Shallow-water environments and their sediments

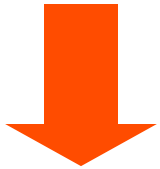
Shelf Seas: areas of submerged continental crust (submerged continental shelf)

TYPES OF SEDIMENTS

Sediments in shallow-water are TERRIGENOUS (BIOGENIC)

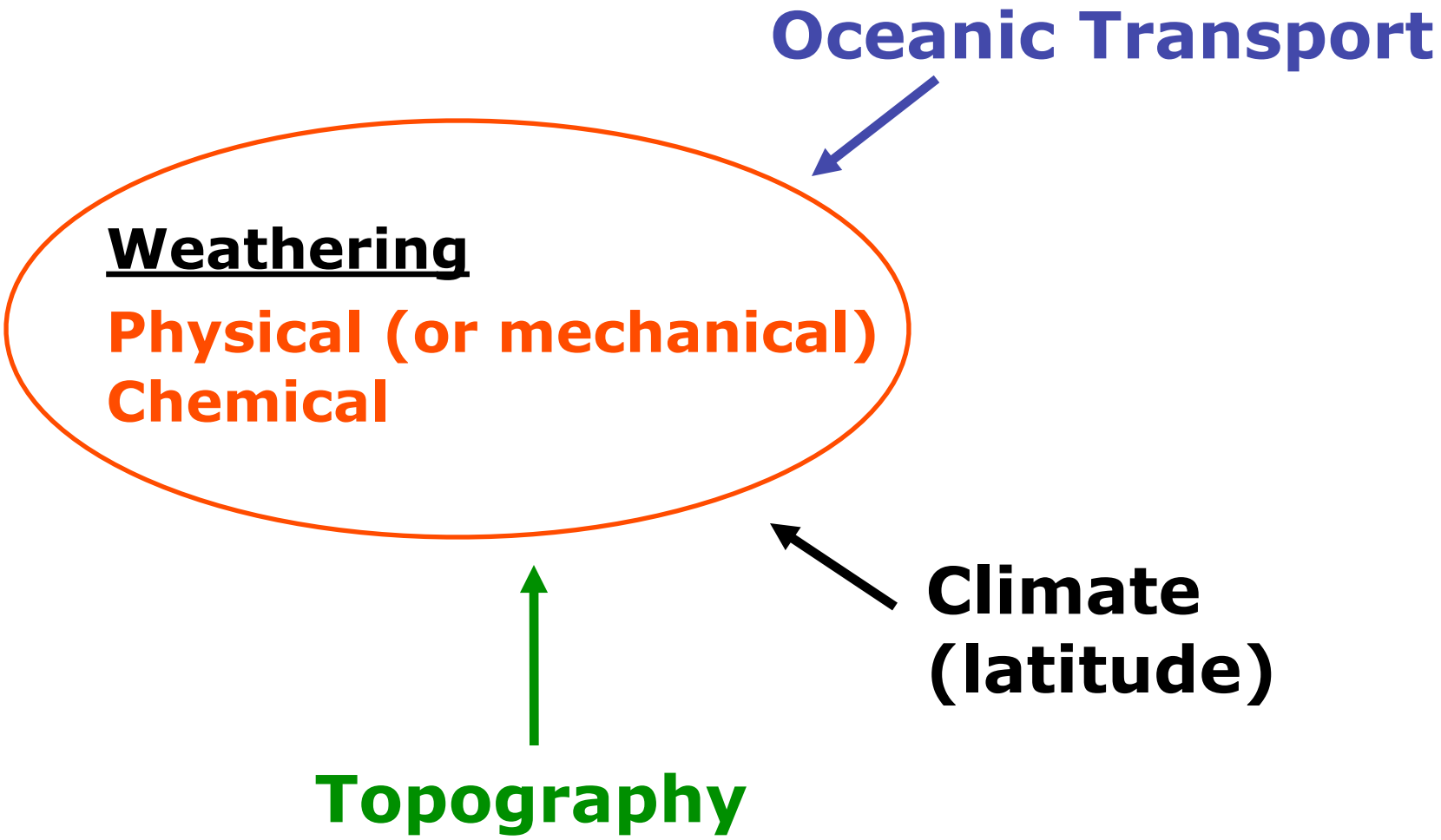
Weathering

Physical (or mechanical)
Chemical



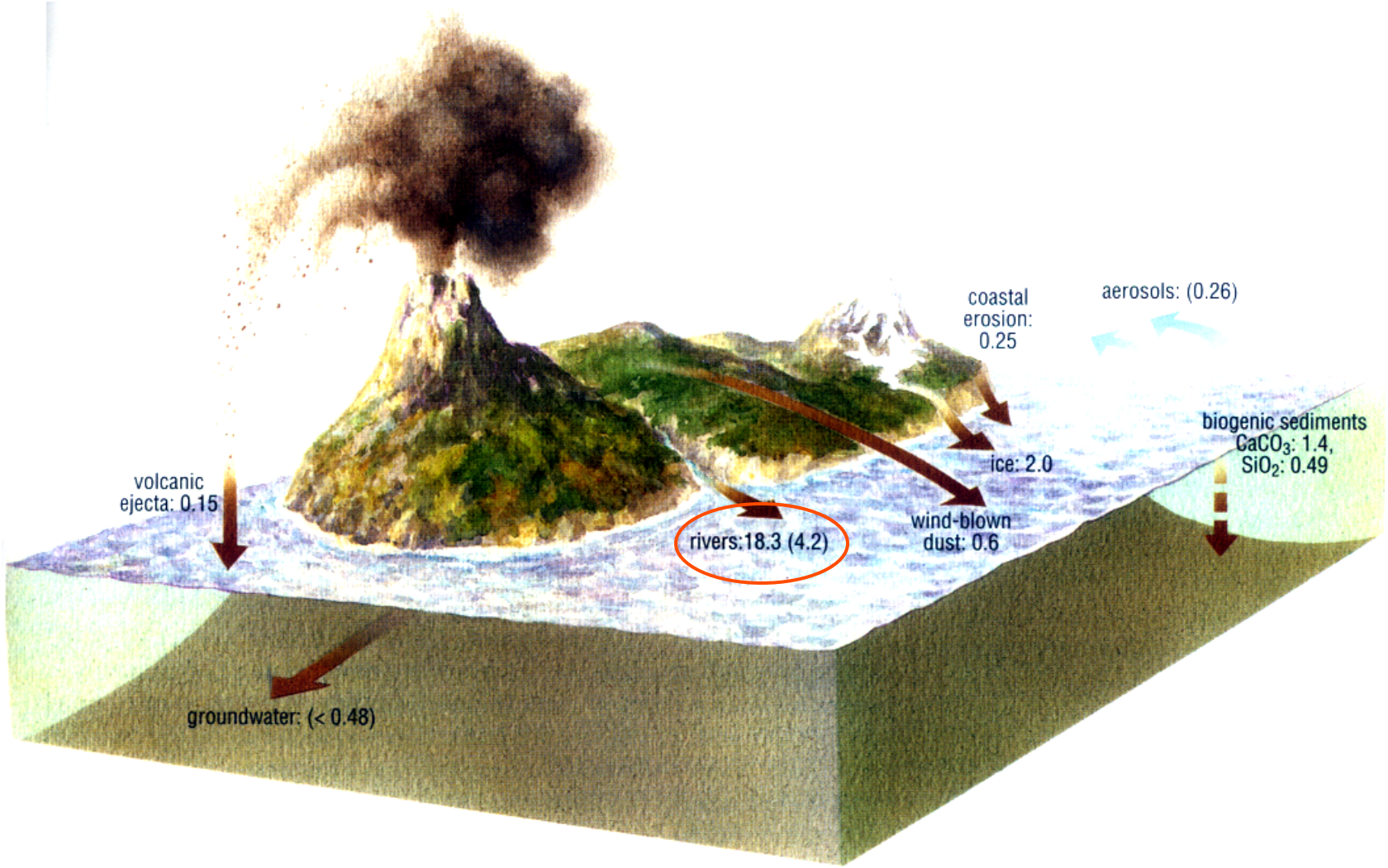
Rock fragments
Quartz
Clays (2 μm)

