Up-Estuary Variation of Sedimentary Facies and Ichnocoenoses in the Mixed-Energy Gomso Bay Estuary, Korea*

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Search and Discovery Article #50156 (2009)
Posted January 16, 2009

*Adapted from oral presentation at AAPG Annual Convention, San Antonio, TX, April 20-23, 2008

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Abstract

Estuaries are commonly associated with transgressive to early highstand coastlines, and since the development of sequence stratigraphy, many estuarine deposits have been recognized in the ancient record. The existing estuarine facies models have been very useful in the interpretation of such deposits, but these models focus on wave- and tide-dominated end members of the spectrum of estuary types and do not represent mixed-energy estuaries effectively. This is a serious shortcoming because such estuaries are common.

The Gomso Bay estuary is a funnel-shaped, coastal embayment, which opens westward to the Yellow Sea. Tides are semidiurnal with a mean range of 4.33 m. Winds are seasonally intense and waves are able to enter the estuary because the tidal flux prevents the development of a protective barrier. Surface sediments, can cores, and topographic profiles reveal that the physical and biological facies within the Gomso Bay estuary are influenced by both tides and waves. Because of the up-estuary decrease in wave energy, physical structures pass from wave-dominated planar lamination and hummocky cross-stratification at the estuary mouth to tide-dominated heterolithic stratification in the inner estuary. The infaunal distribution is sensitive to physiological stresses, and traces increase in size from the inner bay to the outer bay. The mappable trends in sedimentary facies and ichnofacies (i.e., facies belts) are oblique to the estuarine margin in the outer and middle bays because of wave refraction, whereas facies belts in the inner bay are parallel to the estuary margin, reflecting tide-dominated conditions. The findings provide improved criteria to assist in the recognition of the deposits of mixed-energy estuaries, and can be used to make interpretations of the geometry of coastlines and clastic reservoirs in ancient examples.

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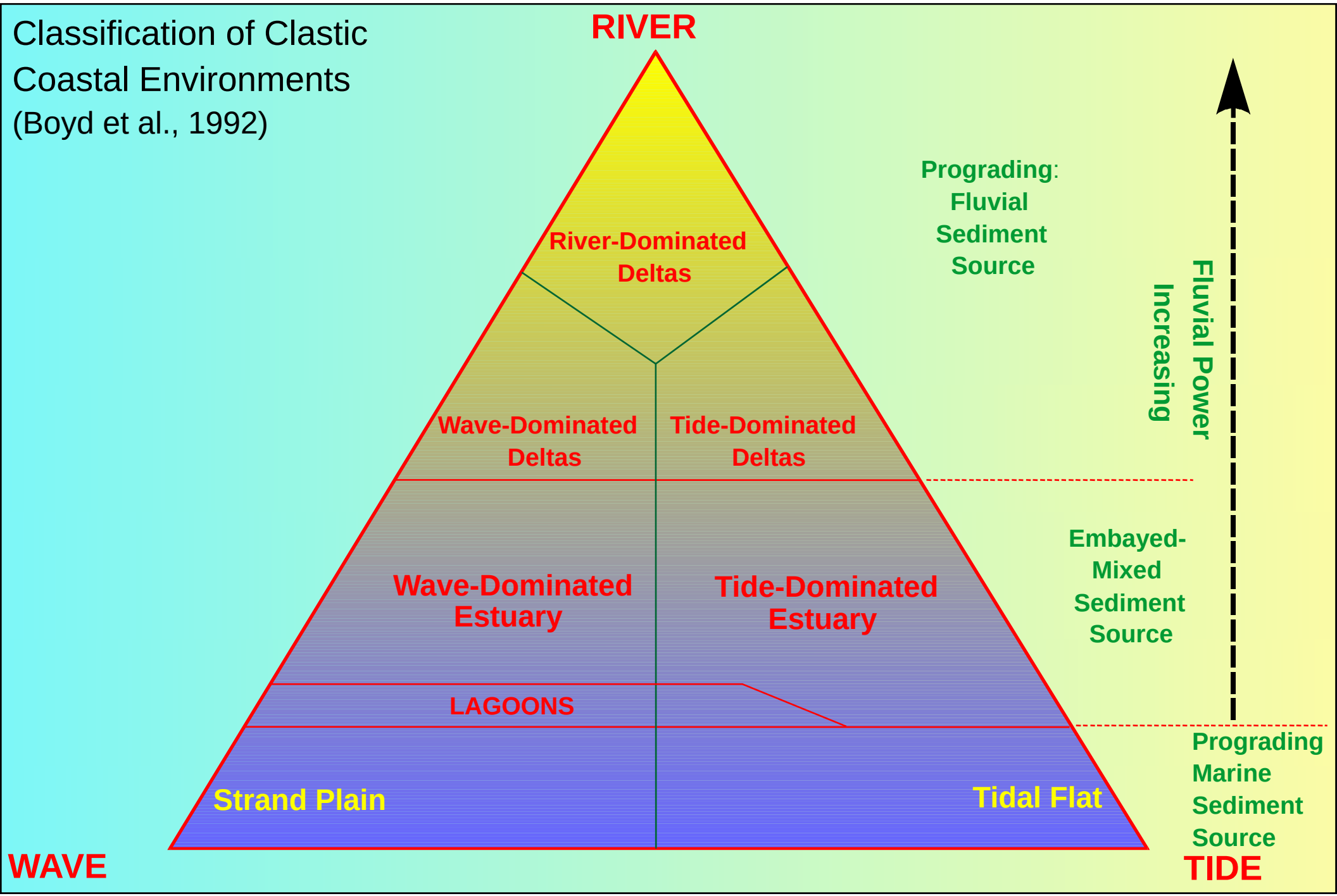
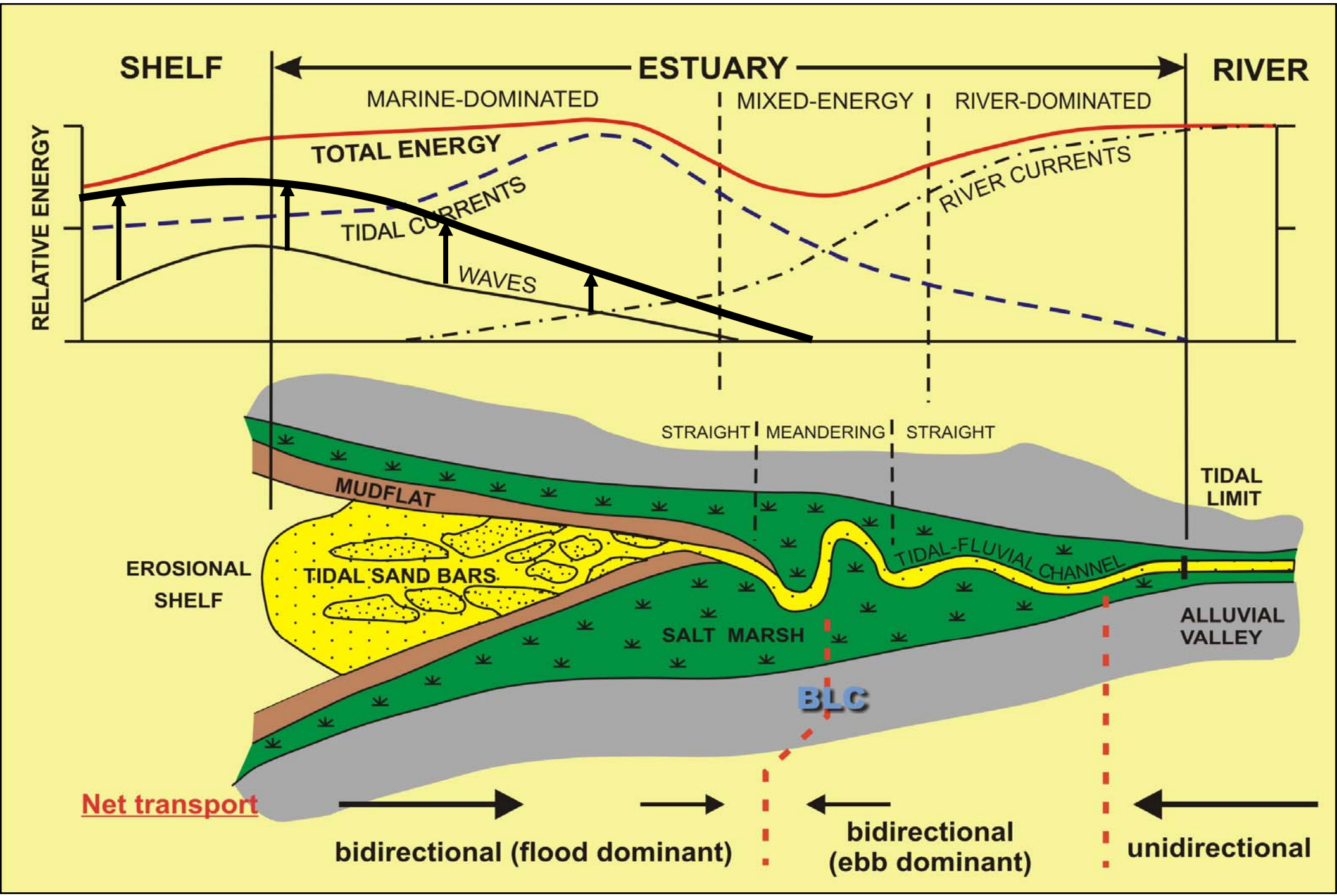
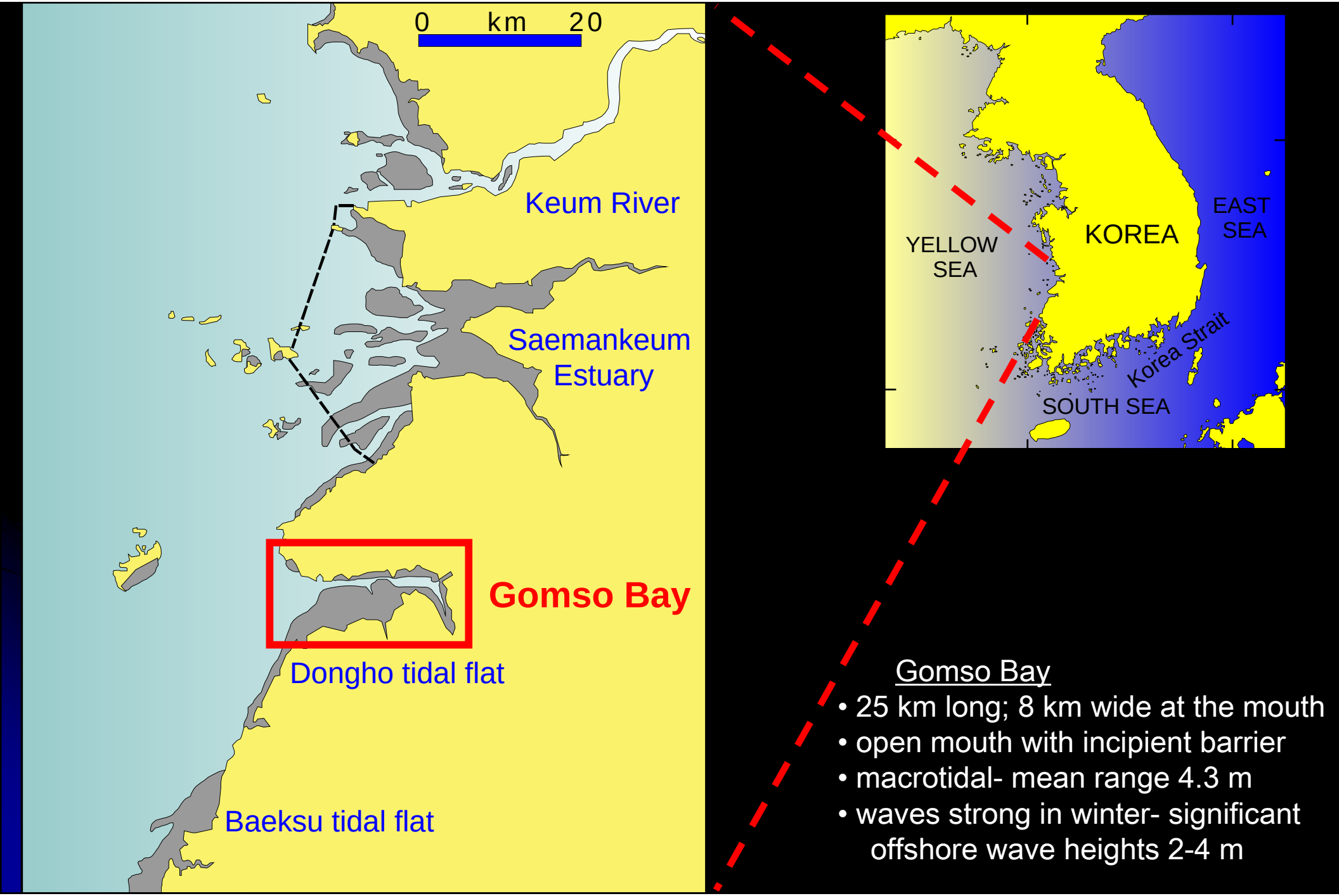

