Impedance Estimation from Ross Lake PP and PS Seismic Data: Ross Lake Oilfield, Saskatchewan

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Outline

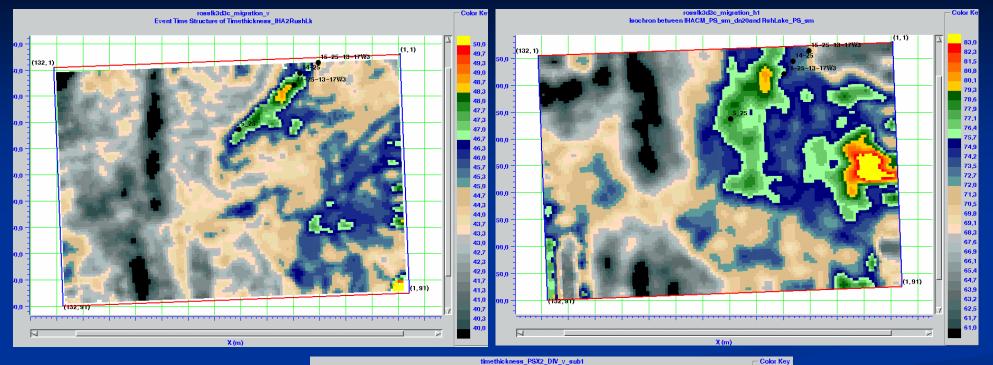
Introduction and review PP data inversion PS data inversion Vp/Vs from inversion Discussion Conclusion Acknowledgements

Introduction and review

- 3D migrated PP and PS-radial data
- Guided by well logs and VSP, horizons of IHACM and RushLake are picked on both PP and PS volumes
- Vp/Vs map calculated from PP time thickness map and PS time thickness map
- Vp/Vs map verified by the horizontal well log

