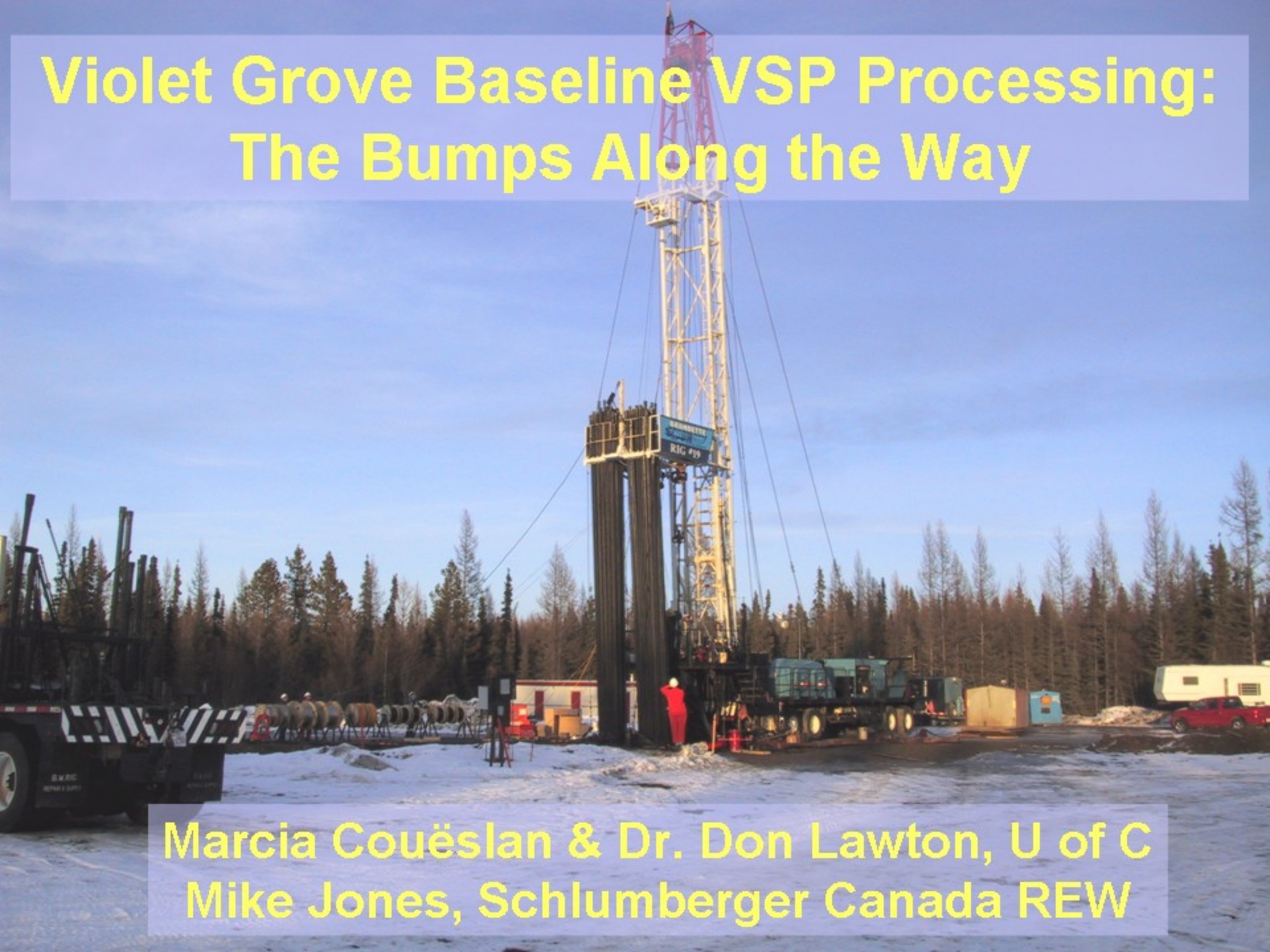
Violet Grove Baseline VSP Processing: The Bumps Along the Way



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

Outline

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

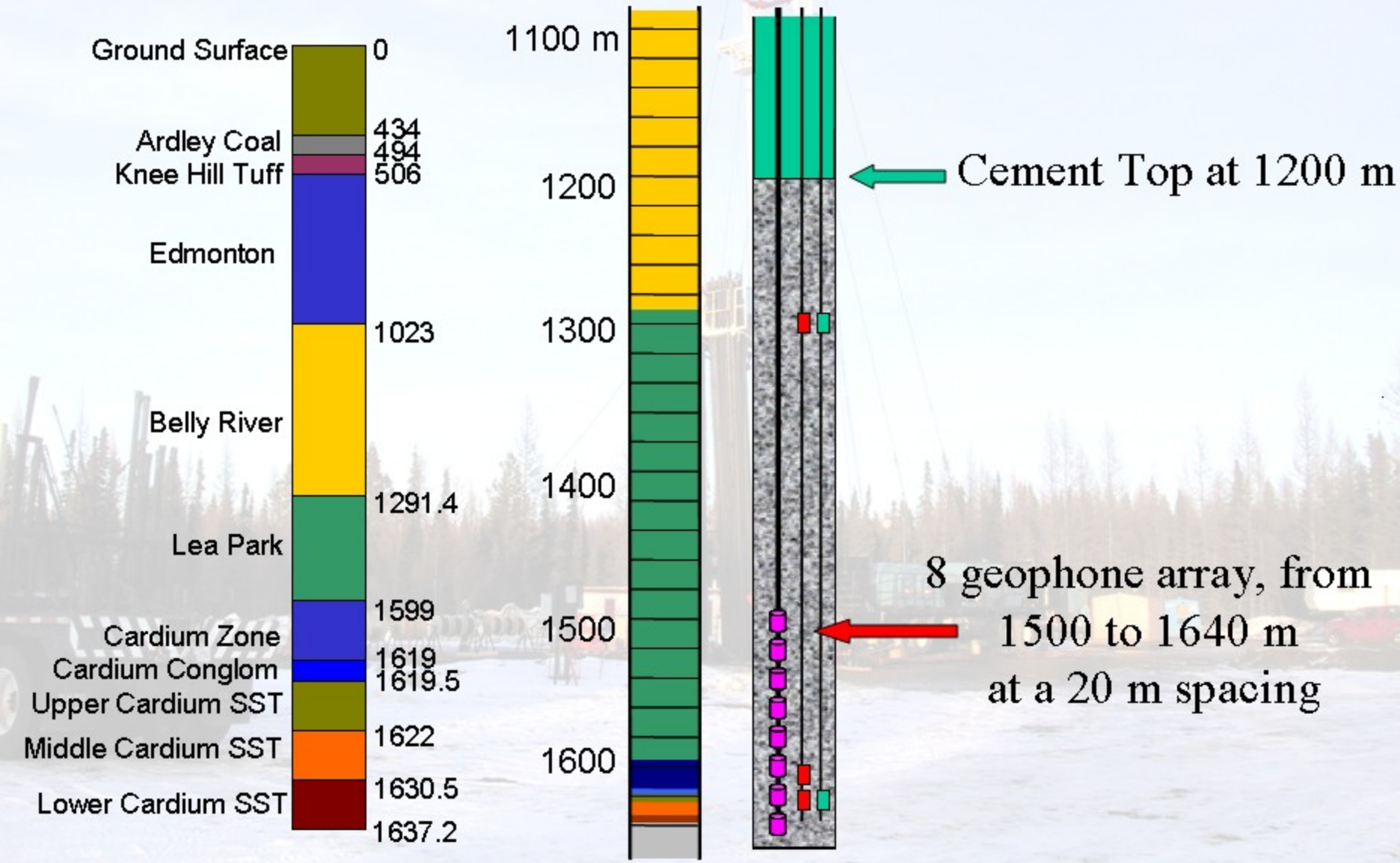
Introduction

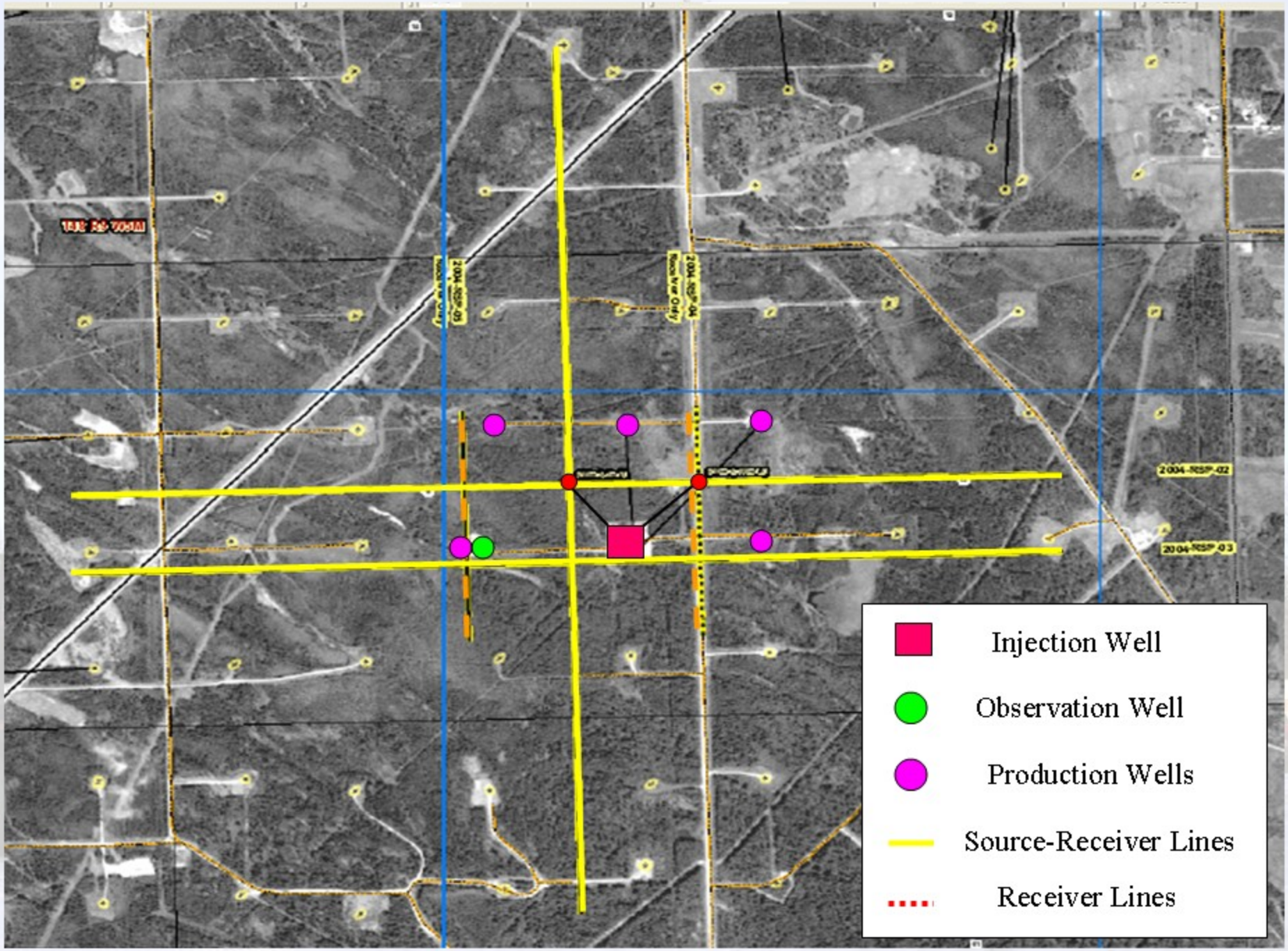
The Violet Grove Project is

- A pilot project that injects CO_2 into the reservoir for EOR and sequestration purposes.

