Optimum aperture length for CMP Cross-Correlation of Surface Waves
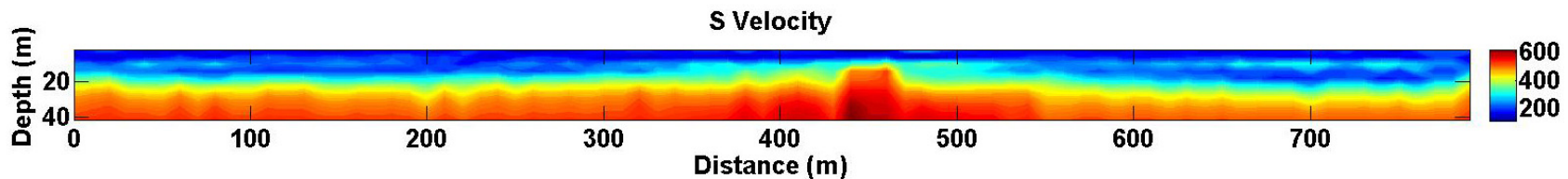
R. Askari,

Outline

- **Objectives**
- **CMP Cross-Correlation of Surface Waves (CCSW)**
- **Optimum aperture length**
- **Application of the method to the static corrections**
- **Conclusion**

Objectives

The Objective is to develop a method to optimize the estimation of near surface shear wave velocity using *surface waves* applicable to *converted wave statics.*

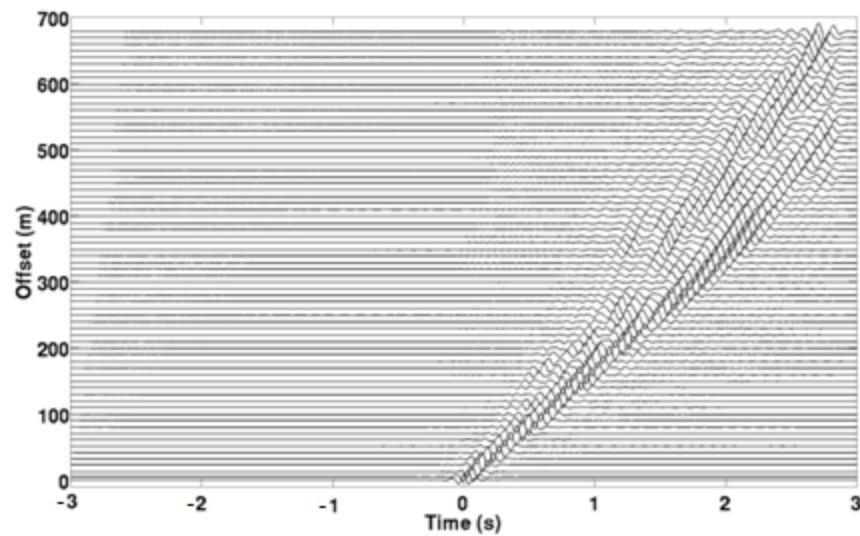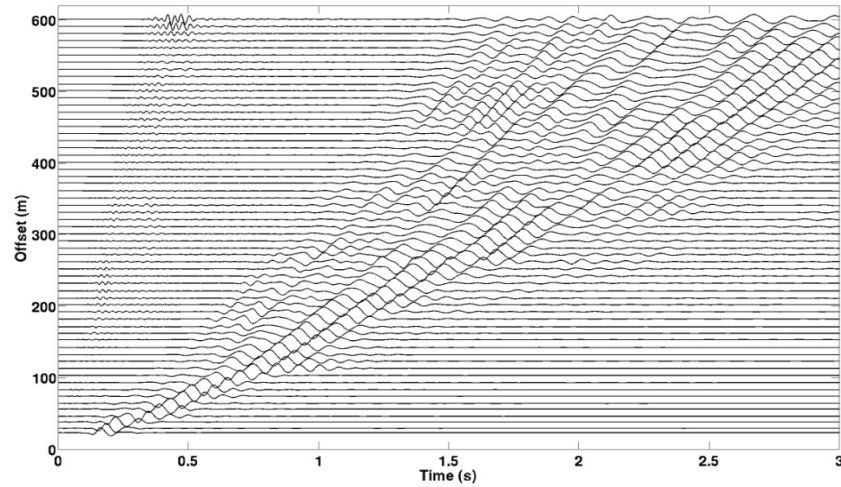# CMP Cross-Correlation of SurfaceWaves (CCSW)

- **The method is similar to MASW. But, it improves the estimation of the phase velocity and lateral resolution simultaneously**
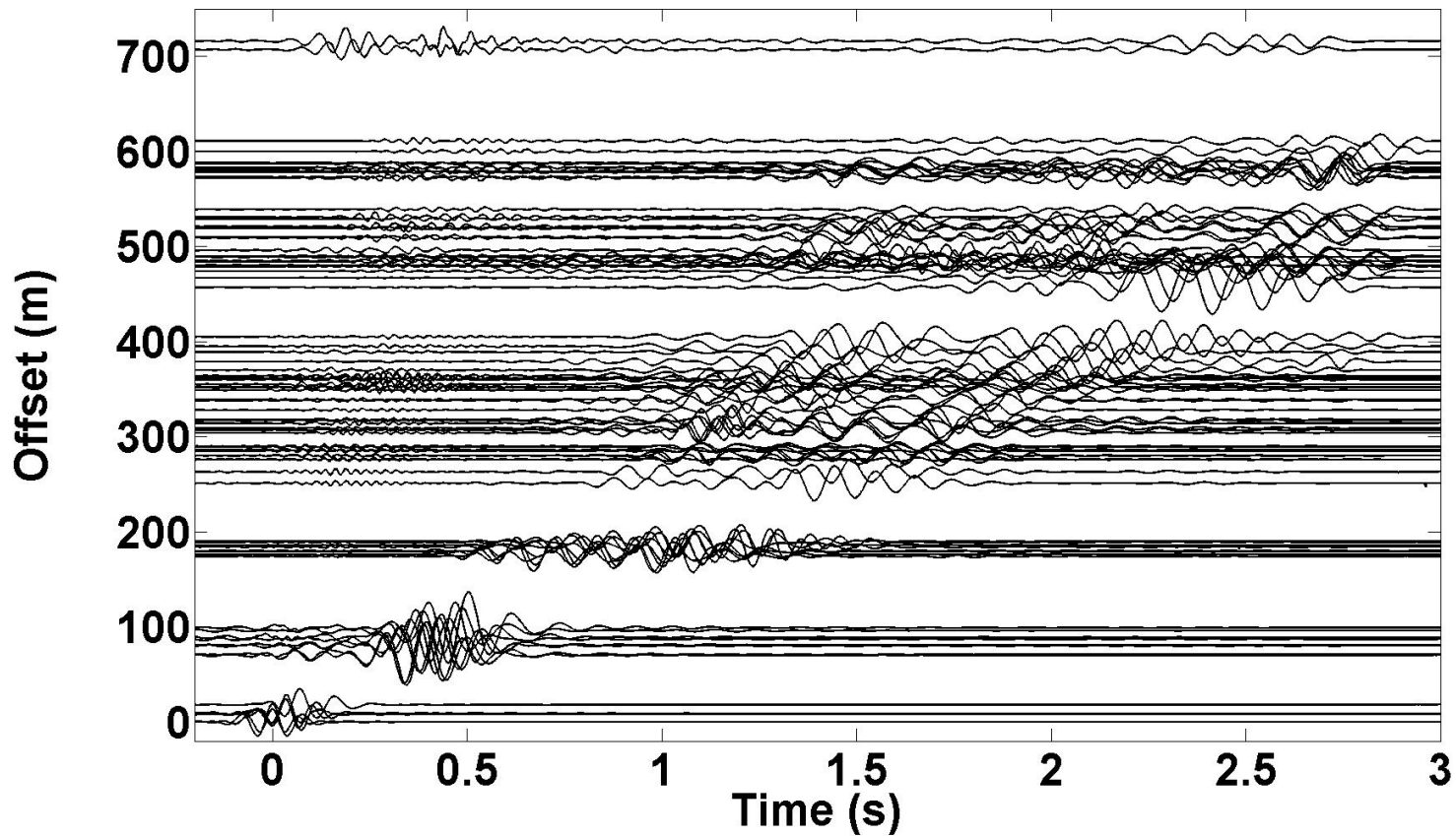
Hayashi and Suzuki, 2004

