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AECOM

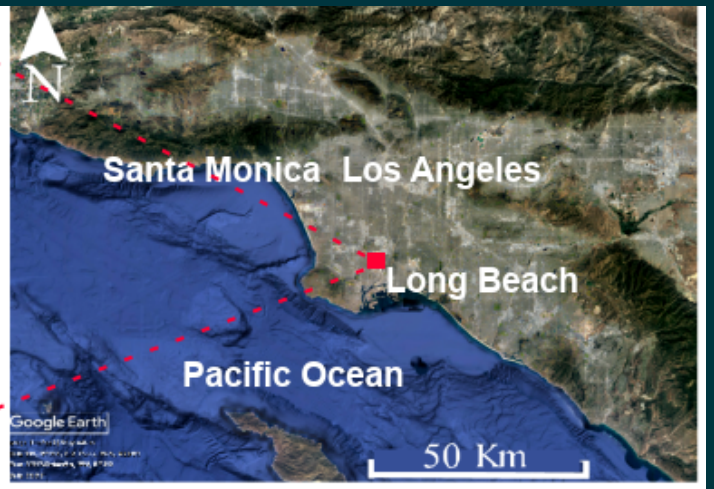
Application of Sequence Stratigraphy in Developing Bioremediation Strategy in a Complex Geological Site

Dr. Junaid Sadeque and Rayan Samuels, AECOM

Case Study

Site location

Cross Section Map



Data: CPT Logs, Core Description, Groundwater, Chemistry

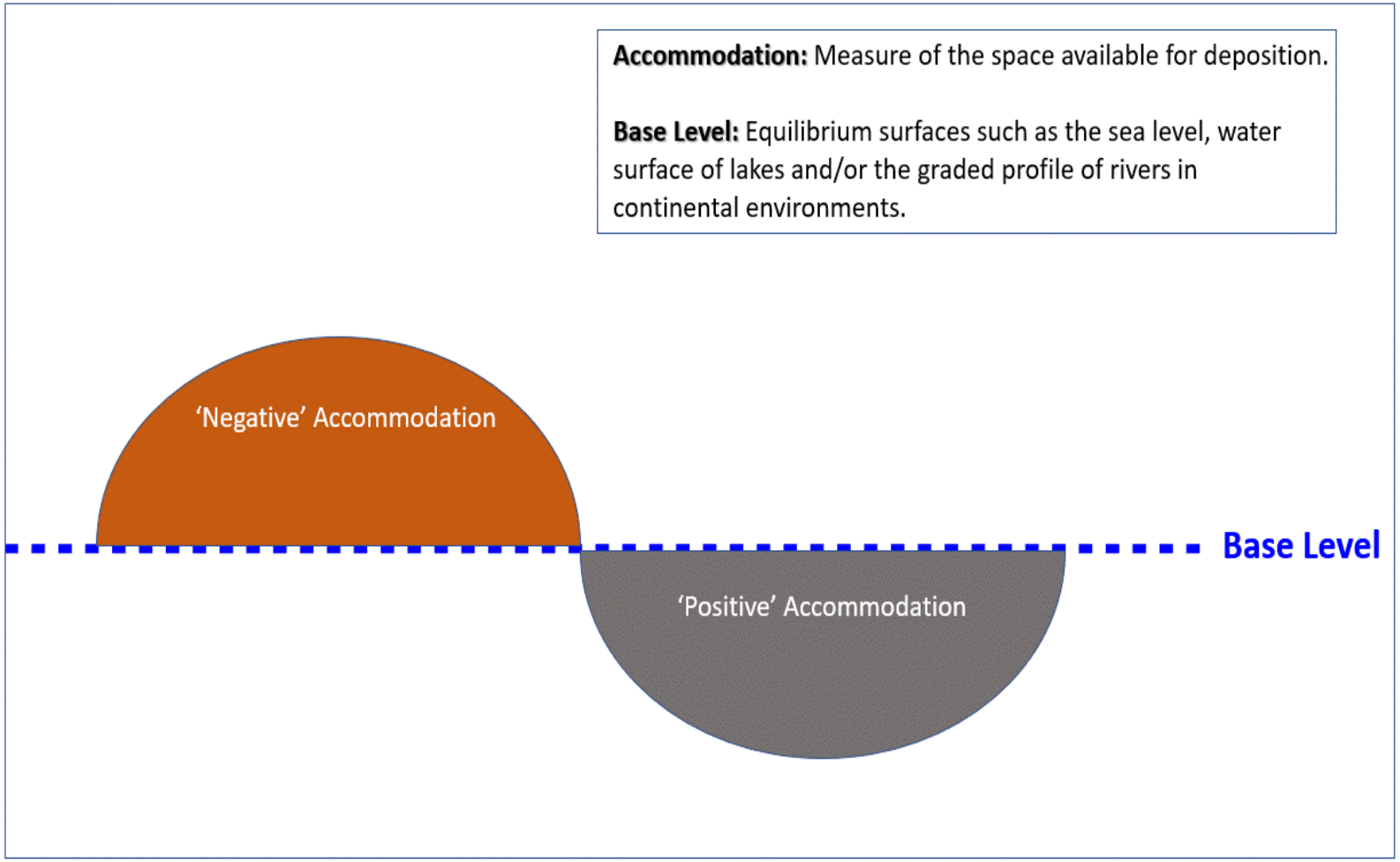
Goals:

- Understand site subsurface heterogeneity by reinterpretation of previous cross-section using sequence stratigraphy.
- Identify high-permeability zones for optimal placement of biosparging tool for LNAPL remediation.

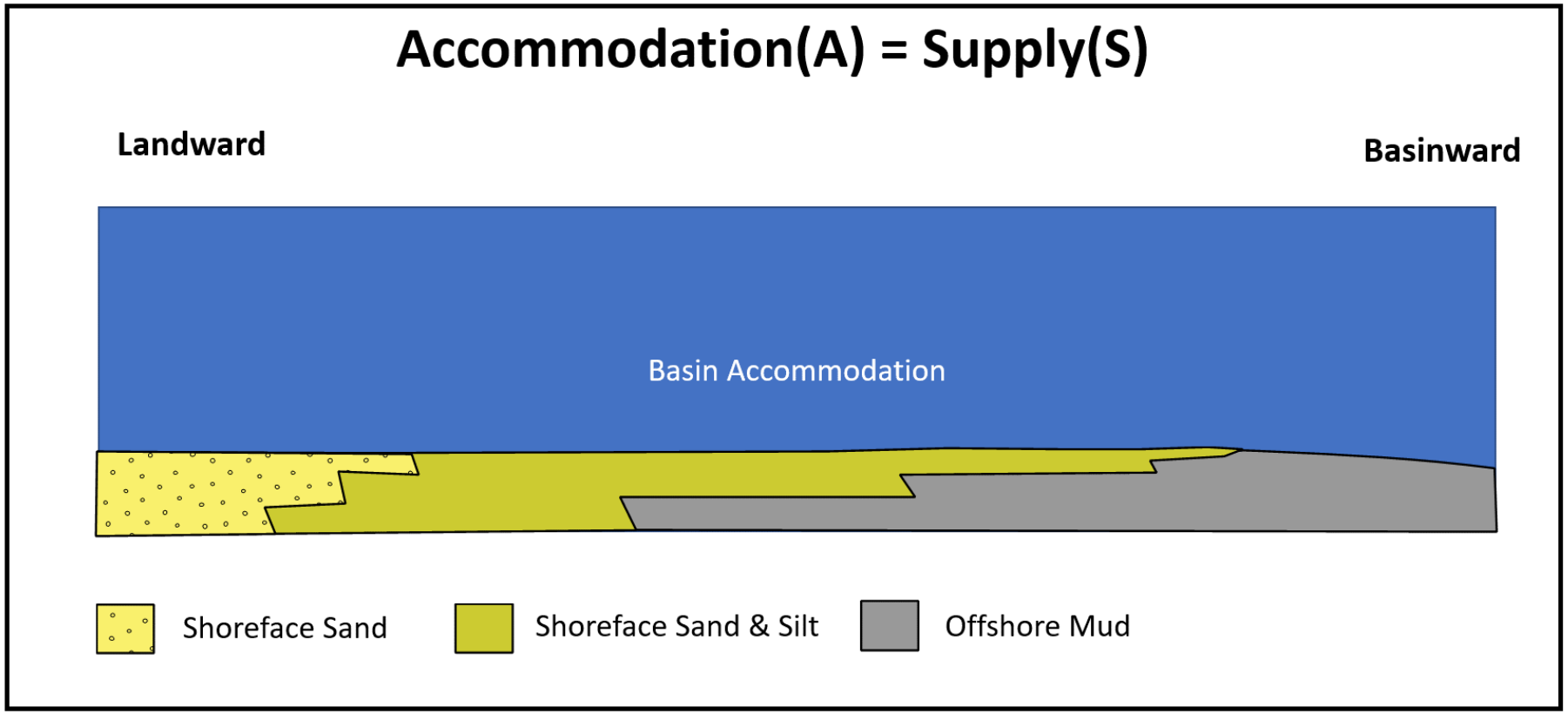
Accommodation and Sequence Stratigraphy

- Stratigraphic architecture is a product of the interplay between ‘accommodation’ and sediment supply

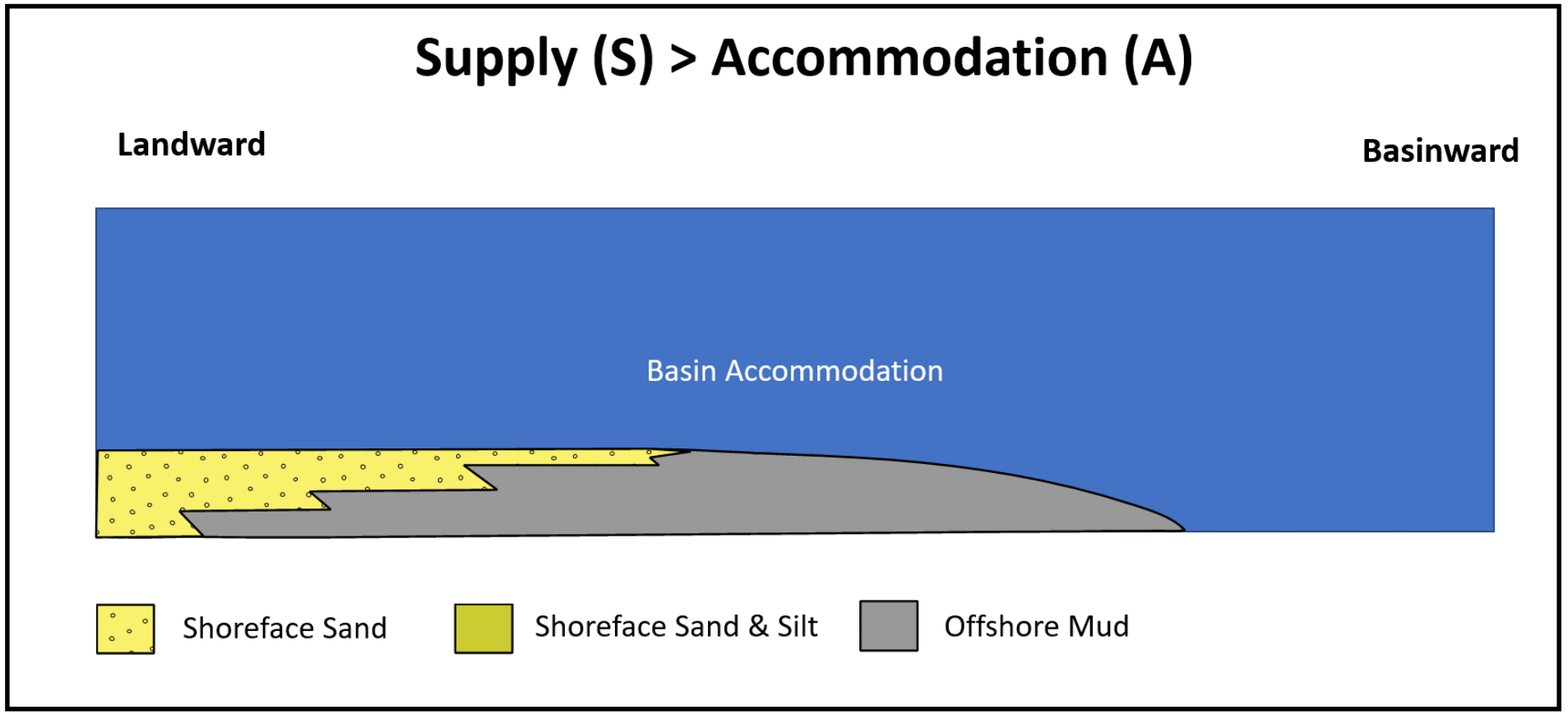
- In coastal settings, accommodation is controlled by sea-level changes



