DATA PROCESSING REPORT

SANTOS LIMITED

2013 McArthur 2D Processing

McArthur Basin, Northern Territory

Date Processed: *September 2013 – March 2014*
Date Compiled: *7th April 2014*
Report Number: *VP14-719*
Compiled By: *Andrew McConville*

Velseis Processing Pty Ltd
ABN 30 058 427 204

Integrated Seismic
Technologies

Disclaimer

This report has been prepared in good faith and with all due care and diligence. It is based on the seismic and other geophysical data presented and referred to, in combination with the author's experience with the seismic technique, and as tempered by the geological and stratigraphic evidence presented in various forms and through discussions with client representatives.

As such, the report represents a collation of opinions, conclusions and recommendations, the majority of which remain untested at the time of preparation. In the light of these facts it must be clearly understood that Velseis Processing Pty. Ltd., its proprietors and employees cannot take responsibility for any consequences arising from this report.

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Introduction

This report describes the processing of 2D land seismic data for Santos Ltd. The data were processed by *Velseis Processing Pty Ltd.* in Brisbane, Australia, from September 2013 – March 2014.

The survey is situated in the McArthur Basin, Northern Territory and consists of 11 lines totalling 497 kilometres of vibroseis data acquired in 2013. See Table 1 for line listing and Figure 1 for a map of the line locations.

Personnel

Velseis:	Andrew McConville	Senior Geophysicist
	Bala Thanabalasingam	Geophysicist
	Natascha Rahn	Technical Assistant
Santos:	Malcolm Horton	Staff Geophysicist

Line Listing

Line	First SP	Last SP	Intvl	Length (km)
mcsan13-01	1001	5340	20	**86.78**
mcsan13-02	1001	6072	20	**101.42**
mcsan13-03	1001	2102	20	**22.02**
mcsan13-04	1001	3166	20	**43.30**
mcsan13-05	1001	3103	20	**42.04**
mcsan13-06	1001	3359	20	**47.16**
mcsan13-07	1001	3029	20	**40.56**
mcsan13-08	1001	4690	20	**73.78**
mcsan13-09	1001	3001	20	**40.00**
			Total	**497.06**

