Table of Contents

1 Onboard Processing Personnel and System

Operators

Processing Geophysicists

05th Jan 2005 - 21st Jan 2005	:	Håvard Åsli	Multiwave

Hardware Description

1 x IBM machine, Xeon 2x3.0GHz

Machines	:	1 x SGI Octane Workstation
Monitors	:	2 x 21" LCD Monitor
Hard Disk Drives	:	1 TB External Disk
Tape Drives	:	2 x IBM 3590 tape drives
Plotters	:	1 x Isys V24 24" Thermal Plotter

Software Description

Processing software	:	ProMAX2D version 2003.3.2
Operating System	:	IRIX 6.5
Plotting software	:	ZehPlot Express 4.4

2 Objectives

2.1 Geophysical Objectives & Reference Parameters

The objective of the survey was to acquire approximately 1500 line Km's of marine seismic 2D data in the Sorell Basin, offshore West Tasmania, Australia.

2.2 Processing Objectives

The main objective of the onboard QC processing was to assess the impact of noise in the data, to check for problems associated with acquisition and recording on a line-by-line basis and to give an overall impression of the data quality.

Various QC methods, including RMS noise displays, single and multi-trace displays, gun hydrophone channels and stacks were to be used to assess compliance with various acceptance criteria and to isolate any other acquisition issues.

The general aim of the QC processing was not to attenuate noise but to show the data as it was recorded, or how it would be presented to a shore or vessel based processing centre. A brute stack was produced every line with minimal processing to enable a thorough QC of the data onboard, and then with Automatic Gain Control applied. In addition to brute stack processing, gun hydrophone channels were checked to QC the performance of the source. Raw shot, near trace and various RMS displays were also generated and examined to identify any noise problems.

3 Processing Sequence

3.1 Parameter Testing

Due to the high production rates expected and short survey duration, parameter testing was kept to a minimum due to the short time lag between production and final QC. Parameter testing was therefore limited to checking suitability of the parameters on the first sequence, along with scaling for the filtered brute stack displays.

3.2 Main Seismic Processing Parameters

Upon completion of a line, the primary Seg-D tape was read to confirm the integrity of the tape and to write the data to disk onto the ProMAX system. A listing of the field file (FFID) and shot point number (SP) and number of channels was printed to clearly identify any lost shots or shots with missing navigation headers. All data, including 480 seismic channels, start of line noise records and auxiliary channels (-1 to -21), were input to a record length of 8000ms. A bulk shift static correction was applied to the data to correct for the 50ms instrument delay of the recording system.

The data was re-sampled from 2 ms to 4 ms, using a minimum phase, high fidelity anti-alias filter applied prior to resample. Further data reduction involved 2-to-1 trace summation after differential NMO, which increased the receiver spacing from 12.5 to 25 meters. A regional velocity function was used for differential NMO prior to trace sum.

A 2D geometry was assigned to the decimated data, using navigation derived P1/90 files and including simple offset and CDP binning calculations (tying SP1001 with CDP10001 for convenience).

Trace editing involved killing any bad traces or shots based on observer log comments and results of the QC.

To balance the shot records, true amplitude recovery using a spherical divergence correction was used and applied to the whole shot record.

3.3 Velocity Work

A regional velocity function was obtained by averaging a set of velocity picks typical for the survey. This was used as an initial guide function to aid in early velocity scans.

Velocities were picked for every line at a 2 km interval using ProMAX's interactive velocity analysis package. This comprised of a semblance display with rms stacking velocity graph and interval velocity graph, CDP super gather panel and function stack panels. To improve the signal to noise ratio, super gathers were formed by combining fifteen adjacent CDP gathers. Stack panels were created from these 15 CDP's using 15 functions varying +/- 25% from the regional velocity function.

Velocities were picked using a two and three pass process due to the large variations in water depth. The first pass was to pick an approximate velocity function to be input in the second pass as a central function for the stack functions.

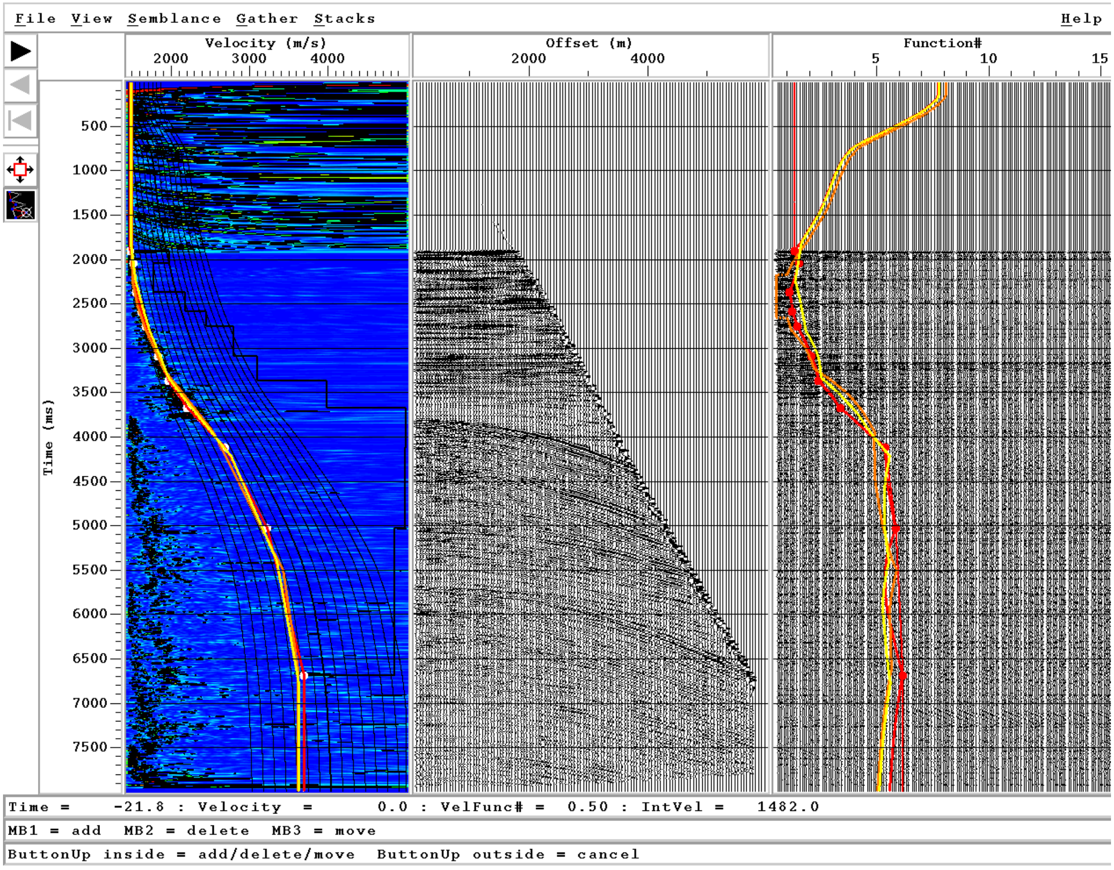

Figure 1 Velocity analysis interface with semblance, super-cdp gather and function stacks (orange - previous, red - present, yellow - next pick) (seq. 0001, SS04-002-001).

To speed up the on screen velocity picking procedure the velocity analysis displays were pre-computed. Normal move-out was applied to the gather to check that the events were lining up well. Velocities were mainly picked off the function stacks due to there being a large percentage of multiples, large dips and reverberations affecting the semblance display.

After velocity picking, velocities were viewed and QC'ed on screen using the ProMax velocity viewer module, which provided an iso-velocity display together with rms stacking velocities. This module was most useful for editing any stray velocity picks. NMO corrected gathers were also displayed on screen both at and between velocity locations for further verification.

