Integrated Services in
Petroleum Exploration and Production

Processing Report

for

2003 Otway Basin Processing Survey OS03 2D

Area:
Otway Basin, VIC/P51

March 2004

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1.0 INTRODUCTION

The 2003 OS03 2D Otway Basin Processing consisted of 18 lines, totalling 470 km. All data was in shallow water (50 – 200msec) with a consistently flat water bottom profile. Consequently, it wasn't necessary to vary the processing parameters to compensate for a change in water depths. The data was recorded in November 2003 with the processing being completed in March 2004.

1.1 PERSONNEL

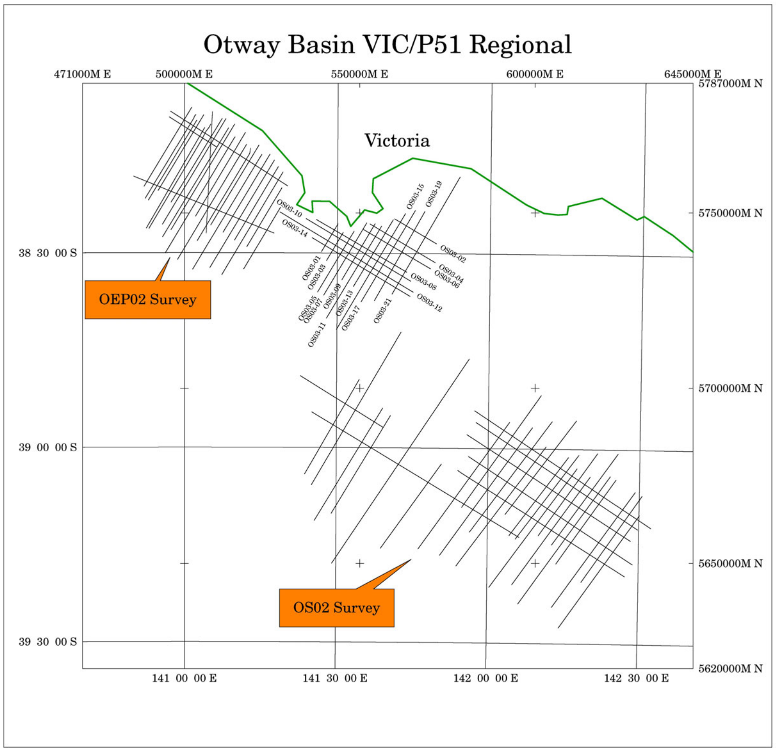
Robertson Research Australia

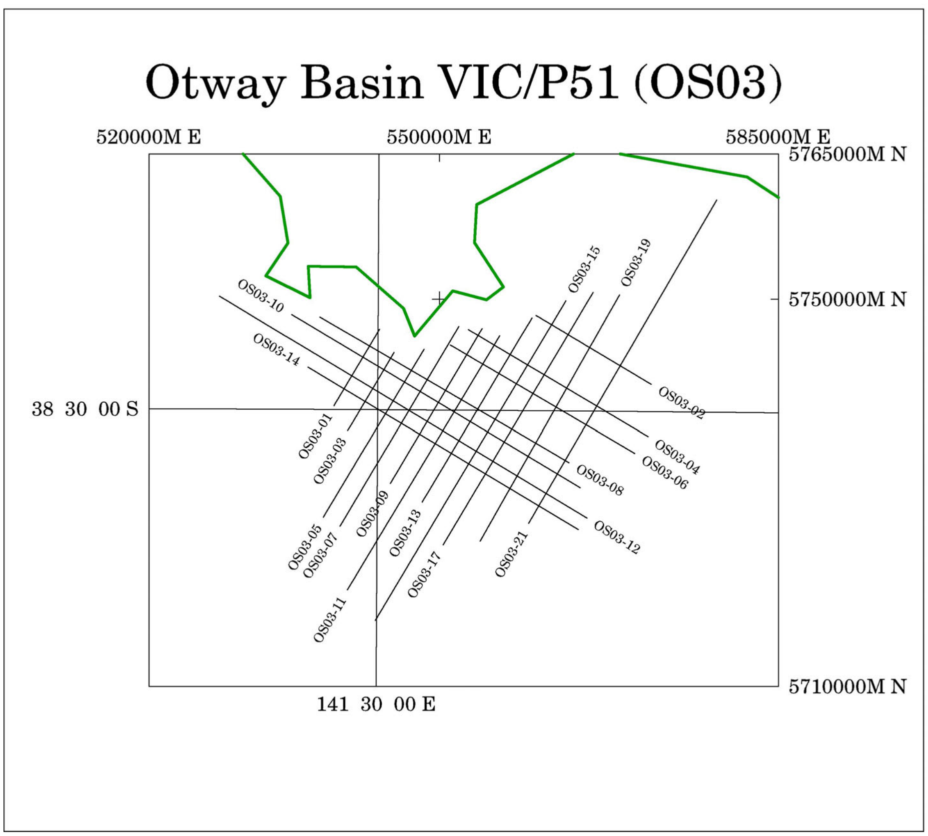
Kelly Beauglehole	Processing Manager
Simon Stewart	Marine Processing Manager
Paul Phythian	Geophysicist

