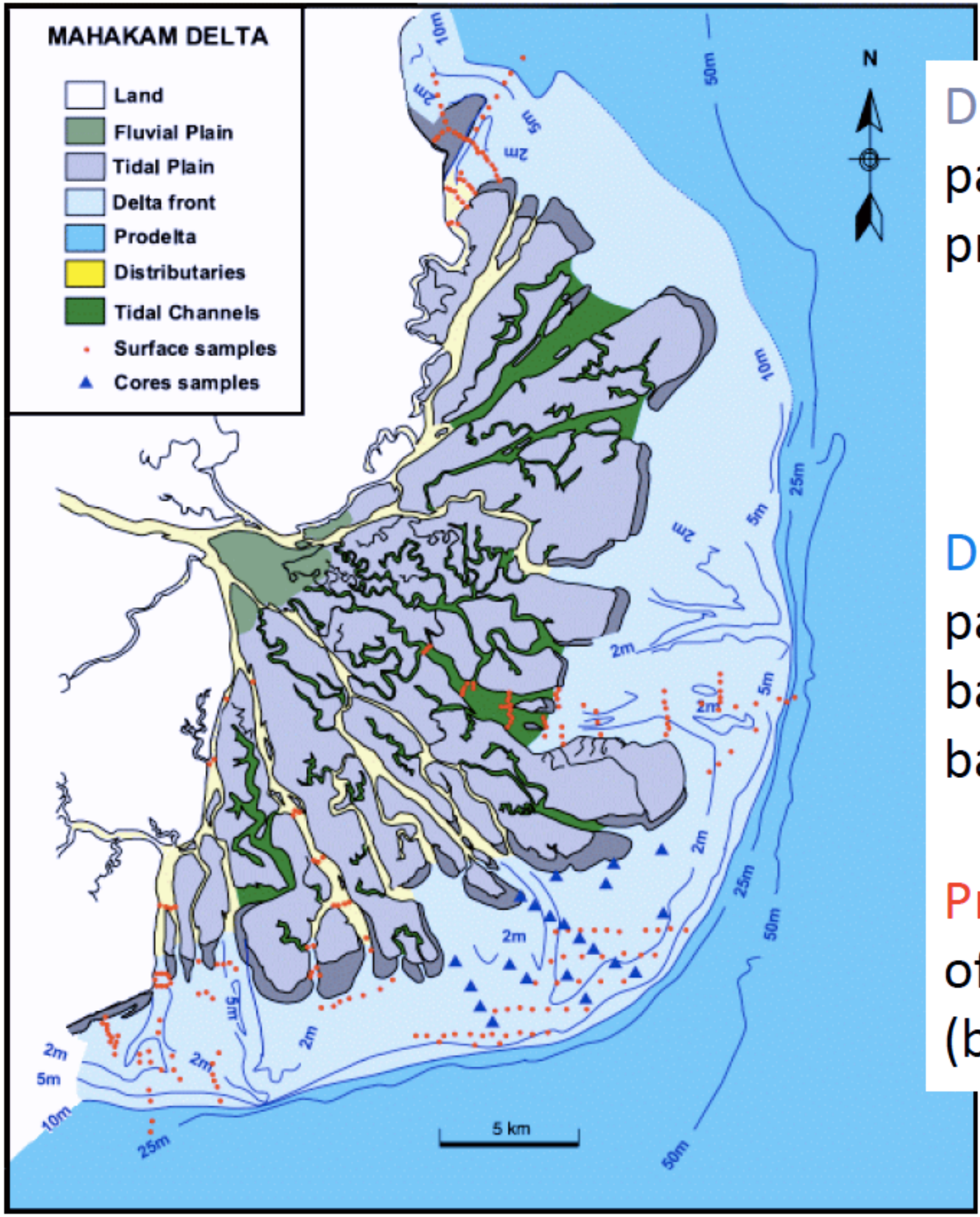
AMBIENTI DELTIZI

Delta del Nilo

Delta del Mississippi

Discrete shoreline protuberances, partly subaerial, built by rivers into a body of permanent water



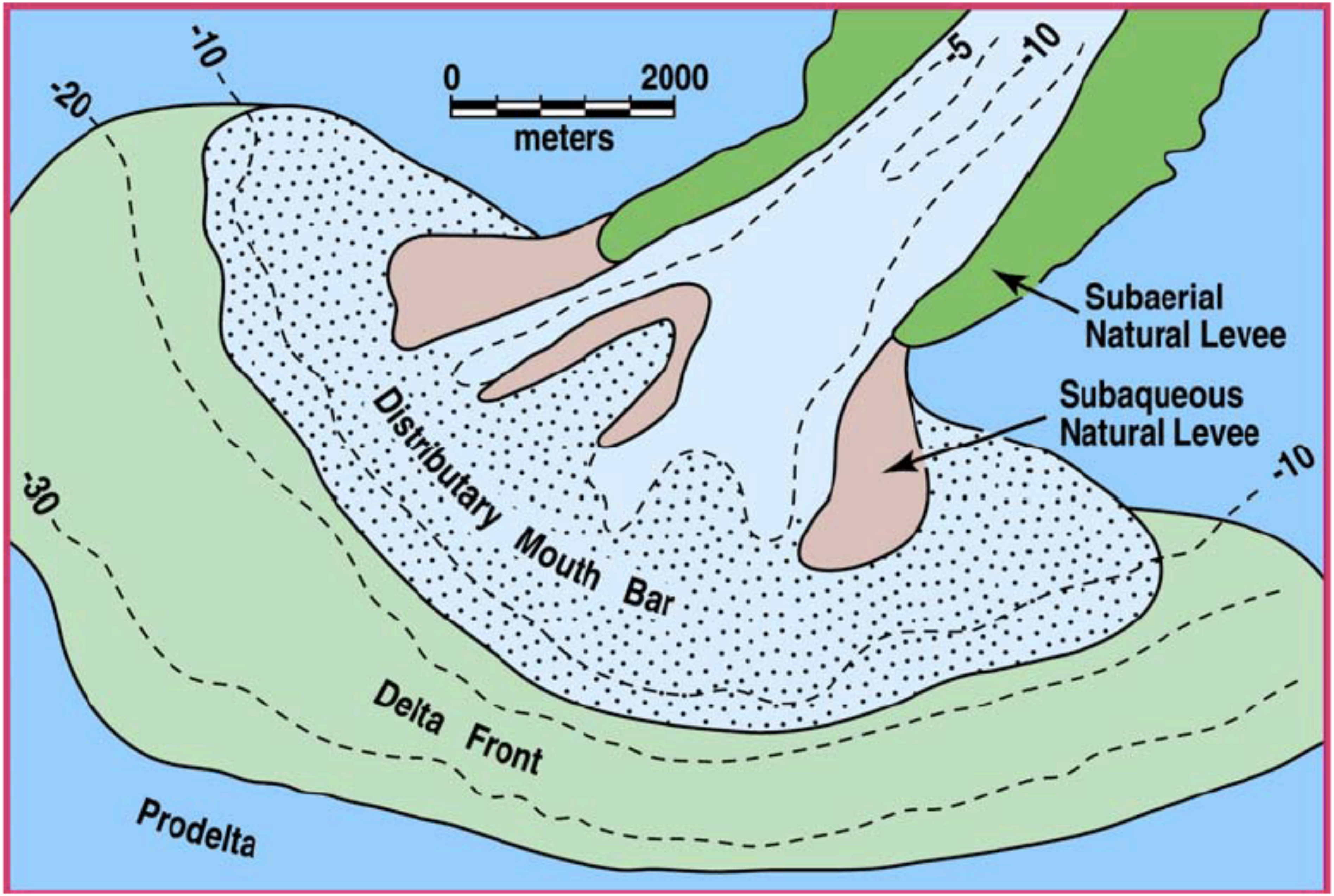
Delta plain: mostly subaerial part of delta complex (fluvial processes)

Distributary channels

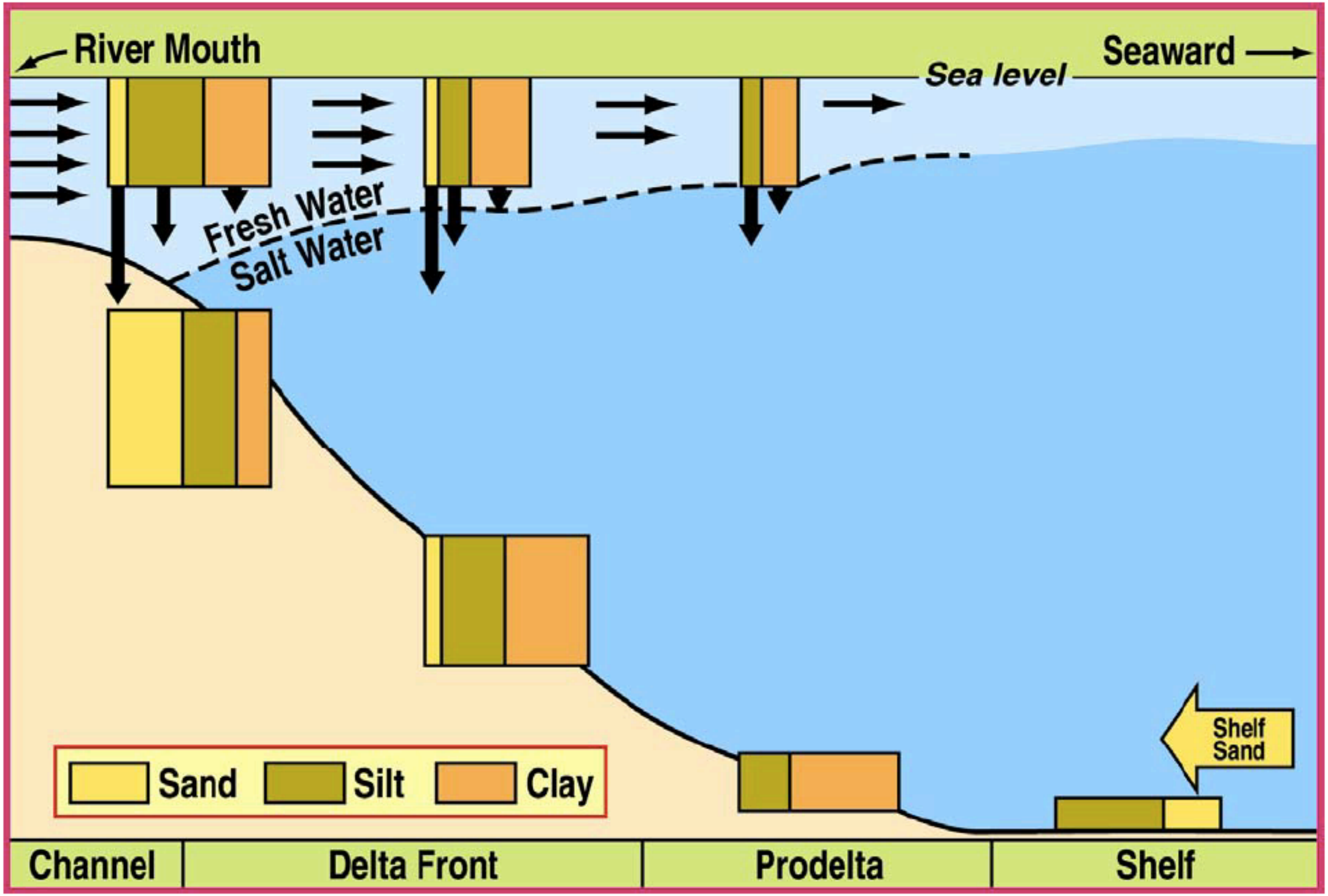
Interdistributary bay

Delta front: shallow subtidal part of delta, above wave base (mix of fluvial and basinal processes)

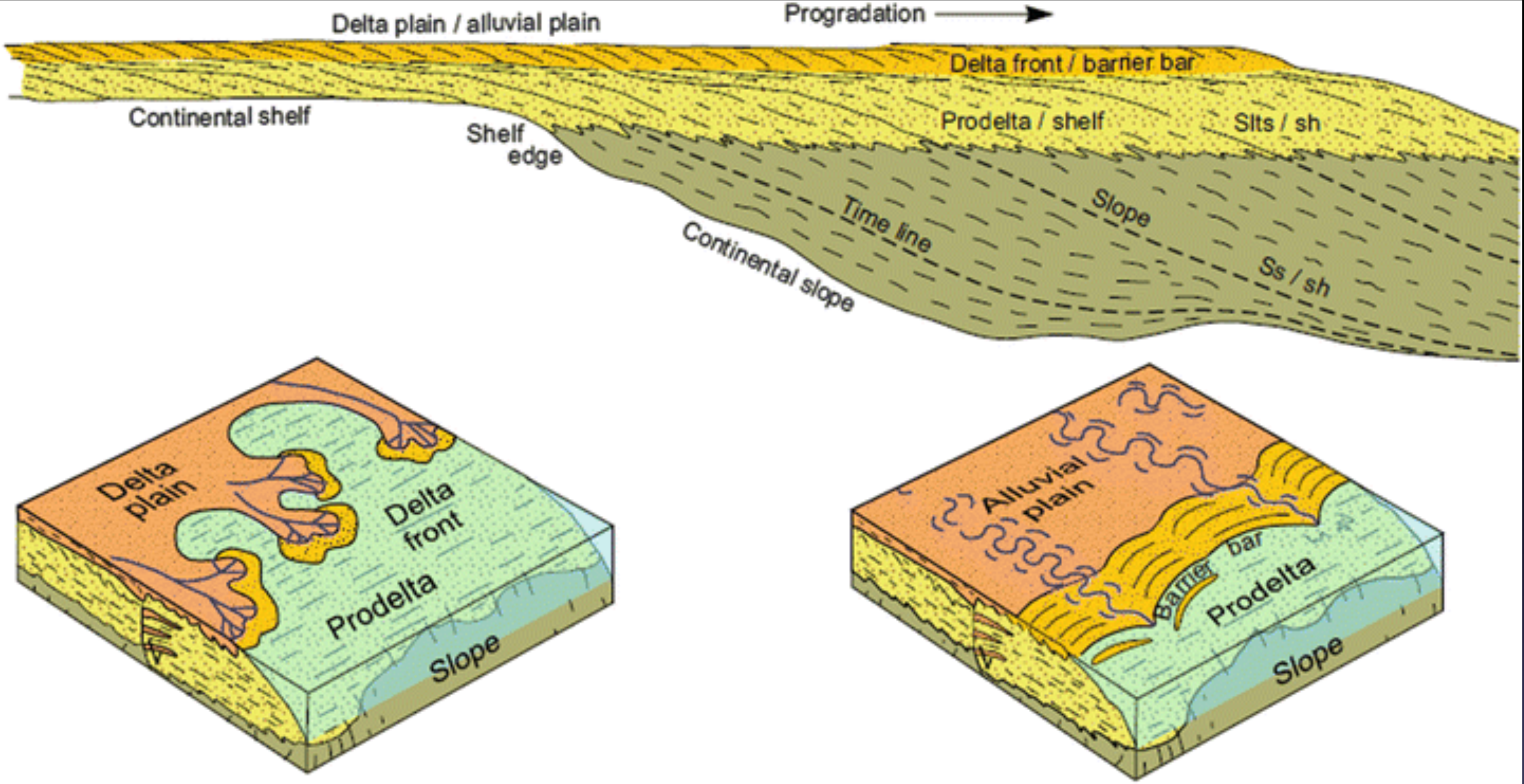
Prodelta: deeper subtidal part of delta, below wave base (basinal processes)



0
2000
meters
-20
-10
-5
-10
Subaerial Natural Levee
Subaqueous Natural Levee
-10
-30
Distributary Mouth Bar
Delta Front
Prodelta



River Mouth
Sea level
Seaward
Fresh Water
Salt Water
Shelf Sand
Sand
Silt
Clay
Channel
Delta Front
Prodelta
Shelf



River-dominated delta

Wave-dominated delta

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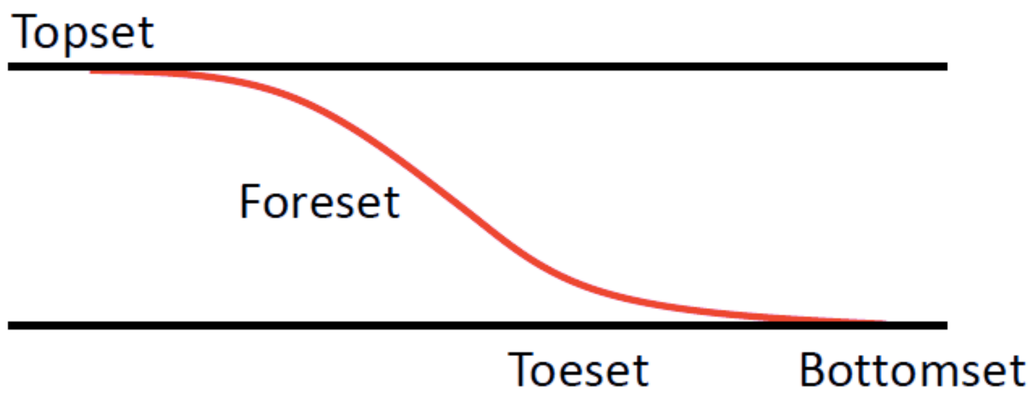
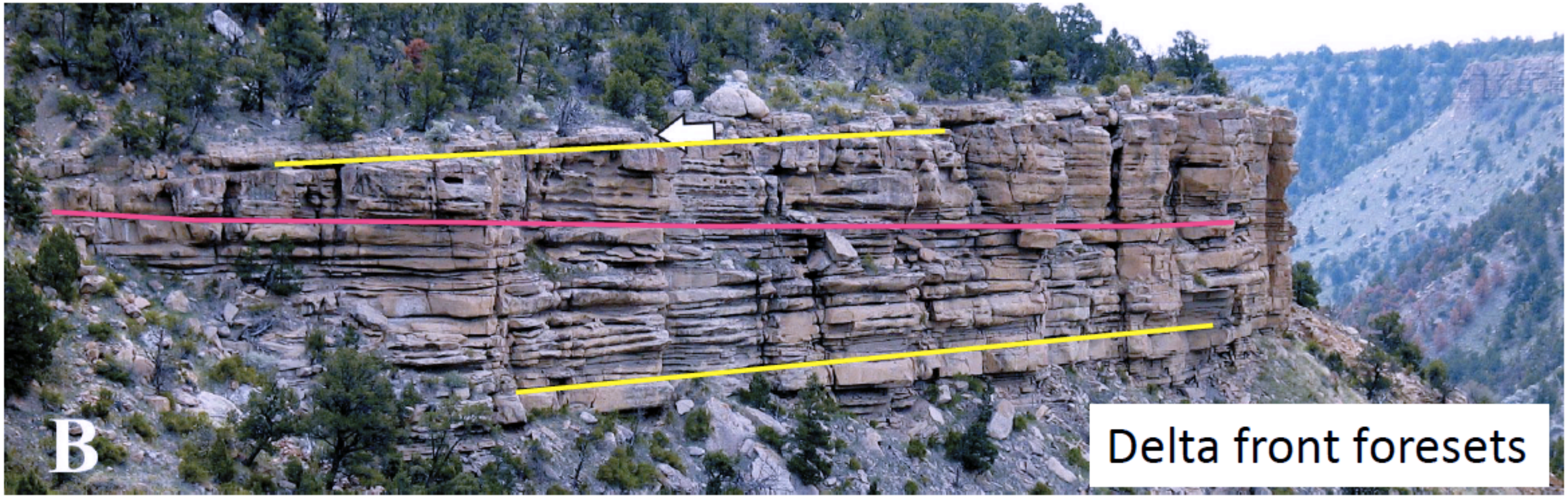
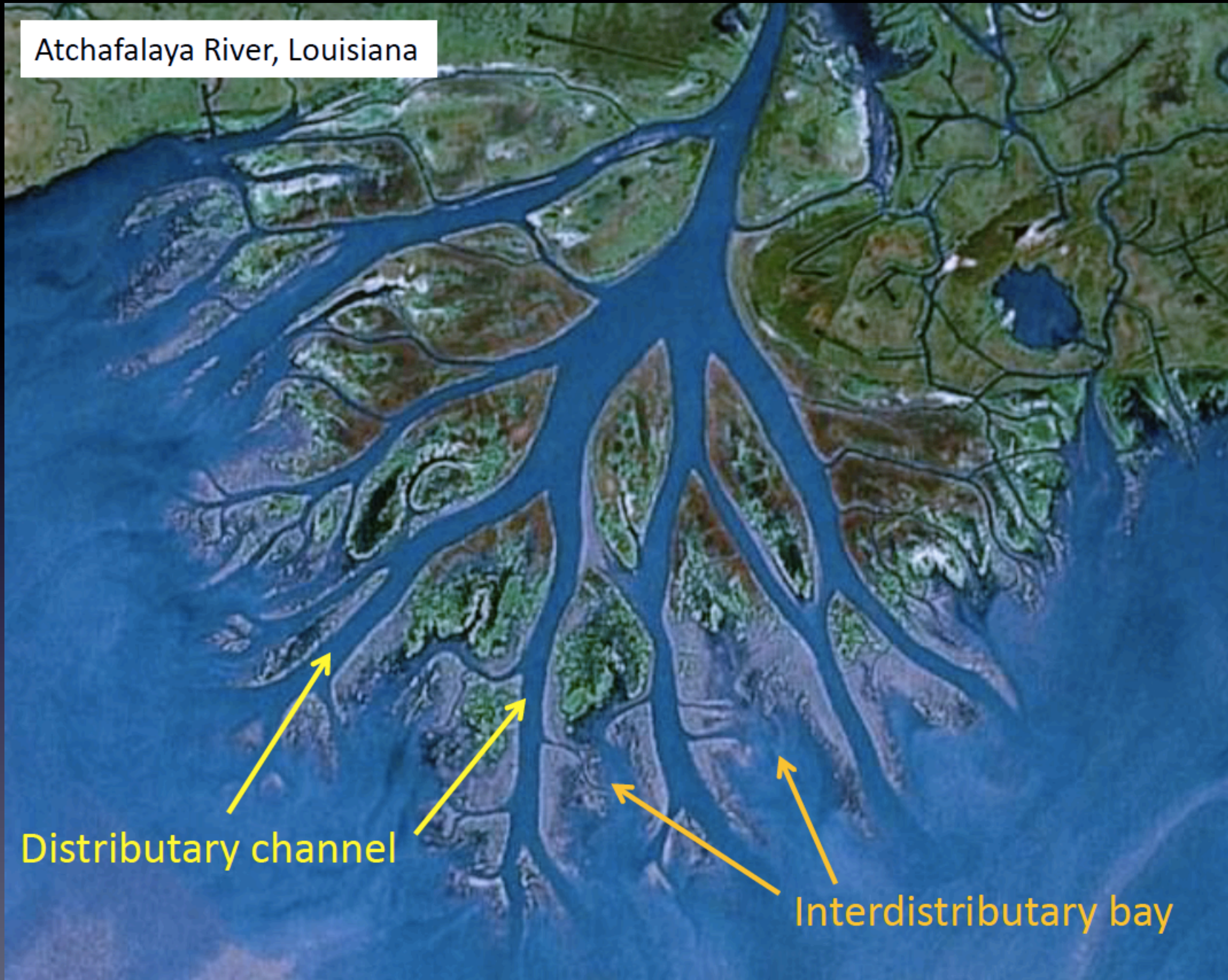
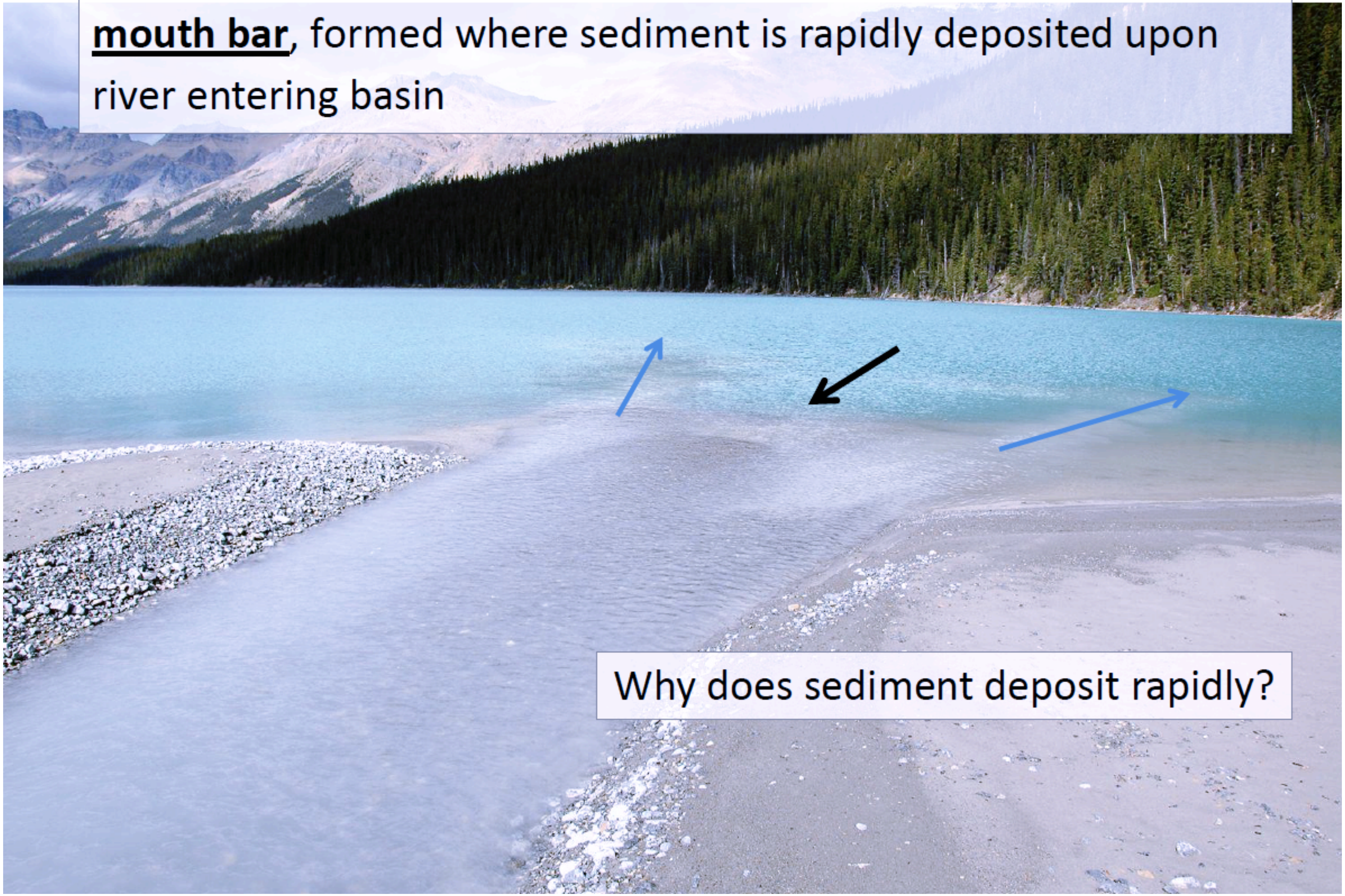
Progradation of relatively steep delta front (1-10°) produces a bed geometry called **clinoforms**