Classification of Clastic Coastal Environments
(Boyd et al., 1992)
RIVER
River-Dominated Deltas
Wave-Dominated Deltas
Tide-Dominated Deltas
Wave-Dominated Estuary
Tide-Dominated Estuary
LAGOONS
Strand Plain
Tidal Flat
WAVE
TIDE
Prograding: Fluvial Sediment Source
Fluvial Power Increasing
Embayed-Mixed Sediment Source
Prograding Marine Sediment Source


SHELF
ESTUARY
RIVER
MARINE-DOMINATED
MIXED-ENERGY
RIVER-DOMINATED
RELATIVE ENERGY
TOTAL ENERGY
TIDAL CURRENTS
WAVES
RIVER CURRENTS
STRAIGHT
MEANDERING
STRAIGHT
MUDFLAT
TIDAL LIMIT
EROSIONAL SHELF
TIDAL SAND BARS
TIDAL-FLUVIAL CHANNEL
SALT MARSH
ALLUVIAL VALLEY
BLC
Net transport
bidirectional (flood dominant)
bidirectional (ebb dominant)
unidirectional

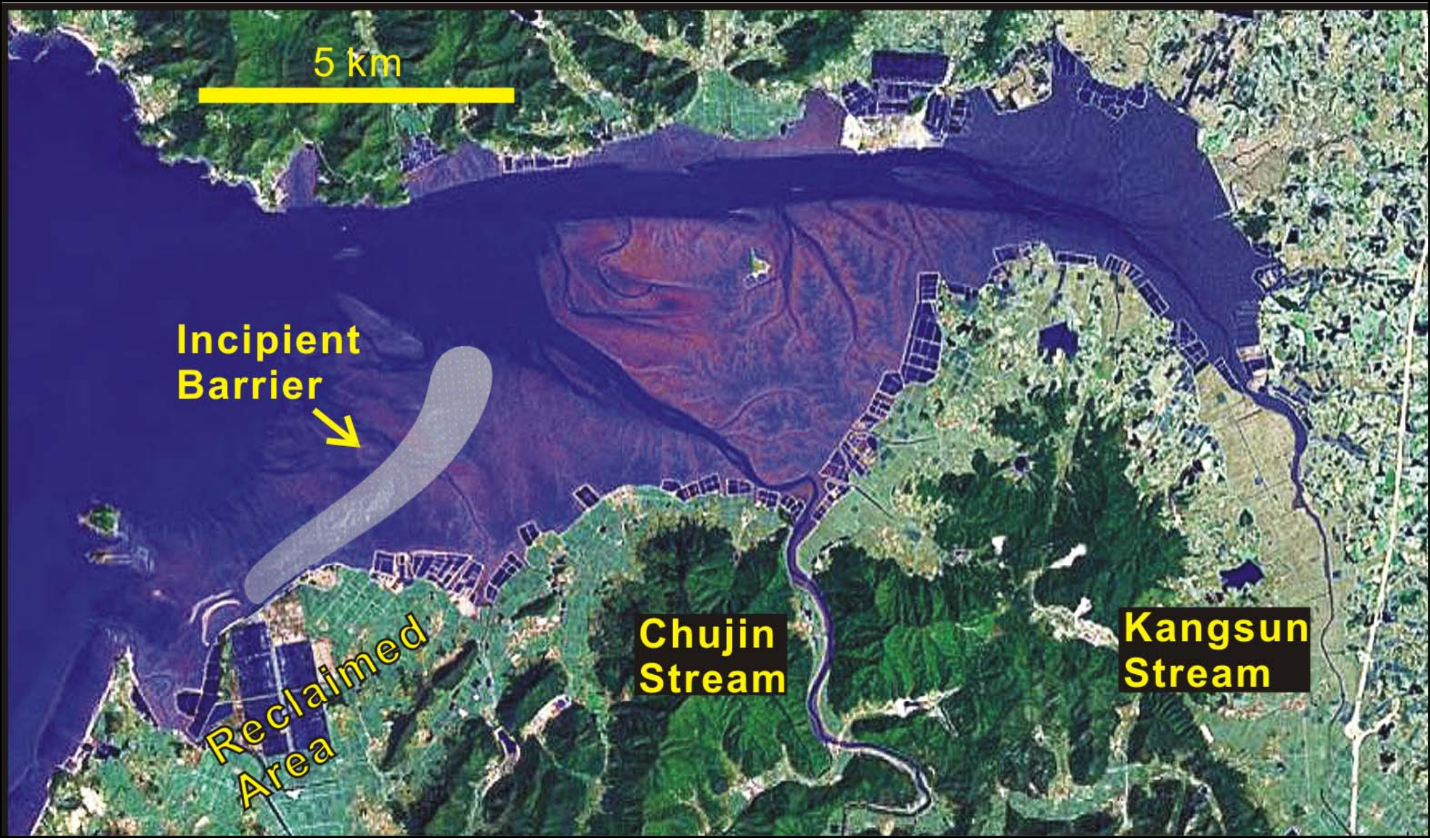

BOHAI BAY
KOREA BAY
KYUNGGI BAY
EAST SEA
KOREA
Study
Area
CHINA
YELLOW SEA
KOREA STRAIT
JAPAN
CHANGJIANG
ESTUARY



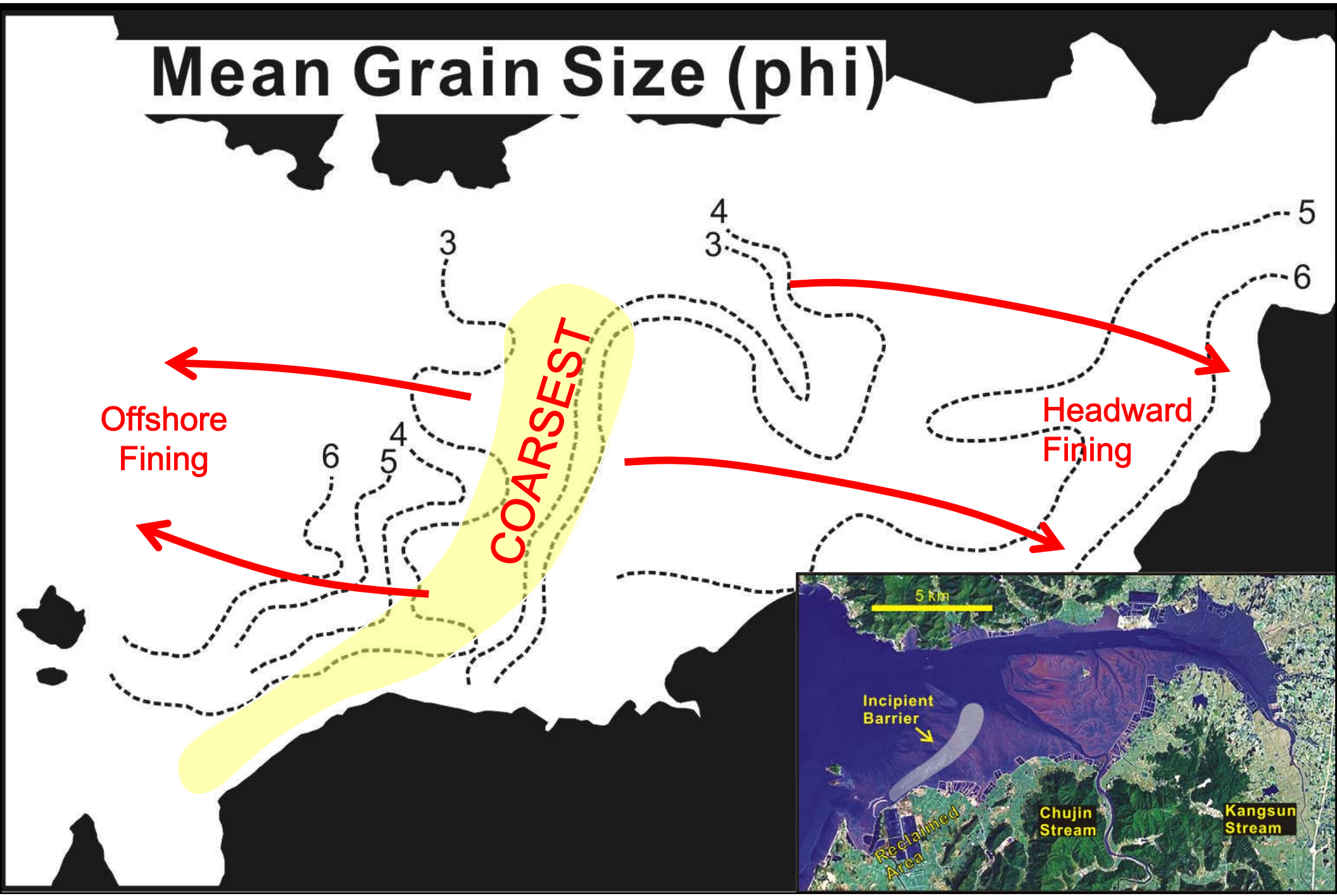
Gomso Bay

- 25 km long; 8 km wide at the mouth
- open mouth with incipient barrier
- macrotidal- mean range 4.3 m
- waves strong in winter- significant offshore wave heights 2-4 m

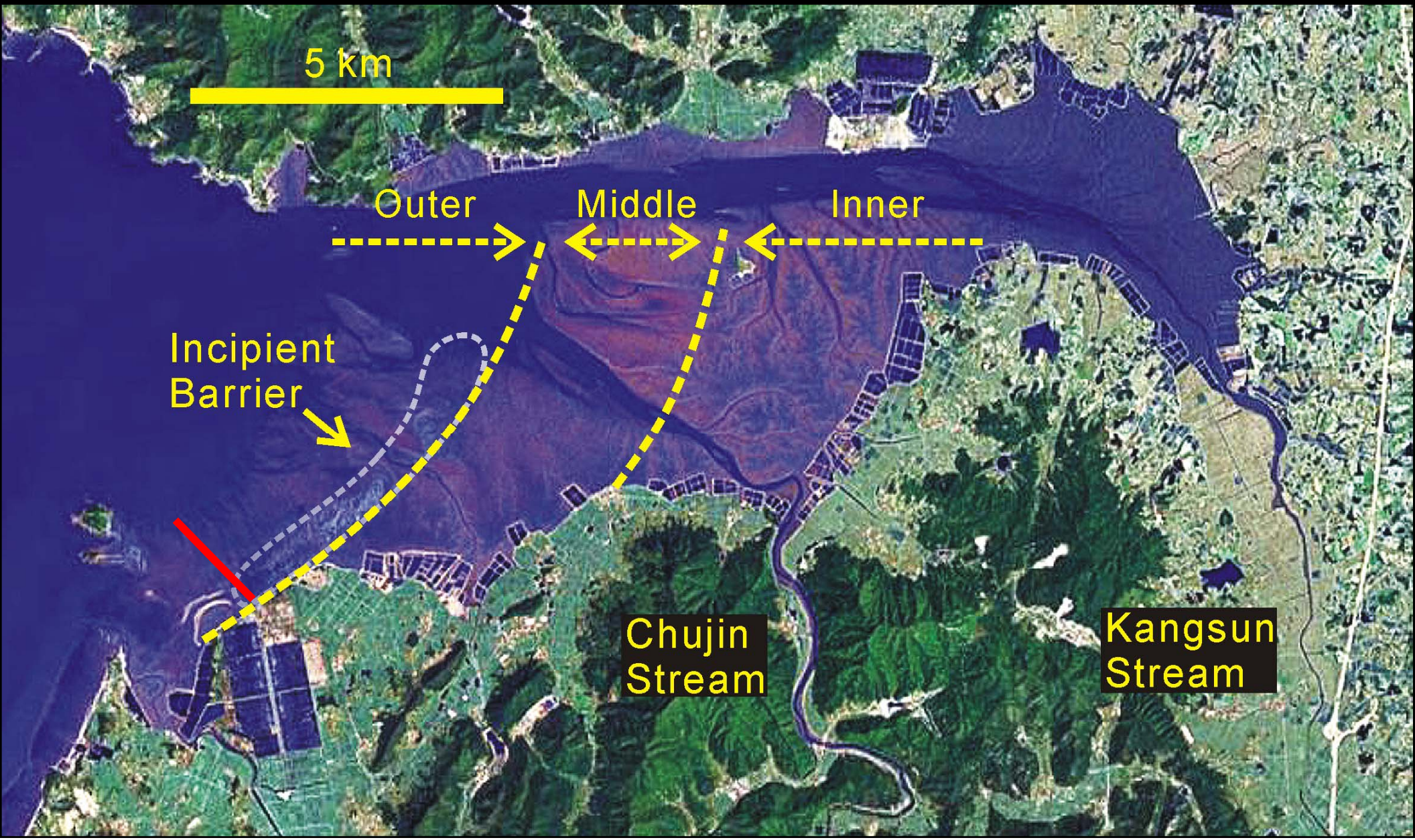
Gomso Bay


5 km
Incipient Barrier
Reclaimed Area
Chujin Stream
Kangsun Stream

Mean Grain Size (phi)



