Multiple attenuation using a high-resolution time-domain Radon transform

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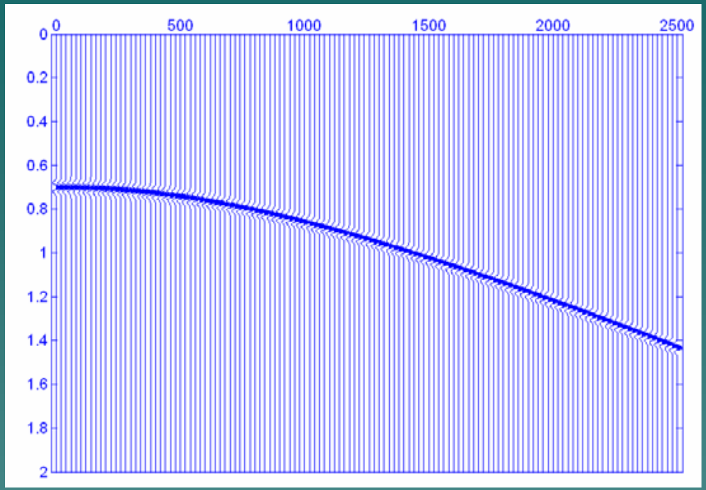
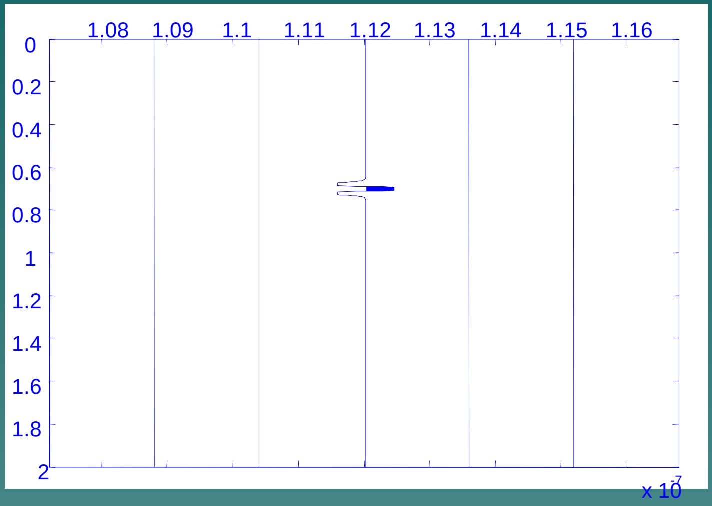
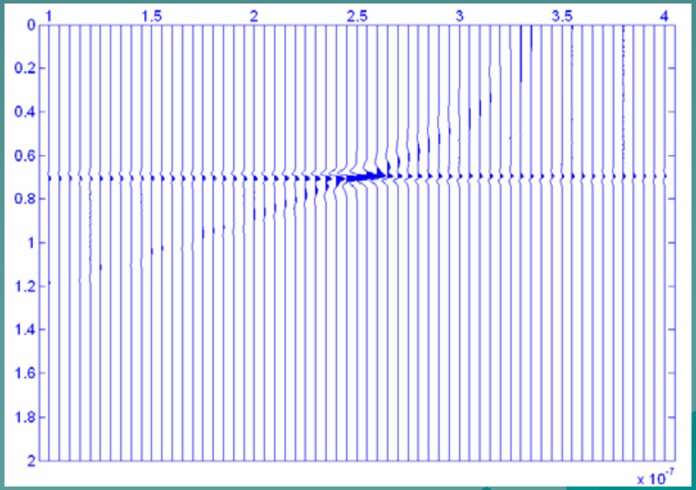
Outlines

- Brief review to the Radon transform
- The high-resolution time-domain Radon transform
- Data examples
- Conclusions
- Acknowledgements

The Radon transform

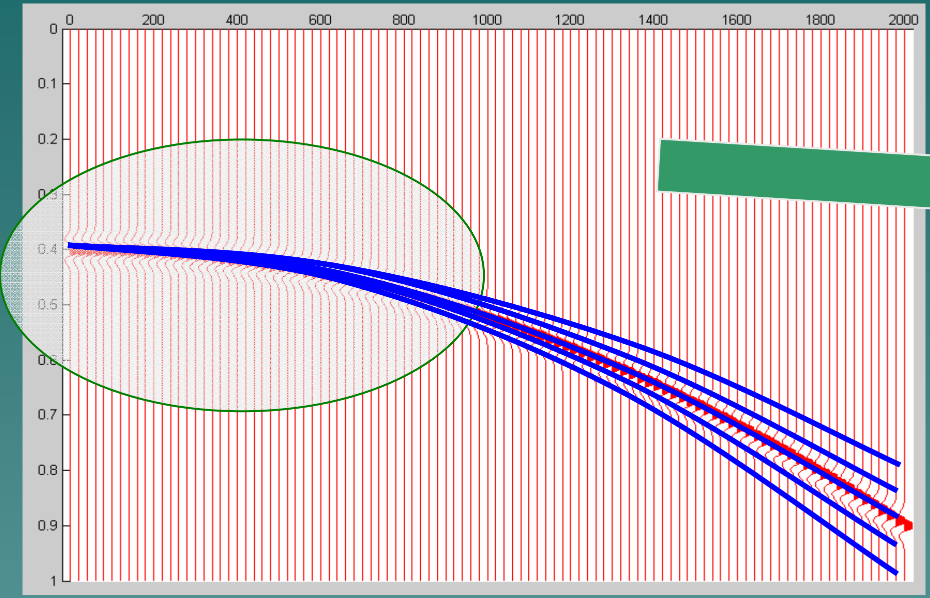



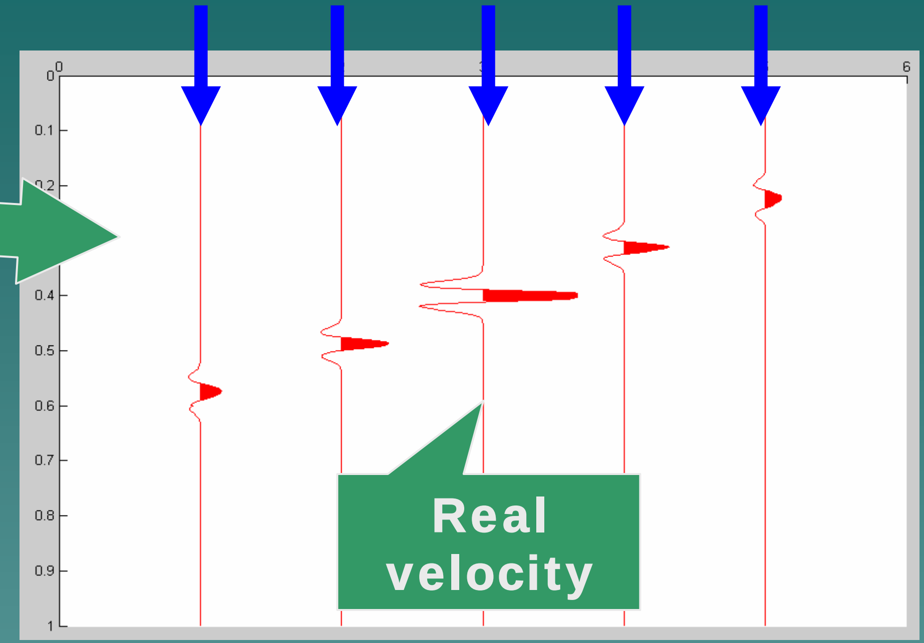
The ideal Radon transform

Why? What can we do about it?

The Radon transform





CMP gather

Radon panel

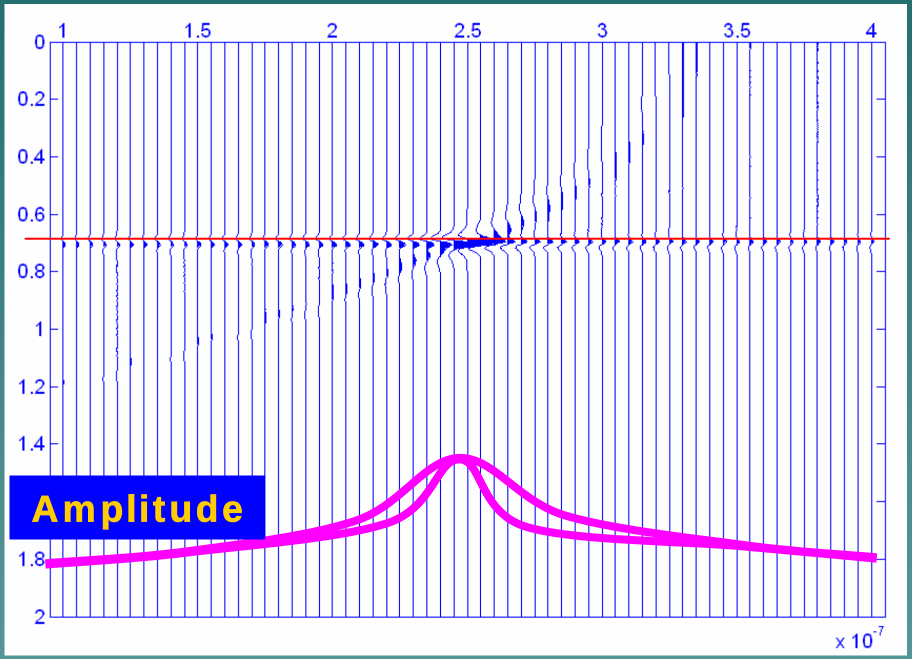
-Near offsets data are repeatedly transformed into the Radon domain;

-Near offsets energy sharing causes smearing problem.

