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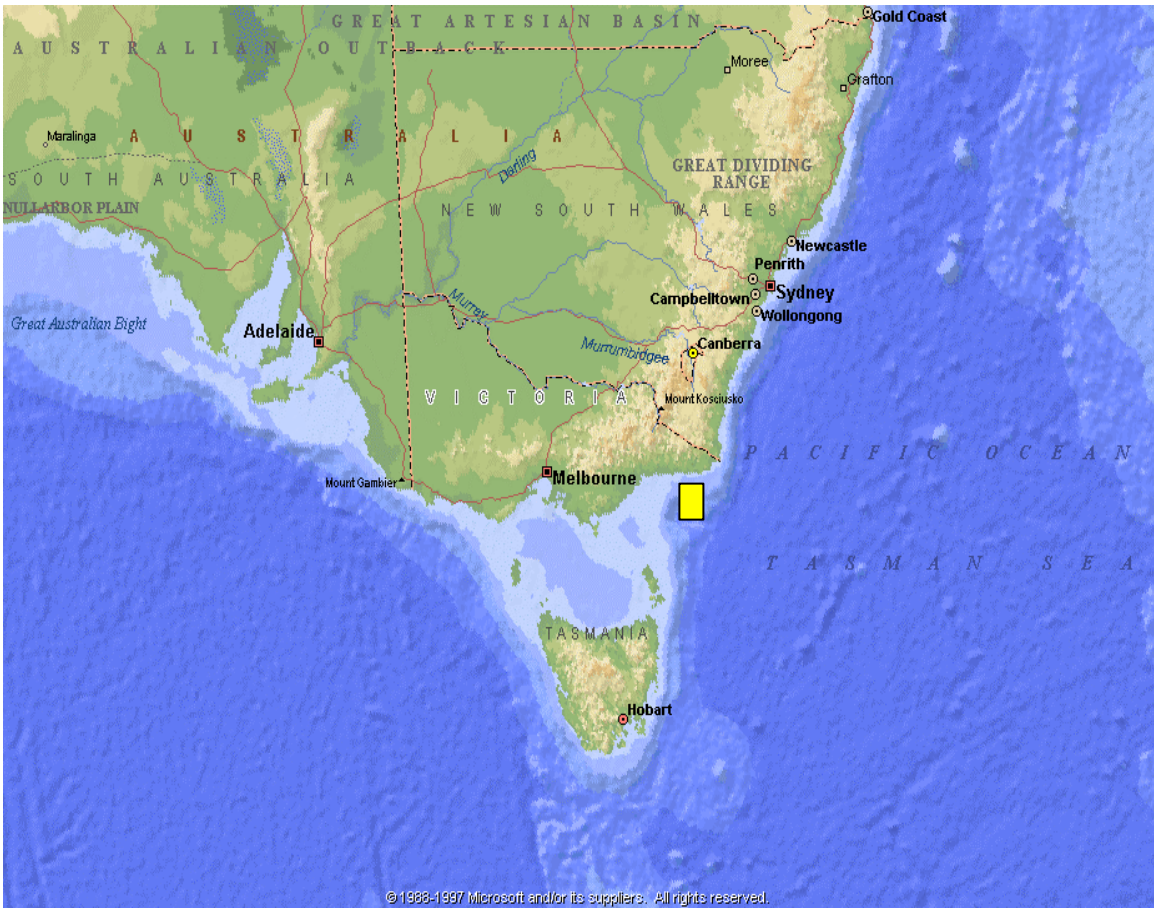
1. Survey Information and Objectives

This program for **Bass Strait Oil Company**, under the auspices of **Santos Limited** (Australia), comprised 203.7 full fold Km of 2D seismic in Victorian waters of Block VIC/P41. Water depths range from 100 to 1700m. The programme consisted of 4 strike lines and 4 dip lines. The dip lines ran North to South with the northern ends of lines running close inshore.

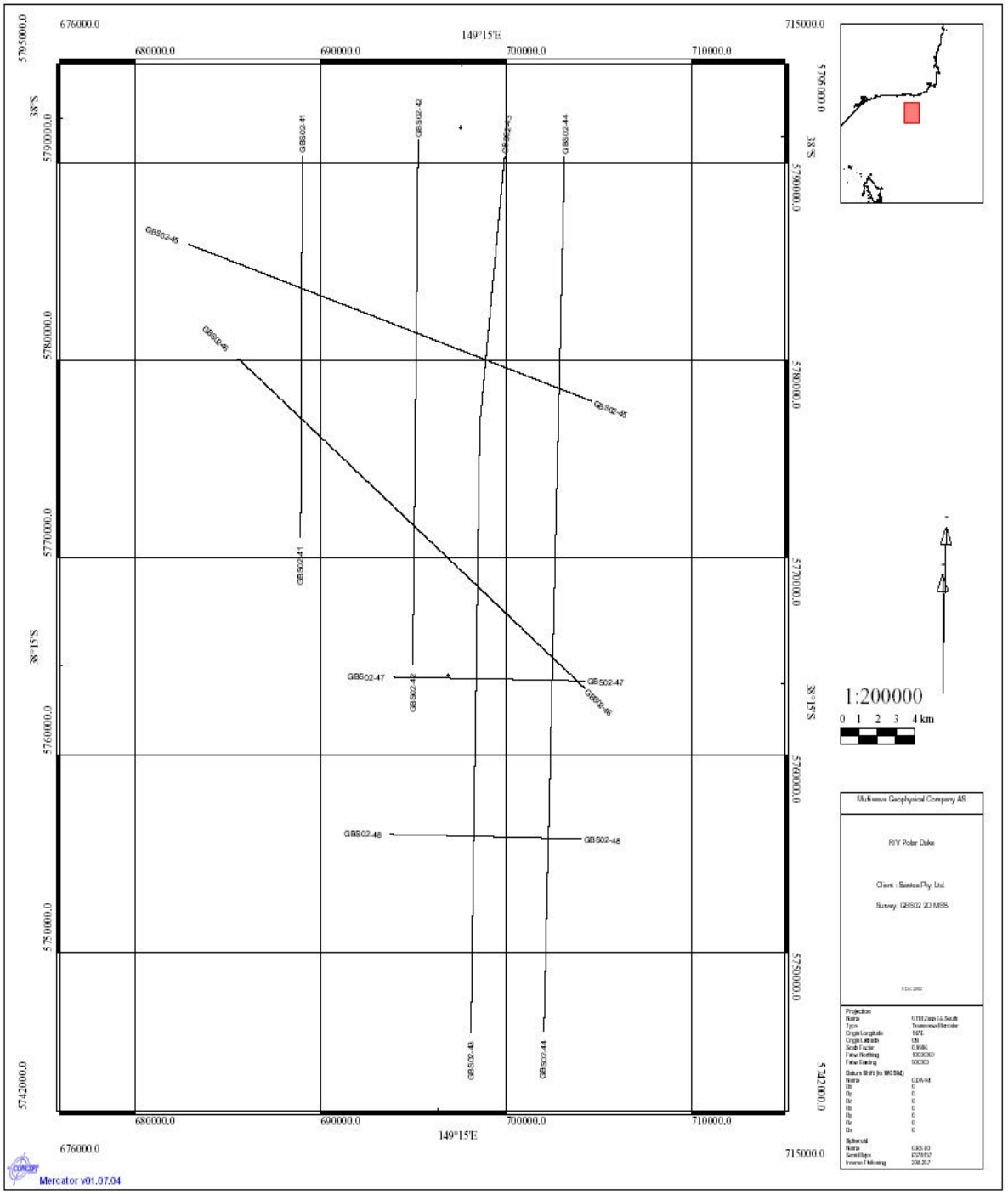
The ***Polar Duke*** carried out the acquisition for **Multiwave Geophysical Company ASA.** Acquisition equipment included a sleeve air gun source array of 3500 cubic inches and a single digital streamer, configured for 324 data traces and a length of 4050m. Positioning was by Differential GPS and onboard Quality Control maintained using a ProMAX QC system.

The vessel initially mobilized for Santos Limited in Cairns, Australia on 5th of November and carried out several prior surveys off Victoria and Tasmania. She then proceeded directly to the survey area and commenced production on 1st of January. The 8 lines of seismic data acquisition were completed in 9 line sequences by 5th of January 2003.

2. Area Location Map



3. Prospect Map



4. Survey Parameters and Original Line Coordinates

Surve y Report

Date Generated: 05/12/2002
Time Generated: 10:06:34

PSD Details

Projection Type: Transverse Mercator
Origin Longitude: 1470000.000E
Origin Latitude: 0000000.000N
Scale Factor: 0.9996000000
False Easting: 500000.00E
False Northing: 10000000.00N

Spheroid Name: GRS 80
Semi Major Axis: 6378137.000
Inverse Flattening: 298.2572221

Datum Name: GDA-94
Dx (m): 0.0
Dy (m): 0.0
Dz (m): 0.0
Rx (sec): 0.0
Ry (sec): 0.0
Rz (sec): 0.0
Ds (ppm): 0.0

Units: meters

2D Survey

Survey Name:

2D Line Name:		GBS02-41		
FSP:		1001	**LSP:**	1775
Segment: 1				
Start Easting:		689029.97	**Start Longitude:**	149°9'12.002"E
Start Northing:		5790361.0	**Start Latitude:**	38°00'53.075"S
End Easting:		688930.92	**End Longitude:**	149°9'26.377"E
End Northing:		5771010.51	**End Latitude:**	38°11'20.548"S
Azimuth/Bearing:	178.964			
Distance:	19350 m			

2D Line Name:		GBS02-42		
FSP:		1001	**LSP:**	2064
Segment: 1				
Start Easting:		695278.04	**Start Longitude:**	149°13'27.275"E
Start Northing:		5791158.95	**Start Latitude:**	38°00'22.435"S
End Easting:		694989.92	**End Longitude:**	149°13'41.628"E
End Northing:		5764583.7	**End Latitude:**	38°14'44.261"S
Azimuth/Bearing:	179.248			
Distance:	26575 m			

Section 1: **General Information**

2D Line Name:		GBS02-43		
FSP:		1001	**LSP:**	2778
Segment: 1				
Start Easting:		699929.97	**Start Longitude:**	149°16'38.744"E
Start Northing:		5790304.95	**Start Latitude:**	38°00'46.472"S
End Easting:		698597.99	**End Longitude:**	149°15'57.697"E
End Northing:		5776769.11	**End Latitude:**	38°8'06.367"S
Azimuth/Bearing:	184.215			
Distance:	13600 m			
Segment: 2				
Start Easting:		698597.99	**Start Longitude:**	149°15'57.697"E
Start Northing:		5776769.11	**Start Latitude:**	38°8'06.367"S
End Easting:		698117.95	**End Longitude:**	149°16'09.048"E
End Northing:		5745945.28	**End Latitude:**	38°24'46.040"S
Azimuth/Bearing:	179.488			
Distance:	30825 m			

2D Line Name:		GBS02-44		
FSP:		1001	**LSP:**	2774
Segment: 1				
Start Easting:		703170.97	**Start Longitude:**	149°18'51.538"E
Start Northing:		5790319.98	**Start Latitude:**	38°00'43.391"S
End Easting:		702054.47	**End Longitude:**	149°18'51.181"E
End Northing:		5746004.32	**End Latitude:**	38°24'40.954"S
Azimuth/Bearing:	180.011			
Distance:	44325 m			

2D Line Name:		GBS02-45		
FSP:		1001	**LSP:**	1926
Segment: 1				
Start Easting:		682903.0	**Start Longitude:**	149°5'05.024"E
Start Northing:		5785869.0	**Start Latitude:**	38°3'23.252"S
End Easting:		704624.6	**End Longitude:**	149°20'03.862"E
End Northing:		5777931.52	**End Latitude:**	38°7'23.837"S
Azimuth/Bearing:	108.787			
Distance:	23125 m			

2D Line Name:		GBS02-46		
FSP:		1001	**LSP:**	2004
Segment: 1				
Start Easting:		685566.0	**Start Longitude:**	149°6'59.641"E
Start Northing:		5780076.02	**Start Latitude:**	38°6'29.131"S
End Easting:		704261.18	**End Longitude:**	149°20'04.016"E
End Northing:		5763362.85	**End Latitude:**	38°15'16.427"S
Azimuth/Bearing:	130.487			
Distance:	25075 m			

2D Line Name:		GBS02-47		
FSP:		1001	**LSP:**	1414
Segment: 1				
Start Easting:		693932.03	**Start Longitude:**	149°12'58.766"E
Start Northing:		5763945.98	**Start Latitude:**	38°15'05.760"S
End Easting:		704255.93	**End Longitude:**	149°20'03.408"E
End Northing:		5763740.99	**End Latitude:**	38°15'04.172"S
Azimuth/Bearing:	89.7648			
Distance:	10325 m			

Section 1: **General Information**

2D Line Name:	GBS02-48		
FSP:	1001	**LSP:**	1413
Segment: 1			
Start Easting:	693758.99	**Start Longitude:**	149°12'59.515"E
Start Northing:	5755970.95	**Start Latitude:**	38°19'24.449"S
End Easting:	704057.11	**End Longitude:**	149°20'03.552"E
End Northing:	5755730.87	**End Latitude:**	38°19'24.006"S
Azimuth/Bearing:	89.9605		
Distance:	10300 m		

Total 2D Line Length: 203.5 km

5. Contract Work Order

CONTRACT WORK ORDER

GENERAL

	CONTRACT
Client:	Santos / Bass Strait Oil Company
Vessel(s):	Polar Duke
Job number:	6151
Bid number	
Client contract number/ref:	
Location:	Gippsland Basin Block VIC/P41
Area:	Victoria, Australia
Type of survey:	2D
Area, or total kms:	203.5 Full-fold km
Line heading:	Various
Number of lines:	8 lines
Line length:	Various
Acquisition method:	Single streamer / single source
Estimated start date:	1st January 2003
Estimated duration:	7-10 days
QHSE checklists completed	
	STREAMER
Type of streamer	SYNTRAK RDA Streamer
Number of streamers	1
Separation	n/a
Streamer length	4050 m
No. of channels	324
Group interval	12.5 m
Streamer depth	**7 m** +/- 1 m Allowed deeper in poor swell conditions.
Water Depth	100-2200m
	RECORDING
Instrument type	SYNTRAK 960-24
Record length	6s records
Sample rate	2ms
Recording filter: Hi-cut	206 Hz @ 276 dB/ Octave
Recording filter: Lo-cut	Out: 3 Hz @ 6 dB/ Octave , IN 3 Hz @ 12 dB/ Octave
Filter type	Linear
Pre-Amplifier Gain	12 dB
Tape format	Seg D Ver.1.00 8058 - 32 Bit IEEE
Recording media	IBM 3590
Tape Copy	Via ProMAX QC
TOC (Diskos/Petrobank) files reqd?	No
	SOURCE
Source type	Airgun
Source controller	GCS-90
Number of sources	1
Source separation	n/a
Volume per source	3500 cu.in.
Source depth	**5 m** +/- 0.5 m
Source pressure	2000 psi
Source length	11.78 m
Number of subarrays per source	4
Subarray separation	6, 13, 6 m
Flip/Flop	No
Shot point interval per shot	**25 m**
Shot point location	Common Midpoint
Near fields to be recorded?	Yes
Total SCFM required at 5.0 knots	1540
Source firing specifications	+/- 1.25 ms
Signed:	Operation Manager

CONTRACT WORK ORDER

NAVIGATION **Side 1**

Geodetic Parameters	
Spheroid	GRS 80
Semi-Major Axis	6378137
Inverse Flattening	298.2572221
Work Datum	GDA 94
Datum Transformation:	0
dX (m)	0
dY (m)	0
dZ (m)	0
rX (arc secs)	0
rY (arc secs)	0
rZ (arc secs)	0
Scale (ppm)	0
Projection	Transverse Mercator
Zone if UTM	
Central Meridian	147°E
Scale Factor	0.9996
False Easting (m)	500000
False Northing (m)	10,000,000
Latitude of Origin	0°
Datum Transformation Test-Coordinate	
Transformation from Datum.	-N/A
Transformation to Datum.	-
Latitude in WGS 84.	-
Longitude in WGS 84.	-
Latitude in Local Datum.	-
Longitude in Local Datum.	-
Northing in Local Projection.	-
Easting in Local Projection.	-
Geoidal Height	
Location of Prospect Centre: Lat	4 different areas, see audit folder
Location of Prospect Centre: Lon.	
Source of Geoidal Height Data	
Navigation System	
Navigation/QC System	SPECTRA
Vessel Positioning Systems	
First Navigation System	Fugro Starfix MRDGPS
First RTCM Delivery System	Spot Optus
DGPS Reference Stations	Melbourne, Bathurst, Adelaide, Brisbane and Dunedin
Sub-Contractor	Fugro Survey A/S
Contact Person	Øyvind Røegh, Tel: +47 22 13 46 43
Second Navigation System	Fugro Starfix MRDGPS
Second RTCM Delivery System	StarfixMN-8 via Inmarsat and Spot AP-Sat
DGPS Reference Stations	Melbourne, Bathurst, Auckland, Kalgoorlie and Dunedin
Sub-contractor	Fugro Survey A/S
Contact person	Øyvind Røegh, Tel: +47 22 13 46 43

CONTRACT WORK ORDER

NAVIGATION **Side 2**

Streamer / Source Positioning Systems	
Tailbuoy positioning	rGPS
Streamer positioning	compasses recorded
Source Positioning	rGPS
Line and Shot Point Numbering	
Line Name Format:	Prefixes GBS02-
	followed by NN-SSS where NN is line no and SSS in sequence.
First SP for prime lines	1001
First SP for reshoot lines	1001
First SP for infill lines	N/A
Incrementing/Decrementing	Yes
Incrementing/Decrementing factor	1
Source firing on even numbers	-
Line and Shot Point Geometry	
Shot Fire Interval	25 m
Receiver Group Interval	12.5 m
Run out	89 shots
Number of Streamers	1
Acquisition Geometry Type	single/single
Offset CS - CFG	80 m
Water Depth Processing	
Echosounder standard settings	VP=1500ms^{-1}, draft=0
Vertical datum	MSL
Tidal corrections	
Tidal correction source	
Echosounder frequency	12 kHz
Power output	More than 1kW
Sea depth	More than 6000m
Gravity and Magnetics	
Gravity Meter Type	n/a
Gravity Recording Interval	n/a
Interface to Navigation systems	n/a
Interface to Echosounder	n/a
Gravity Sub-Contractor	n/a
Magnetometer Type	n/a
Magnetometer Recording Interval	n/a
Magnetometer Sub-Contractor	n/a
Tape Media	n/a
UKOOA P1/90 required	n/a
Delivery Address	
Sub Bottom Profiler	
SBP Type	n/a
SBP Sub-Contractor	n/a
Frequency	n/a
Transmitter Power	n/a
Sea depth	n/a

Notes:

Signed: Navigation Manager

CONTRACT WORK ORDER

NAVIGATION **Side 3**

Data from	Vessel	Office
Turnaround- weeks		

Final Processed Data

Final Deliv	Media	Copies	Notes
P1/90	CD-ROM	1	At end of survey

Raw Data

P2/94	CD-ROM	1	Including GPS observations

Mapping

	Media	Copies	Scale	Notes
Post Plot	electronic	1	Best Fit	GIF files

Miscellaneous

	Media	Copies	Notes
Final Nav	CD ROM	original	

Other Deliverables

Format for Naming of Final Tapes:

Client Contact and Delivery Address

Client contact and address:	Navigation deliverables address:
	TBA
	Attention: TBA

Special Comments

Signed: Navigation Manager

CONTRACT WORK ORDER

SEISMIC QC **Side 4**

PROCESSING PRODUCTS

Processing Product	Comment (incr)	Processing Product	Comment (incr)
Noise Record RMS	per seq. - at SOL	Brute Stack (raw)	per seq.
Near Trace Display	per seq. - all shots	Brute Stack (filtered)	per seq.
Shot-Trace RMS (last 500ms)	per seq. - all shots	FK & FT Analysis	as appropriate
Ambient RMS	per seq. - all shots	Seismic Attributes	as appropriate
Direct Arrival RMS	per seq. - all shots	Spreadsheets, logs	yes
Raw Shot Display	per seq. - every 4th km		
Velocity Picking	per seq. - every 4th km		
CDP Gather Display	per seq. - every 4th km		

DELIVERABLES

	Client	Office		Client	Office
RMS Plots	yes	n/a	QC Logs	yes	yes
Near Trace Plots	yes	n/a	Processing Report	yes	yes
Brute Stack Plots	yes	n/a			
SEG Y Brute Stacks	yes	n/a			
Velocities (ascii format)	yes	n/a			

CLIENT CONTACTS AND DELIVERY ADDRESS

Client contacts and address:	
Seismic deliverables address:	

COMMENTS

	Signed:

6. Seismic & Vessel Particulars

6.1 Streamer and Sensors Details

Item	description	type	amount	remark
Streamer	24 bit, digital distributed electronic	SYNTRAK RDA	4050 m active	
Depth Control	Digicourse	5011	16	Located every 300 m along the streamer
Buoyancy	Kerosene	Isopar		
Retrievers				1 per km
Streamer skin	Polyurethane			
Section Length	75 m			
Lead-in	300 m			
Group Length	12.5 m			
Max number of Channels			324	6.25 m @ 2 ms

6.2 Recording System Details

Item	Description	Type	Amount	Remark
Acquisition	SYNTRAK	960-24		
Format	SED D	Demultiplexed		
Recording	3590 cartridge	IBM comp.	4	
Bird Controller	Digicourse	293B		
Sampling				2ms
Plotter	22”	OYO Geospace	1	
Printer	A4	Epson	3	Label
Printer	A4	HP	2	Logs, tests etc.

6.3 Seismic QC Details

Item	Description	Type	Amount	Remark
QC	ProMAX	2D		
Plotter	24”	OYO Geospace	1	

6.4 Navigation Details

Item	Description	Type	Amount	Remark
Integrated Navigation	Concept	Spectra		
Compasses	Digicourse	5011		Every 300m along the streamer.
Streamer positioning	RGPS	Various	1	Geotrack.
Source Positioning	RGPS	Various	2	Geotrack, on outer sub-arrays.
Data logging	UKOOA	P2/94 P1/90		3590, Exabyte, CD Rom.
Echo Sounder	Simrad	EA500	1	Deepwater transducer.
Gyro				As vessel description.
Helmsman Steering display	Robertson	Robtrack Helmsman		

7 Vessel Specifications

M/V Polar Duke

Main Particulars

Loa	66,65m
L. p. p.	61,44m
B. mld.	13,00m
Draft	5,80m
Draft mld sh. deck	9,50m
Deadweight	1119mt
Fuel Oil	1000cbm
Aviation fuel	50cbm
Fresh water	85cbm
IMO No	8200838
P & I Club	Skuld
Call sign	LACS4
Built	1983
Gross/net tonnage	1646.49/493.95
Flag	Norwegian

Class
DnV no: 13520
DnV + 1Aa-E0-HELDK-Sealer
Classed for Worldwide trade and registered in Norwegian International Ship Register

Offshore survey
Designed for offshore survey, core drilling and hydrographical survey.
Separate joystick manoeuvring.
Can be arranged for ROV handling, towed vehicle, bottom sampling, site survey.
Moonpool. Ø 36 inch.

