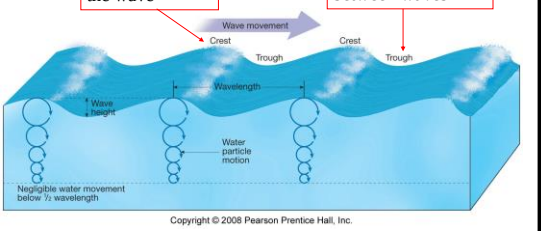
Waves

Waves are created by the wind blowing over the surface of the water

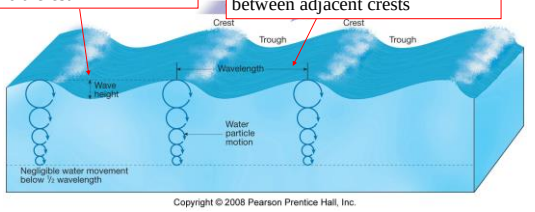
Crest – top of the wave

Trough – low area between waves

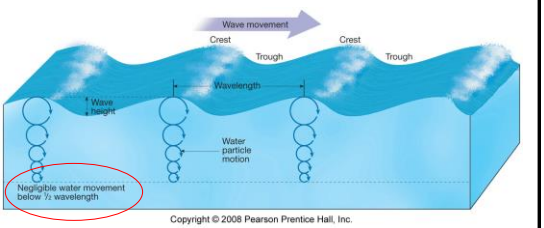


Wave height – the vertical distance between a trough and a crest

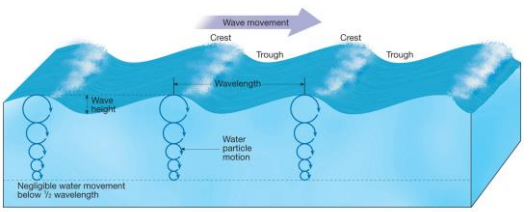
Wavelength – horizontal distance between adjacent crests



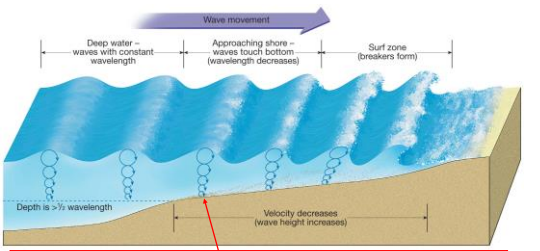
Water Particles at the Surface and Beneath the Waves Move in Circular Orbits



As Waves Travel Away From a Storm Center, They Evolve Into Broad, Rounded Waves Called Swells

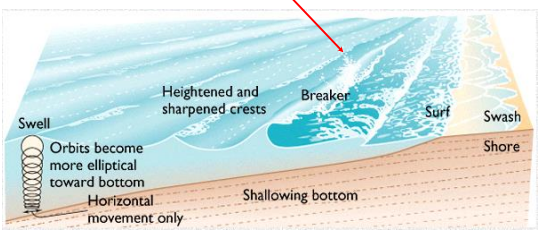


Swells Become Higher As They Approach the Shoreline

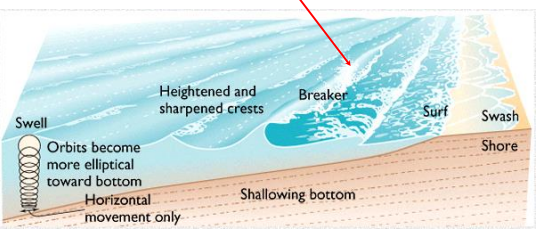


As waves approach the shore, the wave base drags on the shallowing seafloor causing the waves to slow down, increase in height, and become more closely spaced

