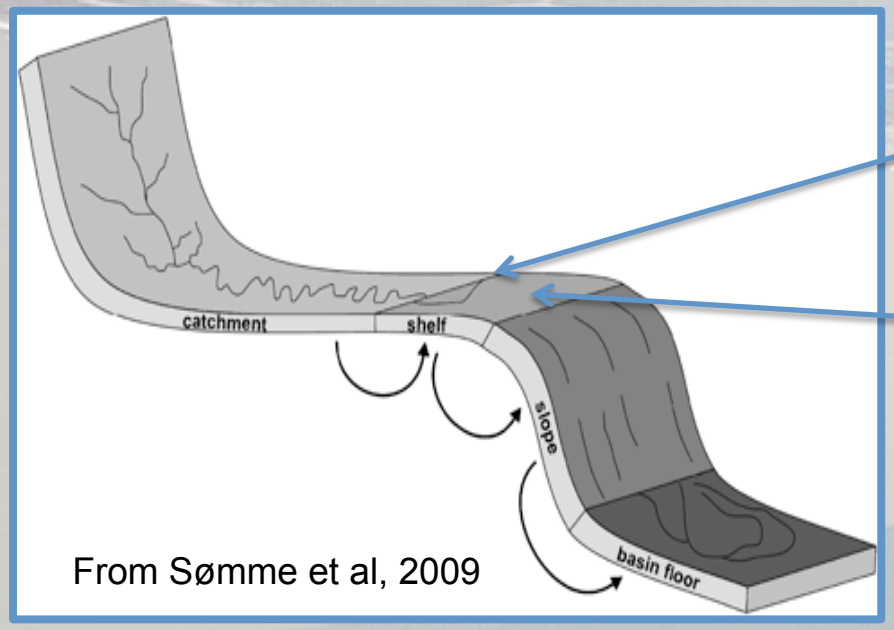
Sediment storage and remobilization in the coastal ocean

Patricia Wiberg, University of Virginia

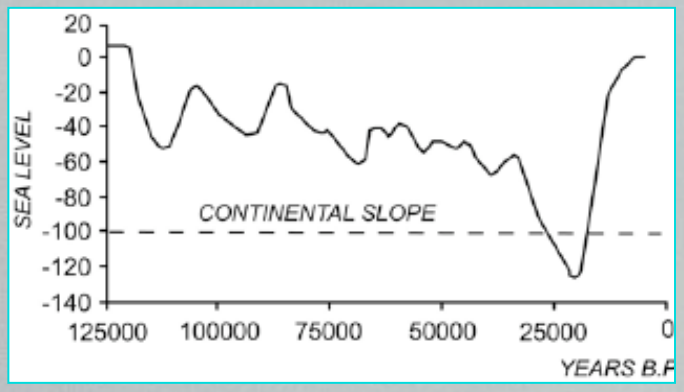
Zones of Storage

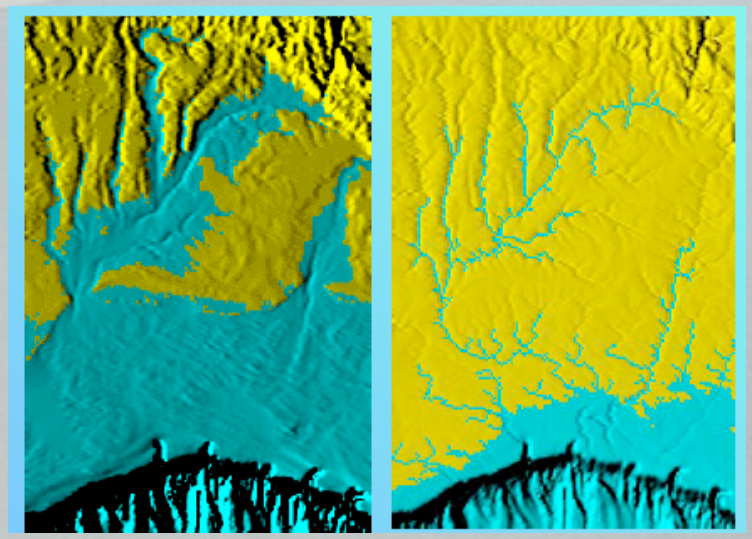


From Sømme et al, 2009

River mouth – ocean boundary

Continental shelf





Present high stand Last low stand

From Fagherazzi et al 2003

Trapping vs Bypassing

$$dV/dt = \text{Inflow} - \text{Outflow}$$

Storage Volume

~ accommodation space on long time scales

Sediment supply rate

Remobilization and sediment flux at the outlet

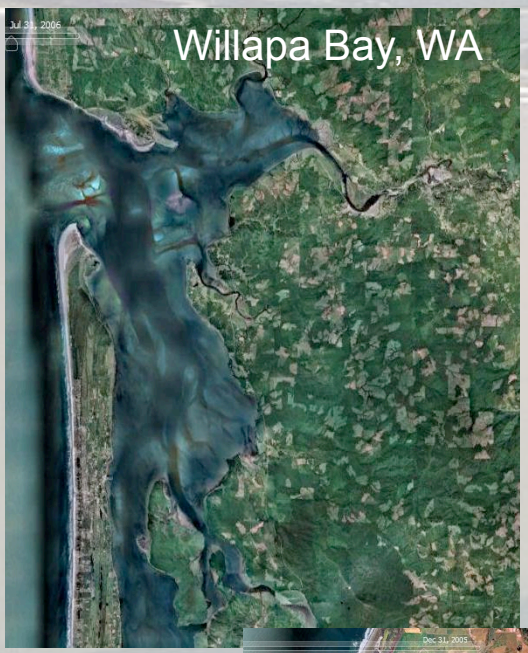
If storage capacity is small relative to input:

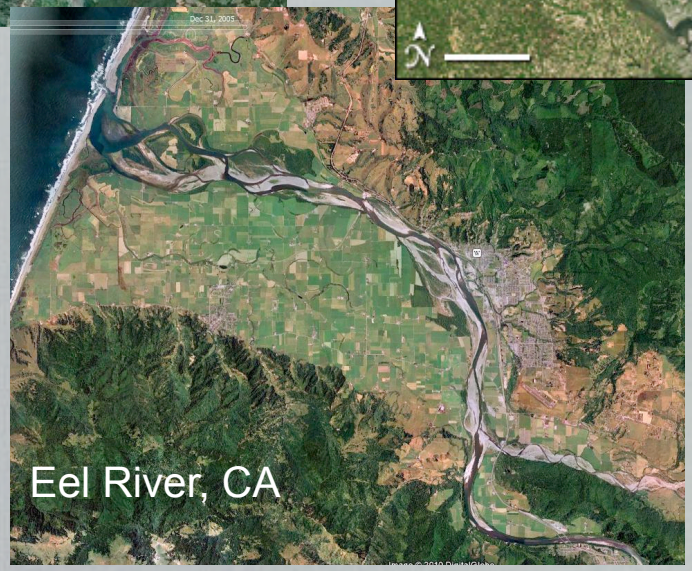
- output ≈ input → bypassing

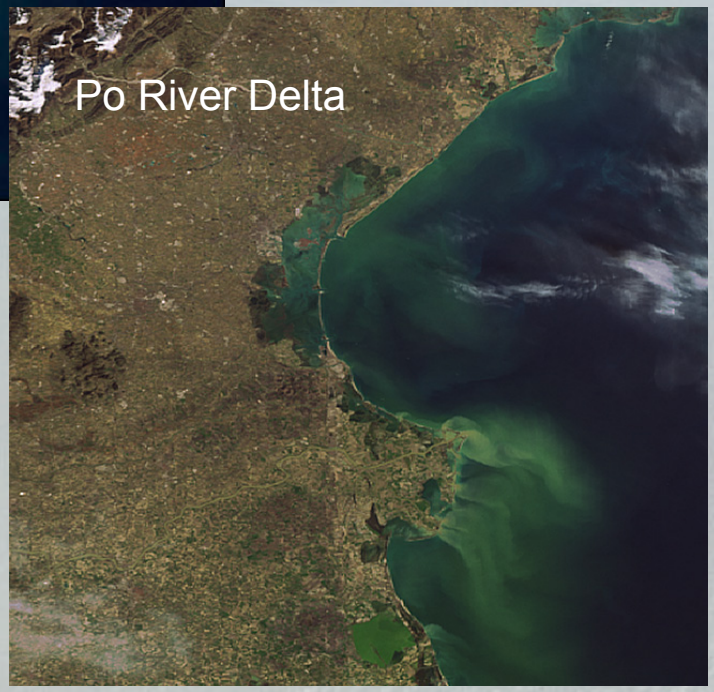
If storage capacity is large relative to input:

- input >> output → trapping

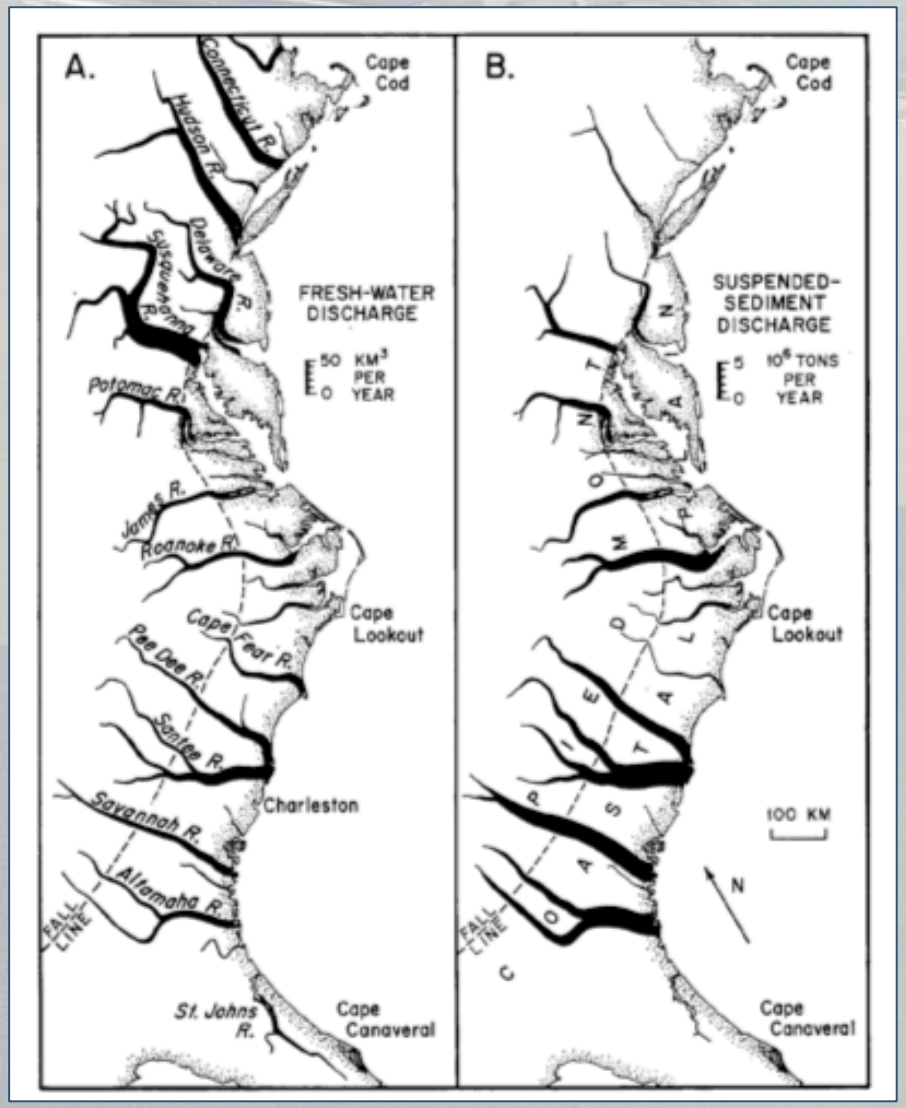
River Mouth – Ocean Boundary



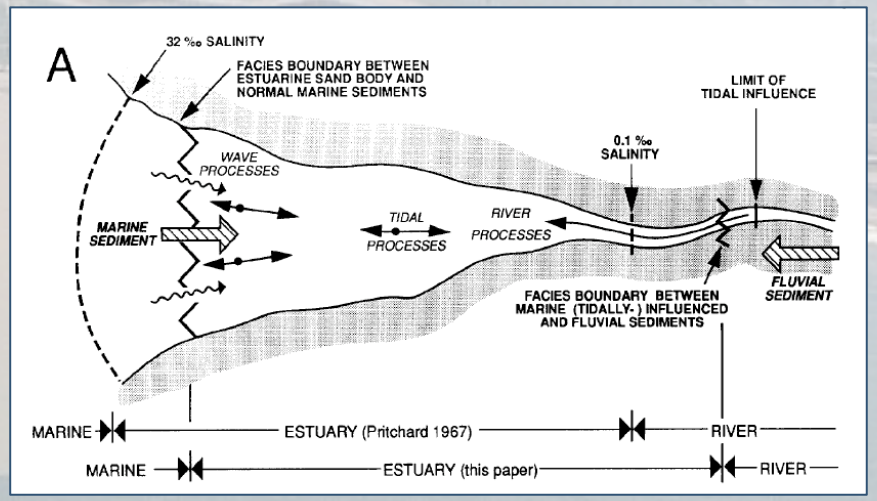




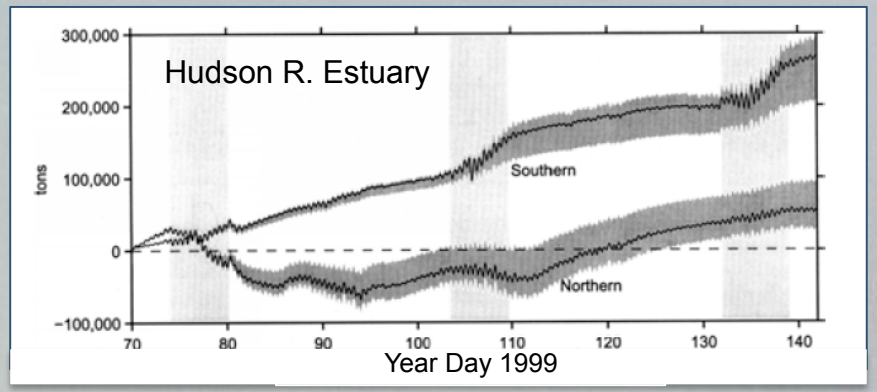
Estuarine trapping



Meade 1969



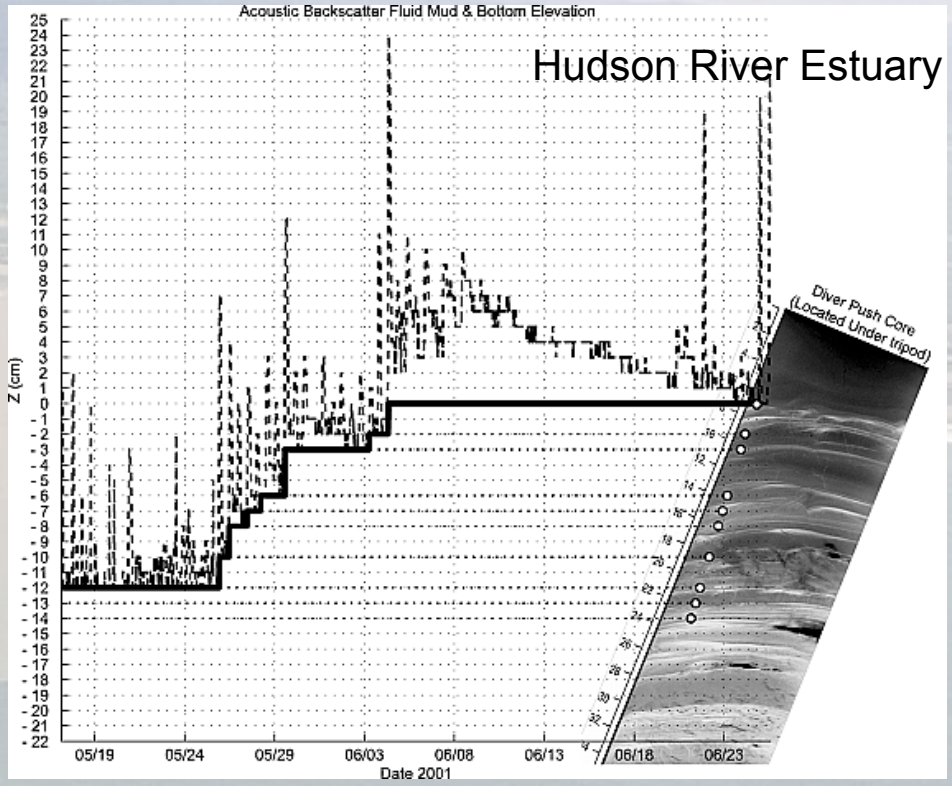
Dalrymple et al 1992



Geyer et al 2001

Short time scales:

- Rapid localized deposition and erosion
- High river discharge can move ETM toward river mouth



Traykovski et al. 2004

Short time scales:

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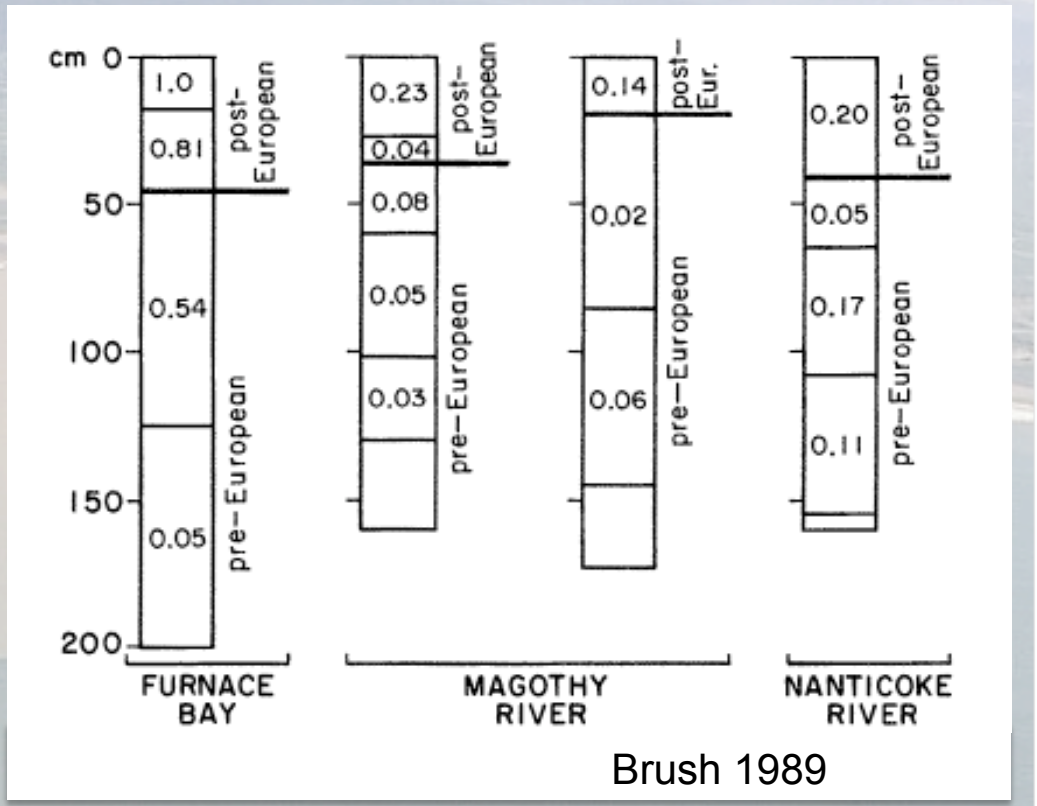
Decadal-century time scales:

- Human alteration of sediment input rates, storage volume
- Inter-annual/decadal variation in river discharge



Sediment deposition rates in Chesapeake Bay

Short time scales:

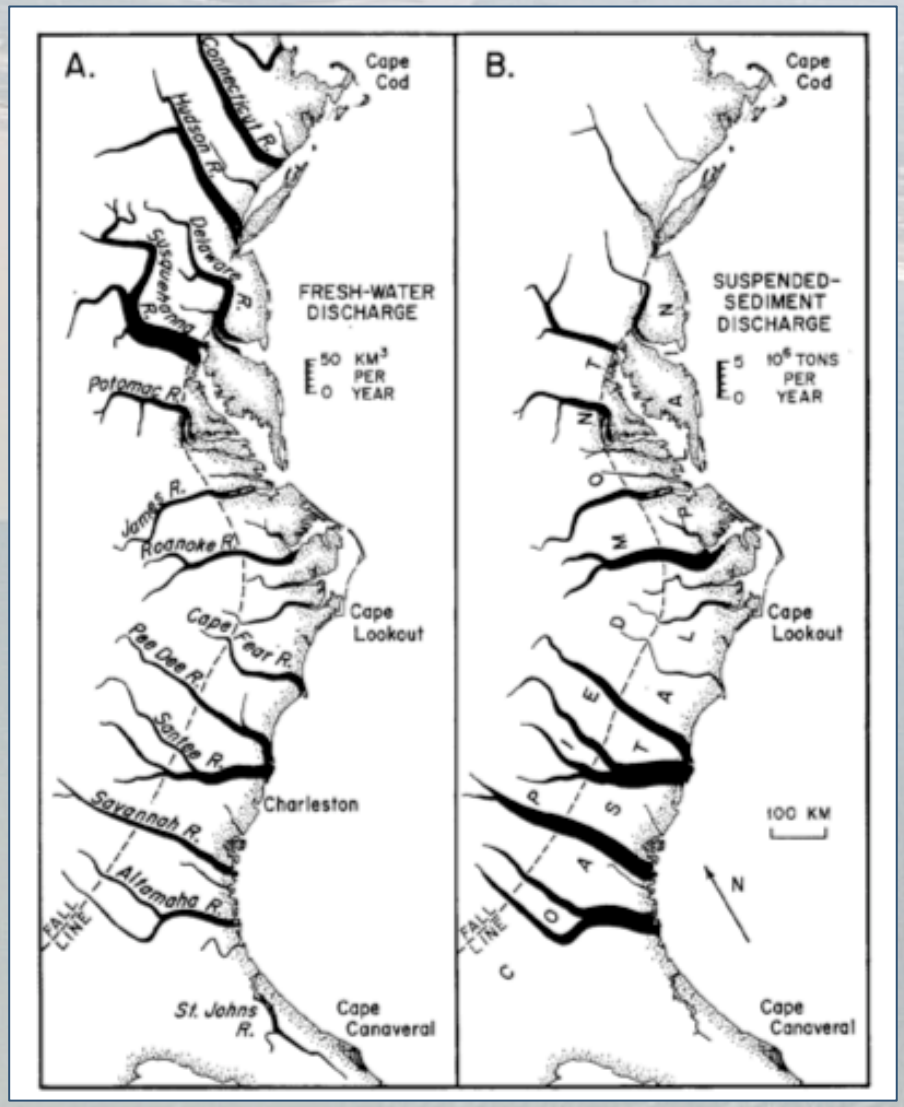
- Rapid localized deposition and erosion
- High river discharge can move ETM toward river mouth

Decadal-century time scales:

- Human alteration of sediment input rates, storage volume
- Inter-annual/decadal variation in river discharge

Longer time scales:

- Progressive estuarine filling; many now “filled”
- Localized areas of high deposition but overall accumulation ~ rate of sea-level rise
- Remobilization during falling sea-levels



