



## Implementation of AVO, AVOAz Inversion and Ant Tracking Techniques in Wembley Valhalla Integrated Merge 3D Seismic Survey, Alberta

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### Introduction:

The Wembley Valhalla 3D survey consists of multiple independent 3D surveys of different vintage merged together to form one continuous survey, Figure 1. AVO and AVOAz inversions as well as Ant Tracking workflows were used over Wembley Valhalla (WV) merged seismic survey to produce various seismic attributes and elastic properties.

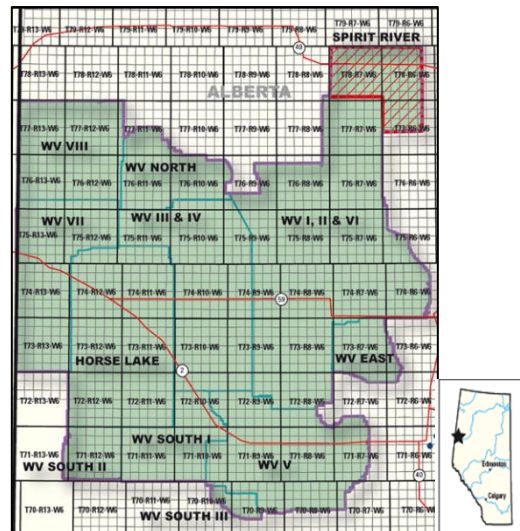


Figure 1, WV Merged Survey Outline

In this study, we performed AVO inversion using two different optimization algorithms, Simulated Annealing (SA) and Gradient Based Optimization (GBO) and observed that GBO outputs were superior. We also cross-checked Shear Velocity Anisotropy, derived from AVOAz Inversion, with Ant Tracking outputs. Shear Velocity Anisotropy is an attribute sensitive to fractures, on the other hand Ant Tracks reveals bigger scale discontinuities embedded in seismic data. We demonstrated that in WV seismic data these two attributes correlate with each other.

### Simultaneous AVO Inversion:

Inversion of reflection coefficients extracted from amplitudes of seismic waves can provide estimates of significant reservoir parameters [1]. The superiority of Simultaneous AVO inversion technique over separate elastic inversion have been well documented, Figure 2.

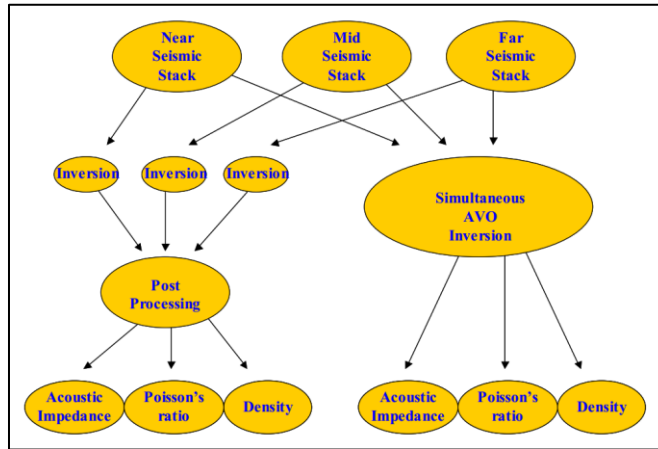


Figure 2, Separate Elastic Inversion vs. Simultaneous AVO Inversion [1]

In Simultaneous AVO Inversion all the seismic data, from different angle stacks, are simultaneously inverted for elastic properties. In this study, we used Aki and Richards approximation to the Zoeppritz to run Simultaneous AVO inversion. We tested two global optimization algorithms, simulated annealing (SA) and Gradient Based Optimization (GBO). The goal of optimization is to find a global minimum of the objective function, Figure 3-4, which includes the misfit between synthetic and observed prestack seismic [2]. We compared the results from the both optimization engines and observed that the GBO produced better solutions for the WV seismic datasets (Figures 5-7).

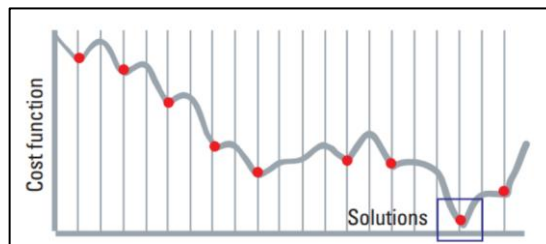


Figure 3, role of global optimization to minimize cost function [3]