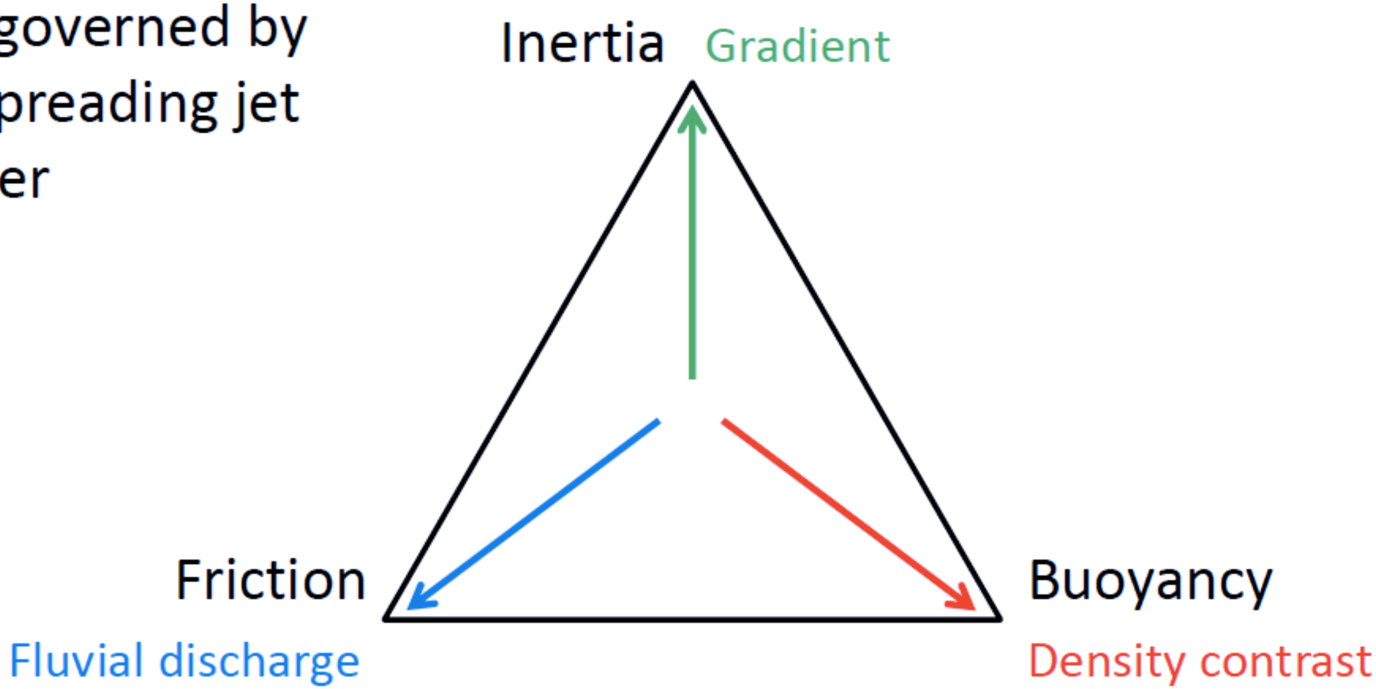

Atchafalaya River, Louisiana
Distributary channel
Interdistributary bay

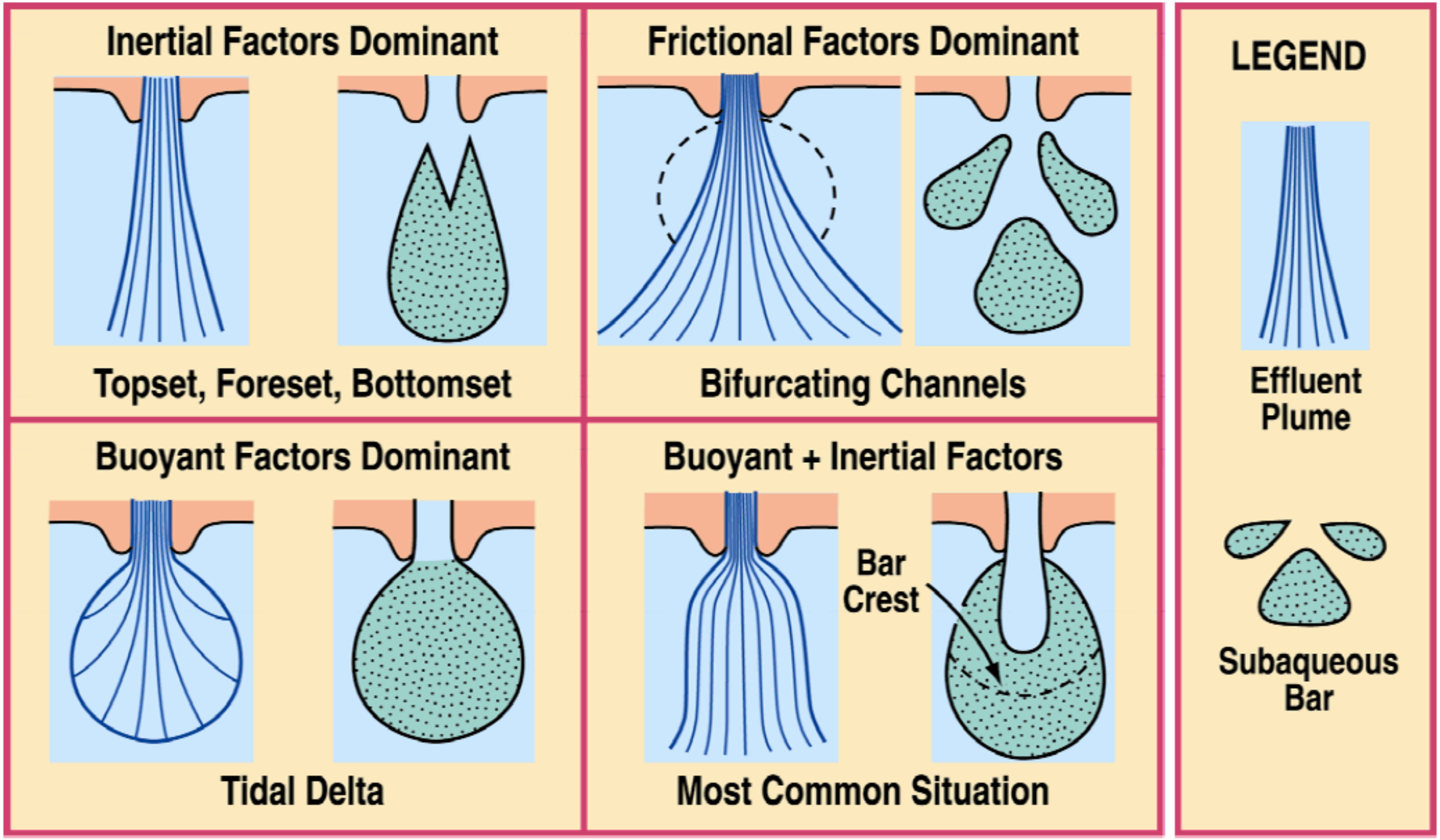
Fundamental sedimentological unit of a delta is the **<u>distributary mouth bar</u>**, formed where sediment is rapidly deposited upon river entering basin



Why does sediment deposit rapidly?

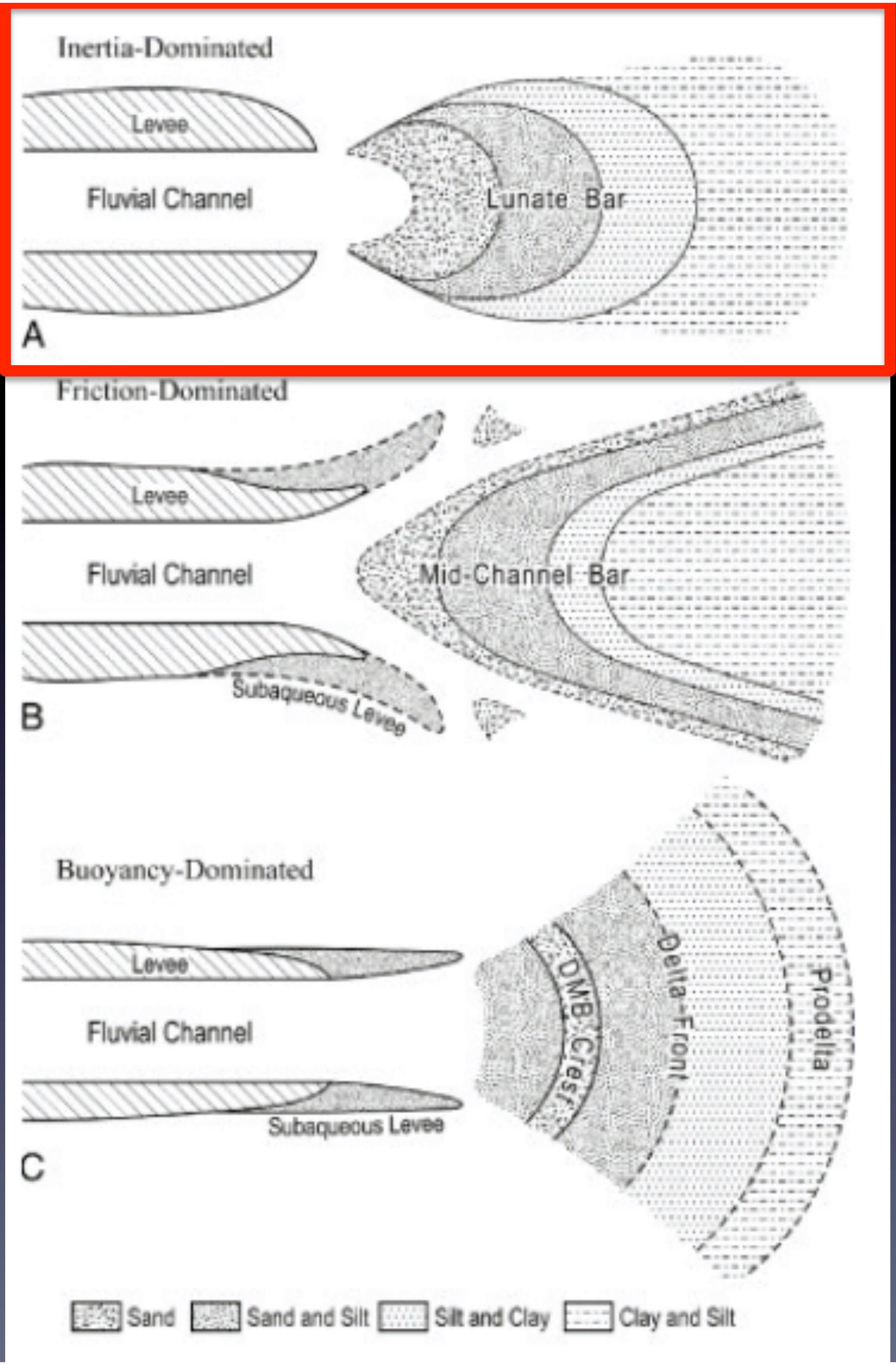
Mouth bar governed by physics of spreading jet of river water




Inertial Factors Dominant
Topset, Foreset, Bottomset
Frictional Factors Dominant
Bifurcating Channels
Buoyant Factors Dominant
Tidal Delta
Buoyant + Inertial Factors
Bar
Crest
Most Common Situation
LEGEND
Effluent
Plume
Subaqueous
Bar

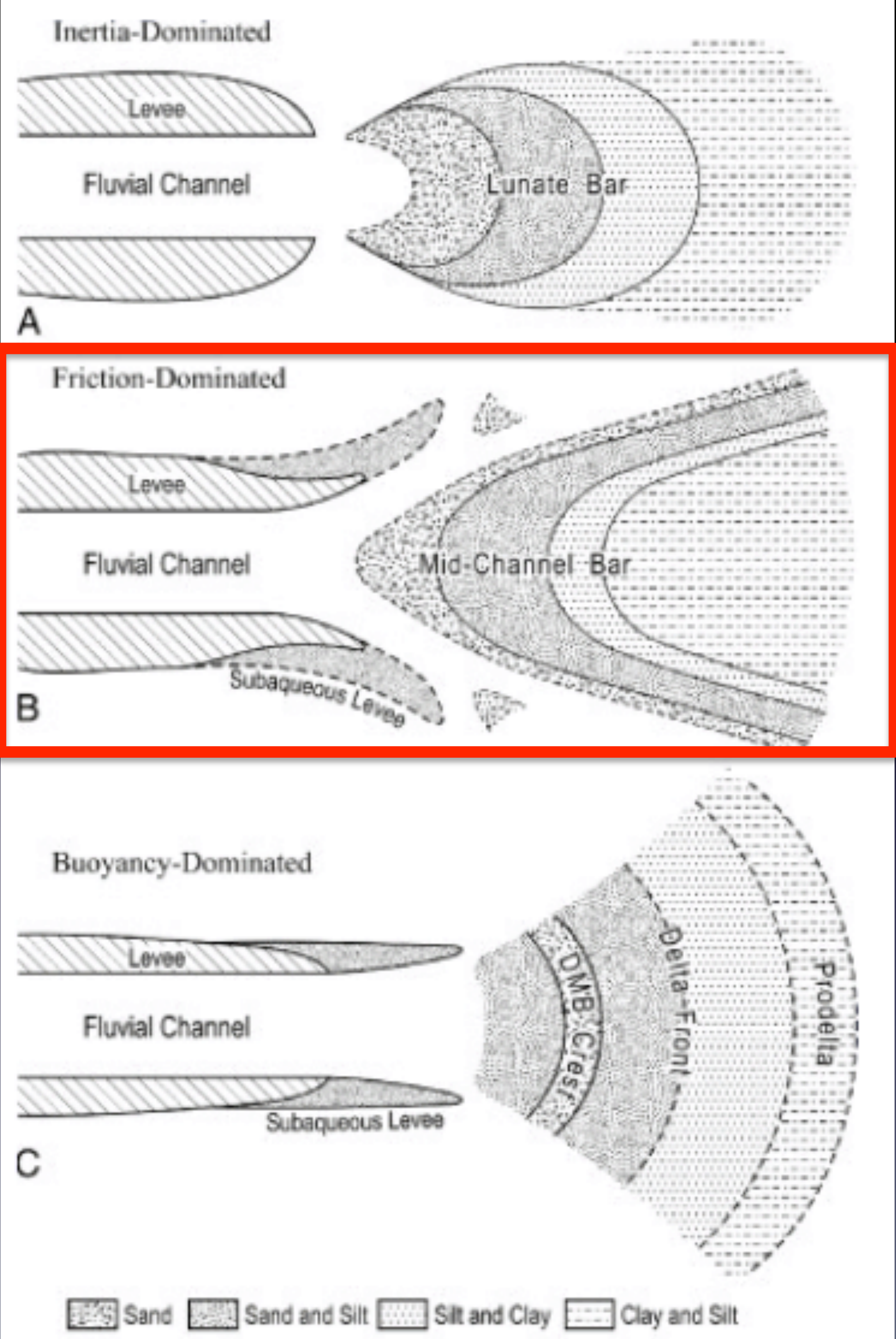
Inertia-dominated deltas

are considered to be an uncommon dominance for deltas. They are associated with high flow velocities and large amounts of turbulence. Sediments are deposited close to the main flow of the channel as it enters the basin. In other words, the deposition of sediments in inertia-dominated deltas does not have a large lateral component.



