If you look at a river or stream, you may be able to notice something about the land around it. The land is higher than the river. If a river is running through a steep valley, you can easily see that the river is the low point. But even in very flat places, the land is sloping down to the river, which is itself running downhill in a low path through the land.

Running water is the major force shaping the landscape over most of Earth. From the broad, flat land around the lower Mississippi River to the steep mountain valleys of the Himalayas, water running downhill changes the land. Running water shapes a variety of landforms by moving sediment in the processes of erosion and deposition. In this section, you will learn how water flows on land in systems of streams and rivers and how water shapes and changes landscapes. You also will learn that water can even carve out new features underground.

NOTE-TAKING STRATEGY
A main idea and detail notes chart would be a good strategy to use for taking notes about streams and Earth's surface.

Drainage Basins and Divides

When water falls or ice melts on a slope, some of the water soaks into the ground and some of it flows down the slope in thin sheets. But within a short distance this water becomes part of a channel that forms a stream. A stream is any body of water—large or small—that flows down a slope along a channel.

Streams flow into one another to form complex drainage systems, with small streams flowing into larger ones. The area of land in which water drains into a stream system is called a **drainage basin.** In most drainage basins, the water eventually drains into a lake or an ocean. For example, in the Mississippi River drainage basin, water flows into the Mississippi, and then drains into the Gulf of Mexico, which is part of the ocean.

Drainage basins are separated by ridges called divides, which are like continuous lines of high land. A **divide** is a ridge from which water drains to one side or the other. Divides can run along high mountains. On flatter ground, a divide can simply be the highest line of land and can be hard to see.

Divides are the borders of drainage basins. A basin can be just a few kilometers wide or can drain water from a large portion of a continent. The Continental Divide runs from Alaska to Mexico. Most water that falls west of the Continental Divide ends up draining into the Pacific Ocean. Most water that falls east of it drains into the Gulf of Mexico and Atlantic Ocean.

Divides and Drainage Basins

Divides are ridges that form the borders of drainage basins.

Denver, Colorado, sits just east of the Rocky Mountains and the Continental Divide.

Downtown Davenport, Iowa, sits in the floodplain of the Mississippi River and was covered with water when the river flooded in 1993.

Valleys and Floodplains

As streams flow and carry sediment from the surface of the land, they form valleys. In high mountains, streams often cut V-shaped valleys that are narrow and steep walled. In lower areas, streams may form broad valleys that include floodplains. A **floodplain** is an area of land on either side of a stream that is underwater when the stream floods. The floodplain of a large river may be many kilometers wide.

When a stream floods, it deposits much of the sediment that it carries onto its floodplain. This sediment can make the floodplain very fertile—or able to support a lot of plant growth. In the United States, the floodplains of the Mississippi River are some of the best places for growing crops.

RESOURCE CENTER
CLASSZONE.COM
Find out more about rivers and erosion.

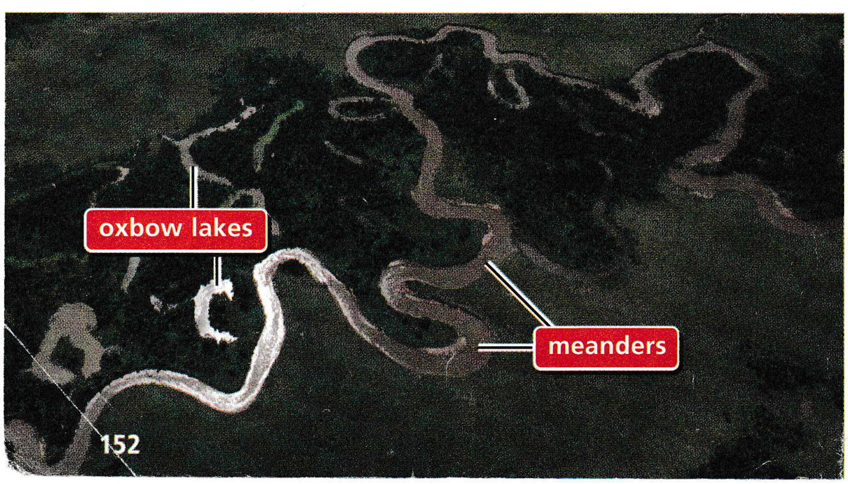
CHECK YOUR READING Why is fertile land often found on flat land around rivers?

Stream Channels

As a stream flows through a valley, its channel may run straight in some parts and curve around in other parts. Curves and bends that form a twisting, looping pattern in a stream channel are called meanders (mee-AN-duhrz). The moving water erodes the outside banks and deposits sediment along the inside banks. Over many years, meanders shift position.

During a flood, the stream may cut a new channel that bypasses a meander. The cut-off meander forms a crescent-shaped lake, which is called an oxbow lake. This term comes from the name of a U-shaped piece of wood that fits under the neck of an ox and is attached to its yoke.