Research facilities
Research facilities are designed for scientific and/or logistic expeditions in Antarctic and Arctic areas.
Lab. survey area - Dry Lab. and Wet. Lab. with uncontaminated sea water system.
Separate climate control and power supply.
Separate store. High-pressure hydraulic system for additional scientific winches. TV-monitoring aft deck.
Heavy duty Mob boat for assistance.
Spare Ø16 inch bottom valve for sonar etc.
Electric and mechanical workshop facilities.
1 PC CTD Winch with 3500m wire ø 10mm speed 50m/min @ 120l/min

Cargo Logistics
Under deck bale capacity of about 1385cbm
Arctic fuel in ships ordinary fuel tanks.
Jet A1 fuel in separate ships tank (56cbm)
12t - 15m / 22t - 8m crane with 100m/50m wire
Provision crane 1,5t - 7,5m

Electronics
Navigation and communication equipment to highest international standards, conventional as well as satellite equipment.

Environment
Equipped with oily water separator and incinerator for garbage. Waste water treatment arrangement. Fuel oil storage arrangement to minimize risk of accidental oil spill. Separate tank for storing bilge water when in Antarctic and Arctic waters

Accommodation

Crew:	11 cabins, 15 berths
Charterer:	15 cabins, 27 berths
Common:	Hospital, 3 berths

Icegoing
DnV "Sealer class", hull strength as icebreaker.
Proven ice-going capability and manoeuvrability during numerous expeditions to the Antarctic.
De-icing in foreship and superstructure.
All equipment well suited to harsh conditions.
Machinery cooling standby arrangement.
Impact resistant low friction paint on underwater hull
Proven rudder and propeller protection.

Seismic Exploration Facilities
2 pc MPD Dual Umbilical winches
1 PC MPD Streamer Winch cap. 7200m + 72mm streamers
2 pc Hamworthy compressors each 800 scfm
2 pc Hamworthy compressors each 400 scfm

Electrical power
1 x E.C.C. 1640kVA shaft generator
1 x Stamford MC 334C - 112,5kVA aux generator
1 x Stamford MC 534C - 305 kVA aux. generator
440/220V 60Hz

Machinery
Main engine:
2 off MAK 6M 453aK 1650 kW / 2250 bhp each at 600RPM

Side thrusters:
Bow 1 x 425 kW / 570 bhp
Stern 1 x 425 kW / 570 bhp

Helicopter Deck
Bell 212, Max 5,08 T. Not currently certified for use in the Philippines.

Safety
Built according to DnV, Solas and Norwegian Ship Control rules. Enclosed lifeboats. Inflatable life rafts. Survival suits for all personnel. Fire detection and monitoring to highest available standard. Special helicopter deck protection arrangement. Internal communication and p.a. system. Q.A. according to highest standard (DnV - SEP). Safety and contingency manuals onboard and in use. Hospital facilities.

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1 List of Key Personnel

1.1 Onboard Personnel

POSITION	CREW 1	CREW 2
Party Chief	John Hennessey	
Captain	Peter Brandal	
Chief Engineer	Anders Fosse	
Chief Observer	Bjorn-Erik Melum	
Chief Navigator	Leif Olav Sætenes	
Chief Mechanic	Gary Herritt	
QC Leader	Adam Gebarski	
Client Representative	Gary McWilliam	

1.2 Office Support Personnel

POSITION	NAME	OFFICE
Operation Manager	Atle Jacobsen	+ 47 55 94 77 65
Operation Supervisor	Kai Aaseboe	+ 47 55 94 77 59
Technical Manager	Jan-Aage Langeland	+ 47 55 94 77 53
Instrument Support	Franck Andersen	+ 47 55 94 77 54
Navigation Support	Willy Forland	+ 47 55 94 77 63
Mechanical Support	Eivind Haavik	+ 47 55 94 77 57
QC Support	Christophe Massacand	+ 47 55 94 77 68

2 Field Information and Observations

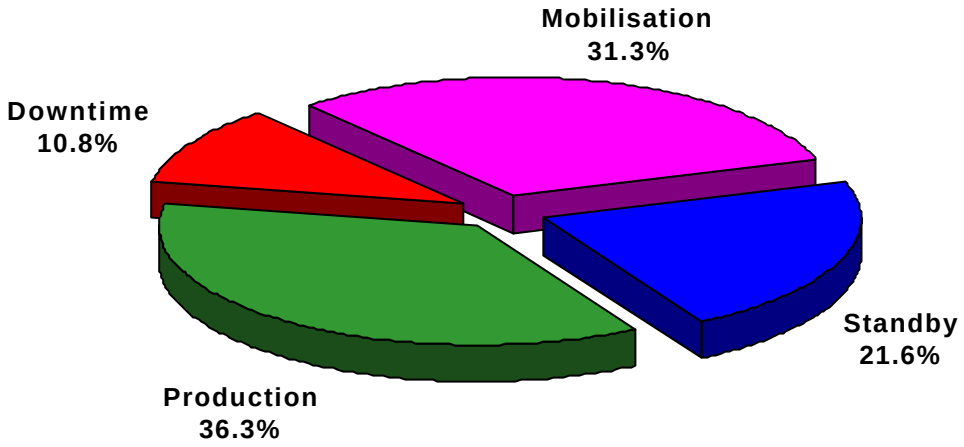
2.1 Timing Summary

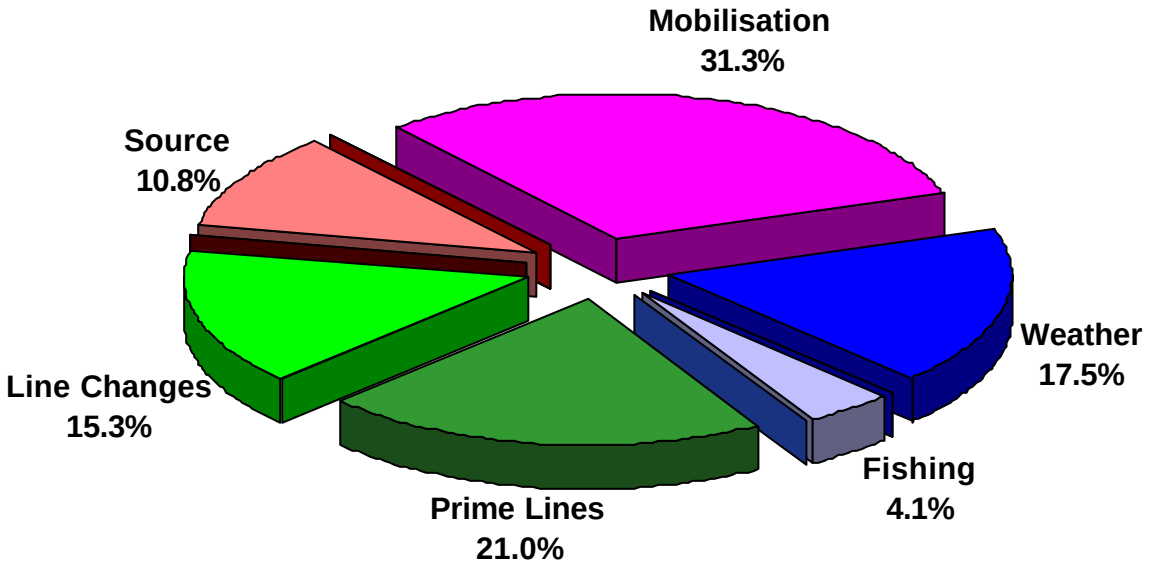
VESSEL	*M/V Polar Duke*
AREA	*GBS02-*
JOB No's.	*6151*
CLIENT	*Santos - Australia*

TIMING SUMMARY

	OPERATIONAL			TECHNICAL DOWN TIME								STAND BY (external downtime)						P R O D.		QHSE
DATE	Prime Lines	Run Out	Line Changes	Instr.	Nav.	Mech.	Streamer	Towing	Maritime	Mob Demob	Transit	Weather	Crew Change	Seis. Interfer.	Obstr / Fishing	Other	Hours	Line Km	Speed	Meeting & Drills
31.Dec											24.00						24.00			
01.Jan	2.66	0.59	4.27							9.48	7.00						24.00	20.6750	4.20	
02.Jan						14.00						10.00					24.00			
03.Jan	5.87	0.55	4.98									12.60					24.00	48.2500	4.44	
04.Jan	10.51	0.91	7.22												5.36		24.00	88.8000	4.56	
05.Jan	5.56	0.52	3.35														9.43	45.9750	4.46	
07.Jan				END OF GBS02 GIPLAND SURVEY																
08.Jan																				
	Prime Lines	Run-Out	Line Changes	Instr.	Nav.	Mech.	Streamer	Towing	Maritime	Mob Demob	Transit	Weather	Crew Change	Seis. Interfer.	Obstr / Fishing	Other	Hours	Line Km	Speed	Meeting & Drills
Total	**24.60**	**2.57**	**19.82**	**0.00**	**0.00**	**14.00**	**0.00**	**0.00**	**0.00**	**9.48**	**31.00**	**22.60**	**0.00**	**0.00**	**5.36**	**0.00**	**129.43**	**203.70**	**4.42**	**0.00**
	46.99			**14.00**						**40.48**		**27.96**								

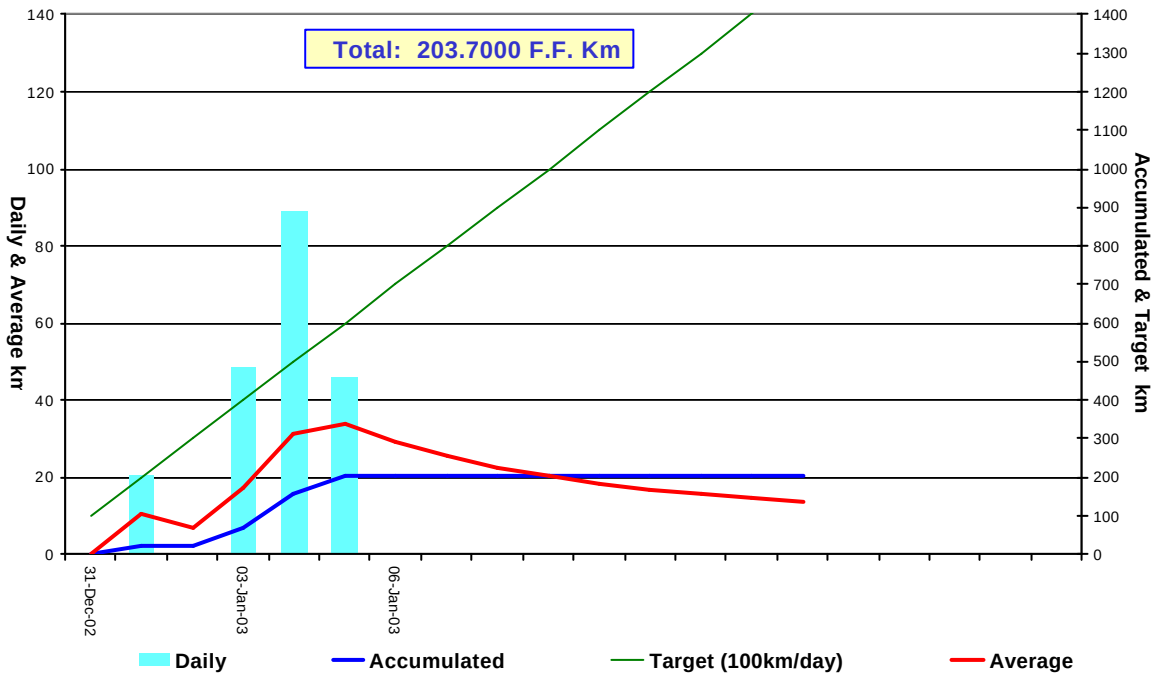
2.2 Timing Summary - Graphical





Hours 129.43		Percent 100%
27.2	Prime Lines	21.0%
19.8	Line Changes	15.3%
0.0	Instruments	0.0%
0.0	Navigation	0.0%
14.0	Source	10.8%
0.0	Streamer	0.0%
0.0	Maritime	0.0%
0.0	Crew Change	0.0%
40.5	Mobilisation	31.3%
22.6	Weather	17.5%
0.0	Seismic Interference	0.0%
5.4	Fishing	4.1%
0.0	Other	0.0%
47.0	Production	36.3%
14.0	Downtime	10.8%
40.5	Mobilisation	31.3%
28.0	Standby	21.6%

2.3 Production Statistics - Gaphical



2.4 Production Log

Seq	Line	Dir	Start Date	First SP	Last SP	Shots	Km's	Notes
001	GBS02-48	270	01/01	1413	1001	413	10.3250	Line complete
001	GBS02-48	270	01/01	1000	912	89	2.225	Full-fold Run-Out shots
002	GBS02-47	090	01/01	1001	1414	414	10.3500	Line complete
002	GBS02-47	090	01/01	1415	1503	89	2.225	Full-fold Run-Out shots
003	GBS02-46	310	03/01	2004	1001	1004	25.1000	Line complete
003	GBS02-46	310	03/01	1000	912	89	2.225	Full-fold Run-Out shots
004	GBS02-45	109	03/10	1001	1926	926	23.1500	Line complete
004	GBS02-45	109	03/10	1925	2015	89	2.225	Full-fold Run-Out shots
005	GBS02-44	180	4/01	2774	1001	1774	44.3500	Line complete
005	GBS02-44	180	4/01	1000	912	89	2.225	Full-fold Run-Out shots
006	GBS02-43	360	4/01	1001	1653	653	16.3250	Line aborted d.t. presence of WHALES
007	GBS02-43	360	4/01	1565	1653	89	2.225	Over-Lap
007	GBS02-43	360	4/01	1654	2778	1125	28.1250	Line complete
007	GBS02-43	360	4/01	2779	2867	89	2.225	Full-fold Run-Out shots
008	GBS02-42	179	5/01	2064	1001	1064	26.6000	Line complete
008	GBS02-42	179	5/01	1000	912	89	2.225	Full-fold Run-Out shots
009	GBS02-41	359	5/01	1001	1775	775	19.3750	Line complete
009	GBS02-41	359	5/01	1776	1864	89	2.225	Full-fold Run-Out shots

2.5 Daily Summary

Tuesday 31st December 2002
After the completion of the previous survey west of Tasmania the vessel was in transit to Gippsland Basin Block VIC P/41. During the transit the crew reconfigured the streamer from its previous configuration of 7200 metres to 4050 metres. Minor adjustments to offset and ballast were necessary upon deployment, in addition to full Instrument Tests.

Wednesday 01st January 2003
The day commenced with the vessel still in transit to the prospect area. Upon arrival on prospect a Temperature/Salinity sample was taken while the streamer was prepared for deployment. During deployment three Active Streamer sections were removed and exchanged; minor ballast and offset adjustments were made to the streamer front end. Once fully deployed a full set of Instrument Tests were performed while the source arrays were being put out. Production began at 16:29 Hours Local on Line GBS02-48-001 which continued through to its completion and subsequent line change. This was repeated with Line GBS02-47-002 and its subsequent line change. The day finished with the vessel on line change to the third line sequence.

Note: Strong currents (difference of 1.0-1.5 knots between bottom speed and water speed) slowing production shooting speed.

Thursday 02nd January 2003
The day began with the vessel experiencing a rupture of the main airline inside the port inner source umbilical. This required the retrieval of all the guns; the complete dismantling of the port inner gun array from the umbilical; and the replacement with a spare umbilical stored onboard. By the time the umbilical had been replaced and tested the vessel was approaching the run-in to Line GBS02-46-003. However, the attempt at the line was aborted due to the inability to keep the ship's steering online and the streamer depths under control (all due to the prevailing sea conditions at that time). The vessel then altered course to due north in order to see if there would be any improvement on the alternate line directions, but problems still encountered with streamer control, swell noise and steering. Weather forecasts indicated gale force winds for the evening and continued strong winds for the next 48 hours, so the streamer was recovered onboard for safety. The day ended with the vessel down for weather.

Friday 03rd January 2003
During the night the seas gradually settled down and at 07:00 local the decision to redeploy the streamer was made. Production began again at 12:36 local on Line GBS02-46-003 which continued through to its completion without problem. This was followed by a standard line change until production resumed on Line GBS02-45-004 – also continued through to completion. The day ended with the vessel on line change.

Note: Strong currents (difference of 1.0-1.5 knots between bottom speed and water speed) again slowed production shooting speed.

Saturday 04th January 2003

The day began with the vessel on line change to Line GBS02-44-005. Production began on this line and continued to conclusion without problems, followed by a standard line change. Production then commenced on Line GBS02-43-006 and continued about 1/3 of the way down the line before it was necessary to abort due to the presence of whales. The vessel circled and later resumed production on Line GBS02-43-007: this segment of the line was shot through to conclusion thereby making the line complete. The day ended with the vessel on line change.

Note: Strong currents and sea conditions again slowed production shooting speeds and created streamer depth control / vessel steering difficulties.

Sunday 05th January 2003

The day commenced with the vessel on line change to Line GBS02-42-008. Production began on this line and continued through to the end without incident, followed by a regular line change. Production resumed again on Line GBS02-41-009 and this line also continued through to completion without any problems at 09:26 hrs local. This marked the completion of the Gippsland GBS02 Survey.

2.6 Field Information and Encountered Problems

2.6.1 Obstructions / Installations on the Field

There were no man-made obstructions or offshore oil installations in the survey area. Water depths range from 100-1700 m. There are no known physical obstructions. The dip lines ended in shallower water.

2.6.2 Traffic / Shipping Lanes

There were designated shipping lanes in the prospect area which ran in a diagonal direction across the southern half of the survey block. Most shipping encountered responded quickly to the VHF radio and there were few problems with traffic.

2.6.3 Fishing Activity

Fishing activity in the prospect area (Block VIC/P41) was non-existent. A small number of local trawlers operated along the eastern boundary of the program block. The client had prepared the prospect well in advance, and there was very good cooperation with the fishing fleets.

2.6.4 Seismic Interference and Time Share

No seismic interference was encountered on this prospect and subsequently there was no need for time sharing operations with any other vessels.

2.6.5 Environmental Obstacles

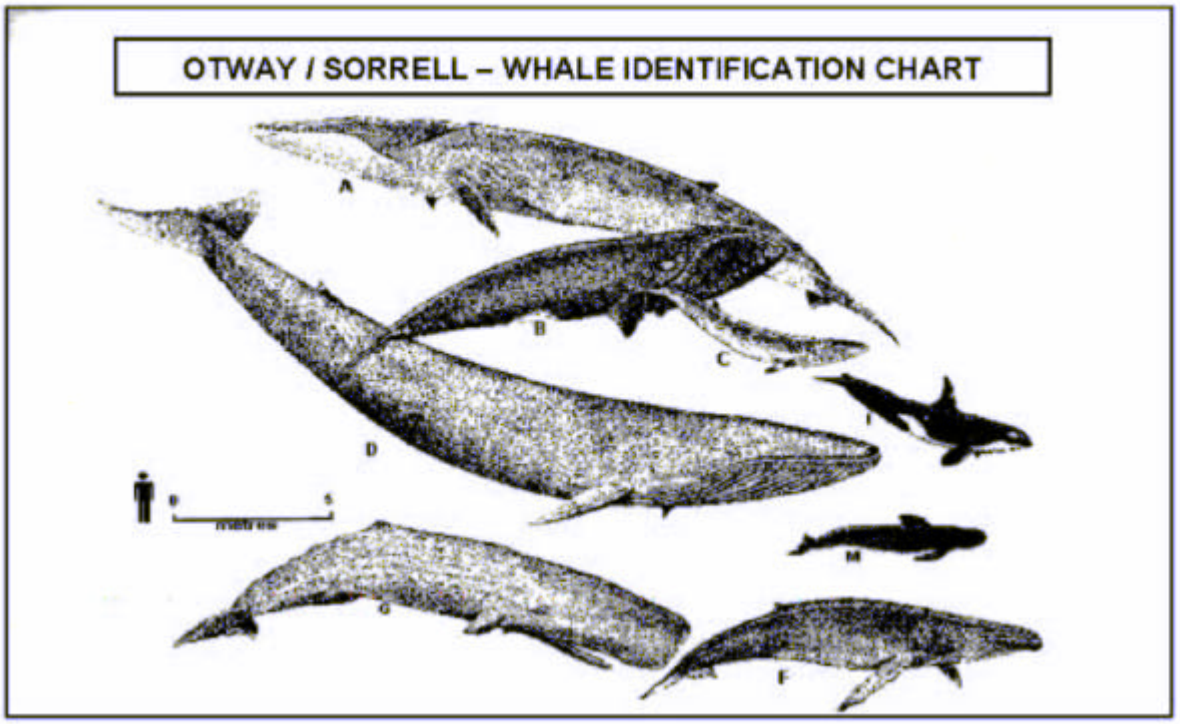
The survey area is strongly affected by oceanic swells from the SW. Large, long period swells usually preceded active weather systems, and their effect remained for up to several days after the storm system dissipated.

2.6.6 Operational Observations

Daily production rates were good with generally calm weather conditions. Strong localized currents, running from southwest to northeast, produced moderately large feather angles and created difficulty steering the preplotted track on some lines.

2.6.7 Cetacean Activity

The survey area appears to be in an area of moderate cetacean activity. The survey took place outside normal whale migratory periods, and standard company precautions were taken to minimise any disturbance, as set out in the flow diagram below.



FIN WHALE (A)
24m long; triangular 0.5m dorsal fin set well back near the tail; series of folds or pleats under the throat; short, flat head; small mouth with shorter baleen; sharp ridge down the back; colouring asymmetrical - right side of lower jaw is white, left side is dark, tongue and baleen are also bicoloured; fast swimmers.

SOUTHERN RIGHT WHALE (B)
Usually found close to shore; seen "sailing" by holding their tails at right angles to the wind; breaching; 15m long; newborn calves up to 6m long; very large head and robust body; long turned-down mouth and long baleen plates between the jaws; large white bumps or collosities on the top of the head and below the jaws which form a different pattern for each individual; no dorsal fin; twin blowholes producing an easily identifiable "V" shaped spout; black colour.

MINKE WHALE (C)
Triangular, high and curved dorsal fin, set well back near the tail; series of folds or pleats under the throat; short, flat head, small mouth with less baleen which is yellowish/white fringed; fast swimmers; 6m long; blue-grey above and white below; distinctive white patch on the outer side of each flipper; pointed snout; small schools.

BLUE WHALE (D)
30m long, females slightly longer than males; gigantic head a quarter of total length; streamlined body; column-like spout 10m high; solitary and easily frightened; slate-blue above and lighter below, underside is often yellowish due to growths of distoms on the pleated or grooved undersurface (100 or more pleats); small triangular dorsal fin set well back near the tail.

