P-S migration using EO method

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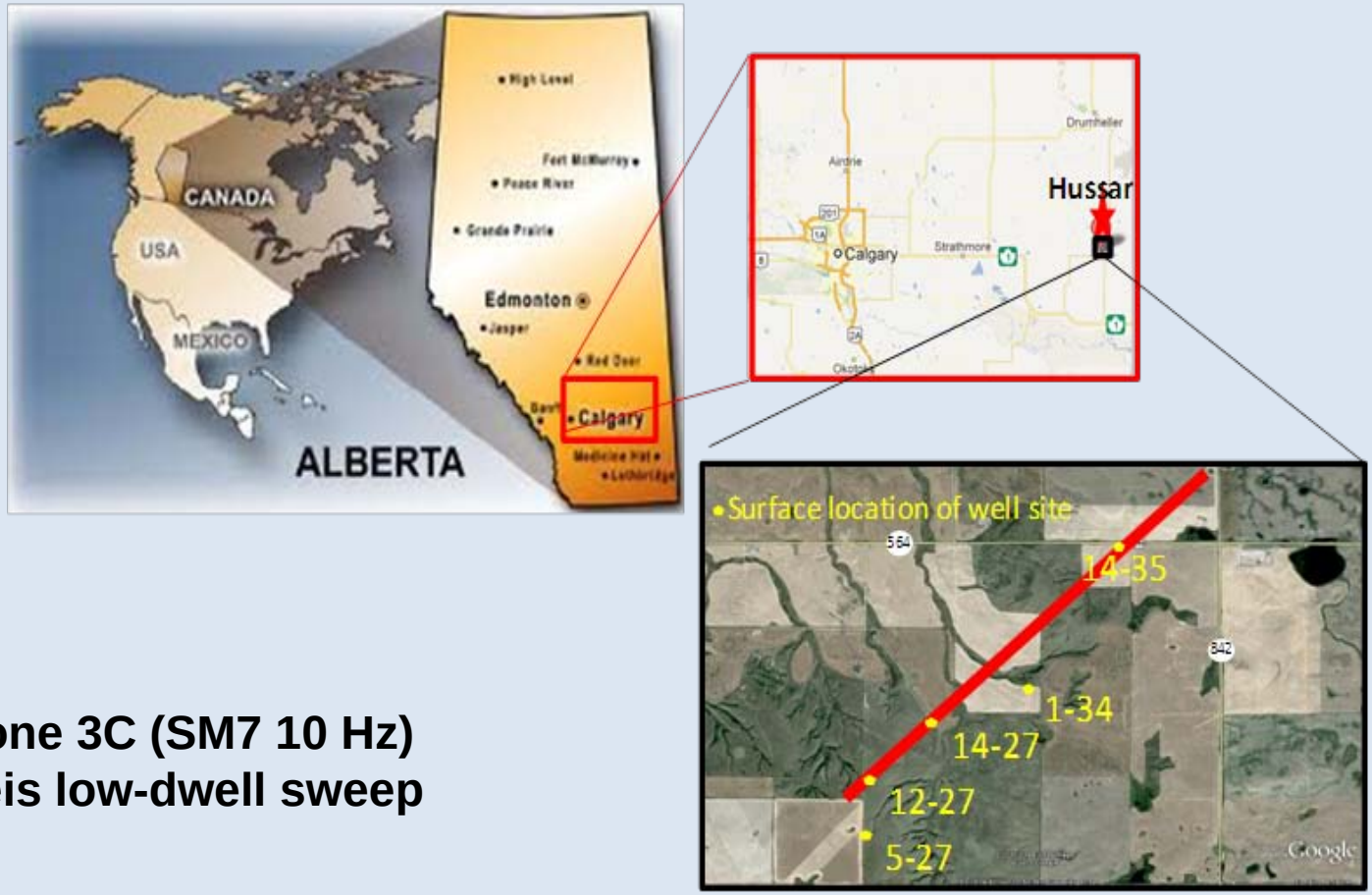
Outline

- Objective
- Examples
  - Hussar
  - Synthetic model
  - NEBC
- Summary
- Acknowledgments

Objective

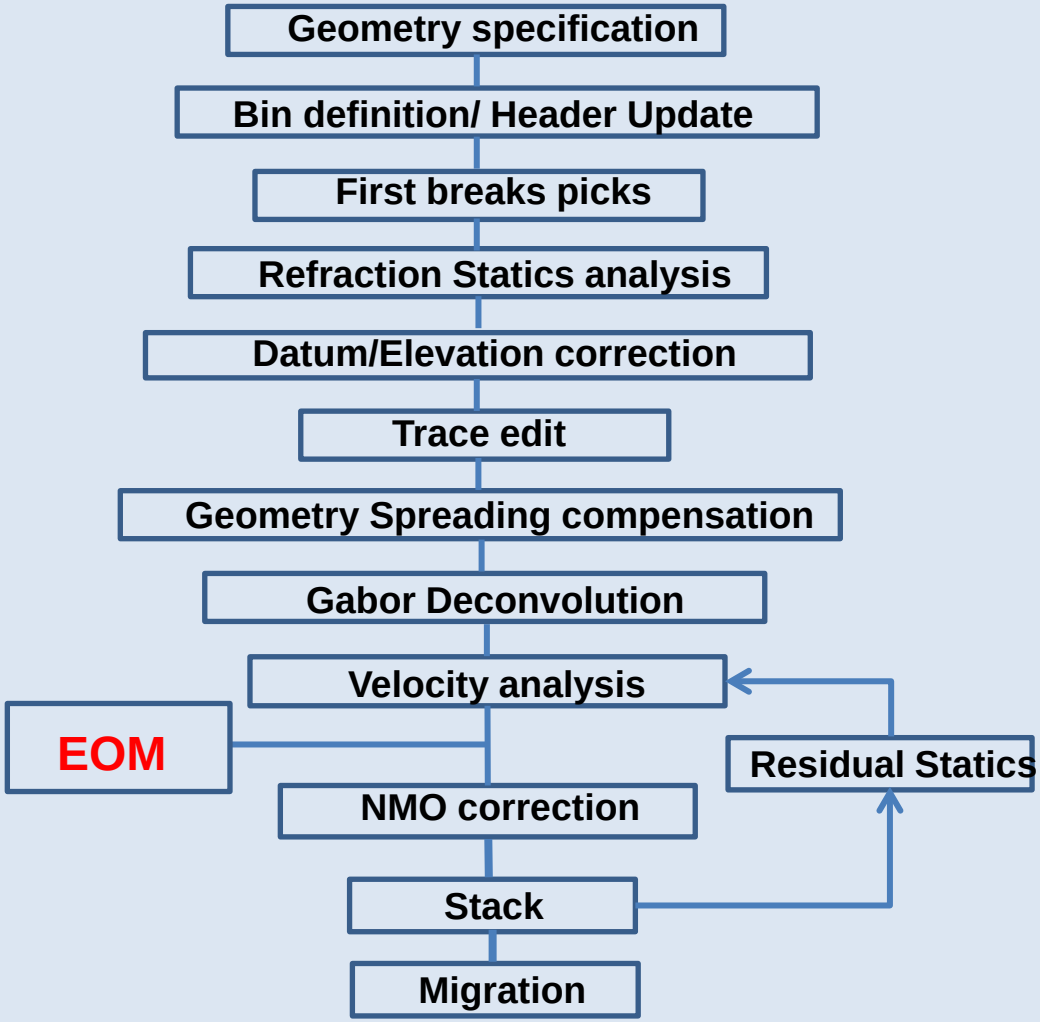
After finding an estimation of the converted wave velocity Vc and shear wave velocity Vs, from P-P and P-S wave data, show the results using EOM.

