Early Project Seismic Application at the Ells River Heavy Oil Project – Maximizing the Value of VSP and Well Data

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Summary

The Ells River Project is a Chevron-operated in situ heavy oil project in an early pre-development phase. The first season of delineation drilling was completed during the winter of 2007. No seismic data was acquired during the initial drilling season and little trade seismic data was available over the area. The first delineation program included a geophysical logging program with dipole sonic logs recorded in a dozen wells, and zero-offset and offset VSP surveys acquired in two wells. The objective of these geophsyical programs was to evaluate the potential for PP conventional and PS converted wave seismic data for characterizing crucial Ells River geologic uncertainties - thickness of bitumen sands, extent of a thin gas cap, vertical and areal continuity of the bitumen sands and muddy heterogeneities. A test multicomponent seismic program was planned for winter 2008 and we hoped to use the multicomponent VSP anaylsis to help justify the program.

Geophysical well log data results were consistent with many other previously published Athabasca oil sands geophysical work (Bellman, Gray, Dumitrescu) – compressional and shear sonic velocities are poor discriminators of lithology, but density has a good correlation to gamma ray and thus lithology or log based electro-facies. While density is the best geophysical parameter for discriminating lithology, it is technically challenging to extract and results have significant uncertainty. Ultimately, a solution for density is our goal; but similarly to Bellman (2007) we found that the Lamé petrophysical parameters of Mu-Rho and Lambda-Rho appear to provide a good starting point for estimating lithology and fluid fill.

The upgoing energy from the offset VSP survey provides near wellbore PP and PS reflection data that can be used to create mini-seismic sections. While these data are not true zero-offset seismic sections, they can provide small PP conventional and PS converted wave seismic sections of common subsurface reflection points. These two data sets are inverted to P and S impedance respectively and then to Lamé parameters of Lambda-Rho and Mu-Rho. These traces are then transformed into facies predictions using the log-derived transforms. We also calculate the associated uncertainty in the facies prediction. These VSP based lithology sections were better than we expected and provided definite insights into the potential benefits using multicomponent

seismic data specifically in the Ells River area. These results supported our decision to proceed with a 2008 test 3D 3C seismic program at Ells River.

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References

Bellman, L.W., 2007, Oil Sands Reservoir Characterization-A Case Study at Nexen/Opti Long Lake: CSEG Technical Abstracts.

Dumitrescu, C et al., 2003, PS and PP AVO Analysis: A Multi-component Seismic Case Study for the Long Lake Oil Sands Project: CSEG Technical Abstracts.

Goodway, W., Chen, T., and Downton, J., 1997, Improved AVO Fluid Detection and Lithology Discrimination Using Lame Petrophysical Parameters; “Lambda*Rho”, “Mu*Rho” and “Lambda/Mu Fluid Stack”, From P And S Inversions: 67th Annual International Meeting, SEG Expanded Abstracts.

Gray, D., 2003, P-S Converted-Wave AVO: CSEG Technical Abstracts.

Gray, D., Anderson, P., Gunderson, J., 2006, Prediction of Shale Plugs between Wells in Heavy Oil Sands using Seismic Attributes: Natural Resources Research, 15,103-109.

Margrave, G.F., Stewart R.R., and Larsen, J.A., 2001, Joint PP and PS seismic inversion: The Leading Edge, 20, 1048-1052.