Sparse log-decon results

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Our Statement

Polarity becomes apparent when deconvolution removes the correct source wavelet

Updates on the methodology

- Non-linear inversion is now done with Quasi-Newton L-BFGS solver
  - Faster convergence
- Non-linear inversion introduces regularization:
  - Penalize coefficients at long lags
  - Enforce symmetry of the filter coefficients if needed (guarantees Ricker-like wavelet).

The inversion: hyperbolic function

- **f**: filter in time domain $$\mathbf{f} = \mathcal{F}^{-1} e^{\mathcal{F}(\mathbf{u})}$$
- Residual for trace d_k $$\mathbf{r}_k = \mathbf{d}_k * \mathbf{f}$$
- Objective function $$\mathcal{H}(\mathbf{u}) = \sum_{k=1}^{ntraces} \sum_{j=1}^{nt} \sqrt{1 + r_{jk}^2} - 1$$
- Gradient $$\nabla \mathcal{H}(\mathbf{u}) = \sum_{k=1}^{ntraces} \overline{\mathbf{r}_k} * \mathtt{softclip}(\mathbf{r}_k)$$

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The inversion: L2 norm

- **f**: filter in time domain $$\mathbf{f} = \mathcal{F}^{-1} e^{\mathcal{F}(\mathbf{u})}$$
- Residual for trace d_k $$\mathbf{r}_k = \mathbf{d}_k * \mathbf{f}$$
- Objective function $$\mathcal{H}_{\ell^2}(\mathbf{u}) = \sum_{k=1}^{ntraces} \sum_{j=1}^{nt} r_{jk}^2$$
- Gradient $$\nabla \mathcal{H}_{\ell^2}(\mathbf{u}) = \sum_{k=1}^{ntraces} \overline{\mathbf{r}_k} * \mathbf{r}_k$$

The inversion: L1 norm

- **f**: filter in time domain $\mathbf{f} = \mathcal{F}^{-1} e^{\mathcal{F}(\mathbf{u})}$
- Residual for trace d$_k$ $\mathbf{r}_k = \mathbf{d}_k * \mathbf{f}$
- Objective function $\mathcal{H}_{\ell^1}(\mathbf{u}) = \sum_{k=1}^{ntraces} \sum_{j=1}^{nt} |r_{jk}|$
- Gradient $\nabla \mathcal{H}_{\ell^1}(\mathbf{u}) = \sum_{k=1}^{ntraces} \overline{\mathbf{r}_k} * \mathtt{sign}(\mathbf{r}_k)$

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What we are showing today

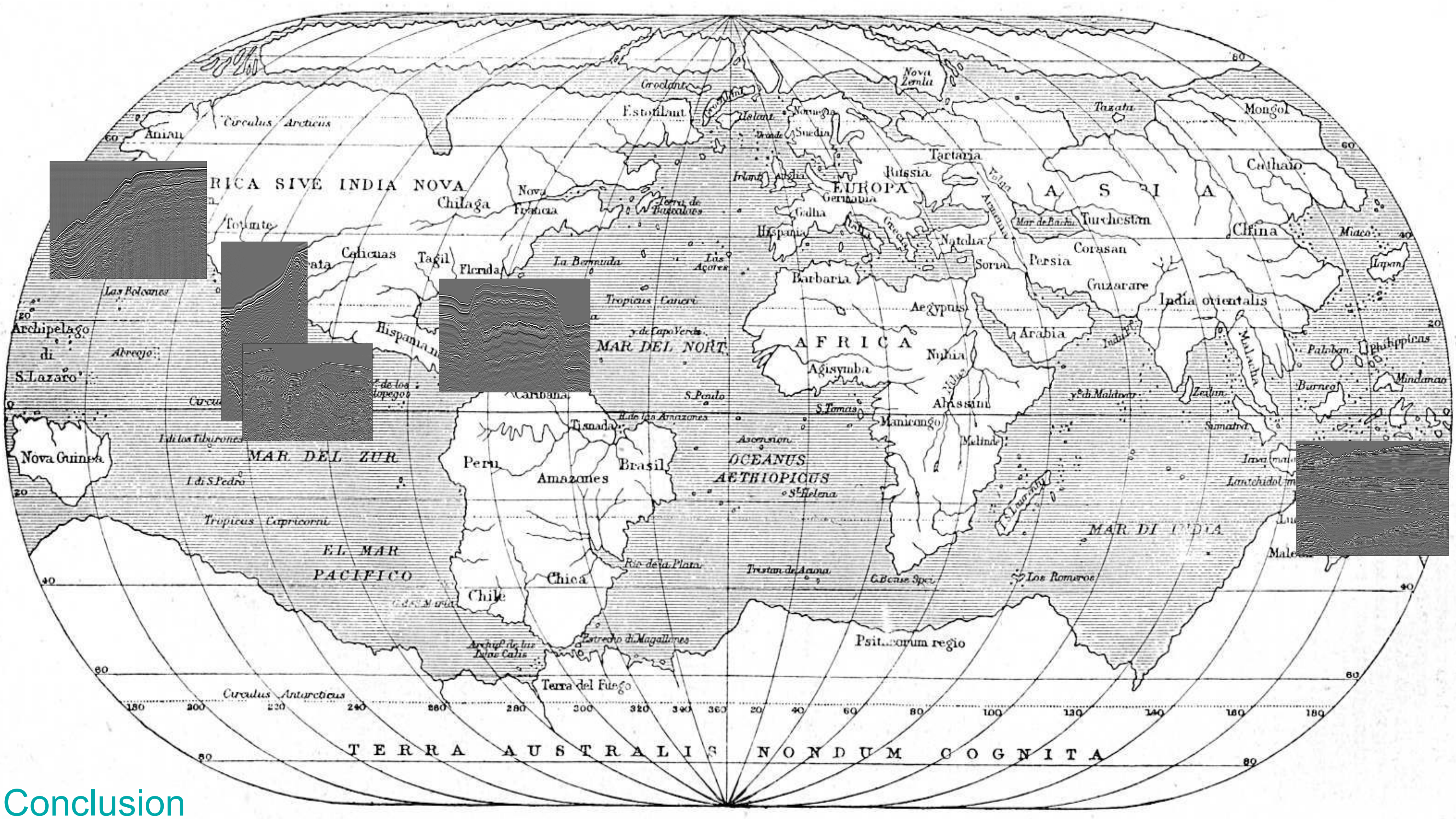
- The log-decon result: $\mathbf{r}_k = \mathbf{d}_k * \mathbf{f}$

- The wavelet in the time domain: $\mathbf{w} = \mathcal{F}^{-1} e^{-\mathcal{F}(\mathbf{u})}$

Ricker decon vs. Sparse log-decon

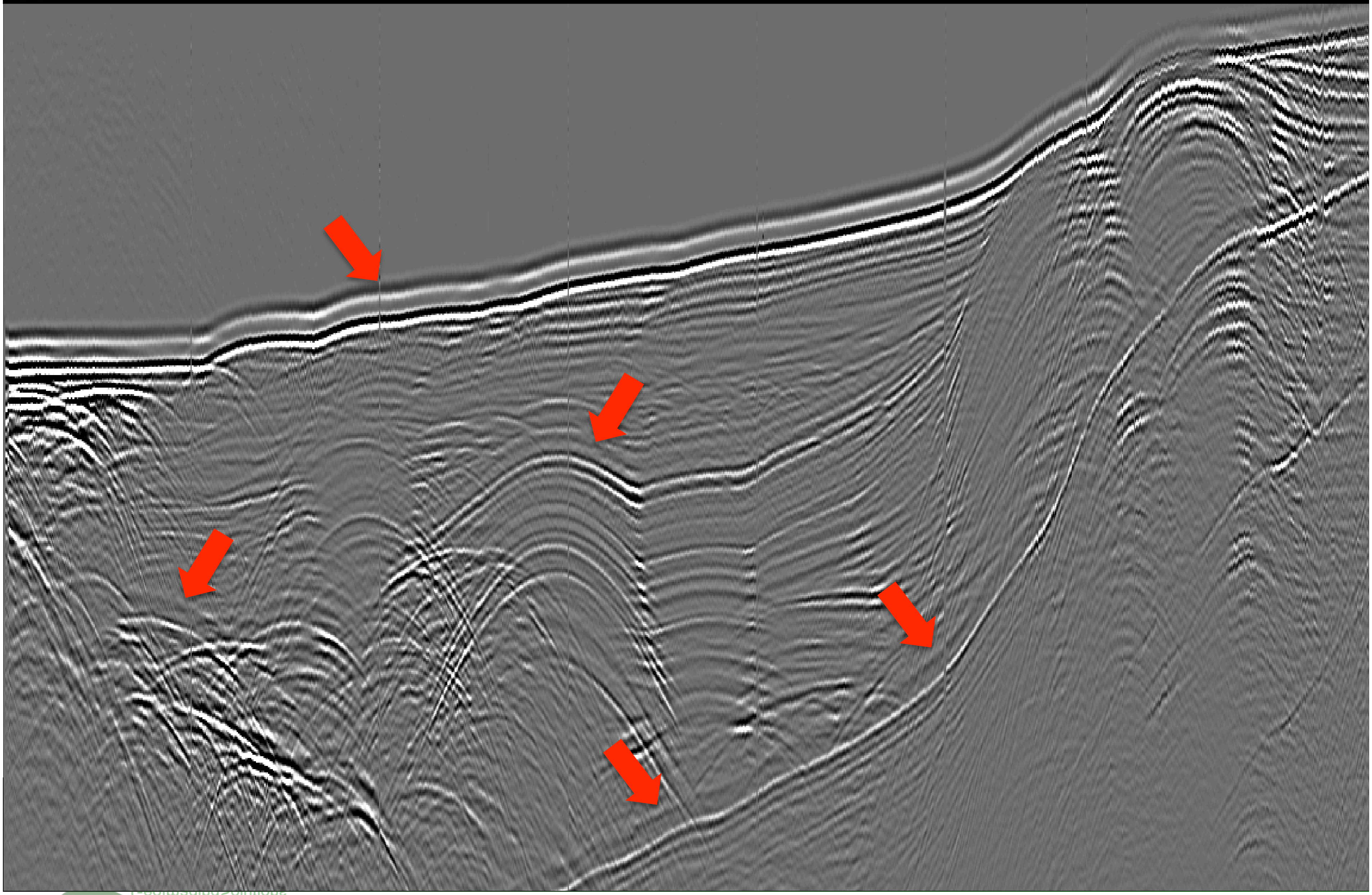
- Ricker decon:
  - Filter coefficients are constrained (odd part goes smoothly to zero)
  - Wavelet is Ricker-like
  - Analytical (fast), less accurate
- Sparse log-decon:
  - Filter coefficients don’t need to be constrained
  - Wavelet can have any shape
  - Optimization (slow), more accurate

