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 in1988, 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

Brown, A.R., 2001, Data polarity for the interpreter: The Leading Edge, v. 20, p. 549.

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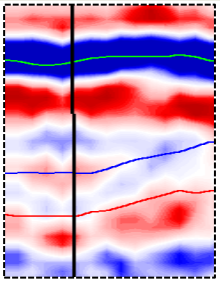
Connolly, P., 1999, Elastic impedance: The Leading Edge, v.18, p. 438–452.

Connolly, P., 2010, Robust Workflows for Seismic Reservoir Characterization: SEG distinguished lecture .

Salah Said, W., M. Yousef, H.Z. El-Mowafy, and A. Abdel-Halim, 2014, Structural geometry and evolution of BED 17 Field, Abu El Gharadig Basin, Northern Western Desert of Egypt: An example of restraining stepovers in strike-slip fault systems: Search and Discovery Article #2026 (2014). Website accessed October 5, 2016, http://www.searchanddiscovery.com/documents/2014/20266said/ndx_said.pdf.

GEO 2016
12th Middle East Geosciences Conference and Exhibition
Conference: 7 – 10 March 2016
Exhibition: 8 – 10 March 2016
BAHRAIN INTERNATIONAL EXHIBITION AND CONVENTION CENTRE



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AAPG
EAGE
EUROPEAN ASSOCIATION OF GEOSCIENTISTS & ENGINEERS
SEG
Society of Exploration Geophysicists
The international society of applied geophysics
ادارة المعارض العربية
Arabian Exhibition Management

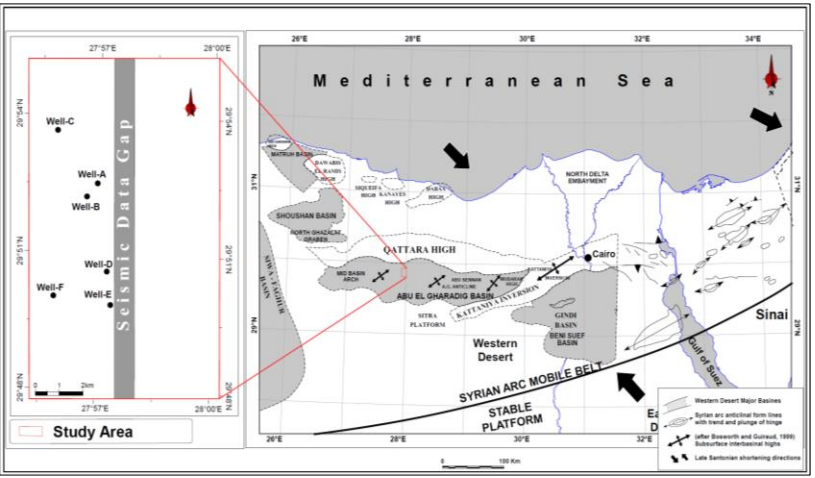
Outline

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

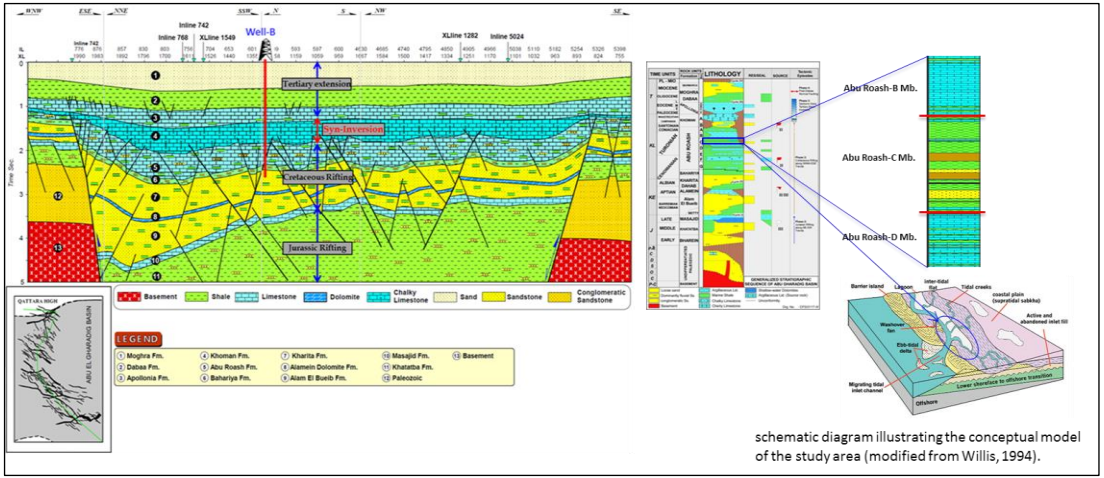
Objectives

- To delineate channelized thin reservoirs.
- To support development activities.
- To identify stratigraphic trapping mechanism for exploration opportunities.

Regional Geological Setting



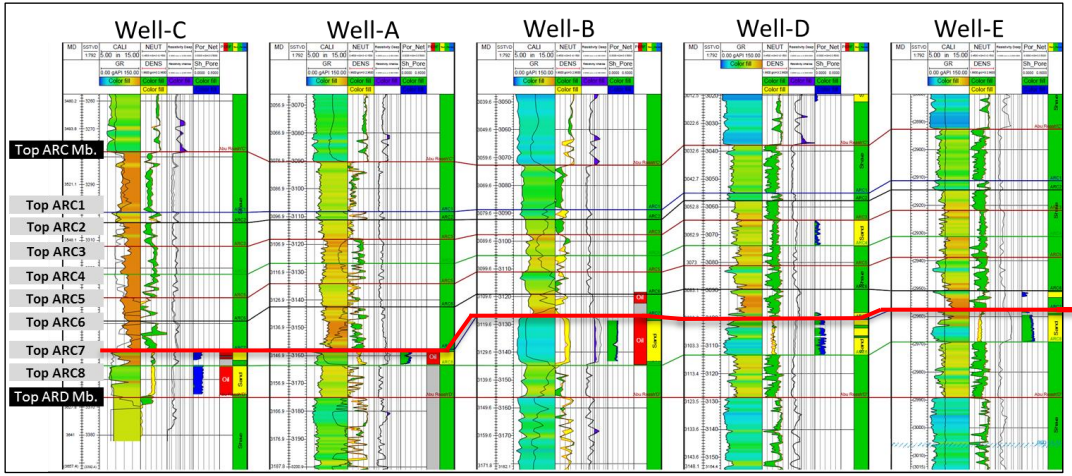
After W. Salah et al., 2014.

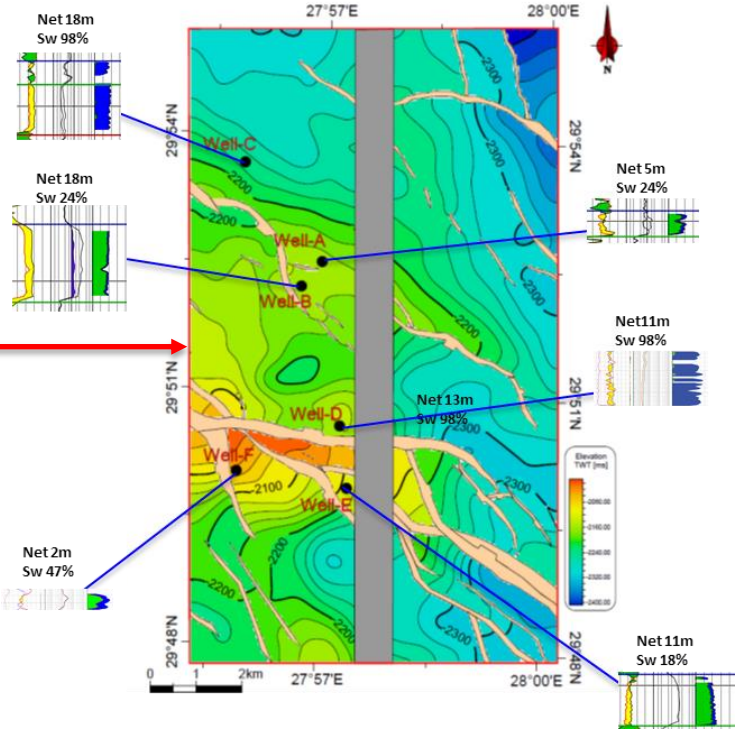


schematic diagram illustrating the conceptual model of the study area (modified from Willis, 1994).