Hussar

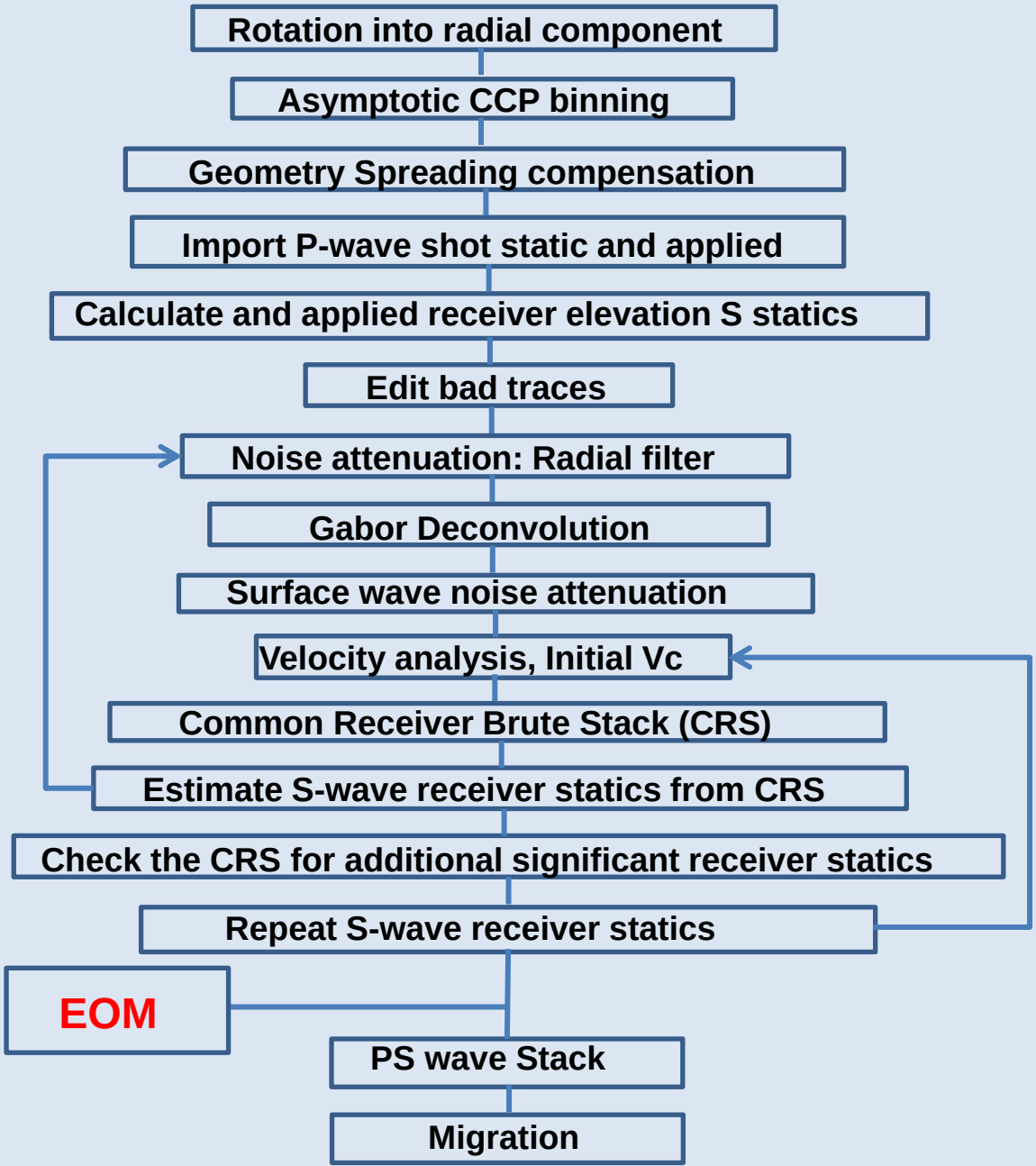


Geophone 3C (SM7 10 Hz)
Vibroseis low-dwell sweep

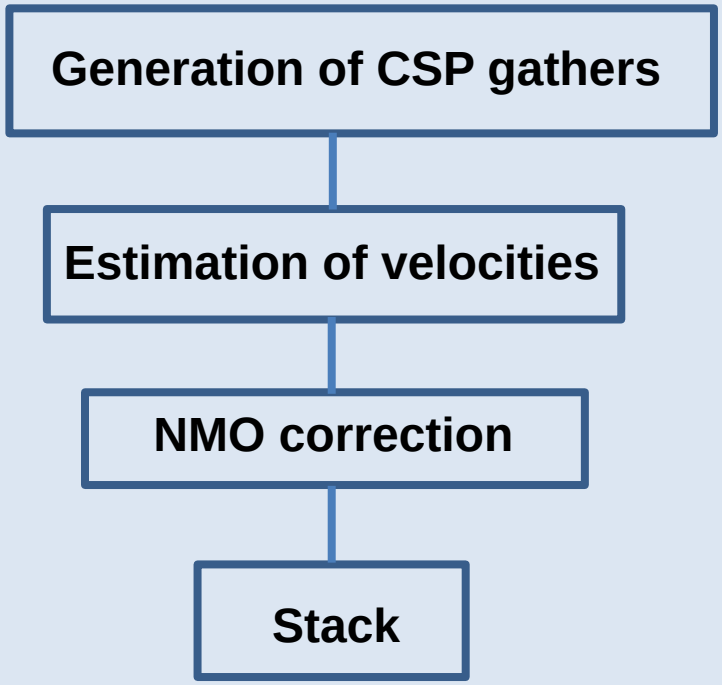
Processing flow for P-P data



Processing flow for P-S data



EOM processing flow



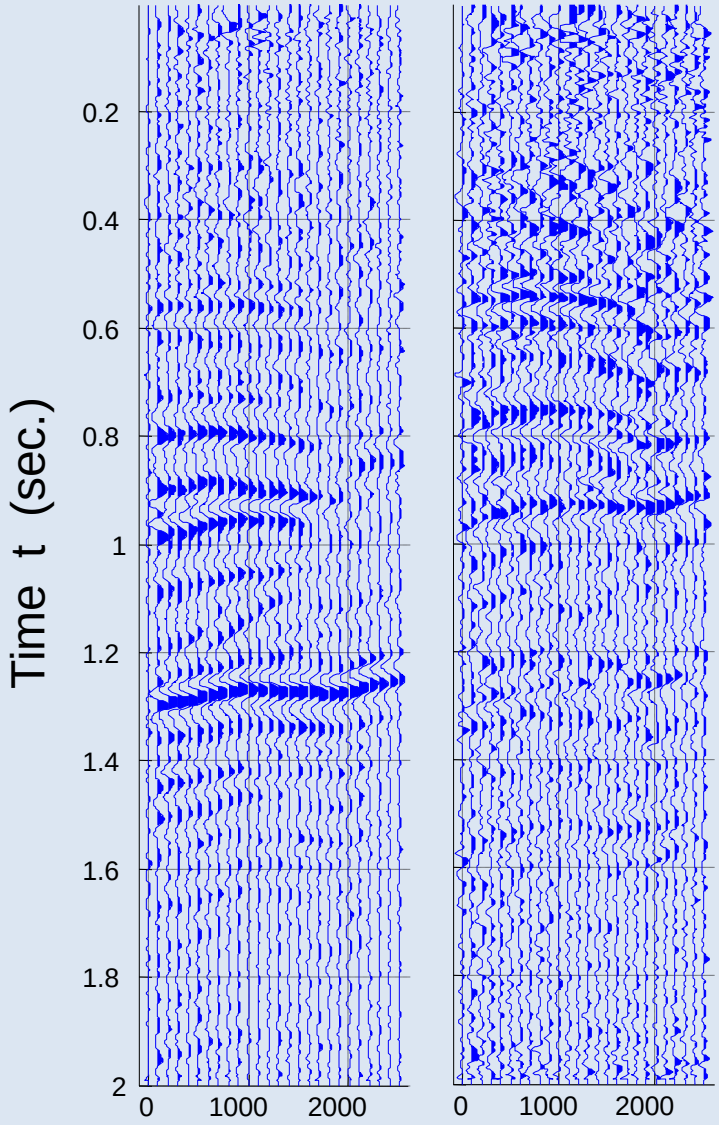
Estimation of the velocities

- Initial V_{c1} with V_p and γ
- Limited range EO gathers
- Pick new V_{c2}
- Estimate V_s
- Full EO gathers with V_p and V_s
- Pick new V_{c3}
- Moveout correction with V_{c3}
- Stack to complete the prestack migration

$$V_c = \frac{2V_{rms-p}V_{rms-s}}{V_{rms-p}+V_{rms-s}}$$

Initial estimate of Vc1

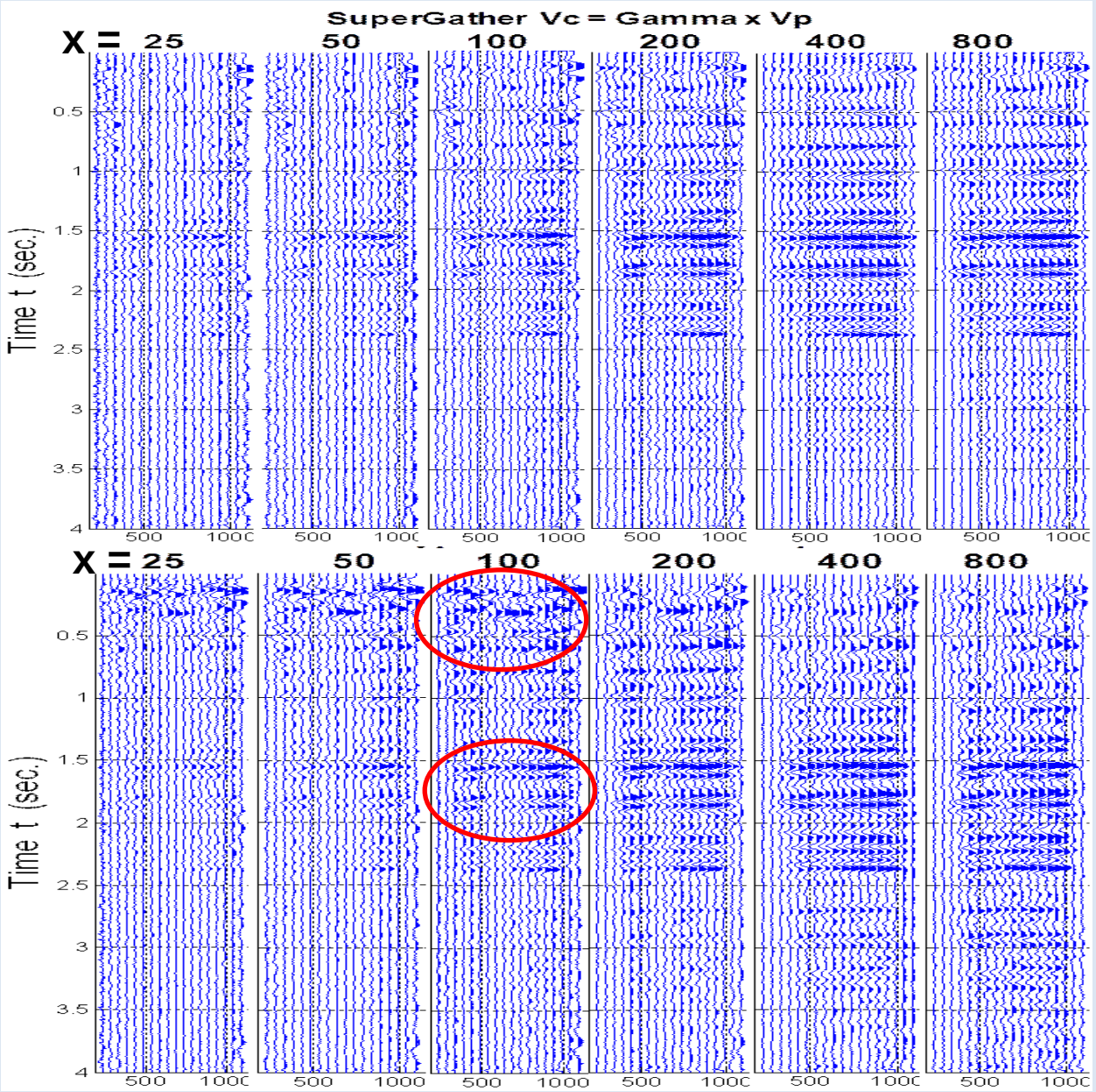
$\gamma = 2$ $\gamma = 2.5$



Initial estimate of Vc1

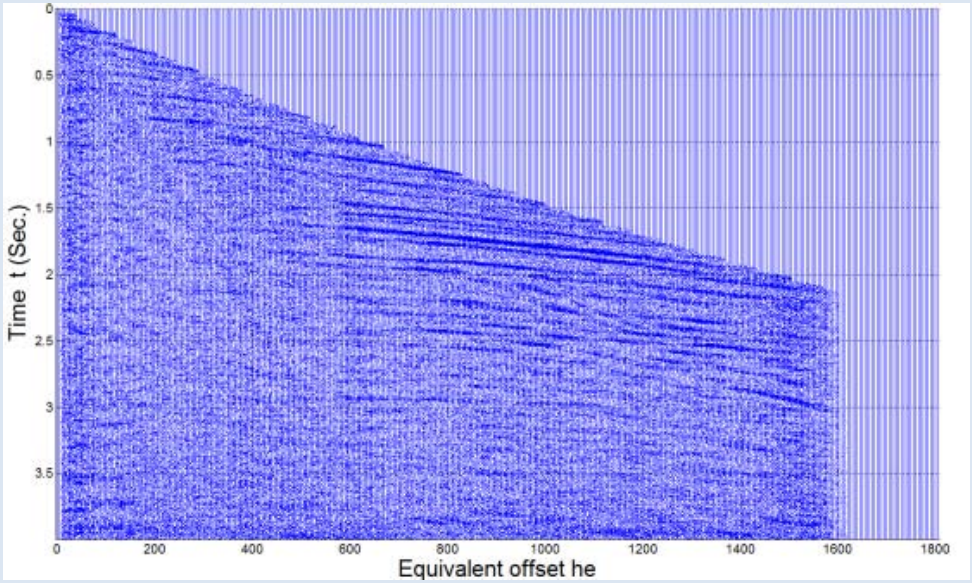
Stacked line
(Supergather)

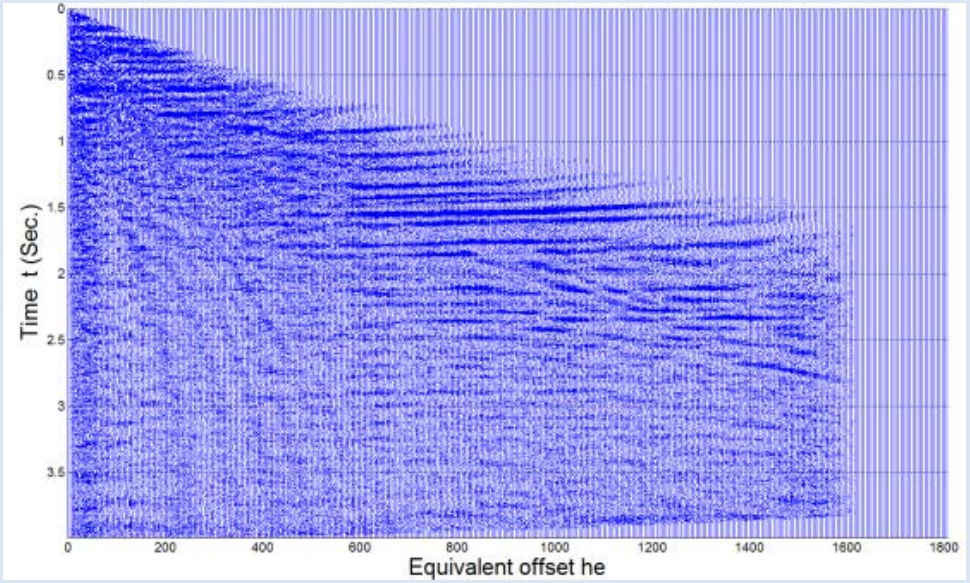
Stacked line
(EO method)



