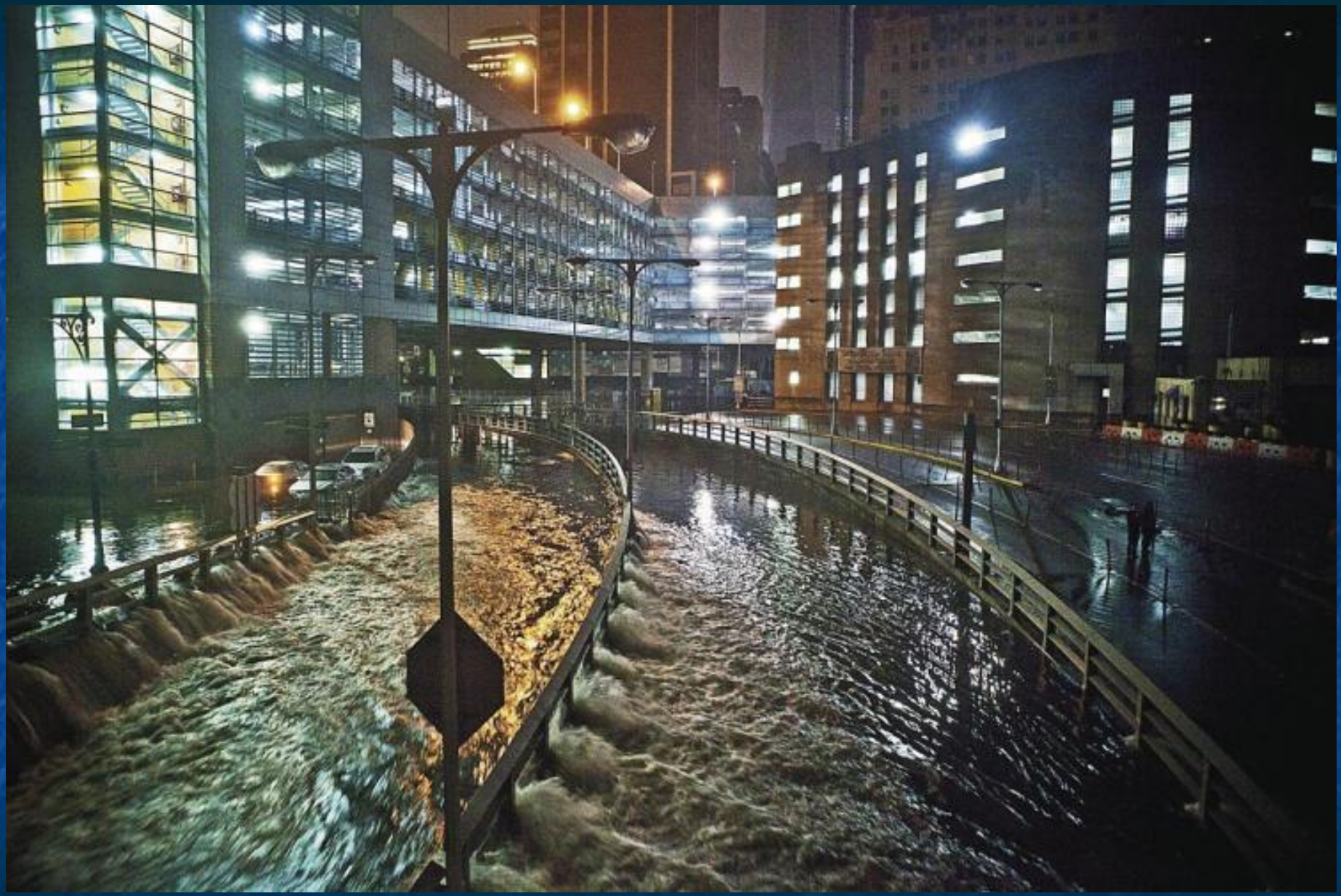
Environmental Geology
Chapter 9 - Coastal Hazards

The Coast

- Coastal environment – setting where terrestrial environment meets marine environment
- Coastlines (or shorelines) –
  - diverse animal life
  - commercial fisheries
  - port cities – commerce and trade, harbors



