Prestack seismic analysis of the Rangeland Basal Belly River gas pool, Twp. 38 R 20 W4 Alberta

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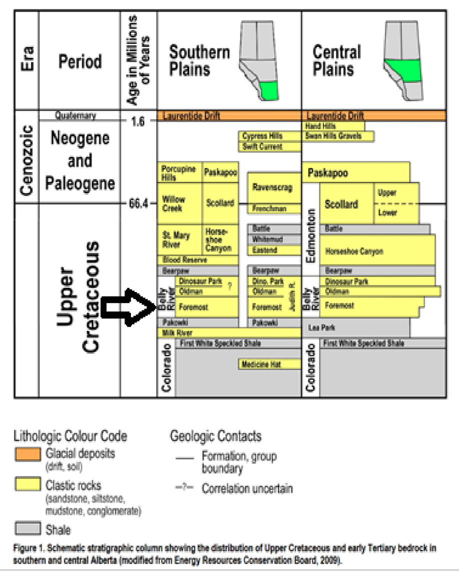
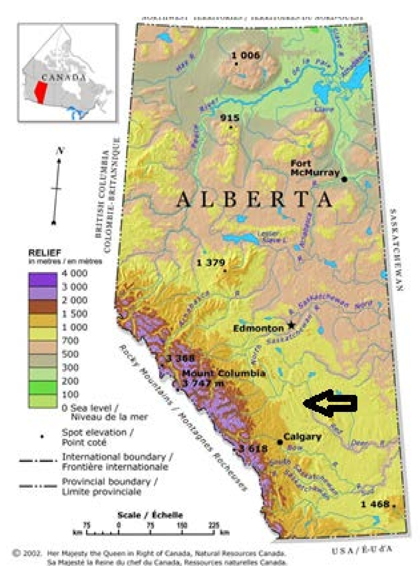
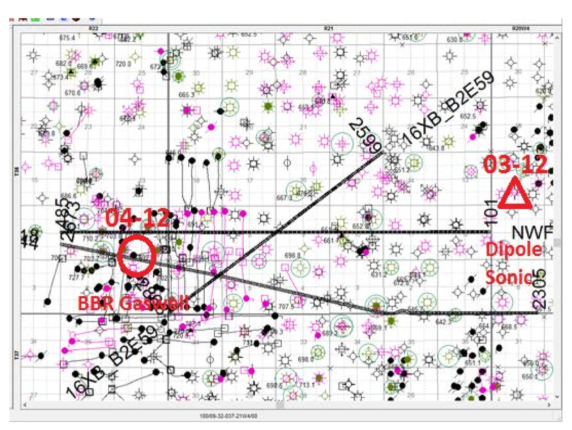
ABSTRACT

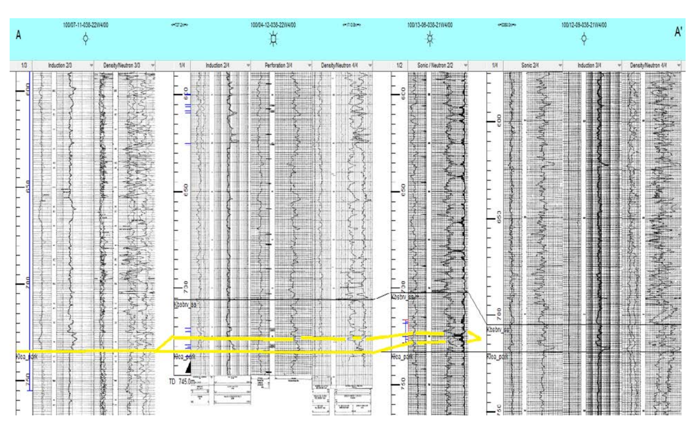
The Basal Belly River is a member of the Belly River Formation (BBR), and is the lowermost member, deposited as a marine or tidal sequence. It is a known oil and gas producer throughout Alberta. In the Rangeland area, the Basal Belly River is at a depth of 725 meters, and has a pay thickness of up to 7 meters. Seismic analysis was performed by using forward modeling, and comparing it to actual seismic data. Poststack, and pre stack seismic models were generated, based on the parameters of the 2-D data, and petrophysical parameters derived from well logs. The seismic data was reprocessed, correlated and interpreted using conventional methods. The results indicate the Basal Belly River gas play is a viable seismic The Basal Belly River pool in Southern Alberta is Upper Cretaceous in age. It is a exploration and development target using pre stack data analysis.