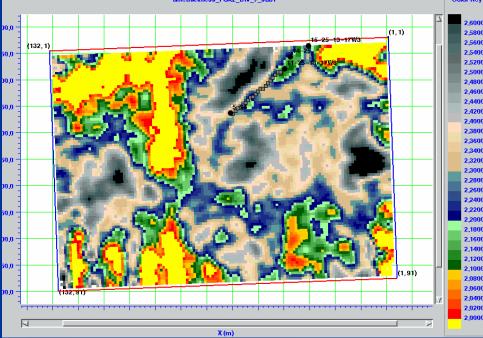
PP time thickness RushLake-IHACM

PS time thickness RushLake-IHACM

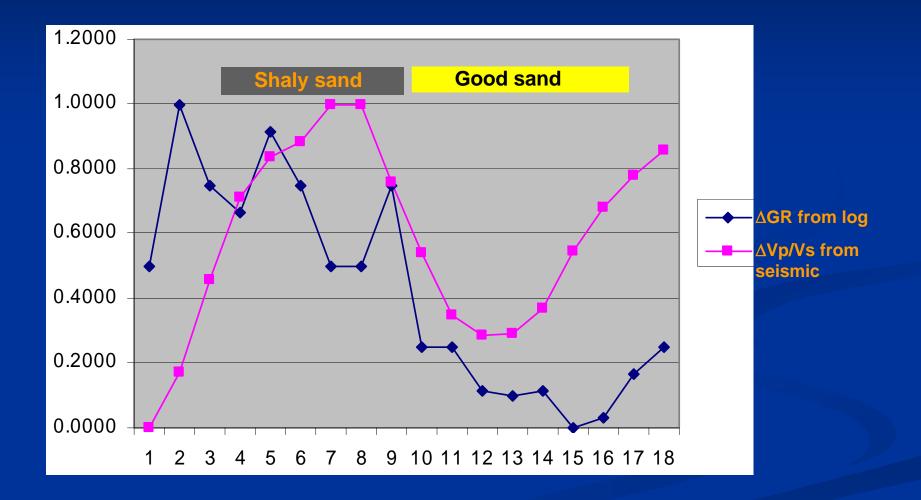


Map of average Vp/Vs between RushLake and IHACM

$$Vp/Vs = \frac{2*\Delta Tps}{\Delta Tpp} - 1$$



Normalized local variation of GR from MWD and Vp/Vs from 3C seismic travel time



Horizontal trajectory of well 5-25, start from MD 1270m to MD 1830m, ~33 m/bin

PP data inversion

 Build the initial model using well 11-25 and 4 horizons

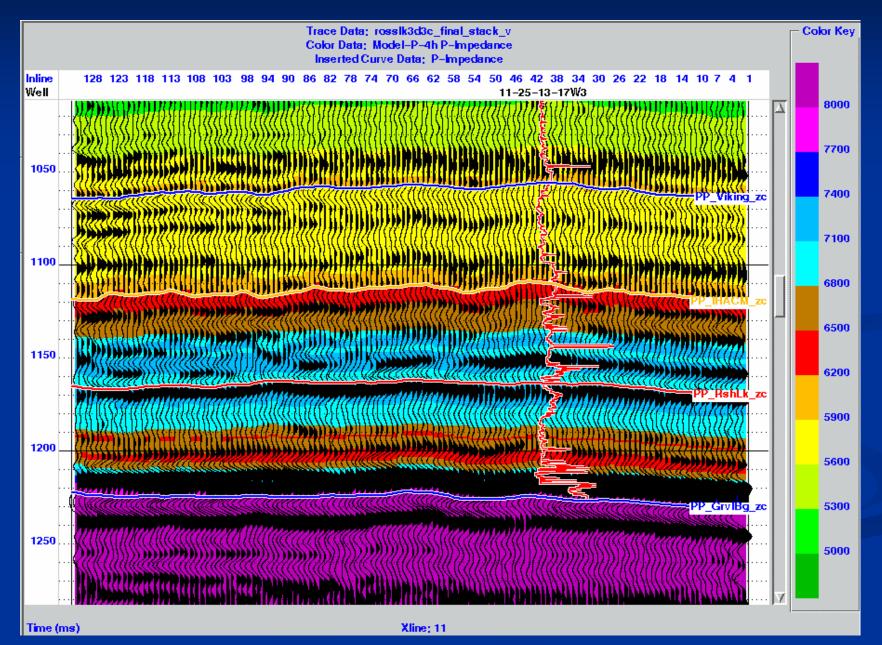
- Low-pass filtering the model
- Extract wavelet from PP seismic traces
- Model-base inversion

