UNIVERSITY OF CALGARY

CREWES
Celebrating 25 Years

Multi-channel analysis of surface waves (MASW) applied to an active fault zone

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Outline

1. Introduction: Objectives, MASW
2. Geologic Setting & Data Acquisition
3. Data Processing
4. Dispersion Analysis
5. *Preliminary* Inversion Results
6. Future Work

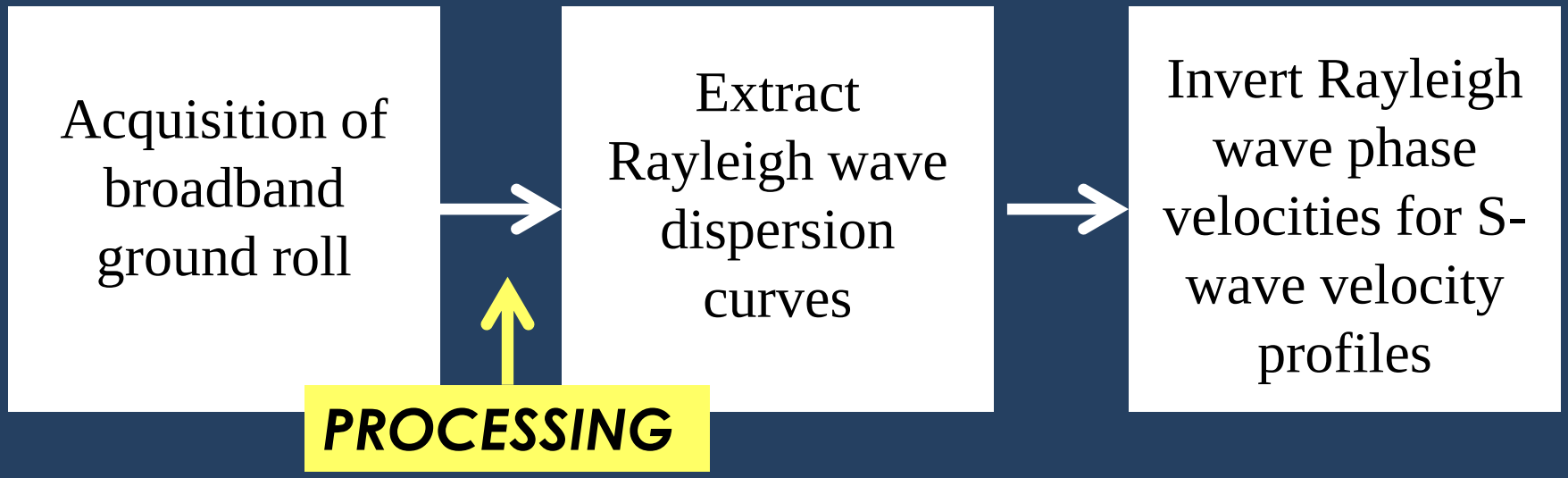
Objectives

1. Apply the MASW method to delineate a known fault zone

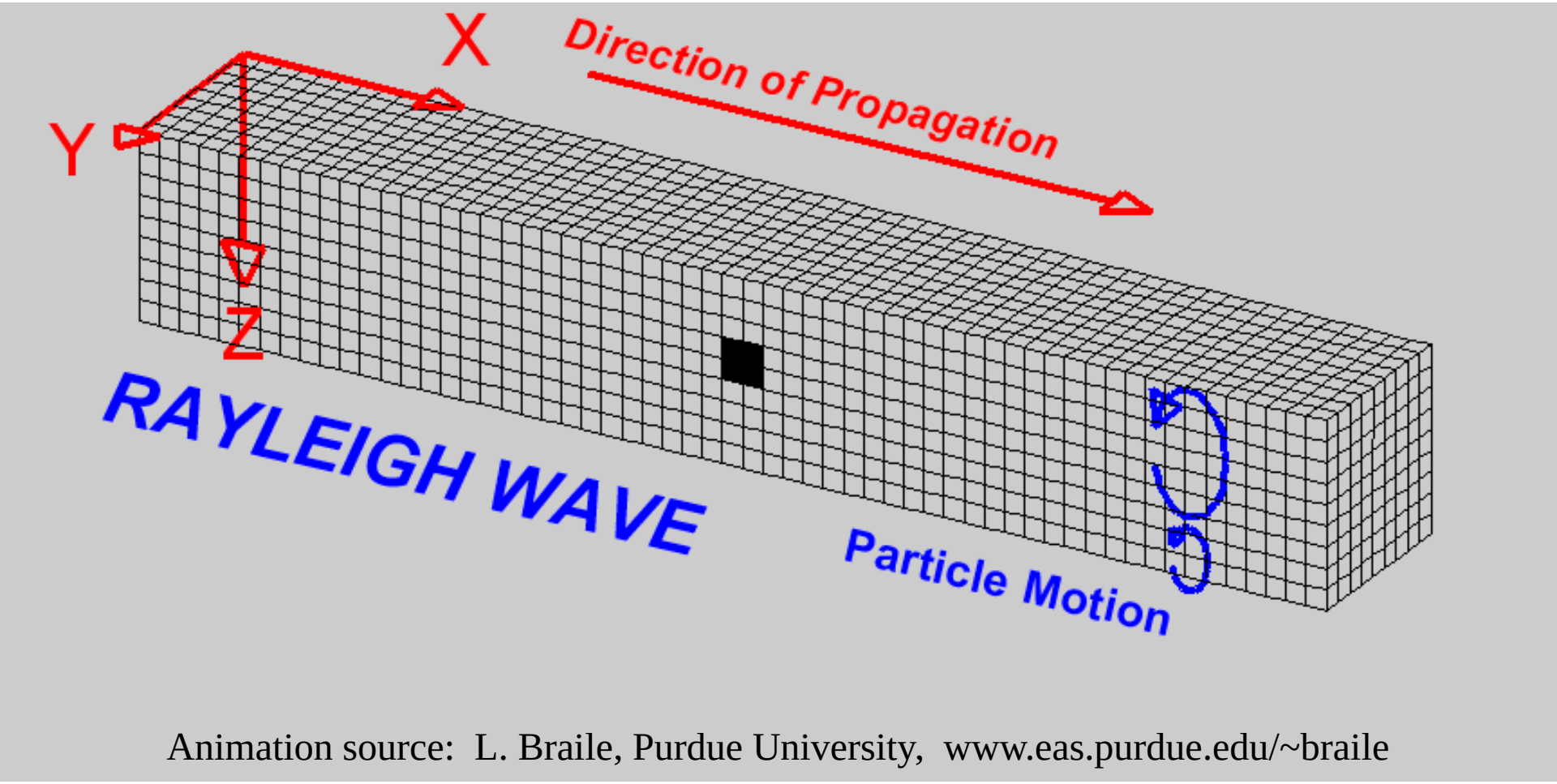
2. Identify soil conditions that have risk for high liquefaction potential

MASW (Park et al., 1999)

- Goal is to generate a Vs profile though multi-channel analysis of surface waves (ground roll)
- Dispersion: For each unique frequency component of a surface wave, a different propagation velocity exists.

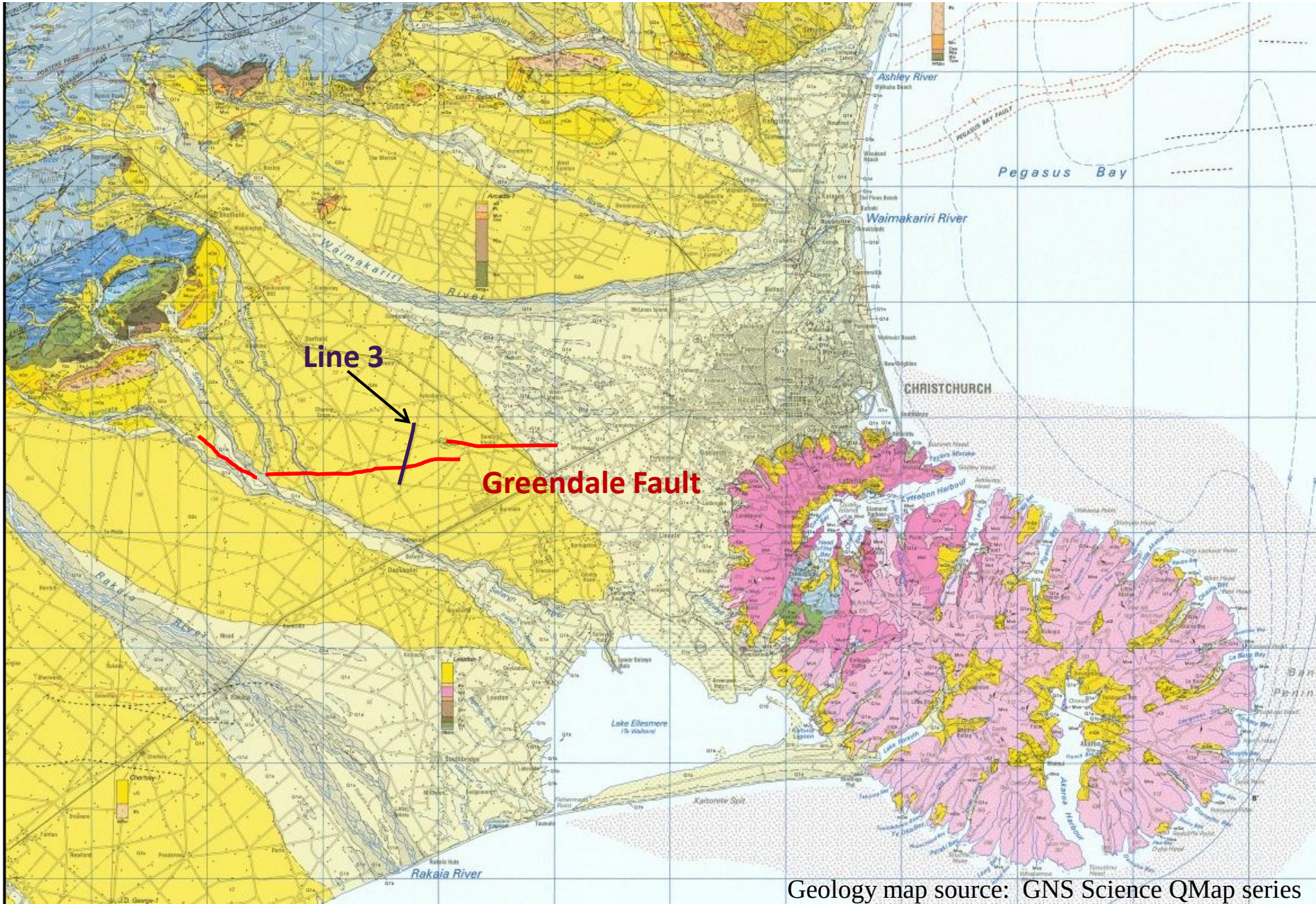


Rayleigh Wave Animation



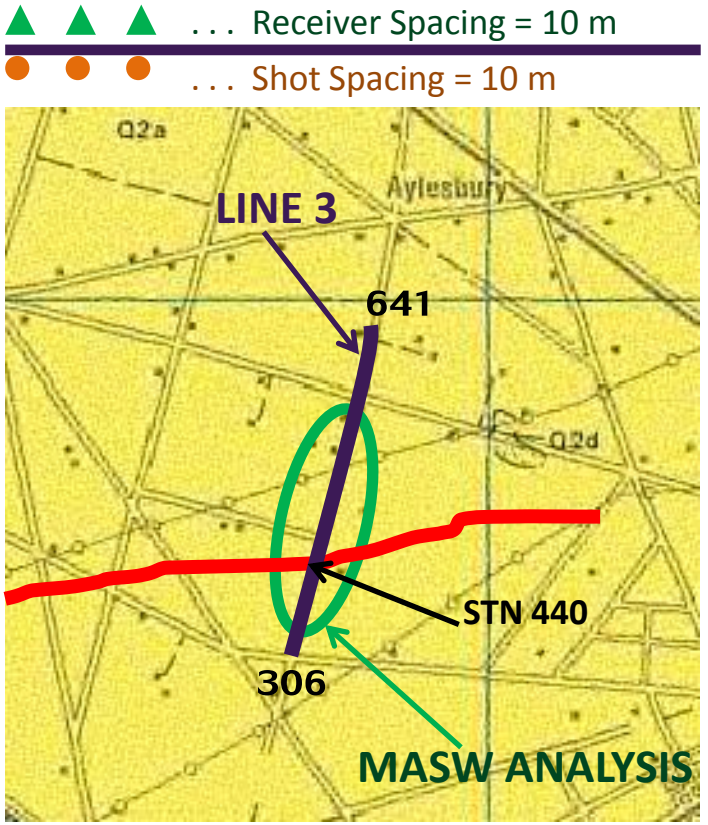
Animation source: L. Braile, Purdue University, www.eas.purdue.edu/~braile

Geologic Setting



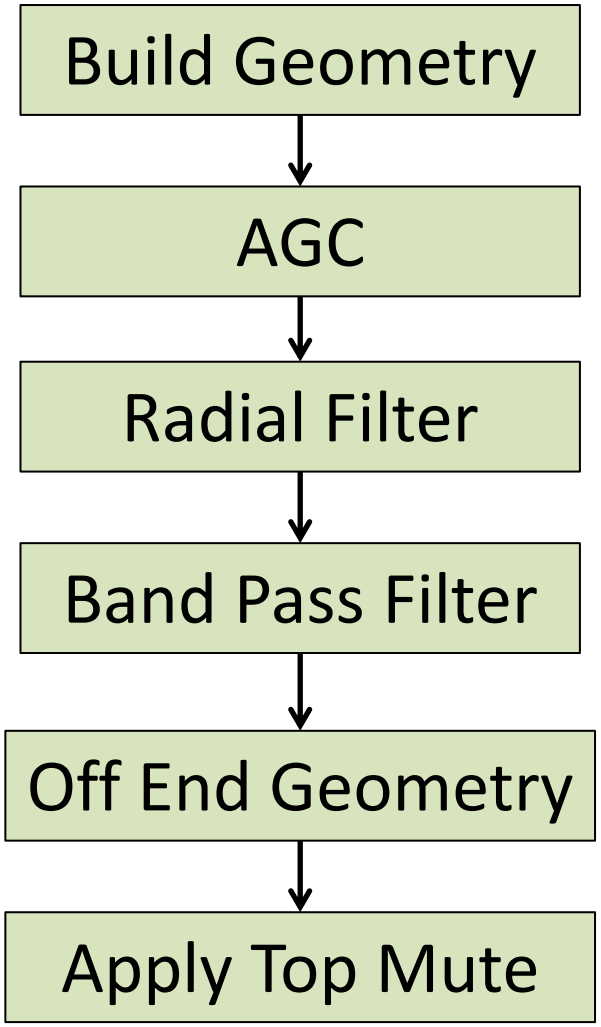
Geology map source: GNS Science QMap series

