Processing Report for

Ormat Technologies

Imperial Valley, CA

3D 3C Wister Survey

Processed By

FairfieldNodal

1776 Lincoln St., Suite 1200

Denver, CO 80203

January, 2012

RECORDING PARAMETERS

A. Contractor

Company	: Dawson Geophysical Company
Date Acquired	: July 2010

B. Recording Parameters

Instruments	: GSR
Max. No. of Recvs	: 924
Sample Rate	: 2 msec.
Listening Time	: 6 Sec.
Data Format	: SEGY

C. Field Filters

Low Cut	: out(3) Hz. 40 Db. /sec.
High Cut	: 207 Hz. 298 Db./sec.
Pre Amp Gain	: 36 Db.

D. Source Parameters

Energy Source	: Vibroseis
Source Interval	: 220 Ft.
Vibrator Model	: AHV-IV
Sub-array length	: Inline Stack over 82.5 ft.
Sweeps/VP	: 4
Sweep control	: Fund. Force Control
Phase Lock	: Ground Force
Number of vibrators	: 2 set of 2
Sweep duration	: 8 sec
Tapers	: .3 ms / .3 ms.
Sweep Frequencies	: 4 – 96 HZ

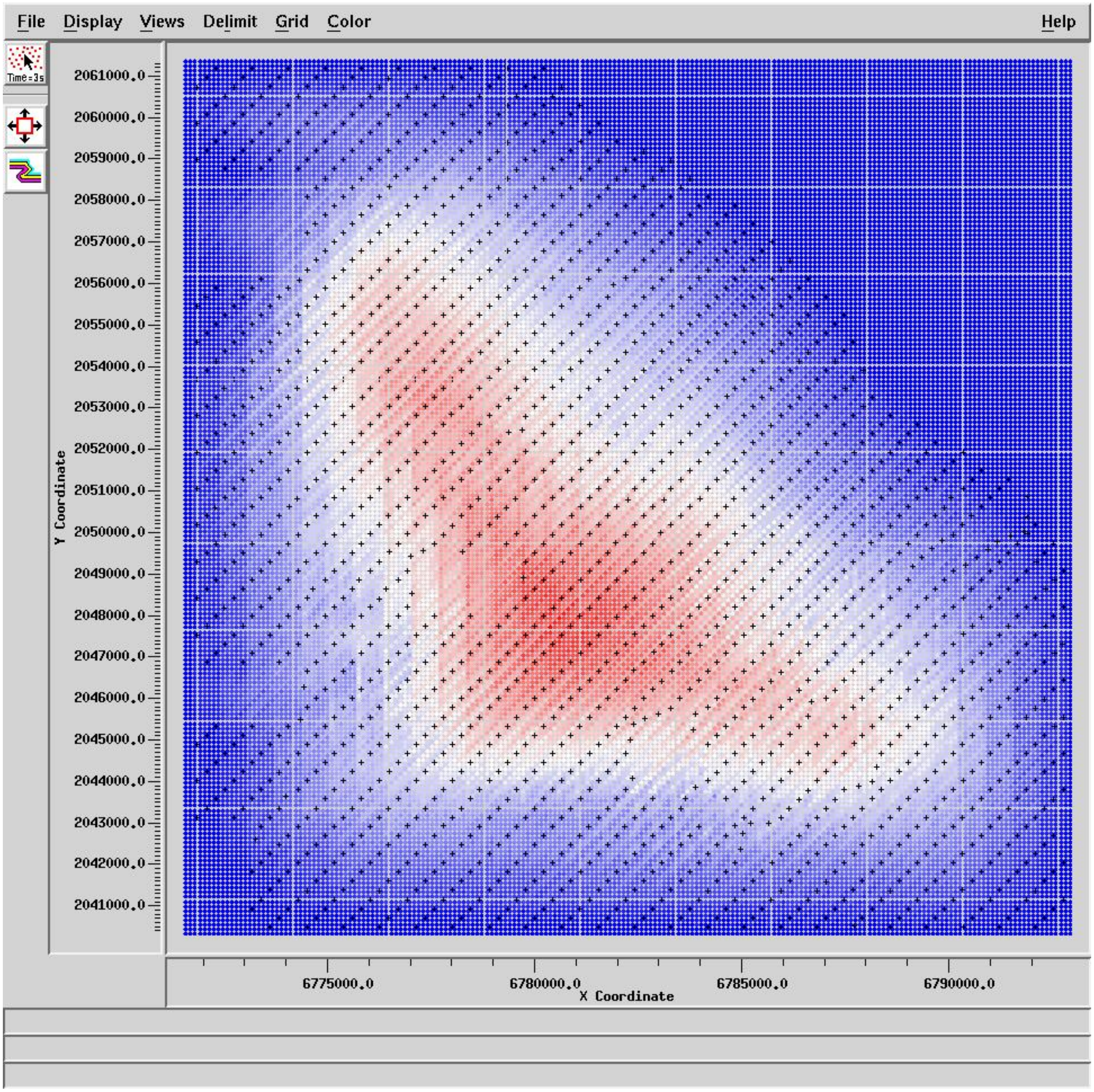
E. Receiver Parameters

Geophone Type	: 3C / 10 HZ
Station Interval	: 311 Ft.
Resonant Frequency	: 10 Hz
Geophone Array	: Single 3C phone
Array Length	: 1
Geophones/Station	: 1

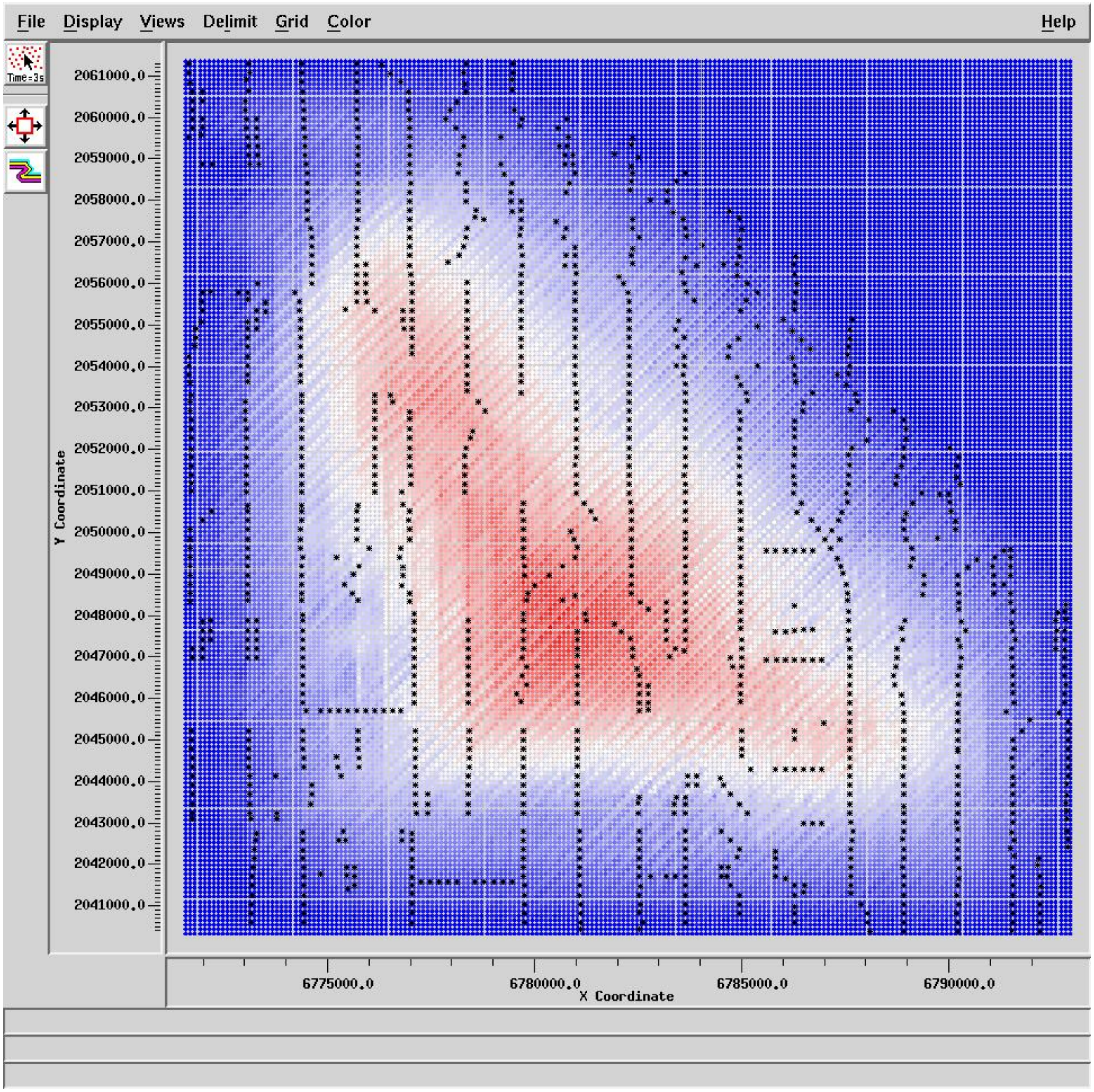
F. Geometry

Channels per Source	: max 924 x 3

Survey:

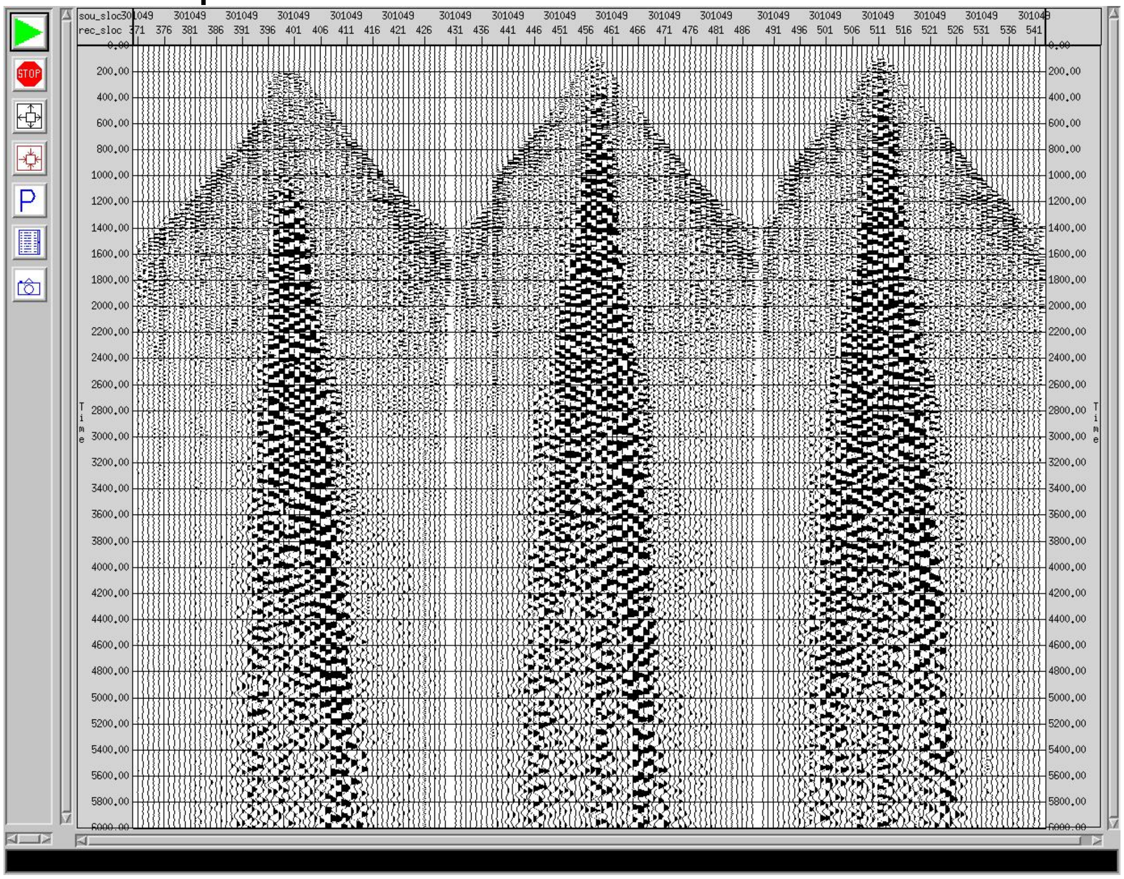


Receiver locations and CDP Fold (Max Fold 75)



