# Source estimation for WRI and its application

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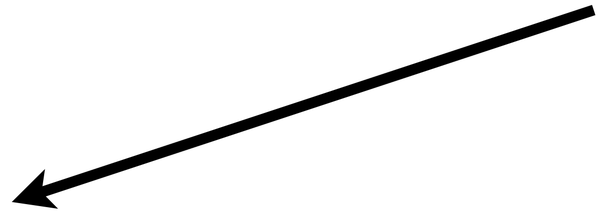
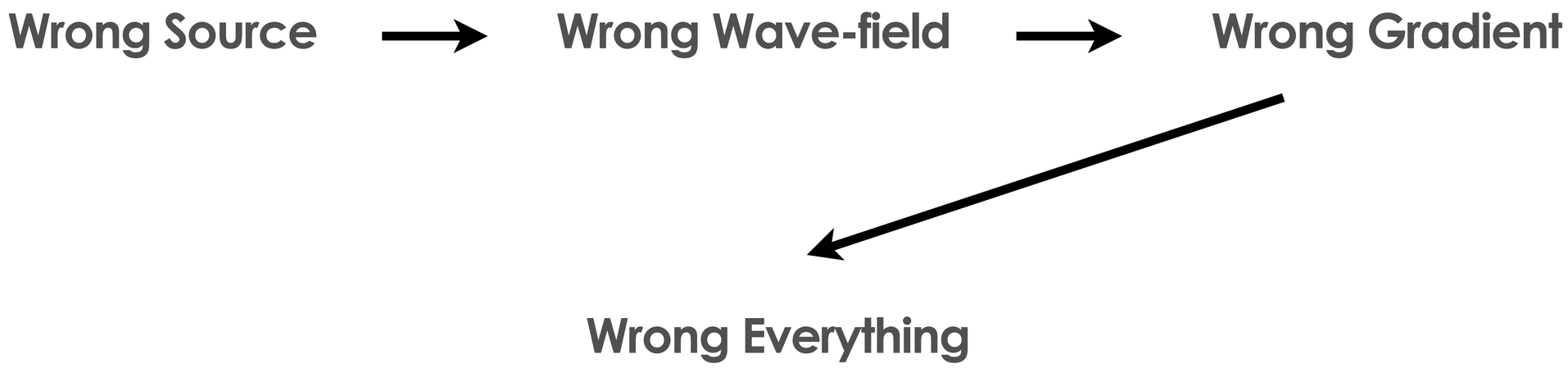
# Motivation

Wrong Source → Wrong Wave-field → Wrong Gradient



Wrong Everything

# Motivation




Source wavelet ~ Grid space

# WRI with source estimation

Problem:

$$\min_{\mathbf{u},\mathbf{m},\alpha} \|\mathbf{Pu}-\mathbf{d}\|^2 + \frac{\lambda^2}{2}\|\mathbf{A}(\mathbf{m})\mathbf{u}-\alpha\mathbf{q}\|^2$$

