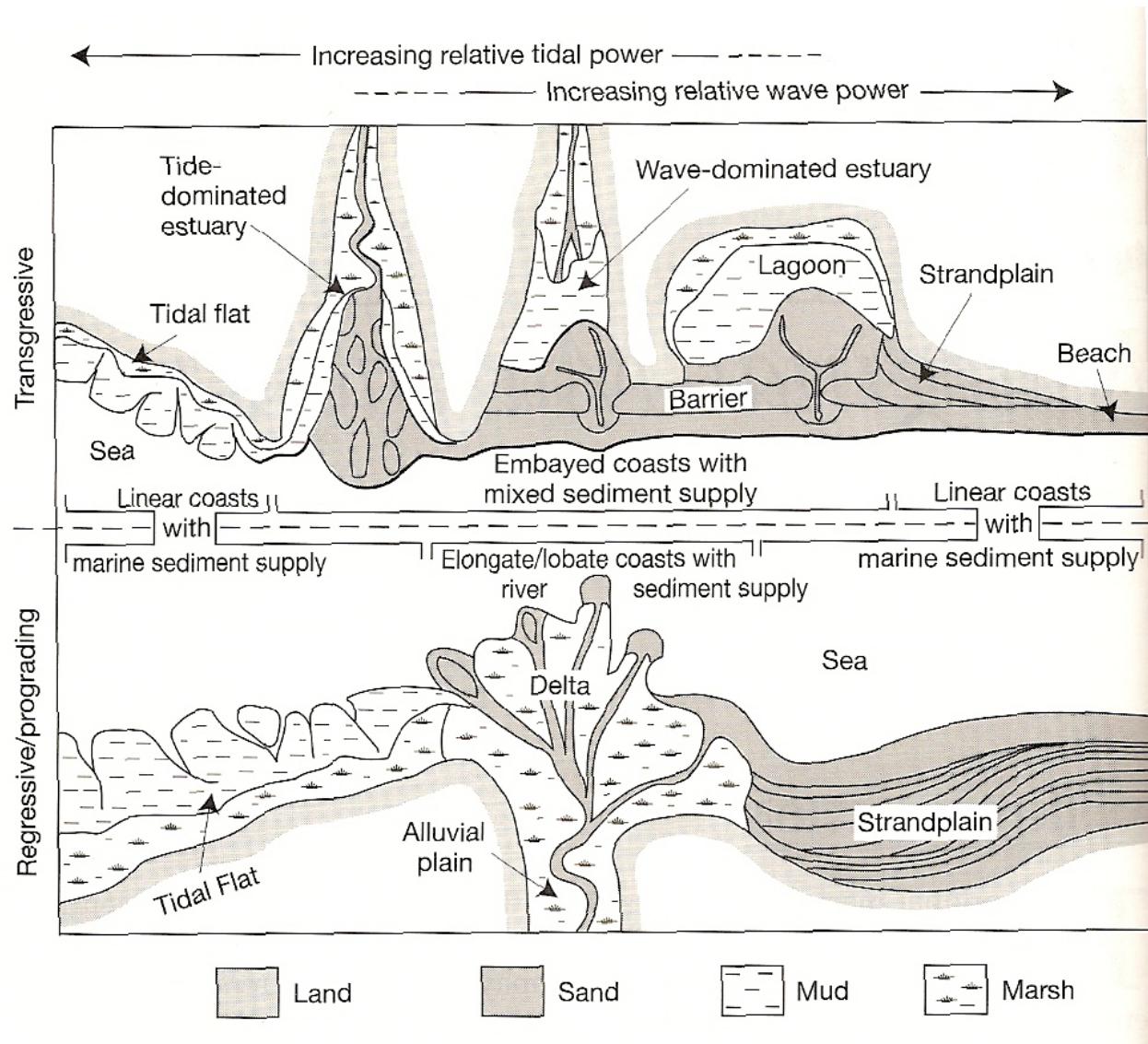


Coastal environments

Deltaic systems

Introduction



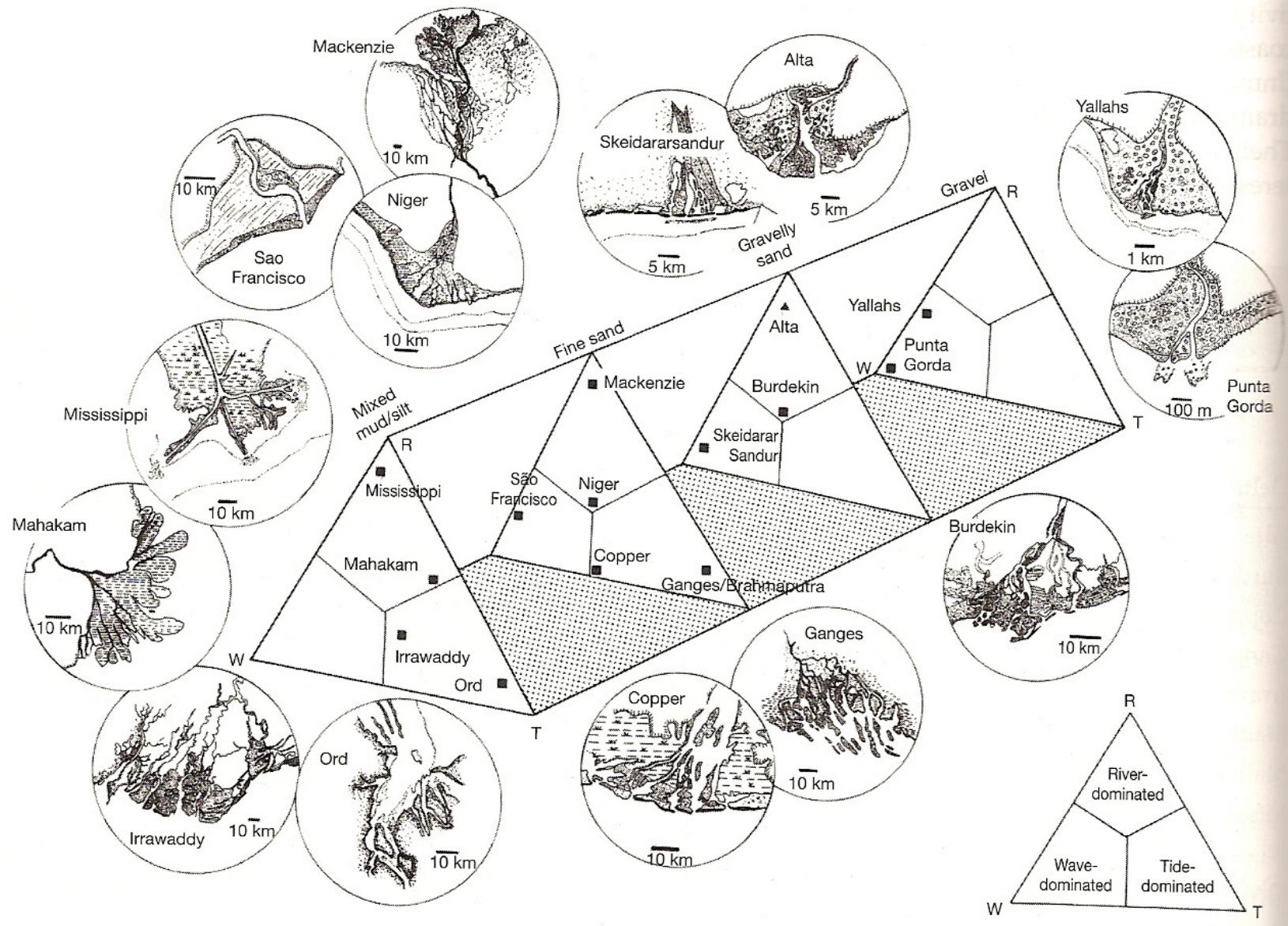
Deltas

- Elliott (1986):
 - “Discrete shoreline protuberances formed where rivers enter oceans, semi-enclosed seas, lakes or lagoons and supply sediment more rapidly than it can be redistributed by basinal processes”

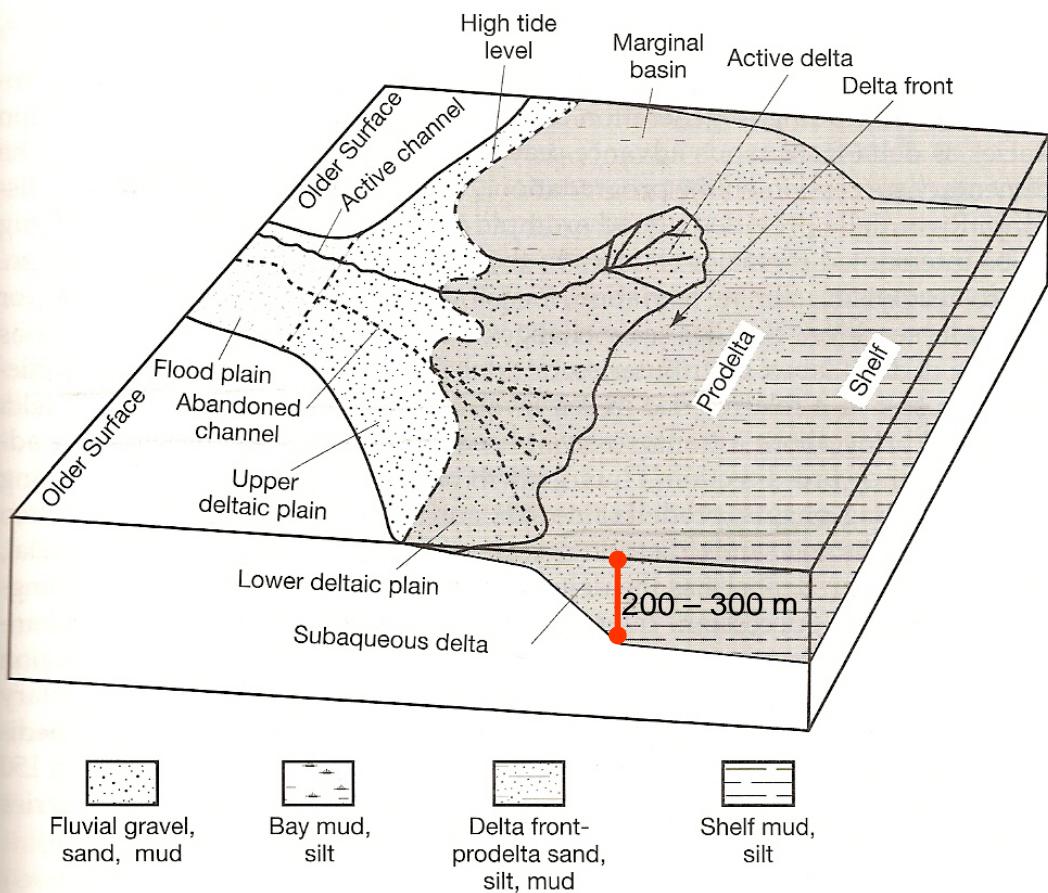
Grain size and shape of sediment bodies

- The size and gradients of terrigenous depositional systems are related to the *grain size* or *calibre* of the sediment
 - Coarse-grained alluvial, deltaic and deep-sea systems are relatively small and steep
 - Sand-rich systems tend to be intermediate in size, with moderate gradients
 - Mud-rich systems are generally large with low gradients

Delta classification



Fluvial-dominated delta system

