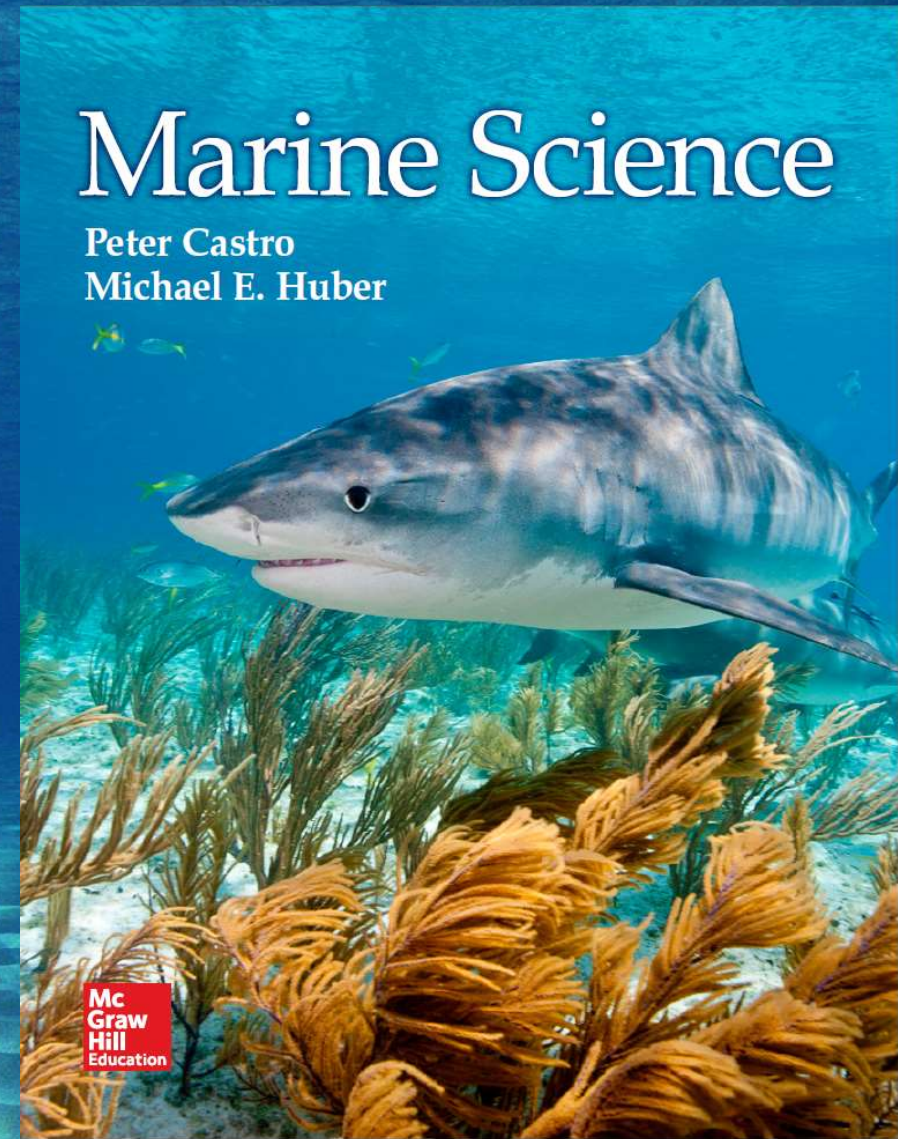


Chapter 4

Waves and Tides



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Essential Questions

- What factors contribute to the formation of a wind driven wave?
- What are the parts of a wave?

Wave Formation

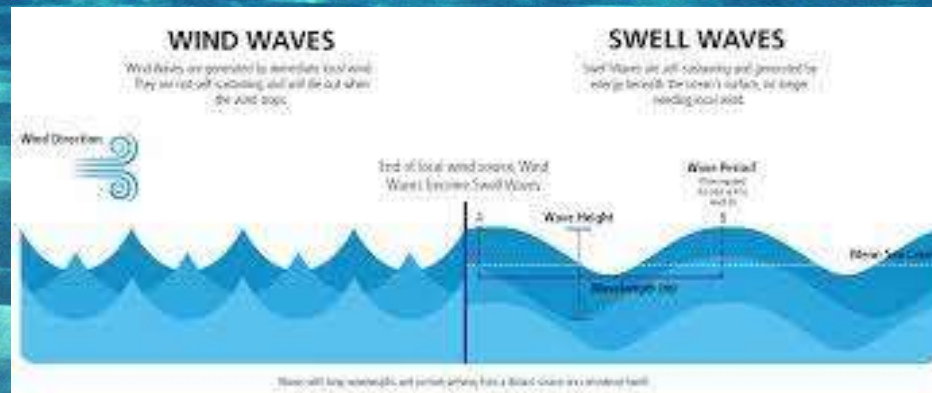
- Waves are started by disturbances called generating forces.
- Three common wave generating forces are **wind, earthquakes, and landslides.**