First Step of CCSW

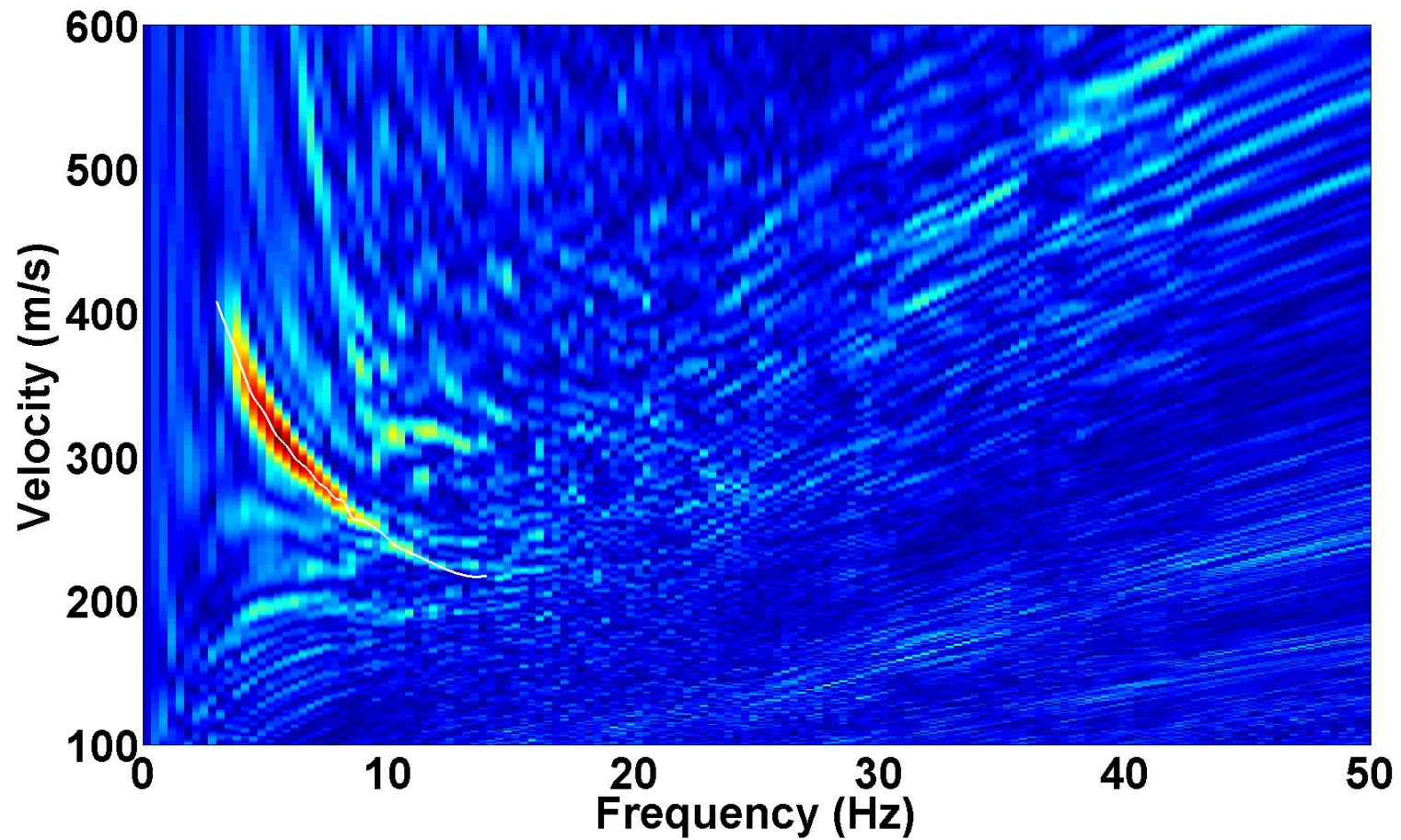**Cross-correlation of traces with a reference trace**

Second Step of CCSW

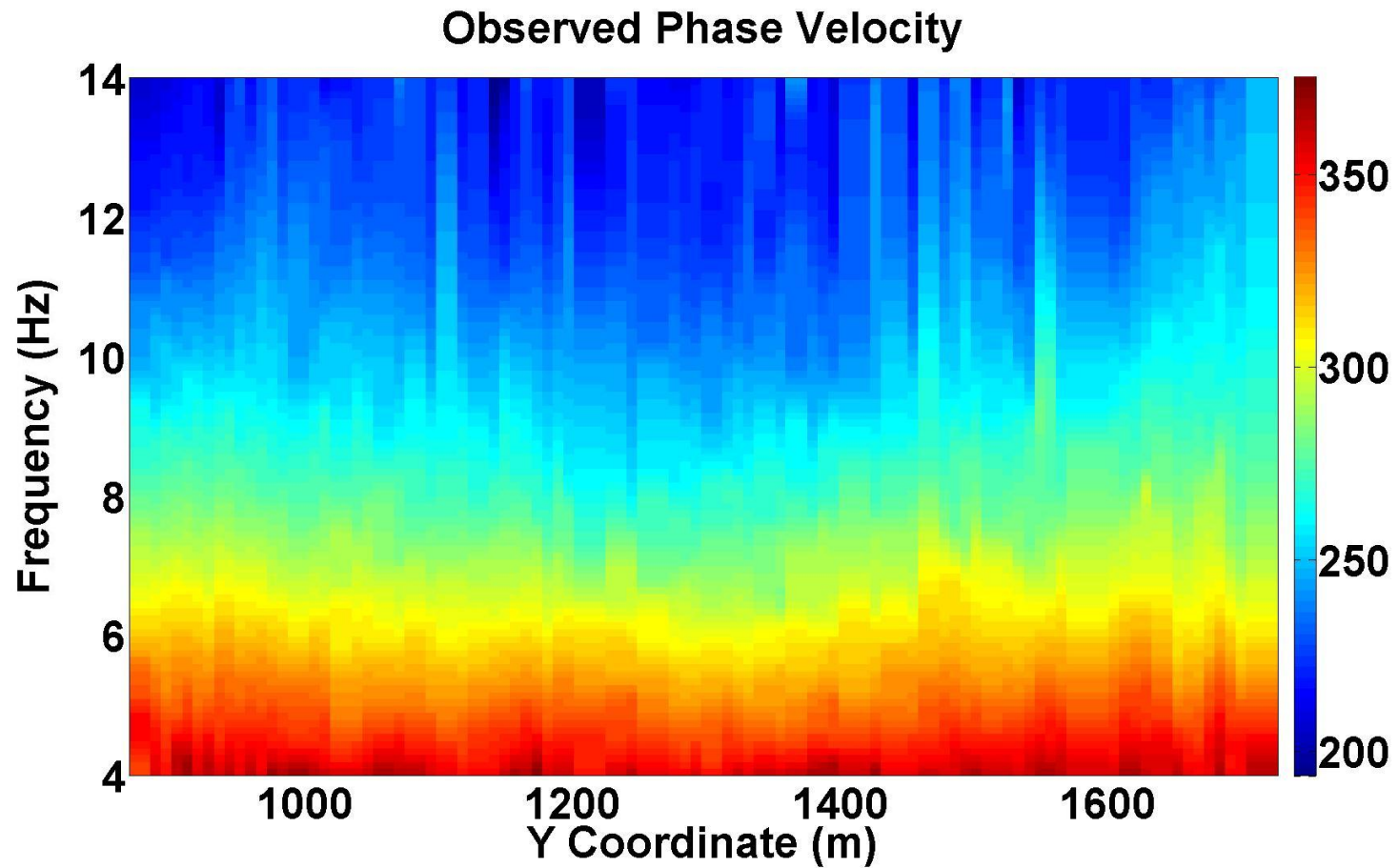The cross-correlated traces from all shots sorted to CMP gathers.