Solution: Variable Projection

# WRI with source estimation

1. Solve:

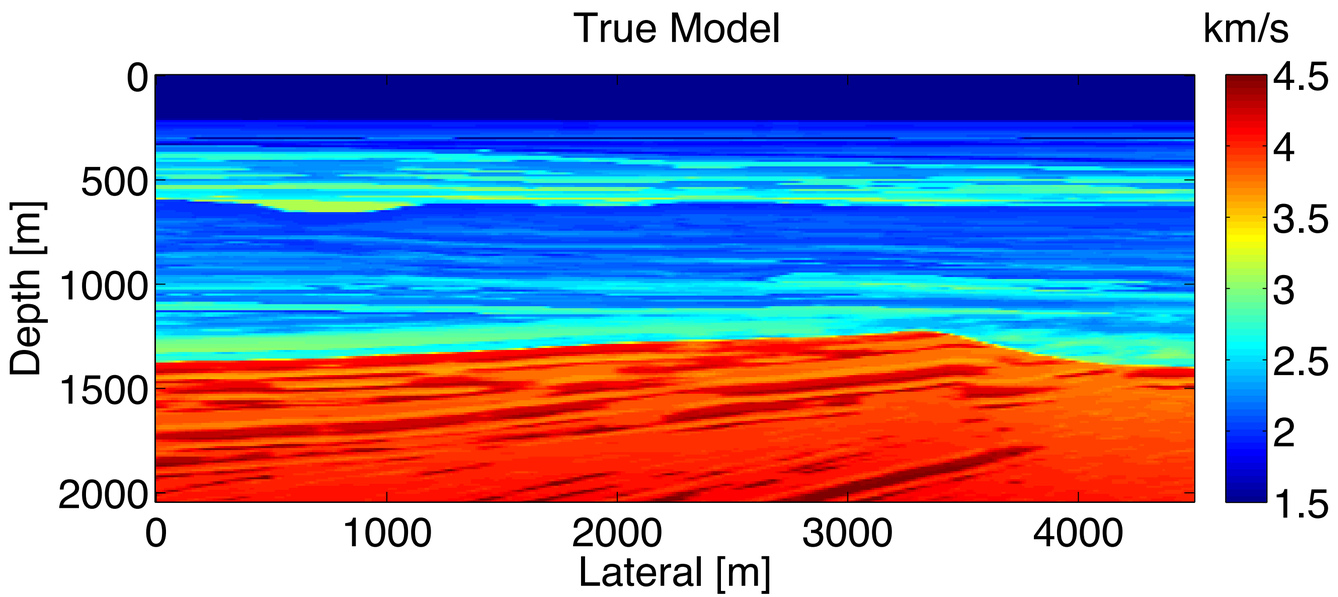
$$\min_{\mathbf{u},\alpha} \|\mathbf{P}\mathbf{u} - \mathbf{d}\|^2 + \frac{\lambda^2}{2}\|\mathbf{A}(\mathbf{m})\mathbf{u} - \alpha\mathbf{q}\|^2$$

by solving:

$$\begin{pmatrix} \lambda\mathbf{A} & -\lambda\mathbf{q} \\ \mathbf{P} & 0 \end{pmatrix} \begin{pmatrix} \mathbf{u} \\ \alpha \end{pmatrix} = \begin{pmatrix} 0 \\ \mathbf{d} \end{pmatrix}$$