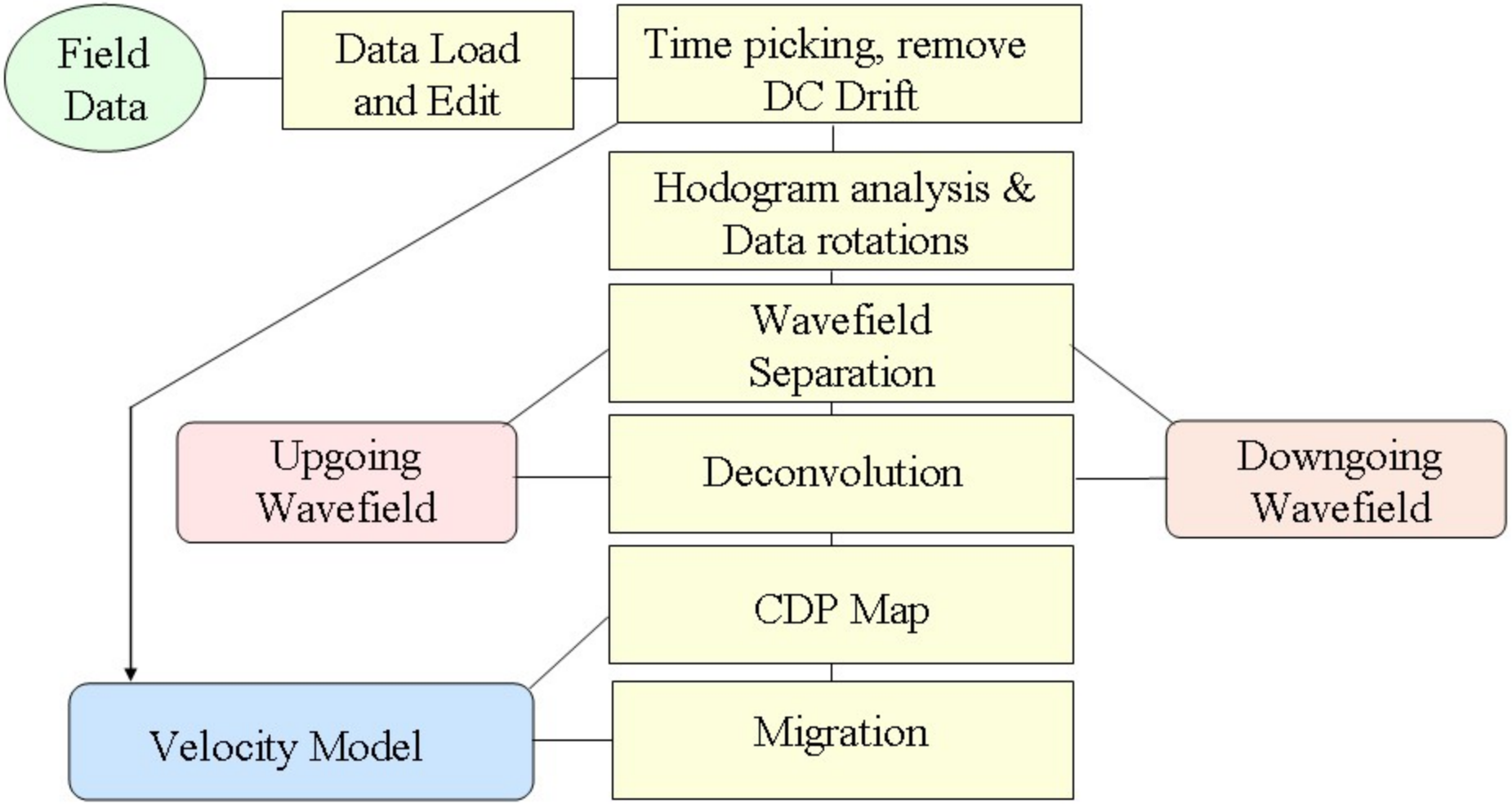
- Uses an innovative surface and borehole seismic program that has been designed to monitor injected CO_2.

Introduction

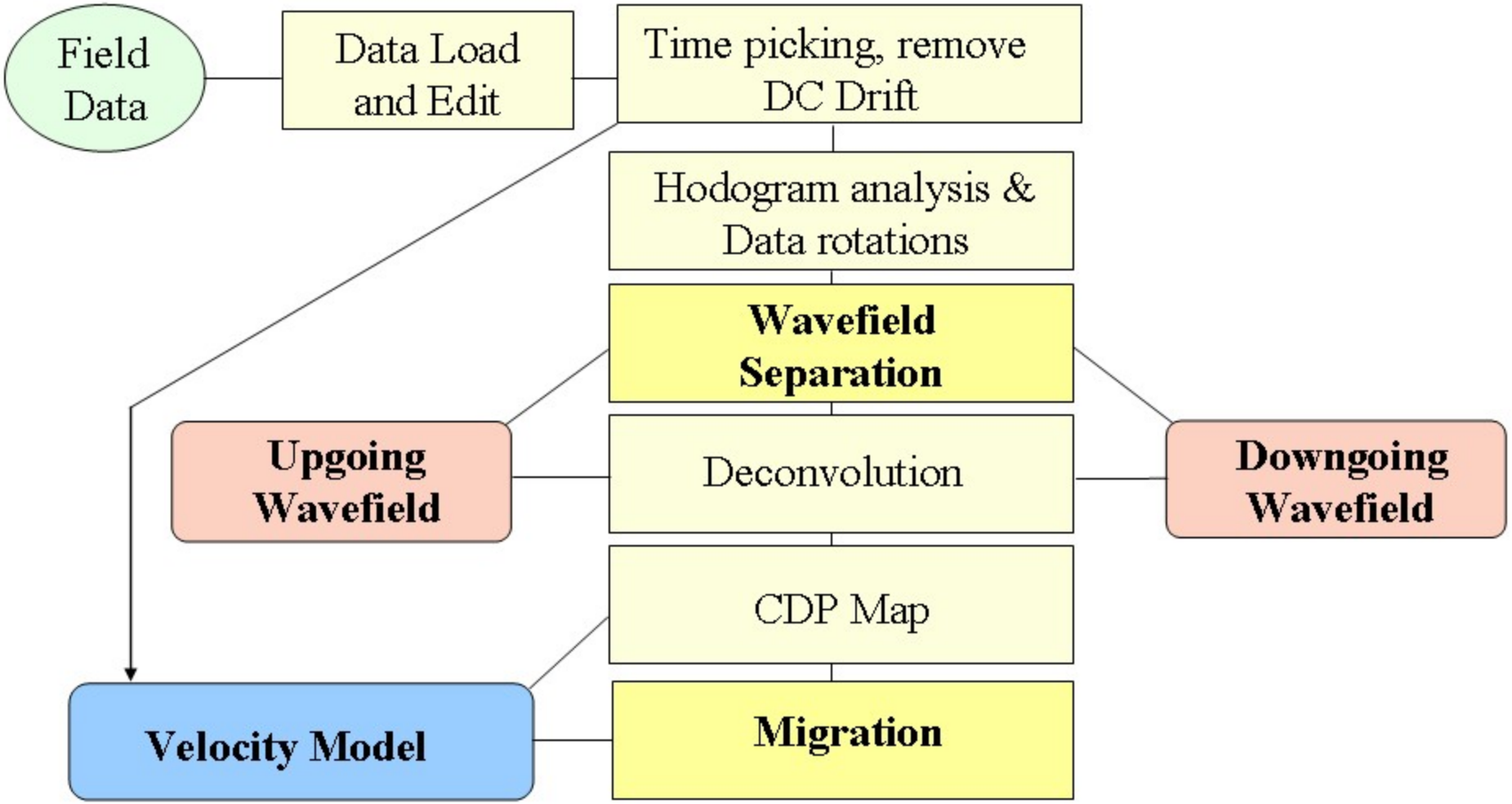



Injection Well
Observation Well
Production Wells
Source-Receiver Lines
Receiver Lines