The meanders of this river and oxbow lakes formed as the river deposited sediment and changed course.



Alluvial Fans and Deltas

Besides shaping valleys and forming oxbow lakes, streams also create landforms called alluvial fans and deltas. Both of these landforms are formed by the deposition of sediment.

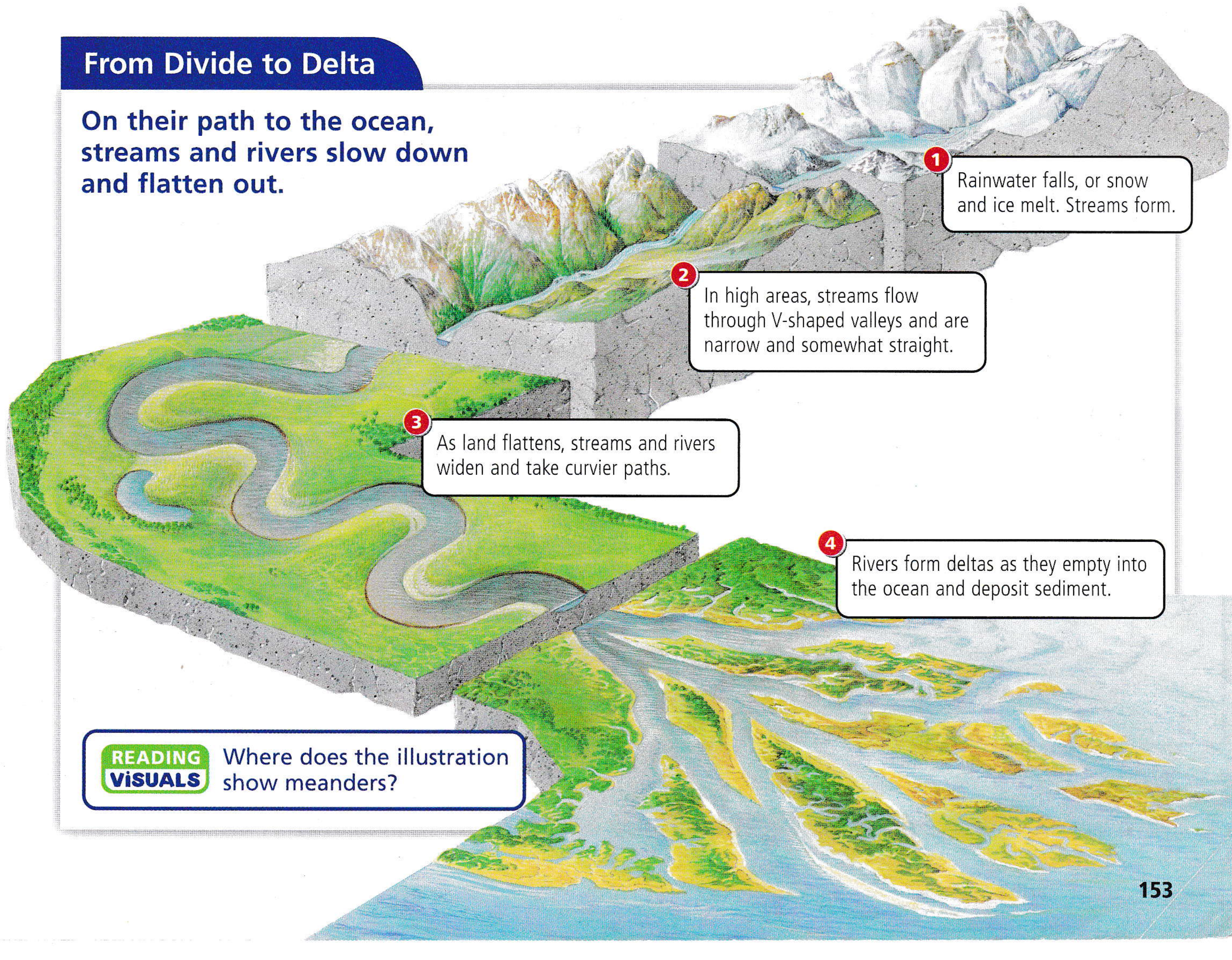
An **alluvial fan** (uh-LOO-vee-uhl) is a fan-shaped deposit of sediment at the base of a mountain. It forms where a stream leaves a steep valley and enters a flatter plain. The stream slows down and spreads out on the flatter ground. As it slows down, it can carry less sediment. The slower-moving water drops some of its sediment, leaving it at the base of the slope.

This alluvial fan was formed by a stream flowing into the Jago River in Alaska.