P-imp: nearly same as above shale, lower than beneath layer S-imp: a little higher than above shale, lower than beneath layer

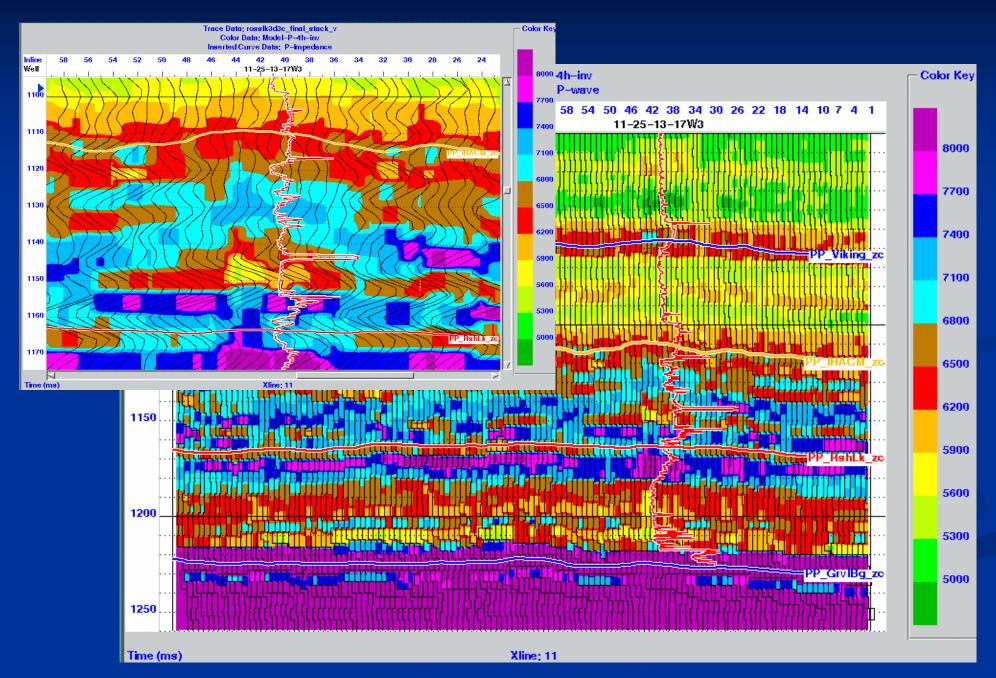
GR Vp/Vs POR P-imp S-imp DEN Vp Vs PP-syn Gamma Ray *P-wave_correlated S-wave_math *Density VpVs_Ratio_math P-Impedance_math S-Impedance_math Porosity from Time 1000 m/s m/s 2000 kg/m3 3000 unitless 2,5 qapi 150 6000 500 3000 1.5 50 3e+06 (m 1,3e+07 0 1e+06 (m 1,1e+07 surface (ms) 111111111 - 1110 1110 1111111 HHHH1120 1120 ,,,,,,,,, 1130 mm1130 1140 1150 5 1140 1160 5 1150 1170 Pyrite 3 1180 //////// 1160 1190 1170 1200 ******* 11 1 2 |||||||| Track 2 Track 3 Track 6 Track 7 Track 1 Track 4 Track 5 Track 8 *wavePP ext2 ho

