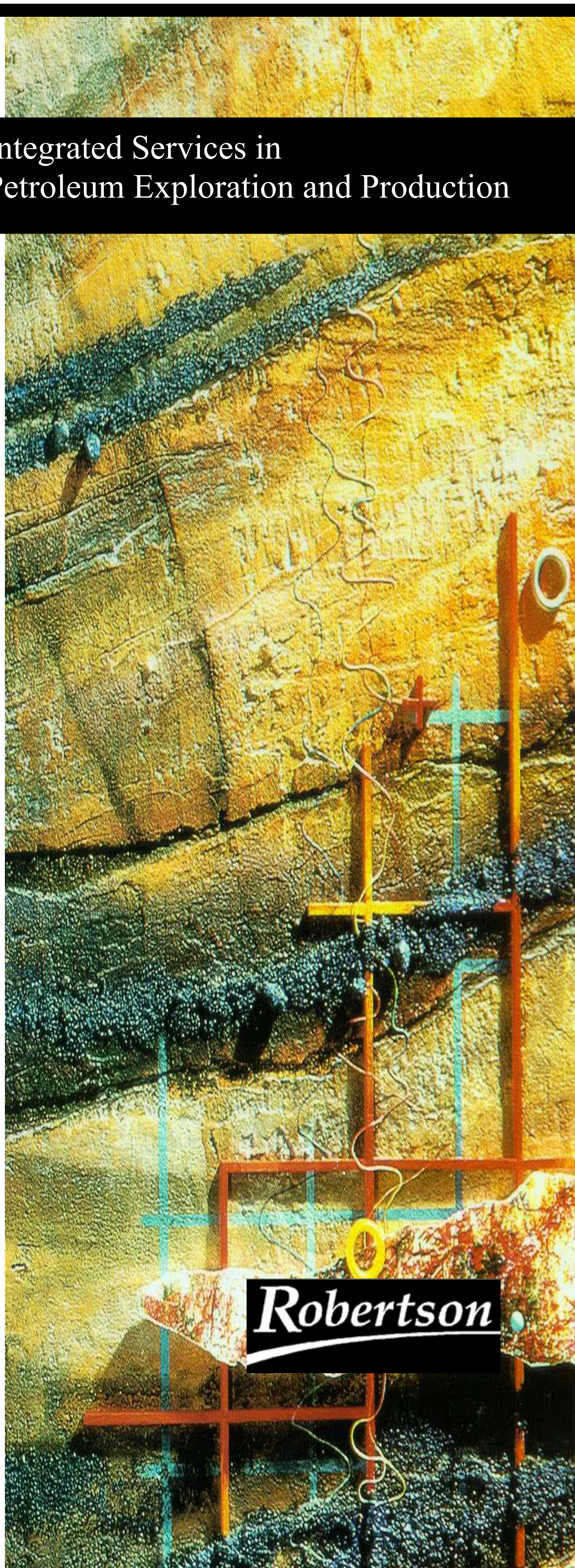
Integrated Services in
Petroleum Exploration and Production



Processing Report

for

2002 Otway Basin Processing Survey OS02 2D

Area: Otway Basin, VIC/P52

March 2003

Robertson Research
Australia Pty. Ltd.

69 Outram Street
West Perth WA 6005
Australia

Tel: +61 (0)8 9322 2490
Fax: +61 (0)8 9481 6721
E-mail: info@robres.com.au

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

The 2002 OS02 2D Otway Basin Processing consisted of 30 lines, totalling 1262 km. The majority of lines were in deep water with a maximum water bottom time of approximately 4000ms. Lines went into water depths as shallow as 200ms. With these dramatically varying water depths, all processes (muting, filtering etc) that were sensitive to changing water depths had parameters that were keyed on water bottom times. The data was recorded in November 2002 with the processing being completed in March 2003.

