



# Depositional Environments, Ichnology and Reservoir Quality of the Hawke Bay Formation, Port au Port Peninsula

Supported by the Petroleum  
Exploration Enhancement Program



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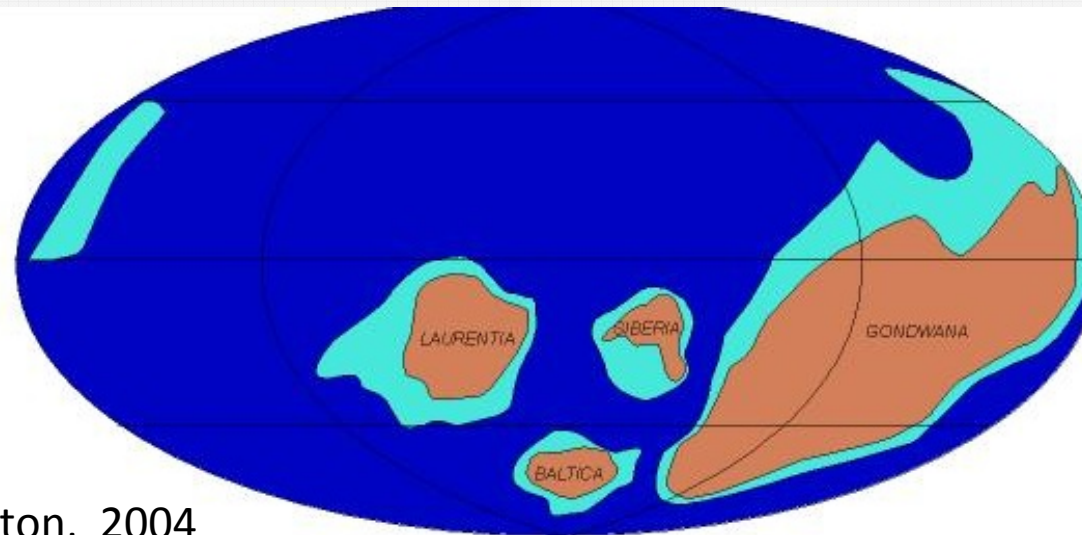
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# Lower Palaeozoic Sandstone Reservoirs

- Quartz sandstones common in Lower Palaeozoic
- Important hydrocarbon reservoirs in North Africa, Middle East and Australia
- Rich trace fossil fauna – “Pipe Rock”
- Bioturbation can increase porosity and permeability of hydrocarbon reservoirs – grain sorting, cementation, conduits.
- Up to 1.5 km thick sandstone sequences in the Middle East and Australia



au Port 1

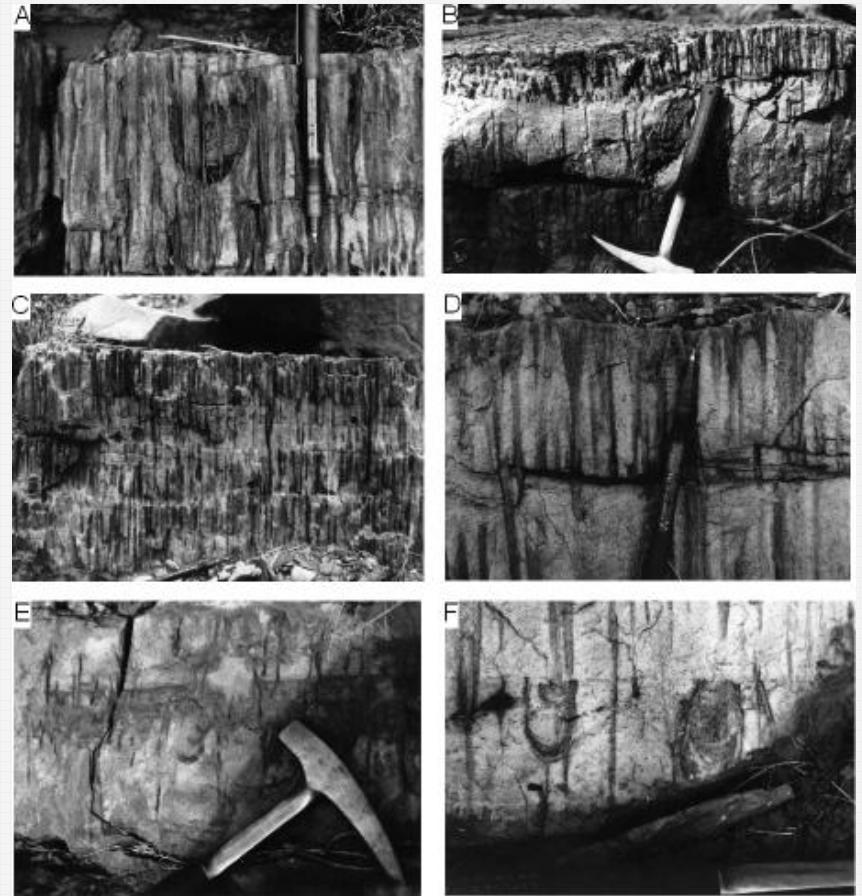
# *Skolithos* - "Pipe Rock" - Ichnofabrics