Wave Formation-Wind

- Waves are the result of wind blowing over the water's surface.
- The size of waves depends on how long and fast the wind blows: longer and faster equals a larger wave.
- Capillary waves, or ripples, are the smallest of the wind driven waves.

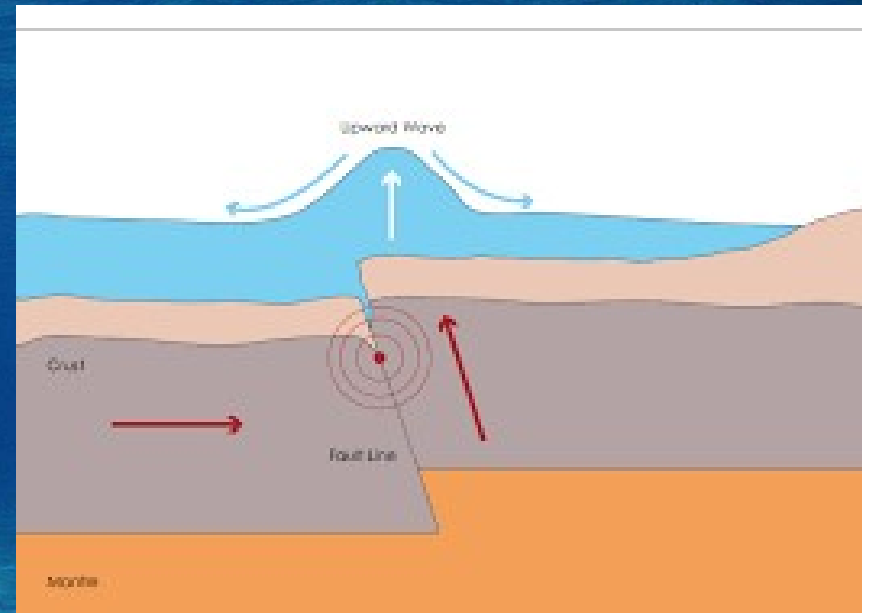
Wave Formation

- After the waves have moved away from the wind or storm that formed them, they settle into swells.
- Swells carry energy long distances across ocean basins.
- Swells are evenly spaced waves with smooth rounded crests and troughs.



Wave Formation-Earthquakes

- When the seafloor is disturbed during an earthquake, a large amount of water is displaced.
- Waves move away from the source of the earthquake.
- Large waves that are produced by earthquakes are called tsunamis.



