Application of Rock Physics to an Exploration Play:
A Case Study from the Brazeau River 3D

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Introduction

The ultimate goal of any Rock Physics analysis is to gain insights into the physical properties of a reservoir. These can be bulk properties such as lithology, porosity, and permeability, or dynamic properties like fluid content or pressure. A geophysical Rock Physics analysis makes use of the measured elastic properties from seismic data to generate attributes that yield information about the reservoir rocks. There are, however, several other sources of Rock Physics information that can and should be used to assist the analyst's understanding of the study area. These other sources can be petrophysical, geophysical, and/or geological in nature. Examples include wireline logs, mudlogs, core, DST/RFT pressure and fluid analyses, VSP, and checkshot surveys. Ultimately, the more tools we use to assist in our understanding of the reservoir, the more we reduce the risk associated with an exploration/exploitation undertaking. This presentation uses a case study from the Brazeau River 3D to illustrate how the integration of a petrophysical analysis not only augmented, but actually directed the course of a successful geophysical analysis.

Model For An Ideal Petrophysical Workflow

Performing a petrophysical analysis prior to a geophysical analysis has many benefits. From wells logs we can a) determine which seismic attribute(s) are most diagnostic (sensitive) to solving our project goals; b) predict, and ultimately verify, expected seismic responses (i.e. calibration); c) perform forward modeling (e.g. Gassmann fluid substitutions); d) provide quality control by editing, reconstructing, and/or estimating well logs for seismic inversions and phase analysis; and e) understand the regional geology to design the optimum geophysical analysis workflow.

Study Area & Goals

The study area is a subset of the Brazeau River 3D Seismic Survey (Figure 1). For the Rock Physics Analysis two targets, one clastic and one carbonate, were identified. The clastic target was the Viking sand interval with the project goal to identify the fluid content. The carbonate target was the Nisku formation where lithology differentiation would be the key to success. Good well control was available in the area with wells penetrating both the Viking and Nisku intervals.

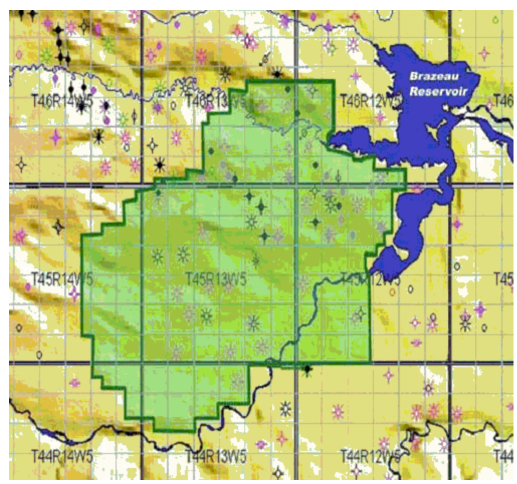

Figure 1: Brazeau River 3D

Case Study Workflow

The petrophysical analysis workflow consisted of: a) log edits and reconstructs as necessary; b) standard formation evaluation; c) lithology driven shear estimation for missing shear sonics based on local Vp/Vs trends for sand, shale, and carbonates; d) calculation of AVO and Rock Property attributes; and e) attribute interpretation. The petrophysical "feasibility" study was instrumental in providing a roadmap to focus the geophysical study. The geophysical work then proceeded with the a) extraction of the pre-stack information through various AVO methodologies; b) inversion of these AVO products to convert the reflectivity attributes into layer properties; c) calculation of Lamé parameters (LMR^{TM}) attributes; d) cross-plotting and interpretation, and e) calibration/comparison with the petrophysical results.

Petrophysical Analysis – Viking

From standard formation evaluation, the Viking interval is a silty sand package (often conglomeratic at the base) with an overall thickness of approximately 15 meters and reservoir-quality sand thicknesses often much less. We used blocked compressional velocity (Vp), shear velocity (Vs), and density logs over the target sand to create half-space, or interface models, to predict the expected seismic response. These half-space models show how the seismic amplitudes behave as a function of angle of