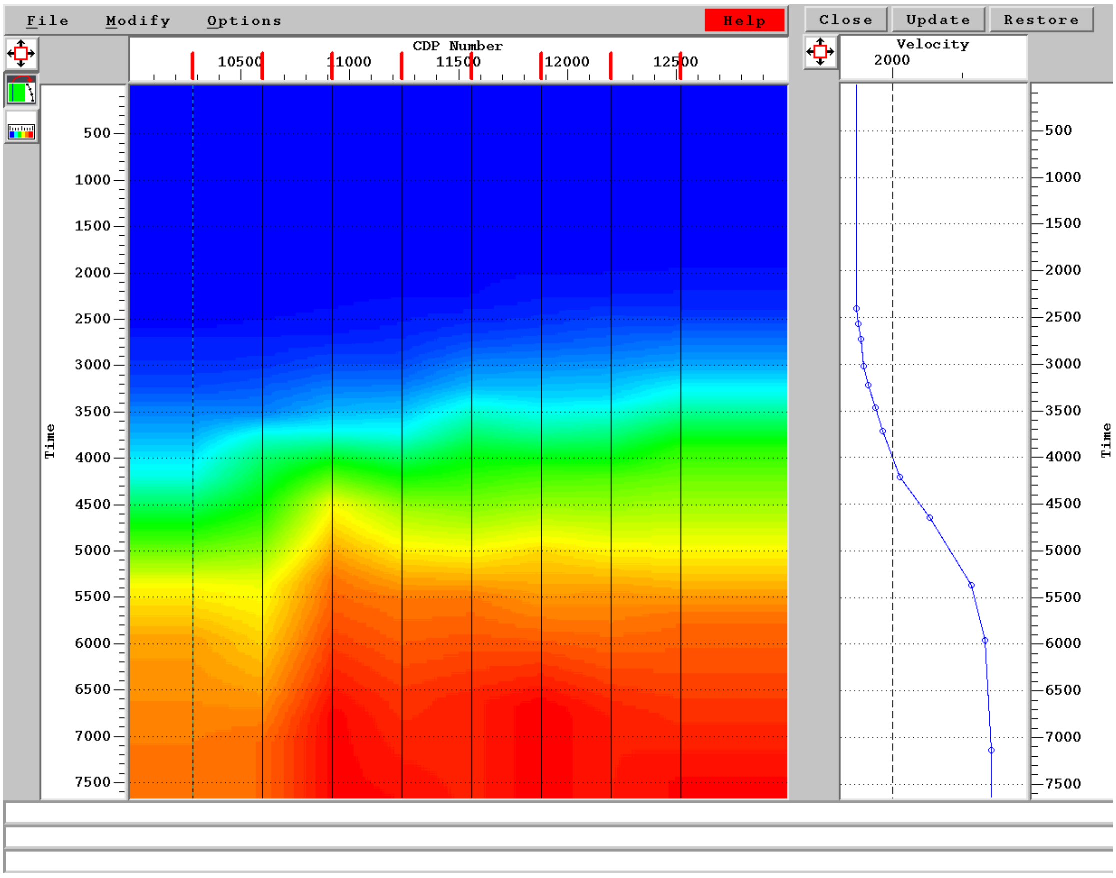

Figure 2 Iso-velocity display in ProMax velocity viewer (seq. 0001, SS04-002-001).

3.3.1 CDP Gather Displays

Gathers were regularly displayed on screen at 4 kilometre intervals to QC the velocities after NMO correction and to ascertain the impact of swell noise and cable impacts on the pre-stack data. The CDP gathers were NMO corrected using the picked RMS stacking velocities.

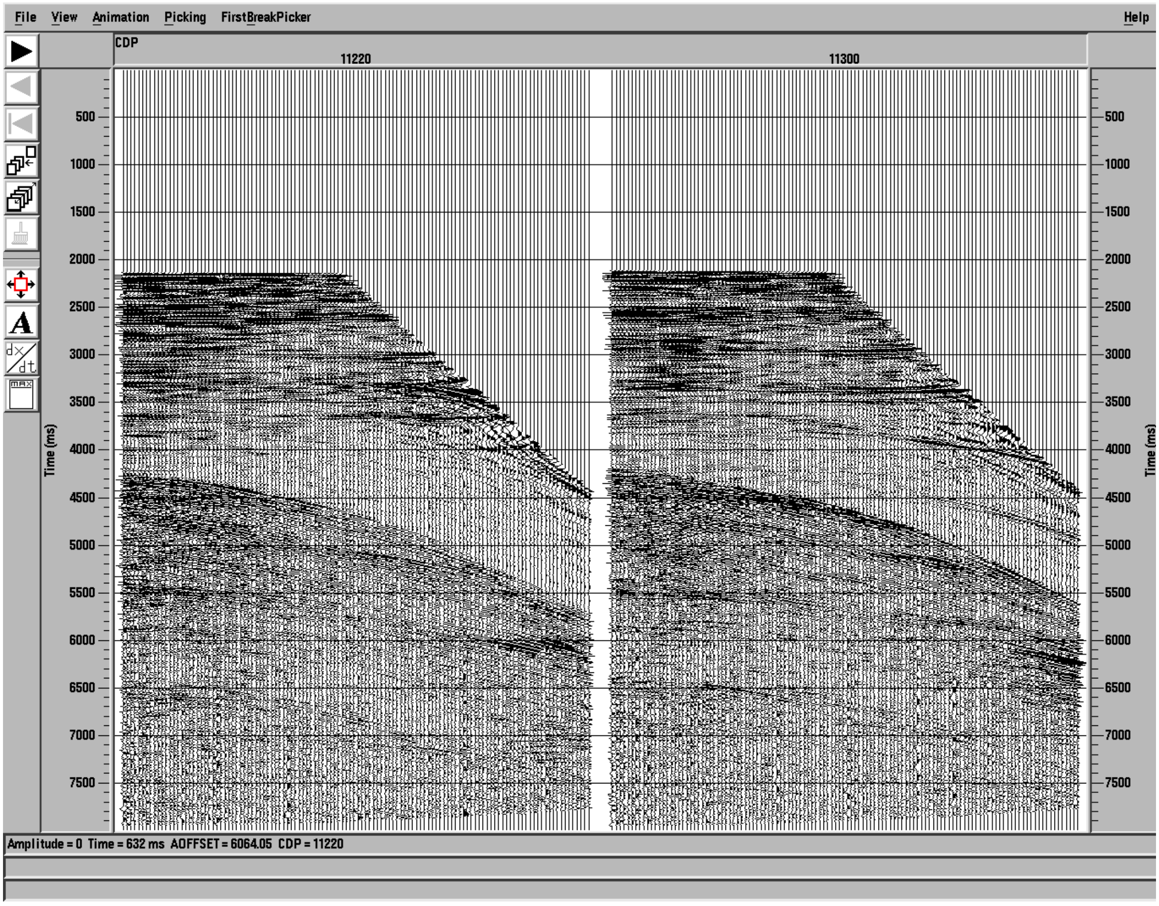

Figure 3 CDP gather (seq. 0001, SS04-002-001) to confirm the velocity picks.

3.3.2 Brute Stack

Brute stacks were produced in duplicate for each line, one raw brute stack and one filtered brute stack with additional Automatic Gain Control and scaling more suitable for screen displays..

Prior to stacking, the data went through a minimum phase predictive deconvolution with 200ms operator length and 24ms prediction distance.

A straight mean vertical stack algorithm was used for CDP stacking, with a root power scalar for normalization of 0.5.

A bulk shift static correction was applied post-stack to correct for the gun and cable depths. Filtering was limited to a 3-90 Hz broadband filter.

The raw brute stacks were then printed to SEG-Y file, captured to gif, and plotted.

The filtered brute stack contained additional automatic gain control with a centered mean scalar operator of 1500ms length, and then the traces were scaled to comprise a more wholesome image of the stack.

Stacks were then output to disk. All brute stacks were written as SEG-Y along with the other QC deliverables to both 3590 tape and DVD. The brute stack headers contain all relevant SP and CDP information.