1.1 PERSONNEL

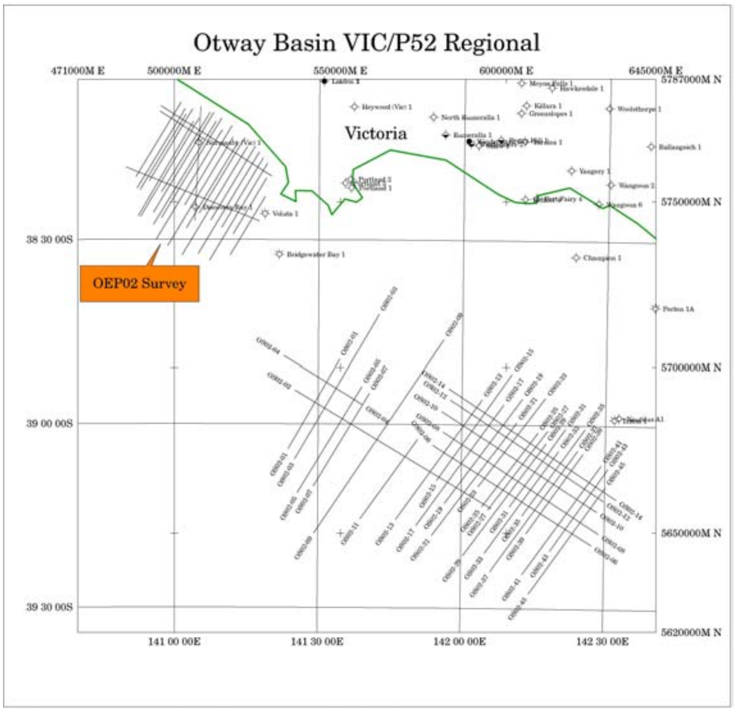
Robertson Research Australia

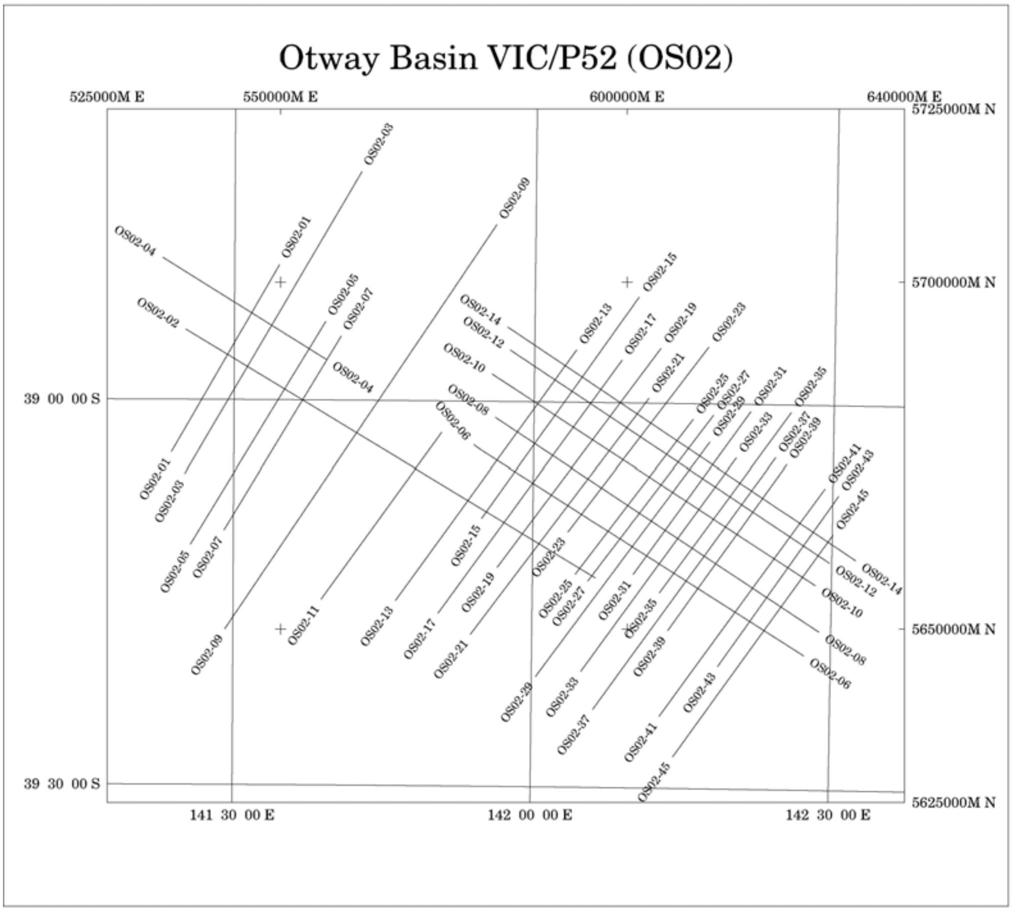
Kelly Beauglehole	Processing Manager
Simon Stewart	Marine Processing Manager
Paul Phythian	Geophysicist