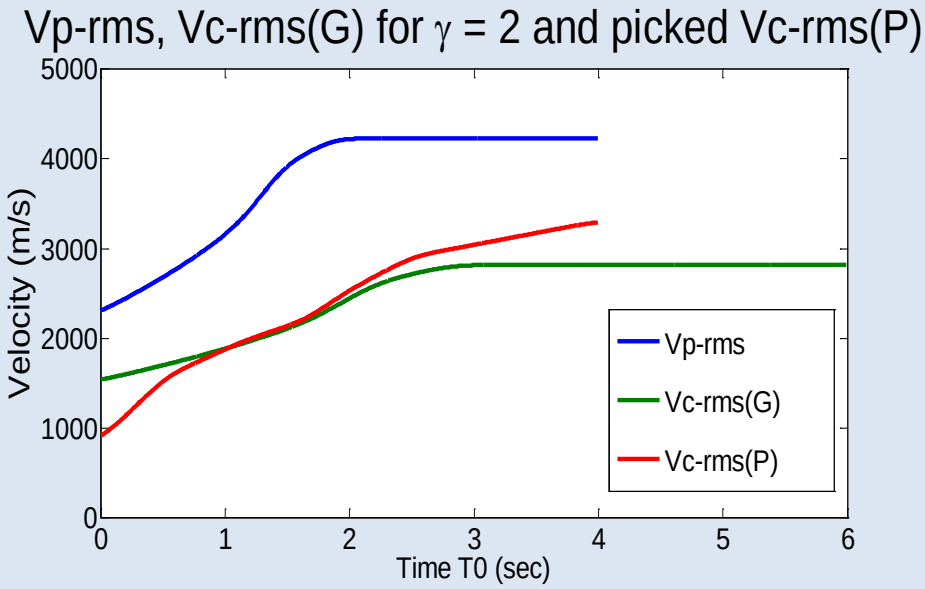
LCCSP gather

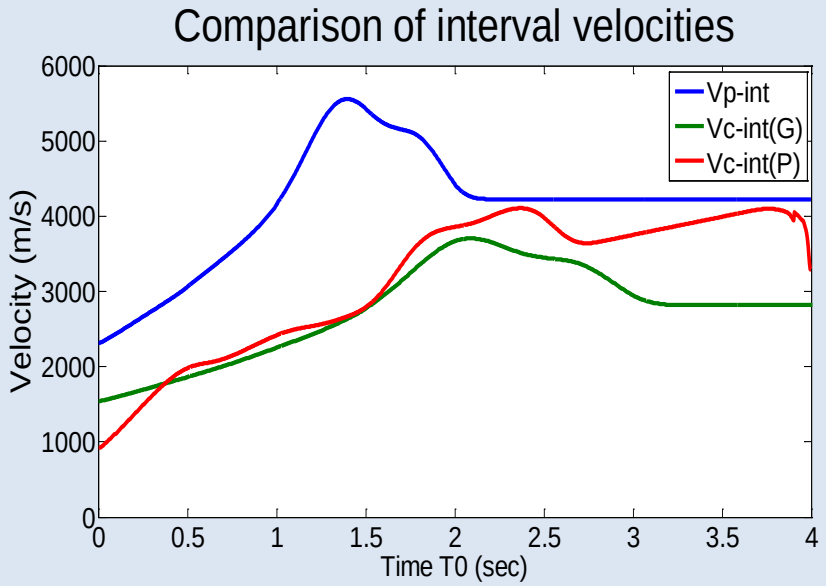
x = 100 m

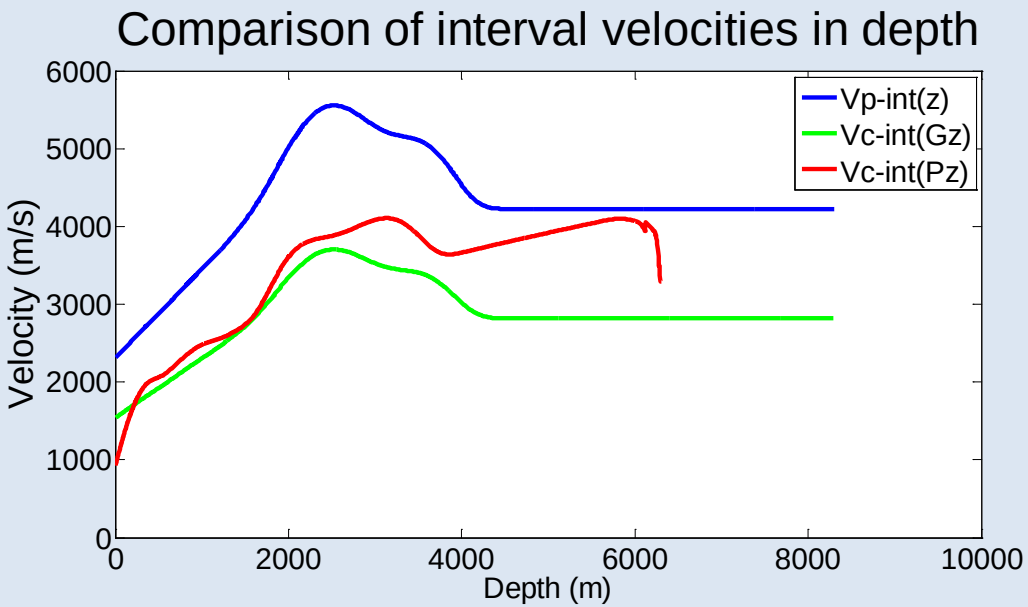




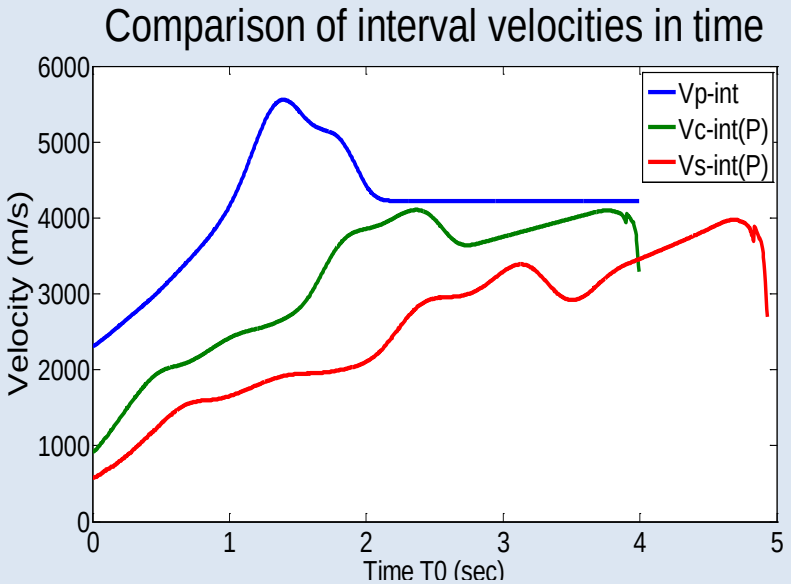
Second estimation of Vc2

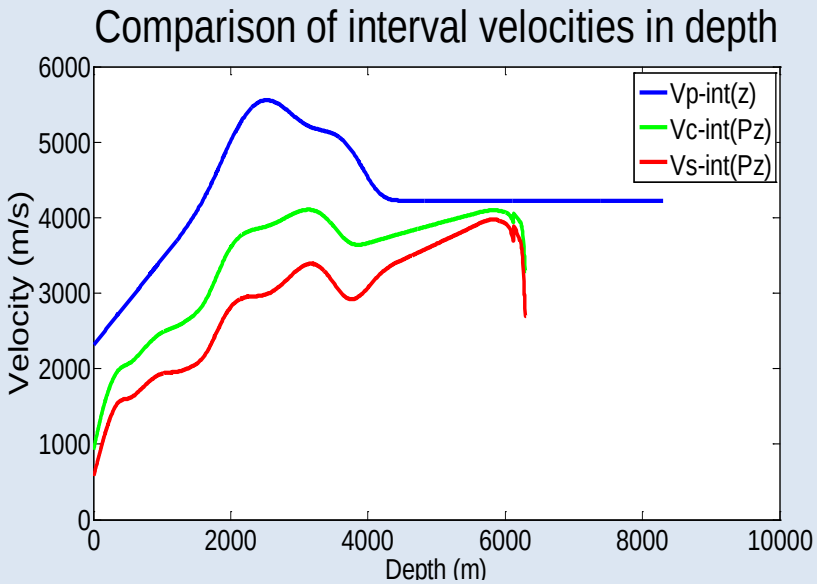


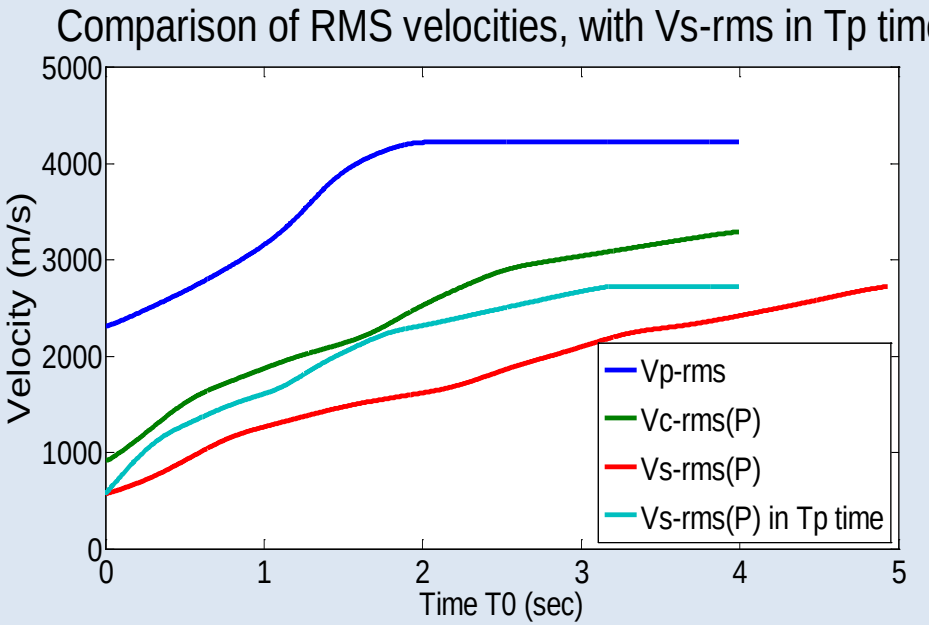




Estimating the S velocities







Full EOM

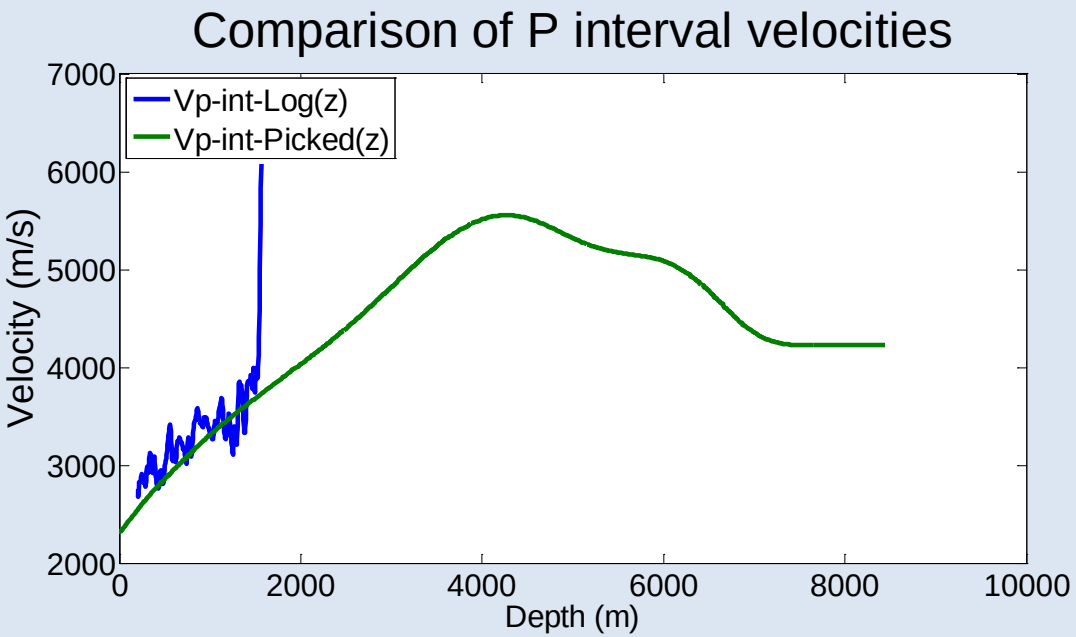
Full EO gathers with V_p and V_s