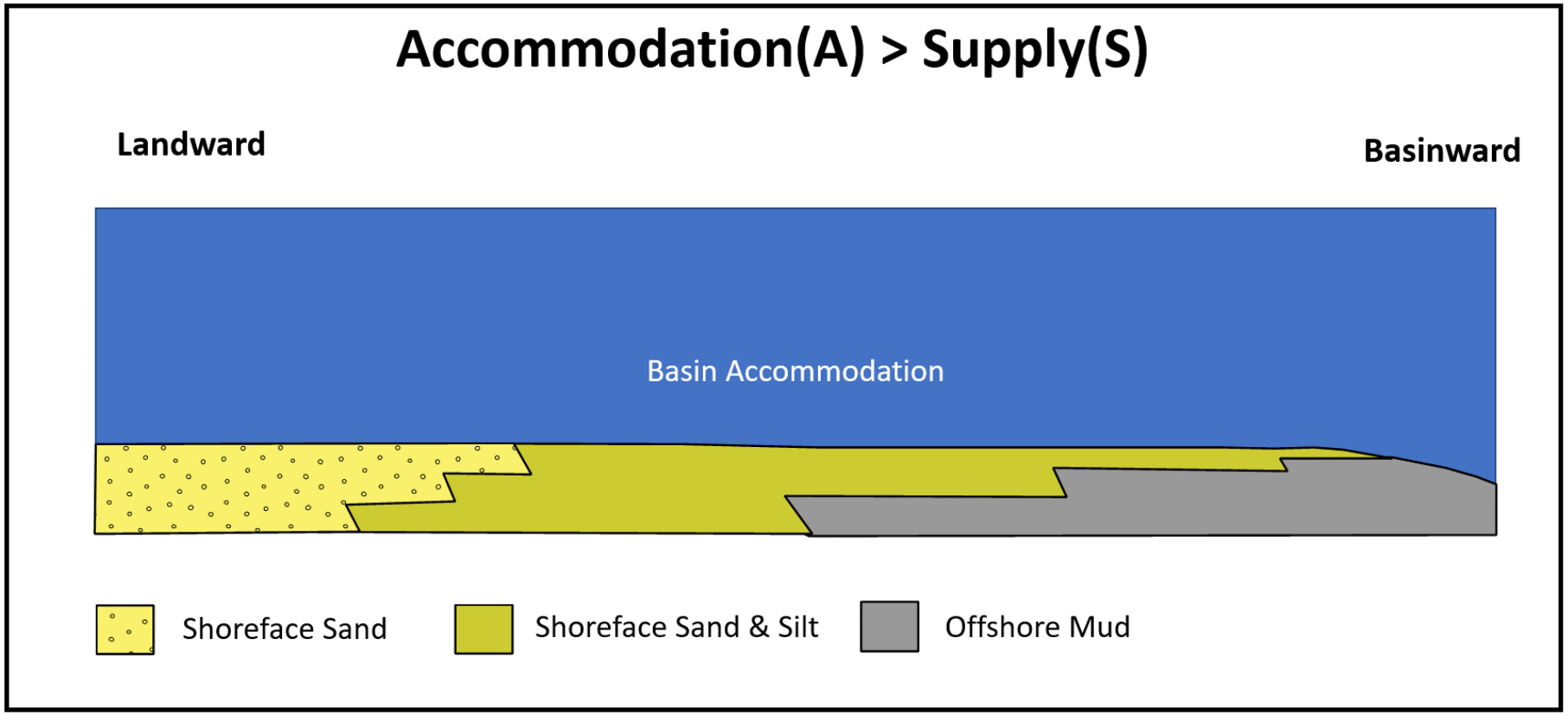
Aggradation (Vertical Stacking)



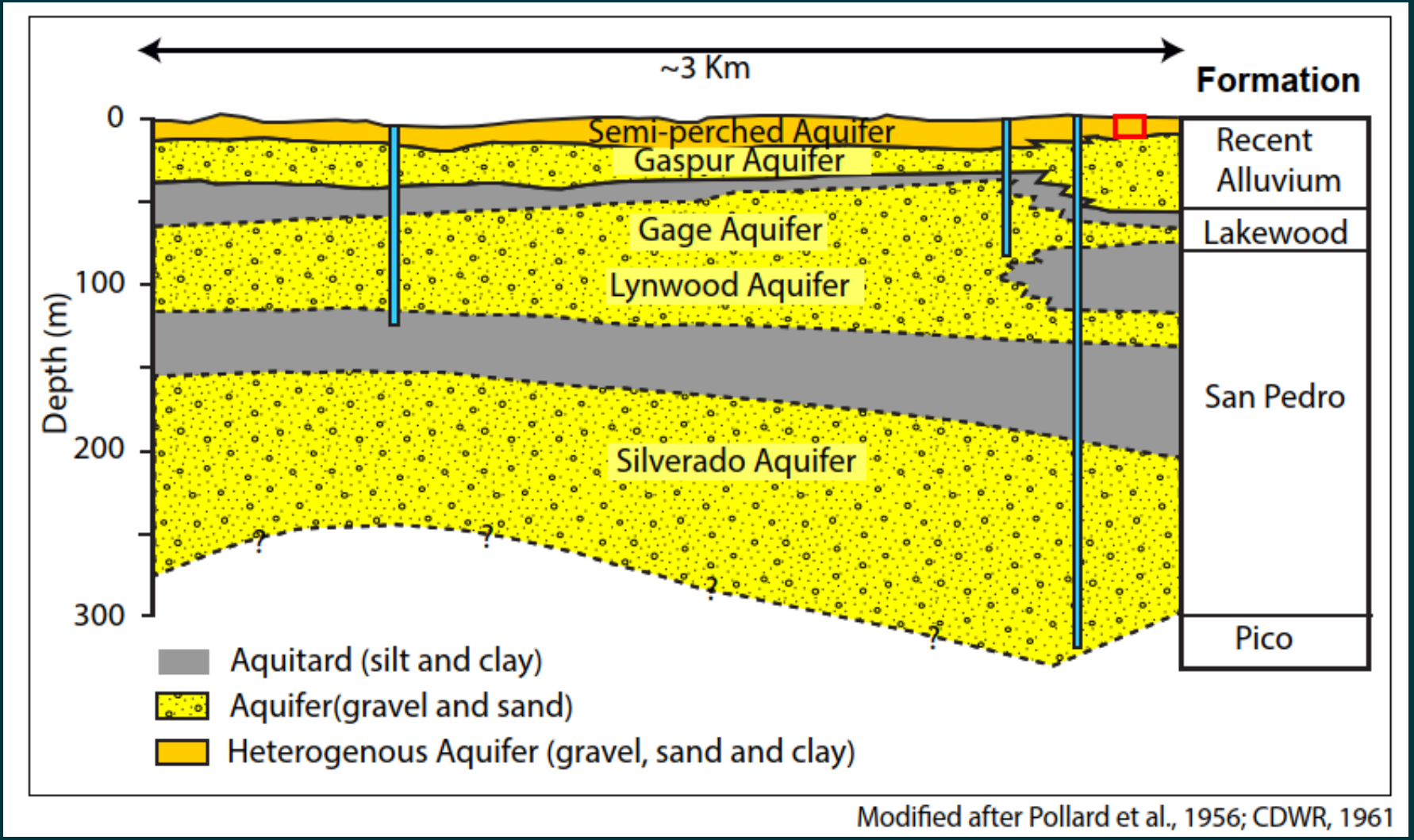
Progradation (Seaward Stepping)



Retrogradation (Backstepping)



Aquifers in the LA Basin: Lithostratigraphic Approach

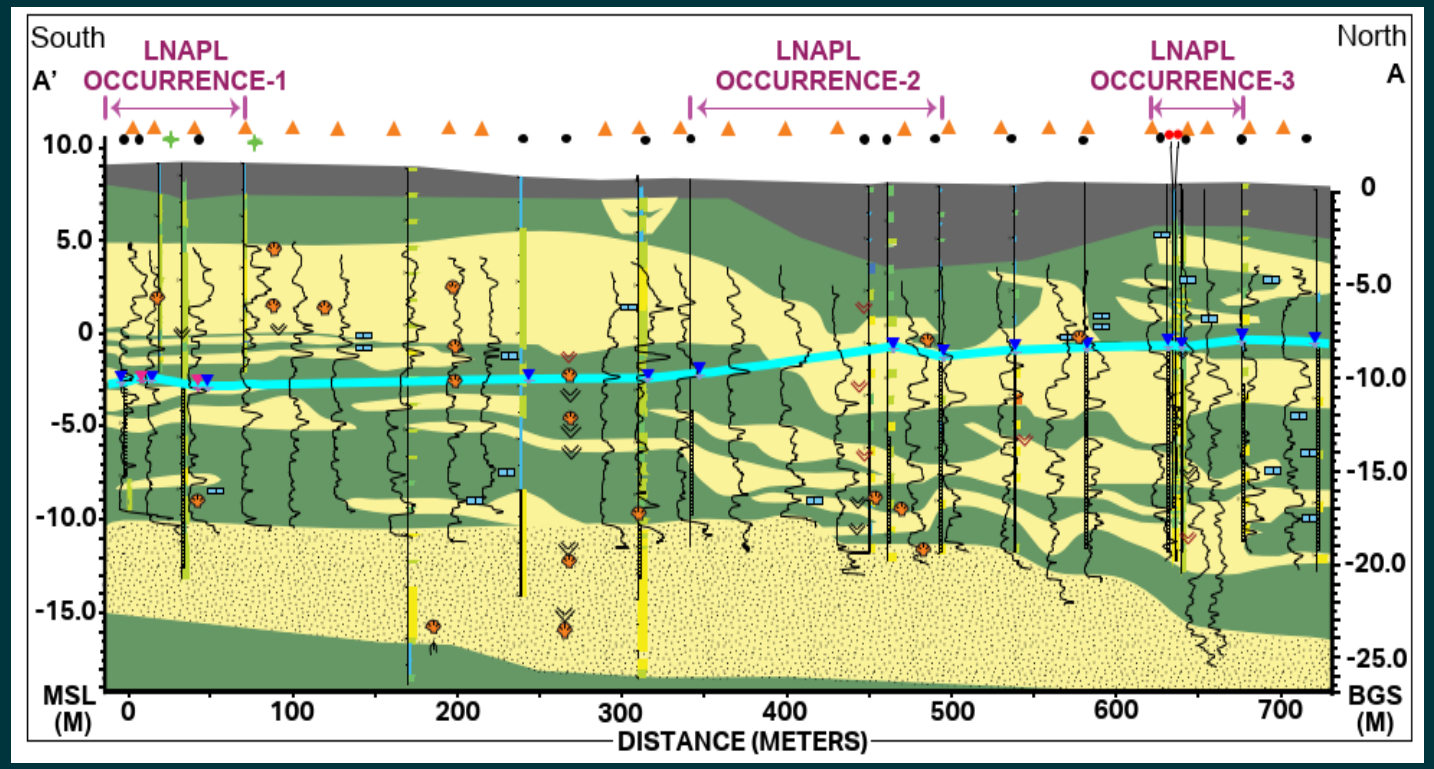


Modified after Pollard et al., 1956; CDWR, 1961

A lithostratigraphic (Layer Cake) approach!