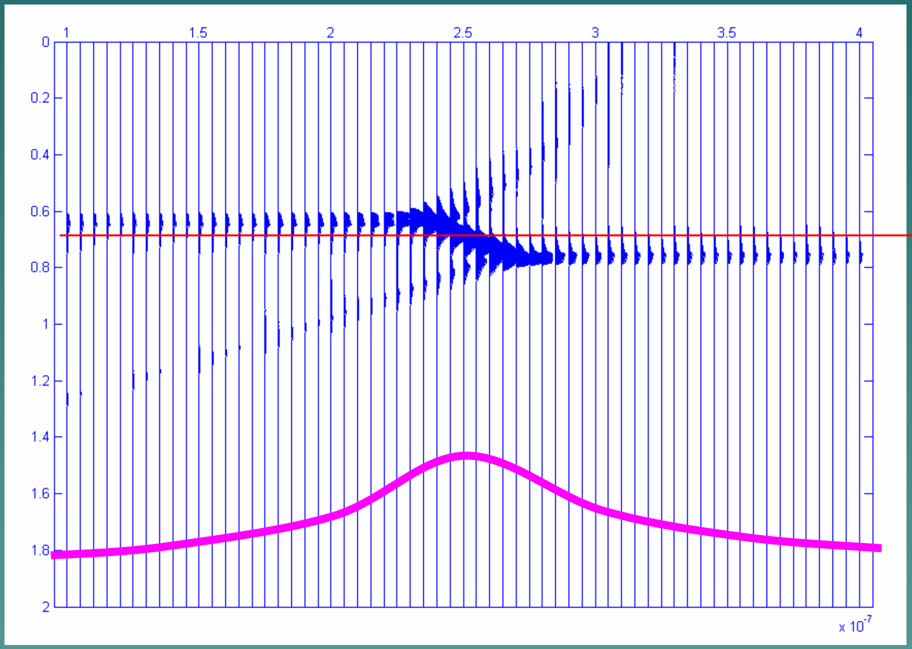
The high-resolution Radon transform

- Step 1 – semblance weighting
  - – Weighting the transform with the semblance of the input gather;
  - – Semblance is independent of amplitudes of events and ranges from 0-to-1;
  - – Semblance is coherency measurement.
- Step 2 - sorting
  - – Find out the most important traces in the Radon domain;
  - – First transform data along these important traces and remove the corresponding data from the input gather.

The high-resolution Radon transform



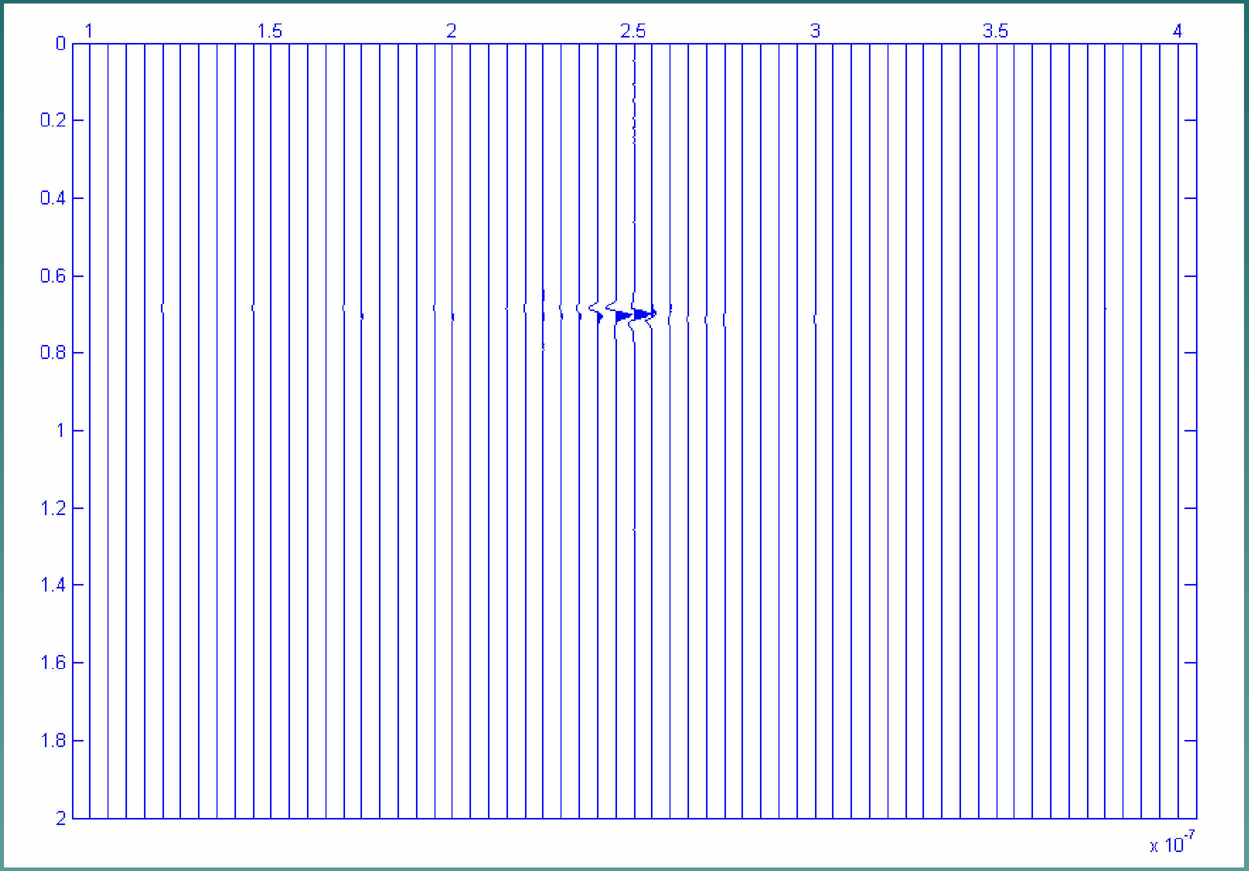
Radon panel



Semblance plot
0 ~ 1

What if we weight the Radon panel by the semblance plot?

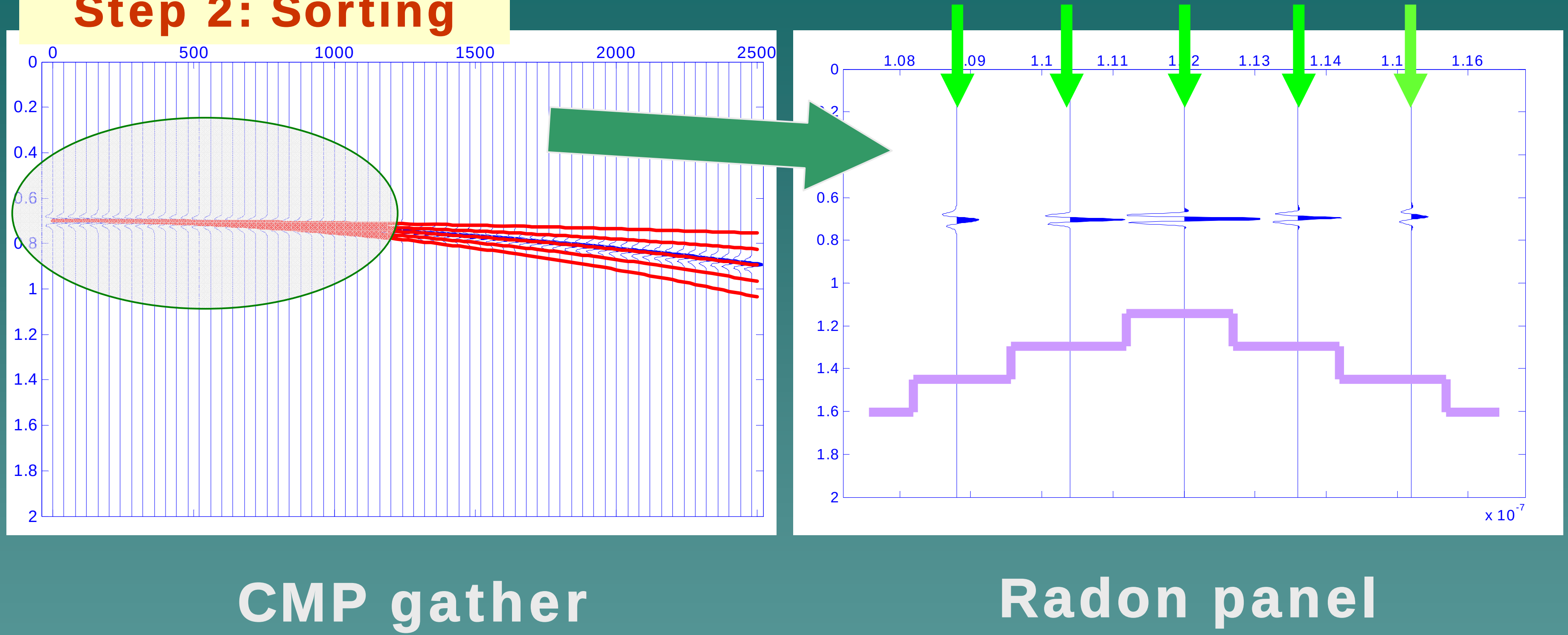
The high-resolution Radon transform



The Radon panel by weighting the conventional Radon transform with the semblance plot

