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Title STRATUS & REINGA 2D PSTM PROCESSING REPORT

Operator CGGVeritas

Author CGGVeritas

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STRATUS & REINGA 2D PSTM PROCESSING 2009

TASMAN SEA AND REINGA BASIN, NEW ZEALAND

SEISMIC DATA PROCESSING REPORT

SUBMITTED BY

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1. INTRODUCTION

1.1 OVERVIEW

This report details the seismic data processing (2D PreSTM) of Stratus 2D and Reinga 2D survey offshore New Zealand at CGGVeritas. Both the Stratus 2D survey and the Reinga 2D survey were shot for CGGVeritas marine 2D data library.

The Stratus 2D seismic data was acquired by CGGVeritas using the vessel Pacific Titan in October 2008. The survey conducted from the Eastern margin of Australia, in the area of Cape and Fault Basins, to the edge of the Taranaki Basin in New Zealand. The survey consisted of 4 lines which took 6 sequences in total. The total length of the 2D lines is about 1441 km. The water depth averaged over 1000 m in the survey area.

The Reinga 2D seismic data was acquired by the same vessel of CGGVeritas in March to April of 2009. The survey located offshore to the Northwest of New Zealand's North Island. The area was between the Reinga Ridge and West Norfolk Ridge, centre of which was approximately 270Nm Northwest of Auckland. The survey consisted of 20 lines which took 27 sequences in total. The total sail length was around 5144 km while the full fold coverage was approximately 5055 km. Water depth varied slowly across the survey area and is between 166 m and 2997 m.

1.2 SURVEY MAP

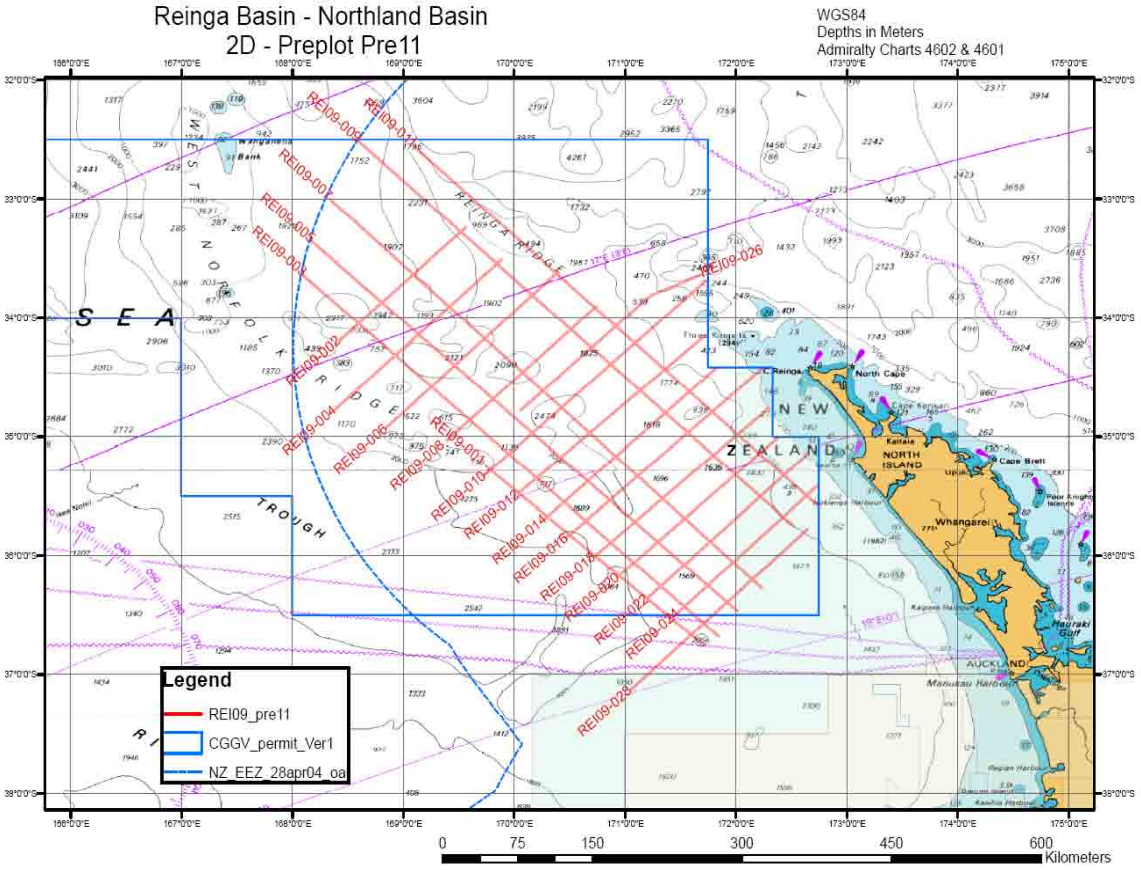

Figure 1: Survey map of Reinga 2D

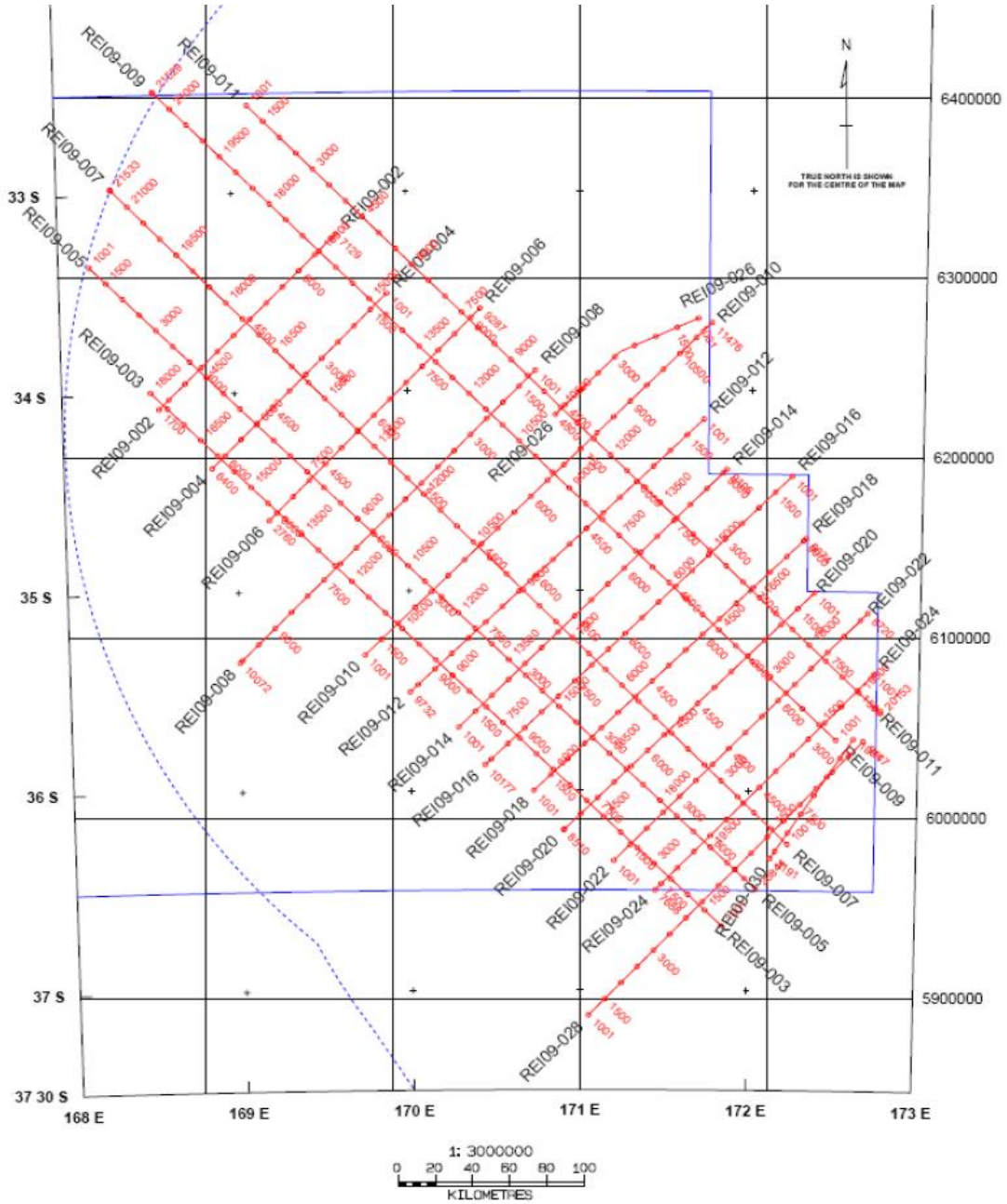

Figure 2: Sail line plot of Reinga 2D

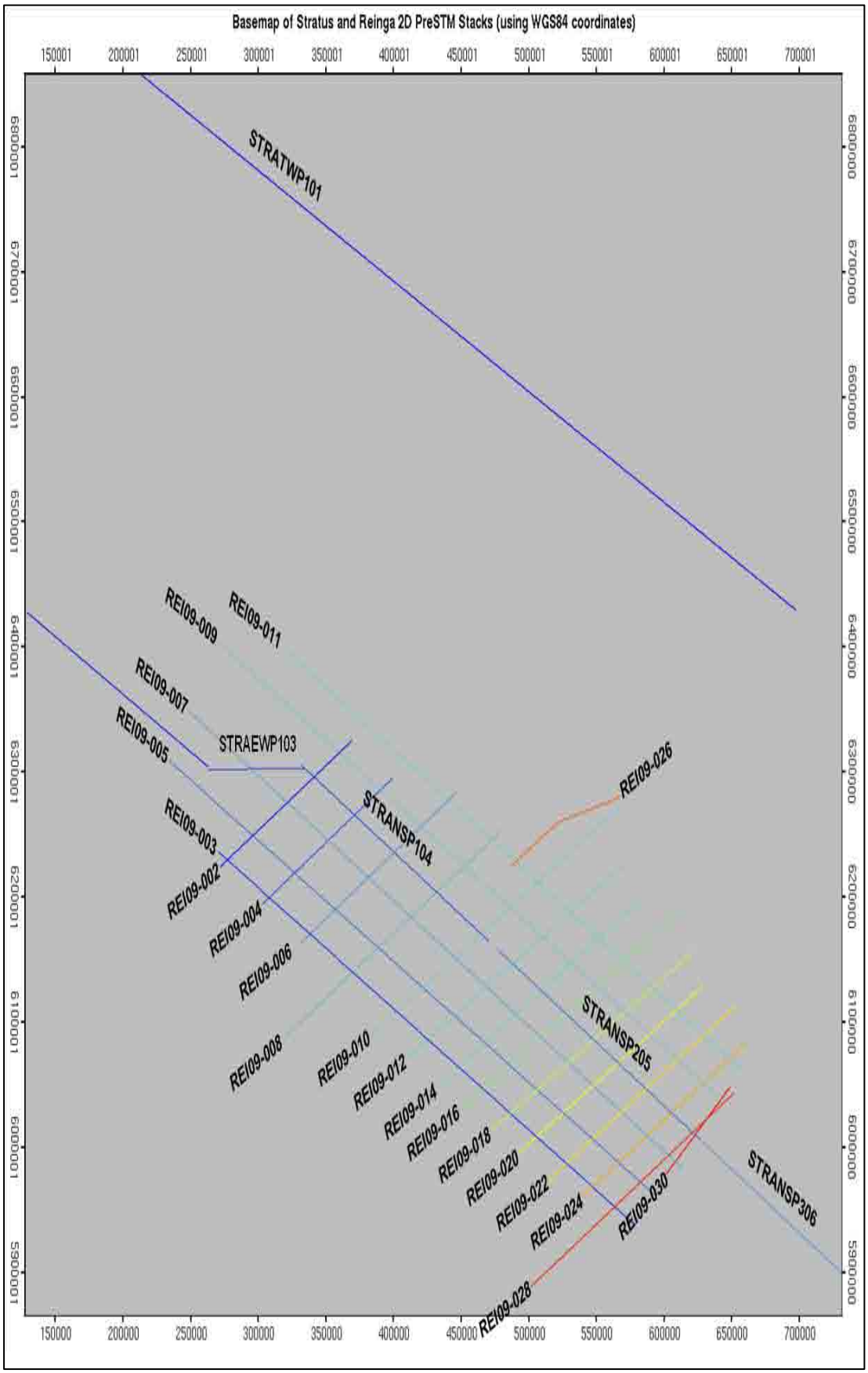

Figure 3: Sail line plot of both Stratus 2D and Reinga 2D

1.3 PERSONNEL

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2. ACQUISITION SUMMARY

2.1 ACQUISITION PARAMETERS

The acquisition was done by CGGVeritas, using M/V Pacific Titan in October 2008 for Stratus 2D survey and in March to April 2009 for Reinga 2D survey. Total sail lengths of the 2D lines were approximately 1441 km and 5144 km for Stratus and Reinga respectively. Group interval was 12.5 m and shot point interval was 25 m. The nominal CMP bin fold coverage was 106 for Stratus survey and was 159 for Reinga survey.

