FUGRO SEISMIC IMAGING PTY LTD

SEISMIC DATA PROCESSING REPORT

FOR SANTOS LTD

Location : Gippsland Basin, Offshore Victoria
Surveys : GISN05 2005 2D MSS
Prospect : VIC/P55
Date : May 2005

Fugro Seismic Imaging Pty Ltd
69 Outram Street
West Perth WA 6005

Tel: +61 (08) 9322 2490
Fax: +61 (08) 9481 6721
E-mail: info@fugro-fsi.com.au

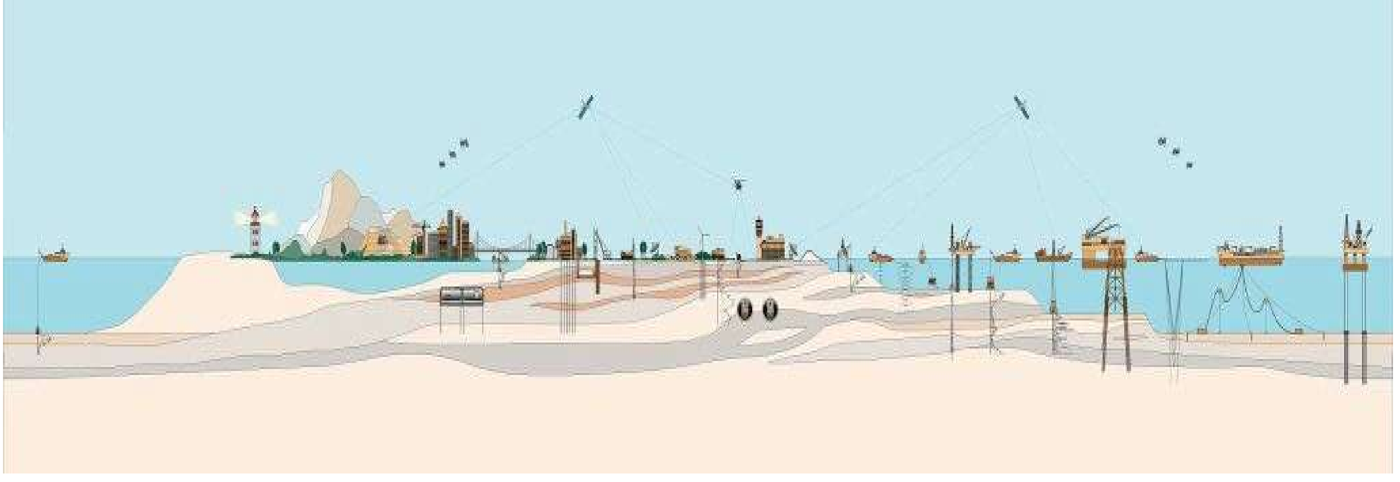


TABLE OF CONTENTS

1 INTRODUCTION

The 2005 GISN05 MSS was recorded in February 2005 and consisted of 18 lines totalling approximately 360km. The survey location was in the VIC/P55 permit in the Gippsland basin, offshore Victoria. The data was recorded by Multiwave Geophysical Company using the M/V Pacific Titan. Processing began on the 24th February 2005 and was completed on the 25th April 2005.

All processing, including velocity picking and QC was undertaken at the Fugro Seismic Imaging office in Perth, Western Australia.

1.1 PERSONNEL

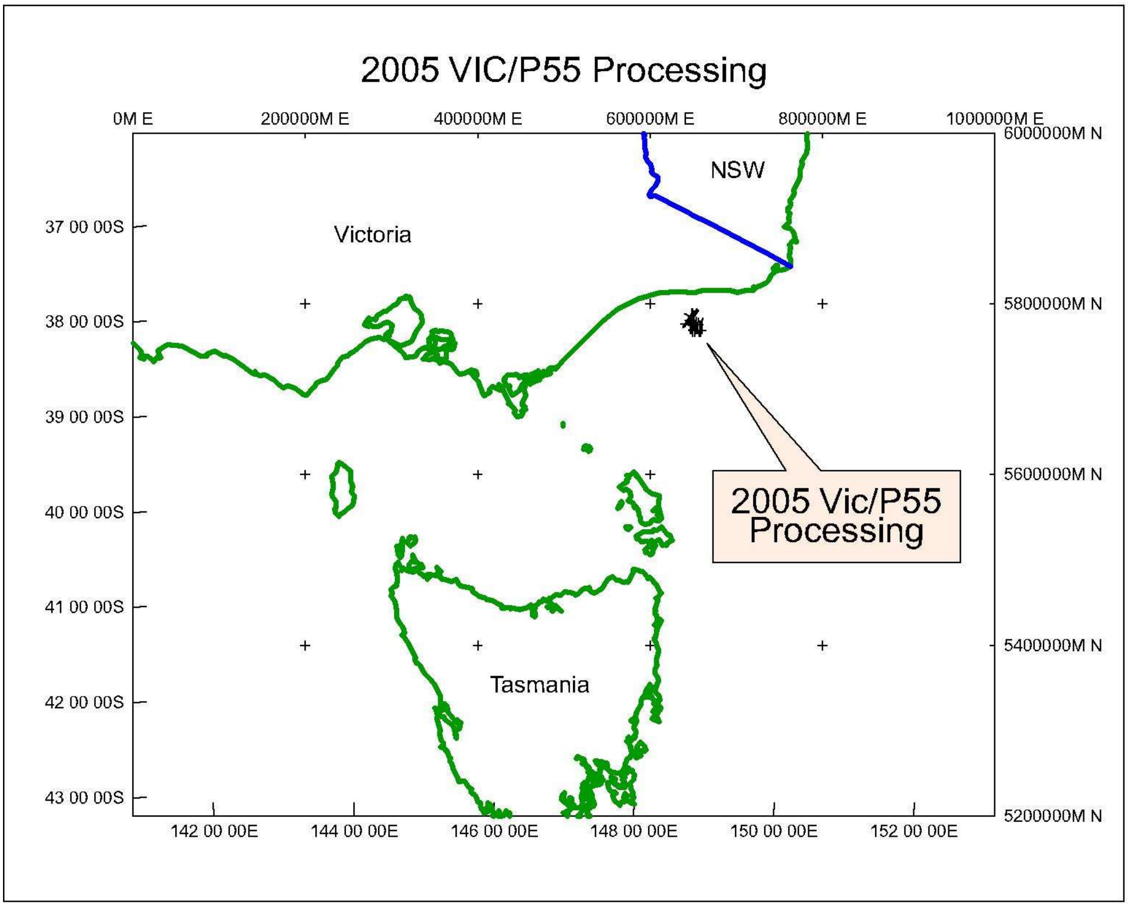
Fugro Seismic Imaging Pty Ltd

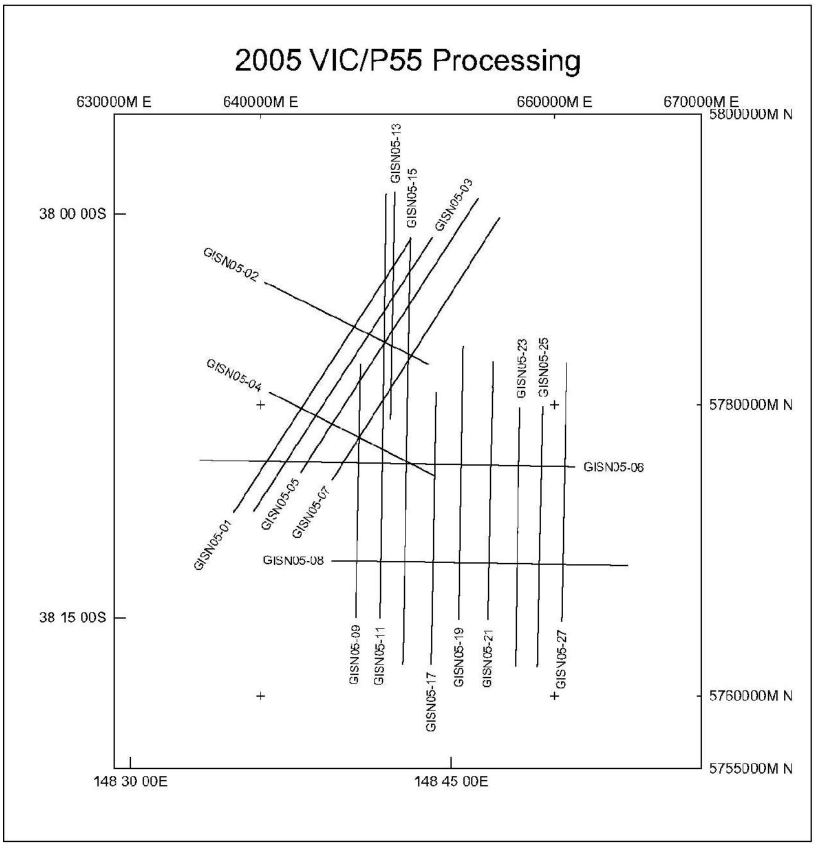
Simon Stewart	Marine 2D Manager
Paul Phythian	Senior Geophysicist

Santos Limited

Stuart Brew	Senior Staff Geophysicist

1.2 LOCATION MAP





2 PARAMETER TESTING

Testing was performed on lines GISN05-06 and GISN05-11 to determine the optimal parameters. The established processing sequence was then used for the remaining lines of the project.

Please refer to the table below for a list of the tests performed.

Description	***Format***
Raw displays	Shot
Gain recovery	Shot
Low Cut Filter	Shot
Swell Noise Attenuation	Shot
Despiking	Shot
F-K filter (shot domain, various cuts, with and without FX interpolation)	Shot
F-K filter with NMO (shot domain, various cuts)	Shot
F-K filter (receiver domain, various cuts, with and without FX interpolation)	Receiver
F-K filter with NMO (receiver domain, various cuts)	Receiver
F-K filter (shot and receiver domain)	Shot and Receiver
Tau-P Linear Noise Removal	Shot/Stack
Tau-P Deconvolution	Shot/Stack
Predictive deconvolution (before stack)	Gather/Stack
F-K Demultiple	Gather/Stack
Radon demultiple	Gather/Stack
Pre stack migration velocity field smoothing	Velocity profile
Pre stack migration aperture	Stack
Stack mutes (outer and inner trace)	Gather/Stack
Residual Radon	Gather/Stack
Incident angles at 5 degree intervals	Gather
Relative amplitude	Stack
Zero Phasing	Stack
Post stack scaling	Stack
Bandpass filter	Stack

Parameter tests were presented as paper displays, or ftp'd to Santos in SEGY format for evaluation on screen.

3 COMMENTS & CONCLUSION

The 2005 GISN05 2D Processing began in February 2005 with the preliminary final migrations being delivered at the end of April. The project was fully completed by May 2005. All lines in the survey had flat waterbottoms with shallow water depths.

Along with the final filtered and scaled full fold pre stack time migrations, the following stack datasets were archived. A full angle raw migration and a near, mid and far angle raw migrations. The near angle stack was from 0-15 degrees, with the mid and the far angle stacks using 15-30 and 30-45 degrees respectively. The full angle raw migration used the same inner and outer trace mute that was used for the final filtered and scaled PSTM. The raw PSTM gathers were also archived. These were NMO corrected using the final stack velocities and had the gun and cable depth correction applied.

All stack and gather archives were zero phased and the data was also phase rotated in order to produce a consistently zero phase trough at the water bottom.

The final stacking velocities were archived in western format. The CDP coordinates for all lines were archived in ASCII format and both of these were burnt with the final report onto CD (4 copies).

Data quality was excellent throughout. The initial PSTM datasets exhibited a rather strong water bottom multiple, especially obvious on lines north of line GISN05-06 and west of line GISN05-17. A residual linear radon demultiple was devised and attenuated this multiple quite well. All comparisons to the previous VIC/P55 reprocessing (reprocessed in 2004) showed vast improvements to data quality, continuity and interperability. All processing parameters have been detailed in Section 5 – Processing Description.

The new acquisition misties the July 2004 reprocessed data by 8ms and 24 degrees. All the reprocessed data was phase and time matched to the G94A data set, this being the most recent vintage of the reprocessed data. Had the reprocessing been conducted in conjunction with the new acquisition then the reprocessed data would have been phase matched to the new data. Consequently, a -8msec and -24 degree shift needs to be applied to the reprocessed data to tie the new acquisition.

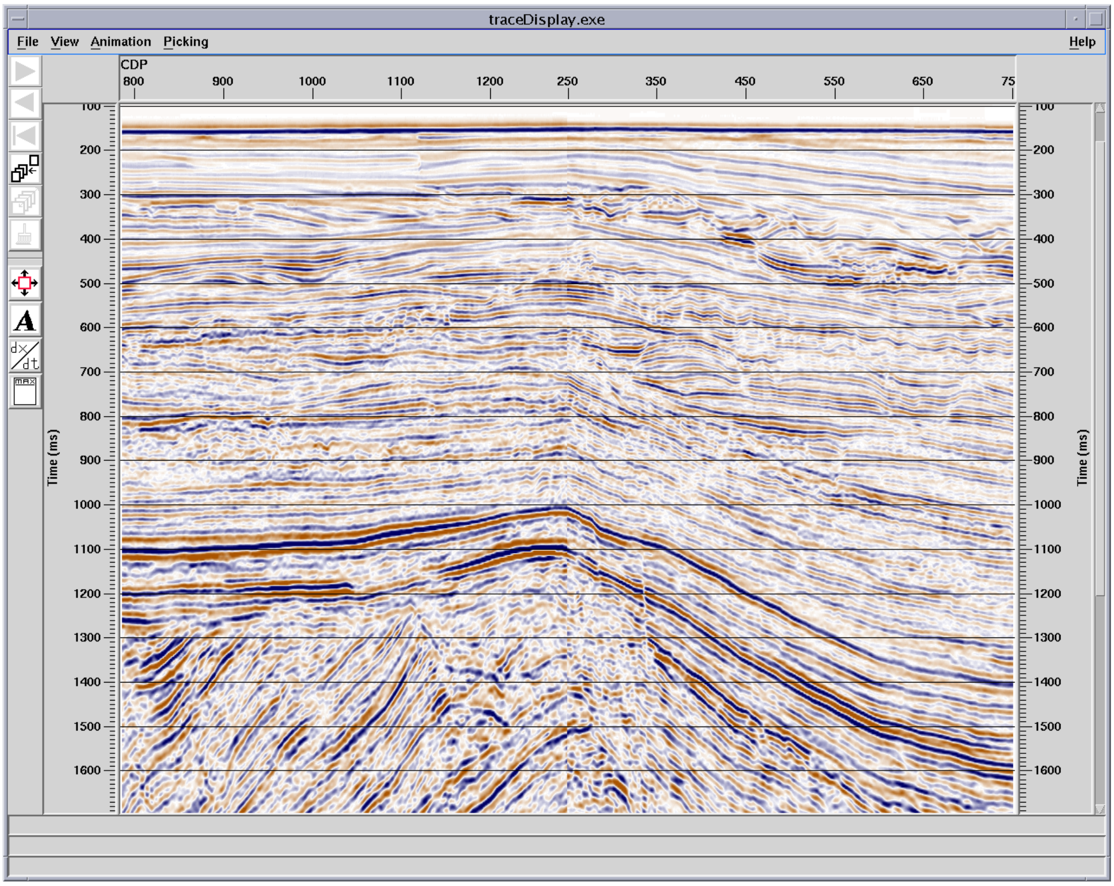


Figure 3.1: Stack display of time and phase match of lines GISN05-06 (left) and G94A-4018 (right). A -8 ms time shift and a -24 degree phase rotation was required to match the reprocessed data to the new GISN05 lines.

4 PROCESSING SEQUENCE

4.1 FINAL PSTM SEQUENCE (FILTERED & SCALED)

TRANSCRIPTION
|
BULK SHIFT
|
GAIN RECOVERY (t^2)
|
LOW CUT FILTER
|
SWELL NOISE ATTENUATION
|
RANDOM SPIKE ATTENUATION
|
F-X INTERPOLATION
|
TAU-P DECONVOLUTION
|
LINEAR TAU-P NOISE REMOVAL
|
DROP INTERPOLATED TRACES
|
ADJACENT TRACE SUMMATION
|
CDP GATHER (120 FOLD)
|
FIRST PASS VELOCITY ANALYSIS (2 km interval)
|
RESAMPLE (2ms to 4ms)
|
F-X INTERPOLATION
|
HI RESOLUTION RADON MULTIPLE ATTENUATION (Parabolic)
|
DROP INTERPOLATED TRACES
|
SECOND PASS (PSTM) VELOCITY ANALYSIS (1 km interval)
|
KIRCHHOFF PRE-STACK TIME MIGRATION
|
THIRD PASS VELOCITY ANALYSIS (0.5 km interval)
|
REVERSE T SQUARED GAIN
|
SPHERICAL DIVERGENCE (URSIN) WITH dB GAIN
|
HI RESOLUTION RADON MULTIPLE ATTENUATION (Linear)
|
RANDOM NOISE REMOVAL (Shallow Only)
|
NMO CORRECTION (Using Final 0.5km Vels)
|
OUTER TRACE MUTE / PRE-STACK AGC SCALING / INNER TRACE MUTE
|
CDP STACK
|
GUN & CABLE STATIC CORRECTIONS
|
ZERO PHASING
|
BAND PASS FILTER
|
POST STACK SCALING
|
ARCHIVE