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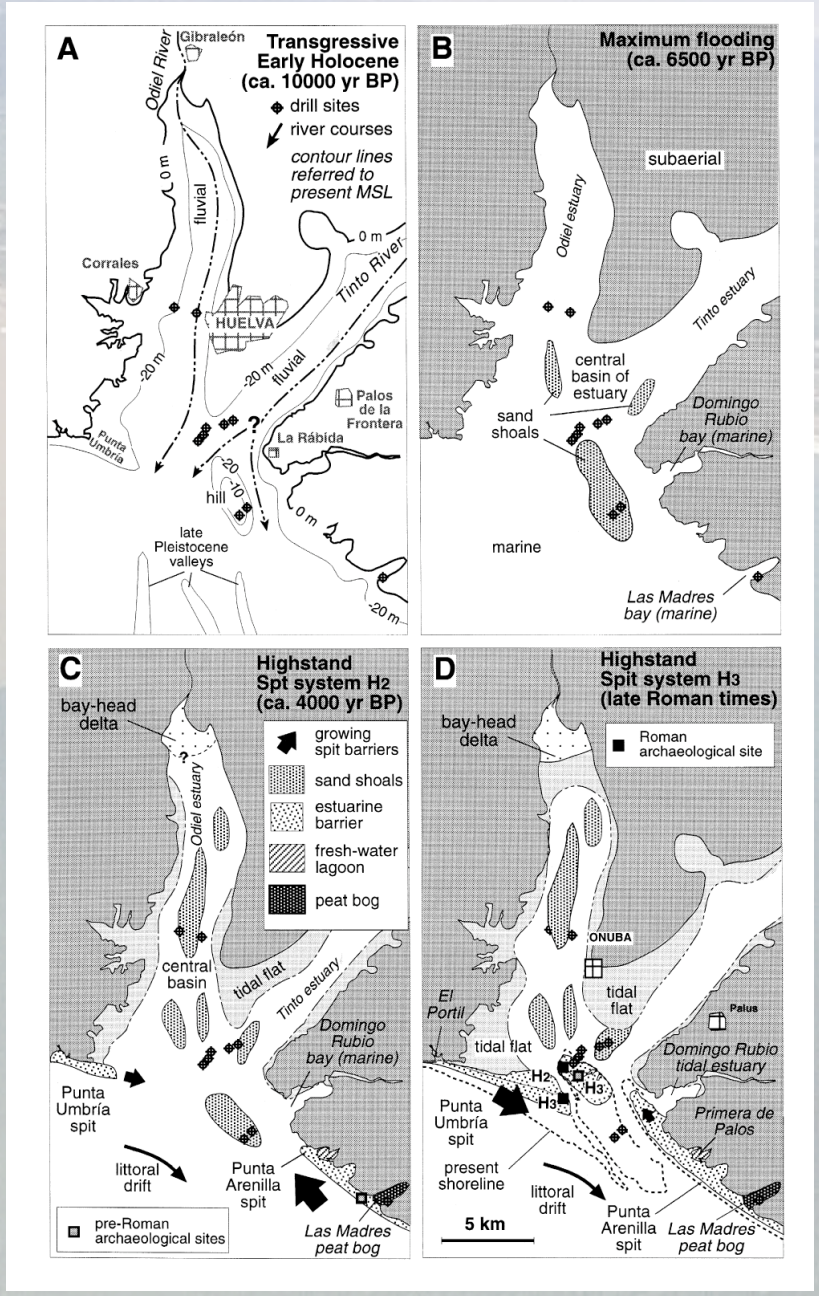
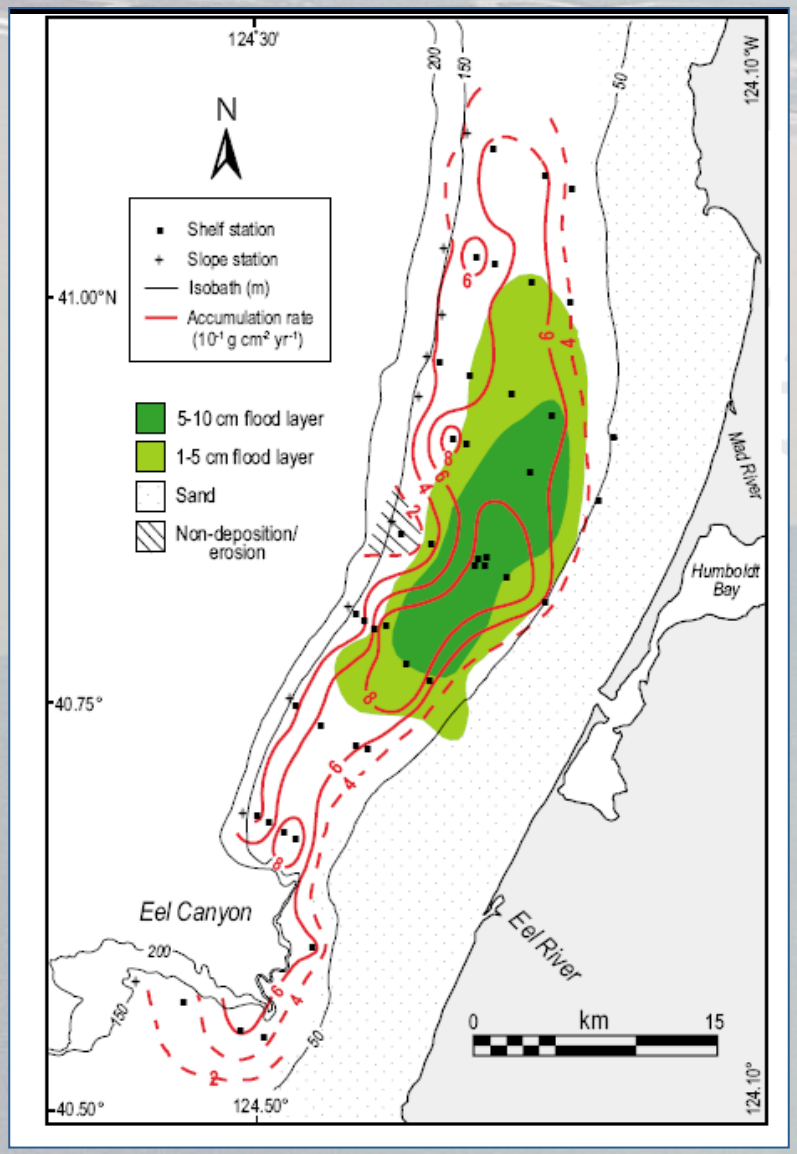
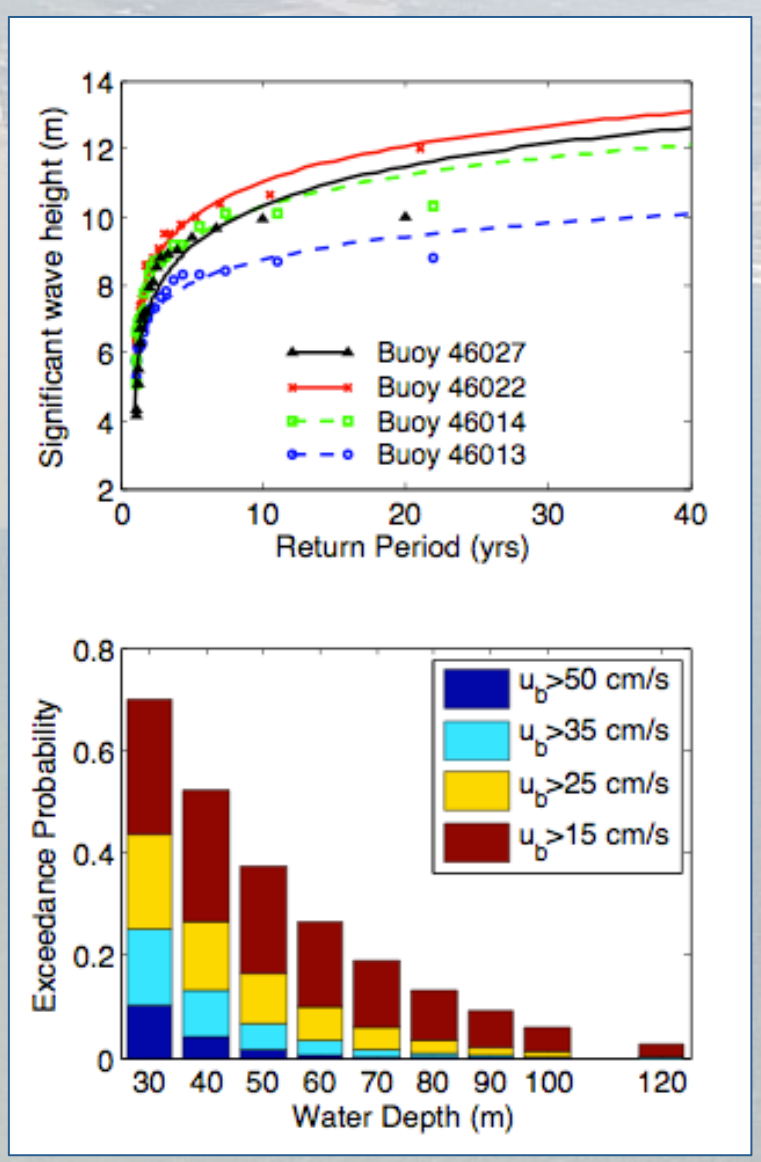