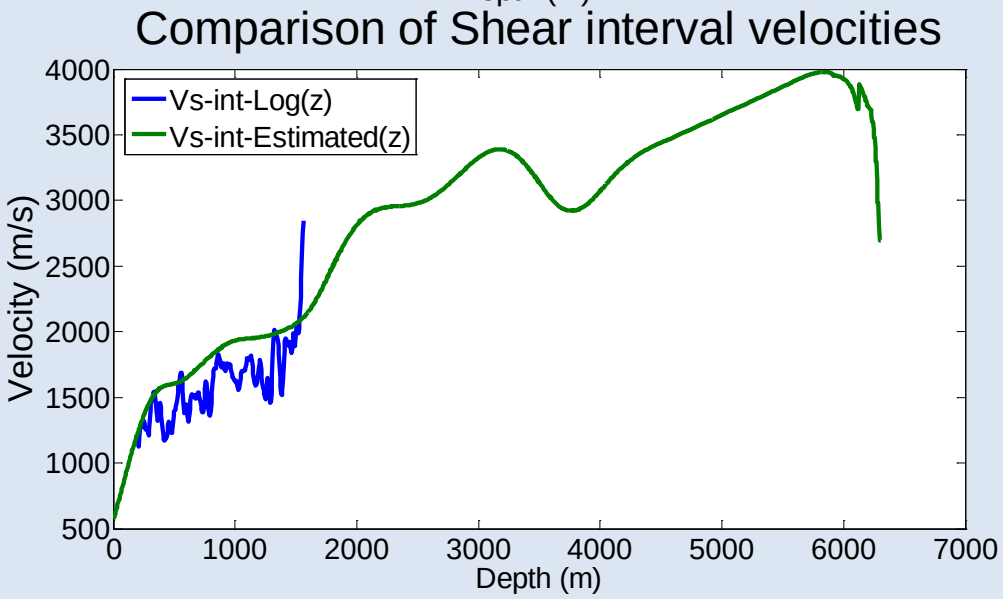
$$t_c = t_s + t_r = \sqrt{\frac{t_{0p}^2}{4} + \frac{(x+h)^2}{V_{rms-p}(t_{0p})}} + \sqrt{\frac{t_{0s}^2}{4} + \frac{(x-h)^2}{V_{rms-s}(t_{0p})}}$$

$$t = \left(\frac{1}{V_{rms-p}} + \frac{1}{V_{rms-s}} \right) \sqrt{\hat{z}_0^2 + h_e^2}$$

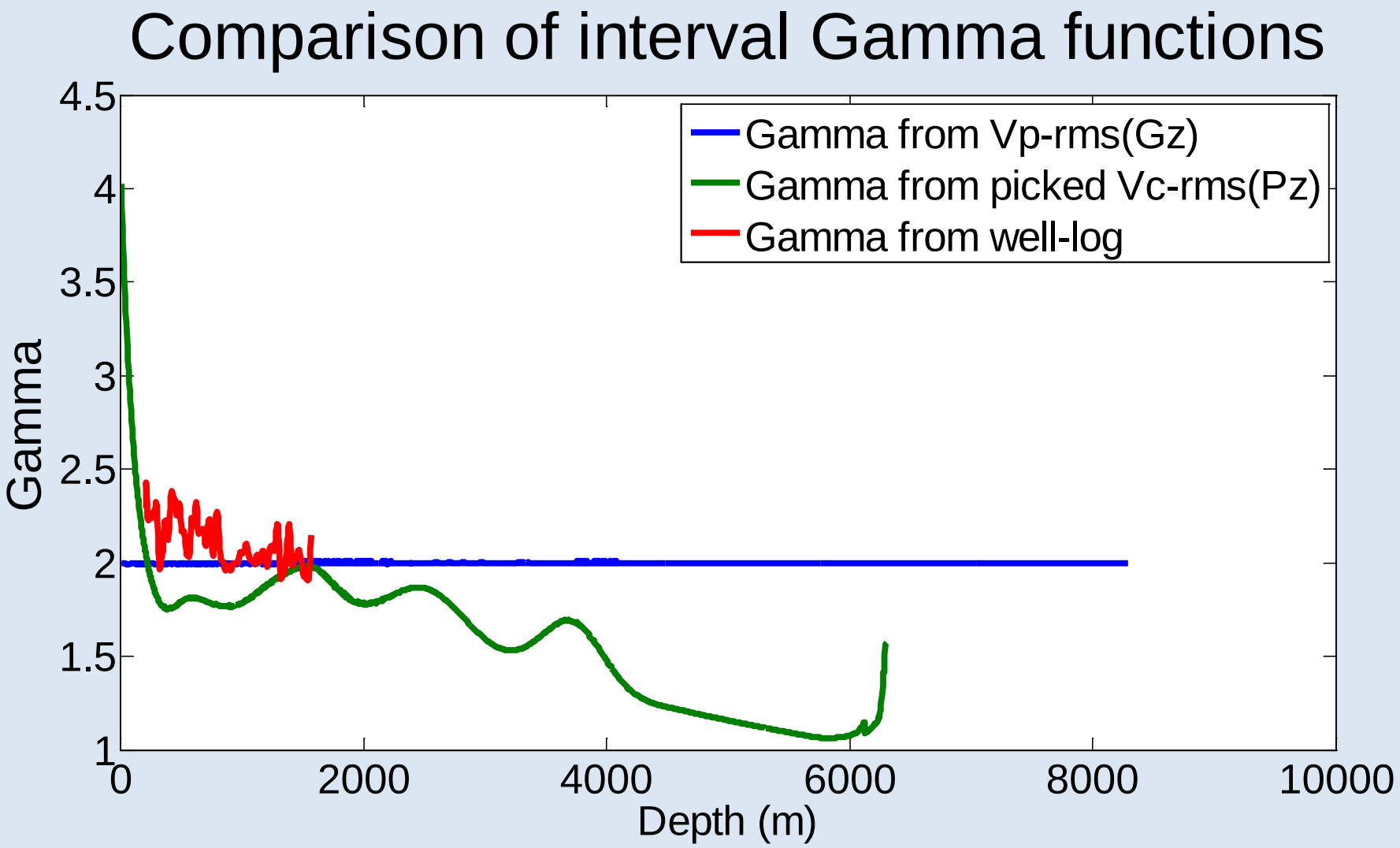
With the Vp and the estimated S velocity, new Vc3 is calculated picked from the new CCSP gathers