Abu El Gharadig Basin Stratigraphy & Tectonic Episodes

Correlation





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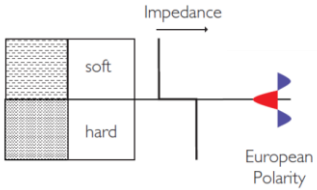
Data Summary

Seismic Data

- (PreSTM)
  - Full Stack
  - Near Stack 10°
  - Mid Stack 20°
  - Far Stack 30°

- Polarity : SEG Reverse (Increase In Impedance is Trough)



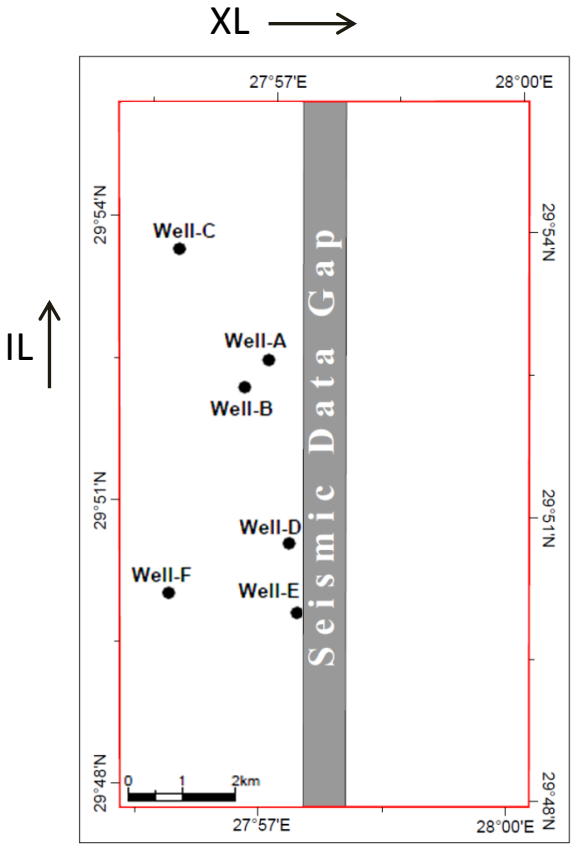
After Brown, 2001

Horizons

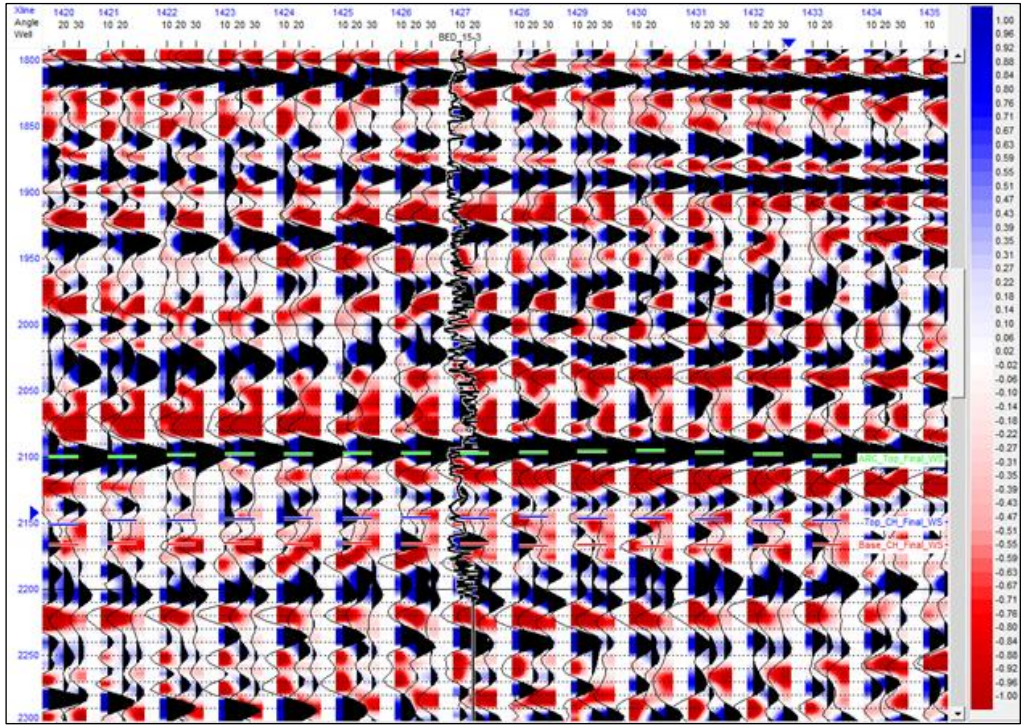
- Three Horizons (ARC Top, Top CH & Base CH)

Wells

- Six wells

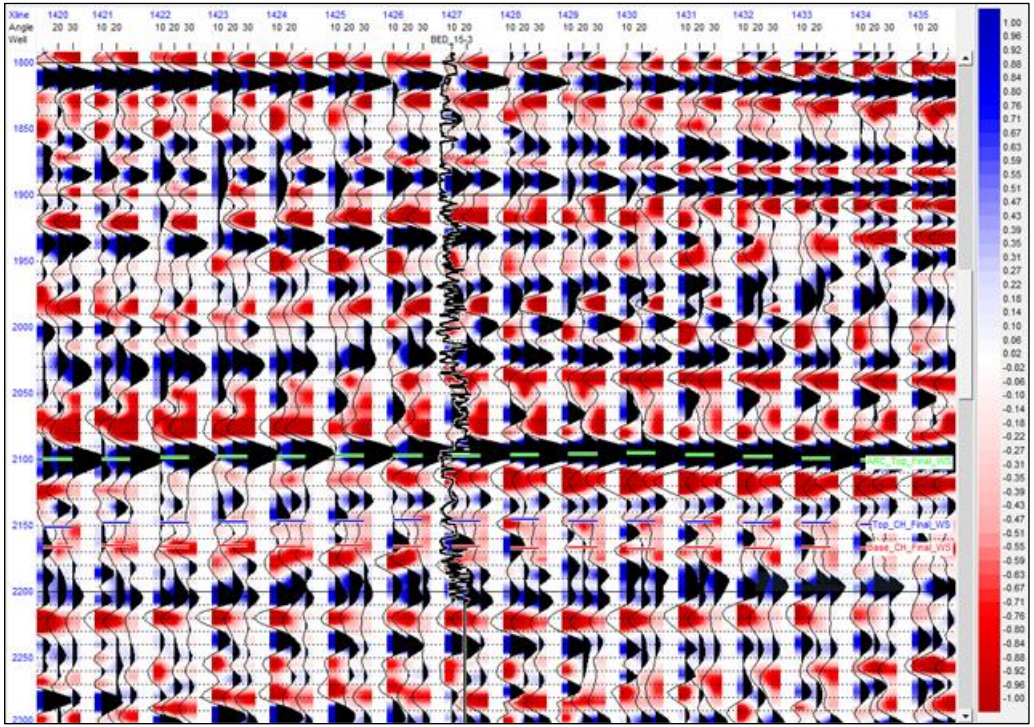


Data Conditioning & QC



Before

Data Conditioning & QC



After

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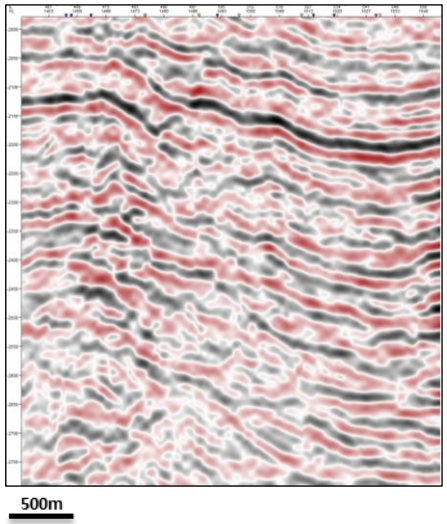
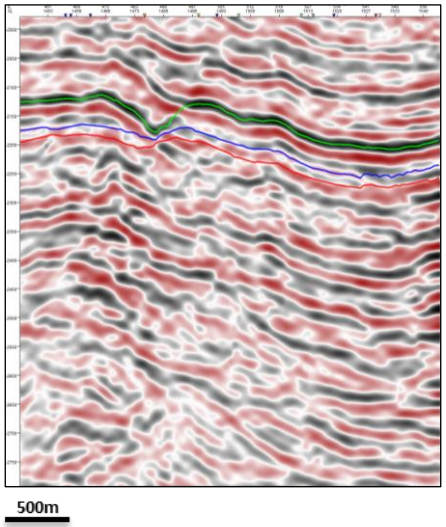
Semblance

