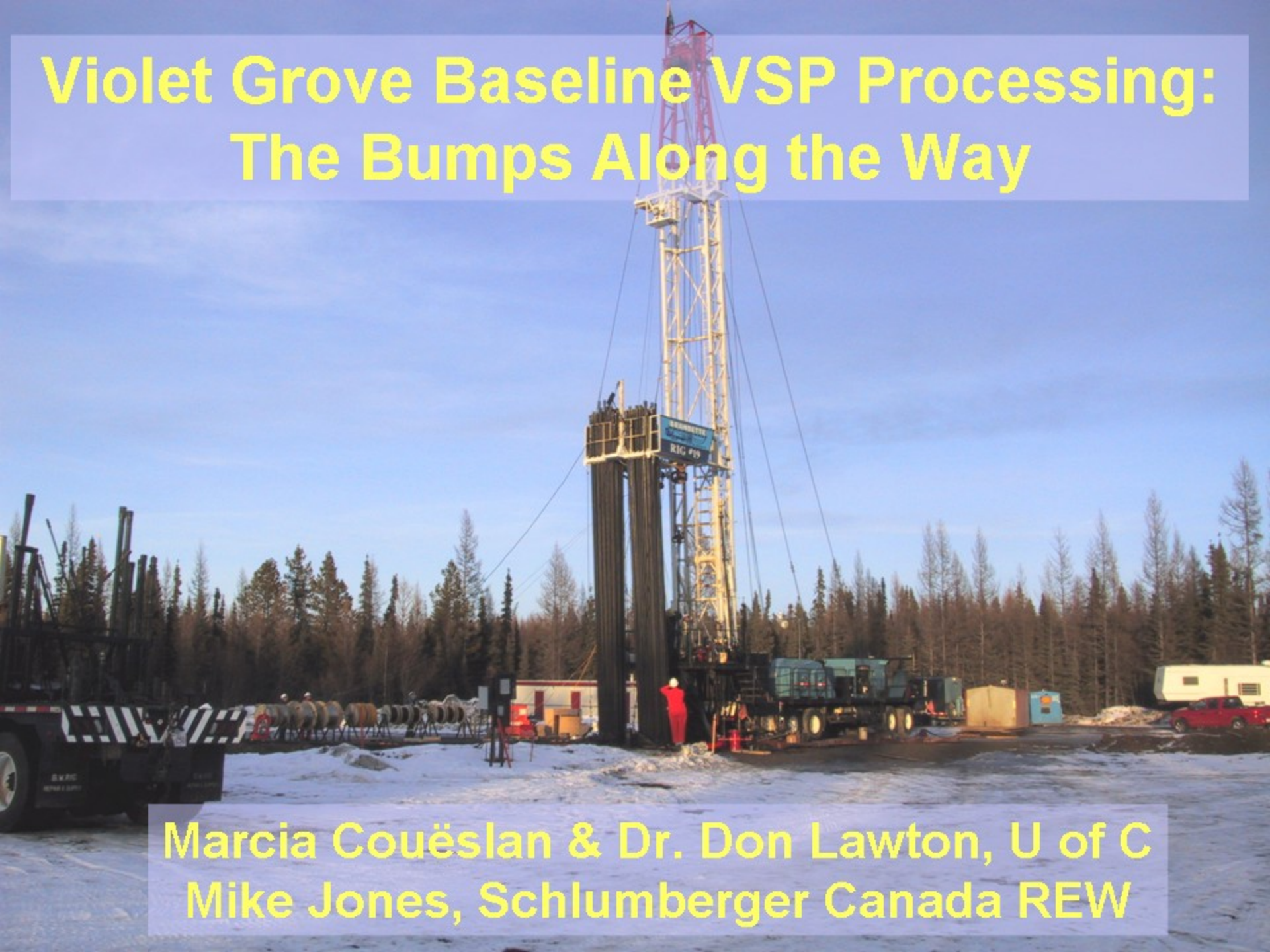


Violet Grove Baseline VSP Processing: The Bumps Along the Way



**Marcia Couëslan & Dr. Don Lawton, U of C
Mike Jones, Schlumberger Canada REW**

Outline

The background of the slide is a photograph of an oil drilling rig in a snowy, wooded area. The rig is tall and yellow, with a red lattice structure at the top. The ground is covered in snow, and there are trees in the background. The overall scene is somewhat hazy and overcast.

- Introduction
- Processing Challenges
 - Wavefield Separation
 - Velocity Modeling
 - Migrations
- Conclusions
- Potential Changes in the Monitor Surveys
- Acknowledgements

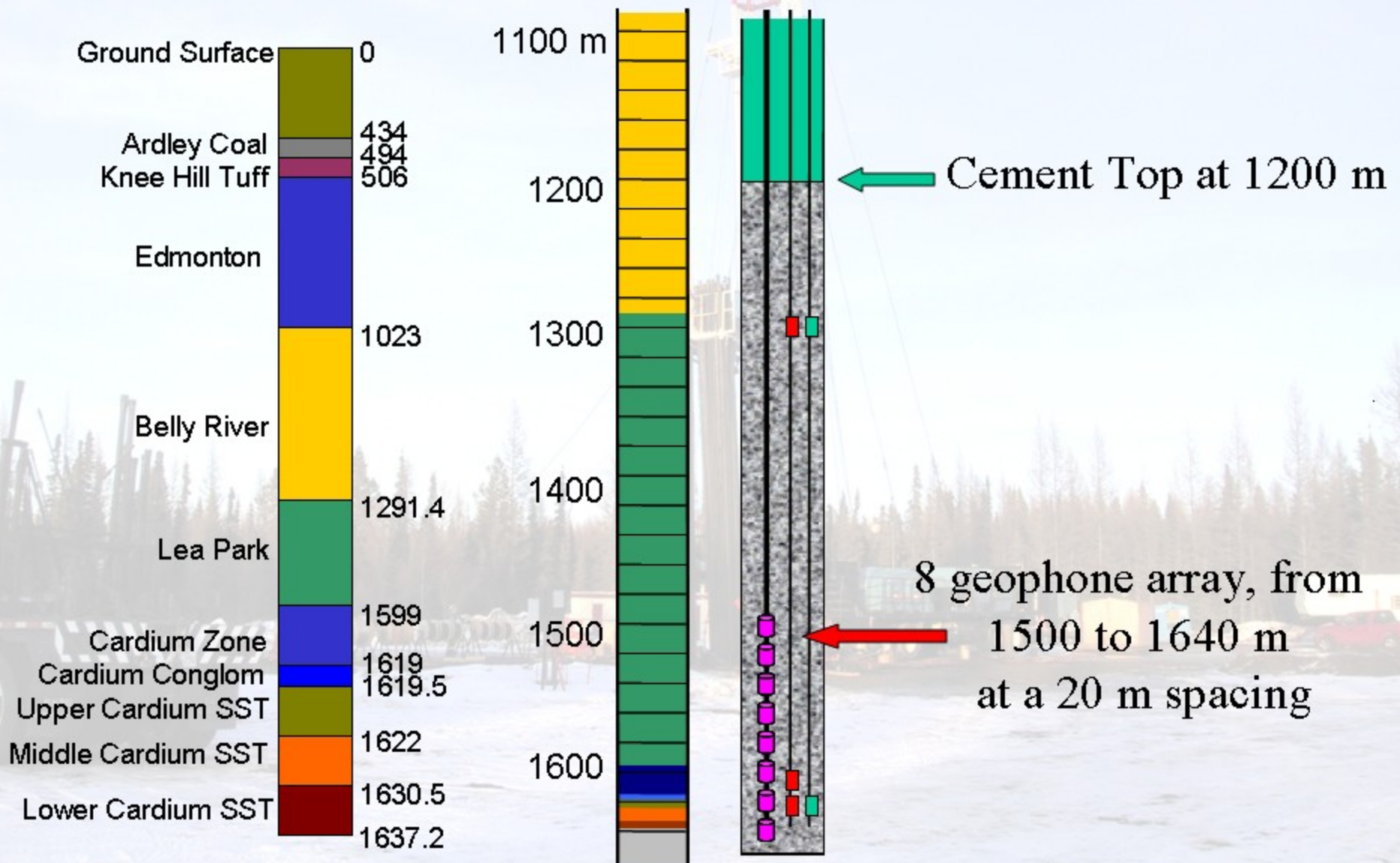
Introduction

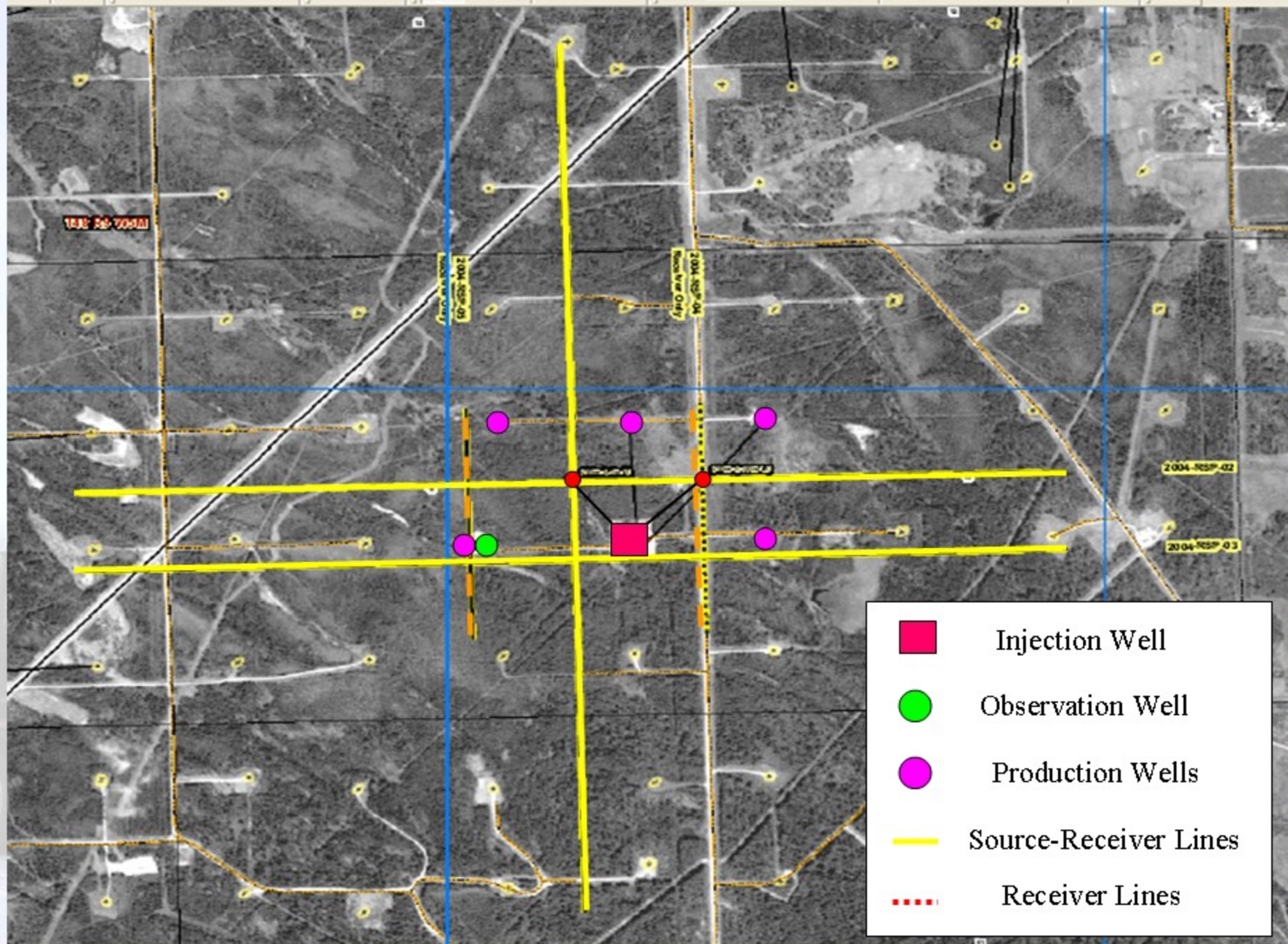
The background of the slide is a photograph of an oil well rig in a snowy, wooded area. The rig is a tall, complex structure with various pipes and platforms. The ground is covered in snow, and there are trees in the background. The overall scene is a winter landscape.