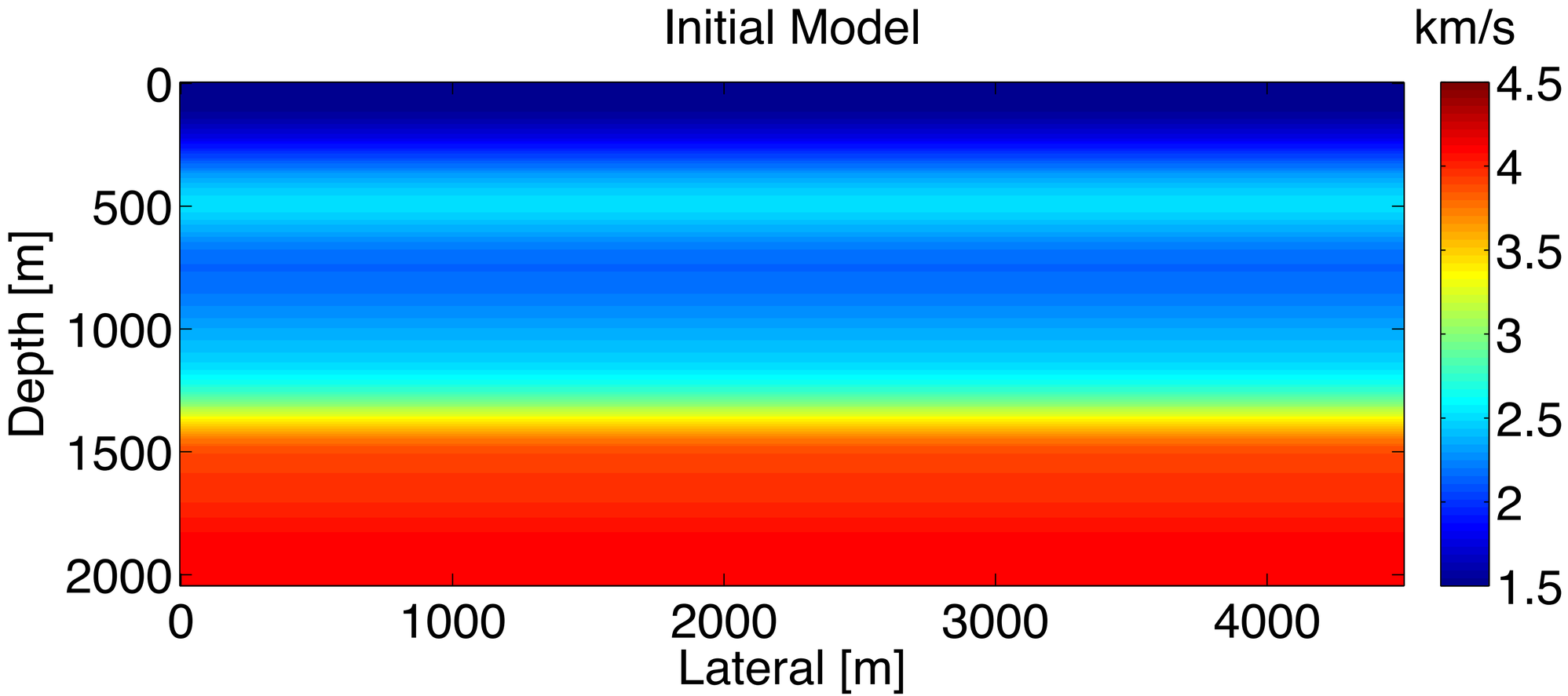
2. Update **m** using Newton method or lbfgs method.

