Influence of Pressurized Shale of Akata Formation on Clastic Reservoir Developments, Offshore Niger Delta Using Seismic-Attributes Modeling*

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Search and Discovery Article #40844 (2011)
Posted December 12, 2011

*Adapted from presentation at AAPG Geoscience Technology Workshop, "International Shale Plays," Houston, Texas, October 11-12, 2011

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Objectives and Summary

Objectives

- To evaluate complex interactions between the structural evolution of basins characterized by shale tectonics and sedimentation using modeling of seismic attributes.
- To develop a workflow approach and assess its efficiency as viable tools for assisting hydrocarbon exploration and production in similar depositional and tectonic settings.

Summary

- Reservoir sand deposition and distribution are mainly faults/diapirs-controlled due to shale tectonics in this area.
- The chance for lateral elongated and connected reservoir deposits might be minimal; because of proximity to the shale layer, there will be continual creation and destruction of accommodation space.
- Workflow combining structural contours, RMS amplitude, time slices, and well data will give a reliable insight in prospecting for reservoir structures and deposits in the subsurface.
- Seismic attributes when validated by well data can be employed in evaluating structural trends, distribution of reservoir deposits, and hydrocarbon occurrences.
- It can be employed as tool for exploration work in complex basins.

Selected References

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Influence of Pressurized Shale of Akata Formation on Clastic Reservoir Developments-Offshore Niger Delta Using Seismic-Attributes Modeling

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Outline

- Objectives
- Geological Settings of Niger Delta
- Proposed sedimentation models due to Shale Tectonics
- Tomboy Field Data and Seismic Well Calibration
- Seismic and Geological Attributes Modeling
- Inferences
- Recommendations

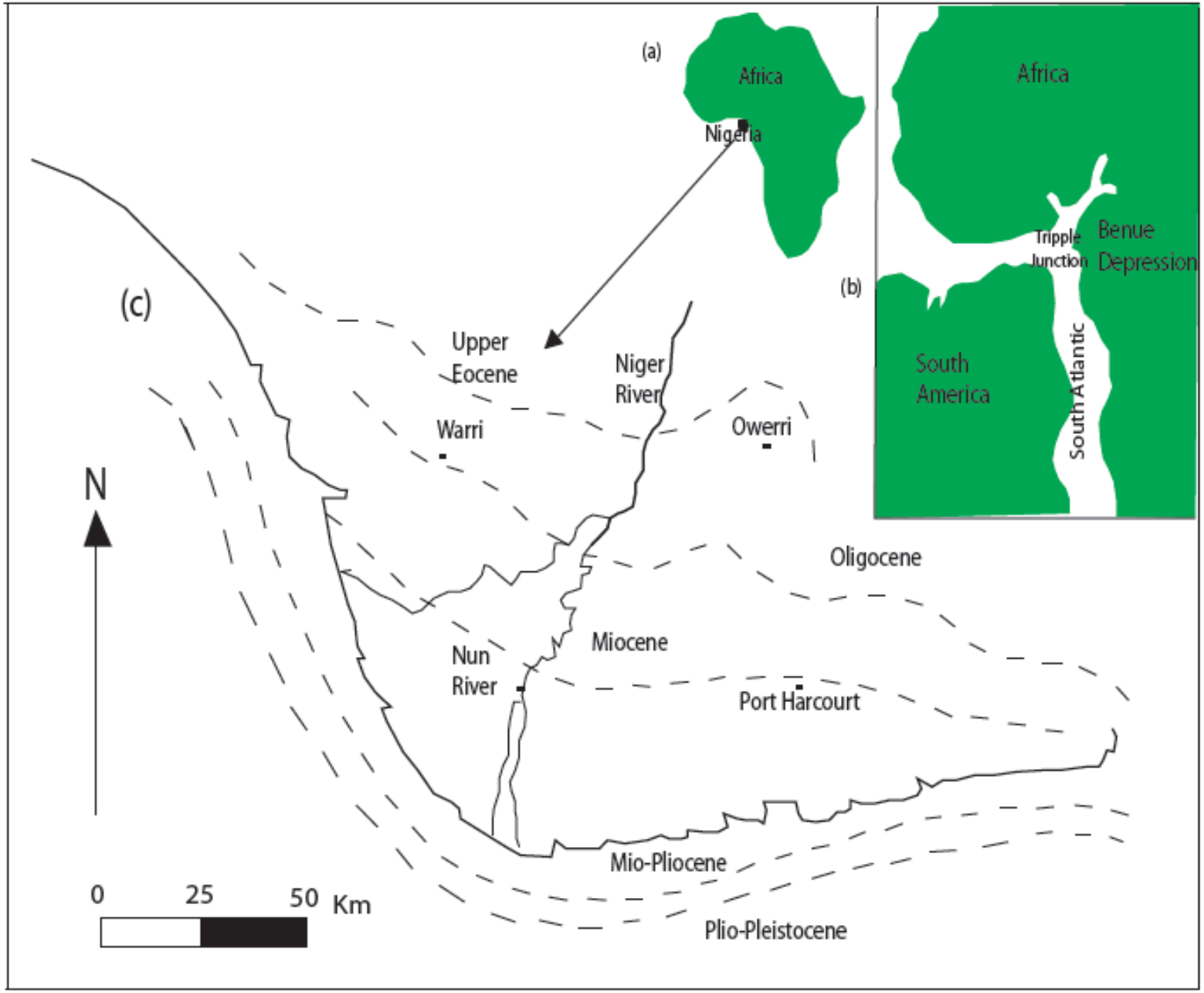
Objectives

- To evaluate complex interactions between the structural evolution of basins characterized by shale tectonics and sedimentation using seismic-attributes modeling

- To develop a workflow approach and assess its efficiency as viable tools for assisting hydrocarbon exploration and production in similar depositional and tectonic settings

Geological Settings

- Lat. 3˚N to 6˚N
- Long.5˚E to 8˚E



Niger Delta Location after Burke et al. 1971

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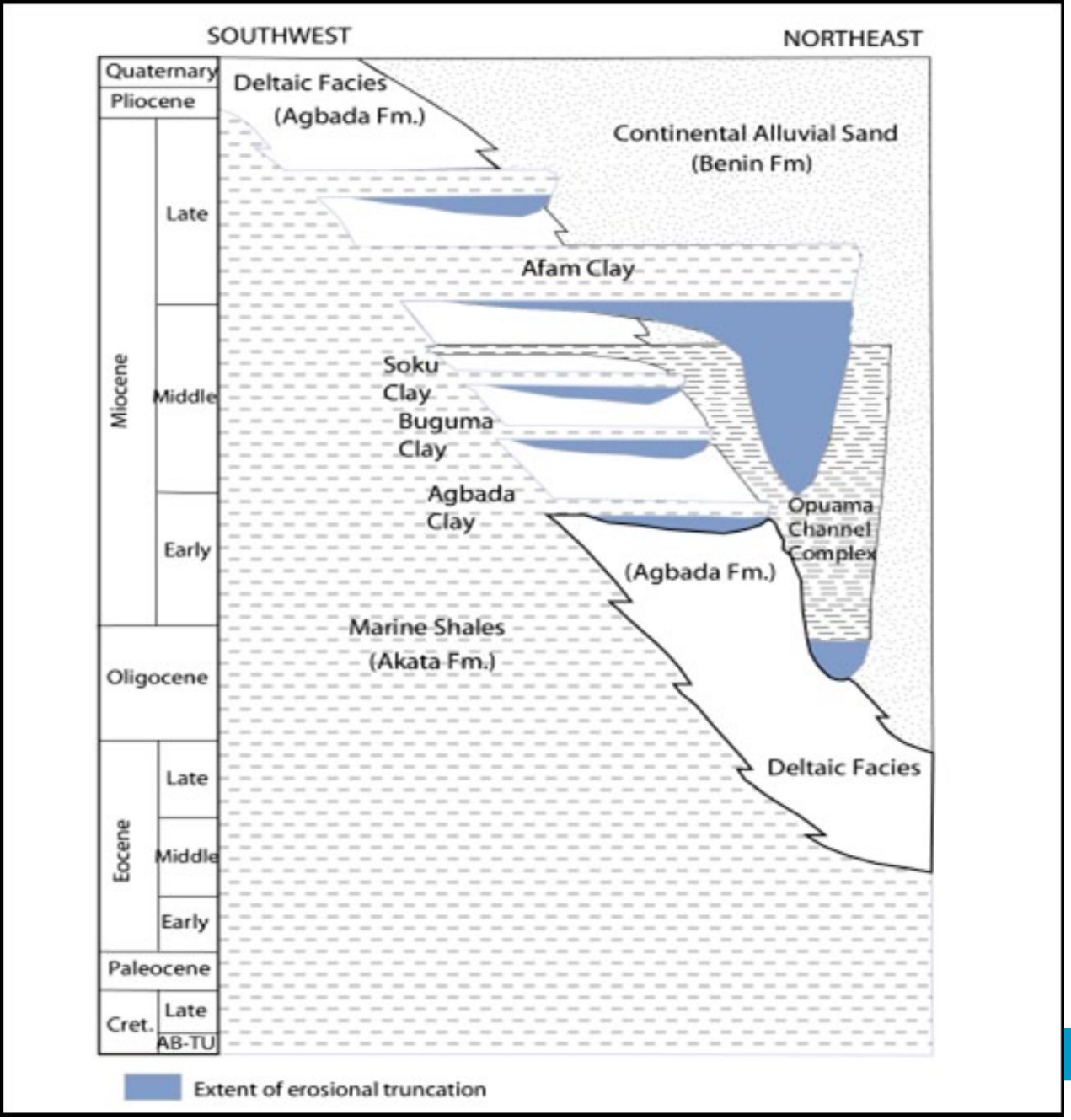

Stratigraphy

Alluvial Sand: Benin Fm.
Deltaic Facies: Agbada Fm.
Marine Shale: Akata Fm.