PROCESSES AFFECTING SEDIMENTATION



SOURCES/SUPPLY OF SEDIMENTS

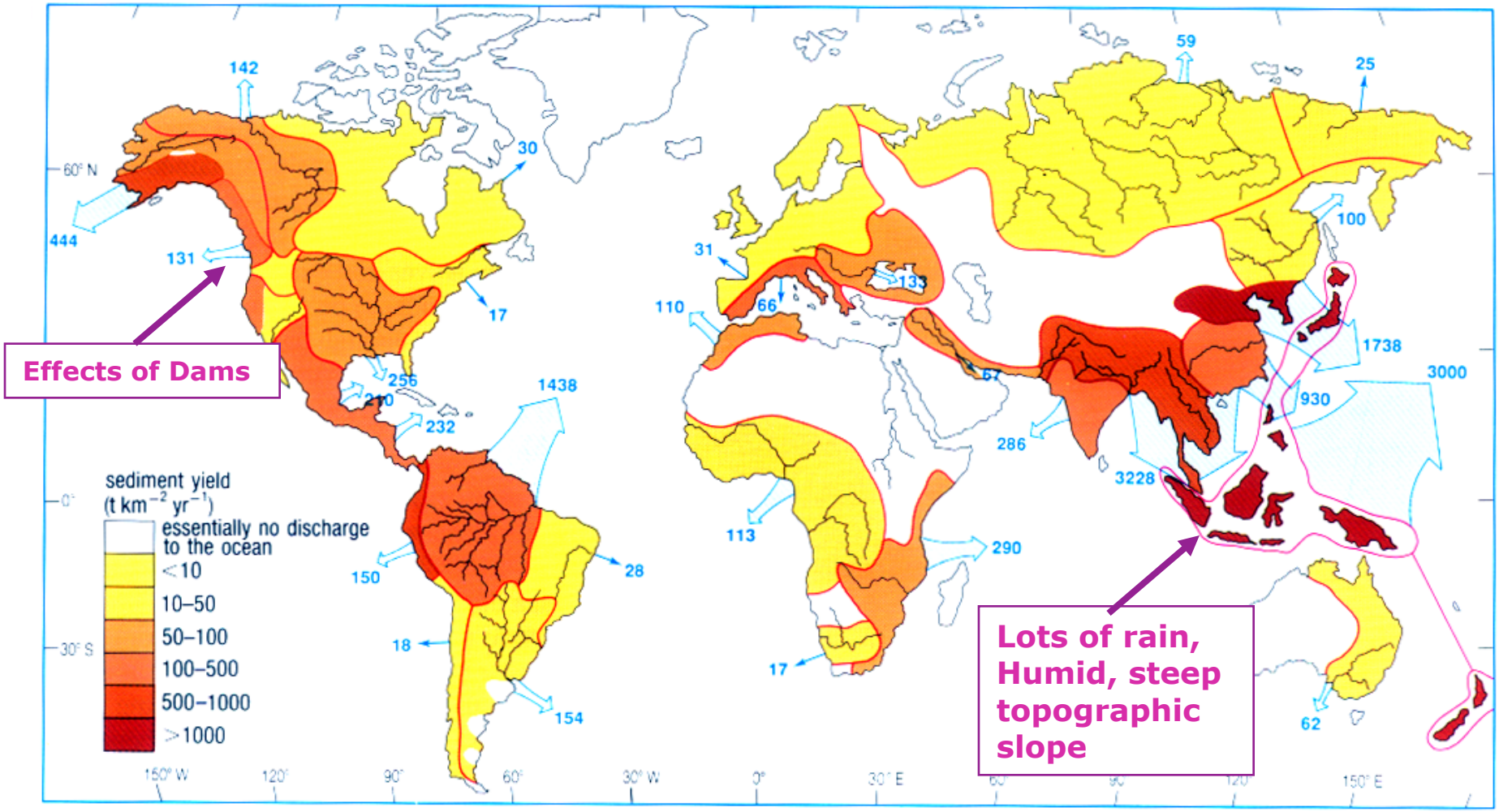
Supply of Sediments to Shelf Seas

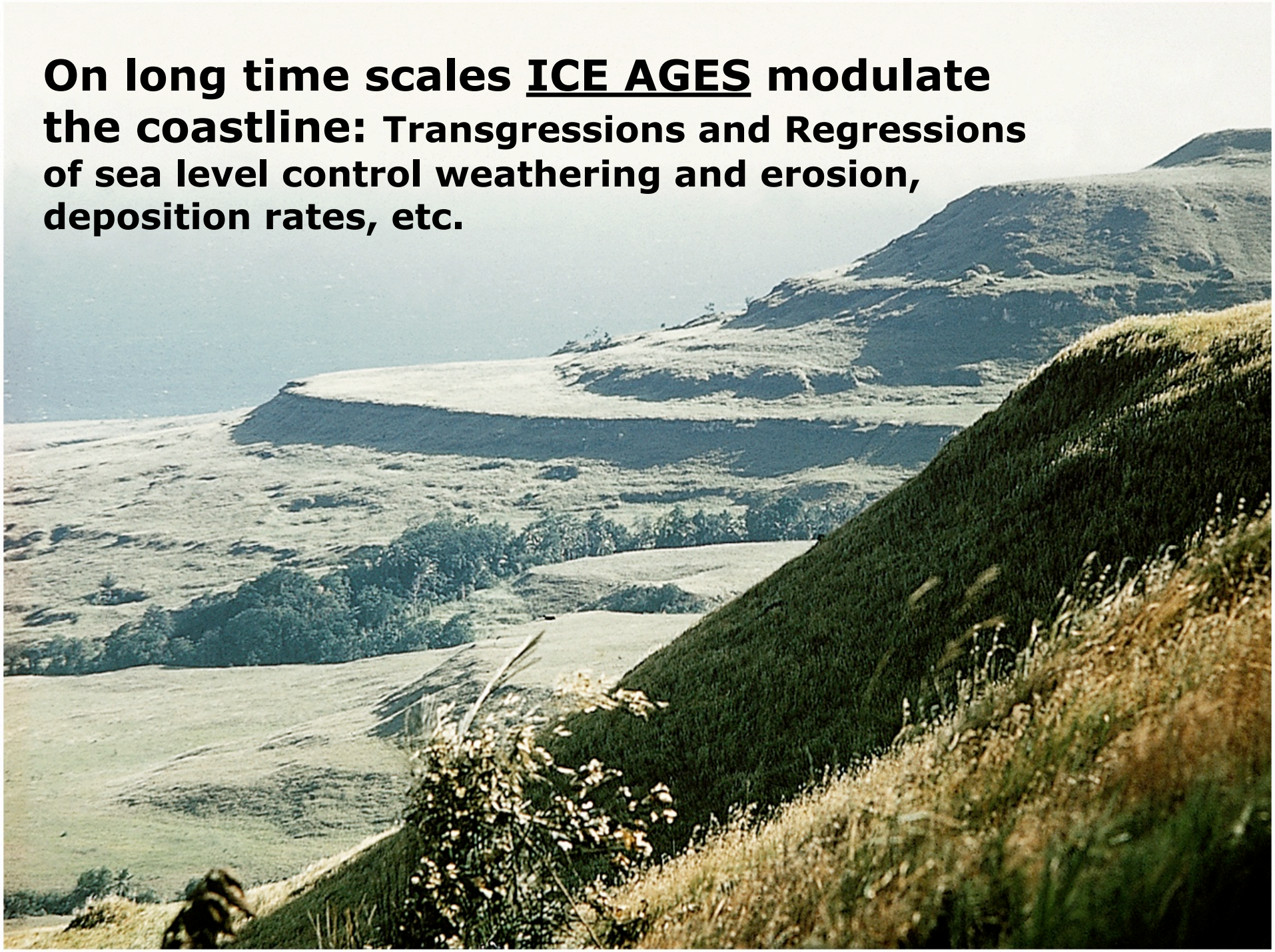


UNITS: 10^9 tonnes/year

SPATIAL DISTRIBUTIONS of SEDIMENT SUPPLY

Discharge from major drainage basins




On long time scales ICE AGES modulate the coastline: Transgressions and Regressions of sea level control weathering and erosion, deposition rates, etc.

Shelf sediments - summary

TYPES

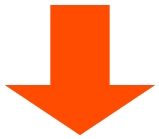
Rock fragments, Quartz and Clays

SOURCE (MAJOR)

Globally: Rivers
Locally: Ice and wind transport and volcanic eruption

SHAPE/STRUCTURE of SHELF SEAS

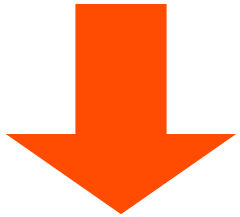
Sea level changes: deposition of rivers/glacial sediments → relict sediments



Reworked by waves and tidal currents

Our GOAL is to understand:

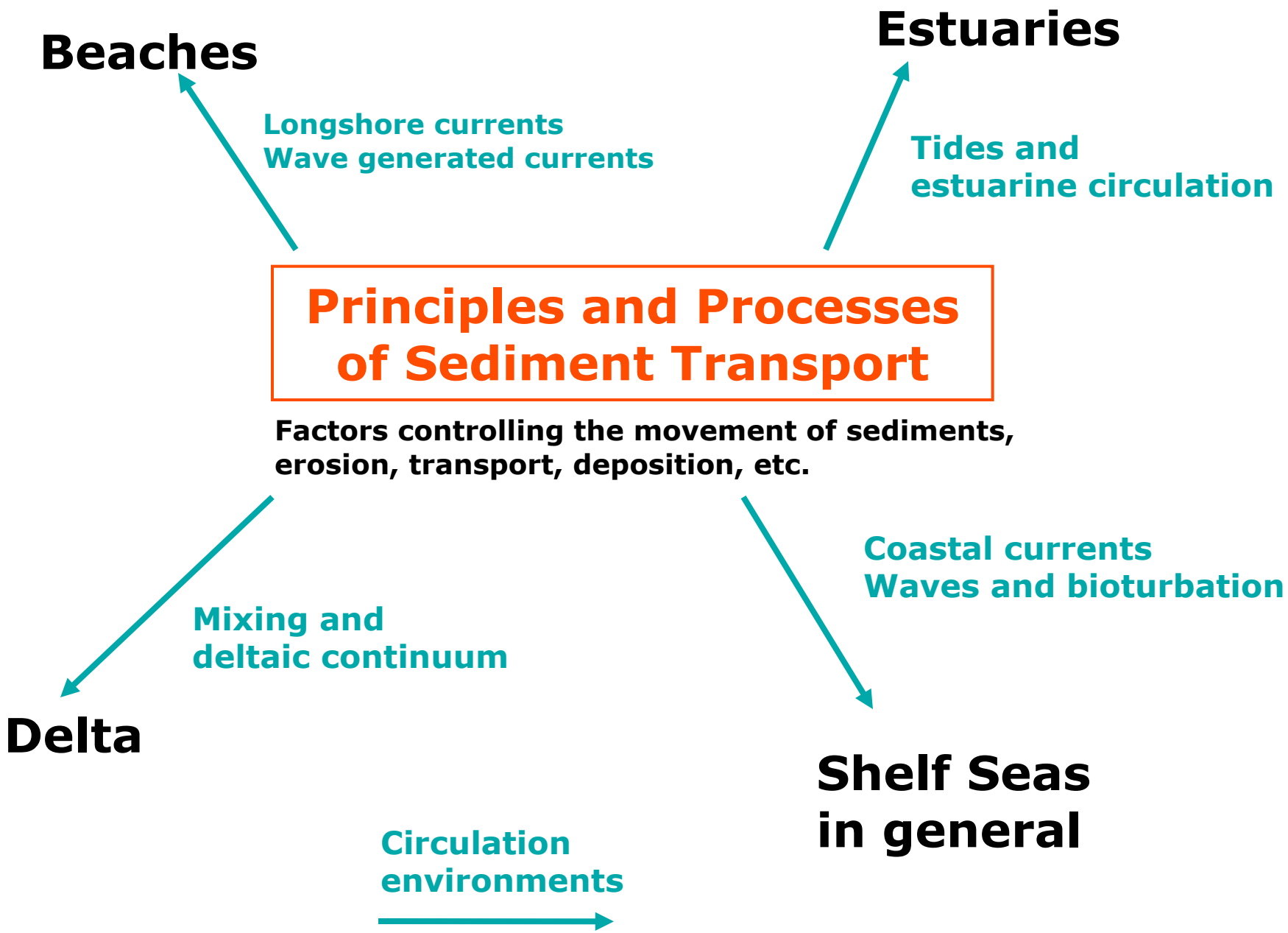
Physical and chemical principles that underlie the transport and deposition of sediments in the near shore.