Santos Limited

Stuart Brew	Senior Staff Geophysicist (Santos)

1.2 SURVEY MAP





2.0 PARAMETER TESTING

All pre and post stack testing was carried out on line OS03-09. The only variation to this was a surface consistent scaling test done on line OS03-08. This line was chosen for this test since it had a low amplitude zone that didn't migrate properly due to the amplitude contrasts with the surrounding data.

Please refer to the table below for further details of the tests performed.

Test	Format		
	Shot Record	CDP Gather	STACK
Shot record displays	✔		
Gain recovery: Amplitude decay analysis	✔		
Gain recovery: exponential gain	✔		
F-K filter (shot domain, various cuts)	✔		✔
F-K filter with NMO (shot domain, various cuts)	✔		✔
F-K filter (shot domain)	✔		✔
Signature deconvolution	✔		✔
Tau-P Linear Noise Removal	✔		✔
Multiple attenuation: F-K method		✔	✔
Multiple attenuation: Radon method		✔	✔
Predictive deconvolution (before stack)			✔
PSTM Testing (SCAMP)		✔	✔
Outer and inner trace mutes		✔	✔
Bandpass filter and Post stack scaling			✔

3.0 COMMENTS & CONCLUSION

The OS03 2D processing began in November 2003 with all processing being completed in March 2004. The processing flow followed the processing sequence used for the VIC/P44 re-processing quite closely. The most notable difference being the application of the surface consistent scaling which tended to suppress the migration artefacts at the low fold ends of the lines. It also gave slightly better amplitude contrasts between the isolated “low amplitude” zones across the survey area and the surrounding data, which in turn reduced the associated migration artefacts.

A DMO / Post Stack Migration fast track volume was produced for this survey. This dataset was delivered on the 24th December 2004. This enabled the initial interpretation to begin while the final PSTM product was still running. It also served as an initial QC of the data quality and continuity. The final products for this survey consisted of final filtered and scaled PSTM full, near and far datasets, along with raw PSTM full, near and far volumes. These “Raw” products had the initial t^2 scaling removed and an Ursin spherical divergence with a dB gain applied. This process of removing the initial gain recovery and applying the Ursin spherical divergence was also used for the filtered and scaled volumes.

As was mentioned earlier, there were some isolated low amplitude areas across the survey. These occurred on lines OS03-07 and OS03-08 with minor occurrences on lines OS03-09 and OS03-13. Even though there was some attenuation to the migration artefacts associated with these zones, there were still quite prominent “dead” zones left in the final product.

The final data was phase matched to the OS02 3D survey that was processed in 2003. It must be noted that the 3D data was archived as zero phase SEG +ve (peak at water bottom) and as such is 180 degrees out of phase with the Australian convention of SEG –ve (trough at water bottom).