Original



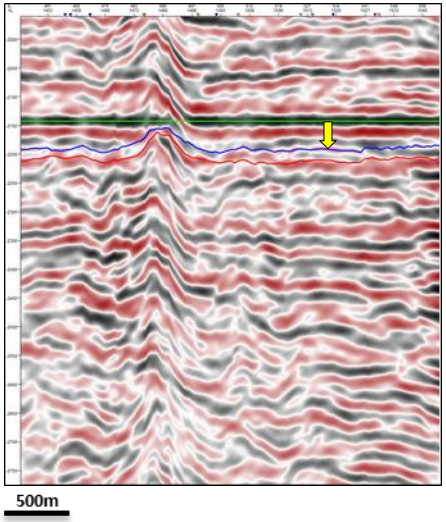
smoothing filter&
Pick up the top seal/
nearest continuous
horizon

filtered



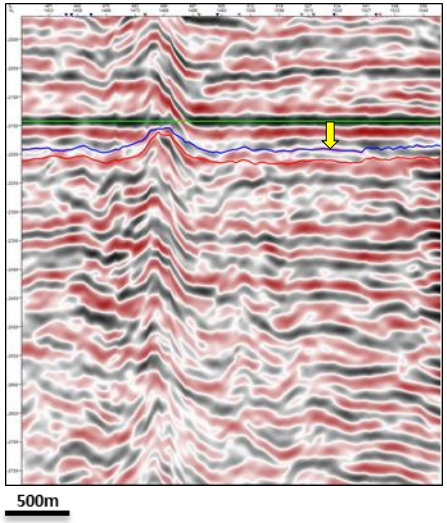
Flatten the volume using
one of the continuous
Horizon ARC

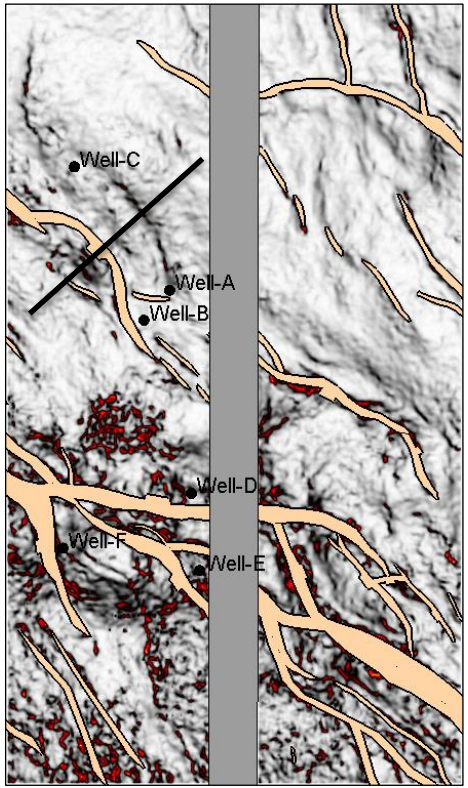
Flattened



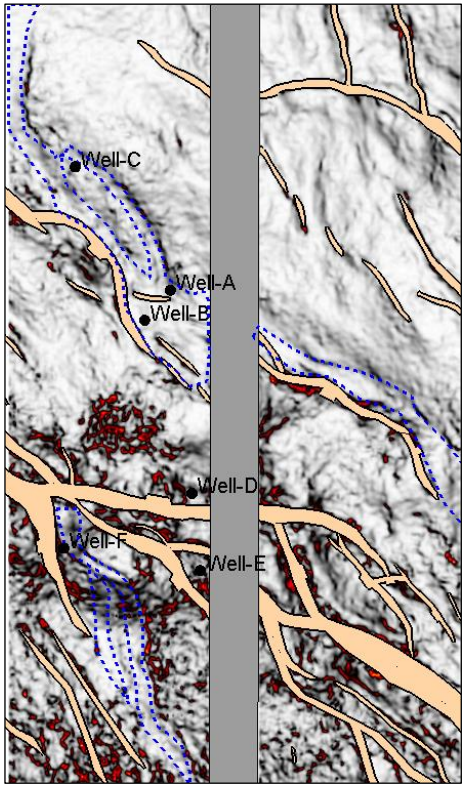
Semblance

Flattened





Semblance Slice @ 2182



Interpreted Semblance Slice @ 2182

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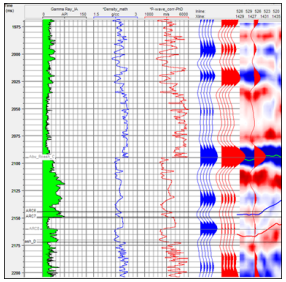
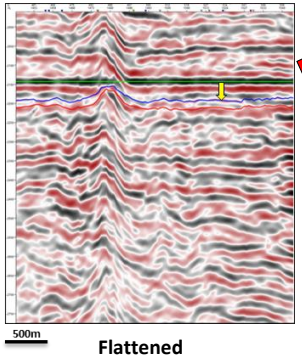
Spectral Decomposition

