

Data Processing Report

for

Santos

Area: Sorell Basin SS02

Permits: T/32P, T/33P

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Table of Contents

1.0 INTRODUCTION	4
2.0 TESTING	5
3.0 PRE-STACK SEISMIC DATA PROCESSING	6
3.1 REFORMAT	6
3.2 LINE MERGING	6
3.3 MARINE 2D GEOMETRY	6
3.4 GUN AND CABLE CORRECTION	6
3.5 LOW-CUT FILTER	7
3.6 PRELIMINARY 8KM VELOCITY ANALYSIS	7
3.7 COMMON RECEIVER POINT GATHER	7
3.8 SWELL NOISE ATTENUATION (SWATT)	7
3.9 COMMON SHOT POINT GATHER	9
3.10 F-K DIP FILTER	9
3.11 RESAMPLE	11
3.12 PRESTACK SHOT INTERPOLATION (2.5D)	11
3.13 K-FILTER / TRACE REDUCTION	11
3.14 COMMON MID POINT GATHER	12
3.15 2KM VELOCITY ANALYSIS	12
3.16 RADON MULTIPLE ATTENUATION	13
3.17 DATA REDUCTION	16
3.18 MARINE 2D GEOMETRY	16
3.19 1KM VELOCITY ANALYSIS	16
3.20 TVF	16
3.21 KIRCHHOFF PRE-STACK TIME MIGRATION	17
3.22 GEOMETRIC SPREADING AMPLITUDE COMPENSATION	19
3.23 FINAL 500M VELOCITY ANALYSIS	19
3.24 NORMAL MOVEOUT	19
3.25 RADON MULTIPLE ATTENUATION	20
3.26 CMP GATHER ARCHIVE	20
3.27 SCALING (INSTANTANEOUS GAIN)	20
3.28 MUTE	21
3.28.1 Inner Trace Mute	21
3.28.2 Outer Trace Mute	21
3.29 STACK	23
3.30 WATER BOTTOM TIME UPDATE	23
3.31 NAVIGATION/SEISMIC DATA MERGE	23
3.32 DATA ARCHIVE	23
4.0 POST-STACK SEISMIC DATA PROCESSING	24
4.1 TAU-P COHERENCY FILTER	24
4.2 TRACE MIX	24
4.3 TVF	25
4.4 SCALING (CASCADED INSTANTANEOUS GAIN)	26
4.5 CGM FILES	26
4.6 DATA ARCHIVE	26
4.7 ANGLE STACKS	26
4.7.1 Near angle stack	26
4.7.2 Far angle stack	26
4.8 DATA ARCHIVE	27
5.0 PERSONNEL	28
6.0 APPENDICES	29
6.1 SURVEY LOCATION MAP	29

6.2	SURVEY LINE INFORMATION	30
6.3	ACQUISITION PARAMETERS	31
6.4	NEAR TRACE OFFSETS	32
6.5	ACQUISITION LINE LISTING	33
6.6	FINAL PROCESSING LINE LISTING	34
6.7	MERGED LINE LISTING	34
6.8	SP/CMP RELATIONSHIPS	35
6.9	TESTING LOG	36
6.9.1	<i>Low Cut Filter</i>	36
6.9.2	<i>Initial Geometry test</i>	36
6.9.3	<i>Swatt</i>	36
6.9.4	<i>Shot FK filter</i>	37
6.9.5	<i>FK spectrum</i>	37
6.9.6	<i>Designature/resample</i>	38
6.9.7	<i>Deconvolution before stack</i>	38
6.9.8	<i>Shot Interpolation/CMP interleave/Intra-gather interpolation</i>	39
6.9.9	<i>Array forming/Kfilter, trace decimate</i>	39
6.9.10	<i>FK demultiple/Radon demultiple</i>	40
6.9.11	<i>Radon demultiple</i>	40
6.9.12	<i>Migration</i>	41
6.9.13	<i>Hybrid Depth migration</i>	42
6.9.14	<i>Pre-migration noise reduction</i>	42
6.9.15	<i>Radon demultiple (final pass)</i>	42
6.9.16	<i>Prestack Scaling</i>	43
6.9.17	<i>Near and Far angle mutes</i>	43
6.9.18	<i>Post stack Noise Reduction</i>	43
6.9.19	<i>Post stack Time Variant Filter (TVF)</i>	44
6.9.20	<i>Post stack scaling</i>	44
6.10	DATA PROCESSING FLOWCHART	45
6.11	EXAMPLE DISPLAYS AT VARIOUS PROCESSING STAGES	47
6.11.1	<i>Line: SS02-05</i>	47
6.11.2	<i>Line: SS02-27</i>	49
6.12	TAPE DISPOSITION	51
6.13	SEG-Y TRACE HEADER BYTE LOCATIONS	52
6.13.1	<i>KPSTM CMP Gathers</i>	52
6.13.2	<i>Stack</i>	52

1.0 Introduction

This report details the data processing by WesternGeco of the 2D Marine Seismic survey shot in the Sorell Basin, west of Tasmania for Santos Limited. The survey was shot over 2 permits, T/32P and T/33P. The survey location map can be found in **Appendix 6.1**

The survey was acquired by Multiwave Geophysical Company's research vessel Polar Duke in December 2002. Acquisition parameters can be found in **Appendix 6.3** along with the navigation header information.

The primary target was the Paaratte formation with the Waarre formation as a secondary target. These are overlain by a thin Tertiary section generally less than 0.5 seconds in thickness. The Cretaceous section is generally between 0.5 and 2 seconds below the sea floor. Sea floor channels and filled canyons within the Tertiary cause water bottom diffractions with non-hyperbolic moveout and out of plane reflectors all of which in turn create significant migration artefacts. As the water bottom can reach 3km in places all 10 seconds of data was required to be processed.

The project consisted of approximately 1256 kilometres for processing. These kilometres were calculated by taking the distance between the first and last supplied shot point for each line using the nominal shot point interval, and removing any overlap between part lines. The area of coverage is shown in **Appendix 6.2**. Data processing was carried out between January 2003 and August 2003, the entire processing being performed and co-ordinated in the WesternGeco office in Perth, Western Australia. The list of lines acquired in the field can be found in **Appendix 6.5**. The list of processed lines and their extents can be found in **Appendix 6.6**.

The processing parameters were optimised and established with Stuart Brew, Senior Staff Geophysicist for Santos. Quality control of data and presentation of test results were either sent by mail to Santos' office in Adelaide, or coordinated through WesternGeco's Adelaide office if WesternGeco's in-house processing software, Omega, was required. The project was managed for WesternGeco by Alison Keighley with geophysical support from Richard Bisley and supervised by Paul Tredgett. Peter Wickens coordinated Omega (QCviewer and IVP) sessions for WesternGeco in WesternGeco's Adelaide office.

Multiwave Geophysical Company (MGC) provided processed P190 navigation files. These were used to update the seismic data headers with XY coordinate information and provide information on the location of merge points. MGC had also provided an 8km velocity field for each line but these were thought to be too fast so a preliminary 8km velocity field was picked by WesternGeco to drive the initial processing.

Example displays showing several processing stages for line SS02-05 and SS02-27 can be found in **Appendix 6.11**.

2.0 Testing

Santos requested that WesternGeco used 2 lines for initial testing. Line 11 in the Northern block was one of those selected as it showed some bright spots. Line 27 was selected for testing in the Southern block as it could be seen from initial QC displays that this line contained some linear noise when it went into shallow water. Swell noise attenuation was tested on line 19 as this was the worst affected line.

QC plots for tests included gathers and stacks before and after the processing and, in some instances, difference displays to help optimise parameters.

Testing was performed concurrently with the production. Some testing was performed on smaller sections of the lines to save time. The sections selected depended on the data and the type of test.

After the 2 pass radon production, Santos started to compare the results of the tests from the SS02-2D survey to the final results from the OS02-2D survey, an adjacent block processed by a different contractor. As Santos wanted the data quality to be similar they provided WesternGeco with the final report for the OS02-2D survey, which contained some of the processing flow parameters. Therefore some of the pre-stack SS02-2D tests had post stack processing applied to reduce noise and make the data look more similar to the OS02-2D.

For a listing of the major tests that were run, including processes that were tested but not used in production see **Appendix 6.9**.

3.0 Pre-Stack Seismic Data Processing

3.1 Reformat

The 576 trace de-multiplexed field data were reformatted from SEG-D to an in-house source-gathered seismic file format.

Diagnostics from the transcription programme list input and output record numbers, plus parity and block length errors. Each printout was checked against the observer logs to ensure that all the data had been correctly transcribed. Every 160th shot record and a near trace section were displayed for quality control on each line.

3.2 Line merging

There were two lines to merge, line SS02-11, sequences 6, 7 and 8 and line SS02-25, sequences 21 and 22. All part lines were shot in the same direction and merging of these lines was done prior to the application of nominal geometry. The part lines were merged based on the shot points provided by the observers logs and checked using source position navigation xy coordinates to ensure the shot points either side of the merge were the nominal shot point spacing apart. **Appendix 6.7** lists the merge points used for the 2 lines.

3.3 Marine 2D Geometry

Nominal marine 2D geometry was assigned to the data.

Parameter values:

Shot interval	: 37.5m
Receiver interval	: 12.5m
CMP interval	: 6.25m
Num of traces / CMP Fold	: 576 / 96
Near trace offset (trace 576)	: variable, see Appendix 6.3

3.4 Gun and Cable Correction

A gun and cable static correction was calculated using the following equation and then applied to the data:

$$\text{Correction} = (\text{Gun depth} + \text{Cable depth}) / \text{Water velocity}$$

Parameter values:

Gun Depth	: 5m
Cable Depth	: variable between 8m and 11m
Water Velocity	: 1500m/s
Static Correction	: variable between 9.75ms and 12ms

3.5 Low-cut Filter

A low-cut filter was applied to the data.

Parameter values:

Phase	: Minimum
Low-cut Frequency	: 3 Hz
Slope	: 18 dB/octave

3.6 Preliminary 8km Velocity Analysis

Velocity analysis was performed using WesternGeco's Interactive Velocity Processing (IVP™) system which displays all the relevant information on an X-terminal controlled by a UNIX- based workstation. This is an integrated velocity interpretation and QC system. This package has been designed to handle both 2D and large 3D surveys effectively.

At 8km intervals on each line, CMP gather data were selected. From this data Multi-Velocity Function (MVF) stacks and velocity semblance values were computed. For each velocity location, MVF data, semblances and gathers are displayed interactively in separate windows on the workstation. Changes made to one window are automatically applied to all other windows. Velocities can be picked from either the MVF or semblance display. When velocities are interpreted at a location a velocity database is updated and the CMP gather is displayed with the NMO correction.

Field velocities were provided by Multiwave Geophysical Co. These velocities were considered by WesternGeco to have been picked too fast and were therefore only used as the center function to generate the 8km preliminary velocities. The 8km velocity analyses were ftp'd to WesternGeco's Adelaide office for Santos' approval.

Parameter Values:

Analysis Spacing	: 8km
Number of CMPs per Analysis (MVF Stack)	: 11
Number of CMPs per Analysis (Semblance Display)	: 3

3.7 Common Receiver Point Gather

The data were sorted into common receiver position gathers.

3.8 Swell Noise Attenuation (SWATT)

Swell noise is caused by data acquisition in rough sea conditions, particularly when the cables are being towed at a relatively shallow depth. SWATT aims to attenuate this noise by transforming the processing gather into the frequency domain and applying a spatial median filter. Frequency bands that deviate from the median amplitude by a specified threshold are either zeroed, or replaced by good frequency bands interpolated from neighbouring traces. The gathers were NMO corrected using a constant velocity of 1700m/s prior to this process being applied and inverse NMO corrected using the same velocity afterwards.

Parameter values:

Width of Spatial Median Filter : 21 Traces
 Frequency Range Processed : 0 to 30Hz

Threshold Values:

Time (ms)	Threshold (%)
0	12
3000	12
5000	6
10500	3

NMO wraparound : constant 1700m/s
 Processing window : 0-1500ms

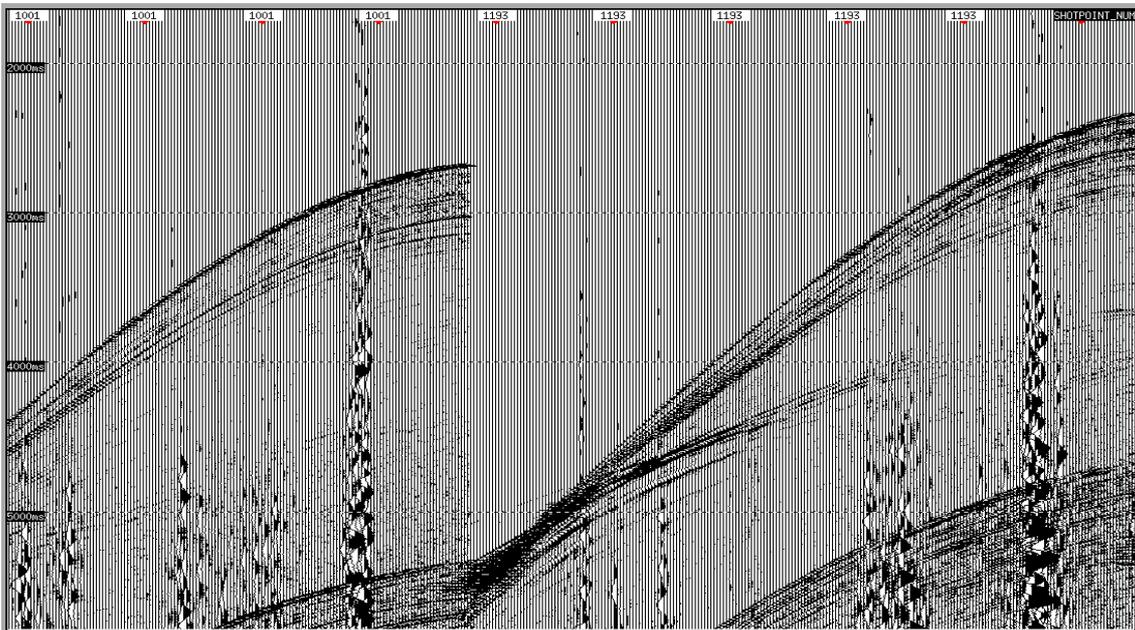


Figure 3.8.1: Shots without swatt applied, line SS02-19

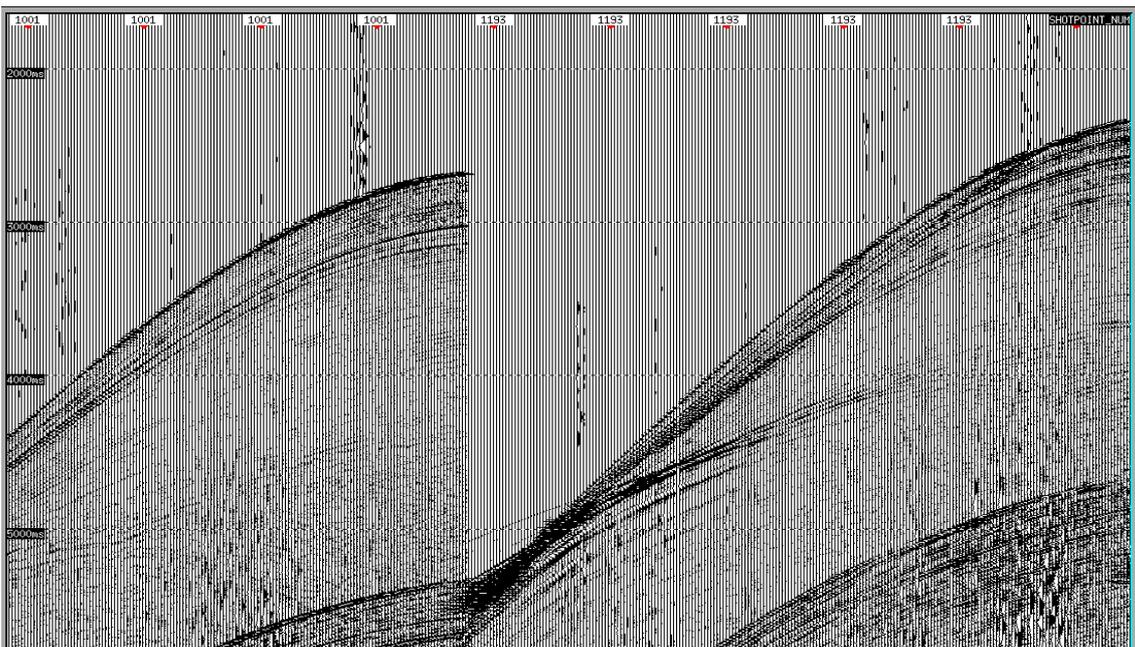


Figure 3.8.2: Shots with swatt applied, line SS02-19

3.9 Common Shot Point Gather

The data were then sorted back into common shot point gathers.

3.10 F-K Dip Filter

A seismic section such as a shot gather, CMP gather or stack section is a two-dimensional array of samples representing the amplitude of the seismic signal as a function of reflection time (t) and trace position (x). Dipping events (including linear noise) which overlap in this time-offset (t-x) domain cannot often be easily separated. However, a Fourier transform can be used to convert the seismic signal to the f-k domain, that is, to a function of temporal frequency (f) and spatial frequency or wavenumber (k). In this domain, dipping events plot along straight lines radiating outwards from the point of zero frequency and zero wavenumber. Gently dipping events plot closer to the frequency (vertical) axis (horizontal events actually plot along this axis), while steeply dipping events plot closer to the wavenumber (horizontal) axis. Events with a positive dip (that is, where the reflection time increases as the trace position increases) have positive wavenumbers and events with negative dips have negative wavenumbers. The events are therefore more easily separated in the f-k domain and unwanted events such as linear noise rejected by applying a user-specified filter. The data are then inverse Fourier transformed to the t-x domain.

(Note: The term dip refers only to the apparent dip of an event measured in time (ms/trace) or velocity ((ft or m)/s) and not to the actual spatial dip of the geologic structure.)

Parameter values:

Velocities (that is, seismic dip in m/s) were used to specify a fan-shaped region of f-k space. This region was passed and consisted of +/- 2100 m/s filter dips. A taper was also applied to the filter boundaries to smooth the transition between the pass and reject zones.

