Earth Science

GEOGRAPHY 1710

DAVID R. SALLEE

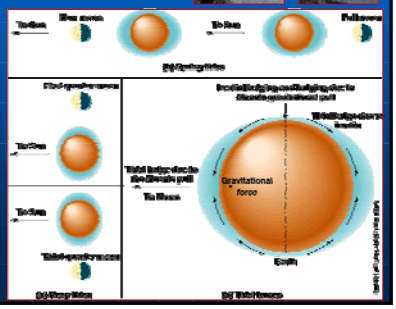
Shorelines and Shoreline Processes

Introduction

- Shorelines are the areas between low tide and the highest level affected by storm waves
  - dynamic areas where waves, tides, and marine currents continually modify features
  - vary from rocky and steep to broad sandy beaches
  - rising sea level threatens coastal property

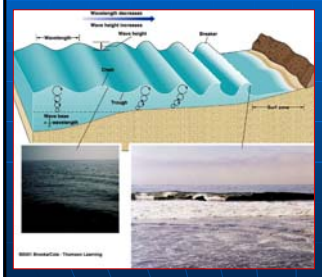
Tides

- Two high and low per day for any location
  - result from the gravitational forces of the moon and sun - a bulge of water is created which Earth rotates through
  - tidal ranges are affected by coast topography and complicated by moon/sun properties



Waves

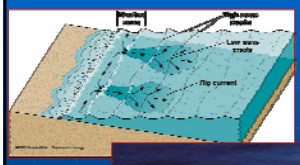
- Oscillations of water surface
  - directly or indirectly responsible for most erosion, transport, and deposition
  - crest and trough
  - wave height and wave length
  - generated primarily by wind, but landslides, earthquakes, and volcanism contribute
  - seas and swells
  - breakers form as crest advances faster than base

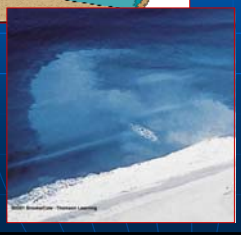


Nearshore Currents

- Zone extending from the upper limit of the shoreline to just beyond where waves break
  - wave refraction is a bending of the wave so that it is more parallel to the shoreline
  - longshore currents are generated as even slightly oblique waves strike the shore and are responsible for much transport and deposition

Nearshore Currents





- Zone extending from the upper limit of the shoreline to just beyond where waves break
  - water carried into the nearshore zone must return to the sea
  - rip currents are narrow surface currents that flow back into the sea through the breaker zone
  - often fed by longshore currents and develop into powerful cells of moving water

Rip Currents

Rip currents, mistakenly called undertow or rip tides, are formed by water being trapped and elevated on the beach face by big breaking waves. This excess water is then funneled back offshore through breaks in the underwater bar; the current can be so strong that even an Olympian cannot successfully swim against it. Rip currents are seldom wider than about 10 yards, but can pull you hundreds or even a thousand feet offshore.

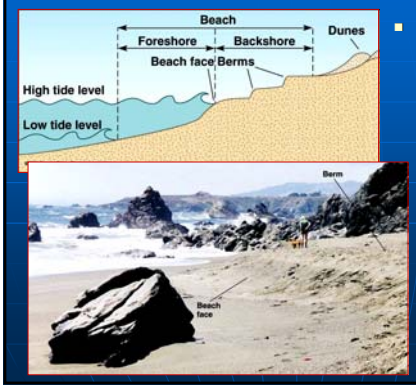
Deposition Along Shorelines

- Features include:
  - beaches
  - spits
  - baymouth bars
  - tombolos
  - barrier islands
- Characteristics determined by waves and longhsore currents

Beaches

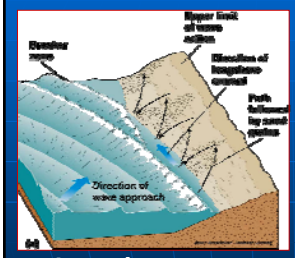
- May be continuous for many miles, or isolated pocket beaches
  - unconsolidated sediment extending from a change in topography to low tide mark

Beaches



- Can be divided into several components
  - backshore is usually dry
  - berms are platforms that slope gently landward
  - beach face is exposed to wave swash
  - foreshore is covered by water in high tide

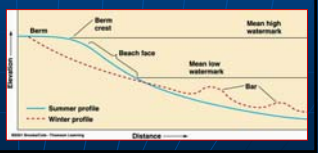
Beaches



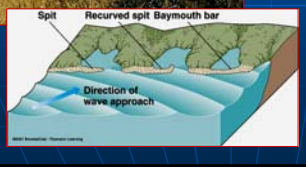
- Longshore currents move sand grains in a zig-zag pattern through the breaker zone
  - groins are often constructed to widen a beach or slow erosion

Seasonal Changes in Beaches

- Beach configuration remains constant under equilibrium conditions
  - seasonal changes are related to wave intensity
  - summer beaches have a wide berm and gently sloping beach face
  - winter beaches are coarser grained, have little or no berm, and have sand stored in offshore sand bars parallel to the shoreline