Modified after Doust and Omatsola, 1990

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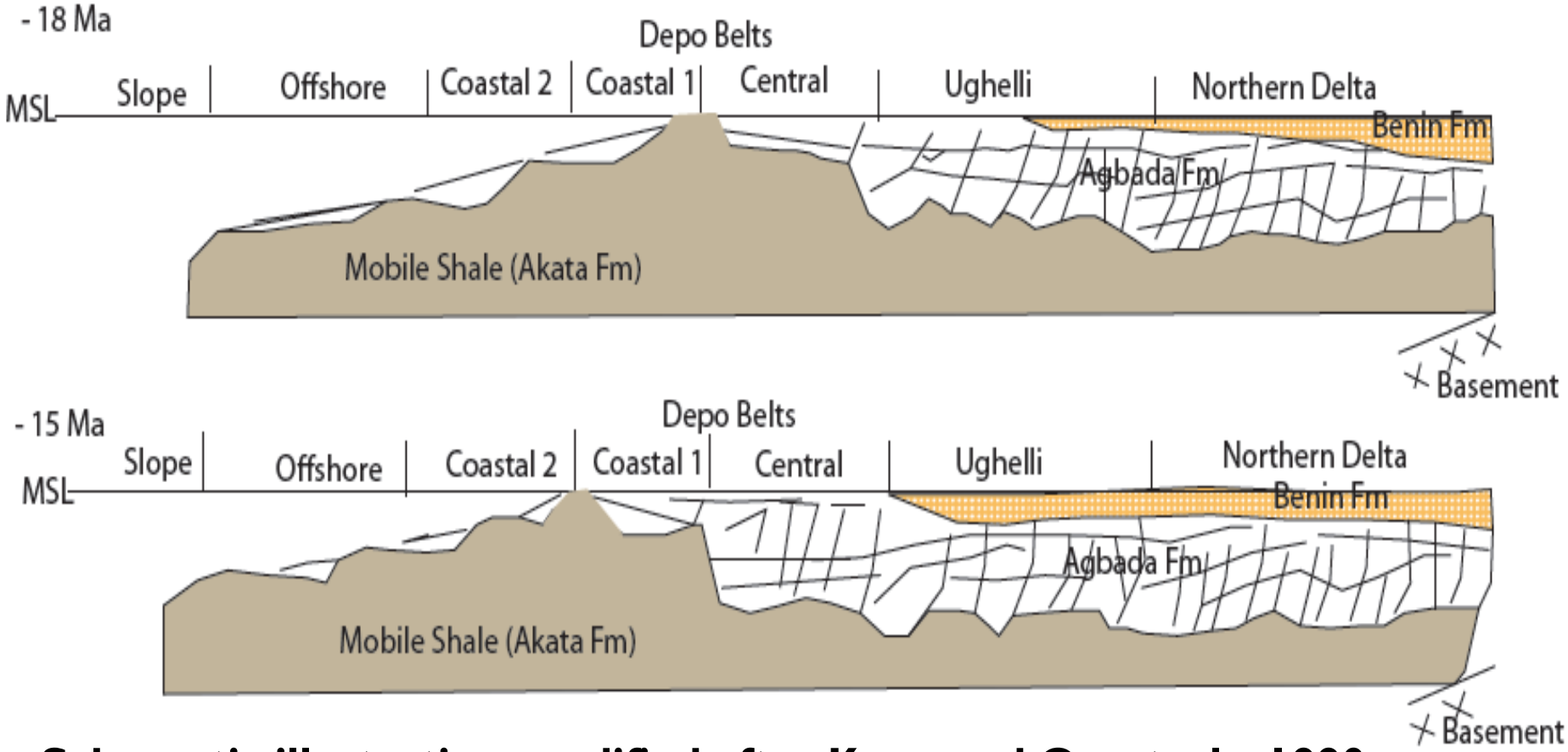
Proposed Sedimentation Models

A. Regression Escalator Model



Schematic illustration modified after Knox and Omatsola, 1990

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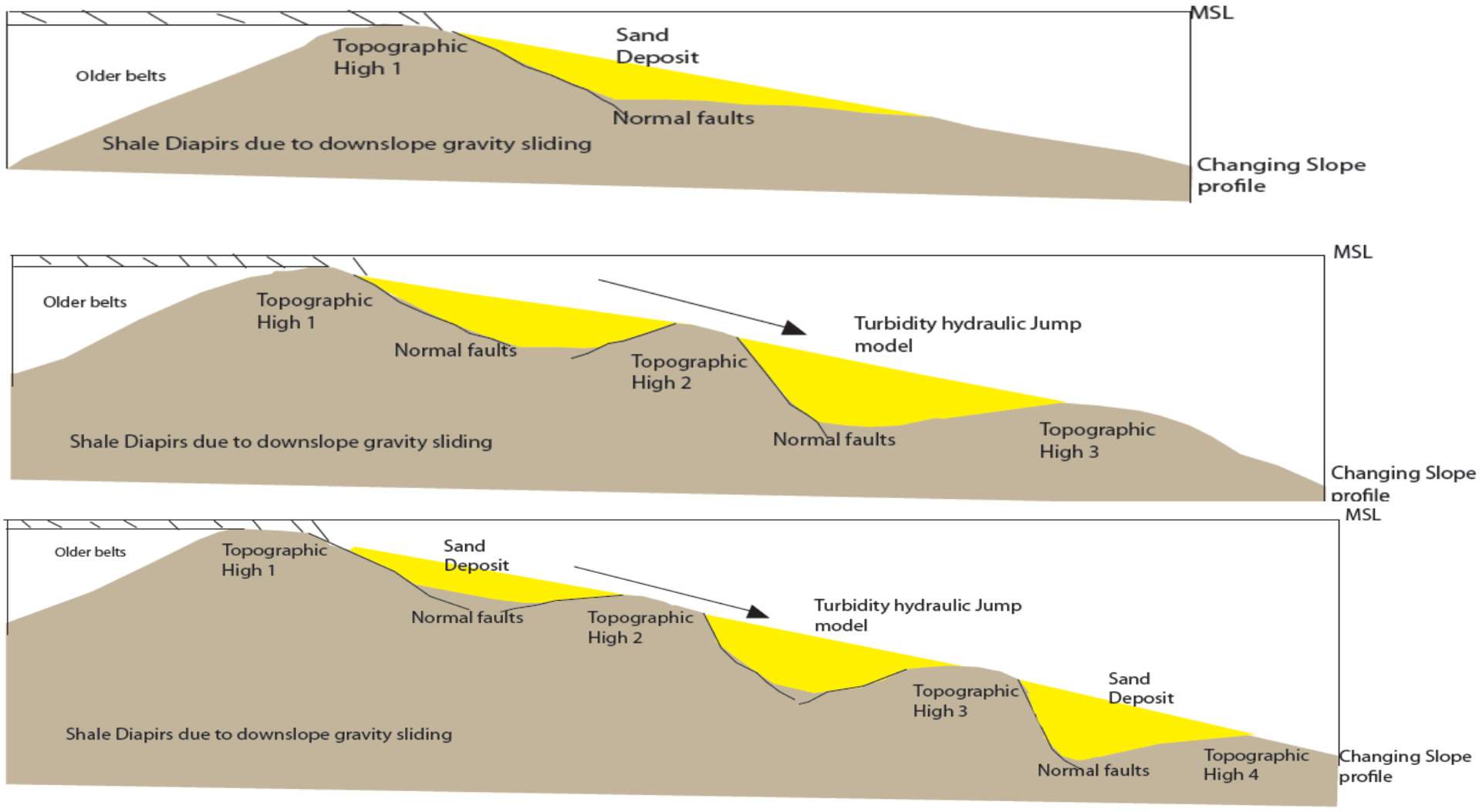
B. Turbidity Hydraulic Jump Model



Schematic illustration modified after Xijin, 2006

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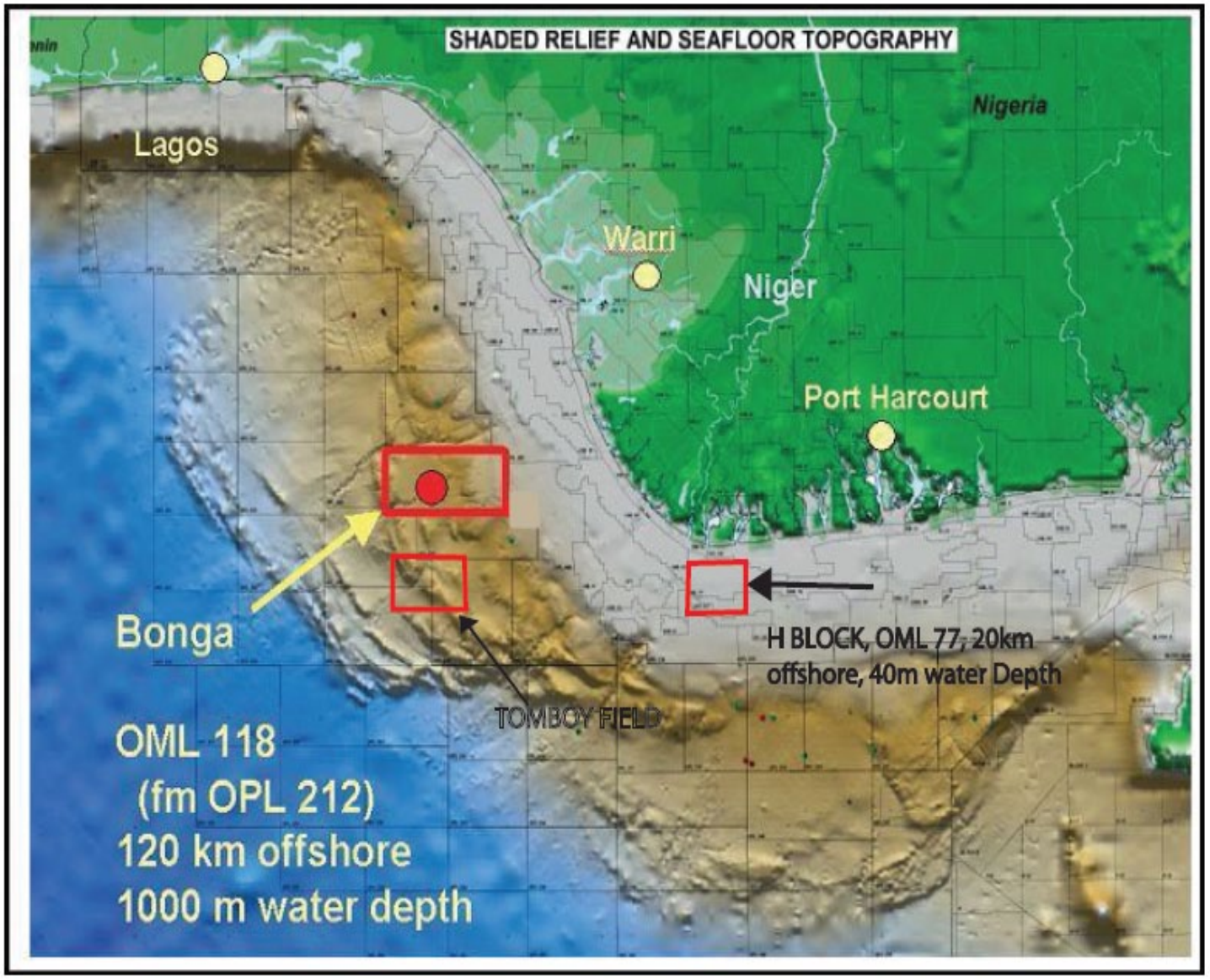

