



**The Coast:
Beaches and Shoreline Processes**
Trujillo & Thurman, Chapter 10

Oceanography 101 



Chapter Objectives

- Recognize the various landforms characteristic of beaches and coastal regions.
- Identify seasonal changes that beaches experience.
- Discuss how longshore currents are created and what longshore drift is.
- Note the origin of sediment for beaches and how the coastline responds to variations in supply.
- Describe how coastal features are formed by wave erosion and deposition.



Chapter Objectives (continued)

- Understand local changes that occur in coastline elevation and explain observed trends in the relative position of sea level.
- Explain how climate change can affect the nature of the coastline.
- Recognize barrier island features and describe how barrier islands are formed and evolve.
- Identify the types of hard stabilization and discuss the effects they have on shorelines.



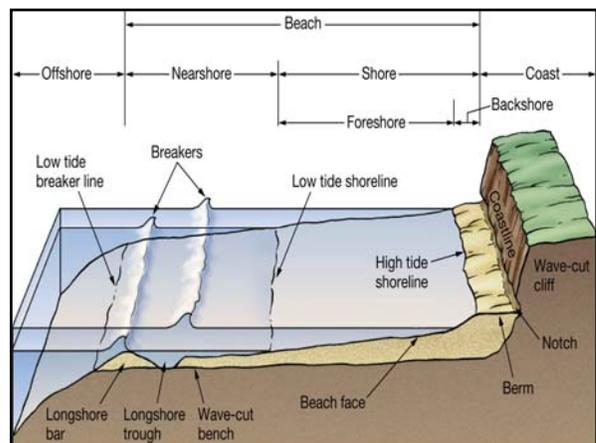
Overview

- Coastal region constantly changes
- Primarily due to waves
 - ☒ Erosion
 - ☒ Deposition
- Many people live in coastal regions
 - ☒ 80% of people in U.S. live within easy access of coast



Coastal regions

- Coast and coastline
- Beach
- Shore, foreshore, backshore
- Nearshore, offshore





Beach profile

Beach

Wave-worked sediments

Wave-cut bench

Recreational beach

Berm

Beach face

Longshore bars

Longshore trough



Composition of beaches

- Locally available material
- May be coarse or fine
 - ☒ Boulders from local cliffs
 - ☒ Sand from rivers
 - ☒ Mud from rivers
- Significant biologic material at tropical beaches
 - ☒ Example, Coral reef material



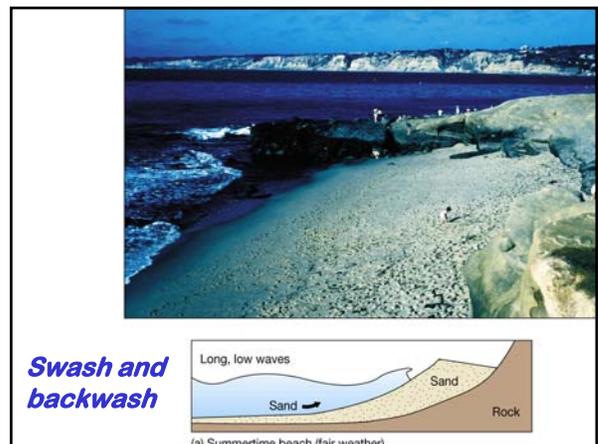
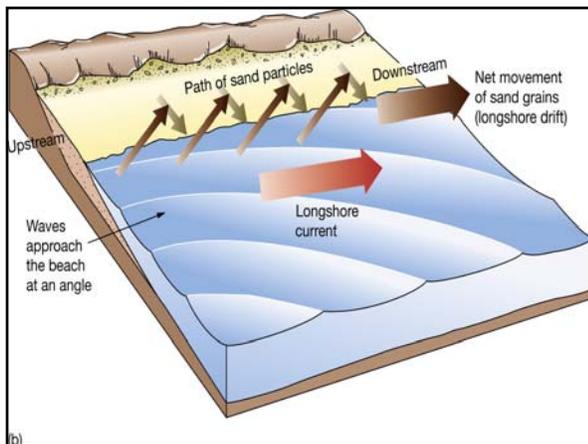
Sand movement along beach

- Perpendicular to shoreline (toward and away)
 - ☒ **Swash and backwash**
- Parallel to shoreline (up-coast or down-coast)
 - ☒ **Longshore current**