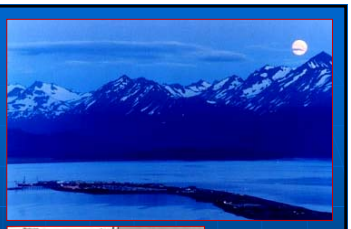
Spits and Baymouth Bars

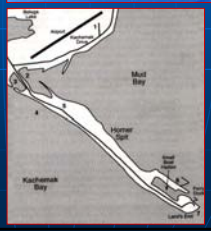


- Spits are fingerlike projections of a beach that form a free end
- Baymouth bars form when spits grow until they close off a bay from open water

The Homer Spit

The first settlers couldn't possibly have envisioned the lively colorful scene that the end of the Homer Spit has become. Back then, shortly before the turn of the century, the 4.5 mile long finger was a grassy, flower-carpeted stretch with a grove of spruce, considerably higher, wider and drier than it is now. The massive 1964 earthquake reduced the Spit to 508 acres, about 350 of which are submerged at mean high tide.

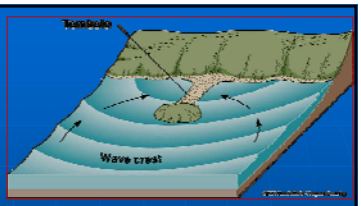




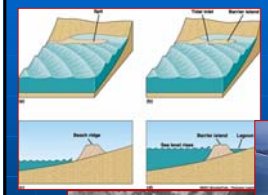
Map of the Homer Spit

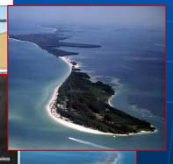
Tombolos

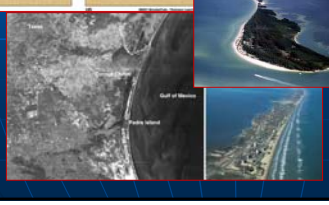
- These sand deposits form as waves are bent around an island
- Long axis is perpendicular to the shoreline



Barrier Islands



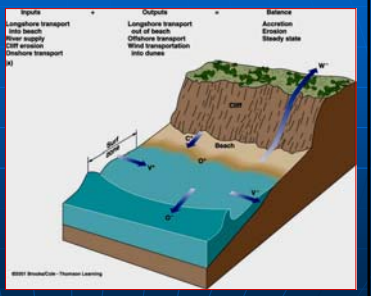




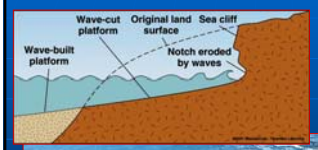
- Long, narrow islands of sand form a short distance offshore
  - beach side is smoothed by waves
  - land side is irregular due to storm washover deposits
  - defined by beaches, wind-blown dunes, and a marshy area

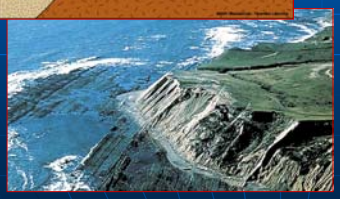
The Nearshore Sediment Budget

- Beaches receive and lose sediment in several ways
  - most sediment is transported by streams and redistributed by waves and currents
  - most sediment loss is due to wind, offshore transport, and deposition in submarine canyons



How are Shorelines Eroded?

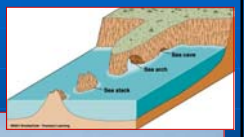




- Where erosion exceeds deposition, sea cliffs develop
  - wave-cut platforms are formed as a gently sloping, beveled surface is abraded by wave action
  - marine terraces are platforms that have been raised above sea level

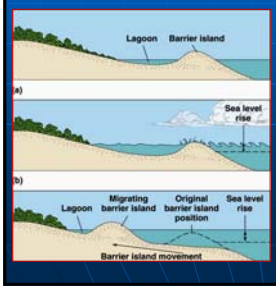
How are Shorelines Eroded?

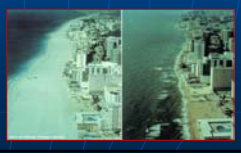
- Headlands are seaward-projecting parts of the shoreline
  - wave action is focused on these areas
  - sea caves, sea arches, and sea stacks may form in the the process of coastal straightening



How are Coastal Areas Managed as Sea Level Rises?

- Risks of living near shorelines include
  - mass wasting, beach loss due to erosion and deposition, storm damage, and rise in sea level, property damage and economic impact
  - riprap, seawalls, groins, and sand replenishment have been used to slow beach erosion





Types of Coasts

- Depositional and Erosional Coasts
- Submergent and Emergent Coasts

Depositional and Erosional Coasts

- Depositional Coasts
  - US Gulf coast characterized by abundant sediment, wide sandy beaches
- Erosional Coasts
  - many beaches of the west coast of the US are steep, irregular, and lack well-developed beaches

Submerged and Emergent Coasts

- Submergent Coasts
  - found where sea level is rising with respect to the land
  - many estuaries of the East coast are drowned river mouths
- Emergent Coasts
  - found where land has risen with respect to sea level
  - tectonics or isostasy is responsible for most emerging coasts today