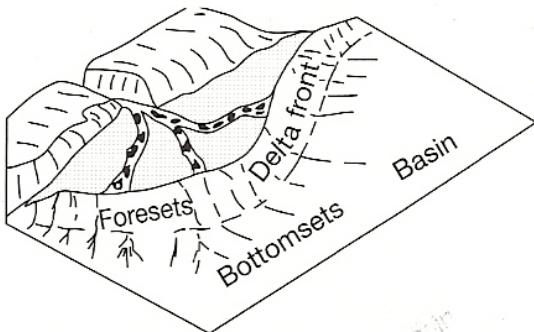


- Upper delta plain
 - Channel and point-bar deposition
 - Overbank flooding
- Lower delta plain
 - Active distributary system (channels)
 - Abandoned distributary-fill deposits
 - Interchannel deposits
 - Natural levees
 - Bay-fill deposits
 - Marshes and swamps
- Subaqueous delta plain
- The prodelta

Fluvial-dominated deltas

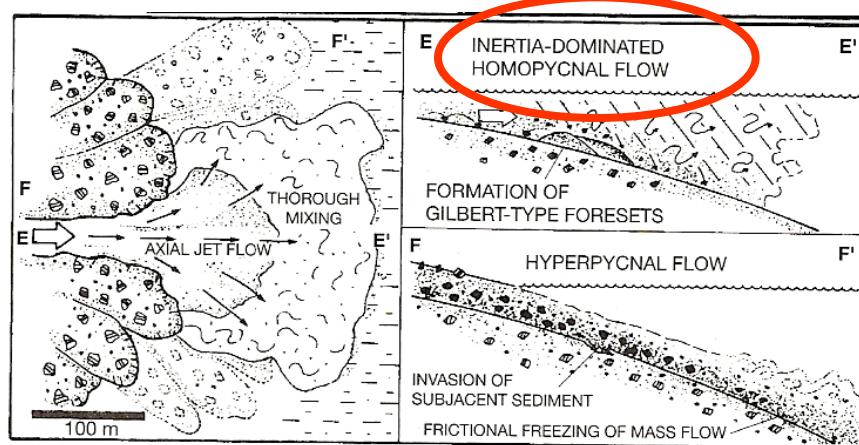
- Density contrast between river and basin waters
 - **Homopycnal** jet flow
 - Little or no density contrast (river outflow in a freshwater lake)
 - Mixing and rapid deposition
 - Gilbert-type deltas
 - **Hyperpycnal** plane-jet flow
 - Density current (common during floods)
 - **Hypopycnal** plane-jet flow
 - Buoyant dominated river mouth
 - Rivers flowing into denser seawater or a saline lake
 - Tends to generate a large, active and low dipping delta-front area

