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1 Onboard Processing Personnel and System

Operators

Senior Geophysicist

21st Jan. – 08th Feb. 2005	:	Emma Buckingham	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 305 surface kilometres of 2D seismic data in the Gippsland area - offshore eastern Victoria, 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. 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 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), 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 and end 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 simple 2D geometry was merged with all the seismic trace data and offset/CDP binning calculations loaded into the seismic trace headers, before the process of 2:1 summation.

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 a series of 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.

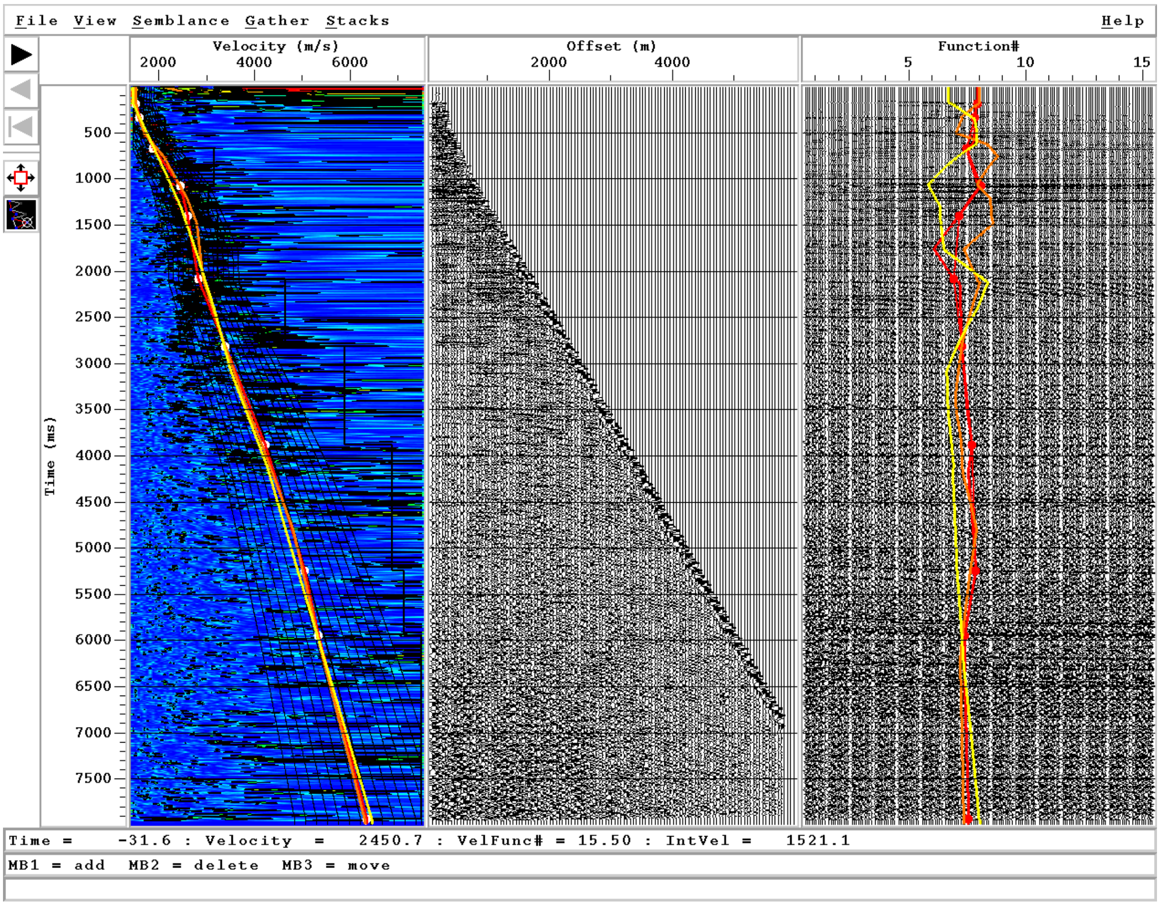

Figure 1 Velocity analysis interface with semblance, super-cdp gather and function stacks (orange - previous, red - present, yellow - next pick) (seq. 001, GISN05-27-01-001).

Velocities were picked using a two pass process. 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.

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.

After velocity picking, velocities were viewed and QC'ed on screen using the ProMAX velocity viewer module, which provided an iso-elocity 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.