Third Step of CCSW

Estimation of a dispersion curve for the traces in a bin
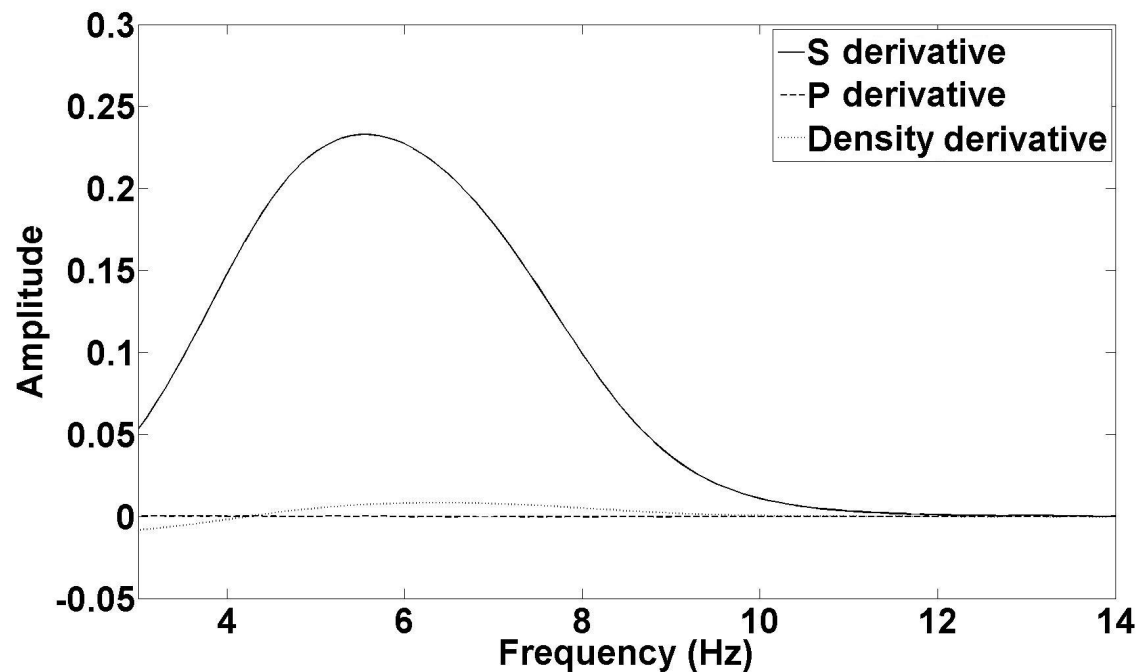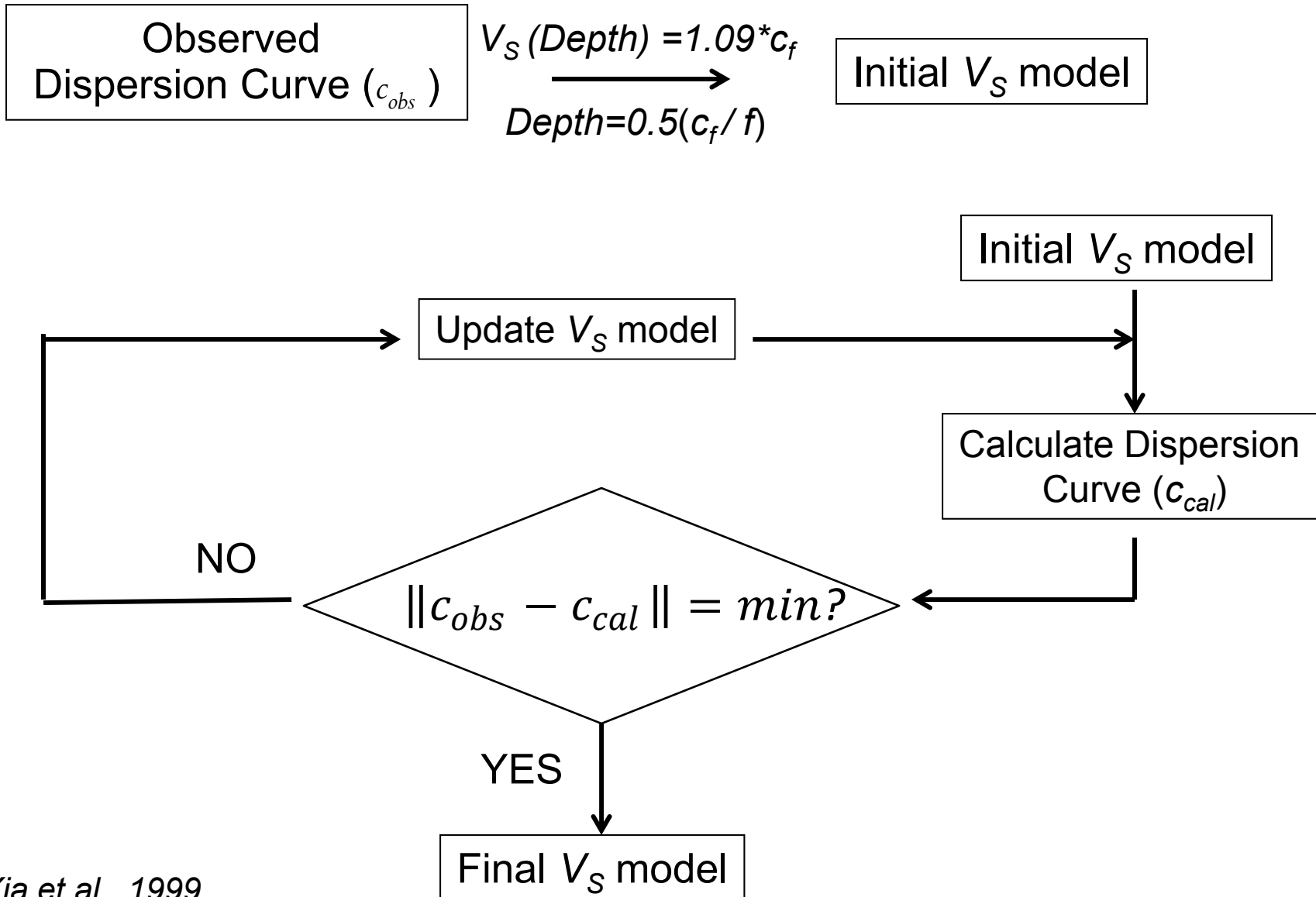
Phase Velocity

Phase Velocity Inversion

Phase velocity is a function of four parameters.

Schwab and Knopoff (1972)

$$F(f, c_f, v_s, v_p, \rho, h) = 0$$

Phase Velocity Inversion

Observed Dispersion Curve (c_{obs})

$V_S \ (Depth) = 1.09 * c_f$

$\longrightarrow$

$Depth = 0.5(c_f / f)$

Initial V_S model

Initial V_S model

Update V_S model

Calculate Dispersion Curve (c_{cal})