Wave Formation-Landslides

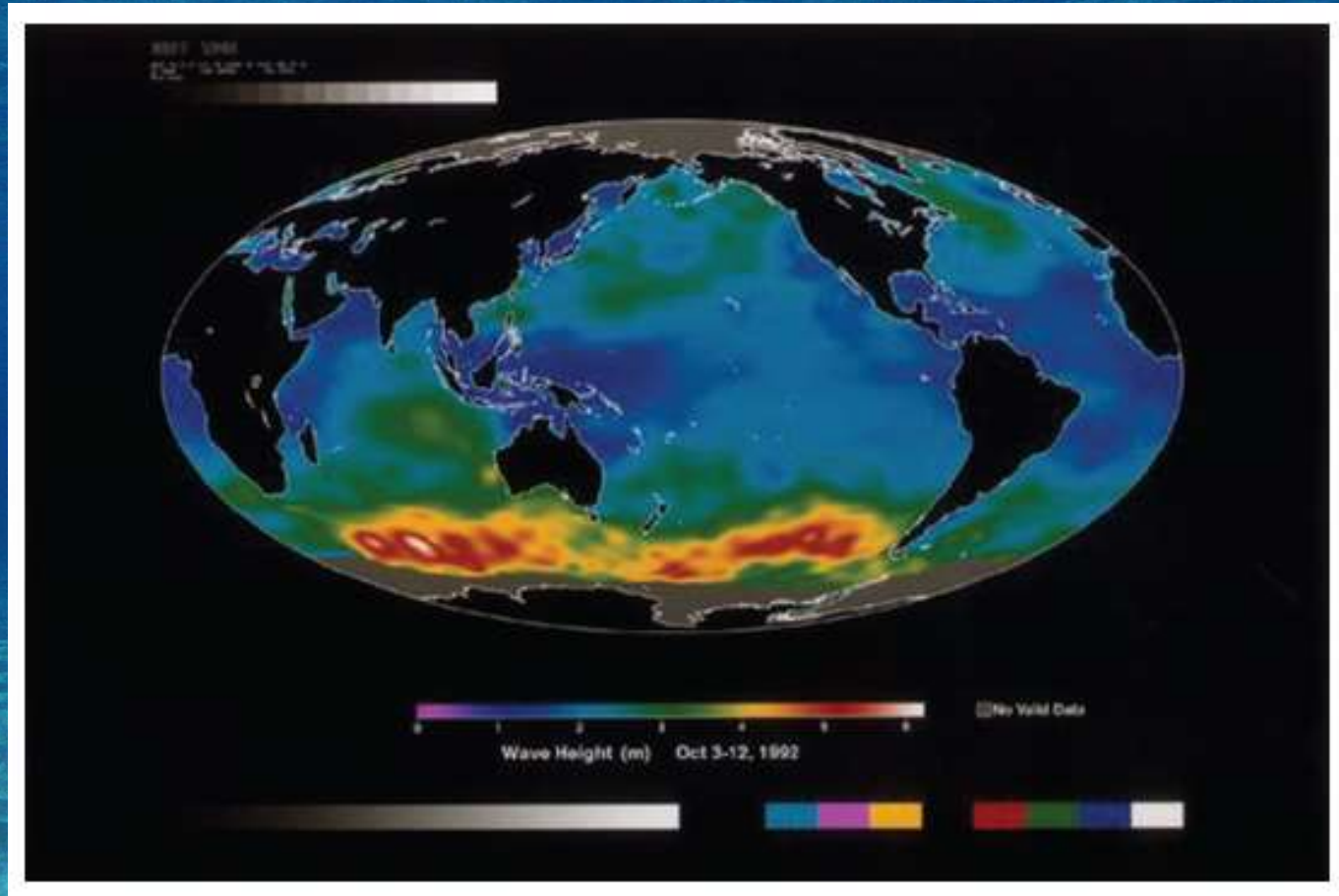
- When landslides occur or ice breaks off glaciers and material falls into the ocean, waves are created.
- Some factors that influence the formation of waves include wind speeds, wind duration, water depth, and fetch.
- Fetch is the amount of open water a wind blows over. [recap video](#)
- [How Waves form](#)
- [How do waves work?](#)

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Wave Height

- Wave height is dependent on three factors: **wind speed, fetch, and wind duration**. The largest waves occur when all three of these factors are maximized.
- The largest waves in the world occur between 40° S and 50° S.

Average Wave Heights Across Globe



Areas of red have the highest wave heights and areas in purple have the lowest.

Wave Dissipation

- Wave energy is dissipated when water particles stop moving because of restoring forces.
- A restoring force is a force that causes the water surface to go back to its undisturbed state.
- There are only two restoring forces—surface tension and gravity.

