Vp/Vs mapping – robustness and quality improvement

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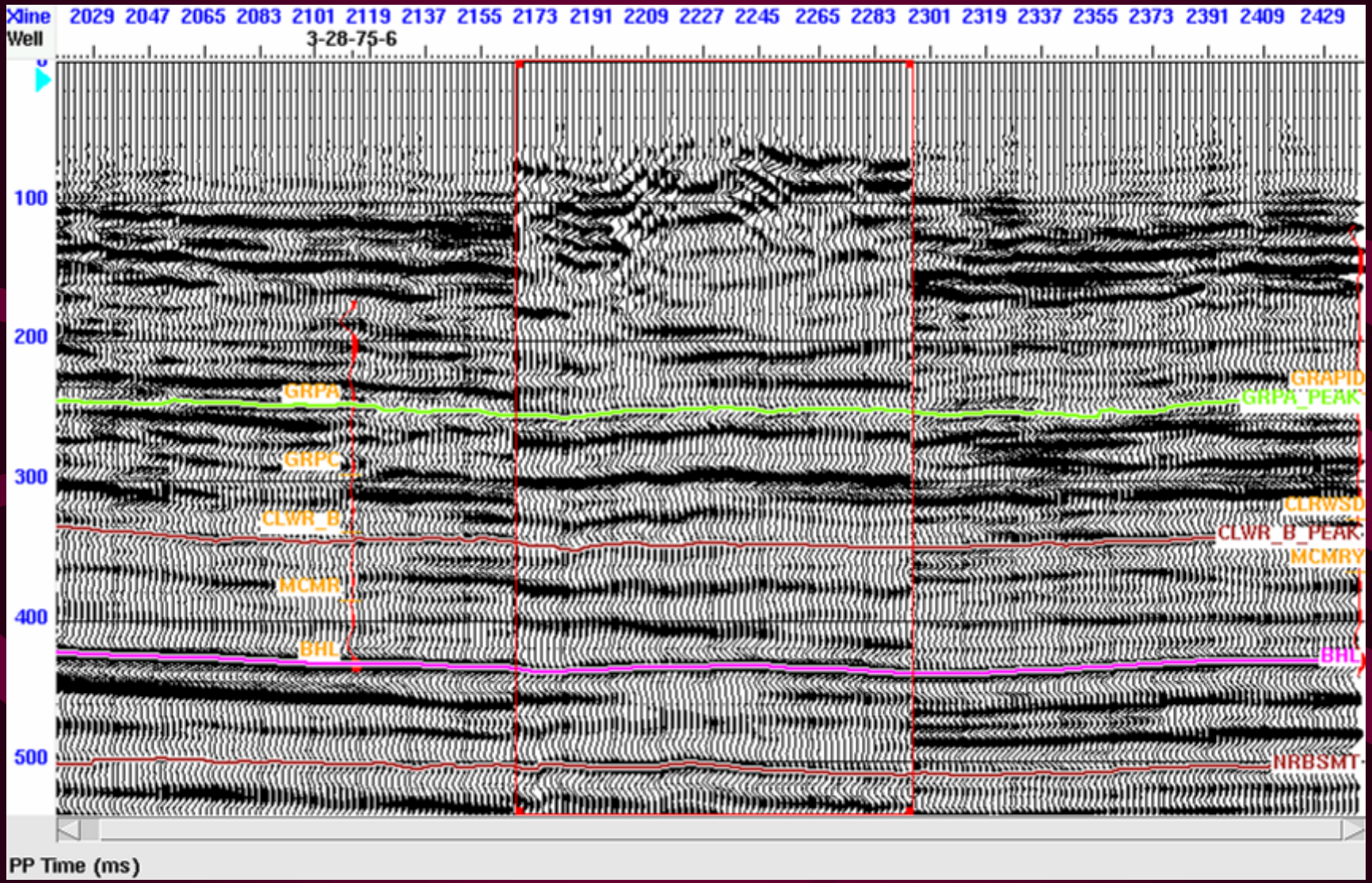
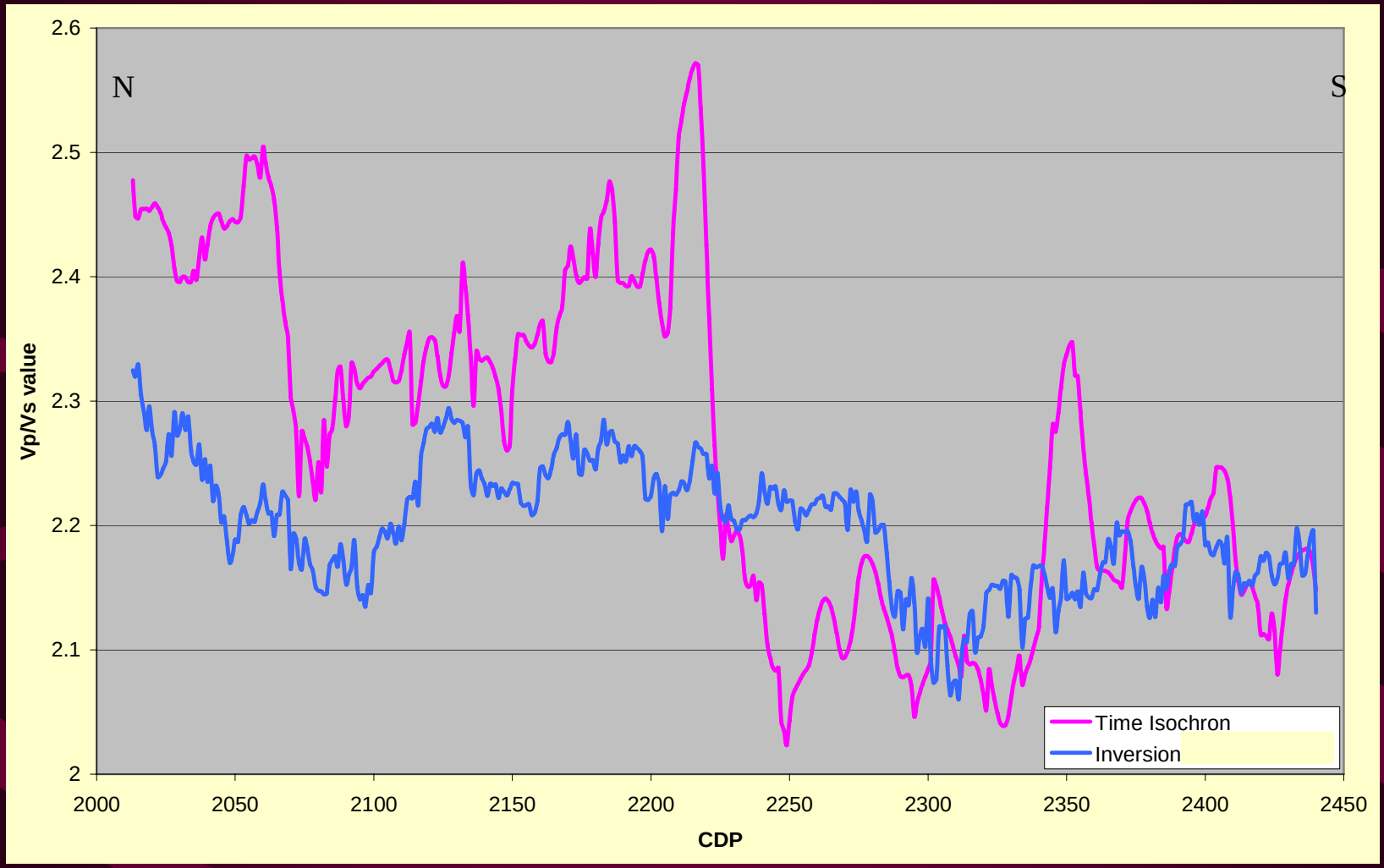
References for more detailed information

- Lines et al. (TLE November 2005)
- Pengelly et al. (CREWES 2005 report)
- Zhang and Lines (TLE June 2006)

