MISSISSIPPI RIVER DELTA OVERVIEW

Science and Engineering Special Team Conference

Louisiana State University

October 9, 2012

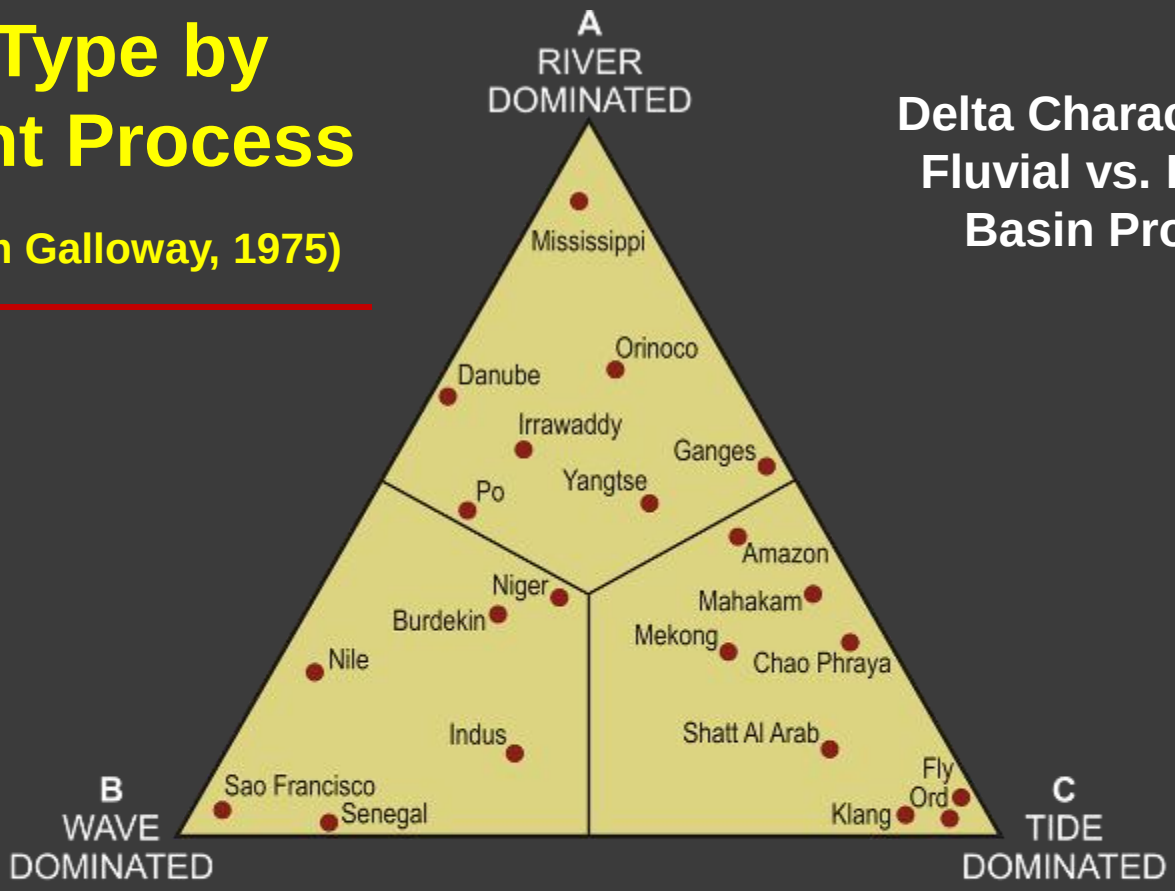
Introduction

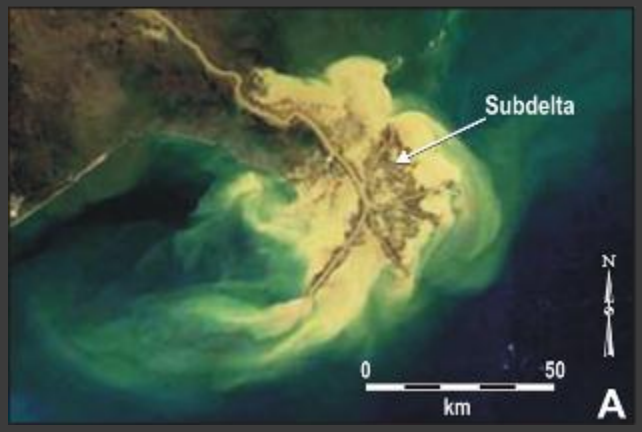
- Basics of the Mississippi Delta
- Natural and Human-Induced Land Loss
- Impact of Sea Level Change
- Projections of Sea Level-Subsidence

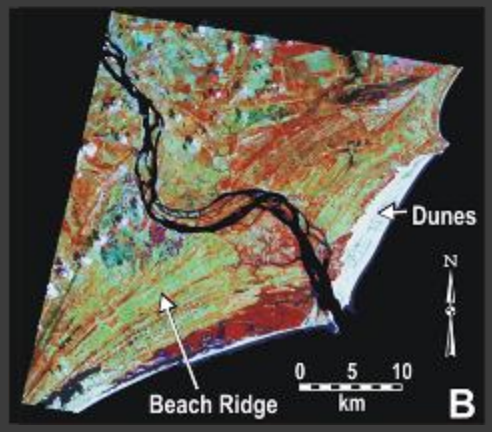
Delta Type by Dominant Process

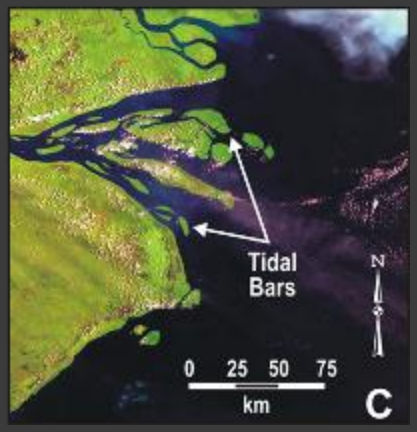
(modified from Galloway, 1975)