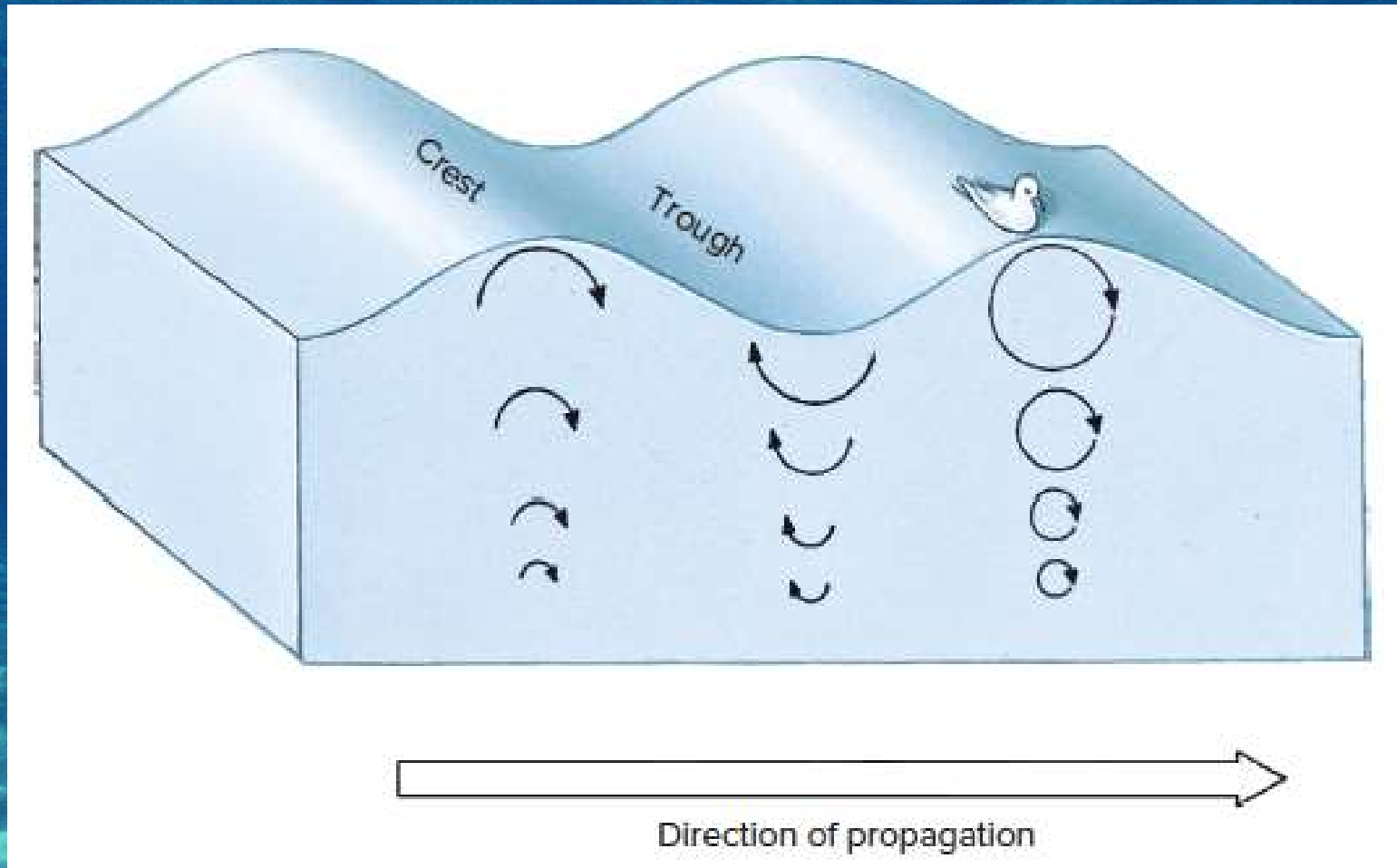
Wave Energy and Motion

- A wave has two different types of energy—potential and kinetic.
- The potential energy comes from the height of the wave.
- The kinetic energy comes from the motion of the wave particles.

Orbital Motion

- Waves carry energy across the sea surface, but they do not transport water.
- As the wave energy moves through the water, it moves water particles up and down in an orbital motion.
- Water particles move in a circular pattern, they do not move in the direction of the wave.
- Let's make a wave...like the football games!