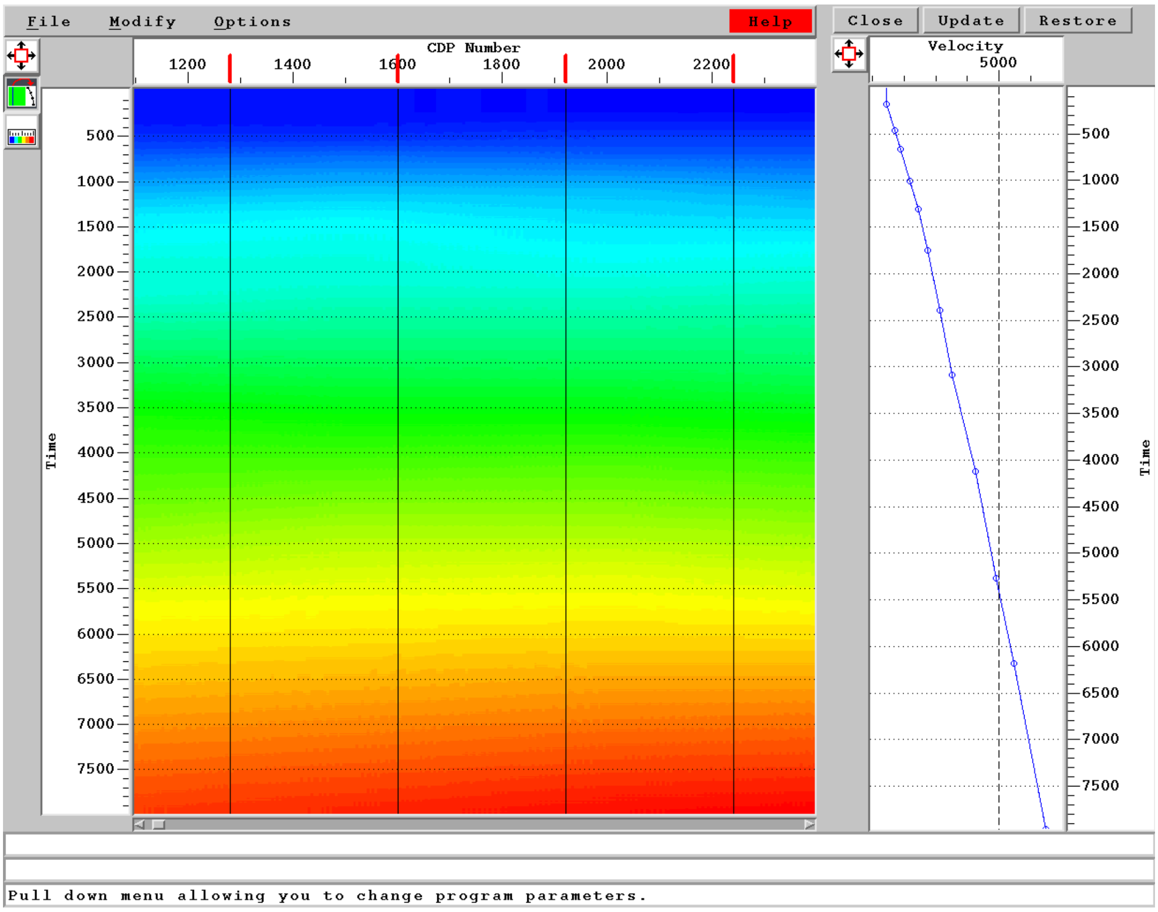

Figure 2 Iso-velocity display in ProMAX velocity viewer (seq. 001, GISN05-27-01-001).

3.3.1 CDP Gather Displays

Gathers were regularly displayed on screen at four kilometre intervals to QC the velocities after NMO correction and 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.

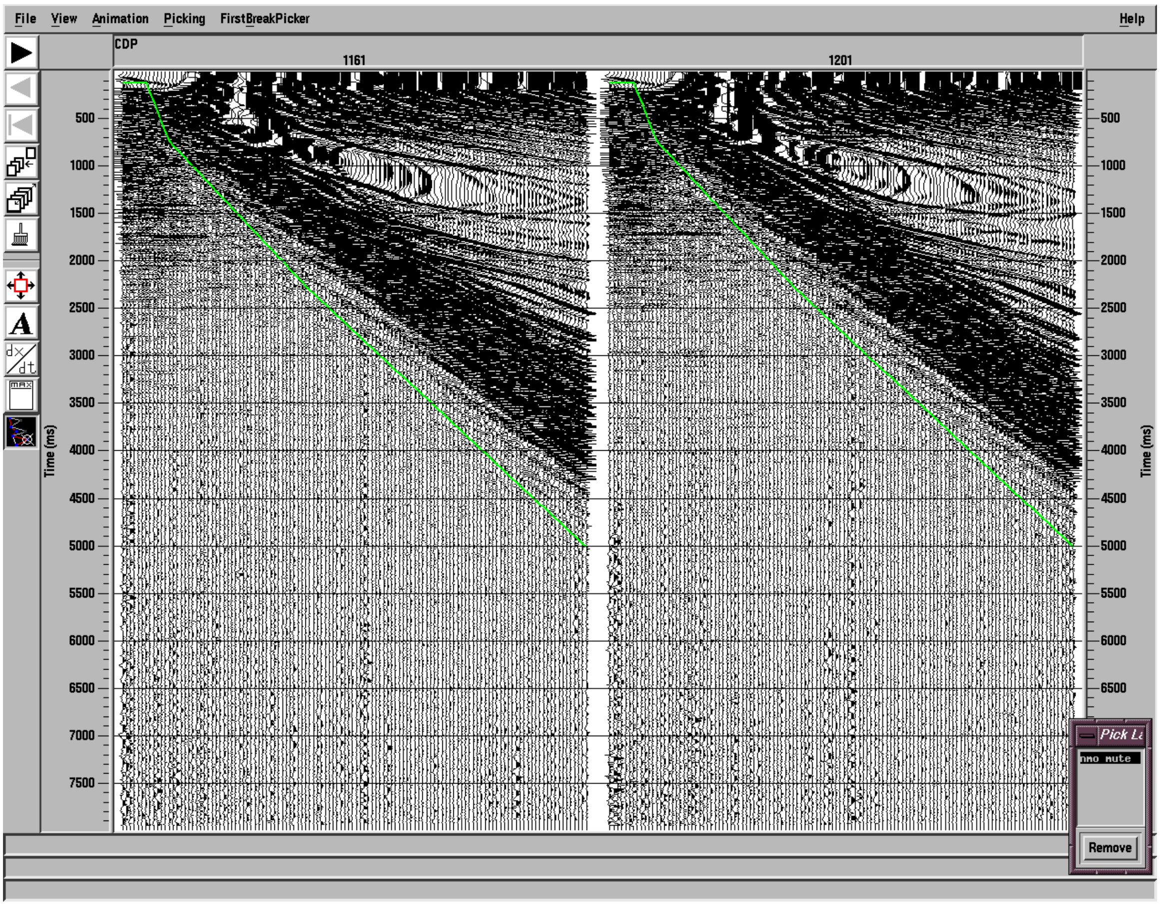

Figure 3 CDP gather (seq. 001, GISN05-27-01-001) to confirm the velocity picks.

3.3.2 Brute Stack

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.

Since amplitudes appeared well-balanced, scaling was limited to overall scaling for the plots.

