

^{AV}The Missing Mud Belts of the Ancient Record: Implications for Sequence Stratigraphy

By

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Abstract

Numerous modern prodeltas have a major along-shore growth component driven by geostrophic circulation. Such mudbelts may extend for hundreds of kilometers from a river mouth and show internal clinoform geometries that transition from oblique in the delta region to sigmoidal further downdrift. While the oblique portion of such systems is represented in sequence stratigraphical models, the sigmoidal portion, often laterally more persistent, remains largely unincorporated. Under existing models, a mudbelt showing an onlapping relationship with pre-existing topography can only be interpreted as either a transgressive healing phase deposit requiring a rise in sea level, or as a lowstand deposit requiring a relative sea level drop. Since their formation is not restricted to only these conditions, we advocate that “mudbelts” be recognized as distinct elements in sequence stratigraphical nomenclature.

Mudbelts are characterized by 1) a transition from oblique to sigmoidal clinoform geometries within the same stratigraphic or seismic unit, 2) offlapping sigmoidal relationships within a mud dominated interval. Examples of individual seismic units displaying transition from oblique to sigmoidal geometries are demonstrated in Pleistocene shelf-edge deltaic successions in the Gulf of Mexico, offshore Alabama. Oblique portions of such units are interpreted as delta lobe deposits, which pass laterally into sigmoidal and coeval mudbelts. A Cretaceous Western Interior example of a mudbelt is indicated by offlapping sigmoidal geometries of bentonite-bounded, mudstone- and siltstone-dominated units within the Cenomanian-aged Lower Belle Fourche Member of the Frontier Formation, Powder River Basin, Wyoming.

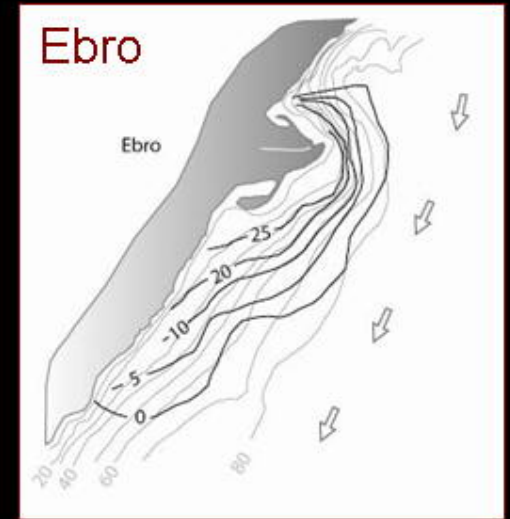
The Missing Mud Belts of the Ancient Record: Implications for Sequence Stratigraphy



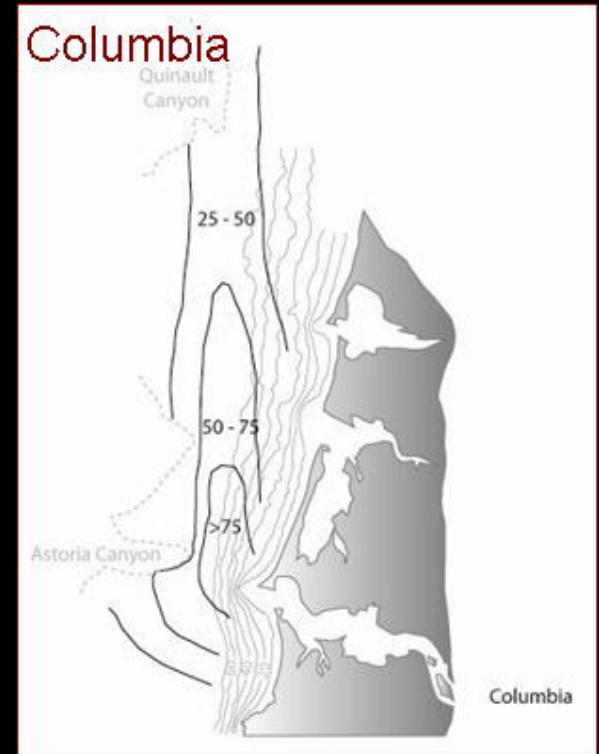
Boyan K. Vakarelov – University of Texas at Dallas
Charles D. Winker - Shell Exploration & Production
Janok P. Bhattacharya - – University of Texas at Dallas

Modern Mud Shelf Deposits

- Subaqueous deltas and mud belts
- Detached or attached to sandy depocenters
- Dominated by along-shelf transport
- Numerous Modern Examples
- Very few ancient examples (Asquith, 1970, Leithold, 1992)
- Not incorporated in stratigraphic models (Mississippi is an exception)

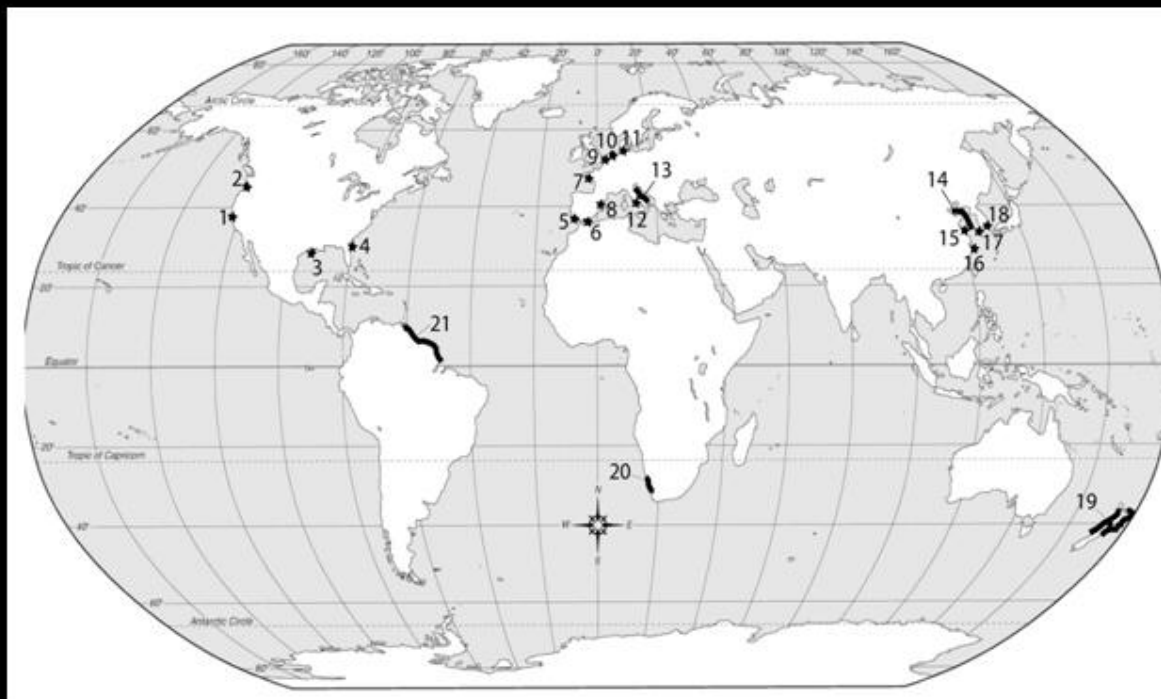


Diaz et al. (1996)



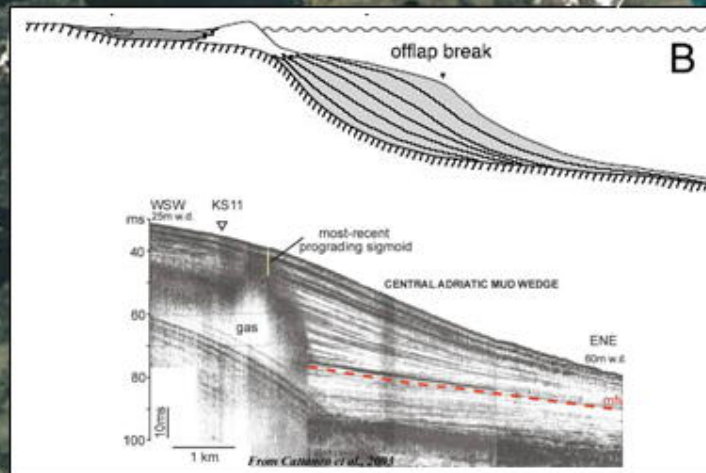
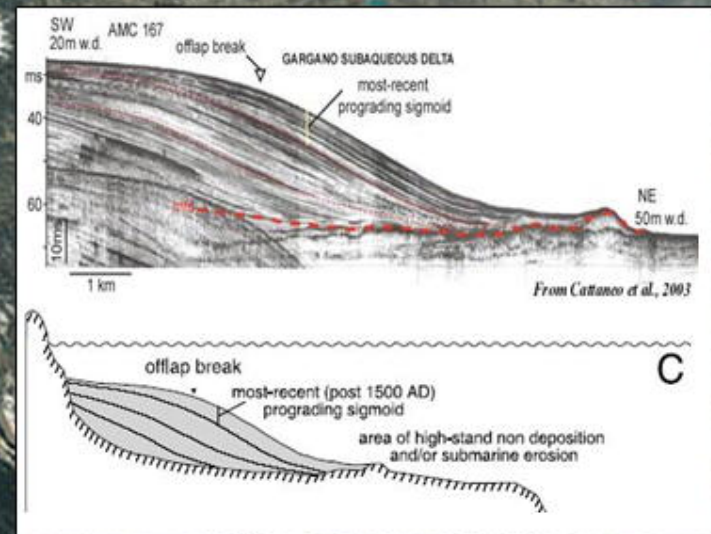
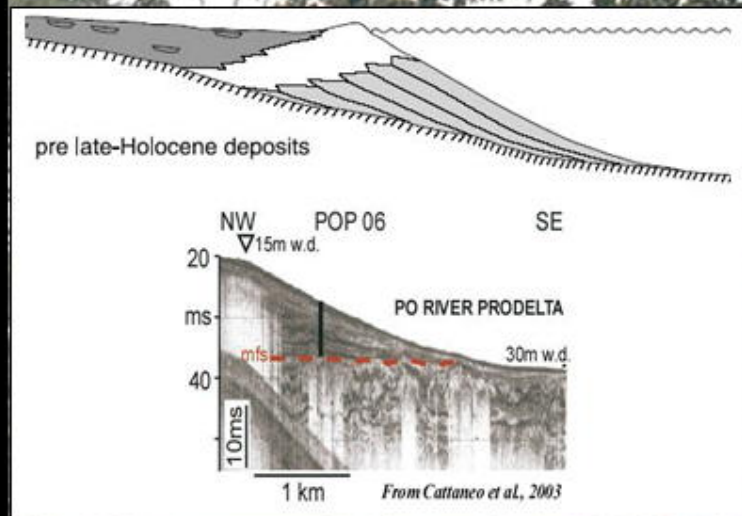
Wright and Nittouer (1995)

Modern Examples of Mud Belts



1. Monterey Bay (Eittreim et al., 2002)
2. Eel (Geyer et al., 2000)
3. Mississippi (Curry, 1960)
4. Coast of Sapelo Island (Howard and Reineck, 1972)
5. Guadalquivir (Fernandez-Selas et al., 2004, Lobo et al., 2004)
6. Guadalhorce (Fernandez-Selas et al., 2004)
7. Gironde mud field (Lesueur et al., 1996)
8. Ebro mud belt (Diaz et al., 1996)
9. Scheldt River (McCave, 1986)
10. Rhine (McCave, 1986)
11. Inner German Bight (Rorjes et al., 1970)
12. Gulf of Gaeta (Reineck and Singh, 1971)
13. Gargano subaqueous delta (Cattaneo et al., 2003)
14. New Huanghe Lobe mud belt (Alexander et al., 1991)
15. Old Huanghe Lobe mud belt (Chough et al., 2002)
16. Yahgtze (Wang Baoyong, 1983)
17. Southeastern Yellow Sea mud belt (Chough et al., 2002)
18. Central South Sea mud belt+ Korea Strait Mud (Park et al, 1999)
19. New Zealand Mud Belts (Carter (1975), Abbott (2000))
20. Southwestern Africa mudbelt (MeadowsEtAl2002)
21. Amazon-Guianas mud belt (Aller et al., 2004)