# Numerical Experiment
# --- BG Model

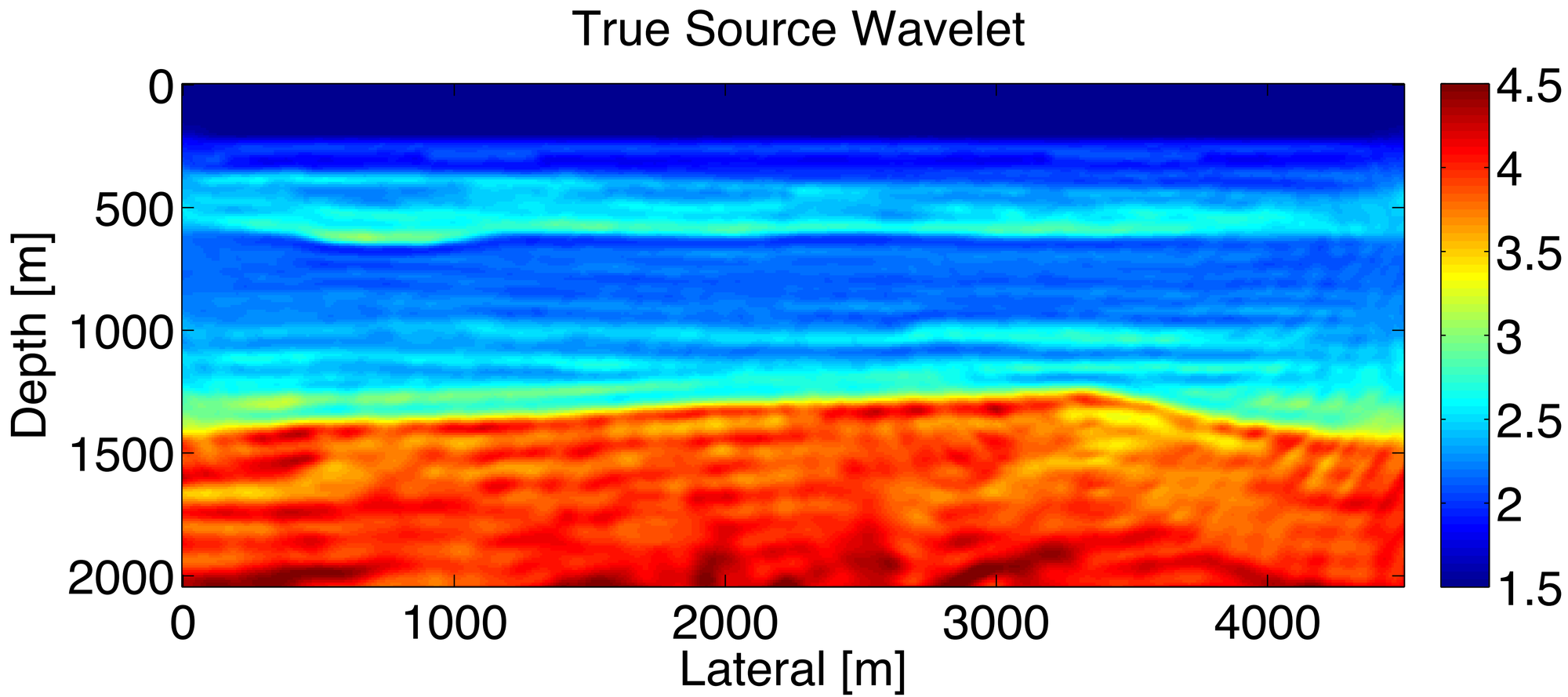



**Source: 91 with 50m interval**
**Receiver: 451 with 10m interval**
**Frequency: 3-17Hz**
**Shot-subsampling: 10shots**
**Iterations per frequency band: 20**

