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

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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


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

By:
Jonathan Johnson
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
Stratigraphy

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

Modified after Doust and Omatsola, 1990
Proposed Sedimentation Models

A. Regression Escalator Model

Schematic illustration modified after Knox and Omatsola, 1990
B. Turbidity Hydraulic Jump Model

Schematic illustration modified after Xijin, 2006
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
Base Map:
- Area: 550 sq km
- Inline: 400
- X-lines: 220
- Wells: 4
Seismic Facies: Amplitude and Reflection Continuity

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
Well Calibration:

- Top Agbada Fm
Faults & Horizons

- MR-1
- MR-2
- MR-3
## LAYER CAKE VELOCITY MODEL: T-D CONVERSIONS

### Pseudo-Interval Velocities Calculation

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**FINAL V-INTERVAL**: 1968.9

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Pseudo-Interval Velocities Calculation
Horizon: MR-1

- Surface Level: MR-1; Faults: Few; Akata proximity: Low
Structural Map

Horizon: MR-3

- Surface Level: MR-3; Faults: Many & Complex; Akata proximity: High
Interval: MR-1 & MR-2

- Depositional thickness is associated with downthrown sides of Faulted Blocks
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)
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)
Reflection Intensity Map

Sand Depo Centre?

Mud Diapir
Responses

Faults F1 and F7

Reflection Intensity
Depth (m)

140
90
40

Scale 1cm: 1km
Time Slice: MR-3 (-2370 ms)

- Time Slice indicating high amplitude difference between F1 and F7?
Time Slice: MR-3 (-2380 ms)

- Increasing **amplitude difference**
- Supposed broader sand depositional centre between F1 and F7?
Time Slice: MR-3 (-2390 ms)

- Sand depositional centre diminishes between F1 and F7?
- Faults terminating?
Shale effects on Mapped Sedimentary Layers

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