Stratus 2D survey:

Acquisition

Recorded by	:	CGGVeritas Marine
Recording vessel	:	M/V Pacific Titan
Date recorded	:	2008

Source

Energy source	:	Airgun array
Shot Interval	:	37.5 m
Source volume	:	4140 cu. in.
Airgun pressure	:	2000 psi
Gun depth	:	6 m (+/- 0.5 m)

Streamers

Cable length	:	7950 m
Configuration	:	Off - End
Number of channels	:	636
Group interval	:	12.5 m
Cable depth	:	7 m (+/- 1 m)
Number of Streamers	:	1

Recording

Record length	:	12000 ms
Sample rate	:	2 ms
Field CMP interval	:	6.25 m
Nominal Fold	:	106
Tape format	:	SEG-D
Polarity	:	Compression negative

Reinga 2D survey:

Acquisition

Recorded by	:	CGGVeritas Marine
Recording vessel	:	M/V Pacific Titan
Date recorded	:	2009

Source

Energy source	:	Airgun array
Shot Interval	:	25 metre
Source volume	:	4140 cu. in.
Airgun pressure	:	2000 psi
Gun depth	:	6 m (+/- 0.5 m)

Streamers

Cable length	:	7950 m
Configuration	:	Off - End
Number of channels	:	636
Group interval	:	12.5 m
Cable depth	:	7 m (+/- 1 m)
Number of Streamers	:	1

Recording

Record length	:	8000 ms
Sample rate	:	2 ms
Field CMP interval	:	6.25 m
Nominal Fold	:	159
Tape format	:	SEG-D
Polarity	:	Compression negative

3. PROCESSING SUMMARY

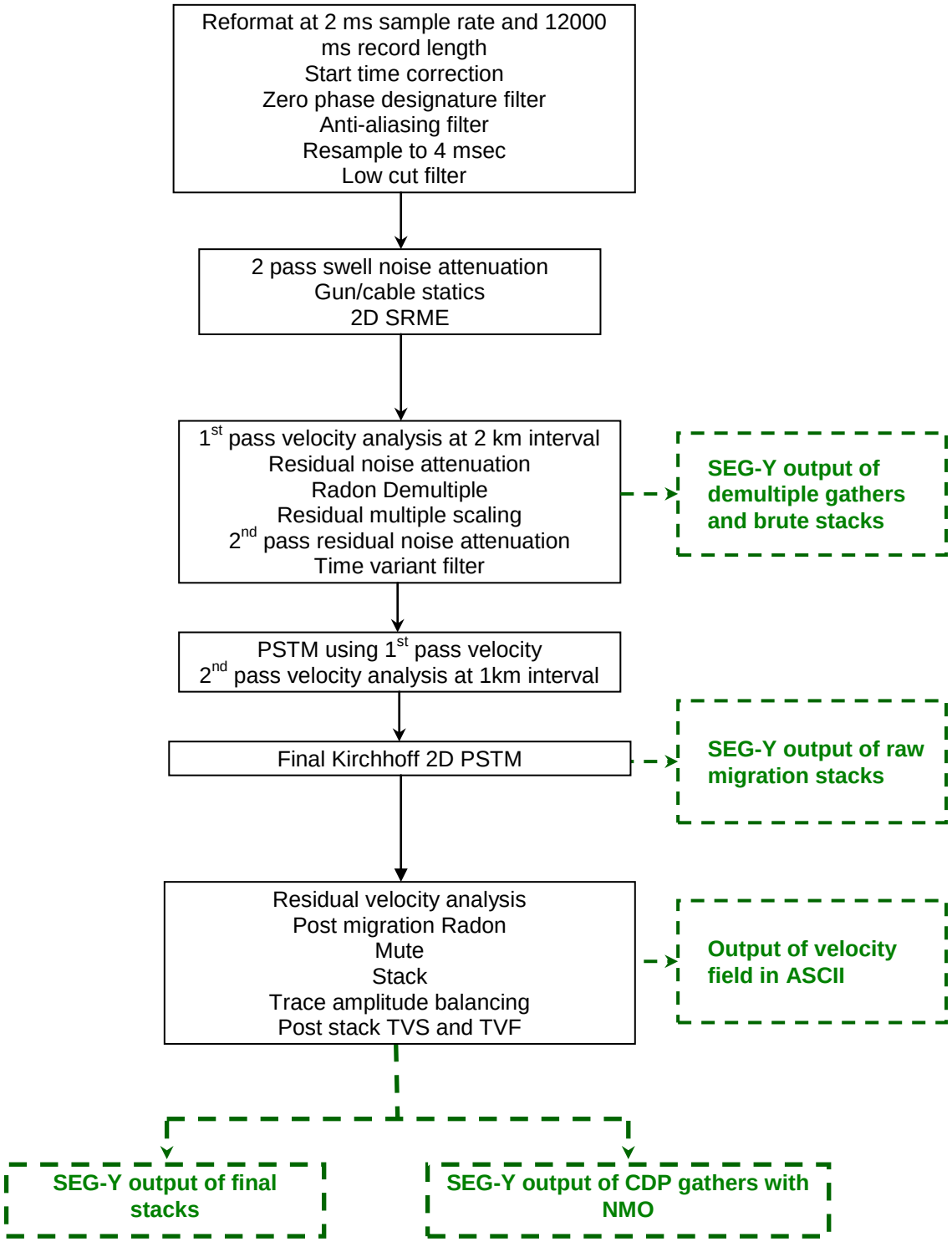
Below listed the brief summary of the processing flow applied to the data.

3.1 STRATUS 2D PROCESSING SUMMARY

3.1.1 2D PSTM PROCESSING FLOW

1. Reformat from SEGY format to CGGVeritas internal format at 2 ms sample rate and 12000 ms record length. Amplitude and frequency QC
2. Start time correction
3. Zero-phase designature
4. Resample from 2 ms to 4 ms with anti-aliasing filter (105 Hz with 120 dB/Oct slope)
5. Low-cut filter at 4 Hz with 18 dB/Oct slope
6. 2 pass swell noise attenuation in shot domain
7. Gun / cable statics correction
8. 2D Surface Related Multiple Elimination
9. 1st pass velocity picking on 2 km grid
10. Residual noise attenuation
11. High resolution Radon demultiple
12. Residual multiple scaling
13. 2nd pass residual noise attenuation
14. Apply time variant filter
15. Muting and stacking for brute sections
16. PreSTM using first pass velocity
17. 2nd pass velocity picking on 1 km grid
18. Final Kirchhoff PreSTM with smoothed 2nd pass picked velocity
19. Residual velocity analysis and moveout correction
20. Post migration high resolution Radon demultiple
21. Muting and stacking for post-migration sections
22. Apply post stack time variant scaling
23. Apply time variant filter
24. Output to SEGY format