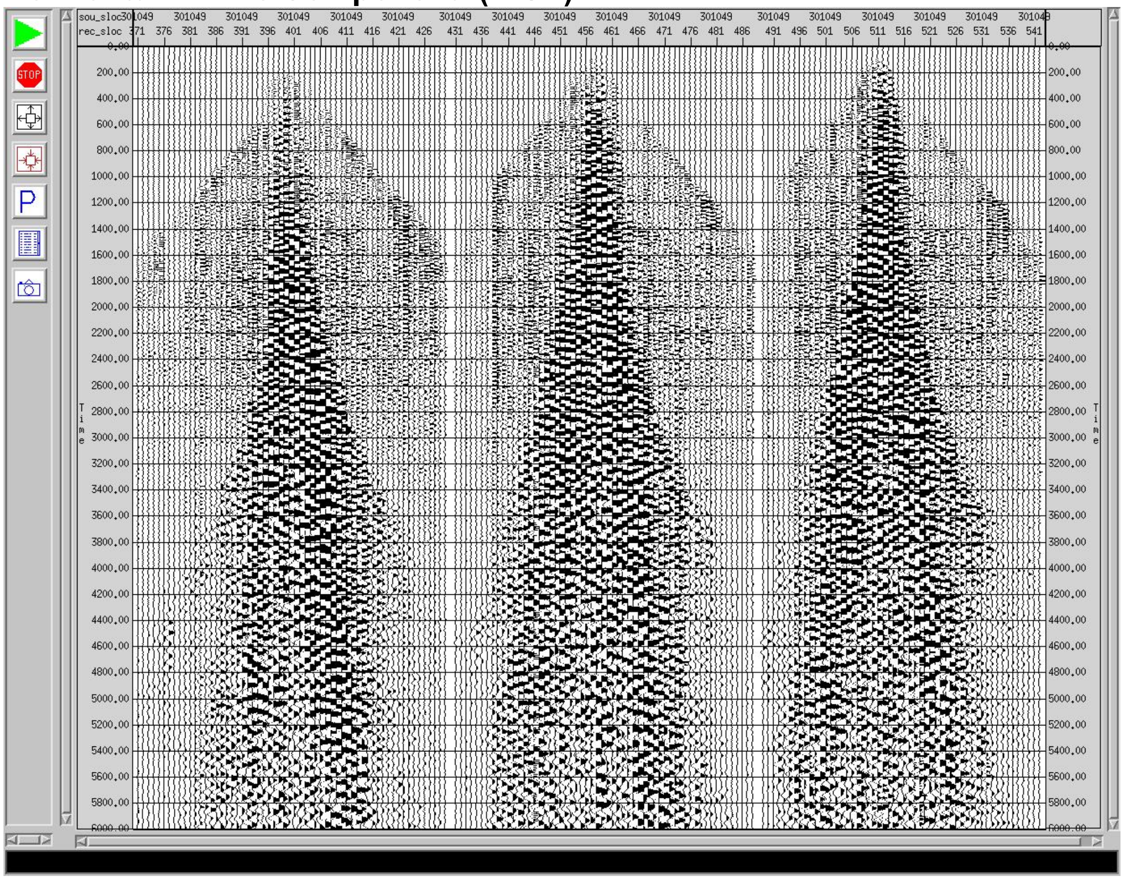
Source Location

Data Quality:
Vertical Component:



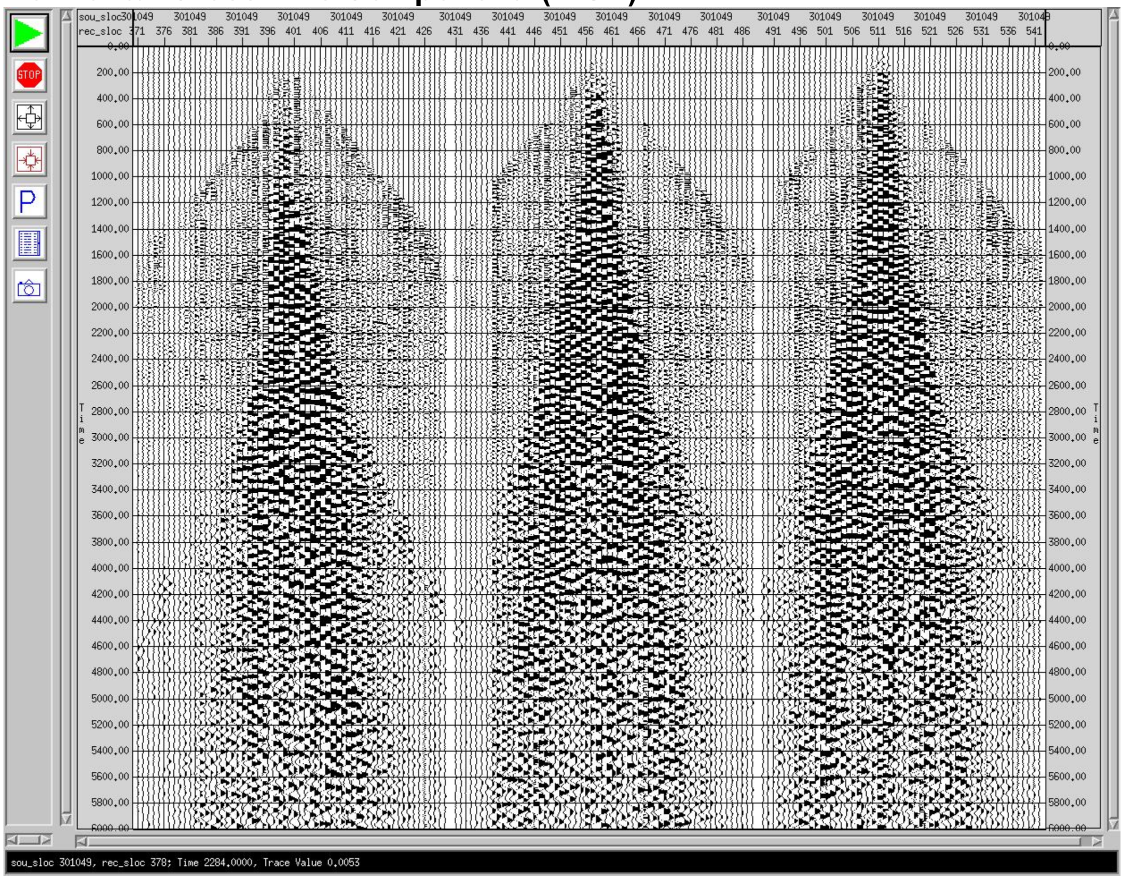
True Amplitude Display. High Amplitude, low velocity noise.

Horizontal In Line Component: (P-SV)



P wave contaminated. Weak coherent Converted wave reflected energy.

Horizontal Cross Line Component: (P-SH)



The converted wave energy appears stronger on the cross line phones then the in line phones suggesting a subsurface median highly anisotropic. In an isotropic median, converted wave energy would be nearly absent on the cross line phones when the phones are in the Transverse direction. Here they are since I have chosen the receiver lines closest to the source.

The processing approach taken when processing 3C 3D projects, is to first process the P-Wave data, resolve the P Wave velocity and statics required to image the Vertical component and then begin the processing of the converted wave energy, using the P Wave velocity function and the P Wave Statics derived during processing.

The first section of this report will be the P Wave Processing Sequence, with diagnostic displays, followed by the C Wave Processing Sequence.

P Wave Processing Sequence, and Diagnostic Displays.

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Geometry Description and Application

Geometry was described in the trace headers as well as supporting SEGP1 files. The technician loads this information, and then verifies the provided information by QC'ing the field records. Verification includes visual inspection of the field records with a linear moveout applied, QCing the moved out data with errant arrival times of the direct arrivals. During inspection traces noisy traces are removed and shots incorrectly recorded are edited.

Datum Static Parameters

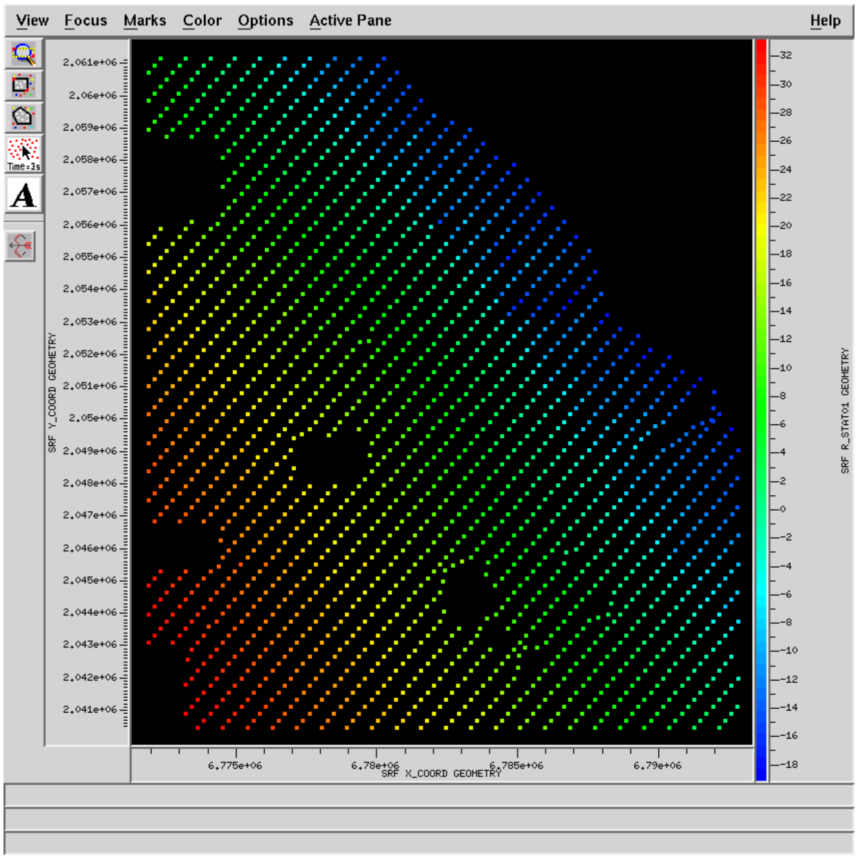
Datum Elevation 0 (Sea Level)
Replacement Velocity 5500 ft/sec.

A pre stack datum is used to correct the gathers with NMO. The Final Datum Static is subtracted from the average Datum static at each CDP.