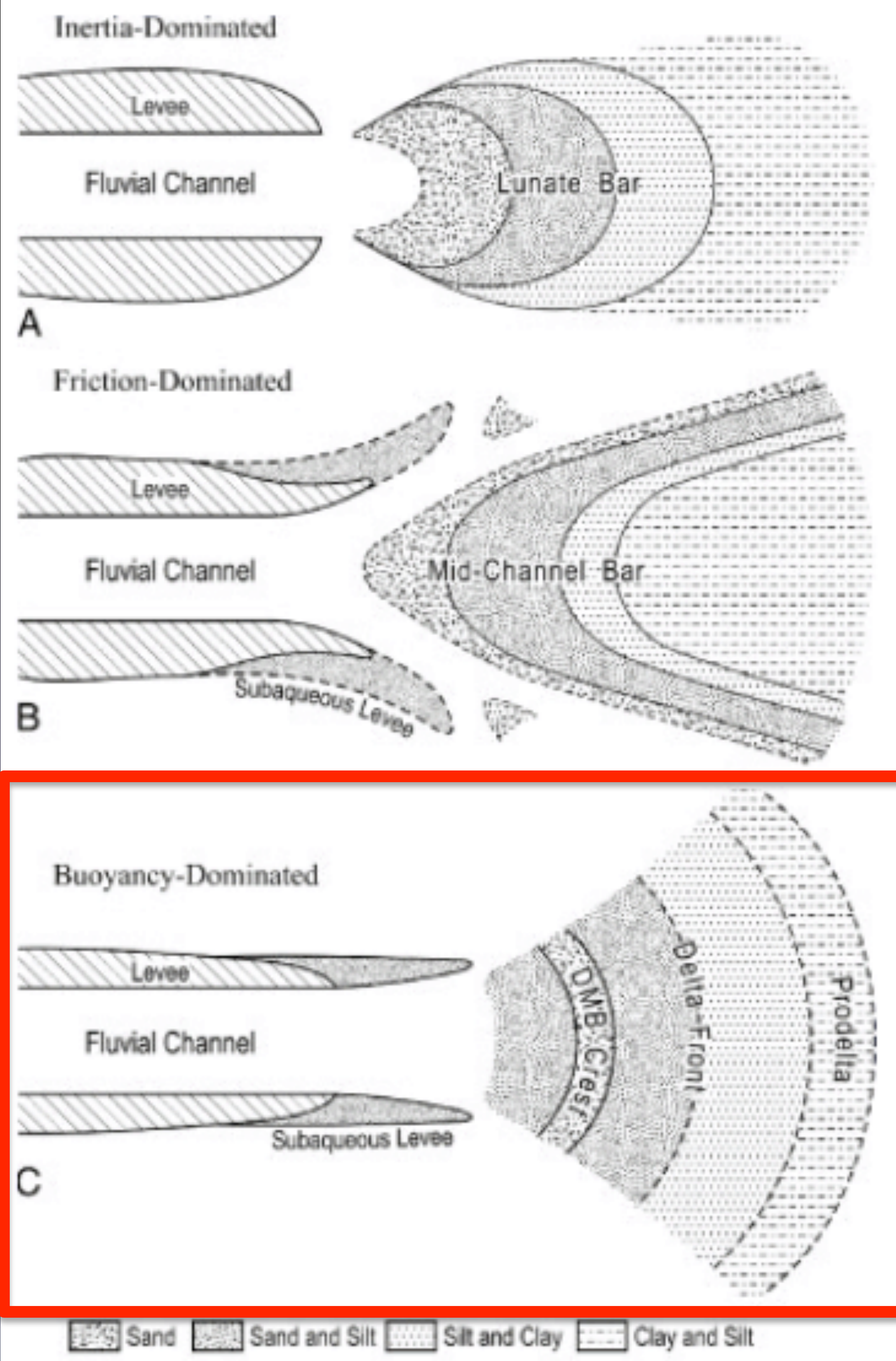
Friction-dominated deltas

are associated with high bed friction and shear stress. These stresses cause the flow to slow down rapidly and deposit sediment with a wider lateral extent than the inertia dominated deltas. The river/basin setting for this type of situation is more common. It consists of a shallow water level where the river flow and basin meet. This shallow area is a major factor in producing a friction-dominated delta. Features associated with this type of delta include subaqueous levees, middle ground bars (fining seaward), and bifurcated channels.



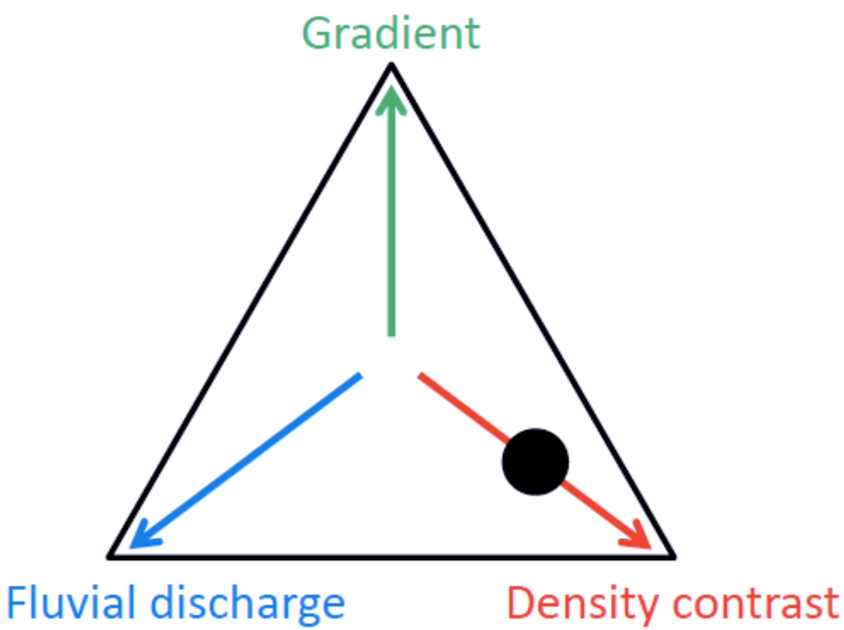
Buoyancy-dominated deltas

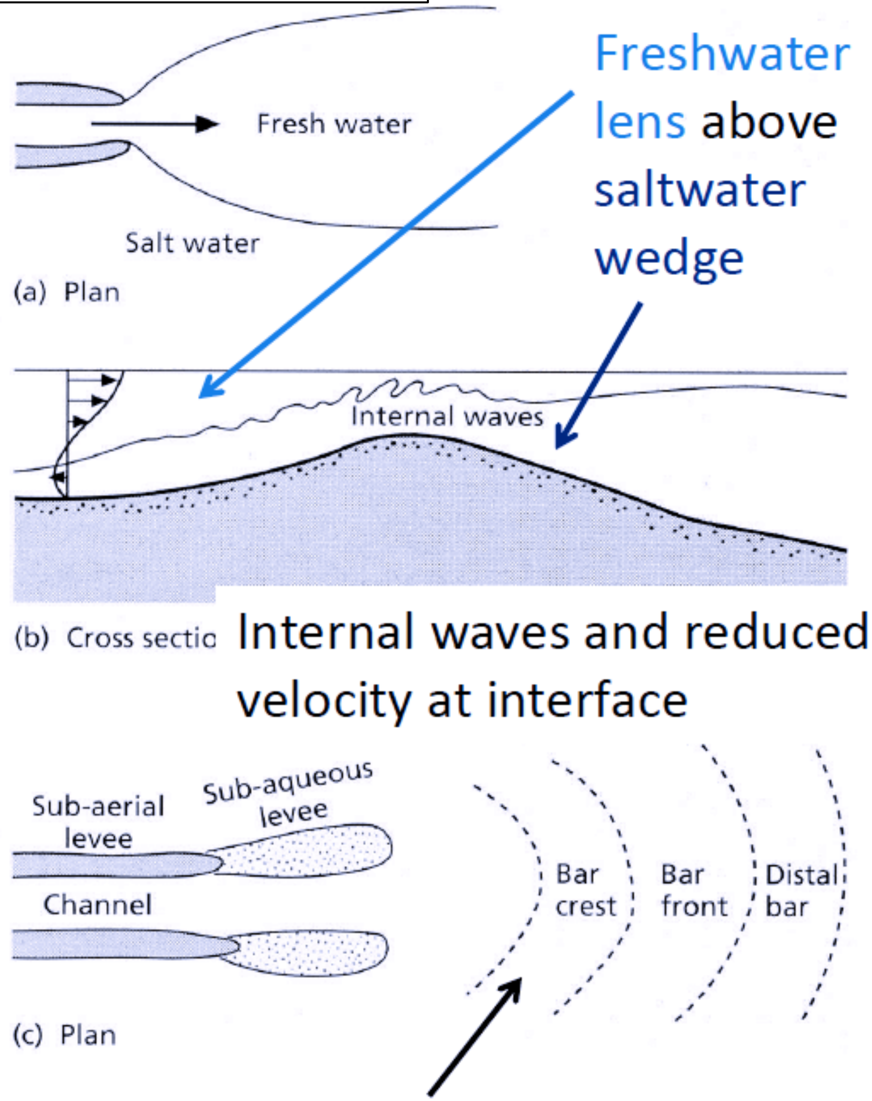
occur where the river/basin setting consists of a deeper water level when compared to the friction-dominated delta. This situation leads to the formation of subaqueous levees (parallel banks extending out from the channel). Other deposits common with this type of delta are distributary mouth bars (grading seaward), bar finger sands, distal bars, and prodelta clays.



Buoyancy-dominated deltas (density contrast)

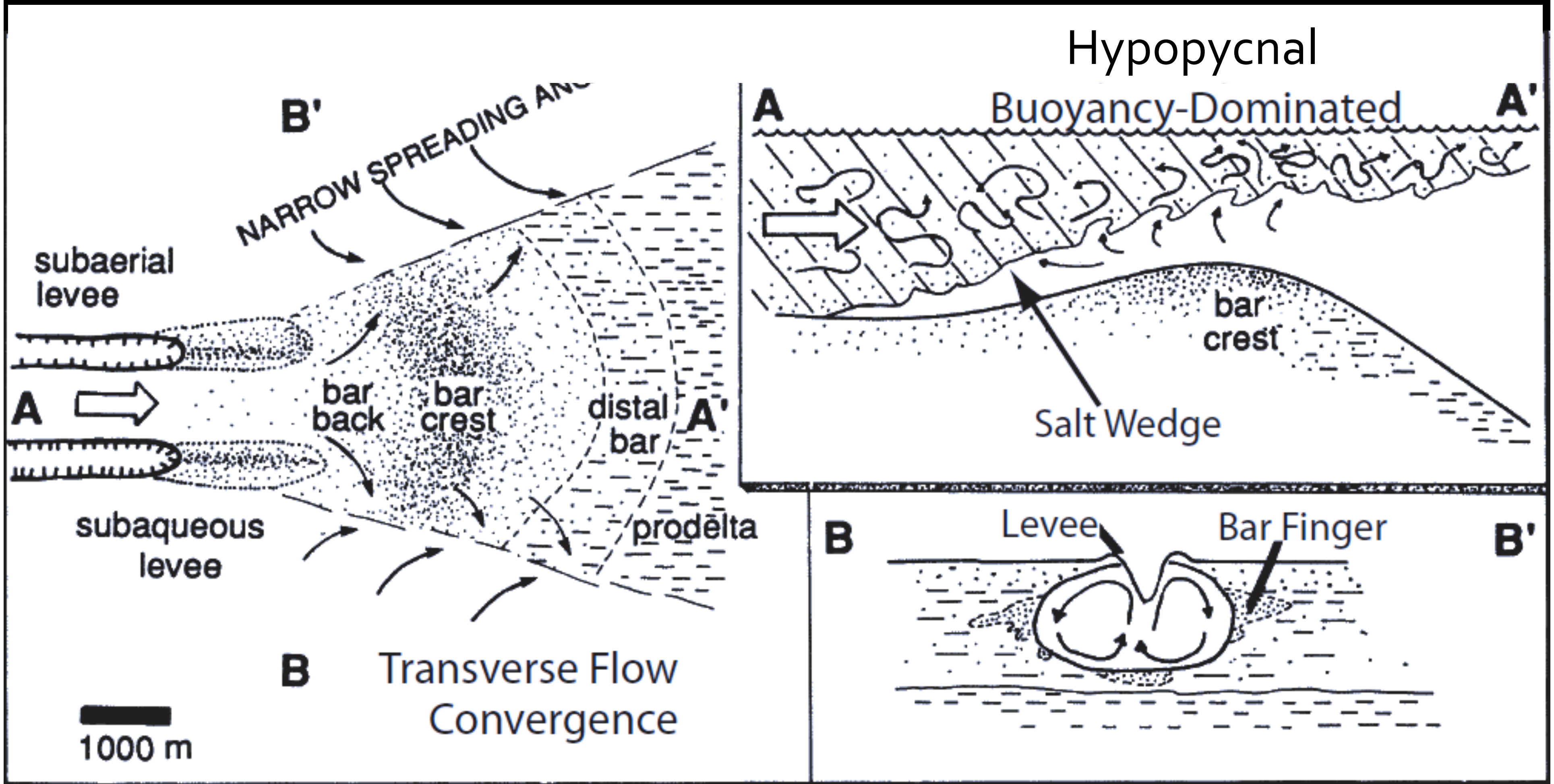
River water is usually less dense than ocean water (hypopycnal)





Deposits sediment on relatively narrow bar crest

What is the proximal-distal grain size trend?



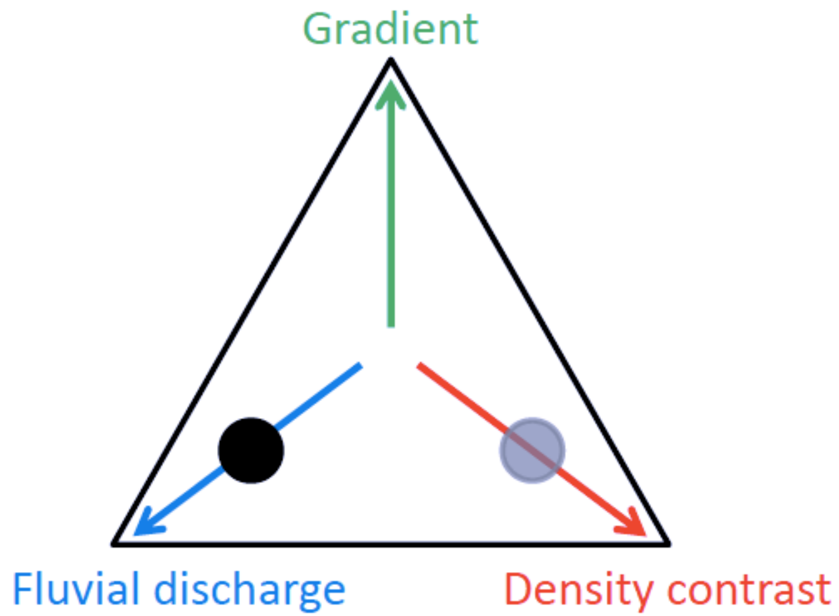
Examples of mouth-bar processes in river-dominated deltas (from Reading and Collinson, 1996, after Orton and Reading, 1993) incorporating ideas of Bates, 1953, Wright (1977) and others.

Friction-dominated deltas (fluvial discharge)