Data acquisition parameters

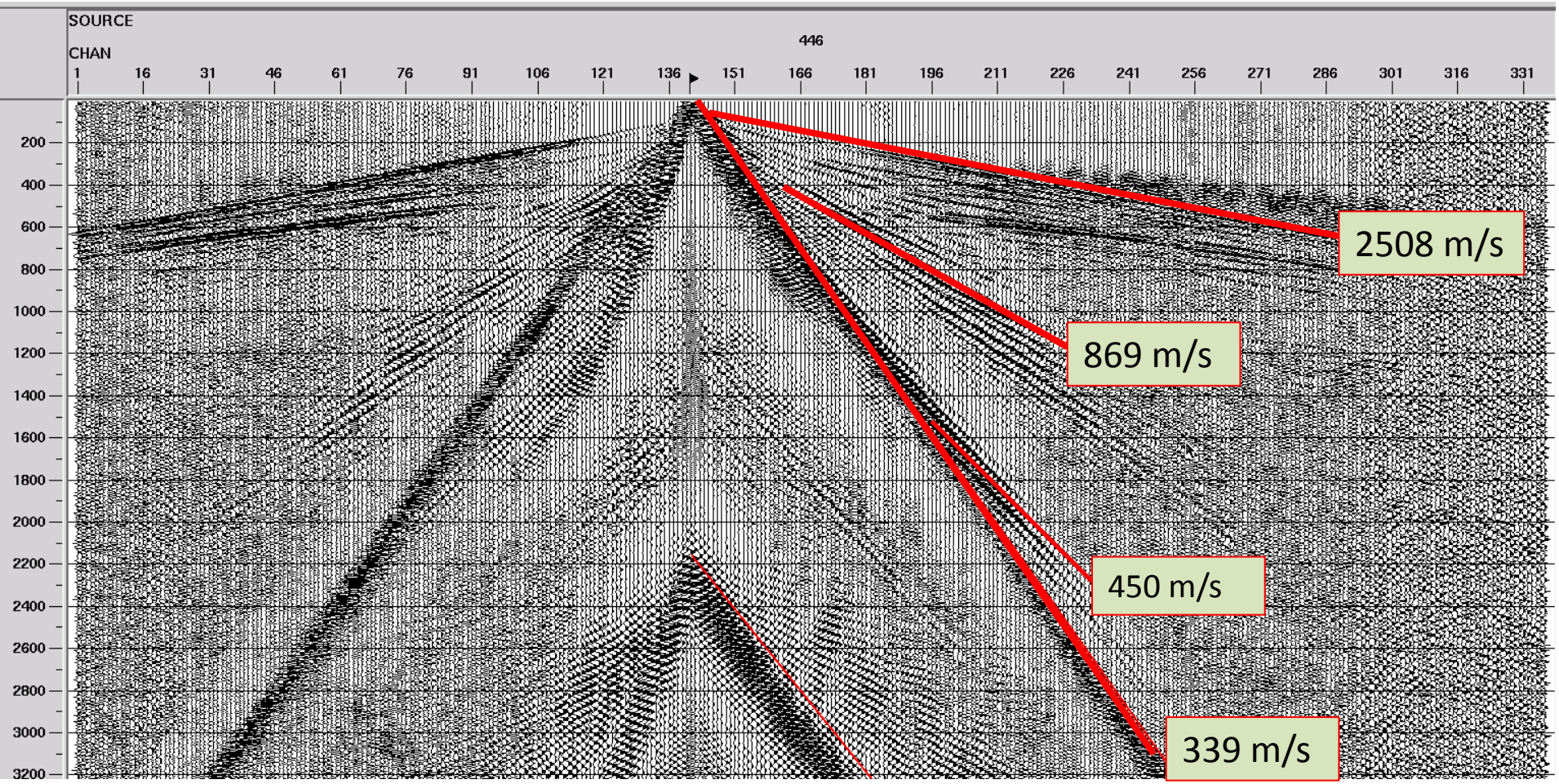


GEOPHONES	Sensor SM-24 10 Hz vertical component
SEISMIC SOURCE	IVI Envirovibe. 10 – 120 Hz Sweep, 10 sec, 8 sweeps.
RECORDER	4000 ms recording length, 1 ms sample rate

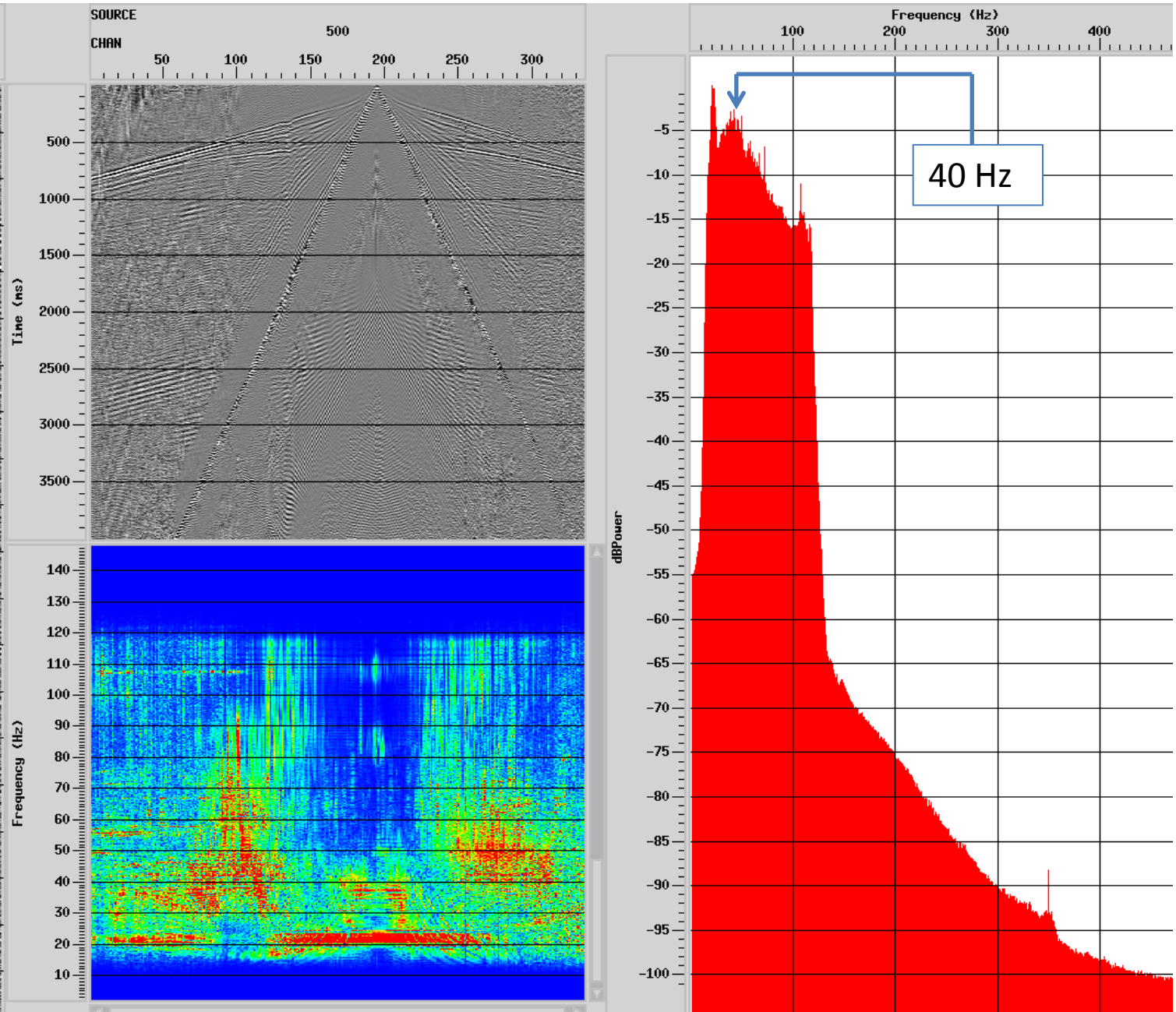
Data Processing (Promax)