Data Locations

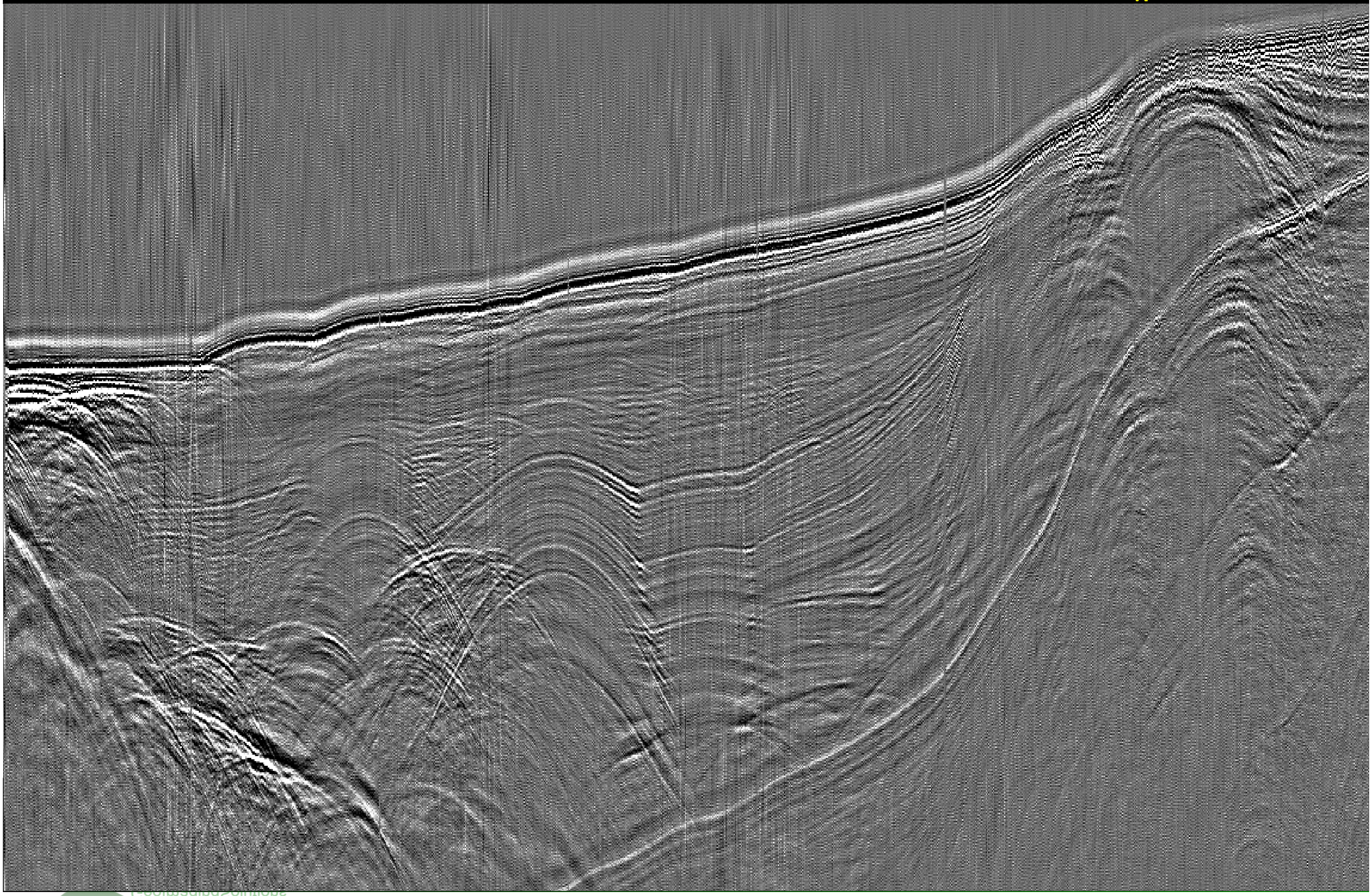


[Conclusion]

