
Beaches

Principles and Processes of Sediment Transport

Factors controlling the movement of sediments, erosion, transport, deposition, etc.

Beaches

Estuaries

Principles and Processes of Sediment Transport

Factors controlling the movement of sediments, erosion, transport, deposition, etc.

Delta

Shelf Seas in general

Beaches

Estuaries

Principles and Processes of Sediment Transport

Factors controlling the movement of sediments, erosion, transport, deposition, etc.

Delta

Shelf Seas in general

Circulation environments →

Beaches **Estuaries**

Longshore currents
Wave generated currents

Principles and Processes of Sediment Transport

Factors controlling the movement of sediments, erosion, transport, deposition, etc.

Delta

Shelf Seas in general

Circulation environments

Beaches

Estuaries

Longshore currents
Wave generated currents

Tides and
estuarine circulation

Principles and Processes of Sediment Transport

Factors controlling the movement of sediments, erosion, transport, deposition, etc.

Delta

Shelf Seas in general

Circulation
environments

Beaches

Longshore currents
Wave generated currents

Estuaries

Tides and
estuarine circulation

Principles and Processes of Sediment Transport

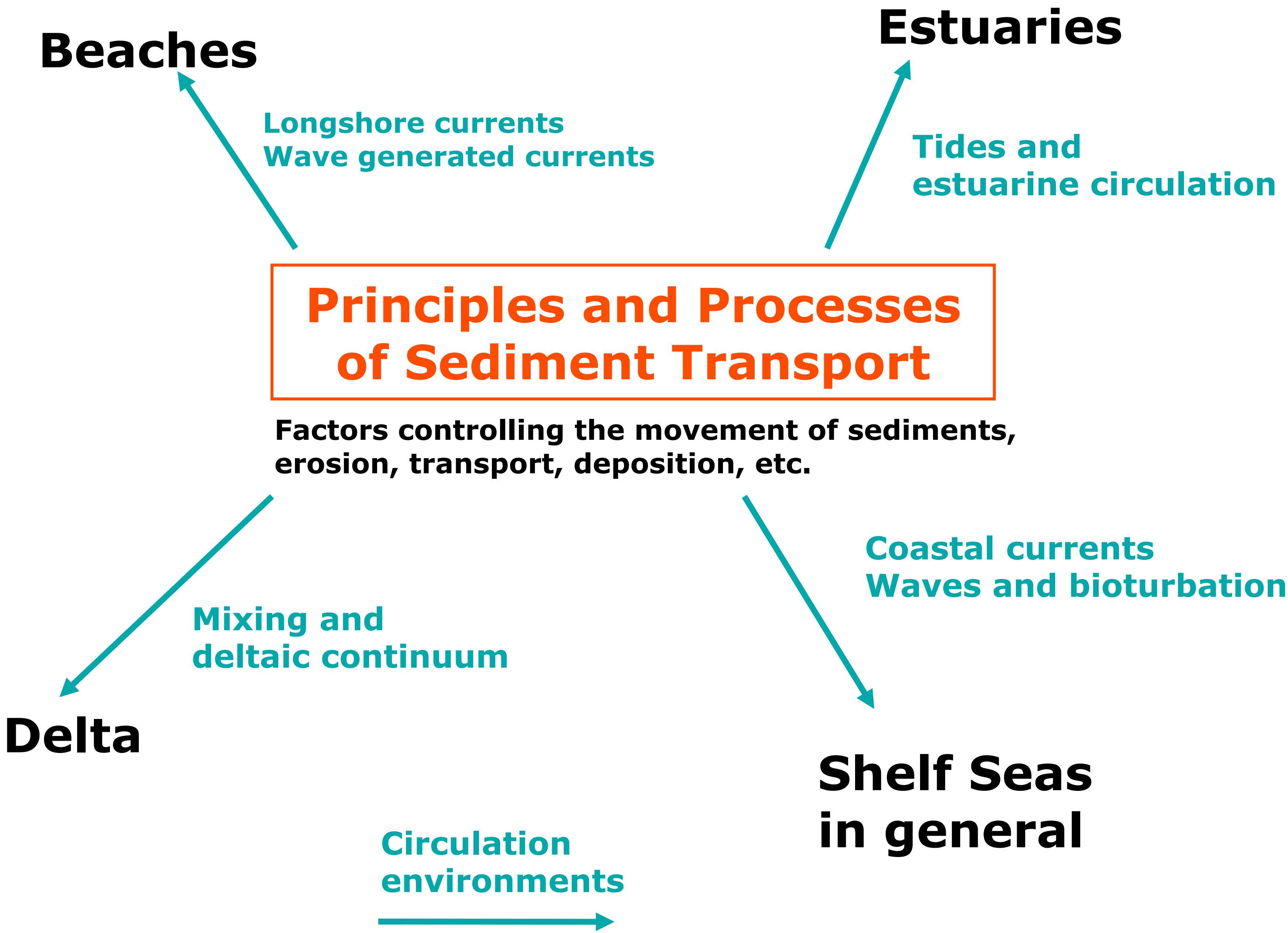
Factors controlling the movement of sediments, erosion, transport, deposition, etc.

Mixing and
deltaic continuum

Delta

Shelf Seas in general

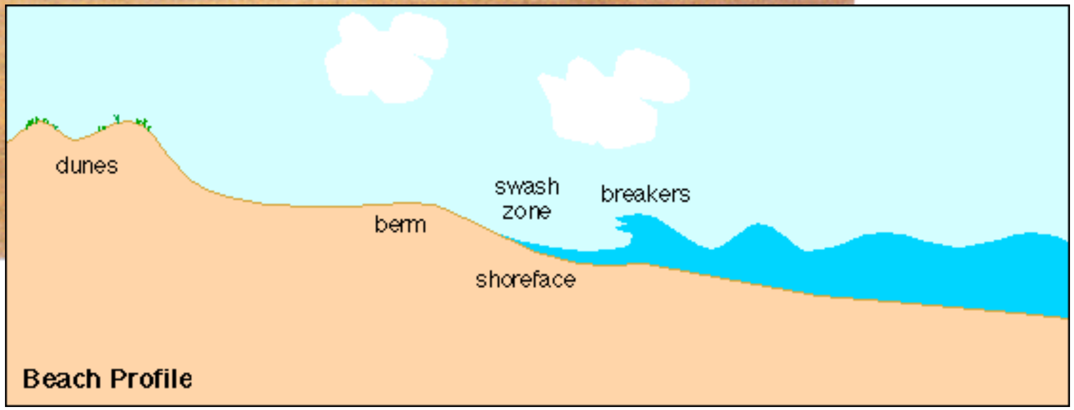
Circulation
environments


Beaches
Estuaries
Longshore currents
Wave generated currents
Tides and
estuarine circulation
Principles and Processes
of Sediment Transport
Factors controlling the movement of sediments,
erosion, transport, deposition, etc.
Coastal currents
Waves and bioturbation
Mixing and
deltaic continuum
Delta
Shelf Seas
in general
Circulation
environments