NO

$$\|c_{obs} - c_{cal}\| = min?$$

YES

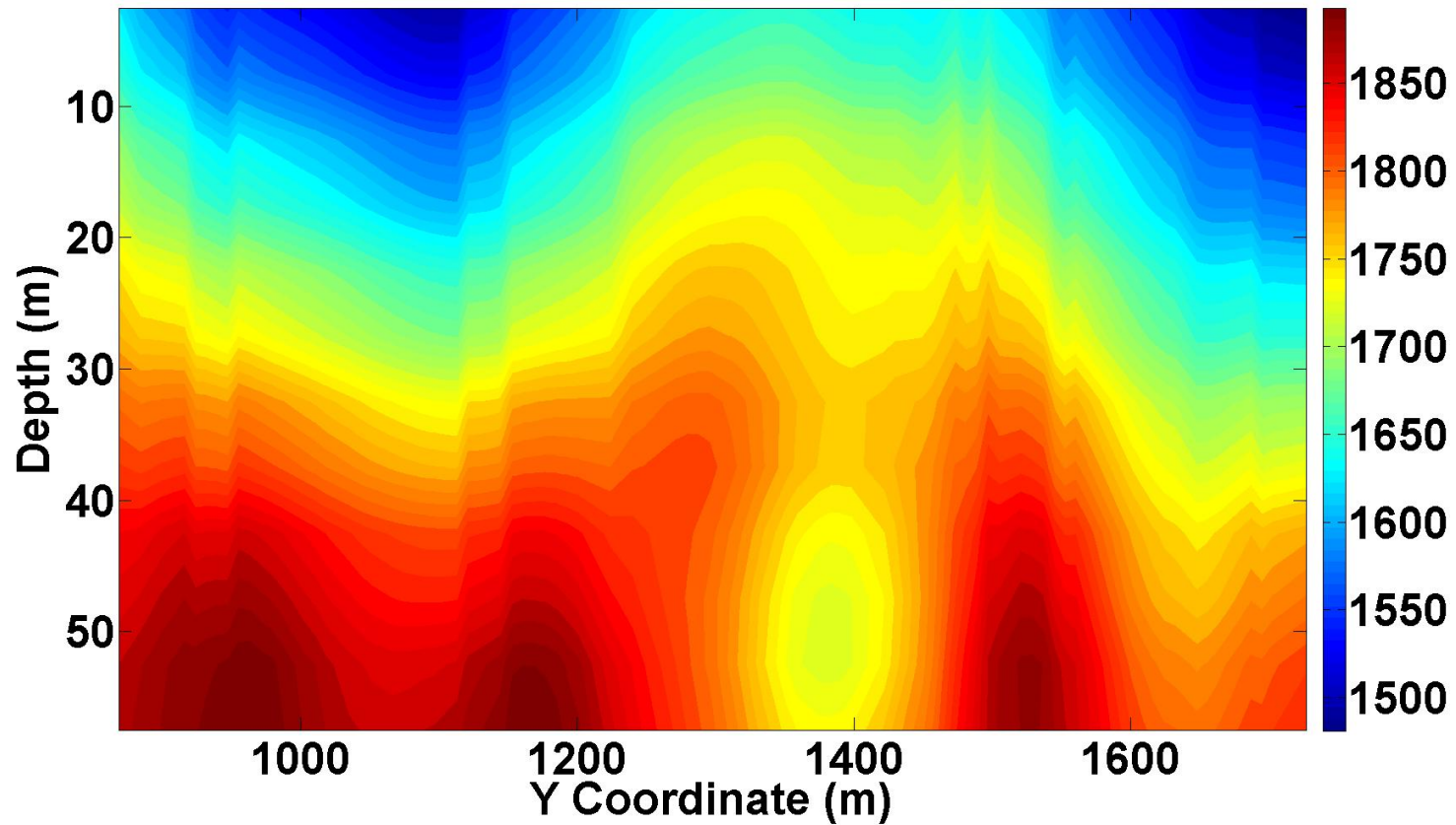| Final V_S model |
|---|

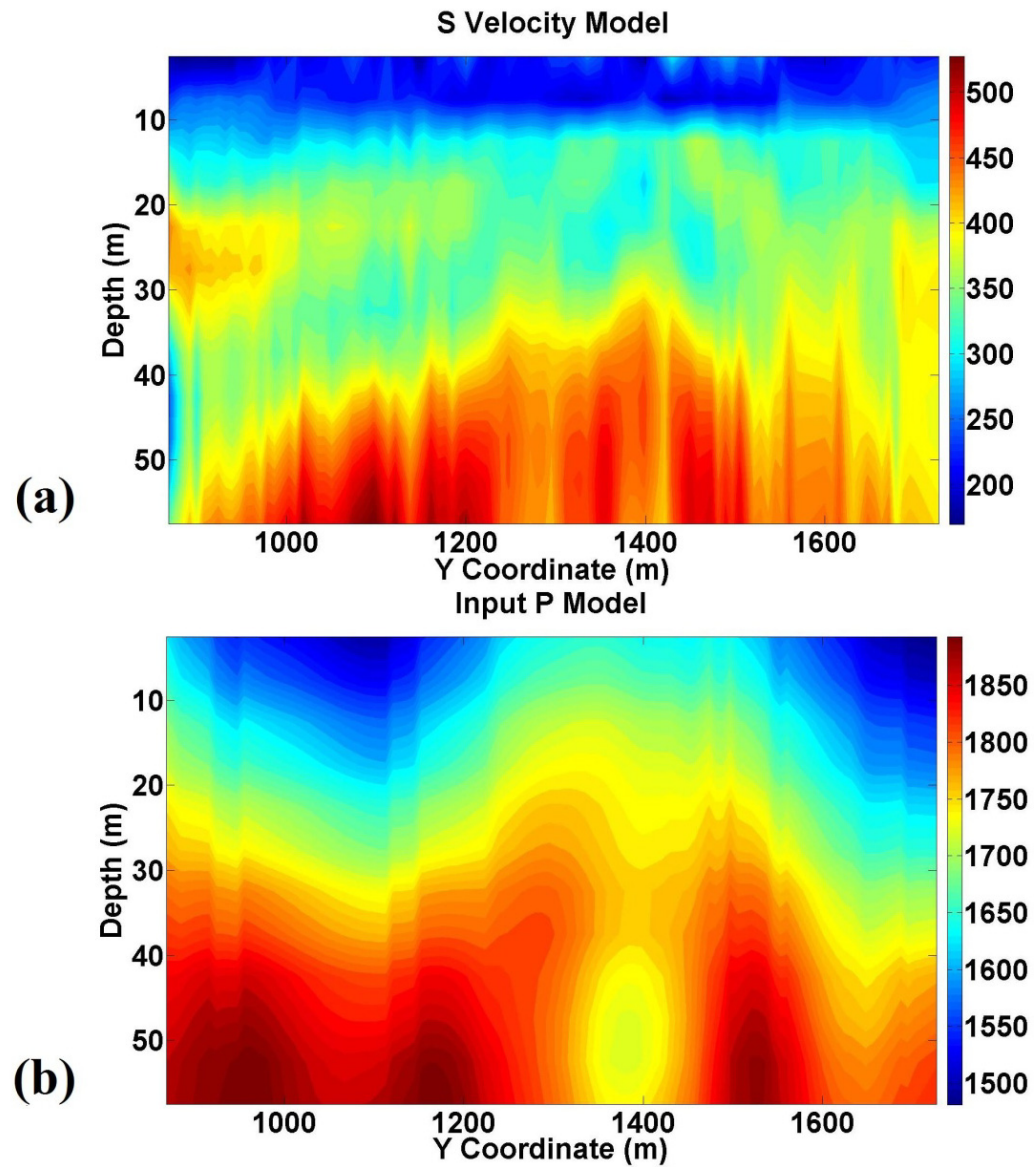*- Xia et al., 1999*

Density and layer thicknesses

- **Density: 2000 kg/m^3**

- **Layer thickness: 5m**

- **P velocity model: tomography**
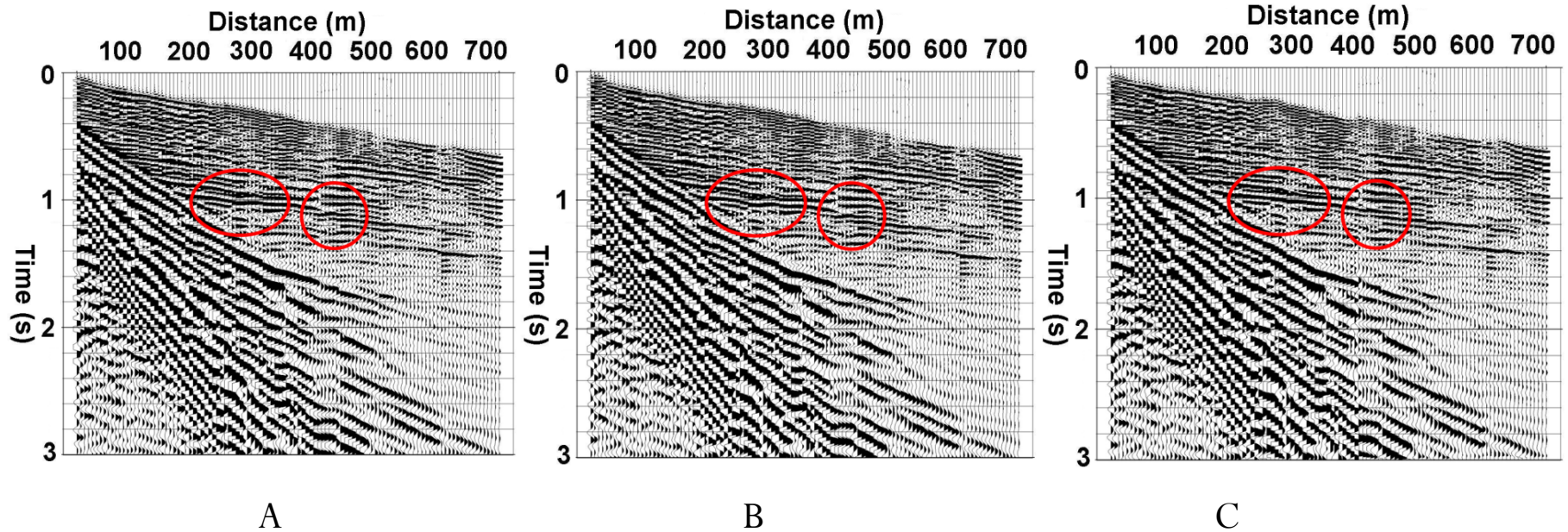
P Velocity Model

