NSERC CRSNG

CREWES

Making shear-wave statics actual statics

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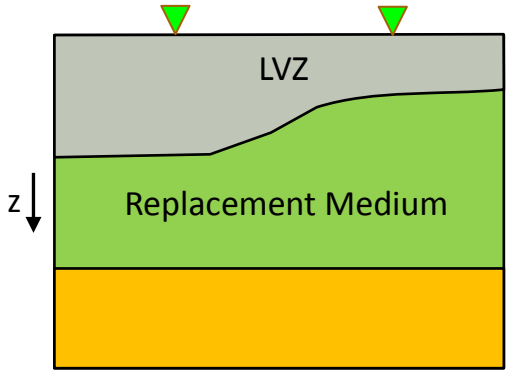
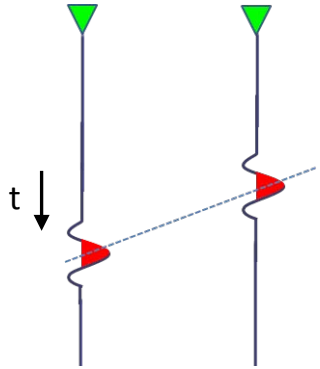
UNIVERSITY OF CALGARY

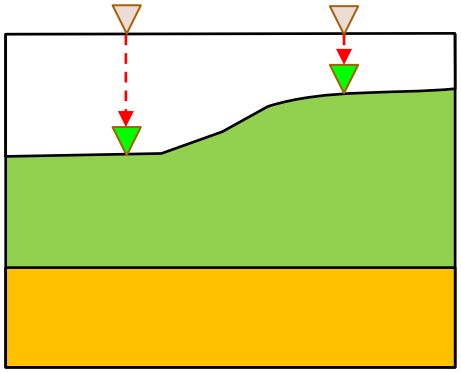
The Statics Problem



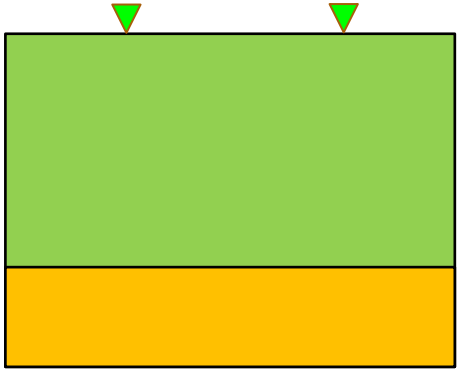


Data without static corrections may show false structures

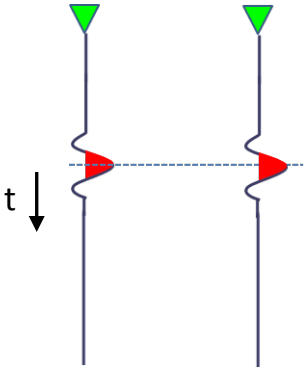
1. Remove the delays caused by the LVZ



2. Replace the LVZ with an imaginary medium with the same velocity of the medium underneath



True structure



Basis for surface consistency

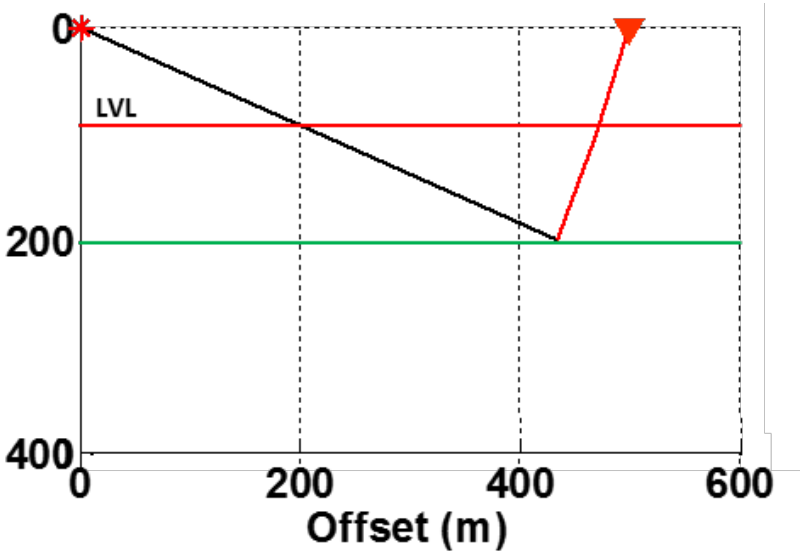
Arguments for surface consistency applied to near-surface corrections:

- ✓ Velocity contrast between the near surface and the medium underneath is strong
  - ✓ Raypaths in the near surface follow vertical trajectories
    - ✓ Corrections are related to shot and receiver surface location
      - ✓ **All traces recorded with the same receiver receive a constant correction**

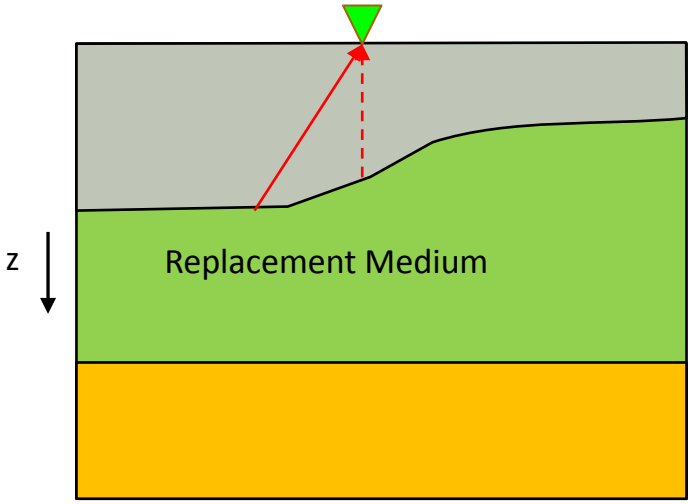
The Converted-wave Problem

Why are C-wave statics hard to solve for:

- ✓ Receiver side statics are controlled by S-wave velocities in the NS
- ✓ S-wave refraction data is not usually available
- ✓ S-wave velocities can be between three and five times slower than P-waves
- ✓ S-wave velocity changes in the NS may be smooth
- ✓ **Surface consistency may not be enough**



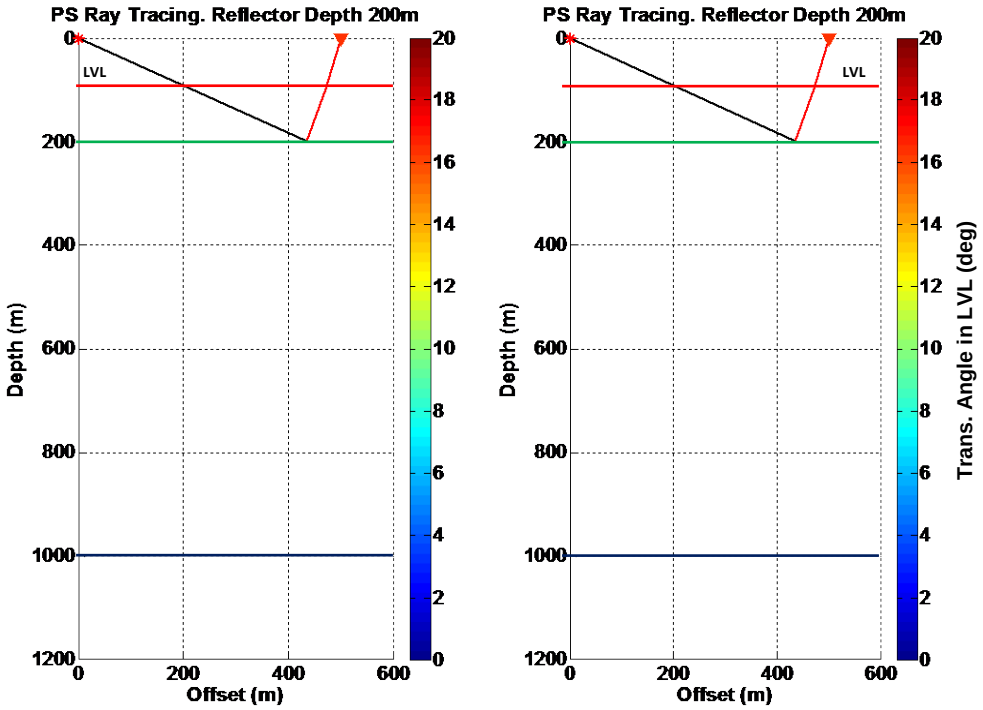
What if raypaths are not vertical?



V_S=500 m/s h=100 m	Vertical Raypath	30deg Raypath
Flat NS	200ms	230ms
5deg Dip NS		243ms

Raypaths in the near surface may be controlled by:

- ✓ Velocity contrast between the NS and medium underneath
- ✓ Dip at the base of the NS
- ✓ Depth of the interface



The proposal

Non-stationary correction in x-t?

Moving the data to a domain where the problem becomes stationary? ✓

$$p = \frac{dt}{dx} = \frac{\sin(\theta)}{V}$$

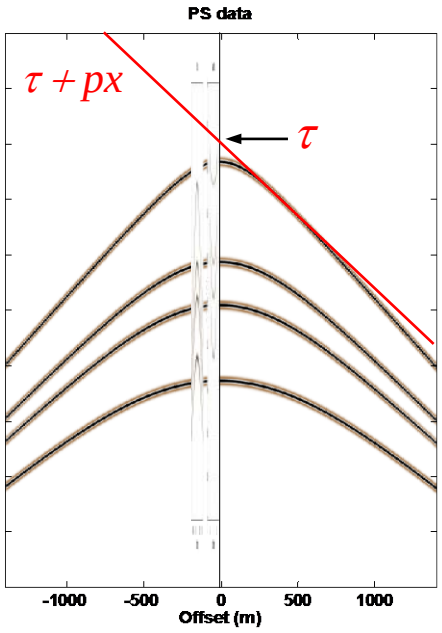
How?

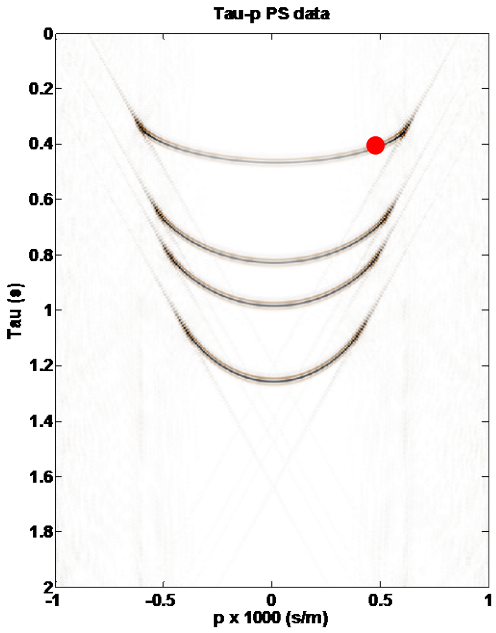
Tau-P Transform

$$U(\tau, p) = \int_{-\infty}^{\infty} u(\tau + px, x)dx$$

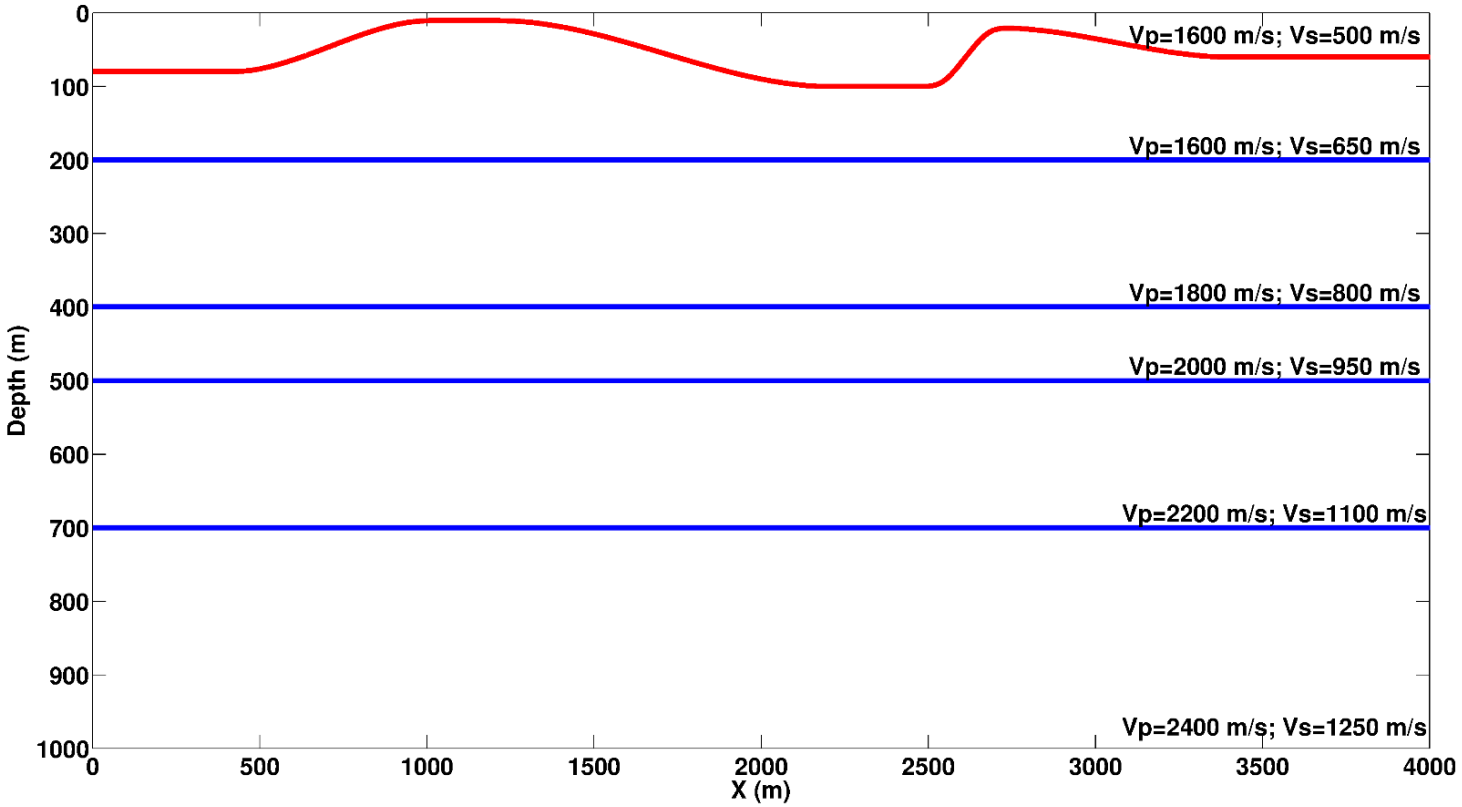
Why?

