

CHAPTER 10
The Coast:
Beaches and Shoreline Processes

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

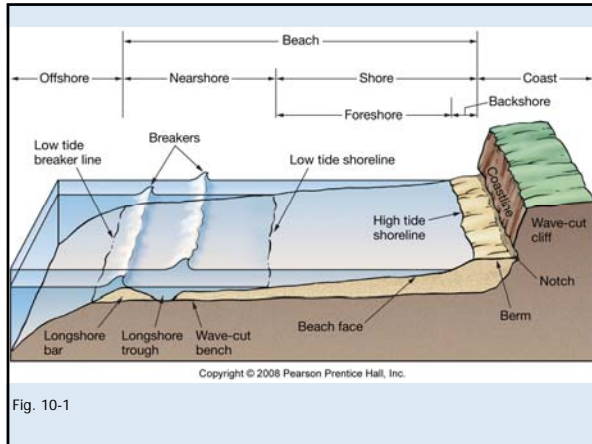


Fig. 10-1

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

- 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

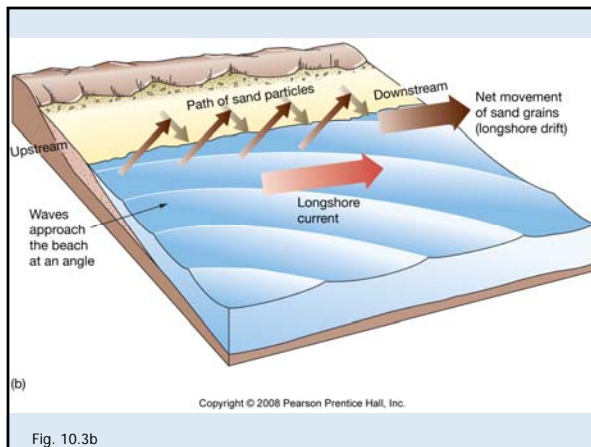
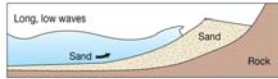


Fig. 10.3b

Swash and backwash

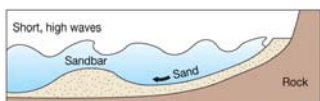


(a) Summertime beach (fair weather)
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Fig. 10.2a

Swash and backwash

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



(b) Wintertime beach (storm)
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Fig. 10.2b

Longshore current

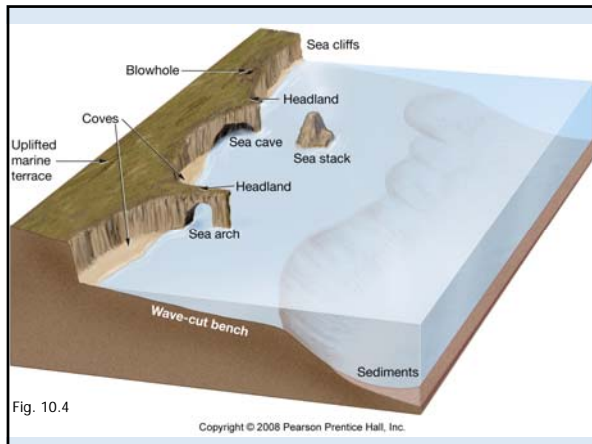
- Wave refraction causes water and sand to move parallel to shore
- Zigzag motion in surf zone
- Longshore current
- Longshore transport

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

Fig. 10.7

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Depositional shorelines

(a)

Fig. 10.8a

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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