Table 1: Line listing with Shot point ranges

Survey map

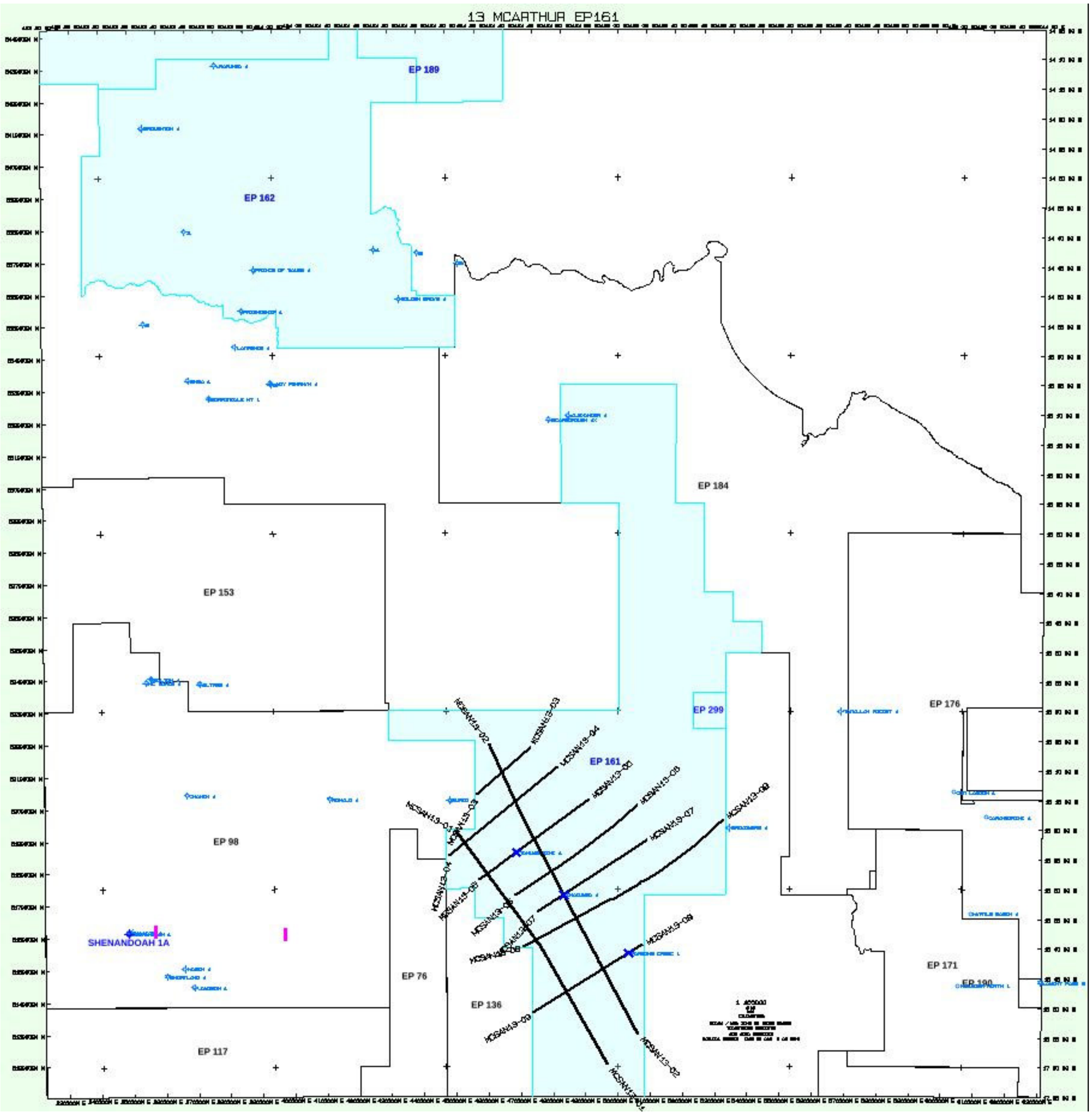


Figure 1: Map of seismic lines

Acquisition Parameters

The data were recorded by Terrex Seismic with the following parameters:

Date:	August to October 2013
Source:	Vibroseis
System:	Sercel 428
Filter:	0.8 Nyquist Linear Phase
Sample Rate:	2 ms
Trace Length:	4000 ms
Number of Vibes:	3
Number of Sweeps:	2
Sweep Frequency:	5 – 90 Hz, 0.3 Cosine Taper, Linear Gain
Sweep Length:	8000 ms
Geophone Array:	12 Inline, length 20 m
Group Interval:	20 m
Shot Interval:	20 m
Spread:	Symmetrical Split Spread
Number of Channels:	480
Fold:	240
Near offset:	10 m
Far offset:	4790 m

Data Quality

The data quality is relatively poor, contaminated by high amplitude, source related noise and environmental noise. There is very little primary signal visible on the shot records; however, strong primary reflectors are present on the brute stacks. The noise is possibly due to near surface geology.

Shot records show that good coupling has been achieved and the quality of the first arrivals is very clear; however, there are some poor quality areas related to higher elevations.

The final stacks and migrations show reasonably good quality data from shallow to basement with good reflector continuity, frequency content and imaging of steep dips.

Examples of data quality can be found in Enclosure 1.

Processing Sequence

The processing sequence was tailored to the specific properties of the survey. SEGY files were provided for assessment at each stage of testing.

Reformat

Input data were reformatted to ProMAX internal data format.

Geometry

Geometry information was assigned to trace headers. Information assigned to each trace includes source, receiver and CDP location along with offsets and CDP fold.

The coordinates are referenced to GDA 94 Zone 53.

Trace Edit

Bad and noisy traces were removed from shot records interactively.

Static Computation

First breaks were picked on a refractor corresponding to the base of weathering. An offset range of 100m to 1000m was selected to ensure consistency between lines.

Statics were calculated with a single layer refraction method. A replacement velocity of 4500 m/s was used. The final datum was set to 300 m, chosen in line with previous processing in this area and which preserves shallow data from being lost above the section.

The first break pick times were used to calculate delay times for each station and the delay times were then used to calculate refractor velocities. Once the delay times and the refractor velocities have been determined, the model construction can take place. The “weathering” velocity from surface to the refractor was set to a constant value of 1000 m/s. Using the “weathering” velocity, the depth of the refractor from the surface was calculated. Calculation of the statics consists of a time from the surface to the refractor at the weathering velocity, plus time to processing datum (300 m) using the replacement velocity (4500 m/s).

Minimum Phase Filter

A filter was created to convert the data from zero phase to minimum phase. The additive noise factor used in making this filter was 0.1%.

Gain Recovery

A spherical divergence correction was applied to all records. The spreading factor used was $1/(\text{time}*\text{velocity}^2)$, and the regional true amplitude recovery velocity function used was:- 0ms-2800m/s; 500ms-3500m/s; 1000ms-4000m/s; 2000ms-4500m/s; 4000ms-5000m/s.

Linear Noise Attenuation

A Fan Filter was applied to attenuate ground-roll up to 2800m/s.

See Enclosure 2 for summary of noise attenuation testing.

Deconvolution

Surface consistent spiking deconvolution was applied. The following parameters were used:

Operator length:	120 ms
White noise level:	0.1%.
Number of iterations:	3

Design Window tailored to each vintage.

See Enclosures 3 & 4 for summary of deconvolution testing.

Velocity Analysis (1st Pass)

Velocities were picked using the ProMAX interactive velocity picking package (IVA). IVA uses velocity spectra, moved out gathers and stacked panels to assist in a careful interpretation of stacking velocities. As the velocity function is altered, revised gathers and stacks are produced until optimised stacking velocities are achieved.

