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Rock Physics and Inversion Case Study of Lower Mannville Lithic Channel - an Interpreter Perspective

Darren Kondrat, Rockyview GeoServices Inc., Valentina Baranova, Azer Mustaqeem, Petro-Explorers Inc.

Summary

Identifying Lower Mannville Lithic channels is challenging, it requires tight integration of geology and geophysics. Rock Physics interpretation yields insight into lithology and porosity changes that are essential to exploit oil and gas reserves within complex geological settings. Our workflow includes a dynamic quantitative solution as a part of a complete interpretation.

Introduction

The Mannville Group comprise the oldest Cretaceous rocks over most of the Western Canada Sedimentary Basin and represent a major episode of subsidence and sedimentation following a long period of uplift, exposure and erosion of older strata.

In this study, a Central Alberta Lower Mannville estuarine system is analyzed using Rock Physics in LMR crossplot space. Pre-stack Simultaneous Inversion is used to derive the Lamda and Shear moduli from 3D seismic data and a new interpretation integration workflow is applied.

Theory

Goodway, 1999, introduced the application of Lame's modulii in the identification of lithology and fluid parameters within any reservoir. The complex lithology within the productive fairways of Lower Mannville system requires a very close look at parameters that can help classify the facies association.

Lambda-Rho vs Mu-Rho crossplot with interactive facies modeling is applied in conjunction with post stack seismic interpretation and geological modeling to achieve a detailed geological model of incised valley and channel fill properties of Lower Mannville strata.

Examples

Lower Mannvile channel fairway consists of various tributaries, floodpains, estuarine fills and fluvial cannibalism. This creates a complex geological system that makes mapping reservior details like porosity using existing wells very difficult.

The post-stack seismic interpretation has often targetted the zone of interest using detailed interpretation and extensive well ties. Mapping isopachs and amplitude changes provide additional informationt to map incised valley fairways.The outcome of the new wells based on these interpretations is sometimes surprsing as the erosion of existing channels or diagenetic changes in estuary fill are difficult to interpret. As an example, the seismic signature of the shale fill in regional versus the porosity filled channel within an estuary may yield similar amplitudes on the seismic.

Extensive geological and geophysical work was carried out at the time we started looking at the quantitative approach. The first step was to create shear data for wells without dipole logs using an existing shear log from a well in the area as a template. Vp, Vs and Density are required to generate models of the gathers. The synthetic models provided us with the attributes that we should see in the seismic gathers.

Processing for prestack inversion requires additional attention to the gathers. The gathers need to be conditioned in order to come up with the cleanest possible flattened primary response. The synthetic gathers were used to QC the seismic gathers at each well location. A significant improvement was obtained to the processing for amplitude preservation.

Pre-stack simultaneous inversion allowed the derviation of Zp, Zs and Vp/Vs attributes. Although density information was inverted, it will not be used in the lithology determination due to its low certainty.

Lambda-Rho and Mu-Rho were derived using log data.The log data showed distinct separation of esturine regional and lithic facies while separating shales, coals and carbonates. Seismic Lambda-Rho and Mu-Rho derived from seismic inversion is then calibrated with well data using cross-plots. Cross-plot interpretation is a dynamic process and it is adapted and tweaked as we go through each well in a similar way as tieing a synthetic to your stacked data. Interpreting the crossplot requires a througouh undstanding of the local geological setting and is best done with the geologist and geophysicist working closely together. Slight movement of the facies boundaries in the crossplot can show signifcant changes to the image of the reservoir. Understanding the robustness of your reservoir is a critical part of the interpretation. The interpretation of the facies in the crossplot domain is not static and should be updated as new data is obtained or further details of the play are understood.

Conclusions

Applying Rock Physics to a Lower Manville lithic channel provides additional reservoir details over conventional seismic interpretation. Integration of Rock Physics, along with a post stack interpretation and detailed geological mapping revealed facies model that explained most of the perplexing complexity within the Lower Mannville channel system.