Delta Characteristics = Fluvial vs. Receiving Basin Processes

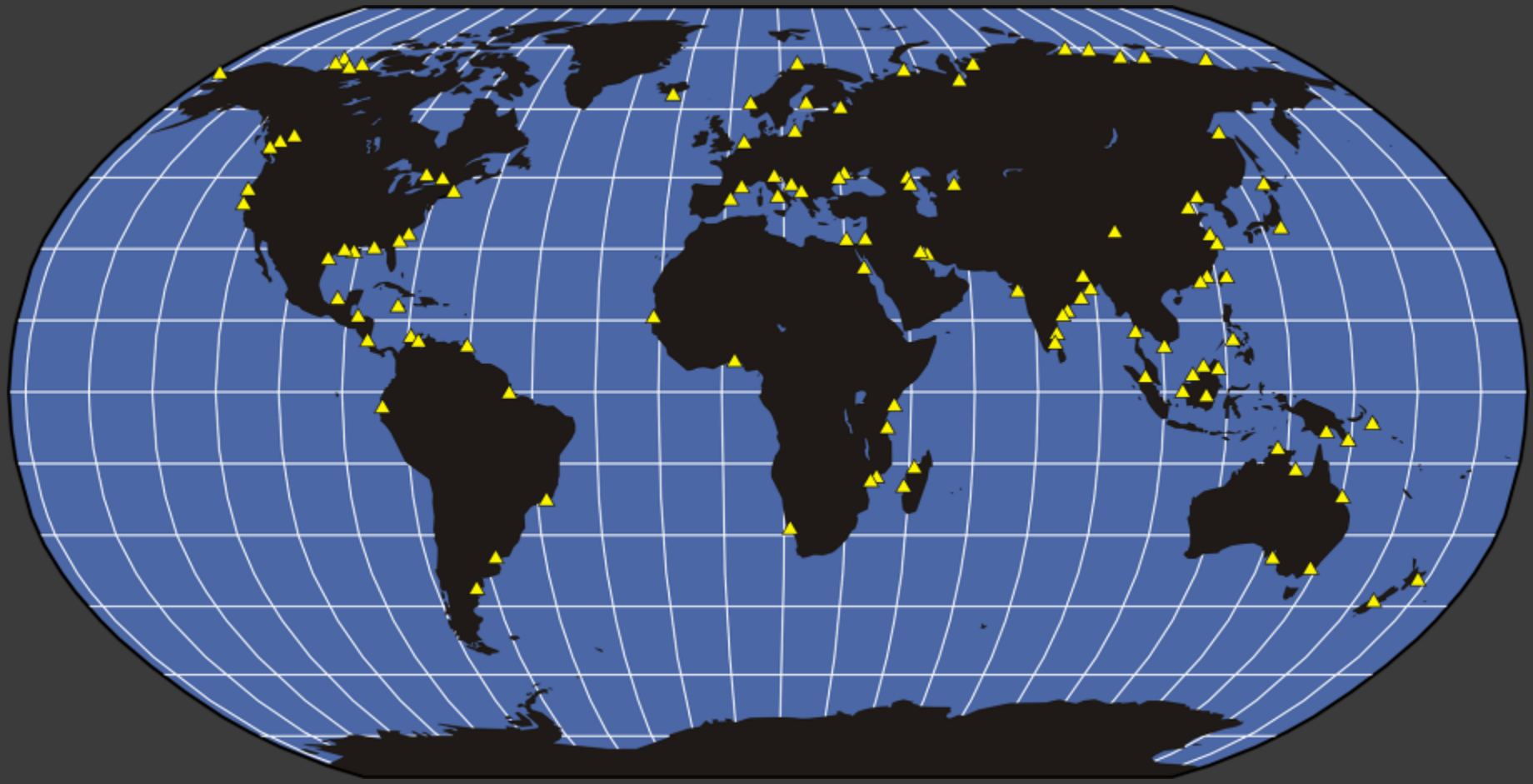




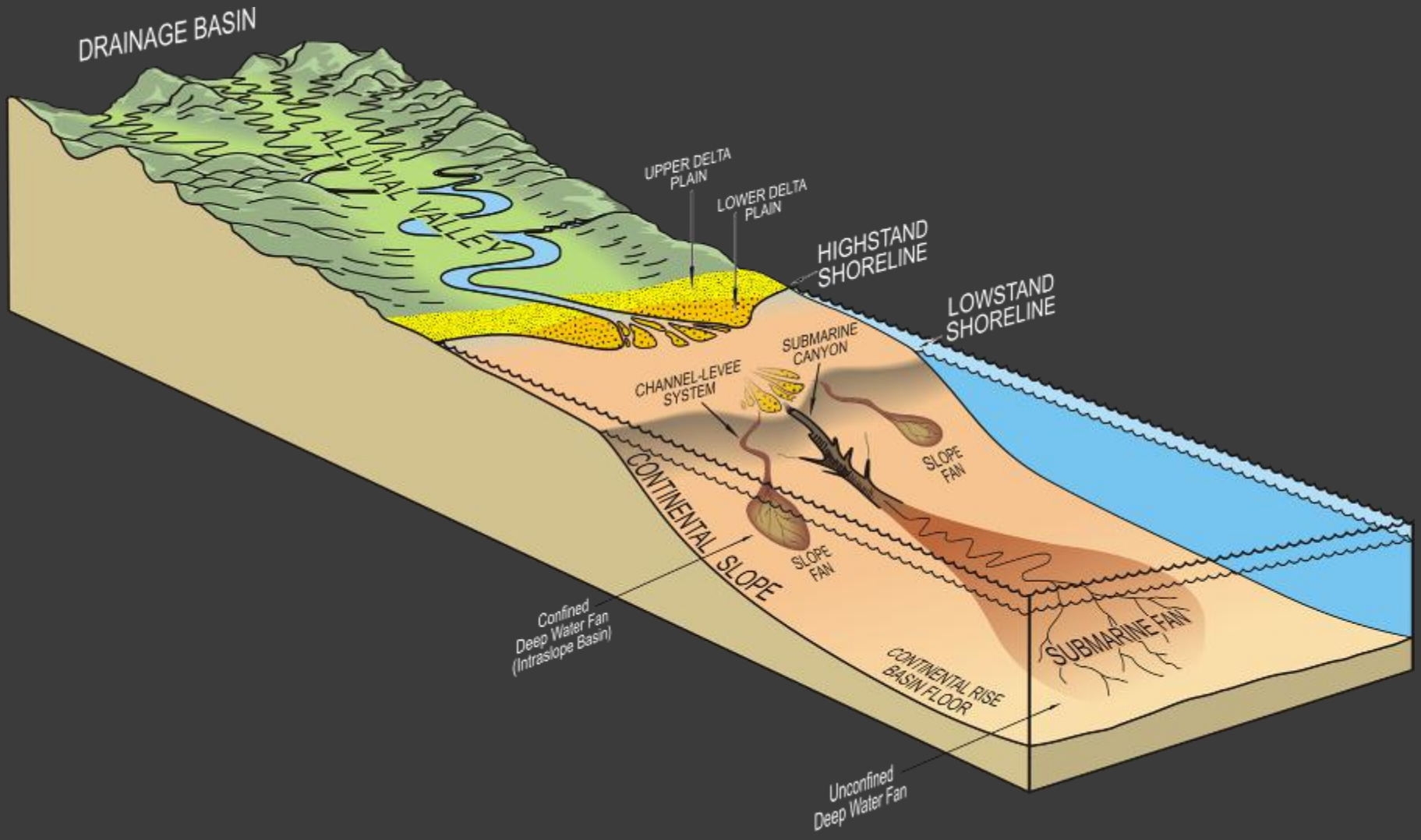




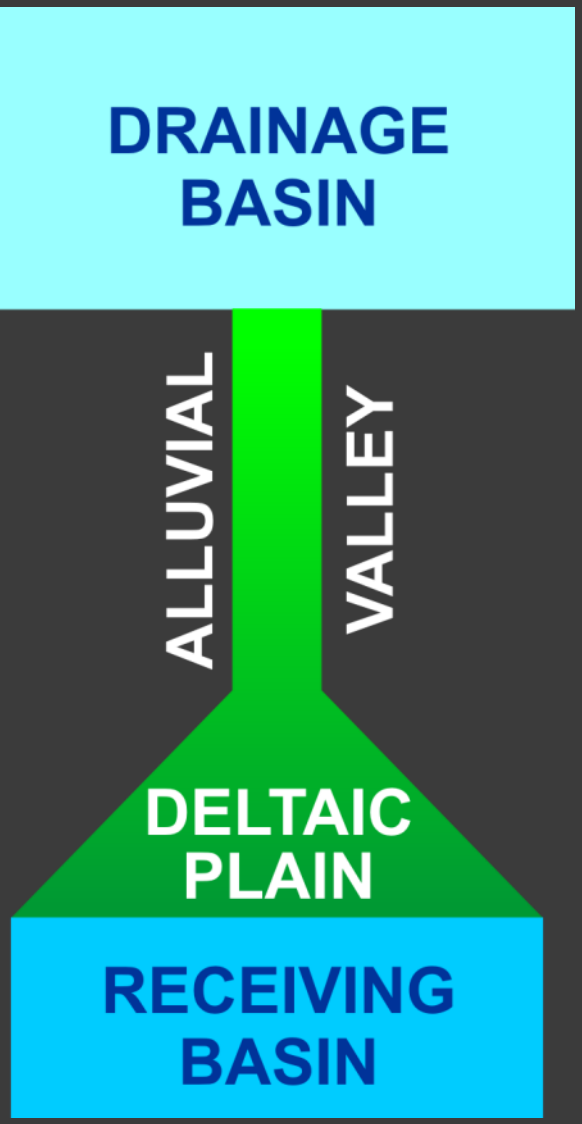
Major Deltas of the World



Deltas are Part of Much Larger System Modulated by Sea Level



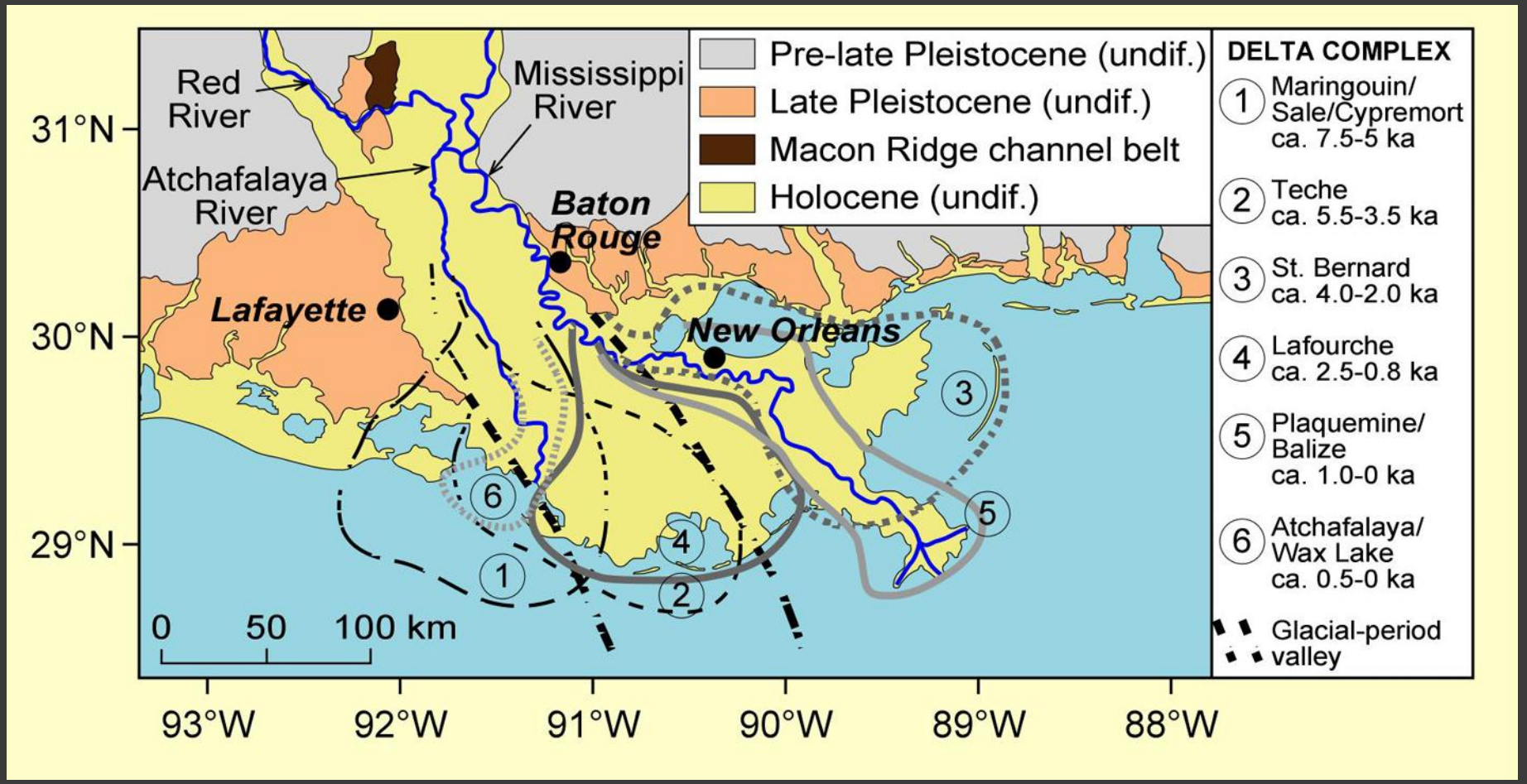
Components of a River-Delta System



Six Major Drainage Basins of the Mississippi River Watershed

Mississippi River Delta

Holocene History of Delta Growth

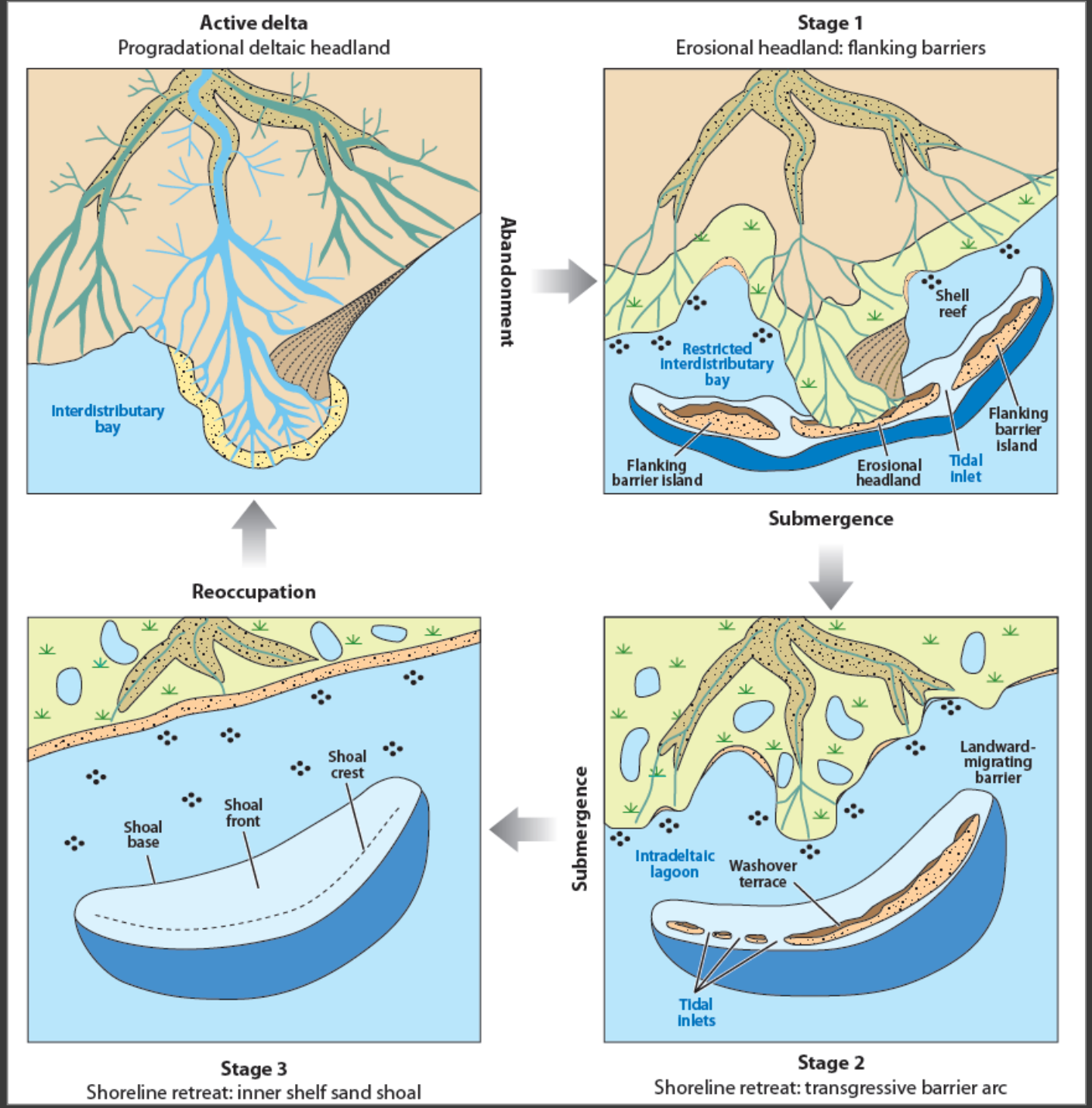


- ***6 major coupled channel belts and delta complexes***
- ***Like most major deltas, growth occurred after ca. 7000 yrs BP***

Temporal Scale of Pulsing Events in Deltaic Systems

Event	Timescale	Impact
River switching	1,000-1,500 yrs	Deltaic lobe formation Net advance of deltaic landmass, Barrier Island Formation
Major river floods	50-100 yrs	Channel switching initiation Crevasse splay formation Major deposition
Major storms	5-20 yrs	Major deposition Enhanced production
Average river floods	Annual	Freshening (lower salinity) Nutrient input Enhanced 1º and 2º production
Normal storm events (Fronts)	Weekly	Enhanced production Organism transport Net material transport
Tides	Daily	Drainage/marsh production Low net transport

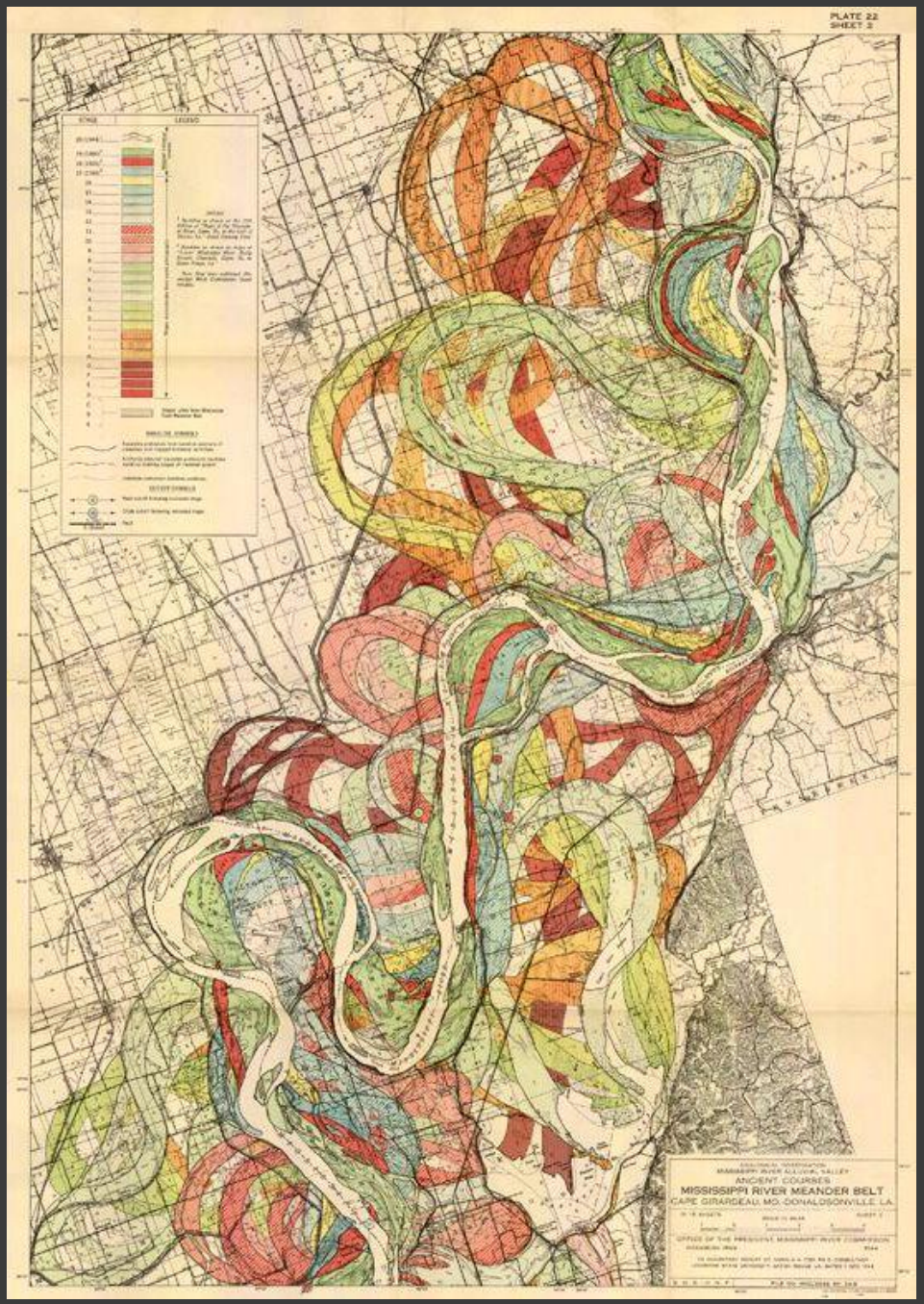
Modified from John Day


Active delta
Progradational deltaic headland
Interdistributary bay
Abandonment
Stage 1
Erosional headland: flanking barriers
Shell reef
Restricted interdistributary bay
Flanking barrier island
Flanking barrier island
Erosional headland
Tidal inlet
Submergence
Reoccupation
Shoal crest
Shoal front
Shoal base
Stage 3
Shoreline retreat: inner shelf sand shoal
Submergence
Landward-migrating barrier
Intradeltaic lagoon
Washover terrace
Tidal inlets
Stage 2
Shoreline retreat: transgressive barrier arc