Dabrio et al 2000, Gulf of Cadiz, Spain

Shelf trapping

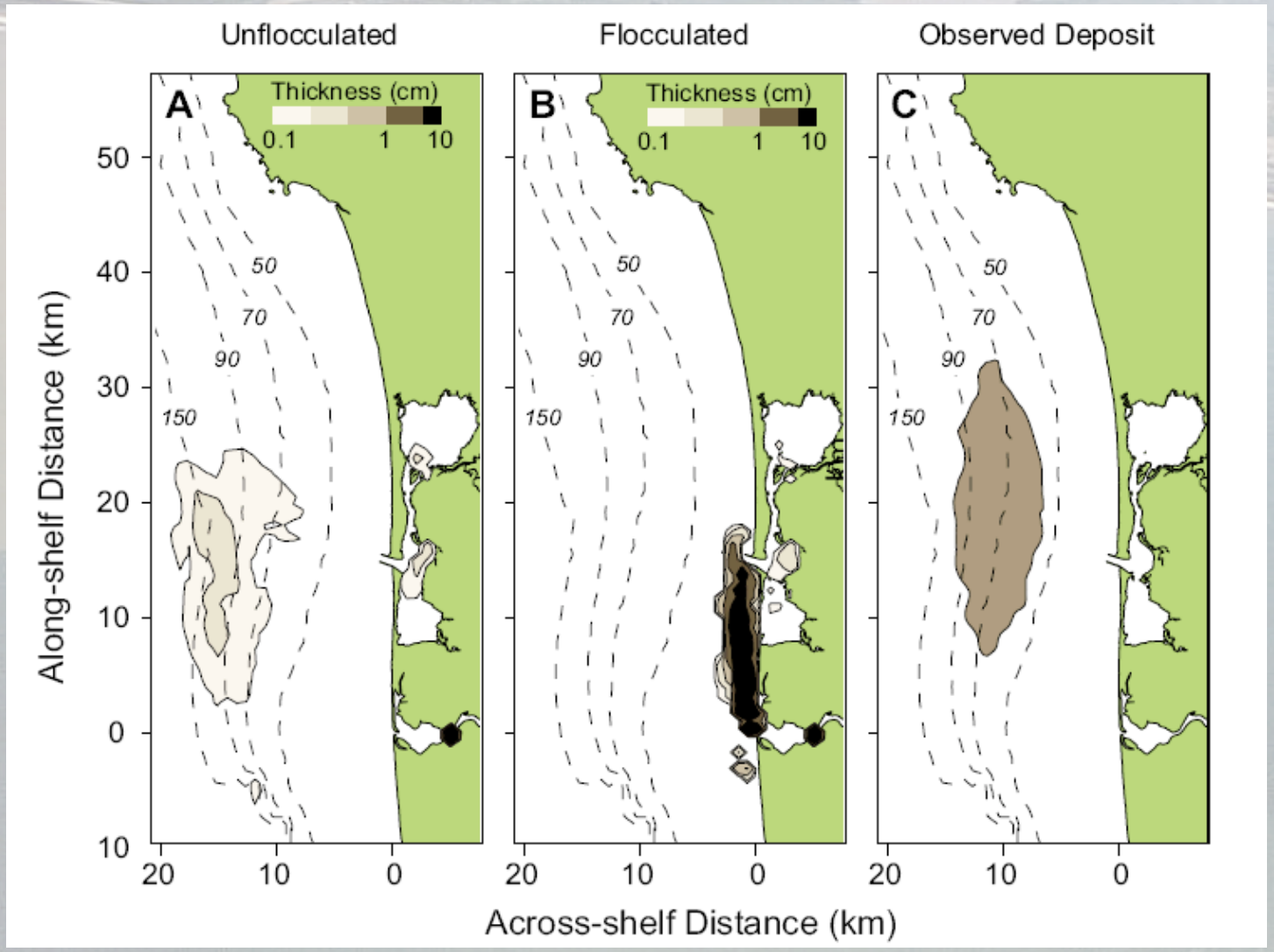


Sommerfield et al. 2007



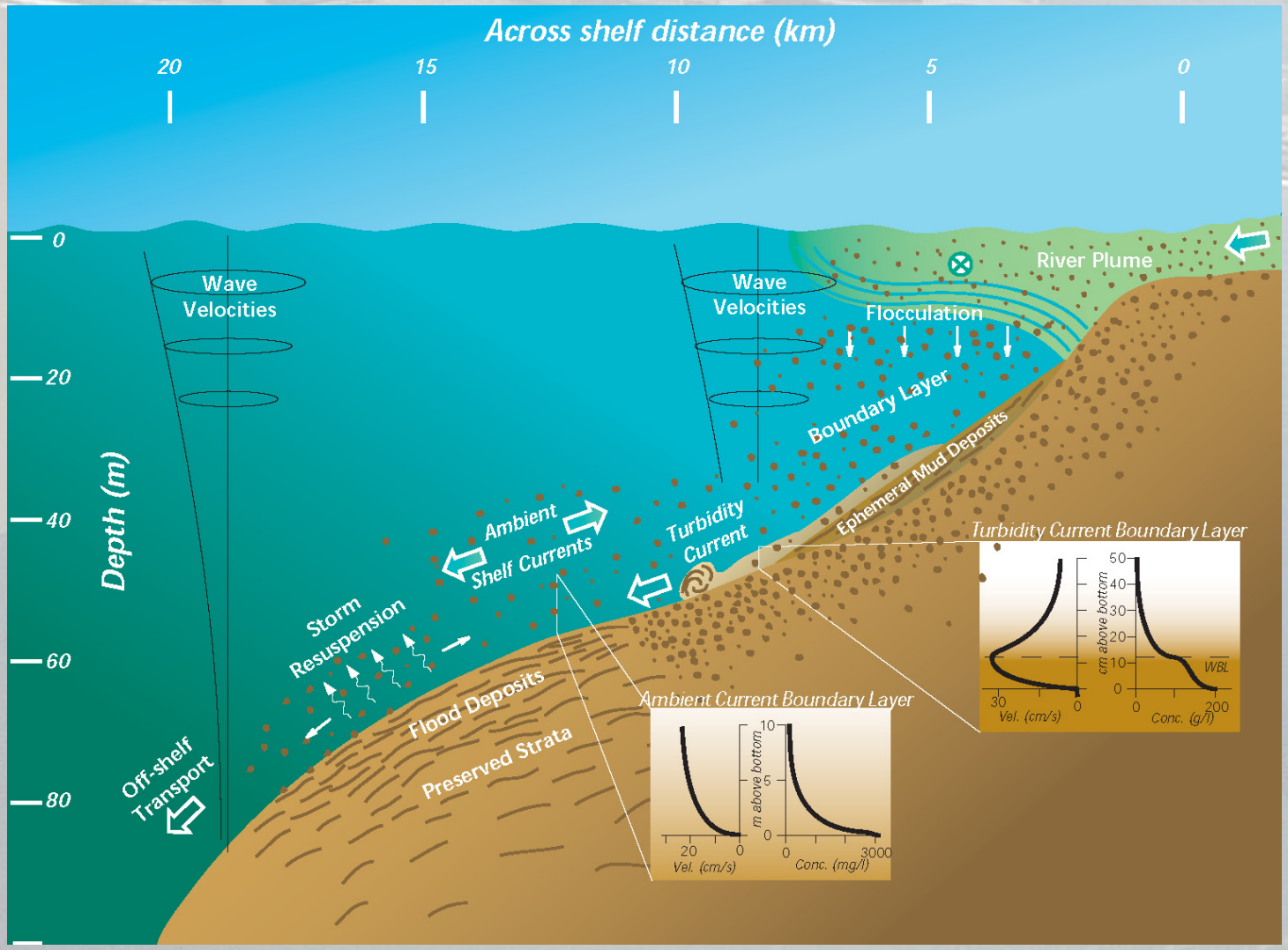
Wiberg 2000

Flood Deposition on the Eel Shelf



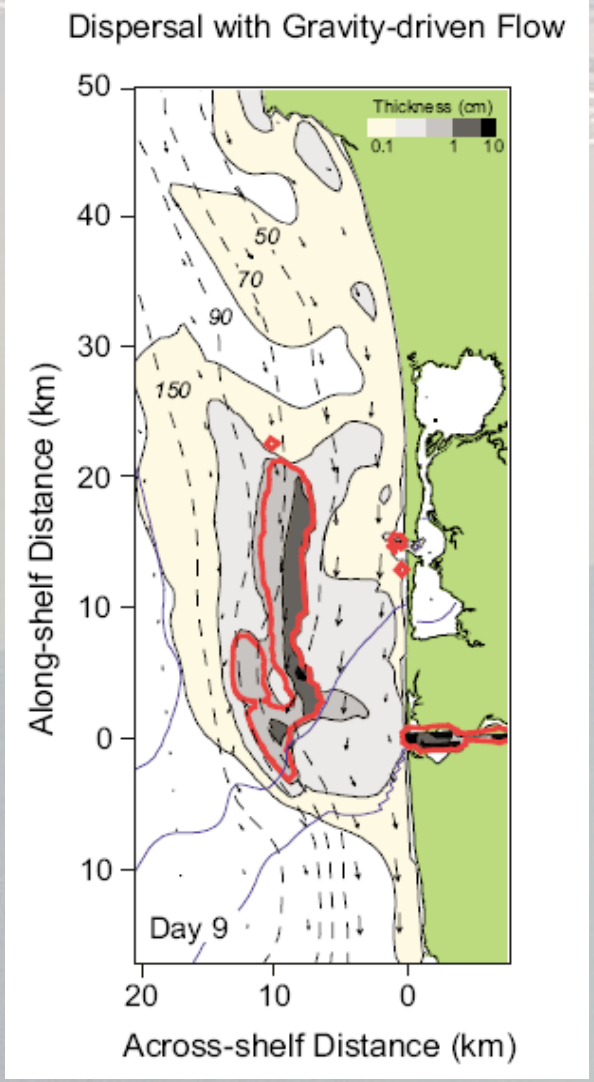