A feel for the data…



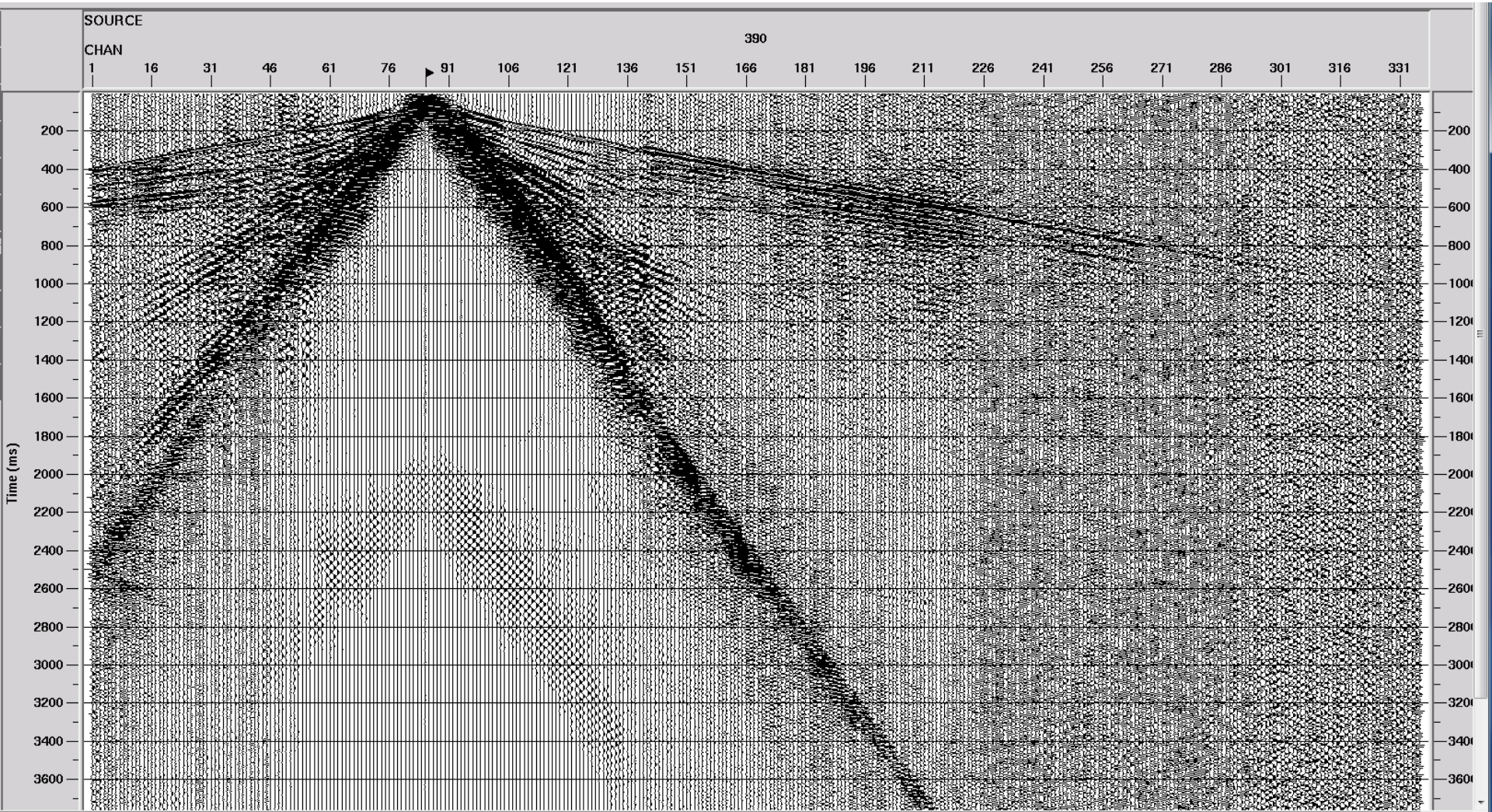
A feel for the data…



Shot 500
AGC 1000

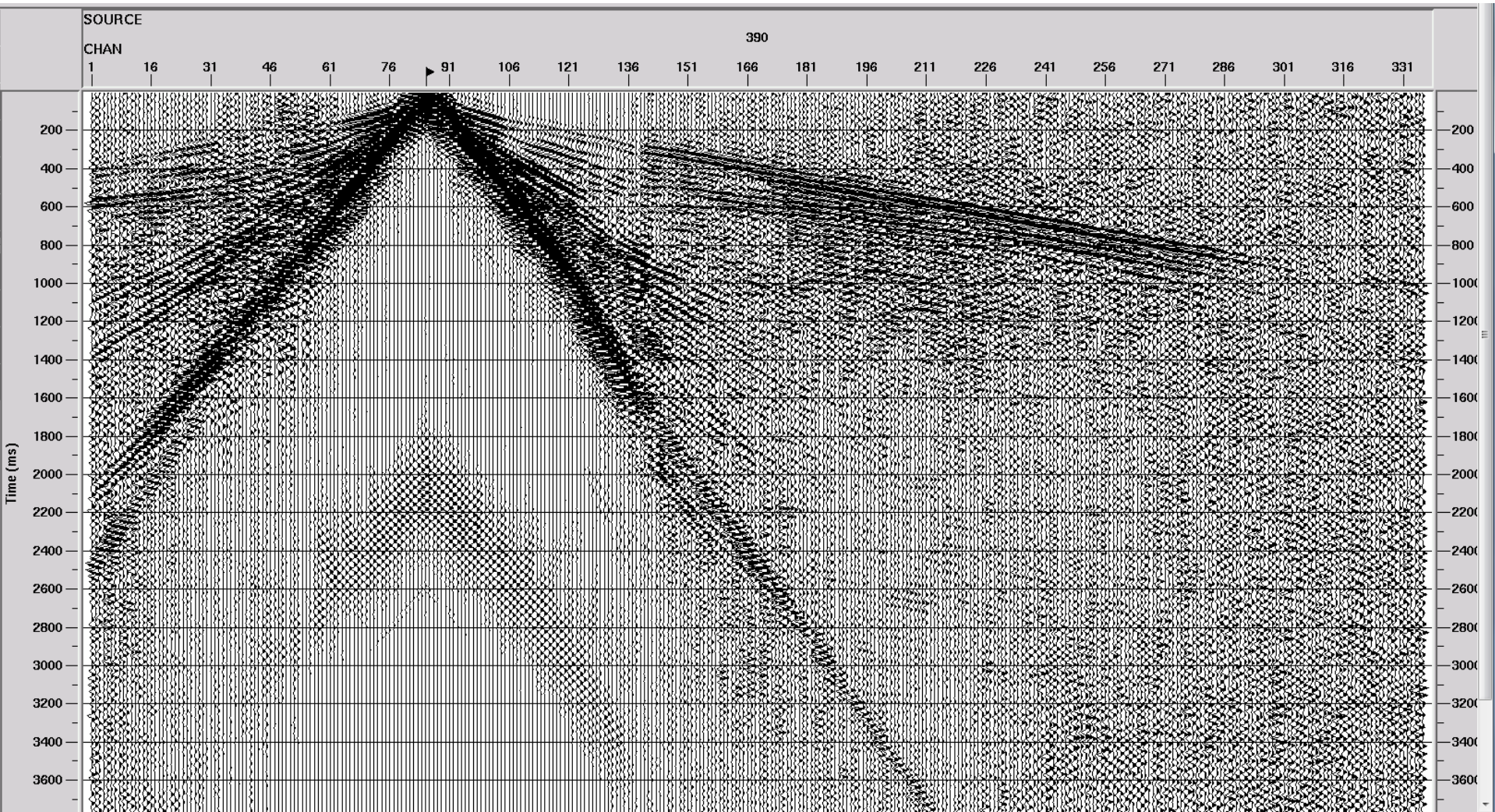
Data Processing

Shot 390
Raw



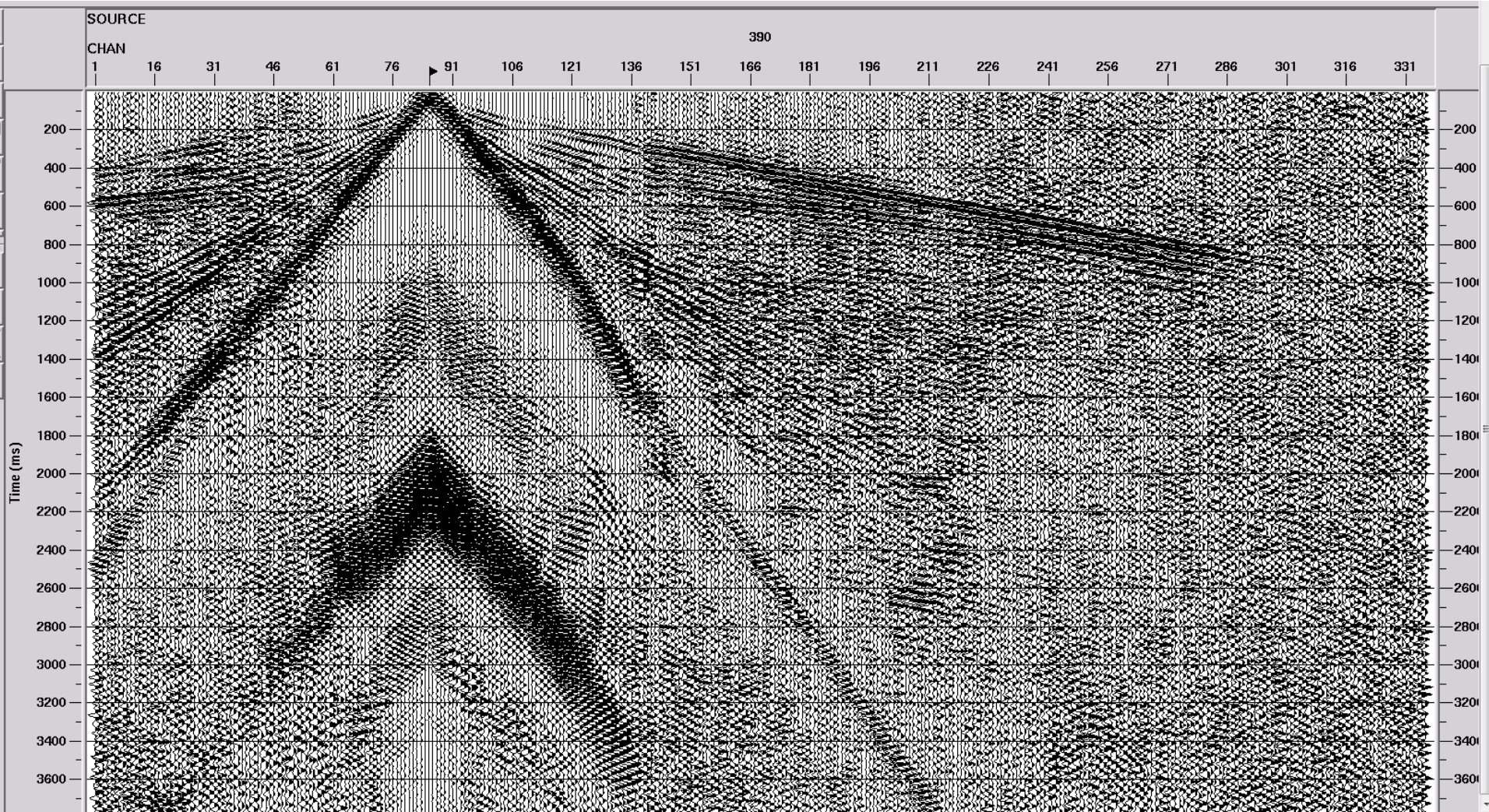
Data Processing

Shot 390
BP Filt 0-4-30-36



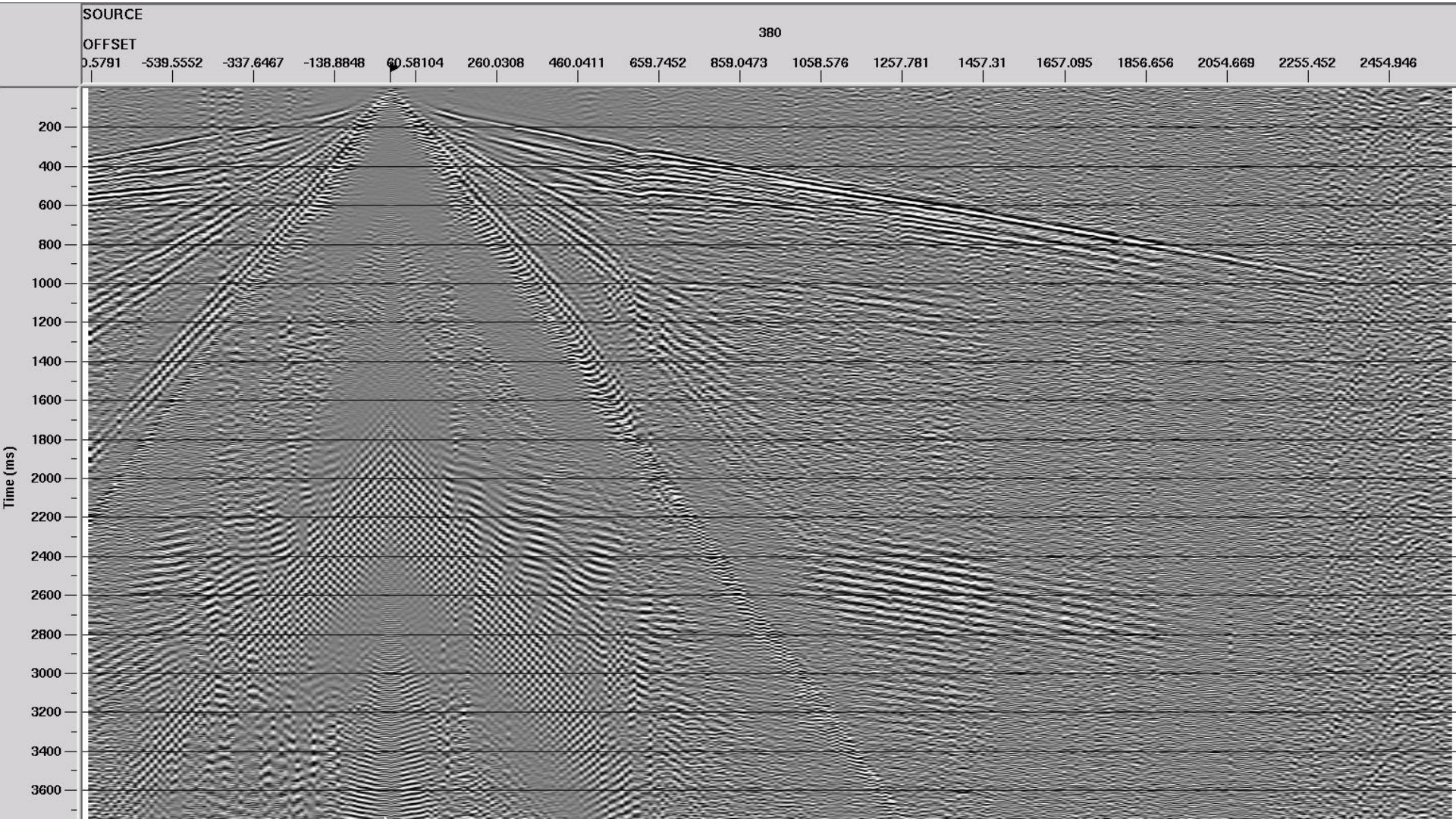
Data Processing

Shot 390
BP Filt 0-4-30-36 & AGC 1000



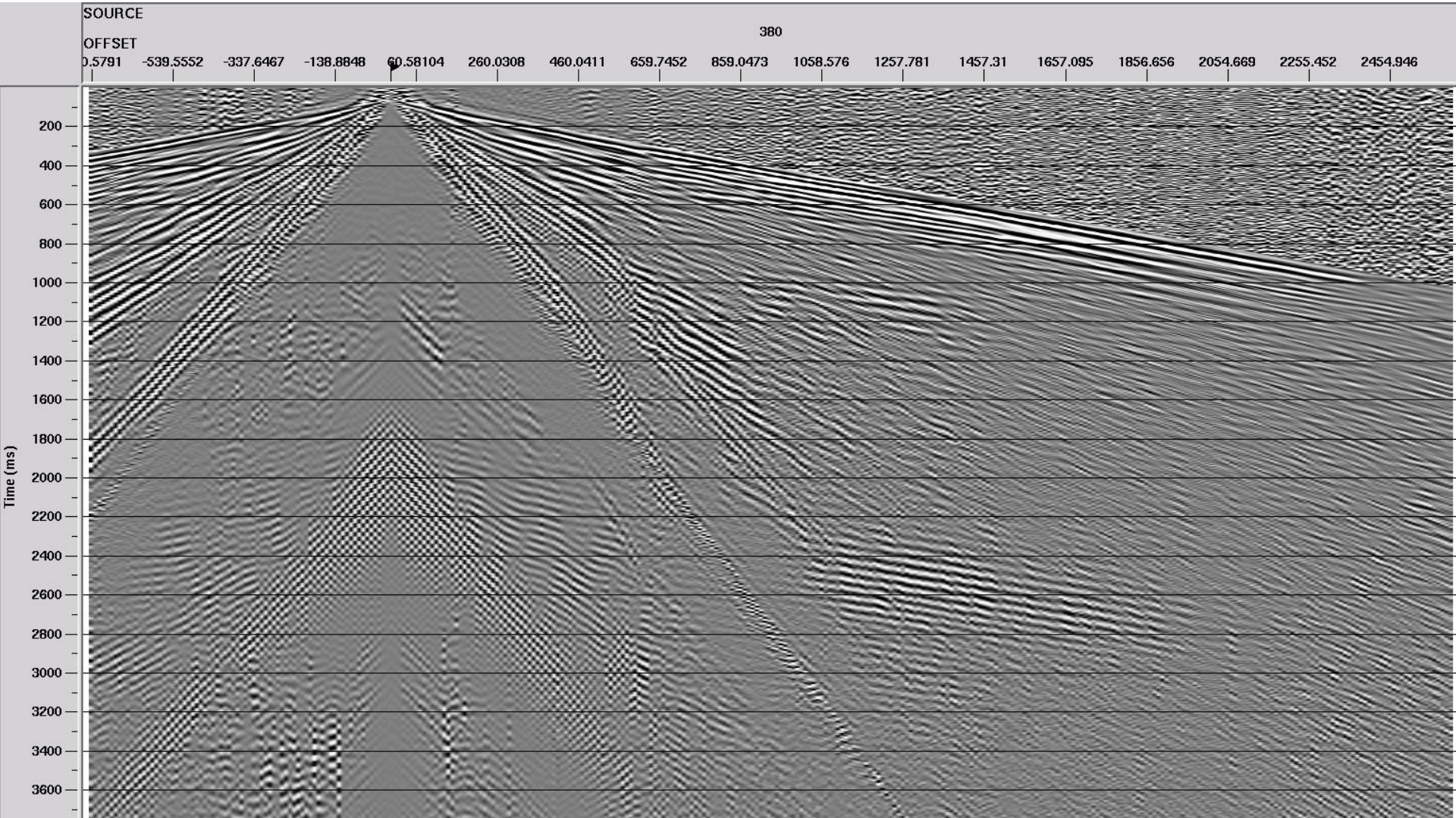
Data Processing: Radial Filter (Max low f = 30Hz)

Shot 380 – Raw with AGC (Mean with OpLen=1000). Gain = 1.5



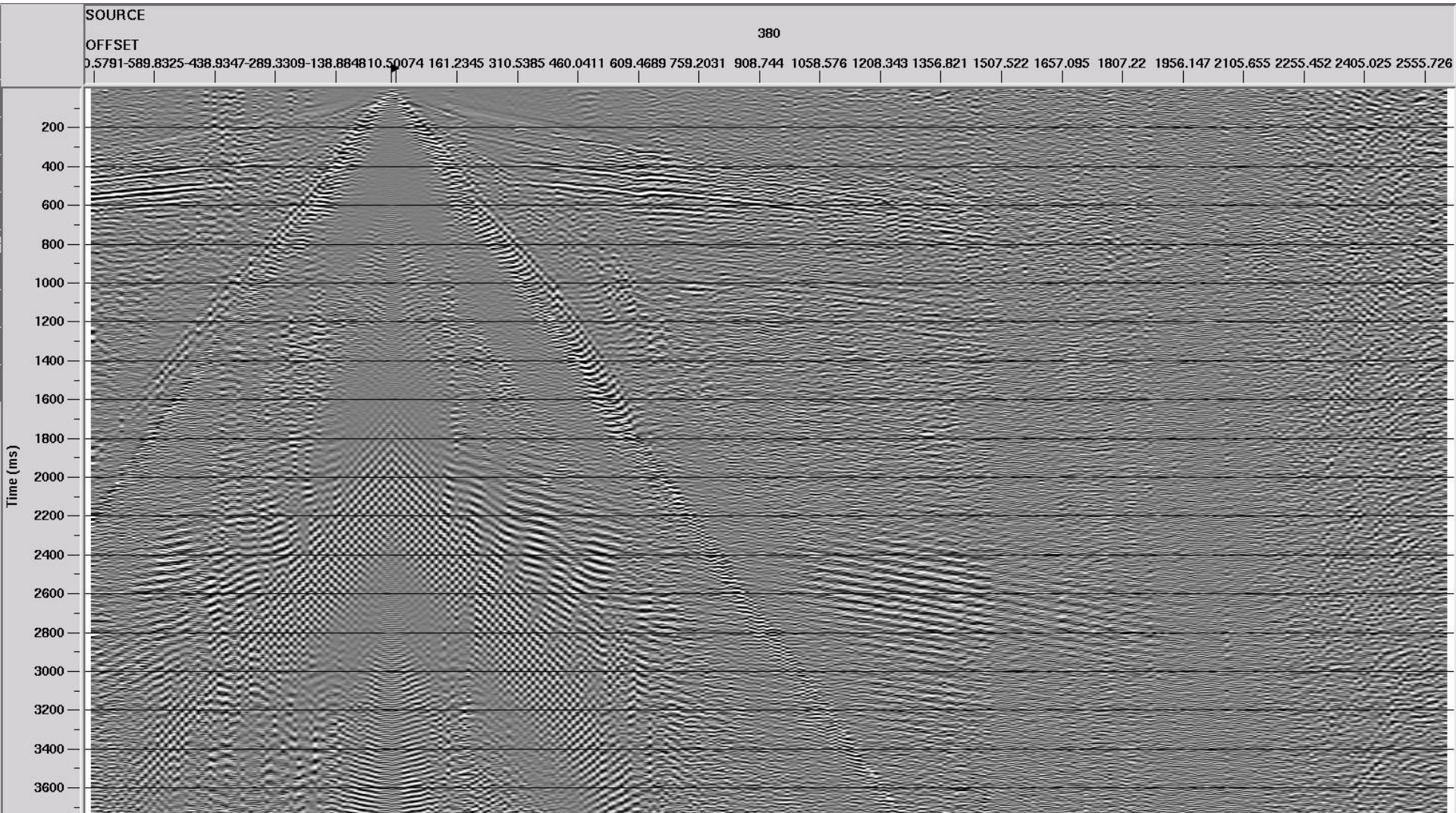
Data Processing: Radial Filter (Max low f = 30Hz)

Shot 380 – What I am keeping (Post-Radial Filter)



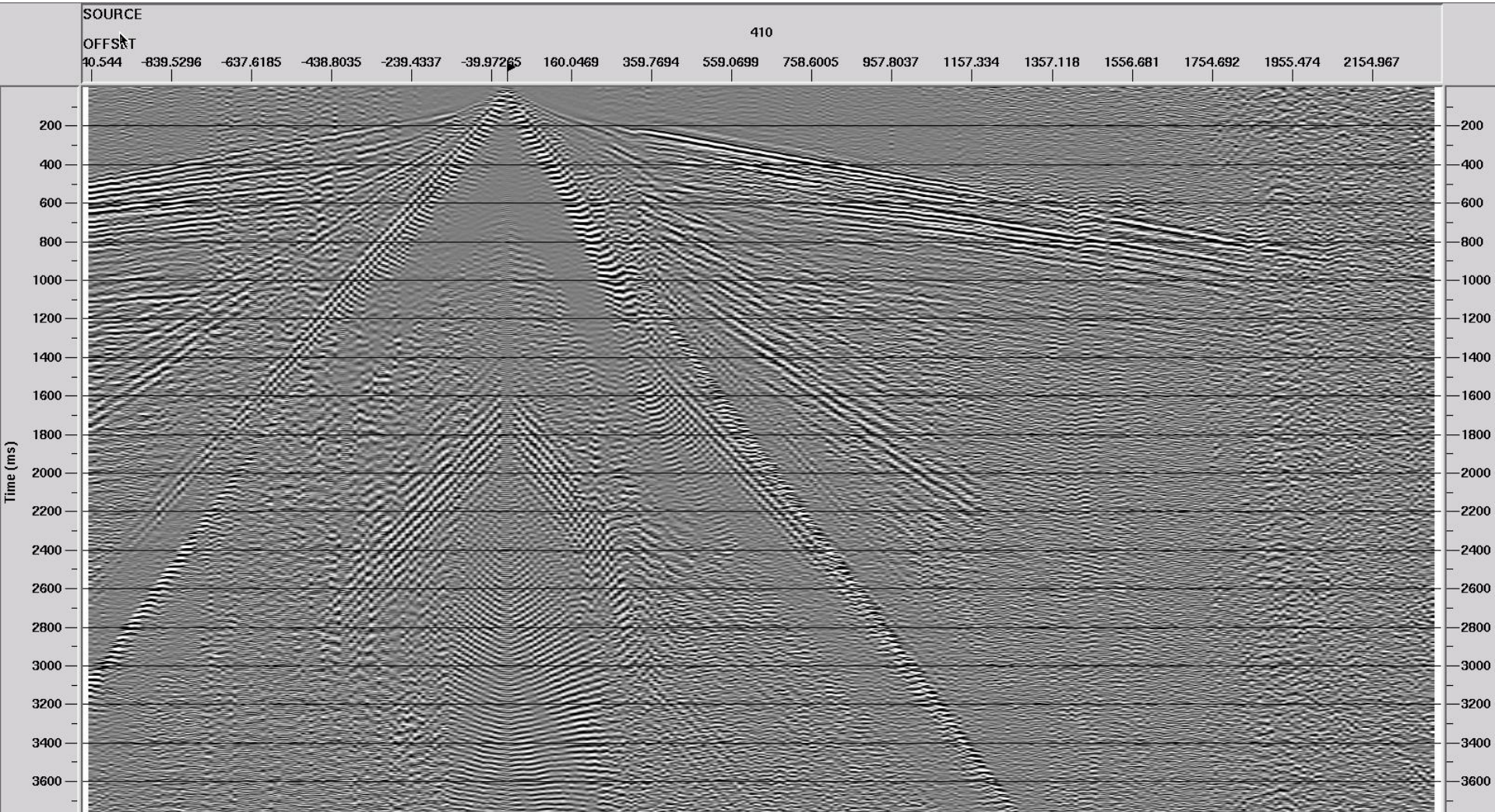
Data Processing: Radial Filter (Max low f = 30Hz)