4.0 PROCESSING SEQUENCE

4.1 POST STACK TIME MIGRATION SEQUENCE

TRANSCRIPTION
|
GAIN RECOVERY (t^2)
|
LOW CUT FILTER
|
SWELL NOISE ATTENUATION
|
F-K FILTER (shot domain +/- 2000 m/s)
|
SIGNATURE DECONVOLUTION (6/12-75/72, Hz/dB/Octave)
|
TAU-P LINEAR NOISE REMOVAL
|
ADJACENT TRACE SUM
|
CDP GATHER
|
FIRST PASS VELOCITY ANALYSIS (2 km intervals)
|
TRACE INTERPOLATION (Receiver Domain)
|
MULTIPLE ATTENUATION (F-K & Radon)
|
DROP INTERPOLATED TRACES
|
DMO
|
SECOND PASS VELOCITY ANALYSIS (1 km intervals)
|
NMO CORRECTION & MUTES
|
CDP STACK
|
GUN & CABLE STATIC CORRECTIONS
|
FINITE DIFFERENCE MIGRATION
|
ZERO PHASING & PHASE ROTATION
|
BAND-PASS FILTER
|
POST STACK SCALING (+)

(+) Final Filtered and Scaled Post Stack Migration. See section 5 for parameter details.

4.2 PRE STACK TIME MIGRATION SEQUENCE (FILTERED & SCALED)

TRANSCRIPTION
|
GAIN RECOVERY (t^2)
|
LOW CUT FILTER
|
SWELL NOISE ATTENUATION
|
F-K FILTER (shot domain +/- 2000 m/s)
|
SIGNATURE DECONVOLUTION (6/12-75/72, Hz/dB/Octave)
|
TAU-P LINEAR NOISE REMOVAL
|
ADJACENT TRACE SUM
|
CDP GATHER
|
FIRST PASS VELOCITY ANALYSIS (2 km intervals)
|
TRACE INTERPOLATION (Receiver Domain)
|
MULTIPLE ATTENUATION (FK & Radon)
|
DROP INTERPOLATED TRACES
|
SECOND PASS (PSTM) VELOCITY ANALYSIS (1 km intervals)
|
PREDICTIVE DECONVOLUTION
|
SURFACE CONSISTENT SCALING
|
KIRCHHOFF PRE-STACK TIME MIGRATION (*)
|
THIRD PASS VELOCITY ANALYSIS (0.5 km intervals) (+)
|
REVERSE t^2 GAIN RECOVERY
|
NMO CORRECTION
|
SPHERICAL DIVERGENCE (URSIN & GAIN)
|
OUTER TRACE MUTE / PRE STACK SCALING / INNER TRACE MUTE
|
CDP STACK
|
GUN & CABLE STATIC CORRECTIONS
|
ZERO PHASING & PHASE MATCHED TO OS02 3D
|
BAND-PASS FILTER
|
POST STACK SCALING (&)

(*) Pre Stack Time Migration gather archive. Hi resolution radon demultiple applied and NMO corrected with the final 0.5km velocities. T squared scaling backed off and Ursin spherical divergence, with a water bottom dependent gain, applied. See section 5 for parameter details.

(+) Final 0.5km velocities (Western format)

(&) Final Filtered and Scaled Pre Stack Time Migration. See section 5 for parameter details.

4.3 PRE STACK TIME MIGRATED ANGLE STACKS (FILTERED/SCALED)

TRANSCRIPTION
|
GAIN RECOVERY (t^2)
|
LOW CUT FILTER
|
SWELL NOISE ATTENUATION
|
F-K FILTER (shot domain +/- 2000 m/s)
|
SIGNATURE DECONVOLUTION (6/12-75/72, Hz/dB/Octave)
|
TAU-P LINEAR NOISE REMOVAL
|
ADJACENT TRACE SUM
|
CDP GATHER
|
FIRST PASS VELOCITY ANALYSIS (2 km intervals)
|
TRACE INTERPOLATION (Receiver Domain)
|
MULTIPLE ATTENUATION (F-K & Radon)
|
DROP INTERPOLATED TRACES
|
SECOND PASS (PSTM) VELOCITY ANALYSIS (1 km intervals)
|
PREDICTIVE DECONVOLUTION
|
SURFACE CONSISTENT SCALING
|
KIRCHHOFF PRE-STACK TIME MIGRATION
|
THIRD PASS VELOCITY ANALYSIS (0.5 km intervals)
|
REVERSE GAIN RECOVERY (t^2)
|
NMO CORRECTION
|
SPHERICAL DIVERGENCE (URSIN & GAIN)
|
HI RESOLUTION RADON
|
OUTER (120%) / INNER TRACE MUTES
|
CDP STACK (Near & Far)
|
GUN & CABLE STATIC CORRECTIONS
|
ZERO PHASING & PHASE MATCHED TO OS02 3D
|
BAND-PASS FILTER
|
POST STACK SCALING