Tomboy

Lat. 4 °N
Long. 4.5 °E
120 Km Offshore
1000-2000 m
Water Depth

Niger Delta Seafloor modified after Marcel De Young, 2002

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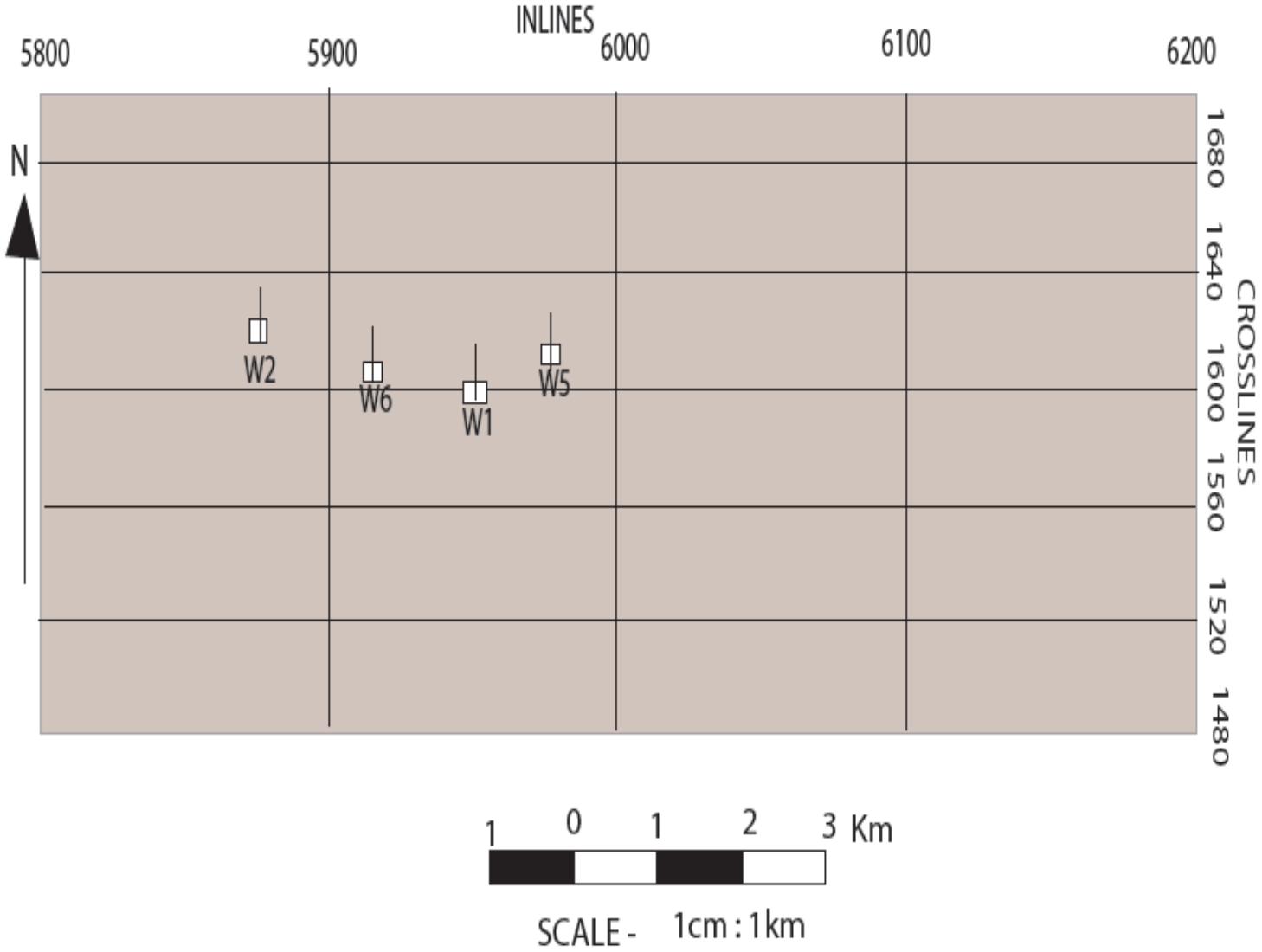

Base Map:

- Area: 550 sq km
- Inline: 400
- X-lines: 220
- Wells: 4

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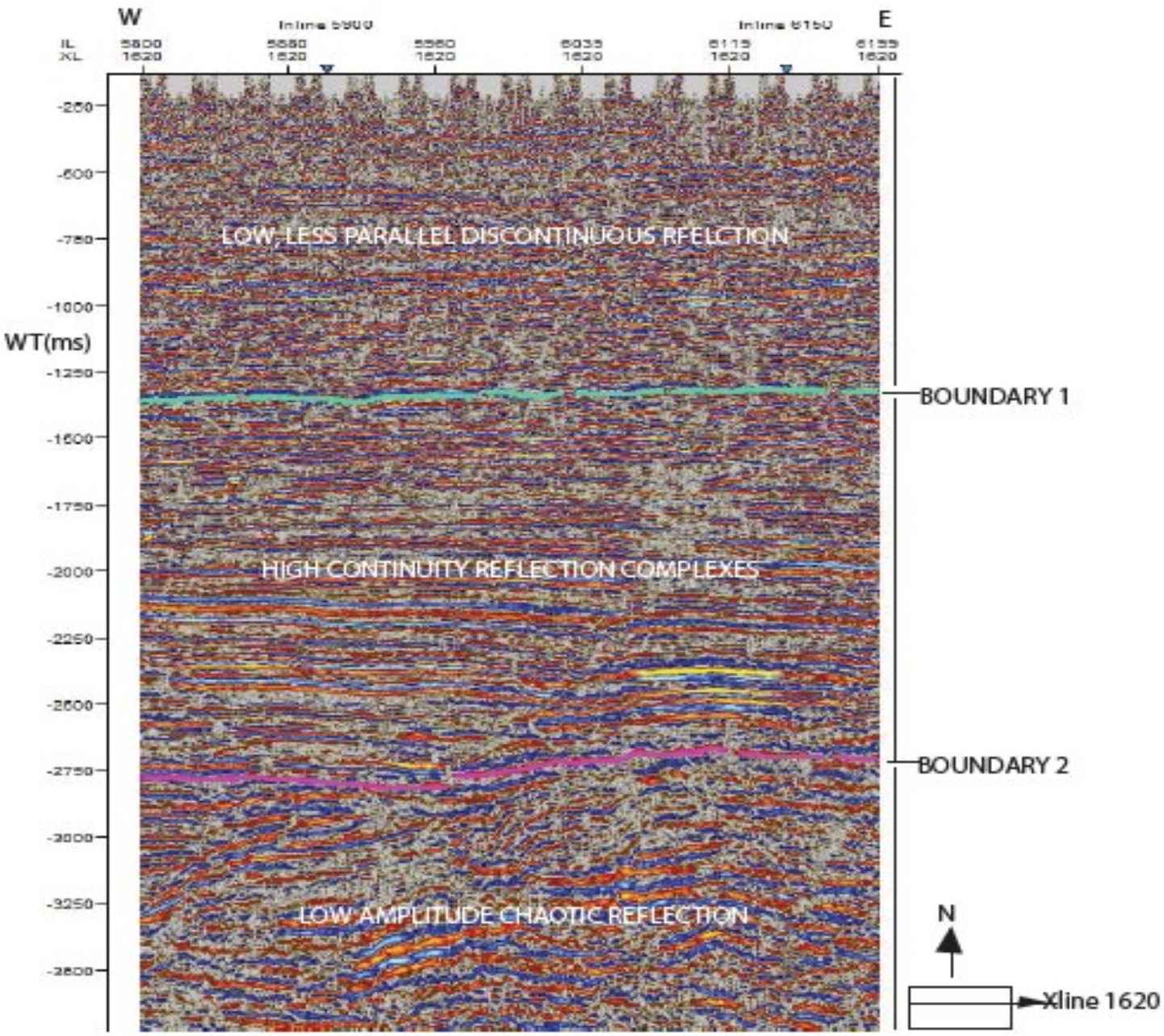

Benin Fm.

TWT 0 – 1.34 s
Low amplitude
Low continuity

Agbada Fm.

TWT 1.34 – 2.75 s
Parallel reflection
High continuity
High amplitude
Highly faulted

Akata Fm.

TWT 2.75 s below
Chaotic reflection
Low amplitude
No continuity

Seismic Facies: Amplitude and Reflection Continuity

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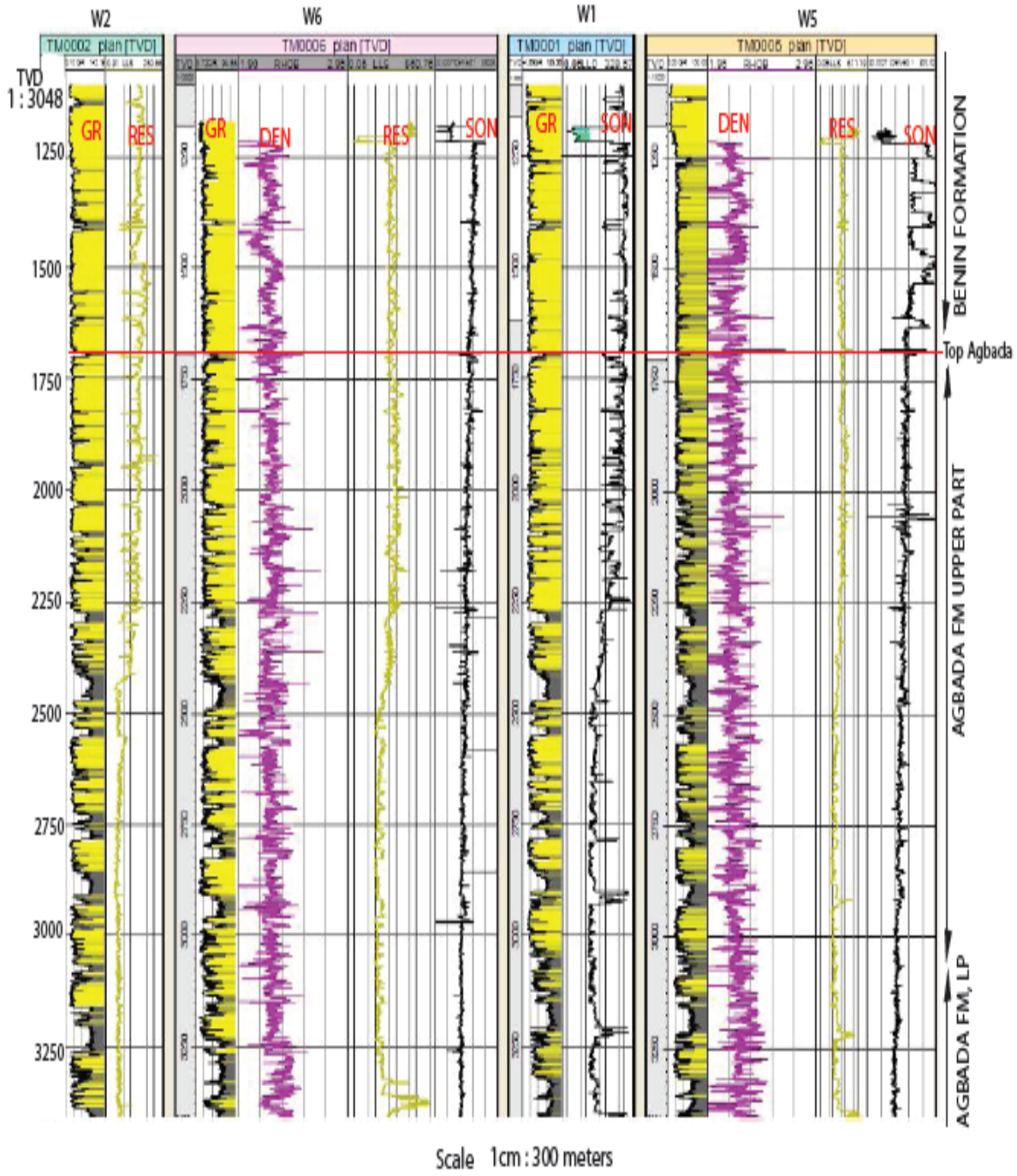
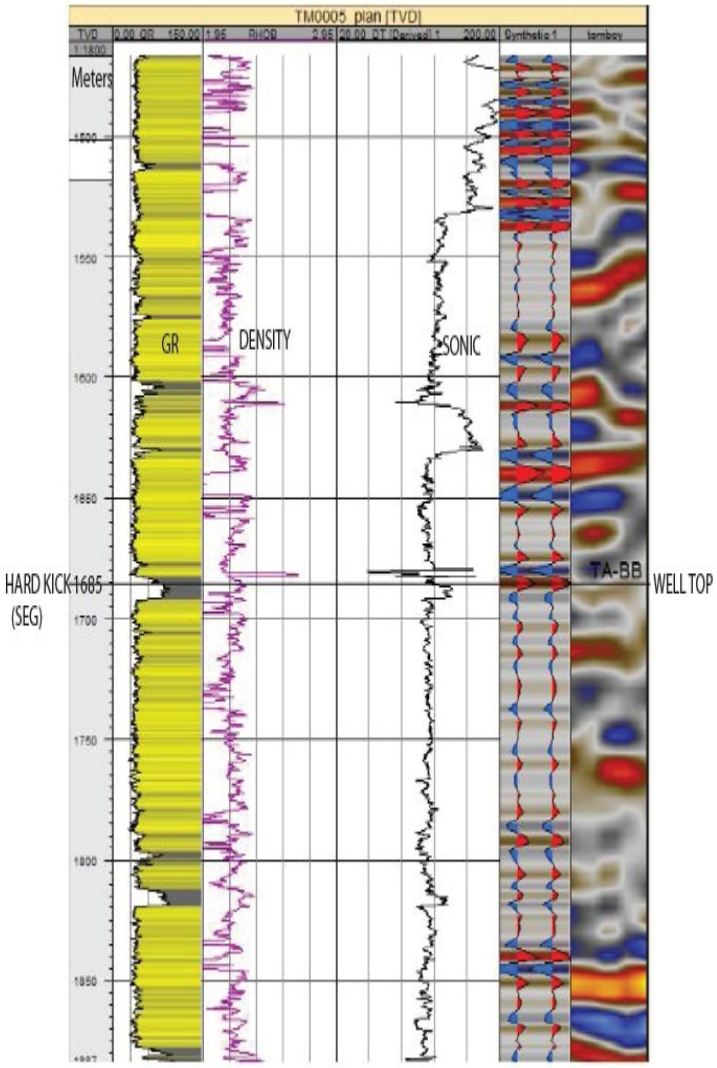
Well Calibration:

- Top Agbada Fm





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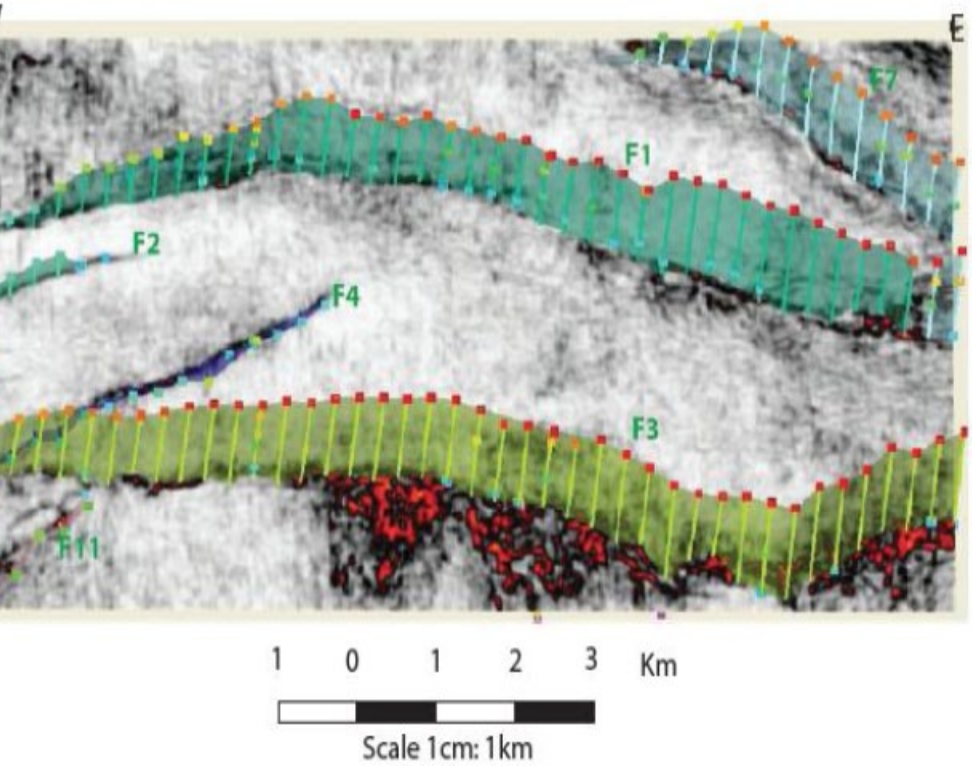

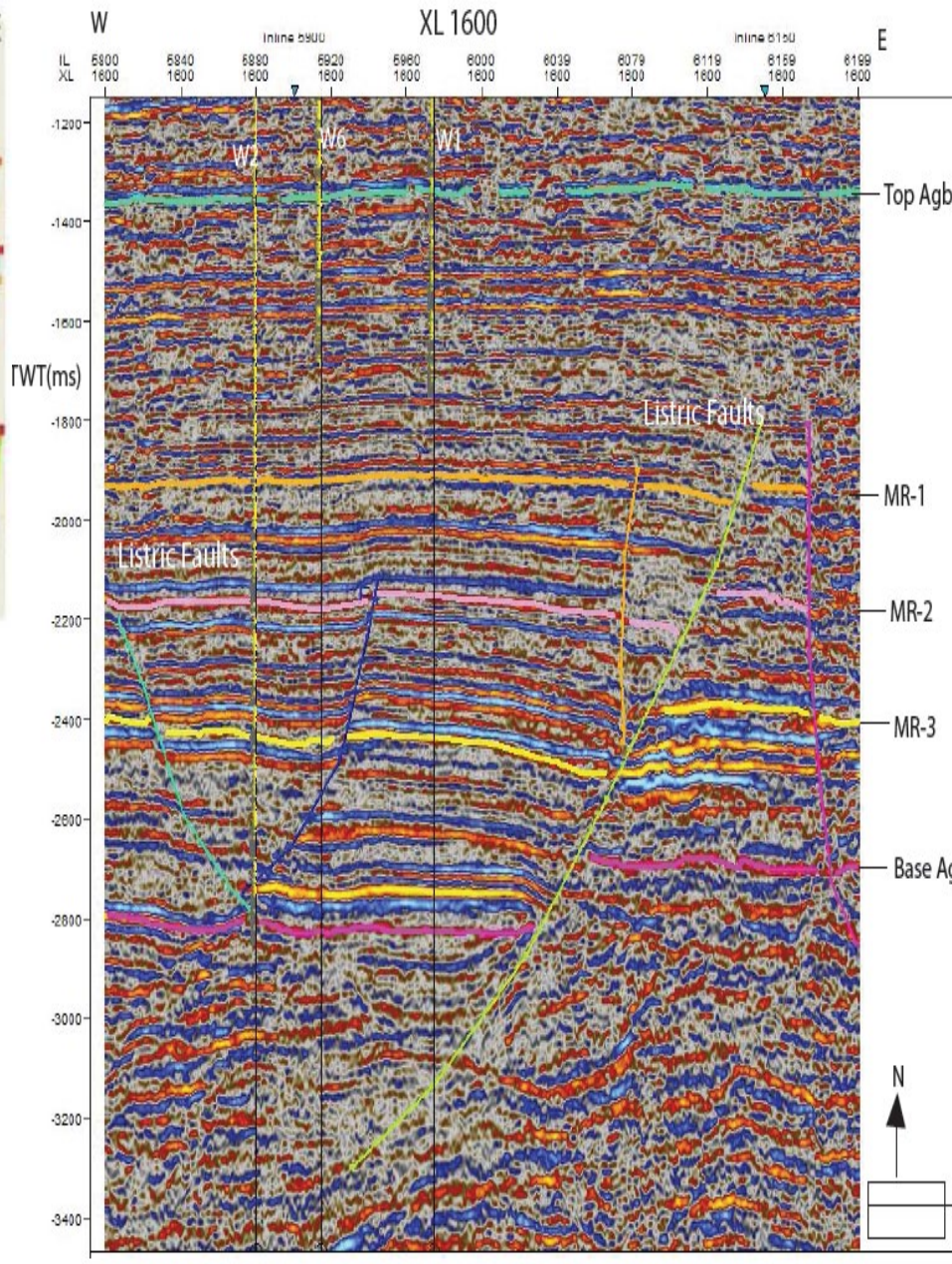

Faults & Horizons

- MR-1
- MR-2
- MR-3

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LAYER CAKE VELOCITY MODEL: T-D CONVERSIONS

INTERVAL	FORMATION BOUNDARY 1- REFLECTOR 1					
Well-Name	TWT Top(s)	TWT Base(s)	Z Top(m)	Z Base(m)	Calculated V-interval	Calculated Depth
TM0002	1359	1928	1396	1965	2000.0	1956.4
TM0006	1354	1913	1369	1930	2007.2	1941.4
TM0005	1339	1910	1400	1940	1891.4	1937.8
			FINAL V-INTERVAL		1966.2	

INTERVAL	REFLECTOR 1 – REFLECTOR 2					
Well-Name	TWT Top(s)	TWT Base(s)	Z Top(m)	Z Base(m)	Calculated V-interval	Calculated Depth
TM0002	1928	2176	1965	2203	1919.4	2200.9
TM0006	1913	2179	1930	2181	1887.2	2203.6
TM0005	1910	2149	1940	2192	2108.8	2173.4
			FINAL V-INTERVAL		1971.8	

INTERVAL	REFLECTOR 2 – REFLECTOR 3					
Well-Name	TWT Top(s)	TWT Base(s)	Z Top(m)	Z Base(m)	Calculated V-interval	Calculated Depth
TM0002	2176	2456	2203	2480	1978.6	2476.5
TM0006	2179	2438	2181	2500	2463.3	2458.6
TM0005	2149	2433	2192	2400	1464.8	2453.0
			FINAL V-INTERVAL		1968.9	