Multicomponent Study by Pengelly et al. (2005) at Jackfish field in Ft. McMurray area



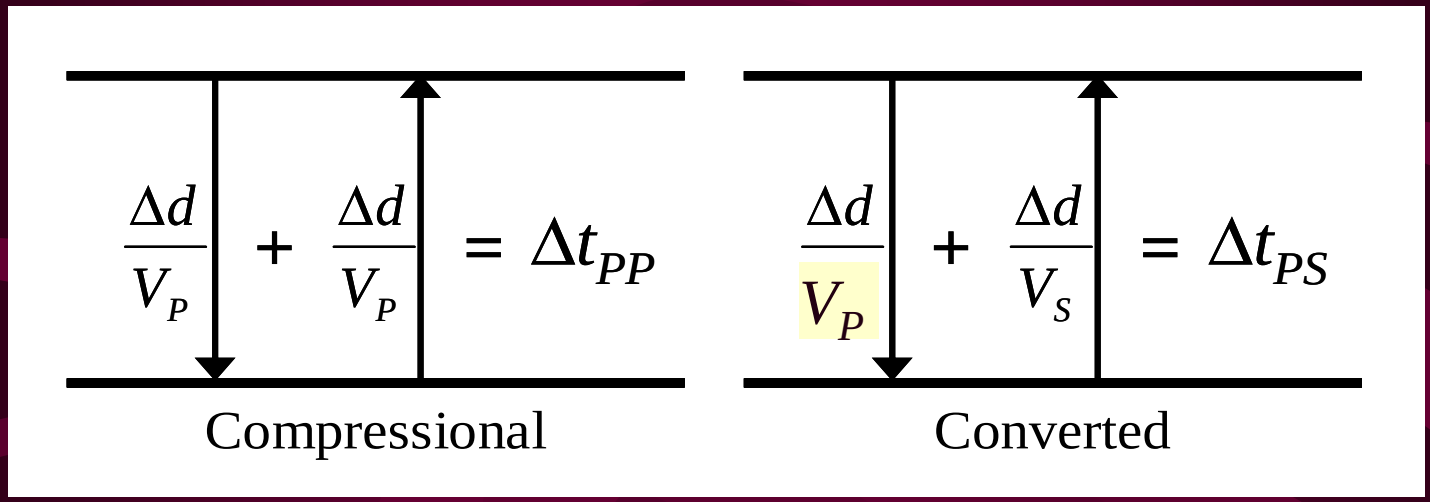
Vp/Vs for McMurray Formation: Jackfish Seismic Line (Pengelly, 2005)



Pengelly's trace amplitude inversion and traveltime inversion showed thickening sand on south part of line.

Since the two inversions are over slightly different depth intervals, we wouldn't expect results to be identical.

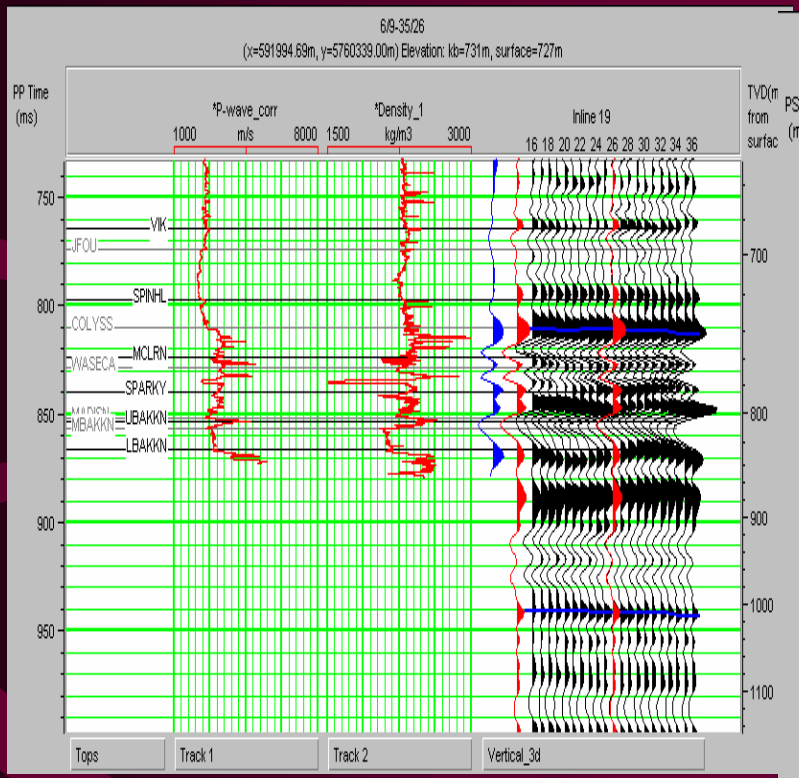
V_P/V_S Ratio From PP and PS Traveltimes

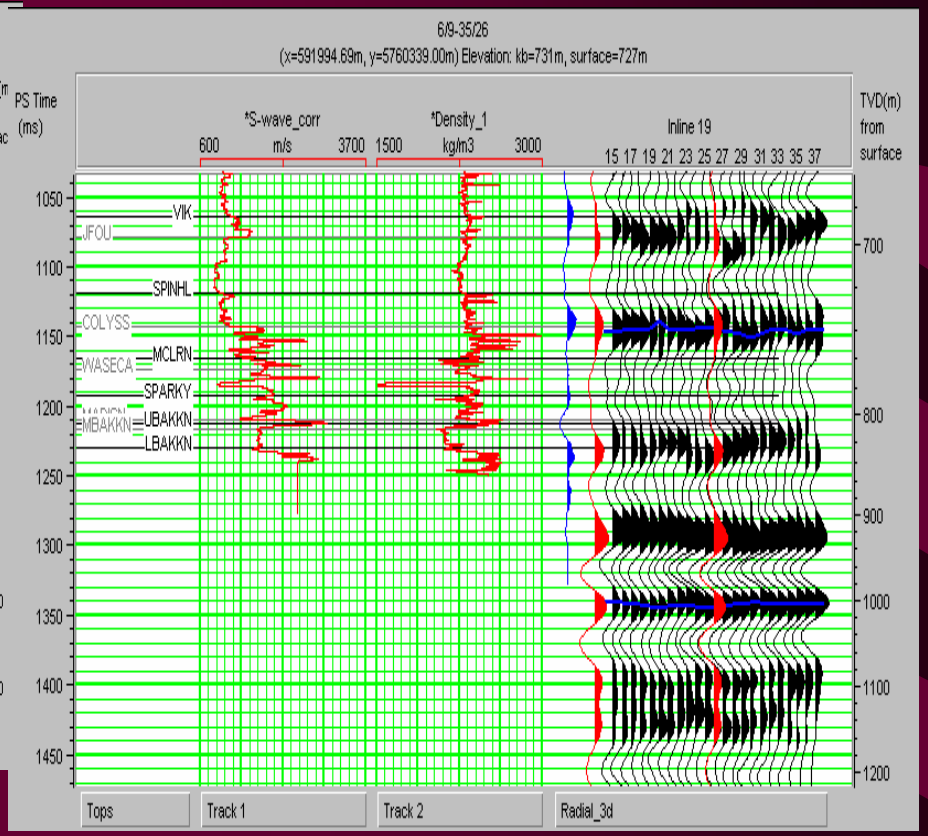


$$\frac{V_P}{V_S} = \frac{2\Delta t_{PS} - \Delta t_{PP}}{\Delta t_{PP}}$$

(From Watson, 2002)