4.2 FINAL PSTM SEQUENCE (RAW)

TRANSCRIPTION

|

BULK SHIFT

|

GAIN RECOVERY (t^2)

|

LOW CUT FILTER

|

SWELL NOISE ATTENUATION

|

RANDOM SPIKE ATTENUATION

|

F-X INTERPOLATION

|

TAU-P DECONVOLUTION

|

LINEAR TAU-P NOISE REMOVAL

|

DROP INTERPOLATED TRACES

|

ADJACENT TRACE SUMMATION

|

CDP GATHER (120 FOLD)

|

FIRST PASS VELOCITY ANALYSIS (2 km interval)

|

RESAMPLE (2ms to 4ms)

|

F-X INTERPOLATION

|

HI RESOLUTION RADON MULTIPLE ATTENUATION (Parabolic)

|

DROP INTERPOLATED TRACES

|

SECOND PASS (PSTM) VELOCITY ANALYSIS (1 km interval)

|

KIRCHHOFF PRE-STACK TIME MIGRATION

|

THIRD PASS VELOCITY ANALYSIS (0.5 km interval)

|

REVERSE T SQUARED GAIN

|

SPHERICAL DIVERGENCE (URSIN) WITH dB GAIN

|

HI RESOLUTION RADON MULTIPLE ATTENUATION (Linear)

|

RANDOM NOISE REMOVAL (Shallow Only)

|

NMO CORRECTION (Using Final 0.5km Vels)

|

OUTER TRACE MUTE / INNER TRACE MUTE

|

CDP STACK

|

GUN & CABLE STATIC CORRECTIONS

|

ZERO PHASING

|

BAND PASS FILTER

|

ARCHIVE

4.3 PSTM ANGLE STACKS SEQUENCE (RAW)

TRANSCRIPTION
|
BULK SHIFT
|
GAIN RECOVERY (t^2)
|
LOW CUT FILTER
|
SWELL NOISE ATTENUATION
|
RANDOM SPIKE ATTENUATION
|
F-X INTERPOLATION
|
TAU-P DECONVOLUTION
|
LINEAR TAU-P NOISE REMOVAL
|
DROP INTERPOLATED TRACES
|
ADJACENT TRACE SUMMATION
|
CDP GATHER (120 FOLD)
|
FIRST PASS VELOCITY ANALYSIS (2 km interval)
|
RESAMPLE (2ms to 4ms)
|
F-X INTERPOLATION
|
HI RESOLUTION RADON MULTIPLE ATTENUATION (Parabolic)
|
DROP INTERPOLATED TRACES
|
SECOND PASS (PSTM) VELOCITY ANALYSIS (1 km interval)
|
KIRCHHOFF PRE-STACK TIME MIGRATION
|
THIRD PASS VELOCITY ANALYSIS (0.5 km interval)
|
REVERSE T SQUARED GAIN
|
SPHERICAL DIVERGENCE (URSIN) WITH dB GAIN
|
HI RESOLUTION RADON MULTIPLE ATTENUATION (Linear)
|
RANDOM NOISE REMOVAL (Shallow Only)
|
RESIDUAL GAIN RECOVERY
|
NMO CORRECTION (Using Final 0.5km Vels)
|
ANGLE MUTES (Near, Mid and Far)
|
CDP STACK
|
GUN & CABLE STATIC CORRECTIONS
|
ZERO PHASING
|
BAND PASS FILTER
|
ARCHIVE

4.4 FINAL PSTM GATHERS WITH RESIDUAL RADON

TRANSCRIPTION
|
BULK SHIFT
|
GAIN RECOVERY (t^2)
|
LOW CUT FILTER
|
SWELL NOISE ATTENUATION
|
RANDOM SPIKE ATTENUATION
|
F-X INTERPOLATION
|
TAU-P DECONVOLUTION
|
LINEAR TAU-P NOISE REMOVAL
|
DROP INTERPOLATED TRACES
|
ADJACENT TRACE SUMMATION
|
CDP GATHER (120 FOLD)
|
FIRST PASS VELOCITY ANALYSIS (2 km interval)
|
RESAMPLE (2ms to 4ms)
|
F-X INTERPOLATION
|
HI RESOLUTION RADON MULTIPLE ATTENUATION (Parabolic)
|
DROP INTERPOLATED TRACES
|
SECOND PASS (PSTM) VELOCITY ANALYSIS (1 km interval)
|
KIRCHHOFF PRE-STACK TIME MIGRATION
|
THIRD PASS VELOCITY ANALYSIS (0.5 km interval)
|
REVERSE T SQUARED GAIN
|
SPHERICAL DIVERGENCE (URSIN) WITH dB GAIN
|
HI RESOLUTION RADON MULTIPLE ATTENUATION (Linear)
|
RANDOM NOISE REMOVAL (Shallow Only)
|
RESIDUAL GAIN RECOVERY
|
NMO CORRECTION (Using Final 0.5km Vels)
|
GUN & CABLE STATIC CORRECTIONS
|
ZERO PHASING
|
ARCHIVE

5 PROCESSING DESCRIPTION

5.1 TRANSCRIPTION

Field data were converted to Fugro Seismic Imaging internal format for processing. Fugro Seismic Imaging internal processing format is trace sequential, with samples in 32 bit IEEE floating point. At intermediate processing stages the data is stored on disk in sixteen-bit integer with a gain ranging scalar for each trace. When reading the format shot records, strategic header values related to acquisition were preserved (where available).

5.2 BULK SHIFT

A -50ms static shift was applied to compensate for the recording delay.

5.3 GAIN RECOVERY

A gain function was applied to the data set to compensate for inelastic attenuation and spherical divergence.

A t^2 gain function was applied where t = two way travel time in milliseconds.

5.4 LOW-CUT FILTER

A low-cut filter of 4/12 Hz/dB/Octave was applied to the shot records.

5.5 SWELL NOISE ATTENUATION

Swell noise attenuation is achieved by shaping the amplitude spectra of selected "swell noise affected" traces.

Analysis and attenuation are performed in the FX domain, processing one source position at a time. For analysis, the amplitude spectra are normalised, considering only the higher frequency range which is less influenced by swell noise. After normalisation the swell noise traces are recognised by their relatively high amplitude, low frequency component. The shallow portion of each shot record is muted before analysis, removing the high amplitude shallow reflections and direct arrivals.

The user nominates a frequency range for analysis, and for spectral scaling. Typically this frequency range is from 0 to 32 Hz. Scalars are calculated to shape the spectra of individual swell noise affected traces to the mean of the non swell noise affected traces. The scalars are fully applied from 0 to one half the defined frequency range, after which the scalars are tapered to zero application at the maximum defined frequency. No modification is made to other traces.

The mechanism of swell noise recognition is not influenced by change in source energy, or by systematic variation in trace amplitude levels. Shots not affected by swell noise will not present any traces for swell noise attenuation.

The swell noise attenuation is monitored by recording the number of channels flagged as being affected by swell noise.

5.6 RANDOM SPIKE ATTENUATION

Despike was applied to remove any anomalous high energy amplitudes which could be the source of noise in the pre stack migration. Amplitudes were measured in a matrix of 45 time windows of 100 ms length. The matrix was composed of seven consecutive time windows across 11 adjacent traces in a shot gather. The amplitude of the centre window is compared to the rest of the matrix and the centre window is defined as containing a spike if the peak to median ratio is greater than 15, or if the centre window median value exhibits more than 8.0 units of standard deviation from the average median. Spike affected windows are scaled to the mean of the matrix.

Despike not performed in the shallow parts of the shot record or near the first breaks, as shown in the following table;

Despike start (at 100m offset)	***Despike start (at 6102m offset)***
2000ms	5000ms

5.7 F-X INTERPOLATION (SHOT DOMAIN)

All data underwent F-X interpolation (in the shot domain) with a window length of 1000ms. Processing was performed by interpolating a single trace in the centre of two original traces. Input 480 channels (12.5m interval), output 959 channels (6.25m interval).

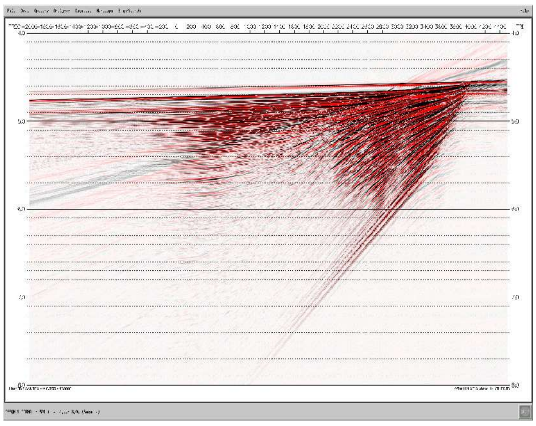
5.8 TAU-P DECONVOLUTION

The data was transformed to the Tau-P domain using the linear transform. Transform limits of -2000 ms to 4500 ms at an increment of 10 ms with a reference offset of 6102m were used.

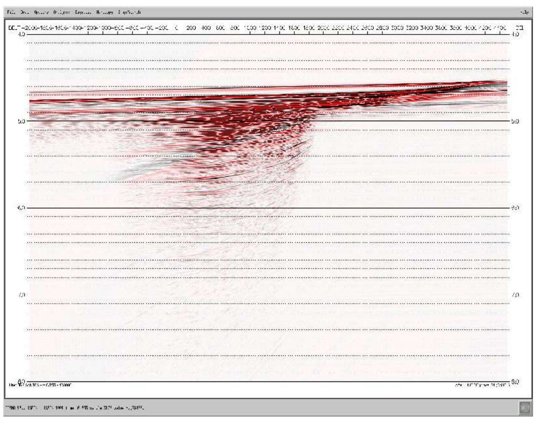
Predicitive deconvolution was performed in Tau-P space to target water layer reverberation. The design window for the deconvolution consisted of a single window, 240ms total operator length and a gap length of 32ms. Application of the deconvolution was to the whole trace length.

5.9 TAU-P LINEAR NOISE REMOVAL

While in Tau-P space linear noise may be removed by the application of scaling and muting sections of the transformed data that represent the noise energy. Careful design can preserve the long offset primary data from being attenuated. For these data the following mutes were applied.



No Tau-P Mute Applied.



Tau-P Mute Applied.

5.10 INTERPOLATED TRACES DROPPED

Traces interpolated as per section 5.7 were discarded.

5.11 ADJACENT TRACE SUM

A 2:1 adjacent trace sum was applied to form a 25m / 25m shot/group interval geometry. This was applied after NMO correcting the shots with a water bottom dependent regional velocity function. A trace mix was also applied during the summation process:

Trace Mix Details :

Time (ms)	***Trace Mix***
0	1 - 2 - 1
6144	1 - 2 - 1

Summation Details :

Input Traces	***Input Trace Interval***	***Output Traces***	***Output Trace Interval***
480	12.5m	240	25m

5.12 CDP GATHER

Shot records were sorted into common depth point gathers with a nominal fold of 120.

5.13 FIRST PASS VELOCITY ANALYSIS

First pass velocities (2km interval) were determined using Fugro Seismic Imaging Pty Ltd "MGIVA" interactive velocity analysis program. Each velocity analysis comprised a semblance display, a CDP stacked panel repeated 14 times with a suite of velocity functions, and a central CDP gather. The suite of functions were generated using 0%, +/-4 %, +/-8%, +/-13%, +/-19 %, +/-25%, +/-32%, and +40% increments from a central velocity function. The central function was a final velocity derived from the previously processed data.

A mild F-K multiple attenuation was applied to enhance the primary energy of the data before the analyses using the following percentages of the brute velocity function: -8% at 0ms, -10% at 800ms, -12% at 2500, -18% at 4500 and -20% at 6000ms. This was applied for the purpose of the analysis only.

The velocity analysis incorporated a map of all velocity locations, and the semblance display included functions from proximate lines. This enabled the velocities to be picked with knowledge of areal velocity trends. Velocity QC can be performed more effectively when discordant velocities can be recognised on the map.

5.14 RESAMPLE

The data was resampled in the frequency domain from 2ms to a 4ms sample period.

5.15 F-X INTERPOLATION (RECEIVER DOMAIN)

All data underwent F-X interpolation (in the receiver domain) with a window length of 1000ms. Processing was performed by interpolating a single trace in the centre of two original traces. Input shot interval is 25m, output shot interval 12.5m.

5.16 RADON MULTIPLE ATTENUATION

Attenuation of multiples was achieved by modelling and subtraction using a least squares, parabolic Radon transform. Normal moveout corrections were performed using the first pass velocities, and the CDP gathers transformed into the parabolic Tau-P domain. The segment of the Tau-P domain corresponding to primary reflections is muted, leaving the multiple energy to be transformed back into the T-X domain and subtracted from the original CDP gather.

Reference offset	6089m
Frequency range	4-90 Hz
Minimum p	-1000 *(parabolic moveout, Delta-t, at reference offset)*
Maximum p	+3500
Number of p traces	451
Multiple p cut	0ms/200;1000ms/200;2000ms/75;6144ms/50
Demultiple start time	Water bottom time +500ms.

5.17 PRE STACK MIGRATION (VELOCITY ANALYSIS)

Full pre stack Kirchhoff time migration was used to migrate target lines for velocity analysis. The migration algorithm was used in straight ray mode, with a 3125m half aperture. The velocity field was constructed by smoothing the first pass velocities. Apertures were muted with a 50% stretch mute to avoid operator aliasing. Migration was performed on 2:1 summed offset planes. The migration generates fully corrected CDP gathers on each line. The migration velocity field is then used to 'remove' the NMO corrections before velocity analysis.

5.18 SECOND PASS VELOCITY ANALYSIS

The second pass of velocities were picked at 1km intervals on first pass PSTM gathers using Fugro Seismic Imaging Pty Ltd “MGIVA” interactive velocity analysis program. Each velocity analysis comprised a semblance display, a CDP stacked panel repeated 14 times with a suite of velocity functions, and a central CDP gather. The suite of functions were generated using 0%, +/-2%, +/-4%, +/-6%, +/-8%, +/-12% , +/-16% and +20% increments from a central velocity function. The first pass of velocities were used as the central function for this suite of velocity variant functions.

5.19 FINAL PRE-STACK TIME MIGRATION

Kirchhoff prestack time migration was applied using a maximum half aperture of 600 traces (7500m). Anti-aliasing protection was applied by pre-filtering the data within the migration scan depending upon the local migration operator dip. Smoothed 100% second pass velocities at 1 km were used in the migration. Migration was performed on all offset planes.

5.20 THIRD PASS VELOCITY ANALYSIS

The third pass of velocities were picked at 0.5km intervals on second pass PSTM gathers using Fugro Seismic Imaging Pty Ltd “MGIVA” interactive velocity analysis program. Each velocity analysis comprised a semblance display, a CDP stacked panel repeated 14 times with a suite of velocity functions, and a central CDP gather. The suite of functions were generated using 0%, +/-2%, +/-4%, +/-6%, +/-8%, +/-12% , +/-16% and +/20% increments from a central velocity function. The second pass of velocities were used as the central function for this suite of velocity variant functions.The MGIVA velocity analysis is a 'map driven' package, where the user can instantly see modifications to the velocity field in map or section view. Neighbouring velocity functions or superimposed on the current location for easy recognition of velocity trends. Velocity interpretation is performed on the pre-computed stack suite, or on a colour contoured semblance display. Semblance interpretation is assisted with markers illustrating the position of potential water layer peg-leg multiples, and with an interval velocity curve.
These final velocities were archived to CD-ROM media as ASCII text in Western Geophysical's 3D velocity format.

5.21 REVERSE GAIN RECOVERY

Backed off t^2 scaling that was applied at the start of processing.

5.22 SPHERICAL DIVERGENCE (URSIN & GAIN)

With the previously applied t^2 gain function removed, it was then replaced with an offset and velocity dependent spherical divergence approximation as described by Bjorn Ursin (GEOPHYSICS Vol.55 No.4, pp492-496 1990).

$$\sqrt{\frac{T0\times V^4}{V0^2}+(2\times(\frac{V}{V0})^2-1)\times X^2+\frac{X^4\times(\frac{1}{V0^2}-\frac{1}{V^2})}{t0^2}}$$

Where T0 is the two way travel time, V is the RMS velocity at T0, and V0 is the velocity in the first layer. Although this method is applicable to uncorrected data as a moveout tracking divergence correction, for algorithmic ease it is applied to NMO corrected CDP gathers.

A gain function was applied to compensate for the transmission loss through the earth. This was in the form of a time variant dB scalar.

Time (ms)	*dB Scalar*
0	0
1000	4
2000	8
6144	8

5.23 RADON MULTIPLE ATTENUATION

Attenuation of multiples was achieved by modelling and subtraction using a least squares, linear Radon transform. Normal moveout corrections were performed using the first pass velocities, and the CDP gathers transformed into the linear Tau-P domain. The segment of the Tau-P domain corresponding to primary reflections is muted, leaving the multiple energy to be transformed back into the T-X domain and subtracted from the original CDP gather.

Reference offset	6077m
Frequency range	4-90 Hz
Minimum p	-1000 *(linear moveout, Delta-t, at reference offset)*
Maximum p	+3000
Number of p traces	401
Multiple p cut	0ms/50;6144ms/50
Demultiple application	0 - 300ms
Demultiple end time	500ms

5.24 RANDOM NOISE REMOVAL

F-X Deconvolution was applied in combination with the linear radon demultiple to target the first water bottom bounce. It was primarily required to clean up the random noise introduced in the linear radon process since we were running on very low fold data. No F-X deconvolution was applied from 0 to 100ms, F-X deconvolution was 100% on from 150 to 300ms and no F-X deconvolution was applied from 500 to 8000ms.

5.25 NMO CORRECTION

Fourth order NMO corrections were applied using the final picked 0.5km PSTM velocity functions.

5.26 OUTER TRACE MUTE

A post NMO outer trace mute was applied to remove any coherent noise on the outer traces and to reduce contamination from the effect of NMO stretch on the far offsets. Muting parameters were spatially varied according to seafloor two way time.

Offset (m)	***Application times (ms)***
280	0
330	200
640	600
2400	1775
6102	4500

5.27 PRE-STACK SCALING

A dual window, time variant AGC method was used for post stack scaling. The negative effects normally associated with AGC are avoided by employing two different length windows to determine the amplitude model (using the minimum of the two mean amplitudes determined at each sample), then conditioning the model by a weighted mix with the amplitude model derived from a single window per trace.

Window lengths of 1200 ms and 400 ms were defined with equalization applied at 60%. Scaling was applied to the final filtered and scaled full migration in addition to the filtered and scaled near, mid and far angle stacks.

No pre-stack scaling was applied to any of the raw PSTM products that were archived.

5.28 INNER TRACE MUTE

A post NMO inner trace mute was applied to help remove remnant multiple energy still apparent on the inner traces following the demultiple.

Offset (m)	***Application times (ms)***
100	1000 – 8000
600	2000 – 8000

5.29 COMMON DEPTH POINT STACK

For the full fold stack with dual AGC and the raw full fold stack, the traces within each common depth point gather were summed using 1/root(N) stack compensation. The raw angle stacks were summed using 1/N stack compensation.

5.30 STATICS

A static compensation for gun and cable depths was applied. The static value applied was calculated using average gun and cable depths supplied in the observers reports (8ms).

5.31 ZERO PHASE CONVERSION

The data was converted from minimum phase data to zero phase, using the Weiner-Levinson double inversion method to derive an operator based on the amplitude spectrum. This correction was followed by a -140 degree phase rotation to produce the best looking “zero phase SEG negative” response at the water bottom.

5.32 BAND PASS FILTER

Unwanted noise that lay outside the frequency range of the desired reflection data was attendated by the application of a series of zero phase time variant filters. These filters employed cosine squared tapers between the limiting frequency pairs.