It is sensitive to the emerging angle of the wavefield at the surface

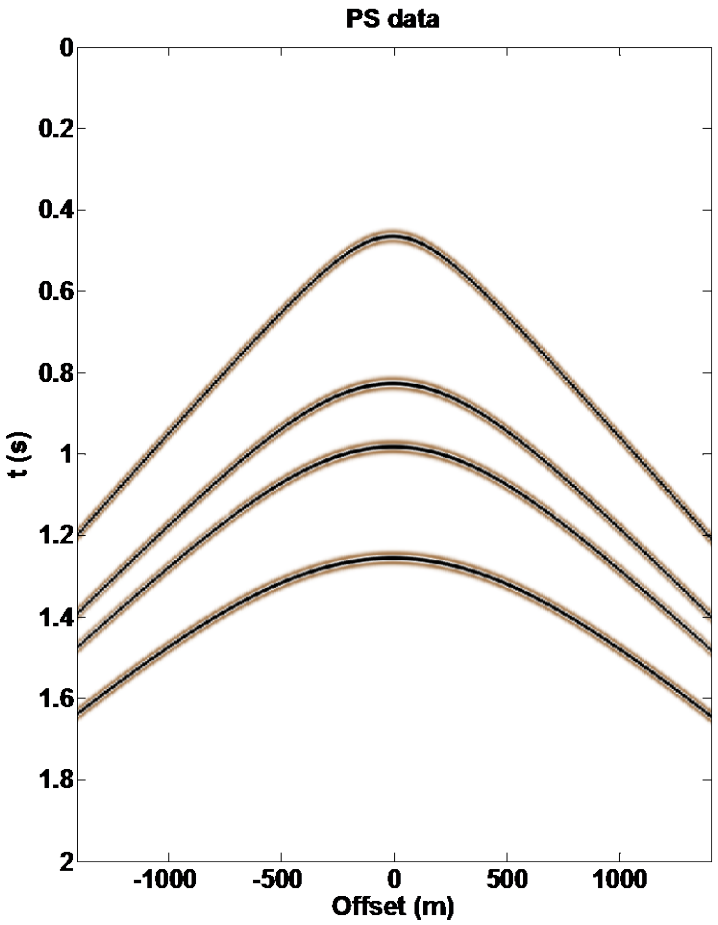


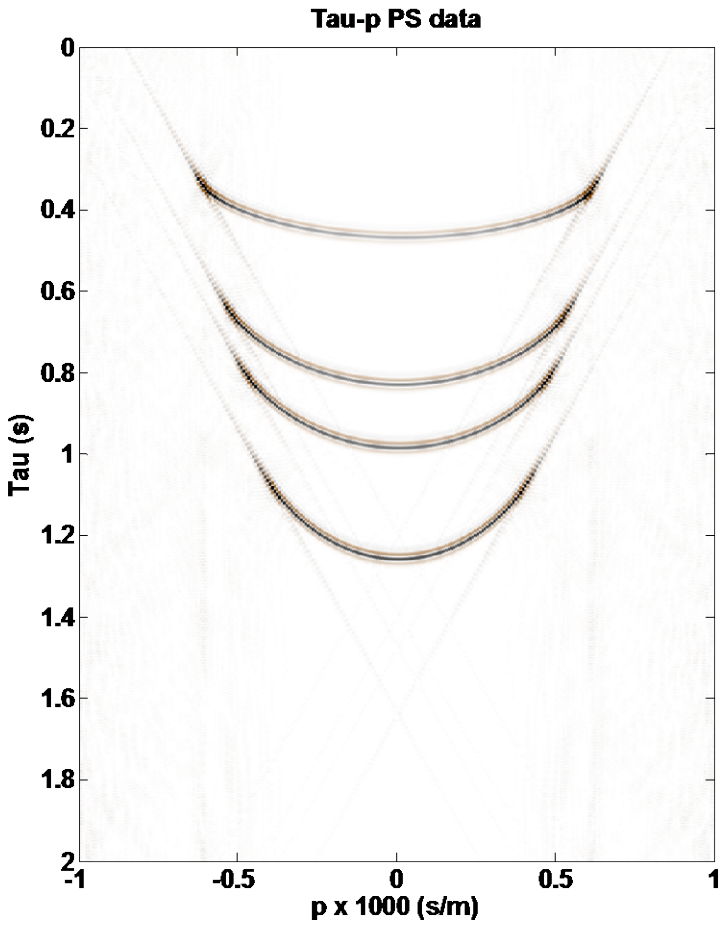


The synthetic test

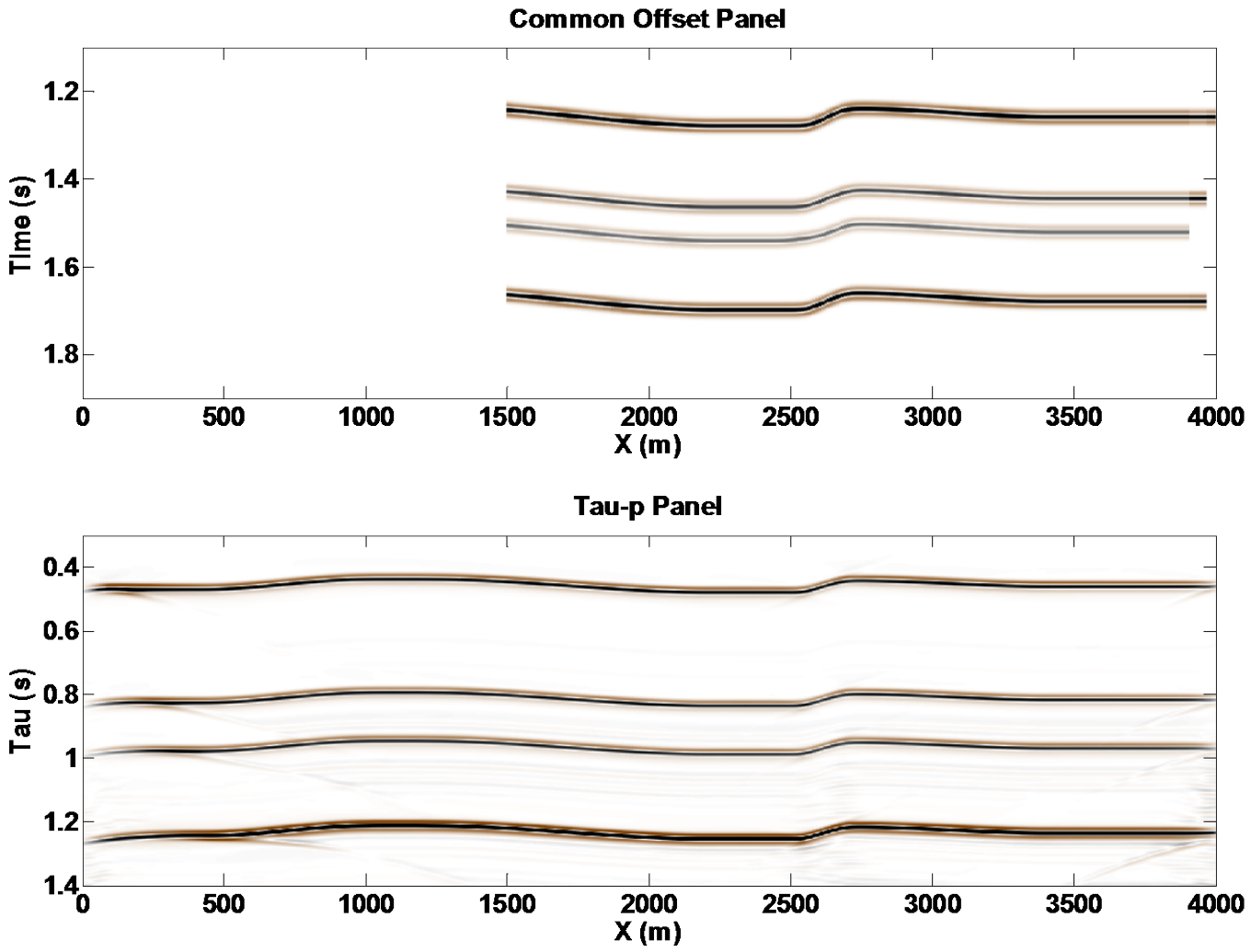


x-t and tau-p gathers

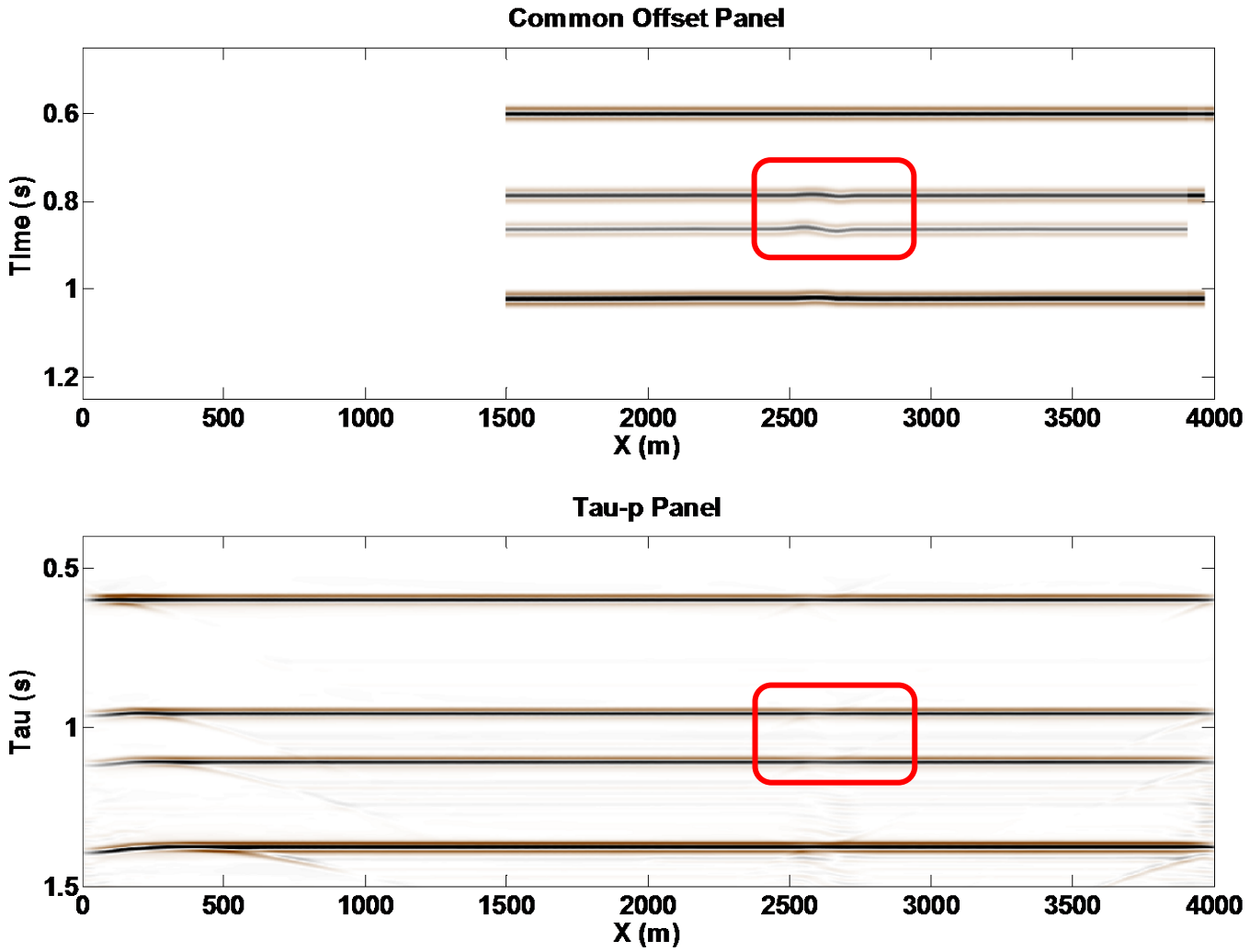




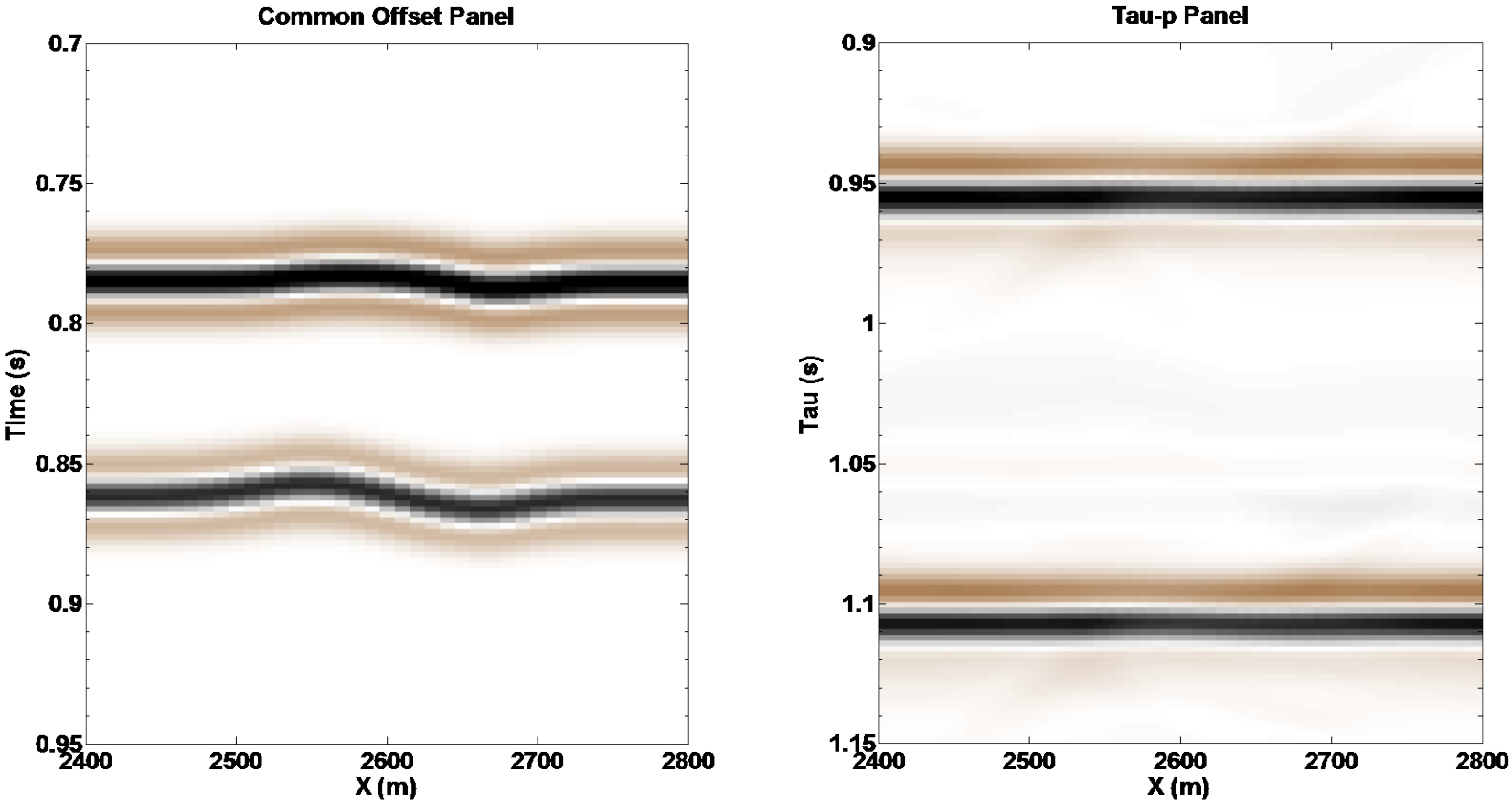
x-t and tau-p panels



Flatten panels

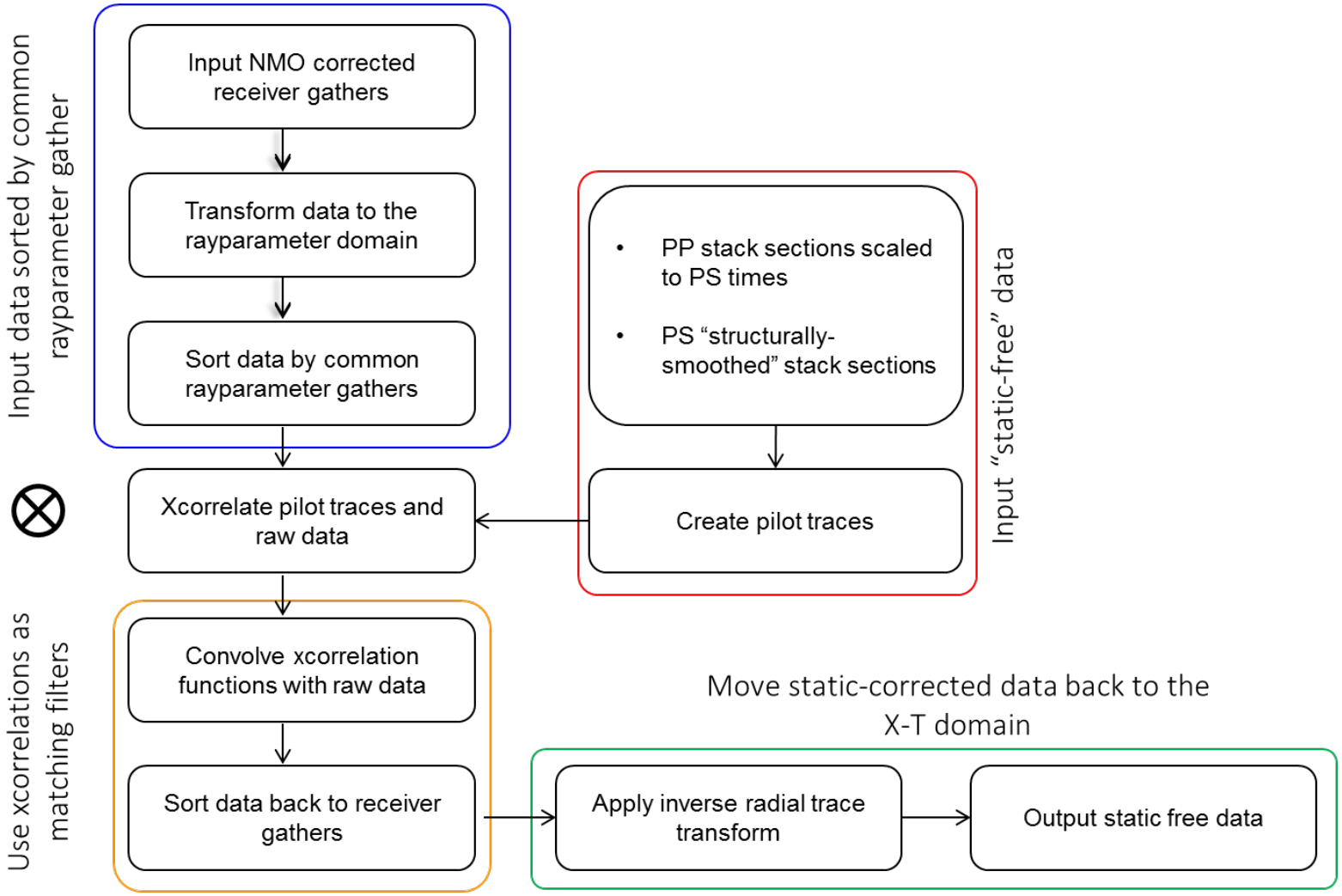


What domain to choose?

