AVO Analysis, Inversion and Spectral Decomposition to Detect Thin Channelized Sandstone Reservoir of BED-15, Western Desert, Egypt*

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Abstract

BED-15 field is located within the Abu Gharadig basin, northern Western Desert. It was discovered in 1988, based on two-dimensional (2D) seismic data, and production comes mainly from the Abu Roash-C sandstone oil-bearing reservoir. The hydrocarbon in BED-15 field is structurally trapped in a tilted fault block, closed to the NE and bounded to the SW by a NW-SE-trending normal fault. Minor faults dissect the culmination. They are, however, laterally discontinuous and do not separate reservoir blocks at Abu Roash-C pay level. Abu Roash-C member sediments were deposited in a coastal to shallow marine setting. Whereas the Lower half of the member was deposited in a coastal marine setting within a back barrier complex, the upper half was deposited under shallow marine conditions. The Abu Roash-C reservoir is preserved in the form of tidal-channel-fill sandstone, ranging in average thickness from 2 to 20 meter. The channel sand boundary represents the stratigraphic entrapment element. Therefore firstly, we focused on the AVO analysis of six wells located in the field to demonstrate that the appropriate use of AVO analysis is a valuable tool for both development and exploration purposes. The wells analyzed include four with hydrocarbons and two wells that failed to find hydrocarbons. The AVO different responses were linked directly to the corresponding wells and extrapolated through the area to figure out their lateral extensions.

Secondly, we performed a feasibility study followed by pre-stack inversion, using three partial angle stacks, to delineate the channelized sandstone reservoir. The results are consistent with the AVO analysis findings.
A third aspect centers on the application of spectral decomposition to the seismic data relating to three wells; it provides further evidence that there are also apparent differences in the spectral characteristics between them. We demonstrated that the spectral decomposition is a very useful tool for channel detection and for delineation of its boundaries quite well.

In summary, this study shows that the integration of different geophysical approaches leads to better reservoir detection and increases the field's potential.

Selected References


“AVO Analysis, Inversion and Spectral Decomposition to Detect Thin Channelized Sandstone Reservoir of BED-15, Western Desert, Egypt”

W. Salah, I. Mohamed and S. Talaat
Outline

• Introduction
• Data QC & Conditioning
• Methodology
  • Semblance
  • Spectral Decomposition
  • AVO analysis/AVO Attributes
  • Pre-Stack Inversion
• Results with upside potential
• Conclusion
Objectives

• To delineate channelized thin reservoirs.
• To support development activities.
• To identify stratigraphic trapping mechanism for exploration opportunities.
Regional Geological Setting

After W. Salah et al., 2014.

Abu El Gharadig Basin Stratigraphy & Tectonic Episodes

schematic diagram illustrating the conceptual model of the study area (modified from Willis, 1994).
Correlation
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**Data Summary**

- **Seismic Data**
  - PreSTM
  - Full Stack
  - Near Stack 10°
  - Mid Stack 20°
  - Far Stack 30°

- **Polarity**: SEG Reverse (Increase in Impedance is Trough)

- **Horizons**
  - Three Horizons (ARC Top, Top CH & Base CH)

- **Wells**
  - Six wells

After Brown, 2001
Data Conditioning & QC

Before
Data Conditioning & QC

After
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Semblance

Original

filtered

Flattened

smoothing filter &
Pick up the top seal/
nearest continuous
horizon

Flatten the volume using
one of the continuous
Horizon ARC
Semblance

Flattened

Semblance Slice @ 2182

Interpreted Semblance Slice @ 2182
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Spectral Decomposition

Seismic to well tie
Decompose into single frequency components
Spectral Analyses @ Well-B

3D Seismic Amplitude Spectrum

Un-Interpreted
Interpreted
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AVO Analysis

AVO in original case (Oil): Sw = 11%

Fluid replacement: Sw = 100%
AVO Attributes
AVO crossplot showing projection axes which typically correlate strongly with particular elastic parameters (after Connolly, 2010).
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Simultaneous Inversion Workflow

- Seismic Angle Stacks → Well Tie & Wavelet Estimation → Wavelets → Simultaneous Inversion
- Well Logs → Well Interpolated LFM (10-15 Hz) → LFM (10-15 Hz)
- Horizons

- Wavelets
- LFM (10-15 Hz)
- Density
- S-Impedance
- P-Impedance
- Vp/Vs

Channel Detection
Pre-Inversion Feasibility Study

Vp/Vs

Sand

Zp

Lambda-Rho

Sand (relatively)

Density

Mu-Rho

Sand (relatively)

Density

Density
Wavelets and Tuning Thickness Estimation
Initial Model

P-Impedance Model

S-Impedance Model

Density Model
Inversion Analysis

Original log

Inverted log
P-Impedance

High

low

Vp/Vs

Zp

Sand
Vp/Vs

High

low

Zs
Lambda-Rho

High

low

Sand (relatively)
Outline

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  - Semblance
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Inversion Crossplot

From Well Data

From Inverted Data
Discussion

Structural Map  Semblance  Spectral Decomposition  AVO projection -47°  AVO projection -75°  Inversion Crossplot
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Conclusion

• Many tools were used to detect ARC thin channelized sand reservoir
  – Spectral decomposition delineates the channels perfectly
  – Semblance did a good job and shows good results
  – AVO attributes at certain projection show the channel trends, supported with Spectral decomposition and Semblance.
  – Inversion product: only the density and lambda rho show, relatively, where the sand is present.
• Integration of many tools increases the confidence of the interpreted channels trends and increases the chance of success for upcoming wells.
• Results will be used to locate placement of the future wells accurately and will help effectively in the development of field planning (FDP).
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References