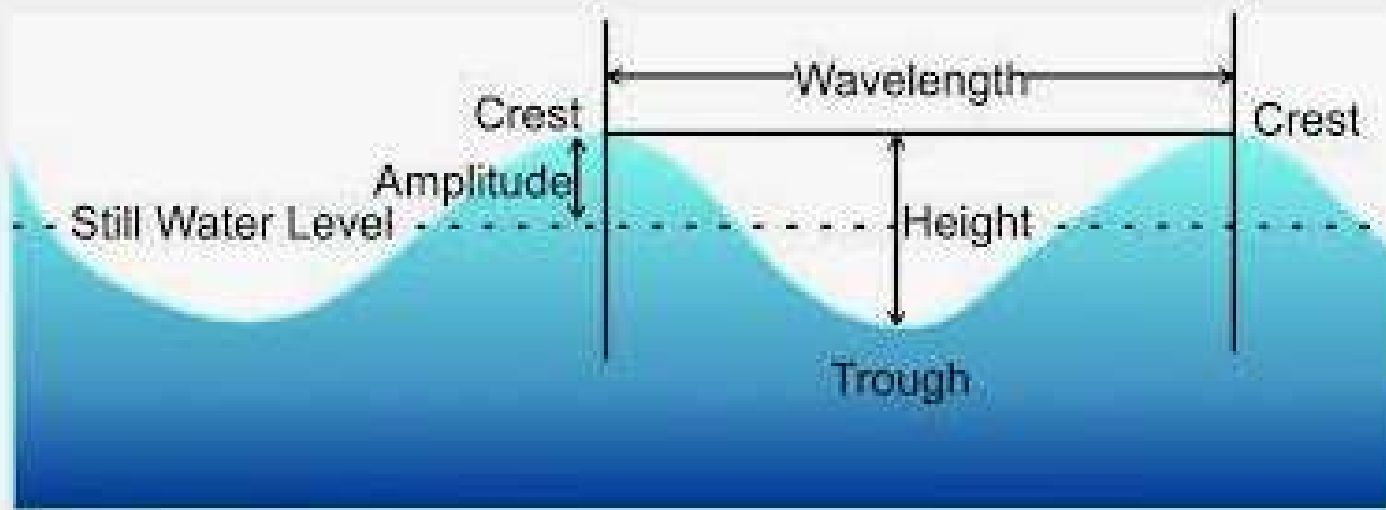
Orbital Motion



Wave Anatomy

- The highest point of a wave is called its **crest**.
- The lowest point in a wave is called its **trough**.
- The height of a wave from the top of the crest to the bottom of the trough is the **amplitude** of the wave.
- The wave **period is the time** it takes for two consecutive crests or troughs to pass a point.
- The **frequency** is the reciprocal of the wave period (**how many waves** pass a point in a given amount of time ex. 1 seconds)

Wave Anatomy



Wave Anatomy

- In deep water, wave speed is dependent on the wavelength of the wave.
- In shallow water, wave speed is dependent on the water depth.
- After a wave forms, its speed can change, but its period remains the same.