Hurricane Sandy in NYC

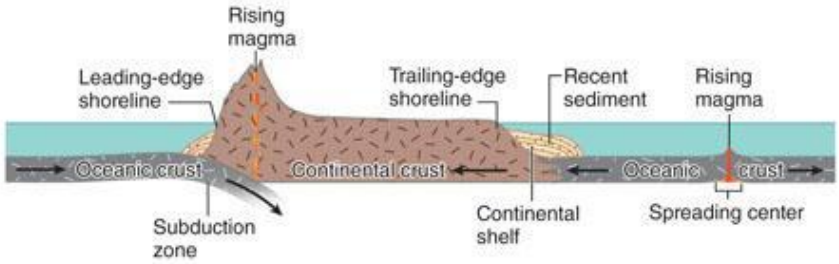

FLORIDA
CITY

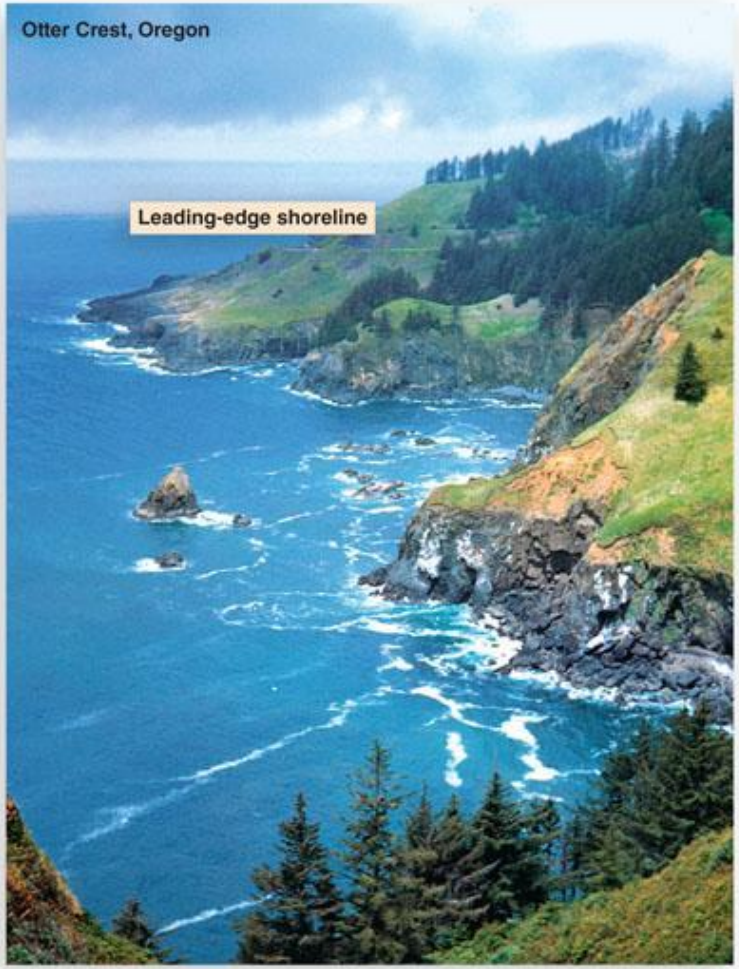
The Coast

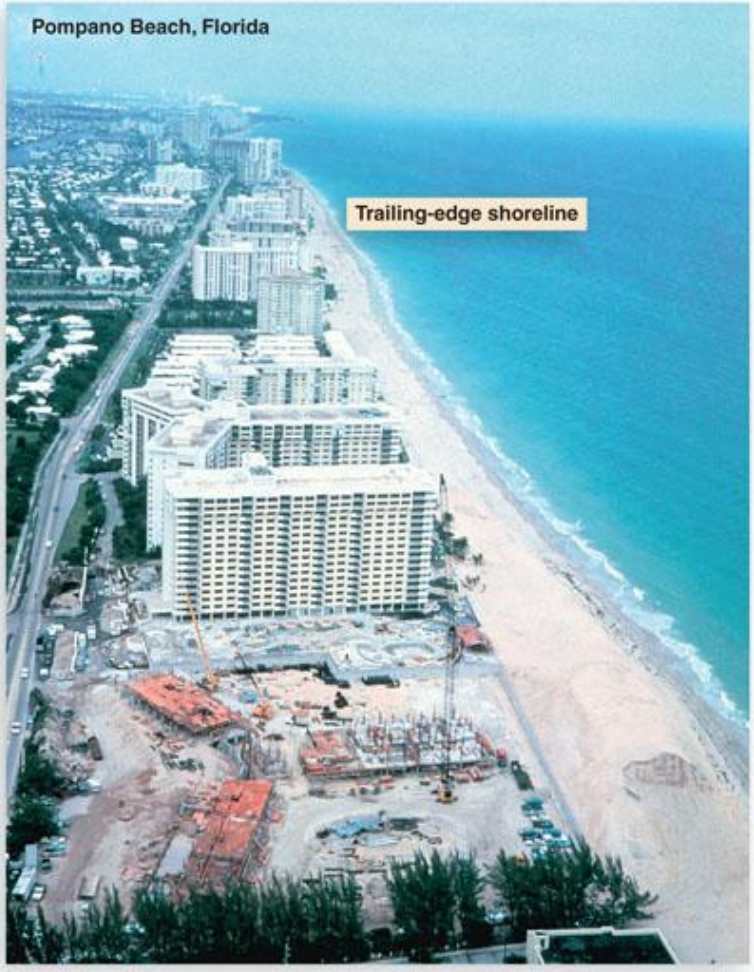
- Human development and consequences
- 53% of U.S. population lives on a coast which is 17% of our land
- 40% of world's population lives within 100 km (62 mi) of a coast
- This chapter discusses marine and freshwater shorelines.

Shoreline Characteristics

- Leading-edge Shoreline
  - Tectonically active; subduction zone
  - Rugged
  - U.S. Pacific coast
- Trailing-edge Shoreline
  - Little to no tectonic activity
  - Straight, flat
  - U.S. Atlantic coast and Gulf area
- Related to plate tectonics and sea level changes; currently rising at 0.6 ft per 100 years







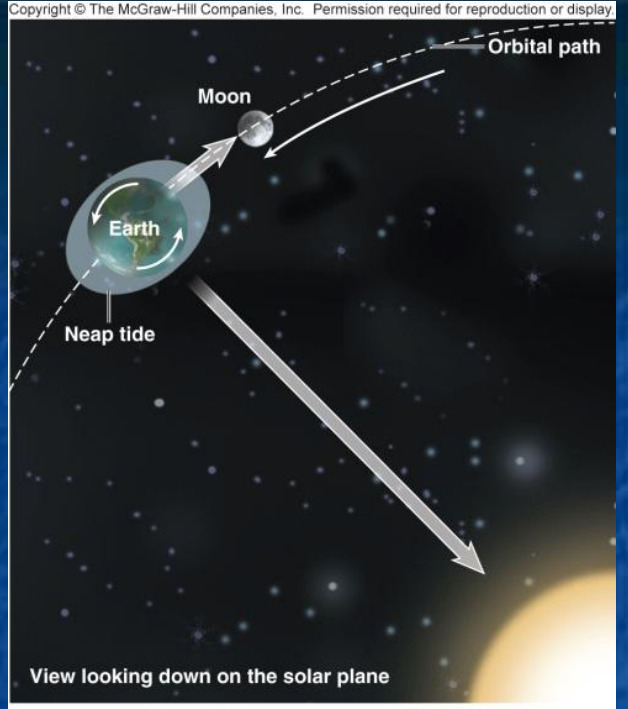
NOAA

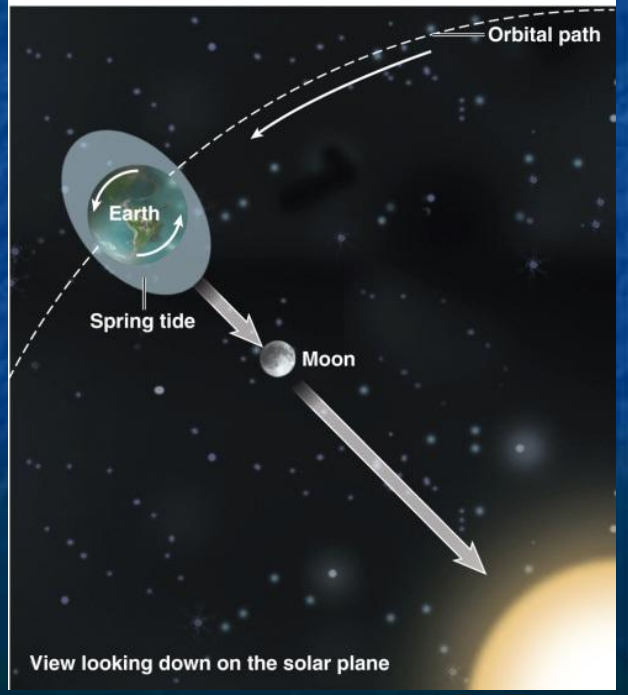
Shoreline Characteristics

- Mass wasting more prevalent along leading edge shoreline
- Trailing edge can shift slowly over geologic time
- Human development can disrupt natural processes (Mississippi Delta and Venice)
- Global climate change
  - Cooling increases glacial ice and lowers sea level
  - Warming melts glacial ice and raises sea level