Interpretation for Plover Lake Data





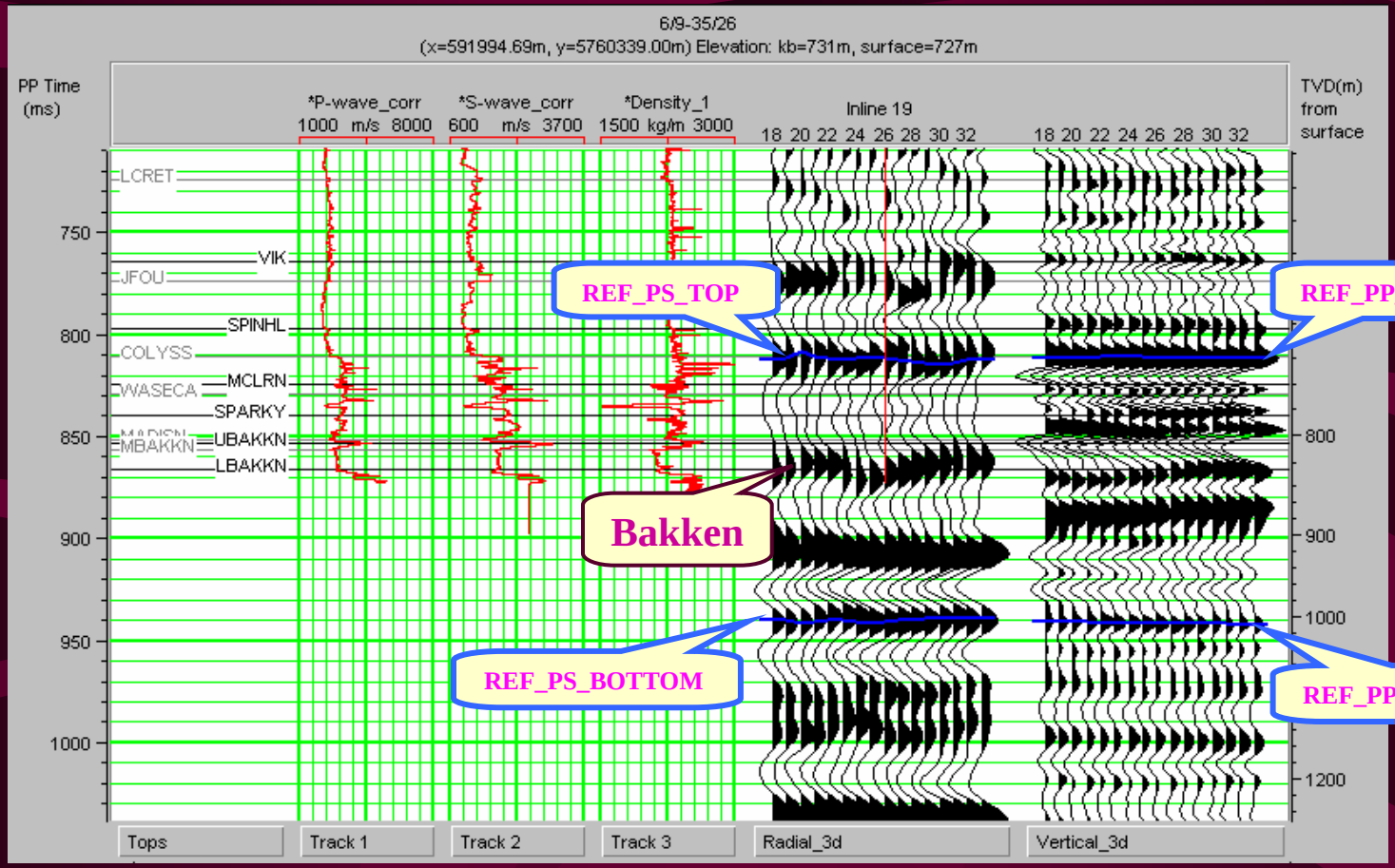
Synthetic Seismogram and real data for PP data

Synthetic Seismogram and real data for PS data

Synthetic seismogram wavelets were extracted from real data.

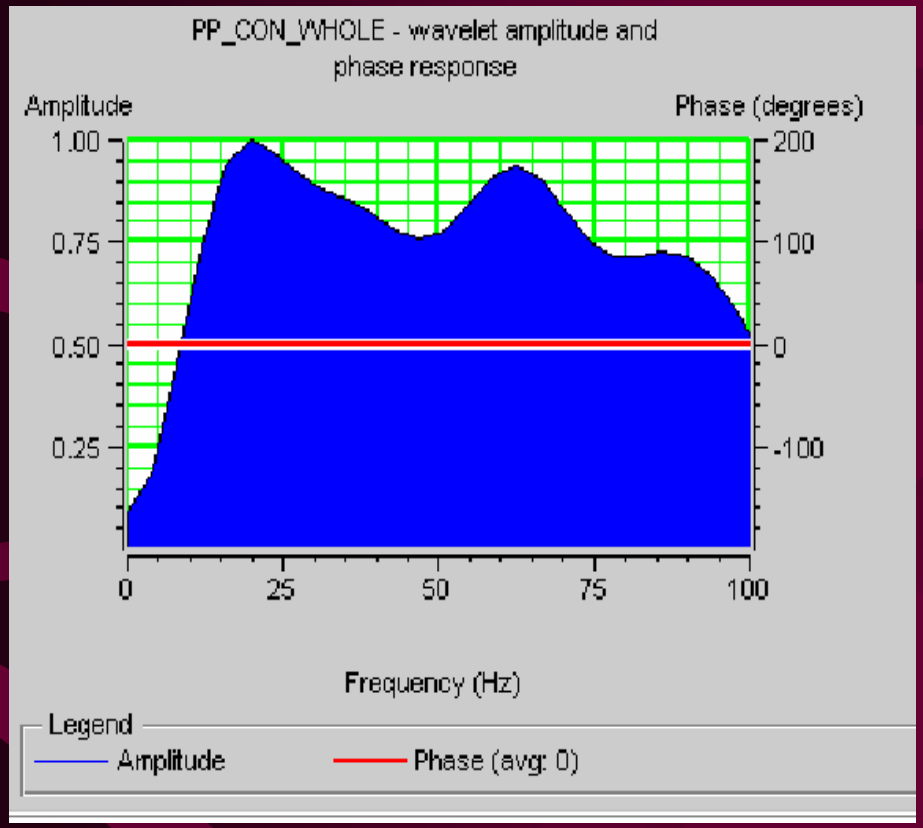
Zhang and Lines (2006)

The criteria to select reference horizons

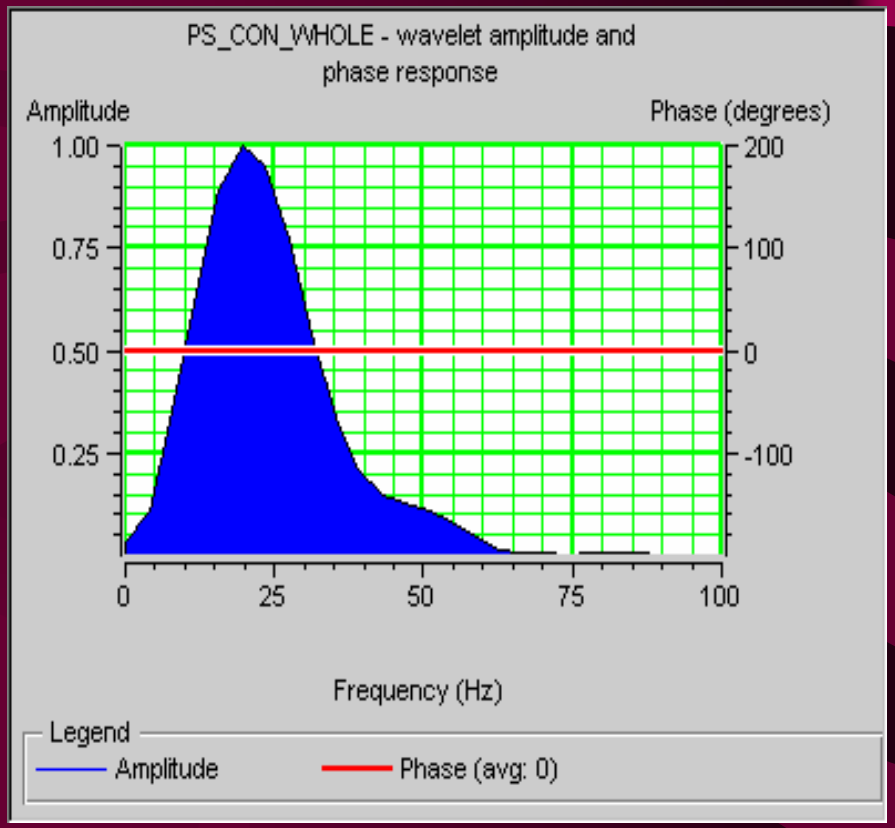


- Coherent events on PP and PS sections (in PP time)
- Events correlate with synthetic seismograms.
- Events bracket the target formation.