Lower Cambrian Eriboll  
Sandstone, Scotland

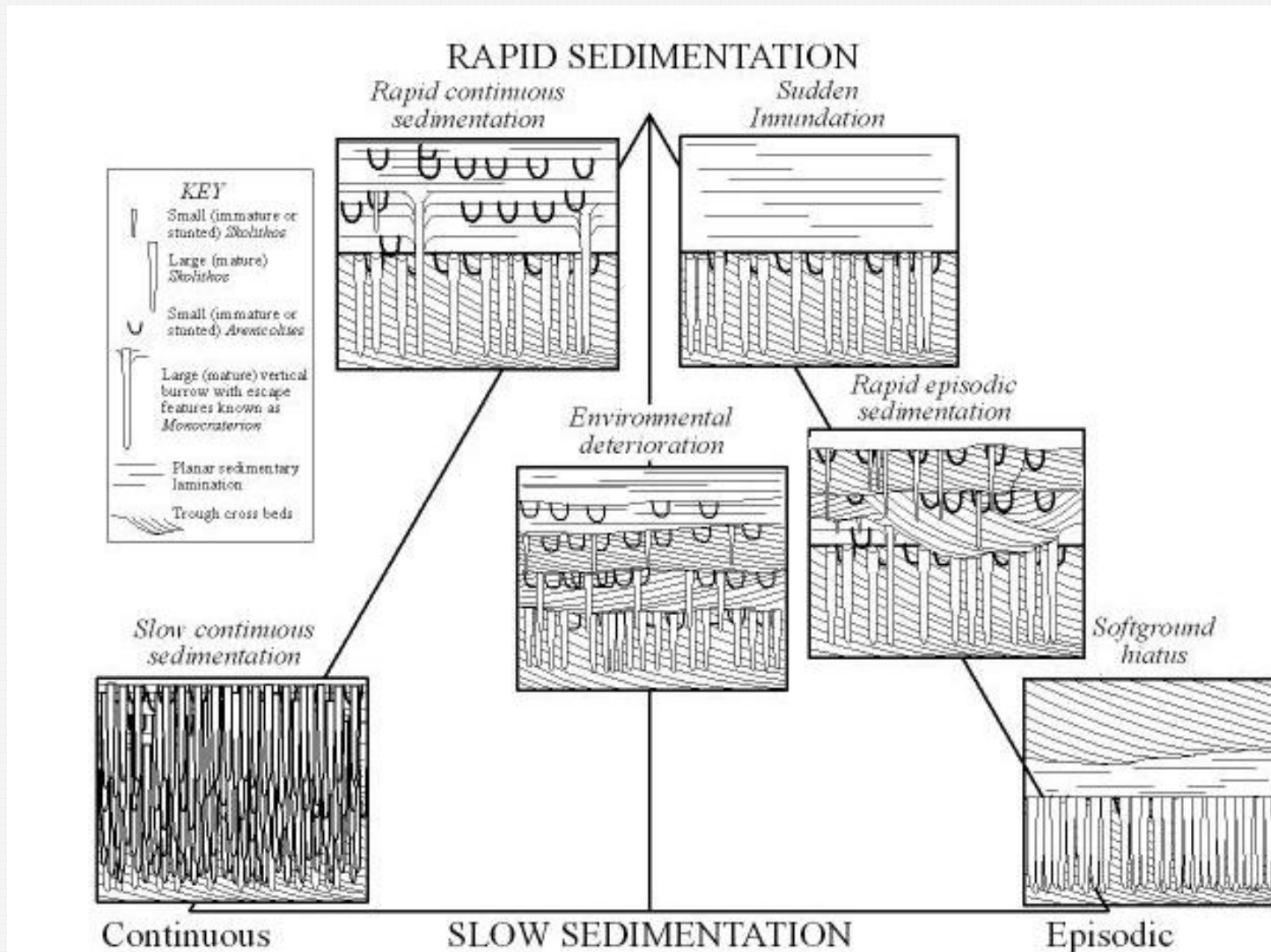
Core from Lower  
Palaeozoic of N. Africa

