SA01 SEISMIC SURVEY COOPER BASIN REGION SOUTH AUSTRALIA

2001 COONATIE 3D SURVEY ACQUISITION AND PROCESSING REPORT

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1 INTRODUCTION

1.1 GENERAL

In the year 2001 Santos Ltd, as operator of petroleum exploration and development in numerous production licence areas in the Cooper/Eromanga Basins in the north-east of South Australia, carried out approximately 1,990 square kilometres of "3D" coverage, as the SA01 Seismic Survey.

A contract was awarded to WesternGeco (A) Pty Ltd (Party 1161) for the acquisition of the survey and also of a similar survey in adjacent parts of south-west Queensland (the SQ01 Seismic Survey). Sub-contractor for line preparation was Denham and O'Keeffe Earthmoving.

Processing of the seismic data was carried out by WesternGeco in their centre in Adelaide.

This report describes part of the year 2001 operations, the Coonatie 3D Seismic Survey, recorded in February 2001. The survey covered the production licence area PPL131.

Santos Ltd contracted John Allen to supervise field operations. Section 4 below, describing field operations, is largely drawn from his report.



1.2 TIMETABLE OF MAIN EVENTS

30 November 2000	:	Notice of Intention to Conduct Seismic Operation sent to
		PIRSA.
30 November 2000	:	Notice of Intended Entry on Land sent to Innamincka.
		lease-holder and manager.
23 January 2001	:	Line preparation commenced.
4 February 2001	:	Line preparation completed.
16 February 2001	:	Recording commenced.
20 February 2001	:	Recording completed.
1 March 2001	:	Data processing commenced.
10 May 2001	:	Data processing completed.

2 <u>SUMMARY</u>

Project:	2001 Coonatie 3D Seismic Survey									
<u>Scope:</u>	 38.45 square kilometres 27 receiver lines, 01-AR1000 ⇔ 01-AR1208, total length 124.68 km, normal interval 320m. 24 source lines, zig-zag, 01-AS5012 ⇔ 01-AS5196, total length 147.526 km, normal interval 320m. 69 source lines, orthogonal, 01-AS6000 ⇔ 01-AS6140, total length 47.68 km, normal interval 160m. 									
Contractors:	Recording and surve Line preparation Data processing	ving : WesternGeco (A) Pty Ltd : Denham & O'Keeffe Earthmoving : WesternGeco (A) Pty Ltd								
Field Parameters:	Vibroseis source (3 v geophone groups), point interval, (24-fo second listen.	ibrators), 768 recording channels (8 lines of 96 40m group interval, 113.14m or 80m vibrator d) 3 second linear upsweep, (5 - 90 Hz), 4								
<u>Environment:</u>	Pastoral holding Terrain Main restrictions	 Innamincka Large sand dunes and interdune corridors. Survey area is bisected by watercourse forming Coonatie Waterhole. Minimum disturbance to vegetation and creek channels, no impediment to water flow. Minimum cutting of dunes, cuts as near as possible to perpendicular to dunes. No vibrator point within 30m of any well or pipeline. 								
<u>Timing:</u>	Line preparation Recording Data processing	: 23/1/01 - 4/2/01 : 16/2/01 - 20/2/01 : 1/3/01 - 10/5/01								

3 SURVEY SCOPE AND OBJECTIVES

The Coonatie Field, located about 70 km north-north-east of Moomba, produces gas from a Basal Callamurra sand in the Triassic Nappamerrie Group and sands in the Permian Epsilon Formation, with gas shows encountered in the Patchawarra Formation and Tirrawarra Sandstone.

A 3D seismic grid was designed over PPL 131 covering the field, with the following primary objectives:

- (a) improved structural and stratigraphic interpretation;
- (b) optimisation of well locations for future appraisal and development;
- (c) cost savings through elimination of uncommercial future wells.

The original program designed for this project covered a surface area of 87.52 sq km in order to achieve full-fold migrated data at the PPL boundary. This would have involved the preparation of 535 km of source and receiver lines, of which approximately 53% would have been outside the PPL boundary.

Unfortunately, Santos was prevented from carrying out any activity outside the PPL boundaries by PIRSA and, in order to progress the project, it was reduced to 38.45 sq km involving 320 km of source and receiver lines. The adjustment led to the flanks of the Coonatie Field (especially the eastern flank) not being adequately imaged, due to the proximity of the PPL boundary preventing optimum build-up of multiplicity of coverage.

Source Lines	Stations	<u>Km</u>	<u>No.</u>	<u>Total Km</u>
<u>Zig Zag</u>				
01-AS5012-5044	1064 - 1134	4.073	5	20.365
01-AS5052-5060	1032 - 1134	5.883	2	11.766
01-AS5068-5148	1000 - 1134	7.693	11	84.623
01-AS5156-5180	1000 - 1102	5.883	4	23.532
01-AS5188-5196	1000 - 1062	3.620	2	7.240
Source Lines				147.526
<u>Ortho</u>				
01-AS6000	1056 - 1206	6.080	1	6.080
01-AS6004-6024	1056 - 1062	0.320	6	1.920
01-AS6028-6032	1040 - 1062	0.960	2	1.920
01-AS6036-6056	1040 - 1046	0.320	6	1.920
01-AS6060-6064	1000 - 1046	1.920	2	3.840
01-AS6004A-6060A	1200 - 1206	0.320	15	4.800
01-AS6064A	1184 - 1206	0.960	1	0.960
01-AS6068-6132	1000 - 1006	0.320	17	5.440
01-AS6068A-6100A	1184 - 1190	0.320	9	2.880
01-AS6104A-6108A	1152 - 1190	1.600	2	3.200
01-AS6112A-6132A	1152 - 1158	0.320	6	1.920
01-AS6136-6140	1000 - 1158	6.400	2	12.800
				47.680

