Earth’s surface is constantly changed by the movement of ice, water, and wind. How does the land change?
How does ice break up rocks?

Form a Hypothesis
Which takes up more space—liquid water or frozen water? Write your answer in the form “If water is frozen in a confined space, then...”

Test Your Hypothesis
1. Starting from the bottom of the container, use a marker and a ruler to mark each centimeter up to 15 cm.
2. Mix 5 drops of food coloring into the water.
3. Fill both containers with water until the water reaches the 10-cm mark.
4. Put caps on both containers. Place one container in a freezer. Leave the other container at room temperature.
5. When the water placed in the freezer has completely frozen, remove it.
6. Observe Is there a change in the height of the water in either container? Is there a change in the shape of either container?

Draw Conclusions
7. Interpret Data How does the amount of space water takes up change when it freezes?
8. Infer What do the results of your experiment indicate about what happens when water freezes in a crack in a rock?

Explore More
Other processes can change the surfaces of rocks. Observe the sidewalks in your neighborhood and pay special attention to cracks or changes in their surfaces. What might have caused these changes?

SI.22 Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
Also covers SI.16, SI.21
What is weathering?

As rain falls on the cliffs of the Palisades in New Jersey, water trickles into cracks in the rocks and collects there. If temperatures drop below the freezing point of water, this liquid water turns into ice. The ice takes up more space than the liquid water and pushes the crack farther apart. Sometimes this causes bits of rock to break off.

Over many years, the cliff will slowly be worn away, or weathered. **Weathering** (WETH•ring) is the process through which rocks or other materials are broken down.

Physical Weathering

Physical weathering is caused by temperature changes, pushing, pulling, or rubbing. As water in cracks of a rock freezes, the frozen water pushes on the rock and can break pieces off.

Trees and other plants can grow out from cracks in a cliff. Their roots push against the walls of the cracks. This pressure can break off particles of rock.

Weathering is slowly wearing away the rocks of the Palisades, which rise above the New Jersey side of the Hudson River.
Gravity pulls these rock pieces down the slope. The rocks bump into other rocks on the slope as they roll downward. With each bump, parts of the rocks may break off.

Winds often blow on exposed rock. The winds pick up small particles of sand or dirt and rub it against the rock. As rocks are carried along in moving water, they may also bump or rub against each other. This rubbing wears away the surface of the rock.

**Chemical Weathering**

Chemical weathering occurs when chemicals break down rocks. When chemicals in groundwater break up underground rock, caves form.

In some parts of the eastern United States, you may see stone or metal statues whose features have been worn away or pitted. Sometimes the color on the statue is changed or damaged. If you see these changes, that statue may have been affected by acid rain.

As you have learned, acid rain forms when gases from factories enter the air and combine with raindrops. Acid rain wears away stone and metals. The worn material may crumble and be swept away by winds and precipitation.

**Quick Check**

**Problem and Solution** How does acid rain damage statues?

**Critical Thinking** How are physical and chemical weathering different?
What is erosion?

When it rains, water soaks into the ground. The water mixes with the soil and forms mud. If it rains very heavily or for a long time, the mud may contain so much water that it cannot stay in place on a slope. The mud starts to flow down the slope. If a large quantity of mud moves, it can knock down trees and destroy whatever is in its path, such as people’s homes. The movement of a large amount of mud and rocks down a slope is called a mudslide.

Erosion (ih•ROH•zhun) is the process through which weathered rock or soil is moved from one place to another. Land can be eroded by gravity, glaciers, running water, waves, or wind.

Gravity

When rocks and soil on a slope are loosened, gravity pulls them downward. A landslide is the movement of a large amount of rock and soil down a slope. Landslides may occur after an earthquake or a volcanic eruption. These events cause the ground to move. This loosens rocks and soil enough that gravity can pull them downward.

Plant roots grow down into soil and around rocks. If many plants grow on a hill, their roots will hold on to the soil and the rocks. These roots help to hold soil in place that might otherwise move in a mudslide or a landslide. Plants can help prevent erosion from gravity.
Glaciers

A glacier (GLAY•shur) is a large mass of slowly flowing ice. Glaciers form in cold areas where snow piles up and freezes. Water freezes in cracks in the rock underneath the snow and weathers the rock. As the glacier moves, it carries away weathered pieces of rock.

The bits of rock wear away the ground at the beginning of the glacier, forming a steep bowl-shaped hollow called a cirque (SURK). The rocks and flowing ice also wear away dirt and rock along the sides of the glacier.