McIlroy & Garton, 2004



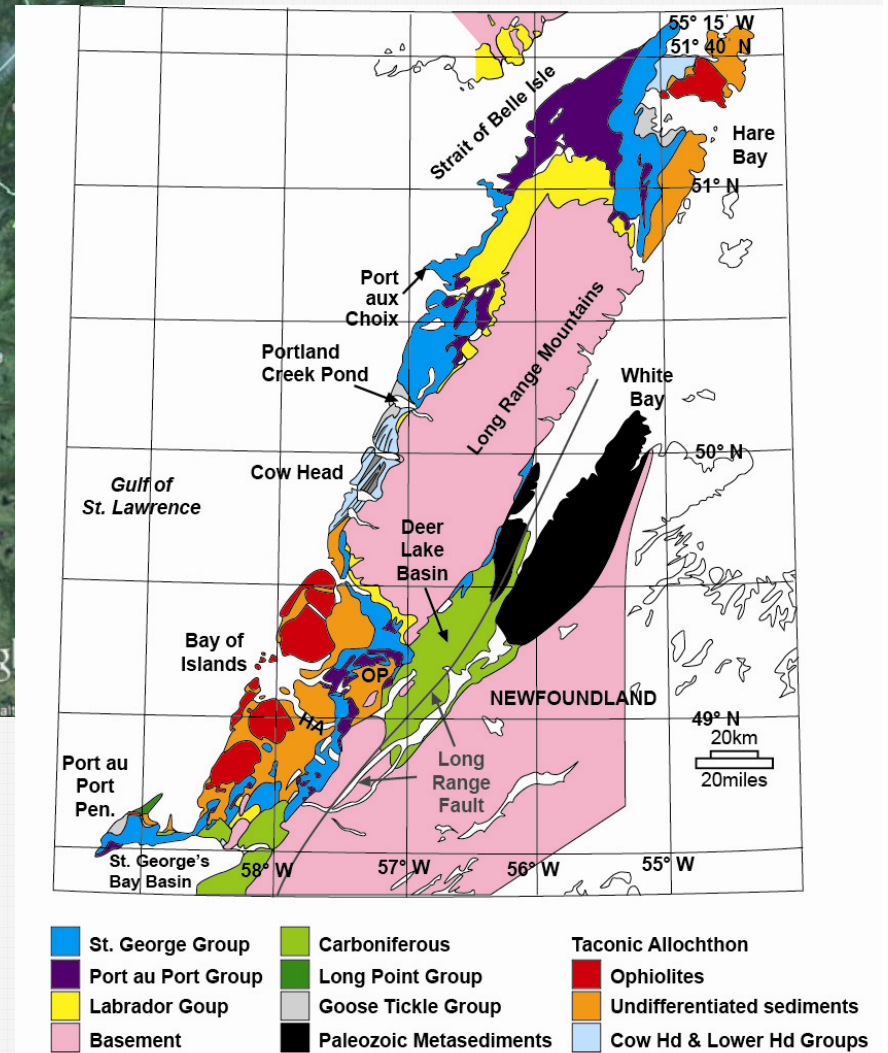
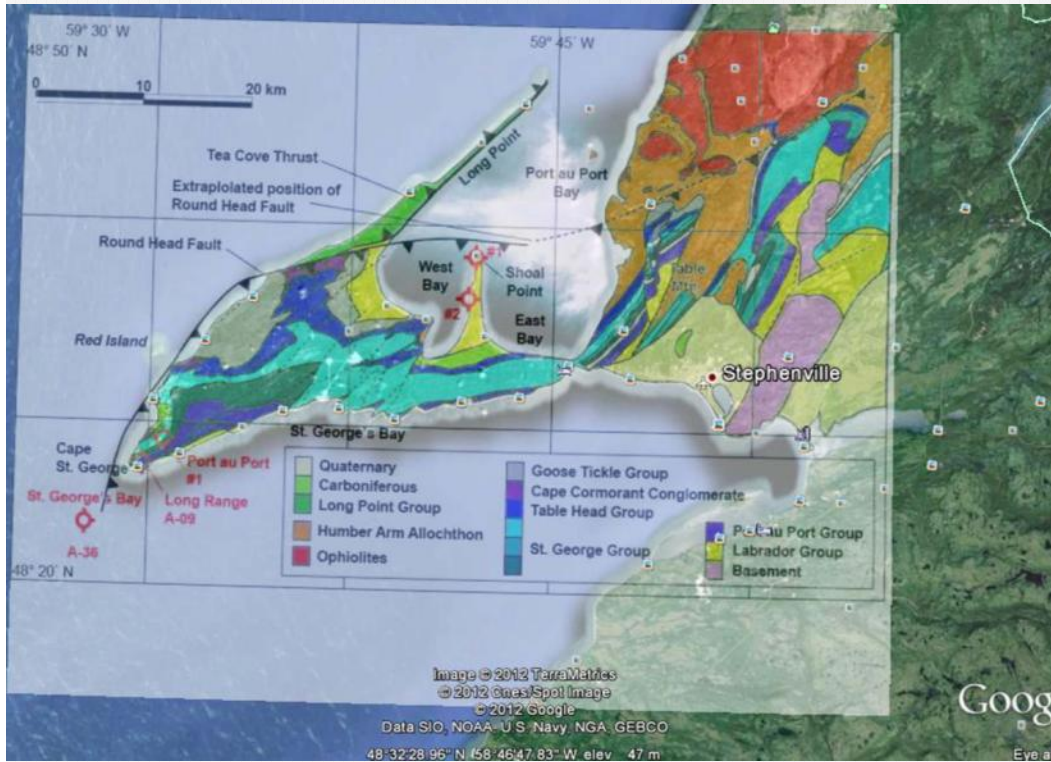
Cambro-Ordovician Pacoota  
Sandstone, Central Australia