The high-resolution Radon transform

Step 2: Sorting

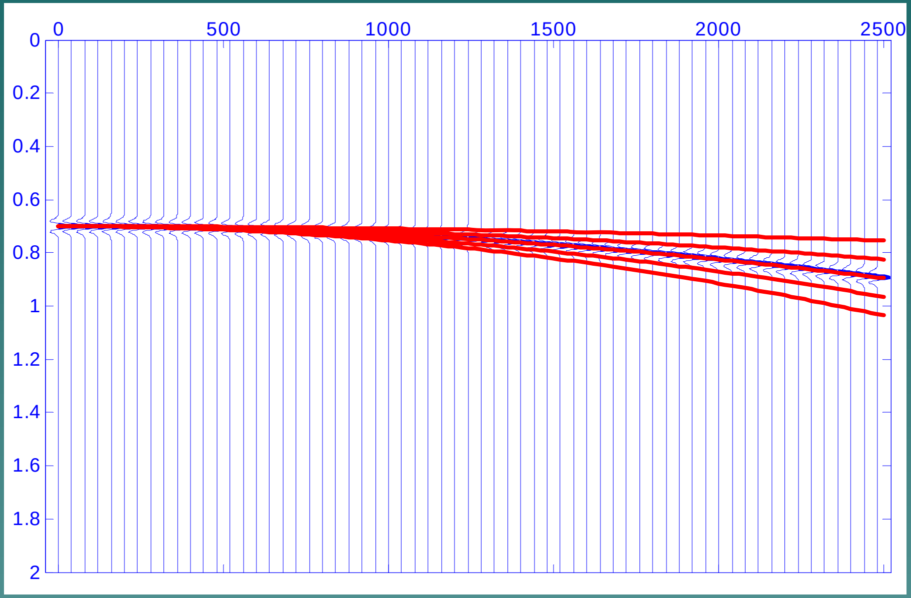


-Near offsets data are repeatedly transformed into the Radon domain, which causes smearing problem;

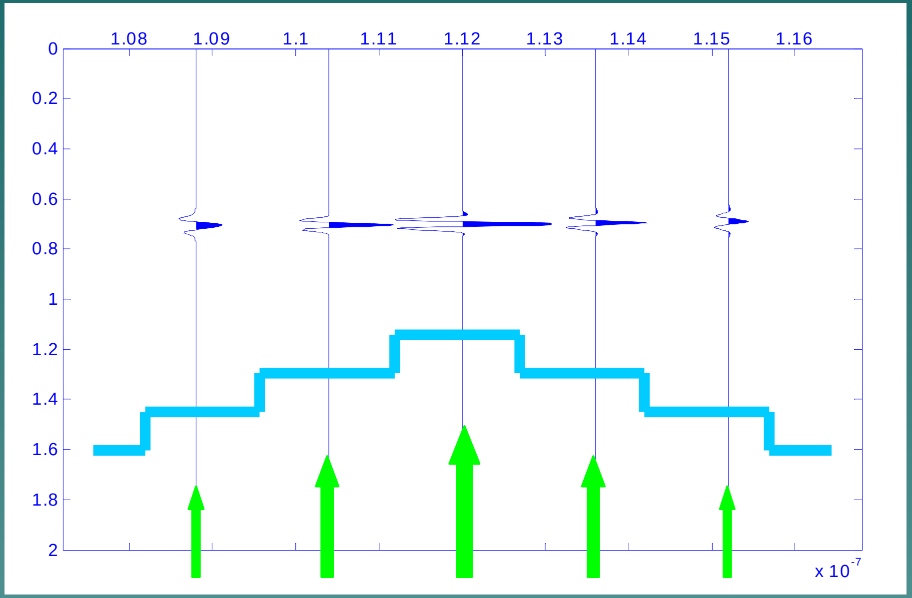
-How to avoid transforming data repeatedly?

-If it is avoided, can we reduce the smearing?

The high-resolution Radon transform



CMP gather

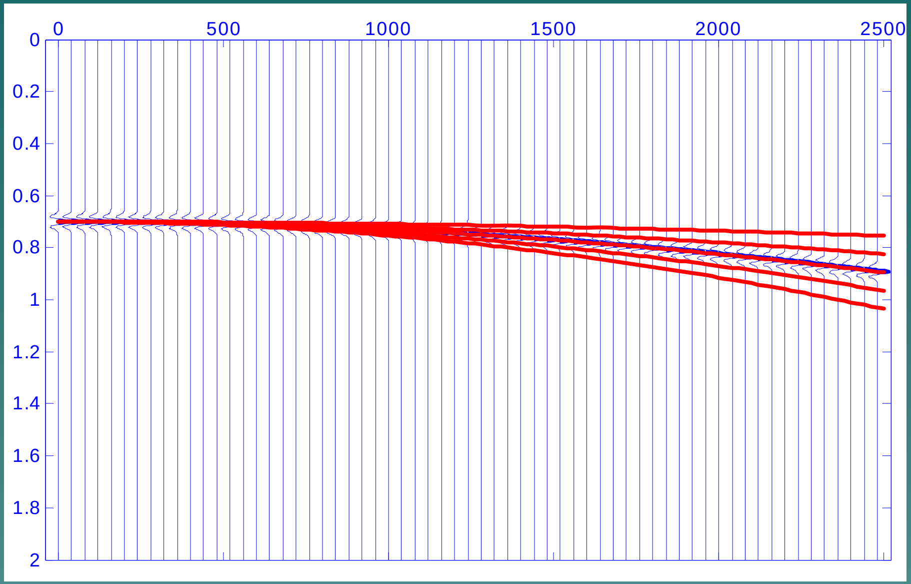


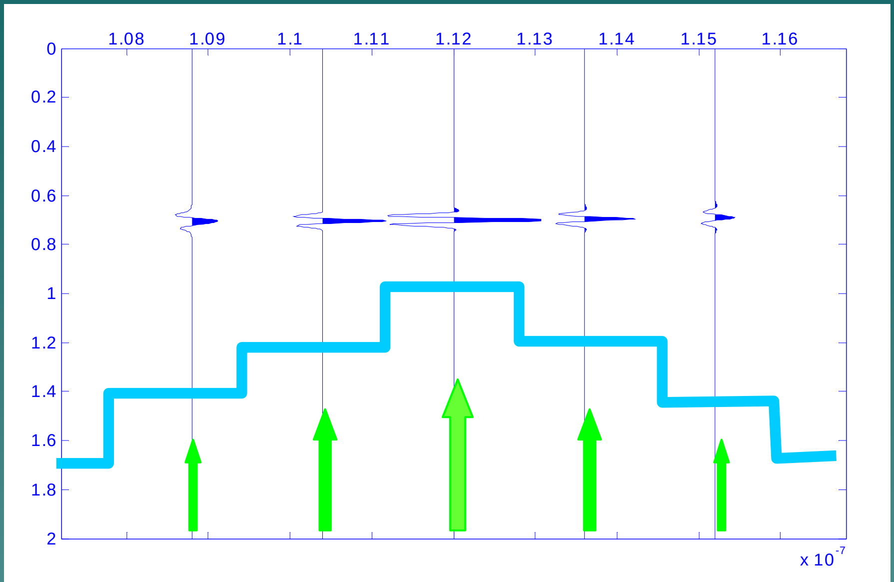
Radon panel

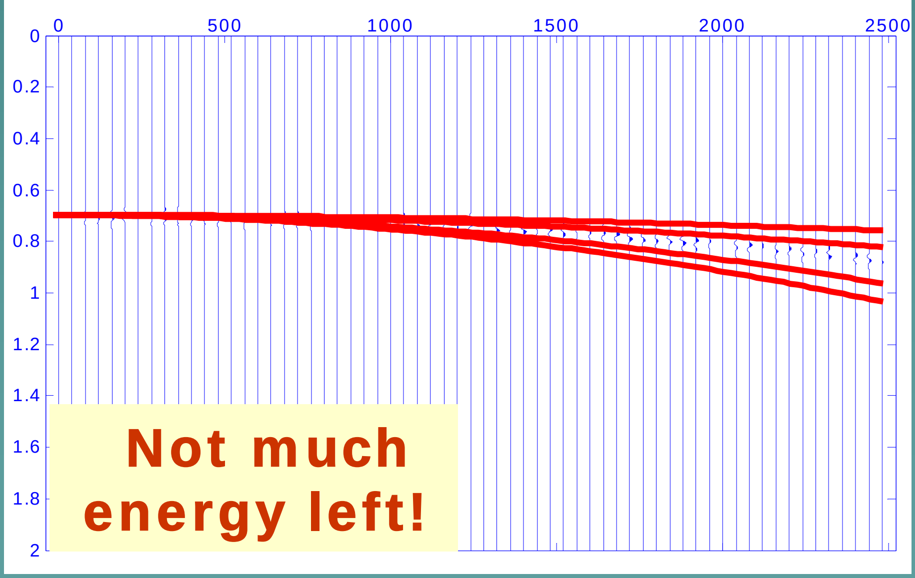
-Once a Radon panel is obtained by the semblance-weighted method, energy along each trace is estimated;