Factors Causing Land Loss – Mississippi Delta

- Natural:
  - **Tectonic Subsidence**
  - **Delta Switching (subsidence under load)**
  - **Consolidation**
  - **Sea Level Rise**
  - **Hurricanes**
  - **Faulting**
  - **Biological**
- Man-Induced
  - **Dams, Levees, Impoundments**
  - **Fluid Withdrawal**
  - **Canal Dredging**
  - **Salt Water Intrusion**

Dynamic Shifting of the Modern Mississippi River



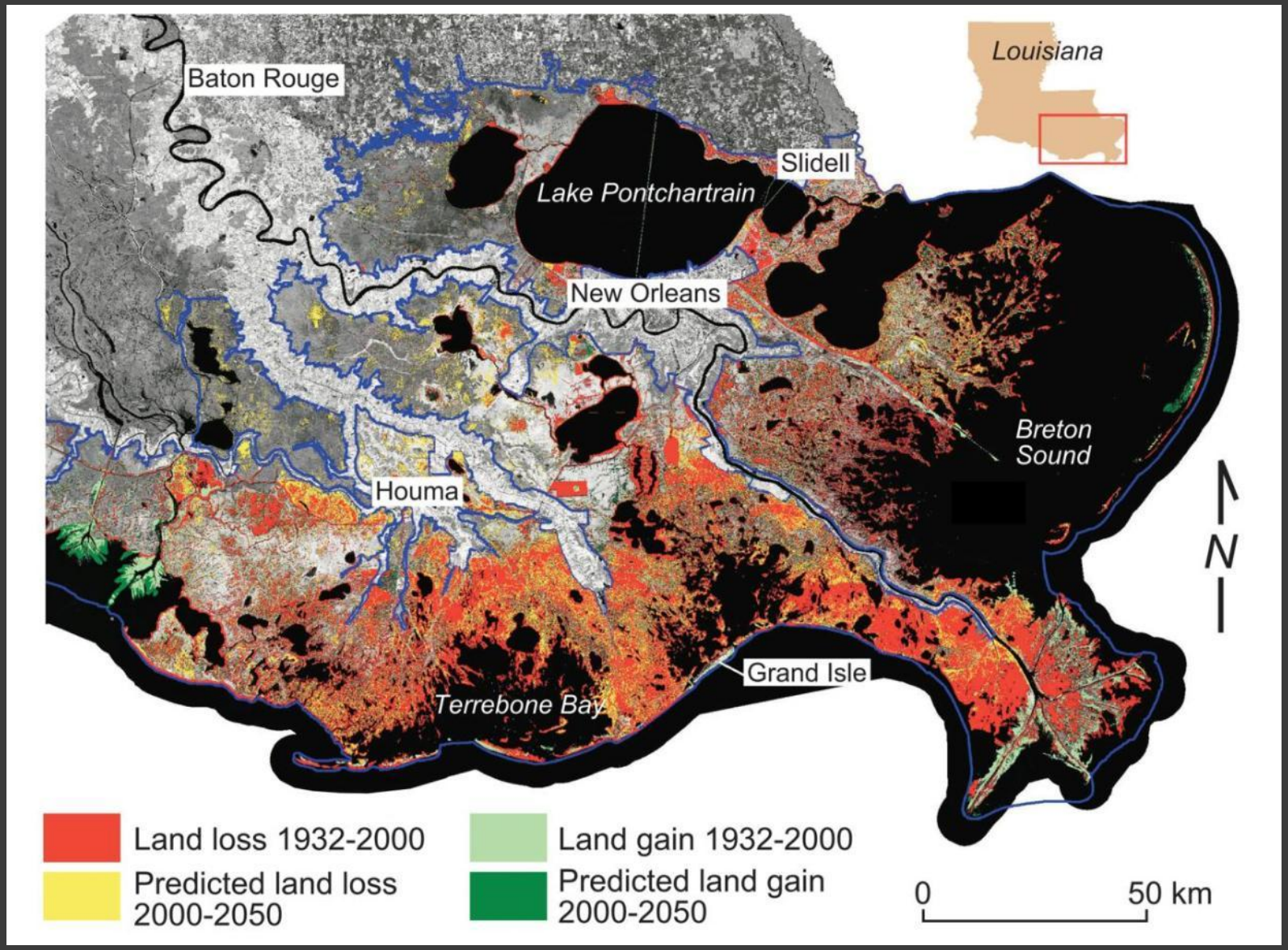
(Fisk, 1944)

Environmental Transformation

- Historic-period levees decoupled delta plain from fluvial sediment source
- Global sea level rise started accelerating

No doubt, the great benefit to the present and two or three following generations accruing from a complete system of absolutely protective levees, excluding the flood waters entirely from the great areas of the lower delta country, far outweighs the disadvantages to future generations from the subsidence of the Gulf delta lands below the level of the sea and their gradual abandonment due to this cause (Corthelll 1897)

Mississippi Delta Land Loss and Gain



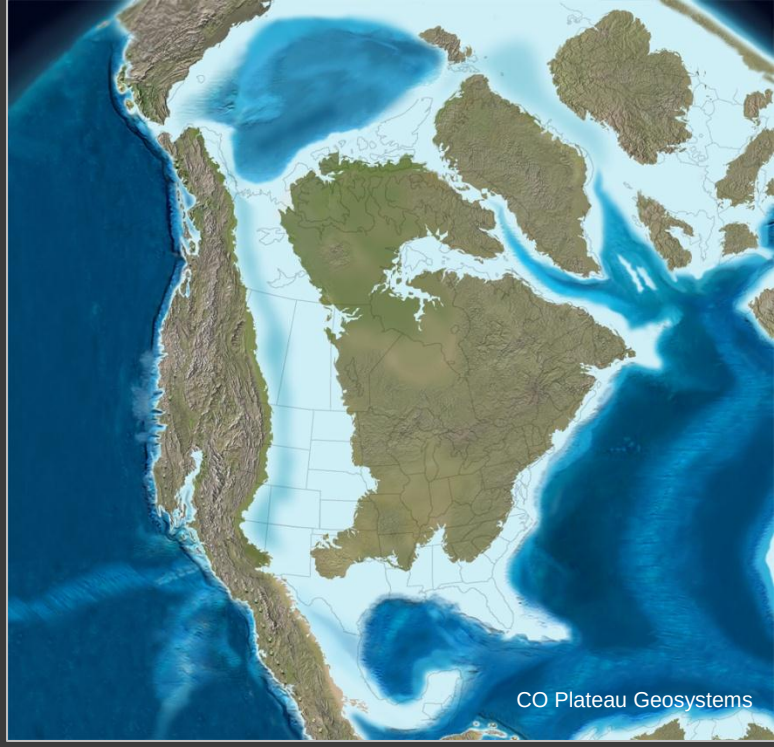
Barras et al. (2003)

Context for Modern Delta by Summarizing Geological History of Lower Mississippi Valley and Delta Region

Geological Framework

Cretaceous 145.5 to 65.5 MYA

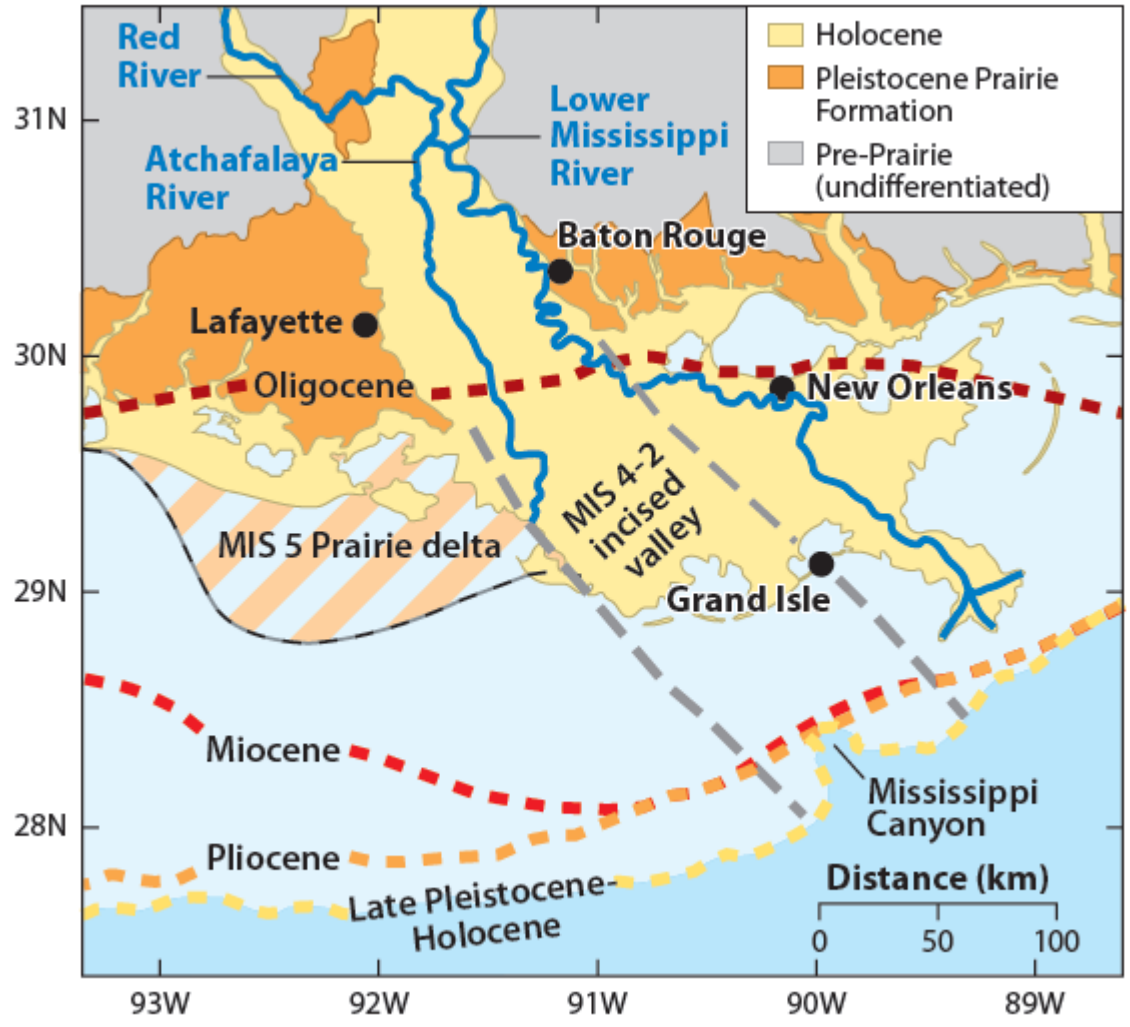
Mississippi Embayment Formed, began to focus sediment input to GOM during Late Cretaceous



- Mississippi Embayment formed, focused sediment in late Cretaceous
- Modern land-surface dynamics
  - Conditioned by longer-term processes indigenous to the Mississippi depocenter