Gilbert-type deltas



Topsets | Foresets | Bottomsets | Basin
 Proximal fan delta to | Delta front | Prodelta
 Transition zone |

(C)
GRAVELLY
BEDLOAD
or
MASS-FLOW
DOMINATED
CHANNELS



Gilbert-type delta



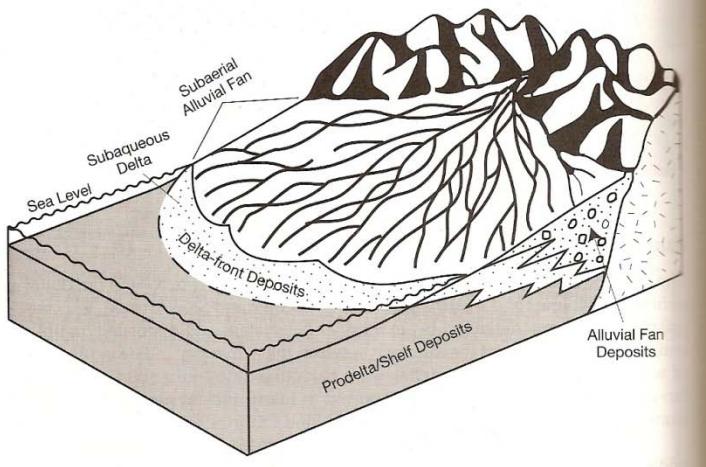
Petawawa, ON

Fan deltas

- “A coastal prism of sediments delivered by an alluvial-fan system and deposited mainly subaqueously at the interface between the active fan and a standing body of water” (cf. p. 299)

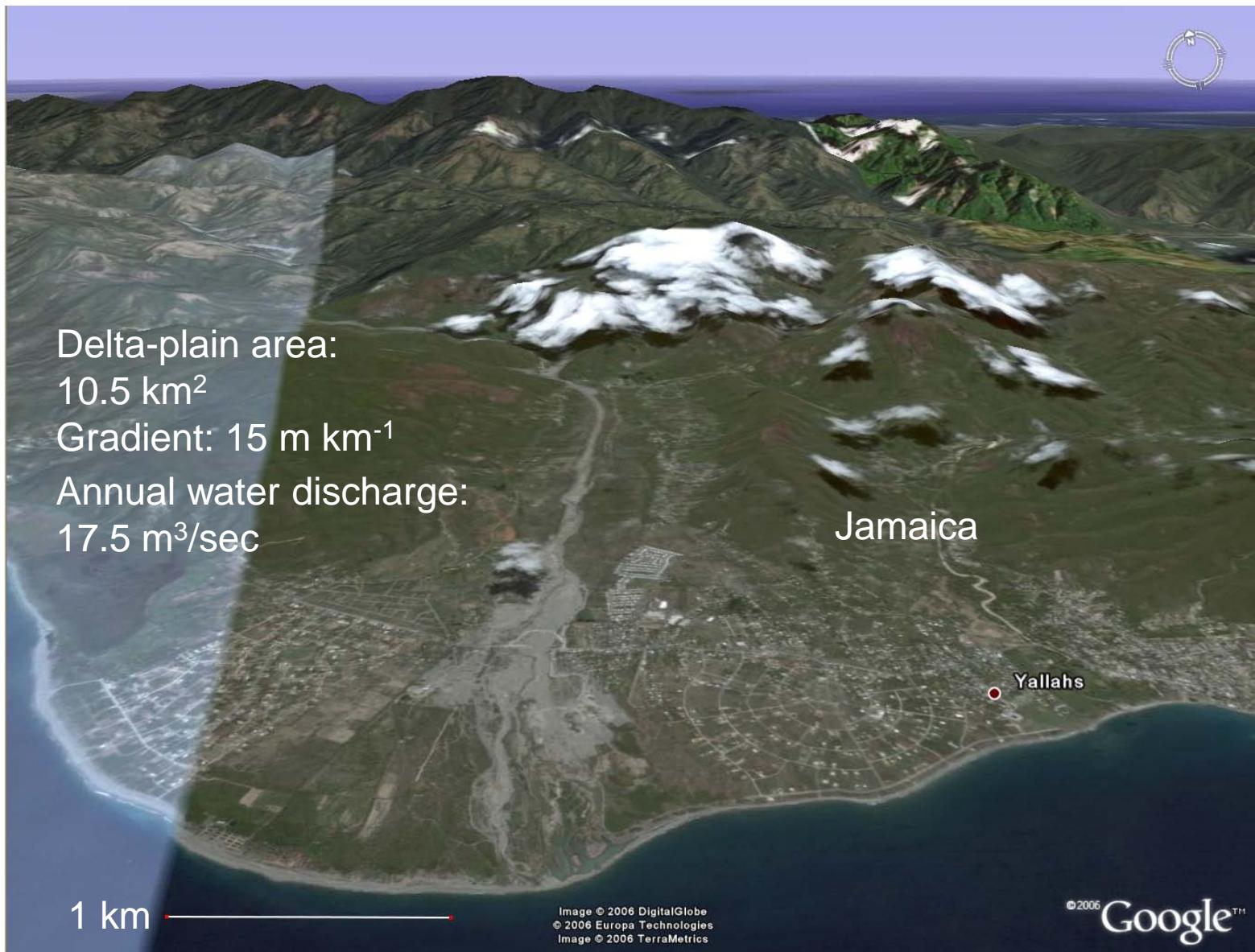
Kurobegawa fan, Japan

Delta at
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Tokyo



- Subaqueous deposition by
 - Slumping
 - Debris-avalanching
 - Turbidity-current flow
 - Inertia (hyperpycnal) flow (flood stages)
- Dense river load
 - overcome buoyancy and frictional effects
 - **Gravel and coarse sand** are transported downslope

