AVO Interpretation – Fluid Factor, Rock Physics, and Scenario Modeling

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Summary

Amplitude Versus Offset (AVO) analysis is a critical tool for seismic interpretation, offering valuable insights into subsurface fluid content and rock properties. This talk will start with historical perspective followed by a focus on interpreting the fluid factor, an essential attribute for distinguishing between lithology and fluid effects. We will then explore the role of rock physics modeling in linking seismic responses to reservoir properties, emphasizing how porosity influences AVO behavior. Additionally, we will discuss the relationship between AVO classes and porosity, providing a framework for understanding variations in seismic amplitude with changes in rock properties.

AVO Application and DHI:

The term AVO (Amplitude Variation with Offset) is often associated with Direct Hydrocarbon Indicators by the general audience (end users of AVO products). While DHI is a specific type of anomalous AVO changes often related to the presence of hydrocarbons in pore spaces, AVO occurs in all seismic data and is influenced by factors such as lithology, impedance contrast, porosity, anisotropy, and fluids. Additionally, if inverted through controlled calibration, it can be used to predict many rock properties.

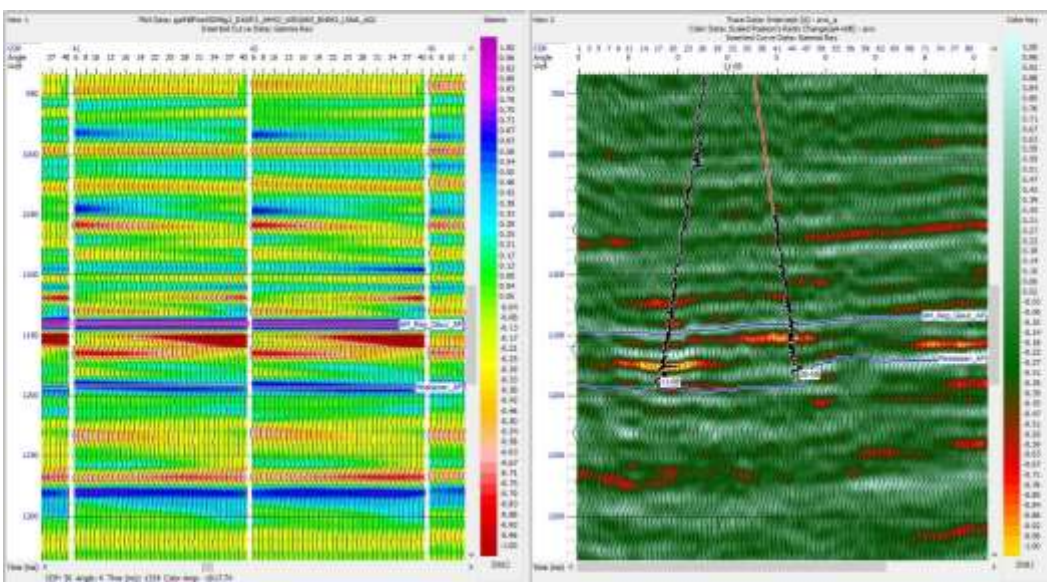

Figure -1: Oil and gas bearing channel systems within Lower Mannville. The fluid factor derived from Intercept and Gradient showing Class III anomalies produced by low impedance sand (Blackfoot 3D Data courtesy of CREWES)

To enhance the interpretability of the pre-stack seismic data and AVO signature, it is recommended to generate fluid and porosity varying synthetic models and compare them to the gathers.

AVO Pitfalls:

We fail more often than we are willing to accept. There is no such thing as quick AVO without looking at all the steps of data processing and understanding the geological context. Unfortunately, the problems with the gathers are often buried deeply in processing that could be very hard to remove in post-processing steps.

As described and explained very well by many esteemed AVO practitioners, following are few of the pitfalls to watch for:

- Flat gathers
- Poor Offset Scaling
- Offset Spectral Balancing
- Offset to angle relationship
- Truncation Bias
- Anisotropy
- Moveout Correction
    - NMO Stretch
    - Offset Tuning
- Random Noise
- Coherent Noise
    - Multiples
    - Mode Conversions
    - Residual Noise

Case Studies: To illustrate these concepts in real-world settings, we will examine case studies from various geological settings worldwide, highlighting how AVO analysis responds to different lithologies, porosity variations, and fluid types. These examples will showcase both the successes and challenges of AVO interpretation across diverse basins, demonstrating the practical impact of rock physics principles in exploration and reservoir characterization. The session will conclude with a discussion of common pitfalls in AVO analysis and best practices for reliable interpretation.

Conclusions

We will present a re-cap of the AVO/QI practices as being implemented in the industry and its continued advancements. Progress requires understanding of the basics and avoiding the pitfalls in the application of the theory.