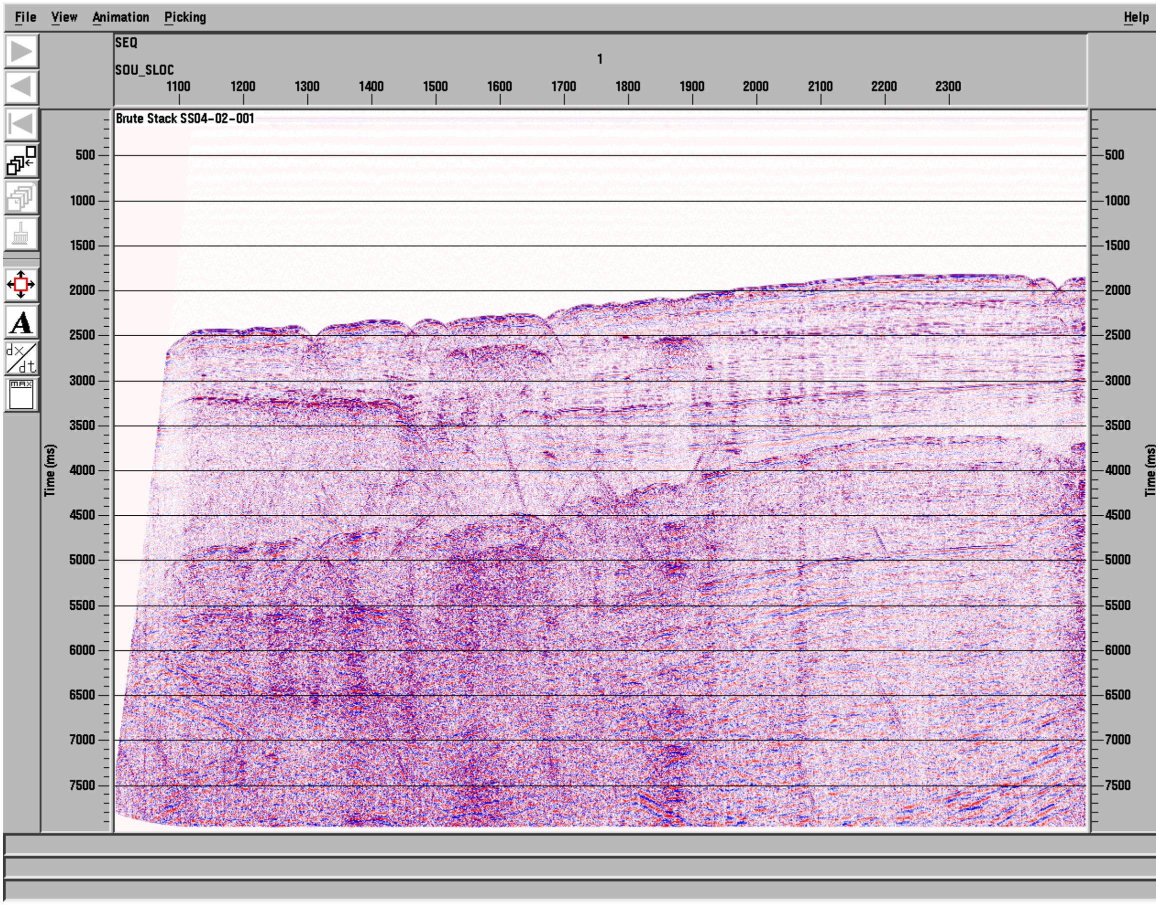

Figure 4 Brute stack (raw) seq. 0001, SS04-002-001

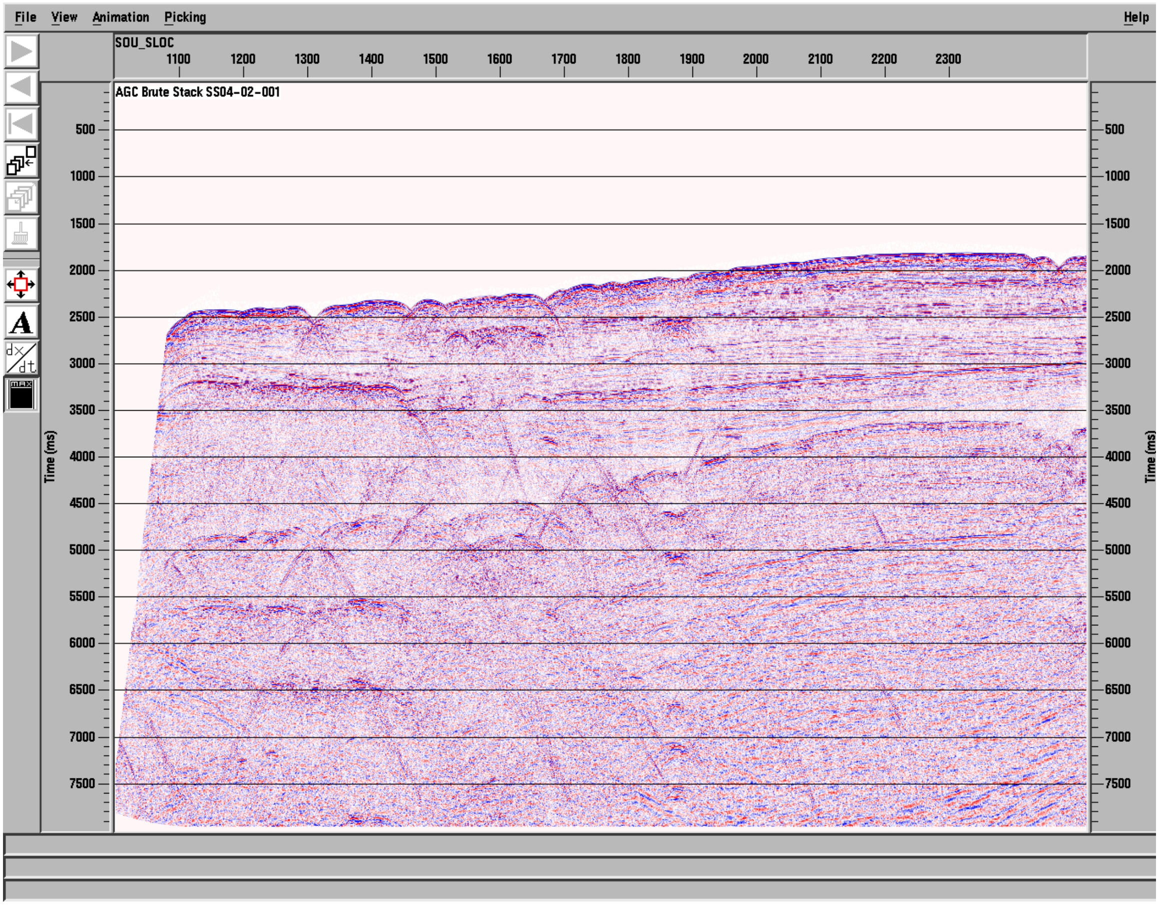

Figure 5 Brute stack, seq. 0001 SS04-002-001, with AGC

3.4 Processing Flow & Quality Control

3.4.1 Quality Control of Processing Steps

At every stage of the processing sequence the data was QC'ed on screen to ensure that there were no problems. RMS analyses were used to check for noisy or spiking channels. The final QC involved close examination of the brute stack.

Processing Flow Chart

SEG-D Input From Tape
Resample / Desample From 2 ms to 4 ms. Hi-Fi anti-alias filter applied in module
Reformat to ProMax internal format Input 8000ms, 480 channels + 21 auxiliary channels
↓ ——→ **Noise Record** Start and end of line, ambient rms
↓
↓ ——→ Shot Vs Chan Colour RMS Analysis Window 7500-8000ms
↓ ——→ SCREEN DISPLAY + GIF FILE
↓ ——→ **Auxiliary Channel QC** On screen QC. Aux channels 1-21, time-break and water-break QC.
↓ ——→ Near Trace Display On screen QC
↓ ——→ Merge with P190 All 480 channels
↓ ——→ **Seismic / Nav Merge QC** On screen QC.Chan1v's predicted arrival
Marine Trace Decimation 2:1 summation using differential NMO
2D Marine Geometry 2D Geometry to trace headers
Bulk Shift Static -50ms for instrument filter delay
↓
↓ ——→ **Raw Shots Display** Every 1 km, 8000 ms, 480 channels
↓ ——→ ON SCREEN QC DISPLAY
Trace / Shot Kill Edits based on Observer's Logs
Band-pass Filter Ormsby, Minimum Phase, 3-6-90-120 Hz
True Amplitude Recovery Spherical Divergence 1/ $t*V^2$ using picked velocity
↓ 2 dB/sec from water bottom to 8000ms
Band-pass Filter Ormsby, Minimum Phase, 3-6-90-120 Hz
↓ ——→ **Velocity Analysis** Every 2 km, Semblance, Gathers, Function Stack
↓ ——→ **ASCII FILE**
Normal Move-out Correction
Deconvolution Min Phase 200ms, Operator Length 24ms.
↓ ——→ **NMO Corrected Gathers** Every 1 km, 8000 ms
↓ ——→ ON SCREEN QC DISPLAY
NMO Stretch Mute Top mute picked from CDP gathers
CDP / Ensemble Stack Mean, Root power scalar for normalization 0.5
Gun and Cable Static
↓ ——→ **Plot Brute Stack** 8000ms, No Scaling

↓ ——→ BRUTE STACK to SEG-Y TAPE
↓ ——→ AGC BRUTE STACK to SEG-Y TAPE

3.5 Acquisition QC Processing

3.5.1 Noise Record RMS

The two noise records were displayed at the start of every line for QC. Amplitude RMS values were computed for all 480 channels and the RMS average was noted in the SeisQC log spreadsheet.