Pseudo-Interval Velocities Calculation

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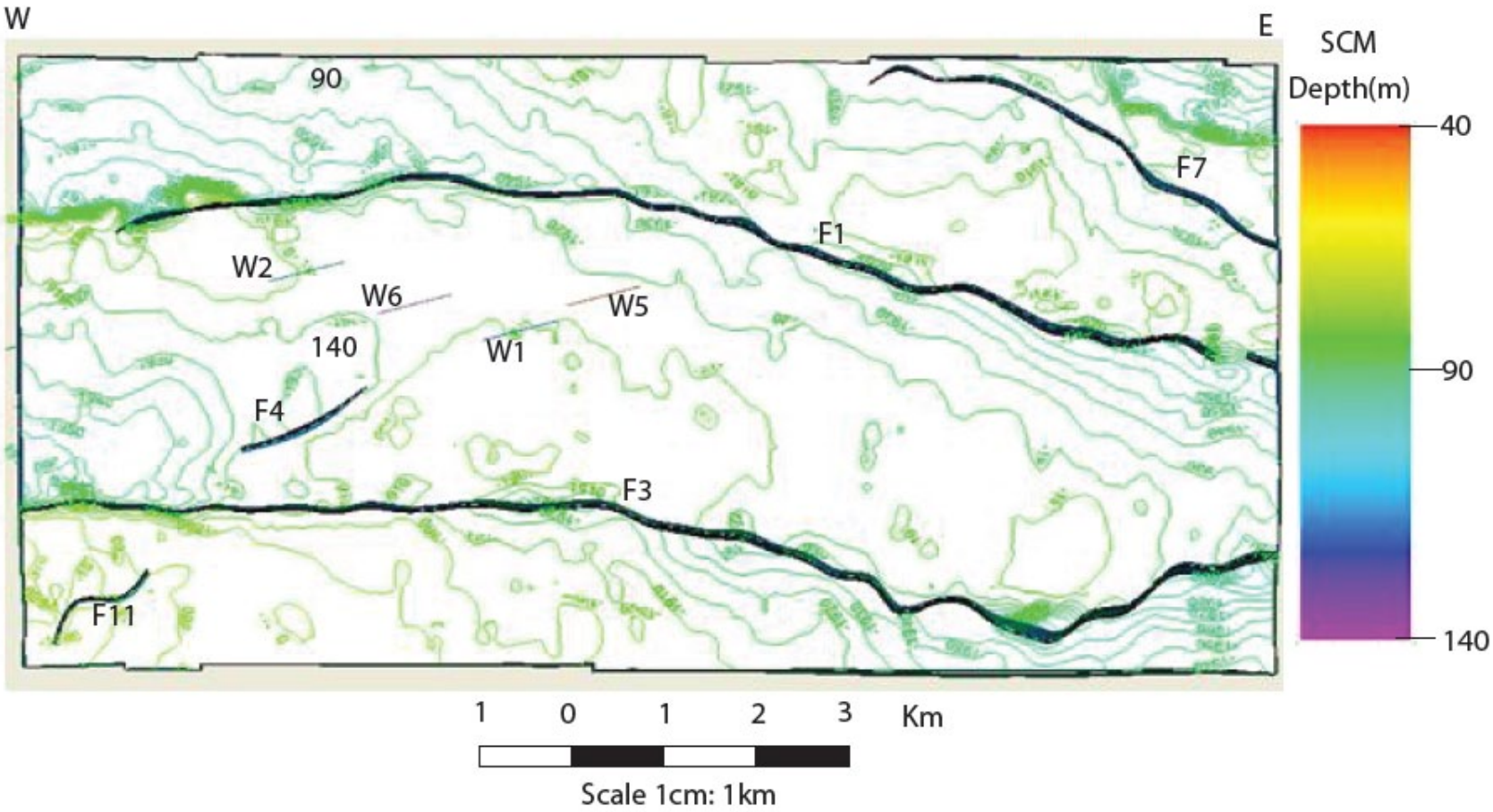
Structural Map



Horizon: MR-I

- **Surface Level:** MR-I; **Faults:** Few; **Akata proximity:** Low

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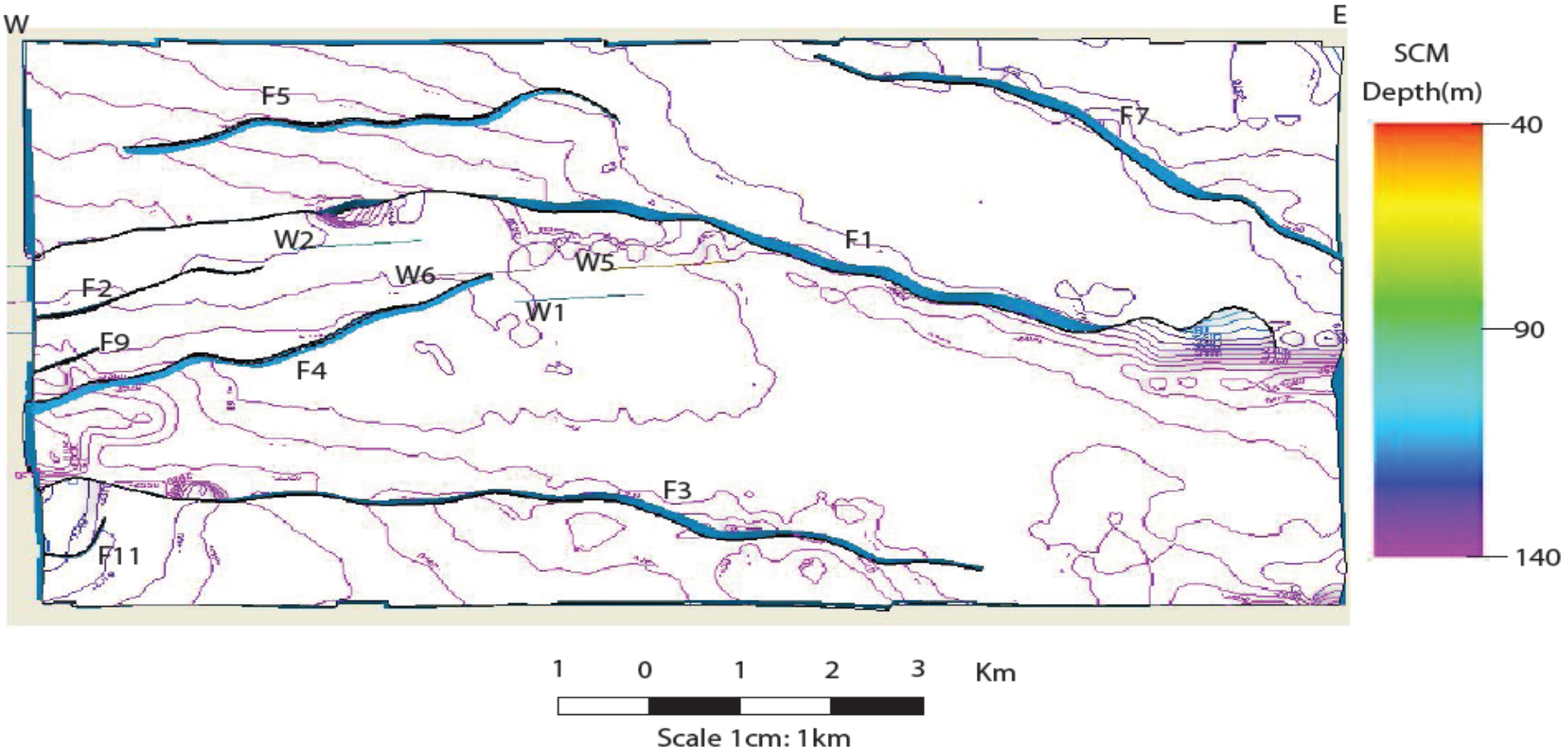
Structural Map



Horizon: MR-3

- **Surface Level:** MR-3; **Faults:** Many & Complex; **Akata proximity:** High

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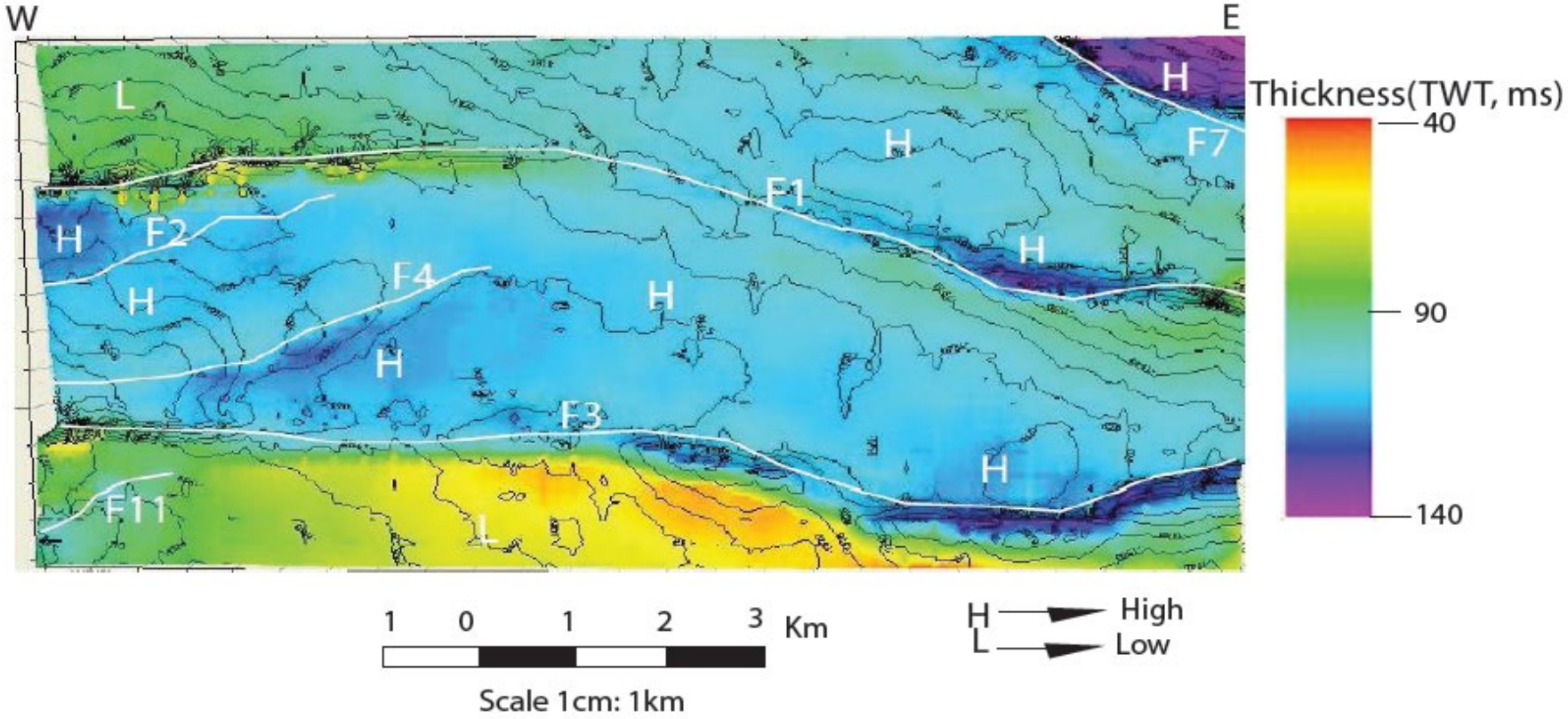
Isochore/Thickness Map