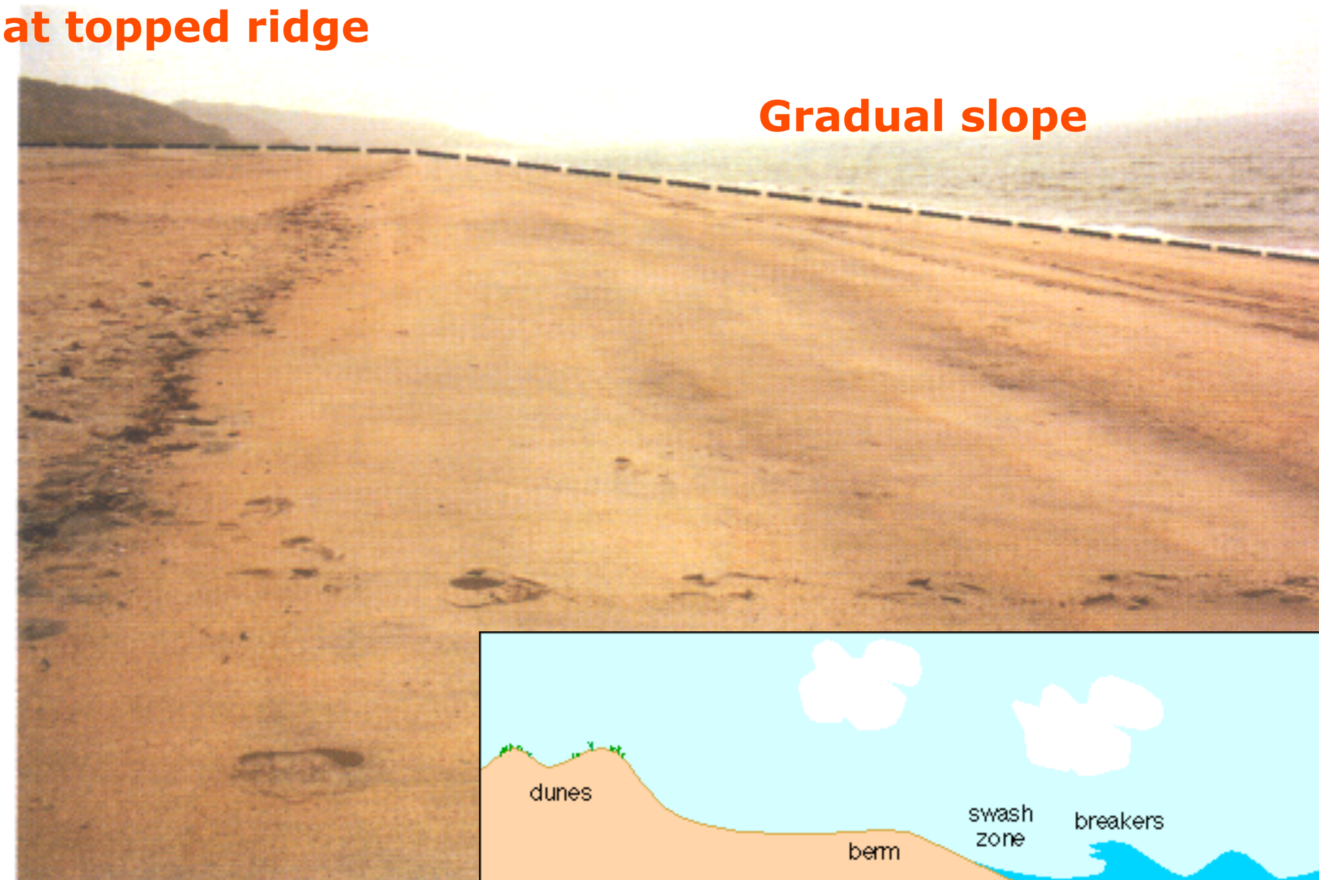
Beach Morphology

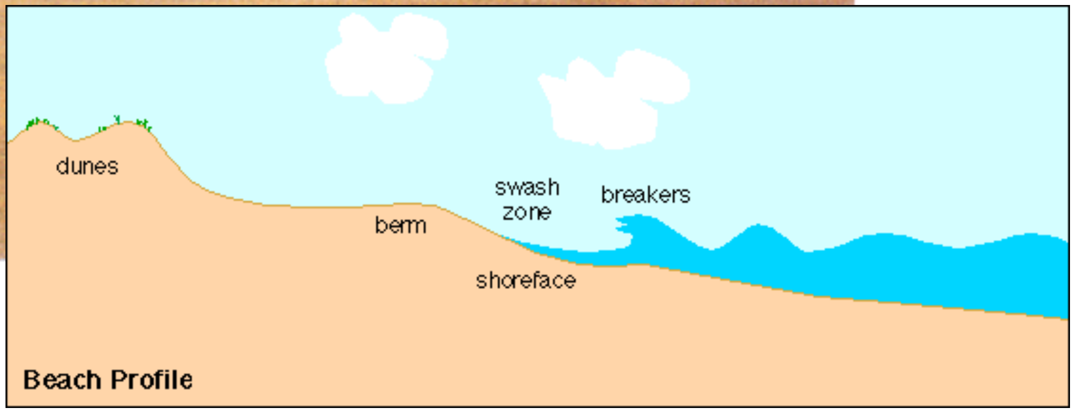
Beach Morphology

Beach Morphology



Beach Morphology



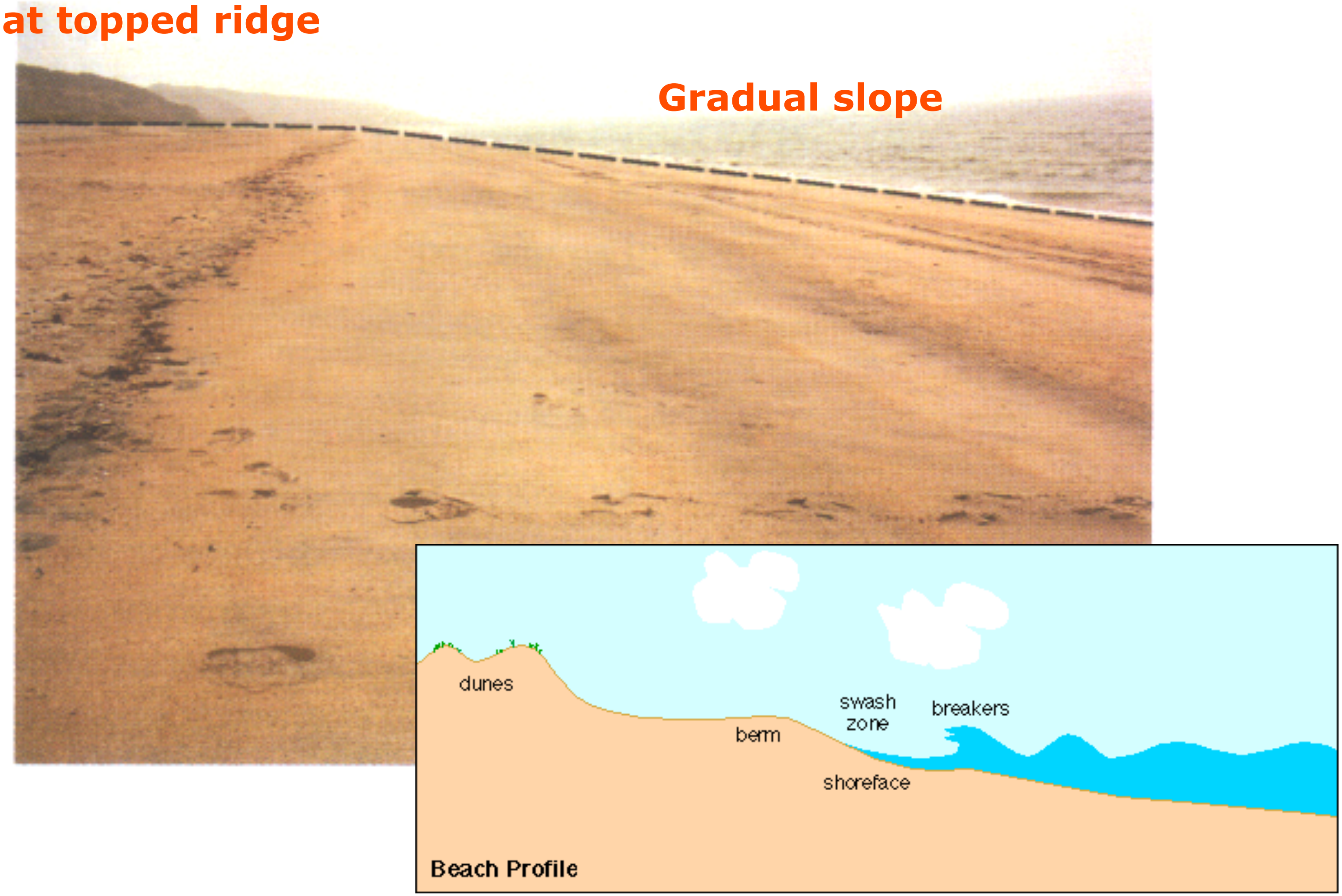


Beach Morphology

berm

Flat topped ridge

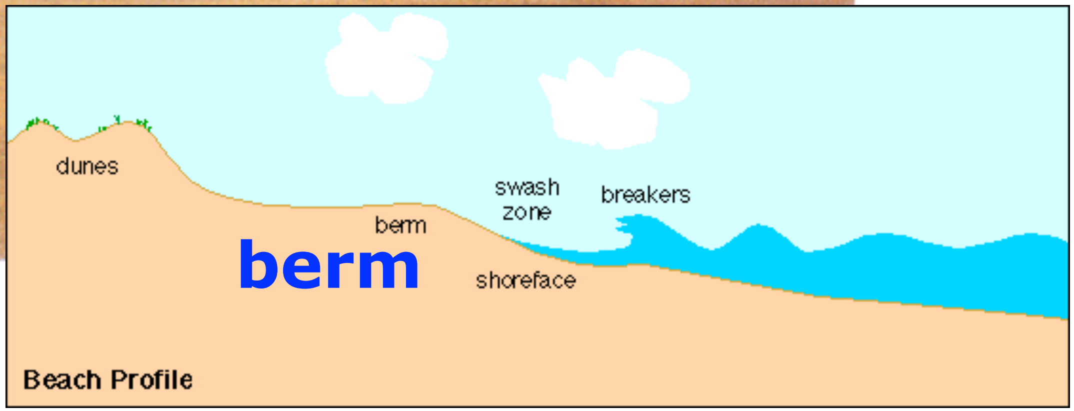
Gradual slope



Beach Morphology

berm

Flat topped ridge



Beach Morphology

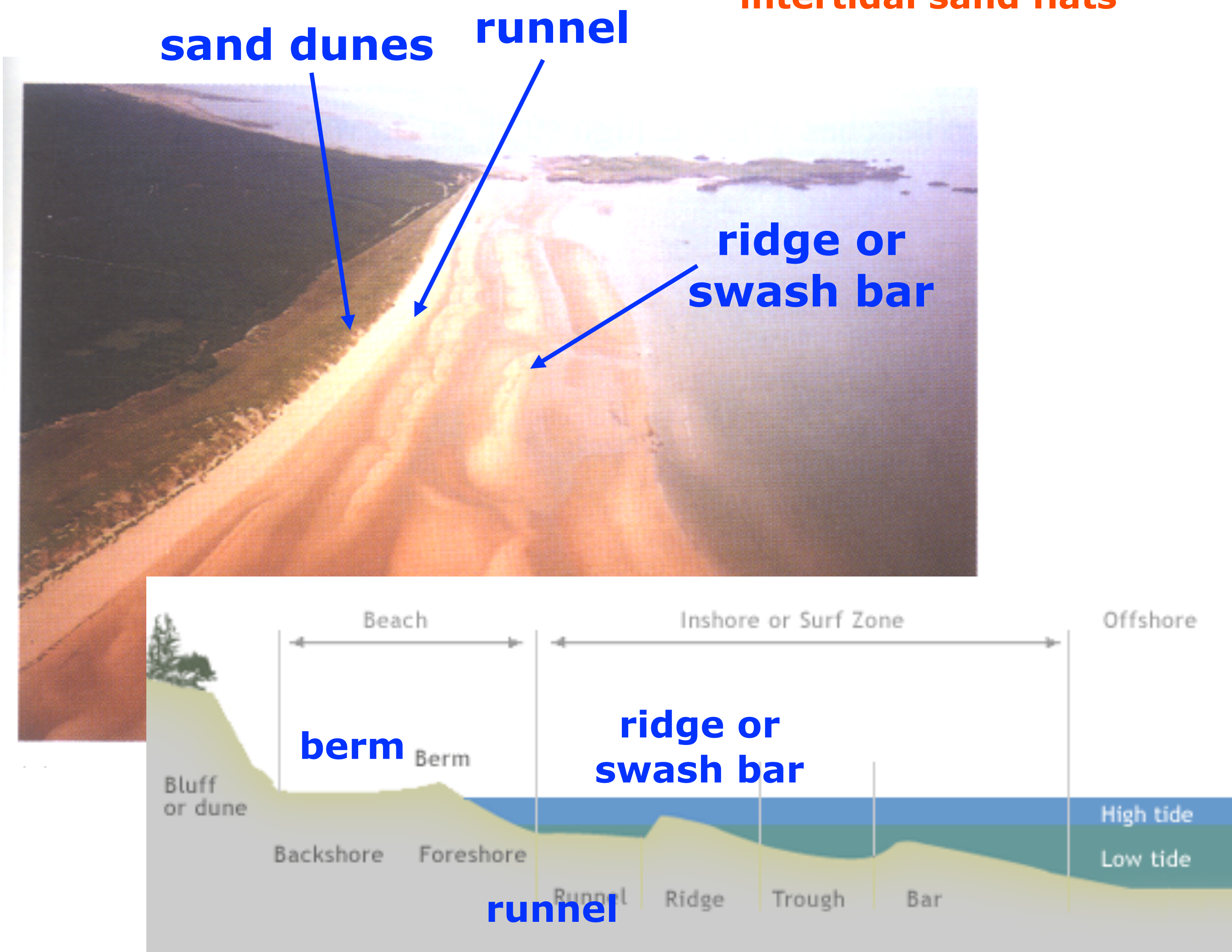
Gradual slope
intertidal sand flats

Beach Morphology

Gradual slope
intertidal sand flats

Beach Morphology

Gradual slope
intertidal sand flats



Beach Morphology

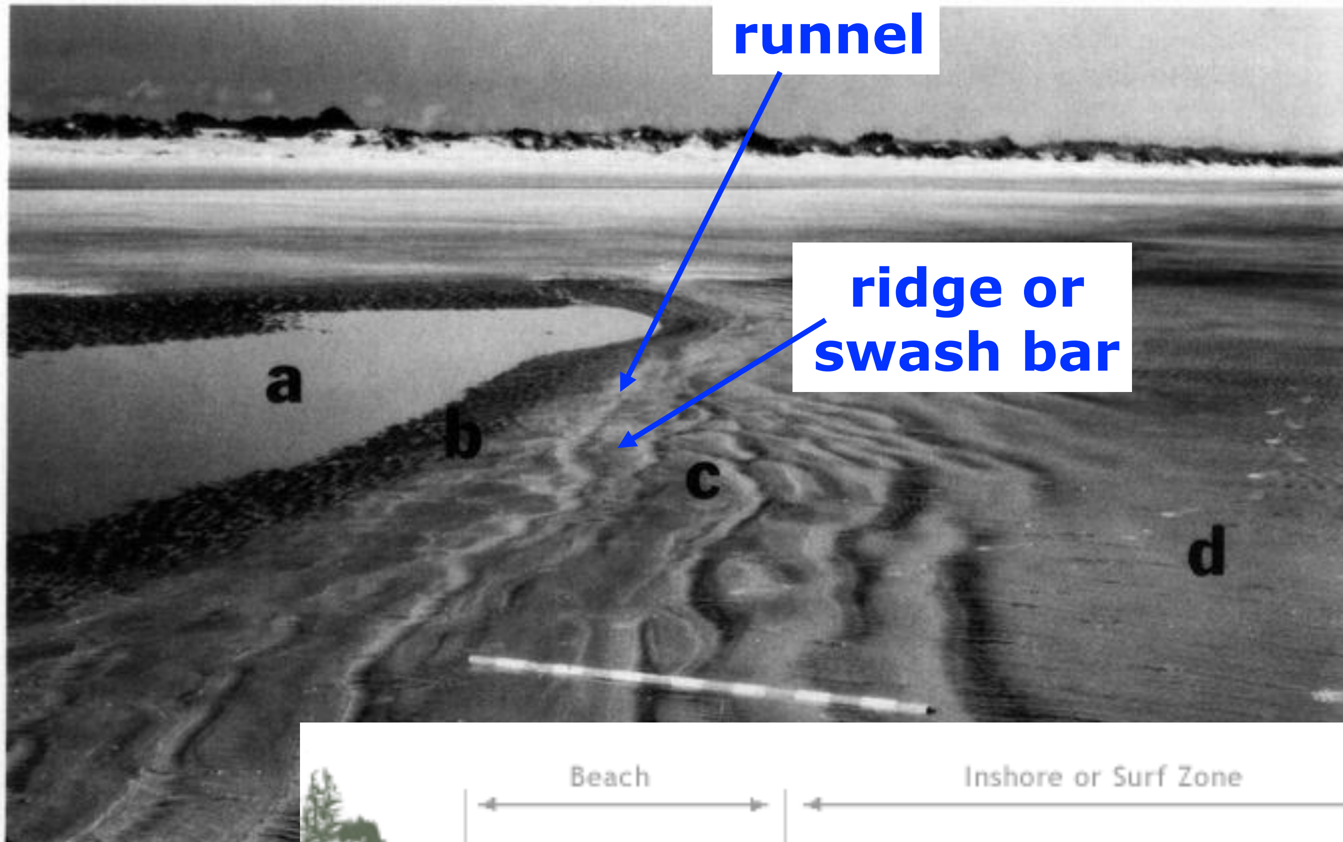
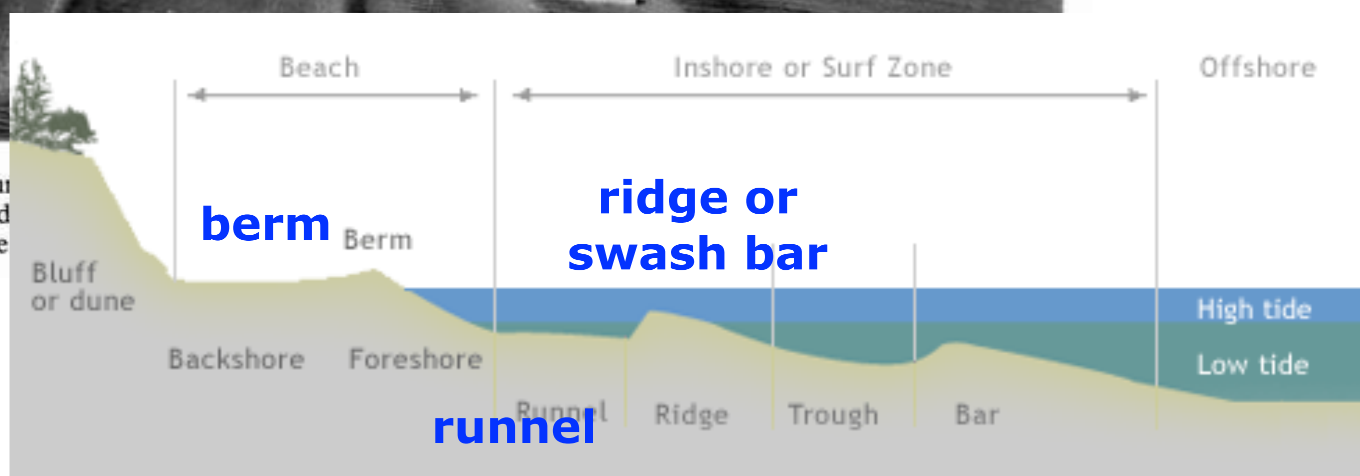
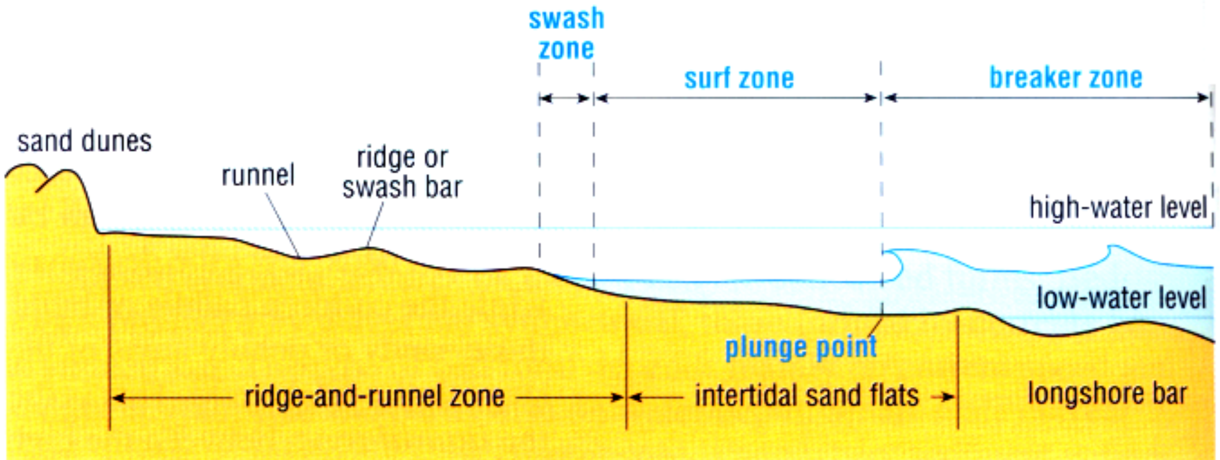


FIG. 5.—Ridge and ru
small ripples (b) to antid
ridge crest is roughly the



Beach Morphology

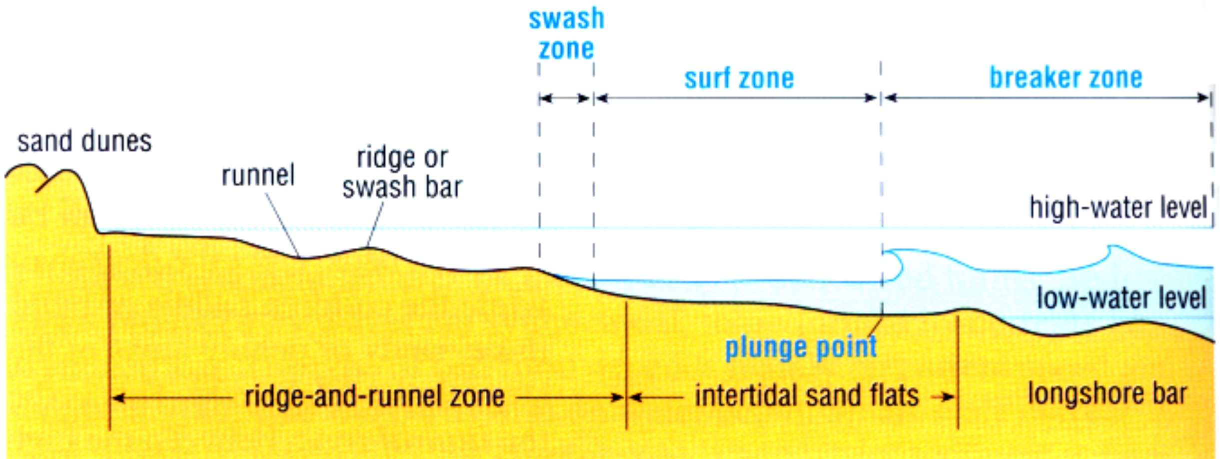
shallow slope



(a)

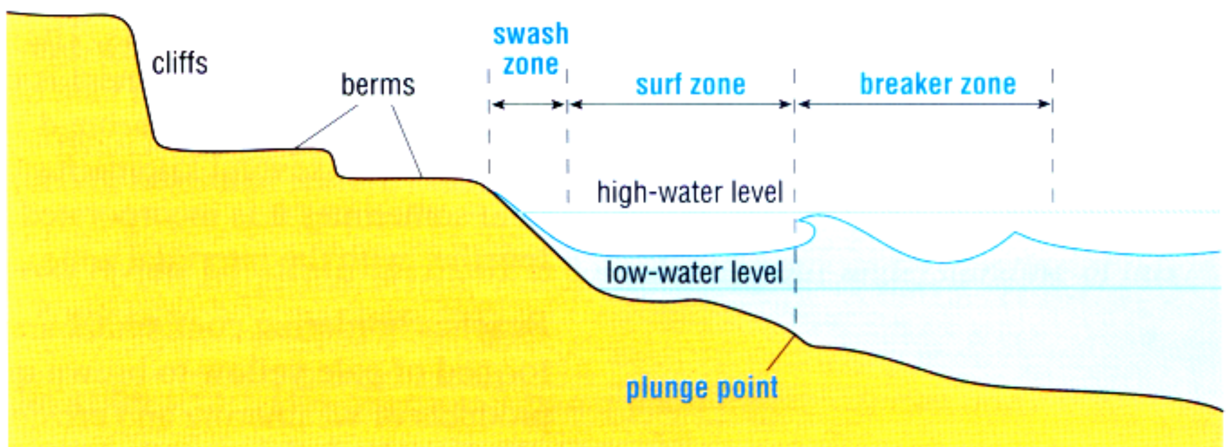
Beach Morphology

shallow slope



(a)

steep slope



(b)

Why do we care of beach morphology?

Changes associated with the seasonal cycle

Autumn

(a)

Autumn

Winter

Autumn

Winter

Winter

(c)

Autumn

Winter

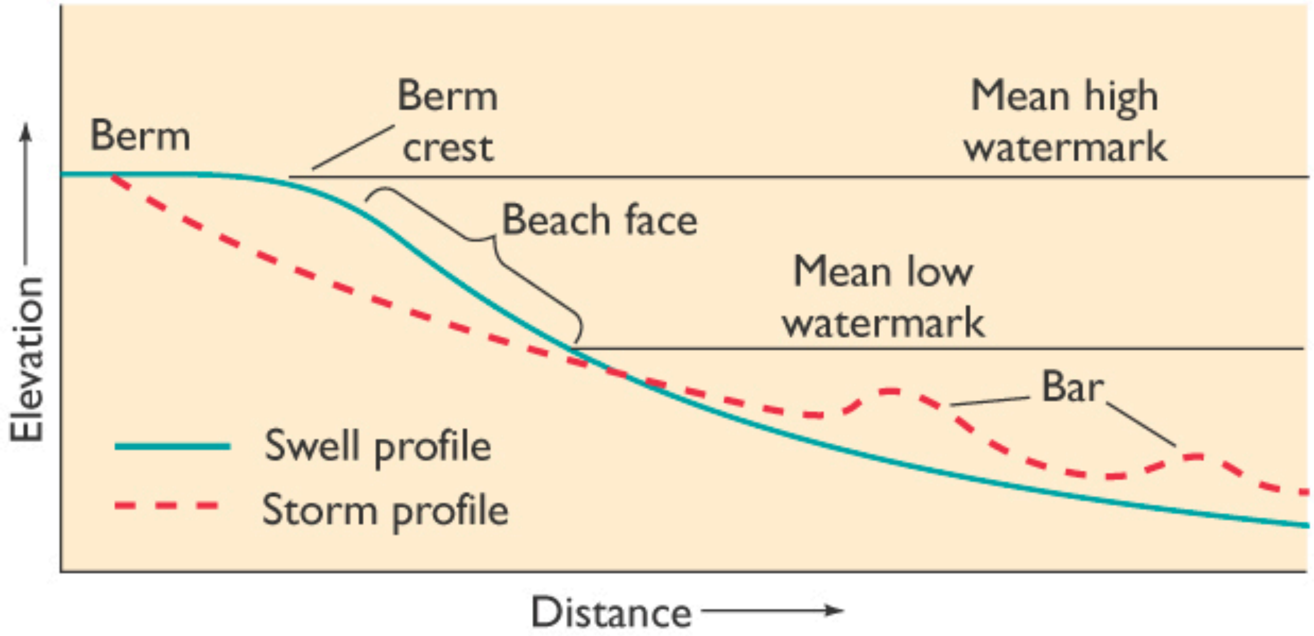
Winter

(c)

Summer

(d)

Beach shapes respond to STORMY weather



What factor determine the beach profile?