Coastal Processes

- Ocean tides – periodic rise and fall of sea level.
- Earth is spinning on same solar plane as Moon and Sun. Net outward force at equator.
  - Tidal Range
  - Spring Tide – max range
  - Neap Tide – small range





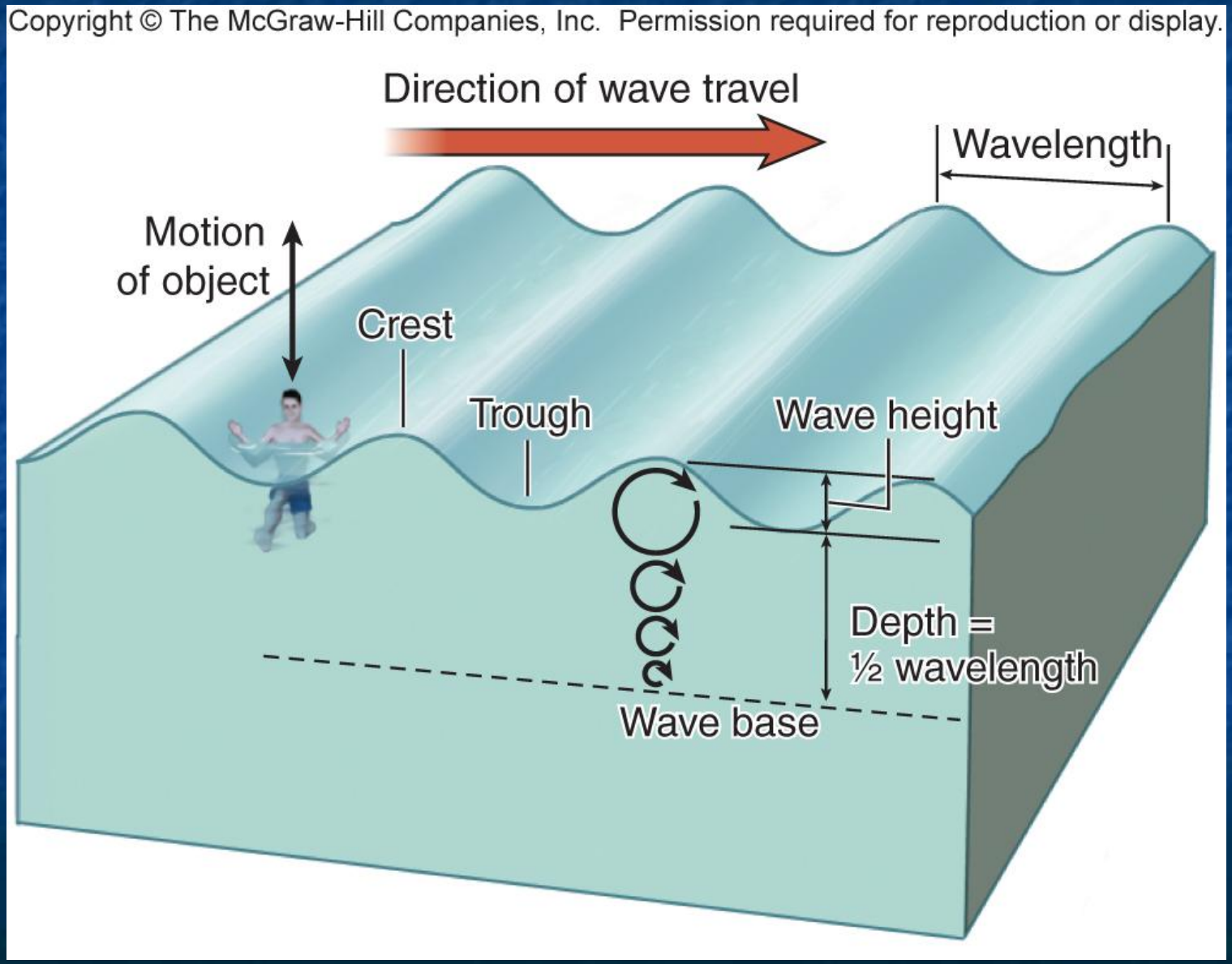
Coastal Processes

- Currents – physical movement of water molecules from one location to another; flow from high to low energy
- 3 Types of Currents:
  - Tidal - high tide water forced into inlets and river channels; reversed at low tide
  - Surface – in open water, wind blown and Earth's rotation, atmospheric pressure
  - Density – cold water more dense; saline water more dense that fresh; "ocean conveyor," transfer heat energy and nutrients

Waves

- Water waves transport energy horizontally
- Water molecules vibrate in circular manner causing objects to move vertically
- Less frictional resistance than rocks
- Water waves lose LESS energy as they travel outward