Receiver Lines

01-AR1000-1032	1060 - 1139	3.160	5	15.800
01-AR1040-1048	1028 - 1139	4.440	2	8.880
01-AR1056-1160	1000 - 1139	5.560	14	77.840
01-AR1168-1192	1000 - 1107	4.280	4	17.120
01-AR1200-1208	1000 - 1063	2.520	2	5.040
				124.680

Surface area covered - 38.4512 sq km

4 DATA ACQUISITION

4.1 PERMITTING

The Coonatie Seismic Survey was located on Innamincka Station. The manager of this station was initially advised of forthcoming seismic operations by letters, with attached maps etc. Five personal visits, and five telephone contacts, by Santos field representatives, were made before, during the course of, and after, field operations.

4.2 LOGISTICS AND COMMUNICATIONS

The prime contractor, WesternGeco (A) Pty Ltd, provided a self-contained, airconditioned, mobile camp, as listed in Appendix III, to house the field management, recording, surveying and maintenance personnel. The line-preparation party provided its own camp facilities.

Senior management of WesternGeco was located in Brisbane, with expediting, warehousing and repair facilities. Food, spare parts and other consumable supplies were delivered from Adelaide to the field weekly by commercial carrier. Fuel and camp water were obtained from Moomba.

Twenty-four-hour telephone and facsimile communications were available to the prime contractors and Santos field representatives by means of Iterra or Optus portable satellite systems. In-field communications were facilitated by the use of radios, with one frequency common to all parties.

Royal Flying Doctor Service radio frequencies were fitted to all SSB radios for use in case of medical emergency etc, but fortunately were not required.

4.3 SURVEYING

4.3.1 EQUIPMENT

- 1 Trimble 4000 SSE GPS receiver
- 4 Trimble 4000 SSI GPS receivers
- 2 Trimble 4400 GPS receivers
- 1 Trimble 4700 GPS receiver
- 6 Trimble DSM GPS units
- 6 Trimble NT200 GPS display units
 Desktop and Notebook computers
 Laser printer
 SSB, VHF, UHF radios

4.3.2 GENERAL

The WesternGeco survey group consisted of six to eight personnel including one senior surveyor, a quality, health, safety and environment adviser sometimes also acting as the dozer pointer, and assistant surveyors and utility personnel.

4.3.3 SURVEY DATUM

GPS field survey data were collected on the World Geodetic System 1984 (WGS84) datum. They were then downloaded into Trimble Navigation's "Trimmap" software for conversion to the appropriate Australian datum. WGS84 co-ordinates were converted to the Australian Geodetic Datum 1984 (AGD84) and output in Australian Map Grid (AMG84) Zone 54 co-ordinates. Ellipsoidal heights were converted to the Australian Height Datum (AHD) using the OSU91A geoid separation model.

Santos databases were converted from AGD84 to GDA94 (Geodetic Datum of Australia 1994) on 11 June 2001. Subsequently, all data submitted to Joint Venture Partners and Government Departments is in GDA94 datum.

4.3.4 CONTROL STATION

Station	Easting	<u>Northing</u>	Elevation	<u>Remarks</u>
BM WNT #2	444 219.44	6 942 931.95	41.80	Wantana #2

4.3.5 DATA PROCESSING AND QUALITY CONTROL

Survey data were collected in the field using the RTK (Real Time Kinematic) method of GPS surveying. The field data were collected in WGS84 format, then downloaded straight into Trimble Navigation's software where datum transformations and geoid separations were applied to obtain AMG Zone 54 co-ordinates and AHD heights. The data were then exported to a text file for editing and quality control checks.

Once the exported text file was edited a series of checks were performed to verify the integrity of the data:

- The base co-ordinates and elevation were checked against the correct data.
- A chaining check, which computes bearing and distance between the station setout co-ordinates and the design co-ordinates. Any points outside tolerance were flagged, checked and moved to the correct position.
- Check shots to other stations in the prospect were computed.
- PM listings were edited and checked.
- Ties to old PMs were checked against Santos-supplied data.
- Files were checked for duplicate stations and gaps

Once the checks were complete the data files were converted to a format suitable to the IMS system. All data were checked against design in the IMS system and any queries sent back to survey for clarification.

At the end of the survey all data files were checked against the IMS database for any discrepancies.

Once the checks were complete the data files were converted to a format suitable for Santos. These files, along with an offset listing and a copy of the Permanent Markers file, were then written to disk and sent to Santos Ltd.

Schlumberger software called "Gecosurv" was used to manage processing tasks, perform checks on data files and format data. Backups were made at regular intervals during processing to safeguard against loss of data due to system failure or file damage.

4.3.6 PERMANENT MARKS

The survey crew placed three Permanent Markers at locations listed below, close to major roads. These markers consisted of a steel fencing post with a steel dumpy placed at the base of the post. An aluminium tag with the line name, station number and any comments was bolted to the top of the post.