Low Dip Cutoff	: 2100 m/s
High Dip Cutoff	: 2100 m/s
Low Dip Taper (centred on the low dip cutoff)	: 300 m/s
High Dip Taper (centred on the high dip cutoff)	: 300 m/s
Taper Type	: Hanning

Fan Origin : Zero Frequency + Zero Wavenumber
The dips were therefore attenuated by the same factor for all frequencies.

NMO wraparound : : 8km velocity field

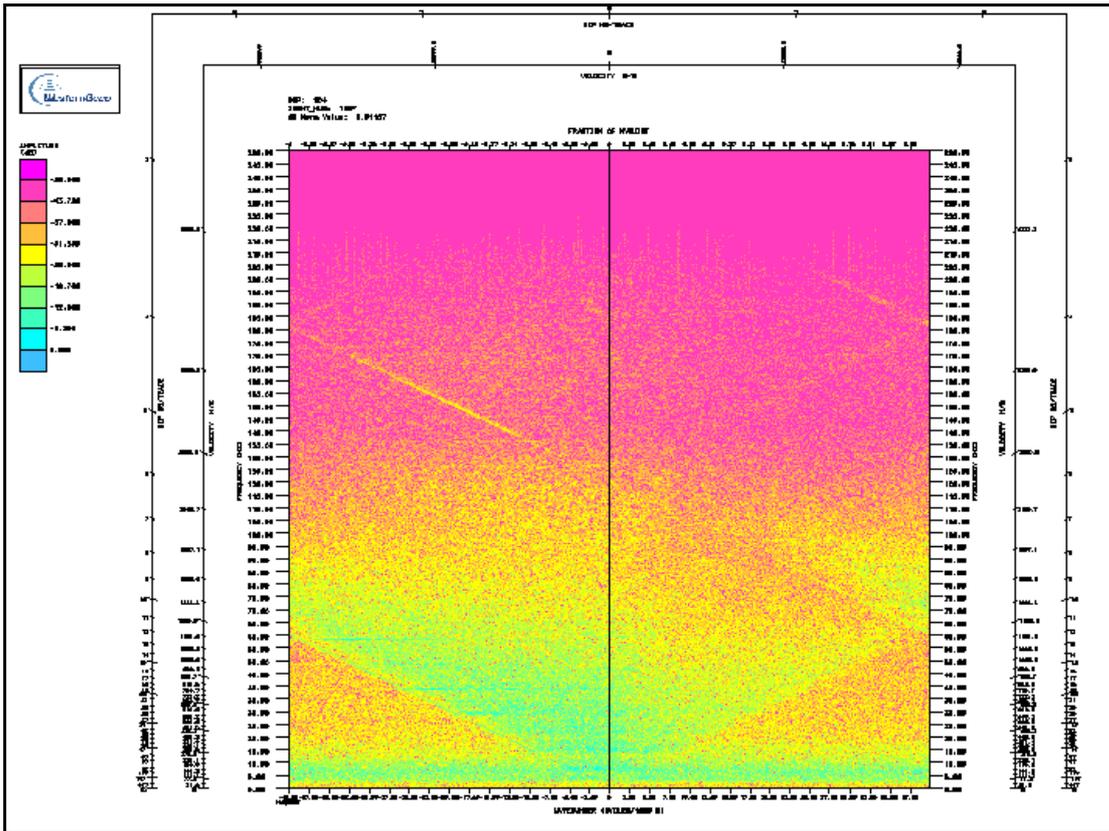


Figure 3.10.1: FK spectrum of a single shot, no FK filtering applied, line SS02-11

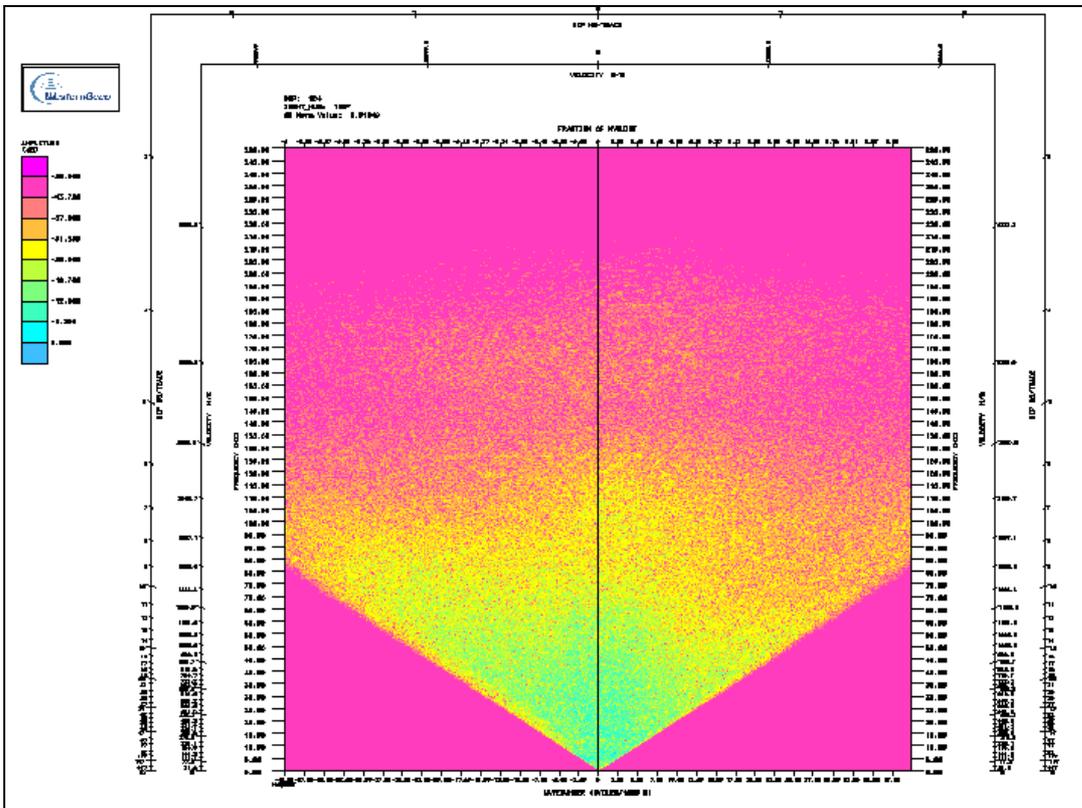


Figure 3.10.2: FK spectrum of a single shot, FK filtering applied, line SS02-11

3.11 Resample

An antialias filter was applied and the data were resampled.

Parameter values:

Input Trace Length	: 10240ms
Output Trace Length	: 10240ms
Input Sampling Interval	: 2.0ms
Output Sampling Interval	: 4.0ms
Antialias Filter:	
Phase	: Minimum
Cutoff Frequency	: 93.75Hz
Cutoff Slope	: 36dB/oct

3.12 Prestack Shot Interpolation (2.5D)

Input shot gathers are read and stored in the form of a cube where the x direction is receiver station number, the y direction is shot station number and the third direction is time. Interpolated shot gathers are then created by a '2.5 D' interpolation.

The cube of data is windowed in all 3 directions to create sub-volumes within which the interpolation takes place. These sub-volumes are overlapped to allow for blending of the interpolation results. This is done in order to conform to the premise of the algorithm that seismic events are linear or planar within each sub-volume.

NMO is also applied prior to interpolation to further conform to this assumption

In the '2.5 D' method, interpolation is then only carried out in the shot (or common detector) direction, after Fourier transform to the f-x-ky domain. The operator used is then an average for all the receivers in the time-space window, which should produce more reliable operators than a simple 2D receiver domain interpolator.

Parameter values:

Input source spacing	: 37.5m
Output source spacing	: 12.5m
Time window length	: 512ms
Time overlap	: 256ms
Maximum dip	: 40ms/tr
Window width in the detector direction	: 20 traces
Window width in the source direction	: 20 traces
Window overlap in the detector direction	: 6 traces
Window overlap in the source direction	: 6 traces

The data was interpolated to decrease the trace spacing within the CMP gathers, to help avoid aliasing in the radon demultiple process. Without interpolation, the trace spacing within the CMP gathers would have been 75m. Interpolation decreased the trace spacing to 25m. The interpolated traces were removed after the radon demultiple process.

3.13 K-Filter / Trace Reduction

A seismic section such as a shot gather, CMP gather or stack section is a two-dimensional array of samples representing the amplitude of the seismic signal as a function of reflection time (t) and trace position (x). A Fourier transform can be used to convert trace position to the spatial frequency or wavenumber (k) domain. A range of wavenumbers was specified to be

passed by the filter and a taper was also applied to the filter boundaries to smooth the transition between the pass and the reject regions.

After k-filtering, the number of traces in each shot record was reduced by dropping alternate traces. Consequently, the k-filter was chosen to act as an anti-aliasing filter in the wavenumber domain, attenuating energy that would otherwise have become aliased when the trace separation was doubled by the dropping of alternate traces. Odd numbered traces were rejected, thus preserving the near trace position (at trace 576).

For convenience, the k-filter was implemented in the f-k domain. A 2-D Fourier transform was used to convert trace position to the wavenumber domain and reflection time to the frequency (f) domain. After implementation of the k-filter the data were inverse Fourier transformed back to the t-x domain.

Parameter values:

Input Shot Records	: 576 traces
Output Shot Records	: 288 traces
High Wavenumber Cutoff	: 0.5 of k-Nyquist (relative to input trace separation)
Taper (centred on the high wavenumber cutoff)	: 0.1 of k-Nyquist

3.14 Common Mid Point Gather

The data were sorted into Common Mid Point (CMP) gathers.

3.15 2km Velocity Analysis

A 2km velocity analysis was performed using the 8km first pass velocity function as the central function. Similarly to the first pass velocity analysis, the 2km velocity analysis were ftp'd to WesternGeco's Adelaide office for Santos' approval.

To aid velocity picking, x and y co-ordinate information for each velocity location was loaded to IVP. This enables all the picks within a user-defined radius to be superimposed on the display. This is especially beneficial in areas where lines intersect, to ensure consistency in the velocity interpretation.

The data input to the velocity analyses were processed through FK demultiple using 80% of the 8km velocity function and applied from water bottom x 1.5.

Parameter Values:

Analysis Spacing	: 2km
Number of CMPs per Analysis (MVF Stack)	: 11
Number of CMPs per Analysis (Semblance Display)	: 3

As part of the QC process, each line was stacked using the 2km velocity field prior to radon demultiple being applied. The stack sections were SEG-Y'd to CD and sent to Santos for their approval.

3.16 Radon Multiple Attenuation

Radon Multiple Attenuation is principally a subtraction process. Unwanted coherent noise is isolated in the tau-p domain, inverse transformed to the x-t domain, and then subtracted from the original data. Multiple energy can be isolated in the tau-p domain because events with different velocities map to different parts of the domain.

CMP gather data are first NMO corrected which means that the primary reflections are over corrected while the multiples are broadly flat or under corrected after the NMO. For convenience we refer to over corrected data as having negative dip (decreasing time with increasing offset), under corrected data has positive dip (increasing time with increasing offset) and 'flat' means no change in time with increasing offset.

The data are then transformed into the tau-p domain by using either a parabolic, hyperbolic or linear radon transform.

The range of p traces was chosen to cover at least the range of multiple energy to be removed. It is not necessary to include primary data in the transform, though its inclusion does no harm. As traces within a gather do not have offsets from zero to infinity a Geometry Compensation Filter must be applied. This filter is deterministic, i.e., based solely on the geometry of the input data, and is used to focus the energy in the tau-p domain. The geometry compensation filter can either be effected using the 'least-squares approach' which separately compensates each p-trace at each temporal frequency or by using 'p-deconvolution', a more simplified approach which computes and applies a separate filter at each temporal frequency but across the p-traces.

To further refine the construction of the model of the multiple energy, parts of tau-p space representing primary energy were zeroed based on the knowledge that primary data is relatively flat and multiples are under corrected.

Inverse tau-p transform and inverse NMO produces a model of the multiple energy. This was subtracted from the original data to produce the multiple attenuated output.

Prior to the Radon transform a 300ms AGC scaling was applied to the data. This has the effect of reducing the impact on the transform of high amplitude events at near and far offsets. After the data were transformed back to the T-X domain the inverse of the scaling was applied, so essentially preserving relative amplitudes.

Santos required the long offset data to be kept for future AVO work, so the demultiple was run in 2 passes, first to help remove some of the linear noise which was cutting across the long offset data and second to remove the multiple energy.

Parameter values:**First Pass:**

NMO velocity	: 2km velocity field
Geometry Compensation Filter	: p-deconvolution
Number of p-traces used	: 373
Maximum frequency	: 93Hz
Moveout type	: Linear
Multiple moveout range	: 2000 to 4000ms
Minimum moveout (i.e. for the first p-trace)	: 2000ms
Maximum moveout (i.e. for the last p-trace)	: 4000ms
Maximum reference offset	: 7300m
Minimum application time	: 500ms

Second Pass (as first pass except):

Number of p-traces used	: 420
Moveout type	: Parabolic
Multiple moveout range	: -500 to 4000ms
Minimum moveout (i.e. for the first p-trace)	: 500ms
Maximum moveout (i.e. for the last p-trace)	: 4000ms

Note: Moveouts used in making intermediate p-traces were linearly interpolated between the minimum and maximum moveouts.

As part of the QC process, each line was stacked using the 2km velocity field. The stack sections were SEG-Y'd to DVD and sent to Santos for their approval.

