Characterising Pay Sand in Basin Floor Channel Complexes using Cognitive Interpretation workflows – a case study from Deep Water Sabah

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Introduction

Sand body delineation remains a challenge in proximal basin floor channel complexes due to the geomorphological complexity. Using Cognitive Interpretation (CI) workflows in combination with Quantitative Interpretation (QI) techniques allowed an interpretation of the pay sand distribution with a higher confidence and reduced uncertainty.

Conventional reservoir mapping in the basin floor settings is a challenge due to the uncertainty of the reservoir horizon interpretations. The use of a Cognitive Interpretation workflow, which is independent of the accuracy of the horizons, produced a higher confidence and more objective result on the characterisation of reservoir intervals.

This workflow was applied to the Sabah deep water project, and the results were used to decide the optimum well location.

Methodology

The Cognitive Interpretation workflow (Paton & Henderson, 2015) involved data conditioning, frequency decomposition and extraction of geobodies. The geobodies were then populated with QI proprieties (P-Impendance and Vp/Vs) in order to characterise the pay sand.

The data conditioning workflow applied post-stack structurally oriented and edge preserving noise cancellation algorithms, including the SO FMH (Structurally Oriented Finite impulse Median Hybrid) filter, which improved the continuity of the reflectors and increased the signal-to-noise ratio.

Different frequency decomposition and RGB blending approaches were tested in the dataset, including algorithms based in Fast Fourier Transform, Continuous Wavelet Transform and modified Matching Pursuit. The modified High Definition Frequency Decomposition (HDFD), which is based on a modified Matching Pursuit algorithm, was chosen as the optimal, due to the optimised vertical resolution of the method.

The geomorphology of the basin floor channel complex was extracted from the HDFD RGB blend using the Adaptive Geobodies technology. This technique uses a data-driven interpreted-guided approach to extract a 3D representation of the channel complex from the HDFD RGB blend. As the HDFD blend has an optimised vertical resolution, the extracted geobody preserved the vertical resolution and produced an accurate representation of the channel complex.

P-Impedance and Vp/Vs volumes were generated using Simultaneous AVO Inversion of partial stack seismic. A rock physics analysis was conducted and it showed that the pay sand can be discriminated from the non-pay sand by using a P-Impedance vs. Vp/Vs cross-plot.

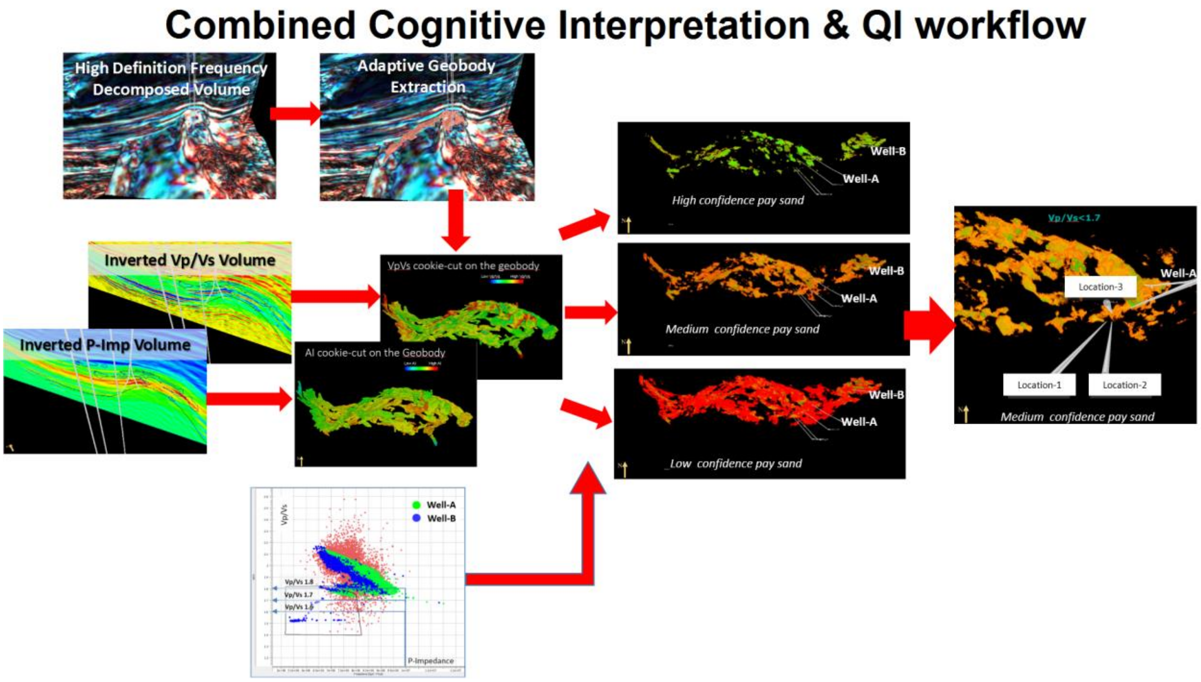

Figure 1 *Combined Cognitive Interpretation & QI Workflow as applied in the Sabah Deep Water Project. This workflow shows the High Definition Frequency Decomposition and Inverted P-Impedance and Vp/Vs volumes which were integrated in 3D space to constraint the pay prediction within the proximal basin floor channel complexes.*