Interval velocities



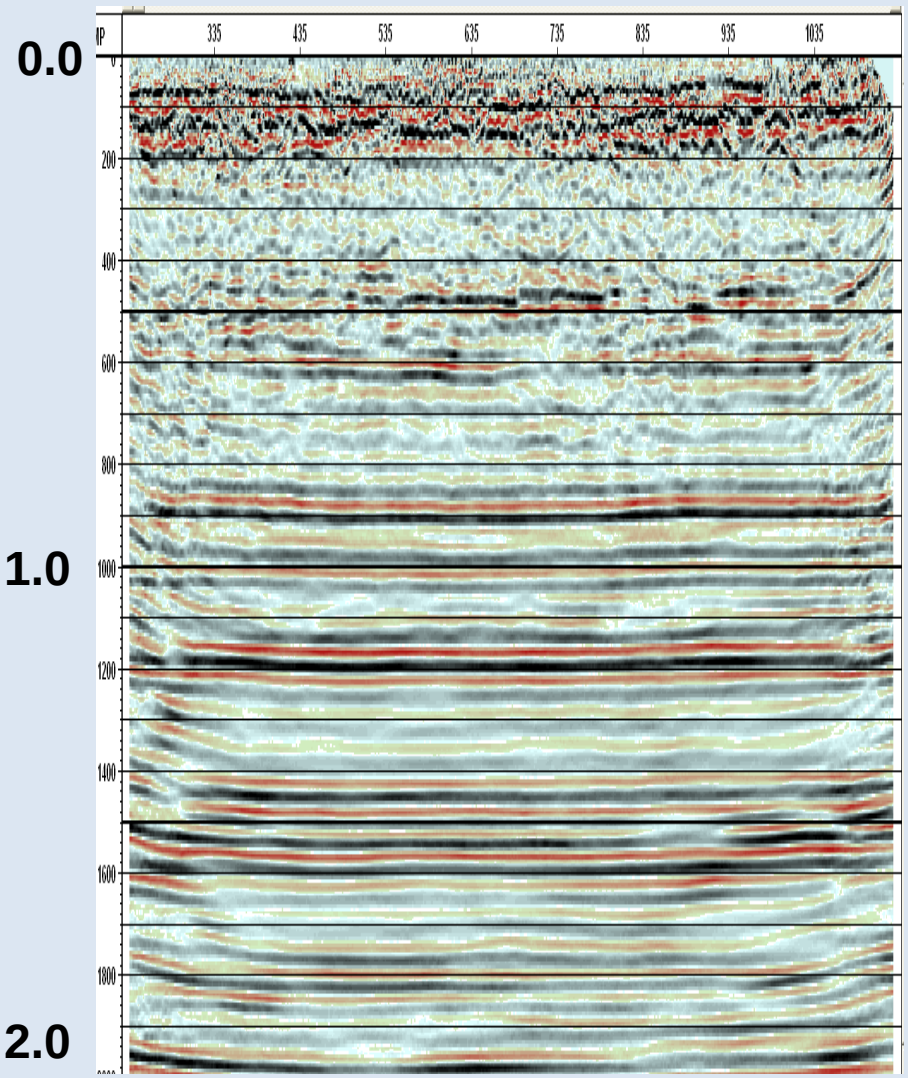


Gamma functions

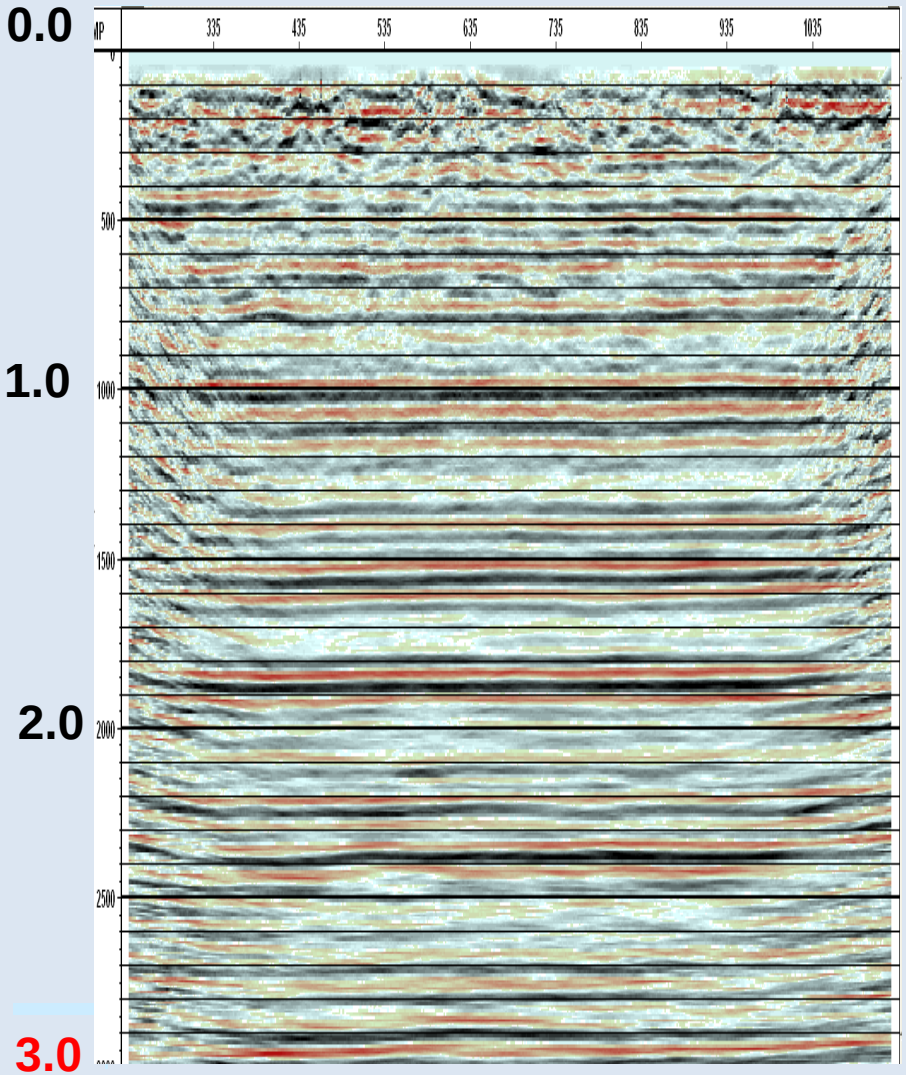


Final stack after Full EOM

P-P section

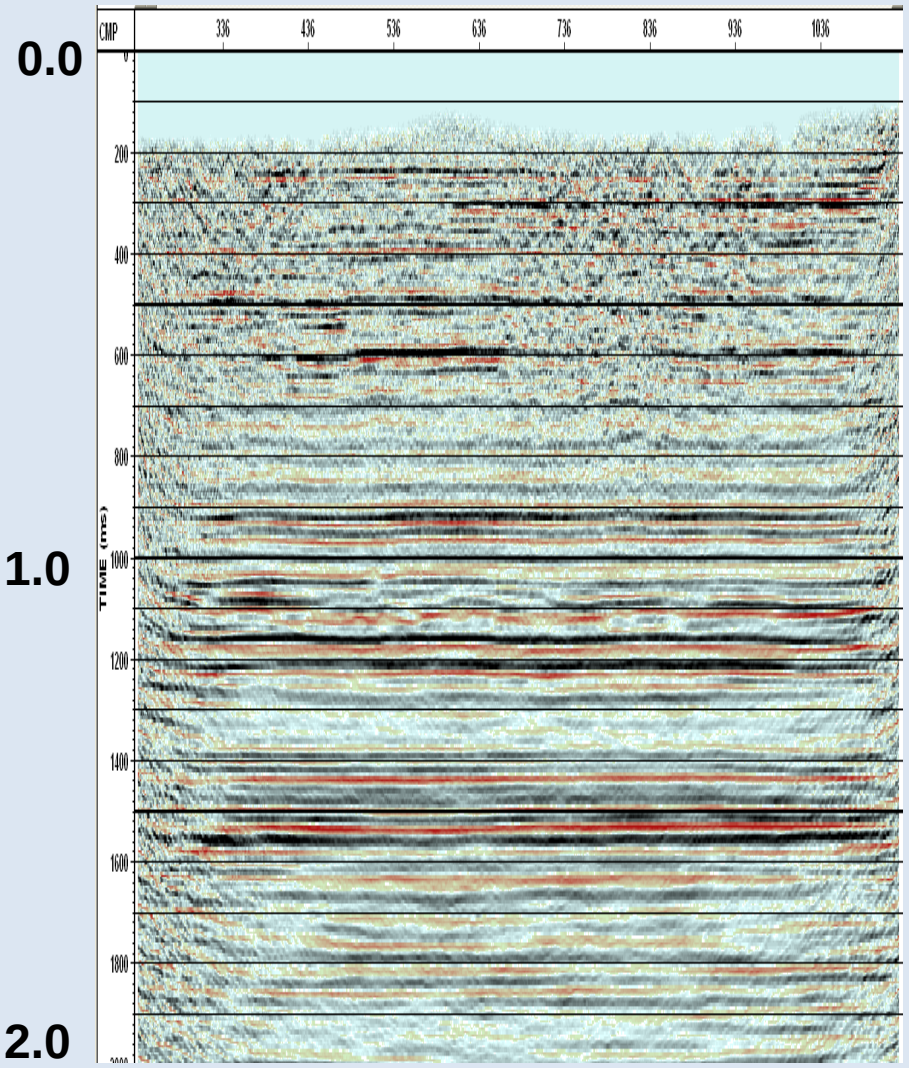


P-S section

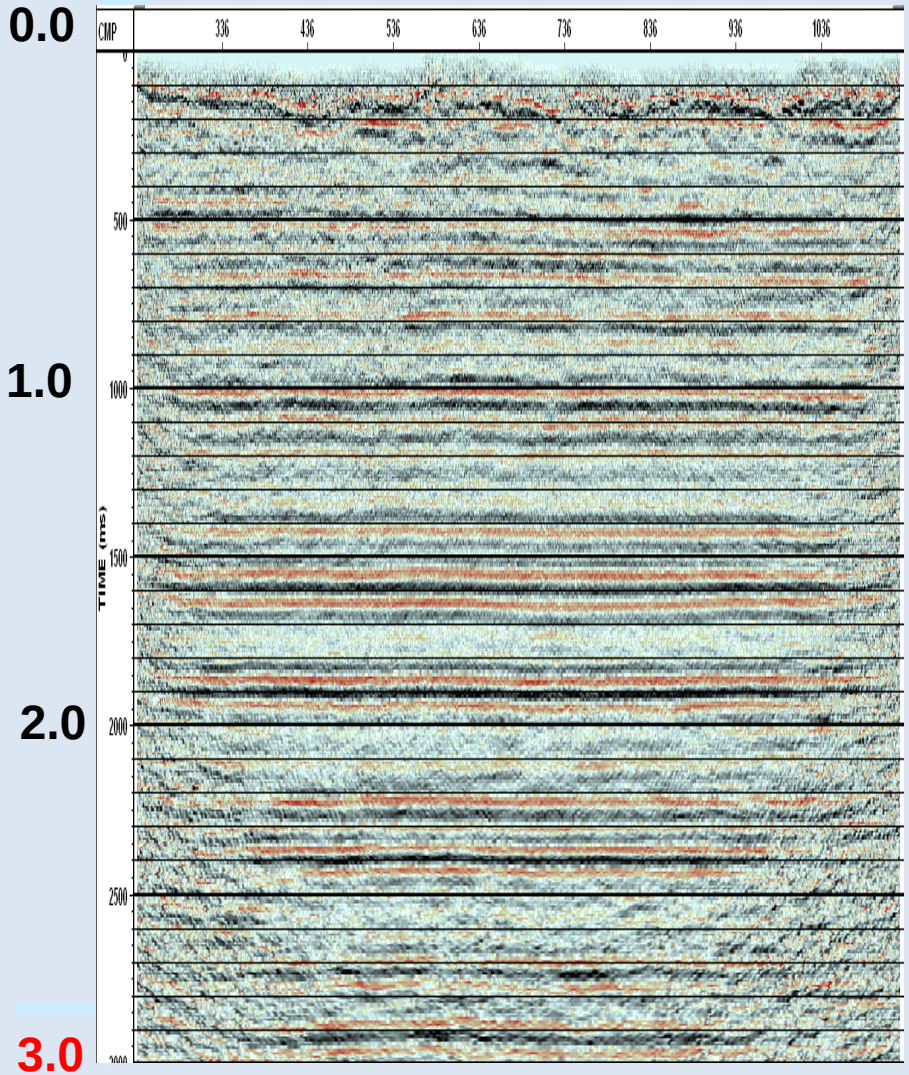


Final stack after post-stack migration