4.4 PRE STACK TIME MIGRATION SEQUENCE (RAW)

TRANSCRIPTION
|
GAIN RECOVERY (t^2)
|
LOW CUT FILTER
|
SWELL NOISE ATTENUATION
|
F-K FILTER (shot domain +/- 2000 m/s)
|
SIGNATURE DECONVOLUTION (6/12-75/72, Hz/dB/Octave)
|
TAU-P LINEAR NOISE REMOVAL
|
ADJACENT TRACE SUM
|
CDP GATHER
|
FIRST PASS VELOCITY ANALYSIS (2 km intervals)
|
TRACE INTERPOLATION (Receiver Domain)
|
MULTIPLE ATTENUATION (FK & Radon)
|
DROP INTERPOLATED TRACES
|
SECOND PASS (PSTM) VELOCITY ANALYSIS (1 km intervals)
|
PREDICTIVE DECONVOLUTION
|
SURFACE CONSISTENT SCALING
|
KIRCHHOFF PRE-STACK TIME MIGRATION
|
THIRD PASS VELOCITY ANALYSIS (0.5 km intervals)
|
REVERSE t^2 GAIN RECOVERY
|
NMO CORRECTION
|
SPHERICAL DIVERGENCE (URSIN & GAIN)
|
OUTER /INNER TRACE MUTE
|
CDP STACK
|
GUN & CABLE STATIC CORRECTIONS

4.5 PRE STACK TIME MIGRATED ANGLE STACKS SEQUENCE (RAW)

TRANSCRIPTION
|
GAIN RECOVERY (t^2)
|
LOW CUT FILTER
|
SWELL NOISE ATTENUATION
|
F-K FILTER (shot domain +/- 2000 m/s)
|
SIGNATURE DECONVOLUTION (6/12-75/72, Hz/dB/Octave)
|
TAU-P LINEAR NOISE REMOVAL
|
ADJACENT TRACE SUM
|
CDP GATHER
|
FIRST PASS VELOCITY ANALYSIS (2 km intervals)
|
TRACE INTERPOLATION (Receiver Domain)
|
MULTIPLE ATTENUATION (F-K & Radon)
|
DROP INTERPOLATED TRACES
|
SECOND PASS (PSTM) VELOCITY ANALYSIS (1 km intervals)
|
PREDICTIVE DECONVOLUTION
|
SURFACE CONSISTENT SCALING
|
KIRCHHOFF PRE-STACK TIME MIGRATION
|
THIRD PASS VELOCITY ANALYSIS (0.5 km intervals)
|
REVERSE GAIN RECOVERY (t^2)
|
NMO CORRECTION (*)
|
SPHERICAL DIVERGENCE (URSIN & GAIN)
|
HI RESOLUTION RADON
|
OUTER (120%) / INNER TRACE MUTES
|
CDP STACK (Near & Far)
|
GUN & CABLE STATIC CORRECTIONS

5.0 PROCESSING TECHNIQUES

A brief description of each of the processes used in the processing sequence follows:

5.1 TRANSCRIPTION

Field data were converted to Robertson's internal format for processing. RRA's internal processing format is trace sequential, with samples in 32 bit IEEE floating point. At intermediate processing stages the data is stored on magnetic tape in sixteen-bit integer with a gain ranging scalar for each trace.

5.2 GAIN RECOVERY

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

Gain functions applied were as follows :

Survey	Gain Function (dB)
All	t^2

where t = two way travel time in milliseconds.

5.3 STATICS

Applied –120ms static shift to compensate for recording delay.

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

A symmetrical "velocity" filter was designed in the F-K domain to preserve the Swell noise attenuation is achieved by normalization of the amplitude spectra of selected "swell" traces.