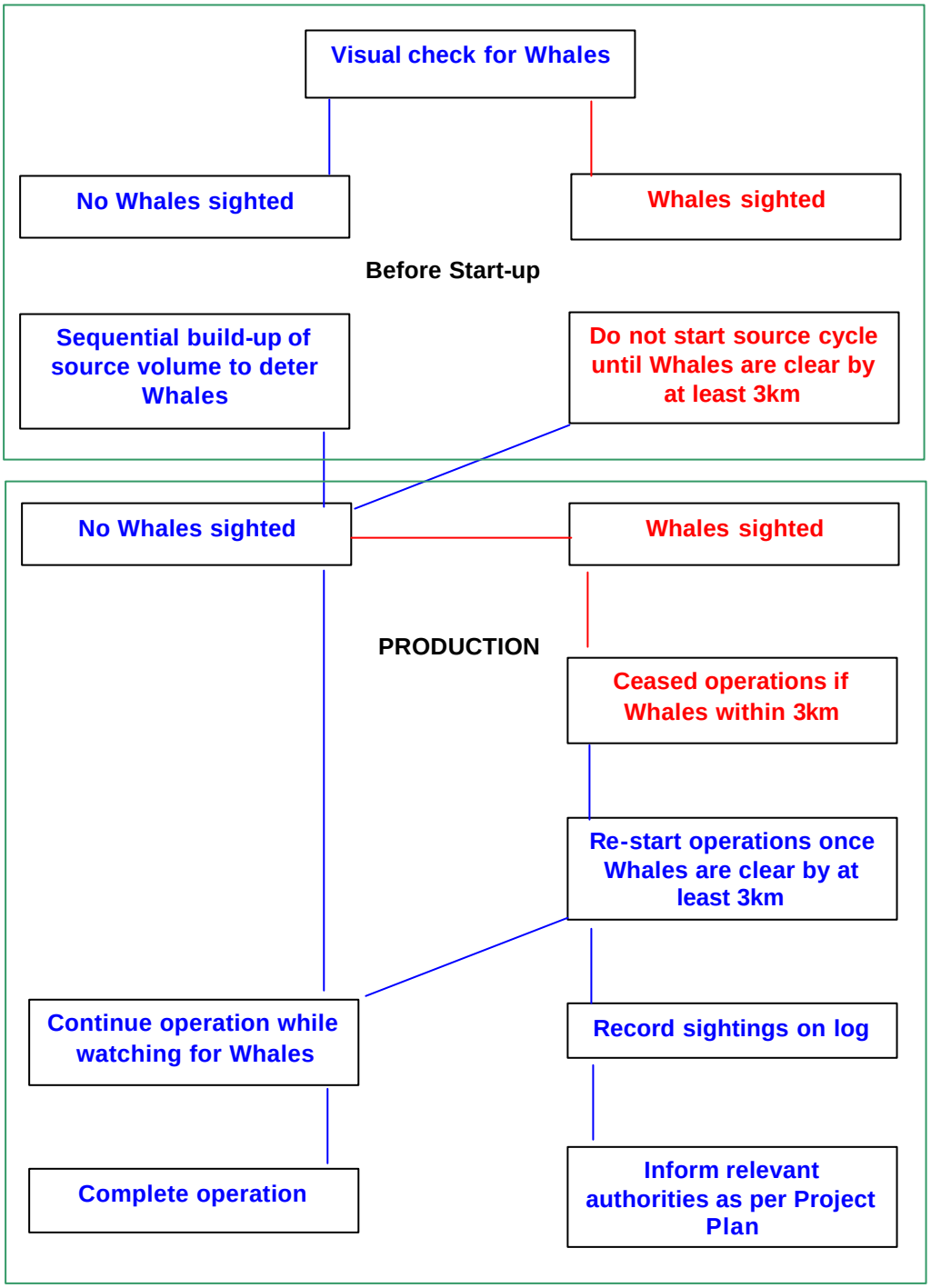
HUMPBACK WHALE (F)
15m long; black above and whitish below; baleen grey-black; large head (1/3 of length); "warts" on head; up to 25 throat grooves or pleats; small dorsal fin slightly aft of midpoint between head and tail; exceptionally long flippers (3.5m+) scalloped on their front margins; sometimes leaps completely out of the water (breaching) and its body is "humpbacked" on re-entering; beats surface with flukes (lobtailing); spout is spherical and about 3m high.

SPERM WHALE (G)
High square fronted head, a third of total length, and the lower jaw does not extend as far forward as the front of the head, directs the spout forward at an angle; no dorsal fin, only a series of bumps, the first and most prominent located about two-thirds of the way from the snout to the tail; flippers relatively extremely small; black or nearly black colour.

KILLER WHALE (I)
Predator which travels in packs; can "stand" on its tail sticking its head out of the water; 10m long (females a third smaller); very large dorsal fin - 2m; flippers are blunt; flukes are very broad; black colour with lens-shaped white spot behind each eye and patches of white under the chin, on the belly and behind the dorsal fin on each side of the streamlined boby.

PILOT WHALE (M)
6m long; uniform black colour except for white patch under the chin which narrows to a slim white line along the stomach; high broad-based dorsal fin located almost exactly in the middle of the back; flippers are lsim and melon-like bulge; travel in schools.

Cetacean Encounter Procedure



3 HSE Summary

Toolbox meetings were held whenever a task involving major equipment and several crew members was about to be carried out. This included but was not limited to work on the seismic source and streamer, and operations with the ship's workboat. All toolbox meetings were noted in the Bridge Log Book and the daily number of meetings held logged by the Party Chief.

New members of the crew were given safety orientation tours of the vessel at the start of the survey, and regular safety drills, SOLAS Training and meetings held.

The following table lists any HSE activities in chronological order during this short survey period.

Date	Action	Hours	Number of crew
31 Dec	Cross-department audit held of the Galley by the instrument room team.	0.5	2
01 Jan	Cross-department audit held for the mechanical dept. by the deck team.	0.5	2
02 Jan.	Cross-department audit held of Recording Room and its associated work areas. Audit performed by galley crew.	0.5	2
02 Jan	Cross-department audit held in the Engine room by the bridge team.	0.5	2

There were no Near Misses, Incidents or cases requiring medical treatment during the survey period.

4 Shipment List

PI Number	Description	Shipped to	Dept.	Date Shipped	Shipped from
PD-2003-001	Processing Plots & Stack Tapes Job 6151 GBS02	Santos, Adelaide	PROC	10-Jan-03	Eden, Victoria
PD-2003-002	Seismic Data Job 6151 GBS02 (Gippsland) Originals	Santos, Adelaide	INS	10-Jan-03	Eden, Victoria
PD-2003-003	Seismic Data Job 6151 GBS02 (Gippsland) Copies	Santos, Adelaide	INS	10-Jan-03	Eden, Victoria
PD-2003-004	NAV Data GBS02 VIC/P41	Santos, Adelaide	NAV	10-Jan-03	Eden, Victoria
PD-2003-005	NAV Data GBS02 VIC/P41	MGC, Bergen	NAV	10-Jan-03	Eden, Victoria

4.1 Seismic Data

Original Tapes

PD-2003-002

7/ Jan. 2003

SENDER: M/V Polar Duke
C/o Beaufort Shipping Agency Company
99,Queensbridge Street, Southbank, Vic. 3006
GPO Box 88A, Melbourne, Victoria 3001
E-Mail beaufort.melb@beaufortshipping.com
Attn. J. Duncan Tel: +61 3 9254 1599
Fax : +61 3 9696 9267

CONSIGNEE:
Santos Australia Ltd.,
Level 29, Santos House,
91 King William Street,
Adelaide, S.A. 5000

Attention: John Hughes

Type of freight	
Sea/Land/Air	**ORIGINAL SEISMIC DATA TAPES**

Box	Item	Serial no.	General description of content	Weight(kg)	Value(US)
1	1	n/a	Box containing 9 seismic Data Cartridges Reel Nos 320-328	2	$200
2	2	n/a	1 x CD containing Seismic observers Logs and Tape Logs for original and copy tapes.	2	N.C.V.
			Paper seismic Observers Logs, Nav logs, Gun Logs, syntrak printouts and Daily QC Test		
			***** Santos / Bass Strait Oil Co. - Gippsland Basin GBS02 Survey : Line Sequences No. 001 - 009 *****		

Total weight: 4 kg

Total boxes: 2 Total value: $200.00

For custom purposes only

Certified true and correct for MGC AS

John Hennessey - Party Chief, M/V Polar Duke

Collected from the Polar Duke by

Name:

Signature

Copy Tapes

MULTIWAVE

PD-2003-003

7/ Jan. 2003

SENDER: M/V Polar Duke
C/o Beaufort Shipping Agency Company
99,Queensbridge Street, Southbank, Vic. 3006
GPO Box 88A, Melbourne, Victoria 3001
E-Mail beaufortmelb@beaufortshipping.com
Attn. J. Duncan Tel: +61 3 9254 1599
Fax: +61 3 9686 9267

CONSIGNEE:
Santos Australia Ltd.,
Level 29, Santos House,
91 King William Street,
Adelaide, S.A. 5000

Attention: John Hughes

Type of freight:	
Sea/Land/Air	**SEISMIC DATA COPY TAPES**

Box	Item	Serial no.	General description of content	Weight (kg)	Value (US)
1	1	n/a	Box containing 9 seismic Data Cartridges Reel Nos. 320-328	2	$200
			***** Santos / Bass Strait Oil Co. - Gippsland Basin GBS02 Survey : Line Sequences No. 001 - 009 *****		

Total weight: 2 kg

Total boxes: 1

Total value: $200.00

For custom purposes only

Certified True and correct for MGC AS

John Hennessey - Party Chief, M/V Polar Duke

Collected from the Polar Duke by

Name:

Signature

4.2 Navigation Data

	PD-2003-004
	Date: January 5, 2003

SENDER: M/V Polar Duke
C/o Beaufort Shipping Agency Company
99,Queensbridge Street, Southbank, Vic. 3006
GPO Box 88A, Melbourne, Victoria 3001
E-Mail beaufort.melb@beaufortshipping.com
Attn. J. Duncan Tel: +61 3 9254 1599
Fax : +61 3 9696 9267

CONSIGNEE:
Santos Australia Ltd.,
Level 29, Santos House,
91 King William Street,
Adelaide, S.A. 5000

Attention: John Hughes

Type of freight:	
COURIER	**SANTOS/Bass Strait Oil Co. GBS02 VIC/P41 - Gippsland, Victoria, Australia - Sequence numbers 001-009**

Box	Item	Serial no.	General description of content	Weight(kg)	Value(US)
1	2	N/a	2 CD's of Navigation Data containing Raw p294/p190/Processed p294,	0.1	$10
			Line Summaries, Logs, Offsets and associated files.		

Total weight: 0.1kg

Total boxes: 1

Total value: $10.00

For custom purposes only

Certified true and correct for MGC AS

Alan Allen - Navigation, M/V Polar Duke

Collected from the Polar Duke by

Name:

Signature

4.3 Processing Data

PD-2003-001

Date: **07-Jan-03**

SENDER: M/V Polar Duke
C/o Beaufort Shipping Agency Company
99,Queensbridge Street, Southbank, Vic. 3006
GPO Box 88A, Melbourne, Victoria 3001
E-Mail beaufort.melb@beaufortshipping.com
Attn. J. Duncan Tel: +61 3 9254 1599
Fax : +61 3 9696 9267

CONSIGNEE:
Santos Australia Ltd.,
Level 29, Santos House,
91 King William Street,
Adelaide, S.A. 5000

Attention: John Hughes

Type of freight:
Air/Land

Box	Item	Serial no.	General description of content	Weight(kg)	Value(US)
1	1-9	N/A	Bass Strait, VIC/P41, Paper plots (Brute stacks, Raw stacks, NTG, RMS Seq 001-009)	2.00	$5.00
	10-13	N/A	Bass Strait, VIC/P41, 4 x 8mm tapes of SEGY stack data, ProMAX archives & UNIX archive of line data	0.50	$10.00
	14	N/A	Bass Strait, VIC/P41, 1 x floppy disk of line stacking velocities	0.10	$1.00
			*** Santos / Bass Strait Oil Co. - Gippsland Basin GBS02 Survey ***		

Total weight: 2.6

Total boxes: 1

Total value: $16.00

For custom purposes only

Certified true and correct for MGC AS

John Hennessey - Party Chief, M/V Polar Duke

Collected from the Polar Duke by

Name:

Signature

4.4 Shipment Address

Santos Australia Ltd.,

Level 29, Santos House,

91 King William Street,

Adelaide, S.A. 5000

Attn: John Hughes

5 Tape Logs

Polar Duke Data Tape Log

Prospect	Santos/Bass Strait Oil Co. GBS02
Box	001
Original/Copy	Original
Shipment No.	PD-03-002

Line Name	Seq	Reel	FSP	LSP	FF	LF	Status
GBS02-48-001	001	320	1413	912	1414	911	SOL/EOL Complete
GBS02-47-002	002	321	1001	1502	1000	1503	SOL/EOL Complete
GBS02-46-003	003	322	2004	912	2005	911	SOL/EOL Complete
GBS02-45-004	004	323	1001	2015	1000	2017	SOL/EOL Complete
GBS02-44-005	005	324	2774	912	2775	911	SOL/EOL Complete
GBS02-43-006	006	325	1001	1653	1000	1654	SOL/Incomplete
GBS02-43-007	007	326	1565	2867	1564	2868	SOL/EOL Complete
GBS02-42-008	008	327	2064	912	2065	911	SOL/EOL Complete
GBS02-41-009	009	328	1001	1864	1000	1865	SOL/EOL Complete
		END OF JOB.					

Polar Duke Data Tape Log

Prospect	SANTOS/Bass Strait Oil Co.
Box	001
Original/Copy	COPY
Shipment No.	PD-03-003

Line Name	Seq	Reel	FSP	LSP	FF	LF	Status
GBS02-48-001	001	320	1413	912	1414	911	SOL/EOL Complete
GBS02-47-002	002	321	1001	1502	1000	1503	SOL/EOL Complete
GBS02-46-003	003	322	2004	912	2005	911	SOL/EOL Complete
GBS02-45-004	004	323	1001	2015	1000	2017	SOL/EOL Complete
GBS02-44-005	005	324	2774	912	2775	911	SOL/EOL Complete
GBS02-43-006	006	325	1001	1653	1000	1654	SOL/Incomplete
GBS02-43-007	007	326	1565	2867	1564	2868	SOL/EOL Complete
GBS02-42-008	008	327	2064	912	2065	911	SOL/EOL Complete
GBS02-41-009	009	328	1001	1864	1000	1865	SOL/EOL Complete
		END OF JOB.					

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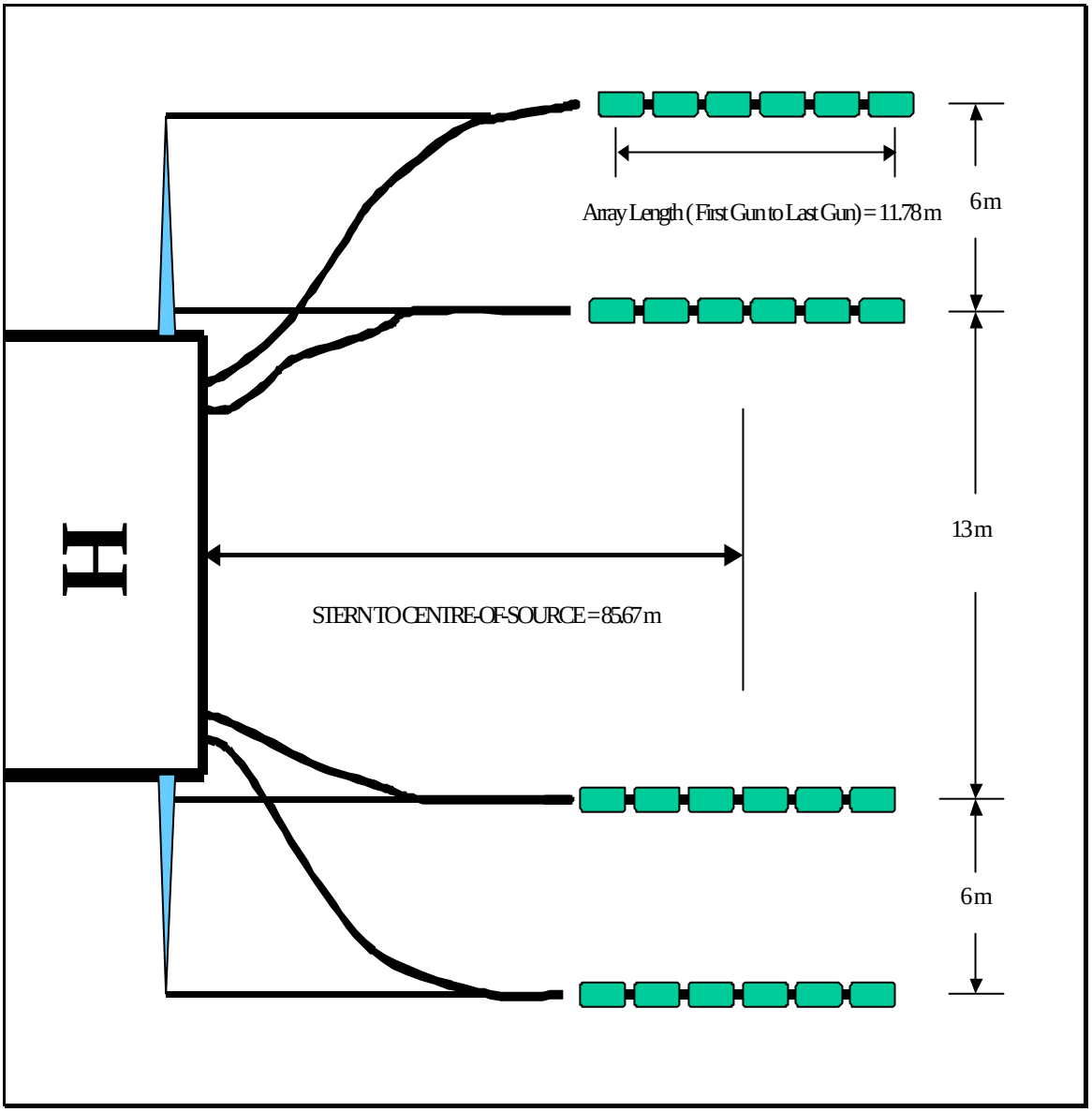
1 Towing Configuration

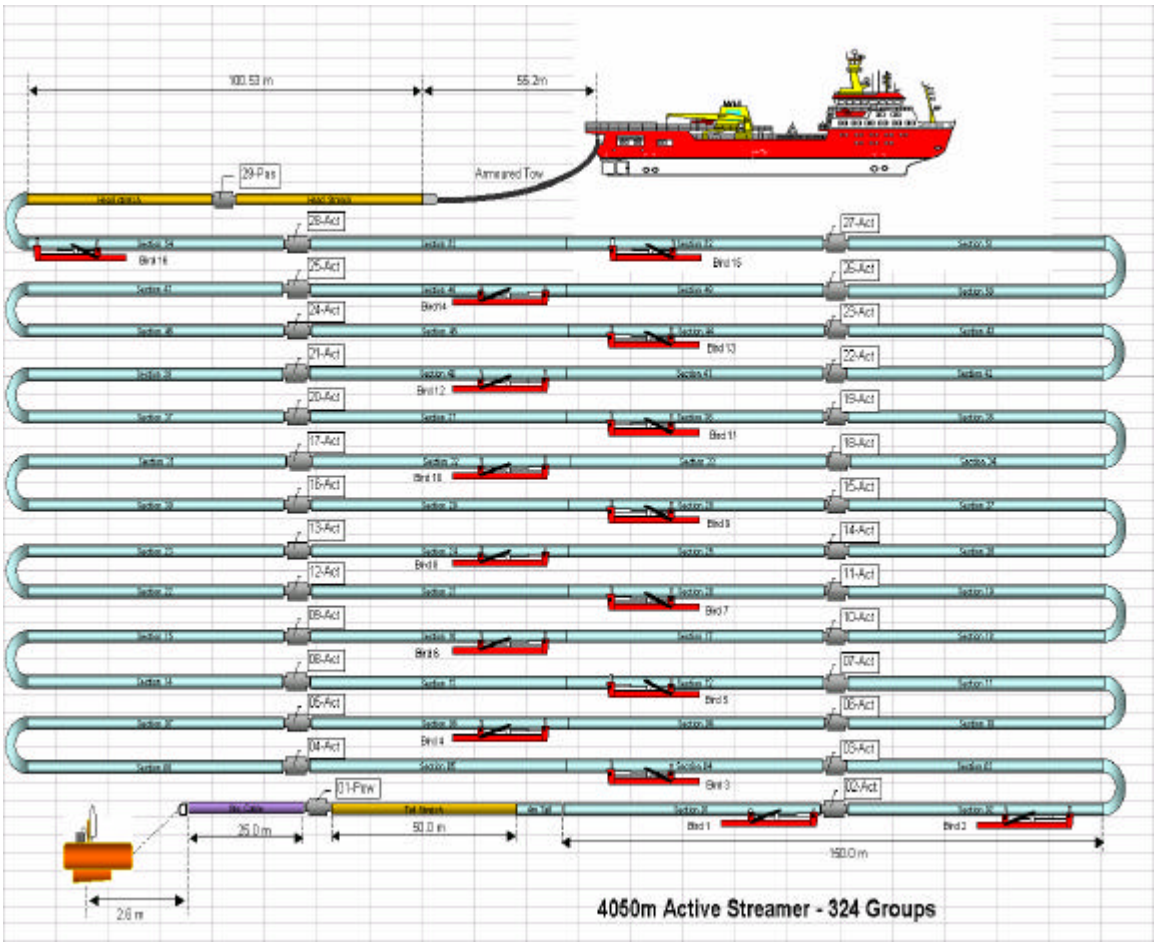


2 Streamer Configuration

2.1 Streamer System Description

Syntrak 960 Streamer Details	
Number of Streamers	1
Type of Streamer	Syntrak 960-24, RDA 1
Numbering Convention	1 Tail – 324 Vessel
Section Length	75-m nominal
Streamer Length	4050m
Groups per Streamer	324 Groups
Group Intervals	12.5m / 16 Phones
Hydrophones Spacing	0.78125m
Jacket Type	Polyurethane, 4mm wall
Hydrophone Array	Benthos RDA split group
Ballast fluid (fluid-quantity)	Isopar-M (200 litres/active sect)
Number of Hydrophones	8-phones / 6.25m
Channels per Electronic Module	12
Data Transmission Link	Twin Axial Pair
Active Group Lengths	12.5m
Streamer Depth	7 m +/- 1 m
Group Capacitance	0.128 uF/6.25
Group Sensitivity	20Volts/Bar
Active Data Acquisition Modules	27
Passive Data Acquisition Modules	2
Passive Power Module	1
Number of Stretch Sections	3
In Front of each Streamer	2
End of each Streamer	1
No of Compasses per Streamer	16
No of Depth Transducers per Streamer	16

2.2 Streamer Layout 4050m



2.3 Streamer Configuration 4050m

POLAR DUKE **STREAMER DIAGRAM**
STREAMER 4050 meters
GROUP INT 12.5m **DATE** 25th Dec 2002
BIRD COILS Head
MODULES 48 Leadin 116m Deployed

