Application of stereotomography to the Hussar data set

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December 3rd , 2020

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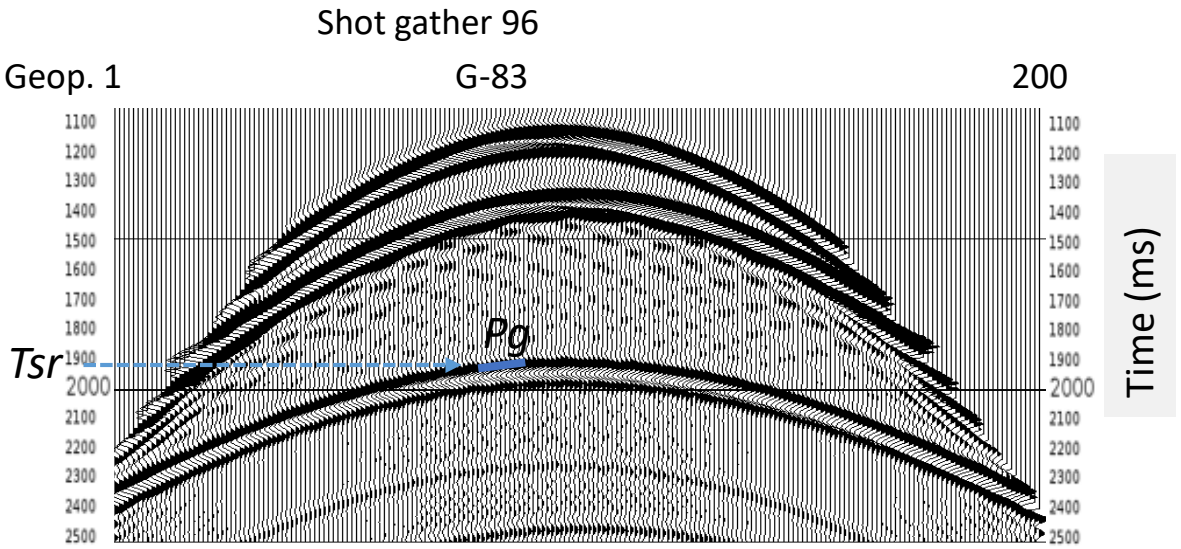
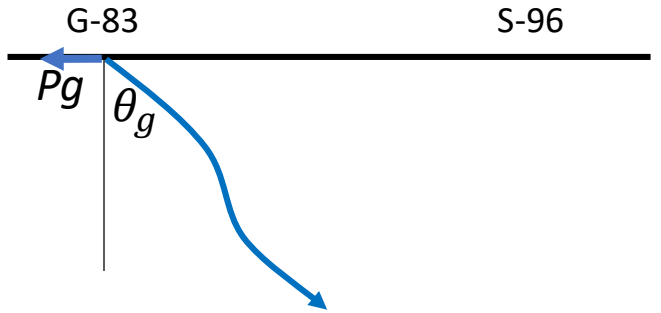
Outline

- Stereotomography
- Synthetic examples (Wedge model and Marmousi model)
- Field data example (Hussar data set)
- Conclusions

