# 3-D Architecture of a Wave-Influenced Parasequence in the Ferron "Notom" Delta, Capital Reef Utah, USA: Implications for Delta Asymmetry Models*

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Search and Discovery Article #50438 (2011)
Posted June 30, 2011

*Adapted from oral presentation at AAPG Annual Convention and Exhibition, Houston, Texas, USA, April 10-13, 2011.

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## Abstract

The recent delta asymmetry models predict sandy shoreface facies on the updrift side and muddier heterolithic lagoon, bay-fill, and barrier/bar facies on the down drift side. These models, however, are largely distilled from modern systems. Studies evaluating their validity in the ancient record are very limited. The Turonian Ferron "Notom" delta in the Capital Reef area of southern Utah, USA, is exposed three dimensionally along a 45 km by 30 km outcrop belt. This provides an ideal opportunity for further testing the asymmetry models.

Thirty-four geological sections documented the 3-D architecture of parasequence 6 in the fluvial-deltaic complex. The parasequence consists of four facies successions and along depositional strike, these show distinct transition from shoreface deposits in the north, into heterolithic, river-dominated delta-front and channel and/or mouth-bar facies south and southeastward, and wave-/storm-reworked delta-front facies farther southeastward. Ichnogenera suites correspondingly show distinct along-strike changes from robust and healthy expressions of the Cruziana and Skolithos Ichnofacies, into suites characterized by horizontal, morphologically simple, facies-crossing structures. Farther southeastward Ichnogenera abundance and diversity increase, reflecting the archetypal suites.

The overall facies distribution in the parasequence suggests delta asymmetry. Different from the recent delta asymmetry models, however, significant muddy paralic, lagoon, and bay-fill facies are not identified on the downdrift side. The lack of these facies is attributed to: 1) a negative paleoshoreline trajectory during delta progradation as indicated by the occurrence of sharp-based proximal shoreface successions on the updrift side and the overall downward- and basinward-stepping of the

studied parasequence with respect to its previous ones; and 2) subsequent transgressive erosion as shown by the decimeter thick transgressive lag overlying the parasequence.

The observations suggest that, depending on shoreline trajectory and reworking after deposition, facies of asymmetric deltas can be different from those predicted by the asymmetric models. Future studies, thus, need to involve paleoshoreline trajectory and depositional history into these models.

## References


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McCubbin, D.G., 1982, Barrier-island and strand-plain facies, *in* P.A. Scholle, and D.R. Spearing, (eds.) Sandstone depositional environments: AAPG Memoir 31, p. 247-279.

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# 3D facies architecture of a wave-influenced parasequence in the Ferron Notom Delta, Capital Reef Utah, USA: implications for delta asymmetry models

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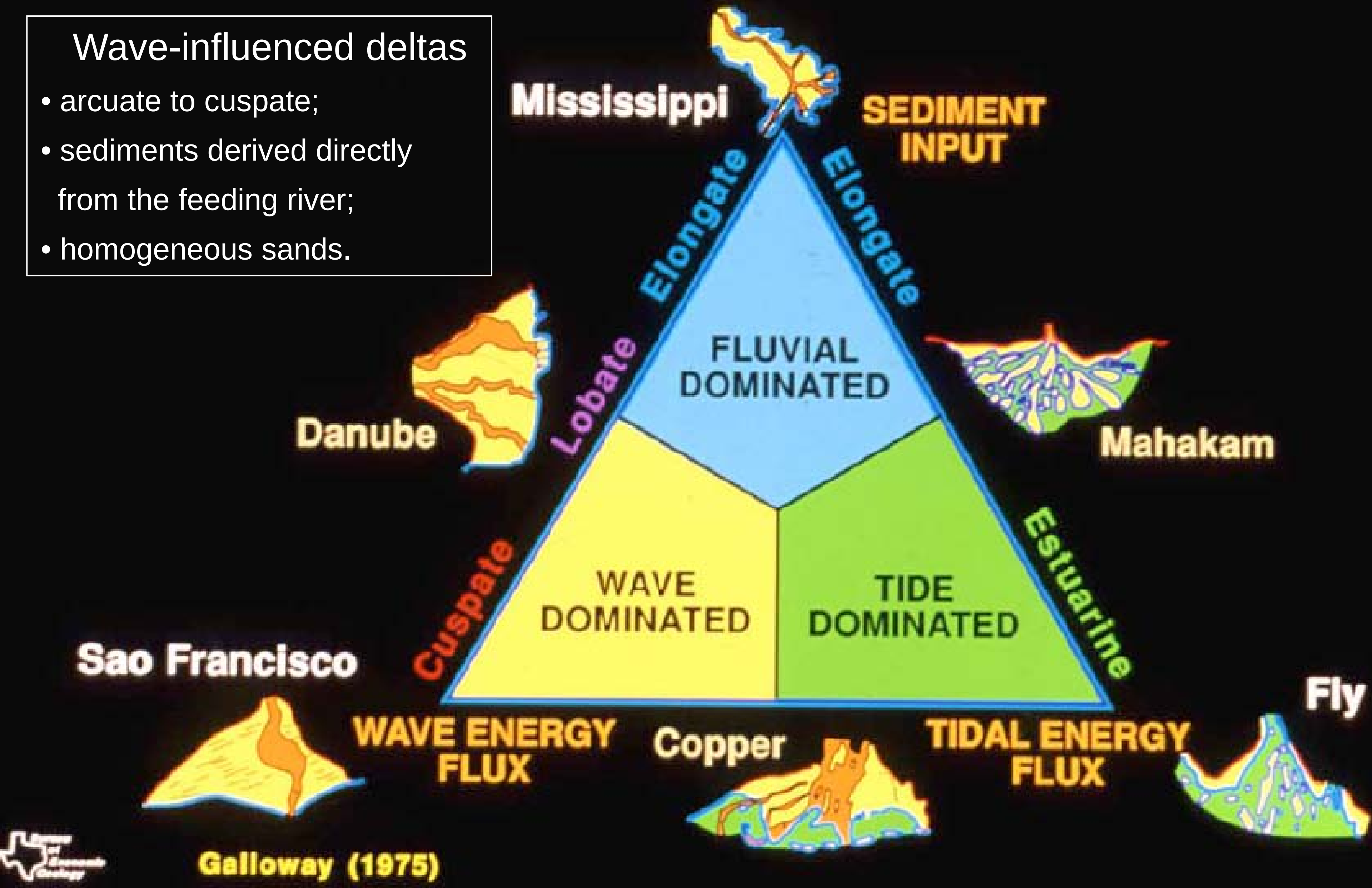
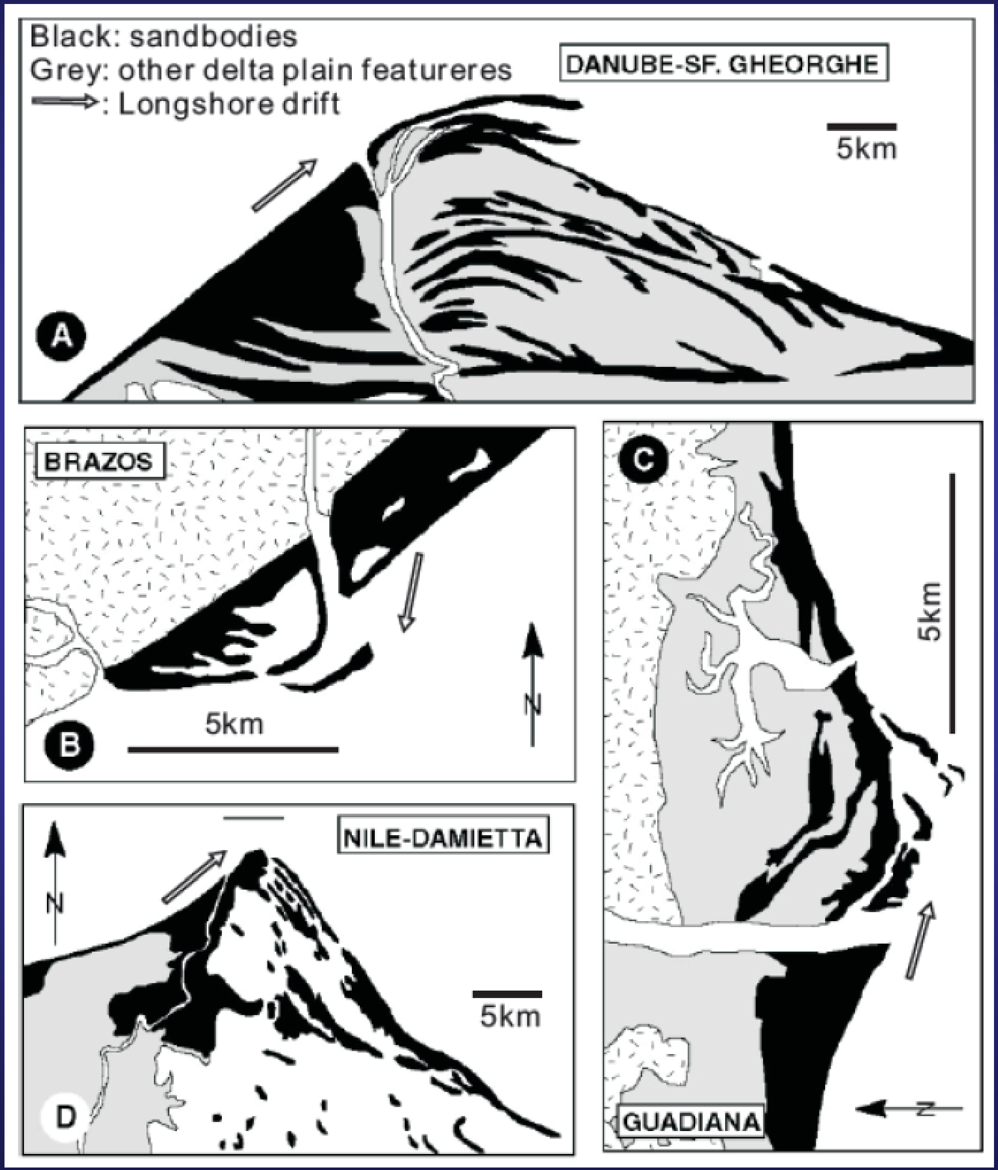
# Early deltaic models