Santos Limited

Stuart Brew	Senior Staff Geophysicist (Santos)
John Cant	Consulting Geophysicist

1.2 SURVEY MAP





2.0 PARAMETER TESTING

Line OS02-37 was the first line shot and was selected as the test line. Only initial pre-stack testing was done on this line. Due to its variable water depths, along with the fact that it passed over the 3D area, line OS02-09 was chosen for the majority of the testing. Line OS02-08 was also chosen to be used in testing due to its rugged water bottom and the fact that it suffered badly from the PreSTM artefacts. It was also a strike line, which ensured parameter decisions were appropriate for the survey as a whole.

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 and receiver domain)	✔		✔
F-K filter with NMO (shot and receiver domain)	✔		✔
Signature deconvolution	✔		✔
Tau-P deconvolution	✔		✔
Multiple attenuation: F-K method		✔	✔
Multiple attenuation: Radon method		✔	✔
Predictive deconvolution (before stack)			✔
PSTM Testing		✔	✔
Moveout Equation Multiple Attenuation (MEMUL)		✔	✔
FK Dip Filter (Common Offset Planes & CDP's)		✔	✔
Trace Mix (Common Offset Planes & CDP's)		✔	✔
Outer and inner trace mutes		✔	✔
Bandpass filter and Post stack scaling			✔
Noise attenuation (Tau-P Filter)			✔

3.0 COMMENTS & CONCLUSION

The processing was completed in April 2003. Post stack fast track volumes (Near, Far and Full fold) were archived and delivered on the 22nd of January to allow preliminary interpretation to begin. Along with the final Pre Stack Time Migrated archive (Raw and Filtered/Scaled), near and far angle stack archives as well as Pre Stack Time Migrated gathers were archived. The gathers were NMO corrected with the final 0.5km velocities. The t^2 gain recovery, that was applied at the start of processing, was removed and an Ursin spherical divergence, with dB gain, was applied. See section 5 for parameter details. The Near and Far angle stacks had the same scaling (t^2 removed and Ursin spherical divergence, with dB gain) applied. Final Migration paper displays and CGM+ files, displayed at 1:50,000 horizontal scale and 5cm/sec vertical scale, were also delivered.

The entire survey suffered from swell noise to some degree. All data however responded well to the swell noise attenuation processing. Portions of lines 19 & 21 required re-shooting due to the noise being out of recording specifications. From a processing point of view this did not make a significant difference to the final product.

With many of the lines having a very rugged and undulating water bottom profile, multiples of the water bottom diffraction caused quite severe migration artefacts after Pre Stack Time Migration. These multiples, due to their non parabolic nature, did not respond to conventional demultiple (Radon or F-K). The post stack time migration “fast-track” data didn’t suffer as badly due to the cancellation of this “noise” in the stack prior to the migration, however migration artefacts were still present on the post stack volume. These migration artefacts were especially a problem with the strike lines while the dip lines, even though they had quite variable water depths, their water bottom profiles were generally gently sloping which in turn didn’t pose the same problems for the PSTM.

With respect to the migration artefacts, the best result from testing came from application of a Moveout Equation Multiple (MEMUL) attenuation in combination with a F-K dip filter both applied in common offset planes.

Since we had output a fast-track data-set which was a DMO/Post Stack Migration flow, using the production demultiple gathers, all observed differences were a comparison to this product. In targeting the PSTM artefacts with the F-K dip filter in the common offsets there were some degradation of fault planes. The benefit though, since we had attenuated these migration “smiles”, was a clear improvement of horizon continuity, especially in the shallow fault blocks. The PSTM and resultant improved PSTM velocity analysis made the deeper section much more interpretable, where previously it was hard to track horizons confidently across seismic sections.