Protect and Manage coastal environments from human intervention

Important principle:

Equilibrium between sedimentation rate and redistribution of sediments


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

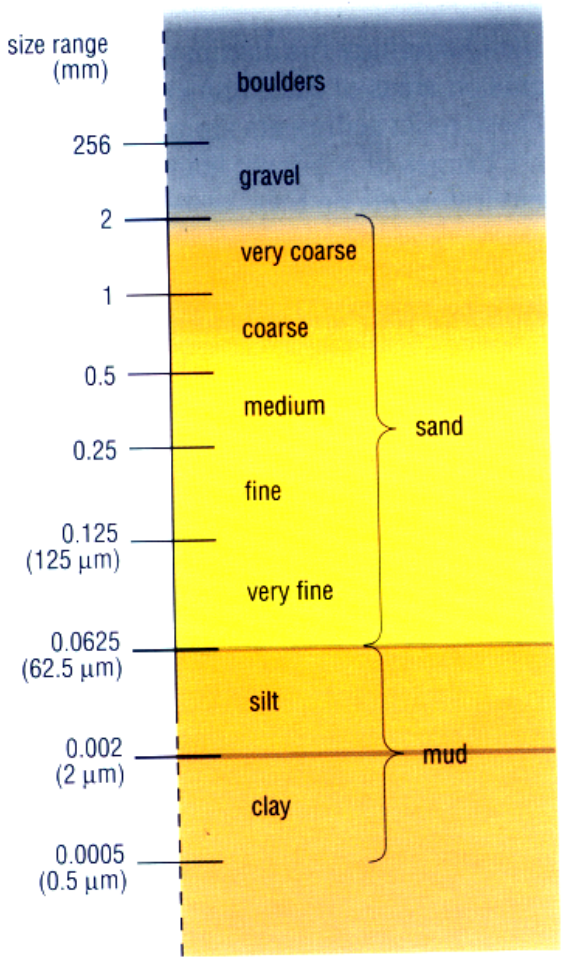
Principles and Processes of Sediment Transport

Factors controlling the movement of sediments

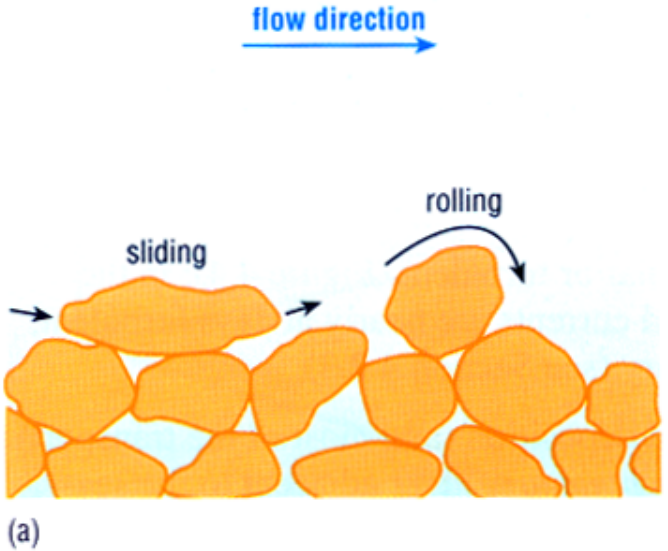
SIZE

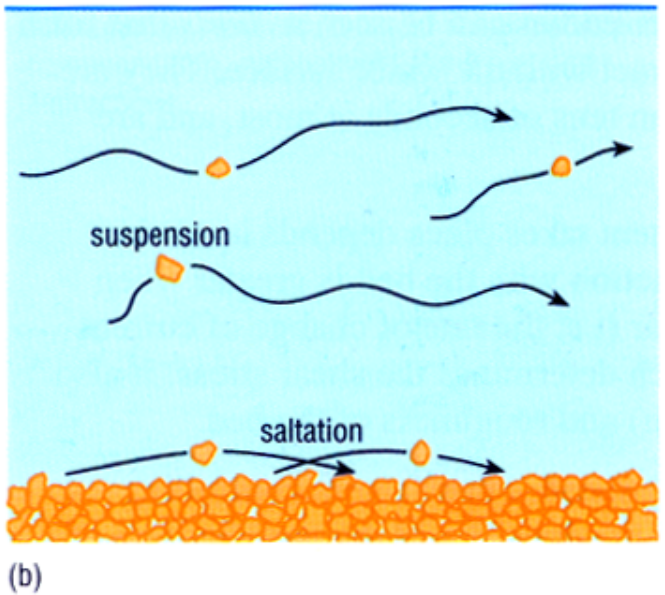
TRASPORT IN WATER

SIZE Classification



TRANSPORT in WATER

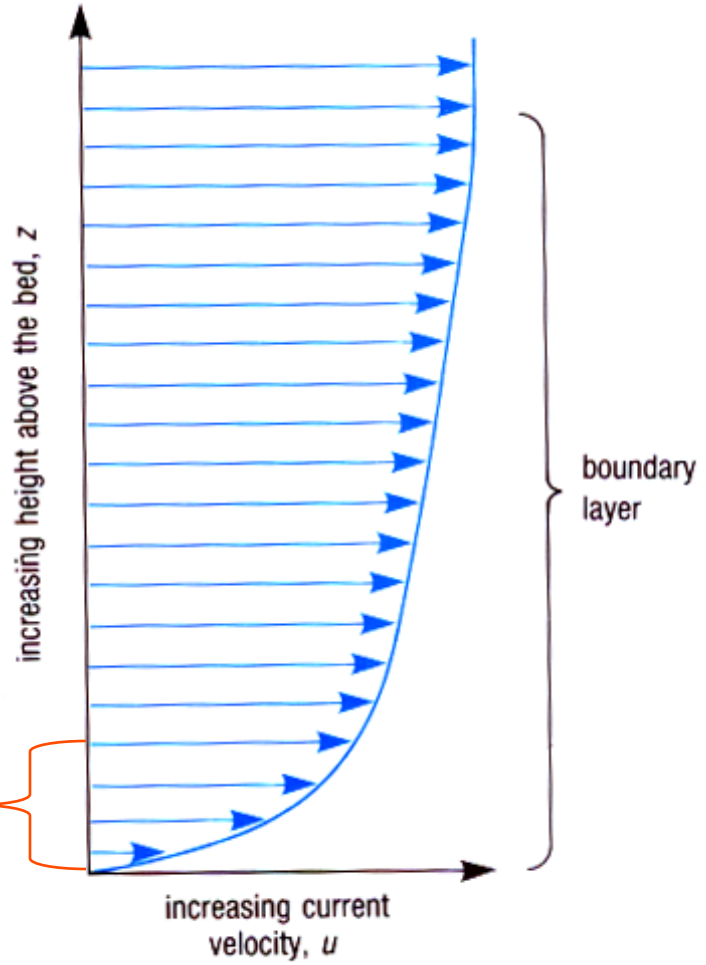




Boundary Layer and Current Shear

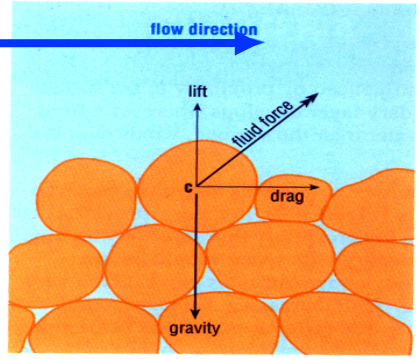
Movement of sediments in the Benthic Boundary Layer depends on:

- **Roughness of sediment bed**
- **Density contrast**
- **Degree of Turbulence**
- **Current Shear**
- **Shear Stress**



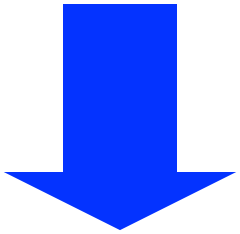
Benthic Boundary Layer
several 10s of meters