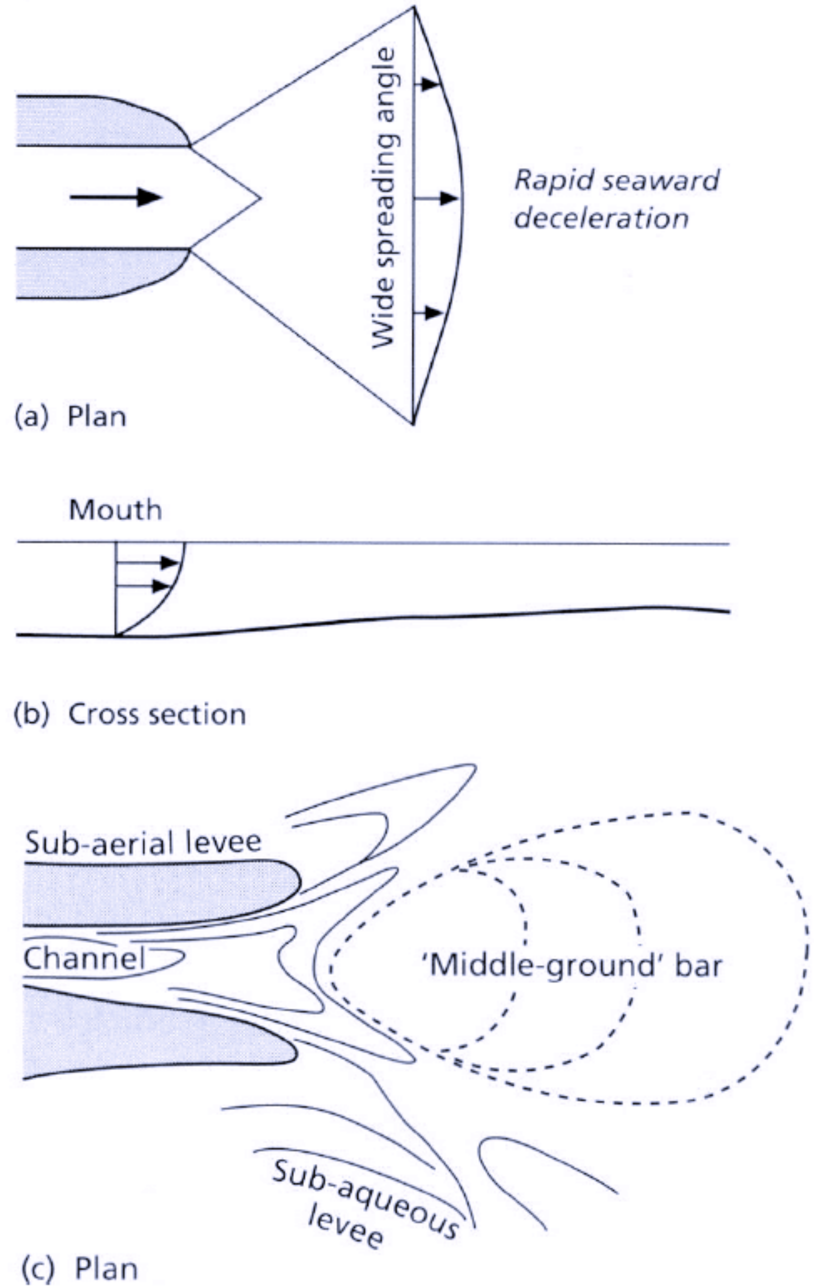
Flood stage pushes salt wedge out

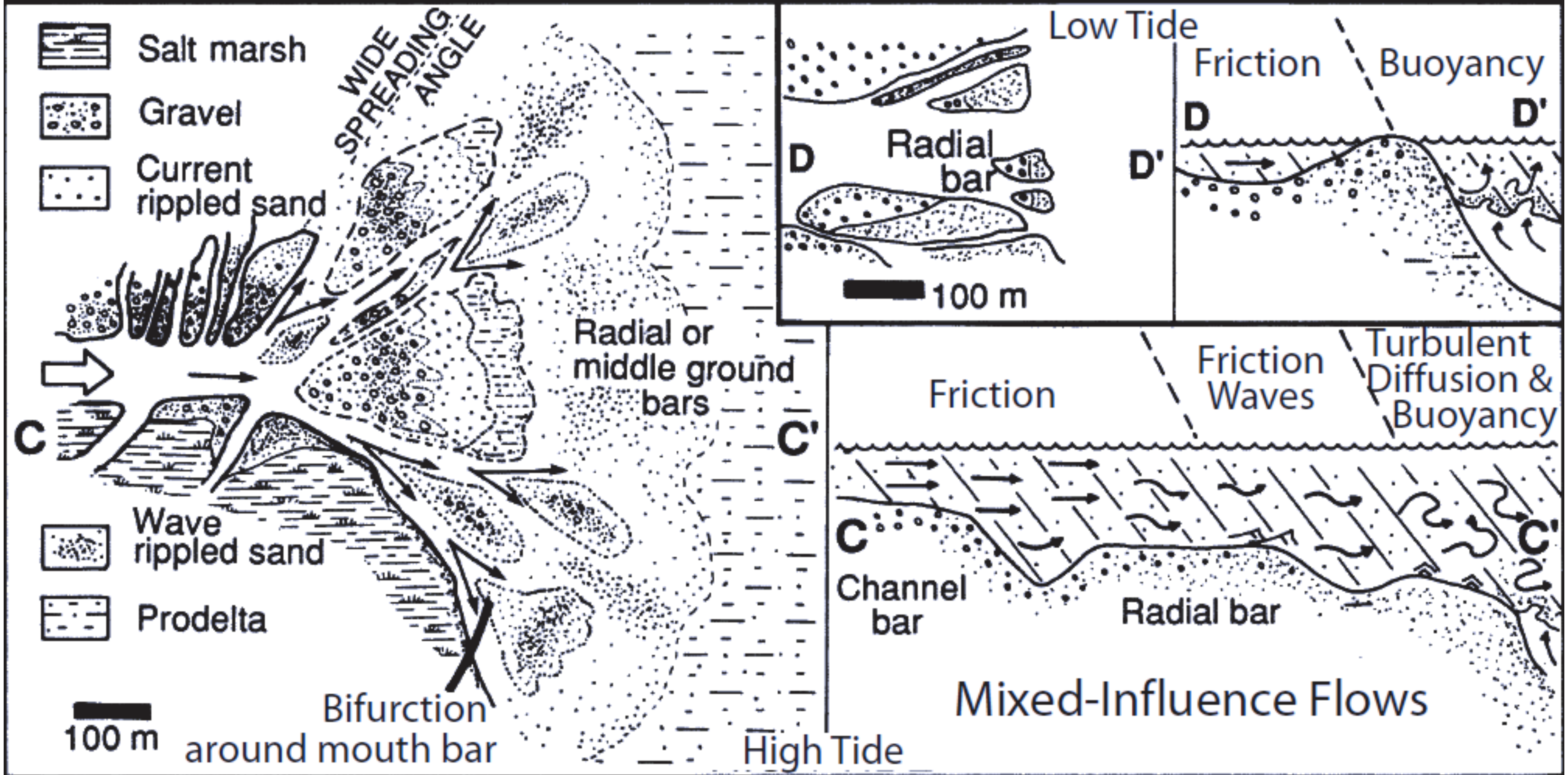
More sediment = lower ρ contrast

Bottom friction dominates



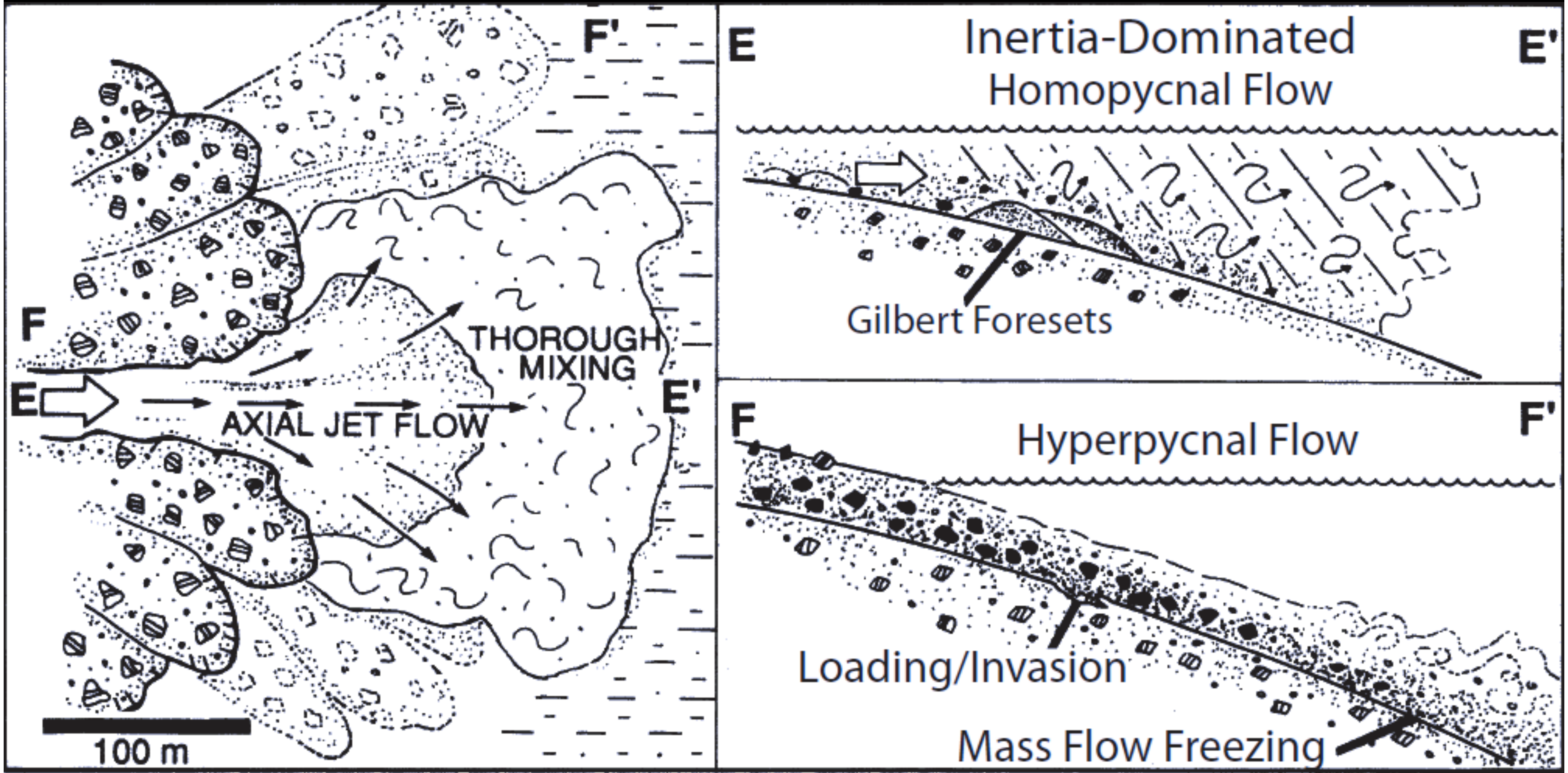
Mouth bar aggrades and progrades (up to 100 m!), forming y-shaped channel bifurcation





Examples of mouth-bar processes in river-dominated deltas (from Reading and Collinson, 1996, after Orton and Reading, 1993) incorporating ideas of Bates, 1953, Wright (1977) and others.

Inertia-dominated deltas (homopycnal flow)



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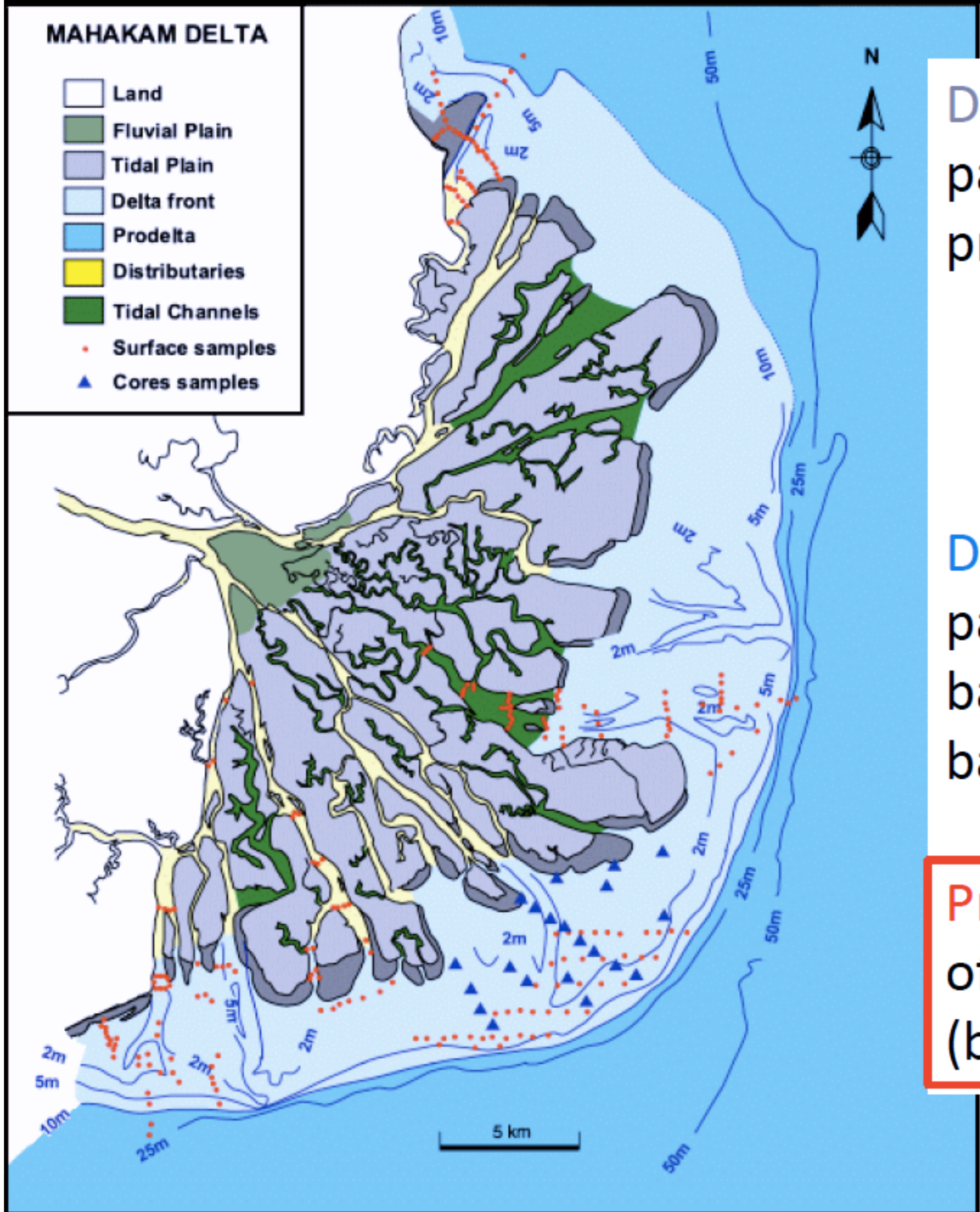


Delta plain: mostly subaerial part of delta complex (fluvial processes)

Distributary channels

Interdistributary bay

Delta front: shallow subtidal part of delta, above wave base (mix of fluvial and basinal processes)

Prodelta: deeper subtidal part of delta, below wave base (basinal processes)

What features would you predict in prodelta sediments?

Grain size?

Sedimentary structures?

Bioturbation?

Hypopycnal plume

Density < seawater

Relatively continuous

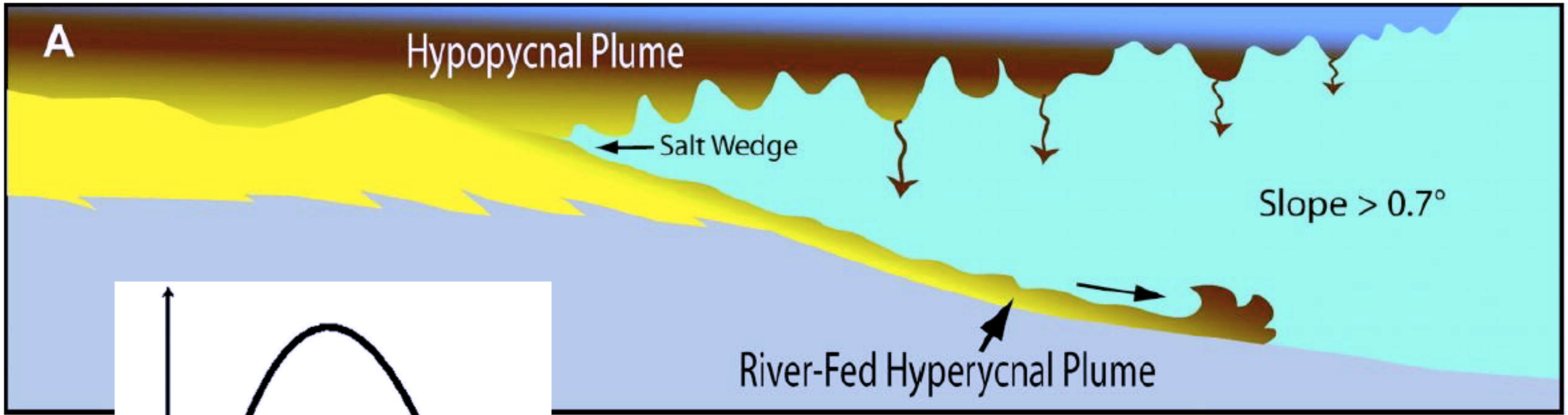
Deposition from suspension (=hemipelagic sedimentation)

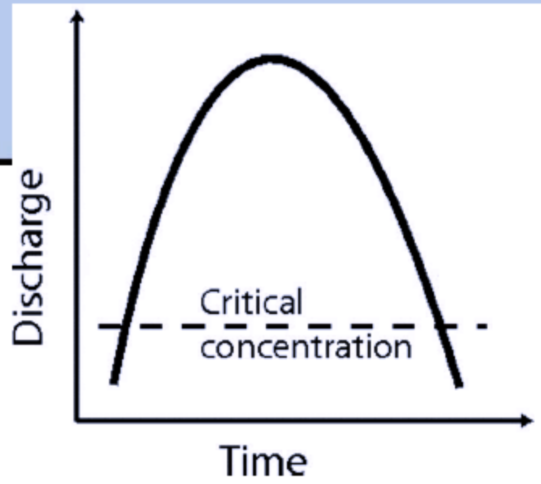
Hyperpycnal plume

Density > seawater

Episodic, lasts hours-days

Deposition from suspension, modified by traction





Hyperpycnal flows are slow, may wax and wane during river flood stage

Deposits called “hyperpycnites”

Waxing/waning flow

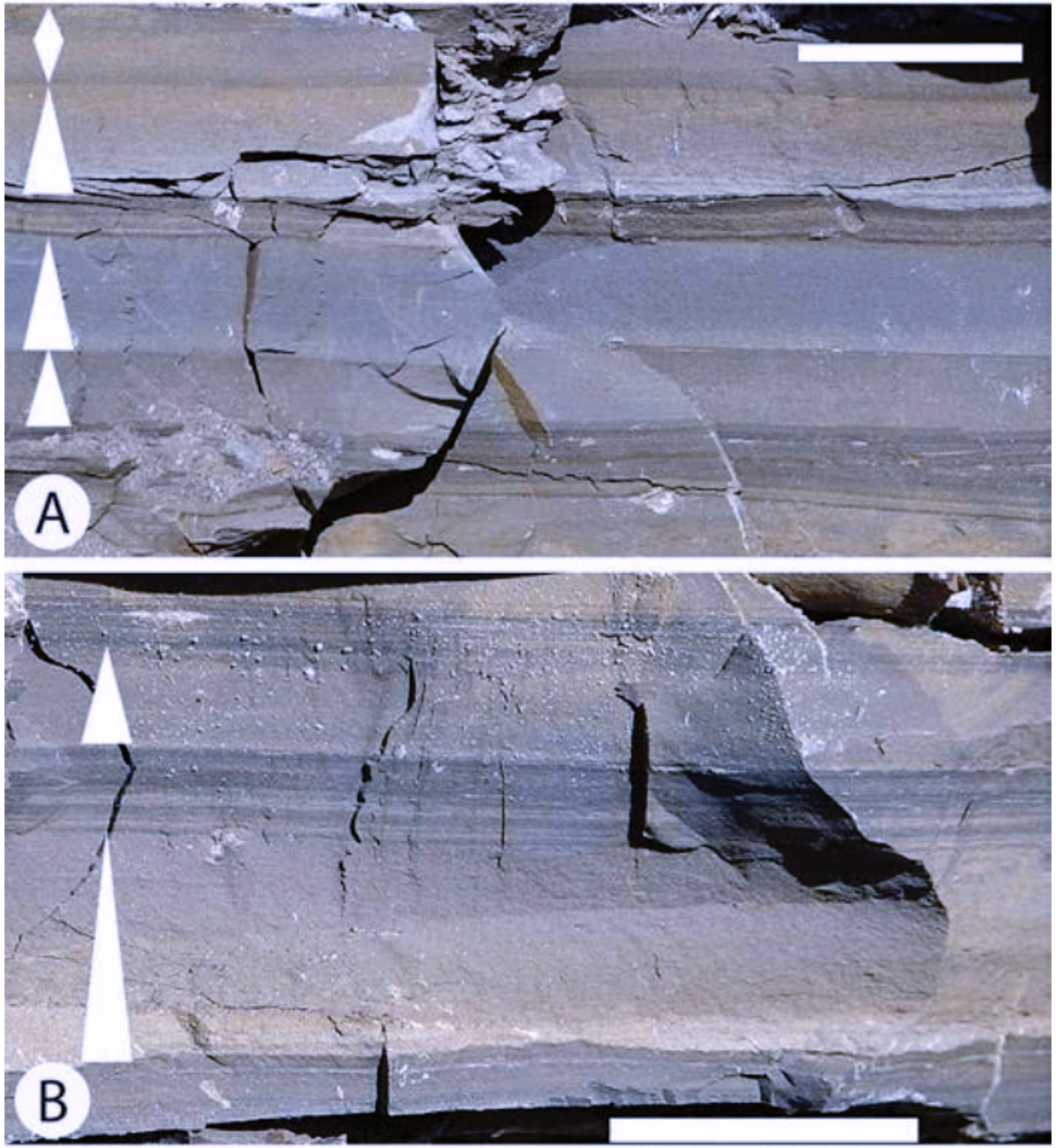
Inverse-normal grading

Hemipelagic sediments

Finely laminated or bioturbated mud

Suspension deposition

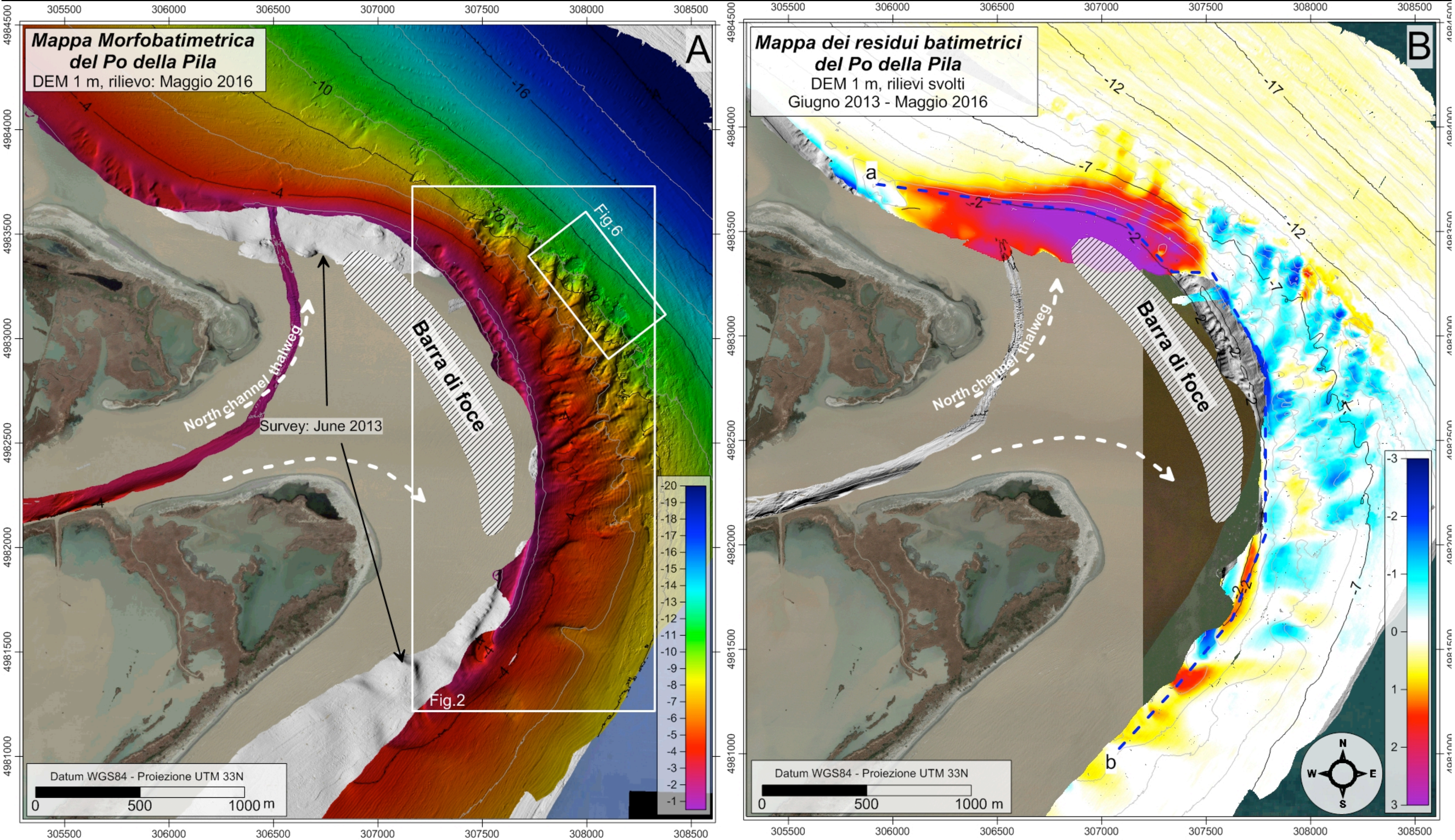
Normal grading



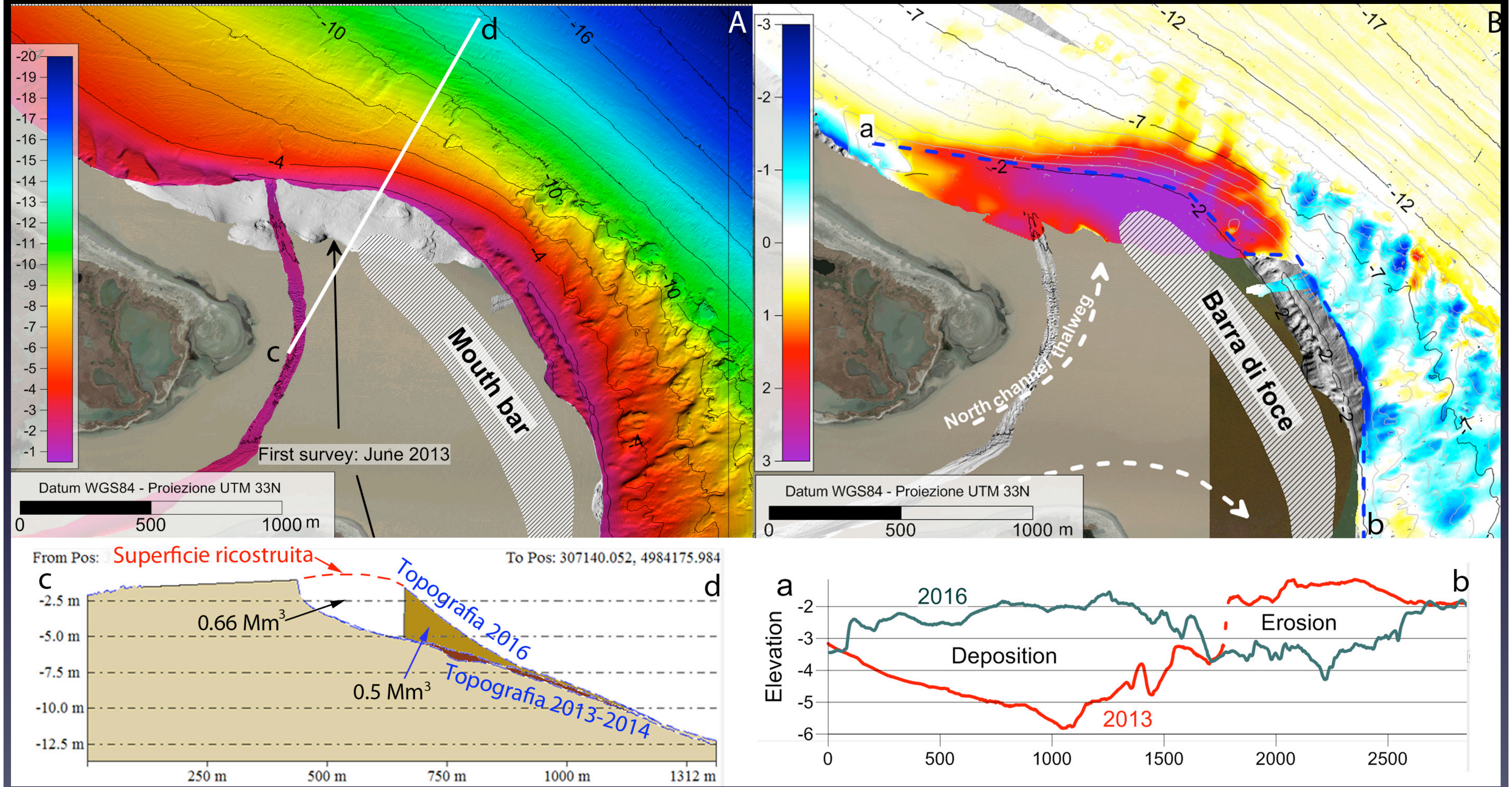
Prodelta slopes are comparatively steep (and have rapid sedimentation rates)