Waves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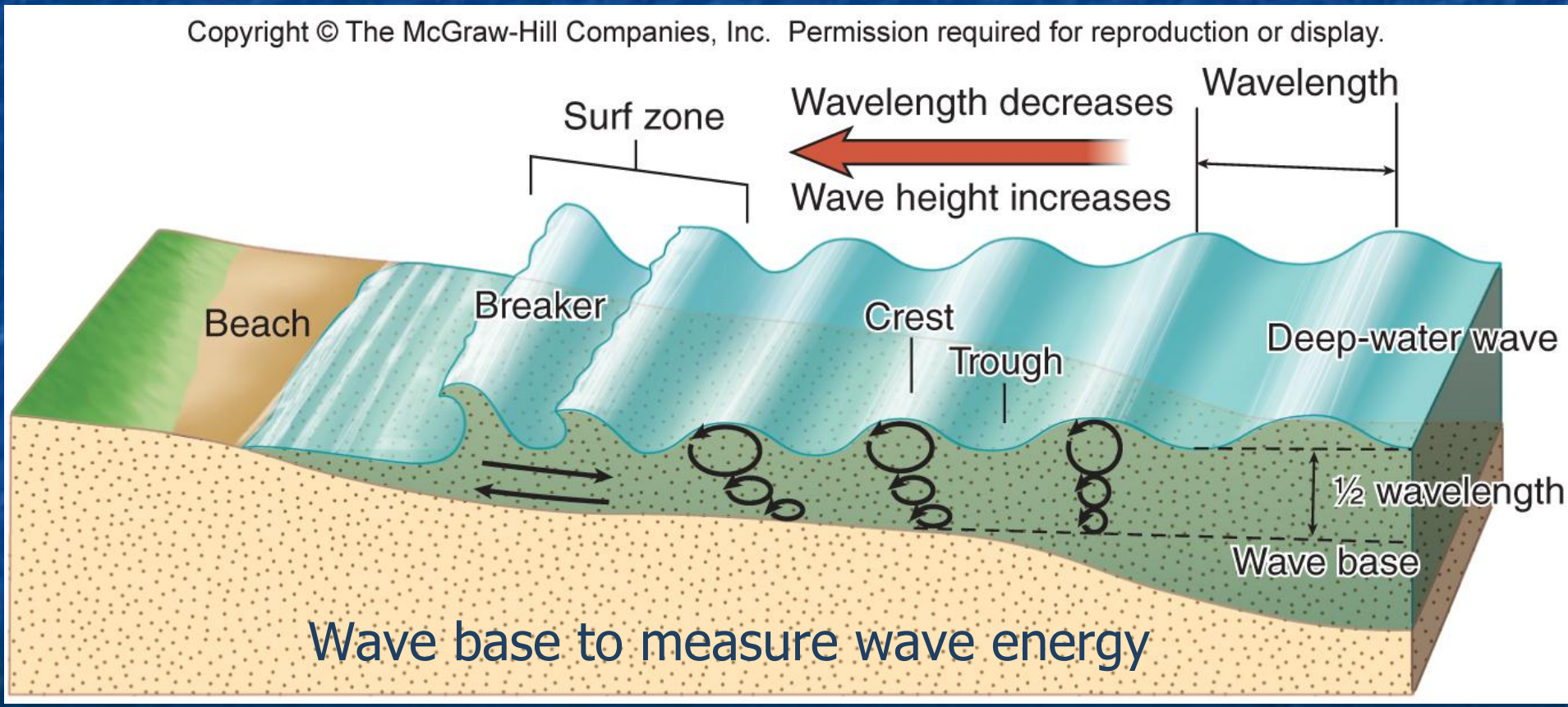
Direction of wave travel
Wavelength
Motion of object
Crest
Trough
Wave height
Depth = ½ wavelength
Wave base

Waves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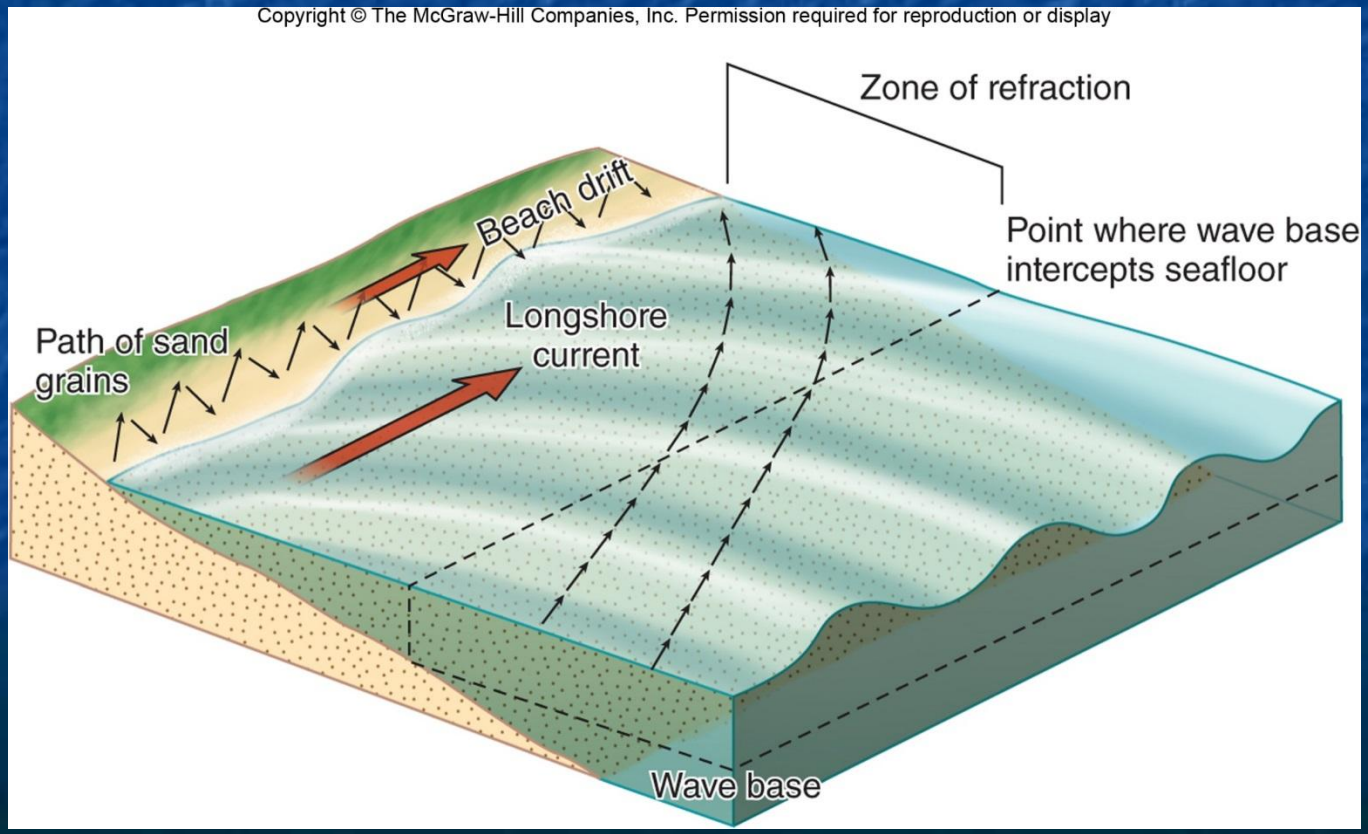
Surf zone
Wavelength decreases
Wave height increases
Wavelength
Beach
Breaker
Crest
Trough
Deep-water wave
½ wavelength
Wave base
Wave base to measure wave energy