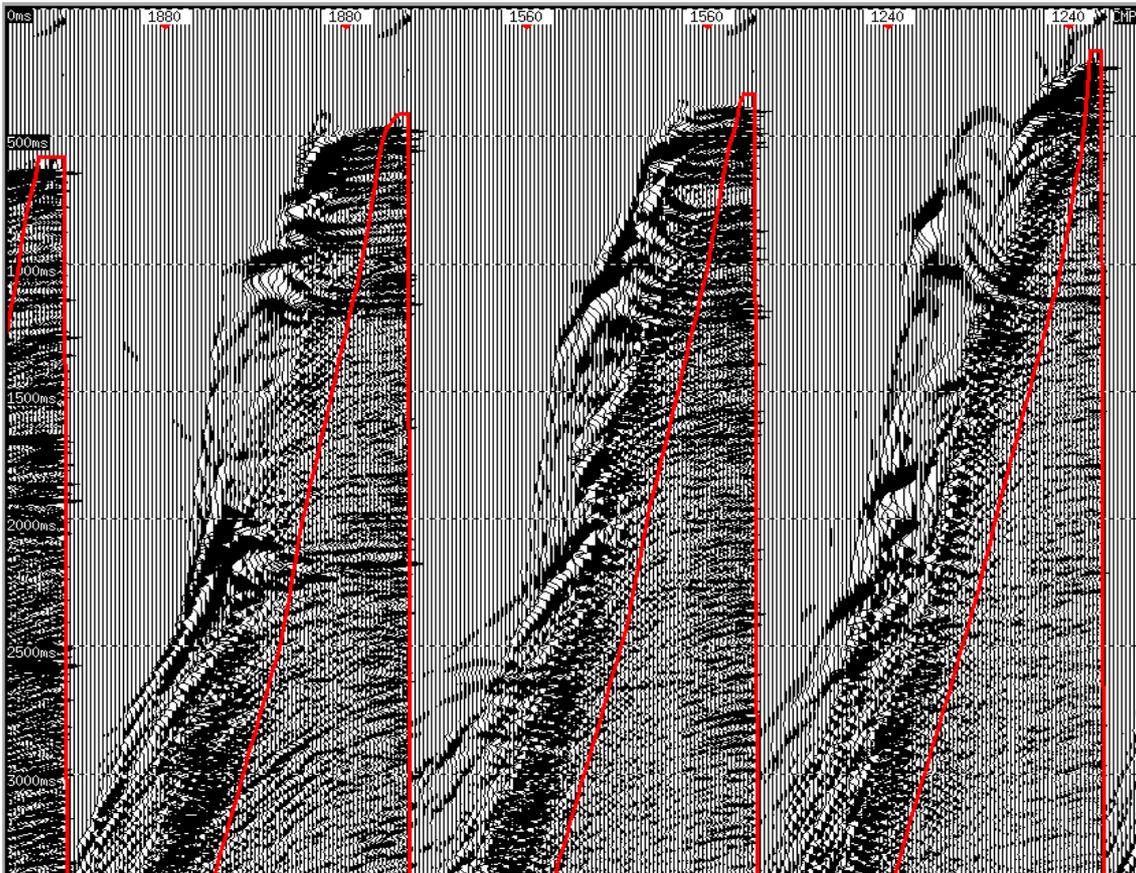


Figure 3.16.1: CMP gathers, no radon applied, line SS02-27

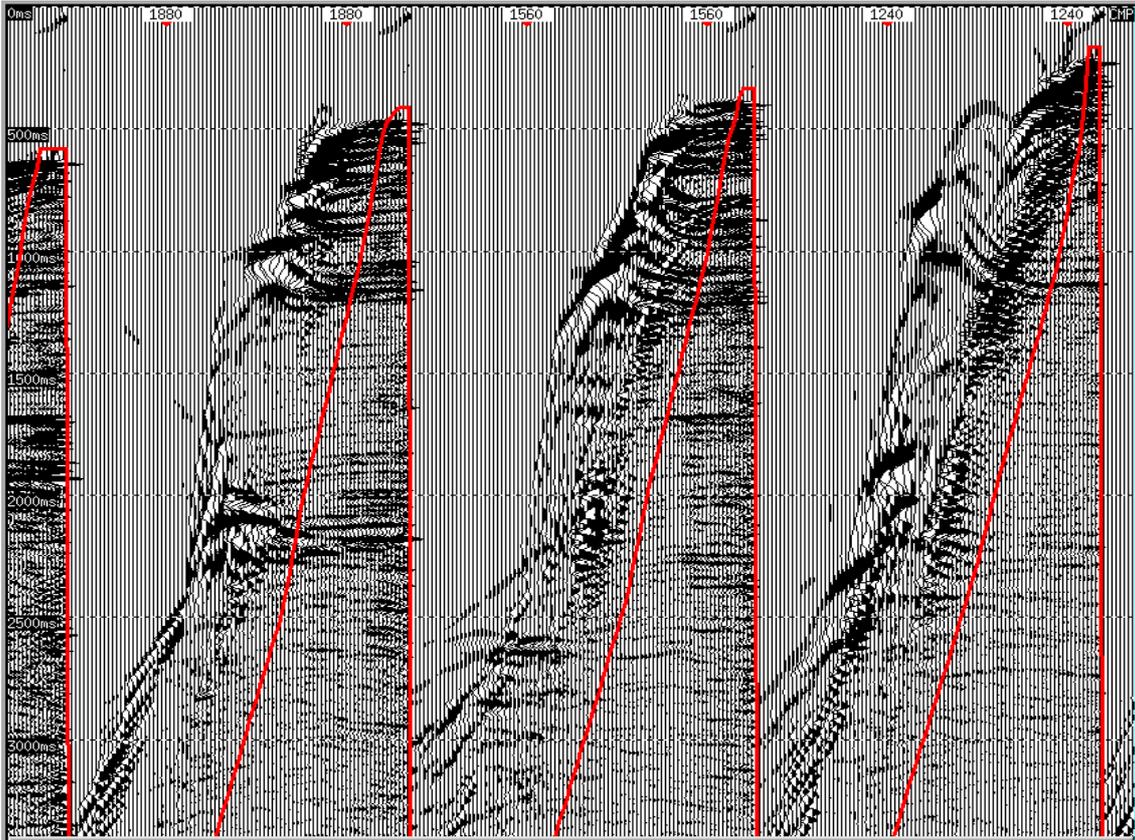


Figure 3.16.2: CMP gathers, single pass of radon applied, line SS02-27

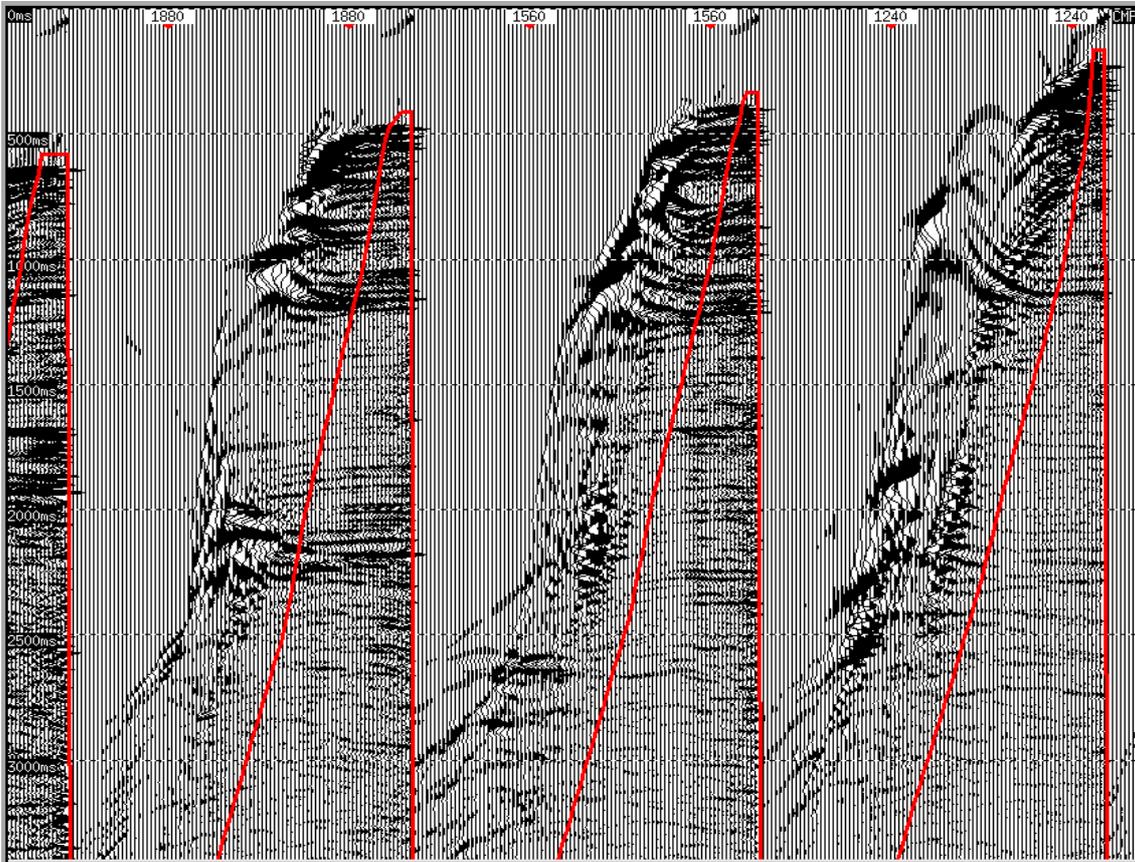


Figure 3.16.3: CMP gathers, 2 pass radon applied, line SS02-27

3.17 Data Reduction

The interpolated traces were removed.

3.18 Marine 2D Geometry

Nominal marine 2D geometry was assigned to the data.

Parameter values:

Shot interval	: 37.5m
Group interval	: 25m
CMP interval	: 12.5m
Num of traces / CMP Fold	: 288 / 96
Near trace offset (trace 288)	: variable, see Appendix 6.4

3.19 1km Velocity Analysis

A third pass of velocity analysis at a 1km interval used the 2km velocity function as the centre function. As per the 2km analysis, x and y co-ordinate information for each velocity location was loaded to IVP to ensure consistency in the velocity interpretation.

These velocity analyses were qc'd and approved by Bruce Hawkes of ECL at WesternGeco's Perth office.

Parameter Values for velocity analysis:

Analysis Spacing	: 1km
Number of CMPs per Analysis (MVF Stack)	: 11
Number of CMPs per Analysis (Semblance Display)	: 3

The data input to the velocity analysis were processed through Kirchhoff prestack time migration utilising the following parameters:

Parameter values for Kirchhoff pre-stack time migration:

Traveltime computation	: RTFM
Aperture computation type	: Ray Bending
Max aperture time	: 5100 ms
Amplitude compensation mode	: 2D
Frequency limits	: 0-125Hz
Dip limit	: 60 degrees

3.20 TVF

A zero-phase TVF (Time Variant Filter) was applied to the data prior to KPSTM. The filter passbands were described by low- and high-cut frequencies and associated dB/octave cutoff slopes. The specified cutoff frequencies are located at the half-power (-3 dB in amplitude) response points and the slopes at these frequencies are equal to the respective dB/octave values. The slope is an approximate cosine squared function in the amplitude domain. The filters were normalized so that the output amplitudes were the same as the input amplitudes for frequency components within the passband.

Parameter values:

Filter Centre Time (ms)	Low-cut Frequency (Hz)	Low-cut Slope (dB/octave)	High-cut Frequency (Hz)	High-cut Slope (dB/octave)
Water bottom time (WB)	3	18	60	36
WB + 1000	3	18	50	36
WB + 2000	3	18	40	36
WB + 3000	3	18	30	36

Note: The times are those at the centre of the filter where the full effect of the filter is attained
The first filter was applied from the beginning of the trace to the first filter centre time
Intermediate filters were linearly tapered and blended with the preceding and succeeding filter between the filter centre times
The last filter was applied from the last filter centre time to the end of the data

3.21 Kirchhoff Pre-Stack Time Migration

In general, with increasing structural complexity, post-stack migration becomes less accurate, and the need for a pre-stack migration (PreSTM) arises.

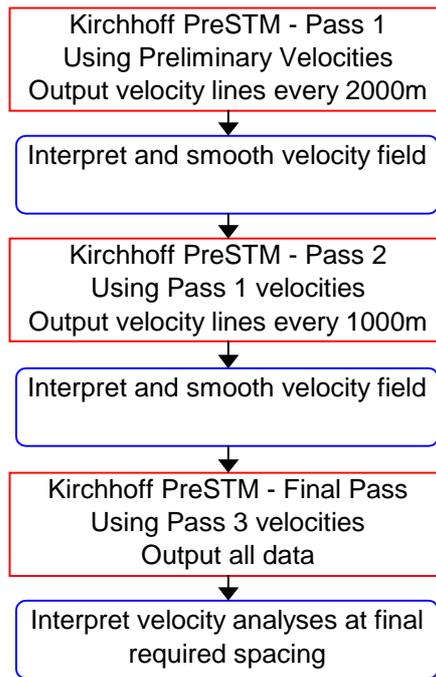
Pre-stack imaging becomes necessary where conflicting dips (or 'stacking conflicts') occur in the data, which results in inaccurate velocity analysis. The stacked section in this case is no longer being a good representation of a zero offset section

Kirchhoff PreSTM has several benefits over the "common zero offset" approach which has been commonly used in recent years, primarily in it's ability to improve structural imaging and provide correctly imaged pre-stack data for subsequent AVO analysis.

Kirchhoff migration is a summation process, which is only performed for input traces that are within an aperture radius of the output point. The aperture radius is a time-variant function of the specified dip-limits. For each input trace and output sample, travel-times are computed to determine the proper input sample to sum. Input sample values are scaled and filtered before summing. Anti-alias filters as a function of dip and midpoint distance are applied to the data during migration.

A V2T amplitude correction is effectively applied during the migration process, so any geometrical spreading correction applied should be removed prior to migration.

The migration is run on common offset volumes, and as migrated velocities are required, it is run in an iterative fashion, giving improved velocity control with each pass. The iterative sequence is illustrated below, using as many passes as deemed necessary.



The migration was run using the 1km velocity field, smoothed over a 5km radius.

Parameter values:

Travelttime computation : RTFM
 Aperture computation type : Ray Bending
 Max aperture time : 4000ms
 Amplitude compensation mode : 2D
 Number of offset planes : 96

Time variant frequency limits;

Time (ms)	Frequency (Hz)
0	90
4000	90
5000	75
6000	65
7000	55
10200	55

Time variant dip limits;

Time (ms)	Dip (degrees)
0	60
6000	60
10200	45

3.22 Geometric Spreading Amplitude Compensation

Time-variant trace scaling functions were applied to the data to compensate for the decay in amplitude resulting from the propagation of a seismic wave from a point source in a layered medium. The functions were calculated from formulae based on the equation:

$$G(T) = \frac{V_x^2 T}{V_1^2}$$

where V is the rms velocity associated with a reflection arriving at the two-way travel time, T , associated with shot-to-receiver offset, x .

V_1 (the first velocity in the velocity function) is used as a normalization factor.

The velocity and travel time information was varied spatially using the 1km velocity field.

3.23 Final 500M Velocity Analysis

The final pass of velocity analysis was performed on a 500m interval using the 1km velocity functions as the center functions. As previously, the xy coordinates were loaded to ensure consistency in the velocity interpretation. The QC was carried out and approved by Bruce Hawkes of ECL at WesternGeco's Perth office.

Parameter Values for velocity analysis:

Analysis Spacing	: 0.5km
Number of CMPs per Analysis (MVF Stack)	: 11
Number of CMPs per Analysis (Semblance Display)	: 3

3.24 Normal Moveout

NMO corrections were applied using velocities from the final 500m velocity field.

Normal moveout adjust the reflection events to their zero offset equivalent using the following equation:

$$t_0 = \sqrt{t^2 - \frac{x^2}{v^2}}$$

where t = travel time at off set x (m/s)

t_0 = zero offset travel time (m/s)

x = absolute value of the source to detector offset distance (m)

v = moveout velocity (m/s)

3.25 Radon Multiple Attenuation

A further pass of Radon Multiple Attenuation was applied to the KPSTM gathers prior to create the near and far angle stacks, and for the CMP gather archive. For more details on this process see section 3.16.

Parameter values:

NMO velocity	: 500m velocity field
Geometry Compensation Filter	: least squares
Number of p-traces used	: 451
Maximum frequency	: 90Hz
Moveout type	: Parabolic
Multiple moveout range	: -500 to 4000ms
Minimum moveout (i.e. for the first p-trace)	: 300ms
Maximum moveout (i.e. for the last p-trace)	: 2000ms
Maximum reference offset	: 7300m
Minimum application time	: 0ms

Note: Moveouts used in making intermediate p-traces were linearly interpolated between the minimum and maximum moveouts.

3.26 CMP gather archive

2 sets of NMO corrected CMP gathers for all lines were archived in SEG-Y format to 3590E tapes. See **Appendix 6.12** for the tape listing and **Appendix 6.13.1** for the trace header byte location information.

3.27 Scaling (Instantaneous Gain)

User-specified time windows were used to derive and apply scale factors to each data sample. These multipliers were calculated by centring the window over a sample, taking the average absolute amplitude of the window, defining a multiplier to make this average 0.9 times the desired output rms amplitude and applying it to the sample. The window centre was then moved down one sample and a new multiplier calculated and applied. In this way, multipliers were computed and applied to each sample from the first window application point to the last window application point.

Parameter values:

RMS Amplitude : 2000
Window length : Constant

Window Length (ms)	Start Time (ms)	End Time (ms)
500	Water Bottom	10240

Note: The times specified are the time of the first sample to be included in the first window and the time of the last sample to be included in the last window.
The last multiplier calculated was applied constantly until the last live sample.

3.28 Mute

3.28.1 Inner Trace Mute

A water bottom dependent inner trace mute was applied to the data in order to suppress multiple energy on the near offsets. To prevent a rapid amplitude change between the muted and live parts of the trace, a taper was applied from zero amplitude to full amplitude. This prevents distortion to the frequency spectrum of the stacked data, which would otherwise be introduced by an abrupt boundary.

Parameter values:	
Taper Zone Length: 64 ms (prior to the mute times detailed below)	
Source-to-Detector Offset m	Mute Time (ms)
For 100 < WB < 1000ms:	
190	1500
720	2000
1540	4000
1690	10000
For 1000 < WB < 2000ms:	
190	1500
720	2000
1540	4000
1690	10000
For 2000 < WB < 3000ms:	
190	3500
720	4000
1540	6000
1690	10000
For 3000 < WB < 3500ms:	
190	4500
720	6000
1540	9000
1690	10000
For 3500 =< WB :	
190	5250
720	7000
1540	10000

Note: Mute times were linearly interpolated between the specified offsets.

3.28.2 Outer Trace Mute

An outer trace mute (water bottom dependent) was applied to remove first break noise and any data which NMO had stretched beyond acceptable limits. To prevent a rapid amplitude change between the muted and live parts of the trace, a taper was applied from zero amplitude to full amplitude. This prevents distortion to the frequency spectrum of the stacked data, which would otherwise be introduced by an abrupt boundary.

Parameter values:	
Taper Zone Length: 32 ms (prior to the mute times detailed below)	
Source-to-Detector Offset (m)	Mute Time (ms)
For 50 < WB < 100ms:	
216	40
290	100
350	300
425	600

1000	960
1975	1500
3550	2499
4975	3497
7300	4502
For 100 < WB < 150ms:	
276	70
350	300
425	600
1000	960
1975	1500
3550	2499
4975	3497
7300	4502
For 150 < WB < 500ms:	
326	150
390	300
475	460
1000	960
1975	1500
3550	2499
4975	3497
7300	4502
For 500 < WB < 1000ms:	
601	505
675	599
975	999
1500	1499
2775	2501
4875	3505
7275	4695
For 1000 < WB < 1500ms:	
1201	965
1500	1501
2025	2496
4350	3499
7275	4494
For 1500 < WB < 2500ms:	
1851	1490
2075	2499
3050	3497
7250	4531
For 2500 < WB < 2700ms:	
2376	2398
3050	3499
4250	4499
7250	5343
For 2700 < WB < 3000ms:	
2466	2610
2690	3001
2990	3499
3590	4000
4190	4501
7265	5418
For 3000 < WB < 3500ms:	
2591	3000
2890	3500
3340	4000
4165	4701
7315	5622

For 3500 < WB < 4000ms:	
2741	3500
3040	4000
4240	5002
7315	5900
For WB >= 4000ms:	
3040	4500
4240	5502
7315	6400

Note: Mute times were linearly interpolated between the specified offsets.

Selected NMO corrected CMP gathers for each line were displayed for quality control, with both the inner and outer trace mute patterns overlaid on the display as a solid line.

3.29 Stack

The traces within each gather were stacked to form a single output trace. The resultant trace is normalized sample by sample using the following function:

$$s(t) = \frac{1}{w(t)}$$

The nominal CMP fold was 96 and the shot points were numbered at source positions.

3.30 Water Bottom Time Update

The water bottoms were re-digitised on internal format QC display stacks generated after KPSTM and the values updated to the trace headers. An ascii file containing the digitised water bottom values was output, linearly interpolated and extrapolated for all CMP locations and updated to the migrated trace headers. Additionally, a mute was applied above these updated WB values to eliminate the migration swing. The water bottom times were converted to depth and stored for placement into the stack SEG-Y trace headers.

3.31 Navigation/Seismic data merge

MCG supplied processed P190 navigation data. This was used to update the seismic trace header literals with the xy coordinates of the source positions. The navigation and seismic data sets were matched using line numbers and shot point numbers.

3.32 Data Archive

The data was also stacked without application of the pre-stack scaling (section 3.27). These raw stack data sets were output to exabyte tape in SEG-Y format for archive. See **Appendix 6.12** for details and **Appendix 6.13.2** for byte header location information.

4.0 Post-Stack Seismic Data Processing

4.1 Tau-P Coherency Filter

The Tau-P coherency filter is a digital time and space variant multichannel filter. It attenuates the random noise and enhances coherent signal within a range of specified dip angles.

Parameter values:

Panel width	: 14 traces
Minimum P value	: -6ms/trc
Maximum P value	: +6ms/trc
Minimum Semblance weighting	: 0.2
Maximum Semblance weighting	: 0.8

4.2 Trace mix

An isotime weighted average of amplitudes over adjacent traces is output. As a result, the spatial coherency of flat events is enhanced.

Parameter values:

Width of weighting function	: 5 traces
Type of weighting function	: Cosine Bell

The above two processes had a profoundly beneficial affect upon the signal to noise ratio, and is clearly illustrated by comparing the final filtered stack with that of the raw stack (see figures below).