General parameter summary:

Application time (ms)	*Frequency limits (Hz/dB/Oct)*
0	6/12 – 90/72
1300	6/12 – 80/72
2000	6/12 – 70/72
3000	6/12 – 60/48
6000	6/12 – 45/48
8000	6/12 – 40/48

5.33 POST-STACK SCALING

A dual window, time variant AGC method was used for post stack scaling. The negative effects normally associated with AGC are avoided by employing two different length windows to determine the amplitude model (using the minimum of the two mean amplitudes determined at each sample), then conditioning the model by a weighted mix with the amplitude model derived from a single window per trace.

Window lengths of 1200 ms and 400 ms were defined with equalization applied at 60%. Scaling was applied to the final filtered and scaled full migration in addition to the filtered and scaled near, mid and far angle stacks.

No pre-stack scaling was applied to any of the raw PSTM products that were archived

5.34 ANGLE STACKS

Angle stacks, stacks generated after restricting input to a portion of the gather corresponding to a particular range of incident angles, were produced for lithology and fluid predictions. The angle of incidence calculations were performed using Walden's method, and considered a smoothed version of the the third pass velocities.The near angle stack was for angles 0 to 15 degrees, the mid angle stack 15 to 30 degrees and the far angle stack 30 to 45 degrees.

6 DATA EXAMPLES

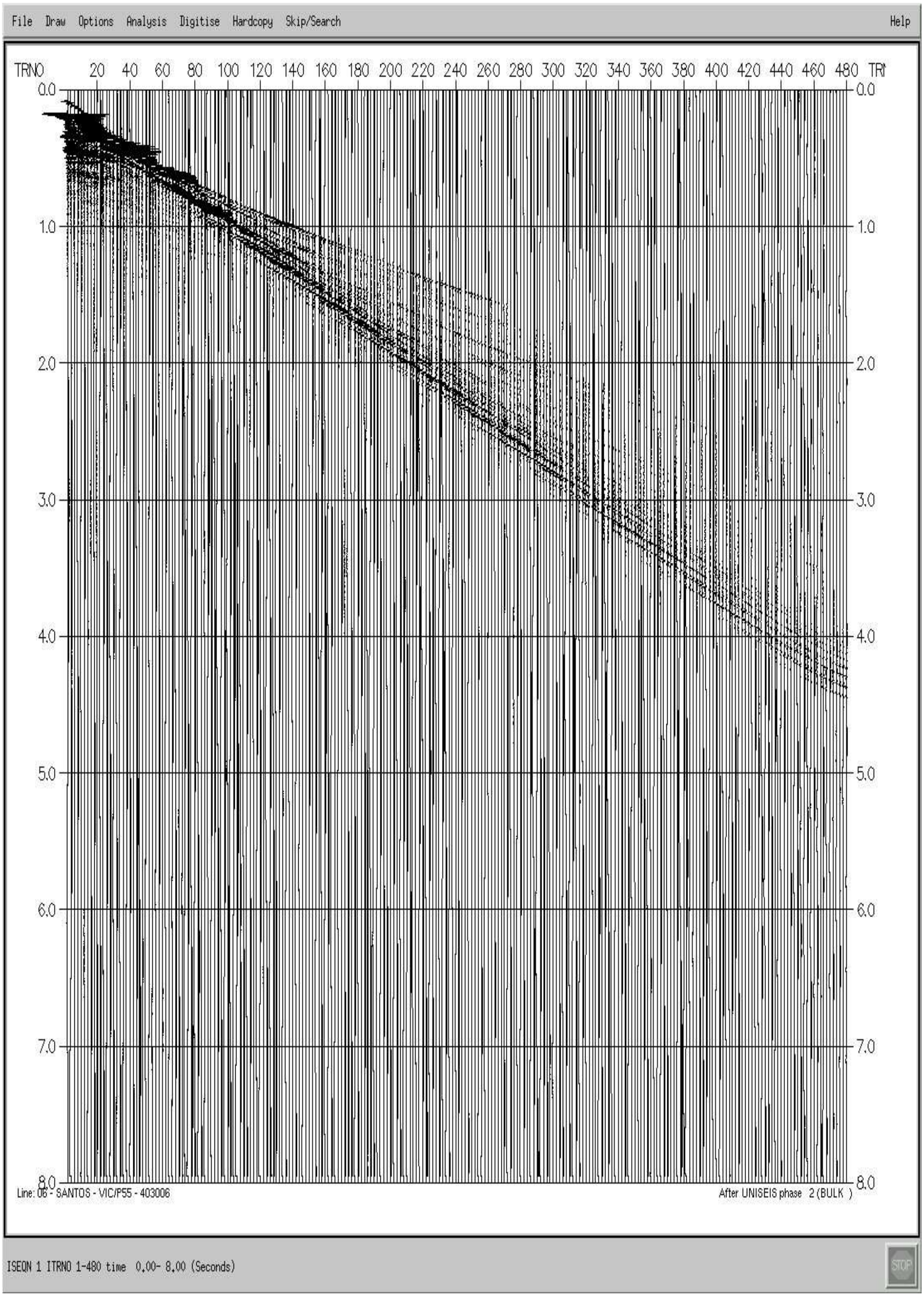


Figure 6.1: Raw shotrecord display (after process 5.2)

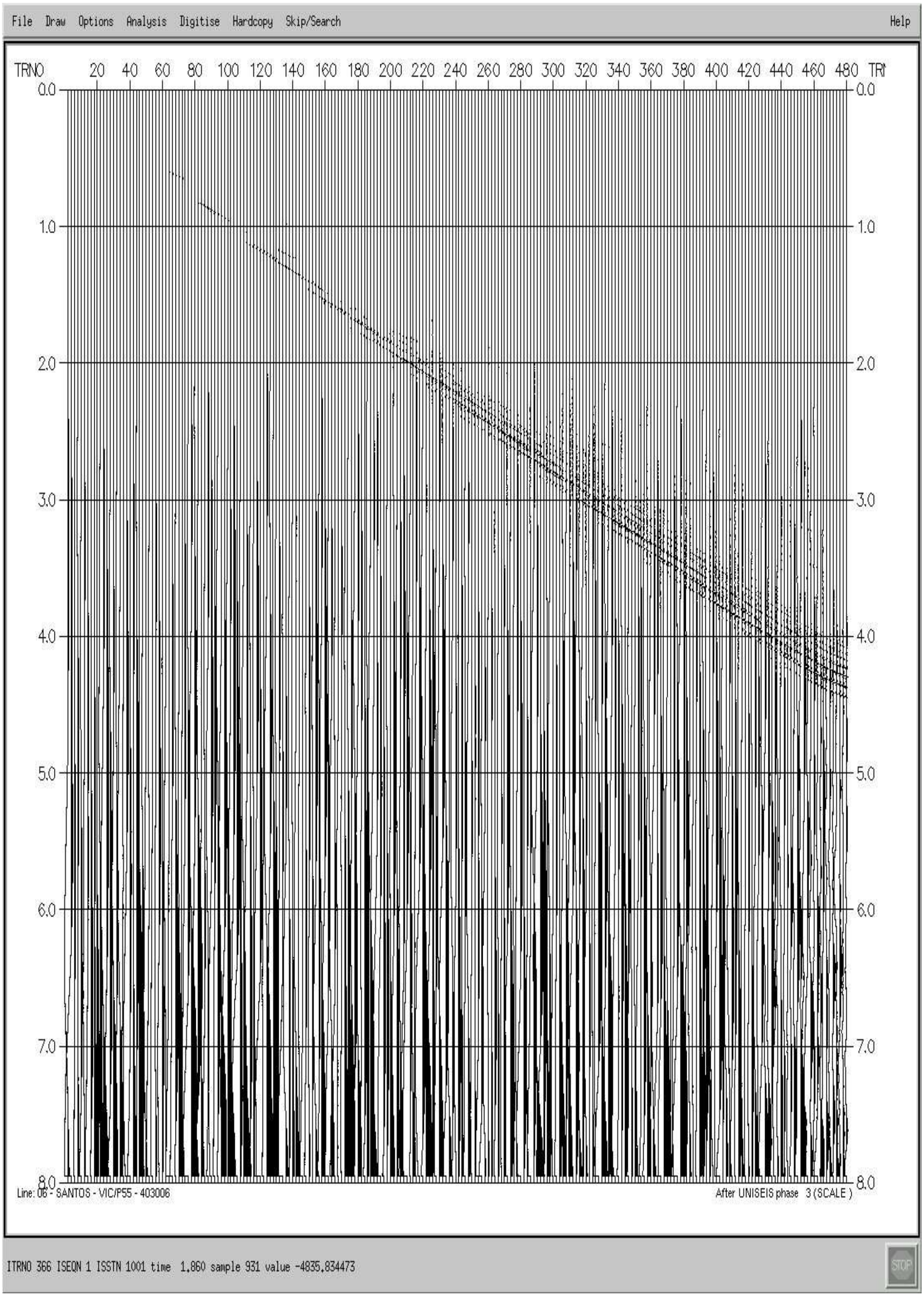


Figure 6.2: Raw shotrecord with T squared gain recovery (after process 5.3)

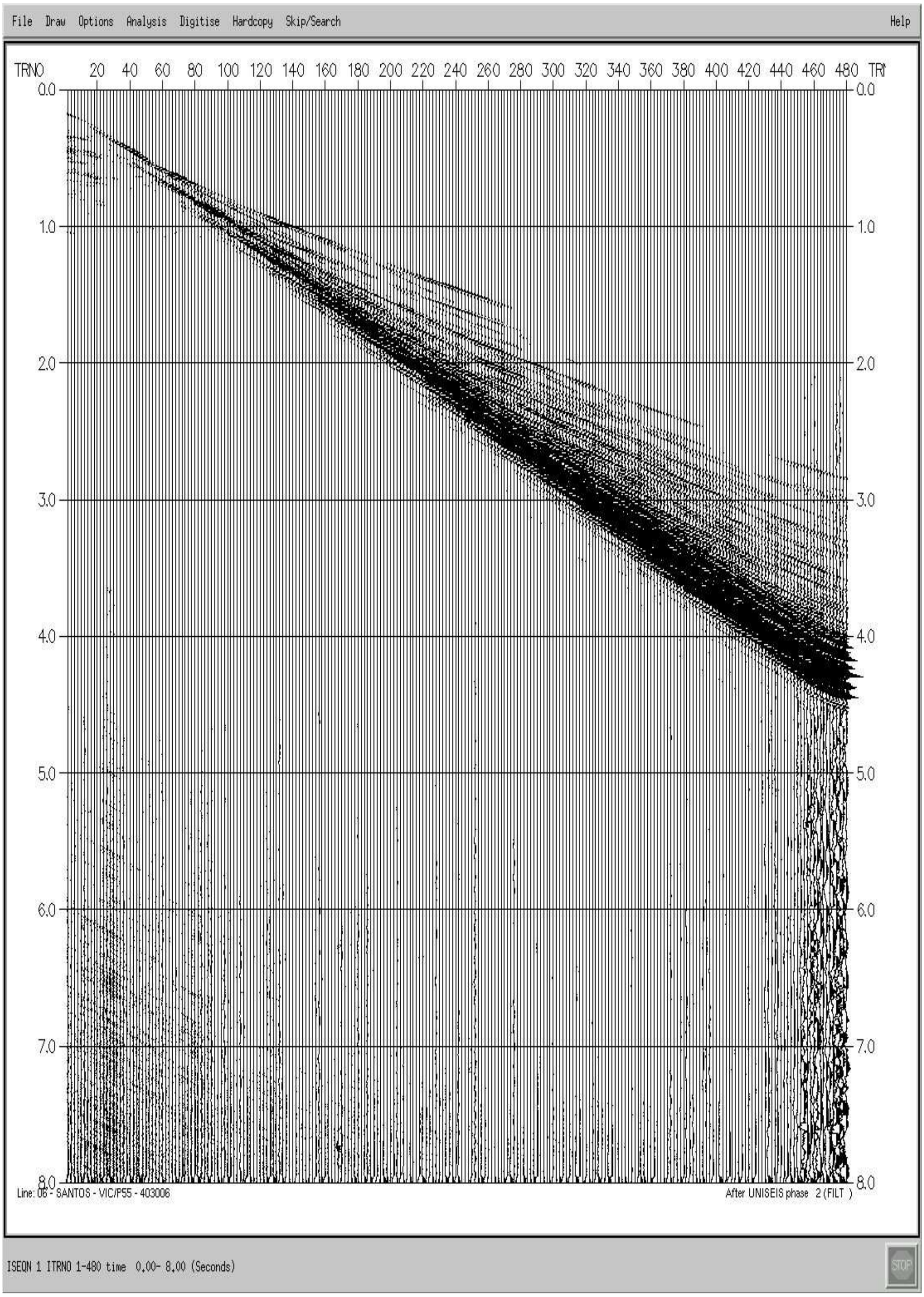


Figure 6.3: Shotrecord with low cut filter (after process 5.4)

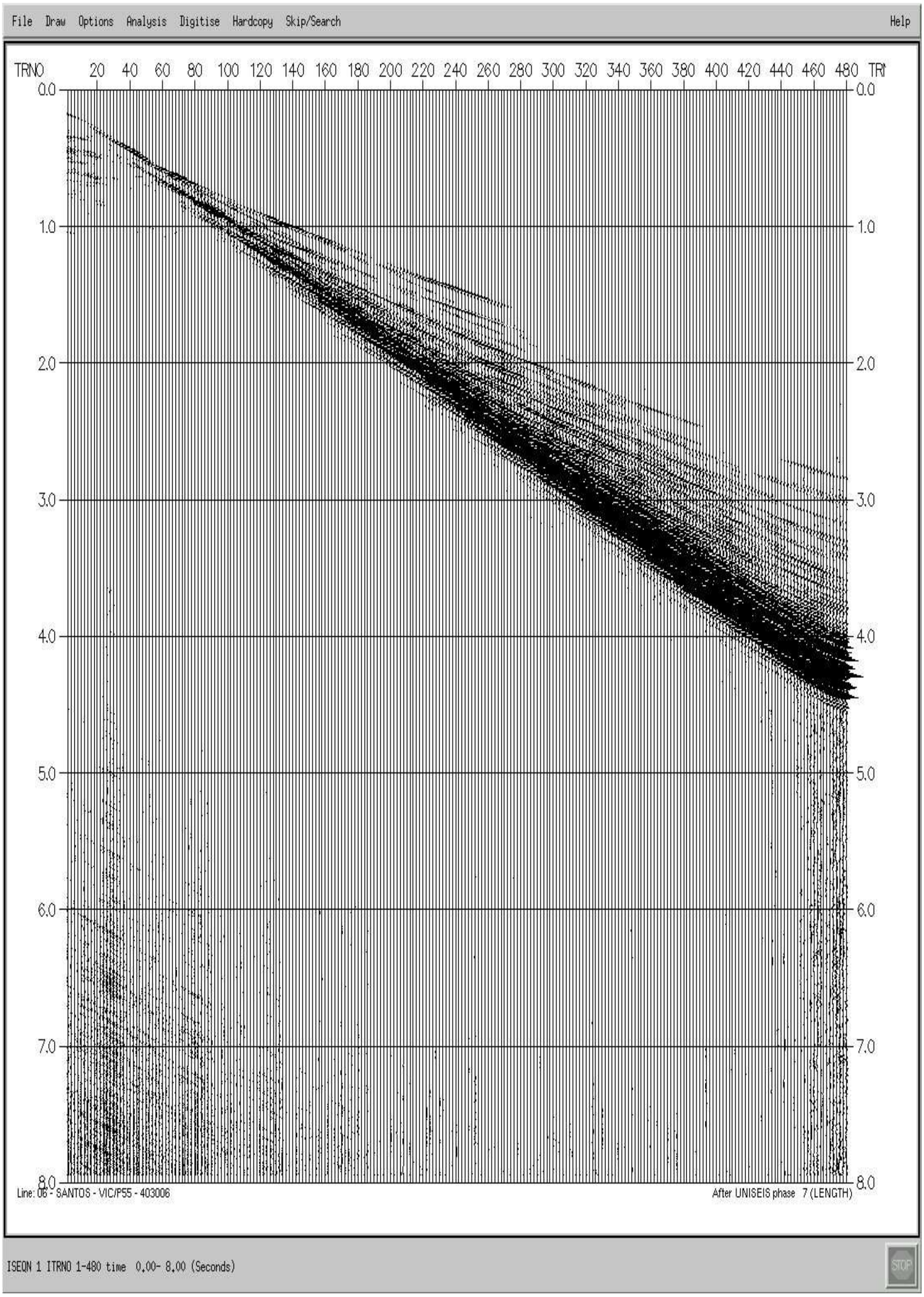


Figure 6.4: Shotrecord with Swell noise attenuation & despike applied (after process 5.6)