Section	Patch	Ser. No	Mdl	clip on	Lead	Weight	Chann.	Bird	S/N	Fin	SRD	Comments.
Lead In												
Slip Ring		10286	2-P									
Armored		0398-10020				60.kg						
Stretch	H	1296-10020										
		10291	1-P									
Stretch		0498-10555HS										
54		0397-10543		3.5	0	3.5kg	319\324	**16**	**7227**			Chnl 319 dead
		3122	27									
53		0397-10598		2	0	2.kg	313\318					
52	C	0297-10496		1.5	0	1.5kg	307\312	**15**	**22741**		**SRD**	
		3142	26									
51		0397-10532		2	0	2.kg	301\306					
50		0397-10562		2	0	2.kg	295\300					
		1924	25									
49	C	0397-10553		2	0	2.kg	289\294					
48	C	0397-10547		3	0	3.kg	283\288	**14**	**8087**			
		2582	24									
47		0397-10589		2	0	2.kg	277\282					
46	C	0397-10583		2	0	2.kg	271\276					
		1898	23									
45	C	0297-10518		3	0	3.kg	265\270					
44		0397-10536		3	0	3.kg	259\264	**13**	**11758**			
		2588	22									
43		0297-10461		2	0	2.kg	253\258					
42		0397-10571		3	0	3.kg	247\252					
		1872	21									
41		0397-10567		3	0	3.kg	241\246					
40		0397-10551		4	0	4.kg	235\240	**12**	**12198**			
		1804	20									
39		0397-10565		3	0	3.kg	229\234					
38		0297-10485		3	0	3.kg	223\228					
		7058	19									
37		0397-10582		3	0	3.kg	217\222					
36		0297-10499		3	0	3.kg	211\216	**11**	**10560**		**SRD**	
		1895	18									patch
35		0297-10505		2.5	0	2.5kg	205\210					
34		0298-31380		1.5	0	1.5kg	199\204					
		7067	17									
33		0397-10545		2	0	2.kg	193\198					
32		0397-10593		2	0	2.kg	187\192	**10**	**15333**			
		7069	16									
31		0598-31587		3	0	3.kg	181\186					
30	C	1197-20982		3	0	3.kg	175\180					
		3133	15									
29	C	0297-10474		3	0	3.kg	169\174					
28		0397-10557		1.5	0	1.5kg	163\168	**9**	**18424**			
		1907	14									
27		0998-31803		3.5	0	3.5kg	157\162					
26		0397-10546		2	0	2.kg	151\156					

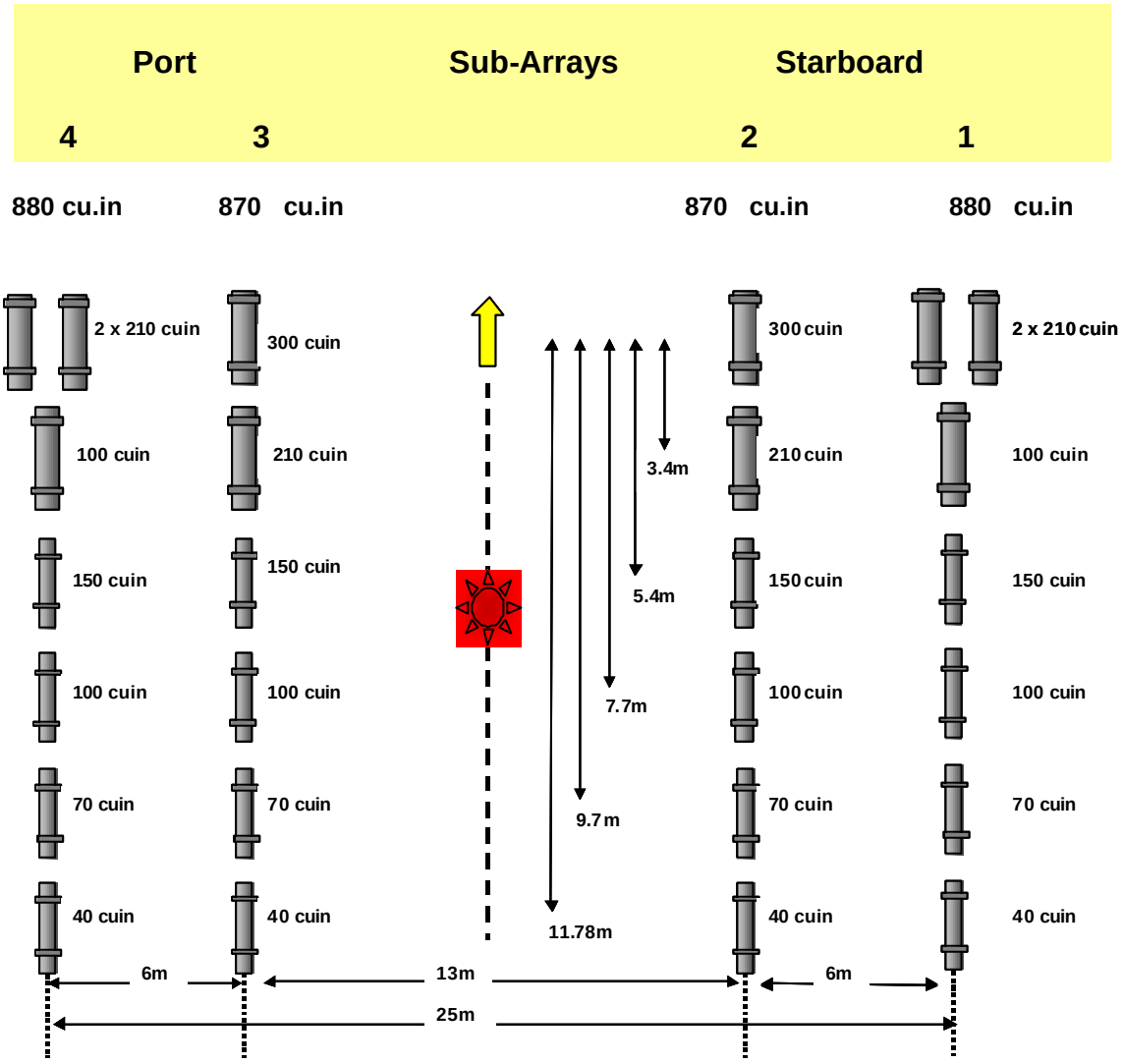
Section	Patch	Ser. No	Mdl	clip on	Lead	Weight	Chann.	Bird	S/N	Fin	SRD	Comments.
		3143	13									
25	C	0397-10577		2	0	2.kg	145\150					
24		0597-10682		3.5	0	3.5kg	139\144	**8**	**19014**			
		3245	12									
23	C	0397-10542		2	0	2.kg	133\138					
22		0297-10524		2	0	2.kg	127\132					
		3238	11									
21	C	0397-10538		3	0	3.kg	121\126					
20		0397-10554		3	0	3.kg	115\120	**7**	**17866**		**SRD**	
		2579	10									
19	C	0397-10548		1.5	0	1.5kg	109\114					
18		0397-10568		1	0	1.kg	103\108					
		3237	9									
17		0197-31025		3	0	3.kg	97\102					
16		0397-10533		2.5	0	2.5kg	91\96	**6**	**7584**			
		3139	8									
15		0297-10489		2	0	2.kg	85\90					
14		0197-10395		3.5	0	3.5kg	79\84					
		2578	7									
13		0397-10579		1.5	0	1.5kg	73\78					
12		0297-10527		1.5	0	1.5kg	67\72	**5**	**26078**			
		3126	6									
11	C	1197-20983		1.5	0	1.5kg	61\66					
10		0697-31296		1.5	0	1.5kg	55\60					
		2583	5									
9		0397-10570		3.5	0	3.5kg	49\54					
8		0297-10587		3	0	3.kg	43\48	**4**	**18848**			
		3251	4									
7		0297-10509		1	0	1.kg	37\42					
6	C	0297-10476		2	0	2.kg	31\36					
		3252	3									
5		0397-10594		2	0	2.kg	25\30					
4		0297-10520		1.5	0	1.5kg	19\24	**3**	**15223**		**SRD**	
		3234	2									
3		0498-31559		1.5	0	1.5kg	13\18					
2		0397-10595		2	0	2.kg	7\12	**2**	**20006**			
		2575	1									
1		0397-10541		1.5	0	1.5kg	1\6	**1**	**7606**			
4metre	1097-10024-4T											
Stretch	SS1-0297-1388HS											
		12156	PP									
Stic												
Tailbuoy												

3 Source Configuration

3.1 Source System Description

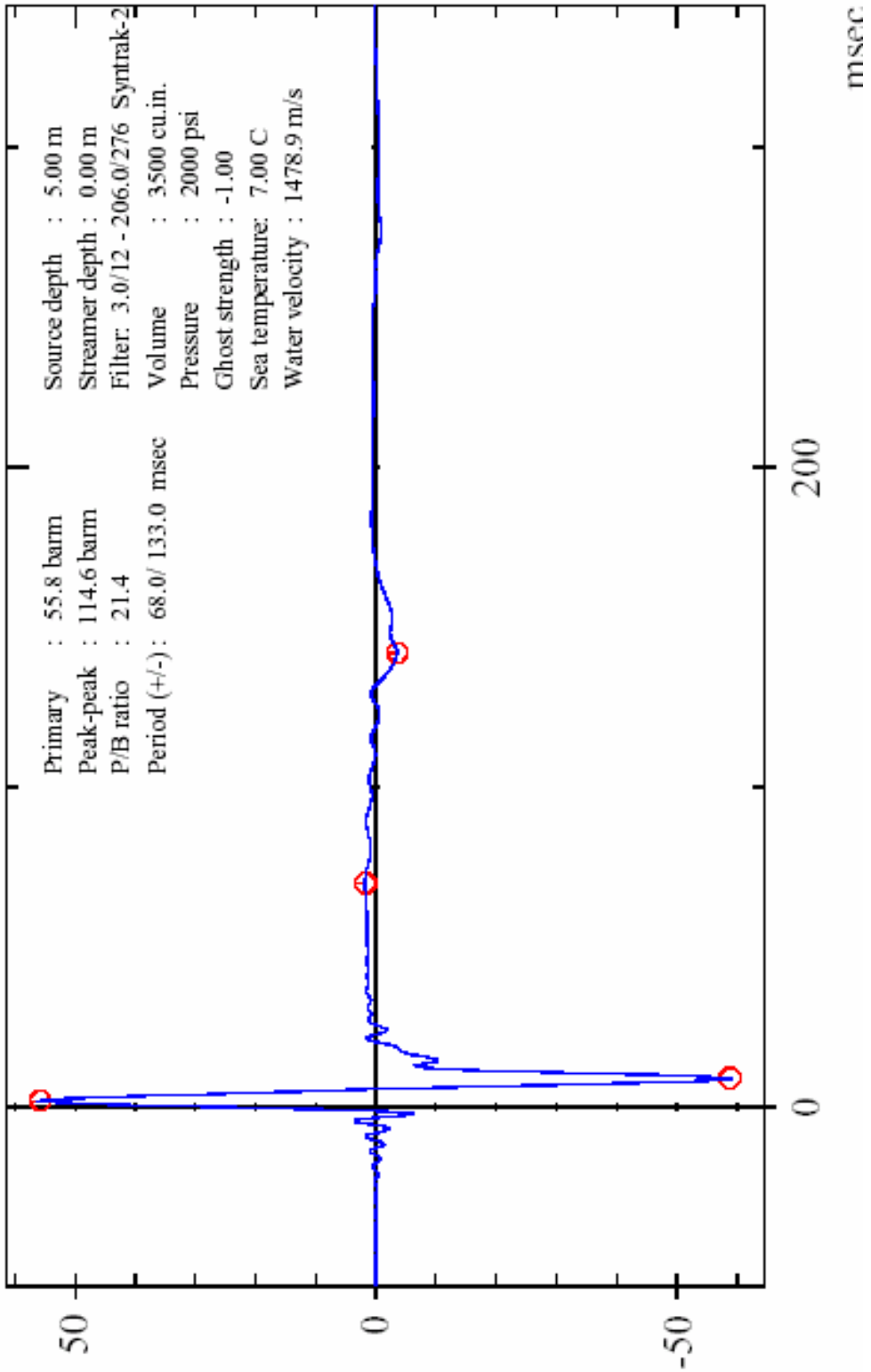
Source Parameters	
Number of Source Arrays	1
Array Separation	N/A
Array Length	11.78m
Array Width	25m
Number of Strings per Array	4
Source Volume	3500 cubic inches
Number of Hydrophones per Array	4
Number of Depth Transducers per Array	12
Number of Guns per Array	26
Number of Clusters per Array	2
Airgun Type	VS-X Sleeve Air Gun
Operating Pressure	2000 psi. (nominal)
Depth of Guns	5m
Peak-to-Peak Amplitude	114.6 barm
Primary-to-Bubble Ratio	21.4

3.2 Source Layout

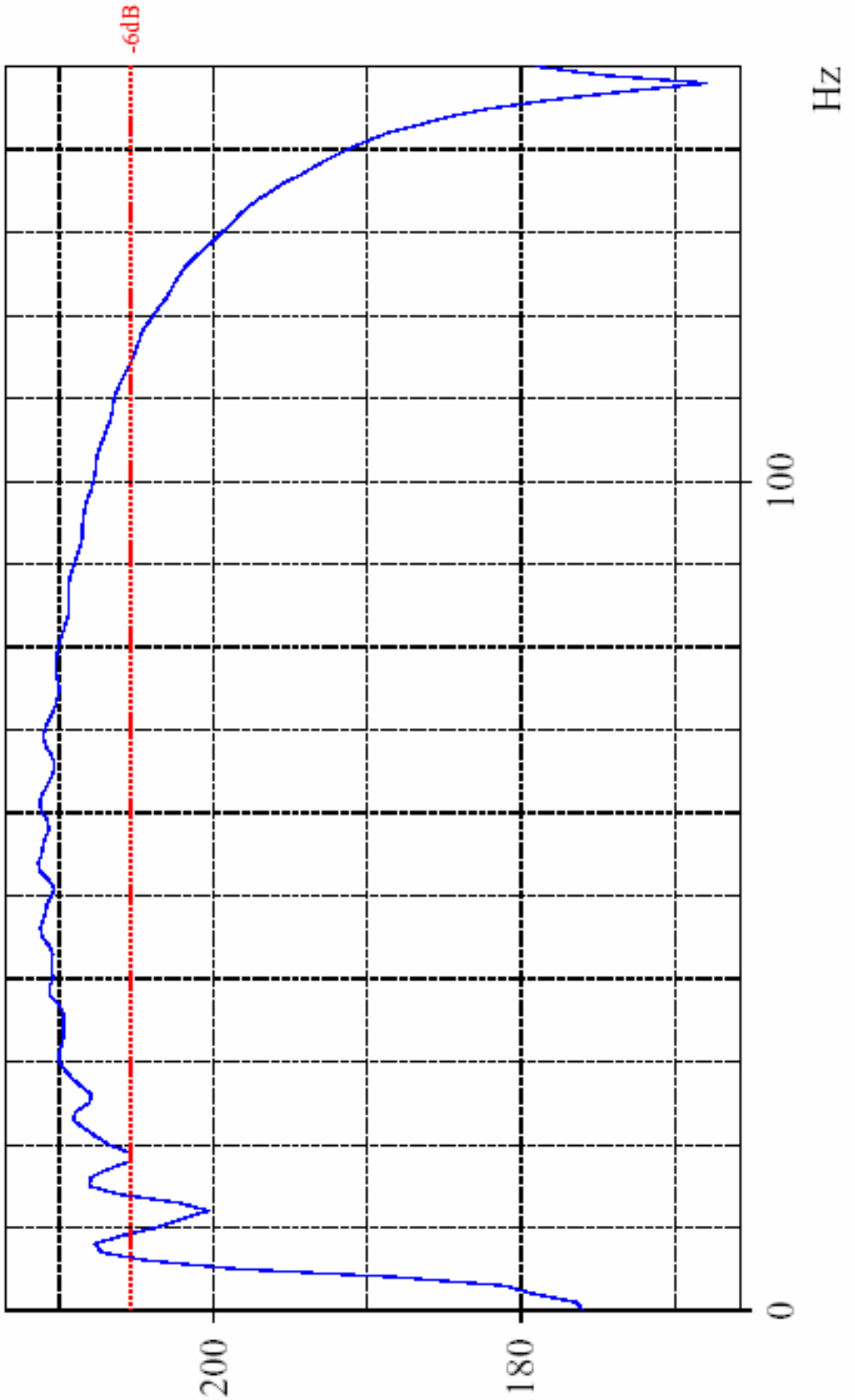


The source array consists of 4 sub-arrays with a total volume of 880 cu.in. for each outer array, and a total volume of 870 cu.in. for each inner array. Each outer sub-array contains 6 gun locations with a total of 7 guns per sub-array. Each inner array consists of only 6 guns.

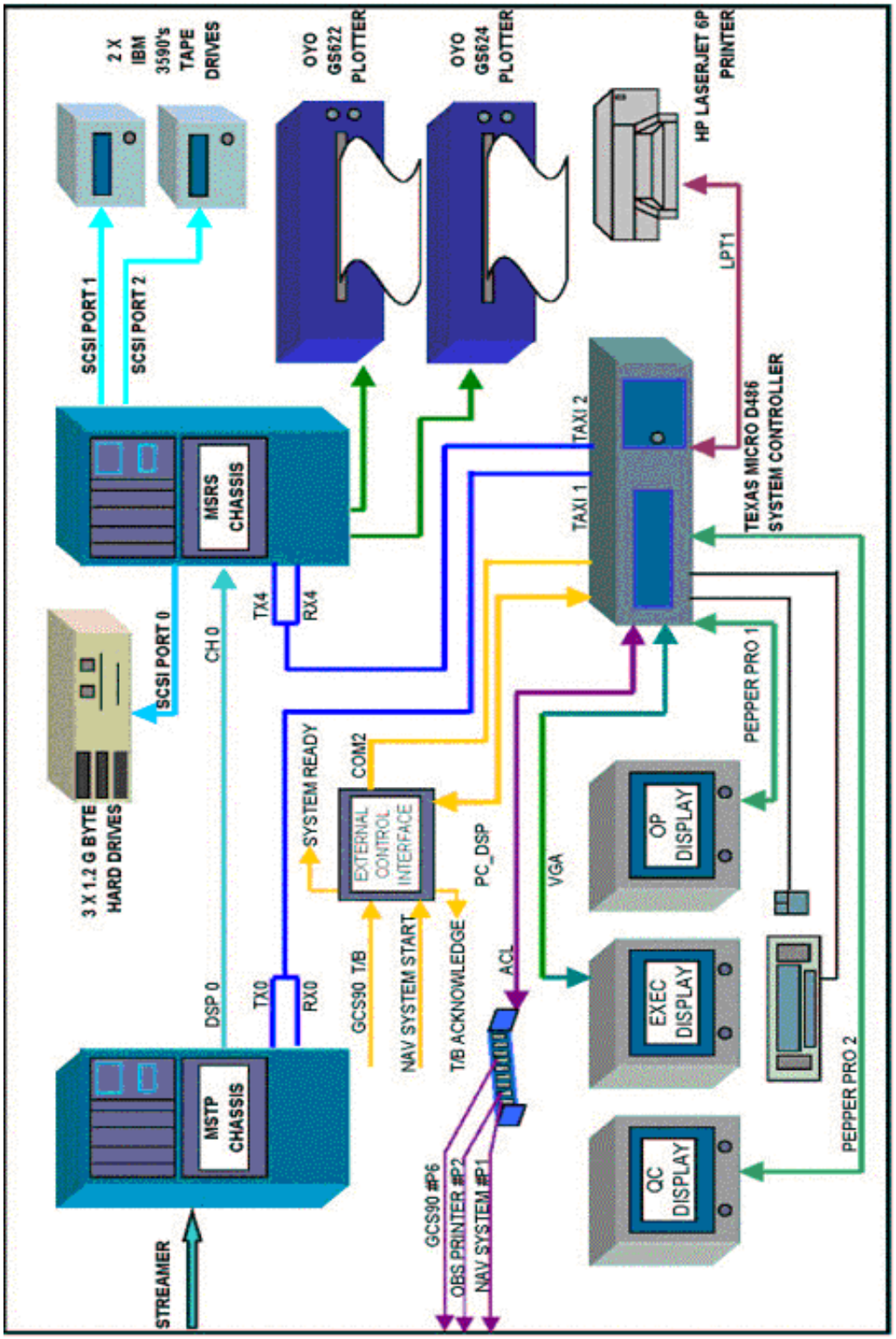
3.3 Far Field Signature



3.4 Amplitude Spectrum



4 Instrumentation Room System Diagram



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1 Navigation and Positioning System Description

1.1 System Configuration

1.1.1 Navigation Hardware and Software

System	Hardware (Type and Serial No.)	Software version
CONCEPT	Spectra Integrated Navigation Sys.	9.8.03
FGPS	SeisPos navigation processing sys	10.80/11.00
External Header	General Header	Syntron v2
Acoustic System	None	
TS-meter	SD204	Minisoft 200W
Echo sounders	Simrad EA-500 12Khz Furuno FCN-271	
Gravity sensor	N/A	
Current Meter	None	

1.2 Survey Positioning Method Used

The survey was carried out using MGC's standard mode of operation for single streamer and single source surveys. Positioning of the vessel was by differential DGPS, with delivery of differential correction data in RTCM-104 format.

Source and front-end streamer positions were computed by gyro compass orientated layback from the reference point to tow-point, and first compass from the tow-point to the centre of source and centre of the near group. The offset from the centre of source to centre of the near group was verified by use of waterbreaks. Streamer tail end positioning was accomplished by compass streamer modelling and an active GPS tail buoy.

1.3 Surface Positioning

1.3.1 Vessel Navigation

Summary

System 1: Trimble 4000SSi Receiver
RTCM Delivery System: Fugro Starfix via the Optus SPOT satellite link
Computation Software: Fugro MRGPS version 2.4.09

System 2: Trimble 4000SSi receiver
RTCM Delivery System: Fugro Starfix via the Inmarsat AP-SAT SPOT satellite link.
Computation Software: Fugro MRGPS version 2.4.09

Fugro MRDGPS interfaced to the Spectra System provided primary vessel positioning.

The two sources of corrections were transmitted to and received onboard the vessel by independent means thereby providing a high degree of redundancy to ensure continuous vessel positioning.

Although Selective Availability was turned off in May 2000 differential corrections are still required in conjunction with GPS positioning to provide a high quality continuous vessel position.

Reference Stations Used (Primary System) Source: Spot Optus

Name	ID	Latitude	Longitude	Distance	Comments
Melbourne	385	037°48’29.014” S	144°57’48.027” E	325 km	Selected constantly
Bathurst	336	033°25’46.902” S	149°34’01.960” E	930km	Selected constantly
Brisbane	275	027°28’38.507” S	153°01’37.338” E	1640km	Selected constantly
Dunedin	026	045° 52’10.214” S	170°30”39.315” E	2550km	Selected constantly
Broome	185	017°57’36.389” S	116°04’32.992” E	2900km	Selected constantly

Reference Stations Used (Secondary System) Source: Inmarsat POR and Spot ApSat

Name	ID	Latitude	Longitude	Distance	Comments
Melbourne	385	037°48’29.014” S	144°57’48.027” E	325 km	Selected constantly
Bathurst	336	033°25’46.902” S	149°34’01.960” E	930 km	Selected constantly
Kalgoorlie	315	030°45’06.959” S	121°28’49.881” E	2000 km	Selected constantly
Townsville	195	019°15’52.647” S	146°48’44.108” E	2200 km	Selected constantly
Darwin	125	012°22’25.628” S	130°52’17.261” E	3100 km	Selected constantly

1.3.2 Float Navigation

Source surface navigation was provided by the MRDGPS software and interfaced to Spectra. The in-sea units incorporated a GPS receiver and interfacing for direct data transmission of the raw satellite position by conventional UHF telemetry radio.

Raw GPS position from the floats was compared against the GPS position of the vessel and a range and bearing calculated. These range / bearing values were input into Spectra with a resultant relative position better than 3 metres.

1.4 Streamer and Source Positioning

1.4.1 Streamer Compasses

4050m Configuration

16 series 5011 Digibird combined magnetic compass and streamer depth controllers were attached to the streamer.