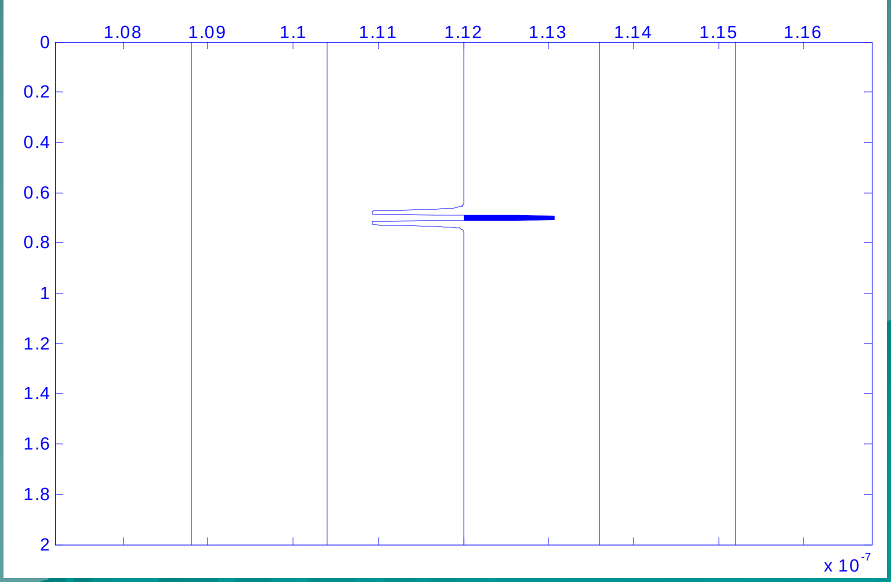
-A new turn of Radon calculation is first performed along the most powerful trace and corresponding data will be removed from the input.

