Transmission Wave-Equation Envelope Tomography

Jon Marius Venstad, NTNU | venstad@gmail.com

The ROSE Meeting, 25 April 2016

Vacancy: tomographer

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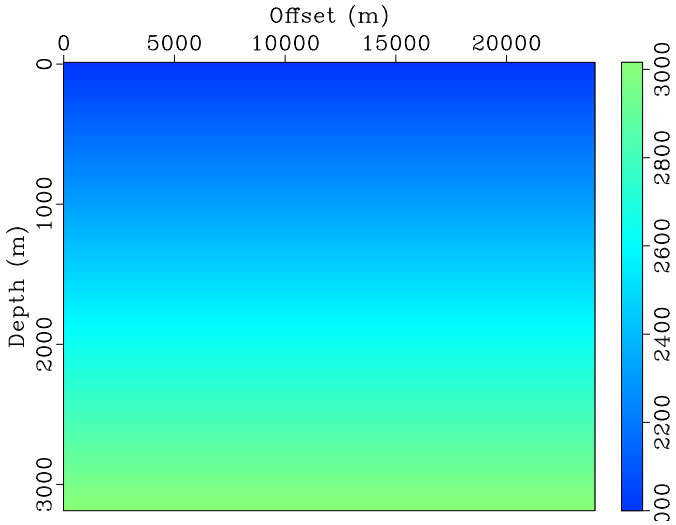

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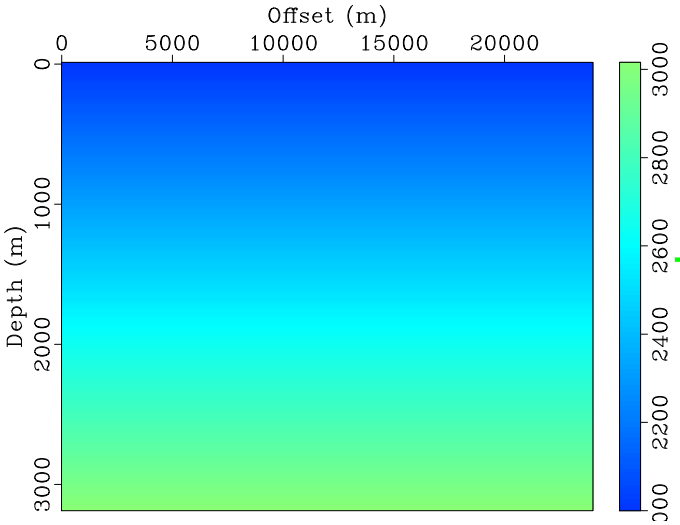
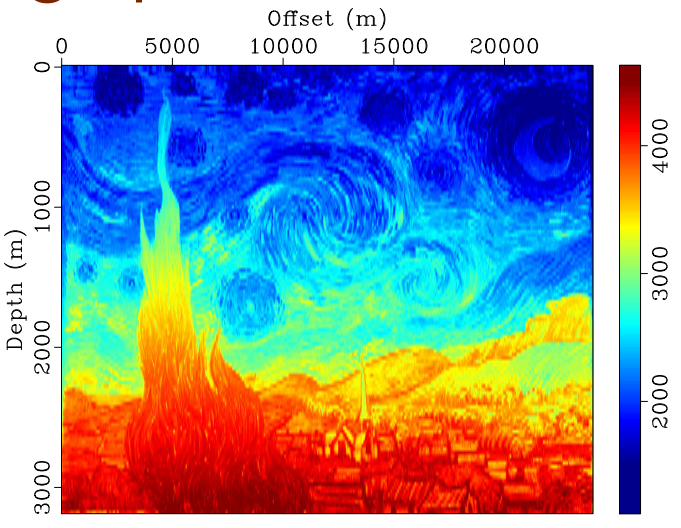


— Ideal →



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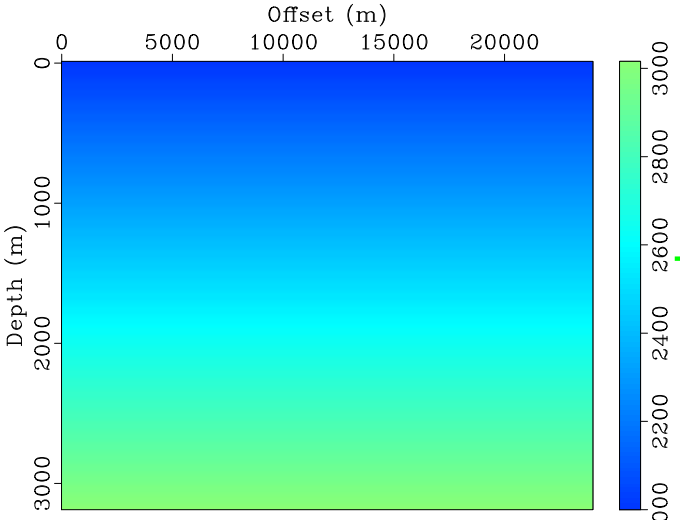

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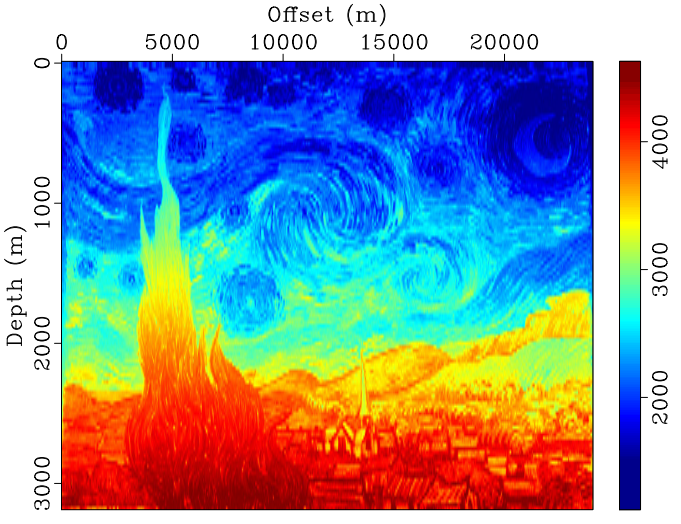

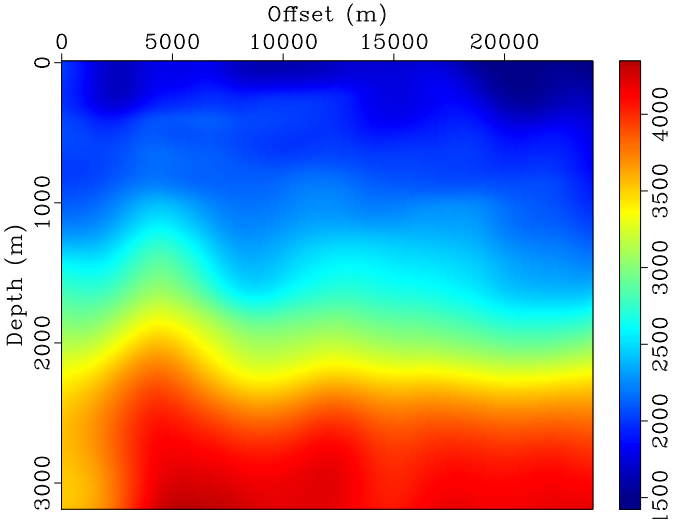

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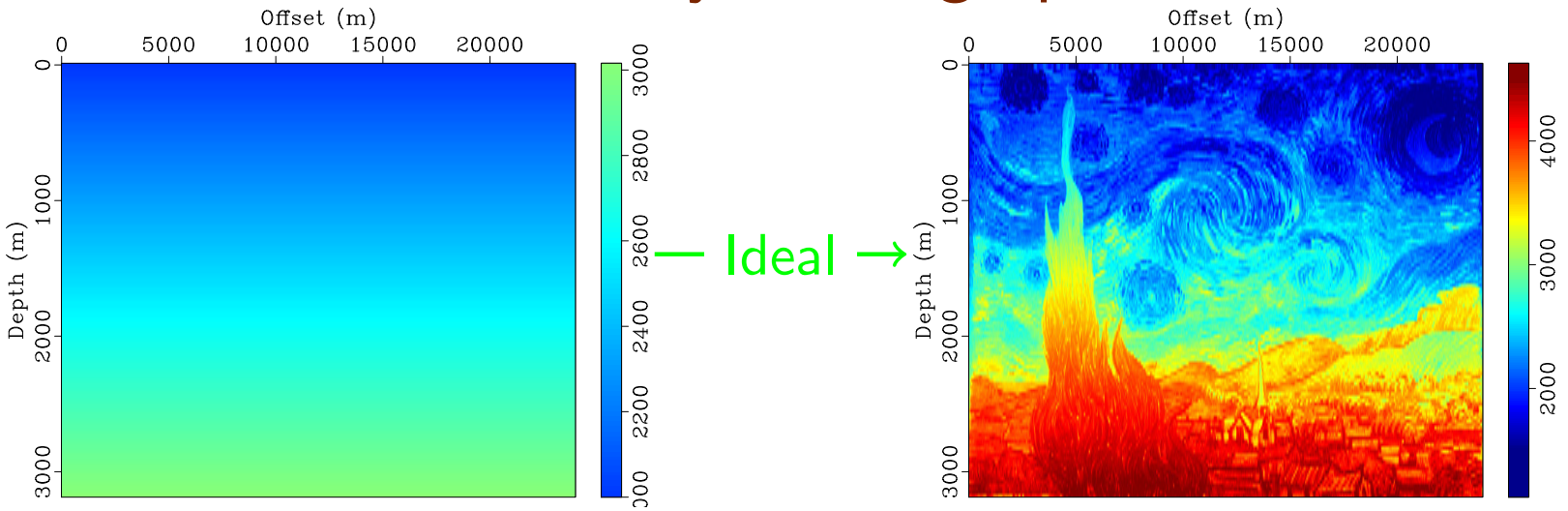

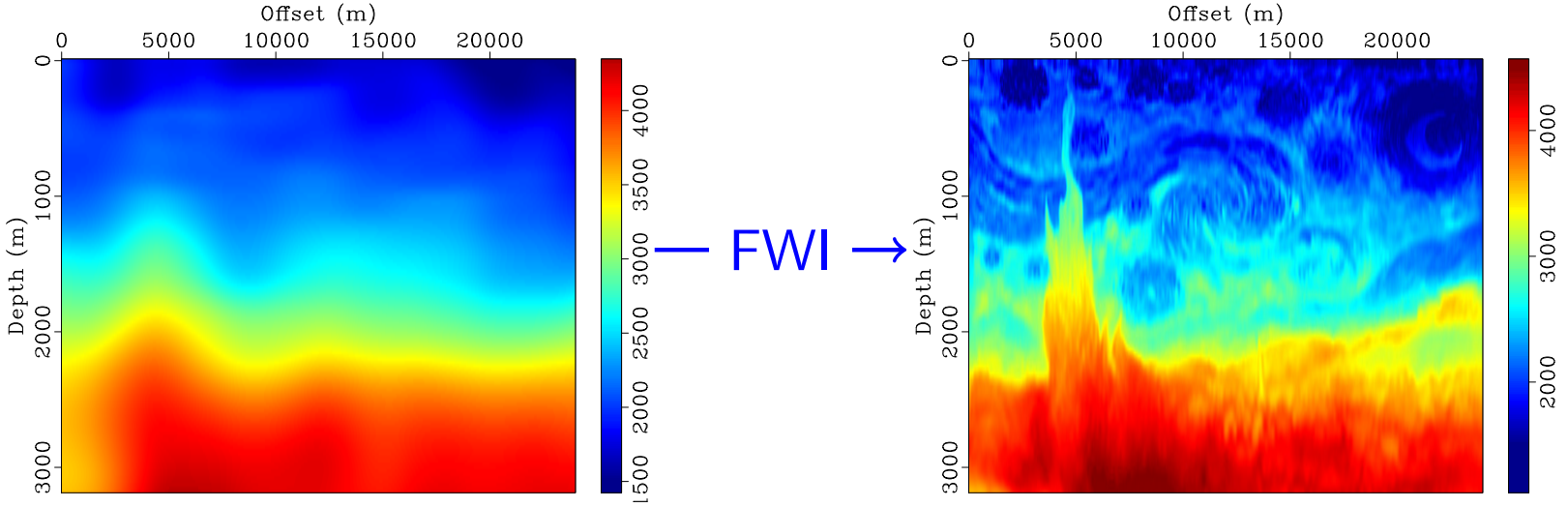

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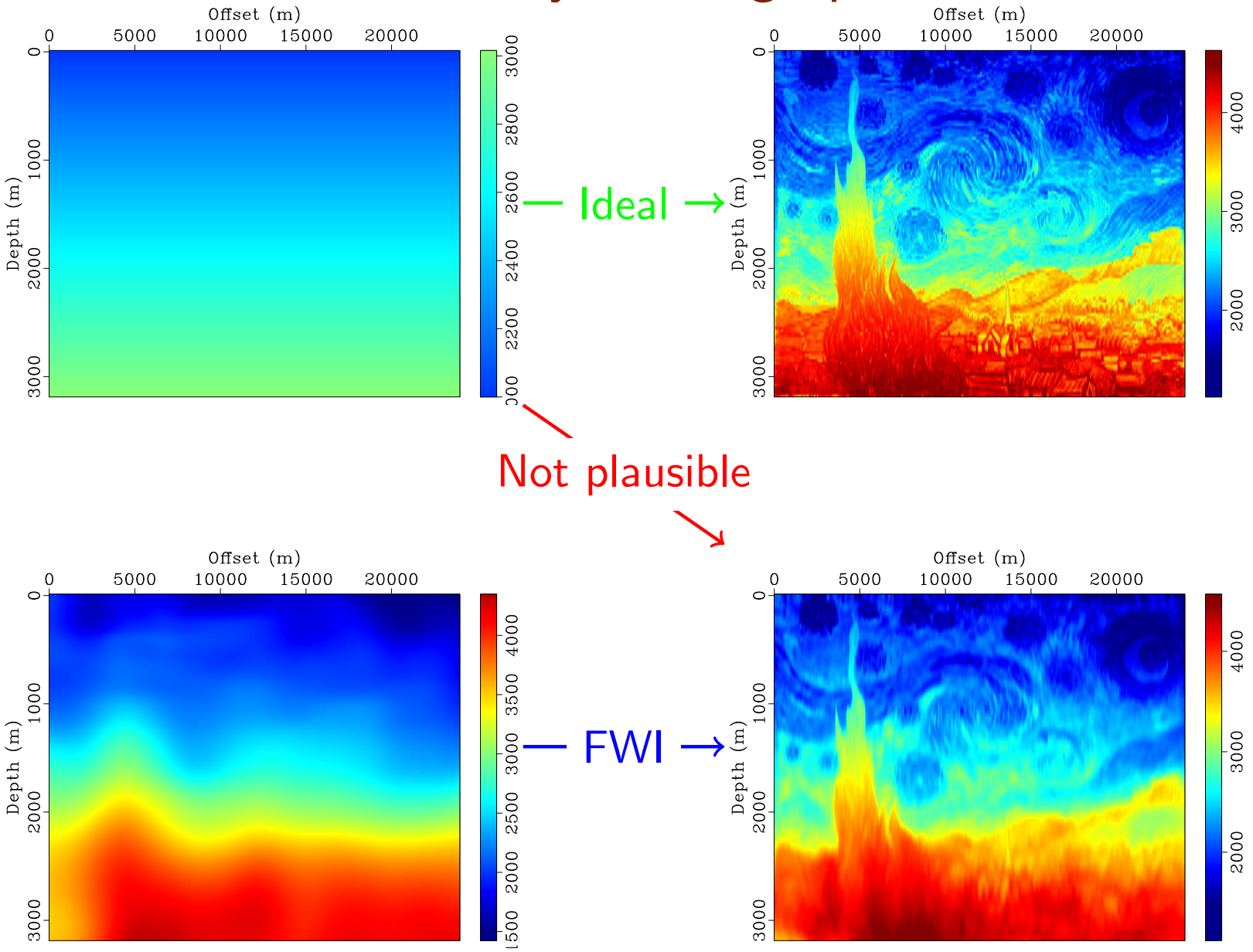

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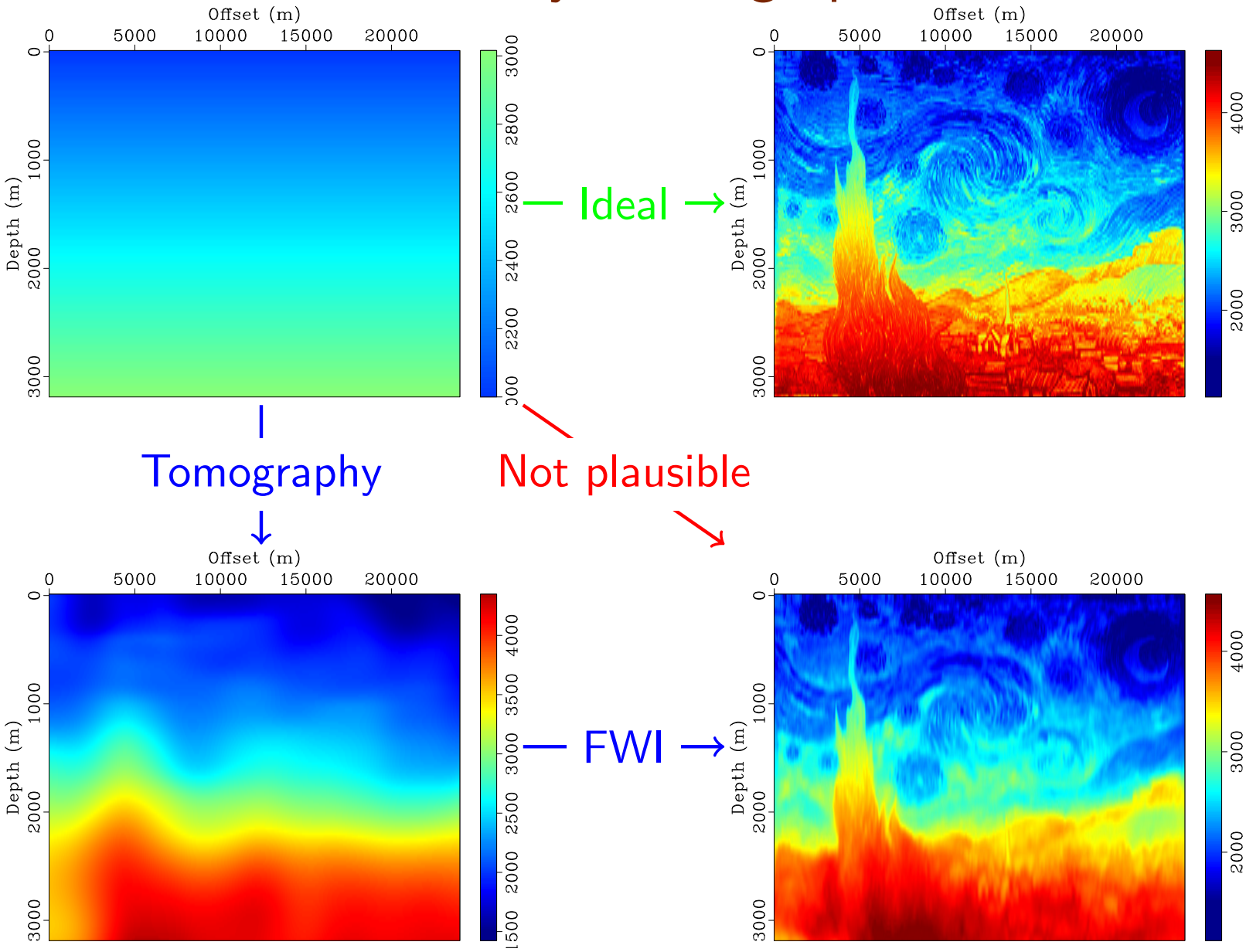

Tomographer candidates

RTT	WET

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manual	automated

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Is it possible to combine the best of both?

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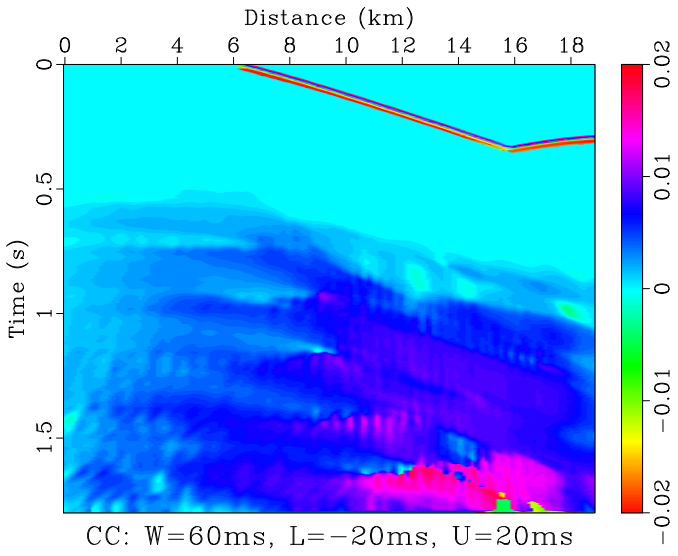
Dynamic Time Warping + Wave Paths?

Automated time shift estimation: Dynamic Time Warping



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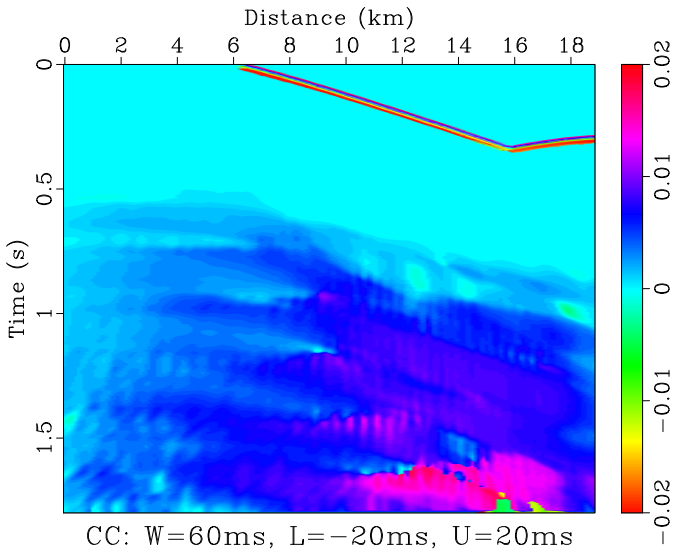

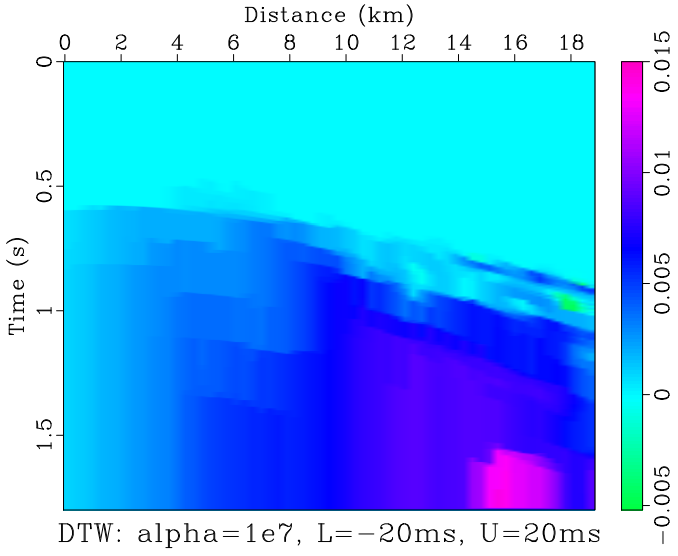

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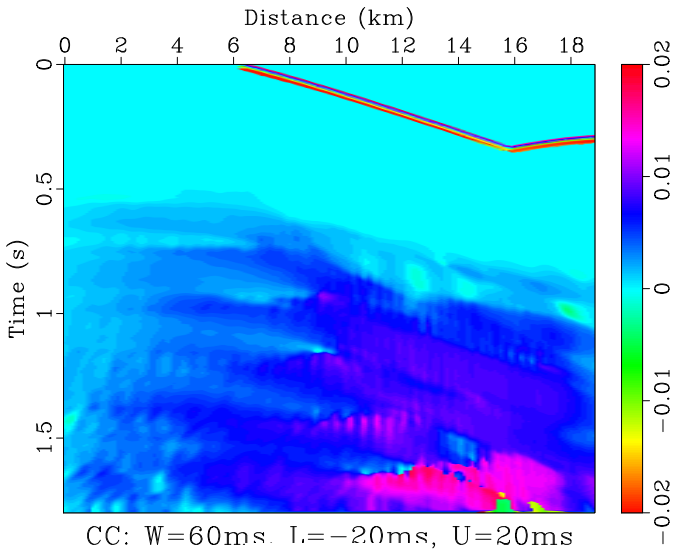
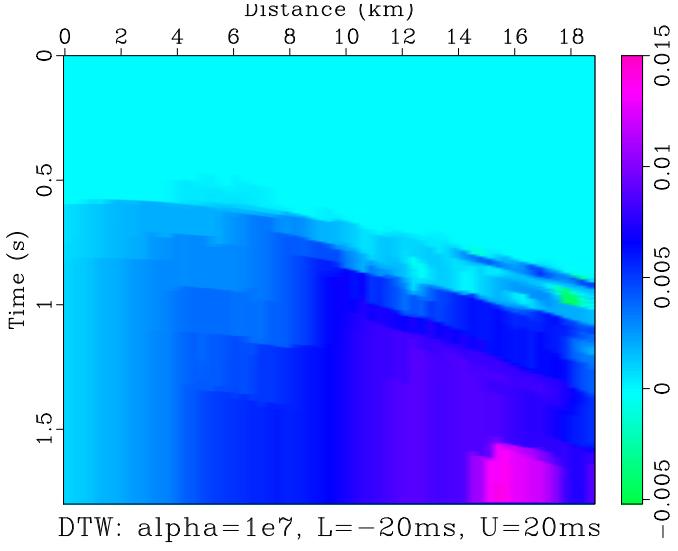


Agree



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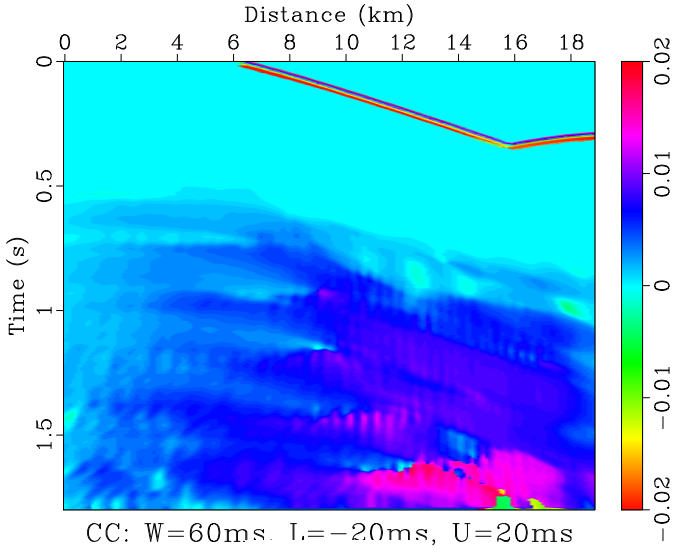

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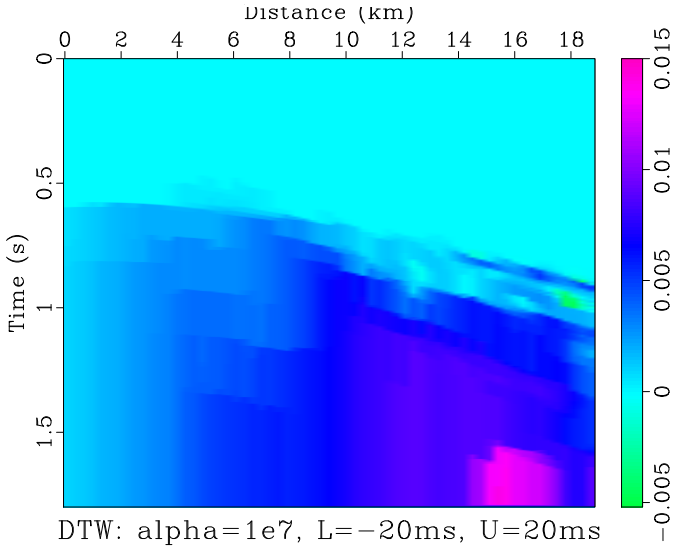

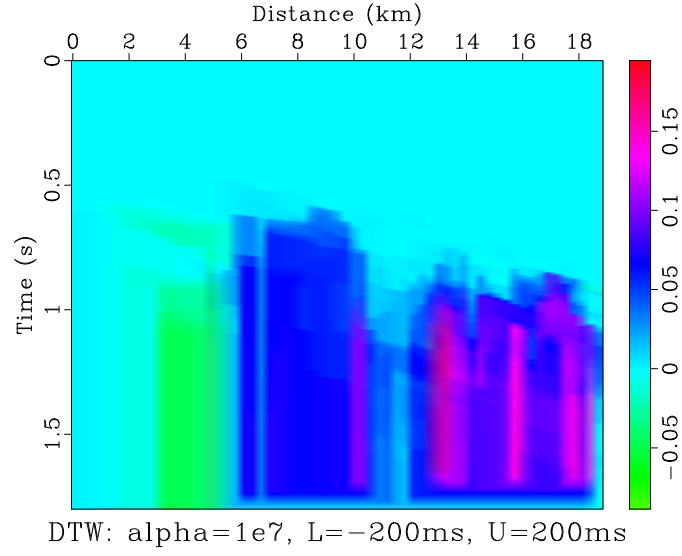

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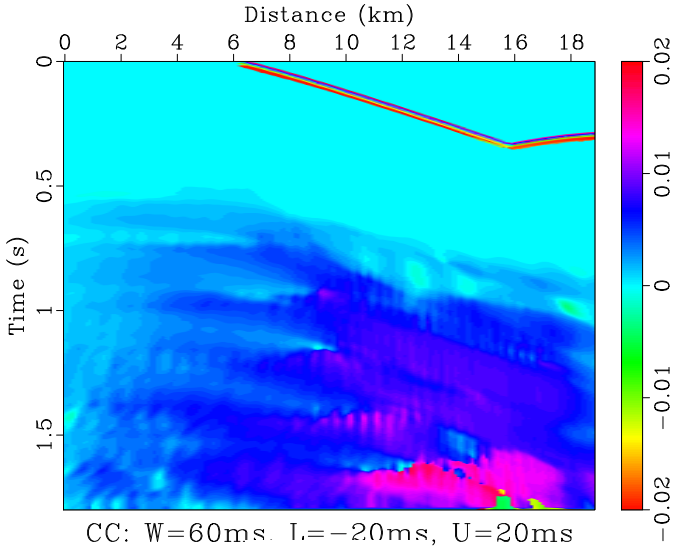

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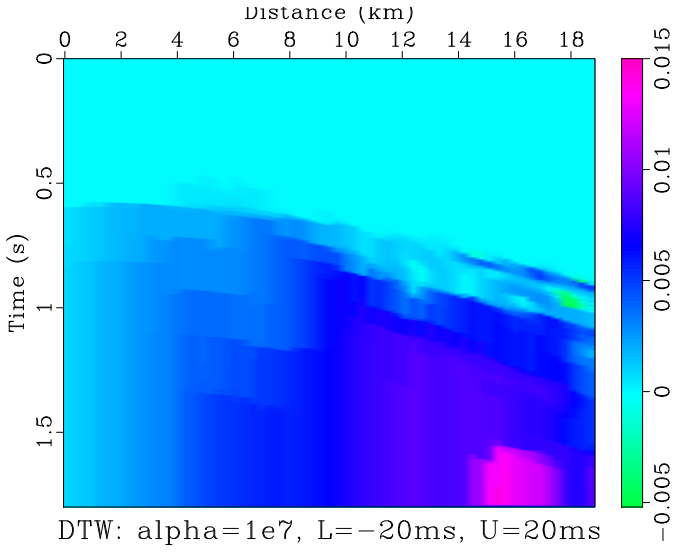