Harris et al 2005

Wave-supported gravity flows

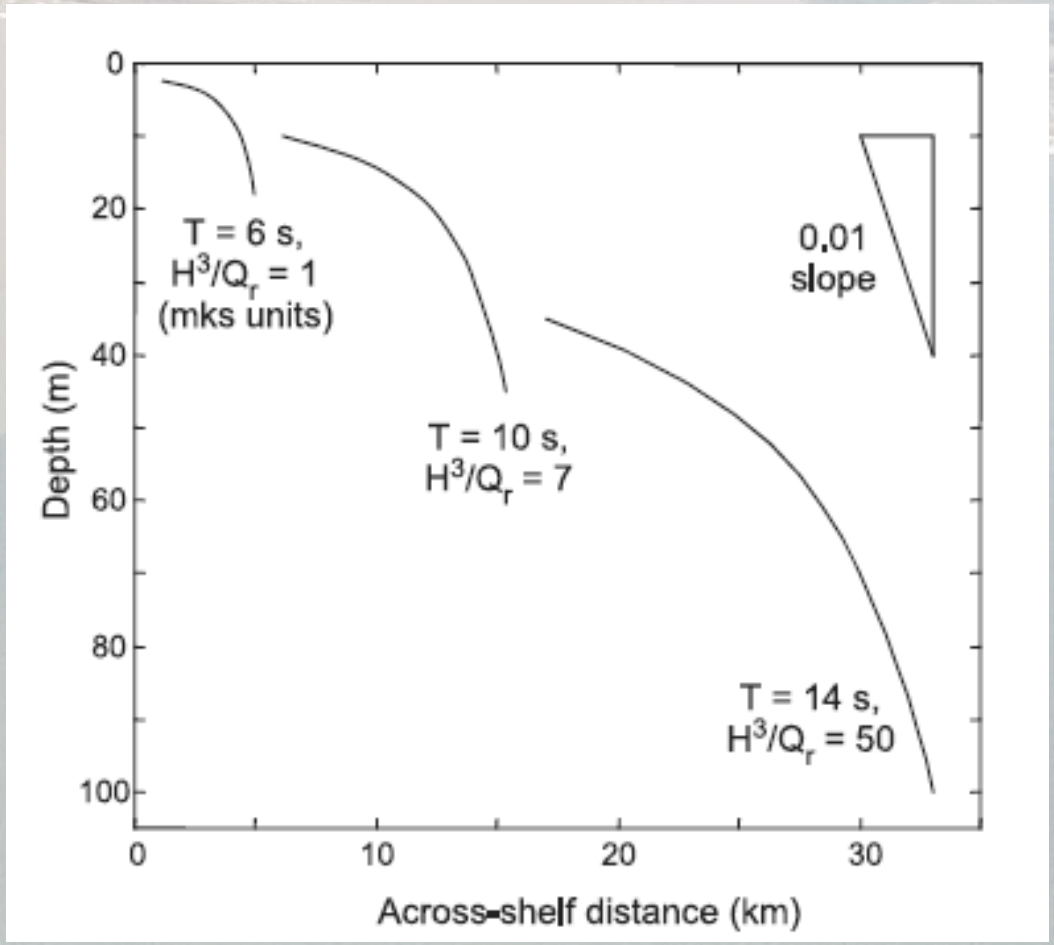


Geyer and Traykovski

Wave-supported gravity flow deposits

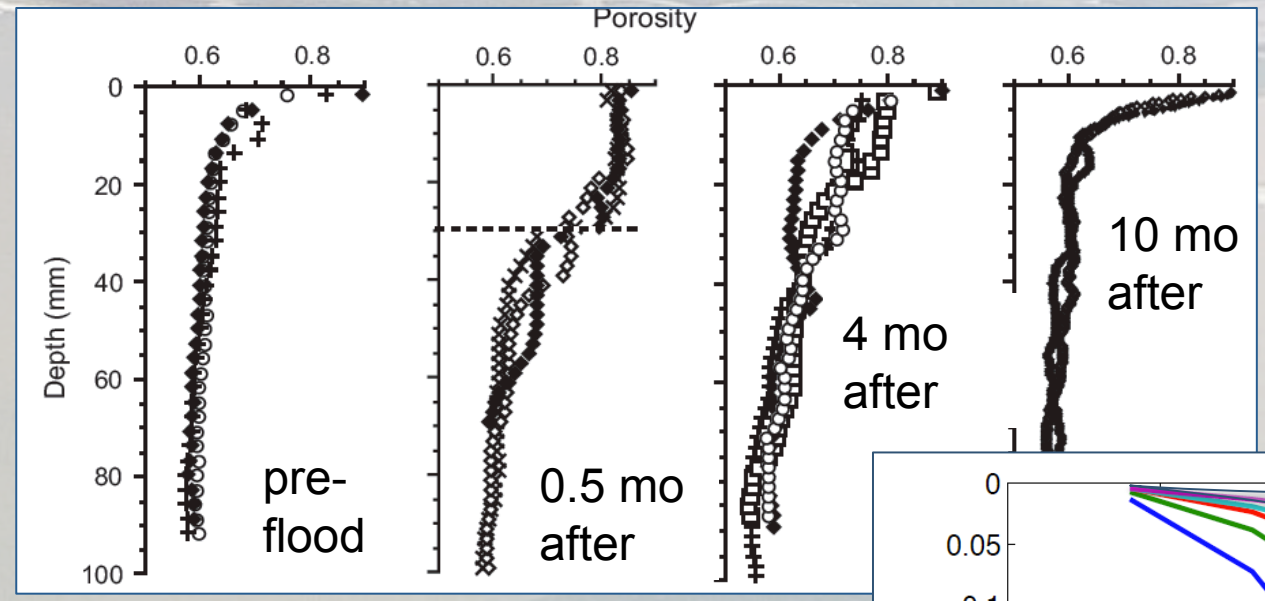


Harris et al 2005

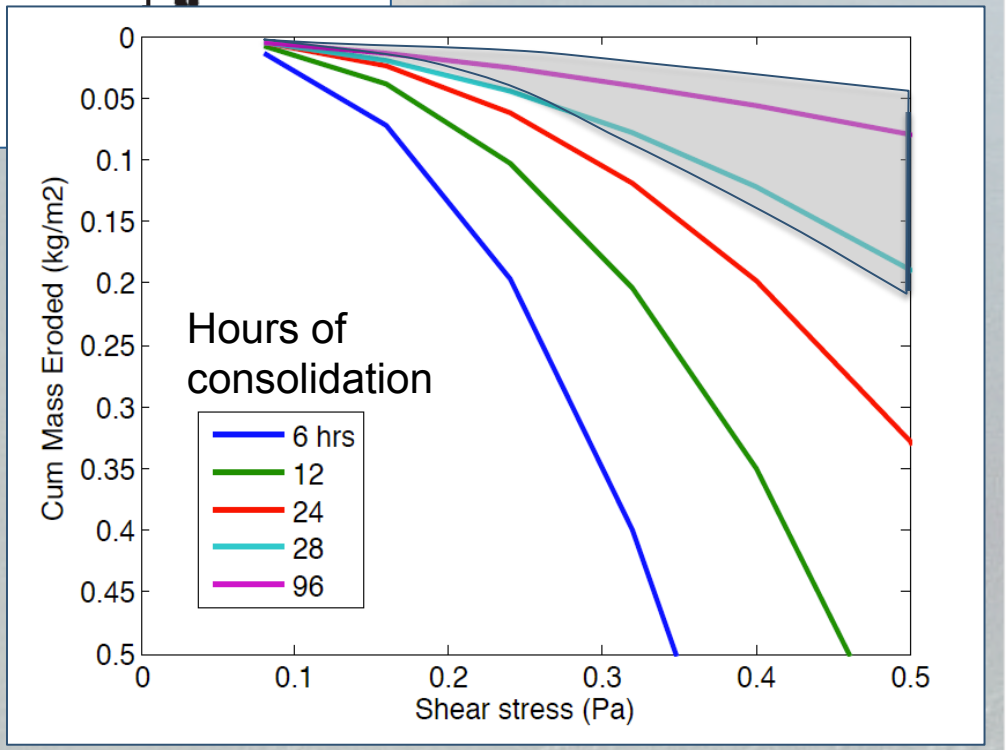