Velocities were picked at 1000 m intervals. Each panel consists of 11 CDPs stacked over 11 velocity stacks, which vary by percentages from a central guide function. The guide was a single, regional velocity function.

Surface Consistent Spiking Deconvolution was applied prior to velocity picking and 1st pass residual statics.

Residual Static Calculation and Application

Surface consistent residual statics were calculated and applied using Maximum Power Autostatics.

Pilot or reference traces were formed for a time gate following structure by flattening all traces along the autostatics horizon over a smash of 11 CDP's.

These traces are summed to form a single pilot trace. Each trace from the active CDP is time shifted relative to the pilot trace and summed with it. The power of the stack is measured for each time shift. This shift-power trace is then summed with other traces having the same shot and receiver in their respective domains.

After the shift spectra has been calculated for the entire line and summed in the Receiver/Shot domains, time shifts are picked at the maximum of the power shift spectra and stored as Static Values.

The pilot stack is updated and the process repeated for a number of iterations. In this case, calculations were conducted for at least 8 iterations or until the RMS of the change in the computed statics was less than 0.05 ms. The maximum permitted static value was 20 ms.

Velocity Analysis

Velocities were picked at intervals of 1000 m. Each panel consisted of 11 CDP's stacked using 11 velocity functions varied by percentage, centred around the 1st pass velocity function.

Residual Static Calculation and Application (2nd Pass)

Surface consistent residual statics were calculated and applied using Maximum Power Autostatics.

CDP Trim Statics

Trim statics application is the process of aligning traces within a gather by correlating them with a pilot trace, then applying appropriate shifts to each trace. Traces with a required shift greater than a pre-set maximum value are killed.

The pilot trace came from the 2nd pass residual statics stack with FX Decon applied, and the maximum shift was 8 ms. Correlation window was 100-3700ms.

Intersection Ties

Santos and Velseis carried out a QC of the line ties at intersection points.

Decon Gather Archive

Decon gathers were output for archive. Statics are not applied to the data, but all statics values are written to the trace headers. See page 18 for an example of the EBCDIC header.

Surface Consistent Amplitude Correction

Amplitudes were estimated over a 300-3900ms time gate and adjustments made to trace amplitudes in the source and receiver domains.

Noise Attenuation: Radial Filter

Dipping noise was still present within the data and various noise attenuation routines were tested. It was decided not to apply any aggressive noise attenuation at this stage due to some loss of primary continuity, especially around steep dips; also, the application of noise attenuation did not offer any significant benefit to stack response. A mild, low cut radial filter was applied to remove some of the stronger noise. The radial filter transforms data within a chosen velocity to the frequency domain and applies a low cut filter, removing noise below 12hz within the noise cone.

See Enclosures 5 & 6 for a summary of noise attenuation testing.

Spectral Whitening

Spectral whitening was applied to balance frequency content, run with 2 frequency panels over 0-5-90-100 Hz.

Gain

A time variant scalar was applied using 125 ms windows with a 50% overlap.

Final Datum

The static shift from floating to final datum of 300 m was applied.

Initial Pre-Stack Time Migration

Curved-Ray Kirchhoff Pre-Stack Time Migration was performed. The data were migrated using the pre-migration velocity field.

See Enclosure 6 for a summary of PSTM testing.

Velocity Analysis

Velocities were picked at intervals of 500 m. Each panel consisted of 11 CDP's stacked using 11 velocity functions varied by percentage, centred around the pre-migration velocity guide function.

Final Pre-Stack Time Migration

The data were migrated with the PSTM velocity function.

Residual Velocity Analysis

Further velocity analysis was performed every 500 m, making fine adjustments to deliver the best stack response.

Normal Moveout

An NMO correction was applied to the data using the post migration velocities.
Dynamic corrections are applied to the data using the following formula.

$$TX^2 = T0^2 + X^2 / V^2$$

TX = time at offset X
T0 = time at zero offset
X = offset of the trace
V = velocity at time T

PSTM Gather Archive

PSTM gathers were output for archive. See page 19 for an example of the EBCDIC header.

Trace Mute

Time-Offset pairs were picked for each vintage. The mute times were:-

Time (ms)	Offset (m)
10	20
225	620
450	1240
1085	2640
1595	3700
2060	4800

Gain

A time variant scalar was applied using 125 ms windows with a 50% overlap.

CDP Stack

Add traces within a common midpoint gather. The post stack trace was scaled by the square root of the sum of fold for each sample in the trace.

Bandpass Filter

A time variant Ormsby zero phase bandpass filter was applied to remove high and low frequency noise. The filter frequencies were:-

Time (ms)	Filter (Hz)
0-2000	10-15-60-70
2200-3200	10-15-50-60
3400-4000	10-15-40-50

Bulk Shift

100 ms bulk shift added to final stack Segy output.