To determine which traces are affected by swell noise the shot record is passed through an fx transform after an appropriate gain function has been applied to the data. Although swell noise is predominantly low frequency it also has a significant proportion of high frequency energy which can be more successfully predicted. The user can limit the range of frequencies they wish to perform analysis on by defining a low cut frequency with the upper limit being restricted to 3/4 of the nyquist frequency. For this data a low cut of 32 hz was defined and analysis performed up to 187.5 hz.

Swell traces are then chosen as those whose amplitude are greater than double a user defined percentile less the minimum amplitude. For this data a value of 30% was used for the user defined percentile. A scalar is then computed to normalize frequencies of the "swell" traces to the mean of the "non swell" traces. None of the calculated scalars are allowed to exceed 1 and they are smoothed with a user defined n point filter before application. For these data a nine point filter was used. The scalar is then fully applied to the amplitude spectra of the "swell" trace up to 1/2 of the user defined low cut frequency. For these data the scalar was fully applied from 0 to 16 hz. The scalar is then tapered to no scaling at the cut off frequency (32hz). The data is then passed on for further processing.

For data that exhibits strong swell noise the scalar values applied will be small, significantly changing the low frequency end of the amplitude spectra for the selected "swell" traces. For data with minimal swell noise the scalars will be close to 1 and result in little change to the low frequency end of the amplitude spectra for the selected "swell" traces. Only the selected "swell" traces are altered, all other traces are passed on for further processing unchanged.

5.6 MULTI CHANNEL FILTER (SHOT DOMAIN)

A symmetrical “velocity” filter was designed in the F-K domain to preserve the primary reflection signal and to discriminate against coherent dipping noise trains. The filter employs a cosine-squared taper from k = 0 to the velocity intercept at each frequency. The input data was conditioned with a 300 ms AGC, and the scalars preserved for removal subsequent to the application of the F-K filter. A cut off velocity of 2000 m/sec was used in the filter design and NMO was applied before and removed after the filter.

5.7 SIGNATURE DECONVOLUTION

Robertson Research's signature deconvolution routine is based on Taner's method for estimating a minimum phase signature from a mixed phase record. The method involves the application of an inverse exponential gain to the data to force the essentially mixed phase data to minimum phase before the Wiener double inverse method (which presumes minimum phase input) is used to derive the minimum phase source signature. However, as this gain will affect the shape of the derived wavelet, it is then removed before deconvolving with the original un-gained data.

A data derived 300 ms wavelet, designed using all offsets was chosen for the sequence. An exponential gain function of -18 dB/sec was applied and removed in the wavelet estimation in accordance with Taner's method of minimum phase conditioning. The output minimum phase wavelets were generally shaped to a bandwidth of 6-75 Hz with filter slopes of 12 dB/oct for the low-cut and 72 dB/oct for the high-cut.

Offset (m)	*Design Windows (ms)*
95	500 - 4500
4132	3000 - 6000

5.8 TAU-P LINEAR NOISE REMOVAL

Transform into the Tau-P space, mute linear noise and transform back into the T-X domain. Transform +/- 3000ms at an increment of 10ms.

5.9 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
6000	1 - 2 - 1

Summation Details :

Input Traces	Input Trace Interval	Output Traces	Output Trace Interval
324	12.5m	162	25m

5.10 CDP GATHER

The shot records were sorted into common depth point gathers.

5.11 FIRST PASS VELOCITY ANALYSIS

First pass velocities were determined using Robertson's "MGIVA" interactive velocity analysis program. Each velocity analysis comprised a semblance display, a 30 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 derived from a brute velocity that varied according to water depth.

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 -25% at 10000ms. This was applied for the purpose of the analyses 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 could be performed more effectively when discordant velocities could be recognised on the map.

5.12 DEMULTIPLE (F-K and Radon)

Multiple attenuation was performed in the F-K domain, using NMO corrected gathers with scaled primary velocity functions. F-K demultiple was fully applied from 0ms to 700ms with zero application at 1200ms.

Time (ms)	*Velocity Percentage*
0	94
800	94
3500	90
6000	86

Radon demultiple, using 100% final velocities, was applied in the deeper portion of data using 450p values between maximum offset delta t values of –1000ms and 3500ms. Move-outs greater than those listed below were modelled and subtracted from the data.