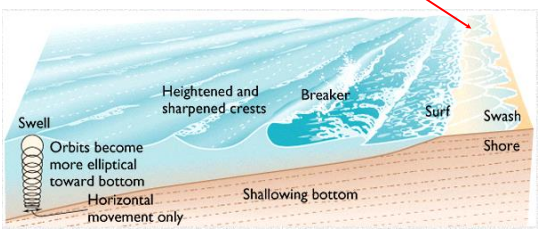
Close to shore, waves evolve into sharp-crested features called breakers



Breakers roll forward into a foamy, bubbly surface called surf along the surf zone

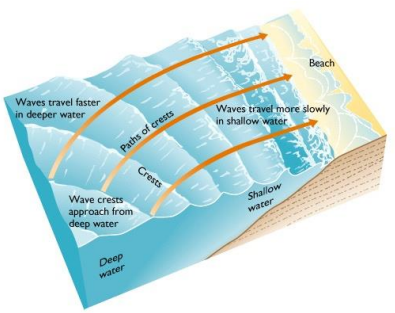


Waves run up onto the beach as swash; run back down as backwash



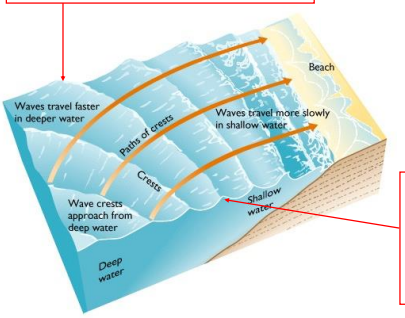
Breakers and Surf Off Flagship Hotel, Galveston Island

Wave Refraction



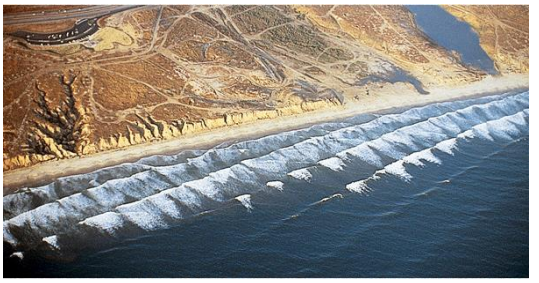
As waves approach the beach, the rows of waves bend in a direction more parallel to the shore (wave refraction)

End further from shore is moving faster and catches up to near-shore end, causing wave to bend parallel with coastline