Comparison of amplitude spectra between PP and PS data

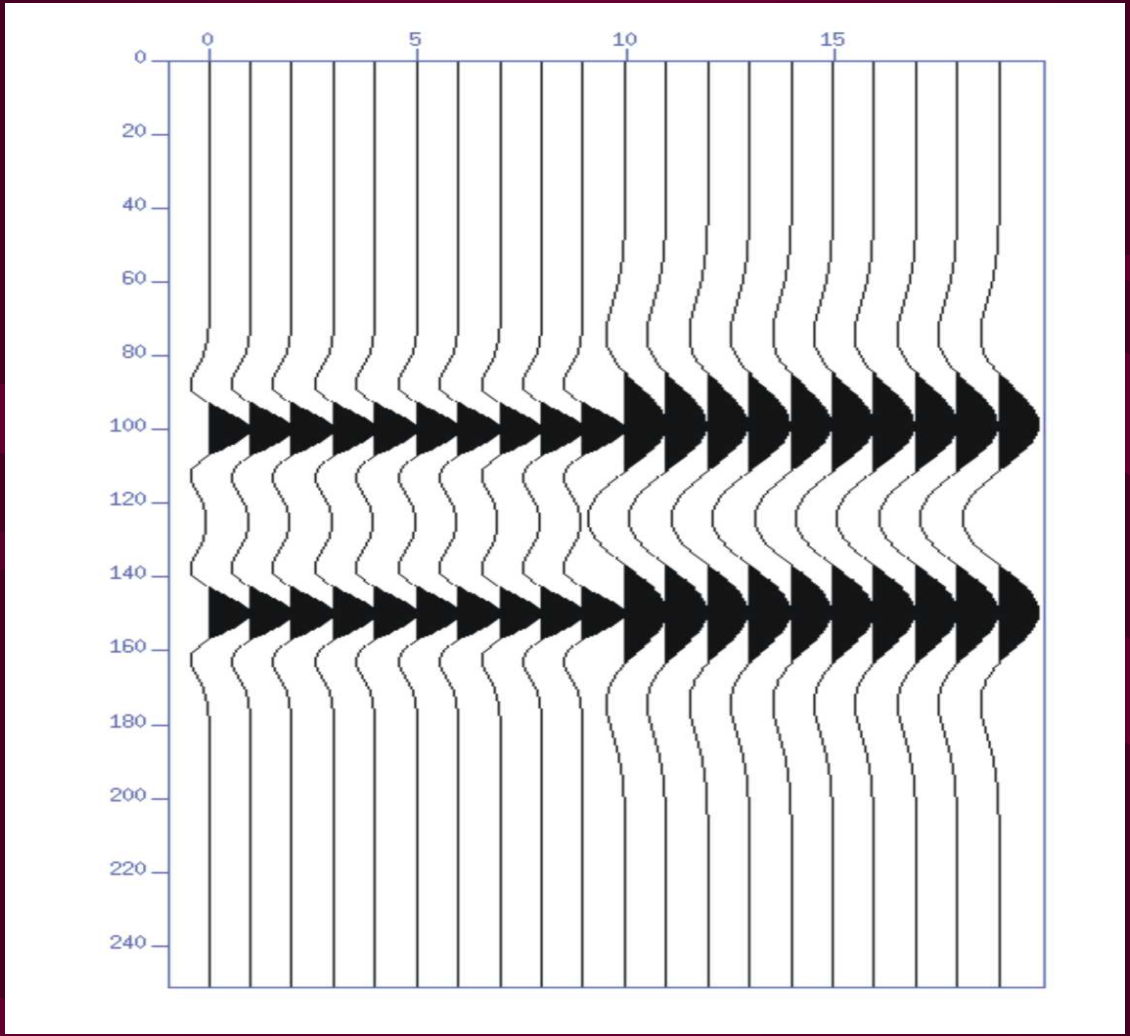


Amplitude spectrum of PP data

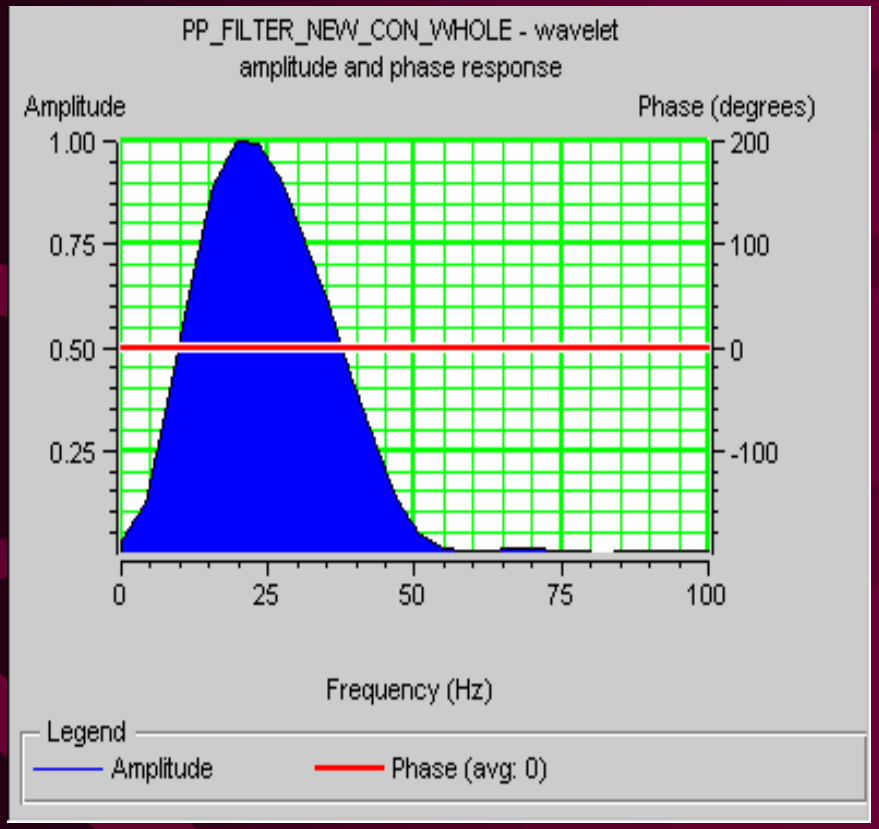


Amplitude spectrum of PS data

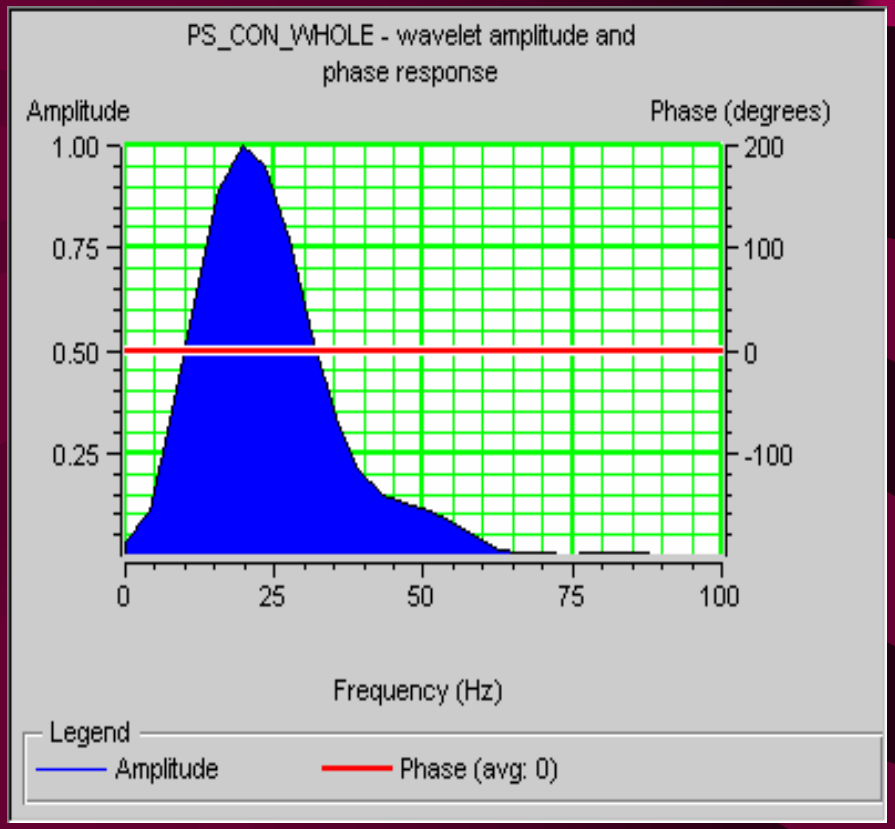
Zero-phase wavelets with different spectral content and the same traveltime interval between peaks