Input P Model
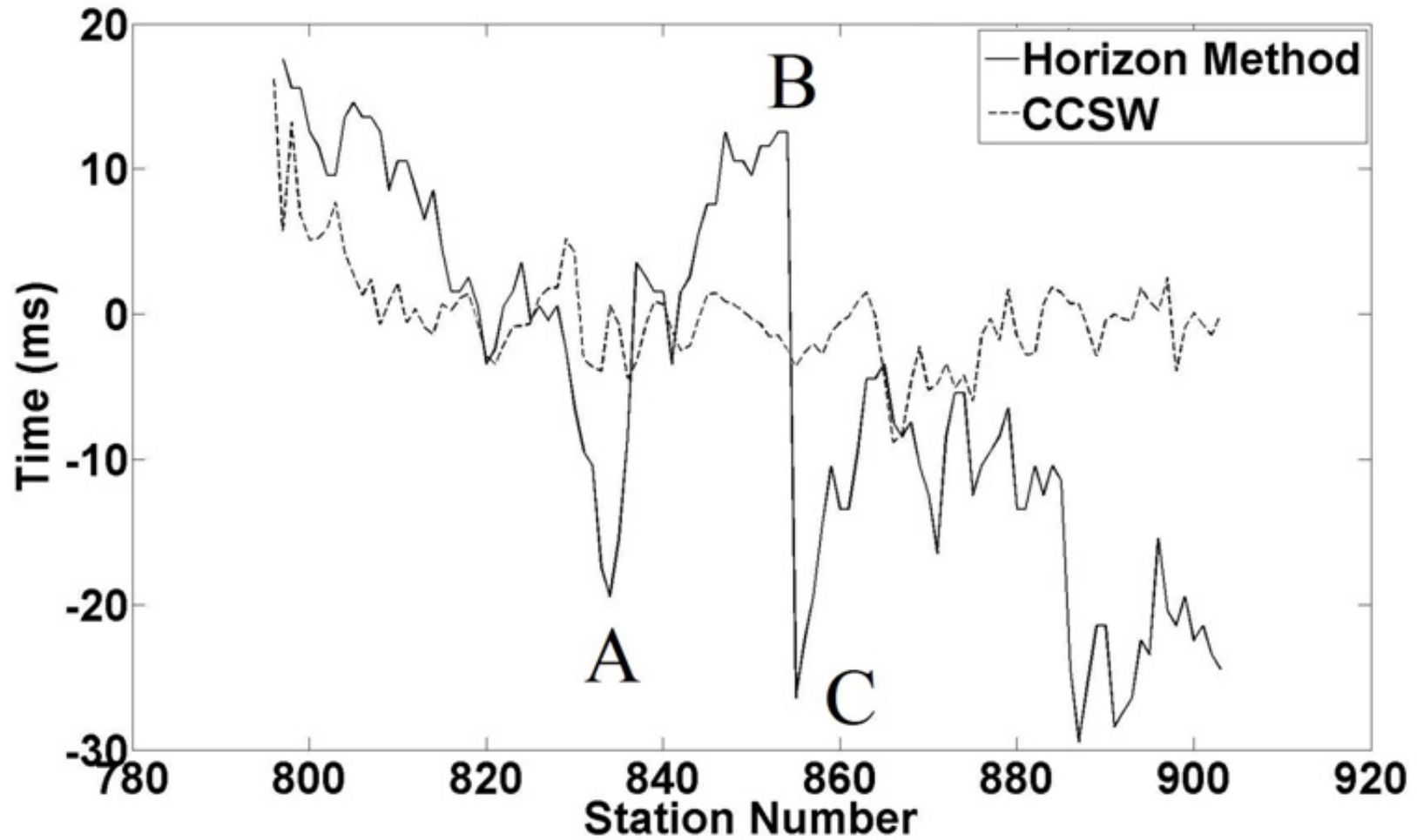
S Velocity Model

(a)

(b)

Static Correction

(A) A shot record without correction, (B) CCSW static corrected and (C) Non-physical Horizon based trim static corrected.
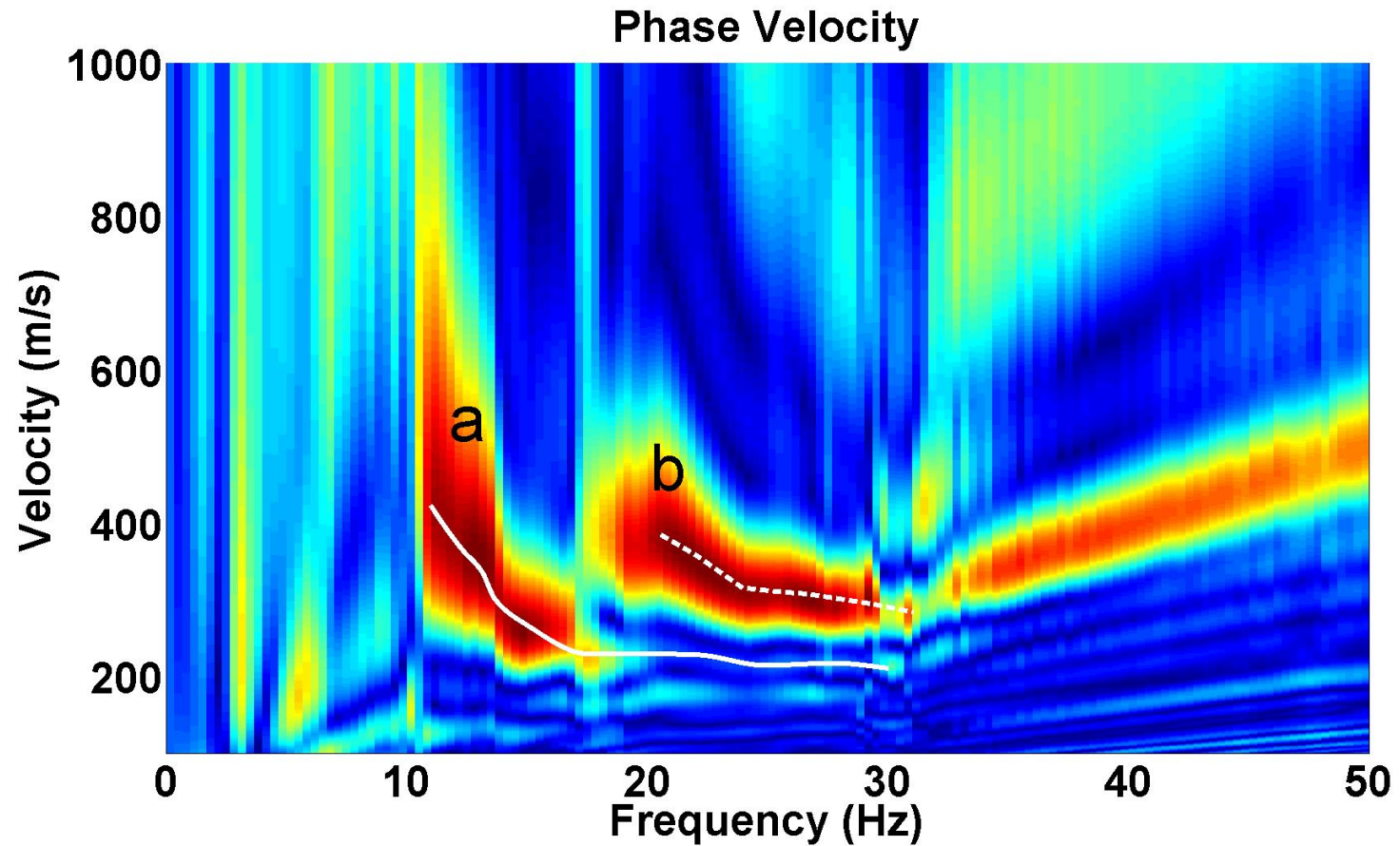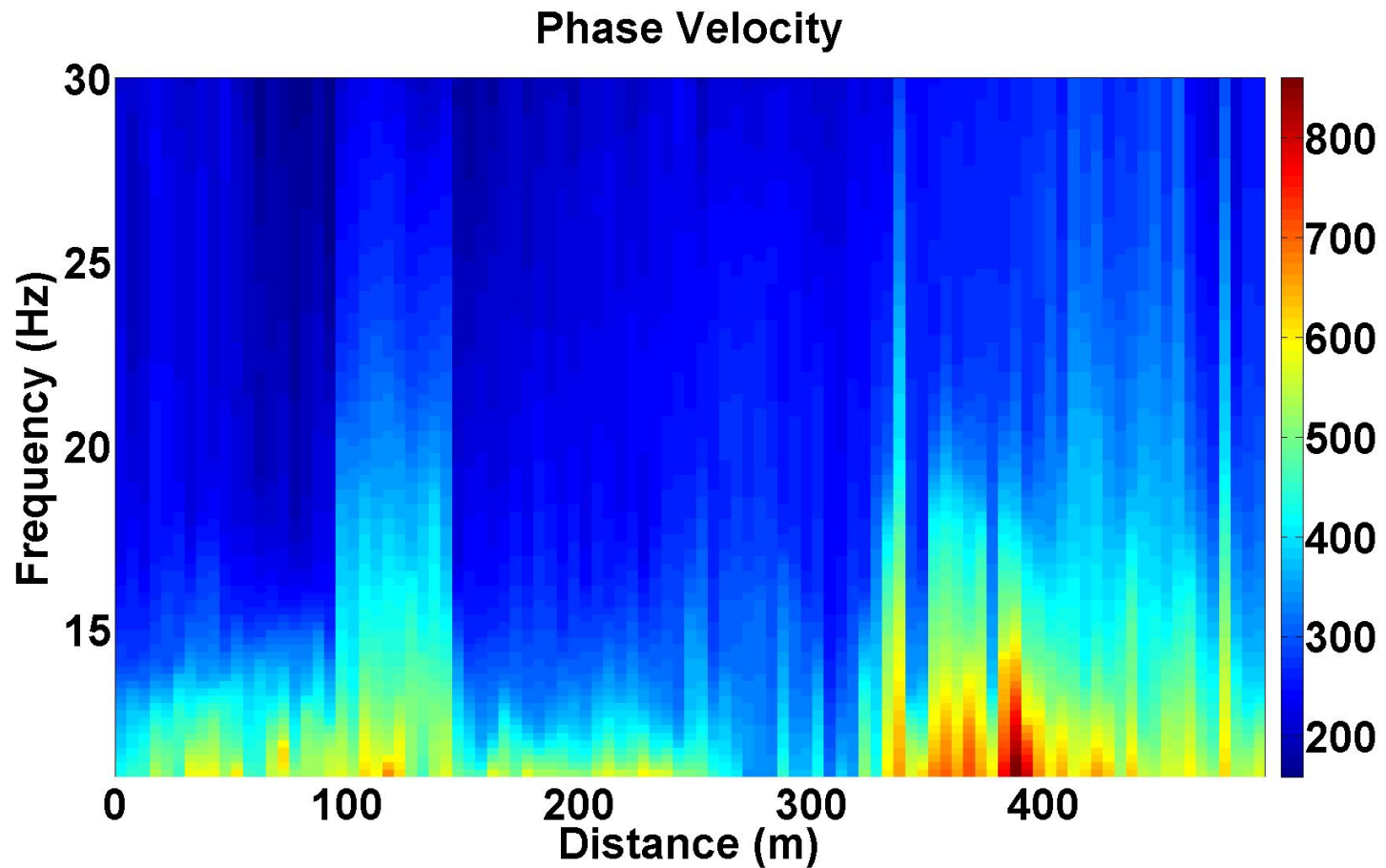
Static Correction