4.0 PROCESSING SEQUENCE

4.1 POST STACK TIME MIGRATION SEQUENCE

TRANSCRIPTION
|
LOW CUT FILTER
|
GAIN RECOVERY (t^2)
|
SWELL NOISE ATTENUATION
|
F-K FILTER (shot & receiver domain +/- 1750 m/s)
|
SIGNATURE DECONVOLUTION (6/18-80/36, Hz/dB/Octave)
|
ADJACENT TRACE SUM
|
CDP GATHER
|
FIRST PASS VELOCITY ANALYSIS (2 km intervals)
|
MULTIPLE ATTENUATION (F-K)
|
DMO
|
SECOND PASS VELOCITY ANALYSIS (1 km intervals)
|
NMO CORRECTION & MUTES
|
CDP STACK
|
GUN & CABLE STATIC CORRECTIONS
|
FINITE DIFFERENCE MIGRATION
|
ZERO PHASING & PHASE ROTATION
| → ANGLE STACKS (*) (See section 4.2)
BAND-PASS FILTER
|
POST STACK SCALING (+)

(*) Near and Far Angle stack archive. See section 5 for parameter details.

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

4.2 ANGLE STACK SEQUENCE

TRANSCRIPTION
|
LOW CUT FILTER
|
GAIN RECOVERY (t^2)
|
SWELL NOISE ATTENUATION
|
F-K FILTER (shot & receiver domain +/- 1750 m/s)
|
SIGNATURE DECONVOLUTION (6/18-80/36, Hz/dB/Octave)
|
ADJACENT TRACE SUM
|
CDP GATHER
|
FIRST PASS VELOCITY ANALYSIS (2 km intervals)
|
MULTIPLE ATTENUATION (F-K)
|
DMO
|
NMO CORRECTION
|
OUTER TRACE MUTE
|
PRE STACK SCALING
|
INNER TRACE MUTE
|
CDP STACK (Near, Far & Full Volumes)
|
GUN & CABLE STATIC CORRECTIONS
|
FINITE DIFFERENCE MIGRATION (Near, Far & Full Volumes)
|
ZERO PHASING & PHASE ROTATION
|
ARCHIVE (Near & Far Volumes)

4.3 PRE STACK TIME MIGRATION SEQUENCE

TRANSCRIPTION
|
LOW CUT FILTER
|
GAIN RECOVERY (t^2)
|
SWELL NOISE ATTENUATION
|
F-K FILTER (shot & receiver domain +/- 1750 m/s)
|
SIGNATURE DECONVOLUTION (6/18-80/36, Hz/dB/Octave)
|
ADJACENT TRACE SUM
|
CDP GATHER
|
FIRST PASS VELOCITY ANALYSIS (2 km intervals)
|
MULTIPLE ATTENUATION (FK)
|
SECOND PASS (PSTM) VELOCITY ANALYSIS (1 km intervals)
|
KIRCHHOFF PRE-STACK TIME MIGRATION (*)
|
THIRD PASS VELOCITY ANALYSIS (0.5 km intervals) (+)
|
NMO CORRECTION
|
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 → ANGLE STACKS (#) (See section 4.4)
|
POST STACK SCALING (&)

(*) Pre Stack Time Migration gather archive. 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)

(@) Raw PSTM stack archive. T squared scaling backed off and Ursin spherical divergence, with a water bottom dependent gain, applied. See section 5 for parameter details.

(#) Near and Far angle PSTM stack archive. T squared scaling backed off and Ursin spherical divergence, with a water bottom dependent gain, applied. See section 5 for parameter details.

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

4.4 PRE STACK TIME MIGRATED ANGLE STACKS SEQUENCE

TRANSCRIPTION
|
LOW CUT FILTER
|
GAIN RECOVERY (t^2)
|
SWELL NOISE ATTENUATION
|
F-K FILTER (shot & receiver domain +/- 1750 m/s)
|
SIGNATURE DECONVOLUTION (6/18-80/36, Hz/dB/Octave)
|
ADJACENT TRACE SUM
|
CDP GATHER
|
FIRST PASS VELOCITY ANALYSIS (2 km intervals)
|
MULTIPLE ATTENUATION (FK)
|
SECOND PASS (PSTM) VELOCITY ANALYSIS (1 km intervals)
|
KIRCHHOFF PRE-STACK TIME MIGRATION
|
REMOVE GAIN RECOVERY (t^2)
|
URSIN SPHERICAL DIVERGENCE
|
WATER BOTTOM DEPENDENT GAIN
|
NMO CORRECTION (*)
|
OUTER / INNER TRACE MUTES
|
CDP STACK (Near & Far)
|
GUN & CABLE STATIC CORRECTIONS
|
ZERO PHASING & PHASE MATCHED TO OS02 3D
|
BAND-PASS FILTER (#)

(*) Pre Stack Time Migration gather archive. 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.

