Data Processing Report

For

SANTOS LIMITED

Santos

Reprocessing 2005

Coonatie 3D

WesternGeco (Australia) Pty Ltd

WesternGeco

INTRODUCTION

The primary objective of the survey is to create Kirchhoff prestack time migrated gathers for AVO investigations together with an enhanced stack for further structural studies. Consequently, noise attenuation prestack is a critical issue.

ACQUISITION PARAMETERS

AQUISITION

RECORDED BY	: WesternGeco
TAPE NUMBERS	: SYD0051
RECORDED SEG NEGATIVE (NORMAL) POLARITY	
FORMAT	: SEGD IEEE DEMUX

INSTRUMENTS

INSTRUMENTS	: I/O System Two
SAMPLE INTERVAL	: 2 MS
FIELD FILTER LO CUT	: 5.5 HZ
HI CUT	: 103 HZ
RECORD LENGTH	: 7.0 S
SWEEP	: 3.0 S
LISTEN	: 4.0 S
DATA TRACES	: 768
PILOT SWEEP	: AUX 1

SOURCE PARAMETERS

Area	: 38.45 sq km
NUMBER OF RECORDS	: 1900
VIBRATORS	: 3 Mertz M26 Inline
SWEEP FREQUENCY	: 5 - 90 HZ
NO OF SWEEPS	: TWO STANDING UP-SWEEPS
SWEEP TAPER	: 200 MS COSINE TAPER
SWEEP FUNCTION	: LINEAR
V.P. INTERVAL	: 80.0 M
MOVE UP	: NONE
PAD TO PAD	: 13.33 M. (Orthogonal)
	: 18.86 M. (Zig-Zag)

RECEIVER PARAMETERS

GEOPHONE ARRAY	: SM4 10HZ
GEOPHONE SPACING	: 6x2 SERIES PARALLEL OVER 36.63 M
GROUP INTERVAL	: 40.00 M

PROCESSING PARAMETERS

FORMAT CONVERSION

Field data was recorded in SEGD format.
This was converted to WesternGeco's internal format.

GEOMETRY UPDATE

Full SPS files were created by WesternGeco in 2001.
Field statics were supplied by Santos.
Geometry and static information was applied to the data.

GRID DEFINE

A processing grid was defined to allow sorting to CMP order.
The primary ordinal number was defined to be two times the shot line number and the secondary ordinal number was defined to be two times the receiver line number.

X COORD	Y COORD	PRIMARY ORDINAL	SECONDARY ORDINAL
431057.00	6965292.00	11996	1996
437267.00	6965292.00	12284	1996
431057.00	6956812.00	11996	2420
437267.00	6956812.00	12284	2420

The cell size for this grid is 20 m x 40 m.
The minimum inline archived was 2000
The maximum inline archived was 2412

AMPLITUDE RECOVERY

Spherical Divergence Compensation & Exponential Gain **4 dB/sec**.

MINIMUM PHASE CONVERSION

An operator was derived from the filtered sweep trace from each area and used to convert that data from zero to minimum phase.

RESAMPLE

The data was resampled from **2 ms to 4 ms**.

NOISE REMOVAL

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 threshold value is measured as a percentage of the median value, i.e. a threshold of 2000% is an amplitude value twenty times the median amplitude value.
Thresholds were varied to find an optimum reduction in noise whilst still maintaining the data integrity for window lengths varying between 250ms and 1000ms over three frequency ranges of 0-30-60-90 Hz.
Window lengths of 500 ms with 20% overlap were used.
Thresholds of 15 at 250ms, 5 at 1000ms, 5 at 2000 ms and 3 at 4000ms and a initial frequency edit of 2-16 Hz were initially chosen and found to be too aggressive which resulted in a deterioration of the data.
This was later reduced to **20 at 250ms, 7 at 1000ms, 5 at 2000 ms and 3 at 4000ms** and an initial frequency edit of **2-12 Hz** for use with the Kirchhoff prestack time migration.

DECONVOLUTION

There was one test line (inline 2236) between the wells **Coonatie #3 & #7.**

Using the experience from previous processing in the Cooper Basin only the following deconvolution tests were performed.
All spiking deconvolution trials were performed using 1.0% white noise and SWATT applied.