Line	Station	Easting	Northing	RL
01-AR1056	10561072	434 354.81	6 962 809.07	35.39
01-AR1120	11201064	434 034.83	6 960 251.10	39.33
01-AR1176	11761081	434 714.51	6 958 014.57	37.56

4.4 LINE PREPARATION

4.4.1 EQUIPMENT

Line preparation was carried out by Denham and O'Keeffe Earthmoving, who supplied as required up to ten personnel, and the following equipment:

- 3 Caterpillar D6R Bulldozers
- 2 Caterpillar 12G Graders Support vehicles
- Self-contained camp

4.4.2 OPERATIONS

Modern line-preparation requires extreme care to avoid unacceptable environmental disturbance such as felling of trees, obstruction of creek channels, removal of rootstock, etc. With a large number of detours the work was completed with minimum disturbance to the environment. The line positioning was accomplished using a Trimble DSM GPS unit coupled with a Trimble NT200 display unit in each dozer and a 4000 SSI GPS receiver on a base station with known co-ordinates. This system obviates the need for line of sight and time consuming ranging, thereby leading to greater line preparation efficiency. The system also allows the operator to weave easily, thus avoiding vegetation and significantly reducing line visibility.

Including 27 receiver lines and 93 zig-zag and orthogonal source lines, a total of 319.886 km of line was prepared for the survey.

4.5 RECORDING

4.5.1 EQUIPMENT

Schlumberger supplied and operated a complete I/O System 2 Digital Telemetric Vibroseis Recording System, including, as required

- 4 Mertz M26 Vibrators
- 1 I/O Line Interface Module
- 1 I/O System Control Module
- 1 I/O System Interface Module
- 1 I/O Correlator Stacker Module
- 2 I/O Operator Console Module Future 486
- 1 Oyo DFM 480 Digital Camera
- 2 Fujitsu 3490 tape decks
- 1 Pelton Vibra Sig QC computer
- 5 Pelton Advance 5 Vibrator Control Units
- 1 Pelton Advance 5 Encoder Sweep Generator
- 1760 Geophone strings, double-ended with 12 x SM4, 10 Hz phones @
 - 3.5 metre spacing, 6 series x 2 parallel
 - I/O Remote Signal Conditioners)

MRX Batteries)
Line cables) Sufficient numbers for efficient
Advance line tap cables) operations
Advance line tap boxes)
Near MRX cables)

with adequate support including battery chargers, test equipment, radios etc.

4.5.2 GENERAL

The Coonatie Seismic Survey consisted of a grid involving 125 km of receiver line and 195 km of zig-zag and orthogonal source lines. The recording required five recording-crew-days.

4.5.3 RECORDING PARAMETERS

Instrumentation		
Instruments	:	I/O System 2
No. Channels	:	768 (8 lines of 96)
Tape Format	:	SEGD, 8058 IEEE Demultiplexed, 3490E Cartridge.
		Noise edited correlated summed record
Filters	:	Hi-cut 103 Hz, 288 dB/Octave
		Lo-cut 5.5 Hz, 12 dB/Octave
Sample Rate	:	2 ms
Record Length	:	4 sec correlated sum
RTC	:	Yes
Correlation Type	:	Zero Phase, After Sum
Stack	:	Diversity Stack plus burst edit
Source Data		
Vibrators		3 x Mertz M26 (1 group)
Flectronics	:	Pelton Advance 2
Sweep Frequency	:	5-90 Hz
Sweep Length	:	3 seconds
Sweep Function	:	Linear Upsweep
No. Sweeps	:	2 standing
VP Interval		113.14m (zig-zag lines), 80m (orthogonal lines)
Source Array	:	3 Vibs in line, P-P 18.86m (zig-zag) 13.3m (orthogonal).
	•	no move-up
End Tapers (cosine)	:	0.2s
Phase Locking Type		Ground force
Amplitude Control	÷	Peak to peak
Sweep amplitude taper	÷	100% (none)
Drive level	:	Maximum varied by amplitude control function
Receiver Data		
Manuf/Model/Res freq.	:	Sensor SM4 10 Hz
No./String	:	12
Connection	:	Series/Parallel (6x2)
Receiver Group Interval	:	40 m
Receiver Location	:	Centred on stations
Receiver Array	:	12 phones, in-line, 3.33m element spacing (no overlap)
Spread Geometry	:	In line, split. Source line between groups 48 & 49 of
-		receiver lines.

4.5.4 OPERATIONAL PROCEDURE

4.5.4.1 QUALITY CONTROL

Prior to the commencement of the survey, a comprehensive set of tests was run on the recording instruments, remote signal conditioners, geophones, cables, etc. An abbreviated set of tests and checks was conducted each day before the start of production recording.

"Hardwire similarities" and "remote nest tests" were run at weekly intervals on all vibrators, and "radio similarities" were run daily. The Pelton Vibra Sig QC package provided continuous monitoring of individual vibrator performance during production operations.

A dedicated oscilloscope allowed the geophone spread to be monitored in real time during operations. Camera monitor records were produced frequently, generally from every tenth vibrator point.

Good line discipline in respect to geophone plants and spacing, and vibrator spacing, contributed to the high quality of seismic data recorded.

4.5.4.2 PRODUCTION RECORDING

The survey recorded 3D coverage through 768 channels in eight parallel receiver lines 320m apart, of ninety-six geophone groups each.