Time (ms)	*No Application (ms)*
100	200
1000	200
2000	75
4000	50

Receiver domain trace interpolation was applied in order to increase the spatial sampling and thus minimise any resulting aliasing. Consequently the fold was doubled from 81 to 162. The interpolated traces were dropped after demultiple. A 300ms AGC was applied prior to, and removed after, multiple attenuation.

5.13 DIP MOVEOUT (Fast Track Only)

Robertson Research's DMO program applies 2D convolution operators to map the data accurately from non-zero to zero offset in the manner described by Deregowski and Rocca (1981). The convolution is conveniently implemented by the summation method, and applied to traces in common offset order. This procedure achieves the desirable partial migration, whereby traces with common mid-points, but different source-receiver offsets, relate to the same sub-surface locations after DMO, for all dips. After DMO all reflection events appear, for the purposes of normal moveout correction, to have originated from horizontal reflectors. Therefore, optimum stack response for all reflector dips can be obtained from conventional moveout corrections based on velocity functions undistorted by reflector dips.

The number of common offset planes used in DMO was equivalent to the maximum fold of the data, in this case 81.

5.14 SECOND PASS VELOCITY ANALYSIS (Fast Track Only)

The second pass of velocities were picked at 1km intervals on DMO gathers using Robertson's "MGIVA" interactive velocity analysis program. Each velocity analysis comprised a semblance display, a 25 CDP stacked panel repeated 13 times with a suite of velocity functions, and a central CDP gather. The suite of functions were generated using 0%, +/-2 %, +/-4%, +/-7%, +/-11 %, +/-15% 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.

5.15 NMO CORRECTION (Fast Track Only)

Fourth order NMO correction was performed using the final picked 1km DMO velocity functions.

5.16 OUTER TRACE MUTE (Fast Track Only)

A post-NMO outer trace mute was applied for two main reasons :

- to remove any coherent noise on the outer traces and
- to reduce contamination from the effect of NMO stretch on the far offsets.

Offset (m)	*Application times (ms)*
95	0
500	200
4120	3000

5.17 PRE-STACK SCALING (Fast Track Only)

General Parameter Summary

Offset Dependent "base level" scaling
Near Offset window length = 700ms
Far Offset window length = 3000ms

5.18 INNER TRACE MUTE (Fast Track Only)

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)*
95	1200-6144
600	2500-6144

5.19 COMMON DEPTH POINT STACK (Fast Track Only)

The traces within each common depth point gather were summed using 1/root(N) stack compensation. Nominal fold is 81.

5.20 STATICS (Fast Track Only)

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 observer's reports. A 10ms static correction was applied to all lines.

5.21 WAVE EQUATION MIGRATION (Fast Track Only)

A third order 65 degree finite difference migration scheme was used. The migration model velocities were based on laterally smoothed 100% stacking velocities.

5.22 ZERO PHASE CONVERSION (Fast Track Only)

Data were converted from minimum phase to zero phase. The spectral estimate was made using the Wiener-Levinson double inverse method.

All lines were then phase rotated –50 degrees to produce a zero phase trough (SEG –ve) at the water bottom.

5.23 BAND PASS FILTER (Fast Track Only)

Unwanted noise that lay outside the frequency range of the desired reflection and diffraction data was removed by the application of a series of zero phase time variant cosine squared tapered filters.
General parameter summary:

Time (ms)	Frequency limits (Hz/dB/Oct)
0	6/12-90/72
1300	6/12-80/72
2000	6/12-70/72
3500	6/12-50/48
4500	6/12-45/48
6000	6/12-40/48

5.24 POST STACK SCALING (Fast Track Only)

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.

General parameter summary
Window lengths of 1200 ms and 400 ms
Equalisation applied : 60
Short window stopped 5000 ms

5.25 SECOND PASS VELOCITY ANALYSIS (Flow continued from 5.12)

The second pass of velocities, picked at 1km intervals on the Pre-stack Time Migrated gathers were again determined using Robertson's "MGIVA" interactive velocity analysis program. Each velocity analysis comprised a semblance display, a 25 CDP stacked panel repeated 13 times with a suite of velocity functions, and a central CDP gather. The suite of functions were generated using 0%, +/-2 %, +/-4%, +/-7%, +/-11 %, +/-15% and +/-20% increments from a central velocity function. The central function was derived from the second pass velocities picked earlier.