Priddis Data (2012)

- **Priddis data: acquired from a site near Priddis, Alberta**

- **Geophone interval: 2m**

- **Shot interval: 4m**

- **Source : vibroseis**

- **Sweep frequency: 10Hz to 120Hz**

- **Listening time:10s**

- *Bin size: 5m*

A CMP gather's phase velocity

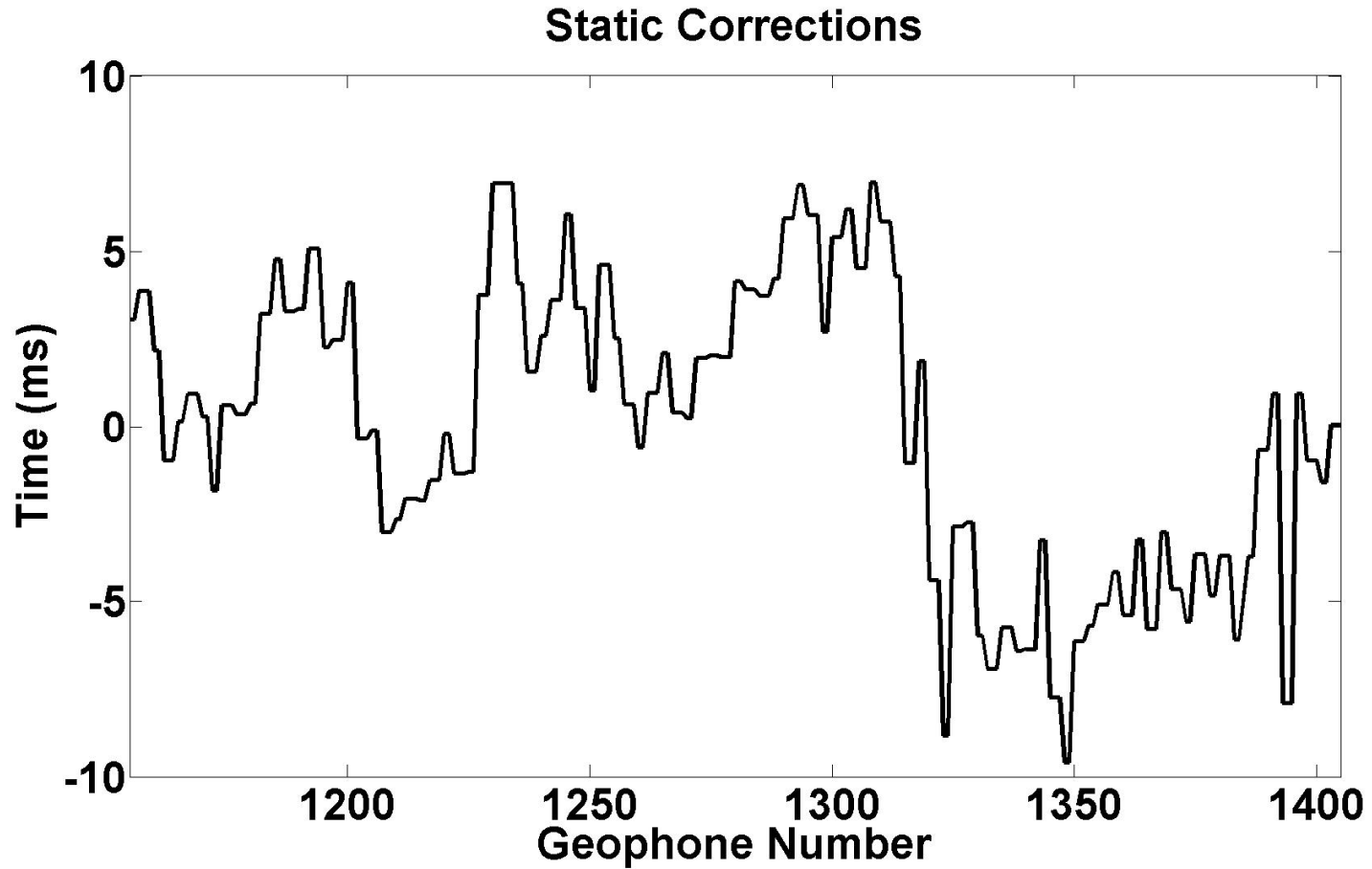# Observed Phase Velocity for the Priddis Data

Data Inversion

- Density: 2300 kg/m^3
- P velocity: estimated from the S velocity based on a given poison ratio (0.45)

$$V_p = V_s \left(\frac{1-\sigma}{0.5-\sigma}\right)^{\frac{1}{2}}$$

- Layer thickness: 2m

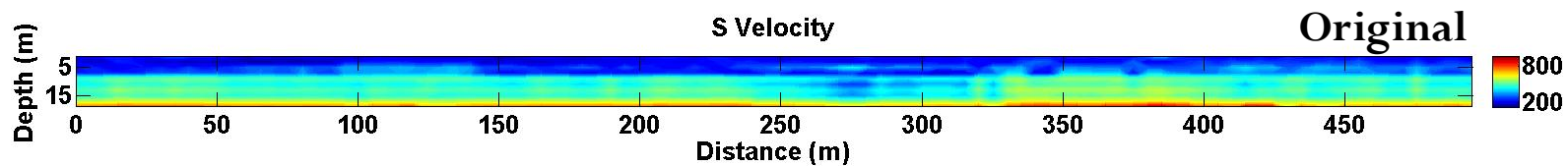# S Velocity Model for the Priddis Data
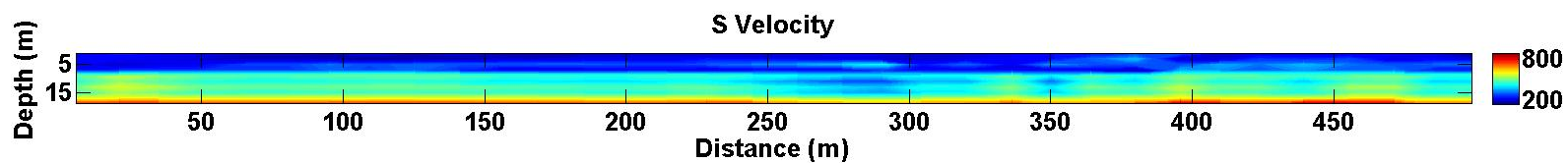