Wave Refraction & Longshore Currents

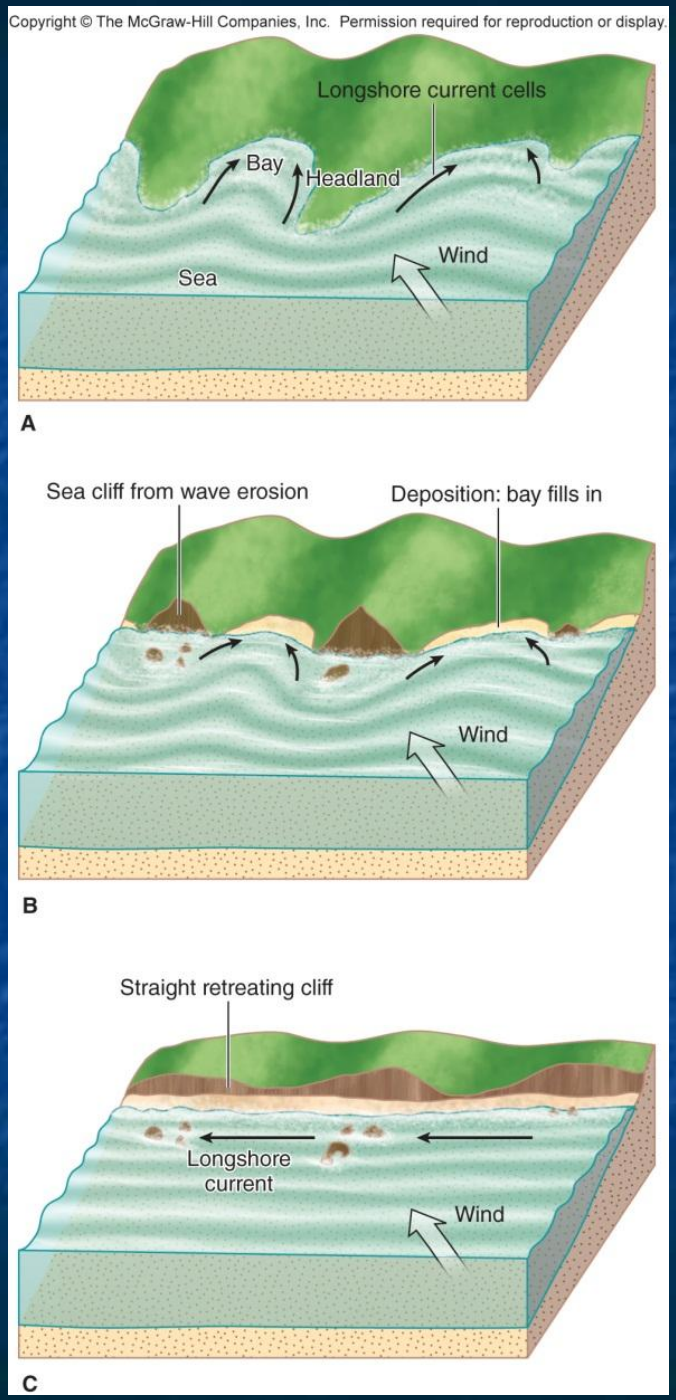
- Wave looses energy as base drags along sea floor
- Wave refraction – as wave approaches shore, decrease in velocity forces it to bend



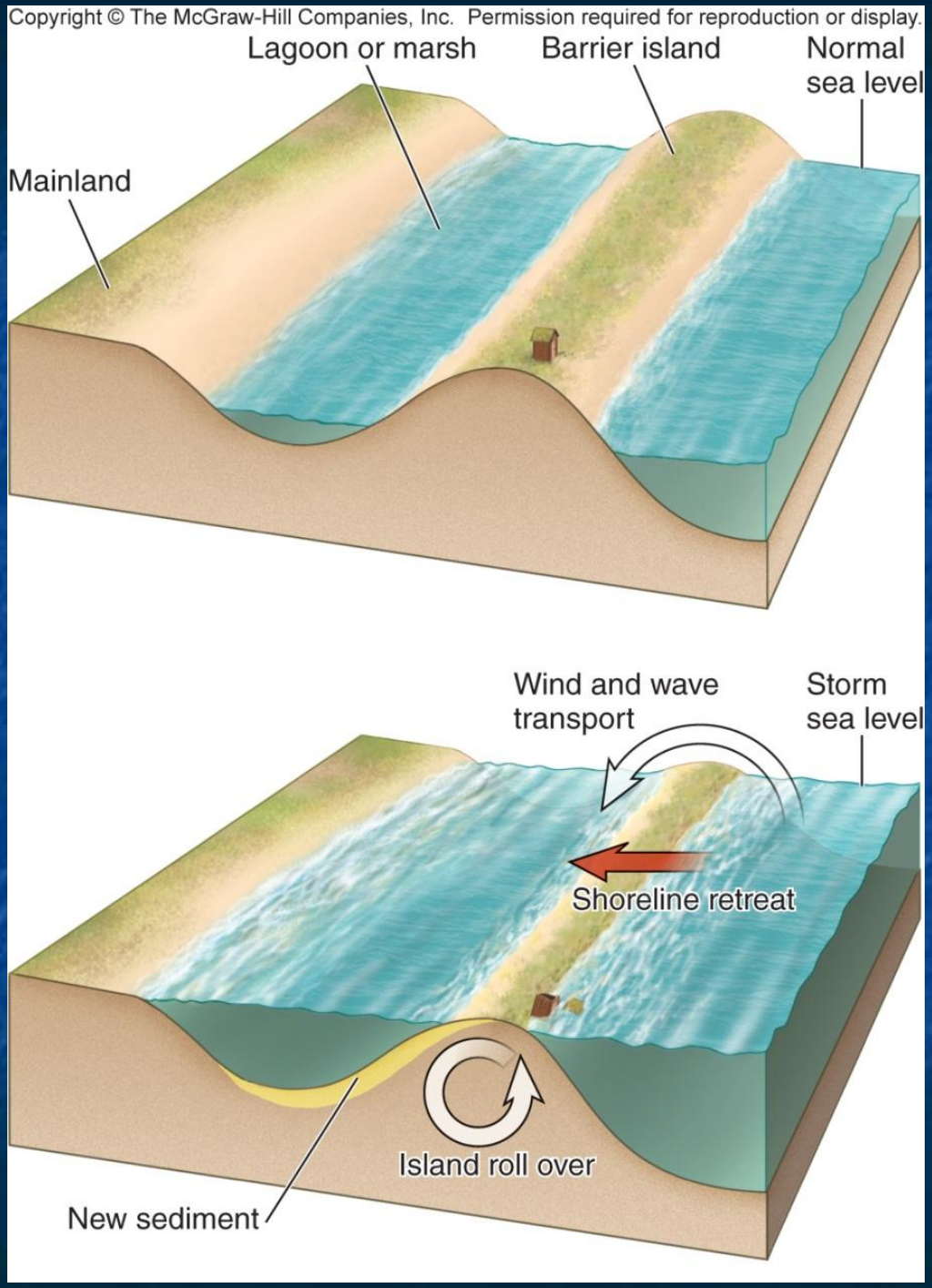
Shoreline Evolution

- Shoreline retreat – shoreline moves landward due to erosion
- Sea arches – wave action breaking rocks apart, causing instability resulting in mass wasting
- Headlands – where wave first hits land
- Coves