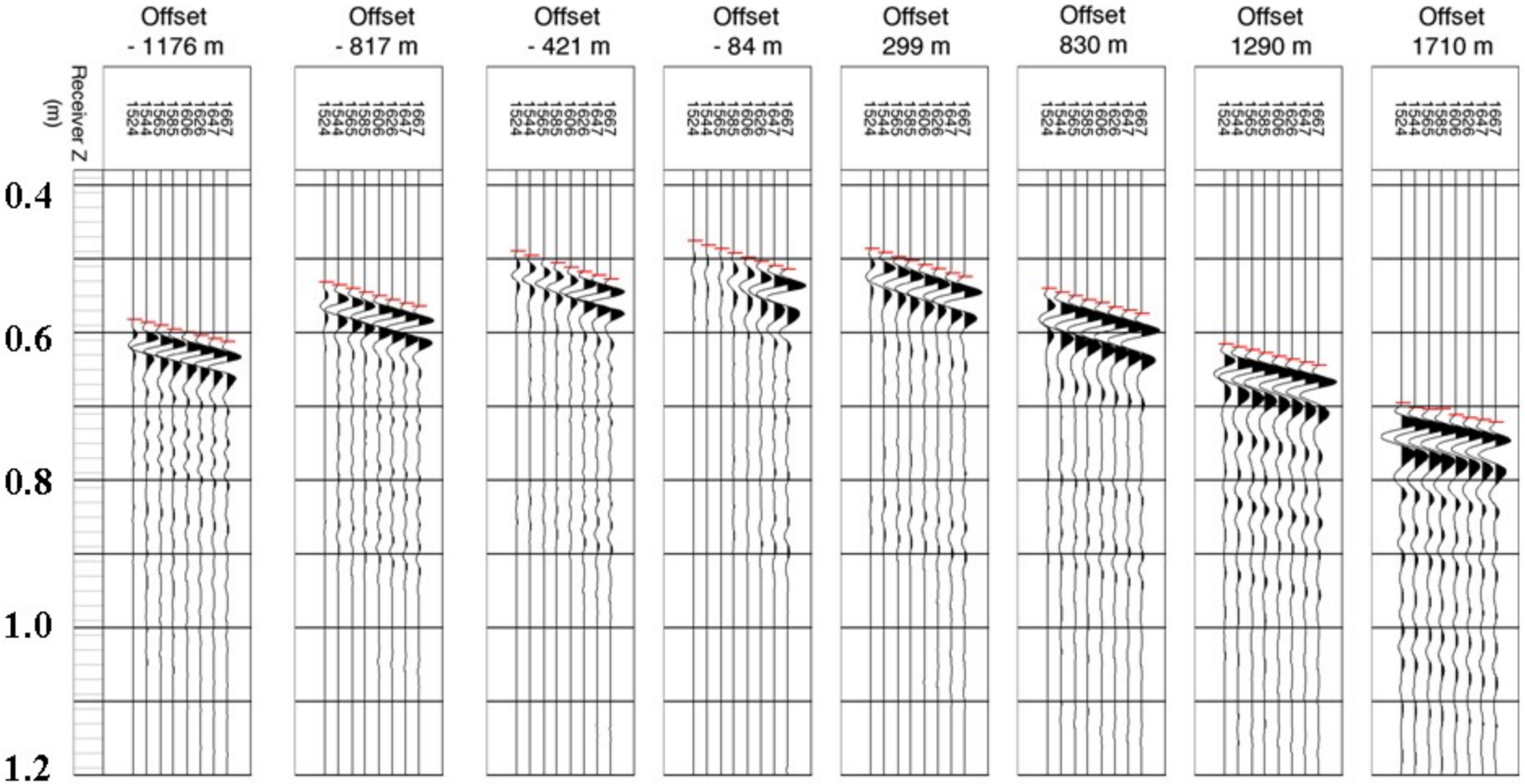
Processing Flow



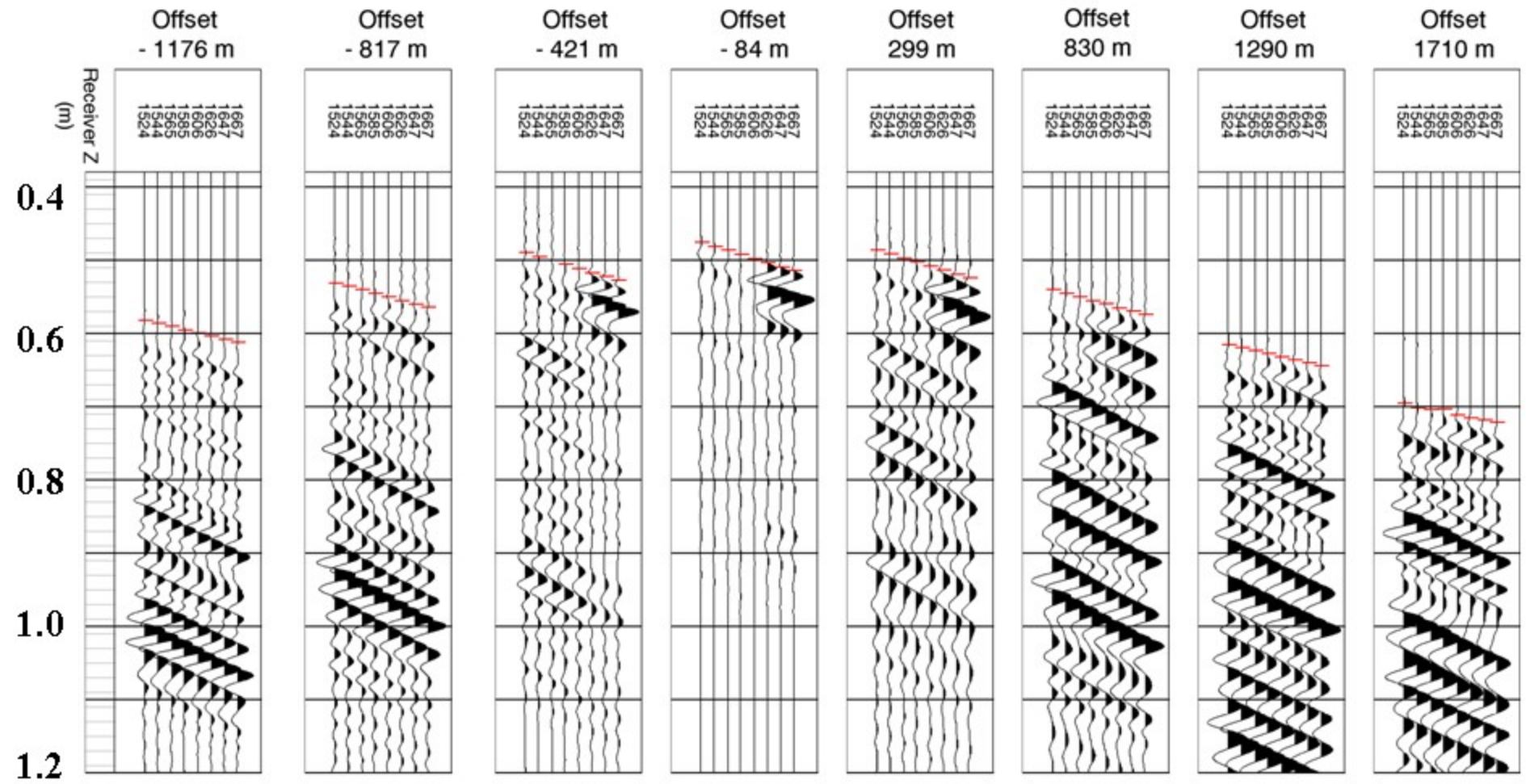
Processing Flow



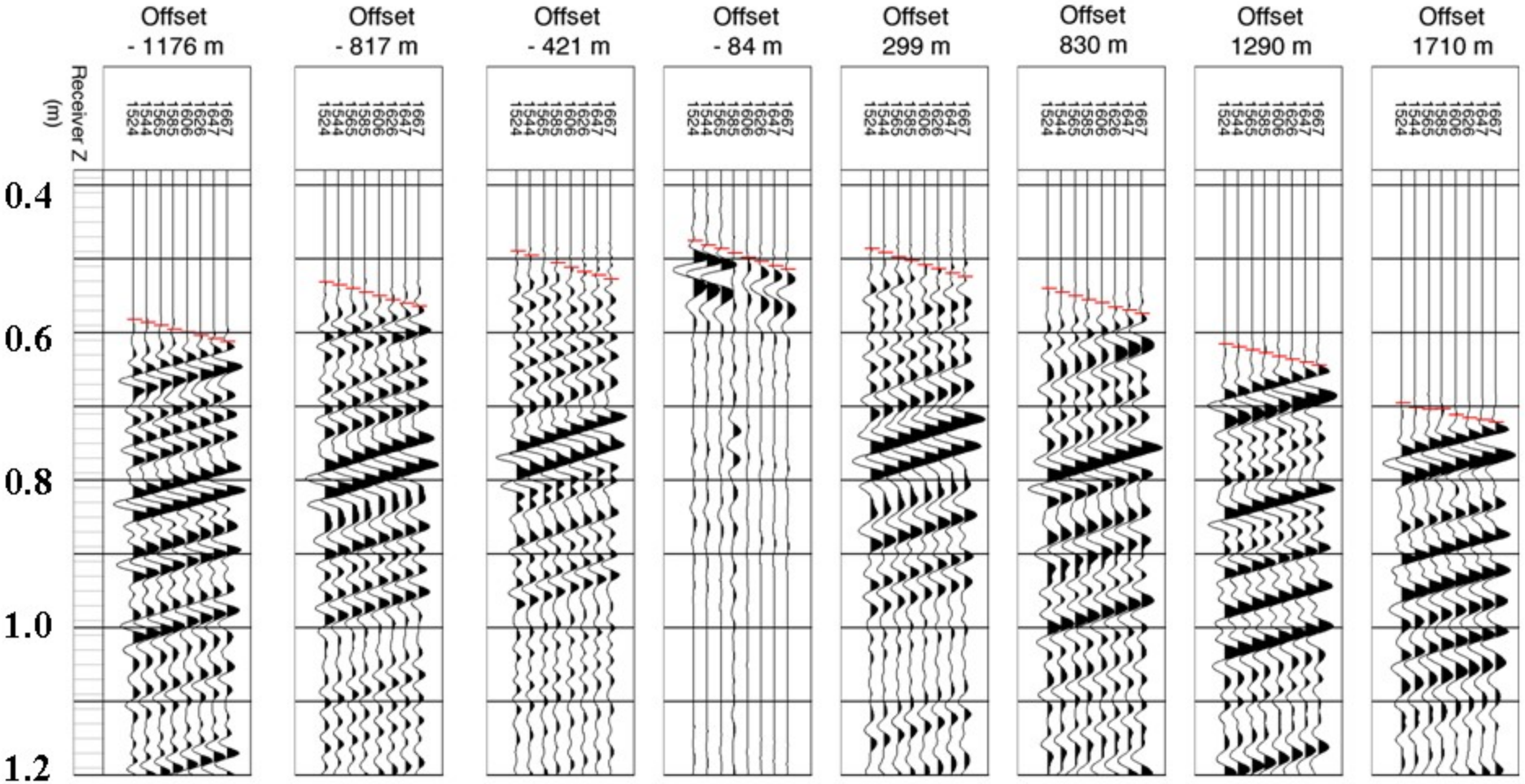
Initial Wavefield Separation: Downgoing P



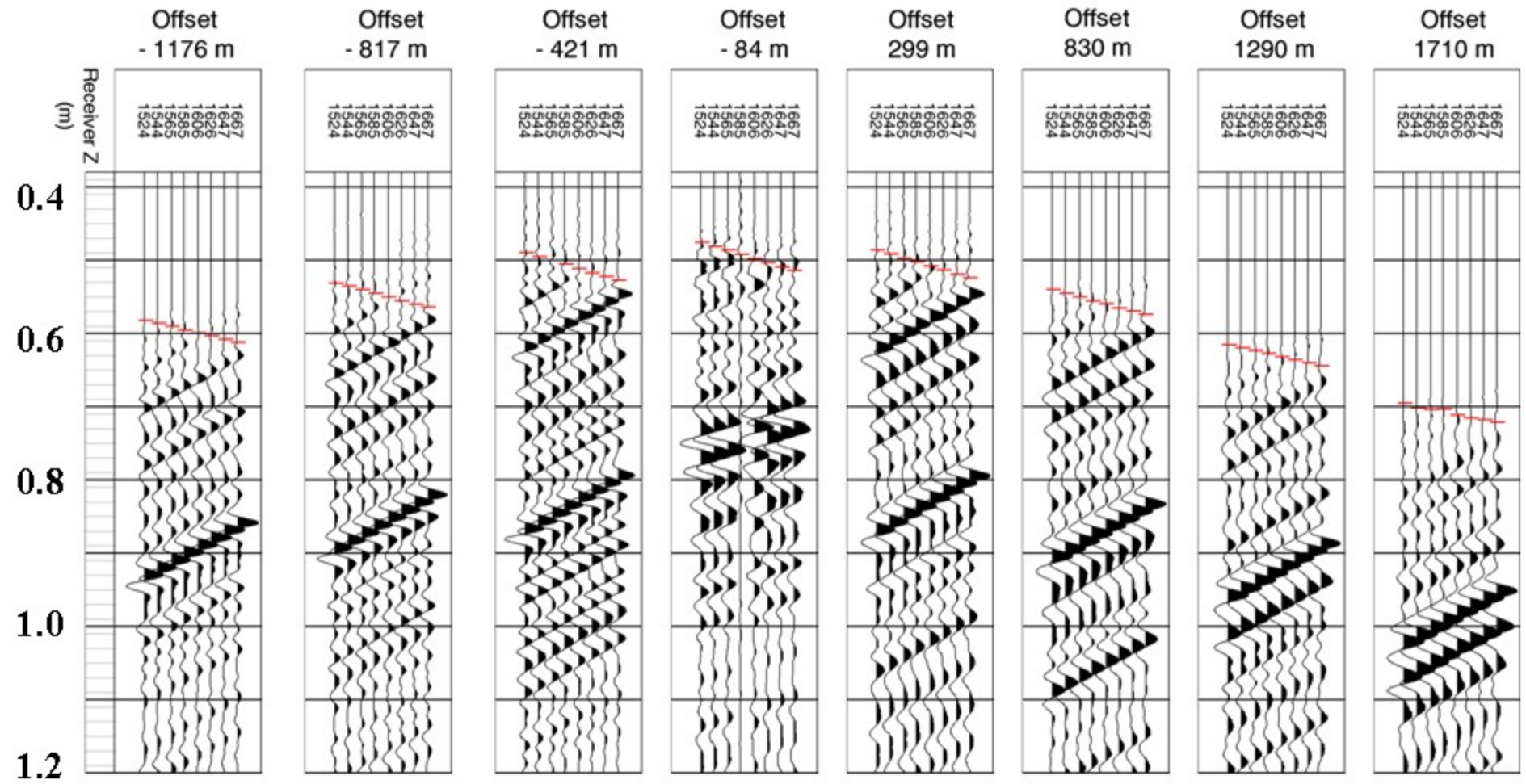
Initial Wavefield Separation: Downgoing S