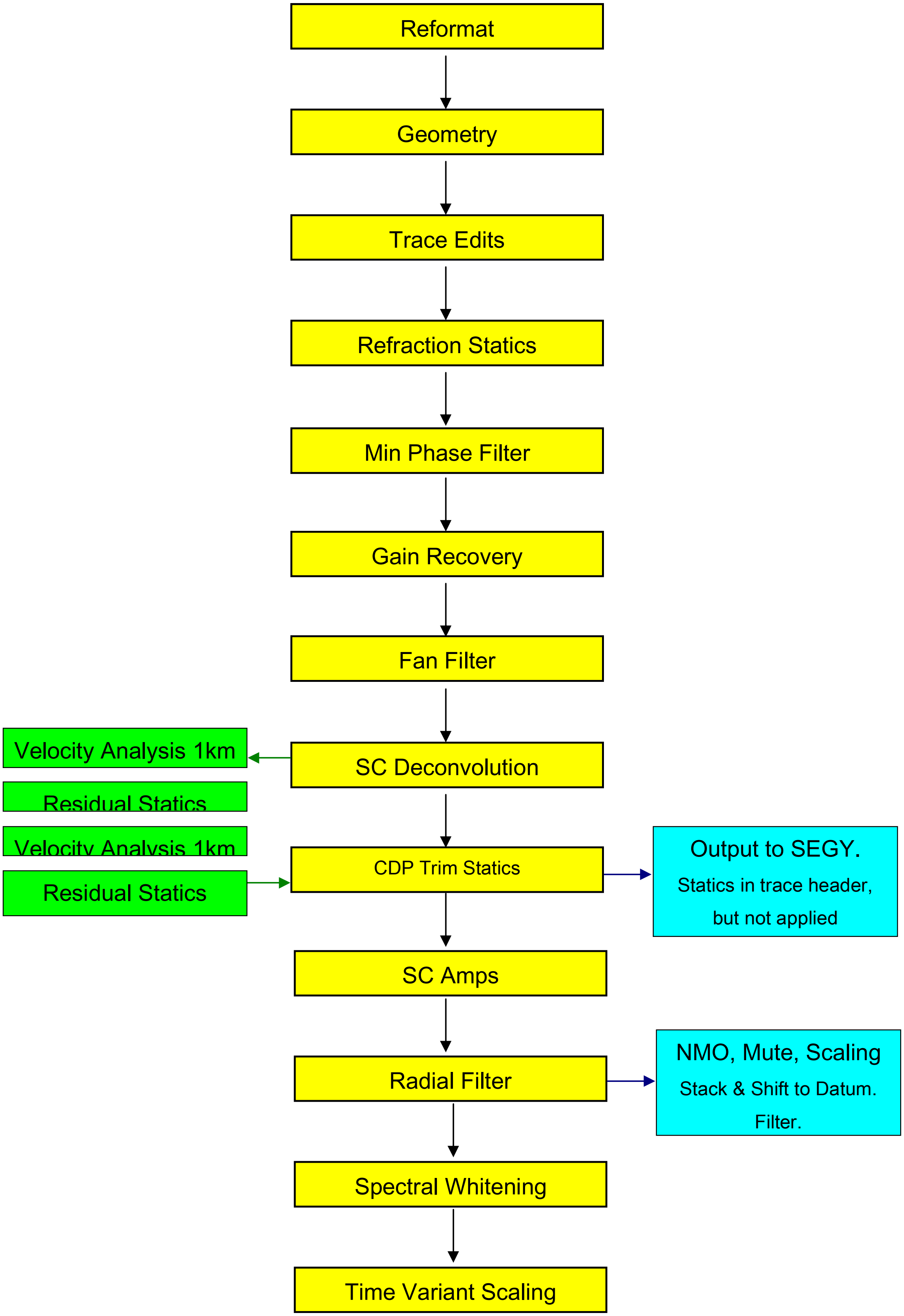
Archive Stacks

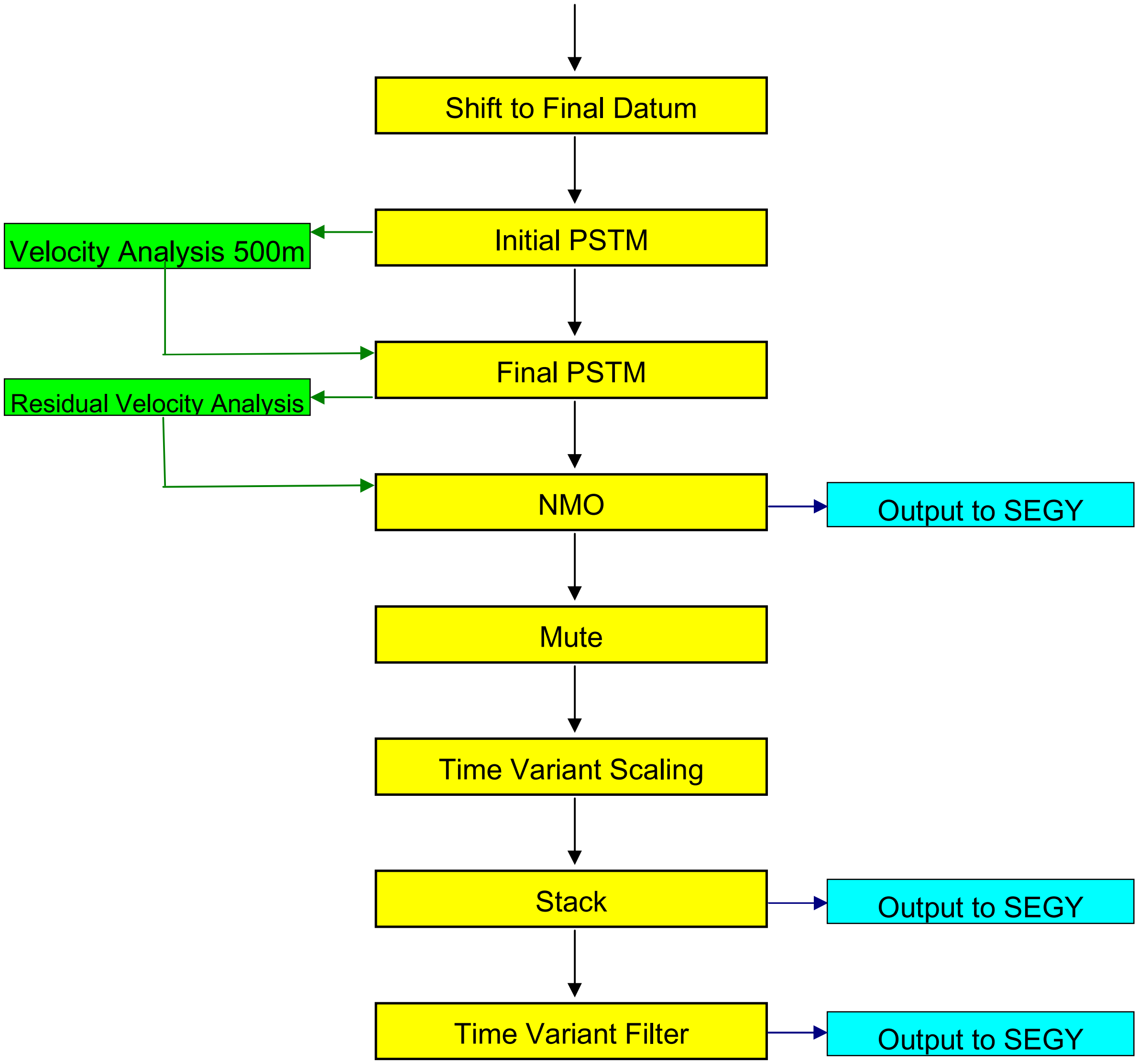
The following stack products were output to SEGY for all surveys:-

Final Stack input to migration - filtered
Final PSTM Stack - raw
Final PSTM Stack - filtered

See page 20 for an example of the EBCDIC header.

Processing Flow Chart




Shift to Final Datum
Velocity Analysis 500m
Initial PSTM
Final PSTM
Residual Velocity Analysis
NMO
Output to SEGY
Mute
Time Variant Scaling
Stack
Output to SEGY
Time Variant Filter
Output to SEGY

Archiving

On LTO2 (LTO-171), 2 copies have been produced, containing the following for all lines of this survey:

IN SEGY FORMAT:

Deconvolved CDP Gathers.
PSTM CDP Gathers

Final Stack, input to migration - filtered
Final PSTM Stack - raw
Final PSTM Stack - filtered

IN ASCII FORMAT:

2ndpass Stacking velocities at surface datum (applied to Decon gathers).
PSTM velocities at final datum.

Shot and receiver refraction statics and residual statics.

CMP Coordinates

On DVD (DVD-891), 2 copies containing the following:

Report in pdf format and Enclosures in ppt format.

Archive data were delivered to:-

Malcolm Horton
Staff Geophysicist
Santos Operations Geophysics
60 Flinders Street
Adelaide
SA 5000