WesternGeco used a line crew of thirty-three or thirty-four to lay and move the geophones, cables and remote signal conditioner boxes. A line boss had responsibility for coordinating the line crew, and trouble-shooting the spread under the direction of the observer.

For the 40m group intervals, geophones were laid along the line at intervals of approximately 3.3m so that there was also an interval of 3.3m between the last geophone of one group and the first geophone of the next. The line crew generally used eight, specially fitted, Toyota geophone and cable trucks, and a line boss' vehicle.

The energy source was three Mertz vibrators in line, nominally 18.9m apart pad-topad (or 13.3m on orthogonal lines), sweeping twice per vibrator point. Each sweep was a 5 to 90 Hz linear upsweep, of three seconds duration. Single, uncorrelated sweeps were recorded through the I/O System 2 instruments, summed and written to tape, followed by the correlated, noise-edited sum. Data format was SEGD with a tape density of 37871 bpi.

Further details of source and spread layouts and parameters are given in sections 4.5.3 and Appendix VI.

4.5.5 **PRODUCTION**

Production details are given in Appendix 1. For the 152 km of recorded source line (orthogonal equivalent) in the 3D survey, average production was 5.24 km per recording hour, and 2. 69 km per chargeable hour.

4.6 WEATHERING SURVEY

4.6.1 GENERAL

No new weathering data were acquired in the area of seismic recording operations. Processing of the data used weathering data acquired in previous years in the area concerned.

4.7 ENVIRONMENTAL CONSIDERATIONS

4.7.1 GENERAL

As operator, Santos Ltd. has, for a number of years, been committed to planning and conducting seismic operations in such a way that environmental disturbance is avoided or minimised, and affected areas can rehabilitate naturally in a reasonable time frame. These objectives have most recently been set out and discussed in the publications "Code of Environmental Practice, Seismic Operations", and "Environmental Procedures for Seismic Exploration in the Cooper Basin, South Australia (PEL's 5 & 6) and Queensland (ATP259P)" Santos Ltd., 1997.

The commitment has normally included the distribution of copies of the above to all contractors' personnel, and continual pressure by Santos Ltd. field representatives on these personnel to conform to the principles and requirements of the Code and Procedures.

Compliance with the Aboriginal Heritage Act has also been stressed, and during the year, the strategy to ensure meticulous adherence to standard Santos procedures relating to Cultural Heritage Management and Environmental Sensitivity was reinforced by special training of key personnel, and daily meetings to re-iterate key issues and procedures.

With occasional, minor exceptions, the crews worked extremely well to complete the survey efficiently under the stringent environmental restrictions applied.

Directives and guidelines issued to field personnel, relating to protection of the environment and cultural heritage, pastoral relations etc, are included in Appendix VI.

4.7.2 ENVIRONMENT RECOVERY MONITORING

A method of systematically monitoring future recovery of the area affected by field operations was originated.

Two monitoring points were selected at intersections of lines. Where possible, intersections close to existing permanent roads or tracks were selected so that they might be readily found and re-occupied in the future with minimal adverse environmental effect. Tagged monuments (star droppers) identifying each monitor point were installed.

Six photographs were taken at each point, in the directions of the intersecting lines, before line preparation, and again as soon as possible after completion of survey operations.

All such sets of photographs will be re-taken at intervals over a number of years, to build an historical photographic record, and allow future assessment, of natural rehabilitation and revegetation of ground occupied during the seismic survey.

4.7.3 EMP LOCATIONS

Environmental Monitoring Points were established at the following locations:

Тад	Easting	Northing	Location			
EMP 1	434 335.00	6964 095.00	R1024/1071.5			
EMP 2	433 055.00	6960 895.00	R1104/1039.5			

5.0 DATA PROCESSING

5.1 GENERAL

The data processing was performed by WesternGeco in their centre in Adelaide.

Four seconds of data were recorded in the field, at a sample rate of 2 milliseconds. In processing, the data were reduced to a datum at sea level. Surface elevations in the areas of operation ranged from 22 metres to 60 metres above datum. Depth of weathering ranged from 5 to 42 metres.

Exploration and production targets in the region occur in the geological interval between the top of the Callamurra Member of the Triassic Nappamerrie Formation, and the pre-Permian basement. In the seismic data recorded in this survey, the top of the Callamurra Member varies from about 2.0 seconds to 2.15 seconds below datum, with the basement ranging from about 2.3 seconds to about 2.4 seconds, reduced time.

Data processing effectively commenced on 1 March with the supply by Santos of the first batch of static corrections to WesternGeco. Processing was completed on 10 May 2001, when Santos approved the archiving on digital tape of the final batch of data.

A report by Santos processing geophysicist, P. Gatley, is given in Appendix V.

The basic sequences, and the major parameters shown below, have been developed over a number of years, during which a large amount of similarly-acquired data from the region has been processed.