Comparison of amplitude spectra between filtered PP and PS data

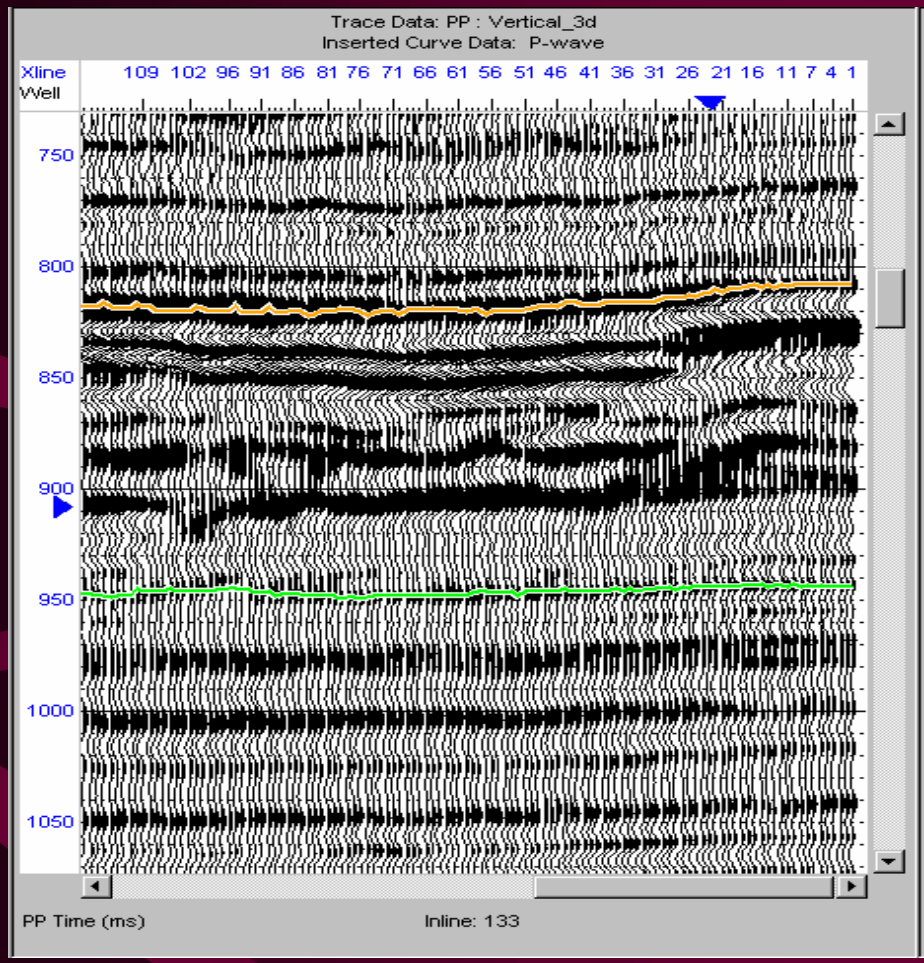


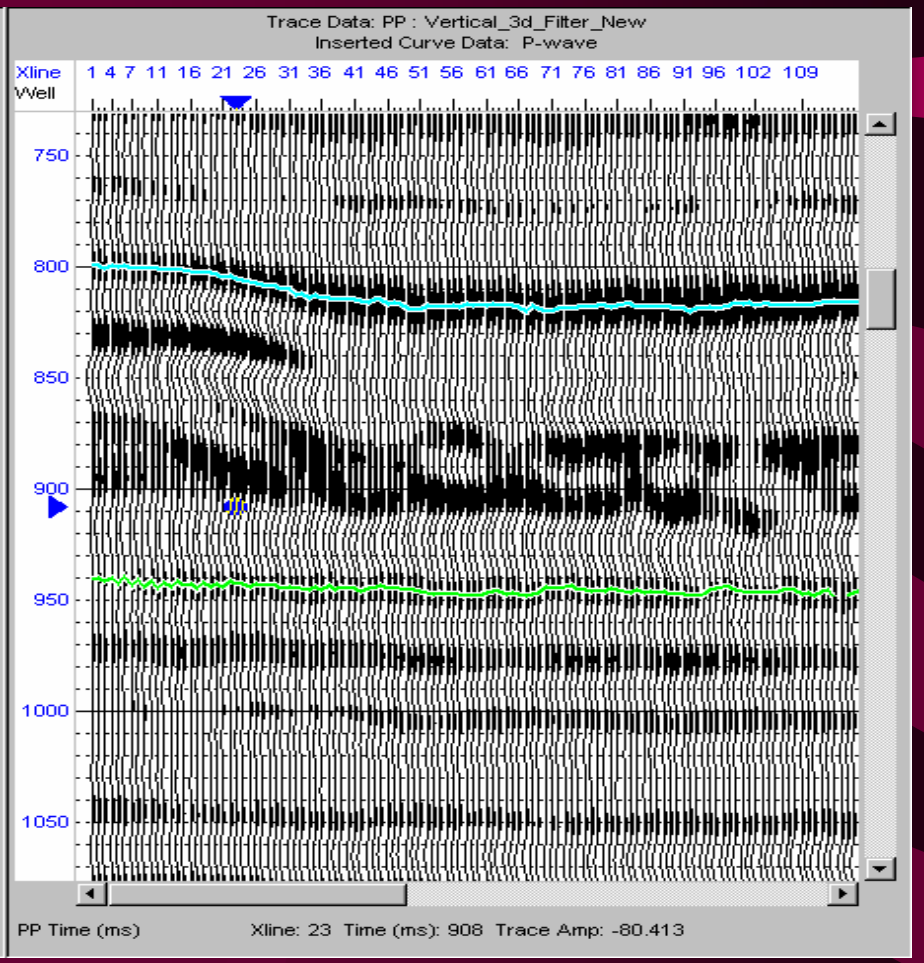
Amplitude spectrum of filtered PP data



Amplitude spectrum of PS data

Comparison between PP and filtered PP data

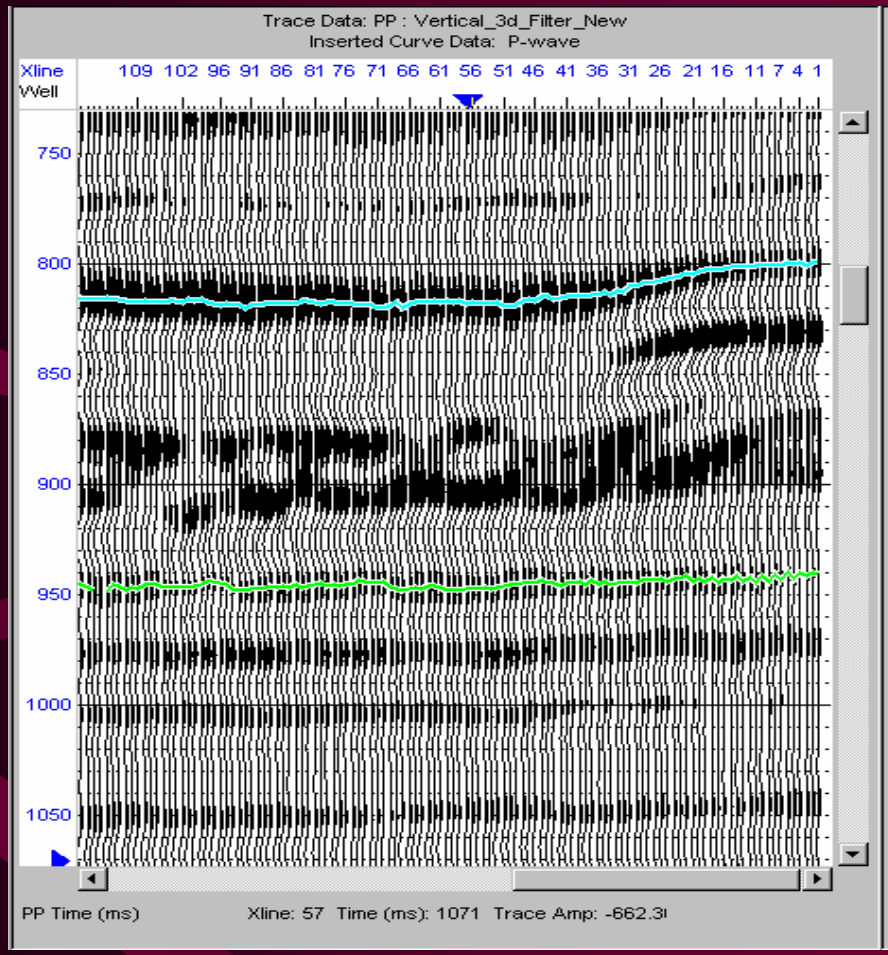


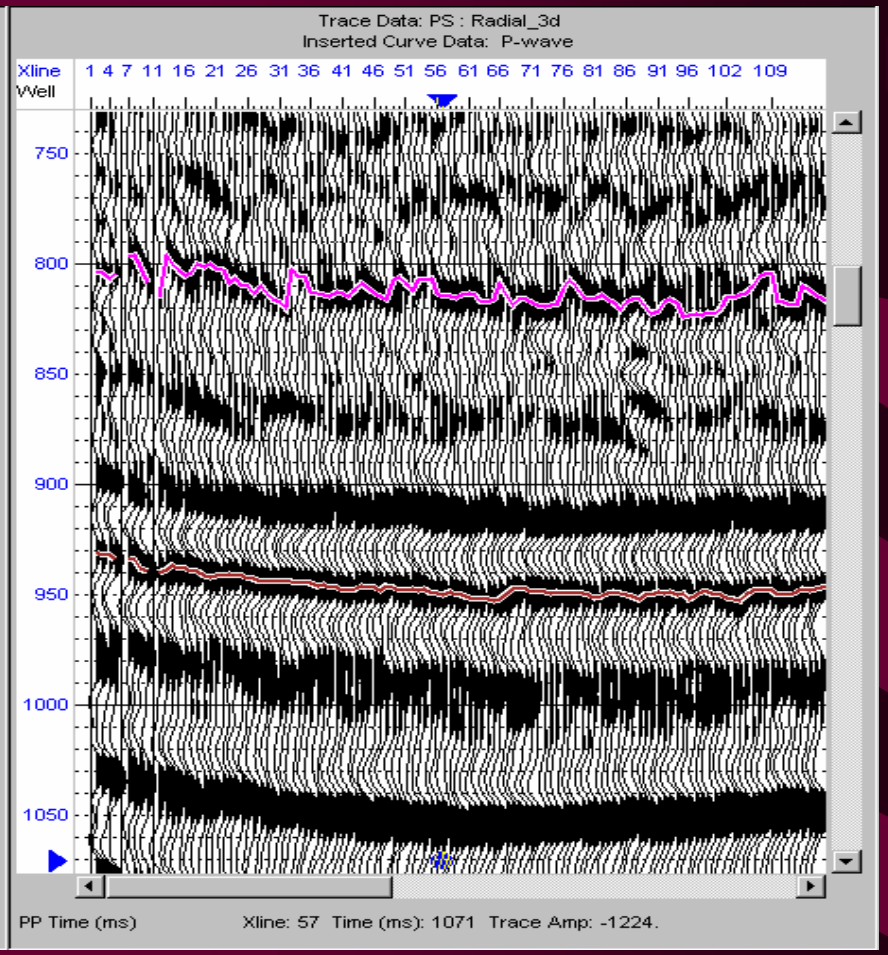