3.1.2 PROCESS FLOW CHART

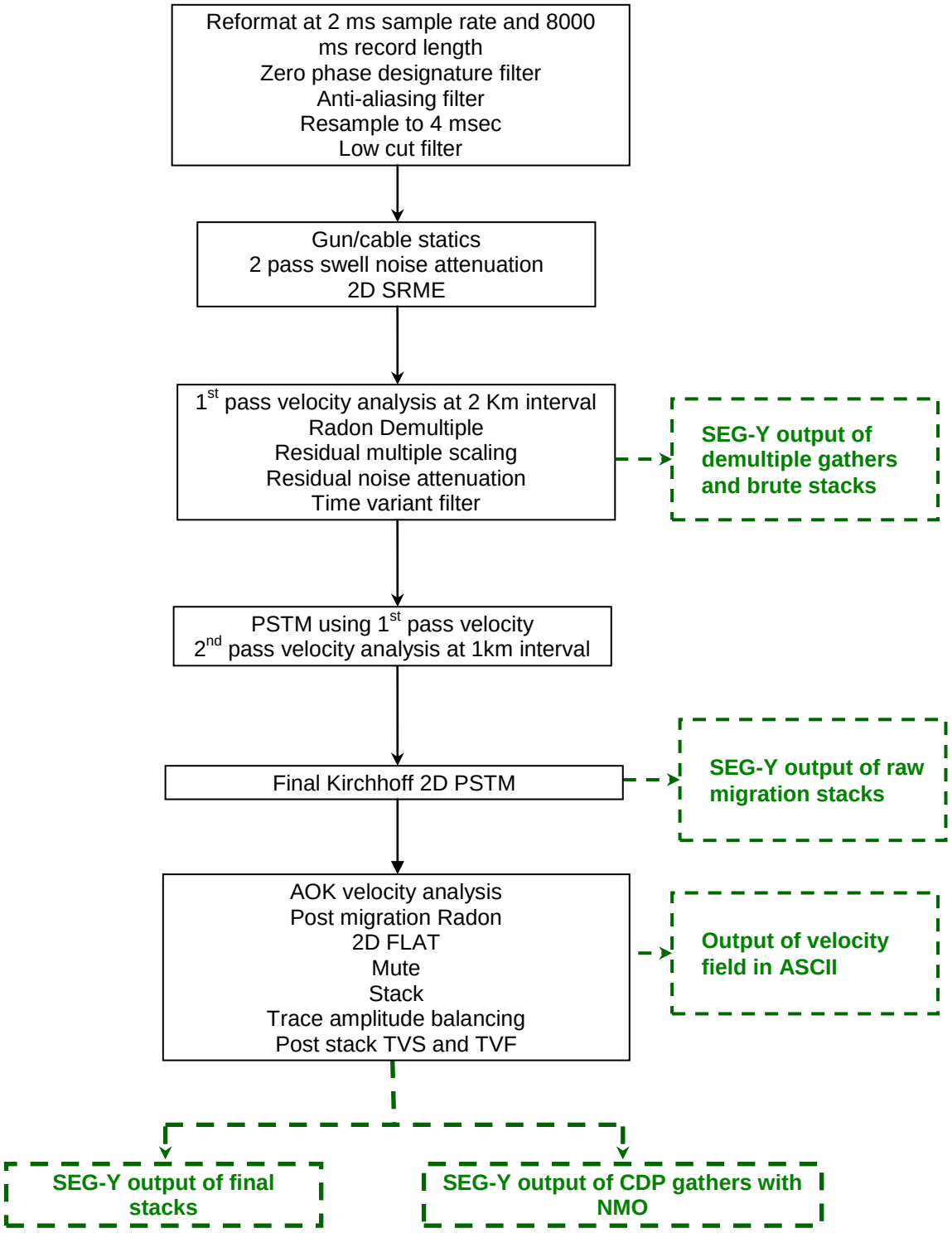


3.2 REINGA 2D PROCESSING SUMMARY

3.2.1 2D PSTM PROCESSING FLOW

1. Reformat from SEGY format to CGGVeritas internal format at 2 ms sample rate and 8000 ms record length. Amplitude and frequency QC
2. Zero-phase designature
3. Resample from 2 ms to 4 ms with anti-aliasing filter (105 Hz with 120 dB/Oct slope)
4. Low-cut filter at 4 Hz with 18 dB/Oct slope
5. Apply trace edit
6. Apply gun / cable statics correction
7. 2 pass swell noise attenuation in shot domain
8. 2D Surface Related Multiple Elimination
9. 1st pass velocity picking on 2 km grid
10. Adjacent trace sum
11. High resolution Radon demultiple
12. Residual multiple scaling
13. Residual noise attenuation
14. Time variant filtering
15. Muting and stacking for brute sections
16. PreSTM using 1st pass velocity
17. 2nd pass velocity picking on 1 km grid
18. Final Kirchhoff PreSTM with smoothed 2nd pass picked velocity
19. AOK (Amplitude Oriented Kinematics) velocity analysis and final moveout correction
20. Post migration high resolution Radon demultiple
21. Apply 2D FLAT
22. Muting and stacking
23. Trace amplitude balancing
24. Apply post stack time variant scaling
25. Apply time variant filter
26. Output to SEGY format

3.2.2 PROCESSING FLOW CHART



4. TESTING

4.1 PRE-MIGRATION TESTS

4.1.1 LOW CUT FILTER TEST

In order to design a filter that attenuates low frequency noise, 3 sets of parameters were tested:

Cut-off frequency	Slope
3 Hz	18 dB/Oct
4 Hz	18 dB/Oct
5 Hz	18 dB/Oct

Based on the test results, the 4 Hz low cut filter with 18 dB/Octave slope was chosen.

01_LowCutFilterTest.pdf

4.1.2 SWELL NOISE ATTENUATION TEST

Swell noise attenuation tests were carried out in channel domain to examine the effects of different parameters and to select the optimal values. (WBT stands for water bottom time.)

Test A: Start time: WBT-500, Lpanel 151, twin tmax; frequency 0-10 Hz; tolerance 2.2
Test B: Start time: WBT-500, Lpanel 151, twin tmax; frequency 0-10 Hz; tolerance 1.8
Test C: Start time: WBT-500, Lpanel 151, twin tmax; frequency 0-10 Hz; tolerance 1.5
Test D: Two passes
1st Pass: Start time: WBT-500, Lpanel 151, twin tmax; frequency 0-10 Hz; tolerance 1.8
2nd Pass: Start time: WBT+800, Lpanel 61, twin 1.0s; frequency 0-10 Hz; tolerance 2.1

Test D was chosen as it best attenuated both low frequency swell noise and high frequency spikes.

02_SwellNoiseAttenuationTest.pdf

4.1.3 2D SURFACE RELATED MULTIPLE ELIMINATION TEST

2D SRME models multiple from primary events and adaptively subtracts multiples from original data. 4 sets of tests were performed to determine the most effective subtraction in SRME.

TEST	FILTER LENGTH	TIME WINDOW (ms)	TRACE WINDOW	START TIME (ms)	AMPLITUDE THRESHOLD
A	36	512	21	2xWBT - 100	1.45
B	36	256	21	2xWBT - 100	1.45
C	36	512	51	2xWBT - 100	1.45
D	36	1024	21	2xWBT - 50	1.45

Judging from the test results, Test A was chosen to be applied during production.

03_2DSRMETest.pdf

4.1.4 HIGH RESOLUTION RADON DEMULTIPLE TEST

High resolution Radon demultiple targets to attenuate long period multiples as well as residual multiples which were not removed by 2D SRME. Testing was done by varying signal protection range. The details are as follows:

	Transform range	Signal range
Test A:	[-1000, 8000]	[-1000,800]
Test B:	[-1000, 8000]	[-1000,500]
Test C:	[-1000, 8000]	[-1000,300]

Radon Start Time: Twice of water bottom time

Test B was selected as it best attenuated multiples while preserving primary events.

04_RadonDemultipleTest.pdf

4.1.5 RESIDUAL MULTIPLE SCALING TEST

Residual multiple scaling is a process which aims to attenuate residual multiples especially in deep water marine. It examines amplitude at times which are multiples of water bottom time and considers any stronger amplitude as multiple that need to be attenuated.

	Window size (ms)	Threshold	Level	Pass
Test A:	500	1.05	0.5	1
Test B :	200	1.25	0.5	1
Test C :	200	1.05	0.5	1
Test D :	200	1.05	0.5	2

Start Time: Twice of water bottom time with mute control

Results of test C were chosen to be the best.

05_ScalemultTest.pdf

4.2 POST-MIGRATION TESTS

4.2.1 POST –MIGRATION HIGH RESOLUTION RADON DEMULTIPLE TEST

2nd pass high resolution Radon demultiple was applied to remove the residual multiples after migration. Due to different behaviours in shallow and deep water, time variant Radon demultiple was tested.

	TRANSFER RANGE (ms)	SIGNAL RANGE (ms)	RADON TIME (ms)
TEST A	[-1000, 8000]	[-1000, 800]	Wbt + 500ms
	[-1000, 8000]	[-1000, 500]	Twice of wbt
TEST B	[-1000, 8000]	[-1000, 500]	Wbt + 500ms

	[-1000, 8000]	[-1000, 300]	Twice of wbt
TEST C	[-1000, 8000]	[-1000, 200]	Wbt + 500ms
	[-1000, 8000]	[-1000, 100]	Twice of wbt
TEST D	[-1000, 8000]	[-1000, 100]	Wbt + 500ms
	[-1000, 8000]	[-1000, 80]	Twice of wbt
TEST E	[-1000, 8000]	[-1000, 200]	Wbt + 500ms
	[-1000, 8000]	[-1000, 140]	Twice of wbt

Test B was selected as it best attenuated multiples while preserving primaries.

06_PostmigrationRadonDemultipleTest.pdf

4.2.2 POST –STACK TVS TEST

Post stack time variant scaling was performed to apply variant exponential gain at different times to the stacked data so as to better image the subsurface events in the deeper parts. Different parameters were tested and Test D was chosen to be applied during production.

TEST	TIME (ms)	GAIN (dB)
TEST A	Wbt	1
	Wbt + 1200	6
	Wbt + 2700	3
	Wbt + 5500	1
TEST B	Wbt	1
	Wbt + 800	6
	Wbt + 1800	12
	Wbt + 2700	6
	Wbt + 5500	3
TEST C	Wbt	1
	Wbt + 800	6
	Wbt + 1800	12
	Wbt + 2700	12
	Wbt + 5500	12
TEST D	Wbt	0
	Wbt + 1500	6
	Wbt + 3000	18
	Wbt + 8000	30

07_TVS_test.pdf

4.2.3 POST –STACK TVF TEST

Post-stack time variant filtering was applied to remove high frequency random noises and to improve stack response. It was designed based on the frequency contents of the data and tests of different parameters were performed. Below is TVF test for Reinga 2D.

TEST	TIME (ms)	PASS BAND (Hz)
TEST A	0 – 3800	4 – 80
	5400	4 – 60
	6600 – 8000	4 – 15
TEST B	0 – 4000	4 – 90

	5200	4 – 80
	6300 – 8000	4 – 25
TEST C	0 – 4000	4 – 90
	5200	4 – 80
	6300 – 8000	4 – 30
TEST D	0 – 3700	4 – 100
	5000	4 – 90
	6250 – 8000	4 – 40
TEST E	0 – 1500	4 – 90
	3000	4 – 80
	5000	4 – 55
	8000	4 – 30

Filters from Test E were chosen.

08_TVF_test.pdf

4.2.4 ANGLE MUTE TEST

Angle mute test was carried out on NMO corrected Pre-Stack Migration Gathers. Muting angles ranging from 1° to 55° were tested in steps of 5°. Based on the test results, near and far angle ranges were set to be 5° ~ 22° and 23° ~ 40° respectively.

09_Angle_mute_test.pdf

5. PRODUCTION PROCESSING

5.1 COMPREHENSIVE PROCESS FLOW AND PARAMETER DESCRIPTION – STRATUS

5.1.1 REFORMAT

The field data recorded in SEG-D format on 3590 cartridges were reformatted and converted to CGGVeritas internal format. The data were at 2 ms sample rate and the record lengths were 12000 ms.

5.1.2 START TIME CORRECTION

A shift of -50 ms was applied to start time due to recording instrument had a time delay of 50 ms during acquisition.

5.1.3 DESIGNATURE

The zero phase designature filter was designed based on the far field signature from the boat. The deconvolution gap used was 48 ms. For cable deghost, the streamer depth used was 7m and water velocity of 1500 m/s.

5.1.4 RESAMPLE WITH ANTI-ALIASING FILTER

An anti-aliasing filter with cut-off frequency at 105 Hz and slope at 120 dB/Octave was applied to the seismic data before it was resampled from 2 ms to 4 ms.

5.1.5 LOW-CUT FILTER

Low-cut filter was applied to shot records to attenuate low frequency noises prior to swell noise attenuation. The filter used had cut-off frequency of 4 Hz and tapering at 18 dB/Octave.

5.1.6 SWELL NOISE ATTENUATION

CGGVeritas module FXEDIT which can detect and repair anomalously high amplitude windows of a trace via FX projection filtering was applied to attenuate swell noise.

The program considers a group of traces at a time (commonly a common shot, receiver, channel or offset gather) over user specified time gates. Within each time window and frequency-by-frequency, rolling median amplitude is calculated. The user specifies a threshold value such that any frequency component of any trace that has window amplitude (relative to the rolling median value) above this threshold is flagged

for repair. Each of the flagged frequency/window components is deleted and re-interpolated.

2 passes of FXEDIT were applied in shot domain for swell noise attenuation. Table of parameters used:

PASS	SPATIAL WINDOW	TIME WINDOW (ms)	EFFECTIVE FREQUENCY RANGE (Hz)	TOLERANCE
1	81	12000	0 – 20	1.8
2	41	12000	0 – 20	2.0

5.1.7 GUN/CABLE STATICS

Gun/cable statics were applied in order to use datum at sea level for subsequent processes. It was performed by adding time shifts calculated from source and receiver depths to original data.

A constant time shift of 8.667 ms was applied to all traces.

5.1.8 2D SRME

SRME (Surface Related Multiple Elimination) was used to remove all multiples created by reflection off the water/air interface at the sea surface. Interbed multiples were not removed.

The approach is to model the surface related multiples from convolution of original data in shot and receiver domain. Non-flatness in underlying reflectors does not affect the accuracy of the prediction. The model is then adaptively subtracted from the original data using least squares algorithm which handle amplitude and other errors in the model.