Slumps may be more common than in wave-dominated coasts

Instabilità gravitativa



DINAMICHE EROSIVO-DEPOSIZIONALI SHORT-TERM



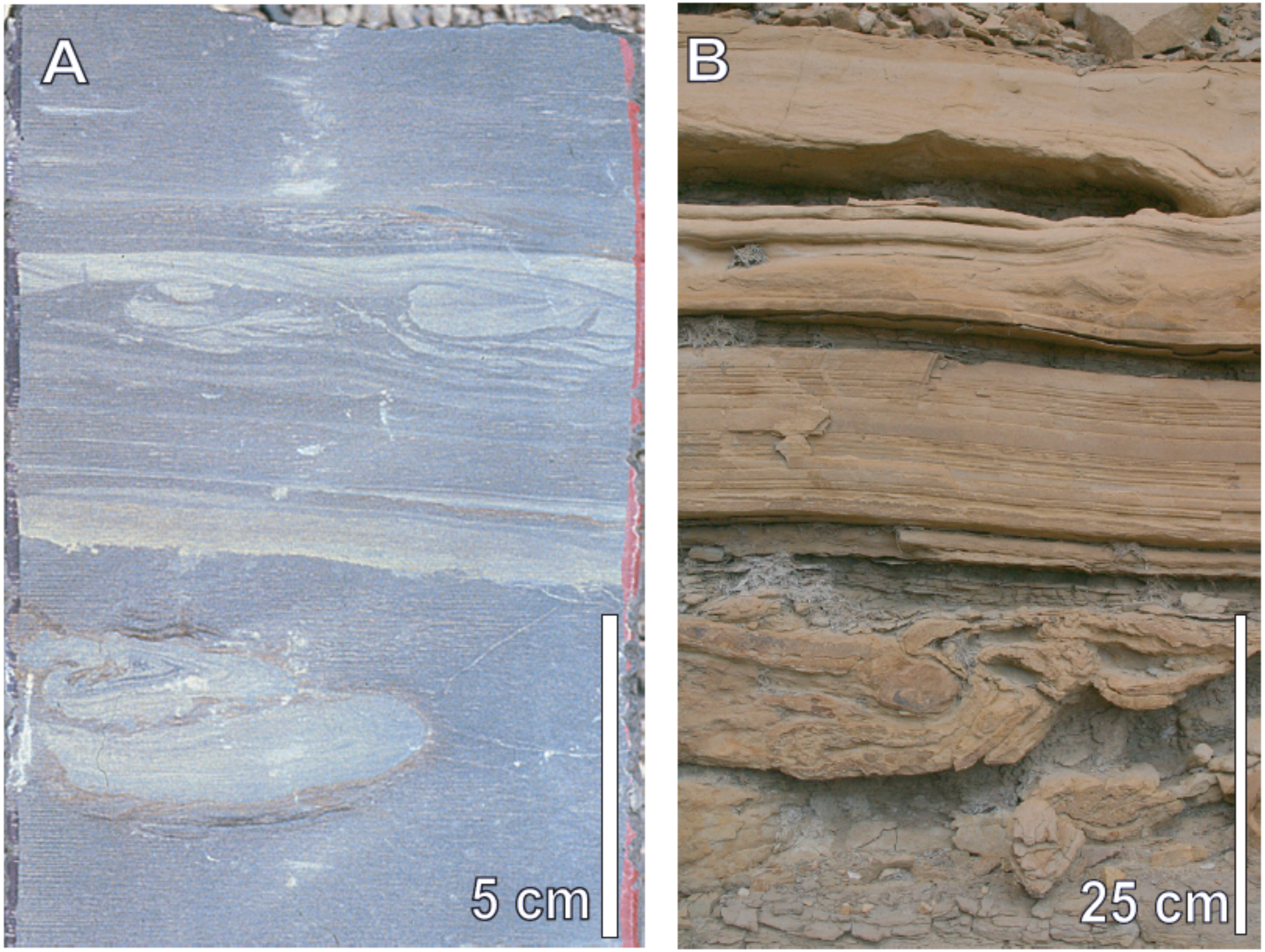
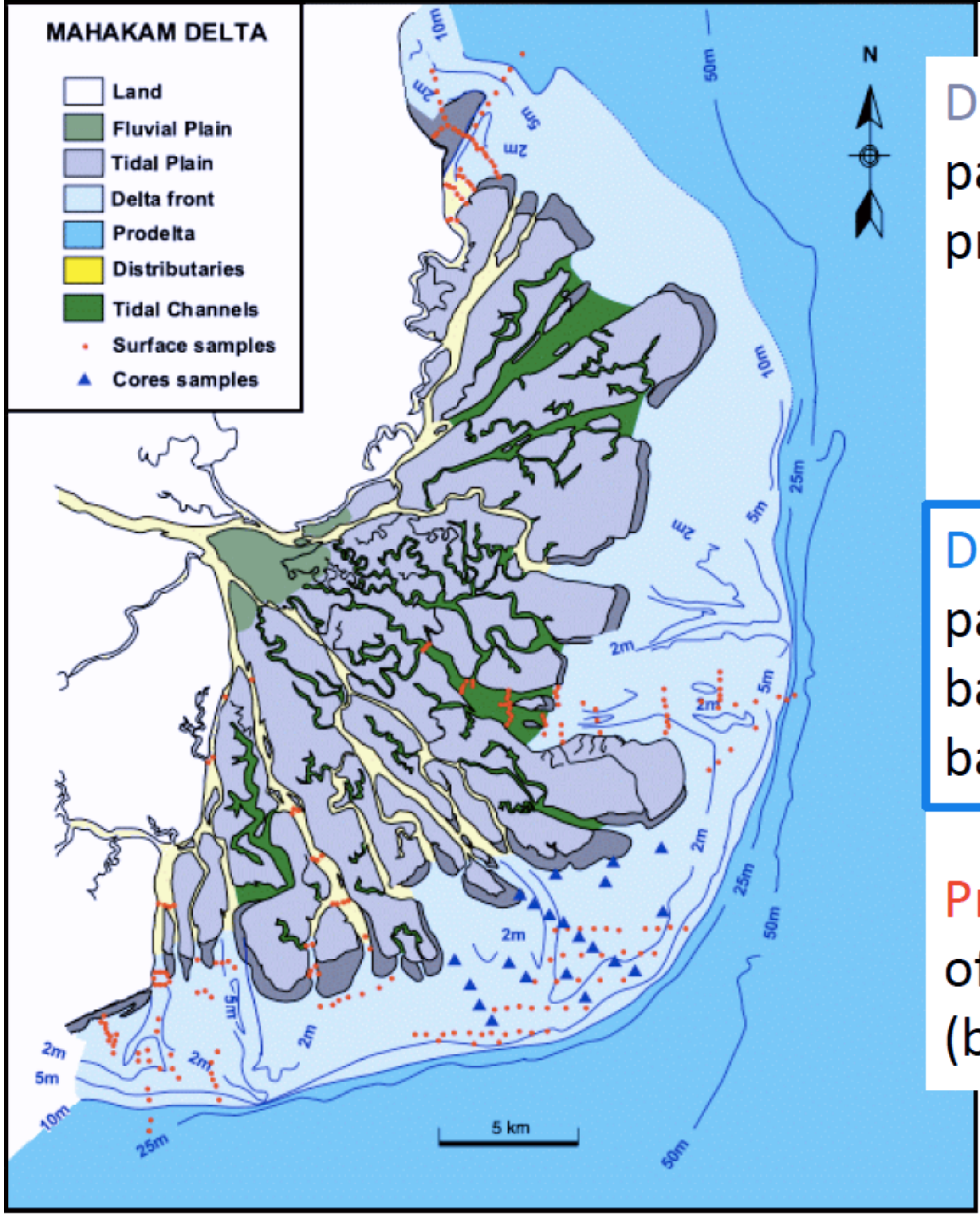


FIG. 29.—Deformation structures (load casts) in: **A)** prodelta mudstones of the Kavik Formation, Prudhoe Bay Field, Alaska, U.S.A. **B)** Deformed sandstone bed overlain by parallel-laminated to rippled delta front splays interpreted as distal delta front, sediment gravity flow deposits, Cretaceous Ferron sandstone, Utah, U.S.A.



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Distributary channels

Interdistributary bay

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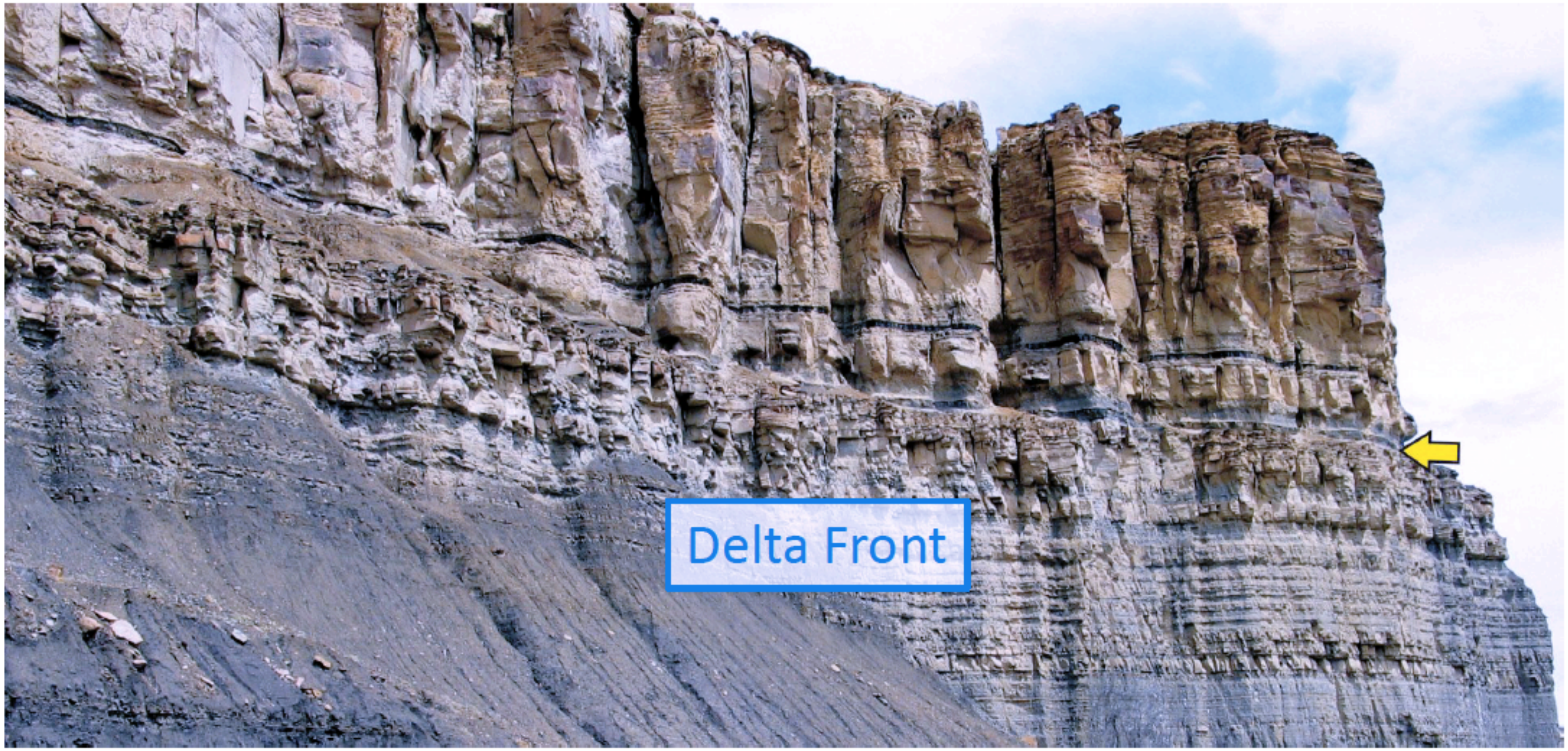
Prodelta: deeper subtidal part of delta, below wave base (basinal processes)

What features would you predict in delta front sediments?

Grain size?

Sedimentary structures?

Bioturbation?

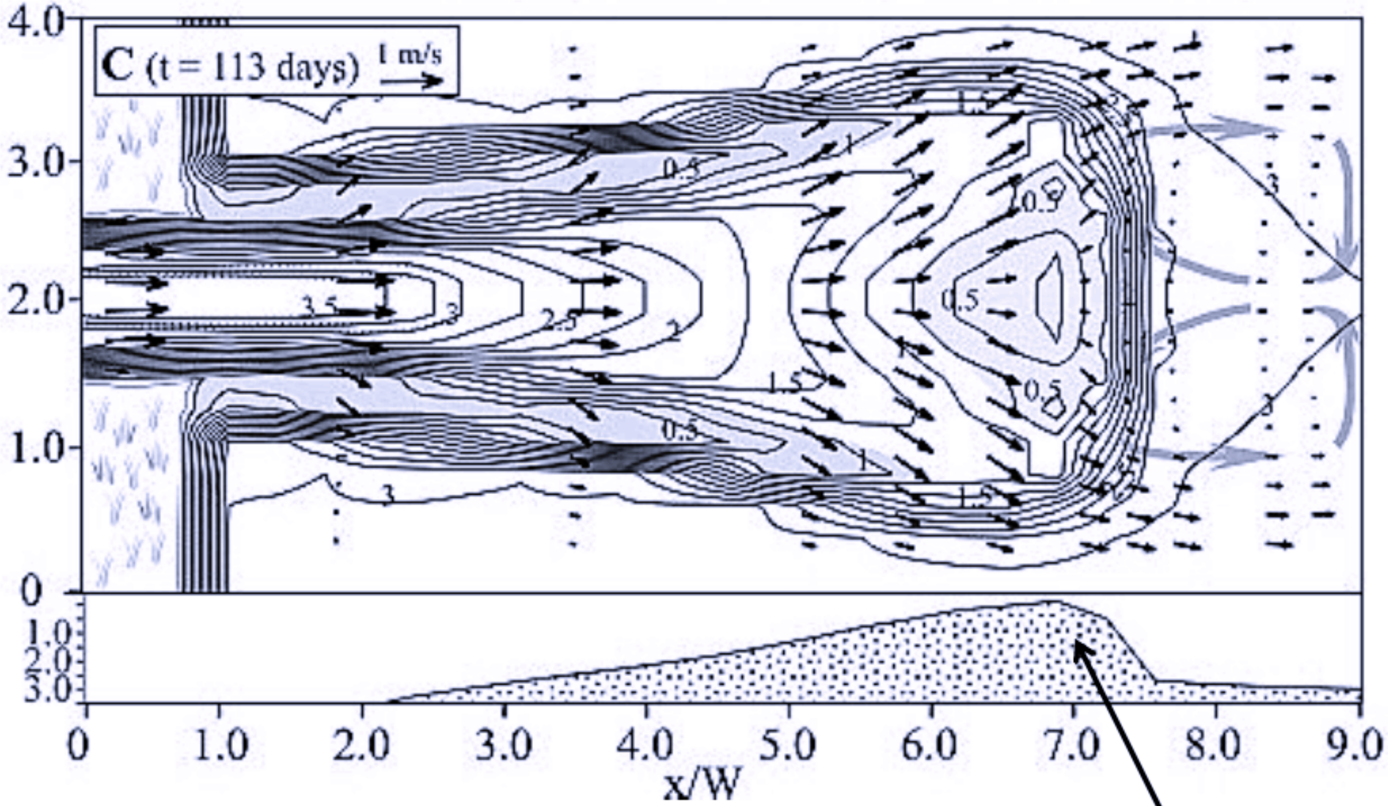


High sedimentation rates during river flood events

Traction deposition with significant contribution from suspension settling

Climbing ripples

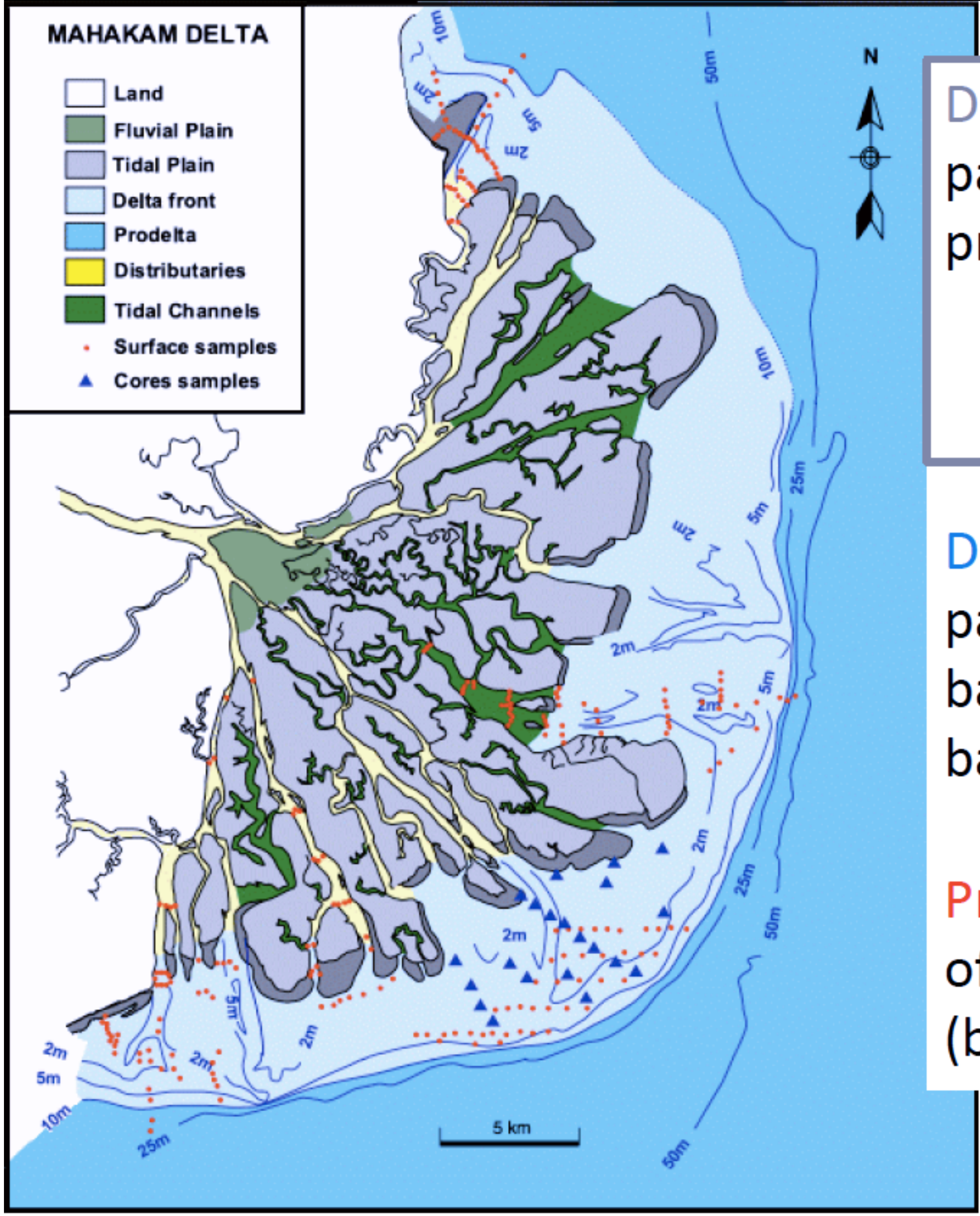
Mouth bar aggrades close to sea level during progradation



Can be emergent during lower flow

Development of small-scale scours (reactivation surfaces) more common near the top of the mouth bar

Bi-direction cross-bedding, upper shoreface/delta front



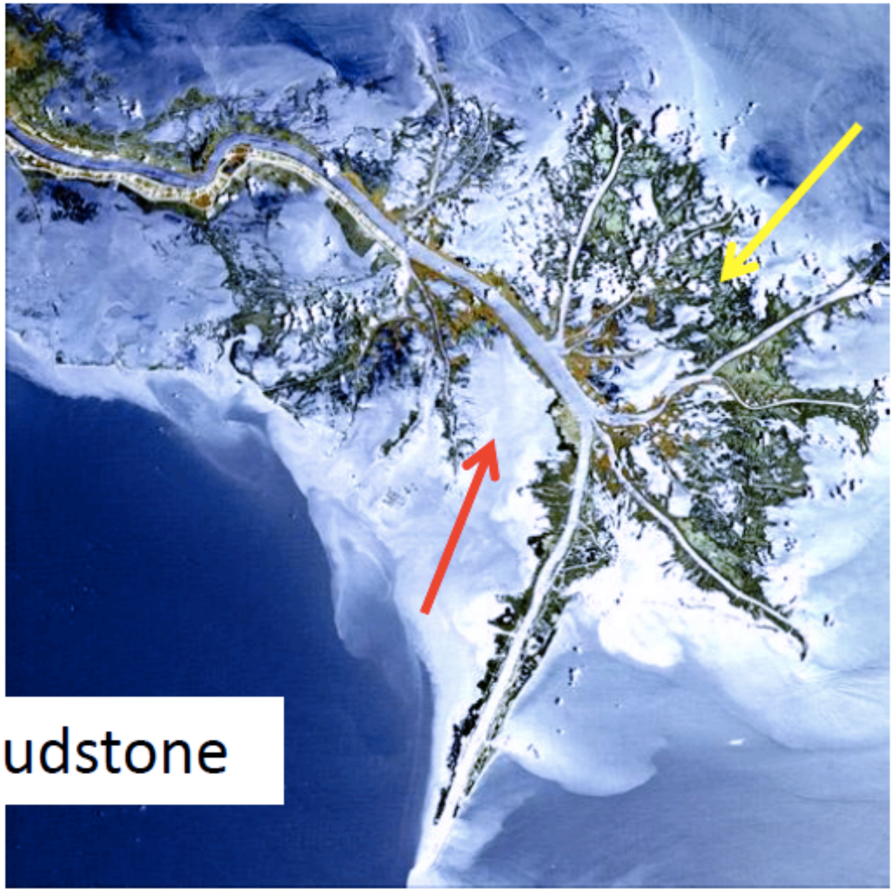
Delta plain: mostly subaerial part of delta complex (fluvial processes)