Eventually, the ice at the front of the glacier will melt. If the ice melts faster than the glacier is moving forward, the glacier will shrink. A valley that had a sharp V-shape before a glacier came through will now have a U-shape, with a flatter bottom and sides.

Quick Lab

Rate of Erosion SI.14, SI.15

1 Form a Hypothesis How does the speed of running water affect how fast soil erodes? Write your answer in the form of a hypothesis.

2 Make a Model Place dirt in two identical baking pans so the dirt is at the same level in each pan.

3 Place a wooden block underneath one end of each pan.

4 Fill a watering can with a sprinkler head with 2 cups of water. Slowly pour the water into the pan. Record your observations.

5 Remove the sprinkler head and fill the watering can with 2 cups of water. Pour the water slowly into the pan. Record your observations.

6 Draw Conclusions Do your results support your hypothesis?

7 How well does this model represent erosion?

Quick Check

Problem and Solution What could people do to reduce the chances of a mudslide happening on a hill?

Critical Thinking If a glacier melted, what would form in the cirque?

Read a Photo

What type of erosion might have formed this valley?

Clue: Look at the sides and bottom of the valley.
What is deposition?

When a glacier erodes dirt and rock, the eroded materials are pushed in front of it. When the glacier starts to shrink, the eroded materials are left behind. The process by which eroded materials are dropped off in another place is called deposition (de•puh•ZIH•shun). Erosion and deposition work together to change the shape of Earth’s surface.

Erosion and Deposition by Running Water

As water runs down hills, it can wash away soil and erode rock. The water, soil, and rocks will eventually flow into a larger body of water, such as a river. Rivers with fast-moving water tend to follow straight paths and have deeper channels and steeper banks. Rivers with slow-moving water tend to follow curving paths and have shallow channels and low banks. More deposition occurs in slow-moving than in fast-moving water.

Meanders (mee•AN•durz), or gentle curves, sometimes form in rivers with slow-moving water. Water moves slowly around the inside of a meander. Particles of soil and rock that are carried along in water are called sediment. Along the slower-moving inside edge of a meander, sediment has time to settle out of the water. As sediment is deposited, it may eventually build new land.

Water moves more rapidly around the outside edge of a meander. The sediment in this part of the river is carried farther downstream. Sometimes additional sediment is eroded from land along the outer edge of the curve.
Erosion and Deposition by Waves

Waves often hit beaches either at an angle or a curve as they move into shallower water. This means that as they erode the shoreline, they move sand and rocks farther down the beach or to the side.

When waves reach a headland, or an area of land that has water on three sides, they curve around it and wash away at the sides of the headland. As the waves continue to erode the sides, an arch forms.

When waves wash sand off beaches, the sand may be deposited in the water rather than back on the beach. Over time, enough sand may be deposited in one area in the water that a strip of sandy land forms. This strip of land is called a sandbar. A sandbar may last for some time until movements of ocean water break it down.

Erosion and Deposition by Wind

Wind can wear away rocks, smoothing them out. Wind also can move sand or sediment from one place to another. When the winds slow down, the sand and soil are deposited.

Sandbars form when waves pick up sand and deposit it in the water.

Quick Check

Problem and Solution  What makes the erosion of sand from a beach a problem for people?

Critical Thinking  How does gravity deposit materials?
How are shorelines changed?

A shoreline, or the edge of a body of water, is changed by the erosion and the deposition of sediment. Sediment is eroded and deposited along a shoreline by running water, waves, and winds.

Running Water

Water runs over the ground into streams and rivers. Sometimes, water enters a river faster than the river can carry it away. When water collects on land that is normally dry, it is called a flood.

Floods occur when water overflows the banks or beaches of a body of water. A flood may also occur during a heavy rainfall. Natural wetlands can soak up water and reduce the chances of a flood. Draining wetlands or cutting down plants along a riverbank may make floods more likely.

Flood waters carry and deposit sediments over the land. A floodplain (FLUH-playn) is a place that is easily flooded when river water rises. Floods also can erode the shoreline of a body of water and change its shape or course.
Waves

When large sandbars stretch for hundreds of kilometers along a coastline, they are called barrier islands. Barrier islands protect the coastline from erosion caused by large waves during storms. The waves hit the barrier islands first and erode the barrier islands rather than the coastline beaches. After severe storms, barrier islands may be so completely eroded that they no longer appear above the water. Without the barrier islands, the coastline’s erosion will be worse during the next storm.