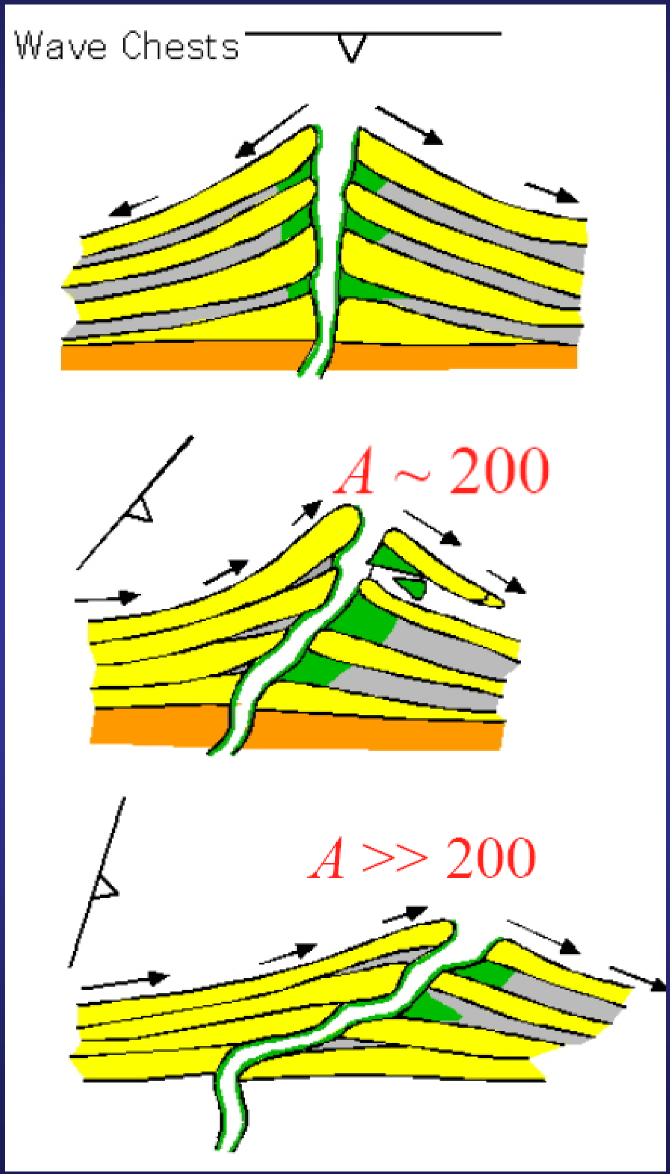
Wave-influenced deltas

- arcuate to cuspate;
- sediments derived directly from the feeding river;
- homogeneous sands.



# Delta asymmetry: models



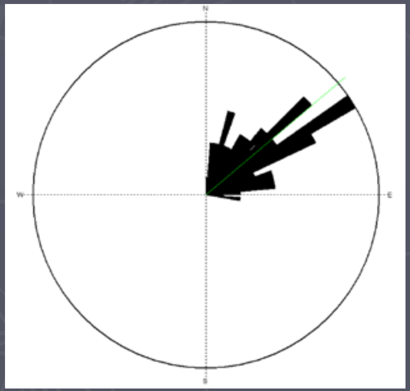




(Bhattacharya and Giosan, 2003)