EBCDIC Header

Decon Gathers

```
C 1 CLIENT: SANTOS   VOLUME: DECON GATHERS
C 2 SURVEY : McARTHUR      AREA : McARTHUR BASIN
C 3 LINE : MCSAN-13-07
C 4 CDP: 2002-6058 STATION : 1001-3029
C 5 BYTES: STN 17, CDP 21,CDPX 141,CDPY 145 (4R)CDP ELEV 237(4R) DTM STAT 233(4R)
C 6 SAMPLE INTERNAL : 2ms    DATA LENGTH : 4000 ms
C 7 PROCESSING DATUM : 450M SURVEY DATUM : GDA94 ZONE 53
C 8 PROCESSING : VELSEIS PROCESSING BRISBANE AUSTRALIA  MARCH 2014
C 9
C10 INPUT TO INTERNAL PROMAX FORMAT  2MS 4S
C11 EDIT NOISY TRACES AND BAD RECORDS
C12 GEOMETRY APPLICATION: ASSIGN SHOT AND RECEIVER COORDINATES
C13 MINIMUM PHASE FILTER
C14 GAIN RECOVERY: SPHERICAL DIVERGENCE CORRECTION 1/(TIME*VEL**2)
C15 REFRACTION STATICS : 300M DATUM, 4500M/S REPLACEMENT VELOCITY
C16 FAN FILTER
C17 SURFACE CONSISTENT SPIKE DECONVOLUTION:160MS WINDOW
C18 INITIAL VELOCITY ANALYSIS: 1KM
C19 RESIDUAL STATICS
C20 VELOCITY ANALYSIS: 1KM
C21 2nd PASS RESIDUAL STATICS
C22 TRIM STATICS
C23***STATICS IN HEADER BUT NOT APPLIED TO TRACES***
C24
C25 NMO
C26
C27
C28
C29
C30
C31 SEGY OUT BYTES:
C32 TRIM STATICS 91(4R), SHOT REFR STATIC 99 (2I), REC REFR STATIC 101 (2I)
C33 SHOT RESID STATIC 185(4R), REC RESID STAT 189(4R) DATUM STAT 193(2I)&233(4R)
C34 SHOT STATIC + RESID STATIC 225(4R), REC STATIC + RESID STATIC 229 (4R)
C35 SHOT STATION 129 (2I) & 209 (4I), REC STATION 133 (2I) & 213 (4I)
C36 CDP 205 (4I), FFID 217(2I), CDP X 141 & 149 (4R) CDP Y 145 & 153 (4R)
C37 CDP ELEV 237 (4R)
C38 CDP STATION 17, CDP 21 (4I)
C39  ***STATICS NOT APPLIED TO GATHERS***
C40 END EBCDIC
```

PSTM Gathers

```
C 1 CLIENT: SANTOS   VOLUME: FINAL PSTM GATHERS
C 2 SURVEY : McARTHUR      AREA : McARTHUR BASIN
C 3 LINE : MCSAN-13-07
C 4 CDP: 2002-6058 STATION : 1001-3029
C 5 BYTES: STN 17, CDP 21,CDPX 73,CDPY 77 (4I)CDP ELEV 221(2I) DTM STAT 233(4R)
C 6 SAMPLE INTERNAL : 2ms    DATA LENGTH : 4000 ms
C 7 PROCESSING DATUM : 300M SURVEY DATUM : GDA94   ZONE 53
C 8 PROCESSING : VELSEIS PROCESSING BRISBANE AUSTRALIA  MARCH 2014
C 9
C10 INPUT TO INTERNAL PROMAX FORMAT  2MS 4S
C11 EDIT NOISY TRACES AND BAD RECORDS
C12 GEOMETRY APPLICATION: ASSIGN SHOT AND RECEIVER COORDINATES
C13 MINIMUM PHASE FILTER
C14 GAIN RECOVERY: SPHERICAL DIVERGENCE CORRECTION 1/(TIME*VEL**2)
C15 REFRACTION STATICS : 300M DATUM, 4500M/S REPLACEMENT VELOCITY
C16 FAN FILTER
C17 SURFACE CONSISTENT SPIKE DECONVOLUTION:160MS WINDOW
C18 INITIAL VELOCITY ANALYSIS: 1KM
C19 RESIDUAL STATICS
C20 VELOCITY ANALYSIS: 1KM
C21 2nd PASS RESIDUAL STATICS
C22 TRIM STATICS
C23 SURFACE CONSISTENT AMPLITUDE CORRECTION
C24 LO CUT RADIAL FILTER
C25
C26 SPECTRAL WHITENING 2 WINDOW 5-90HZ
C27 TIME VARIANT SCALING 125MS WINDOWS
C28 SHIFT TO FINAL DATUM
C29 PSTM VELOCITY ANALYSIS 500M
C30 CURVED RAY KIRCHHOFF PRE STACK TIME MIGRATION
C31 NMO
C32
C33
C34
C35
C36
C37
C38 SEGY OUT BYTES: CDP 21 & 205 (4I), STATION 17 (4I)
C39 CDP_X 141&149, CDP_Y 145&153, CDP_ELEV 237 (4R), DATUM STAT 193(2I)&233(4R)
C40 END EBCDIC
```