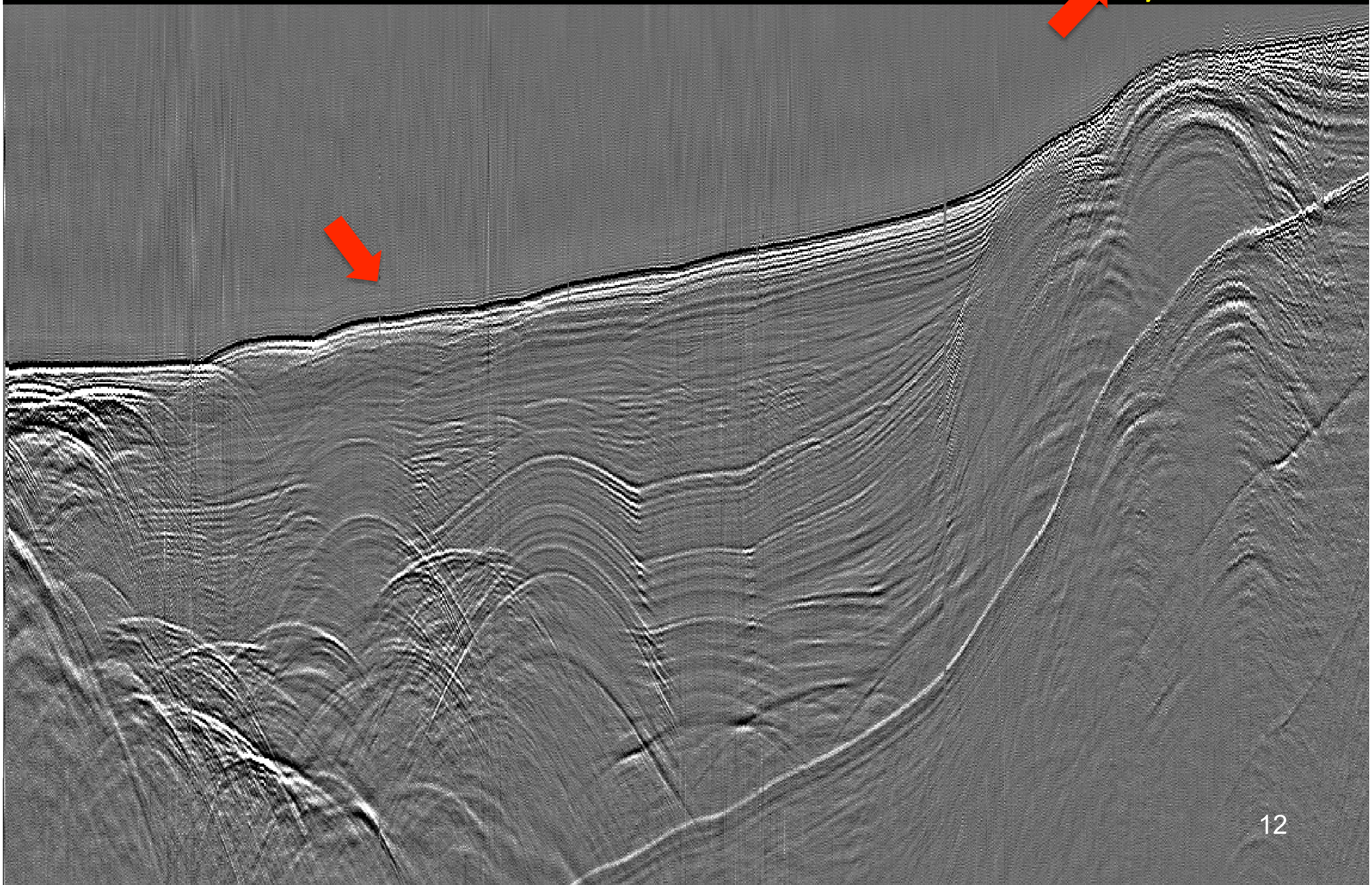
California: Input



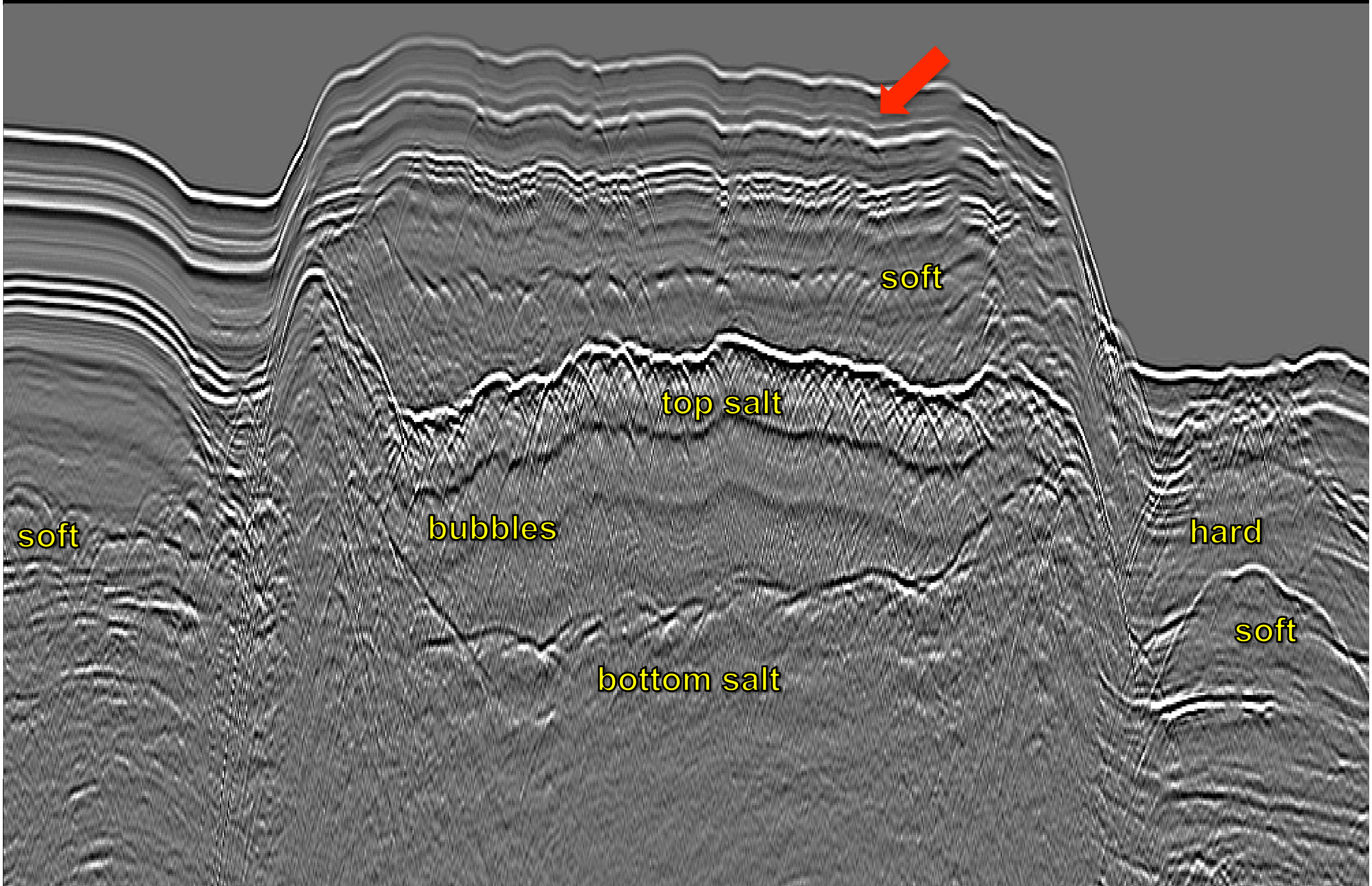
California: Ricker decon



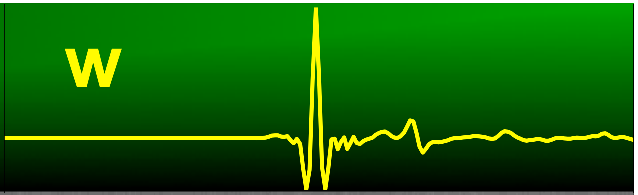
California: Inversion

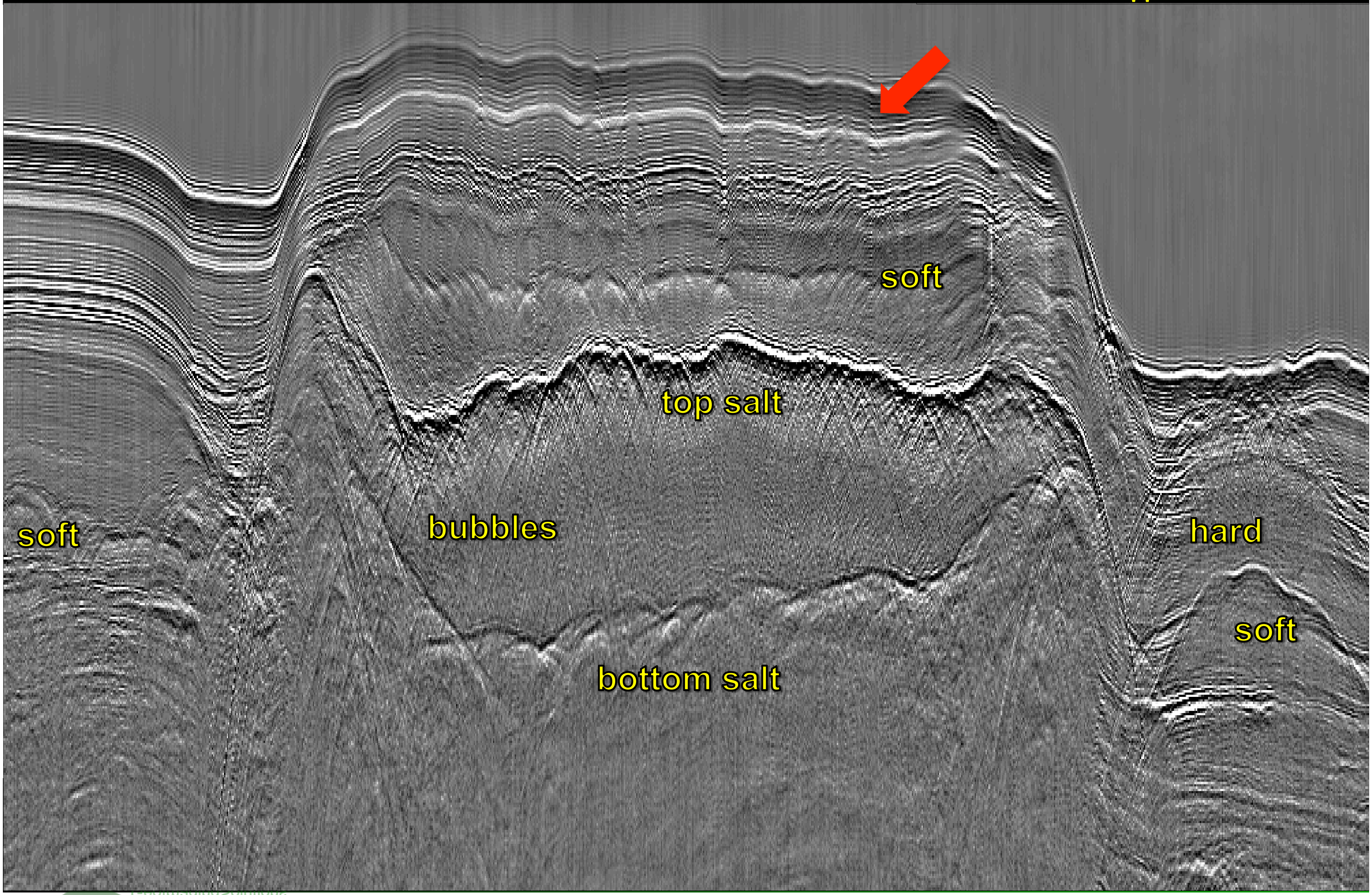


GoM: Input