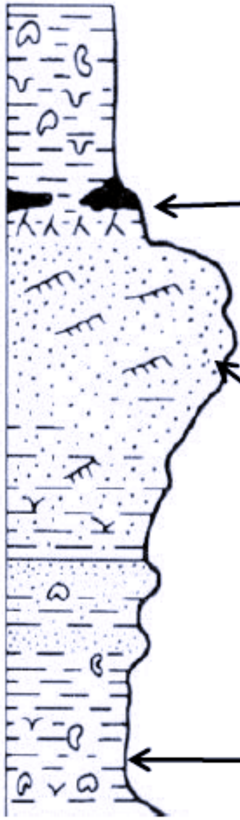
- Distributary channels
- Interdistributary bay

Delta front: shallow subtidal part of delta, above wave base (mix of fluvial and basinal processes)

Prodelta: deeper subtidal part of delta, below wave base (basinal processes)

Small-scale (3-10 m thick) cycles formed due to crevasse-splay and filling of interdistributary bays

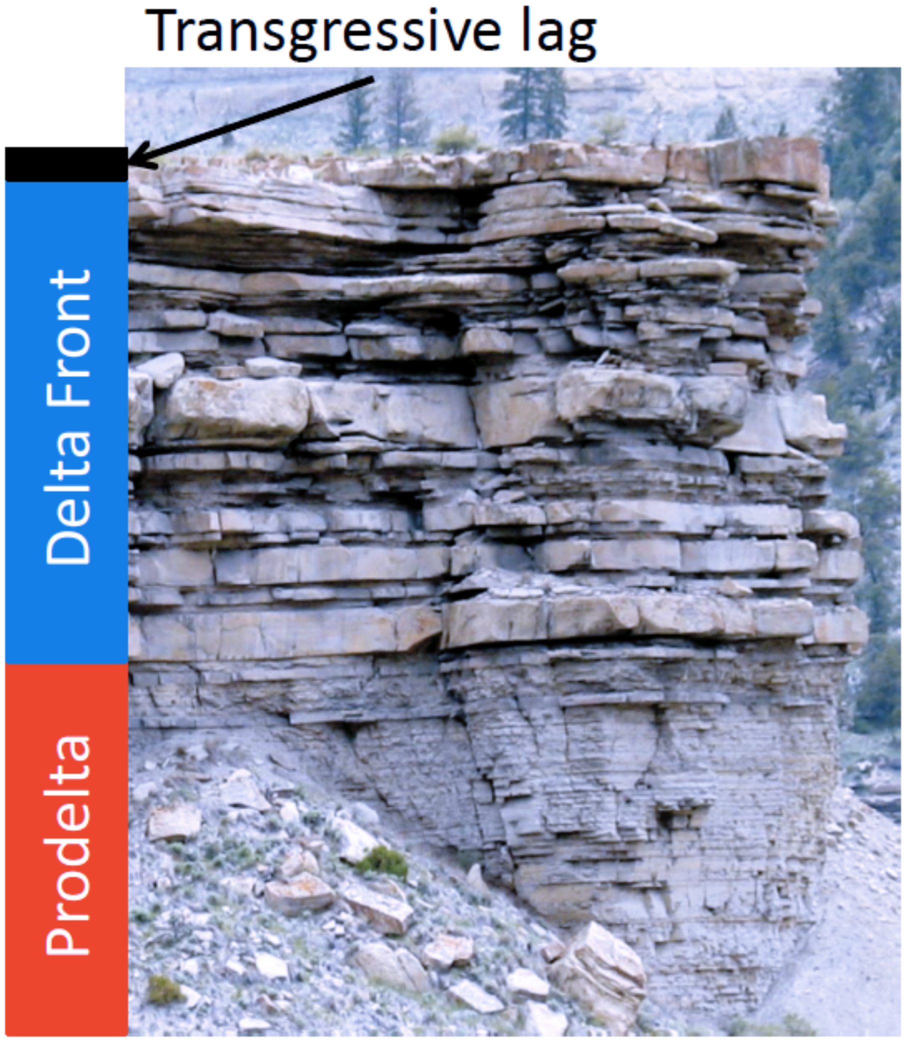




Rooted supratidal mudstone

Increasing overbank sediment from river floods (rippled sandstone)

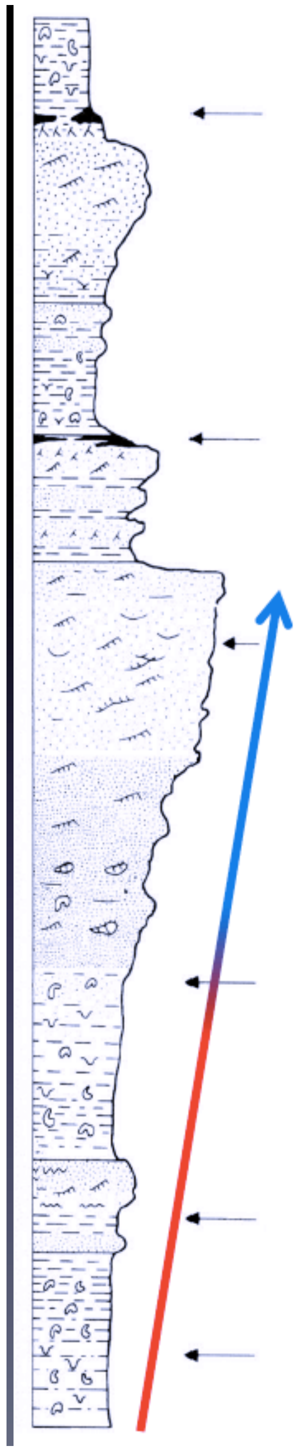
Interdistributary bay mudstone

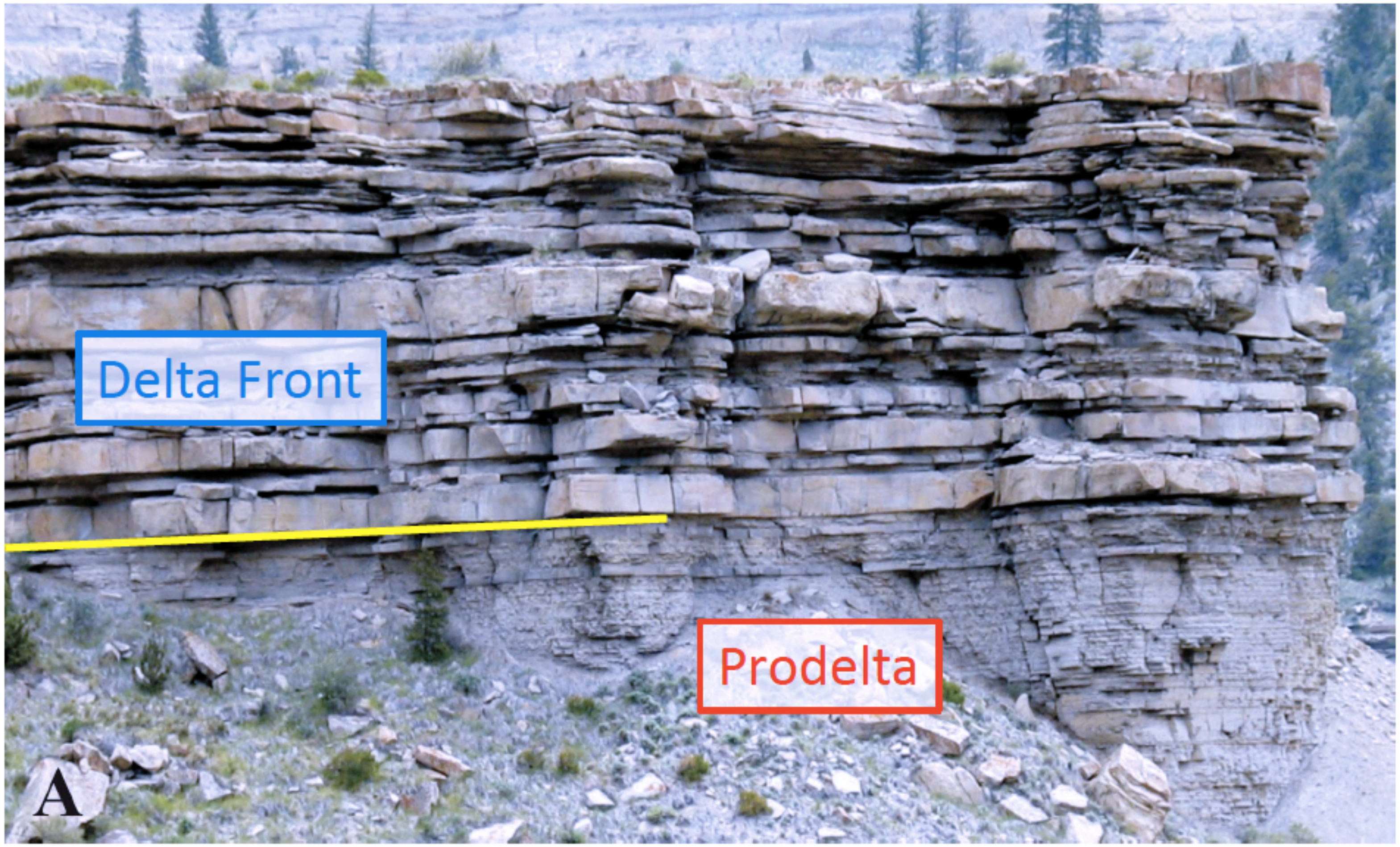


Transgressive lag
Delta Front
Prodelta

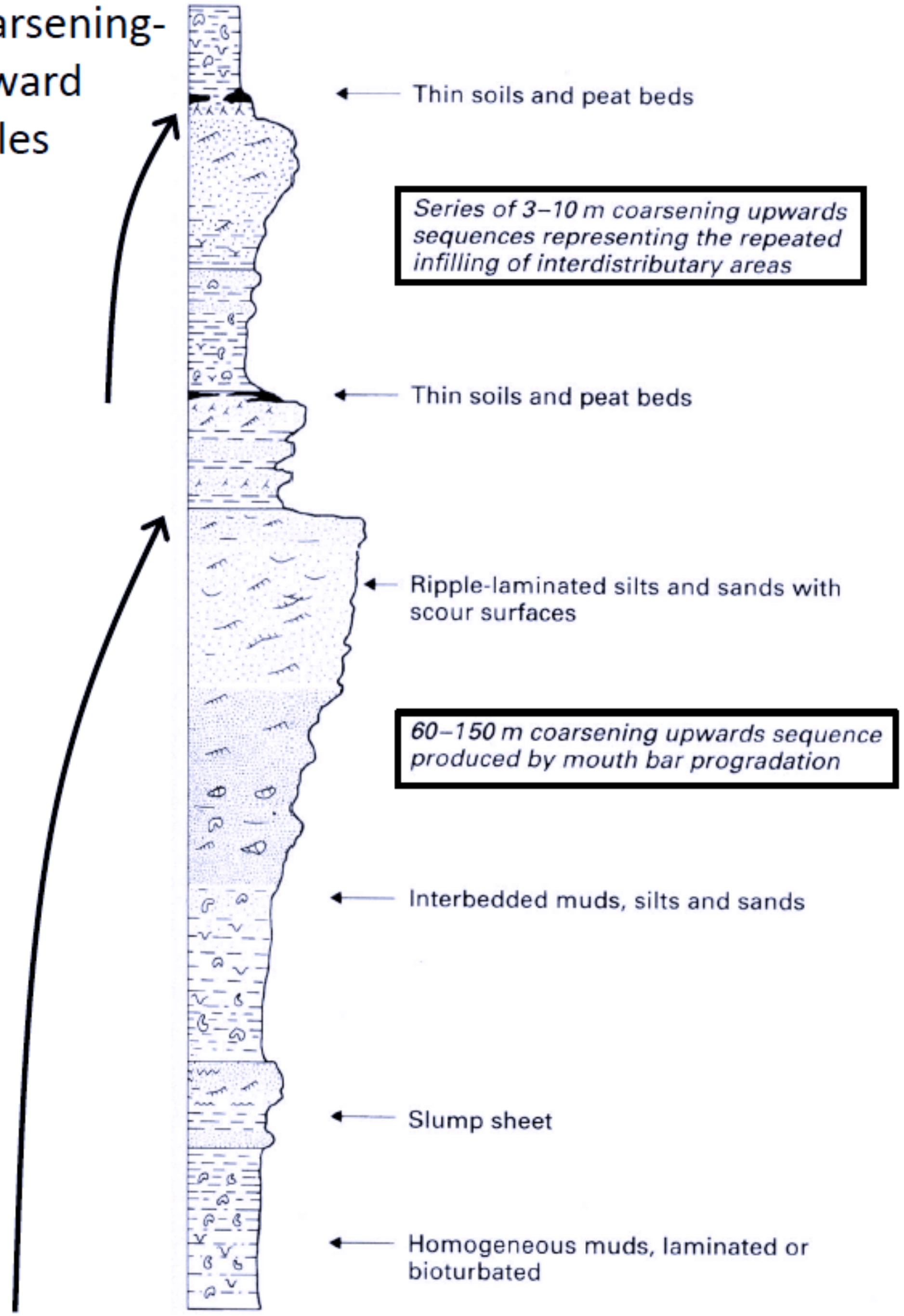
Delta Plain
Delta Front
P

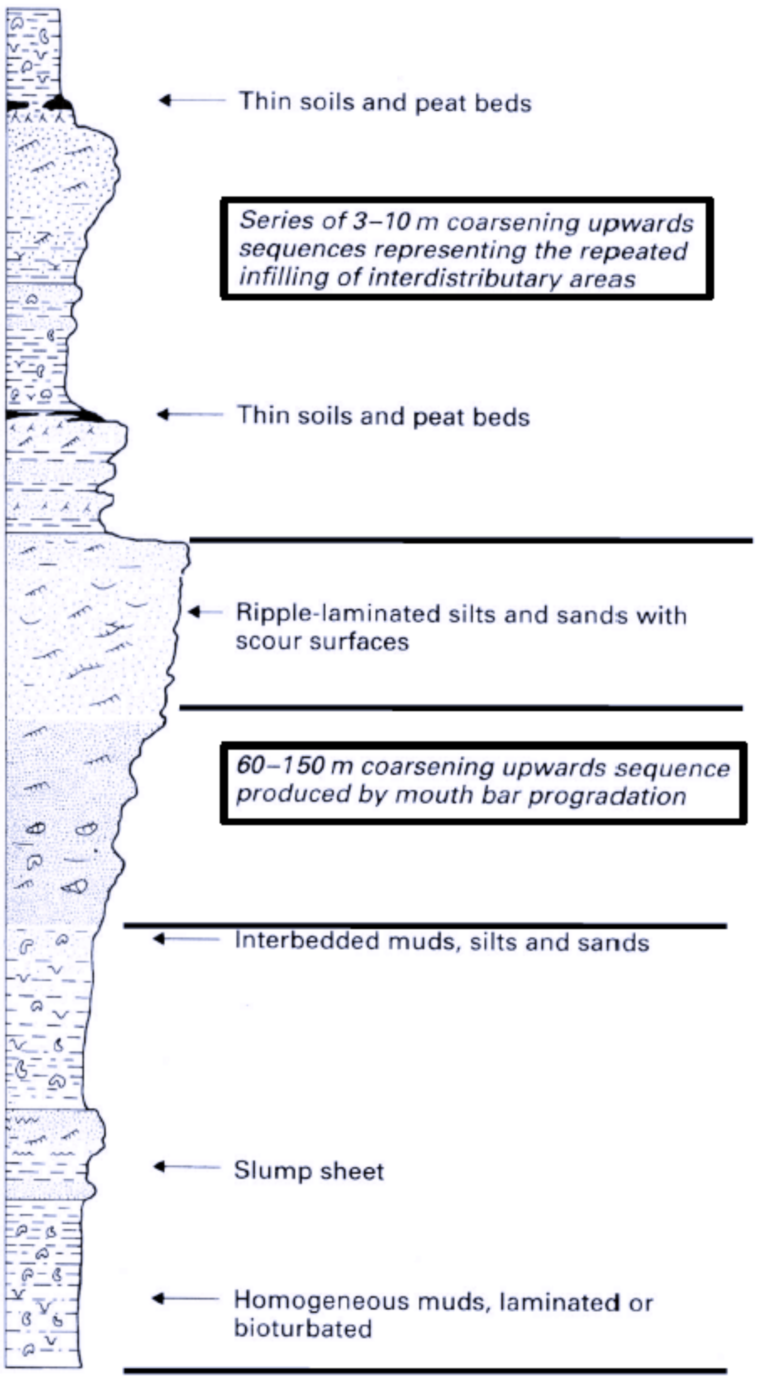
Progradational delta facies coarsen upward from prodelta through delta front to (maybe) delta plain





Coarsening-upward cycles





Interdistributary: Fine-grained tidal flat or bay deposits grading upwards to cross-laminated crevasse-splay units, and/or

Channel/levee: Erosive-based trough or planar x-bedded sandstone from migration of large bedforms in distributary channel

Bar crest: well-sorted sand with cross-lamination, climbing ripples, flat lamination, deposited during river floods

Delta front: increasing parallel and lenticular silt laminae, eventually cross-laminated sand intercalated with mud (waves, distal river deposition, suspension)

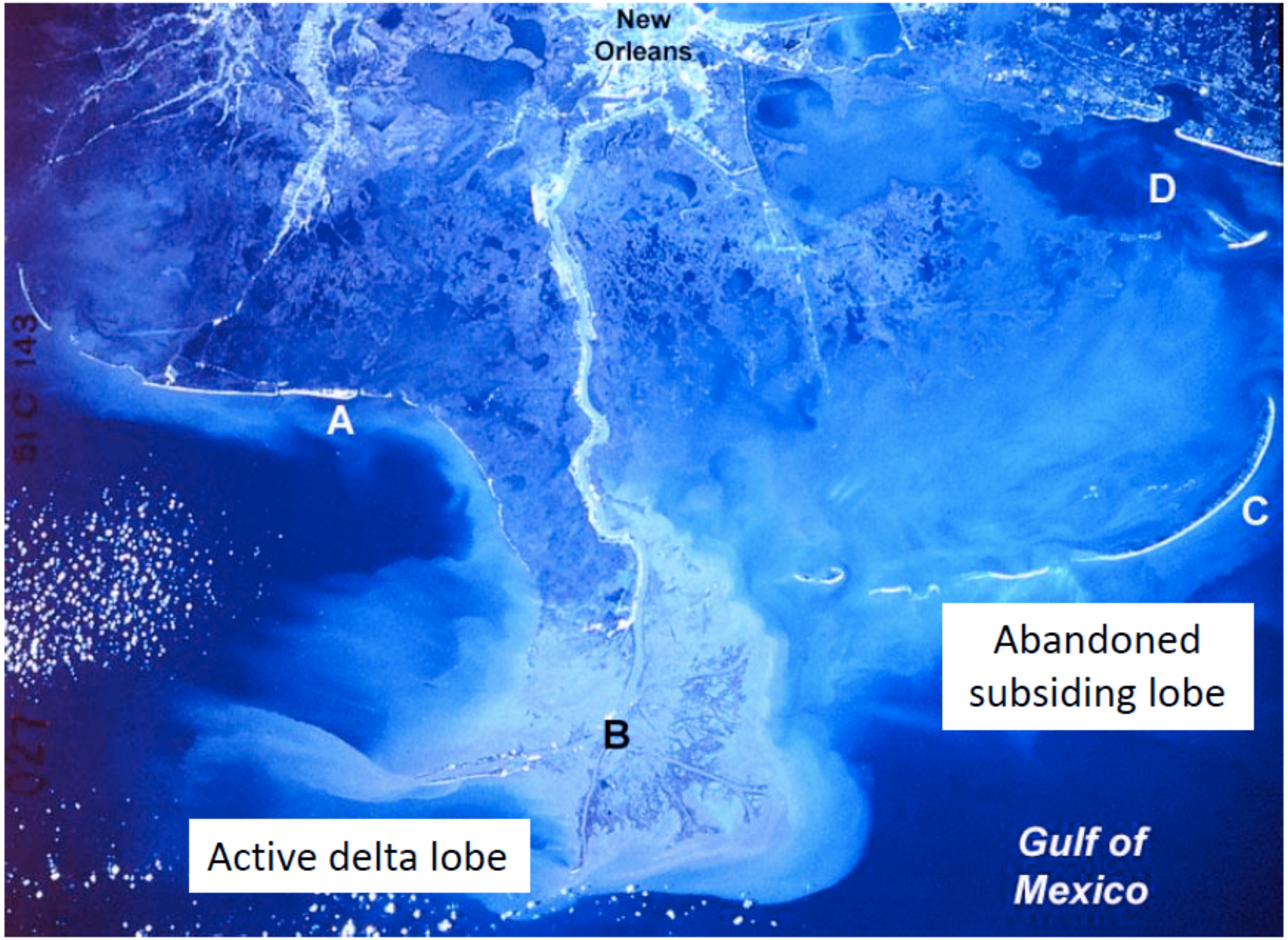
Prodelta muds: lack current- or wave-produced structures, may be banded due to slight grain size differences (fluctuating river discharge)