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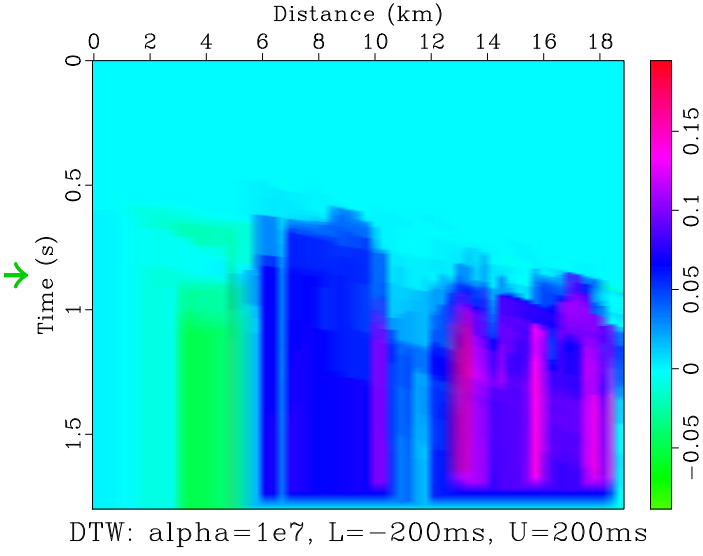

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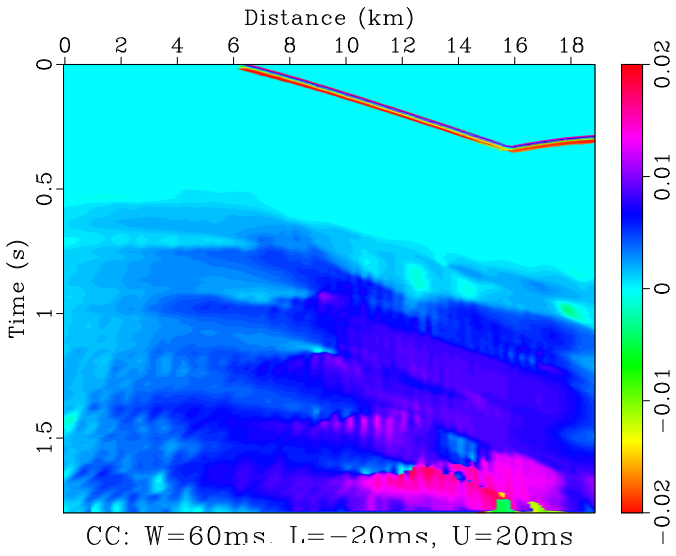
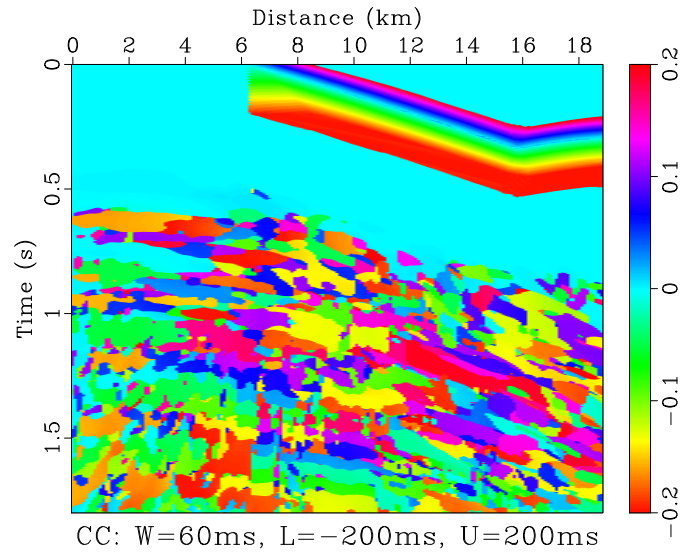
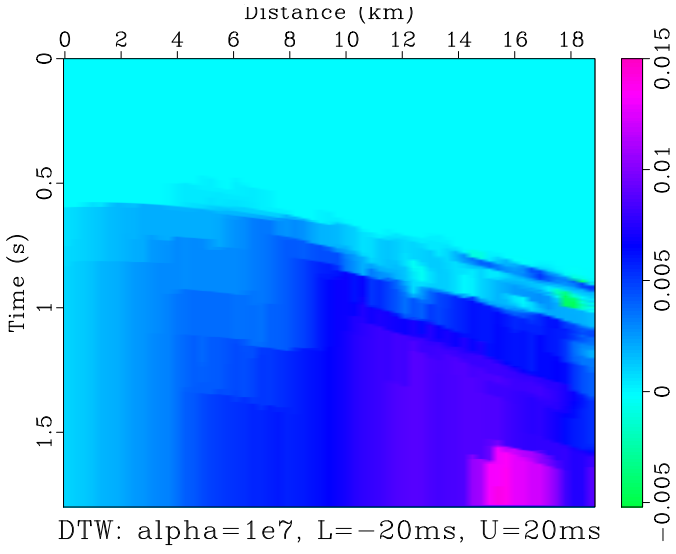




Agree



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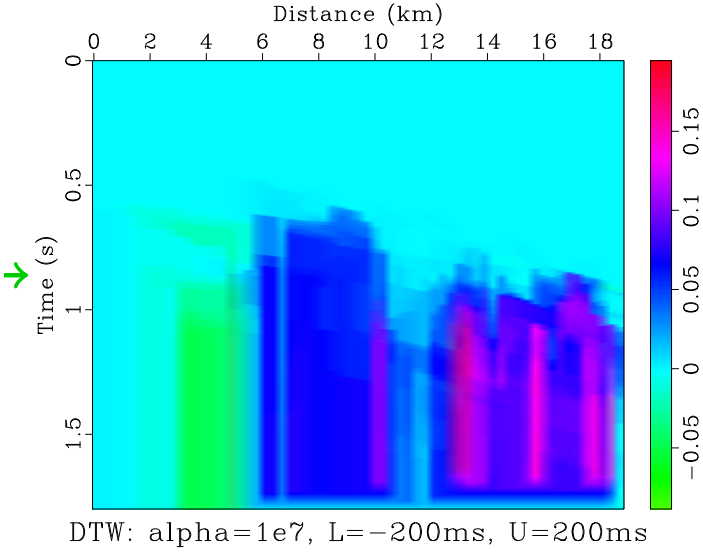

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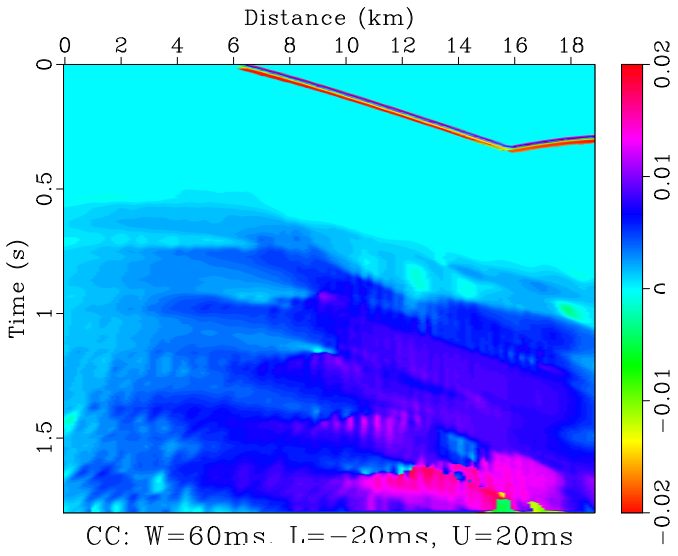
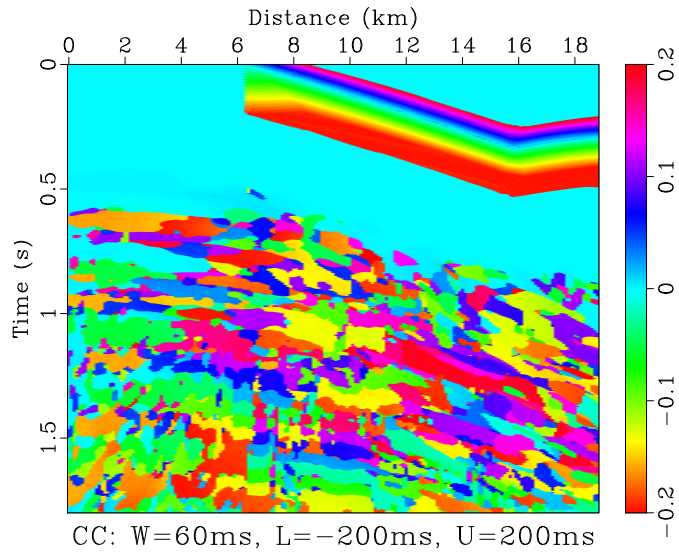


Dissimilar



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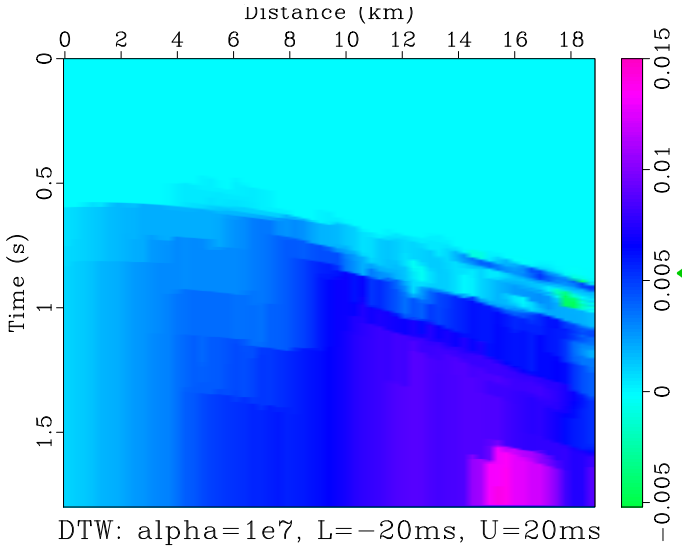

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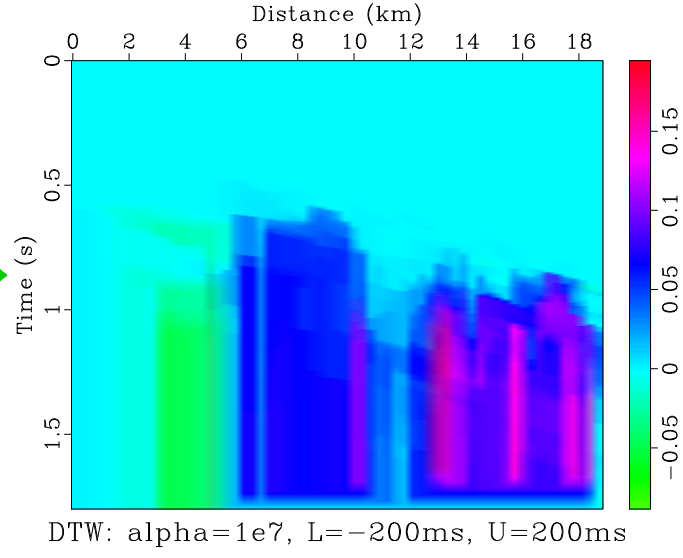

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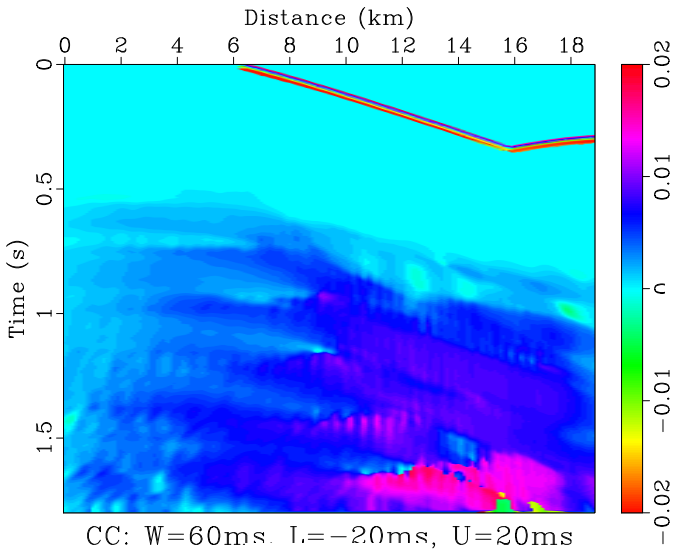

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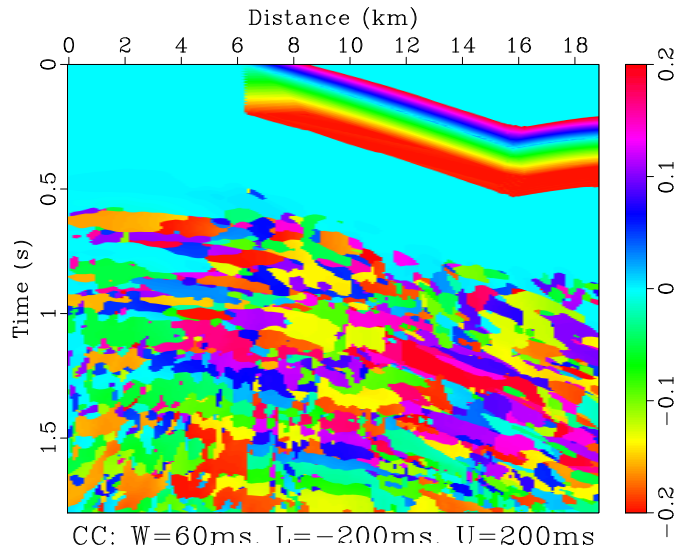
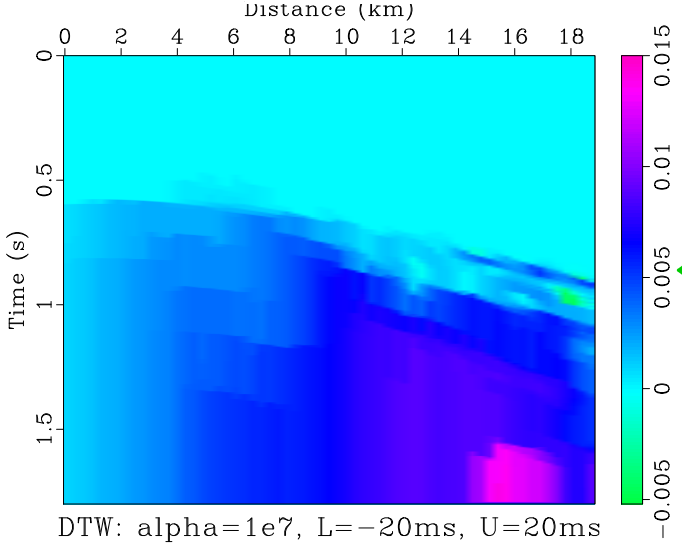


Agree

Disagree



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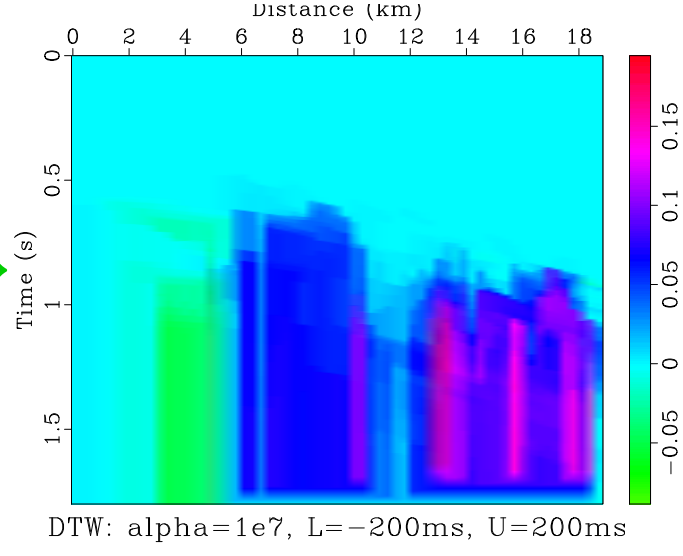
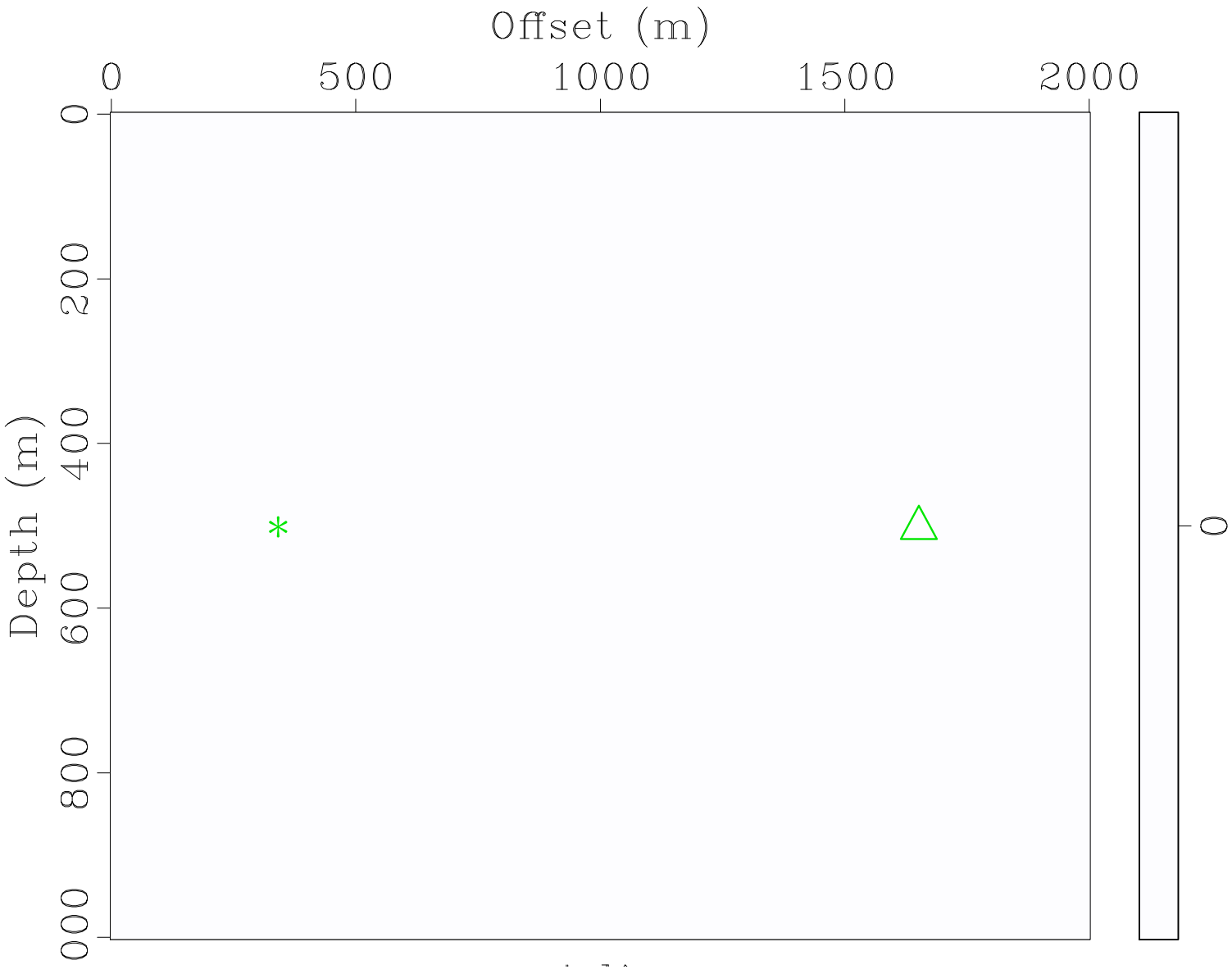


What is a wave path?



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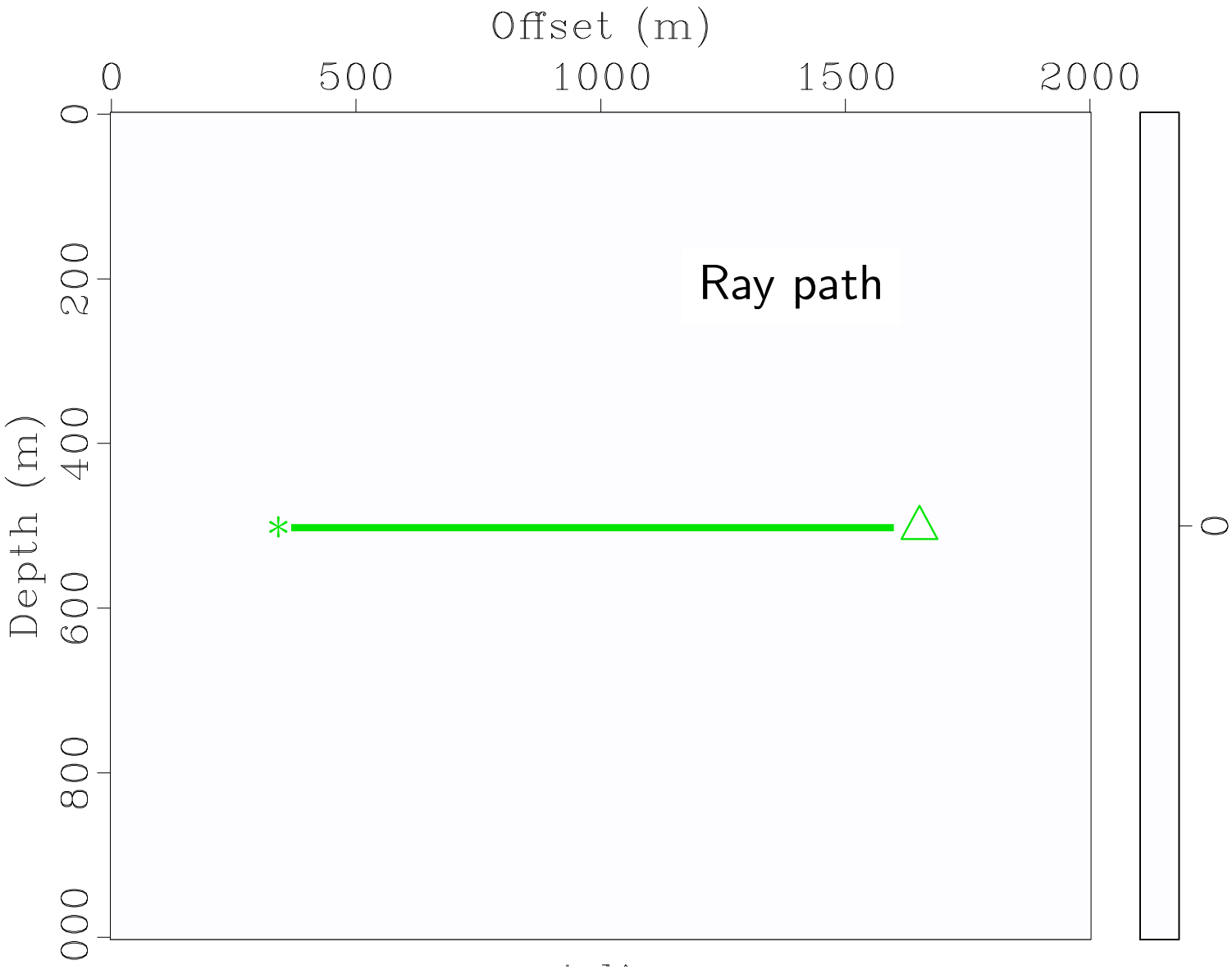

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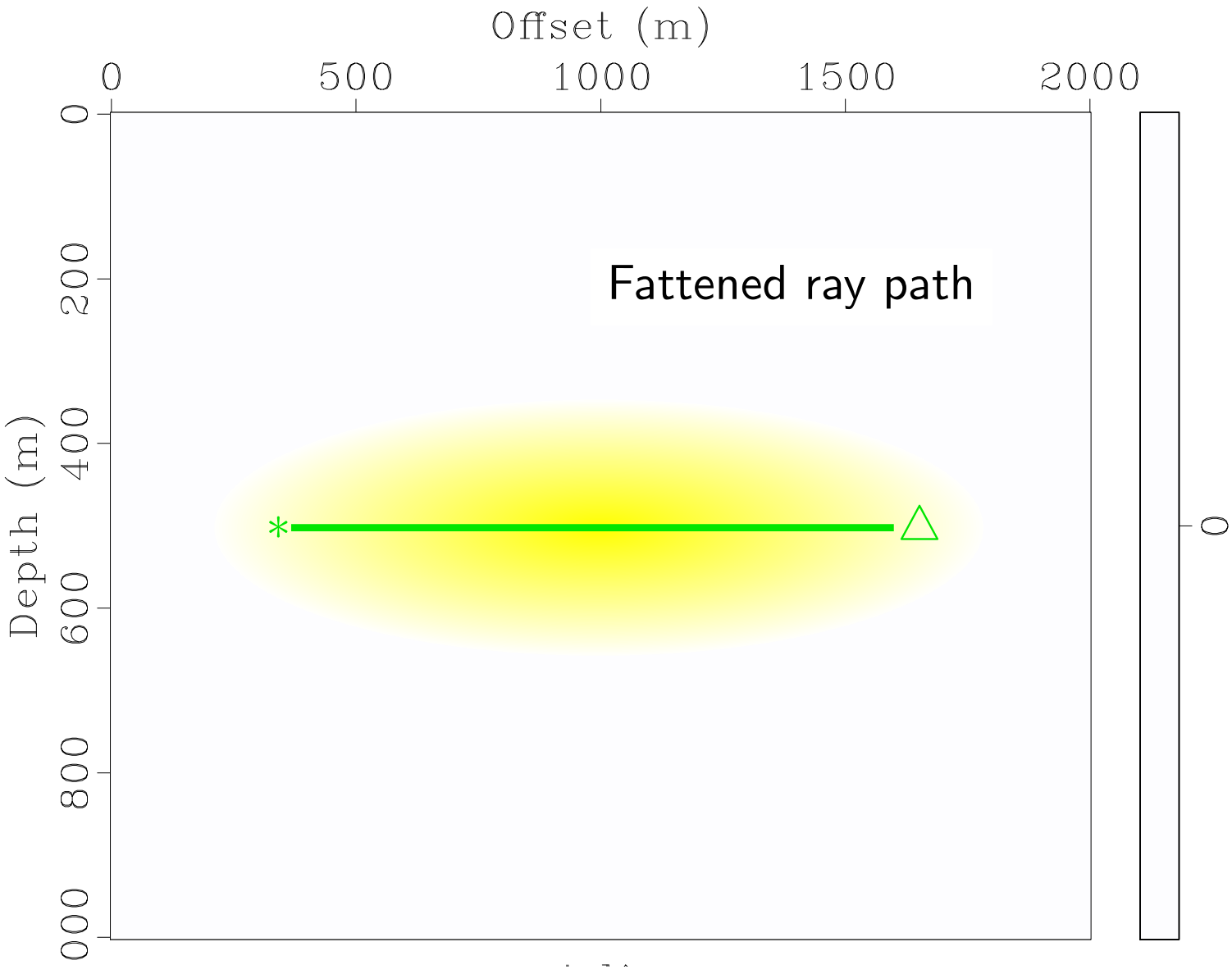

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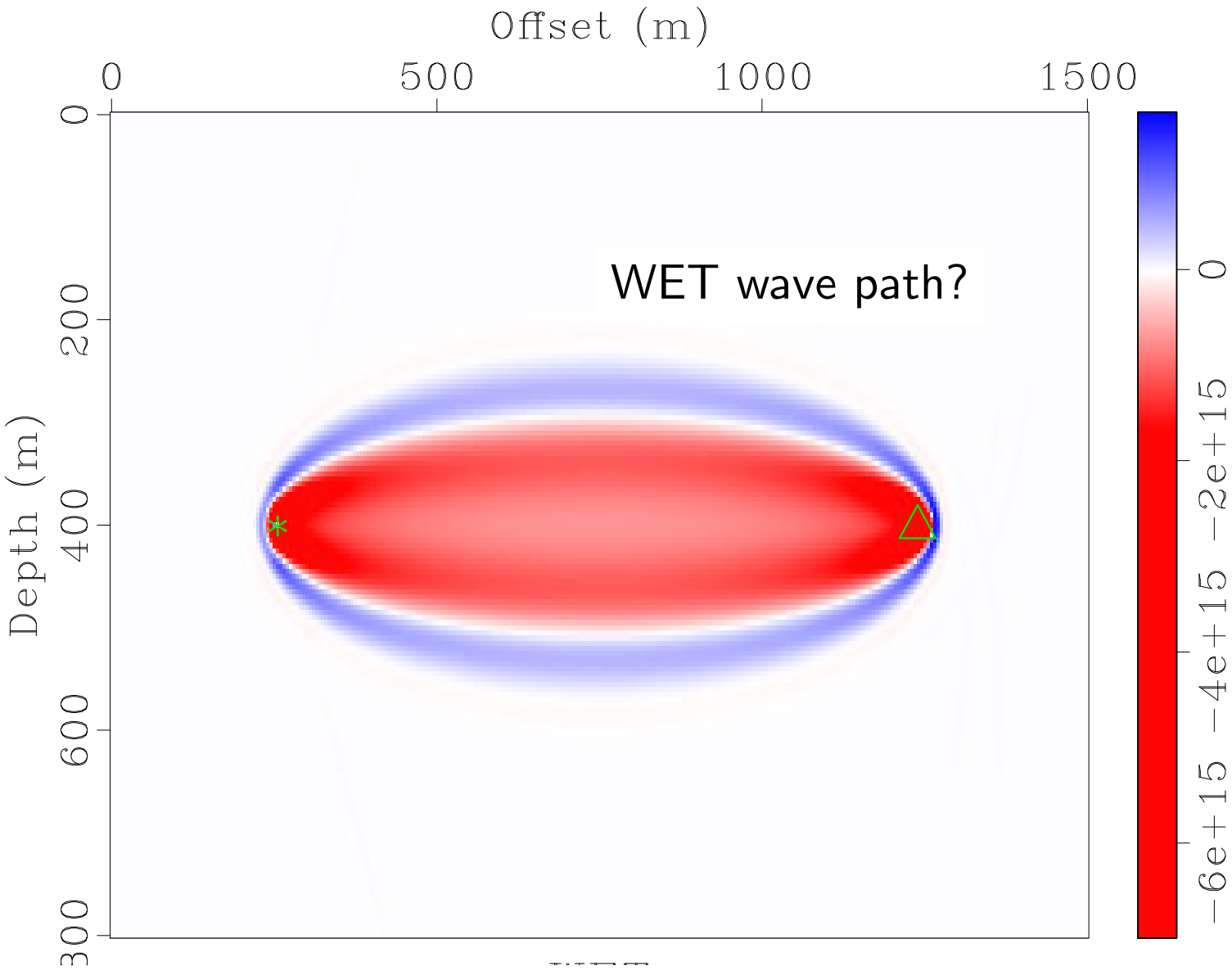