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

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

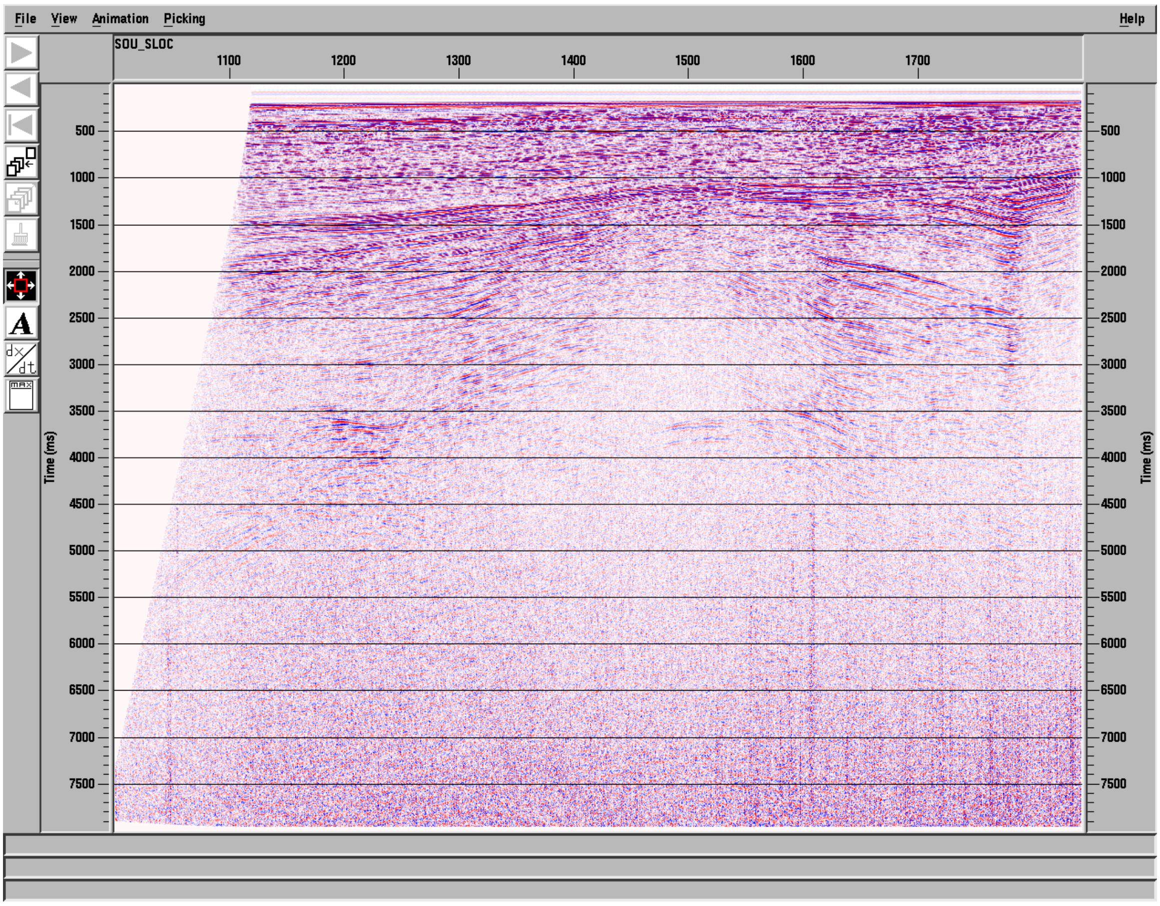

Figure 4 Brute stack seq. 001, GISN05-27-01-001

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 also 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
↓ 1 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

3.5 Acquisition QC Processing

3.5.1 Noise Record RMS

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

3.5.2 Ambient noise - Shot Versus Channel Colour RMS Amplitude Display

Colour 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 7500-7900ms.

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

The colour 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 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 QC log spreadsheet.

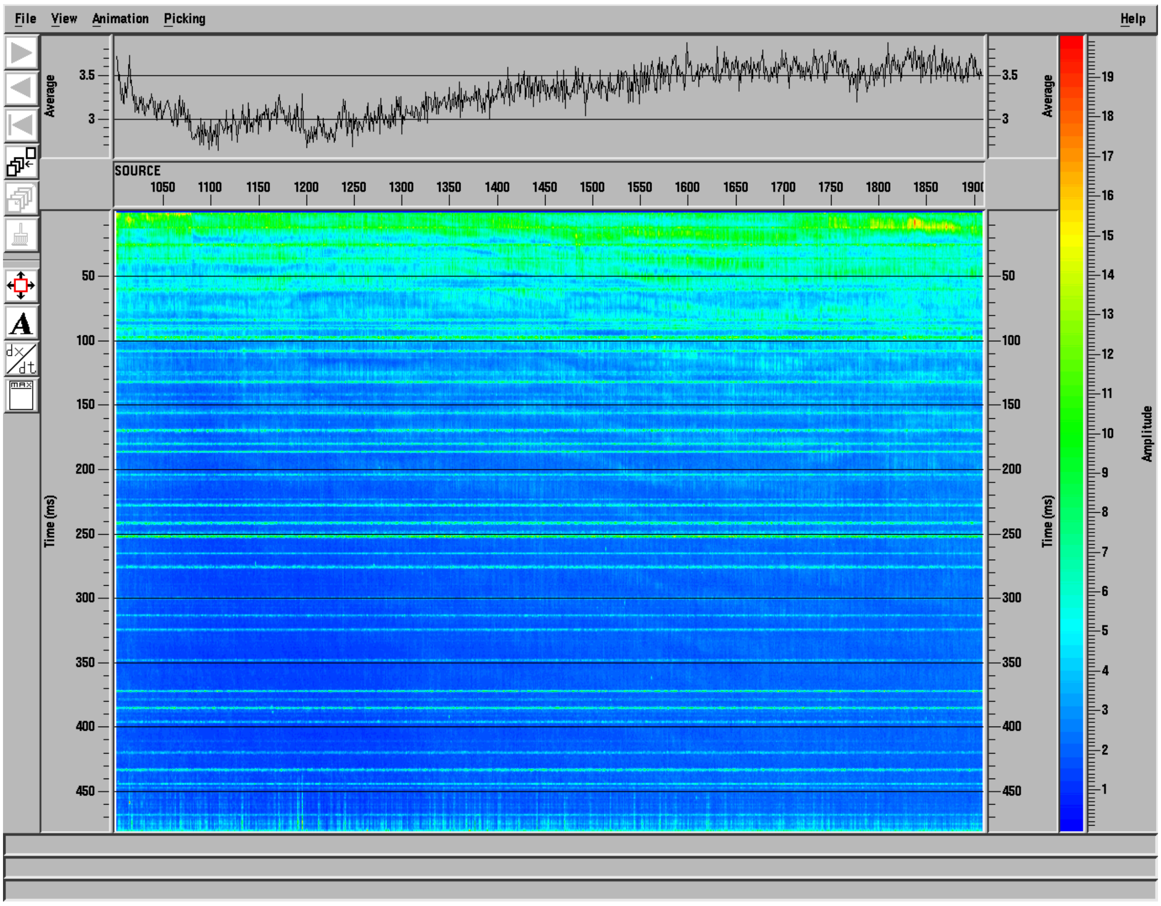

Figure 5 Ambient noise - shot vs. channel colour RMS Amplitude display. A quiet line (sequence 012, GISN05-03-01-012).