Swash and backwash

- **Swash**
 - ☒ After wave breaks, uprush of water (swash) on beach
 - ☒ Sediment moved toward land
- **Backwash**
 - ☒ Water returns to ocean
 - ☒ Sediment moved away from shore
- **Light wave activity**
 - ☒ Swash dominates
 - ☒ Sediment moved toward shore
 - ☒ Wider beach
- **Fair weather**
- **Summertime beach**



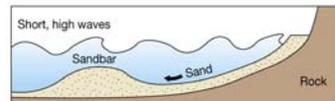


Swash and backwash

- Heavy wave activity
 - ☒ Backwash dominates
 - ☒ Sediment moved away from shore
 - ☒ Narrower beach
- Sand forms offshore sand bars
- Stormy weather
- Wintertime beach



Swash and backwash



Longshore current

- Wave refraction causes water and sand to move parallel to shore
- Zigzag motion in surf zone
- Longshore current
- Longshore transport



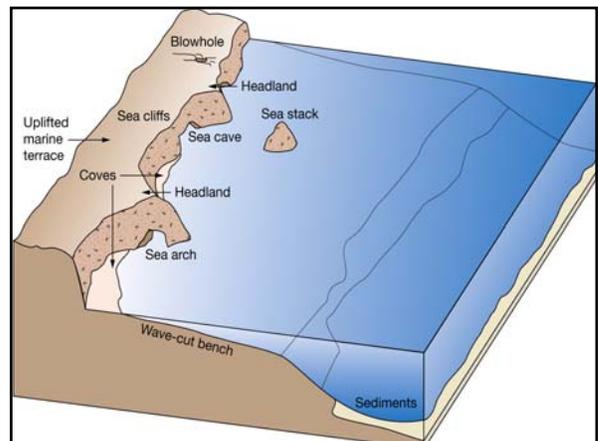
Longshore transport

- Millions of tons of sediment moved yearly
- Direction of transport changes due to wave approach
- In general, sediment transported southward along Atlantic and Pacific coasts of U.S.



Erosional shorelines

- Well-developed cliffs
- Recent tectonic activity
- Headlands
- Wave-cut cliff with sea cave
- Sea arches
- Sea stacks
- Marine terrace
- Wave erosion increases with
 - ☒ More shore exposed to open ocean
 - ☒ Smaller tidal range
 - ☒ Weaker bedrock



Depositional shorelines

- Primarily deposited by longshore drift
- Beach
- Spit
- Bay barrier
- Tombolo
- Barrier island
- Delta
- Beach compartment

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Barrier islands

- Long, narrow offshore deposits parallel to shore
- Most developed due to rise of sea level about 18,000 years ago
- Common East and Gulf coasts of U.S.
- Protect mainland from high wave activity

Barrier island

- Ocean beach
- Dunes
- Barrier flat
- High salt marsh
- Low salt marsh
- Lagoon

Barrier island

- Movement landward over time
- Associated with rising sea levels
- Older peat deposits found on ocean beach

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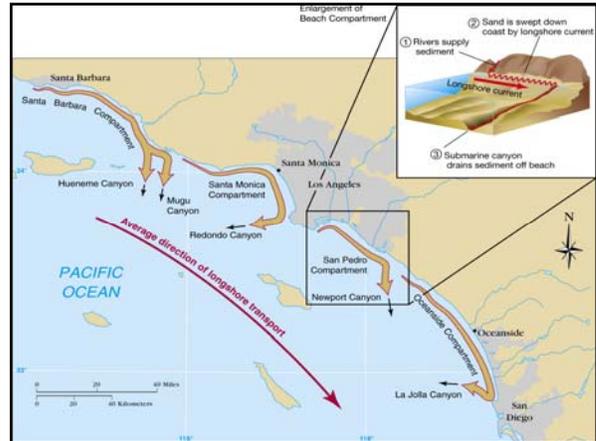
Deltas

- River sediments reworked by ocean processes: waves, tides
- ▣ Distributaries carry sediment to ocean



