Coastal Processes

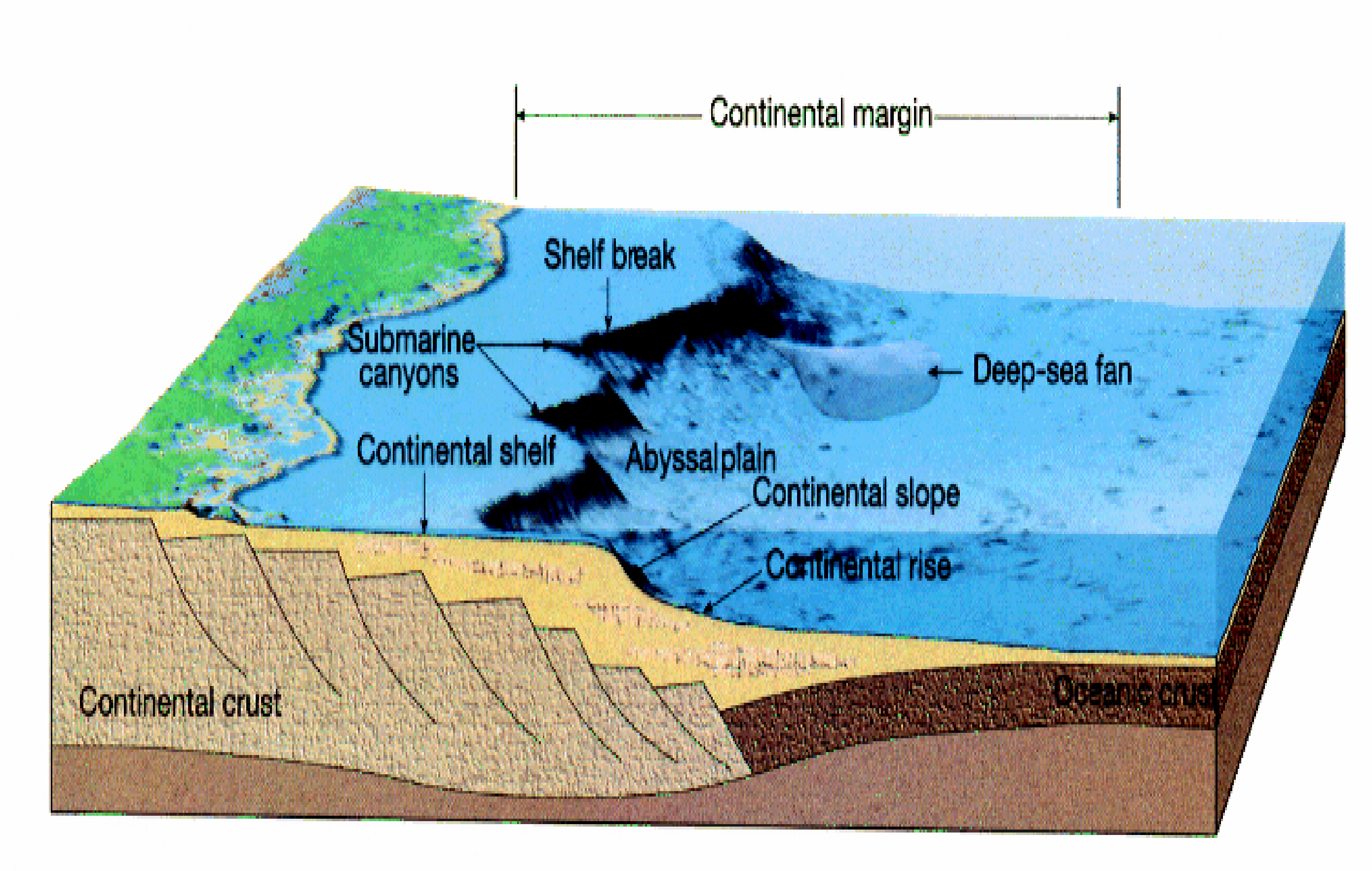
A coast is a relatively physiographic zone that extends for hundreds of kilometers along a shoreline and often several kilometers inland from the shore.

When viewed from the short-time perspective, they appear to be quasi-equilibrium - in balance with the average daily energy conditions.

Coastal Processes

Two general types of coastlines:

- **passive continental margins**
- active continental margins



Coastal Processes

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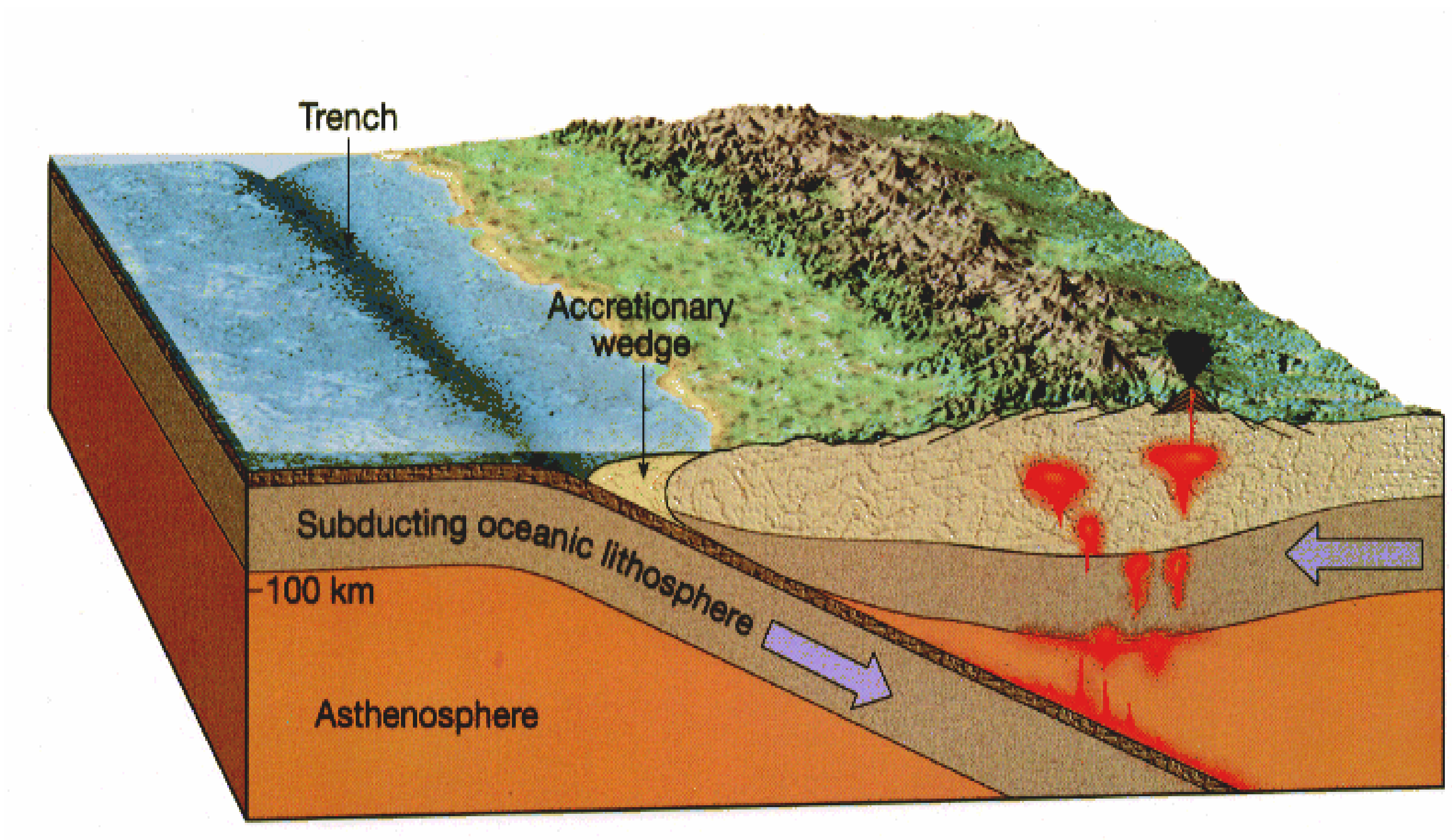

Coastal Processes

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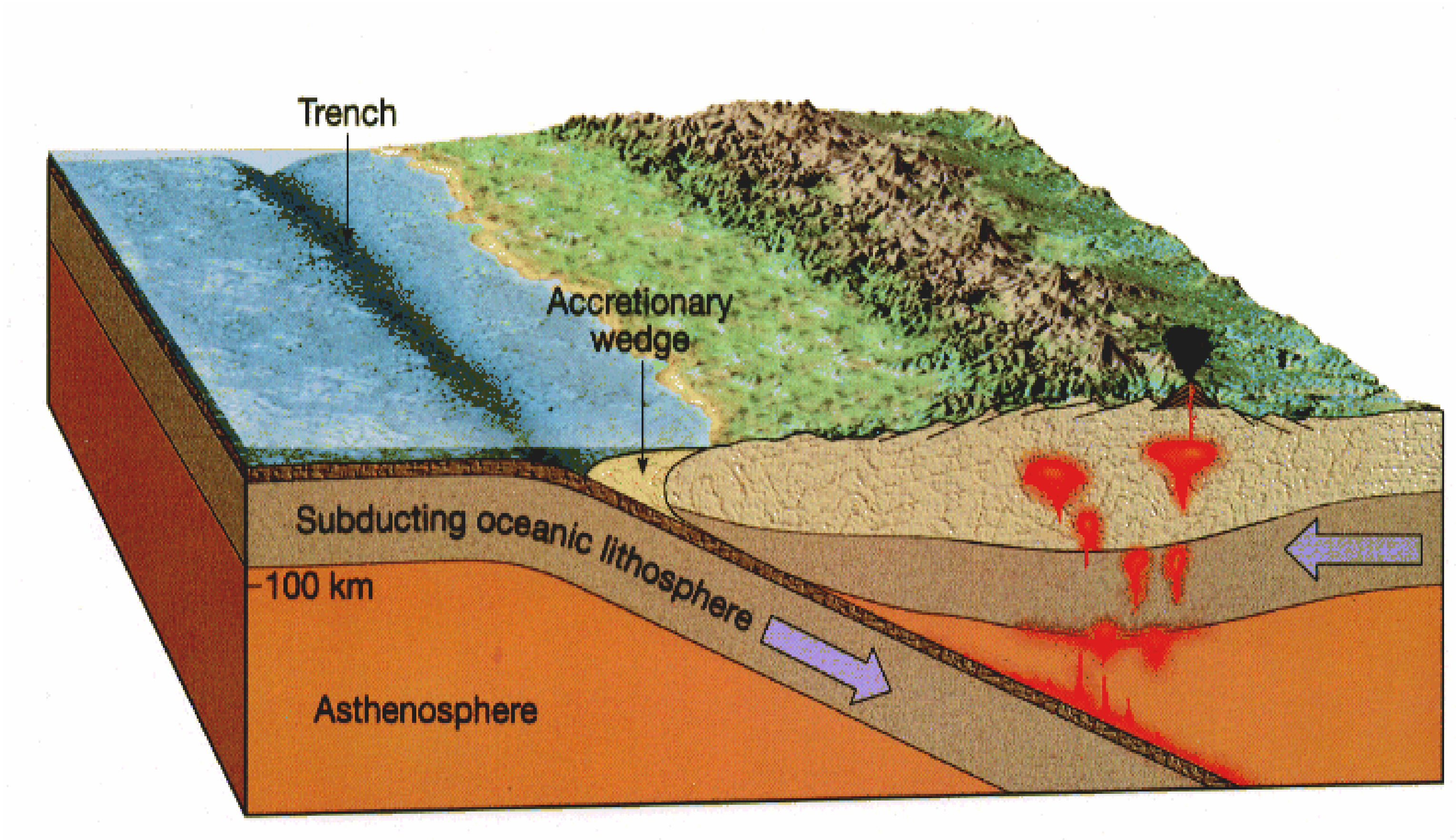


Coastal Processes

The processes which initiate change in the coastal zone are extremely difficult to study because they are driven by interrelated forces of high energy, each of which may produce a different response in the same coastal environment.

Permanent installations designed to provide precise measurements over various time intervals are used. Data measurements include meteorological, wave data, currents, oceanographic, water levels, and near shore bathymetry.

Coastal Processes

Waves

The paramount driving forces in shoreline processes are waves, which the extend energy they obtained in the ocean against margins of the land.

1. ***Wave Generation*** - Most waves that do geomorphic work are generated by strong winds blowing across large portions of open ocean. Precisely how energy is transferred from the wind to the ocean is not completely understood.