Well 11-25 logs

The initial P-impedance model (in color)

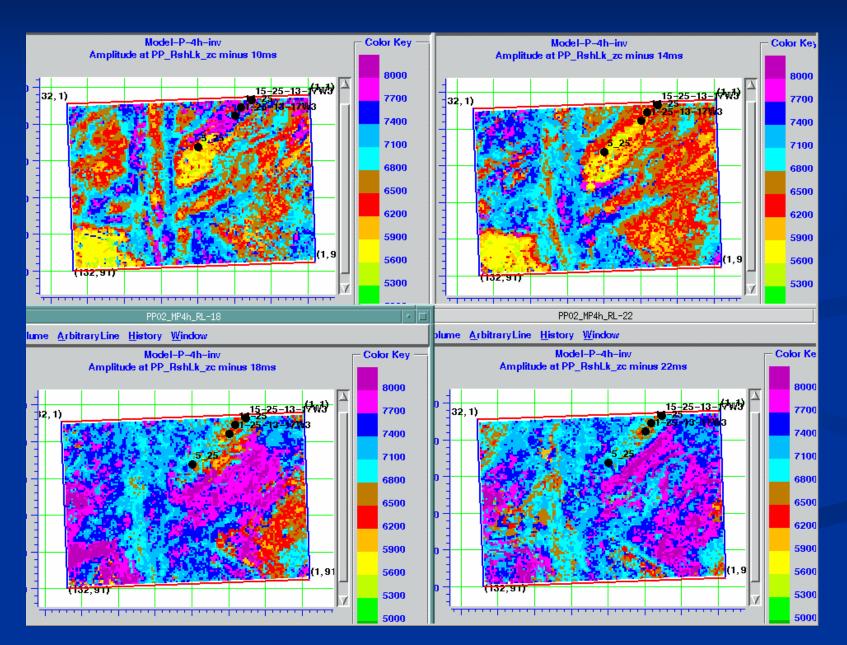


PP inversion result



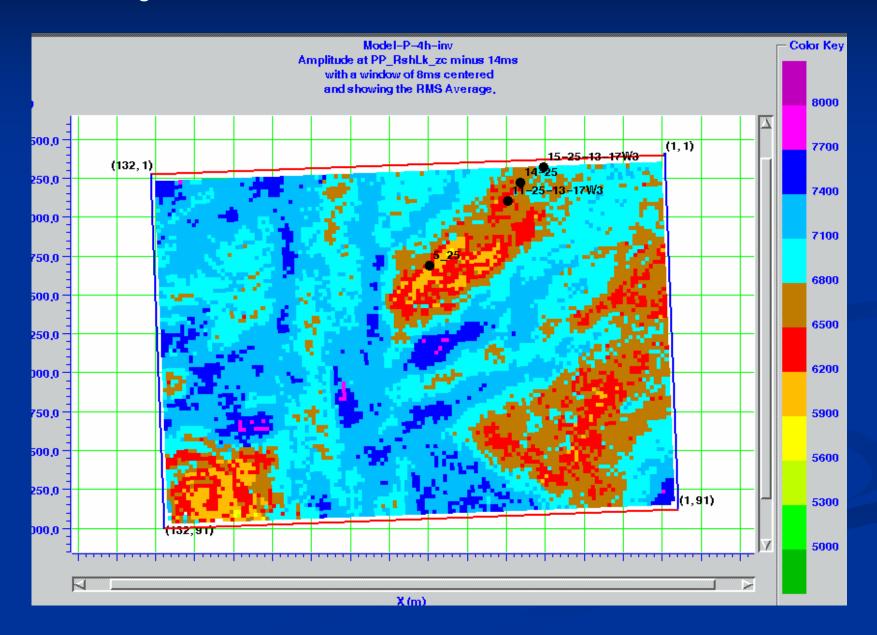
Horizon slices of inverted P-impedance:

10ms, 14ms, 18ms and 22ms above the horizon of RushLake



Horizon slices of inverted P-impedance:

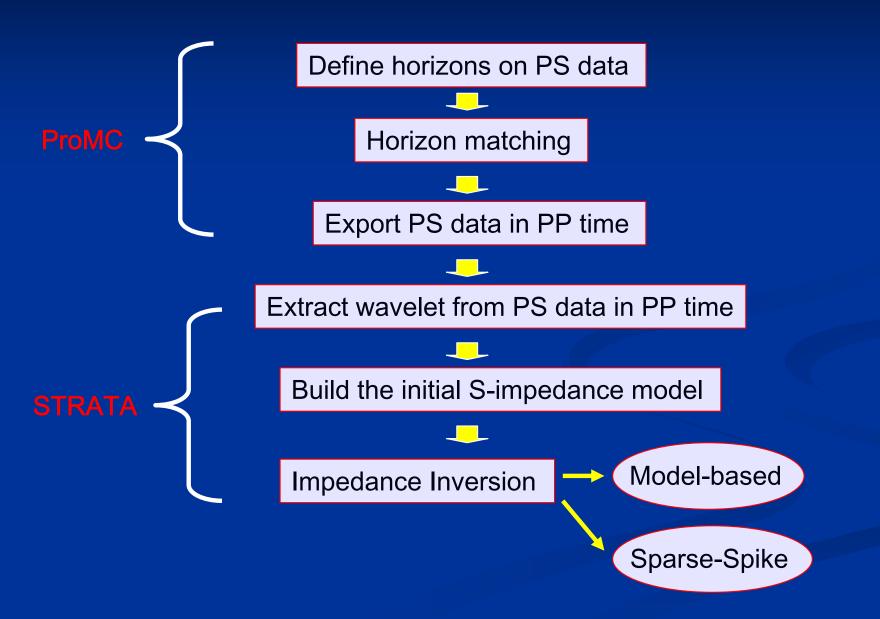
RMS average of a 8ms window centered at the 14ms above Rush Lake horizon