3.5.2 Ambient noise - Shot Versus Channel Color RMS Amplitude Display

Color displays of shot vs. channel RMS values were produced for every line. Raw data with a sample rate of 2 ms was used to calculate the RMS values for every channel on every shot in a time window of 7500-7900 ms.

For all RMS computations a scaling factor of 50.0 was used to convert from millivolts to microbars.

The color RMS displays were viewed on screen, and the screen images were then saved as GIF files. The displays were extremely useful in showing noise trends along the line such as swell noise, noisy/bad channels, bird noise, cable tug, front/end noise, cable strikes, swell noise contamination, auto-fires and misfires, multiple interference, etc. The on screen analysis also allowed the exact shot and channel location of any noise trend to be located and investigated. The average RMS value of each sequence was noted in the SeisQC log spreadsheet.

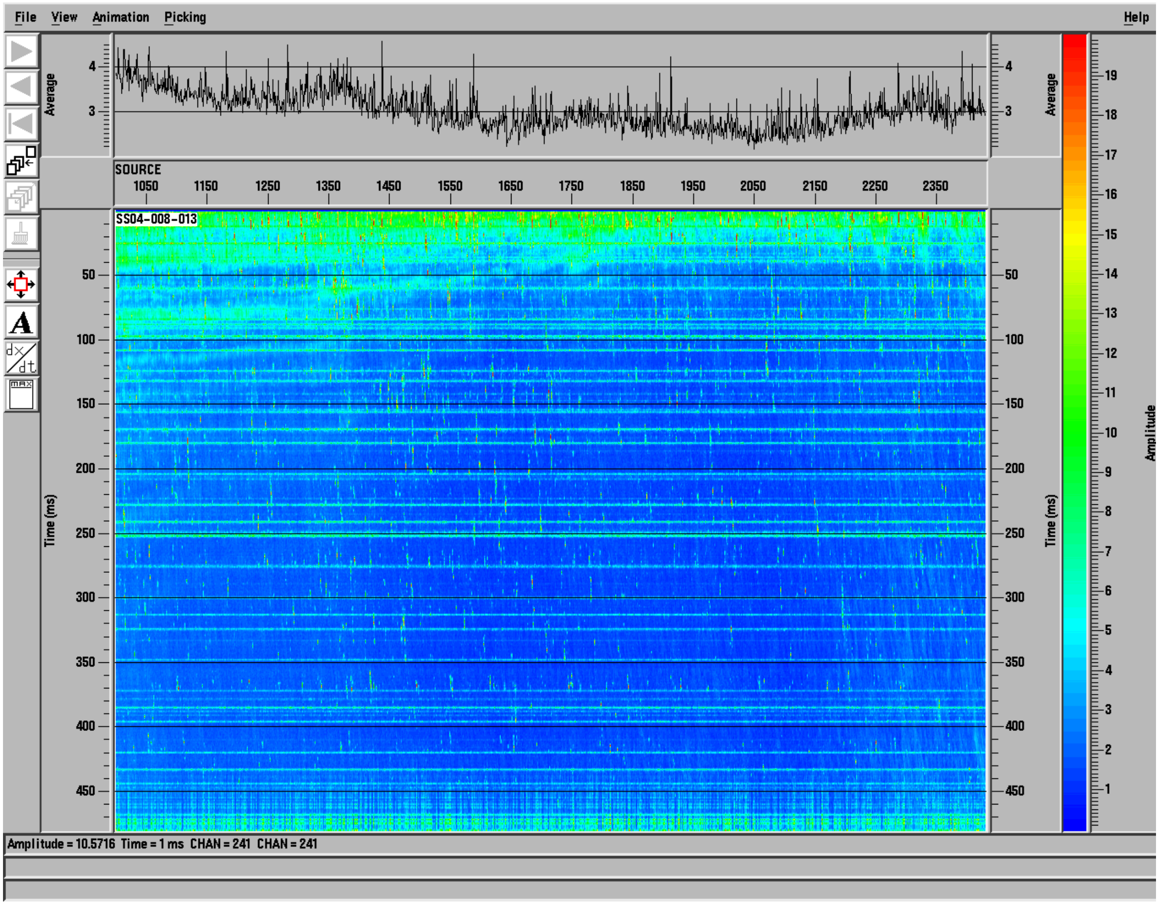

Figure 6 Ambient noise - shot vs. channel colour RMS Amplitude display. A quiet line (sequence 0013, SS04-008-013) with some residual seismic energy SP1001-1400, channels 1-100, and weak tail buoy tug noise.

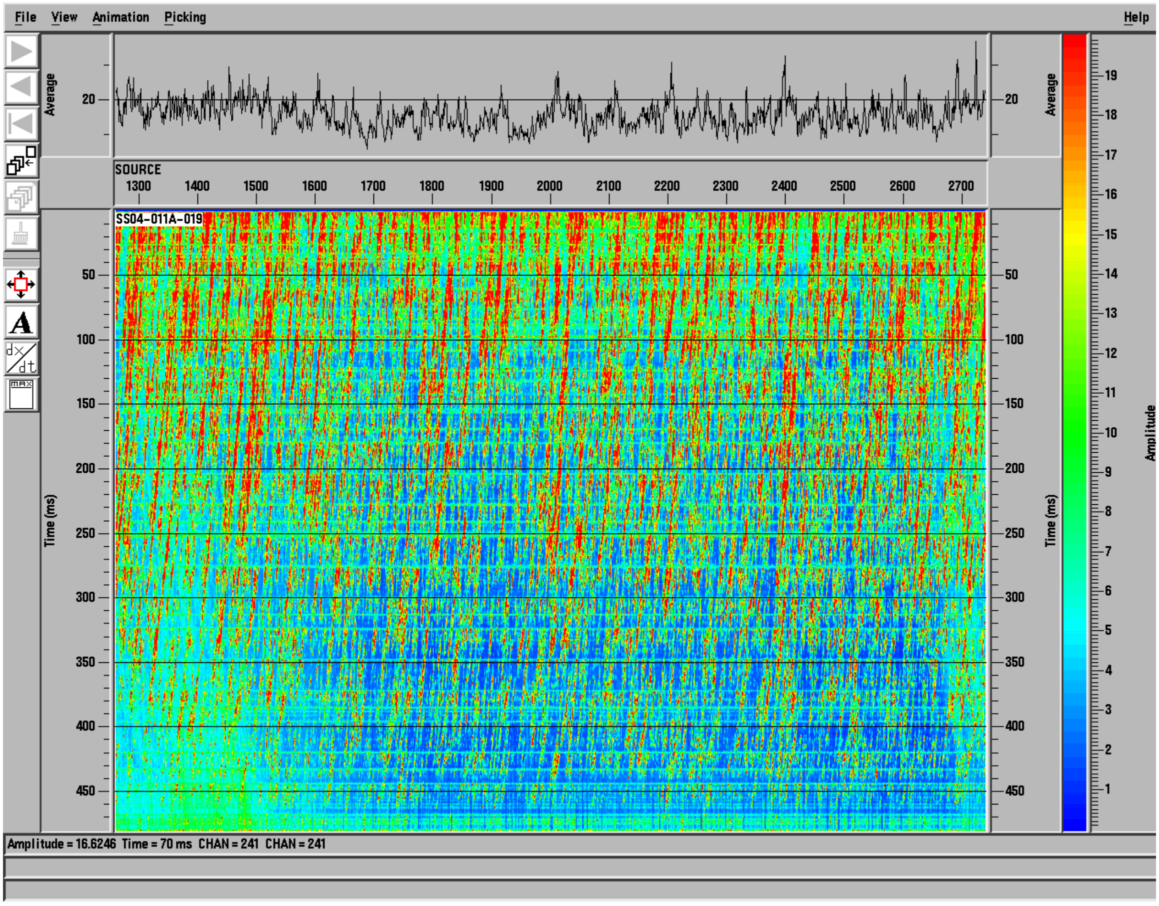

Figure 7 Ambient noise - shot vs. channel colour RMS Amplitude display. A noisy line (sequence 0019, SS04-011A-019) with swell noise throughout the line (red diagonal pattern), residual seismic (weak green in lower left corner).