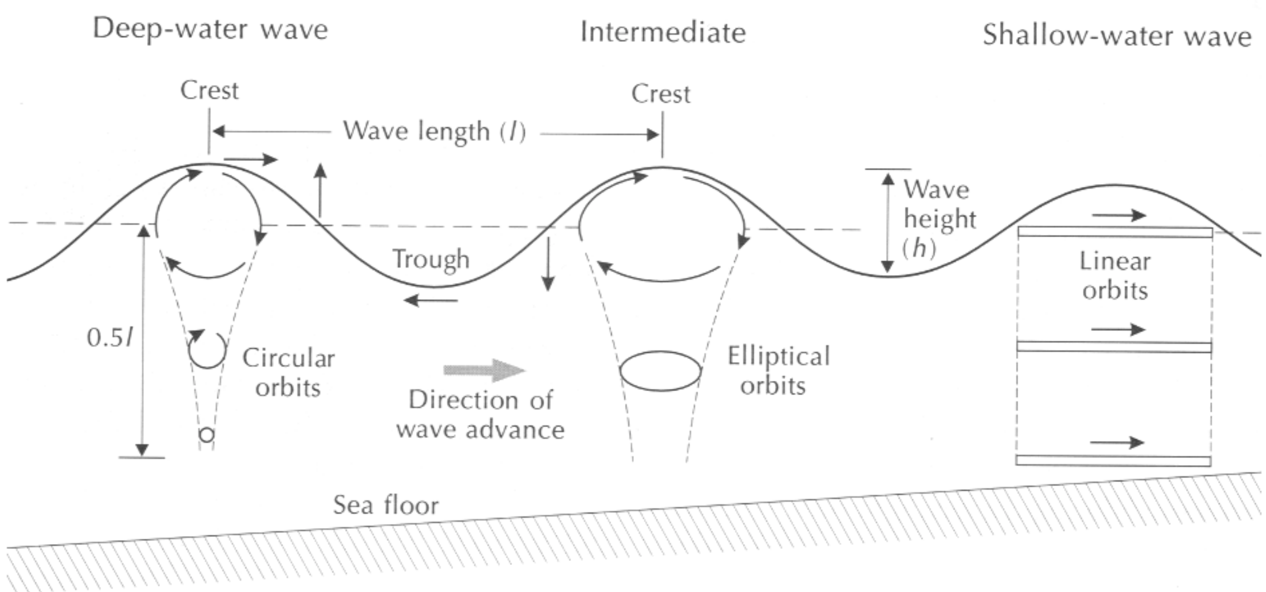
   Studies indicate that energy exchange depend on ***wind velocity, wind duration, and the fetch*** (distance over which the wind blows). The fetch is particularly important in determining the height of waves and their period, a parameter that is merely the time interval between two successive wave crests passing at a fixed point.

   As waves move through water they constantly interact with other waves sets. Rarely are these wave sets in phase and when they interfere with one another they either dampen each other out or enhance each other. (34 m - 112 ft. largest wave measured (February, 1933 in the south Pacific)

Coastal Processes

Waves

Wave dispersion occurs when waves begin to move away from the generation area and begin to separate from each other due to differences in their periods, this causes regularly spaced successions of waves with round crests to migrate from the source zone. Emerging waves typically have a low ratio of wave height to wave length (wave steepness) and appear as the long, low waves commonly known as swells. In swell, water particles assume the circular orbital paths that characterize deep-water ***waves of oscillation***.



Coastal Processes

Waves

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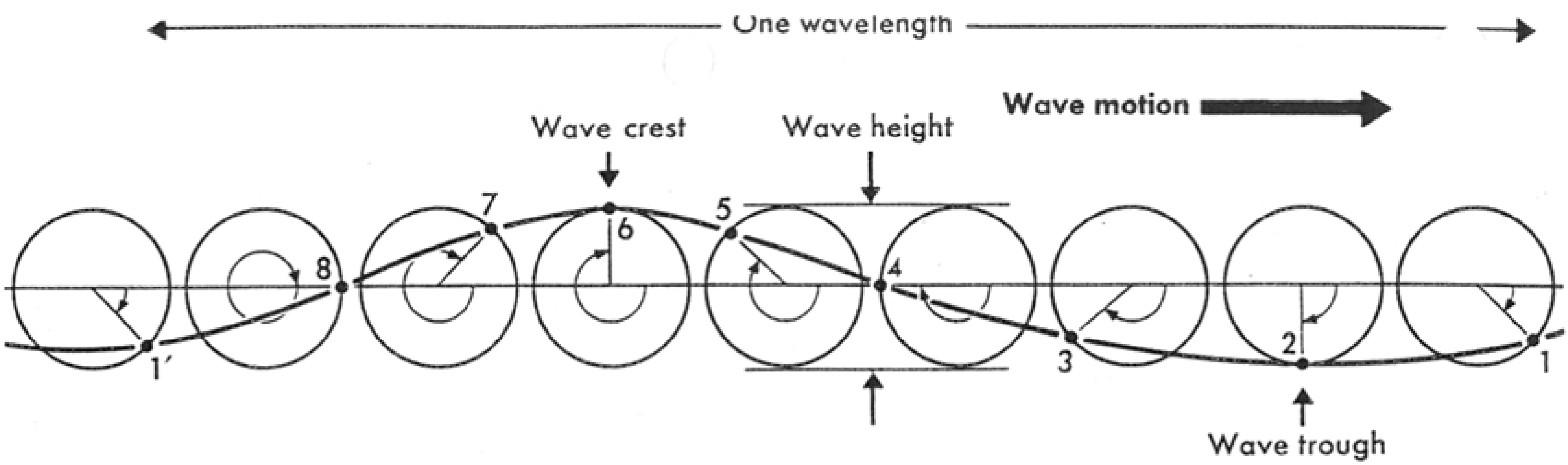
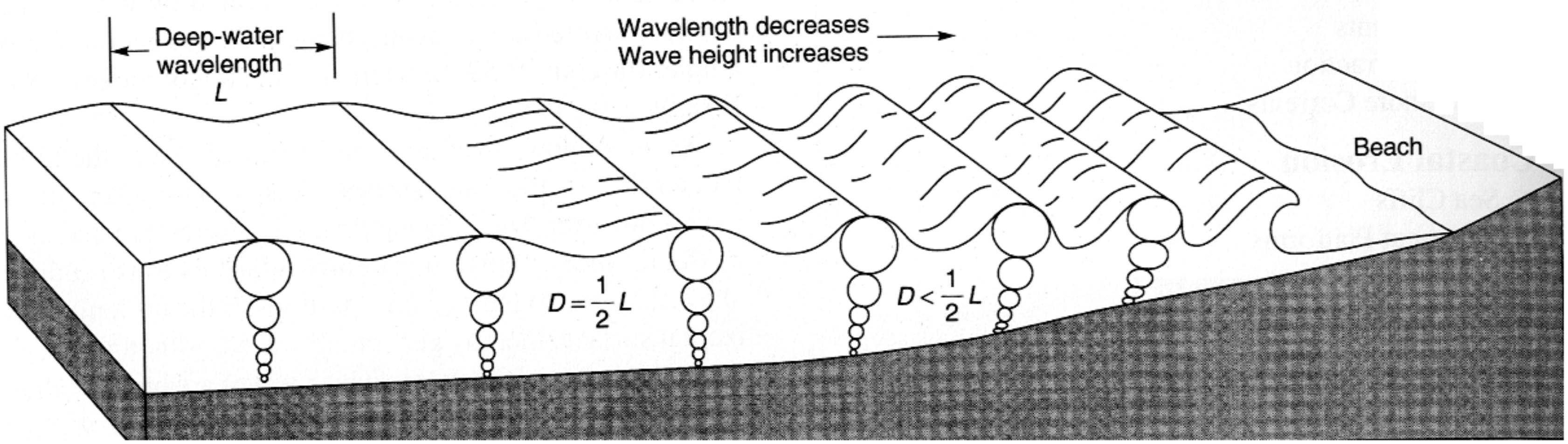


Coastal Processes

Waves

Waves and Shoaling - When the water depth is approximately half the wave length, the oscillatory waves begin a transformation into step-like forms called ***waves of translation.***



Coastal Processes

Waves

As the waves approach the shore, water depth is progressively decreased (a phenomenon called ***shoaling***) and waves begin to "feel bottom."

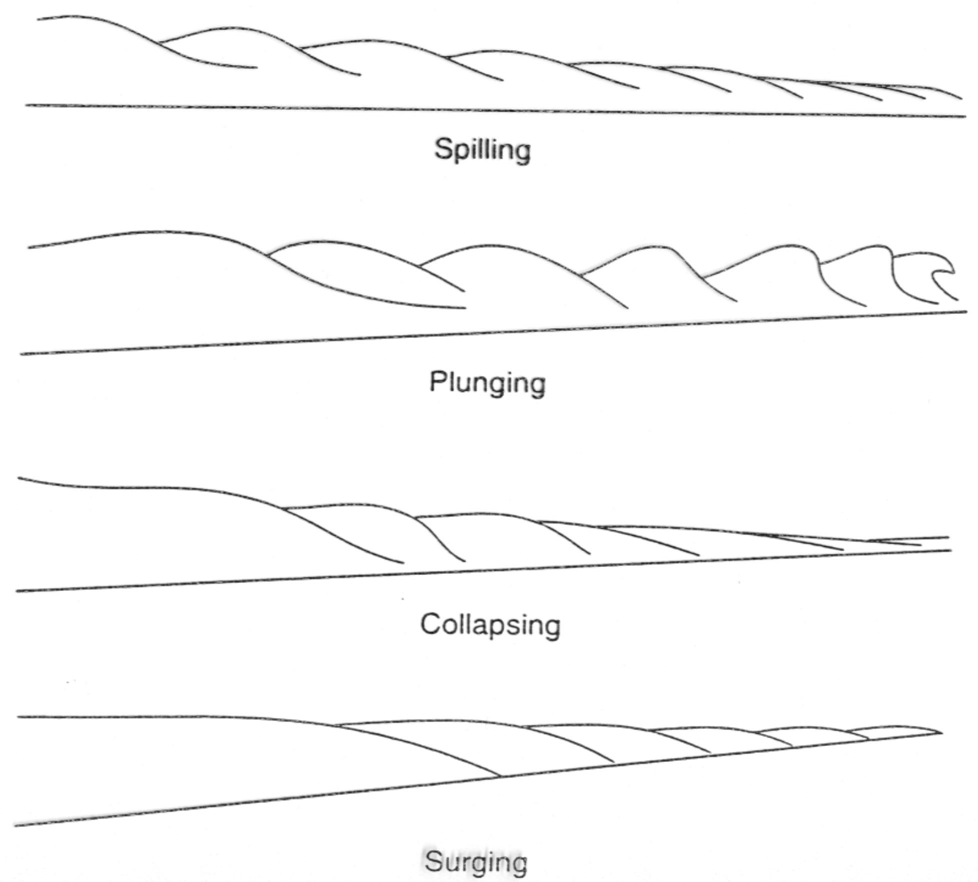
As the wave begins to break, three common types of ***breakers*** called spilling, plunging, and surging are produced.