5.2 WESTERNGECO 3D PROCESSING STREAM AND MAIN PARAMETERS

1.	Correlation	-	Zero phase
2.	Sample Rate	-	4 ms/Resample from 2 ms to 4 ms
3.	Amplitude Recovery	-	"TAR", Alpha = 4 db/s, T2 = 3.0s
4.	Trace Edit	-	Automatic
5.	Conversion	-	Zero to minimum phase
6.	Deconvolution	-	Surface consistent - 120 ms spike - 2 design
			windows
7.	Spectral whitening	-	6 - 90 Hz
8.	Scaling	-	Time variant, 500 ms gates, 10% overlap
9.	Brute stack		
10.	Residual static analysis	-	Single regional function - 1400 - 2600 ms
			window
11.	Preliminary stack		
12.	Velocity analysis	-	9 x 3 CMP cells - surface referenced
13.	NMO, mute and static corrections		
14.	CDP trim static analysis	-	Window 300 - 2500 ms
15.	Trim Stack		
16.	DMO	-	Dip move-out correction
17.	Stack	-	Final stack, data processed -100 to +4000 ms
18.	Interpolation	-	1:2 cross line interpolation to give 20m x 20m
			CDP bins
19.	Migration	-	3D Stolt + residual FD - 100% smoothed
velo	ocities		
20.	Spectral whitening	-	8 - 85 Hz - 7 filters - 300 ms windows
21.	Filtering	-	0 - 1300 ms 15 - 90 Hz, 1500 - 4000 ms 8 -80 Hz
22	Trace cooling		Single window

22. Trace scaling - Single window

~ APPENDIX I ~

RECORDING PRODUCTION STATISTICS

FEBRU	ARY					VIBRO	SEIS	RECO	RDIN	g proi	DUC.	TION								
83A700/	/84B700					SA01 - COONATIE 3D														
									CH/	ARGE HO	our A	NALYSIS								
DATE	PROSPECT	CHNL	GI	SWATH	KM	REC	R/M	S/M	DET	WOS	P/M	T/MOVE	BON	SPRD	S/BY DTHER	TOTAL	TRAV	STNS LD	STNS P/U	CONFIG
09-Feb	Coonatie	768	40								0.70					0.70				Zig-Zag
11-Feb	Coonatie	768	40								2.10				0.30	2.40				Zig-Zag
12-Feb	Coonatie	768	40												0.30	0.30				
13-Feb	Coonatie	768	40												0.30	0.30				
14-Feb	Coonatie	768	40												0.30	0.30				
15-Feb	Coonatie	768	40								4.30				0.30	4.60				Zig-Zag
16-Feb	Coonatie	768	40	26 - 22	16.40000	2.50		0.10	0.90		0.30	1.30			3.40	8.50	0.30	1,232		Zig-Zag
17-Feb	Coonatie	768	40	26 - 17	34.96000	6.20		0.20	2.10			1.20		0.20	0.30	10.20	0.50			Zig-Zag
18-Feb	Coonatie	768	40	17 - 12	23.20000	4.90	1.30	0.50	2.90			0.20			0.30	10.10	0.40			Zig-Zag
19-Feb	Coonatie	768	40	15 - 8	39.04000	7.30	0.50	0.70	1.10			0.40			0.50	10.50	0.30	651	980	Zig-Zag
20-Feb	Coonatie	768	40	7 - 1	38.40000	6.30		0.50	0.40			1.20			0.30	8.70	0.40	128	1,088	Zig-Zag
KM/REC	CHR	5.24																		
KM/CHC	G HR	2.69		STNS LAID/C	HG HR	35.53														
MONTH	LY TOTAL				152.00000	27.20	1.80	2.00	7.40		7.40	4.30		0.20	6.30	56.60	1.90	2,011	2,068	
PROJE	CT TOTAL				152.00000	27.20	1.80	2.00	7.40		7.40	4.30		0.20	6.30	56.60	1.90	2011	2068	

~ APPENDIX II ~

VEHICULAR EQUIPMENT LIST

APPENDIX II VEHICULAR EQUIPMENT LIST

<u>CAMP</u>

Toyota 4x4 (Wagons) (3) Mitsubishi Canter 4x4 (3) International Paystar 6x6 (7)

Hino 4x4 (2) Kenworth 6x6 Trailers/Vans (25)

RECORDING CREW

Toyota 4x4 (Trucks) (16)

Toyota 4x4 (Wagons) (4) Hino 4x4 Mertz (4) International Paystar 6x6 Kenworth Trailer

SURVEY CREW

Toyota 4x4 Trucks (5) Toyota 4x4 Wagon Hino 4x4 International Paystar 6x6 Trailers/Vans (2)

LINE PREPARATION CREW

Caterpillar D6R Bulldozers (2) Caterpillar 12G Grader (2) Nissan 4x4 Trucks (5) Kenworth (2), White Allison (2) Trailers (7) Party Chief, HS&E Officer, Ambulance RTS, Batteries, Rubbish Water (3), Generator/Fuel, Mechanic, Tyres/Flat Deck, General Purpose Supply Fuel Haulage Accommodation (9), Kitchen, Dining, Shower, Laundry, Office, Client Representative, Cable/Geophone Repair, Mechanic's Workshop/ Vibrator Spares, Stores, Fuel, Chemical Toilets, Generators, Spread, Satellite Dish

Observer, Line Boss, Line Crew (8-12), Depegging, Spare etc Line Crew, Vibrator Operators etc Recording Truck Vibrator Trucks Vibrator Maintenance Spread Haulage Spread

Surveyors (3), Dozer Pointer, QHSEA Personnel General Purpose/Stores Water/Fuel/Generator Accommodation/Office, Shower/Laundry

Supervisor, Fuel, Mechanic etc Prime Movers Dozer Floats Accommodation/Kitchen/Shower/Office (2), Workshop/Generator, Water, Fuel, Utility/Storage