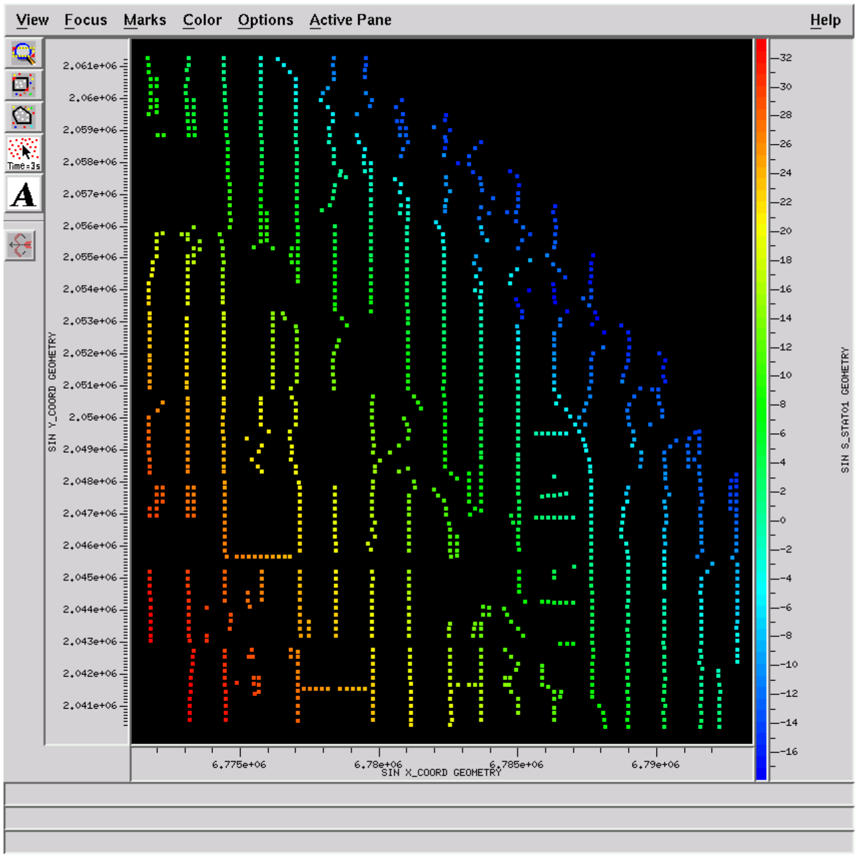
Pre Stack Datum Static = Final Datum Static – Average datum static at CDP

Post Stack Datum Static = Average datum statics at CDP
Receiver Static

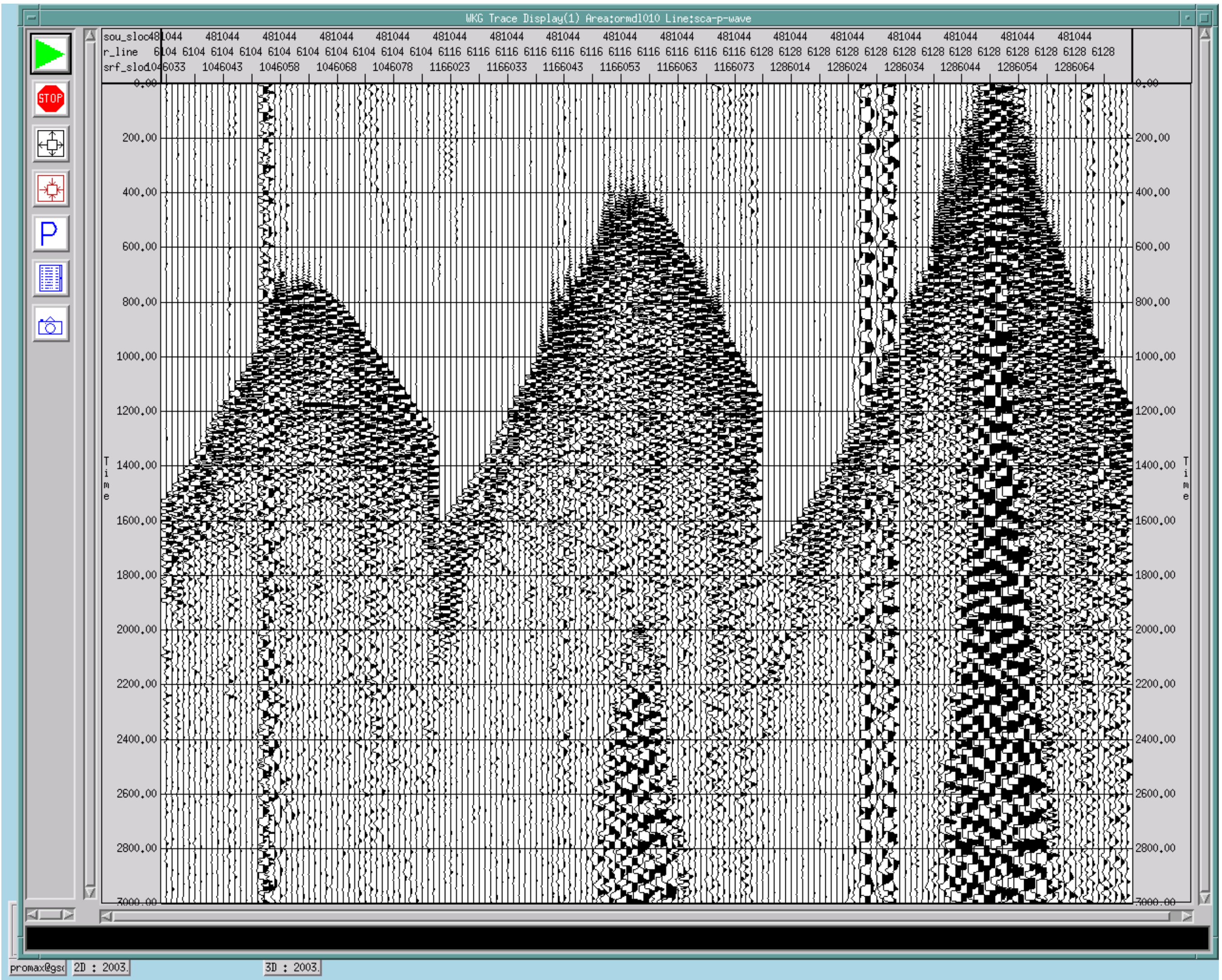
RECEIVER STATICS



SOURCE STATICS

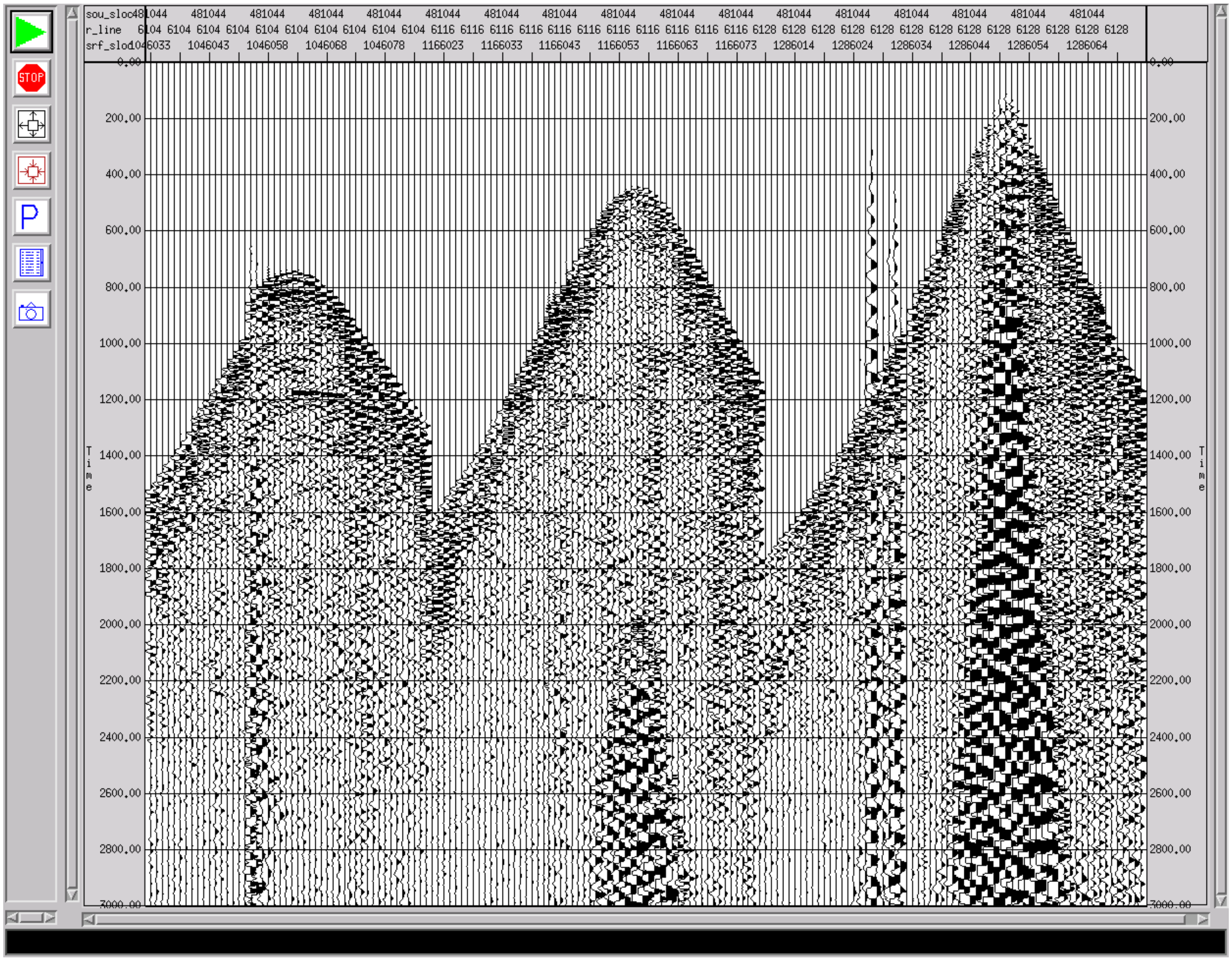


FIELD DATA



A Source Record with 3 of the 14 receiver lines illustrates the
Following applications applied. Near, middle and far receiver line are selected for this illustration.

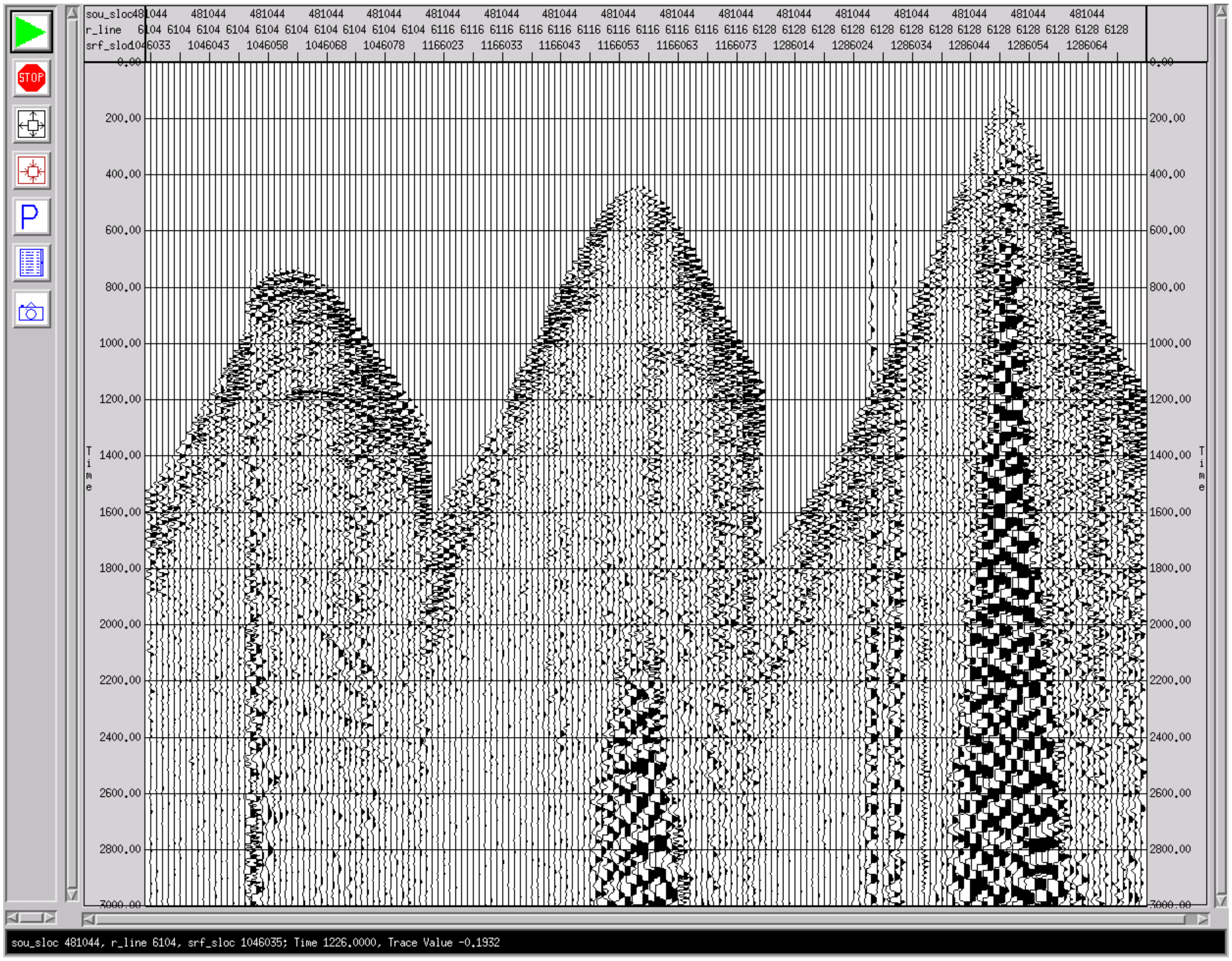
TRUE AMPLITUDE RECOVERY



A Time raised to a power correction Time $^{XX1.8}$.to 2.5 sec.