P-P section

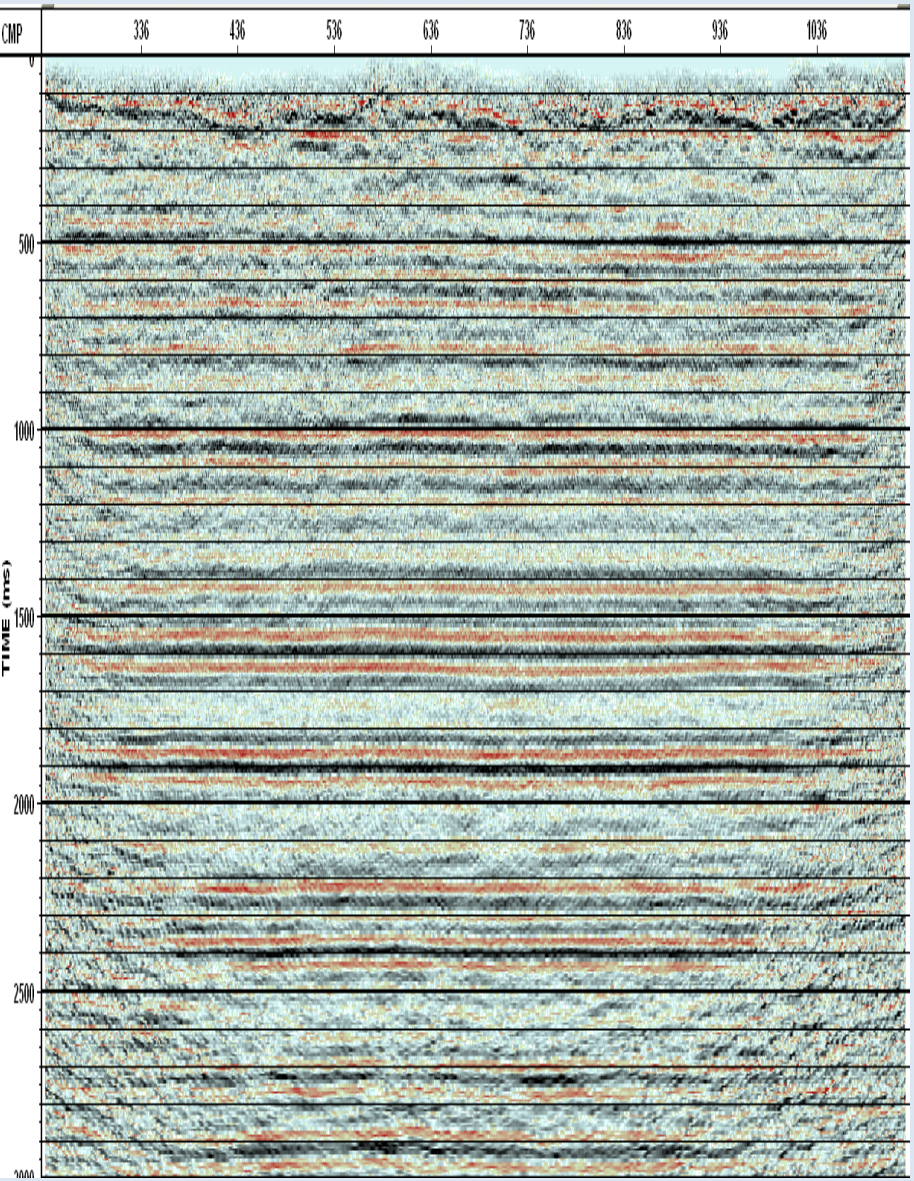


P-S section

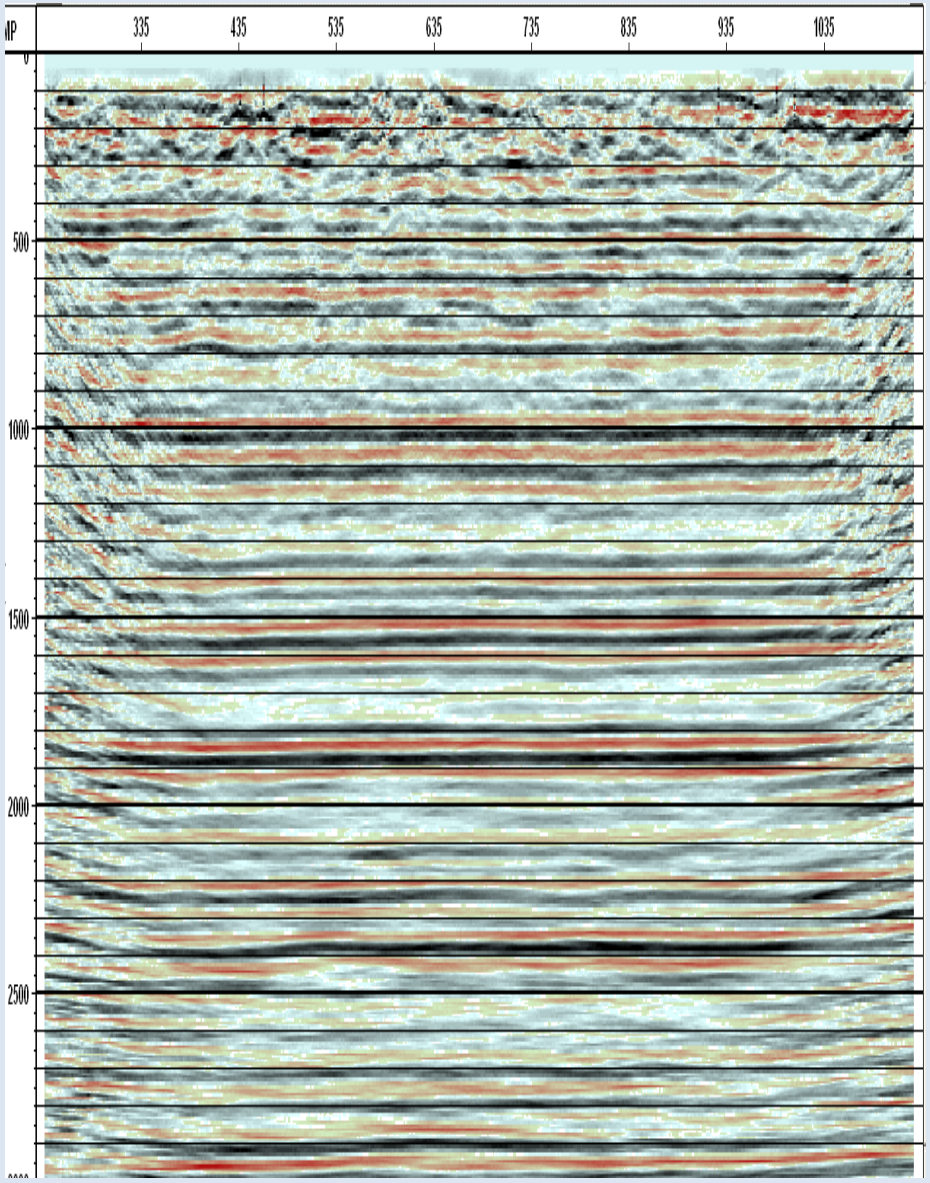


P-S section

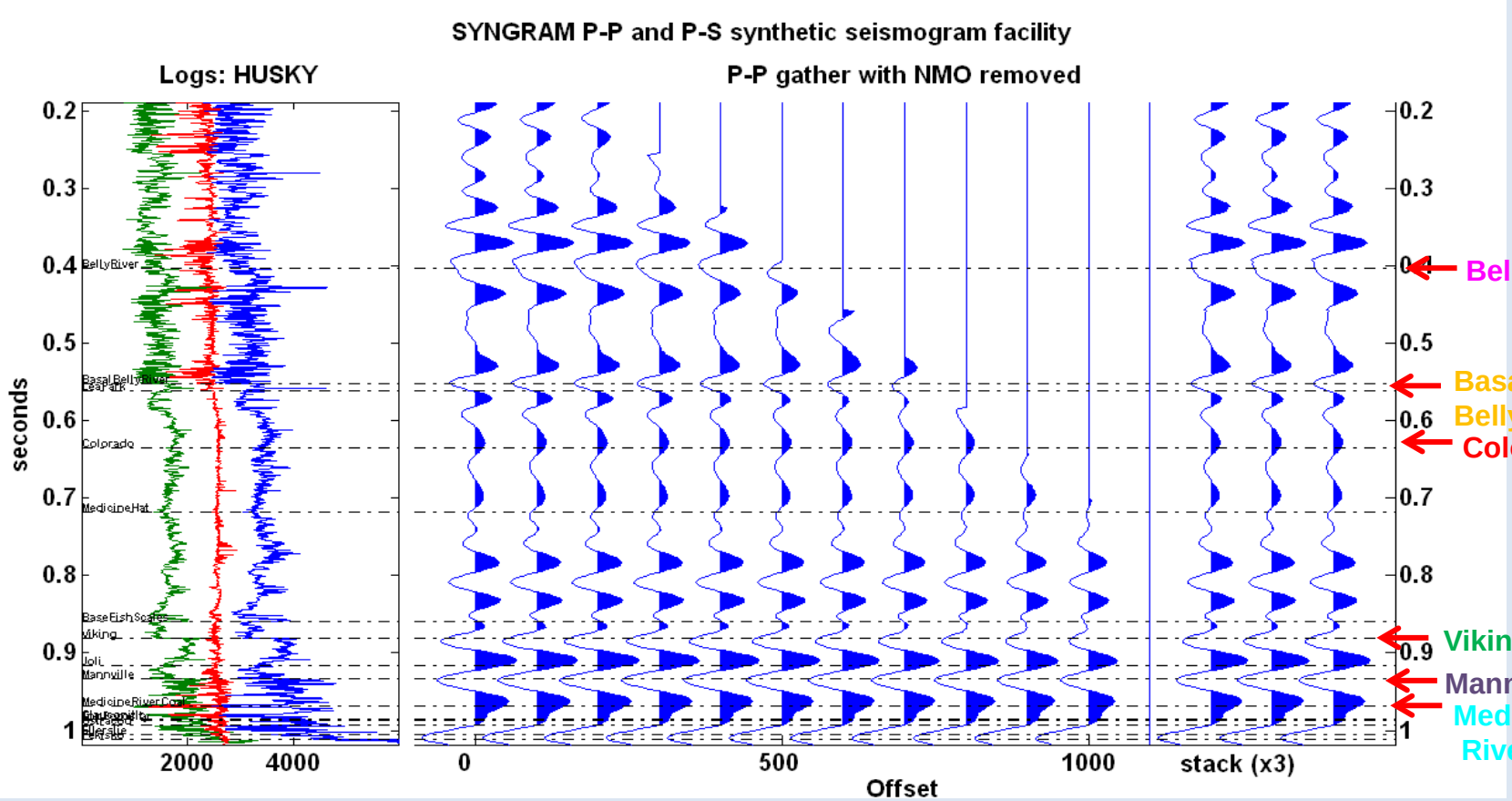
Final stack after post-stack migration



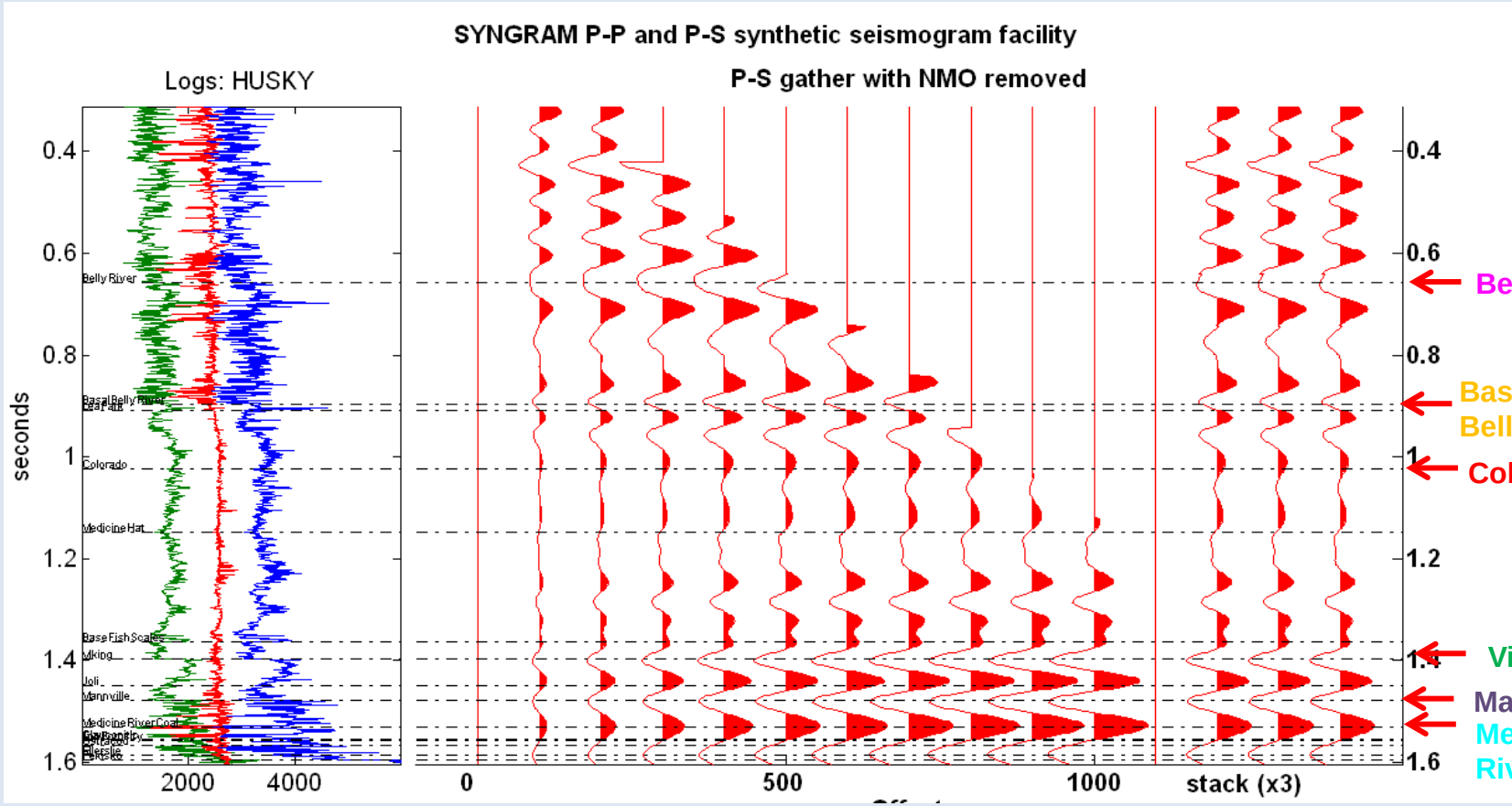
Final stack after Full EOM