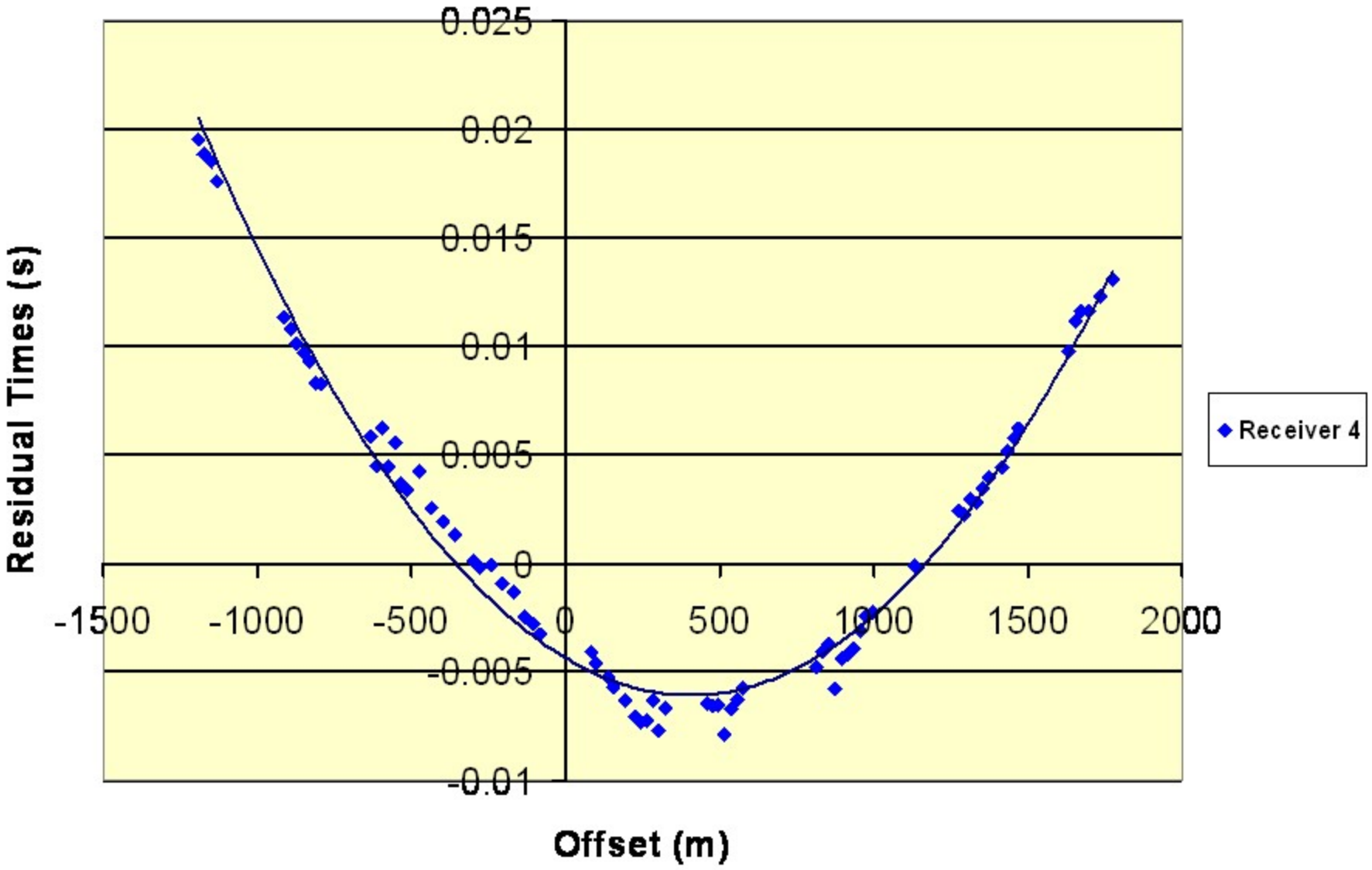
Initial Wavefield Separation: Upgoing P



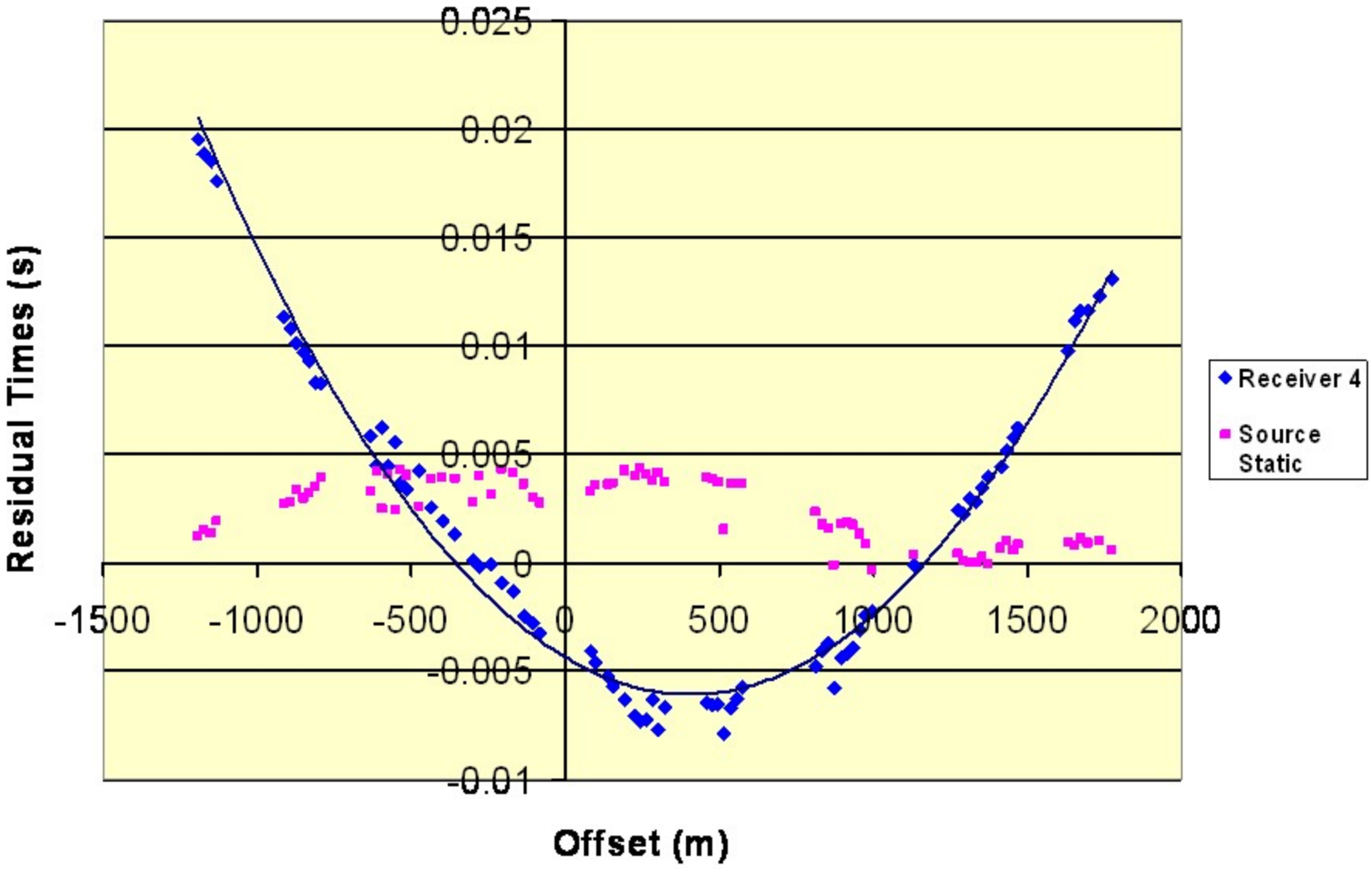
Initial Wavefield Separation: Upgoing PS