Interval: MR-1 & MR-2

- Depositional thickness is associated with downthrown sides of Faulted Blocks

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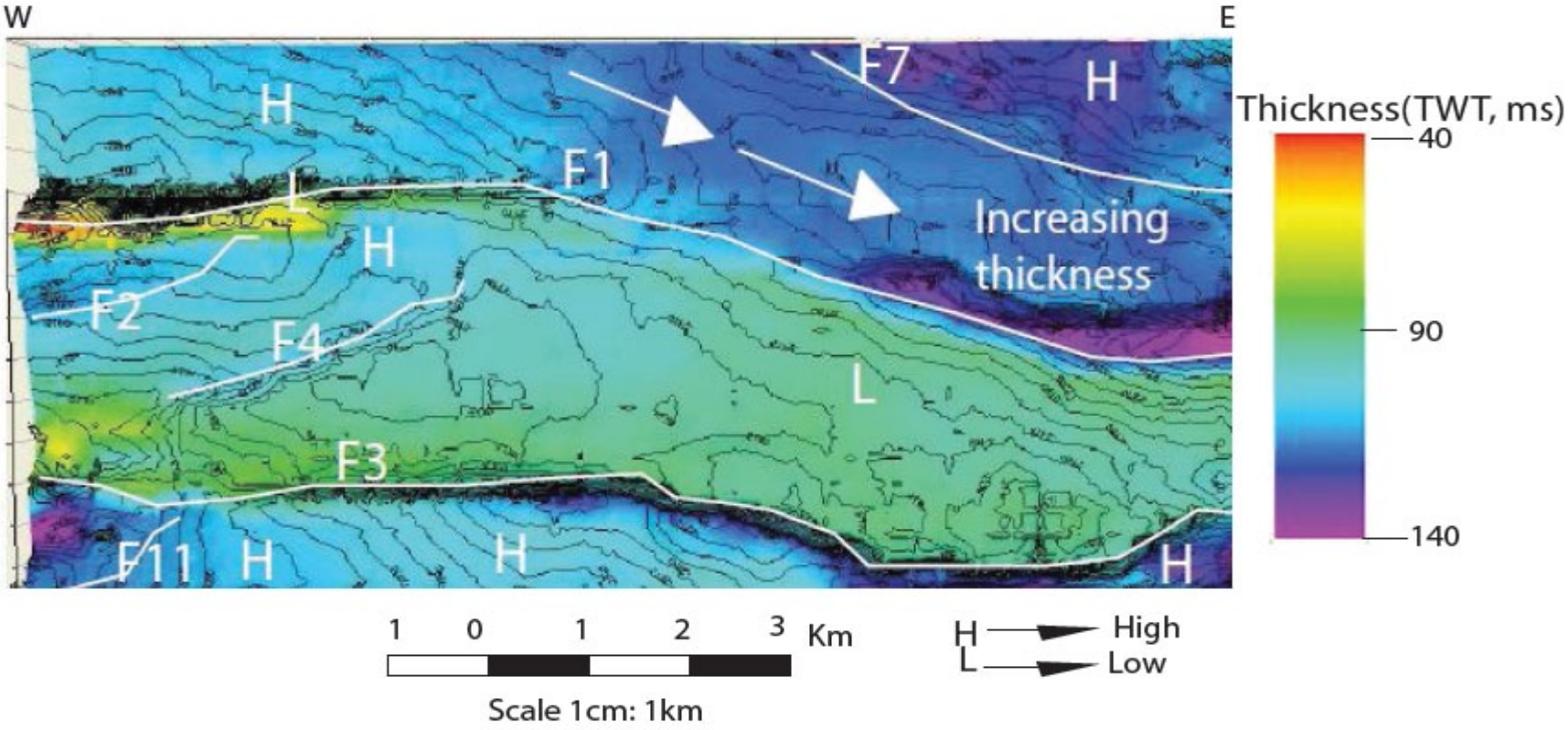
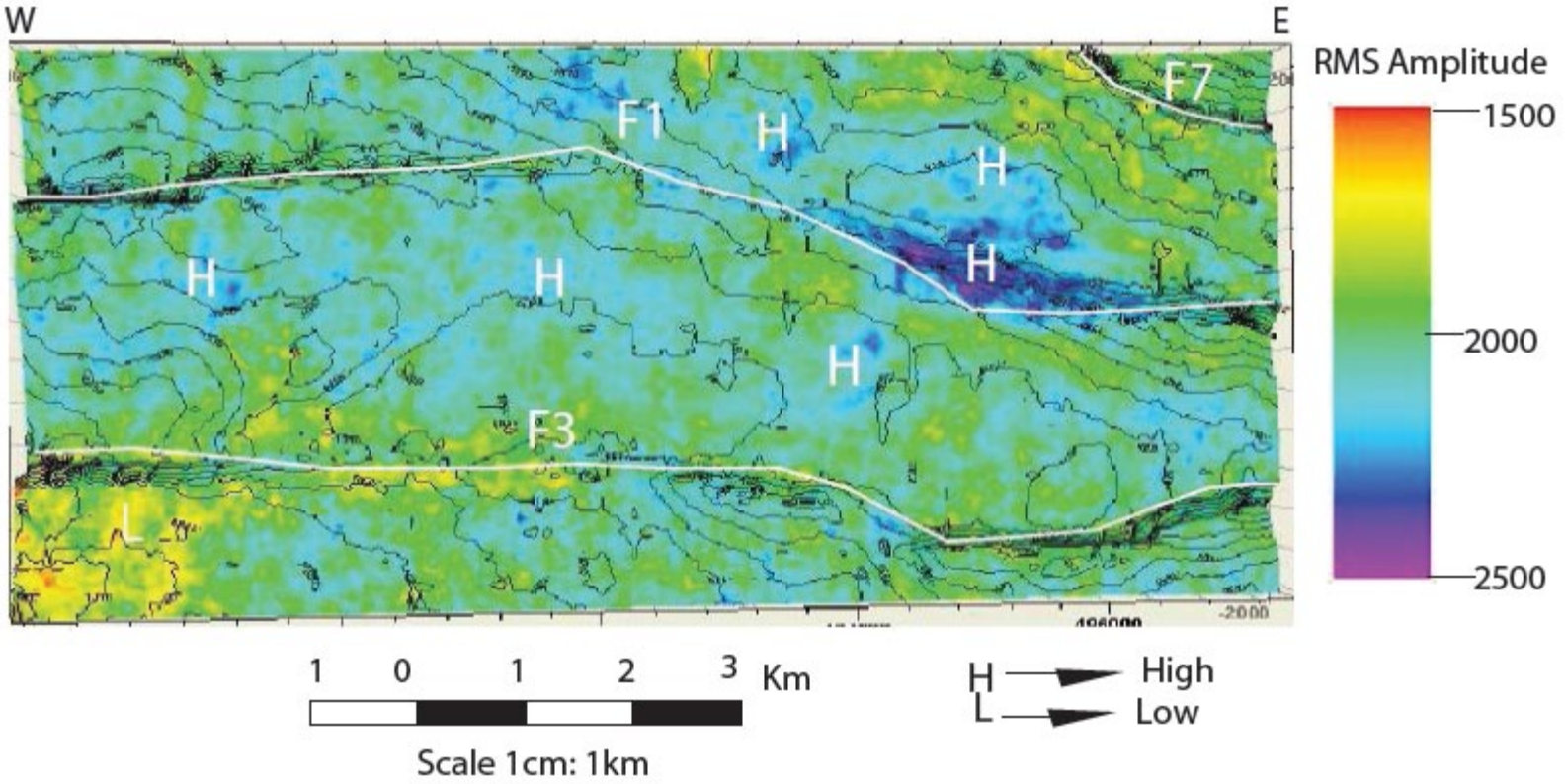
Isochore/Thickness Map



Interval: MR-2 & MR-3

- Increased Depositional thickness close to Mobile Akata Shale layers

RMS Amplitude Maps



Interval: MR-1 & MR-2

- High **RMS Amplitude** associated with homogenous **sand deposits**

(Fugeli & Olsen, 2005; Athmer et al, 2010)

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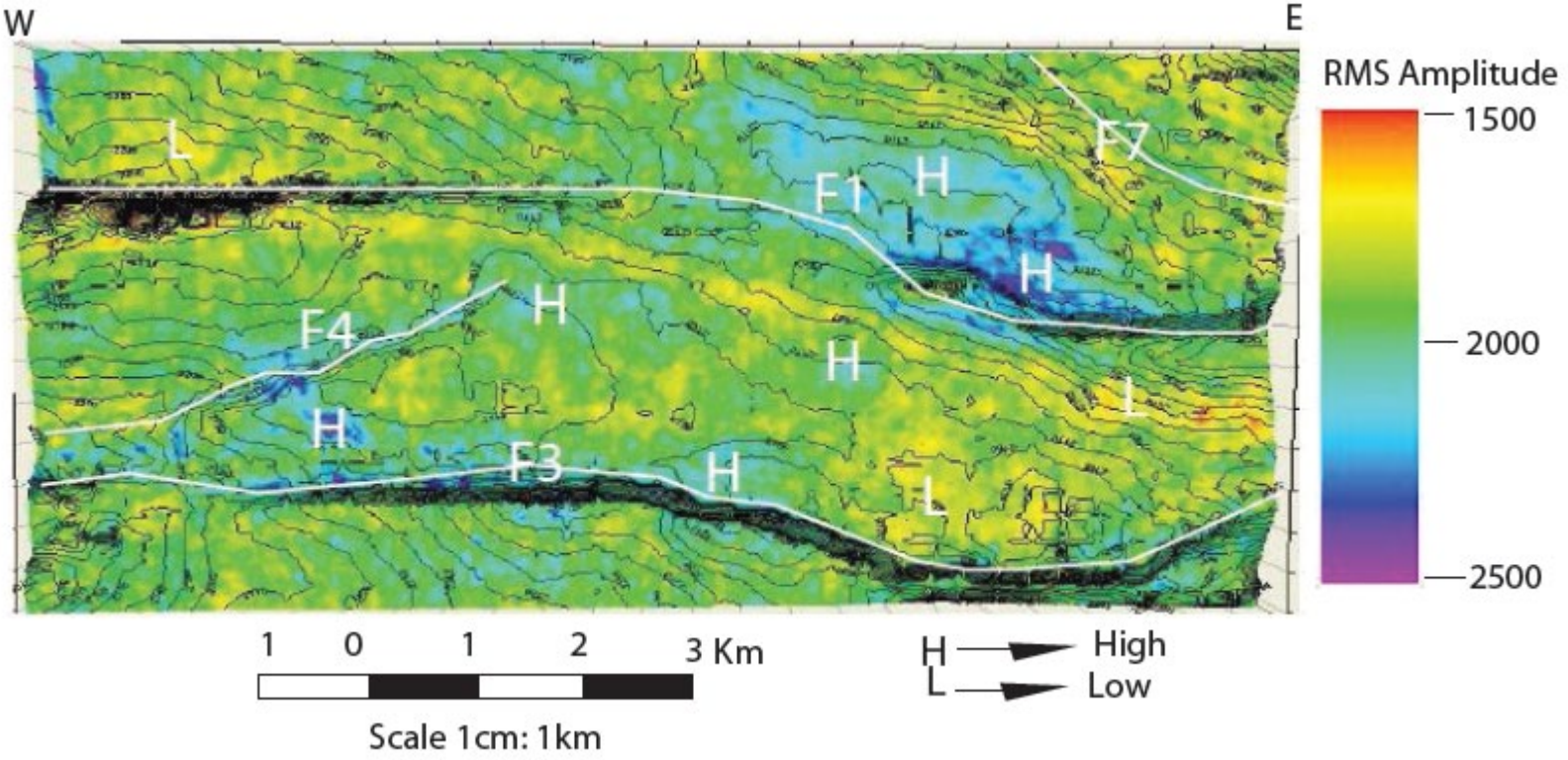
RMS Amplitude Map