In order to produce a pay sand prediction that honours the geomorphology of the proximal basin floor channel complex, the inverted volumes (P-Impedance and Vp/Vs) were embedded inside the geobody extracted from the HDFD RGB blend. The rock physics knowledge from calibrated wells was used to produce a fully volumetric pay sand prediction from the embedded inverted volumes. As part of a sensitivity analysis into the confidence level, three different P-Impedance and Vp/Vs cut-off values were used to produce three different cases with different degrees of confidence.

Result

The workflow produced predicted pay sand volumes that honour the geomorphology of proximal basin floor channel complexes and are independent to the input horizons. The results of this analysis have allowed geologists and geophysicists to select the optimum well location for the next drilling campaign. Selection of optimum well locations was based on the penetration of well into the predicted pay sand body, that fits with the stratigraphic and structural trap.

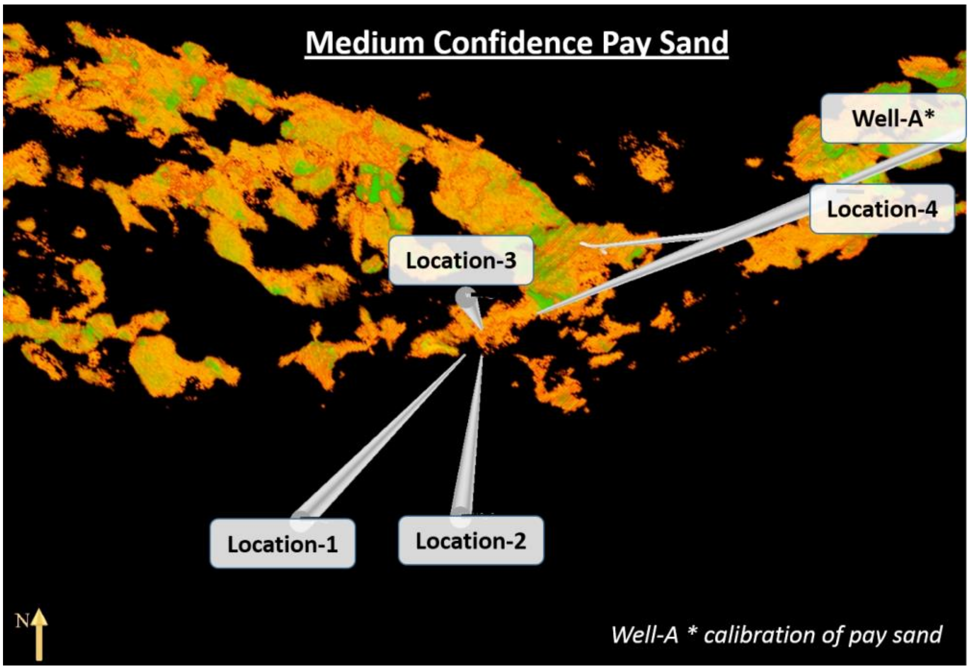

Figure 2 *3D Volume View of Medium Confidence Pay Sand and Well Drilling Location. Four well locations were supplied by the project team based on seismic attributes only. Through integration of seismic geomorphology and AVO inversion products, Location-3 was selected as the optimum drilling location.*

Conclusion

The combined Cognitive Interpretation & Quantitative Interpretation approach successfully demonstrated that a high confidence quantitative analysis and interpretation in a proximal basin floor channel complex can be achieved through data integration in 3D space.

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References

Avseth, P., Mukerij, T. and Mavko, G., 2010, Quantitative Seismic Interpretation, Applying Rock Physics Tools to Reduce Interpretation Risk: Cambridge University Press, 96-101.

Brown, A. R., 2004, Interpretation of Three-Dimensional Seismic Data - Sixth Edition: AAPG Memoir 42, SEG Investigation in Geophysics, No. 9, 153-194.

Fugro-Jason, 2012, Introduction to Simultaneous Inversion: Jason 8.3, 300-301.

McArdle, N.J and Ackers, M.A 2012, Understanding seismic thin-bed responses using frequency decomposition and RGB blending. First Break, 30, 57-65.

Paton, G. and Henderson, J., 2015, Visualization, interpretation, and cognitive cybernetics. Interpretation, 3, 41-48.