The high-resolution Radon transform





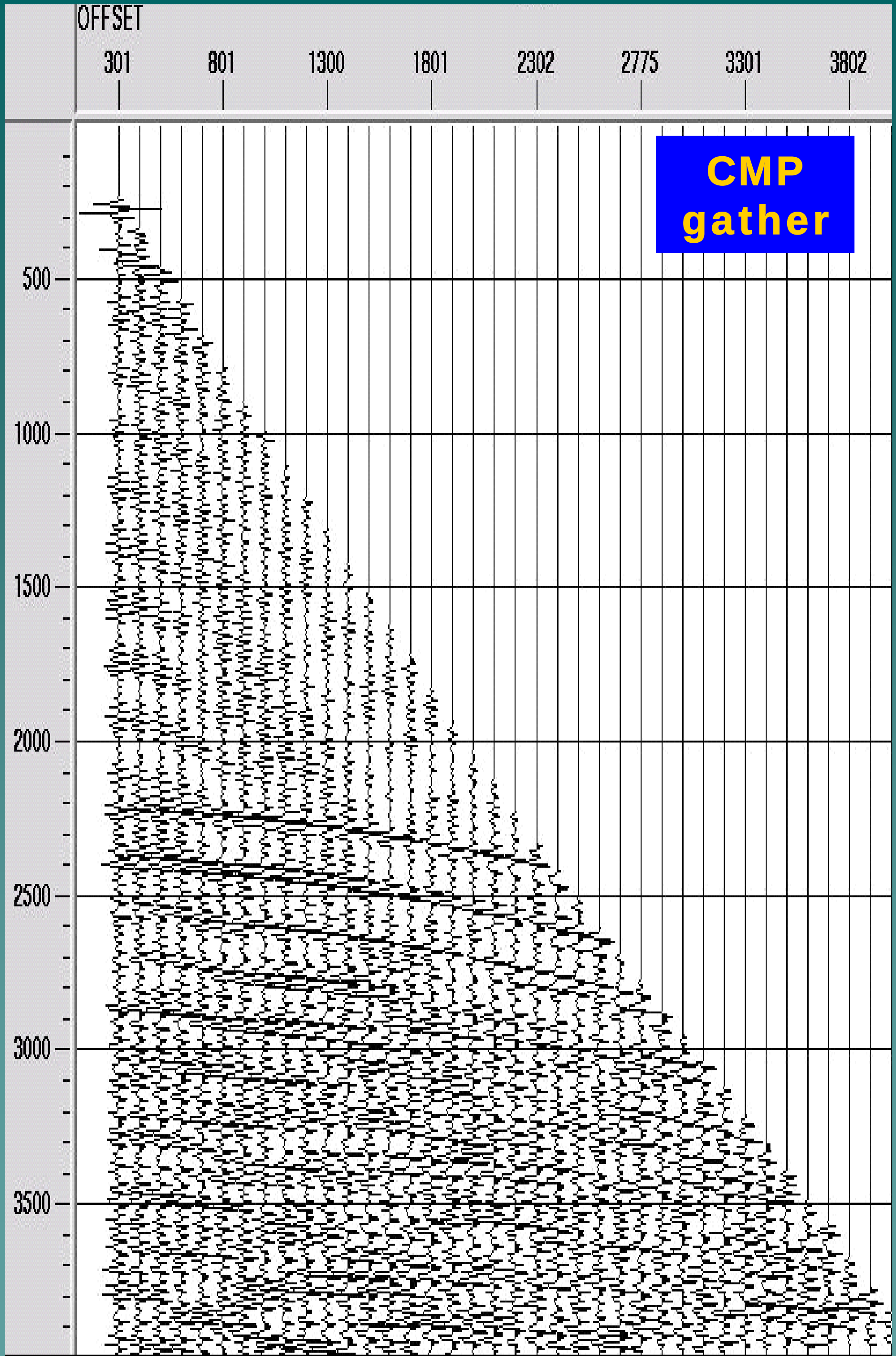




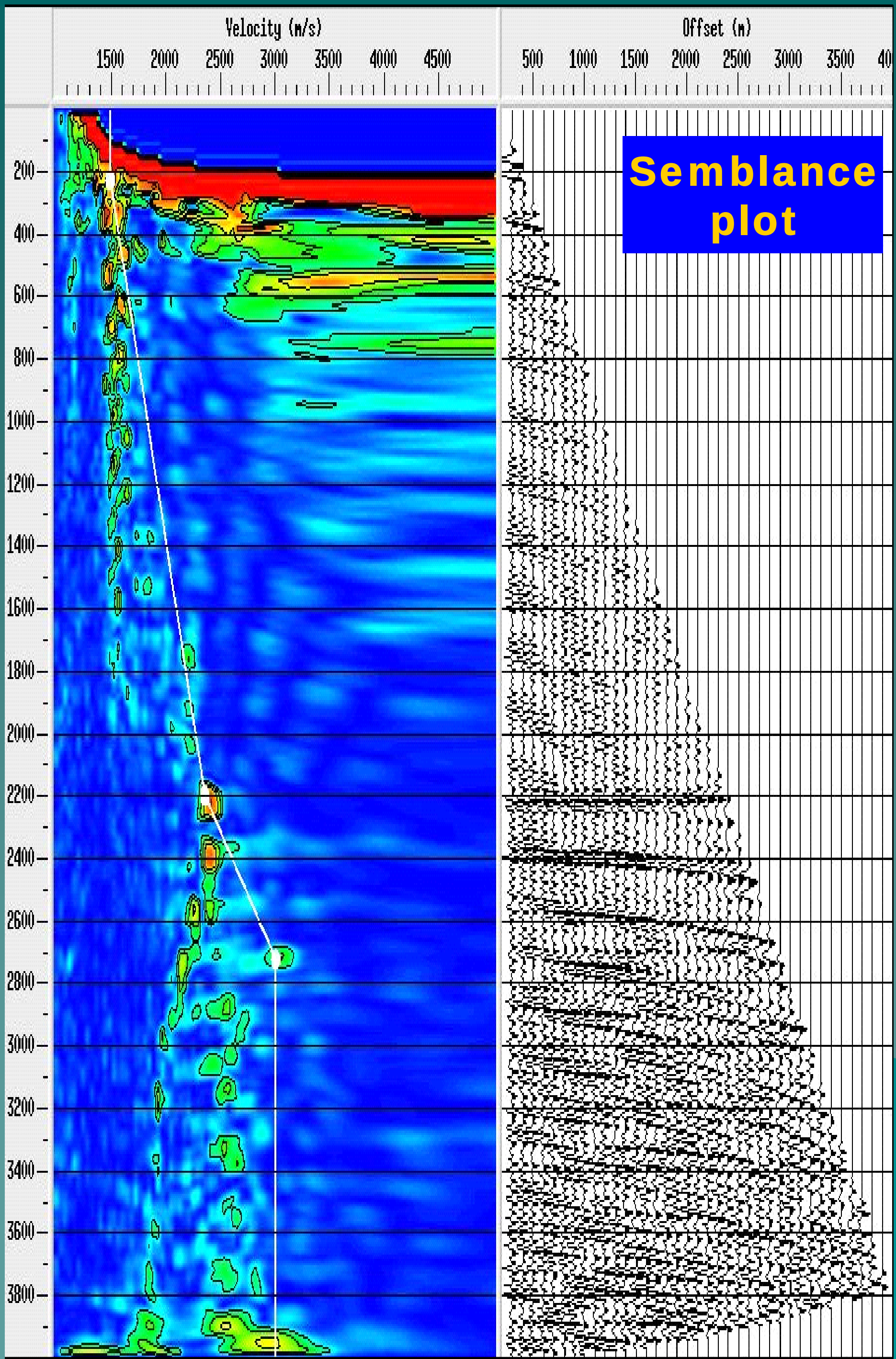
Data Example

- The high-resolution time-domain Radon transform is applied to the White Rose seismic dataset. The water-bottom and peg-leg multiples have strong effects on data quality.

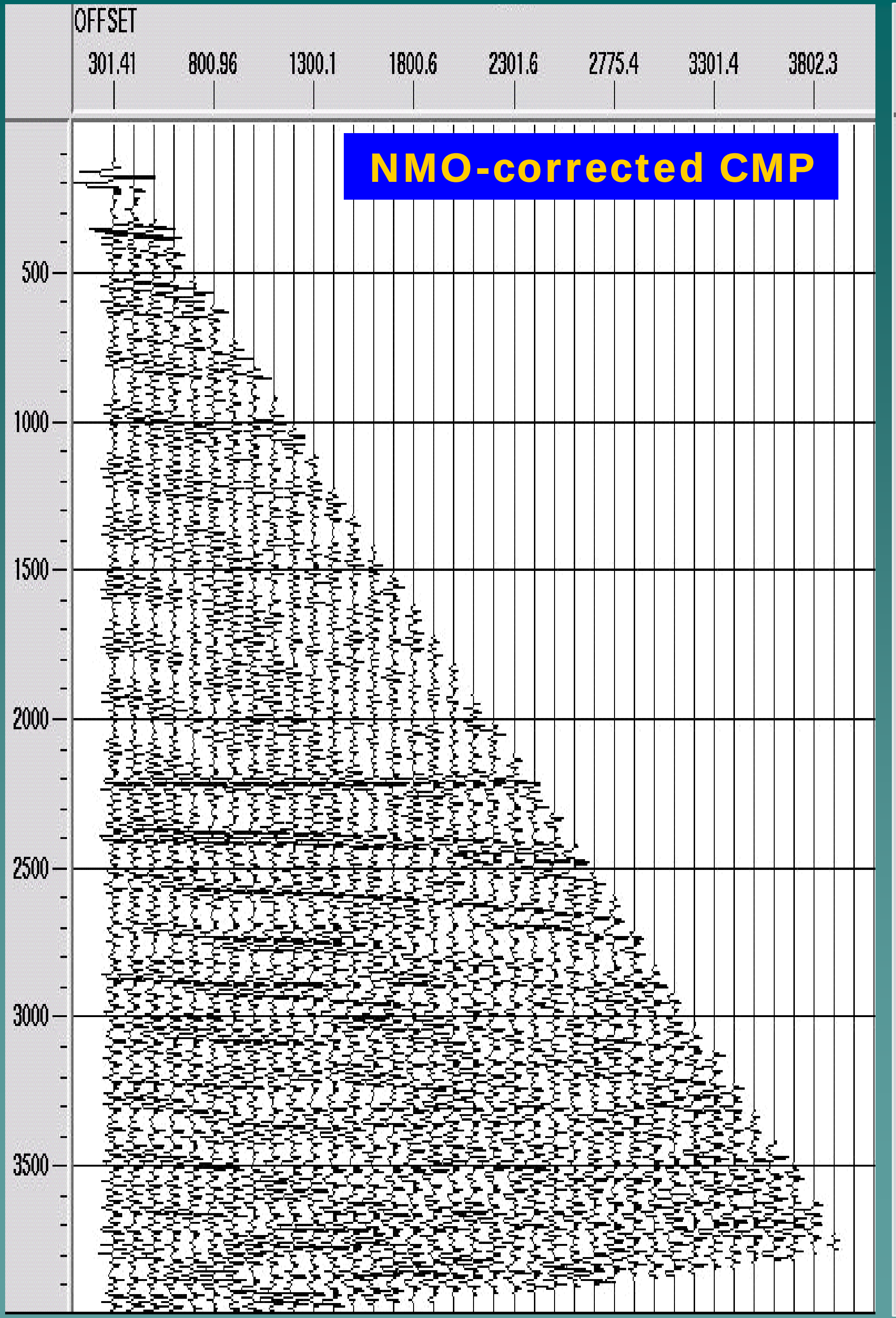
- Multiple attenuation becomes one of the key issues for seismic interpretation.