PS data inversion

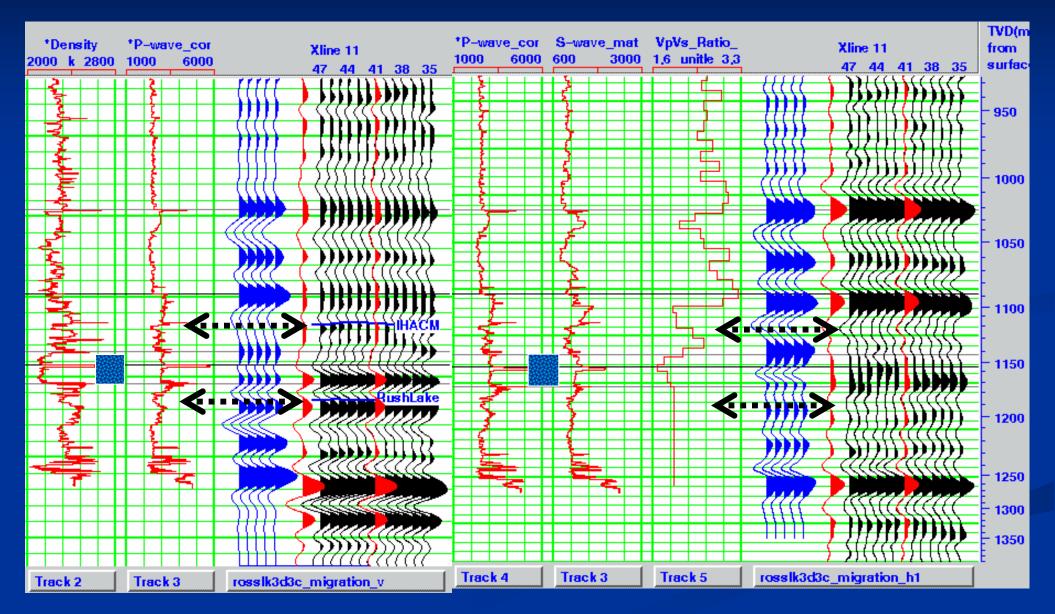
- Assume: PS reflectivity is linearly proportional to the SS reflectivity.
- In reality: more complicated, depends on trace offsets as well as time-dependent incidence angle.
- Relative change of PS reflectivity over small depth may be highlighted by the inversion