Compass Sampling Rate = 2 seconds
Averaging constant = 14 seconds

Magnetic Declination entered into Spectra for the GBS02 prospect was: *13.68°* at Position: 038°30'00.000"S 149°15'00.000"E

The computation was performed using GeoMag V2.2.0.0 for 2002-09-01 and verified by Ship's Charts.

Compass performance was monitored on a line-to-line basis throughout the acquisition phase of the survey.

1.4.2 Gyro Compass

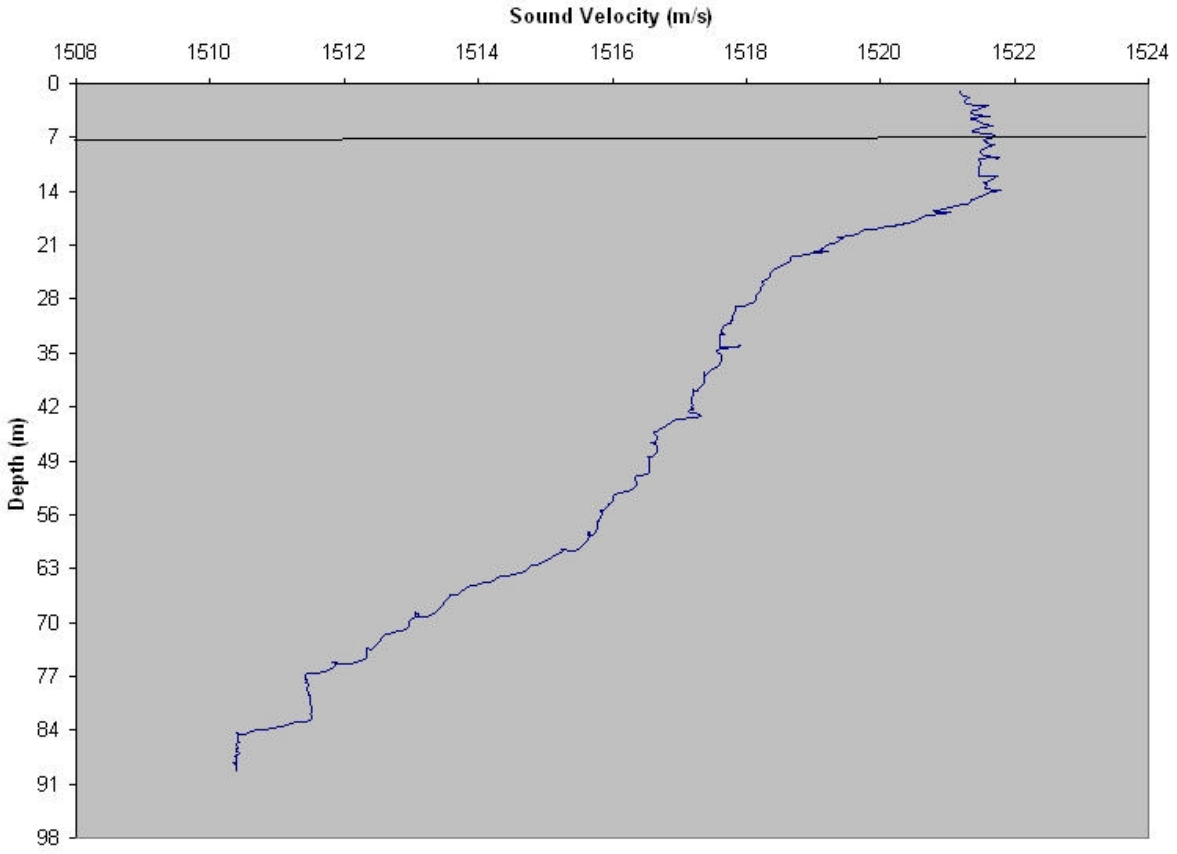
The gyrocompass used during the survey was:

Primary Gyro 1:	Anschutz Kiel Type:110-310 Serial No: 3974
Secondary Gyro 2:	Anschutz Kiel Type:110-310 Serial No: 5185

1.4.3 Velocity of Sound in Water

On the start up of prospect GBS02, the 01st of January 2003, a T/S dip was performed.

The mean value of this T/S dip was 1516 m/s and was entered into Spectra. The result is illustrated in the graph below:



1.4.4 Echo Sounders

Primary echo sounder:	Simrad Model EA500 12KHz
Secondary echo sounder:	Furuno Model FCN-271

The echo sounders speed of sound was set to 1516.0 m/s. A draught correction of ZERO was entered in both echo sounders. The water depth exceeded the range of the secondary echo sounder and consequently no data was recorded with this sensor throughout the survey.

2 Navigation Systems Verification and Monitoring

2.1 Echo Sounder Verification

The primary echo sounder, Simrad EA-500 12khz, was installed and tested by qualified technicians January 15, 2002 while in port Singapore.

A lead-line verification was carried out on the secondary Furuno FCN-271 echo sounder while alongside East Arm Wharf in Darwin, December 2001. Two tests were carried out at one-hour intervals:

Test 1 : 18.5m / 18.0m *Echo sounder reading of 12.1m*

Test 2 : 18.2m / 18.0m *Echo sounder reading of 12.1m*

Average lead-line distance = 18.17m

All depths recorded are based on the position of the Fathometer's transducer on the vessel's Hull. Depths are NOT draught corrected and all depths should have 5.65m added to the depth to give the true water depth from the surface.

2.2 Gyro Monitoring

C&B Survey Group was appointed to carry out the Gyro calibration work on M/V Polar Duke at Cairns dock in Australia. The datum point for GPS observations was PSM no.52097 and verified with measurements to PSM no.45129. The true bearing between the 2 points was calculated from the measured co-ordinates. Two independent RTK measurements were taken at each of the 2 control points and compared to ensure the accuracy of the derived bearing. A Leica TC1010 Total Station was then used to take simultaneous readings to the centres of the stern and bow of the vessel and the UTC time of each observation recorded. Gyro readings onboard were recorded and later compared between the surveyed azimuths and hence a difference was derived. This difference was then applied to both gyros in Spectra as a correction. The Gyro Calibration was performed in a southwesterly direction. The results are shown below:

Gyro calibration results for the 05th of November 2002.

The results were as follows:

Gyro 1 Primary

Ship Heading @ 192°: *-0.90 Degree C-O*

Applied Ships gyro Correction: (minus) -0.90 Degrees

Gyro 2 Secondary

Ship Heading @ 192°: *-1.80 Degree C-O*

Applied Ships gyro Correction: (minus) –1.80 Degrees

2.3 GPS Monitoring

DGPS verification was carried out after the gyro calibration. The primary and secondary GPS antennas were checked before and after a 20 minute logging session using the Differential GPS systems onboard the vessel. The mean of the 2 RTK measured positions for each antenna was compared to the mean of the Differential GPS position logged over the 20-minute period to verify the GPS systems.

The results are shown below:

GPS1	*Latitude*	*Longitude*
Differential GPS Position	*-16.927426*	*145.780393*
RTK Surveyed Position	*-16.927410*	*145.780393*
Difference	*0.000016 (~1.7m)*	*0.00m*

GPS2	*Latitude*	*Longitude*
Differential GPS Position	*-16.927427*	*145.780392*
RTK Surveyed Position	*-16.9274135*	*145.7804085*
Difference	*0.0000135 (~1.5m)*	*0.0000165 (~1.8m)*

2.4 rGPS Monitoring

While alongside in Cairns, an integrity check of the rGPS pods was carried out. A coordinated point was established on the quayside, which was surveyed by taking the mean of 3 independent RTK measurements. Each pod was then positioned upon this point with range/bearing data to each pod being recorded for 10 min sessions. dGPS data was simultaneously recorded during each session. The range/bearing was computed between the vessel's dGPS position and the coordinated point, and then compared with the observed range/bearing to each rGPS pod. The C-O difference for each pod is shown below:

Pods in use	*C-O Difference (Range/Bearing)*
Pod 689	*0.49m / 1.11°*
Pod 869	*0.98m / 0.49°*
Pod 870	*0.12m / 0.68°*

Spare	*C-O Difference (Range/Bearing)*
Pod 1065	*1.10m / 1.12°*
Pod 864	*1.99m / 3.18°*

3 Navigation Processing

Navigation post-processing was carried out on-board through to UKOOA P1/90 final data format.

3.1 The *SeisPos* System

Created and Supported by Fast Geophysical Positioning Solutions (FGPS) in Swanley, Kent, UK.

SeisPos is a Windows NT/2000/98/95 software program, which enables processing of raw navigation data for marine seismic streamer surveys from UKOOA P2 raw data format to UKOOA P1/90 final data format. ***SeisPos*** supports simultaneous multiple projects and background processing. Data formats supported are UKOOA P2/91 and P2/94. The following Modules are used:

Input: reads the data stored in UKOOA P2 format and compiles a log of warnings. Implicitly alerts the user of format integrity problems. Stores all data in a proprietary format relational database.

Precondition: applies user defined gating, filtering and interpolation/extrapolation parameters to all data and presents interactive time series plots enabling quality appraisal and manual editing and rejection. All raw data is *read only*.

Adjust Network: performs a fully integrated weighted least squares adjustment of the positioning network. This includes LS estimates of streamer rotation and stretch and revised compass offsets and bearings for the interpolation of receiver group positions based on the concatenation of circular arcs between all nodes (compass or other) along the streamers.
The adjustment computation outputs final node coordinates and corrected compass positions and bearings along with QC data using a staged process enabling the survey line to be processed in as many sections as may be required according to data quality.

Output: interpolates receiver group positions and outputs selected records to file in UKOOA P1/90 format.

QC: allows analysis and manipulation (comparisons, rate of change etc.) of time series plots of all data and adjustment statistics (coordinates, error ellipse semi-major axes, processed observations, SD's, residuals, rotation, stretch, unit variance, redundancy, number of iterations. Shot time and distance interval).

Database: allows analysis, editing and textual output of all header and data tables stored in the database at all stages of the process.

3.2 Quality Control – *P1Tools*

P1Tools is a quality appraisal and utilities package for the QC of final data stored in UKOOA P1/90 format. The package operates on the Windows platforms. The modules incorporated are:

QC Nodes: enables time series analysis of shot to shot user specified node movement along orthogonal and radial axes. Outputs summary statistics to .csv file.

QC Offsets: enables time series analysis of shot to shot user specified node offsets along orthogonal and radial axes. Also provides integrity check for the type and number of nodes, the source firing sequence and the shot point range. Outputs summary statistics to .csv file.

Compare: enables time series analysis of position differences for user specified nodes between two P1/90 data sets along orthogonal and radial axes. Outputs summary statistics to .csv file.

Extract: outputs user selected data to ascii file for further analysis and third party software use.

Replay: two-dimensional replay of the vessel, source, receiver groups and tail buoy.

4 Observations

4.1 Navigation Summary

All systems performed well throughout the survey period except for ramp in Position Dilution of Precision (PDOP) during which there was a reduced number of satellites in view.
We did also loose gyro #2 d/t a failure with the unit itself. This had no effect on the data since we are using gyro #1 as master in Spectra.

4.1.1 DGPS

V1G1 Primary dGPS System using SCF corrections from stations Melbourne SF (385), Bathurst (336), Brisbane (275), Dunedin (026) and Broome SF (185) performed well throughout the whole survey.

V1G2 Secondary dGPS System using corrections from Melbourne (385), Bathurst (336), Kalgoorlie (315), Townsville (195) and Darwin (125) performed well throughout the whole survey.

Both systems had periods of high PDOP from 1430 to 1830 hours local time due to the occurrence of poor satellite geometry and low number of satellites in view. In these periods both systems were switched to height aiding based on the local geoidal height in the survey area. The geoidal height was based on both observations of the height during Auto 3D positioning and calculations from NIMA EGM96 Calculator. Both methods indicated the same geoidal height. The onboard client also approved this.

4.1.2 rGPS

The tail buoy and source positioning was working fine all through the GBS02 job.

5 Conclusions

In total there were 9 sequences shot, with all navigation systems working well throughout the survey except from gyro #2.

The Transverse Mercator utilised for this survey centred around 147° E with the Survey Datum being GDA-94 in the GRS-80 spheroid. Final p190's were provided in the GDA-94 datum.

6 Navigation System

The navigation system is made up of two GPS (Global positioning system) units with differential corrections and an integrated navigation package (Spectra). The GPS are Trimble 4000SSi units. Differential corrections are supplied by Spot satellite for the primary system whereas the secondary system consists of corrections from Inmarsat. The navigation package allows a great deal of flexibility and reliability.

6.1 Spectra Integrated Navigation System

6.1.1 General

Spectra, a real-time navigation system, sends and receives information via two acquisition systems referred to as Runts which contain interfaces to communicate with the vessel's navigation system. Using triggers (both internal and external), Spectra can synchronize systems with events generated inside and outside of Spectra. Hence data can be conveyed for successful acquisition.

6.1.2 File and Menu Structure

Spectra logs a p294 raw data file and a processed p190 data file, along with quality control and audit files, to a directory that is user selected via a system boot file which, when manually started, instructs Spectra which configuration files to use in the boot process. These configuration files are contained in a user created directory.

6.1.3 Displays

Spectra enables operator-configurable displays that are adjustable in size and content. The display system enables the operator to monitor all attached devices, data quality in real-time as well as multiple video displays of lines being tracked and online statistics. Spectra offers a real-time steering display, which is utilized by the bridge and is a direct representation of the current location.

6.1.4 Survey Line Tracking

Survey pre-plots were supplied using GDA-94 co-ordinates.
The projection used:

Transverse Mercator
Origin Longitude 147°E
Origin Easting: 500000.000
Origin Latitude 000°
Origin Northing: 10000000
Scale factor: 0.9996

Semi-major Axis: 6378137.000
Inverse Flattening: 298.257222100
(No datum shifts were incurred from WGS-84 to GDA-94).

Spectra used a cocktail of the positions from both navigation systems to derive a weighted real-time position, which can be compared to a predictive position, for the next successive position for the shot point.

6.1.5 Data Logging

Spectra was configured to generate a data logging event mark based on a distance of 25 metre spacing. Spectra is configurable to record either all possible records or selected position records. Data is stored in a directory in standard comma delimited ASCII format, allowing files to be easily read by any popular spreadsheet or text editor. Primary media for data storage is hard disk whilst the secondary system consists of a Mammoth Exabyte tape drive.

6.1.6 System Timing

Timing is achieved via independent, stand-alone GPS receivers that are directly interfaced to each of the Runts. Each separate GPS receiver also offers a stand-alone (non-differential) position input in circumstances where either primary or secondary position systems are unavailable. During this survey, a differentially corrected position was available all the time.

6.1.7 Streamer Modelling

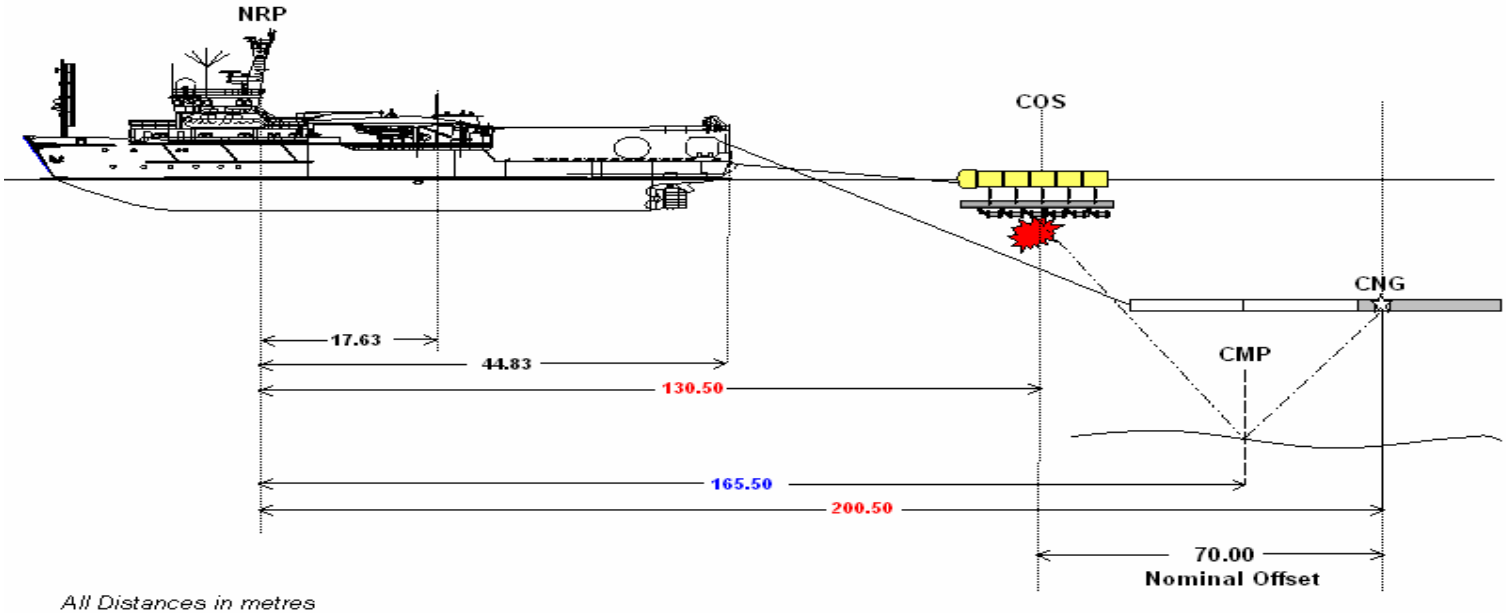
Spectra is able to perform streamer modelling in real time and calculate the associated P190 format for direct logging to disk or output via serial port. The streamer is shown on the graphics window in real time.

6.1.8 Compass Device

The current streamer modelling capability requires the interface to the Digicourse 293A bird surface unit. The configuration of the interface is a typical serial port configuration. Communication can be bi-directional enabling Spectra to query the Digicourse unit as well as receive data from it.

7 Offset Diagram

Polar Duke In-Sea Towing Dimensions / Offset Diagram
Date: January 2003
Client: SANTOS/Bass Strait Oil Company
Area: GBS02 VIC/P41, Victoria, Australia
Streamer Length: 4050m



All Distances in metres

Distances:		Principle Offsets:	
NRP - Stern	44.83	COS - CNG	70.00
Stern - COS	85.67	NRP - CMP	165.50 *(Spectra shot layback)*
Stern - CNG	155.67	NRP - CNG	200.50

DIAGRAM NOT TO SCALE

Key
CNG Centre Near Group
NRP Navigation Reference Point
COS Centre of Source
CMP Common Mid Point

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1 Instrumentation and QC System Description

System	Hardware	Description
Recording System System Controller	Syntrak 960-24 Bit Processor CPU Memory Disk Storage Input Voltage Frequency VME Link Graphics Display, High Res. Graphics Display, VGA Res.	Version 3.60B 80486DX4 32 Mbytes 1.0 Gigabyte 90-132 Vac or 180-264 Vac 47-63 Hz DSP-Controller, 55-mbps serial link Two 1280x1024 Graphic Card One 800x600 Graphic Card
Tape drives	IBM 3590 (10 Gb)	
Plotter	OYO 624 & 622	
Onboard QC	ProMAX	Version 4.76
Source Controller	GCS90 Processor DRAM Hard Disk	Intel 486DX @ 33 MHz 32 Mb 40 Megabytes, IDE
Bird Controller	DigiSCAN Model 293 Processor DRAM Hard Disk	Version 2.72A Am5x86-P75-S @ 133 MHz 64 Mbytes 1.0 Gigabyte
SAGE Gravity Data Acquisition System.	LaCoste & Romberg Gravity Meter / gyro stable platform. Hard Disk drive	
SeaSPY Marine Magnetometer	Proton Precession Marine Magnetometer Sensor	

2 Instrumentation and QC Test Start up Tests

At start of survey, a complete set of instrument tests were performed and all tests were well inside the manufacturer's specifications.

Date	DCR	CGA	HD	CMR	IR	CIO	CIE	HL	RMS	COMMENTS
01/01	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	CH # 223 Leakage CH Dead

2.1 Daily and Monthly Tests

The daily test produced 9 files and the Monthly test 36 files.
Abbreviations used for test names in the test sequence tables:

- ✓ **DCR DCO/Noise/Range**: Performs three tests. DC offset checks the value of the residual voltage remaining across the amplifier's output terminal when the input voltage is zero. Internal Noise Test checks the value of the internal noise level in the module with inputs grounded. Dynamic Range Test checks the ratio of the maximum to the minimum signal input power levels over which the amplifier can operate.

- ✓**CGA** **Channel Gain Accuracy** introduces a known square wave into the amplifier and compares the sampled output signal with the known input.

- ✓**HD** **Harmonic Distortion** test measures amplitude versus frequency characteristics and checks for any undesired harmonics introduced by the modules.

- ✓**CMR** **Common Mode Rejection** test provides synthesized sine waves to both inputs of the preamplifier and measures the rejection of this common signal by the amplifier. The amplitude of the sine wave is 0.8 full scale.

- ✓**IR** **Impulse Response** test measures the response of the system to the low-cut and high-cut as well as the mid-band pass.

- ✓**CIO** **Crosstalk Isolation** (Odd Channels are grounded) test measures the noise appearing in one signal path as the result of coupling from other signal paths.

- ✓**CIE** **Crosstalk Isolation** (Even Channels are grounded) – same as above.

- ✓**HL** **Hydrophone Leakage** test measures the electrical resistance in the phone.

- ✓ **RMS** Checks the noise level in the streamer.

2.2 Daily Tests

Date	DCR	CGA	HD	CMR	IR	CIO	CIE	HL	RMS	COMMENTS
02/01	O.K	O.K	O.K	O.K	O.K	O.K	O.K	O.K	O.K	CH # 223 Hyd Lkg
03/01	O.K	O.K	O.K	O.K	O.K	O.K	O.K	O.K	O.K	CH # 223 Hyd Lkg
04/01	O.K	O.K	O.K	O.K	O.K	O.K	O.K	O.K	O.K	CH # 223 Hyd Lkg
05/01	O.K	O.K	O.K	O.K	O.K	O.K	O.K	O.K	O.K	CH # 223 Hyd Lkg

2.3 End of Job Test

Date	DCR	CGA	HD	CMR	IR	CIO	CIE	HL	RMS	COMMENTS
5/01	O.K	O.K	O.K	O.K	O.K	O.K	O.K	O.K	O.K	CH # 223 Lkg .

2.4 Instrument summary

The Recording instruments suffered very little Technical down time during the survey.

Full System tests were carried out and recorded to tape at the start and finish of the contract. Further daily tests were carried out when the opportunity arose, to verify continued system performance. The tests showed that the Syntrak system was stable and well in specification throughout the contract. At the beginning of the job there were no dead hydrophone groups in the streamer, and only hydrophone leakage on Channel 223 (however not observed as bad on raw and brute stacks).

Nominal streamer/gun offset distance was confirmed using a test shot from a single gun in the centre of the array. Distance to the centre of the first active group was near 70m. These measurements were made regularly to confirm consistent offset positioning throughout the survey.

3 QC Products and Processing Sequence

3.1 General

The stand-alone ProMAX system was used for QC purposes. The system was not connected on line. Therefore data for each sequence was read from the tapes. Two 3590 drives were used for this purpose. The processing sequence was followed in order to produce raw and brute stacks plots, near trace displays and RMS plots.

3.2 Raw/Brute Stacks

Raw and brute stacks were produced for each line. Paper plots of both stacks were made at the end of line.