GoM: Ricker decon





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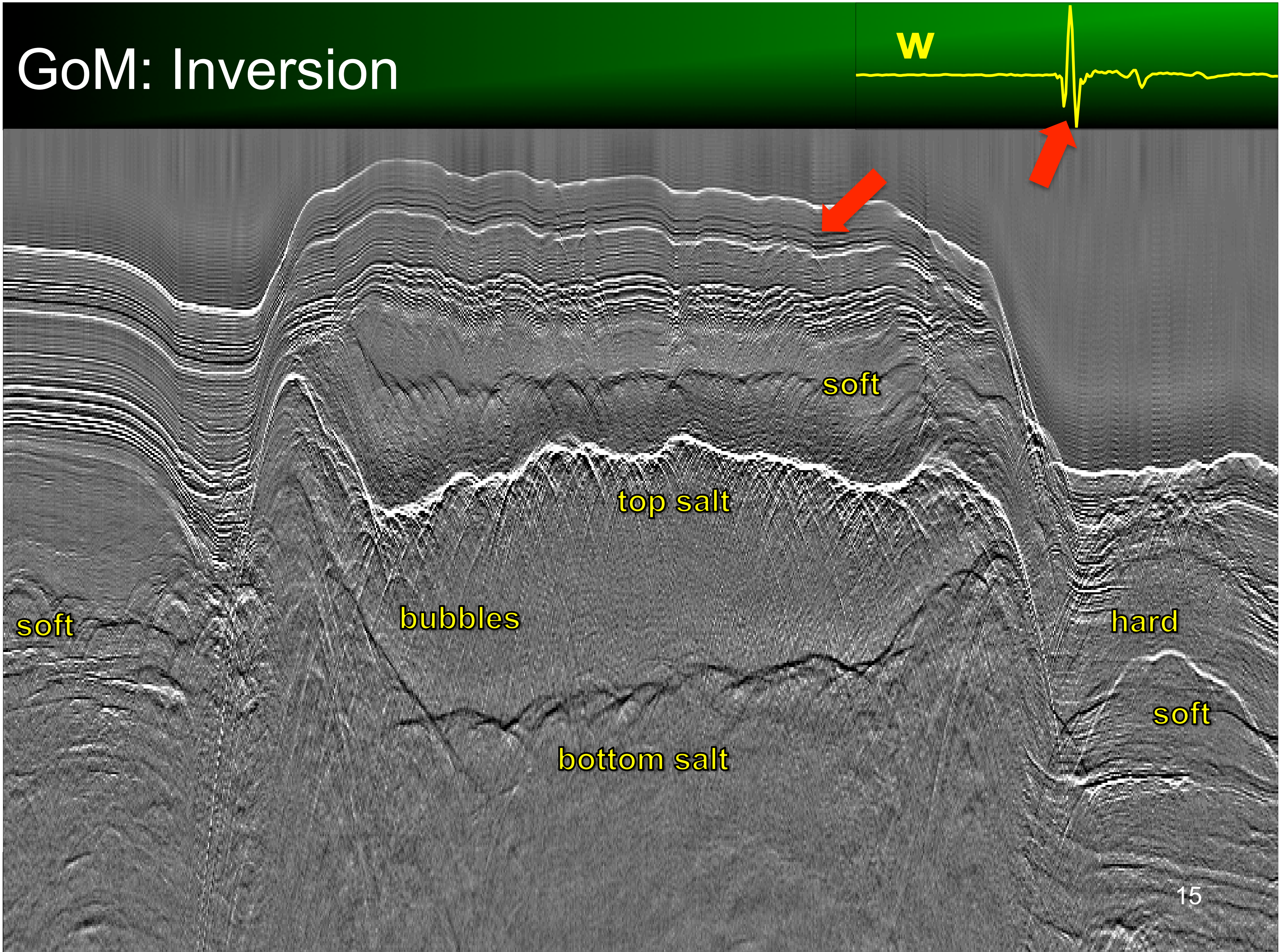
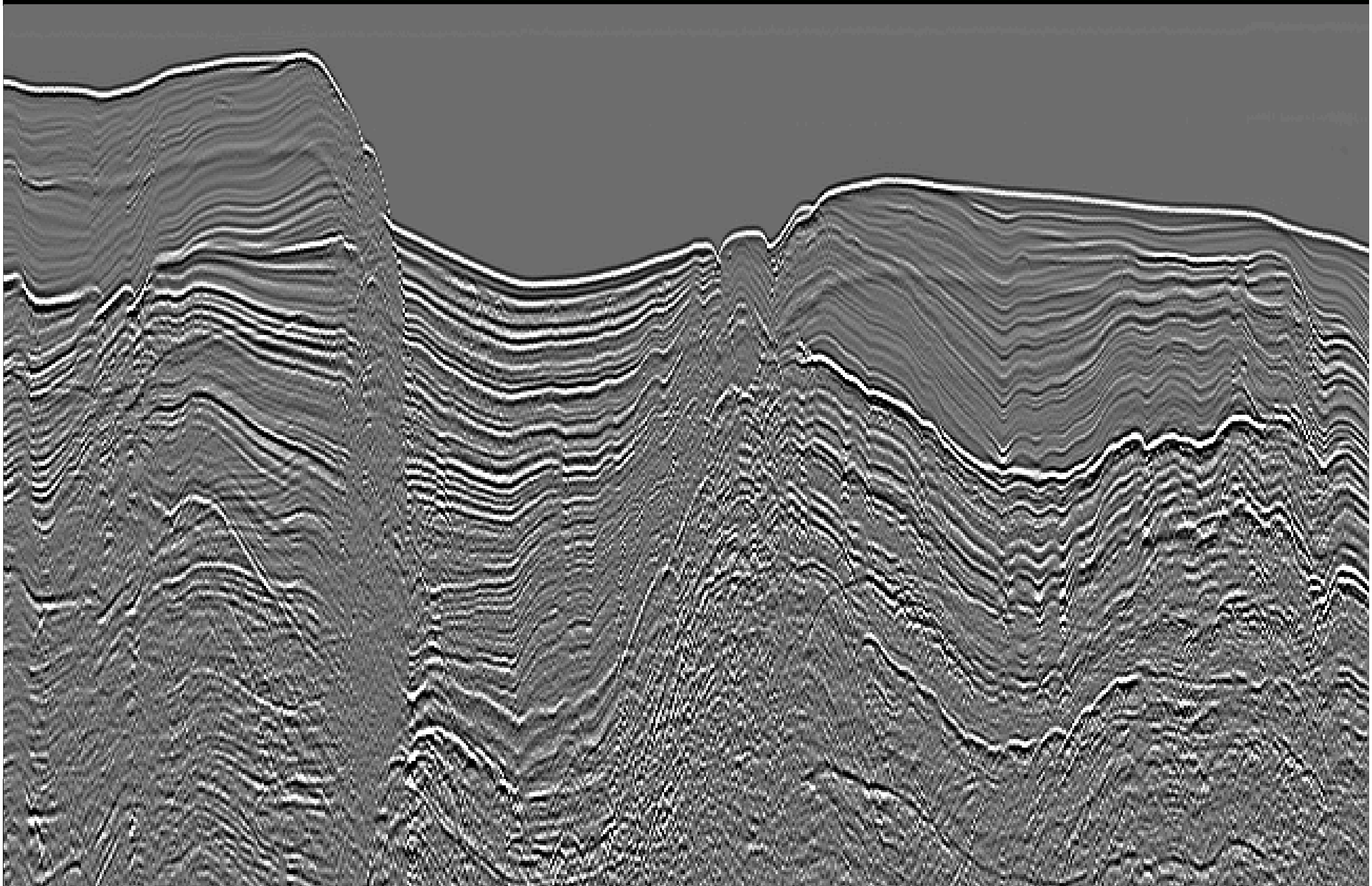
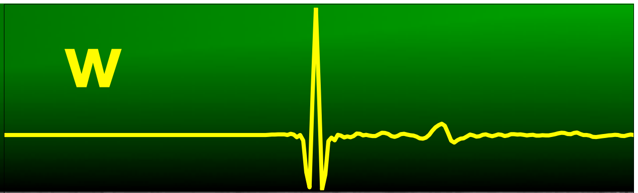
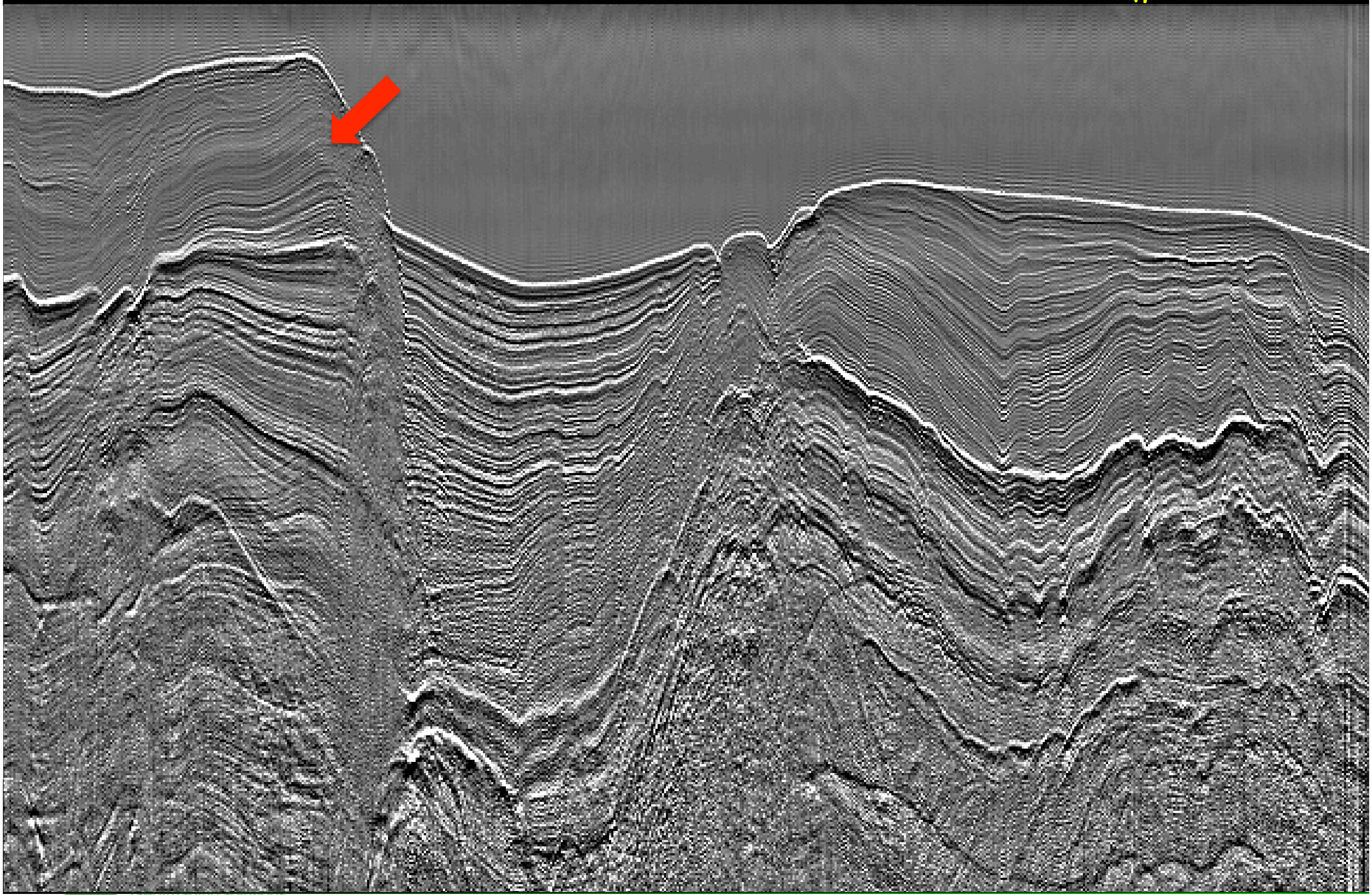