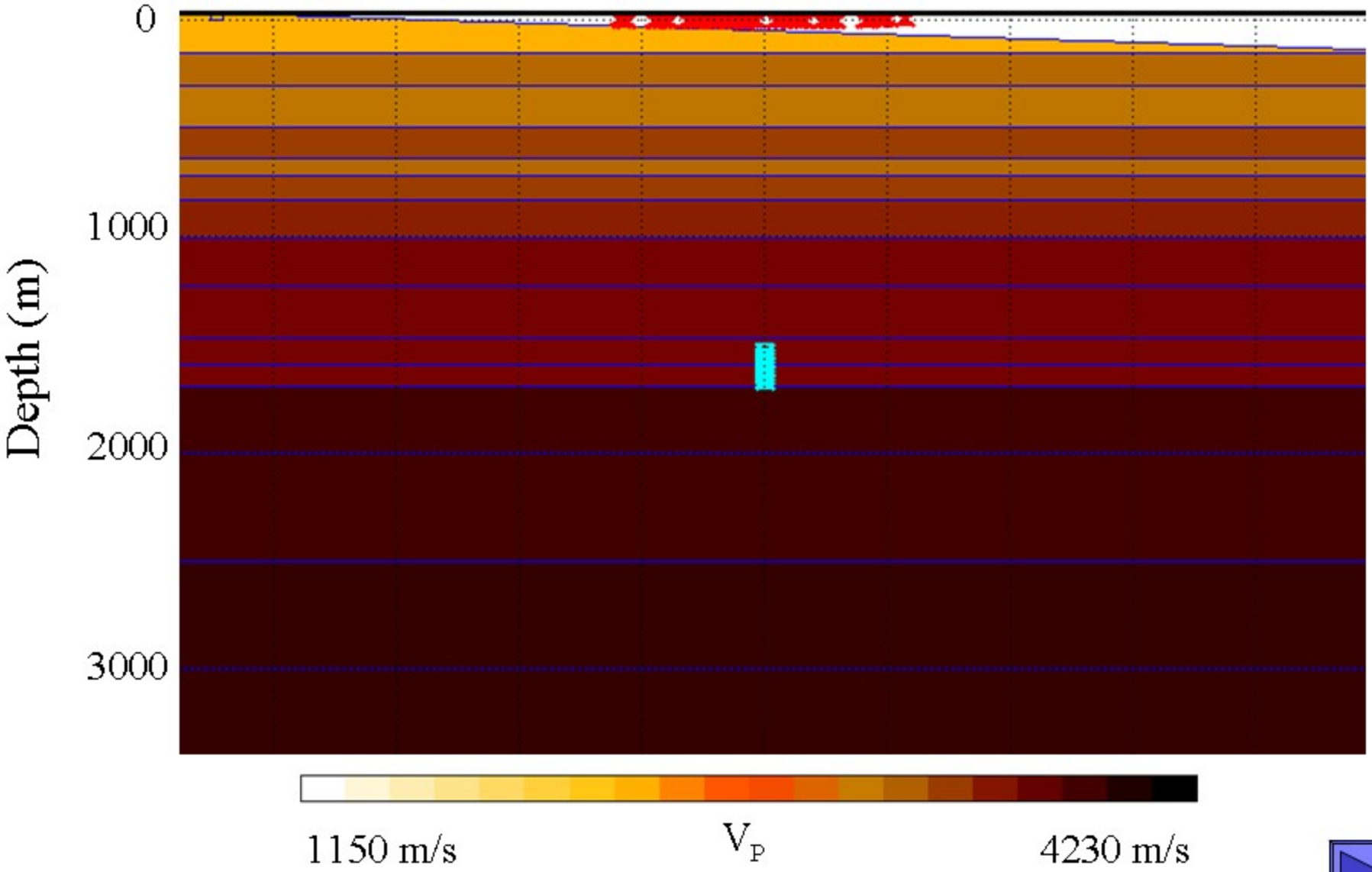
Initial Travel Time Residuals



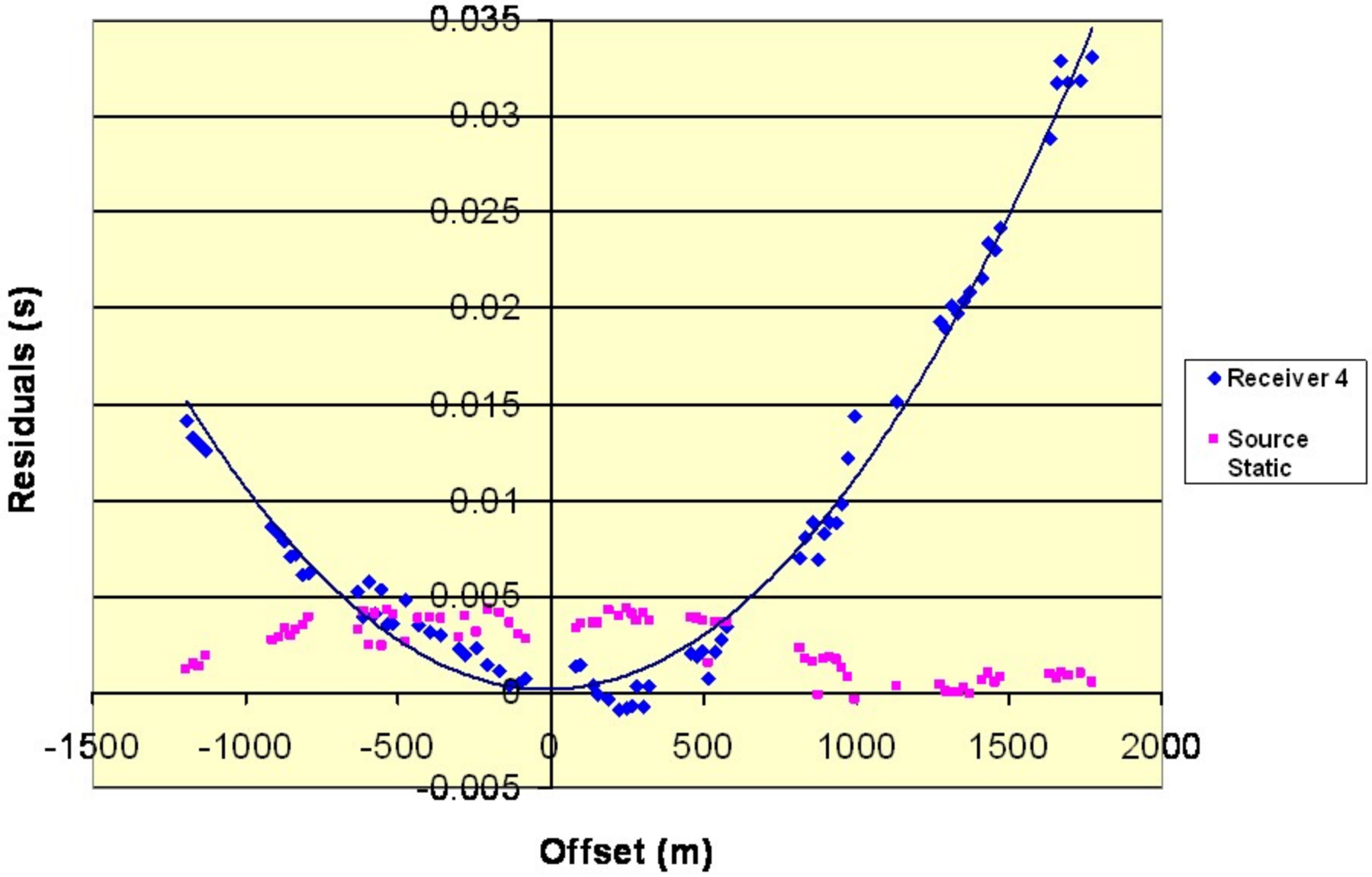
Initial Travel Time Residuals



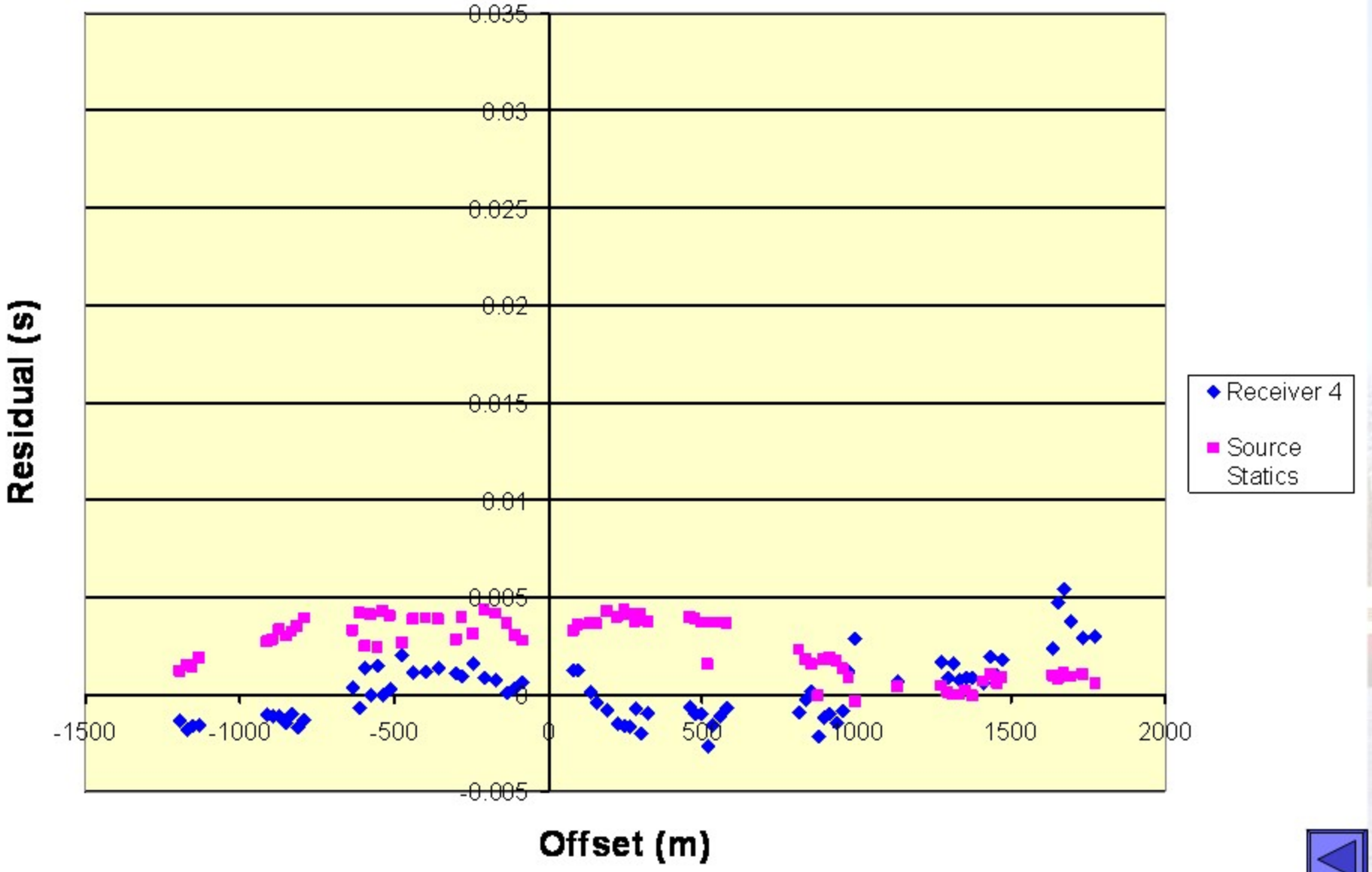
Isotropic Velocity Model: Dipping Layer



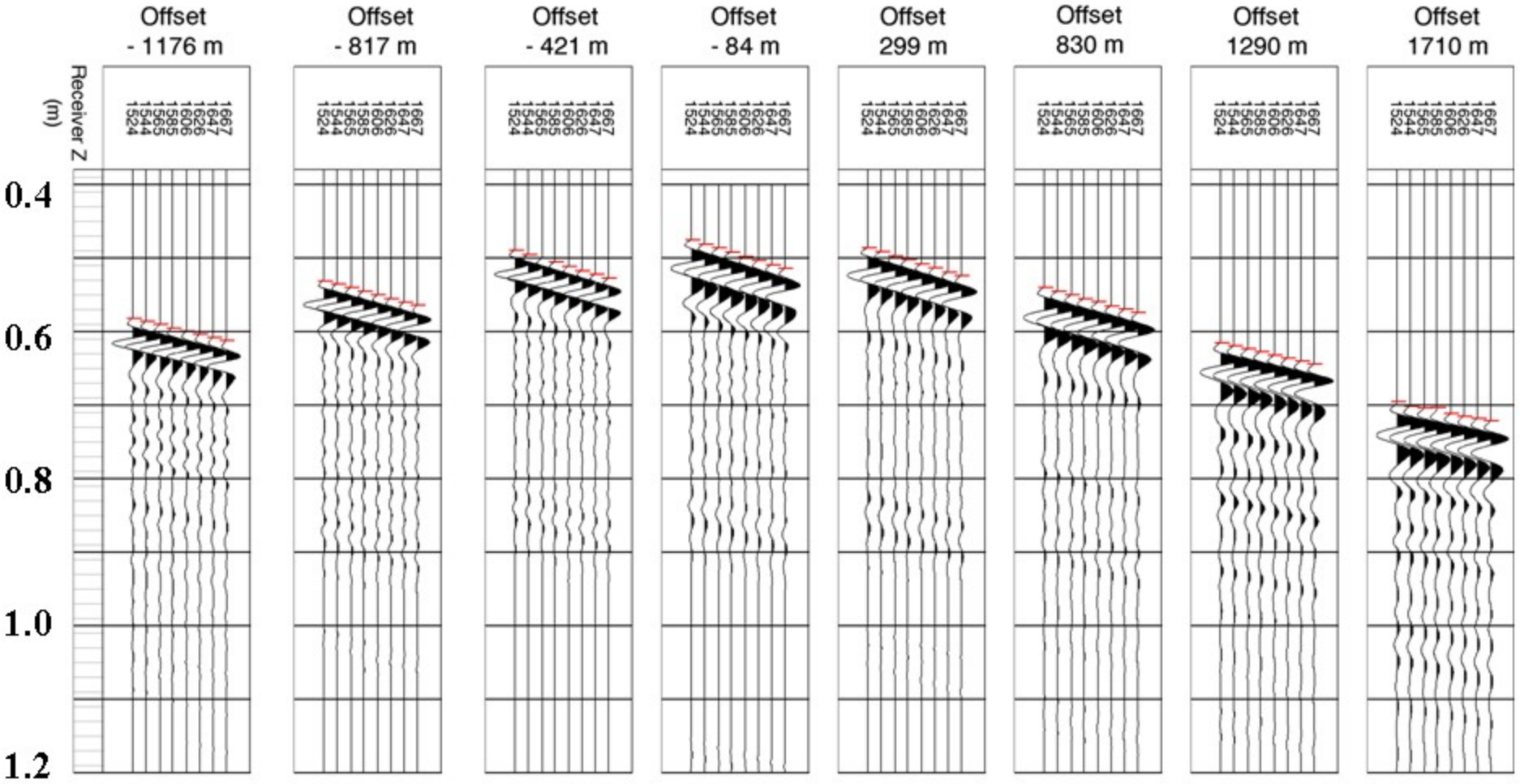
Travel Time Residuals: Dipping Layer



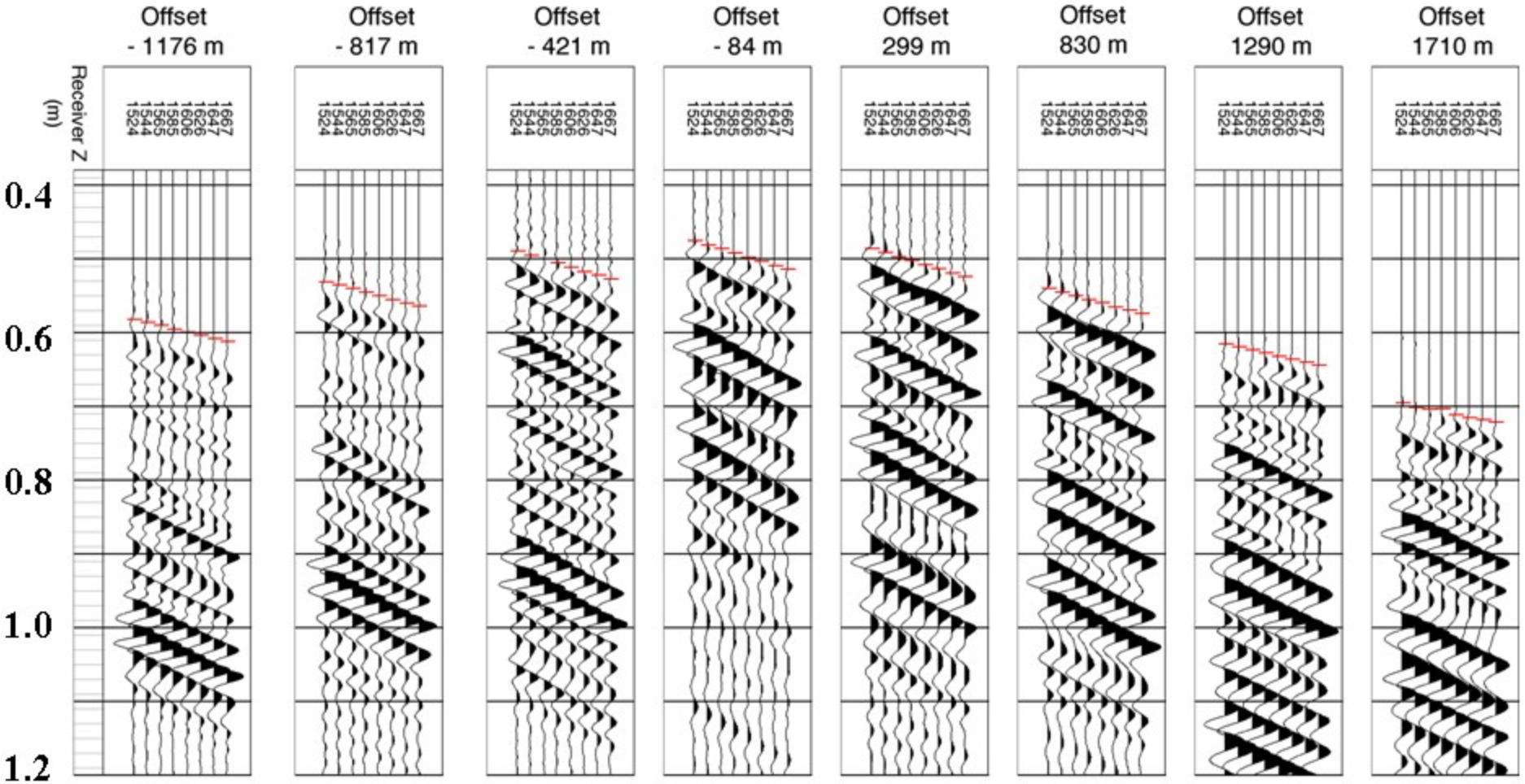
Travel Time Residuals: Anisotropy



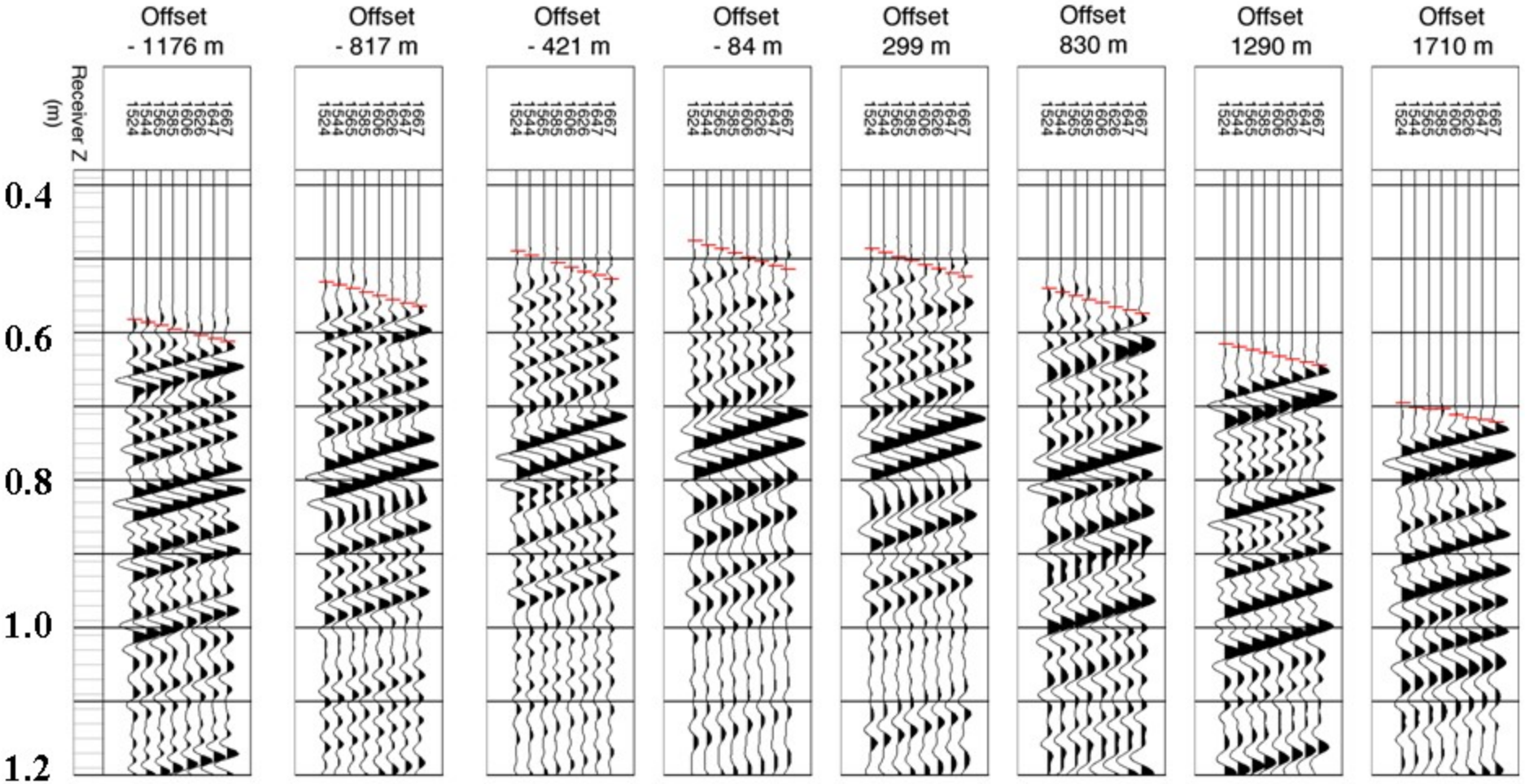
Velocity Based Wavefield Separation: Downgoing P