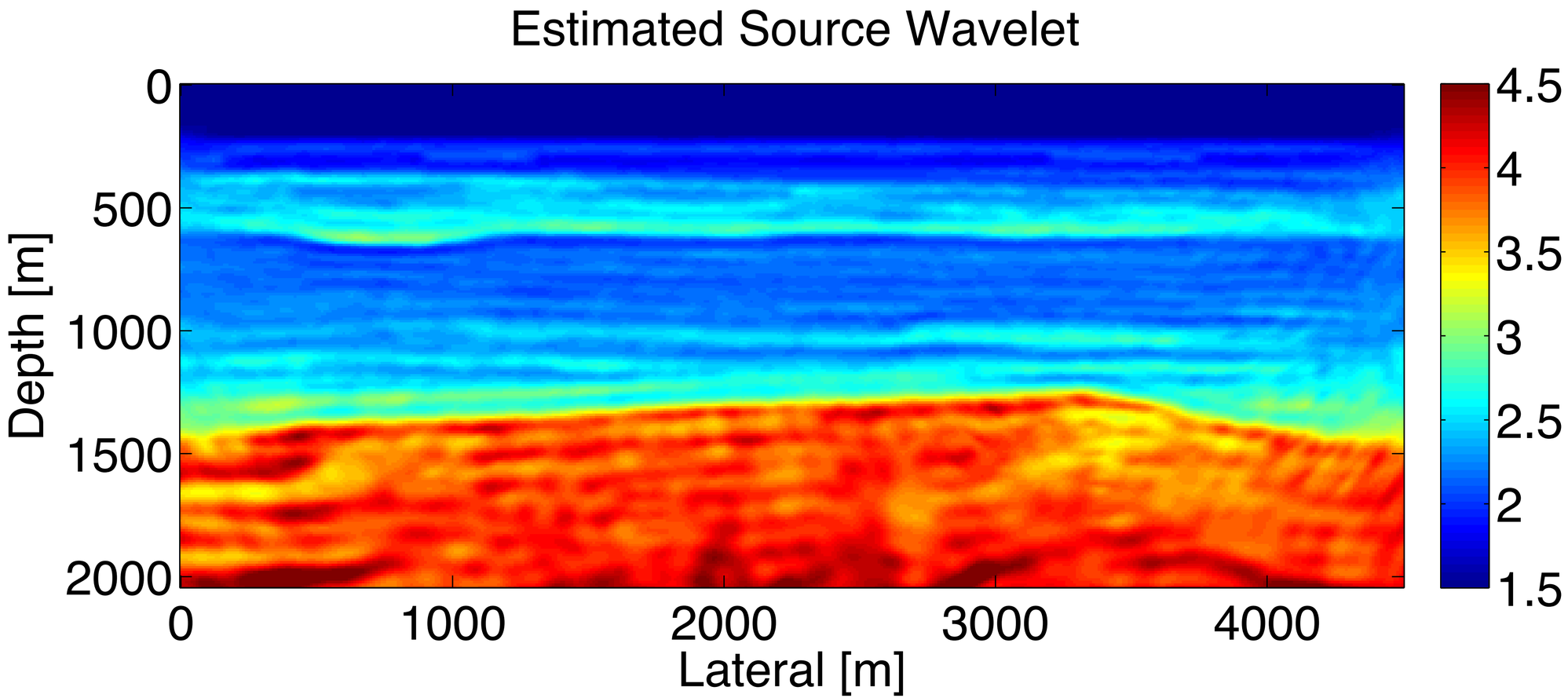
# Numerical Experiment
# --- BG Model



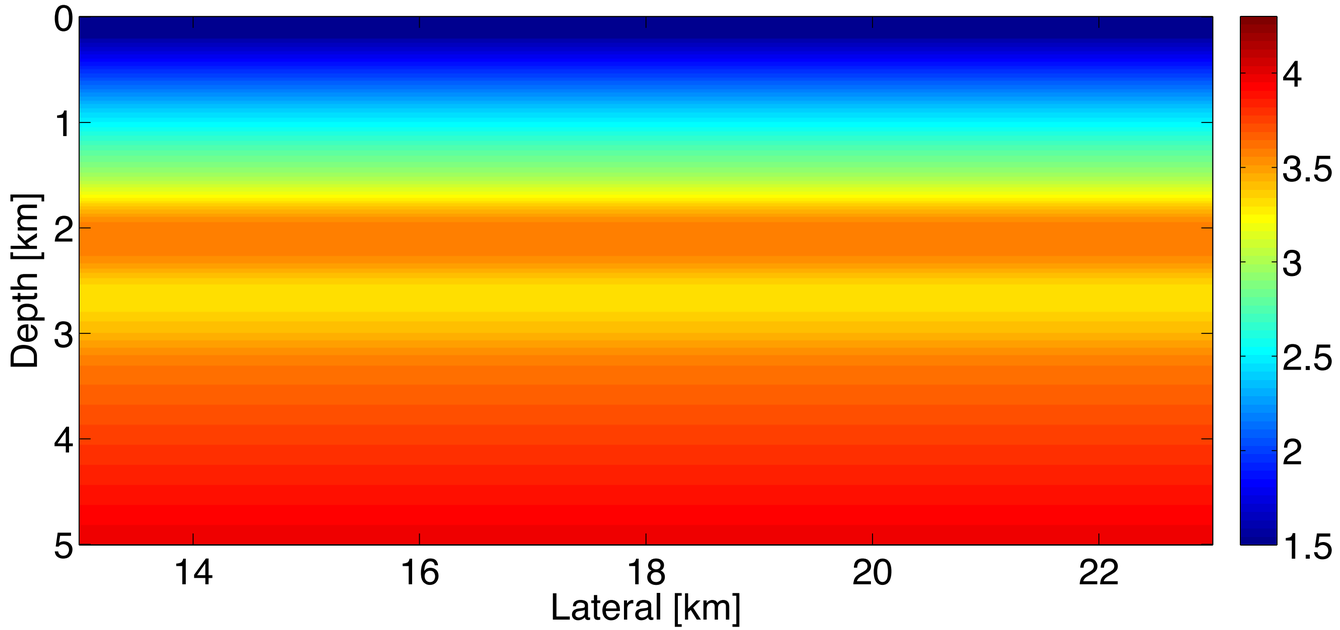
# Inversion with true source wavelet



# Inversion with estimated source