Slumps and convolute bedding from steeper prodelta slope and high-porosity clay mineral fabric

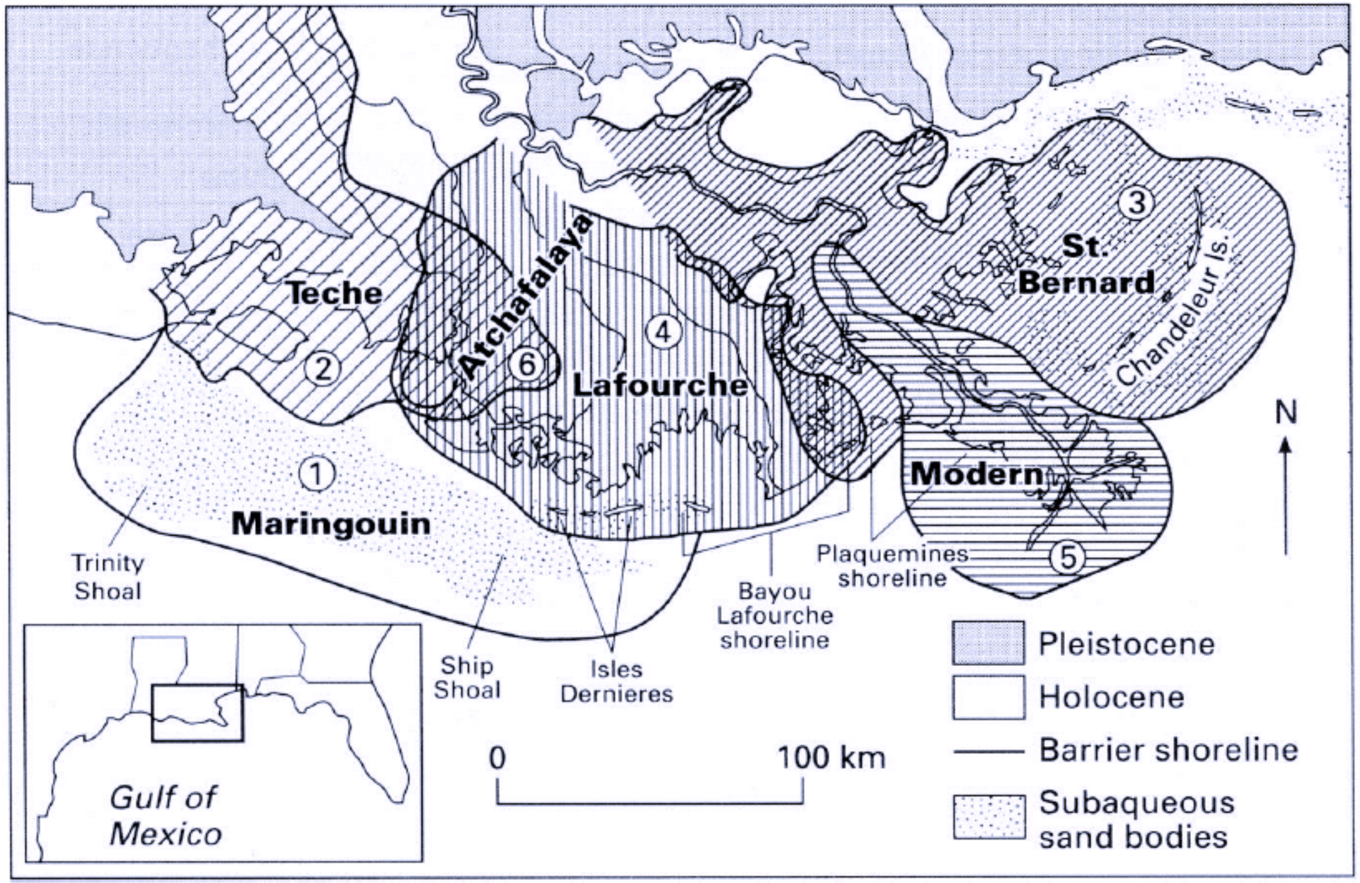
Bioturbation usually low due to high sed. rate

Cycles may be **autocyclic** (inherent due to delta processes) rather than **allocyclic** (due to external forces like base level)

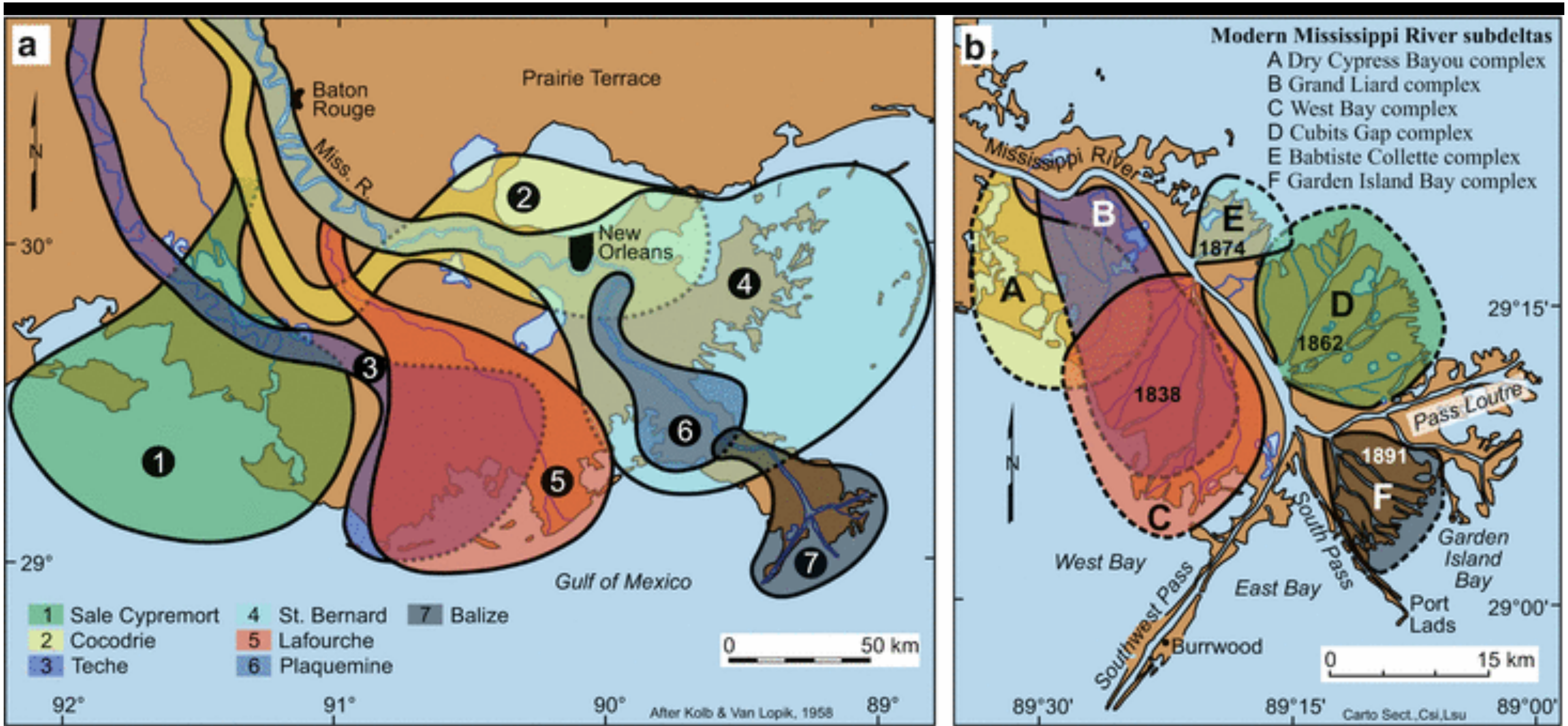
"Lobe switching"



Deltaic sequences cyclic at medium scale (50-150 m thick) due to lobe switching



1. River builds long distributary channels on delta (progradation)
2. Avulsion occurs and river takes new, more favorable path to ocean – forms new delta and abandons old lobe
3. Abandoned lobe continues to subside (facies retrogradation)



Sedimentation in the modern Mississippi delta. When the river water breaks through the levees, crevasse channels and splays are formed, which help to fill the areas between the channels (Coleman and Prior 1980).

(a) Delta lobes which show how the sedimentation has changed during the past 7,000 years. Each lobe of the delta appears to be active for 1,000–1,500 years (Coleman and Prior 1980).

(b) Sedimentation in the last few 100 years.

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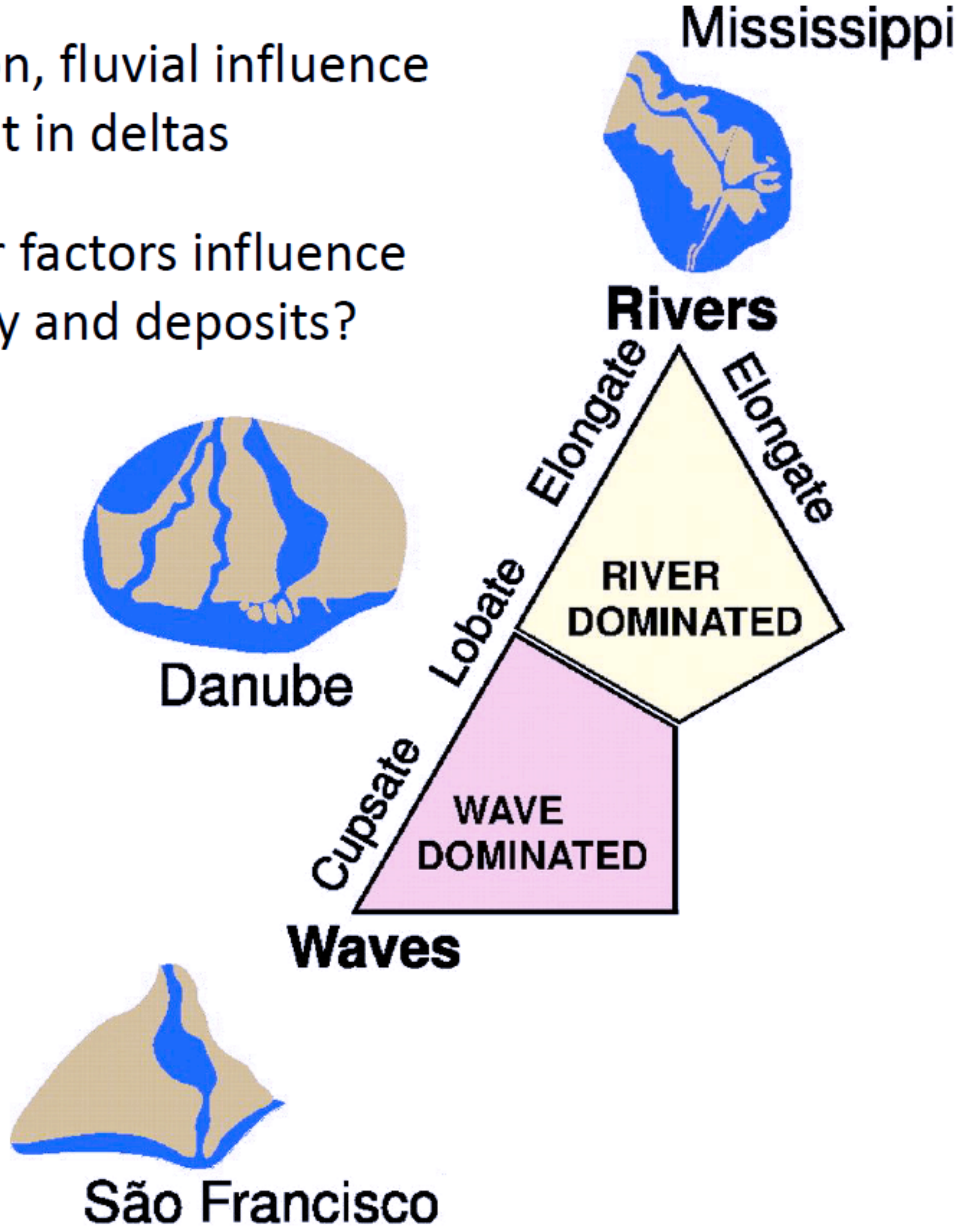
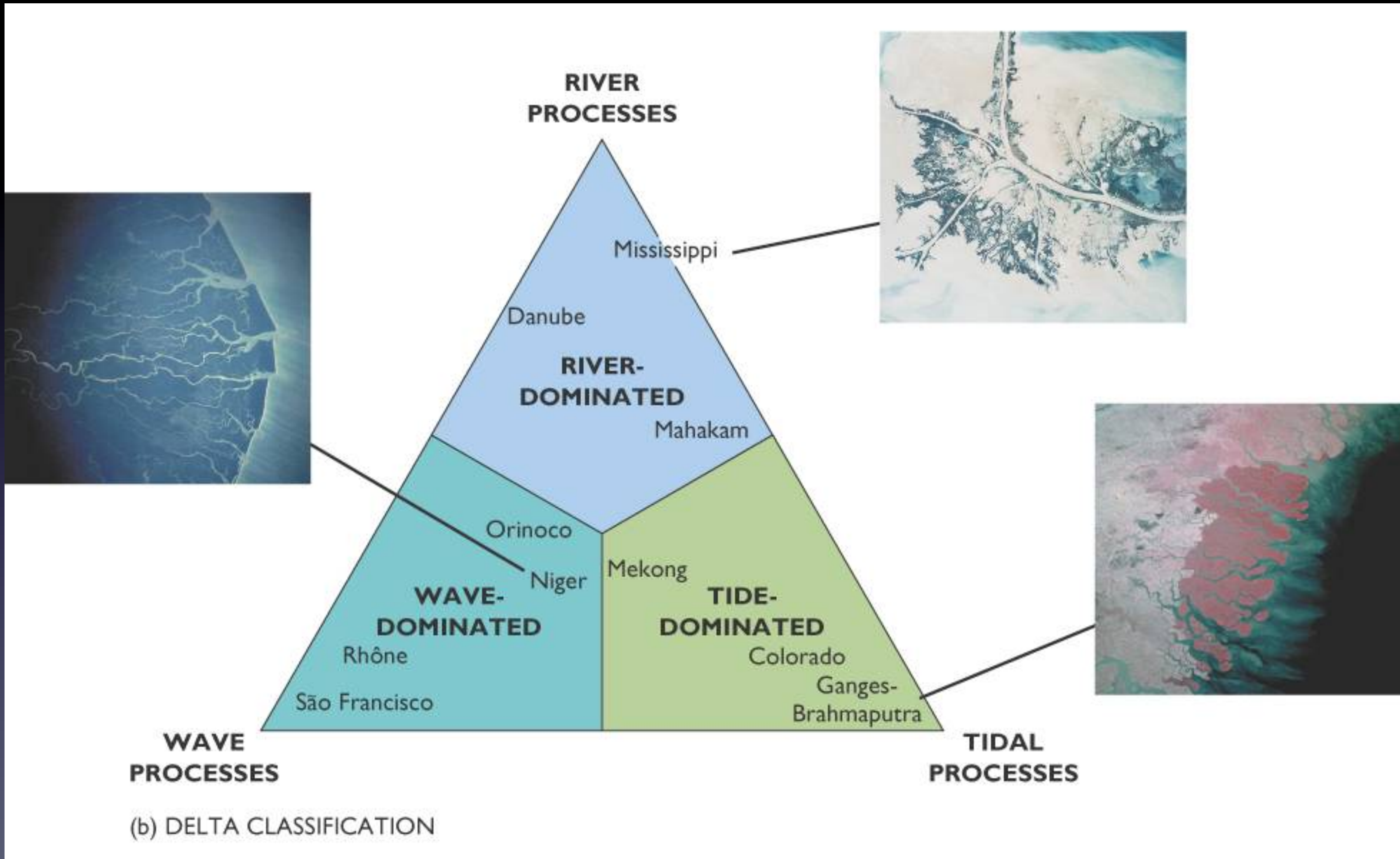
By definition, fluvial influence is important in deltas

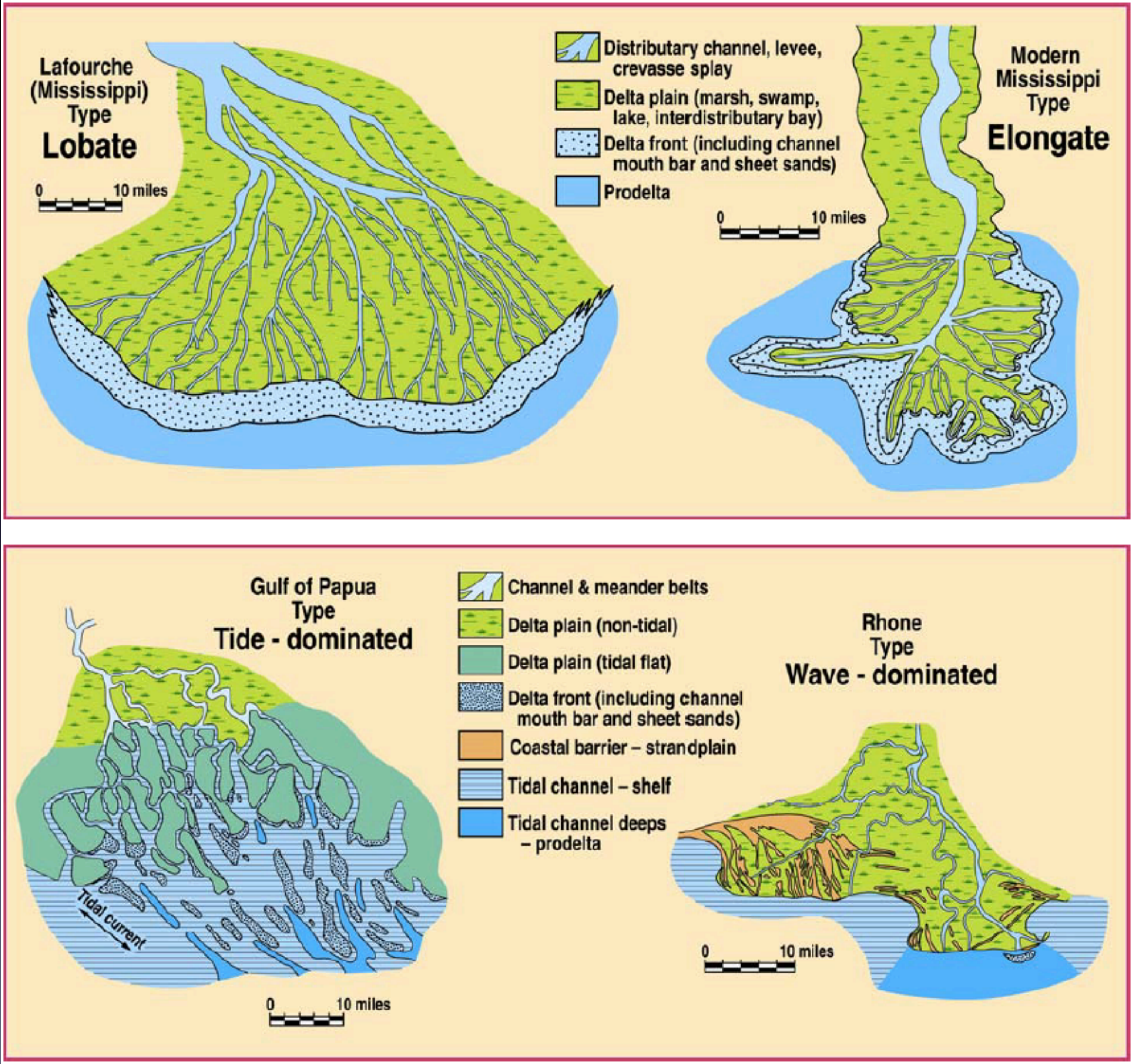
What other factors influence morphology and deposits?