Paleogene 65.6 to 23 MYA

Series of Smaller-Scale River Systems entered GOM in what is now south Louisiana

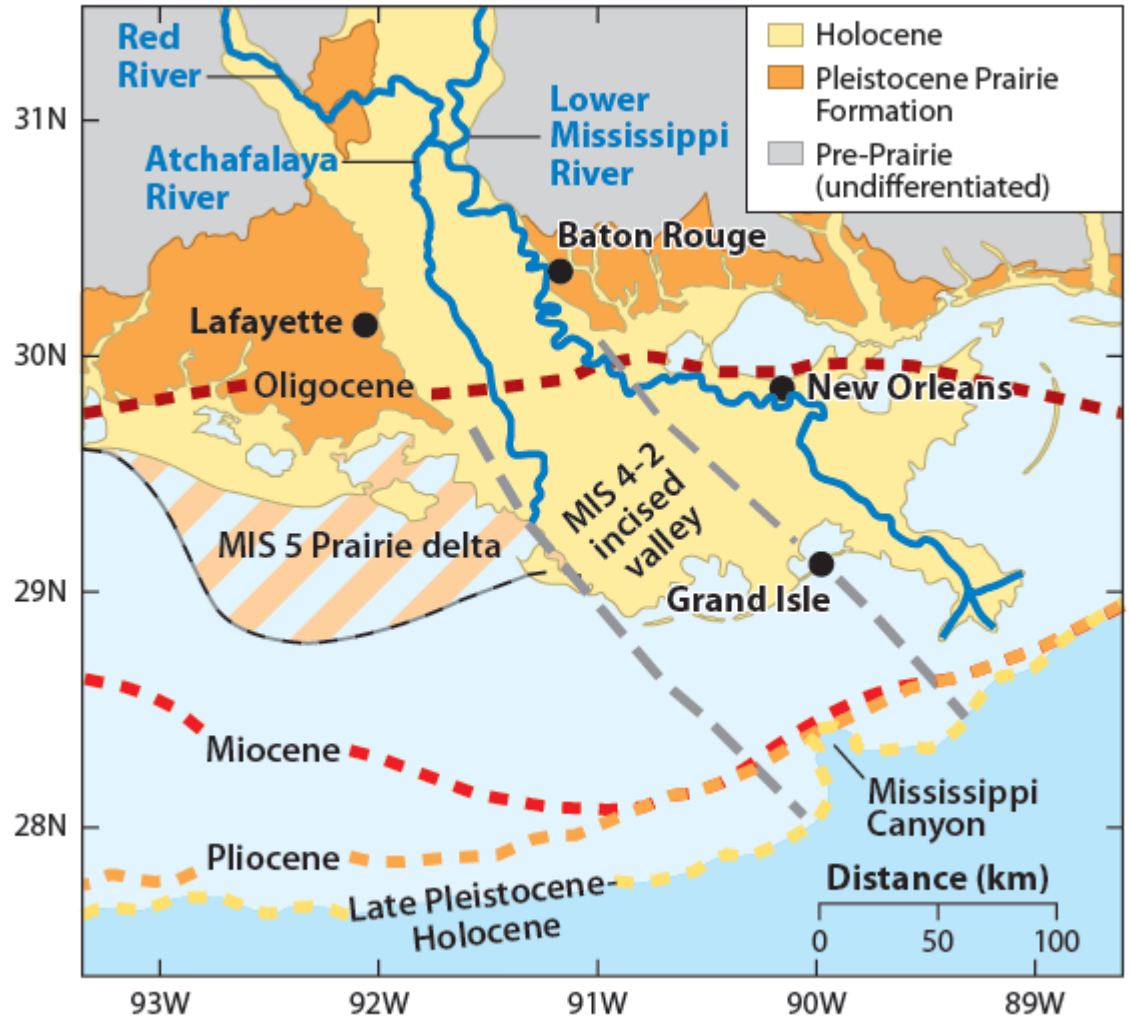


Shelf Margin at New Orleans

34-24 MYA

Miocence 23 to 5.3 MYA

Mississippi Embayment Emerged as Primary Focus for Sediment Input

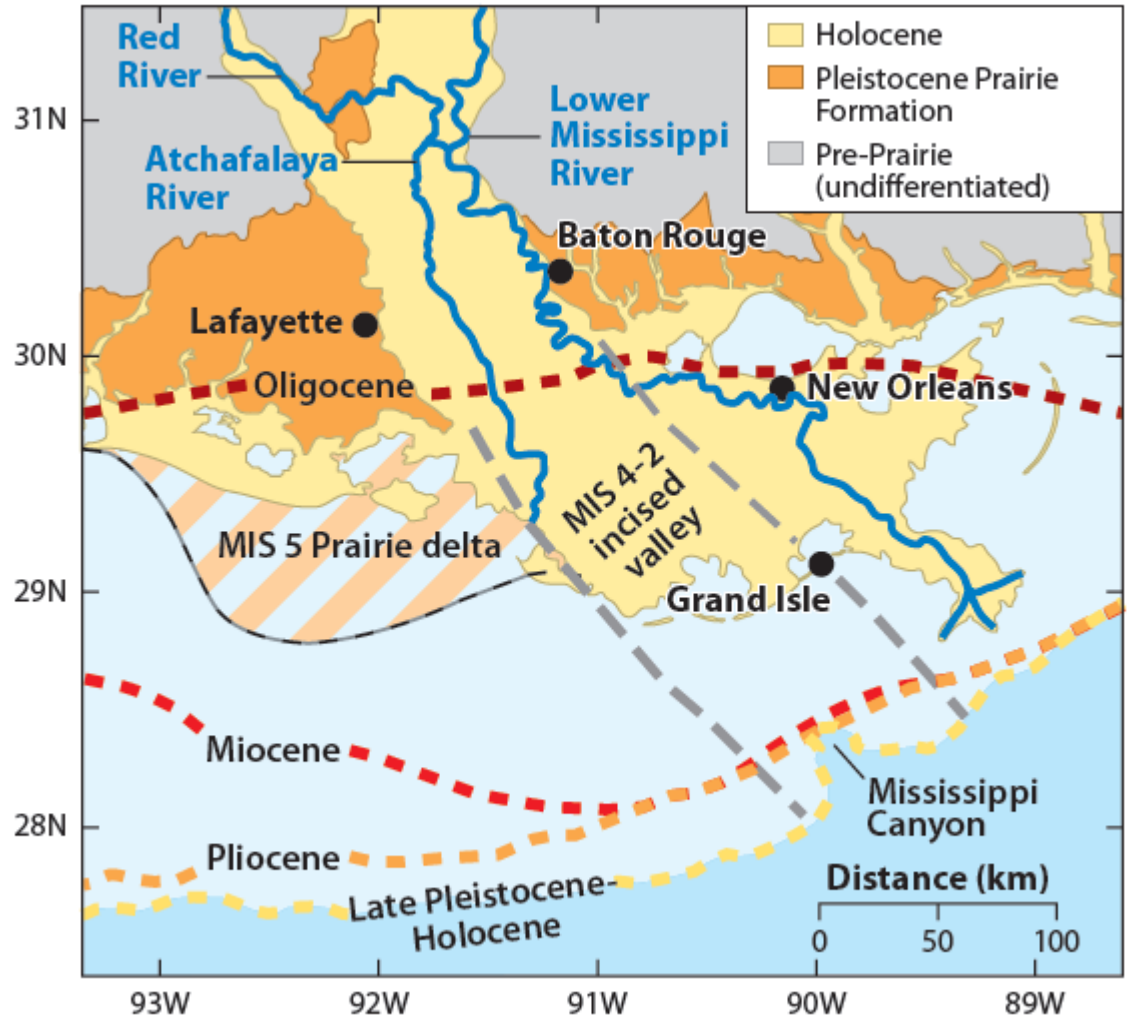


~200 km of shelf margin progradation

Foundation for Modern Delta Region

Plio-Pleistocene < 5 MYA

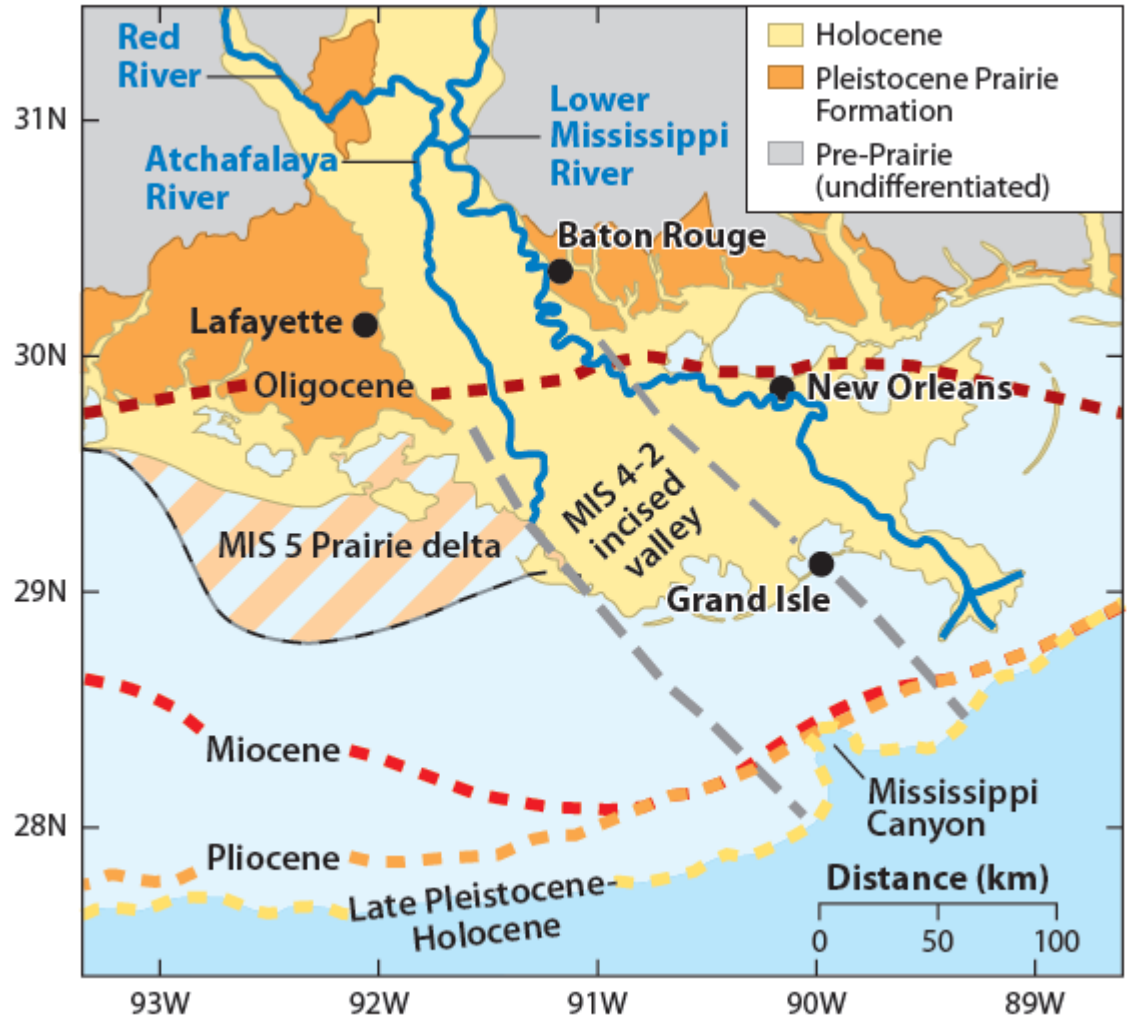
Sediment Loading



Depocenter extends ~400 km along Mississippi and Louisiana Coasts

Foundations for the Modern Delta reflect evolution of Depocenter

Delta Region Foundation



Fluvial to shallow marine sediments >500 m thickness

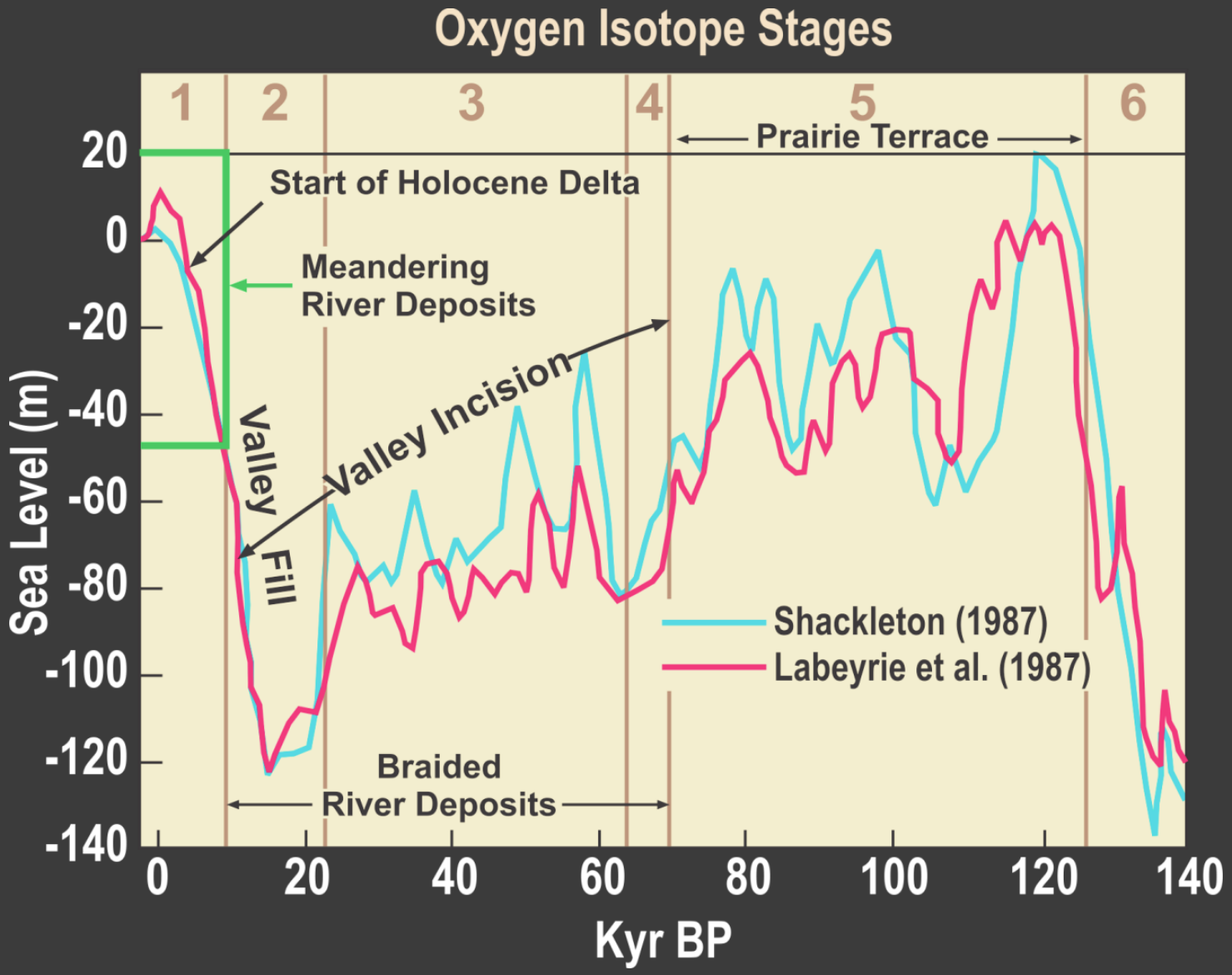
Sediment thickness > 4,000 m

Delta region is inherently unstable, with subsidence processes that are driven by depocenter loading

Modern alluvial-deltaic landscape directly reflects the response of the Mississippi system to climate and sea-level changes from the last interglacial period to the present.