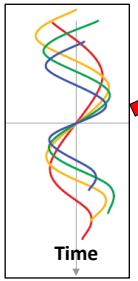


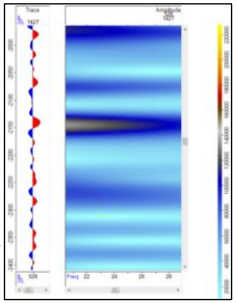
Seismic to well tie



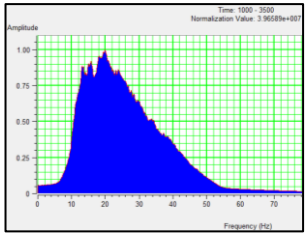
Flattened

Decompose into single frequency components

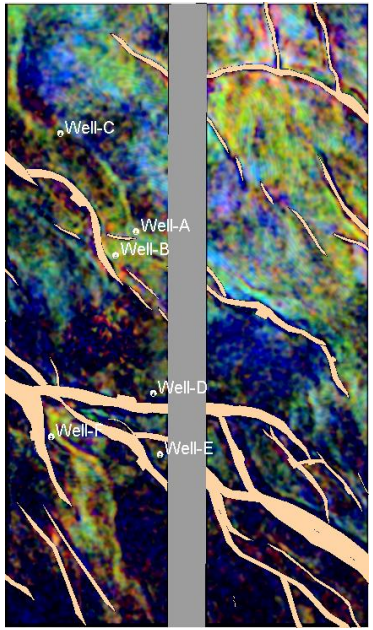




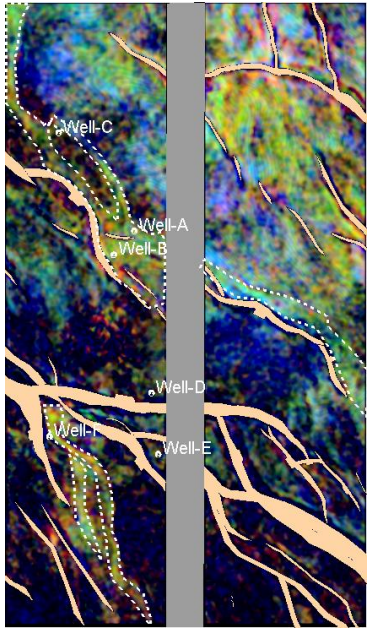
Spectral Analyses @ Well-B



3D Seismic Amplitude Spectrum



Un-Interpreted



Interpreted

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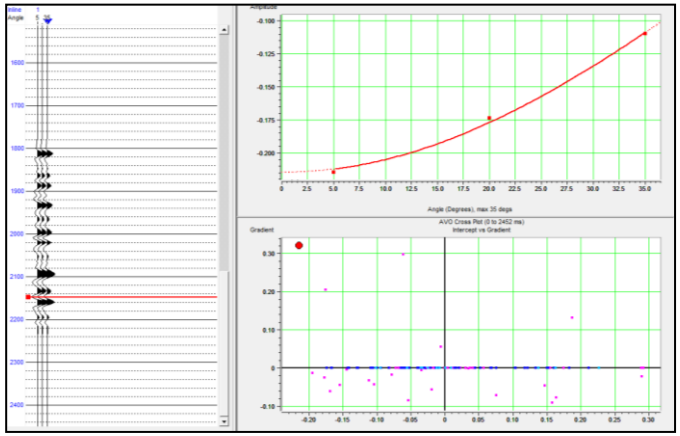
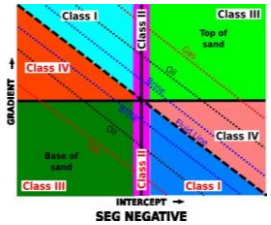
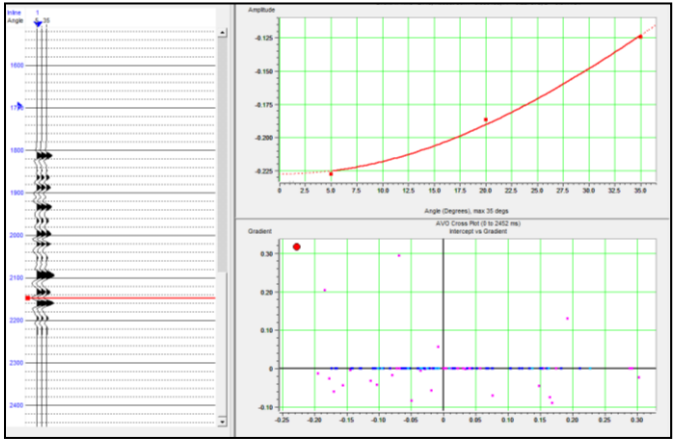
AVO Analysis



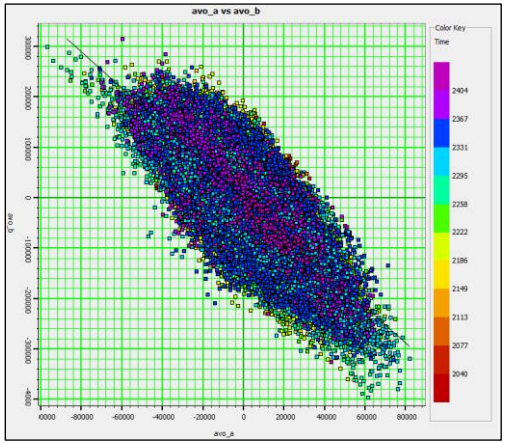
AVO in original case (Oil): Sw= 11%

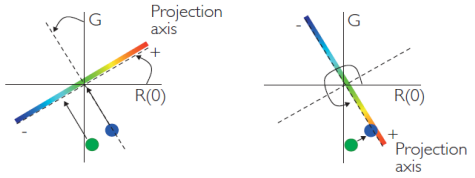


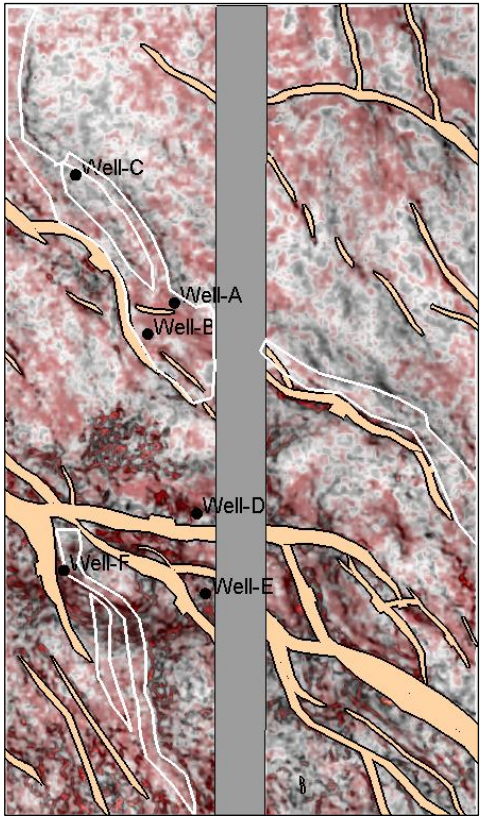


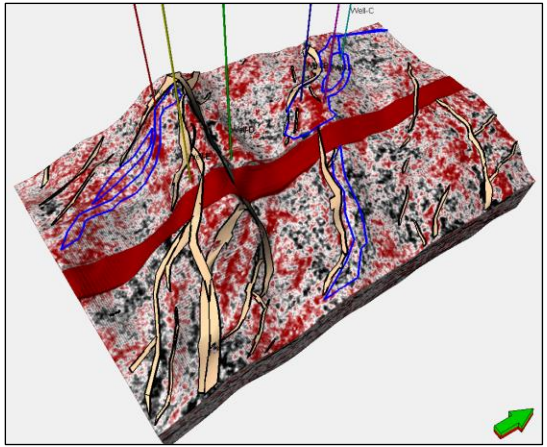
Fluid replacement: Sw= 100%

AVO Attributes

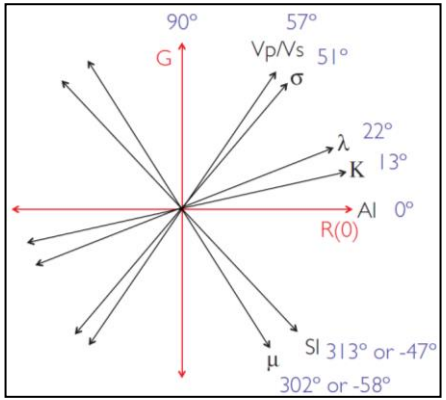




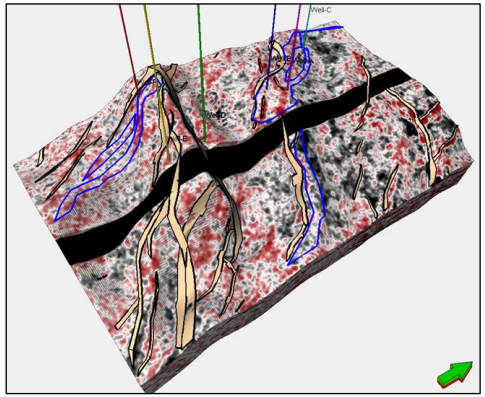


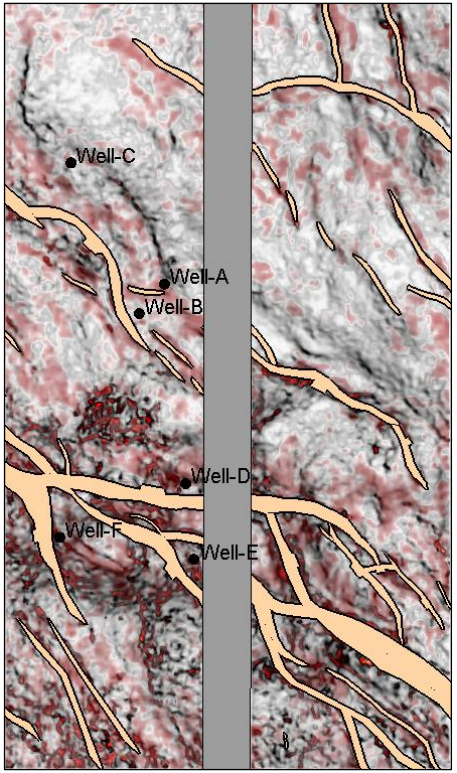


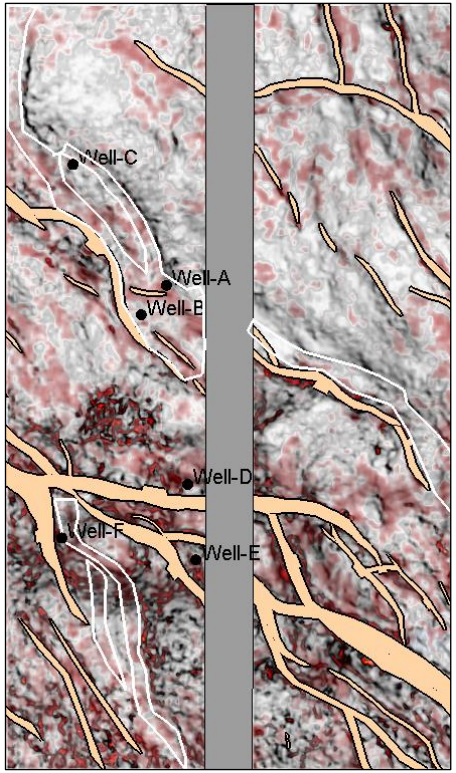
AVO Attributes



AVO crossplot showing projection axes which typically correlate strongly with particular elastic parameters (after Connolly, 2010).