Gomso Bay


5 km
Outer
Middle
Inner
Incipient
Barrier
Chujin
Stream
Kangsun
Stream

Topography: Outer Bay

Muddy Tidal Flat

Incipient Beach Face

Chenier Ridges

Concave-up profile

Summer 2000
Winter 2000
Summer 2001

200
100
0
-100
-200

Elevation from MSL (cm)

2500
2000
1500
1000
500
0

Distance from the Coast (m)

-OUTER BAY-

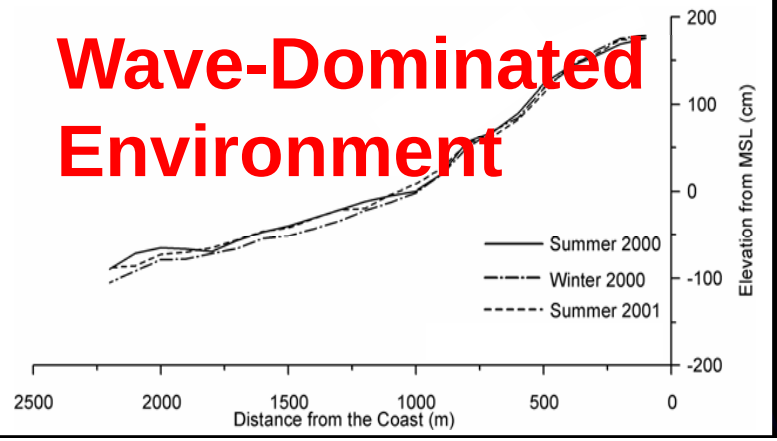
Sedimentology:

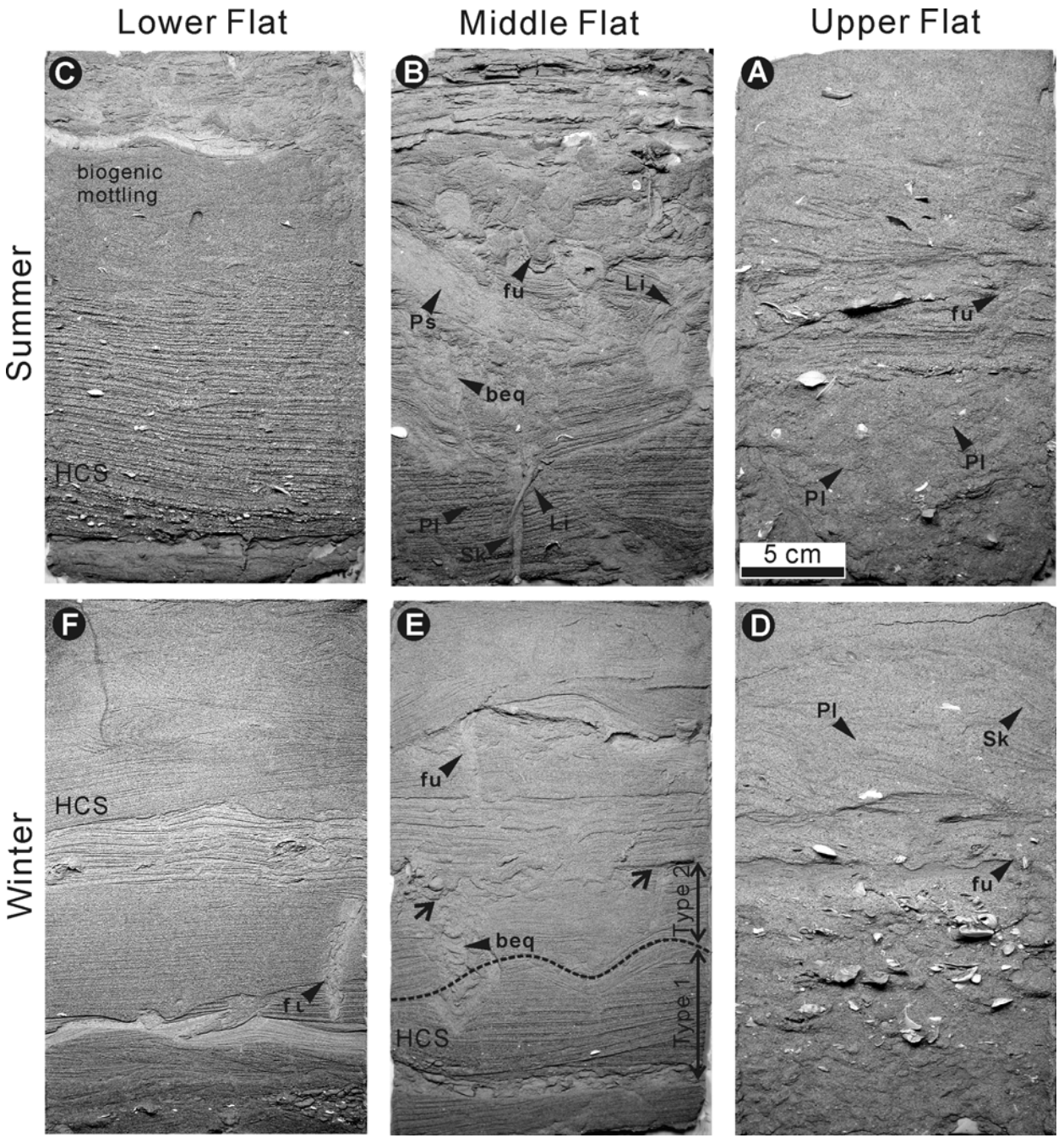
1. Sediment coarsens landward
2. Tempestite-dominated, including planar lam. and HCS
3. Abundant wave-ripple x-lam.
4. Rare tide-influenced facies

Ichnology:

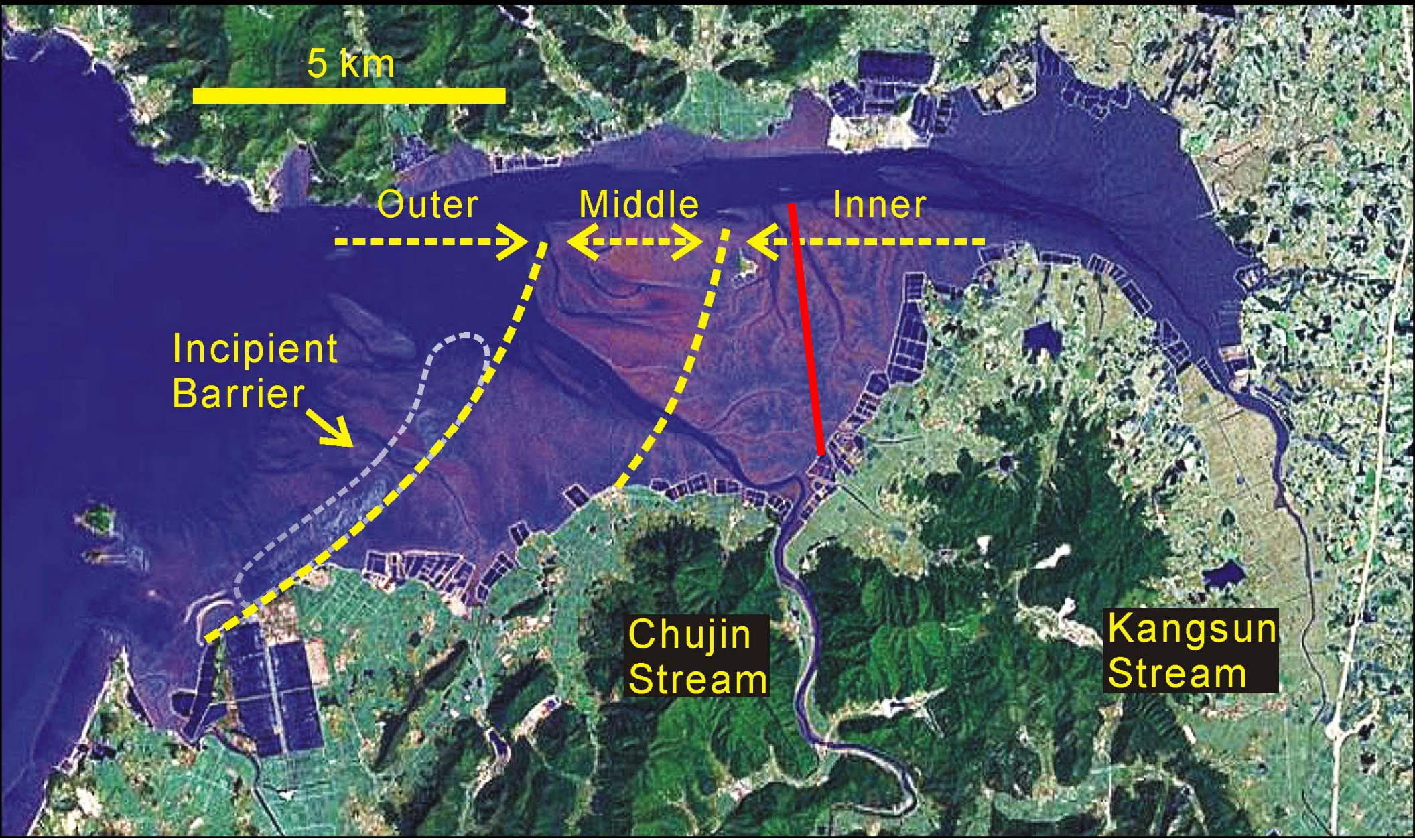
1. Modal diameter of burrows large but decreases landward
2. BI increases landward from BI=0-1 to BI=4