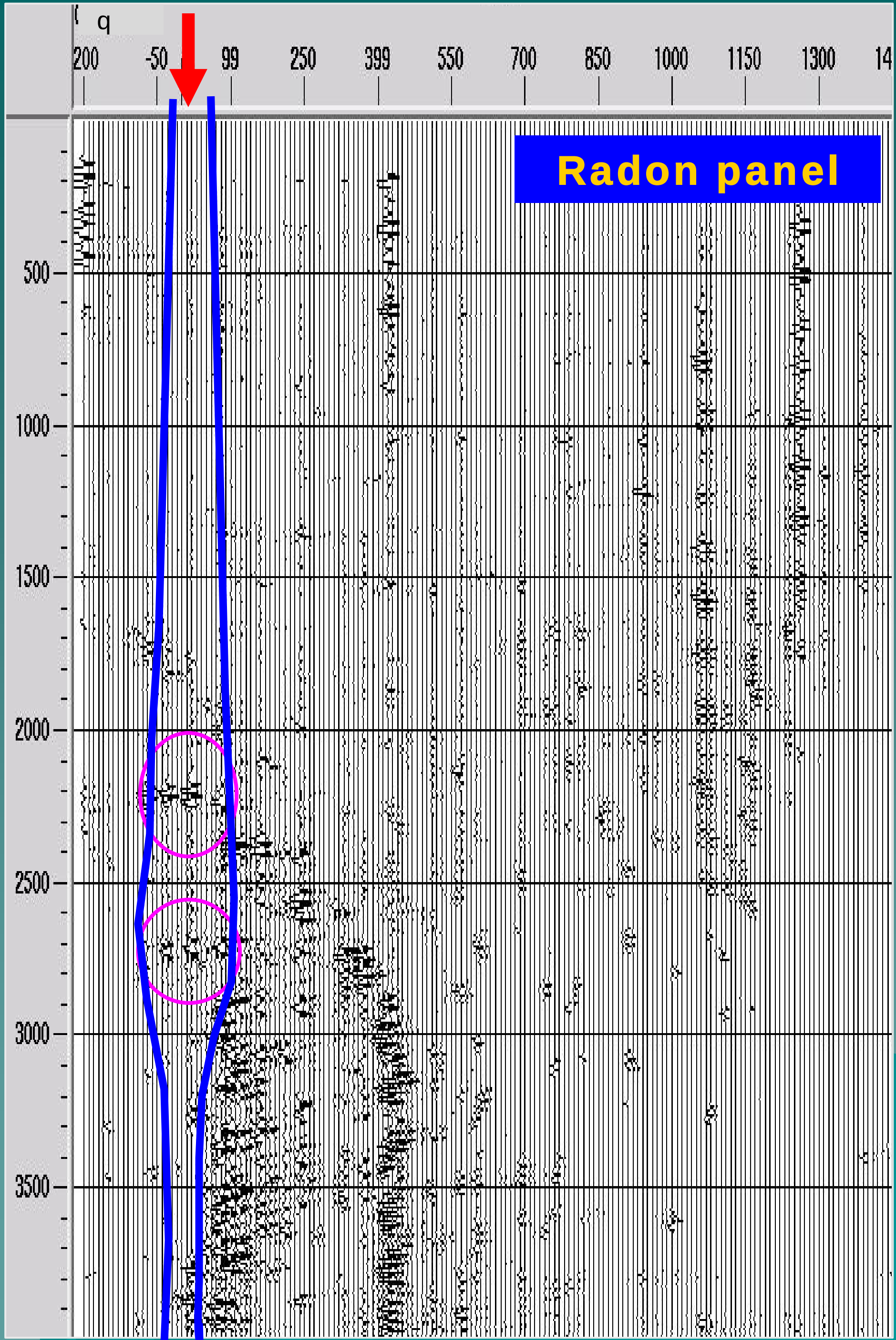


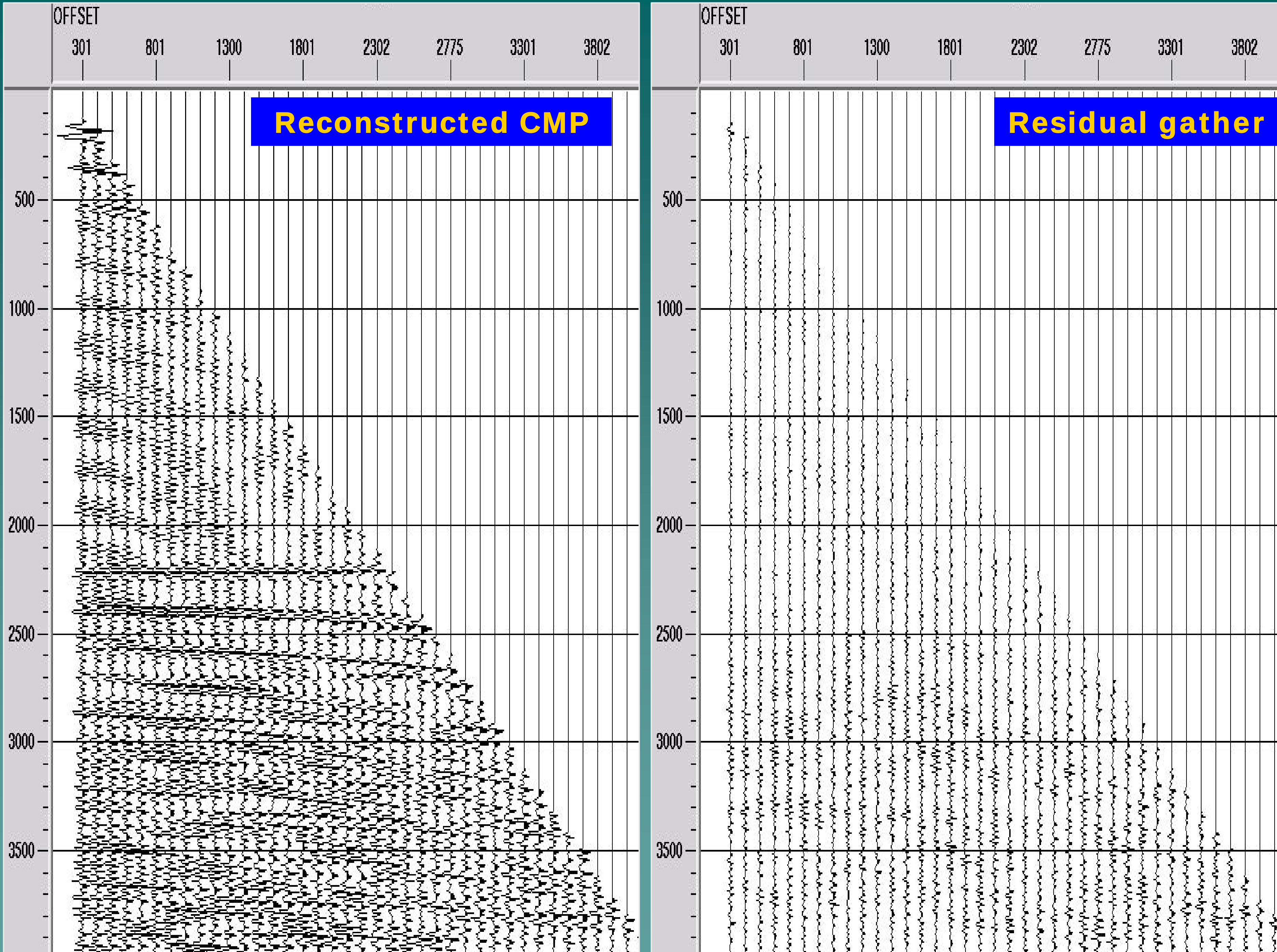
CMP gather
OFFSET
301
801
1300
1801
2302
2775
3301
3802
500
1000
1500
2000
2500
3000
3500