Shoreline Evolution



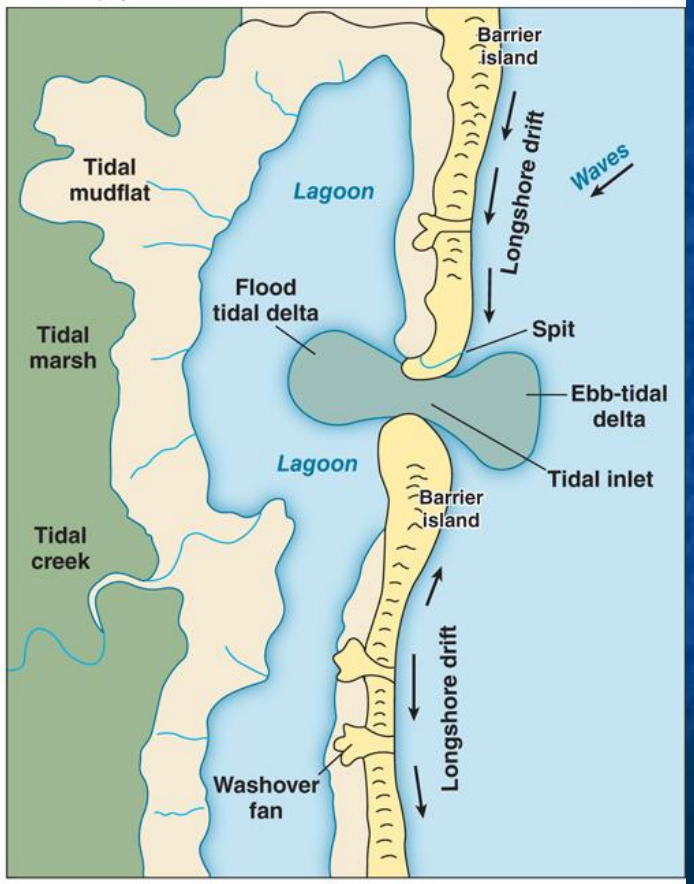
Barrier Islands

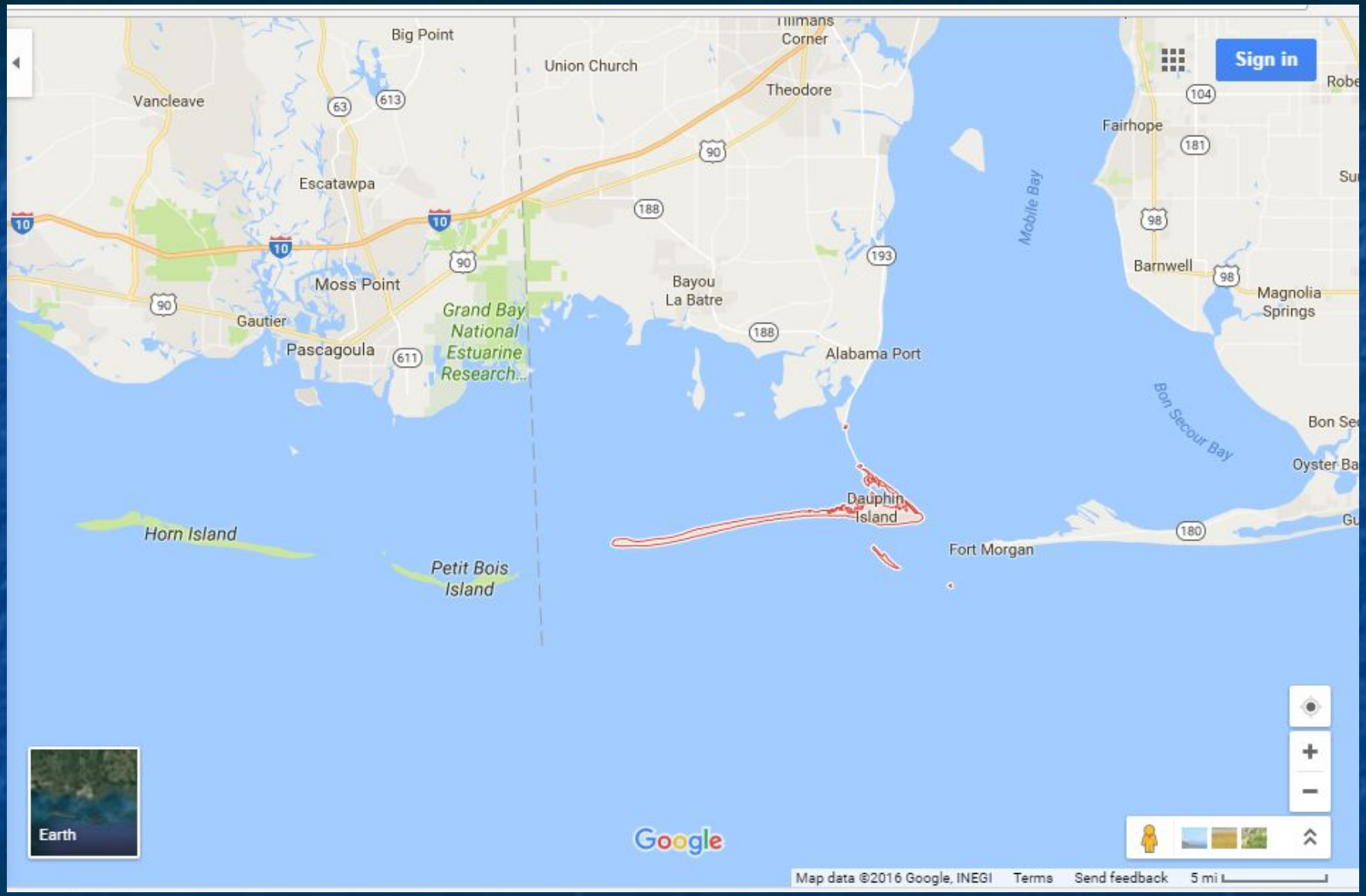


Barrier Islands

Separated from mainland by open water, lagoons, bay, marshes, tidal mudflats

Hutchinson Island, Florida USGS




Big Point
Union Church
Tillmans Corner
Theodore
Vancleave
Escatawpa
Moss Point
Gautier
Pascagoula
Grand Bay National Estuarine Research...
Bayou La Batre
Alabama Port
Mobile Bay
Fairhope
Barnwell
Magnolia Springs
Bon Secour Bay
Dauphin Island
Fort Morgan
Horn Island
Petit Bois Island
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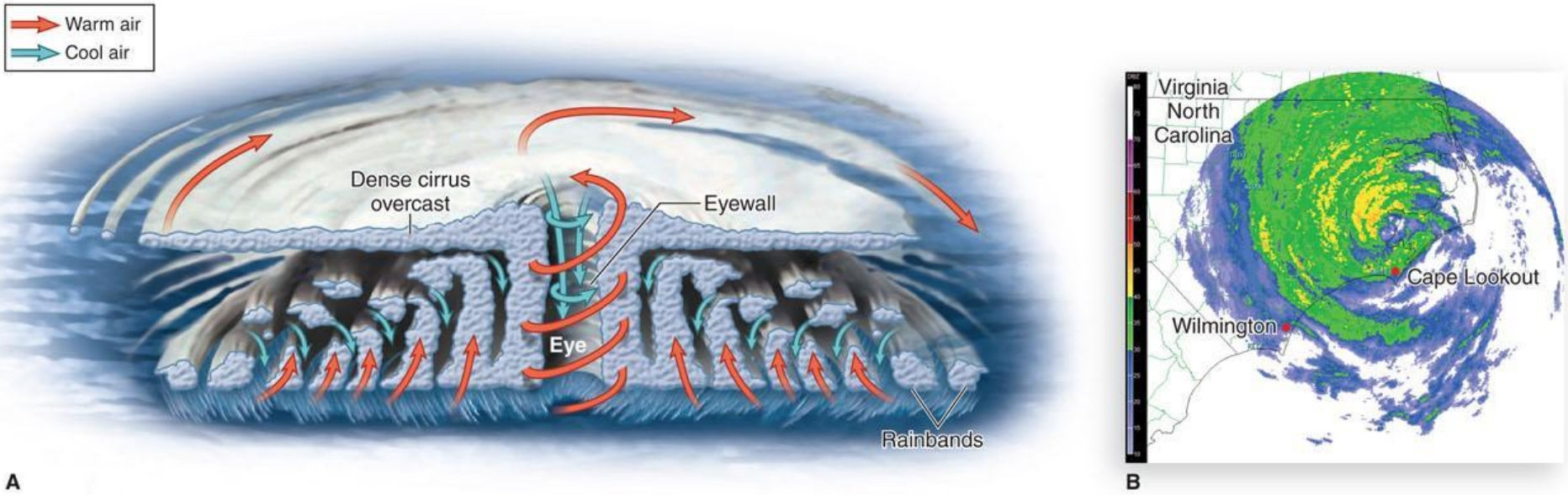
Coastal Hazards & Mitigation

- Hurricanes & ocean storms
  - Tropical Cyclone – large, rotating low-pressure, tropical regions
  - Hurricane or typhoon – stronger, develop over warm tropical oceans
- Hurricanes form over warm tropical waters where low pressure disturbance develops into large rotating storm
  - High velocity winds (>150 mph is catastrophic)
  - Intense rainfall
  - Lasts several hours or more



NOAA

- Figure 9.13, page 270

Hurricanes

- Saffir-Simpson scale measures intensity of winds. Lowest category is 74 mph.