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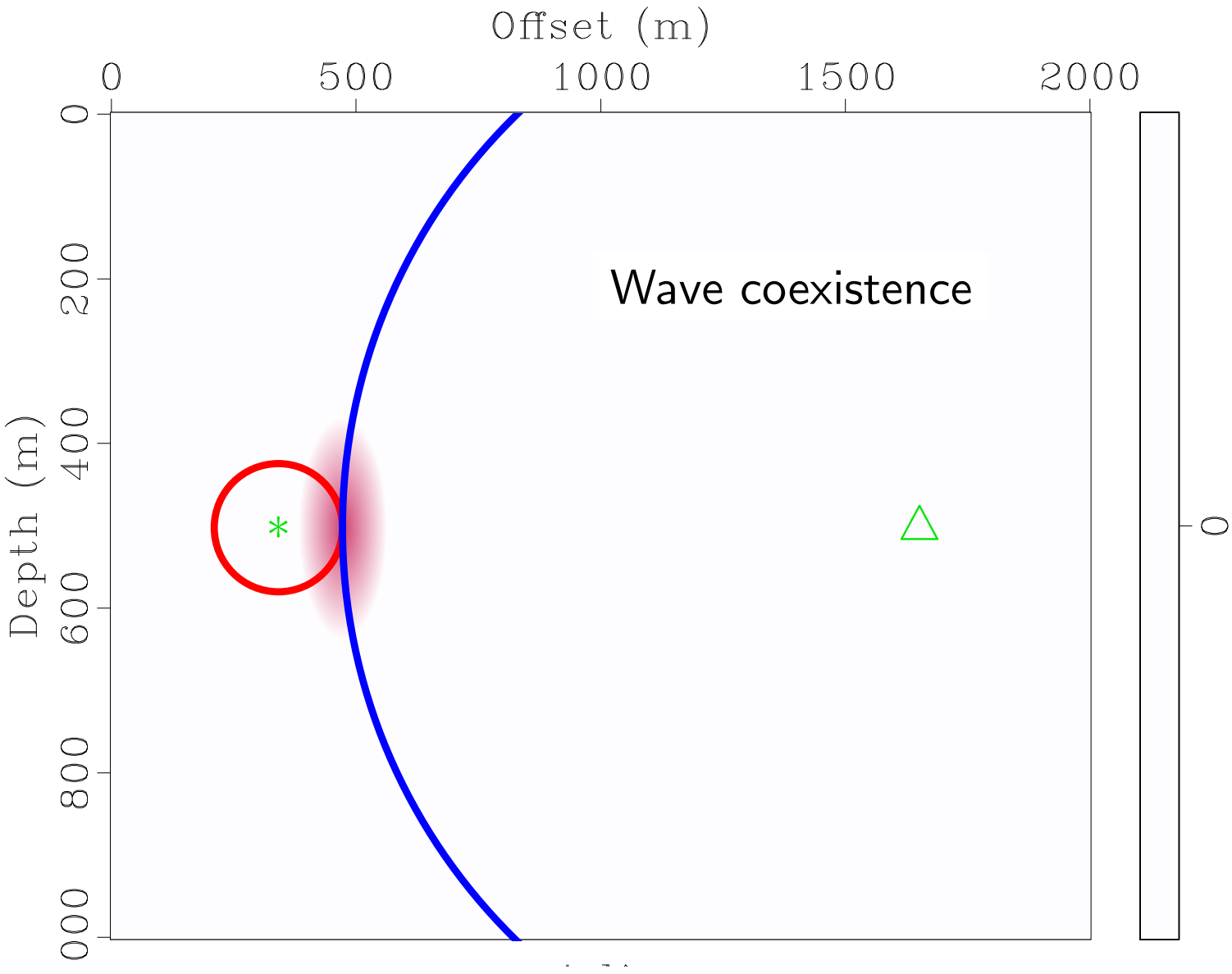

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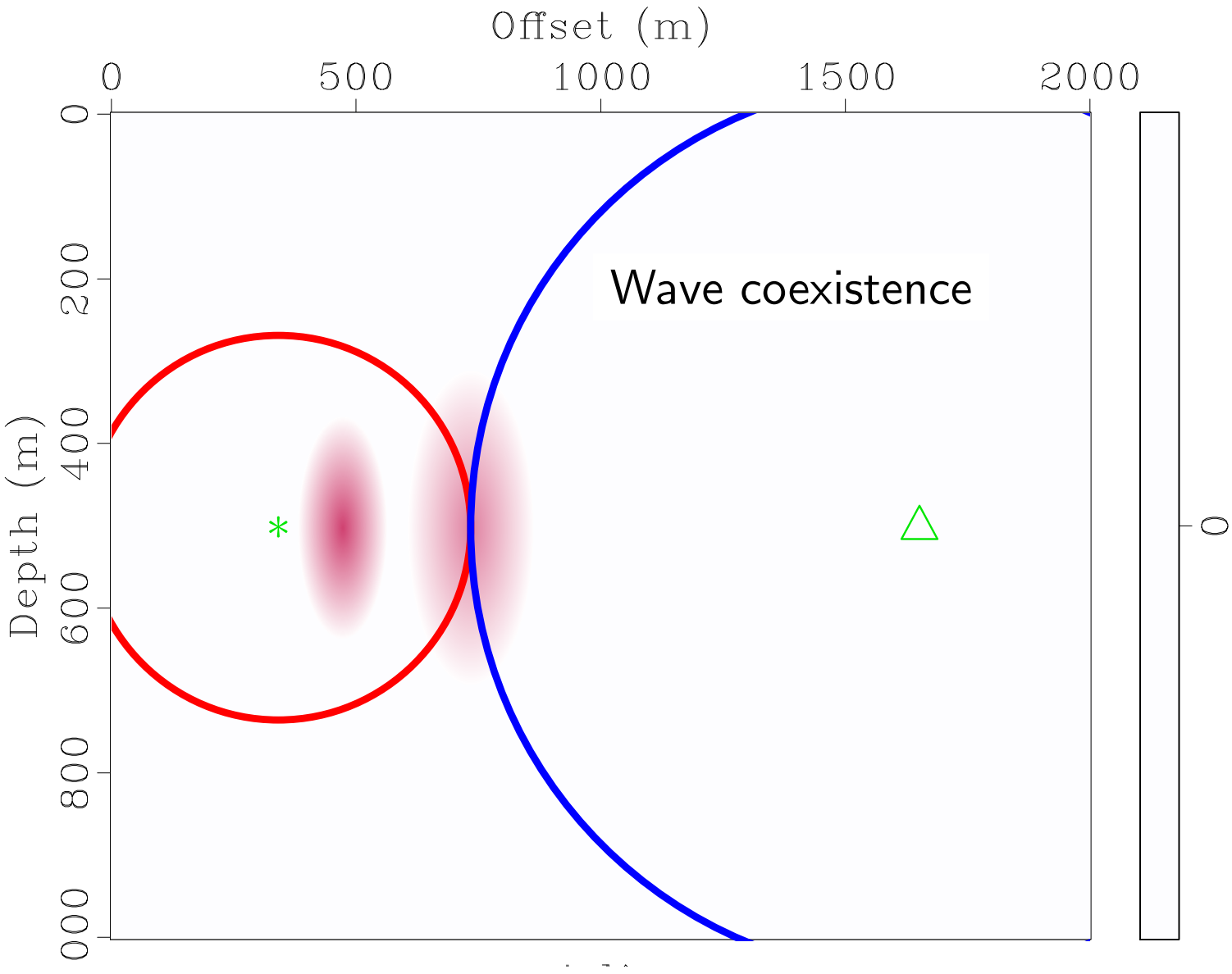

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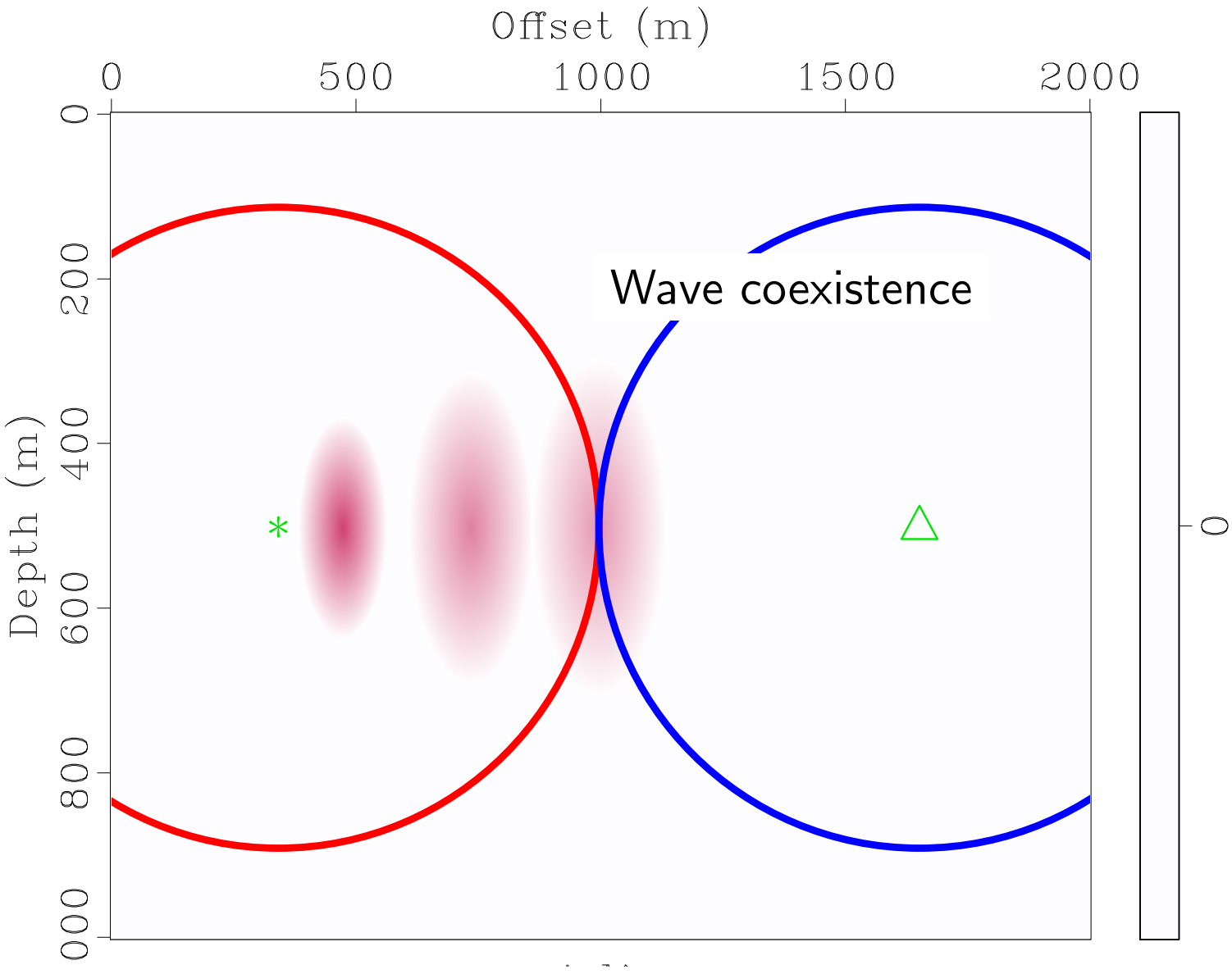

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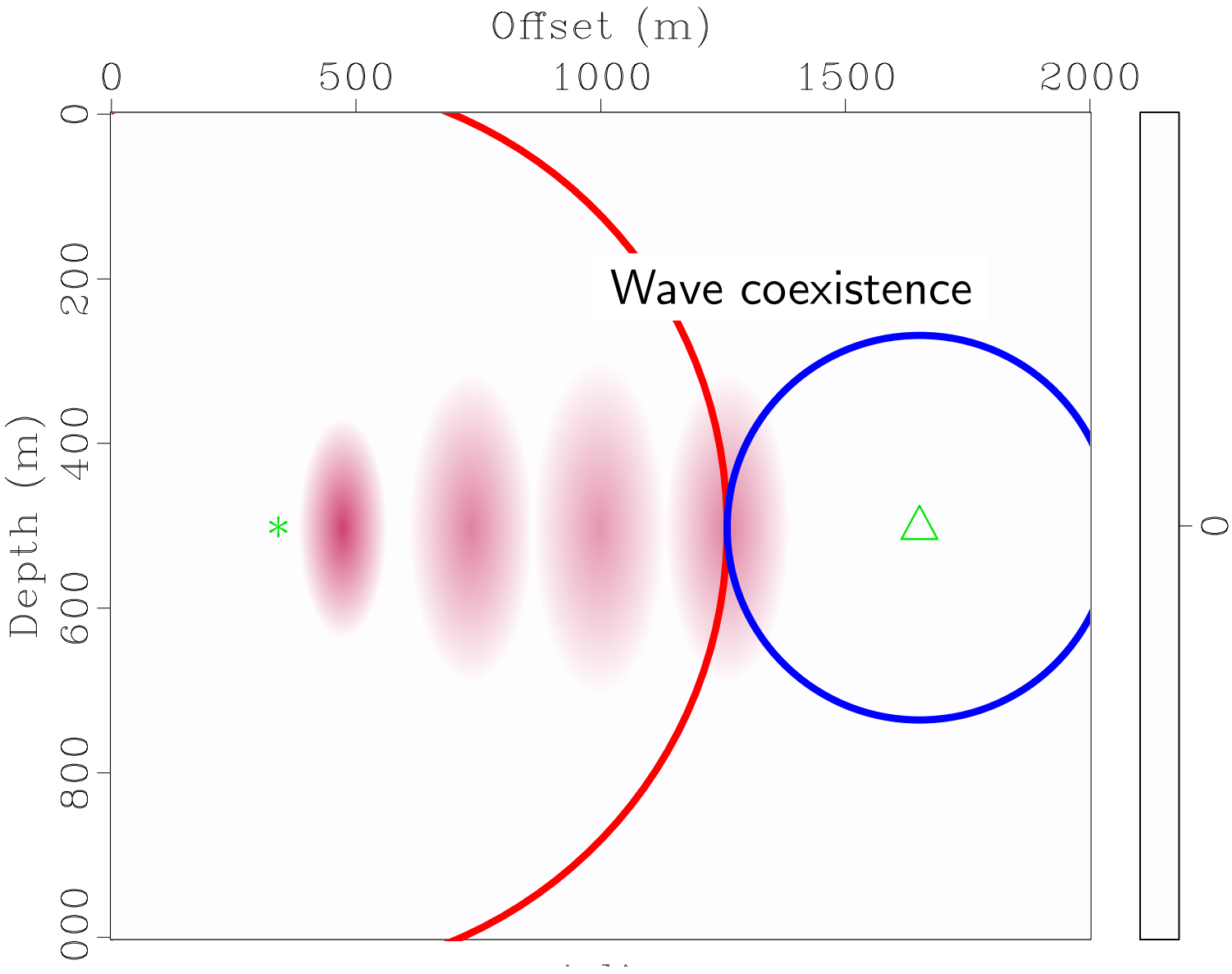

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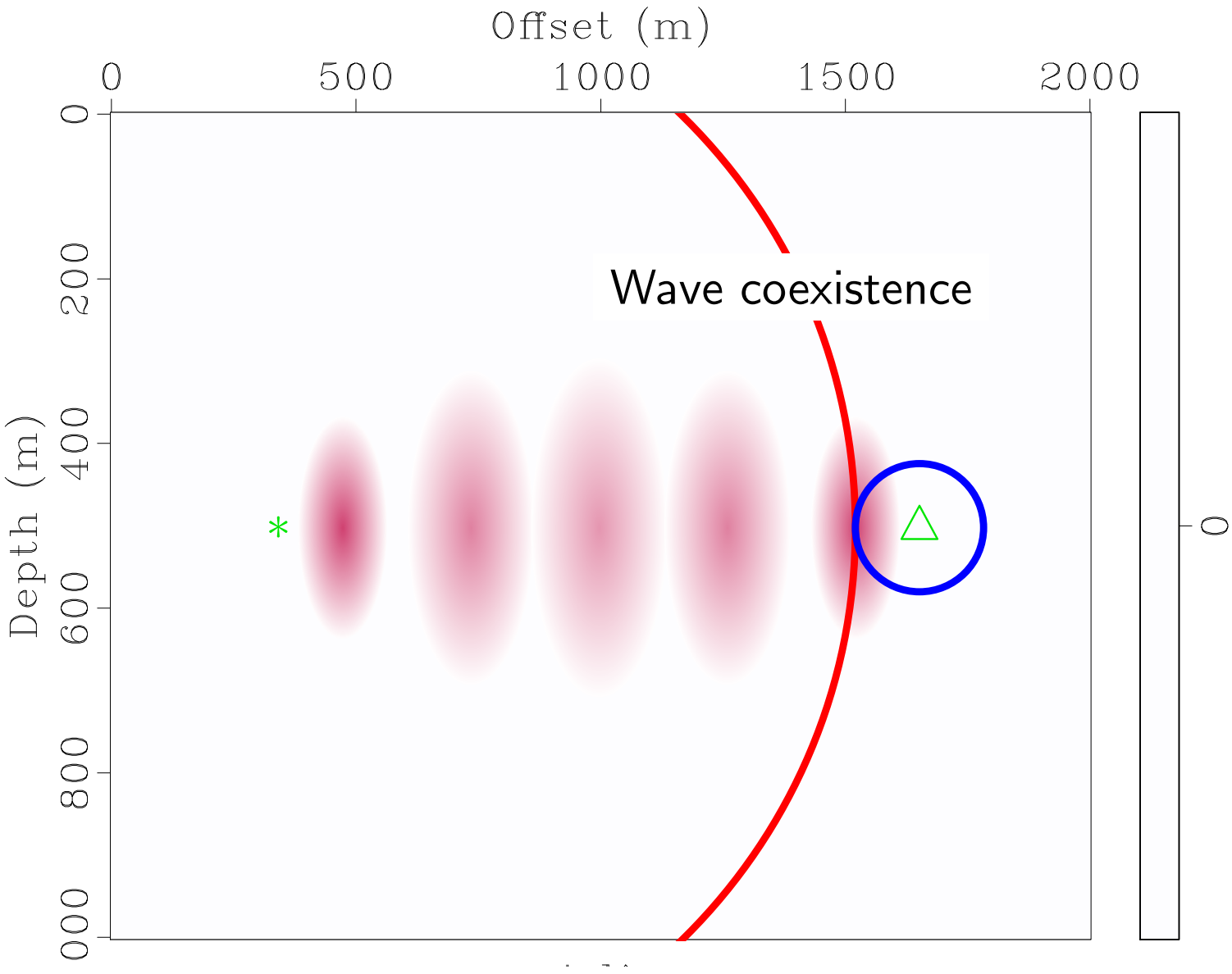

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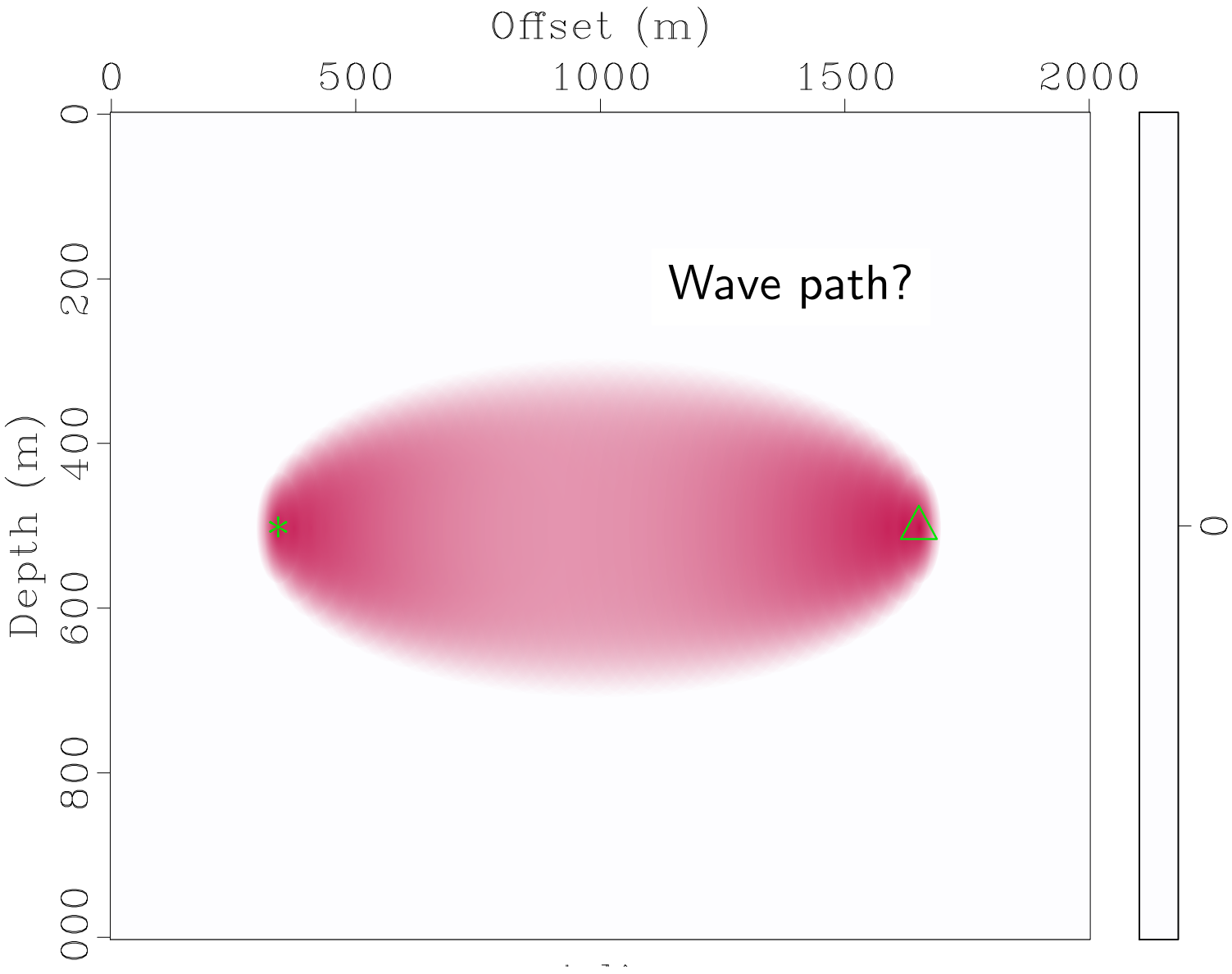

Wave paths are weights, lead to weighted solution

$$\underset{env}{|p|}(\mathbf{x}, t) \tag{1}$$

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$$\underset{env}{|p|}(\mathbf{x}, t)\underset{env}{|p'|}(\mathbf{x}, t) \tag{1}$$

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$$\int \underset{env}{|p|}(\mathbf{x}, t)\underset{env}{|p'|}(\mathbf{x}, t)dt \tag{1}$$

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$$\frac{K(T_+)(\mathbf{x})}{} \tag{4}$$

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$$\underline{K(T_+)(\mathbf{x}) - K(T_-)(\mathbf{x})} \tag{4}$$

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$$\frac{K(T_+)(\mathbf{x}) - K(T_-)(\mathbf{x})}{K(t')(\mathbf{x})} \tag{4}$$

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$$\frac{K(T_+)(\mathbf{x}) - K(T_-)(\mathbf{x})}{K(t')(\mathbf{x}) + \epsilon} \tag{4}$$

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$$p(\mathbf{x}, t) = \int g(\mathbf{x}, t, \mathbf{x}_s, t')w(\mathbf{x}_s, t')d(\mathbf{x}_s, t') \tag{2}$$

$$p'(\mathbf{x}, t) = \int g(\mathbf{x}, t', \mathbf{x}_r, t)p(\mathbf{x}_r, t')\frac{T(\mathbf{x}_r, t')}{t'}d(\mathbf{x}_r, t') \tag{3}$$

$$\frac{\Delta s(\mathbf{x})}{s(\mathbf{x})} = \frac{K(T_+)(\mathbf{x}) - K(T_-)(\mathbf{x})}{K(t')(\mathbf{x}) + \epsilon} \tag{4}$$

Wave paths are weights, lead to weighted solution

$$K(T)(\mathbf{x}) = \int \underset{env}{|p|}(\mathbf{x}, t)\underset{env}{|p'|}(\mathbf{x}, t)dt \tag{1}$$

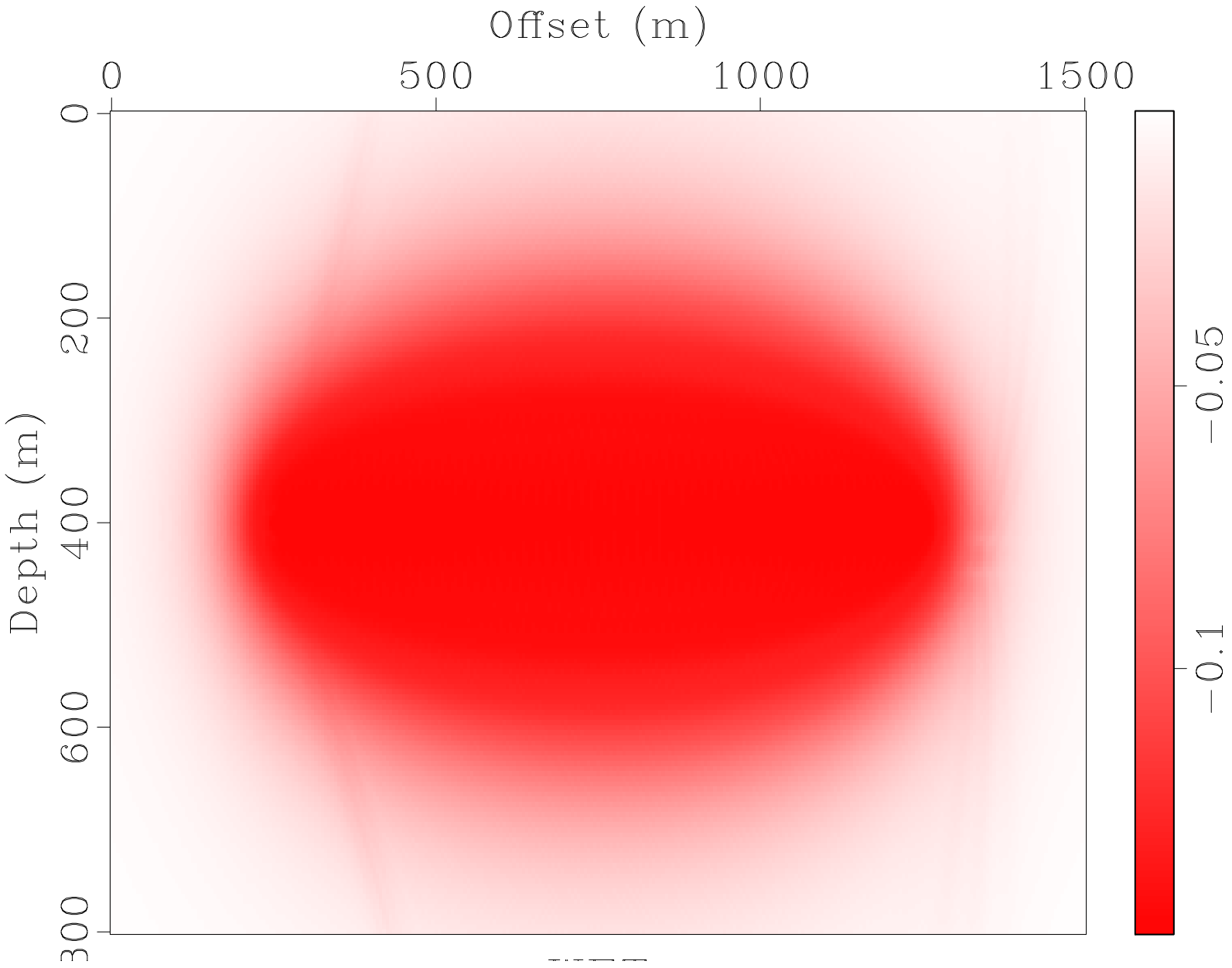
$$p(\mathbf{x}, t) = \int g(\mathbf{x}, t, \mathbf{x}_s, t')w(\mathbf{x}_s, t')d(\mathbf{x}_s, t') \tag{2}$$

$$p'(\mathbf{x}, t) = \int g(\mathbf{x}, t', \mathbf{x}_r, t)p(\mathbf{x}_r, t')\frac{T(\mathbf{x}_r, t')}{t'}d(\mathbf{x}_r, t') \tag{3}$$

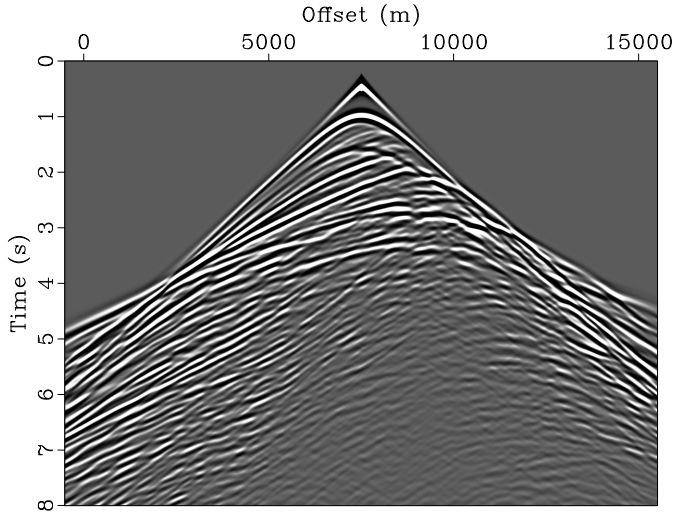
$$\frac{\Delta s(\mathbf{x})}{s(\mathbf{x})} = \frac{K(T_+)(\mathbf{x}) - K(T_-)(\mathbf{x})}{K(t')(\mathbf{x}) + \epsilon} \tag{4}$$

The model update is an average of the solution for each individual event, weighted by their wave paths!