Laminar or Turbulent

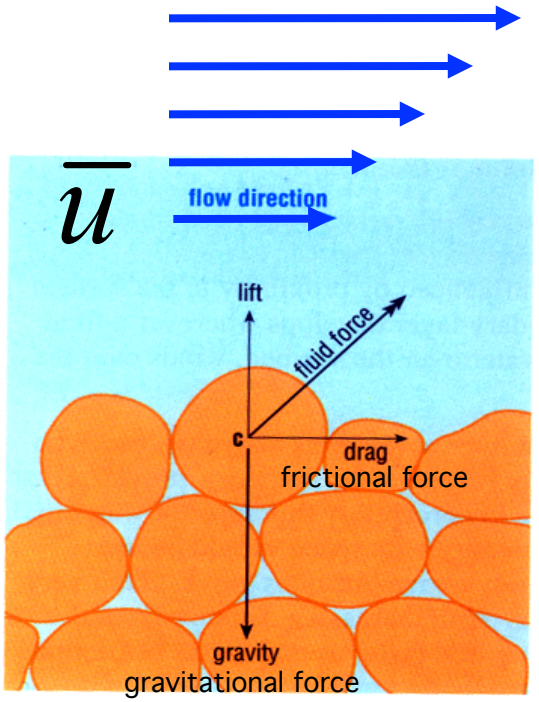


Shear Stress **is proportional to velocity at the bed**

$$\tau = (\mu + \eta)\frac{d\bar{u}}{dz} = \rho u_*^{\,2}$$

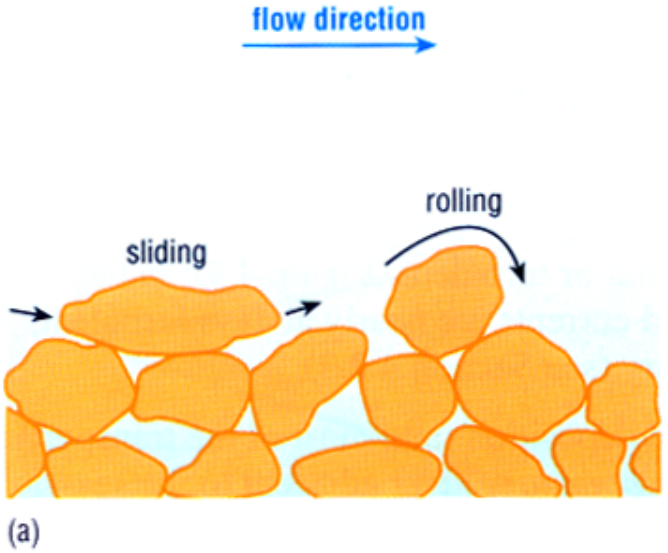


when strong to overcome
frictional and gravitational forces
Critical Shear Stress



TRANSPORT in WATER

Erosion: the process by which we set sediments in motion.

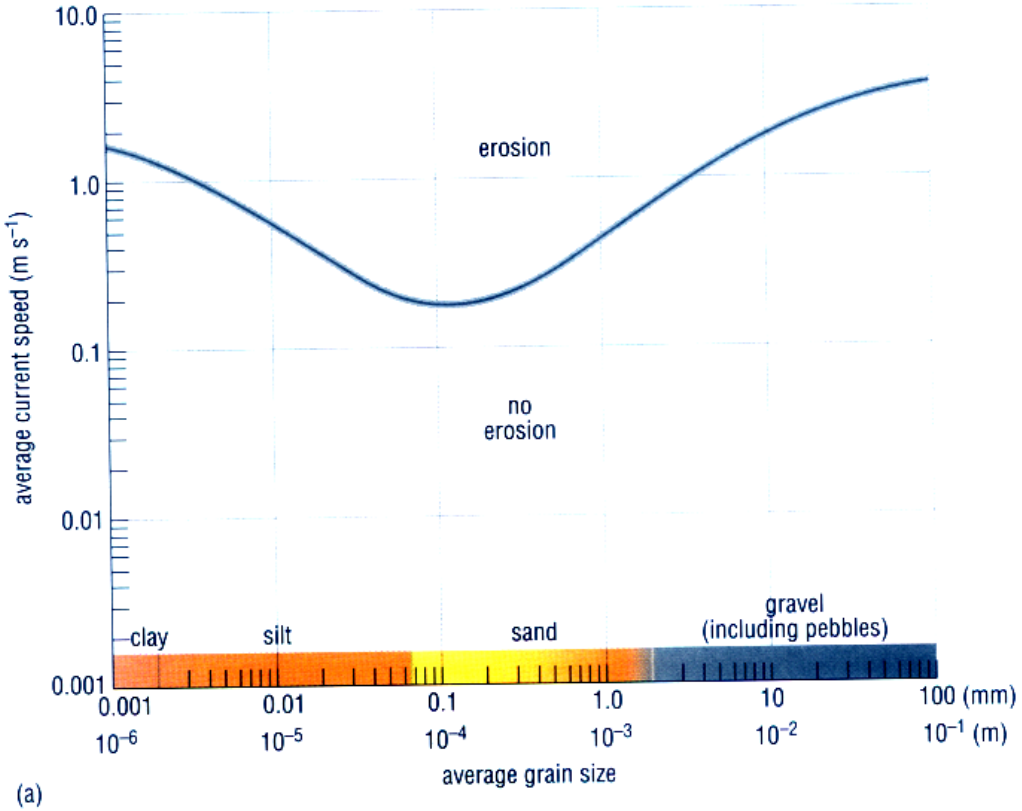


Also take into account:

COHESIVE vs. NON-COHESIVE

WHEN DOES EROSION OCCUR?

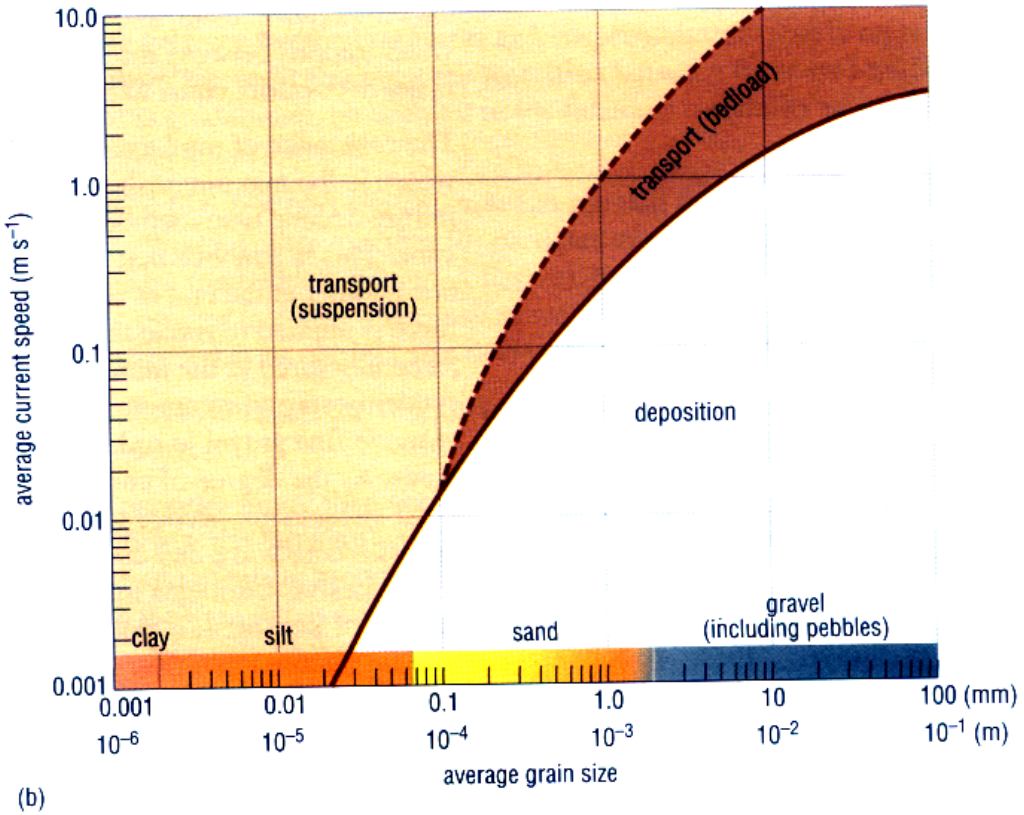
$\overline{u}$



Size of grain

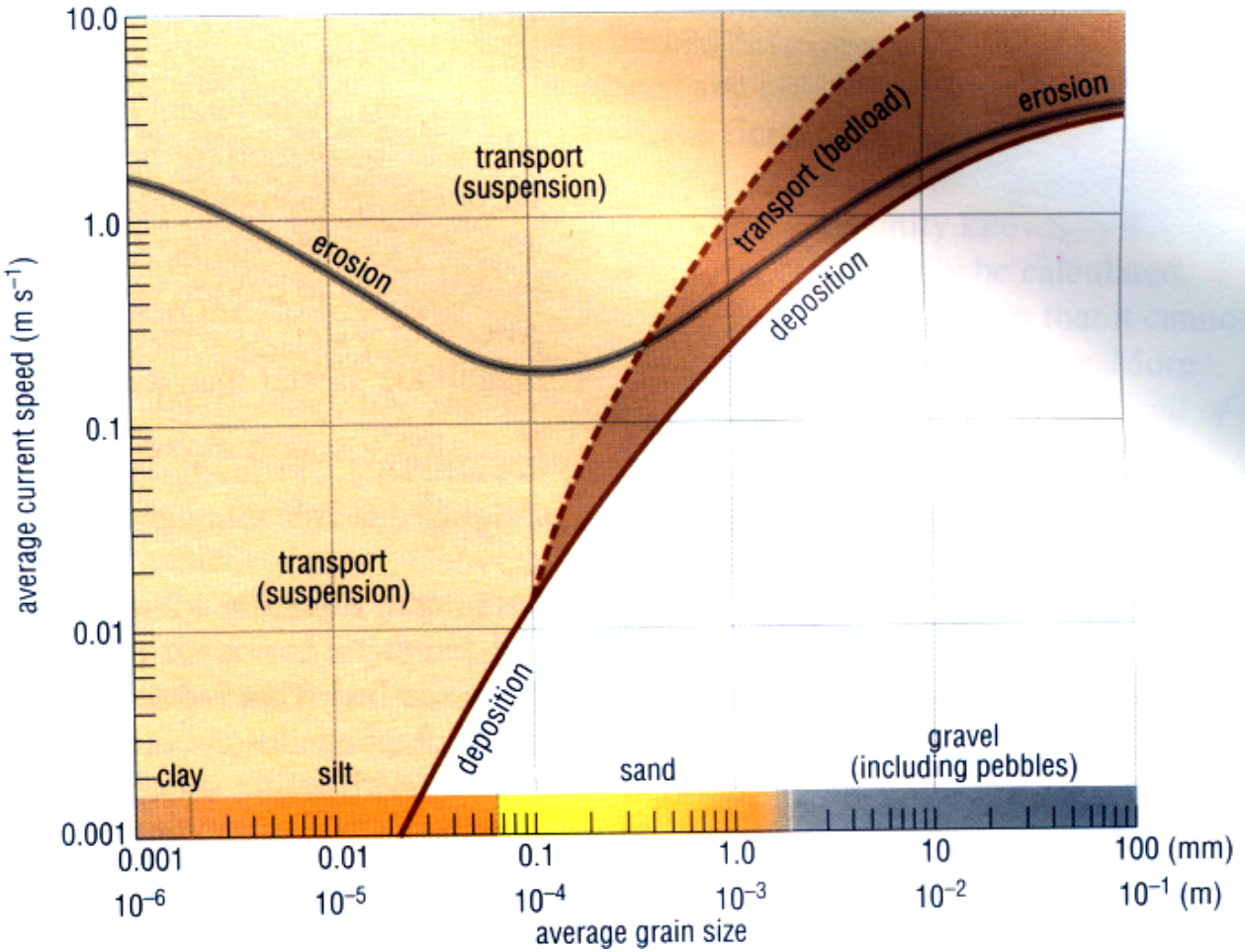
TYPES of TRANSPORT EXPECTED and DEPOSITION

