

SECTION
4

Glaciers

DISCOVER

How Do Glaciers Change the Land?

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



ACTIVITY

Think It Over

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

You are on a boat trip near the coast of Alaska. You sail by vast evergreen forests and snow-capped mountains. Then, as your boat rounds a point of land, you see an amazing sight. A great mass of ice winds like a river between rows of mountains. Suddenly you hear a noise like thunder. Where the ice meets the sea, a giant chunk of ice breaks off and plunges into the water. Carefully, you pilot your boat around the iceberg and toward the mass of ice. It towers over your boat. You see that it is made up of solid ice that is deep blue and green as well as white. What is this river of ice?

Kinds of Glaciers

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

A **continental glacier** is a glacier that covers much of a continent or large island. Continental glaciers are much larger than

GUIDE FOR READING

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

Reading Tip Before you read, preview the headings and key terms in the section. Predict some characteristics of glaciers.

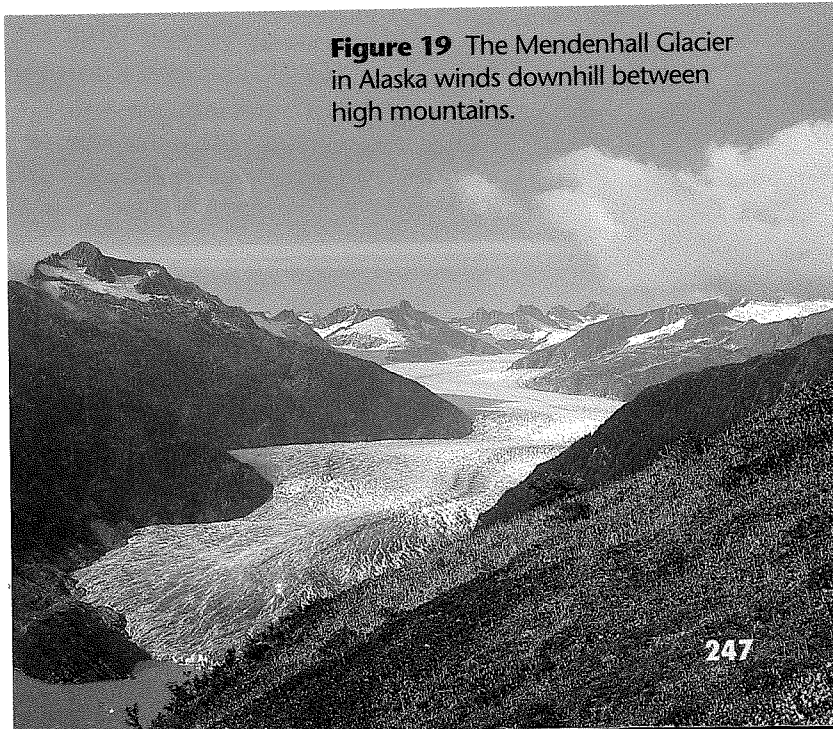


Figure 19 The Mendenhall Glacier in Alaska winds downhill between high mountains.



Figure 20 The continental glacier of the last ice age covered most of Canada and Alaska as well as much of the northern United States. The ice age lasted about 70,000 years and ended about 10,000 years ago.

valley glaciers. They spread out over large areas of the land. Today, continental glaciers cover about 10 percent of Earth's land. They cover Antarctica and most of Greenland. The glacier covering Antarctica spreads out over 14 million square kilometers and is over 2 kilometers thick.

Ice Ages

Many times in the past, continental glaciers have covered large parts of Earth's surface. These times are known as **ice ages**. For example, about 9 million years ago, continental glaciers began to form in North America, Europe, and Asia. These glaciers slowly grew and advanced southward. By about 2.5 million years ago, they covered about a third of Earth's land. The glaciers advanced and retreated, or melted back,

several times. Figure 20 shows how far south the glaciers came on the North American continent during the most recent ice age. They finally retreated about 10,000 years ago.