Interval: MR-2 & MR-3

- Higher **RMS Amplitude** at downthrown side of **faulted block F1**

(Fugeli & Olsen, 2005; Athmer et al, 2010)

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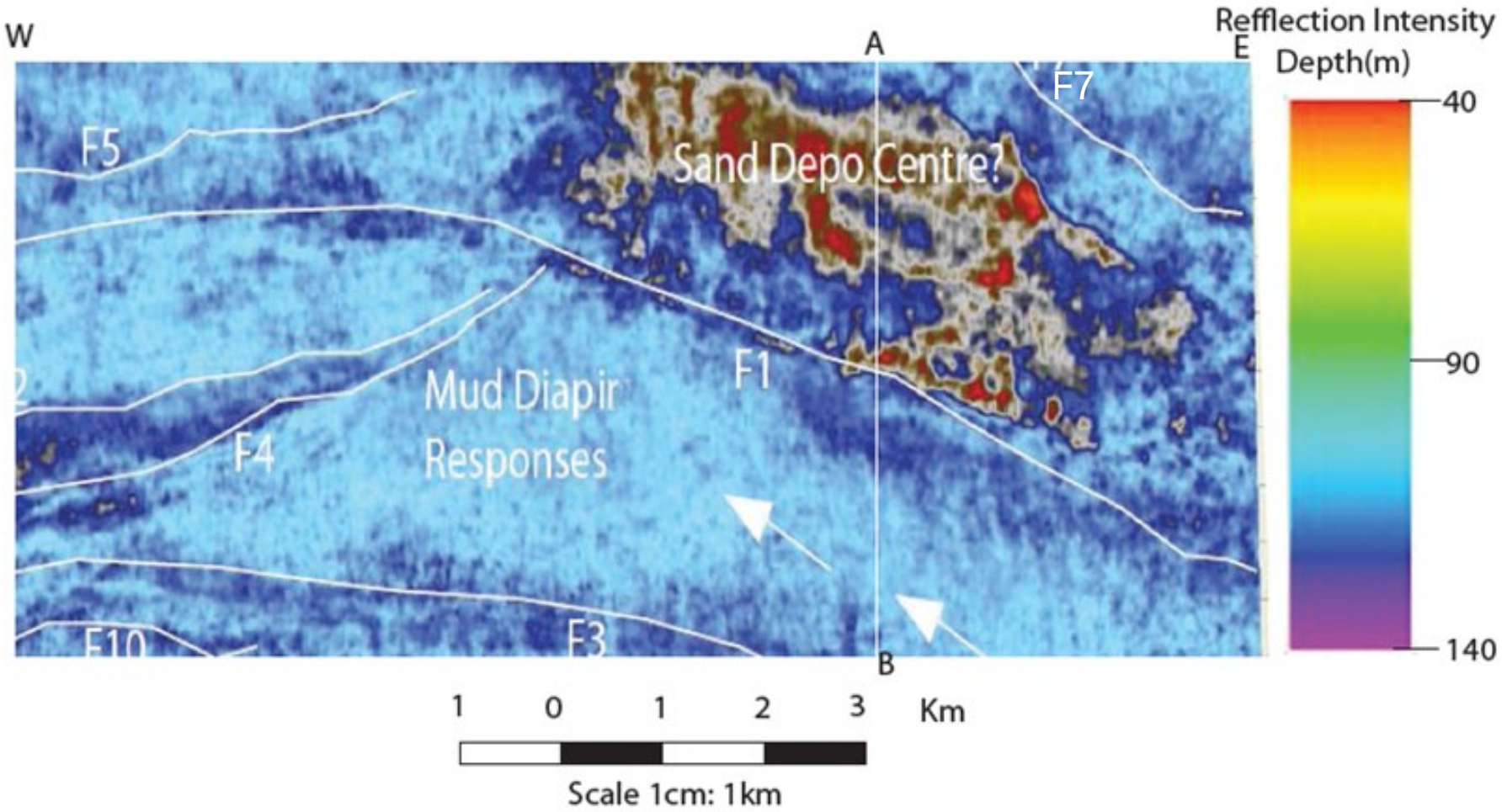
Reflection Intensity Map



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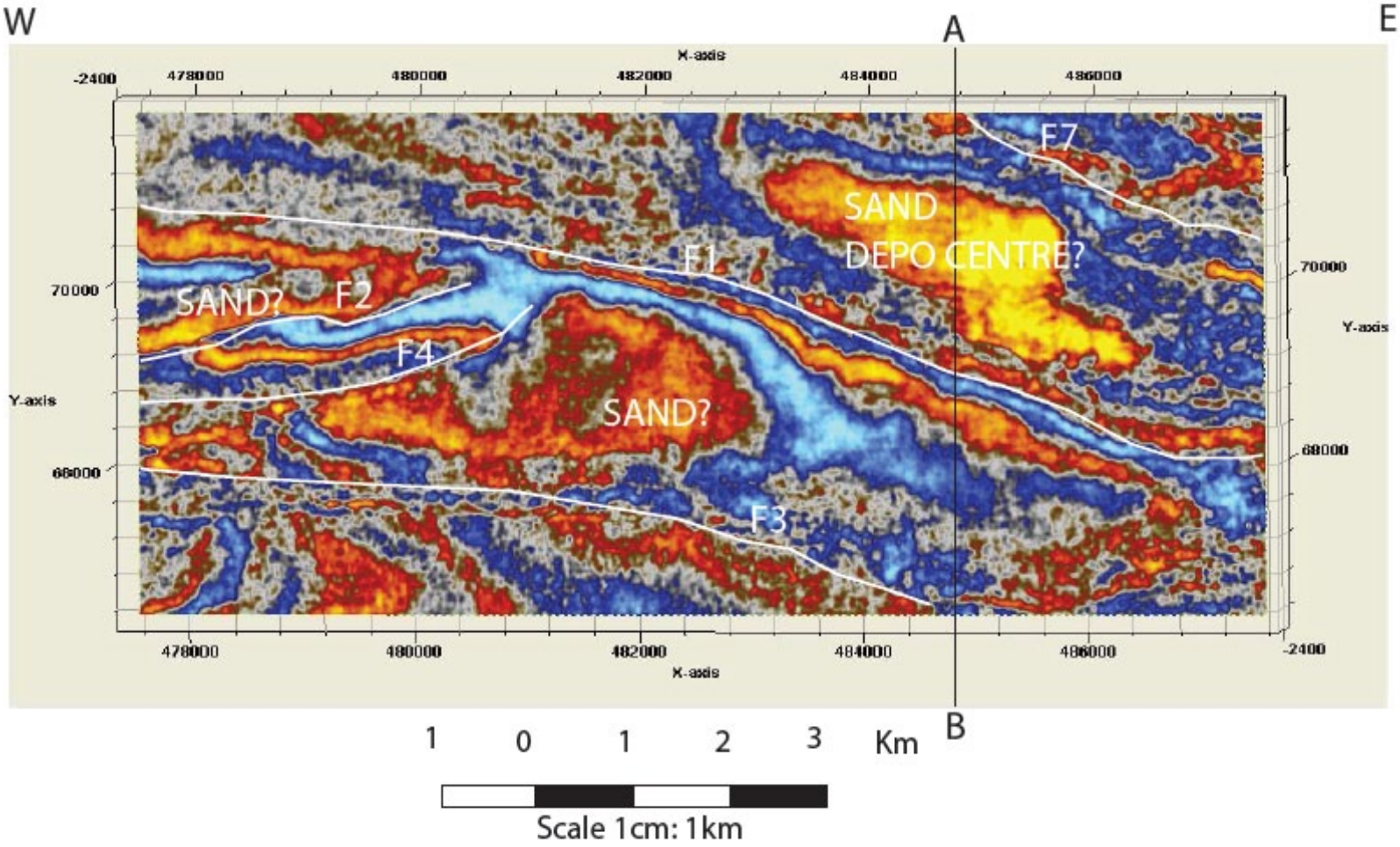
Time Slice: MR-3 (-2370 ms)