Stacks

```
C 1 CLIENT: SANTOS   VOLUME: PSTM STACK - FILTERED
C 2 SURVEY : McARTHUR      AREA : McARTHUR BASIN
C 3 LINE : MCSAN-13-07
C 4 CDP: 2002-6058 STATION : 1001-3029
C 5 BYTES: STN 17, CDP 21,CDPX 73,CDPY 77 (4I)CDP ELEV 221(2I) DTM STAT 233(4R)
C 6 SAMPLE INTERNAL : 2ms    DATA LENGTH : 4000 ms
C 7 PROCESSING DATUM : 300M SURVEY DATUM : GDA94   ZONE 53
C 8 PROCESSING : VELSEIS PROCESSING BRISBANE AUSTRALIA  MARCH 2014
C 9
C10 INPUT TO INTERNAL PROMAX FORMAT  2MS 4S
C11 EDIT NOISY TRACES AND BAD RECORDS
C12 GEOMETRY APPLICATION: ASSIGN SHOT AND RECEIVER COORDINATES
C13 MINIMUM PHASE FILTER
C14 GAIN RECOVERY: SPHERICAL DIVERGENCE CORRECTION 1/(TIME*VEL**2)
C15 REFRACTION STATICS : 300M DATUM, 4500M/S REPLACEMENT VELOCITY
C16 FAN FILTER
C17 SURFACE CONSISTENT SPIKE DECONVOLUTION:160MS WINDOW
C18 INITIAL VELOCITY ANALYSIS: 1KM
C19 RESIDUAL STATICS
C20 VELOCITY ANALYSIS: 1KM
C21 2nd PASS RESIDUAL STATICS
C22 TRIM STATICS
C23 SURFACE CONSISTENT AMPLITUDE CORRECTION
C24 LO CUT RADIAL FILTER
C25
C26 SPECTRAL WHITENING 2 WINDOW 5-90HZ
C27 TIME VARIANT SCALING 125MS WINDOWS
C28 SHIFT TO FINAL DATUM
C29 PSTM VELOCITY ANALYSIS 500M
C30 CURVED RAY KIRCHHOFF PRE STACK TIME MIGRATION
C31 NMO
C32 MUTE
C33 TIME VARIANT SCALING 125MS WINDOWS
C34 STACK
C35
C36 TIME VARIANT BANDPASS FILTER
C37 BULK SHIFT 100MS
C38 SEGY OUT BYTES:
C39 TIME ZERO 105 (2I) DATUM STAT 193(2I)&233(4R)
C40 END EBCDIC
```

Appendix A Hardware

These data were processed by Velseis Processing Pty. Ltd., Brisbane, Australia.

Velseis Processing utilizes ProMAX 2D/3D processing software. This is a totally interactive system allowing the user to view data processing at each stage, producing a final result of the highest quality.

The software executes on a quad processor Sparc 20 Sun workstation and a 212 node, dual CPU/node Linux cluster. Data is viewed via X terminals networked to the main system, each terminal has a high definition monitor to enable accurate representation of the digital data in pixel form.

Velseis Processing is committed to offering a premium product, the software development undertaken by ProMAX resulting in processing algorithms that are state of the art.

Appendix B Glossary

This glossary contains explanations of technical terms and acronyms commonly used to describe seismic processing and interpretation. More comprehensive explanations can be found in standard seismic texts and reference books (e.g. Sheriff, R.E. (1991) Encyclopaedic Dictionary of Exploration Geophysics, Society of Exploration Geophysicists, Oklahoma).

2D	two-dimensional
3D	three-dimensional
AGC	automatic gain control; data-dependent scaling designed to normalise trace amplitude within a running time window
anisotropy	variation of seismic velocity depending on the direction in which it is measured; a sequence of sedimentary bedding produces polar anisotropy (where seismic velocities are symmetric about the bedding); non-horizontal fracturing and microcracks produces azimuthal anisotropy (where seismic velocities are symmetric about the axis perpendicular to the fracturing)
bandpass filtering	attenuation of seismic energy outside of a user-defined frequency bandwidth
CMP stacking	the summation of all traces within a CMP gather
common midpoint (CMP) gather	the set of seismic traces that share the same midpoint between their sources and receivers
common receiver gather (CRG)	a collection of seismic traces recorded at the same geophone (receiver) location
deconvolution	a process designed to restore a waveshape to the form it had before undergoing a filtering action; applied to seismic reflection data to remove the filtering effect of the earth and so improve the resolution of reflected energy
dominant frequency	the predominant frequency of a seismic dataset determined by measuring the time between successive peaks or troughs of the recorded seismic pulse, and taking the reciprocal
fold	the multiplicity of data within a CMP gather; that is, the number of traces within a CMP gather that will contribute to the summed trace at that CMP location
dominant wavelength	the seismic wavelength associated with the dominant frequency; for P waves, equivalent to Vp divided by the dominant frequency
frequency	the repetition rate of a periodic waveform, measured in ‘cycles per second’ or Hertz (Hz)