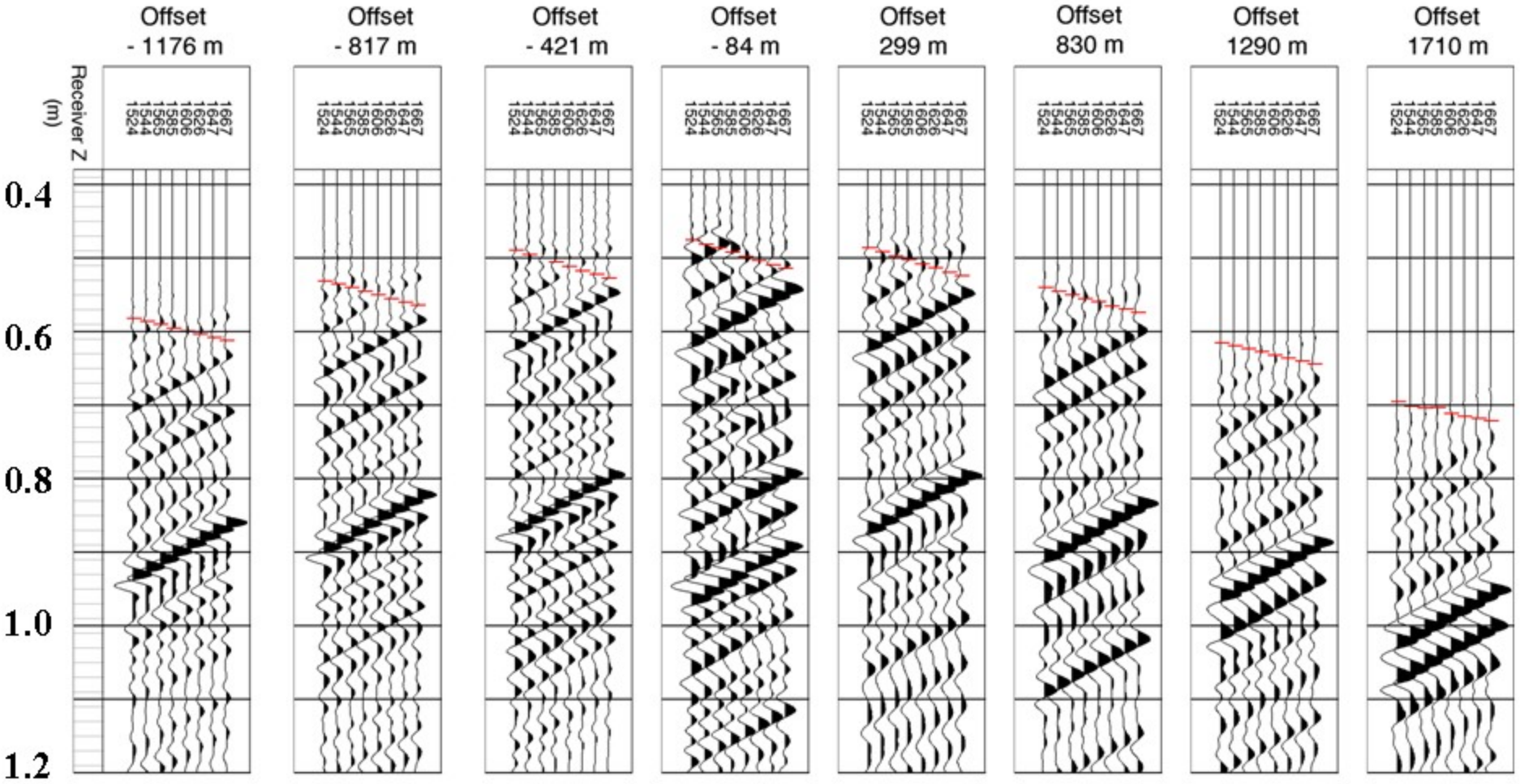
Velocity Based Wavefield Separation: Downgoing S



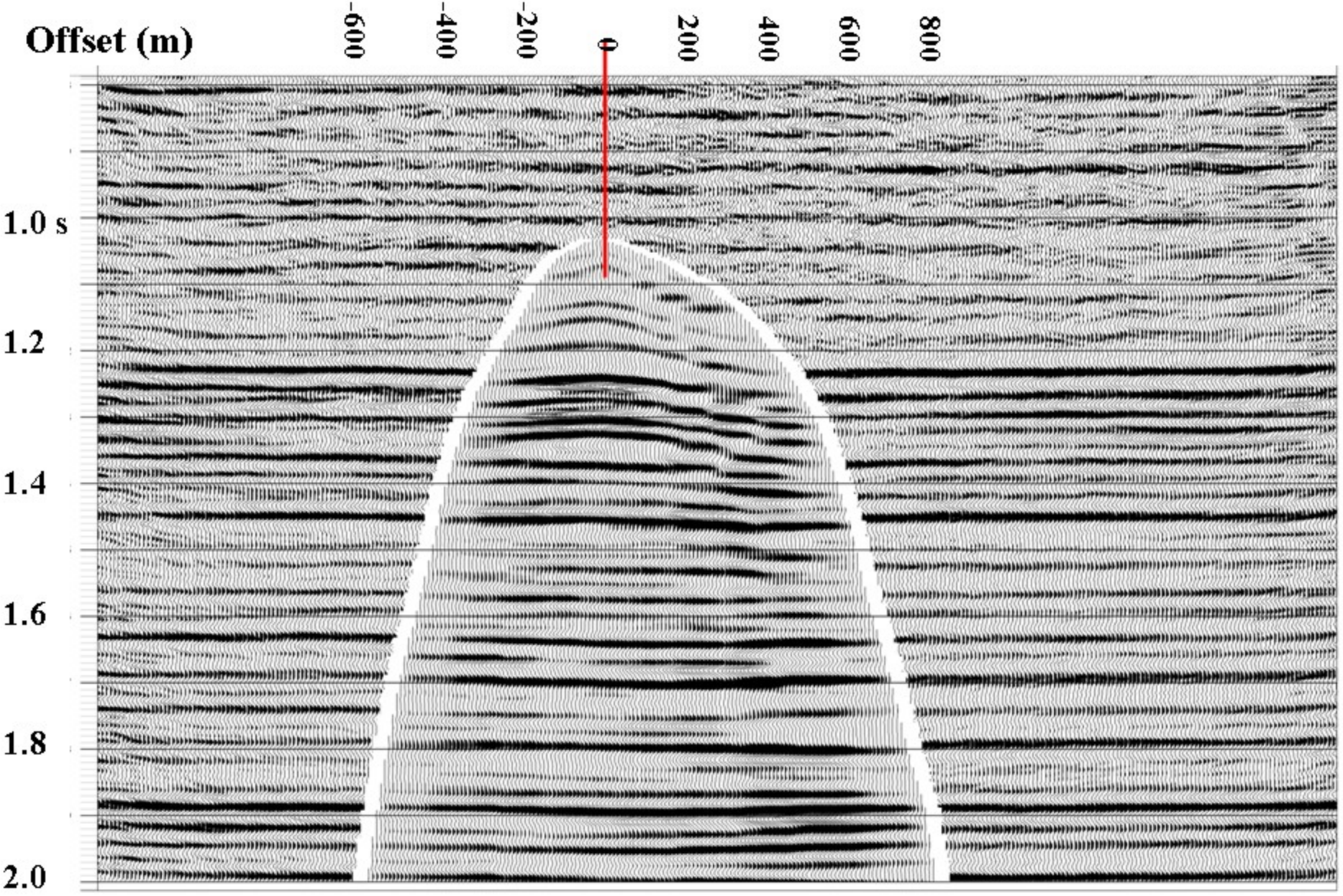
Velocity Based Wavefield Separation: Upgoing P



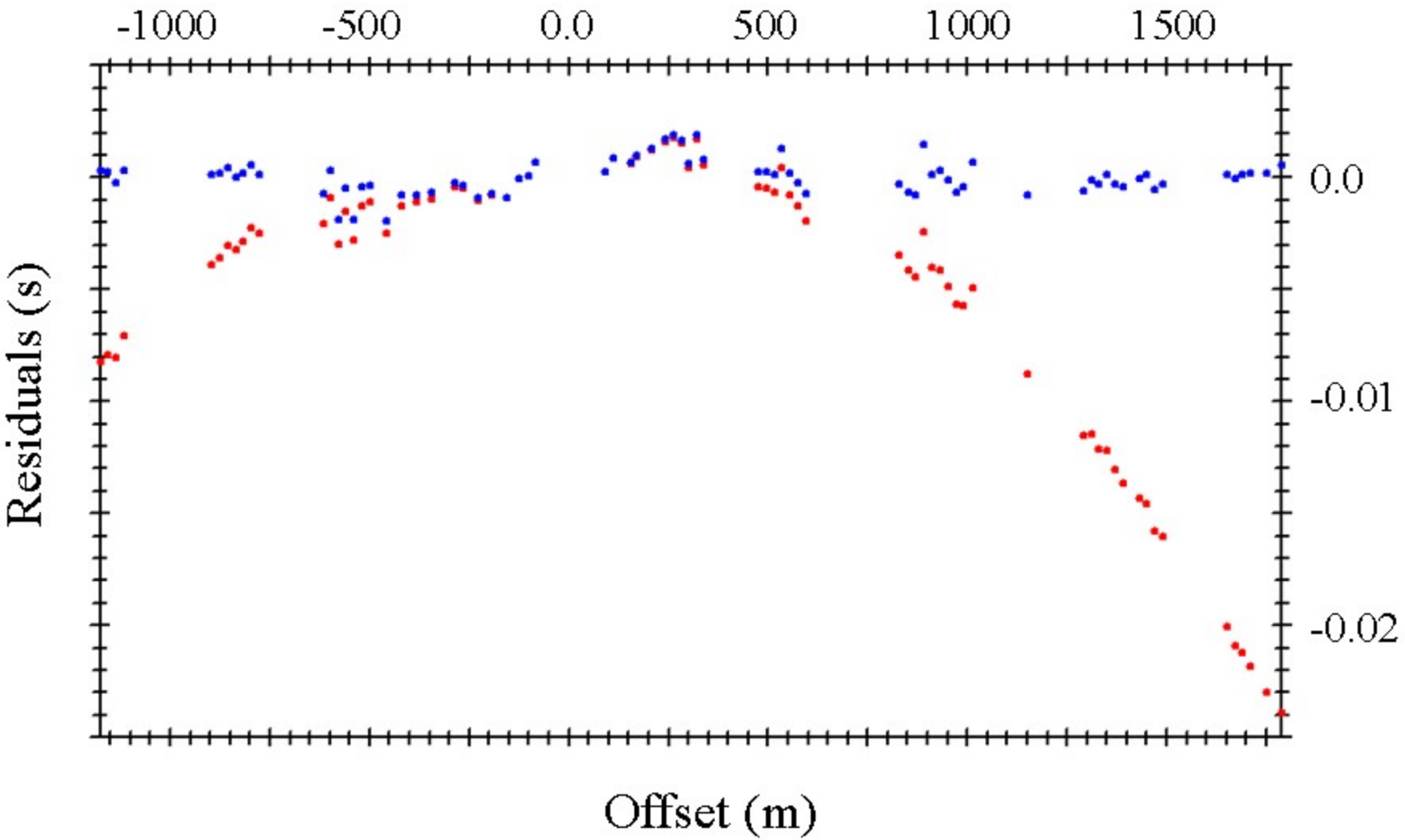
Velocity Based Wavefield Separation: Upgoing PS