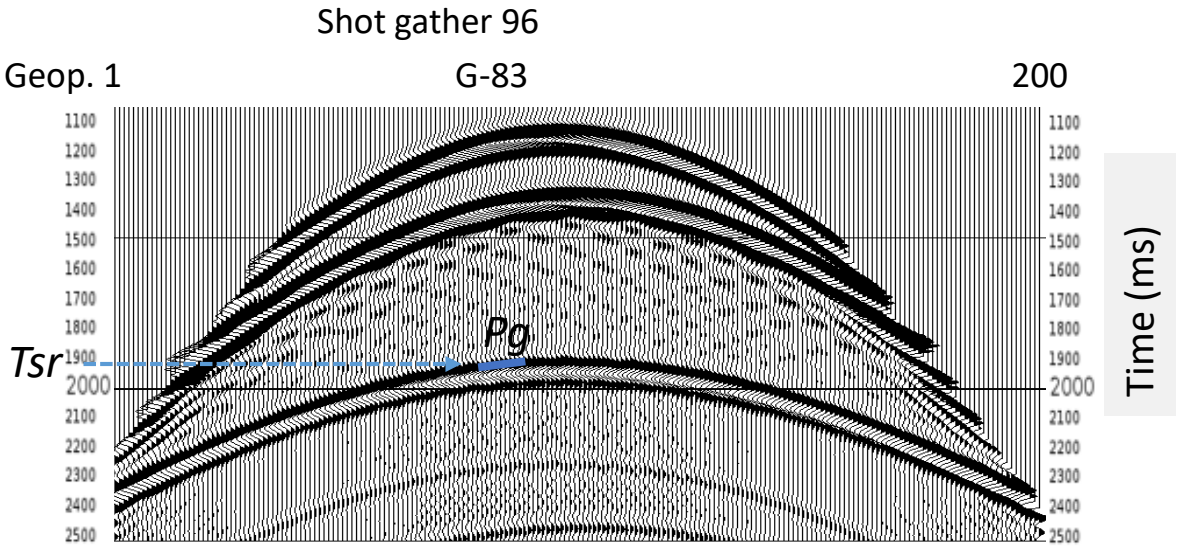
Stereotomography

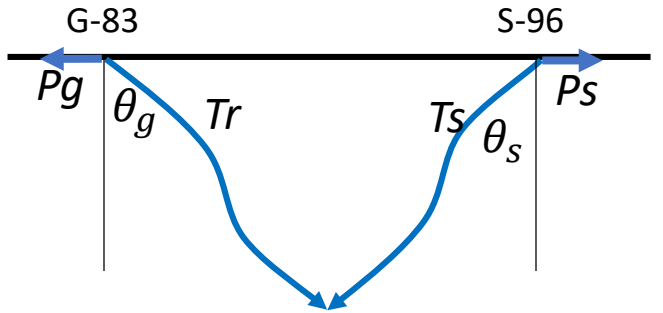




$$Pg = V / \sin \theta_g$$

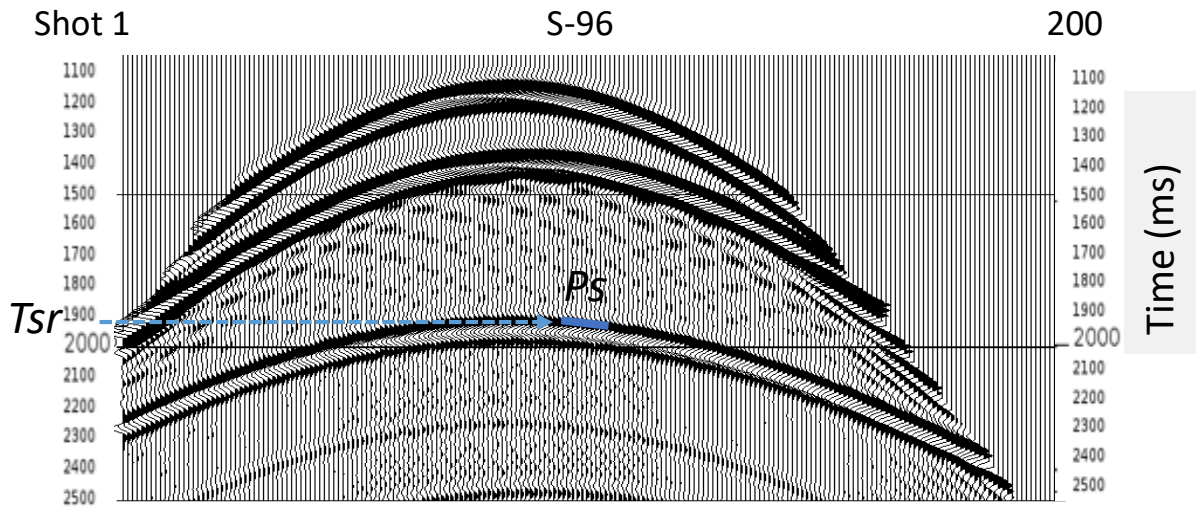
Stereotomography



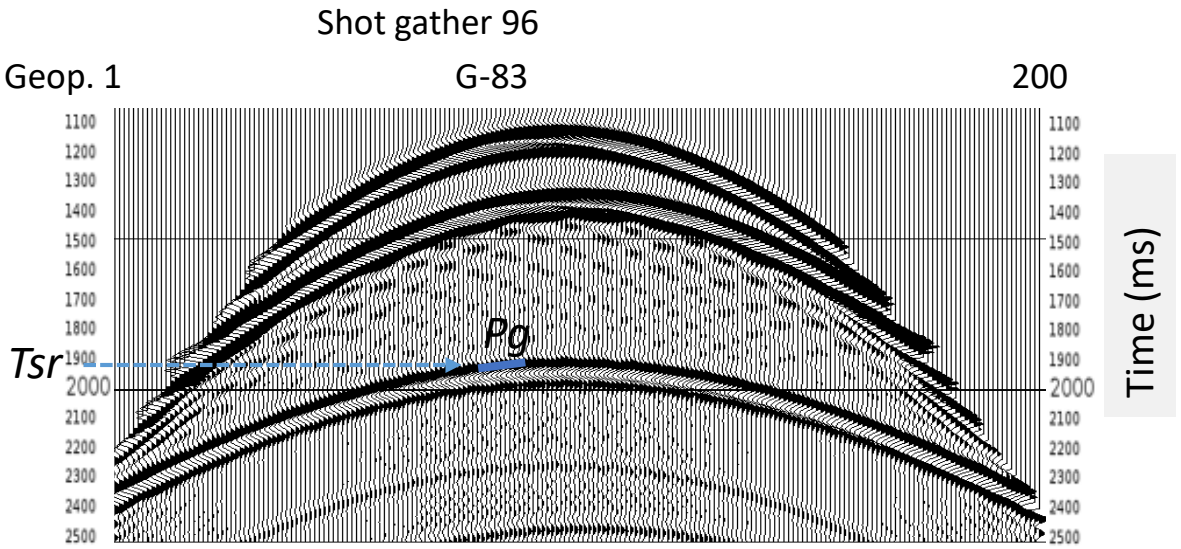


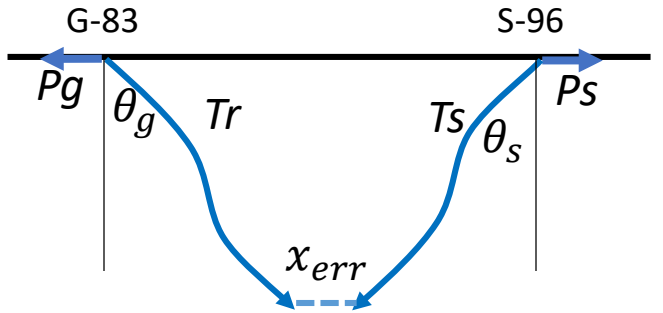
$Pg = V / \sin \theta_g$

$Ps = V / \sin \theta_s$

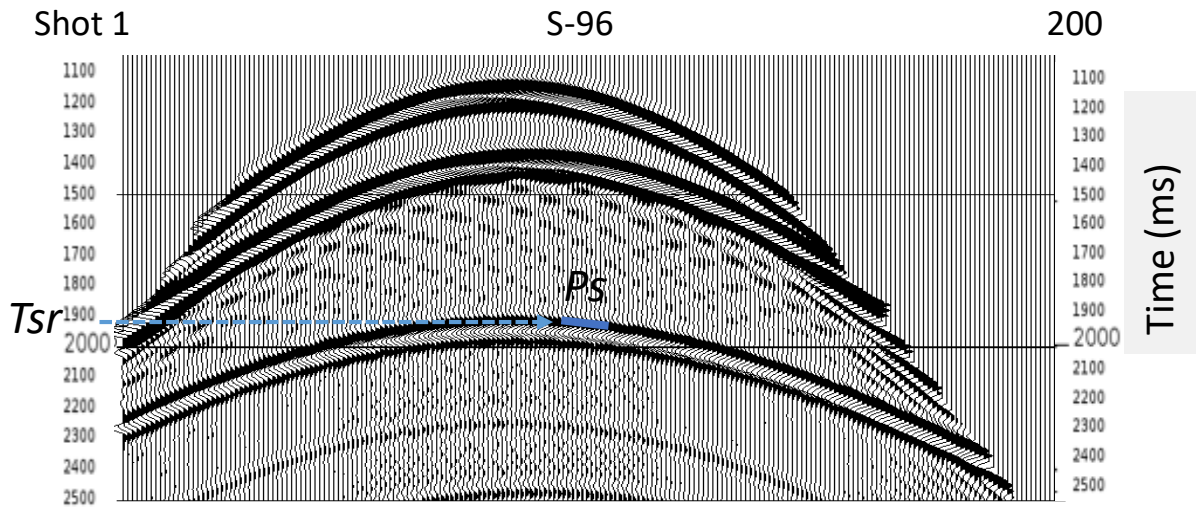


Stereotomography





$Pg = V / \sin \theta_g$ $Ps = V / \sin \theta_s$



Data space : $\mathbf{d} = [X_{err}]_{j=1,N}$

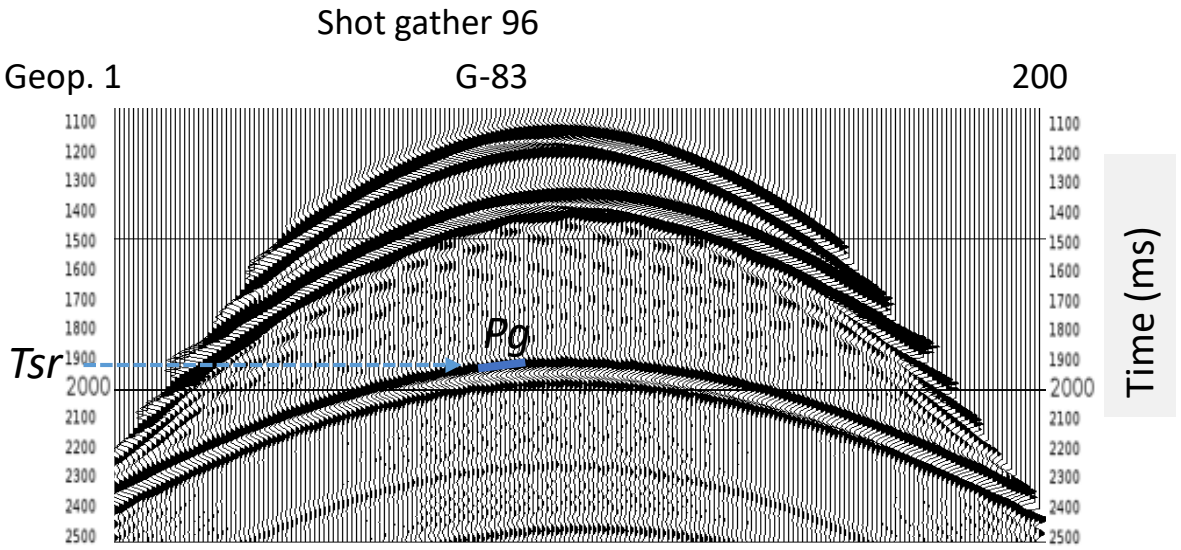
Model space: $\mathbf{m} = [V]_{i=1,M}$

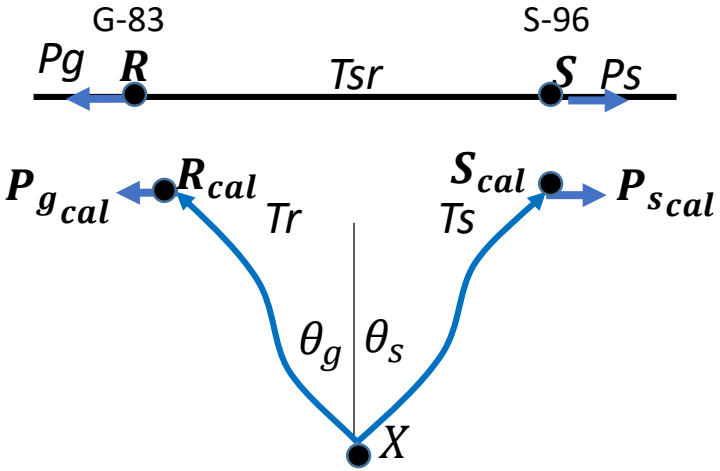
Fréchet derivative: $A_{ij} = \frac{\partial X_{err\,j}}{\partial V_i}$

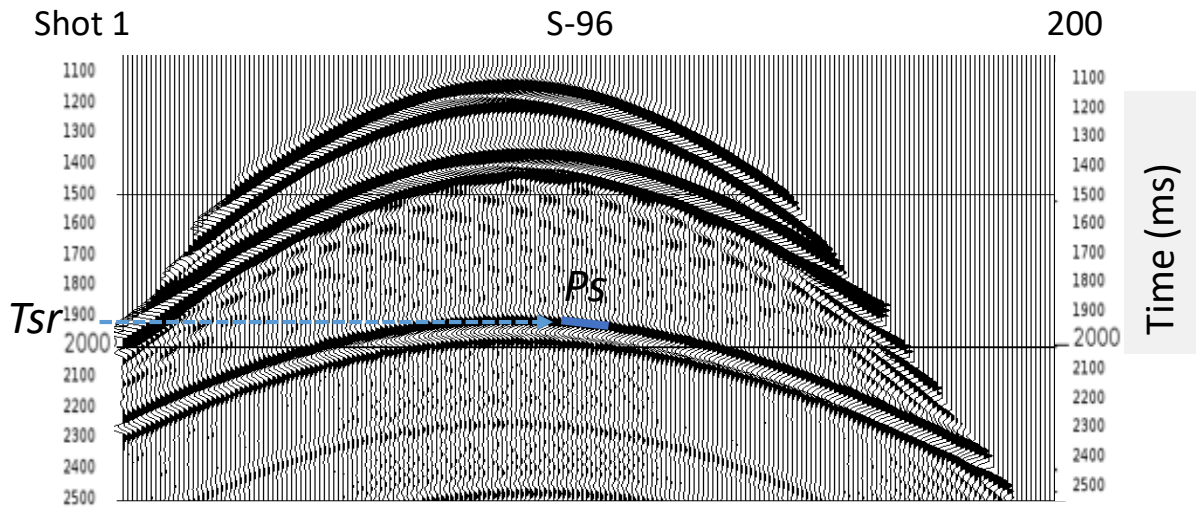
Inversion: $\mathbf{A}\,\mathbf{\Delta V} = -\mathbf{X_{err}}$

Sword 1988

Stereotomography







Data space : $\mathbf{d} = \left[S, R, P_s, P_g, T_{sr} \right]_{j=1,N}$

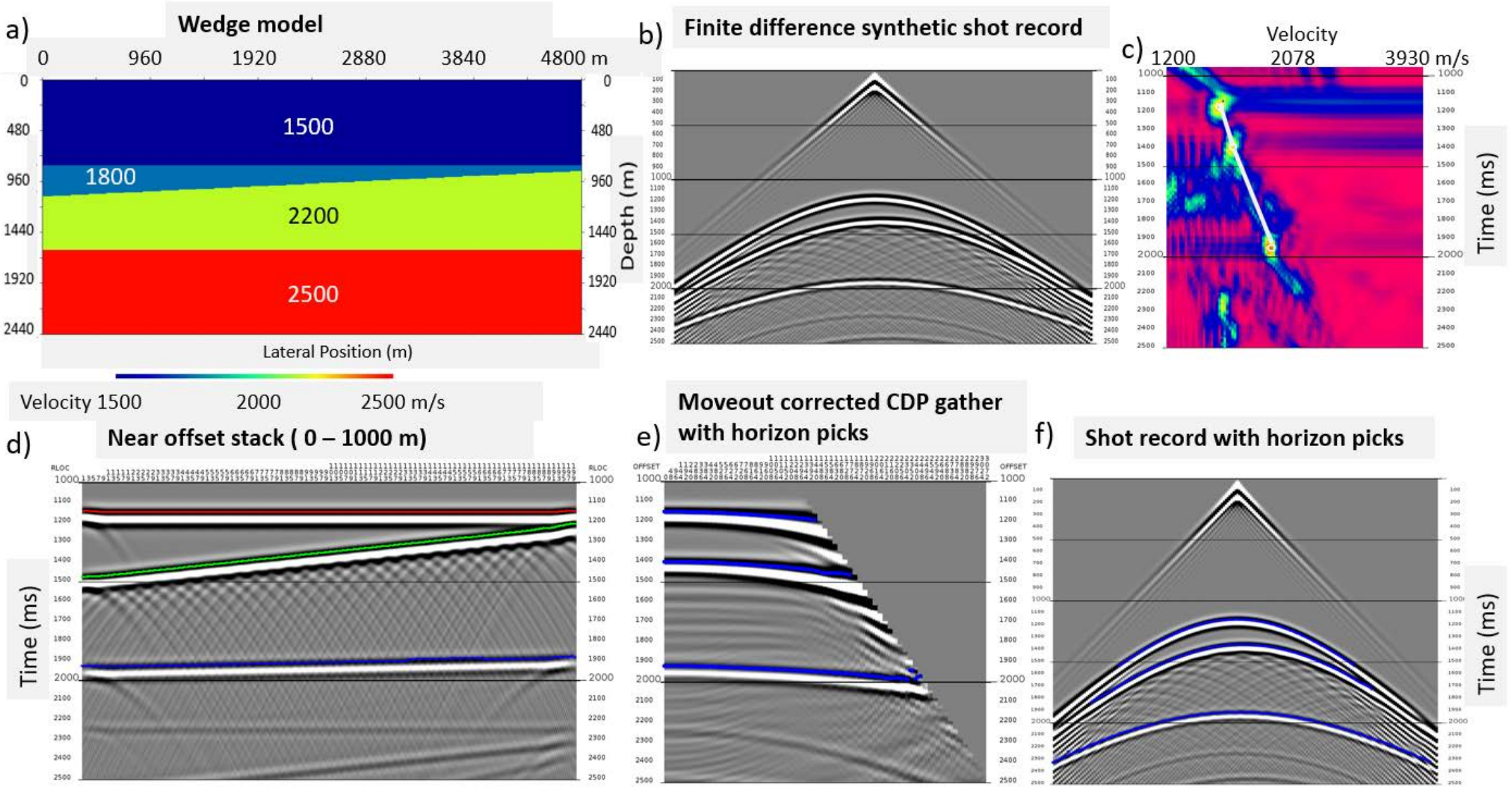
Model space: $\mathbf{m} = [(X, \Theta_s, \Theta_r, T_s, T_r)_{i=1,N}], [V]_{i2=1,M}]$

Fréchet derivative: $A_{ij} = \frac{\partial(S,R,P_s,P_g,T_{sr})}{\partial(X,\Theta_s,\Theta_r,T_s,T_r,V)}$

Inversion: $\mathbf{A}\,\mathbf{\Delta m} = \mathbf{\Delta d}$

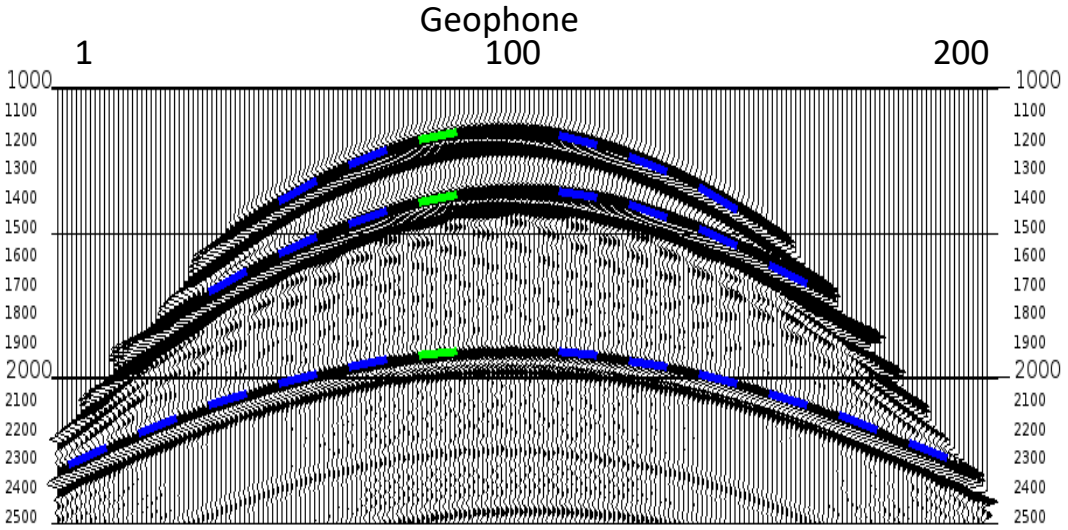
Billette and Lambaré 1998

Synthetic example (Wedge model)