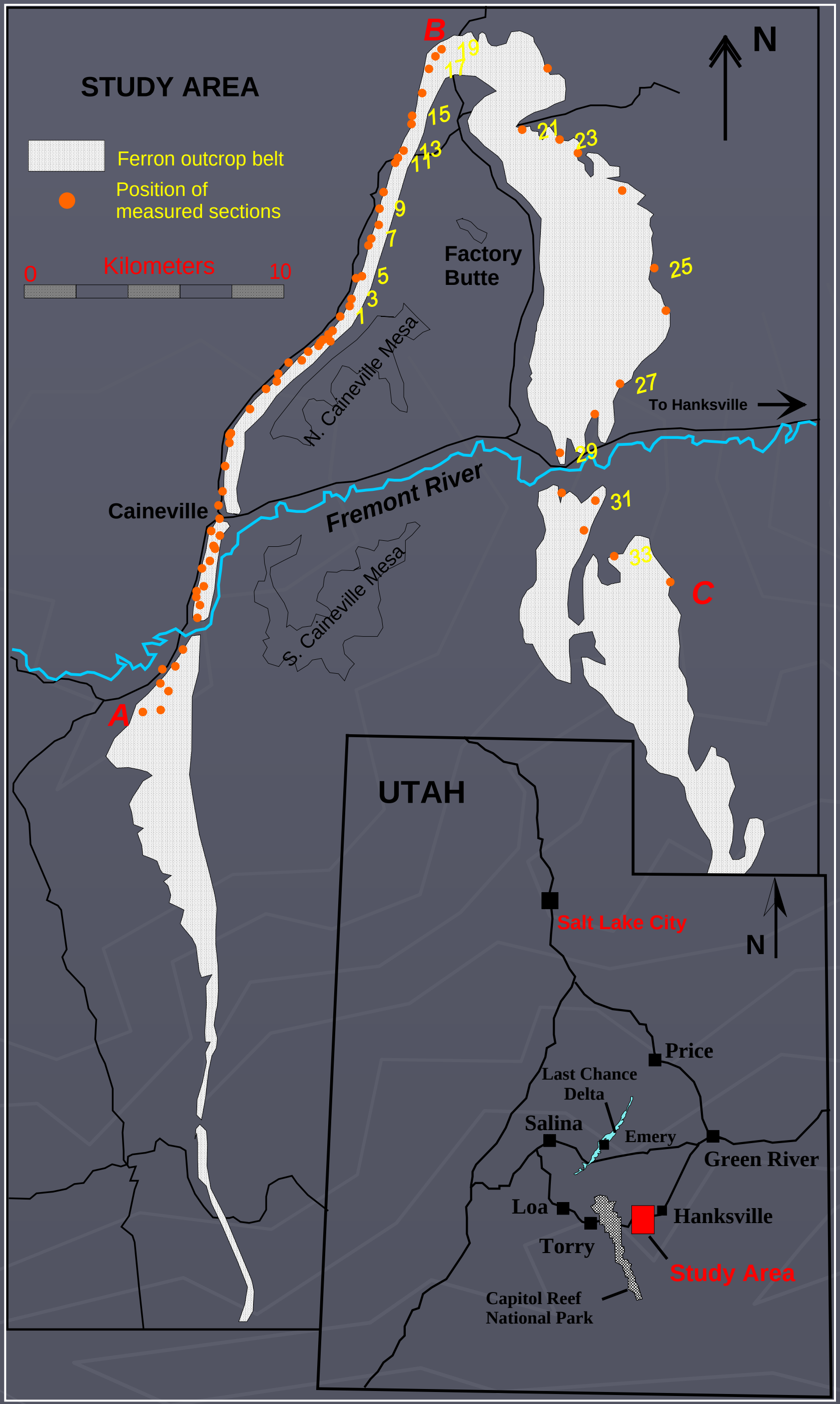
# Study area and data set

- 73 sections total
- 34 to cover the studied parasequence

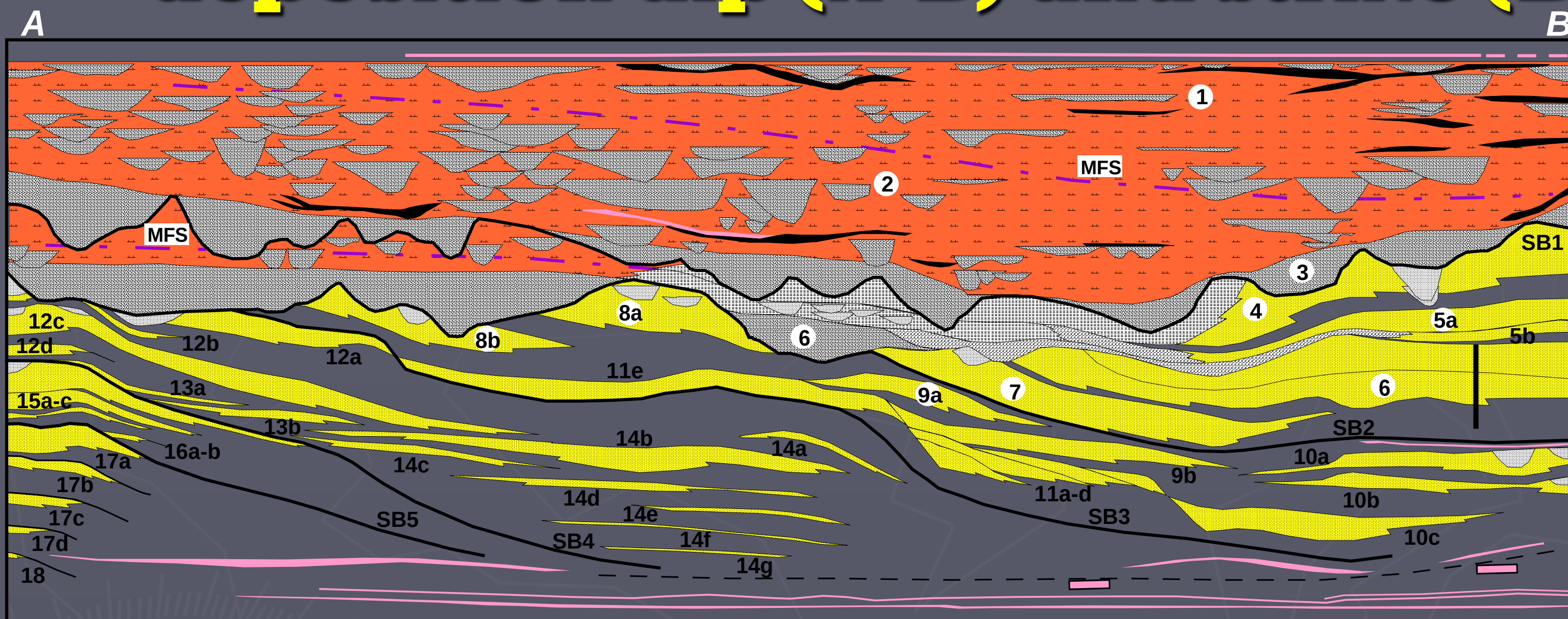
Regional paleocurrent



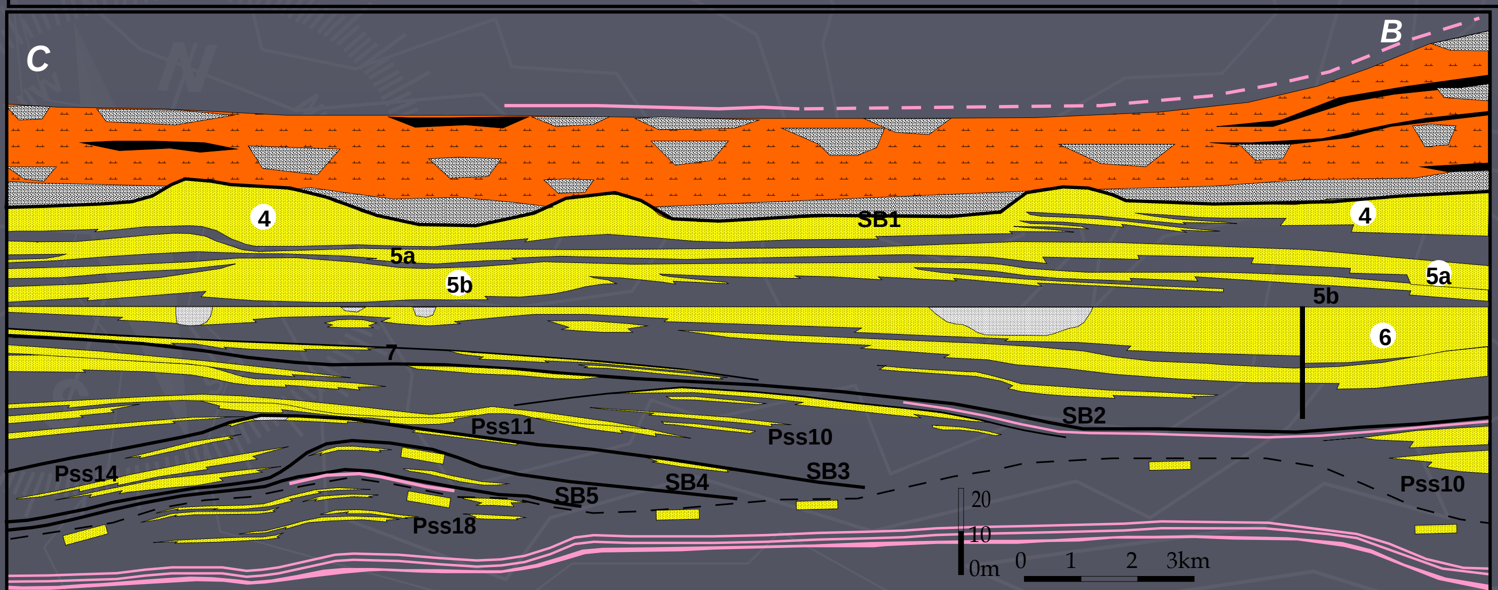
Measurements: N=123
mean: 50

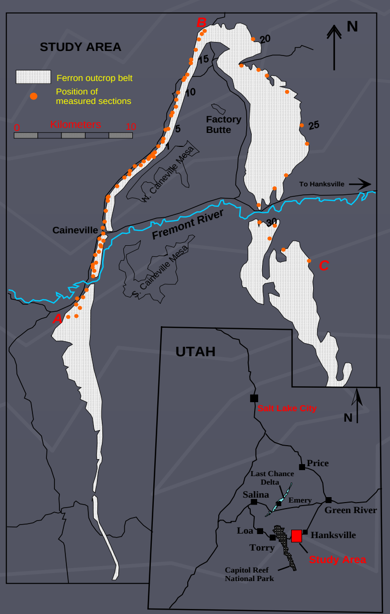


# Sequence stratigraphy: deposition dip (A-B) and strike (B-C)

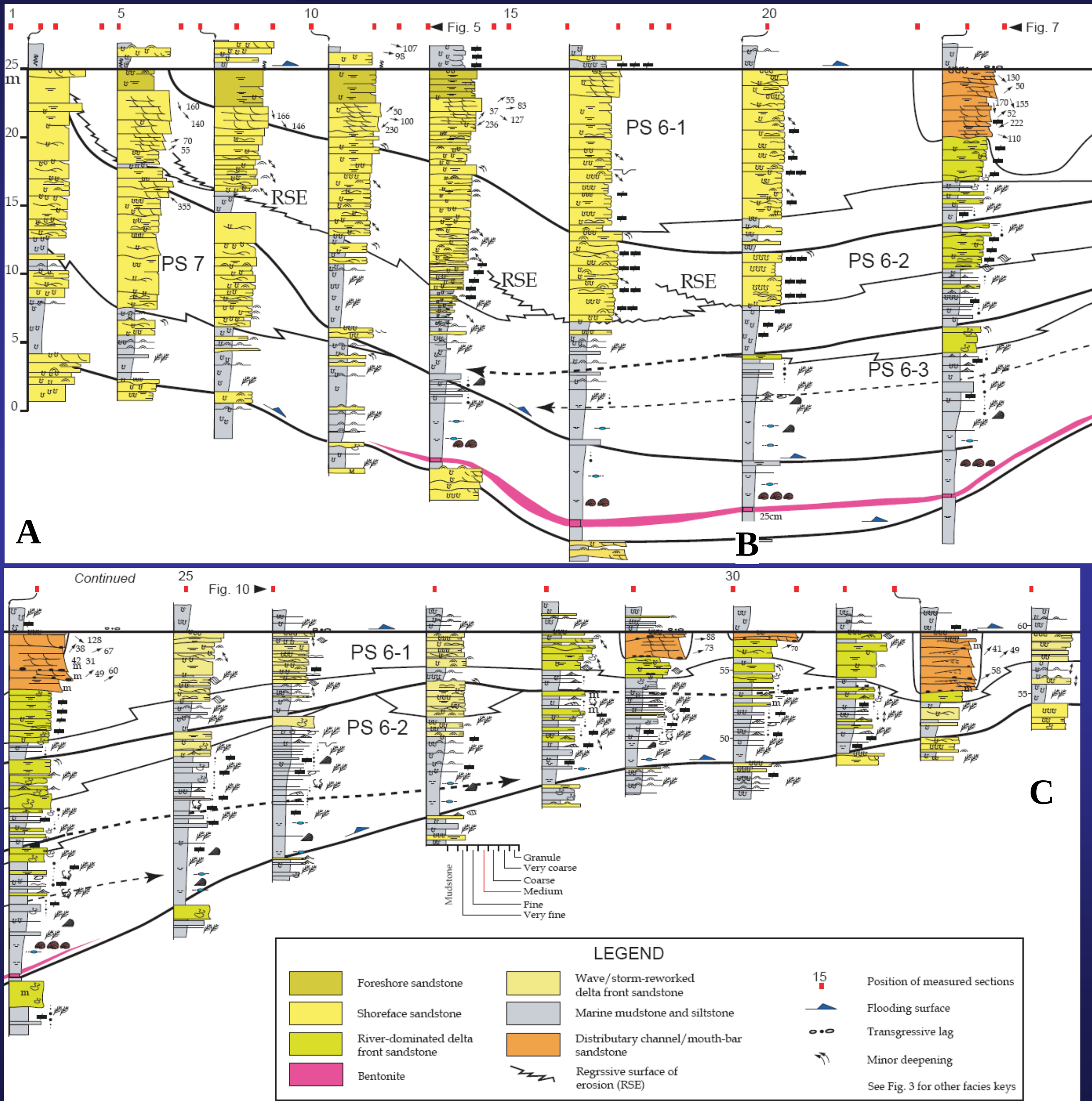



Regional paleocurrent



# Along-strike facies transition: Ps 6



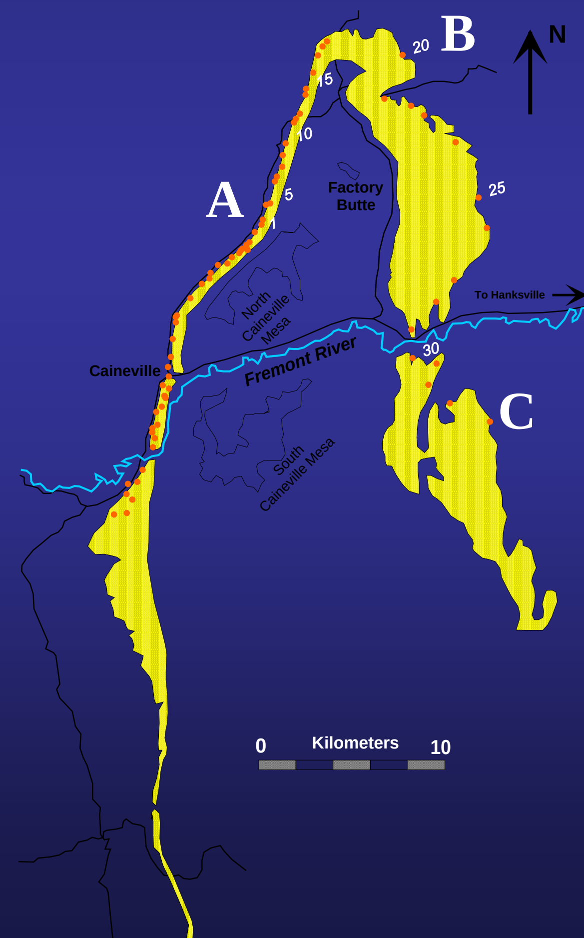

Four major facies types