The Violet Grove Project is

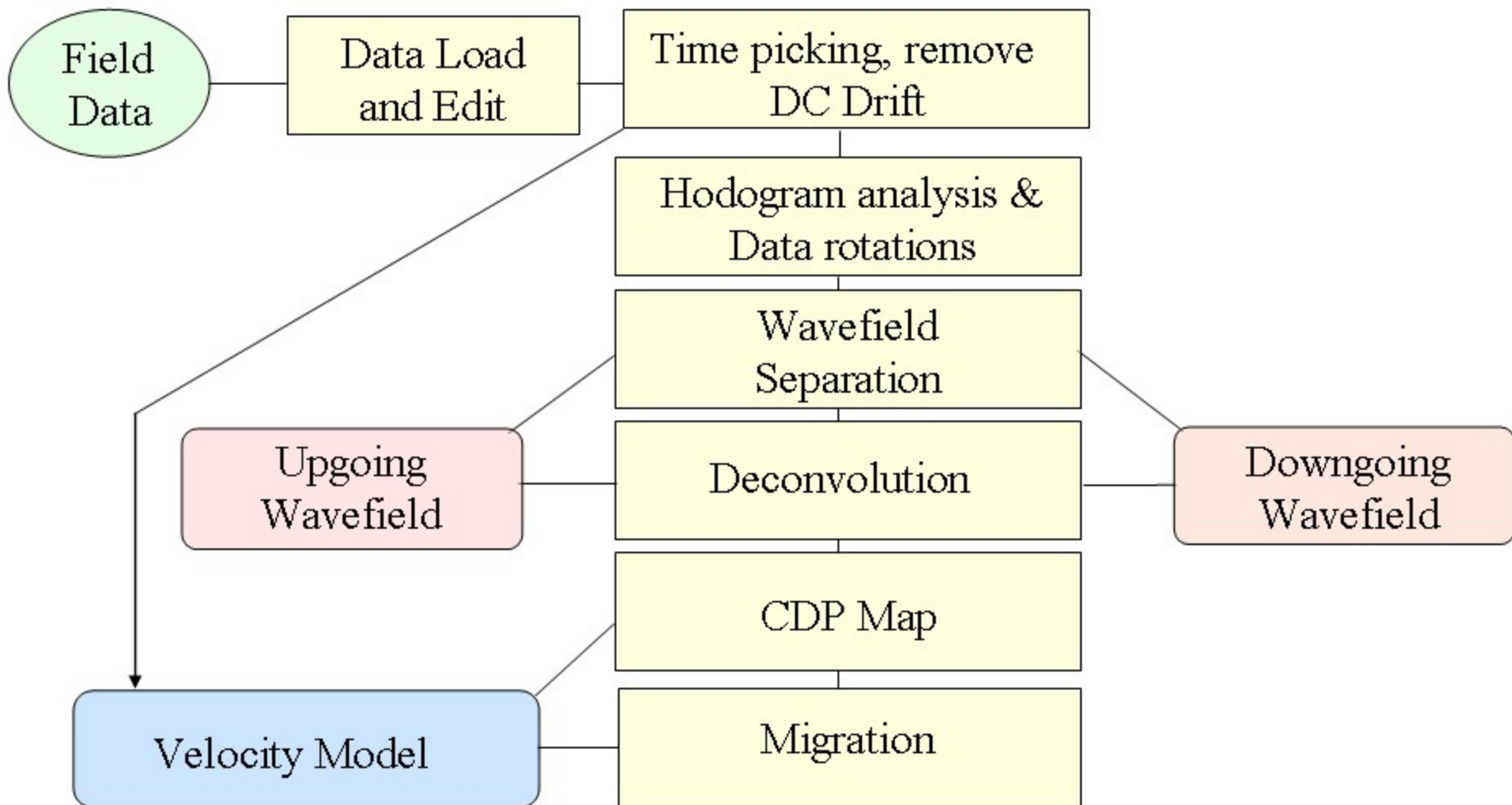
- A pilot project that injects CO₂ into the reservoir for EOR and sequestration purposes.
- Uses an innovative surface and borehole seismic program that has been designed to monitor injected CO₂.