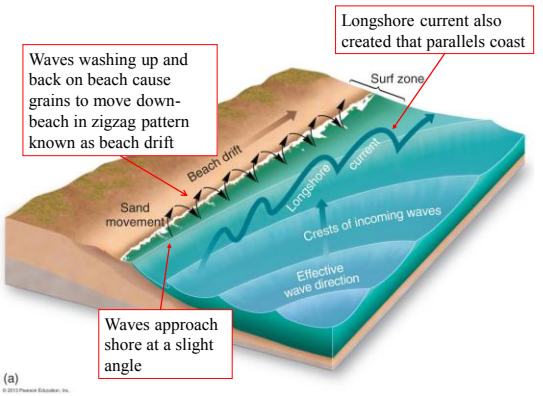


End nearest the shore encounters shallow seafloor first, slowing down

Wave Refraction Causes The Waves To Align Almost Parallel To Beach



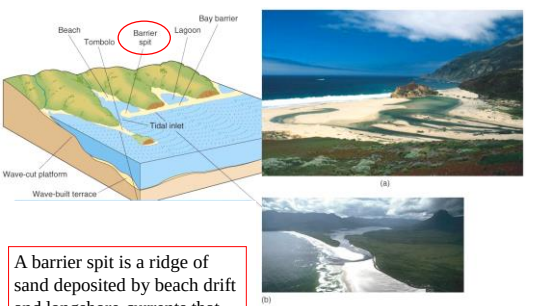
Wave Motion Refraction



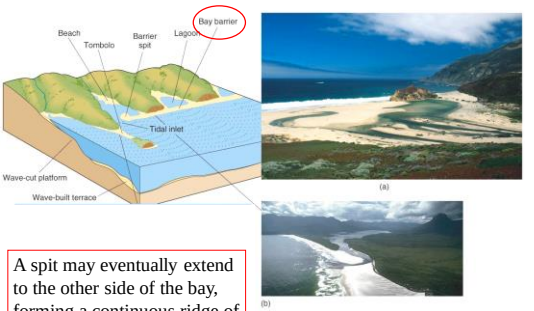
Beach Drift Longshore Current

Depositional Coastal Processes and Landforms

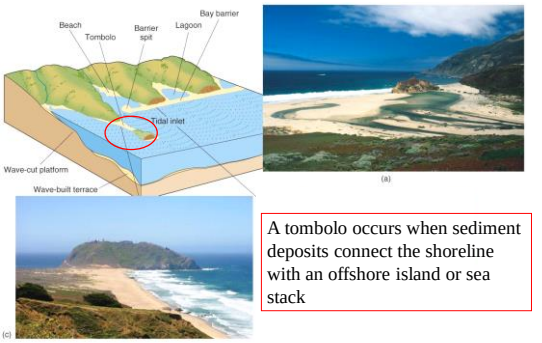
- **Depositional features are related to beach drift and longshore currents:**
  - **Barrier spits**
  - **Bay barriers (baymouth bars)**
  - **Tombolos**
  - **Barrier islands**
  - **Beaches**



A barrier spit is a ridge of sand deposited by beach drift and longshore currents that extends out from the beach into an adjacent bay or cove



A spit may eventually extend to the other side of the bay, forming a continuous ridge of sediment called a Bay Barrier



A tombolo occurs when sediment deposits connect the shoreline with an offshore island or sea stack

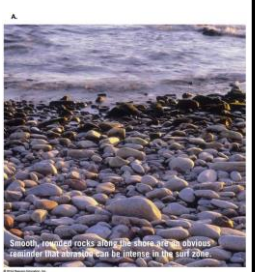
Shelled beach

Beaches

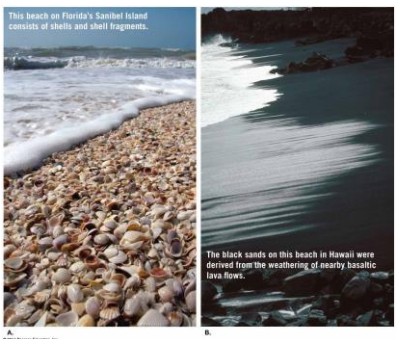
- **Beaches are the most familiar feature on a coastline undergoing sediment deposition:**
  - **Some are stable**
  - **Others cycle seasonally**
- **Quartz sand typically dominate beaches:**
  - **Quartz survives weathering processes**
- **Beach stabilizes a coast by absorbing wave energy**

Different Types Of Beaches

Quartz Sand Beach



Different Types Of Beaches



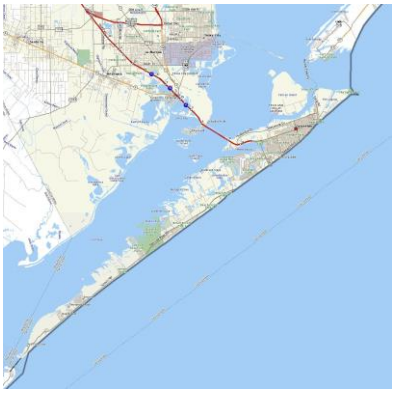
Barrier Islands

Barrier islands are:

- Long sandbars not connected to onshore beaches
- Constructed by longshore currents
- Common along stable continental margins

(a) Florida barrier island

Galveston, Texas, Is A Barrier Island



Characteristics of Barrier Islands

Seaward side:

- High energy wave and current action
- Fairly straight shoreline
- Sand on beach typically clean, well sorted and rounded with ripples and cross bedding

Lagoon side:

- Quieter, low energy, occasional wash-over deposits
- Very irregular shoreline
- Tidal marsh mud and peat deposits