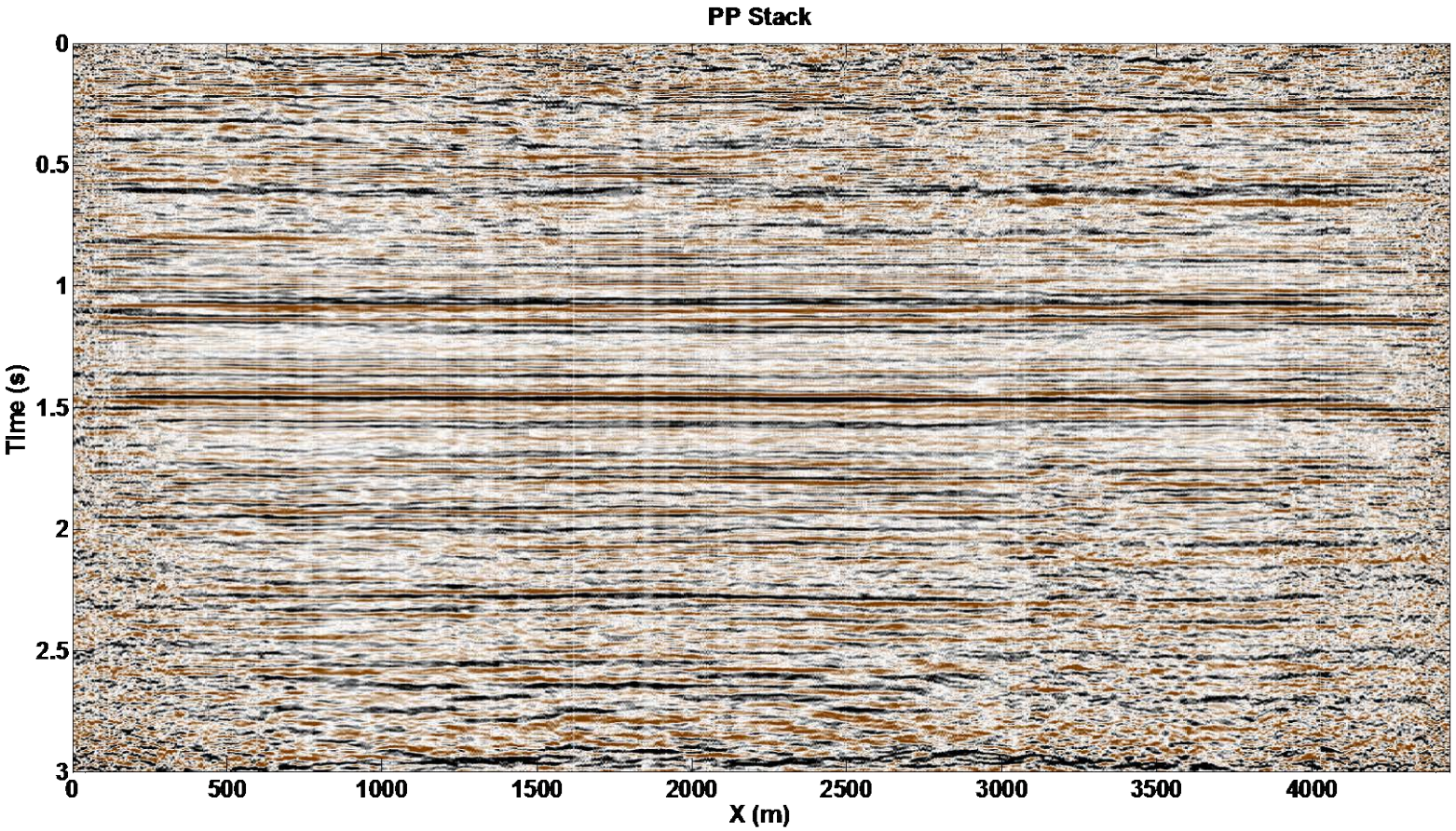


The deformation caused by the near surface is constant (static) for a fixed *p* value.

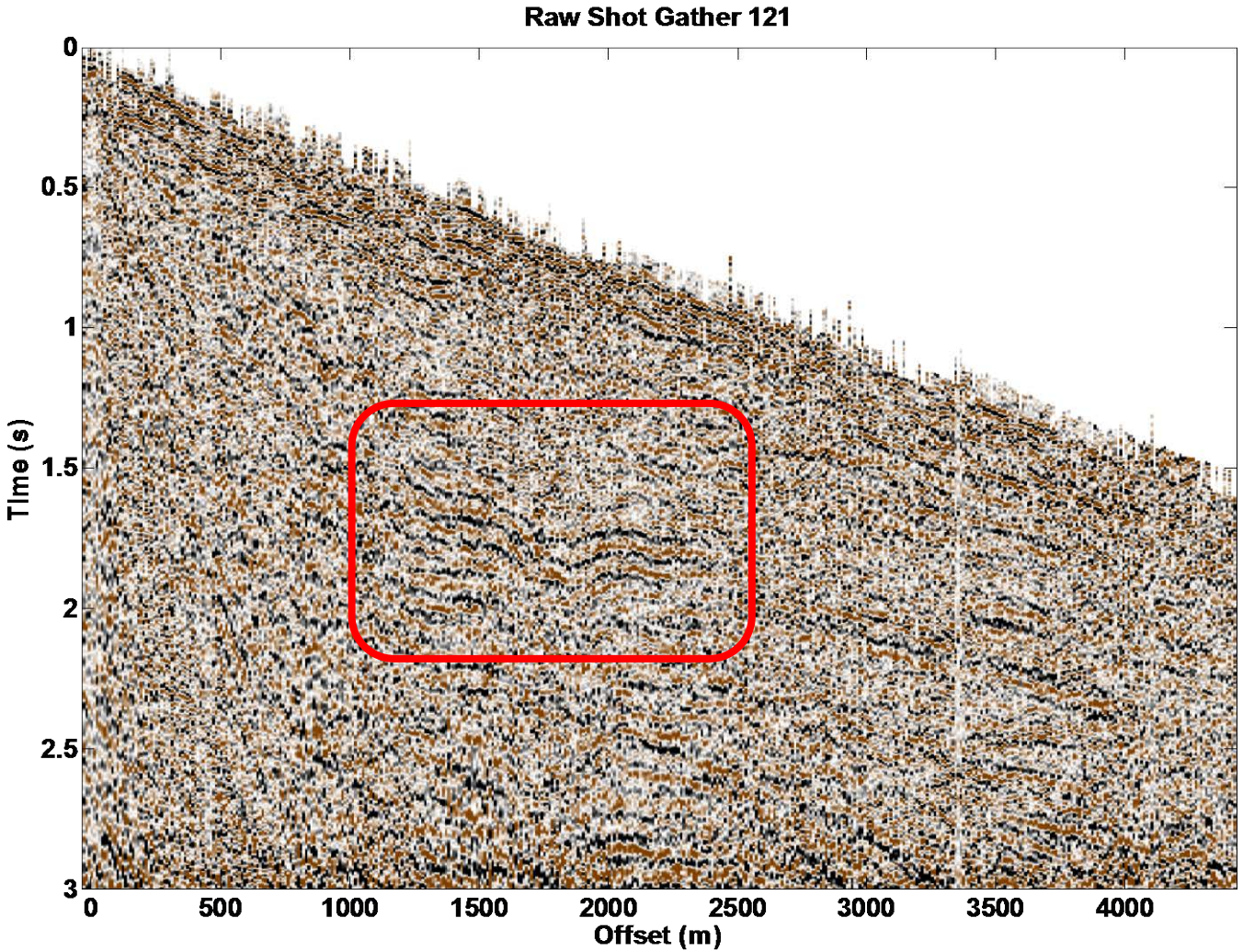
How to process real data?