A **delta** is an area of land formed by the buildup of sediment at the end, or mouth, of a river. When a river enters the ocean, the river's water slows down, and the river drops much of its sediment. This sediment gradually builds up to form a plain. Like alluvial fans, deltas tend to be fan-shaped. Over a very long time, a river may build up its delta far out into the sea. A large river, such as the Mississippi, can build up a huge delta. Like many other large rivers on Earth, the Mississippi has been building up its delta out into the sea for many thousands of years.

From Divide to Delta

On their path to the ocean, streams and rivers slow down and flatten out.



READING VISUALS Where does the illustration show meanders?

This sinkhole took down a large part of a parking lot in Atlanta, Georgia.

process produces open spaces, or caves. Large caves are called caverns. If the water table drops, a cavern may fill with air.

Some caverns have huge networks of rooms and passageways. Mammoth Cave in Kentucky, for example, is part of a cavern system that has more than 560 kilometers (about 350 mi) of explored passageways. Within the cavern are lakes and streams.

A surface feature that often occurs in areas with caverns is a sinkhole. A **sinkhole** is a basin that forms when the roof of a cave becomes so thin that it suddenly falls in. Sometimes it falls in because water that supported the roof has drained away. Landscapes with many sinkholes can be found in southern Indiana, south central Kentucky, and central Tennessee. In Florida, the collapse of shallow underground caverns has produced large sinkholes that have destroyed whole city blocks.

CHECK YOUR READING Why do caverns form in areas with limestone?

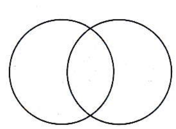
5.2 Review

KEY CONCEPTS

1. What is the difference between a drainage basin and a divide?
2. How do streams change as they flow from mountains down to plains?
3. How do caverns form?

CRITICAL THINKING

4. **Sequence** Draw a cartoon with three panels showing how a sinkhole forms.
5. **Compare and Contrast** Make a Venn diagram to compare and contrast alluvial fans and deltas.



CHALLENGE

6. **Apply** During a flood, a river drops the largest pieces of its sediment on the floodplain close to its normal channel. Explain why. (**Hint:** Think about the speed of the water.)

CHAPTER INVESTIGATION

Creating Stream Features

OVERVIEW AND PURPOSE A view from the sky reveals that a large river twists and bends in its channel. But as quiet as it might appear, the river constantly digs and dumps Earth materials along its way. This erosion and deposition causes twists and curves called meanders, and forms a delta at the river's mouth. In this investigation you will

- create a "river" in a stream table to observe the creation of meanders and deltas
- identify the processes of erosion and deposition

Problem

Write It Up

How does moving water create meanders and deltas?

MATERIALS

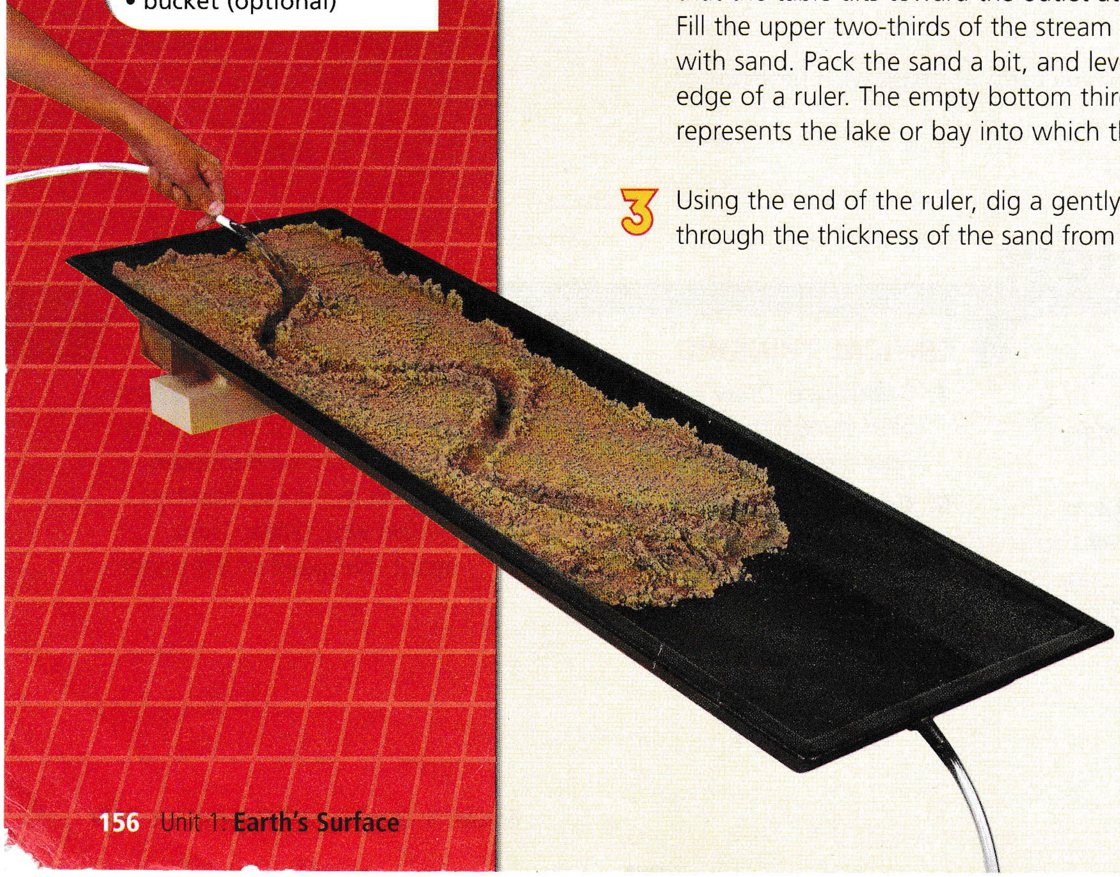
- stream table, with hose attachment or recirculating pump
- sieve (optional)
- wood blocks
- sand
- ruler
- water
- sink with drain
- pitcher (optional)
- bucket (optional)