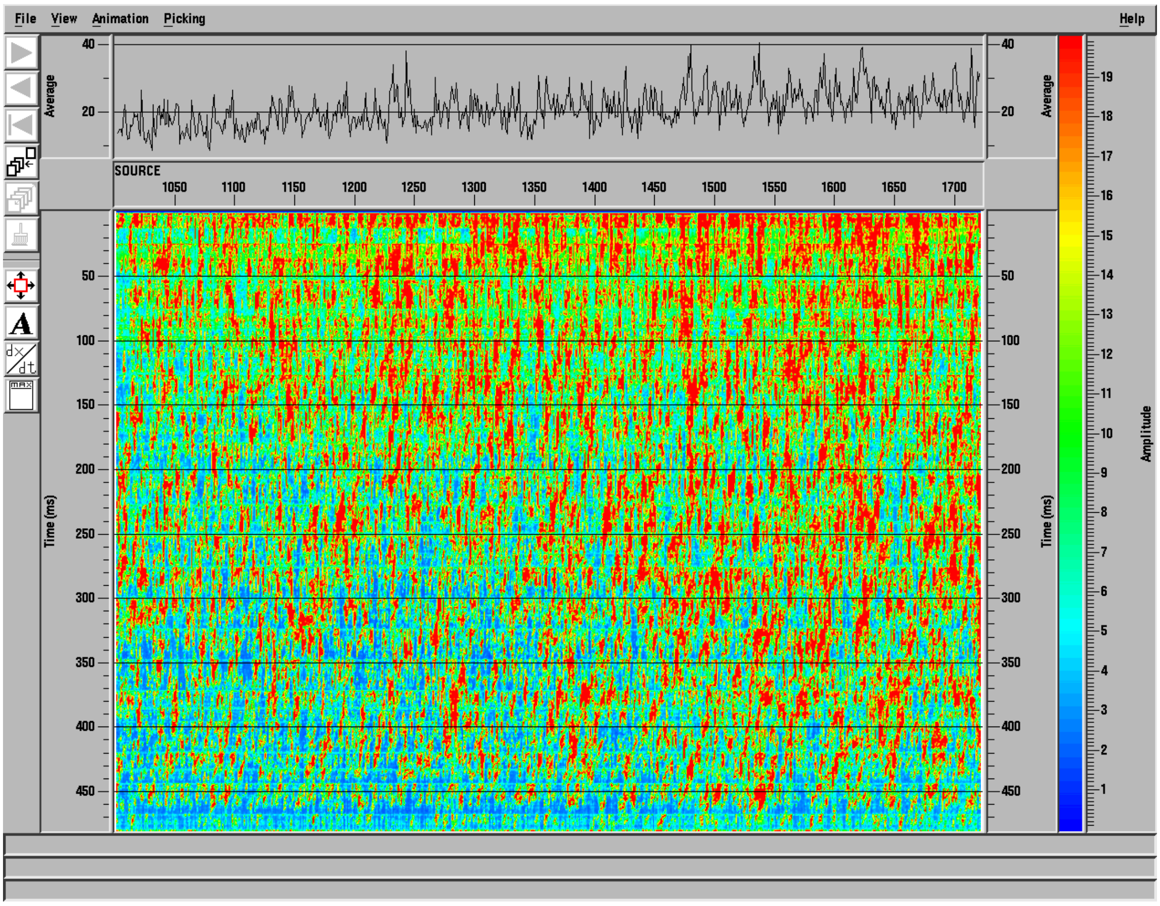

Figure 6 Ambient noise - shot vs. channel colour RMS Amplitude display. A noisy line (sequence 006, GISN05-21-01-006) with swell noise.

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 for every line in order to quickly determine any possible errors with acquisition, e.g. 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, residual seismic multiple energy and swell noise contamination.

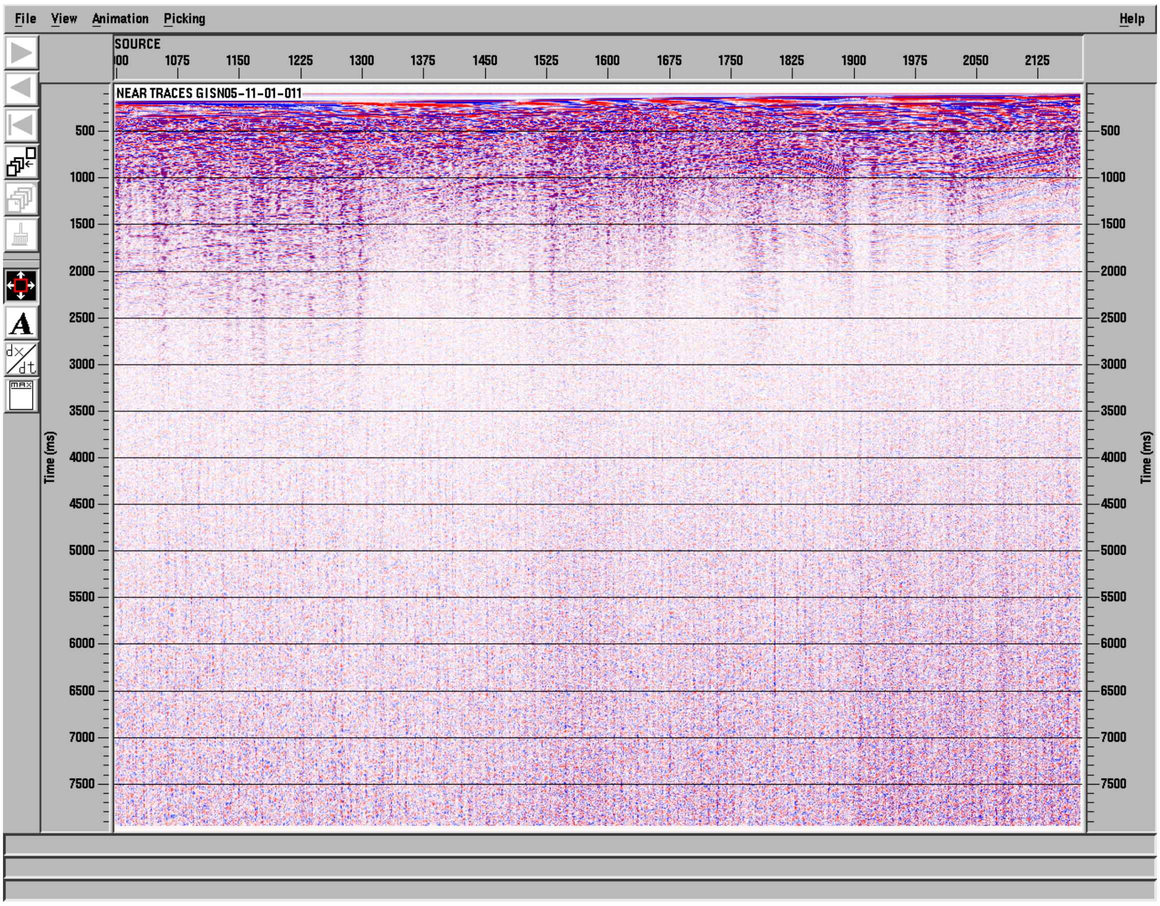

Figure 7 Near trace display (seq. 011, GISN05-011-01-011).

