Wilberforce, it's time to leave!

Ah, I don't wanna!

Come in this instant, young man!

Come an' eat me!

Floop!

Sandbar.

Blur.
COASTAL ENVIRONMENTS

Repeated movement of sediment & water constructs a beach profile reflecting the balance between average daily or seasonal wave forces and resistance of landmass to wave action.

Coasts are classified on the basis of
1) configuration of shoreline
2) stability or relative movement of sealevel
3) influence of marine processes

Beach: the relatively narrow portion of the coast directly affected by wave action; terminates inland at sea cliff, dune field, or permanent vegetation, and oceanward boundary is where bottom is no longer reworked by wave action (littoral zone)
Waves are the driving force, expending energy obtained in the ocean against the margins of the land – waves are generated by surface winds (see text for wave dynamics).

Wave form moves faster than individual water particles: as waves approach land & the bottom shallows, the waves break in the surf zone – high velocity and impacts

energy = geomorphic work

The beach profile represents a topographic form that induces waves to dissipate energy by breaking – larger beach reduces coastal erosion & protects sea cliff.
Berm: nearly horizontal surface on backshore portion of beach

* some beaches have several berms, some have none
* formed by deposition of sediment during backwash
* elevation is function of how high the swash runs up the beach, & of the grain size of the sediment

Beach face: sloping section of beach seaward of berm

* sediment moves up with swash & down with backwash
* range of slopes (large particles = steep slopes)

Longshore bars & troughs: best developed on low gradient beaches; may be several or none; bar reflects breaker position for waves
bioturbation

swash & backwash

ripples
Storm waves destroy or reduce berms & build longshore bars, so the magnitude & frequency of storm waves control the beach profile, producing a summer profile (wide berm, no bars) and a winter profile (no berm, series of bars)

Plan view configuration of beach also reflects balance; best established where no long-term unidirectional movement of sediment occurs parallel to the shoreline

**Figure 13.17**
Generalized beach profile from the dune to approximate mean wave base offshore.
berm, Acadia National Park, Maine

Cape Cod, MA

wind erosion, CA
shell-rich beach strata, Sanibel Island, Florida

grooves in clay, dunes in sand, Australia
The position of the surf zone changes as bottom topography, storms, & tides change

Refraction: waves adjust to contours of bottom topography & bend according to the configuration of the shoreline because deflection of the wave crests is a function of water depth – some sections of the wave crest obliquely approaching the coast are in shallow water & have lower velocity – waves converge on landmass jutting into ocean, concentrating energy

**Figure 13.7**
Refraction of waves along an irregular shoreline. Wave energy converges on headlands that project oceanward while it diverges over recessed embayments.
Offshore topography determines wave refraction, & waves establish equilibrium shoreline configuration

Many shorelines exhibit regularly spaced & shaped crescentic features in a range of sizes. Examples include

1) beach cusps develop at the upper part of the beach face & along the outer fringe of the berm; usually < 30 m apart; horns are cusp projections – form where wave crests strike parallel to shoreline; higher waves = greater spacing interval
2) rhythmic topography & capes – larger features than cusps

- migrate parallel to shoreline at rates of up to 1 km/yr
- much of the topography is submerged – forms as sand waves & bars
- more dependent on bottom configuration in offshore surf zone than are cusps
- function of wave action, cell circulation
- capes spaced at 1-2 orders of magnitude greater than rhythmic topography
- capes may reflect large-scale rhythms related to rotational cells of eddy currents along the western edge of the Gulf Stream
FIGURE 13.27
Large capes and crescentic recessions (bights) along the south Atlantic coast of the United States.

(White 1966)
Waves produced by special conditions are important:

1) tsunamis: waves formed by sudden impulses beneath the ocean (eg. earthquakes > 6.5 on Richter scale) that cause trains of waves to radiate in all directions from the point source – large, but short-lived geomorphic effects

2) storm surges: hurricanes & large storms have compensating upward bulges of ocean levels beneath low pressure centers – when storm enters shallow water, bulge couples with high tides to form waves that inundate coastal lowlands

3) seiche: repeated rise & fall of water level in enclosed or semi-enclosed basin such as lake or harbor due to heavy rain, river flood, etc
Tides and currents also modify coasts

Tides occur as twice daily rise & fall of sealevel caused by gravitational effect exerted on Earth by sun & moon

spring tide: 20% higher than normal
neap tide: lower than normal

tidal bore: pronounced wave front moves inland on constricted estuaries (eg. 8 m high on Amazon River)

 tidal bore, Truro, Nova Scotia

river flow
Besides wave & tide action, two wave-induced currents control water movement in the beach zone:

1) a cell circulation of rip currents – narrow zones of strong flow that move seaward through the surf – they return to the offshore zone water that moved toward the beach by waves of translocation

2) longshore currents generated by waves striking at an angle to the prevailing direction of the shoreline; move sediment parallel to the shoreline for considerable distances; momentum is preserved as waves break & is separated into component directed toward shoreline & component parallel to shoreline

Beach can be visualized as equilibrium form for any set of water & sediment conditions
Coastal landforms indicate whether erosion or deposition dominates

Erosion: forms sea cliffs & causes retreat through
corrosion (chemical solution)
corrasion (grinding)
attrition (diminution of rock particle size during movement on beach or wave-cut platform)
hydraulic action (erosion via water – wave shock pressure, etc)

Cliff retreat leaves beveled surface of wave-cut platform slightly below high tide water level – controlled by lithology & cohesiveness of coastal material & energy of waves

Cliff retreat exposes irregularities as stacks, caves, & arches
coastal platform, Punta Arena, CA

wave-cut platform, Tasmania

wave-cut platform at high tide, northern CA
Gulf of Aqaba, Red Sea
Oahu coast

folded coastal platform (San Andreas Fault), Punta Arena, CA

wavecut platform & marine terrace, n CA

wavecut platform, Japan
southeastern Australia

wavecut platform at low tide, n CA

wavecut platform, southern Australia
sea stacks, southern Australia

retreating coastal platform, southern Australia
Twelve Apostles, southern Australia
southern Australia

sea stacks, Olympic Peninsula, WA

wavecut platform, Oregon
Acadia National Park, Maine