# Bioturbation and Reservoir Quality





# The Hawke Bay Fm., Labrador Gp.



After Cooper et al., 2001

# Logged Sections – Hawke Bay Fm.

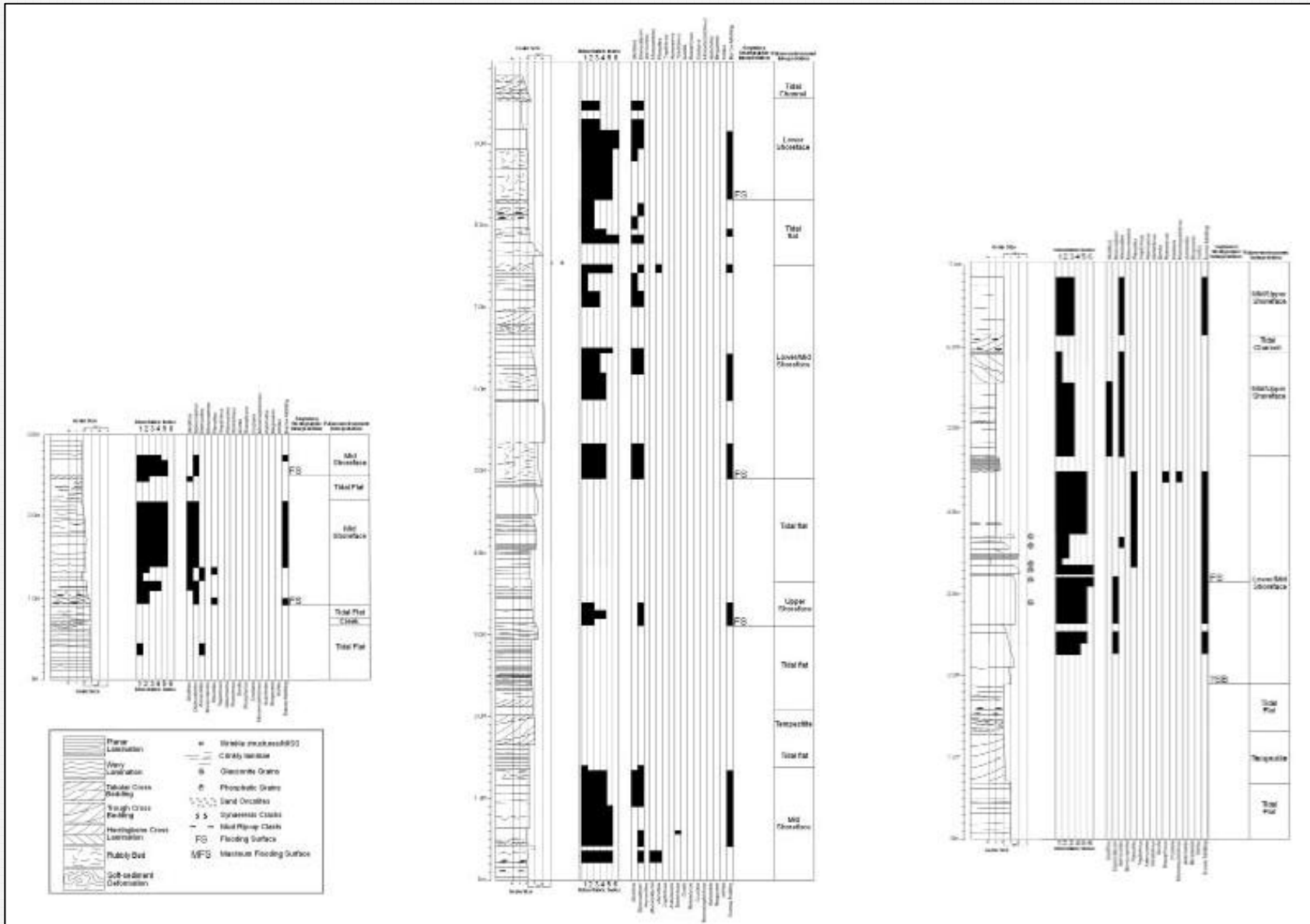




# Hawke Bay Fm. - Port au Port

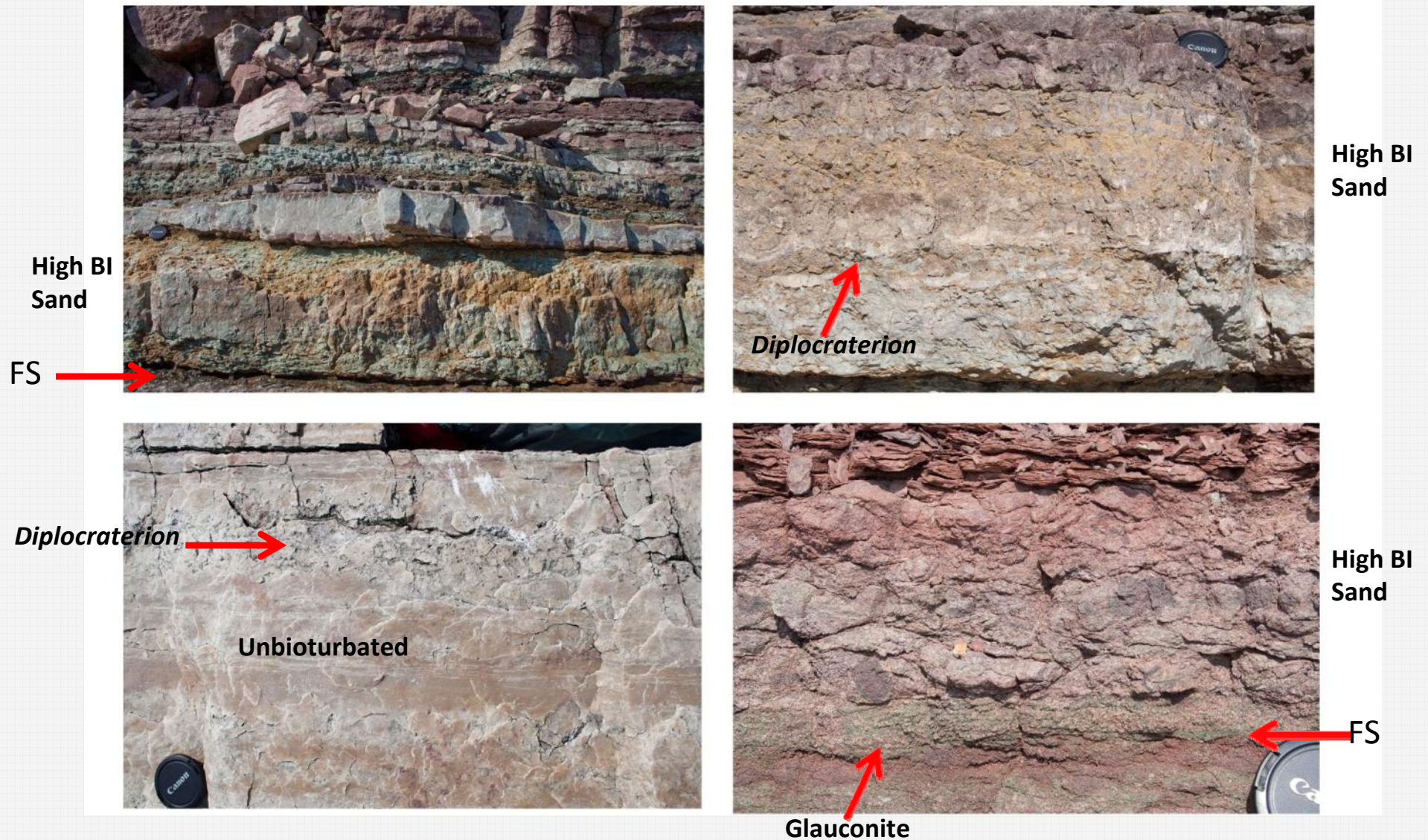


# Example Stratigraphic Sections



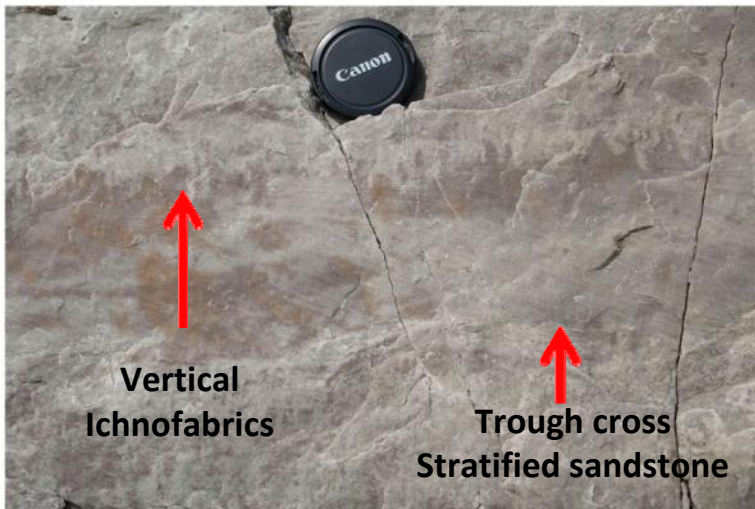


# Lower-Mid Shoreface – High bioturbation intensity sandstones





# Tidal Channels – Low