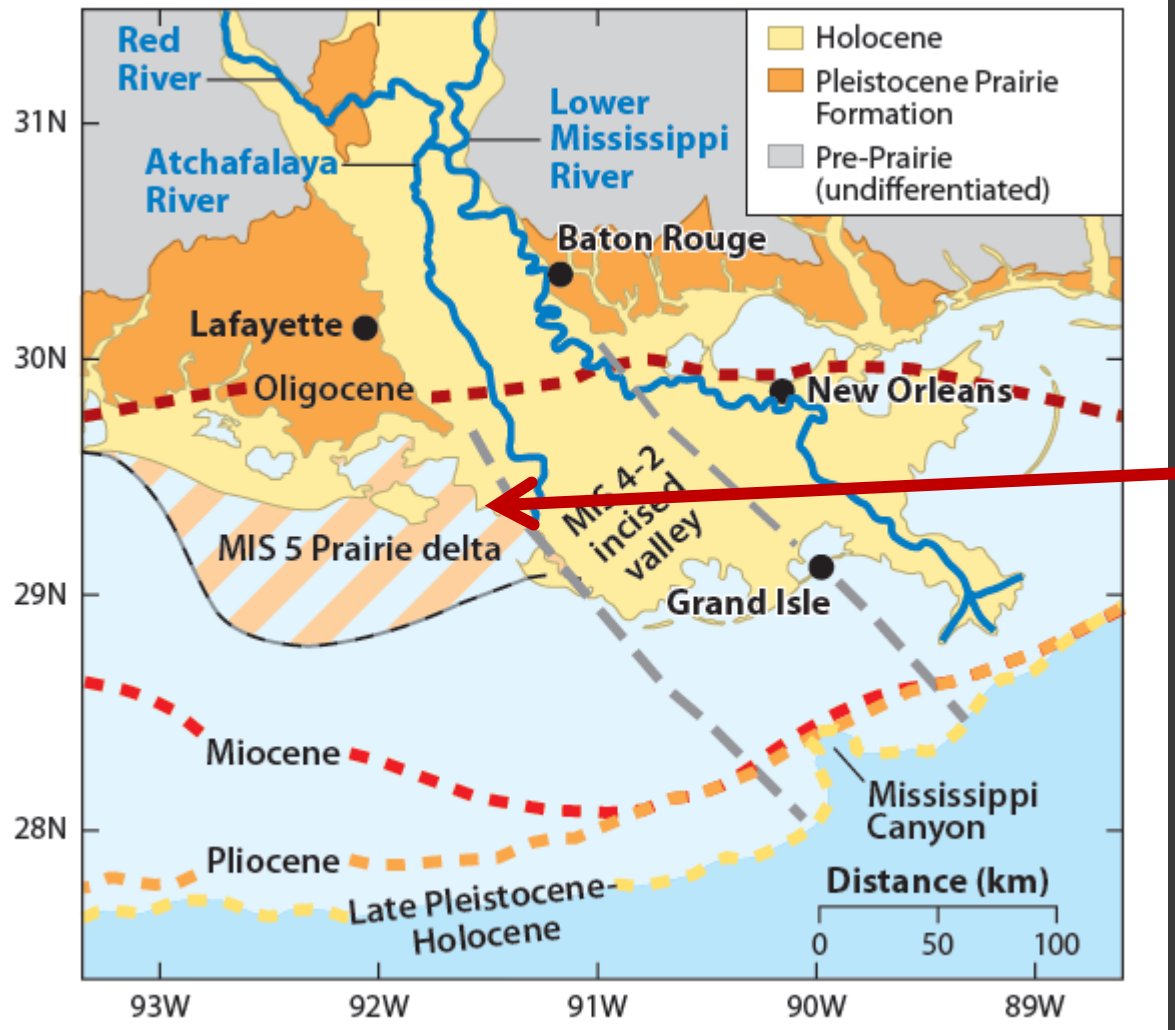
Sea Level History

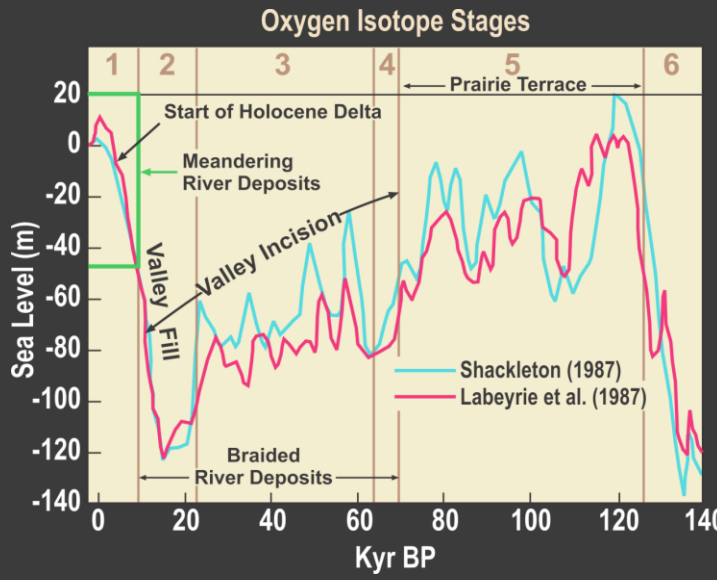
Sea Level History



Marine Isotope State 5 ca. 125-80 KYA

Lower Mississippi and Delta Looked Much Like Today



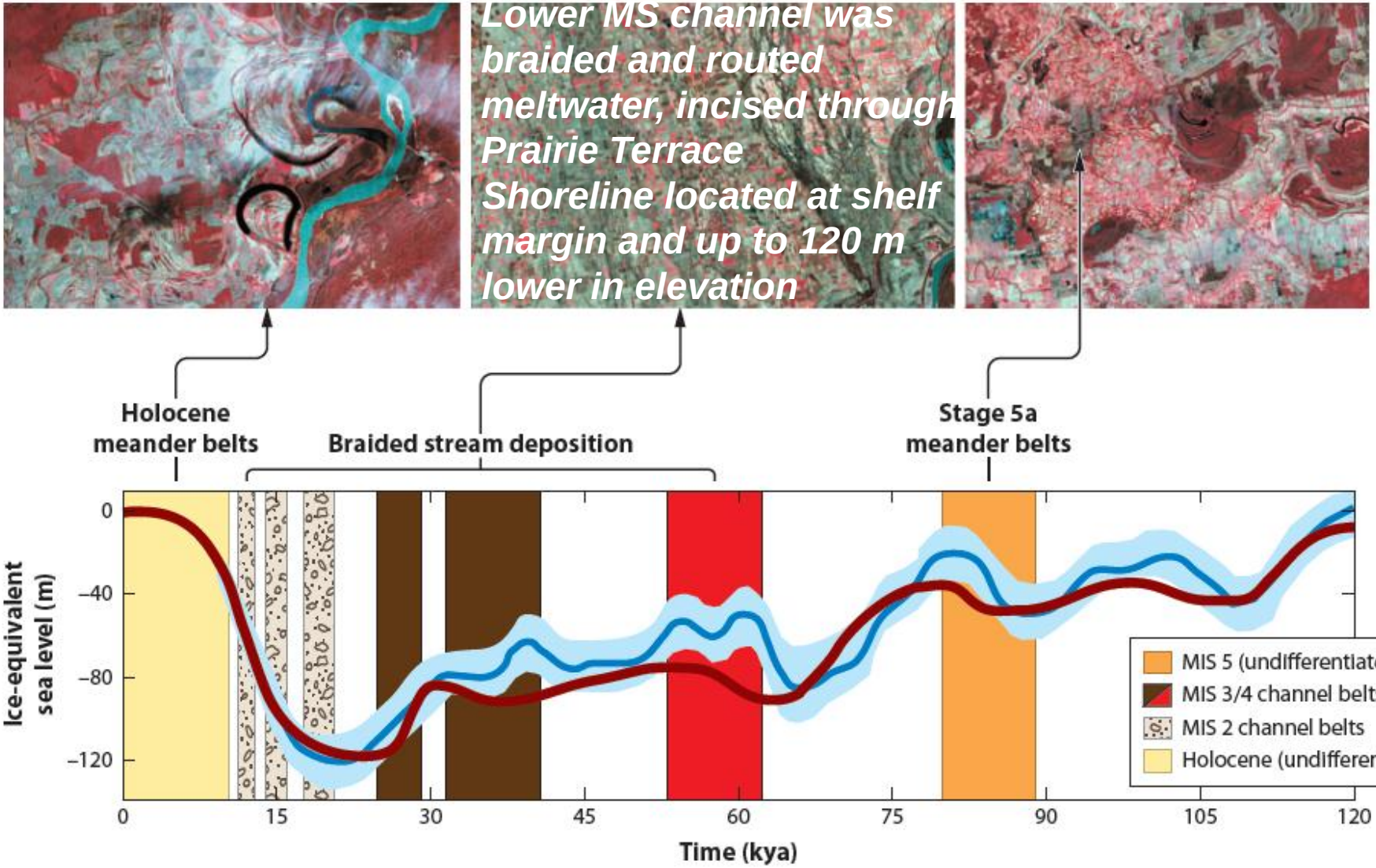


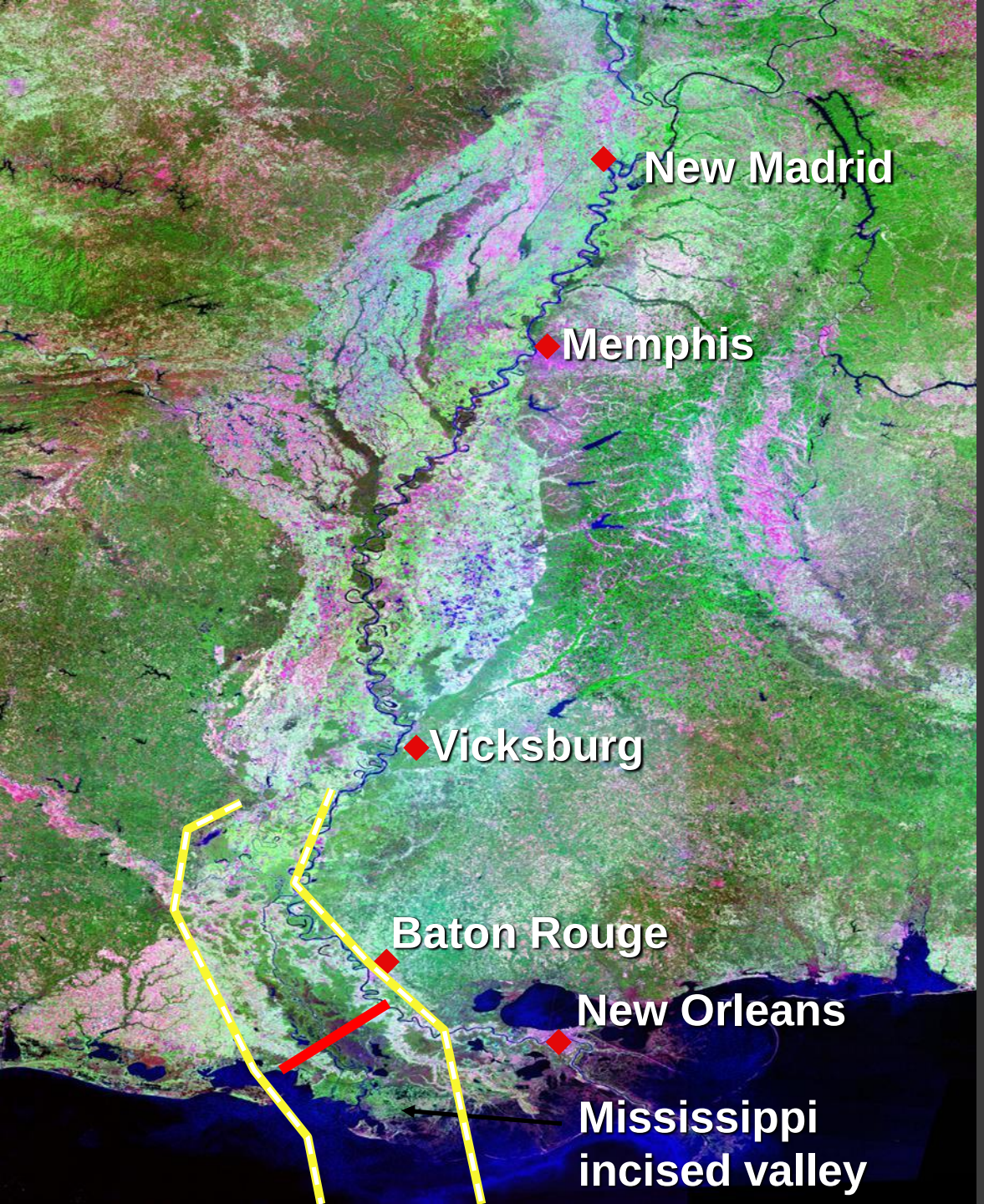
Last Interglacial

MI5 Delta Plain (or Prairie Terrace) extended further west

Meandering channels characterized alluvial valley

Large Scale Changes in Channel Morphology and Climate and Sea-Level Changes





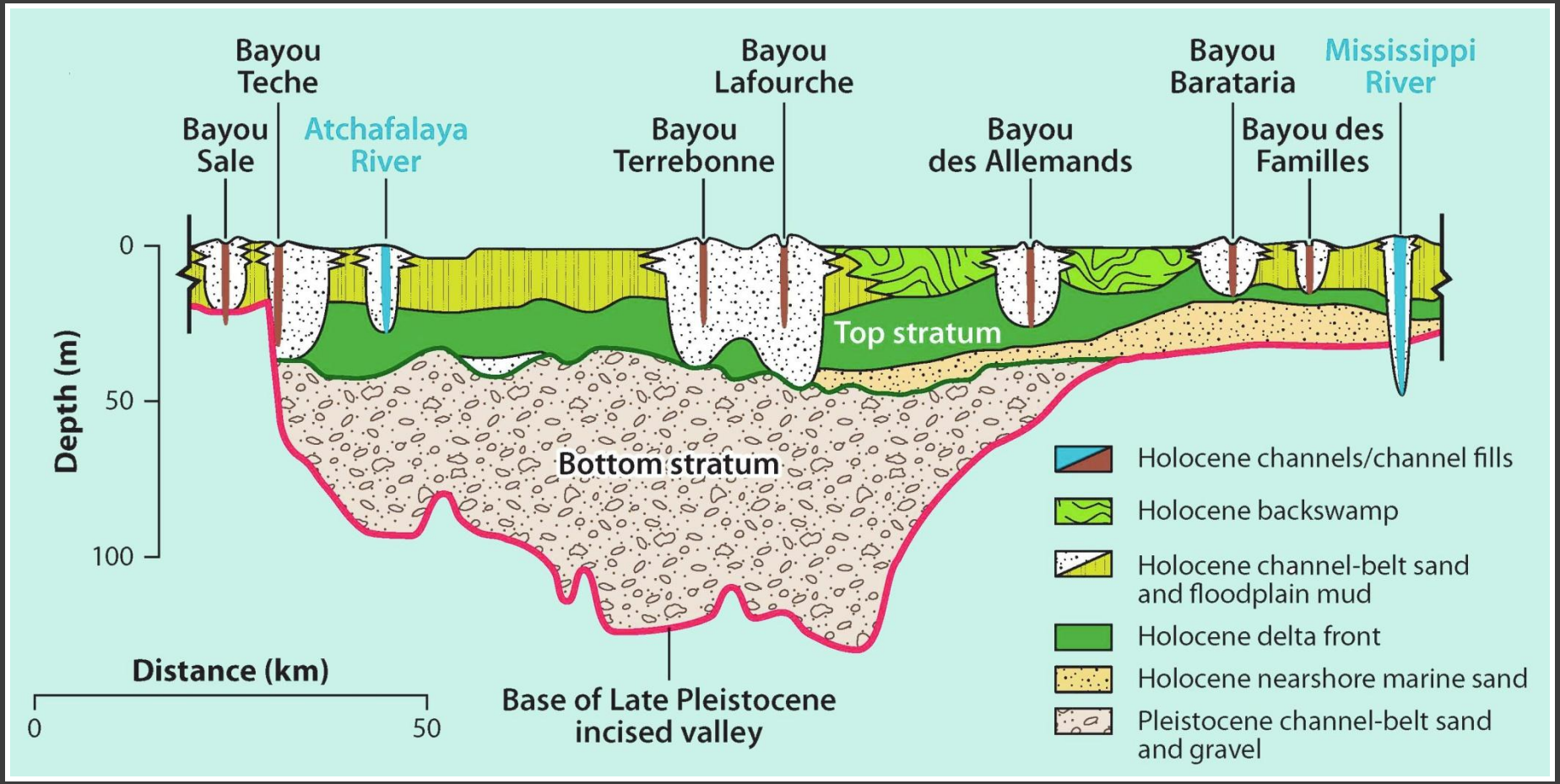
The Lower Mississippi River and Delta

- Glacial-period braided streams within incised valley
- Holocene valley filling and delta construction
