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SANDY BEACHES

Topic

The effects of waves on sandy beaches

Key Question

How are sandy beaches affected by the action of waves?

Learning Goals

Students will:

- compare and contrast wind and water erosion of sandy beaches, and
- observe the effects of water erosion with different sizes of waves and different angles from which the water strikes the beaches.

Guiding Documents

Project 2061 Benchmarks

- *Waves, wind, water, and ice shape and reshape the earth's land surface by eroding rock and soil in some areas and depositing them in other areas, sometimes in seasonal layers.*
- *People can learn about things around them by just observing those things carefully, but sometimes they can learn more by doing something to the things and noting what happens.*
- *A model of something is different from the real thing but can be used to learn something about the real thing.*

NRC Standard

- *Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.*

Science

Earth science

Ocean waves

Integrated Processes

Observing

Comparing and contrasting

Recording

Materials

For groups of 4–6 students:

1-gallon-sized zipper type plastic bag

1–2 liters of sand and fine rock mixture

water containers

4 flat pieces of wood (ruler, lath, or lattice strip)

food coloring

rectangular pans such as oblong cake pans or paint trays

blocks for props (see *Management*)

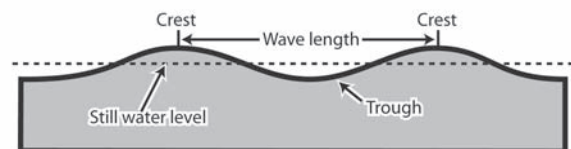
crayon

safety goggles

Background Information

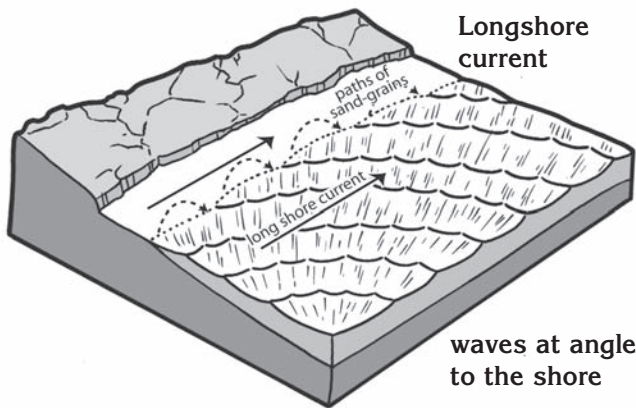
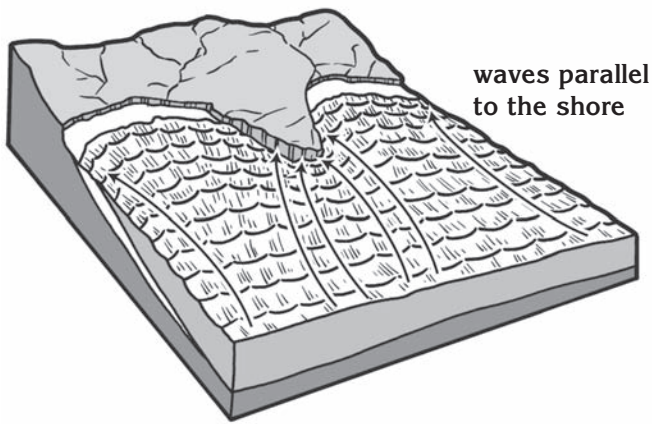
It is important to remember that sand on a beach is always in a dynamic state. If you were to observe a beach everyday for a month, you would see daily, as well as seasonal, changes. Although winds may move dry sand to some extent, waves are the major sculptors of the beach. Wind-generated waves provide most of the energy that shapes and modifies shorelines. Sandy beaches are at the mercy of these waves, which both build and destroy them.

Waves are produced when wind piles up water along the sea's surface. Waves have a high point called a crest and a low point called a trough. The distance between two successive wave crests is a wavelength. As waves arrive at the sloping face of a beach, they reach a point where the water depth is one-half the wavelength. As the wave "feels the bottom," friction slows the trough, but the crest keeps moving forward, eventually plunging over.