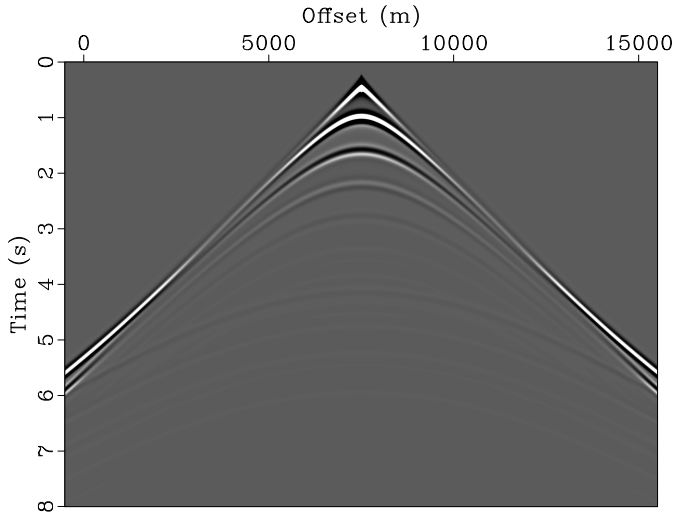
TWEET model update

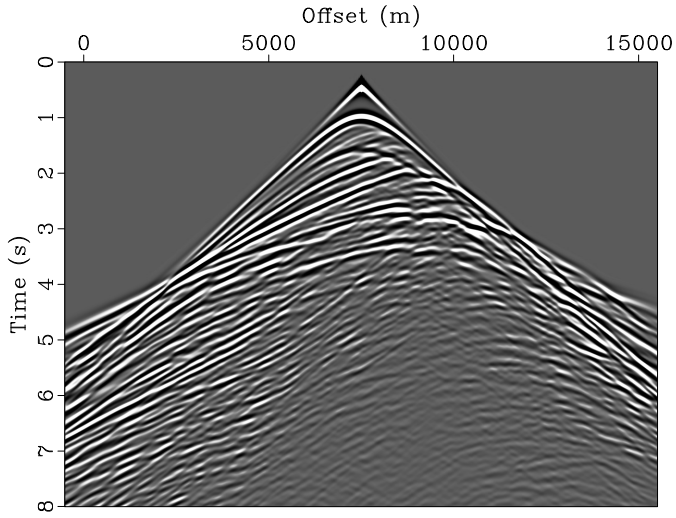


From data to update, example

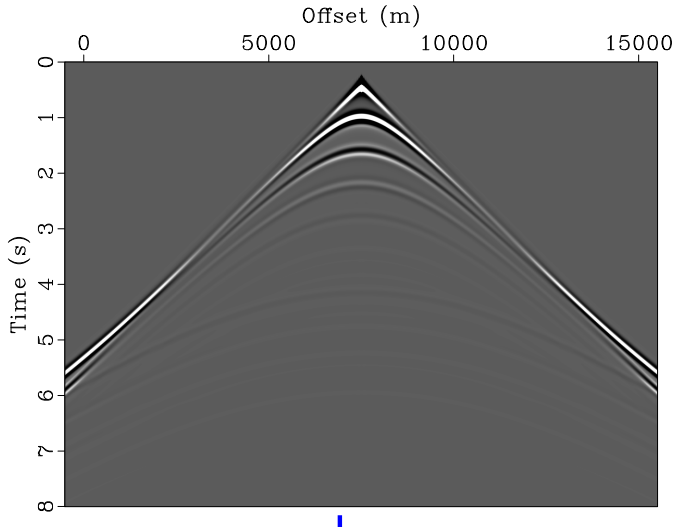


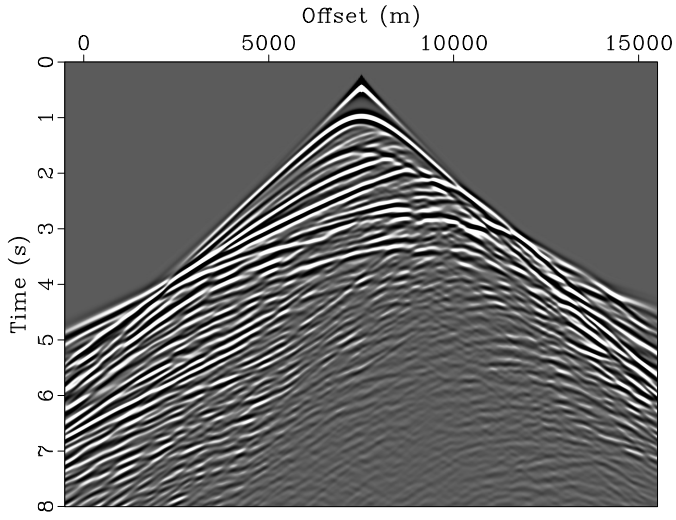
From data to update, example



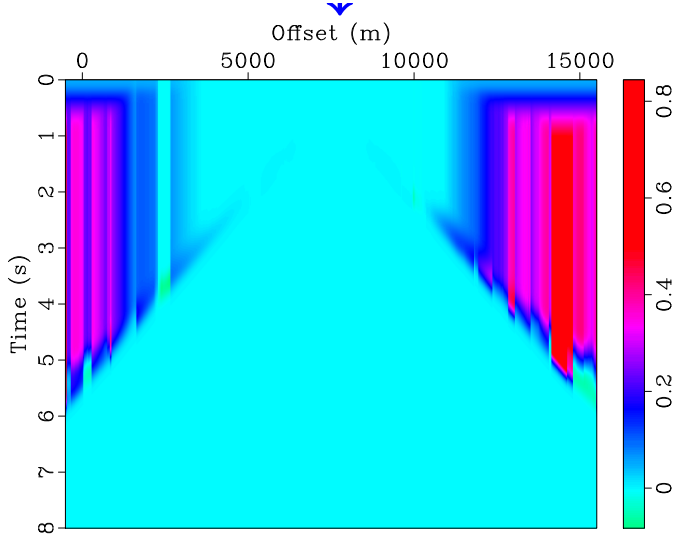


From data to update, example

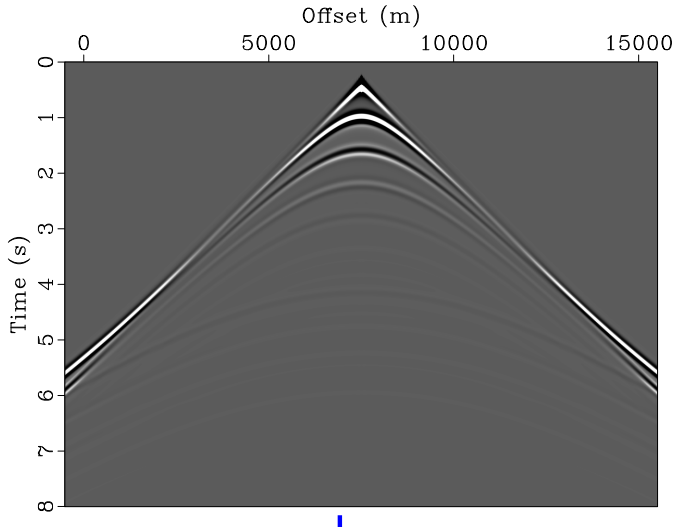


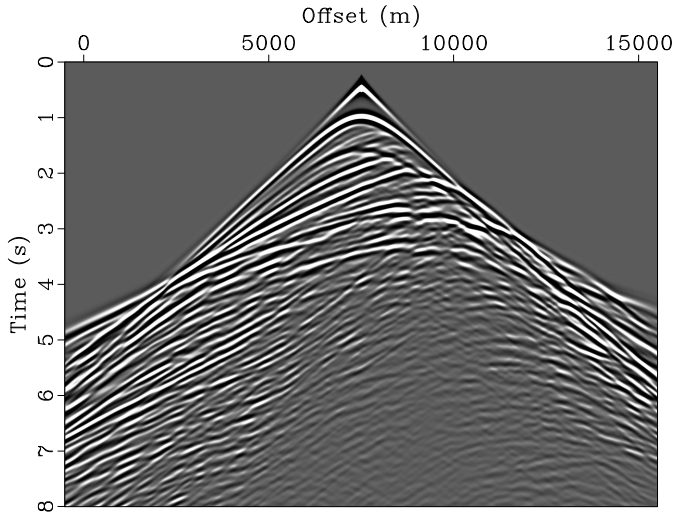


DTW

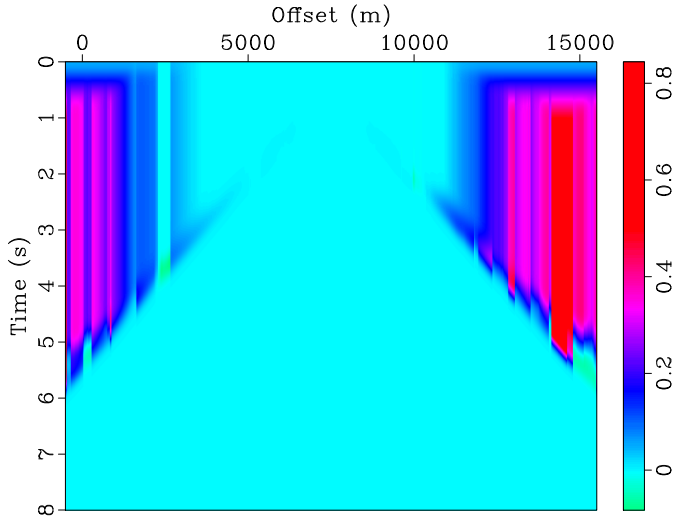


From data to update, example

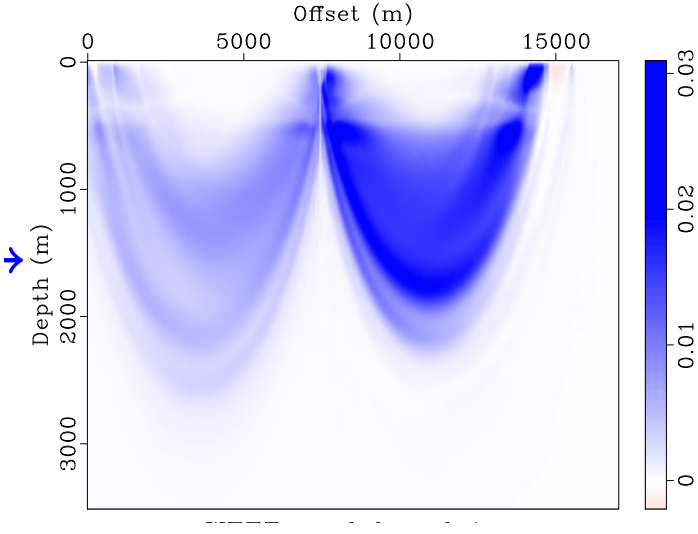




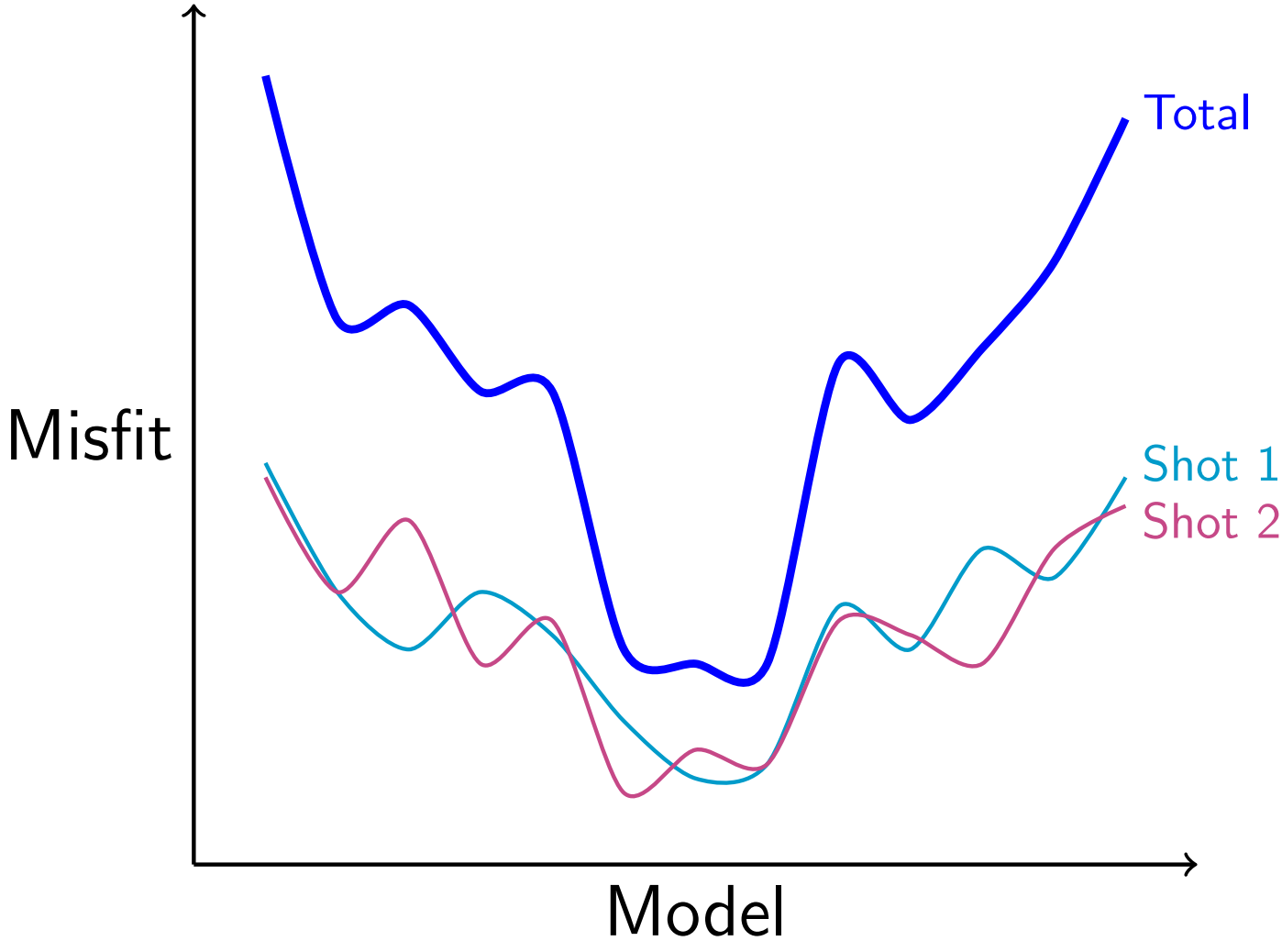
DTW



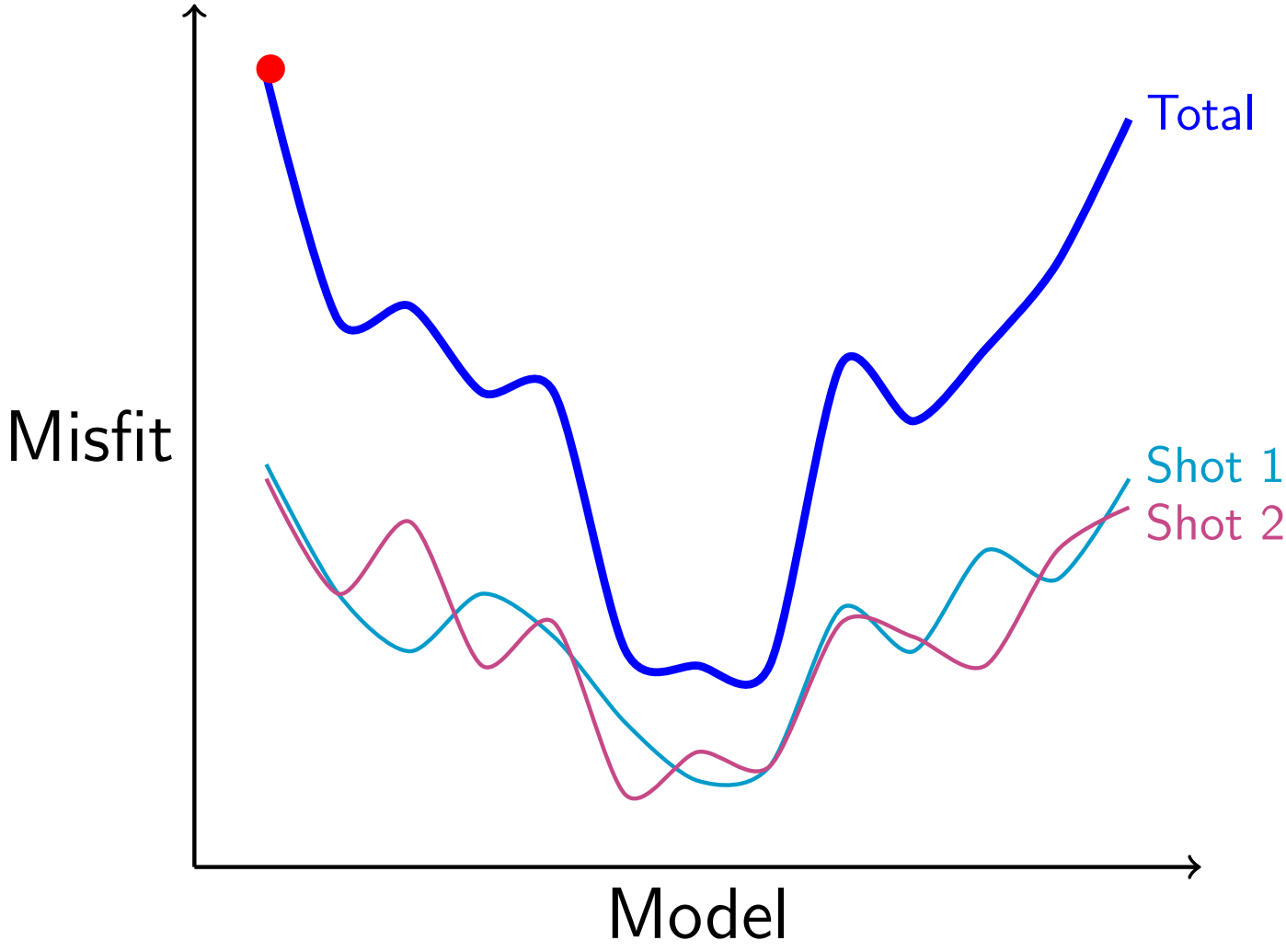
– Update →



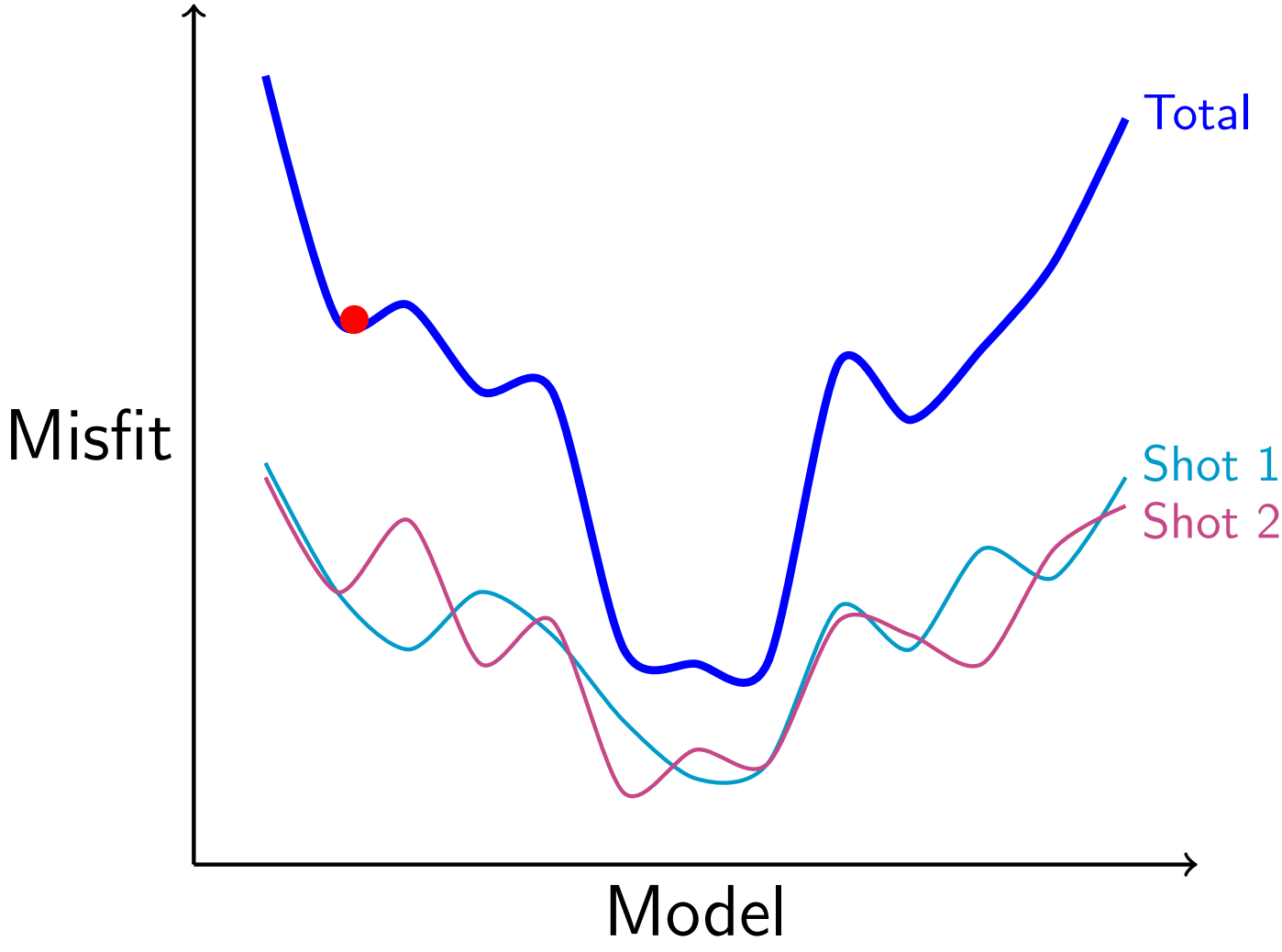
Single shot updates allow meta-heuristic search



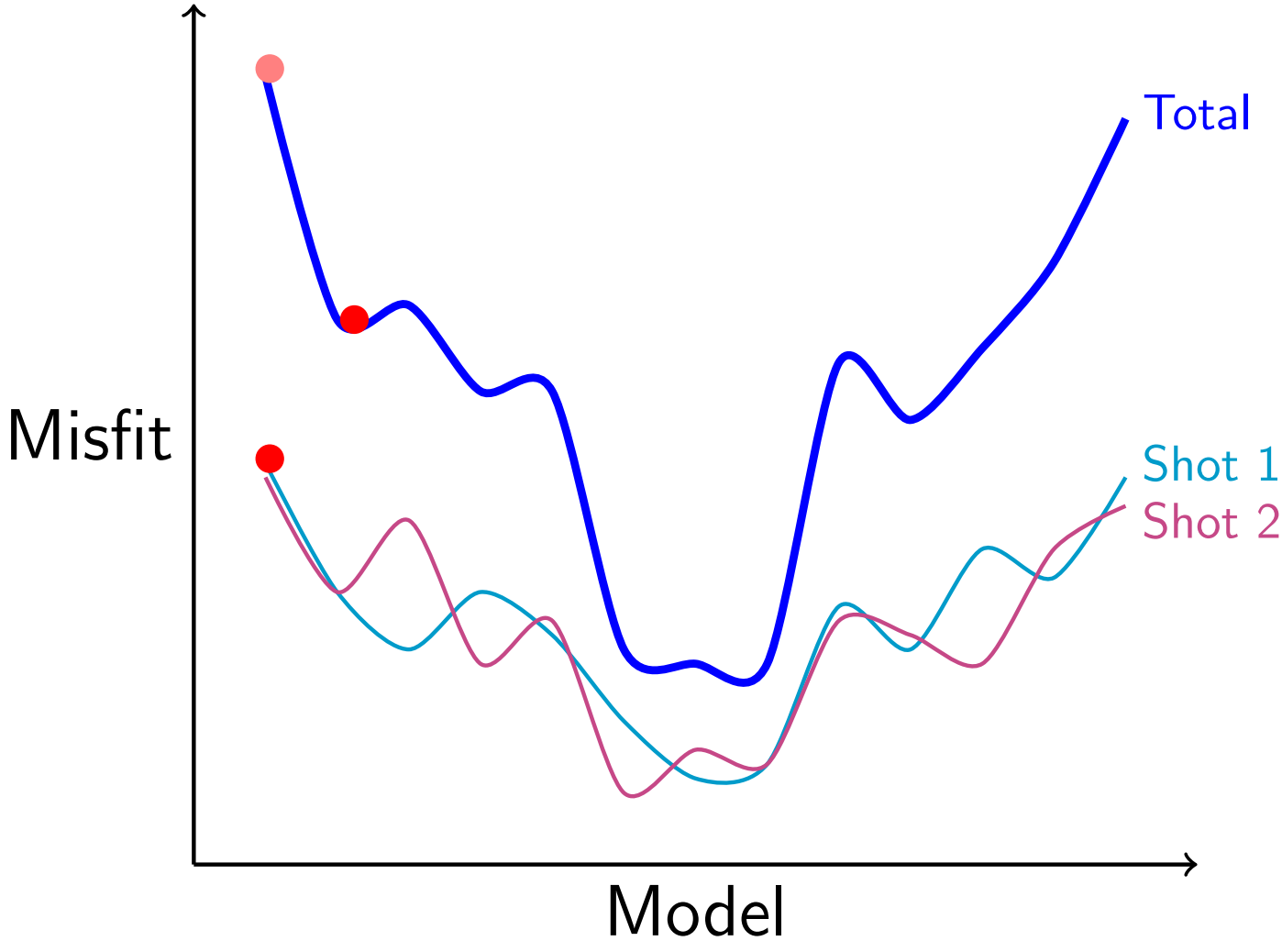
Single shot updates allow meta-heuristic search



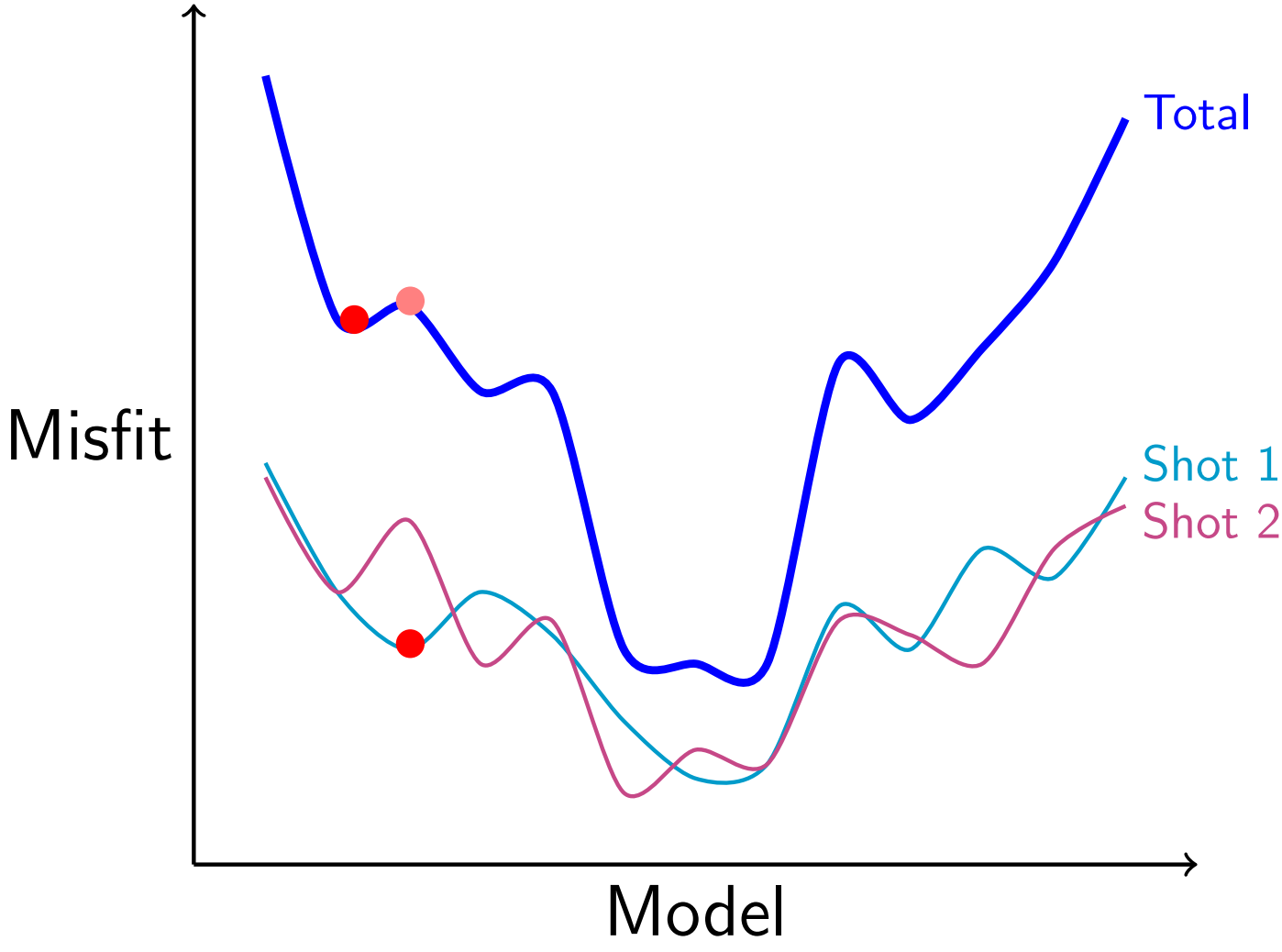
Single shot updates allow meta-heuristic search



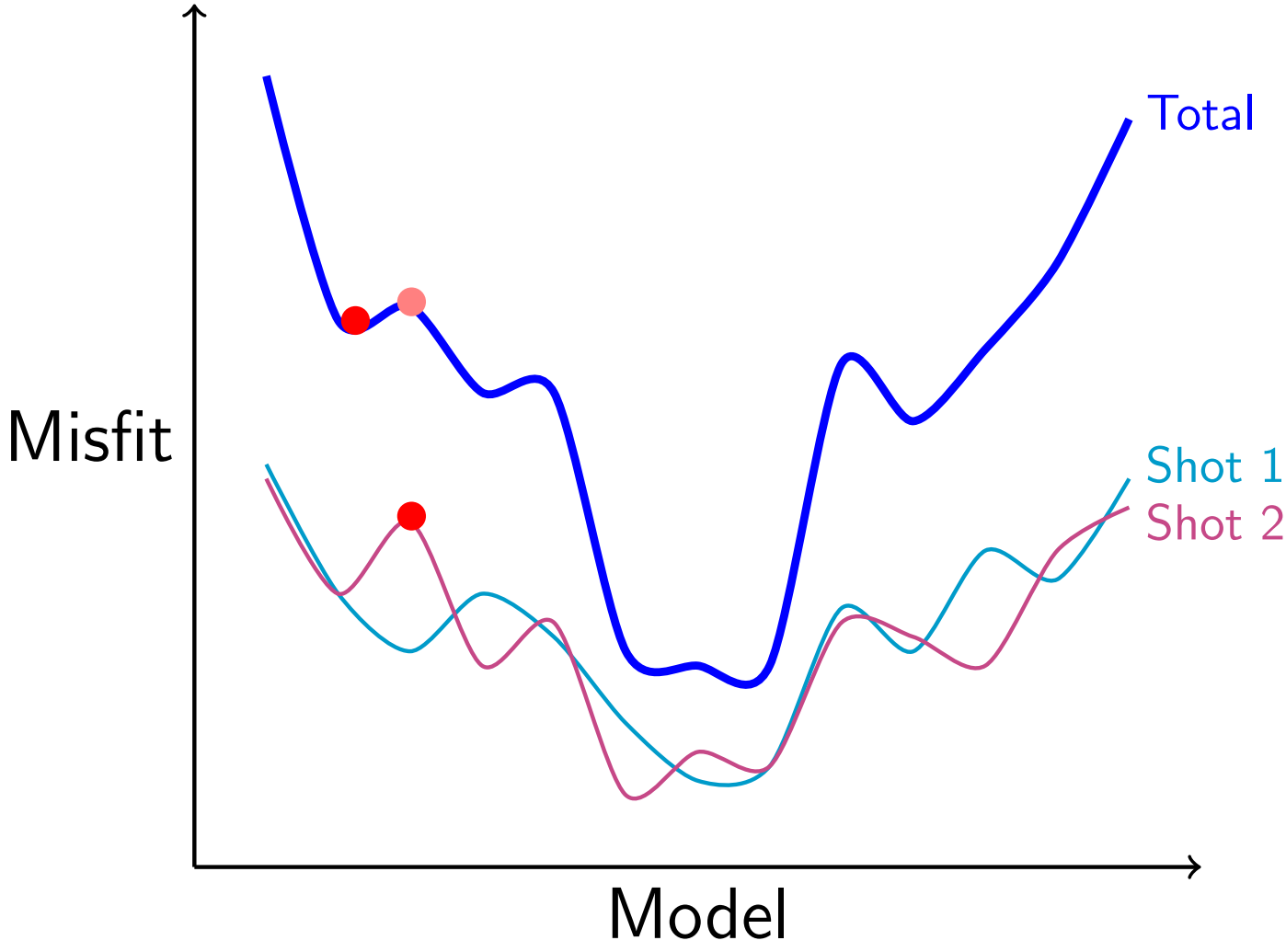
Single shot updates allow meta-heuristic search



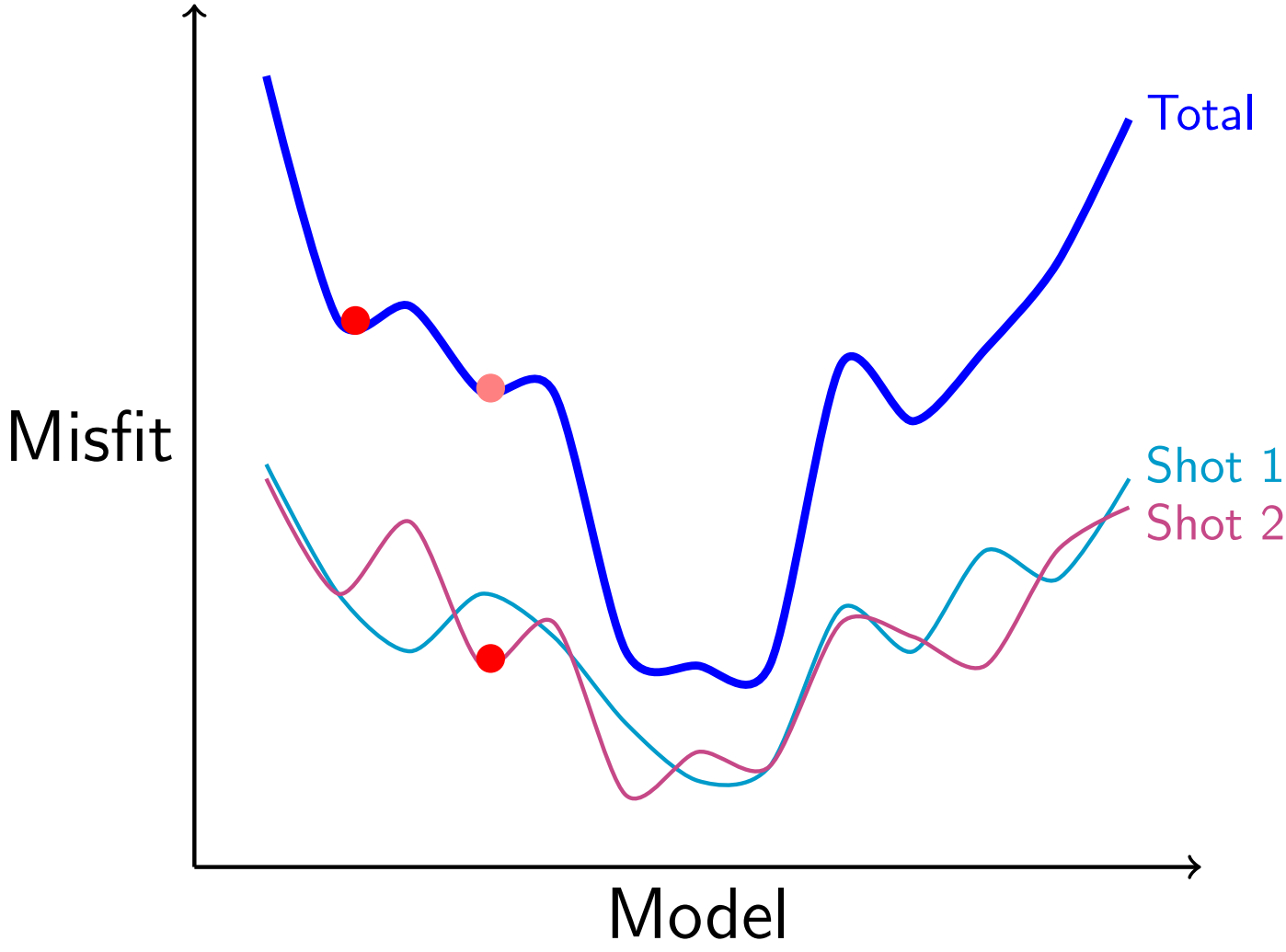
Single shot updates allow meta-heuristic search