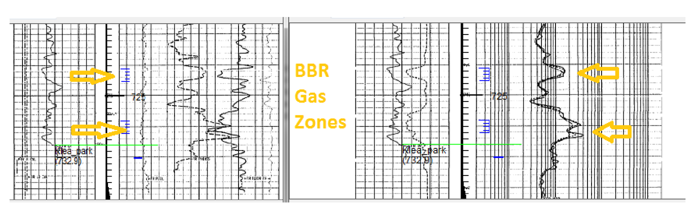




Project area and South and Central Stratigraphic Chart. The arrows illustrate the target formation, and the geographical area of the Rangeland project. (Courtesy ERCB and Natural Resources Canada).

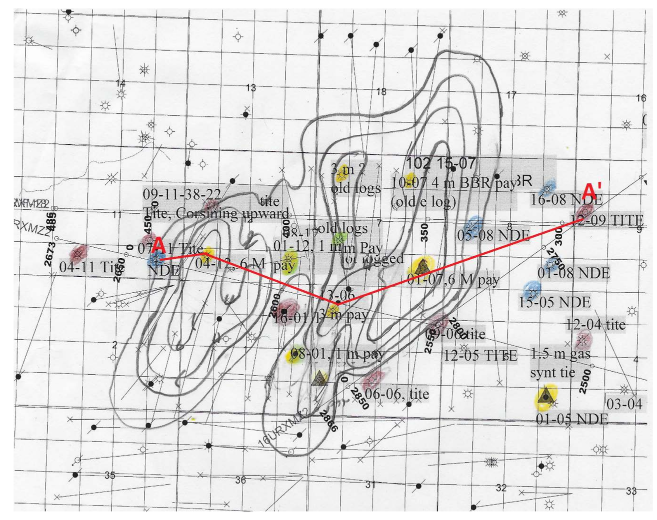


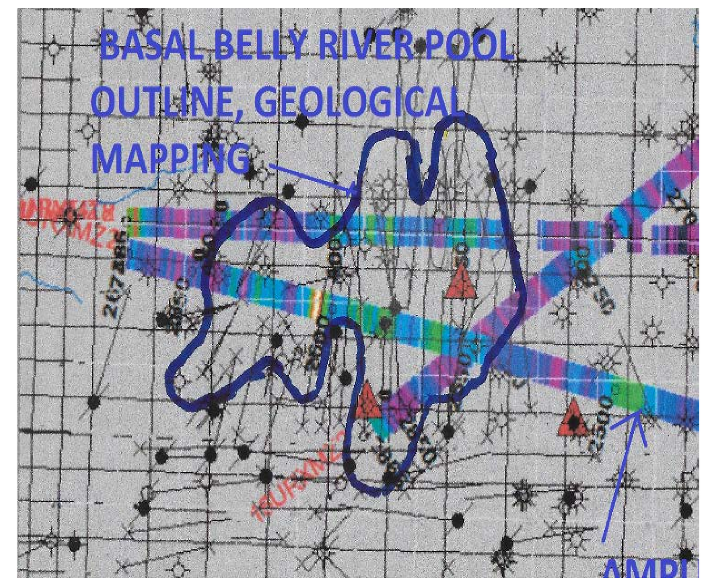




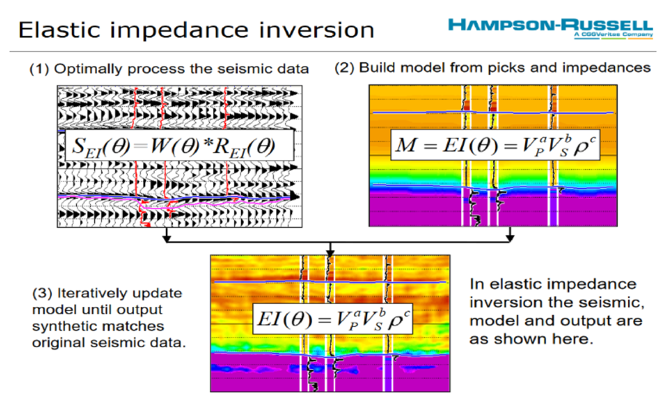
Gas Pay Zones The logs at 04-12-38-22W4 are shown here. The density and induction logs highlight the two pay zones. These are used to model the zero offset response. This well produced gas from the BBR, the perforation