What factor determine the beach profile?

Backwash

What factor determine the beach profile?

Backwash < Wash → Beach grows!

What factor determine the beach profile?

Backwash < Wash → Beach grows!

1) Grain size. **Larger grain → more Percolation of water into sand/pebbles → greatly reduces the backwash.**

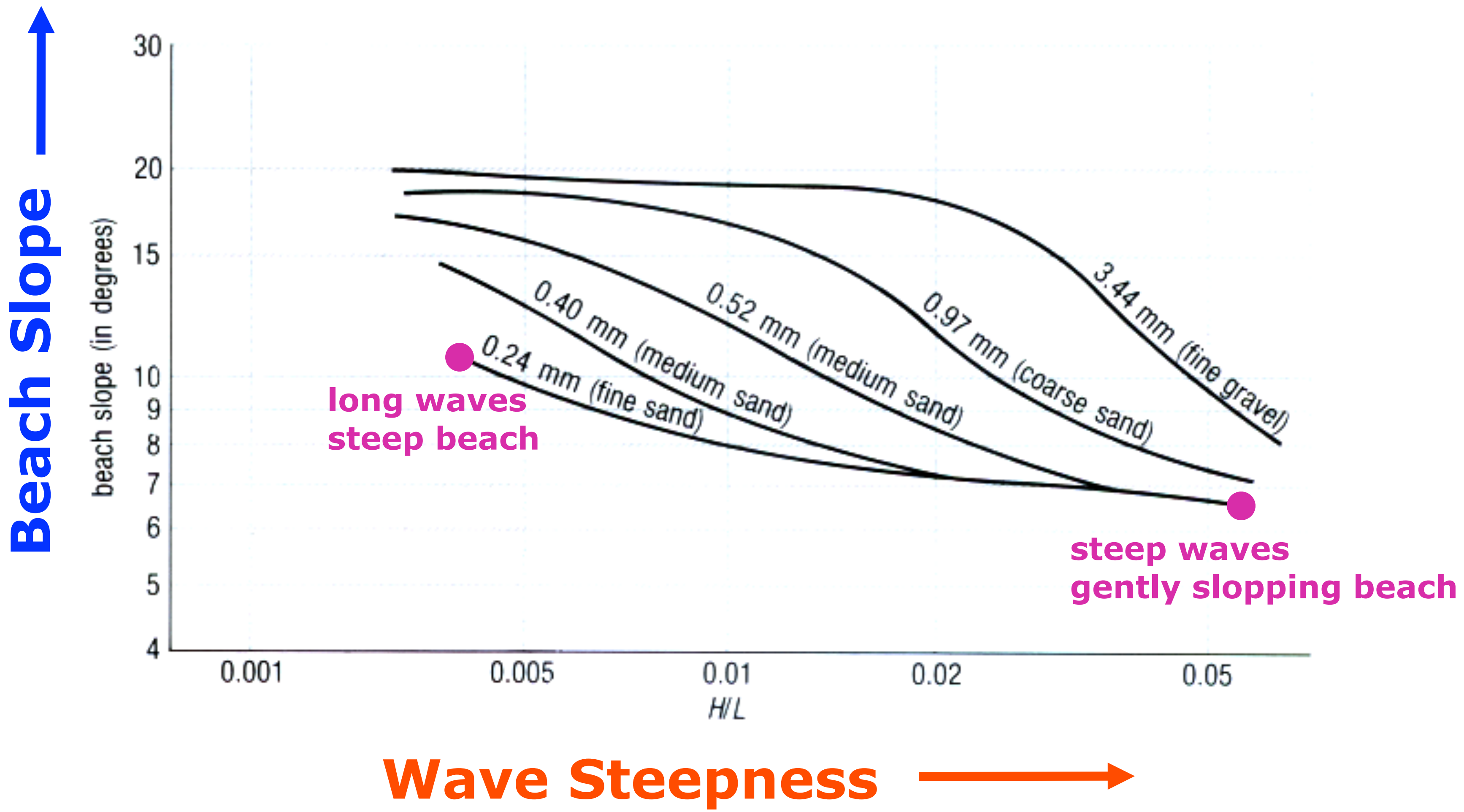
What factor determine the beach profile?

Backwash < Wash → Beach grows!

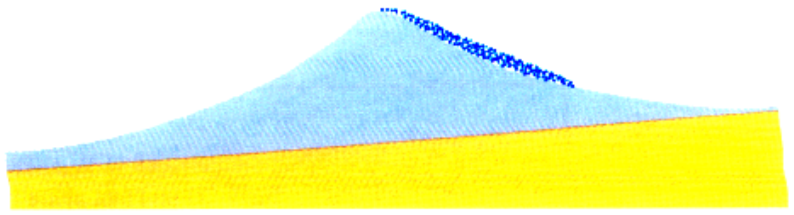
1) Grain size. **Larger grain → more Percolation of water into sand/pebbles → greatly reduces the backwash.**

2) Steepness of the waves …

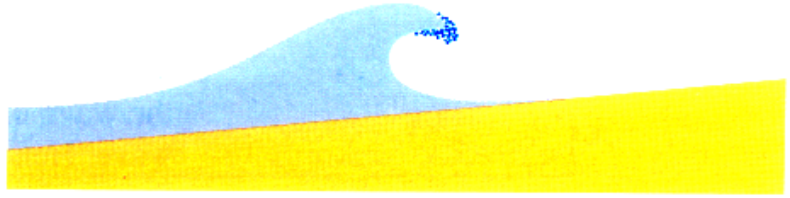
Beach slope, wave steepness and grain size



Effect of steepness on approaching waves

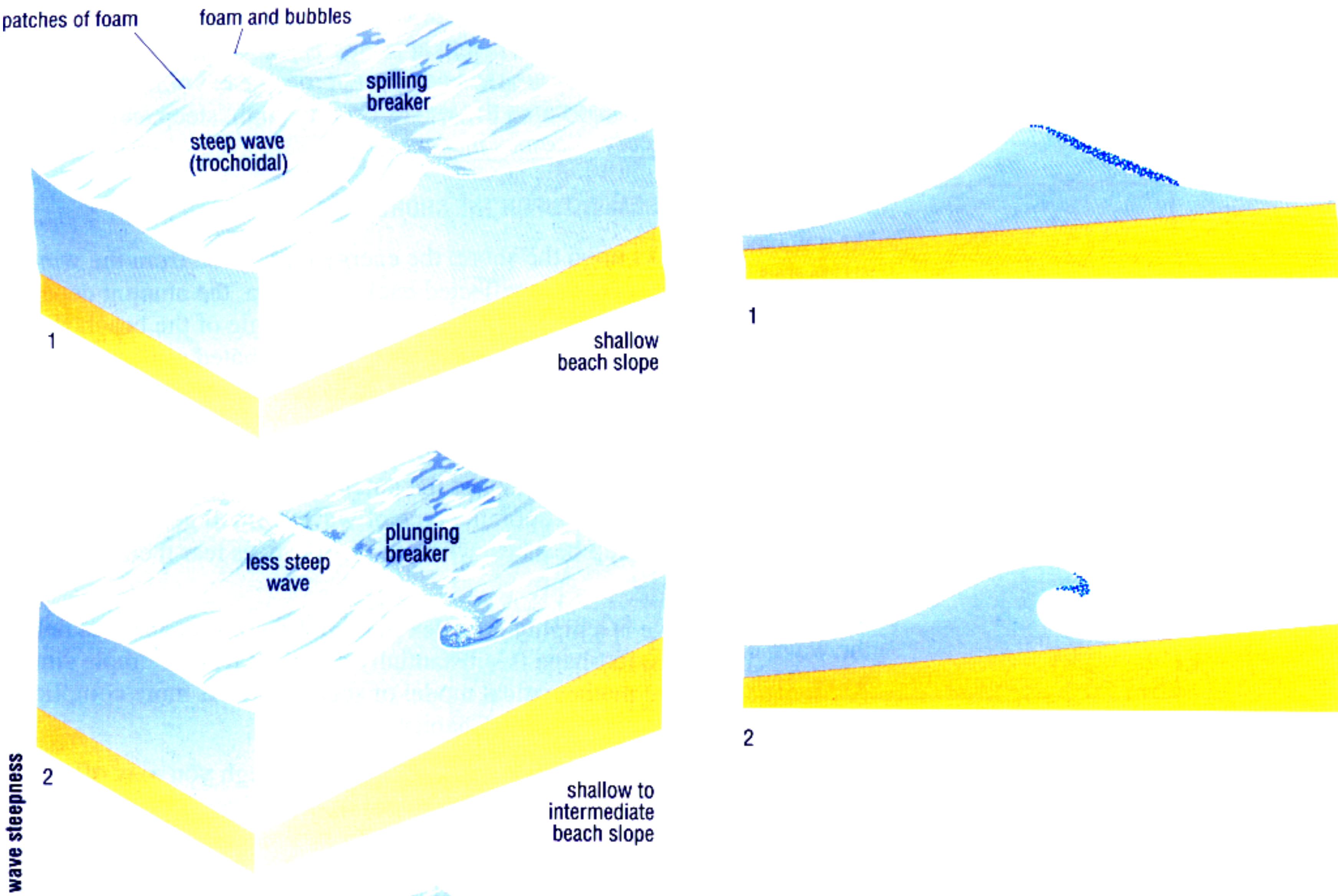


1

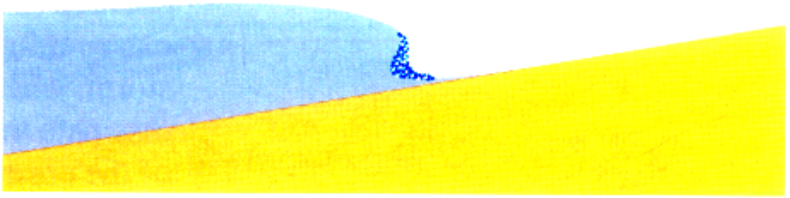


2

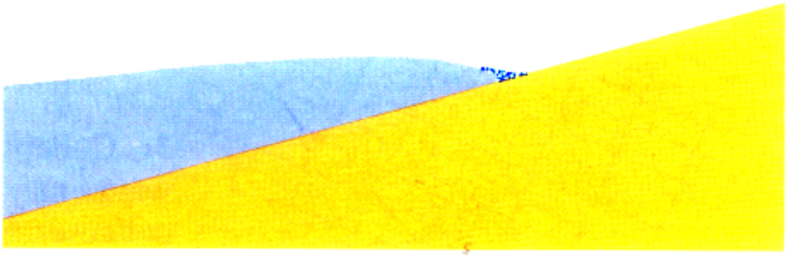
Effect of steepness on approaching waves



Effect of steepness on approaching waves
(more steep!)



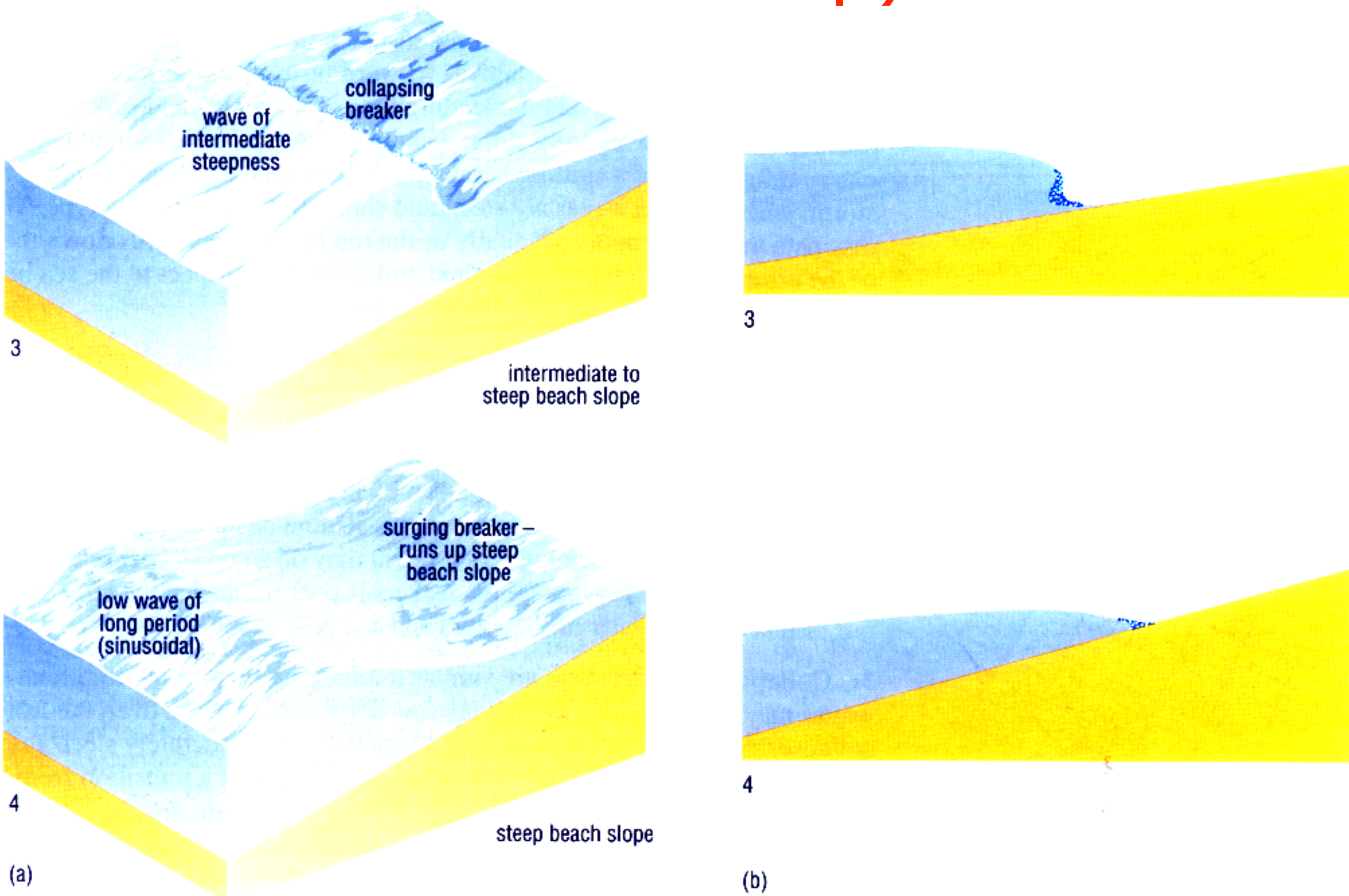
3



4

(b)

Effect of steepness on approaching waves
(more steep!)