How Glaciers Form and Move

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

Valley glaciers flow at a rate of a few centimeters to a few meters per day. But sometimes a valley glacier slides down more quickly in what is called a surge. A surging glacier can flow as much as 6 kilometers a year. Unlike valley glaciers, continental glaciers can flow in all directions. Continental glaciers spread out much as pancake batter spreads out in a frying pan.

Checkpoint How do glaciers form?

Glacial Erosion

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.**

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. Figure 21 shows plucking by a glacier. Plucking can move even huge boulders.

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 *Exploring Glacial Landforms* on pages 250–251.

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.



INTEGRATING
LIFE SCIENCE

Other features left in glacial sediments are prairie potholes. These potholes are shallow depressions in till that were formed by flowing water as the continental glacier melted. Today, prairie potholes contain water for only part of the year. Each prairie pothole is a small oasis for living things. Grasses and moisture-loving plants grow thickly in and around the potholes. In the spring, the potholes brim with water from melting snow or rain. Thousands of migrating ducks and other birds stop off at the potholes to feed and rest on their way north. Some stay to build nests and raise their young.

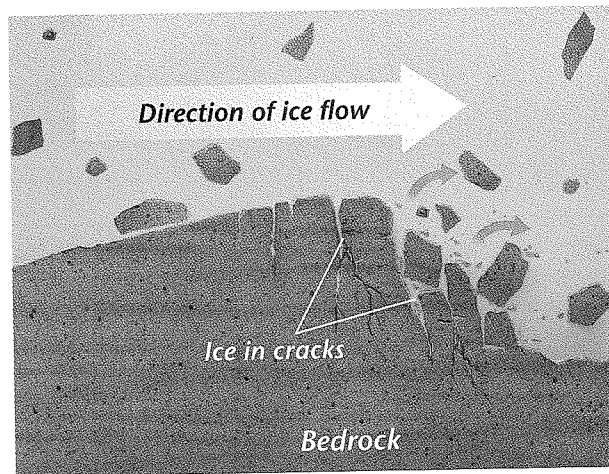


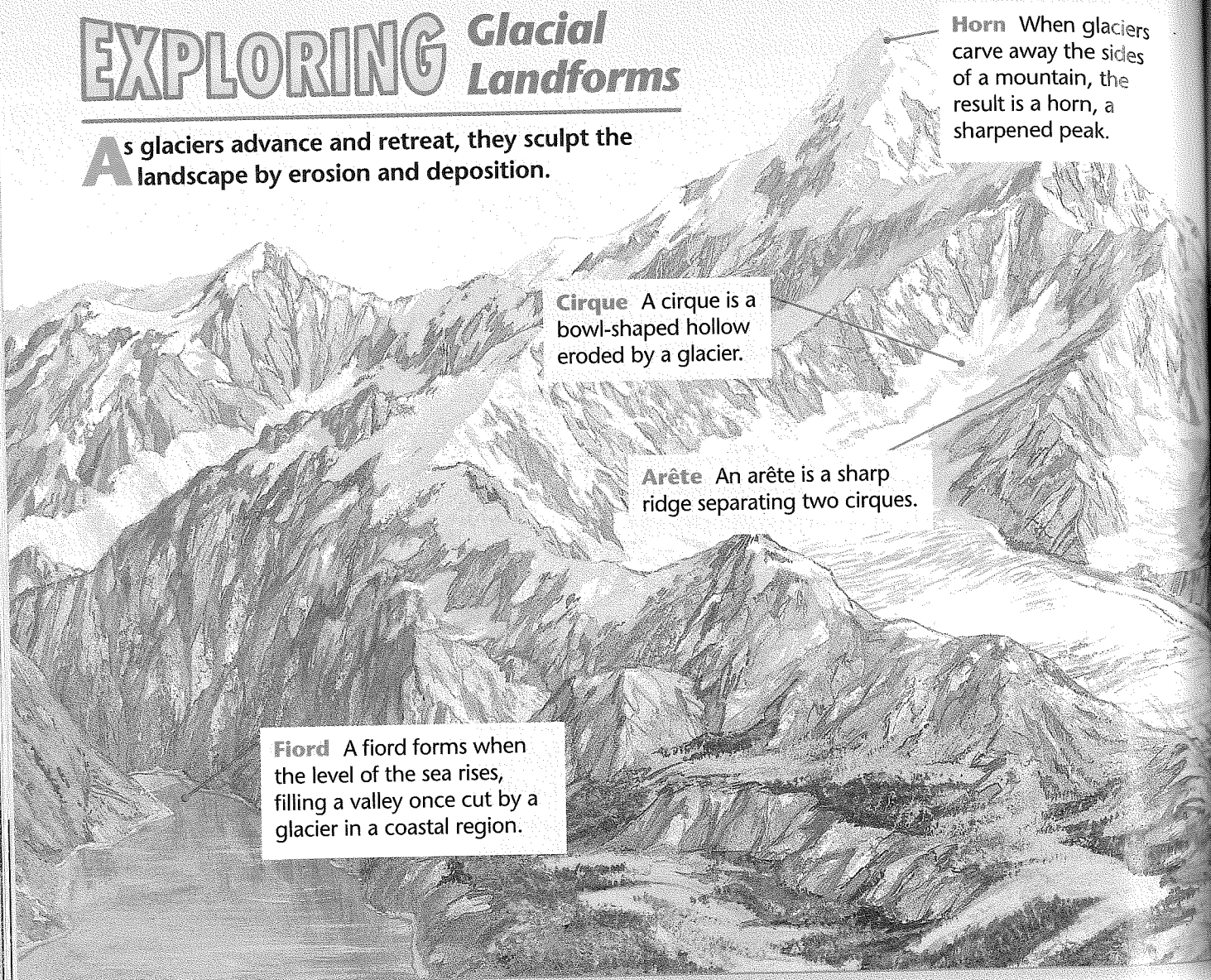
Figure 21 As a glacier moves downhill, the ice plucks pieces of bedrock from the ground. *Predicting* What evidence of plucking might you find after a glacier melts?



Figure 22 This prairie pothole in Wisconsin is surrounded by farmland. Prairie potholes were left in till deposited by glaciers.

EXPLORING *Glacial Landforms*

As glaciers advance and retreat, they sculpt the landscape by erosion and deposition.



Horn When glaciers carve away the sides of a mountain, the result is a horn, a sharpened peak.