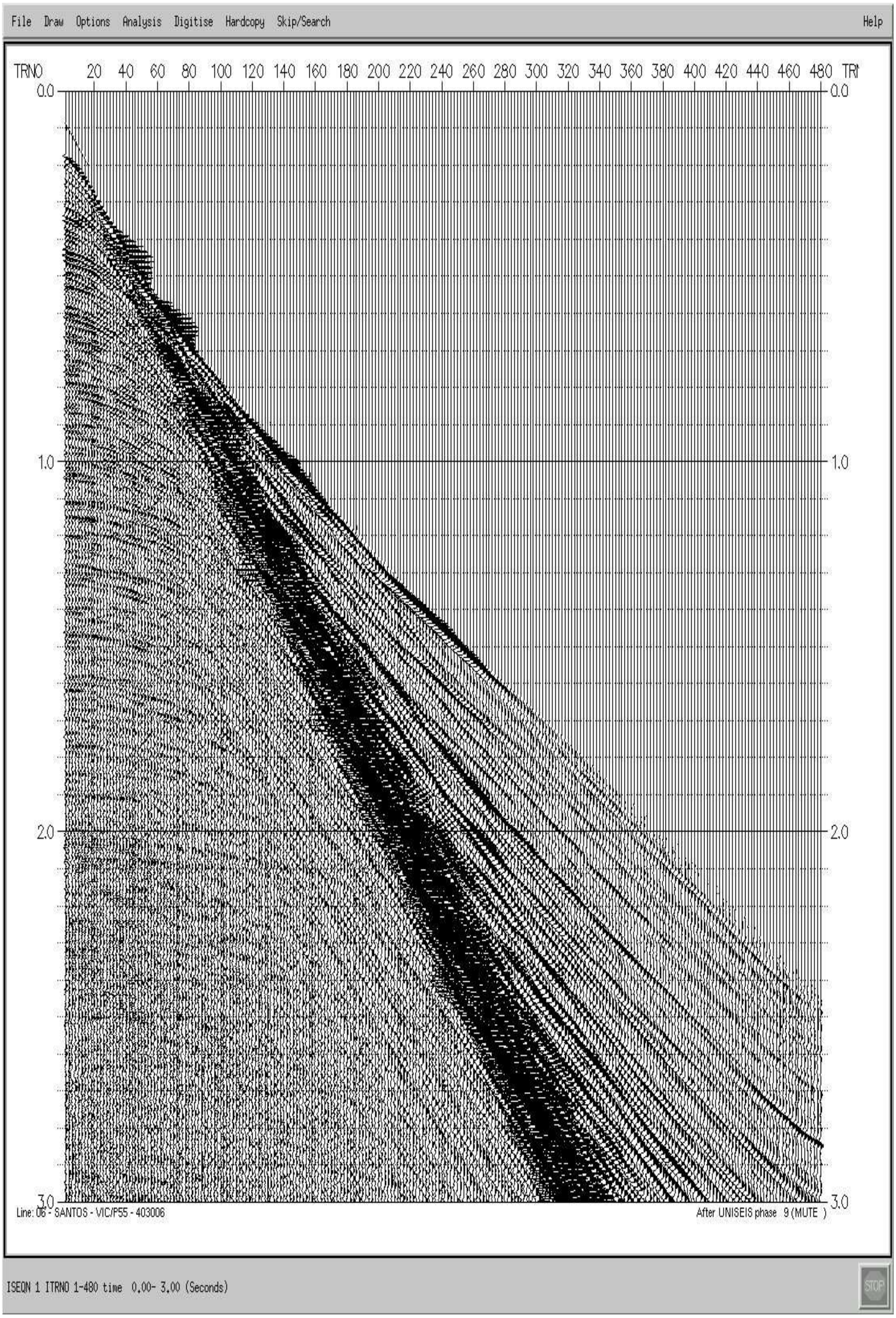


Figure 6.5: Shotrecord (zoomed) after Swell Noise Attenuation & despike (after process 5.6)

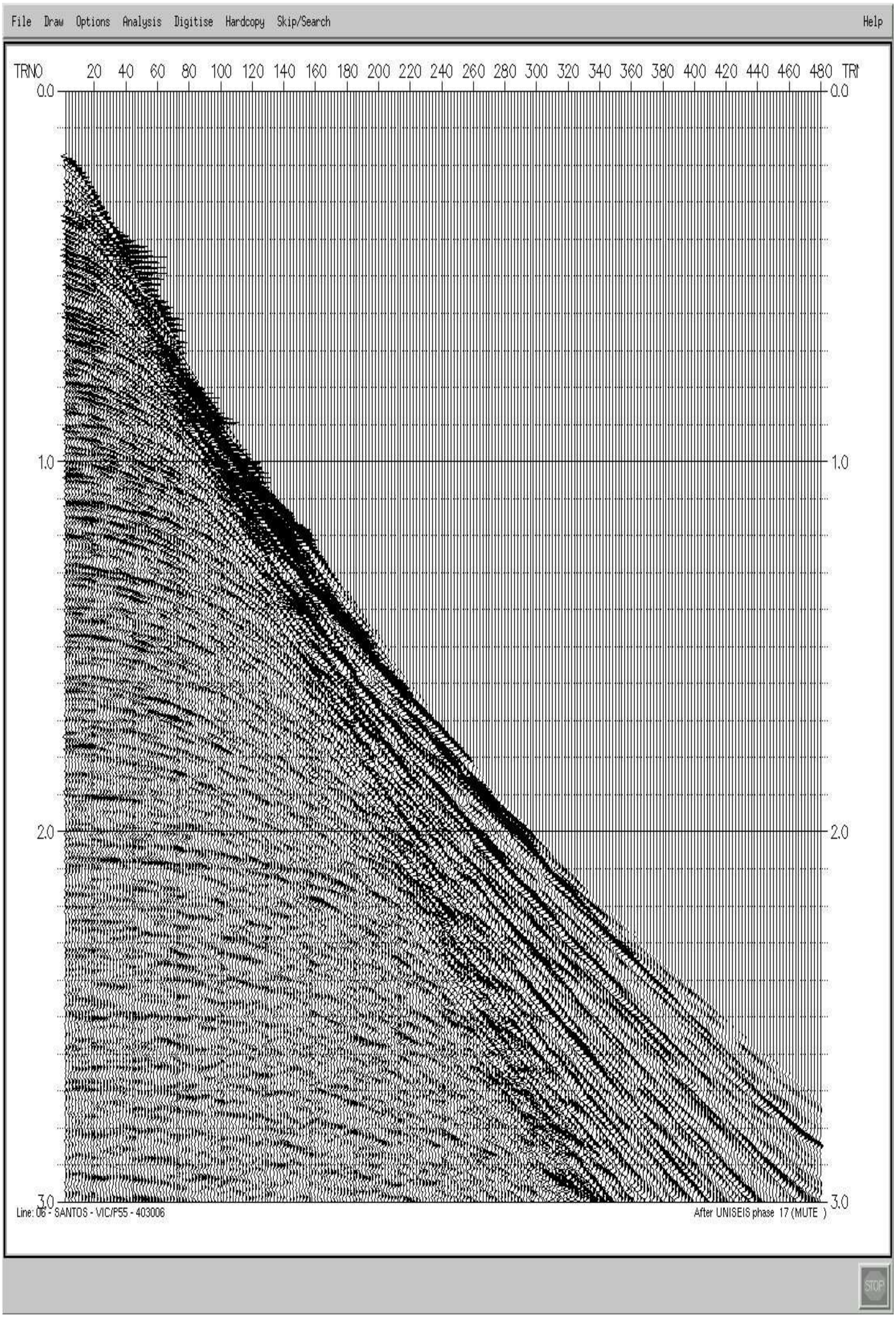


Figure 6.6: Shotrecord (zoomed) after Shot FK.

A Tau-P linear noise removal proved to be more efficient in attenuating the linear noise and was used in production.

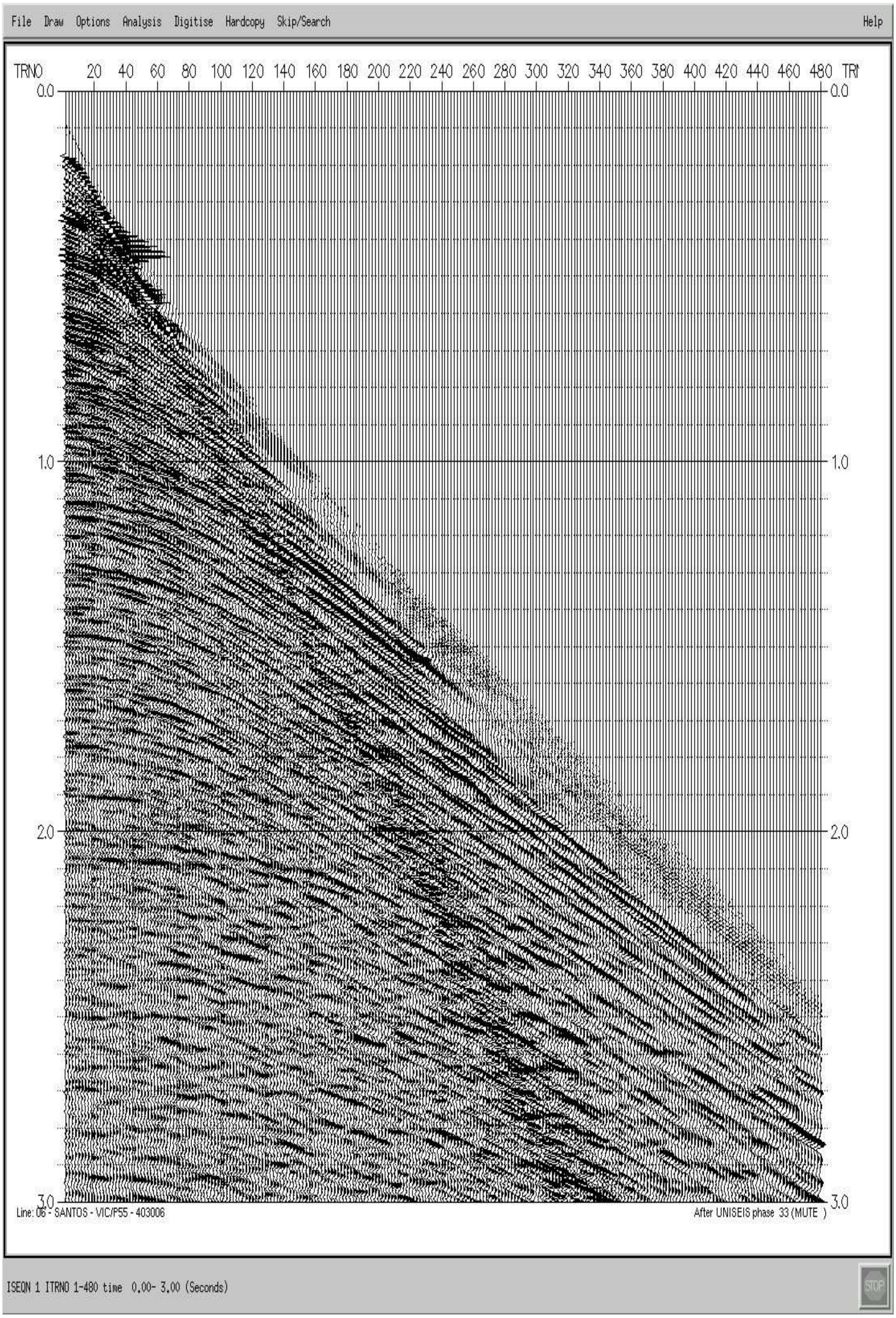


Figure 6.6: Shotrecord (zoomed) after linear taup noise removal (after process 5.9 but with no Tau-P deconvolution applied)

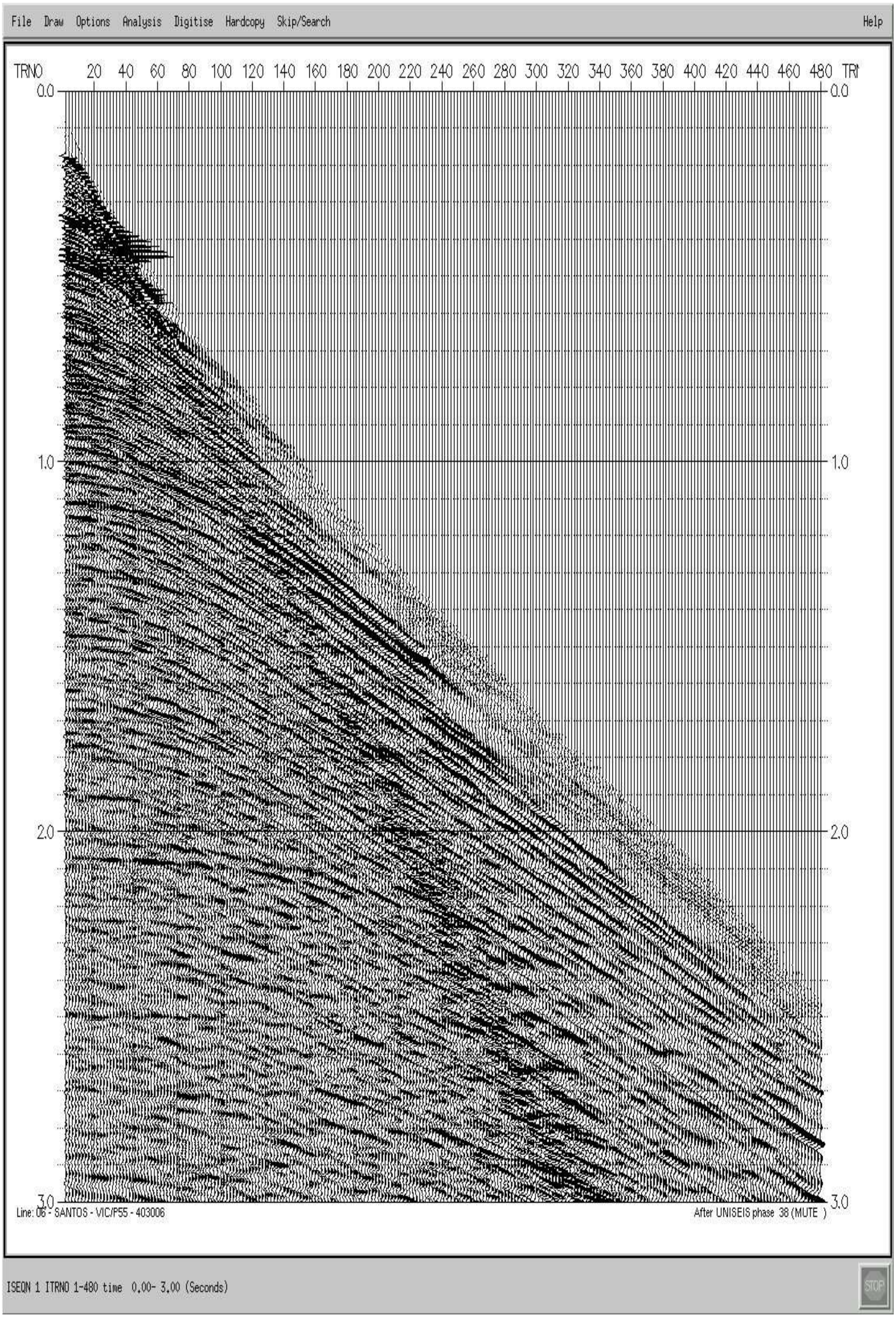


Figure 6.7: Shotreccord (zoomed) after Tau-P deconvolution and linear Tau-P noise removal (after process 5.9). This constituted the production shot processing flow.

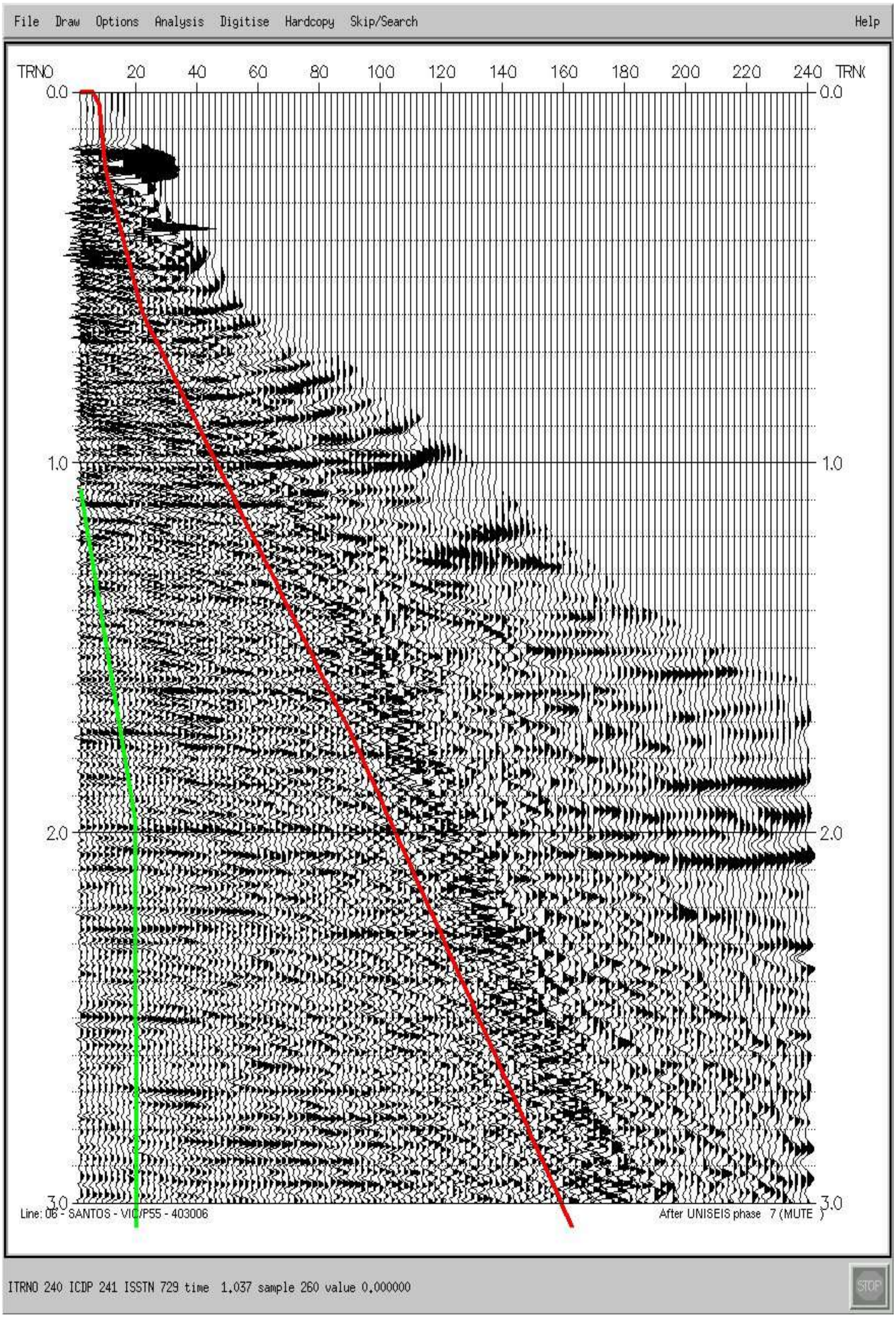


Figure 6.8: CMP gather after production pre-processing but with no demultiple (after process 5.13)