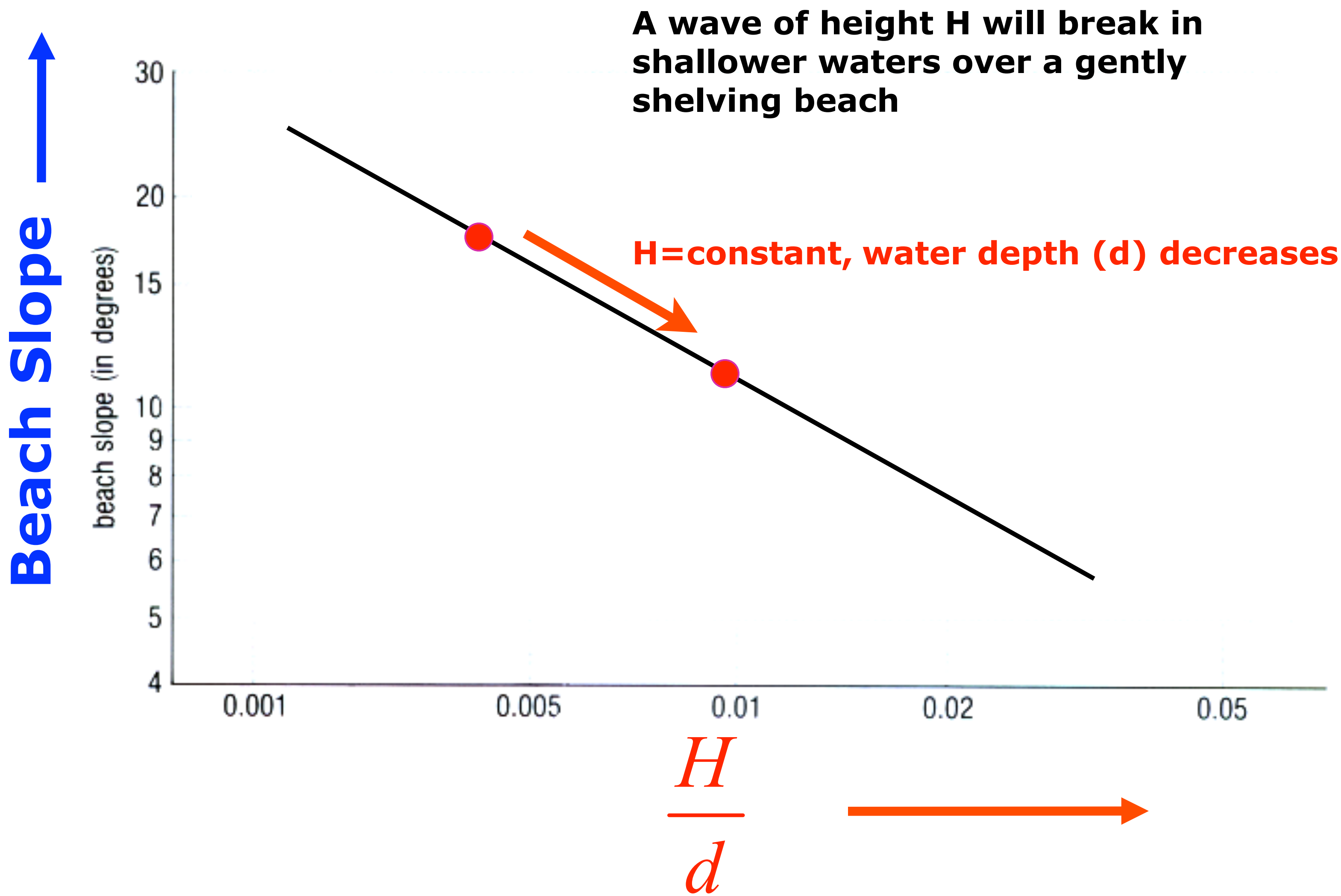


Given a Beach Slope the following is true:

Wave height

$$\frac{H}{d} = const.$$

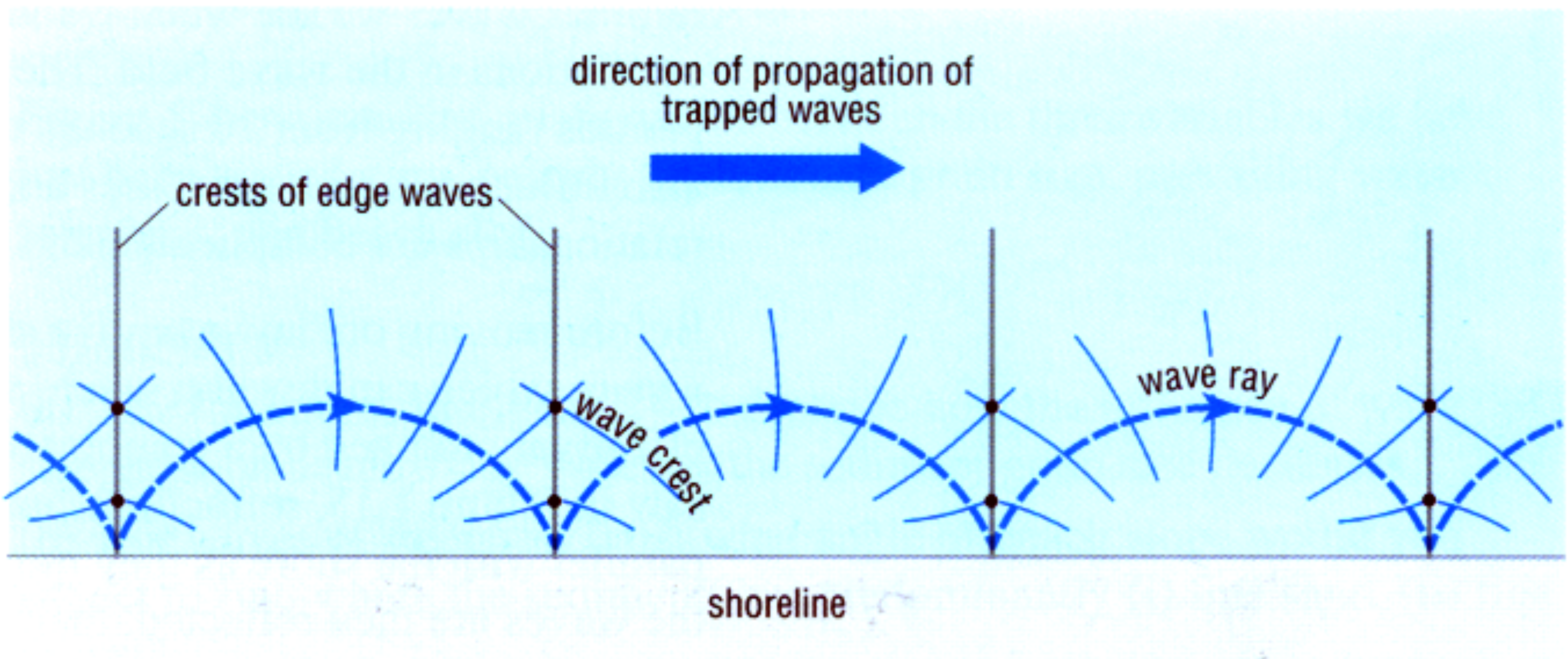
Water depth at breaking point



A wave of height H will break in shallower waters over a gently shelving beach
H=constant, water depth (d) decreases
Beach Slope
beach slope (in degrees)
30
20
15
10
9
8
7
6
5
4
0.001
0.005
0.01
0.02
0.05
H
d

Other type of waves and transport dynamics relevant to beaches

Edge Waves



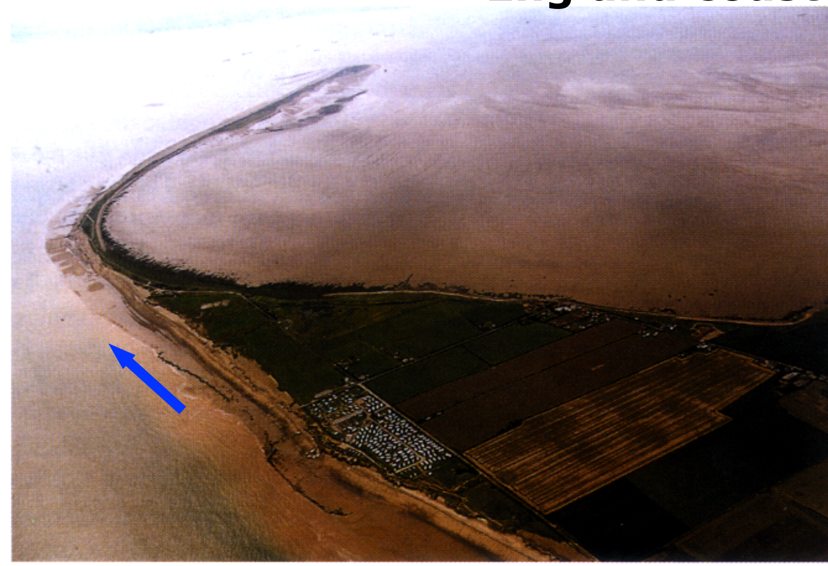
Waves are not always approaching parallel to the shore

Waves are not always approaching parallel to the shore

Waves are not always approaching parallel to the shore

Formation of spits by alongshore drift

England coast



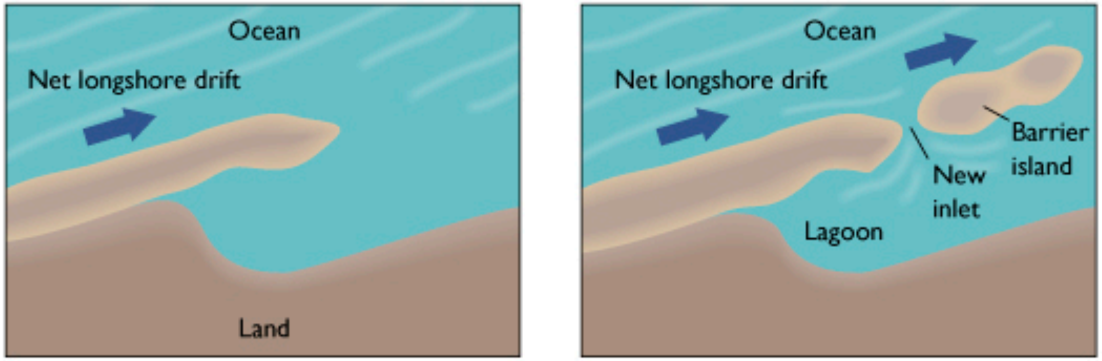
(a)

(b)

Figure 5.13 (a) Spurn Head at the mouth of the Humber (see Figure 6.5) is formed by longshore drift southward along the Humberside (Holderness) coastline (we are looking south, so east is to the left, west to the right). From time to time, the narrowest part of the spit is severed by winter storms.
(b) Closer view of Spurn Point (the lighthouse is about half-way along), showing megaripples and tidal flats (see Section 6.3) on its western shore.

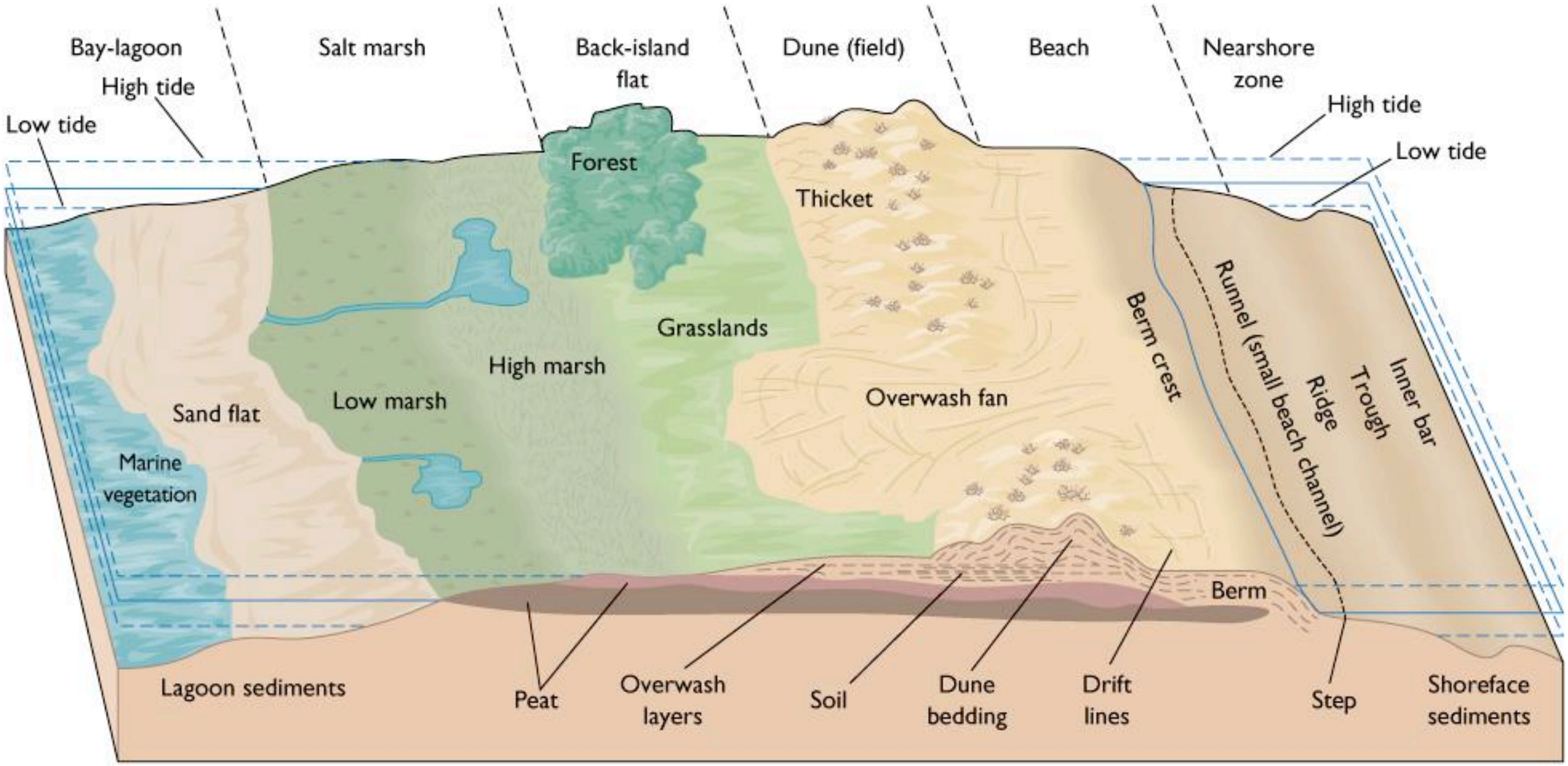
Origin of Barrier Islands

2)



(b) SEGMENTATION OF A SAND SPIT

Mainland ← Ocean



(b) MORPHOLOGY OF A BARRIER-ISLAND SYSTEM

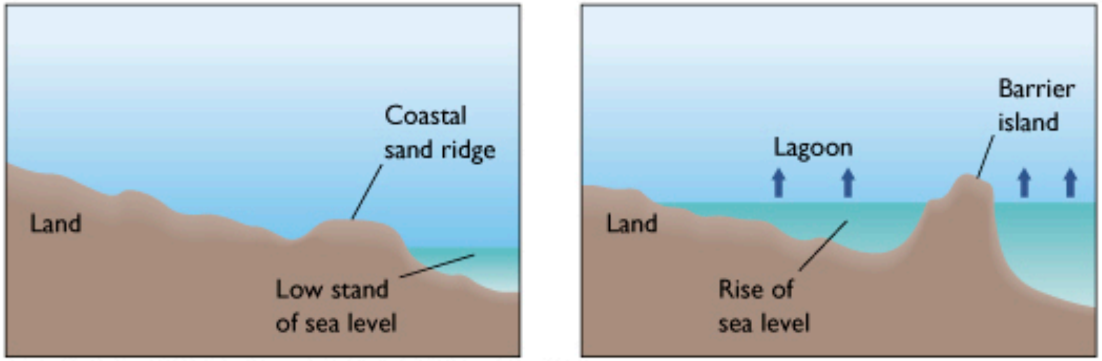
Vegetation and Ecosystem diversity ← Beach environments

Mainland ← **Ocean**

Vegetation and Ecosystem diversity ← Beach environments

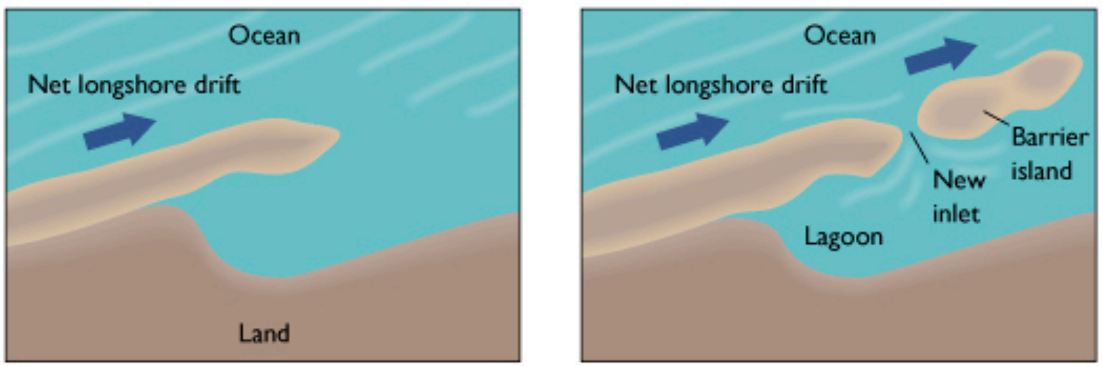
Origin of Barrier Islands

1)



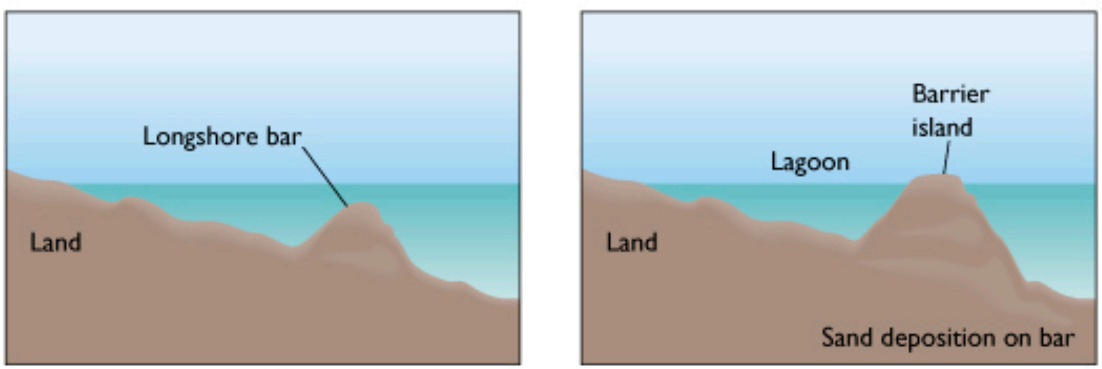
(a) SUBMERGENCE OF A COASTAL SAND RIDGE

2)