Unfiltered PP data

Filtered PP data

Comparison between PS and filtered PP data

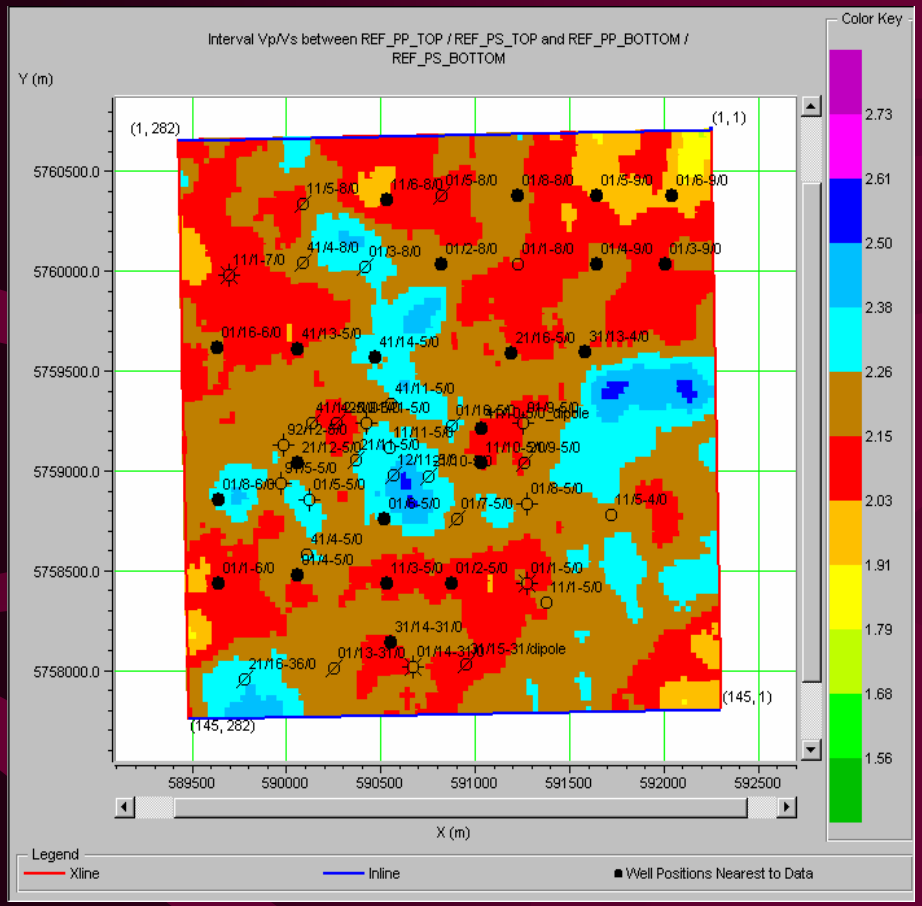


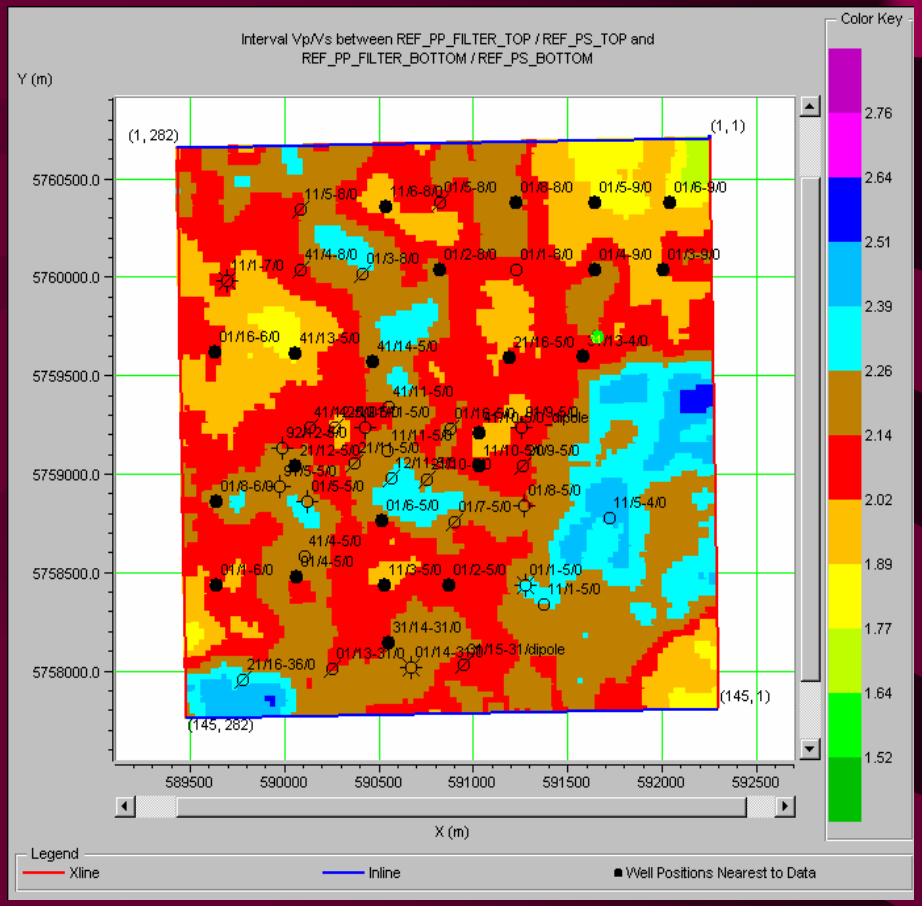


Filtered PP data

PS data

Comparison of V_P/V_S maps



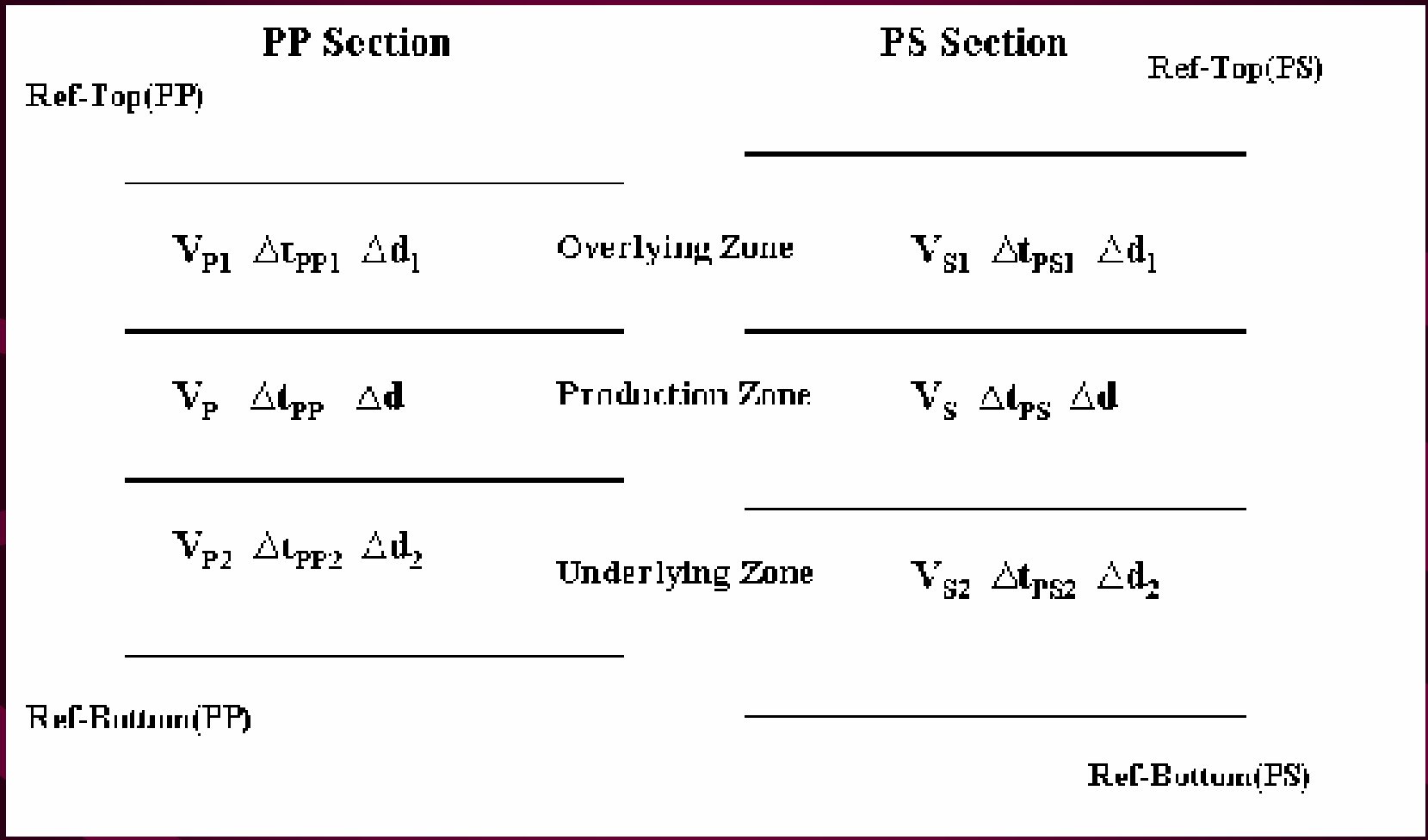


From unfiltered PP and PS data

From filtered PP and PS data