MINIMUM PHASE FILTER APLICATION

ENSEMBLE DECONVOLUTION

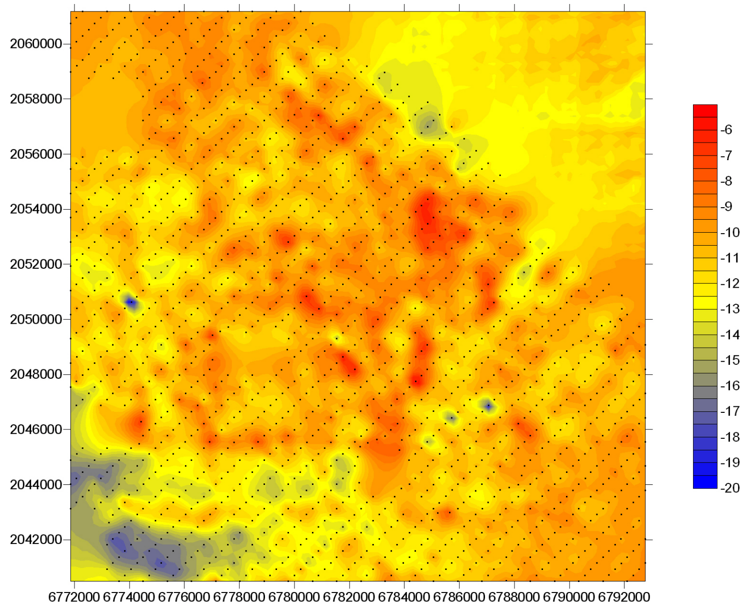


The Minimum phase filter is applied to correct the data to minimum phase. During the sweep and correlation process performed in the field, the data is a mixed phase. The combination af the minimum phase filter application and the Spiking Deconvolution application the resultant phase of the data is zero.

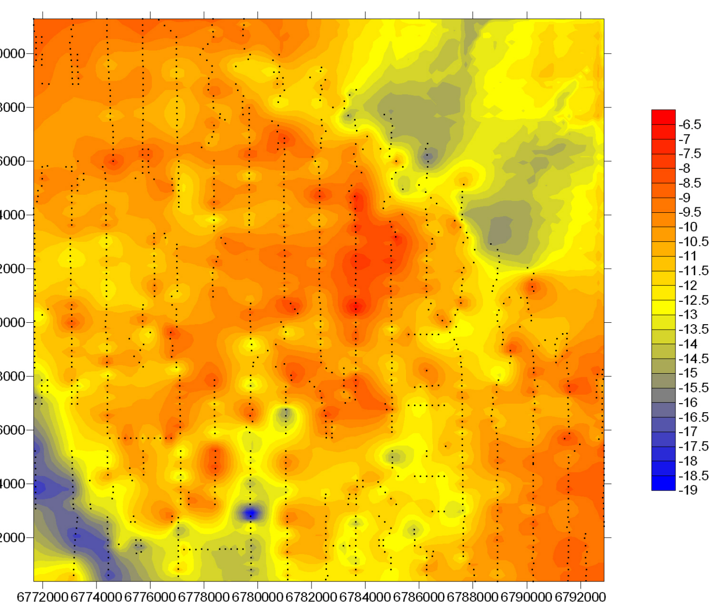
Deconvolution Parameters:

Ensemble Source/Receiver Line	
No. Tr. Average:	11
Operator Length:	120 ms.
% WN:	.01
Gate:	200 – 3500 ms, below first breaks

SURFACE CONSISTENT AMPLITUDE CORRECTIONS



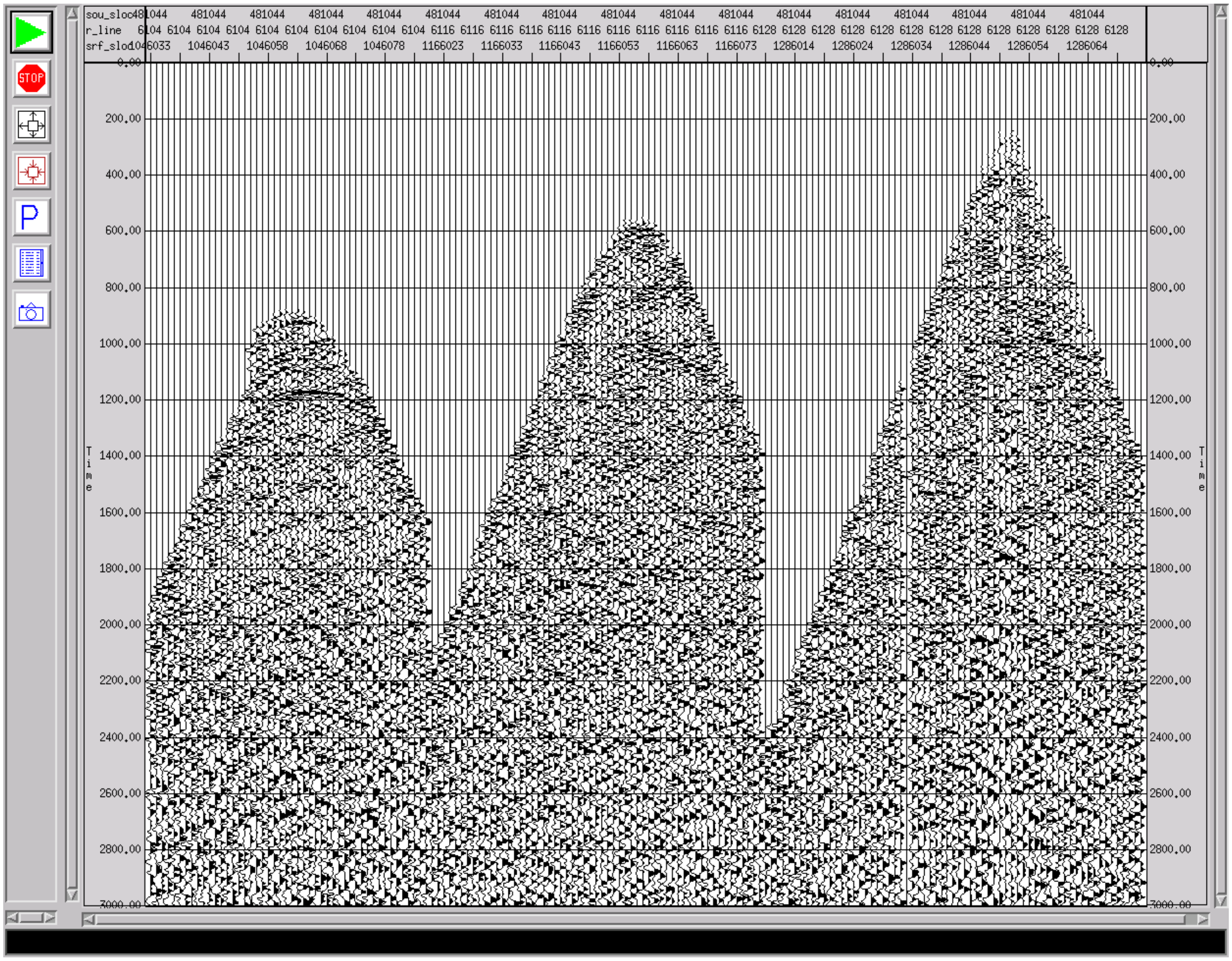
Receiver Corrections in Db



Source Corrections in Db

An rms amplitude level of the traces are measured, and Surface Consistent measurements are removed from the data.

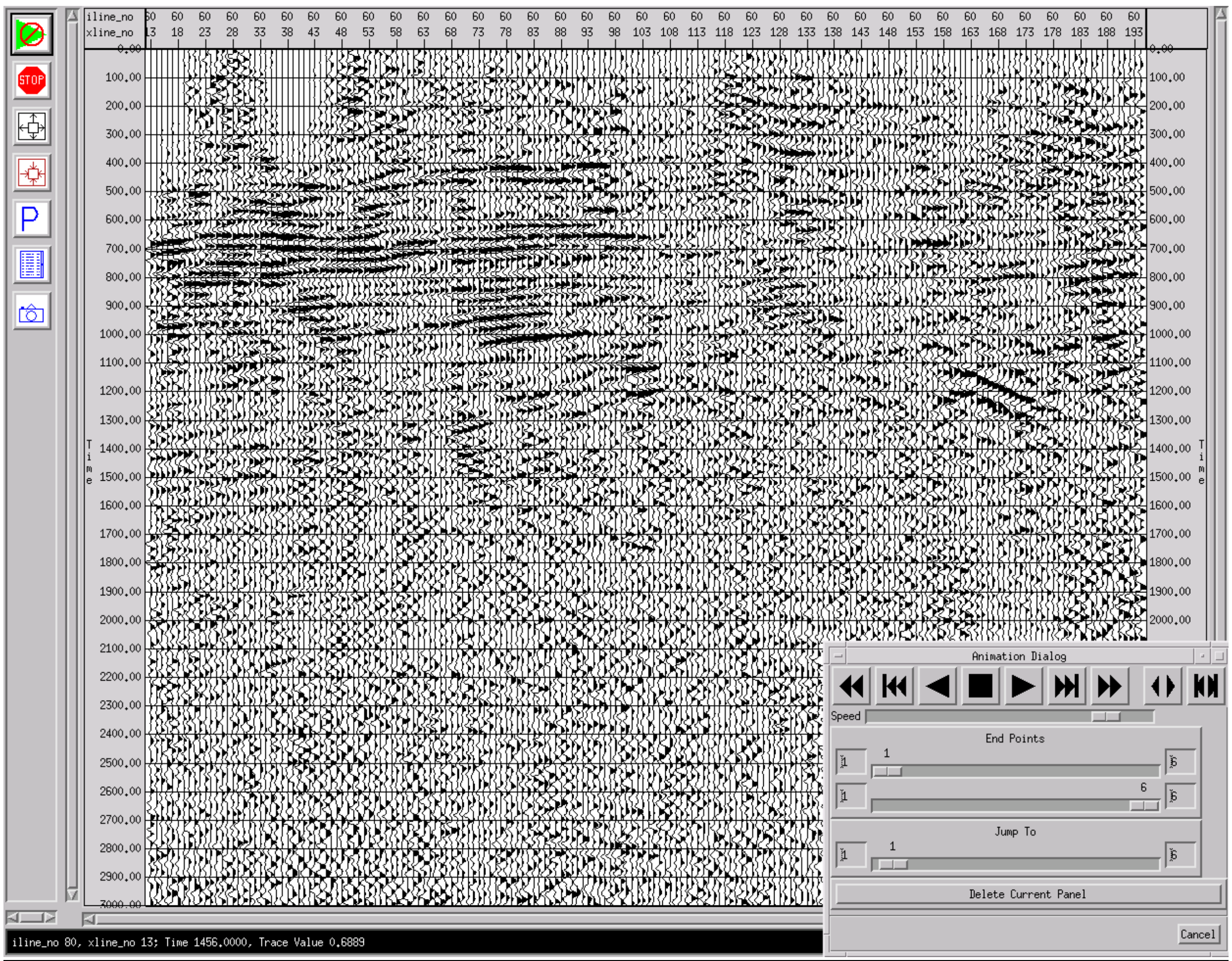
Frequency Dependent Diversity Scaling



Frequency dependent Diversity scaling has also been applied. Comparing this to the previous illustration shows the results. The high amplitude undesireable ground roll energy has been basically eliminated. The remaining energy appears to be downgoing p wave energy and ambient non-coherent noise, the non coherent ambient noise will be attenuated with CDP stack**.**