List of parameters used:

Filter length : 36
Time window : 512 ms
Spatial window : 21
Start time : 2 x Water bottom time - 100 ms

5.1.9 1ST PASS VELOCITY PICKING

The first pass velocity analyses were performed at 2 km intervals using CGGVeritas interactive software, PACESETTER. The output of this package consists of five components:

i.) Displays of stack panels corrected with their respective velocity fan functions
ii.) CMP gathers, NMO may be applied with the latest R MSEC velocities picked
iii.) Displays of semblance contours
iv.) Display of IsoVelocities
v.) Display of velocities map

The 1st pass velocity picking used onboard processing velocity function as reference. The updated velocity was used for high resolution Radon demultiple and stacking.

5.1.10 RESIDUAL NOISE ATTENUATION

CGGVeritas module FXEDIT was applied again to attenuate residual noise. Refer to section 5.1.6 for explanation on FXEDIT.

Table of parameters used:

SPATIAL WINDOW	TIME WINDOW (ms)	EFFECTIVE FREQUENCY RANGE (Hz)	TOLERANCE
81	1000	0 – 20	2.0

5.1.11 HIGH RESOLUTION RADON DEMULTIPLE

The CGGVeritas module XRMULT, which is high resolution Radon demultiple, uses a constrained least squares version of the parabolic transform. The representation of the data in the Radon domain is better focused than with that using conventional transform. It is designed to overcome some of the limitations of the conventional transform. It is able to preserve primary amplitudes better as a function of offset whilst simultaneously giving a more complete attenuation of multiple. It is also more resistant to spatial aliasing and can therefore reduce the need for trace interpolation before the transform.

The input gathers were NMO corrected using first pass velocity and applied CDP domain interpolation and removable AGC before high resolution Radon demultiple.

Processing parameters used:

Radon start time : 2 times water bottom time
Transform range : -1000 ms to 8000 ms
Signal protection range : -1000 ms to 500 ms

NMO was removed from demultiple gathers and the gathers were output to LTO tapes in SEG-Y format.

5.1.12 RESIDUAL MULTIPLE SCALING

CGGVeritas module SCALEMUL is a process aimed at attenuating residual multiples in deep water marine surveys. In areas where the first water bottom bounce is high amplitude, significant residual multiples remain in deep water after conventional demultiple. SCALEMUL estimates the 'background' amplitude which is the amplitude just above the location of the first water bottom multiple. The program then examines all amplitudes below the multiple time within a series of frequency bands and attenuates any sample that has amplitude greater than the threshold amplitude which is the 'background' amplitude times the threshold value.

List of parameters used:

Threshold : 1.25
Scaling factor : 0.5
Time window : 500 ms
No of frequency bands : 4

5.1.13 2nd PASS RESIDUAL NOISE ATTENUATION

CGGVeritas module FXEDIT was applied again on common channel to attenuate residual noise. 2 passes of FXEDIT were applied in order to attenuate both low frequency and high frequency swell noises or spikes. Refer to section 5.1.6 for explanation on FXEDIT.

Table of parameters used:

PASS	SPATIAL WINDOW	TIME WINDOW (ms)	EFFECTIVE FREQUENCY RANGE (Hz)	TOLERANCE
1	151	12000	0 – 10	1.8
2	81	1000	0 – 80	2.1

5.1.14 TIME VARIANT FILTER

Time variant frequency filter was design based on the frequency content of the dataset and was applied before migration to remove random noise.

Description of filter applied:

TIME (ms)	PASS BAND (Hz / dB per Octave)
0	4 / 18 to 100 / 110
5000	4 / 18 to 90 / 100
7000	4 / 18 to 70 / 80
9500	4 / 18 to 50 / 60
11996	4 / 18 to 40 / 50

5.1.15 MUTING AND STACKING FOR BRUTE SECTIONS

Mute functions were picked for each individual line by using CGGVeritas software Tornado which is a suite of tools for velocity analysis and also incorporates mute picking and quality control function.

Stacking is the summation of traces within each CMP producing a single stacked trace for each input gather record. The nominal fold of coverage is 106. The output were brute stacks and written to DVD in SEG-Y format.

Brute_Stack_QC.pdf

5.1.16 1ST PASS PRE-STACK KIRCHHOFF TIME MIGRATION

Pre-stack Kirchhoff time migration algorithm uses ray-traced travel times to replace NMO, DMO and zero-offset migration with one processing step. It migrates the data using actual X, Y locations and provides a better and more accurate sub-surface image. Inverse NMO is then performed on the migrated gathers before picking new velocities. These velocities are picked from data that is close to its correct spatial location and should thus be more accurate than velocities picked from conventional processing.

CGGVeritas' PSTM is implemented in the following manner:

i.) For any input trace, the migration 'corrections' are based on the time varying velocity at its mid-point
ii.) The correction are based on the actual source and receiver locations
iii.) Each input trace is 'sprayed' after corrections and summed into all output target locations
iv.) Anti-aliasing is applied to minimise aliasing noise on the output image

Table of parameters used:

Migration aperture	4000 m
Maximum dip	75°

5.1.17 2ND PASS VELOCITY PICKING

1st pass pre-stack Kirchhoff time migration produced gathers which were used for 2nd pass velocity analysis. 2nd pass velocity picking was also performed by using CGGVeritas interactive software Pacesetter and it was done at 1km intervals and used 1st pass picked velocity as reference.

This picked velocity was verified and smoothed before it was used for the final pre-stack Kirchhoff time migration.

5.1.18 FINAL PRE-STACK KIRCHHOFF TIME MIGRATION

Final pre-stack Kirchhoff time migration was performed using smoothed 2nd pass velocity. The program used was the same as the 1st pass Kirchhoff time migration which is described in more details in section 5.1.16.

Table of parameters used:

Migration aperture	4000 m	
Maximum dip	Time = 0	30°
	Time = 3000 ms	45°
	Time = 3500 ms	75°

5.1.19 RESIDUAL VELOCITY ANALYSIS AND FINAL MOVEOUT

The residual velocity analysis was performed in the same manner as the 2nd pass velocity picking described in section 5.1.9 and 5.1.17 at every 1 km intervals. Final migrated gathers were used as input and 2nd pass velocity was used as reference velocity. Normal moveout was applied to the migrated gathers using the updated

velocity field. The corrected gathers were used as input to post-migration processes such as Radon demultiple and stacking. The final velocity field was output as traces and archived in ASCII format.

5.1.20 POST-MIGRATION HIGH RESOLUTION RADON DEMULTIPLE

A 2nd pass high resolution Radon demultiple was applied to the NMO corrected gathers described in section 5.1.19.

Table of parameters used for Radon demultiple:

Removable AGC	500 ms	
Start time	Wbt x 1.75	
Reference offset	8035 m	
Maximum frequency	110 Hz	
Transform range	-1000 ms to 8000 ms	
Signal protection range	From start time to 1000 ms	-1000 ms to 1500 ms
	From 1000 to 2000 ms	-1000 ms to 800 ms
	From 2000 ms to end time	-1000 ms to 300 ms

5.1.21 MUTING AND STACKING

The mute applied on gathers before stacking for the full stacks included inner and outer mutes. Below is a table of parameters used for the inner mute, which was water bottom time dependent.

WATER BOTTOM TIME (ms)	OFFSET (m)	TIME (ms)
100	150	600
	1000	1600
	1300	3100
	1600	12000
500	150	800
	1000	1900
	1300	3400
	1600	12000
1000	150	1700
	1000	2900
	1300	4400
	1600	12000
2000	150	3700
	1000	4900
	1300	6400
	1600	12000
3000	150	5700
	1000	6900
	1300	8400
	1600	12000

Outer mute functions were picked for each individual line by using CGGVeritas software Tornado which is a suite of tools for velocity analysis and also incorporates mute picking and quality control function.

For angle stacks, angle mutes of 5° ~ 22° and 23° ~ 40° were applied to final gathers followed by generating near and far angle stacks respectively.

Stacking is the summation of traces within each CMP producing a single stacked trace for each input gather record. The nominal fold of coverage is 106.

5.1.22 POST-STACK TIME VARIANT SCALING

A time variant exponential gain was applied to the seismic data as compensation to amplitude decay. The gains applied were water bottom time dependent. Below is a table of time variant gains applied.

WATER BOTTOM TIME (ms)	TIME (ms)	GAIN (dB)
100	100	0
	2100	6
	4100	18
	12000	12
500	500	0
	2500	6
	4500	18
	12000	12
1000	1000	0
	3000	6
	5000	18
	12000	12
2000	2000	0
	4000	6
	6000	18
	12000	12
3000	3000	0
	5000	6
	7000	18
	12000	12

5.1.23 POST-STACK TIME VARIANT FILTER

Post stack time variant frequency filter was design based on the frequency content of the dataset and was applied to remove random noise. The filter parameters were water bottom time dependent.

Description of filter applied:

WATER BOTTOM TIME (ms)	TIME (ms)	PASS BAND (Hz / dB per Octave)
100	0	10 / 18 to 85 / 72
	2100	8 / 18 to 75 / 72
	4100	6 / 18 to 40 / 72
	6100	5 / 18 to 35 / 72

	11996	5 / 18 to 30 / 72
500	0	10 / 18 to 85 / 72
	2500	8 / 18 to 75 / 72
	4500	6 / 18 to 40 / 72
	6500	5 / 18 to 35 / 72
	11996	5 / 18 to 30 / 72
1000	0	10 / 18 to 85 / 72
	3000	8 / 18 to 75 / 72
	5000	6 / 18 to 40 / 72
	7000	5 / 18 to 35 / 72
	11996	5 / 18 to 30 / 72
2000	0	10 / 18 to 85 / 72
	4000	8 / 18 to 75 / 72
	6000	6 / 18 to 40 / 72
	8000	5 / 18 to 35 / 72
	11996	5 / 18 to 30 / 72
3000	0	10 / 18 to 85 / 72
	5000	8 / 18 to 75 / 72
	7000	6 / 18 to 40 / 72
	9000	5 / 18 to 35 / 72
	11996	5 / 18 to 30 / 72

5.1.24 OUTPUT TO SEGY DVD/TAPE

Final stacks, including full stacks, near and far angle stacks were output in SEG-Y format and written into DVD. Final gathers were output in SEG-Y and written into LTO tapes. Raw stacks were also output to DVD in SEG-Y format. Pre-migration demultiple gathers and brute stacks were output to SEG-Y format and written into LTO tapes and DVD respectively.

Stratus2D_angle_stacks_QC.pdf

5.2 COMPREHENSIVE PROCESS FLOW AND PARAMETER DESCRIPTION – REINGA

5.2.1 REFORMAT

The field data recorded in SEG-D format on 3590 cartridges were reformatted and converted to CGGVeritas internal format. The data were at 2 ms sample rate and the record lengths were 8000 ms.

5.2.2 DESIGNATURE

The zero phase designature filter was designed based on the far field signature from the boat. The deconvolution gap used was 48 ms. For cable deghost, the streamer depth used was 7m and water velocity of 1500 m/s.

5.2.3 RESAMPLE WITH ANTI-ALIASING FILTER

An anti-aliasing filter with cut-off frequency at 105 Hz and slope at 120 dB/Octave was applied to the seismic data before it was resampled from 2 ms to 4 ms.

5.2.4 LOW-CUT FILTER

Low-cut filter was applied to shot records to attenuate low frequency noises prior to swell noise attenuation. The filter used had cut-off frequency of 4 Hz and tapering at 18 dB/Octave.

5.2.5 TRACE EDIT

Trace editing was performed to remove any trace with anomalous amplitude or exceptionally high noise level. This editing was based on the onboard records of bad traces.

5.2.6 GUN/CABLE STATICS

Gun/cable statics were applied in order to use datum at sea level for subsequent processes. It was performed by adding time shifts calculated from source and receiver depths to original data.