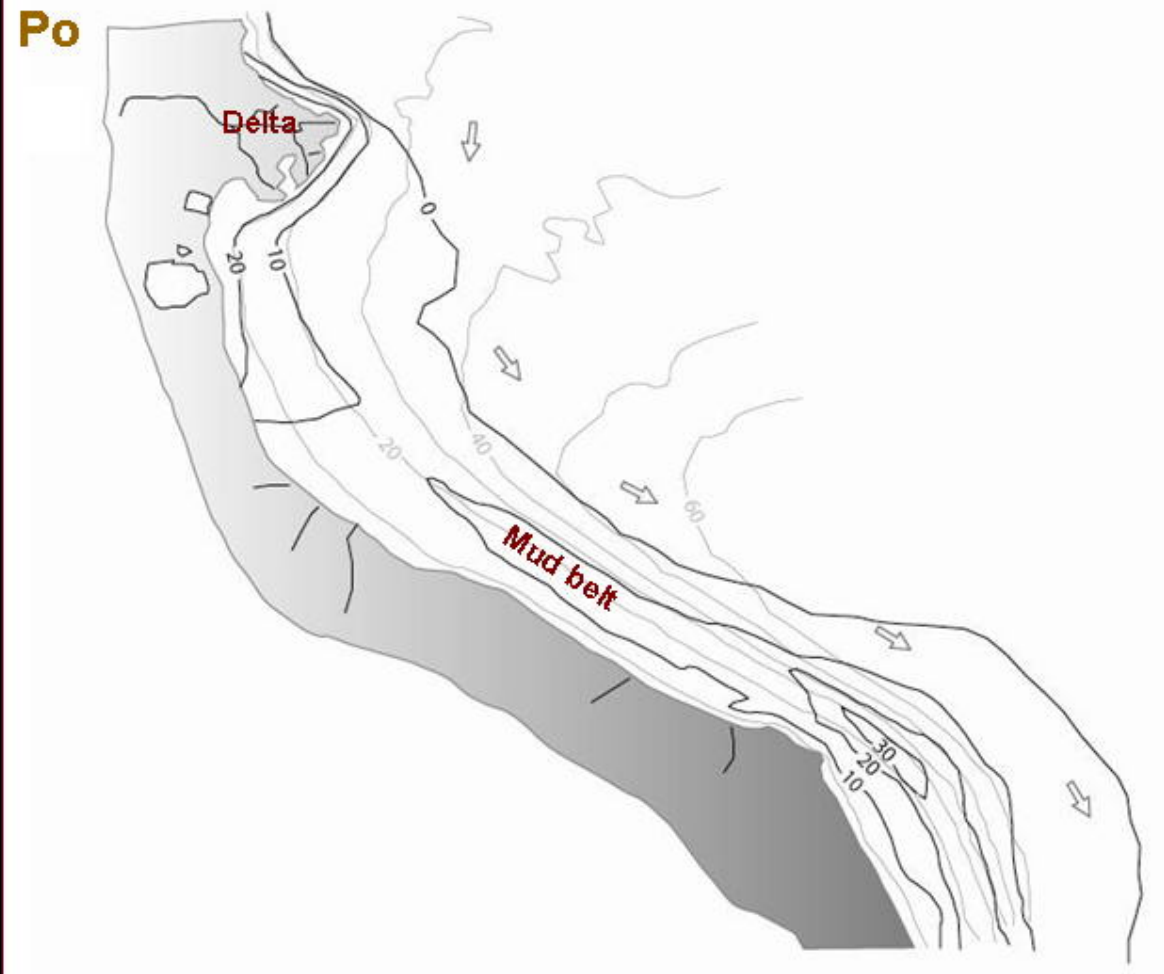
Po Delta / Mud Belt



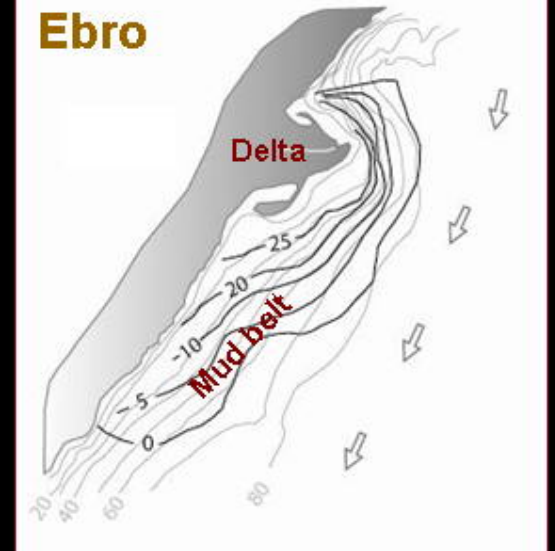
<http://visibleearth.nasa.gov/>

Figures after Cattaneo et al., 2003

Delta to Mud Belt Transition



Modified from Cattaneo et al. (2003)



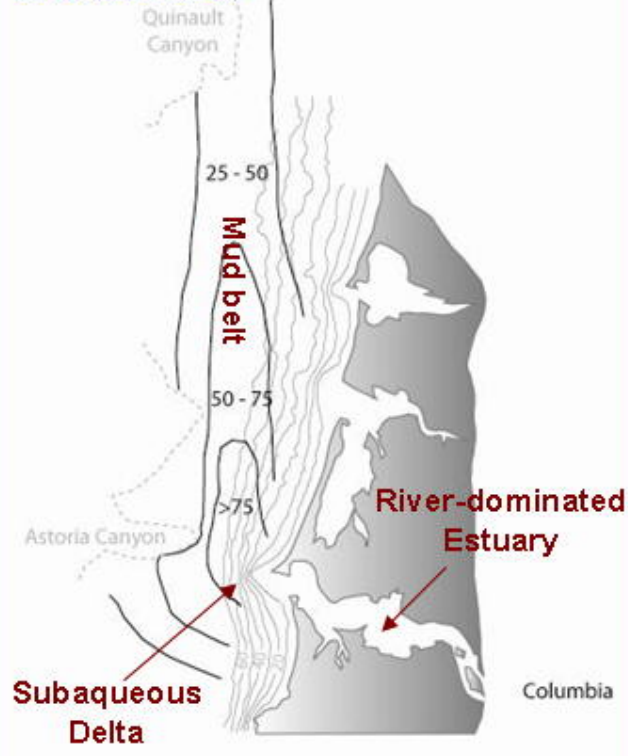
Modified from Díaz et al. (1996)



50km

Subaqueous Deltas and Mud Belts

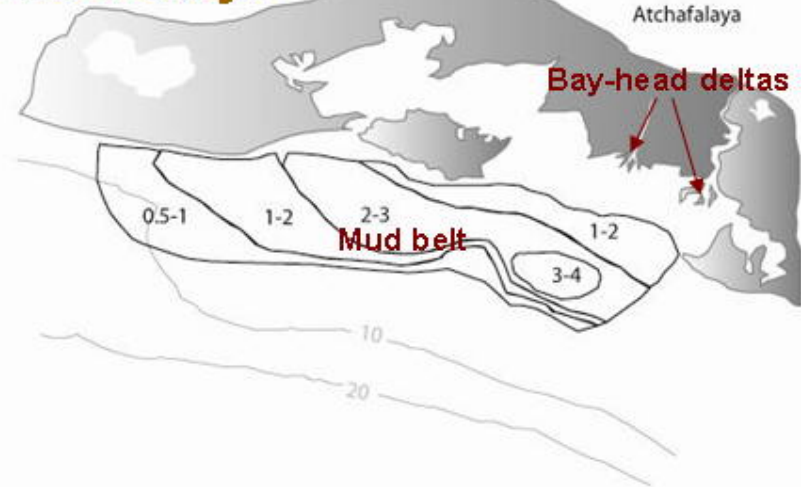
Columbia



Modified from Wright and Nittouer (1995)

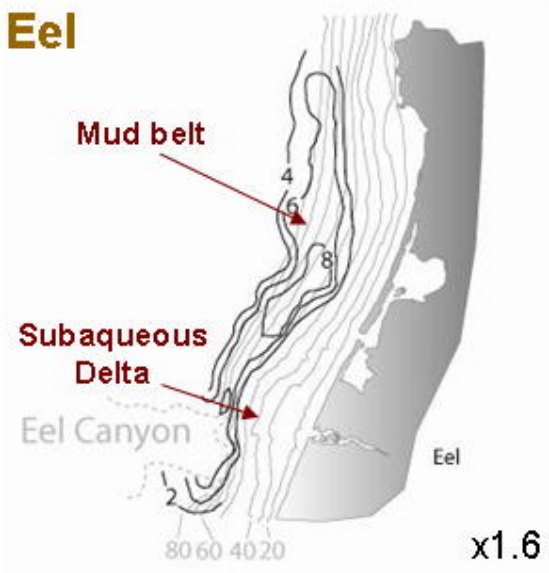
50km

Atchafalaya



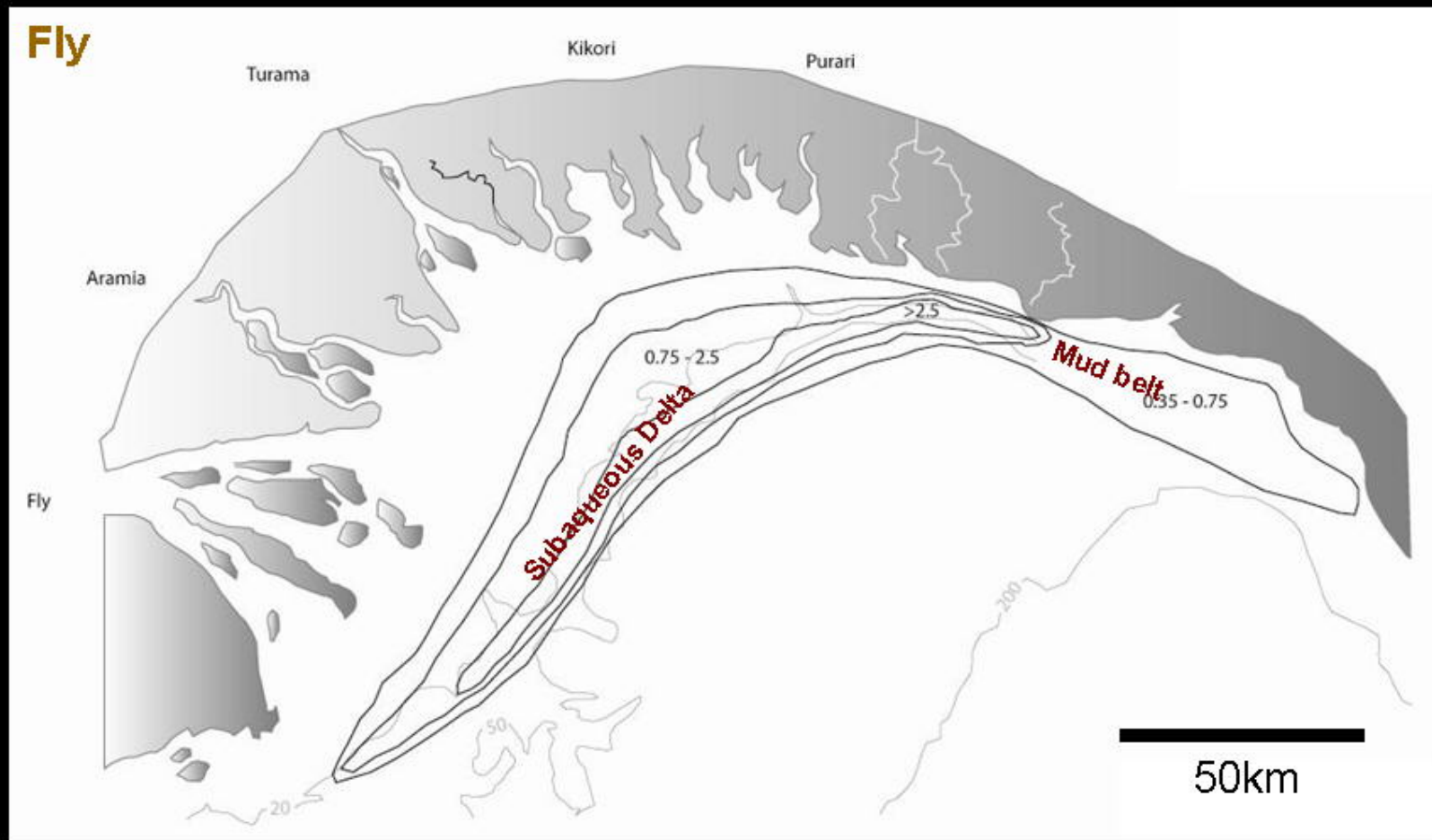
Modified from Draut et al. (1995)