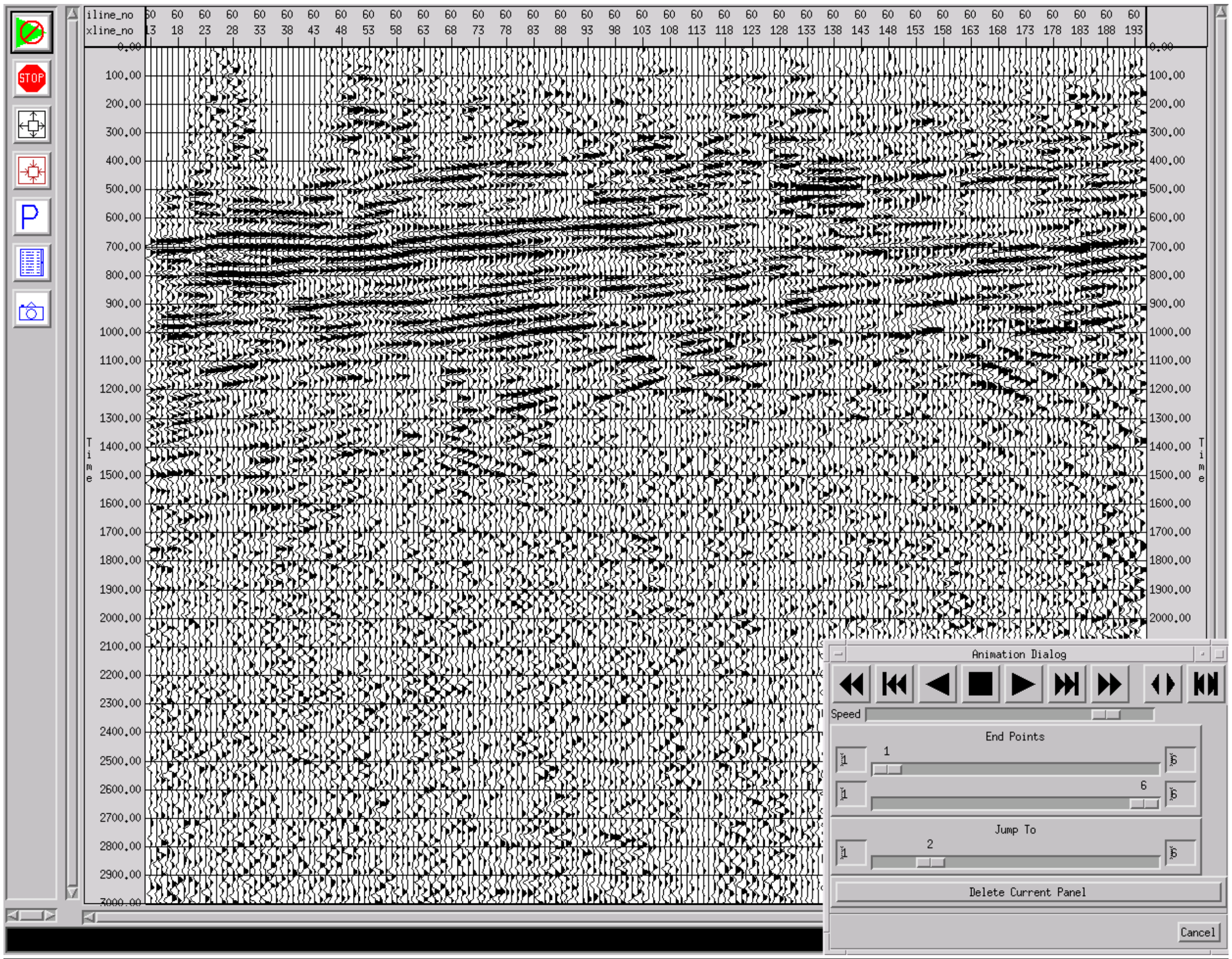
The following illustrations are representative stacks after various stages of the iterations resolving the residual statics and stacking velocities. A final mute, and post stack enhancements are also determined during this stage of the processing sequence. Once a satisfactory solution is obtained the pre stack gathers with the results from the residual statics iterations are input to the Kirchhoff Pre Stack Migration.

Elevation Statics Stack



To verify the refraction statics solution comparisons are made of the stacks. Elevation Statics vs. Refraction Statics. This illustration, and the following one illustrate the improvement in the stack response after the application of refraction statics.

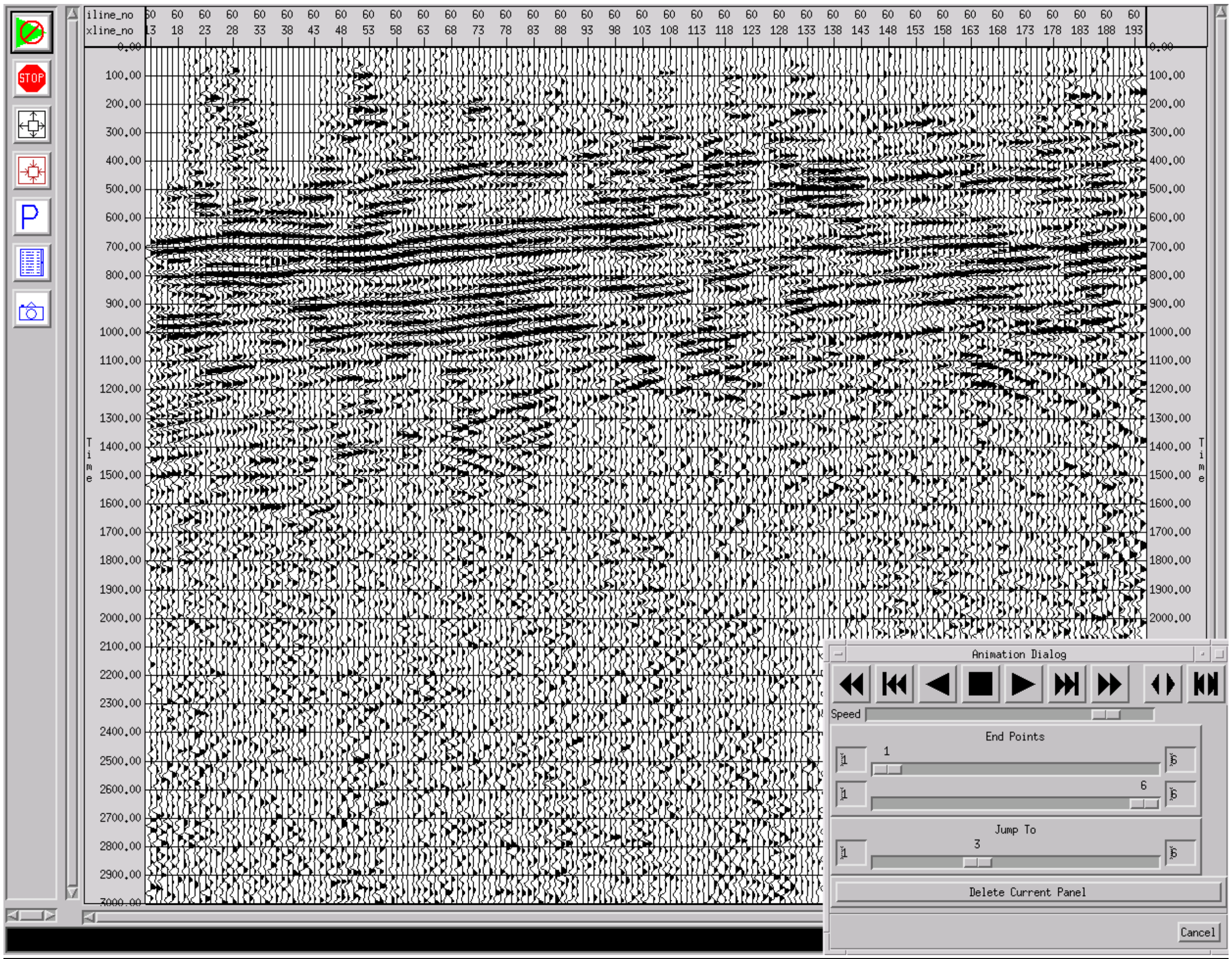
Refraction Statics Stack



A limited offset range of first break picks were used to model the first refractor, The delay times, and the refractor velocity are used to compute a near surface model which is used to recomputed a datum static.

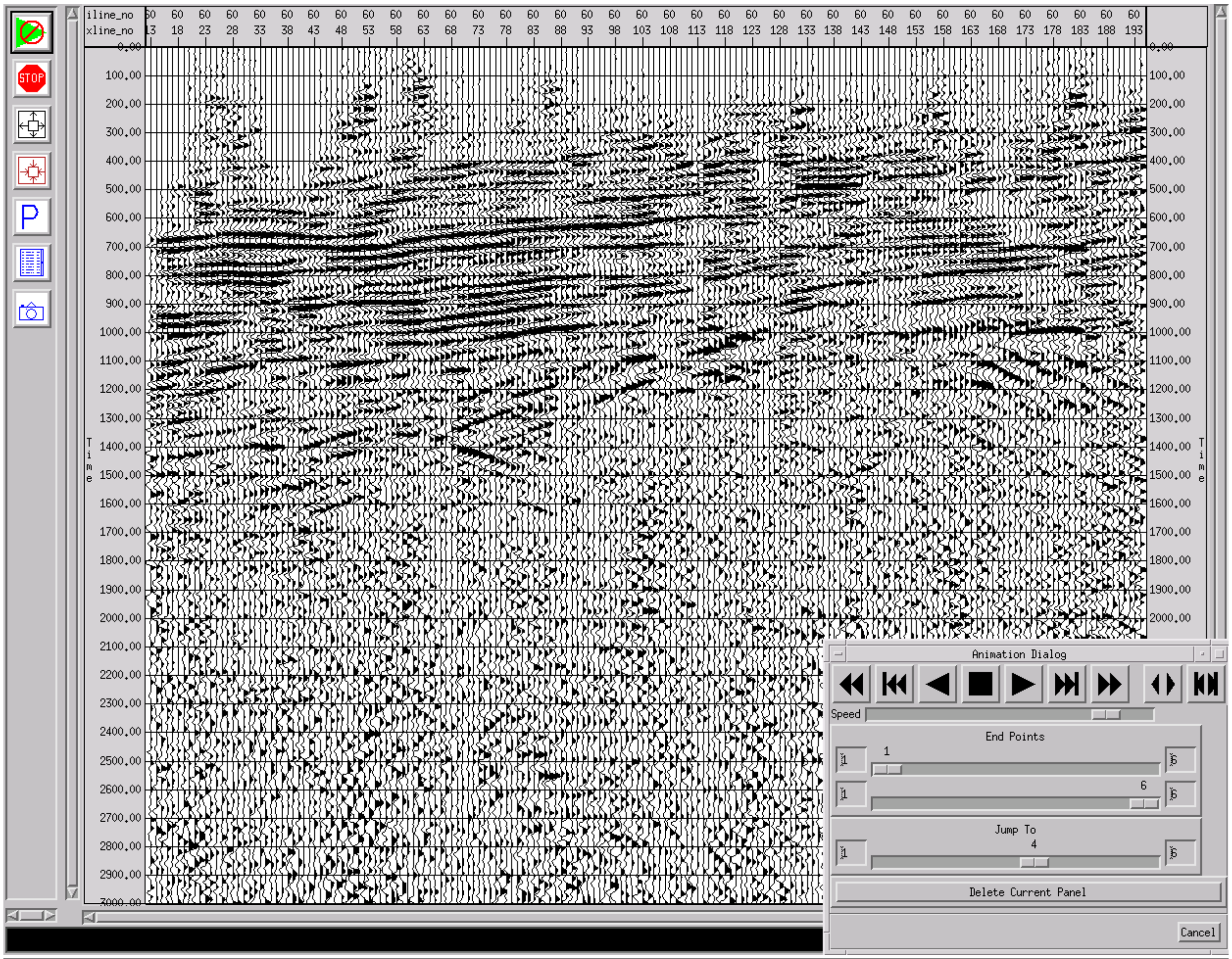
1st Pass Stacking Velocity Analysis by Constant Velocity Stack