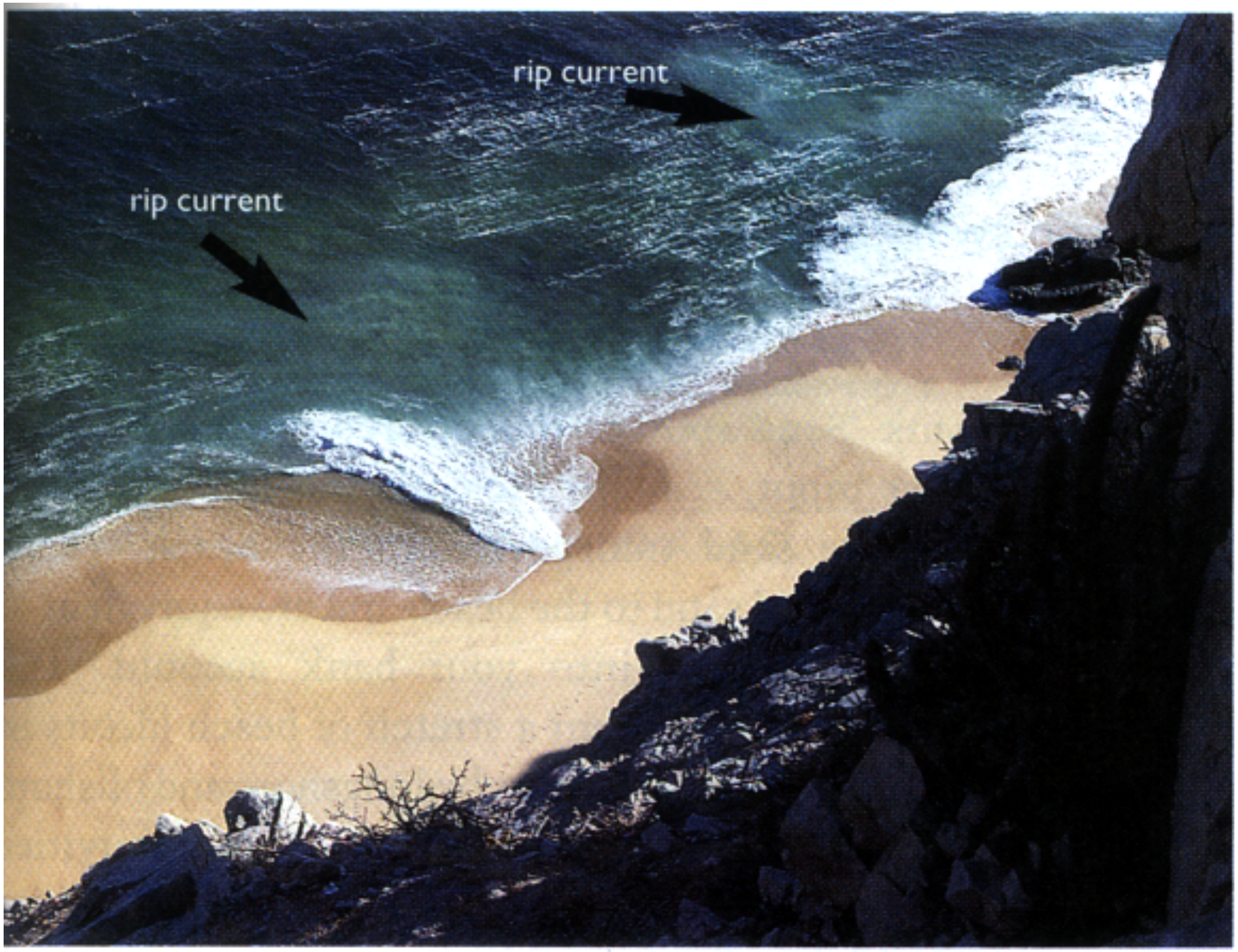
(b) SEGMENTATION OF A SAND SPIT

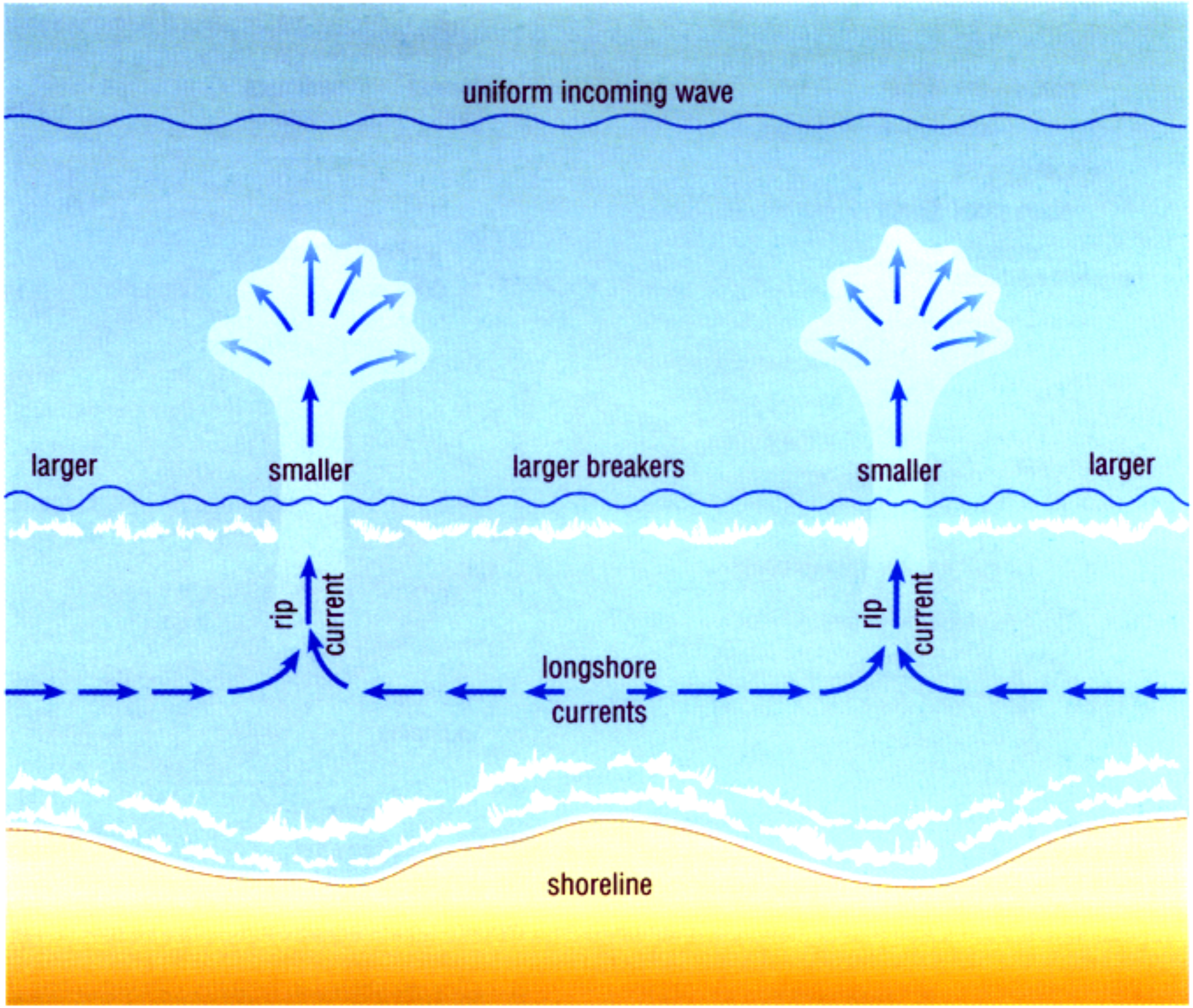
3)



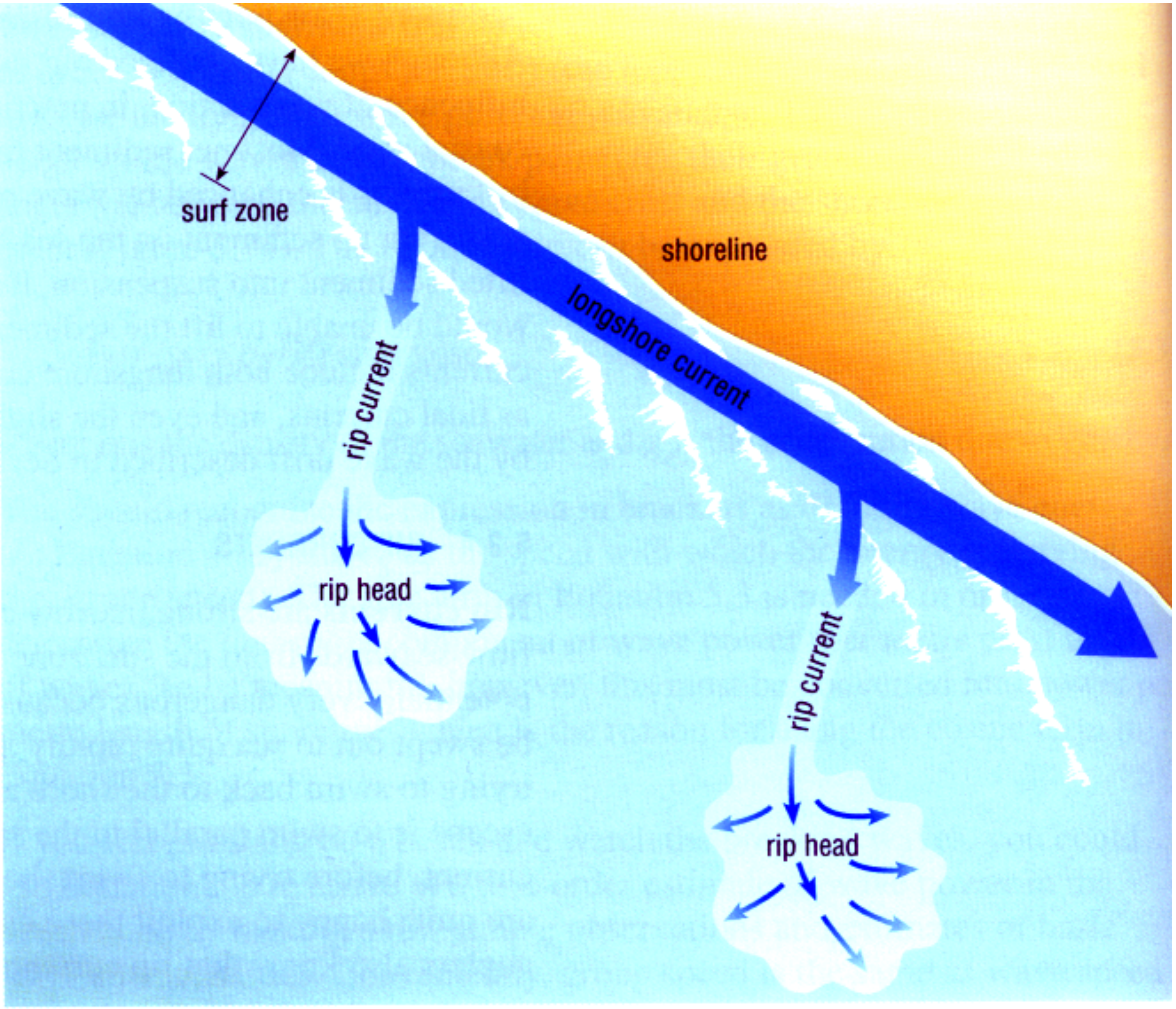
(c) EMERGENCE OF A LONGSHORE BAR

Rip Current



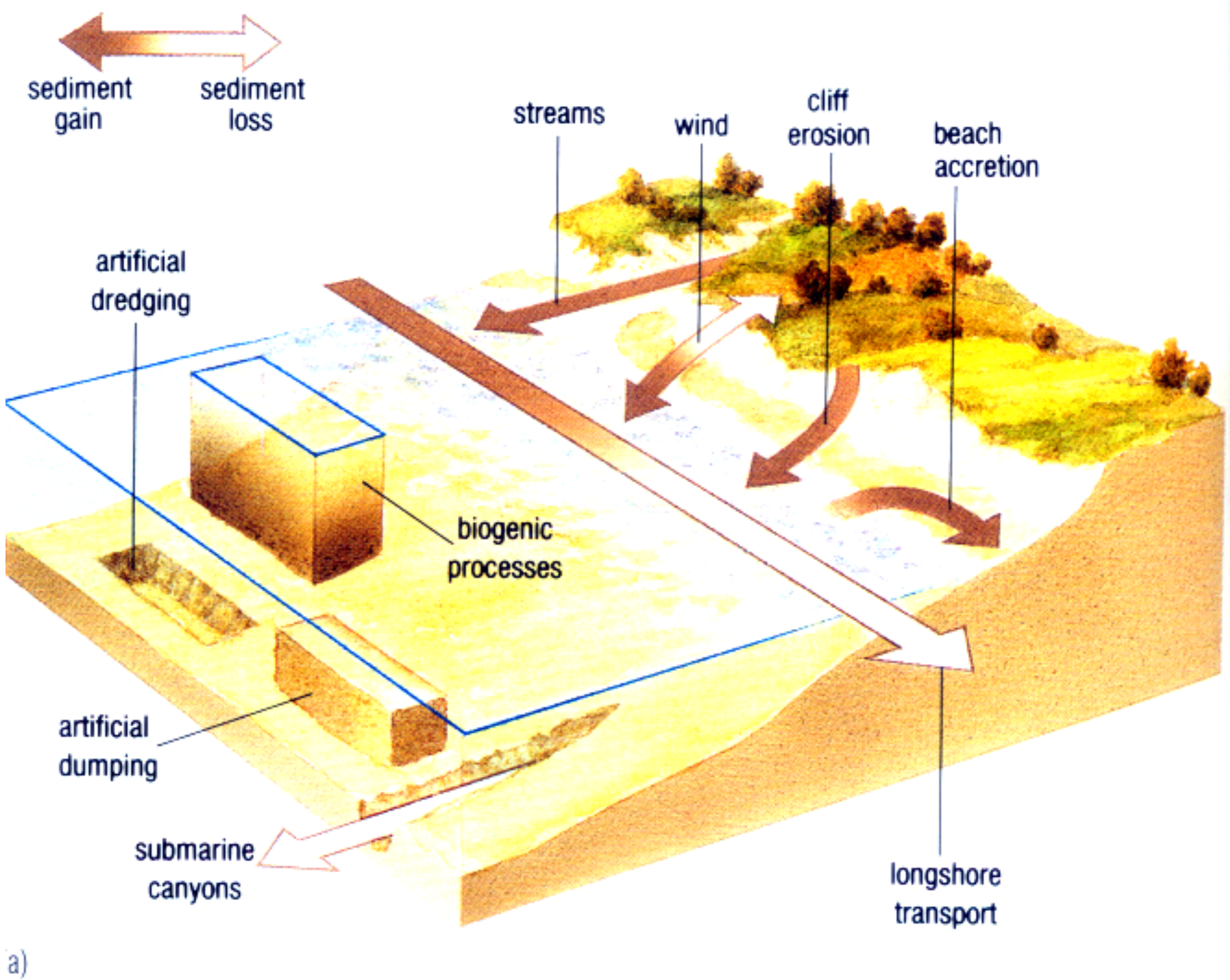

uniform incoming wave
larger
smaller
larger breakers
smaller
larger
rip current
rip current
longshore currents
shoreline