Eel



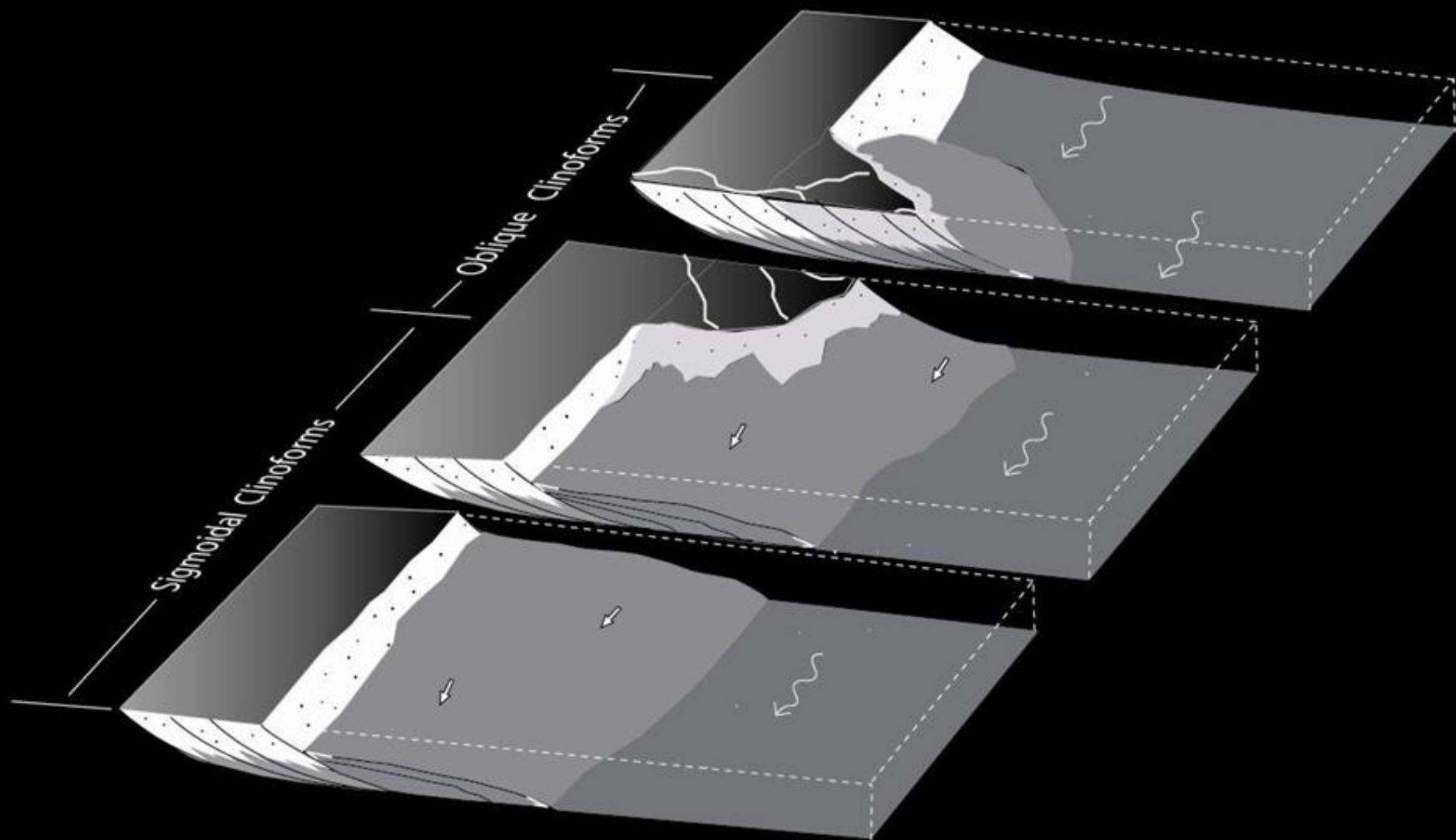
Modified from Nittouer (1999) and Sommerfield and Nittouer (1999)

Large Tidally-Dominated Subaqueous Deltas

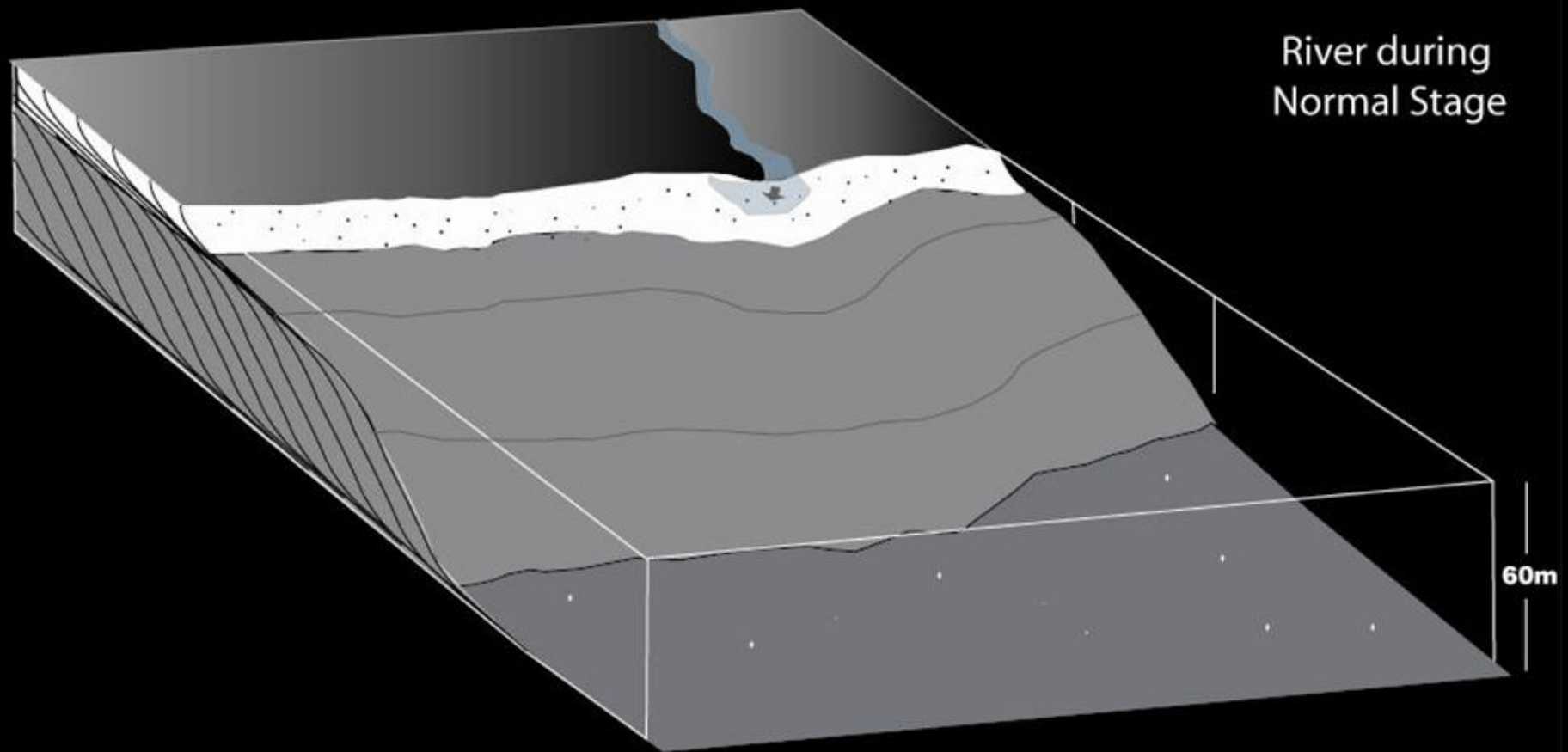


Modified from Walsh et al. (2004)

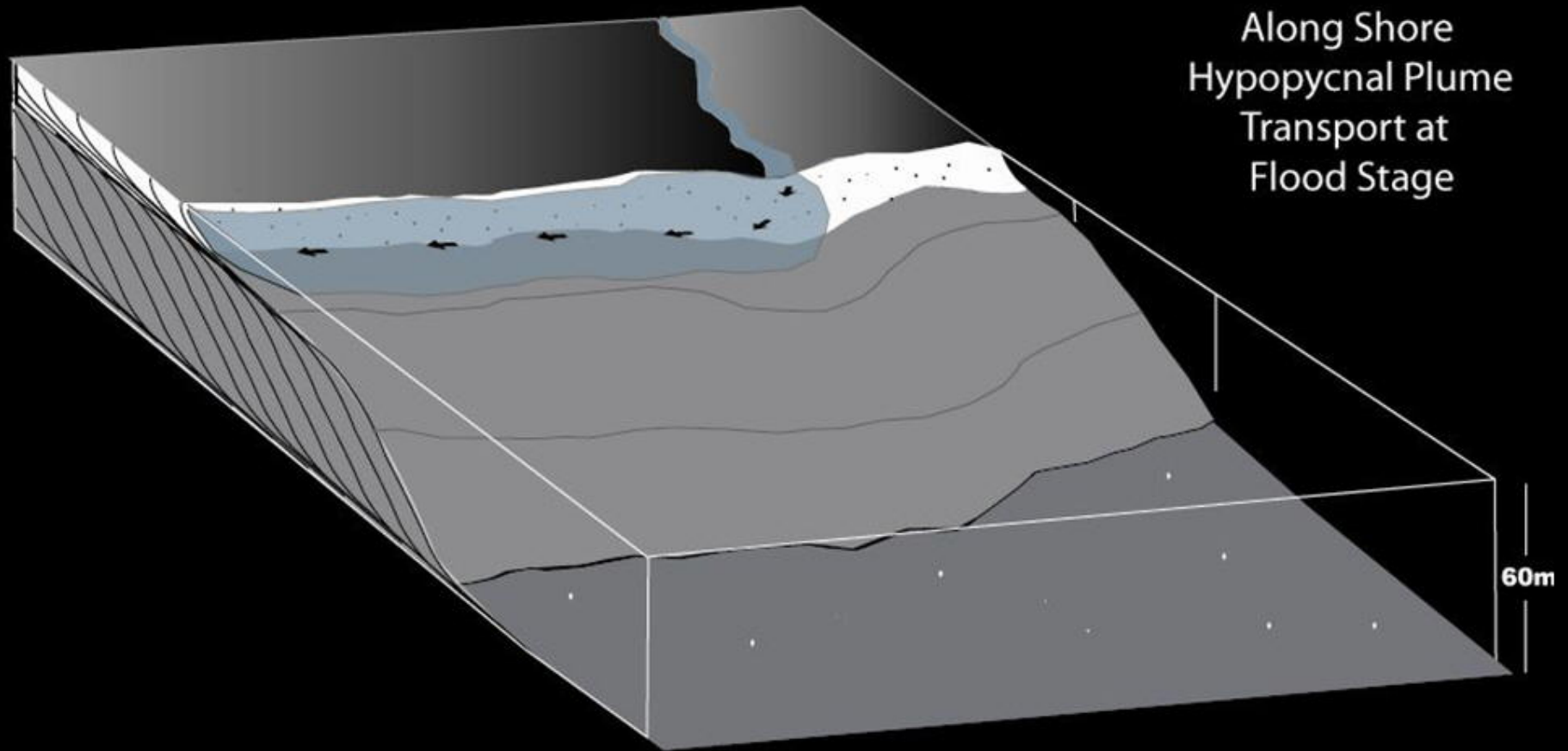
Conceptual Model for Delta / Mud Belt Pair