Procedure

1. Arrange the stream table on a counter so that it drains into a sink or bucket. If possible, place a sieve beneath the outlet hose to keep sand out of the drain. You can attach the inlet hose to a faucet if you have a proper adapter. Or you can gently pour water in with a pitcher or use a recirculating pump and a bucket.

2. Place wood blocks beneath the inlet end of the stream table so that the table tilts toward the outlet at about a 20 degree angle. Fill the upper two-thirds of the stream table nearly to the top with sand. Pack the sand a bit, and level the surface with the edge of a ruler. The empty bottom third of the stream table represents the lake or bay into which the river flows.

3. Using the end of the ruler, dig a gently curving trench halfway through the thickness of the sand from its upper to its lower end.



4 Direct a gentle flow of tap water into the upper end of the trench. Increase the flow slightly when the water begins to move through the trench. You may have to try this several times before you find the proper rate of flow to soak the sand and fill the stream channel. Avoid adding so much water that it pools at the top before moving into the channel. You can also change the stream table's tilt.

5 Once you are successful in creating a river, observe its shape and any movement of the sand. Continue until the top part of the sand is completely washed away and your river falls apart. Scrape the sand back into place with the ruler and repeat the procedure until you thoroughly understand the stream and sand movements.

Observe and Analyze

Write It Up

1. **RECORD** Diagram your stream-table setup, and make a series of drawings showing changes in your river over time. Be sure to label the river's features, as well as areas of erosion and deposition. Be sure to diagram the behavior of the sand at the river's mouth.
2. **RECORD** Write a record of the development of your river from start to finish. Include details such as the degree of tilt you used, your method of introducing water into the stream table, and features you observed forming.

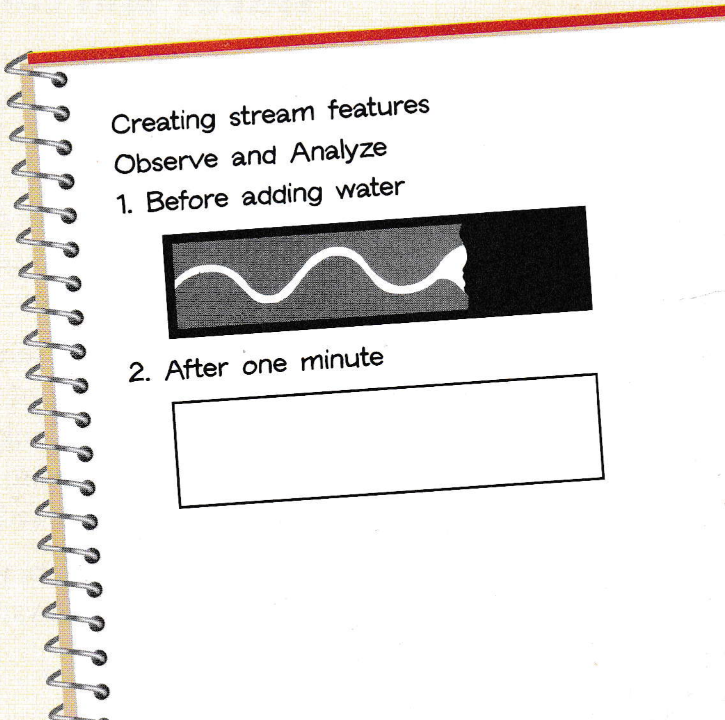
Conclude

Write It Up

1. **EVALUATE** How do you explain the buildup of sand at the mouth of your river? Use the words *speed, erosion,* and *deposition* in your answer. Did the slope of the stream change over time?
2. **INTERPRET** Where in your stream table did you observe erosion occurring? Deposition? What features did each process form?
3. **INFER** What might have occurred if you had increased the amount or speed of the water flowing into your river?
4. **IDENTIFY LIMITS** In what ways was your setup a simplified version of what would actually occur on Earth? Describe the ways in which an actual stream would be more complex.
5. **APPLY** Drawing on what you observed in this investigation, make two statements that relate the age of a stream to (1) the extent of its meanders and (2) to the size of its delta or alluvial fan.