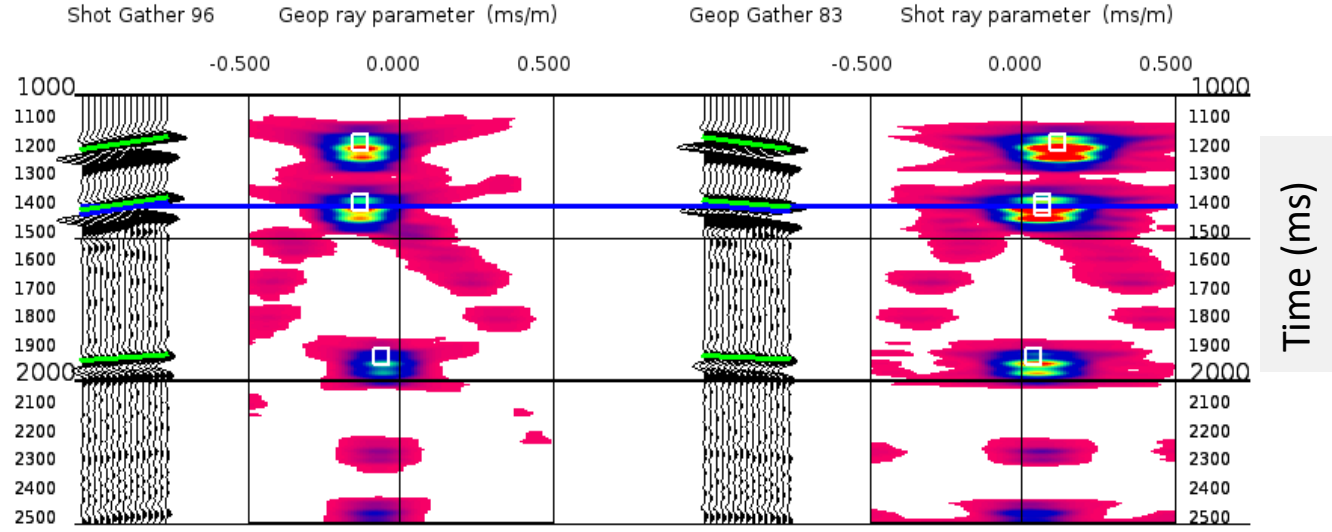


Horizon guided ray parameters and travel time picking

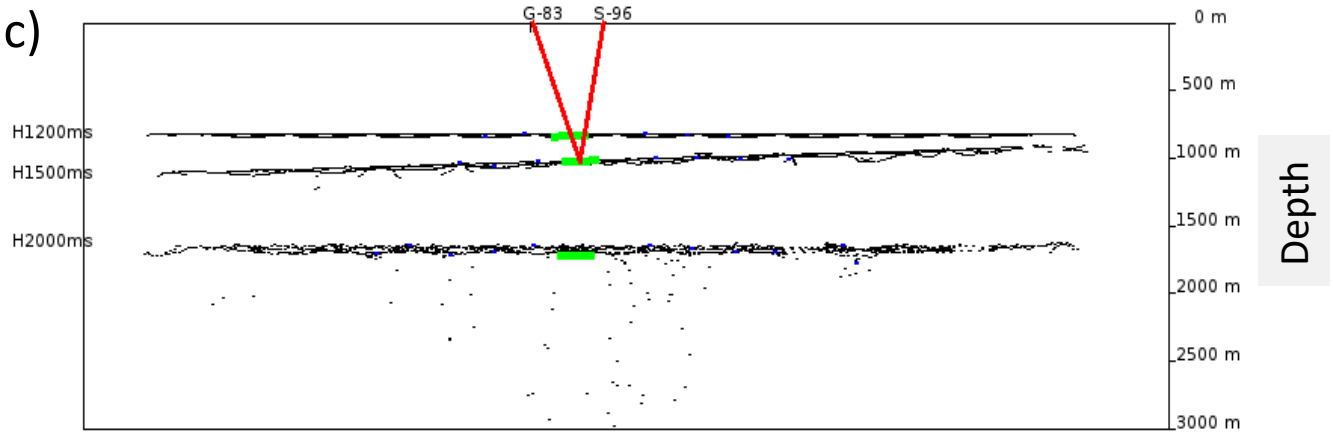
a) Shot gather 96



b)

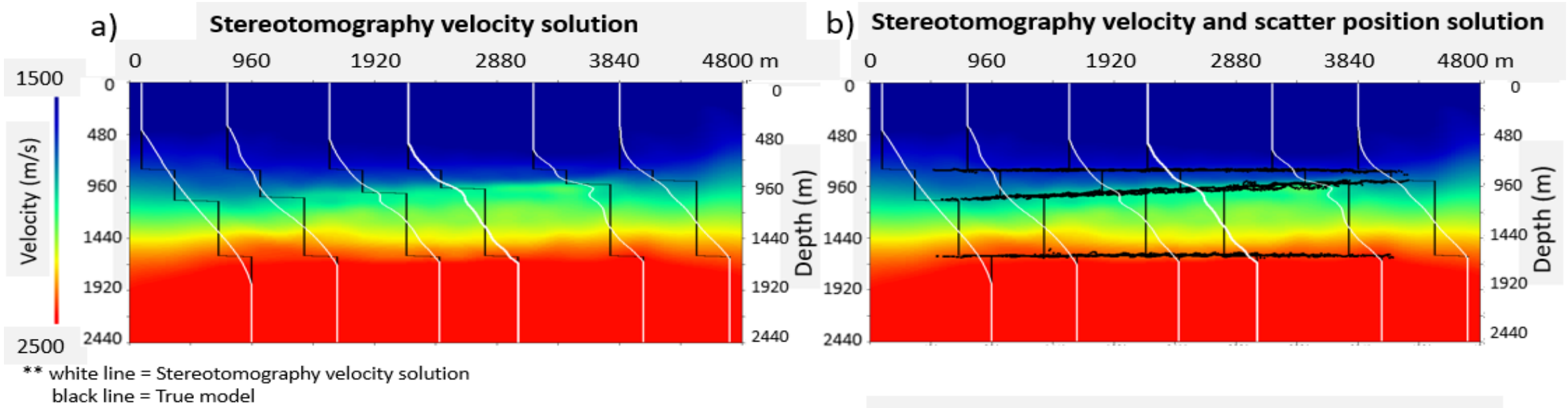


c)

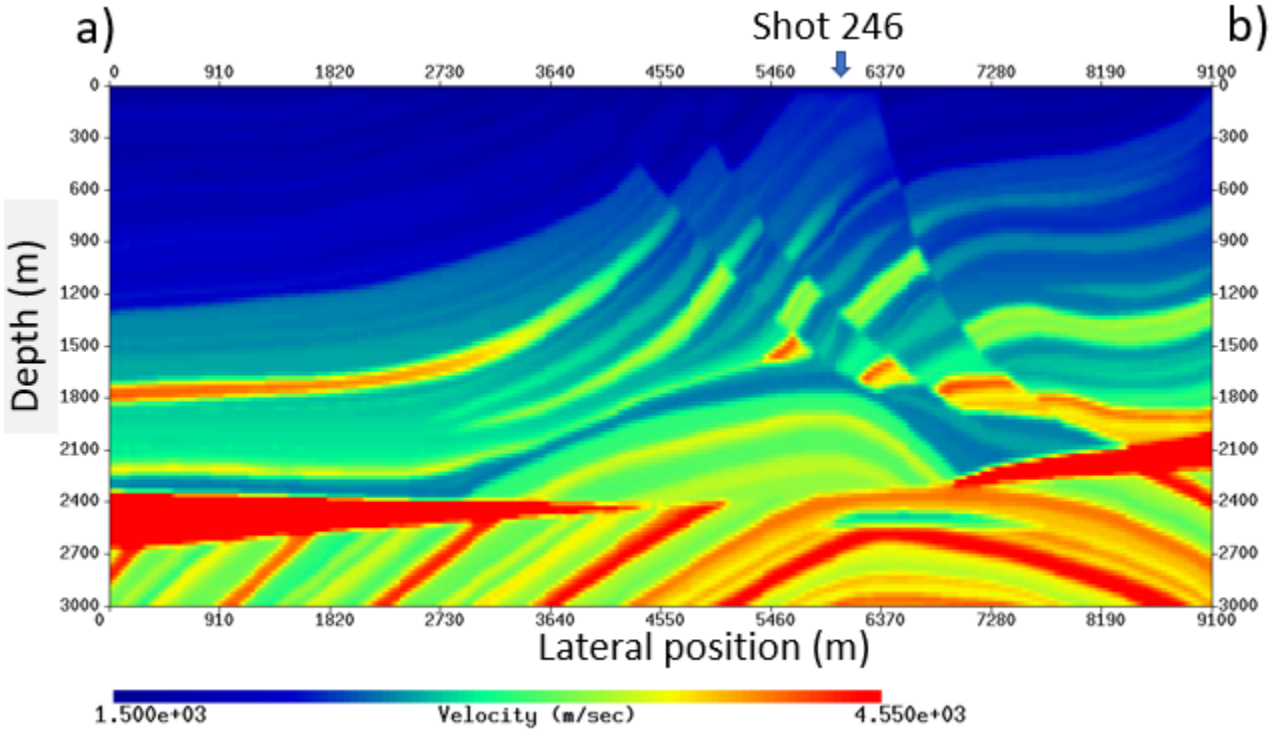


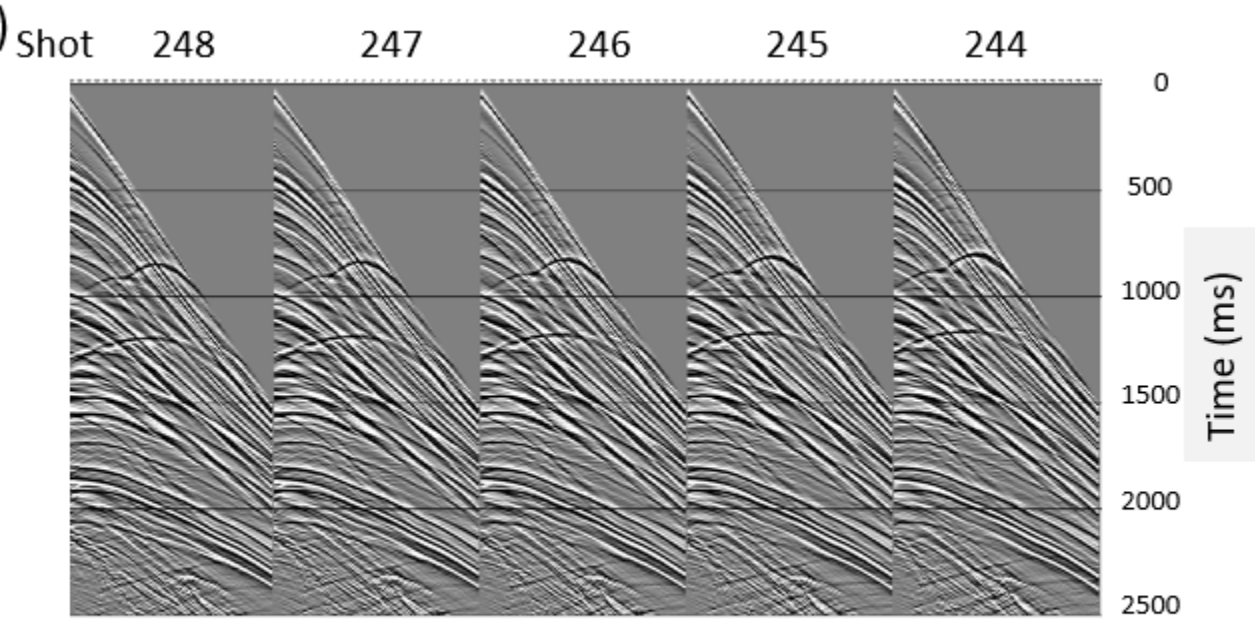
Scatter points with straight ray assumption