5.26 PREDICTIVE DECONVOLUTION

Predictive Deconvolution was used to improve the temporal resolution of the data and to attenuate short period water bottom reverberations and inter-bed multiples.

Operator length:	232	248 ms
Gap	32	48 ms
Near-trace design window:	500-2500	1500-4500 ms
Far-trace design window:	2500-4500	3500-5500 ms
Near-trace application:	0	2000 ms
Far-trace application:	0	3000 ms
Overlap zone: 400ms	White noise: 0.1%	

5.27 SURFACE CONSISTENT AMPLITUDE SCALING

A surface consistent amplitude correction was applied to balance out the amplitudes spatially with the aim being to keep any migration "smiling" down to a minimum while still preserving the true amplitude character of the data. Both source and receiver scalars were applied to the data.

5.28 PRE-STACK TIME MIGRATION

Kirchhoff PreSTM was applied using a maximum half aperture of 600 traces (7500m). Apertures were muted with a 50% stretch mute to avoid operator aliasing. Smoothed 100% third pass 0.5km velocities were used in the migration. Migration was performed on all 81 offset planes.

5.29 THIRD PASS VELOCITY ANALYSIS

The third and final pass of velocities, picked at 0.5km intervals on the final Pre-stack Time Migrated gathers were again determined using Robertson's "MGIVA" interactive velocity analysis program. Each velocity analysis comprised a semblance display, a 25 CDP stacked panel repeated 13 times with a suite of velocity functions, and a central CDP gather. The suite of functions were generated using 0%, +/-2 %, +/-4%, +/-7%, +/-11 %, +/-15% and +/-20% increments from a central velocity function. The central function was derived from the second pass velocities picked earlier.

5.30 DEMULTIPLE (Hi Resolution Radon)

This second pass of demultiple was only applied to the NMO corrected (final 0.5km velocity) Kirchhoff PreSTM gathers that were archived. Radon demultiple, using 100% final velocities, was applied using 250p values between maximum offset delta t values of –500ms and 2000ms. Move-outs greater than those listed below were modelled and subtracted from the data.

Time (ms)	*Moveout (ms)*
0	250
1000	100
2000	75
6144	35

5.31 NMO CORRECTION

Fourth order NMO correction was performed using the final picked 0.5km PSTM velocity functions.

5.32 OUTER TRACE MUTE

A post-NMO outer trace mute was applied for two main reasons :

- to remove any coherent noise on the outer traces and
- to reduce contamination from the effect of NMO stretch on the far offsets.

Offset (m)	*Application times (ms)*
95	0
500	200
4120	3000

5.33 PRE-STACK SCALING

General Parameter Summary

Offset Dependent "base level" scaling
Near Offset window length = 700ms
Far Offset window length = 3000ms

Note: Scaling only applied to the Final Filtered and Scaled Pre Stack Time Migrated dataset.

5.34 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)*
95	1200-6144
600	2500-6144

5.35 COMMON DEPTH POINT STACK

The traces within each common depth point gather were summed using 1/root(N) stack compensation. Nominal fold is 81.

5.36 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 observer's reports. A static correction between 9 and 11ms was applied depending on the cable depth used for that particular line.

5.37 ZERO PHASE CONVERSION / PHASE MATCHING

Data were converted from minimum phase to zero phase. The spectral estimate was made using the Wiener-Levinson double inverse method.

All lines were then phase matched to the OS02 3D Seismic Survey. Please refer to appendix A2 for details of the phase rotations and bulk shifts applied.

5.38 BAND PASS FILTER

Unwanted noise that lay outside the frequency range of the desired reflection and diffraction data was removed by the application of a series of zero phase time variant cosine squared tapered filters.

General parameter summary:

Time (ms)	Frequency limits (Hz/dB/Oct)
0	6/12-90/72
1300	6/12-80/72
2000	6/12-70/72
3500	6/12-50/48
4500	6/12-45/48
6000	6/12-40/48

5.39 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.

