British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

North of 62N Geophysical Survey
RRS Discovery Cruise D254
BGS Project 01/01 Operations Report

Continental Shelf and Margins Programme

Internal Report IR/01/178

BRITISH GEOLOGICAL SURVEY

INTERNAL REPORT IR/01/178

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Foreword

This report covers the operation of Discovery Cruise D254, BGS Project 01/01, a regional geophysical survey of the UK Continental Shelf north of 62°N, carried out from 26 June to 26 July 2001. This field operation was the first part of a two year geophysical survey programme, to be completed in 2002. It was funded by the BGS Science Budget and represents the first phase of the mapping of the UK designated area north of 62°N which should be followed by seabed sampling and shallow drilling to produce the final geological maps.

Acknowledgements

Any offshore programme is a team effort, with each and every person playing their full part in the continuous 24 hour operations. A full list of the BGS personnel taking part is included in the report and their contribution to the success of the operations is acknowledged. Grateful thanks are also due to Capt. Robin Plumley, the crew of RRS Discovery and the technical support provided by the Research Ship Unit and SOC UKORS.

Contents

Summary

This report describes the operation of Discovery Cruise D254, BGS Project 01/01, a regional geophysical survey of the UK Continental Shelf north of 62°N, carried out from 26 June to 26 July 2001. The vessel proved to be excellent for the work and the survey was extremely successful, with a total of 3329Km of generally very good quality data being collected. The survey was allocated Discovery Station Number 14131.

1 Narrative

The vessel sailed from Govan at 0800 on the 26th June on completion of equipment mobilisation and commenced passage to the survey area. Equipment preparations continued throughout the day and a boatdrill/safety exercise was carried out during the afternoon. Passage and equipment preparation continued throughout the following day with the vessel reaching the edge of the survey area in the morning of 28th June in calm conditions. The vessel slowed to deploy equipment at 0800, commencing with the pinger and PES towfish. The remaining seismic equipment, namely two hydrophones, sparker and airguns, were then deployed in that order. Several problems were encountered with the deployment of the airguns including seized sheaves on the A-frame, the deployment winch wire was not long enough and one gun failed to seal. These problems were quickly rectified and by 1300 all seismic systems were running and trials were underway to select the optimum tow configurations. The magnetometer was deployed at 1400, but the first sensor used proved to be very noisy and was changed for the spare. All systems were running correctly by late afternoon and the vessel turned towards the start of the first line. The towing configuration adopted is shown in Figure 1.

Survey operations commenced at 1722 running Line 1 (see Figure 3) to the NE in good conditions. During the course of this line two problems were encountered with the sparker system. Firstly, the earth wire became detached from the sparkarray frame and this was recovered briefly to effect repair. Secondly, the sparker data became very noisy and the problem was traced to the hydrophone deck lead, which was replaced. Line 1 was completed at 0520 the following morning and Line 2, running east, commenced at 0830. This line was completed without incident at 1935, but on the transit to Line 3 the airgun hydrophone became noisy. This was replaced by the spare hydrophone before the start of Line 3, at 2243, running SW. Inspection of the hydrophone did not reveal any problem and it was thought that the noise was due to the hydrophone towing too shallow, occasionally breaking surface in the swell. More weight was added to the front end of the hydrophone and it was returned to use. Also during the course of Line 3 the sparker HV power supply failed, losing some 2 hours of data before it was repaired.

On completion of Line 3 in the afternoon of 30 June, the next four days were spent running a series of NW/SE lines, normal to the slope, in continuing good conditions. Throughout this period there was very occasional, intermittent noise on the airgun hydrophone. The source of this noise remained unresolved. On the completion of Line 7, shortly before midday on 4 July, a long, slope parallel line (Line 8) running NE was run, extending to the More Vest area in Norwegian waters. This was followed by a reciprocal, parallel line to the SW, which was completed shortly after midnight on 7 July. Two relatively short NW/SE lines (Lines 10 and 11) were then run towards the Southwest corner of the survey area, completing in the early morning of 8 July. Line 12, a long NE line, was started at 0503 on 8 July in continuing good conditions, but was terminated abruptly at 1454 by an instant, total ship's power failure. The vessel came to a halt, completely blacked out with the exception of battery powered emergency lighting. The emergency generator had failed to cut in as it should have done in such a situation. As much of the towed equipment as possible was recovered by hand and by 1508 only the airgun frame remained in the water. This was suspended from the large buoy which is towed behind the frame to provide depth control under normal operations. The airlines, trigger leads and tow rope were pulled in as far as possible and made secure. Limited power became available at 1545 and the airguns were recovered to deck. Ship's power was restored on two generators at 1601 and the process of restarting all laboratory, navigation, gravity and logging systems was commenced.

The cause of the fault remained under investigation, with two generators still out of action. These were brought back into service and at 1820 clearance was given to recommence operations. All towed equipment was redeployed and Line 13, a continuation of Line 12 with some overlap, was started at 1915. The power failure was the subject of an investigation and report by the Master and Chief Engineer, but the cause could not be established.

Operations continued with the completion of Lines 13,14 and 15, over the next two days without interruption, in continuing calm conditions. Line 16 was started at 0637 on 11 July, but as the line proceeded, the occasional noise on the airgun hydrophone became more frequent. This coincided with a deterioration in sea conditions, but the noise was much worse than simple sea noise. Line 16 was halted and the vessel circled whilst the hydrophone plug was rewired. This seemed to cure the problem, but on starting Line 17 the noise reappeared. The weather continued to deteriorate, and the hydrophone was exchanged for the spare which was much quieter. By the early afternoon the weather had worsened further and the Line was abandoned at 1442. All towed equipment was recovered and the vessel hove too, waiting for an improvement in sea conditions. Further investigation of the hydrophone noise revealed that it was being generated by the pre-amplifier located at the front of the array. The noise was exacerbated by the flexing of the hydrophone as the swell, and hence movement, increased. The pre-amplifier was replaced by a spare.