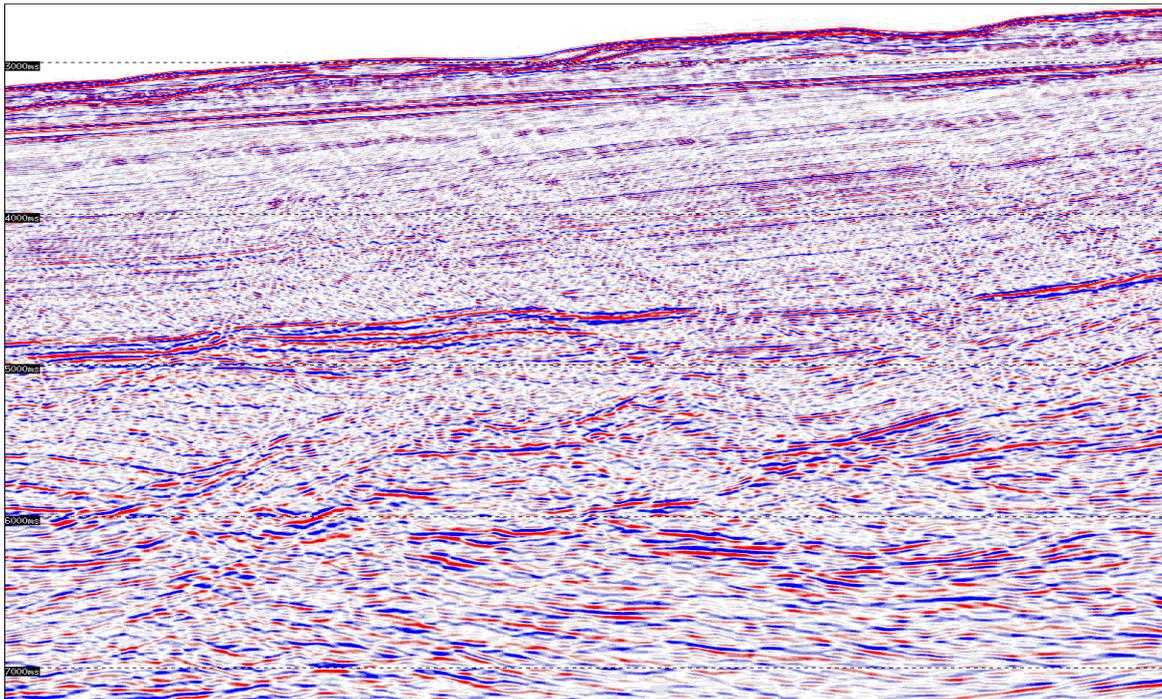


Figure 4.2.1: No taup filtering applied, line SS02-05

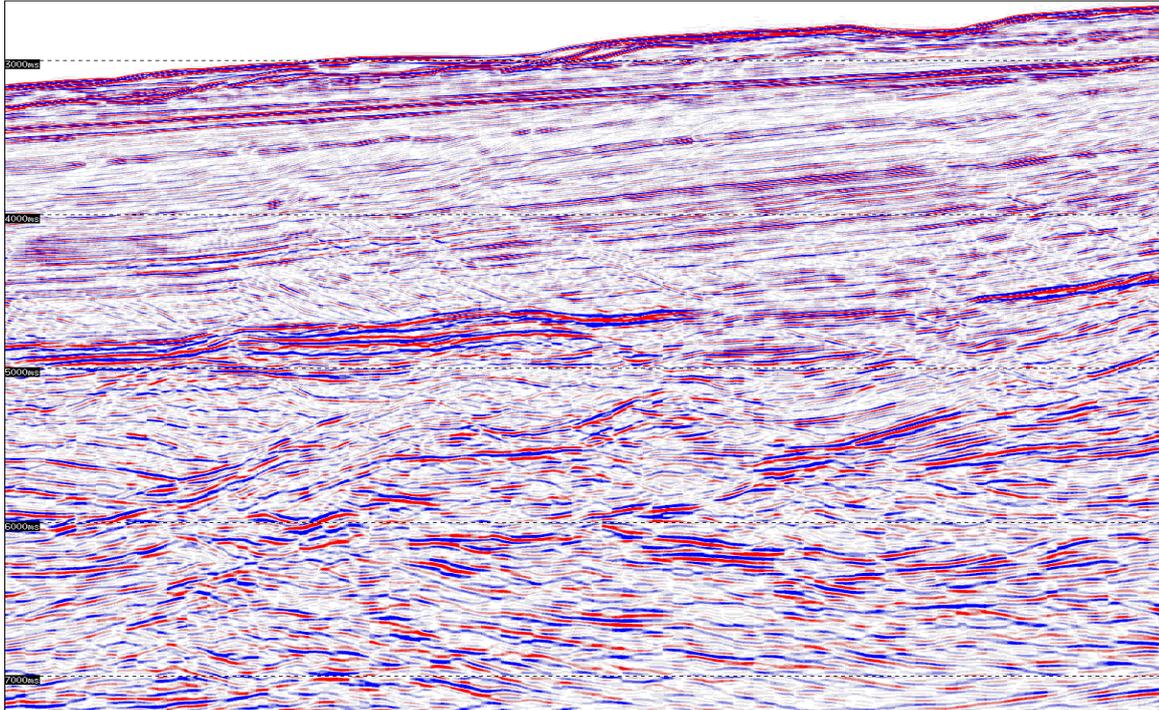


Figure 4.2.2: Taup filtering applied, line SS02-05

4.3 TVF

A zero-phase TVF (Time Variant Filter) was applied to the data.

Parameter values:

Filter Centre Time (ms)	Low-cut Frequency (Hz)	Low-cut Slope (dB/octave)	High-cut Frequency (Hz)	High-cut Slope (dB/octave)
Water bottom time (WB)	10	18	70	36
WB + 500	10	18	70	36
WB + 2000	8	18	60	36
WB + 3000	6	18	40	36
WB + 4000	6	18	30	36

Note: The times are those at the centre of the filter where the full effect of the filter is attained
 The first filter was applied from the beginning of the trace to the first filter centre time
 Intermediate filters were linearly tapered and blended with the preceding and succeeding filter between the filter centre times
 The last filter was applied from the last filter centre time to the end of the data

4.4 *Scaling (Cascaded Instantaneous Gain)*

The cascaded AGC gain consists of two passes of the gain algorithm.

In the first pass, automatic gain control (AGC) was applied to the data. A gain computation zone of 1000ms was used. An average absolute amplitude is computed for the zone, and this value divided into the desired average amplitude (2000 RMS) gives a multiplier that is applied at the midpoint of the gain zone. The zone is then moved down the trace, one sample at a time and the computation repeated so that a multiplier is derived for each sample. From the centre of the first gain zone back to the start of data and from the centre of the last gain zone to the end of the trace, a constant value was applied.

The second pass is the same as the first except that multipliers are computed only for amplitudes which are lower than the new reference averaged amplitude of 1500 RMS with a smaller computation window of 500ms.

The longer 1000ms window was used to scale the overall section with time, whilst the 500ms window was used to compensate for 'shadow' below high amplitude reflectors.

Parameter values:

Type	: Cascaded AGC
Output RMS amplitude for window 1 / window 2	: 2000 / 1500
Window length for window 1/ window 2	: 1000ms / 500ms
Window start time	: Water bottom two-way time

4.5 *CGM Files*

CGM files were created for the final filtered and scaled pre-stack migrated stack sections. All traces were displayed at a scale of 20tr/cm and 5cm/sec. The CGM files had a full side label with a location map, velocity boxes and intersections annotated. Shot point numbers were annotated at source position for all lines.

A CD containing the CGM files was provided as a final product (see **Appendix 6.12**).

4.6 *Data Archive*

The filtered and scaled migrated stack data were output to exabyte tape in SEG-Y format for archive. See **Appendix 6.12** for details and **Appendix 6.13.2** for byte header location information. For a listing of the SP and CMP relationships see **Appendix 6.8**.

4.7 *Angle Stacks*

Angle stacks were created after radon demultiple had been applied to the kirchhoff pre-stack time migrated data (see section 3.25). No pre-stack scaling was applied to the angle stacks.

4.7.1 *Near angle stack*

Near angle stacks were created by applying inner and outer trace mutes, hung from the water bottom. The inner trace mute was the same as that used for the production stack (see section 3.27.1). The outer trace mute was created by taking the midway function between 120% of the final outer trace mute and 100% of the final inner trace mute. See next page for graphical representation of these mutes.

4.7.2 *Far angle stack*

Far angle stacks were created by applying inner and outer trace mutes, hung from the water bottom. The inner trace mute was taken from the mid way function between 120% of the final outer trace mute and 100% of the final inner trace mute i.e. the same as the outer trace mute used for the near angle stacks. The outer trace mute was 120% of the production outer trace mute. See next page for graphical representation of these mutes.

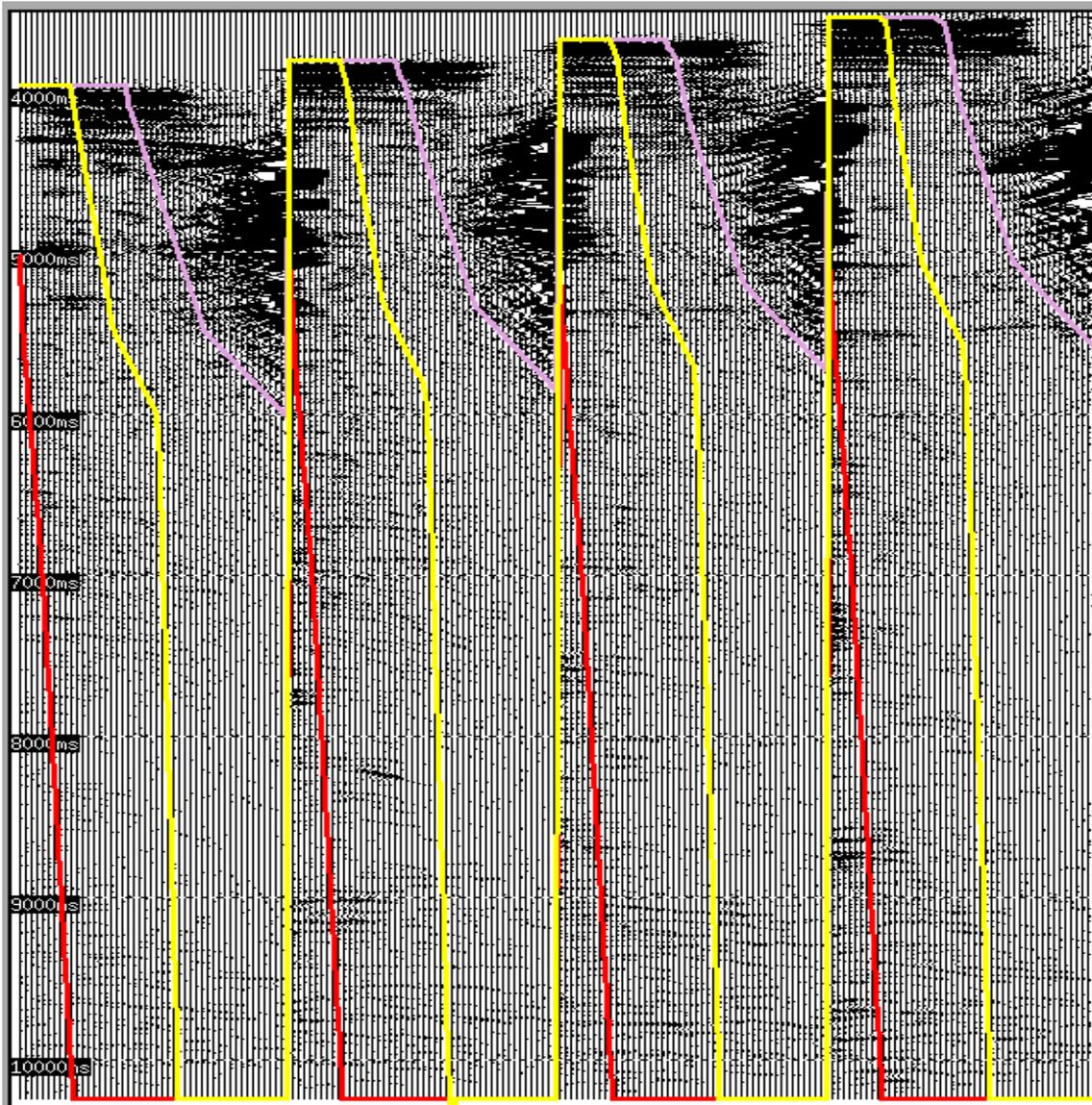


Figure 4.7.1: Graphical representation of mutes used for near and far angle stacks, SS02-11

For the near angle stacks the inner Mute is represented by the red line and the outer mute by the yellow line. For the far angle stacks, the inner mute is represented by the yellow line and the outer mute by the pink line.

4.8 Data Archive

The near and far angle stacks were output to exabyte tape in SEG-Y format for archive. See **Appendix 6.11** for details and **Appendix 6.13.2** for byte header location information.

5.0 Personnel

Key individuals involved in the project were:

For **Santos Limited:**

Stuart Brew	Senior Staff Geophysicist
Ric Smith	Principal Geophysicist
Bruce Hawkes	ECL, Consultant for velocity QC

For **WesternGeco:**

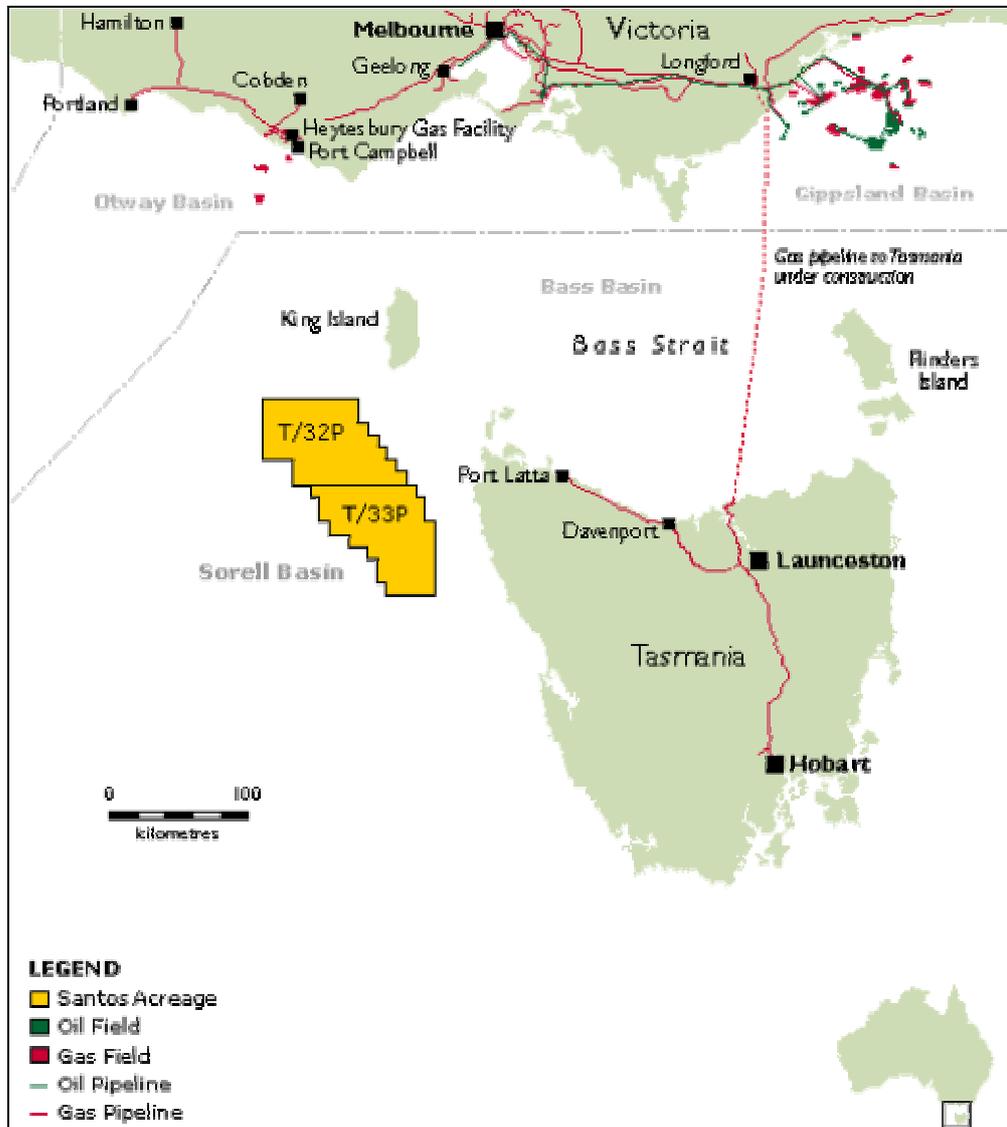
Lawrence Cho	Processing Manager
Paul Tredgett	Supervisor
Richard Bisley	Staff Geophysicist
Alison Keighley	Project Leader
Kenneth Jayan	Geophysicist

Dated:

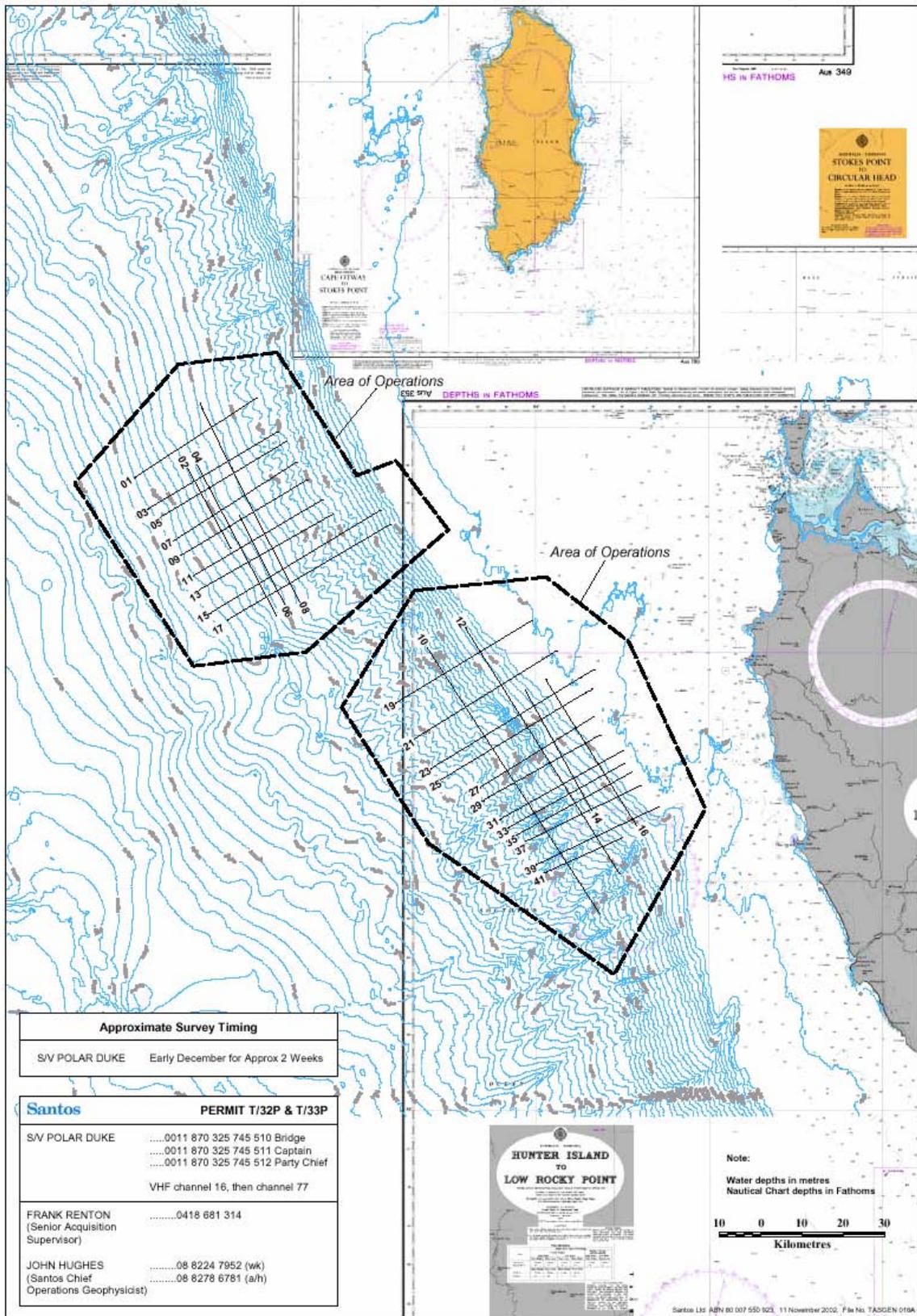
Signed:

6.0 Appendices

6.1 Survey Location Map



6.2 Survey Line Information



6.3 Acquisition Parameters

General

Vessel : MGC – R/V Polar Duke
 Location : Sorell Basin, Australia
 Date shot : December 2002

Recording

Recording format : SEG-D 8058 REV.1
 Record length : 10000 ms
 Sample rate : 2 ms
 Recording low-cut filter : Out 3Hz/6dB analog
 Recording high-cut filter : 206Hz @ 276 dB/Oct
 Nominal fold : 96

Streamer

Number of streamers : 1
 Group interval : 12.5 m
 Streamer length (active) : 7200 m
 Streamer depth : approx. 10 m
 Number of groups : 576
 Near trace : 576
 Near trace offset from source : 125m or 140 m
 Note : Refer to **Appendix 6.4** for near trace offsets.

Source

Shotpoint interval : 37.5 m
 Array volume per source : 3500 cu in
 Source depth : 5 m
 Number of sub-arrays per source : 4

Navigation Header

H0100SURVEY AREA Santos SS02 Sorell Basin, Australia
 H0101SURVEY DETAILS 2D Survey 7200m Streamer
 H0102VESSEL DETAILS vessel1 1
 H0103SOURCE DETAILS Source 301 1 1
 H0104STREAMER DETAILS Streamer 201 576 ch 1 1
 H0105OTHER DETAILS Buoy 401 1 1
 H0200SURVEY DATE 16/12/2002
 H0201TAPE DATE Tuesday 17 December 2002 - 02:40am
 H0202TAPE VERSION UK00A P1/90
 H0300CLIENT SANTOS
 H0400GEOPHYSICAL CONTRACTOR MGC ASA
 H0500POSITIONING CONTRACTOR FUGRO
 H0600POSITIONING PROCESSING MGC
 H0700POSITIONING SYSTEM Spectra
 H0800COORDINATE POSITION Centre of Source
 H0901OFFSET SYSTEM TO SOURCE 1 1 0.00 -130.50
 H0902OFFSET SYSTEM TO STREAMER 1 1 0.00 -270.50
 H0903OFFSET SYSTEM TO ANTENNA 1 1 -4.00 -17.60
 H0904OFFSET SYSTEM TO ANTENNA 1 2 -5.60 -17.60
 H0905OFFSET SYSTEM TO E/S 1 1 0.00 -10.50
 H0906OFFSET SYSTEM TO E/S 1 2 0.00 -9.70
 H1000CLOCK TIME 00:00
 H1100RECEIVER GROUPS PER SHOT 576
 H1400GEODETTIC DATUM AS SURVEYED GDA-94 GRS-80 6378137.000 298.2572221
 H1401DATUM SHIFT SURVEY TO WGS84 -0.0 -0.0 -0.0-0.000-0.000-0.000-0.0000000
 H1500GEODETTIC DATUM AS PLOTTED GDA-94 GRS-80 6378137.000 298.2572221
 H1501DATUM SHIFT PLOT TO WGS84 -0.0 -0.0 -0.0-0.000-0.000-0.000-0.0000000
 H1600DATUM SHIFT SURVEY TO PLOT 0.0 0.0 0.0 0.000 0.000 0.000 0.0000000

H1700VERTICAL DATUM Sea level Echosounder
 H1800PROJECTION TYPE 003 Transverse Mercator
 H2000GRID UNITS 1Metres 1.000000000000
 H2001HEIGHT UNITS 1Metres 1.000000000000
 H2002ANGULAR UNITS 1Degrees
 H2200LONGITUDE OF CM 141 0 0.000E
 H2301GRID ORIGIN (LAT, LON) 0 0 0.000N141 0 0.000E
 H2302GRID ORIGIN (E, N) 500000.00E10000000.00N
 H2401SCALE FACTOR 0.9996000000
 H2402SCALE ORIGIN (LAT, LON) 0 0 0.000N141 0 0.000E
 H2600 WAYPOINT (E, N) 656010.05502873.0
 H2600 WAYPOINT (E, N) 686342.65522259.5
 H2600 Processed by SeisPos release 11.11

6.4 Near Trace Offsets

Line Number SS02-	Near Trc offset (m)
1	140
2	140
3	140
4	140
5	140
6	140
7	140
8	140
9	140
10	140
11	140
12	140
13	140
14	125
15	140
16	125
17	140
19	140
21	140
23	140
25	140
27	140
29	125
31	125
33	125
35	125
37	125
39	125
41	125

6.5 Acquisition Line Listing

Seq No.	Line Name	Direction	FPSP	LSP	COMP/INC	Comments
1	SS02-01-001	056°	1001	2065	Complete	
14	SS02-02-014	331°	1660	897	Complete	
2	SS02-03-002	239°	1999	897	Complete	
15	SS02-04-015	152°	1001	2232	Complete	
3	SS02-05-003	059°	1001	2137	Complete	
13	SS02-06-013	153°	1001	1776	Complete	
4	SS02-07-004	239°	1920	897	Complete	FCSP 1920 d/t recording seis rec probs at SOL
12	SS02-08-012	333°	2447	897	Complete	
5	SS02-09-005	059°	1001	2106	Complete	
18	SS02-10-018	147°	1001	3153	Complete	
6	SS02-11-006	239°	2020	1726	Incomplete	Term Whales
7	SS02-11-007	239°	1725	1154	Incomplete	Line aborted d/t air leak
8	SS02-11-008	239°	1167	897	Complete	
19	SS02-12-019	328°	2882	897	Complete	
9	SS02-13-009	059°	1001	2055	Complete	Term Syntrak.LGSP 2030
33	SS02-14-033	151°	1001	1106	DNP	Term - Whales
34	SS02-14-034	151°	1001	2004	Complete	
10	SS02-15-010	238°	2342	897	Complete	
32	SS02-16-032	328°	2123	897	Complete	
11	SS02-17-011	059°	1001	2306	Complete	
16	SS02-19-016	059°	1001	2188	Complete	
17	SS02-21-017	238°	2100	897	Complete	
20	SS02-23-020	238°	2240	897	Complete	
21	SS02-25-021	058°	1001	2022	Incomplete	Term, Syntrak Lockup
22	SS02-25-022	058°	2011	2289	Complete	
23	SS02-27-023	239°	1844	1825	DNP	Syntrak Lock at SOL
24	SS02-27-024	239°	1859	897	Complete	
25	SS02-29-025	061°	1001	1984	Complete	
26	SS02-31-026	242°	1904	897	Complete	
27	SS02-33-027	064°	1001	1967	Complete	
28	SS02-35-028	244°	1856	897	Complete	
29	SS02-37-029	065°	1001	1949	Complete	
30	SS02-39-030	245°	1850	897	Complete	
31	SS02-41-031	066°	1001	1654	Complete	
Total Km						1256.1

6.6 Final Processing Line Listing

Line Name	FSP	LSP	Length Km
SS02-01-001	1001	2065	39.94
SS02-02-014	1660	897	28.65
SS02-03-002	1999	897	41.36
SS02-04-015	1002	2232	46.16
SS02-05-003	1001	2137	42.64
SS02-06-013	1001	1776	29.10
SS02-07-004	1920	897	38.40
SS02-08-012	2447	897	58.16
SS02-09-005	1001	2106	41.48
SS02-10-018	1001	3153	80.74
SS02-11-006,7,8	2020	897	42.15
SS02-12-019	2882	897	74.48
SS02-13-009	1001	2030	38.63
SS02-14-033,34	1001	2004	37.65
SS02-15-010	2341	897	54.19
SS02-16-032	2123	897	46.01
SS02-17-011	1001	2306	48.98
SS02-19-016	1001	2188	44.55
SS02-21-017	2100	897	45.15
SS02-23-020	2240	897	50.40
SS02-25-021	1001	2289	48.34
SS02-27-023	1859	897	36.11
SS02-29-025	1001	1984	36.90
SS02-31-026	1904	897	37.80
SS02-33-027	1001	1967	36.26
SS02-35-028	1856	897	36.00
SS02-37-029	1001	1949	35.59
SS02-39-030	1850	897	35.78
SS02-41-031	1001	1654	24.53
Total Km			1256.1

6.7 Merged Line listing

Line Name.	SEQ.	DIR	FSP	LSP	KMS
SS02-11-006	6	239	2020	1726	11.06
SS02-11-007	7	239	1725	1168	20.93
SS02-11-008	8	239	1167	897	10.16
SS02-25-021	21	58	1001	2010	37.88
SS02-25-022	22	58	2011	2289	10.46

6.8 SP/CMP Relationships

SP/CMP relationships for the final KPSTM stack SEG-Y datasets are as follows:

SEG-Y LINE	FCMP	LCMP	SP*100 (at source)		SP RANGE	
			fsp	lsp	FSP	LSP
SS02-01	1	3480	90333	206300	1001	2065
SS02-02	1	2577	175767	89900	1660	897
SS02-03	1	3594	209667	89900	1999	897
SS02-04	1	3978	90433	223000	1002	2232
SS02-05	1	3696	90333	213500	1001	2137
SS02-11	1	3657	211767	89900	2020	897
SS02-06	1	2613	90333	177400	1001	1776
SS02-07	1	3357	201767	89900	1920	897
SS02-08	1	4938	254467	89900	2447	897
SS02-09	1	3603	90333	210400	1001	2106
SS02-10	1	6744	90333	315100	1001	3153
SS02-11	1	3657	211767	89900	2020	897
SS02-12	1	6243	297967	89900	2882	897
SS02-13	1	3375	90333	202800	1001	2030
SS02-14	1	3297	90367	200233	1001	2004
SS02-15	1	4620	243867	89900	2341	897
SS02-16	1	3966	222033	89867	2123	897
SS02-17	1	4203	90333	230400	1001	2306
SS02-19	1	3849	90333	218600	1001	2188
SS02-25	1	4152	90333	228700	1001	2289
SS02-21	1	3897	219767	89900	2100	897
SS02-23	1	4317	233767	89900	2240	897
SS02-25	1	4152	90333	228700	1001	2289
SS02-27	1	3174	195667	89900	1859	897
SS02-29	1	3237	90367	198233	1001	1984
SS02-31	1	3309	200133	89867	1904	897
SS02-33	1	3186	90367	196533	1001	1967
SS02-35	1	3165	195333	89867	1856	897
SS02-37	1	3132	90367	194733	1001	1949
SS02-39	1	3147	194733	89867	1850	897
SS02-41	1	2247	90367	165233	1001	1654

6.9 Testing Log

6.9.1 Low Cut Filter

Input: Conversion data, geometry and T² gain applied, every 106th shot for test line 11.

<u>Panel</u>	<u>Comments</u>	<u>Displays Produced</u>	<u>Test No</u>
-	No filter applied	Shot gathers	T01_01ar
1	3Hz low cut filter applied	Shot gathers	T01_02ar
2	4Hz low cut filter applied		
3	5Hz low cut filter applied		
4	6Hz low cut filter applied		

Decision: 3Hz 18dB/oct minimum phase low cut filter to be applied. Santos requirements were to keep as much bandwidth as possible and see what swatt could achieve after a 3Hz filter had been applied.

6.9.2 Initial Geometry test

Input: Conversion data, geometry, field trace edits, gun and cable correction, 3Hz low cut filter and geometric spreading applied, for test lines 11, 16 and 19.

<u>Comments</u>	<u>Displays Produced</u>	<u>Test No</u>
No Mute applied	CMP gathers	T03_00cr
-	Shot gathers	T03_00ar2
Alternate cmps	Geometry stack	T03_00dr

This test was run to use as a base comparison without any processing applied.

6.9.3 Swatt

Line 19 was chosen as the test line as it exhibited the most swell noise.

Input: Conversion data, geometry, field trace edits, gun and cable correction, 3Hz low cut filter and geometric spreading. Tests were also run on lines 11 and 16 for confirmation that swatt was not affecting primary data.

<u>Comments</u>	<u>Displays Produced</u>	<u>Test No</u>
1700m/s NMO wraparound, -400 stretch	CMP gathers	T03_18cr
1700m/s NMO wraparound,-400 stretch	Shot gathers	T03_18ar
1700m/s NMO wraparound,-400 stretch	Swatt stack	T03_18dr
Difference display	Shot gathers	T03_18ahr
Difference display	Stack	T03_18dhr

Displays from T03_18 showed that some of the long offset primary data was being removed due to the stretch mutes. The tests were rerun using a stretch mute of -150:

<u>Comments</u>	<u>Displays Produced</u>	<u>Test No</u>
1700m/s NMO wraparound,-150 stretch	Shot gathers	T03_25ar
Difference display, 1700m/s NMO wraparound, -150 stretch	Shot gathers	T03_25ahr

Decision: Frequency 0-30Hz, Spatial width 21 traces, temporal gate 500ms, wraparound NMO using 1700 m/s constant velocity and -150 stretch limit.

6.9.4 Shot FK filter

Input: Conversion data, geometry, field trace edits, gun and cable correction, 3Hz low cut filter, geometric spreading and swatt applied. NMO wraparound using the 8km picked velocity field was applied to all the shot FK filter tests. Testing was run on lines 11, 16 and 19.

<u>Comments</u>	<u>Displays Produced</u>	<u>Test No</u>
Stretch -400, Passing dips +/- 1900m/s.	Shot gathers	T04_05ar
Stretch -400, Passing dips +/- 1900m/s.	Cmp gathers	T04_05cr
Stretch -400, Passing dips +/- 1900m/s.	Stack	T04_05dr
Difference display, above parameters	Shot gathers	T04_05ahr
Difference display, above parameters	Stack	T04_05dhr
Stretch -400, Passing dips +/- 1700m/s.	Shot gathers	T04_06ar
Stretch -400, Passing dips +/- 1700m/s.	Cmp gathers	T04_06cr
Stretch -400, Passing dips +/- 1700m/s.	Stack	T04_06dr
Difference display, above parameters	Shot gathers	T04_06ahr
Difference display, above parameters	Stack	T04_06dhr
Difference display, swatt of passing dips of +/- 1900m/s and +/- 1700m/s	Shot gathers	T04_09ahr
Difference display, swatt of passing dips of +/- 1900 m/s and +/- 1700m/s	Stack	T04_09dhr

The following tests were run on lines 11 and 16 only.

<u>Comments</u>	<u>Displays Produced</u>	<u>Test No</u>
Stretch -400, Passing dips +/- 2100m/s.	Shot gathers	T04_14ar
Stretch -400, Passing dips +/- 2100m/s.	Cmp gathers	T04_14cr
Stretch -400, Passing dips +/- 2100m/s.	Stack	T04_14dr
Difference display, above parameters	Shot gathers	T04_14ahr
Difference display, above parameters	Stack	T04_14dhr
Stretch -400, Passing dips +/- 2500m/s.	Shot gathers	T04_15ar
Stretch -400, Passing dips +/- 2500m/s.	Cmp gathers	T04_15cr
Stretch -400, Passing dips +/- 2500m/s.	Stack	T04_15dr
Difference display, above parameters	Shot gathers	T04_15ahr
Difference display, above parameters	Stack	T04_15dhr
Stretch -150, Passing dips +/- 1900m/s.	Shot gathers	T04_17ar
Stretch -150, Passing dips +/- 1900m/s.	Cmp gathers	T04_17cr
Stretch -150, Passing dips +/- 1900m/s.	Stack	T04_17dr
Difference display, above parameters	Shot gathers	T04_17ahr
Difference display, above parameters	Stack	T04_17dhr
Difference display, swatt of passing dips of +/- 1900m/s with -400 stretch and -150 stretch	Shot gathers	T04_18ahr
Difference display, swatt of passing dips of +/- 1900m/s with -400 stretch and -150 stretch	Stack	T04_18dhr

Decision: Pass dips of +/- 2100 m/s, taper of 300 ms/trace and NMO wraparound using the 8km velocity field and a -150 stretch limit.