Previous Site Cross-section

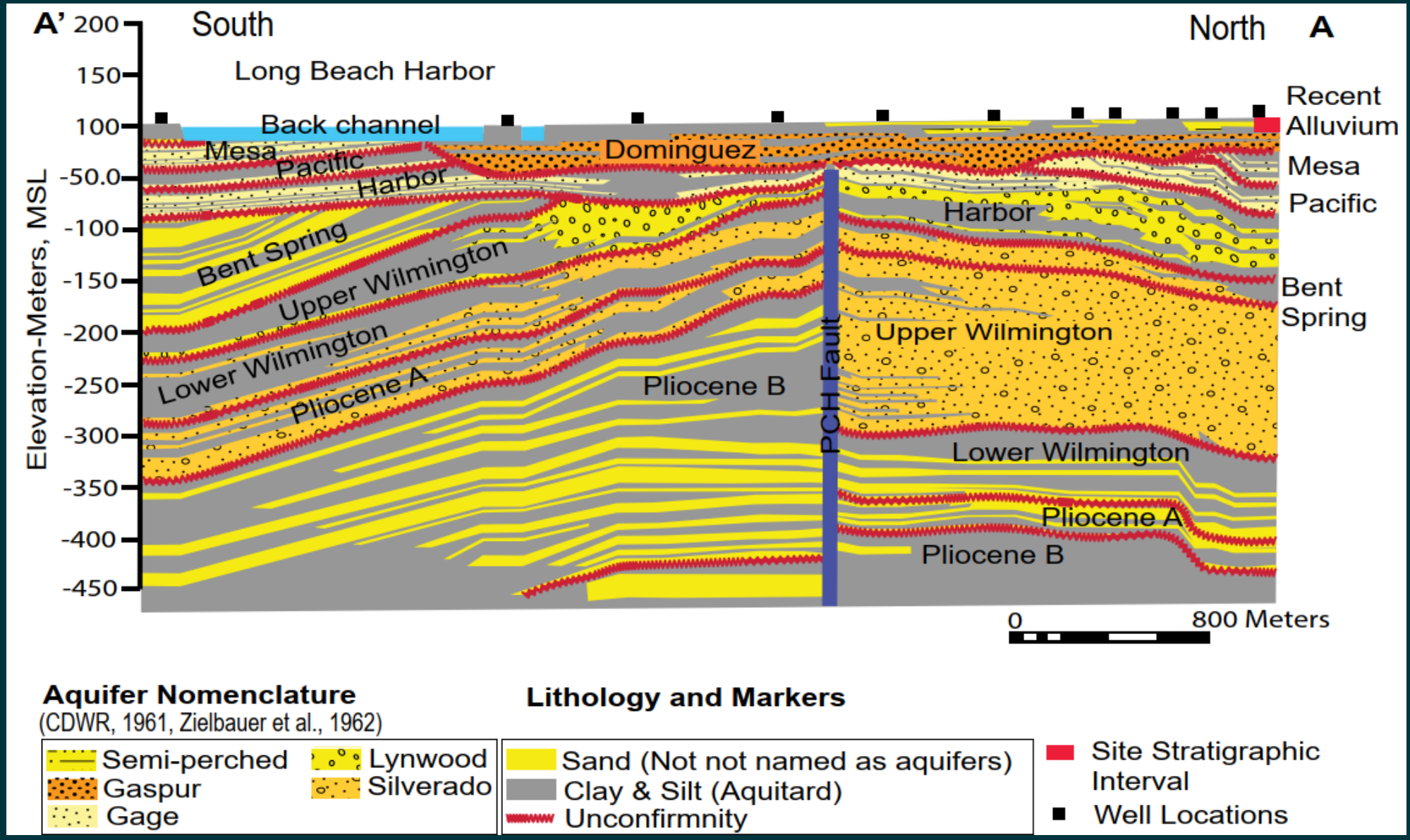
Cross Section Map



- Excellent data coverage: CPT logs and borehole lithology
- Detailed borehole description showing shell fragments, laminations, carbonate cementations
- Good approximation of sandy intervals and muddy intervals

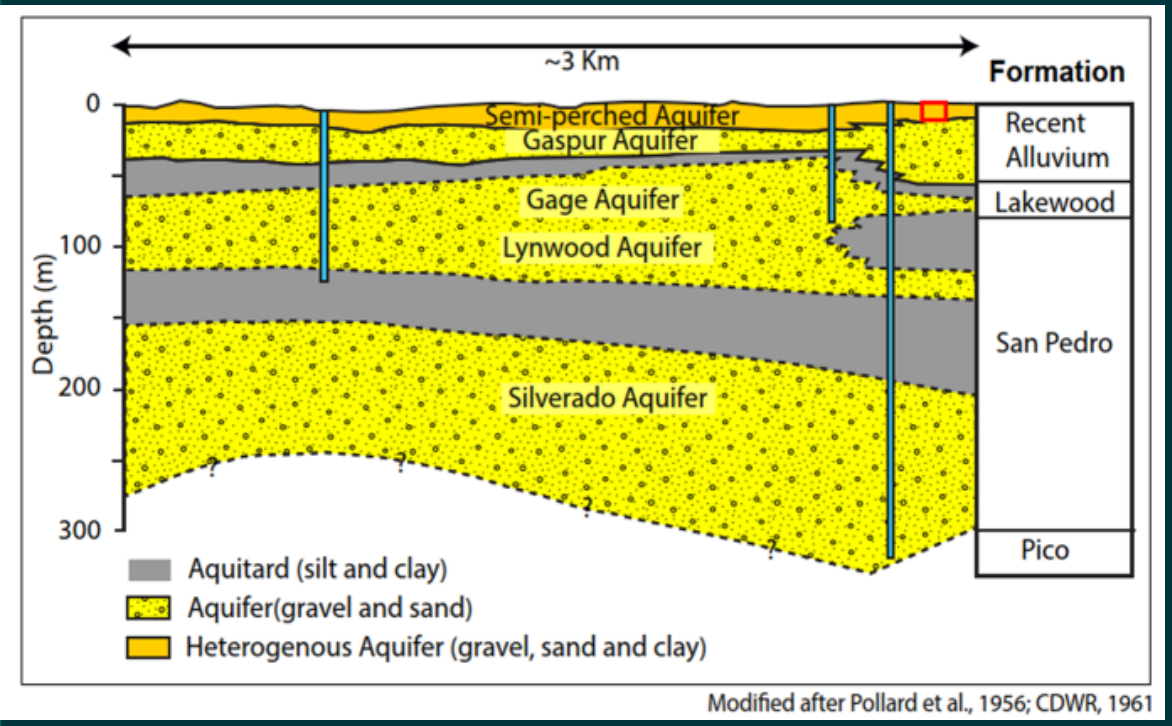
Does not have the resolution for accurate positioning of biosparging tools!

