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How do ocean waves cause erosion?

Objectives

Describe how ocean waves cause erosion. List shoreline features caused by wave erosion.

Key Terms

wave-cut terrace: flat section of rock formed by the erosion of a sea cliff

sea arch: gap formed when waves cut completely through a section of rock

sea stack: column of rock remaining after the collapse of a sea arch

Wave Erosion A wave is an up-and-down movement of water. Ocean waves are formed when wind blows over the water. Tides, storms, and earthquakes also cause waves.

The force of ocean waves striking a shoreline can break rocks into small pieces. The rock pieces grind against one another. This grinding motion causes abrasion. Abrasion wears down the rock particles until they become sand. The sand is then carried away by the waves.



▲ Figure 8-26 Waves crash against a shoreline in Oregon.

Waves also cause chemical weathering of the rocks along a shoreline. As waves meet the shoreline, salt water is forced into cracks in rocks.

The chemical action of salt water causes the rocks to break down and makes the cracks larger. Broken pieces of rock are then carried away by the waves.

1 **DESCRIBE:** How do waves cause shoreline erosion?

Sea Cliffs, Caves, and Terraces Waves pound into the rocks on a rocky shoreline. The rocks are broken down into small pieces. The broken rock is carried away by the waves. A sea cliff is formed. A sea cliff is a steep rock face caused by wave erosion. Soft rock is eroded more quickly than hard rock is. When waves hollow out the soft rock in a sea cliff, a sea cave is formed.

Over time, the bottom of a sea cliff may be slowly worn away. A flat section of rock may remain below the surface of the water. This flat platform is called a **wave-cut terrace**.

2 **DEFINE:** What is a sea cliff?

Sea Arches and Sea Stacks When waves cut completely through a section of rock, a **sea arch** is formed. The sea arch looks like a natural bridge. In time, the top of the sea arch may fall into the water. The remaining columns of rock are called **sea stacks**. Sea stacks were once the sides of an arch.



▲ Figure 8-27 A sea arch in Quebec, Canada

3 **IDENTIFY:** What is left when the top of a sea arch falls into the water?

CHECKING CONCEPTS

1. What are two causes of ocean waves?
2. What are two ways waves break down rocks?
3. What is the term for a steep rock face caused by erosion along a rocky shoreline?
4. What is formed when part of a sea cliff is hollowed out?
5. What is the shoreline feature that looks like a natural bridge called?

THINKING CRITICALLY

6. **ANALYZE:** What processes or events other than wave erosion might change the shape of a shoreline?
7. **HYPOTHESIZE:** The shoreline of Cape Cod, Massachusetts, is made up of loose glacial deposits. Would you expect this shoreline to erode quickly or slowly? Explain.

BUILDING MATH SKILLS

8. **CALCULATE:** Barrier island beaches are easily eroded by storm waves. An entire shoreline can be reshaped in a day. If a shoreline erodes at 1.5 m per year, how much erosion would occur over 25 years?

HEALTH AND SAFETY TIP

Hurricanes are the most powerful storms on Earth. They erode coastlines, damage homes, and cause injury. If a hurricane watch is issued, be sure you have canned goods, gasoline for the car, and first-aid kits on hand. Put fresh batteries in flashlights and portable radios. Tape your windows or close your shutters to avoid flying glass. If a hurricane warning is issued, leave the area if you live near the shore. If you stay, don't go out in the storm. Fill your bathtub with water. Tie down anything that can be blown away. After the storm, watch out for downed power lines and broken gas mains.



Real-Life Science

COASTAL EROSION AND STORMS

Hurricanes batter the U.S. Atlantic coastline each year. During the 1900s, there were more than 20 major hurricanes. In 1989, Hurricane Hugo struck the Atlantic coast. The city of Charleston, South Carolina, was hit hard. Many nearby coastal areas were almost destroyed. Damage from Hurricane Andrew in 1992 was estimated at more than \$25 billion in Florida and Louisiana. This damage was caused by high waves, severe flooding, and strong winds.

Large storms cause rapid changes along a coastline. However, slow changes are always occurring in coastal areas. Beaches are moved, sand grain by sand grain, by wind and waves. A beach washed away in one place may build up in another place. Sand dunes are slowly moved by the wind. Houses built on sand dunes or hills near a shore may be washed away.

People have tried to protect shorelines by building breakwaters and jetties. However, these only slow down coastal erosion. They cannot prevent it.

Thinking Critically Artificial structures can reduce erosion. However, shoreline changes are natural, and some people believe that shorefront development should be limited. What do you think?



▲ Figure 8-28 Hurricane damage in Kitty Hawk, North Carolina