spilling

plunging

surging

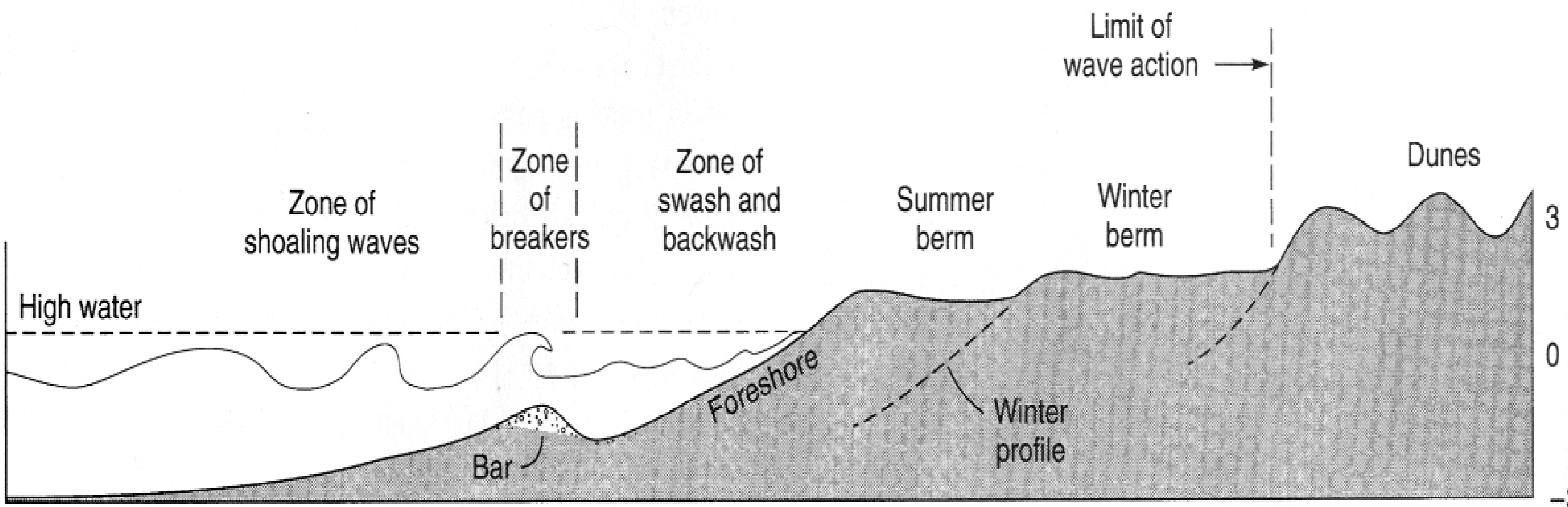
collapsing



Coastal Processes

Waves

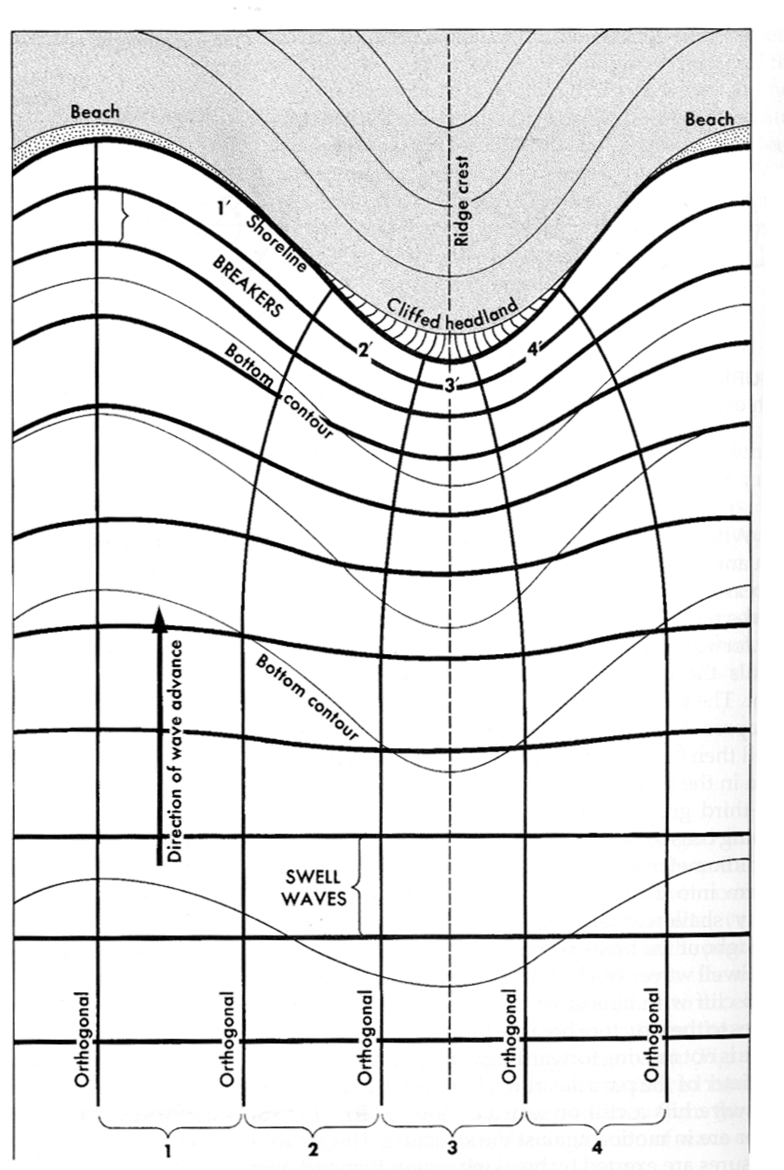
Breakers mark the oceanward limit of a zone, called a ***surf,*** in which the original energy given to the waves receives its final transformation.



Coastal Processes

Waves

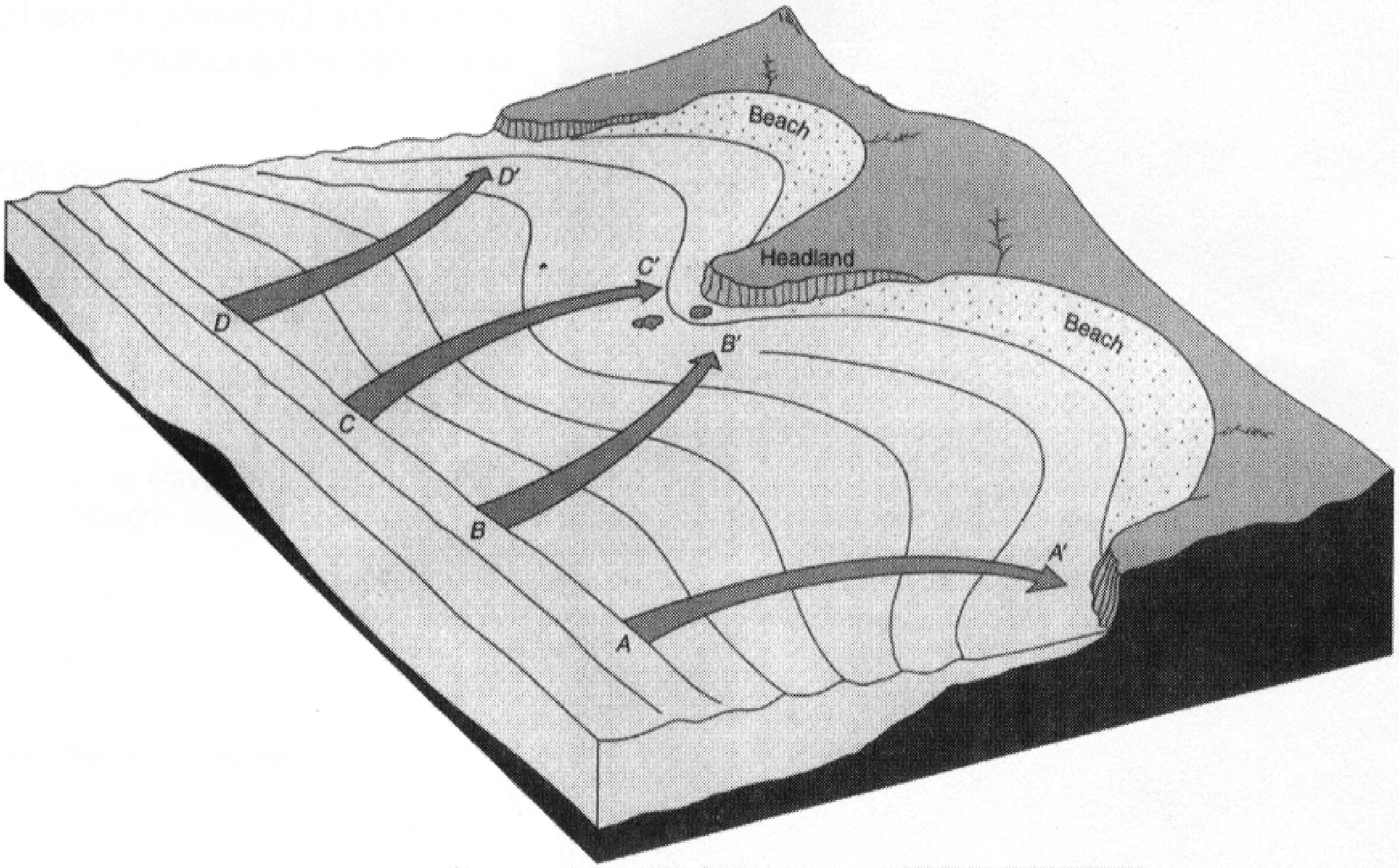
Wave refraction - works because some sections of a wave crest approaching a coast obliquely are moving in shallow water and at lower velocities than other portions of the same wave which are traveling in deeper water.



Coastal Processes

Waves

Wave refraction

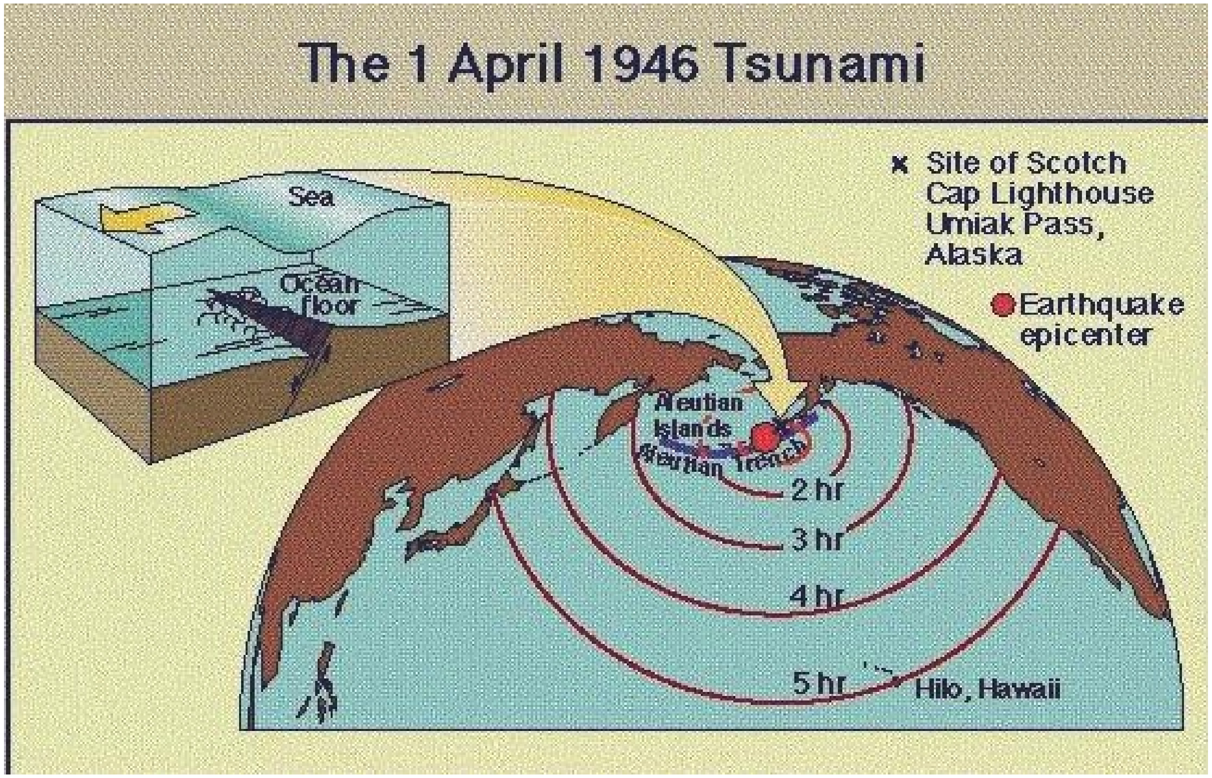


Coastal Processes

Waves

Tsunamis - are waves formed by sudden impulses beneath the ocean that cause trains of waves to radiate in all directions from the point source.

Tsunamis are usually initiated by earthquakes of more than 6.5 magnitude with foci located less than 50 km beneath the ocean floor.



Coastal Processes

Waves

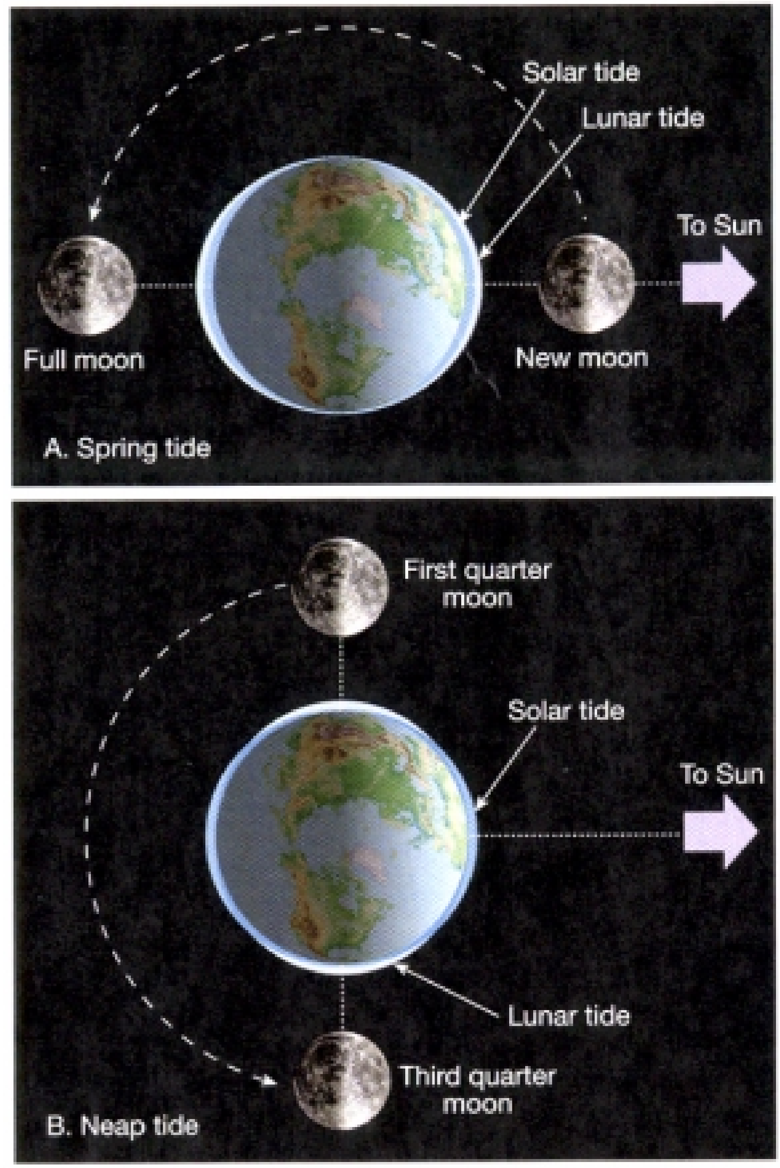
A ***seiche*** is another wave type that is not directly related to a prevailing open ocean wind. A seiche is recognized as a repeated rise and fall of water level; the oscillatory motion begins when some force displaces the water from its equilibrium. When the initiating force passes, the oscillations gradually decrease until equilibrium is attained.