Aquifers in the LA Basin: Sequence Stratigraphic Approach

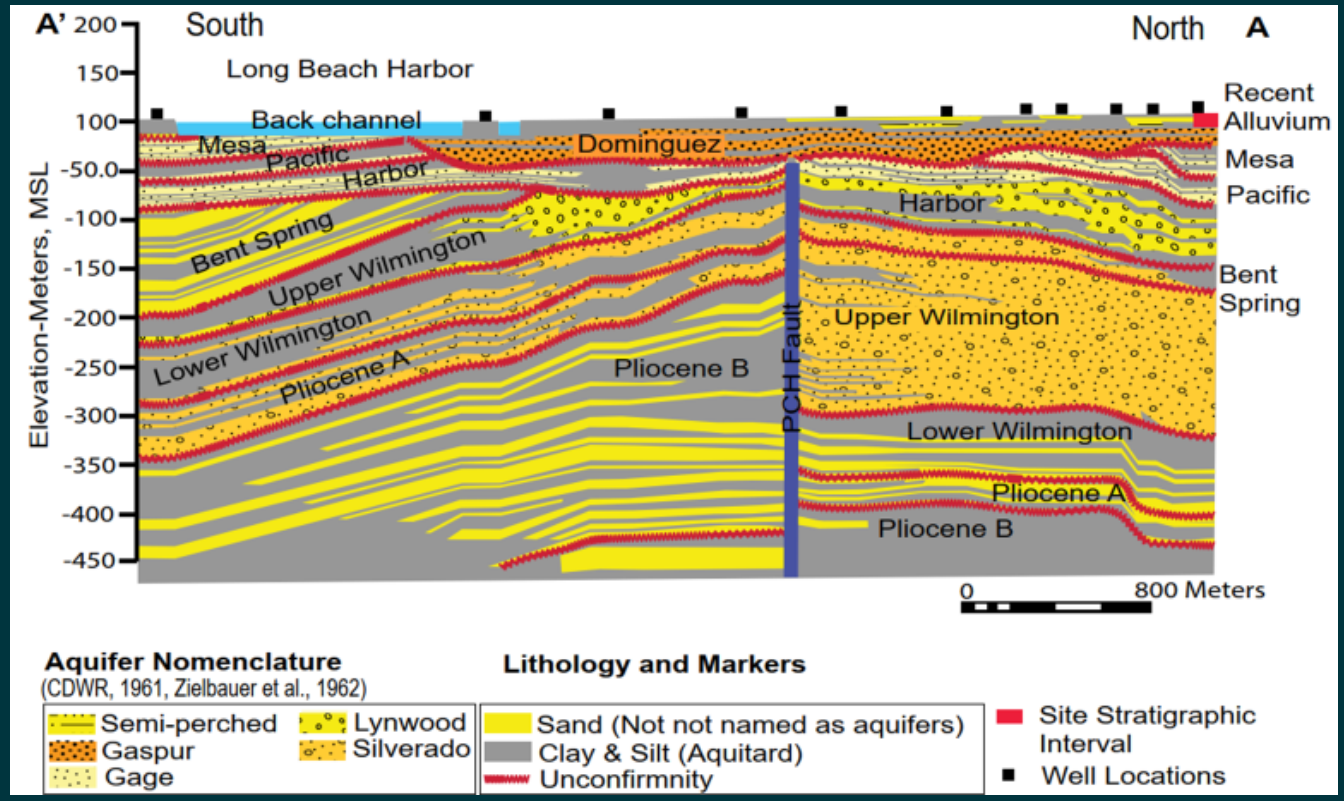


From Ehman, K.D., and B.D. Edwards, 2014

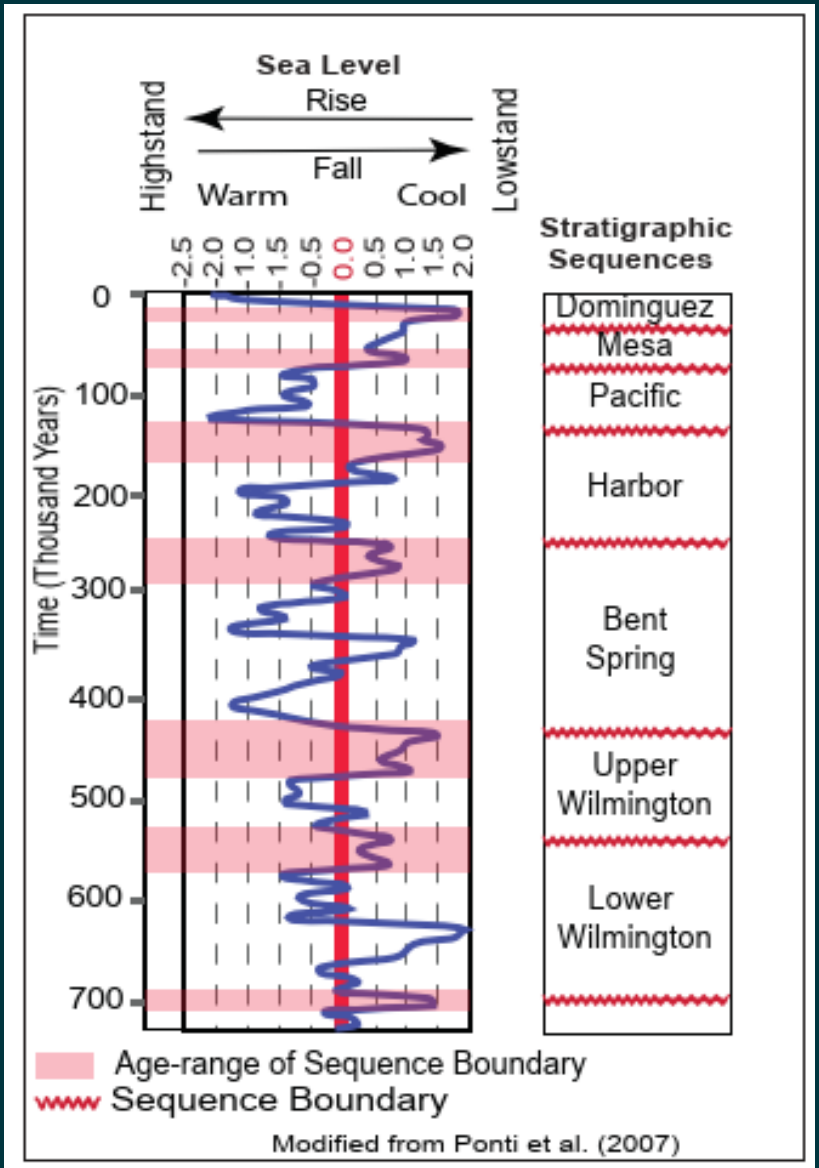
Traditional Method vs. Sequence Stratigraphic Correlation



Modified after Pollard et al., 1956; CDWR, 1961



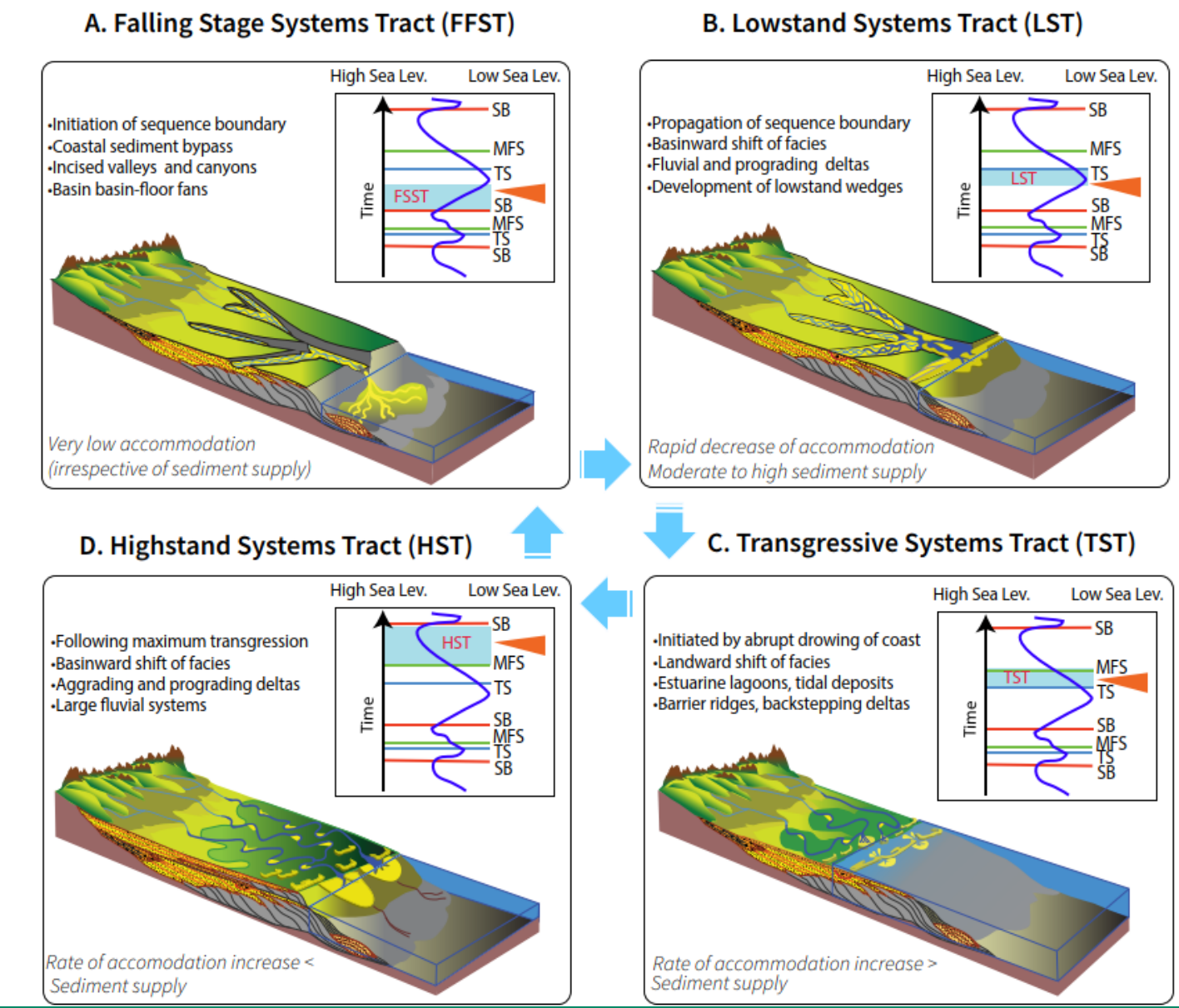
Sea Level Applicable to the LA Basin



Sea-level Rise: Retrogradation
(Coastal Retreat)

Sea-level Fall: Coastal Progradation
(Seaward Movement)

Sequence Stratigraphy as a Predictive Tool

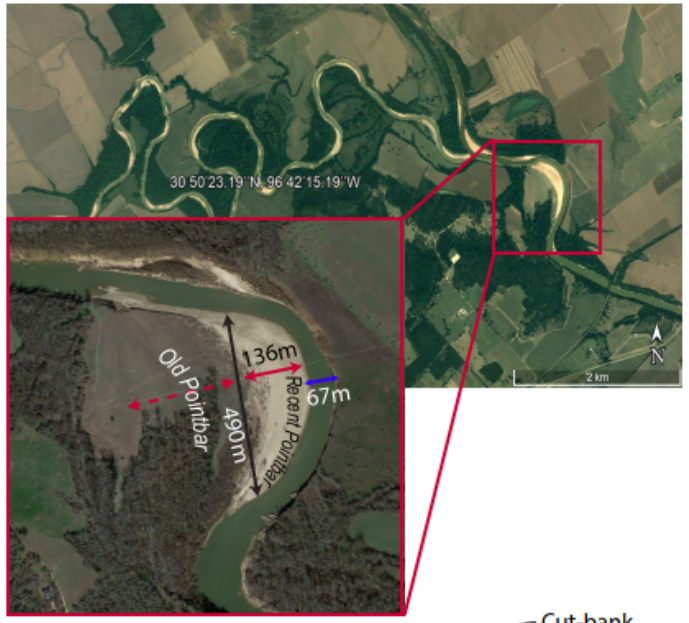


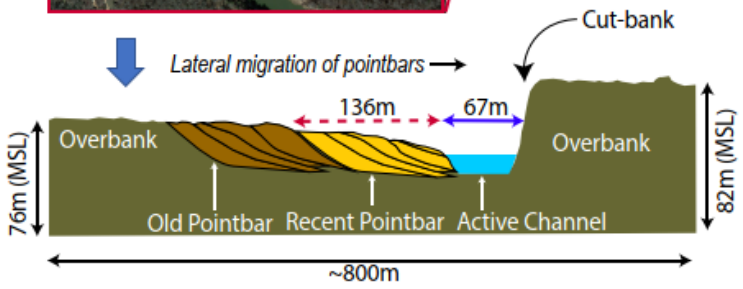
Infer depositional facies in relation to sea-level accommodation – a predictive way of understanding deposition!