S Velocity

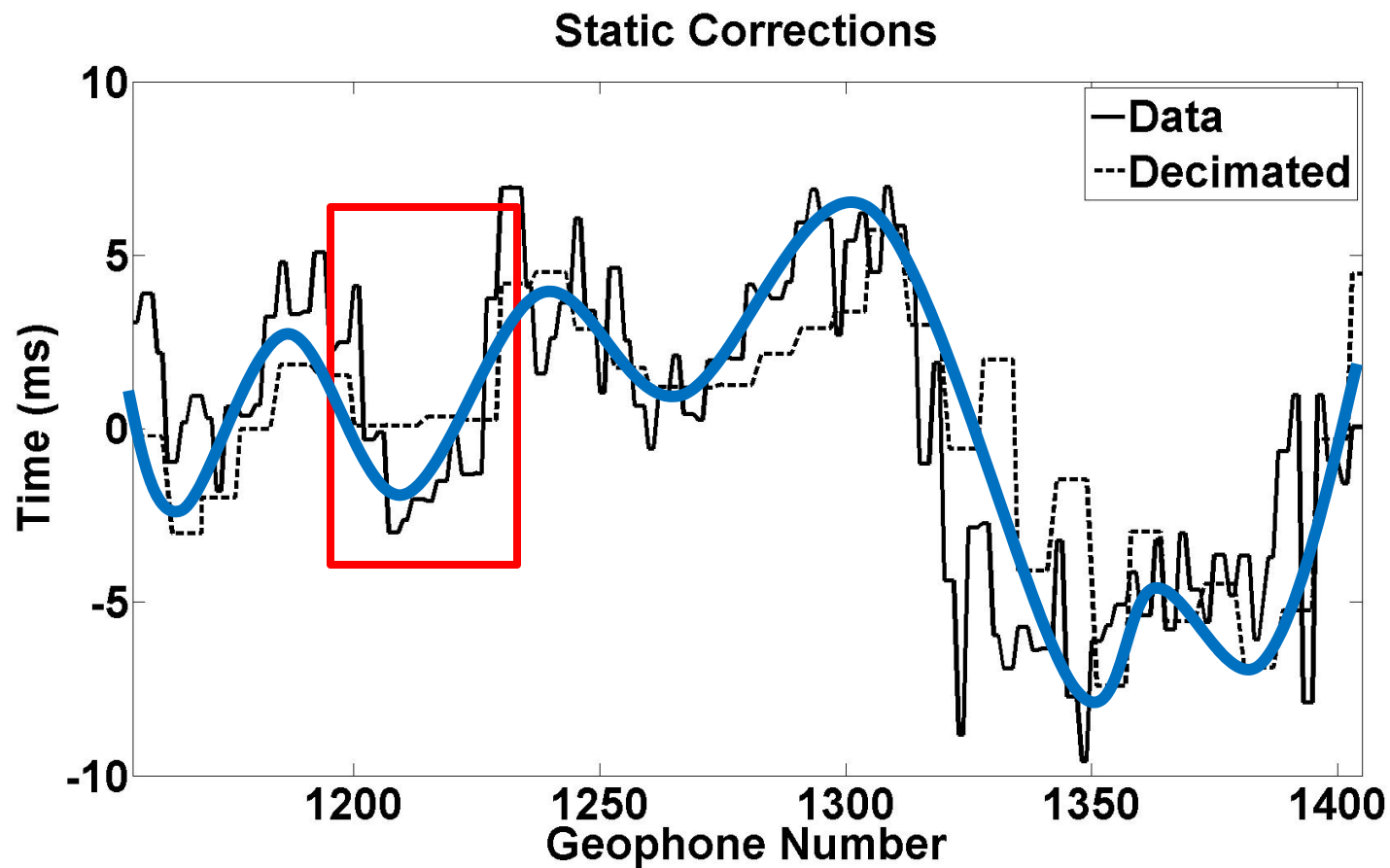# Static Corrections for the Priddis Data

Decimating the Priddis data

- In order to investigate the effect of the geophone interval in CCSW analysis for the static corrections, we decimate the Priddis data to have 8m geophone interval.
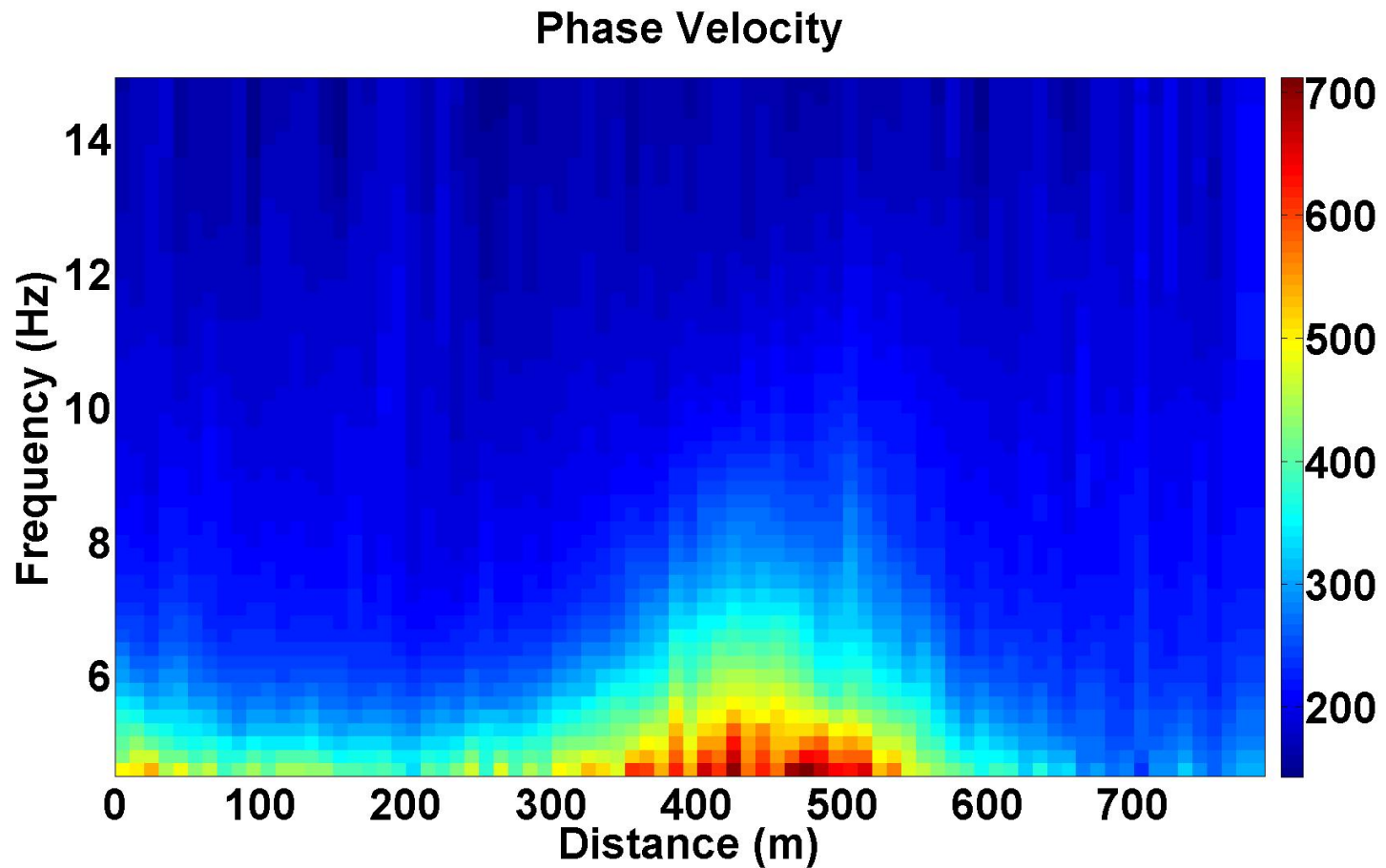
- Bin size:15m

S Velocity Model for the decimated data

Static corrections for the decimated data

Static Corrections

Hussar Data (2011)

- **Hussar data: acquired by CREWES near Hussar, Alberta, Canada.**

- **Source: vibroseis**

- **Sweep: 1Hz to 100Hz**

- **Listening time: 10s**

- **Geophone interval: 10m**
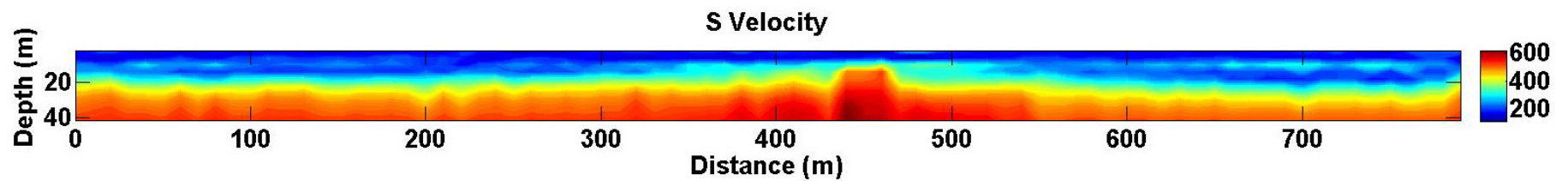
Phase Velocity for the Hussar Data