- Time Slice Indicating high **amplitude difference** between **F1 and F7?**

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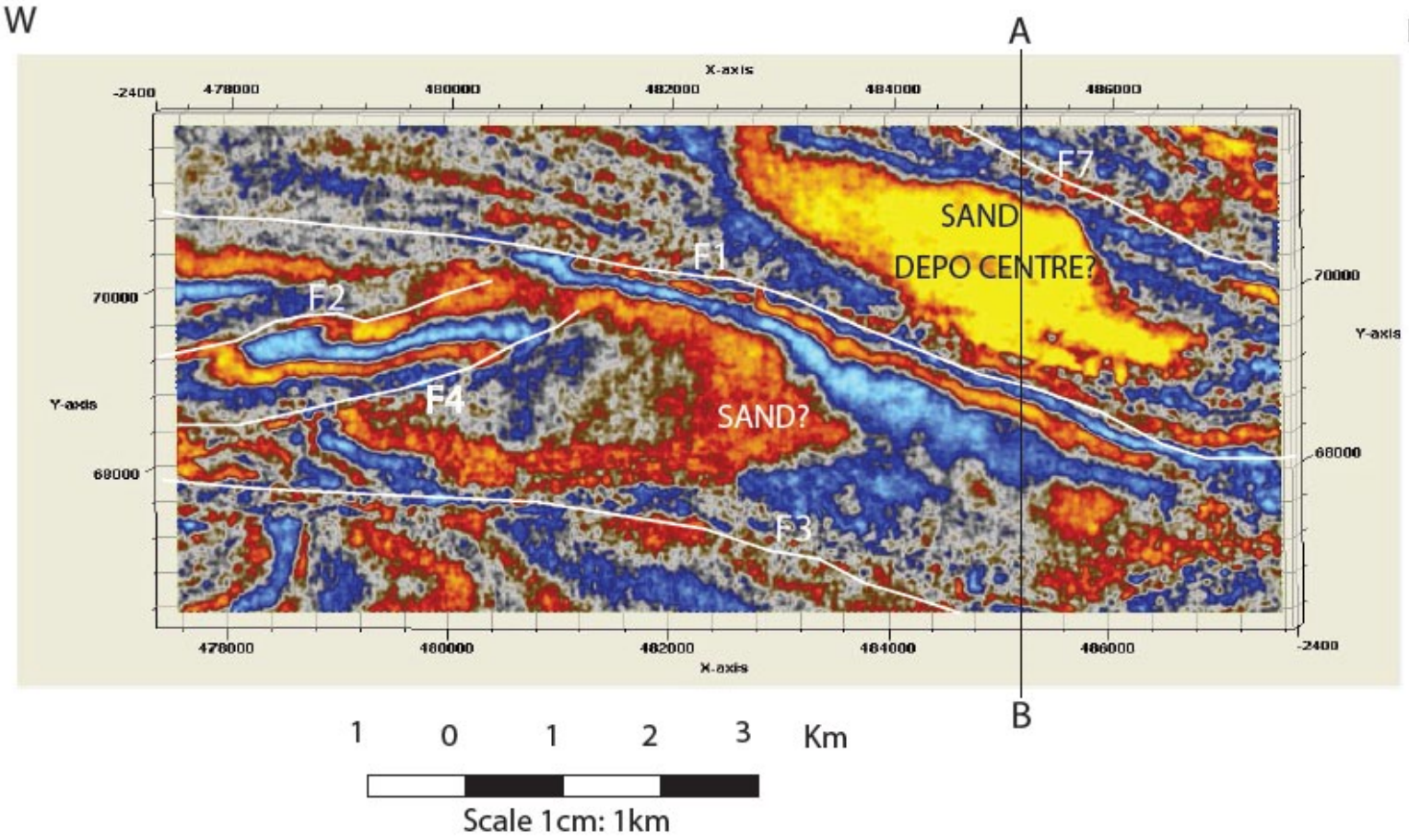
Time Slice: MR-3 (-2380 ms)



- Increasing **amplitude difference**
- Supposed broader **sand depositional** centre between **F1 and F7**?

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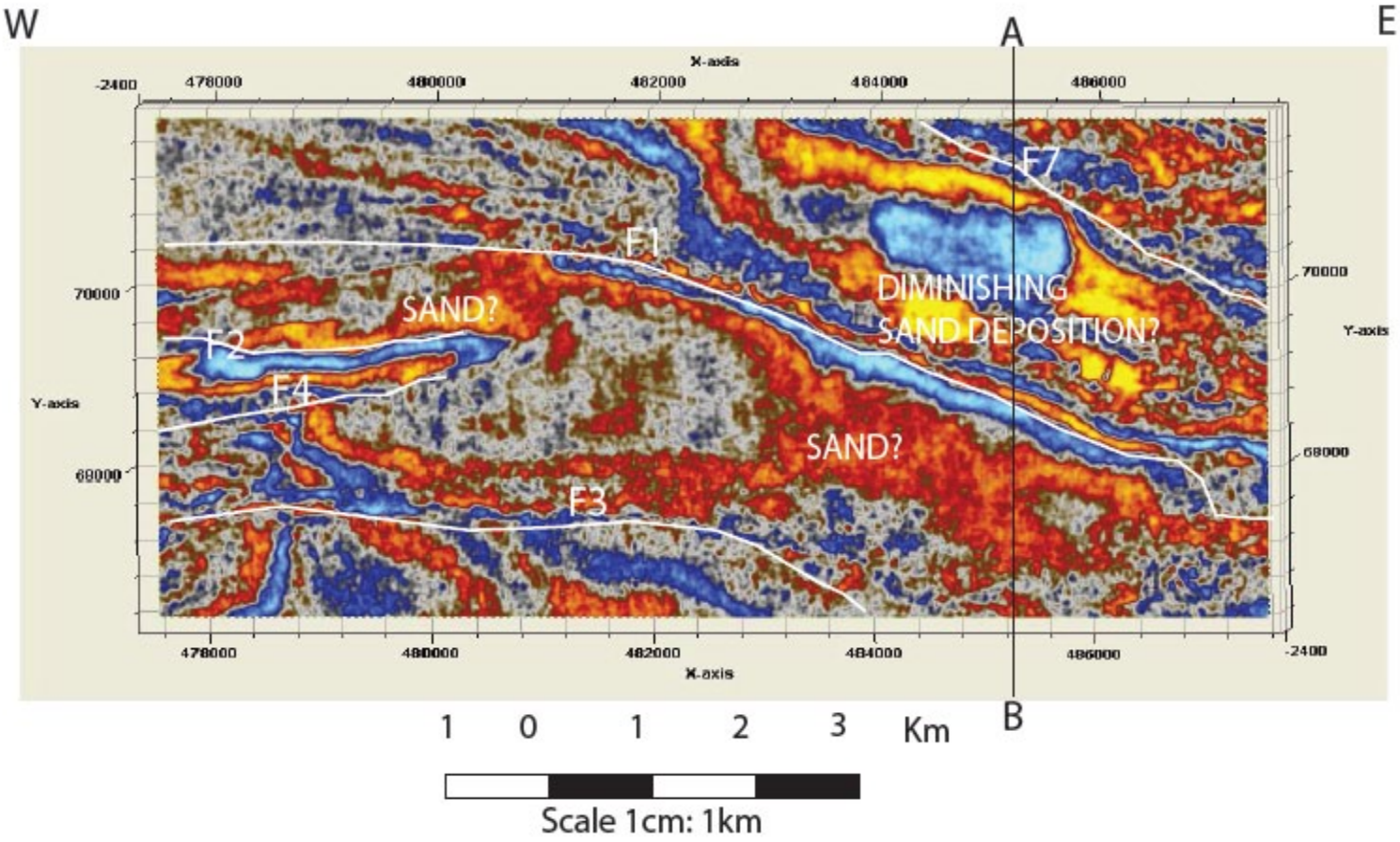
Time Slice: MR-3 (-2390 ms)



- Sand **depositional centre diminishes** between F1 and F7?
- Faults terminating?

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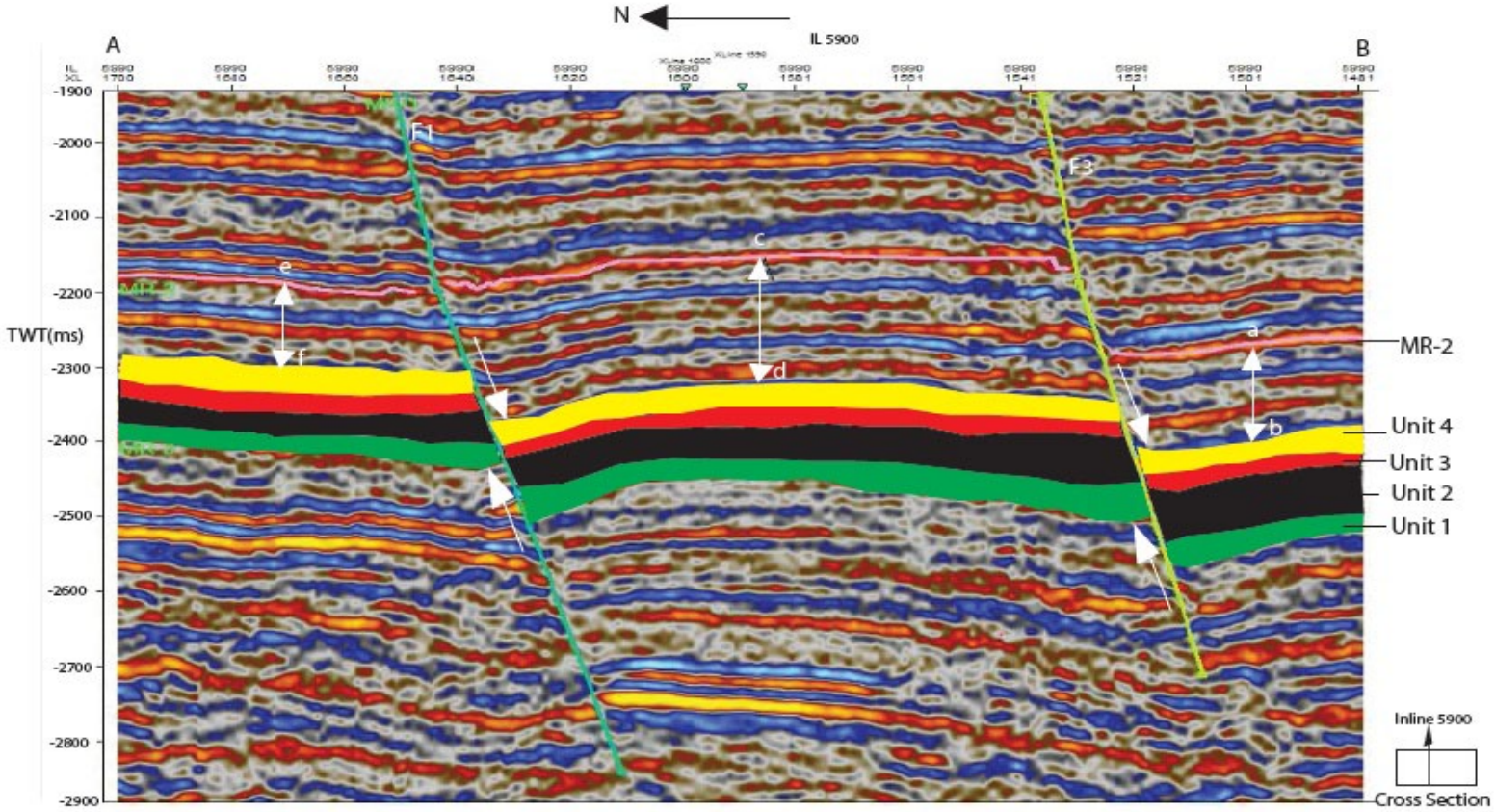
Shale effects on Mapped Sedimentary Layers



- High proximity to **Akata Shale**
- Growth faults: **F1 and F3**
- Shale effects? **A-D** thinner **C-D**

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Inferences

• Reservoir sand deposition and distribution are mainly faults-diapirs controlled due to shale tectonics in this area.

•The chance for lateral elongated and connected reservoir deposits might be minimal; since close to the shale layer, there will be incessant creation and destruction of accommodation space.

•A workflow combining structural contours, RMS amplitude, time slices, and well data will give a reliable insight in prospecting for reservoir structures and deposits in the subsurface.

Constraints

- Absence of Cores and Biostratigraphical Data
- Absence of Pressure data

Recommendations

- Seismic attributes when validated by well data can be employed in evaluating structural trends, distribution of reservoir deposits, and hydrocarbon occurrences.

- It can be employed as tool for exploration work in complex basins.

Thank you for listening

Questions?