Rip currents can generate from longshore currents

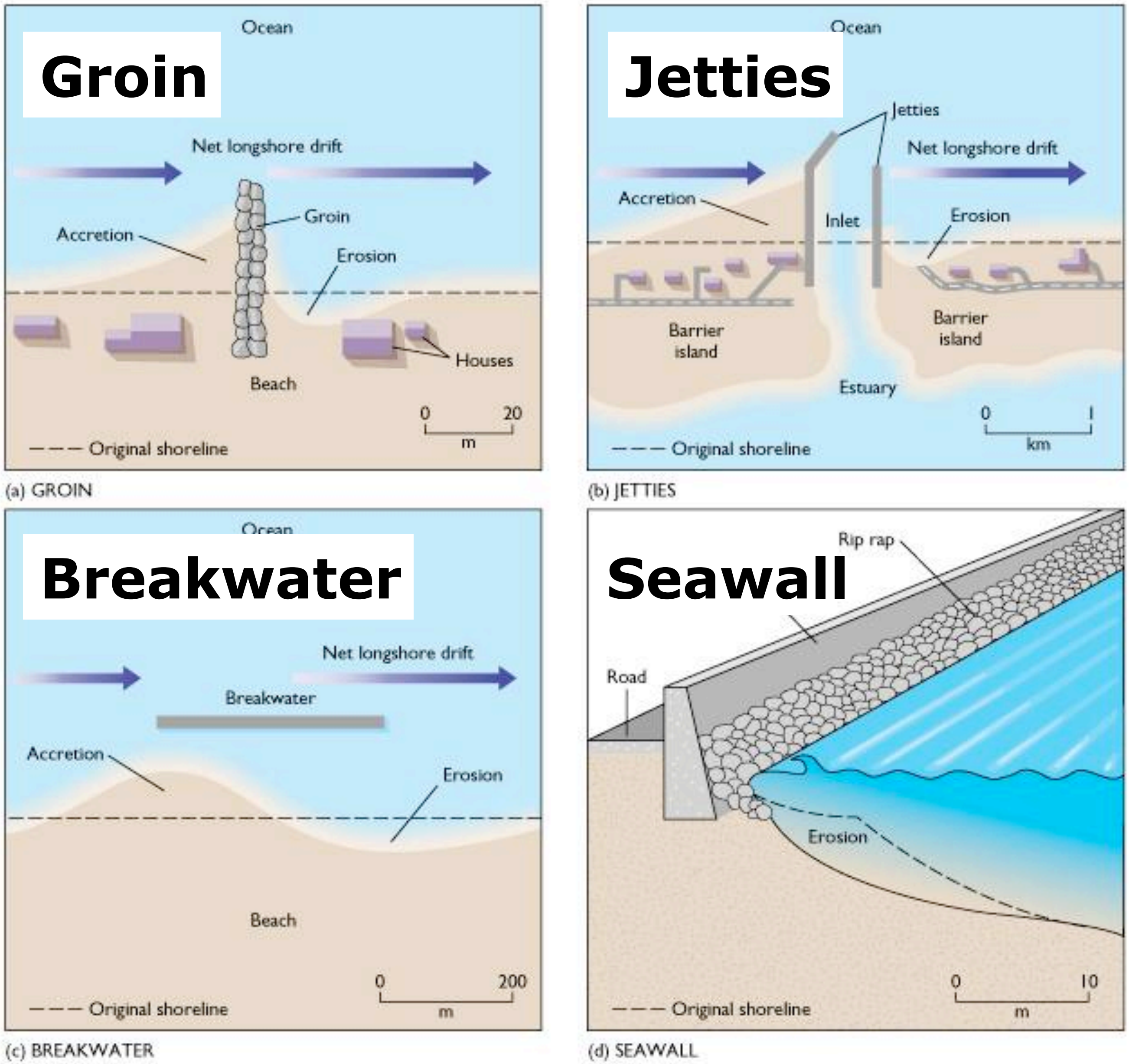


Human intervention → local sediment budget

Sediment/Sand Budget



Coastal engineering structures

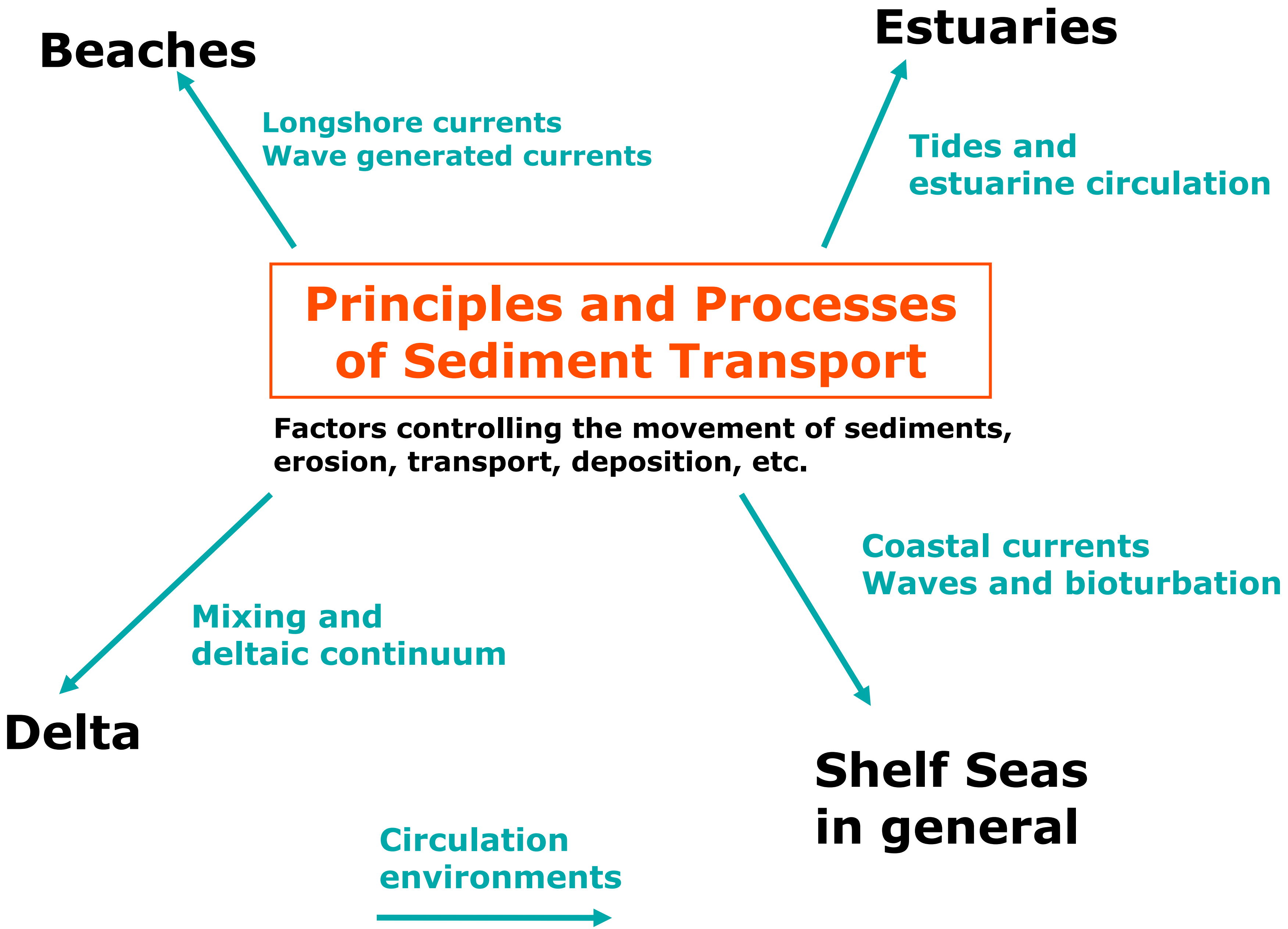


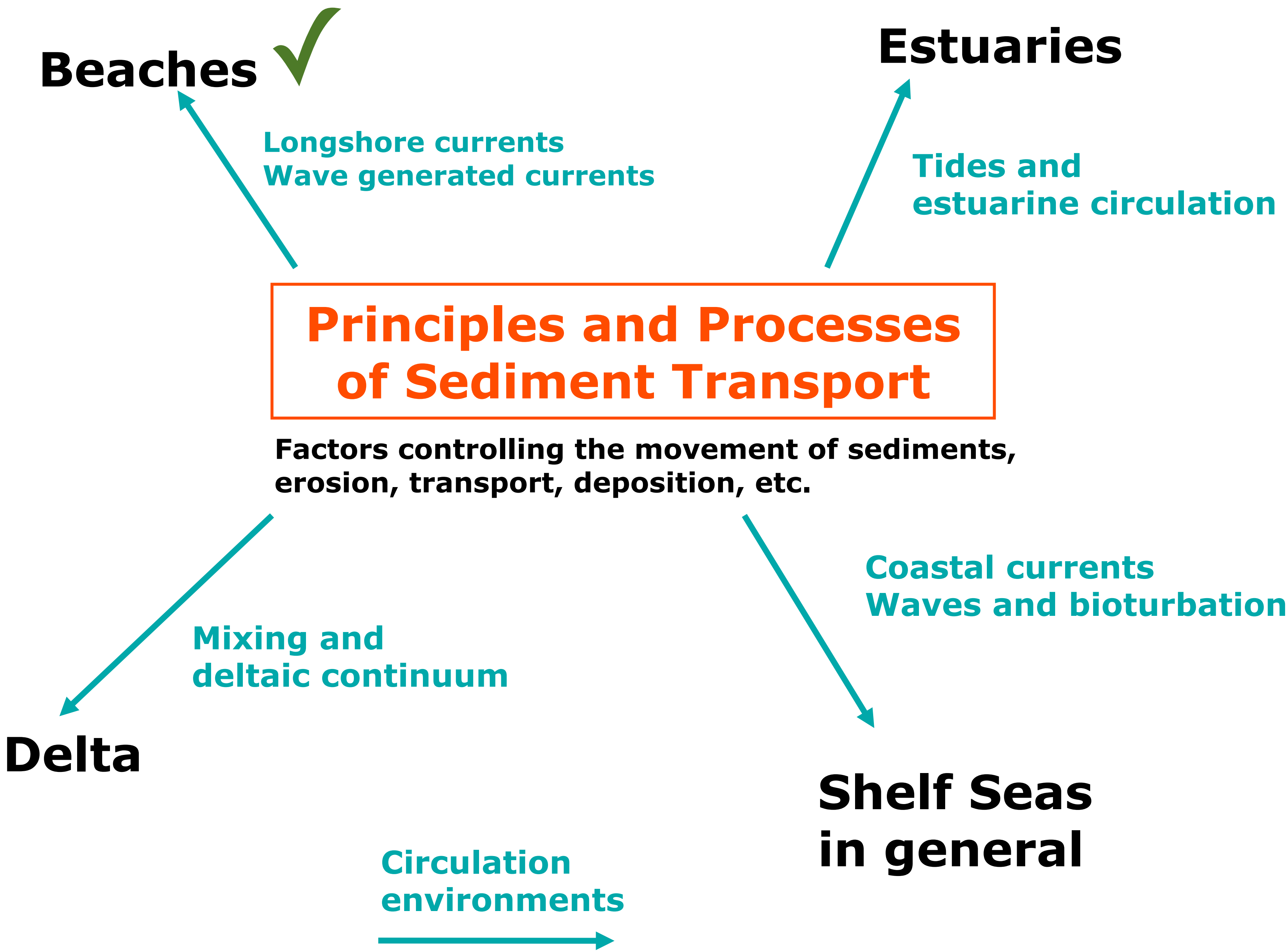
Summary

→ **The combined action of waves and current shape the transport of sediments, the shape of the beaches and littoral regions.**

→**The sand budget is not necessarily in balance**

→**Humans can greatly affect this budget**


Beaches
Estuaries
Longshore currents
Wave generated currents
Tides and
estuarine circulation
Principles and Processes
of Sediment Transport
Factors controlling the movement of sediments,
erosion, transport, deposition, etc.
Coastal currents
Waves and bioturbation
Mixing and
deltaic continuum
Delta
Shelf Seas
in general
Circulation
environments


Beaches
Estuaries
Longshore currents
Wave generated currents
Tides and
estuarine circulation
Principles and Processes
of Sediment Transport
Factors controlling the movement of sediments,
erosion, transport, deposition, etc.
Coastal currents
Waves and bioturbation
Mixing and
deltaic continuum
Delta
Shelf Seas
in general
Circulation
environments

Principles and Processes of Sediment Transport

Factors controlling the movement of sediments, erosion, transport, deposition, etc.

Beaches ✓

Longshore currents
Wave generated currents

Estuaries

Tides and estuarine circulation

Delta

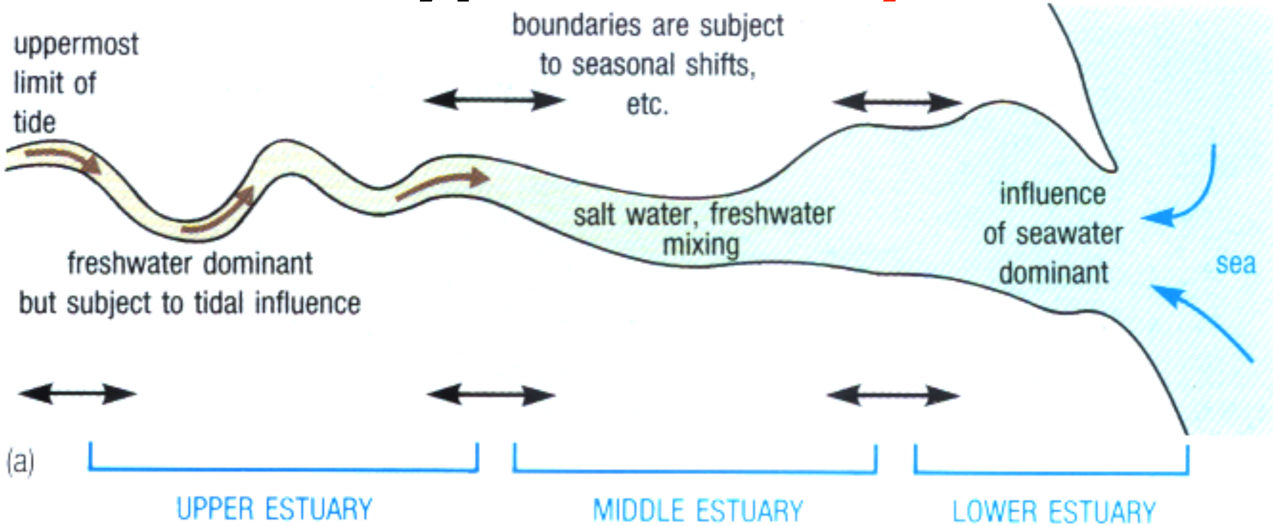
Mixing and deltaic continuum

Shelf Seas in general

Coastal currents
Waves and bioturbation

Circulation environments

Schematic of a typical Estuary



(b)

(c)

Intertidal Zonation

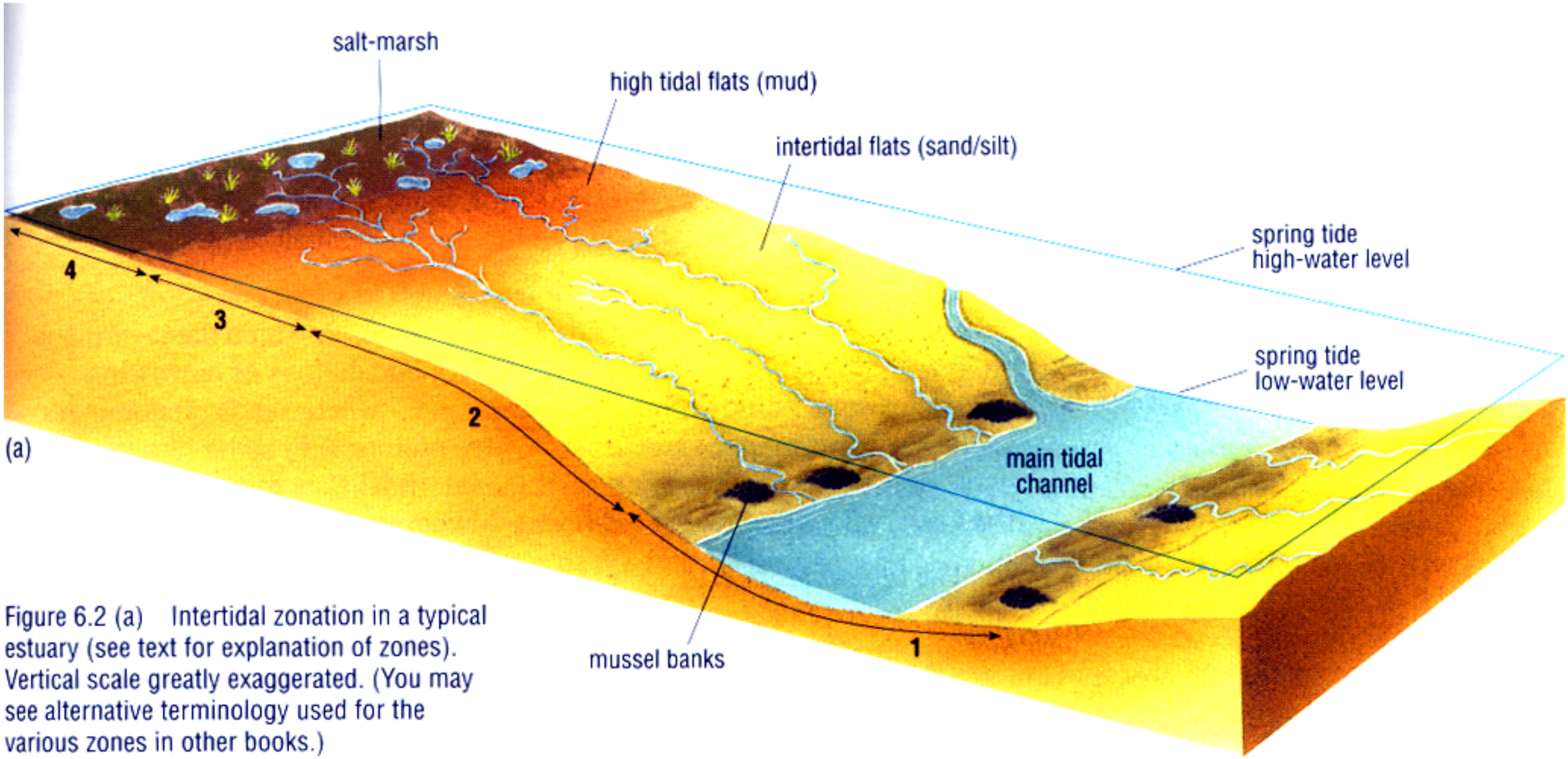


Figure 6.2 (a) Intertidal zonation in a typical estuary (see text for explanation of zones). Vertical scale greatly exaggerated. (You may see alternative terminology used for the various zones in other books.)

Aggregation of Sediments in Estuaries

1 **Biological aggregation** is locally important in some estuaries. Clay particles are ingested by filter-feeding animals and excreted in faecal pellets up to 5 mm long, with settling velocities measured in centimetres per second, rather than millimetres per hour. There may also be 'fluffy' aggregates of dead and dying planktonic material, including bacteria. In estuaries without a great deal of biological activity, however, these processes are less important than:

2 **Flocculation**, which occurs as the result of the molecular attractive forces known as *van der Waals forces*. These forces are not particularly strong, but they vary inversely as the square of the distance between two clay particles and become important when particles are brought very close together. In fresh (river) water, flocculation does not take place because clay minerals normally carry a net negative charge and similarly charged clay particles repel one another. In seawater, however, the positively charged **cations** in solution neutralize these negative charges, so that when clay particles are brought sufficiently close together, the van der Waals forces dominate, and flocculation occurs.