INVESTIGATE Further

CHALLENGE Revise this activity to test a problem statement about a specific stream feature. You could choose to vary the stream's slope, speed, or volume to test the changes' effects on meanders and deltas, for example. Or you could vary the sediment size and observe the movements of each size. Write a hypothesis and design an experimental procedure. Identify the independent and dependent variables.



KEY CONCEPT

5.3 Waves and wind shape land.

BEFORE, you learned
- Stream systems shape Earth's surface
- Groundwater creates caverns and sinkholes

NOW, you will learn
- How waves and currents shape shorelines
- How wind shapes land

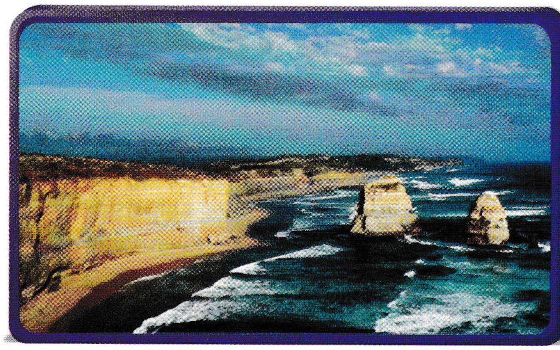
VOCABULARY

longshore drift p. 159
longshore current p. 159
sandbar p. 160
barrier island p. 160
dune p. 161
loess p. 162

THINK ABOUT

How did these pillars of rock form?

The rock formations in this photograph stand along the shoreline near the small town of Port Campbell, Australia. What natural force created these isolated stone pillars? What evidence of this force can you see in the photograph?



NOTE-TAKING STRATEGY
Remember to organize your notes in a chart or web as you read.

Waves and currents shape shorelines.

The stone pillars, or sea stacks, in the photograph above are a major tourist attraction in Port Campbell National Park. They were formed by the movement of water. The constant action of waves breaking against the cliffs slowly wore them away, leaving behind pillarlike formations. Waves continue to wear down the pillars and cliffs at the rate of about two centimeters (one inch) a year. In the years to come, the waves will likely wear away the stone pillars completely.

The force of waves, powered by wind, can wear away rock and move thousands of tons of sand on beaches. The force of wind itself can change the look of the land. Moving air can pick up sand particles and move them around to build up dunes. Wind can also carry huge amounts of fine sediment thousands of kilometers.

In this section, you'll read more about how waves and wind shape shorelines and a variety of other landforms.