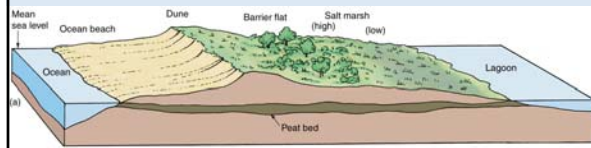


Fig. 10.10a

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Barrier island

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

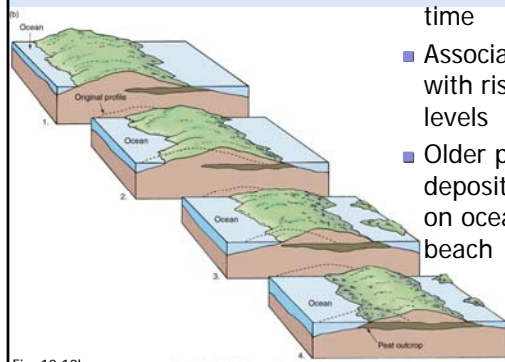


Fig. 10.10b

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Deltas

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

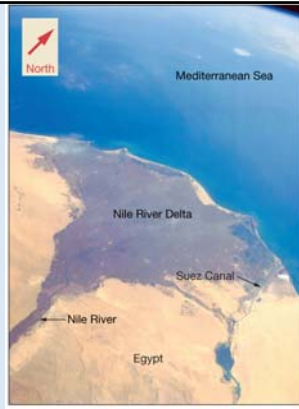


Fig. 10-11b

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Beach compartments

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

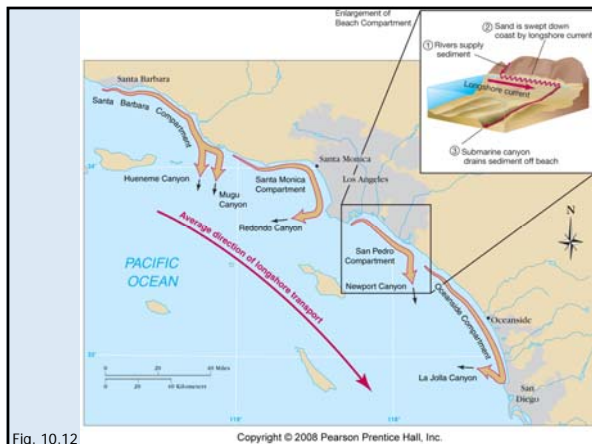


Fig. 10.12

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Emerging shorelines

- Shorelines above current sea level
- Marine terraces

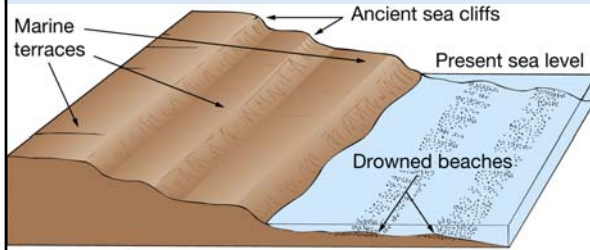


Fig. 10.13

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Submerging shorelines

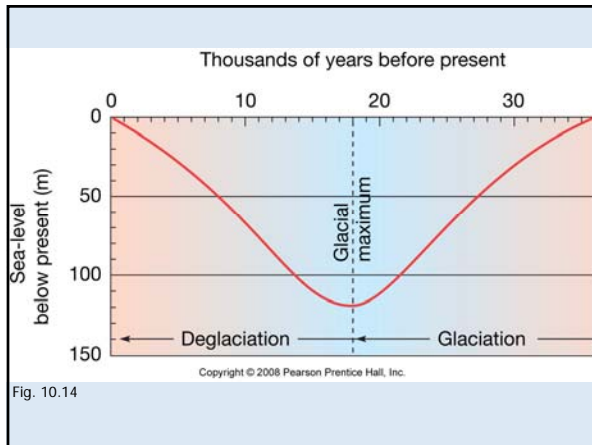
- Shoreline below current sea level
- Drowned beaches
- Submerged dune topography
- Drowned river valleys (estuaries)

Changing sea level

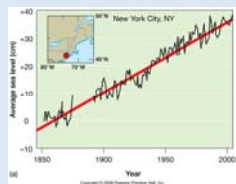
- Local tectonic processes
 - Example, Pacific Coast of U.S. and active plate margin
 - Isostatic adjustments
 - Ice-loading
- Global (eustatic) changes in sea level
 - Changes in seafloor spreading rates
 - Lake buildup or destruction
 - Ice volume changes

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



Global warming and changing sea level



- About 0.6°C (1.1°F) warmer over last 130 years
- Sea level rose 10-15 cm (4-10 in) over past 100 years
- If global warming continues, higher sea level

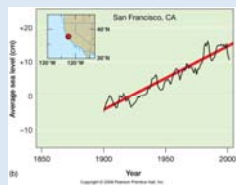
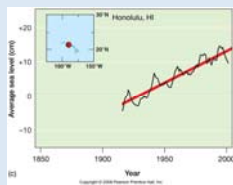


Fig. 10.15



U.S. coasts

- Erosion or deposition dominates
- Type of bedrock
- Tidal range and wave exposure
- Active tectonics
- Eustatic changes in sea level



Fig. 10.17

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Atlantic coast

- Most coasts open to wave attack
- Barrier islands common
- Varied bedrock from resistant rocks to non-resistant sedimentary rocks
- Sea level rising about 0.3 m (1 ft) per century
- Drowned river valleys common
- Average erosion 0.8 m (2.6 ft) per year

Atlantic coast

- Barrier islands
- Drowned river valleys



Fig. 10.18

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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

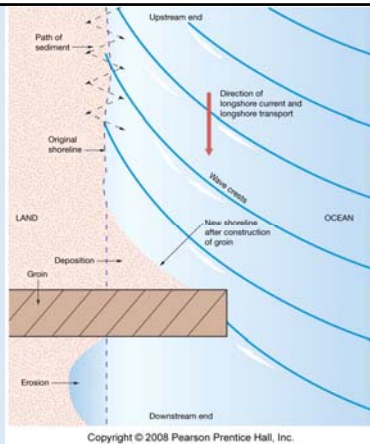
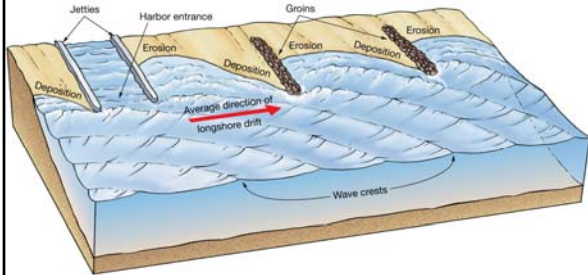


Fig. 10.20

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Jetties



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Fig. 10.22

Breakwaters

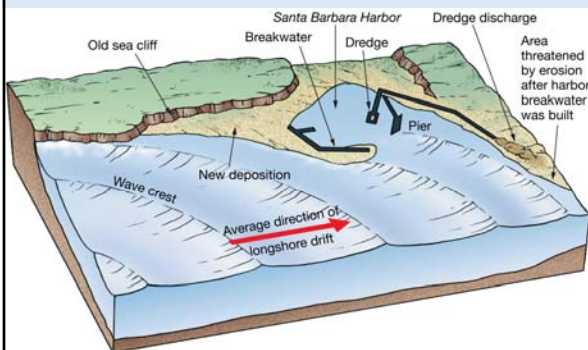


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Seawalls

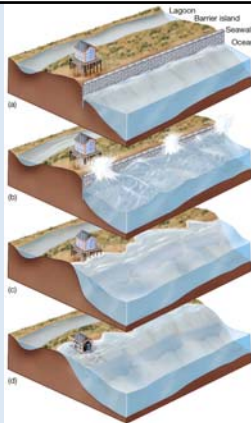


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Alternatives to hard stabilization

- 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



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**End of CHAPTER 10
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