$\overline{u}$



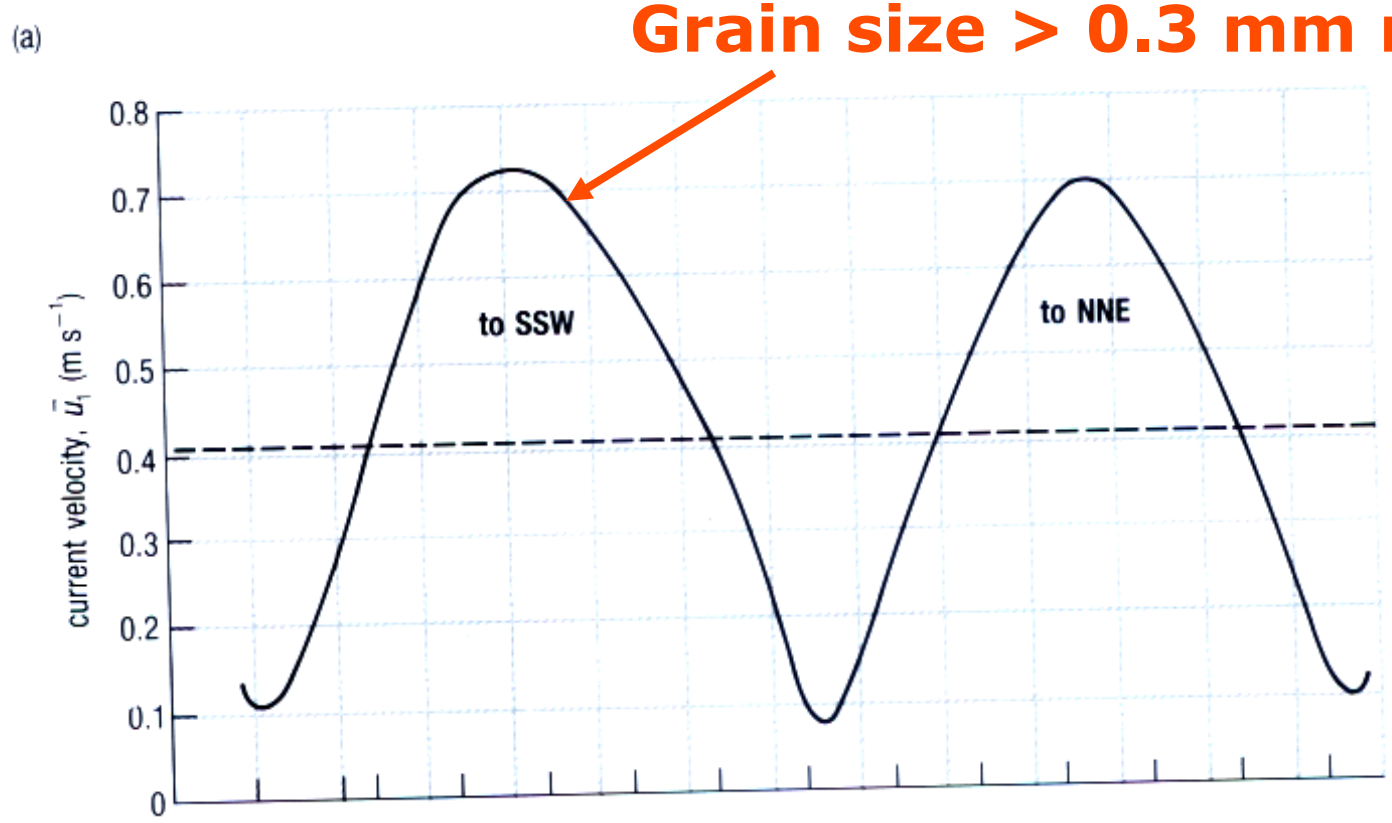
Size of grain

$\overline{u}$



Size of grain

Tidal currents



Rates of sediment transport

Sediment Flux →

A) Bedload

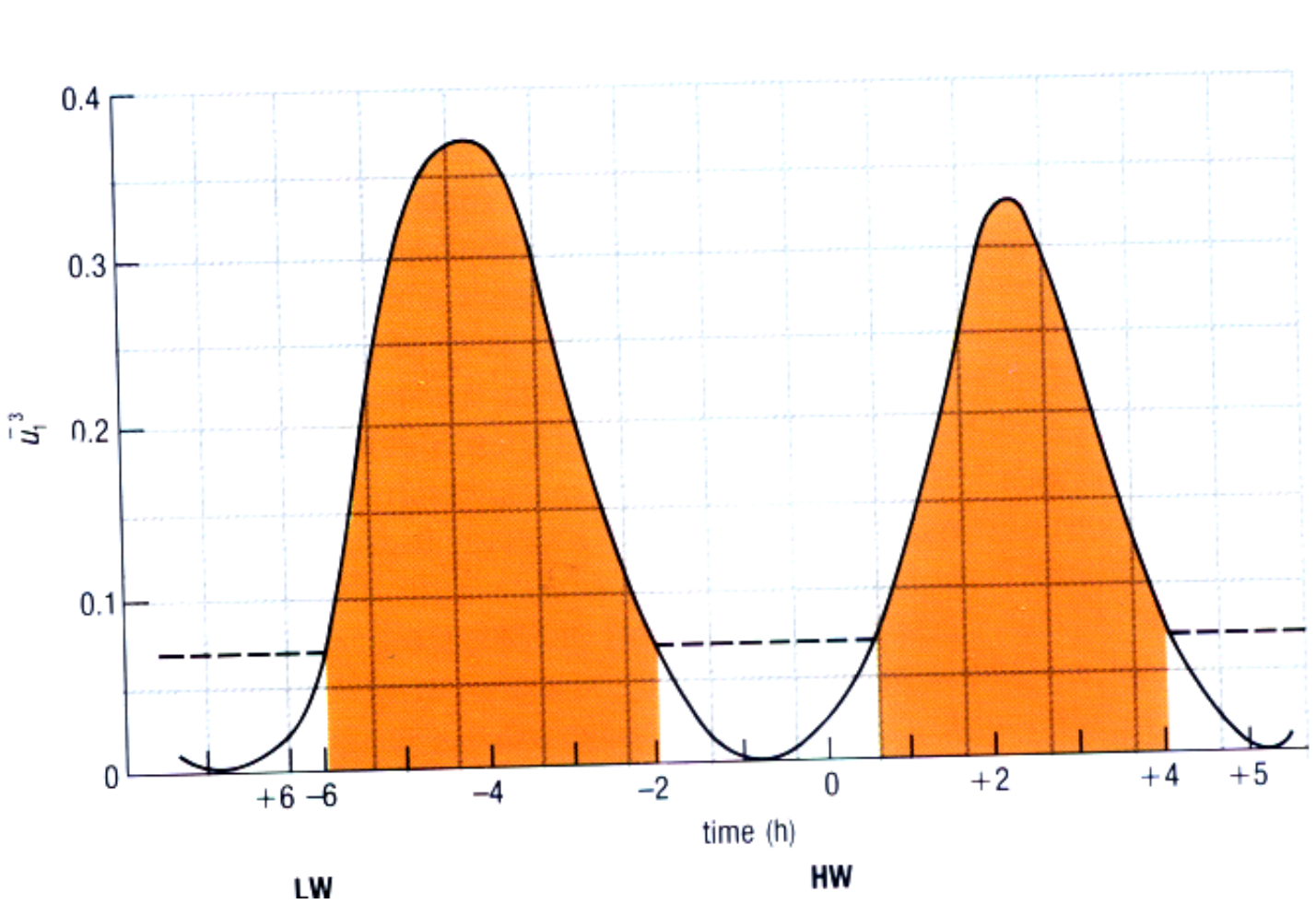
B) Suspended Load

Sediment Flux

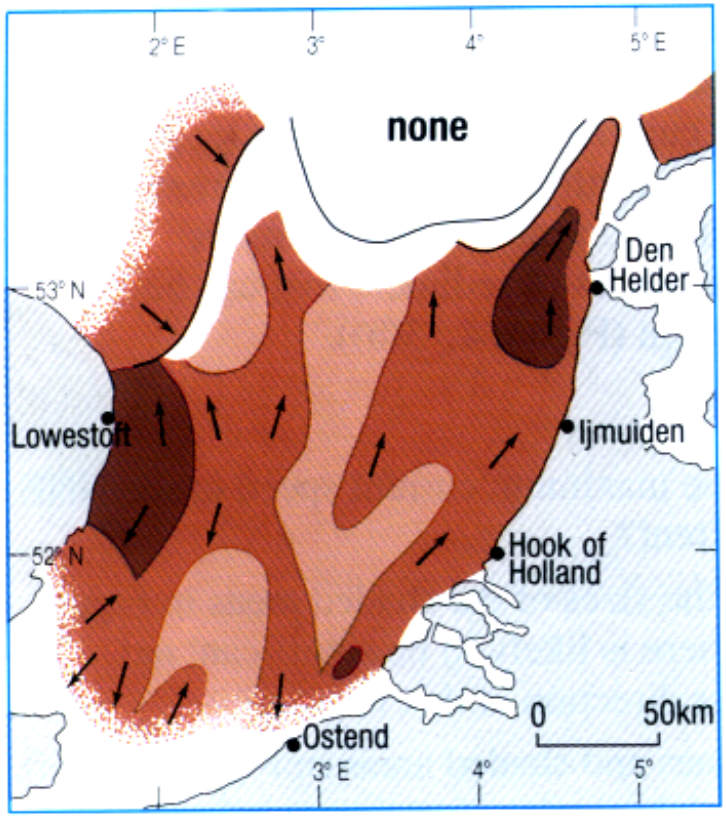
Bedload

$$q \propto \rho u_*^{3}$$

u_*^{3}