Gun depths used were field recorded depths and cable depth was set to 7 m during calculation. Water velocity used was 1500 m/s.

5.2.7 SWELL NOISE ATTENUATION

CGGVeritas module FXEDIT which can detect and repair anomalously high amplitude windows of a trace via FX projection filtering was applied to attenuate swell noise.

The program considers a group of traces at a time (commonly a common shot, receiver, channel or offset gather) over user specified time gates. Within each time window and frequency-by-frequency, rolling median amplitude is calculated. The user specifies a threshold value such that any frequency component of any trace that has window amplitude (relative to the rolling median value) above this threshold is flagged for repair. Each of the flagged frequency/window components is deleted and re-interpolated.

2 passes of FXEDIT were applied in channel domain for swell noise attenuation.

Table of parameters used:

PASS	SPATIAL WINDOW	TIME WINDOW (ms)	EFFECTIVE FREQUENCY RANGE (Hz)	TOLERANCE
1	151	8000	0 – 20	1.8
2	61	1000	0 – 20	2.1

Reinga2D_swellnoise_attenuationQC.pdf

5.2.8 2D SRME

SRME (Surface Related Multiple Elimination) was used to remove all multiples created by reflection off the water/air interface at the sea surface. Interbed multiples were not removed.

The approach is to model the surface related multiples from convolution of original data in shot and receiver domain. Non-flatness in underlying reflectors does not affect the accuracy of the prediction. The model is then adaptively subtracted from the original data using least squares algorithm which handle amplitude and other errors in the model.

List of parameters used:

Filter length : 36
Time window : 512 ms
Spatial window : 21
Start time : 2 x Wbt – 100 ms
Amplitude threshold : 1.45

5.2.9 1ST PASS VELOCITY PICKING

The first pass velocity analyses were performed at 2 km intervals using CGGVeritas interactive software, PACESETTER. The output of this package consists of five components:

vi.) Displays of stack panels corrected with their respective velocity fan functions
vii.) CMP gathers, NMO may be applied with the latest R MSEC velocities picked
viii.) Displays of semblance contours
ix.) Display of IsoVelocities

x.) Display of velocities map

The 1st pass velocity picking used onboard processing velocity function as reference. The updated velocity was used for high resolution Radon demultiple and stacking.

5.2.10 ADJACENT TRACE SUM

Adjacent trace sum was performed in shot domain to change the gridding from 5.25 m x 25 m (CDP spacing x shot spacing) to 12.5 m x 25 m.

5.2.11 HIGH RESOLUTION RADON DEMULTIPLE

The CGGVeritas module XRMULT, which is high resolution Radon demultiple, uses a constrained least squares version of the parabolic transform. The representation of the data in the Radon domain is better focused than with that using conventional transform. It is designed to overcome some of the limitations of the conventional transform. It is able to preserve primary amplitudes better as a function of offset whilst simultaneously giving a more complete attenuation of multiple. It is also more resistant to spatial aliasing and can therefore reduce the need for trace interpolation before the transform.

The input gathers were NMO corrected using first pass velocity described in section 5.2.9 and applied with removable AGC before high resolution Radon demultiple.

Processing parameters used:

Radon start time	: 2 times water bottom time
Transform range	: -1000 ms to 8000 ms
Signal protection range	: -1000 ms to 500 ms

NMO was removed from demultiple gathers and the gathers were output to LTO tapes in SEG-Y format.

5.2.12 RESIDUAL MULTIPLE SCALING

CGGVeritas module SCALEMUL is a process aimed at attenuating residual multiples in deep water marine surveys. In areas where the first water bottom bounce is high amplitude, significant residual multiples remain in deep water after conventional demultiple. SCALEMUL estimates the 'background' amplitude which is the amplitude just above the location of the first water bottom multiple. The program then examines all amplitudes below the multiple time within a series of frequency bands and attenuates any sample that has amplitude greater than the threshold amplitude which is the 'background' amplitude times the threshold value.

List of parameters used:

Threshold	: 1.05
Scaling factor	: 0.5
Time window	: 200 ms
No of frequency bands	: 4

5.1.13 RESIDUAL NOISE ATTENUATION

CGGVeritas module FXEDIT was applied again to attenuate residual noise. Refer to section 5.2.7 for explanation on the CGGVeritas module FXEDIT.

Table of parameters used:

PASS	SPATIAL WINDOW	TIME WINDOW (ms)	EFFECTIVE FREQUENCY RANGE (Hz)	TOLERANCE
1	41	600	1 – 40	2

5.1.14 TIME VARIANT FILTER

Time variant frequency filter was design based on the frequency content of the dataset and was applied before migration to remove random noise.

Description of filter applied:

TIME (ms)	PASS BAND (Hz / dB per Octave)
0	4 / 18 to 90 / 96
3000	4 / 18 to 80 / 90
5000	4 / 18 to 55 / 60
7944	4 / 18 to 30 / 40

5.1.15 MUTING AND STACKING FOR BRUTE SECTIONS

Mute functions were picked for each individual line by using CGGVeritas software Tornado which is a suite of tools for velocity analysis and also incorporates mute picking and quality control function.

Stacking is the summation of traces within each CMP producing a single stacked trace for each input gather record. The nominal fold of coverage is 159. The output were brute stacks and written to DVD in SEG-Y format.

Brute_Stack_QC.pdf

5.2.16 1st PASS PRE-STACK KIRCHHOFF TIME MIGRATION

Pre-stack Kirchhoff time migration algorithm uses ray-traced travel times to replace NMO, DMO and zero-offset migration with one processing step. It migrates the data using actual X, Y locations and provides a better and more accurate sub-surface image. Inverse NMO is then performed on the migrated gathers before picking new velocities. These velocities are picked from data that is close to its correct spatial location and should thus be more accurate than velocities picked from conventional processing.

CGGVeritas' PSTM is implemented in the following manner:

v.) For any input trace, the migration 'corrections' are based on the time varying velocity at its mid-point
vi.) The correction are based on the actual source and receiver locations
vii.) Each input trace is 'sprayed' after corrections and summed into all output target locations
viii.) Anti-aliasing is applied to minimise aliasing noise on the output image

Table of parameters used:

Migration aperture	4000 m
Maximum dip	75°

5.2.17 2ND PASS VELOCITY PICKING

1st pass pre-stack Kirchhoff time migration produced gathers which were used for 2nd pass velocity analysis. 2nd pass velocity picking was also performed by using CGGVeritas interactive software Pacesetter and it was done at 1km intervals and used 1st pass picked velocity as reference.

This picked velocity was verified and smoothed before it was used for the final pre-stack Kirchhoff time migration.

5.2.18 FINAL PRE-STACK KIRCHHOFF TIME MIGRATION

Final pre-stack Kirchhoff time migration was performed using smoothed 2nd pass velocity. The program used was the same as the 1st pass Kirchhoff time migration which is described in more details in section 5.2.16.

Table of parameters used:

Migration aperture	4000 m
Maximum dip	75°

Raw pre-stack time migration stacks were generated and archived to DVD in SEG-Y format.

5.2.19 AOK VELOCITY ANALYSIS AND FINAL MOVEOUT

Amplitude Oriented Kinematics, or AOK is a method to correct seismic velocities based on attributes derived from AVO analysis. Application of AOK improves flatness of pre-stack NMO corrected gathers. This can lead to significant improvements in the reliability of AVO interpretations and also provide a spatially and temporally densely sampled velocity field. AOK updates velocity for every CDP, i.e. at 12.5 m interval.

List of parameters used:

No of iterations : 5
Spatial window : 21 traces

Maximum angle used for computation : 40°
RMS velocity update limit : ±2%
Interval velocity update limit : ±5%

The input was migrated CDP gathers. The output consisted of NMO corrected gathers derived from the updated RMS velocity field based on AOK velocity analysis.

This generated velocity field was reviewed and further refined. The updated velocity field was output as traces which were archived in ASCII format.

AOK_QC.pdf

5.2.20 POST MIGRATION HIGH RESOLUTION RADON DEMULTIPLE

A 2nd pass high resolution Radon demultiple was applied to the NMO corrected gathers using the updated velocity field described in section 5.2.19.

Table of parameters used for Radon demultiple:

Removable AGC	750 ms	
Start time	If wbt > 250 ms	wbt + 500 ms
	If wbt < 250 ms	wbt x 2
Reference offset	8100 m	
Maximum frequency	110 Hz	
Transform range	-1000 ms to 8000 ms	
Signal protection range	From start time to 2 x wbt	-1000 ms to 500 ms
	From 2 x wbt to end time	-1000 ms to 300 ms

5.2.21 GATHER FLATTENING (2D FLAT)

2D Flat function performs a time varying residual moveout correction. It is designed to correct the residual moveout by flattening seismic events within a gather of traces. The residuals are calculated based on the cumulative cross-correlation between neighbouring traces.

Table of processing parameters used:

Average CMP windows	5	
Local residual correction limit	100 ms	
Time range	4 ms to 7948 ms	
Window size	If twt is 400 ms to 4000 ms	50 ms
	If twt is 4025 ms to 7825 ms	100 ms

5.2.22 MUTING AND STACKING

The mute applied on gathers before stacking for the full stacks included inner and outer mutes. Below is a table of parameters used for the inner mute, which was water bottom time dependent.

WATER BOTTOM TIME (ms)	OFFSET (m)	TIME (ms)
100	150	600
	1000	1600
	1300	3100
	1600	7948
500	150	600
	1000	1600
	1300	3100
	1600	7948
1000	150	600
	1000	1600
	1300	3100
	1600	7948
2000	150	600
	1000	1600
	1300	3100
	1600	7948
3000	150	600
	1000	1600
	1300	3100
	1600	7948

Outer mute functions were picked for each individual line by using CGGVeritas software Tornado which is a suite of tools for velocity analysis and also incorporates mute picking and quality control function.

For angle stacks, angle mutes of 5° ~ 22° and 23° ~ 40° were applied to final gathers followed by generating near and far angle stacks respectively.

Stacking is the summation of traces within each CMP producing a single stacked trace for each input gather record. The nominal fold of coverage is 159.

5.2.23 TRACE AMPLITUDE BALANCING

Trace amplitude balancing is performed by computing the average amplitude along temporal and spatial windows for a group of traces.

List of parameters used:

Number of running traces : 501
Time window : 500ms
Maximum scaling factor applied to weak amplitude : 14

5.2.24 POST STACK TIME VARIANT SCALING

A time variant exponential gain was applied to the seismic data as compensation to amplitude decay. Below is a table of time variant gains applied.

TIME (ms)	GAIN (dB)
wbt	0
wbt + 1500	6

wbt + 3000	18
wbt + 8000	30

5.2.25 POST STACK TIME VARIANT FILTER

Post stack time variant frequency filter was design based on the frequency content of the dataset and was applied to remove random noise.

Description of filter applied:

TIME (ms)	PASS BAND (Hz / dB per Octave)
0	4 / 18 to 90 / 96
3000	4 / 18 to 80 / 90
5000	4 / 18 to 55 / 60
7944	4 / 18 to 30 / 40

5.2.26 OUTPUT TO SEGY DVD/TAPE

Final stacks and gathers were output in SEG-Y format and written into DVD and LTO tapes respectively. Raw stacks were also output to DVD in SEG-Y format. Pre-migration demultiple gathers and brute stacks were output to SEG-Y format and written into LTO tapes and DVD respectively.