Stereotomography solution

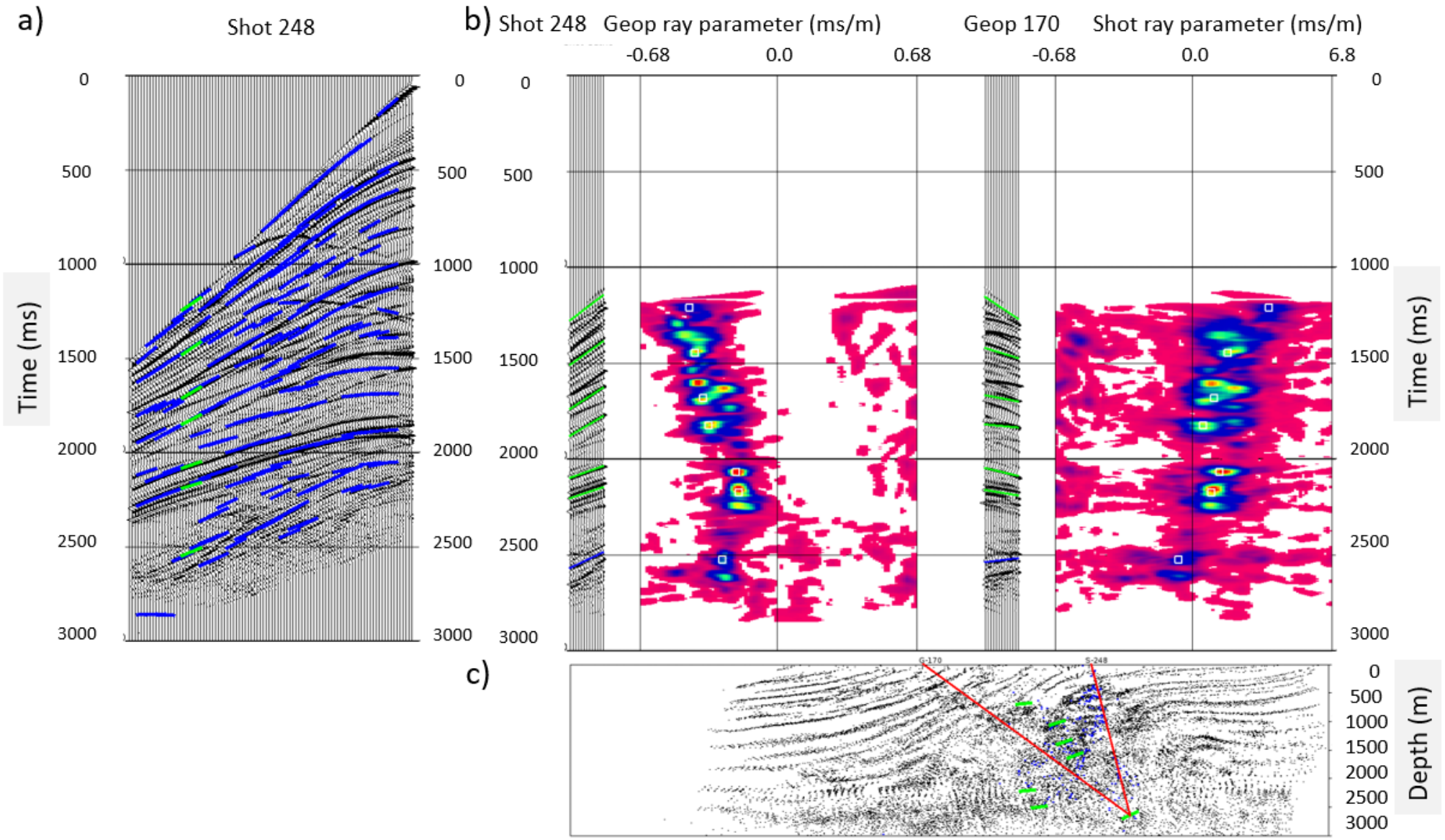


Synthetic example (Marmousi model)





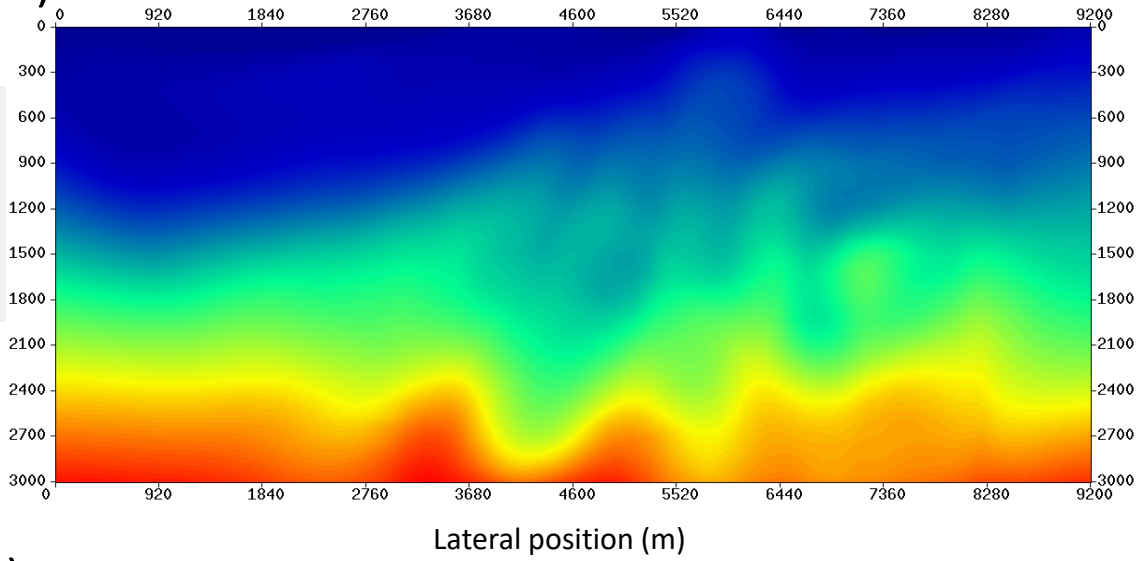
Ray parameters and travel time picking using semblance threshold



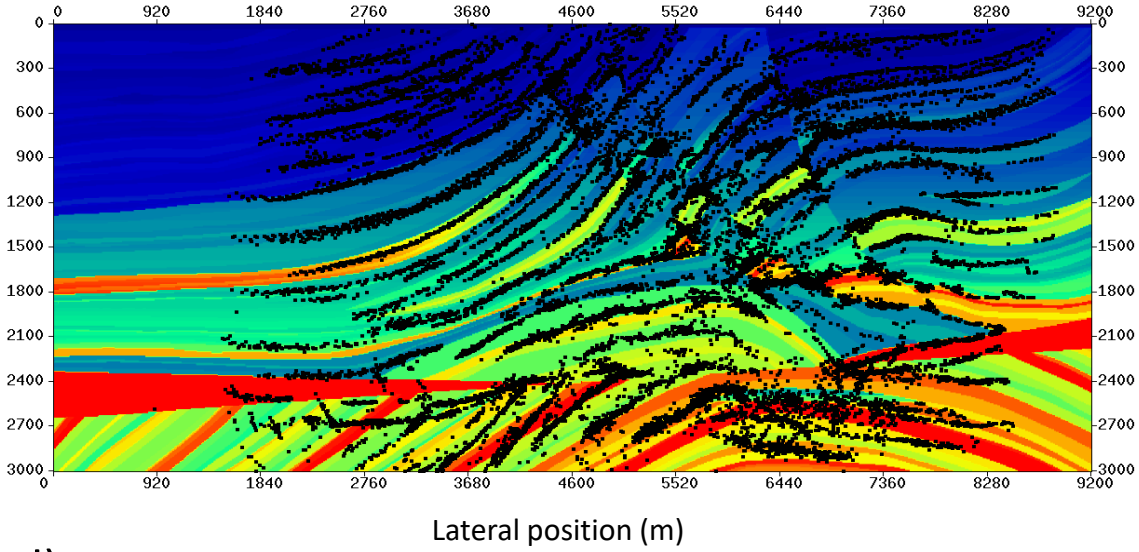
Scatter points with straight ray assumption

Stereotomography solution

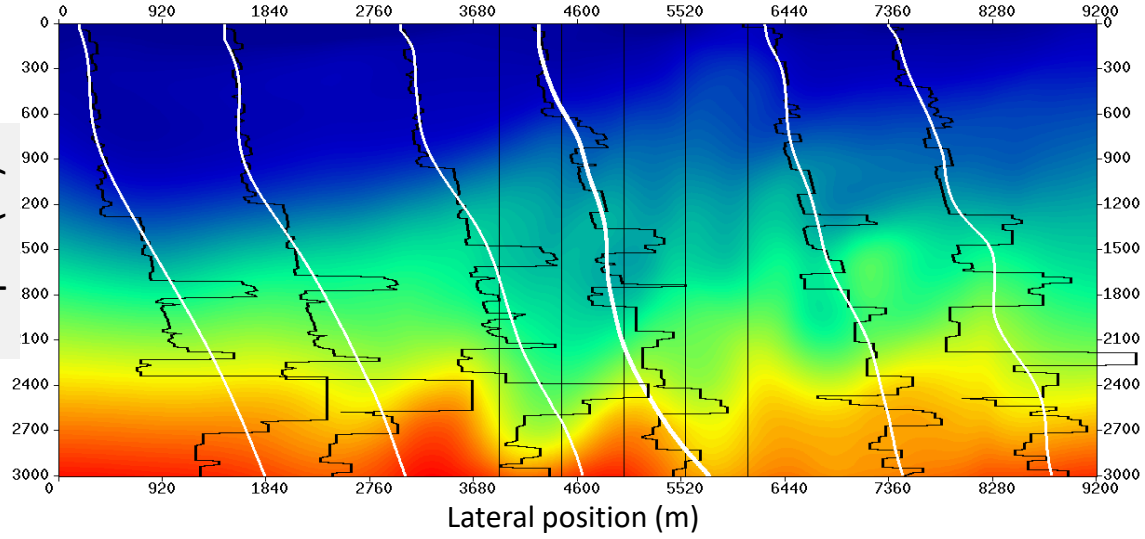
a) **Stereotomography velocity solution**