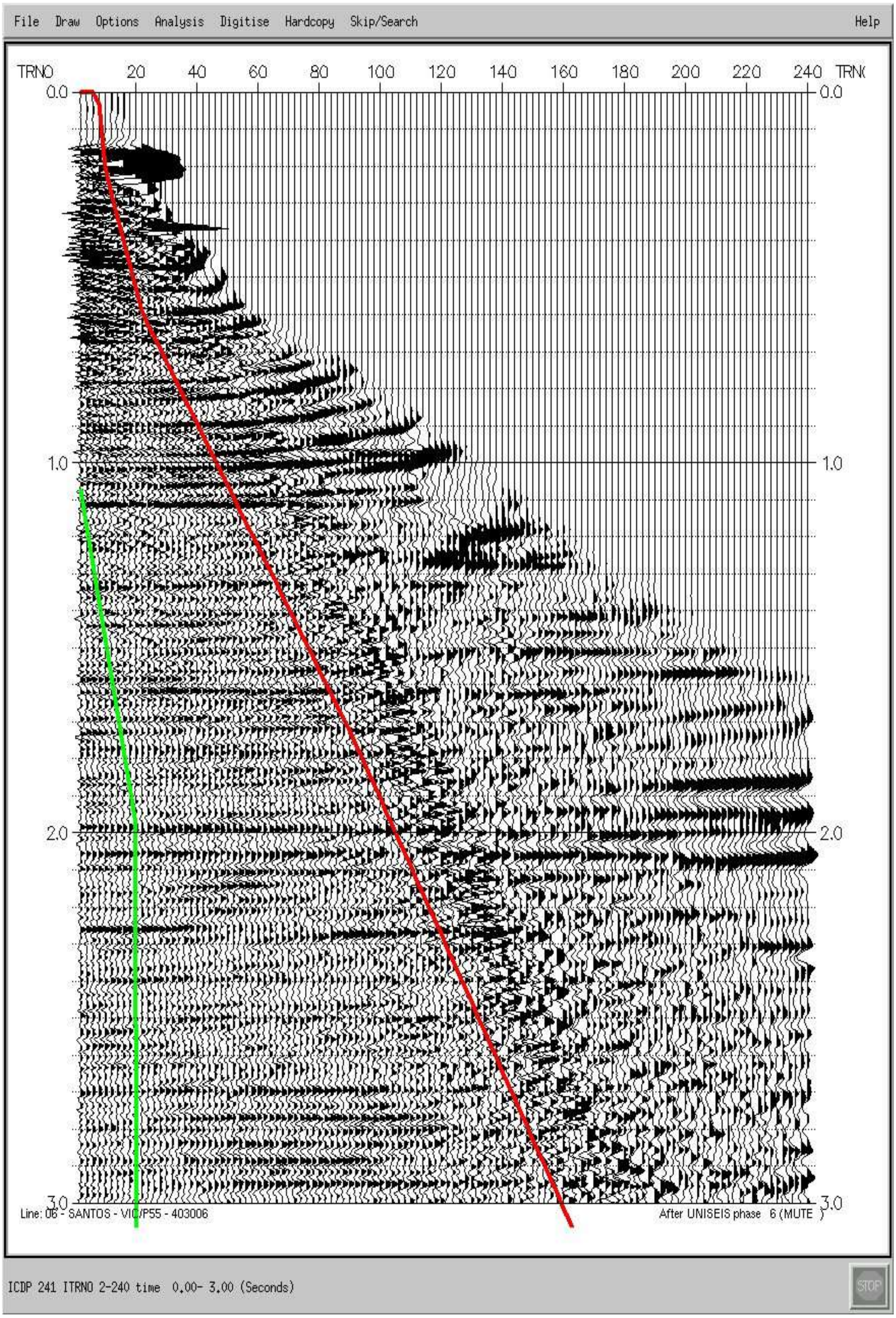


Figure 6.9: CMP gather with Radon demultiple (after process 5.16)

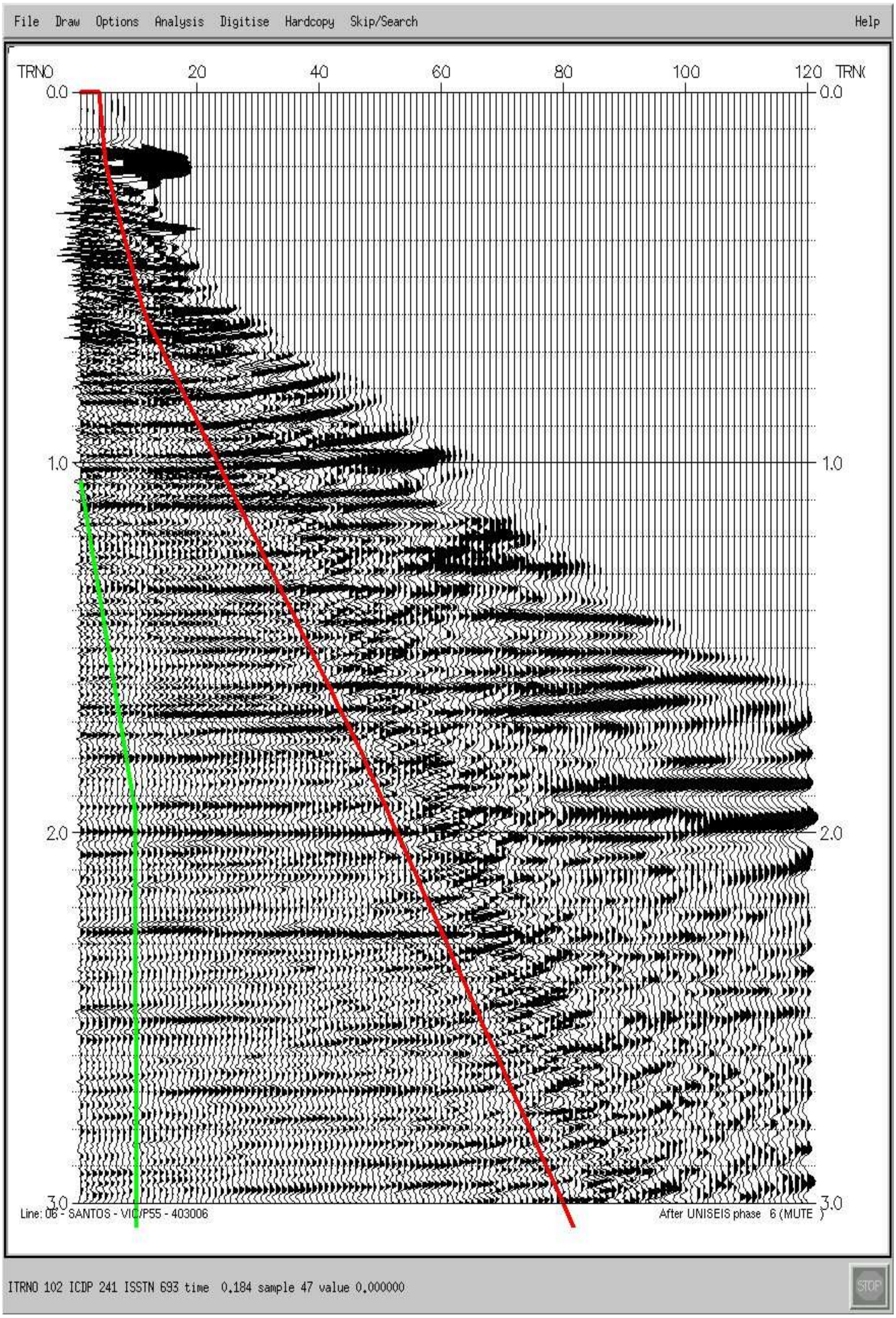


Figure 6.10: CMP gather after Kirchhoff PSTM (after process 5.20)

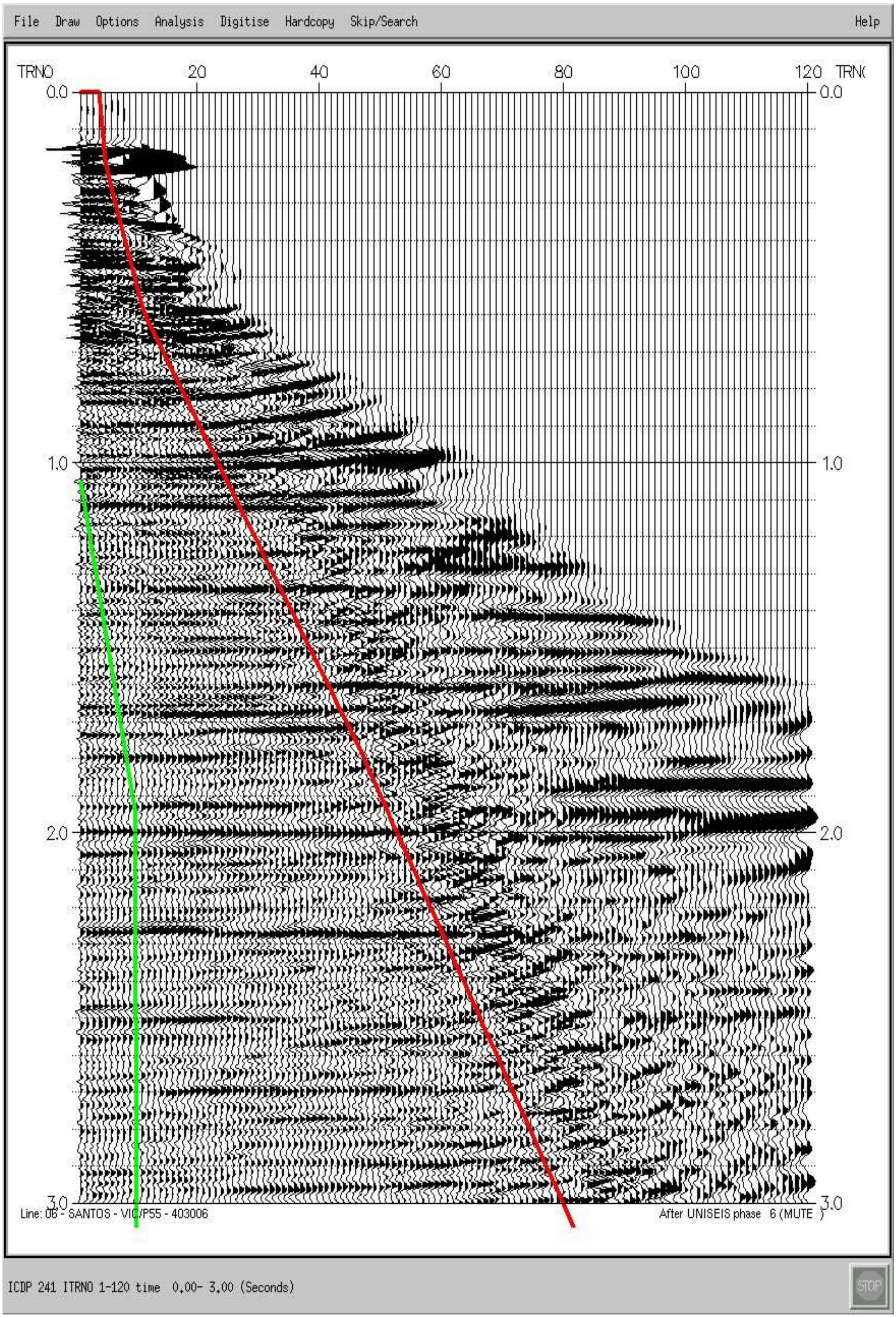
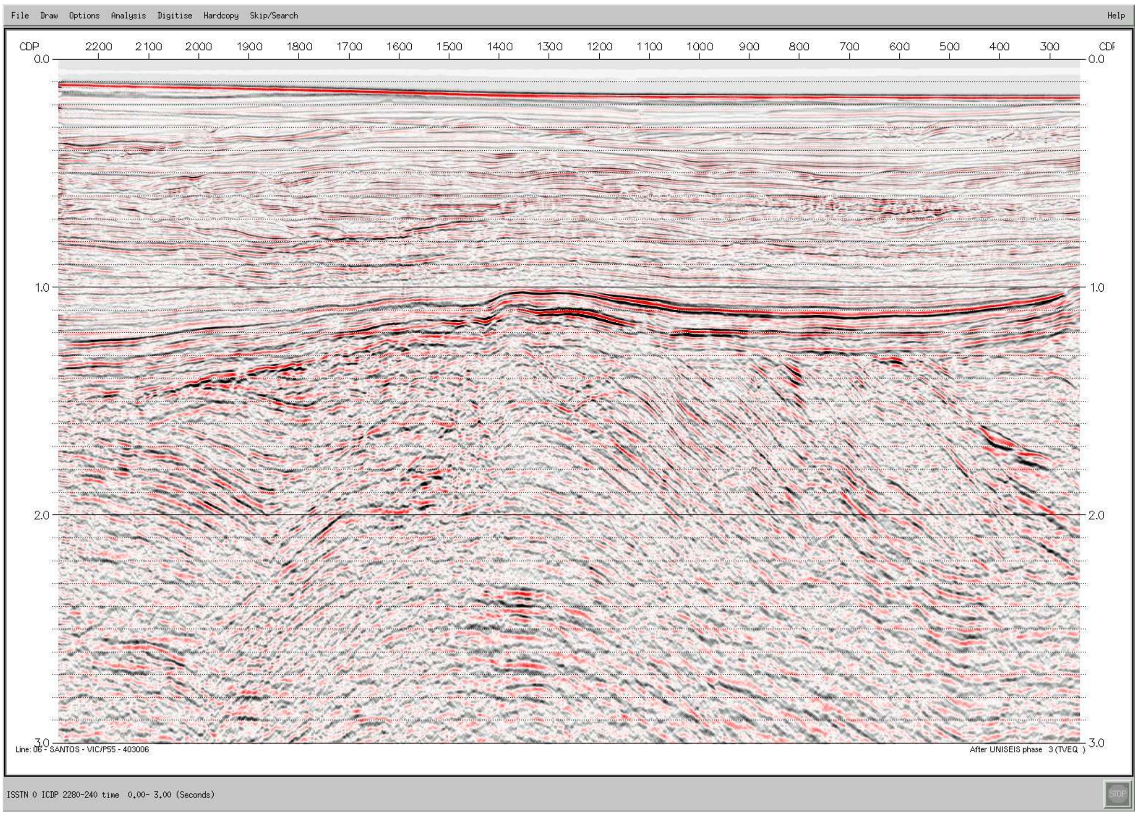
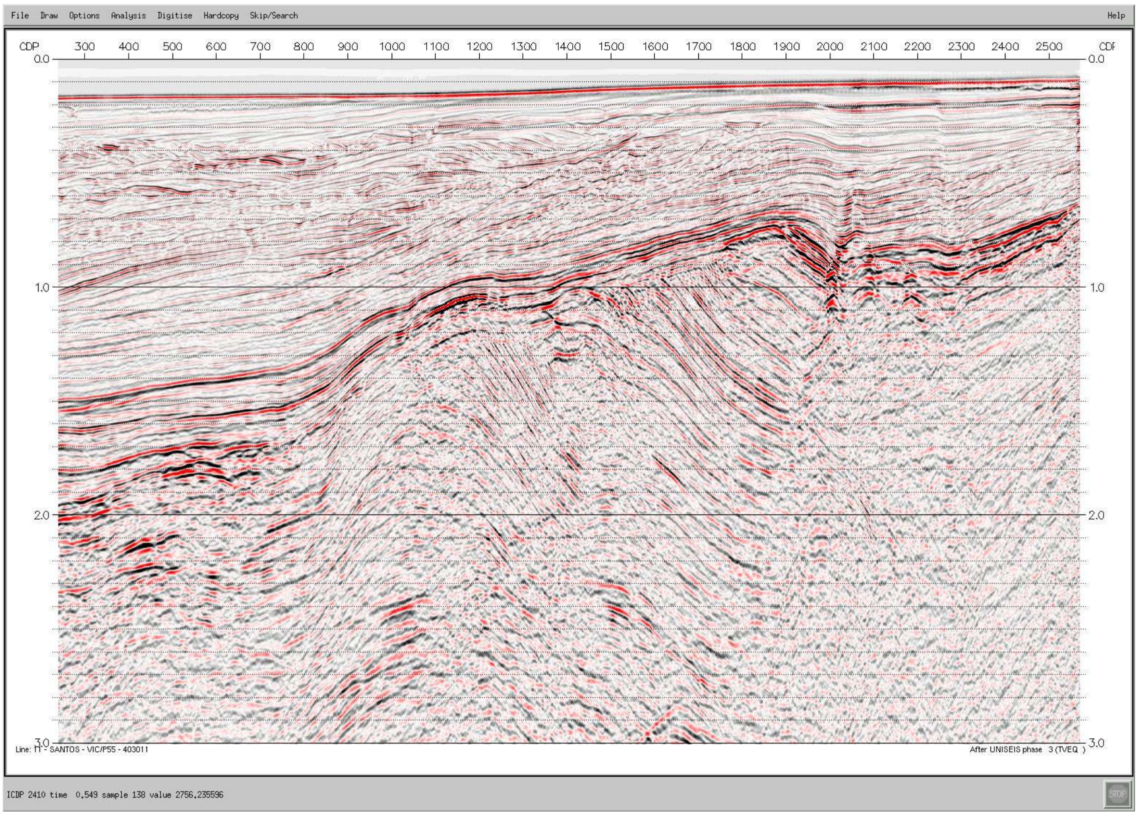


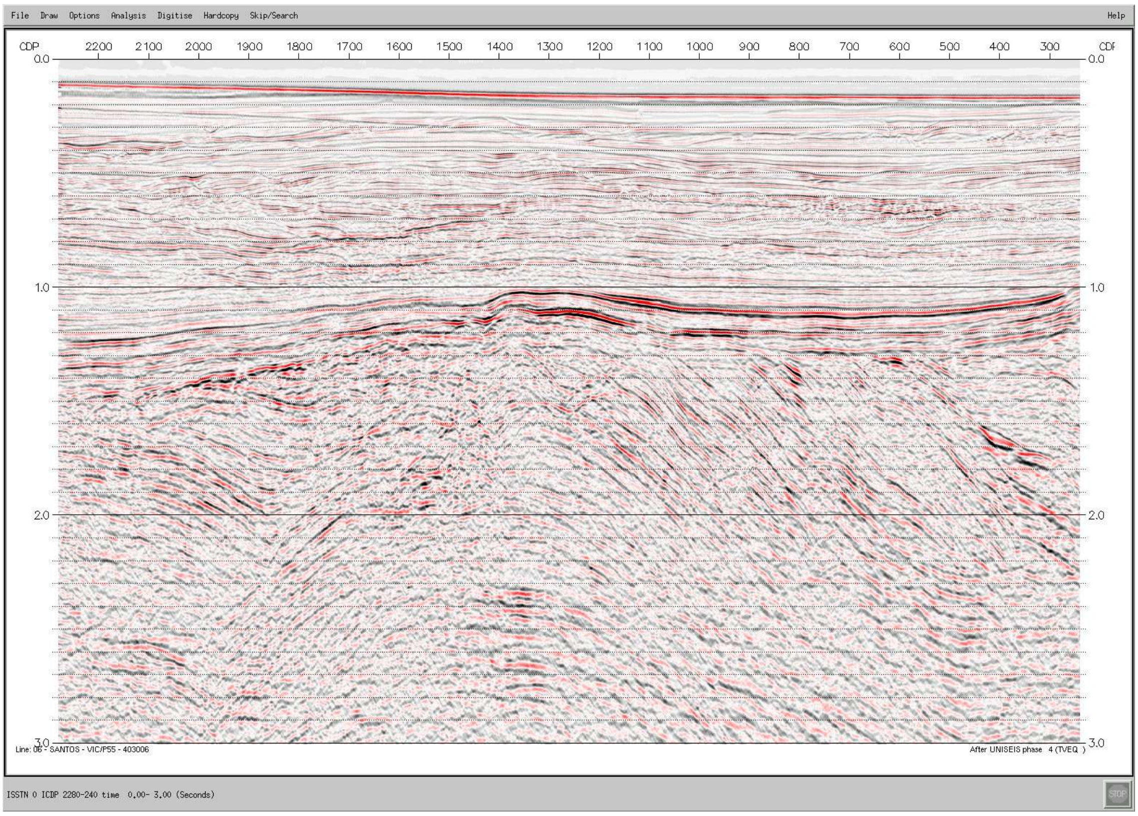
Figure 6.11: CMP gather after residual hi resolution radon (after process 5.25)



