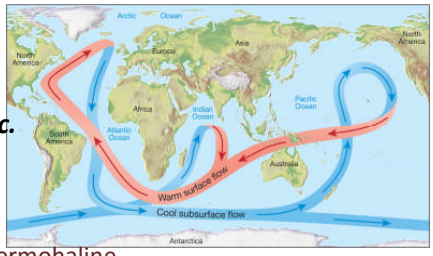
Chapter Outlines

NOTE: This is intended to help students 'organize' their understanding of each topic.
It is <u>not</u> a comprehensive study guide for quizzes or midterms, i.e. <u>study your text!</u>



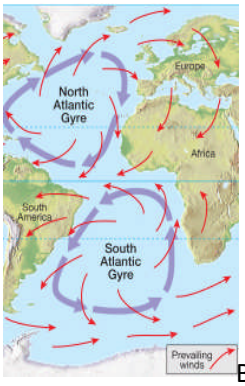
'Thermohaline circulation'

Generalized global surface & deepwater circulation

The Dynamic Ocean

I. Ocean water movements

A. **Surface circulation**



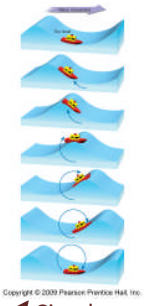
Idealized surface circulation, driven by prevailing winds

1. Ocean currents are masses of water that continually flow throughout the world's oceans
2. Surface currents develop from friction between the ocean and the wind that blows across the surface
3. These currents include five main, huge, slow moving gyres *(large system of rotating ocean current):*
   N. Pacific Gyre; S. Pacific Gyre; N. Atlantic Gyre; S. Atlantic Gyre; Indian Ocean Gyre
4. They are related to atmospheric circulation, and deflected by the Coriolis effect…
   to the right in the Northern Hemisphere; to the left in the Southern Hemisphere
5. Importance of surface currents
   a. Climate – transfers heat using warm currents; influences coasts with cold currents
   b. Upwelling – nutrient-rich cold water rises from deep layers along many west coasts

B. **Deep-ocean circulation**

1. Called '**thermohaline circulation,**' is a response to density differences which result from:
   a. Temperature differences—cold water is dense
   b. Salinity differences— density increases with increasing salinity
2. A simplified model of ocean circulation is a conveyor belt that travels from the Atlantic Ocean, through the Indian and Pacific Oceans, and back again

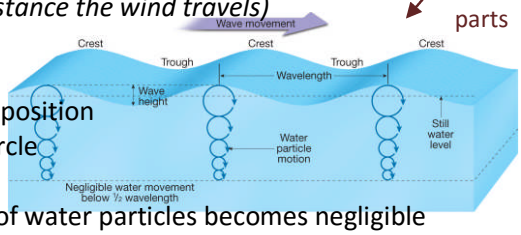
C. Waves - waves derive their energy and motion from wind at the ocean's surface



Circular motion of a wave

1. Basic parts are the **crest** and the **trough**
2. Features of a wave *(the result of wind speed, duration, and fetch - distance the wind travels)*
   a. **Wave height** – vertical from trough to crest
   b. **Wave length** – horizontal from crest to crest
   c. **Wave period**—the time interval for one full wave to pass a fixed position
3. As the wave travels, the water passes energy along by moving in a circle
   a. Waveform moves forward, but not the water
   b. At a depth of about **half the wavelength**, the circular movement of water particles becomes negligible

Names of wave parts

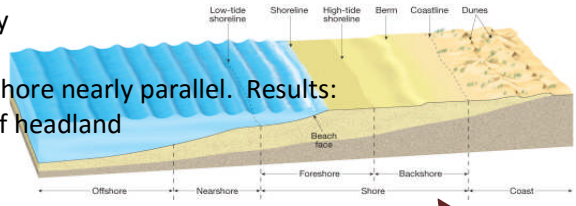


II. Beaches and shoreline processes

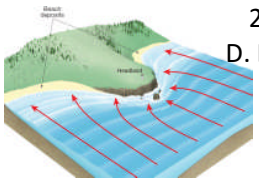
A. Beaches are composed of whatever material is available nearby

B. Wave erosion – breakdown of shore materials by waves

C. **Wave refraction -** bending of waves causing them to arrive at shore nearly parallel. Results:
   1. Wave energy is concentrated against the sides and ends of headland
   2. Wave erosion straightens an irregular shoreline



Names of beach features



Example of wave refraction

D. Longshore transport
   1. **Beach drift**—sediment moves in a zigzag pattern along the beach face
   2. **Longshore current** - current in surf zone flows parallel to the shore and continually moves a substantial amount of sediment along the coast