Shot 380 – What I am throwing away



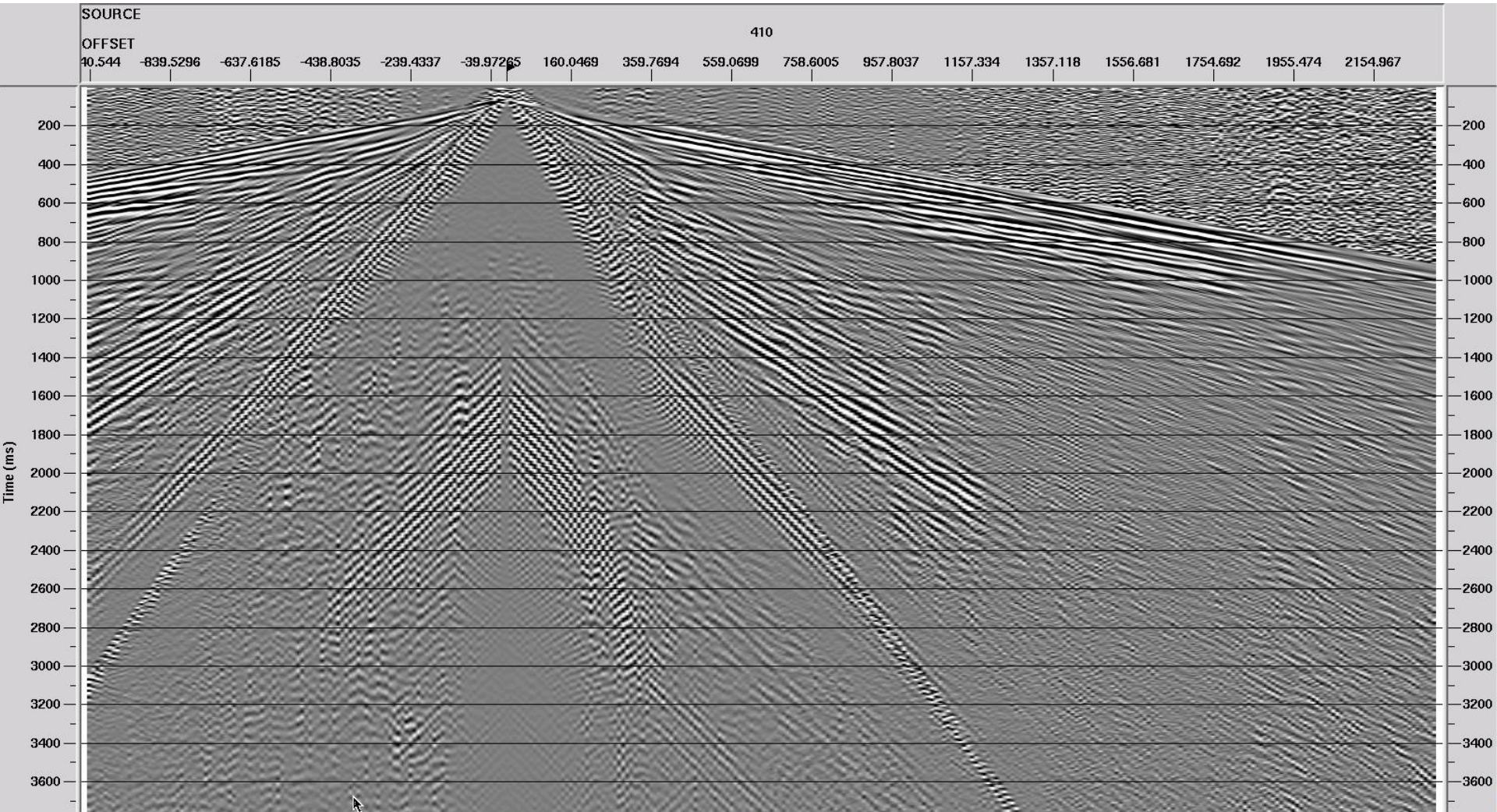
Data Processing: Radial Filter (Max low f = 30Hz)

Shot 410 – Raw with AGC (Mean with OpLen=1000). Gain = 1.5



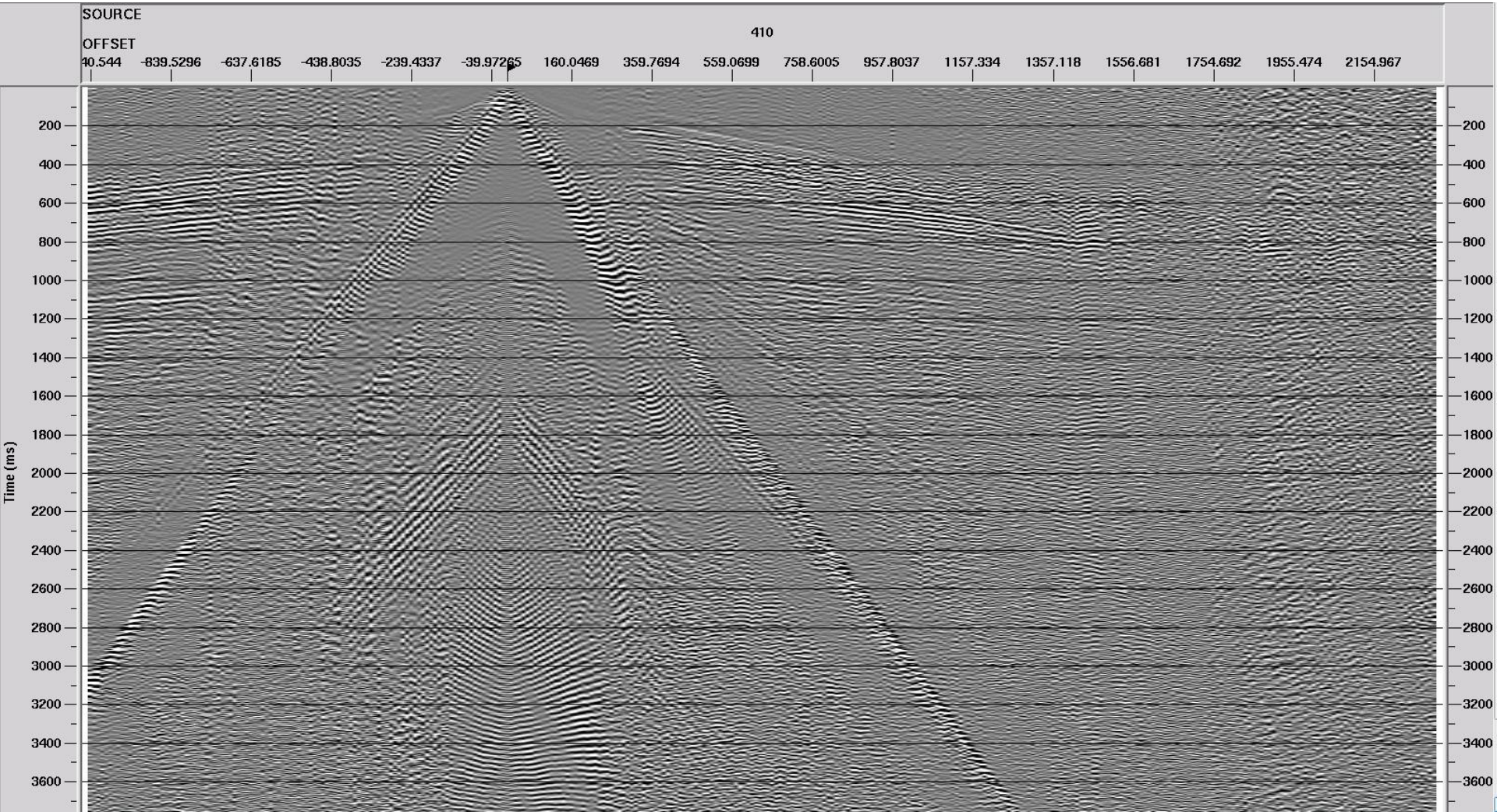
Data Processing: Radial Filter (Max low f = 30Hz)

Shot 410 – What I am keeping (Post-Radial Filter)



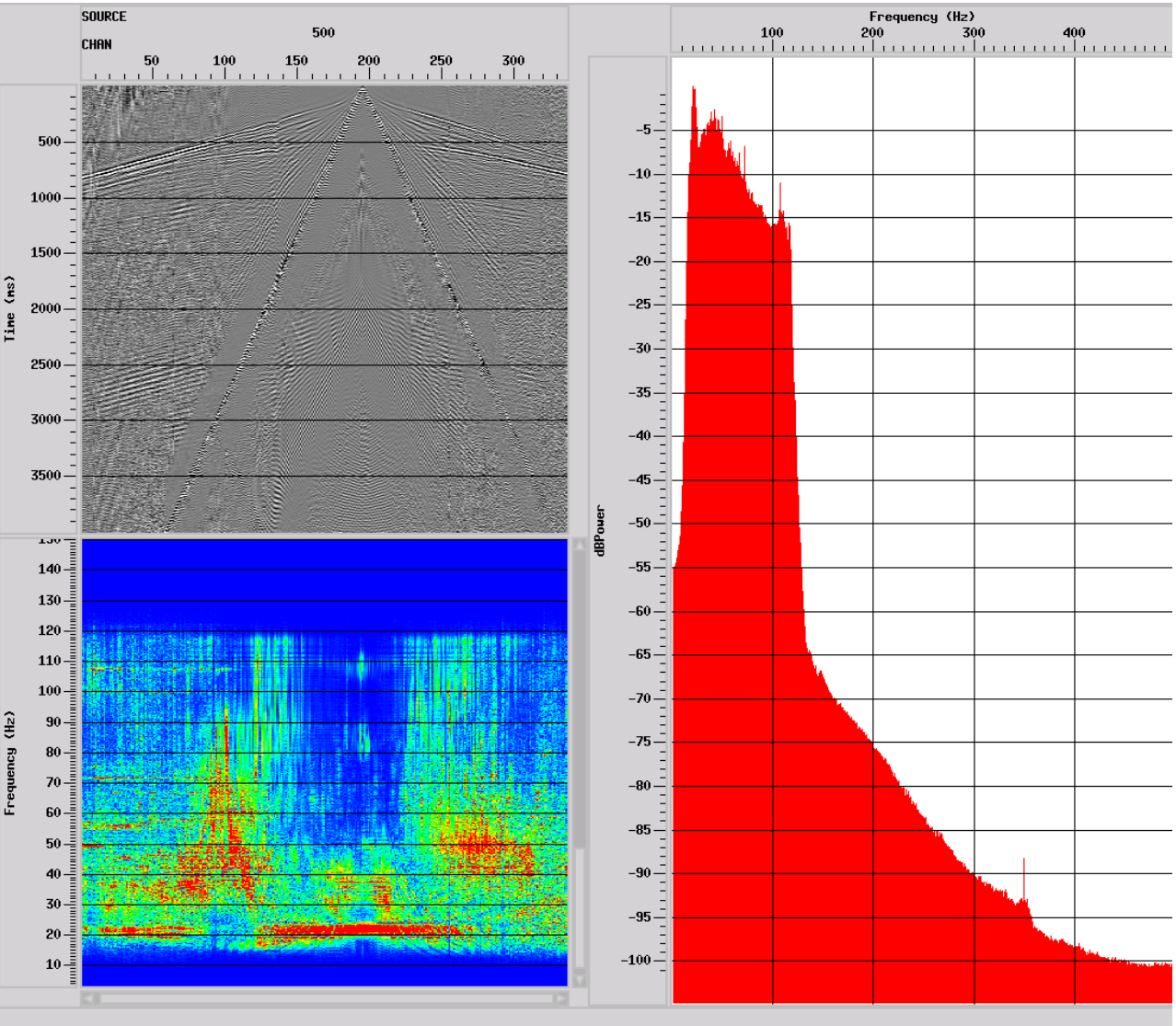
Data Processing: Radial Filter (Max low f = 30Hz)