zones are shown. Gas was produced from the two zones as indicated; gas is shown on logs of high resistivity, and the convergence of the density and neutron porosity. Maximum porosity was 22 % .

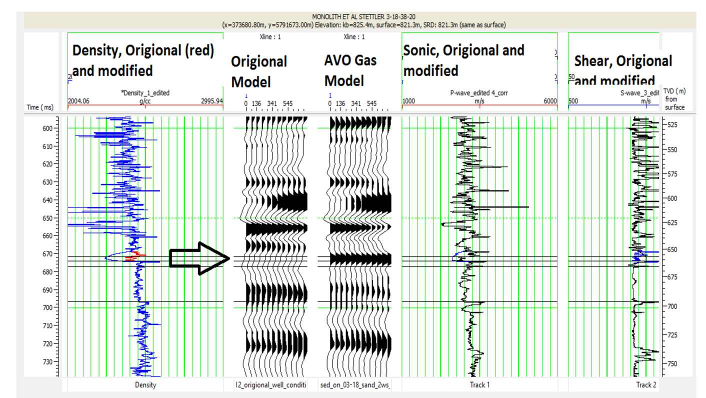
Estuary Example, Scotland, River Nith . This is a modern day template for the Basal Belly River. Imagine this estuary being preserved by a marine transgression. Estuaries will deposit, erode, and resort sediments due to seasonal changes in flow, storm surges, changes in sediment load, and tidal fluctuations (such as the Han River in Korea).