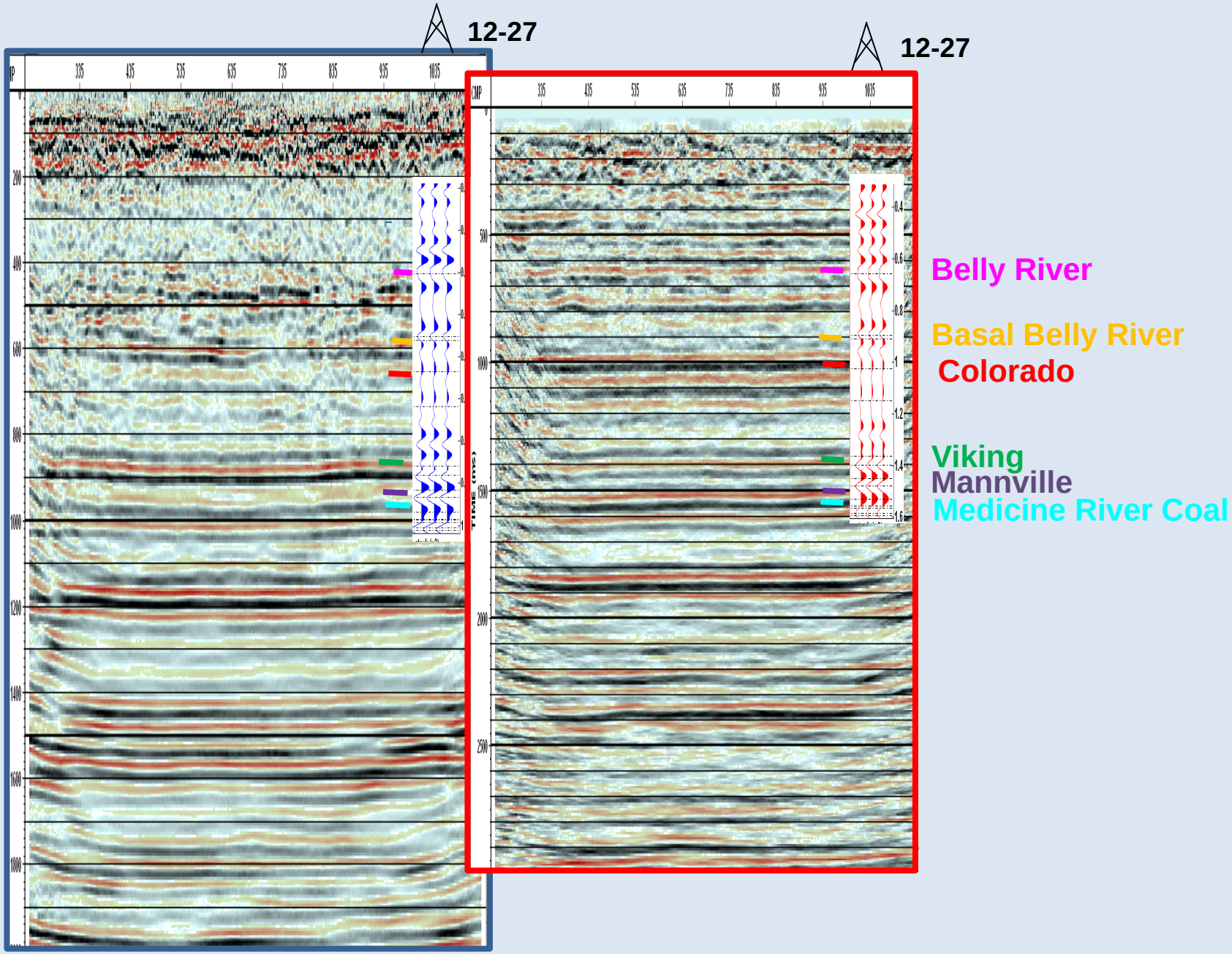
Synthetic seismogram for PP



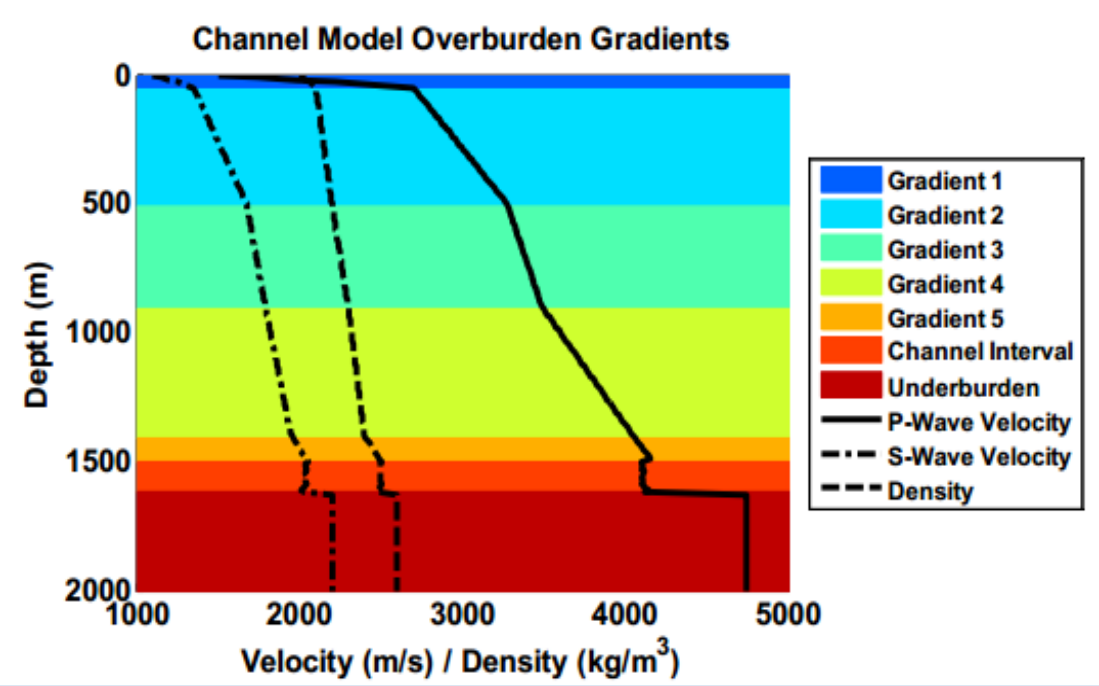
Synthetic seismogram for PS

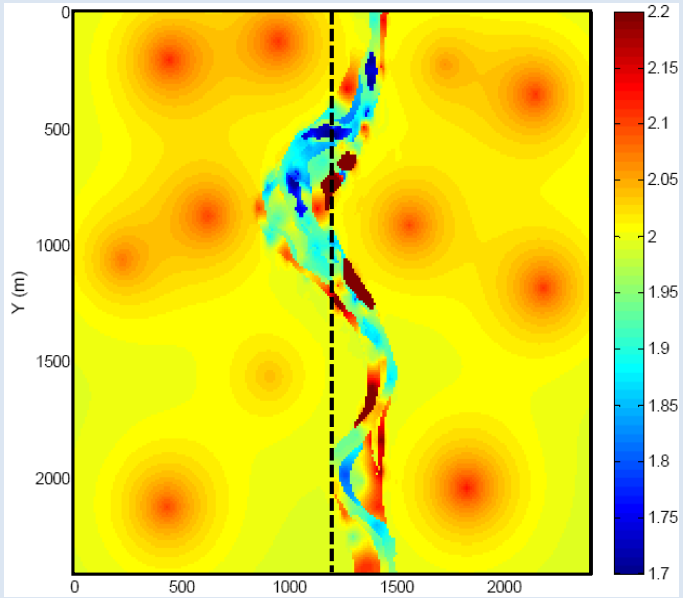


Final stack after Full EOM



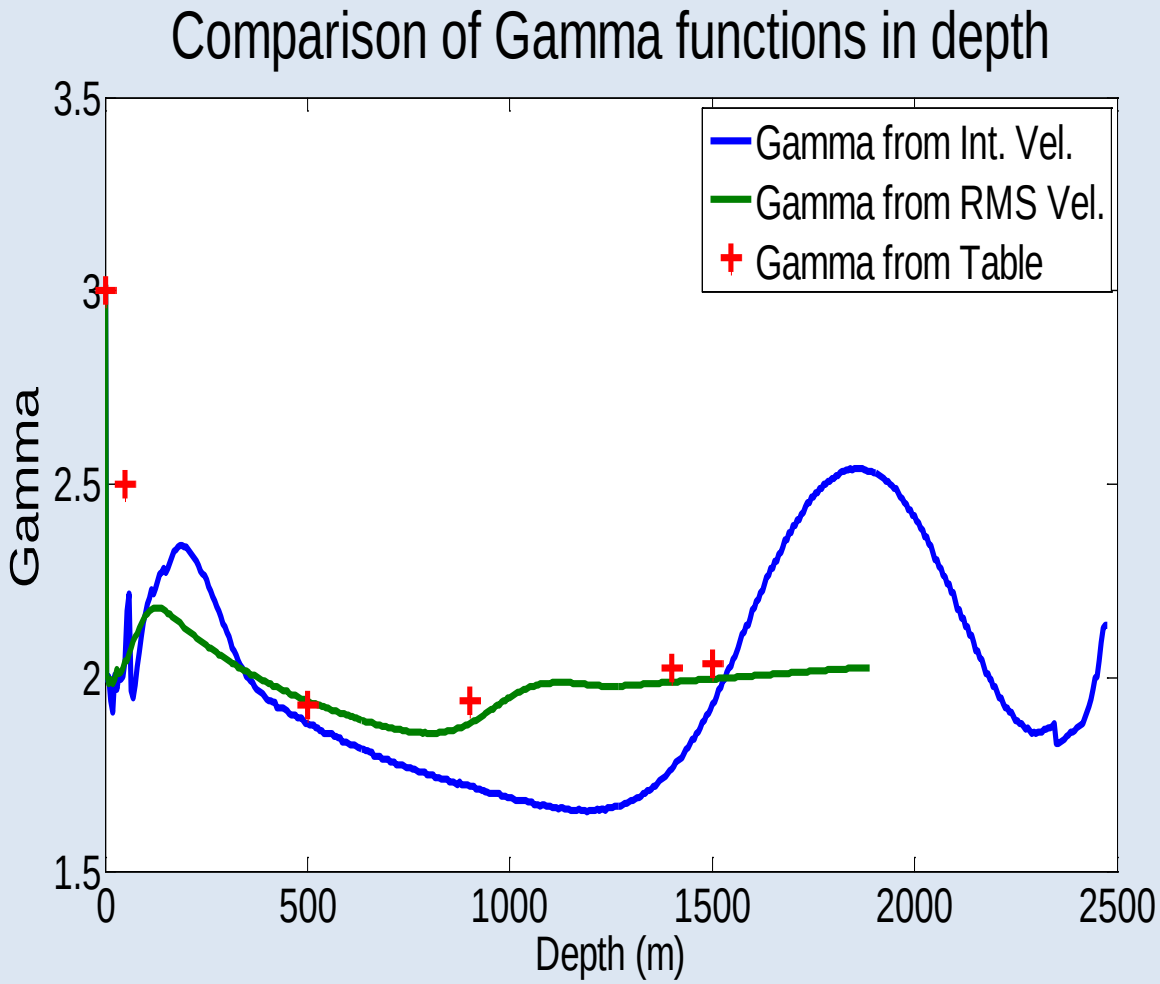
Results
Synthetic model





(Lloyd and Margrave, 2010)