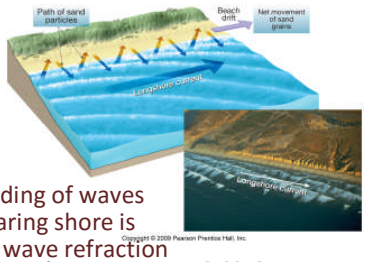
III. Shoreline features

A. Erosional features: **Wave-cut cliff; Wave-cut platform; Marine terraces; Sea arch; Sea stack**

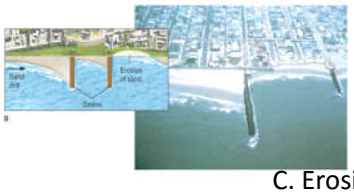
B. Depositional features: **Spit; Baymouth bar; Tombolo; Barrier islands**

IV. Stabilizing the shore

A. Shoreline erosion is influenced by local factors
   1. Proximity to sediment-laden rivers
   2. Exposure to storms
   3. Topography and composition of the land



Bending of waves nearing shore is called wave refraction



4. Prevailing wind and weather patterns

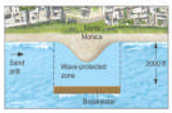
B. Human responses to erosion problems

1. Hard stabilization—the building of structures
   a. Types of structures: **Groins**; **Breakwaters**; **Seawalls**
   b. Often, these structures are not effective or give unexpected results
2. Alternatives to hard stabilization -
   Beach nourishment by adding sand to the beach, or relocating buildings away from beach

East coast homes built too close to shore!

C. Erosion problems along U.S. coasts *(erosion problems are different along the opposite coasts)*

1. Atlantic and Gulf Coasts
   a. Building development occurs mainly on barrier islands, These face open ocean, and receive full force of storms
   b. Development has taken place more rapidly than has our understanding of barrier island dynamics
2. Pacific Coast
   a. Characterized by relatively narrow beaches backed by steep cliffs and mountain ranges
   b. Major problem is the narrowing of the beaches
      1. Sediment supply for some beaches is interrupted by dams and reservoirs
      2. Rapid erosion often occurs along the beaches and adjacent cliffs



Human-made structures to control shore sediments

Submergent coast (Note flooded estuary)

V. Coastal classification - classification based on changes with respect to sea level

1. **Emergent coast** – uplift of land or drop in sea level
   Features: **Wave-cut cliffs and Marine terraces**
2. **Submergent coast** – Subsidence of land or rise in sea level
   Features : highly irregular shoreline and **drowned river mouths *(estuaries)***

Uplifted marine terrace

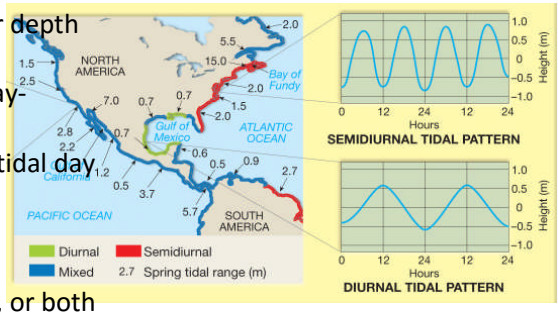
Emergent coast

VI. Tides

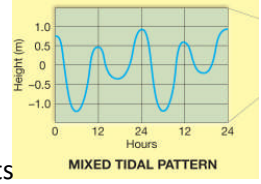
A. Changes in elevation of the ocean surface caused by the gravitational forces of:
   The moon and, to a lesser extent, the sun

B. Monthly tidal cycle
   1. **Spring tide** – occurs during new and full moons
      Combined gravitational forces resulting in especially high and low tides
   2. **Neap tide** – occurs at first and third quarters of the Moon
      Offset gravitational forces resulting in the smallest daily tidal range

C. Tidal patterns
   1. Influenced by many factors:
      shape of the coastline; configuration of the ocean basin; water depth
   2. Main tidal patterns
      a. **Diurnal tidal pattern** - a single high and low tide each tidal day- occurs along the northern shore of the Gulf of Mexico
      b. **Semidiurnal tidal pattern** - two high and two low tides each tidal day
         1. Little difference in the high and low water heights
         2. Common along the U.S. Atlantic Coast
      c. **Mixed tidal pattern** - two high and two low waters each day
         1. Large inequality in high water heights, low water heights, or both
         2. Prevalent along the U.S. Pacific Coast



3. Tidal currents - horizontal water flow accompanying the rise and fall of tides
   a. Types of tidal currents
      1. **Flood current**—advances into the coastal zone and bays
      2. **Ebb current**—seaward-moving water
   b. Sometimes, tidal deltas and large seafloor ripples are created by tidal currents



Mixed Tidal – typical of California coast

Tidal fluctuation in the Bay of Fundy