6.9.5 FK spectrum

Input: Conversion data, geometry, field trace edits, gun and cable correction, low cut filter, geometric spreading and NMO using the 8km picked velocity field applied. Testing ran on lines 11, 16, 19 and 27.

<u>Comments</u>	<u>Displays Produced</u>	<u>Test No</u>
Single shot	CGM of FK spectrum	T04_00_FKspec

Single shot with swatt and FK filter passing dips of –1900m/s	CGM of FK spectrum	T04_05_FKspec
Single shot with swatt and FK filter passing dips of –1700m/s	CGM of FK spectrum	T04_06_FKspec

Tests were run to QC the FK spectrum before and after the swatt and FK filter had been applied.

6.9.6 Designature/resample

Statistical designature tests were run on line 11 using the production geometry data as input. The data was resampled to 4ms after statistical designature had been applied.

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
No desig	Shot gathers and amplitude spectrum	T05_00
Desig, target wavelet 3-75Hz	Shot gathers and amplitude spectrum	T05_01
Desig, target wavelet 3-80Hz	Shot gathers and amplitude spectrum	T05_02
Desig, target wavelet 3-85Hz	Shot gathers and amplitude spectrum	T05_03
Desig, target wavelet 3-90Hz	Shot gathers and amplitude spectrum	T05_04
Desig, target wavelet 3-85Hz,	Shot gathers and amplitude spectrum	T05_05

Confirmation tests for the application of deterministic designature were carried out using a supplied far field signature. Santos required the output to be a zero phase. A 4ms resample was also tested after designature had been applied. These tests were run on lines 11 and 27:

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
Swatt/Fkfilter, no desig	CMP gathers	P0403_FKfilter_320th_cmp
	Scaled stack	P0403_FKfilter_scaled_stk
	Raw stack	P0403_FKfilter_raw_stk
Swatt/Fkfilter, desig, 2ms sample rate	CMP gathers	P0502_Desig_2ms_320th_cmp
	Scaled stack	P0502_Desig_2ms_scaled_stk
	Raw stack	P0502_Desig_2ms_raw_stk
Swatt/Fkfilter, desig, 4ms sample rate	CMP gathers	P0502_Desig_4ms_320th_cmp
	Scaled stack	P0502_Desig_4ms_scaled_stk
	Raw stack	P0502_Desig_4ms_raw_stk

Decision: Designature should not be applied, however the resample to 4ms should be applied after the FK filter.

6.9.7 Deconvolution before stack

All DBS testing was run on line 11 and used a 2 window design and application. CMP gathers and a stack section with an autocorrelation were displayed for each test.

Input data: conversion, geometry, field trace edits, gun/cable correction, 3Hz low cut filter, swatt, fK filter, deterministic designature (using supplied far field signature), geometric spreading and NMO applied.

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
No deconvolution	CMP gathers	T10_00cr
Deconvolution, 16ms gap, operator avg 7trc.	Scaled stack	T10_00ds
	CMP gathers	T10_01cr
Deconvolution, 24ms gap, operator avg 7trc.	Scaled stack	T10_01ds
	CMP gathers	T10_02cr
Deconvolution, 32ms gap, operator avg 7trc.	Scaled stack	T10_02ds
	CMP gathers	T10_03cr
Deconvolution, 48ms gap, operator avg 7trc.	Scaled stack	T10_03ds
	CMP gathers	T10_04cr
Deconvolution, 64ms gap, operator avg 7trc.	Scaled stack	T10_04ds
	CMP gathers	T10_07cr
	Scaled stack	T10_07ds

Deconvolution, 48ms gap, no operator avg.	CMP gathers	T10_05cr
	Scaled stack	T10_05ds
Deconvolution, 48ms gap, opr. avg whole gath.	CMP gathers	T10_06cr
	Scaled stack	T10_06ds
Deconvolution, 48ms gap, operator avg 7trc, with one design window.	CMP gathers	T10_08cr
	Scaled stack	T10_08ds

Decision: Deconvolution before stack will not be applied.

6.9.8 Shot Interpolation/CMP interleave/Intra-gather interpolation

These tests were run on line 11 only, to demonstrate the need for a finer trace spacing within the CMP gathers in order to get better results from the radon demultiple.

Input data: production swatt data, FK filter, 4ms resample and array forming (to produce a 12.5m CMP interval) applied, every 160th CMP.

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
No radon applied	CMP gathers	T06_14cr_noradon
Radon applied	CMP gathers	T06_14cr
3:1 intra-gather interp	CMP gathers	T06_13cr_intrp_noradon
3:1 intra-gather interp/radon	CMP gathers	T06_13cr_intrp
3:1 intra-gather interp/radon/reject interp trc	CMP gathers	T06_13cr
3 CMP interleave	CMP gathers	T06_11cr_intl_noradon
3 CMP interleave/radon	CMP gathers	T06_11cr_intl
3 CMP interleave/radon/uninterleave	CMP gathers	T06_11cr

Input data: production swatt data, FK filter, 3:1 shot interpolation, 4ms resample and array forming (to produce a 12.5m CMP interval) applied, every 160th CMP.

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
No radon applied	CMP gathers	T06_12cr_noradon
Reject interp trc, no radon applied	CMP gathers	T06_12cr2_noradon
Radon applied	CMP gathers	T06_12cr
Radon applied, reject interp trc	CMP gathers	T06_12cr2

Radon demultiple was applied using the following parameters:

NMO:	using 100% 2km velocity field
Method:	least squares modelling
Model parabolic moveout range:	-500 to 4000ms
Reject parabolic moveout range:	250 to 4000ms
Reference offset:	7300m
Velocity mutes:	20% - 98%
No: p-traces:	576
Maximum frequency:	93Hz

Decision: 3:1 shot interpolation to be applied prior to demultiple, to give a trace spacing within the CMP gathers of 25m (75m prior to interpolation).

6.9.9 Array forming/Kfilter, trace decimate

The best method to create a 12.5 m CMP interval was tested on line 11.

Input data: production swatt data, FK filter applied.

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
Array forming applied	Shot gathers	T07_00ar
Kfilter/trace decimate applied	Shot gathers	T08_00ar

A FK spectrum of a shot from each test was also produced.

Decision: apply Kfilter and trace decimate to produce a 12.5m CMP interval prior to demultiple.

6.9.10 FK demultiple/Radon demultiple

The fast track migration on Santos' adjacent survey had FK demultiple applied, so Santos required a comparison test between FK and radon demultiple.

Input data: production swatt data, FK filter, 3:1 shot interpolation and 4ms resample applied, every 320th CMP:

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
No radon applied	CMP gathers	T06_12cr_noradon
Reject interp trc, no radon applied	CMP gathers	T06_12cr2_noradon
Radon applied	CMP gathers	T06_06cr
Radon applied/reject interp trc	CMP gathers	T06_06cr2
FK demultiple applied	CMP gathers	T06_02cr
FK demultiple applied/reject interp trc	CMP gathers	T06_02cr2

Radon demultiple was applied using the following parameters:

NMO:	using 100% 2km velocity field
Method:	least squares modelling
Model parabolic moveout range:	-500 to 4000ms
Reject parabolic moveout range:	250 to 4000ms
Reference offset:	7300m
Velocity mutes:	20% - 98%
No: p-traces:	576
Maximum frequency:	93Hz

FK demultiple was applied using the following parameters:

NMO:	using 90% 2km velocity field
Application window:	WB*1.9 – tmax
Multiple attenuation filter:	Pass Negative zero

Decision: Radon demultiple is to be applied.

6.9.11 Radon demultiple

Radon demultiple was tested on lines 11 and 27.

All test displays were of NMO corrected CMP gathers, NMO using the 2km picked velocity field.

Input data: production swatt, FK filter, 3:1 shot interpolation, 4ms resample and kfilter/trace decimate applied.

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
No radon applied	CMP gather	T06_17cr
No radon applied / interp trc rejected	CMP gather	T06_17cr2
Radon 1	CMP gather	T06_12cr
Radon 1 / interp trc rejected	CMP gather	T06_12cr2
Radon 2	CMP gather	T06_20cr
Radon 2 / interp trc rejected	CMP gather	T06_20cr2
Radon 3 / Radon 2	CMP gather	T06_24cr
Radon 3 / Radon 2 / interp trc rejected	CMP gather	T06_24cr2
Radon 3	CMP gather	T06_23cr

Radon 1 parameters:

NMO:	using 100% 2km velocity field
Method:	least squares modelling
Model parabolic moveout range:	-500 to 4000ms
Reject parabolic moveout range:	250 to 4000ms
Reference offset:	7300m
Velocity mutes:	20% - 98%
No: p-traces:	576
Maximum frequency:	93Hz

Radon 2 parameters:

As per radon 1 parameters except:	
Reject parabolic moveout range:	500 to 4000ms

Radon 3 parameters:

NMO:	using 100% 2km velocity field
Method:	p-decon
Model linear moveout range:	1000 to 4000ms
Reject linear moveout range:	1000 to 4000ms
Reference offset:	7300m
No: p-traces:	576
Maximum frequency:	93Hz

After Santos had QC'd the 2km velocity field, they felt that it had been picked too fast. The field was slowed down and the following confirmation tests were run:

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
No radon	CMP gather Scaled stack	T06_64cr T06_64ds
Radon4 / Radon5	CMP gather Scaled stack	T06_65cr T06_65ds

Radon 4 parameters:

NMO:	using 100% 2km velocity field
Method:	p-decon
Model linear moveout range:	2000 to 4000ms
Reject linear moveout range:	2000 to 4000ms
Time range to form p-traces:	0 to 2500ms
Reference offset:	7300m
Maximum frequency:	93Hz

Radon 5 parameters (as radon 4 except):

Model parabolic moveout range:	-500 to 4000ms
Reject parabolic moveout range:	500 to 4000ms
Velocity mutes:	20% - 95%

Decision: 2 pass radon demultiple is to be applied using the parameters above (radon 4 and 5). Radon is only to be applied below 500ms in order to protect the shallow data.

6.9.12 Migration

Tests were run on line 11 to compare the results of running Kirchhoff pre-stack time migration, DZO pre-stack time migration and a post-stack Kirchhoff migration.

Input data: production FK filter data, radon demultiple and DBS applied.

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
DZO PSTM applied	Migrated Stack	T11_26es_40deg
Kirchhoff PSTM applied	Migrated Stack	T13_16es
DMO stack/post-stack Kirchhoff migration	Migrated Stack	T12_07es

Decision: Kirchhoff pre-stack time migration to be applied, using a maximum dip of 60 degrees from 0-4500ms and 45 degrees from 6000ms.

Confirmation testing of the Kirchhoff PSTM was done on line 27, as this line contained linear noise, was shot in shallow water and also contained a high amplitude residual multiple.

Because of the complicated nature of the water bottom and the underlying structure, Santos thought that migrating the data with a 500m velocity field rather than the proposed 1km velocity field would give better results. This was tested on line 11.

The velocity field was picked on a 500m grid after KPSTM had been applied and smoothed over a 5km radius. For the other test, this velocity field was first decimated to a 1km grid before being smoothed.

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
500m velocity field	CMP gathers Stack	T13_14cr T13_14es
1km velocity field	CMP gathers	T13_15cr

Stack

T13_15es

Decision: Kirchhoff pre-stack time migration to be applied using the 1km velocity field, smoothed over 5km.

6.9.13 Hybrid Depth migration

Due to the uneven nature of the water bottom, a hybrid depth migration test was conducted on line 10 to see if this method of migration stopped the data from sagging under the WB structures and compared to the Kirchhoff PSTM.

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
Kirchhoff pre-stack time migration	Stack	T13_15es
Hybrid pre-stack depth migration	Stack	T16_26es

Decision: Hybrid depth migration is not to be applied.

6.9.14 Pre-migration noise reduction

The following tests were run to try and reduce the migration artefacts caused by the high amplitude residual multiple on line 27.

Input data: production FK filtered data, radon and DBS applied.

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
1000ms AGC prior to KPSTM	CMP gathers	T13_19cr
	Stack	T13_19es
TVF prior to KPSTM	CMP gathers	T13_20cfr
	Stack	T13_20efs
TVF/Despike prior to KPSTM	CMP gathers	T13_21cfr
	Stack	T13_21efs
ZAP, no KPSM applied	CMP gathers	T19_01cr

Decision: Apply TVF prior to Kirchhoff pre-stack time migration:

Time (ms)	Low cut	High cut
WB	3Hz, 18dB/oct	60Hz 36dB/oct
WB+1000	3Hz, 18dB/oct	50Hz, 36dB/oct
WB+2000	3Hz, 18dB/oct	40Hz, 36dB/oct
WB+3000	3Hz, 18dB/oct	30Hz, 36dB/oct

6.9.15 Radon demultiple (final pass)

A final pass of radon demultiple using the final velocity field was tested on lines 5, 11 and 27.

Input: Production KPSTM CMP gathers.

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
No radon	CMP gathers	T22_11_KPSTM_SEGY_CMPS
Radon applied	CMP gathers	T22_11_RADON2_SEGY_CMPS

Radon parameters were as follows:

NMO:	using 100% 500m velocity field
Method:	least squares modelling
Model parabolic moveout range:	-500 to 2000ms
Reject parabolic moveout range:	300 to 2000ms
Reference offset:	7300m
Maximum frequency:	93Hz
Velocity mutes:	20% - 95% of 500m velocity field.

Decision: A final pass of radon demultiple using the final 500m velocity field is to be applied to the KPSTM gathers for archive and also to the near and far angle stacks. It is not necessary to apply it to the final stack dataset.

6.9.16 Prestack Scaling

Pre-stack scaling tests were run on line 5.

Input: production KPSTM gathers. Tau P filter, TVF and cascaded AGC were applied post stack.

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
No pre stack scaling	CMP gathers	T25_15ecr
	Stack	T25_15eds
Pre-stack AGC of 1000ms window length	CMP gathers	T25_16ecr
	Stack	T25_16eds
Pre-stack AGC of 500ms window length	CMP gathers	T25_17ecr
	Stack	T25_17eds
Pre-stack Trace balance	CMP gathers	T25_18ecr
	Stack	T25_18eds

Decision: Apply pre-stack scaling with 500ms window length to the final filtered stack.

6.9.17 Near and Far angle mutes

Mute tests were run on line 5.

Percentages of outer traces mutes (OTM) and inner traces mutes (ITM) were created and applied to a series of KPSTM stacks to help optimise the near and far angle mutes.

Input: Production KPSTM gathers. TauP filter, TVF and AGC were applied post-stack.

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
100% OTM and 100% ITM	Stack	T17_13_KPSTMSTK_100_OTM_100_ITM
100% OTM and 150% ITM	Stack	T17_13_KPSTMSTK_100_OTM_150_ITM
100% OTM and 50% ITM	Stack	T17_13_KPSTMSTK_100_OTM_50_ITM
110% OTM and 100% ITM	Stack	T17_13_KPSTMSTK_110_OTM_100_ITM
120% OTM and 100% ITM	Stack	T17_13_KPSTMSTK_120_OTM_100_ITM
80% OTM and 100% ITM	Stack	T17_13_KPSTMSTK_80_OTM_100_ITM
90% OTM and 100% ITM	Stack	T17_13_KPSTMSTK_90_OTM_100_ITM
All mutes graphed only	CMP gathers	T17_14cr_KPSTM_MUTES

Decisions: The 100% OTM and 100% ITM are to be applied to the final stack.

The near angle stacks are to use 100% ITM and the midway function between 100% ITM and 120% OTM as the outer trace mute.

The far angle stacks are to use the near angle outer mute as the inner mute and 120% OTM as the outer trace mute.

6.9.18 Post stack Noise Reduction

Noise reduction tests were run on line 5.

Input: production KPSTM stack data.

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
No filter applied	Stack	T26_06efs
Dip filter +/- 4ms/tr	Stack	T26_10efs
RPF, 5 traces, fan +/- 5ms/tr	Stack	T23_06efs
TauP, +/- 6 P traces, Min semb 0.2, Max semb 0.8	Stack	T24_14efs
Tracemix, 11 traces	Stack	T29_05efs

Decision: Apply TauP filter (+/- 6 ms/tr) followed by a trace mix using 5 traces.

6.9.19 Post stack Time Variant Filter (TVF)

Post stack filter tests were run on line 5.

Input: production KPSTM stack data.