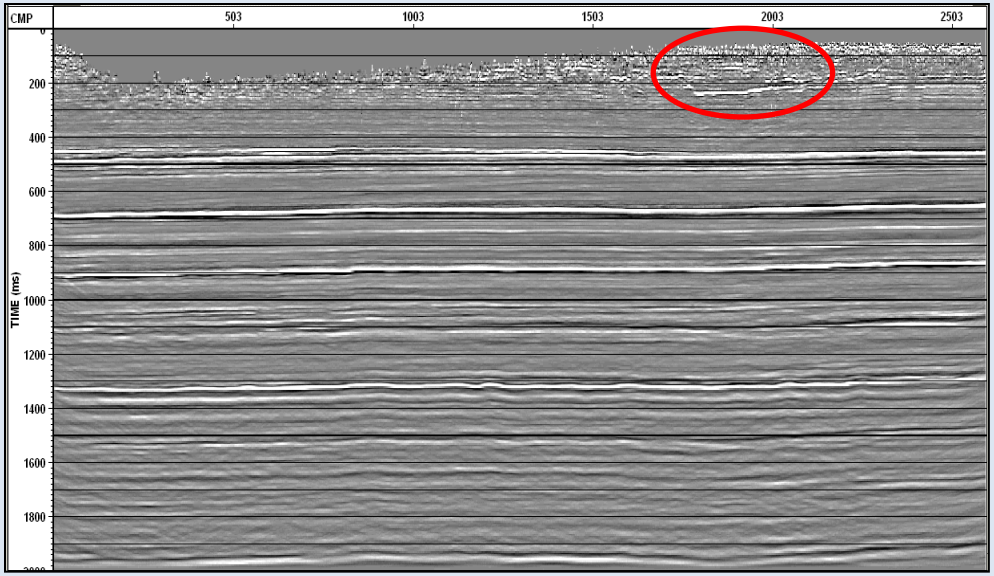
Estimating the velocities



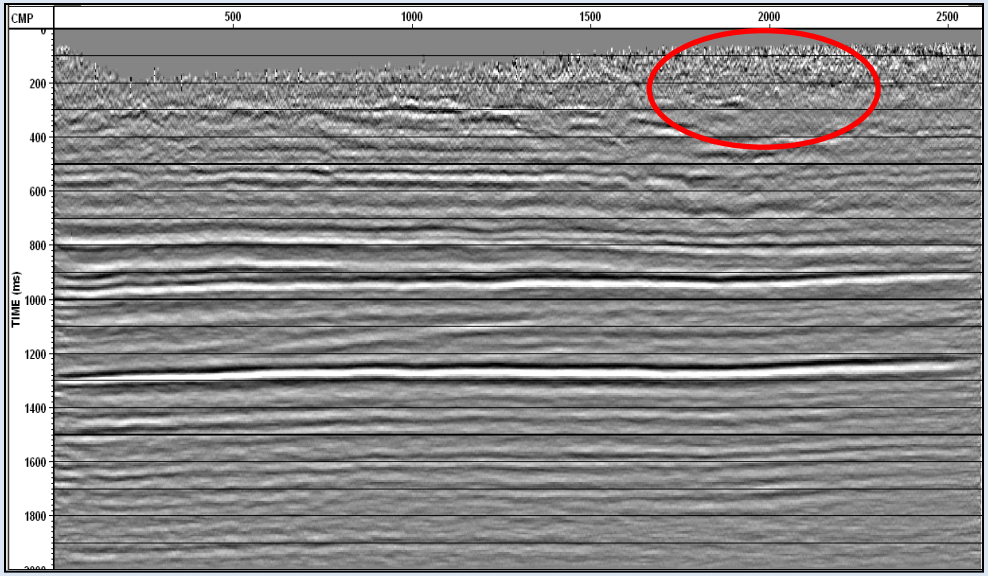
Layer	Vp	Vs	γ
1	1500	500	3
2	2750	1100	2.5
3	3287	1700	1.93
4	3487	1800	1.94
5	4090	2000	2.03
6	4175	2050	2.04

Results NEBC

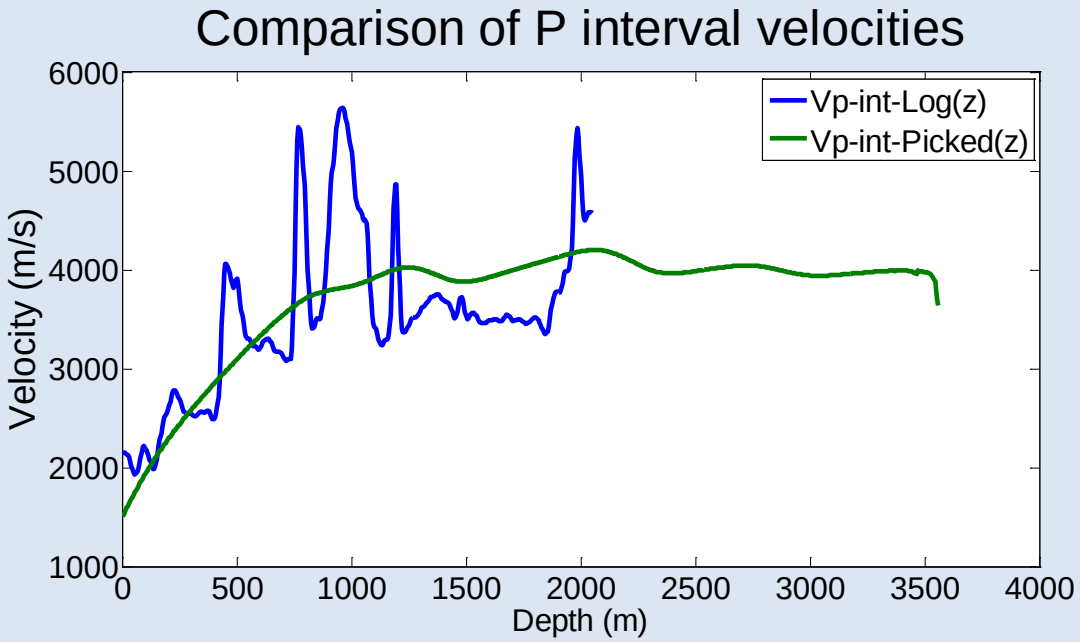
P-P section

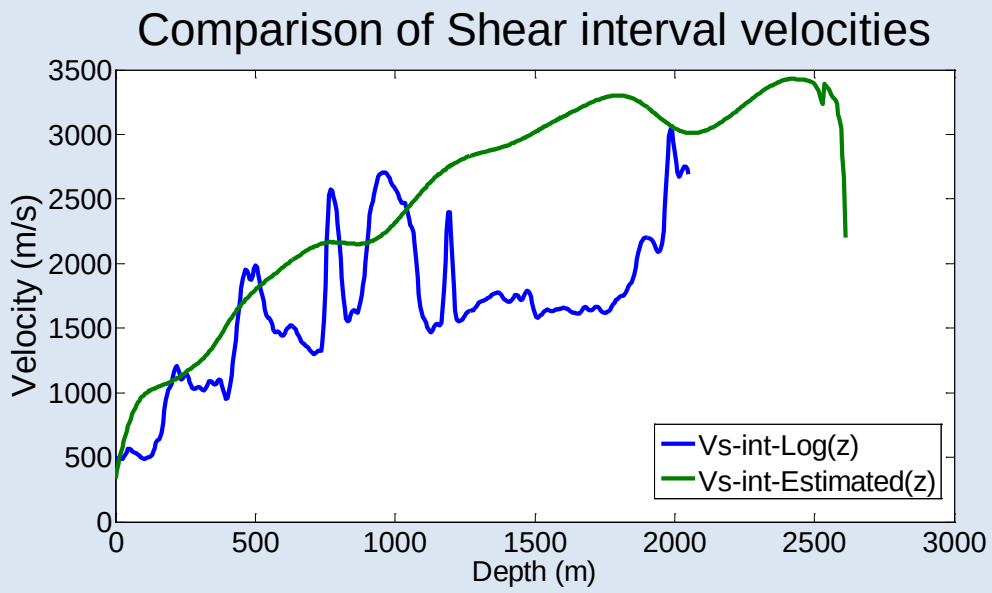


P-S section



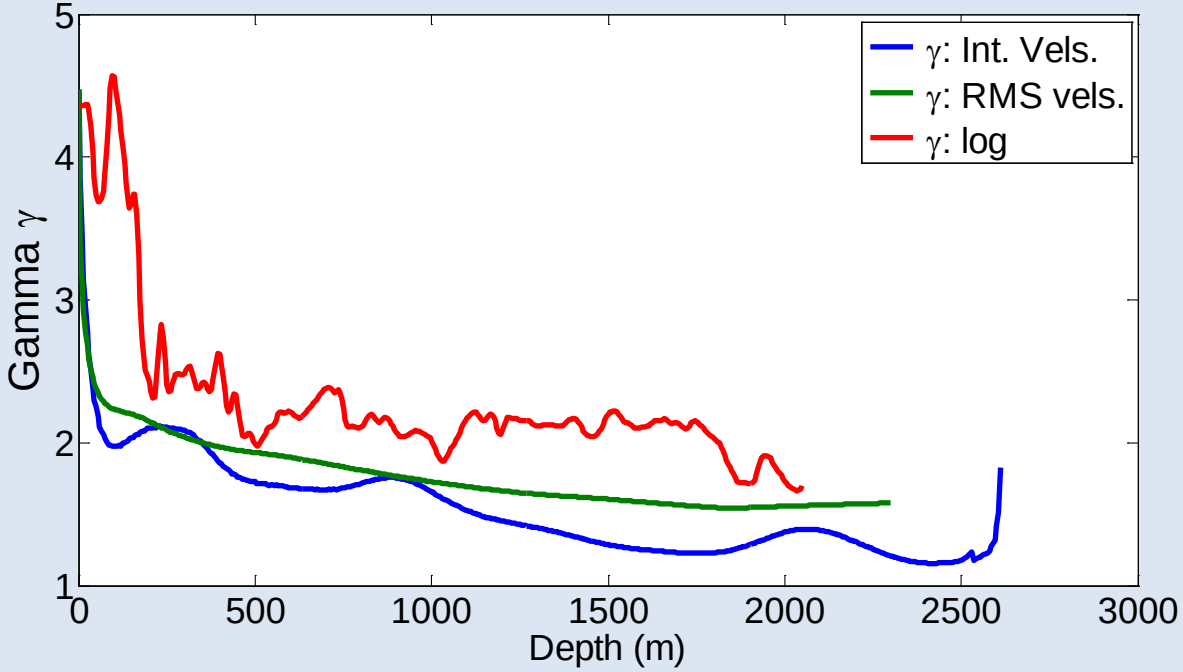
Interval velocities





Estimating the velocities

Gamma functions in depth from picked velocities



Summary

- This initial velocity V_c was estimated from RMS velocities V_p and an initial constant value for the V_p/V_s ratio .

- A reasonably accurate estimate of converted wave velocities V_c is required to form CCSP gathers as part of the Equivalent Offset Migration of converted waves.

- These converted wave velocities (second V_c) were then used to make an initial estimate of the shear wave velocities V_s. These velocities were then used with the V_p velocities for prestack migration.

Summary

(continued)

- The common converted wave scatterpoint (CCSP) gathers were then used to create accurate estimates of V_c in order to improve V_s and γ.

- The quality of the method is demonstrated for the case of Hussar, synthetic model and NEBC dataset. The results show superior imaging when compared with alternative migration algorithms.

- The estimated interval velocities of V_p and V_s are compared with velocities obtained from well-logs and compare favorably.

Acknowledgments

- All CREWES staff.
  - Dr. Margrave
  - Dr. Isaac
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- All CREWES sponsors
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  - Nexen


Thanks