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 8 Time-break, 50ms.

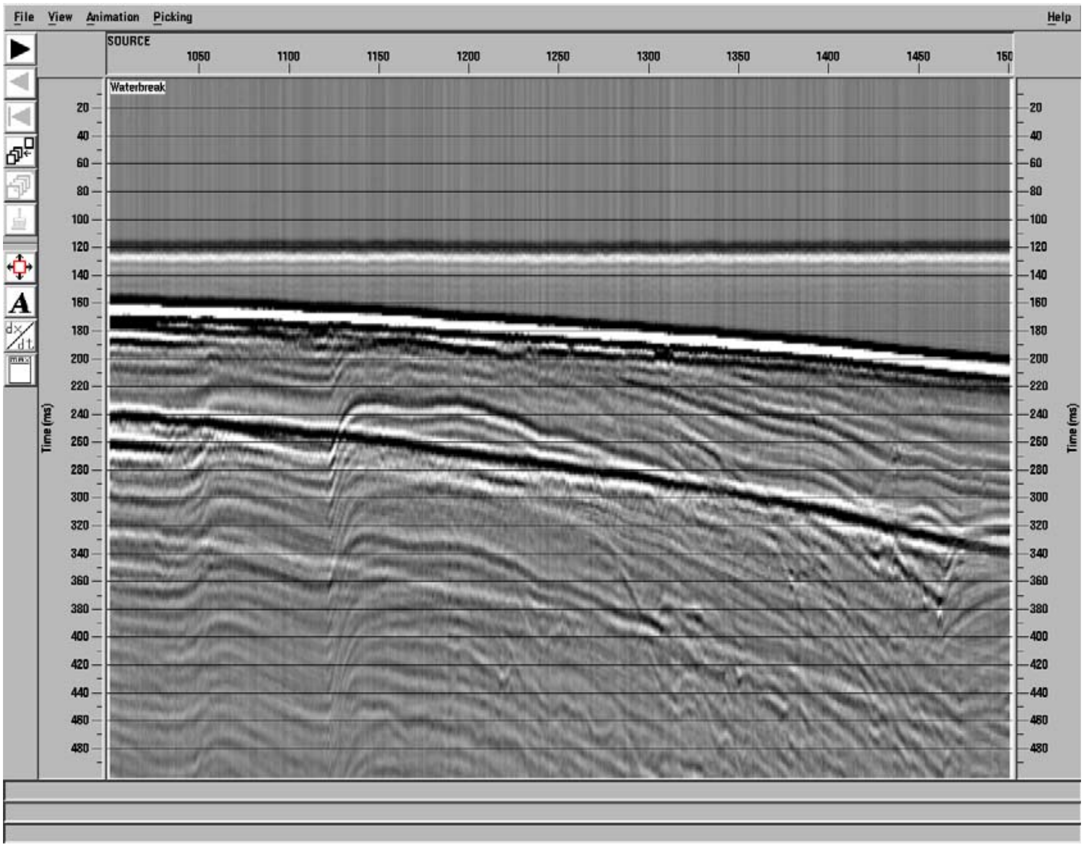

Figure 9 Water-break.

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.

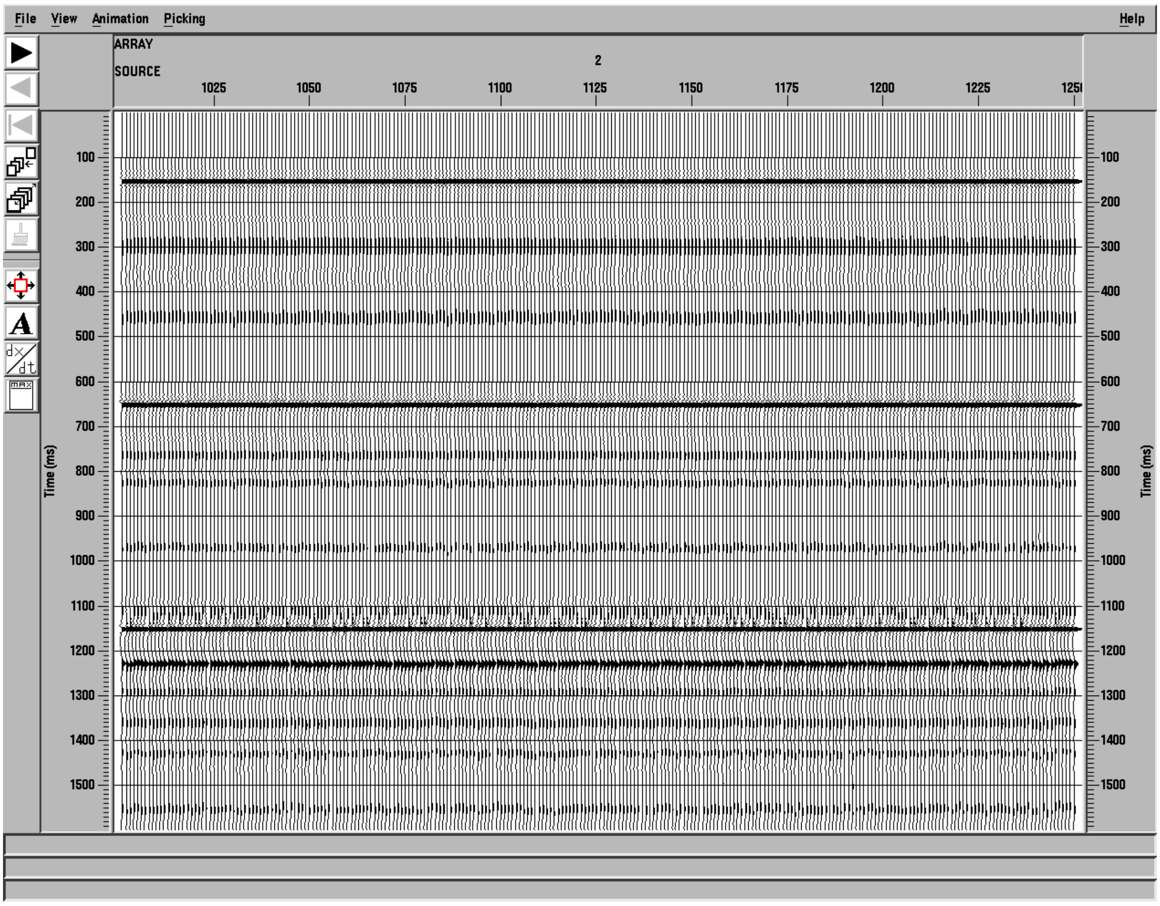

Figure 10 Auxiliary QC, Array 2, 3 near field traces.