Introduction

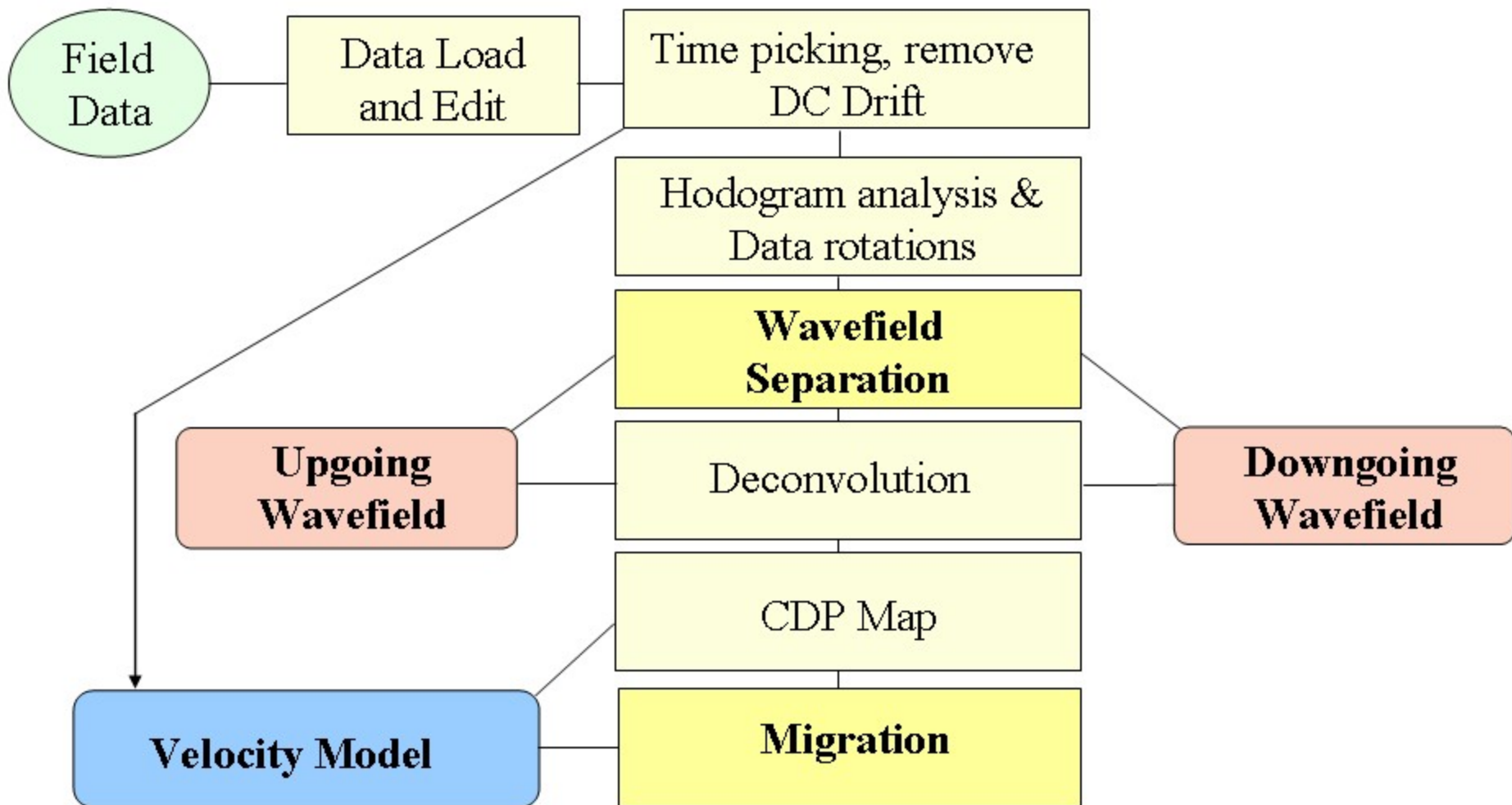




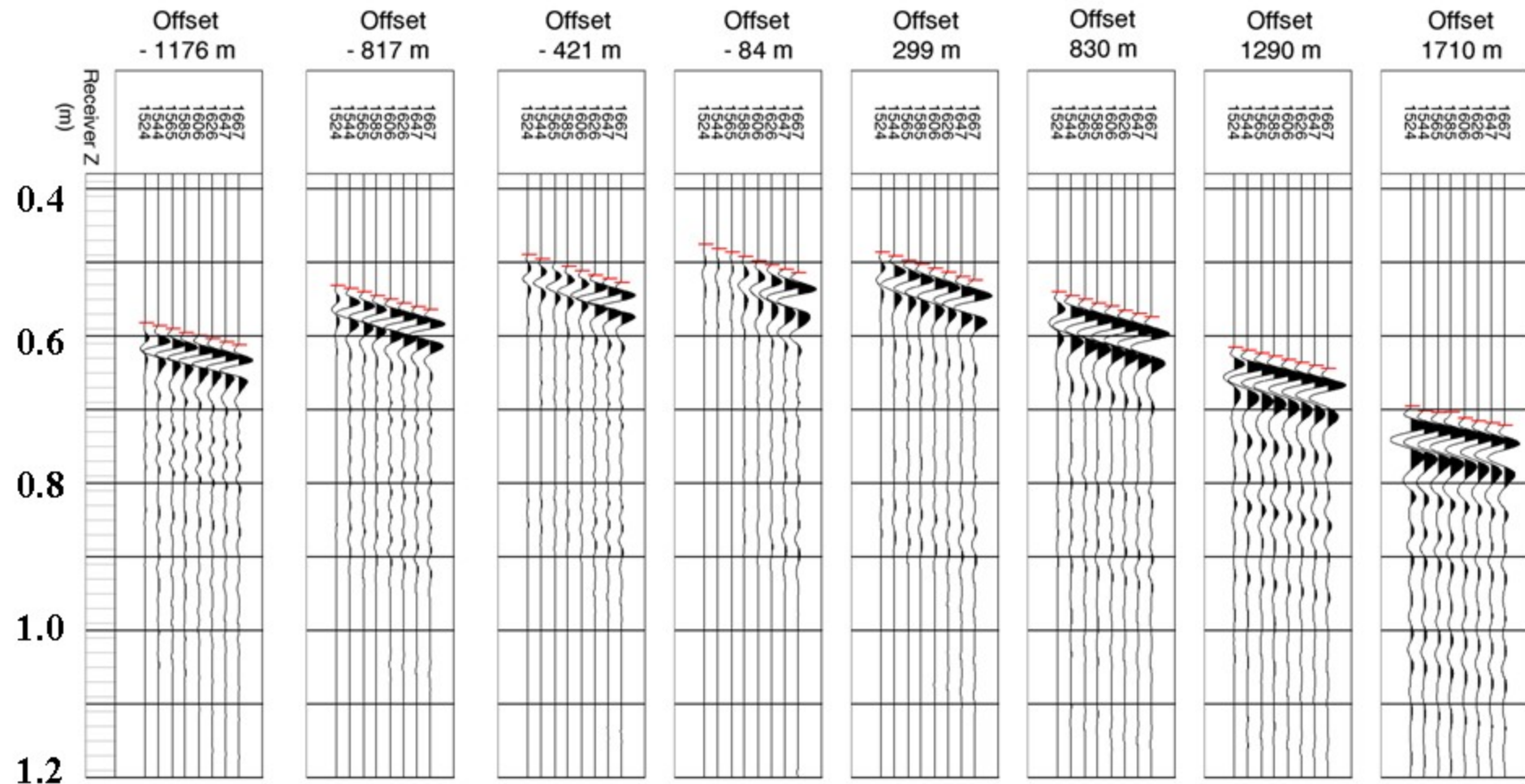
Processing Flow



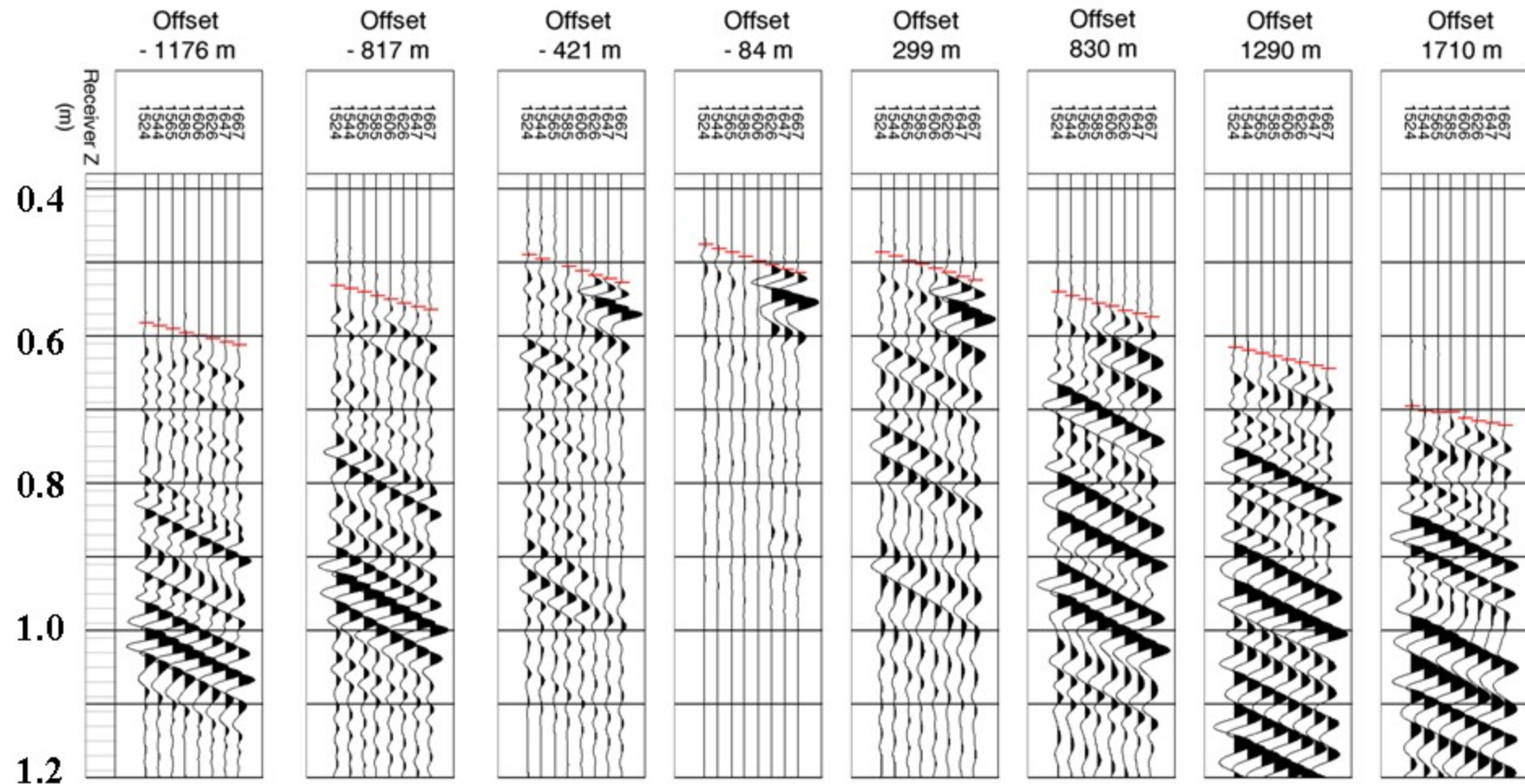
Processing Flow



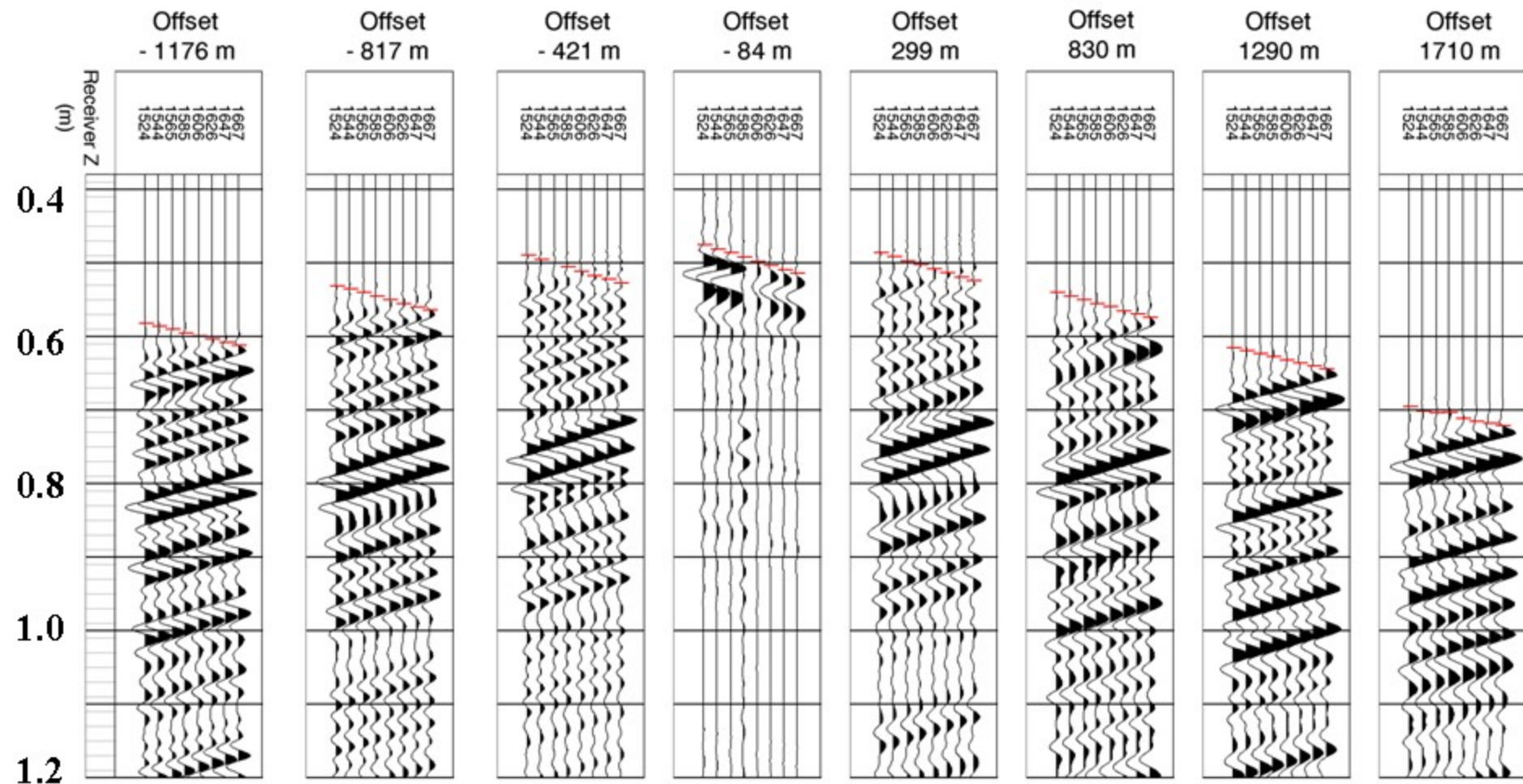
Initial Wavefield Separation: Downgoing P



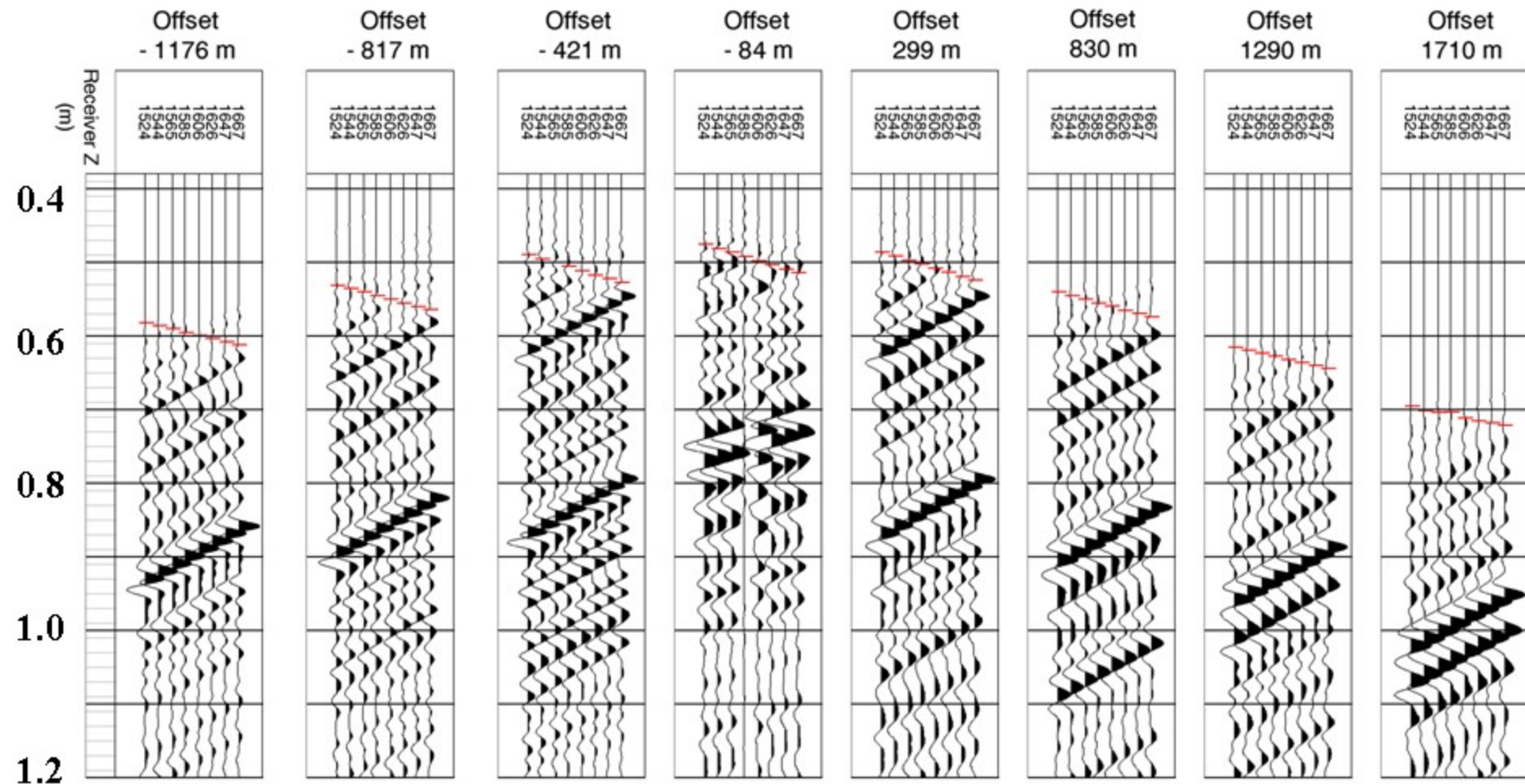
Initial Wavefield Separation: Downgoing S