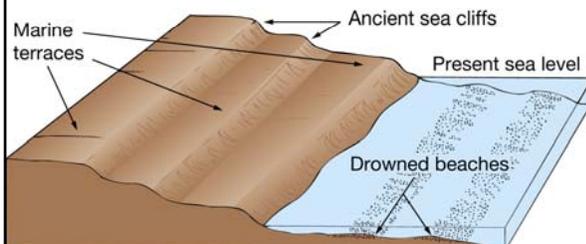
Beach compartments

- Rivers supply sediment
- Beach
- Offshore submarine canyons “drain” sediments from beach
- Beach starvation



Emerging shorelines

- Shorelines above current sea level
- Marine terraces



Submerging shorelines

- Shoreline below current sea level
- Drowned beaches
- Submerged dune topography
- Drowned river valleys (estuaries)



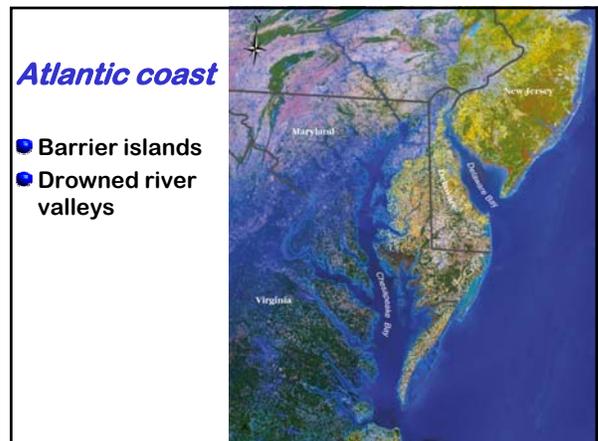
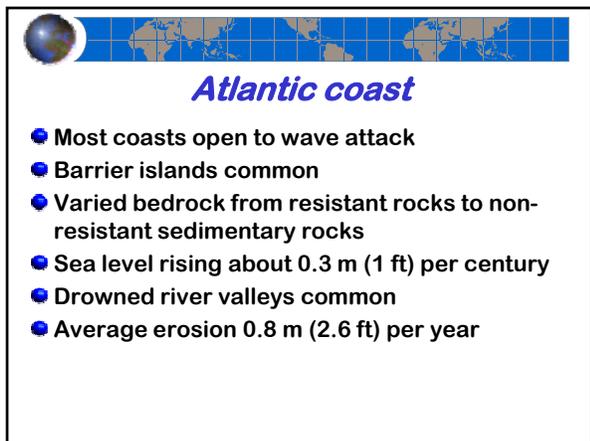
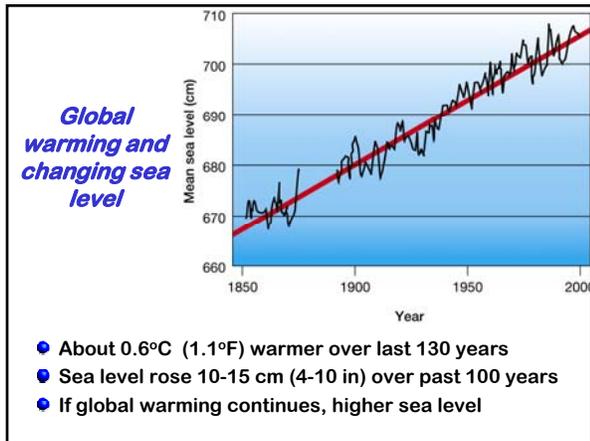
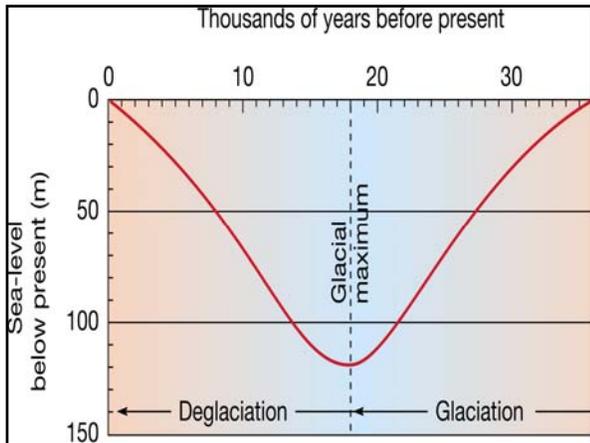
Changing sea level