Bioturbation Intensity Sandstones





# Tidal Flats – Unbioturbated

Planar, horizontal  
and wrinkly laminae



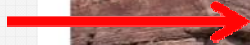
Alternations of well  
and poorly cemented  
laminae



Cross-stratified  
event bed



Tidal flat incised  
by tidal creek



Flat-topped ripples



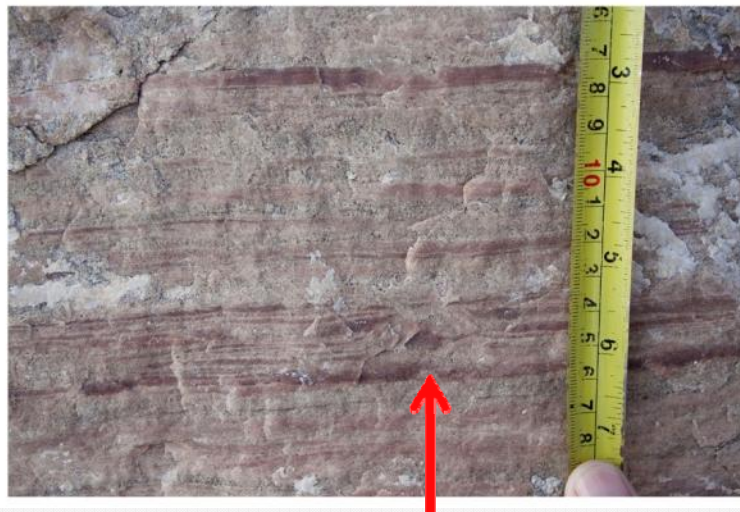


# Microbial Mats – Often in Tidal Flats

Lattice like  
Cracks  
“Rhysonetron”