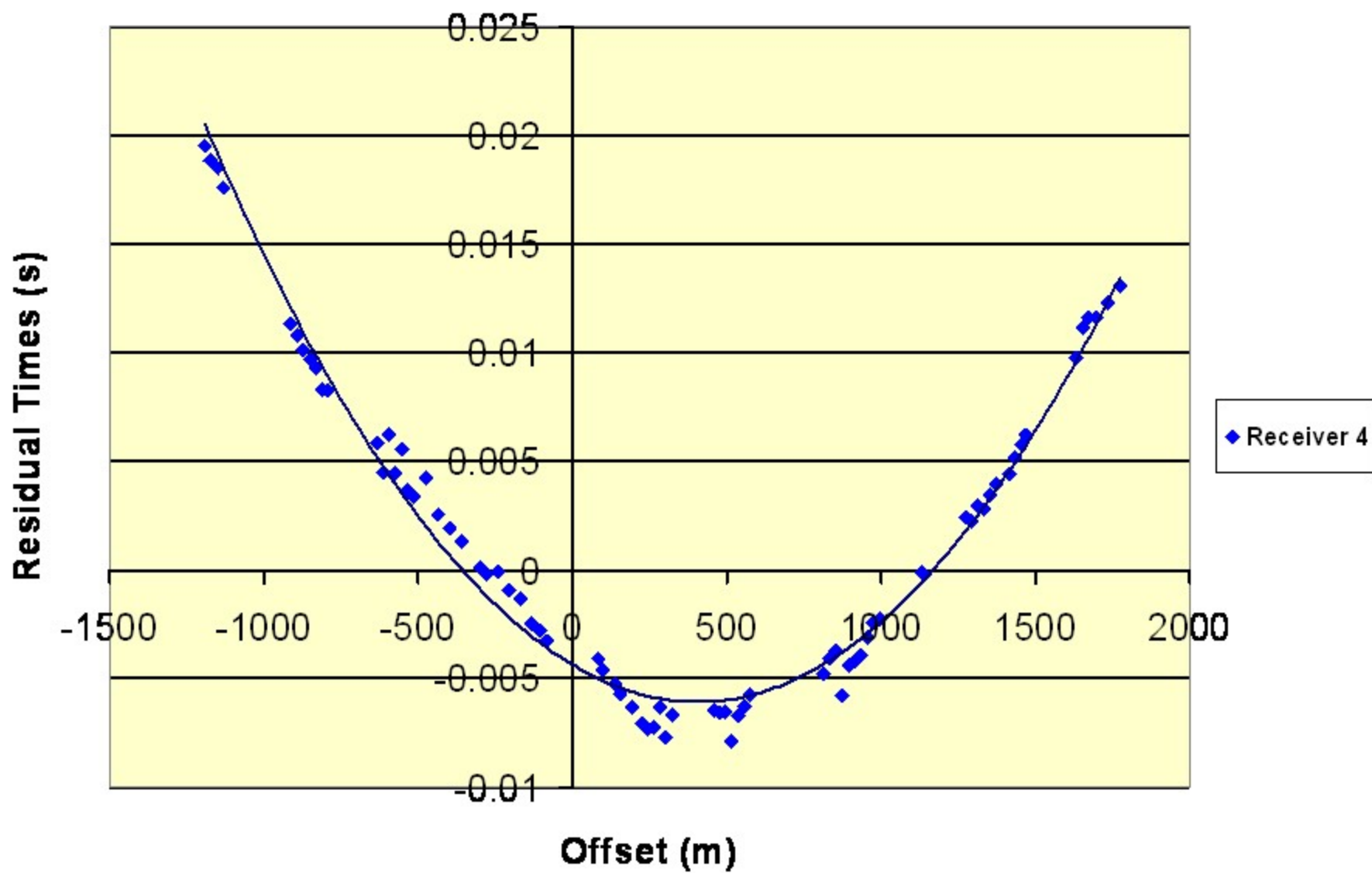
Initial Wavefield Separation: Upgoing P



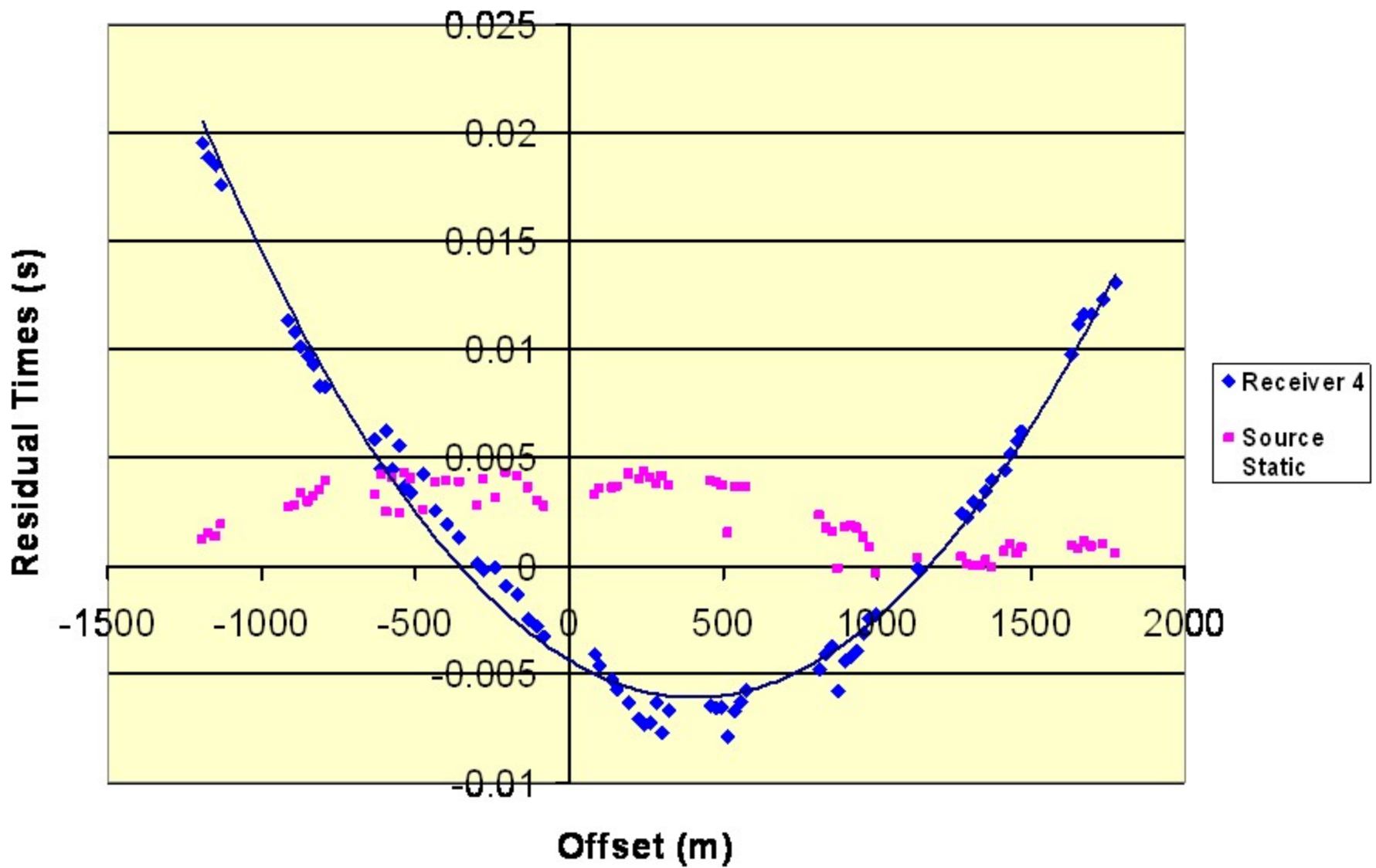
Initial Wavefield Separation: Upgoing PS