- Local tectonic processes
 - Example, Pacific Coast of U.S. and active plate margin
 - Isostatic adjustments
 - Ice-loading
- Global (eustatic) changes in sea level
 - Changes in seafloor spreading rates
 - Lake buildup or destruction
 - Ice volume changes



Eustatic changes in sea level

- Ice build up (glaciation)
- Ice melting (deglaciation)
- Thermal contraction and expansion of seawater
- About 120 m (400 ft) change in sea level





Gulf coast

- Low tidal range
- Generally low wave energy
- Tectonic subsidence
- Mississippi delta dominates
 - ▣ Locally sea level rises due to compaction of delta sediments
- Average rate of erosion 1.8 m (6 ft) per year



Pacific coast

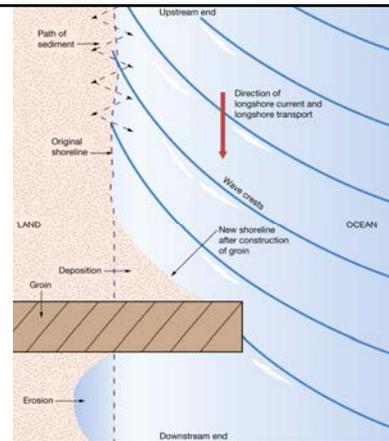
- Tectonically rising
- Bedrock typically non-resistant sedimentary rocks
- Open exposure to high energy waves
- Average rate of erosion 0.005 m (0.016 ft) per year



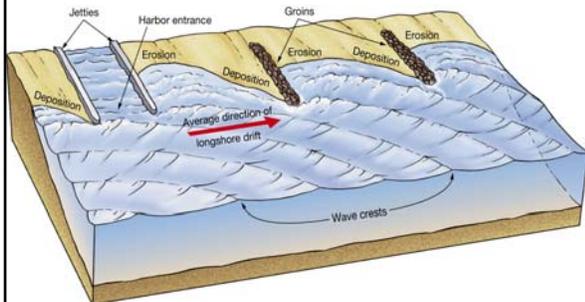
Hard stabilization

- Structures built to decrease coastal erosion and
- Interfere with sand movement
- Often results in unwanted outcomes
 - ▣ Some structures may increase wave erosion
- **Groins and groin fields**
- **Jetties**
- **Breakwaters**
- **Seawalls**

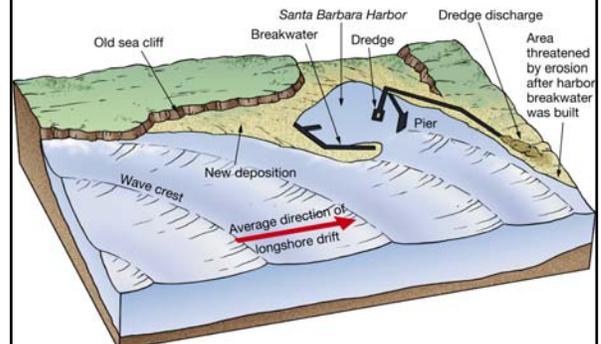
Groins and groin fields

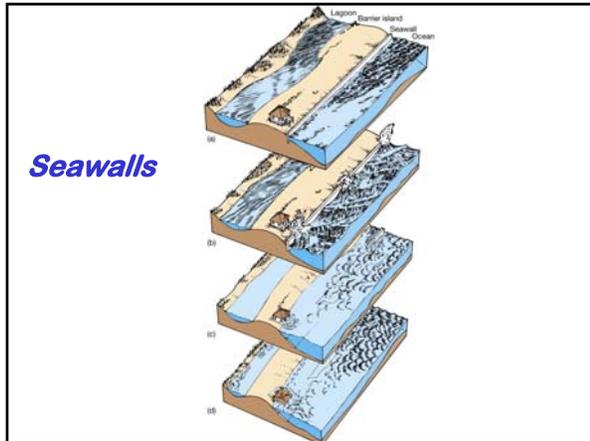


Jetties



Breakwaters





Alternatives to hard stabilization

- **Construction restrictions**
 - ☒ Limit building near shorelines
 - ☒ National Flood Insurance Program encouraged construction
- **Beach replenishment**
 - ☒ Sand added to beach/longshore current

Alternatives to hard stabilization

- **Relocation**
 - ☒ Move structures rather than protect them in areas of erosion