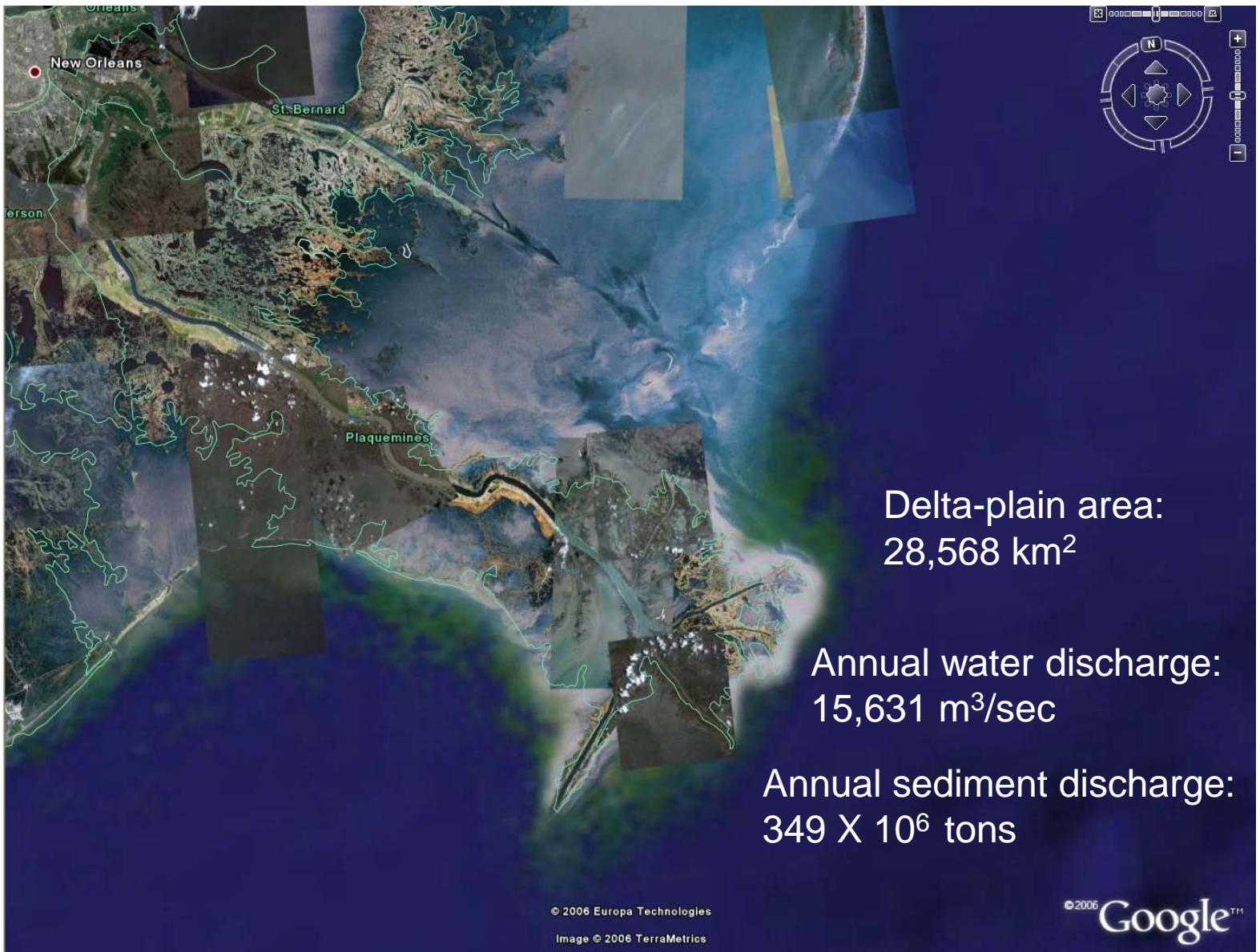
Yallahs Fan Delta



The Mississippi River Delta

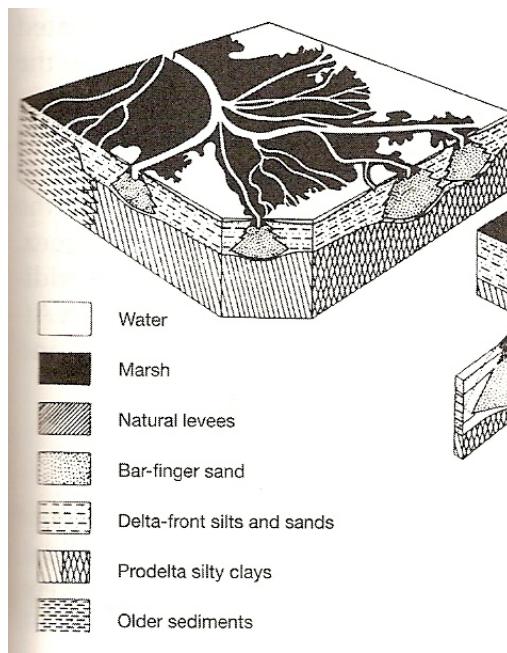


The Mississippi River Delta

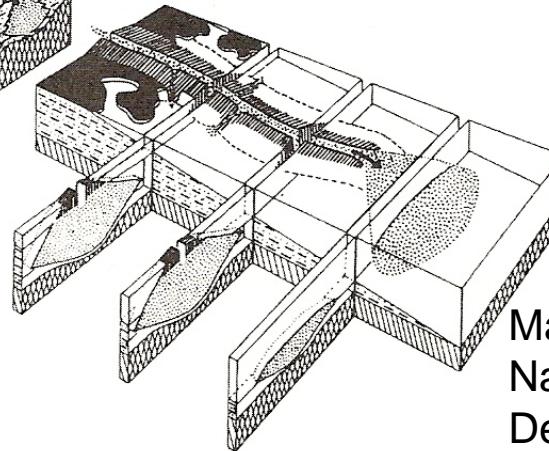


The Mississippi delta

7 distinct lobes
Active during the
past 5 – 6 ka

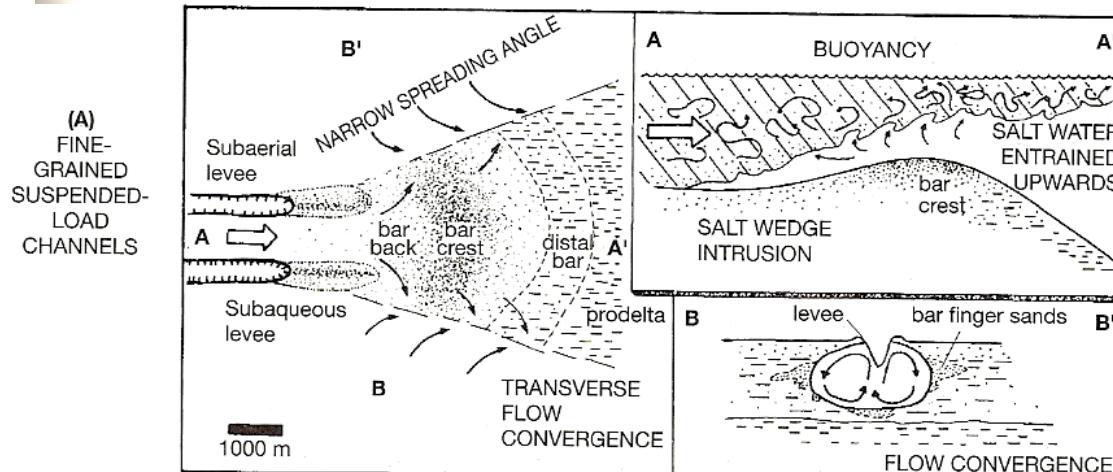


Birdsfoot distributary system
with bar-finger sands



Facies

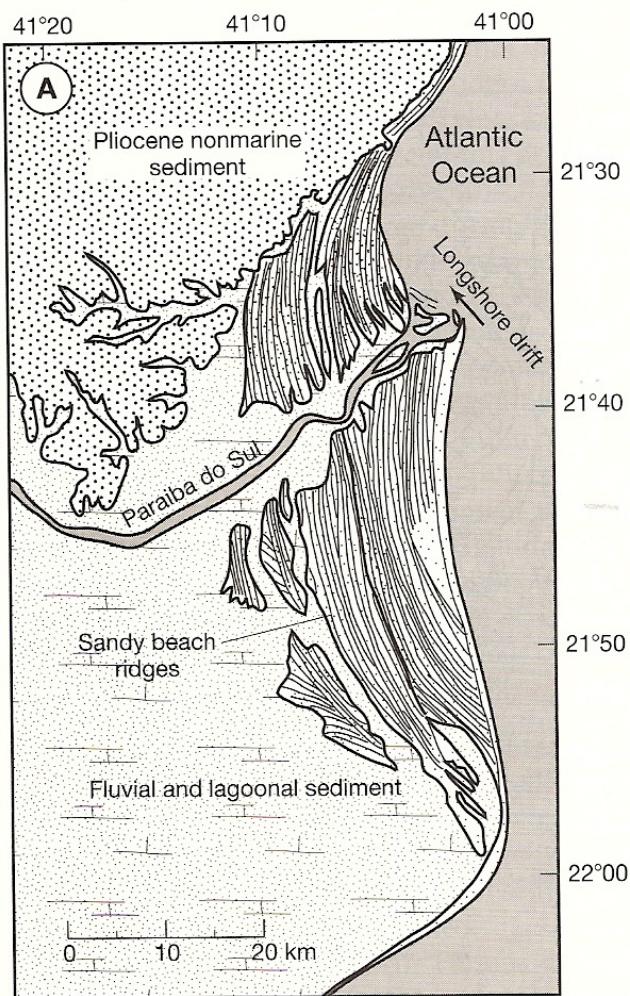
Marsh
Natural-levee deposits
Delta-front silts and sands
Prodelta clays