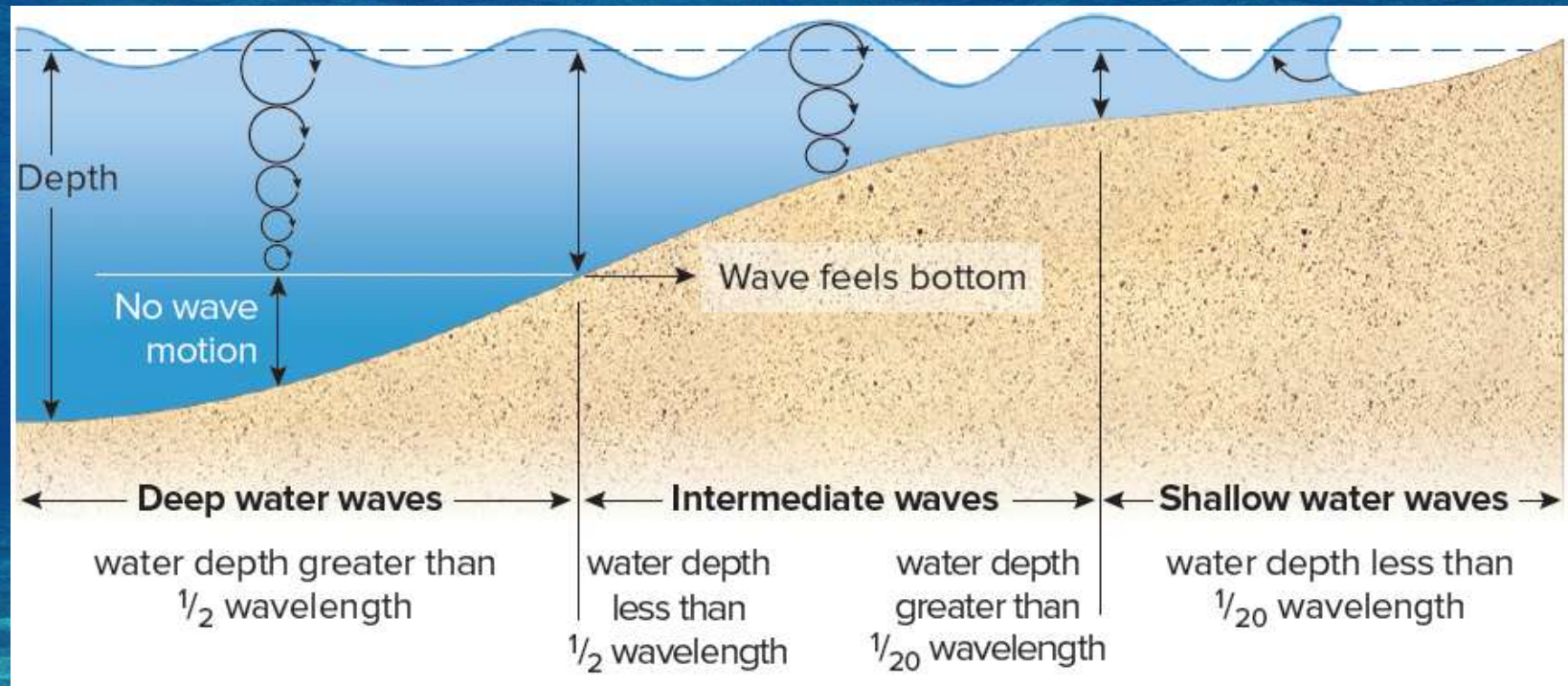
Wave Interaction

- Wave cancellation occurs when the crest of one wave meets the trough of another, and the sea ends up being intermediate between the two waves called destructive waves.
- If the crests of two waves collide, they add together to produce a higher wave which is called wave reinforcement or constructive waves.

Types of Waves

- There are two broad categories of waves—deep-water and shallow-water waves.
- These two types of waves have different characteristics and travel differently through the ocean.
- Whether a wave is a deep-water wave or a shallow-water wave depends on the depth of the ocean and the wavelength.

Types of Waves



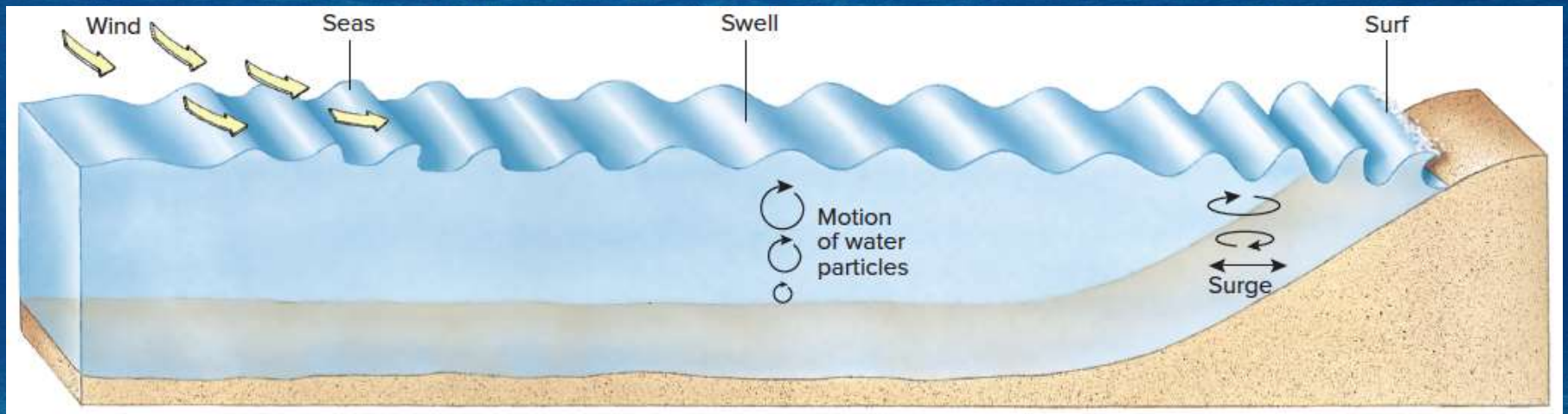
Deep-Water Wave

- A deep-water wave travels in water that is deeper than one half of its wavelength.
- The speed of the wave depends on the wavelength of the wave (not on the depth of the water) and the period.
- There are two types of deep-water waves—progressive wind waves and swell waves.
- These waves are generated by wind, restored by gravity, and progress in a particular direction.