~ APPENDIX III ~

PERSONNEL LIST

APPENDIX III

PERSONNEL LIST

WesternGeco (A) Pty Ltd

Party Chief Assistant Party Chief (1 - 2) Health, Safety, Environment etc Officer Paramedic Cooks (2) Camp Attendants (2) Supply Drivers (2 - 3) IMS Operator Instrument Engineer Technicians (Cable, geophone repair) (2) Mechanic **Mechanics Offsider** Vibrator Technicians (2) Vibrator Operators (4 - 6) Observers (2) Line Crew (33 - 34) GPS Survey Crew (5 - 7)

Denham & O'Keeffe Earthmoving

Supervisor Operators (4 - 5) Mechanic Cook

~ APPENDIX IV ~

SEISMIC DATA PROCESSING REPORT

Seismic Processing Report By Joint Venture(Block) and Area

Page:	
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SAU	-COOM	ATIE	3D	2001 S.A	. 3D S.S.										
Process	ed Line	Acq.	Pro.	Station	Station Int.	Fld	Acq. Date	Stat Proc.	Prelim. Stack	Prelim. Appr.	Final Stack	CGM App.	Migr. Rec.	Tape Arch.	To GQS
01-COC	DN3D	GEC	WGC	-	40.00	24	200201	010301	300301	100401	270401	100501	040501	120601	110501
fotal Ki	lometers						152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
Notes:	SURF/ Large Coona	ACE C sand atie wa	OND dune: iterhc	ITIONS s with ini lle. Eleva	terdune c itions 34-	orrid -57m	lors, bis 1	ected by	watercou	rse formir	Ŋ				
	STATI	CS													
	122 up Hole d	oholes lepth	on 1 30–4	978–199 2m	7 lines .	Flat	base of	weather	ing, 10–30	Om.					
	ARCHI SEG CGM:	VE T# /: MX- : FDX-	APES -989 -190												
	PROCI Spher DBS S design 500m Resid First r Trim s Secor Spatia Cross Migra Spect Filter	ESSIN rical di Surfac n wind s scali ual sta ound statics nd roun al deal line ir tion 3 ral wh 0-130	IG SE verge e Col lows. ng wi veloci wind veloci dias D nterpo D Sto itenin 00ms	EQUENC ence and prestac indows w using sing ty analy dow 300 locity analy dow 300 locity analy dow 300 locity analy dow 300 locity analy dow 300 locity analy for the state of	E 4dB/sec 120ms sp ck spectra vith 10% o gle region sis 9x3 c -2500ms alysis, with progress o give 20r ed by resi tz, 7 filter z, 1500-4	gain bike al wh bverl al fL ells 24m th DI ive s m x 2 dual s, 30	700–19 itening ap inction. NO 9x3 tack, 24 20m bins FD. 100 20ms wi 8–80H	900ms, 1 6–90Hz 1400–26 shift, 9x cells. I fold s. 0% smoo ndows	700–2700 600ms win 5 smash, othed velo	lms dow cities					

Single window scale 400-2400ms

TESTING

Pre-stack deconvolution tests showed improvements in the target Callamurra member above the Toolachee and deeper in the Tirrawarra Sst and Merrimelia formation with 2 window deconvolution design. Migration velocities tested from 98% to 102% . Multi window (300ms) and 2 window (100-1300ms, 1400-2000ms) post stack whitening with 8-80Hz, 8-85Hz and 8-90Hz. Octave passes and low hand high filter passes tested. A low cut of 15Hz chosen for the shallow section.

~ APPENDIX V ~

3D SOURCE AND SPREAD LAYOUT

APPENDIX V 3D SOURCE AND SPREAD LAYOUT

1. Line naming convention

Receiver lines	01-AR1000 - 01-AR1208 (incrementing by 8)
Source lines	01-AS5012 - 01-AS5196 (incrementing by 8)
	01-AS6000 - 01-AS6140 (incrementing by 4)
	01-AS6004A - 01-AS6132A (incrementing by 4)

2. Definitions

Patch	-	All live receivers for source position
Swath	-	All the source positions between any two receiver lines
Panel	-	Defined by the number of source positions able to be recorded in a
		swath before a cross line roll is required

3. Patch layout

Each patch will consist of eight receiver lines of 96 channels when fully rolled on. The standard source position for each swath will be 4 VPs falling between the fourth and fifth receiver lines of each eight line patch.

4. Roll on/Roll off

The standard position for the source line will be between receivers 48/49.

The first and last source lines will shoot into a patch of 5 receiver lines. The first and last source positions on each line will shoot into 48 channels per receiver line.

A normal roll on/roll off will occur until the 96 split is achieved.

5. Boundary steps/Patch definition

Where the boundaries of the surface coverage step in the number of live traces for each receiver line should be maximised up to the standard 96, ie. the number of live traces should not be restricted to the shortest line of the patch but each line in the patch should use all available spread.

6. Source position offset tolerance

A source may be offset by 8 metres ($\pm 20\%$ of the group interval) from its programmed position to avoid terrain or facilities or to enable the line to weave through vegetation and break the line of sight.

If an offset greater than 8 metres is required, it should be parallel to the receiver line direction and be a multiple of 40 metres.

All offsets should be noted in the observer log and SPS file and surveyed to an accuracy of plus or minus 1 metre in the XY direction.

7. Receiver Rollalong

The receivers roll along 8 stations for every source line leg recorded such that the source is between channels 48 and 49 for each receiver line.