Winkle  
structures



Planar and wrinkly laminae  
and domal sand stromatolite



Microbialite  
Dome



# Ichnofabrics

Low intensity  
*Skolithos*



Sparse J-shaped  
Burrow cf. *Arenicolites*



U-shaped  
*Arenicolites*



High intensity  
*Arenicolites* or  
*Diplocraterion*



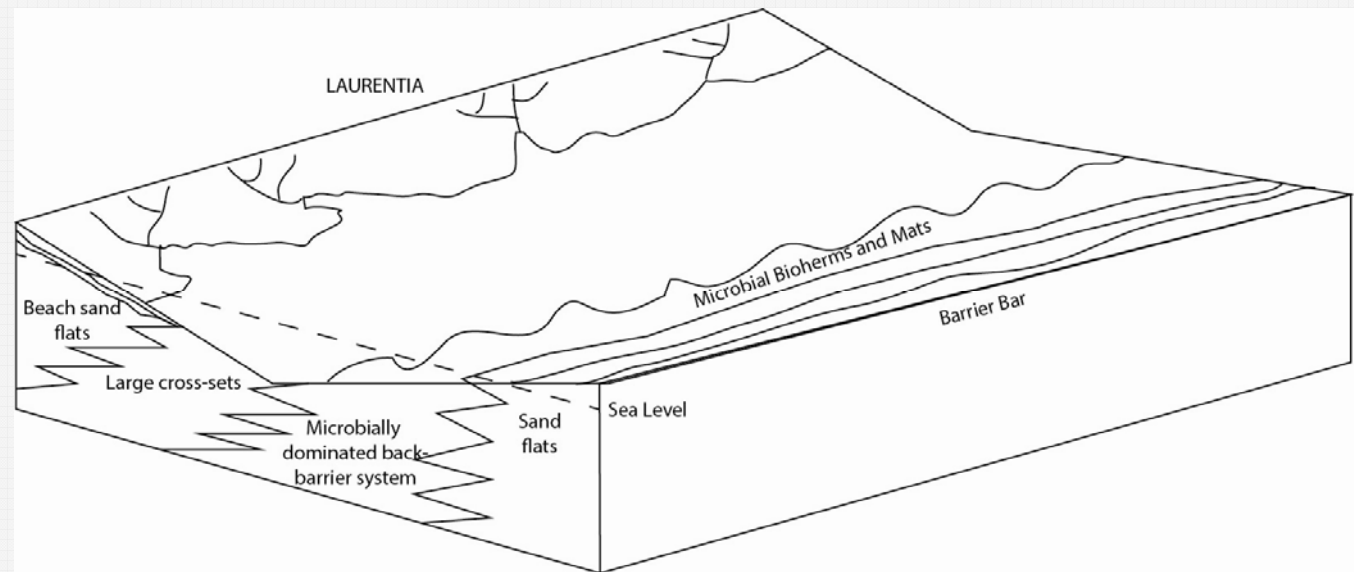
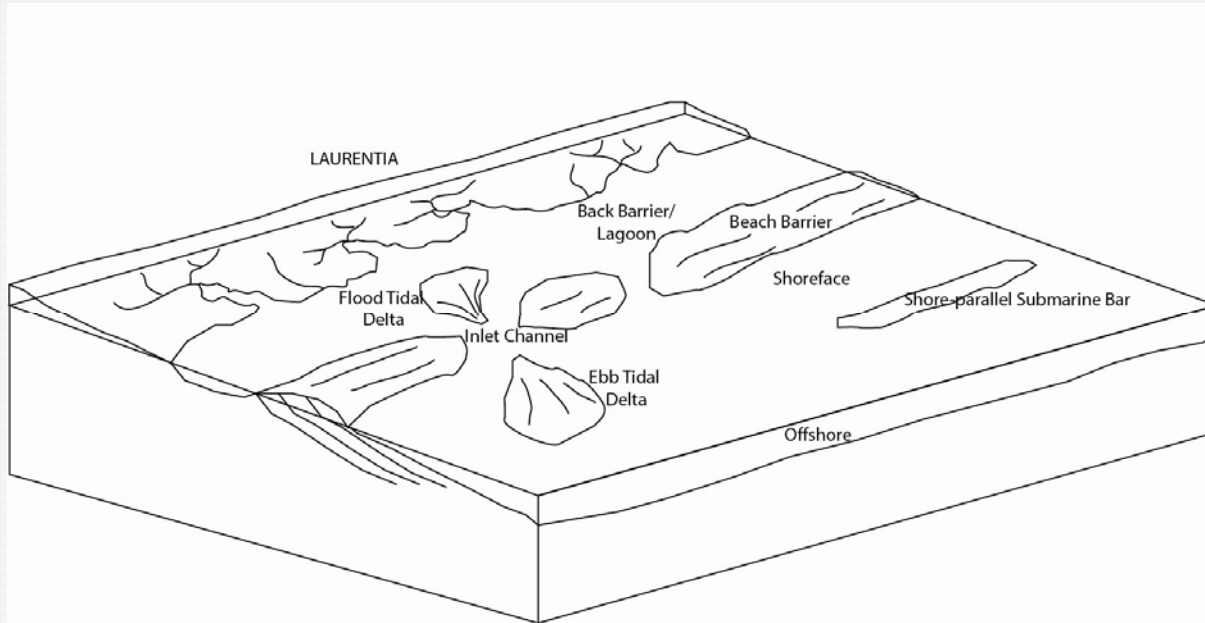
High intensity  
*Skolithos*