frequency bandwidth	range of frequencies over which the recorded seismic signal has significant power
f-x deconvolution	a random-noise attenuation method typically applied to seismic data following CMP stacking; improves the signal-to-noise ratio of the final stack
geometric spreading	see spherical divergence
geophone	the recording device or receiver used to transform seismic energy into an electrical voltage for input into the seismic recording system; a single vertically-oriented geophone is used for conventional seismic acquisition
geophone array	a group of geophones arranged in a linear or areal pattern connected to a single recording channel (i.e. the ground motion recorded by each of the geophones within the array is summed to produce just one seismic recording at the particular receiver station); used to discriminate against waves with certain dominant wavelengths and boost the signal-to-noise ratio
geophone array length	the distance over which a geophone (receiver) array is planted about a receiver station; typically of the order of 20-30m for petroleum-scale recording and 2-5m for coal-scale seismic recording
groundroll	a type of seismic wave that travels along or near the surface of the ground; characterised by relatively low velocity, low frequency and high amplitude; recorded as a steeply dipping, linear event on a seismic shot record; often interferes with desired reflection events
instantaneous frequency attribute	he temporal rate of change of the instantaneous phase; generally has a high degree of variation that can often be related to stratigraphy
instantaneous phase attribute	a measure of the lateral continuity of events on a seismic section
magnitude spectrum	amplitude of seismic recording as a function of frequency
migration	a seismic inversion operation involving rearrangement of seismic data samples so that reflections are plotted at their true locations; required where laterally varying seismic velocities and dipping reflectors cause seismic energy to be recorded at relative positions different to their real physical location
mute	elimination of unwanted energy from seismic traces; typically used over certain time intervals to remove ground roll or noise bursts out of the final stack

normal moveout (NMO)	the variation of the arrival time of reflection energy with offset; NMO corrections compensate for this variation in travel time so that reflection energy from each geological boundary is properly aligned prior to stacking; for horizontal reflectors, P-wave NMO can be described as hyperbolic
offset	the distance from the source point to the receiver location
P waves	longitudinal or compressional seismic waves; characterised by particle motion in the direction of travel; acquired using conventional (single-component) seismic acquisition surveys
predictive deconvolution	a method of deconvolution that takes advantage of the predictability of surface multiples; provided necessary statistical assumptions are met, predictive deconvolution will remove surface multiple energy at the same time as removing the filtering effect of the earth to produce high resolution seismic reflection events
receiver array	see geophone array
reflection amplitude attribute	a measure of the amplitude of seismic energy reflected from a specific geological interface; instantaneous amplitude is the amplitude recorded at the interpreted arrival time of the seismic event; RMS amplitude is the root-mean-square amplitude determined over a window of a specified length centred about the interpreted arrival time of the seismic event
reflection gradient attribute	a measure of the rate of variation in arrival time of a seismic event; anomalously high gradients are generally indicative of structures or rapidly varying depths of the reflector being analysed
residual static corrections	remnant statics associated with incomplete weathering static corrections
resolution	the ability to separate two features which are very close together
resolution limit	for discrete seismic reflectors, the minimum vertical separation so that one can ascertain that more than one interface is involved; the commonly used Rayleigh resolution limit is defined as one quarter the dominant wavelength; the Widess limit is defined as one eighth the dominant wavelength
S waves	transverse or shear seismic waves; characterised by particle motion perpendicular to the direction of travel; acquired using multi-component (3-C) seismic acquisition

seismic attribute	typically refers to some measurement extracted from seismic data beyond conventional reflection two-way time (TWT); typically presented as an auxiliary 3D surface or image; commonly used attributes include reflection amplitude, instantaneous frequency or reflection gradient (dip) (see independent entries for a description of these attributes)
seismic waves	sound waves that propagate through the earth
seismic modelling	generation of a synthetic seismic record given an earth model
seismic reflection	a geophysical method to image the sub-surface using artificially-generated sound waves; typically the arrival times of various seismic waves are used to map sub-surface structure
seismic source	an artificial device that releases energy or seismic waves into the ground; typical coal-seismic sources include small dynamite explosions, MiniSOSIE and Vibroseis
seismic velocity	the propagation speed of a seismic wave through a particular material
shot record	a collection of seismic traces recorded at a number of receivers from the release of seismic energy at a single source location
signal-to-noise ratio (S/N)	the ratio of desired signal to all other recorded energy (noise) in a seismic recording; may be difficult to determine in practice
spectral whitening	a signal processing procedure whereby all frequency components within a signal bandwidth of a seismic recording are equalised
spherical divergence	the decrease in seismic wave strength with distance; caused by seismic waves continually spreading out as they travel through a medium so that energy density decreases
spherical divergence correction	a scaling correction to compensate for decrease in wave strength with distance as a result of geometric spreading
stacking	process by which a set of seismic traces are summed
static corrections	corrective time shifts applied to seismic data to compensate for the effects of variations in elevation, weathering thickness, weathering velocity or reference to datum; the objective is to determine the arrival times which would have been observed if all measurements had been made on a flat plane with no weathering or low-velocity material present

structural interpretation	involves the mapping of geological interfaces and discontinuities (such as faults) via picking of the TWT of seismic reflection energy from target reflectors
trim statics	involves the mapping of geological interfaces and discontinuities (such as faults) via picking of the TWT of seismic reflection energy from target reflectors
TWT	two-way traveltime; refers to the time it takes for seismic energy to travel from the seismic source, down to a reflector, and back to the surface receiver
velocity analysis	calculation of a velocity that will accurately compensate for the effects of NMO; typically involves flattening reflection events in a CMP
wavelength	the distance (in metres) between two successive similar points on two adjacent cycles of a seismic wave, measured perpendicular to the wave front; often represented by the symbol λ