FAC1: shoreface

FAC2: active delta front

FAC3: reworked delta front

FAC4: channel/Mouth bar

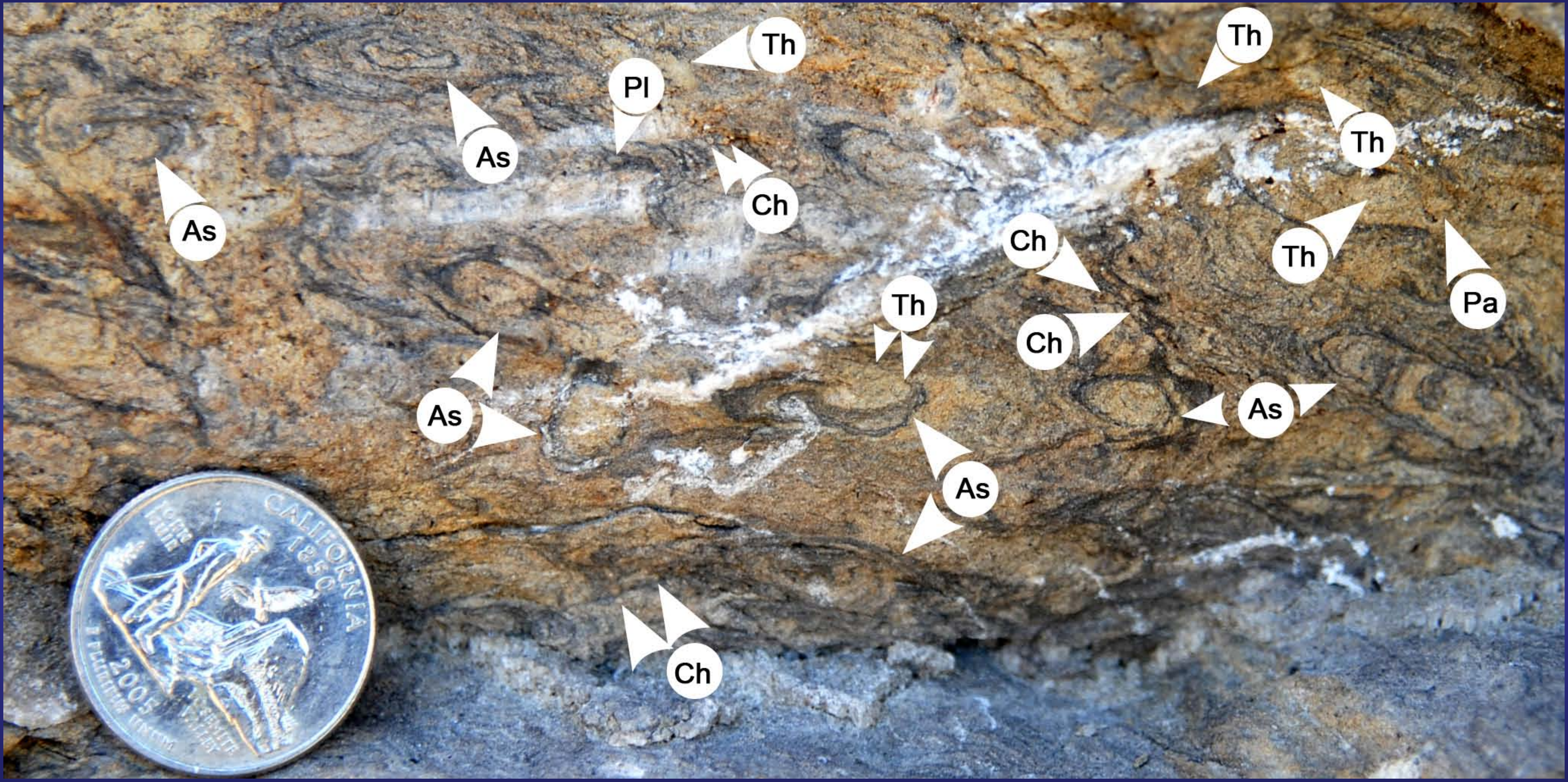


# Shoreface facies: upper shoreface (USF) /foreshore (FS)


HCS

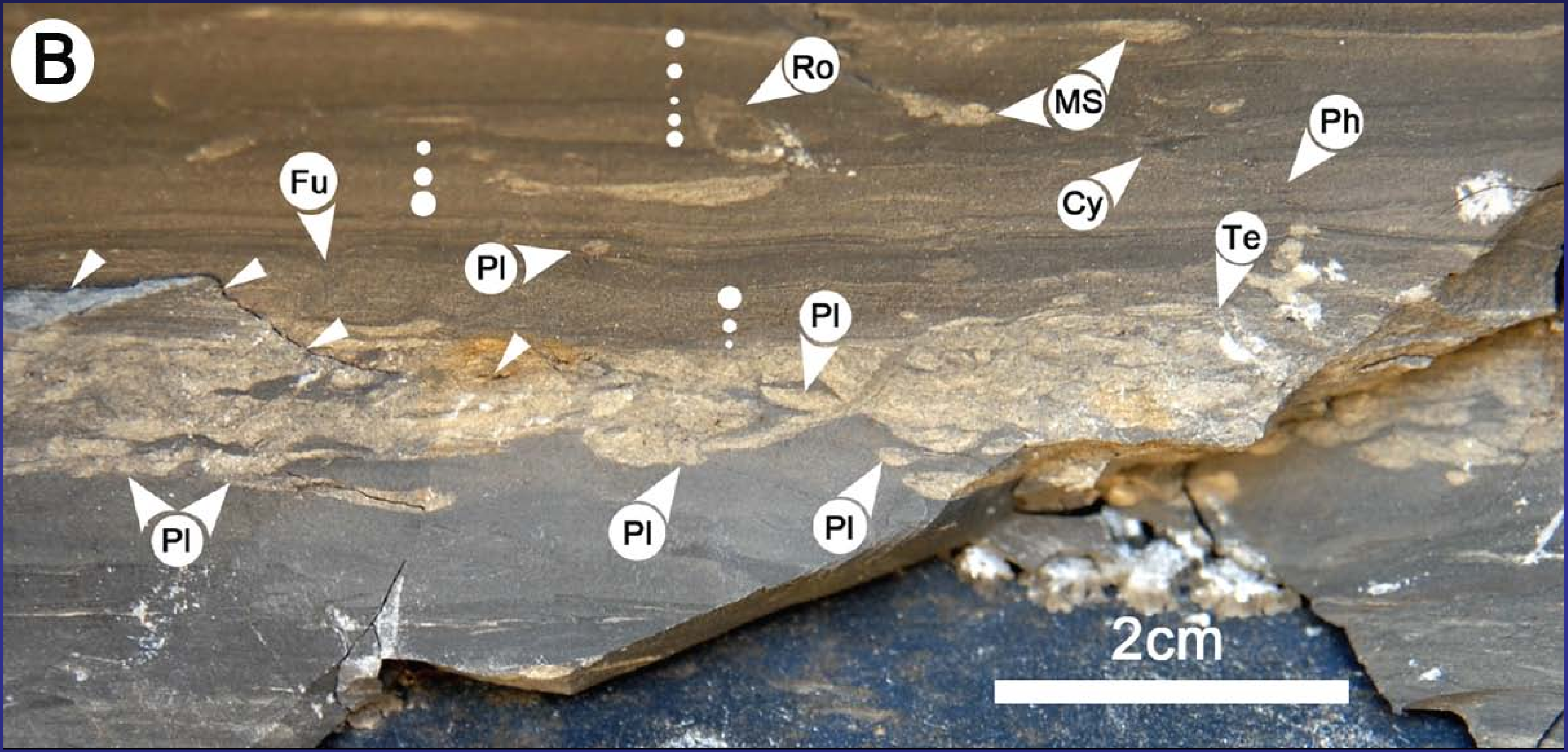

SCS
Typical storm wave-induced structures

# Robust & healthy expression of the *Cruziana* ichnofacies in lower shoreface muddy sandstones



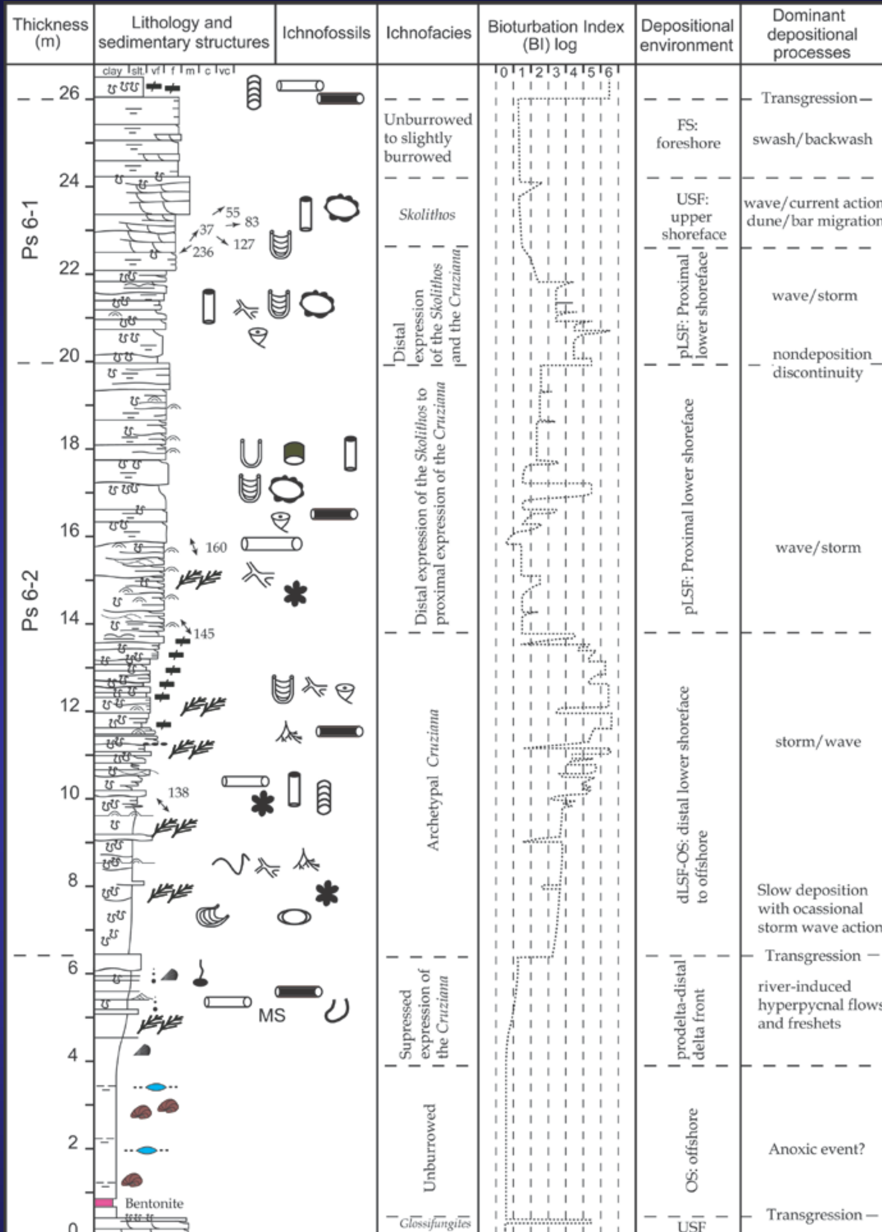

*Asterosoma* (As), *Thalassinoides* (Th), *Chondrites* (Ch), *Planolites* (Pl) and *Palaeophycus* (Pa)