wavelet

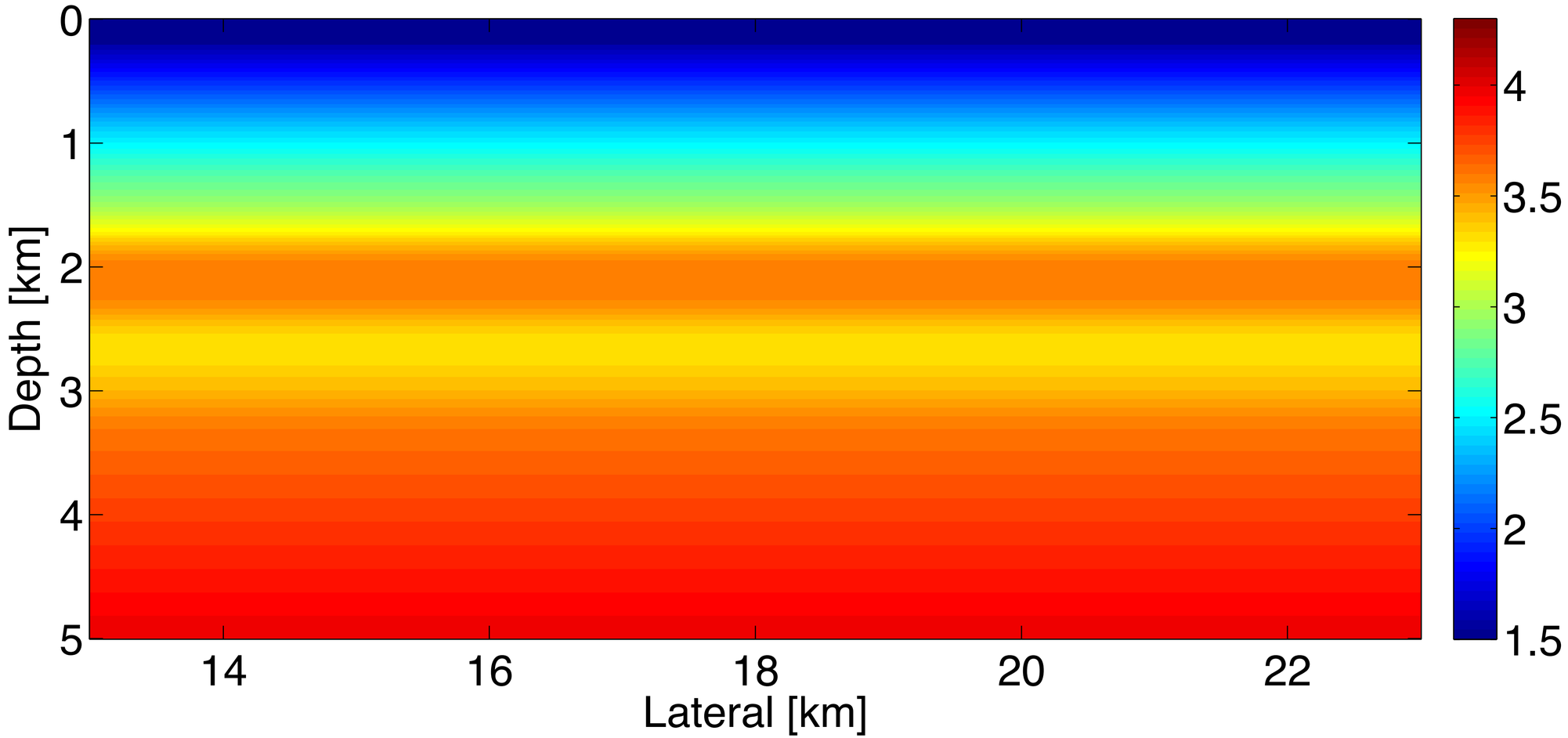


# Chevron blind test

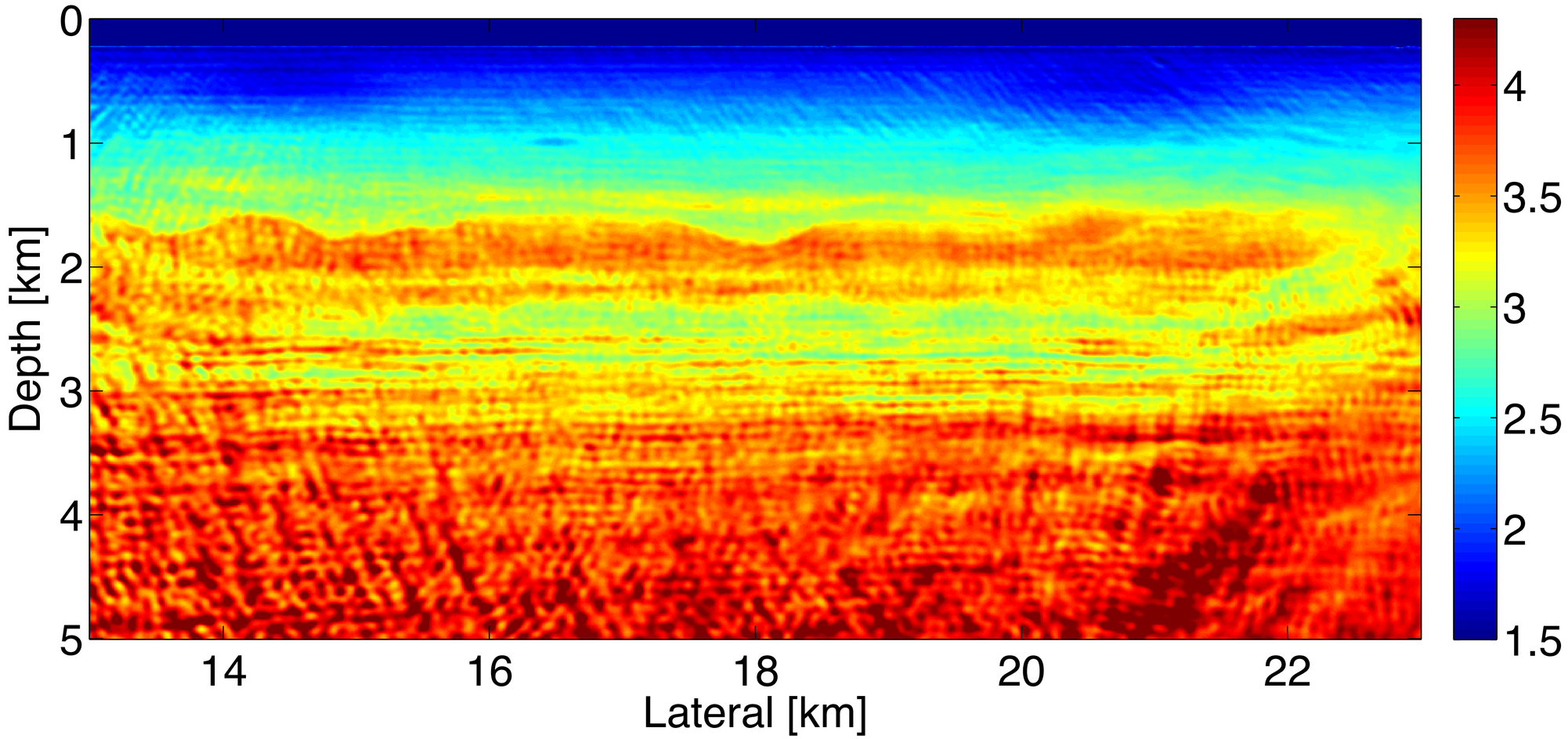



Lateral: 13km-23km
Depth: 0km - 5km
Frequency: 4-20Hz
Shot : 400 with 25m interval
Offset : 600m - 8000m
Shot sub-sampling: 40 shots with jittered sampling
Iterations per frequency band: 13
Grid space: 15m - 10m
Computational resource: 3 cores on Intel(R) Xeon(R) CPU E5-2670 @ 2.60GHz