Baja: Input



Baja: Ricker decon





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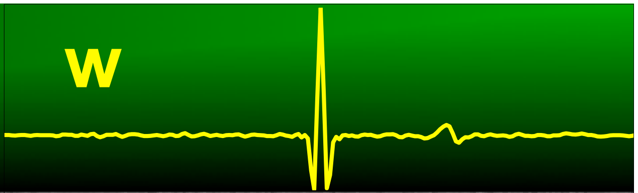
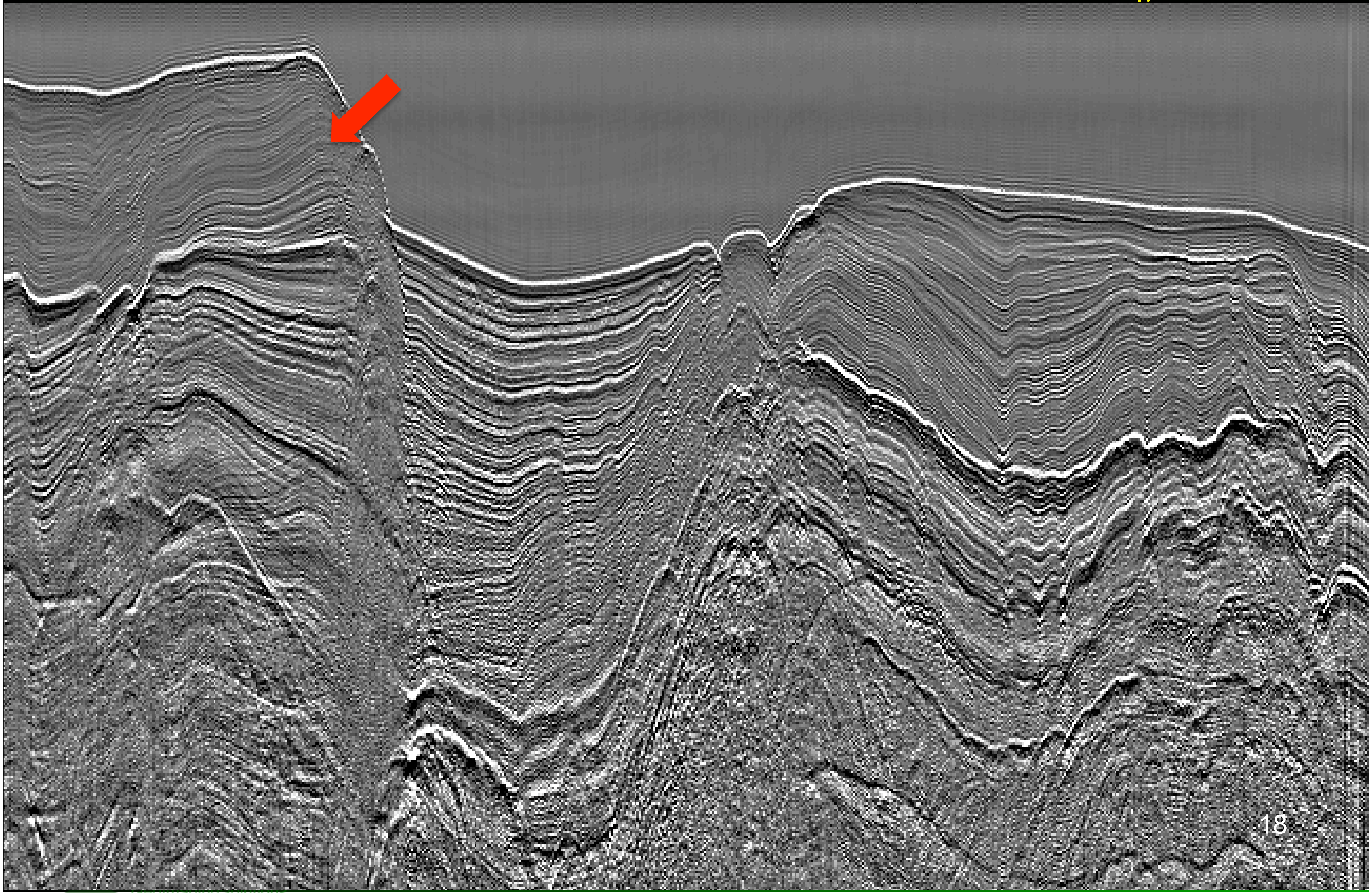
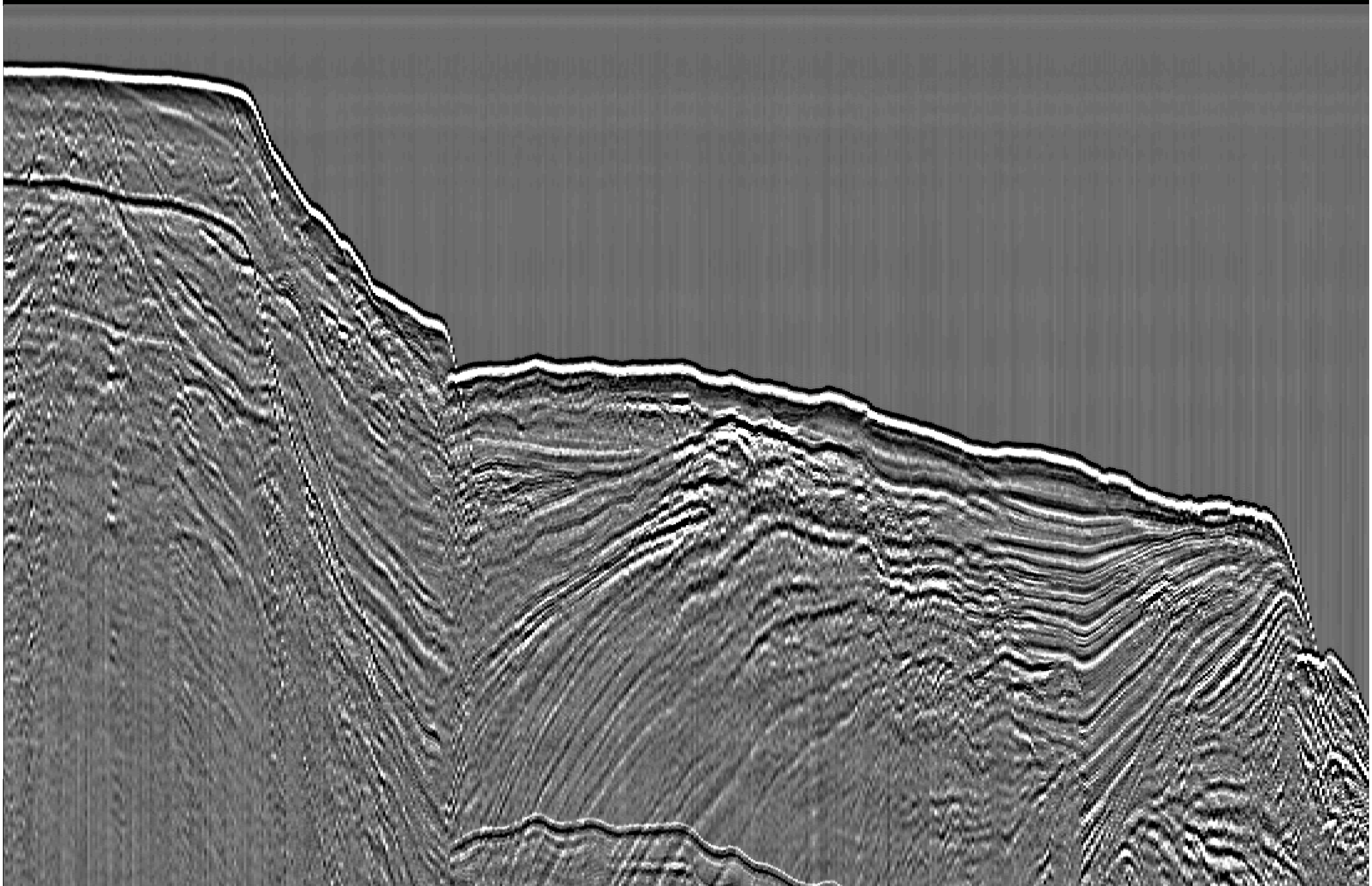
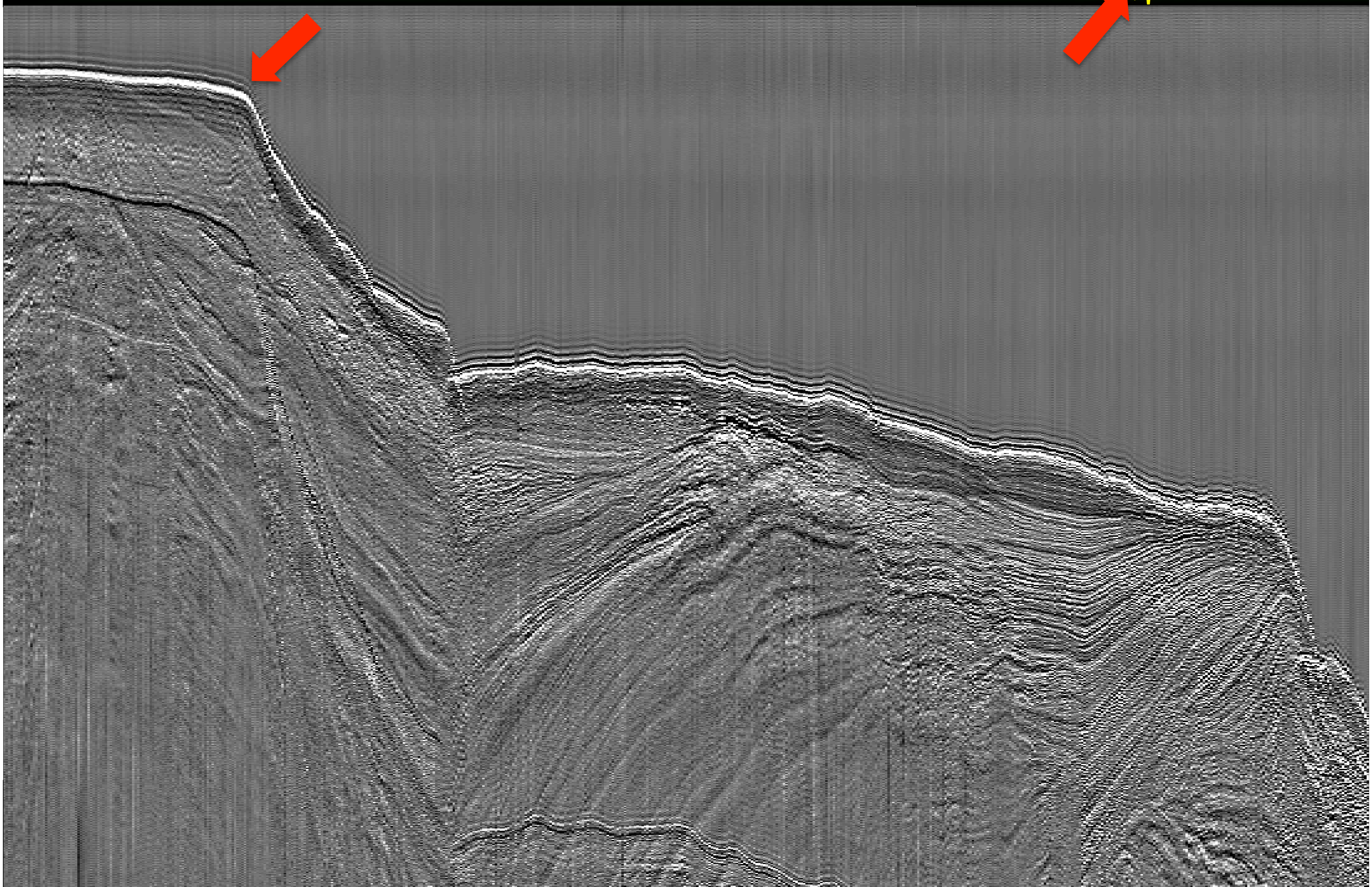