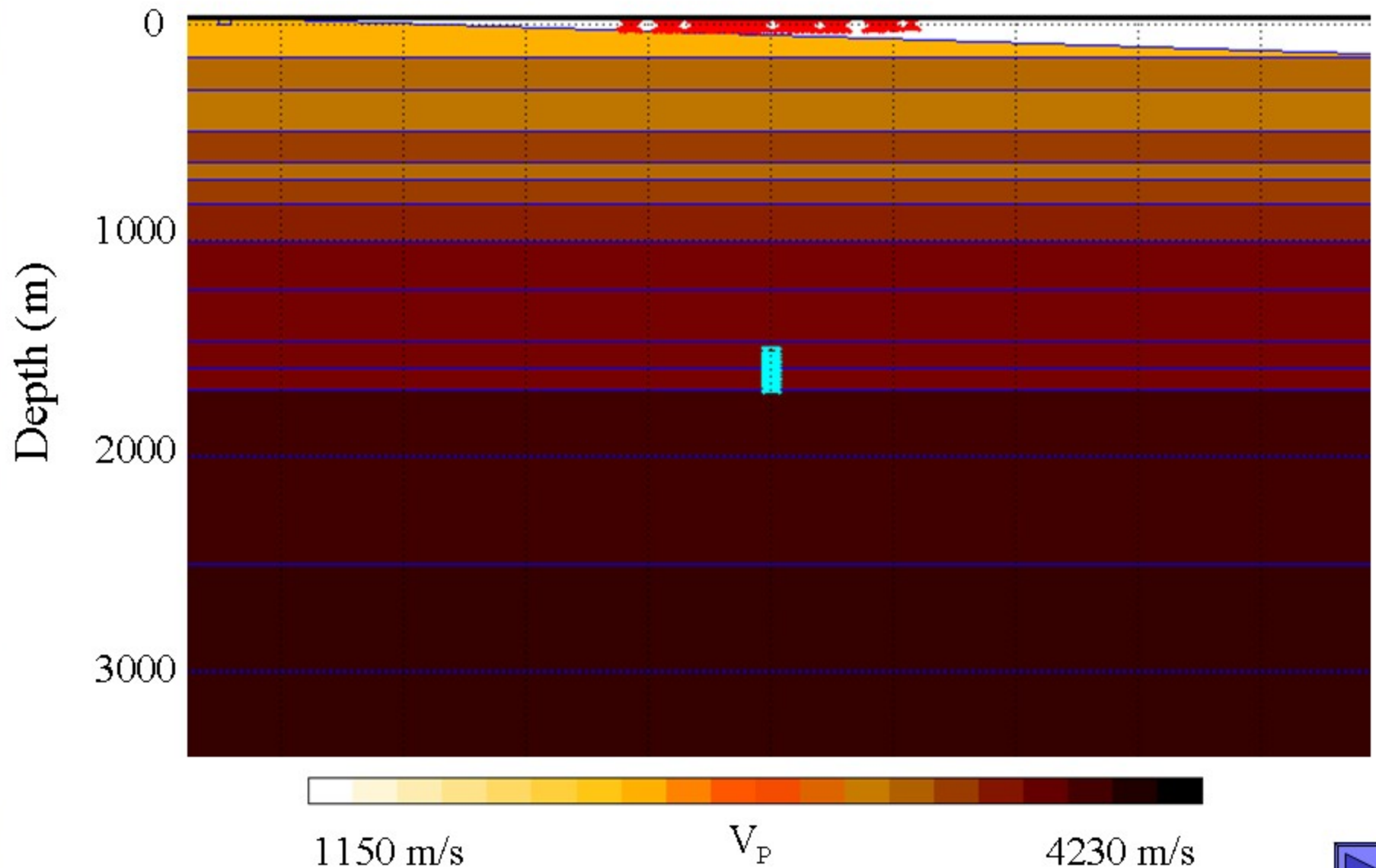
Initial Travel Time Residuals



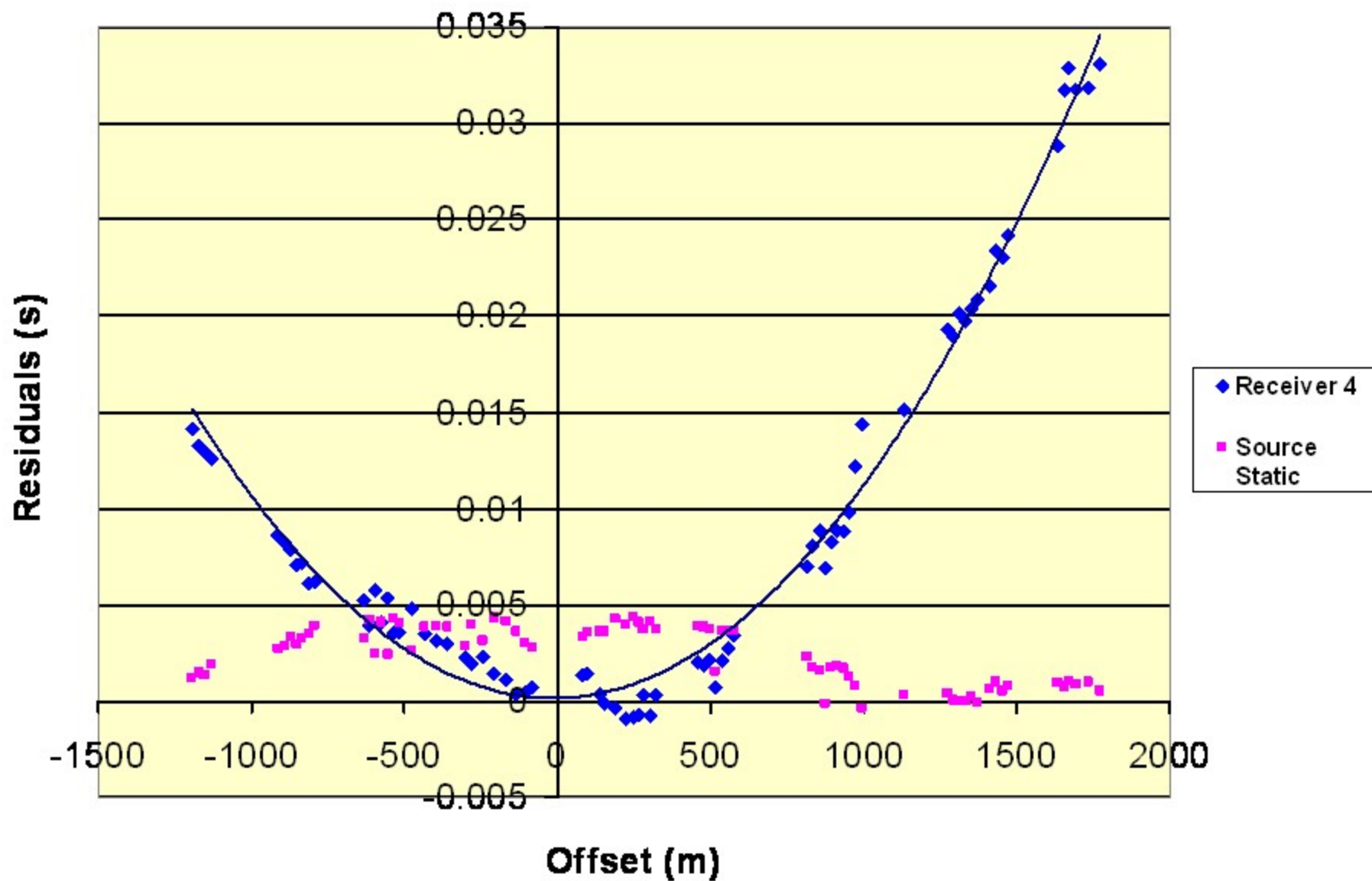
Initial Travel Time Residuals



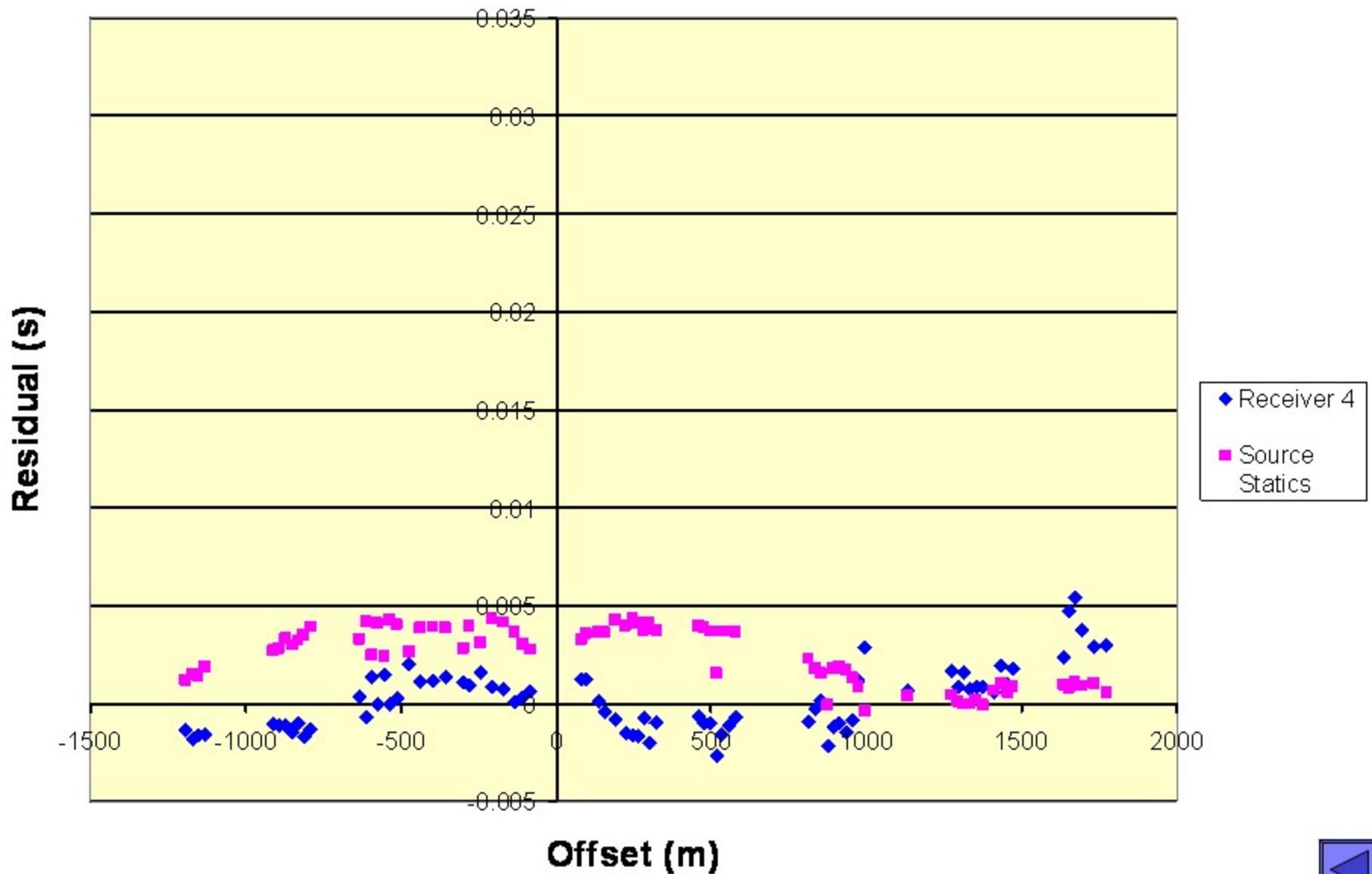
Isotropic Velocity Model: Dipping Layer



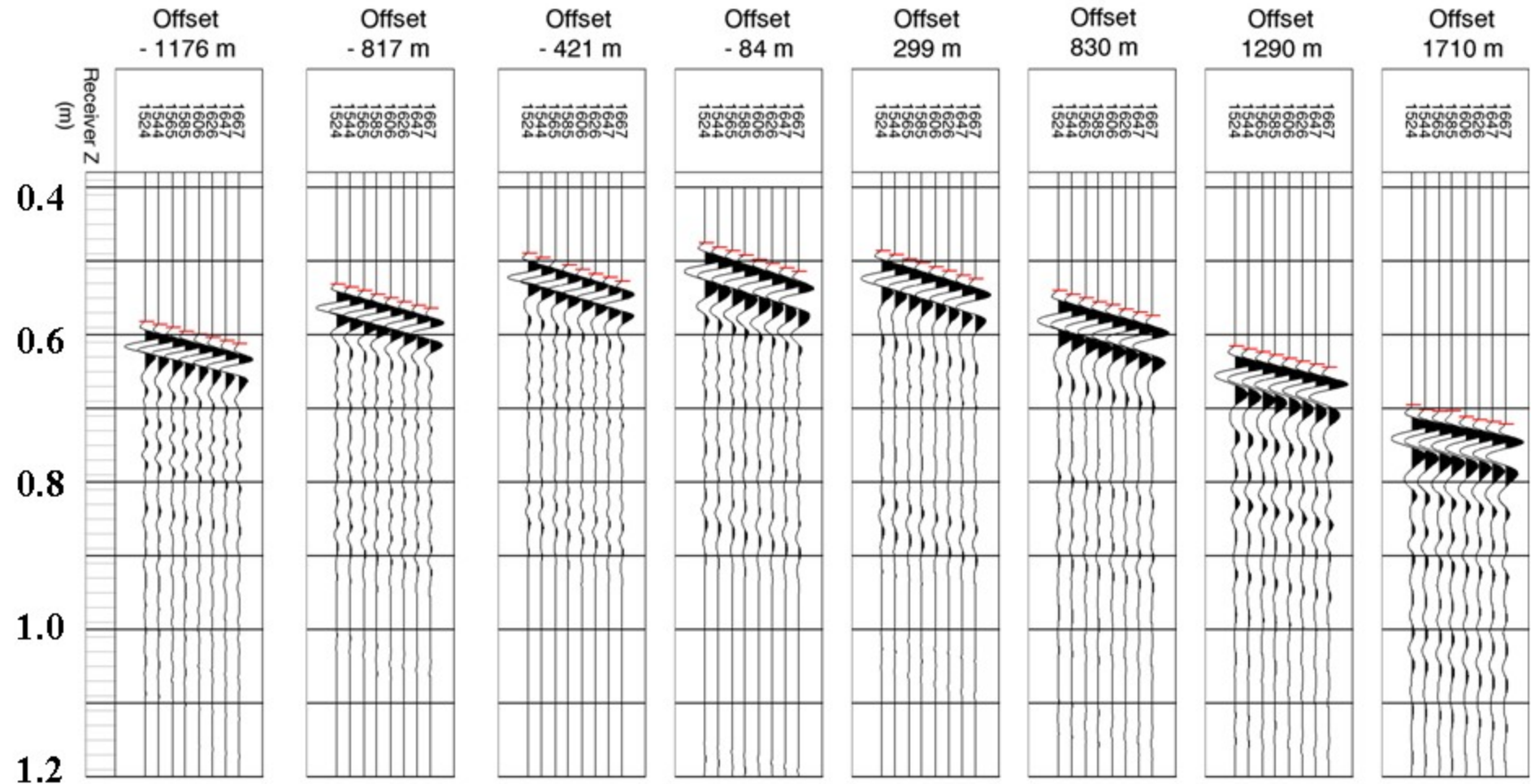
Travel Time Residuals: Dipping Layer



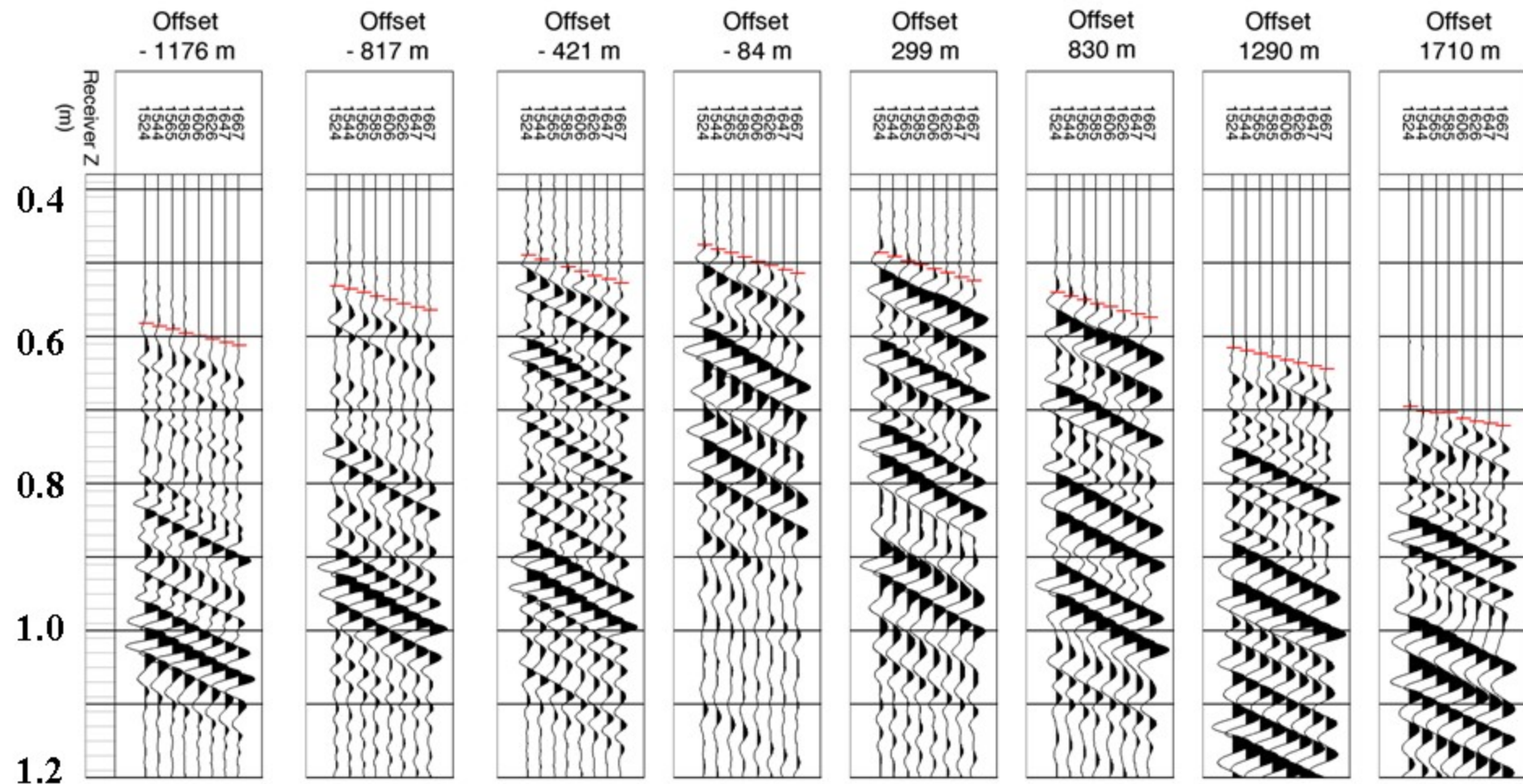
Travel Time Residuals: Anisotropy



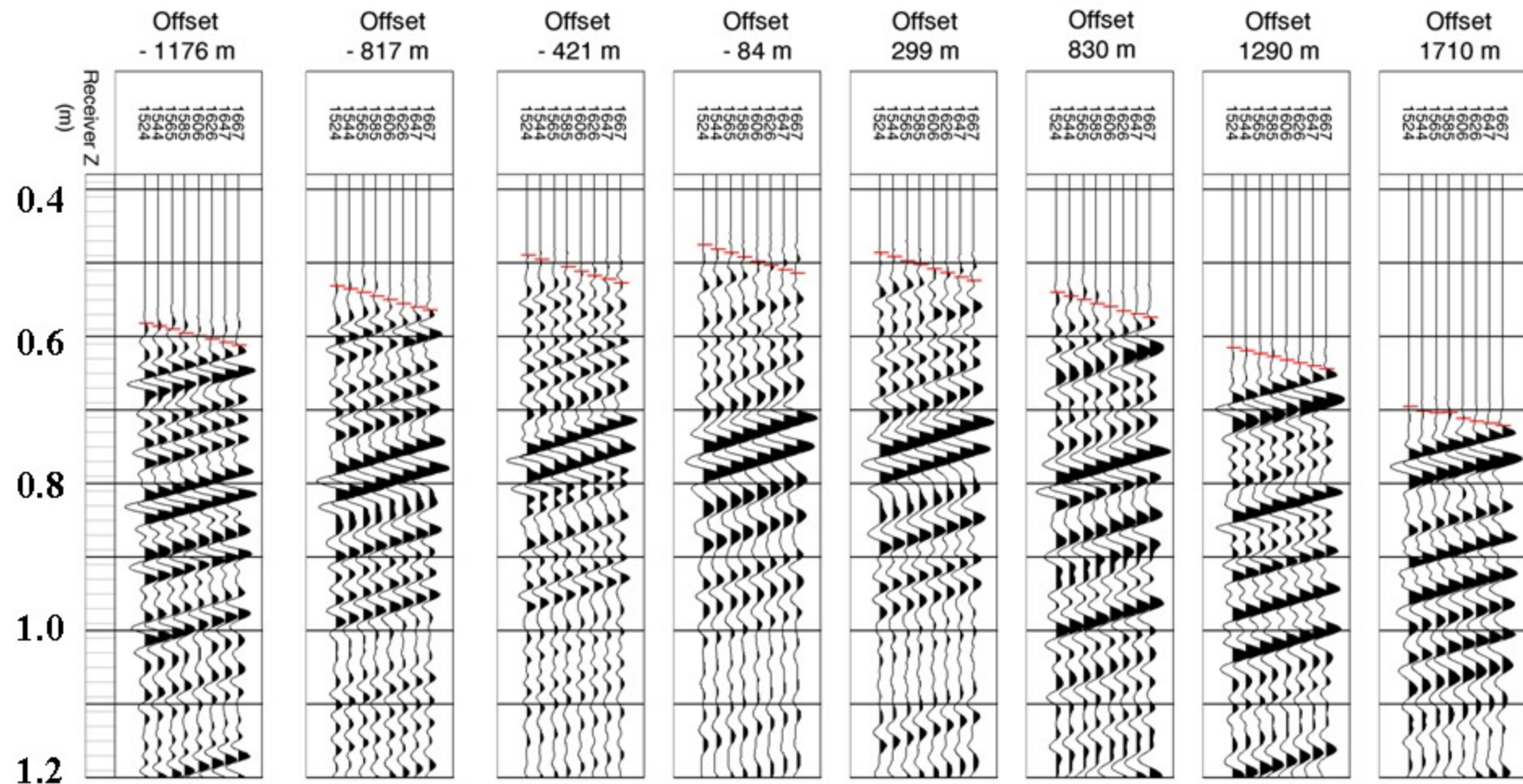
Velocity Based Wavefield Separation: Downgoing P