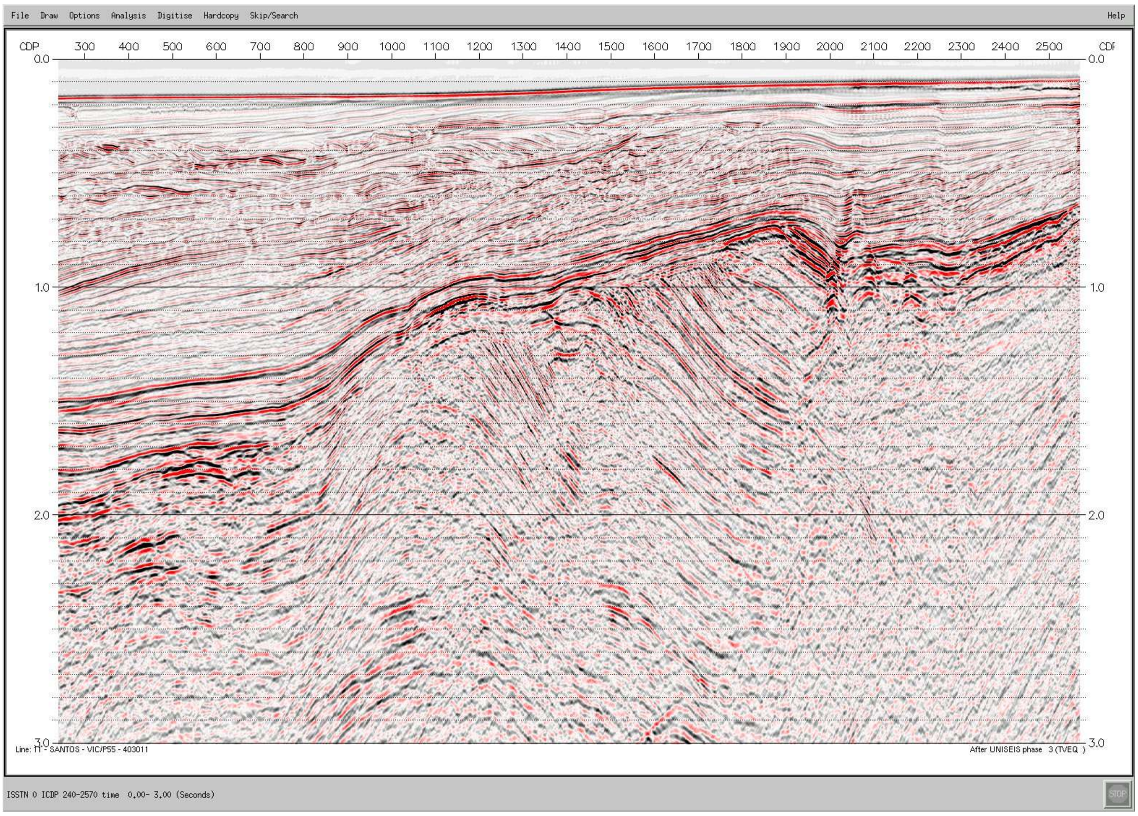
Line GISN05-06 using Shot FK flow. Tau-P flow used in production



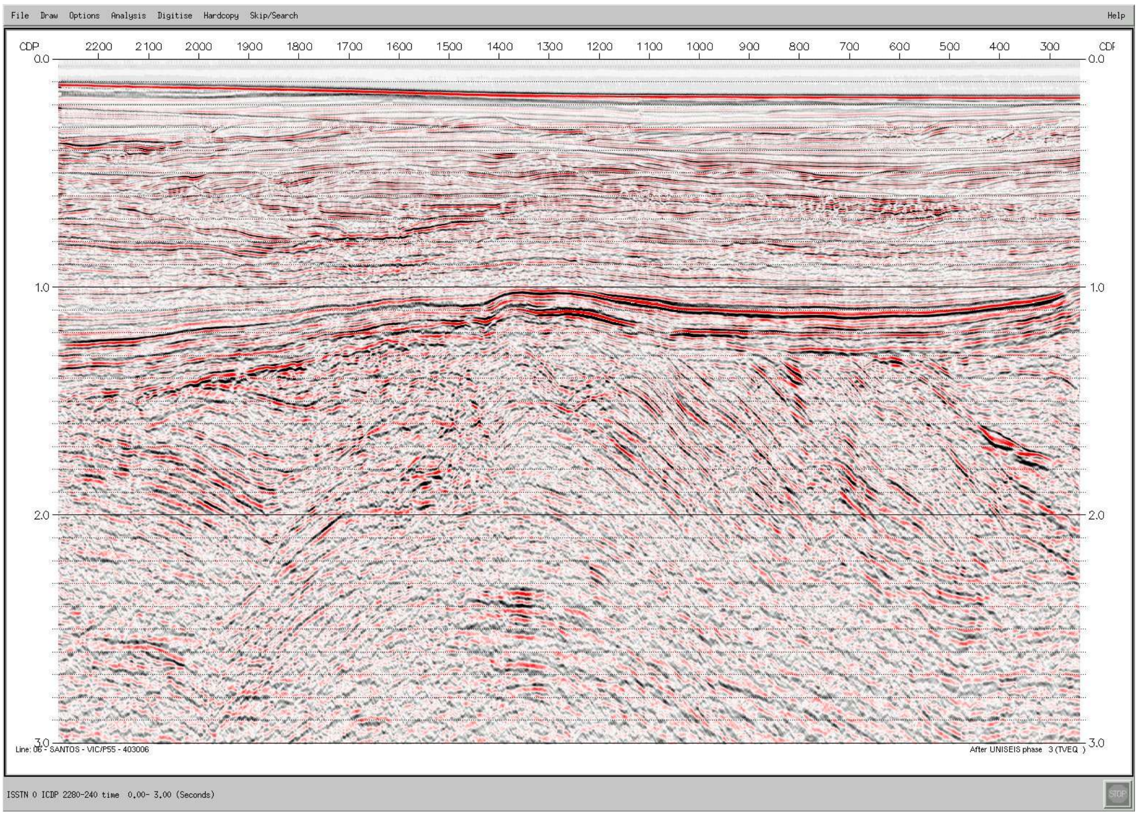
Line GISN05-11 using Shot FK flow. Tau-P flow used in production



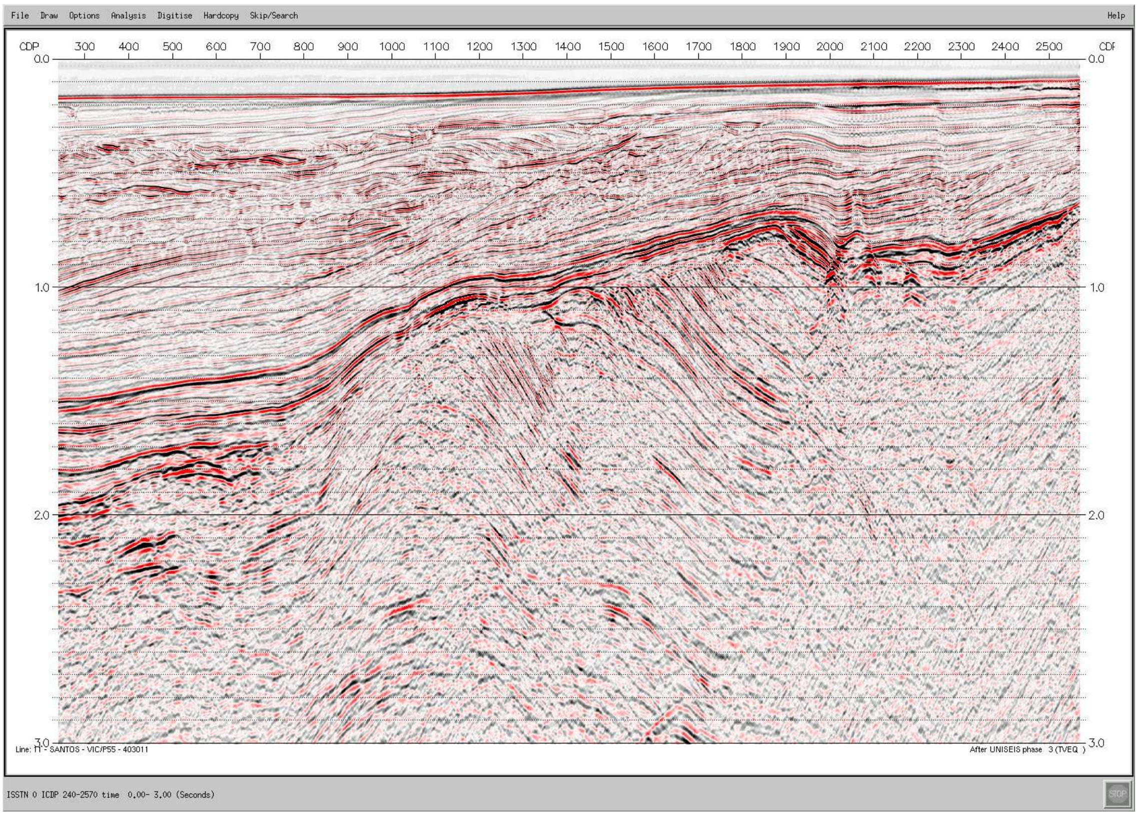
Line GISN05-06 using production Tau-P flow (after process 5.13 but without Tau-P decon)



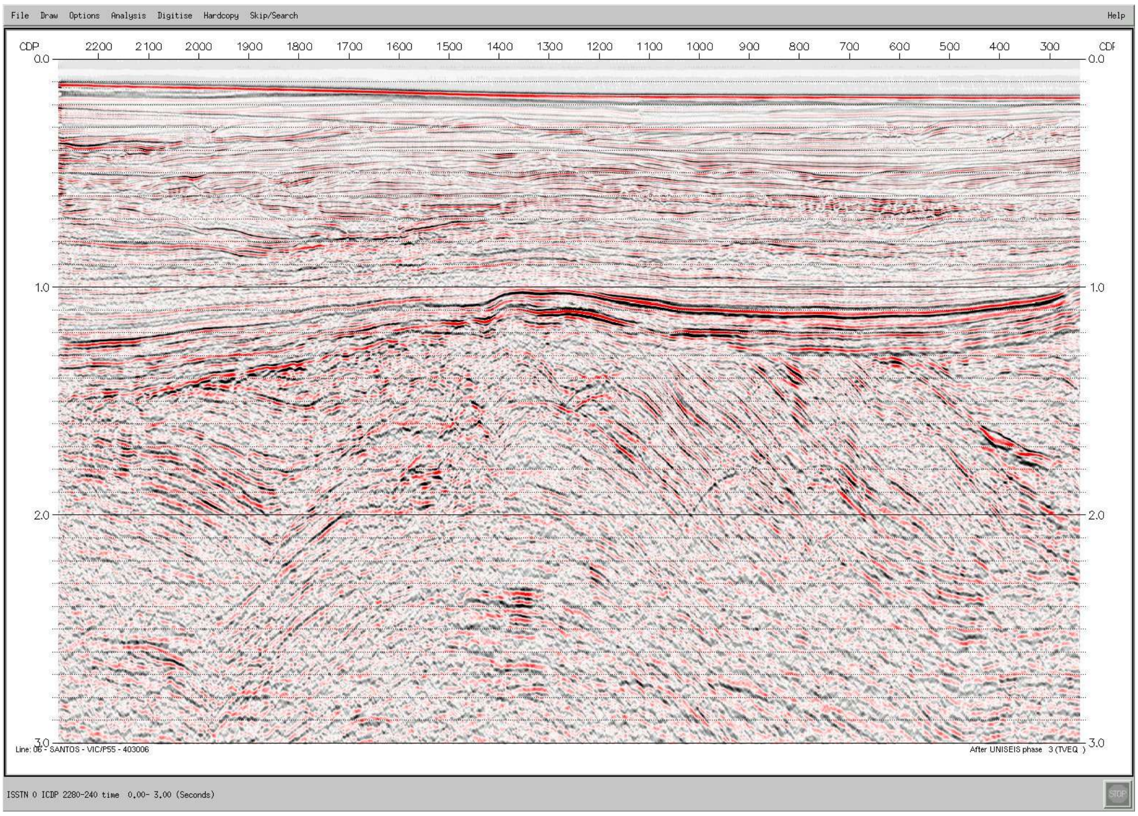
Line GISN05-11 using production Tau-P flow (after process 5.13 but without Tau-P decon)



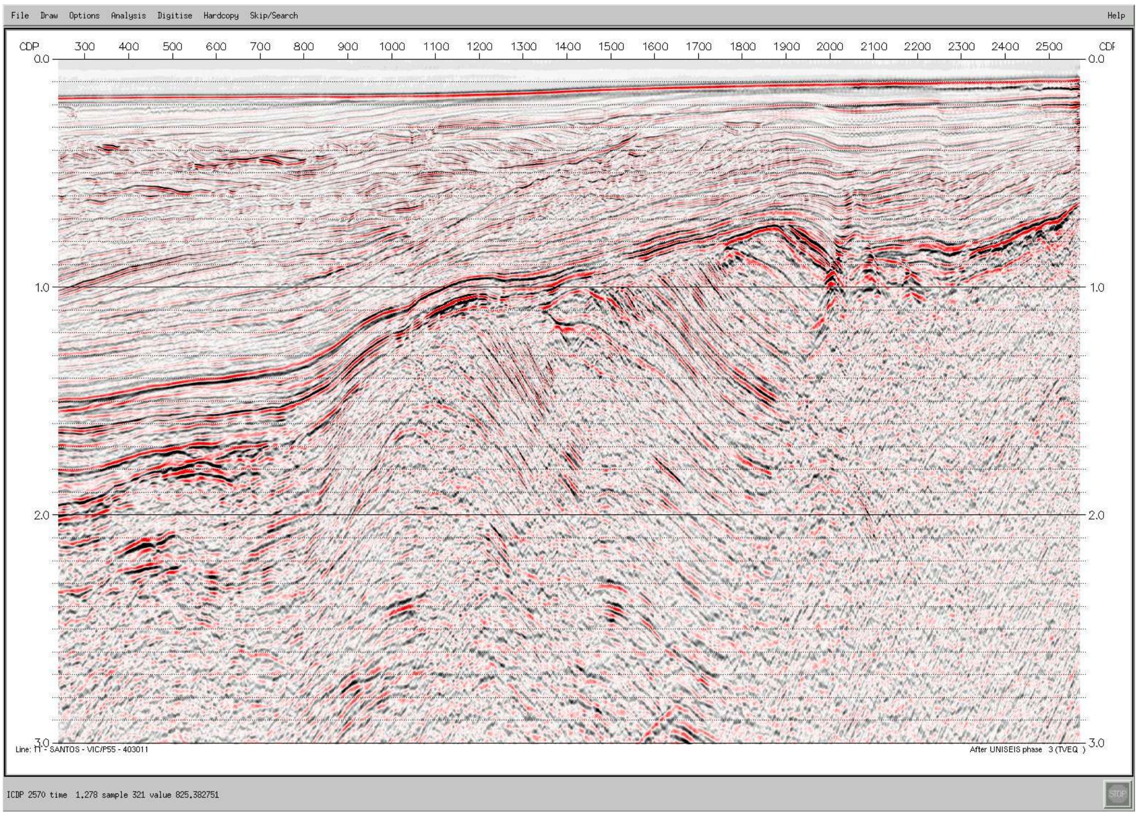
Line GISN05-06 after Tau-P deconvolution (after process 5.13)



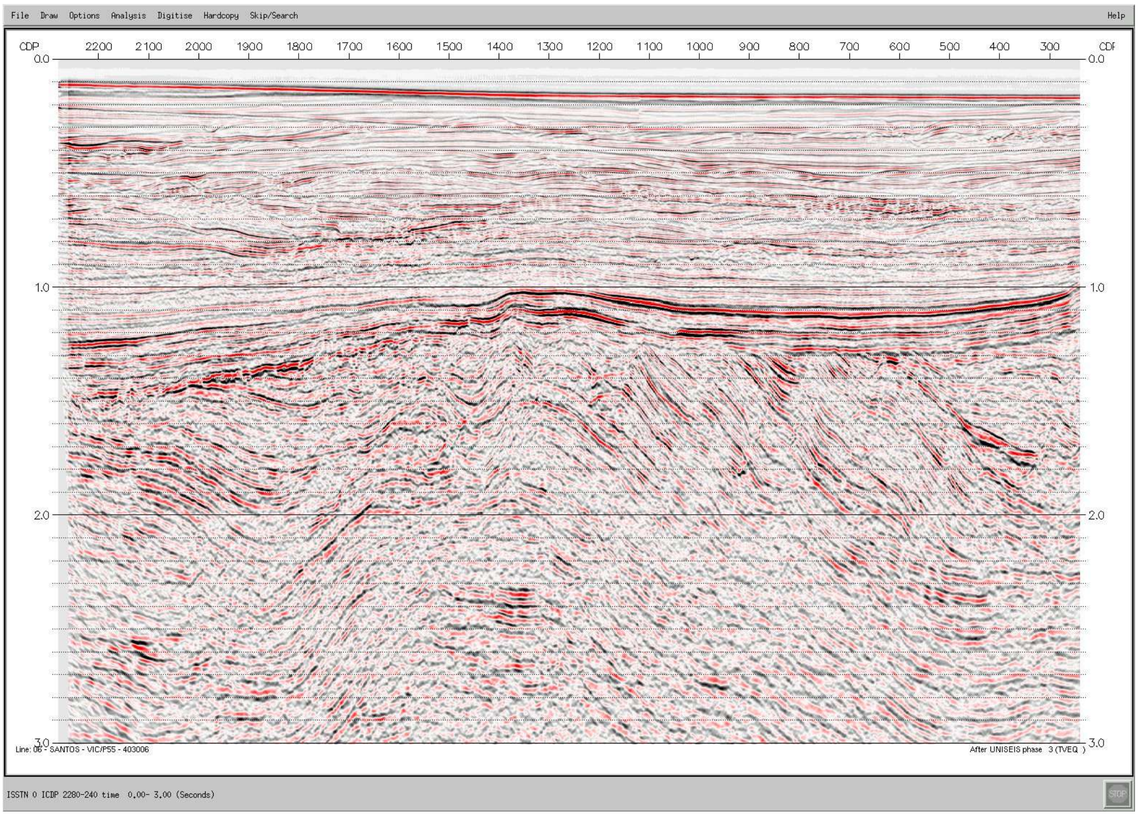
Line GISN05-11 after Tau-P deconvolution (after process 5.13)