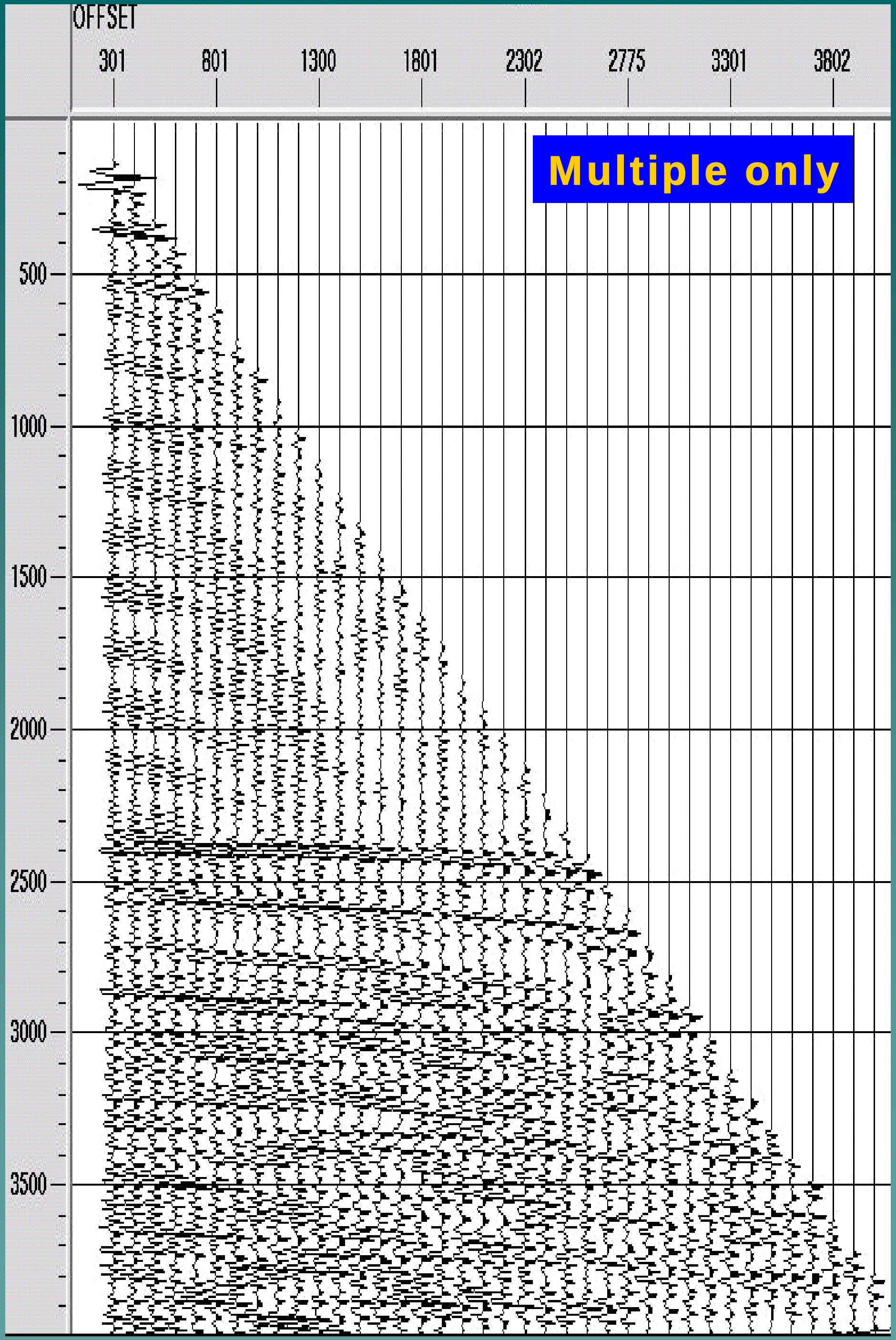


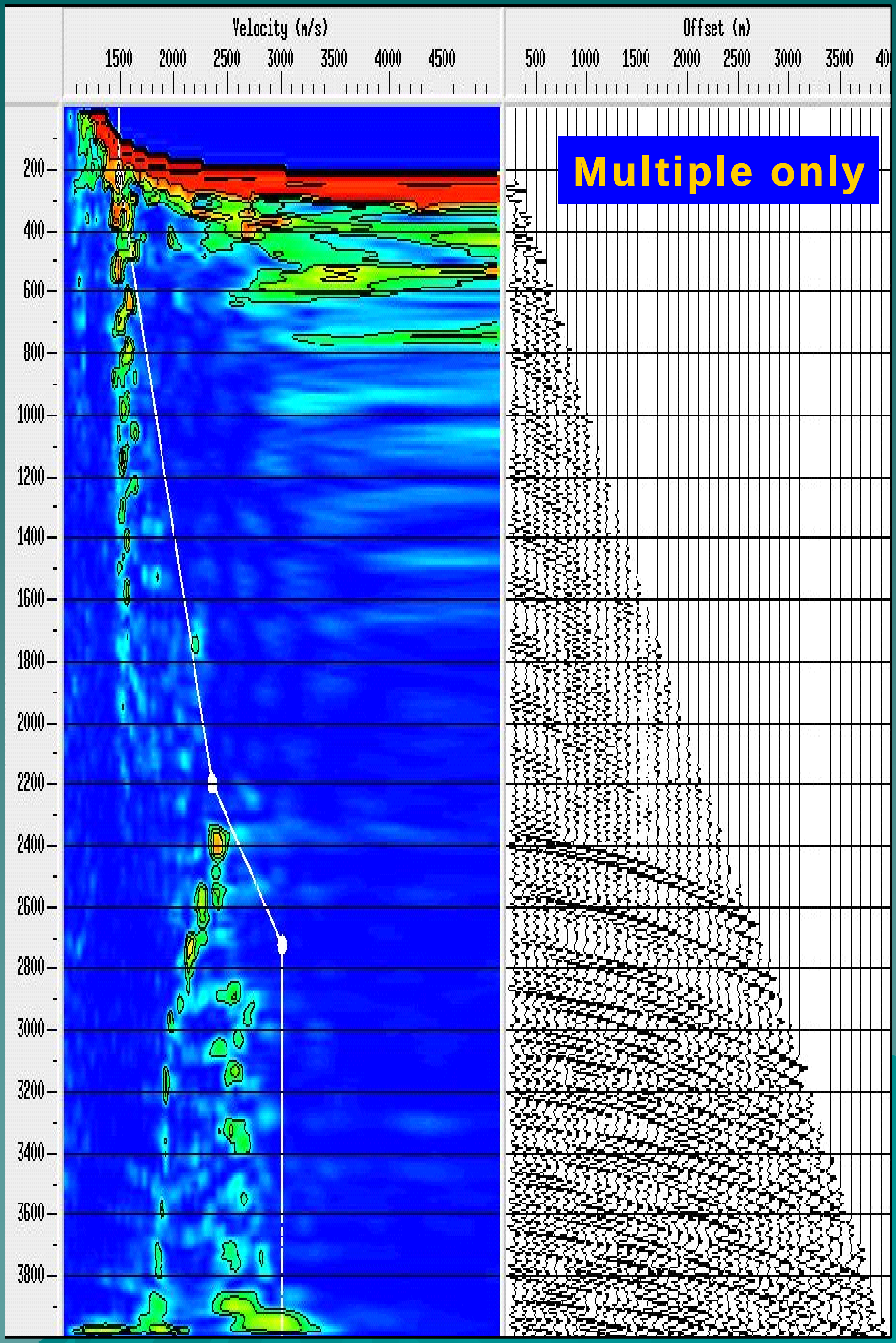
Semblance plot
Velocity (m/s)
1500
2000
2500
3000
3500
4000
4500
Offset (m)
500
1000
1500
2000
2500
3000
3500
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800

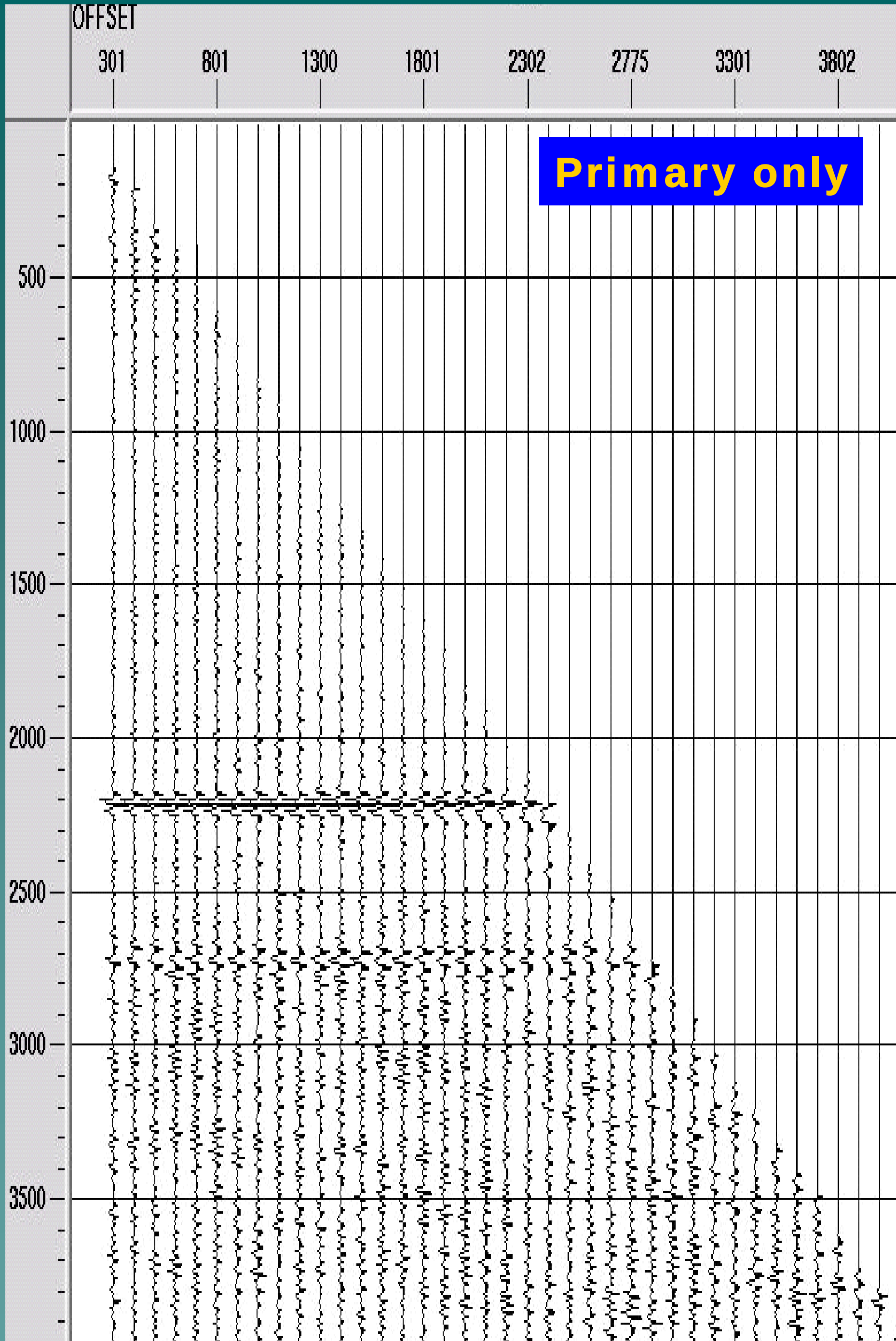

NMO-corrected CMP
OFFSET
301.41
800.96
1300.1
1800.6
2301.6
2775.4
3301.4
3802.3
500
1000
1500
2000
2500
3000
3500