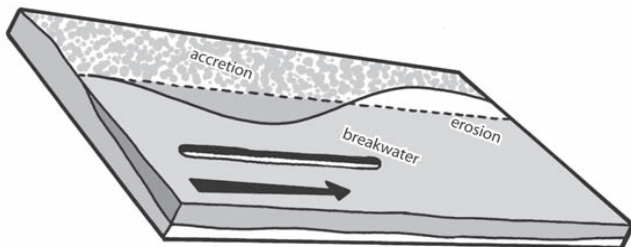


Most waves approach the shoreline at an angle, but as they reach shallow water with a smoothly sloping bottom, the waves are refracted and tend to become more parallel to the shore. This refraction causes the wave impact to be concentrated against the sides and ends of headlands projecting into the water, while, at the same time, its attack is weakened in bays.

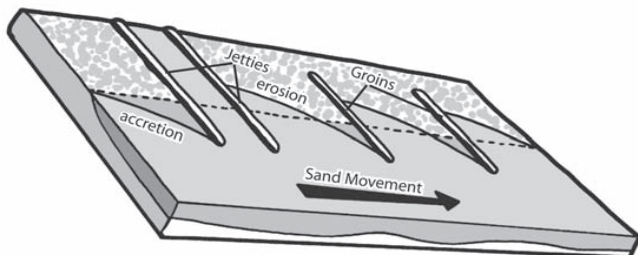
For those parts of the shore where the waves do not flow parallel to the shore, longshore currents are produced that sweep the sand along the shore causing beach drift. Great amounts of sediment are moved by beach drift. At Oxnard, California, the quantity of sand transported along the shore was calculated to be more than 1.5 million tons each year.



Breakwaters (barriers built parallel to the shoreline to protect boats from the force of large breaking waves) and groins (barriers constructed at a right angle to the beach for the purpose of trapping sand that is moving parallel to the shore) impact sand movement by inhibiting wave action and may eventually alter the coastline in unforeseen ways.



Beach Accretion and Erosion



Sandy beaches are commercially, aesthetically, and ecologically important. Sand and gravel are used in construction and the manufacturing of glass and

concrete. The beaches provide us with awesome scenery and great recreational pleasure. These uses often put humans at odds with sandy beaches. The damming of rivers, the dredging of bays, the mining of sand are all changing sand movements. The regular flow of sand is often crucial to survival of estuaries, the “nurseries” of so many commercial fish and invertebrates. Our increasing population and added leisure time puts incredible pressure on what can be a fragile ecosystem. Builders and developers must be aware of the growth and erosion of beaches to properly place their structures.

Key Vocabulary

Accretion: the accumulation of sand on a beach

Breakwater: a structure built parallel to a beach to protect the beach from the force of large, breaking waves

Erosion: the washing away of sand from a beach

Groin: a rigid structure built out from a shore to protect the shore from erosion, to trap sand, or to direct a current

Jetty: a rigid structure built out from a shore to trap sand; usually much longer than a groin

Wave: a moving ridge on the surface of water

Trough: the place in the wave where it is lowest

Crest: the place in the wave where it is highest

Wavelength: the distance from the top of the crest of one wave to the top of the crest of the following wave

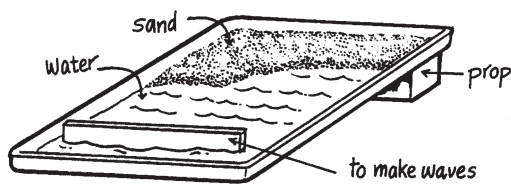
Management

1. Collect the items on the *Materials* list. Be sure to get pans that are two or more inches deep and rectangular. The wave-making sticks should be flat and fit inside the pans. Props for the pans should be able to tilt the pans at a 30° angle.
2. Put a mixture of sand and fine rocks in a plastic bag for each group of 4-6 students.
3. Remind students to catch wet sand and water in a can to keep the sand out of the sink.

