Case Studies Highlighting Tight Sand Reservoir Characterization from the Interpretation of AVO - Inversion Techniques

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Summary

The thin inter-bedded coals, sandstones and shales of the Early Cretaceous Mannville Group can be difficult to map with conventional 3D seismic data. Modern technologies, such as amplitude versus offset (AVO) and inversion have been used and proven to be very successful. The drilling results based on interpretation of the new data have been strongly encouraging. This presentation will outline the processing and interpretation workflow of the project and present a total of three Falher and Cadomin case studies.

Method

The input for the AVO and inversion process was prestack migrated AVO compliant gathers. Firstly deterministic inversion was tested. Results from separate inversion of the AVO attributes, P- and S-wave impedance reflectivity, were compared with the prestack inversion volumes. This inversion analysis used low-frequency models (for P- and S-wave impedance and density) based on well control. Because three-term AVO analysis methods were not applicable with this data, prestack inversion was used to derive the density volume. Secondly, neural network analysis was used to refine and focus the results from deterministic inversion. These new estimated seismic volumes (P- and S-wave impedances and density) compared very well with the well log data and were used to derive other physical properties such as incompressibility (Lambda-Rho) and rigidity (Mu-Rho).

The final interpretation workflow of these volumes began by picking key horizons from the P- wave reflectivity volumes. The horizons themselves derived very accurate maps and were then used to extract different attributes from key rock property volumes. The resulting maps were then tied back and "ground-truthed" to the well control.

Examples

Qualitative comparison of the progression of the workflow will be shown as case studies of multi-zone vertical wells highlighting the Cadomin Formation. A comparison between a 4 well program based on geological mapping will be made to a 5 well program integrating the new interpreted seismic attributes. Two examples of these interpretation techniques leading to the drilling of horizontal wells within a Falher sand body will also be discussed.

Conclusions

By adding AVO and inversion analysis to our geophysical workflow we have demonstrated:

- thin coals layers can be clearly identified, eliminating a key risk factor in reservoir identification;
- the Cadomin Formation can be mapped and correlated with geology and production;

- the Phi-h prediction of prospective zones can be improved;
- high grading well locations to penetrate "sweet spots";
- new opportunities were identified and successfully exploited.

Acknowledgements

References

Dumitrescu, C. C., Mayer, . R. Couzens R., 2009, Exploration of Lower Cretaceous sands in the Leland Area, Alberta, using seismically derived rock properties: First Break, Vol. 27, p. 53-60.

Goodway, W., Chen T., and Downton J., 1997, Improved AVO fluid detection and lithology discrimination using Lame petrophysical parameters; 'Lambda-Pho, Mu-Rho" and "Lambda/Mu stack", from P and S inversion. CSEG Annual Meeting, Abstracts, p. 141-151.

Russell, B, 1998, AVO Workshop, Hampson-Russell (a CGGVeritas Company