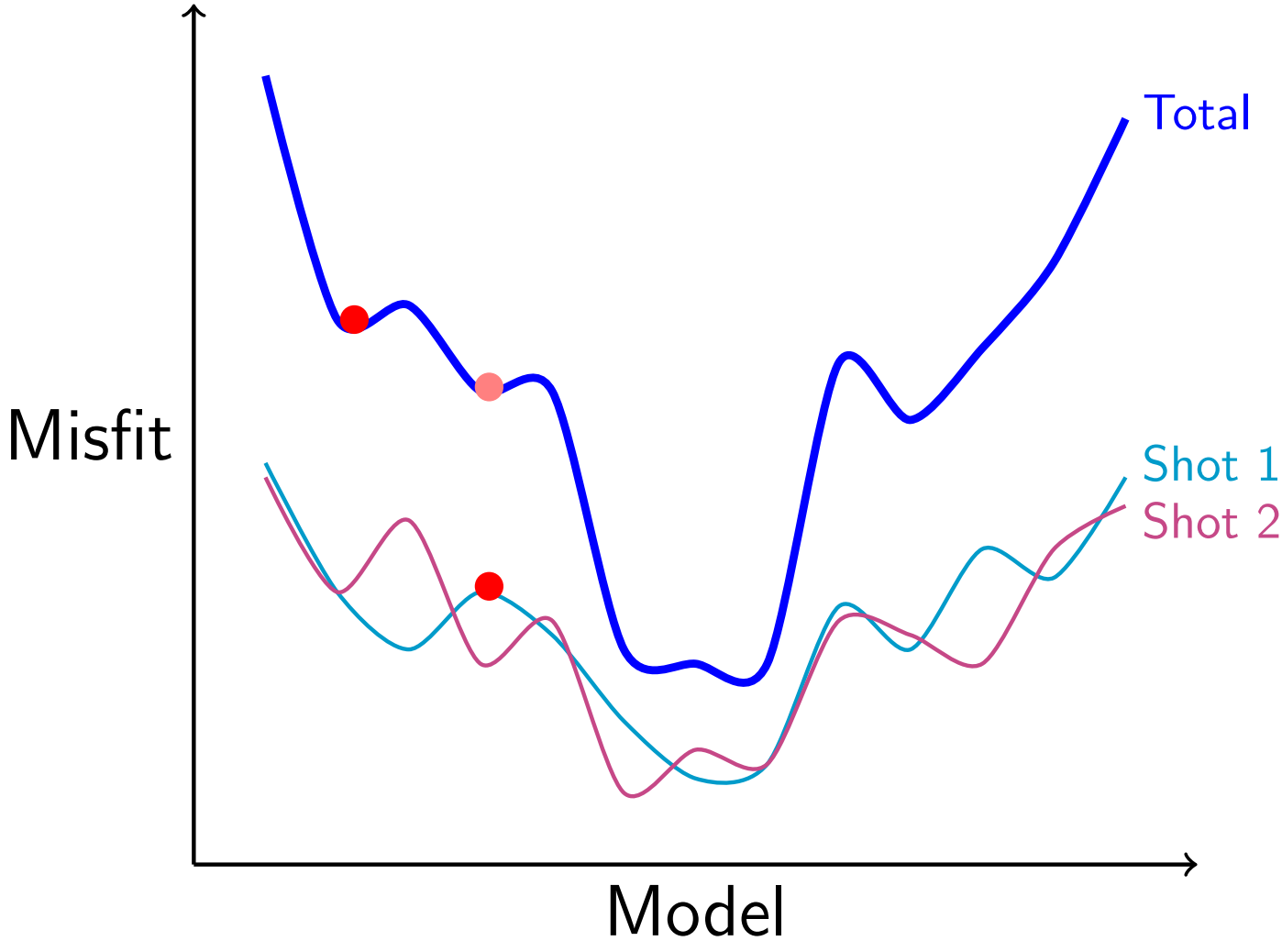
Single shot updates allow meta-heuristic search



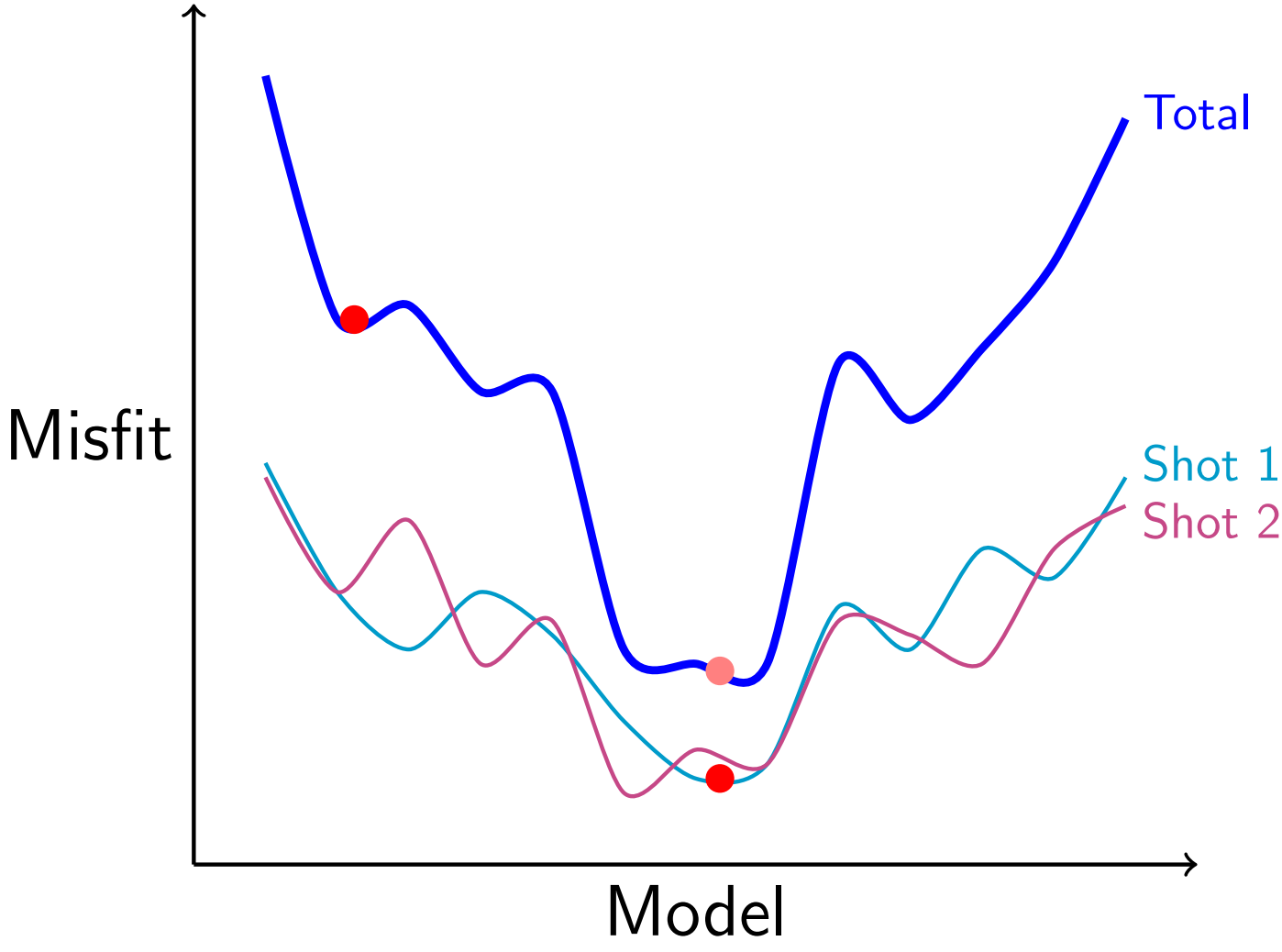
Single shot updates allow meta-heuristic search



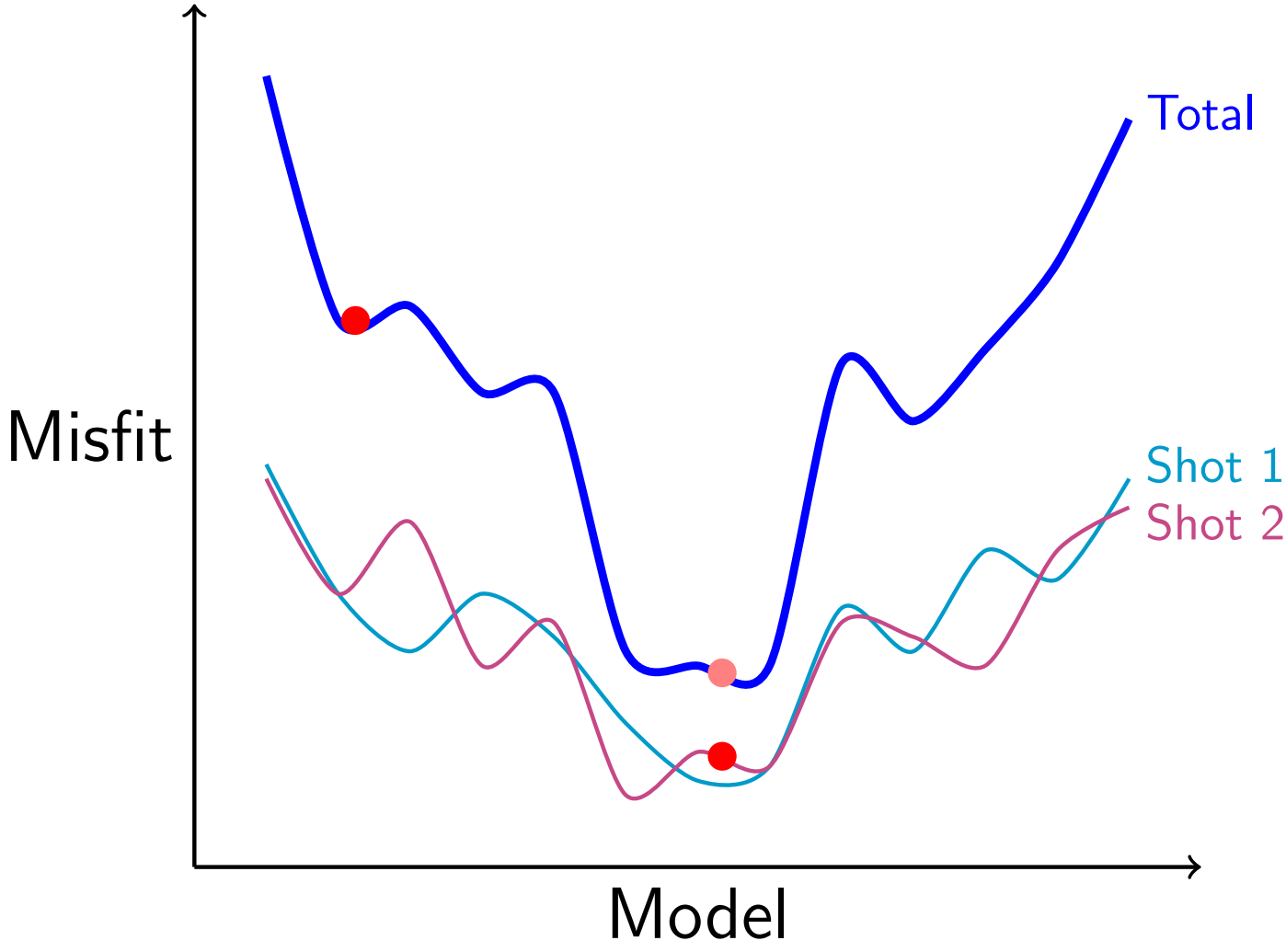
Single shot updates allow meta-heuristic search



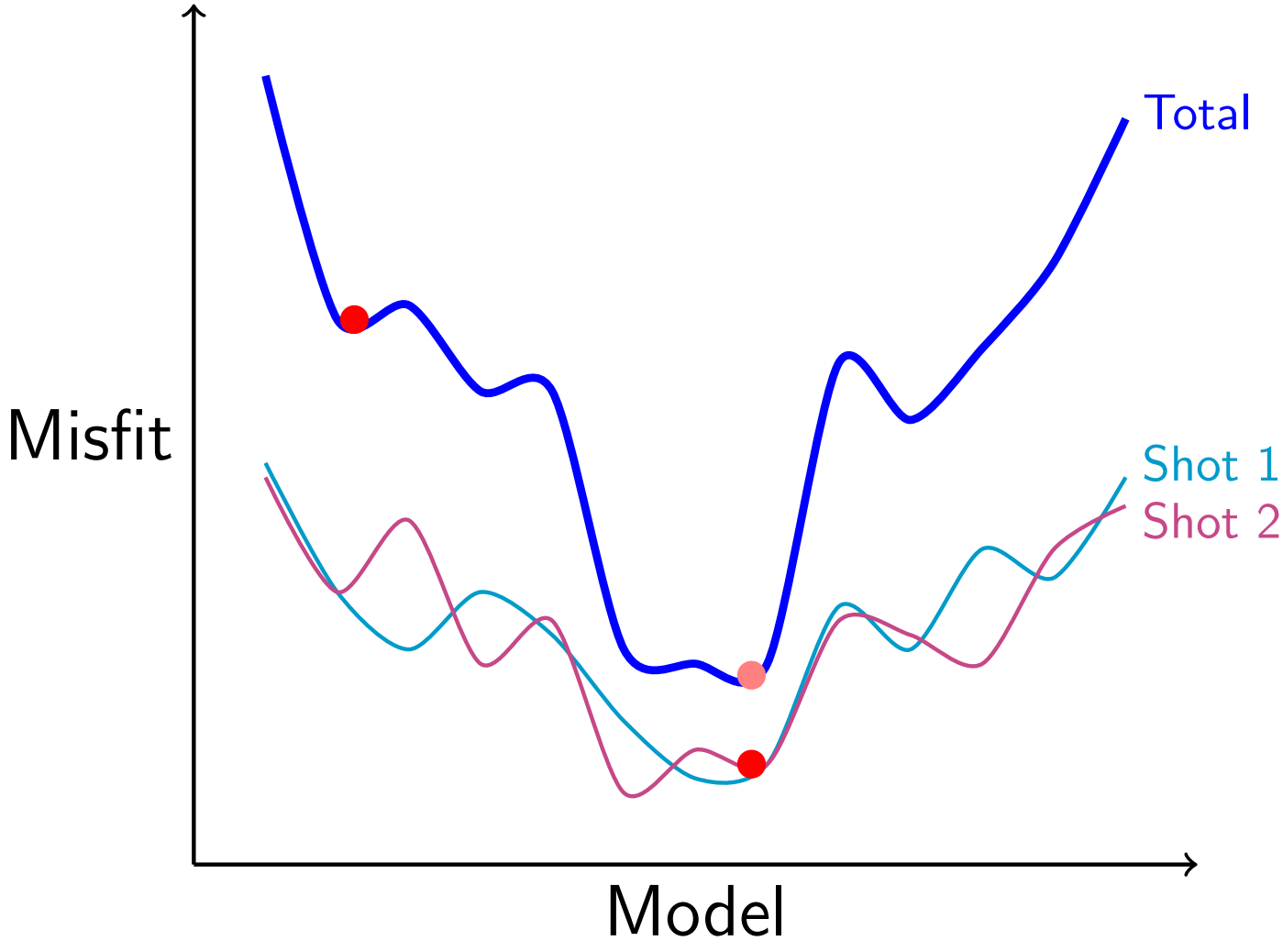
Single shot updates allow meta-heuristic search



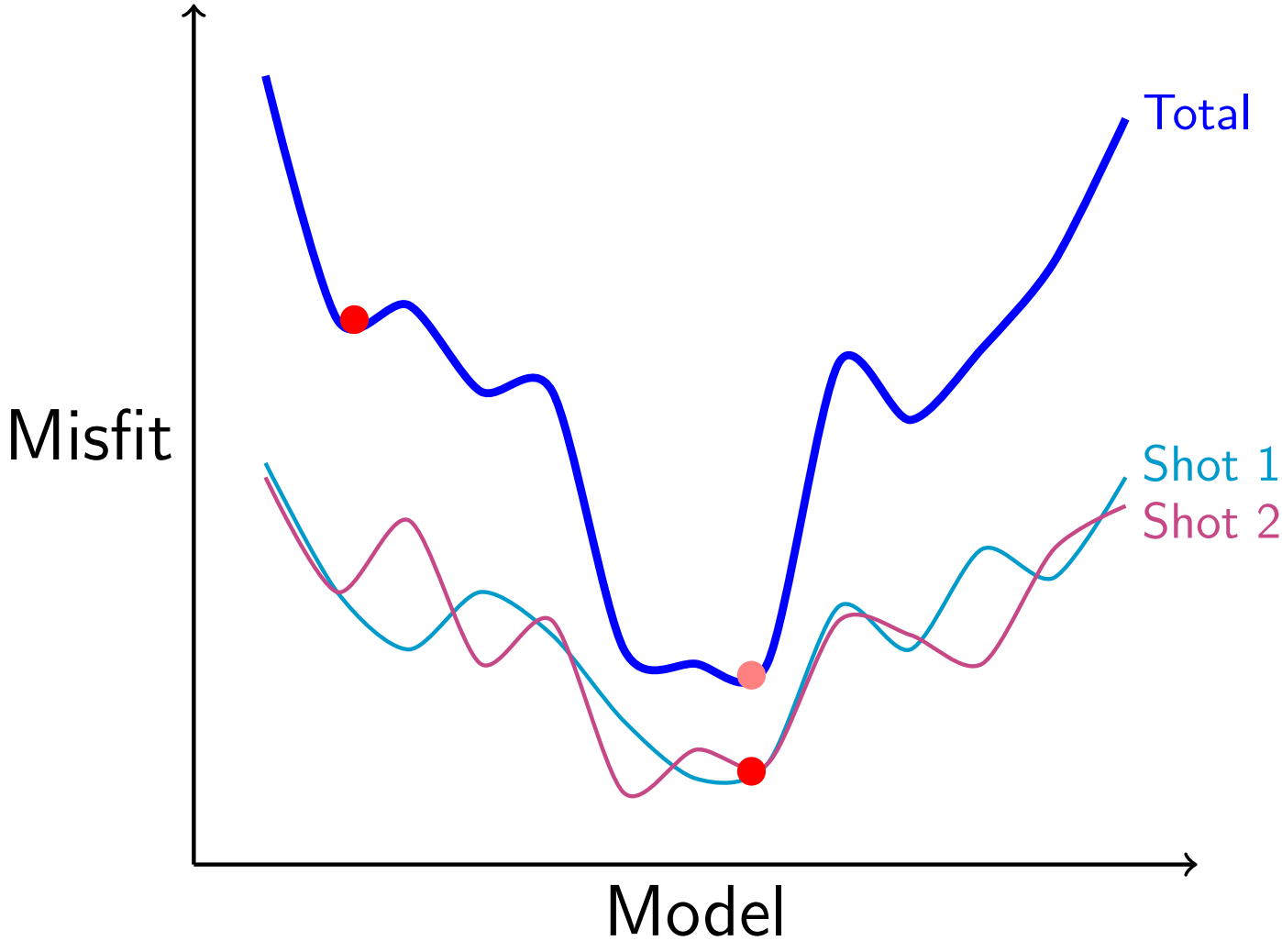
Single shot updates allow meta-heuristic search



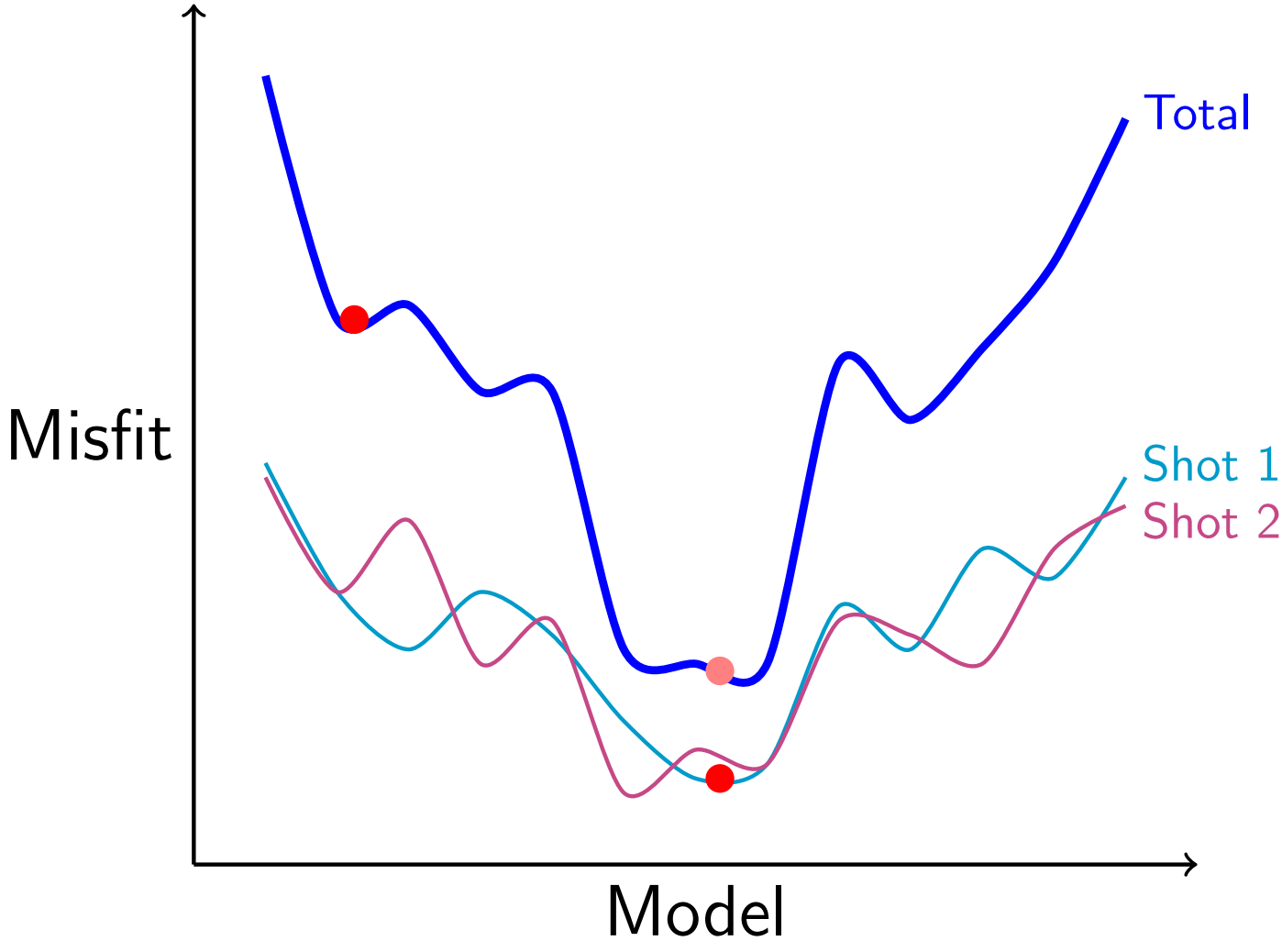
Single shot updates allow meta-heuristic search



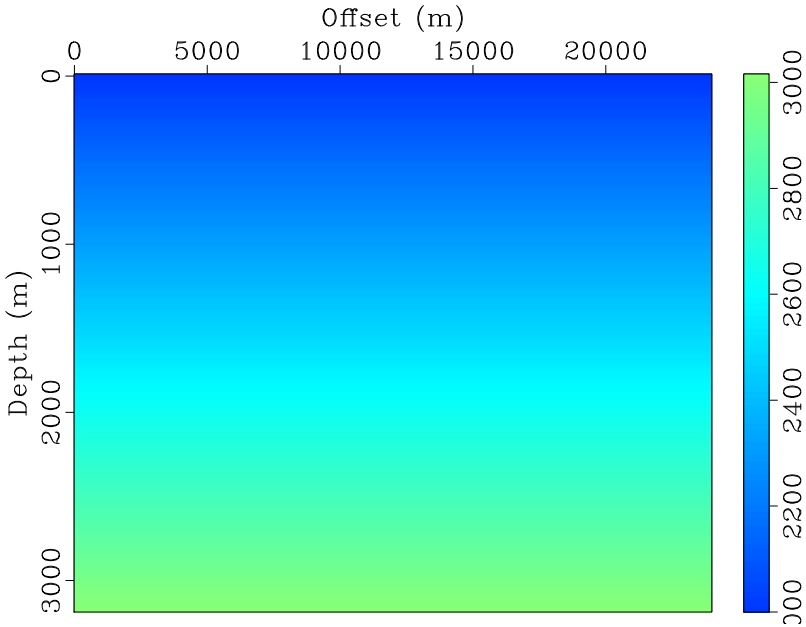
Single shot updates allow meta-heuristic search