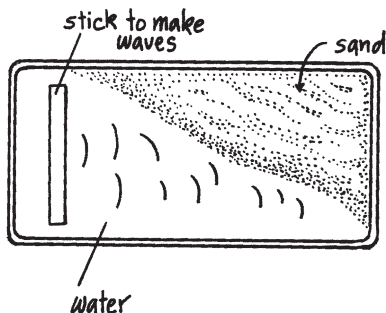
Procedure

1. Ask the *Key Question* and state the *Learning Goals*.
2. Discuss the concept of a sandy beach, its structure, its recreational and economic value for swimmers, fishermen, and surfers, and its ecological value.
3. Use the transparency (see the *Teacher Transparency* page) to introduce or review the basic structure and motion of an ocean wave in deep water, as it moves up a sloping beach.
4. Have students put on safety goggles. Tell them to put dry sand in the pan and gently blow on it. Ask them to observe what size sand grains the “wind” moves.

- Have them make a beach with their sand mixture by placing it in a row across the pan, about one-third of the way down.

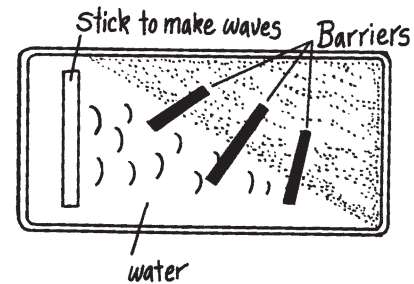


- Instruct one student in each group to tilt the pan with the blocks to about a 30° angle with the sand on the high end.
- Have students carefully add water to the lower end of their pans until the water almost touches the sand.
- Tell students to use a flat piece of wood to make several GENTLE waves that splash the sand. Ask them to observe where the sand moves and compare the movement of different-sized sand grains.
- Have students move the sand back to the starting place and make bigger waves. Ask them to again compare the movement of different-sized sand grains. (Larger “plunging” waves should move different-sized sand grains than smaller “spilling” waves.)
- Tell students to lay the pan flat on the table and make waves that hit the sand at an angle. Either changing the angle of the coastline or changing the angle you make waves can do this.



- Invite students to put a drop of food coloring in the water one inch “offshore.” Again, have them make waves at an angle and observe the movement of the food coloring.
- Tell students to use additional pieces of wood to make barriers along the “beach.” Have them make small waves for several minutes and ob-

serve where the sand collect around the barriers. This represents a method some locations utilize to prevent beach erosion.



- Describe breakwaters and their purposes to students. Have them build them in their wave pans. (It may take some time before students see the movement of sand.)
- Have students design a system of barriers to best combat wave erosion.
- Tell students to carefully dispose of their sand and water, making sure they do not put sand in the sink.

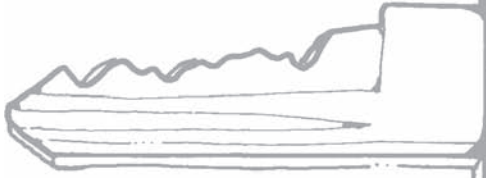
Connecting Learning

- Which has more effect on beach erosion: wind or water? Explain your answer. [water]
- Compare and contrast the actions of the water when it hits parallel to the sandy beach and when it hits at an angle.
- What did you notice about the sand’s movement when you placed barriers in the water?
- Are barriers beneficial to beach owners? ...to creatures living in the estuaries? ...to commercial fishermen? Explain your answers.
- What are you wondering now?

Extensions

- Make irregular shoreline features. Create waves and observe the resulting action of the sand.
- Make jetties and groins. Create and observe the wave action resulting movement of sand.
- Observe local maps of seaside or lakeside areas and see where beaches have been formed around headlands and jetties.
- Contact Coastal Commissions to find out what rules developers need to follow before building along beaches.
- Visit a marine museum or laboratory and observe a wave tank in action.