8. Receiver Lines

Receiver position tolerance in the orthogonal direction is ± 8 metres ($\pm 20\%$ of the group interval). This will enable the line to weave and thus "break line of sight". All receiver positions must be surveyed to an accuracy of plus or minus 1 metre in the XY direction.

9. Recording Panels

The project will be recorded in 1 panel.

~ APPENDIX VI ~

GUIDELINES FOR ENVIRONMENT AND CULTURAL HERITAGE PROTECTION AND PASTORAL RELATIONS

APPENDIX VI

A. STANDARD PRACTICE FOR LINE PREPARATION AND SURVEY CREWS

- 1. Restrict lines to one blade width.
- 2. Move as little earth and vegetation as possible.
- 3. Roll or mark lines only in silcrete and gibber plain areas no blading.
- 4. Walk across claypans and consolidated flat open ground.
- 5. Avoid steep cuts and fills which may cause erosion or landslide problems.
- 6. Cut sand dunes to the minimum depth required for safe access and operation.
- 7. Push sand to side of cut, not to bottom of dune.
- 8. Avoid or reduce to a minimum the formation of windrows.
- 9. Avoid destruction of isolated trees or stands of vegetation.
- 10. Avoid unnecessary blockage of creeks and channels.
- 11. Include erosion control features such as spur drains on sloping terrain.
- 12. Conceal lines from public roads or tracks by cutting 50 metres short on either side or placing a dogleg to reduce line of sight in vegetated areas.
- 13. Offset crossings at drainage channels to avoid the removal of trees and vegetation.
- 14. Avoid sites of natural, historical, heritage, aboriginal and archaeological significance, known or discovered.
- 15. Stop and report all discoveries to supervisor.
- 16. All work is to be carried out with due regard to safety and consideration/ protection of the environment.

B. ADDITIONAL REQUIREMENTS OF FIELD PERSONNEL

- (a) Excessive cutting on sand rises/dunes and the creation of windrows on vegetated flats and flood flats must be avoided. There is to be as little disturbance as possible to the Cooper Creek/Wilson River systems and surrounding floodplains - extreme care to be taken.
- (b) Minimal cutting and disturbance to vegetation is required. No cutting is to occur in gibber hills or flats. Water courses are not to be blocked or water holes disturbed. Vehicle traffic should be confined to the cleared seismic line. No unnecessary detours or short cuts are to be created.
- (c) All metal pin flags must be removed after recording.
- (d) Drill cuttings should be returned to holes or spread out and not left in a mound.
 Holes should be properly reinstated so that subsidence does not occur.
- (e) No litter should be left at camp sites, upholes or on seismic lines.
- (f) Lines intersecting roads or tracks should be concealed with doglegs.
- (g) All gates and fences are to be reconstructed to their original condition and care taken not to disturb cattle.
- (h) Extremely careful measures must be taken for the protection of aboriginal sites and artefacts. These sites/artefacts are to be flagged off and vehicle access/traffic avoided.

C. <u>GUIDELINES FOR COMPLIANCE WITH ABORIGINAL HERITAGE ACT IN SA AND</u> <u>QUEENSLAND CULTURAL RECORD ACT 1987</u>

There are three main points under the Aboriginal Heritage Act and Queensland Cultural Record Act 1987 relevant to field personnel or seismic crews.

- 1. No aboriginal site or object can be disturbed, interfered with or damaged.
- 2. All discoveries of aboriginal sites or objects must be reported to the Minister.
- 3. No aboriginal artefacts can be collected.

Each one of these points carries a \$50,000 fine for the company or a \$10,000 fine or 6 months imprisonment for the individual.

Santos Procedure for Aboriginal Site Avoidance

- A record of all known sites is kept in Adelaide office this is updated regularly. All seismic programme maps are checked against these maps before being sent to the field. Appropriate changes are made to the programme if the proposed lines cross a known site.
- While recognising that archaeological sites can be found throughout the Cooper Basin, there are some areas where it is more predictable that sites of archaeological significance will be found for example the low, pale dunes adjacent and parallel to water courses. When a seismic programme is planned to cross one of these areas this will be highlighted in the field instructions to the crew to pay extra attention to any scatters etc. See general rules outlined below.

Santos will endeavour to identify as many types of predictable areas as possible.

General Rules

- Avoid all areas which are obviously different from the surrounding area this mostly applies to the presence of rocks.
 - rocks on a sand dune are out of place, therefore avoid
 - piles of rocks on clay pans should be avoided
- Take extra care in dunes or sandy rises on the edges of waterholes or isolated dunes in the floodplain area where there is a high possibility of "rock scatter" being found.
- Avoid regular arrangements of rocks something obviously moved by man.
- If in doubt leave the blade up this is in line with normal environmental procedures.
- Rebury any skeletons uncovered in dune cuts, record the location and move the line away from the site.
- Remember to record any sites suspected of archaeological significance and report the location to the bird dog. The bird dog will record the location by shot point number and refer information to Environmental Officer for ultimate recording by the Heritage Branch.

• Major sites of archaeological significance, such as quarries, caves, art sites occur in locations/situations which normal environmental techniques will avoid anyway.