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. In this area of shallow water depths seismic reflections were found to interfere and contaminate the direct arrival values.

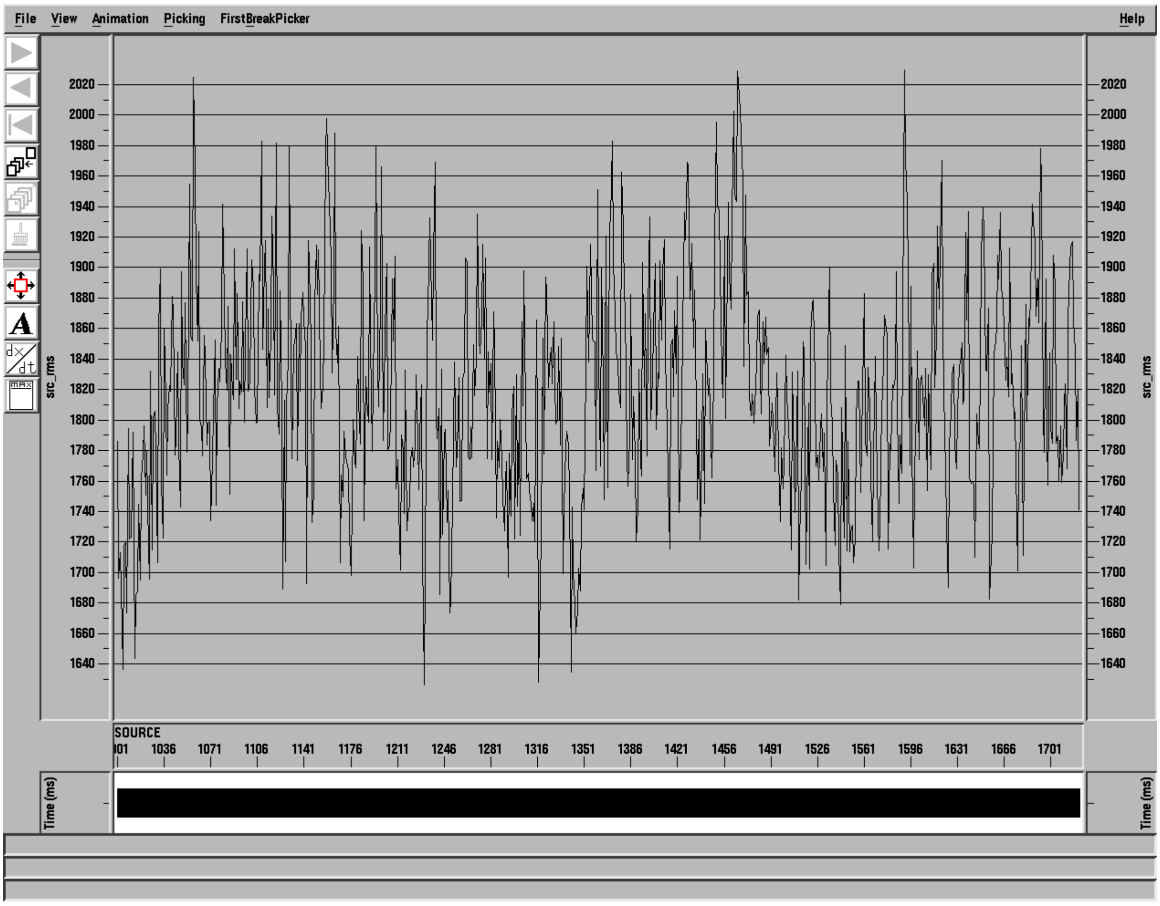

Figure 11 Direct arrival RMS.

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.

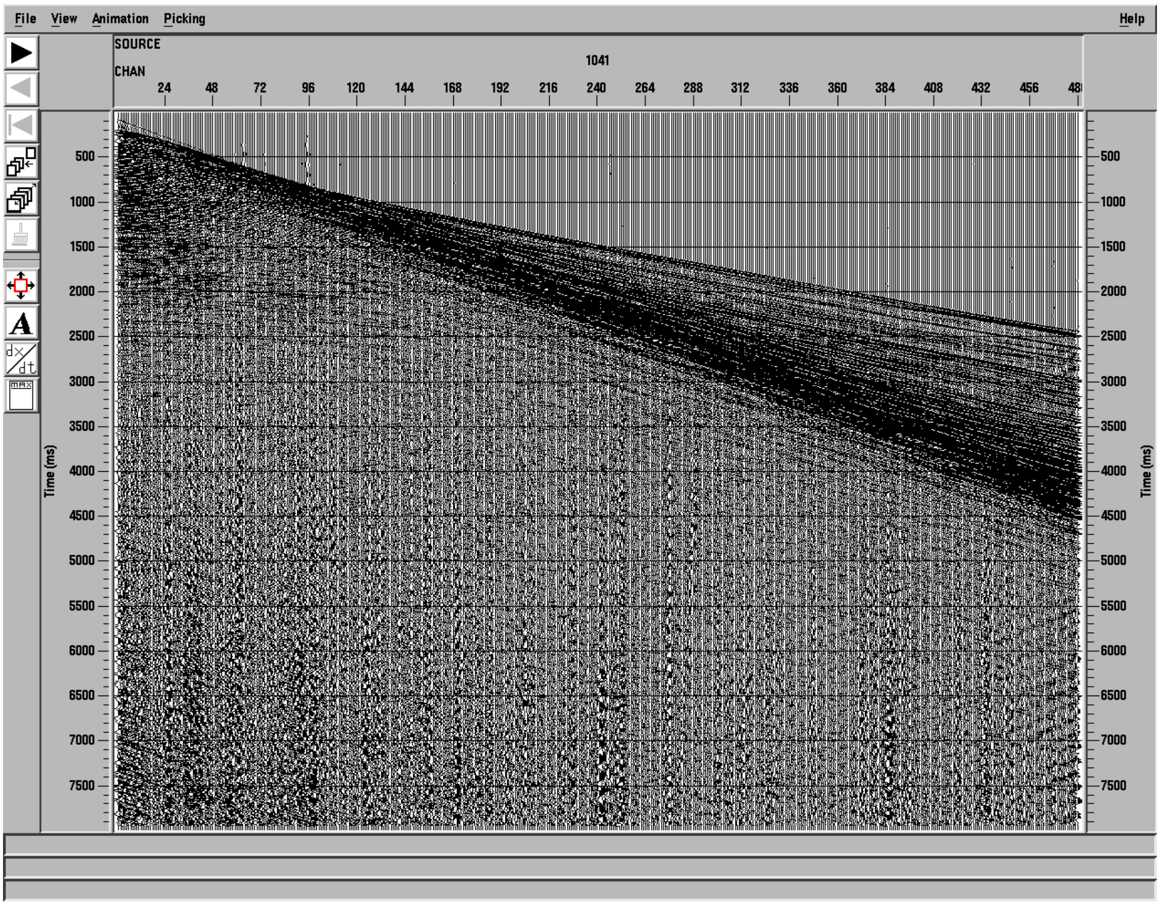

Figure 12 Shot gather. SP1041 sequence 001, GISN05-27-01-001.