The RMS amplitudes for each sequence (including ambient noise only) were combined to yield a sequence vs. channel RMS amplitude display. In this way it was possible to compare the sequences to one another and identify any swell noise increase or cable deterioration. This also proved to be an extremely useful method for QC'ing any dead, noisy or spiking channels sequence-to-sequence. See appendix for display.

3.5.3 Near Trace Display

Near traces were displayed on screen routinely at the end of each line. This proved useful in quickly determining any possible errors with acquisition. They revealed gun volume changes, bad records, time break problems and any auto fires not reported by the recording system. The near traces also provided a good indication of the geological conditions including strength of the water bottom multiples, remnant multiple interference and swell noise contamination.

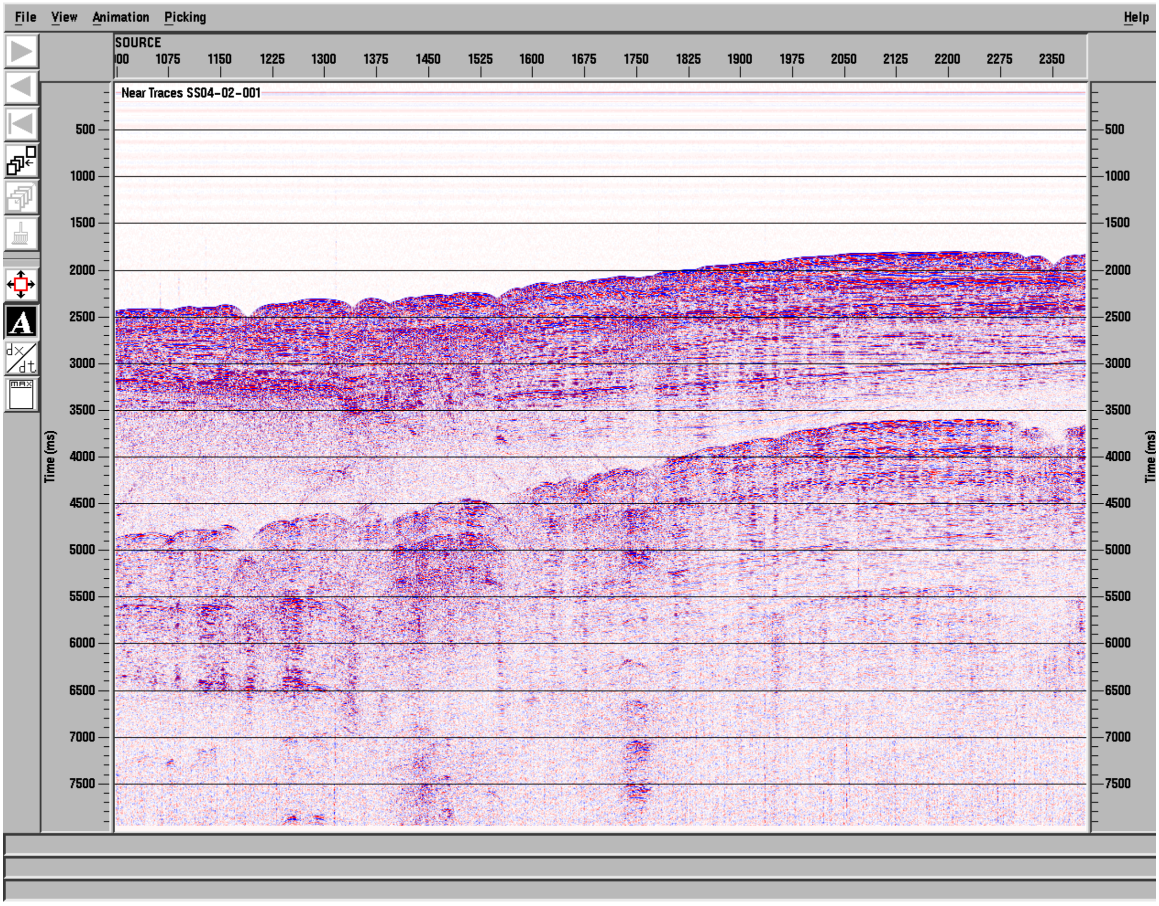

Figure 8 Near trace display (seq. 0001, SS04-002-001).

3.5.4 Auxiliary Channel QC

The 21 auxiliary channels loaded during the SEG-D read were separated from the 480 data channels, stored in a separate data file, and used for on screen analysis. These records consisted of the time break, the water break, and 9 near-field hydrophones for the three sub-arrays.

Time-break and water-break channels were displayed as a single trace display on screen.

Figure 9 Time-break, 50ms.

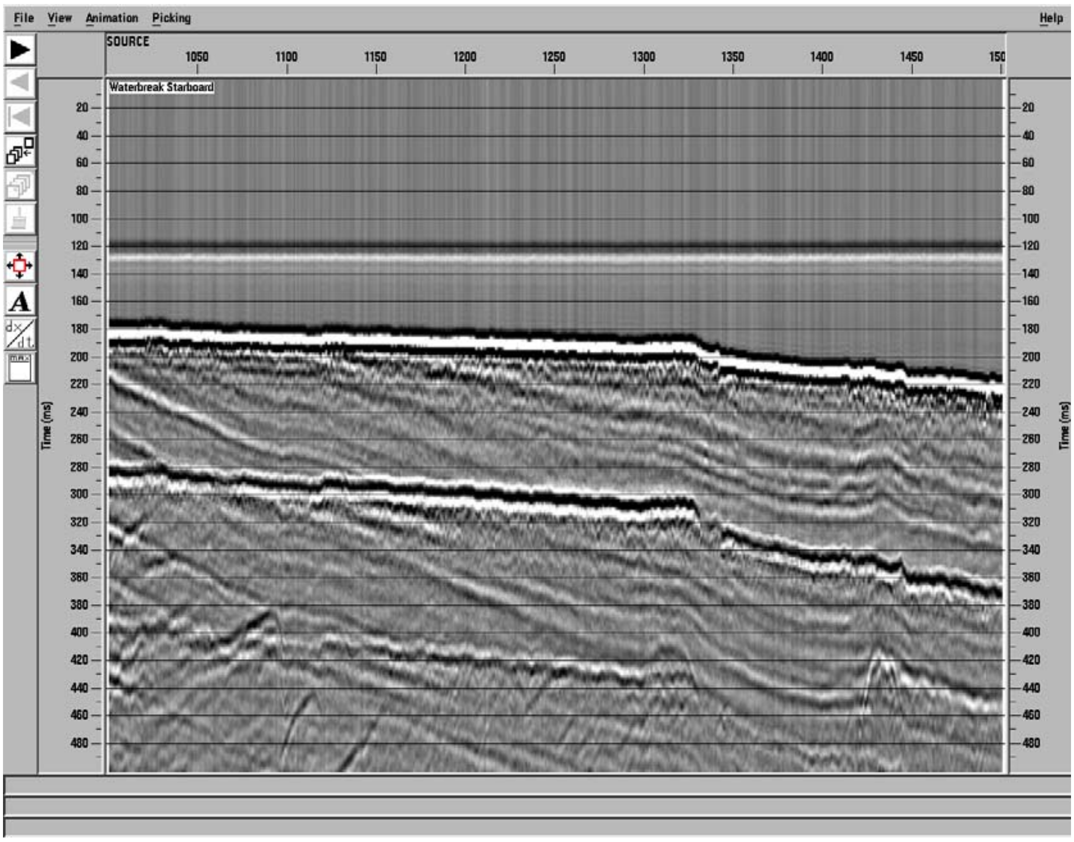

Figure 10 Water-break, 116ms.