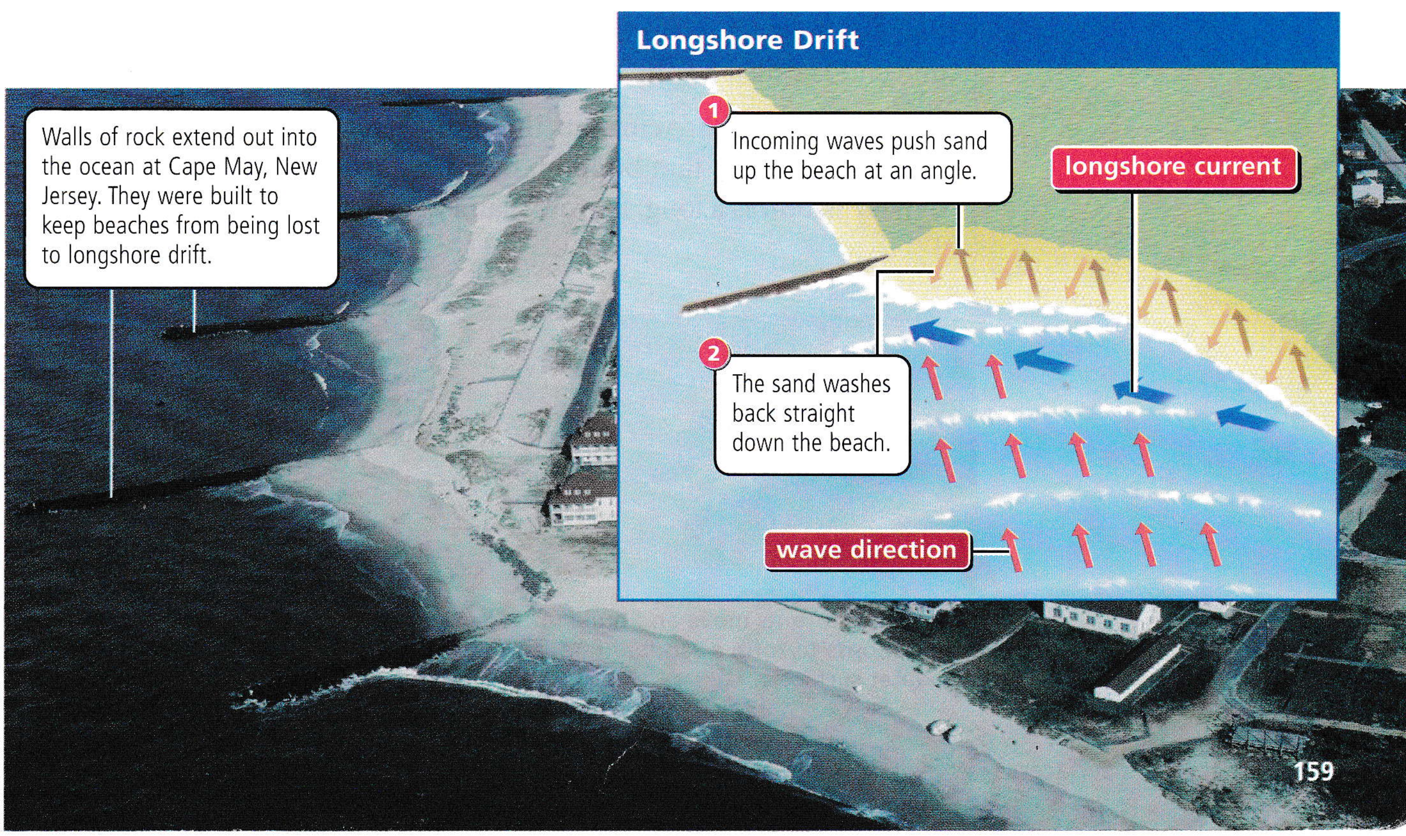
Shorelines

Some shorelines, like the one near Port Campbell, Australia, are made up of steep, rock cliffs. As waves crash against the rock, they wear away the bottom of the cliffs. Eventually, parts of the cliffs above break away and fall into the water, where they are worn down and carried away by the water.

While high, rocky coasts get worn away, low coastlines often get built up. As you read earlier, when a stream flows into an ocean or a lake, it deposits its sediment near its mouth. This sediment mixes with the sediment formed by waves beating against the coast. Waves and currents move this sediment along the shore, building up beaches. Two terms are used to describe the movement of sediment and water along a shore: *longshore drift* and *longshore current.*

- **Longshore drift** is the zigzag movement of sand along a beach. Waves formed by wind blowing across the water far from shore may hit a shoreline at an angle. These angled waves carry sand up onto the shore, and then gravity pulls the water and sand directly back into the water. The sand gradually moves down the beach. The illustration below shows longshore drift.
- A **longshore current** is movement of water along a shore as waves strike the shore at an angle. The direction of the longshore current can change from day to day as the direction of the waves striking the shore changes.

Longshore drift moves large amounts of sand along beaches. It can cause a beach to shrink at one location and grow at another.



INVESTIGATE Longshore Drift

How does sand move along a beach?

PROCEDURE

1. Prop up a book as shown.
2. Hold a coin with your finger against the bottom right corner of the book.
3. Gently flick the coin up the slope of the book at an angle. The coin should slide back down the book and fall off the bottom. If necessary, readjust the angle of the book and the strength with which you are flicking the coin.
4. Repeat step 3 several times. Observe the path the coin takes. Record your observations. Include a diagram that shows the general path the coin takes as it slides up and down the book.

WHAT DO YOU THINK?

- What path did the coin take on its way up? On its way down?
- In this model of longshore drift, what represents the beach, what represents the sand, and what represents a wave?

CHALLENGE In this model, in which direction will the longshore current move? How could you change the model to change the direction of the current?

SKILL FOCUS
Observing

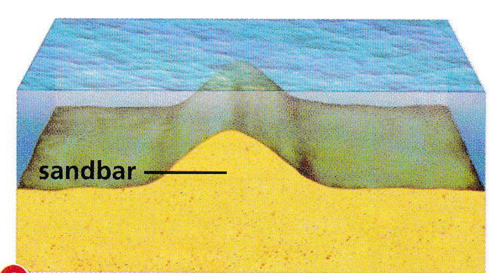
MATERIALS
- 2 or 3 books
- coin

TIME
15 minutes

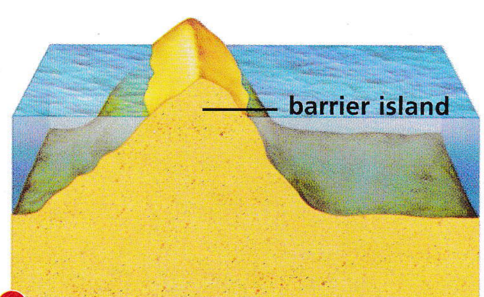
Sandbars and Barrier Islands

As they transport sand, ocean waves and currents shape a variety of coastal landforms. Longshore currents, for example, often deposit sand along shorelines. The sand builds up to form sandbars. A **sandbar** is a ridge of sand built up by the action of waves and currents. A sandbar that has built up above the water's surface and is joined to the land at one end is called a spit. The tip of Cape Cod, Massachusetts, is a spit.