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 1520m/s overlaid on the near trace as seen below.

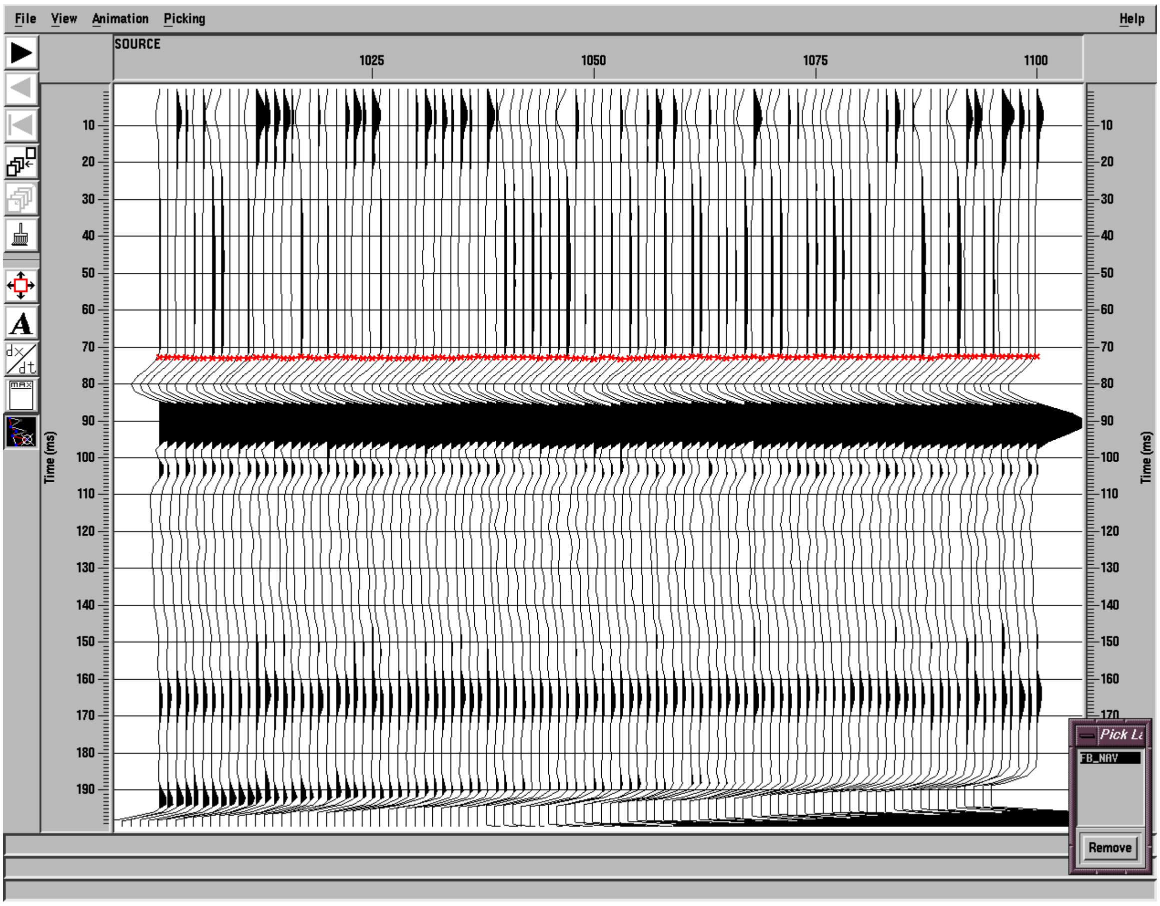

Figure 13 Navigation QC, checking the consistency between first breaks and navigation derived first breaks (red).

4 Summary

The overall quality of the data was of a high standard. Random swell bursts were prominent throughout the survey, with bad weather affecting at the worst sequences 006 and 009 with rms levels up to 35 µb, though stacks were still of good quality. Average noise levels were consistently of 3-5 µb. All brute stacks showed good data quality with structure visible down to 7.5 seconds.

Sequence 002 was NTBP due to the towing and gun geometry collapsing.

For sequences 006, 007, 009 and 010 the streamer depth was lowered to 8m.

A complete list of all lines is included in Appendix 5.2.