Each gun hydrophone was also displayed as a single trace display on screen. Additionally, the first 500ms of the 3 hydrophones from a single sub-array were stacked vertically and displayed. This proved extremely useful in determining whether spurious signals were genuine gun timing problems or just electrical noise on the signal.

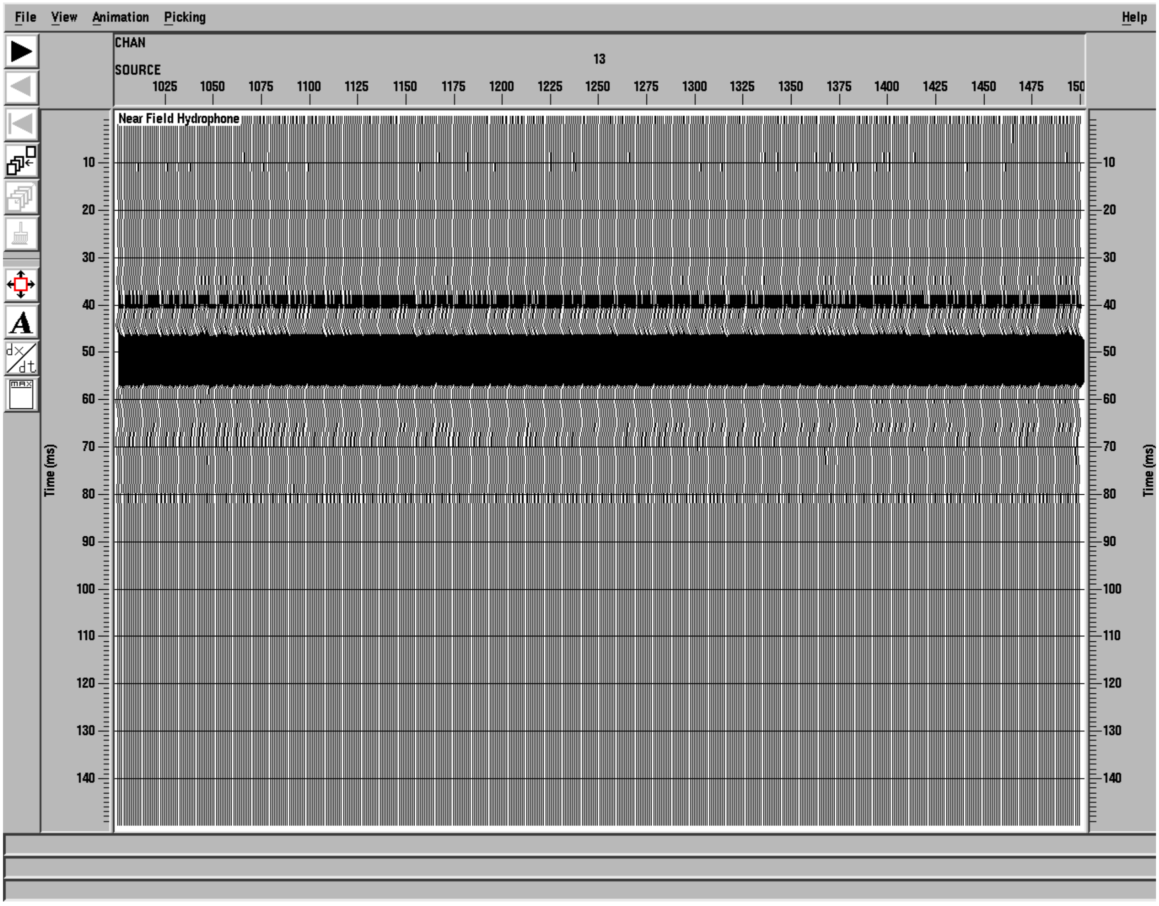

Figure 11 Near Field hydrophone, number 1 on starboard sub array, auxiliary channel 13.

3.5.5 Direct Arrival RMS

To confirm the consistency of the source strength, an amplitude analysis was performed over the direct arrival for the 10 first traces for all shots, and displayed as a function of source point. At the most shallow water depths seismic reflections were found to interfere and contaminate the direct arrival values.

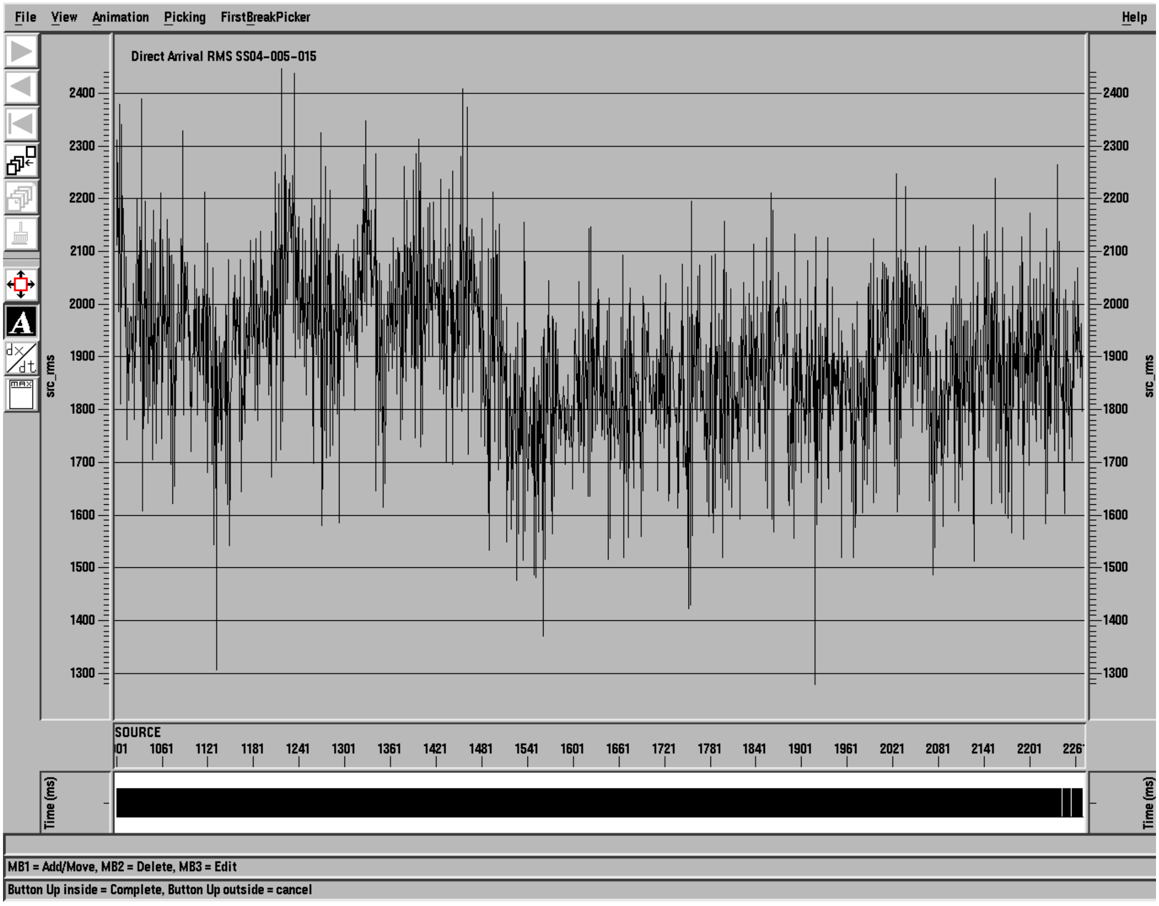

Figure 12 Direct arrival RMS.

3.5.6 Shot Record Displays

Shot records were filtered to the signal bandwidth and balanced with a true amplitude gain recovery. They were displayed on screen at 1 km intervals for each line. Individual records were examined on screen if an issue with acquisition was suspected, such as noise, residual seismic energy or auto-fires. The colour RMS displays were frequently used to pinpoint bad/suspicious shots, whose shot gathers were subsequently investigated on screen.