Although maps are similar, the map on the right showed generally better agreement with well information.

Error analysis



The sketch of interpreted model

IF

$$\Delta T_{PP} = \Delta t_{PP1} + \Delta t_{PP} + \Delta t_{PP2}$$

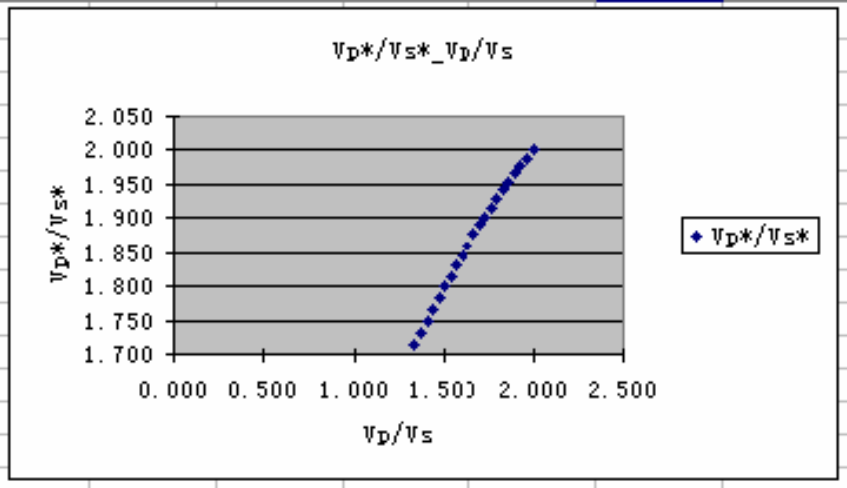
$$\Delta T_{PS} = \Delta t_{PS1} + \Delta t_{PS} + \Delta t_{PS2}$$