High intensity  
*Diplocraterion* on  
Bedding plane at  
Flooding surface



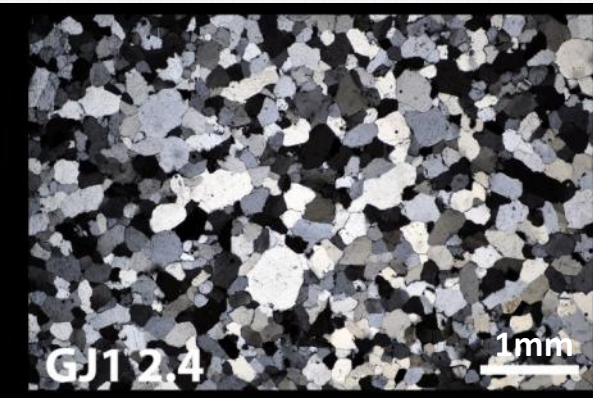
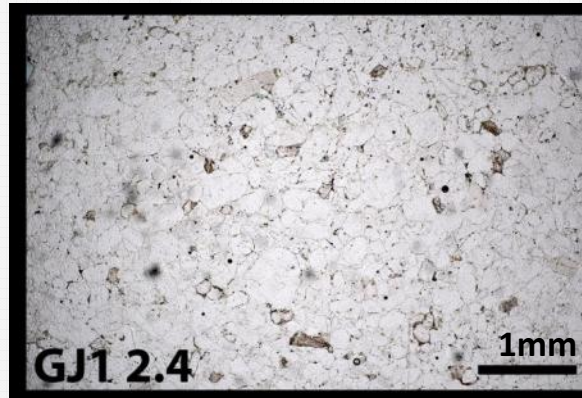
# Palaeoenvironmental Model



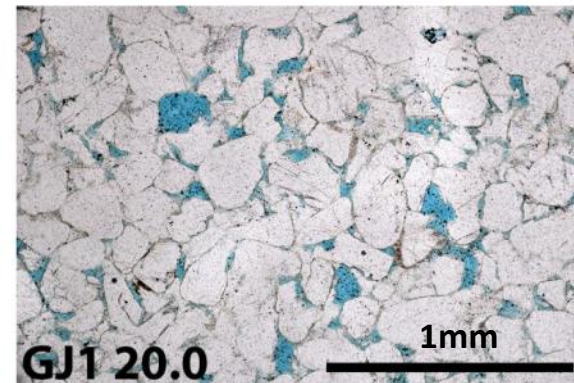
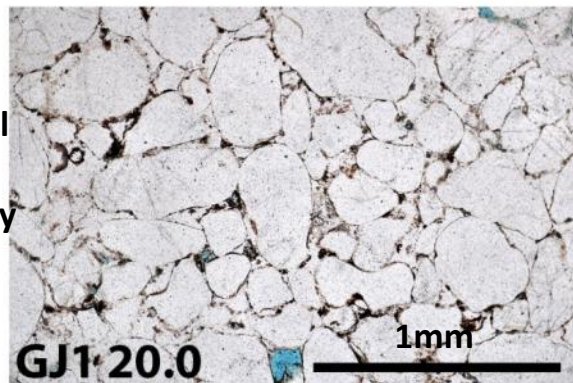


# Sandstone Petrography

Upper shoreface  
Clean, arkosic  
Sandstone,  
c. 0% Porosity

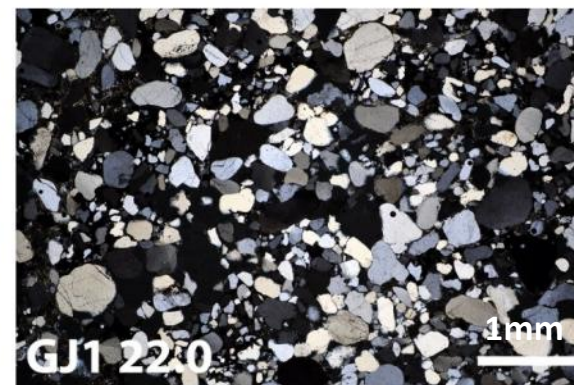
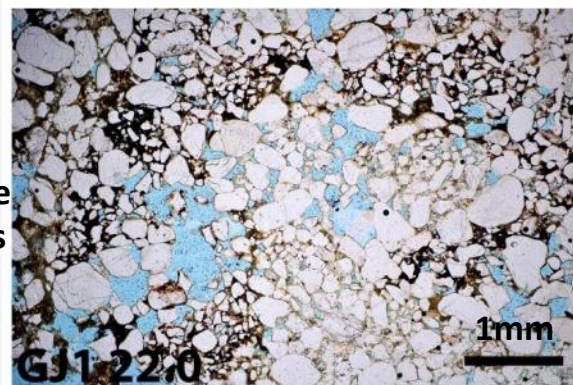