# River-dominated delta front



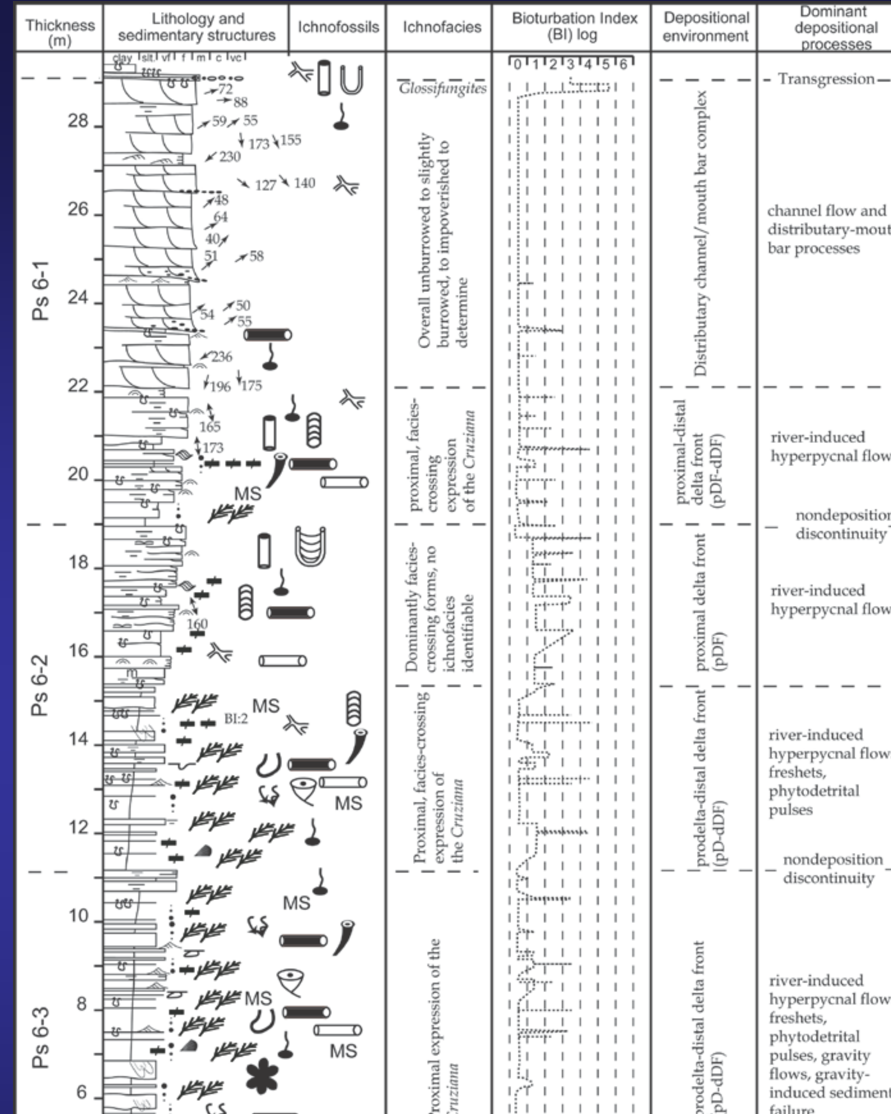

*Planolites (Pl), Teichichnus (Te), Phycosiphon (Ph), fugichnia (Fu), Rosselia (Ro) and "mantle and swirl" structures (MS).*

- Ichnogenera: low diversity and abundance;
- Overall low bioturbation, with high spikes;
- MS structures, sediment-swimming of organism in soupy substrata;
- Erosional truncation indicates emplacement of hyperpycnal flows.




# Strongly wave-influenced Shoreface

- Typical storm wave-induced structures;
- Diverse, healthy, and robust ichnogenera.

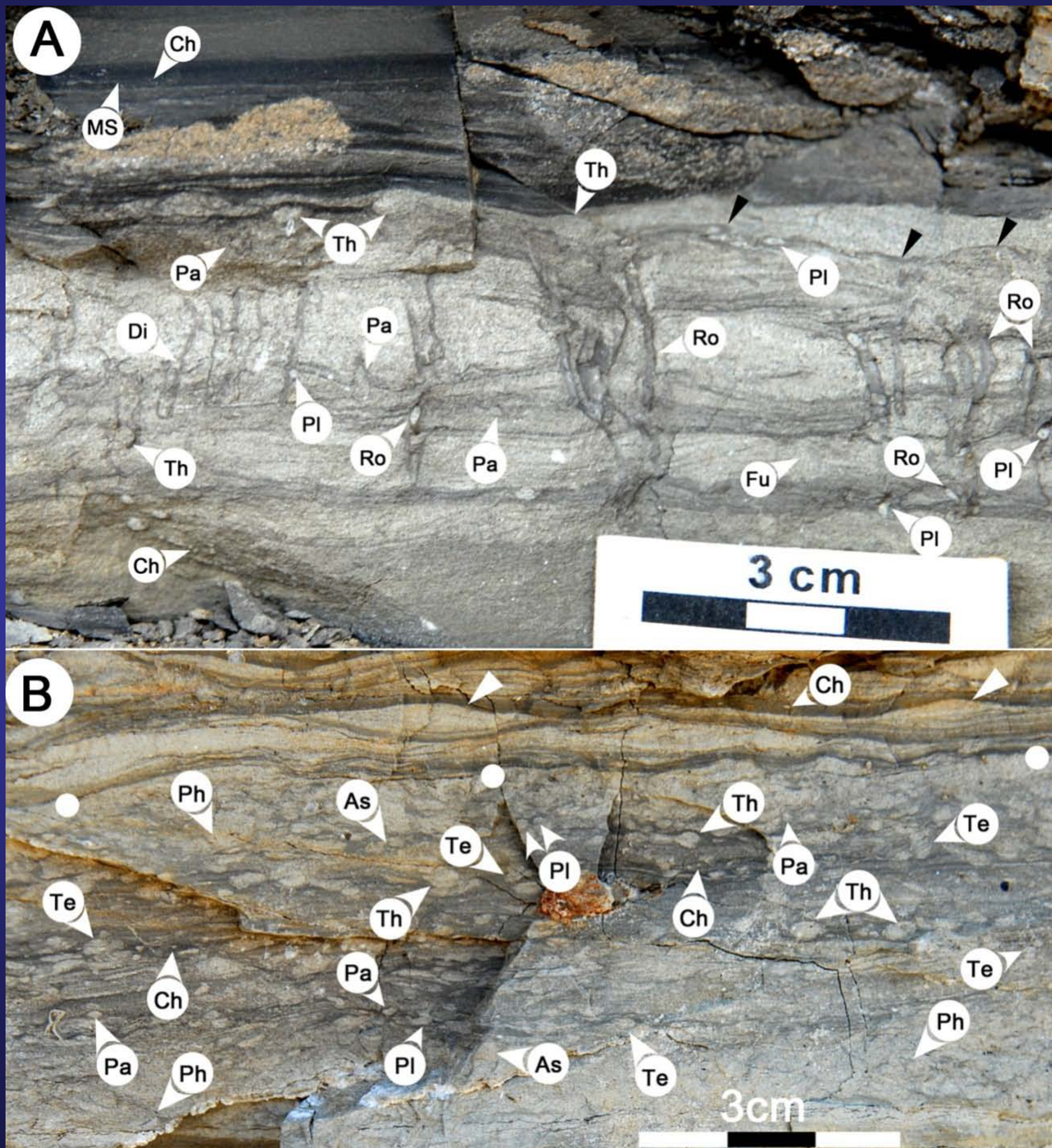



# Strongly River-influenced delta front

- Muddier and heterolithic, typical unidirectional flow induced structures;
- Low diverse suppressed ichnogenera;
- Dominated by facies-crossing, morphological-simples ichnological structures