Potential Sites of Archaeological Significance

- <u>Dunefield margins</u> the first couple of dunes particularly adjacent to floodplain/alluvial areas but also stone/gibber areas.
- Dunes/sandy rises adjacent waterholes
- Isolated dunes in floodplains
- Dunes adjacent claypans likely to hold water for a time
- Outcroppings of stone in both dissected tablelands and in dune fields.
- The sites in dunes will occur on deflated clay flanks.
- Water course margins within gibber/tableland regions.

D. SANTOS' CULTURAL HERITAGE MANAGEMENT STRATEGY

The following is a summary of the strategy in place to ensure adherence to standard Santos procedures relating to Cultural Heritage Management and Environmental Sensitivity. In summary, this will be achieved by:

- Inductions of all personnel (Category B).
- Daily toolbox meetings prior to work commencement to re-iterate key issues and procedures.
- Occasional presence on the crew of Adelaide or Brisbane environmental staff.
- Permanent presence of a WesternGeco QHSE Adviser with the Line Preparation Crew.

Detailed steps in the above strategy are as follows:

- All members of the crew will be inducted (Category B) whilst operating in the QLD licence area. These inductions will primarily involve cultural heritage issues but will also cover pastoral relations and health/safety. These inductions will be given by the QHSEA or nominated representative and will be valid for a 12 month period.
 - Personnel load charts will indicate the personnel who have attended.
- 2. The crew will be issued with appropriate documentation and handbooks, posters, etc for all personnel to access.
- 3. Supervision/overview of the line preparation operation <u>and</u> subsequent field operations will be maintained by QHSEA, Birddog and Environmental Department staff (QNTBU occasional field visits).
- 4. All sites of archaeological or cultural heritage significance identified during the course of the survey will be noted, pegged, flagged, avoided and reported as per Santos procedures.
 - "Environmental Report Form Seismic" to be completed for each site in our usual manner (Site Identification).

E. <u>CODE OF CONDUCT FOR SEISMIC CREW PASTORAL RELATIONS</u>

- 1. ALWAYS BEAR IN MIND YOU ARE ON SOMEONE ELSE'S PROPERTY. TREAT LANDHOLDERS AND THEIR FAMILIES WITH COURTESY. OBEY ALL LANDHOLDER SIGNS.
- 2. WHEN IN QUEENSLAND, ENSURE YOU CAN ALWAYS PRODUCE YOUR RIGHT OF ENTRY FORMS.
- 3. ALWAYS REVIEW THE "LANDHOLDER NOTIFICATION, PERMISSION AND CHECKLIST" FORM FOR THE PROPERTY YOU ARE WORKING ON TO ENSURE YOU ARE AWARE OF ANY RESTRICTIONS OR SPECIFIC REQUIREMENTS. ENSURE THIS FORM IS DISPLAYED ON THE CREW ENVIRONMENTAL NOTICE BOARD.
- 4. ALWAYS LEAVE GATES AS THEY ARE FOUND. (IF YOU COME ACROSS AN OPEN GATE REPORT IT TO THE LANDHOLDER VIA THE BIRD-DOG OR CREW MANAGEMENT.) LIKEWISE REPORT ANY DAMAGED GATES OR FENCES.
- 5. DO NOT LAY DOWN FENCES UNLESS YOU HAVE SPECIFIC PERMISSION FROM THE LANDHOLDER TO DO SO. IF SO ENSURE THEY ARE LAID DOWN AND PINNED TO MINIMISE DAMAGE TO THE WIRES.
- 6. REMOVE WATER ONLY FROM THOSE LOCATIONS AGREED TO BY THE LANDHOLDER.
- 7. NEVER SET UP CAMP CLOSER THAN ONE KM TO A STOCK WATERING POINT.
- 8. MINIMISE OR AVOID ALL DISTURBANCES TO STOCK.
- 9. STAY WITHIN SPEED LIMITS AT ALL TIMES AND, IN PARTICULAR, MINIMISE CREATION OF DUST CLOUDS ON STATION TRACKS NEAR HOMESTEADS. LOOK OUT FOR CHILDREN AND ANIMALS IN VICINITY OF HOMESTEADS.
- 10. MINIMISE OR AVOID CUTTING UP TRACKS OR RIVER CROSSINGS FOLLOWING WET WEATHER. IF UNAVOIDABLE, INFORM LANDHOLDER AND INSTIGATE PLANS TO RECTIFY DAMAGE.
- 11. DO NOT STRAY FROM WORK AREAS AND KEEP OFF-LINE ACTIVITY TO A MINIMUM (NO SHORTCUTS!).
- 12. RESTORE ALL DISTURBED AREAS AS NEAR AS POSSIBLE TO THEIR ORIGINAL STATE AND REMOVE ALL RUBBISH AND PIN FLAGS. PAY PARTICULAR ATTENTION TO TREATMENT OF FUEL AND OIL SPILLS.

NB. Non-adherence to any of the above rules will result in disciplinary action and may possibly lead to termination of employment or contract.

~ APPENDIX VII ~

TAPE LIST

COONATIE 3D SEISMIC SURVEY TAPE LISTING

TAPE NUMBERS

34 tapes

201069A
201070A
201071A
201073A
201074A
201075A
201076A
201077A
201078A
201079A
201080A
201081A
201082A
201083A
201084A
201069B
201070B
201071B
201073B
201074B
201075B
201076B
201077B
201078B
201079B
201080B
201081B
201082B
201083B
201084B
FMX-972
FMX-973
SPS_1
SPS_COPY

SA 01 SEISMIC SURVEY