1st Pass Surface Consistent Residual Statics



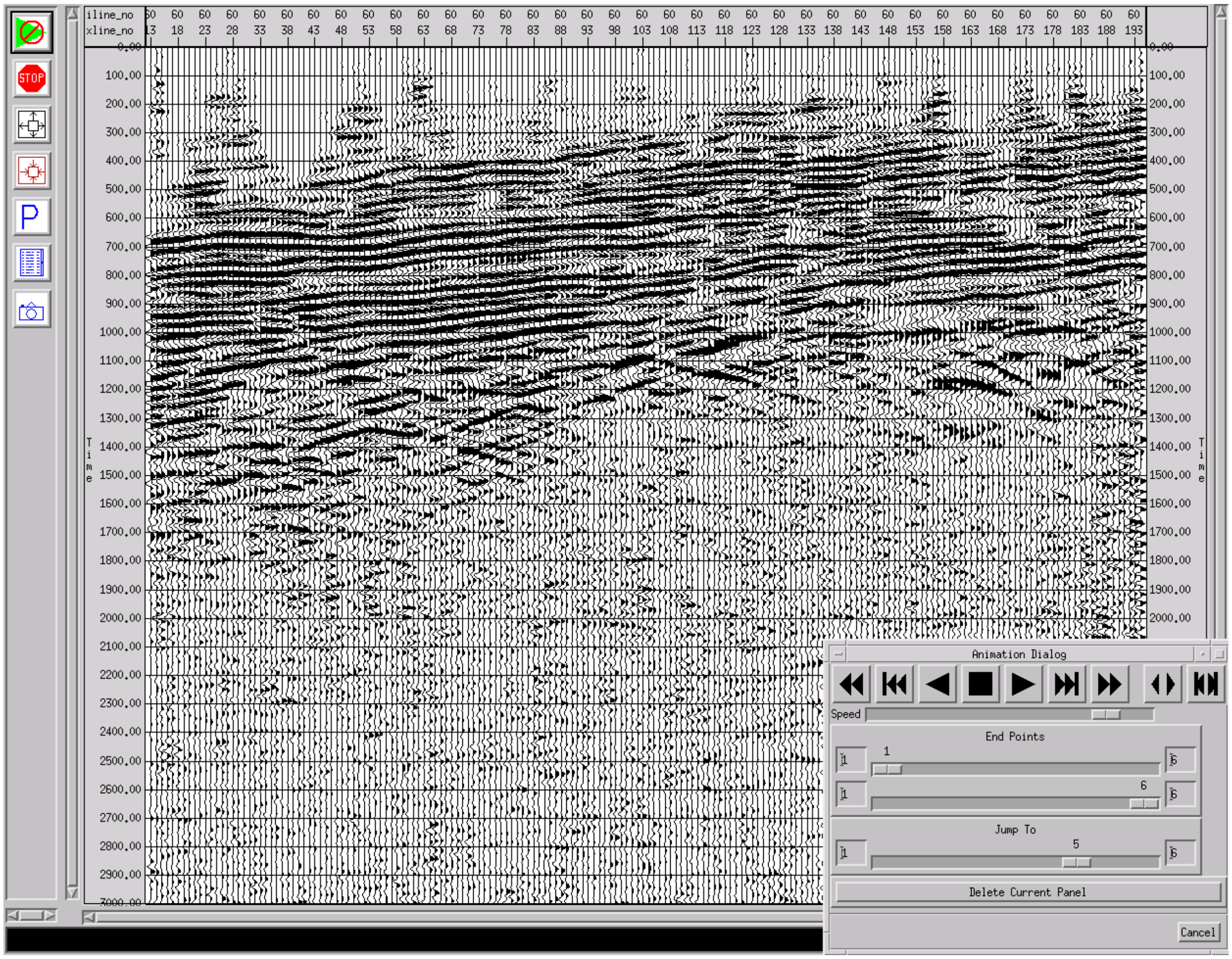
Stacking velocities were picked on a ½ mile grid. A maximum power surface consistent residual statics application was used to compute the statics. A gate designed over the coherent signal was used to derive the statics.

Final Mute selection



Final pre stack parameters have been selected.

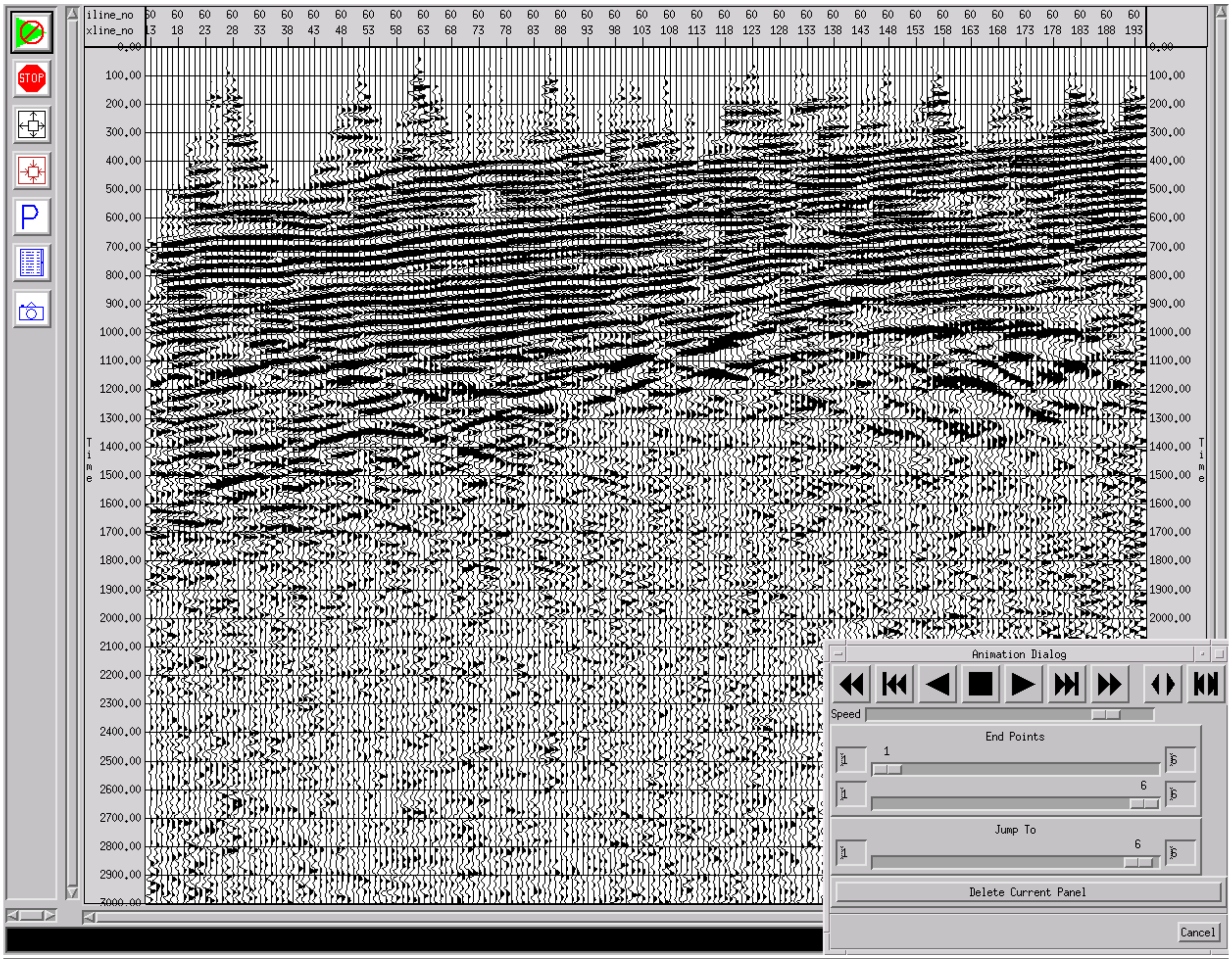
Post Stack Signal Enhancements



Post Stack Enhancements have been selected. An inline fx filter followed by an fk filter, and then the same has been applied in the cross line direction.

2nd Pass Stacking Velocity Analysis by Constant Velocity Stack

2nd Pass Surface Consistent Residual Statics



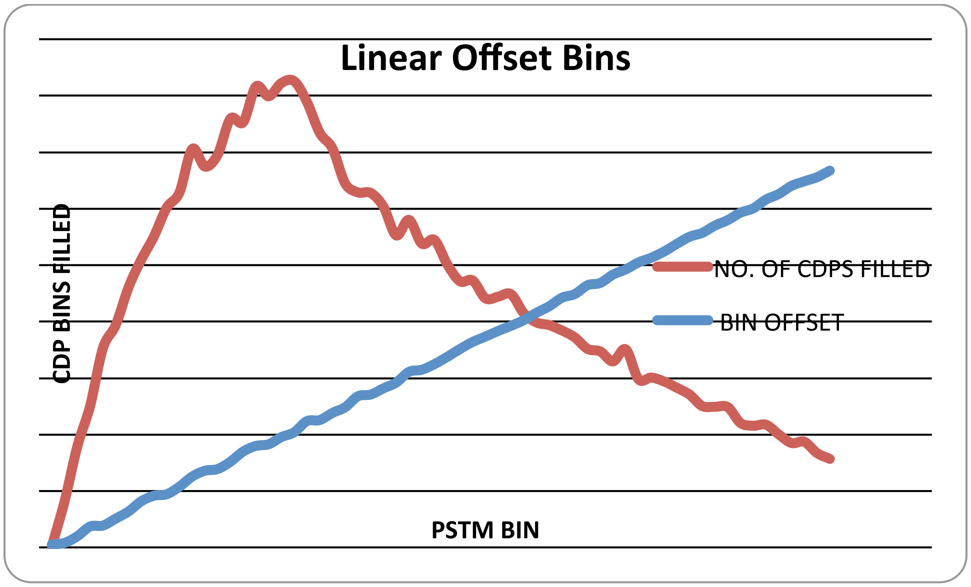
Final Iterations of surface consistent statics and stacking velocities are applied. As well as the final post stack enhancements.

Kirchhoff Pre Stack Time Migration

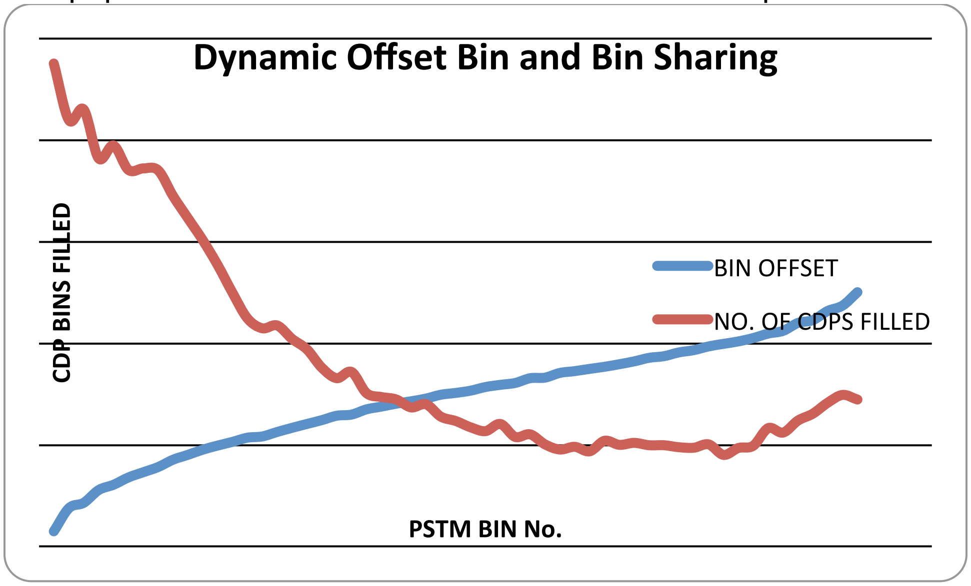
The offset bin definition for Kirchhoff Pre Stack Time Migration is arbitrary. The most important consideration for the prestack migration is defining an offset bin such that all CDP's are populated with live traces. Two approaches offered by FairfieldNodal are OVT binning, and Dynamically offset binning with bin sharing. Recently OVT binning has been added to our toolkit to preserve offset and azimuth for pre stack analysis. The reason for OVT binning is to interpret the velocity effects on offset and azimuth. This is very useful for projects like this to observe the anisotropy with pre stack time migrated gathers. Dynamic offset binning is useful for improving the quality of each offset bin for AVO analysis. At the time of this project OVT binning was not available. The Kirchhoff Pre Stack Migration product for this project was dynamically offset binned.