(#) Near and Far angle PSTM stack archive. T squared scaling backed off and Ursin spherical divergence, with a water bottom dependent gain, applied. See section 5 for parameter details.

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 LOW-CUT FILTER

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

5.3 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.

5.4 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.

5.5 MULTI CHANNEL FILTER (SHOT & RECEIVER 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 1750 m/sec was used for the shot and receiver domain. All F-K filtering had NMO applied.

5.6 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 -6 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 6-80 Hz with filter slopes of 18 dB/oct for the low-cut and 36 dB/oct for the high-cut.

Design Windows

Water Bottom Time : 100ms		*Water Bottom Time : 500ms*	
Offset (m)	*Application times (ms)*	*Offset (m)*	*Application times (ms)*
500	500 - 3500	500	700 - 3650
4122	3000 - 5600	4122	3100 - 6100

Water Bottom Time : 1000ms		*Water Bottom Time : 2000ms*	
Offset (m)	*Application times (ms)*	*Offset (m)*	*Application times (ms)*
500	1150 - 4150	500	1900 - 5100
4122	3100 - 6100	4122	2900 - 6200

Water Bottom Time : 3000ms		*Water Bottom Time : 4000ms*	
Offset (m)	*Application times (ms)*	*Offset (m)*	*Application times (ms)*
500	2900 - 6100	500	2900 - 7100
4122	3600 - 7000	4122	4500 - 7500

5.7 ADJACENT TRACE SUM

A 2:1 adjacent trace sum was applied to form a 37.5m / 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 – 5000	0 - 1 - 2 - 1 - 0
8000 - 10240	1 - 2 - 3 - 2 - 1

Summation Details :

Input Traces	Input Trace Interval	Output Traces	Output Trace Interval
576	12.5m	288	25m

5.8 CDP GATHER

The shot records were sorted into common depth point gathers.

5.9 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.

5.10 DEMULTIPLE (F-K)

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 10240ms.

Time (ms)	*Velocity Percentage*
0	94
800	92
2500	92
4500	90
6500	88
10000	85

Adjacent CDP’s were merged to form supergathers (thus reducing the potential for aliasing). After demultiple the supergathers were split back to their original component CDP’s. A 300ms AGC was applied prior to, and removed after, multiple attenuation.

5.11 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 96.

5.12 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.

5.13 NMO CORRECTION (Fast Track Only)

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

5.14 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.

Water Bottom Time : 250ms		*Water Bottom Time : 600ms*	
Offset (m)	*Application times (ms)*	*Offset (m)*	*Application times (ms)*
258	0	130	300
360	200	588	300
720	600	1008	1000
2734	1750	2950	2050
5454	3100	5572	3300
8778	4450	8778	4450

Water Bottom Time : 1000ms		*Water Bottom Time : 2000ms*	
Offset (m)	*Application times (ms)*	*Offset (m)*	*Application times (ms)*
130	800	130	1800
768	800	1046	1800
1098	1400	1368	2400
3018	2525	3220	3500
5610	3800	5721	4700
8778	5100	8778	5900

Water Bottom Time : 3000ms		*Water Bottom Time : 3700ms*	
Offset (m)	*Application times (ms)*	*Offset (m)*	*Application times (ms)*
130	2800	130	3500
1440	2800	2040	3500
1800	3400	2460	4200

3544	4300	4039	5100
5899	5300	6171	6050
8778	6500	8778	7100

5.15 PRE-STACK SCALING (Fast Track Only)

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

Window lengths of 1200 ms and 400 ms
Equalisation applied : 60
Short window stopped 8000 ms

5.16 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.