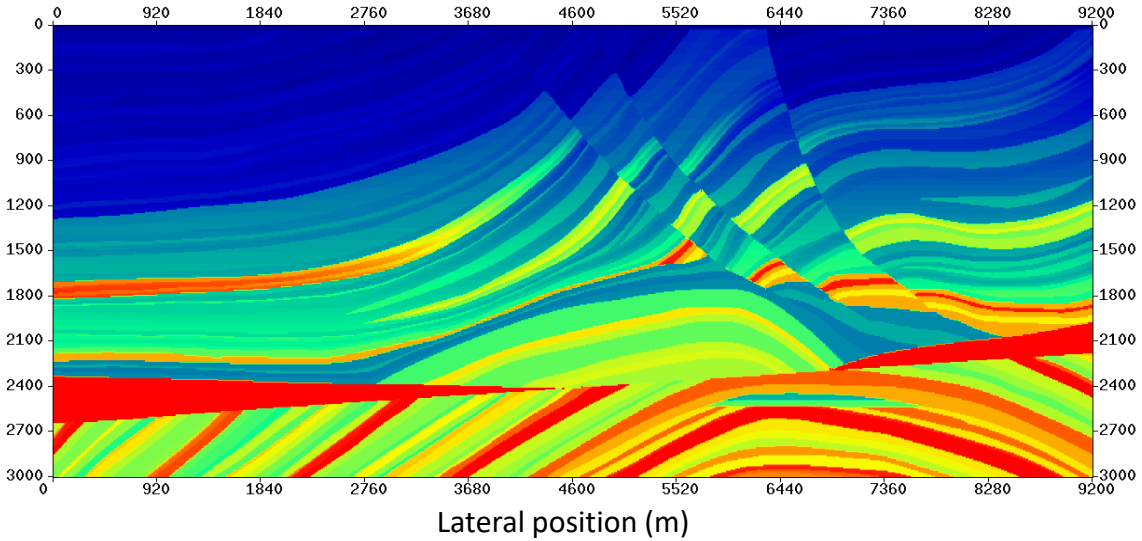
b) **Scatter positions and true model**



c) **Stereotomography velocity solution**



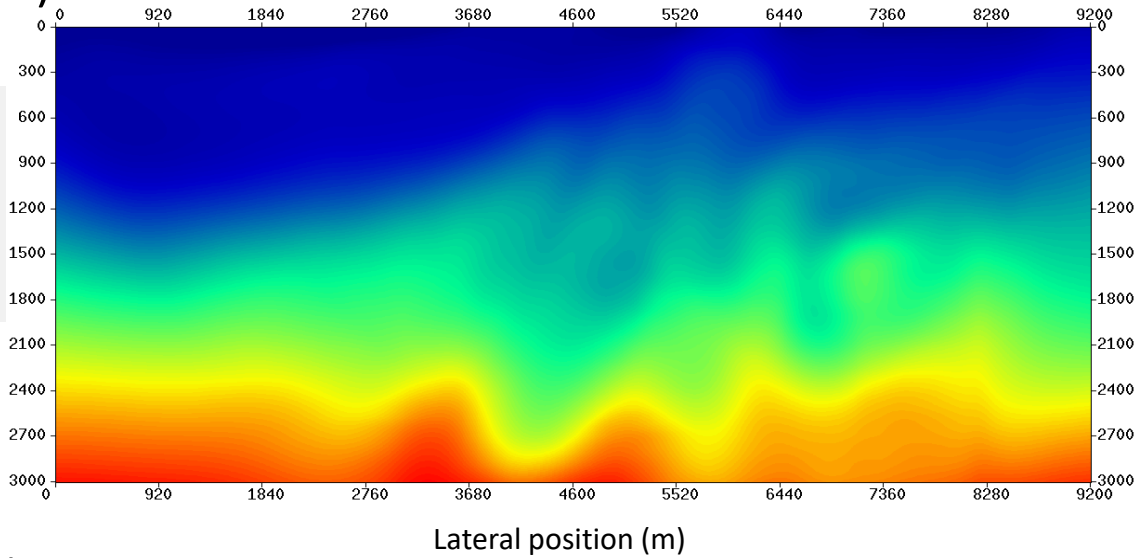
d) **True Model**



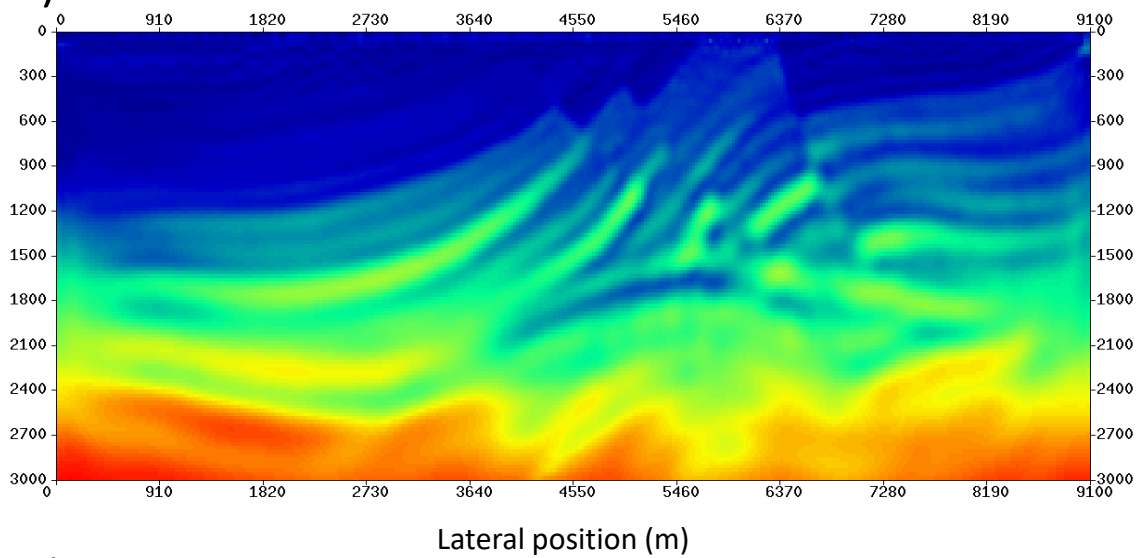
** white lines = Stereotomography solution
black lines = True model

FWI comparison

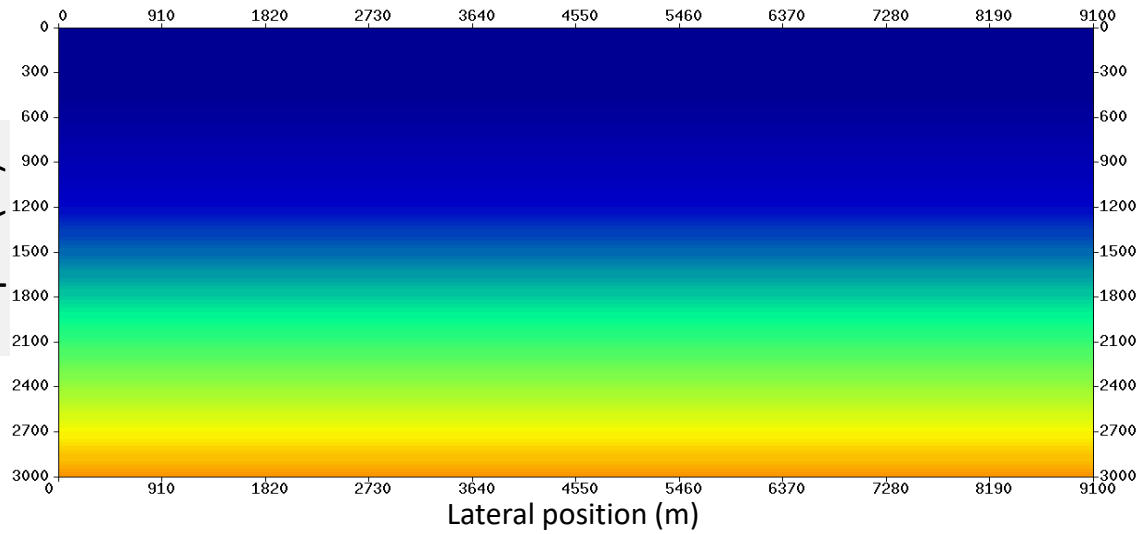
a) **Stereotomography velocity solution**



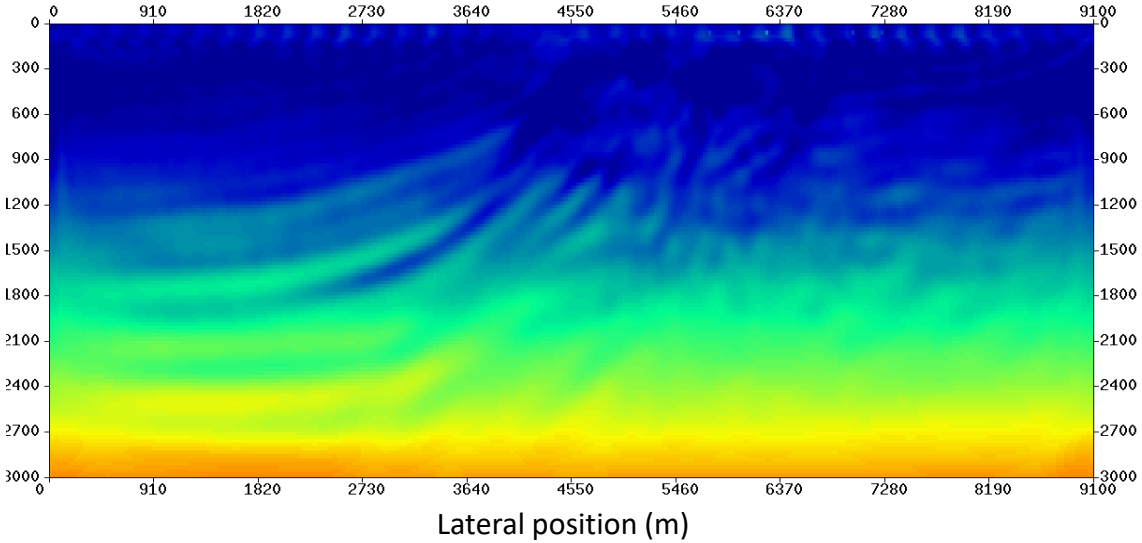
b) **FWI solution**



c) **Vertical velocity gradient**

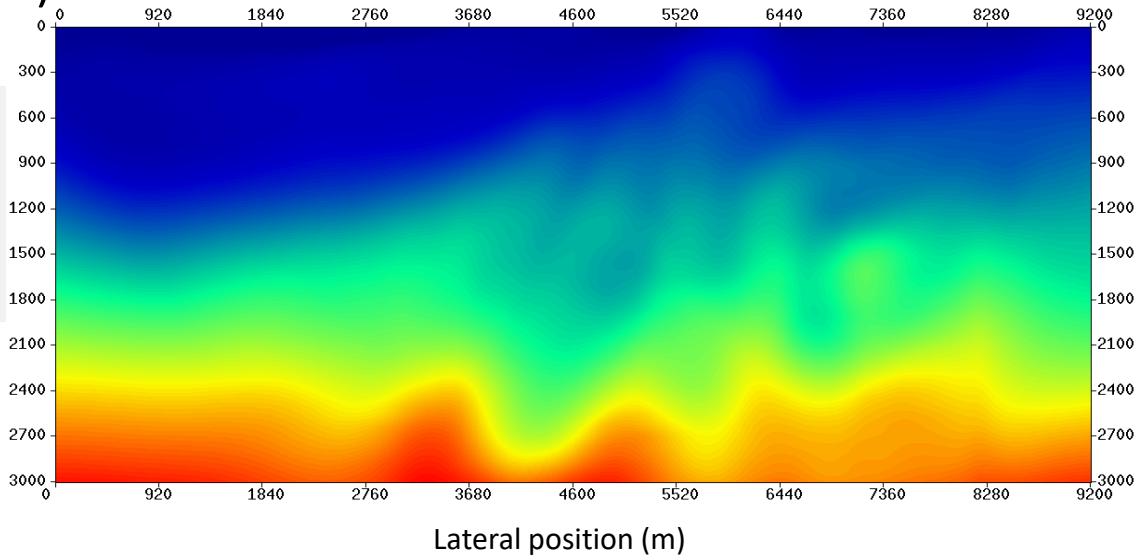


d) **FWI solution**

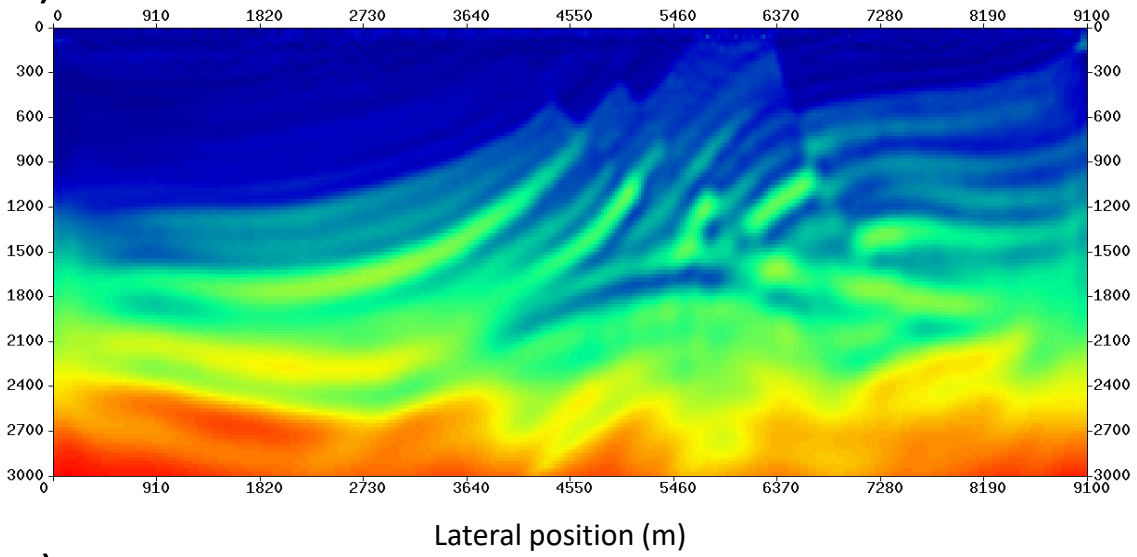


FWI comparison

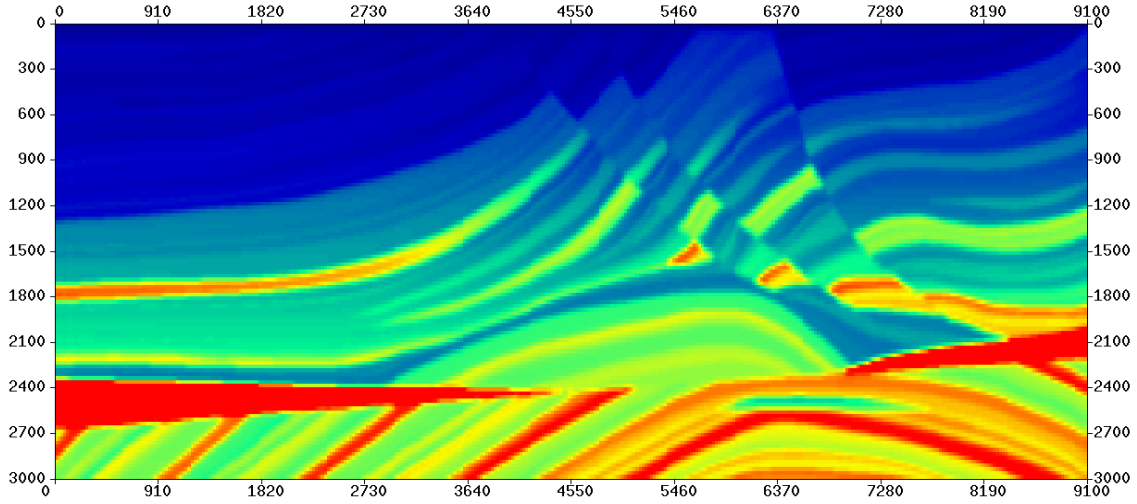
a) **Stereotomography velocity solution**