Coastal Processes

Waves
Tides and Currents

Tides

- ***spring tide***
- ***neap tide***
- ***Perigean spring tide***



Coastal Processes

Waves
Tides and Currents

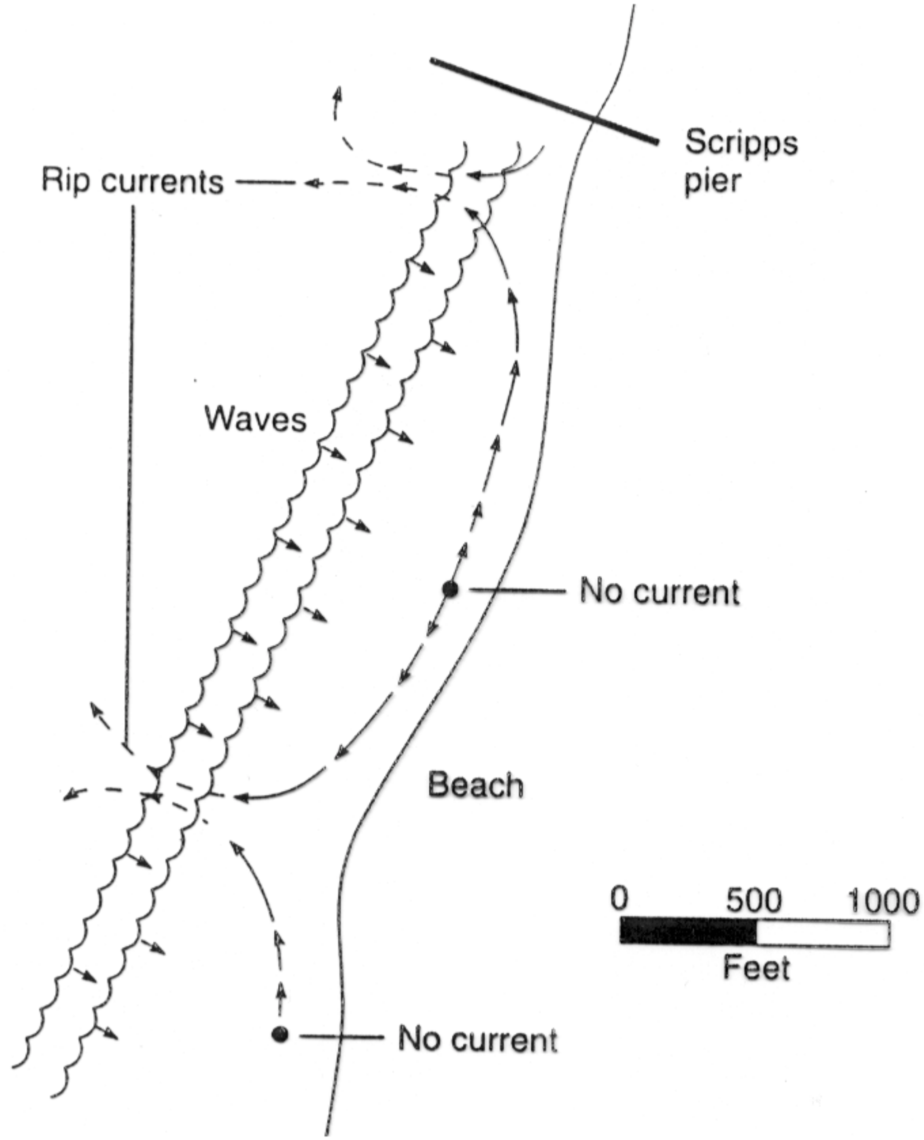
Nearshore Currents - Other than wave action itself, two wave-induced currents control water movement in the beach zone:

1. a cell circulation consisting of ***rip currents*** and their associated longshore currents and
2. ***longshore currents*** that usually are generated by waves striking at an angle to the prevailing direction of the shoreline but may also be caused by tides or storms.

Coastal Processes

Waves
Tides and Currents

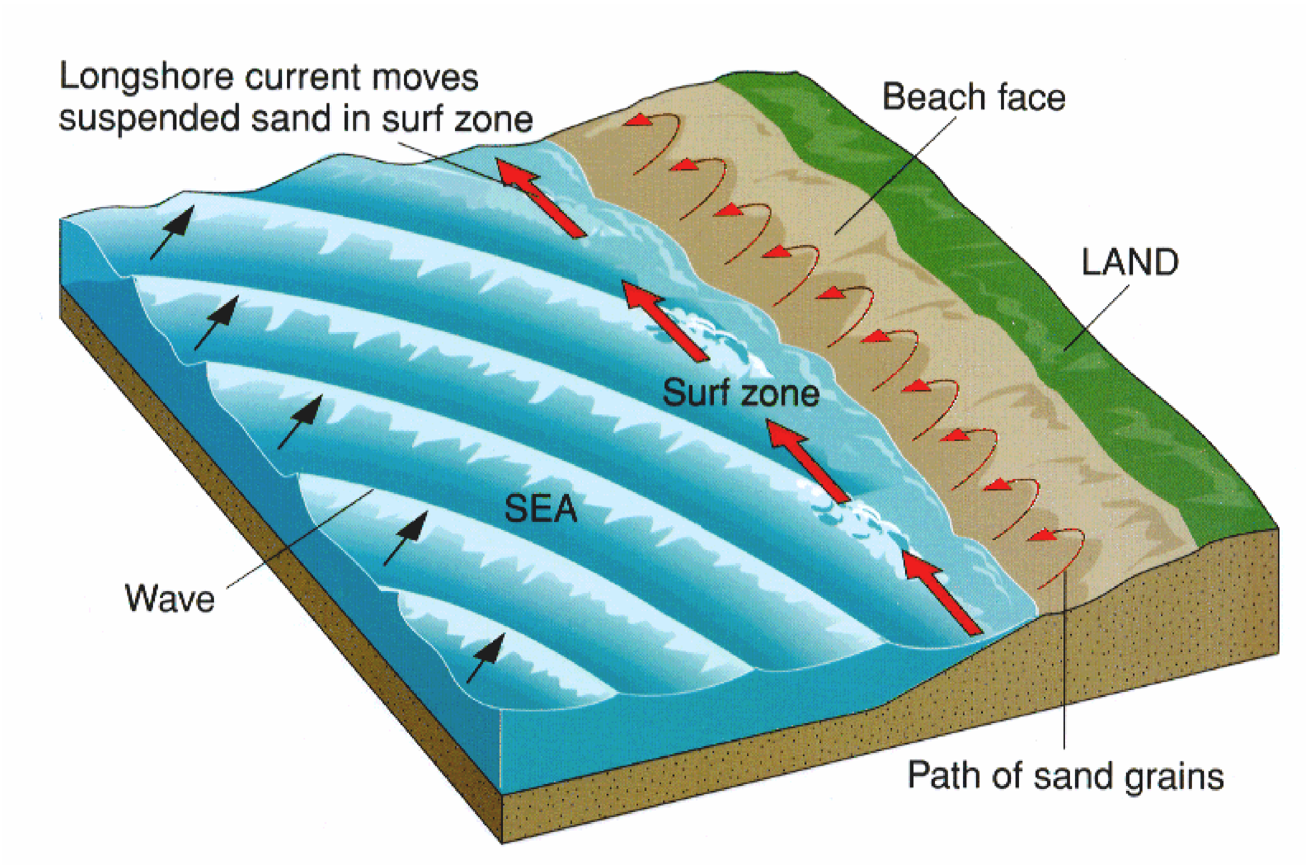
Rip Currents and Cell Circulation



Coastal Processes

Waves
Tides and Currents

Longshore Currents from Oblique Waves



Coastal Processes

Waves
Tides and Currents

Longshore Currents from Oblique Waves

Coastal Processes

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Coastal Processes

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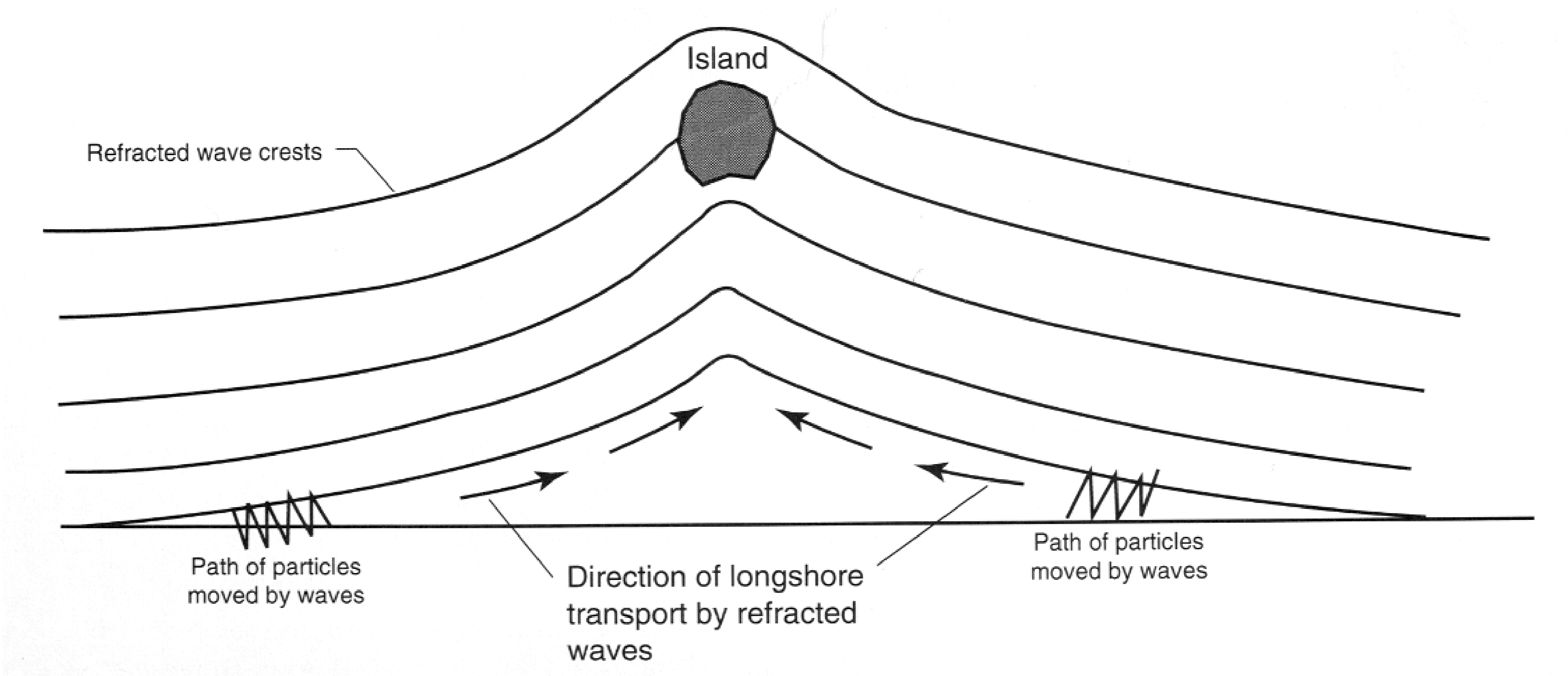


Coastal Processes

Waves
Tides and Currents

Longshore Currents from Oblique Waves

Coastal Processes

Waves
Tides and Currents

Longshore Currents from Oblique Waves

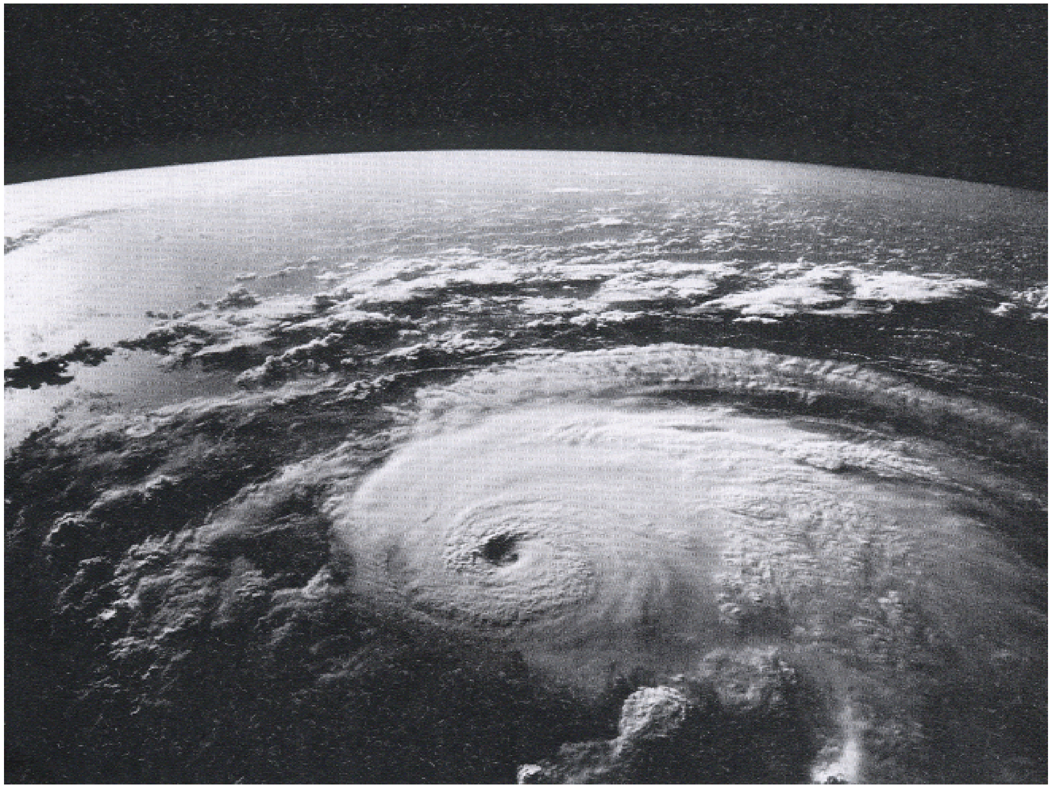
Coastal Processes

Coastal Storms

Dynamics of coasts are directly affected by storms that impinge on the shoreline. Two types of coastal storms - tropical and extratropical. Both are cyclones.