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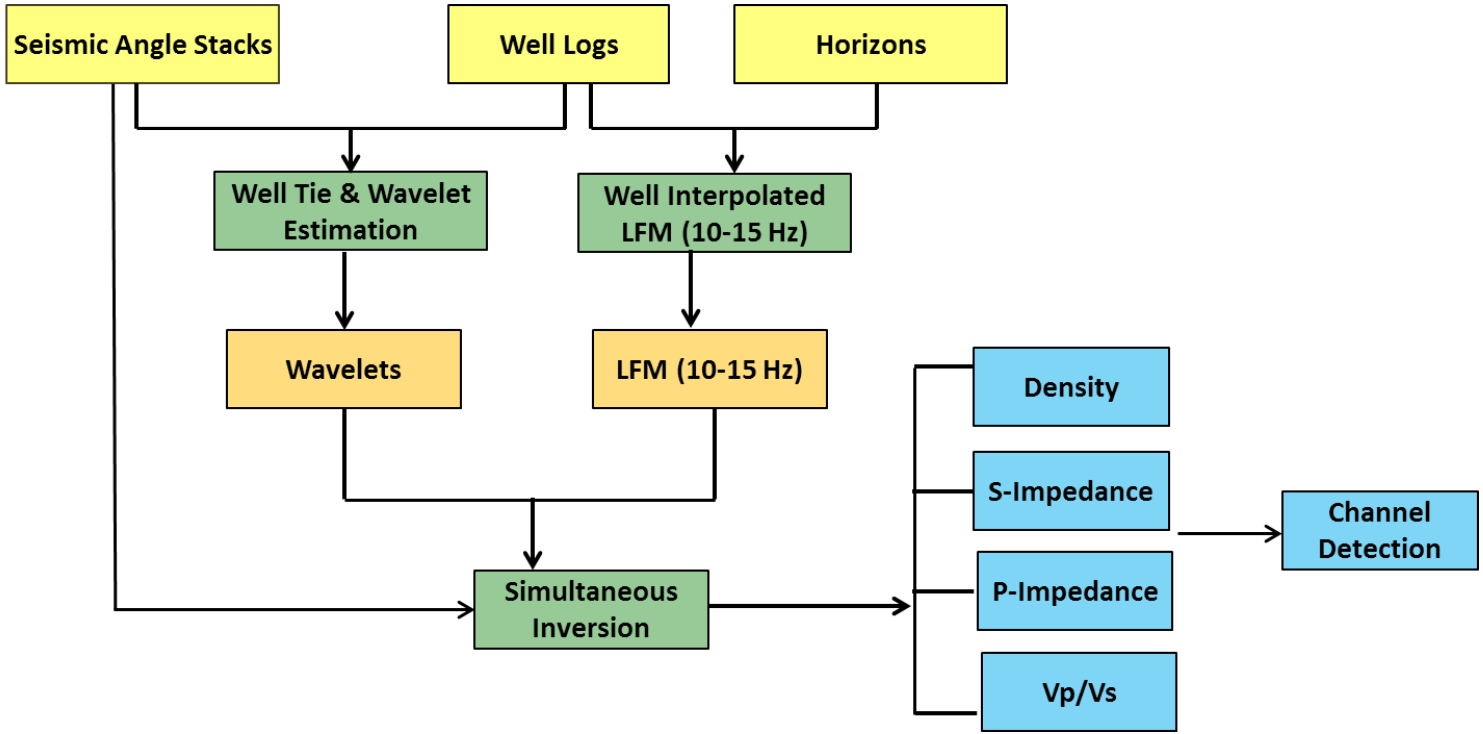
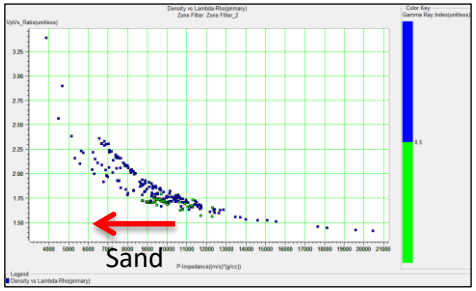
Simultaneous Inversion Workflow