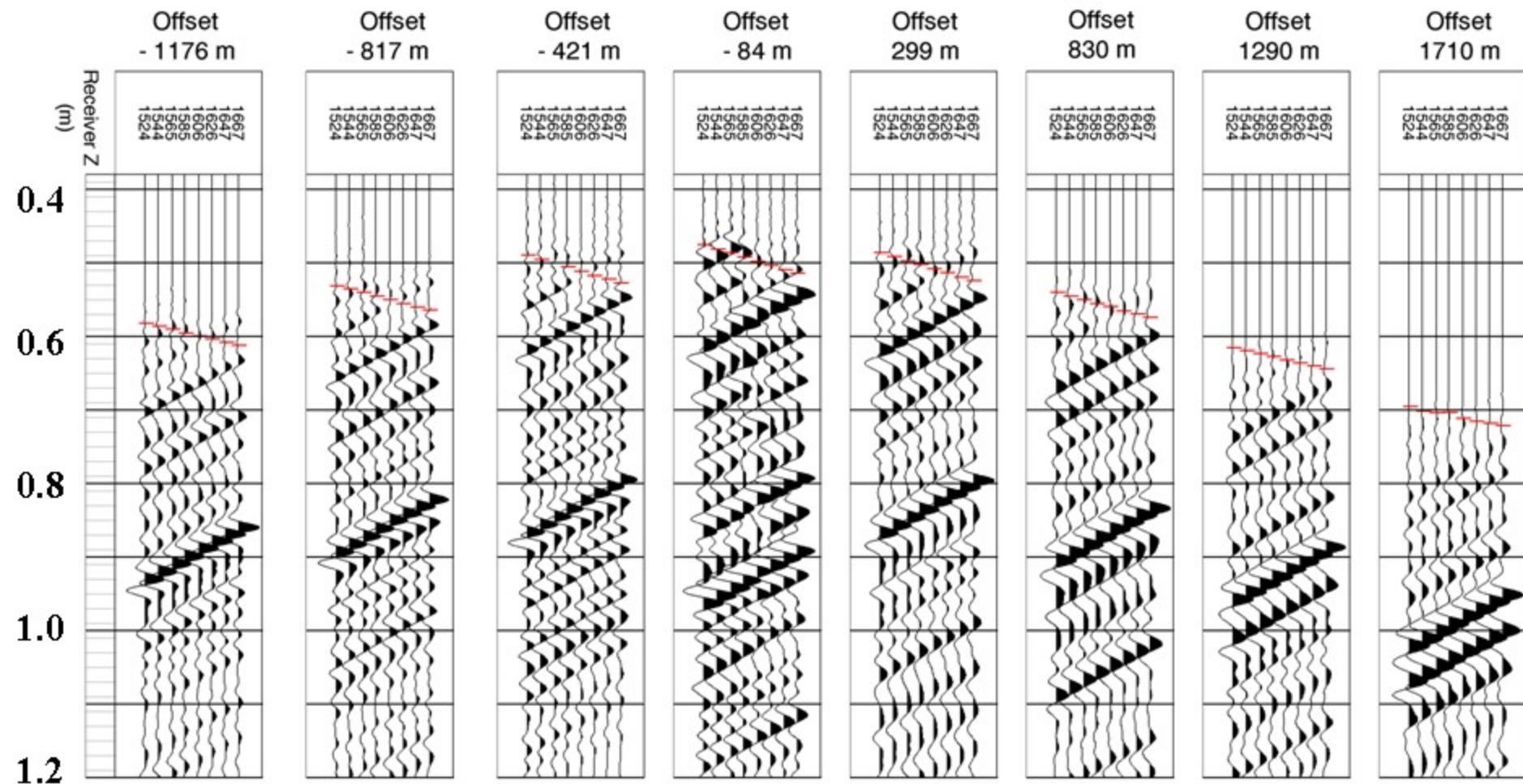
Velocity Based Wavefield Separation: Downgoing S



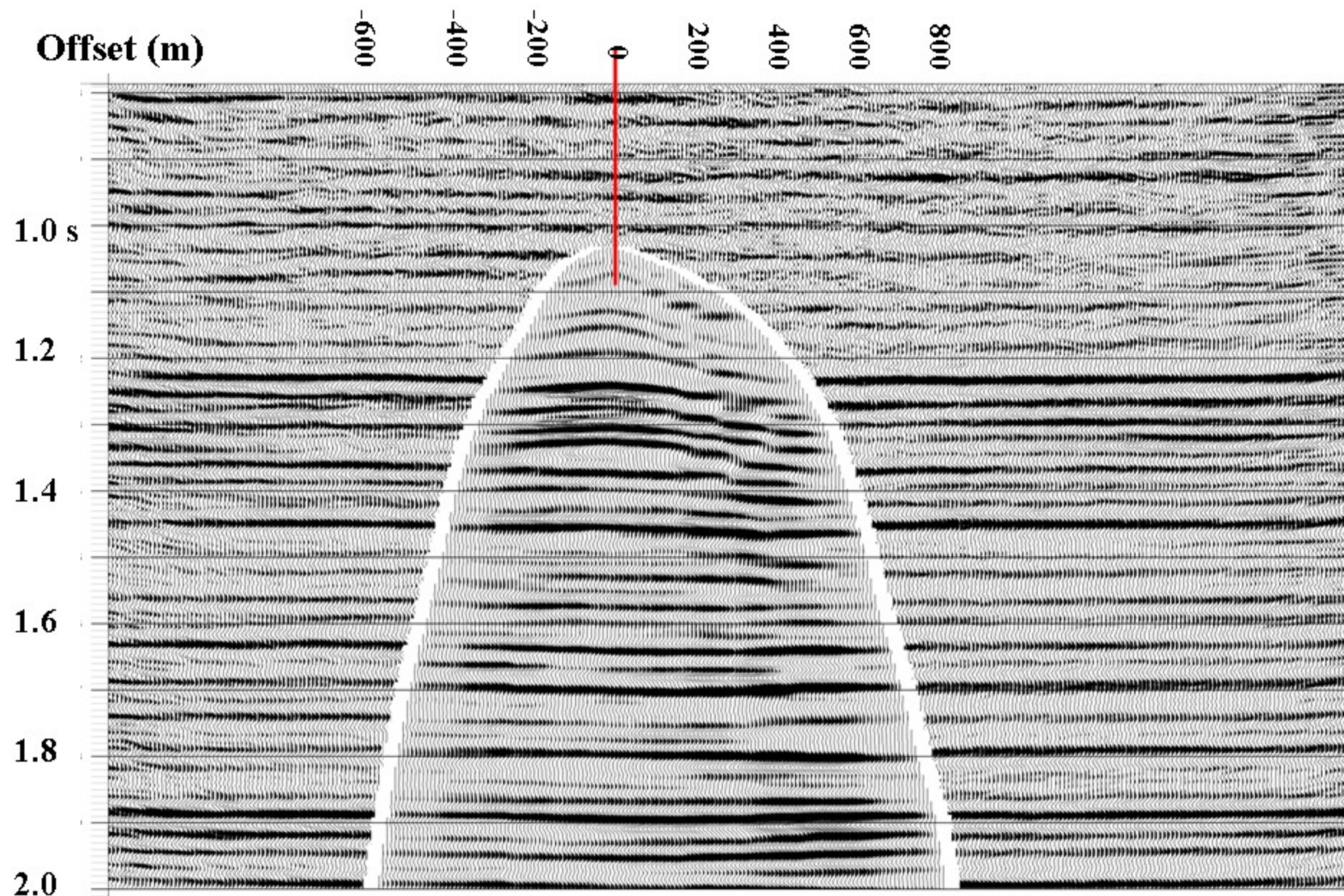
Velocity Based Wavefield Separation: Upgoing P



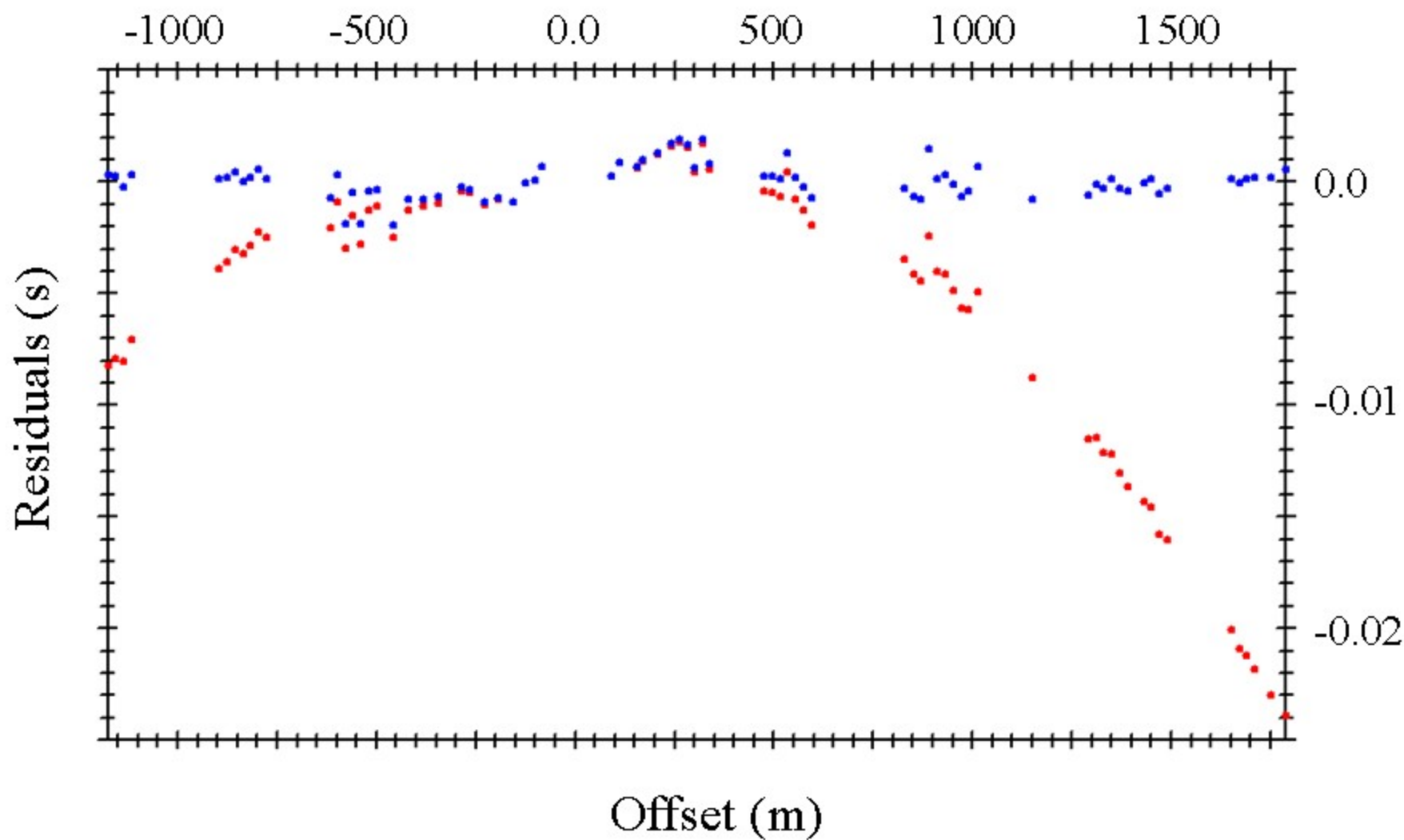
Velocity Based Wavefield Separation: Upgoing PS