# wave-rework delta front, planar/wavy bedding

# Ichnogenera in wave-reworked distal delta front (dDF)




**(A)**

***Thalassinoides* (Th),**

***Diplocraterion* (Di),**

***Planolites* (Pl),**

***Chondrites (Ch)* ,**

***Palaeophycus* (Pa),**

***Rosselia (Ro*) ,**

***Fugichnia (Fu*)**

***"mantle and swirl"***

***structures (MS).***

a low-diversity, proximal expression of the *Cruziana* ichnofacies

**(B)**

***Planolites* (Pl),**

***Palaeophycus* (Pa),**

***Thalassinoides* (Th),**

***Teichichnus* (Te),**

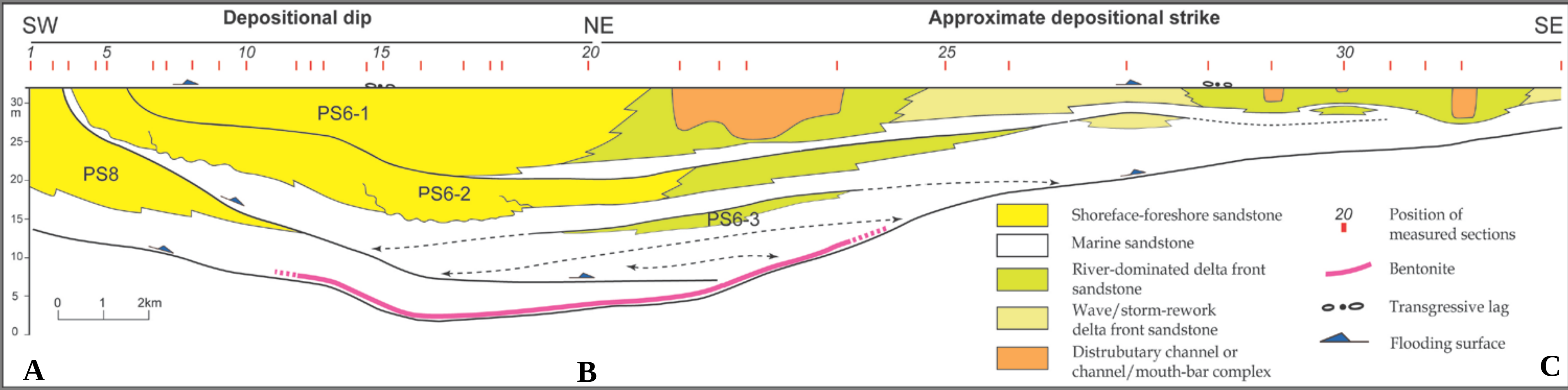
***Rosselia (Ro*),**

***Phycosiphon* (Ph),**

***Chondrites* (Ch)**

a more healthy expression of the *Cruziana* ichnofacies

# Along-strike facies transition



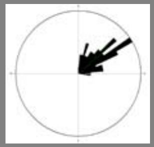

## Four major facies types

FAC1: shoreface

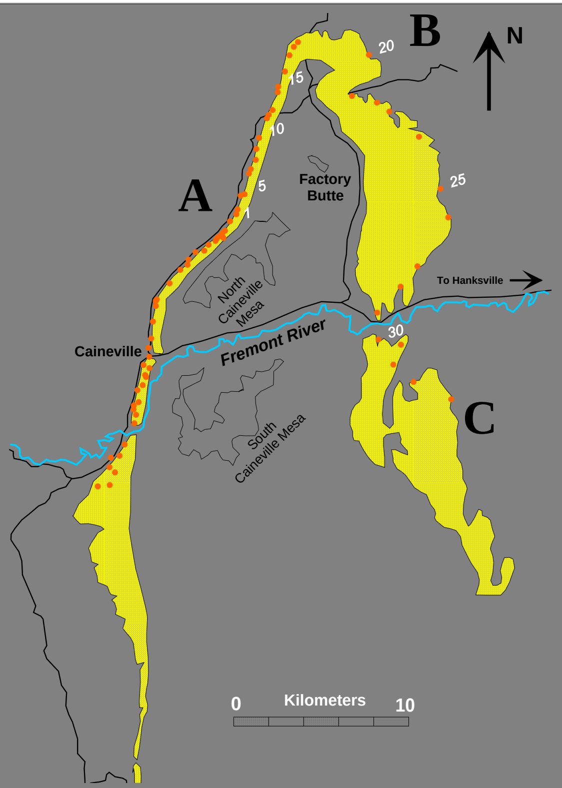