b) **FWI solution**



c) **True model**

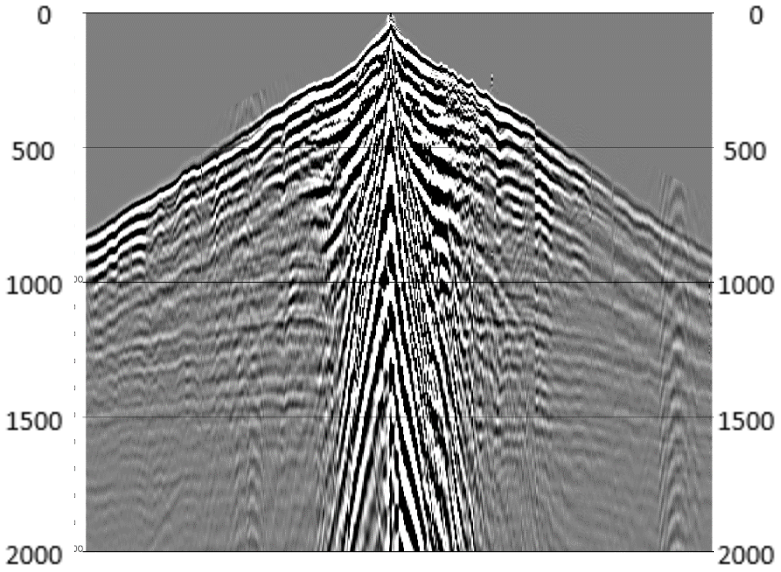


Hussar data

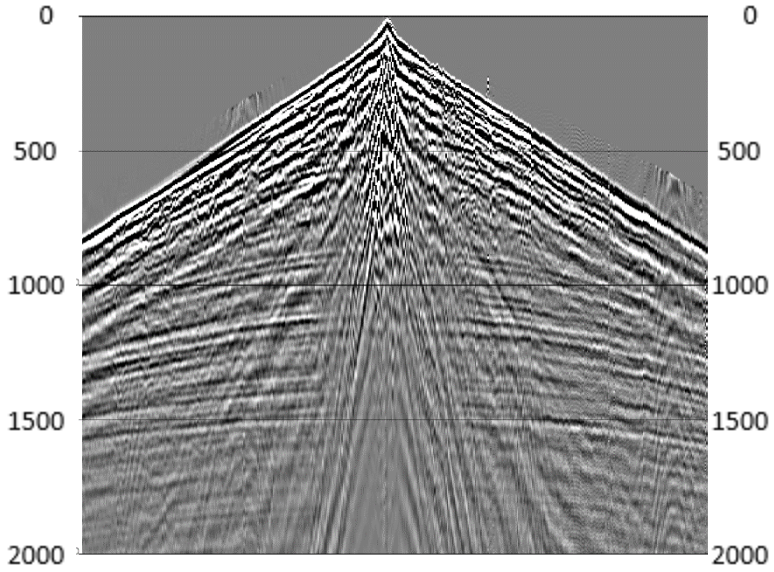
a) **Hussar seismic line and nearby wells**

(From Margrave et al.,2011)

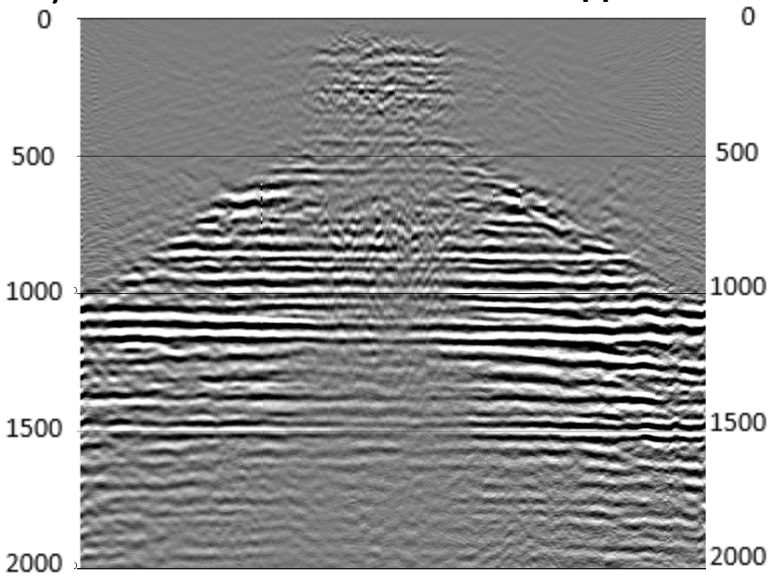
b) **Shot 335**



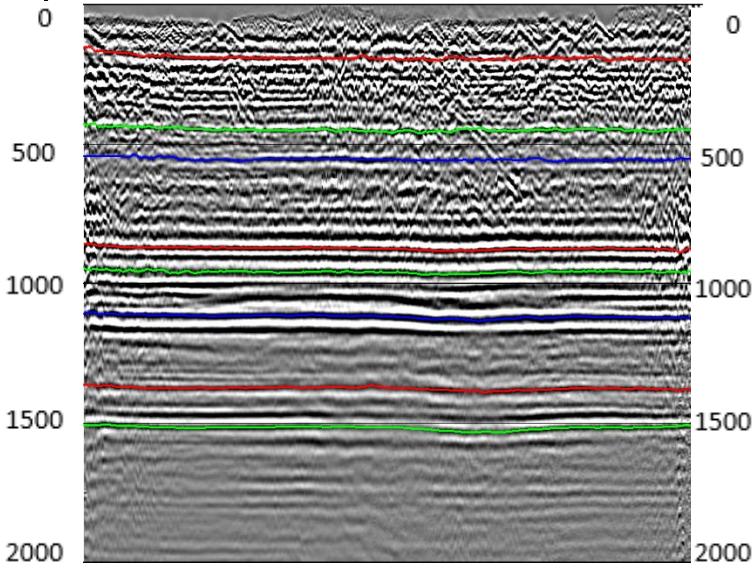
c) **Deconvolved and weathering correction**



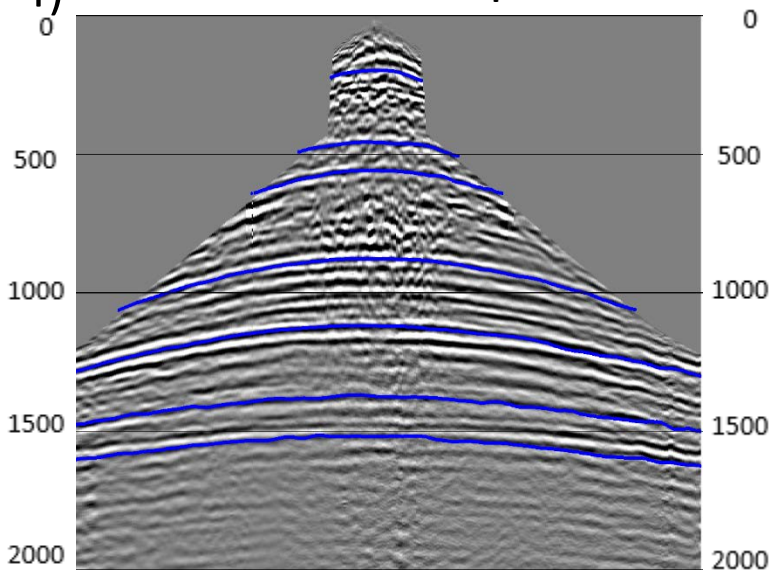
d) **Moveout corrected and noise suppression**



