Shoreline Erosion and Deposition

**BEFORE YOU READ**

After you read this section, you should be able to answer these questions:

- What is a shoreline?
- How do waves shape shorelines?

**How Do Waves Form?**

Waves form when wind blows over the surface of the ocean. Strong winds produce large waves. The waves move toward land. When waves crash into the land over a long time, they can break rock down into smaller pieces. These pieces are called sand.

A shoreline is a place where the land and the water meet. Most shorelines contain sand. The motion of waves helps to shape shorelines. During **erosion**, waves remove sand from shorelines. During **deposition**, waves add sand to shorelines.

**WAVE TRAINS**

Waves move in groups called **wave trains**. The waves in a wave train are separated by a period of time called the **wave period**. You can measure the wave period by counting the seconds between waves breaking on the shore. Most wave periods are 10 to 20 s long.

When a wave reaches shallow water, the bottom of the wave drags against the sea floor. As the water gets shallower, the wave gets taller. Soon, it can’t support itself. The bottom slows down. The top of the wave begins to curl, fall over, and break. Breaking waves are called **surf**.

**National Science Education Standards**

ES 1c

**STUDY TIP**

**Summarize** Read this section quietly to yourself. Talk about what you learned with a partner. Together, try to figure out the answers to any questions that you have.

**READING CHECK**

1. Compare How is wave erosion different from wave deposition?

2. Calculate A certain wave train contains 6 waves. The time between the first wave and the last wave is 72 seconds. What is the wave period?

Waves travel in groups called wave trains. The time between one wave and the next is the wave period.
POUNDING SURF

The energy in waves is constantly breaking rock into smaller and smaller pieces. Crashing waves can break solid rock and throw the pieces back toward the shore. Breaking waves can enter cracks in the rock and break off large boulders. Waves also pick up fine grains of sand. The loose sand wears down other rocks on the shore through abrasion.

What Are the Effects of Wave Erosion?

Wave erosion can produce many features along a shoreline. For example, sea cliffs form when waves erode rock to form steep slopes. As waves strike the bottom of the cliffs, the waves wear away soil and rock and make the cliffs steeper.

How fast sea cliffs erode depends on how hard the rock is and how strong the waves are. Cliffs made of hard rock, such as granite, erode slowly. Cliffs made of soft rock, such as shale, erode more quickly.

During storms, large, high-energy waves can erode the shore very quickly. These waves can break off large chunks of rock. Many of the features of shorelines are shaped by storm waves. The figures below and on the next page show some features that form because of wave erosion.

**Reading Check**

3. **Identify** Give two ways that waves can break rock into smaller pieces.

**Critical Thinking**

4. **Identify Relationships** When may a storm not produce high-energy waves?

**Take a Look**

5. **Compare** How is a sea stack different from a sea arch?
What Are the Effects of Wave Deposition?

Waves carry many materials, such as sand, shells, and small rocks. When the waves deposit these materials on the shoreline, a beach forms. A beach is any area of shoreline that is made of material deposited by waves. Some beach material is deposited by rivers and moves down the shoreline by the action of waves. ✔

Many people think that all beaches are made of sand. However, beaches may be made of many materials, not just sand. The size and shape of beach material depend on how far the material traveled before it was deposited. They also depend on how the material is eroded. For example, beaches in stormy areas may be made of large rocks because smaller particles are removed by the waves.

The color of a beach can vary, too. A beach’s color depends on what particles make up the beach. Light-colored sand is the most common beach material. Most light-colored sand is made of the mineral quartz. Many Florida beaches are made of quartz sand. On many tropical beaches, the sand is white. It is made of finely ground white coral. ✔

Beaches can also be black or dark-colored. Black-sand beaches are found in Hawaii. Their sands are made of eroded lava from volcanoes. This lava is rich in dark-colored minerals, so the sand is also dark-colored. The figures on the next page show some examples of beaches.
This beach in New England is made of large rocks. Smaller sand particles are washed away during storms.

This beach in Florida is made of light-colored quartz sand.

This beach in Hawaii is made of dark-colored sand from igneous rocks.

The sand at this beach in California is made of light-colored minerals.

WAVE ANGLE AND SAND MOVEMENT

Waves can move sand along a beach. The movement of the sand depends on the angle at which the waves hit the shore. *Longshore currents* form when waves hit the shore at an angle. The waves wash sand onto the shore at the same angle that the waves are moving. However, when the waves wash back into the ocean, they move sand directly down the slope of the beach. This causes the sand to move in a zigzag pattern, as shown in the figure below.

TAKE A LOOK

9. Explain Why are some beaches made mostly of larger rock pieces, instead of sand?

TAKE A LOOK

10. Infer Why don’t longshore currents form in places where waves hit the shore head-on?
SECTION 1 Shoreline Erosion and Deposition continued

OFFSHORE DEPOSITS

Longshore currents can carry beach material offshore. This process can produce landforms in open water. These landforms include sandbars, barrier spits, and barrier islands.

A sandbar is a ridge of sand, gravel, or broken shells that is found in open water. Sandbars may be completely under water or they may stick up above the water.

A barrier spit is a sandbar that sticks up above the water and is connected to the shoreline. Cape Cod, Massachusetts, is an example of a barrier spit. It is shown in the figure below.