3.3 Processing Sequence for Raw Stack:

Input 1 cmp line per sail line:	*324 channels*
Data reduction	*Resampled from 2ms to 4ms; Marine Trace Decimation (2:1 trace summation)*
Edits:	*Exclude bad shots, noisy/spiking channels*
Filter:	*Single band-pass filter: Ormsby 4-8-90-120 Hz*
Gain recovery:	*Spherical divergence: 1dB/s from water bottom to 6.0 s*
Normal Move-out Correction:	*Velocities picked for each line every 4km and written to velocity database*
Pre-stack mute:	*Tied to water bottom times*
Stack:	*Mean method for trace summing*
Stack Root N scaling	*81 fold*
Bulk shift static	*9 ms*
Output:	*To disk file*
Method of scaling:	*Un-scaled*
Display:	*Paper plots: 8 cm/s, 20 traces/cm*

3.4 Processing Sequence for Brute Stack:

Input 1 cmp line per sail line:	*324 channels*
Data reduction	*Resampled from 2ms to 4ms; Marine Trace Decimation (2:1 trace summation)*
Edits:	*Exclude bad shots, noisy/spiking channels*
Filter:	*Band-pass filter:* *Ormsby 4-8-90-120 Hz*
Gain recovery:	*Spherical divergence: 1dB/sec from water bottom to 6.0 s*
Pre-stack mute:	*Pre-decon mute; Tied to water bottom times*
Minimum phase predictive deconvolution	*Operator length = 240 ms* *Operator prediction distance = 32 ms* *Deconvolution gate, tied to water bottom times*
Filter:	*Band-pass filter:* *Ormsby 4-8-90-120 Hz*
Normal Move-out Correction:	*Velocities picked for each line every 4km and written to velocity database*
Pre-stack mute:	*Post NMO mute;* *Tied to water bottom times*
Stack:	*Weighted method for trace summing, based on square root of offset*
Stack Root N scaling	*81 fold*
Bulk shift static	*9 ms*
Output:	*To disk file*
Method of scaling:	*AGC with operator of 1000ms*
Display:	*Paper plots:* 9 cm/s, 40 traces/cm

3.5 FK, FT and Spectral Analysis

This helped to identify noise sources and QC data. The analysis was performed in a window of 500-6000ms. Although FK and FT plots/displays were produced for a number of lines, the spectral analysis proved to be the most useful to determine the frequency range for noise and data.

3.6 RMS Analysis

3.6.1 Shallow RMS Window

RMS values from 1000ms to 1500ms of the record were calculated for every trace and each shot. These values were displayed for identification of noise sources and noisy traces. Filtered shot vs. trace RMS values were produced by applying a bandpass filter prior to the RMS calculation. Cable averaged RMS values were stored on disk for the later use.

3.6.2 Processing sequence:

1. Data Input:	*All shots, all channels, window 1000-1500ms.*
2. Scaling:	*By 50 to convert amplitudes from millivolts to microbars.*
3. RMS analysis:	*RMS values calculated for each channel over the range of all shots.*
4. Output:	*To disk file.*
5. Bandpass Filter:	*Ormsby: 4-8-90-120 Hz*
6. Output:	*To disk file.*

3.7 Near Trace Displays, Offline Plots

Near trace data were displayed and annotated with direct arrival times.

1. Collect near traces:	*324 channels*
2. Display:	*0-6000 ms* *8.5 cm/s, 20 traces/cm.*

3.8 Attributes, Online Analysis

ProMAX was set up as an off-line system; therefore real-time data feed was not available.

4 Data Quality / Observations

4.1 Quality Control Summary

The ProMAX system proved to be extremely reliable for checking data quality. The content of all field tapes was checked for each line. Different types of noise were identified and noted in the Observer's Logs where appropriate.

- ✓ Ship Noise
- ✓ Spikes and noisy channels
- ✓ Geological effects (water bottom multiples)
- ✓ Swell Noise
- ✓ Source problems (autofires, misfires, changes in gun volume)
- ✓ Parities Problems
- ✓ Earth Leakage

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1 Introduction

Seismic processing was carried out in order to QC the seismic data acquired by the vessel ***Polar Duke*** on behalf of **Santos and Bass Strait Oil Co**. The survey was conducted in the Bass Strait, offshore Gippsland (State of Victoria) in Australia. This comprised the VIC/P41 block. Acquisition was implemented using a source array of 3500 cu in. volume and a single streamer with 324 primary and 12 auxiliary channels.

The survey commenced recording on the 1st January 2003, and was completed on the 5th January 2003. A total of 9 sequences and approximately 203.7 km of full fold seismic data were acquired. Raw and Brute 2D Stacks were processed for all of these lines. On board processing maintained an average processing throughout of 40.7 kilometres per day of 2D, 6000ms record length, 81 fold data.

The data quality was generally very good throughout the survey, with extraneous noise coming primarily from swell. Seismic reflections were easily visible throughout the sections and sharply defined. Multiple energy was also readily apparent. Brute stack processing included an offset weighted stack. The weather conditions were generally good during the survey. A variable degree of swell noise was visible on most of the raw stack sections.

The deliverables for this project were paper copies of QC plots including Raw Stacks, Brute Stacks, Near Trace Displays and RMS plots. 8mm Exabyte tape copies of raw stacks and brute stacks were made in SEG-Y format. Velocities were saved as ASCII files, which were then UNIX tarred to Exabyte tape as well as copied to floppy disk at the end of the survey.

The ProMAX system was a stand-alone machine, with a single operator and two 3590 tape drives. The system performed well throughout the survey with no system or processing problems. Field tape copies were generated in SEG-D format on 3590 tapes, using the ProMAX tape copying utility.

Although the ProMAX was not set up as an on-line system, it was still possible to process every sequence through to brute stack, and produce all the necessary QC plots at a fast enough rate to keep close behind the data acquisition. The two 3590 tape drives proved to be adequate for both tape copying and data loading operations.

The ProMAX system and QC processing consultants were provided by Exploration Partners International Ltd of Mannez Alderney, Channel Islands, UK. Eurotech Computer Services Ltd of Cranleigh, Surrey, UK, set up the computer system and Landmark Graphics Corporation Ltd installed the ProMAX software.

2 Acquisition Parameters

Recording Instruments

Recording System	:	Syntrak
Source controller	:	Syntron GCS-90
Recording format	:	3590 SEG-D 8058 Rev 1
Record length	:	6000 ms
Sample rate	:	2 ms
Low cut filter	:	3Hz – 6dB/Oct
High cut filter	:	206Hz - 276 dB/oct
Channel set 1	:	324 Seismic channels
Channel set 2	:	12 Auxiliary channels

Streamers

Streamer type	:	Syntron
Number of streamers	:	1
Active length	:	4050 m
Number of groups	:	324
Group interval	:	12.5 m
Near trace	:	324
Streamer depth	:	7.0 m +/- 1m
Near trace offset from source	:	70 m

Source

Array type	:	Airgun
Total volume	:	3500 cu in
Air pressure	:	2000 psi
Gun depth	:	5.0 m +/- 0.5 m
Number of sub arrays	:	4
Shot point interval	:	25.0 m

Navigation

Primary Navigation	:	Fugro MRDGPS: Starfix+ Dual frequency
Secondary Navigation	:	Fugro MRDGPS Inmarsat Direct Injection

3 Personnel and ProMAX QC System

EPI Consultant Processing Geophysicists

1st January 2003 to 5th January 2003: Adam Gebarski

Onboard Processing Hardware

Machines	:	*1 SUN Ultra 60 (2xUltraSPARC-II 450MHz)*
Memory	:	*1024 Mb*
Monitor	:	*Iiyama*
Hard Disk Drives	:	*70 GB*
Tape Drives	:	*2 x 3590 IBM tape drives*
	:	*2 x 8mm, Exabytes, Artecon*
CD Drives	:	*1 x DVD*
Plotters	:	*1 OYO GS-624 thermal plotter (24 inch)*

Software

ProMAX 2D	:	Version 1998.6
IBM Operating System	:	UNIX (SunOS Rel 5.6)

Data loading was accomplished entirely via 3590 copy tapes. There was no on-line connection of the ProMAX to the data acquisition system.

As there was no on-line SEGD tape copying, the ProMAX system had to be used for all the Tape Copying operations. Copy tapes were generated in SEG-D format on 3590 tapes using the ProMAX tape copy utility. Copy tapes were used for data loading and seismic processing for verification of original as well as copy tapes.

4 Raw Stack Processing Sequences:

SEG-D Input From Tape		
Reformat to ProMAX internal format		Read 324 channels + 12 auxiliary channels. Input 10000ms
↓		
Resample / Desample		From 2 to 4 ms. Hi-Fi antialias filter applied in module
↓	——→ **Auxiliary Channel QC**	On screen QC. All auxiliary channels
↓	——→ **Near Trace Display**	On screen QC. Ch 324
	Pick WBT	
↓	–→ **HARDCOPY (with direct arrival RMS)**	
Marine Trace Decimation		2:1 trace summation after differential NMO
2D Marine Geometry		Spreadsheet / Database preparation
Bulk Shift Static		0ms for instrument filter delay
↓	——→ **RMS Shot Analysis**	Shot RMS, Av. RMS for channels 71-91
↓		Shallow RMS window 100-600ms
↓		Conversion factor from µV to µbar=50
↓		——→ **STACK HEADERS & PLOT**
↓	——→ **Raw Shots Display**	Every 4 km, 6000 ms, 324 channels
↓		——→ **ON SCREEN QC DISPLAY**
Trace / Shot Kill		Edits based on Observer's Logs
Band-pass Filter		
Type of filter specification		Ormsby band-pass
Details of filter		Minimum Phase, 4-8-90-120 Hz
True Amplitude Recovery		
Apply dB/sec corrections		Spherical Div. 1 dB/sec from water bottom to 10000ms
Maximum application time		6000 ms
↓	——→ **Velocity Analysis**	Every 4 km, Semblance, Gathers, Function Stack
↓		——→ **ASCII FILE**
Normal Move-out Correction		
↓	——→ **NMO Corrected Gathers**	Every 4 km, 6000 ms
↓		——→ **ON SCREEN QC DISPLAY**
NMO Stretch Mute		Top mute picked from CDP gathers and tied to WBT
CDP / Ensemble Stack		
METHOD for trace summing		Mean
Root power scalar for stack normalisation		0.5
Gun and Cable Static		+ 9 ms
Display Stack	——→ **Raw Stack**	6000 ms. Unfiltered, Unscaled.
		——→ **SEG-Y TAPE**
		——→ **HARDCOPY PLOT** + Shot RMS values

5 Brute Stack Processing Sequences:

SEG-D Input From Tape		
Reformat to ProMAX internal format		Read 324 channels + 12 auxiliary channels. Input 6000ms
↓		
Resample / Desample		From 2 to 4 ms. Hi-Fi antialias filter applied in module
Spike to Median Ratio editor		Automatic spike / Noise Burst edit. Used only when needed.
Marine Trace Decimation		2:1 trace summation after differential NMO
2D Marine Geometry		Spreadsheet / Database preparation
Bulk Shift Static		0ms for instrument filter delay
Trace / Shot Kill		Edits based on Observer's Logs
Band-pass Filter		
Type of filter specification		Ormsby band-pass
Details of filter		Minimum Phase, 4-8-90-120 Hz
True Amplitude Recovery		
Apply dB/sec corrections		Spherical Div. 1 dB/sec from water bottom to 6000ms
Maximum application time		10000 ms
Pre-deconvolution First Break Mute		Picked from CDP gathers + tied to Water Bottom Times
Spiking / Predictive Deconvolution		
TYPE of deconvolution		Minimum phase predictive
Decon operator length		240 ms
Operator prediction distance		32 ms
Operator white noise level		0.1 %
Design gate		Single gate & tied to WBT
Band-pass Filter		
Type of filter specification		Ormsby band-pass
Details of filter		Minimum Phase, 4-8-90-120 Hz
↓	—→ **Velocity Analysis**	Every 4 km, Semblance, Gathers, Function Stack
↓		—→ **ASCII FILE**
Normal Move-out Correction		
↓	—→ **NMO Corrected Gathers**	Every 4 km, 6000 ms
↓		—→ **ON SCREEN QC DISPLAY**
NMO Stretch Mute		Top mute picked from CDP gathers and tied to WBT
Inner Trace Mute		Bottom Mute picked from CDP gathers and tied to WBT
CDP / Ensemble Stack		
METHOD for trace summing		Weighted. Weight factor = sqrt(offset)
Gun and Cable Static		+ 9 ms
Display Stack	—→ **Brute Stack**	6000 ms. Unfiltered. Unscaled.
		—→ **SEG-Y TAPE**
		—→ **HARDCOPY PLOT** 6000ms, 1000ms op AGC

6 Start of Line RMS Noise Analysis (Appendix C)

Using the start of line noise record, channel RMS values were computed for all 324 channels.

The data was not re-sampled, and no filter was applied. The RMS values for each individual channel were computed using a gate of 500-10000ms to look at the ambient noise levels.

The plots were analysed in conjunction with the colour RMS displays to check for dead or noisy channels, and these were then crosschecked with the edits in the Observer's logs.

These RMS values also gave a good indication as to the amount of swell noise at the start of each line, and the results could be analysed as soon as the first tape was available.

The average ambient noise from this unfiltered RMS analysis was normally around 2-5 µbar on the noise record, and similar values were observed on the shot records. A 3-6-100-120Hz filter was applied to the data before prior to this RMS analysis.

A scaling factor of 50 was used to convert from millivolts to microbars, and hardcopy plots were included in each of the line files.

7 Auxiliary Channel QC (Appendix D)

All 12 auxiliary channels were input from tape during the SEGD tape loading procedure. The auxiliary channels were then separated from the data channels and stored in a separate data file, which could have been used for on screen analysis.

Unfortunately not all the gun hydrophone channels were connected during this survey. Auxiliary channels -1 (Gun 1-1), -2 (Gun 2-1), -5 (Gun 3-1) and -6 (Gun 4-1) were good, and were quality controlled on screen using colour amplitude displays, to monitor gun volumes and pressures. Gun performance was also monitored using a direct arrival RMS QC on the near trace displays. Appendix D shows the example of drop in pressure/volume due to the gun air leak.

8 Near Trace Displays (Appendix E)

Near traces were displayed on screen routinely at the end of each line. This proved to be useful in quickly determining any possible errors with acquisition. They revealed gun volume changes, bad records, internal time break problems and any auto-fires not reported by the recording system.

In addition to looking at the entire near trace display, an averaged direct arrival RMS was computed over the 12 nearest traces. An RMS window of 12-30ms was used after the 12 near traces were LMO corrected. The direct arrival RMS was plotted along the top of all the near trace displays. Variations in source volume and pressure were visible on the direct arrival graph, but the amplitude of the direct arrival was often variable due to vessel speed, feather angle and cable jerk. This display was really only useful when used in conjunction with the gun hydrophone channels to QC any undetected source anomalies.

RMS amplitude and dominant frequency statistics were also calculated for the direct arrival. These were viewed on screen whenever further investigations were required.

The near traces also provided a good indication of the geological conditions including strength of the water bottom multiples, remnant multiple interference and reflection data.

Hardcopy plots of the near trace displays were made for all lines. Plots were generated using a high level of gain, which helped to show up any amplitude variations in the direct arrival, and also assisted in the assessment of the level of swell noise whenever the weather condition deteriorated.

9 Shot vs Channel Colour RMS Displays for 324 channels (Appendix F)

RMS and trace statistics were calculated for every shot and all 324 channels. A shallow analysis window of 1000-1500 ms was used, and RMS values were computed for both unfiltered and filtered data. The band-pass filter was a 4-8-90-120 Hz Ormsby.

Colour RMS amplitude displays were made for all 324 channels for the entire line. These display were used as channel QC, and also to identify noise trends as the line progressed. For example swell noise deterioration, water currents or external seismic interference. In each case the affected shot point range was listed in the comments section in the Observer's Log. Only shots that were significantly affected were listed as bad shots.

In addition to the RMS computations further trace statistics included:

Trace amplitude	*- Average trace energy.*
Spikiness	*- Ratio of max magnitude sample to trace signal amplitude.*
Dominant Frequency	*- Based on a count of zero crossings within signal window.*
Frequency Deviation	*- Based on statistical scatter of frequency estimates.*
Amplitude Decay	*- Estimated late trace energy decay rate (in dB/sec).*

These statistics were averaged within the ProMAX database for the source, CDP and channel domains, where they could be viewed in the various different domains using the ProMAX database display tools.

In addition to a colour plot being generated for all shots for every sequence, a sequence-by-sequence RMS display was also generated. This involved extracting 200 shots from each sequence, and then displaying the colour RMS side by side. These displays enabled a direct comparison of bad traces and noise conditions from sequence to sequence.

All filtered colour RMS displays were saved to disk as GIF image files, and these were Unix tarred to Exabyte tape. The images were included in the data shipments and a final copy tape was generated at the end of the survey.

10 Shot RMS

Shot RMS values were calculated by averaging the RMS values for the central 21 channels (after 2:1 summation) from the streamer. RMS values were calculated using a fixed shallow window at 100-600 ms to look at ambient noise. The central 21 channels were chosen to avoid contamination by the direct arrival and any shallow water bottom events.

Ambient noise RMS values were also calculated using 3 different filters. A band-pass filter of 3-6-70-90 Hz was used to look at ambient noise levels within the signal bandwidth, and a 6-9 Hz high cut filter was used to look at the amplitude of the lower frequency swell noise. A further low cut filter of 50-70 Hz was used to look at ambient noise levels at the high frequency end of the spectrum. The ambient noise remained around 3-6 µbar.

This shallow window RMS provided a good estimation of the background ambient noise levels for each line. Increases in swell noise could be clearly identified on the ambient noise RMS plots above the raw stack, which also had a more spiky appearance whenever the swell noise picked up.

Noise levels in microbars provided a good statistical means of confirming the amount of swell noise interference visible on both the raw shot records and stack. One of the main advantages of using these RMS values to assess the swell noise, was that they could be processed during the SEGD tape loading operation if necessary, and were therefore available well before the raw stack could be processed.

A scaling factor of 50 was used to convert from millivolts to microbars. This is the conversion factor used for the recording system, which has a sensitivity of 20 Volts per Bar.

Noise (6-70Hz), Noise (<6Hz), Noise (>70Hz), Signal (6-70Hz) and signal to noise ratio RMS graphs were plotted above all Raw stacks, so any noise contamination on the stack could be verified statistically on the RMS plots. All CDP averaged RMS values were written into the SEGY brute stack headers as a backup.

11 Raw Shot Displays

Shot records were filtered to the signal bandwidth and balanced with a true amplitude gain recovery. Shot records were displayed at 3 km intervals for each line. Hardcopy displays were produced when necessary, and individual records were examined on screen if there was felt to be a problem with acquisition, or to investigate the source of anomalous seismic energy. This was useful in confirming the start of any seismic interference or for confirming auto-fires, which could be identified on the near trace displays.

The raw shot displays were used to estimate the amplitude and amount of swell noise on the raw 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.

12 Velocity Analysis (Appendix G)

Velocities were picked at regular 4 km intervals along every line, using one of the ProMAX's on screen interactive velocity picking utilities.

The ProMAX velocity-picking module included a semblance display; CDP super gather, which could have NMO applied instantly, a series of Function Stack Panels and an interval velocity graph. To improve the signal to noise ratio super-gathers were formed by combining 5 adjacent CDP gathers, and these CDP's also made up the Stack panels.

A regional velocity function was used as the central guide function for the stack panels. A total of 11 stack panels were processed using a +/- 10% velocity variation.

To speed up the on screen velocity picking procedure the velocity analysis displays were pre-computed. When primary velocities were clearly defined they were normally picked off the semblance display, and normal move-out was applied to the gather to check that the events were lining up well. Velocities could also be picked off the Function stacks whenever the velocities were poorly defined on the Semblance display.

Velocities were generally poorly defined, with multiple energy being dominant below a couple of seconds. For final velocity analysis an FK de-multiple or Radon demultiple filter may be required in order to pick reliable velocities. Unfortunately the increased run times required for the radon filter, meant that it was not a practical option for normal QC processing.

Velocity functions were output to ASCII file for every line, and then put on 8mm Exabyte tapes as well as floppy disk for data shipments.

13 CDP Gather Displays

These displays were essentially used to verify the velocity picking. On screen displays and sometimes hardcopy plots were made of NMO corrected gathers with an NMO stretch mute applied. The gathers were displayed at 4 km intervals. When swell noise levels were high they also provided a good indication as to whether the swell noise would stack out or not. They were also useful for identifying consistently spiking traces.

All mutes and time gates were picked interactively on screen using CDP gathers sorted into water bottom time order. By picking all the mutes and time gates in this manner it was possible to tie them all to water bottom depth, and therefore make the gates and mutes extremely accurate. As all the gates were tied to water bottom depth, this in turn speeded up the picking of mutes considerably and enabled the mutes and gates to be carried over from one line to the next. All gates were carefully quality controlled on screen before running the stack processing flows.

14 Raw and Brute Stack Processing (Appendix H)

The main objective of onboard QC processing is to stack each line with minimal processing to enable a thorough QC of the data onboard.

Normally, the general aim of the QC processing is not to attenuate noise but to show the data as it is recorded, or how it would be presented to a shore or vessel based processing centre. This means that band-pass filtering is normally confined to the anti-alias filter prior to re-sampling to 4ms, and a wide band-pass filter at the signal bandwidth after deconvolution to clean up the high frequency noise introduced by the deconvolution operator. It is also important to avoid using an AGC as this tends to soften and hide background noise, so raw stacks were always plotted out without any AGC scaling.

For all lines a basic raw stack with minimal processing, and a brute stack with deconvolution and some de-multiple attenuation were processed. The raw stack was essentially used for QC purposes only and the brute stack was used more to look at the geological structure.

The SEG-D data was input from 3590 copy tapes, re-sampled to 4ms and output to hard disk as 16 bit data. An anti-alias filter was applied internally within the ProMAX resample module to prevent aliasing of frequencies above 125 Hz.

Minimum Phase Predictive Deconvolution and True Amplitude Recovery tests were carried out on the first sequence, and the parameters for the entire survey were set up at this time. Deconvolution parameters were picked off CDP gathers, with corresponding autocorrelations plotted along the bottom of the display. Analysis of the results indicated that an operator length of 240ms and gap of 32ms would provide a good average for the entire survey. Due to the length of the lines, further more detailed testing will reveal more optimal spatially variable de-convolution parameters. The deconvolution gates were picked from the CDP gathers and tied to water bottom times, the start of the gate being approximately 20ms below the water bottom and the end of the gate being close to the bottom of the record. Deconvolution was only used for the brute stack processing, and no deconvolution was applied to the raw stack.

True Amplitude Recovery tests indicated that the data was better balanced when the dB/sec amplitude recovery started at the water bottom, rather than at T0. The optimal parameters were Spherical Divergence correction followed by a 1dB/sec correction tied to the water bottom time. These parameters resulted in a reasonably well-balanced stack, however as the water depth became shallower the amplitudes of the deeper data often dropped off significantly. For QC purposes the True Amplitude of the stacked data was preferred, but for interpretation purposes a post-stack AGC would be very beneficial to suppress the high amplitude events near the water bottom and bring up the amplitudes of the weaker events at depth.