Shallow-Water Wave

- Shallow-water waves travel in water that is less than $1/20^{\text{th}}$ of their wavelength.
- The speed of shallow-water waves is dependent on the depth of the water, not on the wavelength of the wave.
- The orbital motion of water particles shifts to become more elliptical as the wave approaches shore. The drag of the wave across the bottom is what causes waves to break and form surf.

Shallow-Water Waves



Water Refraction

- Waves are refracted, or bent, as they move from deep water to shallow water.
- Waves usually approach the shore at an angle.

Water Refraction

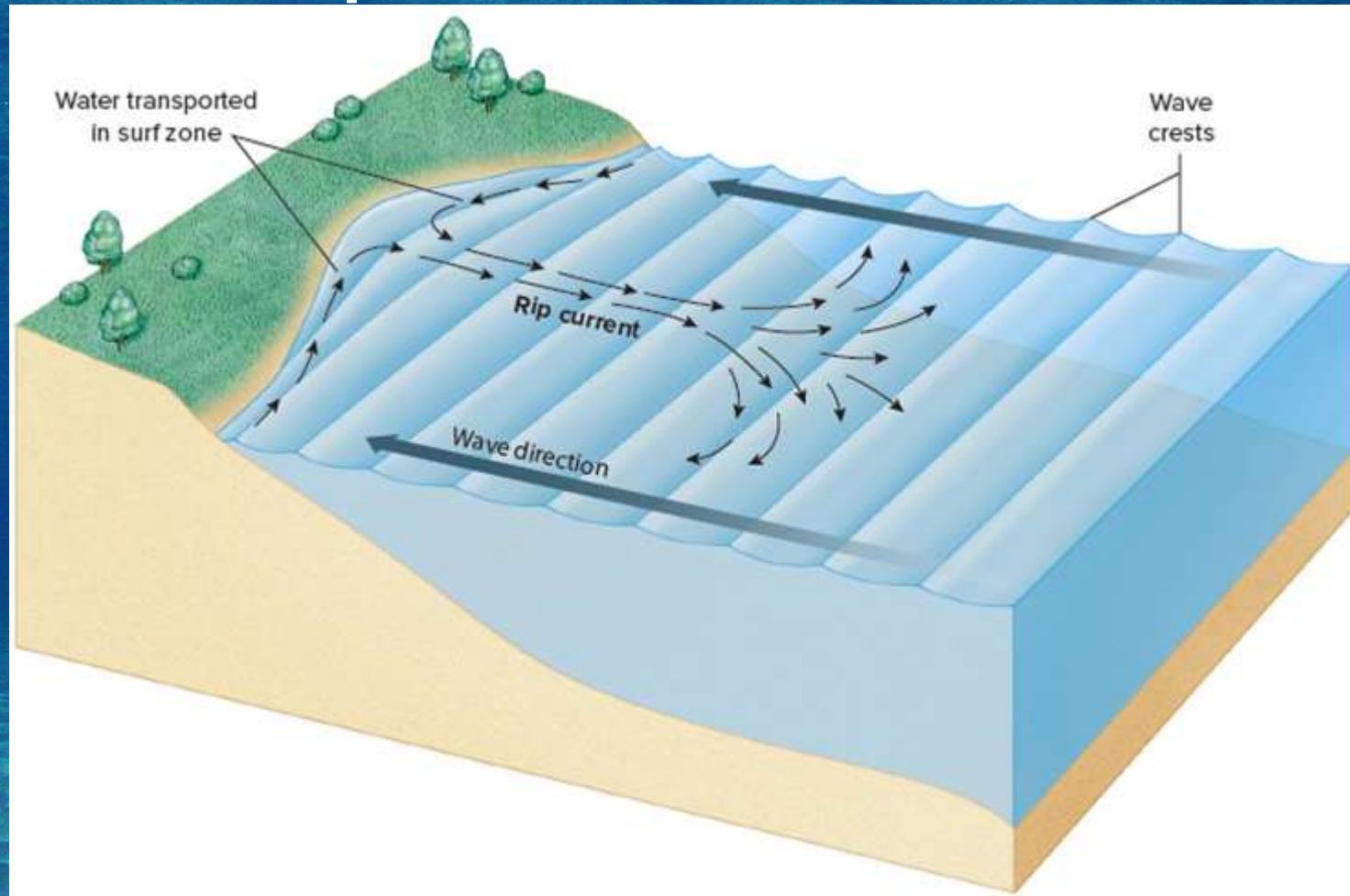
- When the bottom of the waves slow down as the water gets shallower, the part of the wave that remains in deeper water continues to move at the original speed. Because of this, the waves bend and the waves along the surf are parallel to the shore.
- Waves can also bend and wrap an island depending on the seafloor surrounding the island.