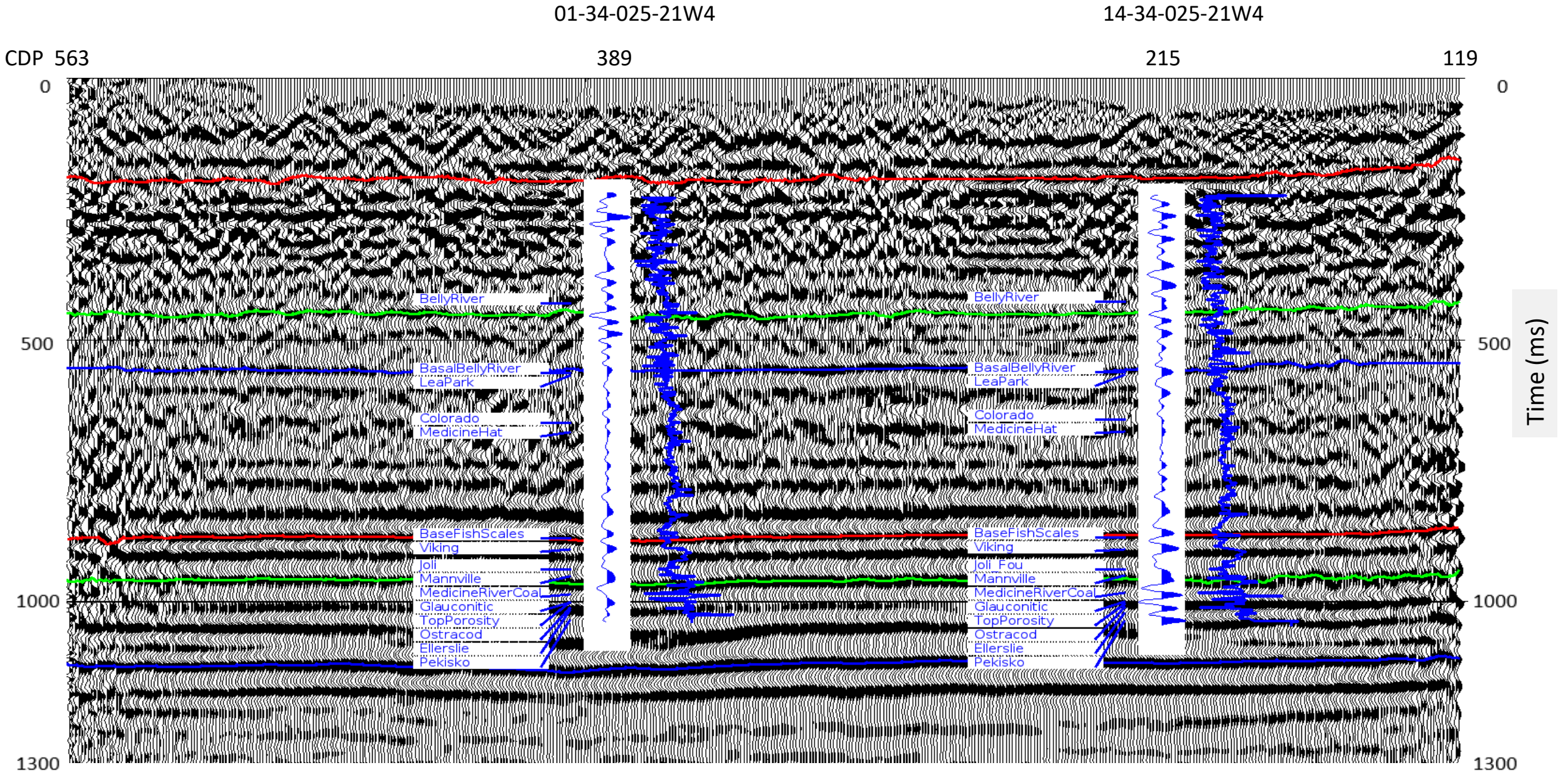
e) **CDP stack with horizon picks**



f) **Shot 335 with horizon picks**

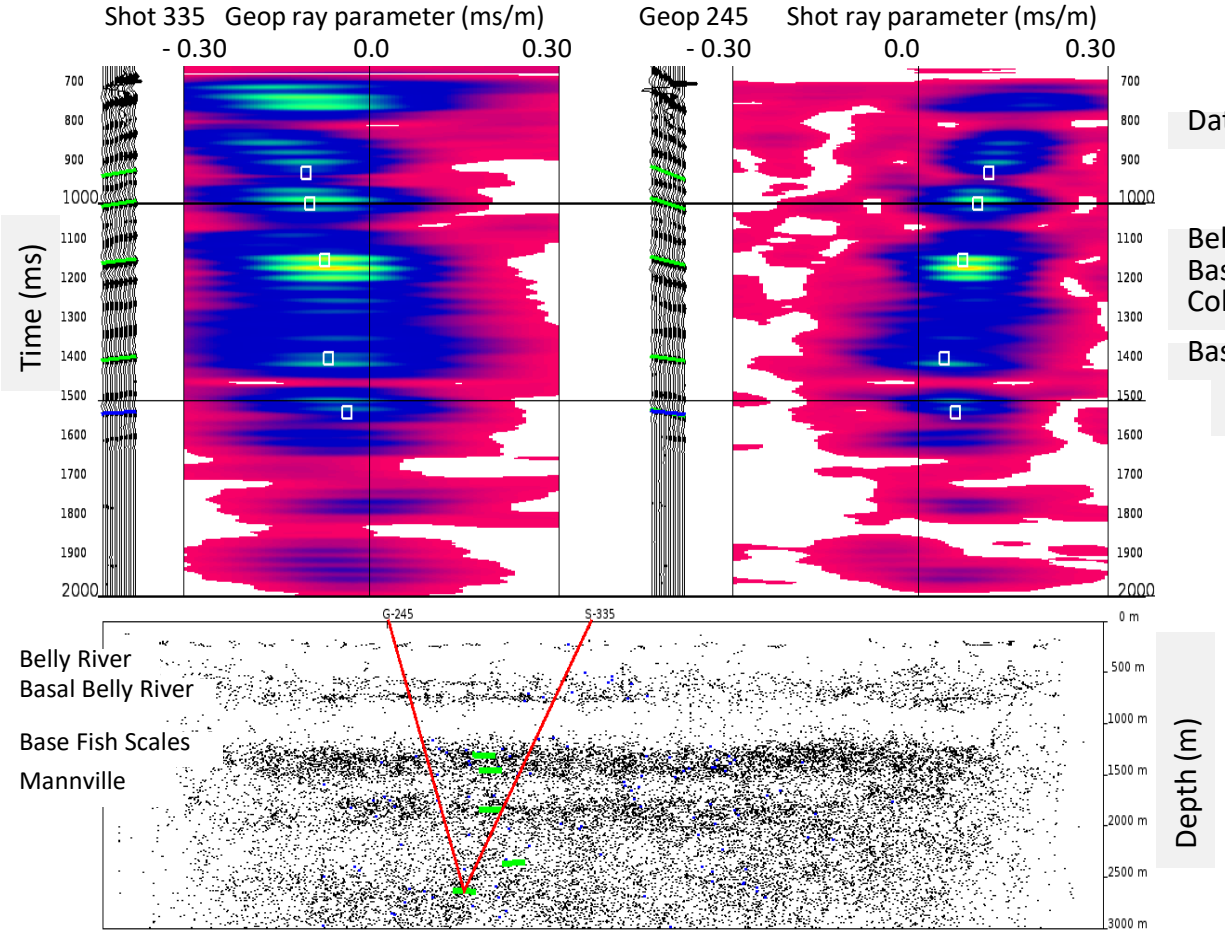


Hussar CDP stack



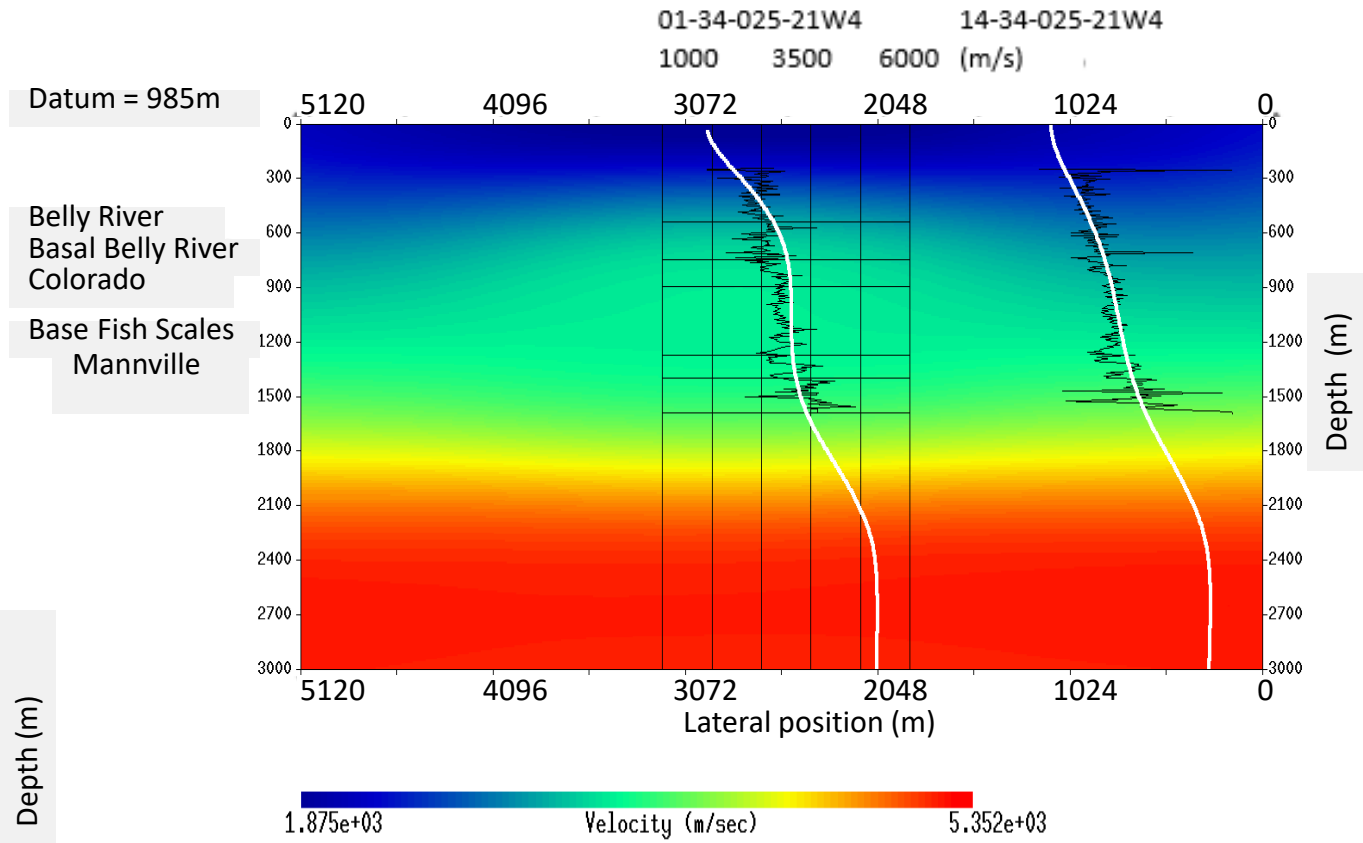
Horizon guided ray parameters picking

a) Traveltime and ray parameter picks



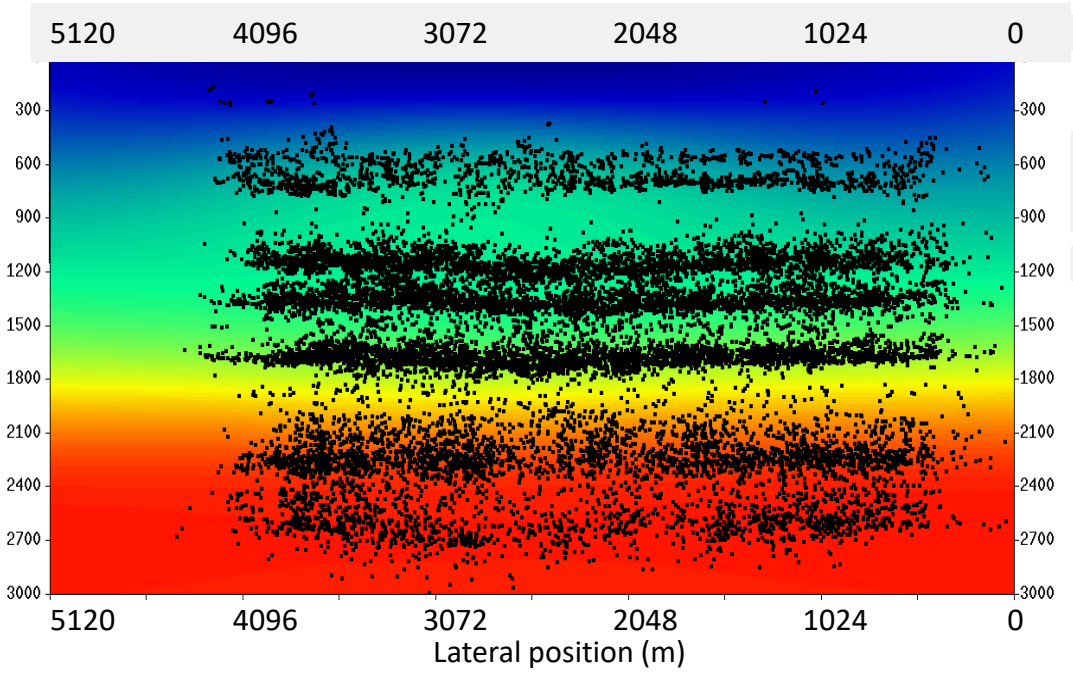
Scatter points with straight ray assumption