Wave-Dominated Environment

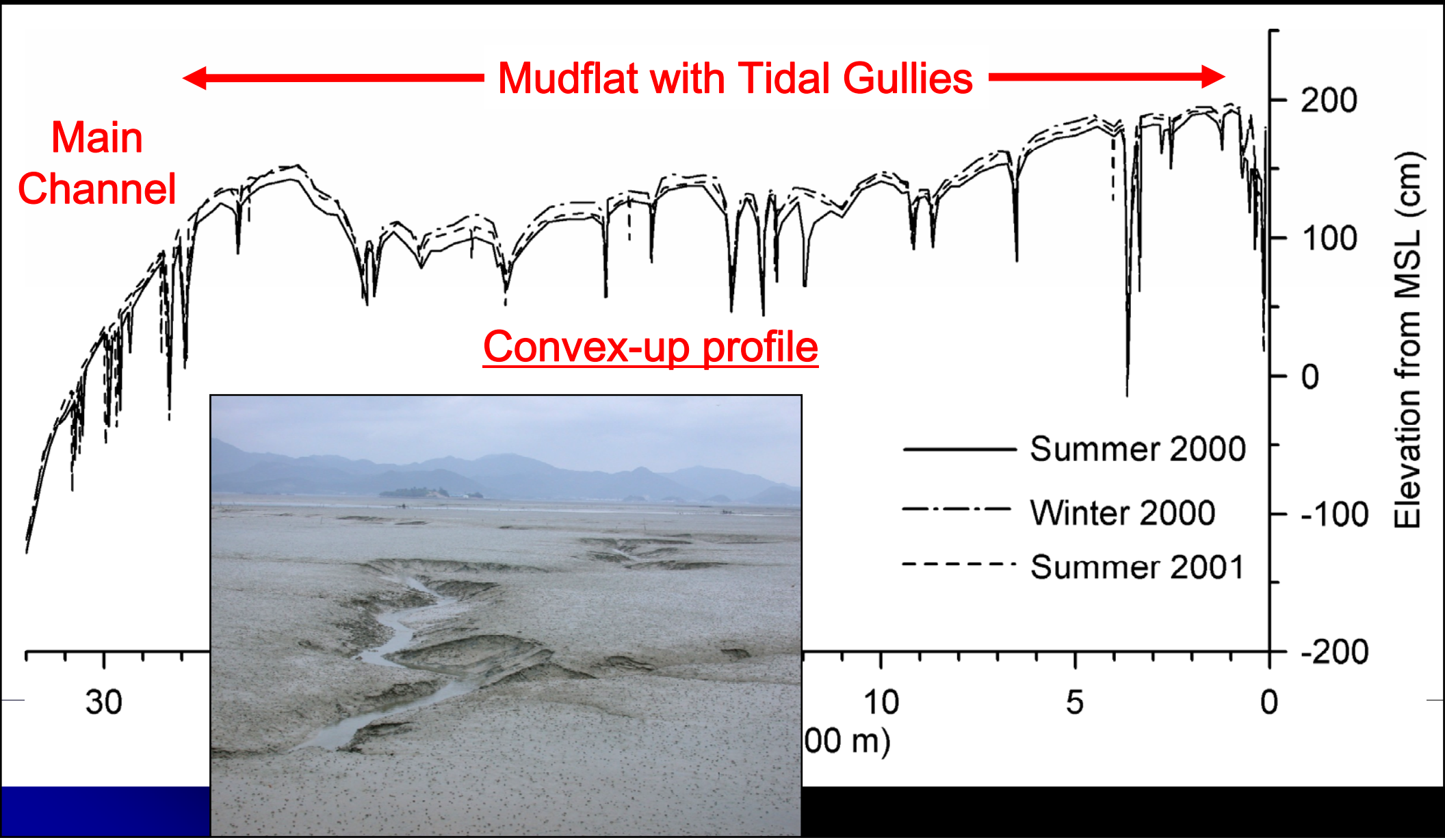




Gomso Bay


5 km
Outer
Middle
Inner
Incipient
Barrier
Chujin
Stream
Kangsun
Stream

Topography: Inner Bay



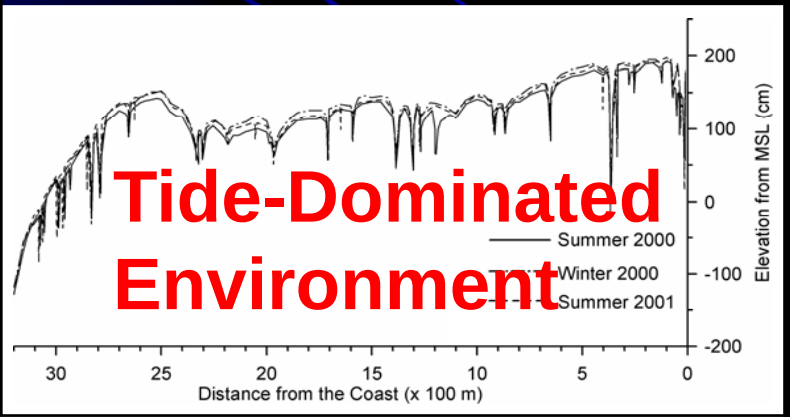
-INNER BAY-

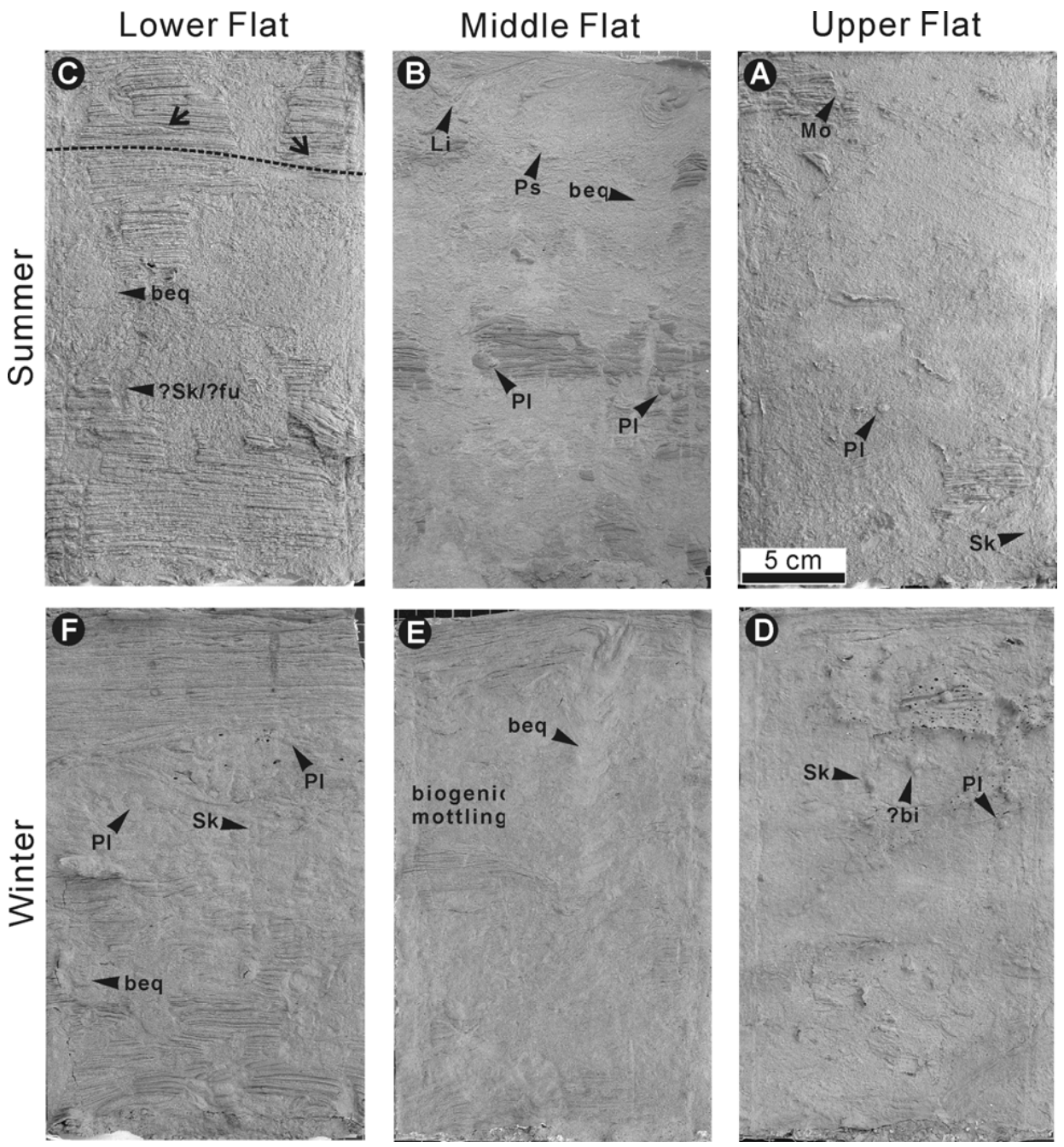
Sedimentology:

1. Sediment fines landward
2. Abundant tide-dominated facies, including heterolithic facies, tidal rhythmites, herringbone x-lamination
3. Wave-influenced facies rare except for graded rhythmites

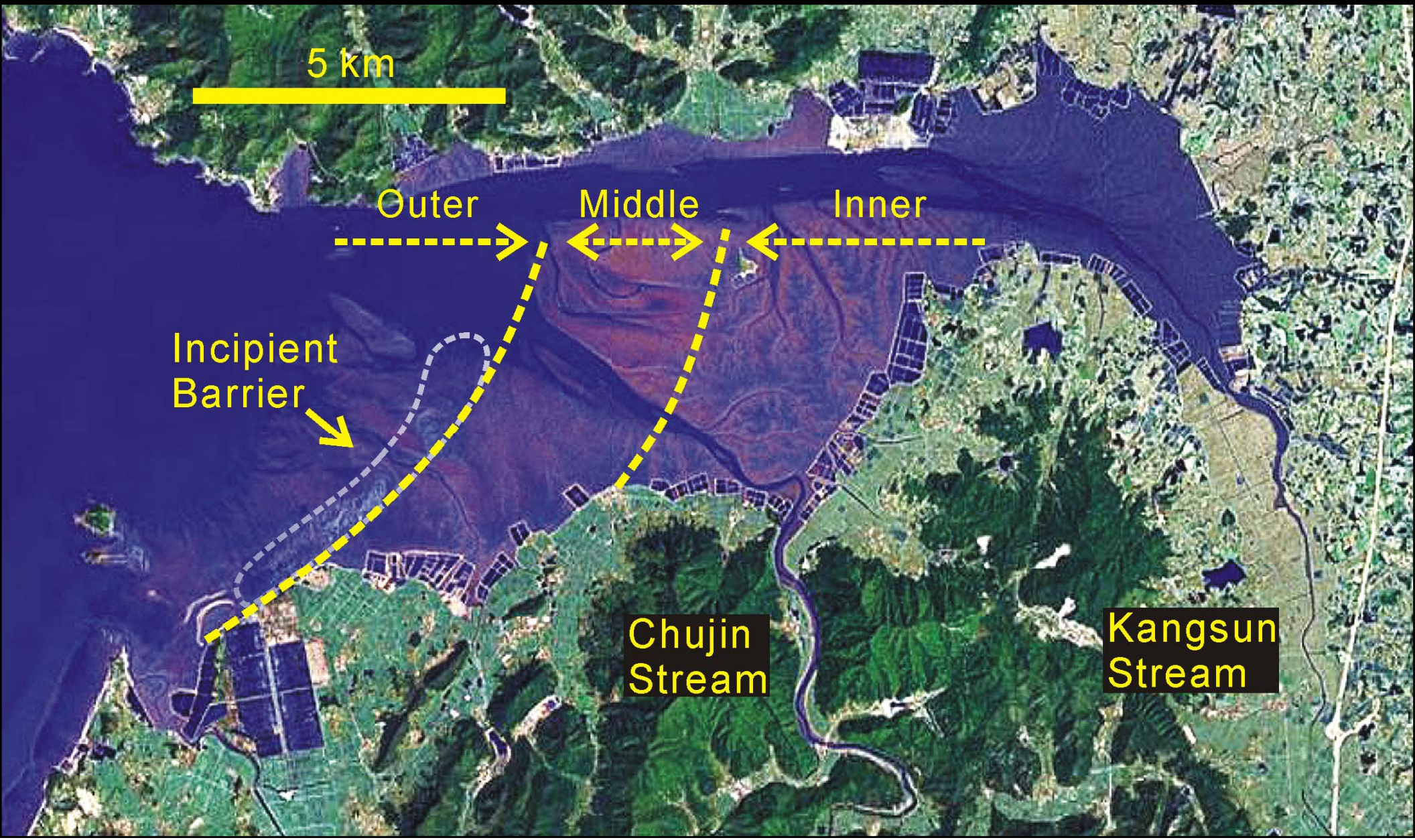
Ichnology:

1. Modal diameter of burrows decreases landward
2. BI increases landward from BI=3 to BI=5





Gomso Bay


5 km
Outer
Middle
Inner
Incipient
Barrier
Chujin
Stream
Kangsun
Stream

-MIDDLE BAY-

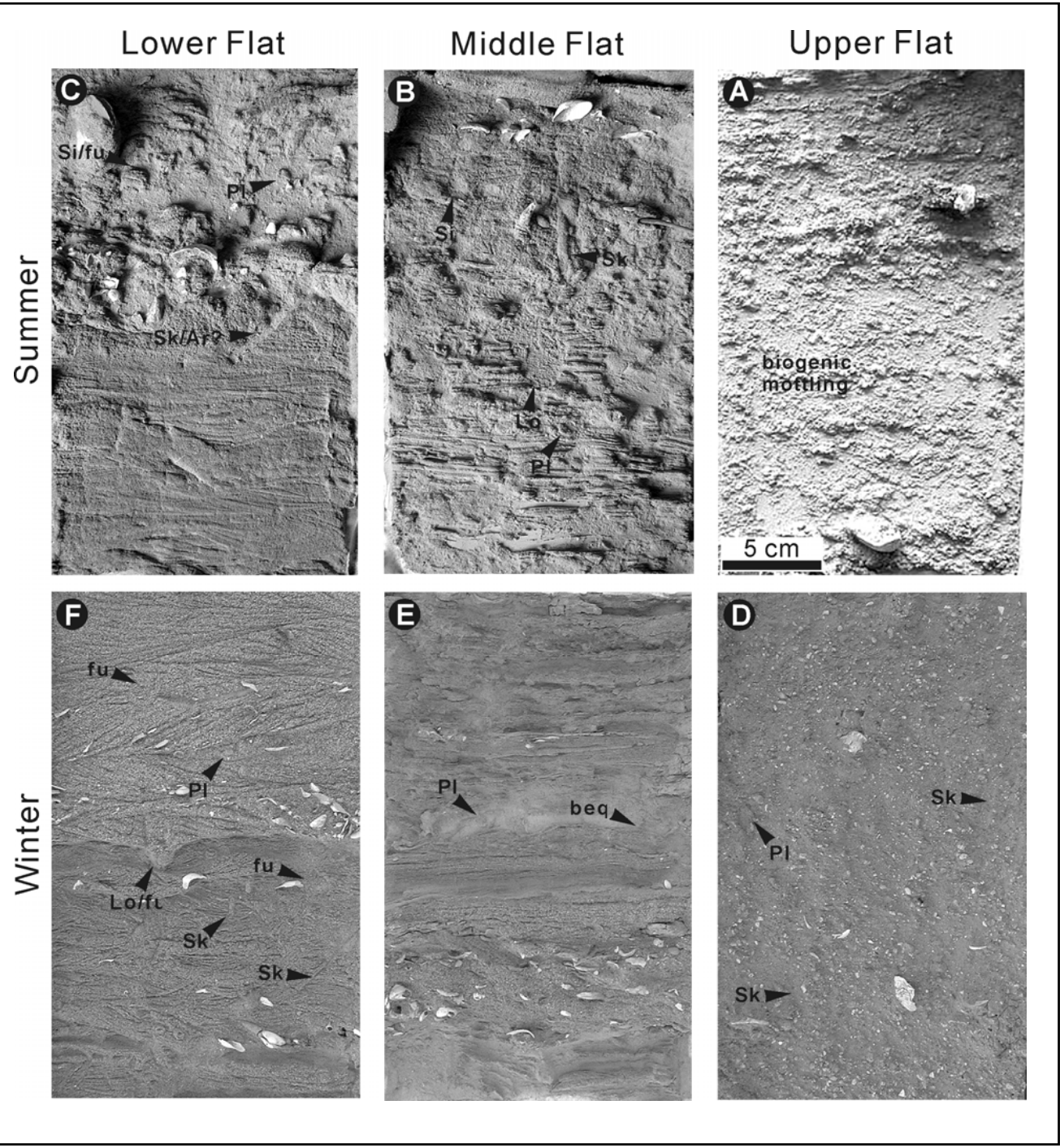
Sedimentology:

1. Tide-dominated facies during low-energy conditions, including heterolithic facies, tidal rhythmites, herringbone x-lam.
2. Wave-dominated facies during high-energy conditions, including planar lamination and HCS, but they are rare

Ichnology:

1. Modal diameter of burrows decreases landward
2. BI increases in landward from BI=2 to BI=5

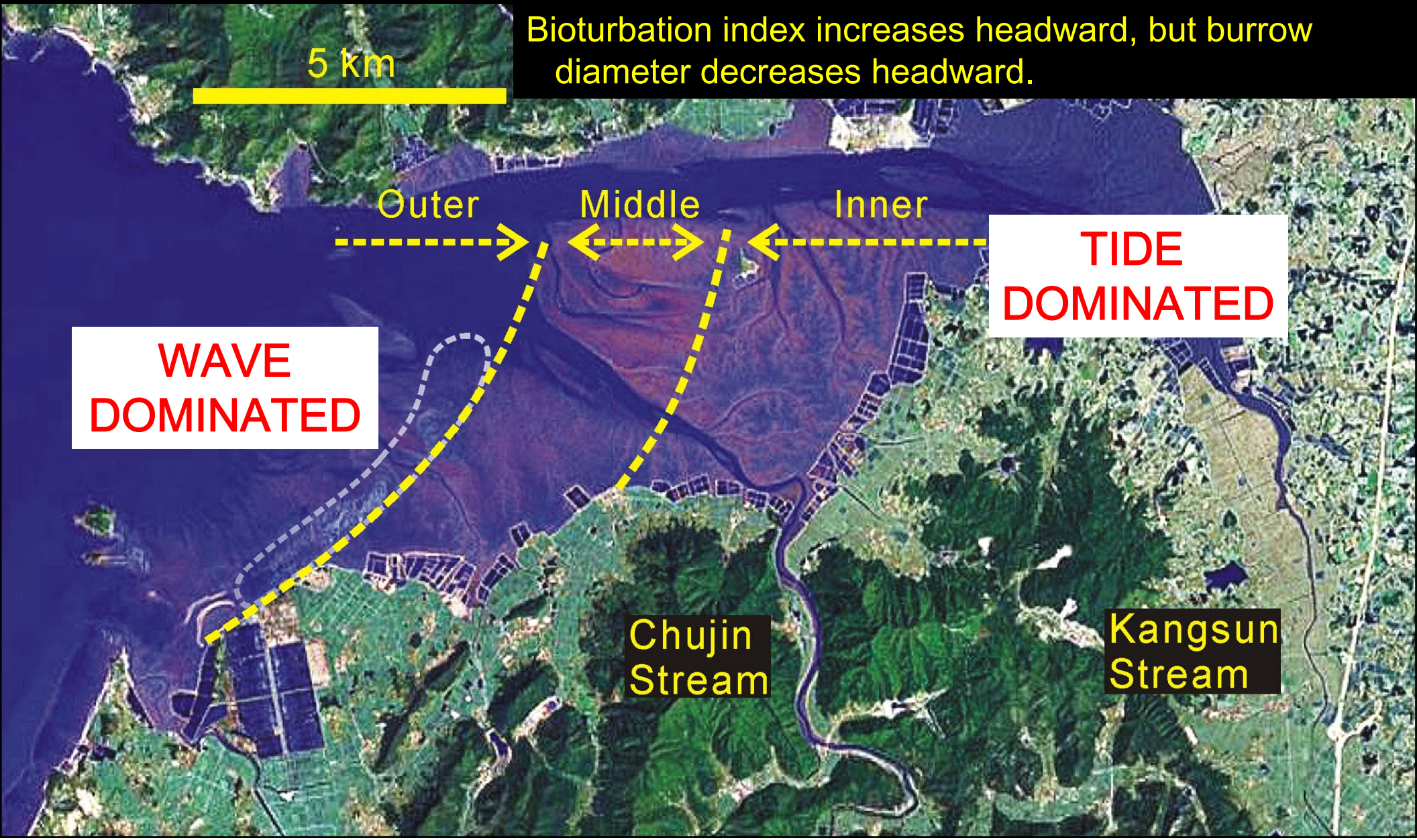
Mixed-Energy Environment



Longitudinal Trends

Wave influence decreases headward allowing the relative influence of tidal processes to increase headward.

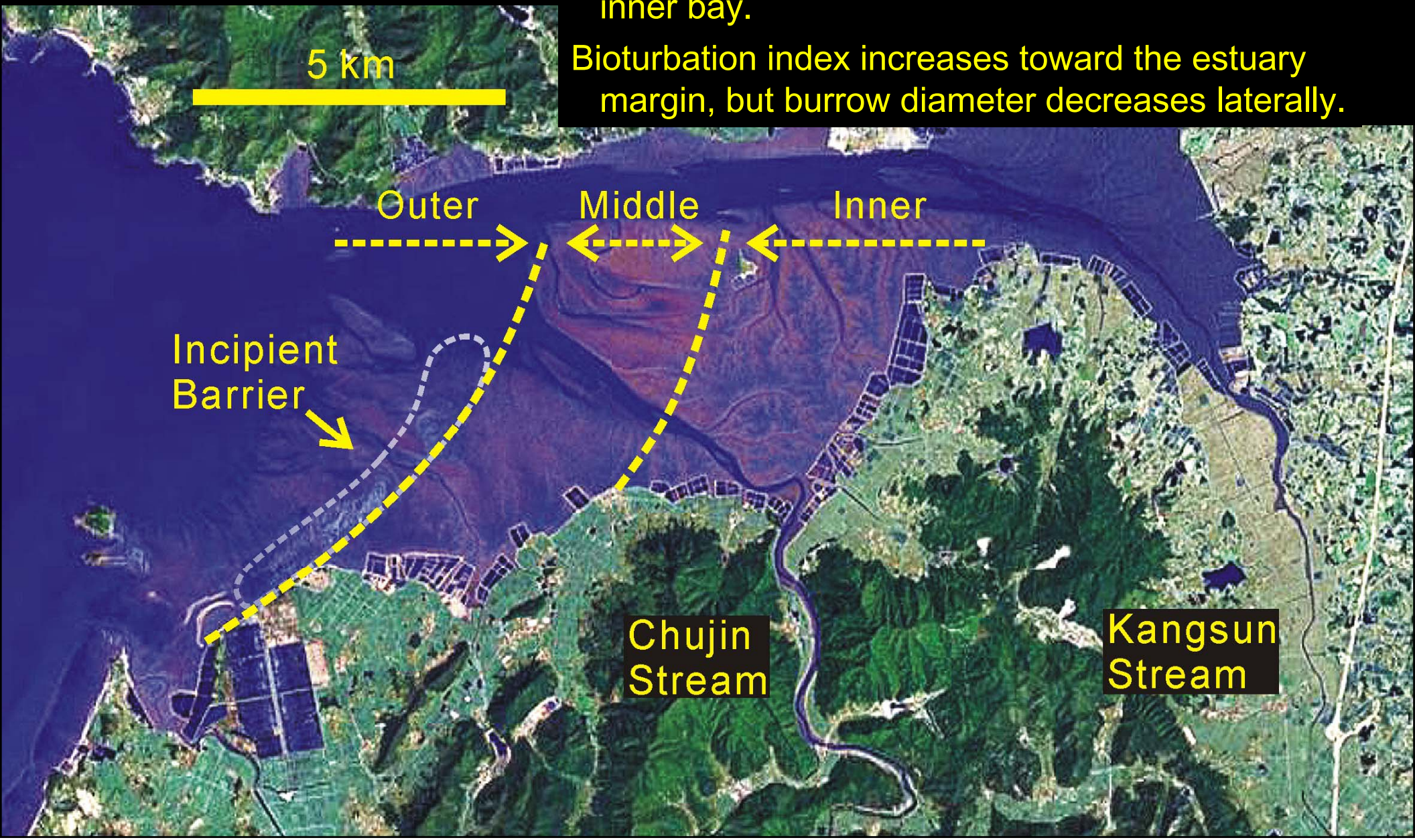
Bioturbation index increases headward, but burrow diameter decreases headward.