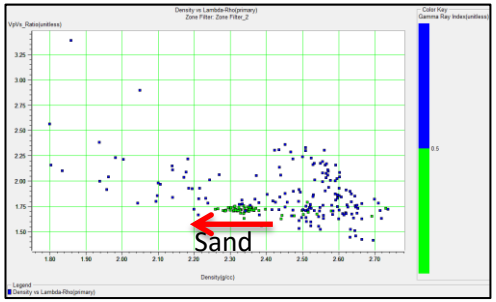
Pre-Inversion Feasibility Study

Vp/Vs



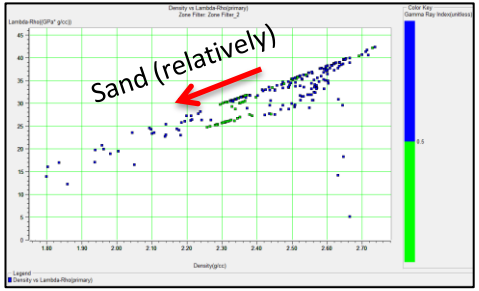
Zp

Vp/Vs



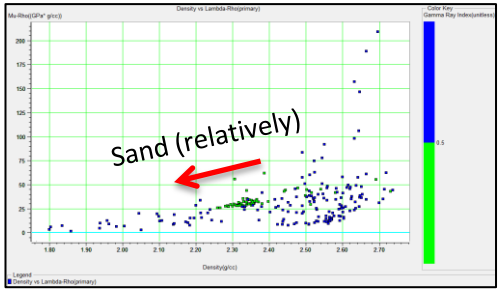
Density

Lambda-Rho



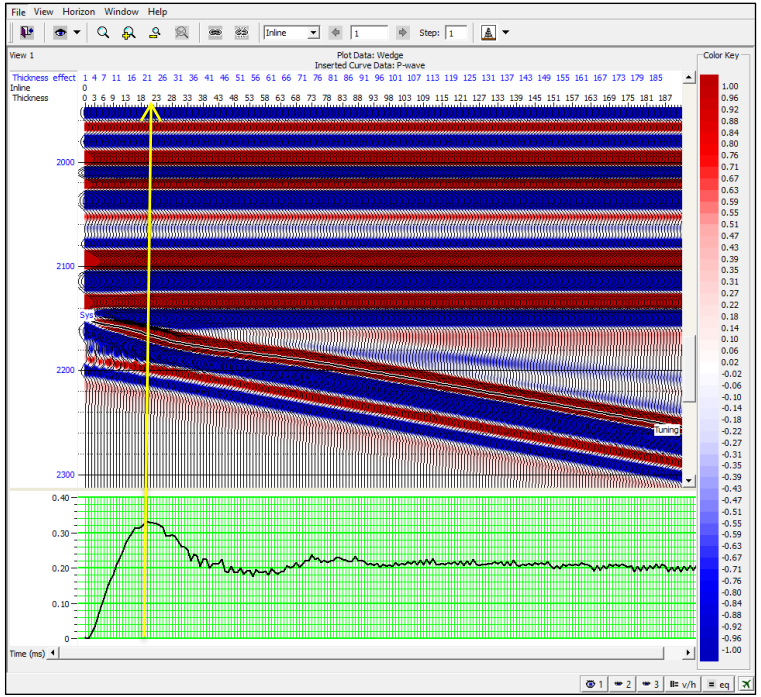
Density

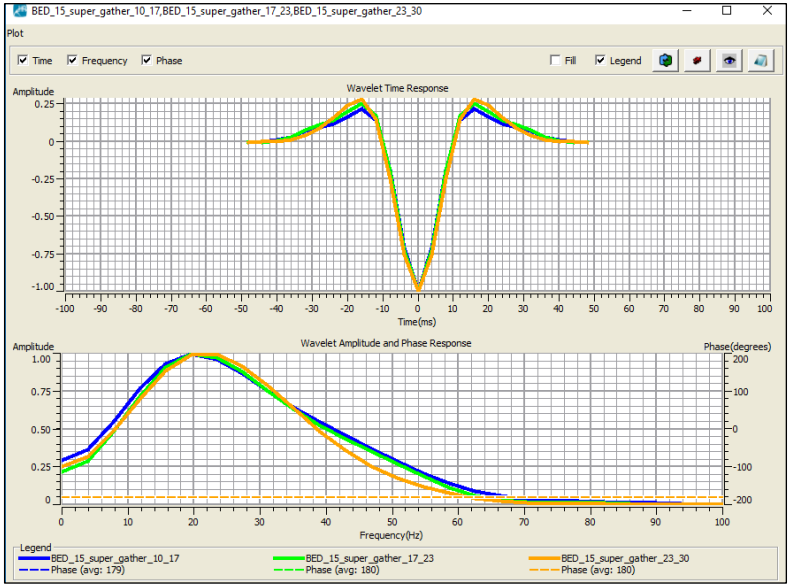
Mu-Rho



Density

Wavelets and Tuning Thickness Estimation



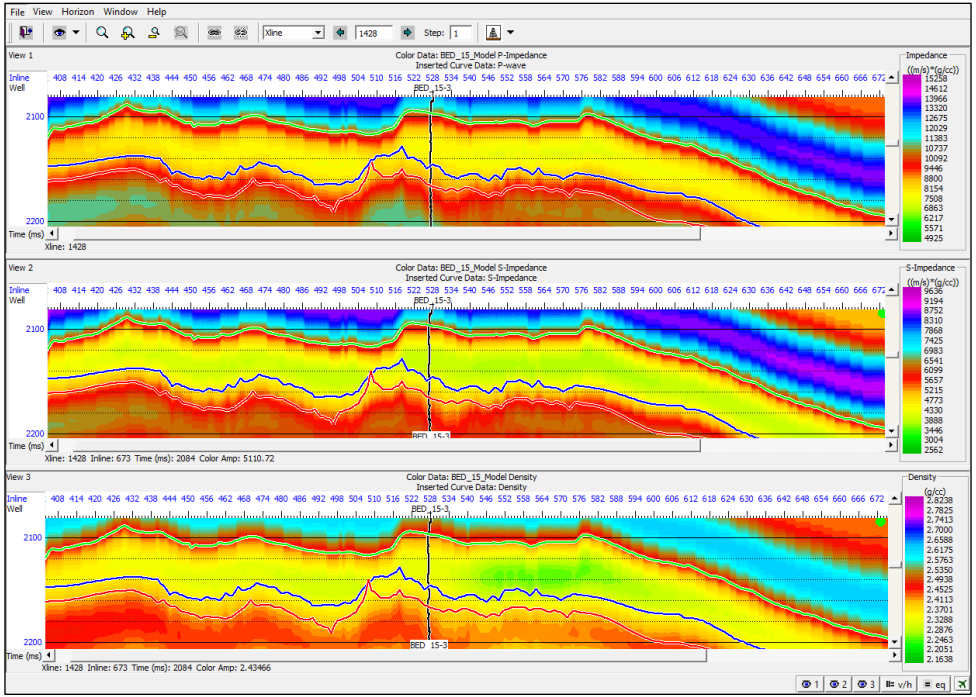


Initial Model

P-Impedance Model

S-Impedance Model

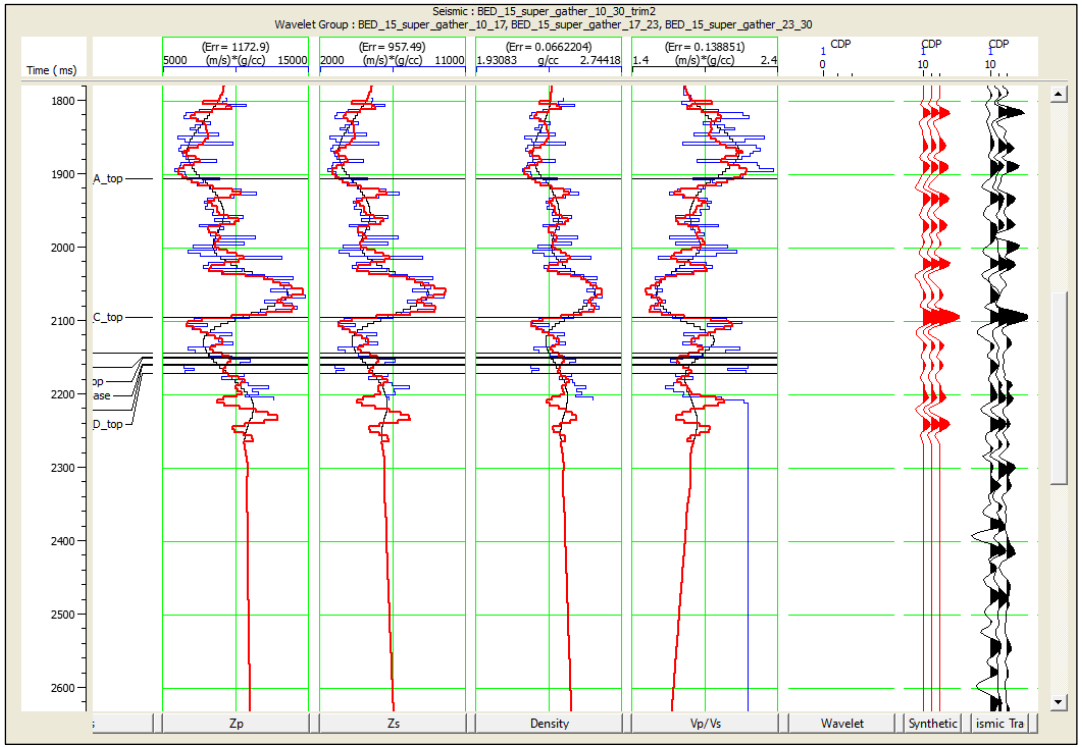
Density Model



Inversion Analysis

Original log

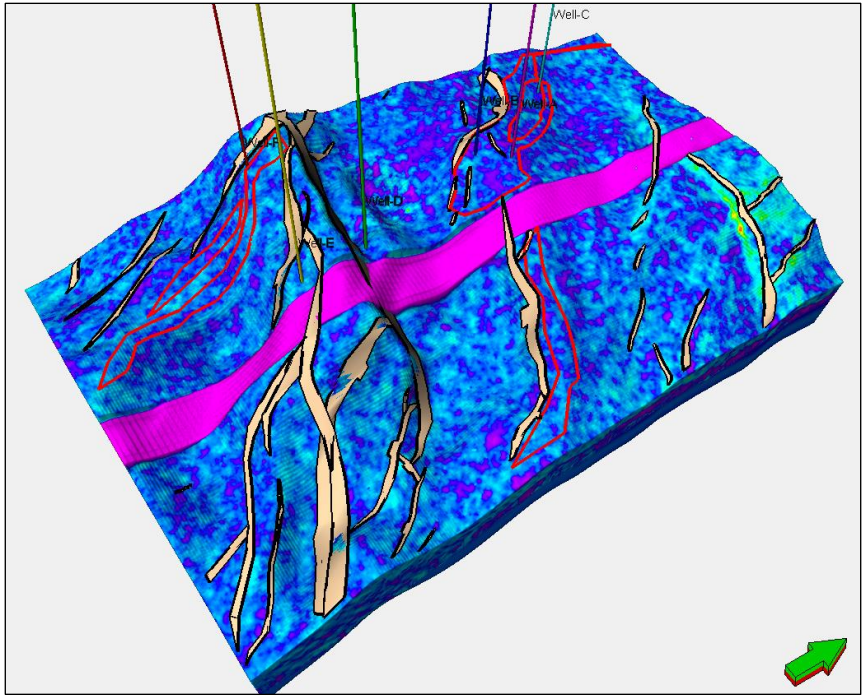
Inverted log



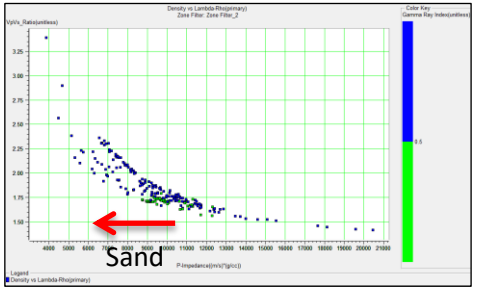
P-Impedance

High

low



Vp/Vs