- Valley fill reflects interactions between climate and sea-level change

COASTAL STUDIES INSTITUTE

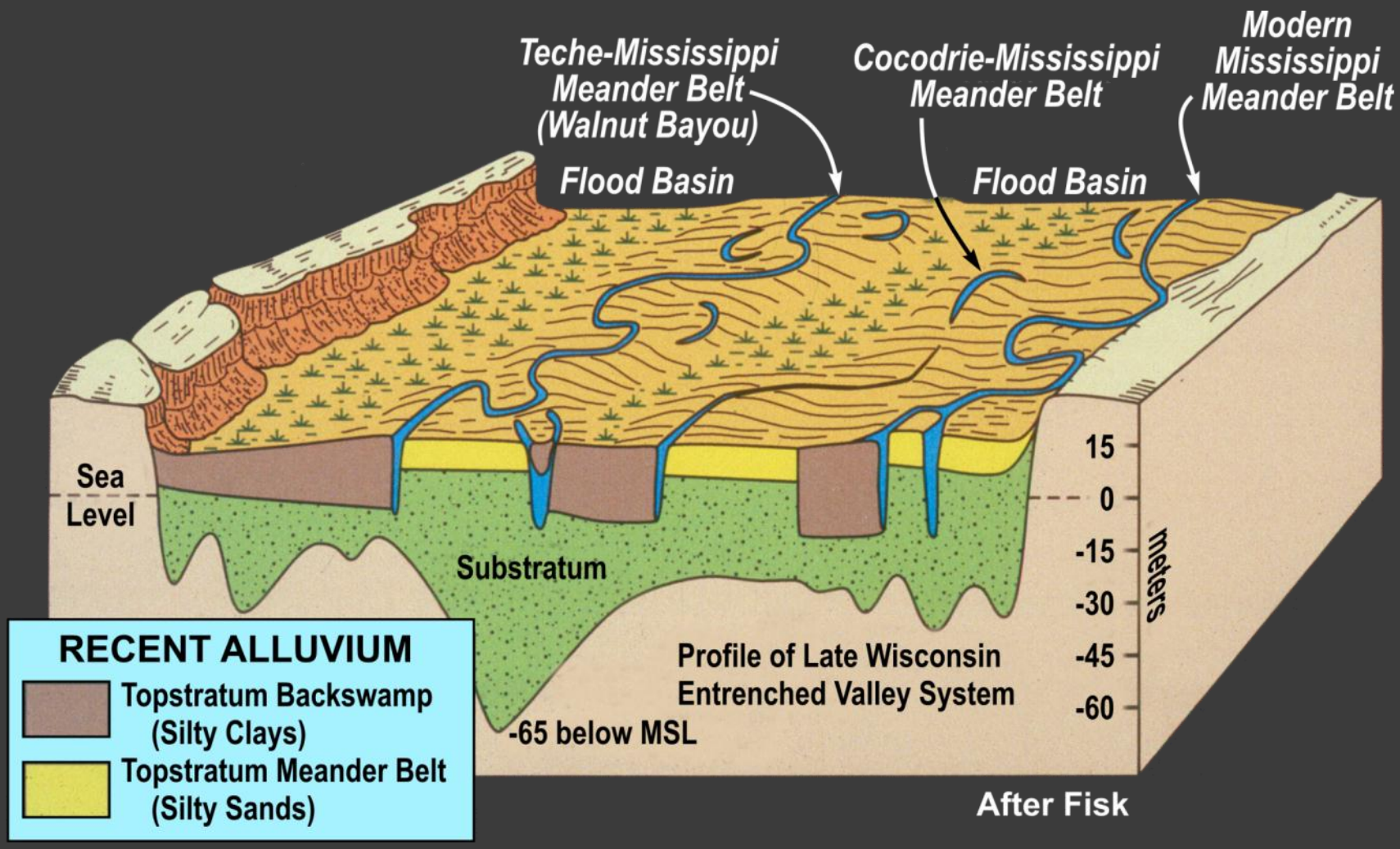
Delta Plain Landscape

Glacial Period Incised Valley and Complex Deltaic Deposits

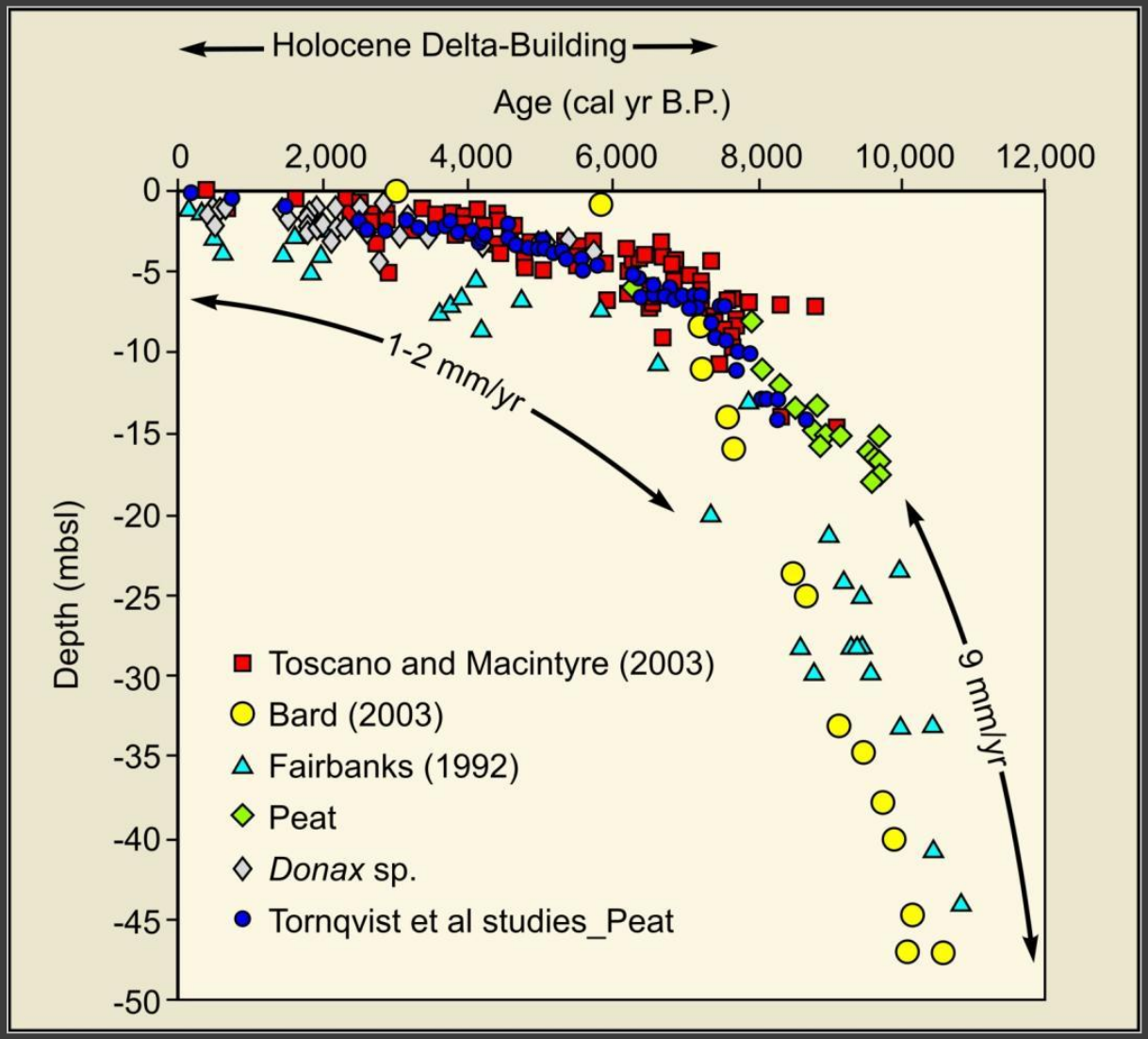


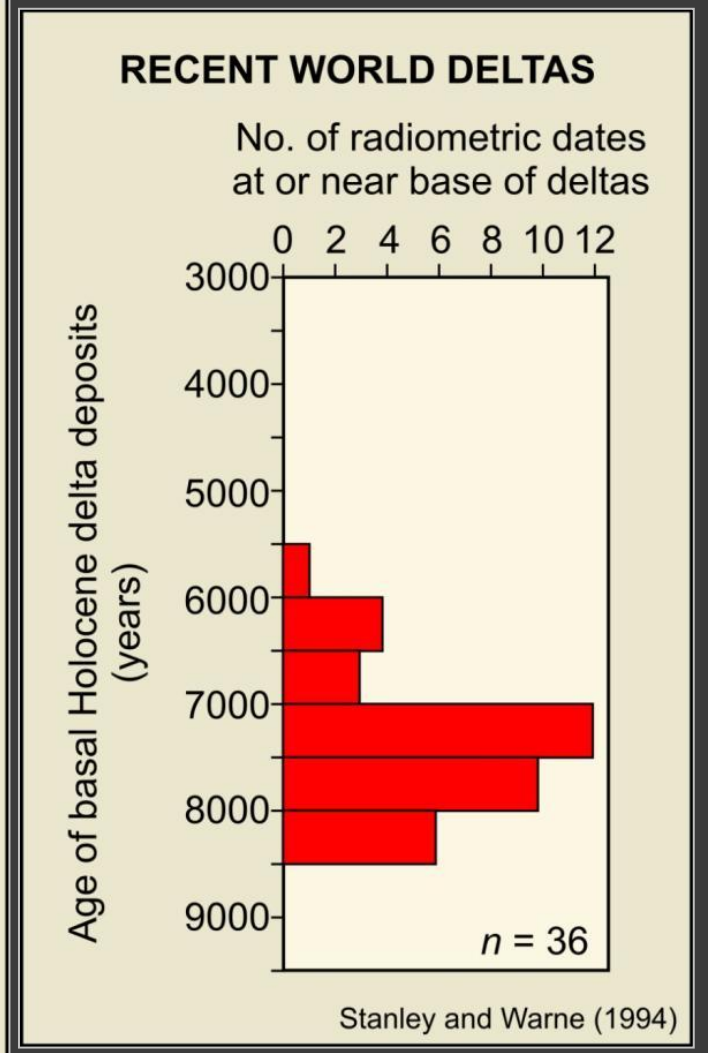
Modified from Autin et al 1991

Block Diagram of Mississippi Alluvial Valley at the Latitude of Natchez, MS

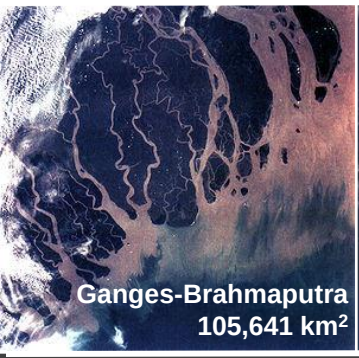


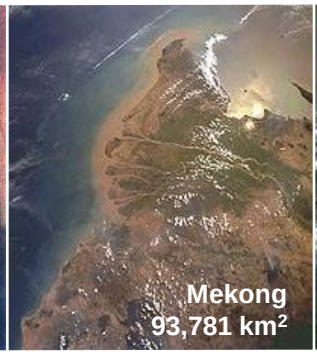
Initiation of Holocene World Deltas

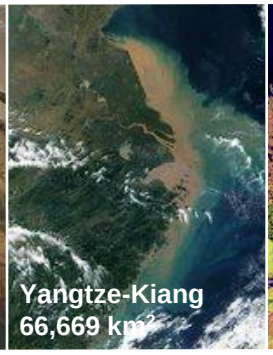


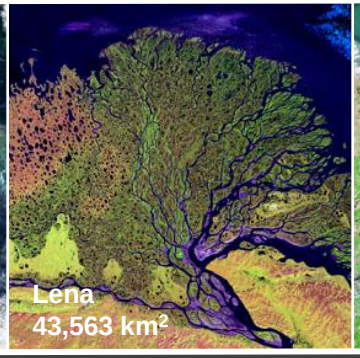


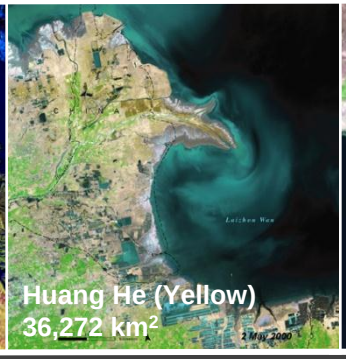
Most Holocene Delta Plains Similarly Constructed, after SLR Decelerated