Longshore Transport

video explanation

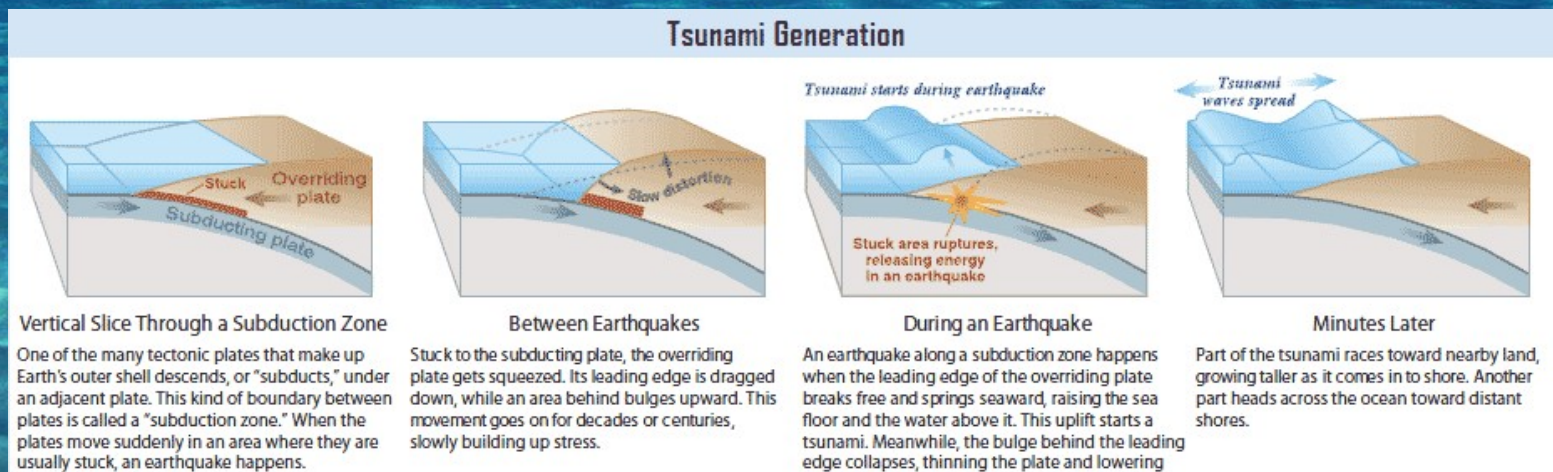
- As a wave moves toward the shore, the particles of water are transported toward the shore and down the beach in the direction of the waves. This is called longshore transport.
- Longshore transport is responsible for moving sand and sediments down a beach.
- Rip currents are areas of rapid seaward-flowing water and are hazardous to swimmers.

Rip Currents video



Tsunamis video

- Sudden movements of Earth's crust, such as an earthquake or an underwater volcano eruption, can cause tsunamis.
- Tsunamis, or seismic sea waves, can travel very long distances and they can cause great damage to coastal areas.
- Tsunamis carry great amounts of energy and they are hard to track across open water.



Other Types of Waves

- Waves traveling in depth between half and $1/20^{\text{th}}$ of their wavelength are intermediate waves.
- Intermediate waves have characteristics of deep- and shallow-water waves.

Other Types of Waves

- Waves forming under the surface are called internal waves.
- Standing waves are waves that do not progress because they form in enclosed bodies of water such as bays and estuaries.
- Instead of progressing in one direction, standing waves oscillate around a single point called a node.
- standing wave

Standing Waves