SANDY BEACHES



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Wave: a moving ridge on the surface of water

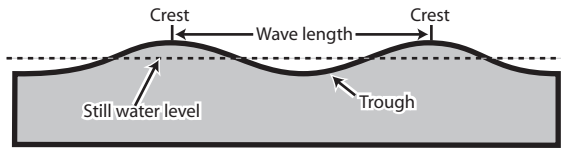
Trough: the place in the wave where it is lowest

Crest: the place in the wave where it is highest

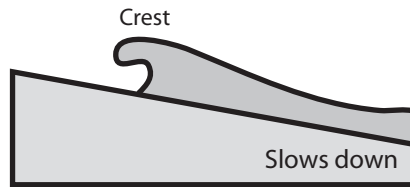
Wavelength: the distance from the top of the crest of one wave to the top of the crest of the following wave

SANDY BEACHES

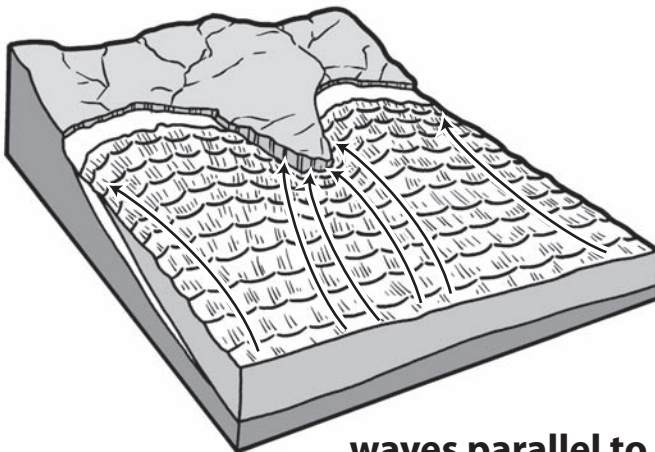
teacher transparency



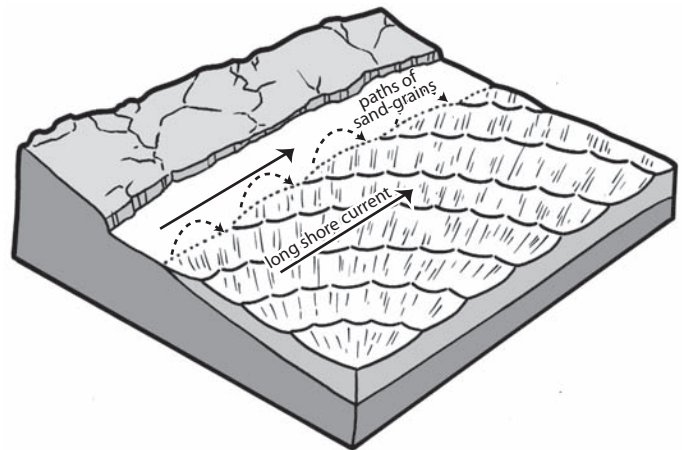
deep water wave



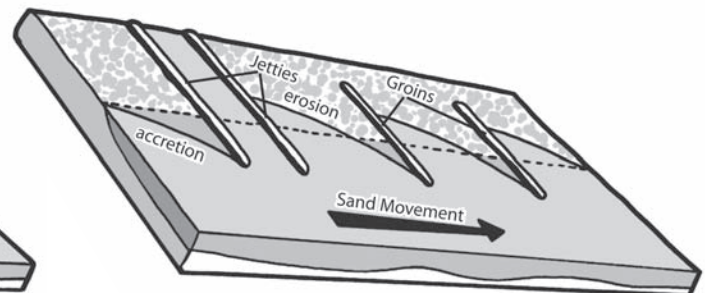
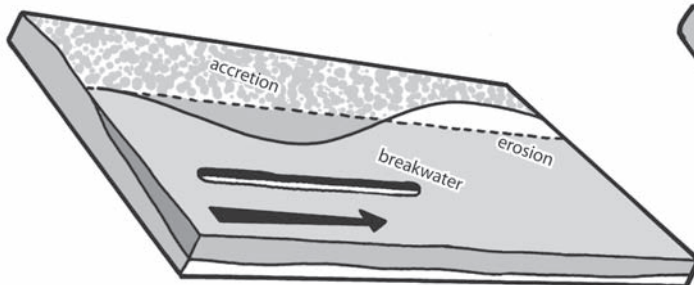
beach wave