Extratropical storms derive their energy mechanically in a process associated with the interaction of air motion between zones of high and low pressure.

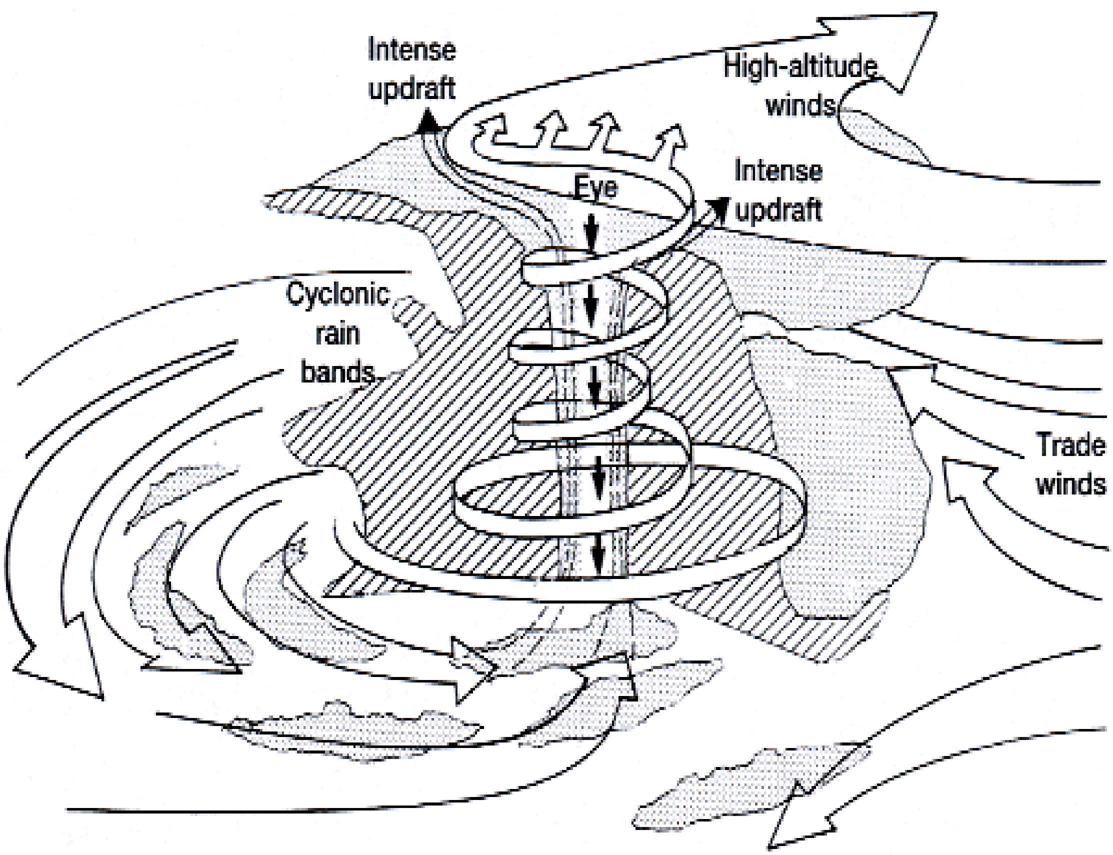
Tropical storms are fueled by latent heat from the evaporation of water.



Coastal Processes

Coastal Storms

Tropical storms - in the US, hurricane is employed when wind velocity exceed 74 mph.



Coastal Processes

Coastal Storms

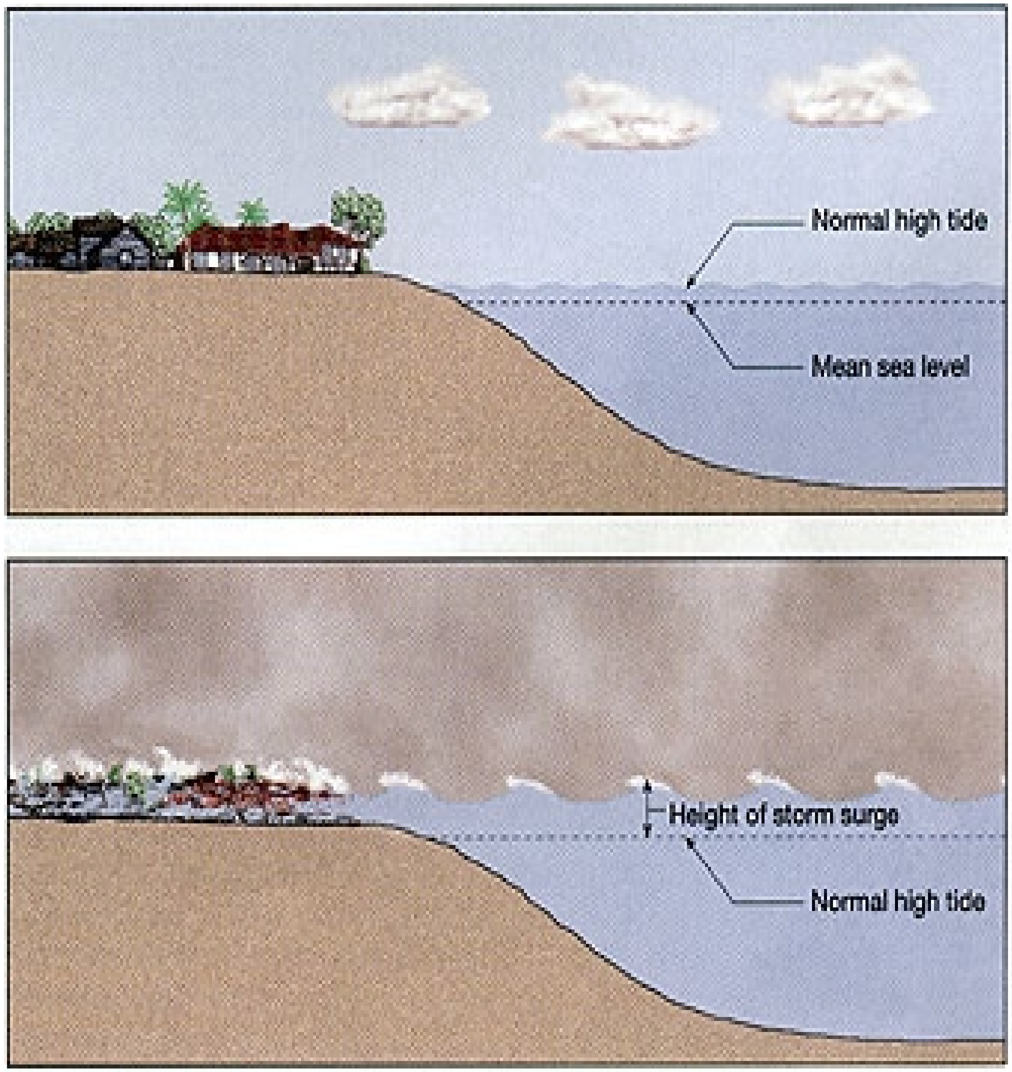
Tropical storms

Hurricane Fran
9/04

Coastal Processes

Coastal Storms

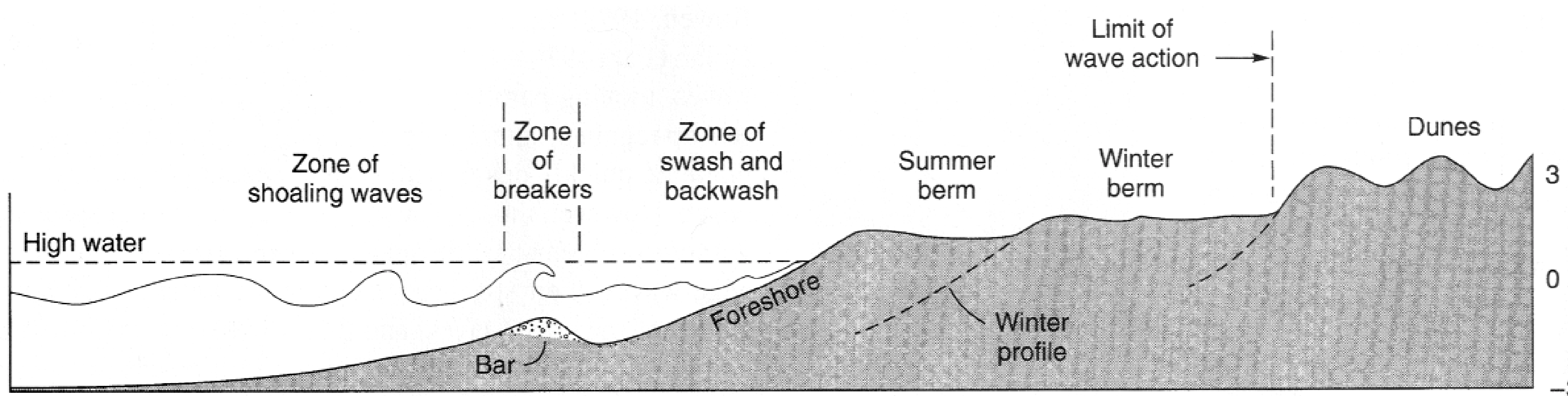
A ***storm surge*** is an elevation of normal water level in response to a passing storm.



Coastal Processes

Beaches

Beach is a relatively narrow portion of a coast that is directly affected by wave action. It usually terminates inland at a sea cliff, a dune field or at the boundaries of permanent vegetation. Part of the beach is continuously submerged because it lies beneath low-tide sea level. However, the bottom is subject to wave action. In that sense the term beach is synonymous with the littoral zone, an expression used commonly in geological work.



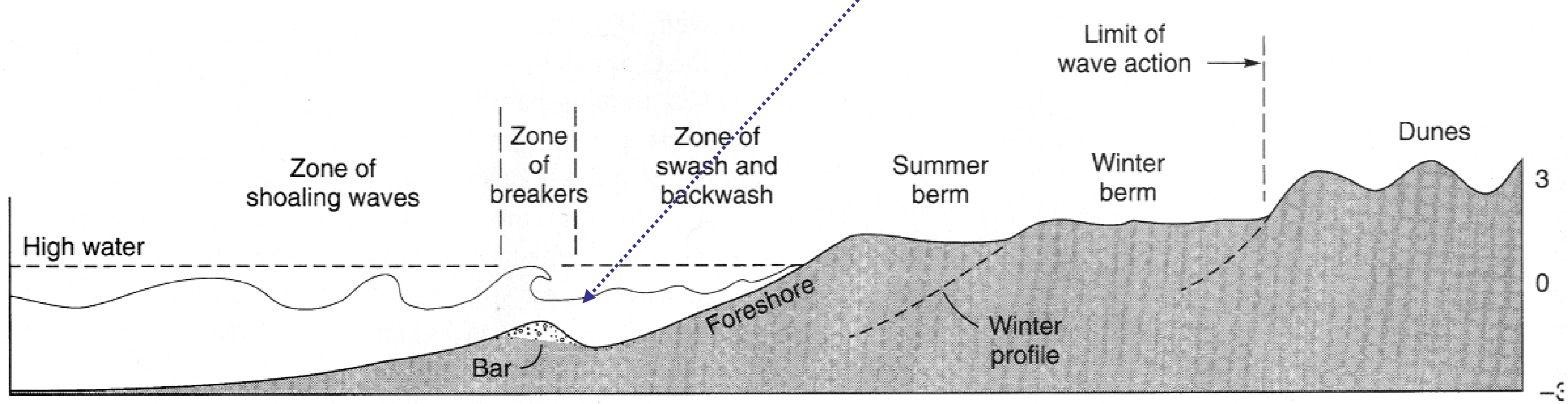
Coastal Processes

The Beach Profile

Surf occurs when the deeper waves begin to drag on the ocean bottom and form breakers.

The ***beach face*** is the sloping section of the beach profile immediately seaward of the berm.

In the zone seaward from the beach face, a submerged longshore bar is commonly, but not always present. An associated trough develops between the bar and the beach face.



The Beach Profile

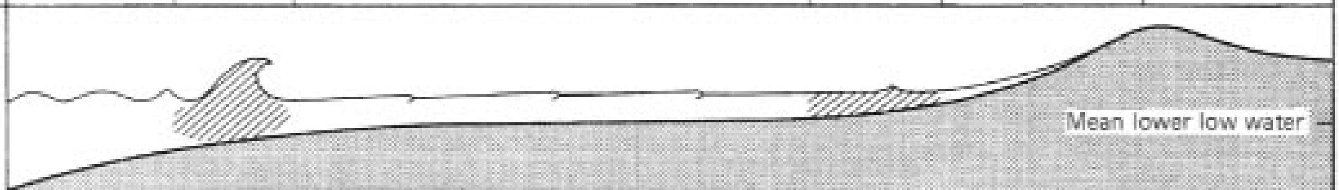
WATER MOTION	Oscillatory Waves	Wave Collapse	Waves of Translation (bores): Longshore Currents: Seaward Return Flow; Rip Currents	Collision	Swash; Backwash	Wind
DYNAMIC ZONE	Offshore	Breaker	Surf	Transition	Swash	Berm Crest
PROFILE						
SEDIMENT SIZE TRENDS	— Coarser →	Coarsest Grains	← Coarser →	Bi-modal Lag deposit	← Coarser —	Wind-winnowed lag deposit
PREDOMINANT ACTION	Accretion	Erosion	Transportation	Erosion	Accretion and Erosion	
SORTING	← Better —	Poor	Mixed	Poor	— Better →	
ENERGY	— Increase →	High	— Gradient →	High		

FIGURE 19-16. Major dynamic zones in the nearshore zone of a sandy coast. Two regions of maximum sand suspension and transport are shaded (Ingle, 1966, Figure 116).