PS data inversion

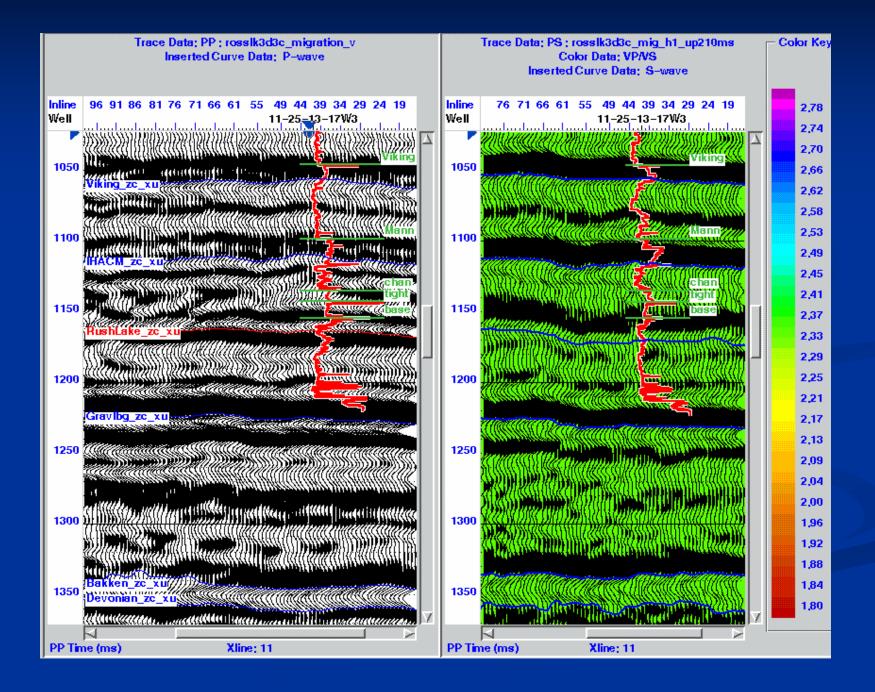


PP synthetic

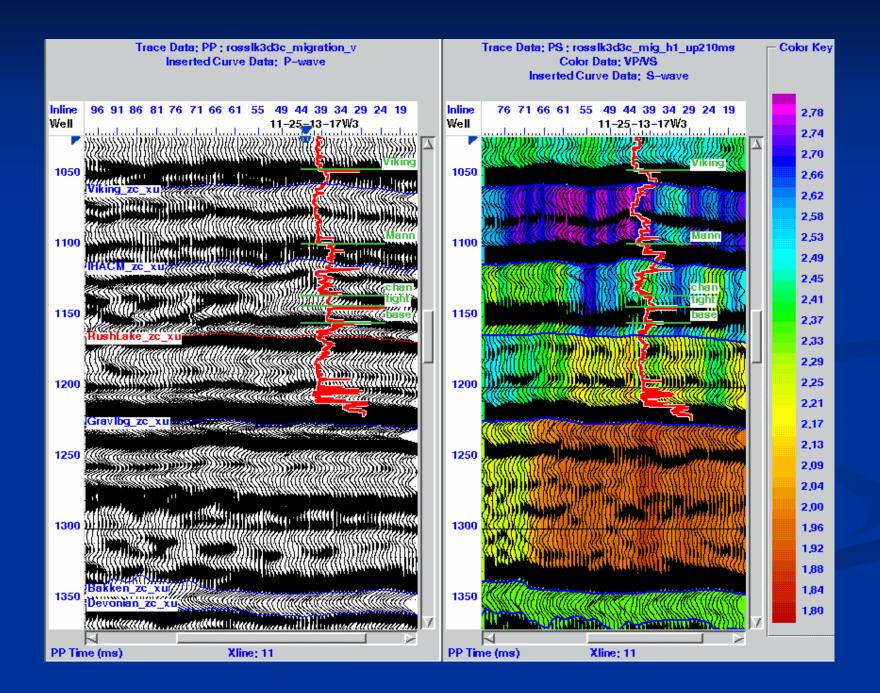
PS synthetic



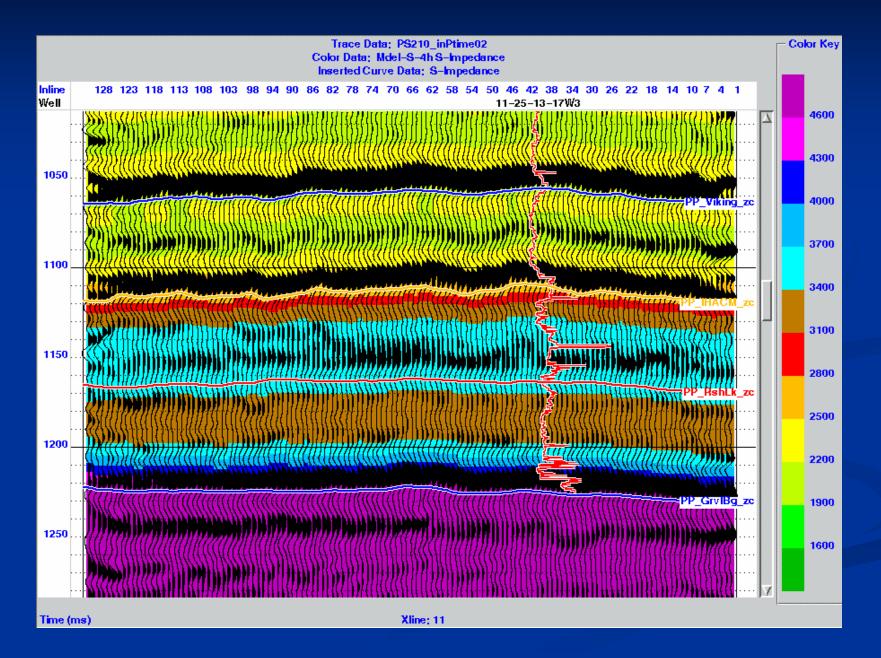
PP data (left) and PS data (right) in PP time, using constant Vp/Vs=2.35