As for the band-pass filter, it was decided to leave this as open as possible for QC purposes. For this reason little testing was carried out apart from some initial spectral analyses, and the band-pass filter was set at 4-8-90-120 Hz. Spectral Analysis of the data revealed that this filter would not affect the data in any way, and would remove only a minimal amount of swell noise contamination. A filter was applied prior to TAR and deconvolution to clean up any high amplitude low frequencies, and then again after deconvolution to remove any noise that might be introduced by the deconvolution process itself.

Noisy and dead traces were killed, as well as bad shots noted in the Observer's Logs. The brute stack was run after QC had been completed and the data had been thoroughly analysed. Any additional shots with time-break errors, gun problems and any new noisy traces were edited from the brute stacks.

Full details of all the processing flows and parameters are listed in section 4 of this report.

An un-scaled, unfiltered raw stack was plotted out on board of the vessel for every line. A fairly high level of gain was sometimes applied to the raw stack plot to boost up the amplitudes of the deep data, but this had the adverse effect of over scaling the water bottom and near surface events. Trace equalisation was occasionally added to the plotting routine to improve the brute stack plots. Shot ambient noise RMS values were plotted above the raw stack, as already discussed in the shot RMS part of this report. The raw stack plot was intended solely for QC purposes.

In addition to the un-scaled raw stack plot generated for every sequence, a brute stack was plotted out with an AGC operator of 1000ms, to look at the geological structures along the line.

All shot points with misfires, spread errors or timing errors over 1.0 millisecond were killed. In addition to this all dead or noisy channels were eliminated from the stack.

The CDP to station tie used for brute stacks in this prospect was

$$\text{Station} = \text{first SP} + ((\text{CDP}-162)/2).$$

The results of all stacked sections were discussed with the onboard Santos representative. A processing log was maintained throughout the survey with notes concerning noise problems and data quality (Appendix A).

All raw stacks and brute stacks were backed on 8mm Exabyte tapes in SEGY format, and shipped to the client office at the end of the survey. The SEGY headers include the shot point numbers, CDP numbers and complete listing of the acquisition and data processing parameters. The water bottom times and CDP averaged RMS values are also included in the SEGY trace headers for convenience.

15 Additional QC Displays (Appendix I)

Spectral analysis displays were generated for several lines to evaluate the power and frequency content of the data.

FK plots and FT displays were also occasionally displayed, but the spectral analysis displays were found to be more useful for analysing the frequency range of both noise and data.

16 Tape Copying

As there were insufficient 3590 tape-drives available on the Syntrak recording system, it was necessary to use the ProMAX system to generate copy tapes. Tape copies were generated by the ProMAX system in SEG-D format on 3590 tapes.

17 Summary

Many potential problems were analysed using ProMAX including checking bad field tapes or whether a tape had closed properly; checking shot records for noise bursts, swell noise or auto-fires; confirming bad or noisy channels, etc. It was also useful for investigating data problems whilst acquisition was still in progress.

Although the ProMAX was not an online system, it still managed to carry out a full and thorough QC of every sequence. Tape loading was a time consuming procedure, but the benefits were that every single field tape could be independently verified and checked. In addition to this, any errors in the Observer's Logs such as incorrect file numbers or incomprehensible logs were detected, and corrected.

Data quality was good in this area but swell noise was the major concern. Multiple energy was also apparent on all lines. Factors affecting data quality included the following:

- ✓ Ship noise
- ✓ Spikes / noisy channels
- ✓ Geological noise
- ✓ Swell noise

Ship noise - Although the centre of source to centre of first group was 70m, ship noise was visible on the noise records. Spectral analysis and FK analysis of this noise revealed what was thought to be propeller noise with 5Hz harmonics, within the 10-70Hz frequency range. FK analysis revealed that the move-out of this noise was 1500m/s. As would be expected for ship noise, the strength of these frequencies was strongest on the near offset traces and minimal at the far offsets.

Spikes / noisy channels - Most of the time all 324 channels were good. The spiking/noisy channel was dealt with by editing in processing and later in acquisition by replacing streamer sections.

Geological noise - Water bottom multiples were apparent on the shot records as well as the stack sections.

Diffractions were often visible and were probably caused by the prodigious faulting and not uniform water bottom apparent in many of the sections.

Swell Noise – Was the major cause of noise and affected most of the sequences. This low frequency noise was peaking up to 5-20μbars on the most sequences.

18 Conclusion

The ProMAX system proved to be extremely reliable and performed extremely well. There was not a single system crash or hardware malfunction that could have resulted in loss of processed data on the hard disk.

The survey averaged approximately 40.7 km per day. Data processing also averaged approximately 40.7 km per day. The ProMAX system was more than capable of keeping pace with these acquisition rates, and as a result it was possible to thoroughly QC and stack every line.

19 APPENDICES

Appendix A

PROMAX PROCESSING LOG

Section 6: **Onboard Processing**

Seq	Line	Dir	Date	First SP	Last SP	FFID	CDP's Processed	Noise Record RMS	SOL FK Analysis	SOL Spectral Analysis	Tape Copy	SEG-D Input	2D Geom S/Shheet	Near Trace	Plot Near Traces	2:1 Sum / Geom Assign	Near Trc WBT Pick	Database Fill WBT	WBT to Trc Headers	480 Chan Col RMS	Aux QC	Delete Raw Shots	Pick Decon / Mute Gates	Velocity Analysis	RMS for Stack	Pick NMO Mute	Raw Stack	Brute Stack + Decon	Plot Raw Stack + RMS	Merge Stacks	Plot Brute Stack	Delete Geom Shots	Stack to Archive	Vel to ASCII	Archive / Delete Line	Segy Stack to Tape	Shipment date	Notes
001	GBS02-48-001	270	1/01	1413	912	1413-912	3-1164	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**GOOD.** SOL RMS noise 1-7ubar peaking up to 54ubar on channel 258. ITB telemetry errors present on five shots. Near offset at 70m causes slight increase in the noise level. Strong water bottom multiples present on the entire line. Swell noise visible up to 2.5s on the raw stack.
002	GBS02-47-002	90	1/01	1001	1503	1001-1503	1-1166	X	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X	X	**GOOD.** RMS noise at the start of line 1-7ubar peaking up to 80ubar on channel 169. ITB telemetry errors present on fifteen shots (verified in QC process). Swell noise visible up to 2s on the raw stack.
003	GBS02-46-003	310	3/01	2004	912	2004-912	1-2346	X	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X	X	**GOOD.** SOL RMS noise 1-5ubar peaking up to 9.5ubar on near channels. Turning noise evident between SP 1311 and SP 1080. Very strong water bottom multiples present on the entire line. Swell noise visible up to 2.0s at its strongest.
004	GBS02-45-004	109	3/10	1001	2015	1001-2015	1-2190	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X	X	**GOOD.** RMS noise at the start of line 1-4ubar increasing gradually from approximately channel 200 to 8.5ubar on channel 324. Very strong multiple energy present on the entire line. Spectral analysis performed on the shot record in order to find channels with lesser frequency contents as channels 100 to 324 affected by very strong multiple energy on the Shot vs. Channel RMS display. Channel 247 found to be weak. Swell noise visible up to 2.5s on the raw stack.

| | | |

Appendix B

DATA SHIPMENTS

Appendix B - List of Deliverable Products

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The following data shipment was sent on 10 January 2003.

1. Paper Displays for Gippsland Basin GBS02 Survey (Sequences 001-009):
Start of line RMS noise, Near Trace displays, Raw Stacks and Brute Stacks.

2. 1 x 8mm tape containing SEGY format Raw Stacks for Gippsland Basin GBS02 Survey.
Seq. 001-009 (SEGY files 1-009)

3. 1 x 8mm tape containing SEGY format Brute Stacks for Gippsland Basin GBS02 Survey.
Seq. 001-009 (SEGY files 1-009)

4. 1 x 8mm tape for seq. 001-009 of Gippsland Basin GBS02 Survey containing:
Velocities (ASCII files, UNIX tar –cvf format).
Colour RMS, Start of Line RMS Noise (GIF files, UNIX tar –cvf format).

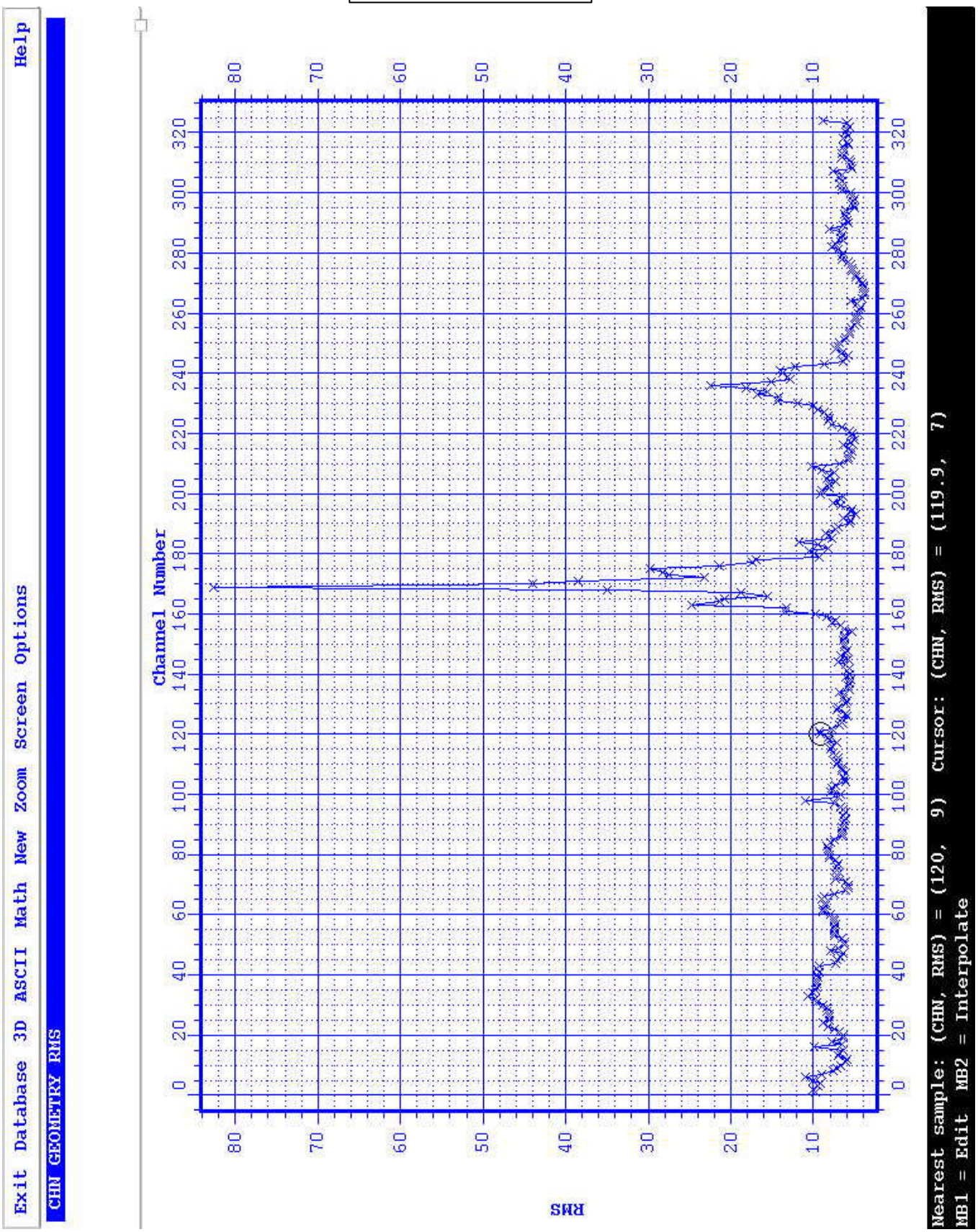
5. 1 x 8mm tape for seq. 001-009 of Gippsland Basin GBS02 Survey containing:
Master flows, Stacks, Near Traces, Shot vs. Chan RMS
(ProMAX archive format).

6. 1 x floppy disk for seq. 001-009 of Gippsland Basin GBS02 Survey containing:
Velocity files (ASCII format).

Appendix C

START OF LINE NOISE RECORD RMS ANALYSIS

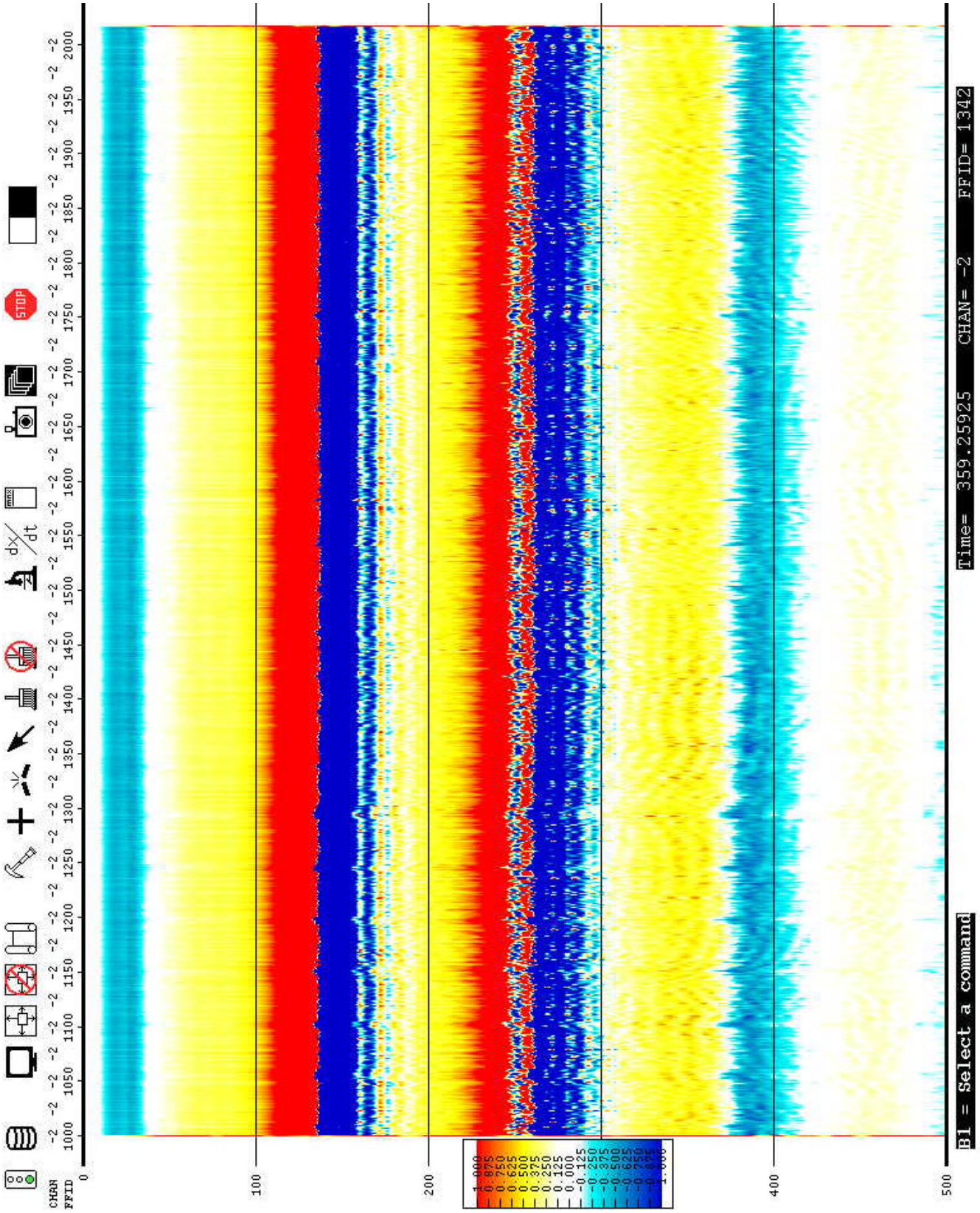
Line:GBS02-47-002



Appendix D

AUXILIARY CHANNELS DISPLAY

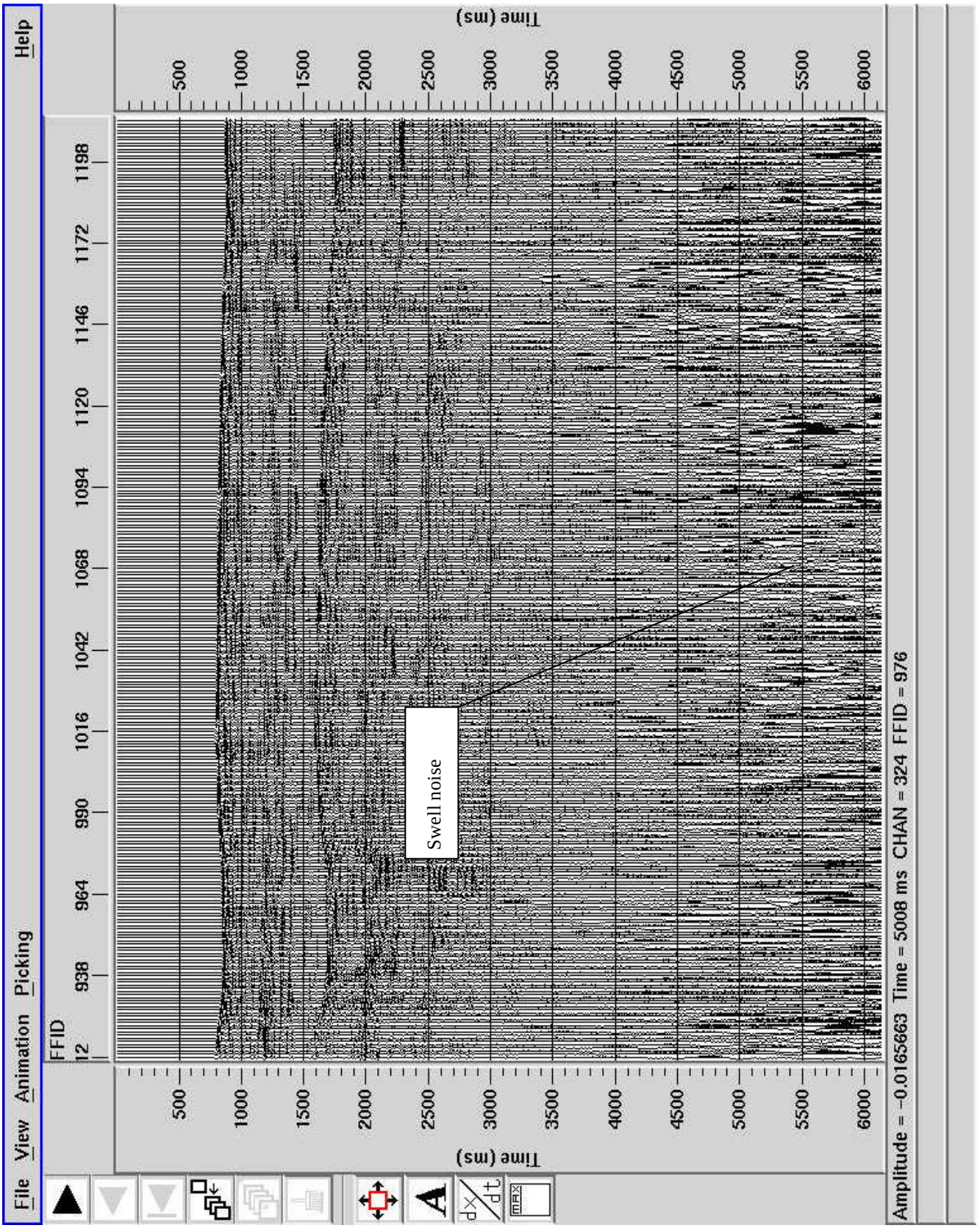
Display of auxiliary channel mounted on Gun 2-1. Line: GBS02-45-004