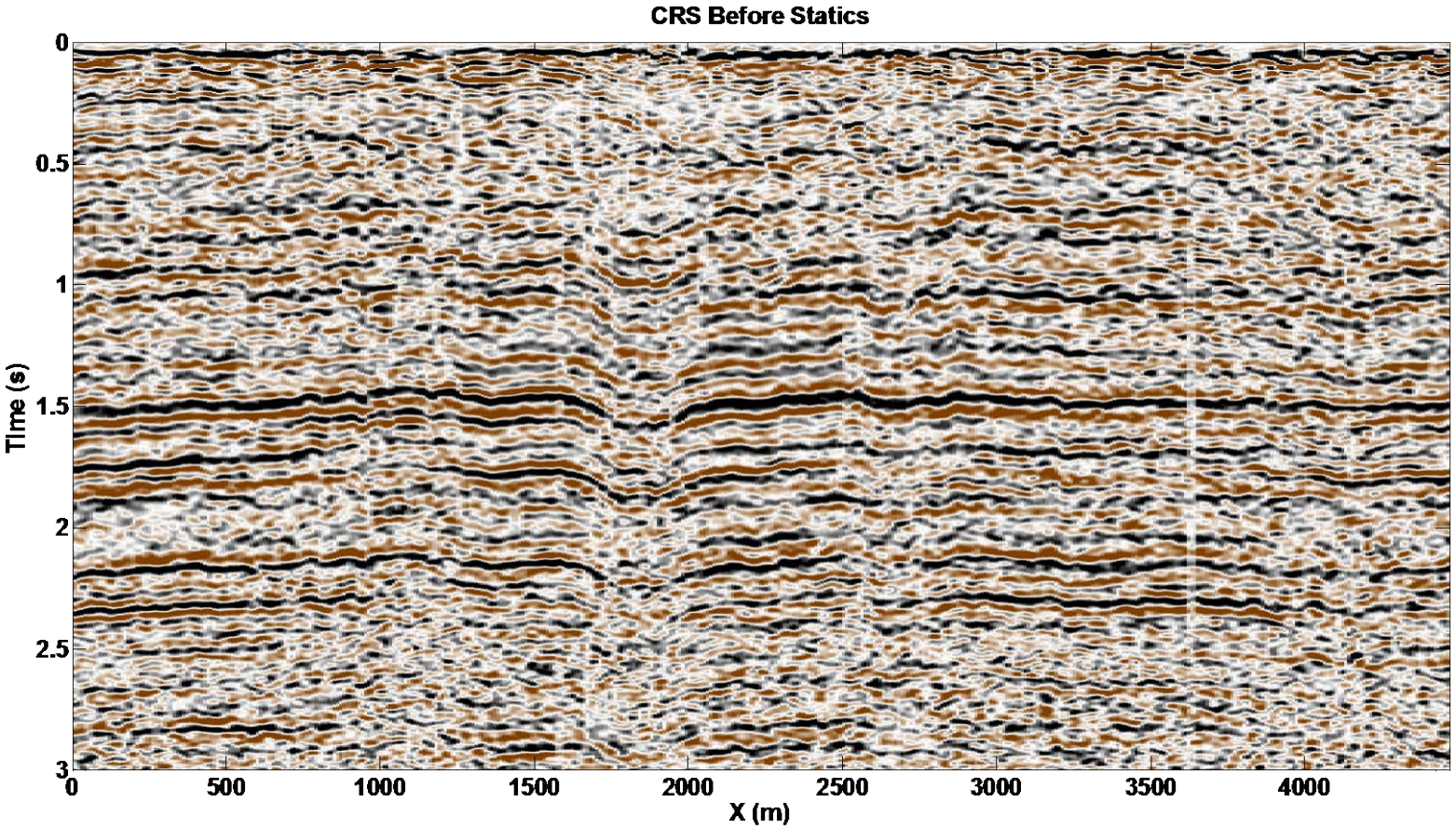
Hussar PP Stack



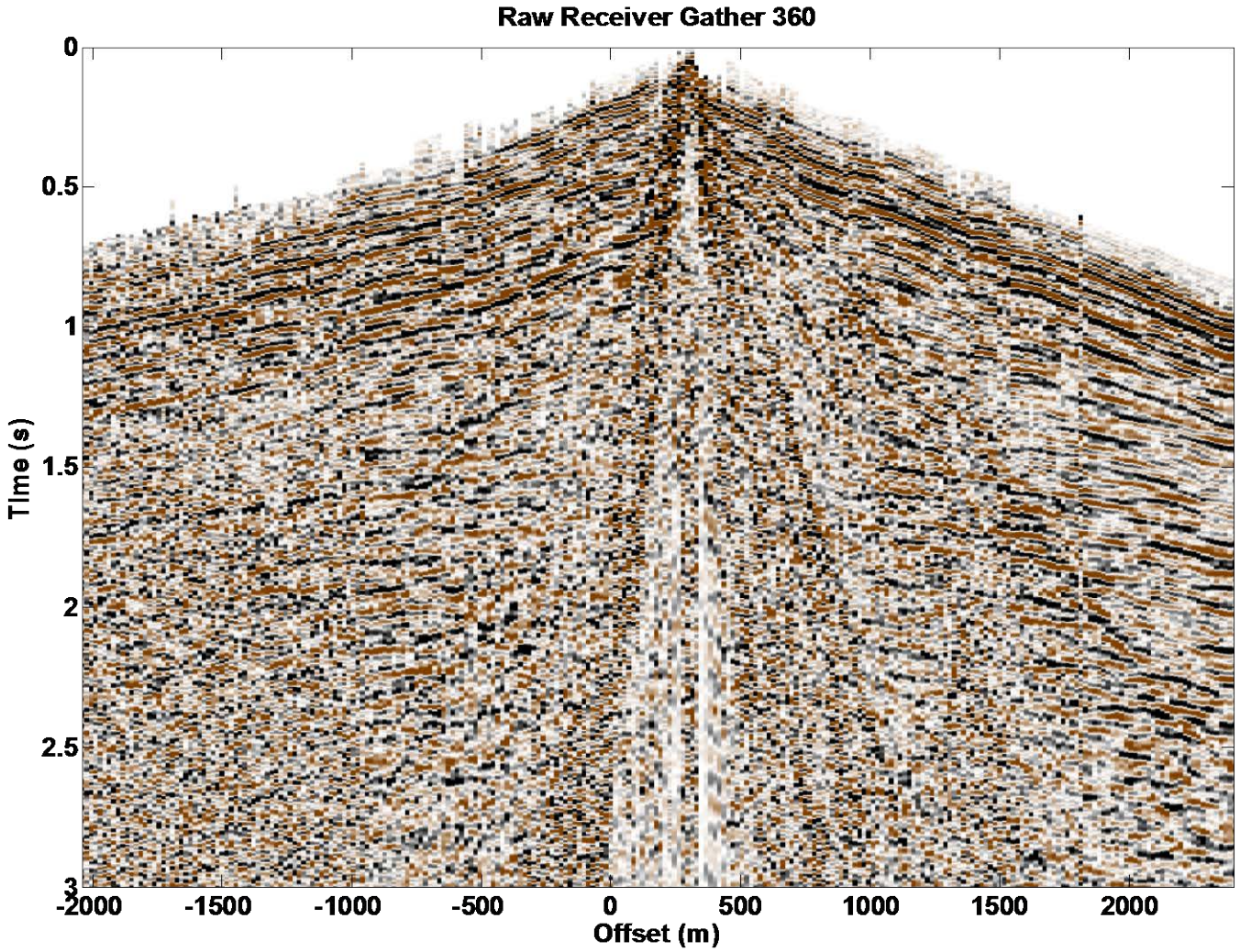
Radial component gather



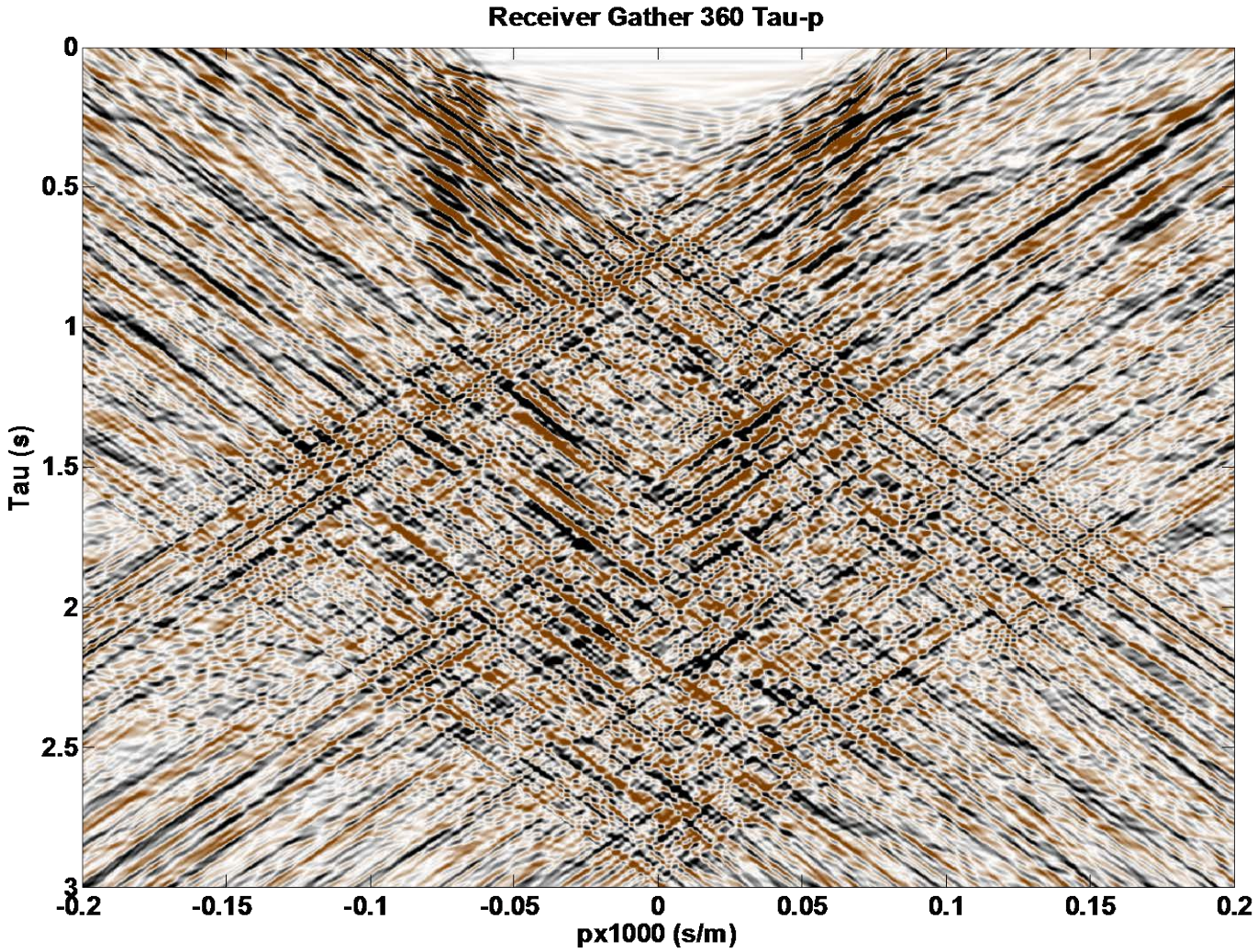
Raw common receiver stack



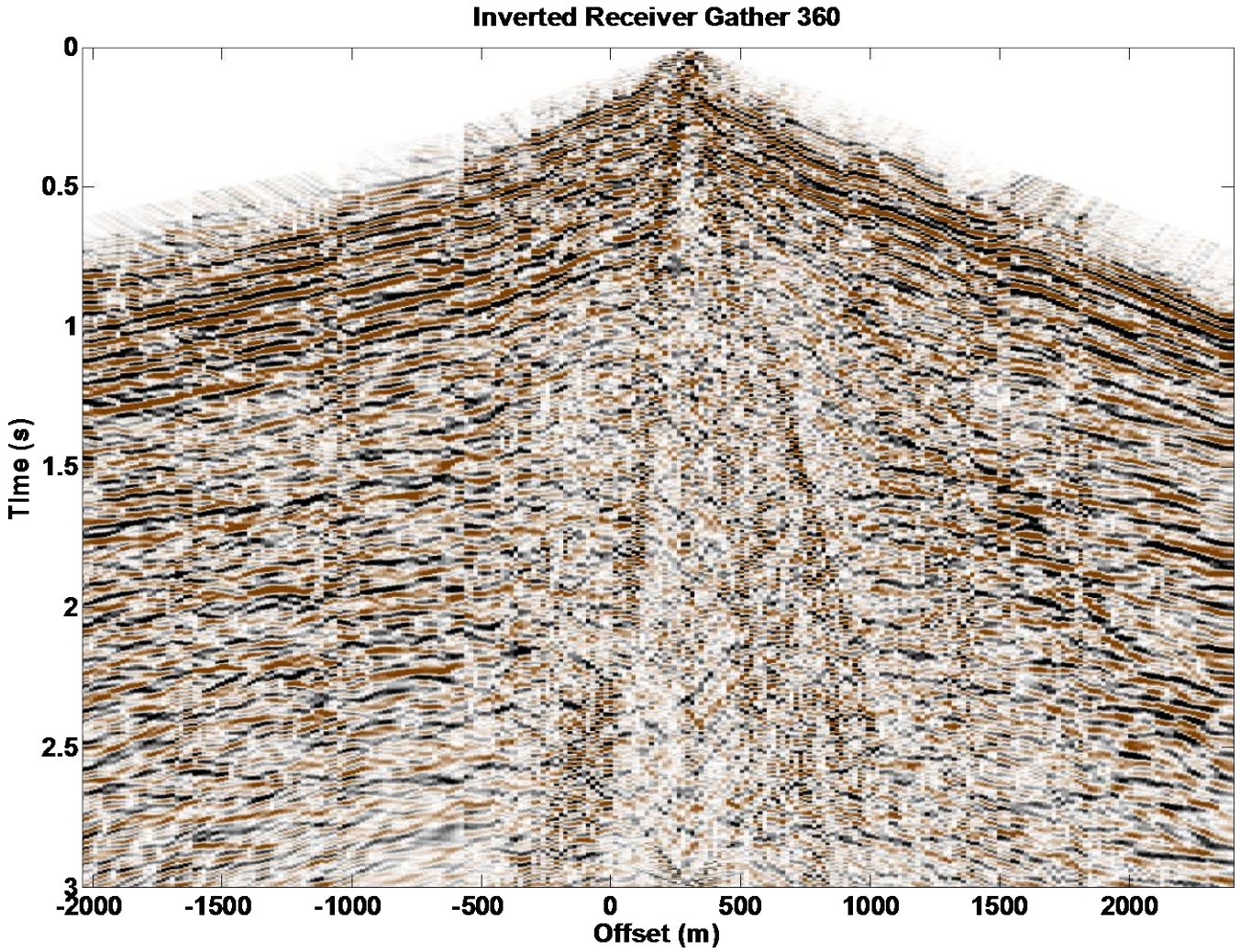
Receiver gather before statics



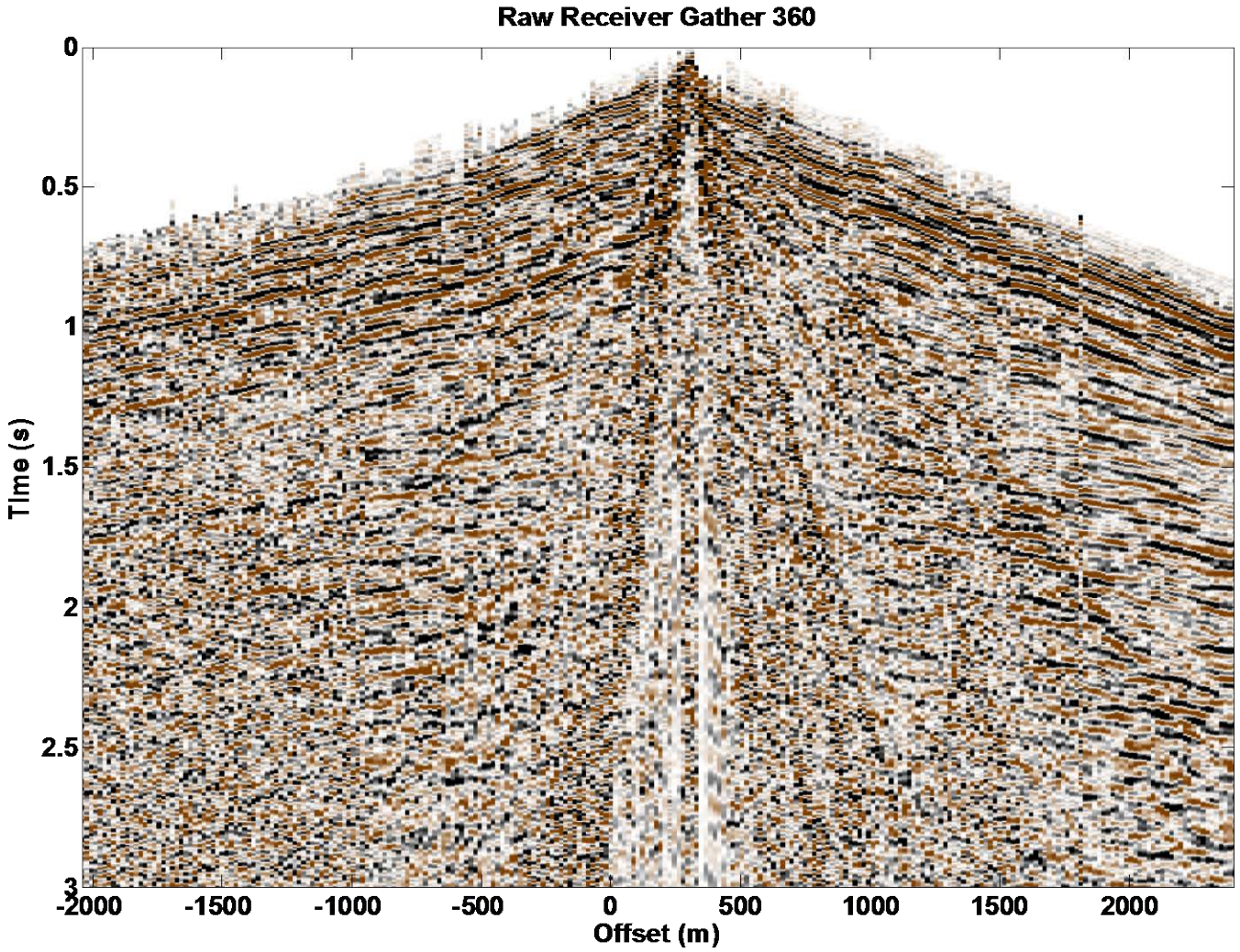
Rec. gather transformed to the tau-p domain