Phase Velocity

Data Inversion

- **Density: 2200 kg/m^3**
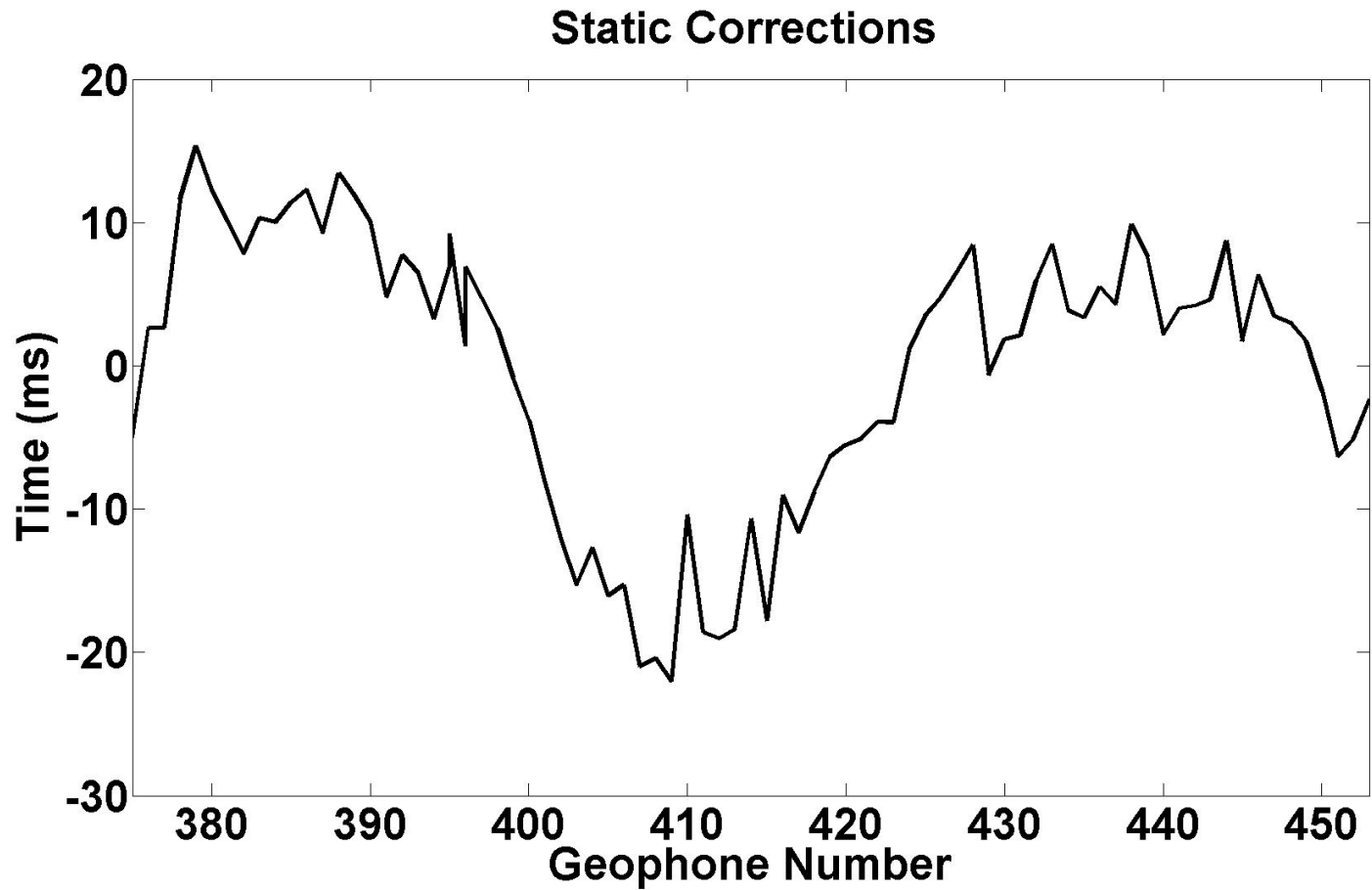- **P velocity: estimated from the S velocity based on a given poison ratio (0.45)**

$$V_p = V_s \left(\frac{1-\sigma}{0.5-\sigma}\right)^{\frac{1}{2}}$$
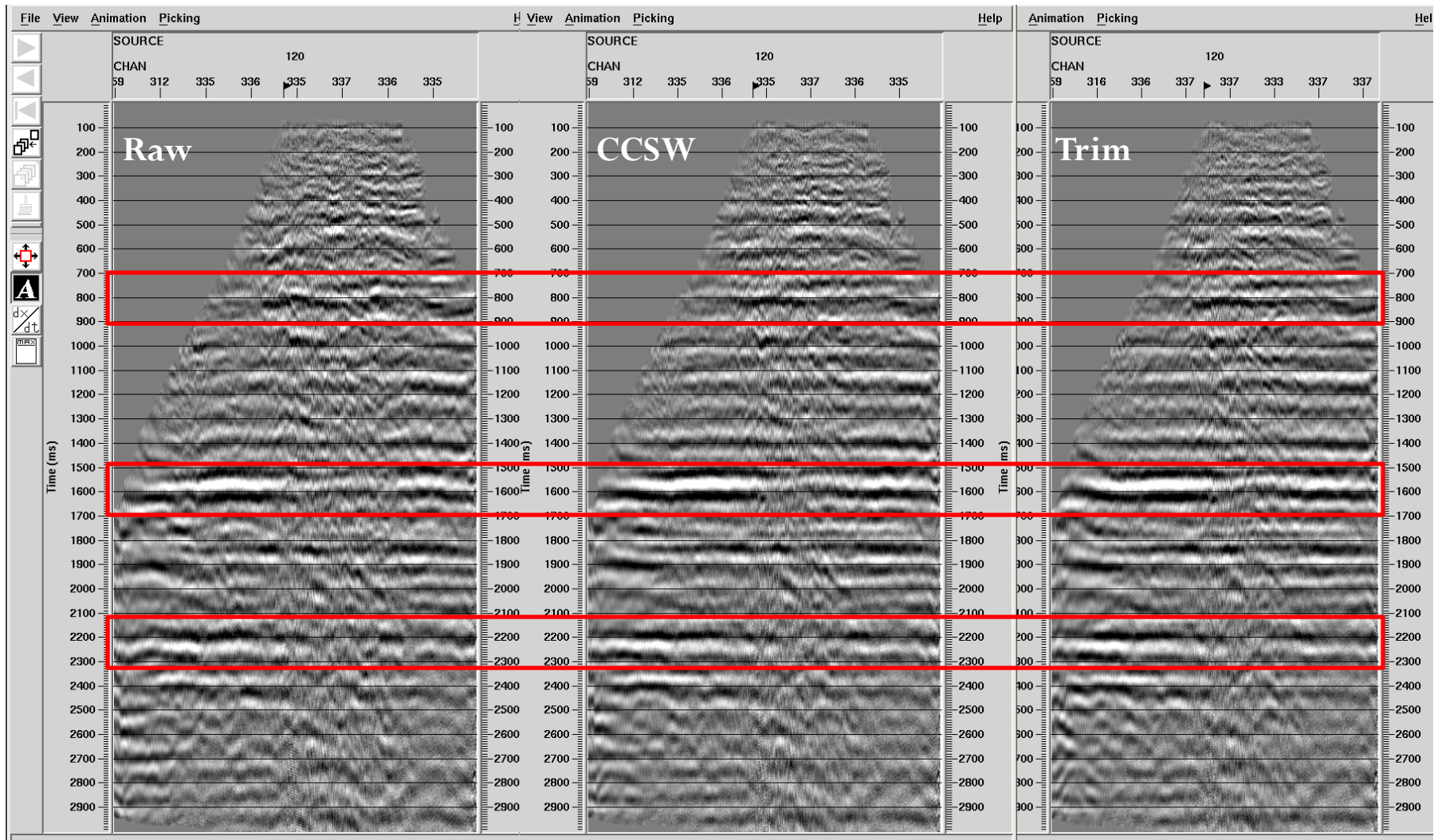
- **Layer thickness: 4m**

S Velocity for the Hussar Data

PS Static Corrections for the Hussar Data

Static Corrections

PS Static Corrected Data

Conclusion

- **CCSW: a good lateral resolution for the static correction of converted waves**

Acknowledgements

- CREWES and its sponsors for their generous support
- Dr. Ferguson for his supports
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- Dr. DeMeersman for useful discussions
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