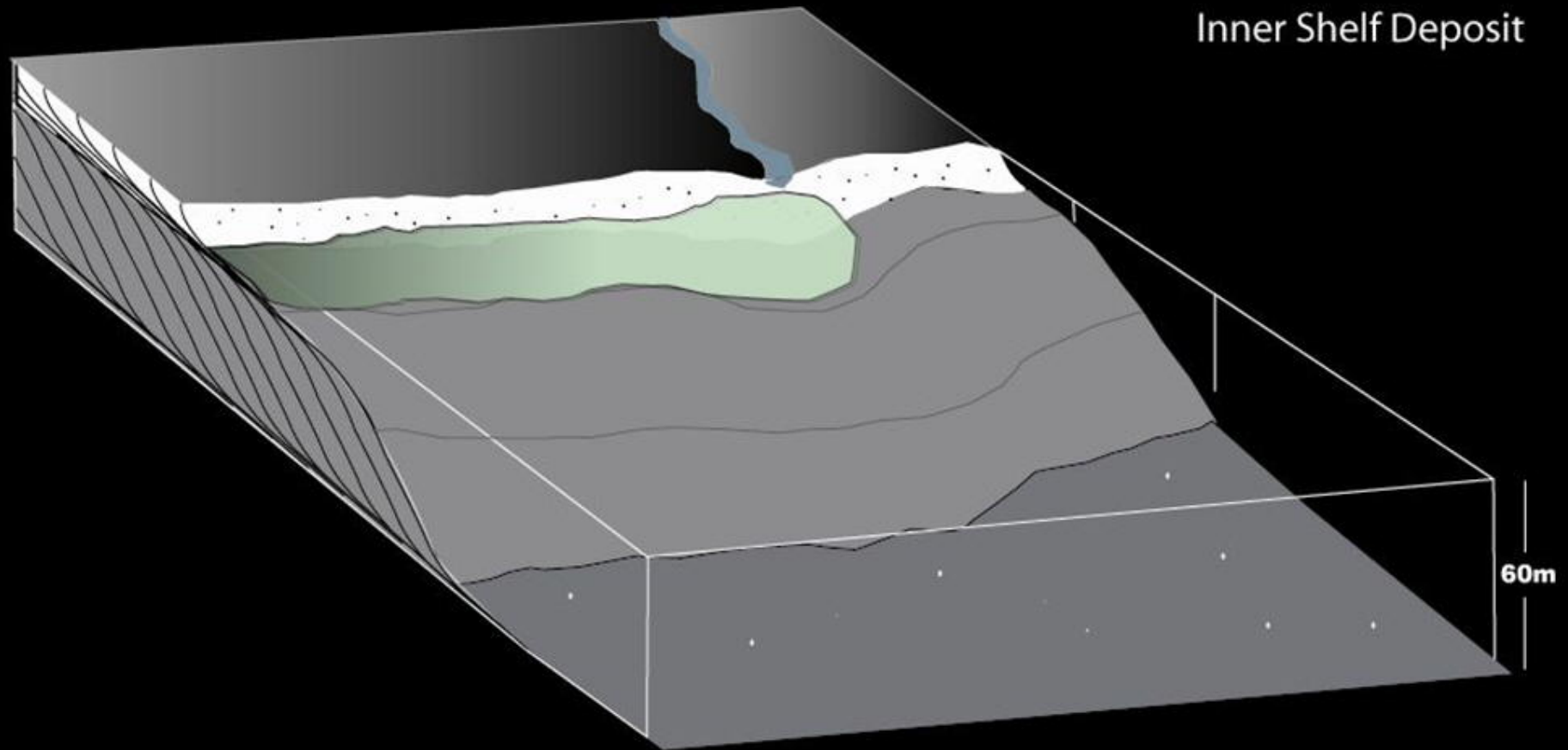
Processes Responsible



Along Shore Hypopycnal Plume Transport

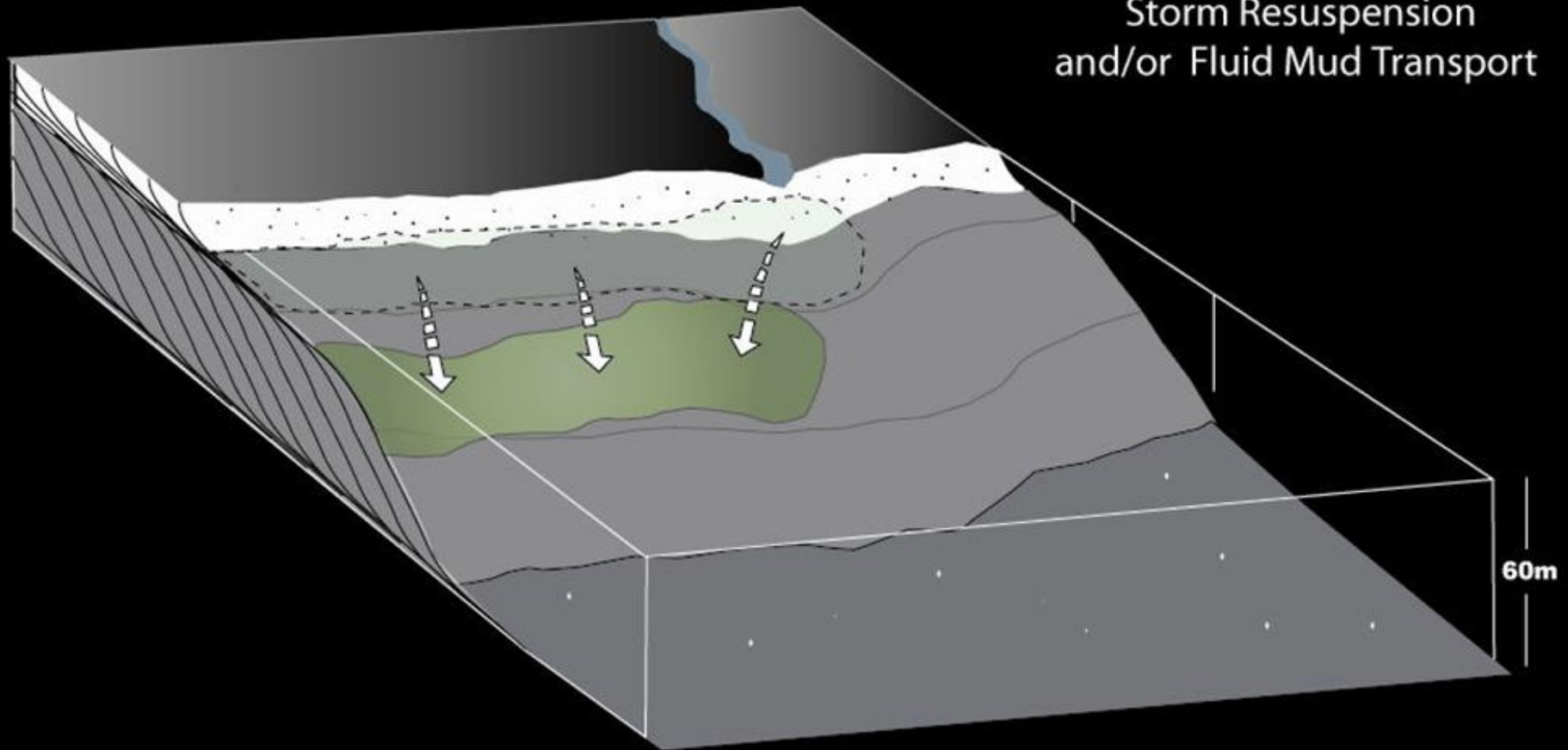


Deposition from Suspension

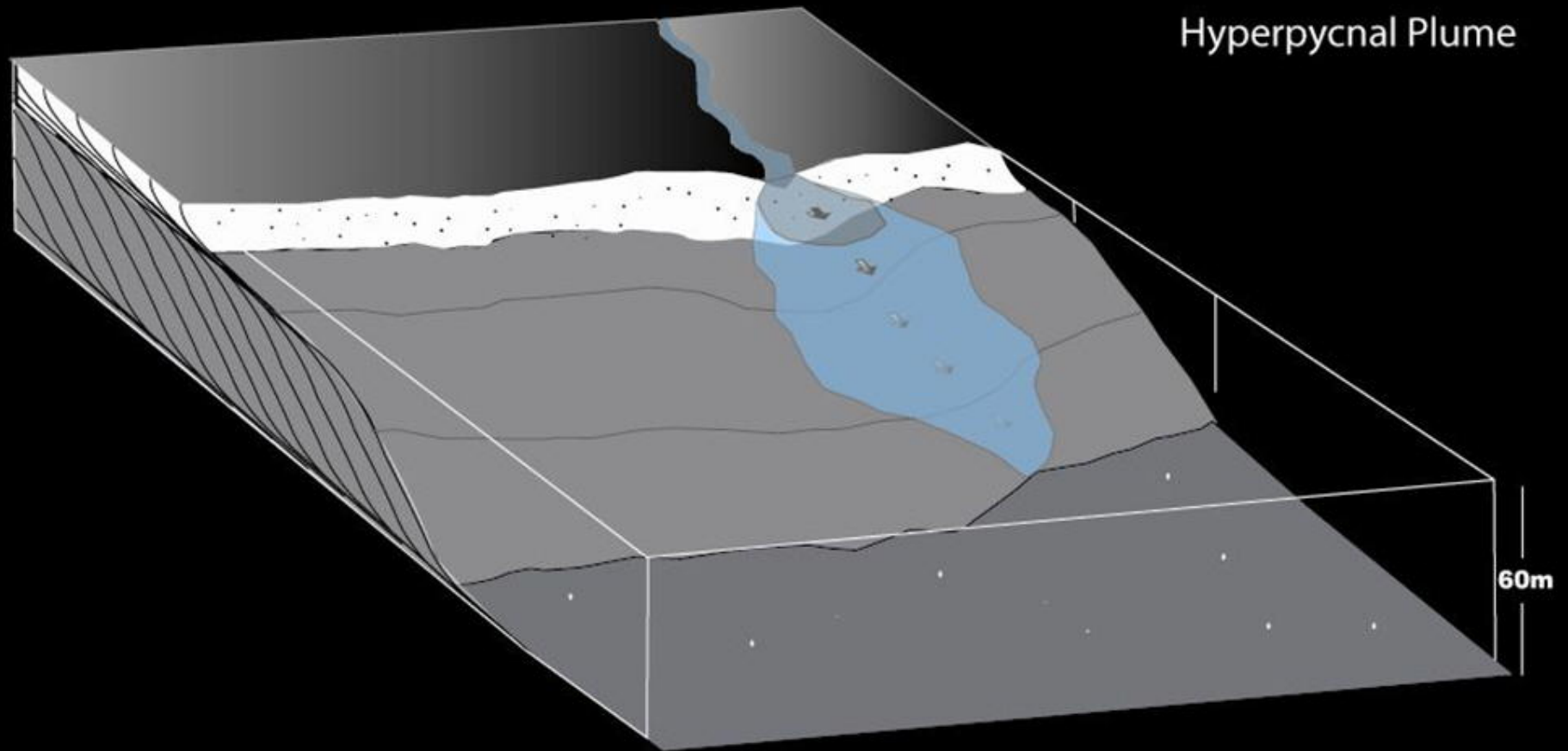


Resuspension and Redeposition

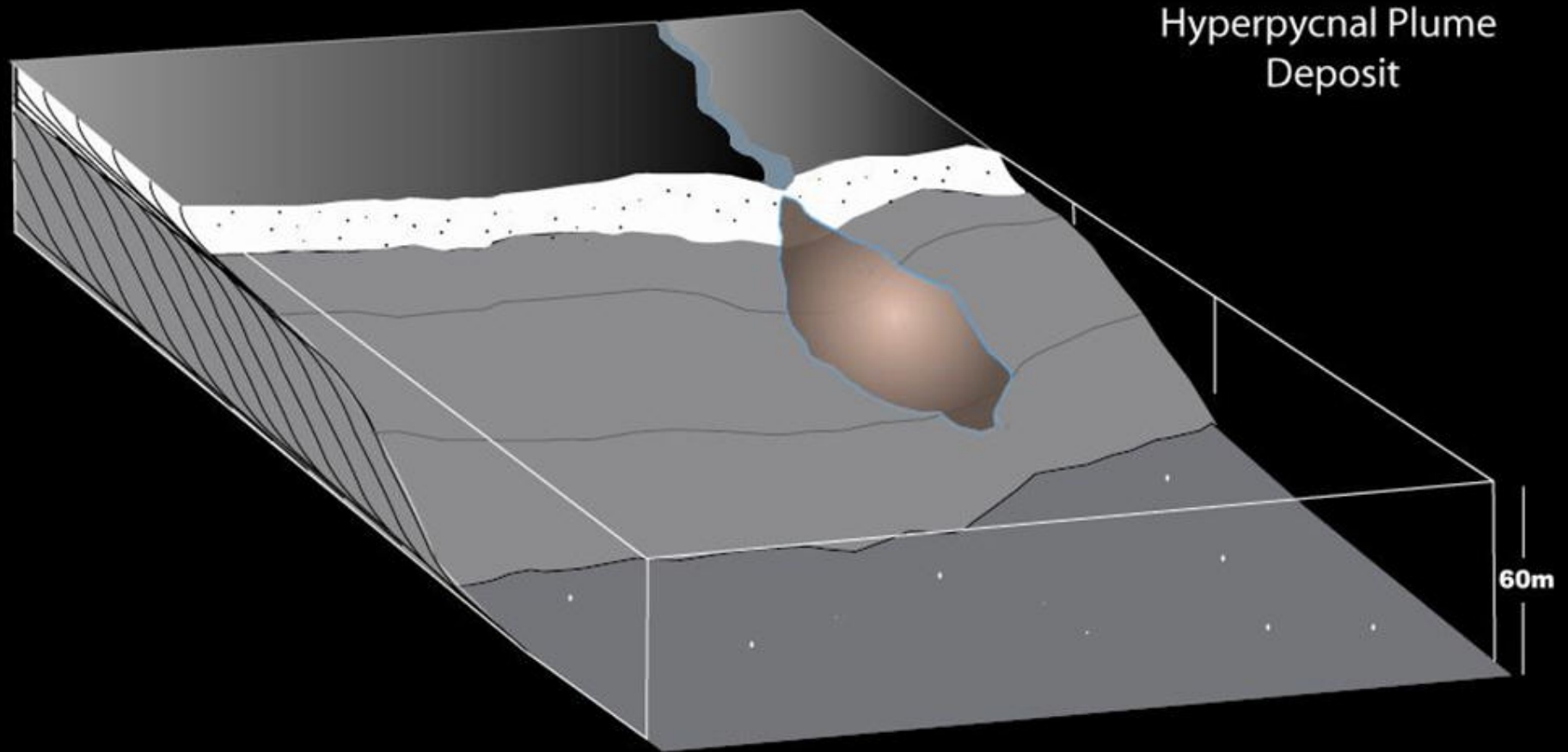
Storm Resuspension
and/or Fluid Mud Transport