General parameter summary

Window lengths of 1200 ms and 400 ms
Equalisation applied : 60
Short window stopped 5000 ms
Note: Scaling only applied to the Final Filtered and Scaling Pre Stack Time Migrated dataset.

5.40 ANGLE STACKS

Using the full fold inner and outer trace mutes, the remaining “live” data was split (equal fold) to produce near and far angle stack datasets. The Pre Stack Scaling (5.34) and the Post Stack Scaling (5.40) were omitted from the angle stack flow. The T squared scaling was backed off (prior to NMO correction) and an Ursin spherical divergence, with water bottom dependent scaling, was applied. Scaling was as follows:

Time (ms)	*Scalar (dB)*
WB	0
WB+1000	0
WB+2000	8
WB+6000	8

6.0 ACQUISITION PARAMETERS

Data recorded by:	PGS Exploration A/S
Date recorded:	2003
Vessel:	Orient Explorer
Seismic Source:	
Type:	Sleeve Airgun
Pressure/Volume:	1800 psi / 2500 cu.in.
Depth:	6m
Shot interval:	25m
Gun delay:	0
Recording System:	
Record length:	6144 ms
Sample interval:	2 ms
Filters:Low	3 Hz - 12 dB / Octave
:High	206 Hz – 276 dB / Octave
Recording Delay	120 ms
Streamer:	
Streamer length:	4037.5 m
Streamer depth:	7 – 10 m
No. of groups:	324
Near group no:	324
Group interval:	12.5 m
Near group offset:	95 m
Antenna-source:	180 m
SP annotation:	SHOTPOINT

APPENDICES

A.1 LINE LISTING

Line	1st SP	Lst SP	SP Int	Kms
OS03-01	1372	1740	25	9.23
OS03-02	1000	1554	25	13.88
OS03-03	1000	1375	25	9.40
OS03-04	1000	1864	25	21.63
OS03-05	1000	1809	25	20.25
OS03-06	1000	1885	25	22.15
OS03-07	1000	1960	25	24.03
OS03-08	1000	2192	25	29.83
OS03-09	1000	1743	25	18.60
OS03-10	1000	2391	25	34.80
OS03-11	1000	2224	25	30.63
OS03-12	1000	2774	25	44.38
OS03-13	1000	1886	25	22.18
OS03-14	1000	2303	25	32.60
OS03-15	1000	2537	25	38.45
OS03-17	1000	2214	25	30.38
OS03-19	1000	2169	25	29.25
OS03-21	1000	2545	25	38.65
			Total Kms	470.275

A.2 PHASE MATCHING

All data was zero phased with the spectral estimate made using the Wiener-Levinson double inverse method. The data was then phase matched to the OS02 3D that was shot in the area. A 120 degree phase rotation and a -4 ms bulk shift was applied to match the 3D data. This was only applied to the final filtered stack data. It was not applied to the raw "true amplitude" unfiltered data, and it was not applied to the gathers.

A.3 DELIVERABLES

Item	Format	Media	Tape No.
Whale Analysis Raw Field Data (Single Channel)	SEGY	Exabyte	302RS001E
Final Filtered/Scaled Migrations (Original) Zero Phase & Phase Matched Full, Near and Far Datasets	SEGY	Exabyte	302FM002E
Final Filtered/Scaled Migrations (Copy1) Zero Phase & Phase Matched Full, Near and Far Datasets	SEGY	Exabyte	302FM003E
Final Filtered/Scaled Migrations (Copy2) Zero Phase & Phase Matched Full Dataset only	SEGY	Exabyte	302FM004E
Raw Migrations (Original) Full, Near and Far Datasets	SEGY	Exabyte	302RM005E
Raw Pre-Stack Time Migration gathers (Original)	SEGY	3590	302GA006C - 302GA010C
Final Stacking Velocities (PSTM) 0.5km Intervals	Western	CD	302FV011CD
Final Processing Report (Original)	PDF	CD	302FR012CD
Final Processing Report (Copy 1)	PDF	CD	302FR013CD
Final Processing Report (Copy 2)	PDF	CD	302FR014CD
CDP End-Point Co-ordinates	ASCII	Floppy Disk	302XY015F
Final Processing Report	Paper Copy		