FAC2: active delta front

FAC3: wave-reworked delta front

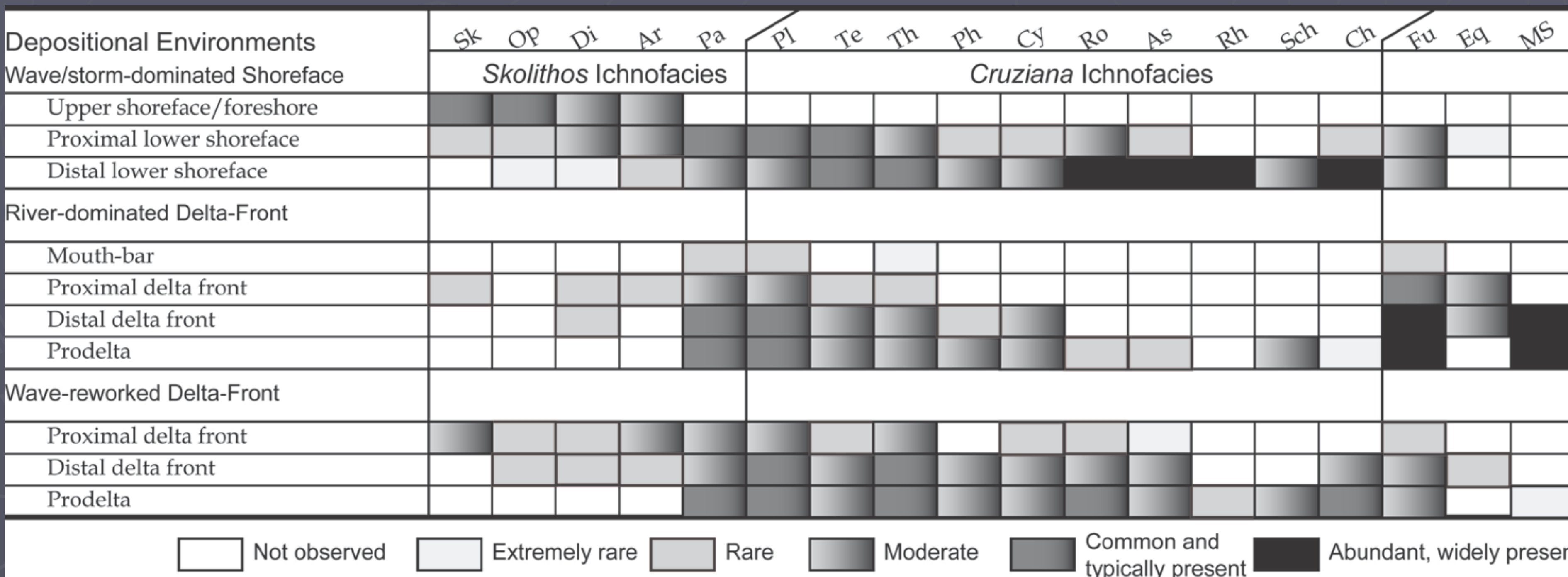
FAC4: distributary/mouth bars



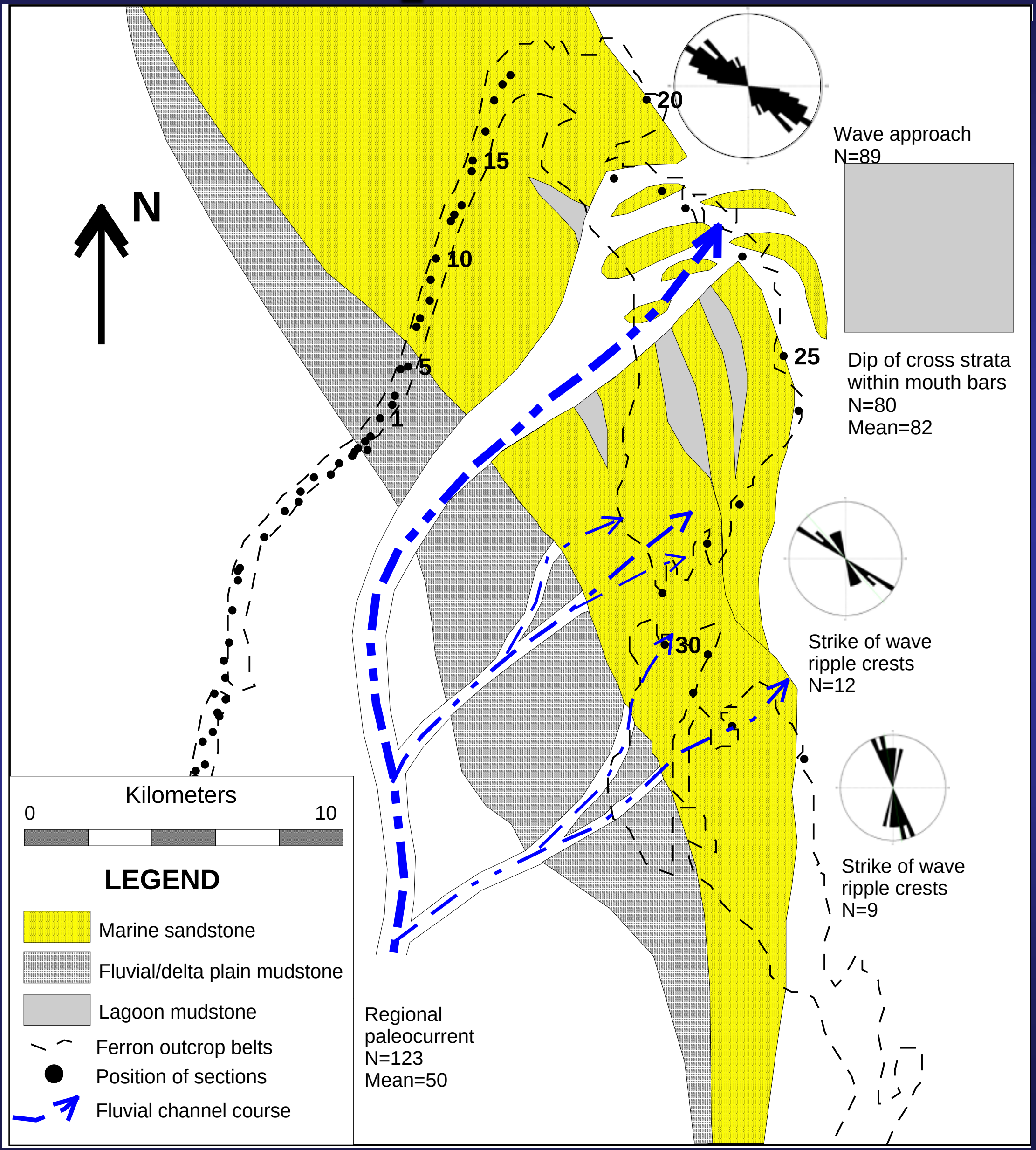
Regional paleocurrent

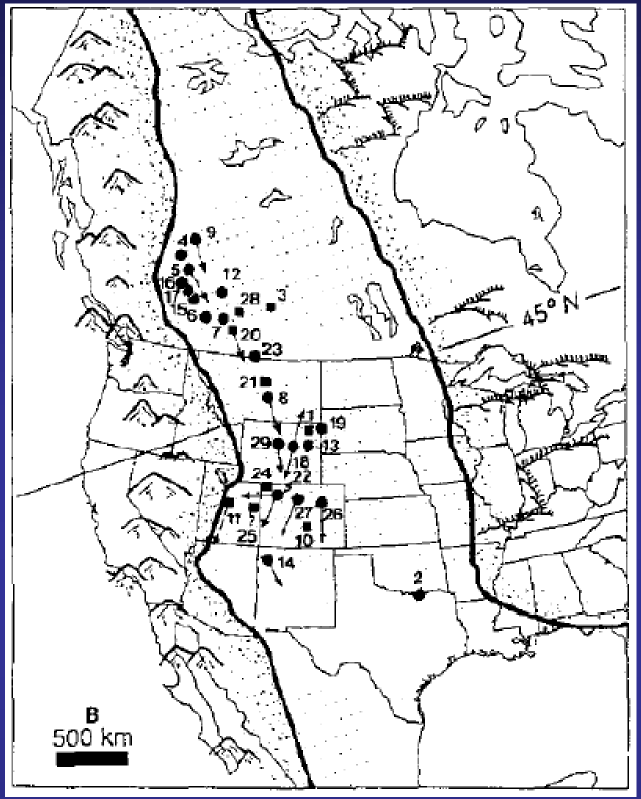


# Ichnological response to different physico-chemical processes

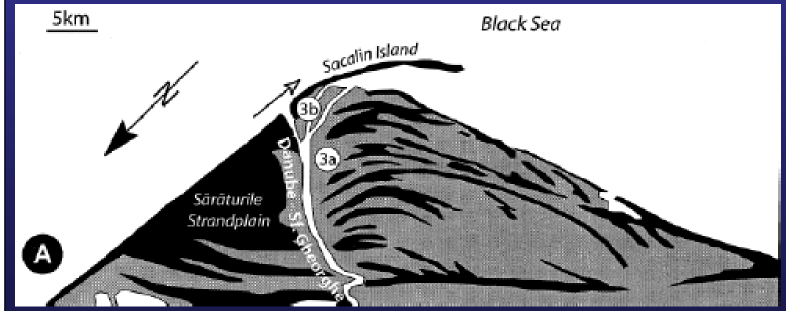


# Paleogeographic reconstruction and comparison with modern examples



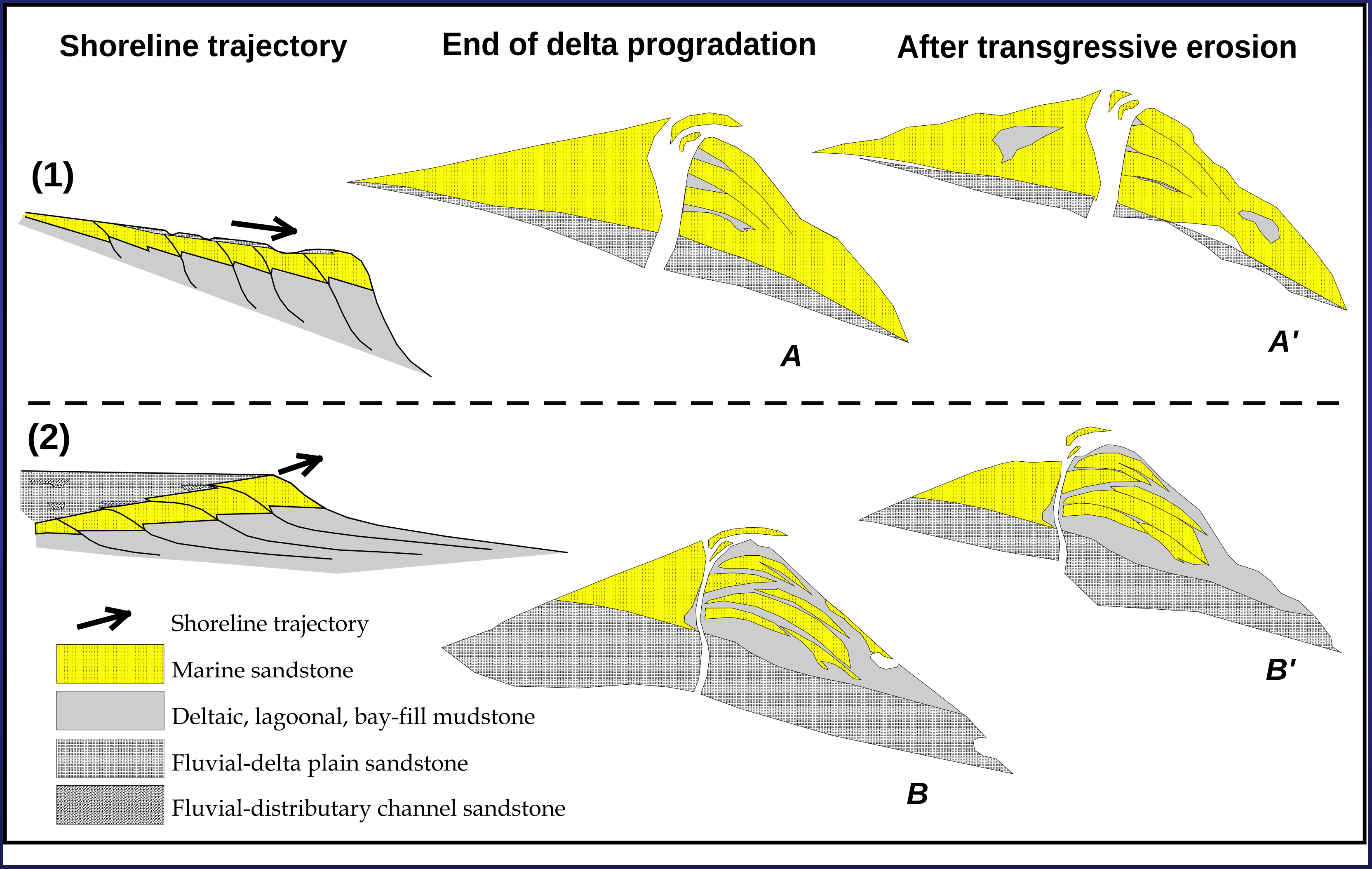




Ericksen and Slingerland (1990)

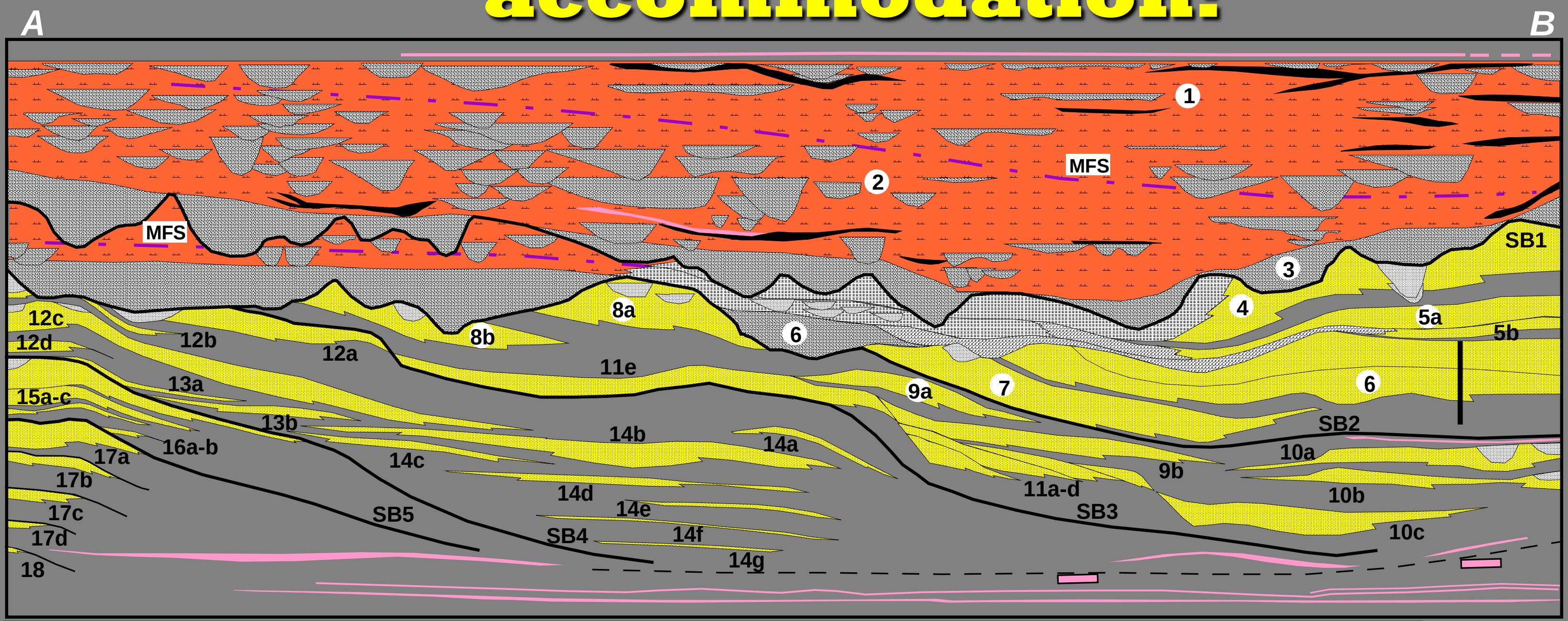



Sf. Gheorghe lobe, Danube delta, (Bhattacharya and Giosan, 2003)

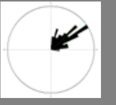
# Facies of asymmetric deltas as a function of shoreline trajectory

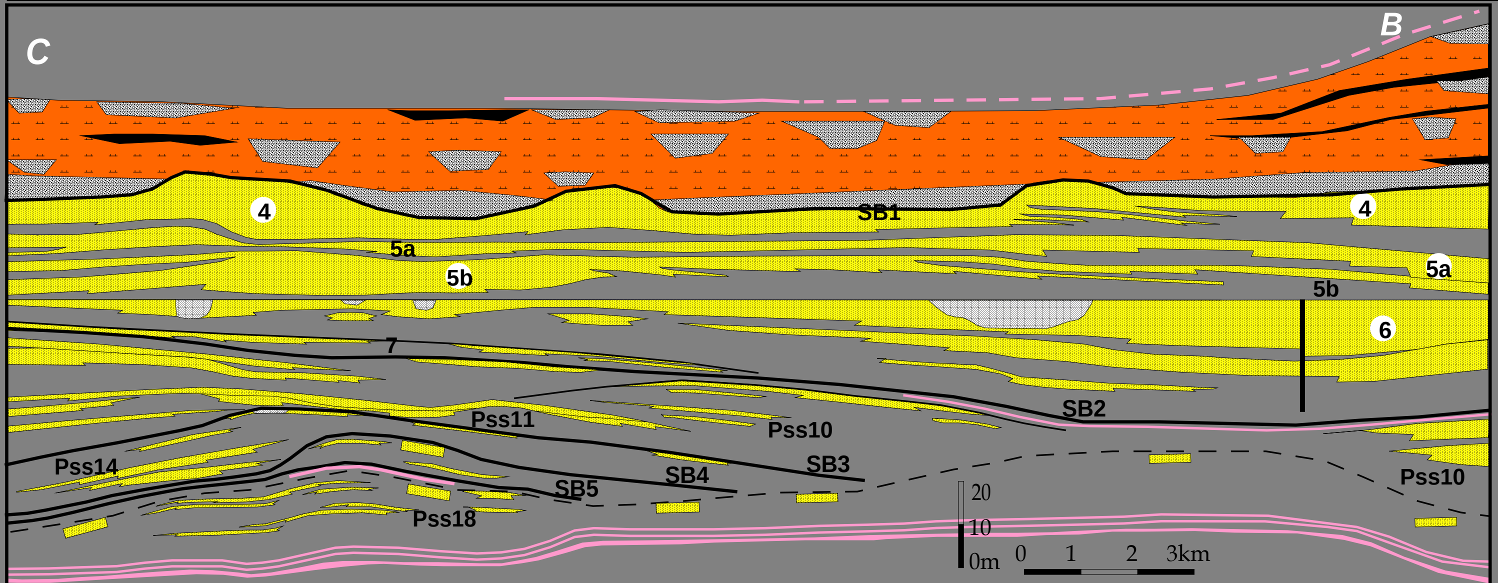


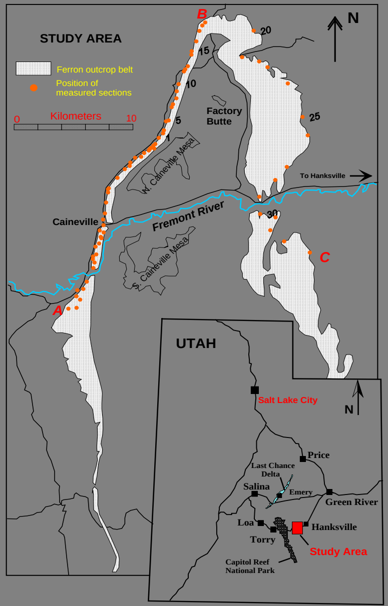
# Progradation of PS6 under minimal accommodation!