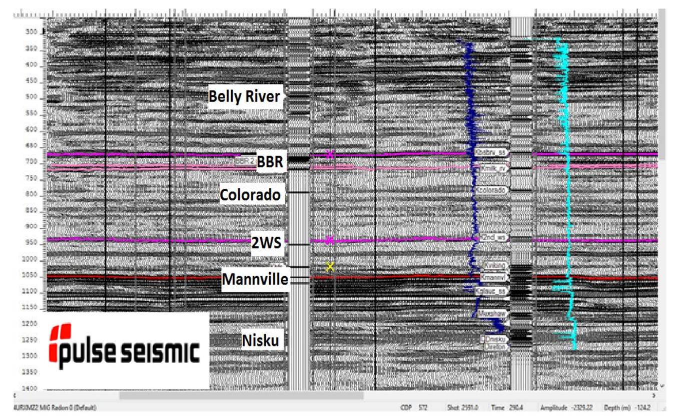


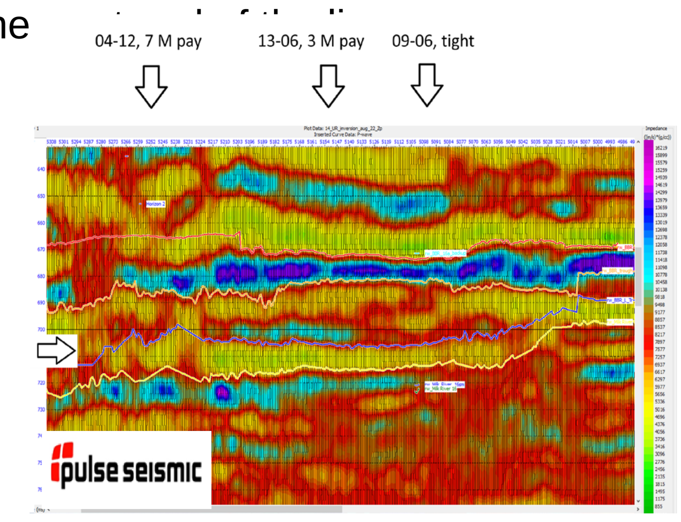
Base Belly River, Net Pay, Pay Zone (left). This shows the wells used in the geologic interpretation of this area. The porosity cut off was 12 %, The contours took into consideration the seismic amplitudes. The map on the right is a combination 3 meter pay cut-off, combined with seismic amplitudes. There is a good match between seismic amplitudes and gas pay.



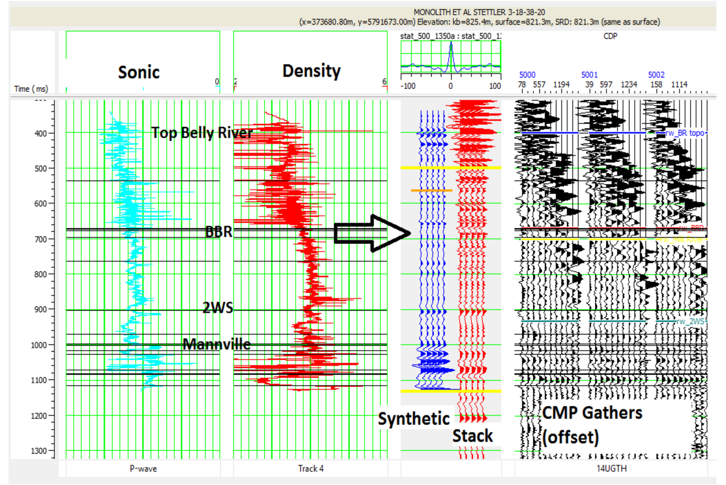


Prestack Inversion Process. The pre stack inversion is a simultaneous process, it iteratively updates the model until the synthetic traces match the original seismic data. The higher the fold, and the lower the noise, the better the result. Line 14 was limited to 6 fold at the zone of interest, and had significant coherent noise toward the





Poststack inversion. The inversion shows the East pool boundary, and a thickening as the pay increases from 3 meters to 7 meters in the West direction. The signal is then lost in the noise, making the inversion difficult to interpret. The inversion generated good results in the vicinity of the 13-16 gas well.



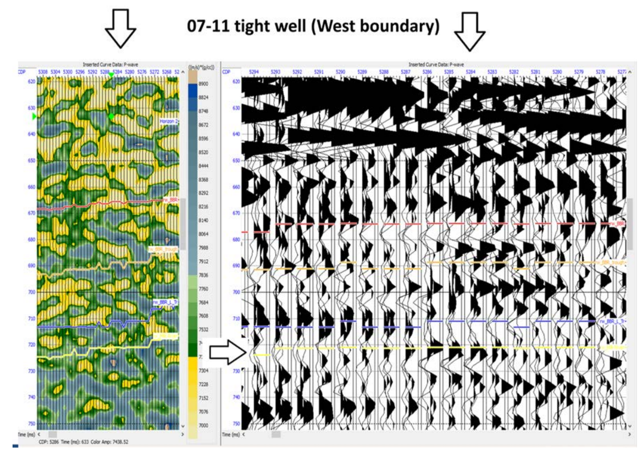
$$R_{PP}(\theta) = c_1 R_P + c_2 R_S + c_3 R_D$$

where:

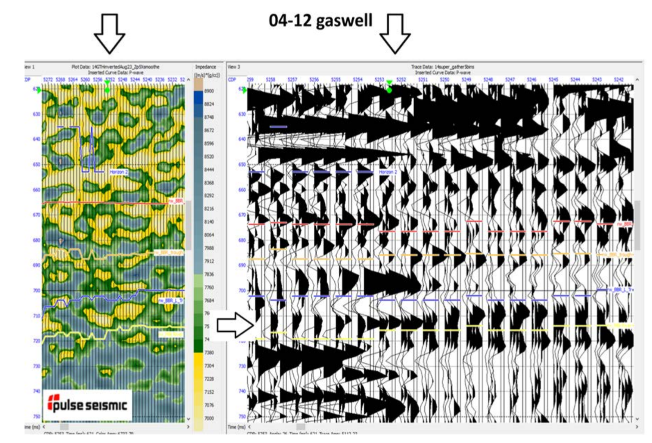
$$c_1 = 1 + \tan^2\theta$$
$$c_2 = -8\gamma^2 \sin^2\theta$$
$$c_3 = -\frac{1}{2}\tan^2\theta + 2\gamma^2 \sin^2\theta$$
$$\gamma = \frac{V_S}{V_P}$$

$$R_P = \frac{1}{2}\left[\frac{\Delta V_P}{V_P} + \frac{\Delta\rho}{\rho}\right]$$
$$R_S = \frac{1}{2}\left[\frac{\Delta V_S}{V_S} + \frac{\Delta\rho}{\rho}\right]$$
$$R_D = \frac{\Delta\rho}{\rho}$$

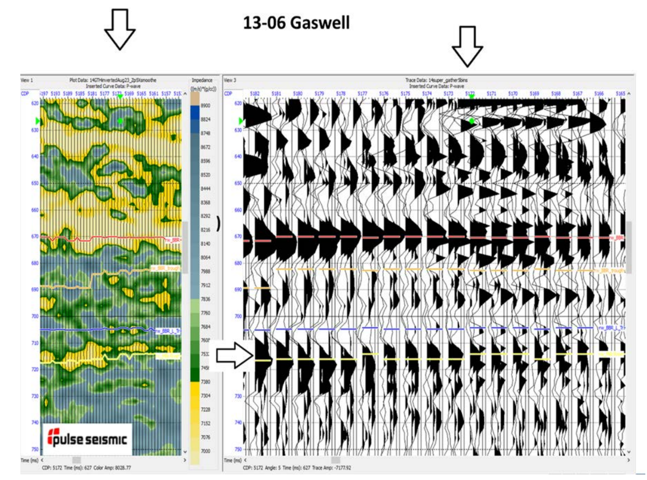
This is a Geoview display (left) of the seismic correlation from synthetic to Well , 03-18-34-22W4. There are CDP gathers included in this display. The equation on the right is the basis for prestack inversion, expressing P reflectivity as a function of incident angle.