Appendix E

NEAR TRACE DISPLAY

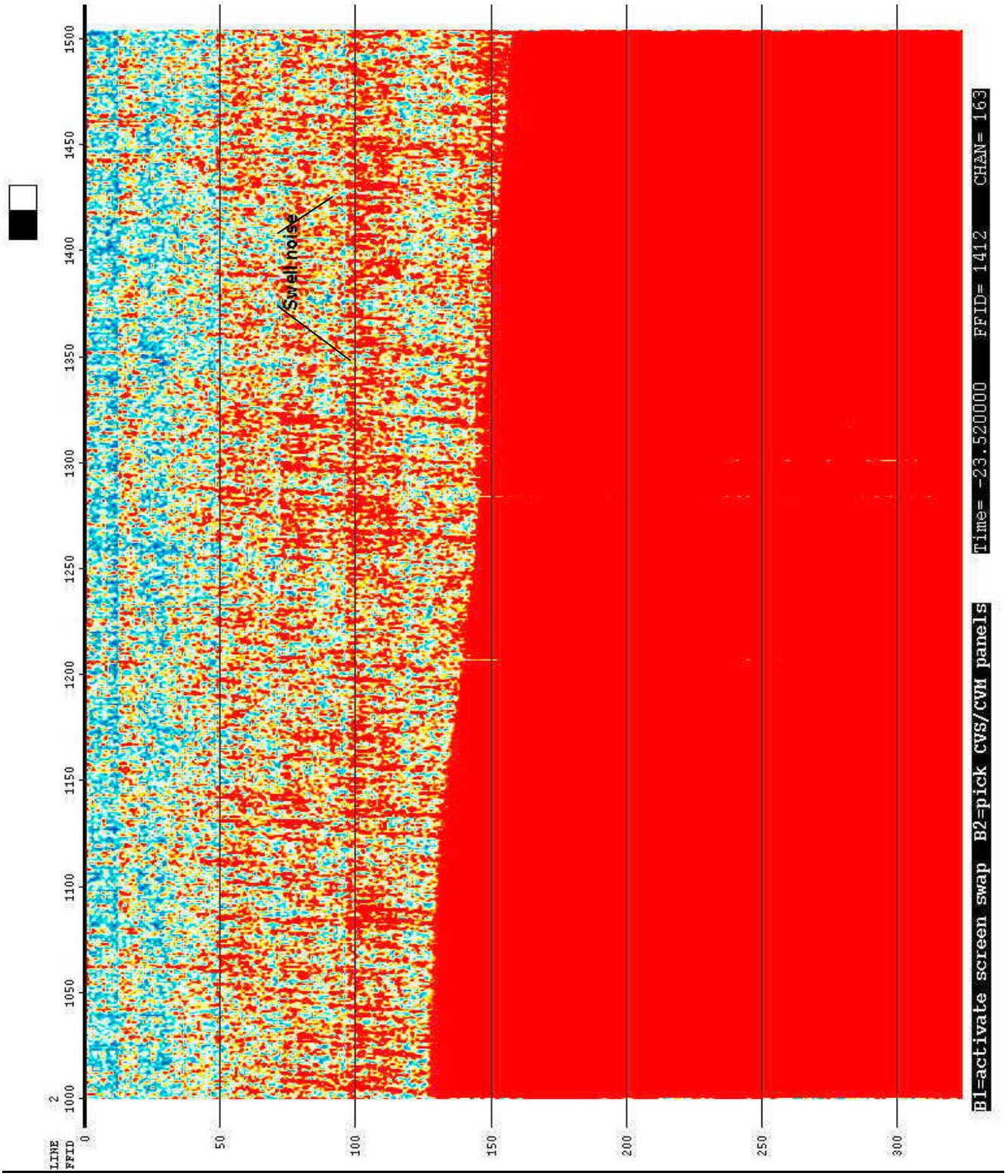
Near trace gather; Line: GBS02-48-001



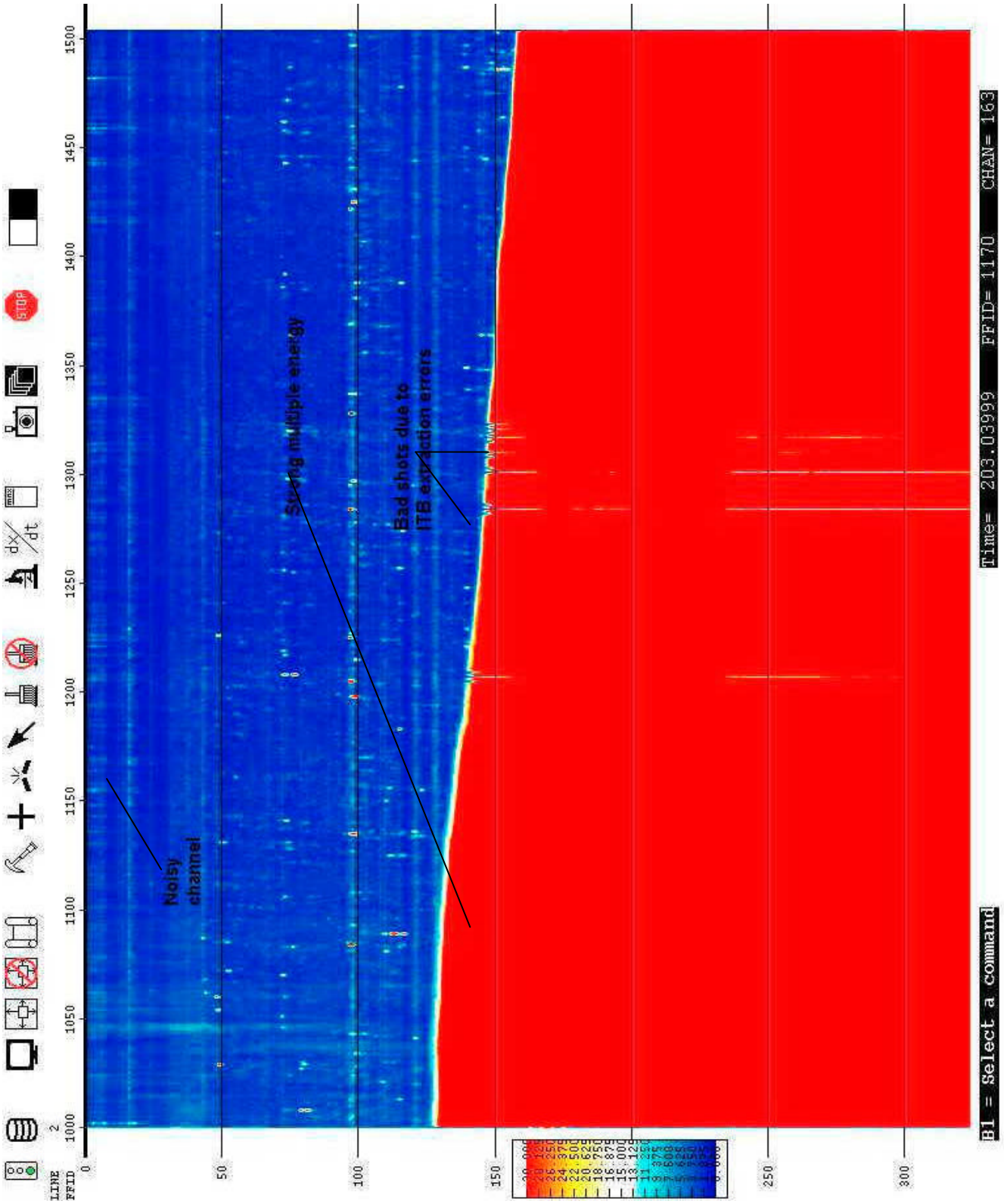
Appendix F

SHOT vs. CHANNEL COLOUR RMS

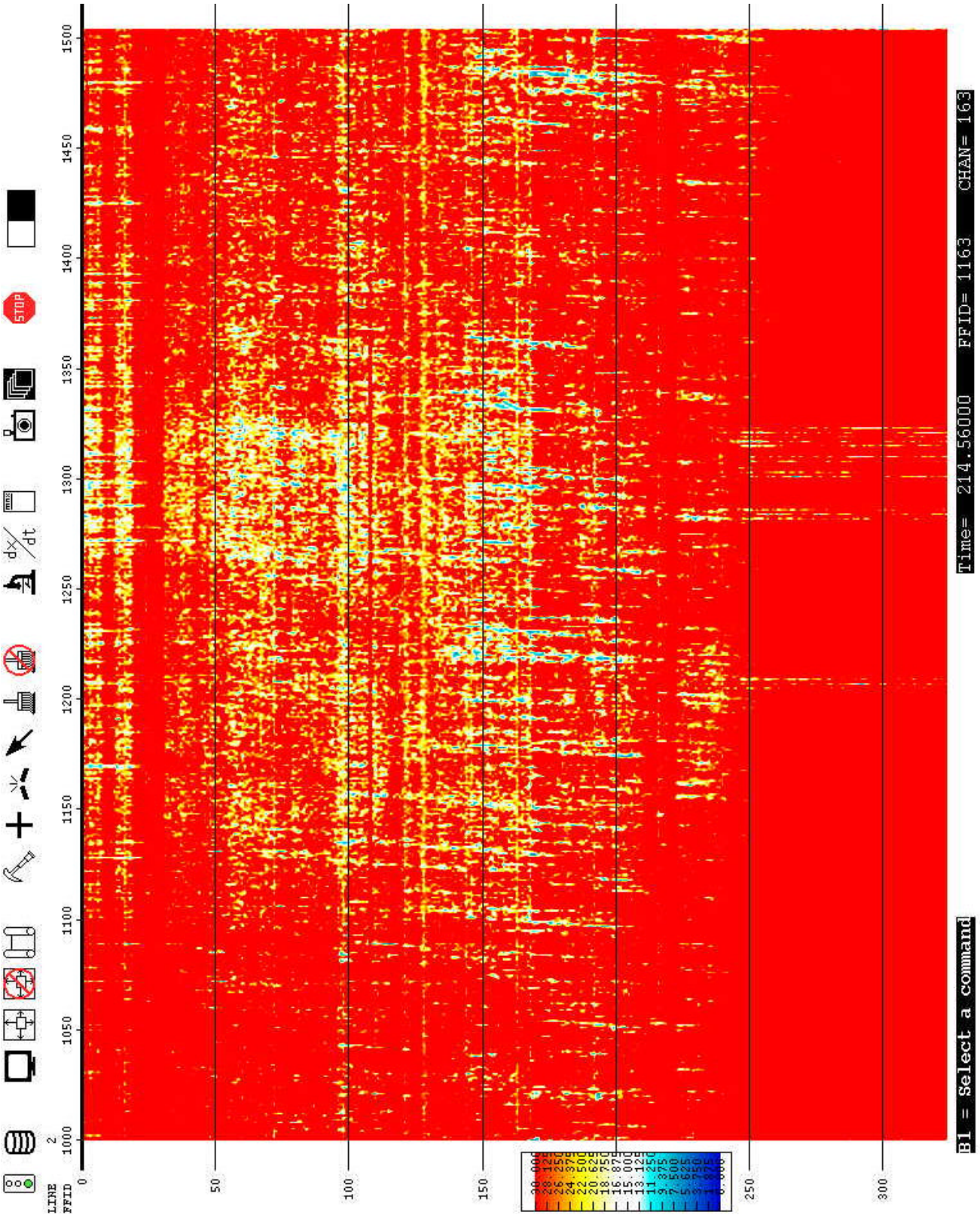
Shot vs. Channel RMS, No filter applied; Line: GBS02-47-002



Shot vs. Channel RMS, Ormsby band-pass filter 4-8-90-120 Hz applied; Line: GBS02-47-002



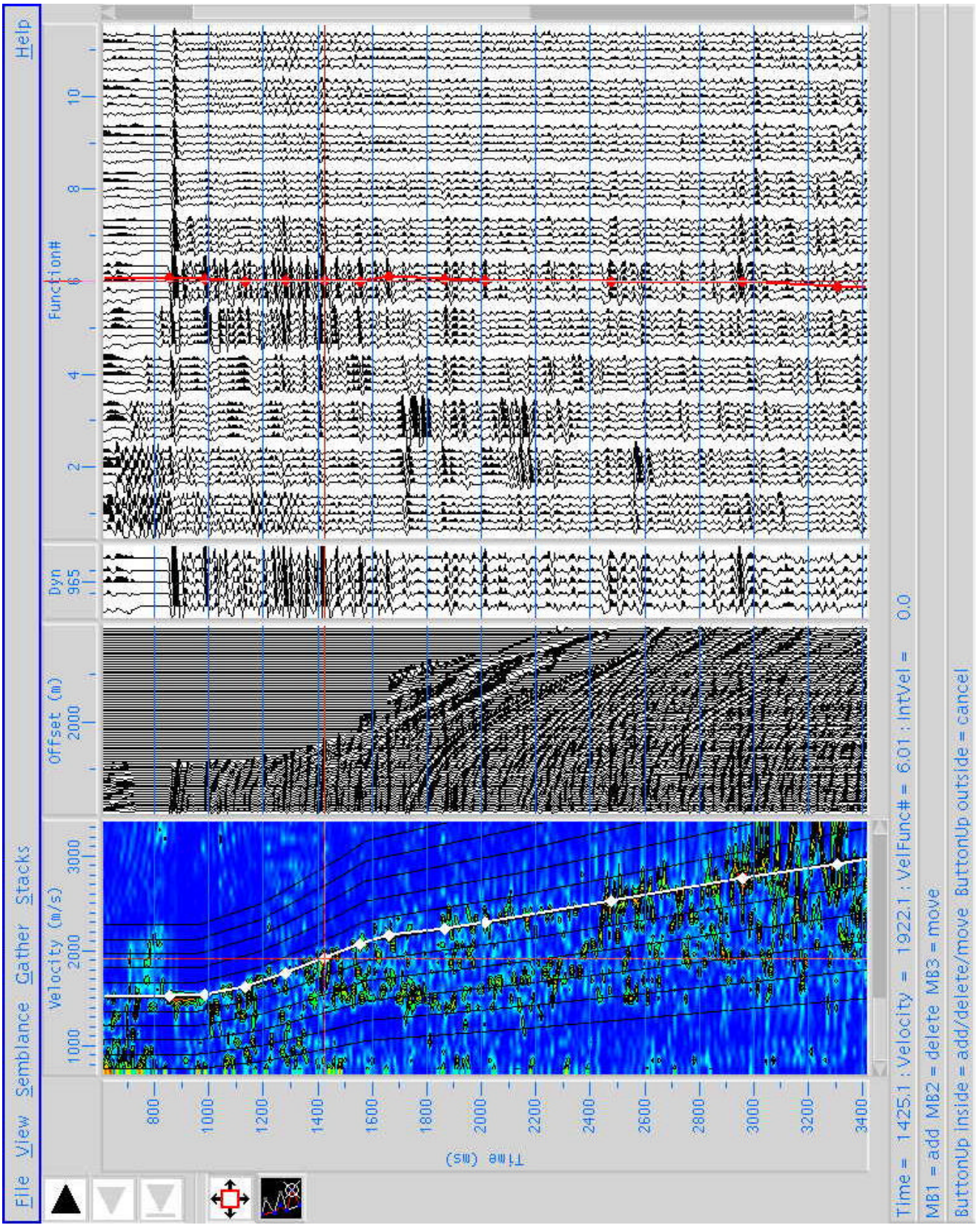
Shot vs. Channel RMS, Dominant frequency; Line: GBS02-47-002



Appendix G

VELOCITY ANALYSIS

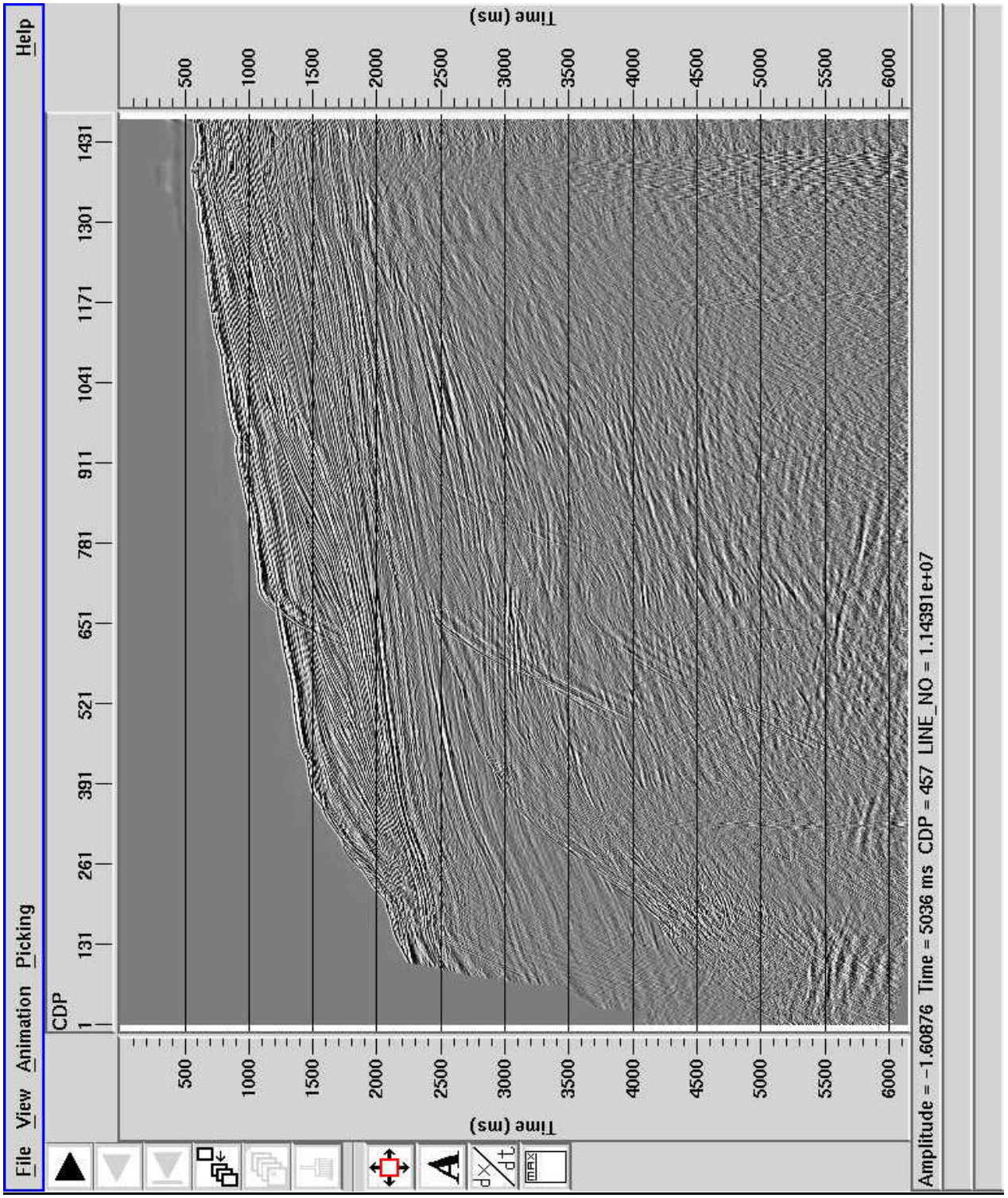
Line GBS02-43-006



Appendix H

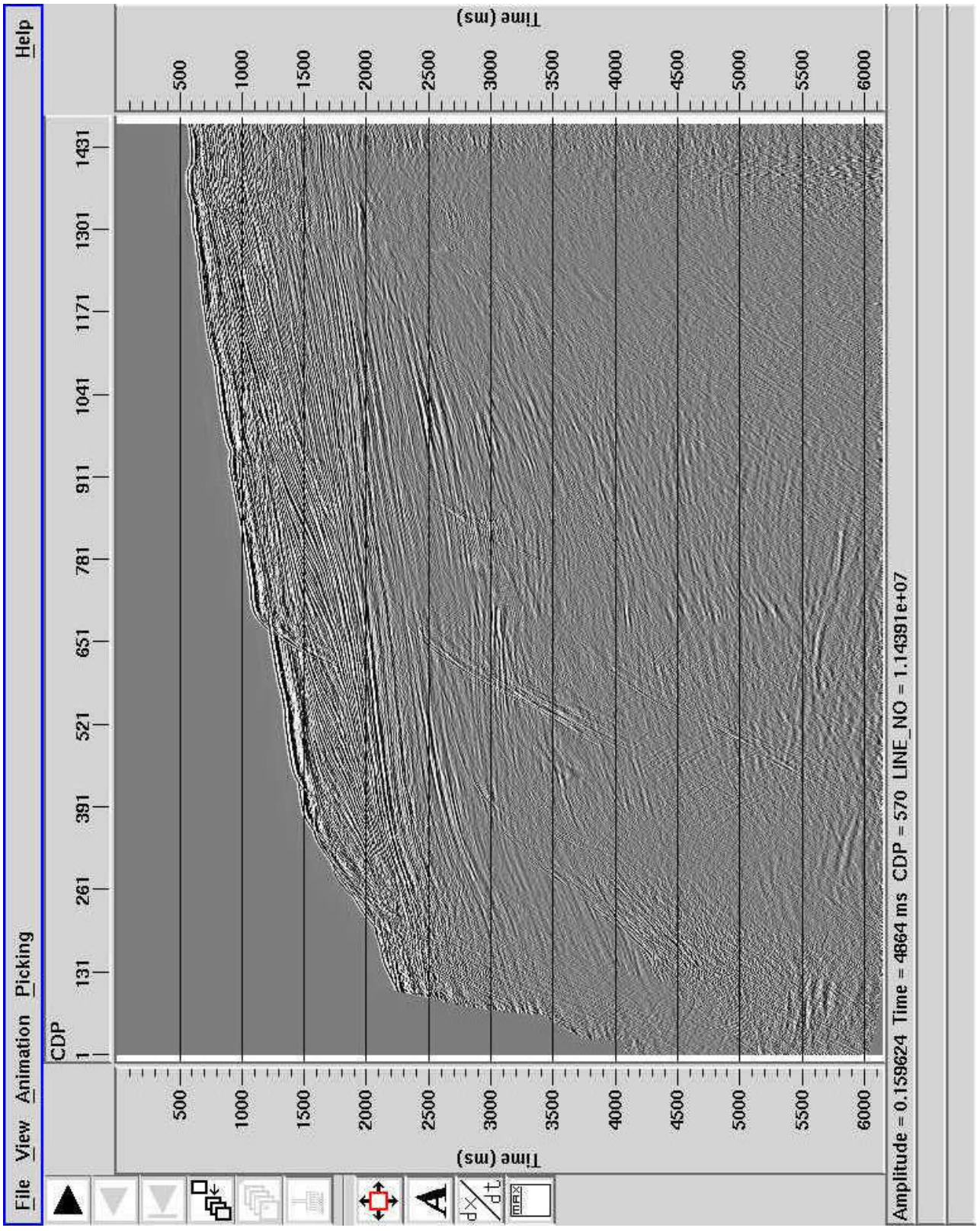
STACKS

Raw stack: Ormsby bandpass 4-8-90-120 Hz filter applied; Line: GBS02-43-006

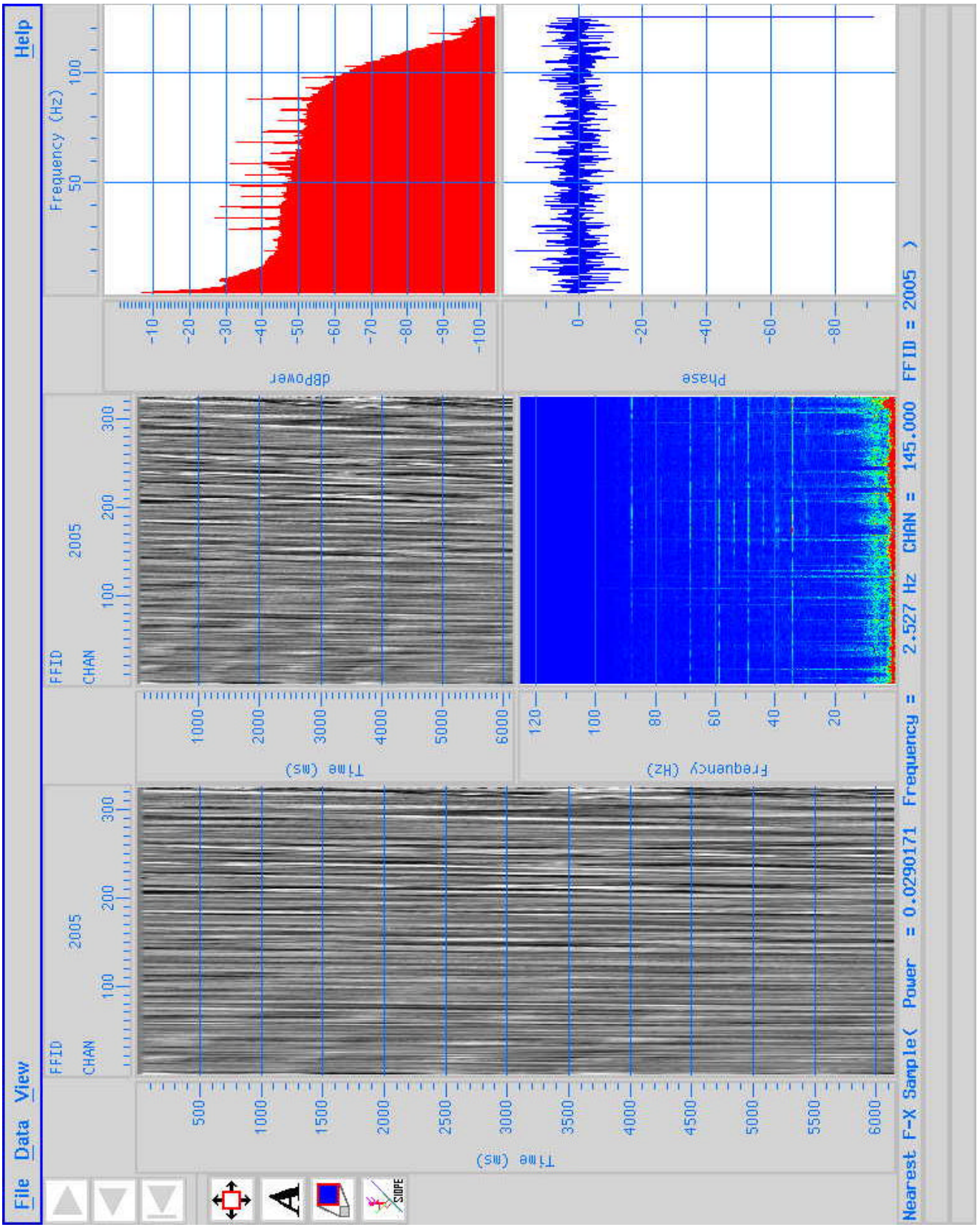


Brute stack: Ormsby band-pass filter, inside trace mute and predictive deconvolution applied;

Line: GBS02-43-006



Appendix I

SPECTRAL ANALYSIS

Line GBS02-46-003