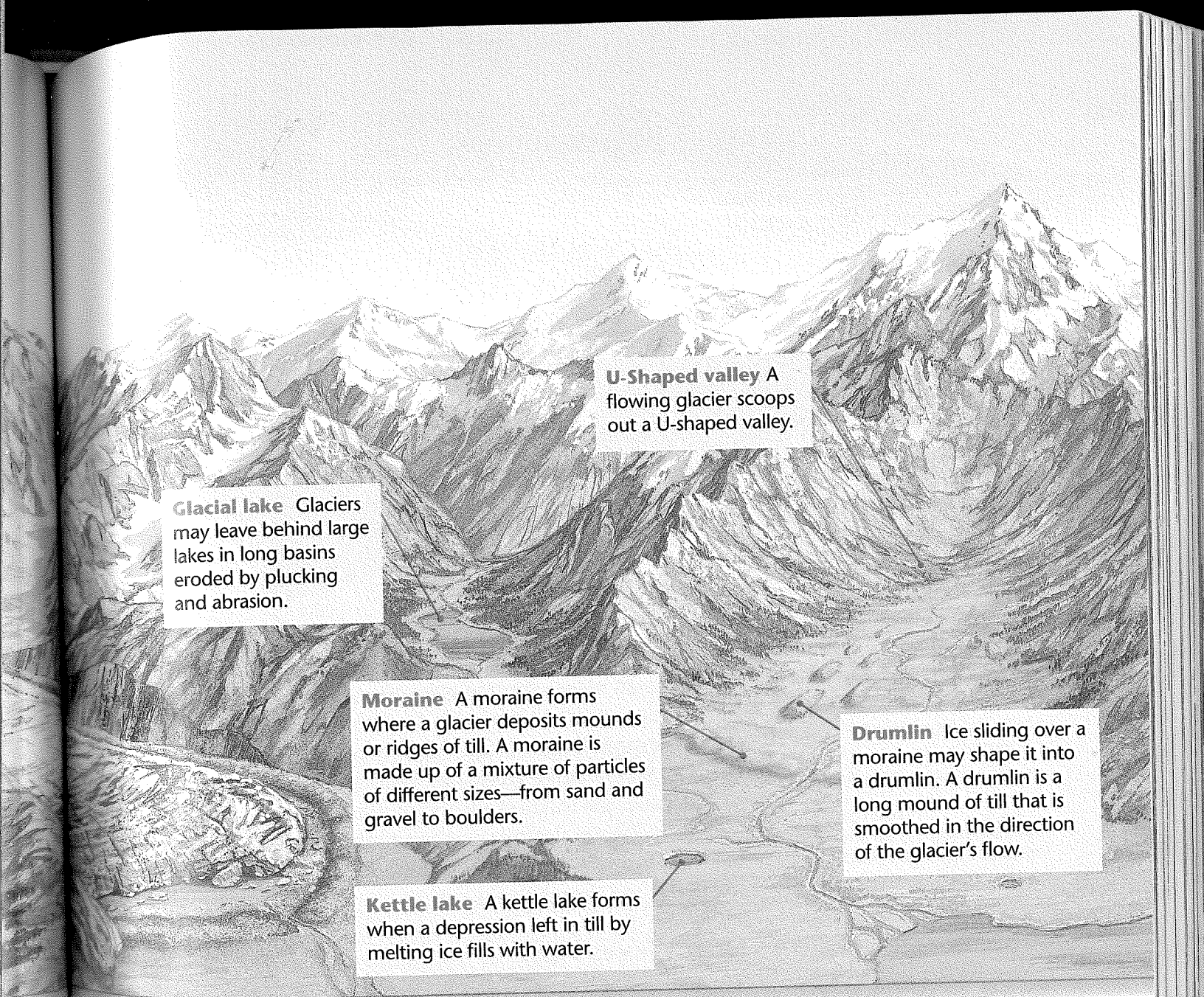
Cirque A cirque is a bowl-shaped hollow eroded by a glacier.

Arête An arête is a sharp ridge separating two cirques.

Fiord A fiord forms when the level of the sea rises, filling a valley once cut by a glacier in a coastal region.

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 that were covered with ice.

The continental glacier of the last ice age also formed the Great Lakes. Before the ice age, there were large river valleys in the area now occupied by the lakes. As the ice advanced over these valleys, it scooped out loose sediment and soft rock, forming broad, deep basins. The Great Lakes formed over thousands of years as the glaciers melted and these basins filled with water.



Glacial lake Glaciers may leave behind large lakes in long basins eroded by plucking and abrasion.

U-Shaped valley A flowing glacier scoops out a U-shaped valley.

Moraine A moraine forms where a glacier deposits mounds or ridges of till. A moraine is made up of a mixture of particles of different sizes—from sand and gravel to boulders.

Drumlin Ice sliding over a moraine may shape it into a drumlin. A drumlin is a long mound of till that is smoothed in the direction of the glacier's flow.

Kettle lake A kettle lake forms when a depression left in till by melting ice fills with water.



Section 4 Review

1. How are valley glaciers and continental glaciers different?
2. What are two types of glacial erosion?
3. Describe three features formed by glacial deposition.
4. **Thinking Critically Relating Cause and Effect**
Driving through the countryside in Michigan, you and your family come upon a series of small, round lakes. Explain the process that formed these features.

CHAPTER PROJECT

Check Your Progress

Now you are ready to begin building your second model. Pattern the model after your drawing that predicts the effects of erosion and deposition. The model will show how gravity, water, and glaciers have changed your model landscape. Where on your model would glaciers be likely to form?