3D Reservoir Characterization in the Grand Rapids

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Introduction

The Grand Rapids Formation has not received as much attention as the McMurray with respect to recent oil sands exploration and development activity. Nevertheless, industry has recognized the considerable potential in the clean shoreface sands of this formation in the Wabasca area of northeastern Alberta and several operators have identified viable projects in the area. Laricina Energy holds a total of 63 sections in the fairway with an estimated 2.5 billion barrels of bitumen in place. The Grand Rapids zone is divided broadly into lower, middle and upper reservoir units capped by the Joli Fou shales. The upper unit containing the bitumen resource ranges from 15 to 30m gross thickness. Net bitumen pay thickness ranges from 8.5 to 23.7m with average bitumen saturation of 70 percent or 11.6 weight percent bitumen.

The upper Grand Rapids shoreface sand is regionally extensive, clean and homogeneous with very rare mud interbeds and occasional thin, discontinuous high density concretions. The key aspects and concerns in the SAGD development of the Grand Rapids bitumen resource include clearly identifying the porosity base, the bitumen-water contact and any impedance to vertical permeability. To address these issues, a detailed 3D reservoir characterization was required. This paper will describe the process of integrating core, log and 3D seismic data in the Germain area to produce a volume of deterministically derived lithology and fluids within the reservoir.

Method and Results

Wireline logs directly (or indirectly) measure P-wave velocity, S-wave velocity and density. From these measured logs, the rock physics attributes lambda (incompressibility) and mu (shear rigidity) can be calculated. Cross-plot analysis of these and various other attributes leads to empirical limits and guidelines for lithology and fluid discrimination based on core facies. Figure 1 is a cross-plot of density vs mu*density calculated from well logs in the Grand Rapids zone with the points coloured by core facies. It clearly shows the clustering and separation of different facies in this domain. The relationships between attributes and facies determined from the cross-plots are then used to calibrate and classify the equivalent properties derived from seismic data.

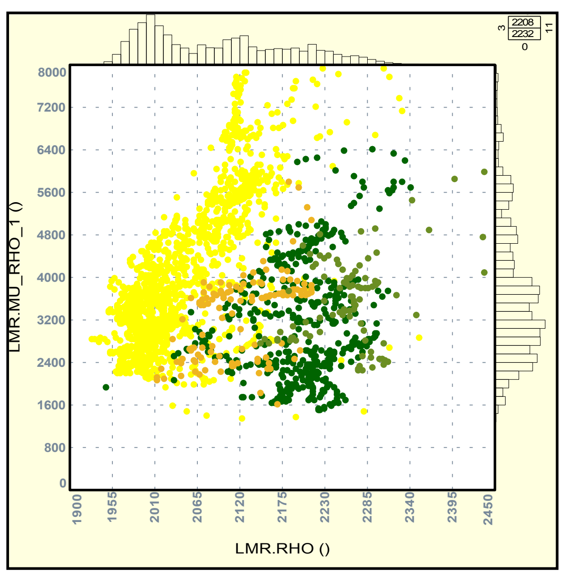

Figure 1: Log density vs mu*rho with points coloured by core facies.

The seismic process involves the use of AVO (amplitude vs offset) analysis to separate the compressional (P-wave) and shear (S-wave) components of the seismic data. The resulting components are used to calculate the physical rock properties through inversion and multi-attribute analysis. When these attributes are classified based on the log and core analysis, the result is a seismic volume transformed to a detailed lithological characterization of the reservoir within the zone of interest. Figure 2 is an example portion of a line through the 3D classified by this method. Gamma ray logs are shown at the two wells intersecting this profile.

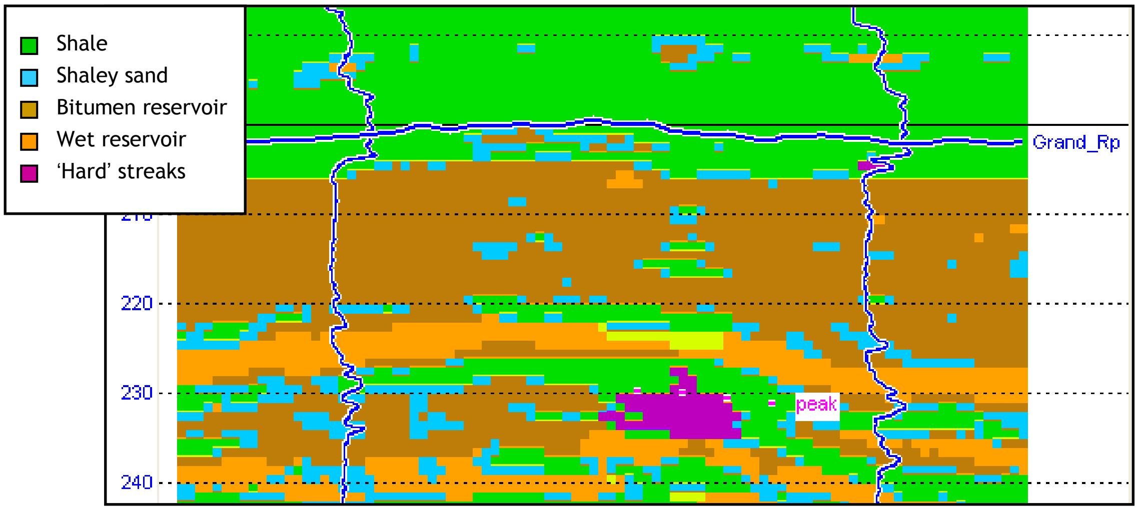

Figure 2: 3D profile through two wells in the project area. The colours represent lithology and fluids.

Applying this process in the Germain area provided Laricina geologists and engineers with the information required to make decisions regarding important SAGD issues such as the presence and location of barriers to vertical permeability, base of pay and bottom-water thickness. Consequently, future evaluation and horizontal drilling can be planned more effectively and with greater confidence.

Acknowledgements

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References

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