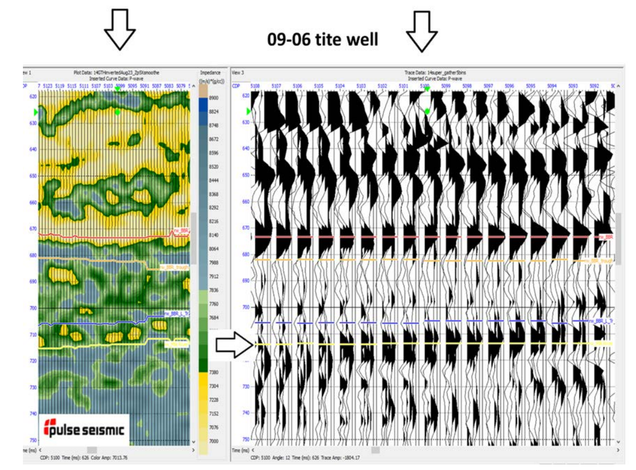
07-11-038-22W4 Tight



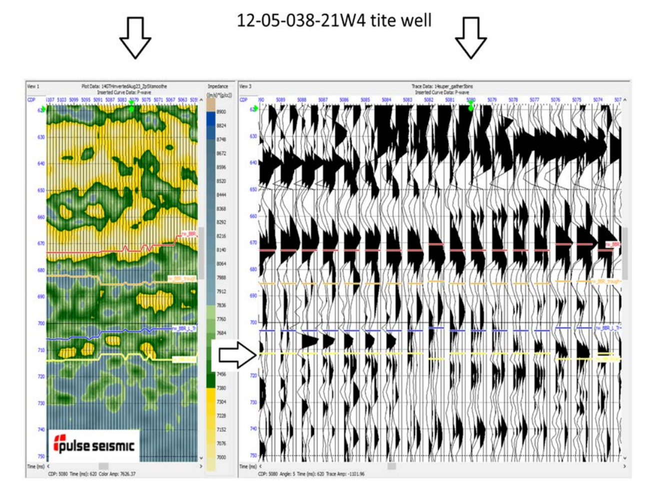
04-12-038-22W4 7 meters gas pay



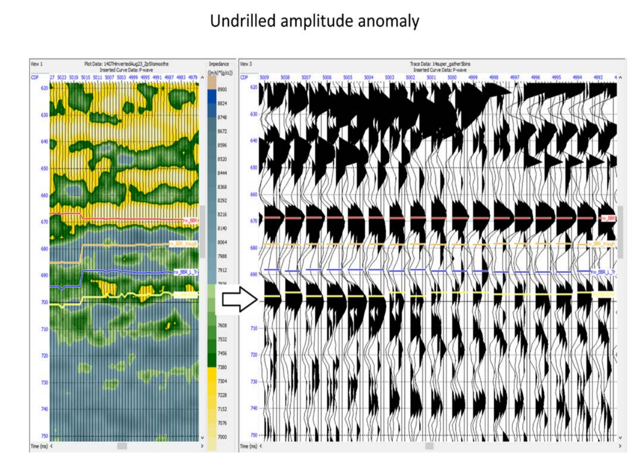
13-06-34-21W4 4 meters gas pay



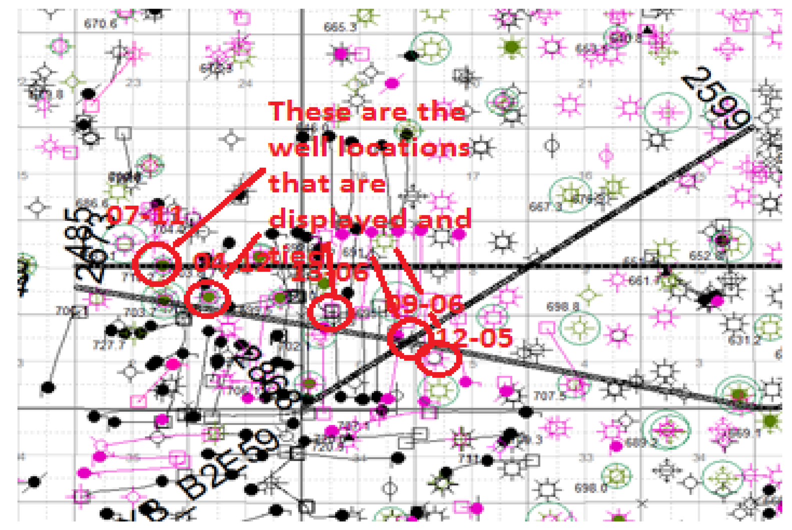
09-06-038-21W4 tight



12-05-038-21W4 tight



Undrilled BBR amplitude



Seismic well tie analysis points

The 2-D seismic trade was reprocessed and used for gas detection of gas reservoirs. The displays above show the results at a number of well ties. AVO processed supergathers appear to be a good way to identify potential targets. To accurately evaluate the BBR, 3-D or 2-D data with a minimum of 12 – 20 fold would be required at the zone of interest for future work.

Future Work: Acquire a large 3-D over a Duvernay microseismic project and compare the results predicted by seismic inversion to microseismic events. A converted survey would be useful in directly determining PS reflectivity.

We thank the sponsors of CREWES for continued support. This work was funded by CREWES industrial sponsors and NSERC (Natural Science and Engineering Research Council of Canada) through the grant CRDPJ 461179-13.