Wave-dominated deltas

- Strong waves cause
 - Rapid diffusion and deceleration of river outflow
 - Constricted or deflected river mouths
 - Distributary-mouth sediments are
 - Reworked by waves
 - Redistributions along the delta front by longshore currents
 - Wave-built shoreline features (e.g. beaches)

Paraiba do Sul delta, Brazil

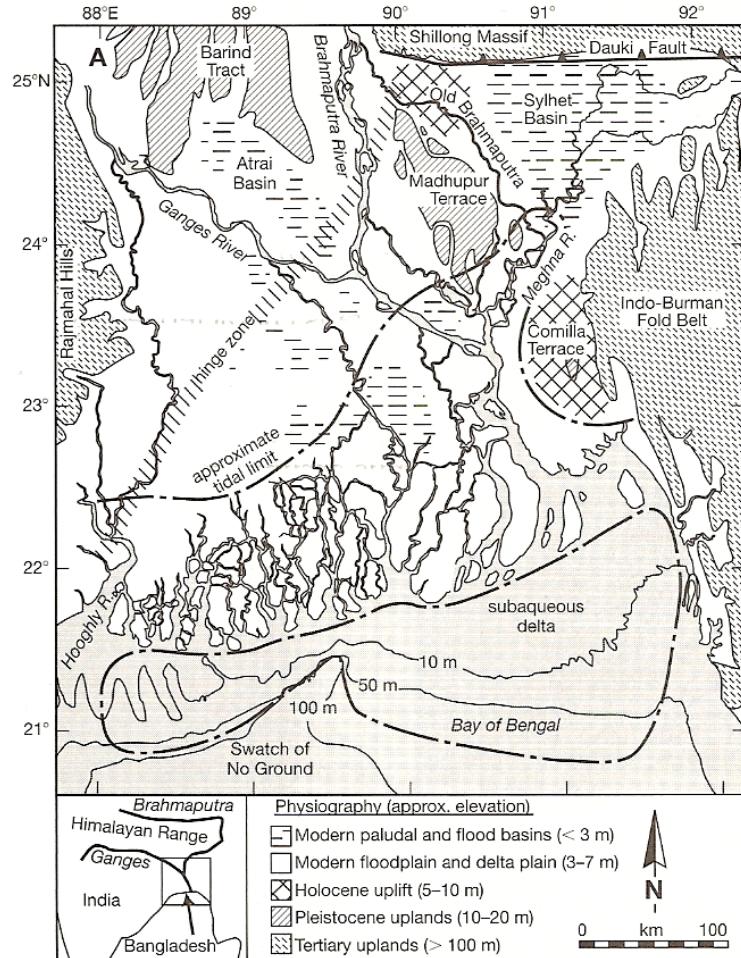


- Moderate tidal range
- High wave energy
- High river discharge
- Muds only accumulate locally in lagoons