Maps of SAND TRANSPORT



theoretical net sand transport

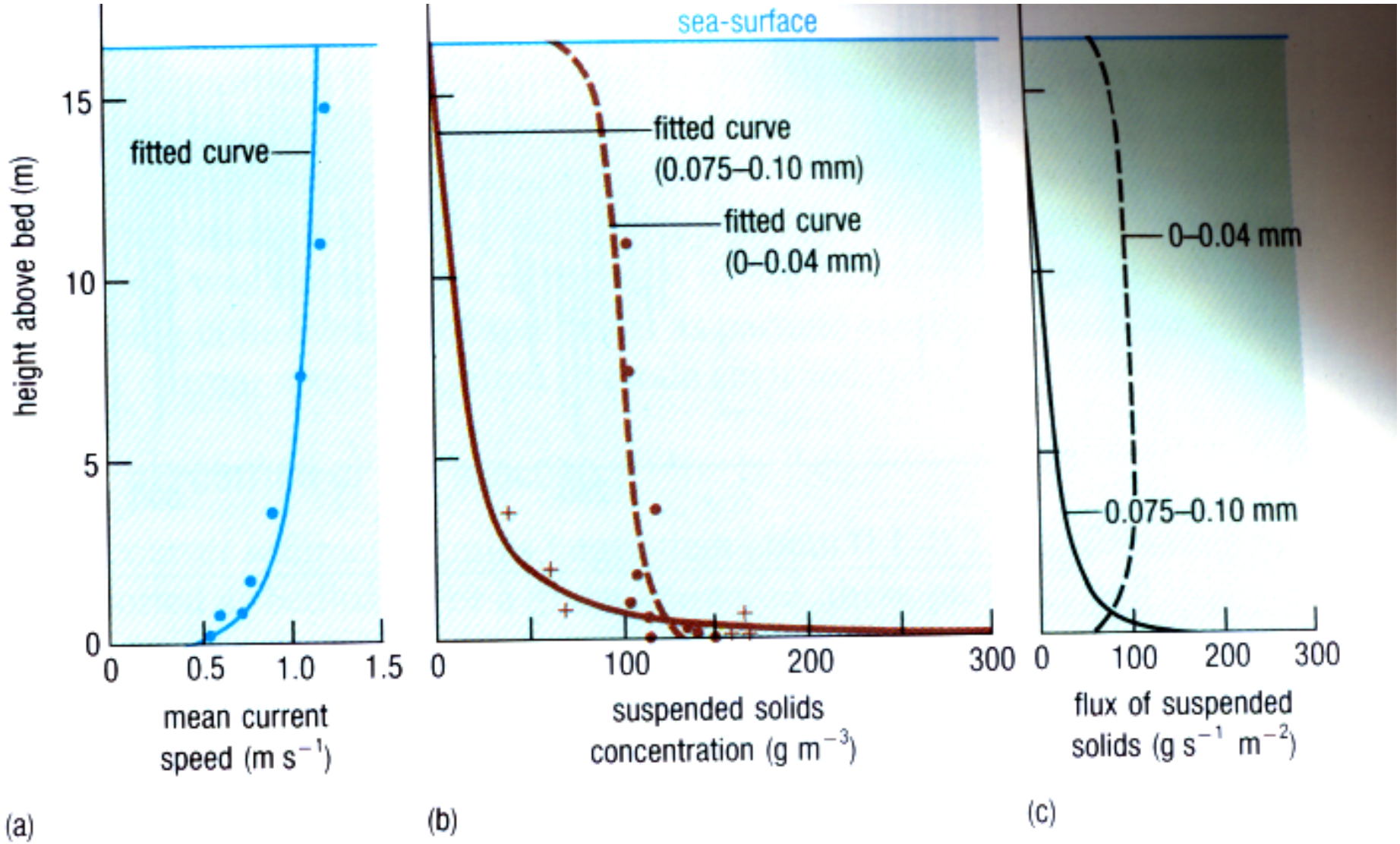
high

moderate

low

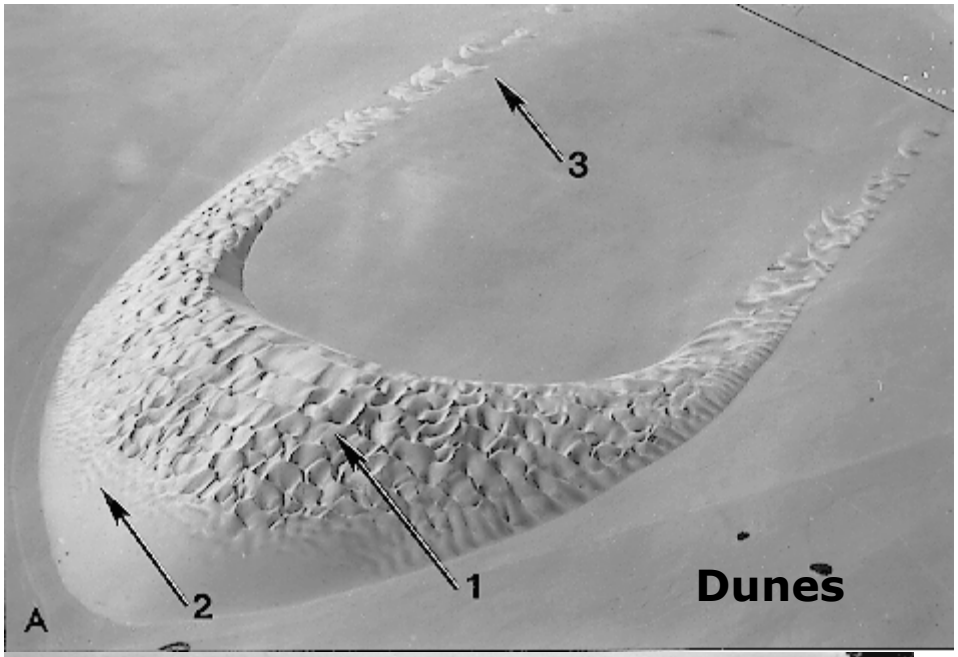
Sediment Flux

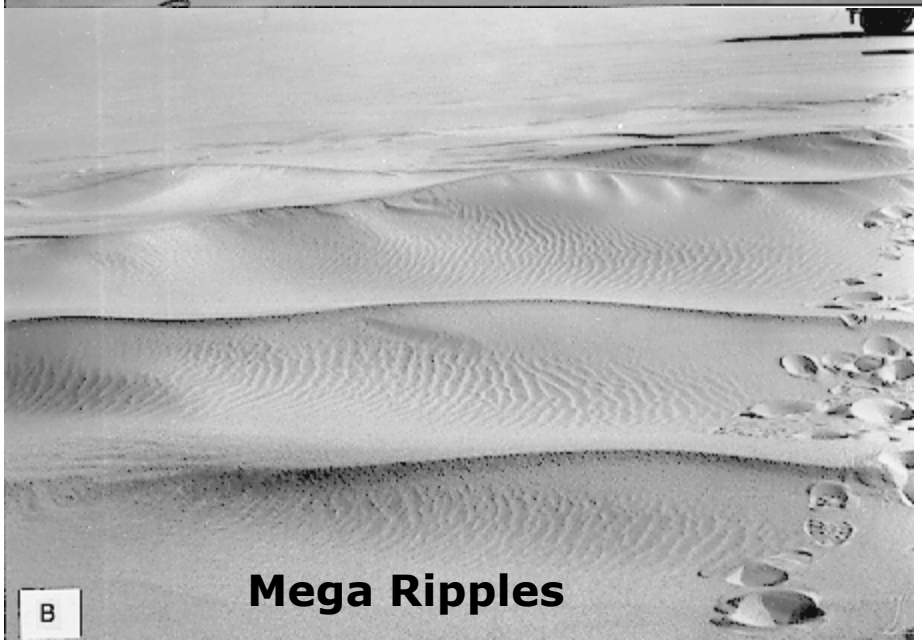
Suspended Load

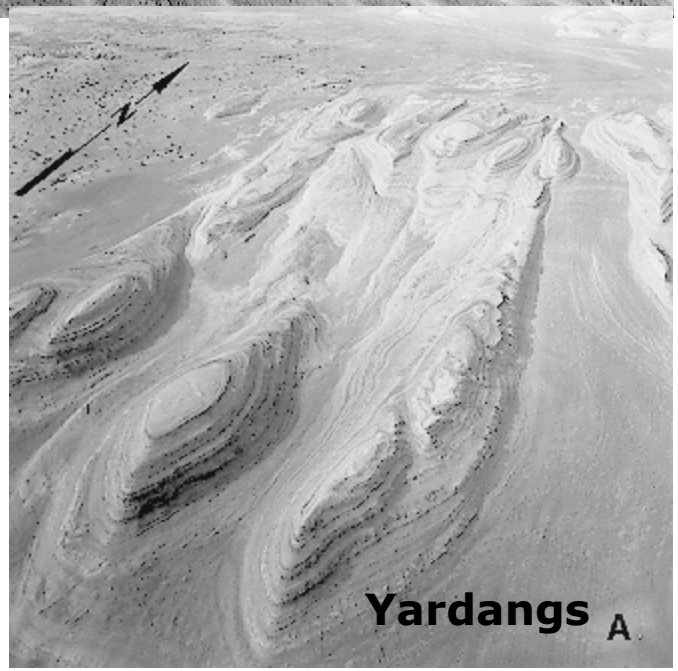


Bed Forms

In the ocean the systematic study of bed forms started in 1940 with echo-sounding techniques