Kendall C (2006) SEPMSTRAT.org, http://sepmstrata.org

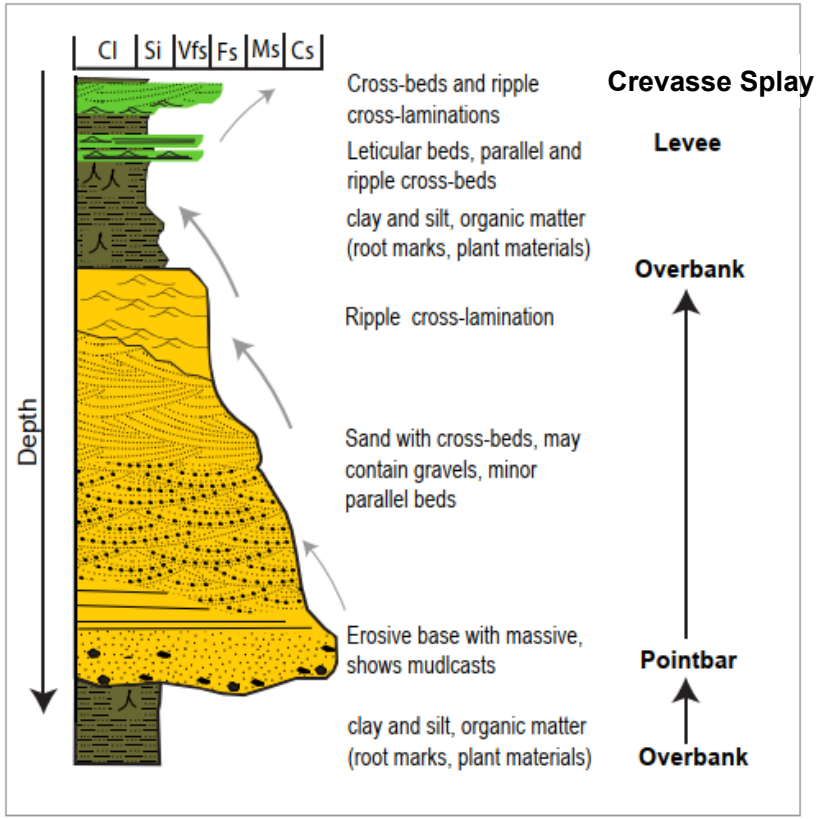
Facies Identification: Fluvial Facies

A) Modern Analog of Fluvial Pointbar Deposits





B) Vertical Facies Model for Fluvial Pointbar

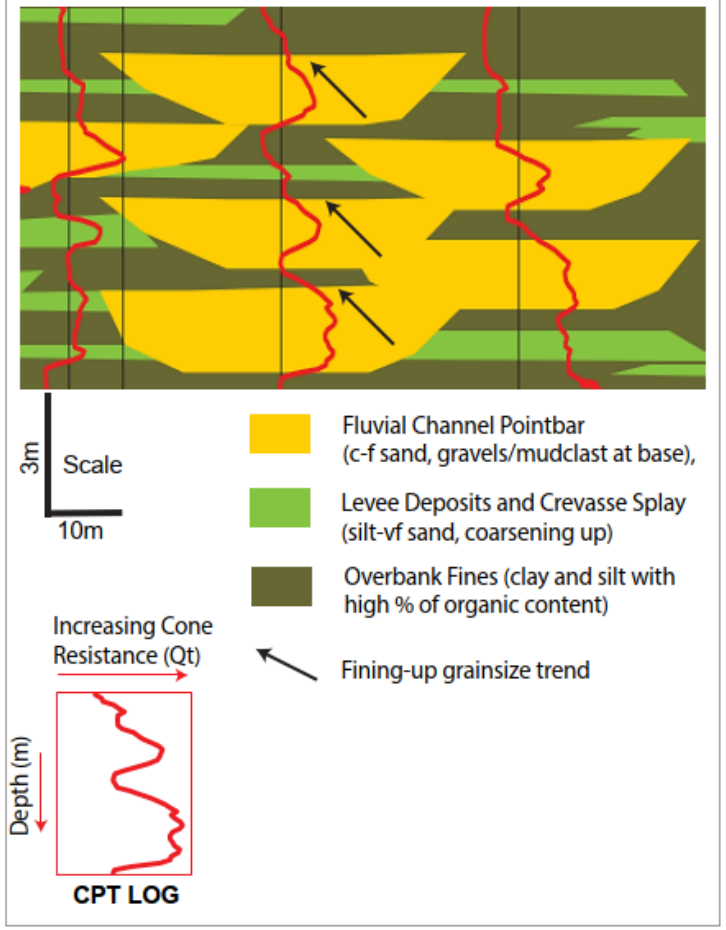


Cl= Clay
Si= Silt
Vfs= Very Fine Sand
Fs = Fine Sand
Ms= Medium Sand
Cs= Coarse Sand

Fining-up grainsize trend

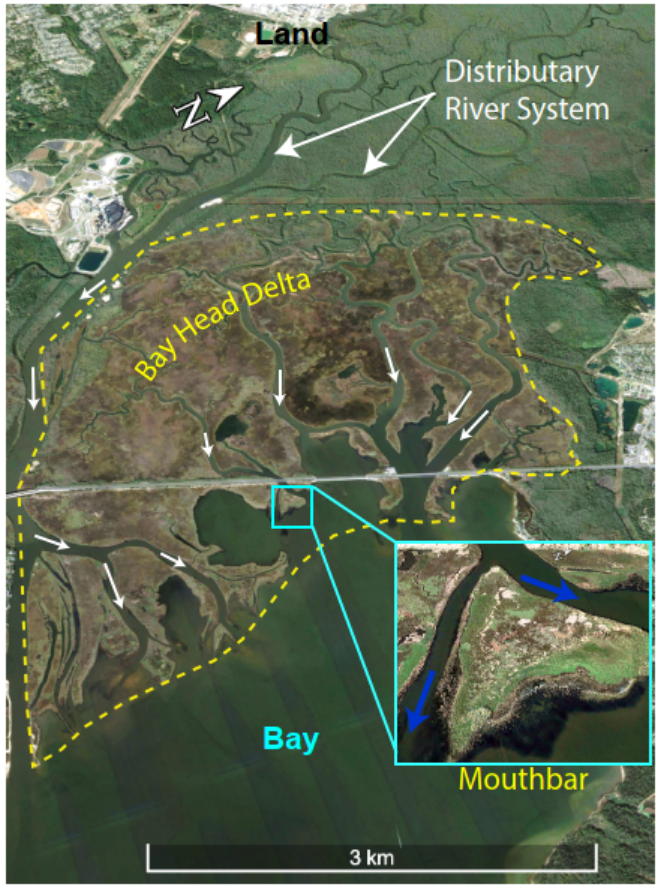
Coarsening-up grainsize trend

C) Fluvial Facies Association at the Site



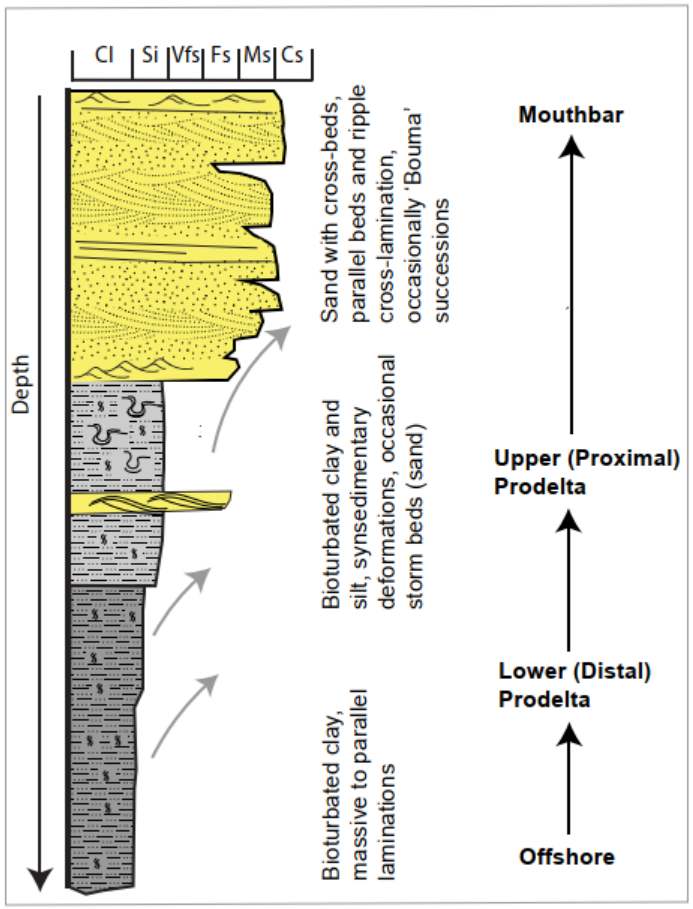
Facies Identification: Bayhead Delta Mouthbar Facies

A) Modern Analog of Bayhead Delta Mouthbar

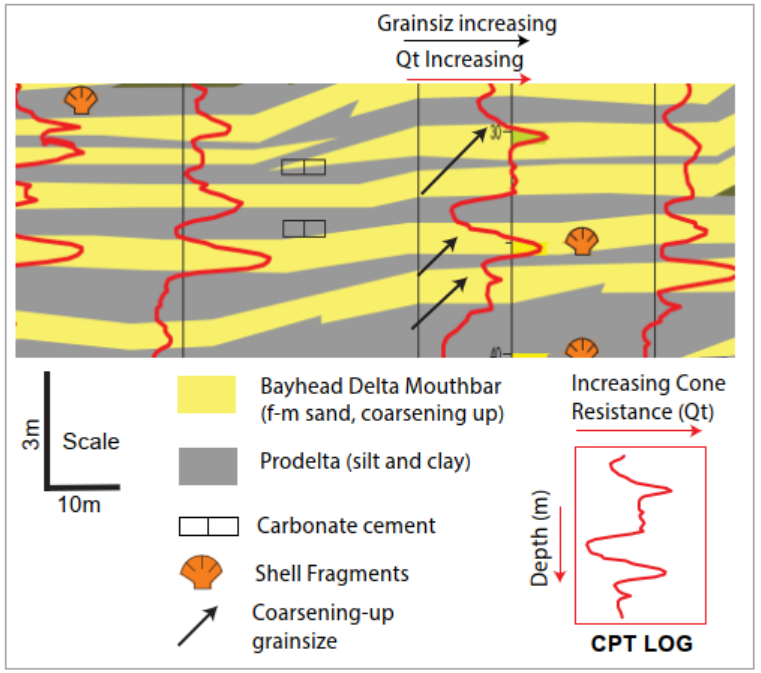


Pensacola, Florida *Courtesy of GoogleEarth*

B) Vertical Facies Model for Delta Mouthbars



C) Bayhead Delta Facies Association at the Site



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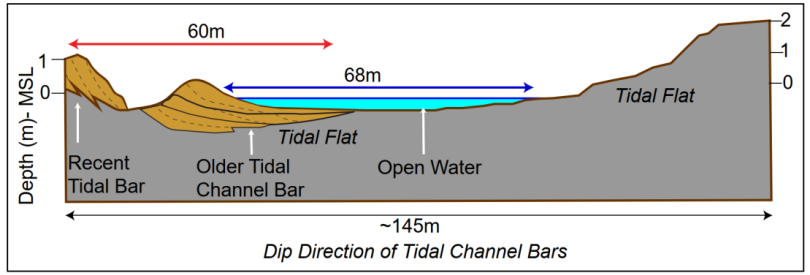
Ms= Medium Sand
Cs= Coarse Sand