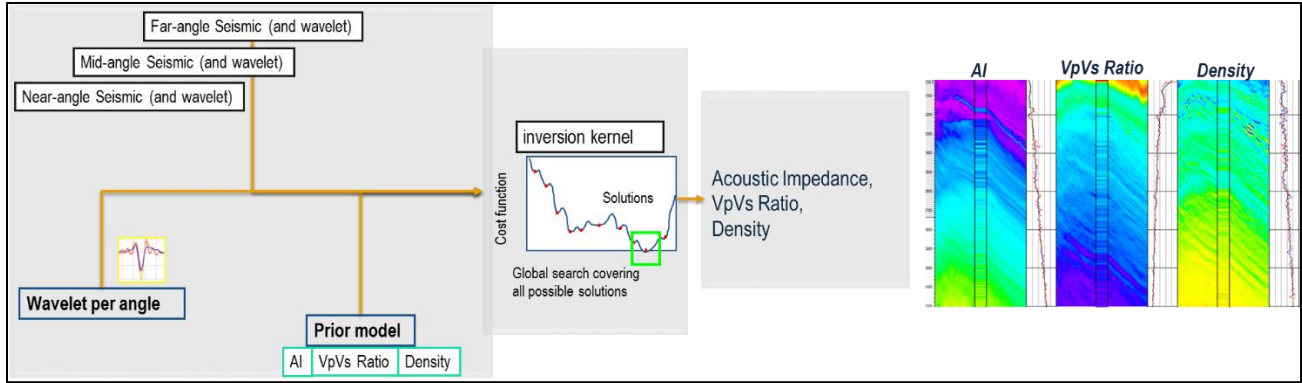


Figure 4, Simultaneous AVO Inversion Workflow [3]

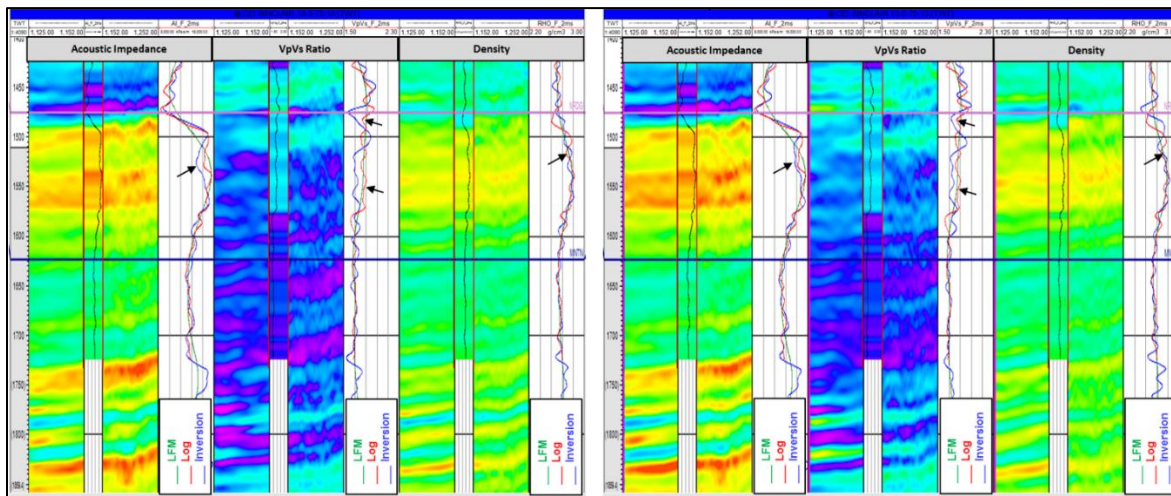


Figure 5, Simultaneous AVO Inversion results demonstrated at one well; SA Global Optimization (left), GBO Global Optimization (right)

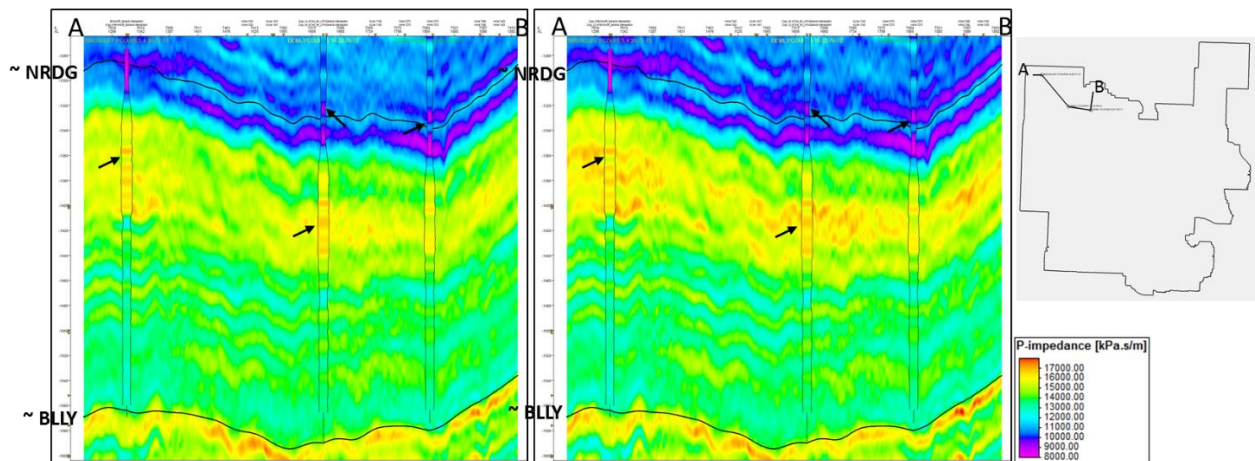


Figure 6, Arbitrary Line from Acoustic Impedance; SA Global Optimization (left), GBO Global Optimization (right)

