Beaches, Coasts and Continental Margins

Processes and Factors Affecting Coasts
Coasts are in a more or less constant state of change, attempting to achieve a balance, or equilibrium between:
- Erosion
- Sedimentation

Opposing this are changes in sea level that occur as a consequence of:
- Changes in ocean volume (eustatic sea level)
- Tectonic processes

Eustatic Sea Level Change
- Ocean temperature: Water expands with increasing temperature; A 1°C rise in ocean temperature will increase sea level by about 0.7 m
- Ice volume: Water stored as ice on continents reduces the volume of the oceans. 18,000 years ago, at the height of the last glaciation, sea level was 130 m lower than today. Sea level continues to rise by about 1 foot per century in New York City.
- A rise in sealevel of up to a meter is predicted for the coming century as a consequence of global warming & glacial melting.

Tectonic Factors Affecting Sea Level
- Velocities of Lithospheric Plates: higher velocities means hotter, more elevated ocean floor, raising sea level.
- Local uplift or down-drop of continental margin
- Glacial Rebound: glaciers depress the mantle beneath them; mantle then rebounds when the ice melts.

Coasts are rarely in equilibrium - changes in coastal morphology happen more slowly than the geologic events driving them - so coasts are often “playing catch-up” with the last geologic event.

Types of Coasts
- Primary
  - Coasts shaped by non-marine (subaerial) processes
  - Including volcanism, tectonics, subaerial erosion and deposition
- Secondary
  - Coasts shaped by marine processes
  - Including those shaped by wave erosion & marine deposition
  - Secondary coasts are more mature, closer to equilibrium.

Marine Terraces
- Reflect a combination of quick uplift (e.g., in an earthquake) and slow work of waves

Work of Waves
- Waves are agents of coastal change
- Waves begin to affect the bottom when the depth is less than half the
wavelength (D<L/2).

- Waves from strong storms can affect the bottom as deep as 100 m.
- More commonly, waves begin to disturb sediment at depths of 10 to 20 m.
- Sediment moved by waves acts as an abrasive.
- Eventually this cuts a gently sloping terrace or platform

**Beaches**

- Beaches are sediment in transport across an abrasion platform.
- Products of both deposition and erosion.
- They are transitory, impermanent features
- Generally in a constant state of change.
- Beaches are shaped by wave energy.

**Anatomy of a beach**

- Sand or other sediments rest upon a wave-cut terrace.
- Sometimes backed by wave-cut cliff.
- Berms are sediment deposits produced by storms; typically have steep face and relatively flat top and back.
- Bars, elongate shallow areas, may exist offshore.

**Boulder Beach to Mudflat?**

- Nature of sediment deposited on the shore depends on the *water speed*, which in turn depends on *wave size*.
- The greater the wave energy, the coarser the sediment.
- Wave energy also governs the beach slope: low-energy shores are flat, high energy ones are steep.

**Seasonal Changes**

- Because the wave energy is typically greater in winter than in summer, the nature of sediment on a beach will change.
- Beaches are steeper, have coarser sediment in winter.

**Focusing Wave Energy**

- Refraction concentrates energy on headlands and away from bays.
- In these cases, erosion occurs on the headlands while deposition occurs in the coves.
- Effect of waves is to straighten the coast.

**Longshore Current**

- Sediment and water are transported along the coast as a consequence of waves striking the shore at an angle.
- Coasts can often be divided into distinct regions with independent sediment budgets called littoral circulation cells, each with a source and sink of sediment.
- Leads to the creation of a number of features, including spits, barrier islands, and tombolos.

**Barrier Islands**

- Barrier islands, like beaches are in a continual state of change.
- Changes occur as a consequence of storms, changes in sand budget, rising sea level.
- Because of rising sea level, the tendency has been for barrier islands to
move landward.

**Estuaries**
- Estuaries are zones where (fresh) river water and sea water mix.

**Importance of estuaries.**
- Because river water is often richer in nutrients than seawater, biological productivity is exceptionally high.
- Estuaries are often important spawning grounds and nurseries.
- Because of the changes in water velocity and water chemistry that occur there, particularly increasing salinity (ionic strength), estuaries are areas of high sedimentation rate.
- Because they afford protection from waves, they are often used as harbors and are regions of intense human settlement.

**Estuaries Classified by Origin**
- Coastal Plain Estuaries: e.g., Chesapeake & Delaware Bays
- Fjord: e.g., Cook Inlet, Alaska
- Tectonic Estuary: e.g., San Francisco Bay
- Barrier Island Estuary: e.g. Biscayne Bay

**Estuarine Circulation**
- Well mixed vs. Salt Wedge depends on ratio of river to tidal flow

**Continental Margin Anatomy**
- Continental Shelf: mean slope 0°07'
- Shelf Break: mean depth 135 m
- Continental Slope: mean slope 4°
- Continental Rise: mean slope 0°02'

**How do Deep Sea Canyons form?**

**Turbidity Currents**
- Turbidity currents are mixtures of sediment (mud, sand, etc.) and water.
- The mixture has a density greater than water and therefore flow downward under gravity.
- Agents of erosion in submarine canyons
- Agents of deposition on continental rise

**Some Study Questions**
- What processes might result in global rise in sea level?
- What processes might produce local changes in sea level?
- Are the drowned river valleys of the Mid-Atlantic states primary or secondary coasts?
- Explain why wave energy tends to be focused on headlands.
- In what way are beaches products of both deposition and erosion?
- Explain the seasonal changes that typically occur on beaches. Explain why these changes occur.
- Under factors favor a salt-wedge estuary?
- How do turbidity currents produce graded bedding?