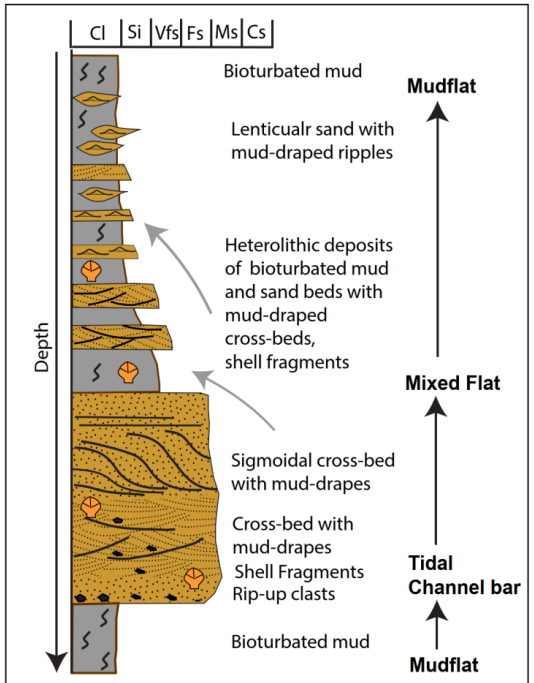
Coarsening-up grainsize trend

Facies Identification: Tidal Channel Facies

A) Modern Analog of Tidal Channel Deposits



B) Vertical Facies Model for Tidal Channel Deposits

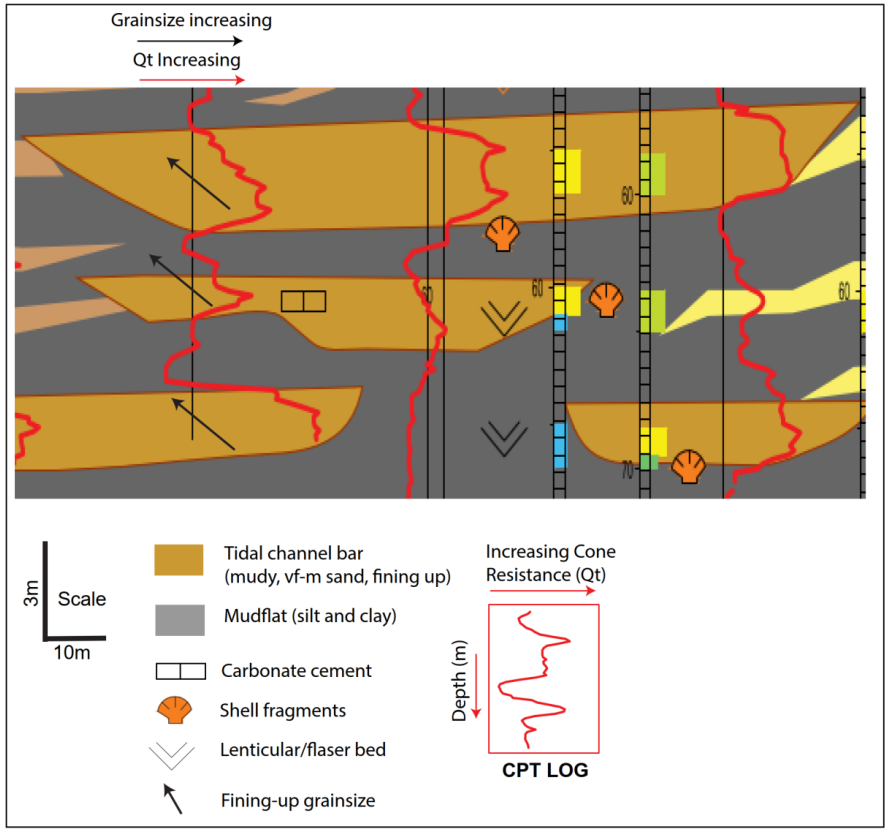


Modified after Van Wagoner et al., 1990

Cl= Clay
Si= Silt
Vfs= Very Fine Sand
Fs = Fine Sand
Ms= Medium Sand
Cs= Coarse Sand

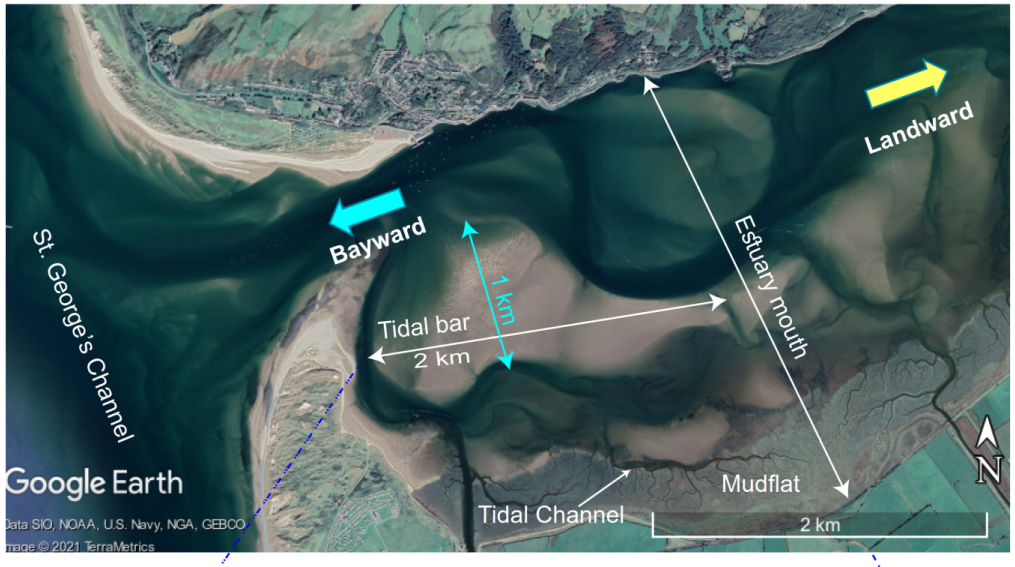
Fining-up grainsize trend

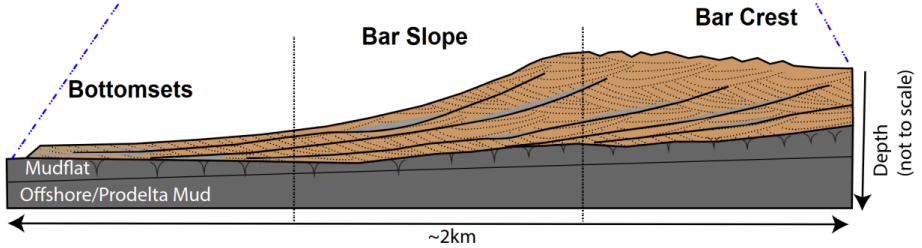
C) Tidal Facies Association (Tidal Channel Bar) at the Site



Facies Identification: Tidal Bar Facies

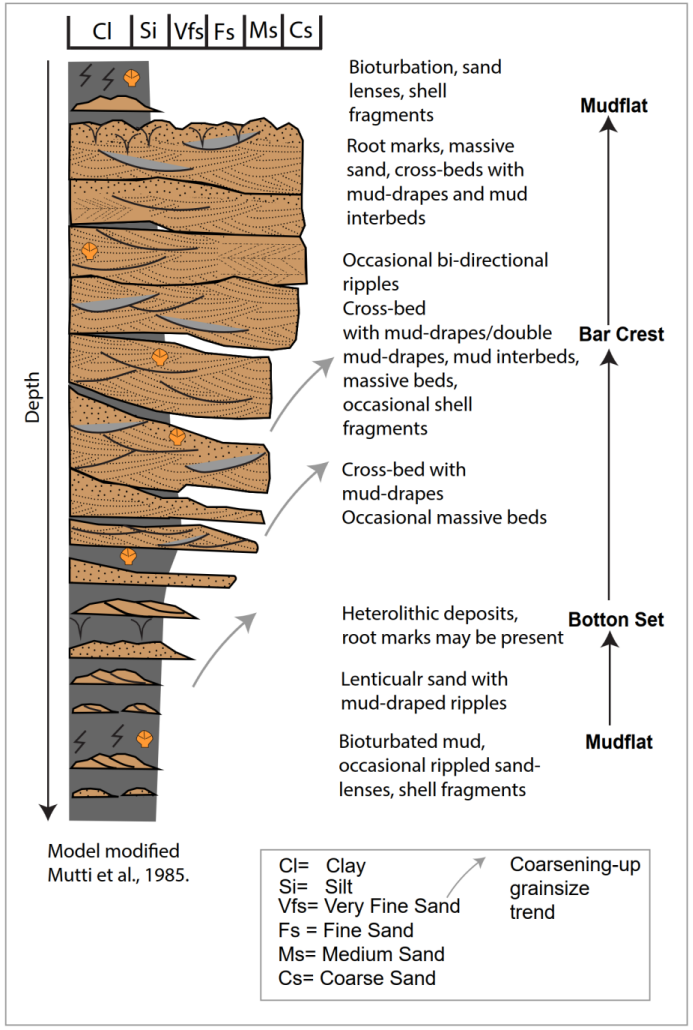
A) Modern Analog of Tidal Mouthbar Deposits



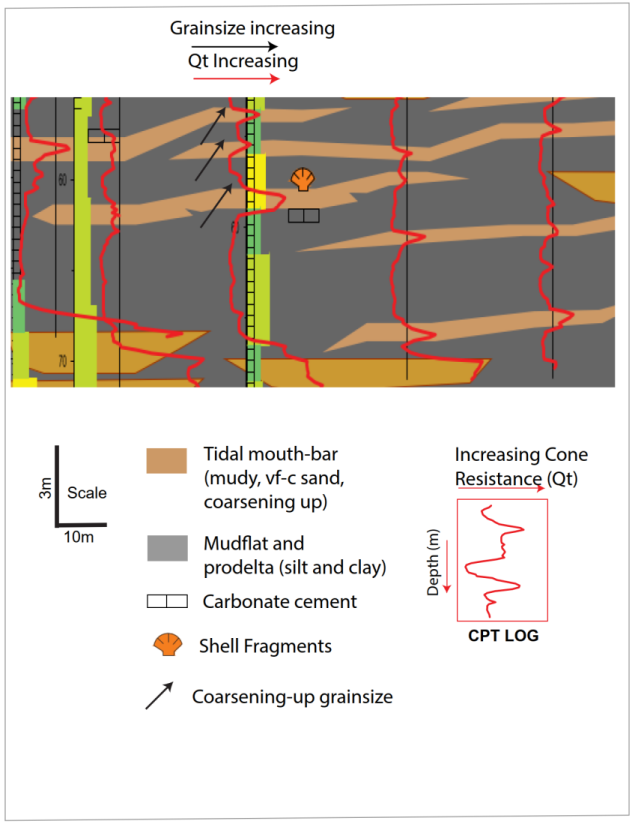


Model modified after Mutti et al., 1985.

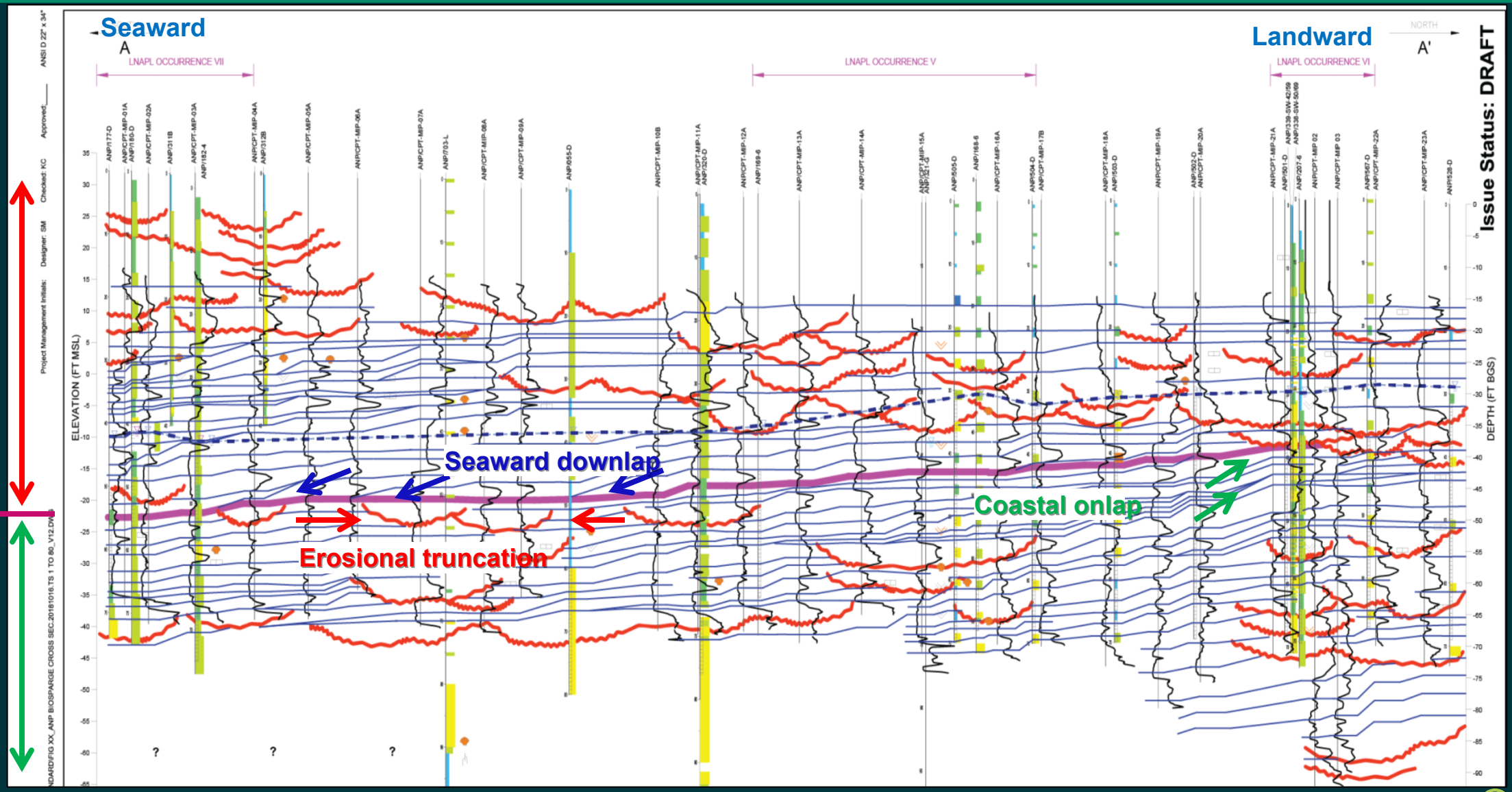
B) Vertical Facies Model for Tidal Mouthbar Deposits