1) 100 ms spiking s/c deconvolution - 1 window 200-2700ms
2) 120 ms spiking s/c deconvolution - 1 window 200-2700ms
3) 160 ms spiking s/c deconvolution - 1 window 200-2700ms
4) 200 ms spiking s/c deconvolution - 1 window 200-2700ms

5) 100 ms spiking s/c deconvolution - 2 windows 700-2700ms
6) 120 ms spiking s/c deconvolution - 2 windows 700-2700ms
7) 160 ms spiking s/c deconvolution - 2 windows 700-2700ms
8) 200 ms spiking s/c deconvolution - 2 windows 700-2700ms

9) 100 ms spiking s/c deconvolution - Tracking C to P Horizons
10) 120 ms spiking s/c deconvolution - Tracking C to P Horizons
11) 160 ms spiking s/c deconvolution - Tracking C to P Horizons
12) 200 ms spiking s/c deconvolution - Tracking C to P Horizons

Window times are specified at the zero offset, Tracking C to P Horizons the start time was **200ms** before the C horizon and with a length of **1000ms**.

It was decided to use a **120 ms Spiking Deconvolution with the single window tracking C to P Horizons**.

PRE STACK GAIN

Surface-Consistent Amplitude Compensation was applied , where only the source and detector terms were applied.
The data was normalized to a RMS amplitude of 2000.
For the **residual & trim static computation processing 500ms gates with 10% overlap** were applied.

COMMON MIDPOINT SORT

The data was sorted to common midpoint order.

VELOCITY ANALYSIS

Final velocities from the 2001 processing were used
These Velocities were smoothed to maintain residual static stability to give a regional velocity field.
(These were confirmed using WesternGeco's InVA software)

NMO

The regional velocity field was applied to the data.

MUTE

Pre Stack Mute applied

Offset (m)	Time (ms)
500	0
650	550
1300	1000
2300	1800

A brute stack was produced at this stage.

RESIDUAL STATICS

The determination of residual statics consists of two parts, the statics deviation picker and the statics computation. The picker derives reflection times and quality factors. The statics are obtained by decomposing the reflection pick times into surface consistent source and receiver statics using the Gauss-Seidel iterative algorithm.
The window used for Residual Statics Analysis was, 1400 – 2500 ms.
The residual statics were applied and a preliminary stack produced at this stage.

VELOCITY ANALYSIS

Velocities were run at 480 m intervals.
Velocity interpretation was done using WesternGeco's InVA software

TRIM STATICS ANALYSIS

Trim Statics analysis were run over a 500 – 2500 ms window.
The trim statics were applied and a trim stack produced at this stage.

COMMON OFFSET GATHER

Surface consistent deconvolved data with the **modified SWATT applied** was sorted into common offset gathers using a statistical equal trace distribution method.
Residual statics and the trim statics were applied.

AMPLITUDE RECOVERY

The Spherical Divergence Compensation & Exponential Gain were removed prior to the PreStack Time Migration

PRE STACK TIME MIGRATED VELOCITY ANALYSIS

Velocities were run at 480 m intervals.
Velocity interpretation was done using WesternGeco's InVA software

PRE STACK TIME MIGRATION

The Kirchhoff Time Migration Seismic Function Module (SFM) performs seismic time migration using the Kirchhoff summation method. The migrated image is constructed by summing weighted amplitudes along diffraction curves or curved surfaces for the 3D case. These diffraction curves are determined by two-way travel times from the surface to subsurface scatterers that are computed from the user-supplied velocity field. In prestack mode, migration is performed on common offset volumes for 3D data.
Prestack migration is achieved by migrating the sorted common-offset panels into individual zero-offset panels. During migration the traces are effectively NMO-corrected; however, inverse NMO using the migration velocity is typically applied prior to output of the data. This allows a final velocity analyses and moveout to be performed on the data prior to stacking it.
The data was moved back to the smoothed surface from the mean sea level datum

PRE STACK TIME MIGRATED VELOCITY ANALYSIS
Velocities were run at 480 m intervals.
Velocity interpretation was done using WesternGeco's InVA software

INVERSE NMO / NMO
The velocity functions were applied to the data

TRIM STATICS ANALYSIS
Trim Statics analysis were run over a 500 – 2400 ms window.
The trim statics were applied and a trim stack was produced at this stage.