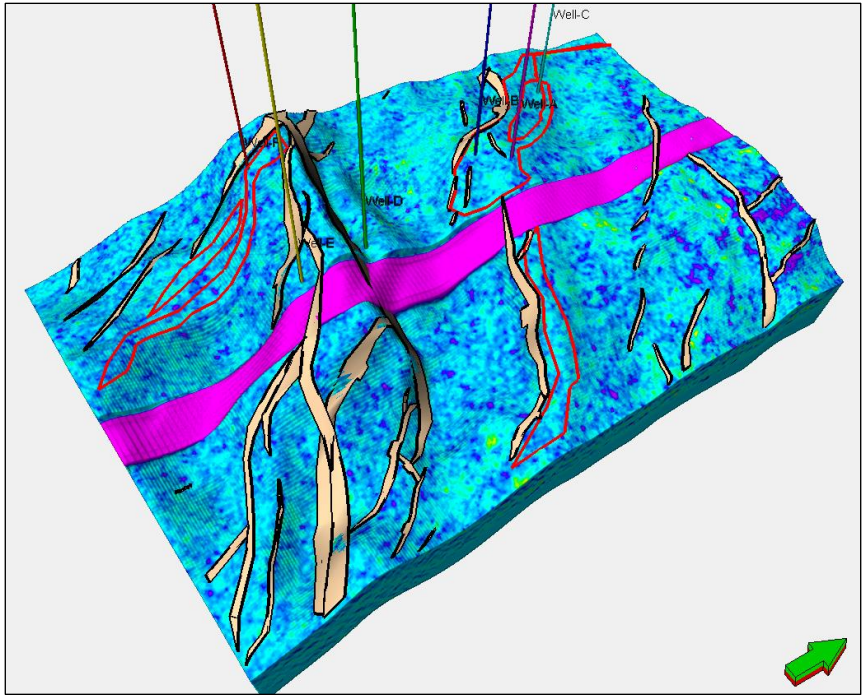


Zp

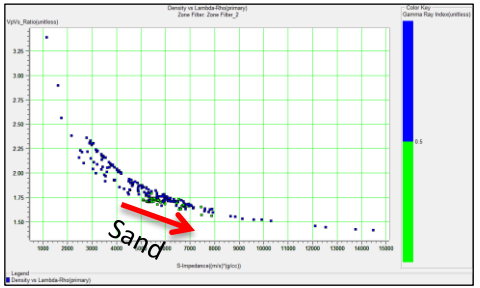
Vp/Vs

High

low



Vp/Vs

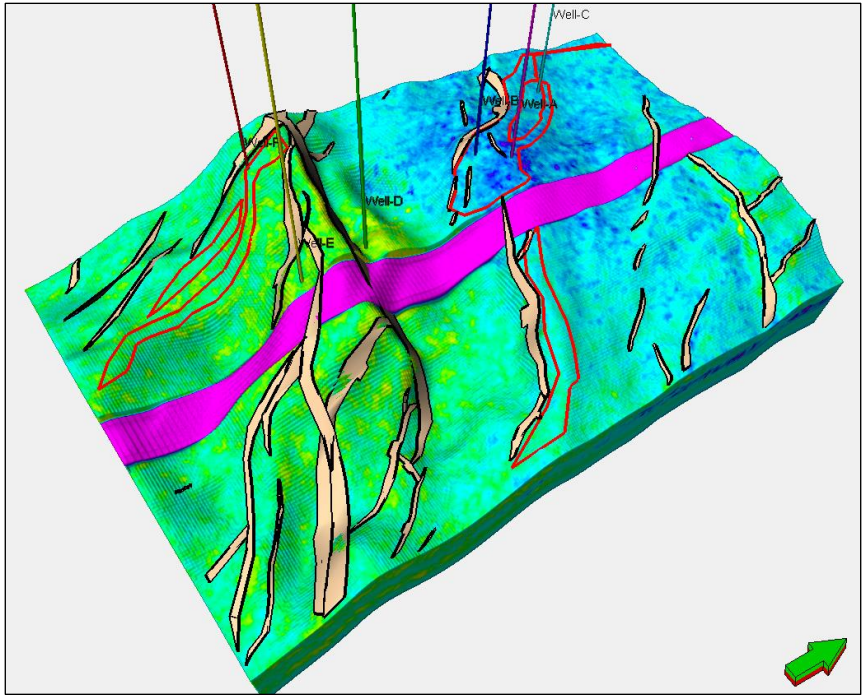


Zs

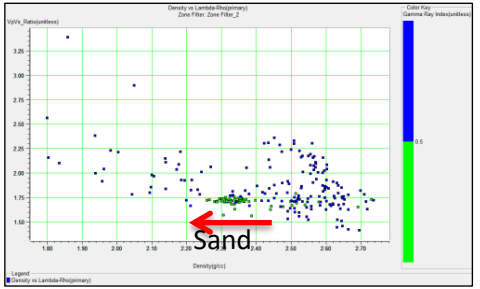
Density

High

low



Vp/Vs

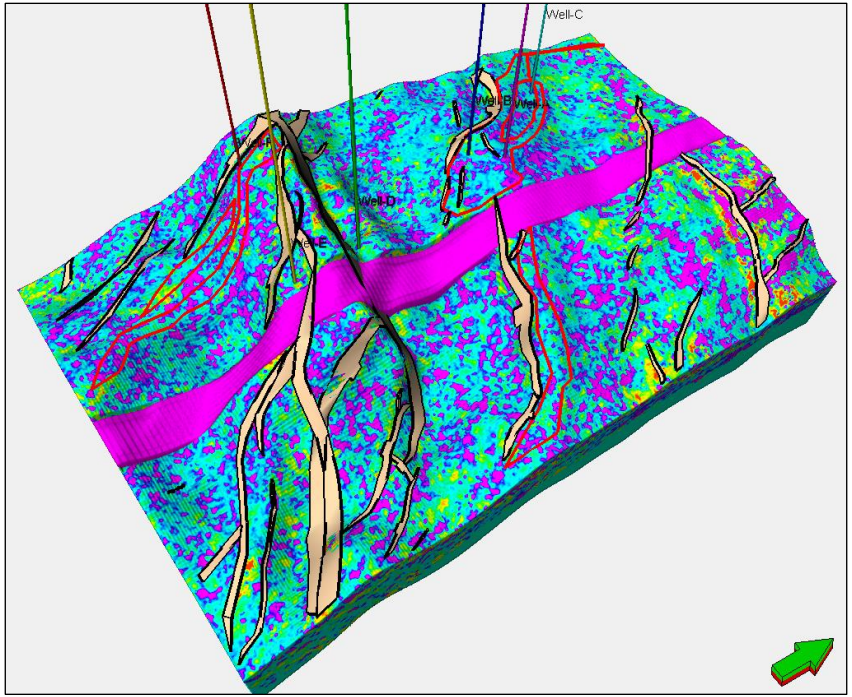


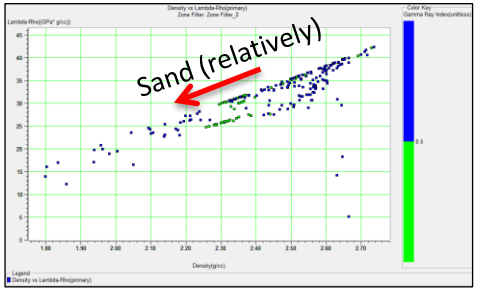
Den

Lambda-Rho

High

low

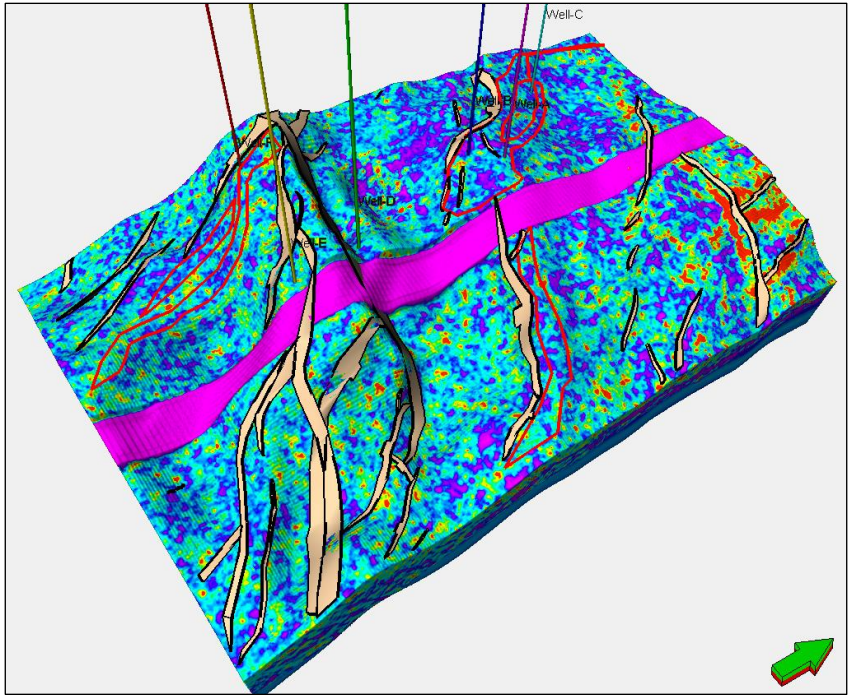


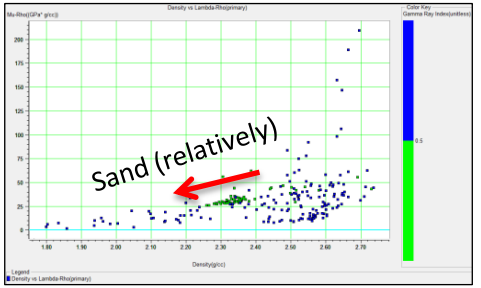


Mu-Rho

High

low





Outline

- Introduction
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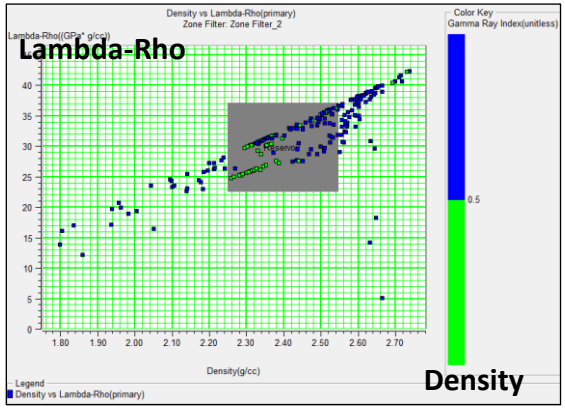
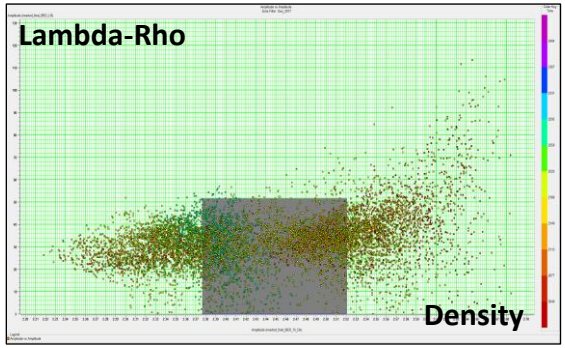
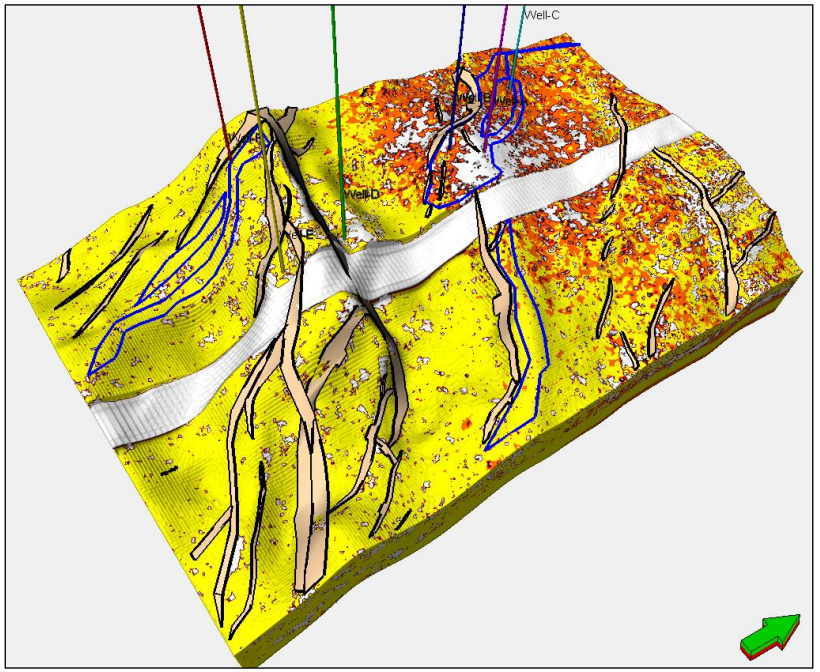
Inversion Crossplot