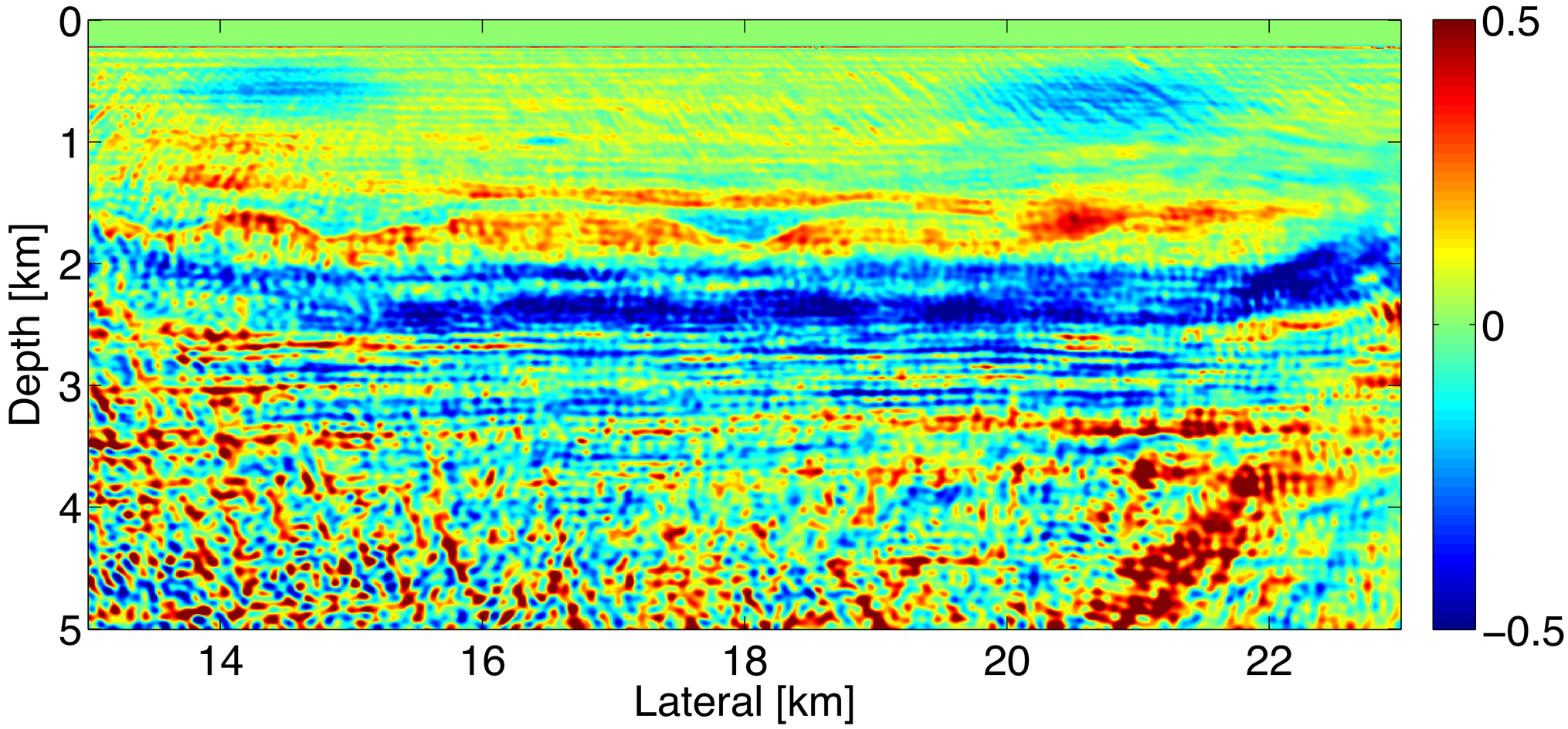
# Initial Model



# Inversion result



# Difference



# Conclusion

1. Simultaneously update the wave-field and source wavelet can solve the source estimation problem in WRI.

# Future Plan

1. Use the adaptive method to select the batch size dynamically to reduce the computational cost.

2. Apply this source estimation method on 3D WRI.

3. Apply this method on other part of the Chevron blind test.

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