Single shot updates allow meta-heuristic search



Does it work?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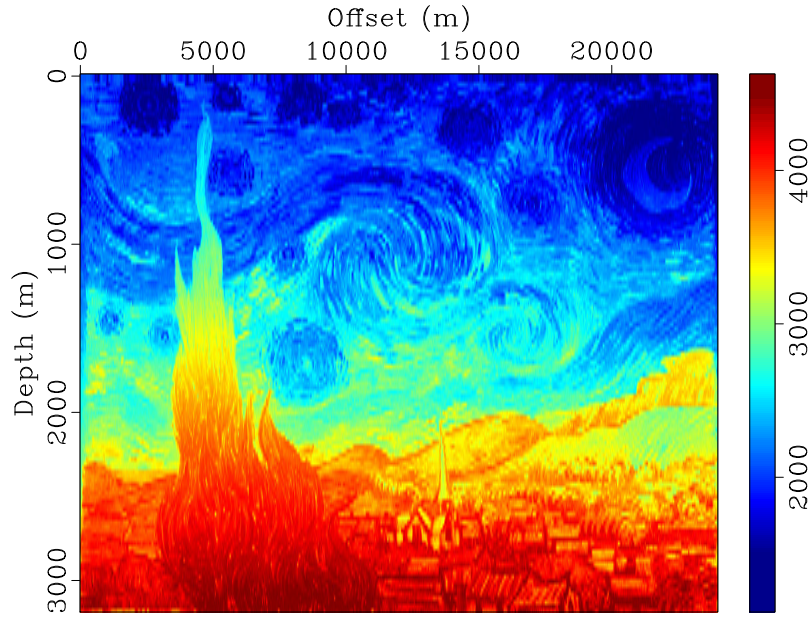
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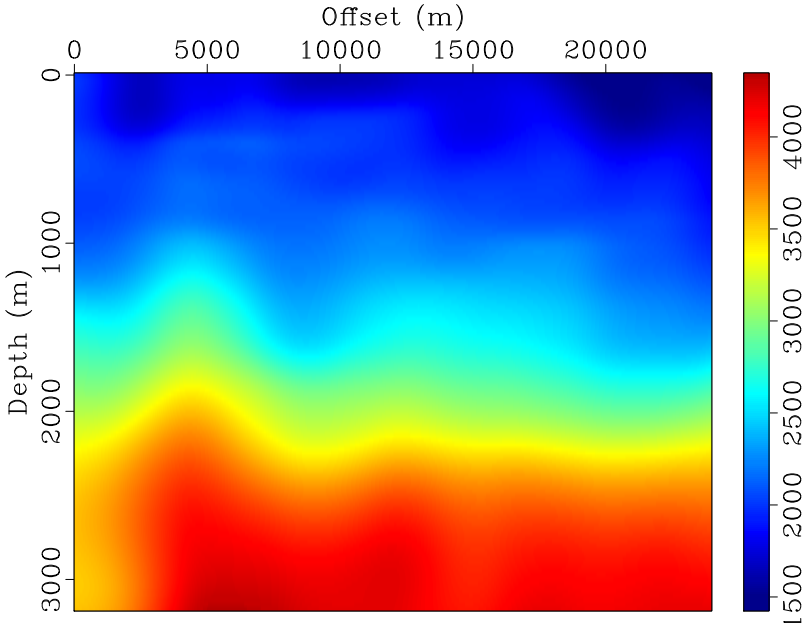
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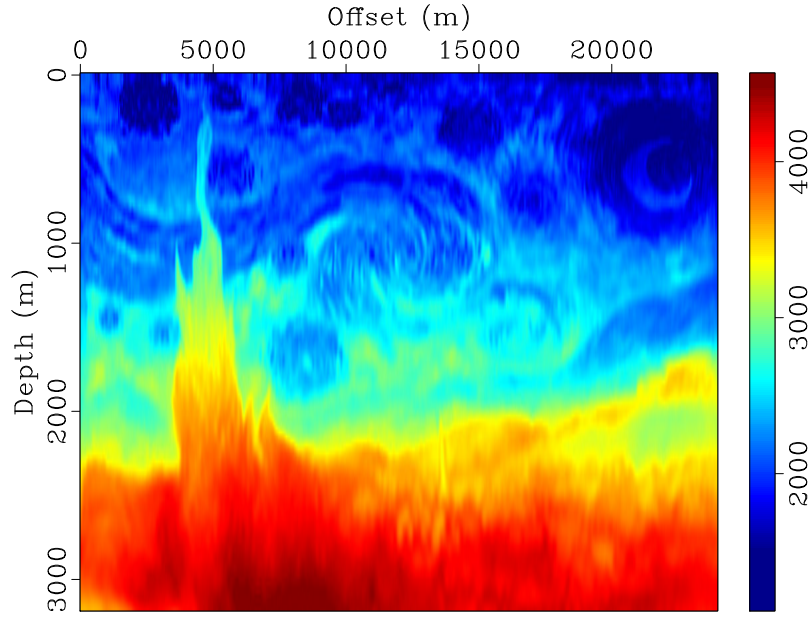
Offset (m)
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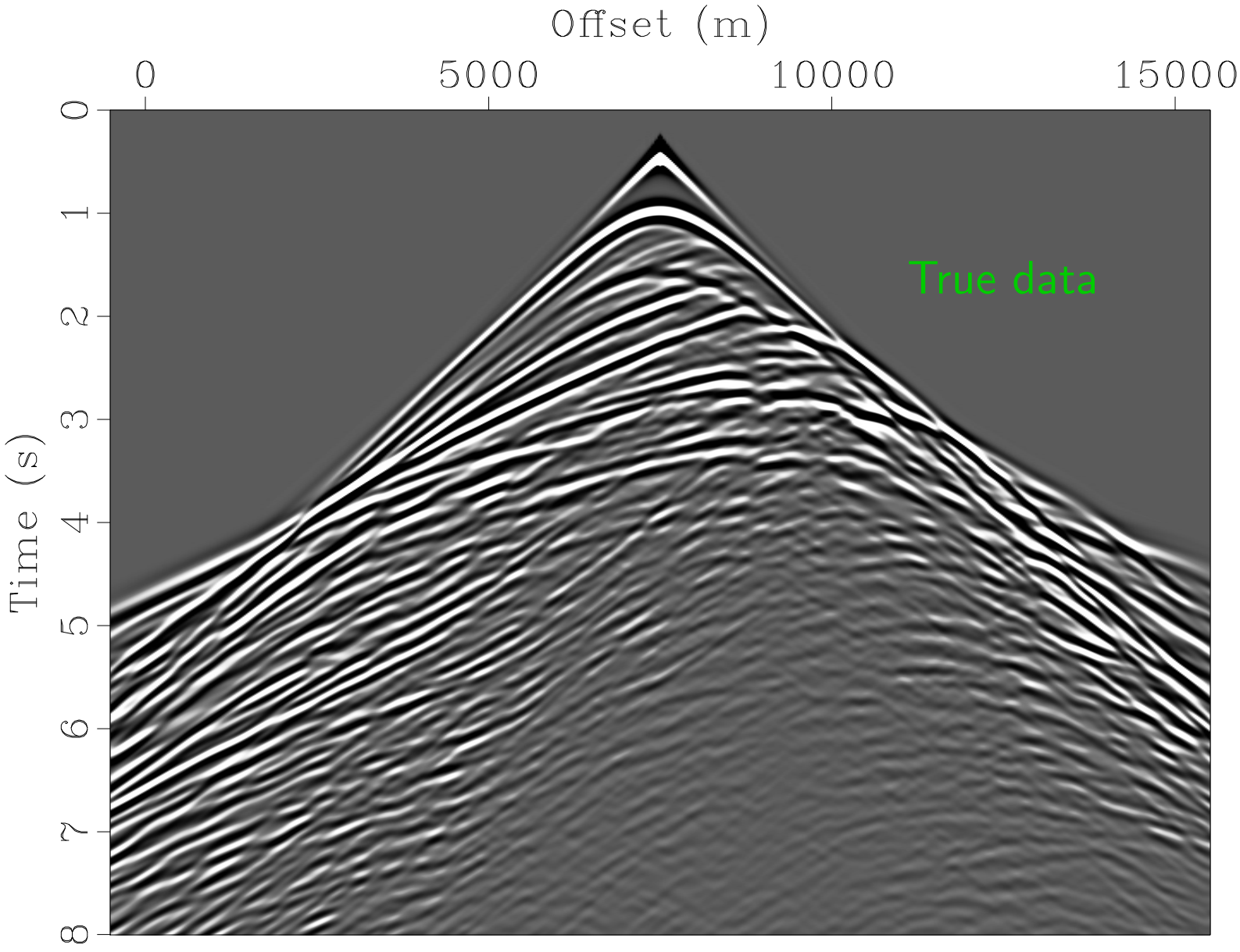
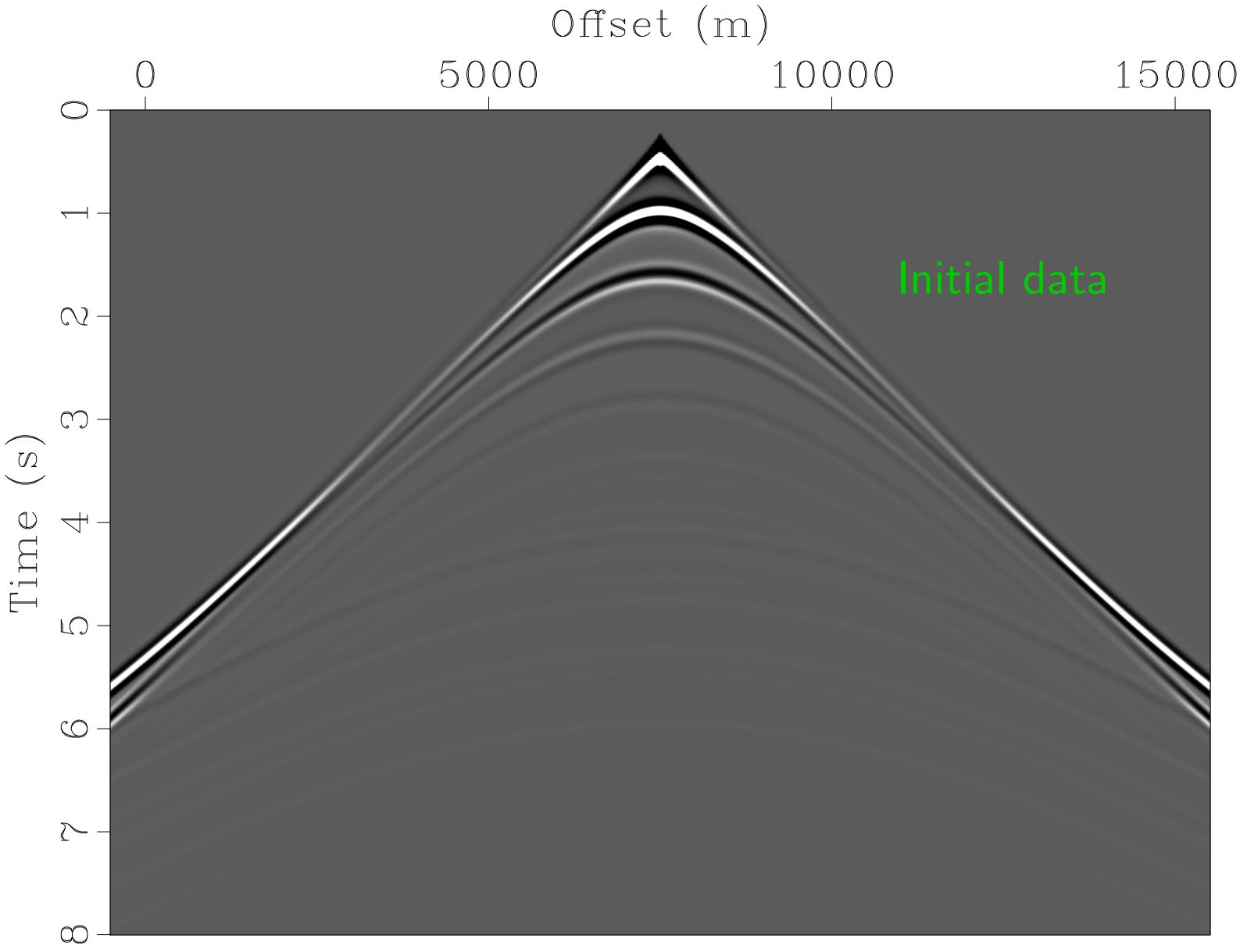
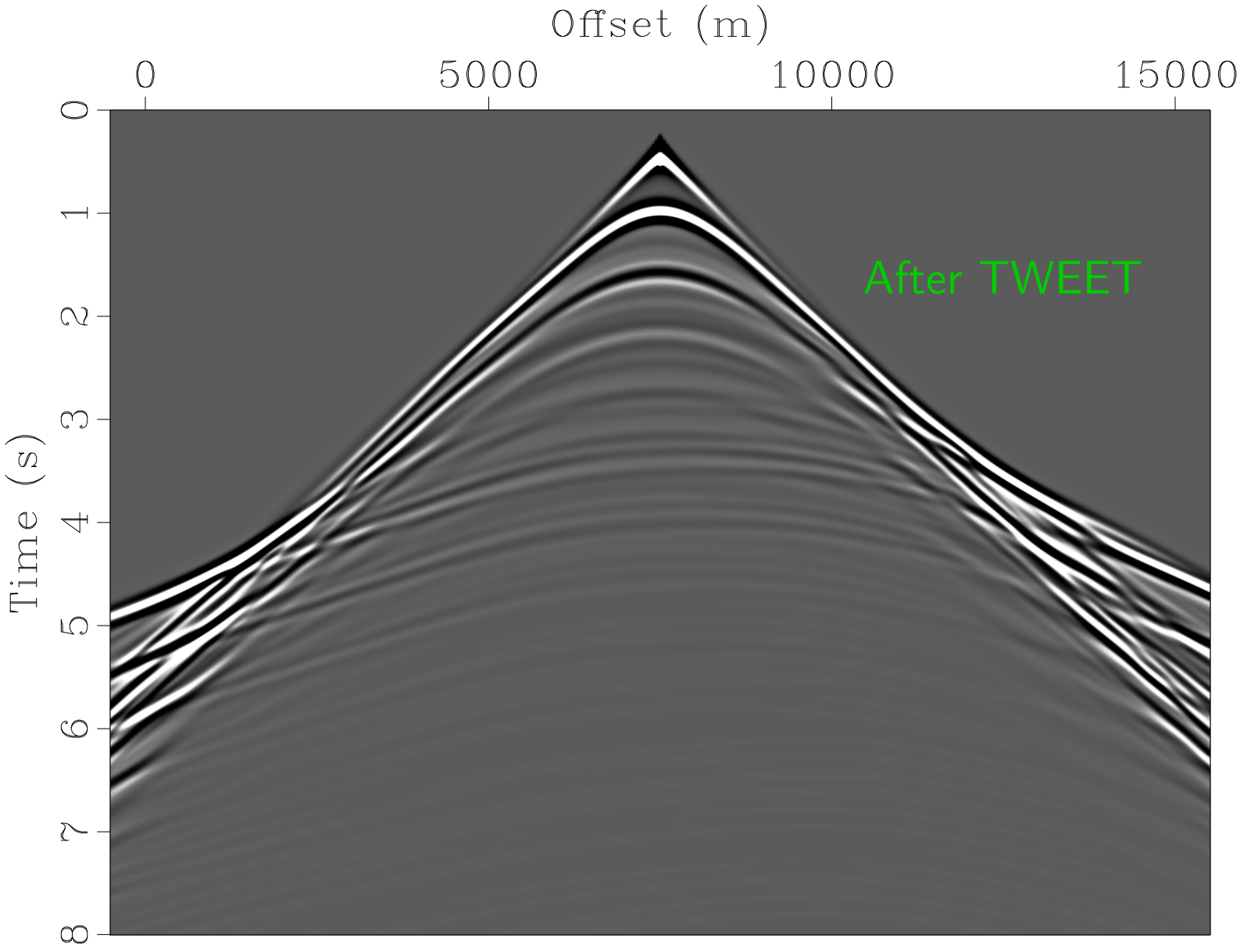
Inversion, data example