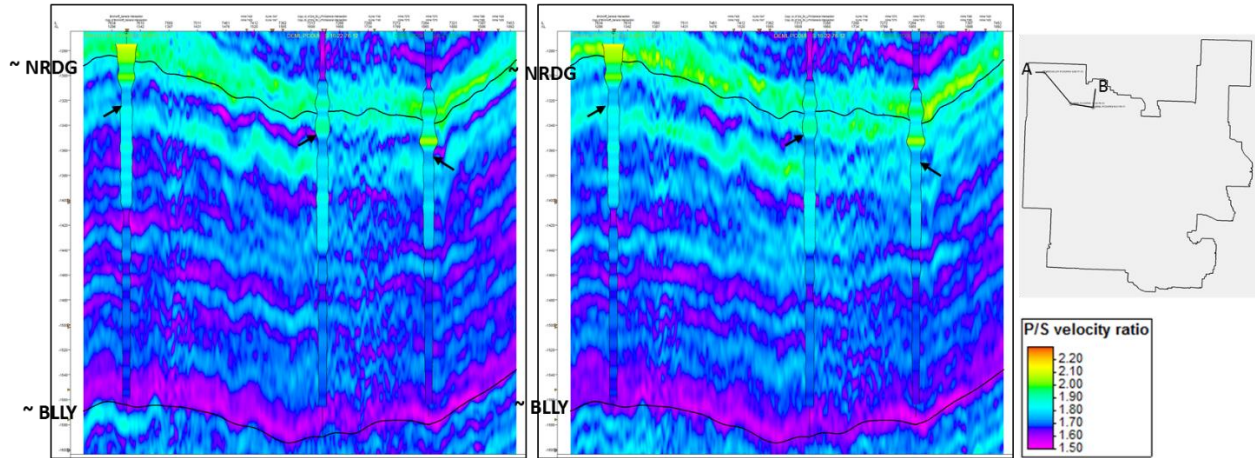


Figure 7, Arbitrary Line from VpVs Ratio; SA Global Optimization (left), GBO Global Optimization (right)

**AVOAz Inversion and Ant Tracking:**

In addition to the AVO inversion, we also performed AVOAz inversion and Ant Tracking workflows. We then used the AVOAz results to produce Shear Velocity Anisotropy. Shear anisotropy, an indicator of micro scales natural fractures, was cross-checked with Ant Tracking results which is more sensitive to meso and macro scale fractures, Figures 8-9. We observed that these two attributes correlate with each other.

	Geological Features	Seismic Observations	Data Analysis
Micro-Scale	Diffuse Fractures	Seismic Anisotropy	Anisotropy Analysis & Inversion
Meso-Scale	Fracture Corridors	Subtle Discontinuities & Scattering	Fracture Cluster Mapping
Macro-Scale	Faults	Truncated Horizons	Ant Tracking, Fault Transmissivity

Figure 8, Manifestation of different scales geological discontinuities in seismic [3]

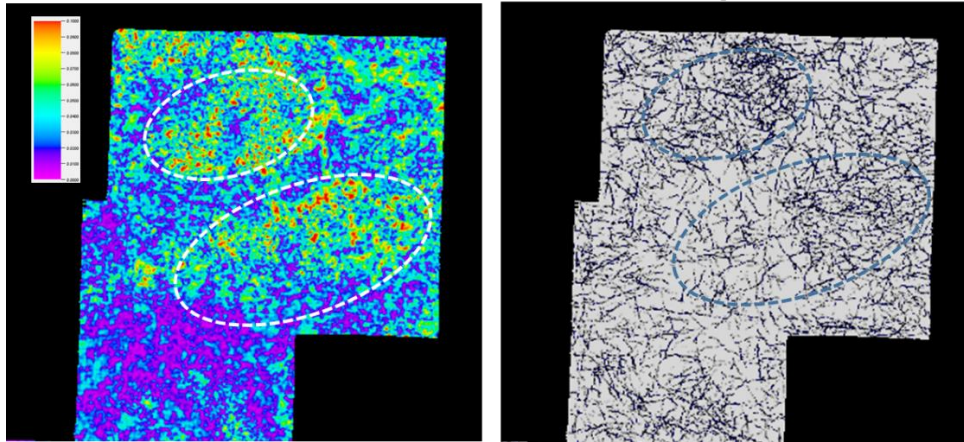


Figure 9, Horizons slice from Shear Velocity Anisotropy (left) and from Ant Tracks (right)

## Conclusions

We demonstrated that AVO inversion results benefiting from GBO optimization algorithm were superior than SA optimization results. We also observed that Shear Velocity Anisotropy, from AVOAz inversion, and Ant Tracks, both indicators of discontinuities that are embedded in seismic, correlates with each other.

## Acknowledgements

We are thankful to WesternGeco Multiclient for their permission to present this work.

## References

- [1] Kim Gunn Maver and Klaus Bolding Rasmussen, Simultaneous AVO Inversion for Accurate Prediction of Rock Properties, 2004
- [2] Xin-Quan Ma, Simultaneous inversion of prestack seismic data for rock properties using simulated annealing, 2002
- [3] Schlumberger Internal and External Material