A barrier island is a long, narrow island that forms parallel to the shoreline. Most barrier islands are made of sand.

Cape Cod, Massachusetts, is an example of a barrier spit. Barrier spits form when sandbars are connected to the shoreline.

Santa Rosa Island in Florida is an example of a barrier island.

READING CHECK

11. Define What is a sandbar?

TAKE A LOOK

12. Identify What is a barrier spit?

TAKE A LOOK

13. Compare What is the difference between a barrier island and a barrier spit?
Section 1 Review

SECTION VOCABULARY

<table>
<thead>
<tr>
<th>beach</th>
<th>an area of the shoreline that is made up of deposited sediment</th>
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<tbody>
<tr>
<td>shoreline</td>
<td>the boundary between land and a body of water</td>
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1. **Compare**  How is a shoreline different from a beach?

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2. **Explain**  Where does the energy to change the shoreline come from? Explain your answer.

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3. **Identify**  Give two examples of different-colored beach sand and explain why each kind is a certain color.

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4. **Explain**  How do longshore currents move sand?

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5. **List**  Give five landforms that are produced by wave erosion.

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How Can Wind Erosion Affect Rocks?

Wind can move soil, sand, and small pieces of rock. Therefore, wind can cause erosion. However, some areas are more likely to have wind erosion than other areas. For example, plant roots help to hold soil and rock in place. Therefore, areas with few plants, such as deserts and coastlines, are more likely to be eroded by wind. These areas also may be made of small, loose rock particles. Wind can move these particles easily.

Wind can shape rock pieces in three ways: saltation, deflation, and abrasion.

SALTATION

Wind moves large grains of soil, sand, and rock by saltation. **Saltation** happens when sand-sized particles skip and bounce along in the direction that the wind is moving. When moving sand grains hit one another, some of the grains bounce up into the air. These grains fall back to the ground and bump other grains. These other grains can then move forward.
DEFLATION

Wind can blow tiny particles away from larger rock pieces during deflation. **Deflation** happens when wind removes the top layers of fine sediment or soil and leaves behind larger rock pieces.

Deflation can form certain land features. It can produce *desert pavement*, which is a surface made of pebbles and small, broken rocks. In some places, the wind can scoop out small, bowl-shaped areas in sediment on the ground. These areas are called *deflation hollows*.

ABRASION

Wind can grind and wear down rocks by abrasion. **Abrasion** happens when rock or sand wears down larger pieces of rock. Abrasion happens in areas where there are strong winds, loose sand, and soft rocks. The wind blows the loose sand against the rocks. The sand acts like sandpaper to erode, smooth, and polish the rocks.

<table>
<thead>
<tr>
<th>Process</th>
<th>Description</th>
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<tbody>
<tr>
<td>Deflation</td>
<td>Large particles bounce and skip along the ground.</td>
</tr>
<tr>
<td>Abrasion</td>
<td></td>
</tr>
</tbody>
</table>

What Landforms Are Produced by Wind Deposition?

Wind can carry material over long distances. The wind can carry different amounts and sizes of particles depending on its speed. Fast winds can carry large particles and may move a lot of material. However, all winds eventually slow down and drop their material. The heaviest particles fall first, while light material travels the farthest.

LOESS

Wind can deposit extremely fine material. Thick deposits of this windblown, fine-grained sediment are known as **loess**. Loess feels like talcum powder. Because the wind can carry light-weight material so easily, a loess deposit can be found far away from its source. In the United States, loess deposits are found in the Midwest, the Mississippi Valley, and in Oregon and Washington states.
DUNES

Barriers, such as plants and rocks, can cause wind to slow down. As it slows, the wind deposits particles on top of the barrier. As the dropped material builds up, the barrier gets larger. The barrier causes the wind to slow down even more. More and more material builds up on the barrier until a mound forms.

A mound of wind-deposited sand is called a dune. Dunes are common in sandy deserts and along sandy shores of lakes and oceans.

THE MOVEMENT OF DUNES

Wind conditions affect a dune’s shape and size. As the wind blows sand through a desert, it is removed from some places and deposited in others. This can cause dunes to seem to move across the desert.

In general, dunes move in the same direction the wind is blowing. A dune has one gently sloped side and one steep side. The gently sloped side faces the wind. It is called the windward slope. The wind constantly moves sand up this side. As sand moves over the top of the dune, the sand slides down the steep side. The steep side is called the slip face.

STANDARDS CHECK

ES 1c Land forms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.

6. Define What is a dune?

READING CHECK

7. Identify In what direction do dunes generally move?

TAKE A LOOK

8. Compare How is the windward slope of a dune different from the slip face?

The wind blows sand up the windward slope of the dune. The sand moves over the top of the dune and falls down the steep slip face. In this way, dunes move across the land in the direction that the wind blows.
1. Identify  Give two land features that can form because of deflation.

2. Describe  What areas are most likely to be affected by wind erosion? Give two examples.

3. Identify  The figure shows a drawing of a sand dune. Label the windward slope and the slip face. Draw an arrow to show the direction of the wind.

4. Explain  How do dunes form?

5. Apply Concepts  Wind can transport particles of many different sizes. What sized particles are probably carried the farthest by the wind? Explain your answer.