Shot 410 – What I am throwing away



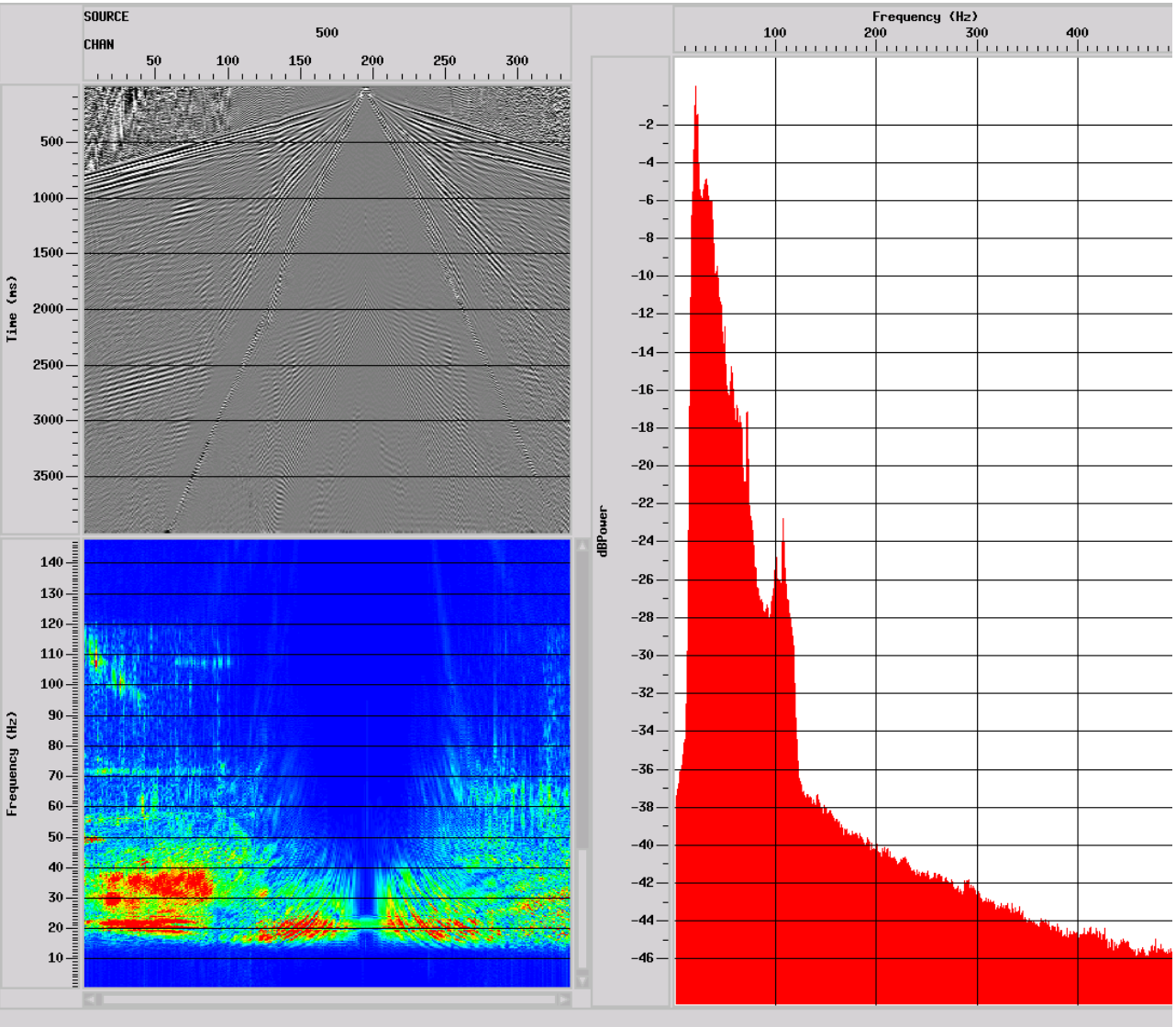
Data Processing

SHOT 500: AGC. Before Radial Filter



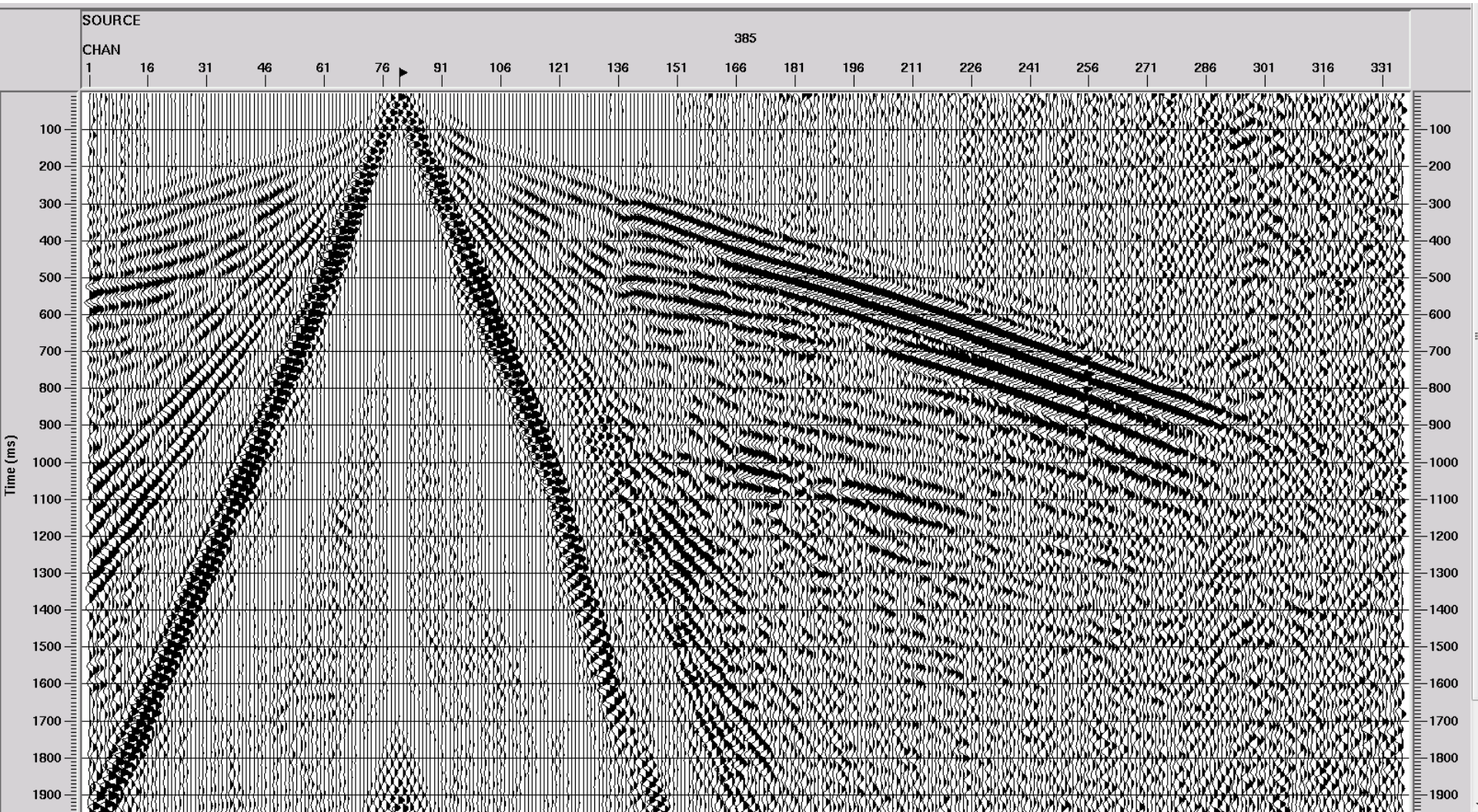
Data Processing

SHOT 500: AGC. After Radial Filter 30 Hz max



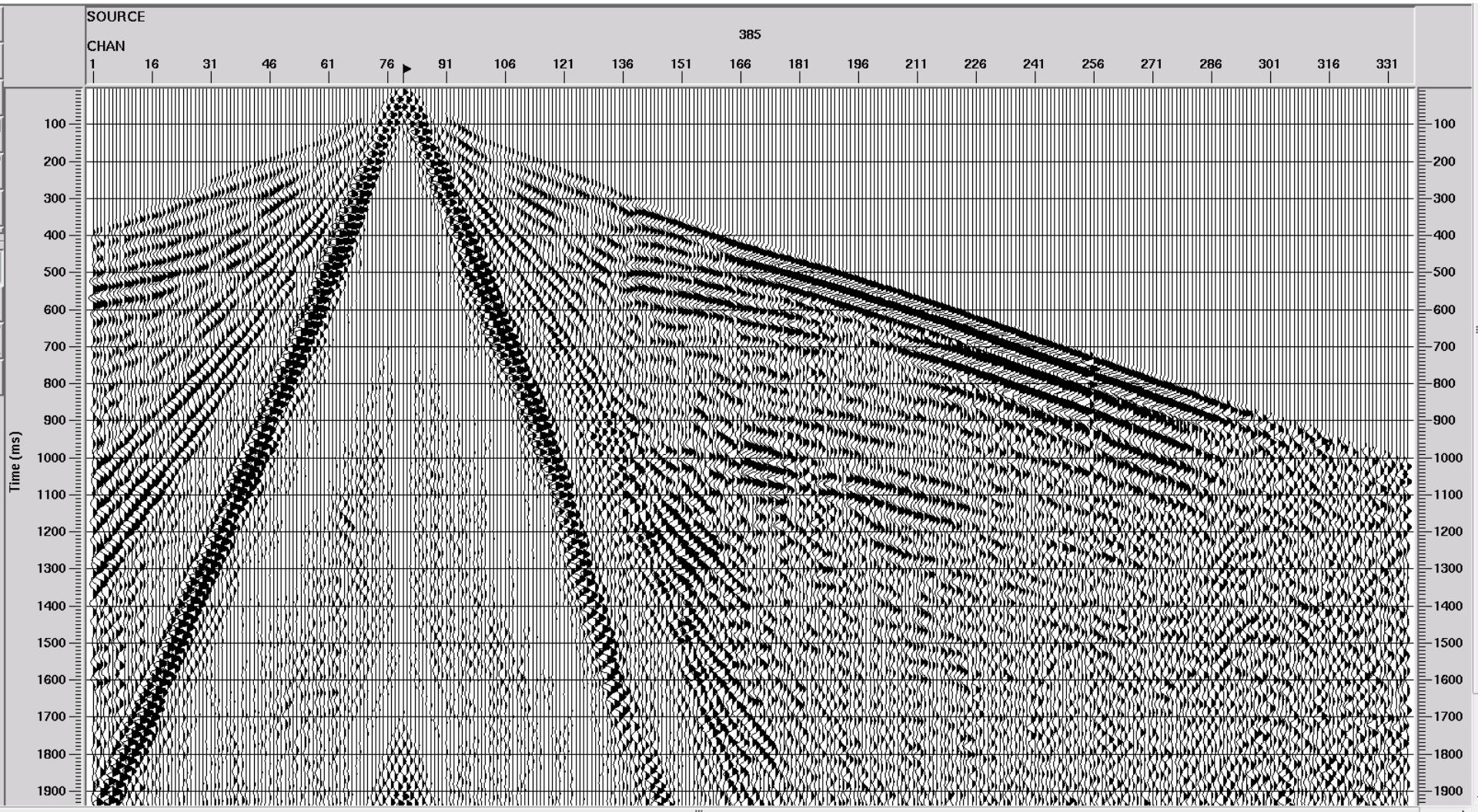
Data Processing

POST RADIAL FILT: No Mute



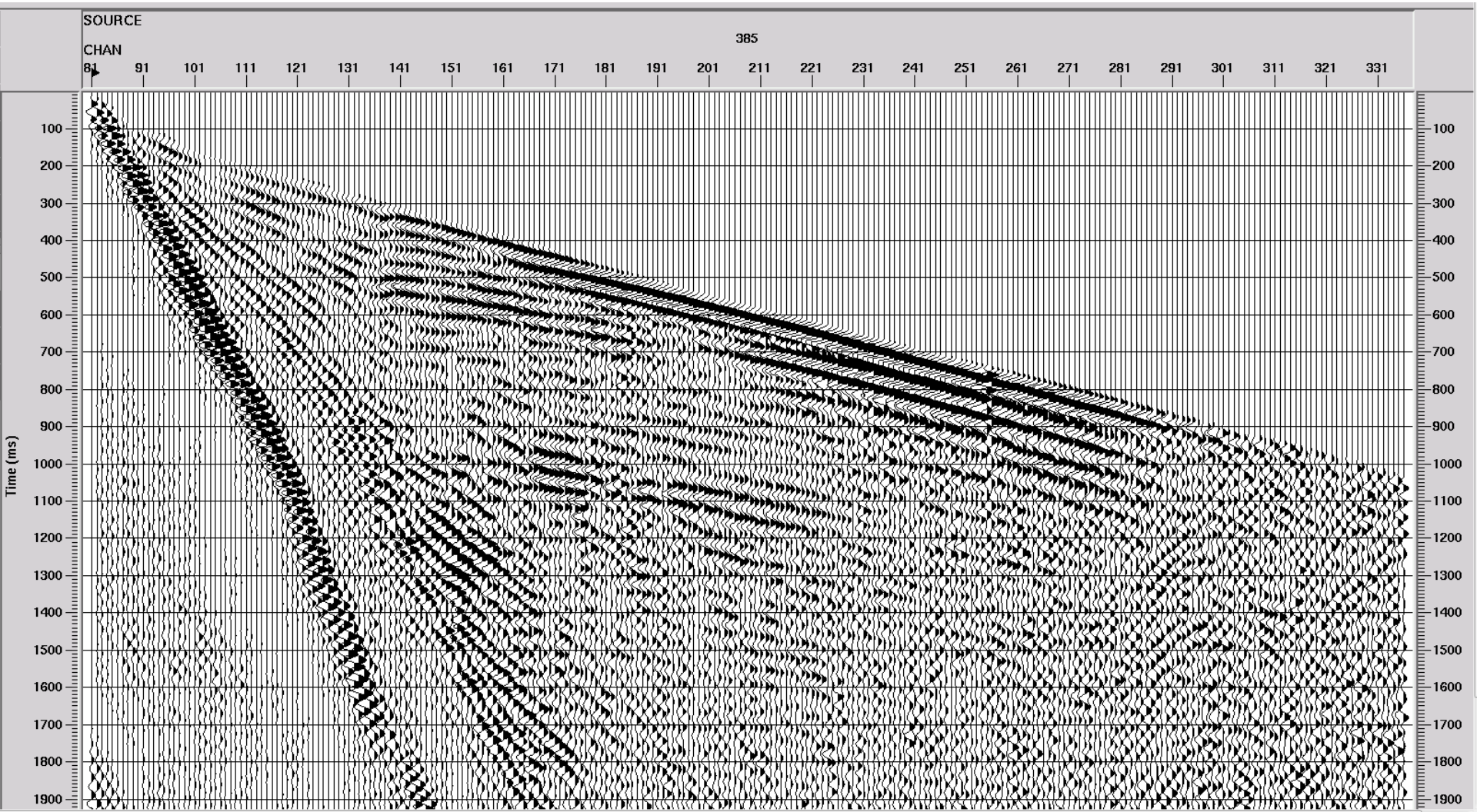
Data Processing

POST RAD FILTER: WITH TOP MUTE



Data Processing

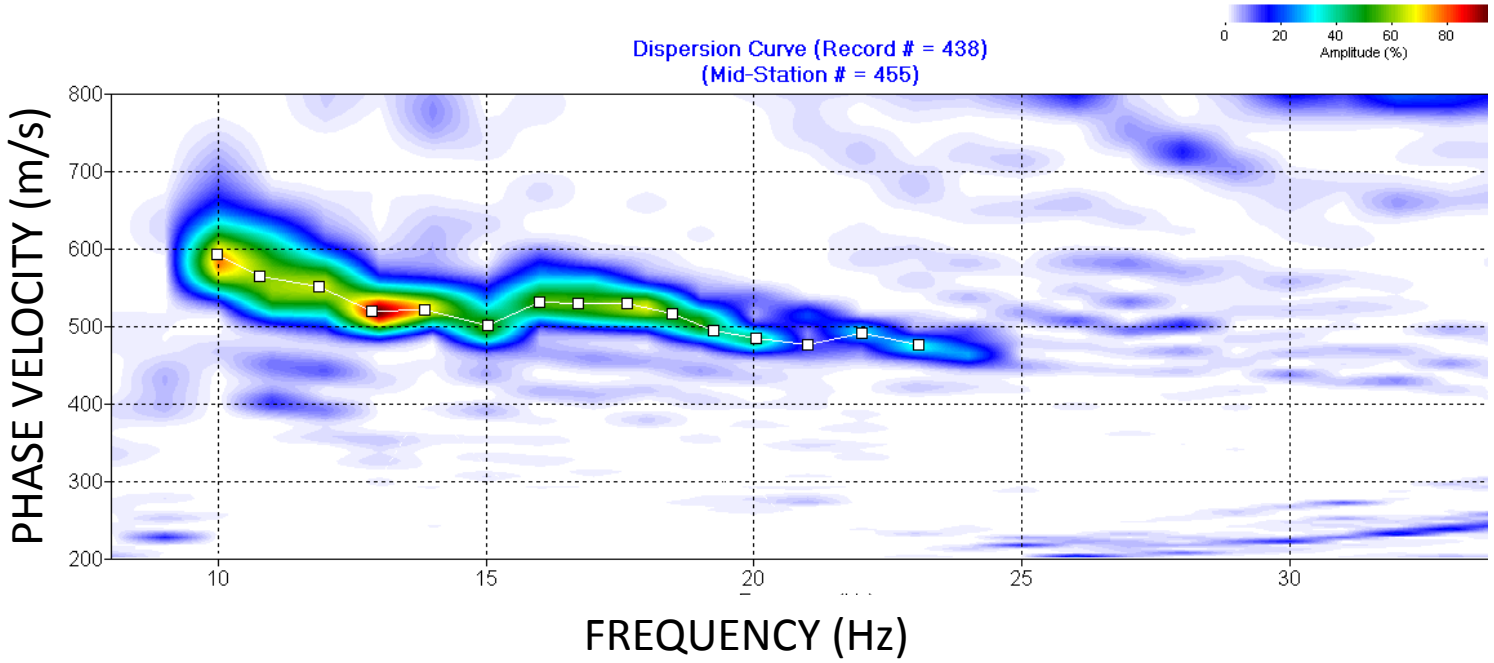
POST RADIAL FILTER Mute & Off-END GEOM

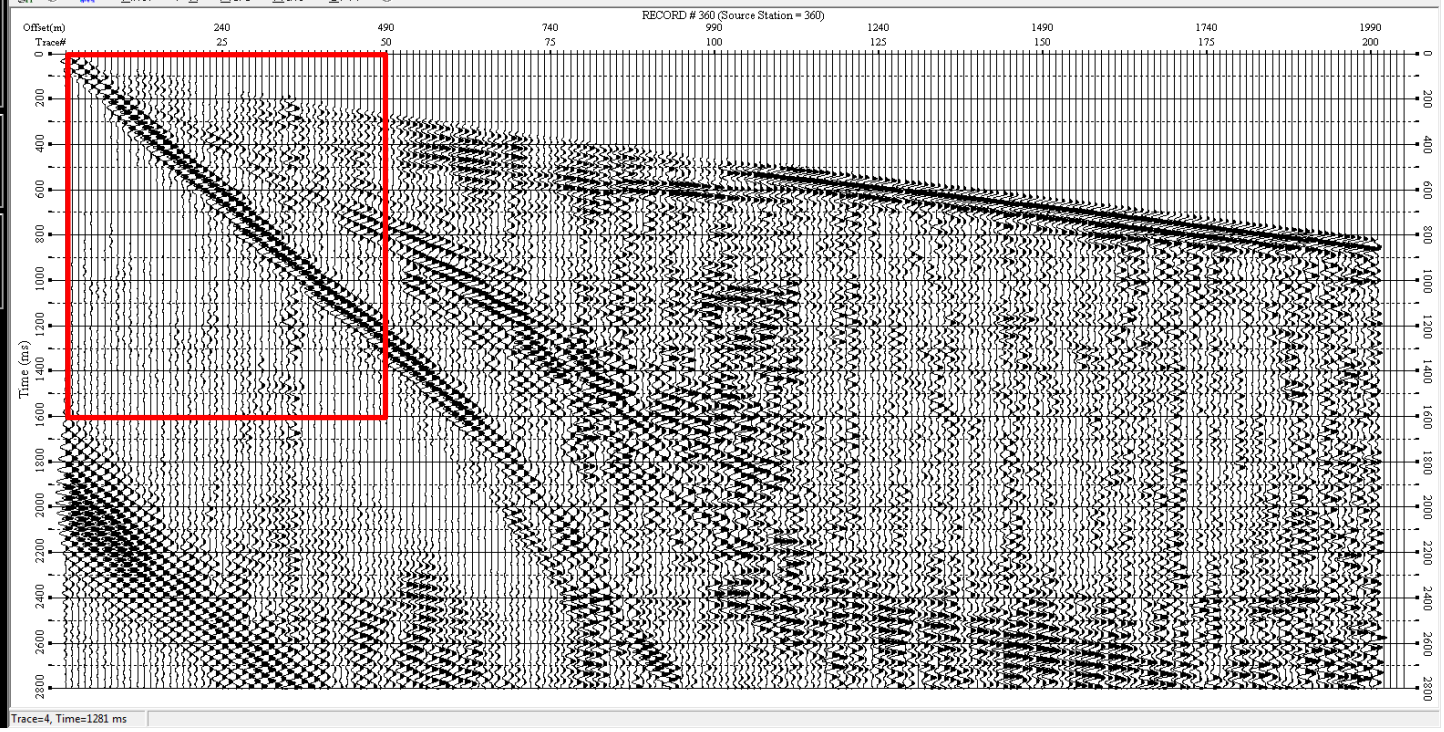


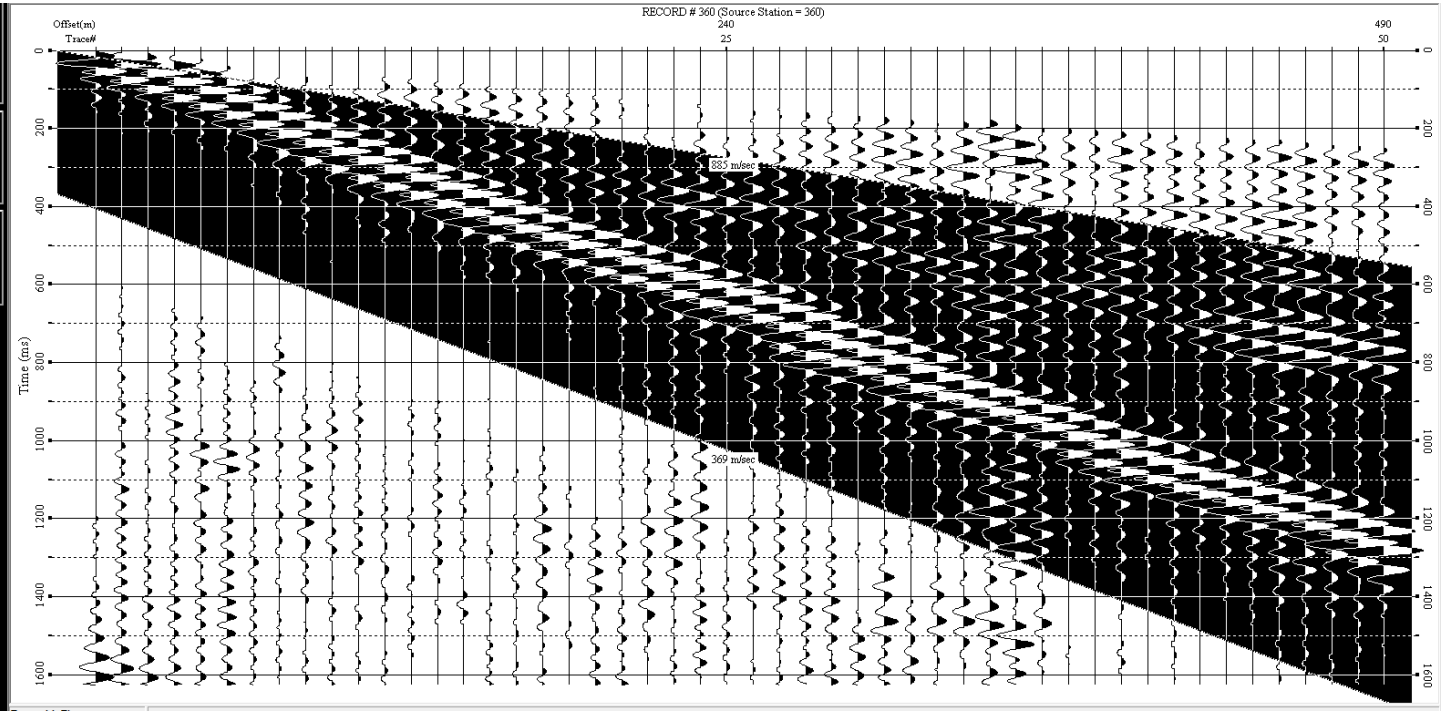