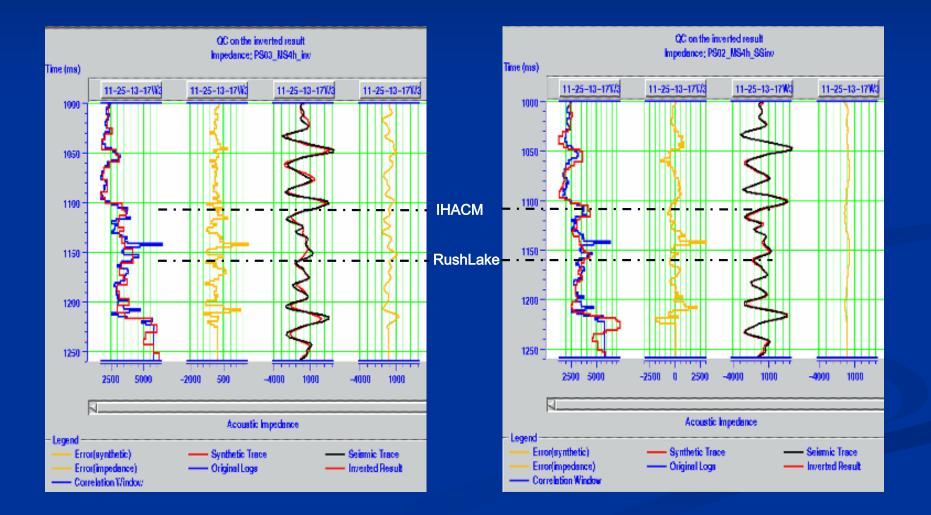
After horizon matching



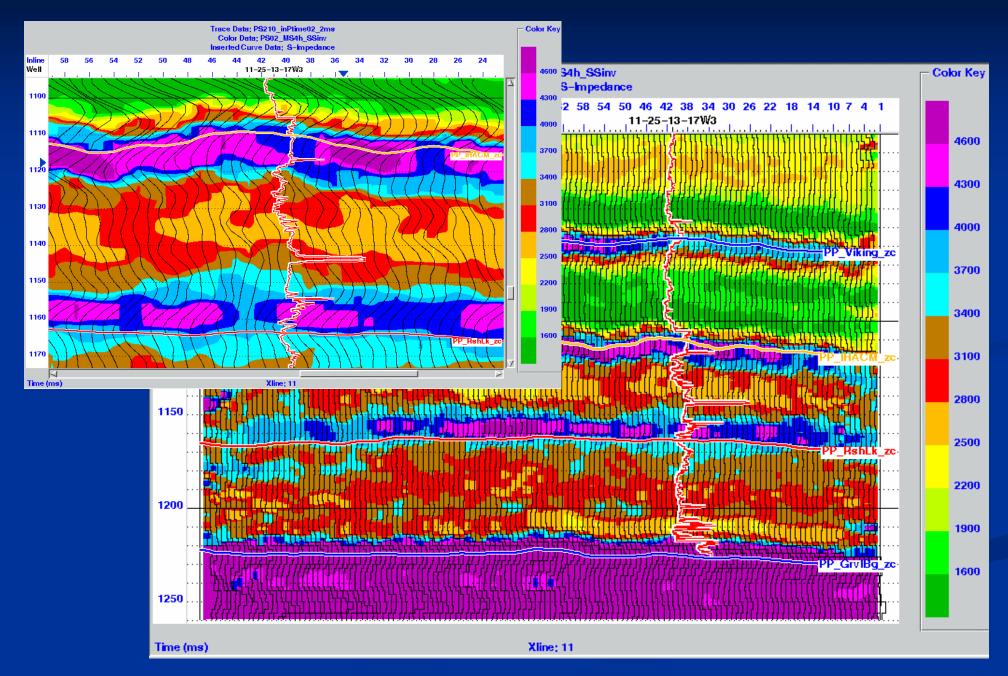
The initial S-impedance model



Two inversion methods: Model-based and Sparse-spike



Choose: inverted S-impedance, Sparse-spike



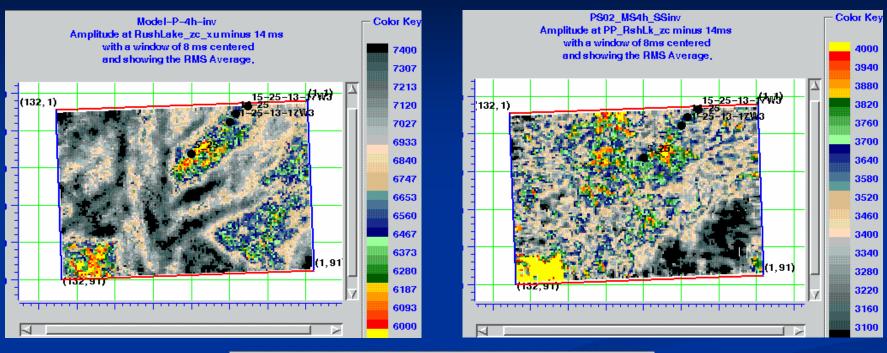
Horizon slices of inverted S-impedance:

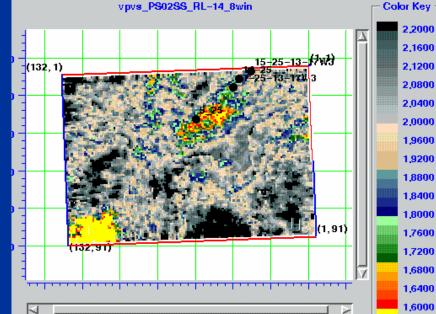
PS03 MS4h inv PS03 MS4h inv Color Key Color Key Amplitude at PP_RshLk_zc minus 10ms Amplitude at PP_RshLk_zc minus 14ms 4600 4600 15-25-13-**(**7w13 15-25-13-17Wa 4300 4300 2.1) 132, 1) 4000 4000 3700 3700 3400 3400 3100 3100 2800 2800 2500 2500 Q: 2200 2200 132,91 102 9 1900 1900 1600 1600 PS03_MS4h_inv_RL-18 PS03_MS4h_inv_RL-22 lume <u>A</u>rbitraryLine <u>H</u>istory <u>W</u>indow ume <u>A</u>rbitraryLine <u>H</u>istory <u>W</u>indow PS03_MS4h_inv Color Key PS03_MS4h_inv Color Key Amplitude at PP_RshLk_zc minus 18ms Amplitude at PP_RshLk_zc minus 22ms 4600 4600 15-25-13-17W3 32, 1) 15-25-13-**(7**W3 4300 4300 2.1) 4000 4000 3700 3700 3400 3400 3100 3100 2800 2800 2500 2500 2200 2200 9 1900 1900 5Z.9

10ms, 14ms, 18ms and 22ms above the horizon of RushLake

P-impedance, 8ms window

S-impedance, 8ms window



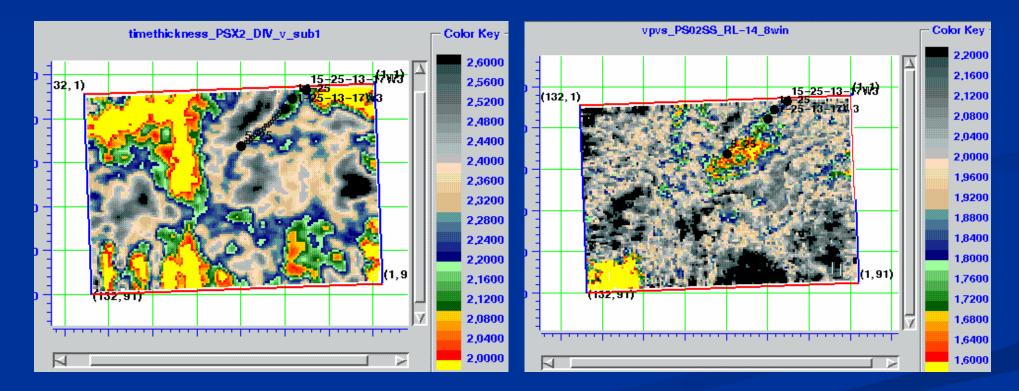


Vp/Vs, 8ms window

Comparison: travel-time-derived Vp/Vs and impedance-derived Vp/Vs

Vp/Vs from travel-time

Vp/Vs from impedance



Discussion

To get SS reflectivity from post-stack PS data ...

Vp/Vs: result from PP and PS travel time combination appears comparable with that from post-stack PP & PS inversion

Go pre-stack

Conclusion

- PP and PS inversions show that the oilbearing sand has a relative low Pimpedance and a bit high S-impedance
- Both travel time Vp/Vs and impedance Vp/Vs show promising anomalies
- The reservoir sand has a eastern direction extension

Acknowledgement

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