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
KPSTM- no filter	Stack	T28_00eds
Low cut 6Hz, High cut 20Hz	Stack	T28_01edf
Low cut 21Hz, High cut 30Hz	Stack	T28_02edf
Low cut 31Hz, High cut 40 Hz	Stack	T28_03edf
Low cut 41Hz, High cut 50 Hz	Stack	T28_04edf
Low cut 51Hz, High cut 60 Hz	Stack	T28_05edf
Low cut 61Hz, High cut 70 Hz	Stack	T28_06edf
Low cut 71Hz, High cut 80 Hz	Stack	T28_07edf
Low cut 6Hz, High cut 20Hz	Stack	T28_09edf
Low cut 6Hz, High cut 30Hz	Stack	T28_10edf
Low cut 6Hz, High cut 40 Hz	Stack	T28_11edf
Low cut 6Hz, High cut 50 Hz	Stack	T28_12edf
Low cut 6Hz, High cut 60 Hz	Stack	T28_13edf
Low cut 6Hz, High cut 70 Hz	Stack	T28_14edf
Low cut 6Hz, High cut 80 Hz	Stack	T28_15edf
Low cut 4Hz, High cut 60Hz	Stack	T28_16edf
Low cut 6Hz, High cut 60Hz	Stack	T28_17edf
Low cut 8Hz, High cut 60 Hz	Stack	T28_18edf
Low cut 10Hz, High cut 60 Hz	Stack	T28_19edf
Low cut 12Hz, High cut 60 Hz	Stack	T28_20edf
Low cut 14Hz, High cut 60 Hz	Stack	T28_21edf

Decision: Apply the following final post-stack TVF:

Filter Time	Low-cut filter	High-cut filter
WB	10Hz, 18dB/oct	70Hz, 36dB/oct
WB + 500ms	10Hz, 18dB/oct	70Hz,36dB/oct
WB + 2000ms	8Hz, 18dB/oct	60Hz,36dB/oct
WB + 3000ms	6Hz, 18dB/oct	40Hz,36dB/oct
WB + 4000ms	6Hz, 18dB/oct	30Hz,36dB/oct

6.9.20 Post stack scaling

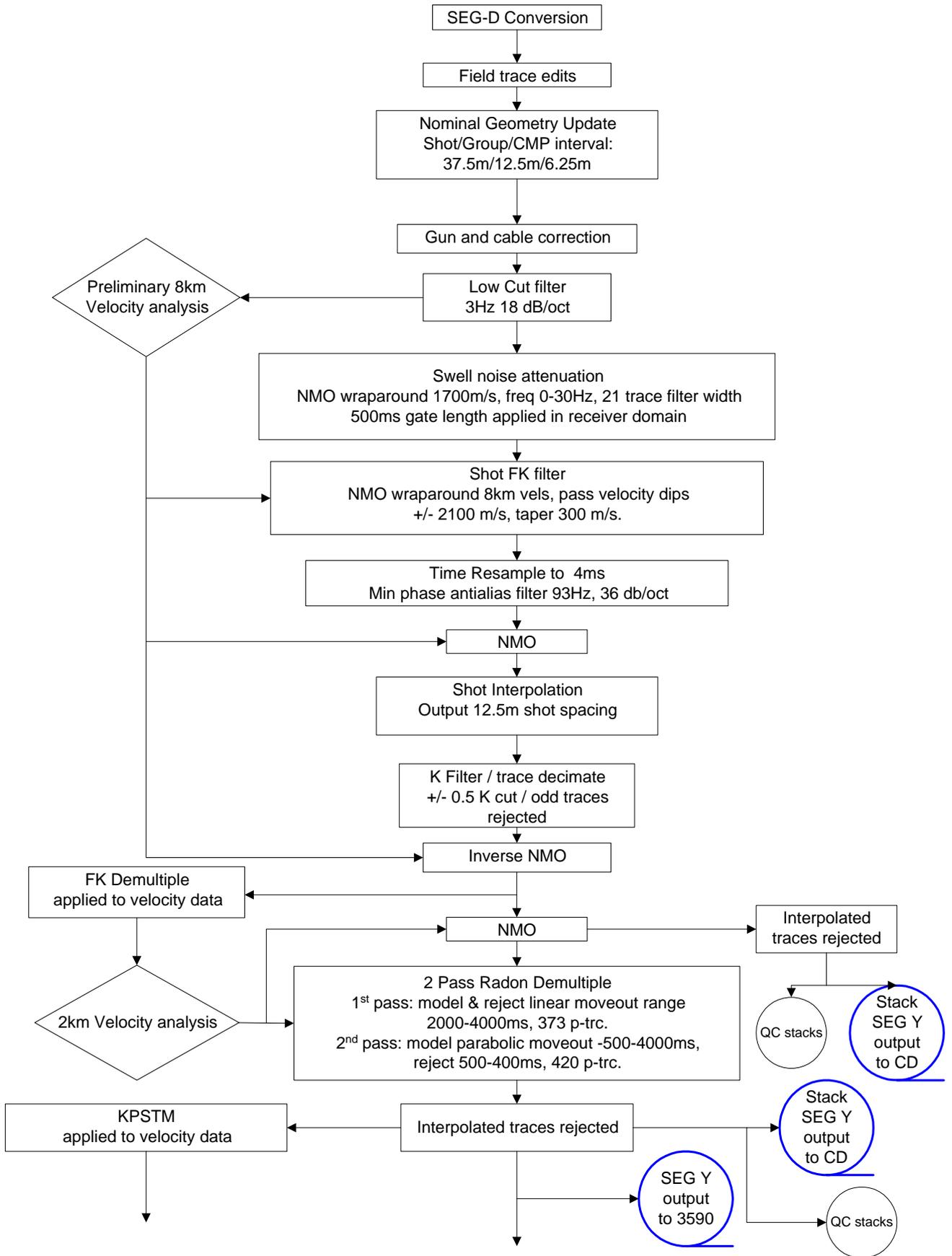
Scaling tests were run on line 5.

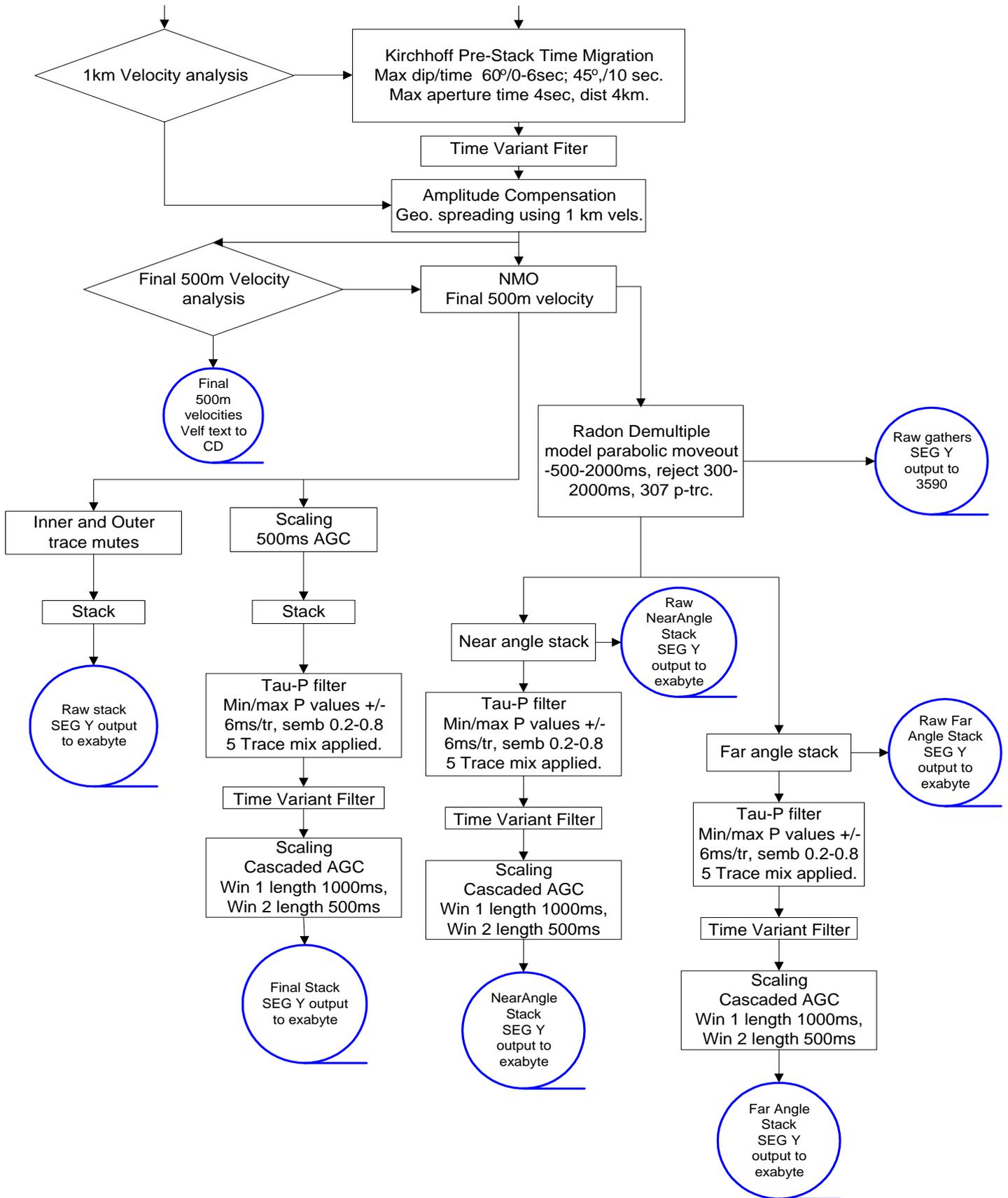
Input: production KPSTM stack data.

<u>Comments</u>	<u>Display</u>	<u>Test No</u>
500ms AGC	Stack	T30_02efs
1000ms AGC	Stack	T30_04efs
1500ms AGC	Stack	T30_05efs
Cascaded AGC: Win1: 1000ms, Win2: 250ms	Stack	T30_09efs
Cascaded AGC: Win1: 1000ms, Win2: 500ms	Stack	T30_10efs
Cascaded AGC: Win1: 500ms, Win2: 250ms	Stack	T30_13efs
Cascaded AGC: Win1: 750ms, Win2: 250ms	Stack	T30_14efs
Cascaded AGC: Win1: 1500ms, Win2: 250ms	Stack	T30_15efs

Decision: Apply cascaded AGC with window length 1: 1000ms and window length 2: 500ms.

6.10 Data Processing Flowchart





6.11 Example displays at various processing stages

6.11.1 Line: SS02-05

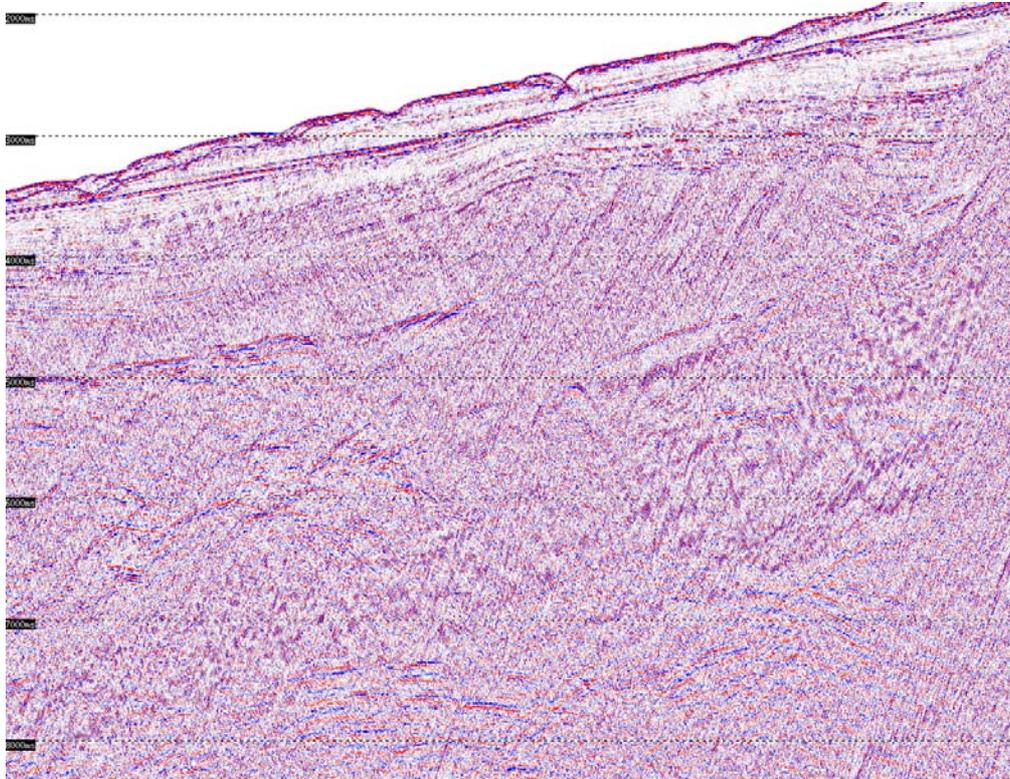


Figure 6.11.1.1: QC stack, no radon demultiple applied, stacked using 2km velocity field.

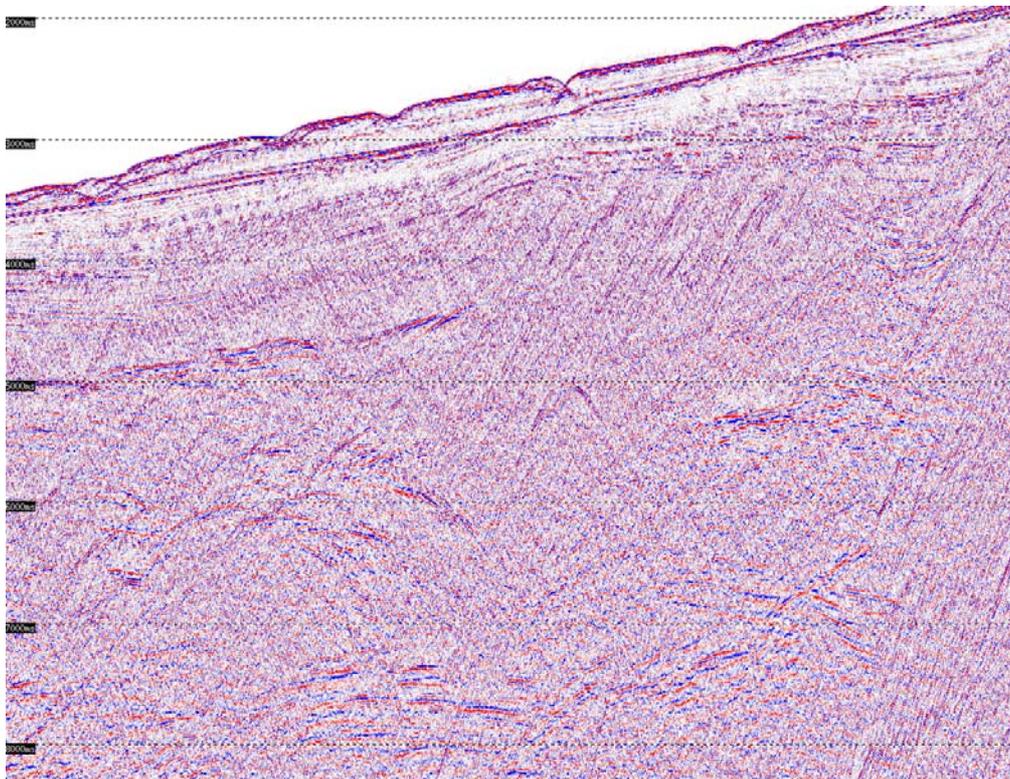


Figure 6.11.1.2: QC stack, radon demultiple applied, stacked using 2km velocity field.

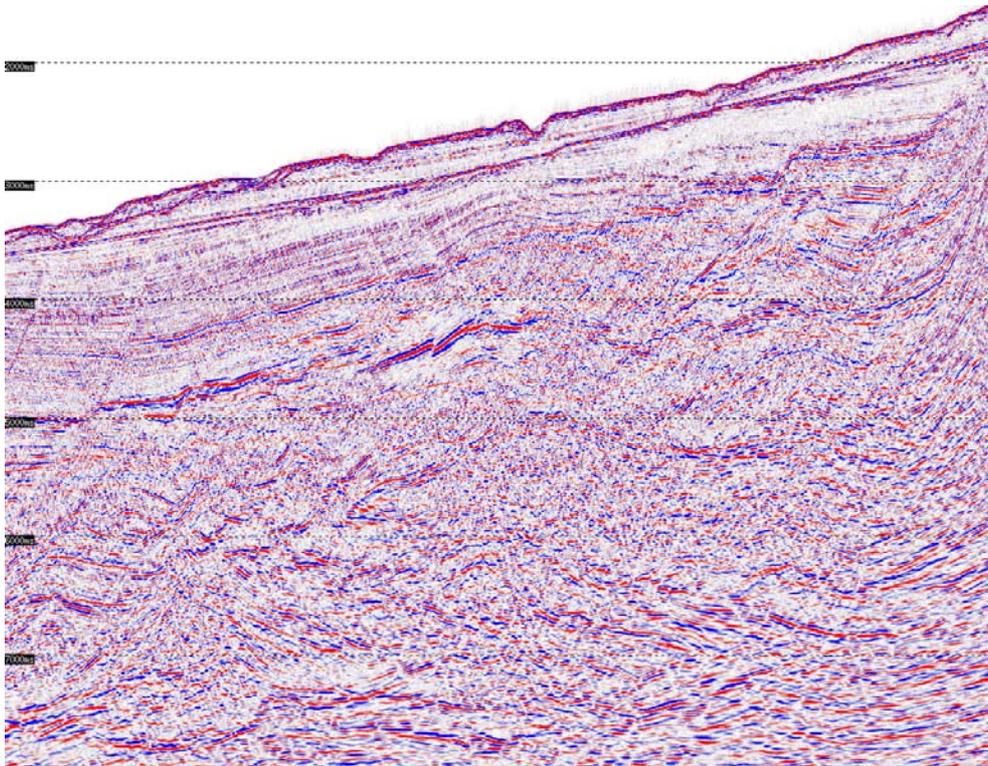


Figure 6.11.1.3: QC migrated stack, KPSTM applied, stacked using 1km velocity field.

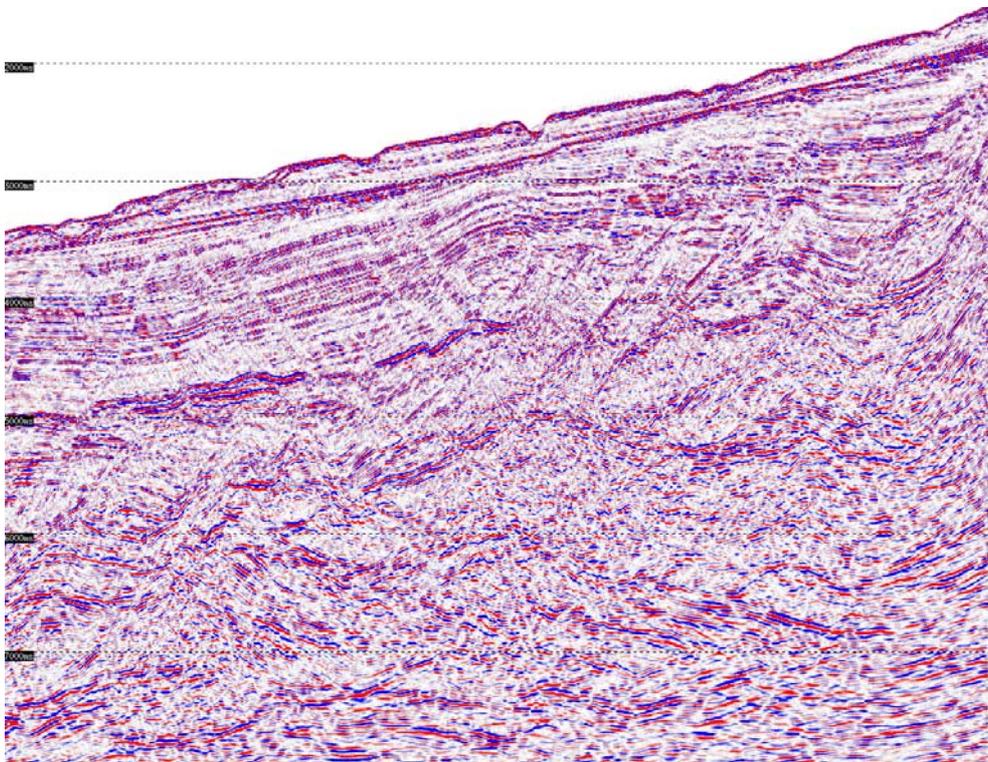


Figure 6.11.1.4: Filtered migrated stack, KPSTM and post stack processing applied.