Dispersion Analysis WITH KGS *SURFSEIS*

1. Create the best overtone image as possible to analyze changing phase velocity patterns with frequency.

2. Find best parameters to pick dispersion curve







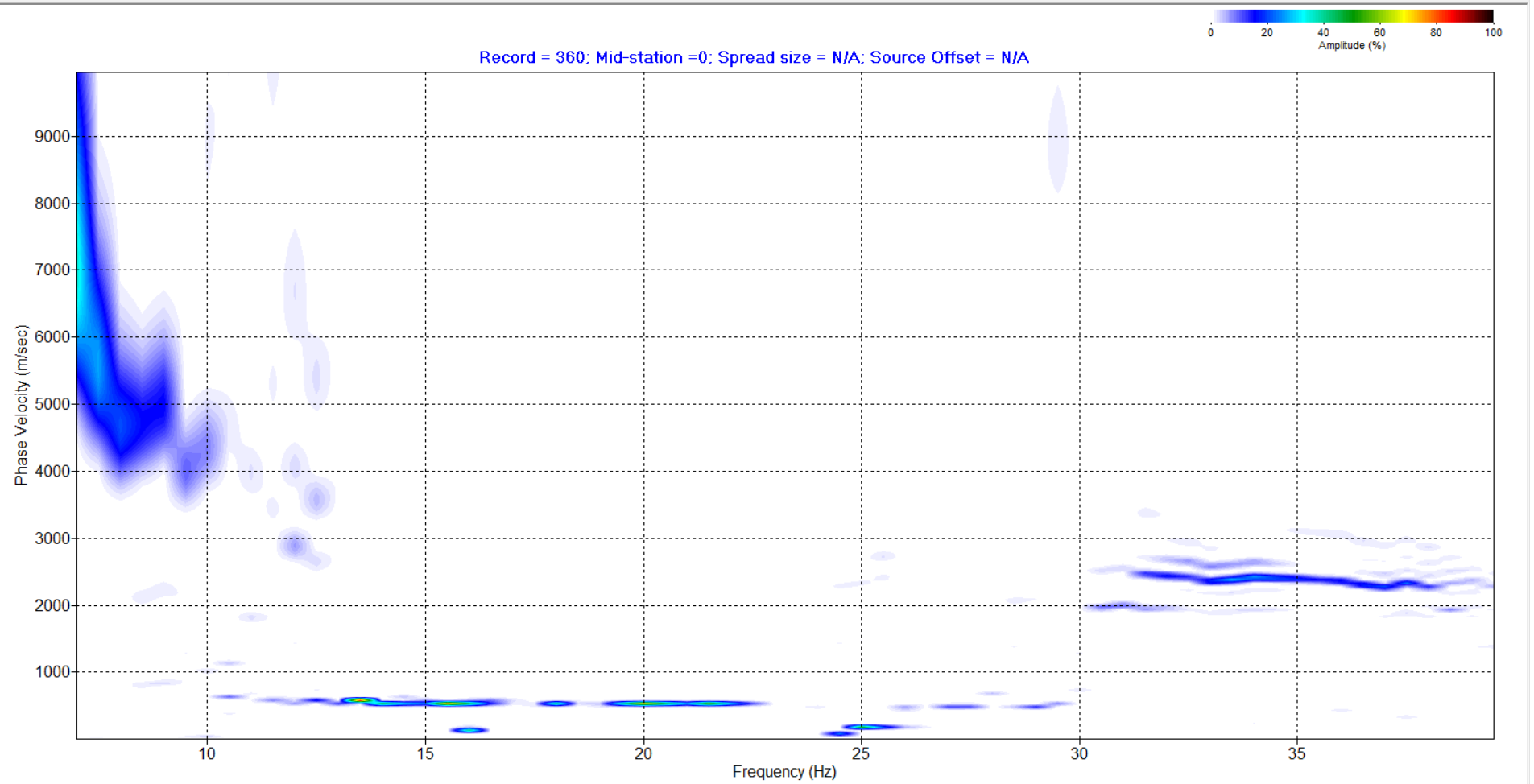
Shot 360

Offset: 0 - 500 m

Time: 0 – 1600 ms

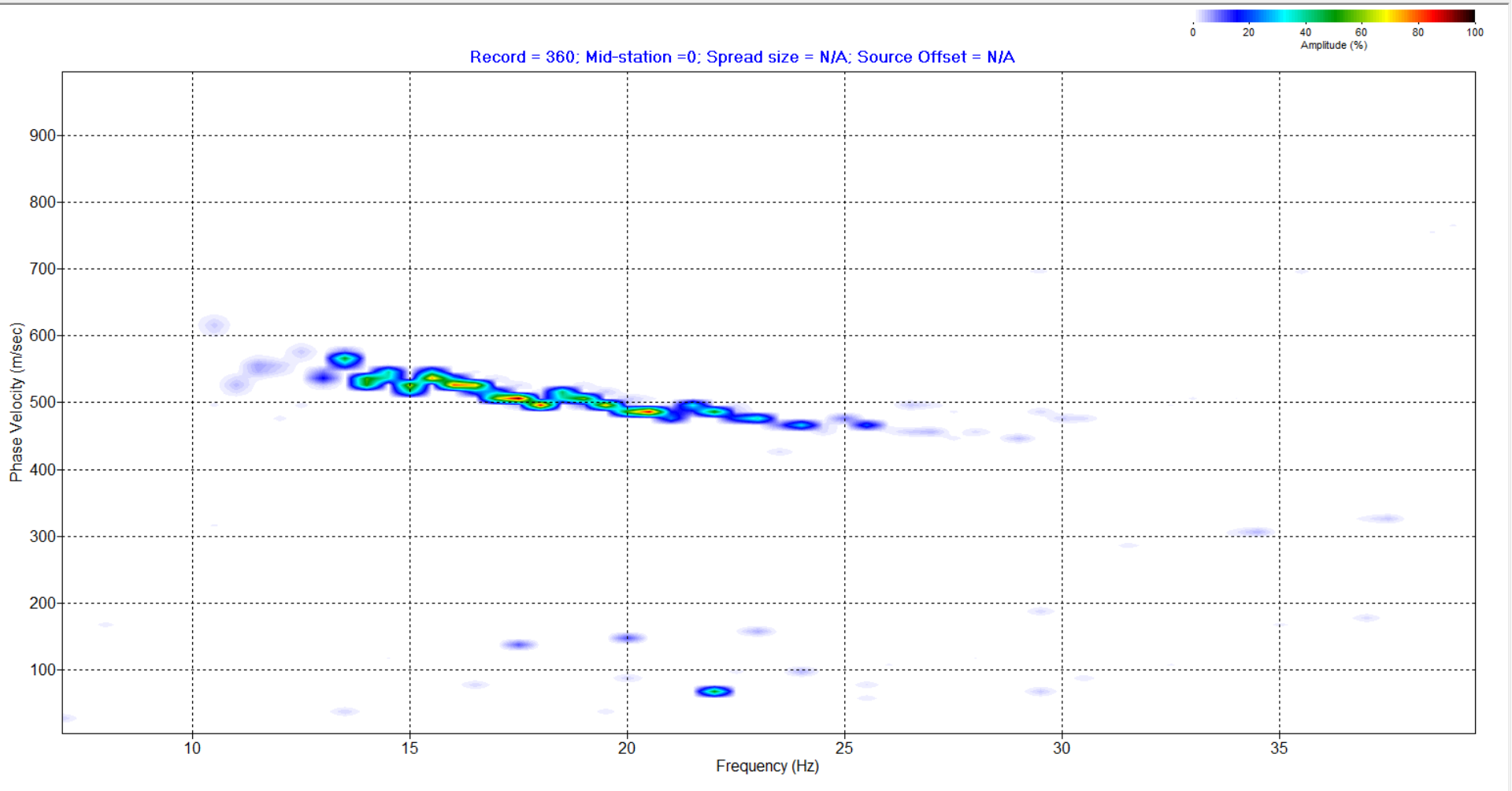
Dispersion Analysis: THE BIG PICTURE

Shot 360:
Phase Velocity: 0 – 10000 m/s
Frequency: 6 – 40 Hz

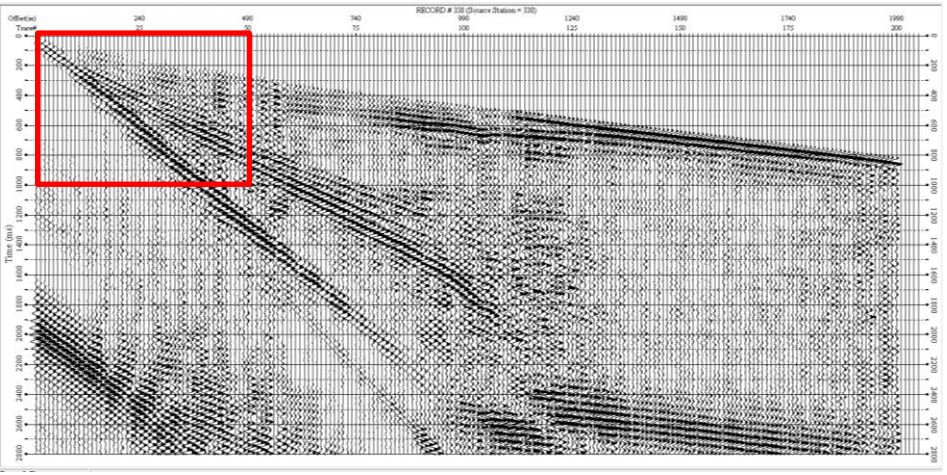


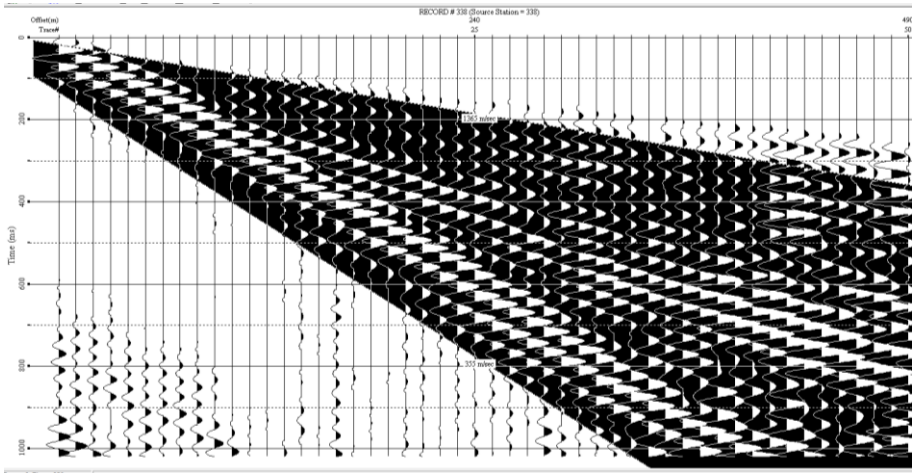
Dispersion Analysis: Within the expected range