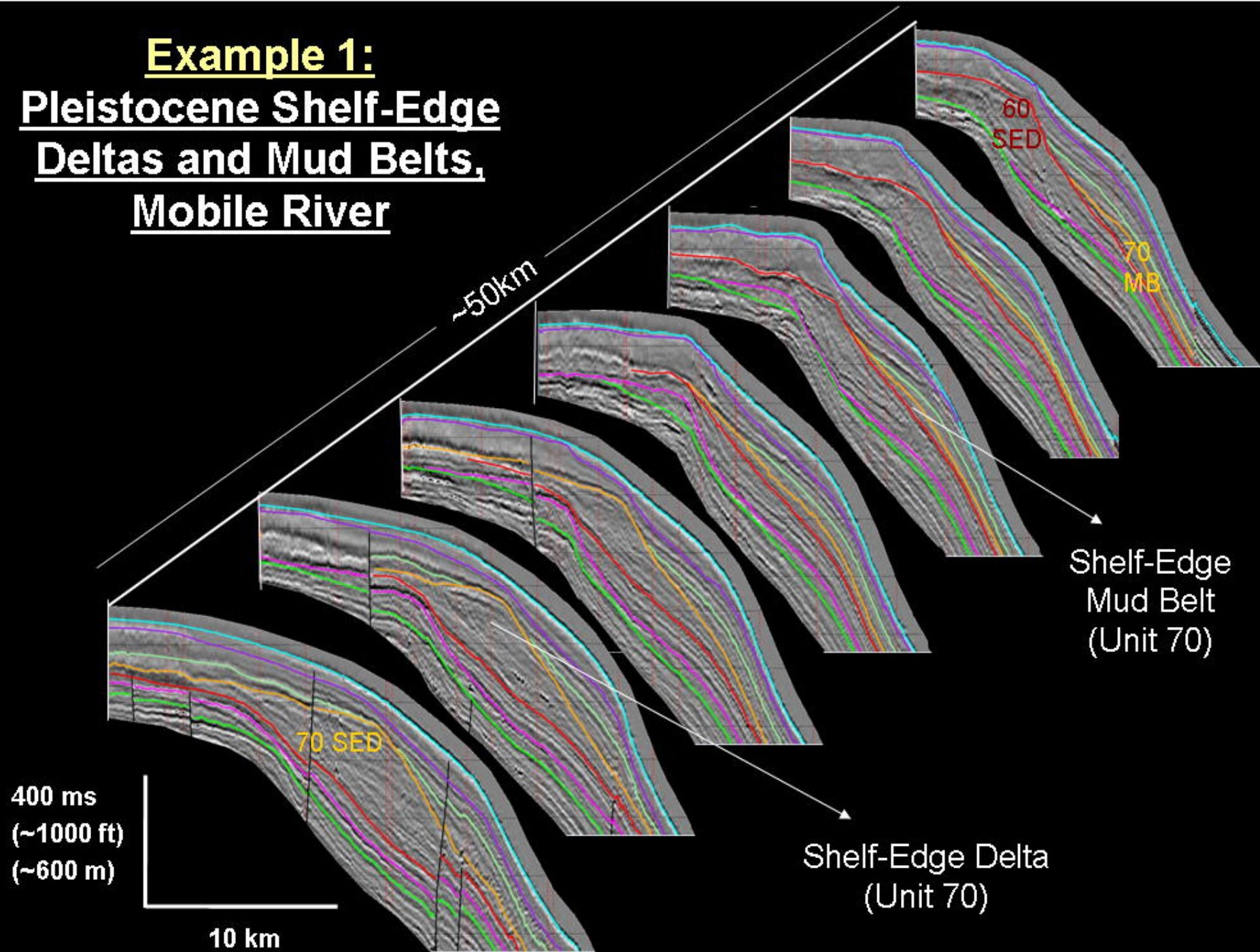
Hyperpycnal Plume



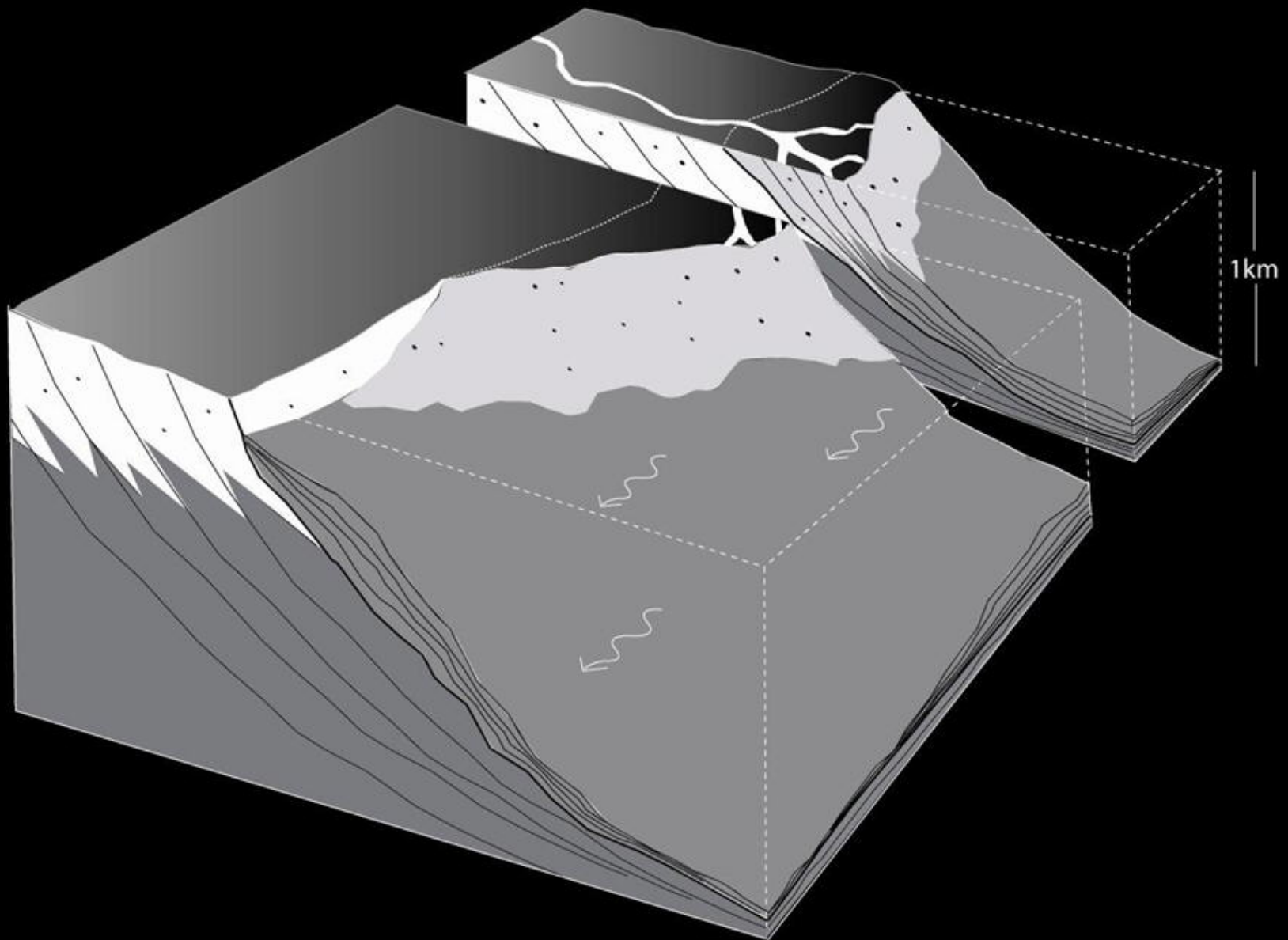
Hyperpycnal Deposit



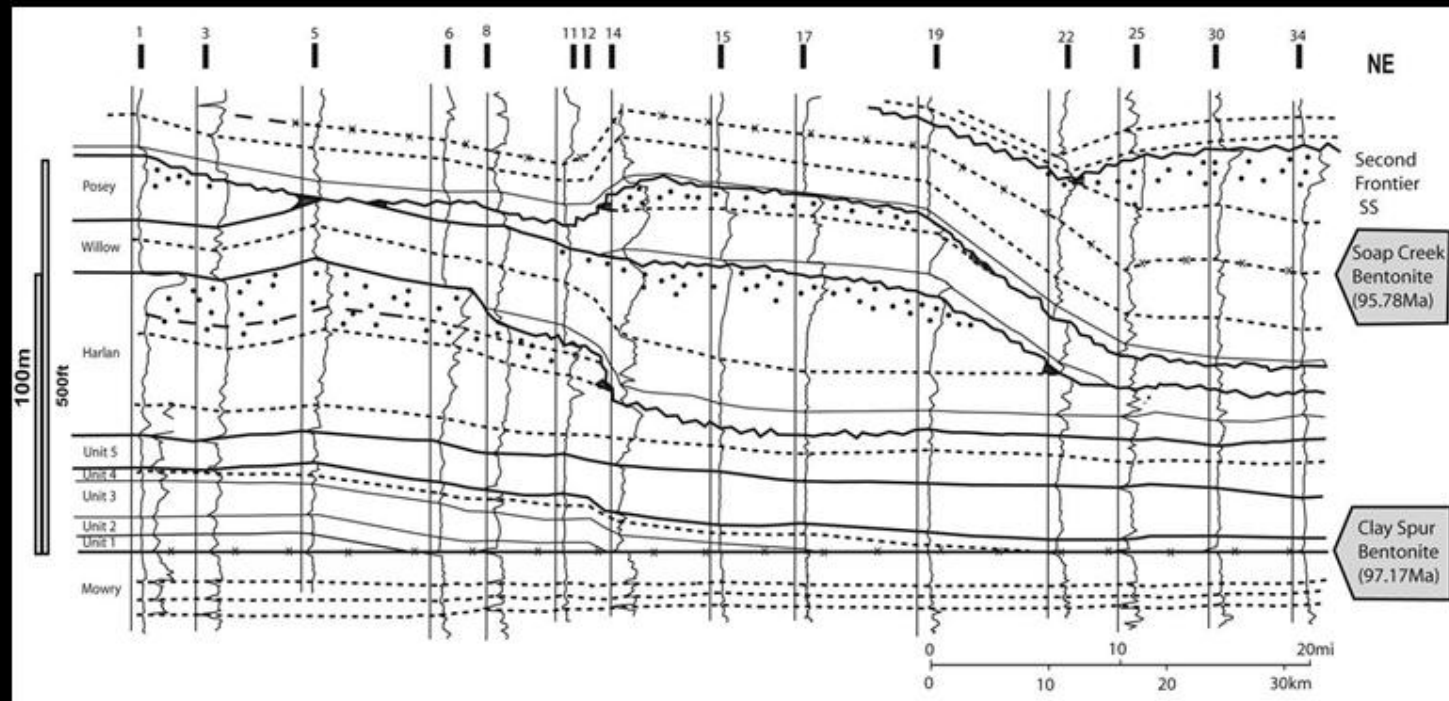
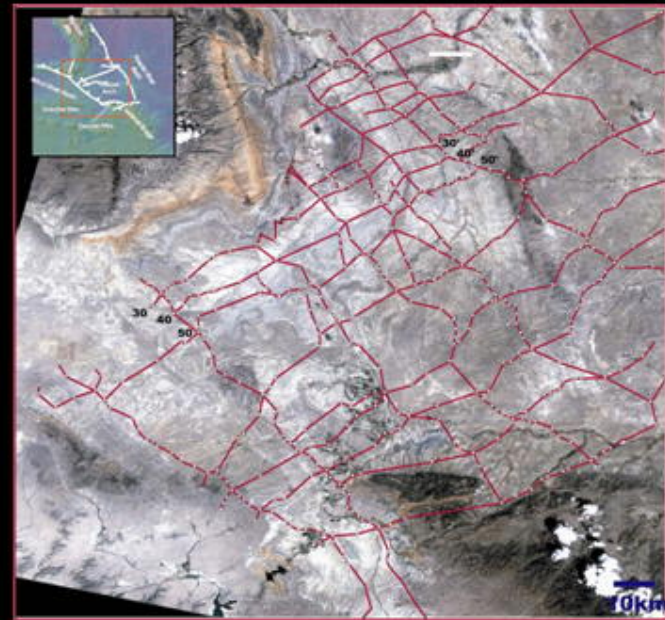
Example 1:
Pleistocene Shelf-Edge