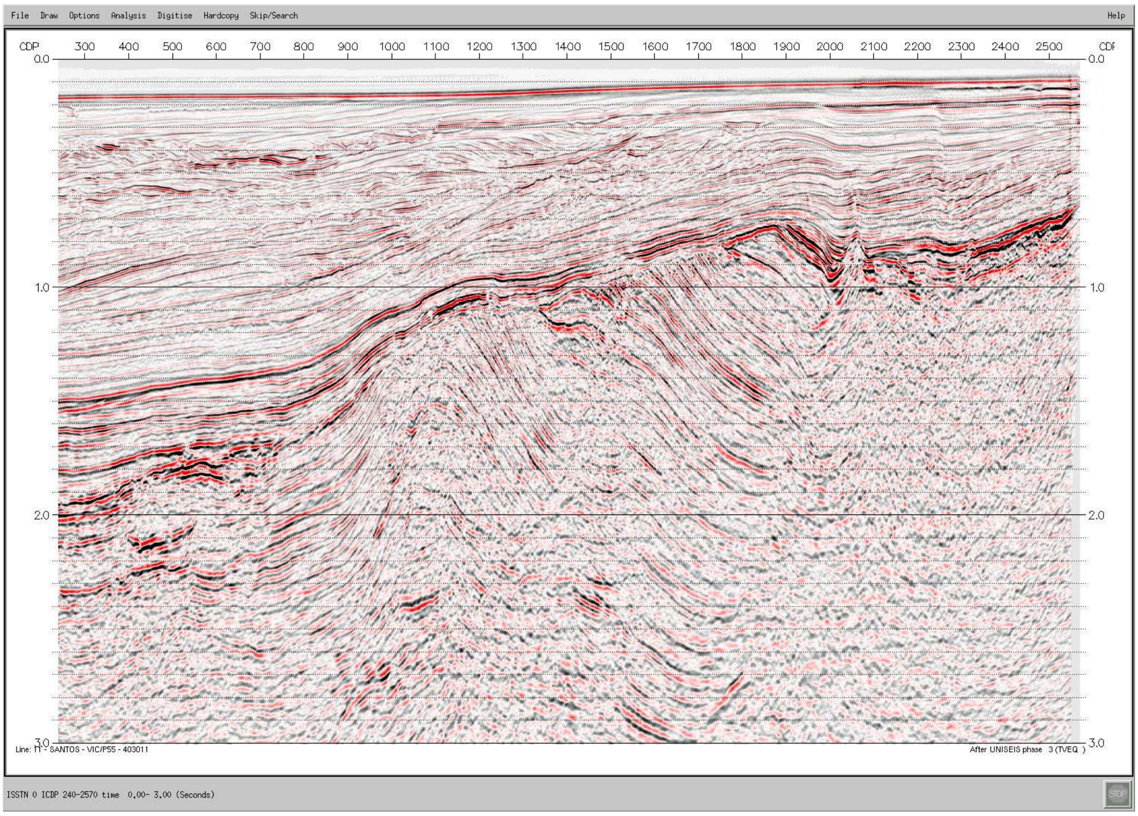
Line GISN05-06 after Radon demultiple (after process 5.16)



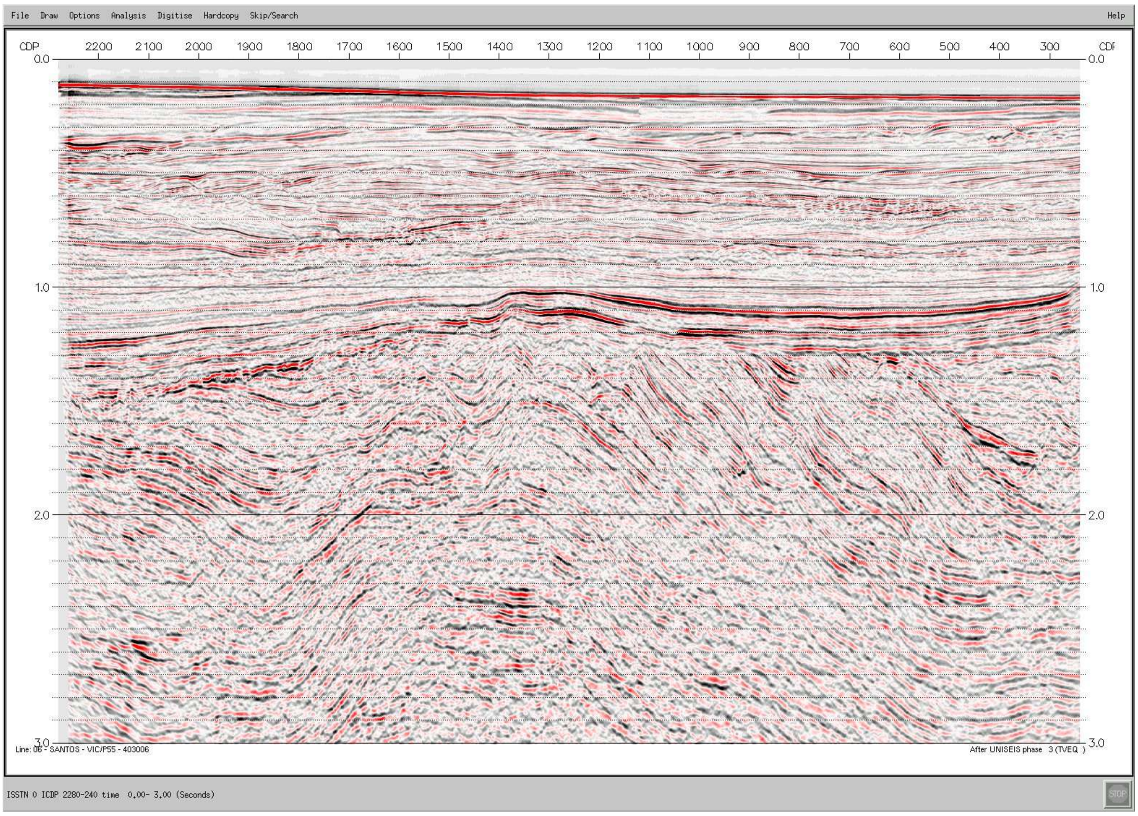
Line GISN05-11 after Radon demultiple (after process 5.16)



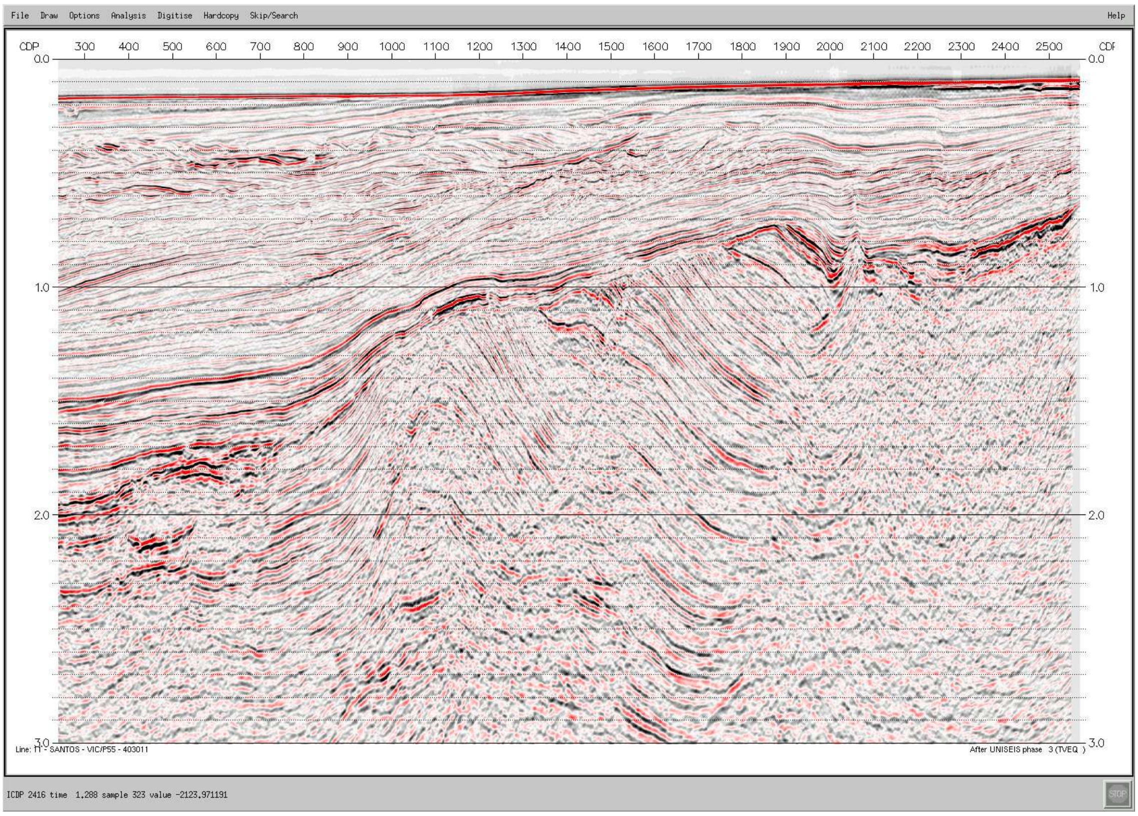
Line GISN05-06 Kirchhoff PSTM stack (after process 5.19)



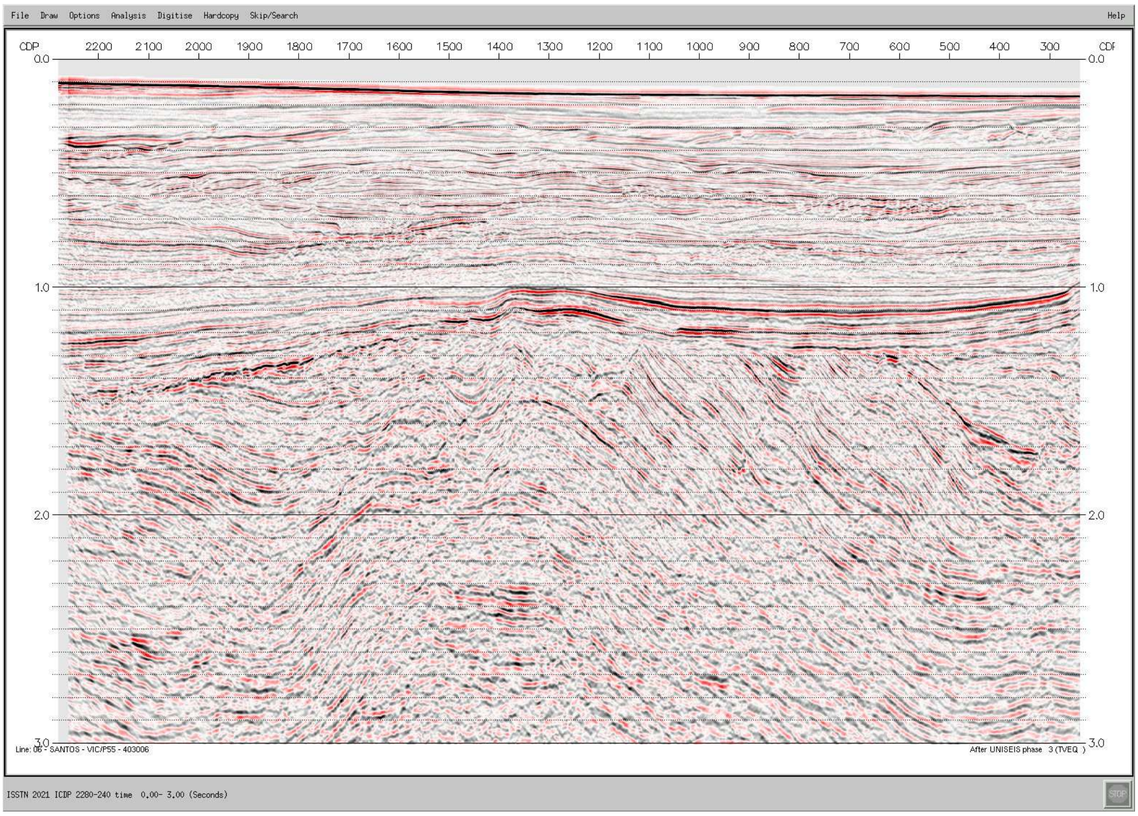
Line GISN05-11 Kirchhoff PSTM stack (after process 5.19)



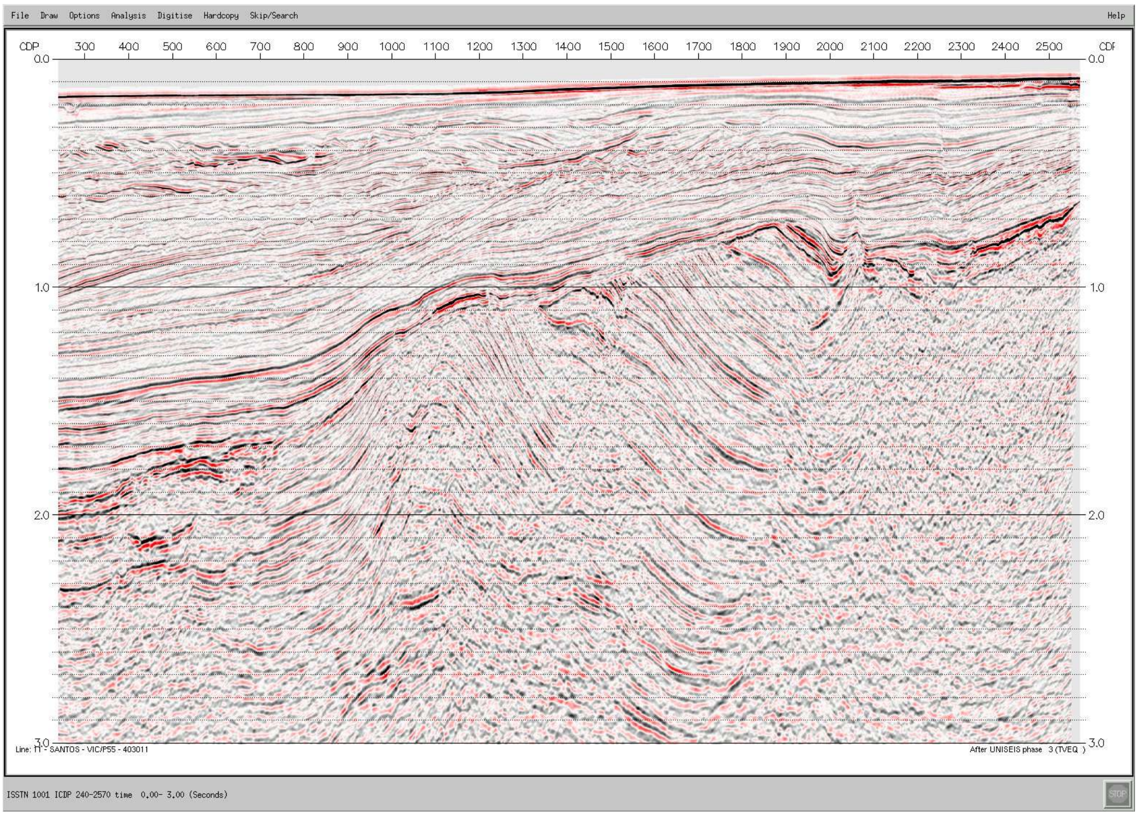
Line GISN05-06 after Kirchhoff PSTM and final 0.5km velocities (process 5.22)



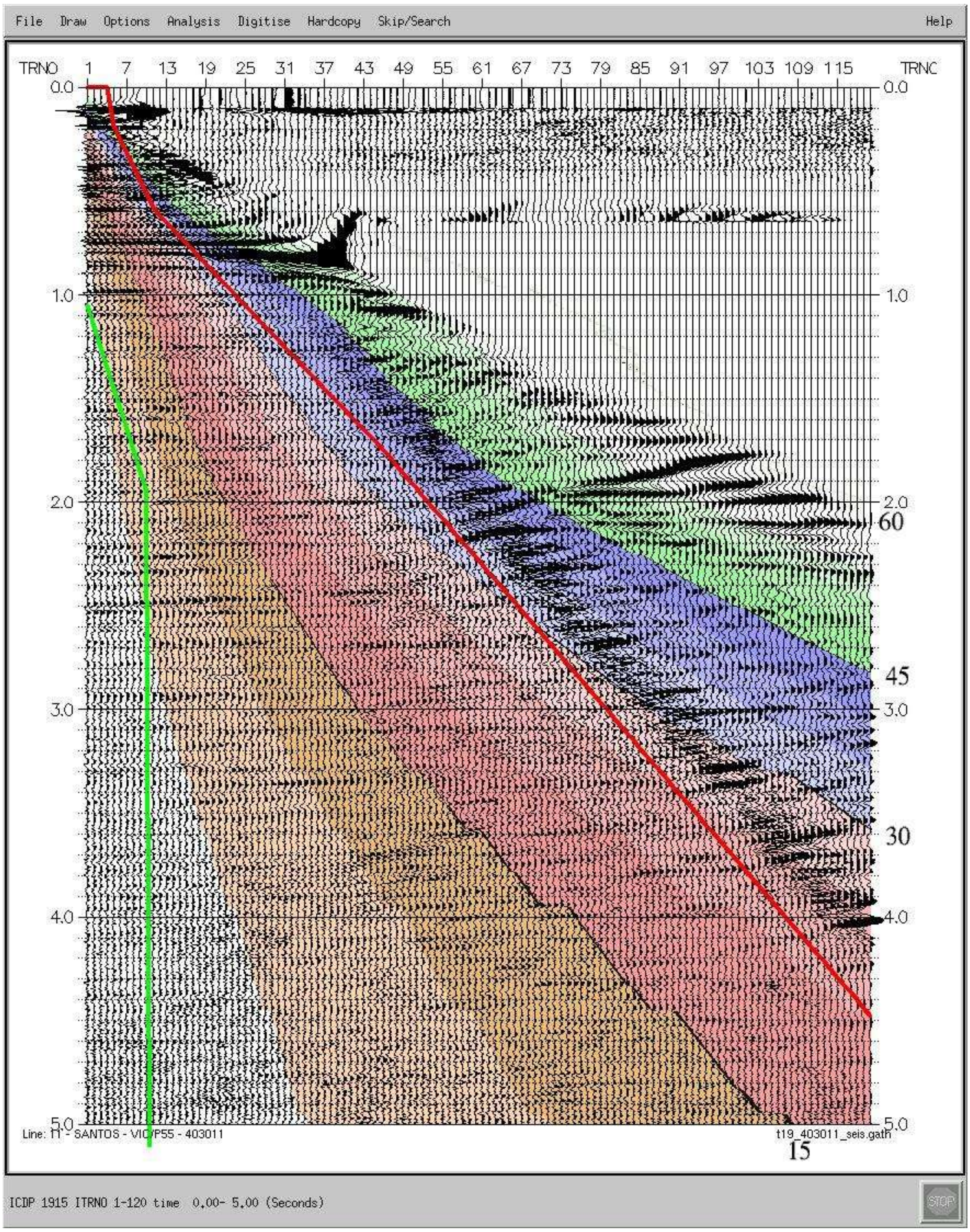
Line GISN05-11 after Kirchhoff PSTM and final 0.5km velocities (process 5.22)



Line GISN05-06 after zero phasing. Final archived Filtered & Scaled PSTM (full fold)



Line GISN05-11 after zero phasing. Final archived Filtered & Scaled PSTM (full fold)



Example final PSTM gather with angles overlayed. The annotated inner and outer mutes (green and red respectively) are the final mutes applied to the final filtered and scaled full fold PSTM stacks and the raw full fold PSTM stacks. While the raw near angle PSTM stack used angles 0 to 15 degrees, the raw mid angle PSTM stack used angles 15 to 30 degrees and the raw far angle PSTM stack used angles 30 to 45 degrees.