b) Stereotomography velocity solution

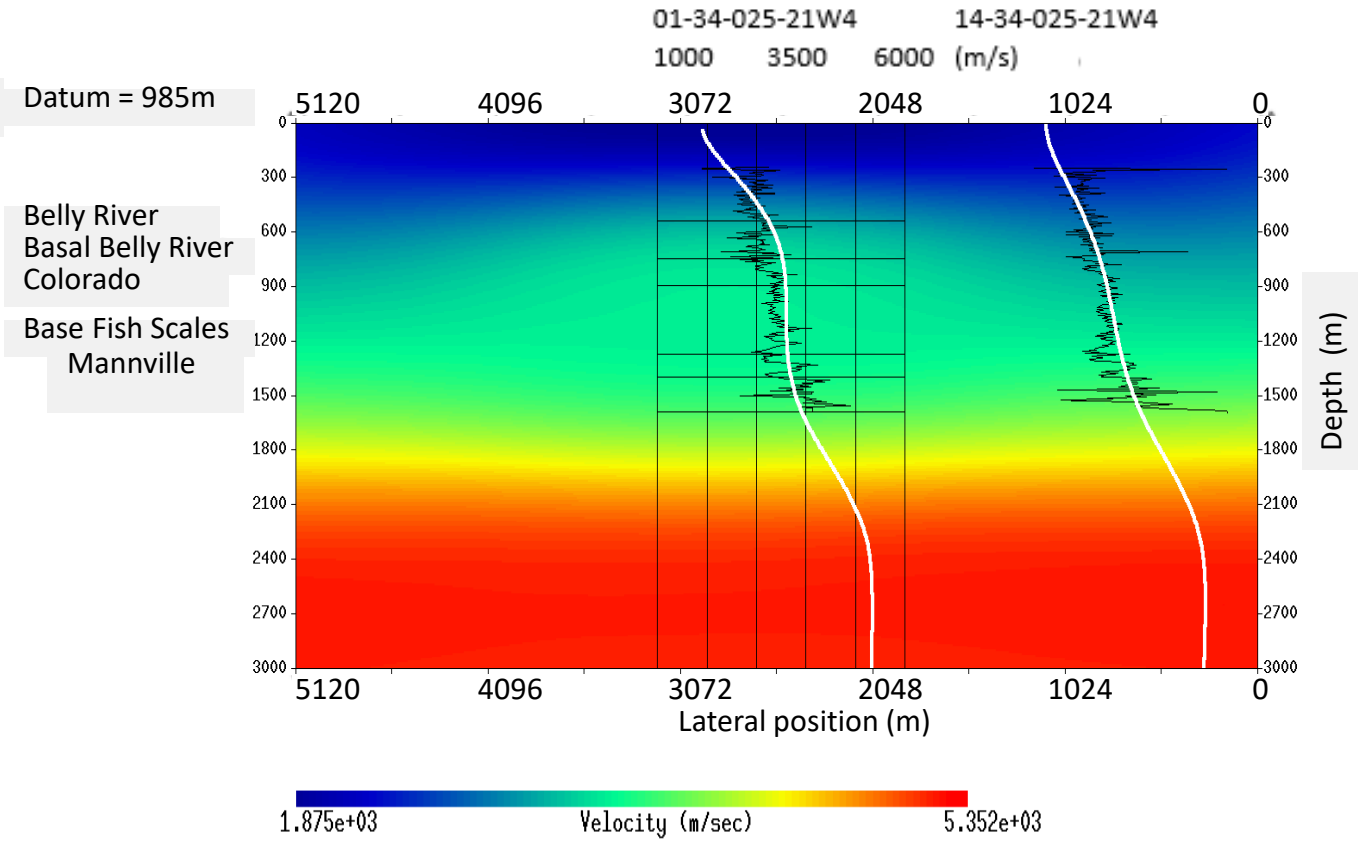


Stereotomography solution

a) Stereotomography scatter positions

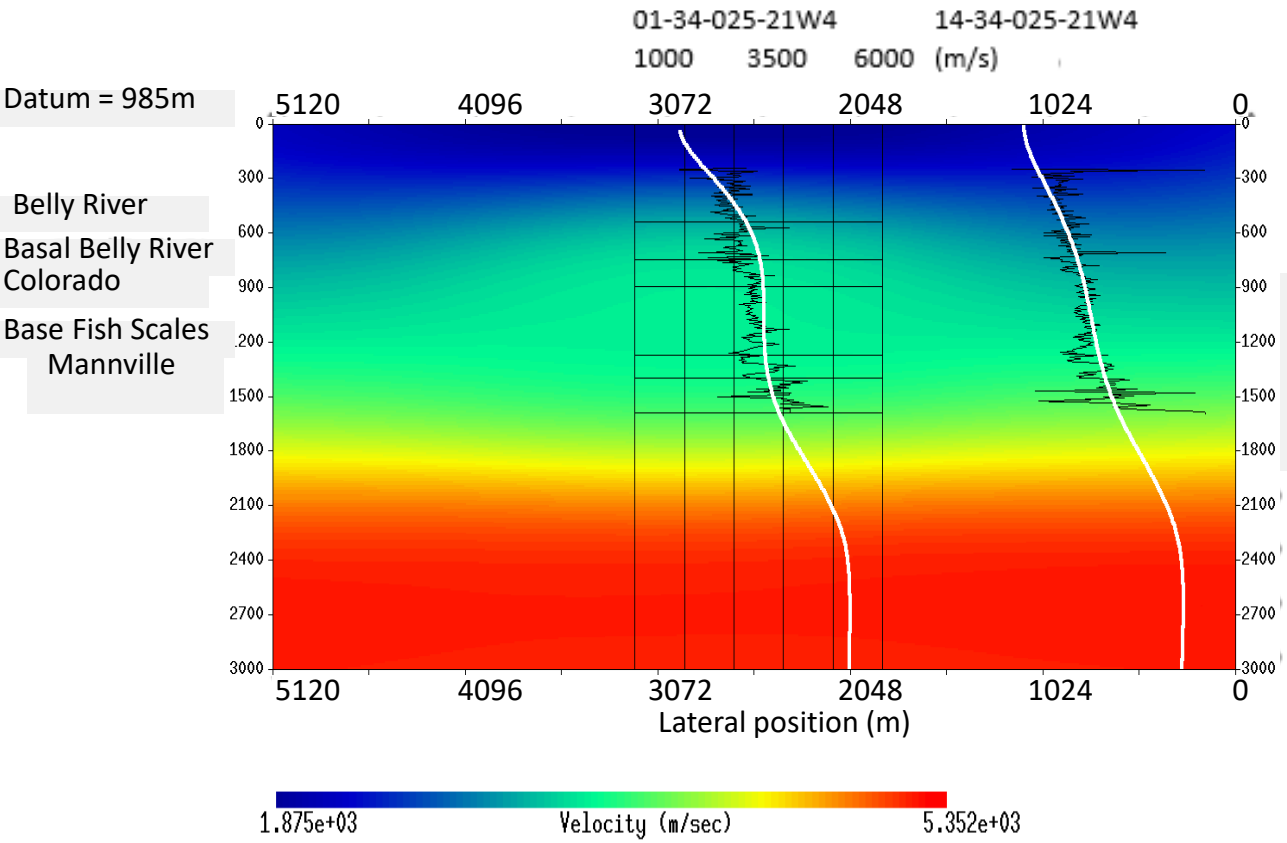


b) Stereotomography velocity solution

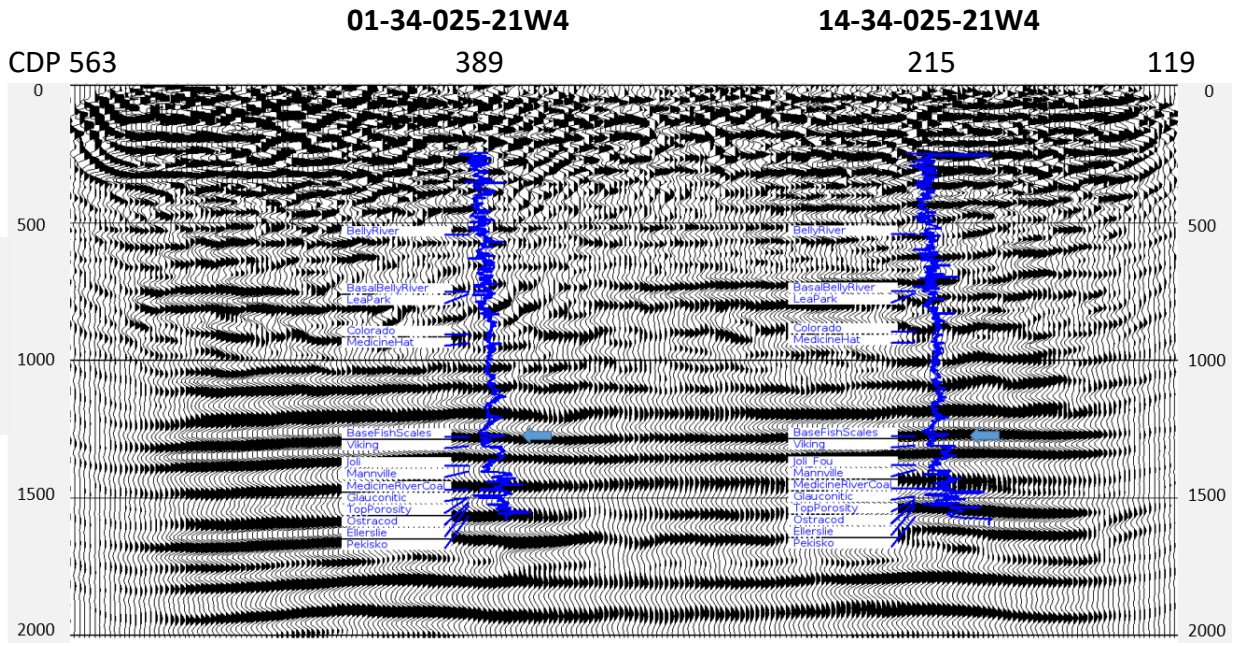


Depth migration using stereotomography solution

a) Stereotomography velocity solution

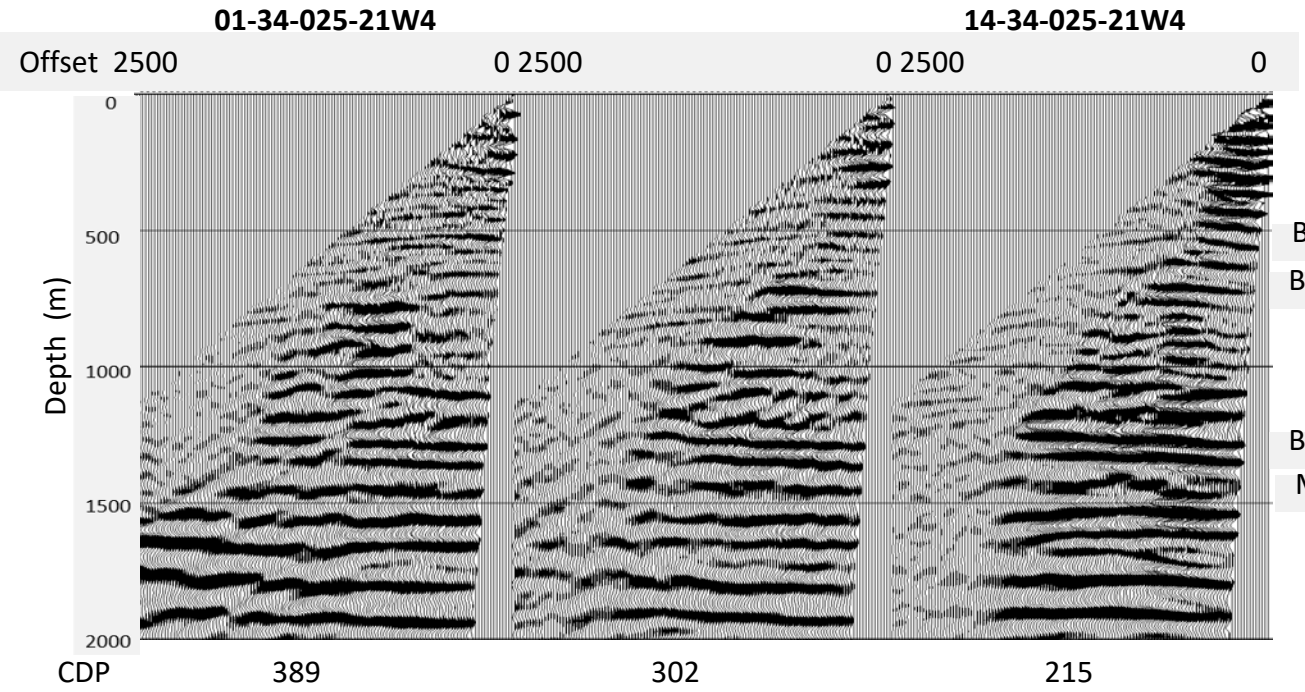


b) Depth migration using stereotomography solution

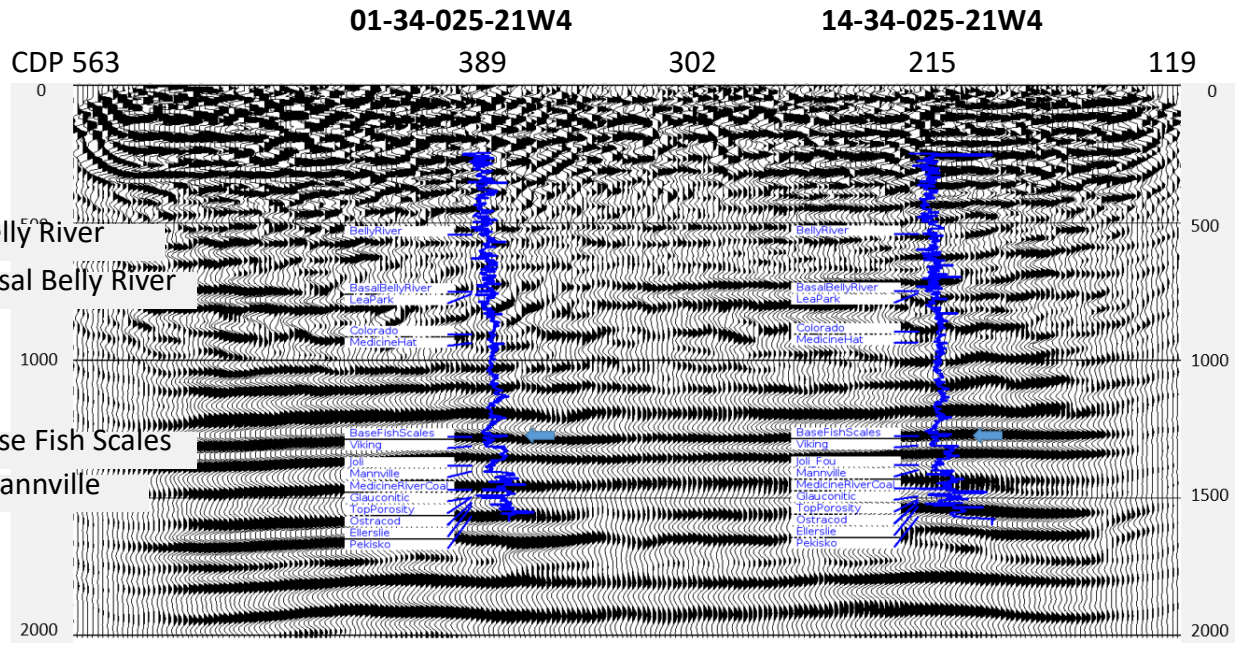


Depth migration using stereotomography solution

a) Common image gathers



b) Depth migration using stereotomography solution



Conclusions

- We reviewed the stereotomography method
- We demonstrated the picking procedure and the accuracy of stereotomography with synthetic models
- Finally, we use stereotomography on the Hussar data set
- The stereotomography velocity solution matches the long wavelength components of the two well logs
- The depth migration using the stereotomography solution also ties with the well logs in depth

Acknowledgements

- CREWES Industrial Sponsors
- NSERC (CRDPJ 461179-13, CRDPJ 543578-19)
- CREWES Staff and Students