Coastal Processes

Coastal Processes

Coastal Processes

Shoreline Configurations - Beach Cusps

Considering the large variety of waves, energy conditions, and shoreline configurations possible it seems unlikely that coincidence can be attributed to the similarity in shape and spacing for many beaches.

The most common crescentric forms are beach cusps.

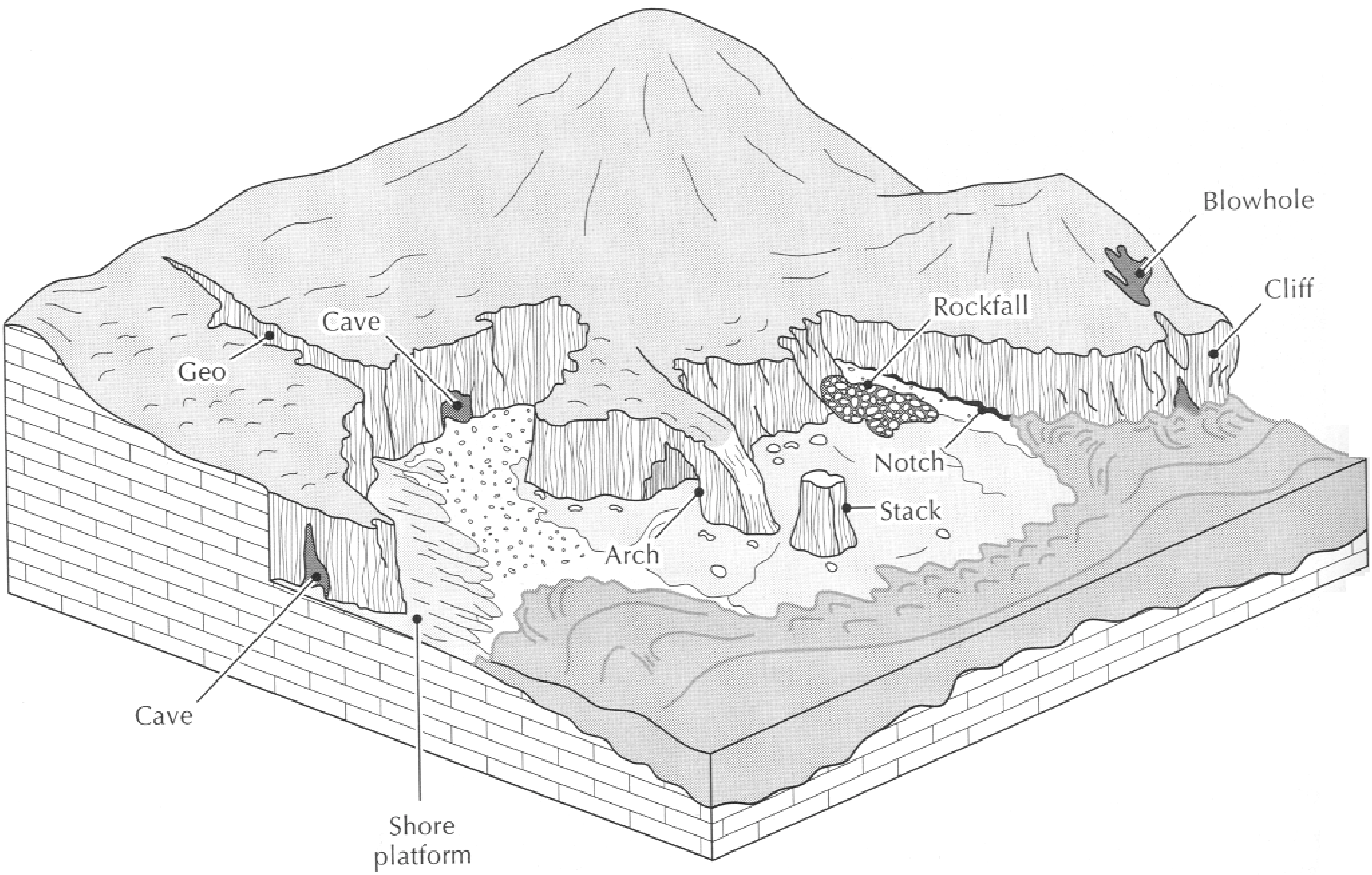
Coastal Processes

Erosional Landforms

Erosion of shorelines constitutes one of the major problems facing scientists, engineers, and land managers throughout the world.

Coastal Processes

Erosional Landforms



Coastal Processes

Erosional Landforms

Because of the increased use of the entire coastal zone, engineers and coastal zone managers have placed considerable attention on the processes and rates of sea cliff erosion. Most notable are corrosion (solubility) and corrasion (abrasion).

Coastal Processes

Erosional Landforms

The rates of cliff erosion are highly variable. The variability is derived from differences in geology, wave climate, and time.

As the cliff retreats, it leaves behind a beveled surface called the ***wave-cut platform*** that stands slightly below water level at high tide.

Coastal Processes

Erosional Landforms

Stacks are isolated parts of the headland formed when narrow oceanward extensions of the coastal rocks are cut into isolated remnants by wave attack.

Coastal Processes

Erosional Landforms

As sea caves grow, they may extend completely through the headland to produce a ***sea arch.***