Dunes form in the direction that the wind usually blows. As the wind blows, it will pick up sand from the dunes closest to the water and blow it farther inland. This can cause dunes to shift position.

Dunes protect areas farther inland from the large waves that can occur during storms. Dunes also shelter inland areas from the wind. If severe winds or waves occur, dunes may be completely eroded.

Wind

Some coastal areas have one or more sets of dunes running along the shoreline directly inland from the beach. A dune forms when wind erodes sand and deposits it along the back of the beach.

Quick Check

Problem and Solution  What is more likely to happen if wetlands are drained?

Critical Thinking  Why might some beaches have laws against driving vehicles on the dunes?
How can shorelines be protected?

A shoreline may be damaged when more sand is being eroded than deposited. People may take steps to prevent further erosion or to reduce the rate of erosion.

People can protect river shorelines by changing the speed or the direction of running water. Dams can control the speed of the flow of water in a river.

Other structures change or block the direction in which water can travel. Levees (LE•veez) are walls built to hold back water or prevent a flood. Canals or channels can be dug to carry away water that would otherwise cause floods.

Barricades can be built in the water along beaches to slow erosion. People can move sand from the water back onto the beach using pumps and hoses. Sometimes sand is even brought from other places to replace sand that was lost through erosion.

How do people prevent wind from eroding beaches and dunes? Fences are often put up near sand dunes to decrease the speed of the wind so less sand is blown away. Sometimes people plant grasses on dunes so the roots will grow into the sand and hold on to it.

Quick Check

Problem and Solution How does planting grasses prevent wind from eroding dunes?

Critical Thinking When trying to prevent or reduce erosion, why should you consider the entire shoreline?
Visual Summary

Weathering wears away land. Weathering can be physical or chemical.

Erosion moves land from one place to another.

Moving water can cause flooding and build and break down land.

Think, Talk, and Write

1. Vocabulary As the speed of river water slows, ________ is deposited.

2. Problem and Solution If you needed to prevent waves from eroding a beach, what would you do?

   - Problem
   - Steps to Solution
   - Solution

3. Critical Thinking How might you tell which type of weathering had worn away a cliff?

4. Test Prep Which is a sandbar?
   - A a strip of sandy land in water
   - B a wall built to hold back water
   - C sediment in the mouth of a river
   - D rock moved by slowly flowing ice

5. Test Prep Which moves sand dunes from one place to another?
   - A water
   - B gravity
   - C acid rain
   - D wind

6. Essential Question How do weathering and erosion shape the land?

Make a Foldables Study Guide

Make a trifold book. Use the titles shown. Then summarize what you have learned.

Writing Link

Fictional Writing
Write about a trip down the Mississippi River. Describe the different areas of the river that you would see.

Social Studies Link

Effects of Floods
Research how the ancient Egyptians used the annual flooding of the Nile River in Africa to water their crops.
Beaches all over the world are eroding. I had learned from reading books how many beaches are changing shape, losing sand, and becoming narrower. However, I had thought that erosion had no real effect on my life—until my grandparents’ dream home crashed into the sea.

After many years of working hard and saving their money, my grandparents bought a beautiful house on the beach. I used to love to visit them there. Their house stood high up on stilts, which protected their home from the water. I would sit in the front room, facing the ocean, and listen to the rhythm of the pounding waves, breathing in the salty ocean air. It was thrilling.

One afternoon, my grandparents received a devastating phone call. Their house had collapsed. Over time, the rolling waves had pulled sand off the beach and back into the ocean. Without the support and protection of the sand, the seawater had slowly weakened the stilts on which their house once stood.

Now, my grandparents’ dream is just a memory. However, the lesson we learned is still with us all: The sea can be a mighty foe. It can erode the beaches and change the land. The sea can also destroy homes—and dreams.
Personal Narrative

A good personal narrative
▶ tells a story from personal experience;
▶ expresses the writer’s feelings by using the first-person point of view;
▶ uses descriptive language;
▶ has an interesting beginning, middle, and end;
▶ shares events in a sequence that makes sense;
▶ uses time-order words, such as before and after, to connect ideas and show the sequence of events.

Write About It

Narrative Writing  Tell a personal story about the effects of beach erosion and the need to protect beaches. Use descriptive details, and retell events in a logical order. Use the first-person point of view and add dialogue if appropriate. Using print and online research, include information about why beaches are important.

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