Before illustrating the results of this stage of the processing I will present some diagnostic displays for using Dynamic Offset Binning with bin sharing.
Dynamic Offset binning with bin sharing designs bins based on equal area. The acquisition design for this survey was not orthogonal. The receiver lines were at a 45 degree angle from the direction of the source lines. The maximum offset used to compute the bins for the source line direction was 7260', and for the receiver line direction was 5720' yielding 55 offset bins.

TOTAL NUMBER OF CDP's FOR THIS SURVEY : 29964.

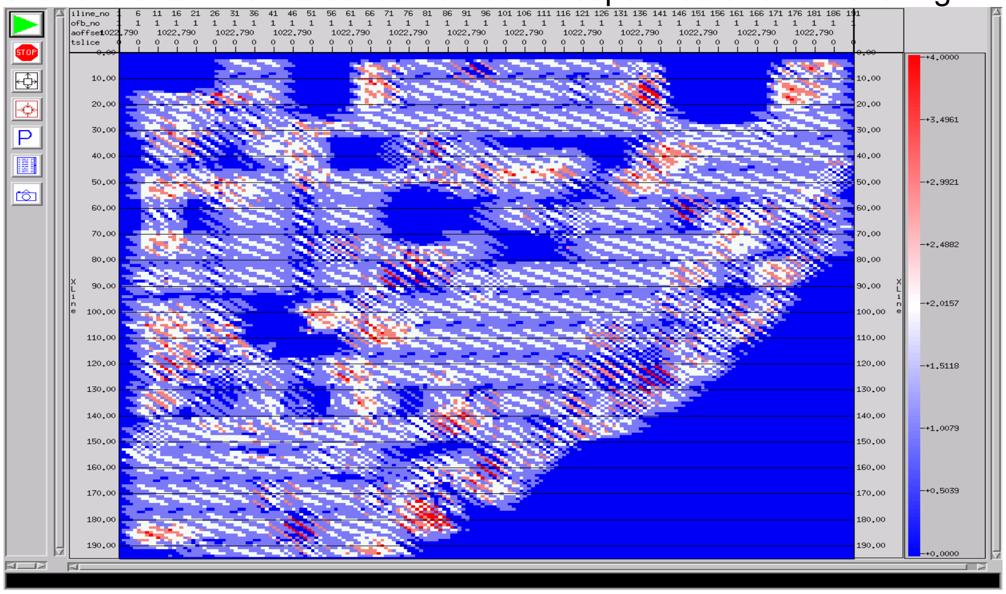


The population of CDP's for the near offset is less .5 percent of the total number of cdps.

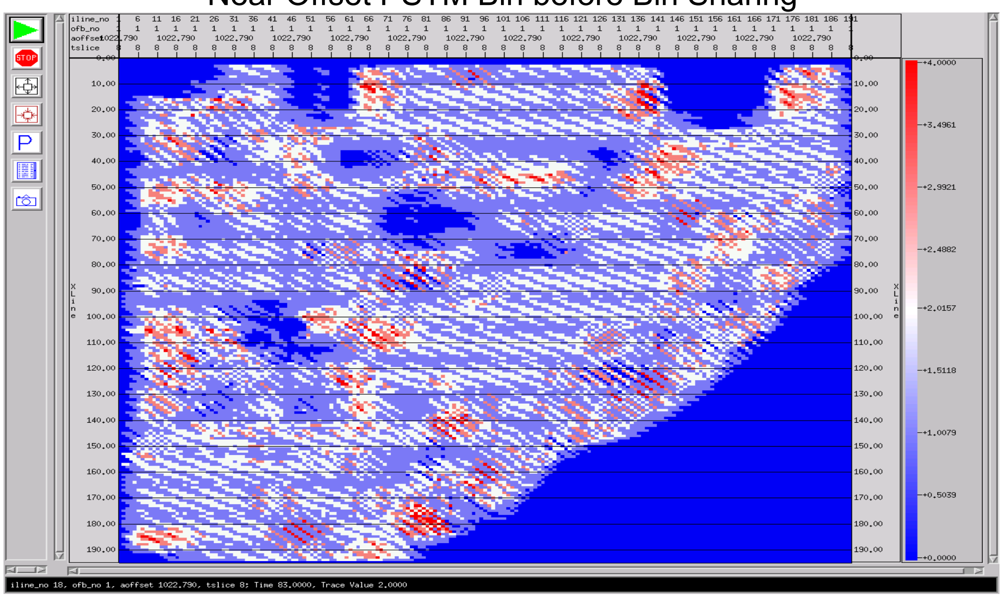


The population of CDP's for the near offset is more than 45 percent of the total number of cdps.

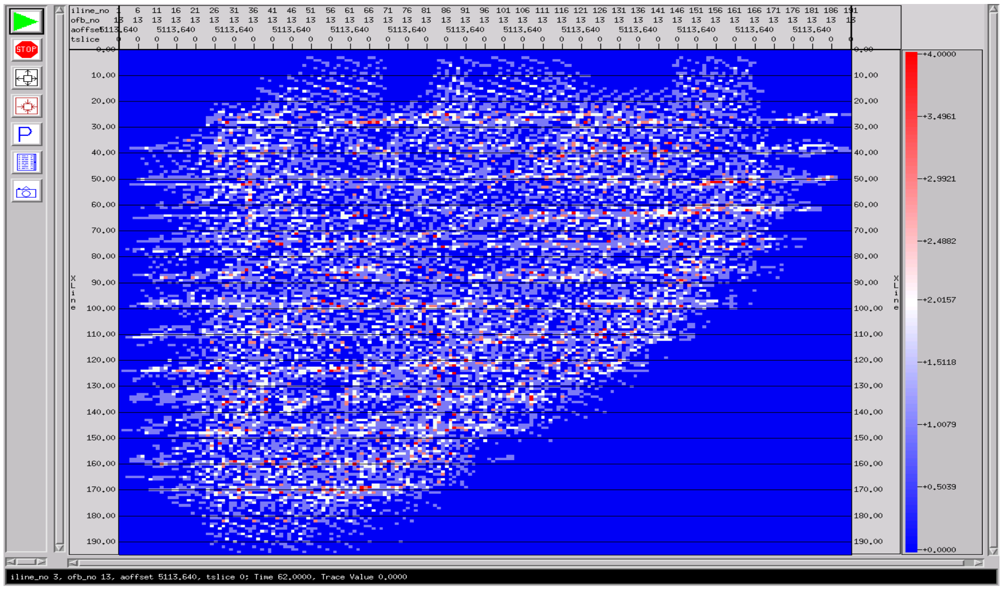
Bin Sharing borrows traces from adjacent PSTM bins to populate additional cdps. The following illustrations show the increased number of cdps filled after bin sharing.