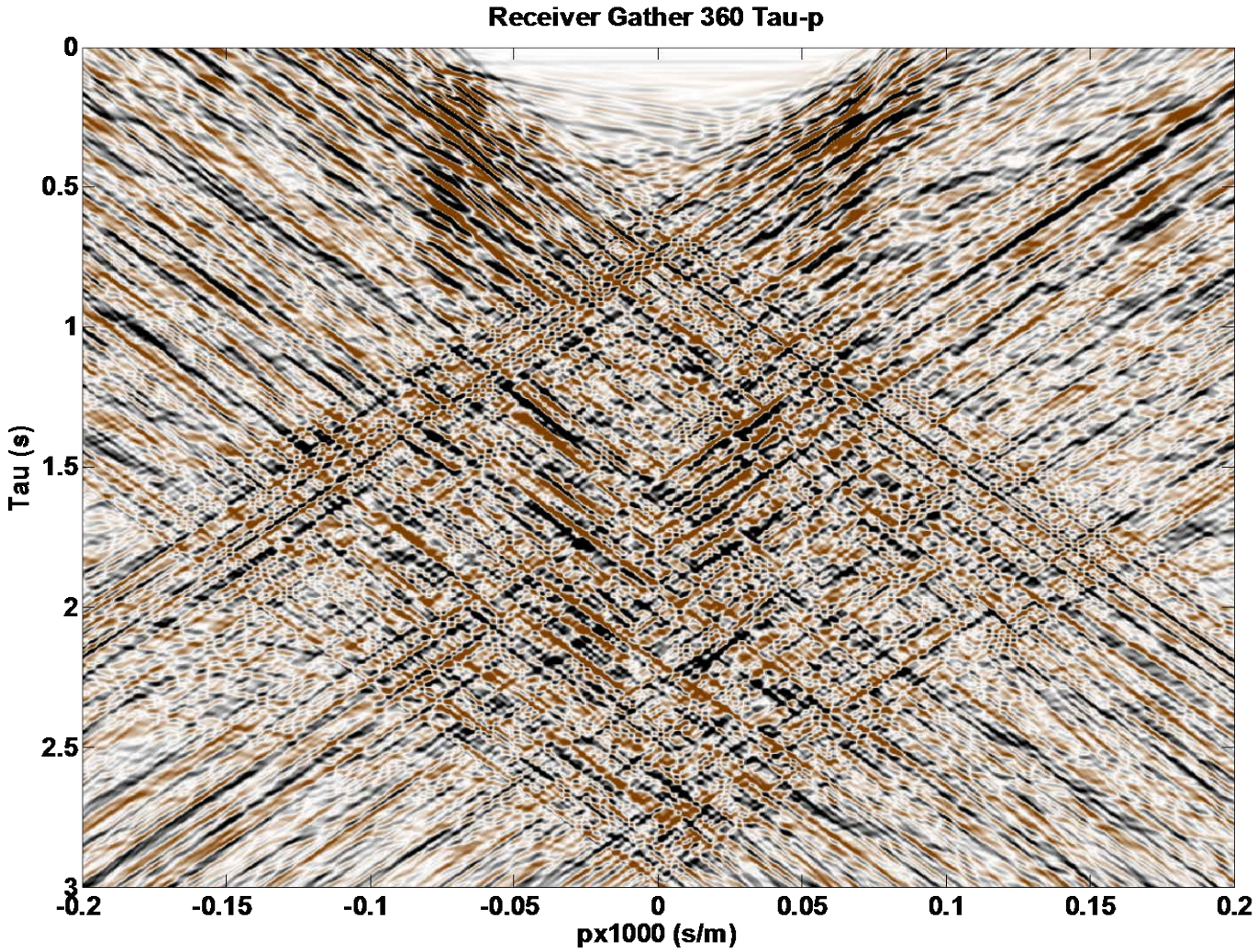
Checking for invertibility



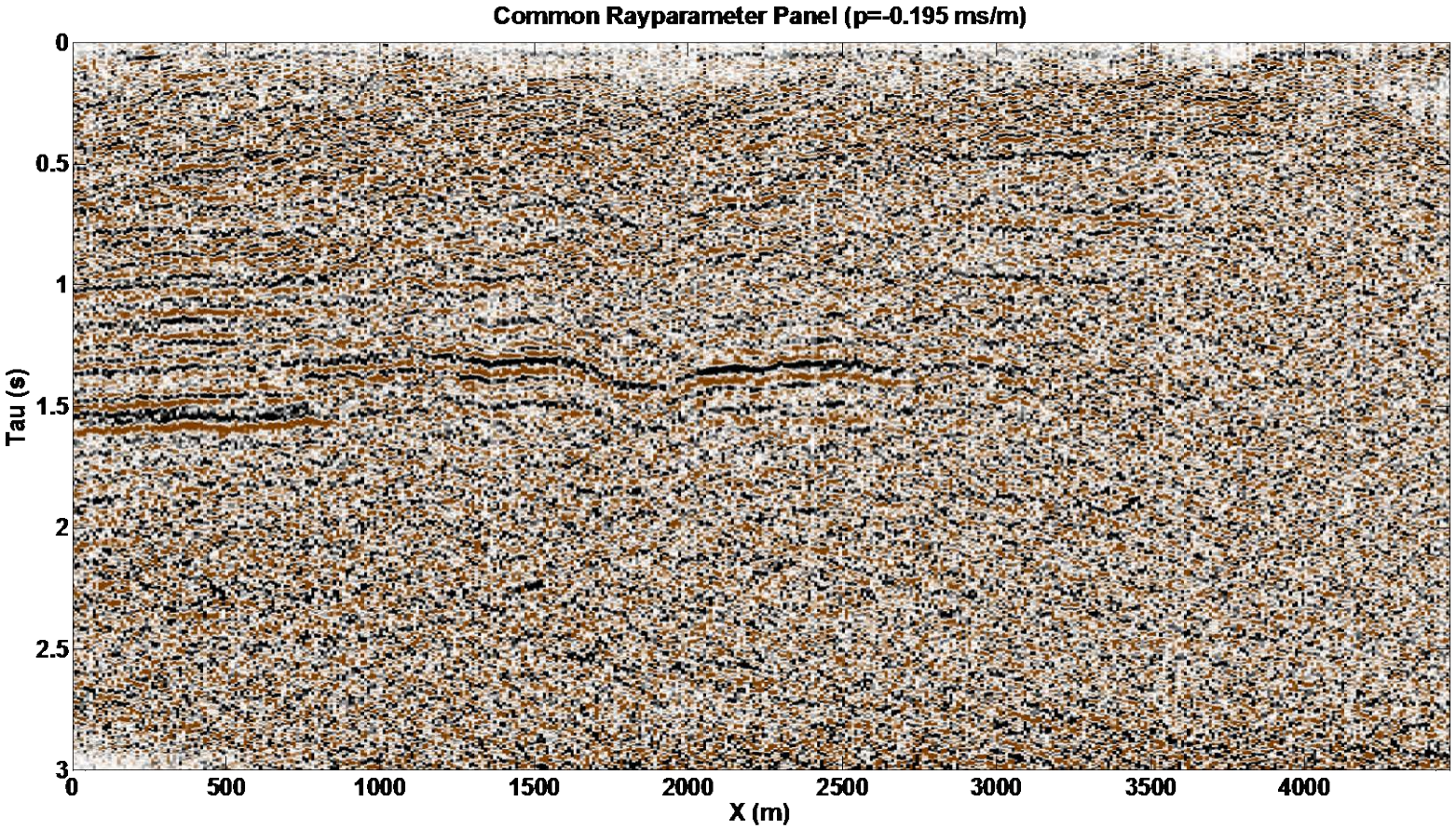
Checking for invertibility



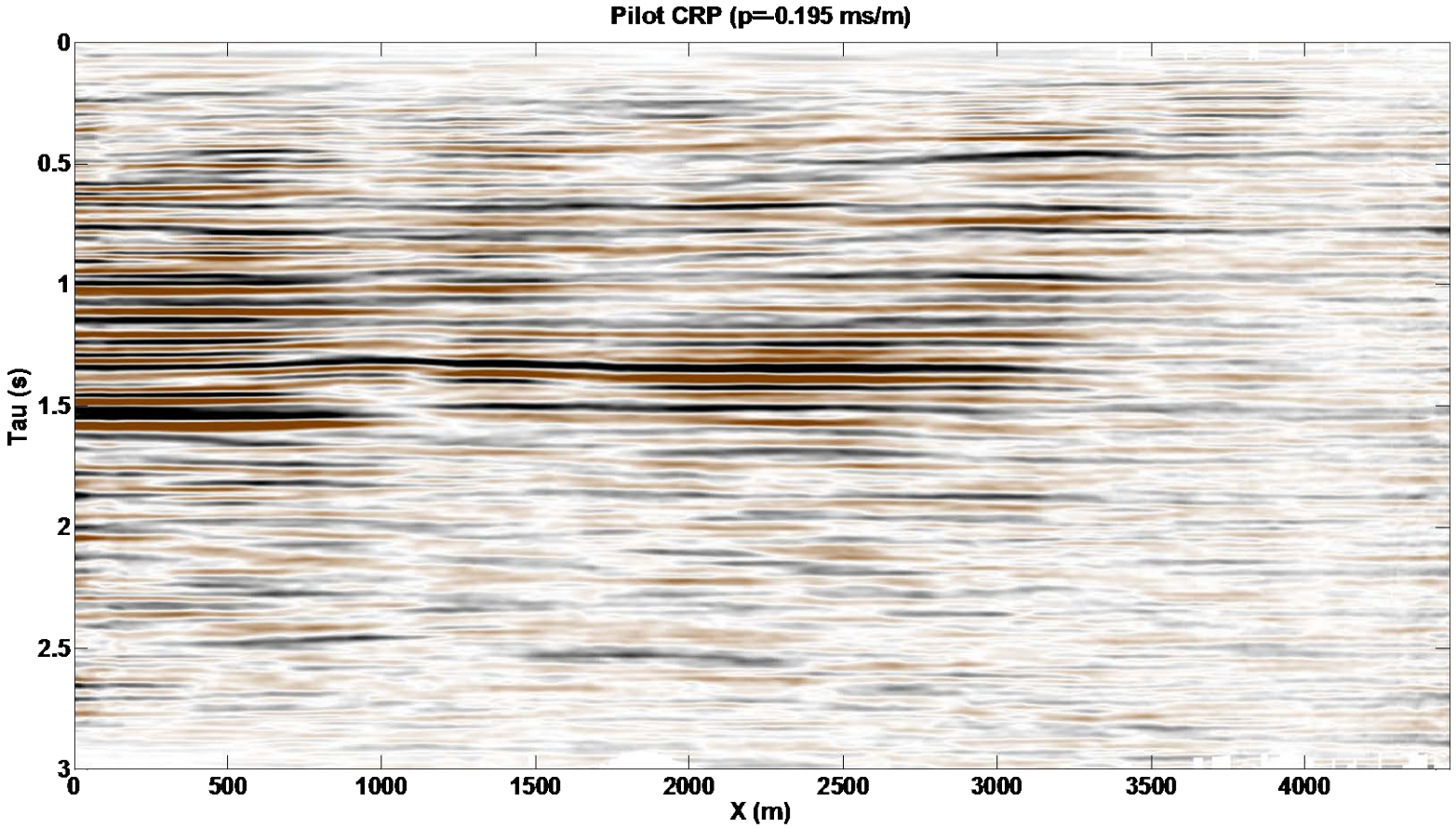
Back to the processing



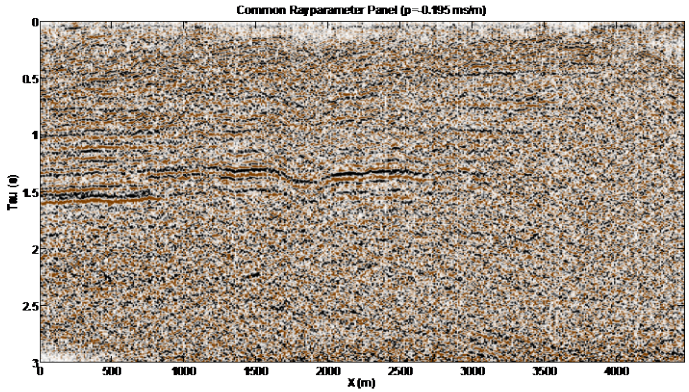
Common rayparameter panel

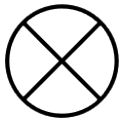


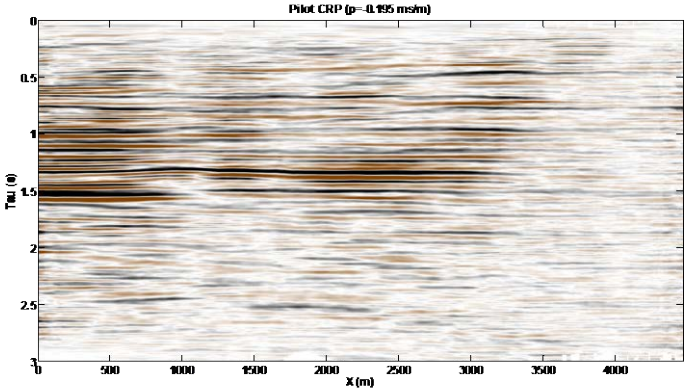
Pilot rayparameter panel

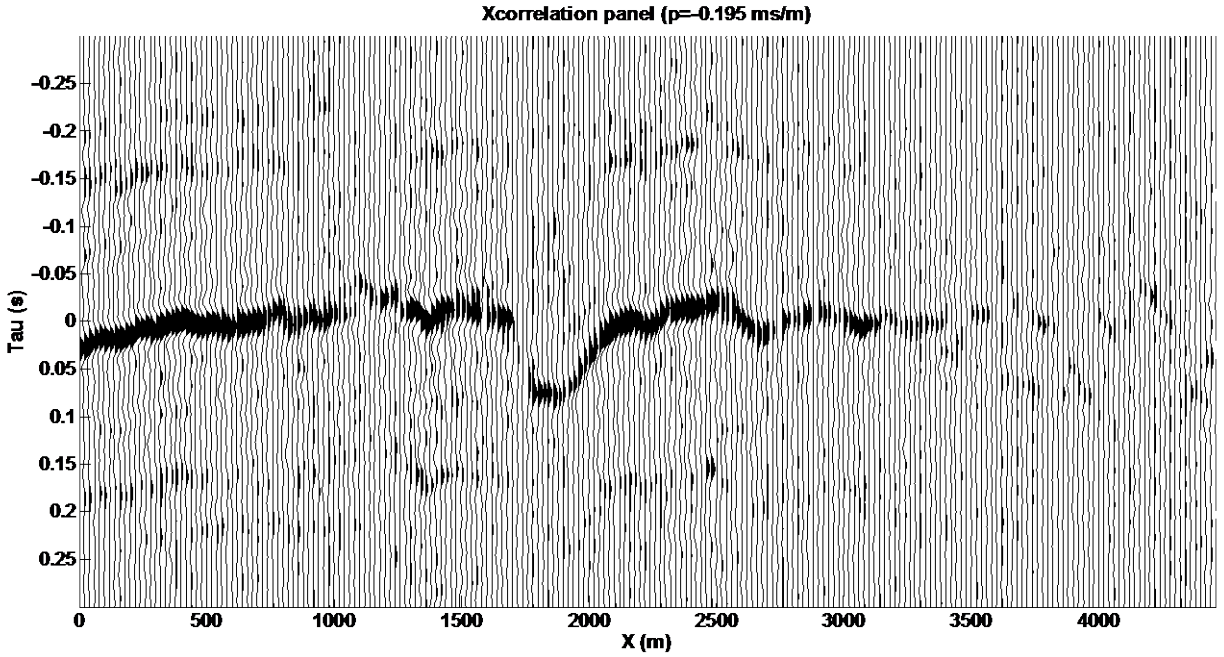


Computing the xcorrelation functions

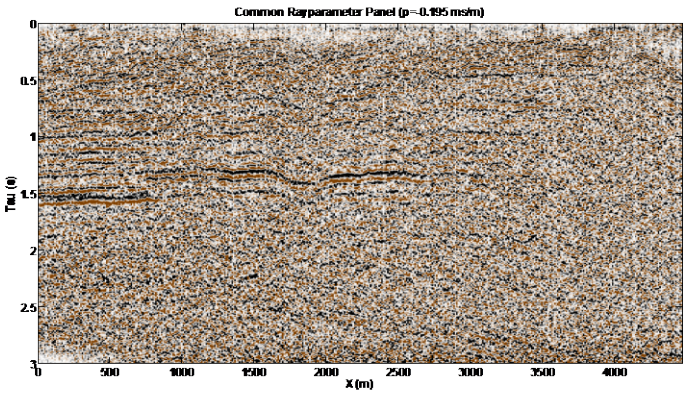


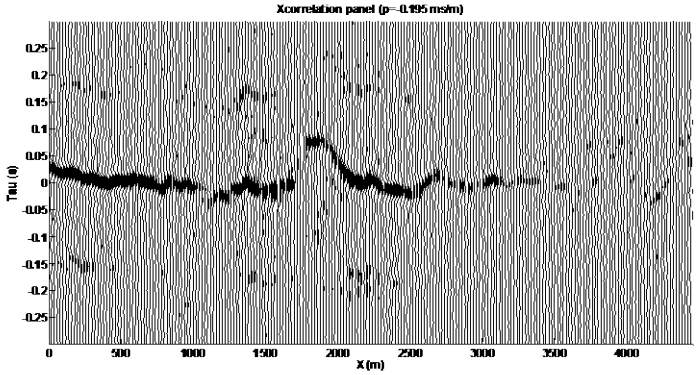


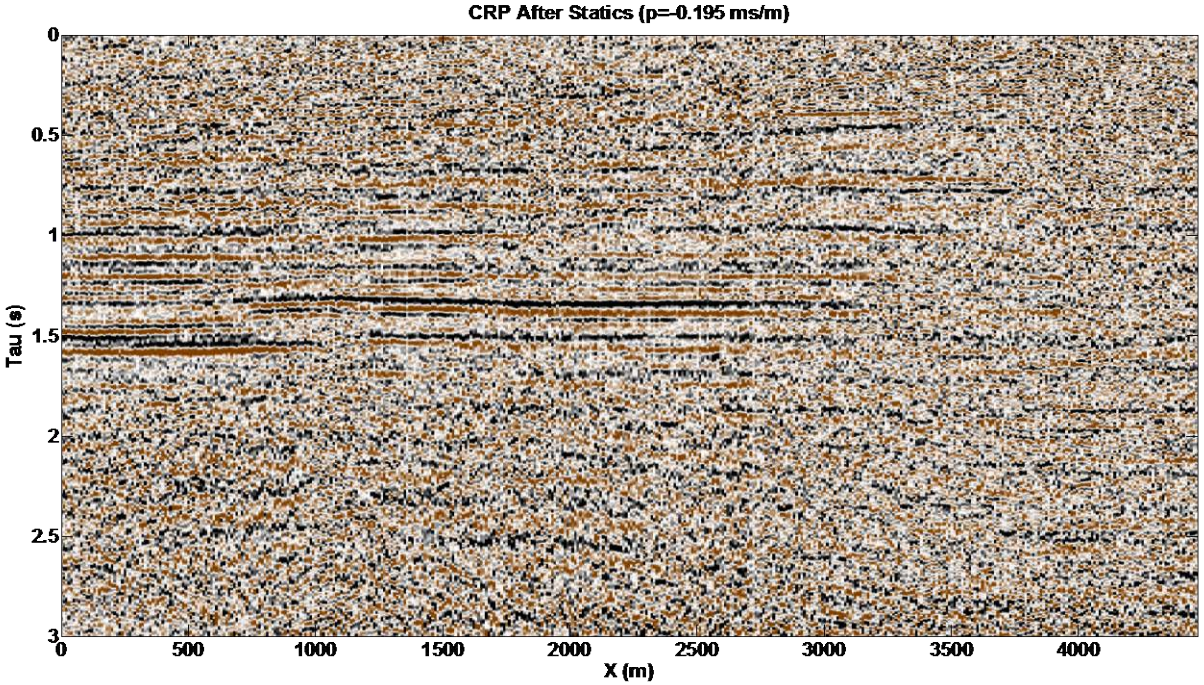




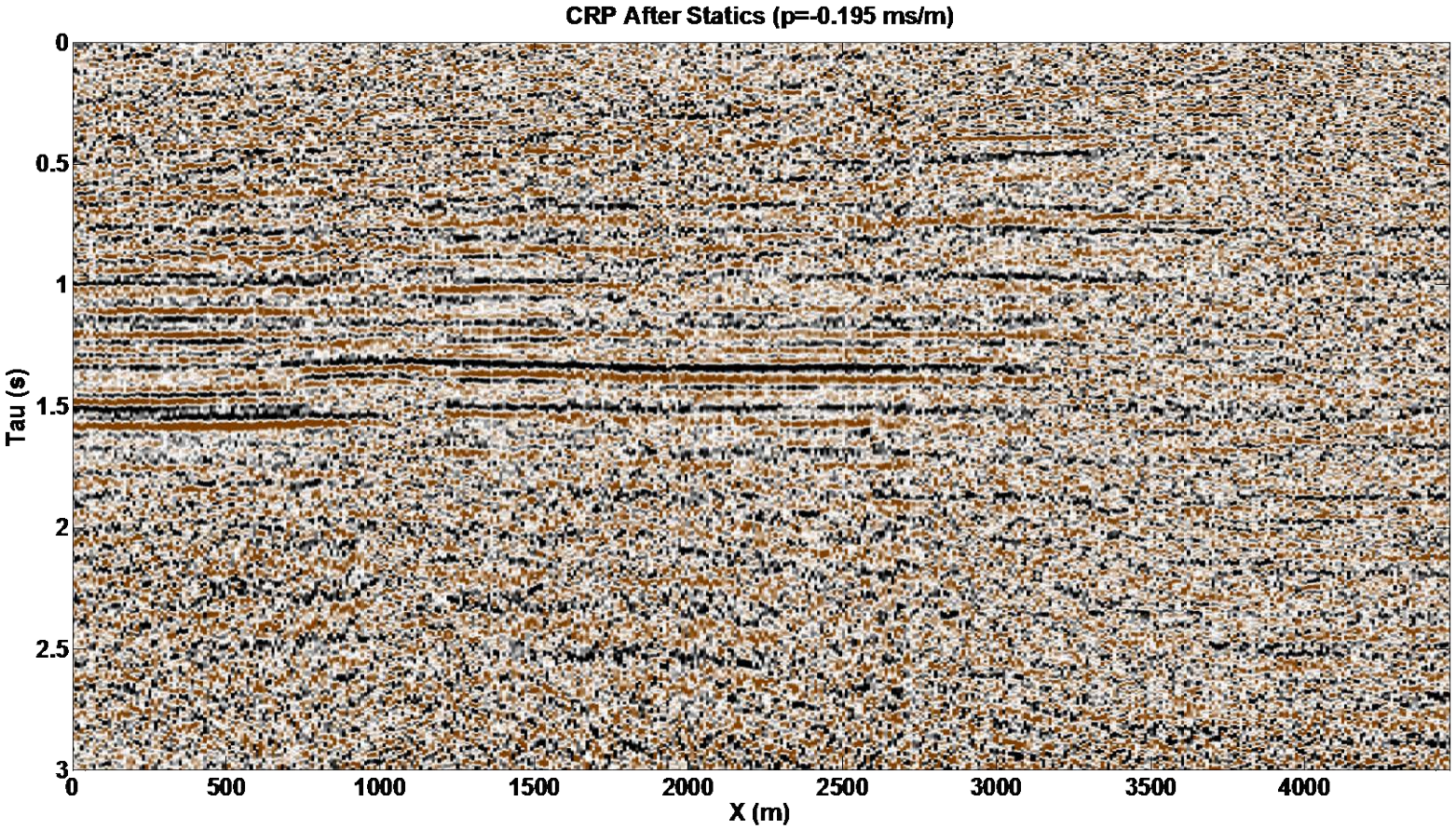