7 APPENDICES

7.1 LINE LISTING

Test lines have been highlighted in red.

Line	First SP	Last SP	First CDP	Last CDP	SP Interval	Total KMS
GISN05-01	1001	1895	1	2028	25	22.38
GISN05-02	1001	1499	1	1236	25	12.48
GISN05-03	1001	1897	1	2032	25	22.43
GISN05-04	1001	1507	1	1252	25	12.68
GISN05-05	1001	1896	1	2030	25	22.40
GISN05-06	1001	2021	1	2280	25	25.53
GISN05-07	1001	1855	1	1948	25	21.38
GISN05-08	1001	1806	1	1850	25	20.15
GISN05-09	1001	1697	1	1632	25	17.43
GISN05-11	1001	2166	1	2570	25	29.15
GISN05-13	1001	1624	1	1486	25	15.60
GISN05-15	1001	2174	1	2586	25	29.35
GISN05-17	1001	1749	1	1736	25	18.73
GISN05-19	1001	1752	1	1742	25	18.80
GISN05-21	1001	1711	1	1660	25	17.78
GISN05-23	1001	1711	1	1660	25	17.78
GISN05-25	1001	1716	1	1670	25	17.90
GISN05-27	1001	1712	1	1662	25	17.80

Total	**359.70**

7.2 ACQUISITION PARAMETERS

DESCRIPTION	***DETAILS***
Data recorded by:	Multiwave Geophysical Company
Date recorded:	2005
Vessel:	M/V Pacific Titan
***General**:*	
Field CMP Interval	6.25 m
Nominal Fold	120
Recording Format:	SEG-D 8058
***Seismic source**:*	
Type	Bolt 1500LL & 1900LL-XT Airguns
Volume	3040 cu.in.
Pressure:	2000 psi
Depth:	5m +/- 1.0 m
Shot interval:	25 m
Gun Delay	0 ms
***Recording system**:*	
Type:	Seal
Record length:	8000 ms
Sample interval:	2 ms
Number of Channels:	480
Near Channel:	1
Recording Delay:	50 ms
Low Cut Filter:	Out
High Cut Filter:	200 Hz ,370 dB/octave
***Receivers**:*	
Centre near group to centre far group:	5987.5 m
Streamer depth:	7m +/- 1 m
Number of groups:	480
Group interval:	12.5 m
Centre source to center near group:	114 m
Number of Streamers:	1

7.3 DELIVERABLES

Item	*Format*	*Media*	*Tape No.*
Final Filtered/Scaled Full PSTM Raw Full/Near/Mid/Far PSTM (Stacks, Zero Phased)	SEGY	DVD	403FM001DVD
Final Filtered/Scaled Full PSTM Raw Full/Near/Mid/Far PSTM (Stacks, Zero Phased)	SEGY	DVD	403FM002DVD
Final Filtered/Scaled Full PSTM Raw Full/Near/Mid/Far PSTM (Stacks, Zero Phased)	SEGY	DVD	403FM003DVD
Final Filtered/Scaled Full PSTM Raw Full PSTM (Stacks, Zero Phased)	SEGY	DVD	403FM004DVD
NMO Corrected PreSTM Gathers with Residual Radon	SEGY	DLT	403GA005L
Final Stacking Velocities (PSTM) CMP Coordinates Final Processing Report	Western/ASCII & PDF	CD	403FV006CD
Final Stacking Velocities (PSTM) CMP Coordinates Final Processing Report	Western/ASCII & PDF	CD	403FV007CD
Final Stacking Velocities (PSTM) CMP Coordinates Final Processing Report	Western/ASCII & PDF	CD	403FV008CD
Final Stacking Velocities (PSTM) CMP Coordinates Final Processing Report	Western/ASCII & PDF	CD	403FV009CD
Final Processing Report	Paper Copy		

7.4 SEGY HEADER INFORMATION

FINAL FILTERED AND SCALED PSTM STACK (FULL)

C01 CLIENT : SANTOS LIMITED SURVEY : VIC/P55 (GISN05)
C02 LINE : GISN05-02
C03 AREA : GIPPSLAND BASIN
C04 DATASET : FINAL FILTERED AND SCALED PSTM STACK (FULL)
C05
C06 ACQ. YEAR : 2005 DATE PROCESSED : APRIL 2005
C07 SHOT INTERVAL : 25 m GRP INTERVAL : 12.5 m
C08 CABLE LENGTH : 5987.5 m GRPS PER CABLE : 480
C09 MIN OFFSET : 114 m MAX OFFSET : 6101.5 m
C10 DATUM OF REF : GDA-94 PROJECTION : UTM STH (ZONE 55 CM 147E)
C11 COORDINATE UNITS: METRES VERTICAL DATUM : MEAN SEA LEVEL
C12 SRATE (micro s) : 2000 MAX TIME (ms) : 8000
C13
C14 PROCESSING SEQUENCE: BY FUGRO SEISMIC IMAGING
C15 REFORMAT / BULK STATIC SHIFT / GAIN RECOVERY (T SQUARED) / TRACE EDITS
C16 4HZ LOWCUT FILTER / SWELL NOISE ATTENUATION / DESPIKE / F-X INTERPOLATION
C17 LINEAR TAUP NOISE ATTENUATION / TAUP DECONVOLUTION
C18 DROP INTERPOLATED TRACES / ADJACENT TRACE SUM / CDP GATHER (120 FOLD)
C19 1ST PASS VEL ANAL (2KM) / F-X INTERPOLATION
C20 MULTIPLE ATTENUATION (RADON) / DROP INTERPOLATED TRACES
C21 2ND PASS (PSTM) VEL ANAL (1KM) / KIRCHHOFF PRE-STACK TIME MIGRATION
C22 3RD PASS VEL ANAL (0.5KM) / REVERSE T SQUARED GAIN
C23 NMO (4TH ORDER) USING FINAL 0.5KM PSTM VELS
C24 URSIN SPH.DIV. WITH GAIN / OUTER MUTE / PRE-STACK SCALING / INNER MUTE
C25 STACK / GUN AND CABLE DEPTH CORRECTION / ZERO PHASING
C26 FILTER / SCALING / ARCHIVE
C27
C28
C29 TRACE HEADER DEFINITION
C30 ITEM BYTES FORMAT
C31 SHOTPOINT 017 - 020 INTEGER
C32 CDP 021 - 024 INTEGER
C33 Easting 193 - 196 INTEGER
C34 Northing 197 - 200 INTEGER
C35
C36 SP/CDP RELATIONSHIP: CDP 240 = SP 1001
C37 CDP 440 = SP 1101
C38 SP RANGE : 1001 TO 1499
C39 CDP RANGE : 1 TO 1236
C40 END OF EBCDIC HEADER

FINAL RAW PSTM STACK (FULL)

C01 CLIENT : SANTOS LIMITED SURVEY : VIC/P55 (GISN05)
C02 LINE : GISN05-02
C03 AREA : GIPPSLAND BASIN
C04 DATASET : FINAL RAW PSTM STACK (FULL)
C05
C06 ACQ. YEAR : 2005 DATE PROCESSED : MAY 2005
C07 SHOT INTERVAL : 25 m GRP INTERVAL : 12.5 m
C08 CABLE LENGTH : 5987.5 m GRPS PER CABLE : 480
C09 MIN OFFSET : 114 m MAX OFFSET : 6101.5 m
C10 DATUM OF REF : GDA-94 PROJECTION : UTM STH (ZONE 55 CM 147E)
C11 COORDINATE UNITS: METRES VERTICAL DATUM : MEAN SEA LEVEL
C12 SRATE (micro s) : 2000 MAX TIME (ms) : 8000
C13
C14 PROCESSING SEQUENCE: BY FUGRO SEISMIC IMAGING
C15 REFORMAT / BULK STATIC SHIFT / GAIN RECOVERY (T SQUARED) / TRACE EDITS
C16 4HZ LOWCUT FILTER / SWELL NOISE ATTENUATION / DESPIKE / F-X INTERPOLATION
C17 LINEAR TAUP NOISE ATTENUATION / TAUP DECONVOLUTION
C18 DROP INTERPOLATED TRACES / ADJACENT TRACE SUM / CDP GATHER (120 FOLD)
C19 1ST PASS VEL ANAL (2KM) / F-X INTERPOLATION
C20 MULTIPLE ATTENUATION (RADON) / DROP INTERPOLATED TRACES
C21 2ND PASS (PSTM) VEL ANAL (1KM) / KIRCHHOFF PRE-STACK TIME MIGRATION
C22 3RD PASS VEL ANAL (0.5KM) / REVERSE T SQUARED GAIN
C23 NMO (4TH ORDER) USING FINAL 0.5KM PSTM VELS
C24 URSIN SPH.DIV. WITH GAIN / OUTER MUTE / INNER MUTE
C25 STACK / GUN AND CABLE DEPTH CORRECTION / ZERO PHASING
C26 ARCHIVE
C27
C28
C29 TRACE HEADER DEFINITION
C30 ITEM BYTES FORMAT
C31 SHOTPOINT 017 - 020 INTEGER
C32 CDP 021 - 024 INTEGER
C33 Easting 193 - 196 INTEGER
C34 Northing 197 - 200 INTEGER
C35
C36 SP/CDP RELATIONSHIP: CDP 240 = SP 1001
C37 CDP 440 = SP 1101
C38 SP RANGE : 1001 TO 1499
C39 CDP RANGE : 1 TO 1236
C40 END OF EBCDIC HEADER

FINAL RAW PSTM ANGLE STACKS (NEAR, MID AND FAR)

C01 CLIENT : SANTOS LIMITED SURVEY : VIC/P55 (GISN05)
C02 LINE : GISN05-02
C03 AREA : GIPPSLAND BASIN
C04 DATASET : FINAL RAW PSTM STACK (NEAR)
C05
C06 ACQ. YEAR : 2005 DATE PROCESSED : MAY 2005
C07 SHOT INTERVAL : 25 m GRP INTERVAL : 12.5 m
C08 CABLE LENGTH : 5987.5 m GRPS PER CABLE : 480
C09 MIN OFFSET : 114 m MAX OFFSET : 6101.5 m
C10 DATUM OF REF : GDA-94 PROJECTION : UTM STH (ZONE 55 CM 147E)
C11 COORDINATE UNITS: METRES VERTICAL DATUM : MEAN SEA LEVEL
C12 SRATE (micro s) : 2000 MAX TIME (ms) : 8000
C13
C14 PROCESSING SEQUENCE: BY FUGRO SEISMIC IMAGING
C15 REFORMAT / BULK STATIC SHIFT / GAIN RECOVERY (T SQUARED) / TRACE EDITS
C16 4HZ LOWCUT FILTER / SWELL NOISE ATTENUATION / DESPIKE / F-X INTERPOLATION
C17 LINEAR TAUP NOISE ATTENUATION / TAUP DECONVOLUTION
C18 DROP INTERPOLATED TRACES / ADJACENT TRACE SUM / CDP GATHER (120 FOLD)
C19 1ST PASS VEL ANAL (2KM) / F-X INTERPOLATION
C20 MULTIPLE ATTENUATION (RADON) / DROP INTERPOLATED TRACES
C21 2ND PASS (PSTM) VEL ANAL (1KM) / KIRCHHOFF PRE-STACK TIME MIGRATION
C22 3RD PASS VEL ANAL (0.5KM) / REVERSE T SQUARED GAIN
C23 NMO (4TH ORDER) USING FINAL 0.5KM PSTM VELS
C24 URSIN SPH.DIV. WITH GAIN / 0 - 15 DEGREE ANGLE MUTE
C25 STACK / GUN AND CABLE DEPTH CORRECTION / ZERO PHASING
C26 ARCHIVE
C27
C28
C29 TRACE HEADER DEFINITION
C30 ITEM BYTES FORMAT
C31 SHOTPOINT 017 - 020 INTEGER
C32 CDP 021 - 024 INTEGER
C33 Easting 193 - 196 INTEGER
C34 Northing 197 - 200 INTEGER
C35
C36 SP/CDP RELATIONSHIP: CDP 240 = SP 1001
C37 CDP 440 = SP 1101
C38 SP RANGE : 1001 TO 1499
C39 CDP RANGE : 1 TO 1236
C40 END OF EBCDIC HEADER

RAW PSTM GATHERS, WITH RESIDUAL RADON DEMULTIPLE

C01 CLIENT : SANTOS LIMITED SURVEY : VIC/P55 (GISN05)
C02 LINE : GISN05-02
C03 AREA : GIPPSLAND BASIN
C04 DATASET : RAW PSTM GATHERS
C05
C06 ACQ. YEAR : 2005 DATE PROCESSED : MAY 2005
C07 SHOT INTERVAL : 25 m GRP INTERVAL : 12.5 m
C08 CABLE LENGTH : 5987.5 m GRPS PER CABLE : 480
C09 MIN OFFSET : 114 m MAX OFFSET : 6101.5 m
C10 DATUM OF REF : GDA-94 PROJECTION : UTM STH (ZONE 55 CM 147E)
C11 COORDINATE UNITS: METRES VERTICAL DATUM : MEAN SEA LEVEL
C12 SRATE (micro s) : 2000 MAX TIME (ms) : 8000
C13
C14 PROCESSING SEQUENCE: BY FUGRO SEISMIC IMAGING
C15 REFORMAT / BULK STATIC SHIFT / GAIN RECOVERY (T SQUARED) / TRACE EDITS
C16 4HZ LOWCUT FILTER / SWELL NOISE ATTENUATION / DESPIKE / F-X INTERPOLATION
C17 LINEAR TAUP NOISE ATTENUATION / TAUP DECONVOLUTION
C18 DROP INTERPOLATED TRACES / ADJACENT TRACE SUM / CDP GATHER (120 FOLD)
C19 1ST PASS VEL ANAL (2KM) / F-X INTERPOLATION
C20 MULTIPLE ATTENUATION (RADON) / DROP INTERPOLATED TRACES
C21 2ND PASS (PSTM) VEL ANAL (1KM) / KIRCHHOFF PRE-STACK TIME MIGRATION
C22 3RD PASS VEL ANAL (0.5KM) / REVERSE T SQUARED GAIN
C23 NMO (4TH ORDER) USING FINAL 0.5KM PSTM VELS
C24 URSIN SPH.DIV. WITH GAIN
C25 GUN AND CABLE DEPTH CORRECTION / ZERO PHASING / DB SCALING
C26 ARCHIVE
C27
C28
C29 TRACE HEADER DEFINITION
C30 ITEM BYTES FORMAT
C31 SHOTPOINT 017 - 020 INTEGER
C32 CDP 021 - 024 INTEGER
C33 Easting 193 - 196 INTEGER
C34 Northing 197 - 200 INTEGER
C35
C36 SP/CDP RELATIONSHIP: CDP 240 = SP 1001
C37 CDP 440 = SP 1101
C38 SP RANGE : 1001 TO 1499
C39 CDP RANGE : 1 TO 1236
C40 END OF EBCDIC HEADER

7.5 SEGY TRACE HEADERS (STACK)

Type	*Offset*	*Description*
I32	0	Trace number within line.
I32	4	Trace number within reel.
I32	8	Sequential record number.
I32	8	Original field record number.
I32	12	Trace number.
I32	16	Shot point number.
I32	20	CDP number.
I32	24	Trace no. within the CDP.
I16	28	Trace identification code.
I16	30	No. of summed traces.
I16	32	Total number of traces in CDP.
I16	34	Data use 1=production, 2=test.
I32	36	Trace offset (integer).
I32	40	Elevation at receiver.
I32	44	Elevation at source.
I32	60	Water depth at source.
I32	64	Water depth at receiver.
I16	68	Scaler to be applied to elevations
I16	70	Scaler to be applied to coordinates
I32	72	Source easting.
I32	76	Source northing.
I32	80	Receiver easting.
I32	84	Receiver northing.
I16	88	Coordinate units (m/arc)
I16	98	Source static correction.
I16	100	Receiver static correction.
I16	102	Total static applied.
I16	108	Delay recording time (ms).
I16	110	Mute time start.
I16	112	Mute time end.
I16	114	No. of samples.
I16	116	Samp interval in microseconds.
I16	156	Year of recording
I16	158	Julian day number (1-366)
I16	160	Hour of day (24 hour clock)
I16	162	Minute of hour
I16	164	Second of minute
I16	166	Time base code 1.local,2.gmt,3.?
I16	180	Seqn record no. (pre-stack only)
I32	180	3D Line number.
I32	184	CDP no. within 3D line.
I32	188	2D shotpoint number (Maersk)
I32	192	Easting of CDP.
I32	196	Northing of CDP.
I16	200	Scaler to be applied to SPNO.