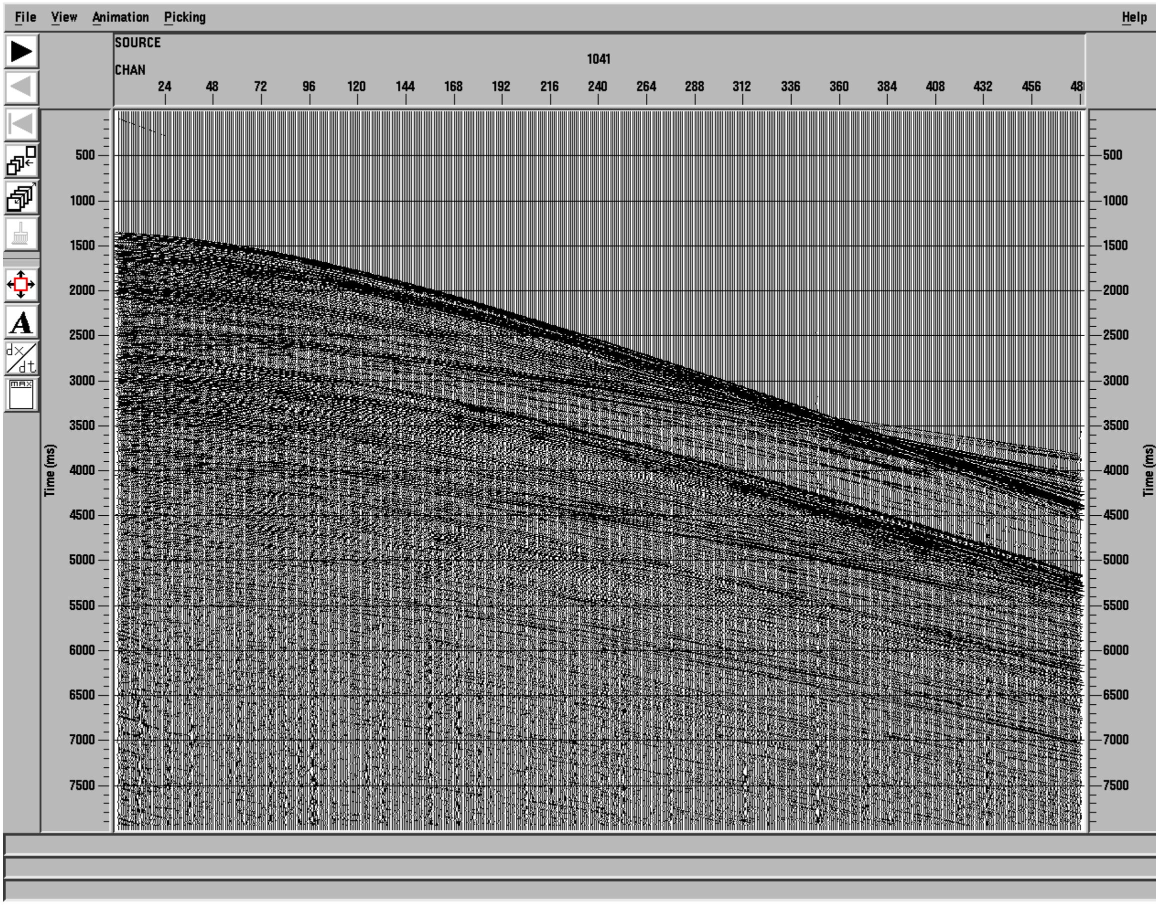

Figure 13 Shot gather. SP1041 sequence 6, SS04-015-006.

The raw shot displays could also be used to estimate the amplitude and amount of any external noise on the shot records prior to further processing. Consistently noisy channels were also identified on the raw shot displays, and any edited channels on the observer's logs were verified.

3.5.7 Additional QC Displays

Spectral analysis displays were generated for occasional lines to evaluate the power and frequency content of the data and noise. FK plots and FT displays were also occasionally displayed.

3.6 Navigation Processing

In order to QC navigation data, the final processed P190 navigation files were merged with the near trace for each line. The theoretical first break time was then computed using a water velocity of 1502m/s overlaid on the near trace as seen below.

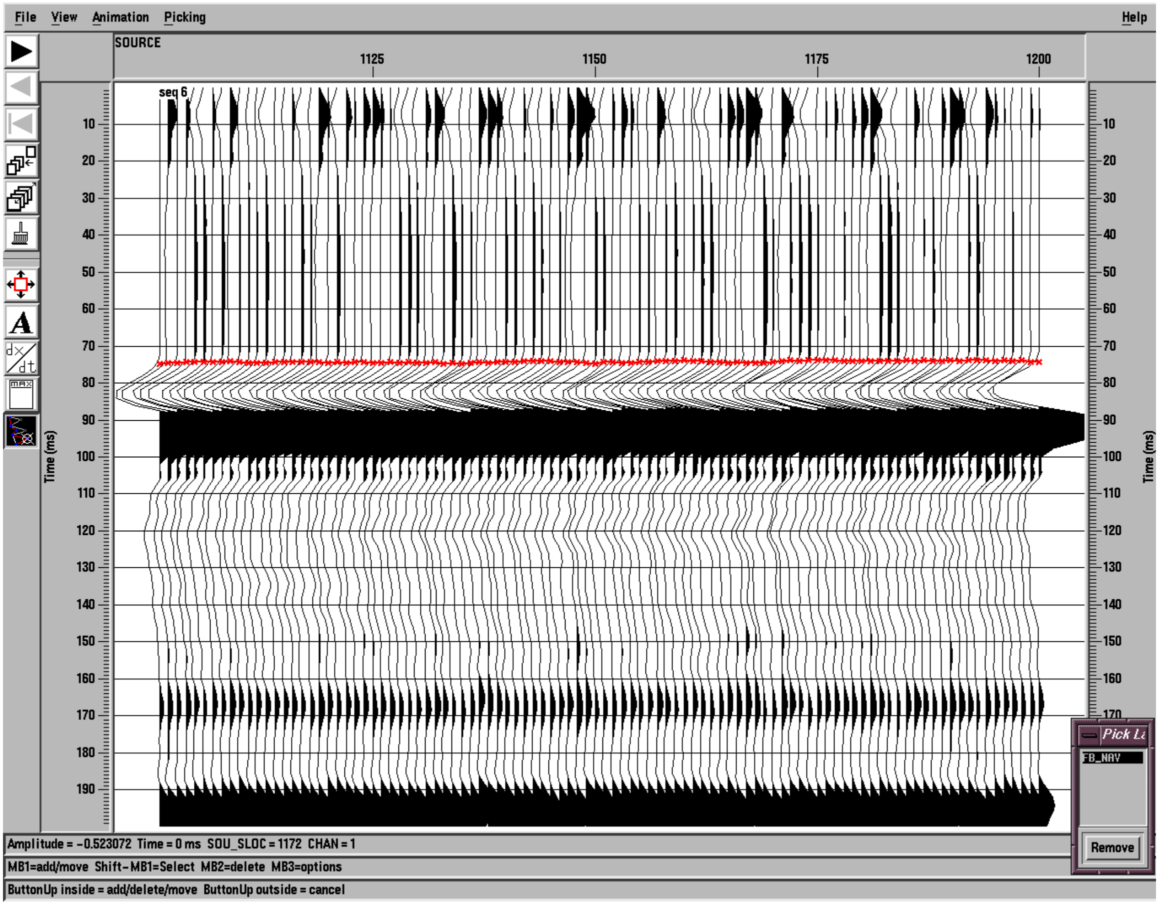

Figure 14 Navigation QC, checking the consistency between first breaks and navigation derived first breaks (red).

4 Summary

Throughout the survey, bad weather hampered production. On the best days, data quality was uniformly good and average noise levels were consistently around 3µB, however all lines were still deemed acceptable with higher average noise levels. The stacks of the noisier lines were surprisingly good with swell noise generally only visible below 3.5-4.0 seconds even for the worst cases. All brute stacks showed good data quality and contained amounts of reverberations, dipping surfaces, strong diffractions and strong multiples.

At sequences 9-19 weak tug noise from the tail buoy is present.

The seismic data is considered to be of good quality, somewhat affected by swell noise.