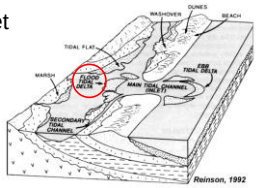
Tidal Deltas

Tidal deltas created by tidal currents that flow through inlets:

- Flood deltas deposited landward of the inlet such as within a lagoon behind a barrier island during rising tide
- Ebb deltas deposited on seaward side of inlet during falling tide

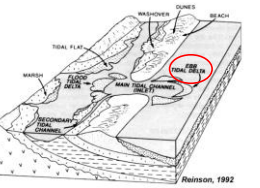
San Luis Pass: A Tidal Inlet

Flood tidal delta deposited during high tide, when Gulf water flows into lagoon



San Luis Pass: A Tidal Inlet

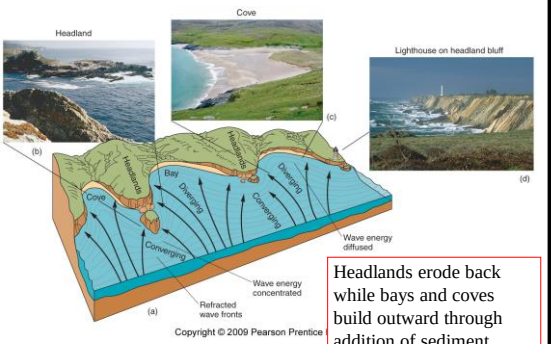
Ebb tidal delta deposited during low tide, when lagoon water flows out into Gulf



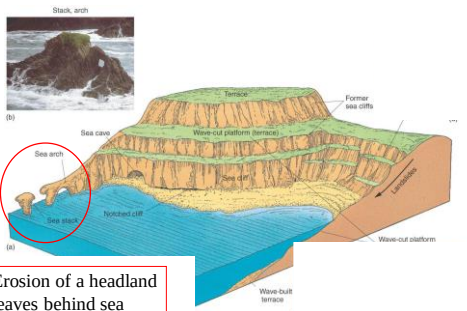
Erosional Coastal Processes and Landforms

- Features along coasts undergoing erosion include:
  - Sea cliffs
  - Marine terraces
  - Wave-cut platforms
  - Sea caves
  - Sea arches
  - Sea stacks

Coastal Erosion

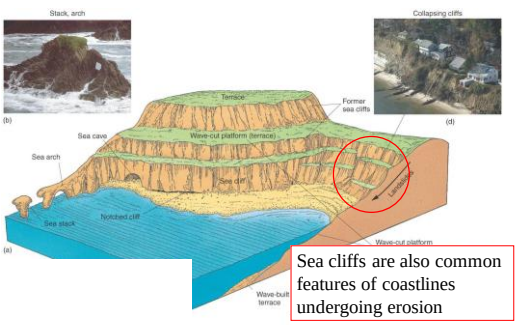


Headlands erode back while bays and coves build outward through addition of sediment