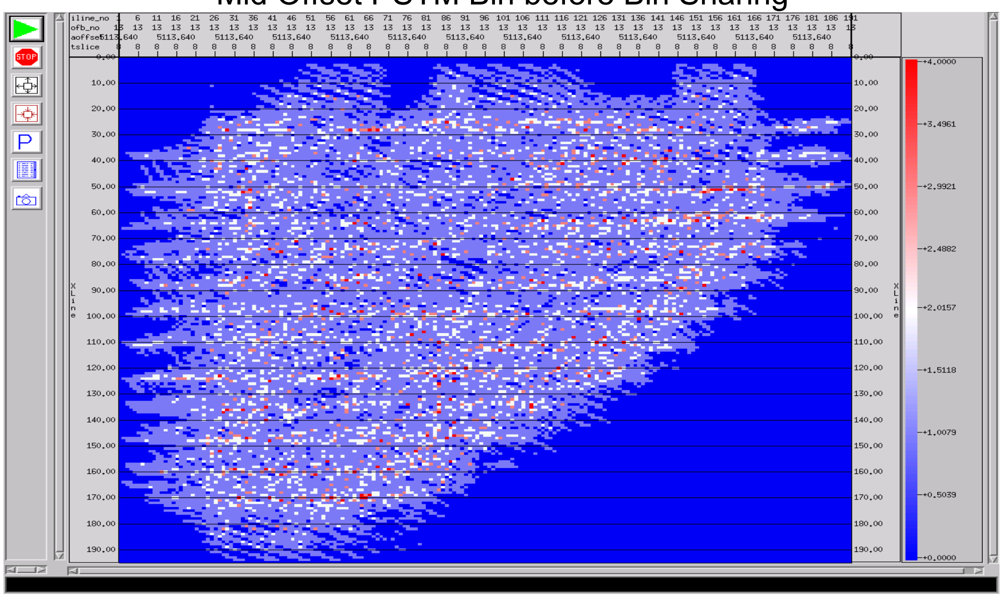
Near Offset PSTM Bin before Bin Sharing



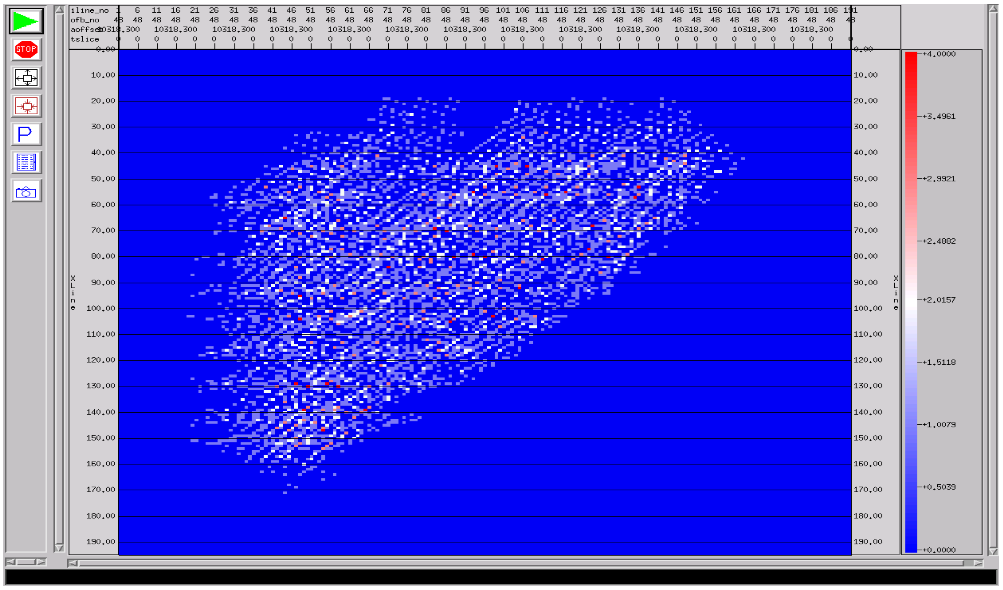
Near Offset PSTM Bin after Bin Sharing



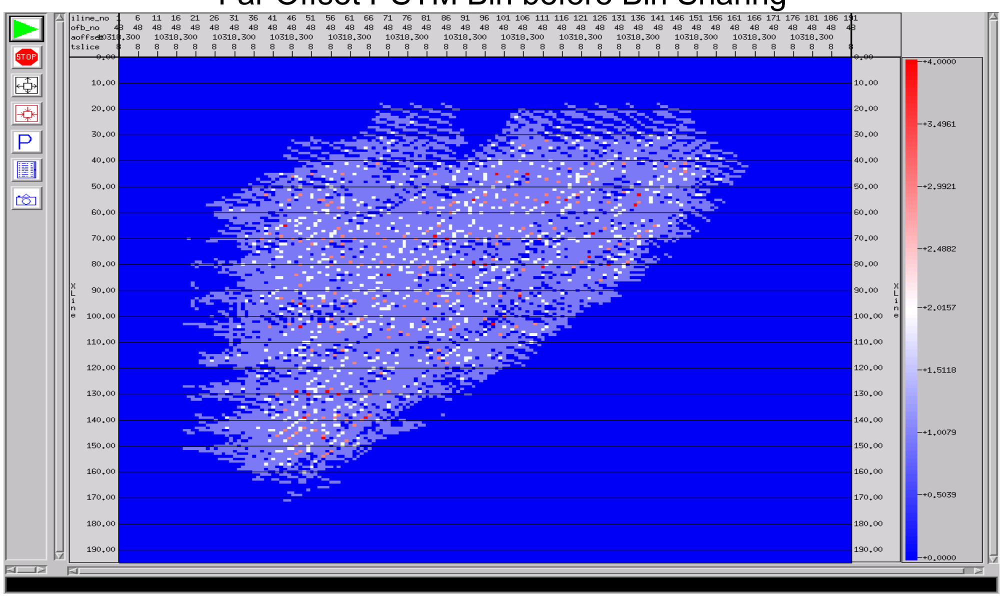
Mid Offset PSTM Bin before Bin Sharing



Mid Offset PSTM Bin after Bin Sharing

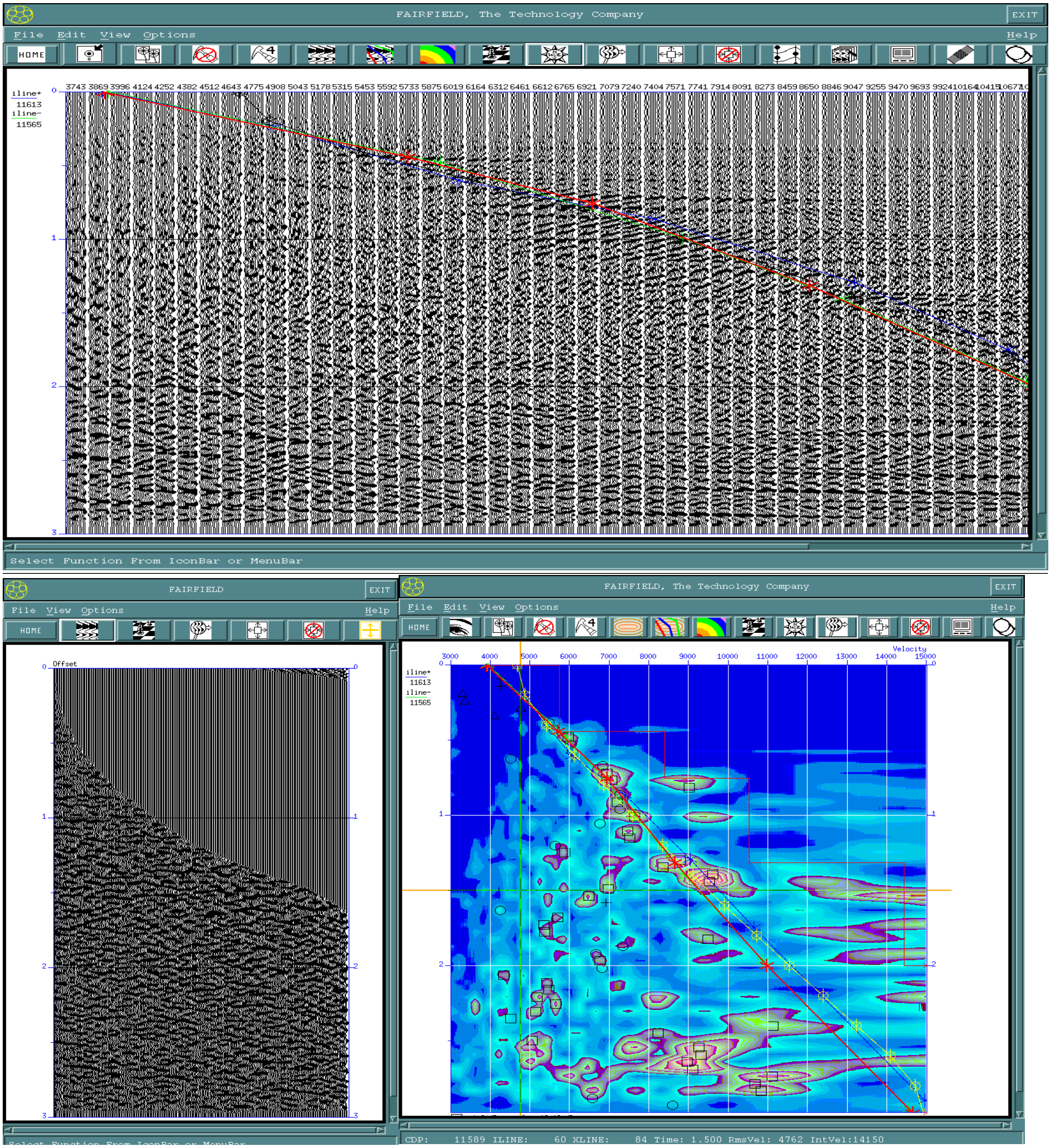


Far Offset PSTM Bin before Bin Sharing



Far Offset PSTM Bin after Bin Sharing

Kirchhoff Pre Stack Time Migration Velocity Analysis

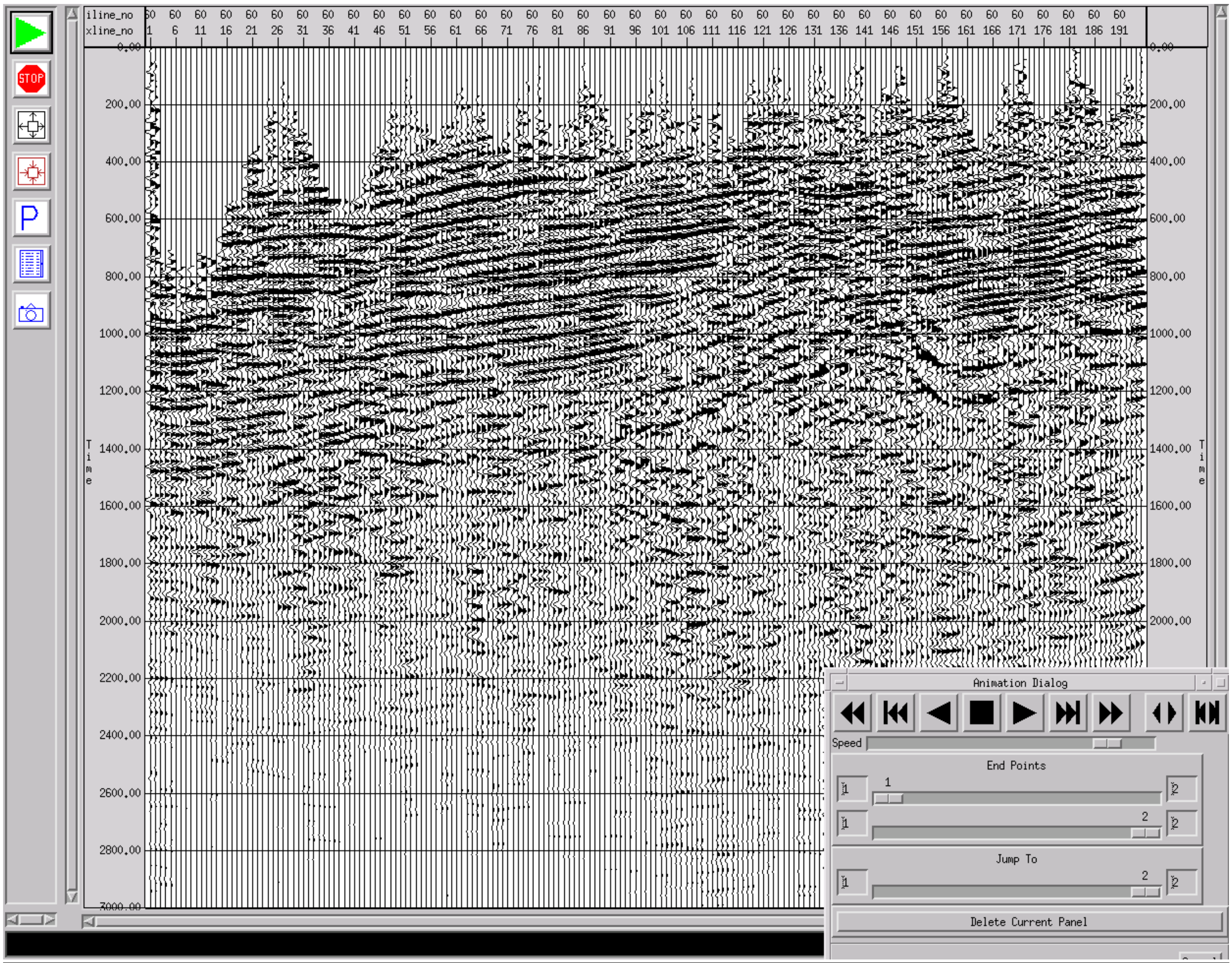


The illustrations above are the displays of a velocity analysis. The approach used to resolve the PSTM velocities consisted of a velocity analysis like this on migrated gathers. A Migration is applied to the data with a smooth stacking velocity from the conventional stack. A velocity analysis is run on ½ x ½ mile grid. The velocity function is smoothed and Kirchhoff Pre Stack

Migration is applied to the whole volume. A residual velocity analysis is run to flatten the gathers.

Kirchhoff Pre Stack Time Migrations

Post Stack Signal Enhancement



Final signal enhancements included:

Spectral Whitening:	6-84 Hz. 10 hz panels, 256 ms gate length.
2x2 FX Deconvolution:	6-84 Hz.
2x2 Frequency Wavenumber Filter:	Reject Operator: 15 tr x 34 ms., 13 to 79 ms/tr

CONCLUSION

P-Wave Pre Stack Sequence:

1. Geometry Description
   - Read in field geometry from tape headers. Made adjustments were noted by observer. All field recorded were plotted to confirm source location.

2. True Amplitude Recovery
   - 1.8 Time Power Constant applied to 2.5 sec.

3. Minimum Phase Filter correction operator for Zero Phase Source

4. Refraction Statics
   - Datum: 0 Ft.
   - Replacement Velocity: 5500 Ft. /sec.
   - 500 – 4000 Ft. offset ranges were used in model
   - Refraction static stack showed improvement over a conventional elevation statics solution.

5. Surface Consistent Amplitude Analysis and Application
   - Source and Receiver
   - Gate below first breaks to 3.0 sec.

6. Ensemble Deconvolution (Receiver Line ensembles)
   - Spiking
   - 11 trace average
   - 210 ms Operator
   - .01% white noise
   - Single gate design from below first breaks to 3.5 sec.

7. Frequency Dependent Diversity Scaling.
   - Receiver Line Ensemble
   - 200 ms time gate
   - 5 freq panels,

8. Two passes velocity analysis, 2 passes surface consistent residual statics
   - First pass 1 Mile Grid / Second Pass ½ Mile Grid

Conventional CDP Stack Post Stack Sequence:

1. CDP Stack

2. Post Stack Enhancement
    - 2x2 FX Deconvolution, T-X dip filter
    - +/- 10 msec. Per trace in both directions

Pre-stack Time Migration Processing Sequence

Input to PSTM sequence Conventional CDP gathers prior to CDP Stack

1. Defining Arbitrary PSTM Binning
    a. Compute Equal Area Binning
    b. Compute Bin Sharing Parameters
    c. Compute Pre-stack Scaling

2. Kirchhoff PSM Velocity Analysis
    a. Pre-stack Kirchhoff curved ray time migration
    b. 20 iline x 20 xline velocity grid

3. Picked new velocity field on migrated gathers

4. Kirchhoff Pre Stack Migration full Volume
    a. Mute Pre Stack Volume

5. PSTM Residual Velocity Analysis
    a. Conventional Stacking Velocity Analysis

6. CRP Stack

7. Post Stack Enhancement
    a. 2x2 FX Deconvolution
    b. T-X dip filter
        i. +/- 10 msec. per trace in both directions

8. SEGY output Final Enhanced Pre-stack Time Migration
    a. File: final-p-wave-pstm.segy