Flocculation is thus an important process where freshwater and seawater mix, and it occurs in all estuaries. There are three main ways in which clay particles can be brought close together for van der Waals forces to take effect:

1 By wind- or current-generated turbulence in the water column.

2 By *Brownian motion*: very small suspended clay particles are continually buffetted by the random motion of water molecules.

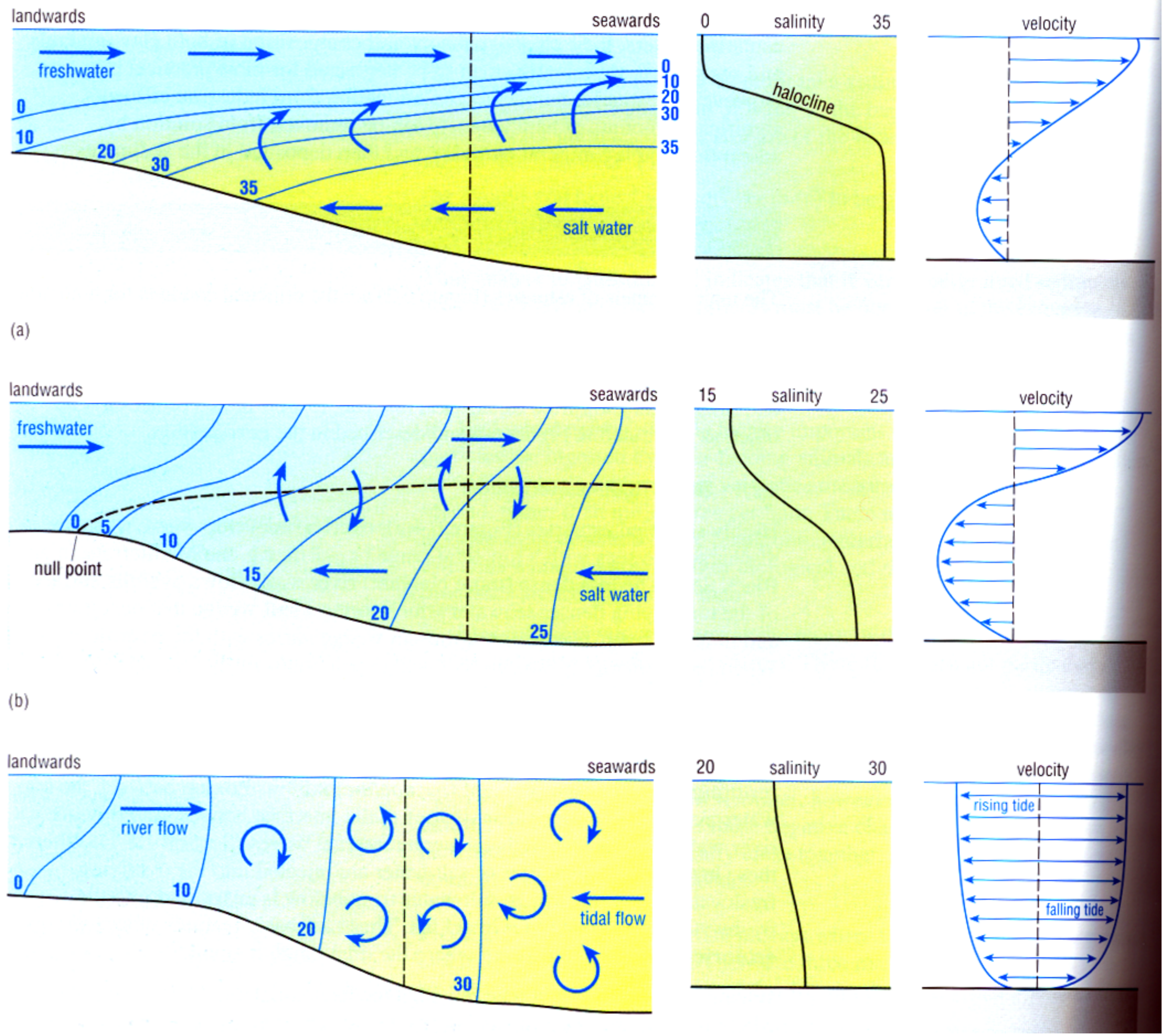
3 By being **scavenged** by larger particles which sink rapidly through the water column, collide with smaller particles and 'capture' them.

The Estuarine Continuum

Salt-wedge

Partially Mixed

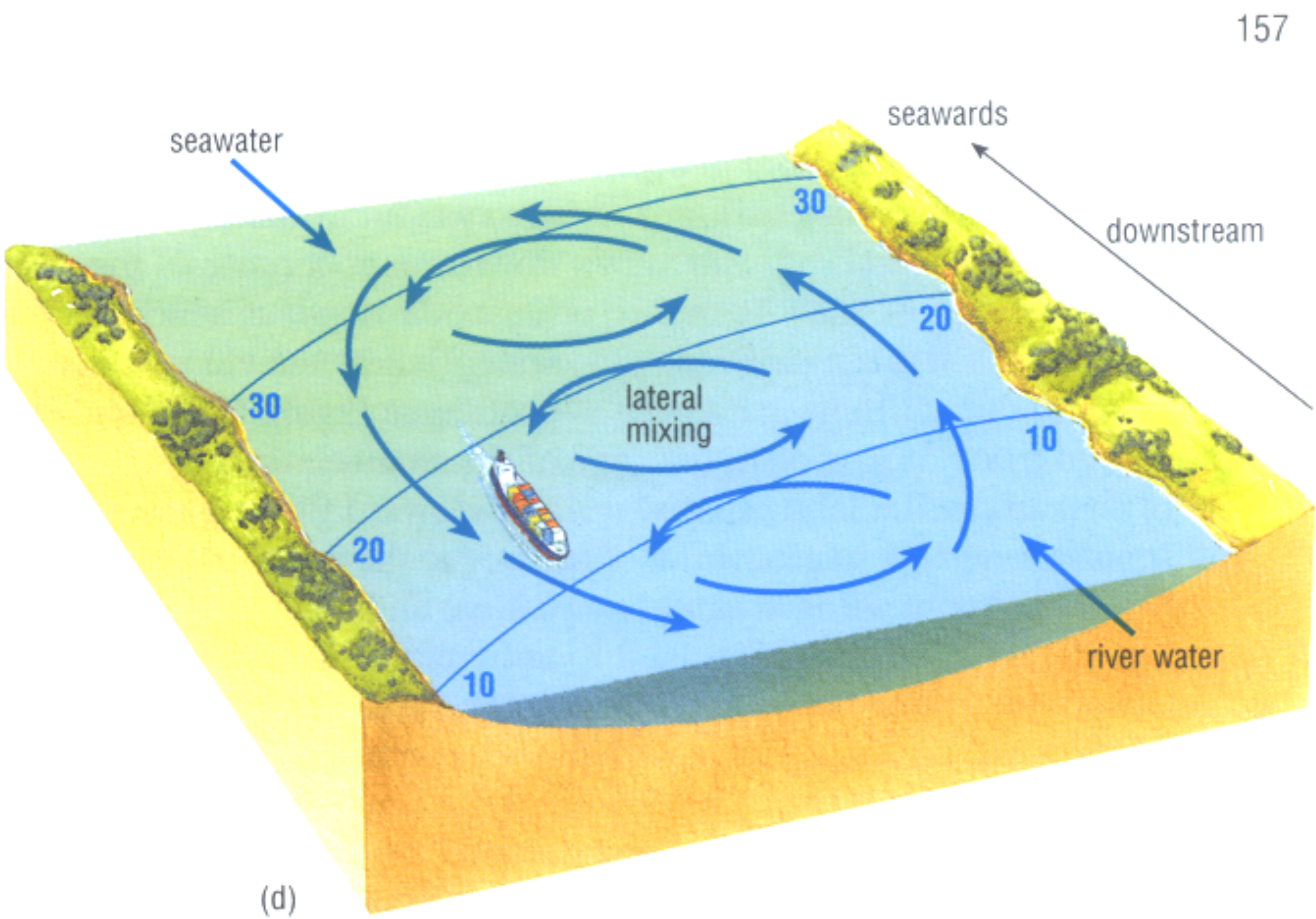
Well-Mixed



Tides not important

Tides dominate

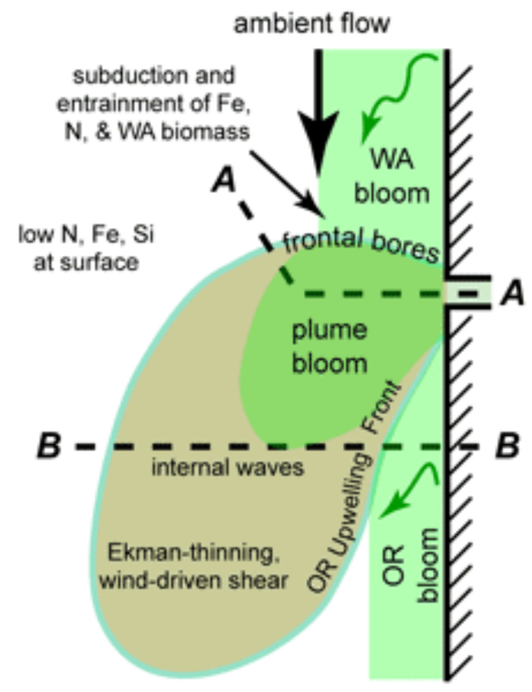
Coriolis Effect on Estuarine Circulation



River Influences on Shelf Ecosystems

Columbia River Plume

PLAN VIEW



(c) ***plan-view of plume (schematic)***

Processes affecting plume productivity

★ Tidally-driven mixing in the estuary

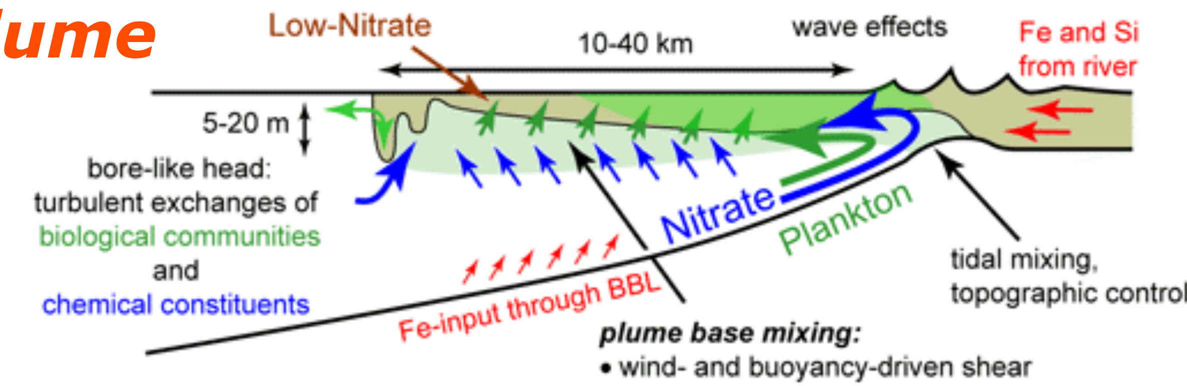
★ Large bore-like internal waves at the plume front

★ Wind-driven mixing can act across the whole area of the plume.

River Influences on Shelf Ecosystems

Columbia River Plume

VERTICAL SECTION



(a) *section A-A: near river mouth*

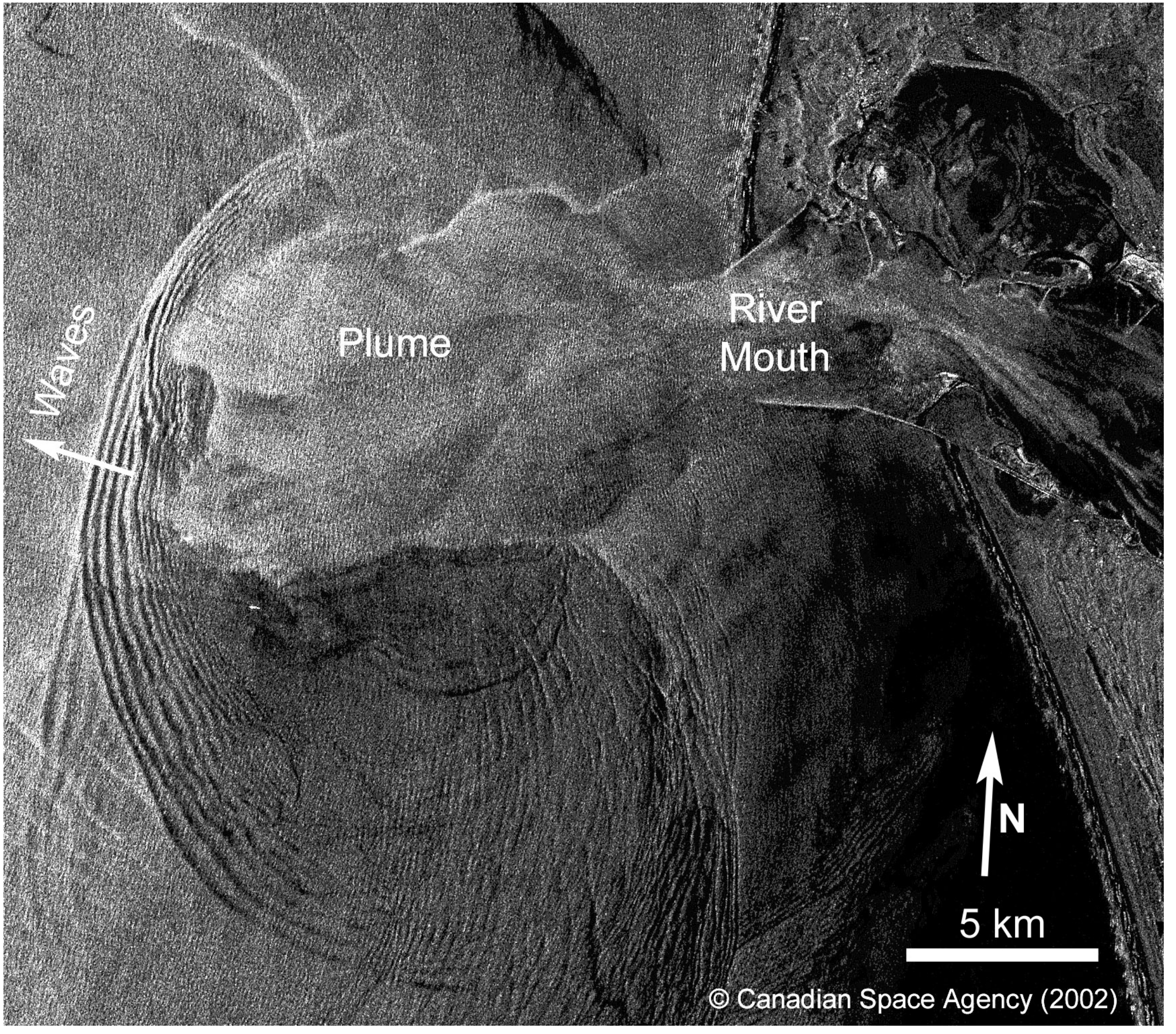
<u>Processes affecting plume productivity</u>

★ Tidally-driven mixing in the estuary

★ Large bore-like internal waves at the plume front

★ Wind-driven mixing can act across the whole area of the plume.

Columbia River Plume

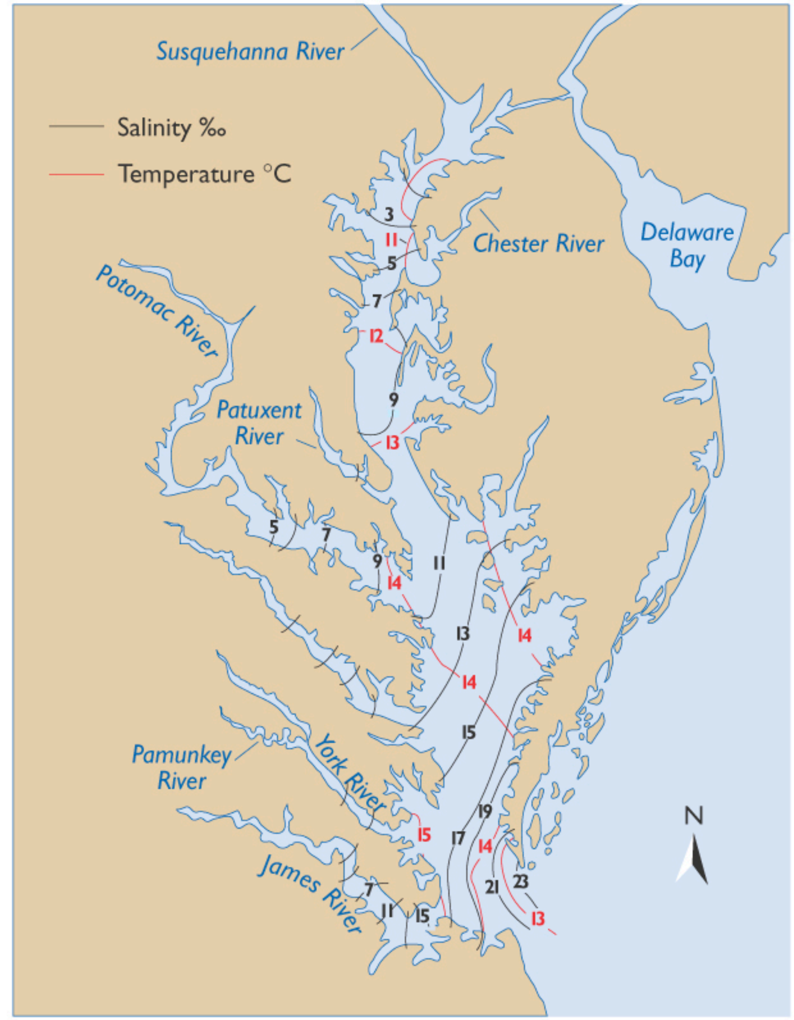


This satellite image shows the influence of the Columbia River, which forces fresh water into the Pacific Ocean on the outgoing tide. The interface between the fresher, surface waters originating from the Columbia and saltier, deeper waters, forms a system that creates large-amplitude waves.