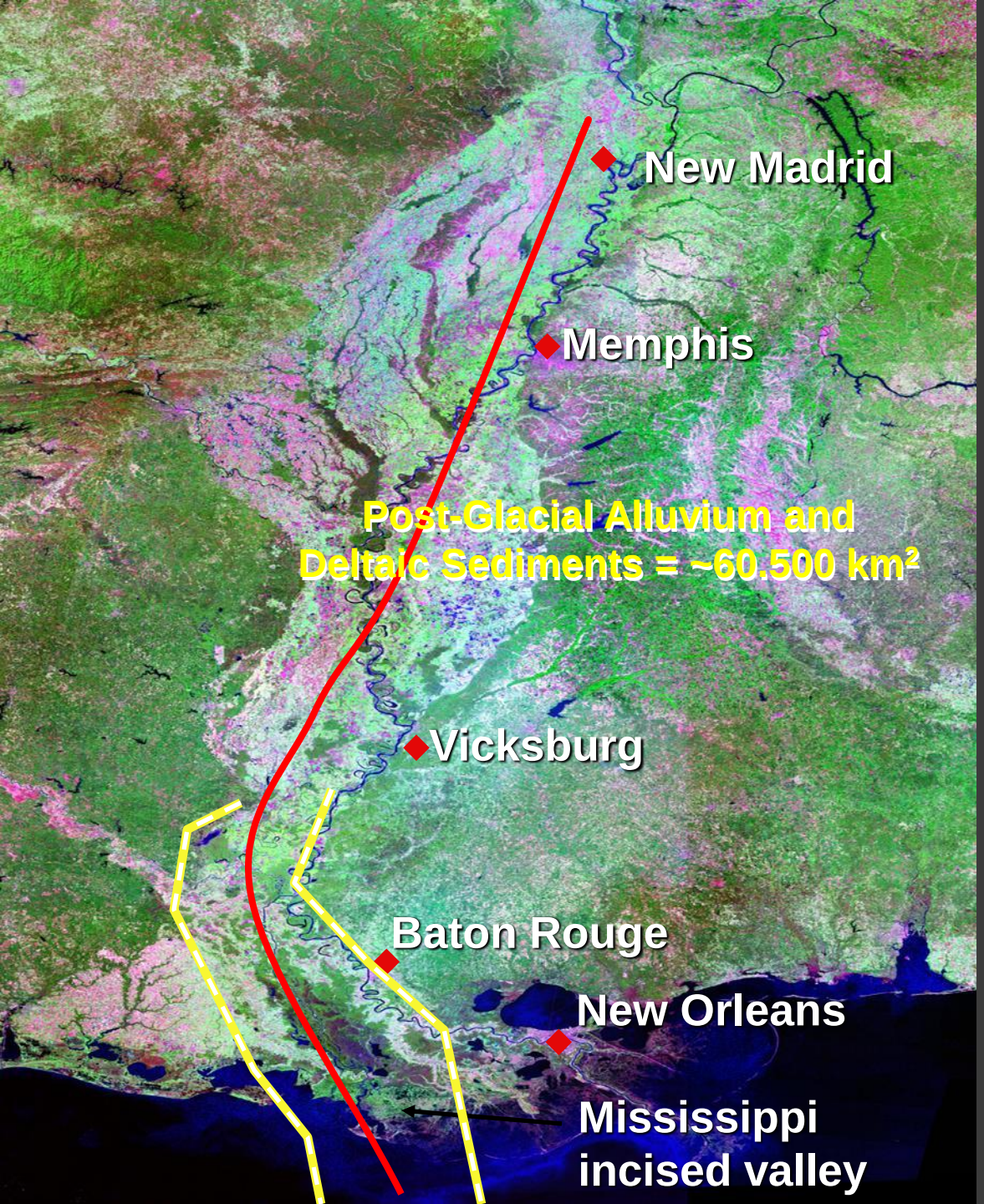








Sediment Storage in the System Before Human Intervention



The Lower Mississippi River and Delta

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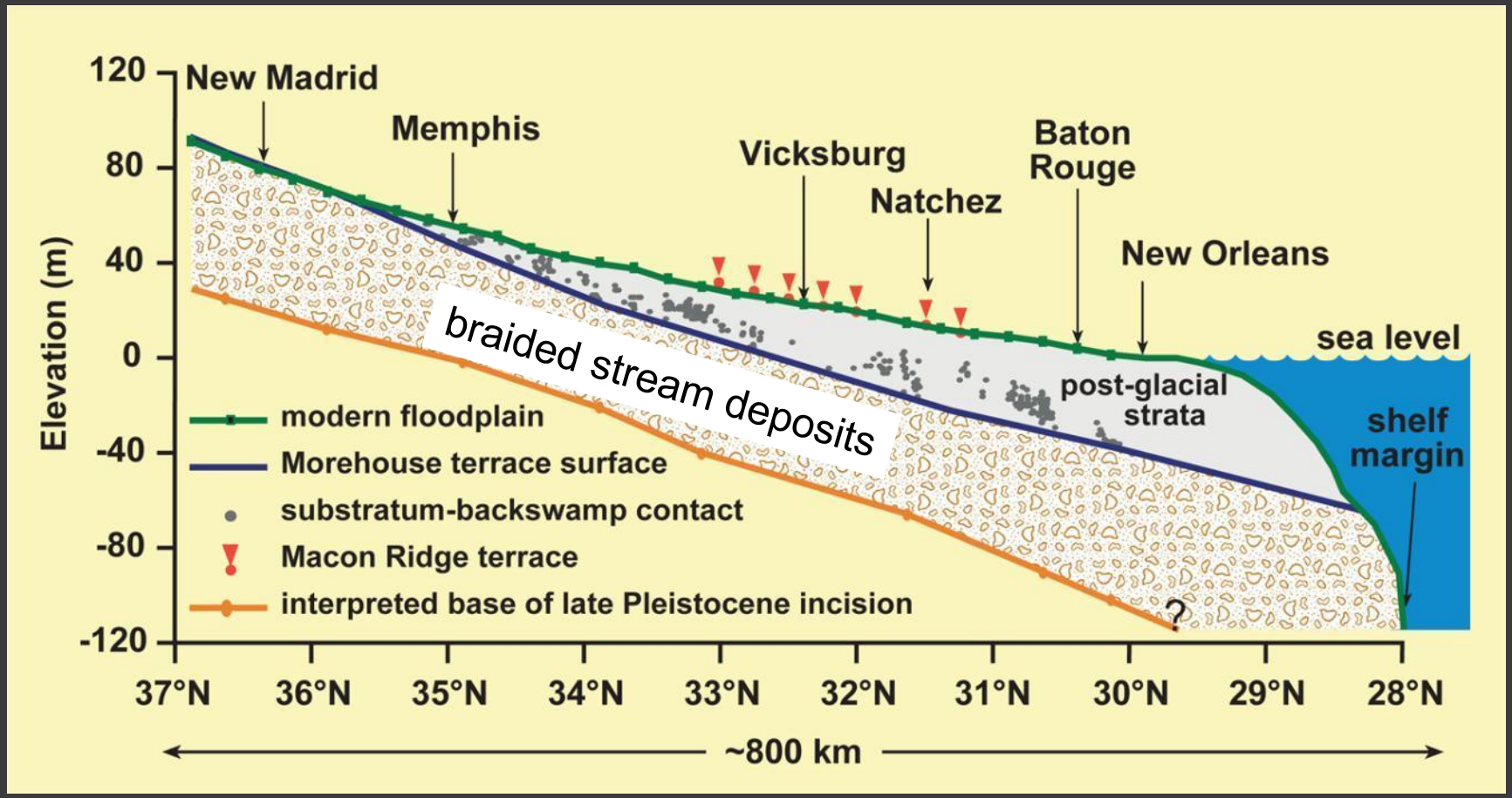
Longitudinal Profile of the Lower Mississippi Valley and Delta

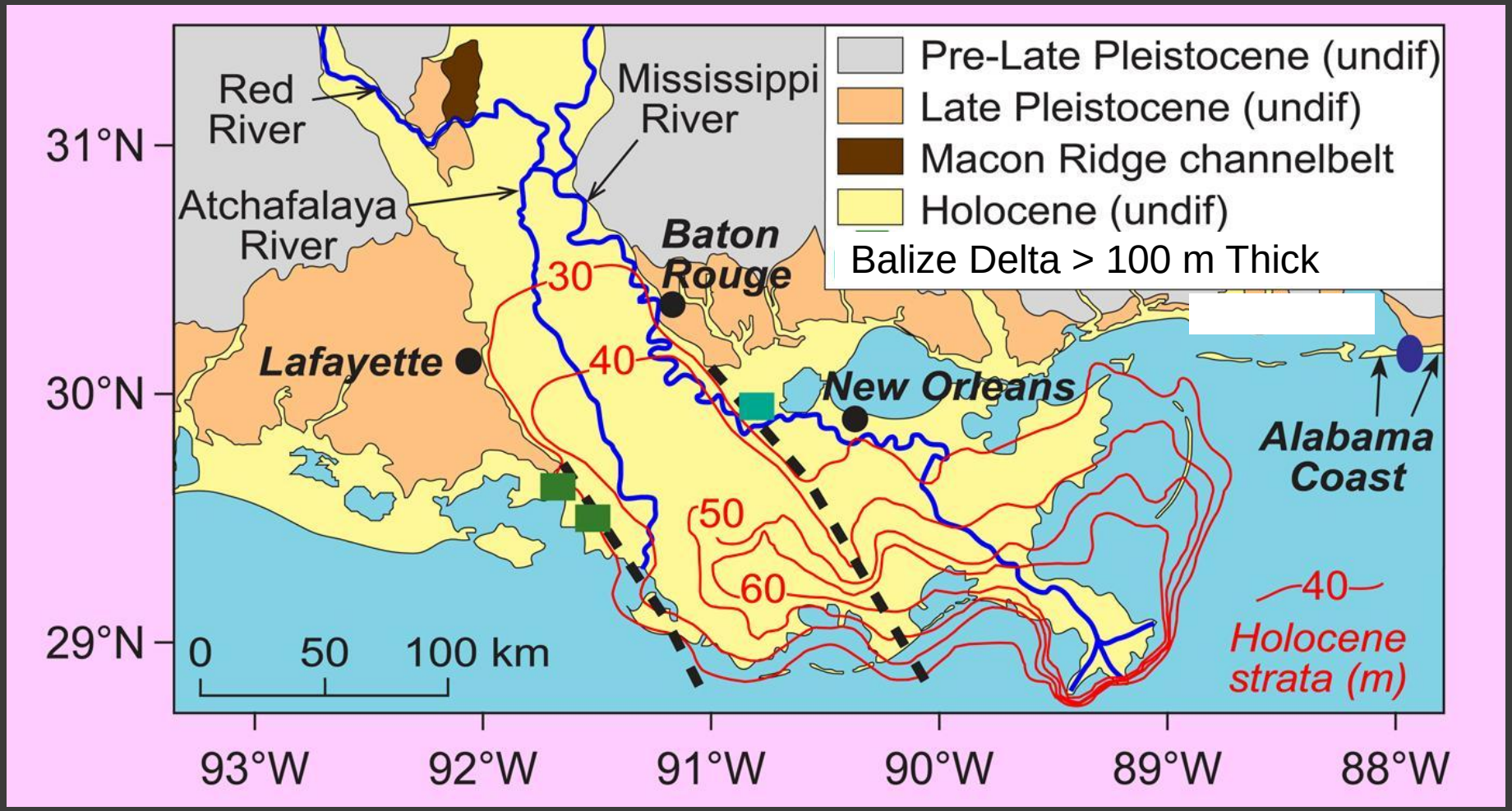
Tracing Late Pleistocene Braided Streams into the Subsurface Using Base of Backswamp Deposits



Based on 325 USACE boreholes

from Blum et al. (2008)