Coastal Processes

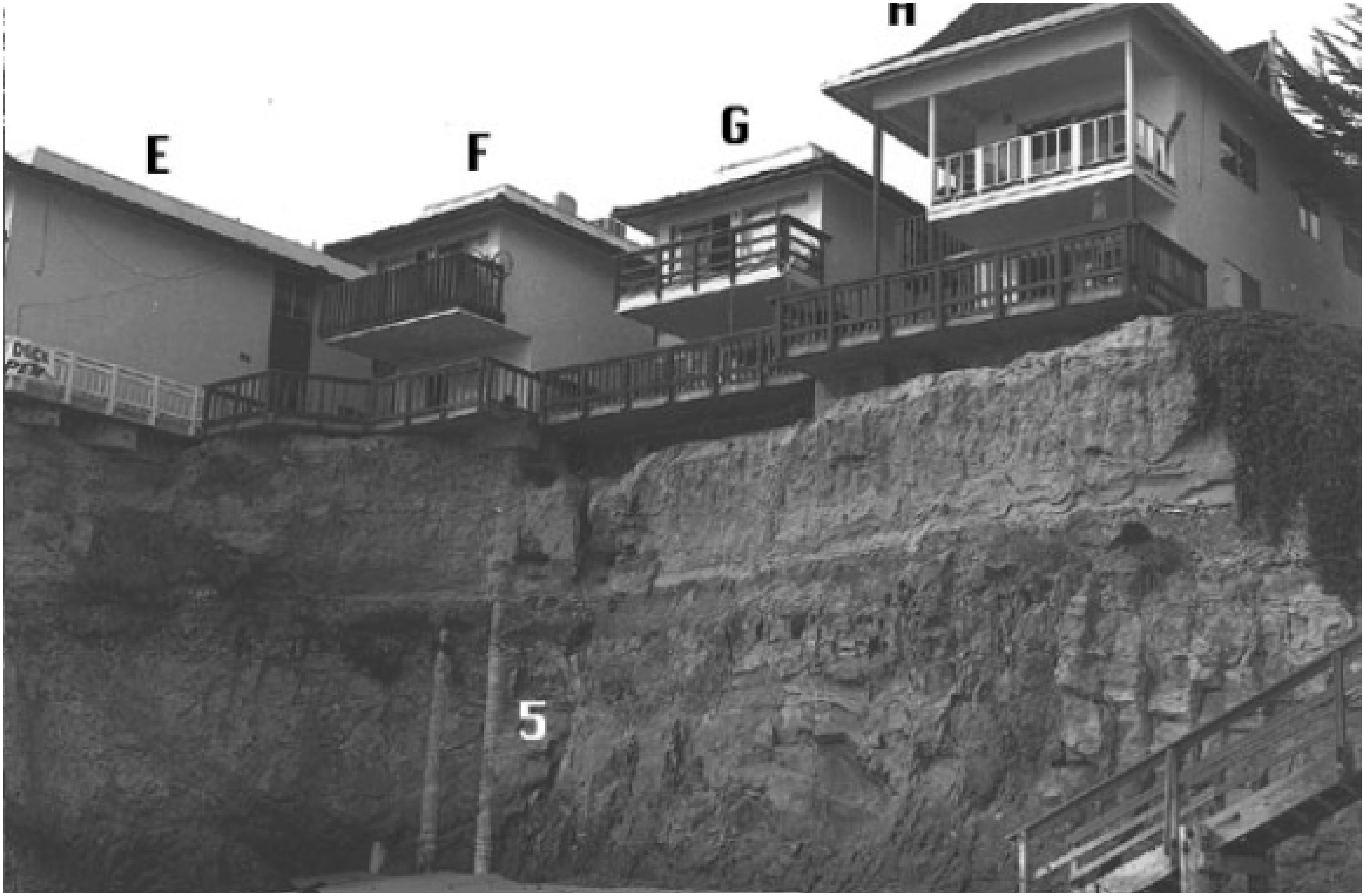
Erosional Landforms – winter, 1989

Coastal Processes

Erosional Landforms – February, 1990

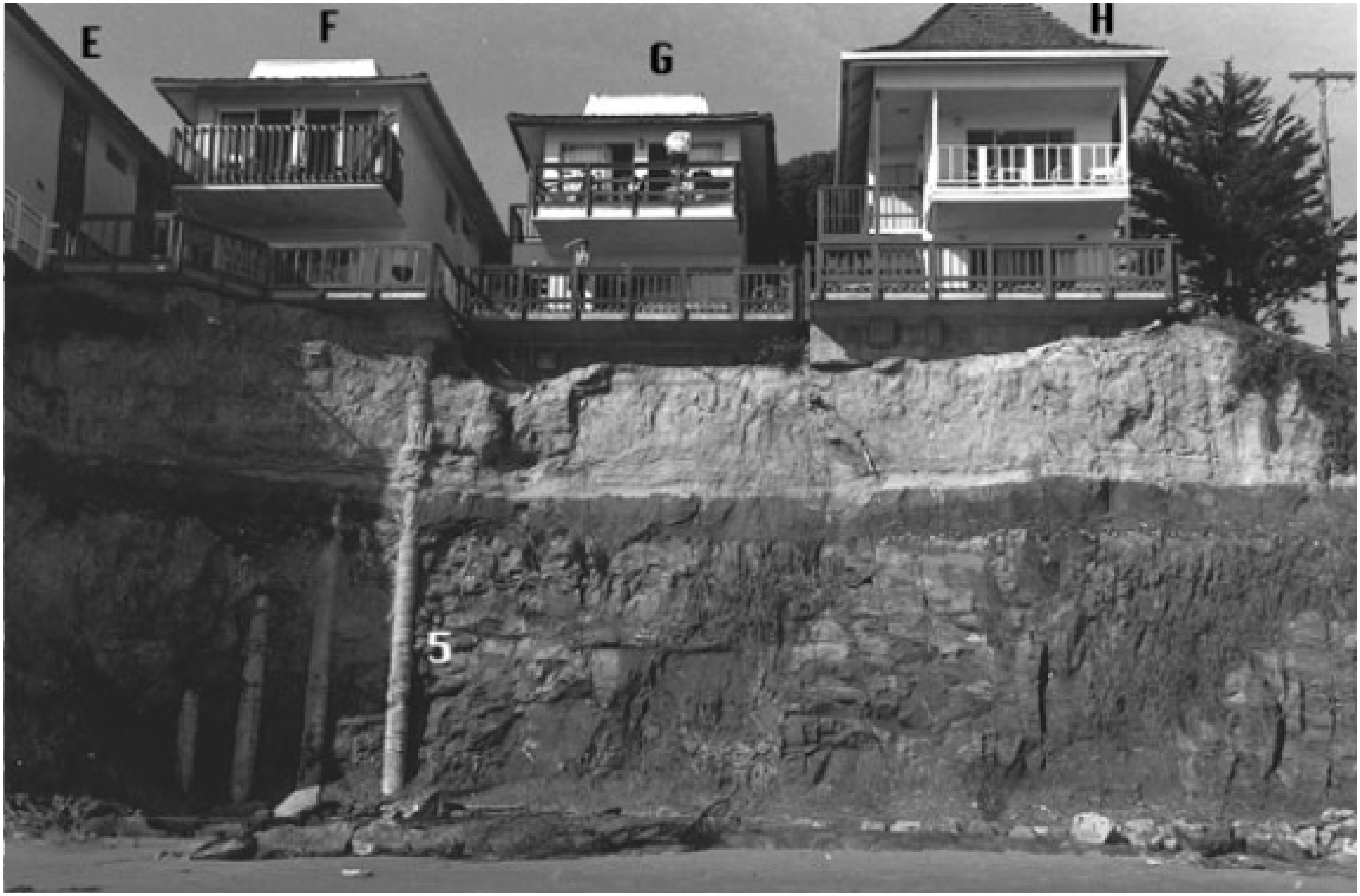
Coastal Processes

Erosional Landforms – February, 1991



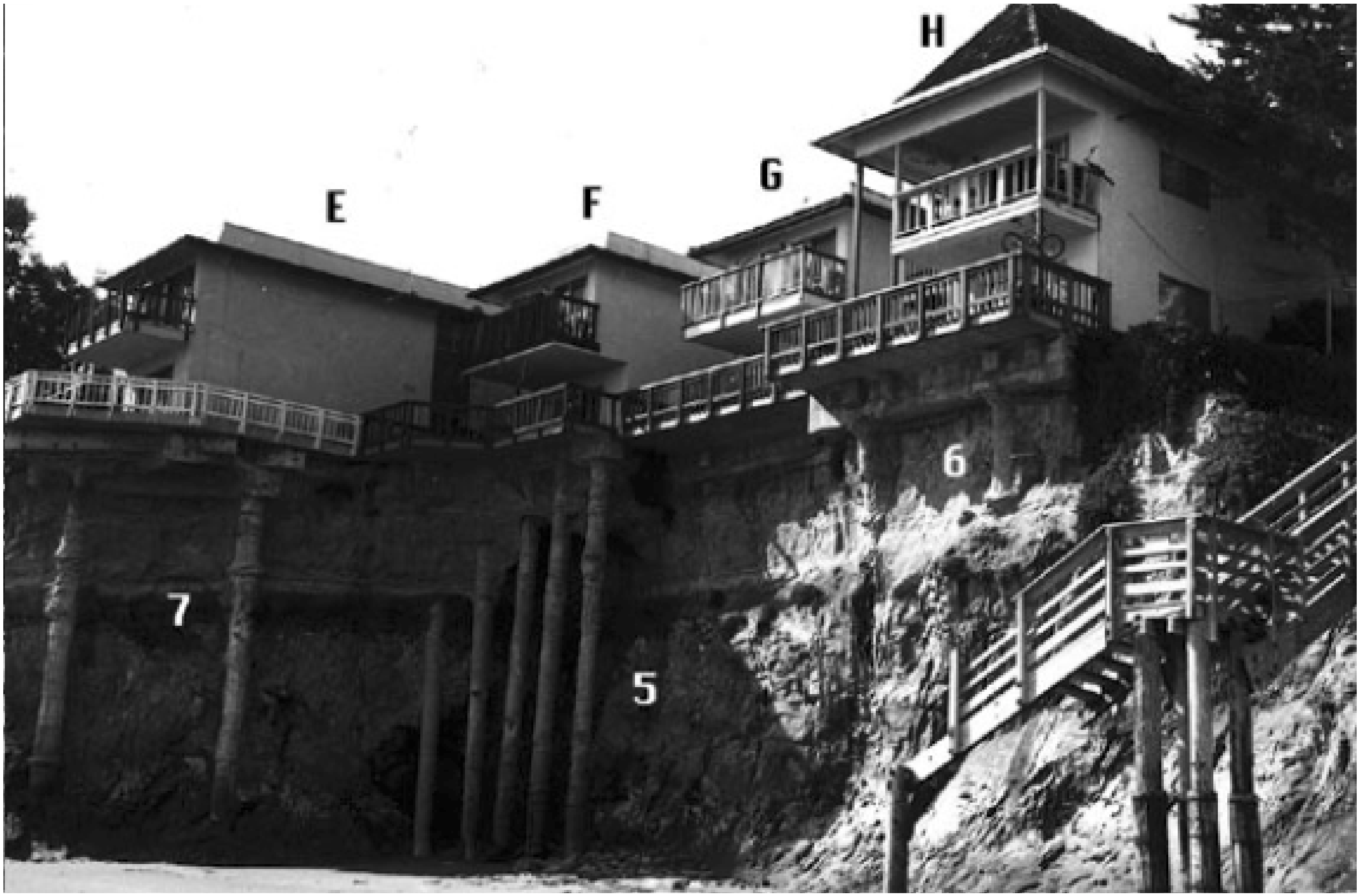
Coastal Processes

Erosional Landforms – February, 1993



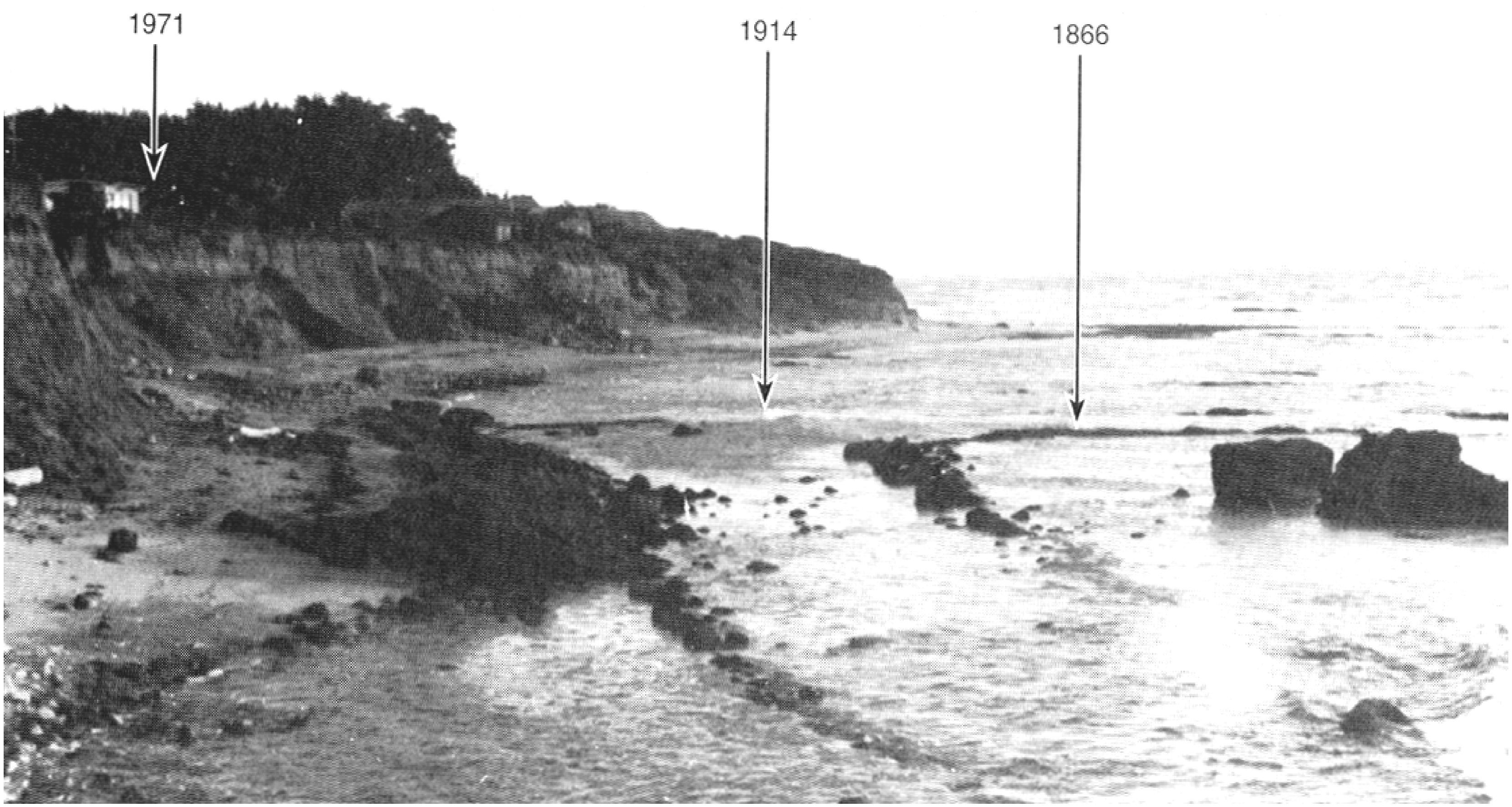
Coastal Processes

Erosional Landforms – March, 1999



Coastal Processes

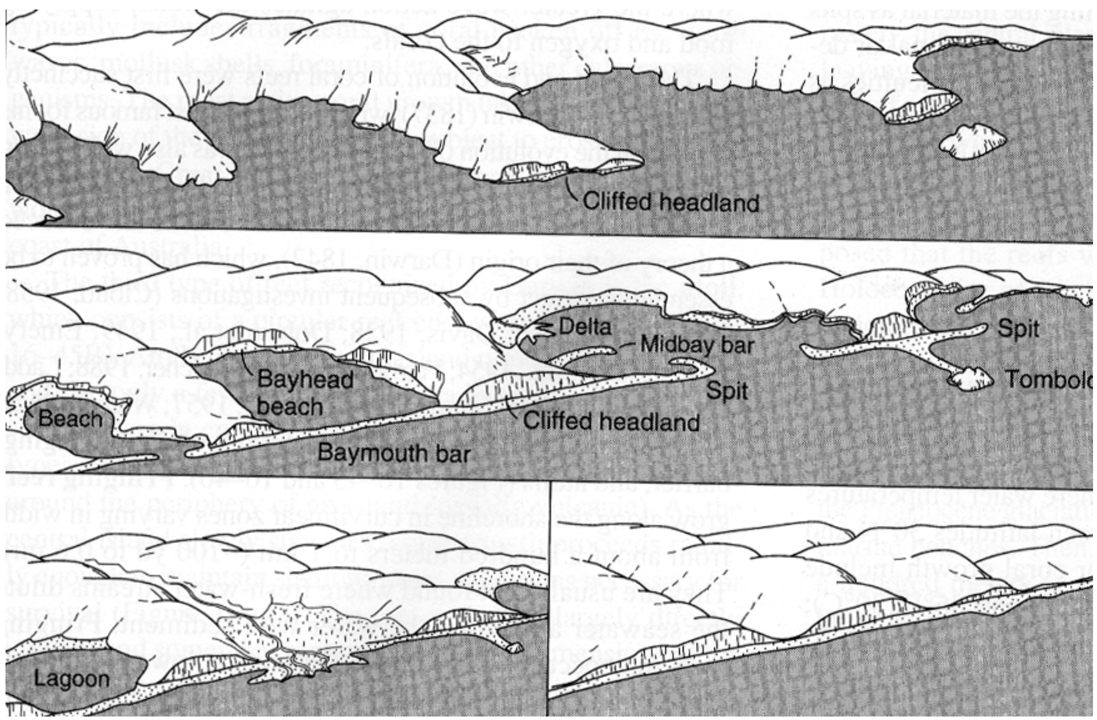
Erosional Landforms - *San Mateo County, Ca. (photo by K. Lajoie – USGS)*



Coastal Processes

Depositional Landforms

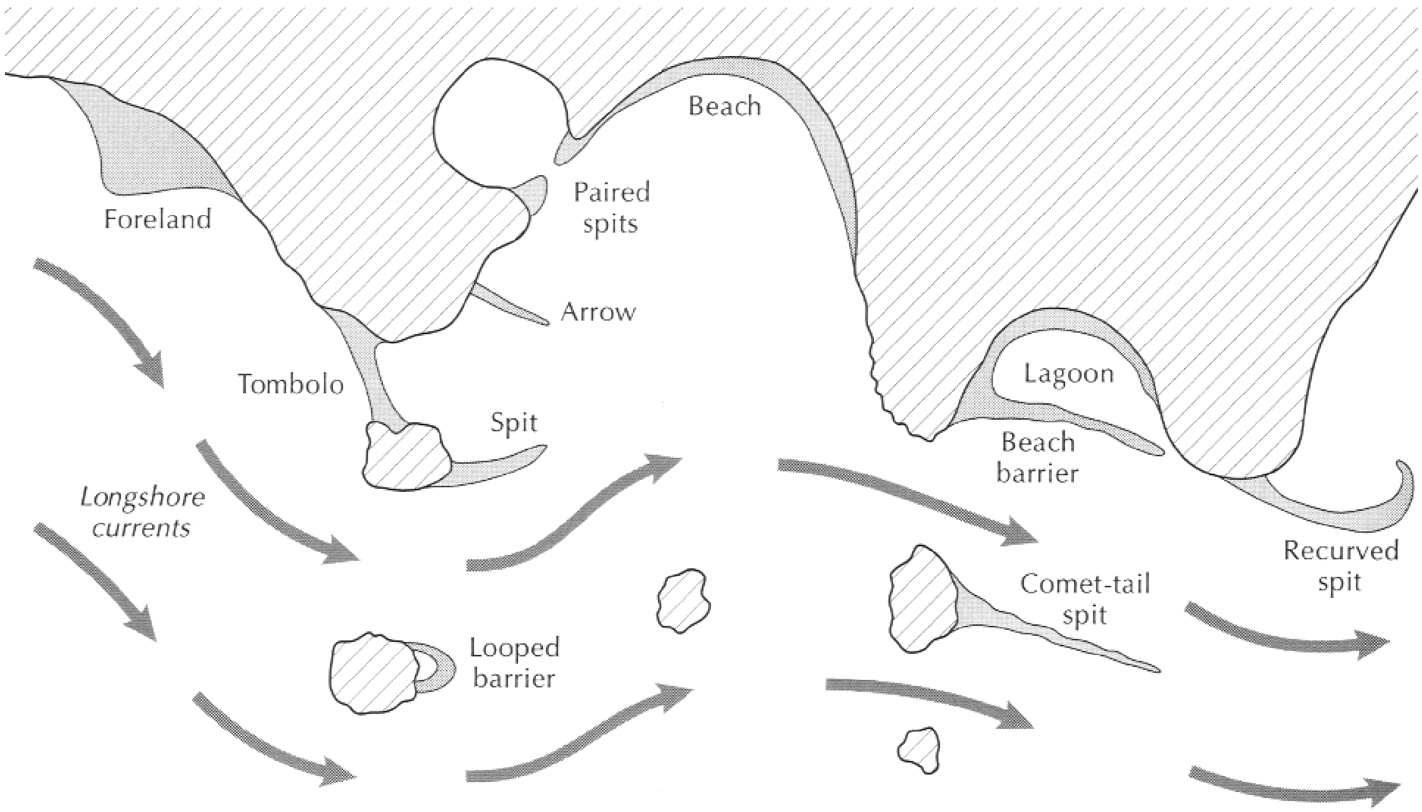
In coastal areas where the supply of sand is abundant and local ocean forces are capable of transporting sediment, the shapes of the landforms are determined by depositional events.