  - <74 mph is tropical storm/depression
- Storm surge
- High winds
- Inland flooding

Other Ocean Storms

- Strong storms at higher lats (Pacific Northwest) when cold and warm air masses collide along frontal boundaries
- "northeasters" – on East coast cold arctic air collides with warm humid air associated w/ Gulf Stream – Hurricane Sandy moved north and merged with cold front

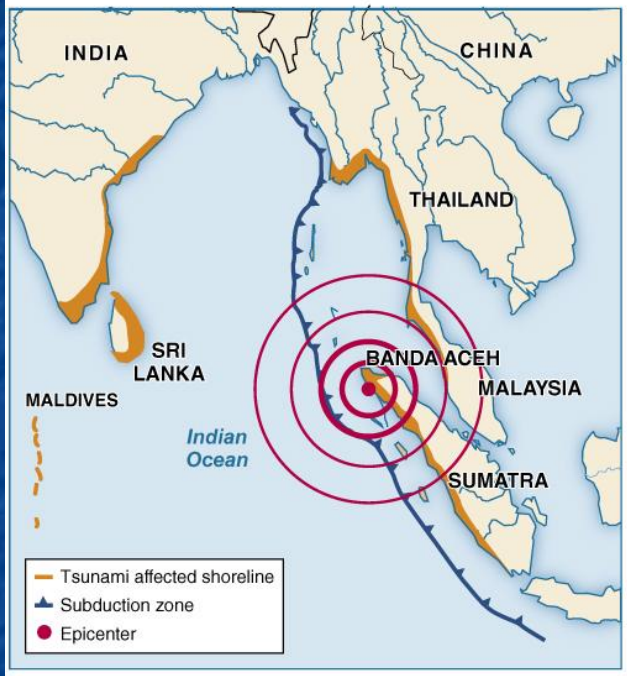
Mitigating Storm Hazards

- Avoid building in areas of high % landfall
  - See Figure 9.20
- Better forecasting and early warning
  - 1900s ships radioed weather info
  - Post WWII, Air Force pilots recorded data
  - Now satellites, aircraft, computer models
- Good emergency planning
  - Evacuations
  - See page 276 paragraph about New Orleans
- Construction and building design strategies

Coastal Hazards and Tsunamis

- Unusually high energy waves
- Form from transfer of energy from earthquakes, landslide, meteor impact
- Interaction with sea floor makes them dangerous closer to shore
- “run up” – waves break pushing water far above surf zone; can be >100 feet