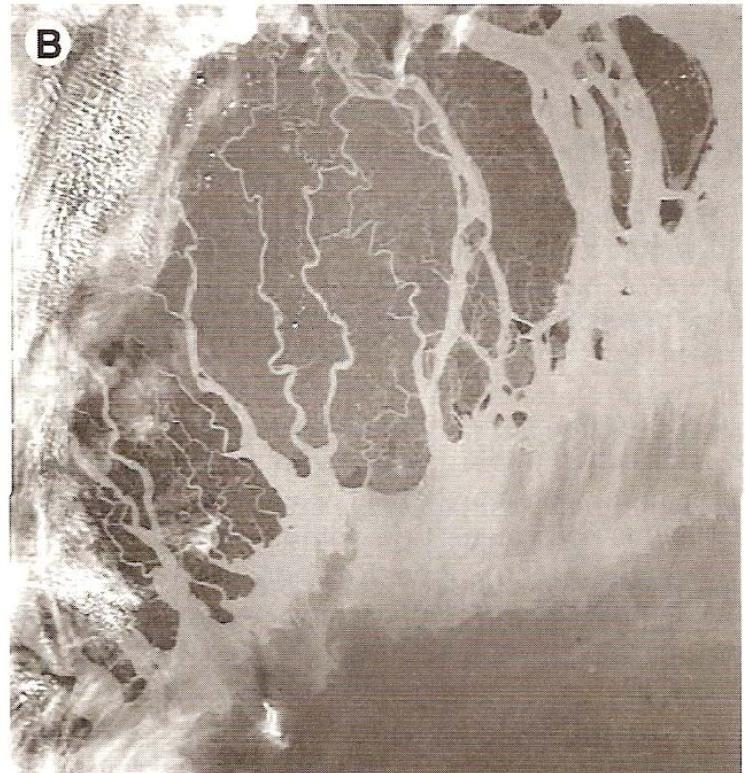
Tide-dominated deltas

- Tidal currents are stronger than river outflow
- Bidirectional currents redistribute river-mouth sediments
 - Sand-filled, funnel-shaped distributaries
 - Mouth bar may be reworked into a series of **linear tidal ridges**
 - Extend out onto the subaqueous delta-front platform

Ganges-Brahmaputra delta



Tidal-bar or tidal-ridge sands,
channel-fill sands, natural levees,
Tidal-flat and floodbasin muds

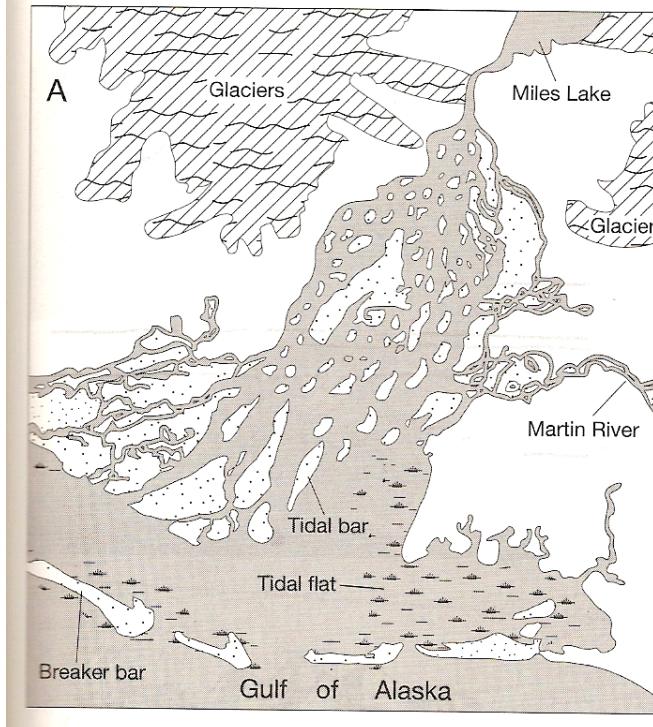


Mean tidal range = 4 m
Tidal currents up to 3.8 m/s
Wave energy is low
Intense sand transport during the monsoon season

Mixed-process deltas

- Many deltas have characteristics that are transitional between the “end-member” types

Copper River delta, Alaska



- Tidal range may > 3 m
- Tidal currents up to 2 m/s
- Strong wind-driven swells
- Westerly marine current
- Westward **longshore drift**

Subaerial deltaic plain

- marsh deposits
- Distributary channel fills

Tidal lagoon

- Tidal sands and mudflats
- Tidal channel fills

Wind-influenced shoreface

- marginal island
- Breaker bar
- Shoreface sand and mud
- Prodelta / shelf mud



Copper River delta, Alaska

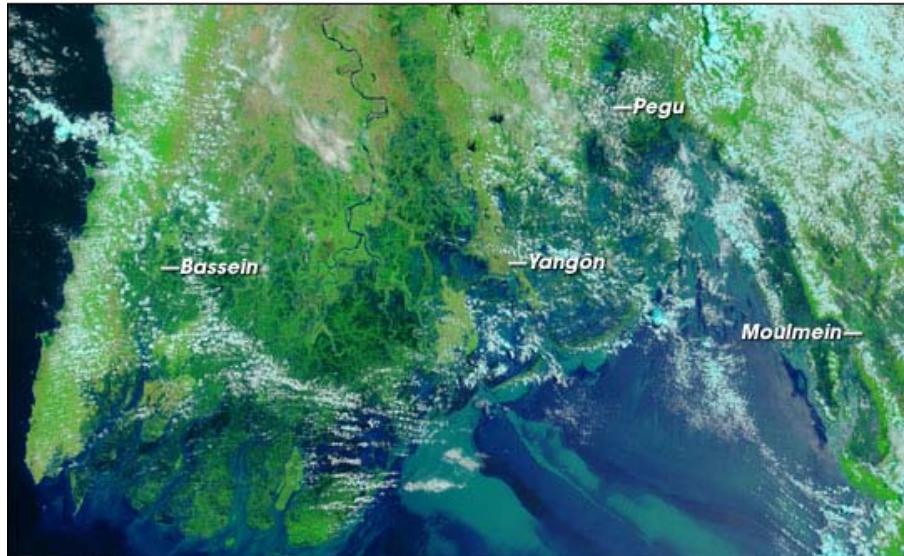
Image IBCAO
© 2013 Google
Image Landsat
Image © 2014 DigitalGlobe