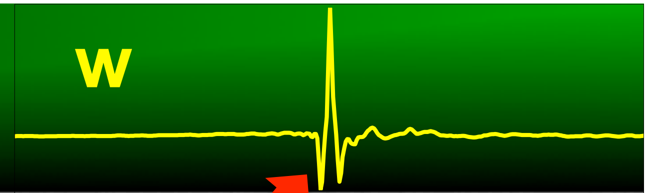
Cascadia - a: Input

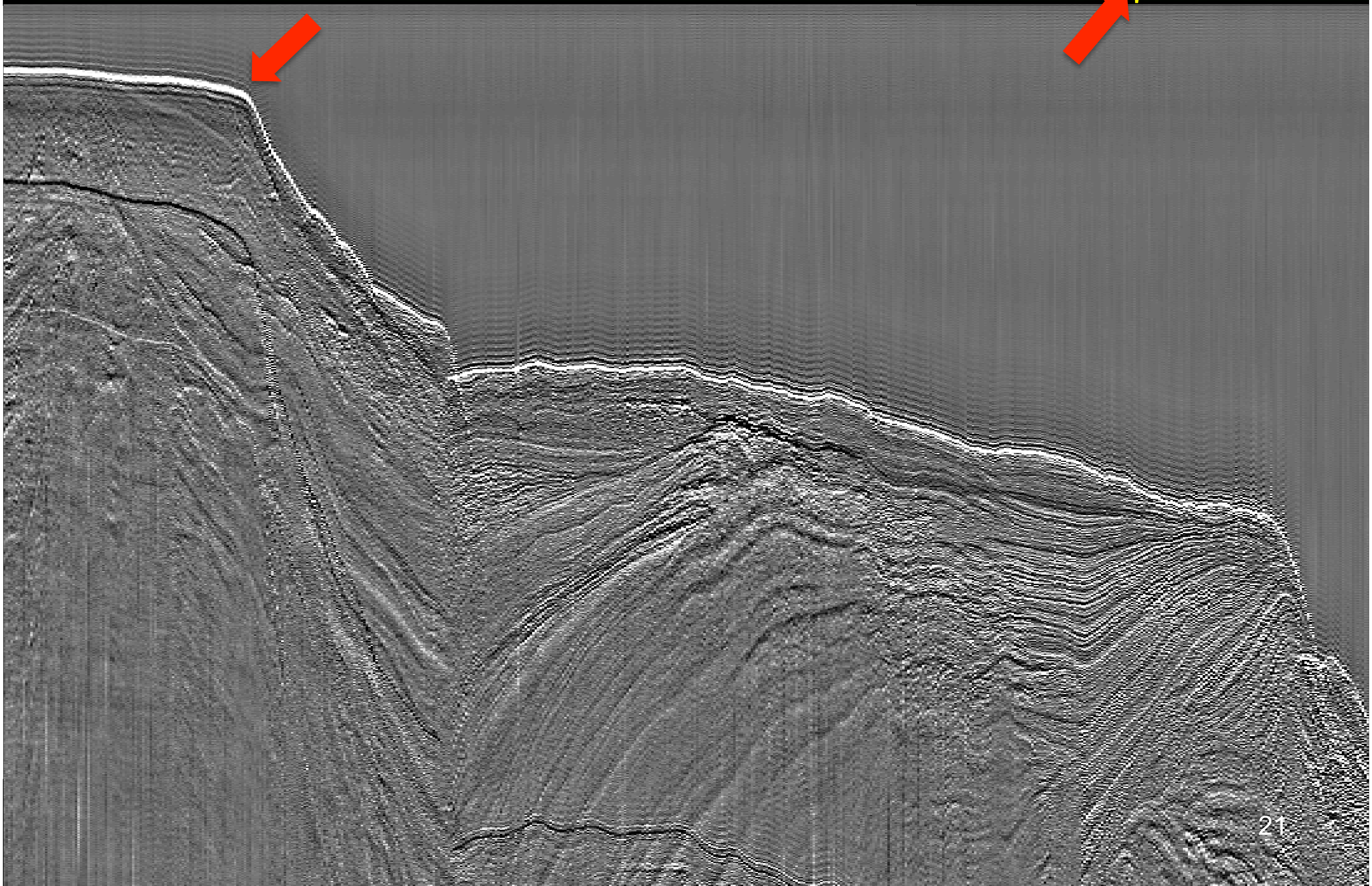


Cascadia - a: Ricker decon

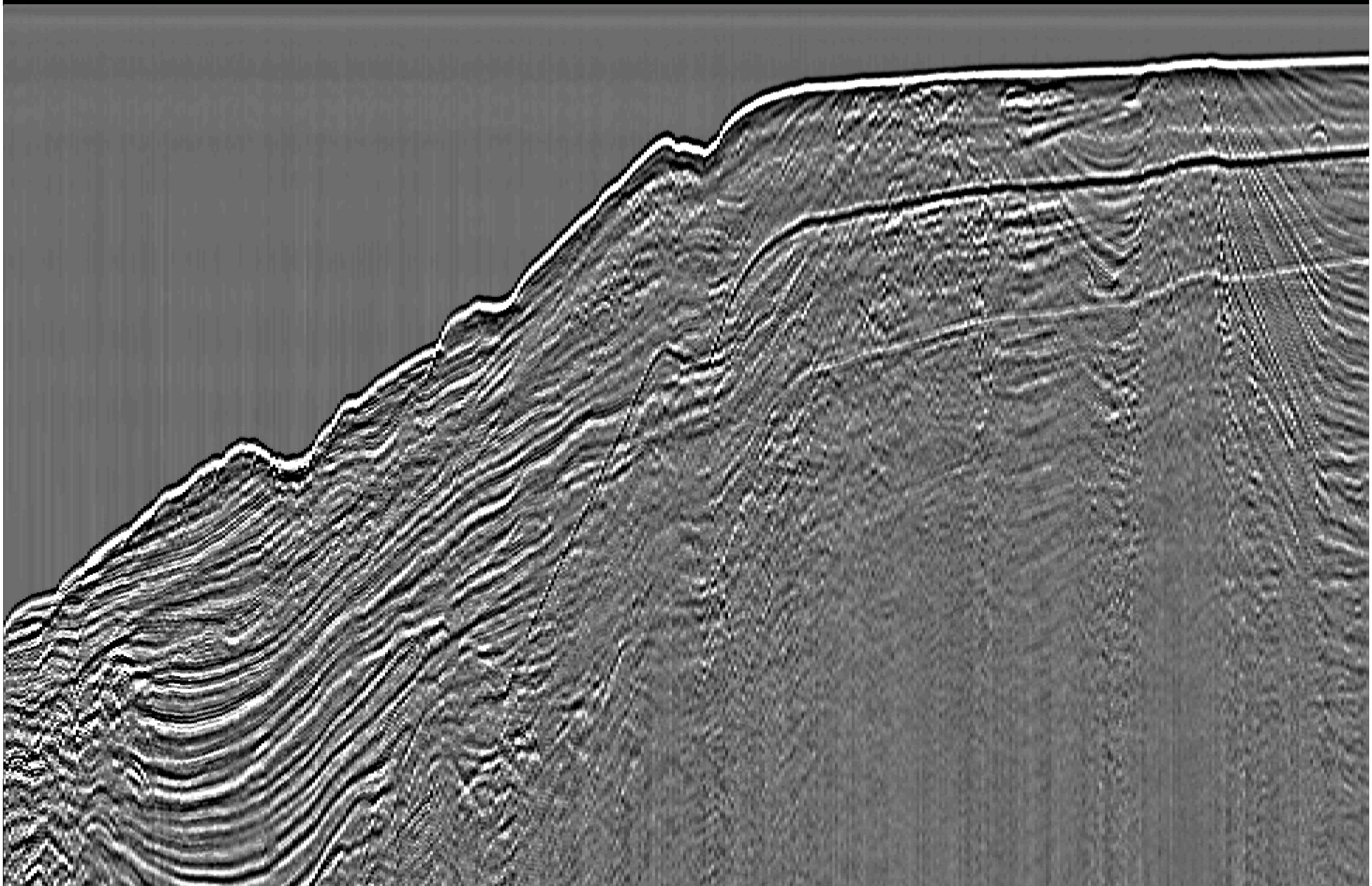


Cascadia - a: Inversion

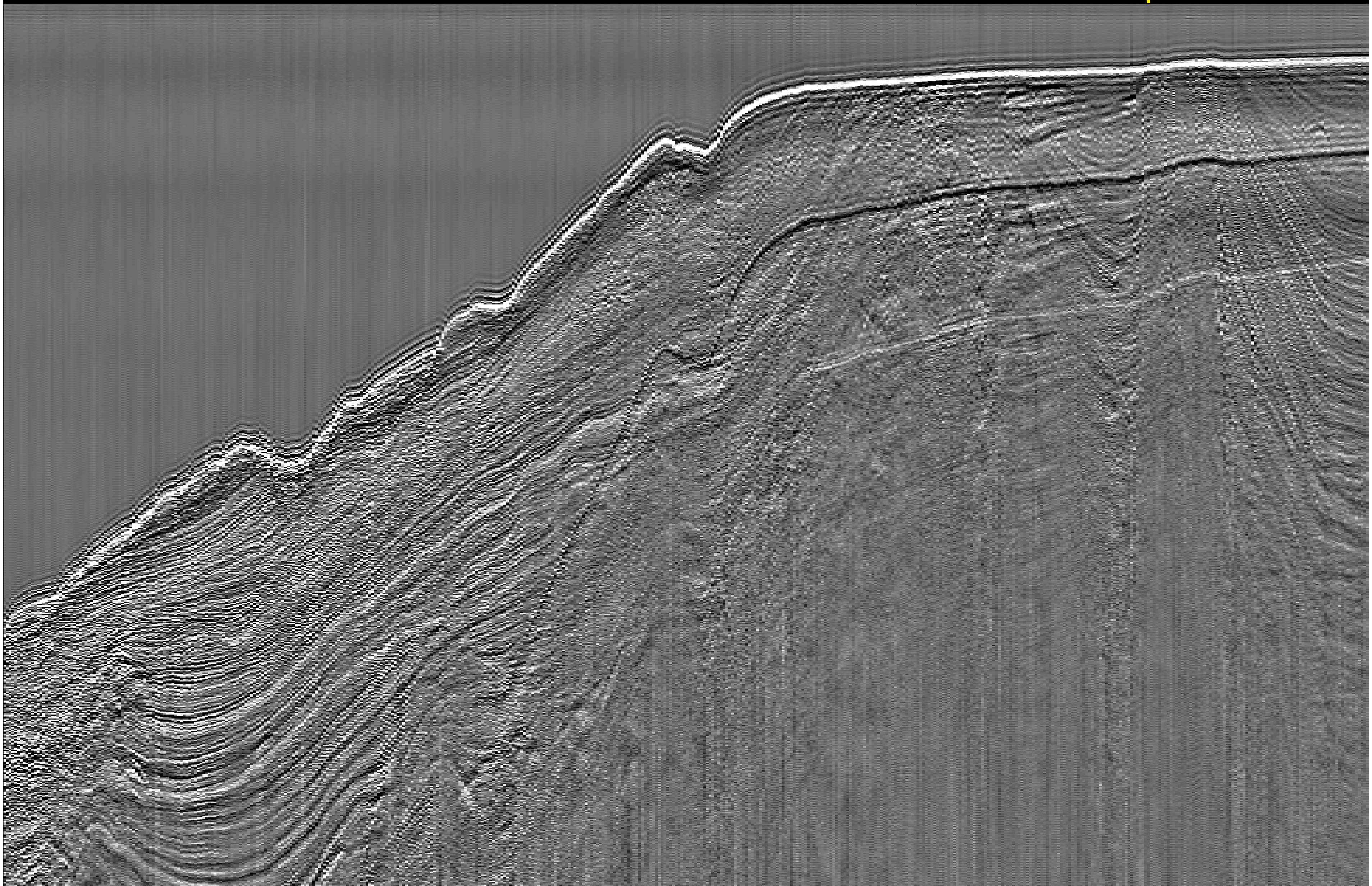




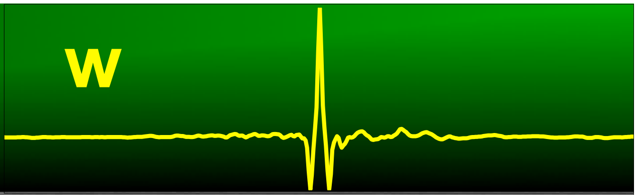
Cascadia - b: Input

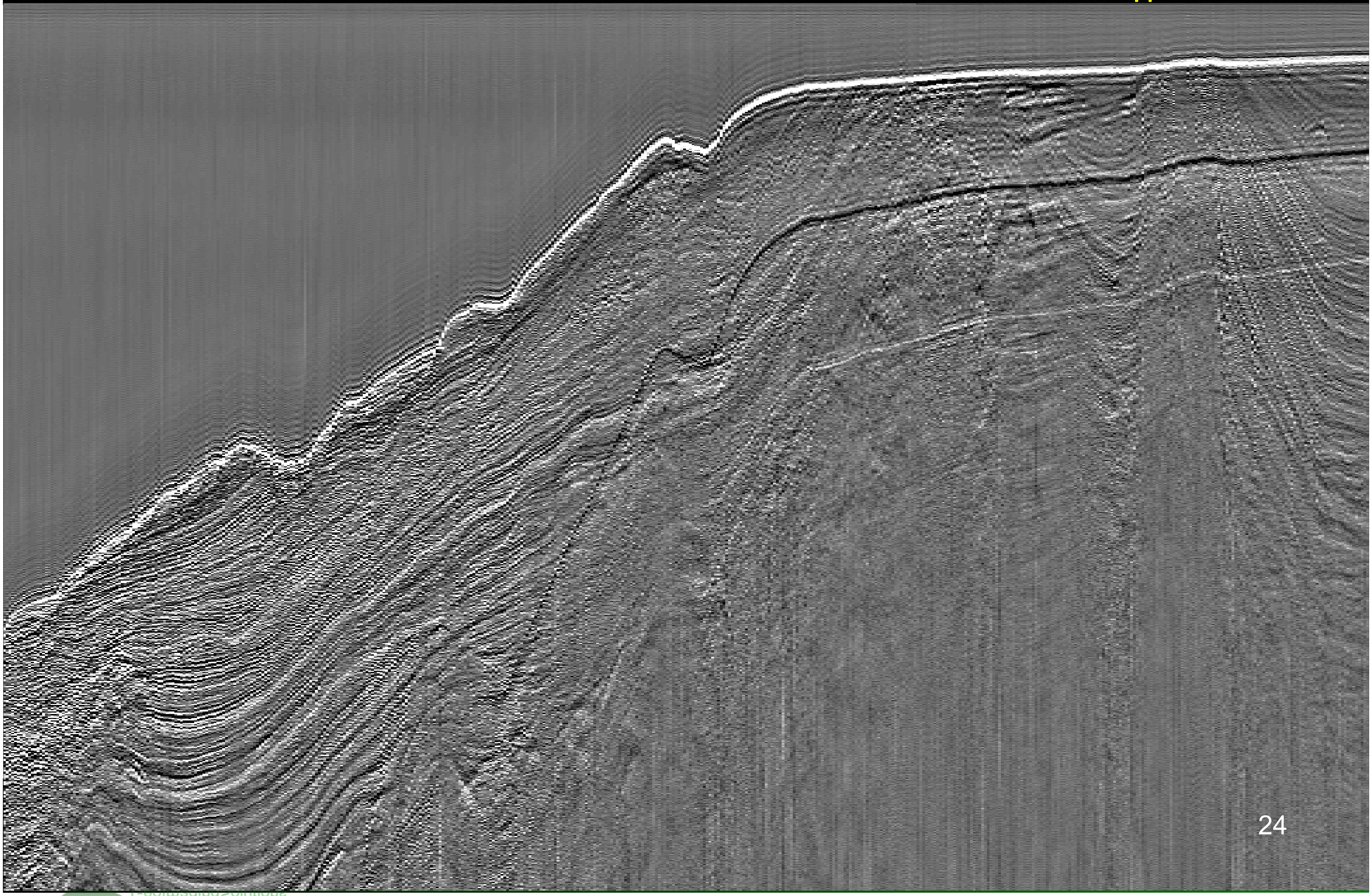