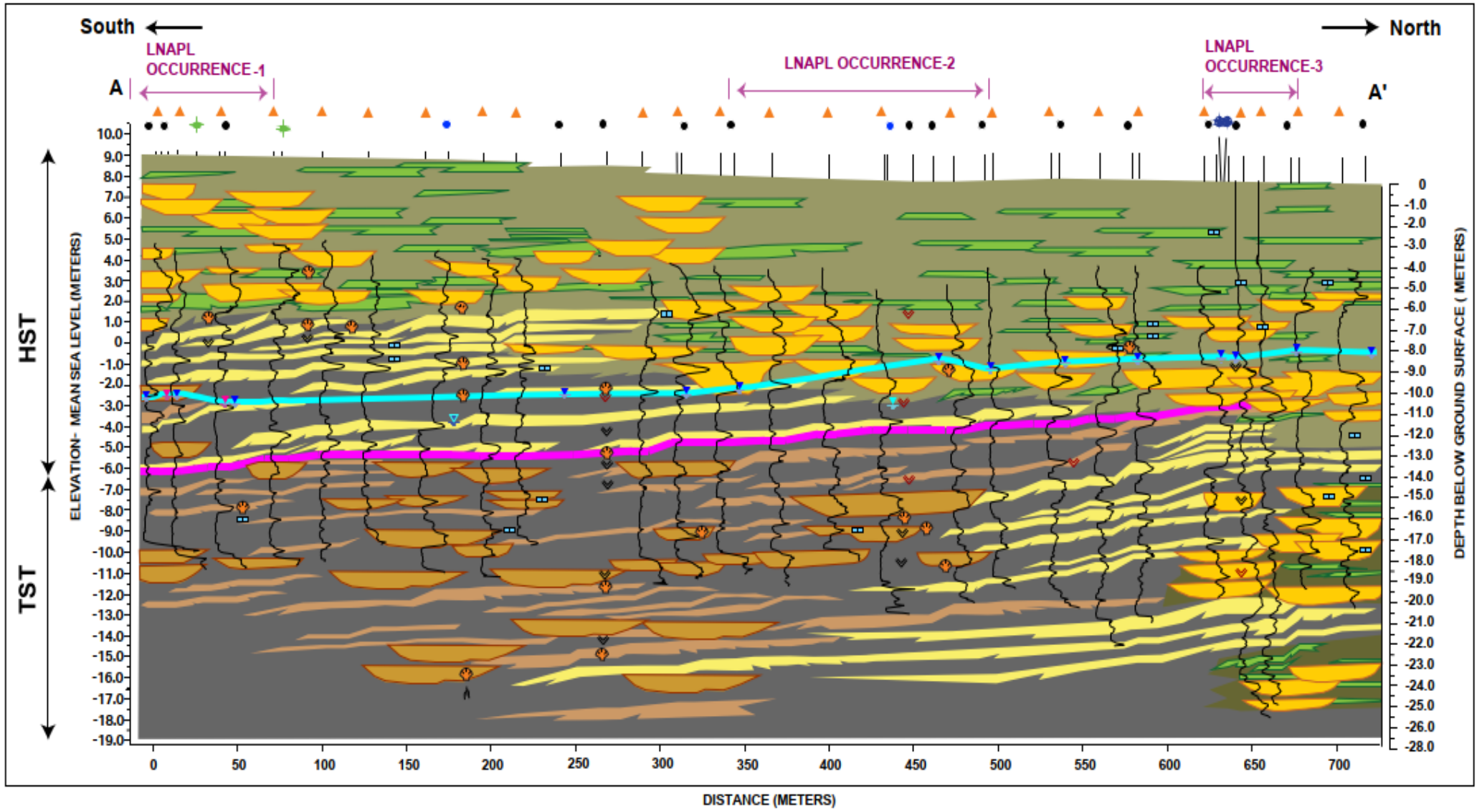
C) Tidal Facies Association (Tidal Mouthbars) at the Site



Sequence Stratigraphic Correlation



Sequence Stratigraphic Correlation



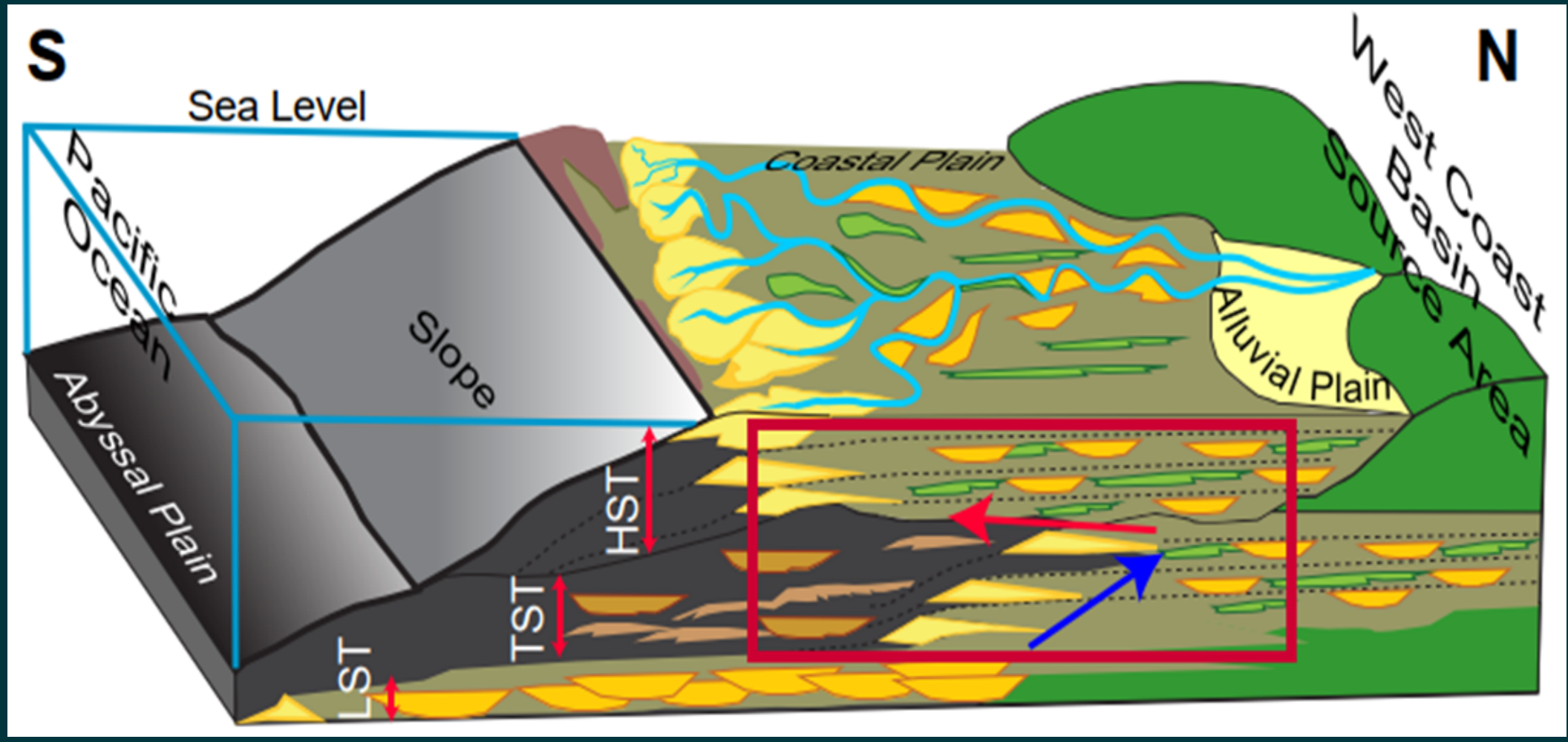
DEPOSITIONAL FACIES & SURFACES

- FLUVIAL CHANNEL POINT BAR
- BAYHEAD DELTA MOUTH BAR
- LEVEE & CREVASSE SPLAY DEPOSITS
- TIDAL CHANNEL BAR
- TIDAL MOUTHBAR
- FLOODPLAIN
- MUDFLAT
- MAXIMUM FLOODING SURFACE (MFS)

LITHOLOGY SYMBOLS

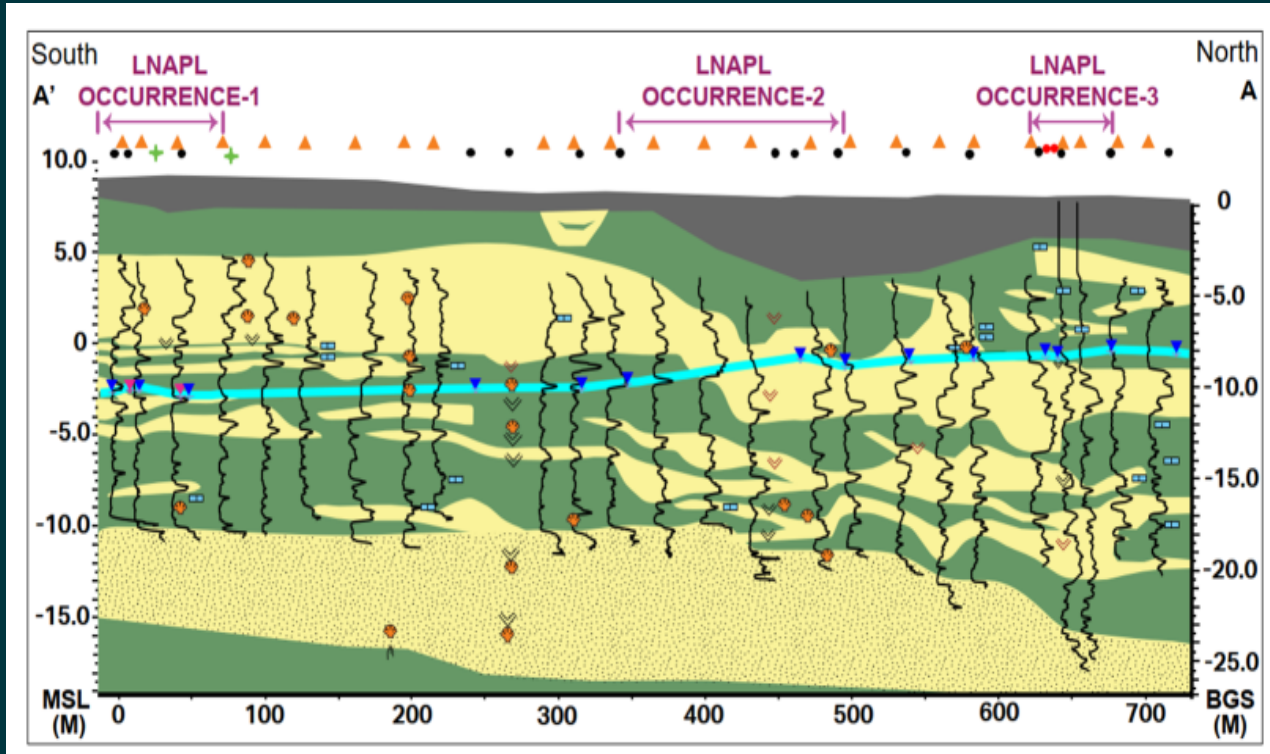
- SHELL FRAGMENTS
- LENTICULAR BEDS
- FLASER BEDS
- CALCAREOUS CEMENTATION
- PLANT DEBRIS