5 Appendices

5.1 Ambient noise history- Sequence Versus Channel Colour RMS Amplitude Display

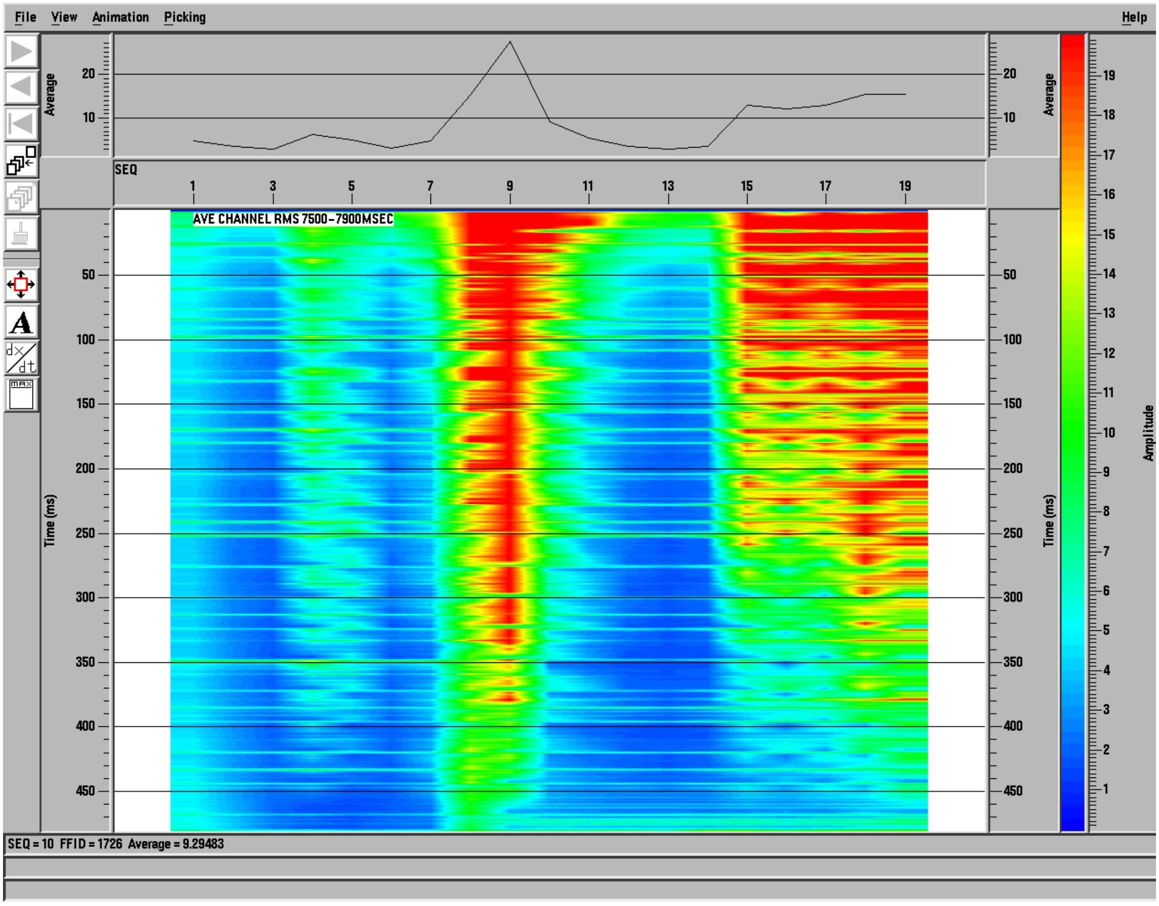

Figure 15 Final sequence vs. channel RMS display. A good tool for comparing noise levels sequence-to-sequence and identifying faulty channels.

5.2 ProMAX QC Log

Sequence	Line	Heading (°)	Date of shot	DATA QUALITY
0001	002	147	09.01.05	Noise rec's ave 3.1µB. Quiet line. Cable strikes SP991-ch356, SP1004-ch227. RMS level ave 4.9µB. Good clean stack.
0002	002A	147	09.01.05	Noise rec's ave 1.6µB. Very quiet line. Rare swell bursts. Good clean stack. RMS level ave 3.5µB.
0003	002B	147	09.01.05	Noise rec's ave 2.4µB. Quiet line. Screw noise ch1-50, ~SP5228-5240. Bend noise due to dog-leg, SP4022-4040, visible on stack 4000ms and down. Good clean stack. RMS level ave 2.9µB.
0004	019	065	09.01.05	Noise rec's ave 5.0µB. Moderate swell, visible on stack 4000ms and down. RMS level ave 6.4µB.
0005	017	245	10.01.05	Noise rec's ave 20.3µB. Swell, visible on stack 4000ms and down. RMS level ave 5.1µB.
0006	015	064	10.01.05	Noise rec's ave 3.1µB. Quiet line. RMS level ave 3.2µB. Bad SP1653-1665 d/t guns out of spec.
0007	013	244	10.01.05	Noise rec's ave 15.4µB. Slight swell throughout line. RMS level ave 4.8µB. Good stack, swell rarely visible 5000ms and down.
0008	011	064	10.01.05	Noise rec's ave 30.3µB. Swell throughout line, visible on stack 3500ms and down. RMS level ave 15.4µB. Line prematurely aborted due to weather.
0009	001	037	17.01.05	Noise rec's ave 33.1µB. Strong swell throughout line. RMS level ave 27.6µB. Swell affecting stack 4000ms and down. Direct Arrival RMS values contaminated by seismic reflection towards end of line. Weak tail buoy tug noise throughout line.
0010	010	152	17.01.05	Noise rec's ave 11.4µB. Swell throughout line. RMS level ave 9.3µB. Swell affecting stack 4500ms and down. Weak tail buoy tug noise throughout line.
0011	012	151	18.01.05	Noise rec's ave 6.2µB. RMS level ave 5.4µB. Swell visible on stack 4500ms and down. Weak tail buoy tug noise throughout line.
0012	006	332	18.01.05	Noise rec's ave 3.1µB. Quiet line. Occasional swell bursts. RMS level ave 3.7 µB. Good clean stack, some swell noise visible 6000ms and down. Weak tail buoy tug noise throughout line.
0013	008	152	18.01.05	Noise rec's ave 2.8µB. Quiet line. Occasional swell bursts. RMS level ave 3.0µB. Good clean stack. Weak tail buoy tug noise throughout line.
0014	004	332	18.01.05	Noise rec's ave 3.3µB. RMS level ave 3.5µB. Weak tail buoy tug noise throughout line. Good clean stack.
0015	005	064	19.01.05	Noise rec's ave 13.5µB. Swell noise throughout line. RMS level ave 12.9µB. Weak tail buoy tug noise throughout line. Swell visible on stack 4000ms and down.
0016	003	245	19.01.05	Noise rec's ave 23.6µB. Swell noise throughout line. RMS level ave 12.1µB. Swell visible on stack 4000ms and down. Weak tail buoy tug noise throughout line.
0017	007	064	19.01.05	Noise rec's ave 13.6µB. Strong swell noise throughout line. RMS level ave 12.9µB. NB Gun constellation change, especial SP1031-1032 BAD, see obs log. Swell visible on stack 4000ms and down. Weak tail buoy tug noise throughout line.
0018	009	245	19.01.05	Noise rec's ave 65.6µB. Swell noise throughout line. RMS level ave 15.1µB. Cable turn noise at SOL. Swell visible on stack 3500ms and down. Weak tail buoy tug noise throughout line.
0019	011A	243	19.01.05	Noise rec's ave 18.8µB. Swell noise throughout line. RMS level ave 15.5µB. Swell visible on stack 4000ms and down. Weak tail buoy tug noise throughout line.

5.3 Shipments

One shipment (Proforma Invoice & Packing List **PT-2005-018**) was made upon completion of the survey; 21st. of January 2005, and sent to:

Santos – SS04 Survey
Robertson Research Australia Pty Ltd
69, Outram Street
West Perth
WA 6005

Att: Simon Stewart

Contents:

Brute stack plots (raw), sequences 1-19
AGC brute stack plots, sequences 20-38
DVD Final QC deliverables containing brute stacks (SEG-Y and GIF), all RMS displays (GIFS), all Near Trace Displays (GIFS), all velocities (ASCII files), and the QC processing log.xls spreadsheet.
3590 tape Final QC deliverables containing brute stacks (SEG-Y and GIF), all RMS displays (GIFS), all Near Trace Displays (GIFS), all velocities (ASCII files), and the QC processing log.xls spreadsheet.

For details: See copy in Section 2, §6 page 17