The biology at Estuaries

Rich in Nutrients!

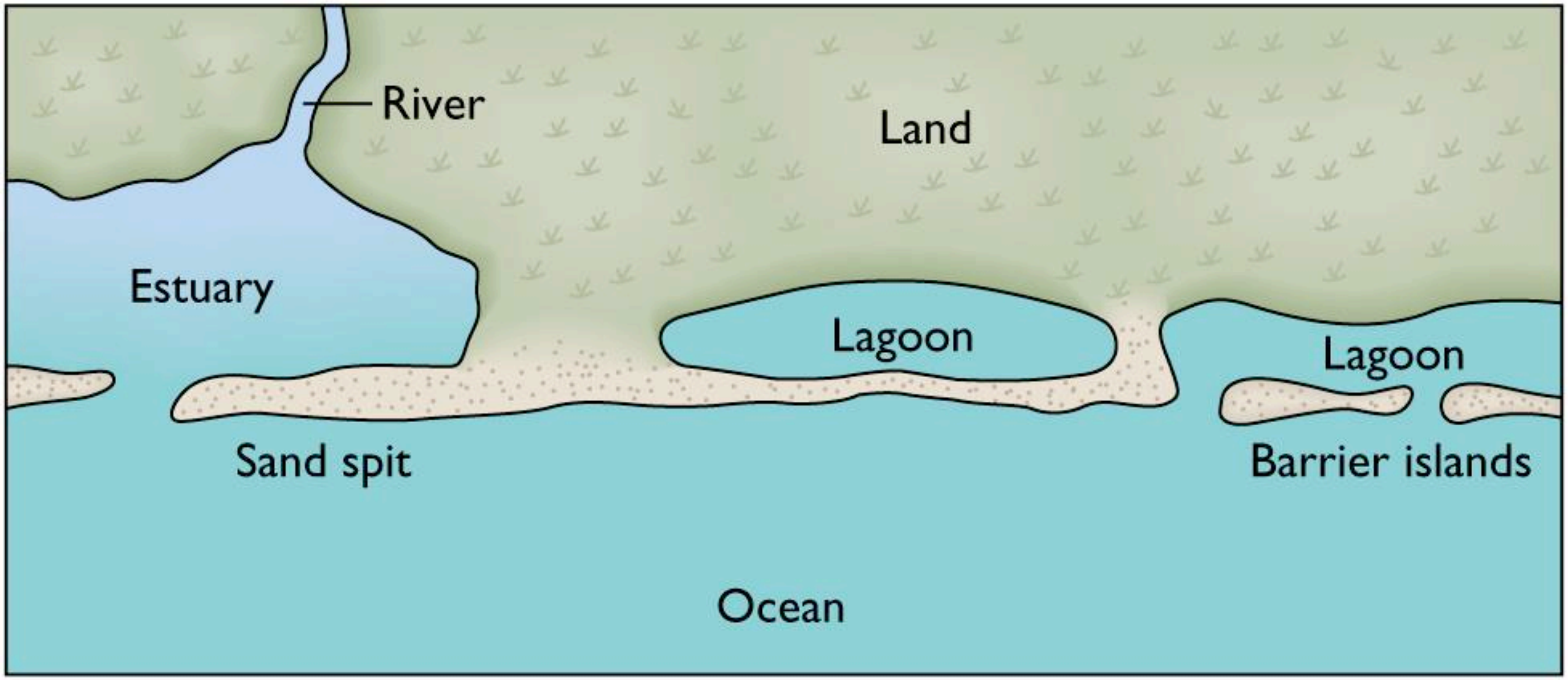
Salinity and Temperature of Chesapeake Bay.



(b) SALINITY AND TEMPERATURE OF CHESAPEAKE BAY

Phytoplankton, Zooplankton, Benthos

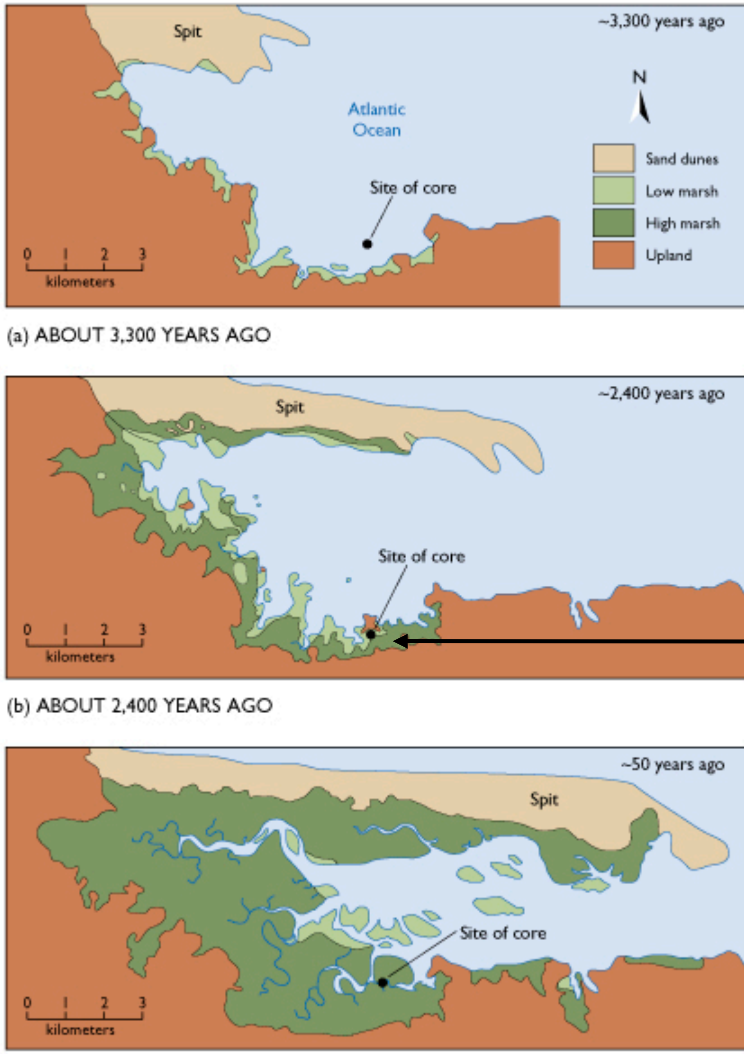
Sessile filters


River
Land
Estuary
Lagoon
Lagoon
Sand spit
Barrier islands
Ocean

Lagoons near Faro Portugal

(a)

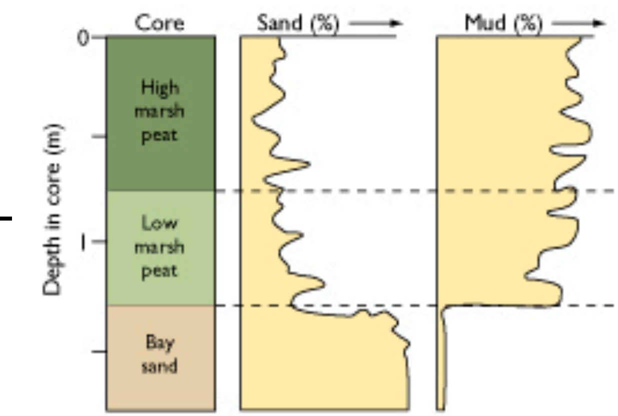
Barnstable salt marsh, Massachusetts, about 3,300 Years Ago.



(a) ABOUT 3,300 YEARS AGO

(b) ABOUT 2,400 YEARS AGO

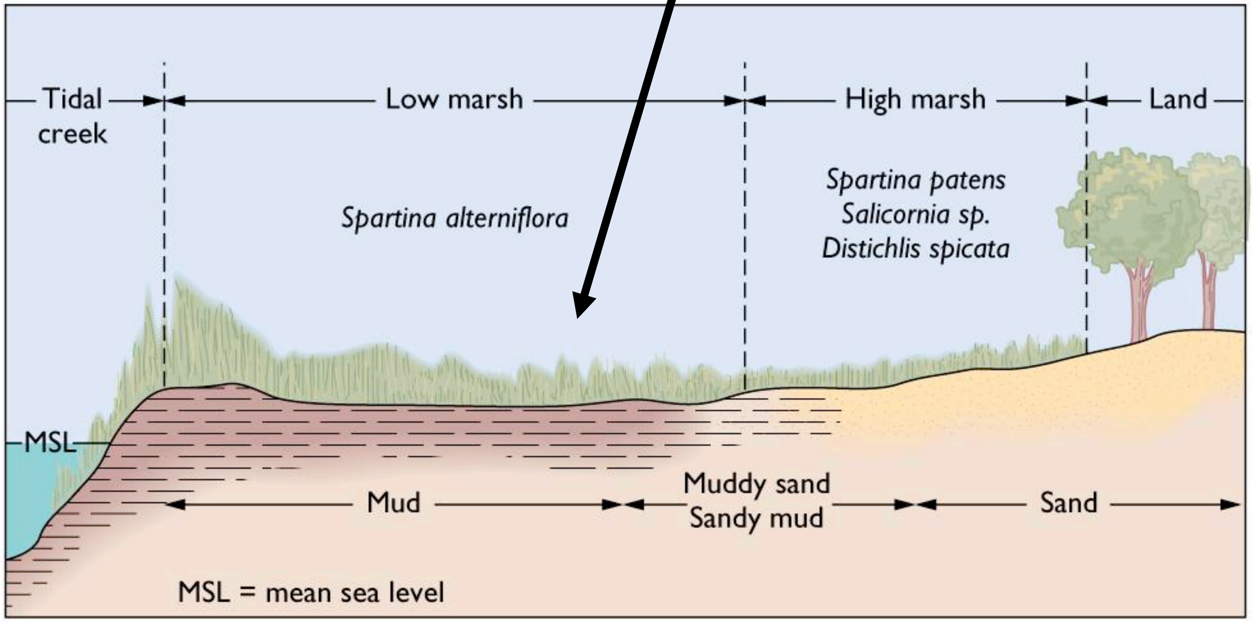
(c) ABOUT 50 YEARS AGO



Salt Marshes

Grass & Plant colonies (high to mid latitudes)

Spartina alterniflora, the dominant species of the low marsh, and in the high marsh.



This view of red mangrove forests of southrn Florida illustrates the dense tree growth and lush canopy that characterize these enviroments.

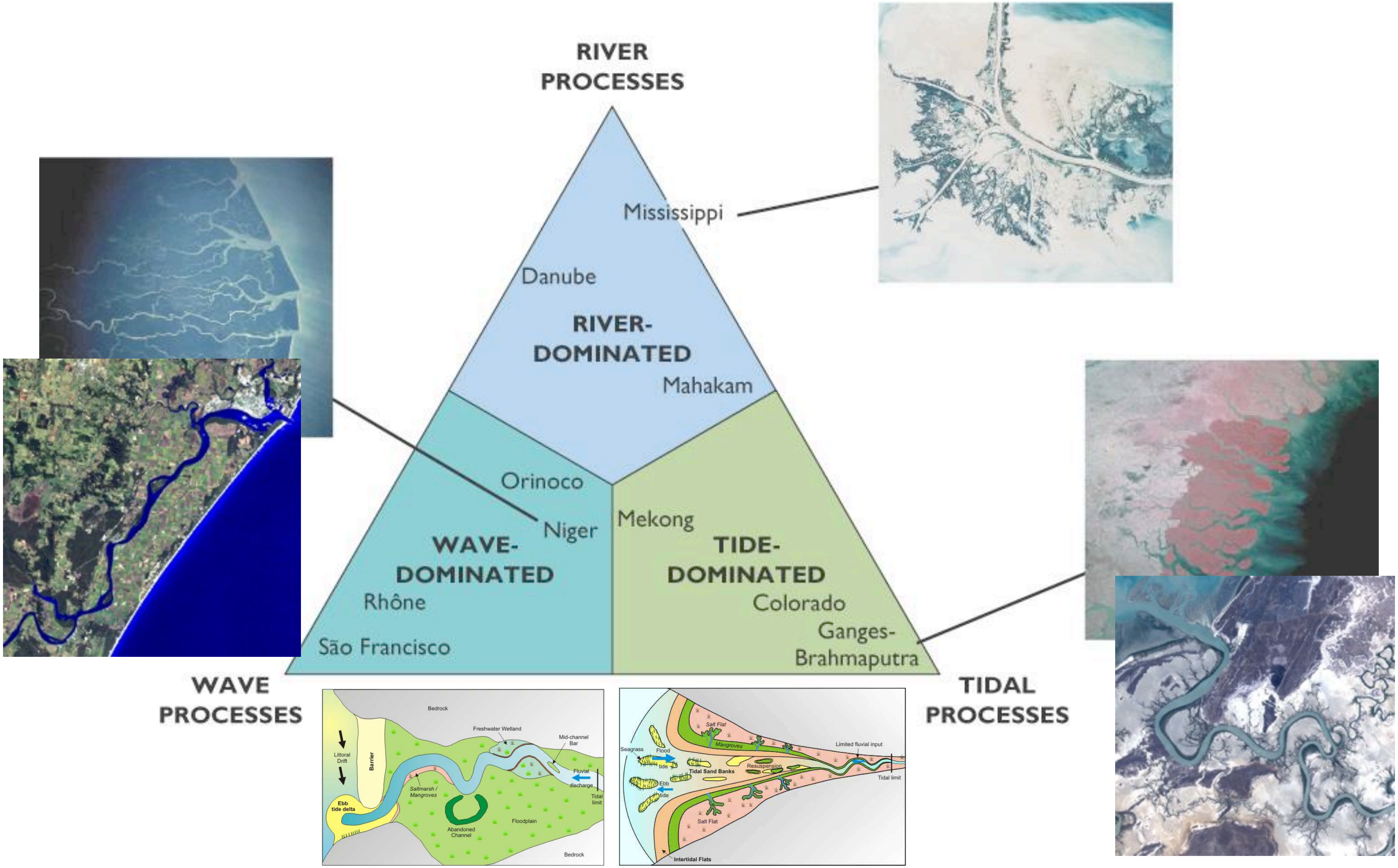
Salt Marshes

Mangrove swamps (low latitudes)

They develop when the rate of sediment supply > rate of removal

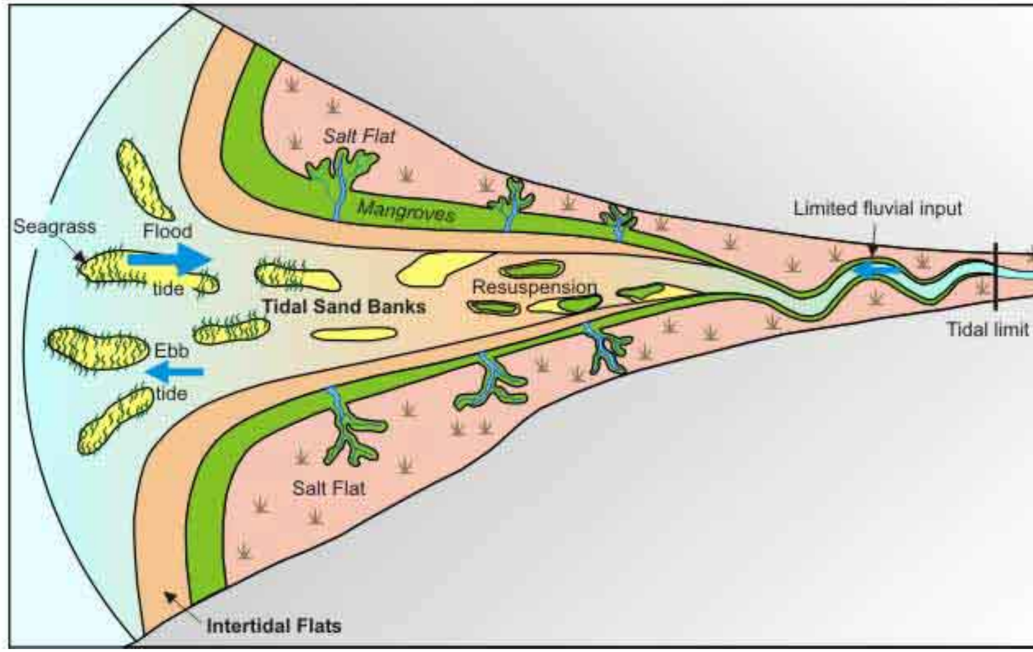
DELTAs

rate of sediment supply > rate of removal



DELTAs

Tide dominated



Wave dominated