Kanak Island
Google earth

Role and impact of “catastrophic” events



April 15, 2008

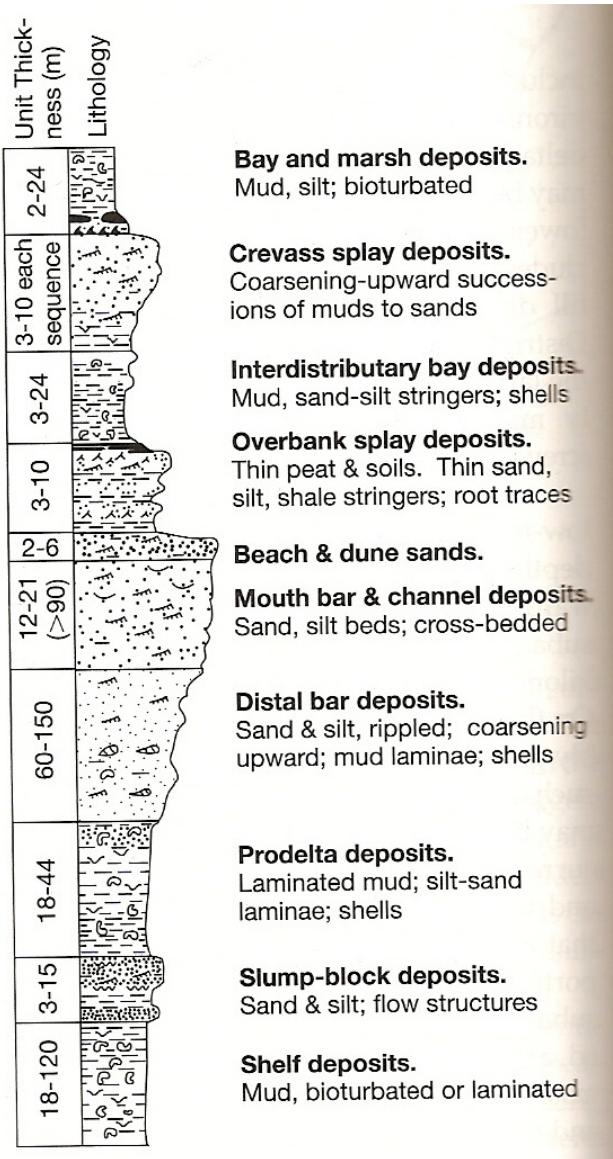


May 5, 2008

- 2008 cyclone Nargis
- Image above
 - Rivers and lakes are sharply defined
- The entire coastal plain is flooded on the May 5 image
- Yangon (population > 4 M) is surrounded by floods
- Muddy runoff colors the Gulf of Martaban turquoise

Images from NASA

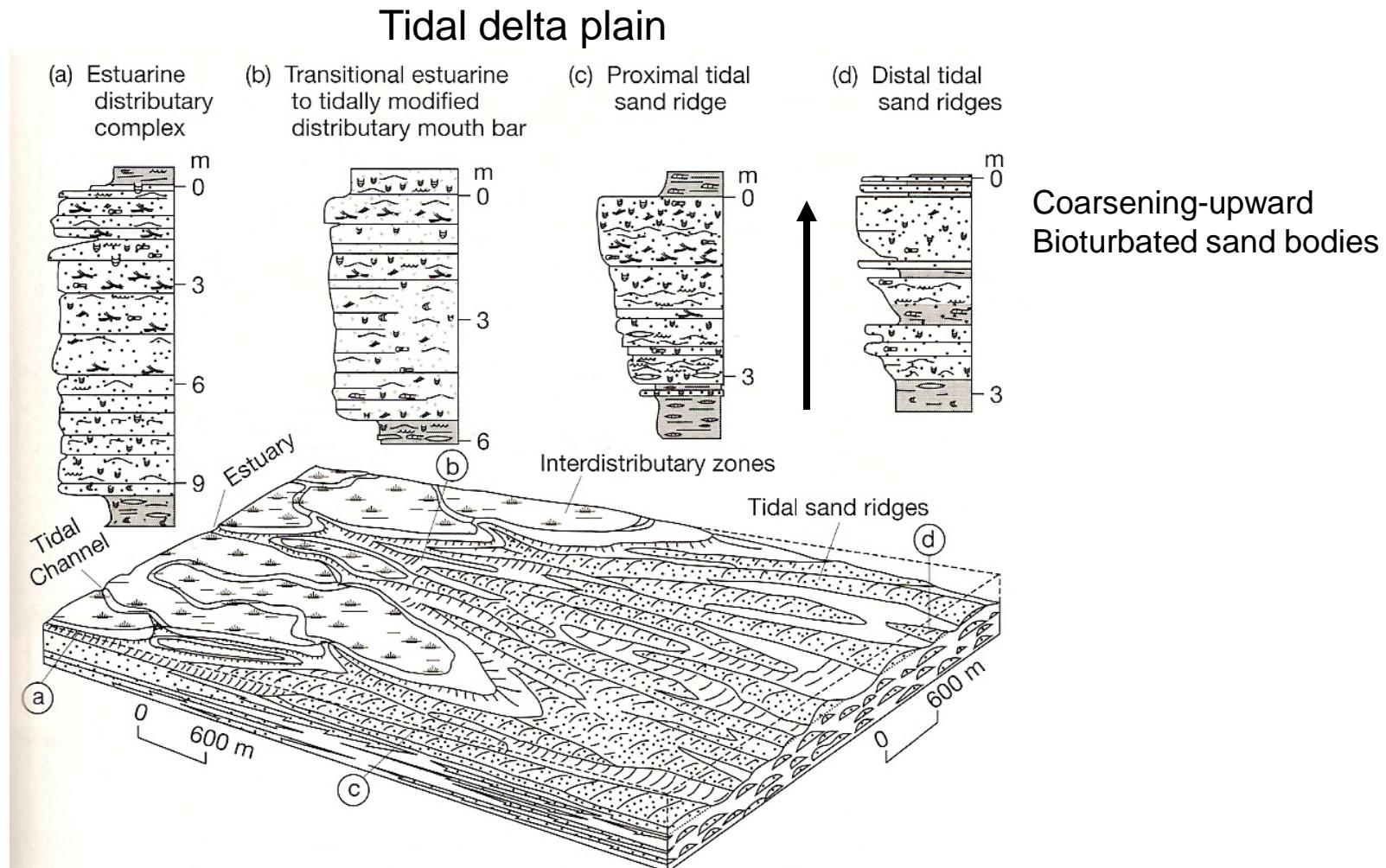
Delta cycles



- Seaward progradation
 - Coarsening-upward sequence
- May be affected by
 - Tectonism
 - Climate change
 - Diversions of rivers
 - Sea level change
 - Switching of delta lobes, distributaries, or tidal channels