low

currents

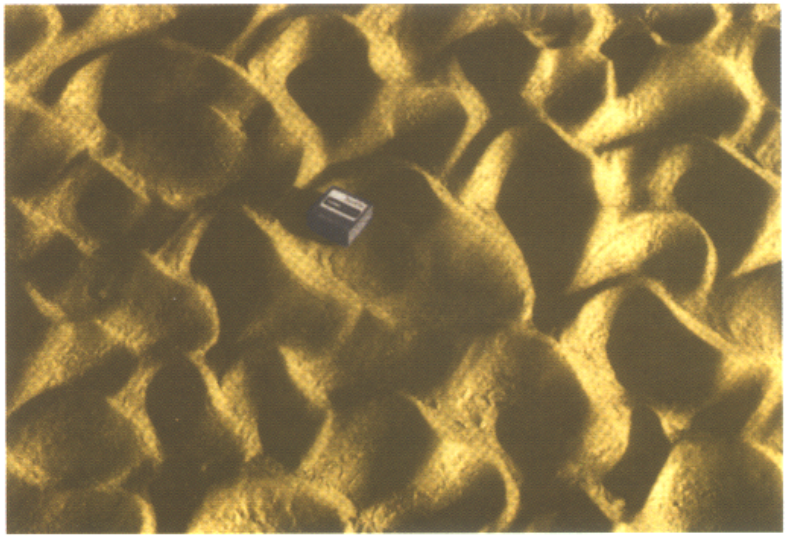
height

wavelegnth

high

Ripples

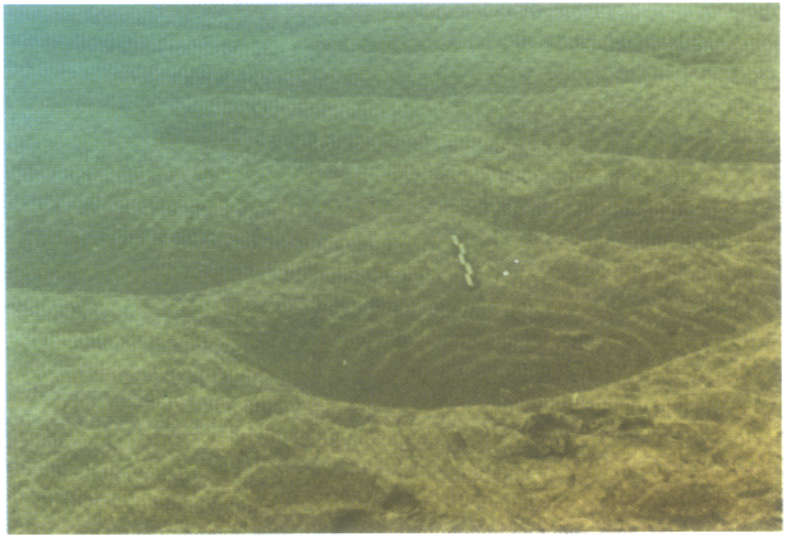
slow current
0.6 mm grain size
need viscous sublayer



(a)

Mega Ripples

stronger currents
up to 1 meter high
disturbs ocean surface



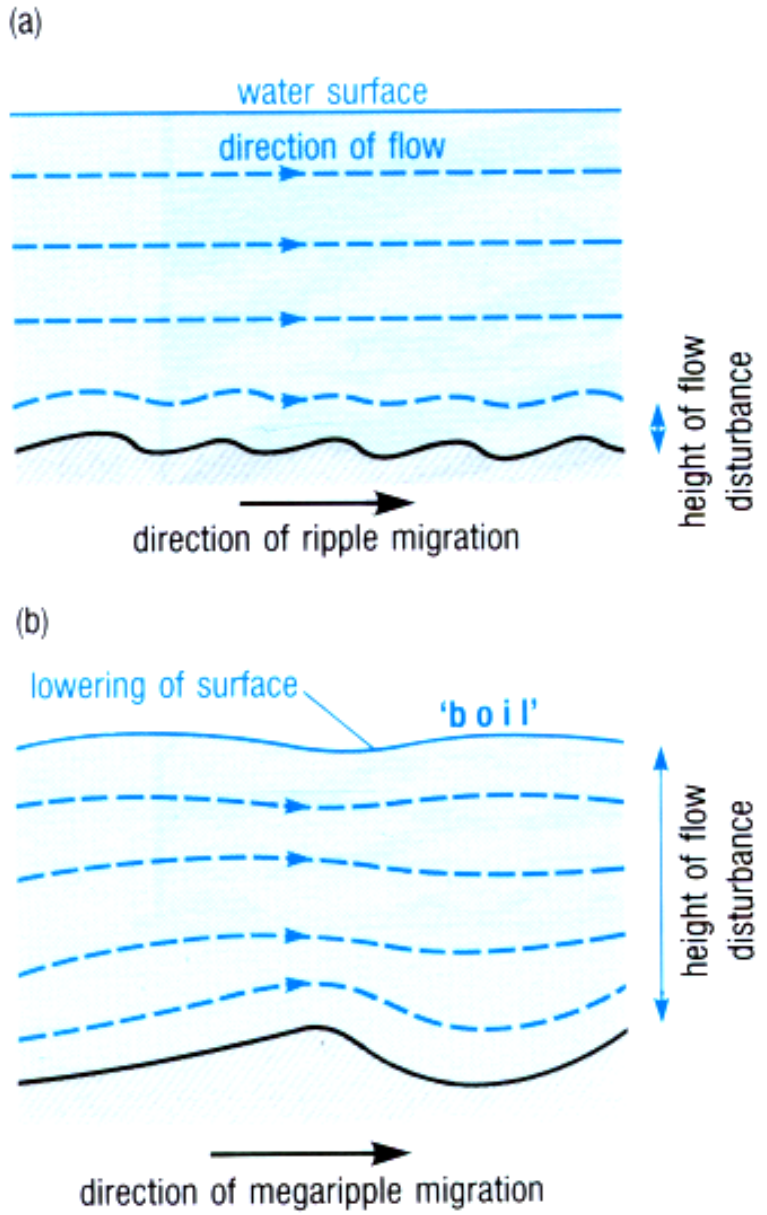
(b)

