Rosemary 3C3D: An AVO, VSP and Converted Wave Case Study

Brian Rex, John Parkin, Connie McLaren - PanCanadian Energy*

CSEG Geophysics 2002

Abstract

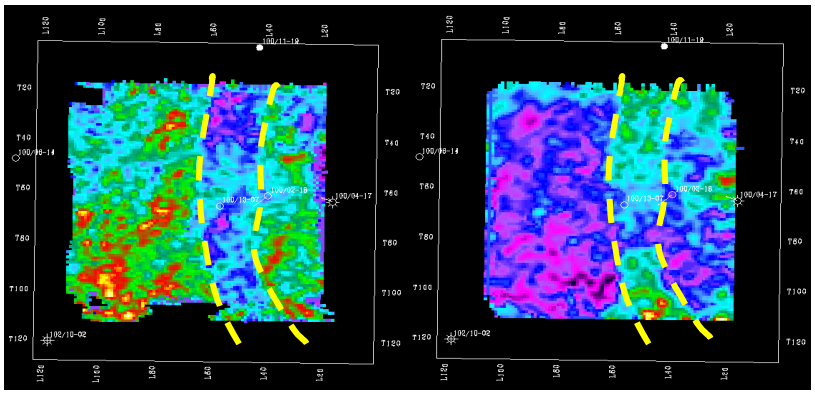
Conventional 3D seismic methods have been used with great success in the plains of Southern Alberta. Rising commodity prices and advances in technology have given explorationists the opportunity and perhaps the curse to examine formerly non-economic trends. The challenges of irregular porosity distribution and determining fluid content have been addressed by innovative work in AVO and multi-attribute analysis. Despite an appreciation of the potential for shear wave information, interpreters rarely use converted wave data as part of their exploration strategy. This case study illustrates how VSP calibrated PS data will compliment PP AVO techniques to reduce risk in high volume drilling programs.

The Rosemary Study Area in Township 21 Range 15 contains play types common to conventional Cretaceous exploration in Southern Alberta. The goal of the exploration program was to continue the exploitation of two well understood and regionally extensive channel trends. The younger of the two trends is a gas prone channel, incised into the top of the Mannville package at Basal Colorado level. The older feature, a regionally extensive lower glauconite incised valley is oil prone and lies dangerously close to the strong reflector at the Mississippian unconformity. The gas charge in the Basal Colorado / Upper Manville valley system is often identifiable on conventional seismic and provides a useful verification of the converted wave interpretation. The Glauconite valley system has an unpredictable porosity distribution that is difficult to identify. The difficulty of successfully exploiting this trend with AVO attribute analysis suggests that the future of this reservoir may lie in the shear response.

The PanCanadian Energy Ltd. 2001-exploration program at Rosemary was founded on a 27 square mile conventional 3D survey. A four-section subset of the survey area was selected for the 3C trial study. To calibrate the converted wave study, VSP data was acquired in one of the wells that encountered both valley systems. The VSP program consisted of conventional near and far offset surveys as well as a zero offset pure shear survey acquired with shear wave mini-vibrators. The offset VSP provided converted wave data, unattenuated by near surface effects while the pure shear survey provided an accurate control on the shallow Vp/Vs. This Vp/Vs or gamma ratio is critical for processing and interpreting converted wave data. Without an accurate estimate of gamma it becomes very difficult to correlate the primary section to the low frequency converted wave response recorded at the surface.

We are fortunate to have a gamma value that remains near 2 for many exploration targets in southern Alberta. Under these conditions the converted wave response reliably approximates the zero offset shear response from the shear log synthetic. Unfortunately this is not the case for shallow targets where our VSP control is suggests that the VP/VS exceeds 4.

The value of converted wave data is well documented for high profile reservoirs affected by gas clouds or weak subsalt reflectors. Those applications do not address the exploration problem at Rosemary of highlighting porosity and permeability in thin and heterogeneous reservoirs. The inability of P-wave data to distinguish between a gas charged reservoir and a wet reservoir with small gas accumulations is due to the large effect that trace gas has on the overall compressibility of the medium. This study suggests that the shear amplitude response is relatively unaffected by fluid in the pores and more directly reflects changes in density and porosity in the reservoir. This independent information can be used along with conventional seismic for a more complete interpretation.



P-P Glauconite Channel response *P-S Glauconite Channel Response*

References

Aki, K., and Richards, P.G., 1980, *Quantitative Seismology:Theory and Methods*, W.H. Freeman and Co., San Francisco, 932 pp.

Batzle, M., and Wang, Z., 1992, *Seismic properties of pore fluids.* Expanded Abstracts, Soc. Expl. Geophys., 2001 annual meeting

Gassman F,1951 "Elastic waves through a packing of spheres: Geophysics 16, 673-685.

Goodway, W., Chen, T., and Downton, J., 1997, *Improved AVO fluid detection and lithology discrimination using Lamé petrophysical parameters; □□, μ□, & □/μ fluid stack, from P and S inversions*: 67th Ann. Internat. Mtg., Soc. Expl. Geophys., Expanded Abstracts, 183-186

Mavko, G., and jikba, D., 1991, Estimating grain-scale fluid effects on velocity dispersion in rocks. Geophys.,**56**, 1940-1949.

Zaengle, J.F. and Frasier, C.W., Correlation and Interpretation of P-P and P-SV Data Zamora Gas Field, Yolo County, California. Expanded Abstracts, Soc. Expl. Geophys., 2000 annual meeting