6.11.2 Line: SS02-27

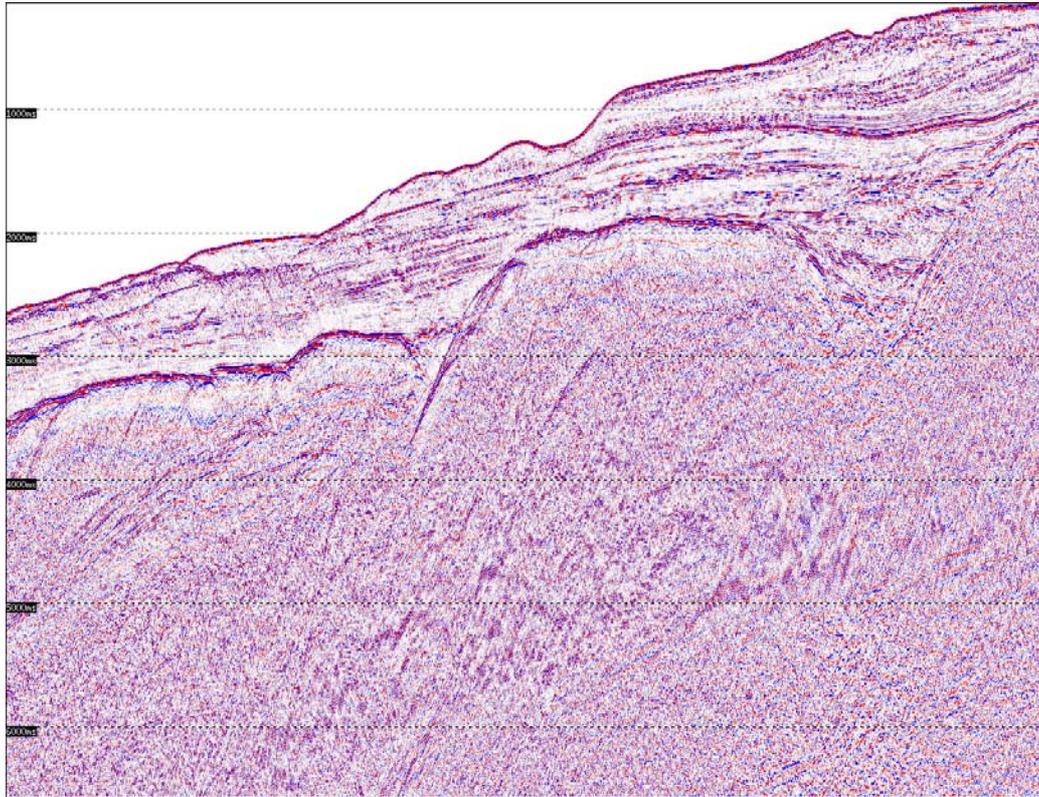


Figure 6.11.2.1: QC stack, no radon demultiple applied, stacked using 2km velocity field.

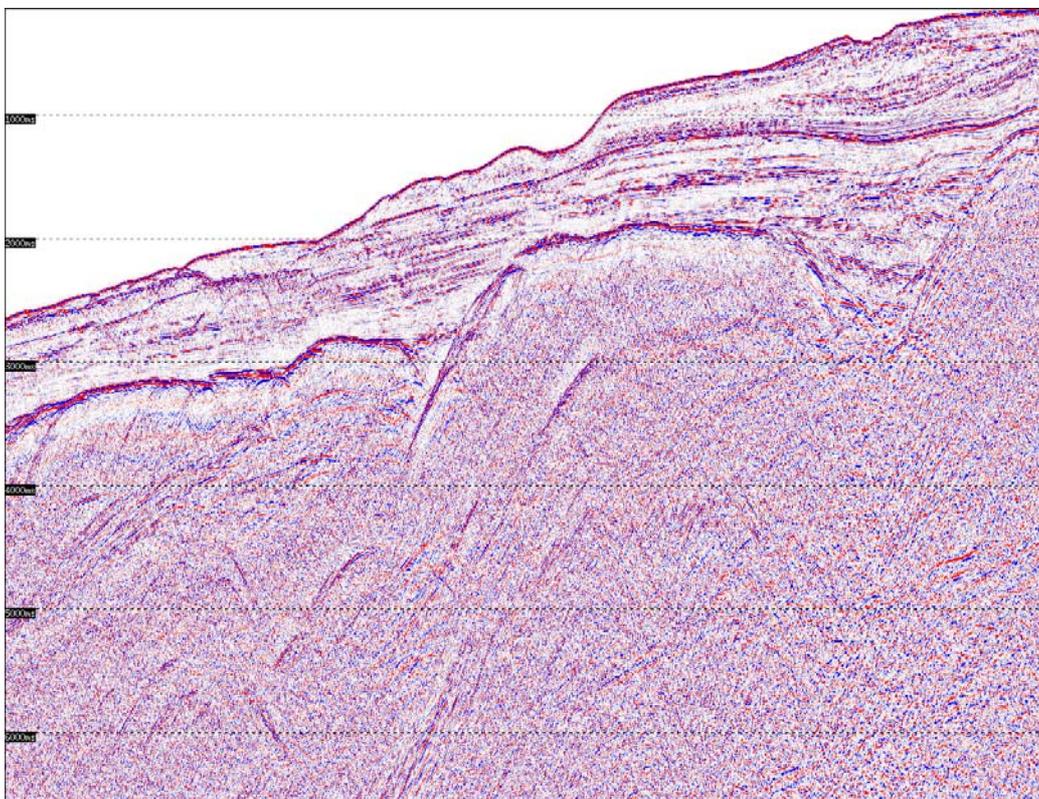


Figure 6.11.2.2: QC stack, radon demultiple applied, stacked using 2km velocity field.

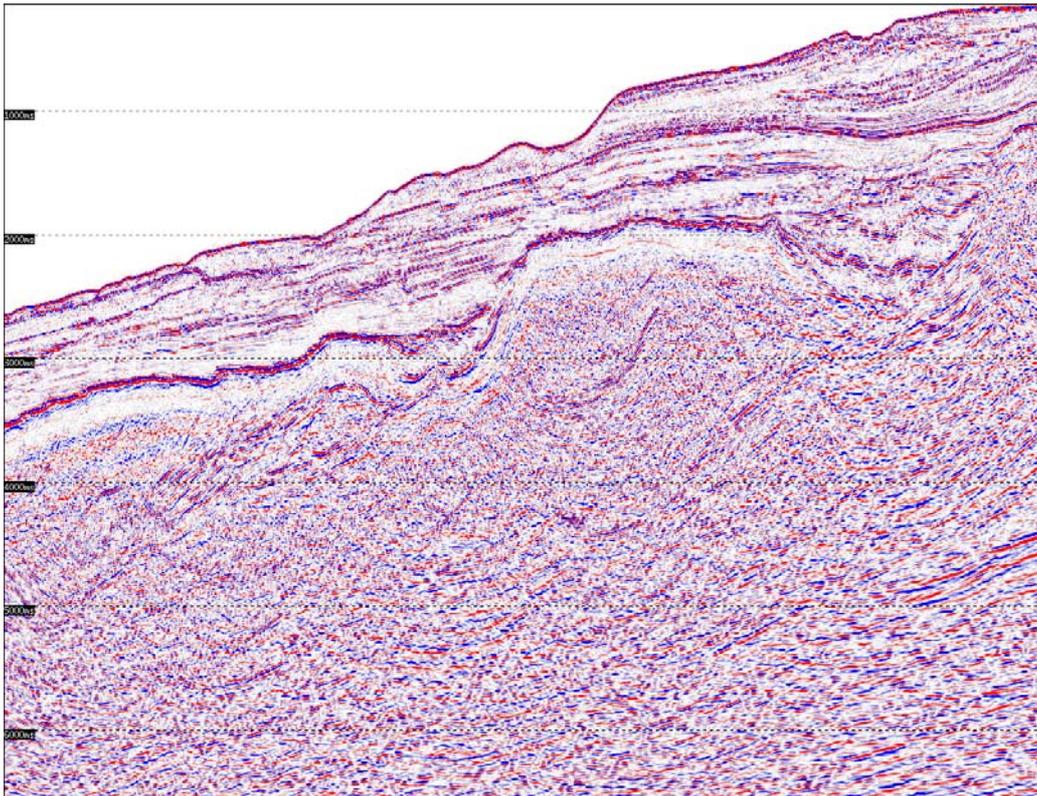


Figure 6.11.2.3: QC migrated stack, KPSTM applied, stacked using 1km velocity field.

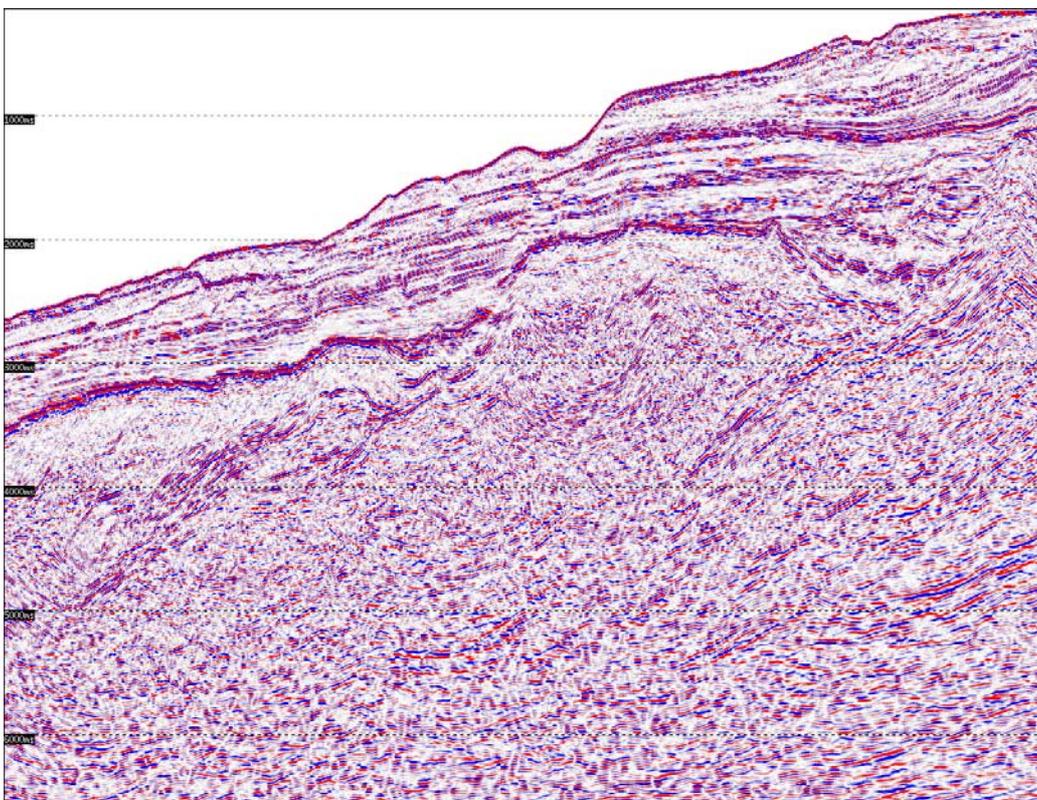


Figure 6.11.2.4: Filtered migrated stack, KPSTM and post stack processing applied.

6.12 Tape Disposition

<u>Data</u>	<u>Permit</u>	<u>Media</u>	<u>Copies</u>	<u>Tape Nos.</u>	<u>Date Sent</u>
Demultiple stacks	T/32P,T/33P	DVD	1	OP000464	29/05/2003 (hand carried)
Final filtered stacks	T/32P,T/33P	Exabyte	2	X00828	15/08/2003
				X00834	15/08/2003
	T/32P	Exabyte	1	X00829	15/08/2003
	T/33P	Exabyte	1	X00830	15/08/2003
Filtered near angle stks	T/32P,T/33P	Exabyte	2	X00831	15/08/2003
				X00835	15/08/2003
	T/32P	Exabyte	1	X00832	15/08/2003
	T/33P	Exabyte	1	X00833	15/08/2003
Filtered far angle stks	T/32P,T/33P	Exabyte	2	X00836	15/08/2003
				X00842	15/08/2003
	T/32P	Exabyte	1	X00837	15/08/2003
	T/33P	Exabyte	1	X00854	15/08/2003
Raw filtered stacks	T/32P,T/33P	Exabyte	2	X00838	15/08/2003
				X00843	15/08/2003
	T/32P	Exabyte	1	X00839	15/08/2003
	T/33P	Exabyte	1	X00841	15/08/2003
Raw near angle stks	T/32P,T/33P	Exabyte	2	X00838	15/08/2003
				X00843	15/08/2003
	T/32P	Exabyte	1	X00839	15/08/2003
	T/33P	Exabyte	1	X00841	15/08/2003
Raw far angle stks	T/32P,T/33P	Exabyte	2	X00844	15/08/2003
				X00848	15/08/2003
	T/32P	Exabyte	1	X00845	15/08/2003
	T/33P	Exabyte	1	X00853	15/08/2003
Velocity field	T/32P,T/33P	CD	1	OP000594 CD-R1	15/08/2003
	T/32P	CD	1	OP000594 CD-R2	15/08/2003
	T/33P	CD	1	OP000594 CD-R3	15/08/2003
Radon PSTM Gathers	T/32P,T/33P	3590E	2	Q50870-Q50898	15/08/2003
				Q50900-Q50928	15/08/2003
Final report	T32/P,T/33P	CD	3	CD-Report1a	13/10/2003
				CD-Report1b	13/10/2003
				CD-Report1c	13/10/2003
	T/32P	CD	1	CD-Report2	13/10/2003
	T/33P	CD	1	CD-Report3	13/10/2003
CGMs	T/32P,T/33P	CD	1	CD-CGM1	02/10/2003

6.13 SEG-Y Trace Header Byte Locations

6.13.1 KPSTM CMP Gathers

DATA_TYPE	Starting BYTE	Description
'INTEGER'	17	'CMP'
'INTEGER'	21	'CMP'
'HALFWORD'	33	'STACK WORD'
'INTEGER'	61	'WATER DEPTH Midpoint'
'INTEGER'	65	'WATER DEPTH Midpoint'
'INTEGER'	73	'XCORD Midpoint'
'INTEGER'	77	'YCORD Midpoint'
'INTEGER'	81	'XCORD Midpoint'
'INTEGER'	85	'YCORD Midpoint'
'HALFWORD'	91	'Water Velocity'
'HALFWORD'	99	'Source Correction'
'HALFWORD'	101	'Cable Correction'
'HALFWORD'	103	'Total Gun and Cable Correction (Microsec)'
'INTEGER'	125	'XCORD Midpoint'
'INTEGER'	129	'YCORD Midpoint'
'HALFWORD'	141	'Anti Alias Filter * 100 (Hz)'
'HALFWORD'	143	'Anti Alias Filter Slope (db/oct)'
'HALFWORD'	149	'Low Cut Frequency (Hz)'
'HALFWORD'	151	'High Cut Frequency (Hz)'
'HALFWORD'	153	'Low Cut Filter Slope (db/oct)'
'HALFWORD'	155	'High Cut Filter Slope (db/oct)'
'HALFWORD'	157	'Year data recorded'
'HALFWORD'	159	'Julian day of the Year'
'INTEGER'	181	'XCORD Midpoint'
'INTEGER'	185	'YCORD Midpoint'
'INTEGER'	189	'CMP'
'INTEGER'	193	'CMP'
'INTEGER'	213	'WATER DEPTH Midpoint'
'INTEGER'	217	'CMP'
'INTEGER'	233	'Line Number'

6.13.2 Stack

DATA_TYPE	Starting BYTE	Description
'INTEGER'	17	'Shotpoint Number'
'INTEGER'	21	'CMP'
'HALFWORD'	33	'STACK WORD'
'INTEGER'	61	'WATER DEPTH Midpoint'
'INTEGER'	65	'WATER DEPTH Midpoint'
'INTEGER'	73	'XCORD Midpoint'
'INTEGER'	77	'YCORD Midpoint'
'INTEGER'	81	'XCORD Midpoint'
'INTEGER'	85	'YCORD Midpoint'
'HALFWORD'	91	'Water Velocity'
'HALFWORD'	99	'Source Correction'
'HALFWORD'	101	'Cable Correction'
'HALFWORD'	103	'Total Gun and Cable Correction (Microsec)'
'INTEGER'	125	'XCORD Midpoint'
'INTEGER'	129	'YCORD Midpoint'
'HALFWORD'	141	'Anti Alias Filter * 100 (Hz)'
'HALFWORD'	143	'Anti Alias Filter Slope (db/oct)'
'HALFWORD'	149	'Low Cut Frequency (Hz)'
'HALFWORD'	151	'High Cut Frequency (Hz)'
'HALFWORD'	153	'Low Cut Filter Slope (db/oct)'
'HALFWORD'	155	'High Cut Filter Slope (db/oct)'
'HALFWORD'	157	'Year data recorded'
'HALFWORD'	159	'Julian day of the Year'
'HALFWORD'	167	'Time code 1 = Local'
'INTEGER'	181	'XCORD Midpoint'
'INTEGER'	185	'YCORD Midpoint'
'INTEGER'	189	'Shotpoint Number'
'INTEGER'	193	'CMP'
'INTEGER'	213	'WATER DEPTH Midpoint'
'INTEGER'	217	'CMP'
'INTEGER'	233	'Line Number'