Site Depositional Model



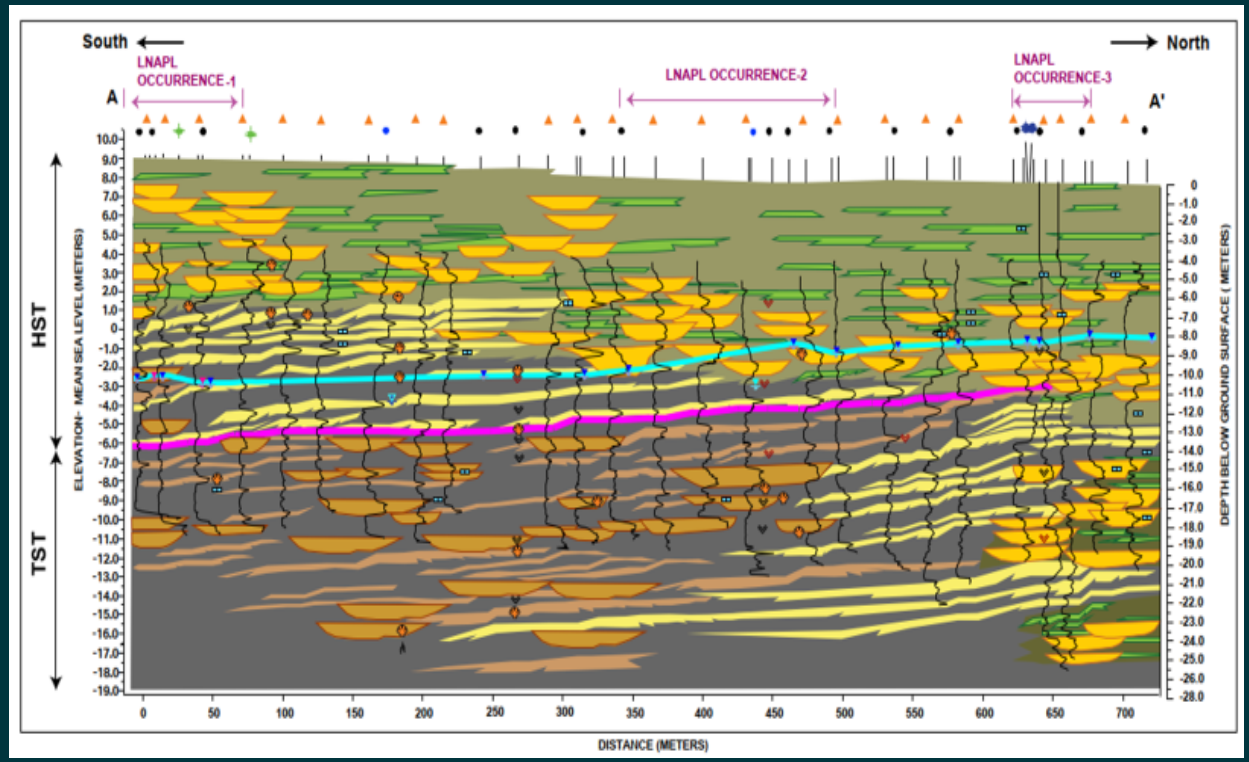
Lithostratigraphy vs. Sequence Stratigraphy

Before



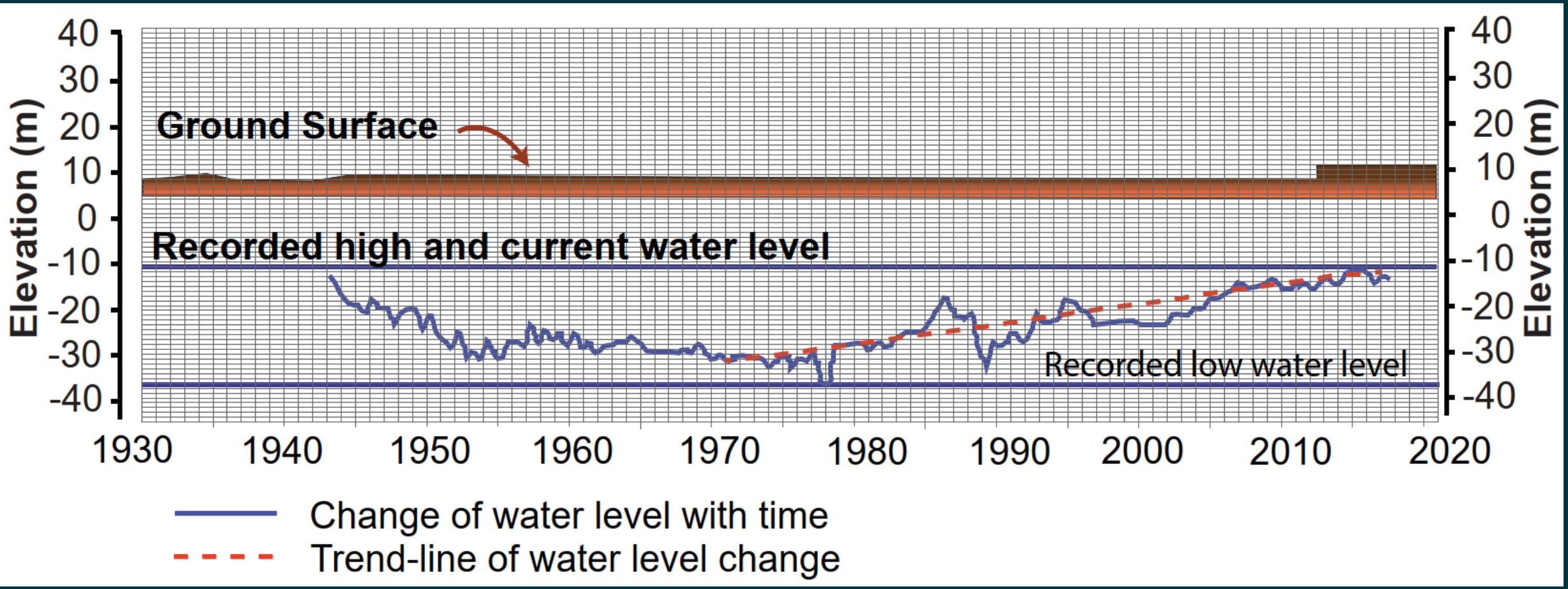
- Not based on known facies models
- Heterogeneity is unpredictable
- Permeable zones poorly identified

After

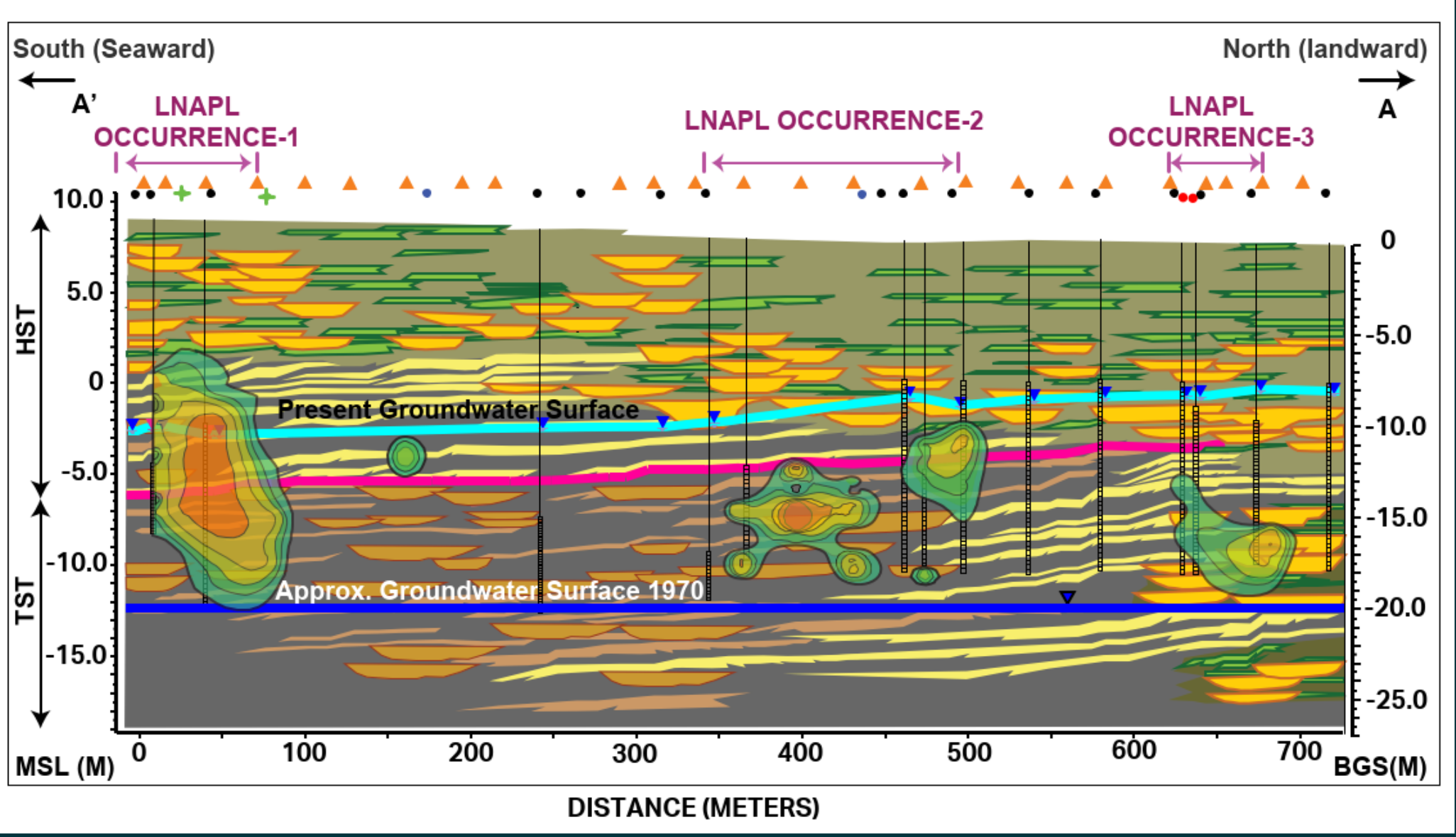


- Not based on known facies models
- Heterogeneity is predictable
- Permeable zones precisely identified

Groundwater Movement Over Time at Site



LNAPL Contamination in Relation to Stratigraphy



Thank You!

Contact: Junaid.Sadeque@aecom.com

Sadeque J. and Samuels R. (2023), 'The application of sequence stratigraphy to the investigation and remediation of LNAPL contaminated sites', in Advances in the Characterization and Remediation of Sites Contaminated with Petroleum Hydrocarbons. **Springer Nature** (in press).