Lower Mississippi Valley and Delta
Magnitude of Post-Glacial Deposition

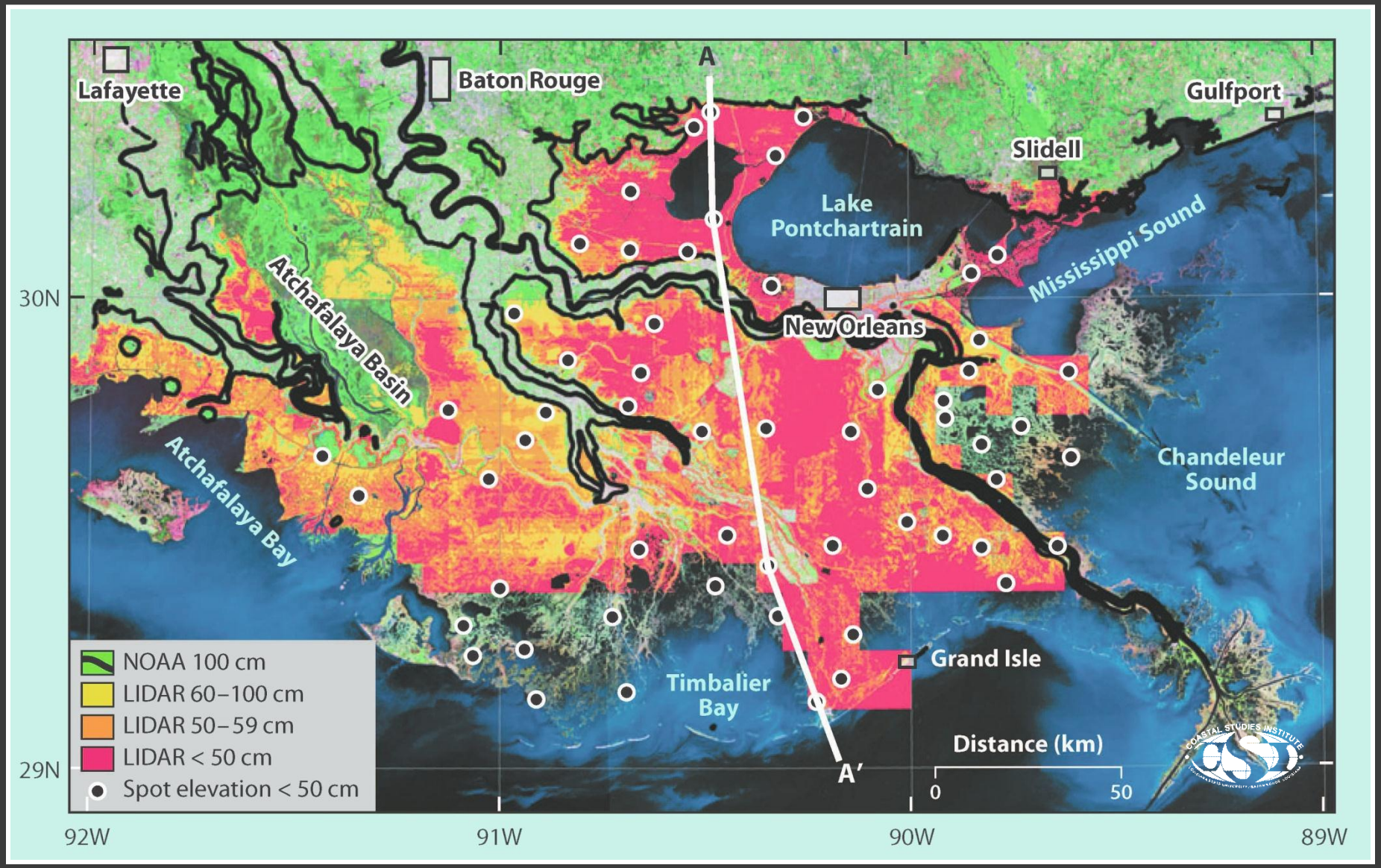


Total storage = 1860-2300 km^3 or 2790-3450 BT of sediment

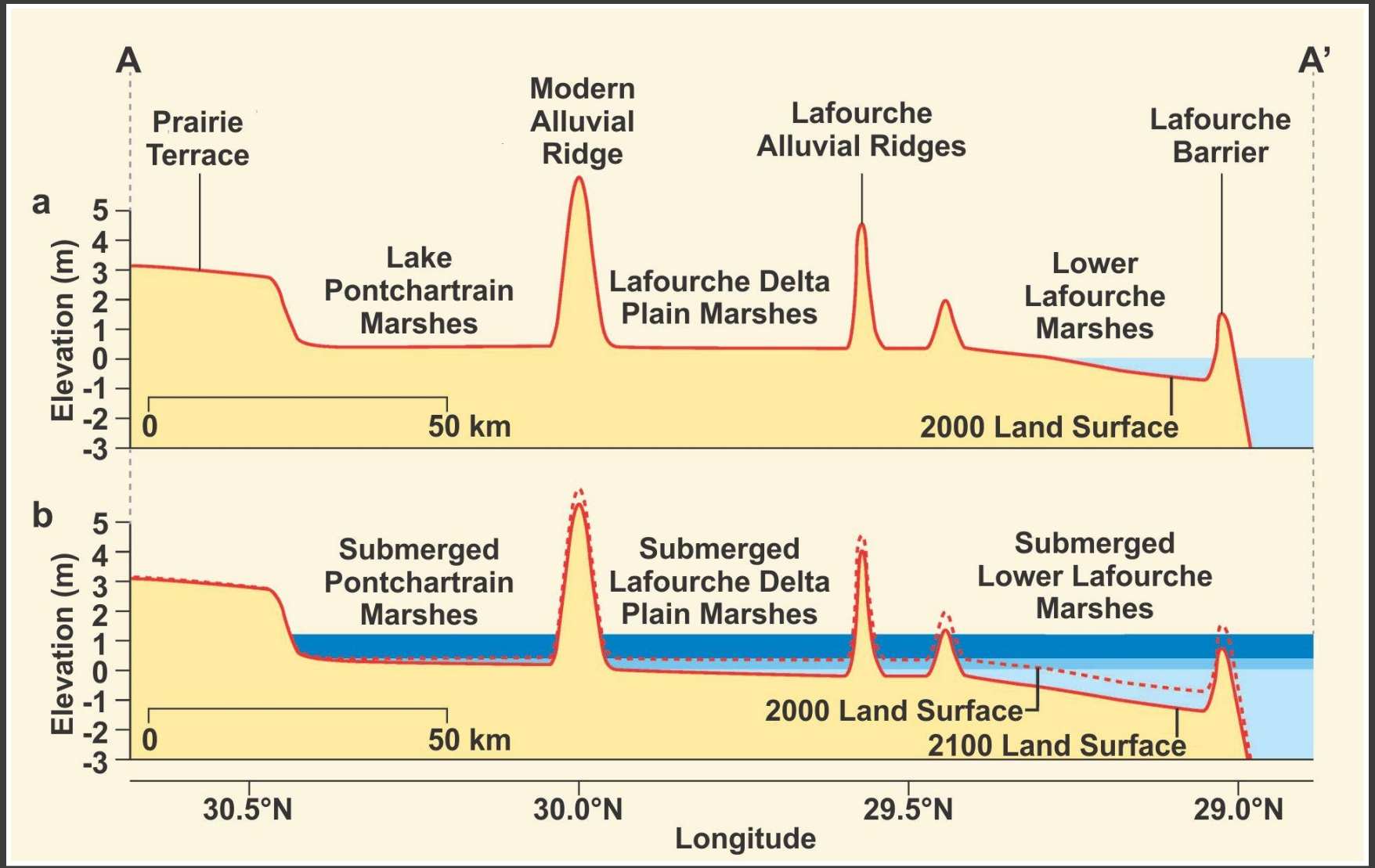
Storage rate = ~230-290 MT/yr over 12,000 yr post-glacial period

sediment isopachs adapted from Kulp (2000)

Coastal Plain Elevations

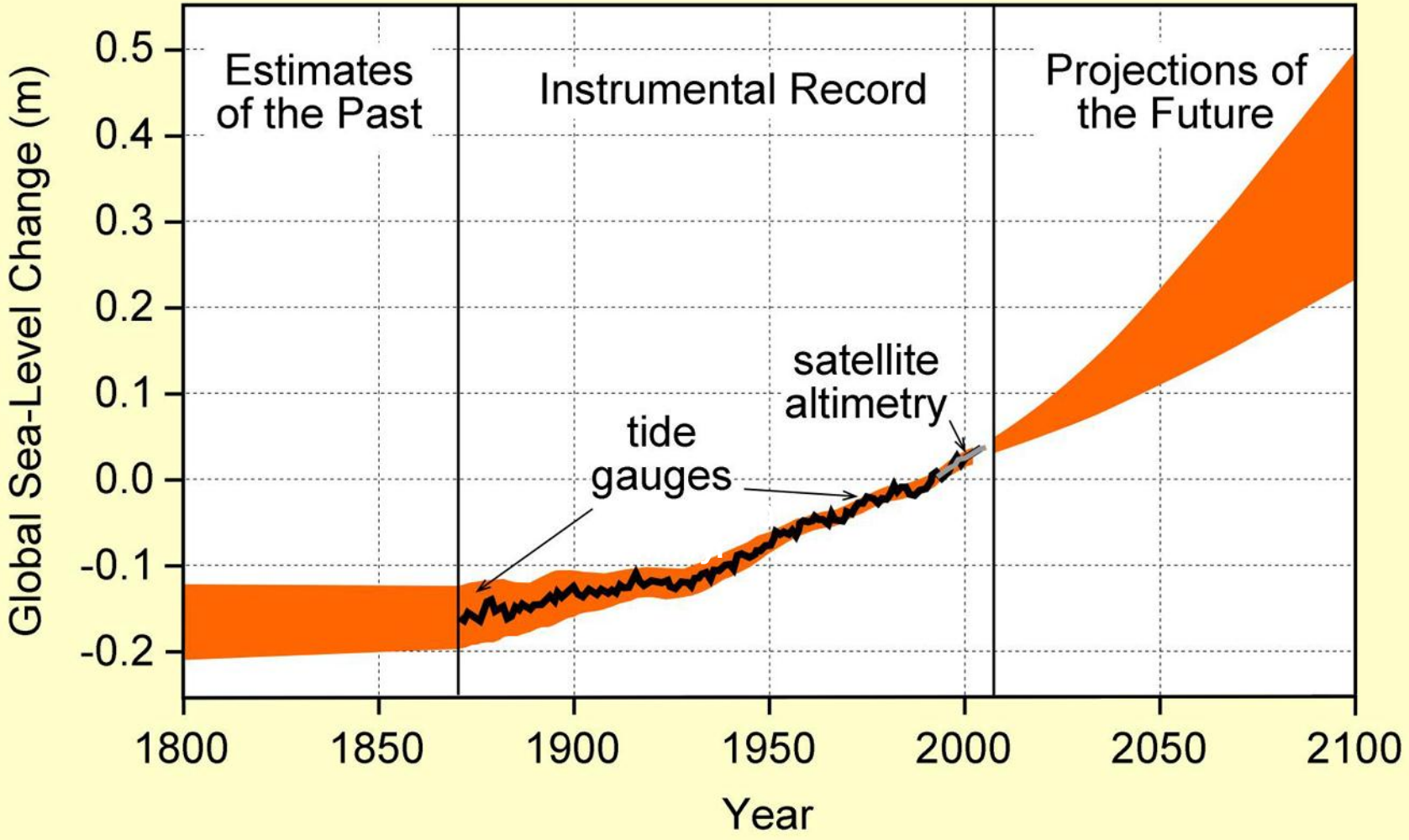


Projected Submergence: 2000 vs 2100



Global Sea-Level Rise

Sea-Level Change Data and Projections

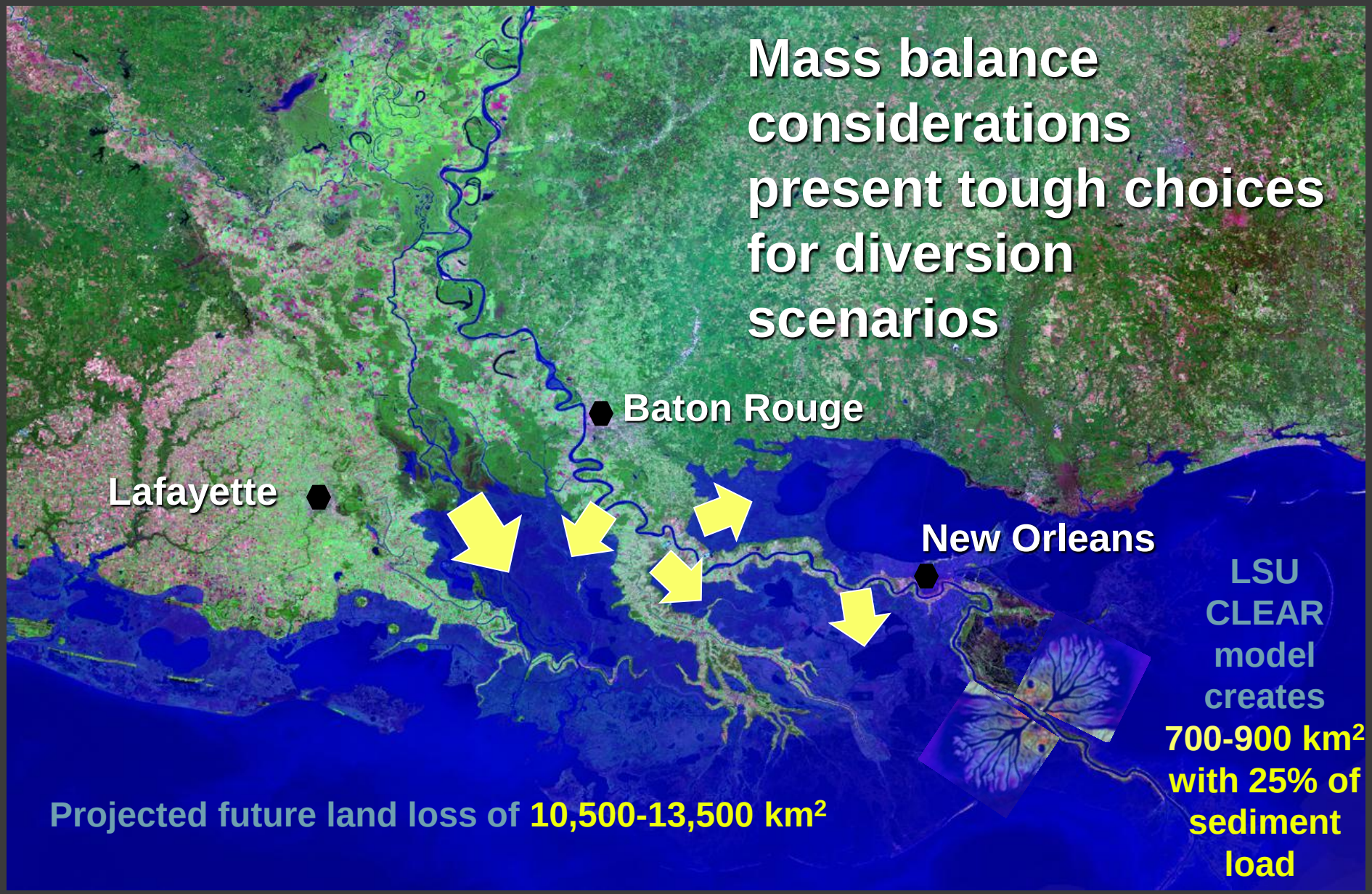


from IPCC 2007

The Louisiana Coast in 2000

The Louisiana Coast in 2100?

The Louisiana Coast in 2100?




Questions?

Delta Switching