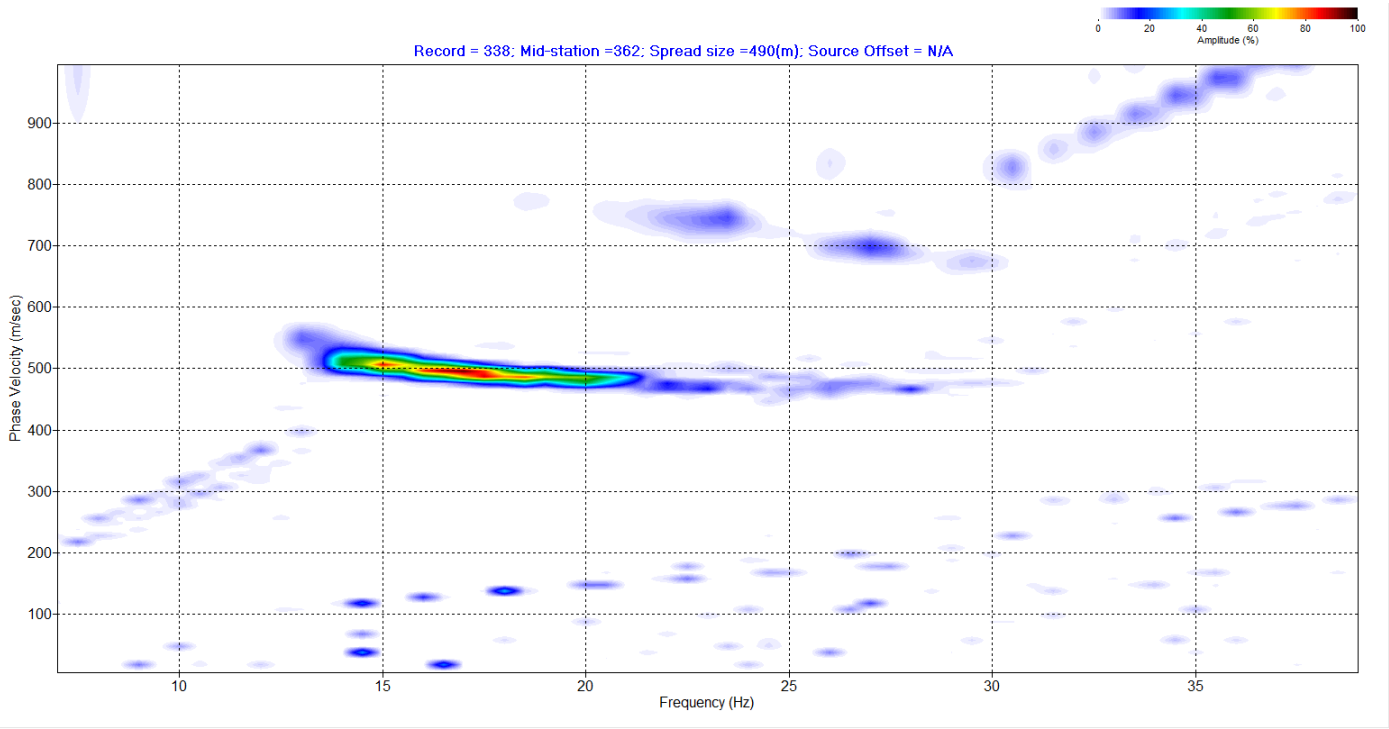
Shot 360:
Phase Velocity: 0 – 1000 m/s
Frequency: 6 – 40 Hz