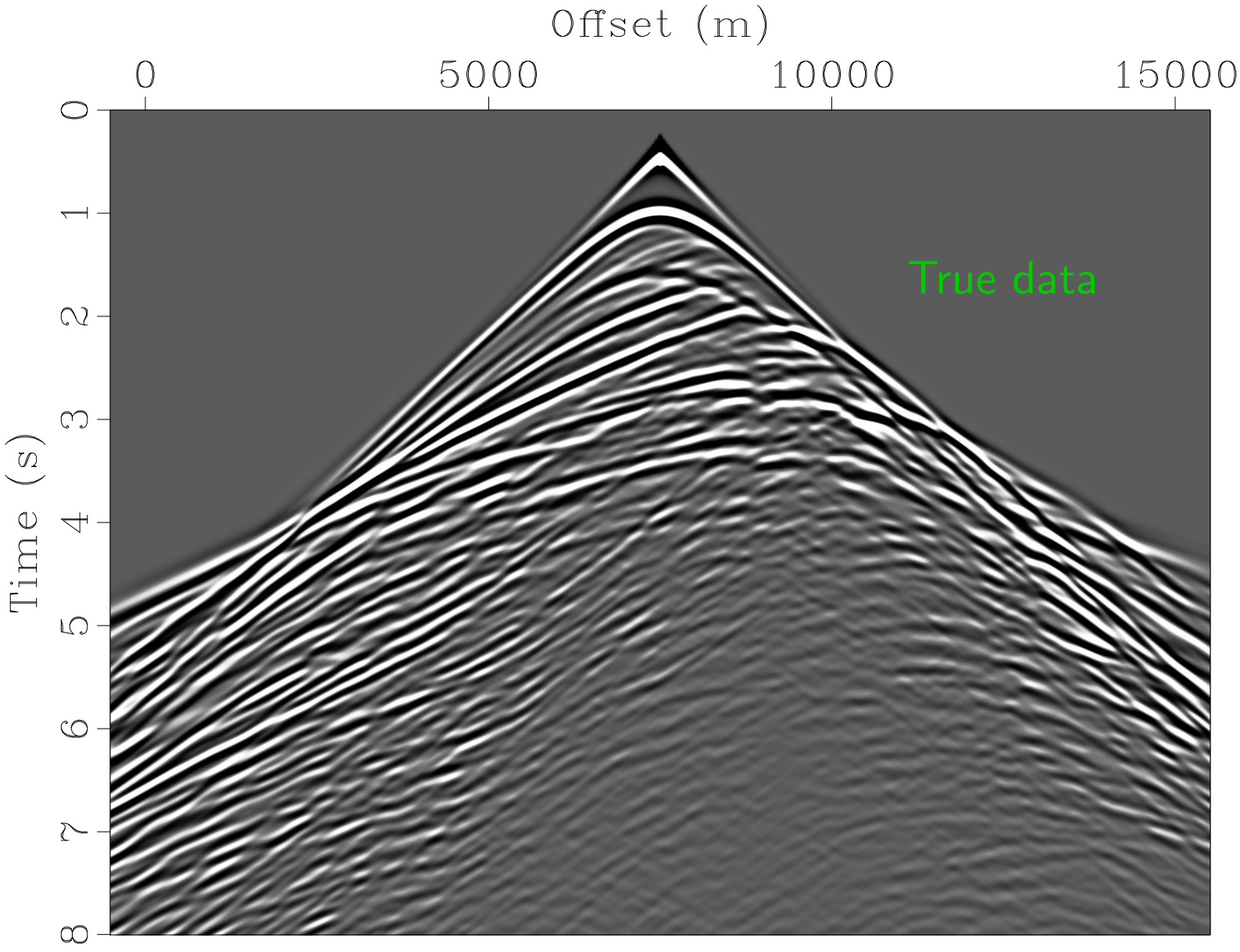
Inversion, data example



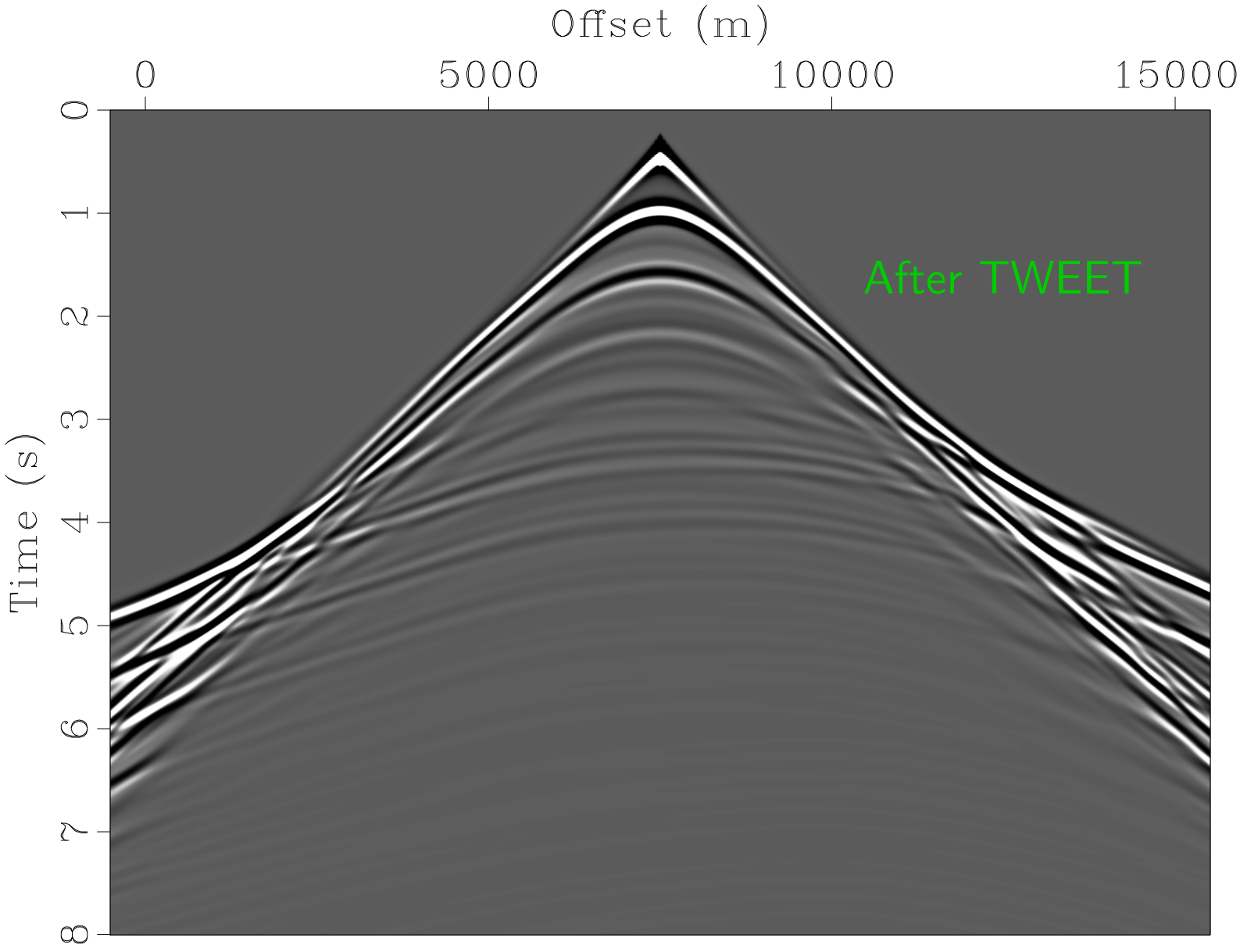
Inversion, data example



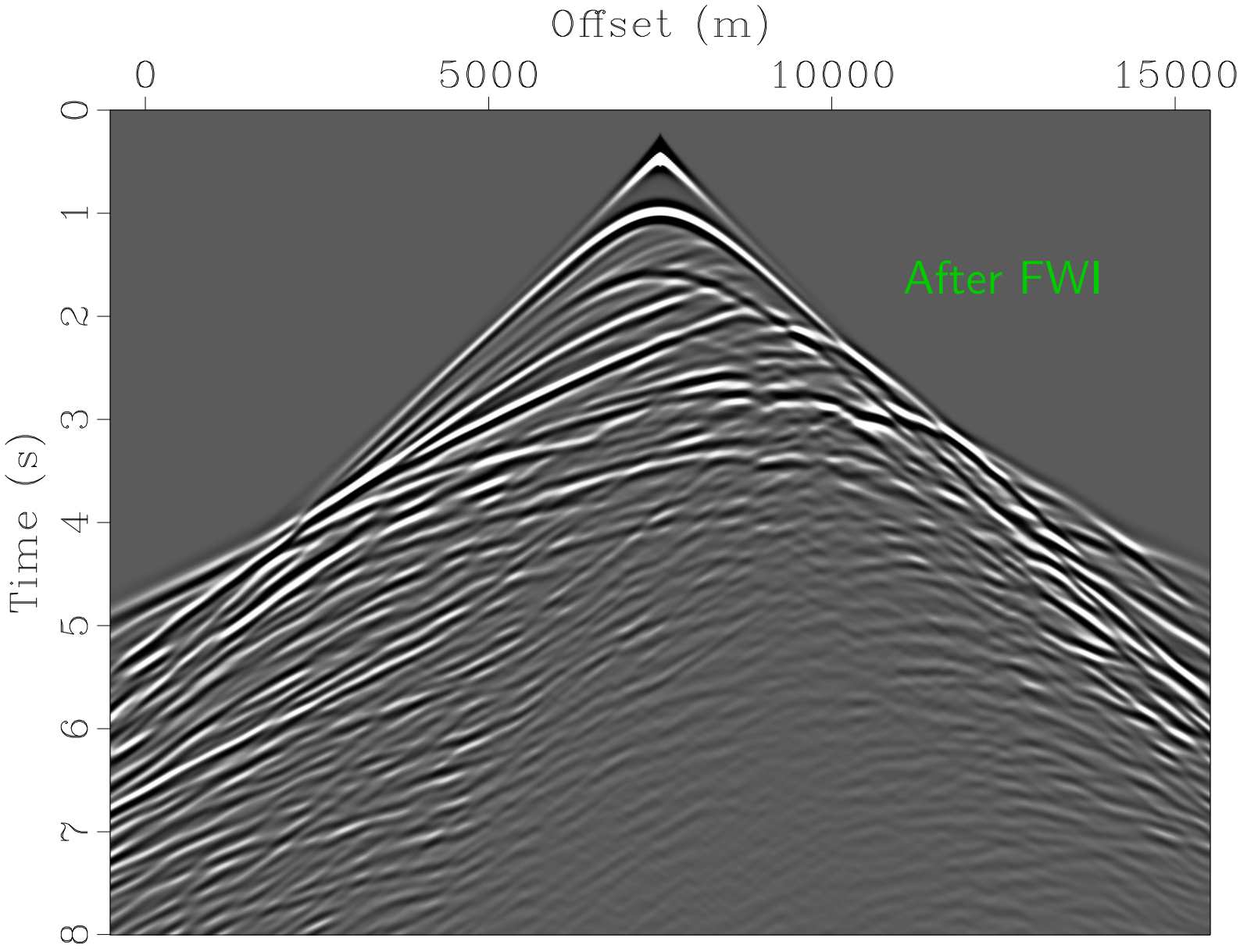
Inversion, data example



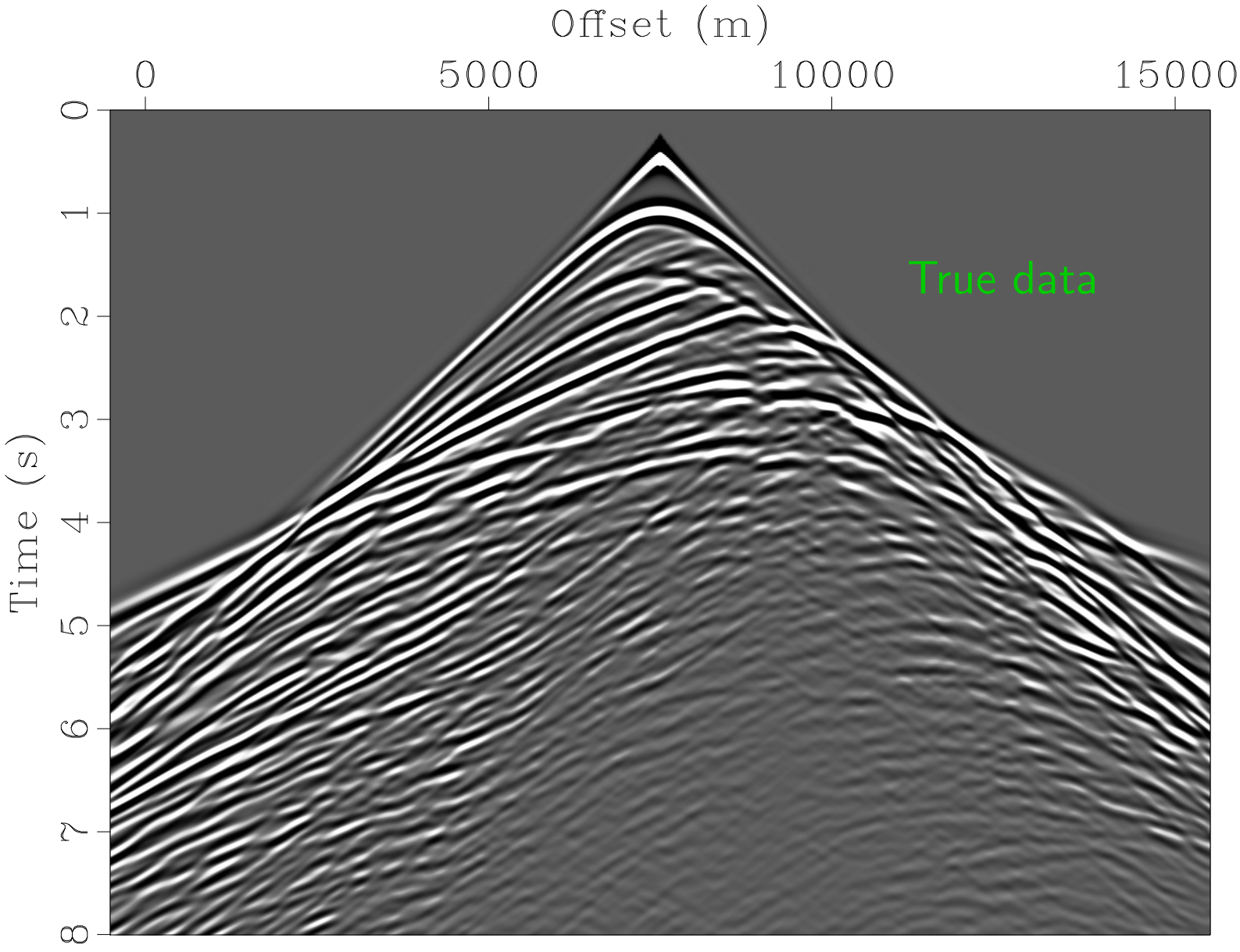
Inversion, data example



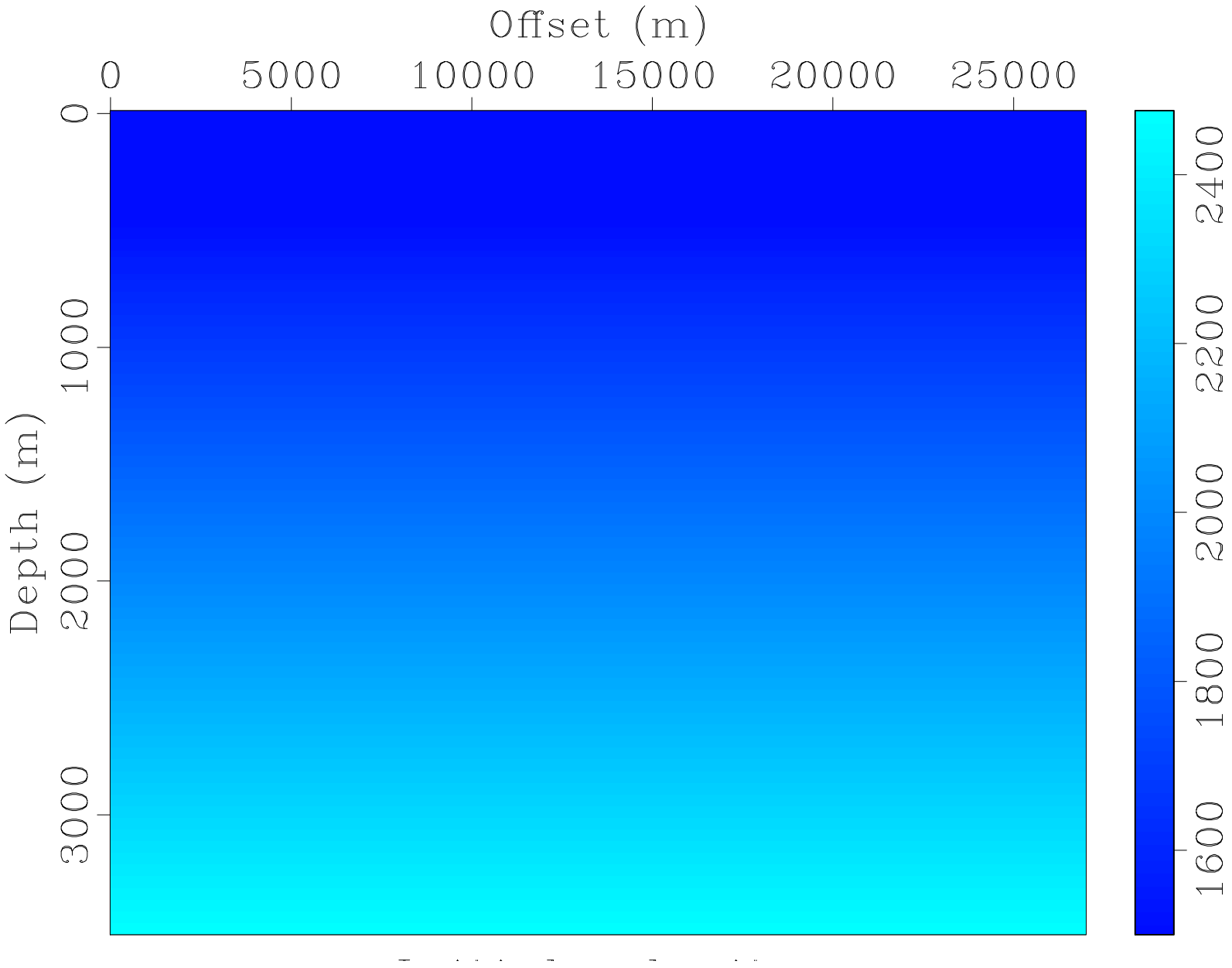
Inversion, data example



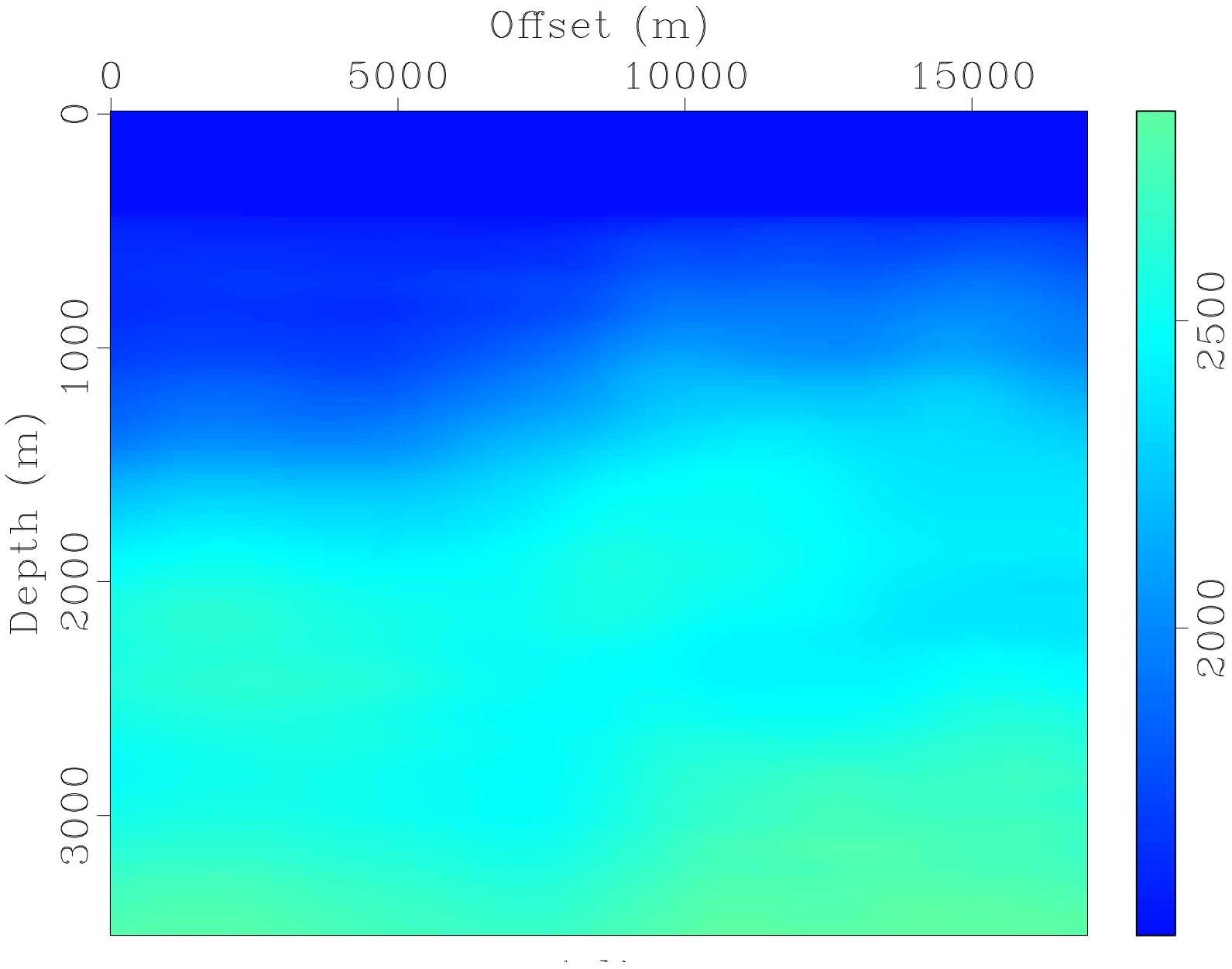
Inversion, data example



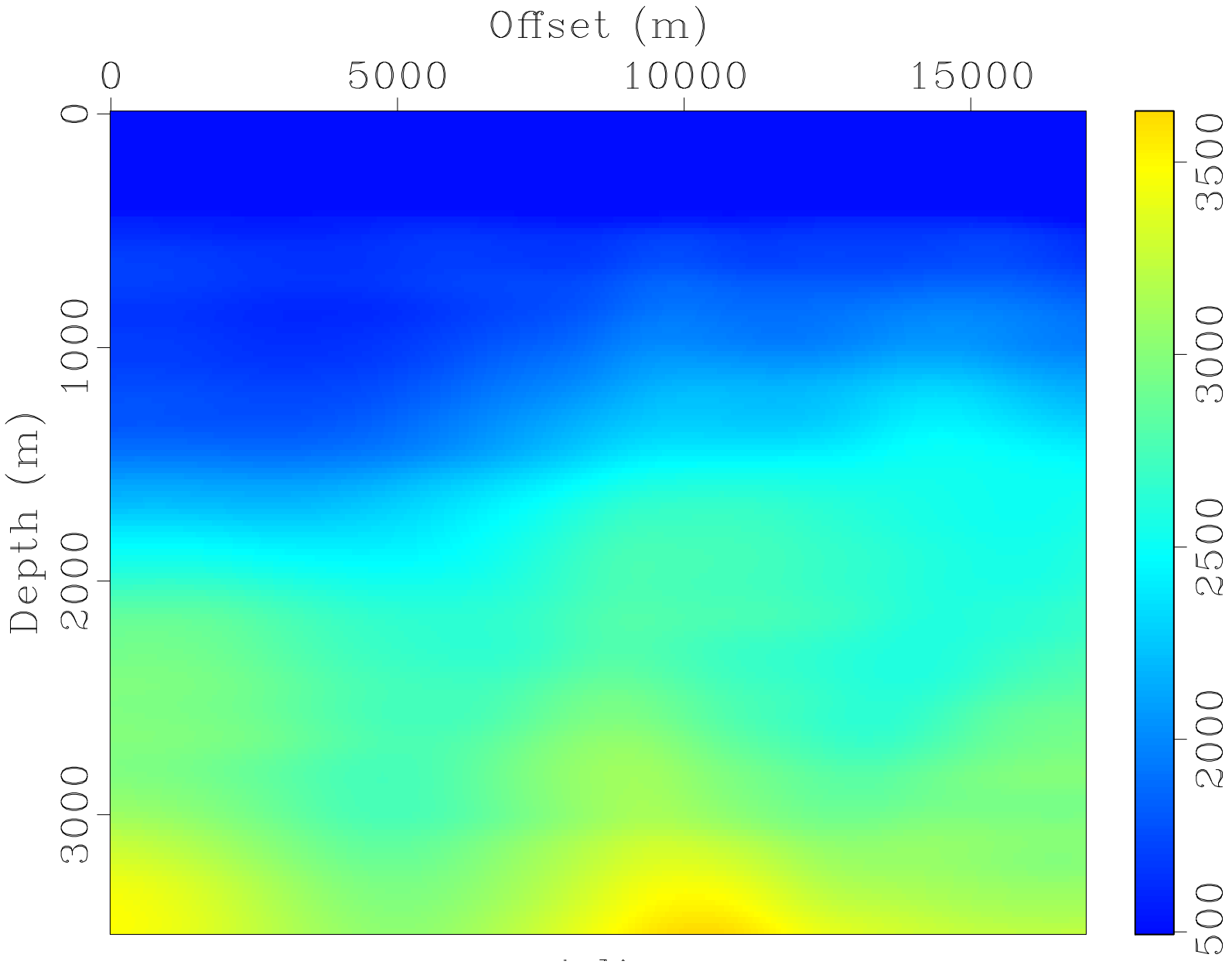
Inversion, model example



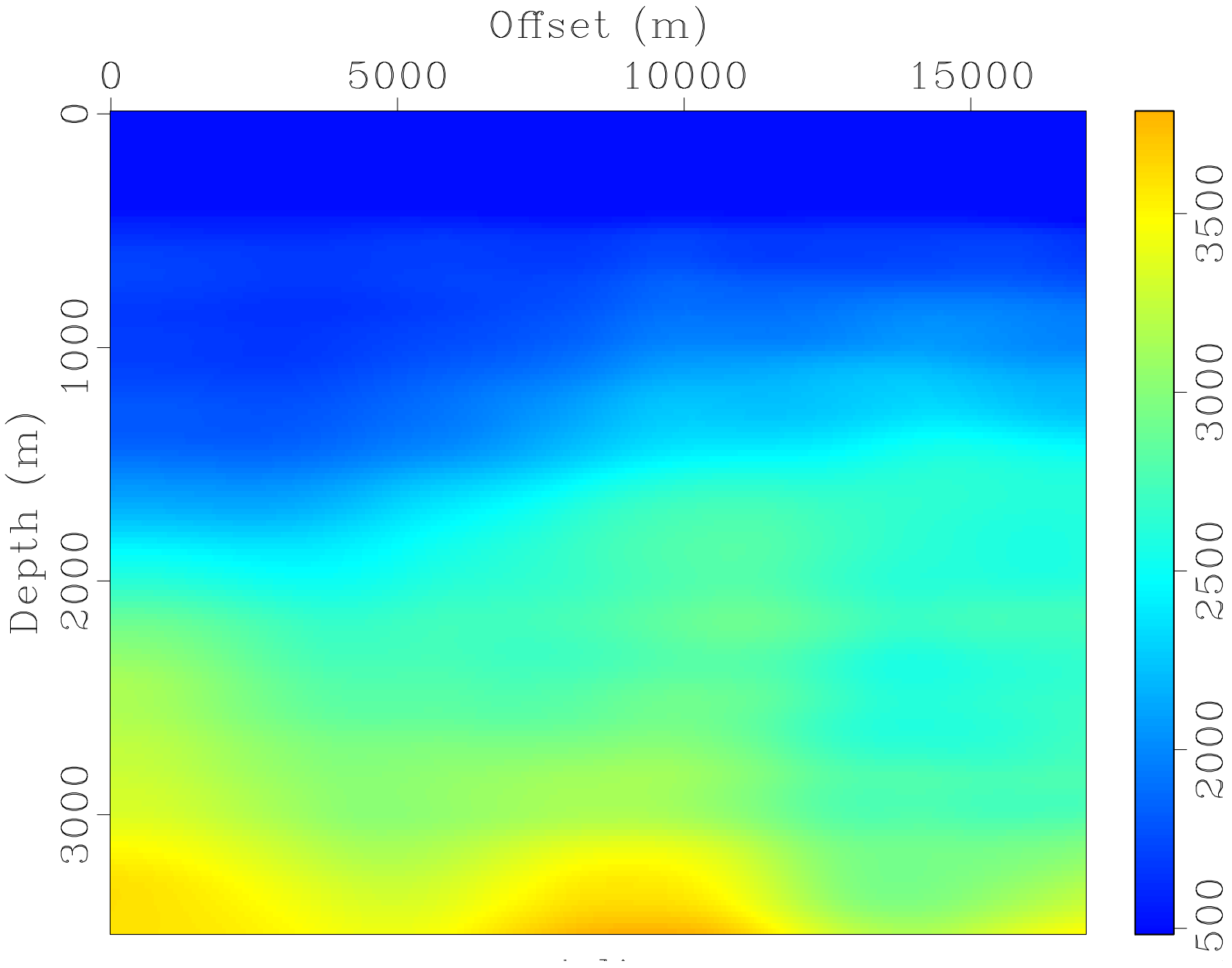
Inversion, model example



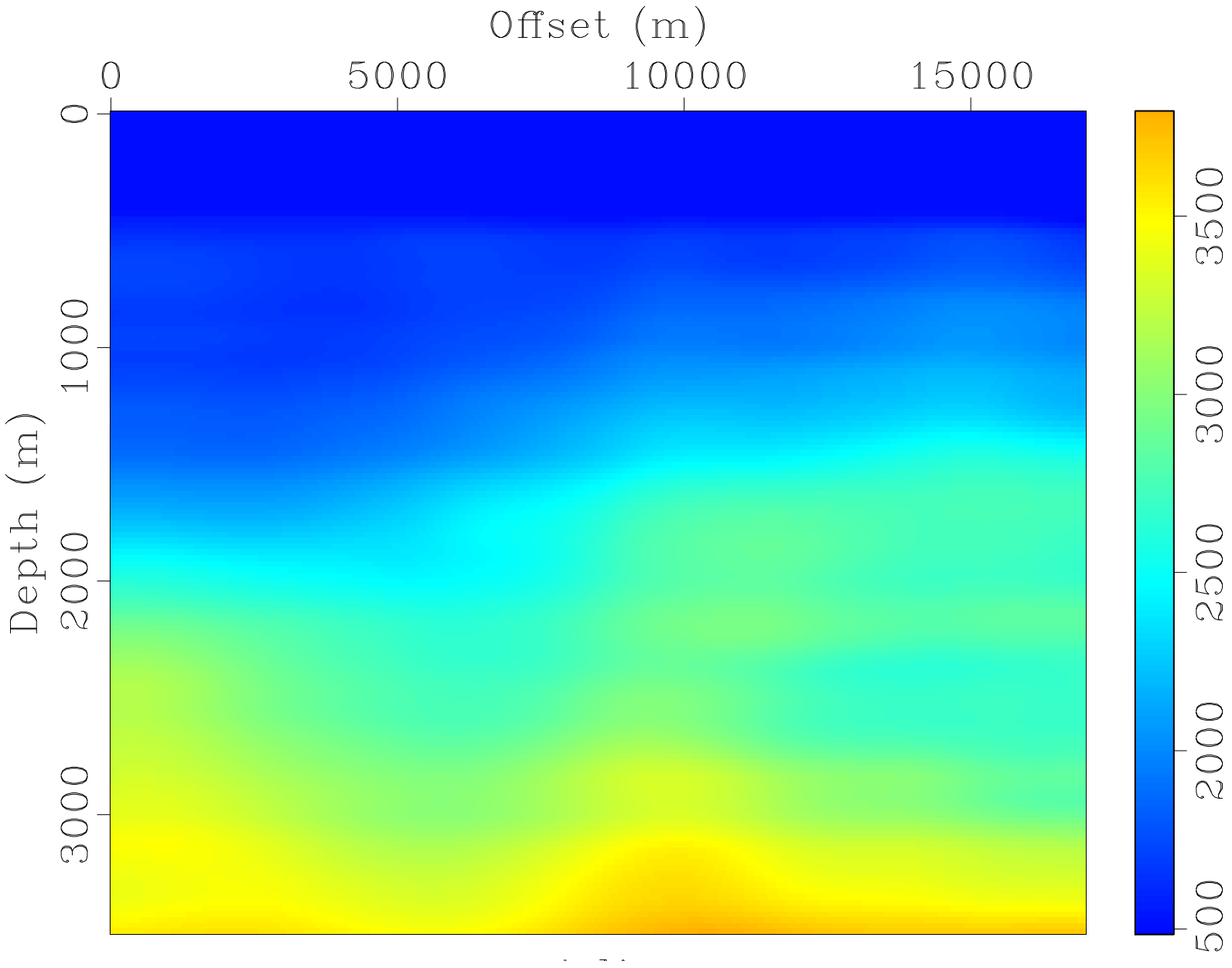
Inversion, model example



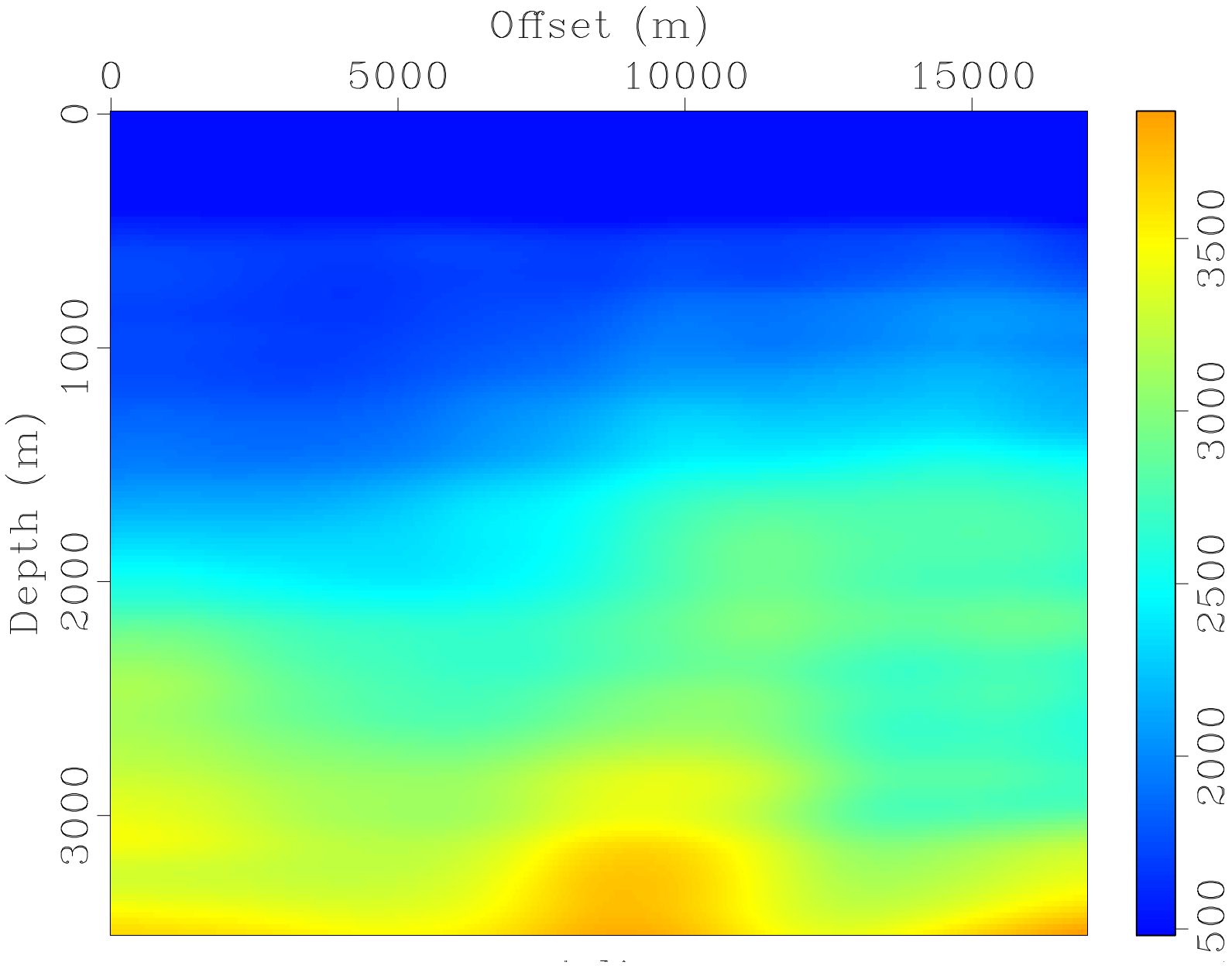
Inversion, model example



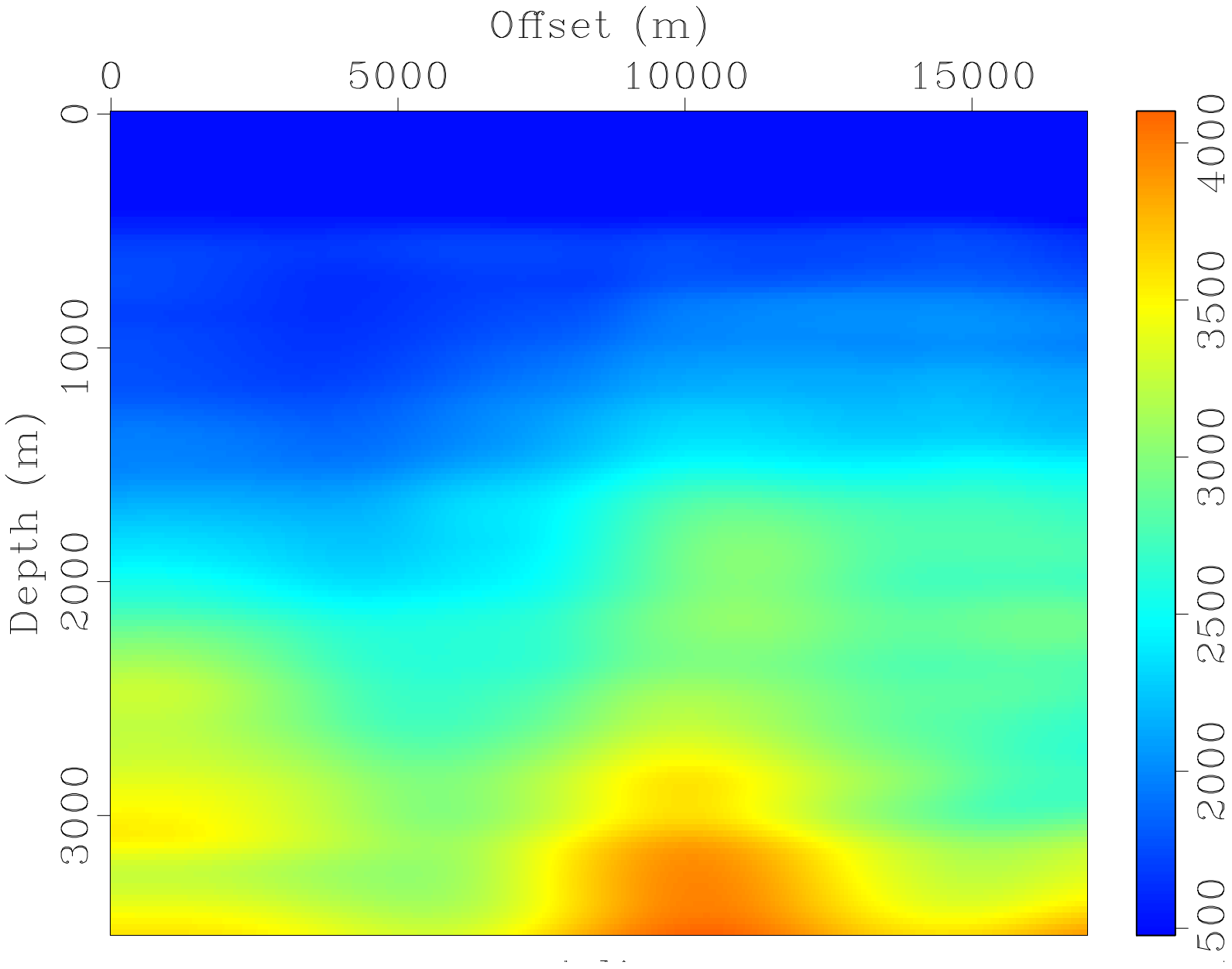
Inversion, model example



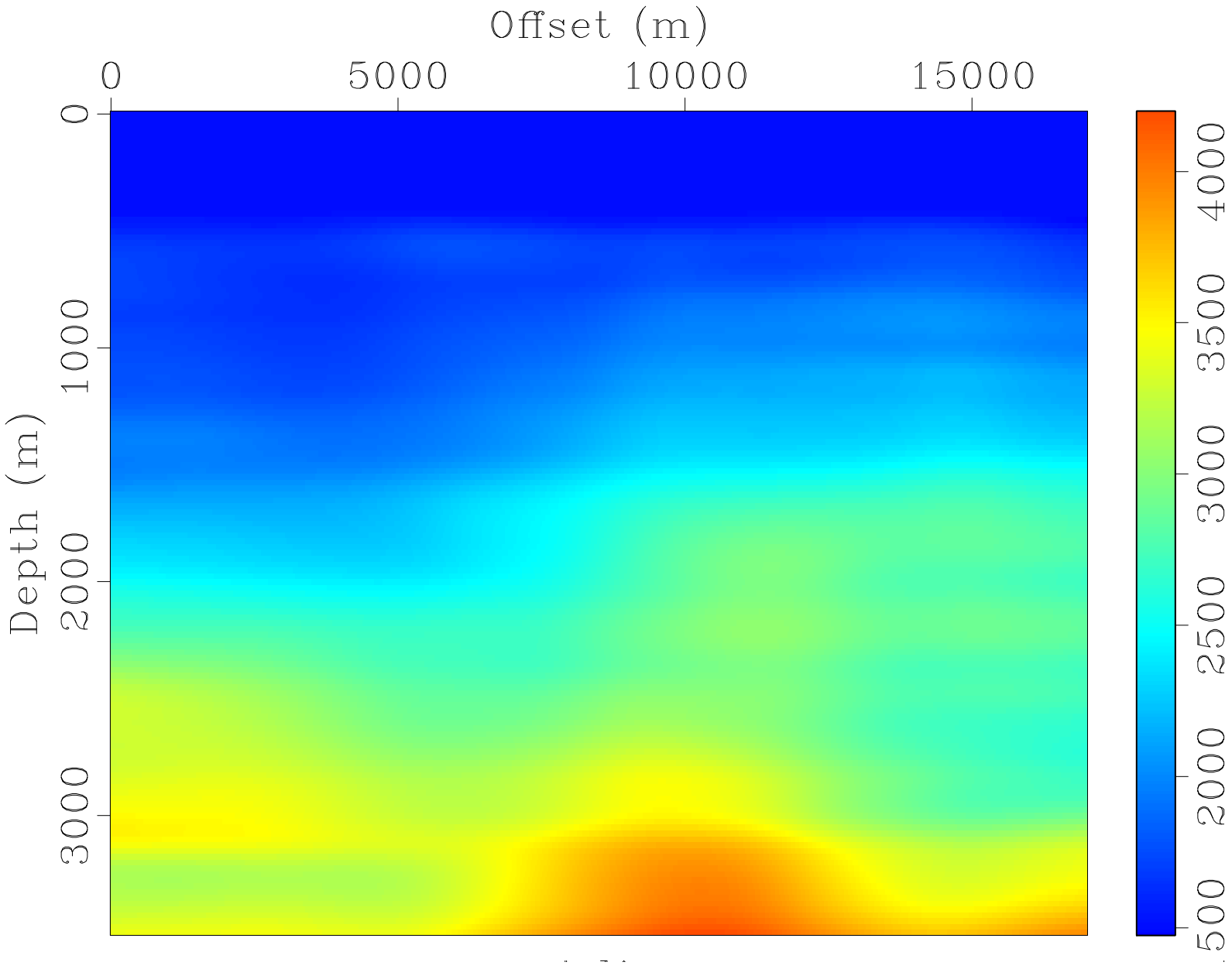
Inversion, model example



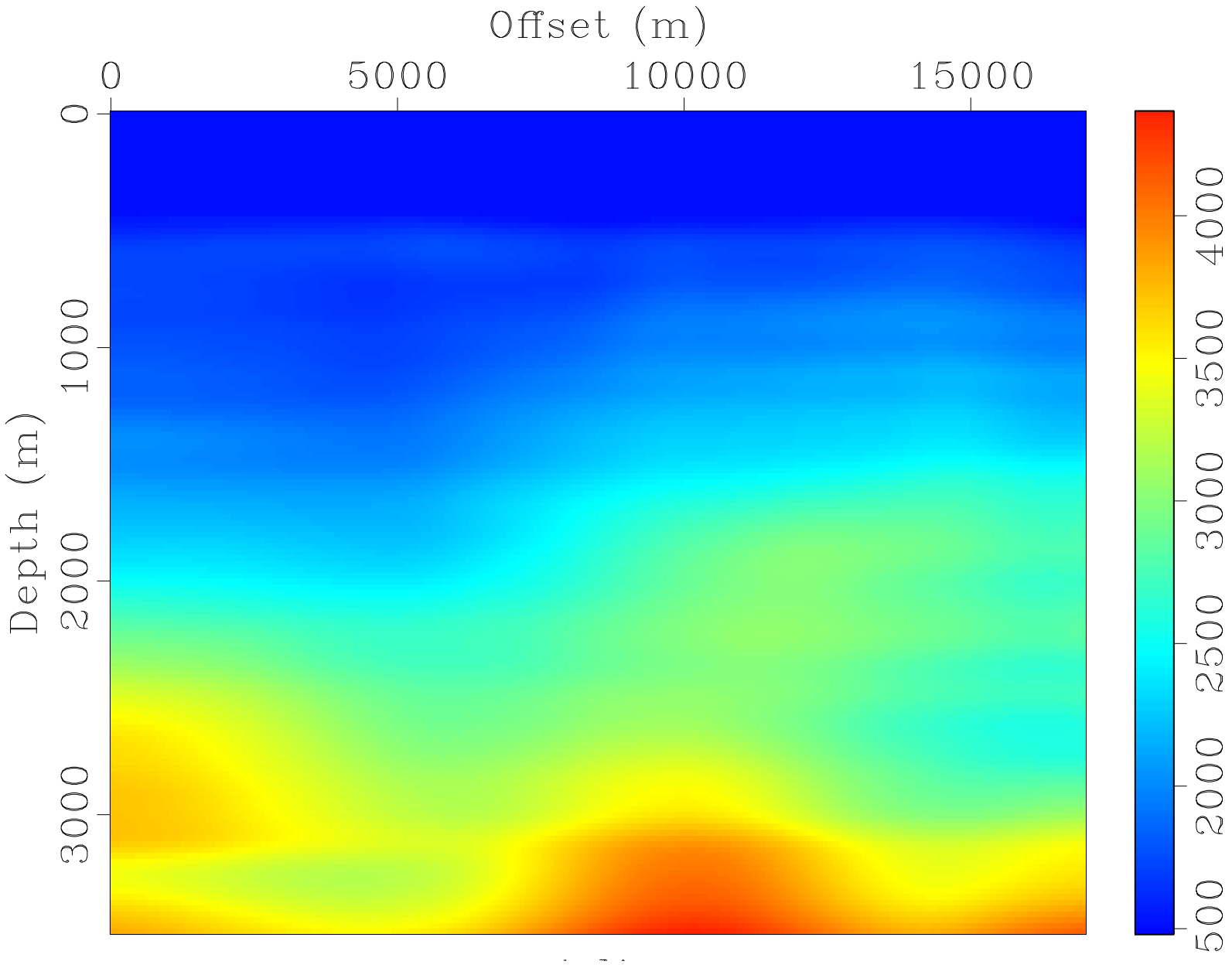
Inversion, model example



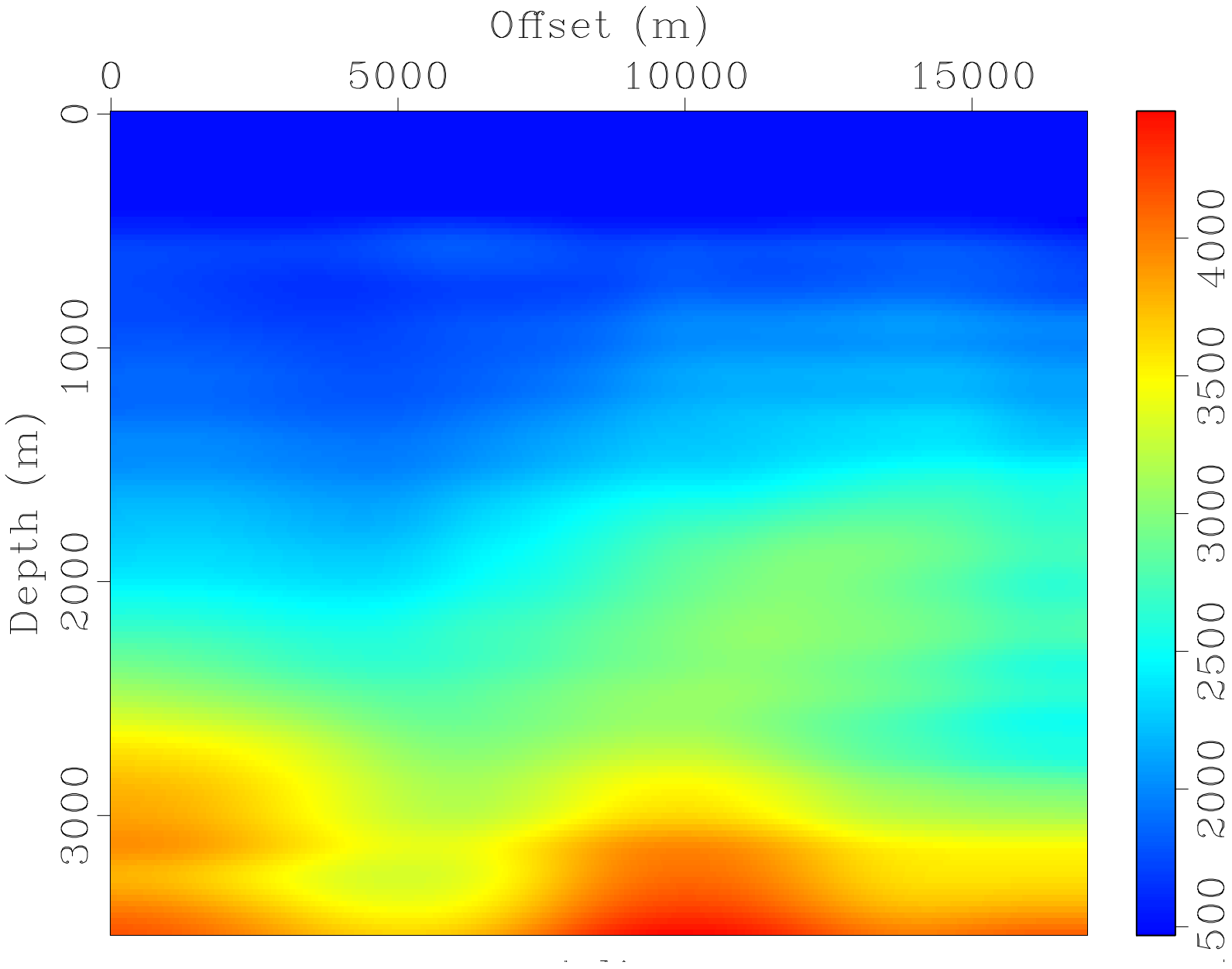
Inversion, model example



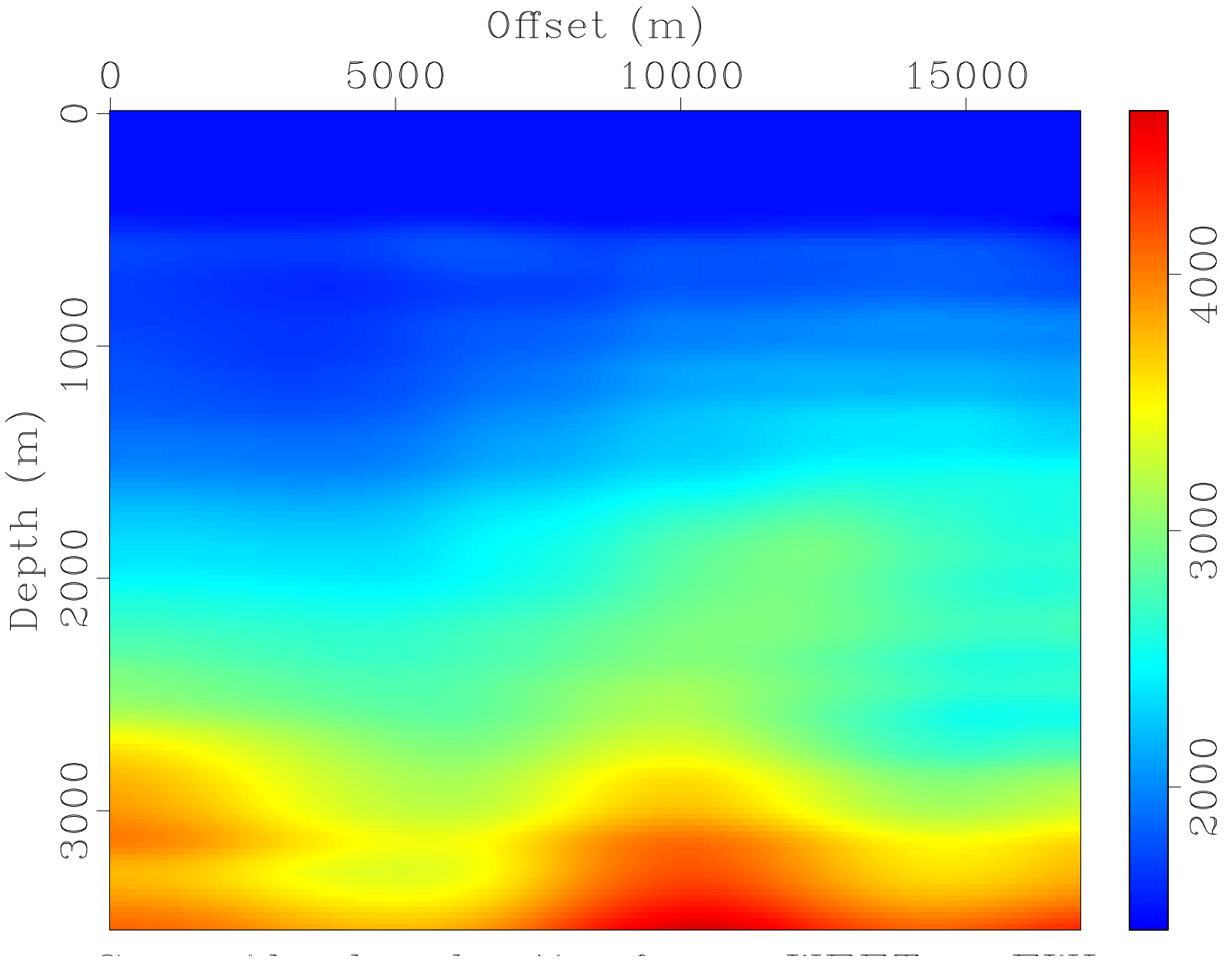
Inversion, model example



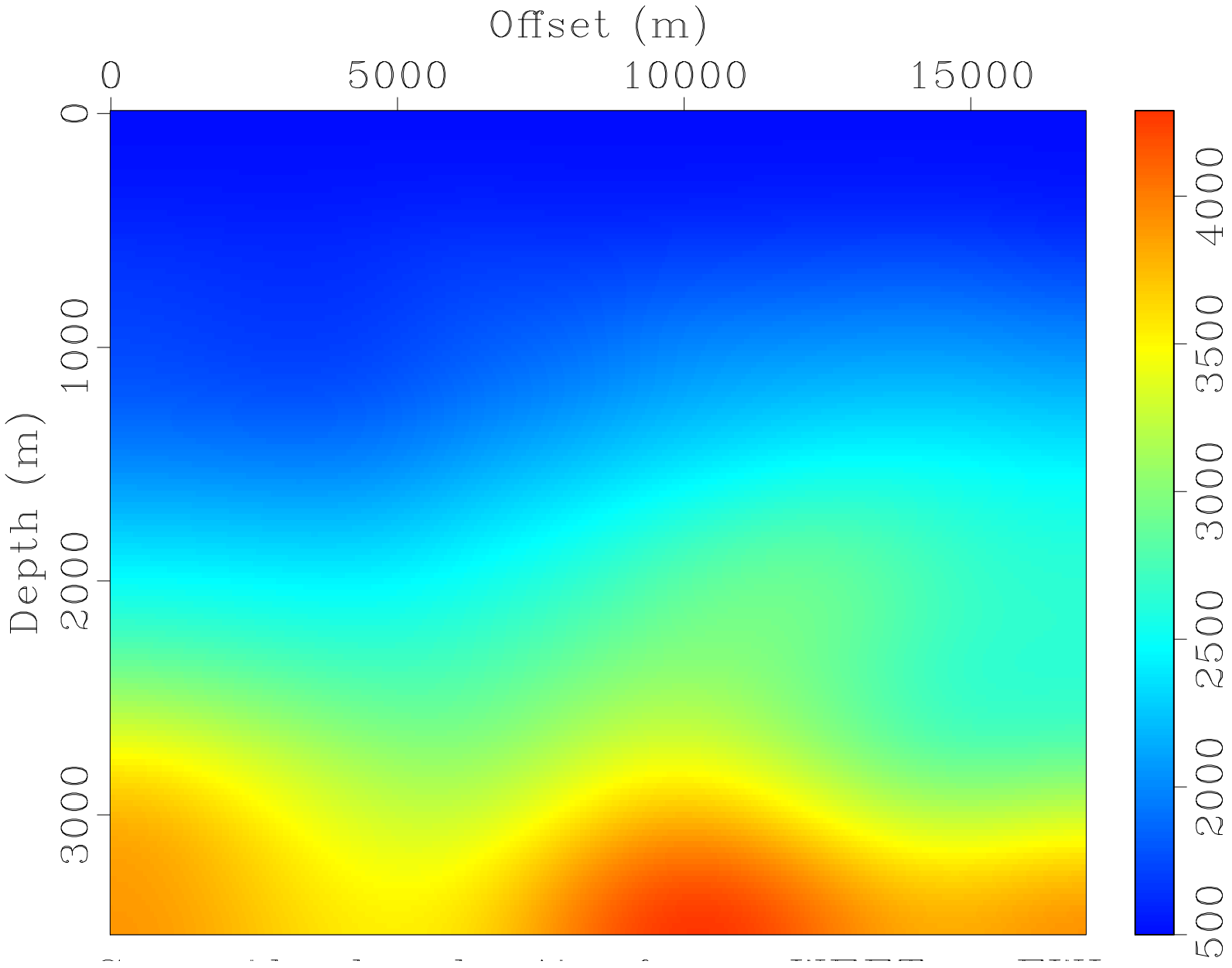
Inversion, model example



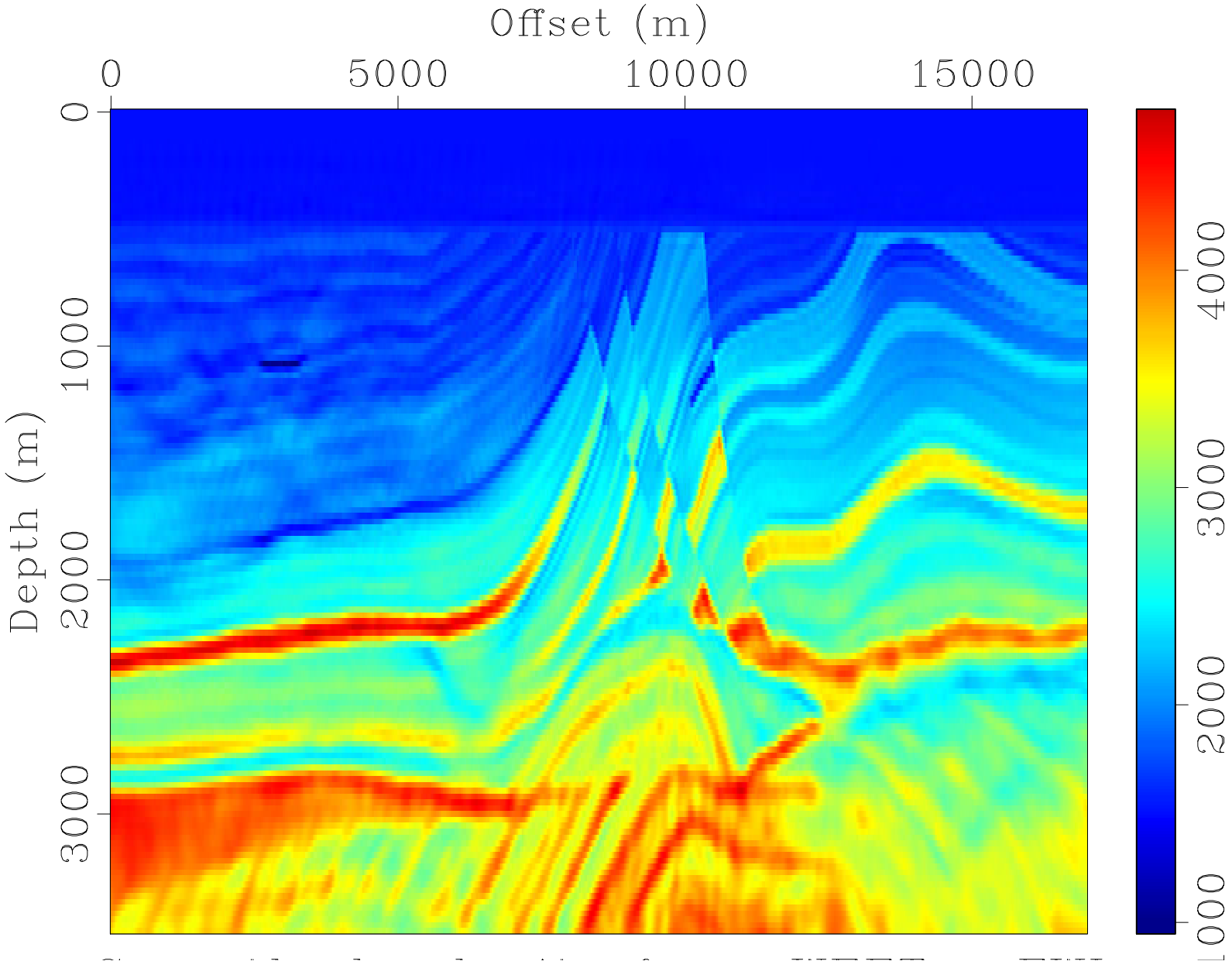
Inversion, model example