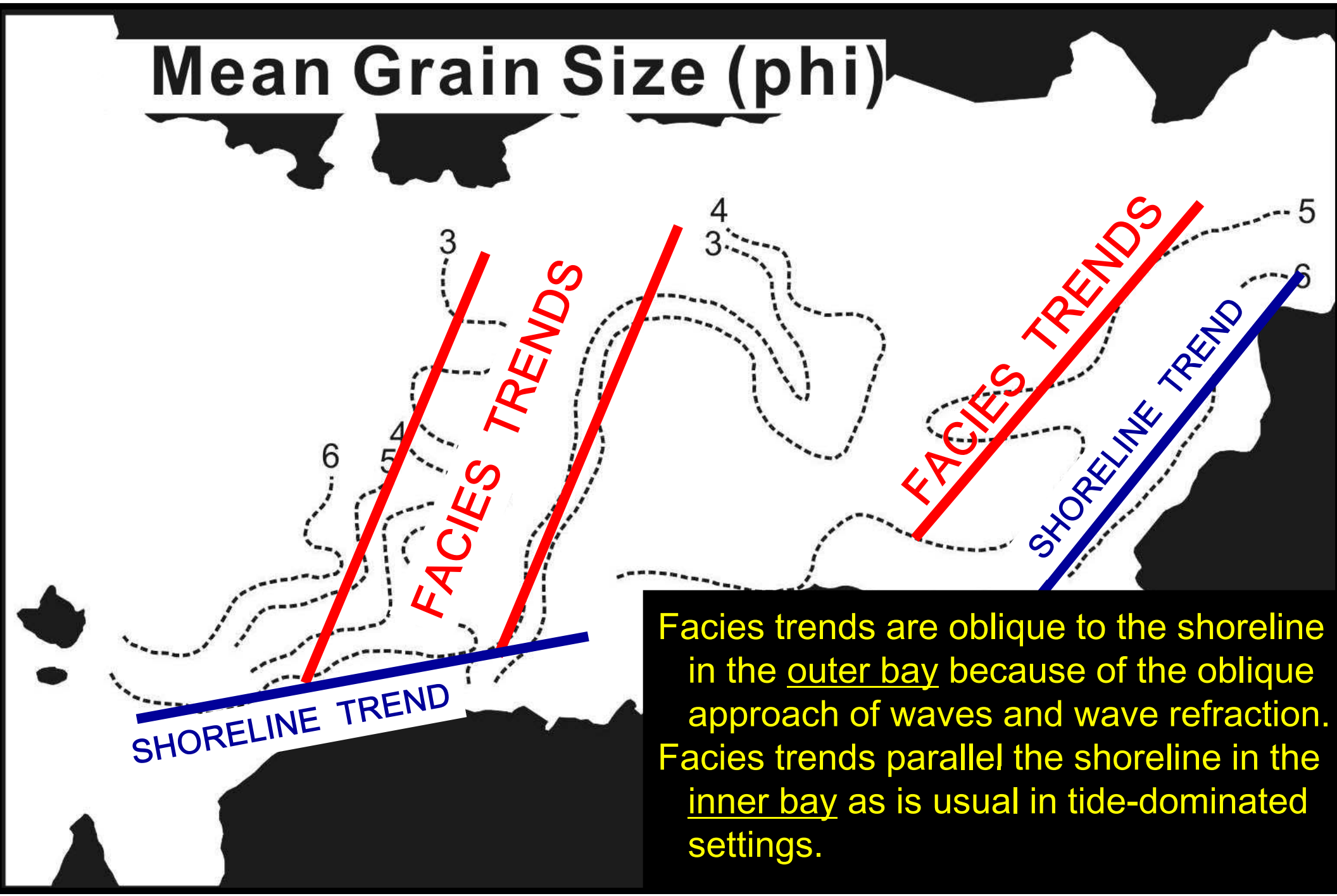
Lateral Trends

Grain size increases toward the estuary margin in the outer bay, but decreases toward the margin in the inner bay.

Bioturbation index increases toward the estuary margin, but burrow diameter decreases laterally.



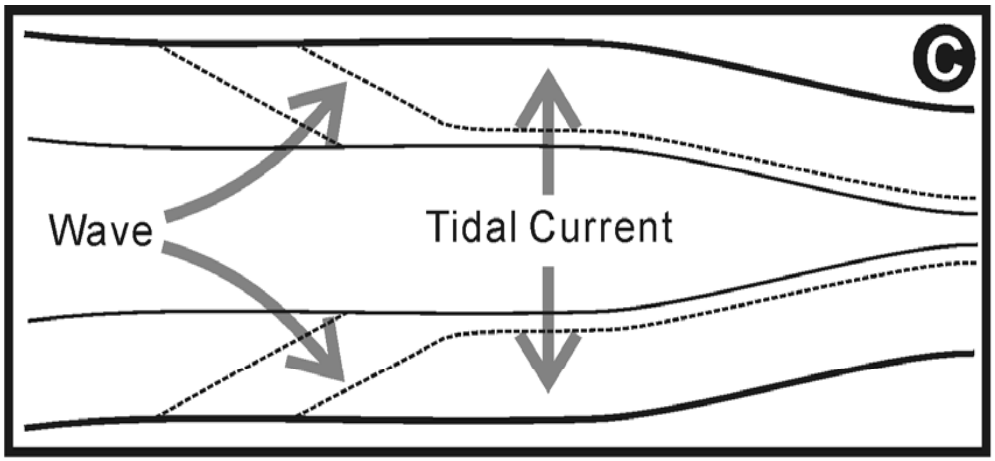
Mean Grain Size (phi)



Facies trends are oblique to the shoreline in the outer bay because of the oblique approach of waves and wave refraction.

Facies trends parallel the shoreline in the inner bay as is usual in tide-dominated settings.

Facies trends may be a useful way to distinguish between estuary types in the ancient record.



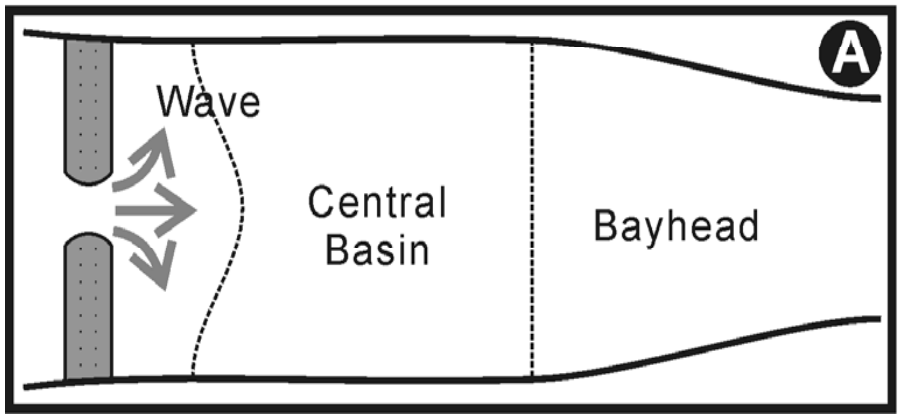
Oblique→Parallel

More studies of mixed-energy estuaries are needed.

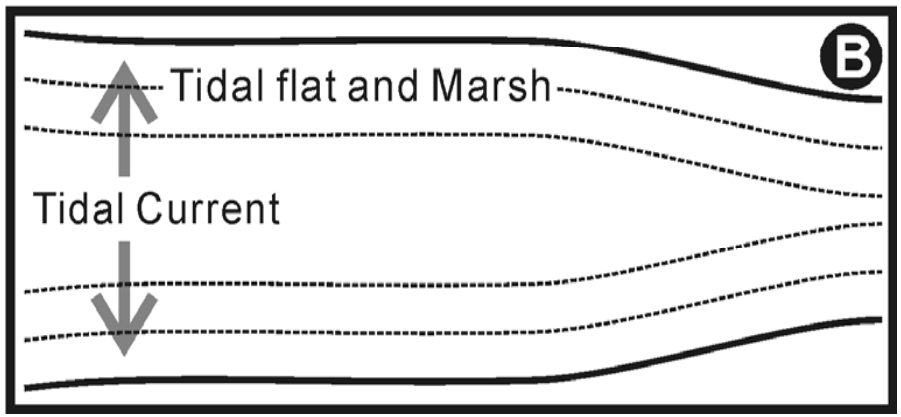
Wave Dominated | Mixed Energy | Tide Dominated

ESTUARY

Transverse



Parallel



Reference

Boyd, R., R. Dalrymple, and B.A. Zaitlin, 1992, Classification of clastic coastal depositional environments: Sedimentary Geology, v. 80, p. 139-150.

THANK YOU