Friedrichs and Wright 2004

Sediment consolidation



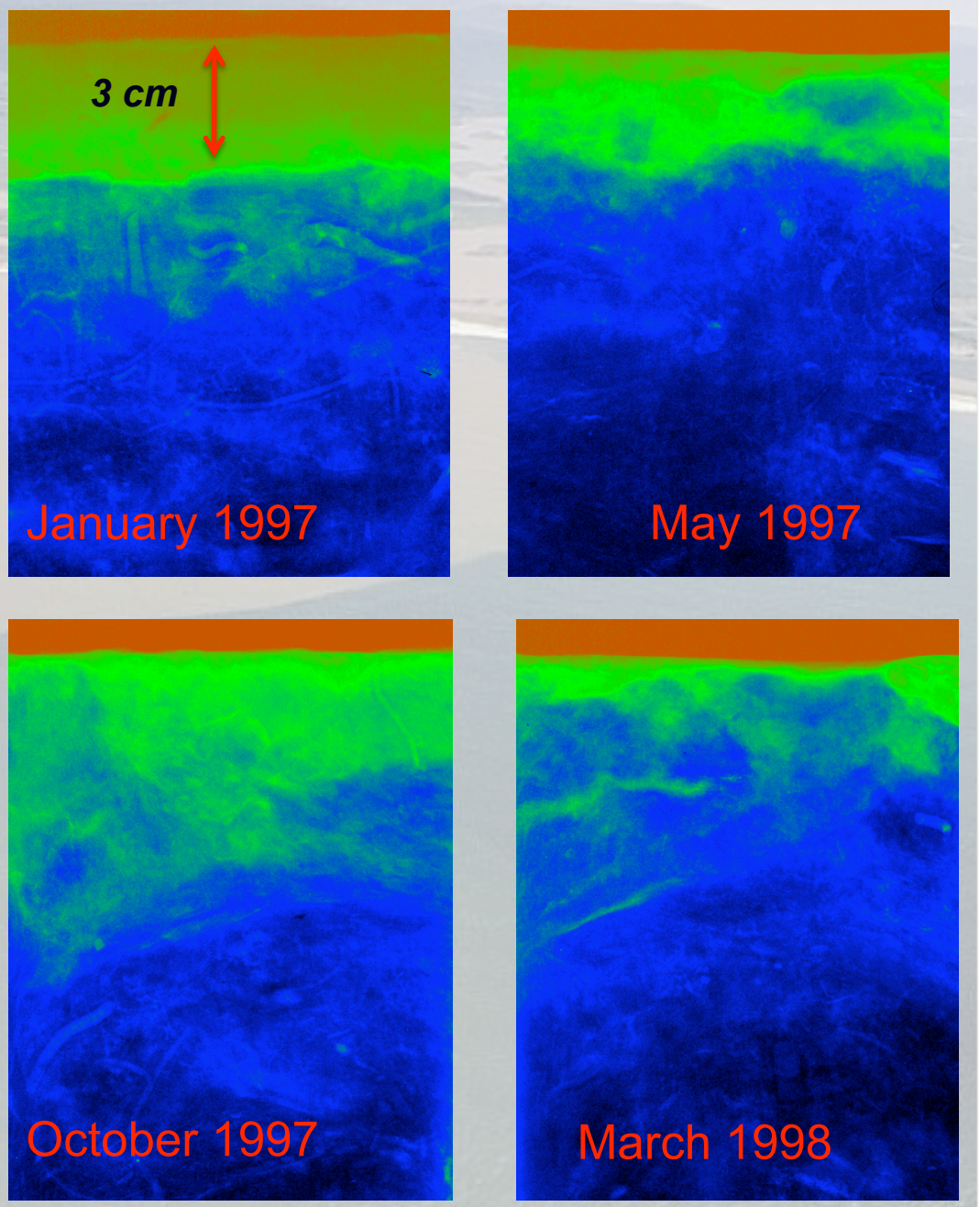
Wheatcroft et al 2007



Wiberg et al, in prep

Short time scales:

- Rapid localized deposition by WSGF followed by consolidation
- Bioturbation, reworking