Sand Waves

stronger currents
up to 18 meter high
1 km wavelegnth

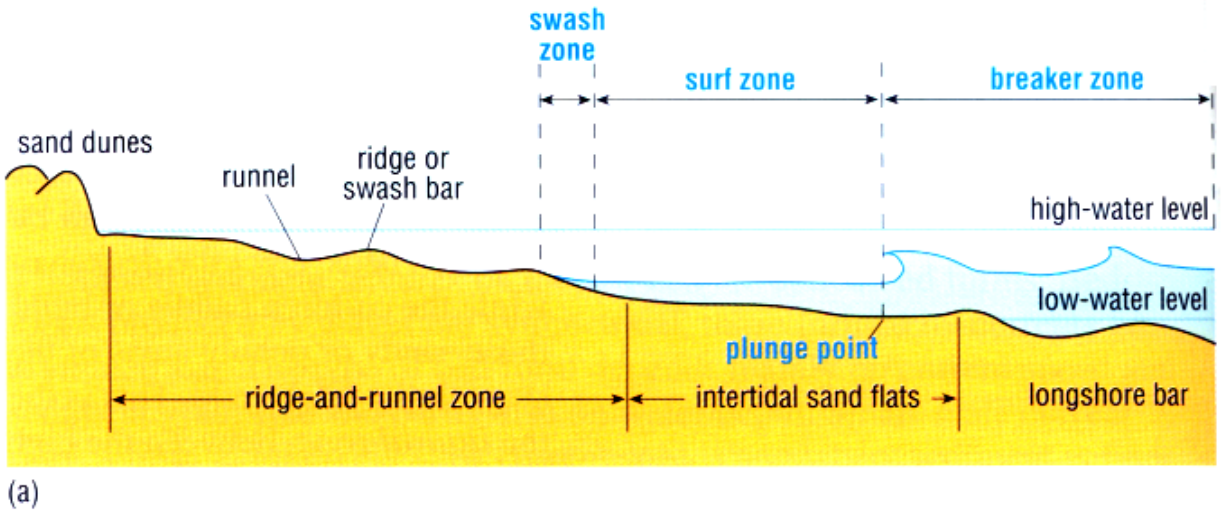
Ripples

Mega Ripples



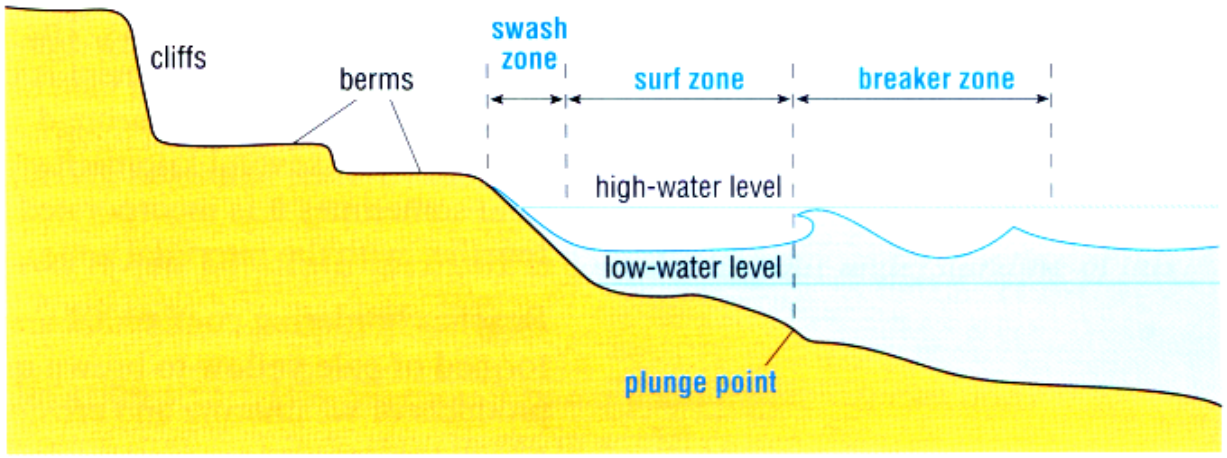
Beach Morphology

shallow slope



(a)

steep slope

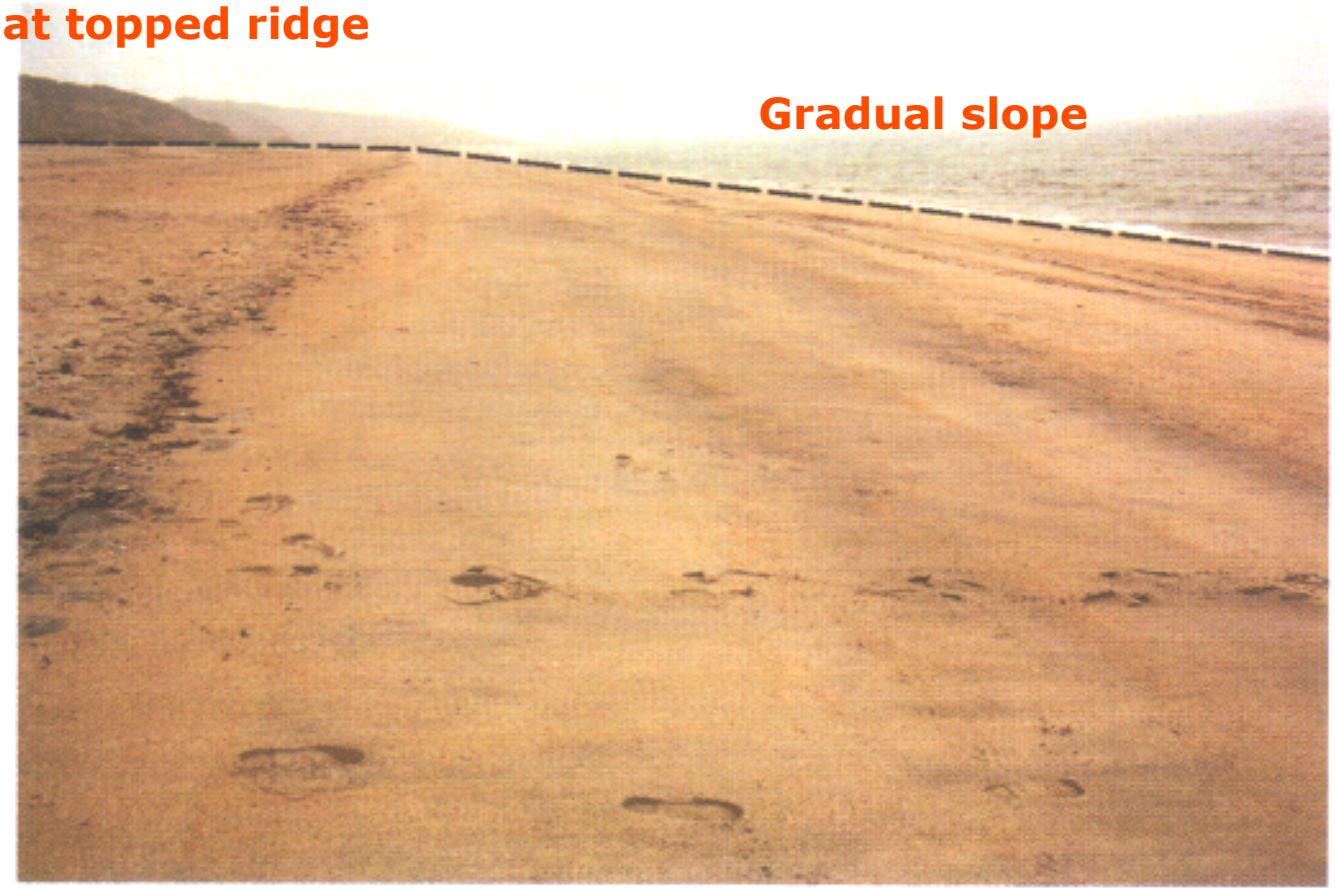


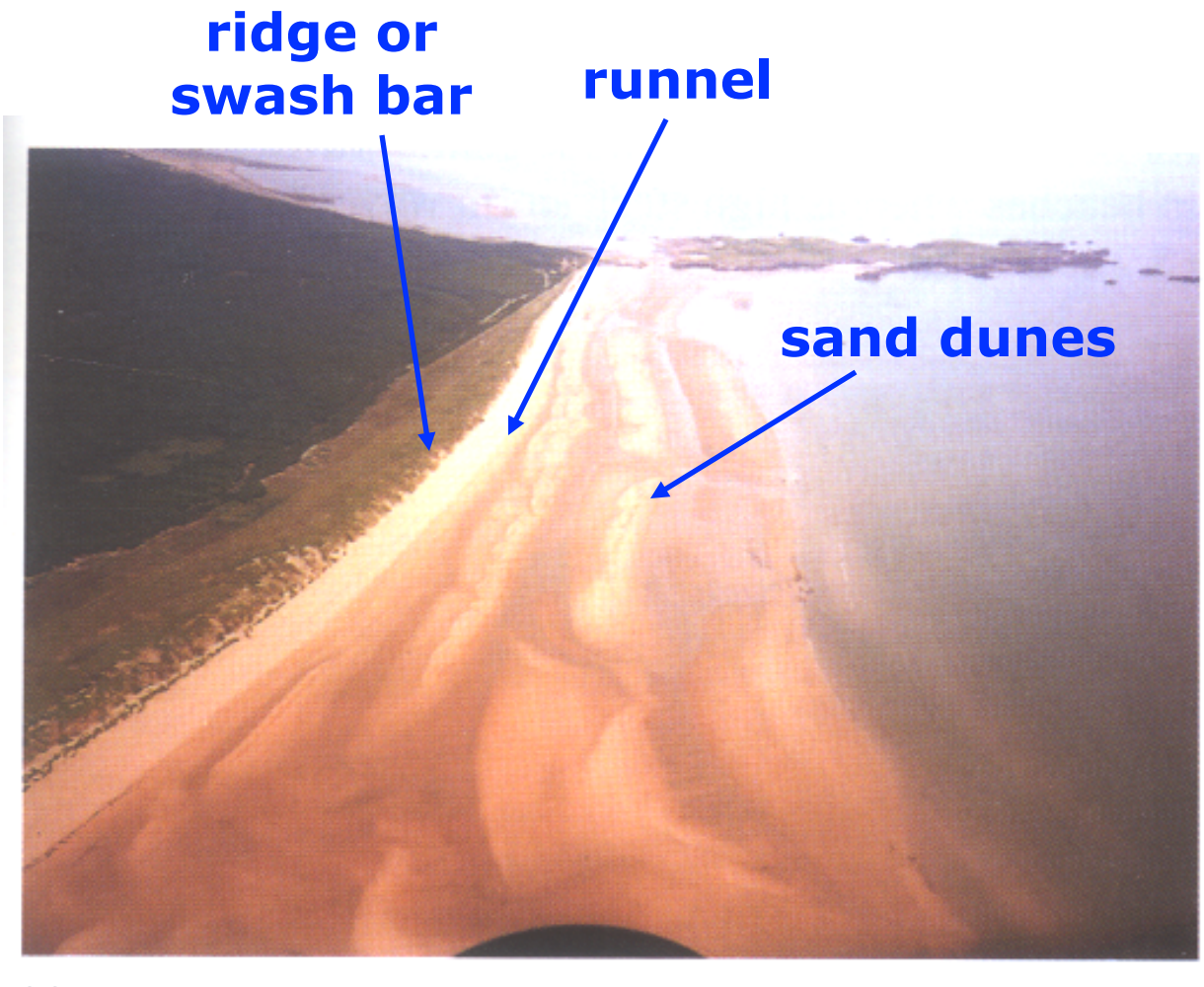
(b)


Surf Zone
Breaker Zone

berm

Flat topped ridge





Gradual slope
intertidal sand flats

ridge or swash bar

runnel

(f)

Autumn

(a)

Winter

(b)

Winter

(c)

Summer

(d)