From Well Data



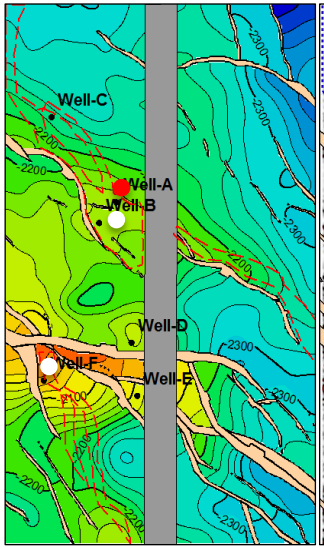
From Inverted Data



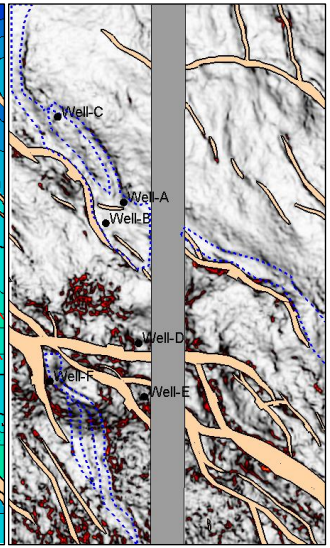


Discussion

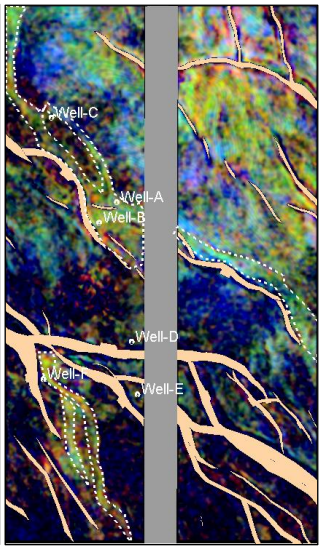
Structural Map



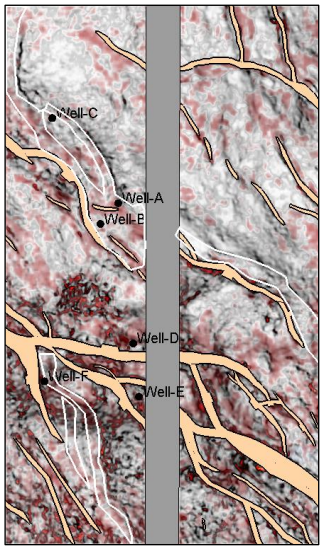
Semblance



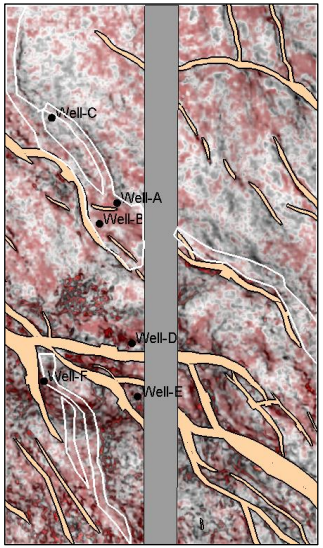
Spectral Decomposition



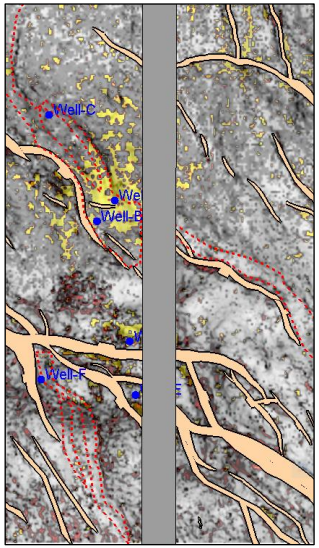
AVO projection -47°



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).

Acknowledgement

Mr. Ali Khairy (Bapetco Exploration General Manager) **Dr. Ali Bakr** (Regional Work Flow Consultant PG, Shell Egypt N.V.)

Mr. Amgad Rashwan (Bapetco Drafting General Manager)

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