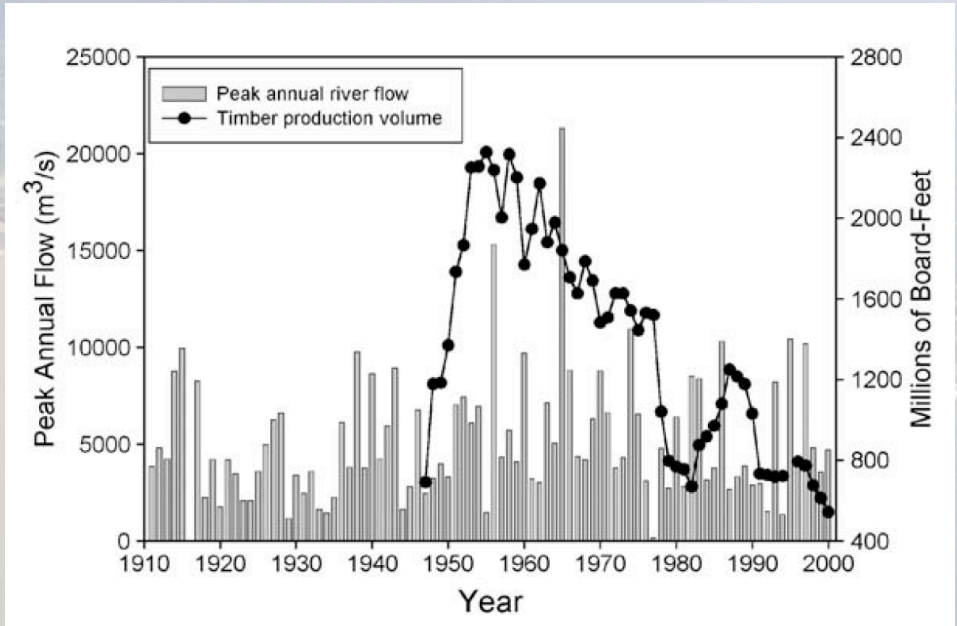
R. Wheatcroft

Short time scales:

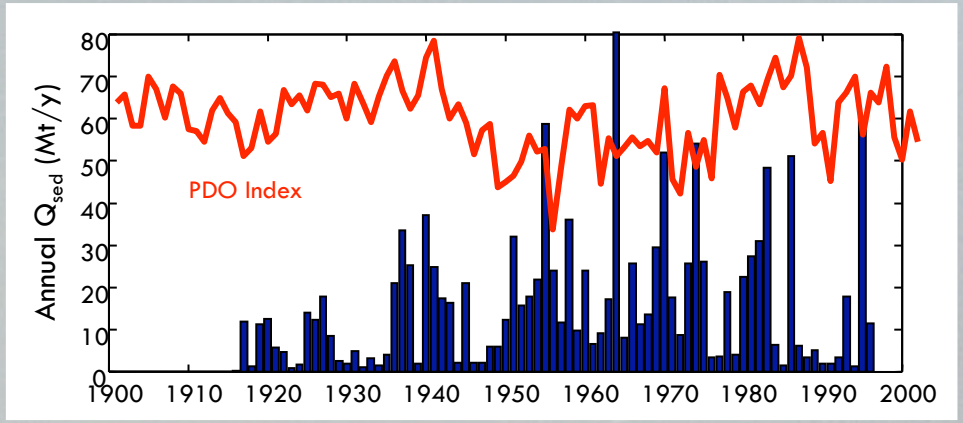
- Rapid localized deposition by WSGF and consolidation
- Bioturbation

Decadal-century time scales:

- Human alteration of sediment input rates
- Inter-annual/decadal variation in floods and storms



Leithold et al 2004



Short time scales:

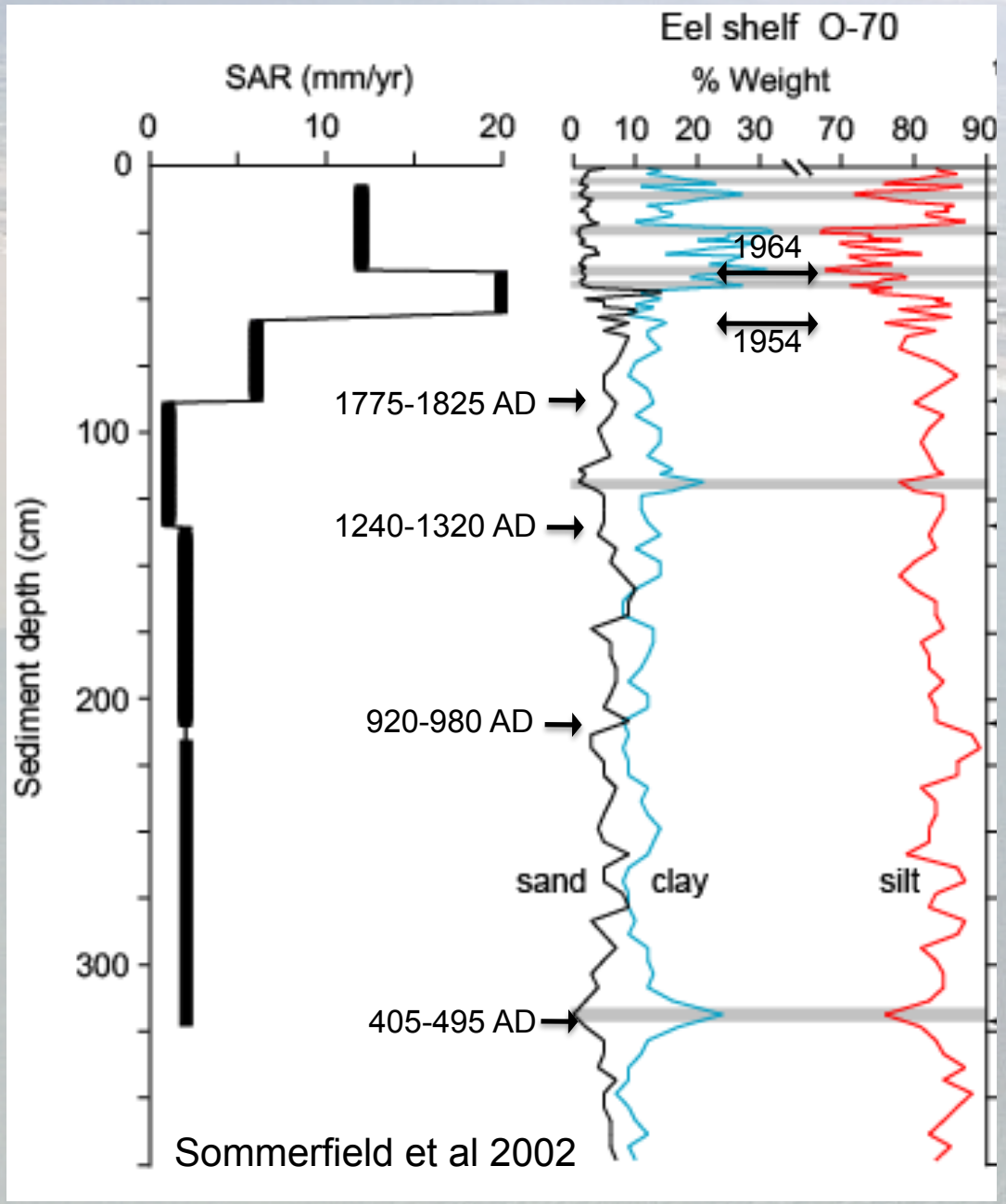
- Rapid localized deposition by WSGF and consolidation
- Bioturbation

Decadal-century time scales:

- Human alteration of sediment input rates
- Inter-annual/decadal variation in floods and storms

Longer time scales:

- Limited accommodation space
- Low preservation potential in absence of rapid burial
- Remobilization during falling sea-levels



Implications for S2S

- Strong influence of large river discharge events in depositional patterns in coastal/shelf storage zones
- Trapping of flood sediment in coastal/shelf storage areas represents the most seaward extent of the direct effect of individual river discharge events on most margins
- With the exception of large estuaries, accumulation rates are largely paced by rates of sea-level rise
- Climate variability and climate change are important controls on storage and remobilization
- There is a large signal from human activities in the modern record. How well can it be separated from natural variability?
- This whole system becomes terrestrial during sea-level low-stands.