Water Bottom Time : 100ms		*Water Bottom Time : 500ms*	
Offset (m)	*Application times (ms)*	*Offset (m)*	*Application times (ms)*
130	900-10240	130	1300-10240
800	2100-10240	1100	2500-10240

Water Bottom Time : 1000ms		*Water Bottom Time : 2000ms*	
Offset (m)	*Application times (ms)*	*Offset (m)*	*Application times (ms)*
130	1800-10240	130	3000-10240
1300	3000-10240	1400	4200-10240

Water Bottom Time : 3000ms		*Water Bottom Time : 4000ms*	
Offset (m)	*Application times (ms)*	*Offset (m)*	*Application times (ms)*
130	4200-10240	130	5200-10240
1600	5400-10240	1600	6400-10240

5.17 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 96.

5.18 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.

5.19 SCALING (Fast Track Only)

Water bottom dependent gain function applied to balance the amplitudes of the deeper part of the section. The function applied was:

Time (ms)	*Scalar (dB)*
WB	0
WB+1000	5
WB+2000	10
WB+10000	10

5.20 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 stacking velocities with the following percentages of reduction.

Time (ms)	*% of velocity*
0	100
WB+2500	100
WB+5000	96
WB+10000	85

5.21 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.

5.22 ANGLE STACKS (Fast Track Only)

Using the full fold inner and outer trace mutes, the remaining “live” data was split (equal fold) to produce near and far angle stack volumes. Note: Pre Stack Scaling (5.19) was applied to the angle stacks.

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:

Water Bottom Time : 200ms		*Water Bottom Time : 1000ms*	
Time (ms)	Frequency limits (Hz)	*Time (ms)*	Frequency limits (Hz)
500	6-10-80-96	1000	6-10-80-96
1400	6-10-70-84	1800	6-10-70-84
2300	6-10-60-72	2600	6-10-60-72
3200	6-10-50-60	3400	6-10-50-60
4100	6-10-40-50	4200	6-10-40-50
5000	6-10-30-40	5000	6-10-30-40
5800	6-10-25-35	5800	6-10-25-35
6500	6-10-20-30	6500	6-10-20-30
7500	6-10-15-25	7500	6-10-15-25

Water Bottom Time : 1600ms		*Water Bottom Time : 2500ms*	
Time (ms)	Frequency limits (Hz)	*Time (ms)*	Frequency limits (Hz)
1600	6-10-80-96	2500	6-10-80-96
2300	6-10-70-84	3200	6-10-70-84
3000	6-10-60-72	3900	6-10-60-72
3700	6-10-50-60	4600	6-10-50-60
4400	6-10-40-50	5300	6-10-40-50
5100	6-10-30-40	6000	6-10-30-40
5800	6-10-25-35	6700	6-10-25-35
6500	6-10-20-30	7400	6-10-20-30
7500	6-10-15-25	8000	6-10-15-25

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 THIRD PASS VELOCITY ANALYSIS (Flow continued from 5.8)

The third and final pass of velocities, picked at 0.5km 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 MOVEOUT-EQUATION MULTIPLE ATTENUATION

Moveout-equation based multiple elimination method, which consists of two steps. Extrapolating an observed record through an additional round trip to the sea floor, and subtracting modelled multiples from the original traces. The multiple subtraction is accomplished by an adaptive matching. The whole process was applied to common offset planes.

5.27 PRE-STACK TIME MIGRATION

Kirchhoff PreSTM was applied using a maximum half aperture of 300 traces (3750m). Apertures were muted with a 50% stretch mute to avoid operator aliasing. Smoothed third pass velocities were scaled (see table below) and used in the migration. Migration was performed on all 96 offset planes.

Time (ms)	*% of velocity*
WB	100
WB+2500	100
WB+5000	96
WB+10000	85

5.28 F-K DIP FILTER

An F-K dip filter, set to attenuate all dips above +/-5ms per trace, was applied in an attempt to eliminate resulting migration artefacts. This was applied to common offset planes.

5.29 FOURTH 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 NMO CORRECTION

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

5.31 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.