Deltas and Mud Belts,
Mobile River

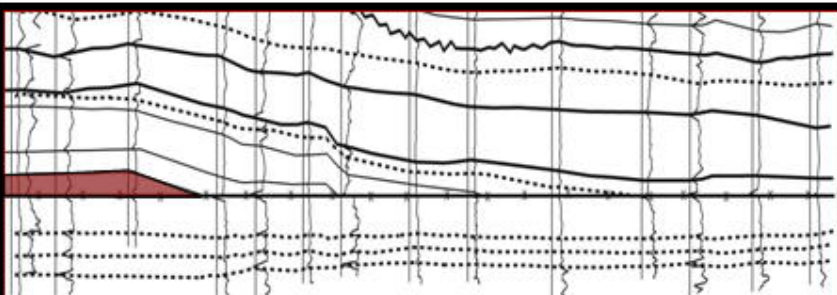


Shelf-Edge Delta / Mud Belt Conceptual Model

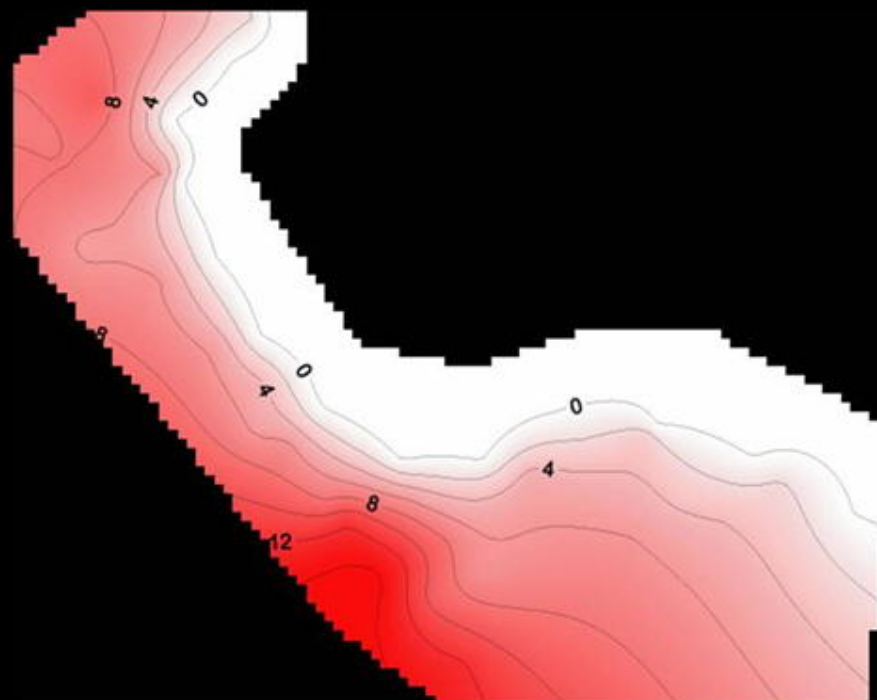


Example 2: Cretaceous Mud Belt in Frontier Fm, Wyoming?