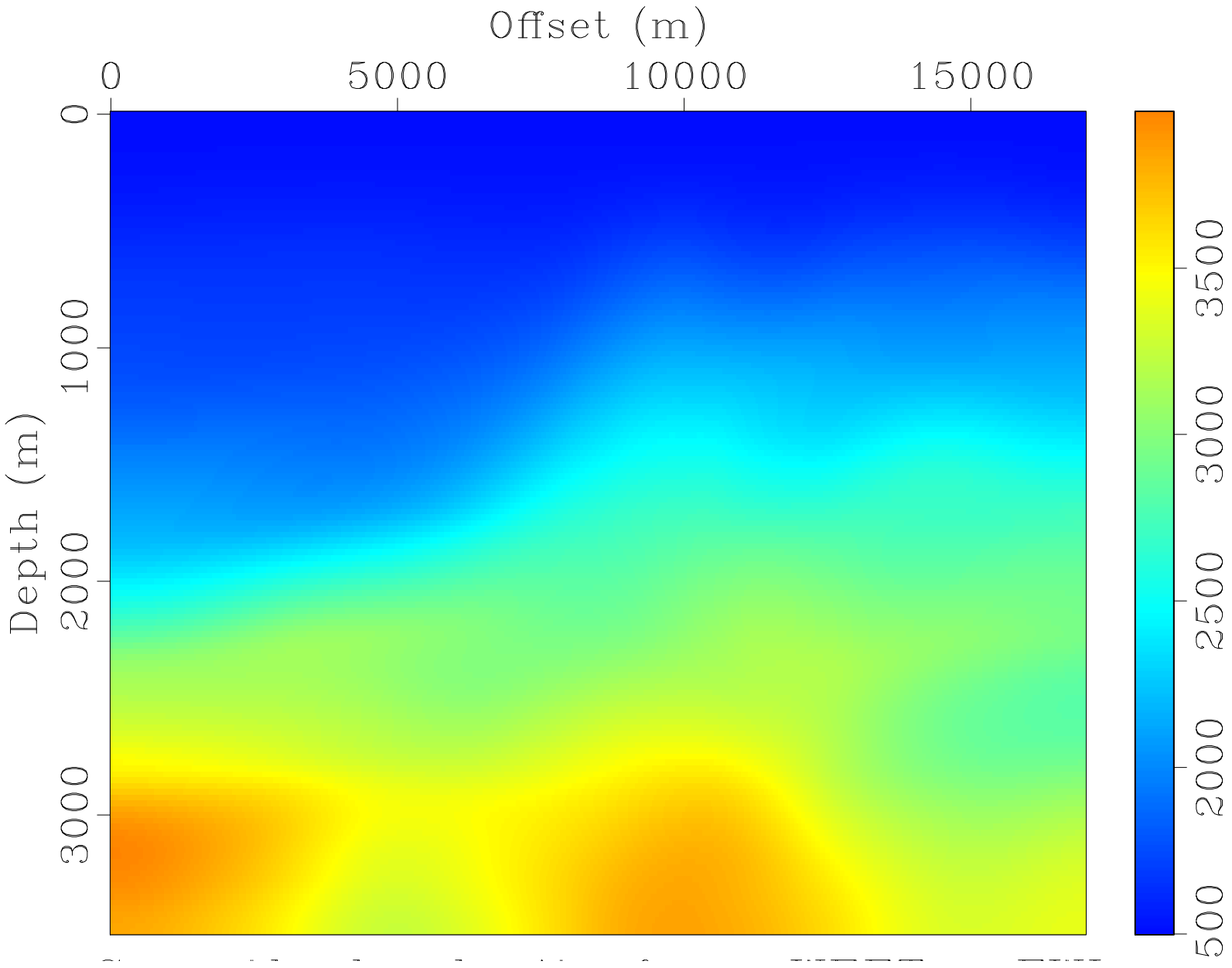
Inversion, model example



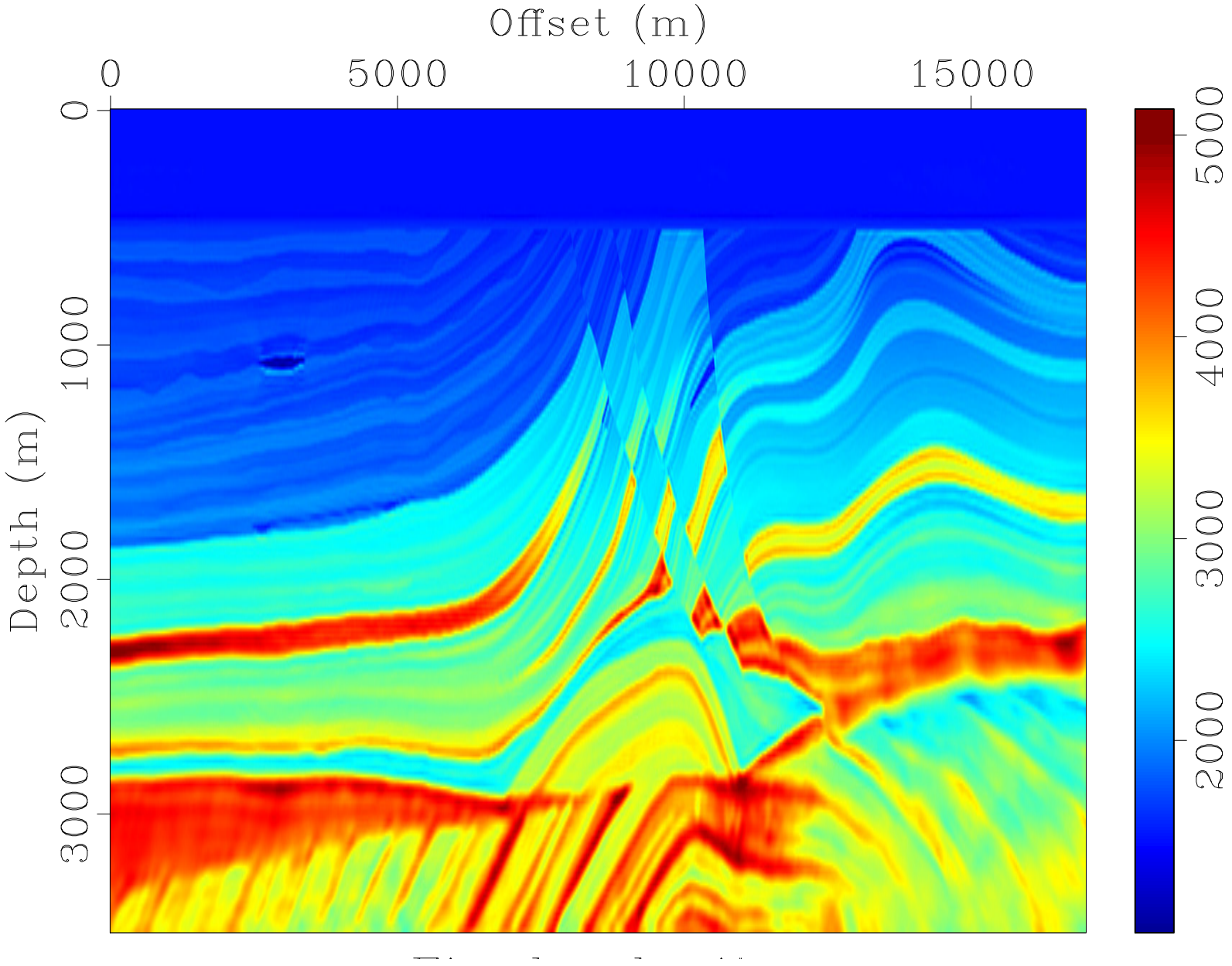
Inversion, model example



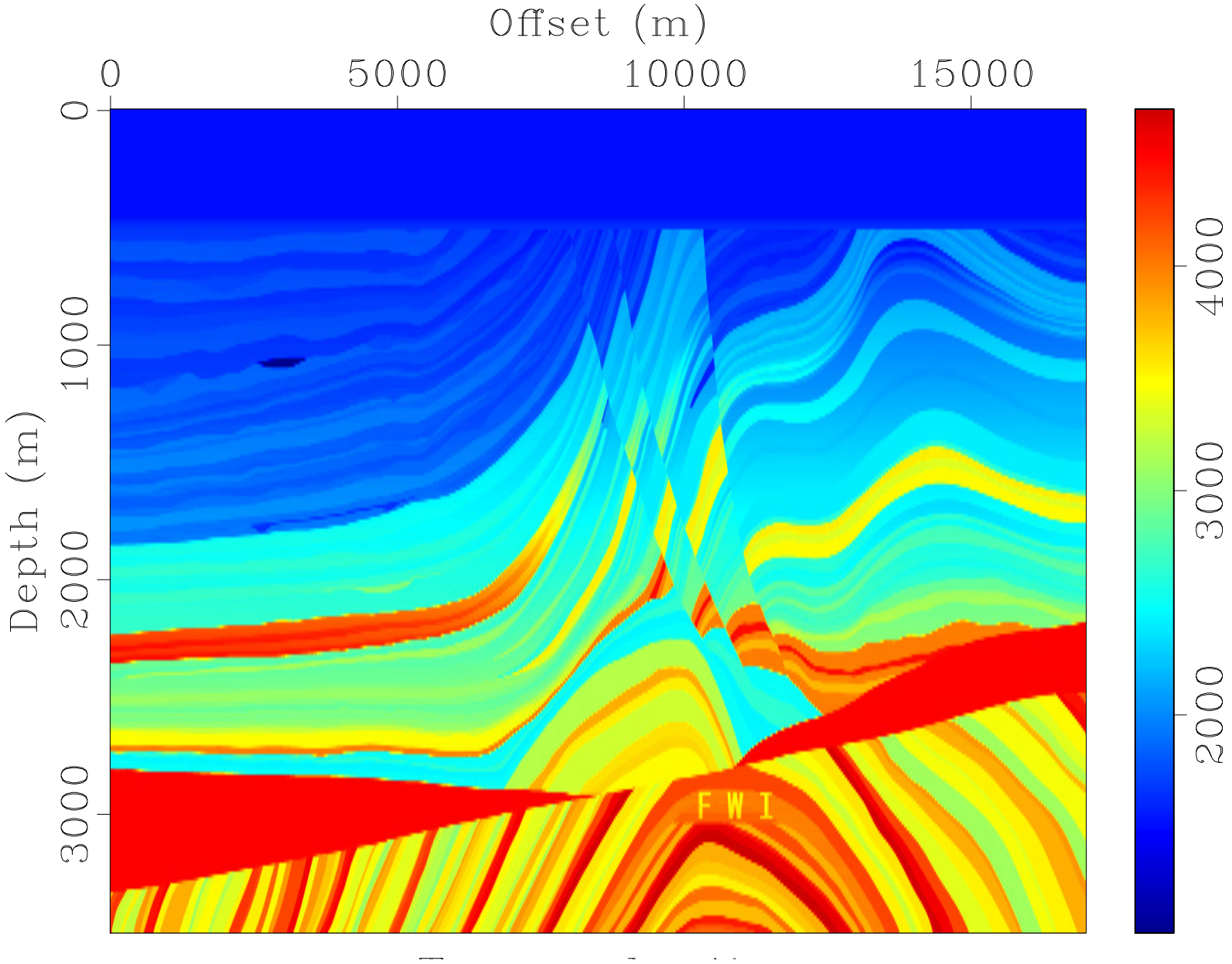
Inversion, model example



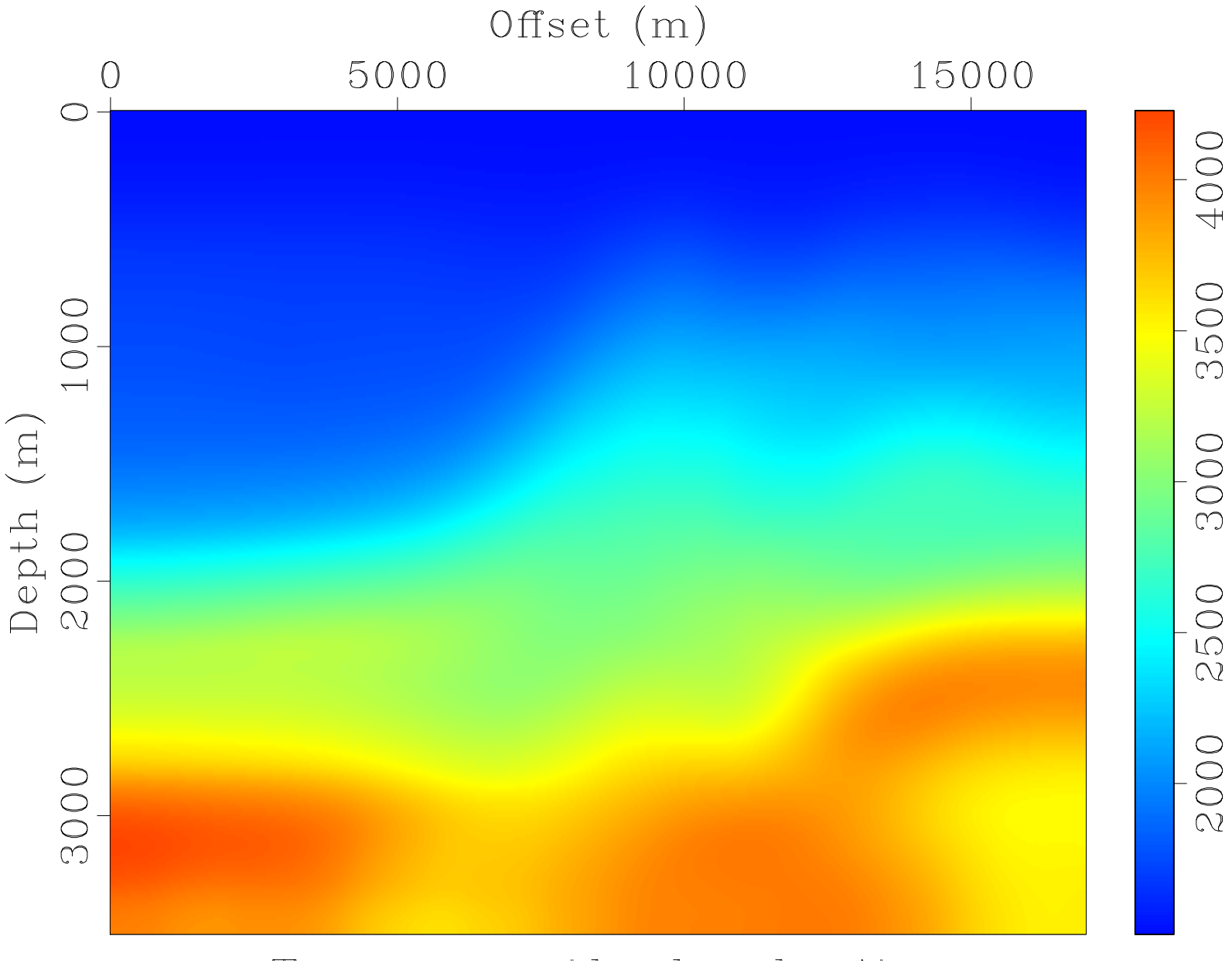
Inversion, model example



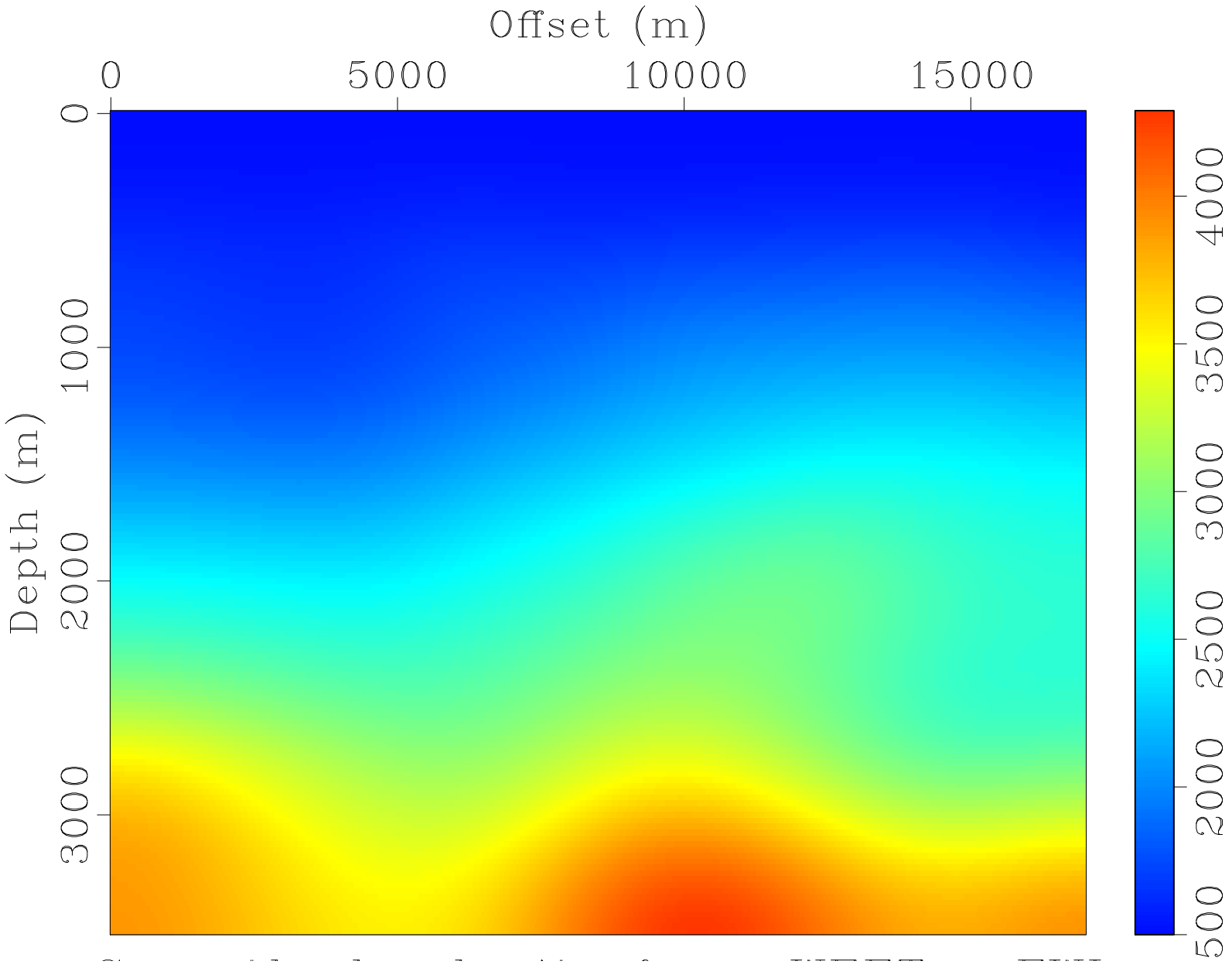
Inversion, model example



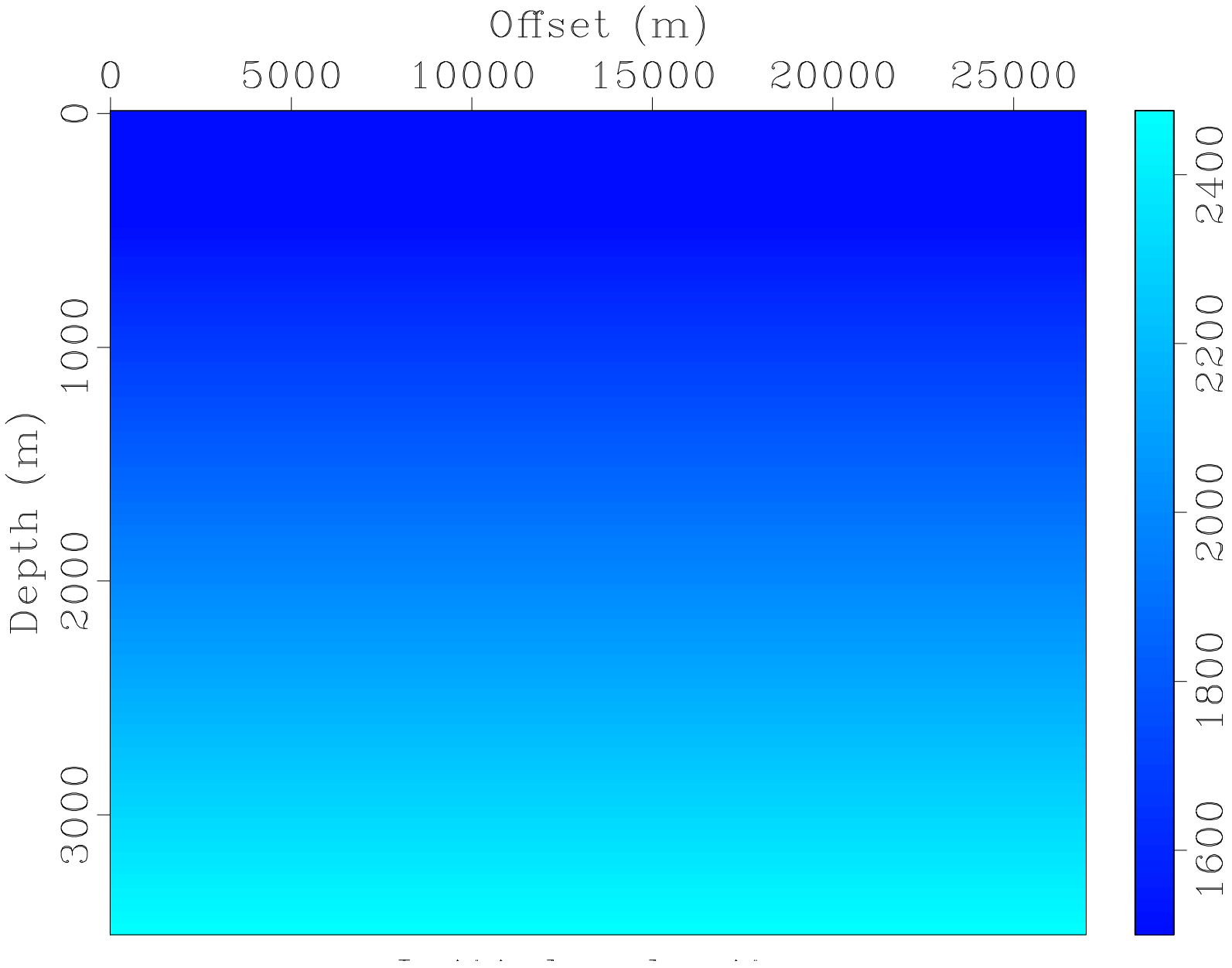
Inversion, model example



Inversion, model example



Inversion, model example



Tomographer candidates, continued

RTT	WET
manual	automated
picked events	full data set
event identification	cross-correlation
ray-paths	steepest descent
some complexity	high complexity
works	doesn't work

Tomographer candidates, continued

RTT	WET	TWEET
manual	automated	
picked events	full data set	
event identification	cross-correlation	
ray-paths	steepest descent	
some complexity	high complexity	
works	doesn't work	

Tomographer candidates, continued

RTT	WET	TWEET
manual	automated	automated
picked events	full data set	
event identification	cross-correlation	
ray-paths	steepest descent	
some complexity	high complexity	
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works	doesn't work	???