Applying the corrections



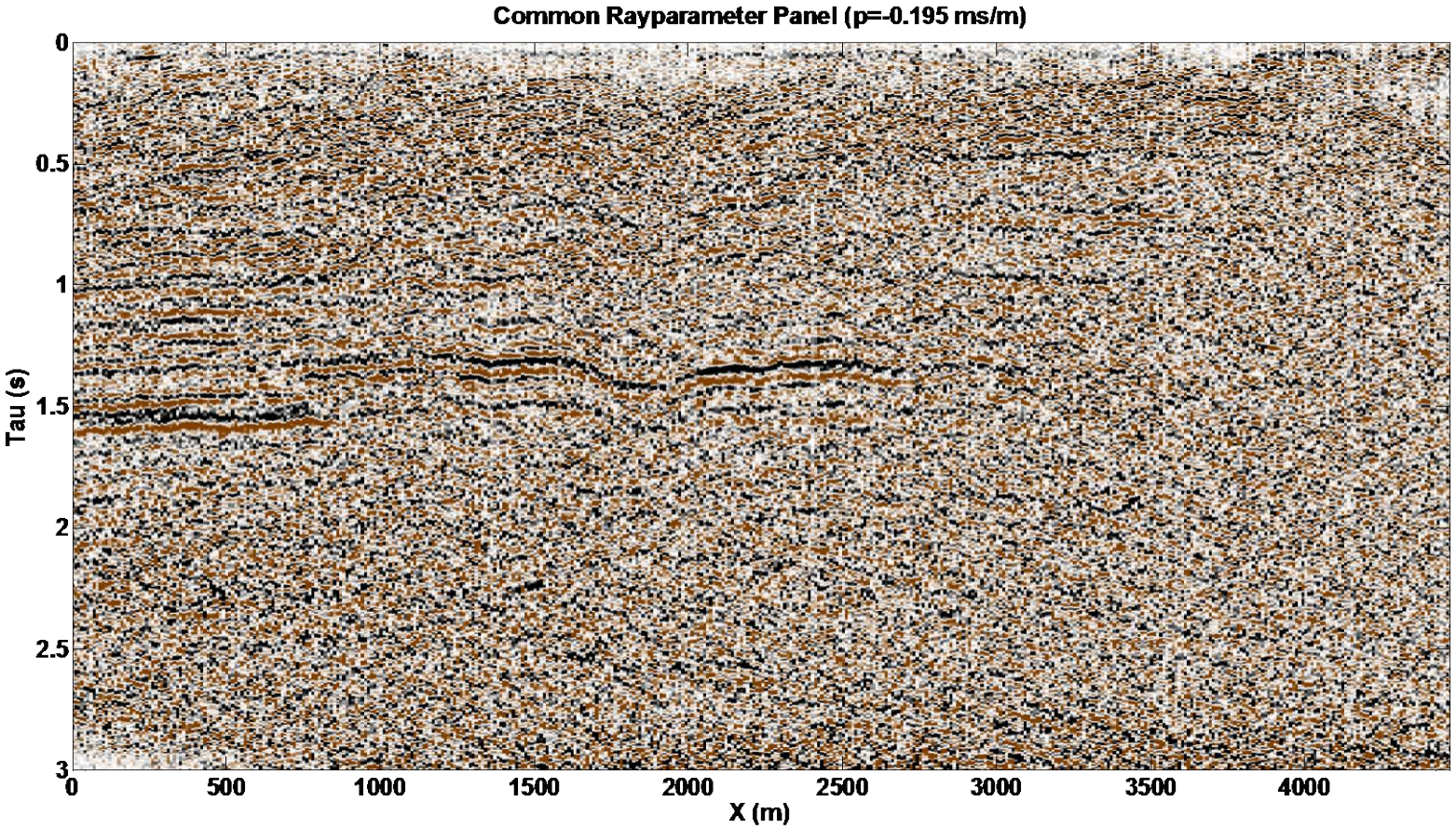




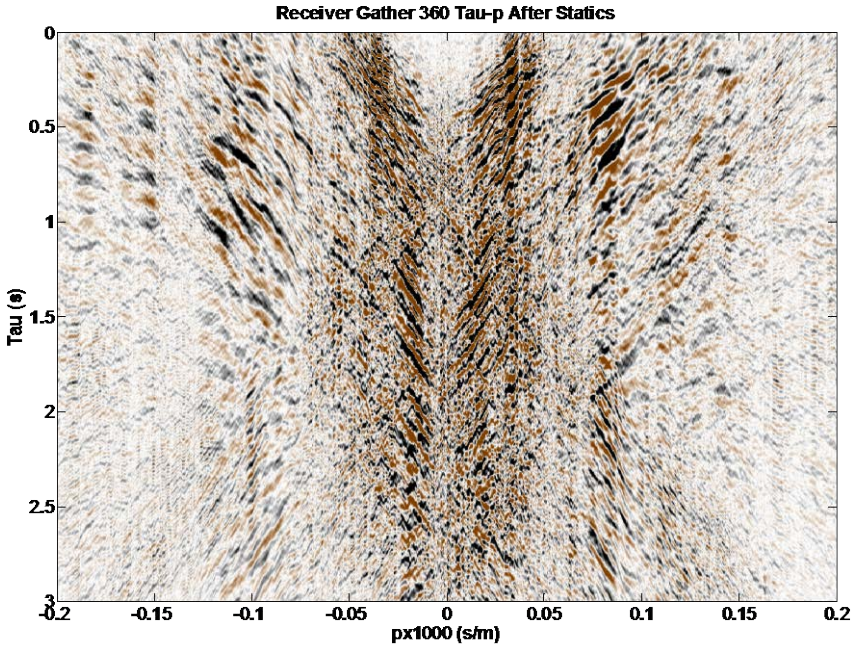
CRP after corrections

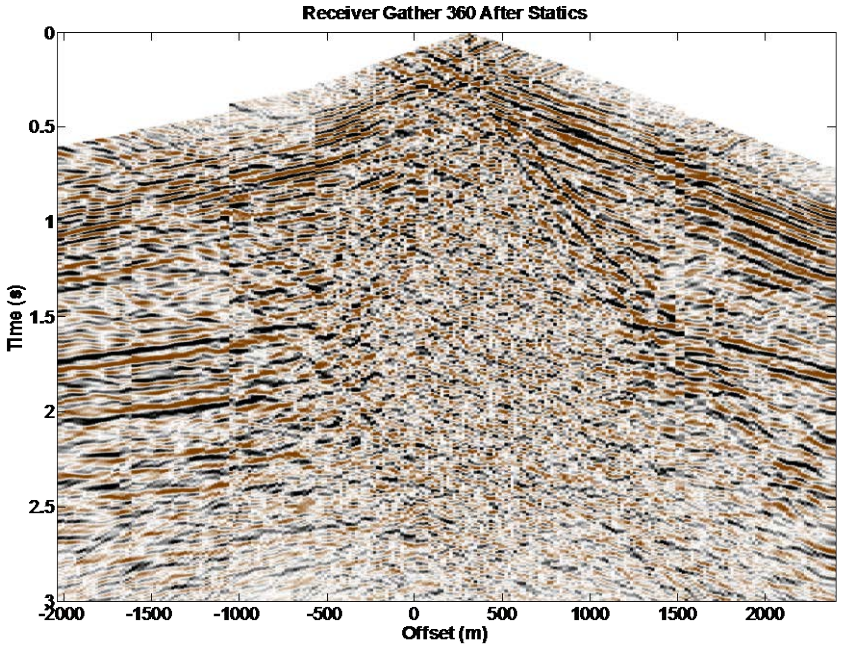


CRP before corrections

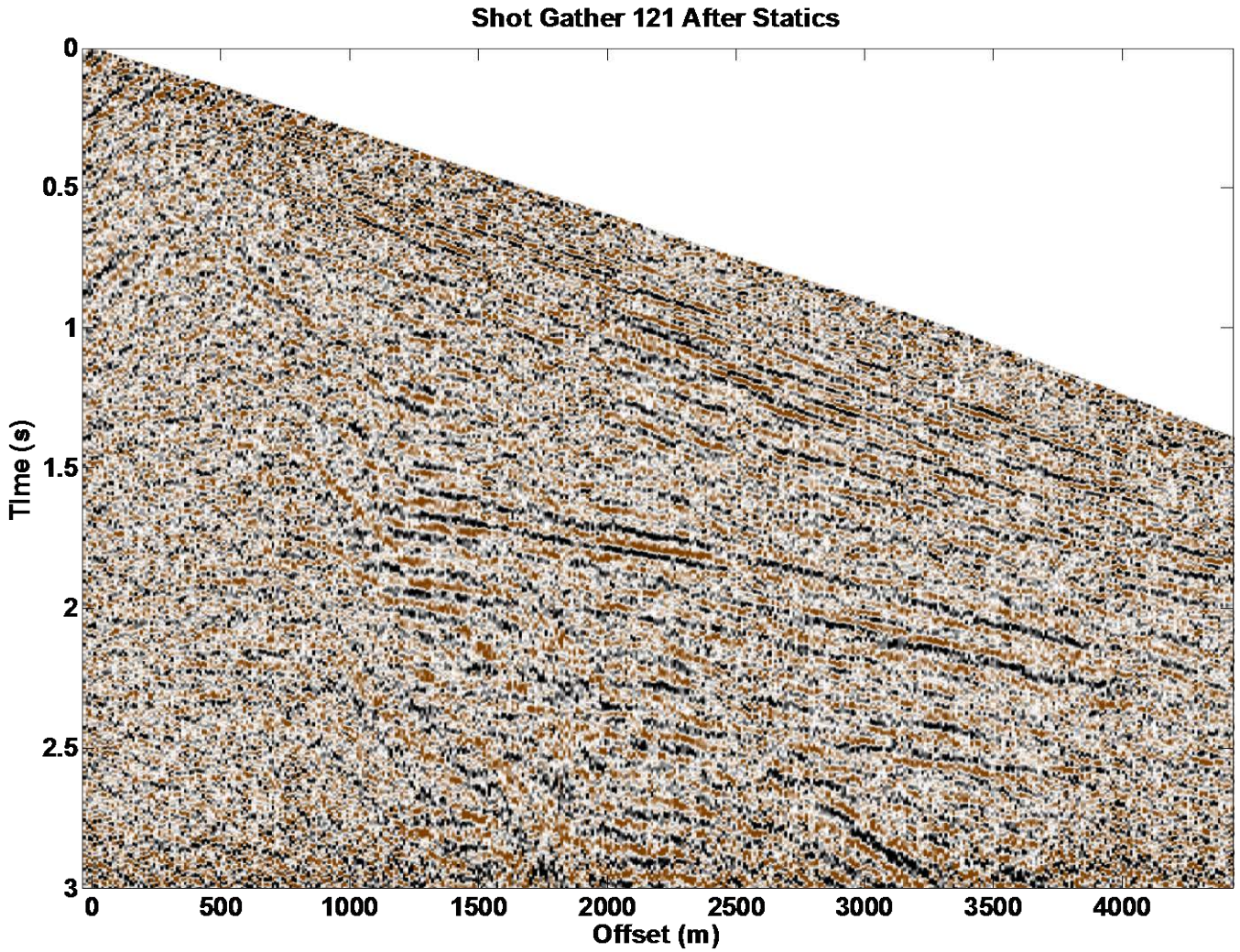


Taking the data back to x-t

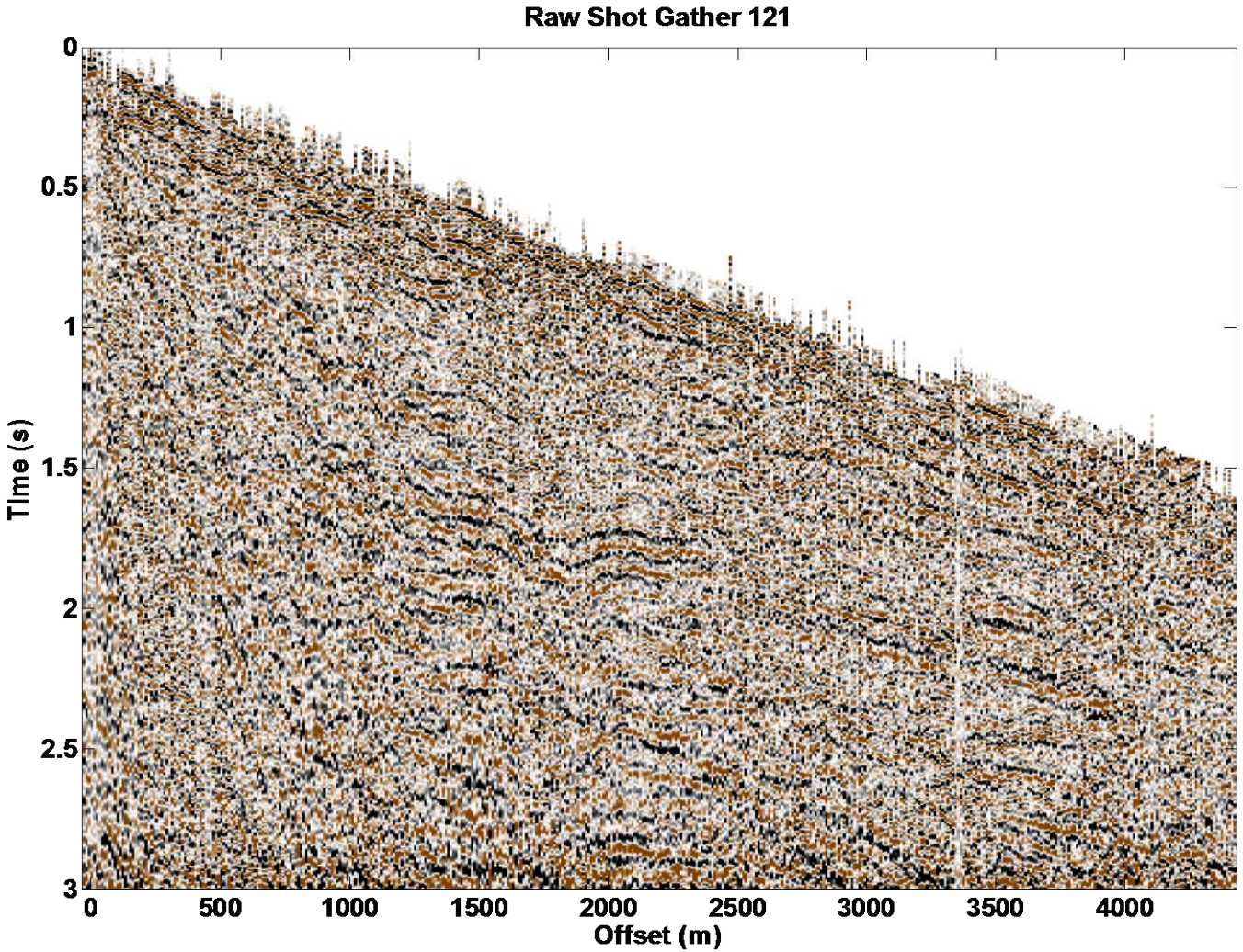




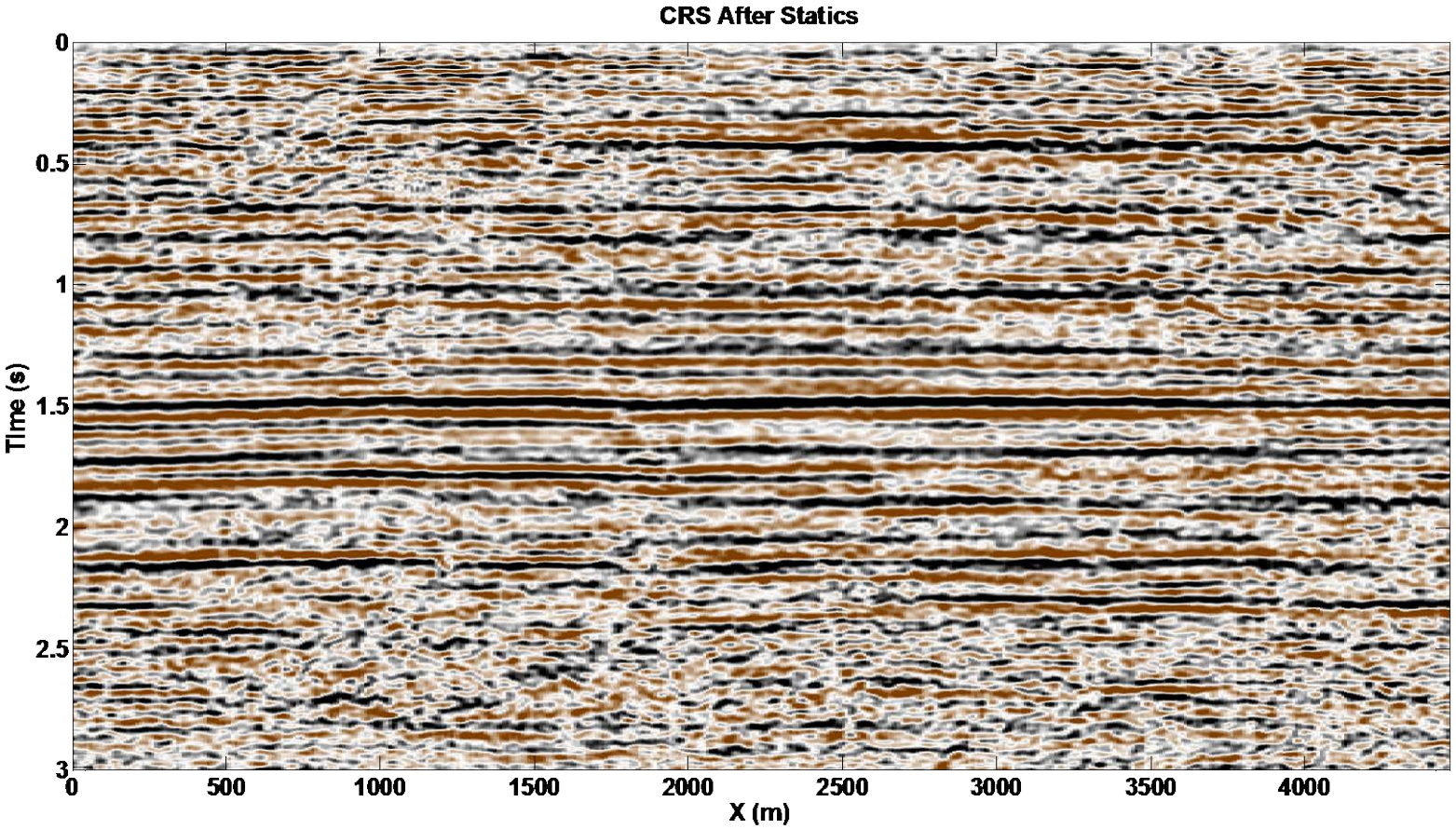
Checking results in x-t: shot gather



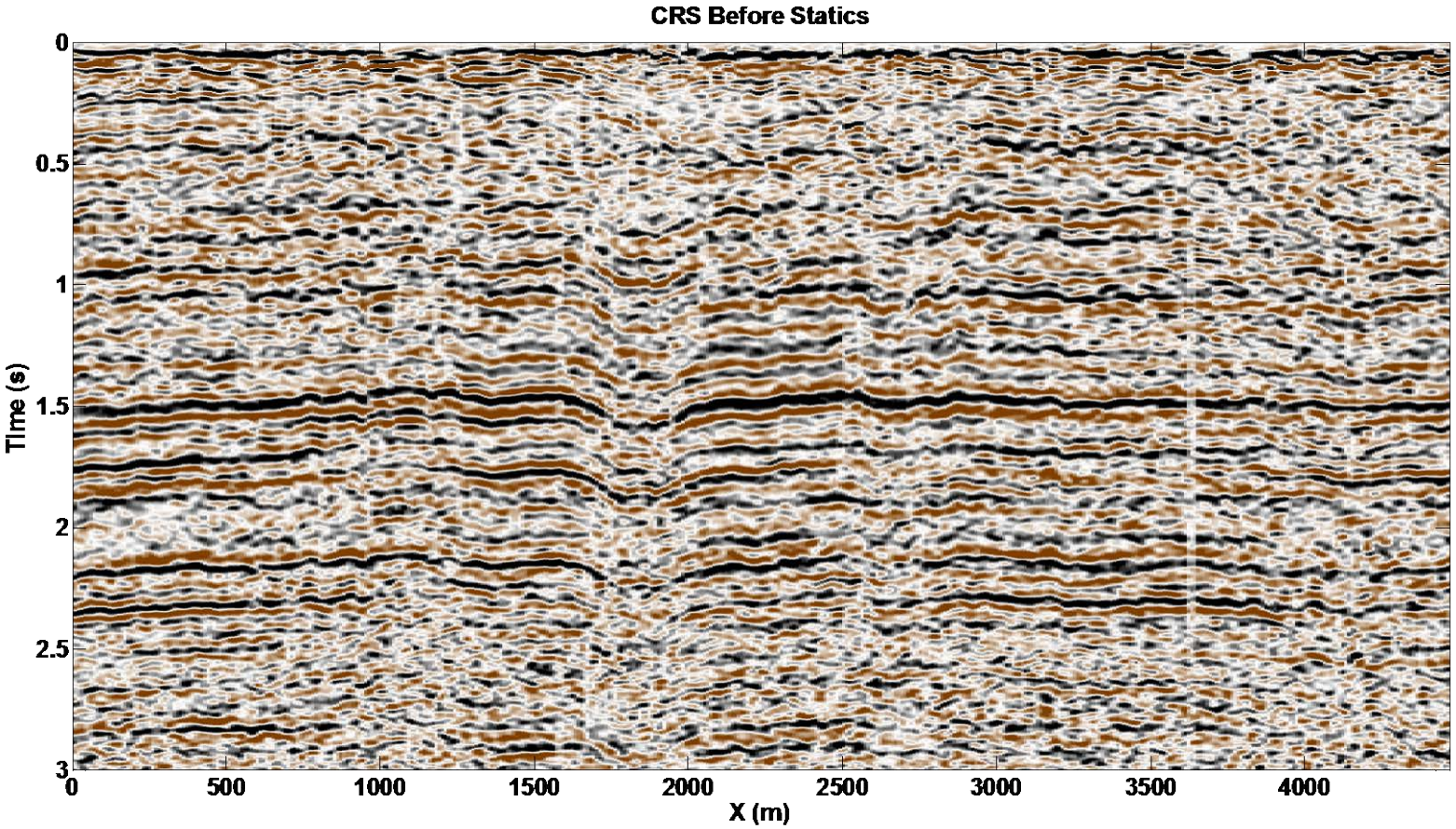
Checking results in x-t : shot gather



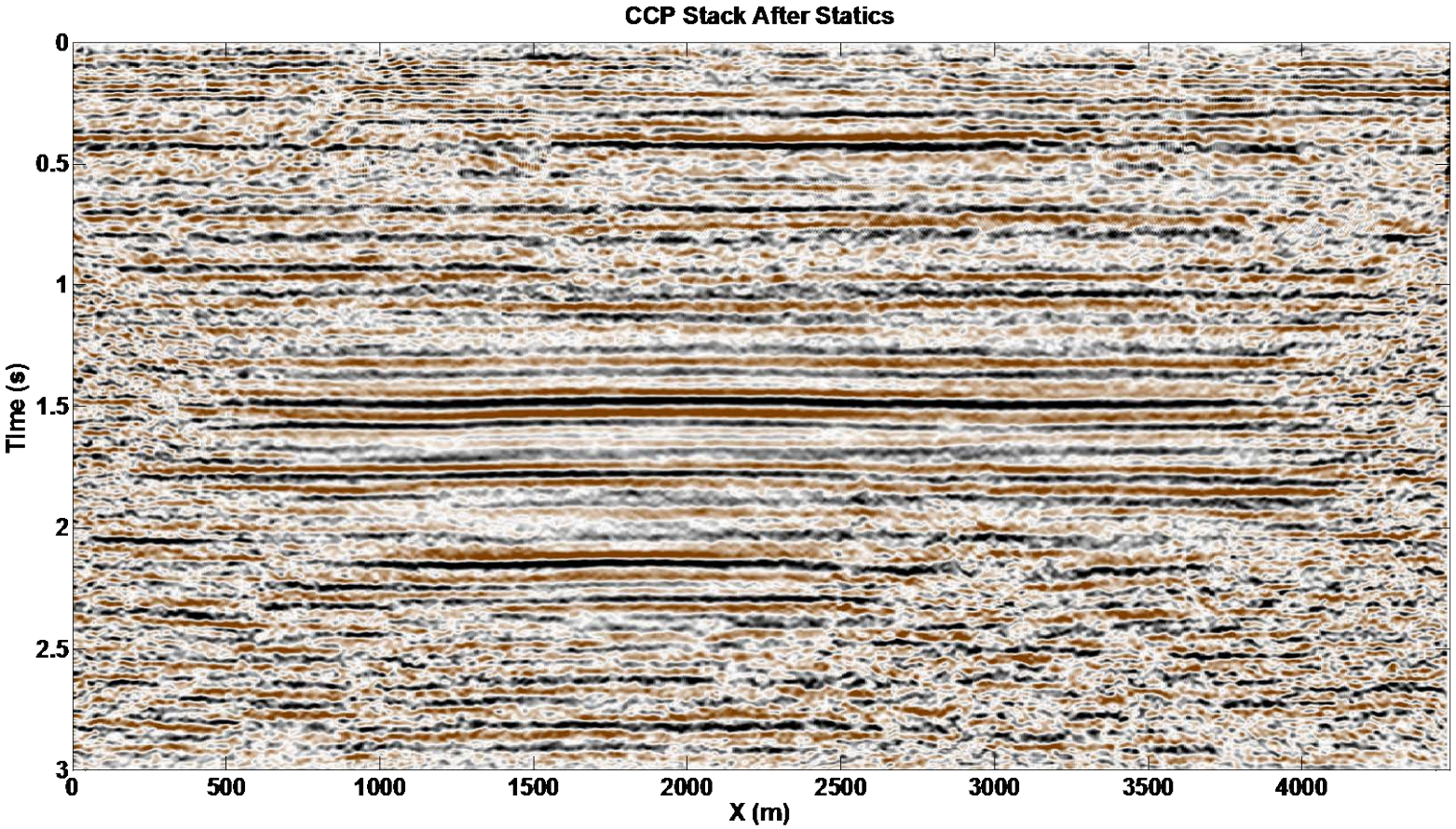
Checking results in x-t : Common Rec. Stack



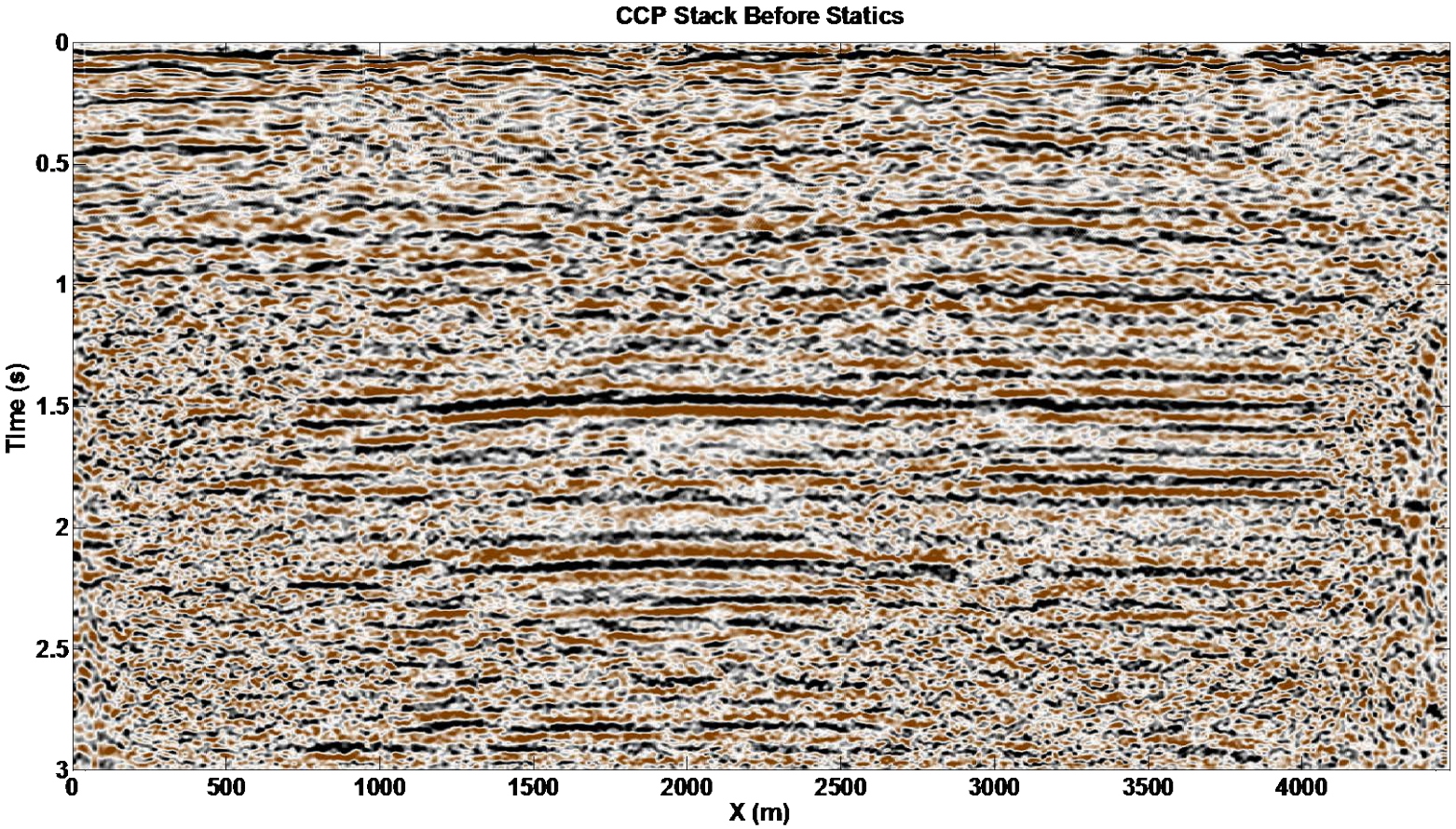