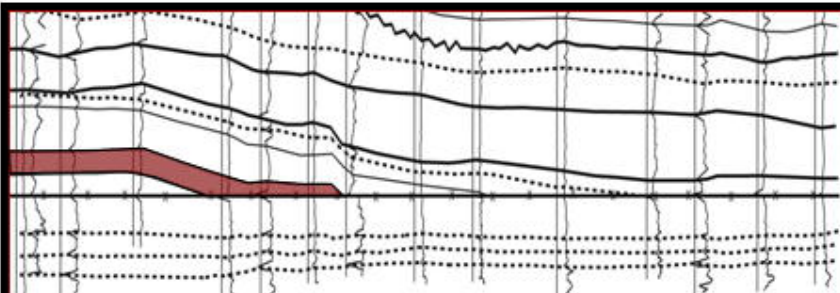


ISOPACH MAP: UNIT 1

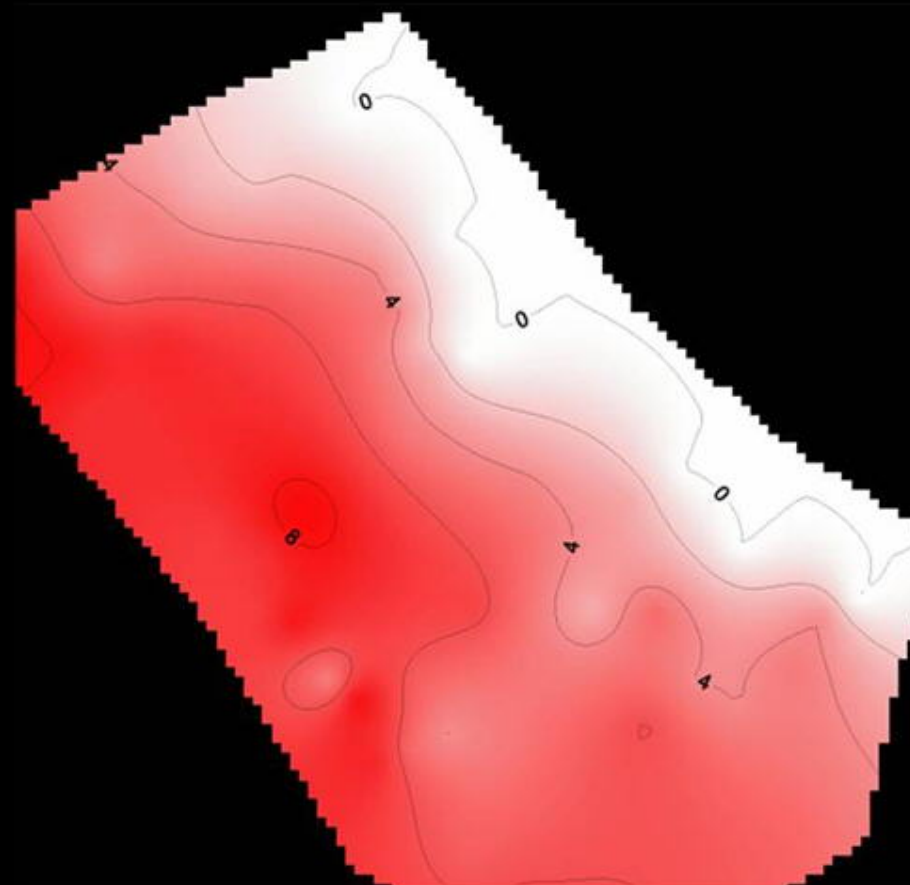


30 km

Thickness in Meters

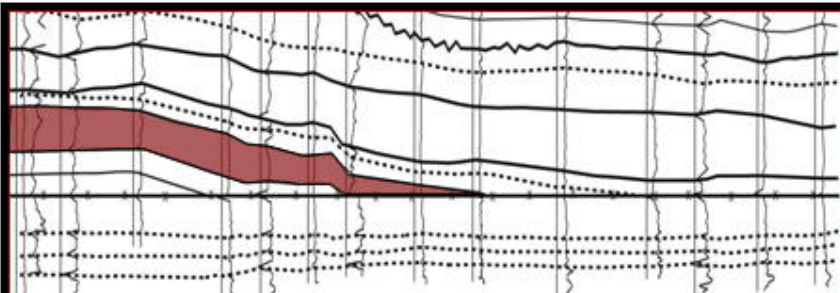


ISOPACH MAP: UNIT 2

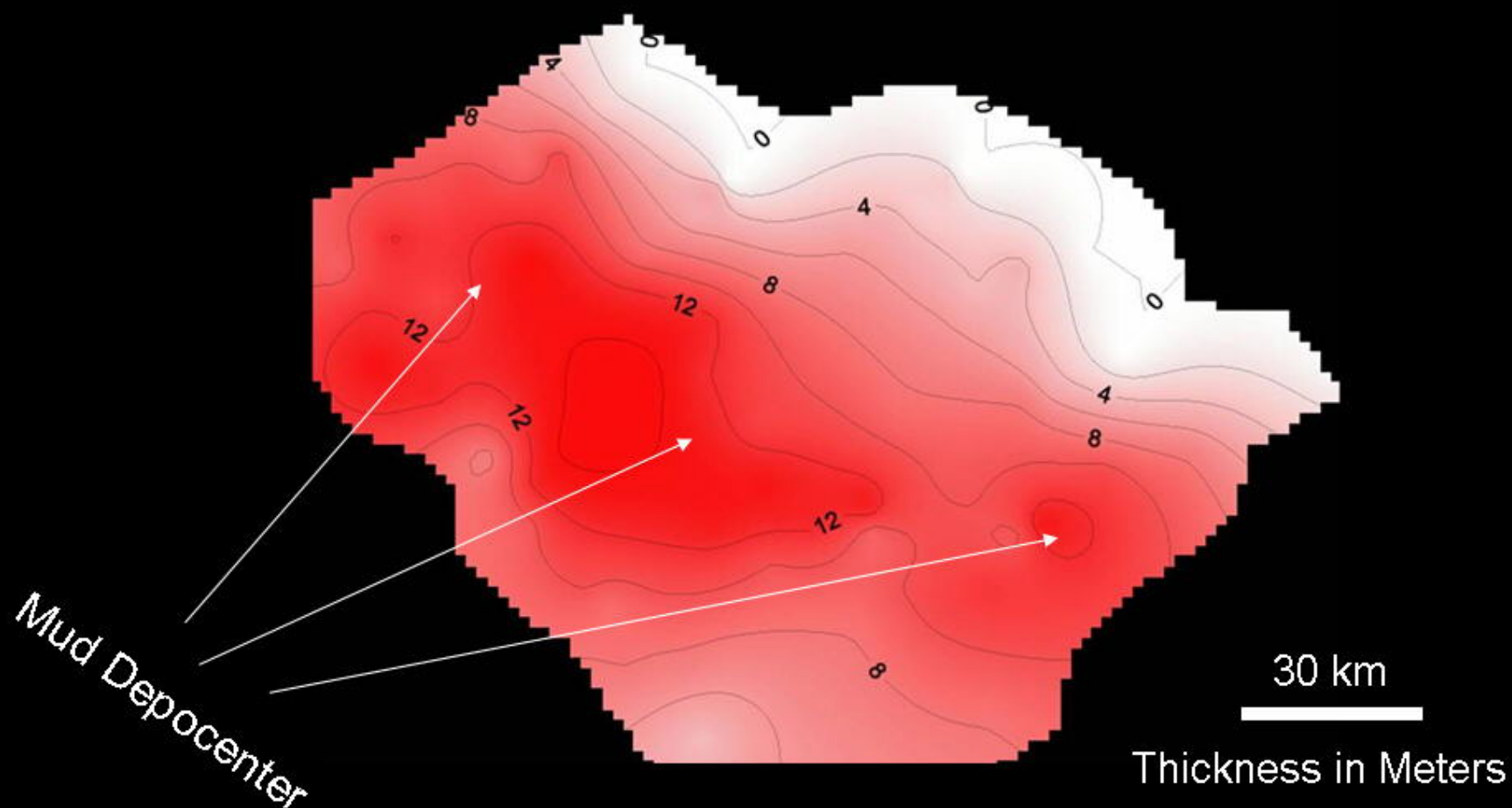


30 km

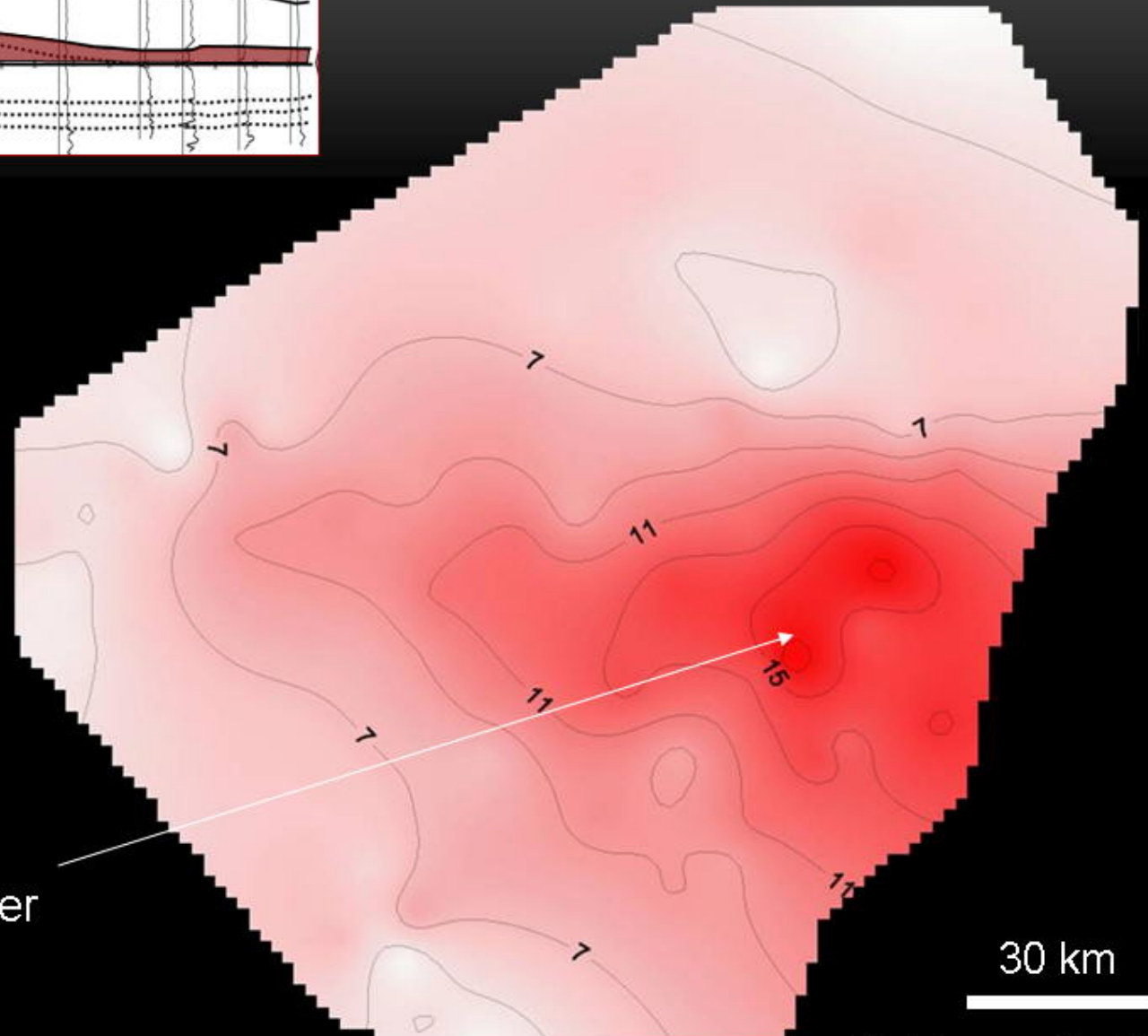
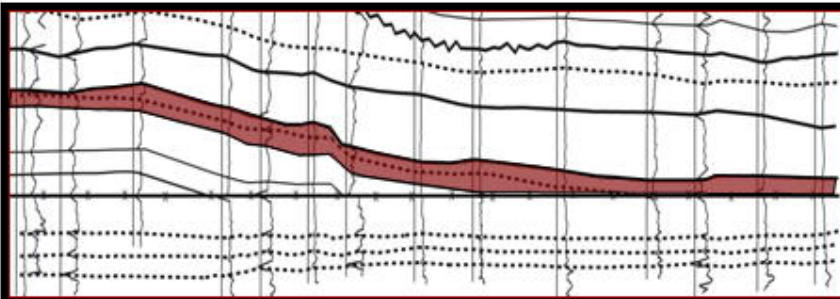
Thickness in Meters