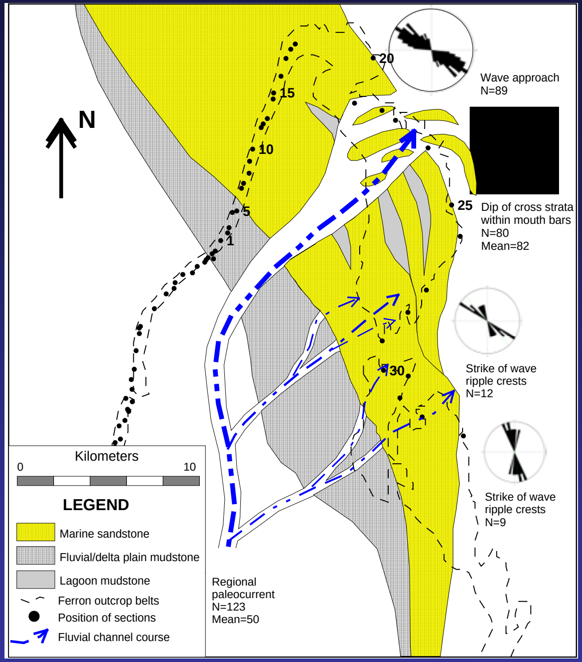



Regional paleocurrent





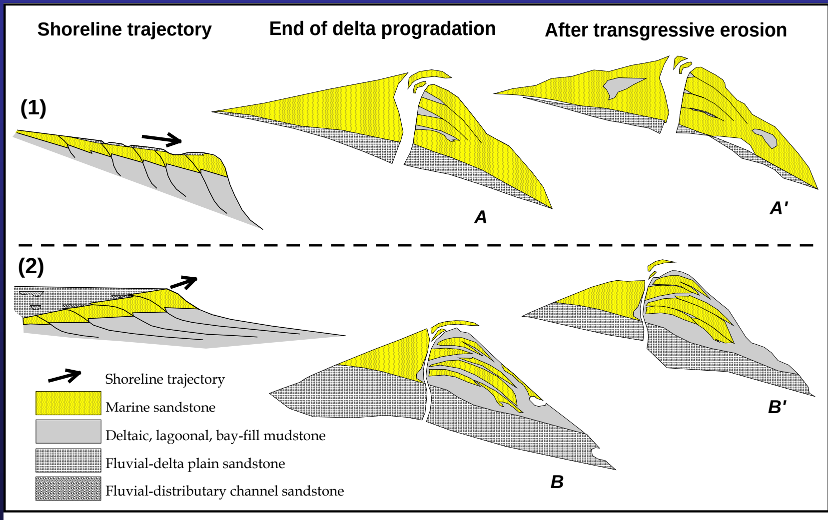



# Conclusions

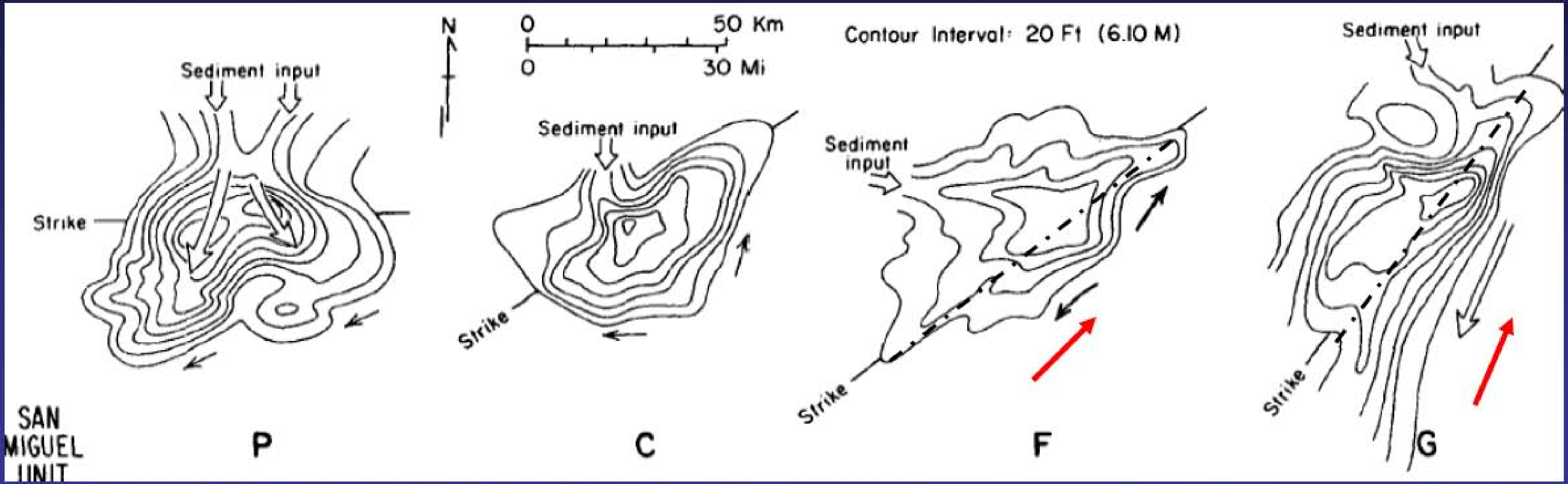
1. The studied parasequence 6 (PS6) shows delta asymmetry. The asymmetric delta is fed both by the trunk river flowing NE and by longshore transport from the NNW to the SSE.

2. Ichnogenera shows distinct along-strike changes in response to physico-chemical process in the asymmetric delta, and ichnological analysis is effective to identify river influences.

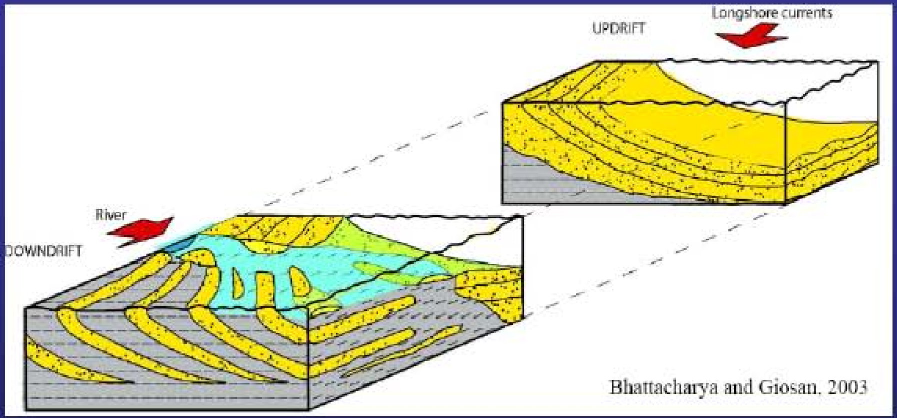
3. Using the asymmetric delta models in the ancient record should incorporate regional stratigraphy and paleoshoreline activity, both of which could control the overall deltaic facies.



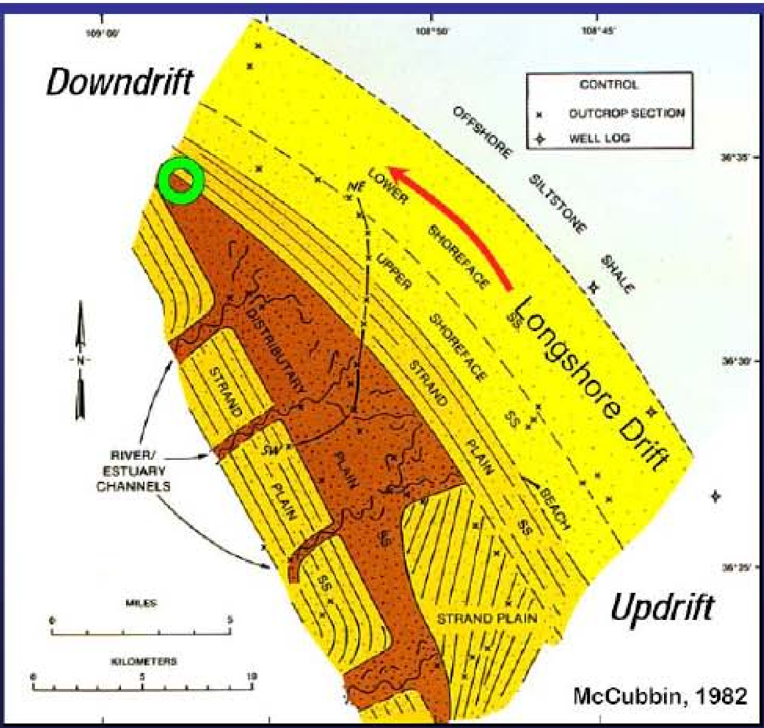
# Exploration significance




(Upper Cretaceous, Miguel Formation, Maverick Basin, South TX, Weise, 1980)




- **Clean sands updrift**
  - **Potentially sharp-based shoreface deposits.**
- **Heterolithic facies downdrift**
  - **May include river and wave successions**




Gallup Sandstone, NM

*Thanks for your attention*