Strong longshore currents that mostly move in one direction may produce sandbars that build up over time into barrier islands. A **barrier island** is a long, narrow island that develops parallel to a coast.



1. Waves and currents move and build up sand deposits to form a sandbar under the water surface.



2. As more sand is deposited, the sandbar rises above the surface to become a barrier island.

This lighthouse on a barrier island in North Carolina had to be moved because of beach erosion. The photograph shows the lighthouse before it was moved.

A barrier island gets its name from the fact that it forms a barrier between the ocean waves and the shore of the mainland. As a barrier island builds up, grasses, bushes, and trees begin to grow on it.

Barrier islands are common along gently sloping coasts around the world. They occur along the coasts of New Jersey and North Carolina and along the coastline of the Gulf of Mexico. Padre Island in Texas is a barrier island about 180 kilometers (110 mi) in length.

Barrier islands constantly change shape. Hurricanes or other storms can speed up the change. During large storms, waves can surge across the land, carrying away huge amounts of sediment and depositing it elsewhere. Houses on beaches can be destroyed in storms.

CHECK YOUR READING How and where do barrier islands form?

Wind shapes land.

At Indiana Dunes National Lakeshore, not far from the skyscrapers of Chicago, you can tumble or slide down huge sand dunes. First-time visitors to the Indiana dunes find it hard to believe that sand formations like these can be found so far from a desert or an ocean. What created this long stretch of dune land along the southern shore of Lake Michigan? The answer: wind. A **dune** is a mound of sand built up by wind.

Like water, wind has the power to transport and deposit sediment. Although wind is a less powerful force of erosion than moving water, it can still shape landforms, especially in dry regions and in areas that have few or no plants to hold soil in place. Wind can build up dunes, deposit layers of dust, or make a land surface as hard as pavement.

CONNECTING SCIENCES

EARTH SCIENCE AND LIFE SCIENCE

The leaves of American beach grass contain silica, the main component of sand. The leaves are therefore very tough. Why is this important on a dune?

Life on Dunes

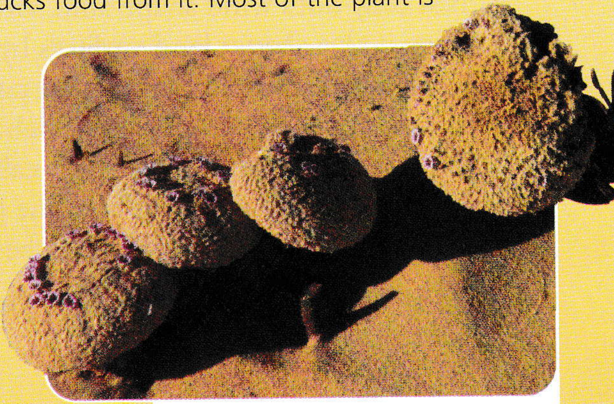
Sand dunes are a difficult environment for most organisms. For example, few plants can gather enough nutrition from sand to grow quickly. However, any plant that grows slowly is likely to be buried by the shifting sand. Plants and animals that thrive on dunes generally have unusual traits that help them survive in dune conditions.

American Beach Grass

Among the first plants to grow on new coastal dunes is American beach grass. It grows faster as sand begins to bury it, and it can grow up to 1 meter (more than 3 ft) per year. Its large root system—reaching down as much as 3 meters (about 10 ft)—helps it gather food and water. The roots also help hold sand in place. As the grass's roots make the dunes stable, other plants can begin to grow there.

Sand Food

One of the most unusual plants in desert dunes is called sand food. It is one of the few plants that cannot convert sunlight into energy it can use. Instead, its long underground stem grabs onto the root of another plant and sucks food from it. Most of the plant is the stem. Sand food plants may be more than 2 meters (almost 7 ft) long.



In spring, sand food produces a small head of purple flowers that barely comes out of the ground. How does growing mostly underground help sand food survive?

Fowler's Toad

Fowler's toad is one of the animals that can live in coastal dunes. During the day, sunlight can make the top layer of the sand very hot and dry. These toads dig down into the sand, where they are safe, cool, and moist. They are most active at night.

Fowler's toads have a brownish or greenish color that makes them hard to see against a sandy background. How would this help protect them from animals that want to eat them?

EXPLORE

1. **GENERALIZE** Dune plants often have long roots. Propose an explanation for this.
2. **CHALLENGE** Use library or Internet resources to learn about another plant or animal that lives on dunes. Describe how it has adapted to the conditions in which it lives.