Water Bottom Time : 250ms		*Water Bottom Time : 600ms*	
Offset (m)	*Application times (ms)*	*Offset (m)*	*Application times (ms)*
258	0	130	300
360	200	588	300
720	600	1008	1000
2734	1750	2950	2050
5454	3100	5572	3300
8778	4450	8778	4450

Water Bottom Time : 1000ms		*Water Bottom Time : 2000ms*	
Offset (m)	*Application times (ms)*	*Offset (m)*	*Application times (ms)*
130	800	130	1800
768	800	1046	1800
1098	1400	1368	2400
3018	2525	3220	3500
5610	3800	5721	4700
8778	5100	8778	5900

Water Bottom Time : 3000ms		*Water Bottom Time : 3700ms*	
Offset (m)	*Application times (ms)*	*Offset (m)*	*Application times (ms)*
130	2800	130	3500
1440	2800	2040	3500
1800	3400	2460	4200
3544	4300	4039	5100
5899	5300	6171	6050
8778	6500	8778	7100

5.32 PRE-STACK SCALING

A post-NMO outer trace mute was applied for two main reasons :
General Parameter Summary:
Window lengths of 1200 ms and 400 ms
Equalization applied : 60
Short window stopped 8000 ms
Note: Scaling only applied to the Final Filtered and Scaled Pre Stack Time Migrated dataset.

5.33 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.

Water Bottom Time : 100ms		*Water Bottom Time : 500ms*	
Offset (m)	*Application times (ms)*	*Offset (m)*	*Application times (ms)*
130	900-10240	130	1300-10240
800	2100-10240	1100	2500-10240

Water Bottom Time : 1000ms		*Water Bottom Time : 2000ms*	
Offset (m)	*Application times (ms)*	*Offset (m)*	*Application times (ms)*
130	1800-10240	130	3000-10240
1300	3000-10240	1400	4200-10240

Water Bottom Time : 3000ms		*Water Bottom Time : 4000ms*	
Offset (m)	*Application times (ms)*	*Offset (m)*	*Application times (ms)*
130	4200-10240	130	5200-10240
1600	5400-10240	1600	6400-10240

5.34 COMMON DEPTH POINT STACK

The traces within each common depth point gather were summed using 1/root(N) stack compensation. Nominal fold is 96.

5.35 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 10ms static correction was applied to all lines.

5.36 SCALING

Water bottom dependent gain function applied to balance the amplitudes of the deeper part of the section. The function applied was:

Time (ms)	*Scalar (dB)*
WB	0
WB+1000	5
WB+2000	10
WB+10000	10

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:

Water Bottom Time : 200ms		*Water Bottom Time : 1000ms*	
Time (ms)	Frequency limits (Hz)	*Time (ms)*	Frequency limits (Hz)
500	6-10-80-96	1000	6-10-80-96
1400	6-10-70-84	1800	6-10-70-84
2300	6-10-60-72	2600	6-10-60-72
3200	6-10-50-60	3400	6-10-50-60
4100	6-10-40-50	4200	6-10-40-50
5000	6-10-30-40	5000	6-10-30-40
5800	6-10-25-35	5800	6-10-25-35
6500	6-10-20-30	6500	6-10-20-30
7500	6-10-15-25	7500	6-10-15-25

Water Bottom Time : 1600ms		*Water Bottom Time : 2500ms*	
Time (ms)	Frequency limits (Hz)	*Time (ms)*	Frequency limits (Hz)
1600	6-10-80-96	2500	6-10-80-96
2300	6-10-70-84	3200	6-10-70-84
3000	6-10-60-72	3900	6-10-60-72
3700	6-10-50-60	4600	6-10-50-60
4400	6-10-40-50	5300	6-10-40-50
5100	6-10-30-40	6000	6-10-30-40
5800	6-10-25-35	6700	6-10-25-35
6500	6-10-20-30	7400	6-10-20-30
7500	6-10-15-25	8000	6-10-15-25

5.39 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 (5.32), the water bottom dependent scaling (5.36) and the Post Stack Scaling (5.37) 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	5
WB+3000	15
WB+10000	15

5.40 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.