3D FREQUENCY – WAVENUMBER FILTER (KxKy)
KxKy can suppresses the footprint from low fold stack volumes.
For non-complex structures the geometry footprint may be detected from the KxKy peaks at each temporal frequency slice.
It is run in the automatic mode to detect KxKy spots which it notch filters with an inline and cross line width of 0.05 cycles/cmp.
The data quality was not enhanced and so was **not applied**.

RADON MULTIPLE ATTENUATION

Radon Multiple attenuation was evaluated using a **multiple velocity which was 96% of the stacking velocity** together with a minimum/maximum moveout of +/-2000ms and was applied to the final data
This was **not applied** to the final less severe noise attenuated volumes.

MUTE

The Pre Stack Mute was chosen by Santos for application to the full, near and far stack volumes.

Full stack volume

Offset (m)	Time (ms)
500	0
700	550
1400	1000
1700	1400
2200	1800

Near Offset stack volume - outside mute

Offset (m)	Time (ms)
0	0
180	550
900	1000
1150	1400
1250	1800
1260	4000

Far Offset stack volume - inside mute

Offset (m)	Time (ms)
0	0
180	550
900	1000
1150	1400
1250	1800
1260	4000

Far Offset stack volume - outside mute

Offset (m)	Time (ms)
500	0
700	550
1400	1000
1700	1400
2200	1800

PRE STACK TIME MIGRATED STACK

The data was stacked and subsequently shifted from the smoothed surface to the mean sea level datum.

3D INTERPOLATION

Inline Bin Spacing 20 m

SPECTRAL WHITENING

Spectral whitening was evaluated for various envelope frequencies and the following parameters were chosen
Window : 300 ms
Envelope **10 - 60 Hz**
Target : 5 Bands 7 (0.01) - 10 (1.0) - 60 (1.0) – 65 (0.01)

FILTER

A post stack filter of: **8Hz / 18dB - 75Hz /36dB /octave** was applied.

GAIN

None was applied

CONCLUSION

The processed volume was produced with the noise attenuated to an acceptable level.
The AVO response showed unusual characteristics.
These were never solved, nor their source fully understood.
Many tests were carried out to ascertain where the irregularity originated from.
Noise in the pre-migrated gathers, or a geometry footprint was evaluated.
Varying the offset for each trace in migration gather was also tried.
The effect of applying the offset term in the **Surface-Consistent Amplitude Compensation** was tested – normally this is never applied.

QC gathers were created in segy format and transferred to Santos' ftp site at the following processing stages:
Post gain curve & spherical divergence
Post noise attenuation.
Post deconvolution.
Post residuals.
Post trim.
Post prestm.
Post radon.

ARCHIVE TAPES

Data with more severe noise reduction		
CMP gathers	DL1254	09.May.2006
Final PSTM radon stack	DVD-A043	16.May.2006
Final PSTM stack	DVD-A043	16.May.2006
Raw PSTM radon stack	DVD-A043	16.May.2006
Raw PSTM stack	DVD-A043	16.May.2006
Raw PSTM radon far stack	DVD-A043	16.May.2006
Raw PSTM radon near stack	DVD-A043	16.May.2006
Raw PSTM far stack	DVD-A043	16.May.2006
Raw PSTM near stack	DVD-A043	16.May.2006
PSTM gathers	DL1255	09.May.2006
PSTM radon gathers	DL1256	09.May.2006
Data with less severe noise reduction		
CMP gathers	DL1708	03.October.2006
Final PSTM stack (no gain)	DVD-A048	04.September.2006
Raw PSTM stack (no gain)	DVD-A048	04.September.2006
Final PSTM stack (gain)	DVD-A048	04.September.2006
Raw PSTM stack (gain)	DVD-A048	04.September.2006
Raw PSTM far stack	DVD-A049	26.September.2006
Raw PSTM near stack	DVD-A049	26.September.2006
PSTM gathers	DL1706	03.October.2006