Checking results in x-t : Common Rec. Stack



Checking results in x-t : CCP Stack



Checking results in x-t : CCP Stack



Conclusions

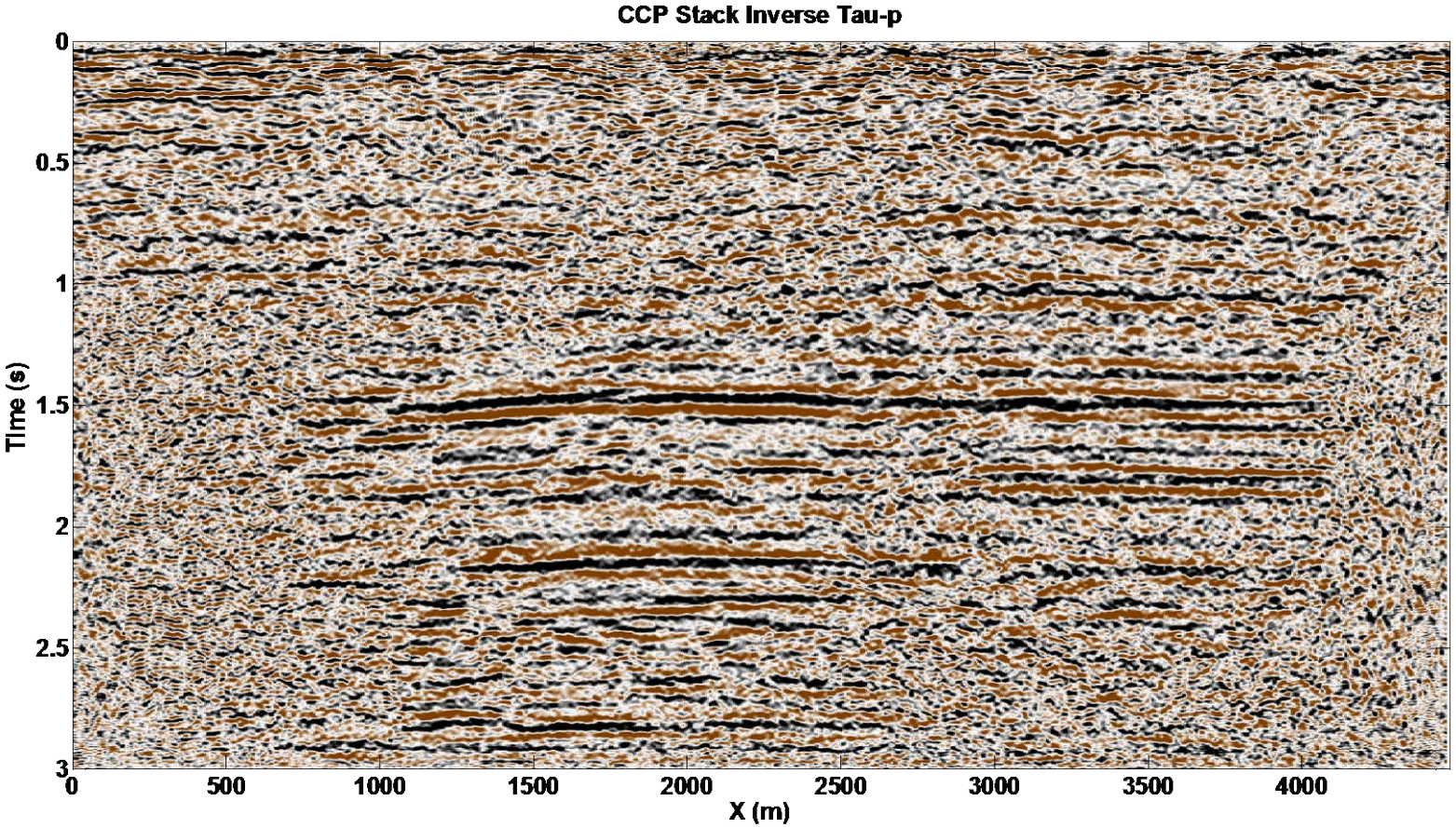
- ✓ Raypath-consistency provides a more accurate framework for correcting near surface effects.
- ✓ The cross-correlation functions derived from the interferometric processing may provide information about the velocities in the near surface
- ✓ An accurate tau-p algorithm is needed to assure data integrity

Acknowledgements

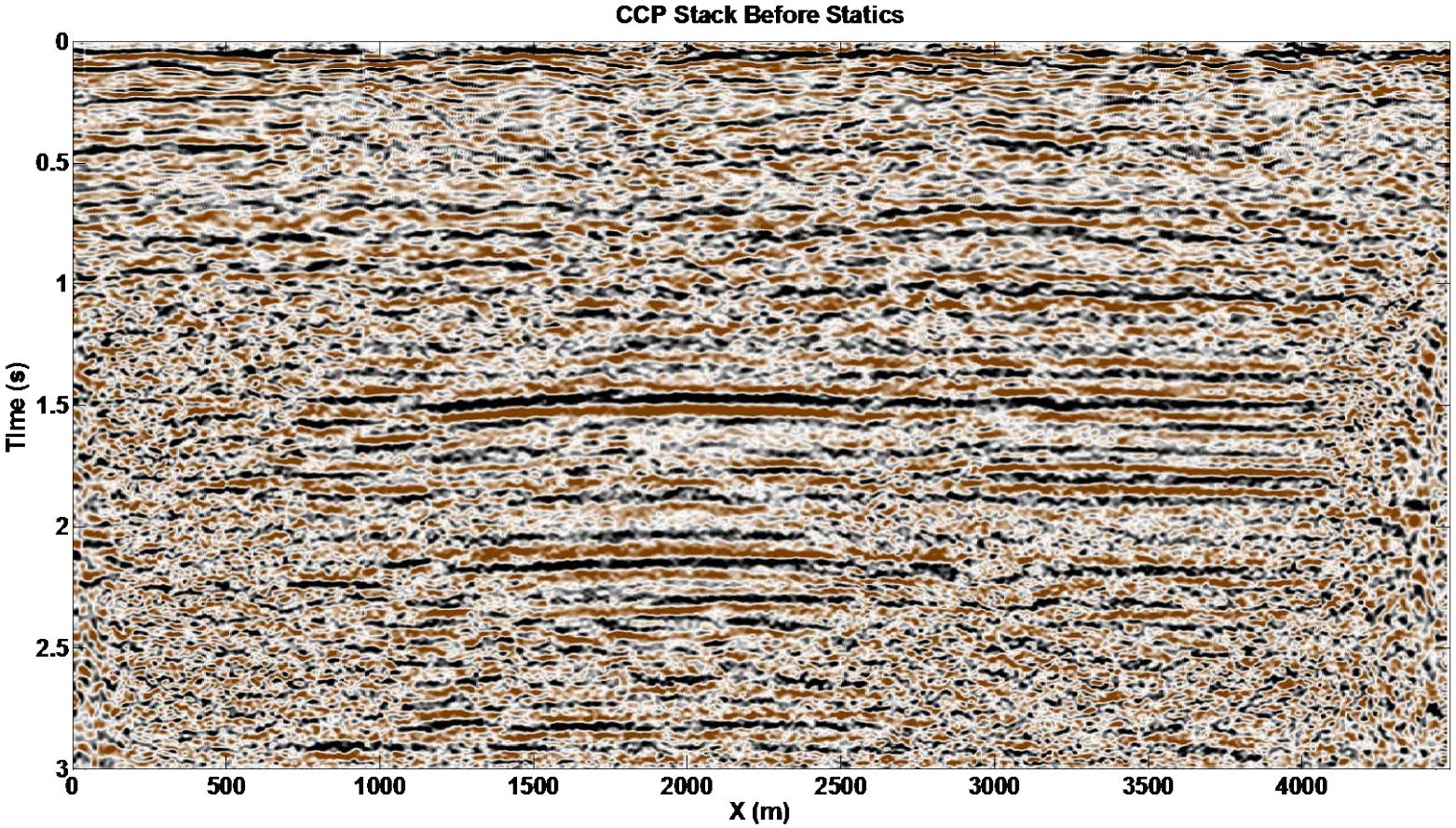
- David Henley
- Kris Innanen
- NSERC
- CREWES Staff and Students

Thanks!