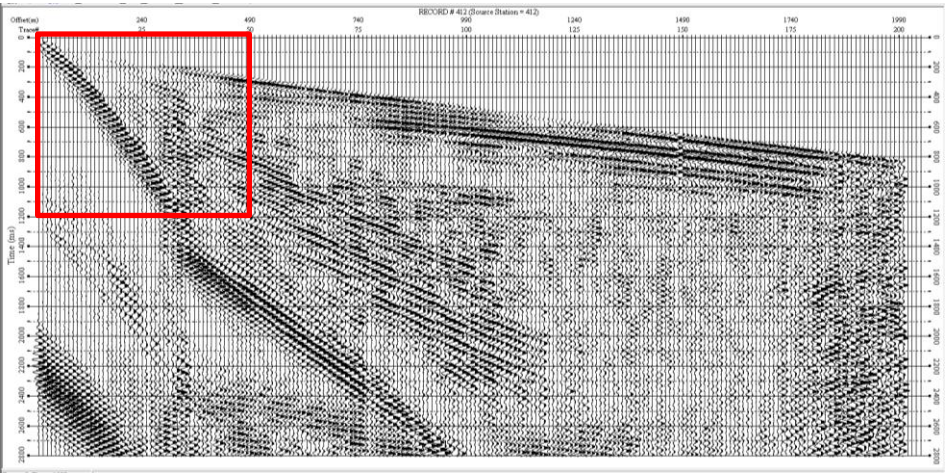
Dispersion Analysis SHOT 338

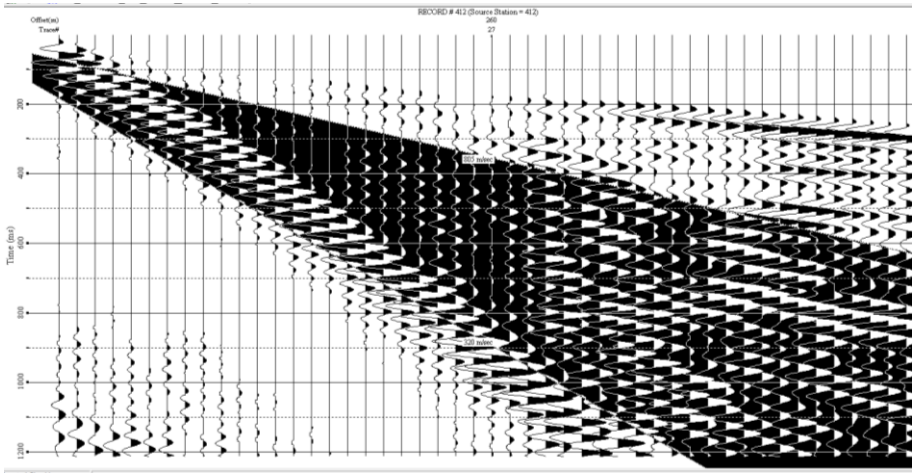


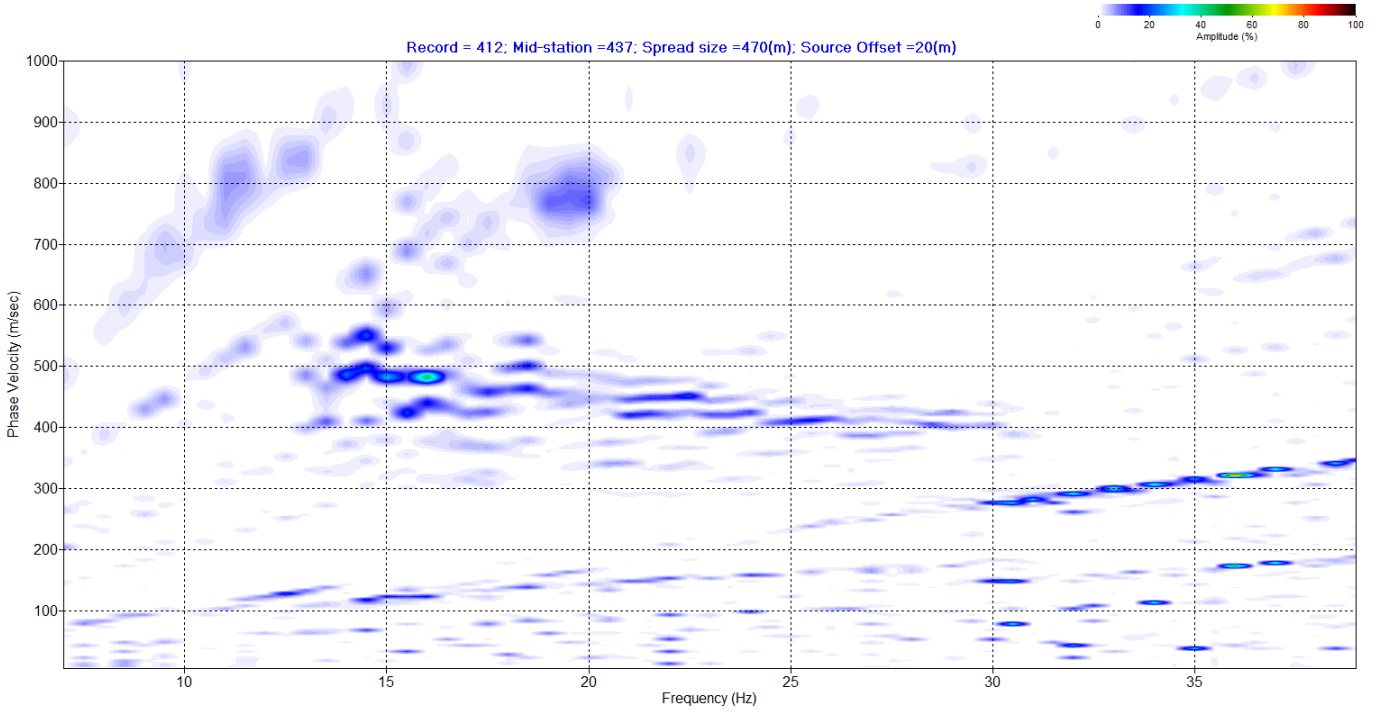




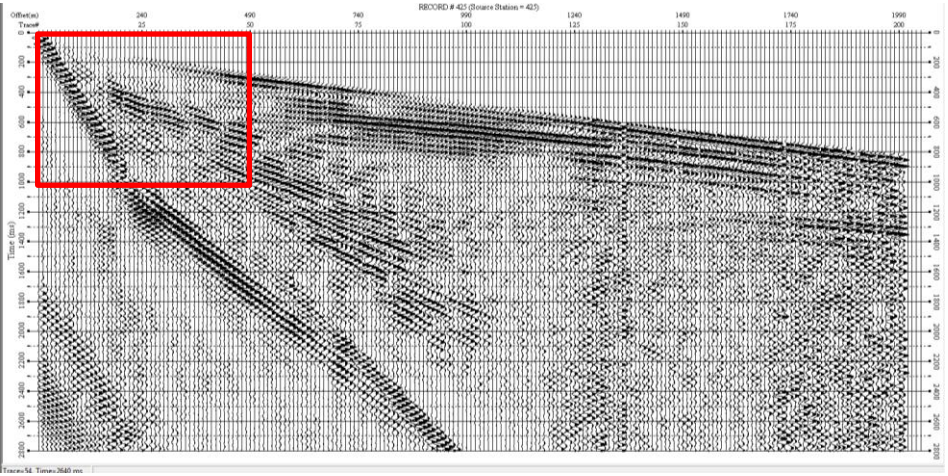
Dispersion Analysis SHOT 412

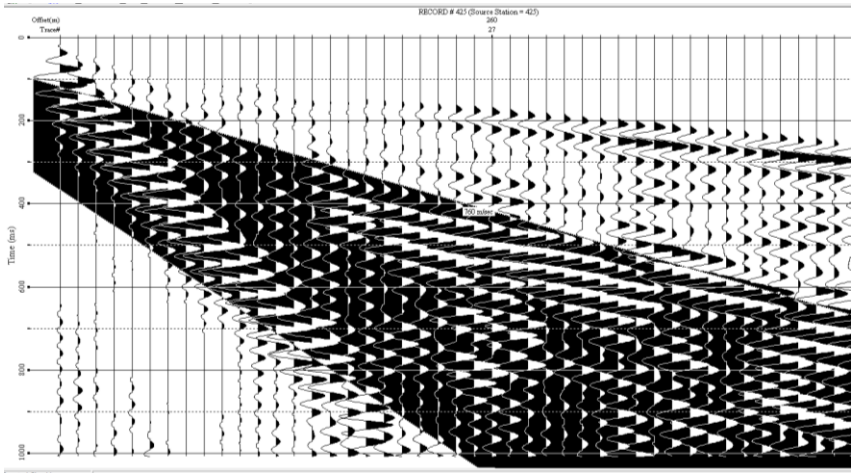


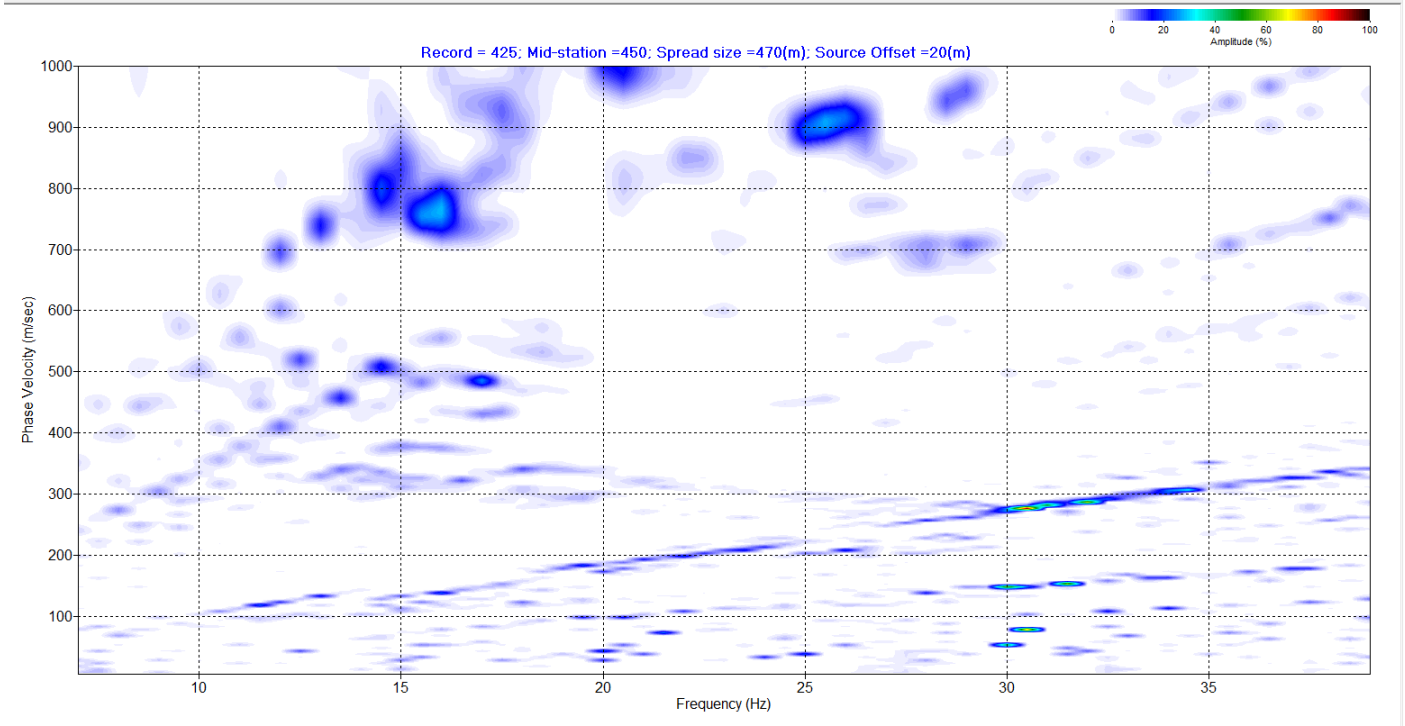




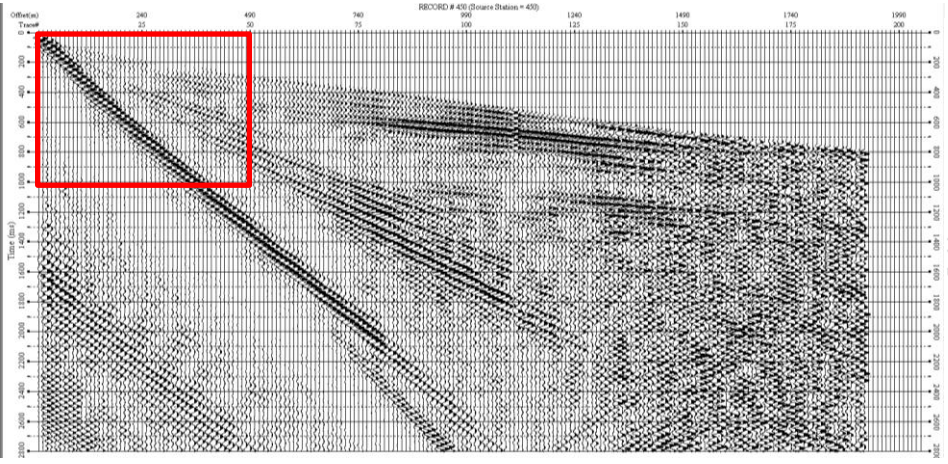
Dispersion Analysis SHOT 425

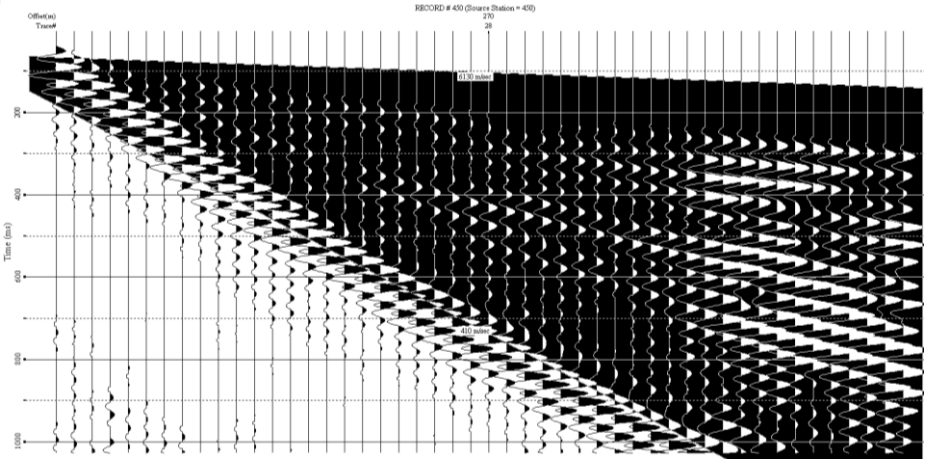


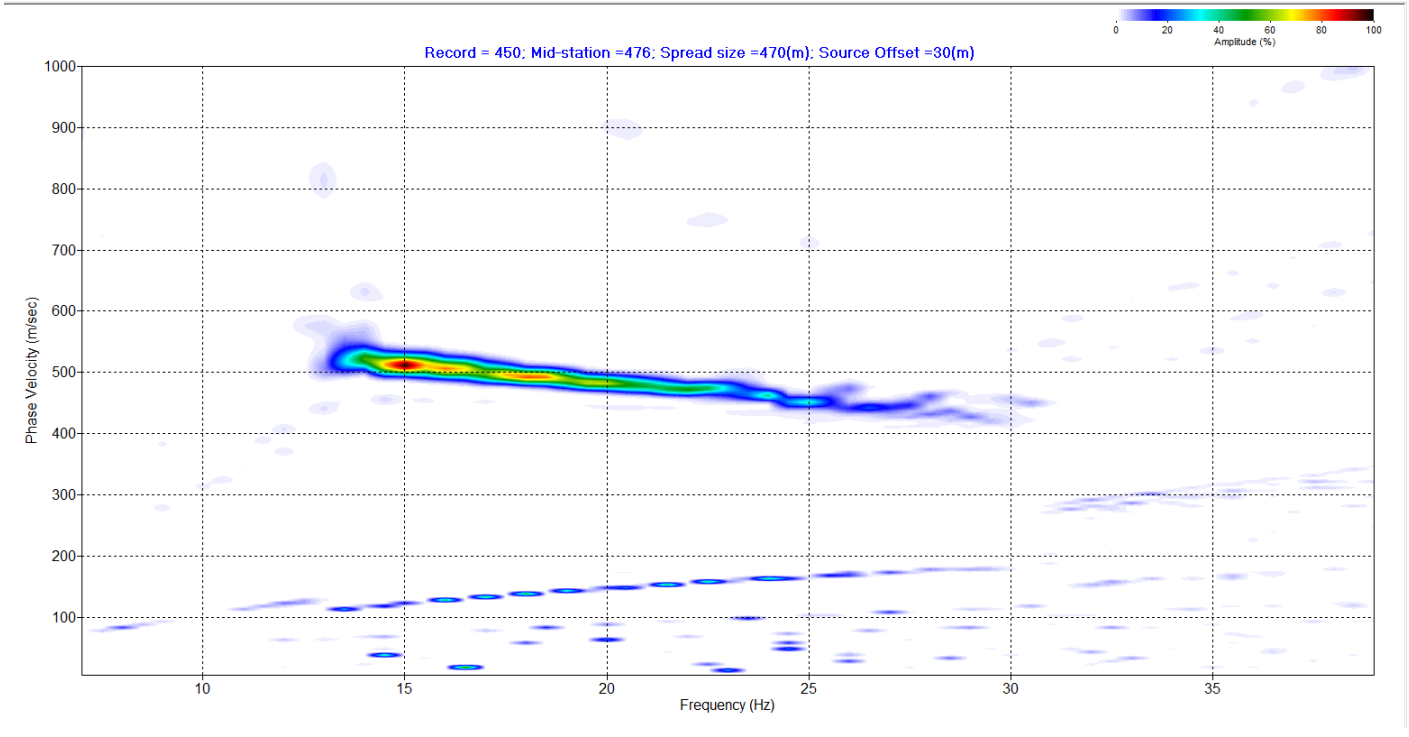




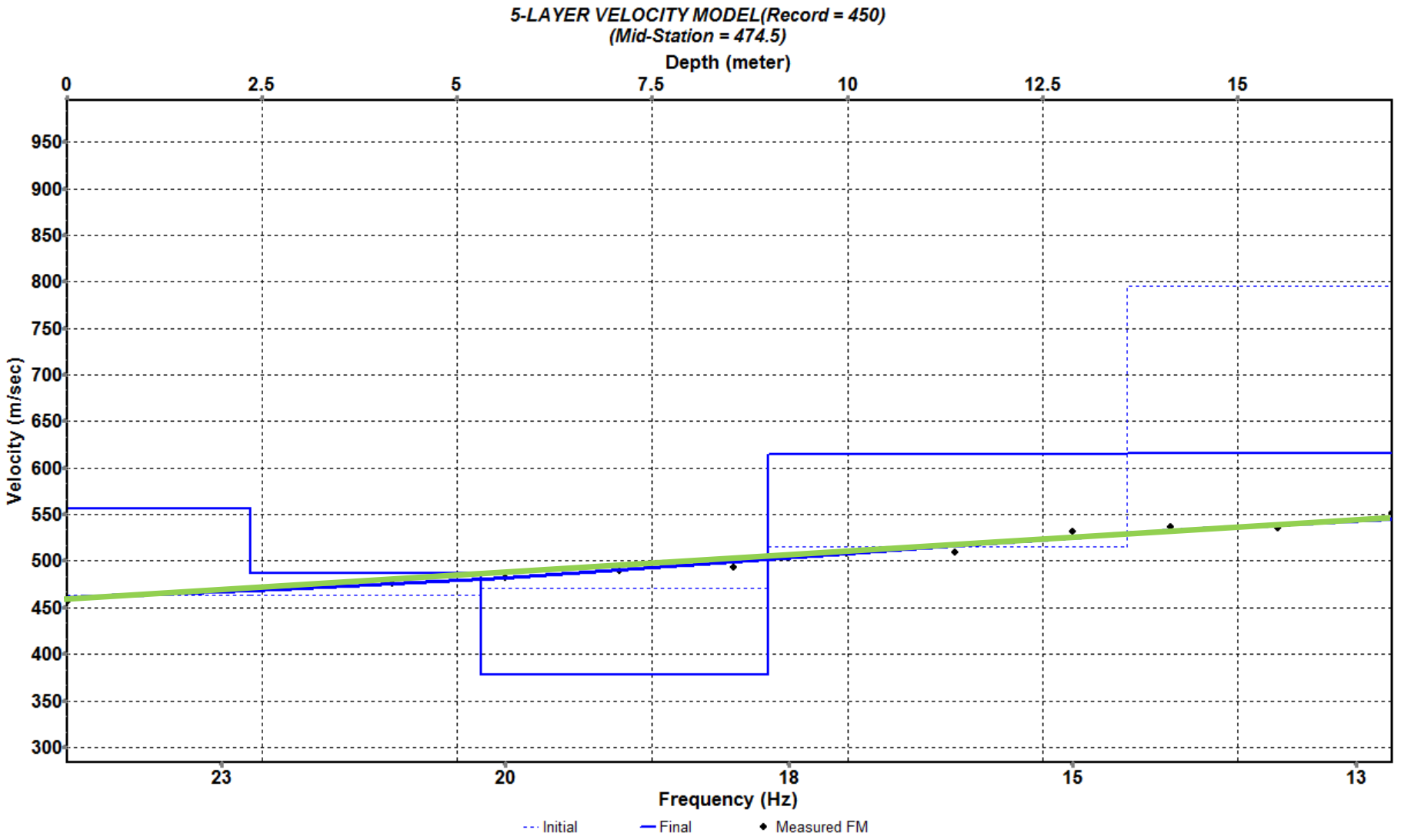
Dispersion Analysis SHOT 450





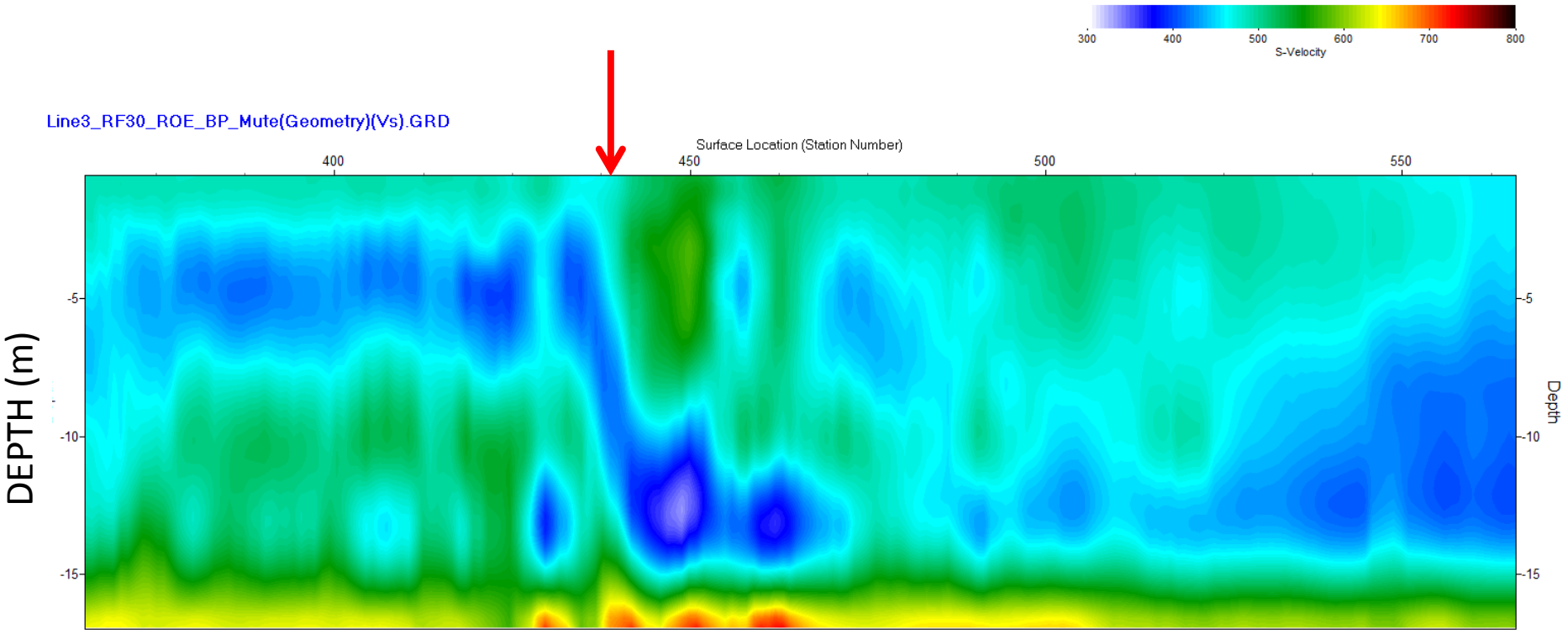


S-WAVE VELOCITY MODEL SHOT 450

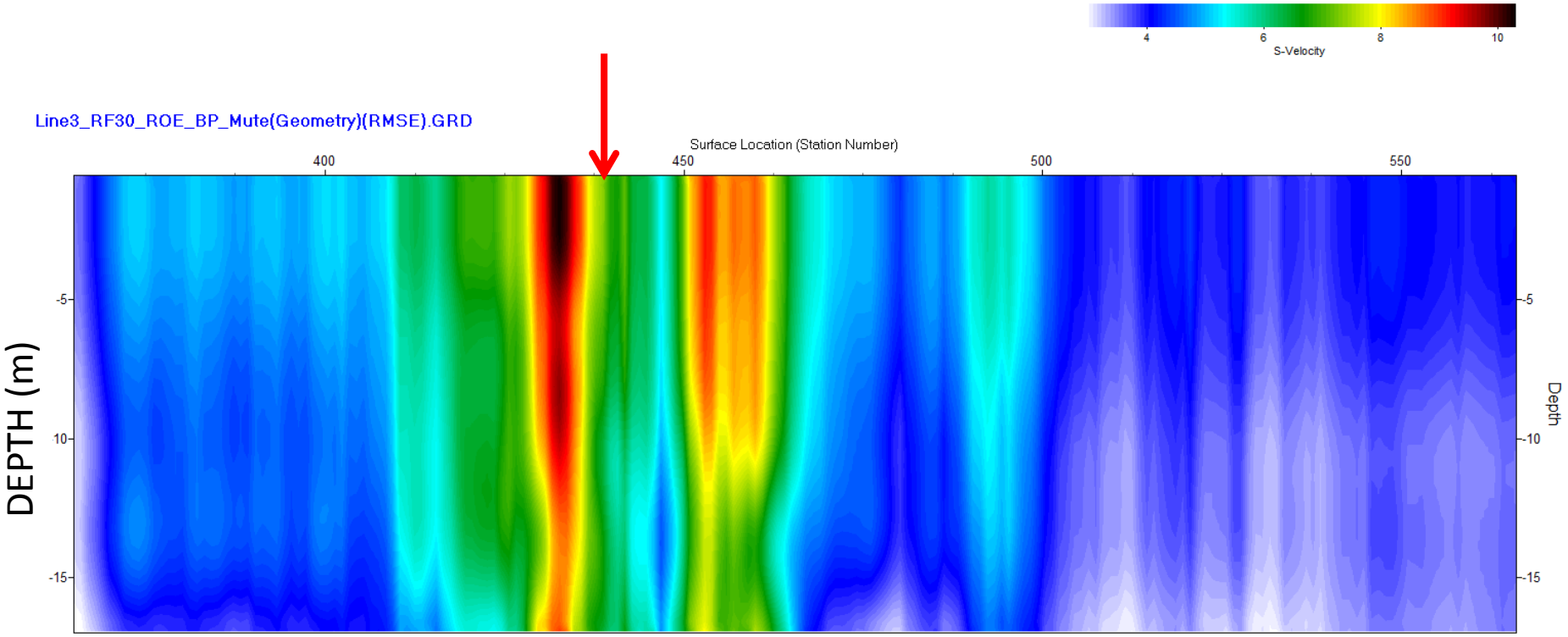


Preliminary Inversion Results

Initial model created from each dispersion curve



RMS Error


4
6
8
10
S-Velocity
Line3_RF30_ROE_BP_Mute(Geometry)(RMSE).GRD
Surface Location (Station Number)
400
450
500
550
DEPTH (m)
-5
10
-15
Depth
-5
-10
-15

Future Work

1. Consider applying additional FK Filters
2. Analysis of left Off-End records
3. Further analysis of inversion parameters
4. Interpretation of results
5. Consider all suggestions from today's meeting!

Thank you

- Helen Isaac and Malcolm Bertram
- David Henley
- Kevin Hall
- Roohollah Askari
- CREWES Sponsors

References

Park, C.B., R.D. Miller, and J. Xia, 1999, Multichannel analysis of surface waves, Geophysics, **64**, 800-808.