6.0 ACQUISITION PARAMETERS

Data recorded by:	Multiwave Geophysical Company
Date recorded:	2002
Vessel:	R/V Polar Duke
Seismic Source:	
Type:	Sleeve Airgun
Pressure/Volume:	2000 psi / 3500 cu.in.
Depth:	5m
Shot interval:	37.5m
Gun delay:	0
Recording System:	
Record length:	10244 ms
Sample interval:	2 ms
Filters:Low	3 Hz - 6 dB / Octave
:High	206 Hz – 276 dB / Octave
Streamer:	
Streamer length:	7187.5 m
Streamer depth:	7 m
No. of groups:	576
Near group no:	576
Group interval:	12.5 m
Near group offset:	140 m
Antenna-source:	130.4 m
SP annotation:	SHOTPOINT

APPENDICES

A.1 LINE LISTING

Line	1st SP	Lst SP	SP Int	Kms
OS02-01	1728	897	37.5	31.20
OS02-02	1001	2844	37.5	69.15
OS02-03	1001	2347	37.5	50.51
OS02-04	1640	897	37.5	27.90
OS02-05	1897	897	37.5	37.54
OS02-06	1001	2507	37.5	56.51
OS02-07	1001	1871	37.5	32.66
OS02-08	1001	2496	37.5	56.10
OS02-09	1001	2874	37.5	70.28
OS02-10	2382	897	37.5	55.73
OS02-11	1688	897	37.5	29.70
OS02-12	2373	897	37.5	55.39
OS02-13	2190	1001	37.5	44.63
OS02-14	2506	897	37.5	60.38
OS02-15	1001	2045	37.5	39.19
OS02-17	2099	897	37.5	45.11
OS02-19	1001	2051	37.5	39.41
OS02-21	2034	897	37.5	42.68
OS02-23	1001	1894	37.5	33.53
OS02-25	1644	897	37.5	28.05
OS02-27	1696	897	37.5	30.00
OS02-29	2020	897	37.5	42.15
OS02-31	1001	1772	37.5	28.95
OS02-33	1001	2016	37.5	38.10
OS02-35	1001	1859	37.5	32.21
OS02-37	2094	897	37.5	44.93
OS02-39	1683	897	37.5	29.51
OS02-41	1001	2084	37.5	40.65
OS02-43	1001	1805	37.5	30.19
OS02-45	1950	897	37.5	39.53
			Total Kms	1261.84

A.2 PHASE MATCHING

All data was zero phased with the spectral estimate made using the Wiener-Levinson double inverse method. The data was phase matched to the OS02 3D that was shot in the area. A 120 degree phase rotation and a -16 ms bulk shift was applied to match the 3D data.

A.3 DELIVERABLES

Item	Format	Media	Tape No.
Raw Migration and Final Filtered/Scaled Migrations (Original)	SEGY	Exabyte	227FM001E
Raw Migration and Final Filtered/Scaled Migrations (Copy 1)	SEGY	Exabyte	227FM002E
Raw Migration and Final Filtered/Scaled Migrations (Copy 2)	SEGY	Exabyte	227FM003E
Raw Migration and Final Filtered/Scaled Migrations (Copy 3) – Truncated Lines	SEGY	Exabyte	227FM004E
Near and Far Angle Stacks (Original)	SEGY	Exabyte	227AS006E
Near and Far Angle Stacks (Copy 1)	SEGY	Exabyte	227AS007E
Near and Far Angle Stacks (Copy 2)	SEGY	Exabyte	227AS033E
Near and Far Angle Stacks (Copy 3) Truncated Lines	SEGY	Exabyte	227AS034E
Final (PSTM) Velocities 0.5km Intervals (Copy 1)	Western	CD	227FV036CD
Final (PSTM) Velocities 0.5km Intervals (Copy 2)	Western	CD	227FV037CD
Final (PSTM) Velocities 0.5km Intervals (Copy 3)	Western	CD	227FV038CD
Final (PSTM) Velocities 0.5km Intervals (Copy 4)	Western	CD	227FV039CD
Final Processing Report	PDF	CD	227FR040CD
Pre-Stack Time Migration gathers (Original)	SEGY	3590	227GA009C - 227GA020C
Pre-Stack Time Migration gathers (Copy 1) – Truncated Lines	SEGY	3590	227GA021C - 227GA032C
Final Migrations (CGM+ display files) (Original)	CGM+	Exabyte	227FD008E
Final Migrations (CGM+ display files) (Copy 1)	CGM+	Exabyte	227FD035E
Final Migrations (Paper displays)	Paper Print (1:50,000 scale, 5cm/sec)		