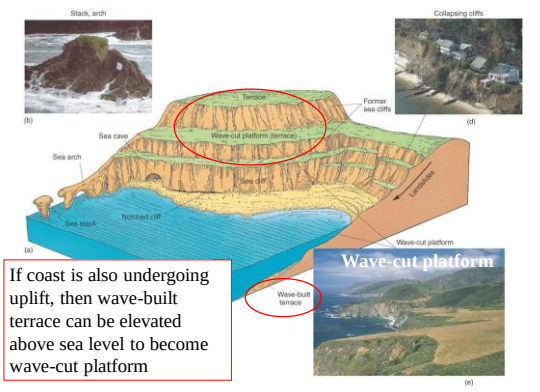


Erosion of a headland leaves behind sea stacks and sea arches

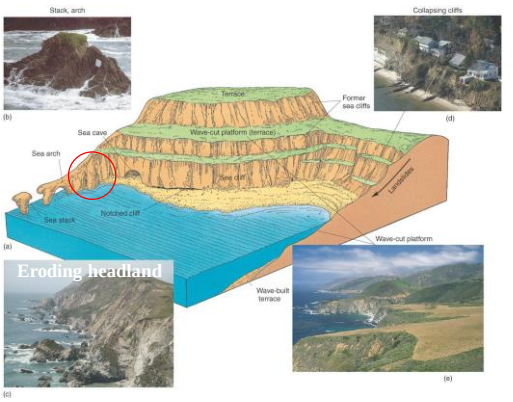
Sea Stack



Sea cliffs are also common features of coastlines undergoing erosion



If coast is also undergoing uplift, then wave-built terrace can be elevated above sea level to become wave-cut platform



Emergent Coastlines

- Emergent coastlines due to tectonic uplift or sea-level fall can result in significant coastal erosion
- Wave-cut platform (wave-built terrace) uplifted above sea level becomes a marine terrace

Submergent Coastlines

Submergent coastlines form due to land subsidence and/or sea level rise; Can result in drowned river valleys called estuaries

Beach Erosion

Factors Affecting Beach Erosion

Factors that affect beach erosion include:

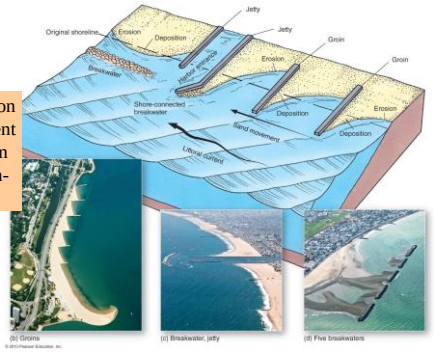
- Proximity to sediment-laden rivers
- Degree of tectonic activity/subsidence
- Topography and composition of land
- Wind and weather patterns
- Configurations of coastline and near-shore areas

Dealing with Beach Erosion

- **Structures and barriers:**
  - **Jetties are barriers at entrance to harbor**
  - **Groins constructed perpendicular to beach**
  - **Breakwaters are offshore barriers parallel to beach**
  - **Seawalls constructed behind the beach**
  - **Geotubes buried at vegetation line behind beach**
- **Beach nourishment (adding sand)**
- **Relocate buildings**

Various Constructions That Attempt To Control Beach Drift And Longshore Drift Disrupt Sediment Movement

Deposition on the up-current side; Erosion on the down-current side



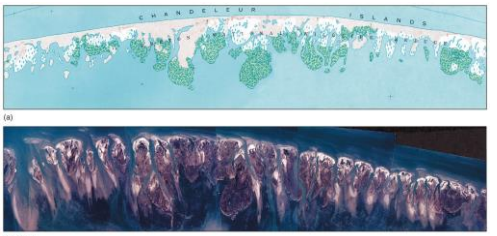
Coastal Stabilization

Galveston Groins Constructed To Keep Beach Sand In Place, But Are Not Very Effective

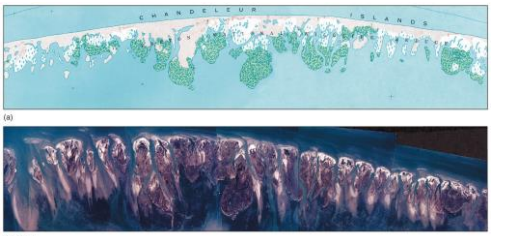
Seawall Constructed Along Beach to Protect Structures Behind It

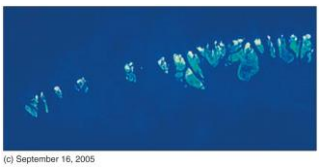
Beach Nourishment, Miami Beach, Florida

A. B.



Chandeleur Islands, Offshore Louisiana And Mississippi After Hurricanes Georges (1988)

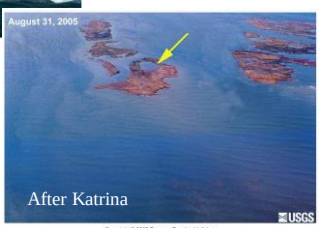




Chandeleur Islands, Offshore Louisiana And Mississippi After Hurricanes Georges (1988)