5 Appendices

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

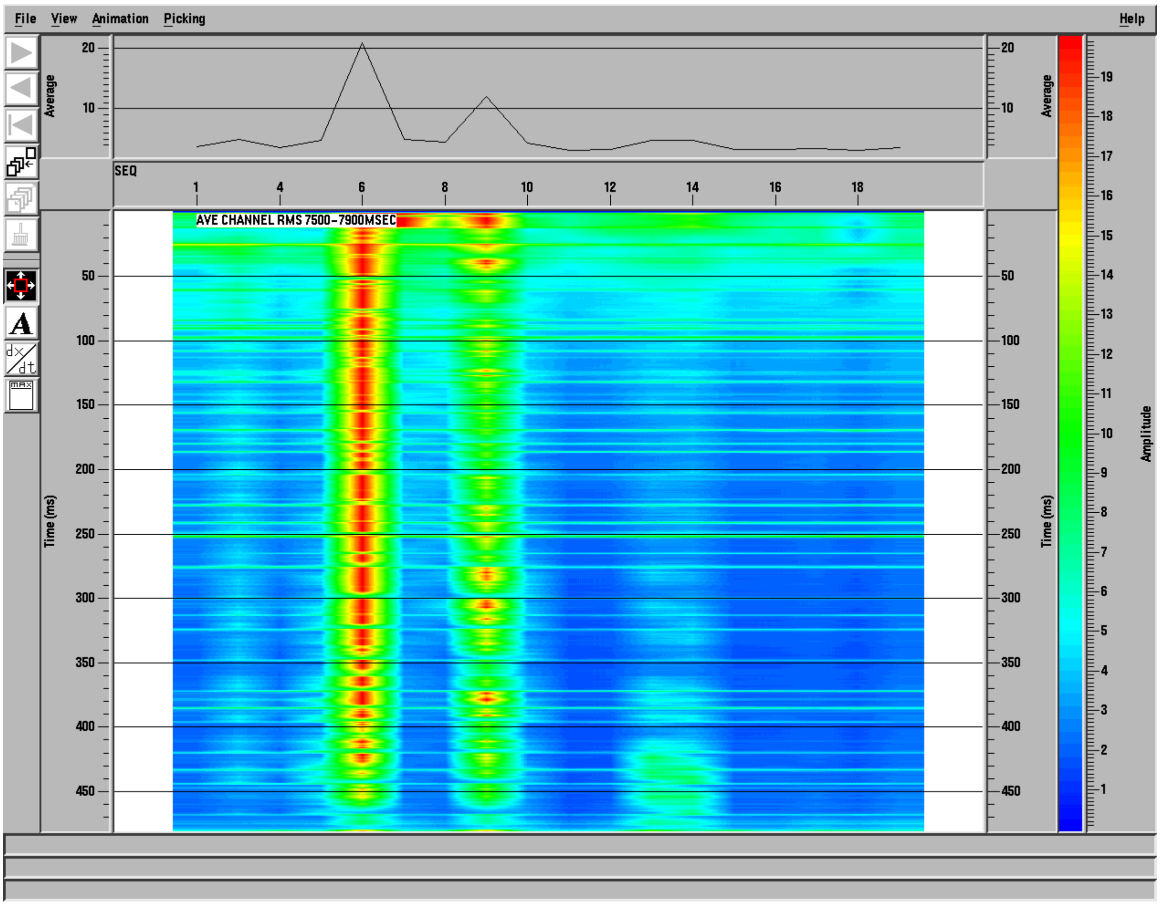

Figure 14 Final sequence vs. channel RMS display. A good tool for comparing noise levels sequence-to-sequence and identifying faulty channels.

5.2 ProMAX QC Log

Sequence	Line	Heading (°)	Date of shot	Noise level @ SOL [µB]	DATA QUALITY	Ambient RMS average µB
001	27-Jan	360	02/04/2005	3.5	Good stack. Occasional swell noise throughout line, random bursts on stack seen below 4.5 secs. Higher amplitudes seen on front 50 chans d/t front end noise	3.6
002	23-Jan	NTBP	02/05/2005		NTBP d/t towing/gun geometry collapsed	
003	23-Feb	180	02/05/2005	5	Increase in swell noise affecting stack below 4.5 secs. Good stack otherwise. Front end noise evident in rms. Chan 25 noisy.	5
004	19-Jan	360	02/05/2005	5	Good clean stack. Some tugging noise evident at SOL and EOL. Diffractions seen in stack around sp: 1500. High front end noise and occasional swell bursts seen in rms. Chan 25 noisy.	3.6
005	25-Jan	180	02/05/2005	4	Swell noise affecting up to 10% of traces, max rms 12ub. Ships noise evident in stack, below 5.5 secs from SOL-1200. Chan 25 noisy.	4.8
006	21-Jan	360	02/05/2005	37	Swell noise affecting up to 60% of traces. Max rms 40ub. Stack thoroughly affecting by swell for whole of line, below 2 secs. Line accepted,	21
007	02-Jan	296	02/05/2005	6	Bird 1 shallow throughout line, increasing front end noise affecting 12 chans. Chan 25 noisy. Swell noise affecting 4% of traces seen in stack below 2 secs. Stack ok. Max rms 10ub.	5
008	04-Jan	116	02/06/2005	3.6	Bird 1 shallow throughout line, increasing front end noise. Chan 25 noisy. Swell noise on up to 6% of traces, seen below 3 secs on stack. Deep structure seen below 6-7 secs in stack.	4.5
009	13-Jan	360	02/06/2005	20	Increase in swell noise. Up to 35% of traces affected, max rms of 25ub. Below 2 secs on stack. Chan 25 noisy.	12
010	17-Jan	180	02/06/2005	5	Swell noise affecting up to 10% of traces, decreasing towards end of line. Good stack. Front strumming noise seen on stack at EOL.	4.3
011	11-Jan	360	02/06/2005	3	Good clean stack with strong structure, refractions and reflections. Also seen in rms. Chan 25 noisy.	3
012	03-Jan	211	02/07/2005	3.5	Chan 25 and 252 noisy. Quiet line, good clean stack with strong refractions at SOL. Deep reflectors seen in stack and rms.	3
013	07-Jan	031	02/07/2005	4	Swell throughout line below 4.5 secs on stack, affecting most the far traces. Chan 25 and 252 noisy.	4.7
014	01-Jan	211	02/07/2005	4.5	Swell affecting up to 5% of traces. Seen below 5 secs in stack. Structure still visible in deep, good stack. Chan 25 + 252 noisy.	4.7
015	05-Jan	031	02/07/2005	3.4	Clean and quiet line. Burst on rms ~sp1596. Good deep structure seen in stack. Strumming noise apparent in stack. Chan 25 + 252 noisy	3.3
016	15-Jan	180	02/07/2005	3.6	Good clean stack. Deep structure seen as a higher level of rms from ambient noise on near channels on rms plot. Occasional swell burst on far channels. Chan 25 + 252 noisy.	3.3
017	09-Jan	360	02/07/2005	3	Spiky chan seen in stack, sp 1628 due to Cable impact. Strong diffractions seen at SOL for far chans on rms and stack. Good clean stack with good structure. Random occasional bursts of swell seen in rms. Noisy chans: 25 and 252.	3.4
018	08-Jan	090	02/08/2005	3	Good clean stack. Minor swell bursts seen on rms. Noisy chans: 25 and 252	3.1
019	06-Jan	270	02/08/2005	5	Good stack. At SOL tail end of streamer in bend seen on rms and stack affecting last 10 chans. Swell noise from occasional bursts increasing from sp1525-EOL. Bursts seen in stack below 4.5 secs. Noisy chans 25 and 252.	3.5

5.3 Shipments

One shipment was made completion of the survey, February 2005.

To:
Santos - GISN05 Survey
Level 29 Sabtos House
91 King William Street
Adelaide, SA 5000
Australia

Attn: John Hughes

Contents:
Brute stack plots, sequences 1-19
Final QC deliverables on CD containing
brute stacks (SEG-Y and GIF), RMS displays (GIFS), Near Trace Displays (GIFS), velocities (ASCII files), and the QC processing log.xls spreadsheet.
3590 tape Final QC deliverables containing
brute stacks (SEG-Y)