ISOPACH MAP: UNIT 3



ISOPACH MAP: UNIT 4

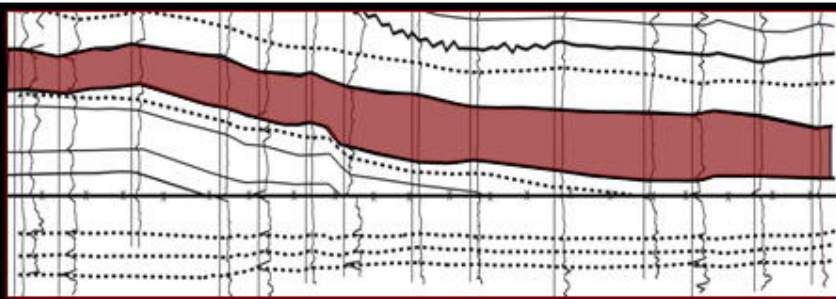


Mud Depocenter

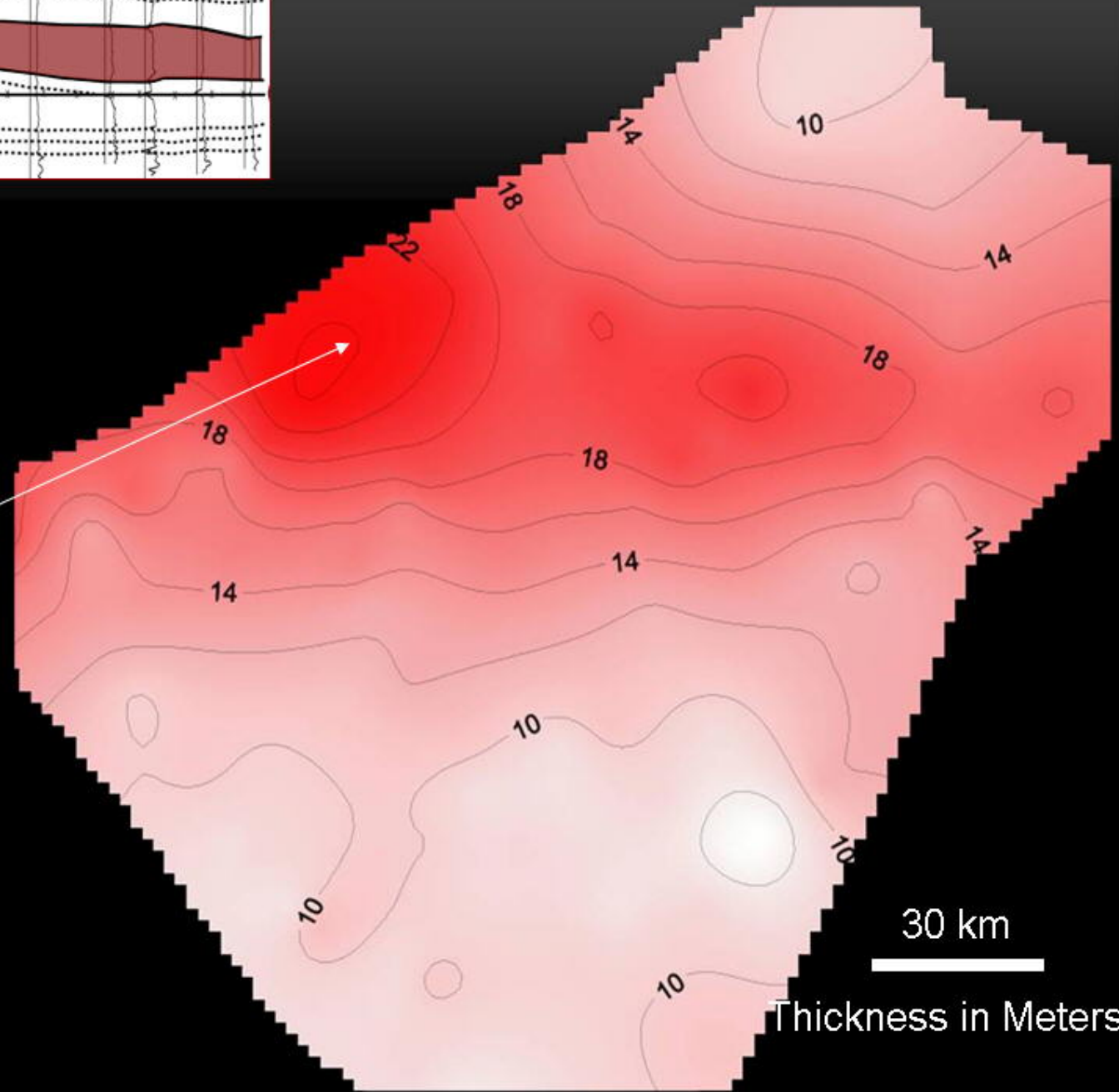
30 km

Thickness in Meters

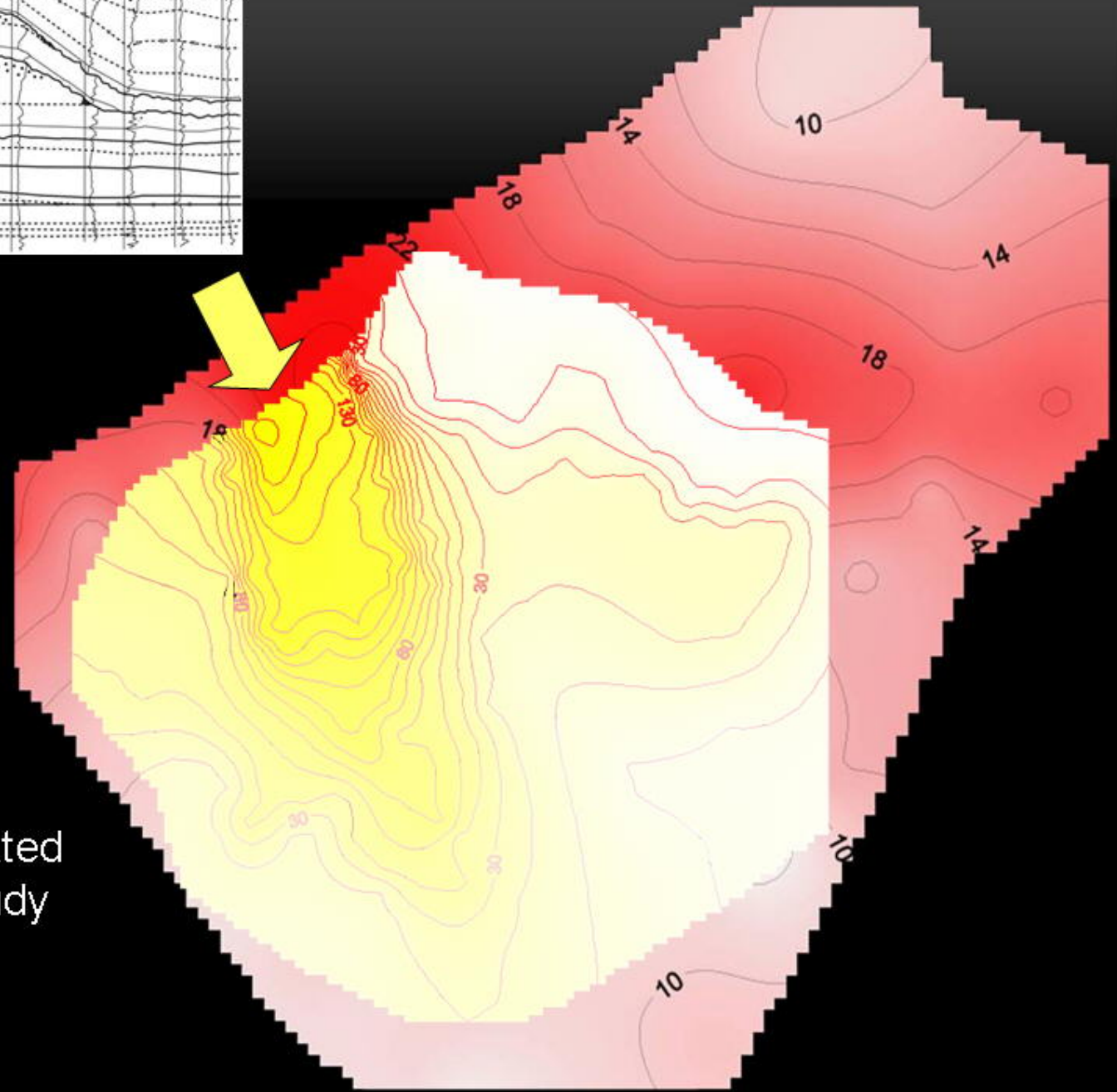
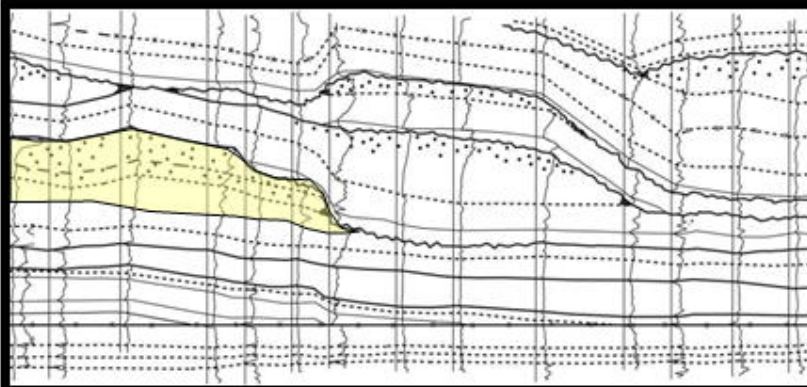
ISOPACH MAP: UNIT 5



Mud Depocenter



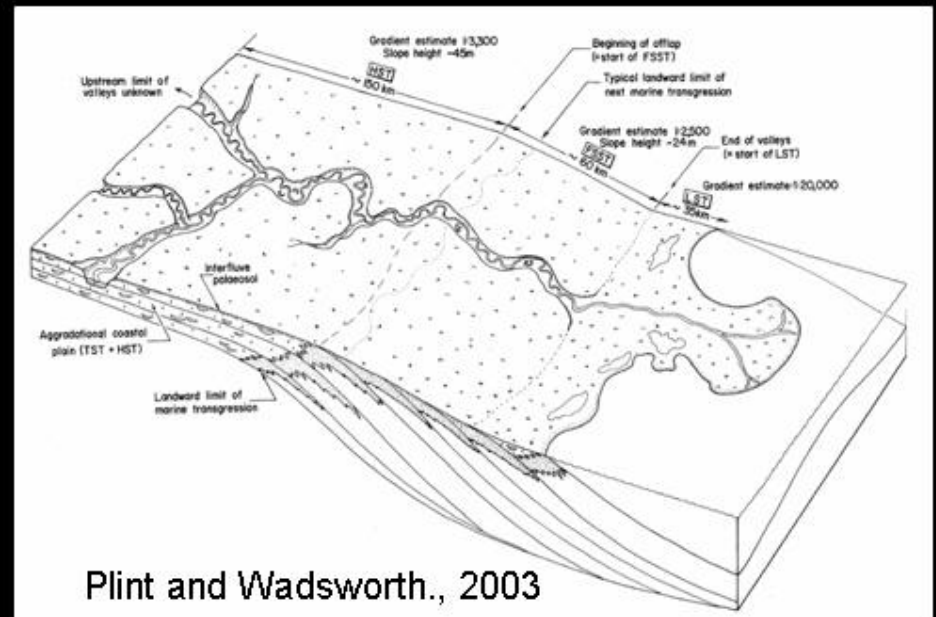
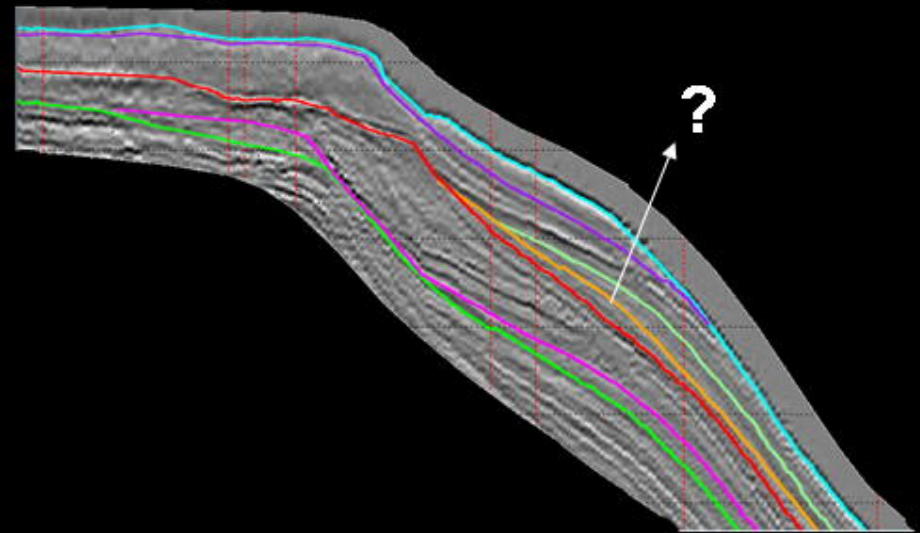
HARLAN ISOLITH MAP:



First Sand-dominated
Interval in the Study
Area

Mud Belts and Sequence Stratigraphy

- Not incorporated in existing models
- Possible confusion with healing phase or lowstand deposits
- Predictive power



Acknowledgments

- We wish to thank Shell International E&P for permission to present the results of this study
- We wish to thank Veritas for permission to show seismic data.