Coarse-grained, well  
cemented tidal flat  
lamina c. 0% porosity

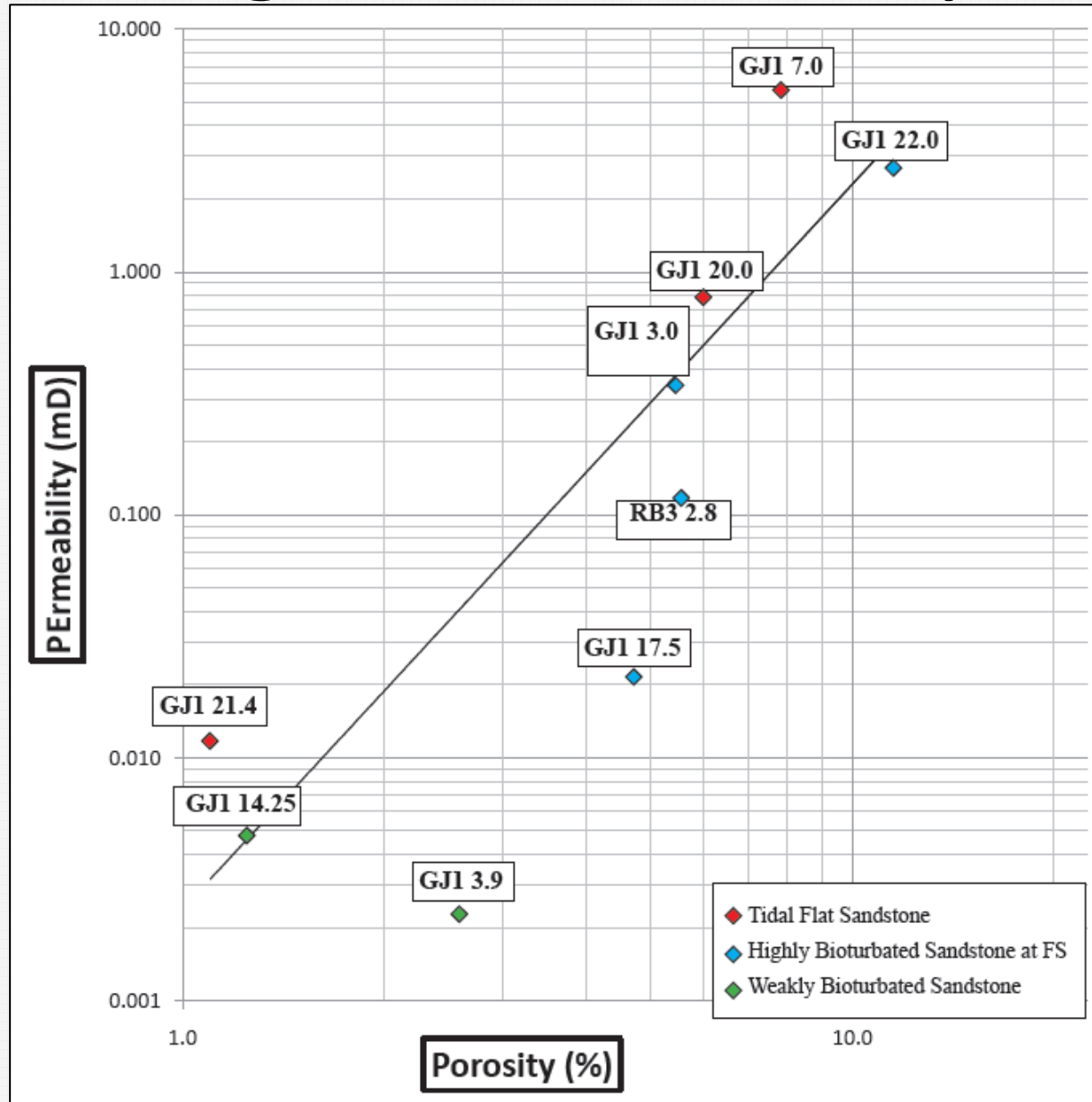


Finer-grained, poorly  
cemented tidal flat  
lamina c. 10% porosity

Bioturbated, lower  
shoreface sandstone  
c. 10% porosity, plus  
clay minerals



# Plug Por-Perm Analysis



# Conclusions

- Depositional environments include lower-mid shoreface, tidal bars and channels and tidal flats.
- Bioturbation intensity controlled by facies, relative sea level.
- Highest BI in lower shoreface at flooding surfaces.
- Porosity 1.3-11.5%.
- Permeability 0.003 D to 7.4mD.
- Best reservoir quality in lower shoreface sandstones and in some tidal flat laminae. Worth producing a regional palaeoenvironmental maps.
- $k_v$  likely to be poor,  $k_h$  good where present.



# Acknowledgements

- Petroleum Exploration Enhancement Program - Government of Newfoundland and Labrador
- Larry Hicks (Department of Natural Resources) and Ian Knight (Geological Survey of NL)