DELTA Input sedimentari > tasso d’erosione



DELTA MORPHOLOGY



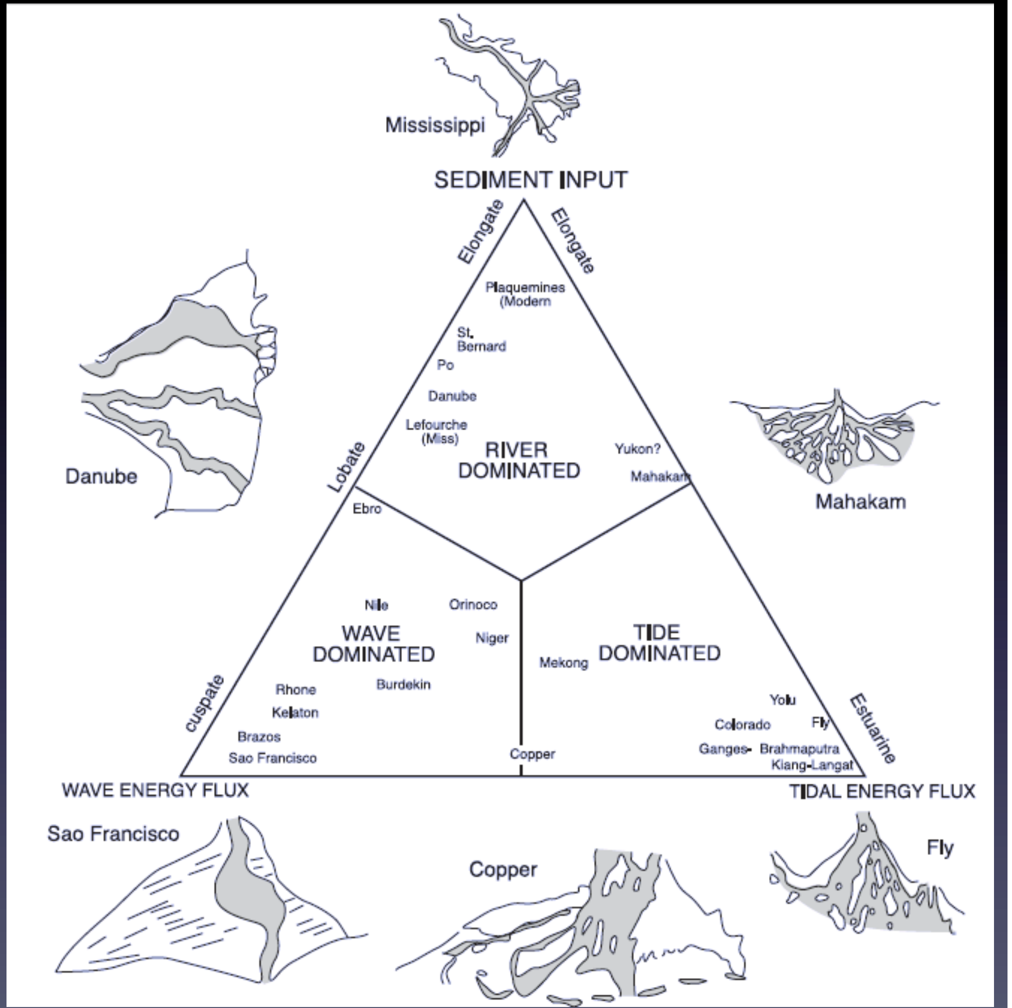
DELTA TYPES

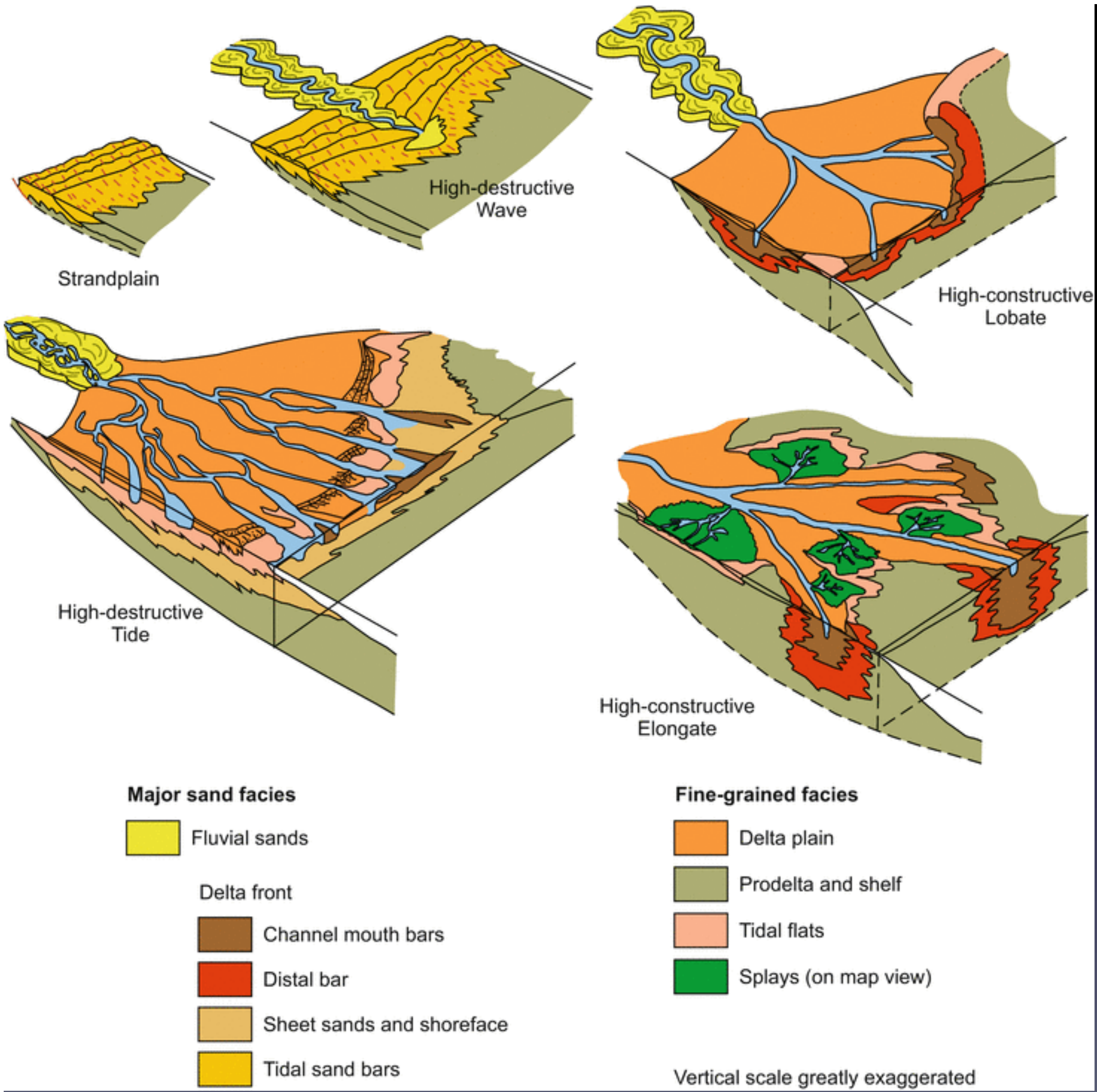
1. Constructional deltas

- Dominated by the fluvial system
- Strongly progradational/regressive
- **Lobate - Elongate**

2. Destructional deltas

- Dominated by marine processes
- Common marine reworking with transgressive intervals
- **Cuspate**





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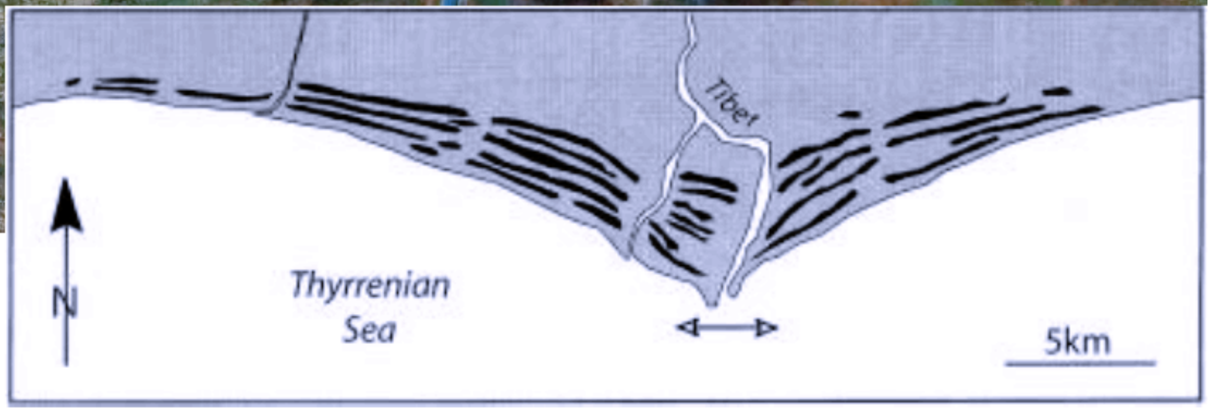
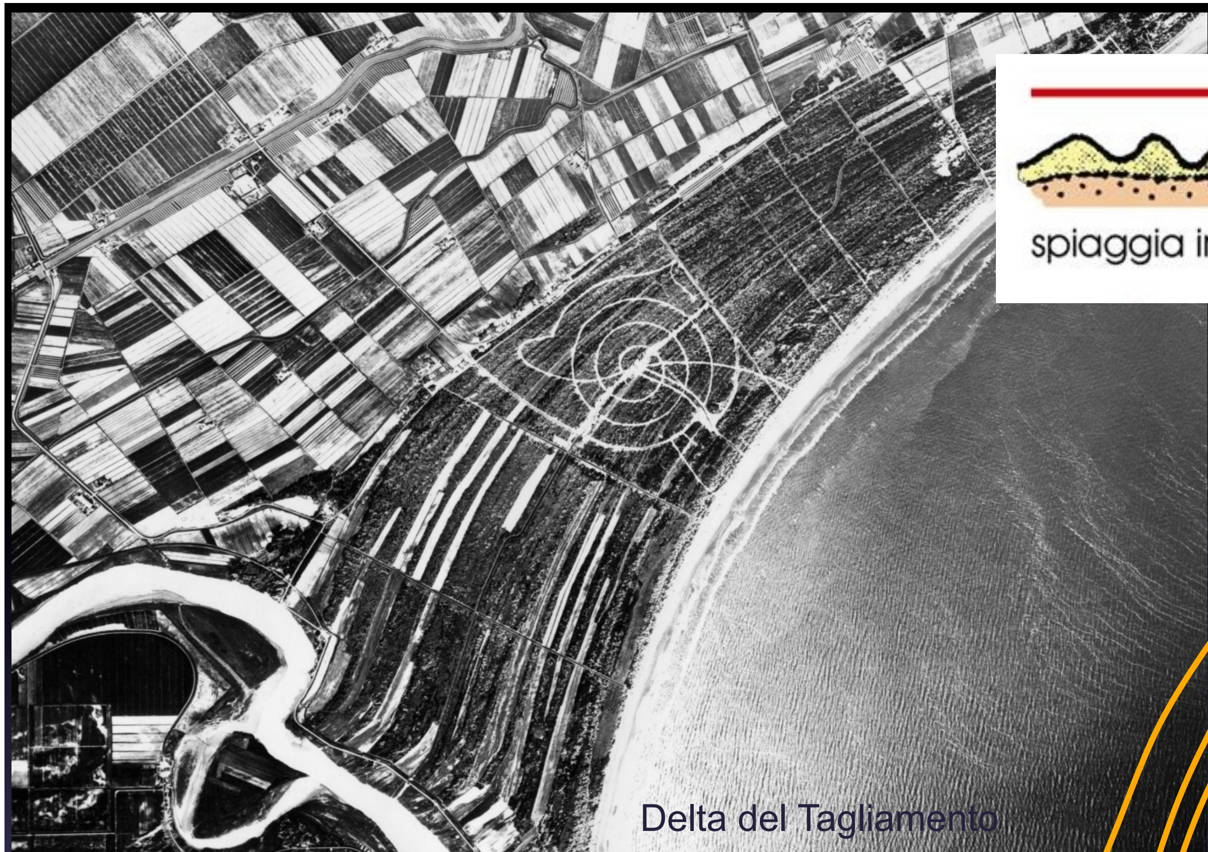
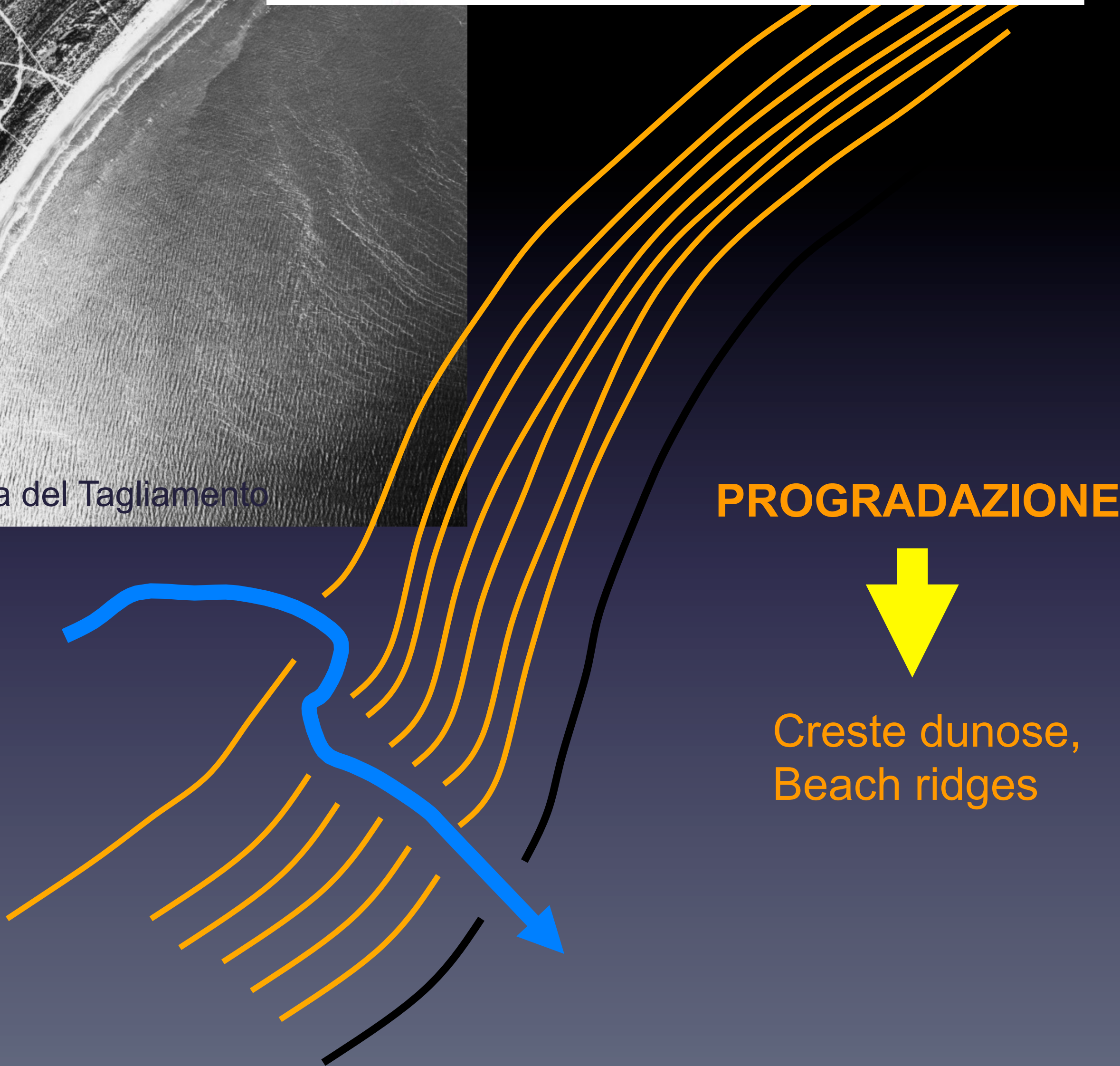
Mouth bars modified by wave action into linear beach ridge sandbody complexes.



Tiber delta, Italy



DELTA CUSPIDATO =
Wave-dominated delta



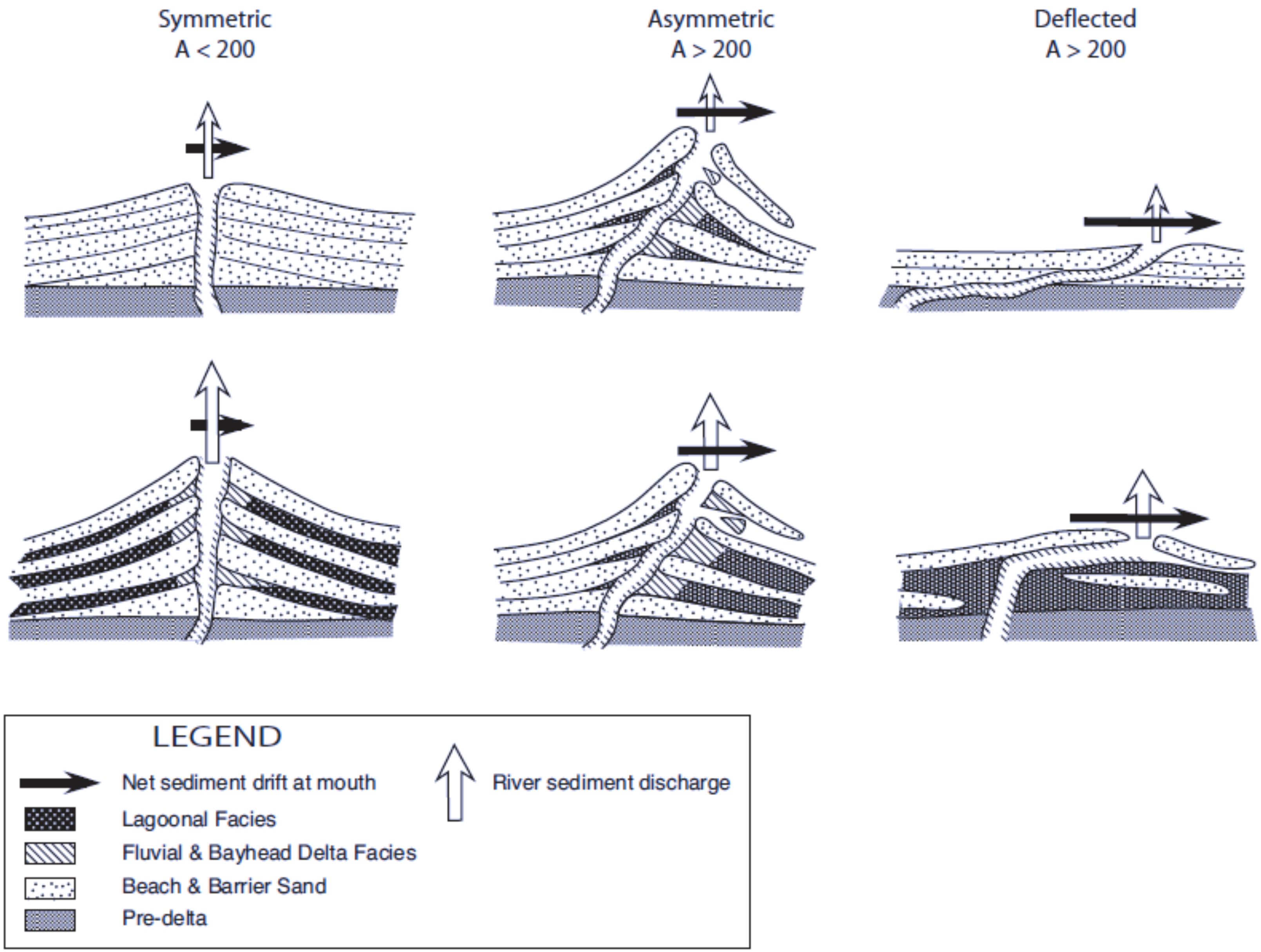
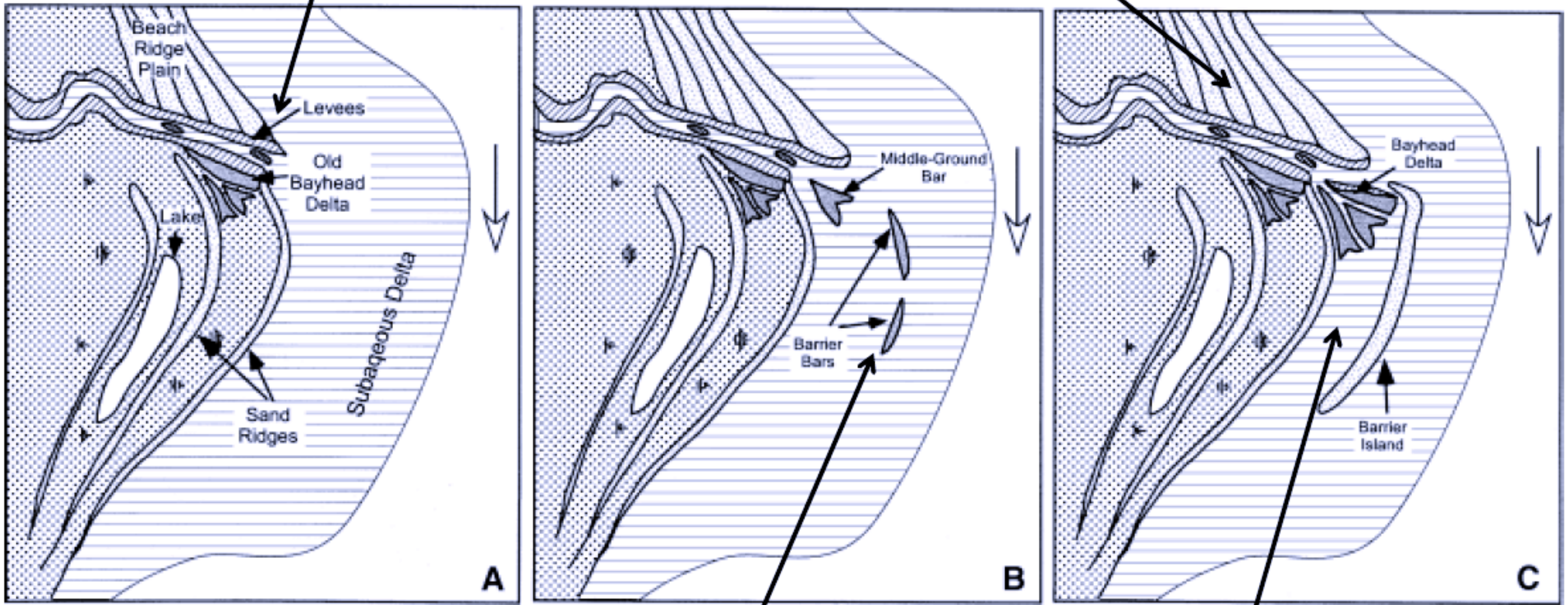


FIG. 6.—Morphology of wave-influenced deltas. Top row represents lower fluvial discharge compared to bottom row. River plume acts as a groyne that traps sediment updrift (after Bhattacharya and Giosan, 2003). Asymmetry index represents the ratio of fluvial sediment discharge to alongshore sediment transport rate.

When significant longshore current present, wave-influenced delta may be substantially asymmetrical

Prograding river levee acts as groin to block longshore drift

Wave-influenced strandplain shoreface forms on upcurrent side



Mouth bar modified into elongate barrier bars

Become emergent, allowing for fine-grained back-barrier deposition