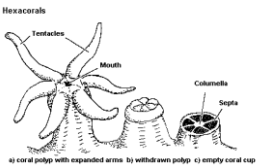
After Katrina (2005)

Hurricane Katrina and the Chandeleur Islands

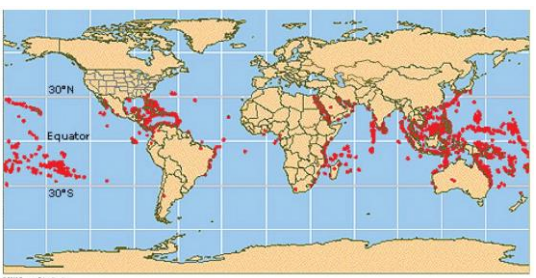


Biological Processes: Corals

- A coral is a simple marine animal with a saclike body called a polyp:
  - Secretes calcium carbonate to form a hard, external skeleton
- Corals function in a symbiotic relationship with algae:
  - Algae photosynthesize some food for the coral
  - Coral provides some nutrients and shelter for the algae
- Coral reefs are the most diverse marine ecosystems



Coral Reef Distribution



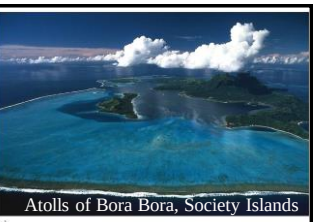
Colonial corals occur in warm marine water between latitudes 30° N and 30° S

Sequence Of Reef Growth Formed Around A Subsiding Volcanic Island

Seamounts Coral Reef

Coral Forms

(b) Maldive Islands, Indian Ocean

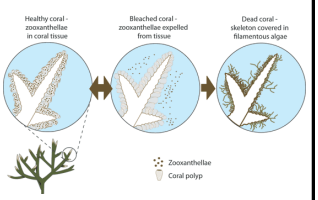


Atolls of Bora Bora, Society Islands (c)

Bahamas (d)

Coral Bleaching

- Colorful corals can turn stark white by expelling nutrient-supplying algae:
  - Occurring in Caribbean Sea, Indian Ocean, offshore Australia, Florida, Texas etc.
- Why corals eject their symbiotic partner is unknown, but may be linked to warming of the sea-surface and increasing acidity of oceans
- Significant loss of reefs over the last couple decades



Increasing Ocean Acidity

- **About one-third of human-generated carbon dioxide currently ends up in the oceans**
- **Atmospheric CO_2 dissolved in seawater forms carbonic acid, lowering the ocean's pH:**
  - **Surface waters of the oceans have already absorbed enough CO_2 since preindustrial times to lower pH by 0.1 pH units**
  - **Current trend of CO_2 emissions could result in pH decrease of at least 0.2 pH units by the year 2100**
- **Increasing ocean acidity threatens a variety of calcite-secreting organisms including microbes and corals**

Wetlands

- **Wetlands are saturated with water often enough to support plants that grow in water or very wet soil**
- **Wetlands occur in a variety of locations:**
  - **Coastlines**
  - **Bogs (land areas where water table is high)**
  - **Potholes in prairie lands**
  - **Cypress swamps**
  - **River bottom**
  - **Flood plains**
  - **Arctic and subarctic environments that experience permafrost**

Two Main Types Of Coastal Wetlands

Salt marshes:

- Form north of the 30th parallel
- Form in estuaries and behind barrier beaches and spits
- Mud supports salt-tolerant plants
- Vegetation traps sediment

Salt Marsh

Mangrove swamps:

- Occur along tropical coastlines
- Prop roots of mangroves visible above the water line
- Provide habitat for specialized life forms
- 40% - 80% loss globally since preindustrial times

Mangrove Swamp

Mangrove Swamp