KEY CONCEPT

5.4 Glaciers carve land and move sediments.

BEFORE, you learned
- Running water shapes landscapes
- Wind changes landforms

NOW, you will learn
- How moving ice erodes land
- How moving ice deposits sediment and changes landforms

VOCABULARY

glacier p. 165
till p. 168
moraine p. 168
kettle lake p. 169

EXPLORE Glaciers

How do glaciers affect land?

PROCEDURE

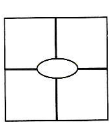
1. Flatten the clay on top of a paper towel.
2. Drag the ice cube across the clay as shown. Record your observations.
3. Leave the ice cube to melt on top of the clay.

WHAT DO YOU THINK?
- What happened when you dragged the ice cube across the clay?
- What happened to the sand and gravel in the ice cube as it melted?

MATERIALS
- modeling clay
- paper towel
- ice cube containing sand and gravel

Glaciers are moving bodies of ice.

VOCABULARY
Remember to add a four square diagram for *glacier* to your notebook.

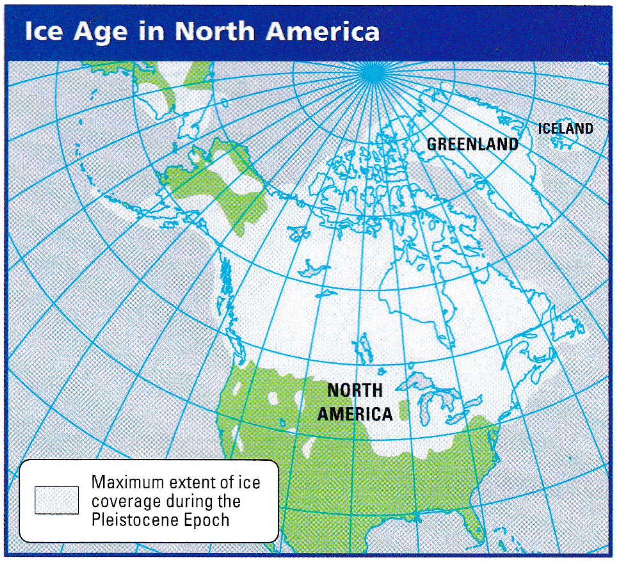


You might not think of ice as something that moves. But think about what happens to an ice cube on a table. The cube begins to melt, makes a small puddle, and may slide a little. The water under the cube makes the table surface slippery, which allows the ice cube to slide.

A similar process happens on a much larger scale with glaciers. A **glacier** is a large mass of ice that moves over land. A glacier forms in a cold region when more snow falls than melts each year. As the snow builds up, its weight presses the snow on the bottom into ice. On a mountain, the weight of a heavy mass of ice causes it to flow downward, usually slowly. On flatter land, the ice spreads out as a sheet. As glaciers form, move, and melt away, they shape landscapes.

Extent of Glaciers

Glaciers can exist only in places where it is cold enough for water to stay frozen year round. Glaciers are found in mountain ranges all over the world and in land regions near the north and south poles.



Today, glaciers cover about 10 percent of Earth's land surface. However, the amount of land surface covered by glaciers has varied greatly over Earth's history. Glaciers have expanded during long cold periods called ice ages and have disappeared during long warm periods. About 30,000 years ago—during the last major ice age—glaciers extended across the northern parts of North America and Eurasia. They covered nearly 30 percent of the present land surface of Earth.

There are two major types of glaciers: alpine glaciers and continental glaciers.

RESOURCE CENTER
CLASSZONE.COM
Learn more about the movement and effects of glaciers.

Alpine Glaciers

Alpine glaciers, also called valley glaciers, form in mountains and flow down through valleys. As these glaciers move, they cause erosion, breaking up rock and carrying and pushing away the resulting sediment. Over time, an alpine glacier can change a V-shaped mountain valley into a U-shaped valley with a wider, flatter bottom.

Some glaciers extend all the way down into the lower land at the bases of mountains. At an alpine glacier's lower end, where temperatures are warmer, melting can occur. The melting glacier drops sediment, and streams flowing from the glacier carry some of the sediment away. If an alpine glacier flows into the ocean, big blocks may break off and become icebergs.

Continental Glaciers

Continental glaciers, also called ice sheets, are much larger than alpine glaciers. They can cover entire continents, including all but the highest mountain peaks. An ice sheet covered most of Canada and the northern United States during the last ice age. This ice sheet melted and shrank about 10,000 years ago.

Today, ice sheets cover most of Greenland and Antarctica. Each of these glaciers is shaped like a wide dome over the land. The ice on Antarctica is as much as 4500 meters (15,000 ft) thick.

CHECK YOUR READING What are the two major types of glaciers and where do they form?