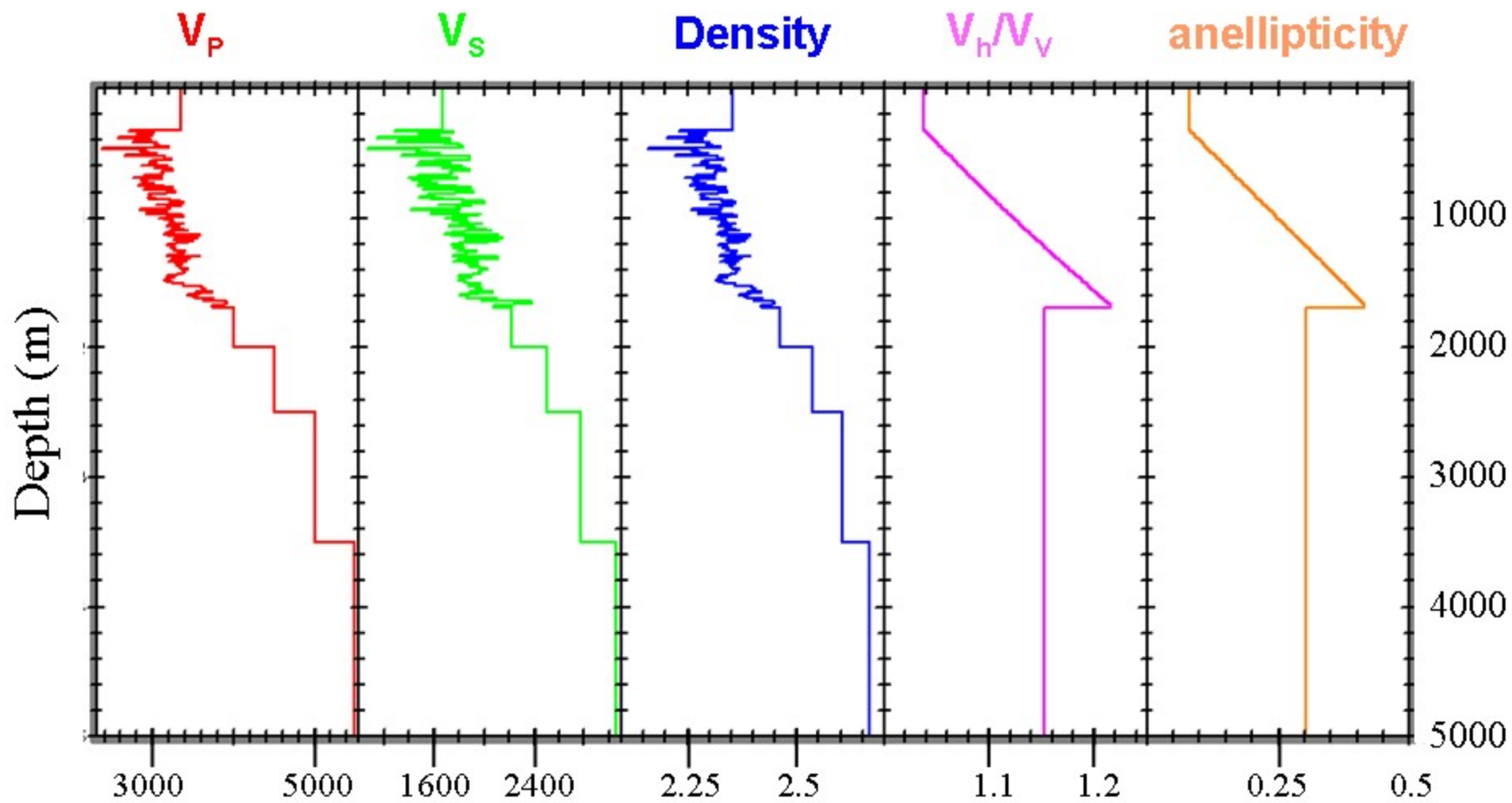
PP Surface Seismic & VSP



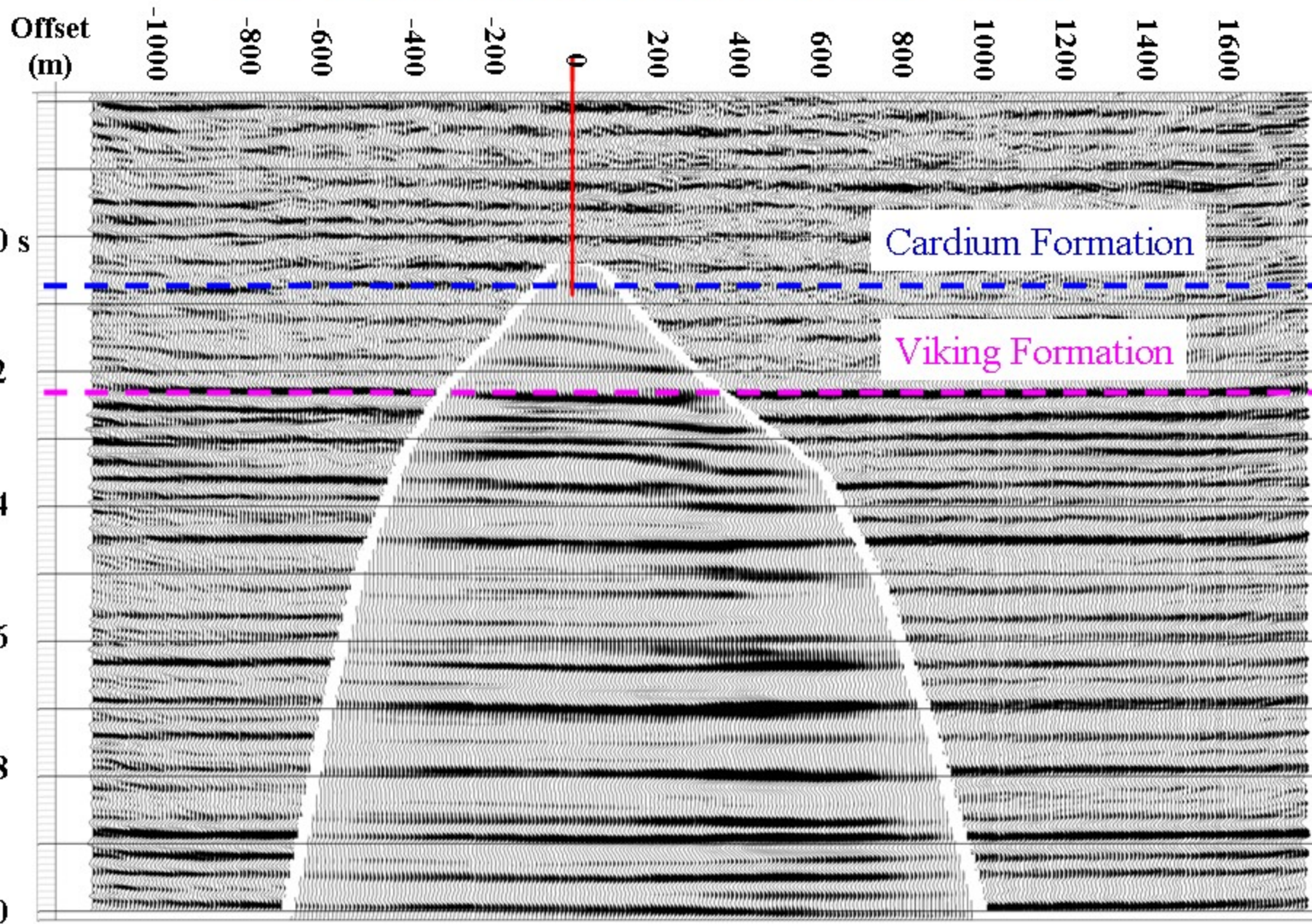
Anisotropic Velocity Model: Residuals



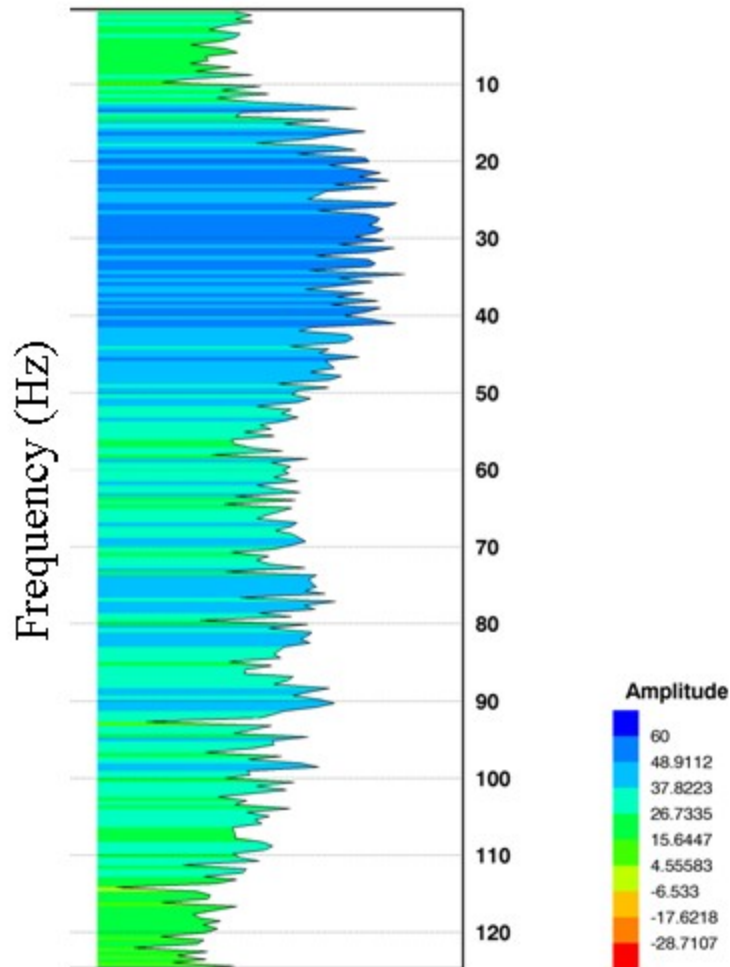
Anisotropic Velocity Model



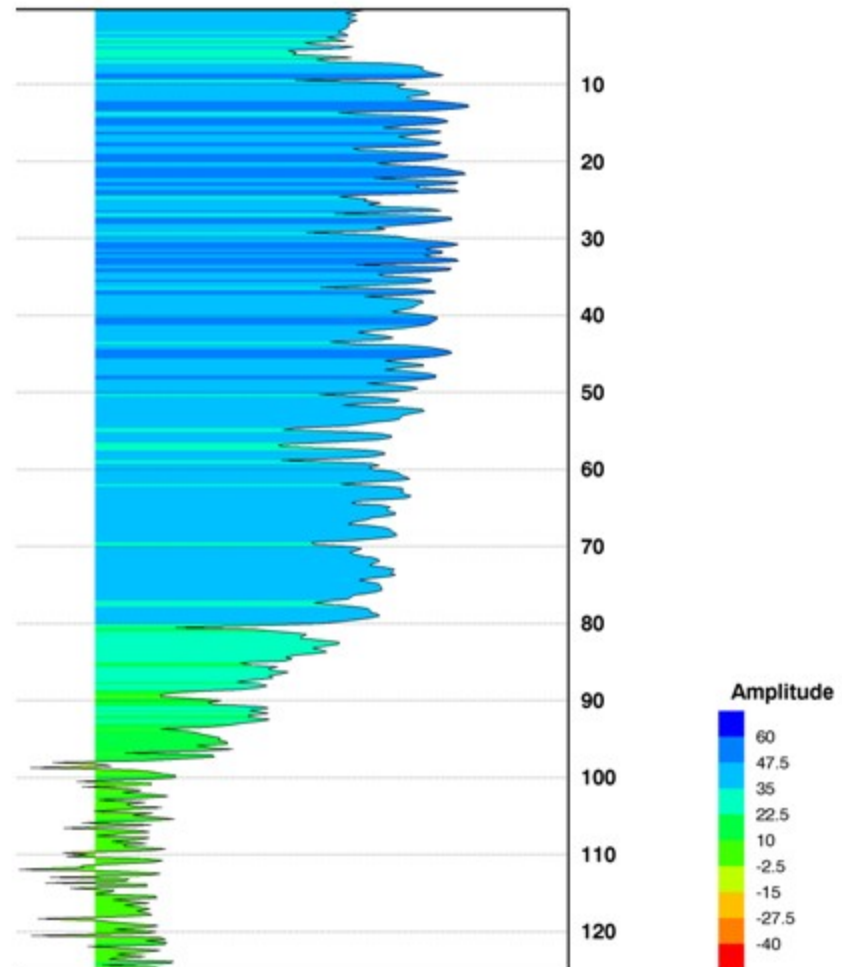
PP Surface Seismic & VSP



Comparison of P-wave Amplitude Spectra

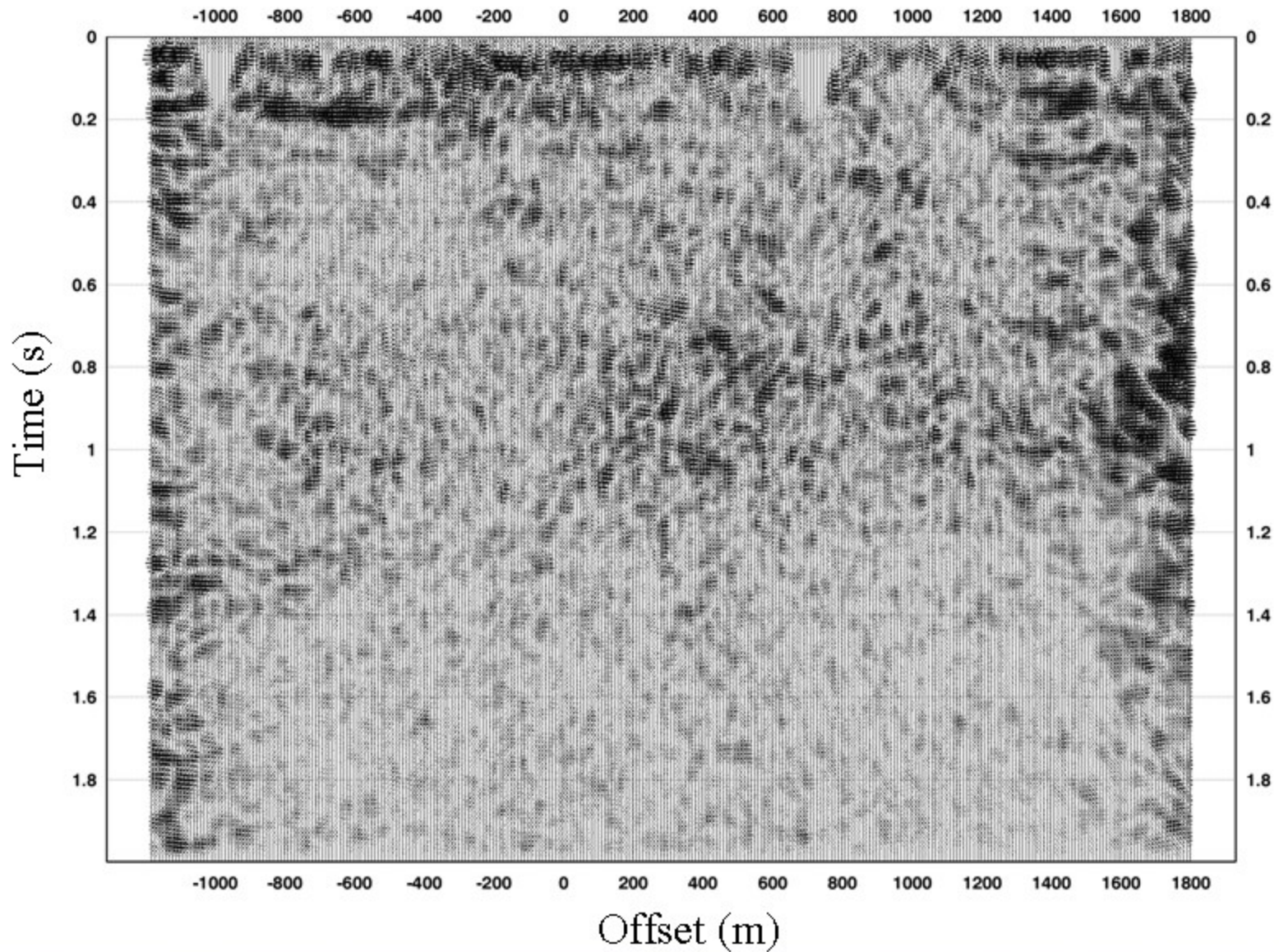


Zero offset amplitude spectrum
Of P-wave surface seismic

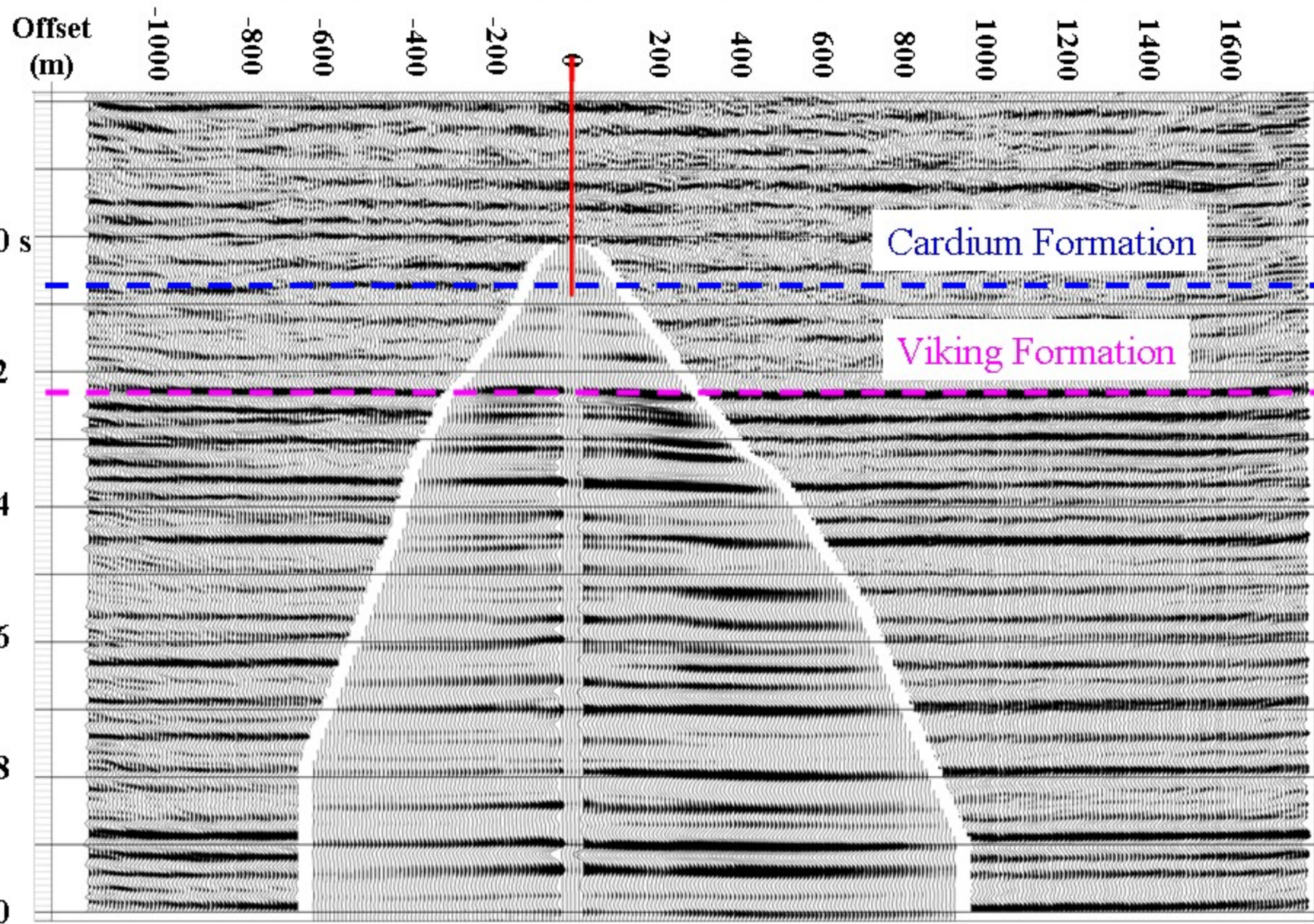


Zero offset amplitude
spectrum of P-wave VSP

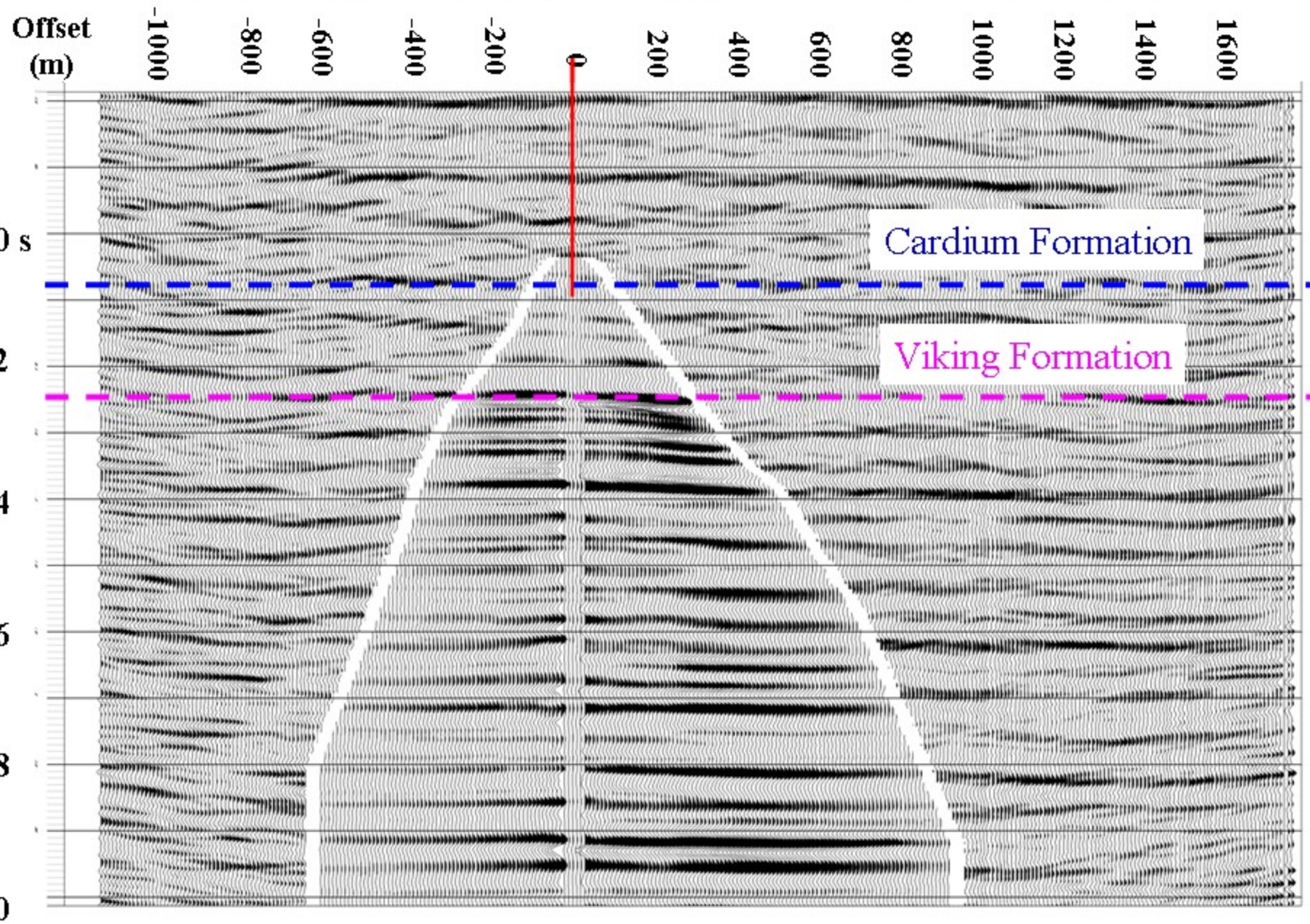
Surface Seismic Data: 80 to 110 Hz



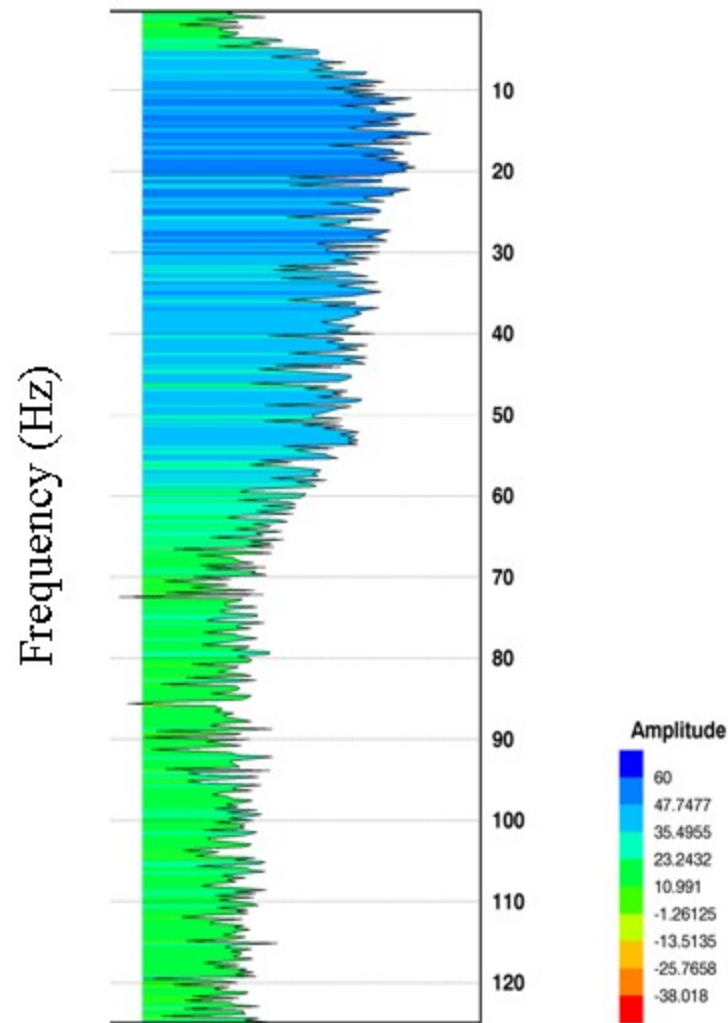
PP Surface Seismic & PS-VSP



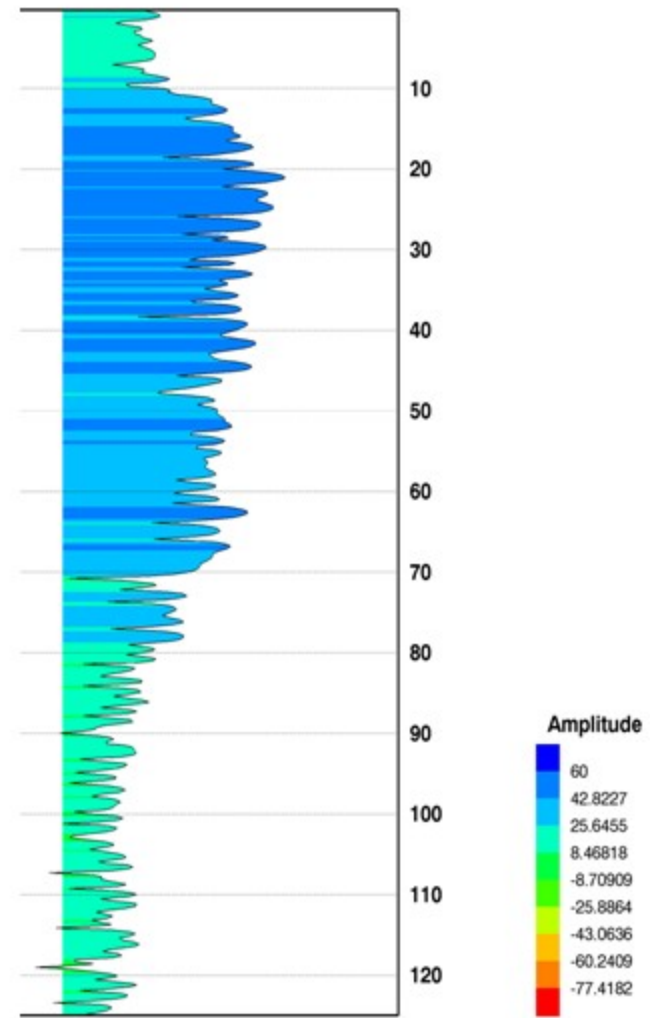
PS-Wave Surface Seismic & VSP



Comparison of S-wave Amplitude Spectra



Zero offset amplitude spectrum
of S-wave surface seismic



Zero offset amplitude
spectrum of S-wave VSP

Conclusions

- Parametric wavefield decomposition was used successfully to separate the downgoing and upgoing wavefields
- The VSP data images an area around the monitor well of ~ 200 m
- The P- and PS-wave VSP images tie the P-wave surface seismic very well
 - Both VSP images display higher frequency bandwidth and resolution than the surface seismic
- The PS-wave VSP tie to the PS-wave surface seismic is less certain due to poorer data quality

Potential Changes in Monitor Surveys

- Properties expected to change:
 - Overburden stress as the reservoir is depleted
 - Fluid composition as the CO₂ is injected
- Expected seismic response:
 - Increased travel times
 - Change in reservoir amplitudes
- Geophone array is a fixed
 - Can be used to calibrate source variability and overburden travel times between the surveys

Acknowledgements

The background of the slide is a faded photograph of an oil well drilling site in winter. A tall drilling rig is the central focus, with its derrick extending into the sky. The ground is covered in snow, and there are various pieces of equipment, including a large truck and smaller containers, scattered around the base of the rig. The overall scene is industrial and cold.

- DCS for allowing me to work on my project in the Schlumberger office
- Alberta Energy Research Institute (AERS)
- Natural Resources Canada (NRCan)
- PennWest Petroleum
- CREWES for financial support