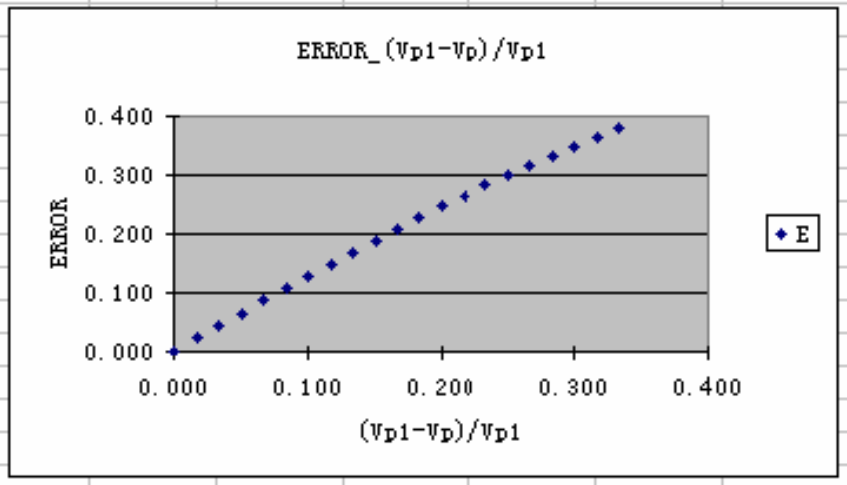
THEN

$$\frac{V_P^*}{V_S^*} = \frac{2\Delta T_{PS}}{\Delta T_{PP}} - 1 = \frac{2(\Delta t_{PS1} + \Delta t_{PS} + \Delta t_{PS2})}{\Delta t_{PP1} + \Delta t_{PP} + \Delta t_{PP2}} - 1$$

The error analysis result

Vp	(Vp1-Vp)/Vp1	Vp/Vs	Vp*/Vs*	E
2000	0.333	1.333	1.714	0.381
2050	0.317	1.367	1.732	0.366
2100	0.300	1.400	1.750	0.350
2150	0.283	1.433	1.767	0.334
2200	0.267	1.467	1.784	0.317
2250	0.250	1.500	1.800	0.300
2300	0.233	1.533	1.816	0.282
2350	0.217	1.567	1.831	0.265
2400	0.200	1.600	1.846	0.246
2450	0.183	1.633	1.861	0.227
2500	0.167	1.667	1.875	0.208
2550	0.150	1.700	1.889	0.189
2600	0.133	1.733	1.902	0.169
2650	0.117	1.767	1.916	0.149
2700	0.100	1.800	1.929	0.129
2750	0.083	1.833	1.941	0.108
2800	0.067	1.867	1.953	0.087
2850	0.050	1.900	1.966	0.066
2900	0.033	1.933	1.977	0.044
2950	0.017	1.967	1.989	0.022
3000	0.000	2.000	2.000	0.000

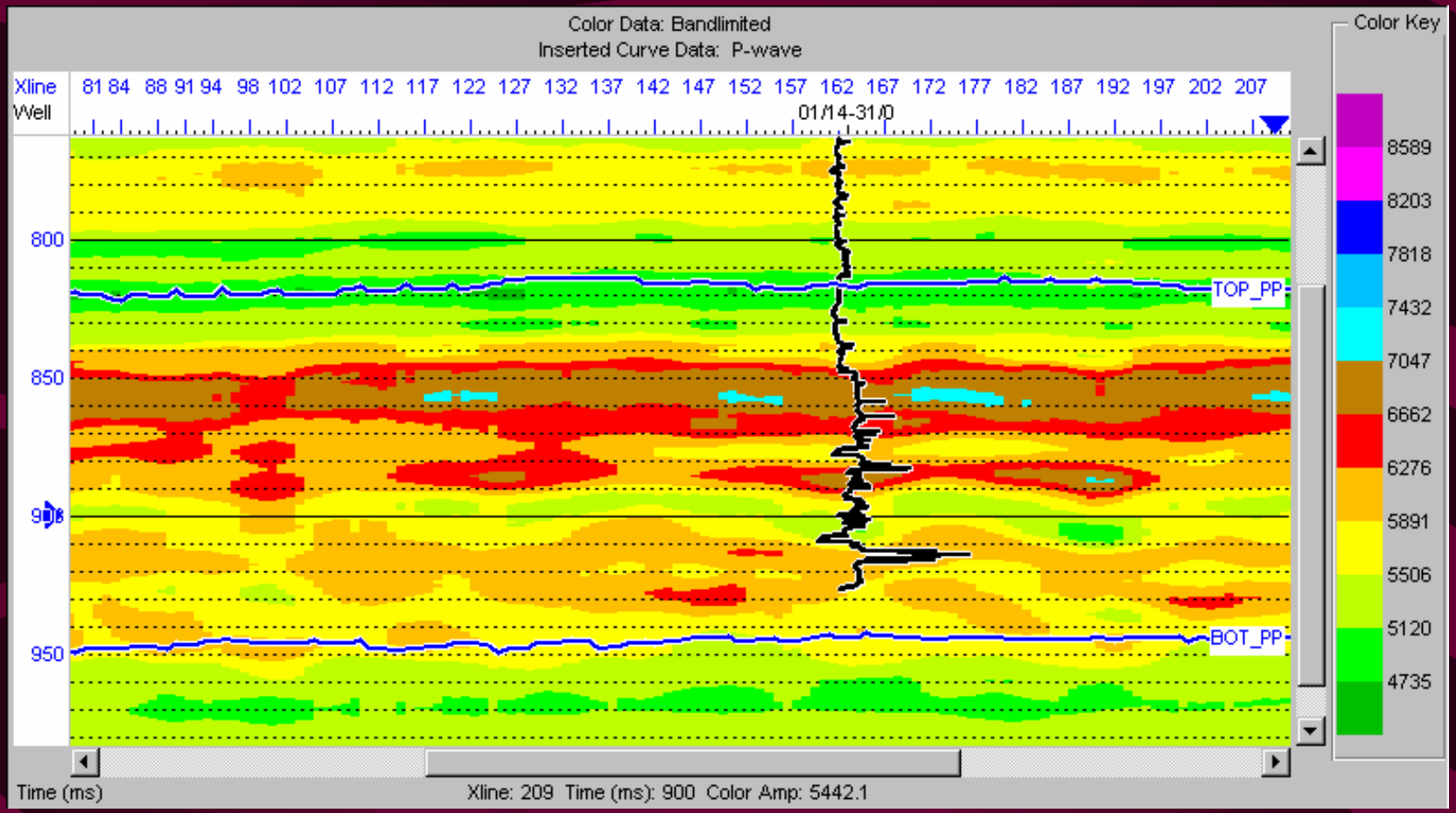




Assumption: V_P/V_S ratio of overlain and underlain formations doesn't change laterally

Why is the traveltime mapping fairly robust in this case

- The pay formation is overlain and underlain by shale.
- Shaly layers in this area show little lateral variation in velocity.
- The reflection events from thick shaly formations are usually coherent.
- Due to these conditions, our method is robust.



The inversion result from PP seismic volume

Conclusions

- Low-pass filtering of the PP seismic volume before picking will enhance the similarity between PP and PS seismic volumes and will generally help us get more a better result;

- If V_{P1}/V_{S1} of surrounding zone doesn't change much laterally, V_P^*/V_S^* calculated from interpreted interval will keep the similar pattern with V_P/V_S of pay zone;

- In our case, the V_P^*/V_S^* map is not overly sensitive to the average effects from the overlain and underlain formations.

Acknowledgments

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