waves parallel to shore



**longshore current
waves at angle to shore**

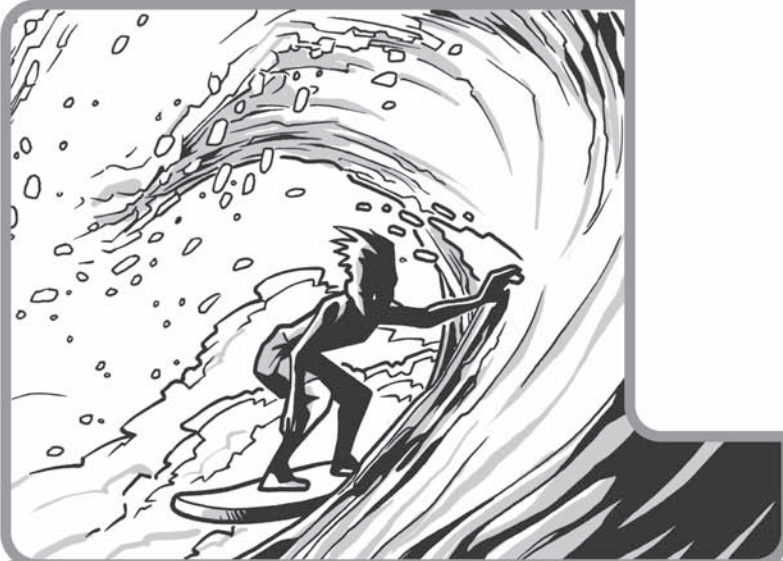


beach accretion and erosion

SANDY BEACHES

1. Gently blow on your sandy beach.

**Describe what happens.
Which grains of sand move?**



2. Draw a picture of what you observed before and after the waves hit the beach.



before



after

**SMALL
WAVES**



before



after

**LARGE
WAVES**

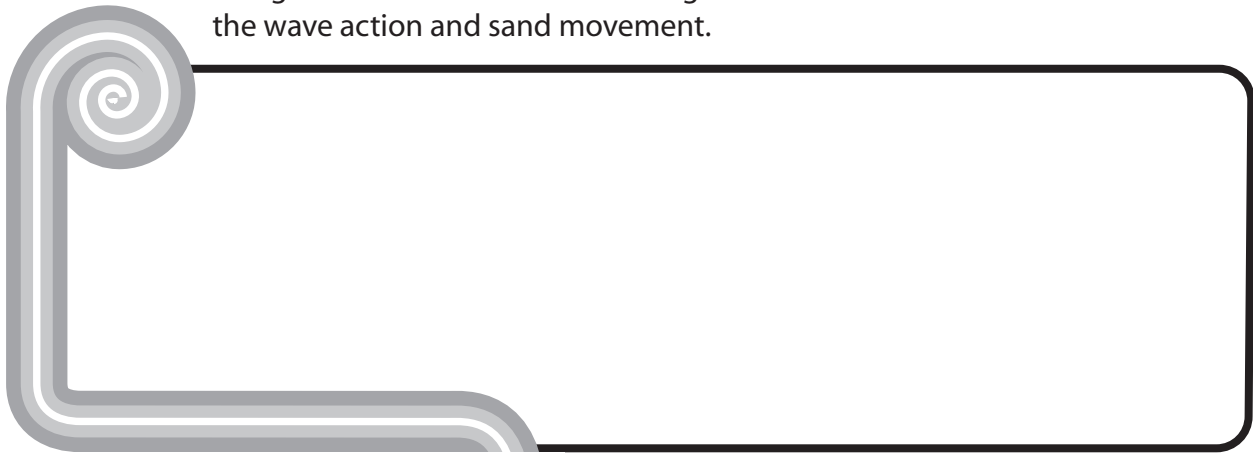
3. Describe the differences in sand movement.

SANDY BEACHES

4. Picture and explain what happens when waves come at an angle.



5. Design and build a breakwater using the barriers. Picture and describe the wave action and sand movement.



SANDY BEACHES

Connecting Learning

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2. Compare and contrast the actions of the water when it hits parallel to the sandy beach and when it hits at an angle.
3. What did you notice about the sand's movement when you placed barriers in the water?
4. Are barriers beneficial to beach owners? ...to creatures living in the estuaries? ...to commercial fishermen? Explain your answers.
5. What are you wondering now?