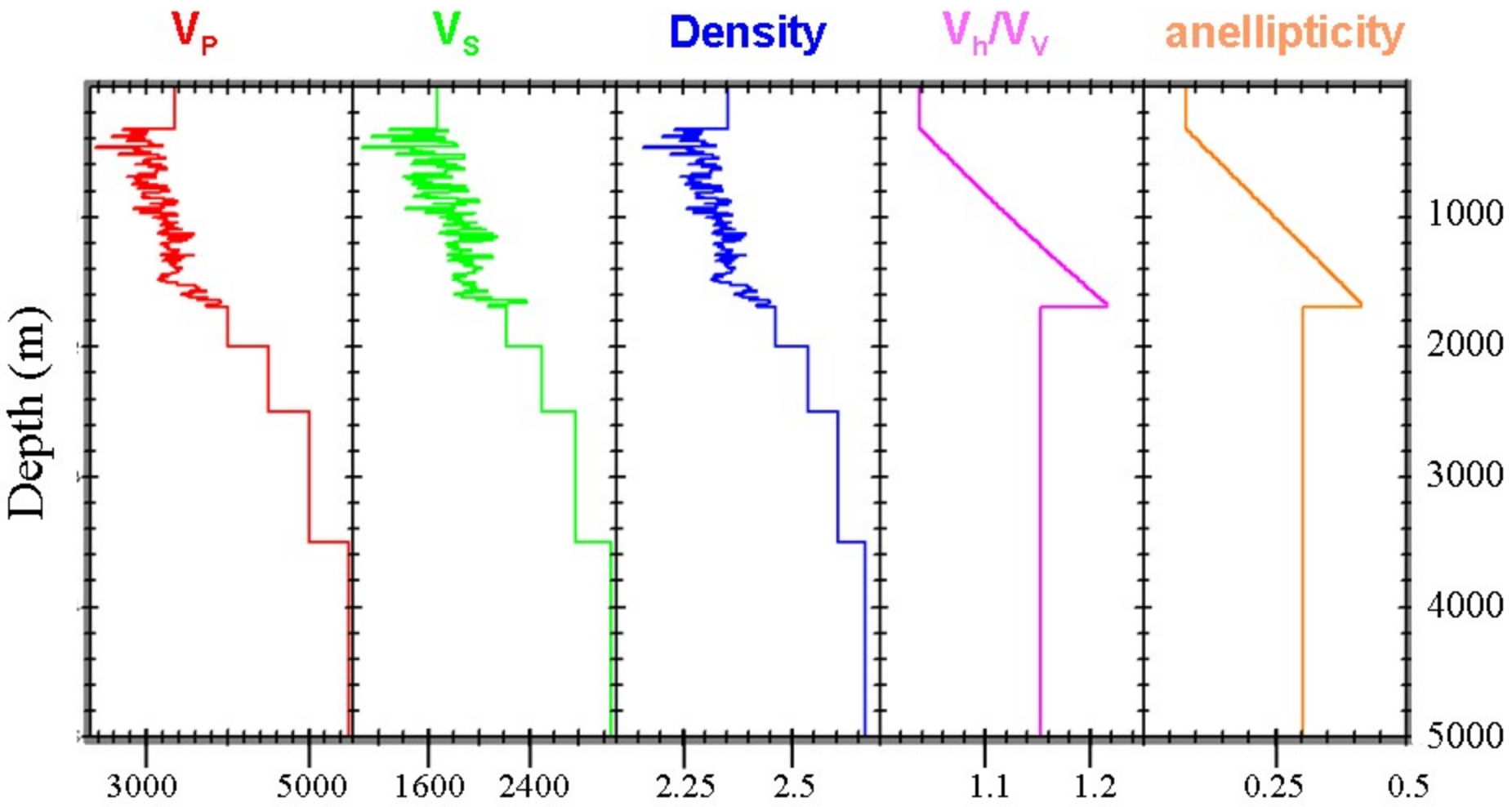
PP Surface Seismic & VSP



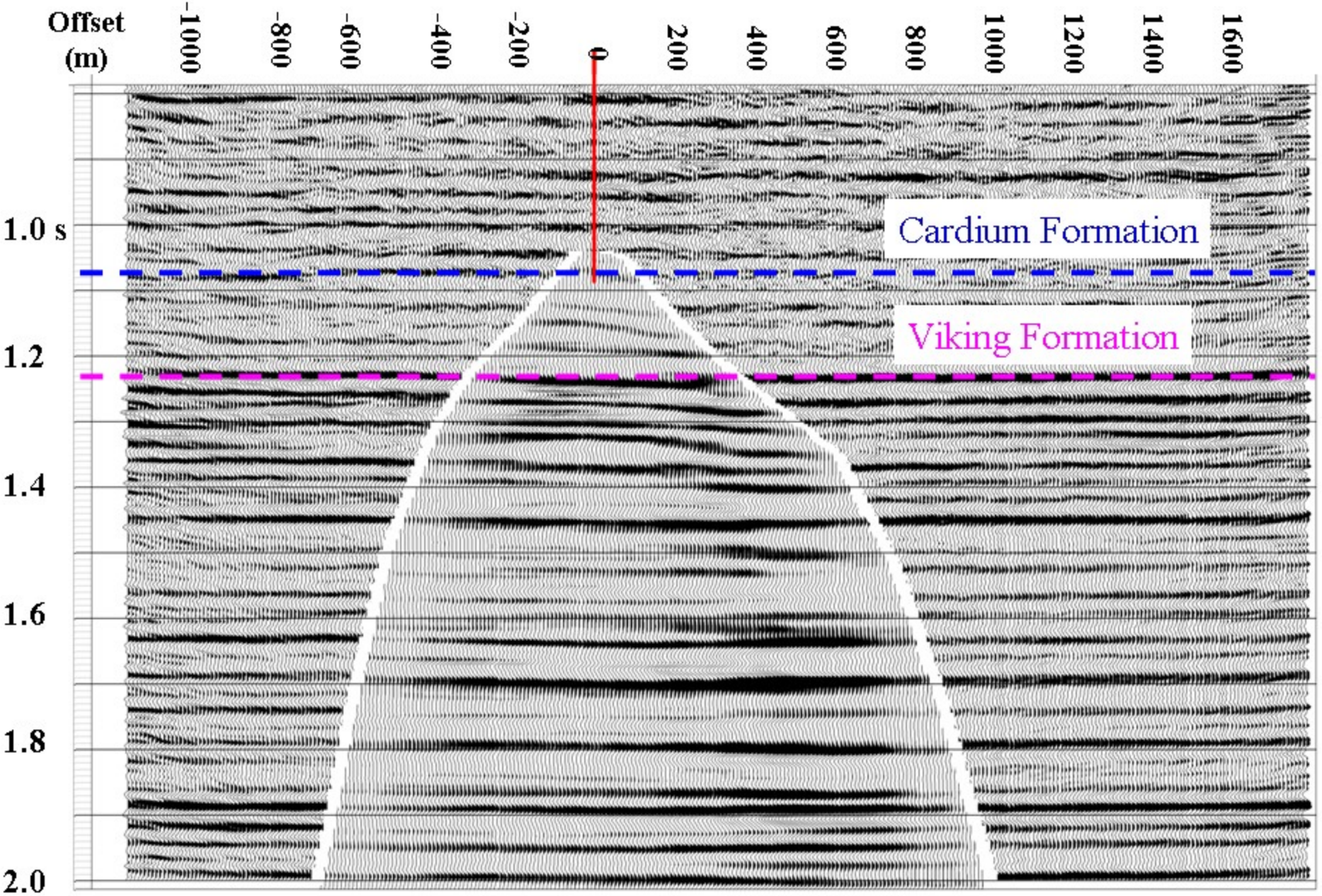
Anisotropic Velocity Model: Residuals



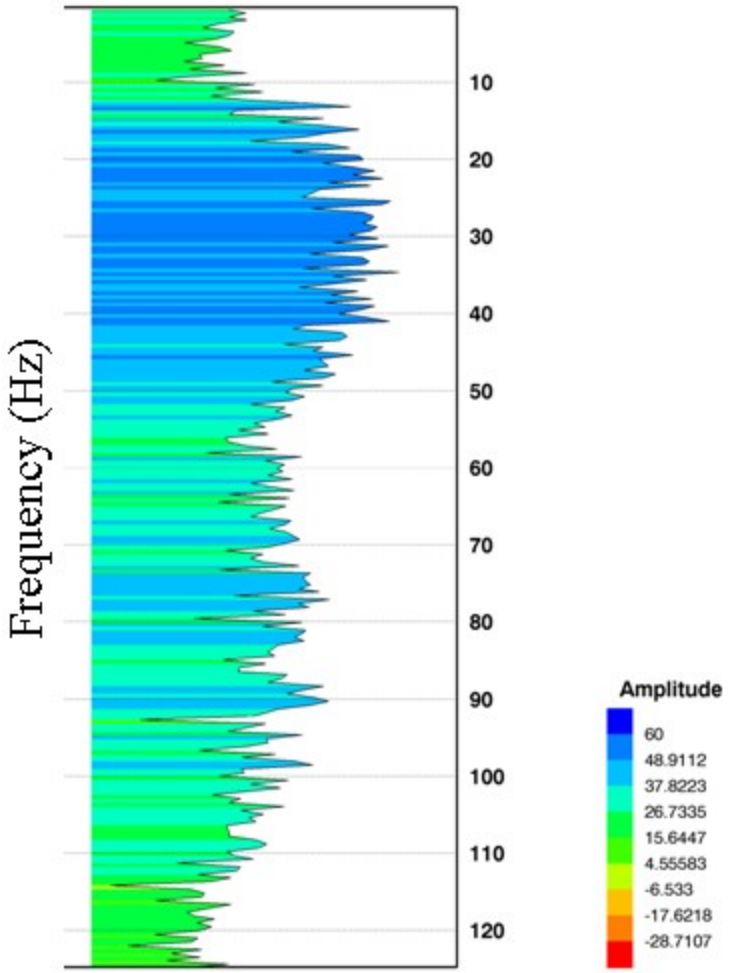
Anisotropic Velocity Model



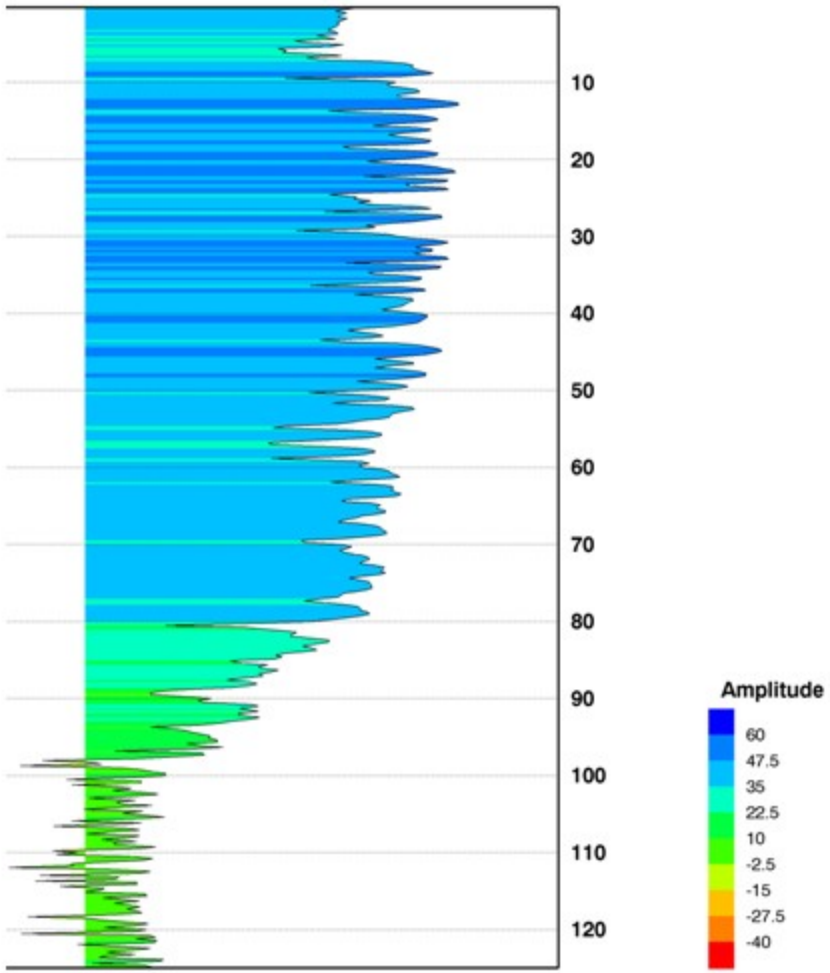
PP Surface Seismic & VSP



Comparison of P-wave Amplitude Spectra

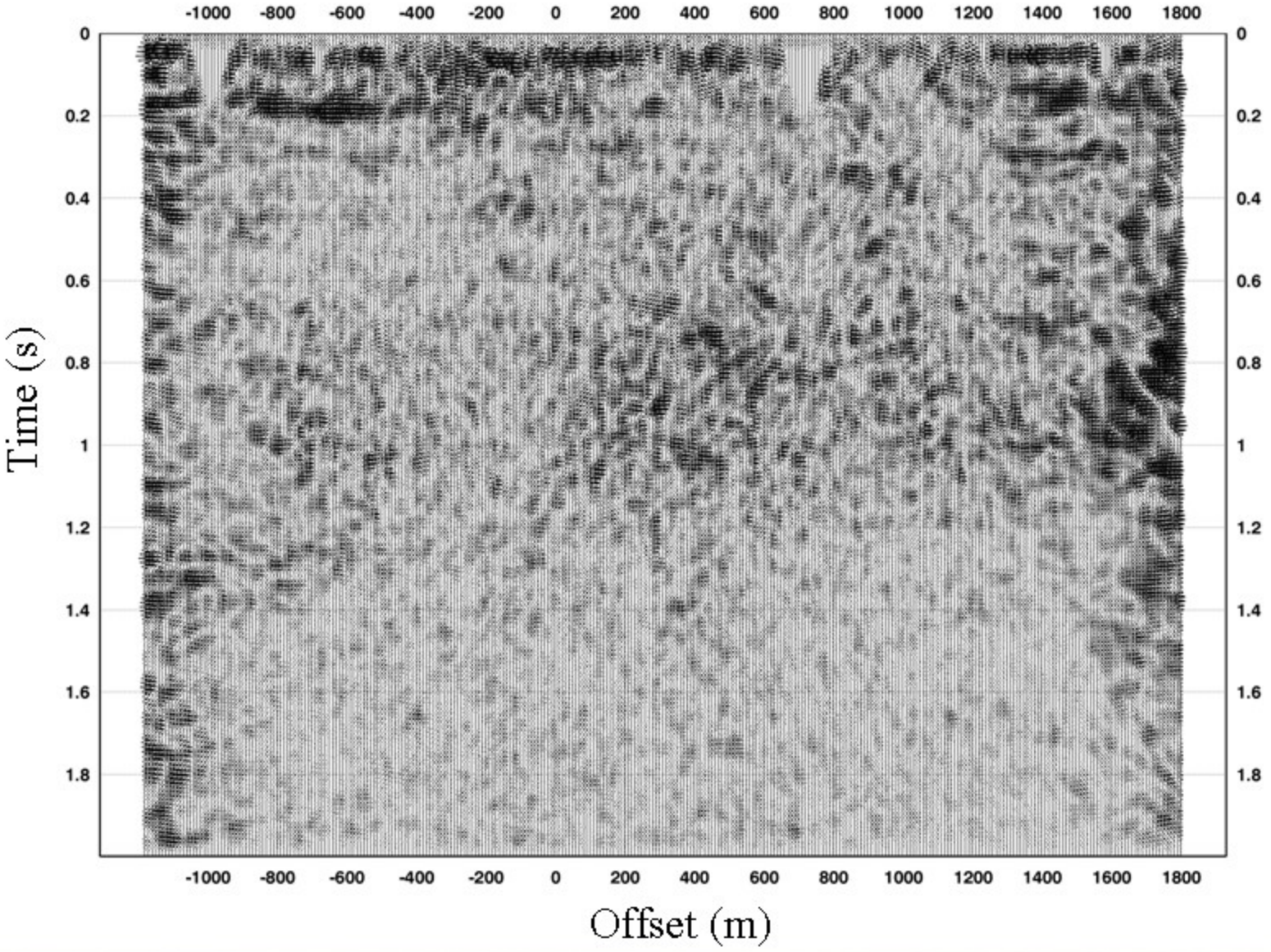


Zero offset amplitude spectrum
Of P-wave surface seismic

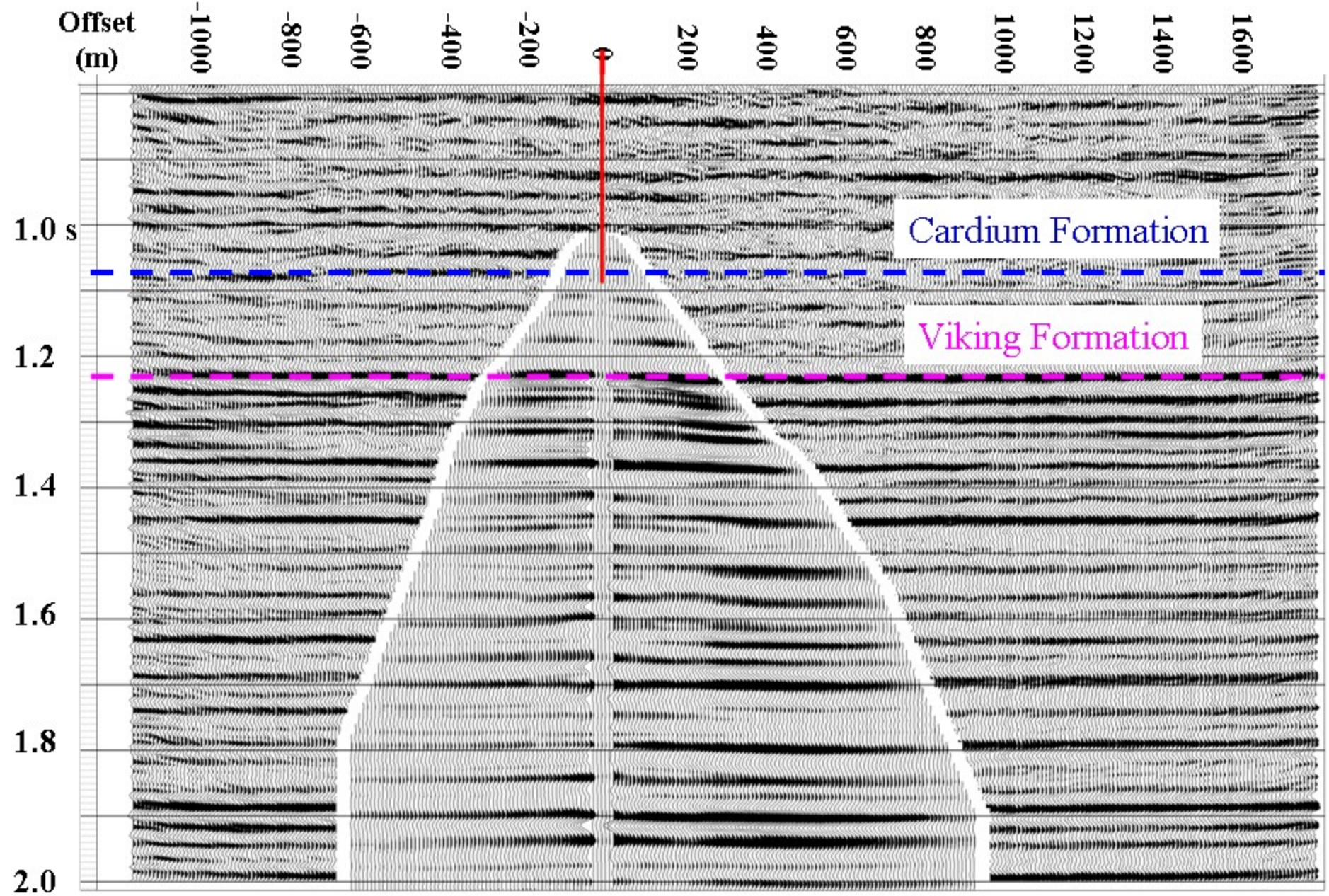