Coastal Processes

Depositional Landforms

Spits and ***baymouth bars*** are essentially the same feature, except spits extend into the open ocean and baymouth bars cross the gap between two headland reaches.



Coastal Processes

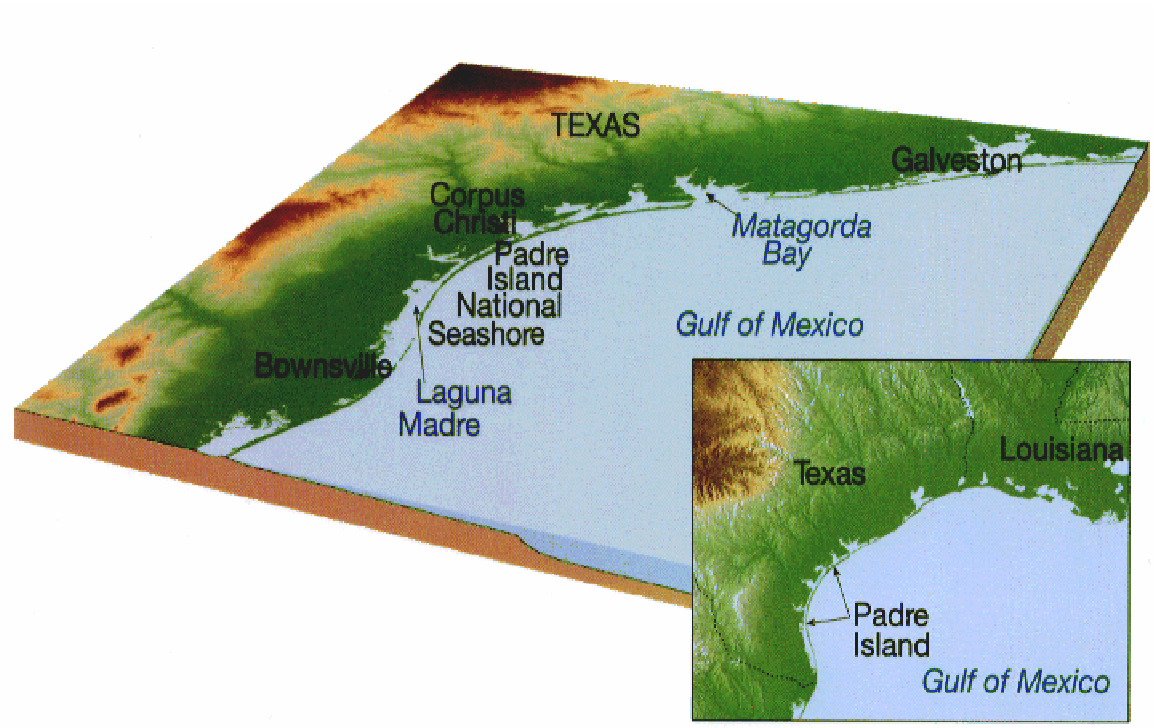
Depositional Landforms

Spits and ***baymouth bars*** are essentially the same feature, except spits extend into the open ocean and baymouth bars cross the gap between two headland reaches.

Coastal Processes

Depositional Landforms

Barrier islands are elongated bodies of sand that are not attached to the mainland but are separated from it by a lagoon or bay.



Coastal Processes

Depositional Landforms

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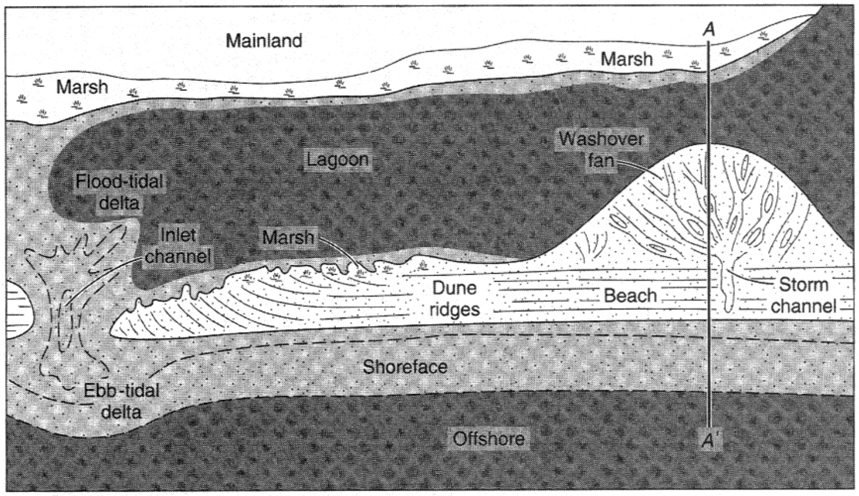

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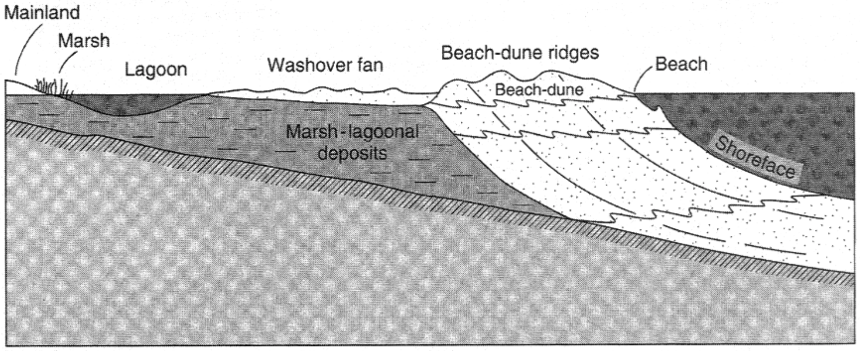

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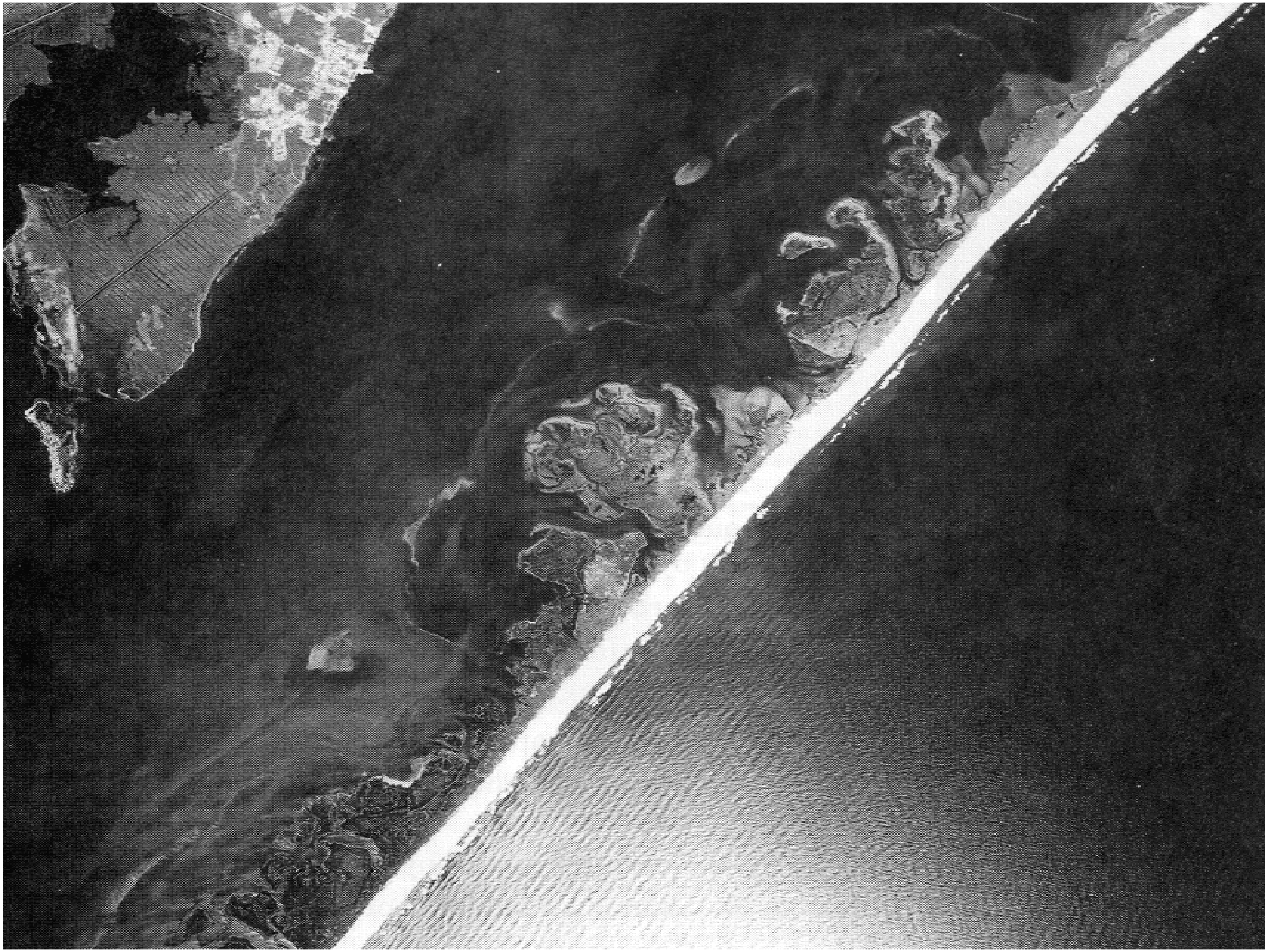


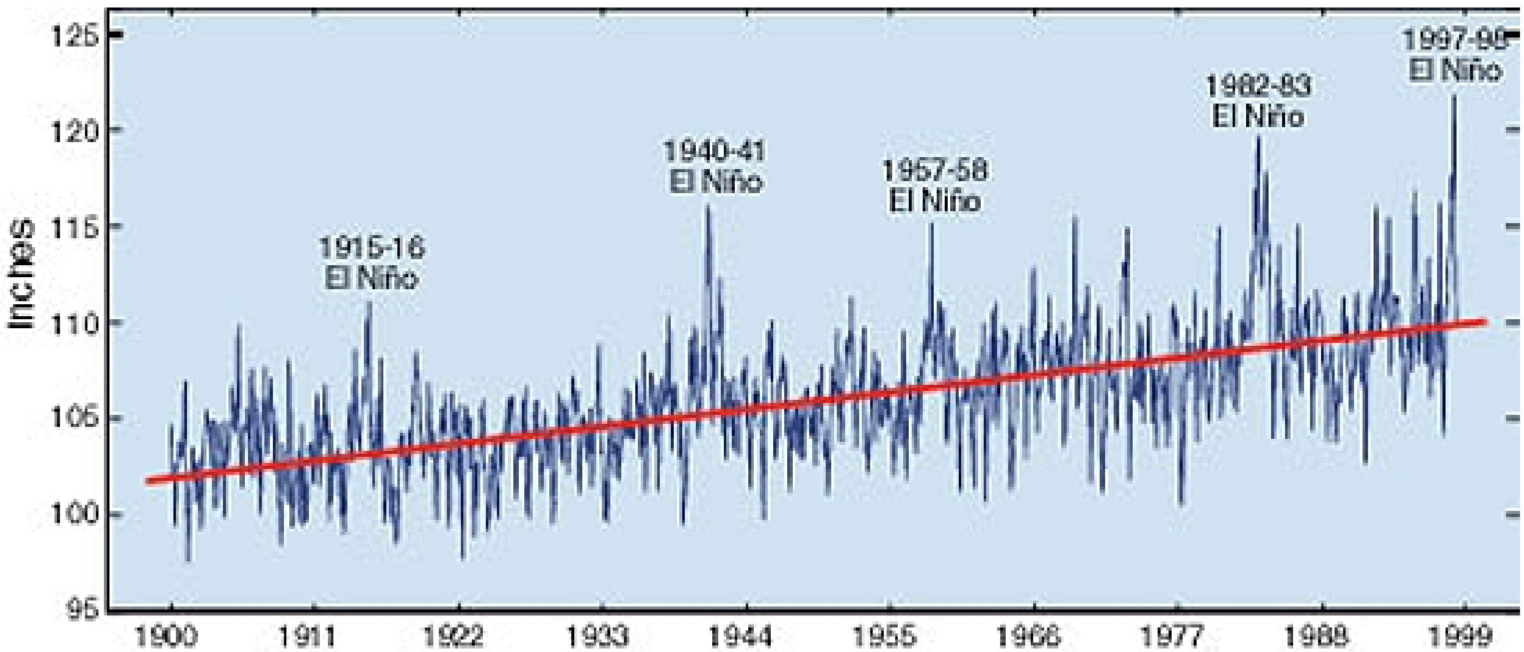
Coastal Processes

Depositional Landforms

Spits and ***baymouth bars*** are essentially the same feature, except spits extend into the open ocean and baymouth bars cross the gap between two headland reaches.

Coastal Processes

Sea Level Changes



Coastal Processes

Sea Level Changes – wave cut terraces

Coastal Processes

Sea Level Changes – wave cut terraces

Coastal Processes

Sea Level Changes – wave cut terraces

Coastal Processes

Sea Level Changes – drowning shorelines

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