Reinga2D_angle_stacks_QC.pdf

APPENDIX A – DELIVERABLES

Description	Media	Format	Copies
Final Pre Stack Time Migration Sections	DVD	SEGY	2
Final Angle Stack Data	DVD	SEGY	2
Raw Pre Stack Time Migration Sections	DVD	SEGY	2
Brute Stack Sections	DVD	SEGY	2
Pre Stack Demultiple CMPs	LTO	SEGY	1
Final Pre Stack Time Migration Gathers	LTO	SEGY	1
Final Velocities	DVD	ASCII	2
Post Stack Navigation	DVD	UKOOA	2
CDP/SP Relationship	DVD	ASCII	2
Seismic Processing Report	DVD	PDF	2

APPENDIX B – FORMAT DESCRIPTION

B.1 Final Pre Stack Time Migration Sections

1 DVD containing Stratus 2D final PreSTM stack in SEGY format

CDP Spacing : 6.25M
Trace Interval : 12.5M
Time Interval : 4 ms
MaxTime : 12/8 Second

File Name	Shotpoint Range	CDP Range
stratwp101_fstk.sgy	1001 - 18200	2 - 103830 /Inc. 2
stratep102_fstk.sgy	1010 - 5749	53 - 29081/Inc. 2
straewp103_fstk.sgy	1030 - 2827	61 - 11477/Inc. 2
transp104_fstk.sgy	1015 - 6173	53 - 31577/Inc. 2
transp205_fstk.sgy	6522 - 12119	53 - 34211/Inc. 2
transp306_fstk.sgy	12268 - 15371	53 - 23657/Inc. 2

Data Log

CLIENT : CGGVERITAS MULTICLIENT DATA LIBRARY
AREA : REINGA BASIN, NEW ZEALAND
SURVEY : STRATUS 2D
PROCESS CONTRACTOR : CGGVERITAS ASIA PACIFIC LTD
PROCESS : FINAL 2D PSTM STACK
FORMAT : SEGY
GRID : 6.25M

MAXTIME : 12 Second
TIME INTERVAL : 4 ms
DOMAIN : TIME
DATE : 29 July 2009

TAPE HEADERS INFORMATION

TAPE HEADERS	BYTE LOCATIONS
SHOTPOINT	BYTES 17 - 20
CDP	BYTES 21 - 24
CDPX(WGS84)	BYTES 73 - 76
CDPY(WGS84)	BYTES 77 - 80
CDPX(WGS84)	BYTES 81 - 84
CDPY(WGS84)	BYTES 85 - 88
WBT	BYTES 111 – 112
CDPX(WGS84)	BYTES 181 - 184
CDPY(WGS84)	BYTES 185 - 188
LINE NUMBER	BYTES 201 – 204

Notes:
6cdps/sp

Files In Total: 6

1 DVD containing Reinga 2D final PreSTM stack in SEGY format

CDP Spacing : 6.25M
Trace Interval : 12.5M
Time Interval : 4 ms
MaxTime : 12/8 Second

File Name	Shotpoint Range	CDP Range
rei09-002-fstk.sgy	1001 - 7129	2802 - 25144/Inc. 2
rei09-003-fstk.sgy	1001 - 18000	6 - 68628/Inc. 2
rei09-004-fstk.sgy	1001 - 6400	6 - 22228/Inc. 2
rei09-005-fstk.sgy	1001 - 20844	6 - 80004/Inc. 2
rei09-006-fstk.sgy	2760 - 9287	7042 - 33776/ Inc. 2
rei09-007-fstk.sgy	1001 - 21533	6 - 82760/Inc. 2
rei09-008-fstk.sgy	1001 - 10072	6 - 36916/Inc. 2
rei09-009-fstk.sgy	1001 - 21529	6 - 82744/Inc. 2
rei09-010-fstk.sgy	1001 - 11476	6 - 42532/Inc. 2
rei09-011-fstk.sgy	1001 - 20153	6 - 77240/Inc. 2
rei09-012-fstk.sgy	1001 - 9729	6 - 35560/ Inc. 2
rei09-014-fstk.sgy	1001 - 9106	6 - 33052/ Inc. 2
rei09-016-fstk.sgy	1001 - 10177	6 - 37336/Inc. 2
rei09-018-fstk.sgy	1001 - 9074	6 - 32924/Inc. 2
rei09-020-fstk.sgy	1001 - 8510	6 - 30668/Inc. 2
rei09-022-fstk.sgy	1001 - 8717	6 - 31512/ Inc. 2
rei09-024-fstk.sgy	1001 - 7688	6 - 33052/Inc. 2
rei09-026-fstk.sgy	1001 - 4800	6 - 15828/Inc. 2
rei09-028-fstk.sgy	1001 - 9447	6 - 34416/ Inc. 2
rei09-030-fstk.sgy	1001 - 4191	6 - 13392/ Inc. 2

Data Log

CLIENT : CGGVERITAS MULTI-CLIENT DATA LIBRARY
AREA : REINGA BASIN, NEW ZEALAND
SURVEY : REINGA BASIN 2D
PROCESS CONTRACTOR : CGGVERITAS ASIA PACIFIC LTD
PROCESS : FINAL 2D PSTM STACK
FORMAT : SEGY
GRID : 6.25M

MAXTIME : 8 Second
TIME INTERVAL : 4 ms
DOMAIN : TIME
DATE : 29 July 2009

TAPE HEADERS INFORMATION

TAPE HEADERS	BYTE LOCATIONS
SHOTPOINT	BYTES 17 - 20
CDP	BYTES 21 - 24
CDPX(WGS84)	BYTES 73 - 76
CDPY(WGS84)	BYTES 77 - 80
CDPX(NZGD49)	BYTES 81 - 84
CDPY(NZGD49)	BYTES 85 - 88
WBT	BYTES 111 - 112

CDPX(NZGD2000)	BYTES 181 - 184
CDPY(NZGD2000)	BYTES 185 - 188
LINE NUMBER	BYTES 201 - 204

Notes:
4cdps/sp

Files In Total: 20

B.2 Final Angle Stack Data

1 DVD containing PreSTM Angle Stacks of Stratus 2D in SEGY format

CDP Spacing	**: 6.25M**
Trace Interval	**: 12.5M**
Time Interval	**: 4 ms**
MaxTime	**: 12 Second**

DVD Log

CLIENT	: CGGVERITAS MULTI-CLIENT DATA LIBRARY
AREA	: TASMAN SEA, NEW ZEALAND
SURVEY	: STRATUS 2D
PROCESS CONTRACTOR	: CGGVERITAS ASIA PACIFIC LTD
PROCESS	: PSTM ANGLE STACKS
FORMAT	: SEGY
GRID	: 6.25M
MAXTIME	**: 12 Second**
TIME INTERVAL	**: 4 ms**
DOMAIN	**: TIME**
TAPE TYPE	: DVD
DATE	: 23 Oct 2009

TAPE HEADERS INFORMATION

TAPE HEADERS	**BYTE LOCATIONS**
SHOTPOINT	BYTES 17 - 20
CDP	BYTES 21 - 24
CDPX(WGS84)	BYTES 73 - 76
CDPY(WGS84)	BYTES 77 - 80
CDPX(WGS84)	BYTES 81 - 84
CDPY(WGS84)	BYTES 85 - 88
CDPX(WGS84)	BYTES 181 - 184
CDPY(WGS84)	BYTES 185 - 188
LINE NUMBER	BYTES 201 - 204

Notes: 6cdps/sp

SEGY File List:

1. strat001_nastk.sgy
2. strat001_fastk.sgy
3. strat002_nastk.sgy
4. strat002_fastk.sgy
5. strat003_nastk.sgy
6. strat003_fastk.sgy
7. strat004_nastk.sgy
8. strat004_fastk.sgy
9. strat005_nastk.sgy
10. strat005_fastk.sgy
11. strat006_nastk.sgy
12. strat006_fastk.sgy

Files In Total: 12

2 DVD containing PreSTM Angle Stacks of Reinga 2D in SEGY format

CDP Spacing	**: 6.25M**
Trace Interval	**: 12.5M**
Time Interval	**: 4 ms**
MaxTime	**: 8 Second**

DVD Log

CLIENT	: CGGVERITAS MULTI-CLIENT DATA LIBRARY
AREA	: REINGA BASIN, NEW ZEALAND
SURVEY	: REINGA BASIN 2D
PROCESS CONTRACTOR	: CGGVERITAS ASIA PACIFIC LTD
PROCESS	: PSTM ANGLE STACKS
FORMAT	: SEGY
GRID	: 6.25M

MAXTIME	**: 8 Second**
TIME INTERVAL	**: 4 ms**
DOMAIN	**: TIME**
TAPE TYPE	: DVD
DATE	: 23 Oct 2009

TAPE HEADERS INFORMATION

TAPE HEADERS	**BYTE LOCATIONS**
SHOTPOINT	BYTES 17 - 20
CDP	BYTES 21 - 24
CDPX(WGS84)	BYTES 73 - 76
CDPY(WGS84)	BYTES 77 - 80
CDPX(NZGD49)	BYTES 81 - 84
CDPY(NZGD49)	BYTES 85 - 88
CDPX(NZGD2000)	BYTES 181 - 184
CDPY(NZGD2000)	BYTES 185 - 188
LINE NUMBER	BYTES 201 - 204

Notes: 4cdps/sp

DVD1 SEGY File List:

1. rei09-002-nastk.sgy
2. rei09-002-fastk.sgy
3. rei09-003-nastk.sgy
4. rei09-003-fastk.sgy
5. rei09-004-nastk.sgy
6. rei09-004-fastk.sgy
7. rei09-005-nastk.sgy
8. rei09-005-fastk.sgy
9. rei09-006-nastk.sgy
10. rei09-006-fastk.sgy
11. rei09-007-nastk.sgy
12. rei09-007-fastk.sgy
13. rei09-008-nastk.sgy
14. rei09-008-fastk.sgy
15. rei09-009-nastk.sgy
16. rei09-009-fastk.sgy
17. rei09-010-nastk.sgy

18. rei09-010-fastk.sgy

DVD2 SEGY File List:

1. rei09-011-nastk.sgy
2. rei09-011-fastk.sgy
3. rei09-012-nastk.sgy
4. rei09-012-fastk.sgy
5. rei09-014-nastk.sgy
6. rei09-014-fastk.sgy
7. rei09-016-nastk.sgy
8. rei09-016-fastk.sgy
9. rei09-018-nastk.sgy
10. rei09-018-fastk.sgy
11. rei09-020-nastk.sgy
12. rei09-020-fastk.sgy
13. rei09-022-nastk.sgy
14. rei09-022-fastk.sgy
15. rei09-024-nastk.sgy
16. rei09-024-fastk.sgy
17. rei09-026-nastk.sgy
18. rei09-026-fastk.sgy
19. rei09-028-nastk.sgy
20. rei09-028-fastk.sgy
21. rei09-030-nastk.sgy
22. rei09-030-fastk.sgy

Files In Total: 40

B.3 Raw Pre Stack Time Migration Sections

1 DVD containing Raw PreSTM Stacks of Stratus 2D in SEGY format

CDP Spacing	**: 6.25M**
Trace Interval	**: 12.5M**
Time Interval	**: 4 ms**
MaxTime	**: 12 Second**
DVD_ID	**: RAW_PSTM_STK**

DVD Log

CLIENT	: CGGVERITAS MULTI-CLIENT DATA LIBRARY
AREA	: TASMAN SEA, NEW ZEALAND
SURVEY	: STRATUS 2D
PROCESS CONTRACTOR	: CGGVERITAS ASIA PACIFIC LTD
PROCESS	: RAW PSTM STACKS
FORMAT	: SEGY
GRID	: 6.25M
MAXTIME	**: 12 Second**
TIME INTERVAL	**: 4 ms**
DOMAIN	**: TIME**
TAPE TYPE	: DVD
DATE	: 1 Oct 2009