Zero offset amplitude
spectrum of P-wave VSP

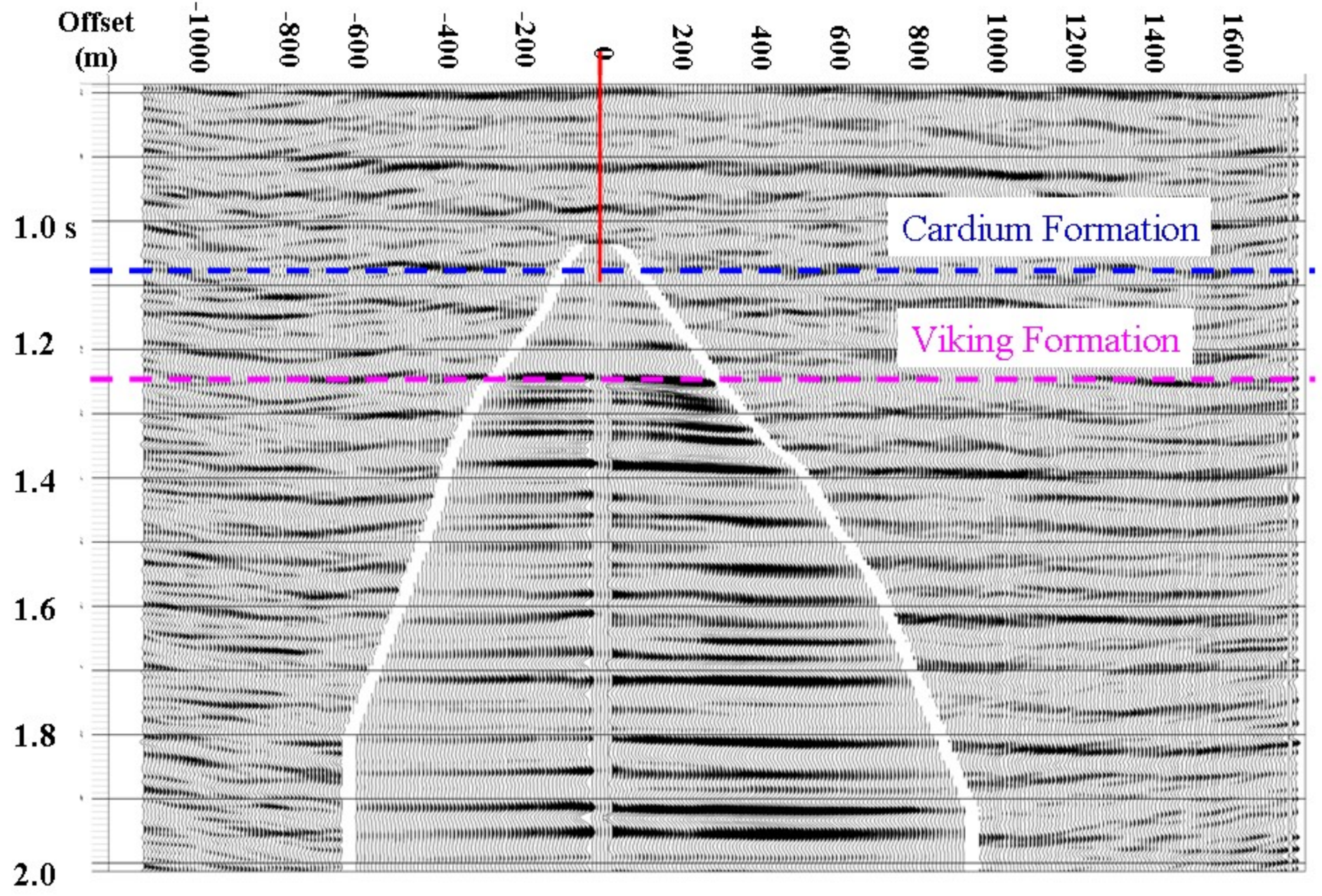
Surface Seismic Data: 80 to 110 Hz



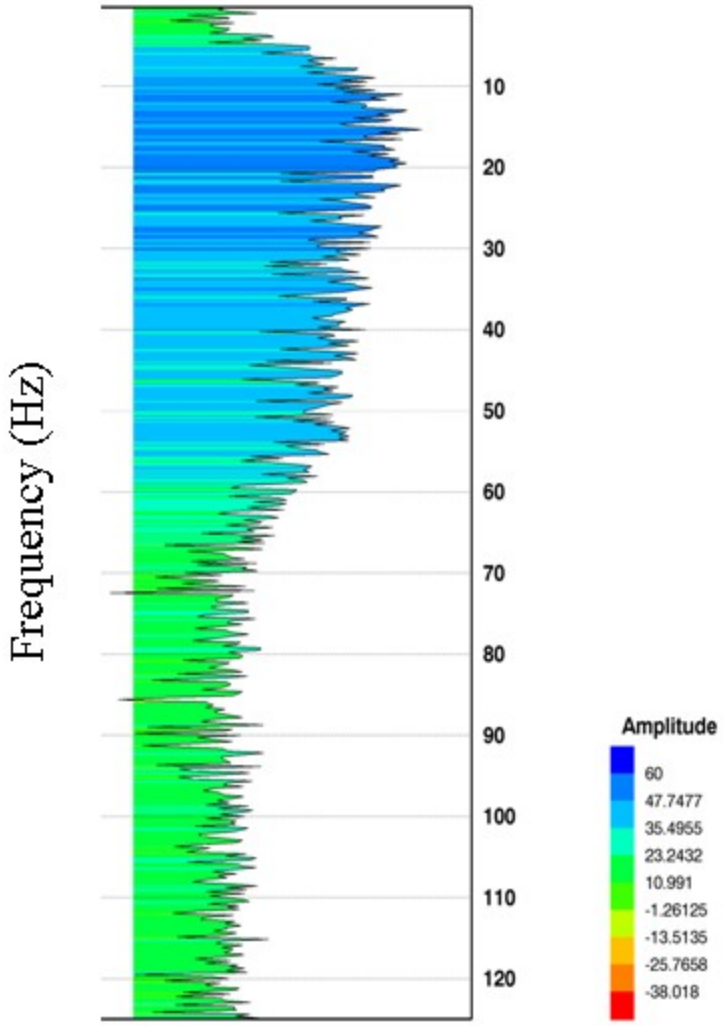
PP Surface Seismic & PS-VSP



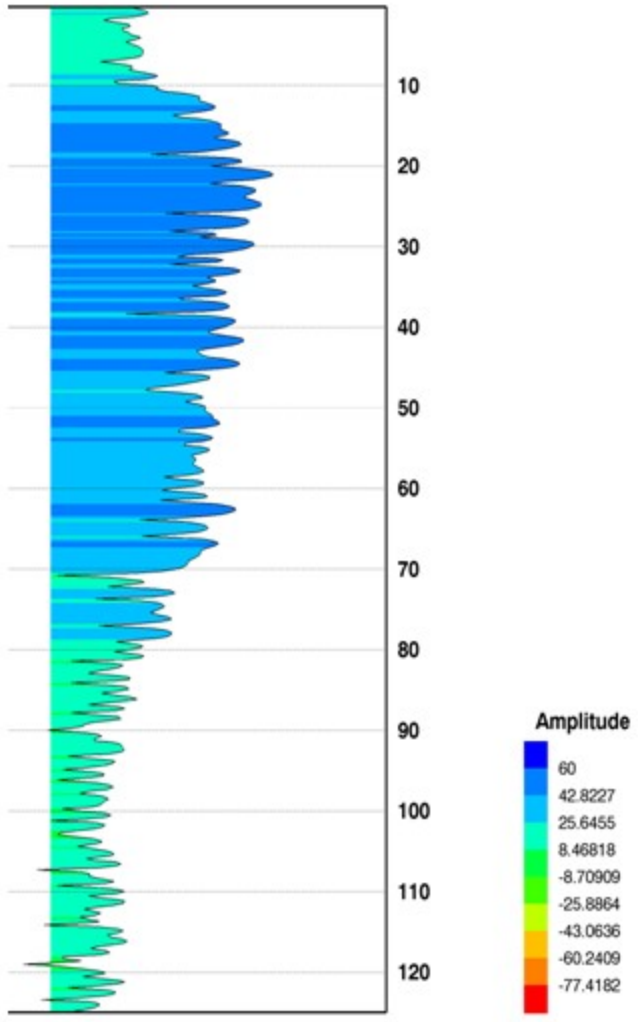
PS-Wave Surface Seismic & VSP



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 CO_2 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

- 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