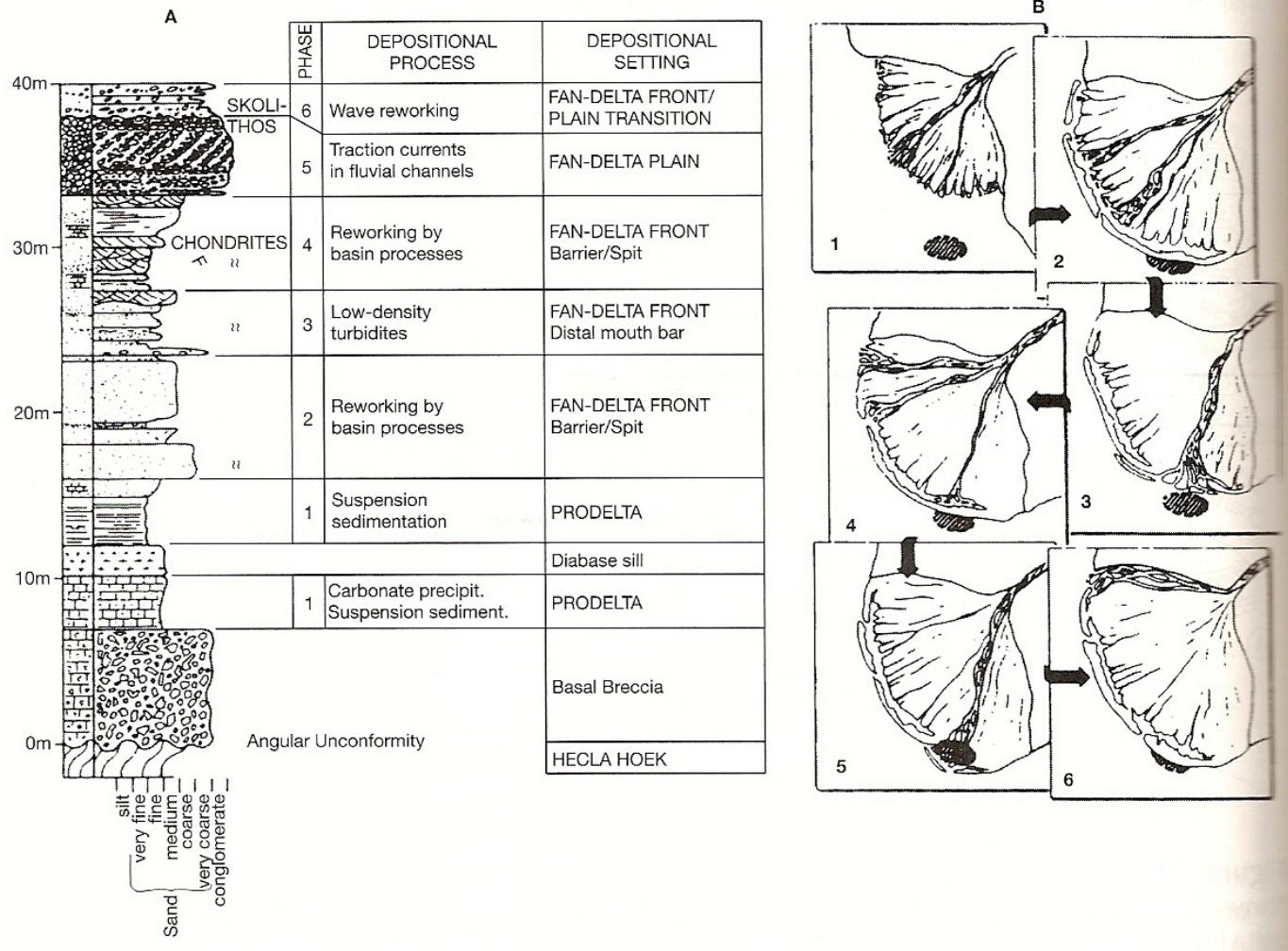
Fluvial-dominated system

Ancient deltaic systems



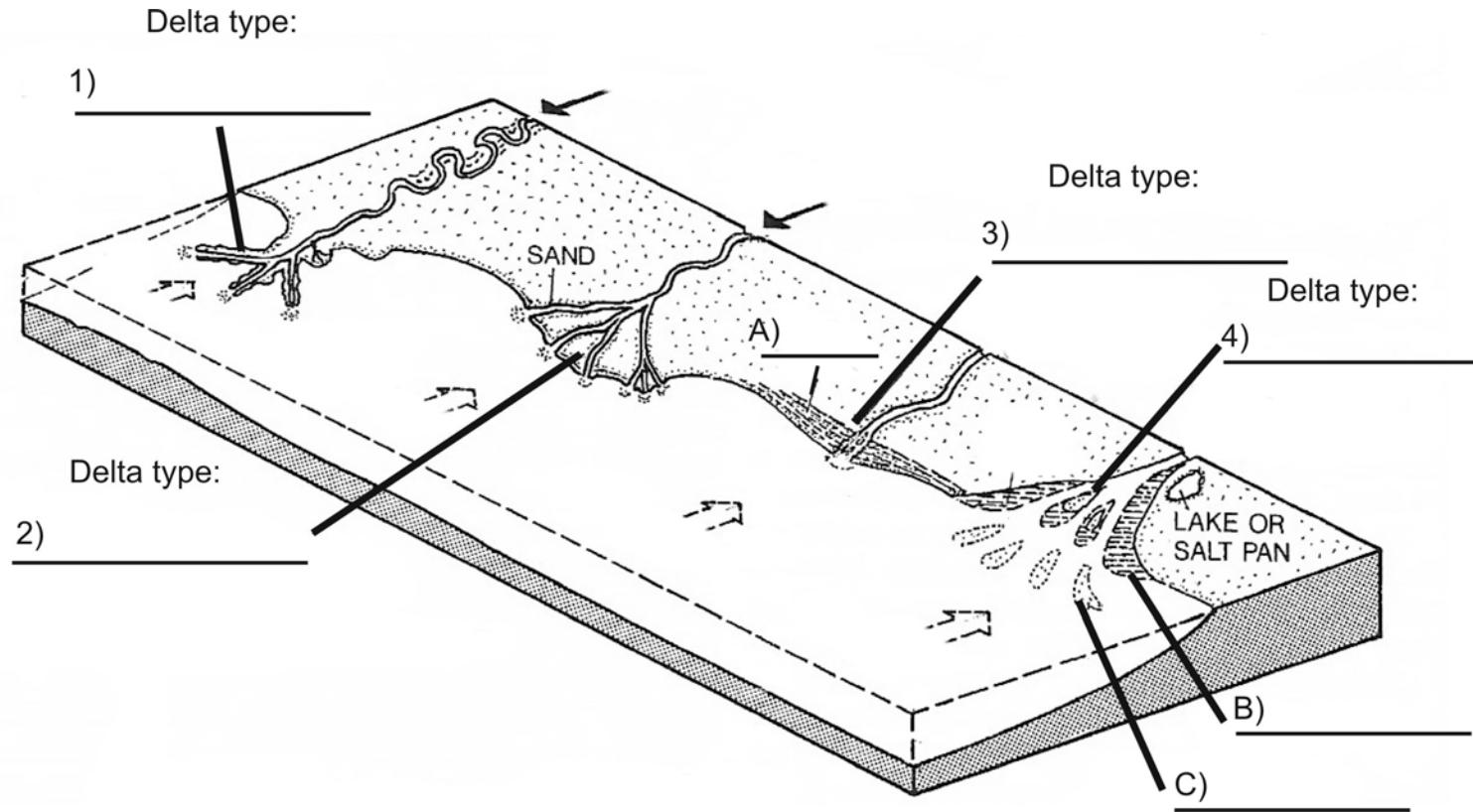
Eocene Misoa Formation, Maracaibo Basin, Venezuela

Ancient fan-delta



Note: In paleontology, chondrites are a common trace fossil (ramifying tunnel structures)

Question/Problem



- Indicate the dominant process involved in their formation
- Indicate for each arrow the energy level (Low, Med, High) or sediment input (Med, High)
- Name distinguishing characteristics (A, B, C)