Cascadia - b: Ricker decon

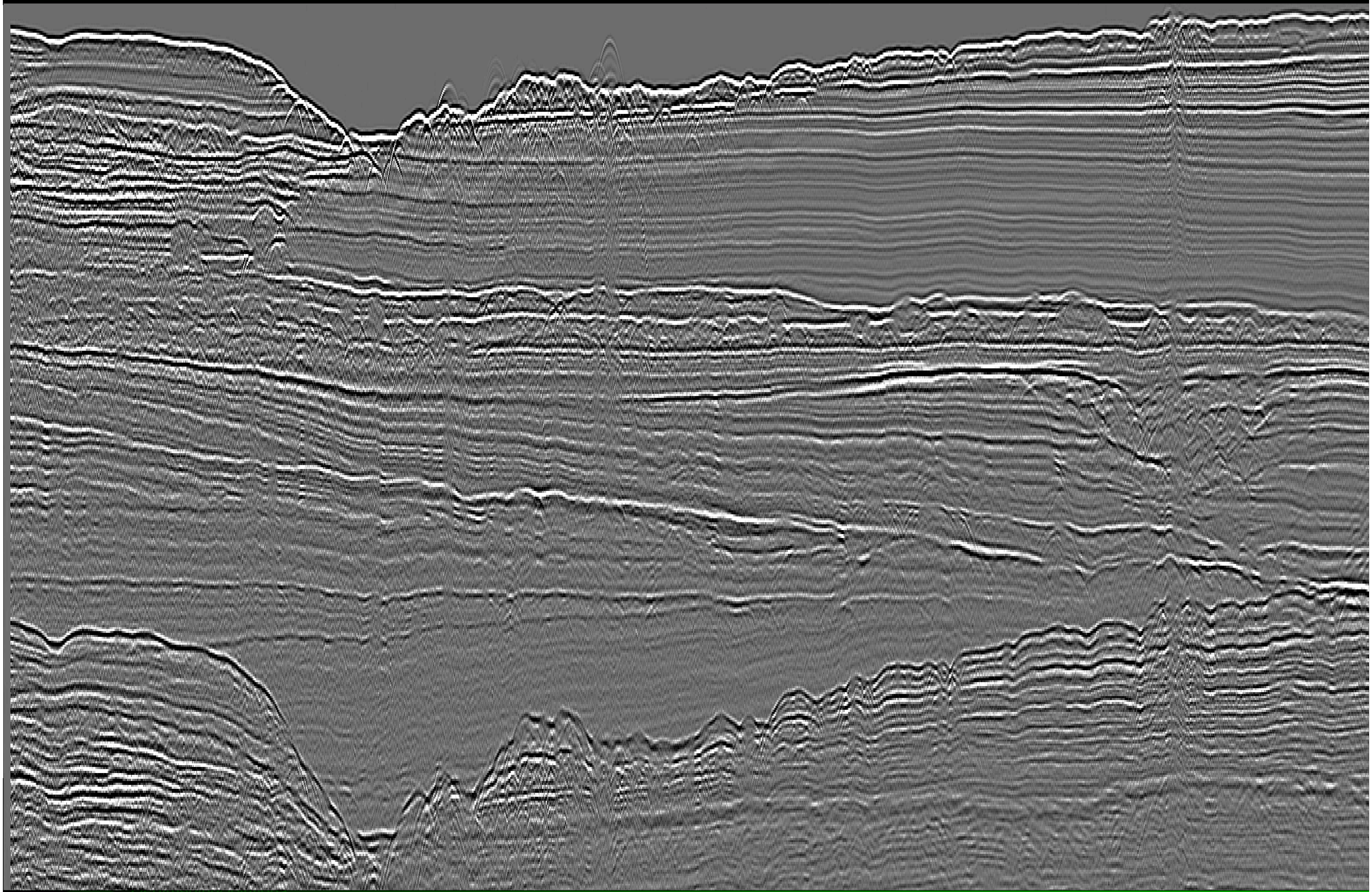


Cascadia - b: Inversion

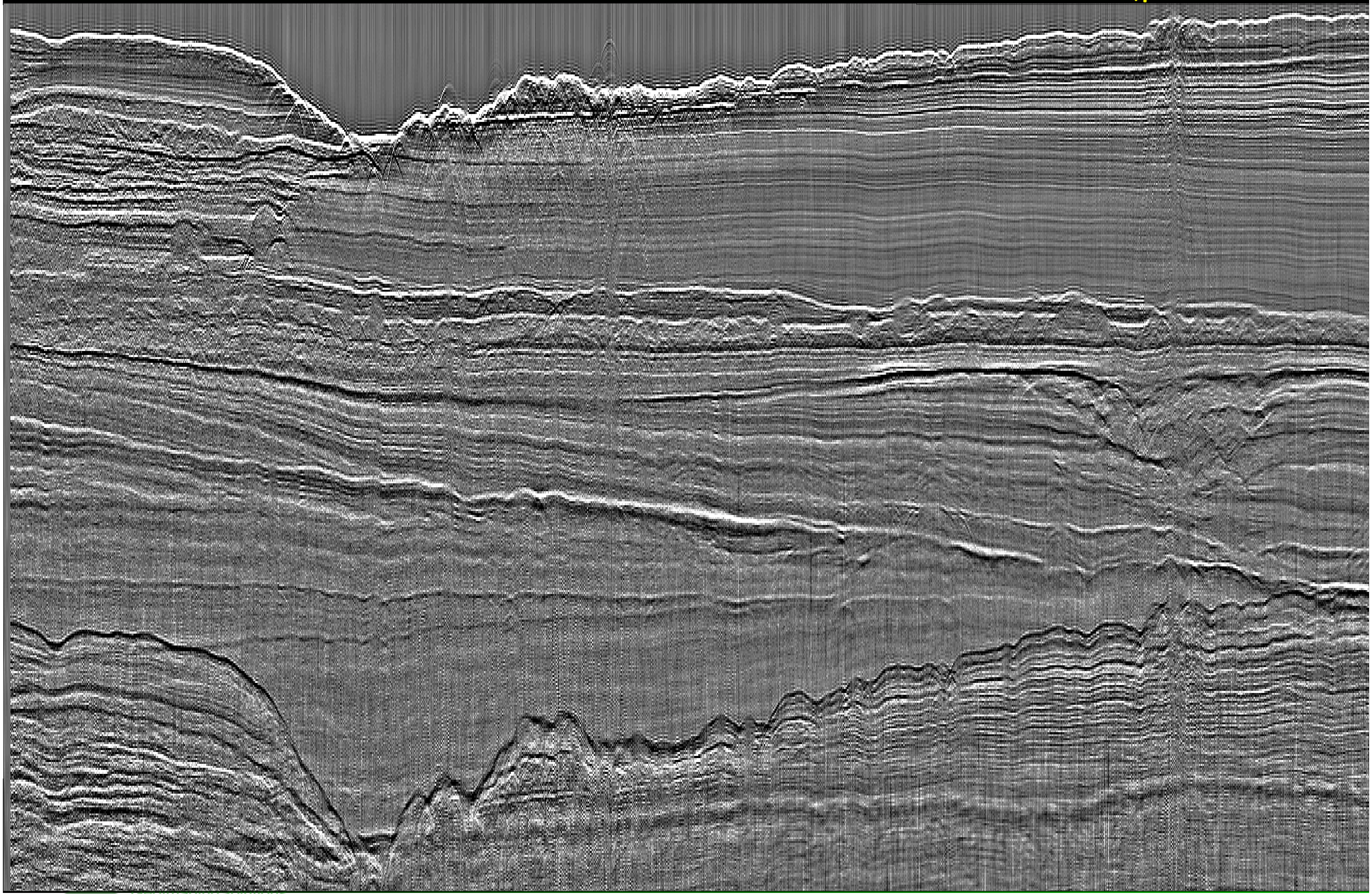




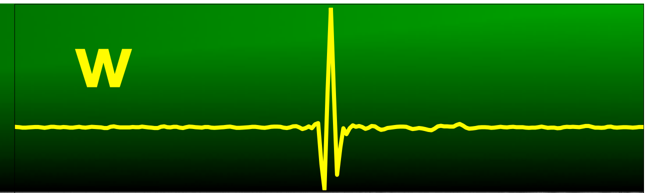
Australia: Input

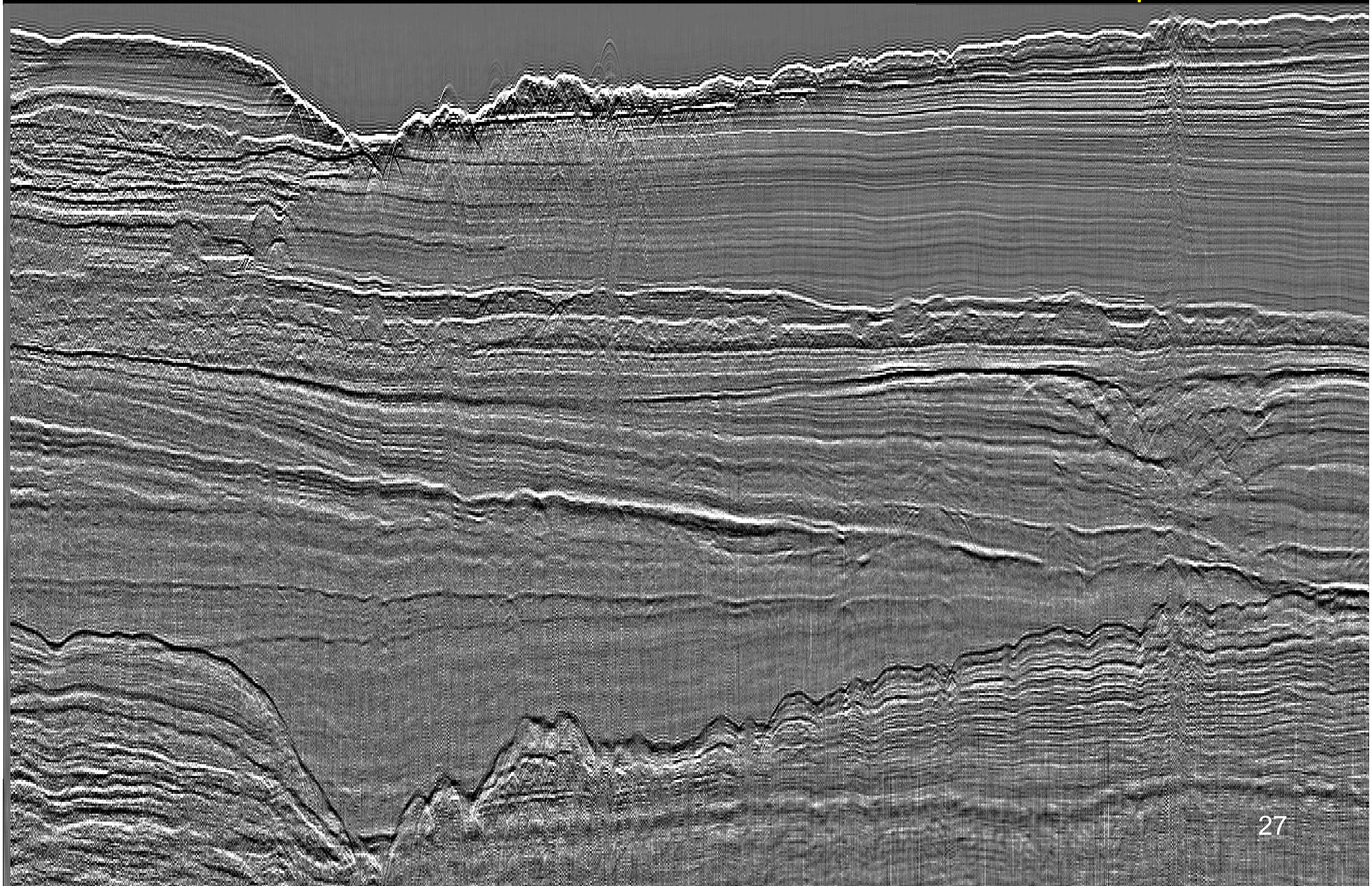


Australia: Ricker decon



Australia: Inversion





Conclusions

- Sparse-decon yields similar to better results than Ricker-decon approach
  - Accommodate difficult “un-Ricker” wavelets
  - Usually cleaner
- Sparse-decon results are not always sparse!
  - our assumption is often wrong
- Sparse-decon yields very good wavelets
  - Polarity becomes very obvious
- Sparse-decon needs to be improved
  - Non-stationarity needed (angle,time,etc…)

Acknowledgments

WesternGeco

Chevron Australia