Tsunamis



A

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B

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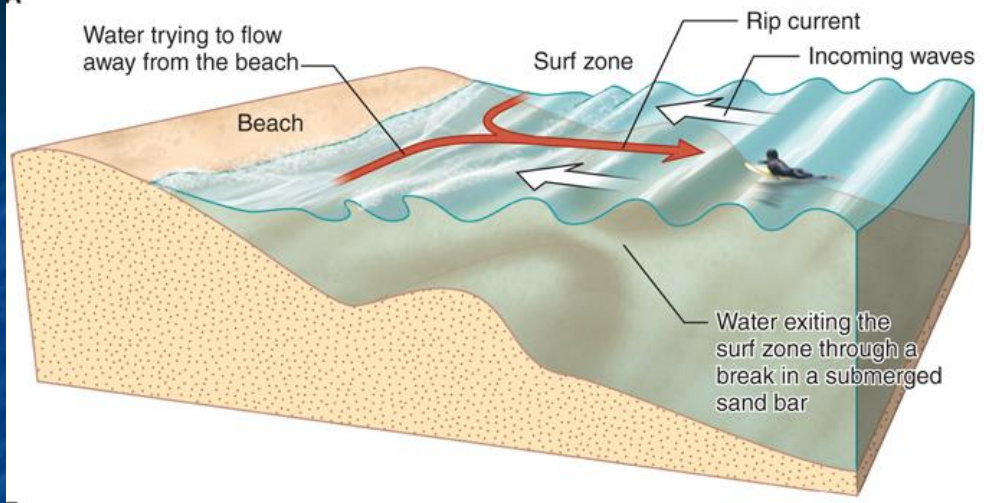
Rip Currents

A



B

Wendy Carey, Delaware Sea Grant

Shoreline Retreat

- Increased frequency of storms accelerates erosion
- Effects of sea-level rise
  - See Figure 9.29 – Southern U.S.
- Disruptions of sediment supply
  - Dredging – to make rivers deeper for ships
  - Artificial levees
  - Fig. 9.30 page 286

Mitigating Effects of Shoreline Processes

- Seawalls
- Groins
- Jetties
- Breakwaters
- Beach nourishment
- Natural retreat

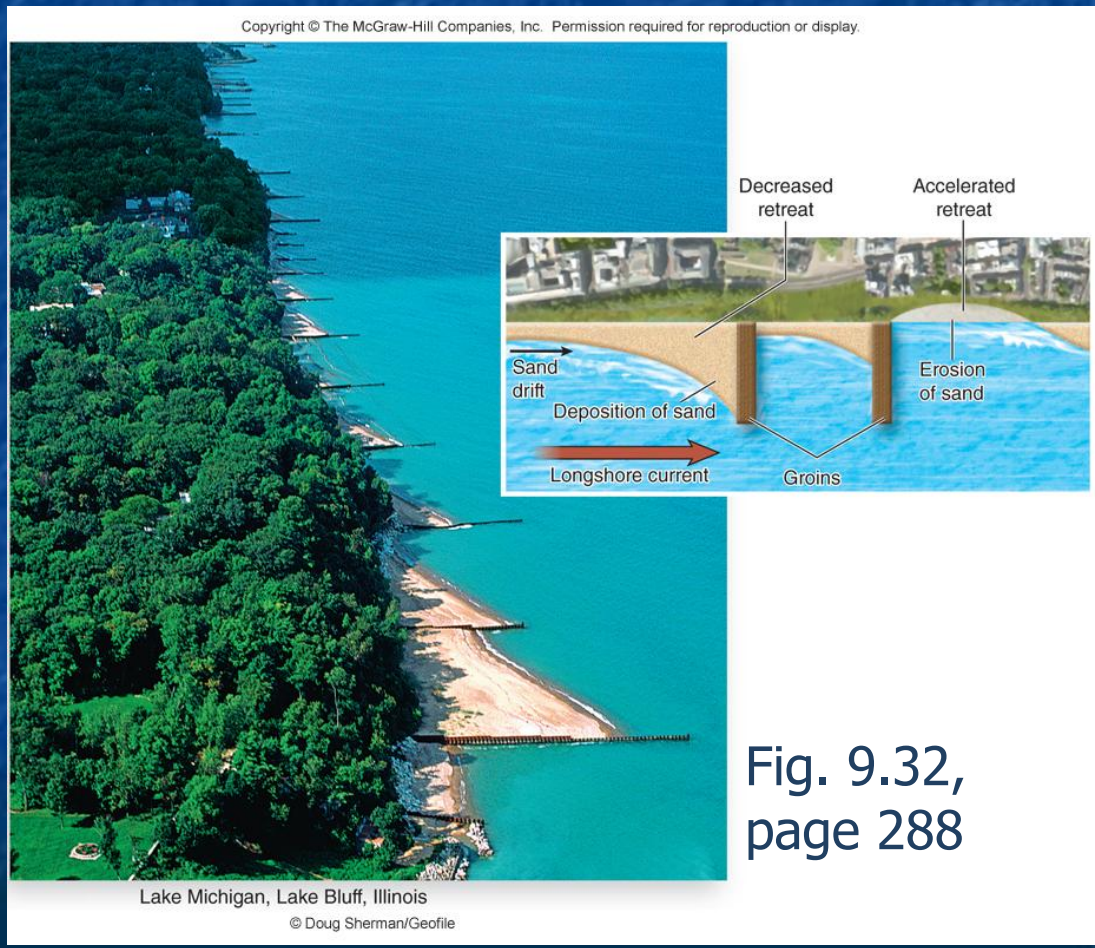


Fig. 9.32, page 288

Mitigating Effects of Shoreline Processes

- Seawalls – physical barrier (concrete, steel, wood, rocks) built along shore to protect real estate or buildings. But, prevents deposition and beach gets smaller due to erosion.
- Groins – alternative to seawall, barrier is perpendicular to shore and interrupts longshore current so sand accumulates. But, if groin is too long then long term erosion is a problem.

Mitigating Effects of Shoreline Processes

- Jetties – long barriers (up to a mile) of rocks, concrete or steel along an inlet to prohibit deposition so that boats can travel into harbor. But, prohibits deposition of sand down drift (beach starvation). See Fig. 9.33, Page 288
- Breakwaters – large linear structures placed offshore to protect coast; helps beach grow. But, prohibits deposition down drift, increases shoreline retreat. See Fig 9.34, Page 289

Mitigating Effects of Shoreline Processes

- Beach nourishment – most cost effective way (but can still be pricey depending on how often it has to be done) to replenish sand, pumping more sand from offshore deposits. Widens beach, reduces erosion, improves recreational use = tourism $$
- Natural retreat – let nature take its course in areas with small economic base and high erosion rates