TAPE HEADERS INFORMATION

TAPE HEADERS	**BYTE LOCATIONS**
SHOTPOINT	BYTES 17 - 20
CDP	BYTES 21 - 24
CDPX(WGS84)	BYTES 73 - 76
CDPY(WGS84)	BYTES 77 - 80
CDPX(WGS84)	BYTES 81 - 84
CDPY(WGS84)	BYTES 85 - 88
WBT	BYTES 111 - 112
CDPX(WGS84)	BYTES 181 - 184
CDPY(WGS84)	BYTES 185 - 188
LINE NUMBER	BYTES 201 - 204

Notes: 6cdps/sp

SEGY File List:

1. strat001_rstk.sgy
2. strat002_rstk.sgy
3. strat003_rstk.sgy
4. strat004_rstk.sgy
5. strat005_rstk.sgy
6. strat006_rstk.sgy

Files In Total: 6

1 DVD containing Raw PreSTM Stacks of Reinga 2D in SEGY format

CDP Spacing	**: 6.25M**
Trace Interval	**: 12.5M**
Time Interval	**: 4 ms**
MaxTime	**: 8 Second**

DVD Log

CLIENT	: CGGVERITAS MULTI-CLIENT DATA LIBRARY
AREA	: REINGA BASIN, NEW ZEALAND
SURVEY	: REINGA BASIN 2D
PROCESS CONTRACTOR	: CGGVERITAS ASIA PACIFIC LTD
PROCESS	: RAW PSTM STACKS
FORMAT	: SEGY
GRID	: 6.25M
MAXTIME	**: 8 Second**
TIME INTERVAL	**: 4 ms**
DOMAIN	**: TIME**
TAPE TYPE	: DVD
DATE	: 29 Sep 2009

TAPE HEADERS INFORMATION

TAPE HEADERS	**BYTE LOCATIONS**
SHOTPOINT	BYTES 17 - 20
CDP	BYTES 21 - 24
CDPX(WGS84)	BYTES 73 - 76
CDPY(WGS84)	BYTES 77 - 80
CDPX(NZGD49)	BYTES 81 - 84
CDPY(NZGD49)	BYTES 85 - 88
WBT	BYTES 111 - 112
CDPX(NZGD2000)	BYTES 181 - 184
CDPY(NZGD2000)	BYTES 185 - 188
LINE NUMBER	BYTES 201 - 204

Notes: 4cdps/sp

SEGY File List:

1. rei09-002-rstk.sgy
2. rei09-003-rstk.sgy
3. rei09-004-rstk.sgy
4. rei09-005-rstk.sgy
5. rei09-006-rstk.sgy
6. rei09-007-rstk.sgy
7. rei09-008-rstk.sgy
8. rei09-009-rstk.sgy
9. rei09-010-rstk.sgy
10. rei09-011-rstk.sgy
11. rei09-012-rstk.sgy
12. rei09-014-rstk.sgy
13. rei09-016-rstk.sgy
14. rei09-018-rstk.sgy
15. rei09-020-rstk.sgy
16. rei09-022-rstk.sgy

17. rei09-024-rstk.sgy
18. rei09-026-rstk.sgy
19. rei09-028-rstk.sgy
20. rei09-030-rstk.sgy

Files In Total: 20

B.4 Brute Stack Sections

1 DVD containing PreSTM Brute Stacks of Stratus 2D in SEGY format

CDP Spacing	**: 6.25M**
Trace Interval	**: 12.5M**
Time Interval	**: 4 ms**
MaxTime	**: 12 Second**

DVD Log

CLIENT	: CGGVERITAS MULTI-CLIENT DATA LIBRARY
AREA	: TASMAN SEA, NEW ZEALAND
SURVEY	: STRATUS 2D
PROCESS CONTRACTOR	: CGGVERITAS ASIA PACIFIC LTD
PROCESS	: BRUTE STACKS
FORMAT	: SEGY
GRID	: 6.25M
MAXTIME	**: 12 Second**
TIME INTERVAL	**: 4 ms**
DOMAIN	**: TIME**
TAPE TYPE	: DVD
DATE	: 30 Oct 2009

TAPE HEADERS INFORMATION

TAPE HEADERS	**BYTE LOCATIONS**
SHOTPOINT	BYTES 17 - 20
CDP	BYTES 21 - 24
CDPX(WGS84)	BYTES 73 - 76
CDPY(WGS84)	BYTES 77 - 80
CDPX(WGS84)	BYTES 81 - 84
CDPY(WGS84)	BYTES 85 - 88
CDPX(WGS84)	BYTES 181 - 184
CDPY(WGS84)	BYTES 185 - 188
LINE NUMBER	BYTES 201 - 204

Notes: 6cdps/sp

SEGY File List:

1. str09-001-bstk.sgy
2. str09-002-bstk.sgy
3. str09-003-bstk.sgy
4. str09-004-bstk.sgy
5. str09-005-bstk.sgy
6. str09-006-bstk.sgy

Files In Total: 6

1 DVD containing PreSTM Brute Stacks of Reinga 2D in SEGY format

CDP Spacing	**: 6.25M**
Trace Interval	**: 12.5M**
Time Interval	**: 4 ms**
MaxTime	**: 8 Second**

DVD Log

CLIENT	: CGGVERITAS MULTI-CLIENT DATA LIBRARY
AREA	: REINGA BASIN, NEW ZEALAND
SURVEY	: REINGA BASIN 2D
PROCESS CONTRACTOR	: CGGVERITAS ASIA PACIFIC LTD
PROCESS	: BRUTE STACKS
FORMAT	: SEGY
GRID	: 6.25M
MAXTIME	**: 8 Second**
TIME INTERVAL	**: 4 ms**
DOMAIN	**: TIME**
TAPE TYPE	: DVD
DATE	: 30 Oct 2009

TAPE HEADERS INFORMATION

TAPE HEADERS	**BYTE LOCATIONS**
SHOTPOINT	BYTES 17 - 20
CDP	BYTES 21 - 24
CDPX(WGS84)	BYTES 73 - 76
CDPY(WGS84)	BYTES 77 - 80
CDPX(NZGD49)	BYTES 81 - 84
CDPY(NZGD49)	BYTES 85 - 88
CDPX(NZGD2000)	BYTES 181 - 184
CDPY(NZGD2000)	BYTES 185 - 188
LINE NUMBER	BYTES 201 - 204

Notes: 4cdps/sp

SEGY File List:

1. rei09-002-bstk.sgy
2. rei09-003-bstk.sgy
3. rei09-004-bstk.sgy
4. rei09-005-bstk.sgy
5. rei09-006-bstk.sgy
6. rei09-007-bstk.sgy
7. rei09-008-bstk.sgy
8. rei09-009-bstk.sgy
9. rei09-010-bstk.sgy
10. rei09-011-bstk.sgy
11. rei09-012-bstk.sgy
12. rei09-014-bstk.sgy
13. rei09-016-bstk.sgy
14. rei09-018-bstk.sgy
15. rei09-020-bstk.sgy
16. rei09-022-bstk.sgy
17. rei09-024-bstk.sgy

18. rei09-026-bstk.sgy
19. rei09-028-bstk.sgy
20. rei09-030-bstk.sgy

Files In Total: 20

B.5 Prestack Demultiple CMPs

1 LTO3 tape containing Demultiple Gathers of Stratus 2D in SEGY format

CDP Spacing	**: 6.25M**
Trace Interval	**: 12.5M**
Time Interval	**: 4 ms**
MaxTime	**: 12 Second**

Tape Log

CLIENT	: CGGVERITAS MULTI-CLIENT DATA LIBRARY
AREA	: TASMAN SEA, NEW ZEALAND
SURVEY	: STRATUS 2D
PROCESS CONTRACTOR	: CGGVERITAS ASIA PACIFIC LTD
PROCESS	: DEMULTIPLE GATHERS
FORMAT	: SEGY
GRID	: 6.25M
MAXTIME	**: 12 Second**
TIME INTERVAL	**: 4 ms**
DOMAIN	**: TIME**
TAPE TYPE	: LTO3 tape
DATE	: 12 Nov 2009

TAPE HEADERS INFORMATION

TAPE HEADERS	**BYTE LOCATIONS**
SHOTPOINT	BYTES 17 - 20
CDP	BYTES 21 - 24
CDPX(WGS84)	BYTES 73 - 76
CDPY(WGS84)	BYTES 77 - 80
SHOTX(WGS84)	BYTES 169 - 172
SHOTY(WGS84)	BYTES 173 - 176
RECX(WGS84)	BYTES 177 - 180
RECY(WGS84)	BYTES 205 - 208
LINE NUMBER	BYTES 201 - 204

Notes: 6cdps/sp

SEGY File List:

1. str09-001-xrmtg.sgy
2. str09-002-xrmtg.sgy
3. str09-003-xrmtg.sgy
4. str09-004-xrmtg.sgy
5. str09-005-xrmtg.sgy
6. str09-006-xrmtg.sgy

Files In Total: 6

2 LTO3 tape containing Demultiple Gathers of Reinga 2D in SEGY format

CDP Spacing	**: 6.25M**
Trace Interval	**: 12.5M**
Time Interval	**: 4 ms**
MaxTime	**: 8 Second**

Tape Log

CLIENT	: CGGVERITAS MULTI-CLIENT DATA LIBRARY
AREA	: REINGA BASIN, NEW ZEALAND
SURVEY	: REINGA BASIN 2D
PROCESS CONTRACTOR	: CGGVERITAS ASIA PACIFIC LTD
PROCESS	: DEMULTIPLE GATHERS
FORMAT	: SEGY
GRID	: 6.25M
MAXTIME	**: 8 Second**
TIME INTERVAL	**: 4 ms**
DOMAIN	**: TIME**
TAPE TYPE	: LTO3 tape
DATE	: 12 Nov 2009

TAPE HEADERS INFORMATION

TAPE HEADERS	**BYTE LOCATIONS**
SHOTPOINT	BYTES 17 - 20
CDP	BYTES 21 - 24
CDPX(WGS84)	BYTES 73 - 76
CDPY(WGS84)	BYTES 77 - 80
SHOTX(WGS84)	BYTES 169 - 172
SHOTY(WGS84)	BYTES 173 - 176
RECX(WGS84)	BYTES 177 - 180
RECY(WGS84)	BYTES 205 - 208
CDPX(NZGD49)	BYTES 81 - 84
CDPY(NZGD49)	BYTES 85 - 88
SHOTX(NZGD49)	BYTES 209 - 212
SHOTY(NZGD49)	BYTES 213 - 216
RECX(NZGD49)	BYTES 217 - 220
RECY(NZGD49)	BYTES 221 - 224
CDPX(NZGD2000)	BYTES 181 - 184
CDPY(NZGD2000)	BYTES 185 - 188
SHOTX(NZGD2000)	BYTES 225 - 228
SHOTY(NZGD2000)	BYTES 229 - 232
RECX(NZGD2000)	BYTES 233 - 236
RECY(NZGD2000)	BYTES 237 - 240
LINE NUMBER	BYTES 201 - 204

Notes: 4cdps/sp

SEGY File List:
Tape 1:

1. rei09-002-xrmtg.sgy
2. rei09-003-xrmtg.sgy
3. rei09-004-xrmtg.sgy
4. rei09-005-xrmtg.sgy

5. rei09-006-xrmtg.sgy
6. rei09-007-xrmtg.sgy
7. rei09-008-xrmtg.sgy

Tape 2:

1. rei09-009-xrmtg.sgy
2. rei09-010-xrmtg.sgy
3. rei09-011-xrmtg.sgy
4. rei09-012-xrmtg.sgy
5. rei09-014-xrmtg.sgy
6. rei09-016-xrmtg.sgy
7. rei09-018-xrmtg.sgy
8. rei09-020-xrmtg.sgy
9. rei09-022-xrmtg.sgy
10. rei09-024-xrmtg.sgy
11. rei09-026-xrmtg.sgy
12. rei09-028-xrmtg.sgy
13. rei09-030-xrmtg.sgy

Files In Total: 20

B.6 Prestack Time Migration Gathers

1 LTO3 Tape containing PreSTM Gathers of Stratus 2D in SEGY format

CDP Spacing	**: 6.25M**
Trace Interval	**: 12.5M**
Time Interval	**: 4 ms**
MaxTime	**: 12 Second**

Tape Log

CLIENT	: CGGVERITAS MULTI-CLIENT DATA LIBRARY
AREA	: TASMAN SEA, NEW ZEALAND
SURVEY	: STRATUS 2D
PROCESS CONTRACTOR	: CGGVERITAS ASIA PACIFIC LTD
PROCESS	: FINAL PSTM GATHERS
FORMAT	: SEGY
GRID	: 6.25M
MAXTIME	**: 12 Second**
TIME INTERVAL	**: 4 ms**
DOMAIN	**: TIME**
TAPE TYPE	: LTO3 Tape
DATE	: 6 Nov 2009

TAPE HEADERS INFORMATION

TAPE HEADERS	**BYTE LOCATIONS**
SHOTPOINT	BYTES 17 - 20
CDP	BYTES 21 - 24
CDPX(WGS84)	BYTES 73 - 76
CDPY(WGS84)	BYTES 77 - 80
CDPX(WGS84)	BYTES 81 - 84
CDPY(WGS84)	BYTES 85 - 88
CDPX(WGS84)	BYTES 181 - 184
CDPY(WGS84)	BYTES 185 - 188
LINE NUMBER	BYTES 201 - 204

Notes: 6cdps/sp

SEGY File List:

1. str09-001-fgth.sgy
2. str09-002-fgth.sgy
3. str09-003-fgth.sgy
4. str09-004-fgth.sgy
5. str09-005-fgth.sgy
6. str09-006-fgth.sgy

Files In Total: 6

1 LTO3 tape containing PreSTM Gathers of Reinga 2D in SEGY format

CDP Spacing	**: 6.25M**
Trace Interval	**: 12.5M**
Time Interval	**: 4 ms**
MaxTime	**: 8 Second**

Tape Log

CLIENT	: CGGVERITAS MULTI-CLIENT DATA LIBRARY
AREA	: REINGA BASIN, NEW ZEALAND
SURVEY	: REINGA BASIN 2D
PROCESS CONTRACTOR	: CGGVERITAS ASIA PACIFIC LTD
PROCESS	: FINAL PSTM GATHERS
FORMAT	: SEGY
GRID	: 6.25M
MAXTIME	**: 8 Second**
TIME INTERVAL	**: 4 ms**
DOMAIN	**: TIME**
TAPE TYPE	: LTO3 tape
DATE	: 6 Nov 2009

TAPE HEADERS INFORMATION

TAPE HEADERS	**BYTE LOCATIONS**
SHOTPOINT	BYTES 17 - 20
CDP	BYTES 21 - 24
CDPX(WGS84)	BYTES 73 - 76
CDPY(WGS84)	BYTES 77 - 80
CDPX(NZGD49)	BYTES 81 - 84
CDPY(NZGD49)	BYTES 85 - 88
CDPX(NZGD2000)	BYTES 181 - 184
CDPY(NZGD2000)	BYTES 185 - 188
LINE NUMBER	BYTES 201 - 204

Notes: 4cdps/sp

SEGY File List:

1. rei09-002-fgth.sgy
2. rei09-003-fgth.sgy
3. rei09-004-fgth.sgy
4. rei09-005-fgth.sgy
5. rei09-006-fgth.sgy
6. rei09-007-fgth.sgy
7. rei09-008-fgth.sgy
8. rei09-009-fgth.sgy
9. rei09-010-fgth.sgy
10. rei09-011-fgth.sgy
11. rei09-012-fgth.sgy
12. rei09-014-fgth.sgy
13. rei09-016-fgth.sgy
14. rei09-018-fgth.sgy
15. rei09-020-fgth.sgy
16. rei09-022-fgth.sgy
17. rei09-024-fgth.sgy

18. rei09-026-fgth.sgy
19. rei09-028-fgth.sgy
20. rei09-030-fgth.sgy

Files In Total: 20

APPENDIX C – Example of EBCDIC Header

C01 CLIENT : CGGVERITAS
C02 LINES : REINGA 2D LINE - 002
C03 PROCESS: FINAL 2D PSTM STACK
C04 SP : 1700 - 7129
C05 SRATE : 4MS, TMAX : 8000MS
C06 GRID : 6.25 M
C07 RECORDING PARAMETERS
C08 SEGD 8058 RECORD LENGTH 8.0 SECONDS; SAMPLE RATE: 2 MS
C09 LOW CUT FILTER 4.3HZ @ 12DB/OCT; HI CUT FILTER 200HZ @ 370DB/OCT
C10 START OF DATA: 50.0 MS BEFORE FTB
C11 CONFIGURATION: SINGLE SOURCE SINGLE STREAMER
C12 SOURCE DEPTH : 6 M SHOT INTERVAL : 25.0 M
C13 STREAMER LENGTH: 7950 M NO. OF CHANNELS: 636
C14 STREAMER DEPTH : 7.0 M GROUP INTERVAL : 12.5 M
C15 NEAR OFFSET : 152.0M
C16 PROCESSING DATE: MAY, 2009; CONTRACTOR: CGGVERITAS
C17 PROCESSING HISTORY:
C18 REFORMAT SEGD TO PROMAX FORMAT
C19 INSTRUMENT DELAY -50ms
C20 SHOT AND CHANNEL EDITS MARKED BY TRC_TYPE 2 BASED ON OBSERVER LOGS
C21 GEOMETRY UPDATE - UPDATE HEADERS WITH NAVIGATION FROM P/190
C22 OUTPUT TO SEGY BY ONBOARD PROCESSING
C23 REFORMAT FROM SEGY (8 SECOND RECORD LENGTH, SRATE 2MS)
C24 ZERO-PHASE DEPHASE-DEBUBBLE,
C25 RESAMPLE TO 4MS WITH ANTI-ALIAS FILTER 105 HZ @ 120 DB/OCT,
C26 LOW-CUT FILTER 4.0HZ @ 18.0 DB/OCT, TRACE EDIT AND GUN/CABLE STATICS
C27 2 PASSES CHANNEL DOMAIN SWELL NOISE ATTENUATION AND 2D SRME
C28 1ST PASS VELOCITY PICKING ON 2KM GRID
C29 ADJACENT TRACE SUM AND HI-RES RADON DEMULTIPLE
C30 RESIDUAL NOISE REMOVAL, TIME-VARIANT FILTER AND GRID PSTM
C31 2ND PASS VELOCITY PICKING ON 1KM GRID AND FINAL KIRCHHOFF PSTM
C32 AOK,POST MIGRATION RADON DEMULTIPLE AND 2D FLAT
C33 INNER AND OUTER TRACE MUTE, STACK, TVS AND TVF
C34 OUTPUT TO SEG-Y FORMAT
C35 SEGY HEADERS:
C36 SHOTPOINT :BYTE 17-20 CDP :BYTE 21-24
C37 CDPX(WGS84) :BYTE 73-76 CDPY(WGS84) :BYTE 77-80
C38 CDPX(NZGD49) :BYTE 81-84 CDPY(NZGD49) :BYTE 85-88
C39 CDPX(NZGD2000) :BYTE 181-184 CDPY(NZGD2000) :BYTE 185-188
C40 LINE NUMBER :BYTE 201-204

APPENDIX D – Example of SP/CDP Relationship Header

LINESEQ	CDP	SHOTPOINT	WGS84CDPX	WGS84CDPY	NZGD49CDPX	NZGD49CDPY	NZ2000CDPX	NZ2000CDPY
REI09-002	2802	1539	271955.8125	6223904.5000	2097888.2500	6781847.0000	1187355.5000	6217682.0000
REI09-002	2804	1540	271964.5000	6223913.5000	2097896.7500	6781856.0000	1187364.0000	6217691.0000
REI09-002	2806	1540	271973.1875	6223922.5000	2097905.2500	6781865.0000	1187372.5000	6217700.0000
REI09-002	2808	1541	271981.8750	6223931.5000	2097913.7500	6781874.0000	1187381.0000	6217709.0000
REI09-002	2810	1541	271990.5625	6223940.5000	2097922.2500	6781883.0000	1187389.5000	6217718.0000
REI09-002	2812	1542	271999.2500	6223949.5000	2097930.7500	6781892.0000	1187398.0000	6217727.0000
REI09-002	2814	1542	272007.9375	6223958.5000	2097939.2500	6781901.0000	1187406.5000	6217736.0000
REI09-002	2816	1543	272016.6250	6223967.5000	2097947.7500	6781910.0000	1187415.0000	6217745.0000
REI09-002	2818	1543	272025.3125	6223976.5000	2097956.2500	6781919.0000	1187423.5000	6217754.0000
REI09-002	2820	1544	272034.0000	6223985.5000	2097964.7500	6781928.0000	1187432.0000	6217763.0000
REI09-002	2822	1544	272042.6875	6223994.5000	2097973.2500	6781937.0000	1187440.5000	6217772.0000
REI09-002	2824	1545	272051.3750	6224003.5000	2097981.7500	6781946.0000	1187449.0000	6217781.0000
REI09-002	2826	1545	272060.0625	6224012.5000	2097990.2500	6781955.0000	1187457.5000	6217790.0000
REI09-002	2828	1546	272068.7500	6224021.5000	2097998.7500	6781964.0000	1187466.0000	6217799.0000
REI09-002	2830	1546	272077.4375	6224030.5000	2098007.2500	6781973.0000	1187474.5000	6217808.0000
REI09-002	2832	1547	272086.1250	6224039.5000	2098015.7500	6781982.0000	1187483.0000	6217817.0000
REI09-002	2834	1547	272094.8125	6224048.5000	2098024.2500	6781991.0000	1187491.5000	6217826.0000
REI09-002	2836	1548	272103.5000	6224057.5000	2098032.7500	6782000.0000	1187500.0000	6217835.0000
REI09-002	2838	1548	272112.1875	6224066.5000	2098041.2500	6782009.0000	1187508.5000	6217844.0000
REI09-002	2840	1549	272120.8750	6224075.5000	2098049.7500	6782018.0000	1187517.0000	6217853.0000
REI09-002	2842	1549	272129.5625	6224084.5000	2098058.2500	6782027.0000	1187525.5000	6217862.0000
REI09-002	2844	1550	272138.2500	6224093.5000	2098066.7500	6782036.0000	1187534.0000	6217871.0000
REI09-002	2846	1550	272146.9375	6224102.5000	2098075.2500	6782045.0000	1187542.5000	6217880.0000
REI09-002	2848	1551	272155.6250	6224111.5000	2098083.7500	6782054.0000	1187551.0000	6217889.0000
REI09-002	2850	1551	272164.3125	6224120.5000	2098092.2500	6782063.0000	1187559.5000	6217898.0000
REI09-002	2852	1552	272173.0000	6224129.5000	2098100.7500	6782072.0000	1187568.0000	6217907.0000

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