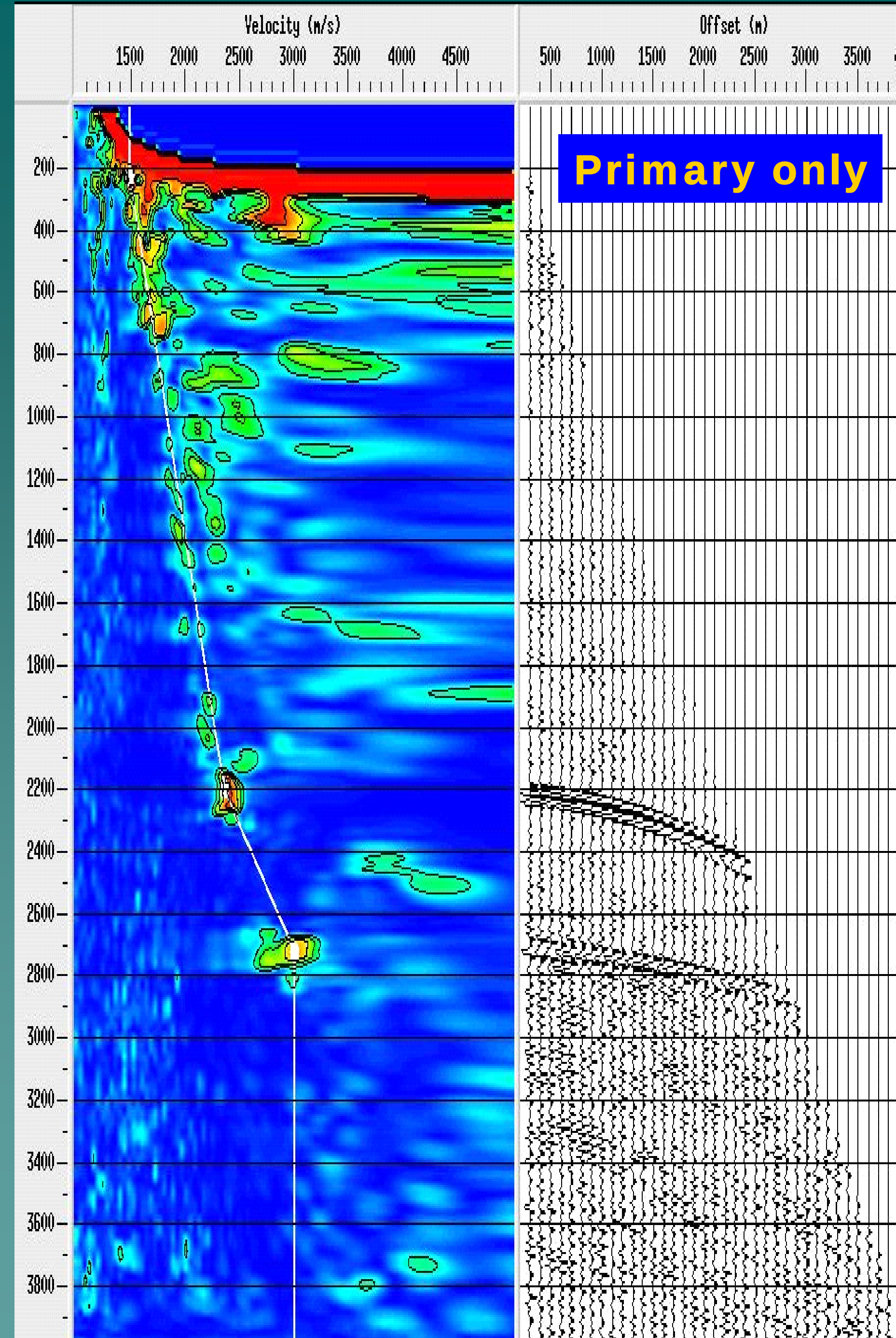

Radon panel
q
200
-50
99
250
399
550
700
850
1000
1150
1300
500
1000
1500
2000
2500
3000
3500

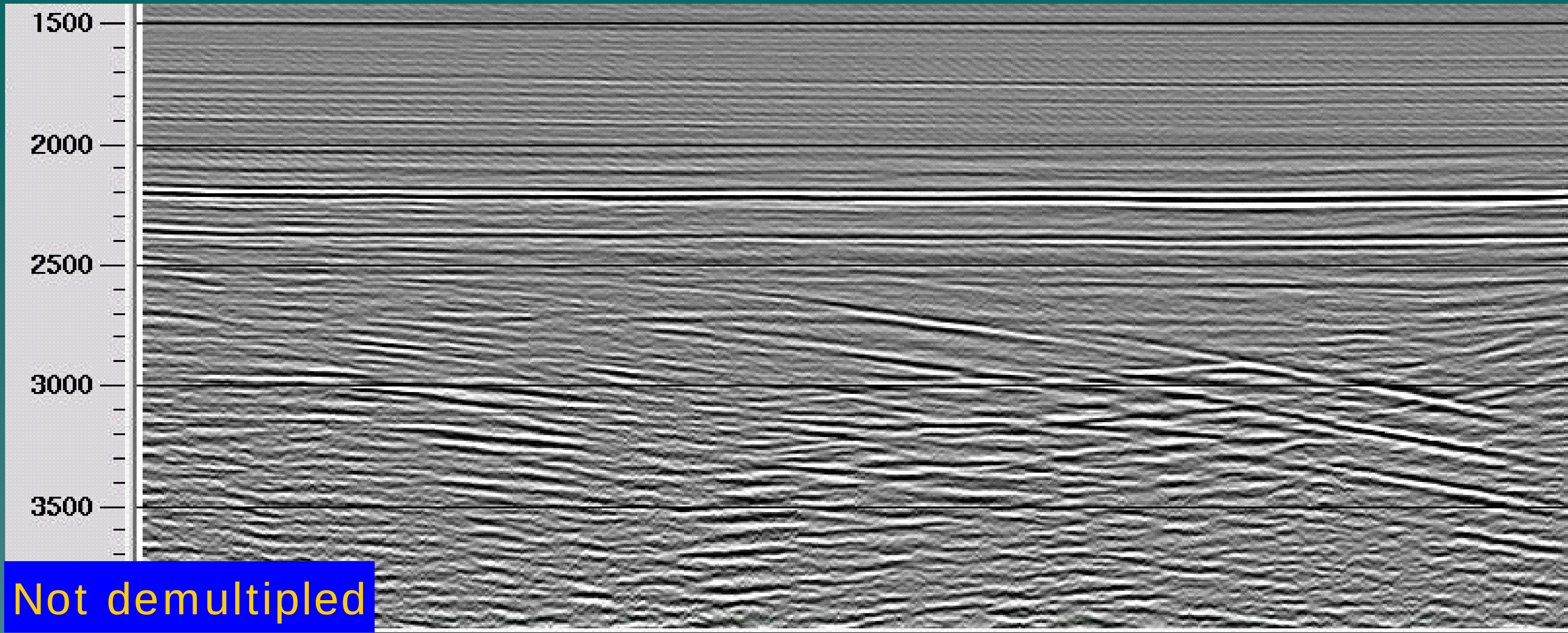

Reconstructed CMP
Residual gather
OFFSET
301
801
1300
1801
2302
2775
3301
3802
500
1000
1500
2000
2500
3000
3500

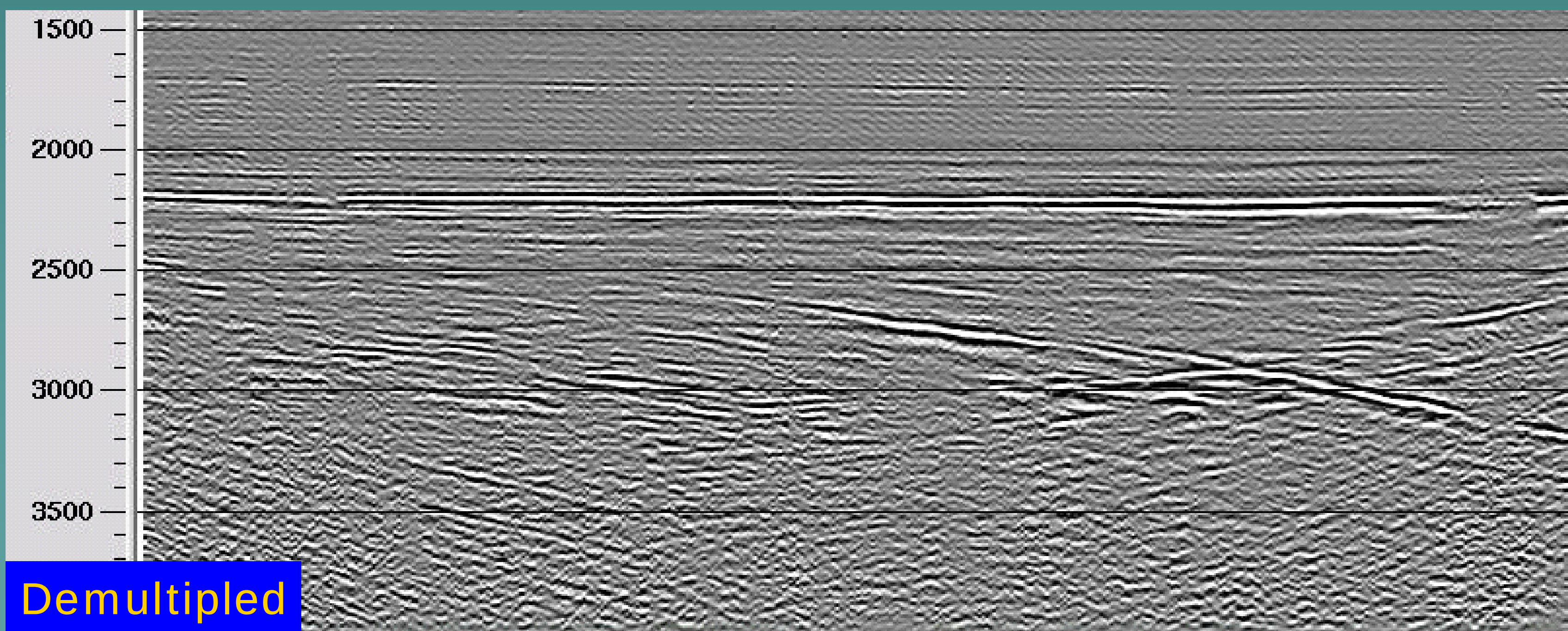

OFFSET
301
801
1300
1801
2302
2775
3301
3802
500
1000
1500
2000
2500
3000
3500
Multiple only


Velocity (m/s)
1500
2000
2500
3000
3500
4000
4500
Offset (m)
500
1000
1500
2000
2500
3000
3500
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
Multiple only


OFFSET
301
801
1300
1801
2302
2775
3301
3802
500
1000
1500
2000
2500
3000
3500
Primary only


Velocity (m/s)
1500
2000
2500
3000
3500
4000
4500
Offset (m)
500
1000
1500
2000
2500
3000
3500
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
Primary only


1500
2000
2500
3000
3500
Not demultipled


1500
2000
2500
3000
3500
Demultipled

Conclusions

- The Radon transform is reviewed;
- The estimation and utilization of the energy power along the *q* axis lead to the high resolution in the Radon domain;
- The application of the high-resolution Radon method to a real dataset approved the validity of the algorithm.

Acknowledgements

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