Checking for data integrity

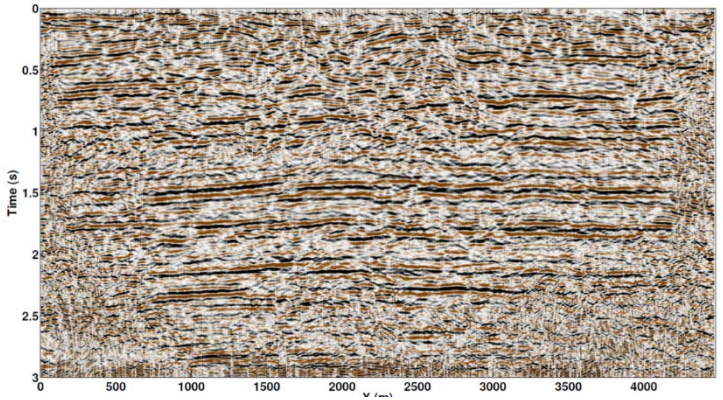


Checking for data integrity

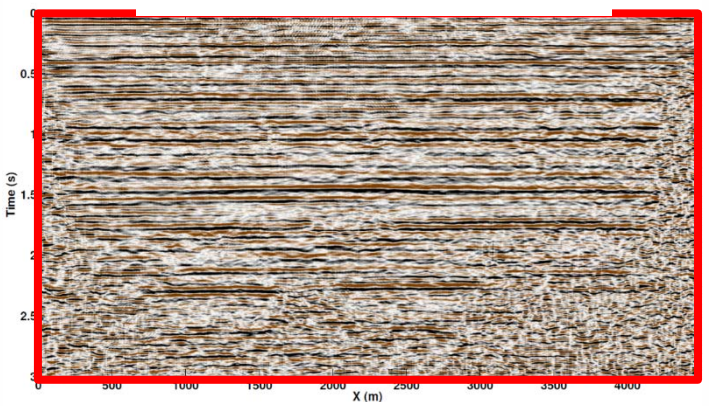


Rayparameter Domain Statics

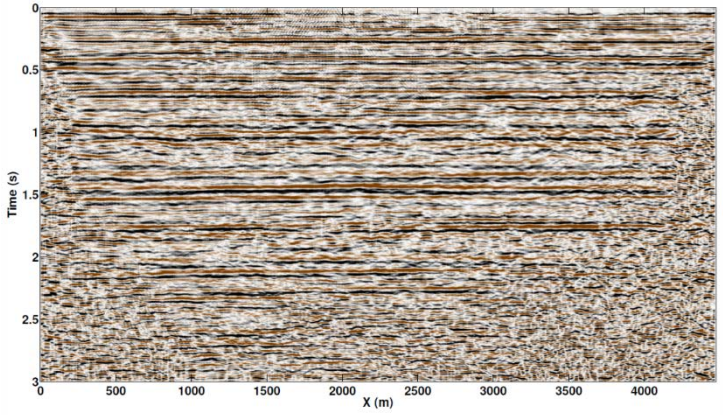
Raw ACP Stack



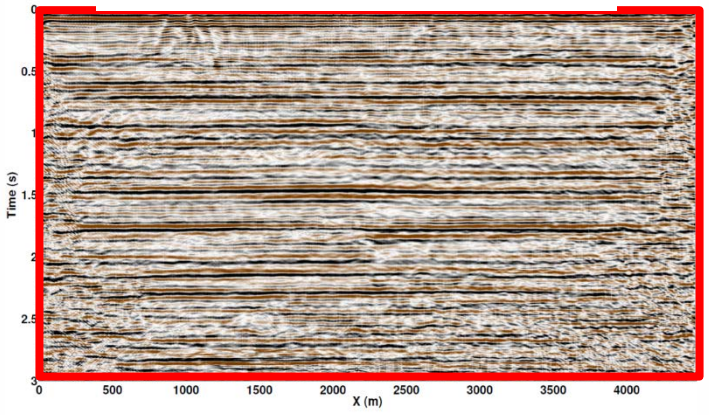
RT Domain Static Corrections



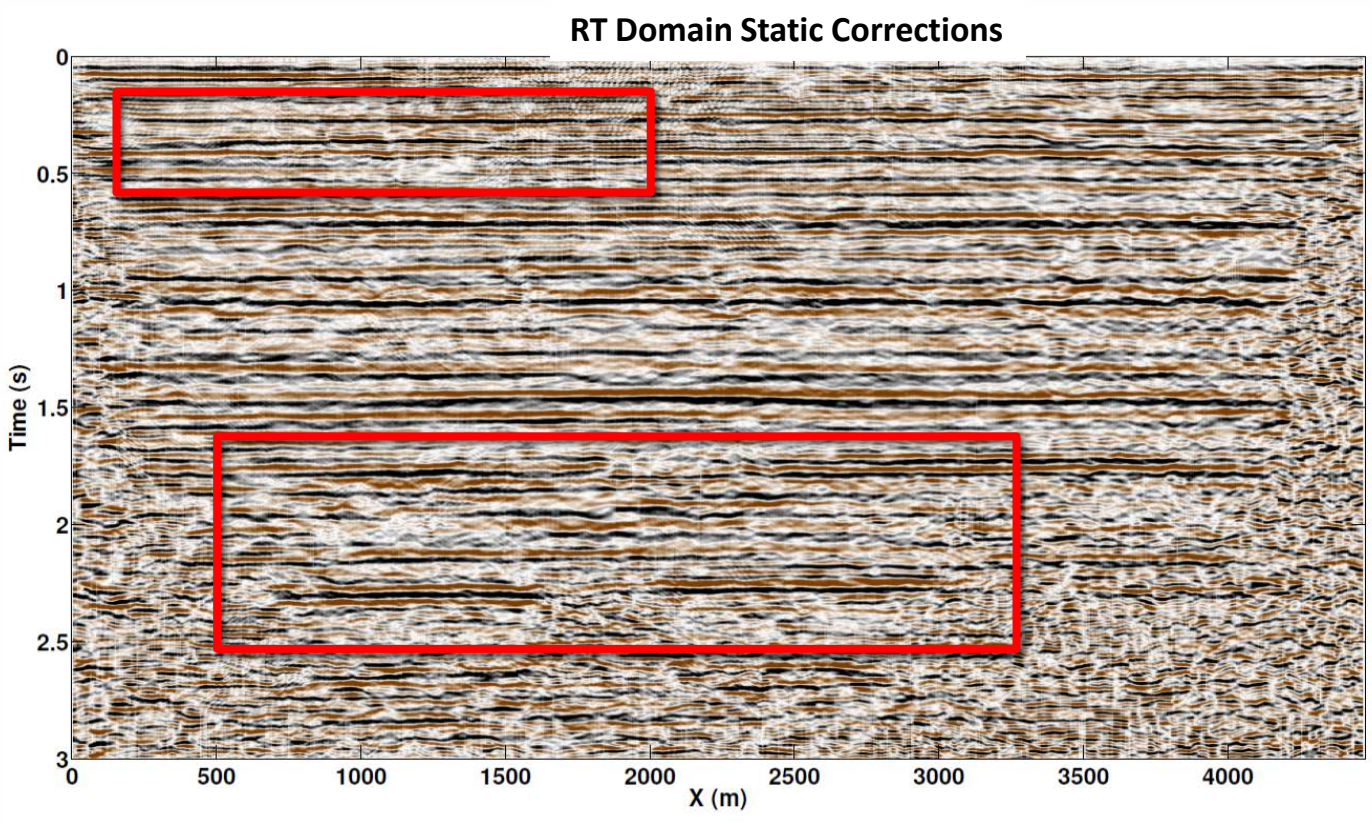
Snell-Trace Domain Static Corrections



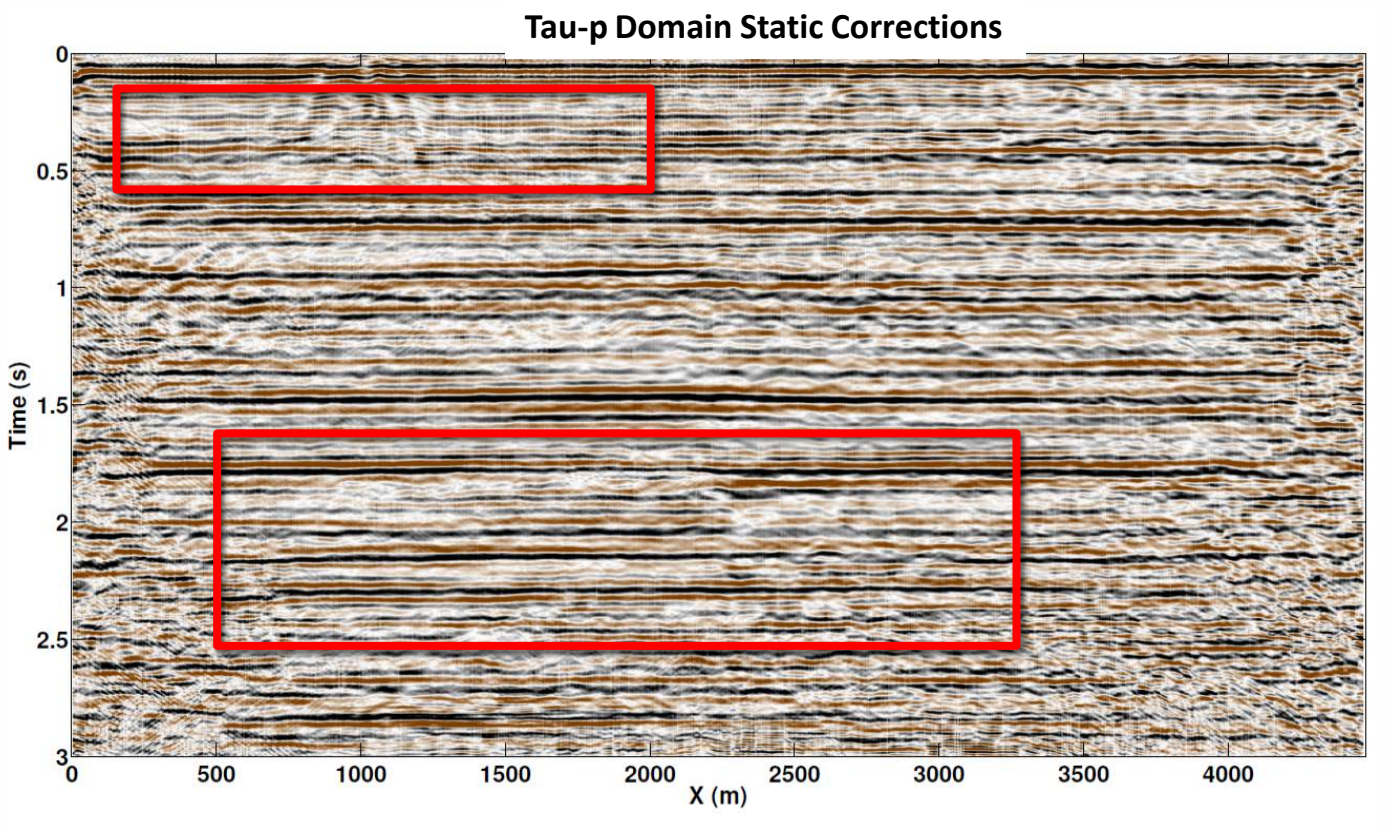
Tau-p Domain Static Corrections

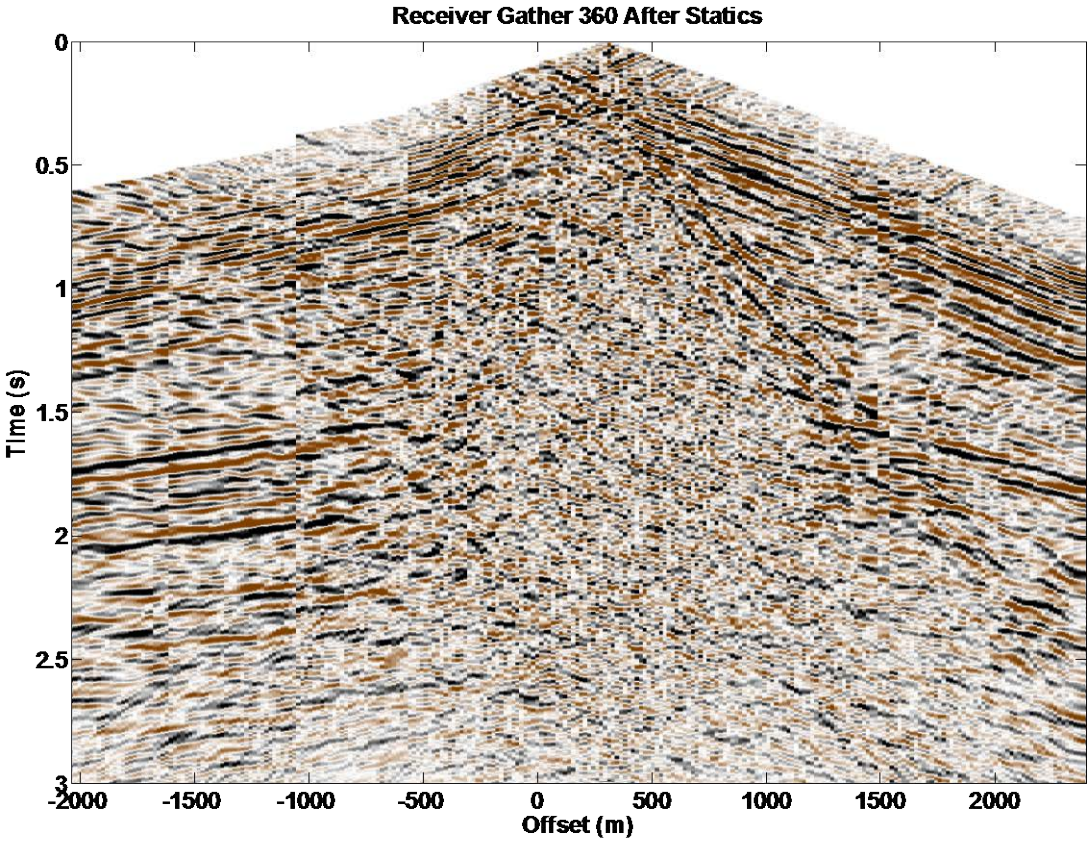


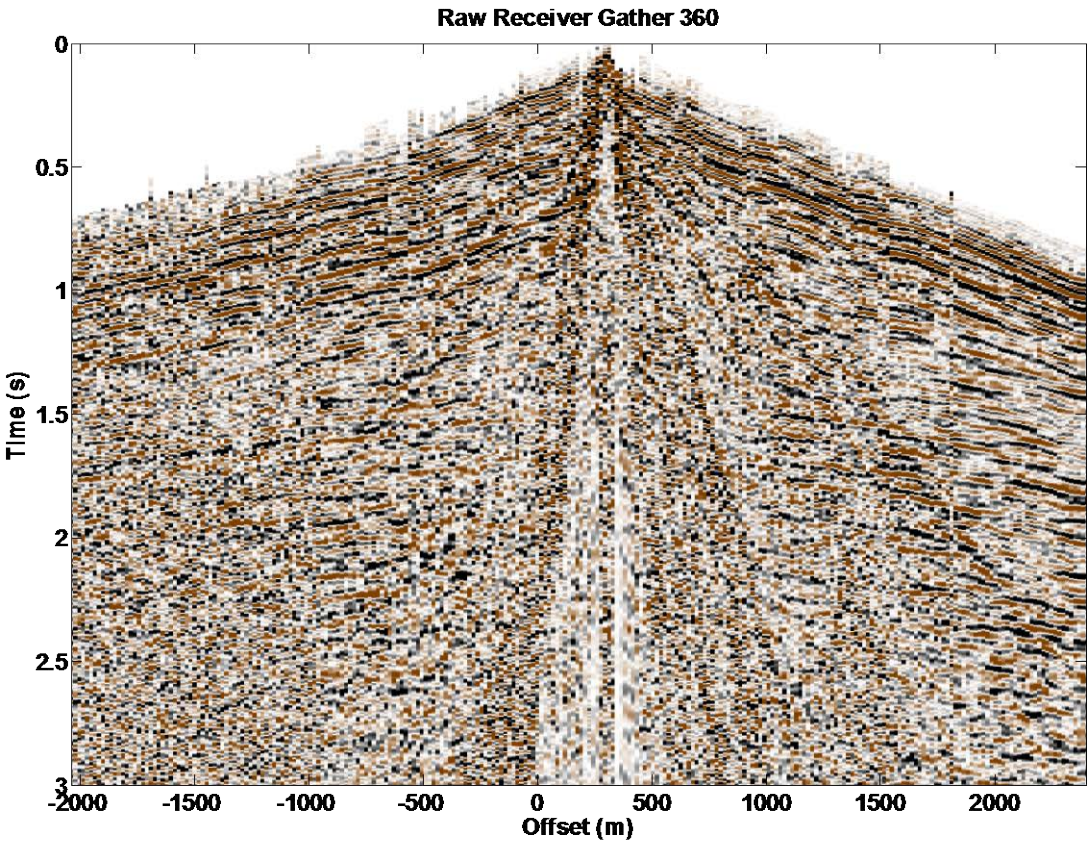
Rayparameter Domain Statics



Rayparameter Domain Statics




Receiver Gather 360 After Statics
Time (s)
0
0.5
1
1.5
2
2.5
3
-2000
-1500
-1000
-500
0
500
1000
1500
2000
Offset (m)


Raw Receiver Gather 360
Time (s)
0
0.5
1
1.5
2
2.5
3
-2000
-1500
-1000
-500
0
500
1000
1500
2000
Offset (m)