Thirty-three hours were lost in this period of weather downtime and it was not until shortly before midnight on 12 July those operations recommenced, running Line 18, a long line to the NE. This line was started at the original start of Line 16 and included a complete re-run of the two short Lines 16 and 17, which were both of poor quality. The repaired airgun hydrophone was used, the noise problem having been completely cured. Operations continued without interruption over the next four days in continuing good conditions, completing Lines 18-21 inclusive. At the end of Line 21 at 1225 on 17 July all equipment was recovered to make a full speed transit to the next line which was some distance away. All gear was redeployed and Line 22, running SE, was started at 1524. As this line proceeded the weather conditions deteriorated steadily and at 0900 the following morning operations were suspended in Force 7 conditions and all towed gear was recovered. There then followed an extended spell of very poor weather over the next three days, with the wind blowing steadily at Force 7/8, from a northerly direction. It was not until the afternoon of 21 July that conditions eased enough to recommence operations. By this time the vessel had moved to the Southeast corner of the survey area and Line 23 was run to the NW as a continuation of Line 22, but run in the opposite direction. The line was continued until sufficient overlap had been made with the later stages of Line 22, which had been recorded in deteriorating conditions. This was completed the following morning, 22 July and Line 24 running SE was started at 1300. This was completed without incident at 1946, which marked the end of useable survey time. All gear was recovered and the vessel commenced passage to Southampton at 2030. As much equipment as possible was demobilised and packed on passage, with the vessel docking at Southampton shortly before midnight on 25 July. All equipment was cleared from the vessel the following morning. Twenty-four survey lines were completed, totalling 3329Km. Figure 2 shows a summary of the time utilisation and Figure 3 gives a summary track chart.

2 Equipment Used

2.1 AIRGUN SYSTEM

Source: An array of 5 x 40 cumin. Bolt 600B airguns with waveshape kits and time break solenoids. Routinely, up to four guns were fired simultaneously, keeping the fifth gun as a ready spare. The number of guns used was varied with water depth, with a minimum of two being used in the shallower areas. The firing rate varied from 6 – 8 seconds depending on water depth. Gun synchronisation was achieved by monitoring the time break solenoids and manually adjusting as required. This introduced a short time delay into the system of between 36 and 38 msec and thus the sea-bed return time was not an absolute measurement of depth. The vessel's Hamworthy 4TH compressors were used to power the guns, using one compressor running at half speed.

Hydrophone: Two channel Geomechanique summed to give a single channel 30m active length.

Recording: CODA DA200 four channel digital recording and processing system. The data was recorded on Exabyte tape in CODA format with a sampling interval of 0.2msec, record length of 4 seconds and bandpass filter of 25-500Hz. The start of recording was delayed in deep water to permit a minimum of 2 seconds of data below the sea bed. The CODA system also received a navigation data string from the navigation processor, and logged position on each shot.

On-line processing: In addition to the recording described above, the CODA system was alsoused to process the data on-line and to produce a real time hard copy output on a Waverley 3710 thermal printer. Processes applied were time varied gain (TVG), time varied filtering (TVF) and trace mixing. Both TVG and TVF were applied from the sea bed, which was tracked automatically. A 50Hz notch filter was also applied to eliminate mains interference. A 1.4sec record length was used for the on-line hard copy, with a delay adjusted to give an optimum record in the prevailing water depth. Other records were replayed off-line at the request of the geologist.

2.2 SPARKER SYSTEM

Source: EG&G, nine candle, multi-tip array with 135 tips.

High Voltage Power Supply: Applied Acoustic Engineering CSP3000 capacitor charging unit. This was a single unit, powered from the ship's mains and with a switchable output up to a maximum of 3KJ.

Hydrophone: Teledyne, 10m, 7 channels with all summed to give a single output.

Recording: The same CODA DA200 four channel digital recording and processing system as for the airgun with the data being recorded on the same Exabyte tape in CODA format. The data were recorded with a sampling interval of 0.1msec, record length of 1.5 seconds and a bandpass filter of 130-2000Hz. The start of recording was delayed in deep water to permit a minimum of 1 second of data below the sea bed. As with the airgun, position was recorded with every shot.

On-line processing: A second CODA system was used to process the data on-line and to produce a real time hard copy output on a Waverley 3710 thermal printer. Processes applied were time varied gain (TVG), time varied filtering (TVF), swell filter and trace mixing. Both TVG and TVF were applied from the sea bed, which was tracked automatically. A 500msec record length was used for the on-line hard copy, with a delay adjusted to give an optimum record in the prevailing water depth. Other records were replayed off-line at the request of the geologist.

2.3 SUB- BOTTOM PROFILER

IOS 3.5kHz system: This is a high resolution, deep water (up to 6000m) swept or 'chirp' frequency profiling system consisting of 4 major components; the Recorder, Transceiver, Correlator and towfish. The transceiver is Raytheon PTR 105B producing 6 kWatts of acoustic power, the recorder is a Waverley 3710 Linescan recorder and was selected for a 500 ms or 375 m sweep. A small programmer allows the transceiver and recorder to be pulsed at an optimum repetition rate for a given depth range. The corellator is of IOS design and converts the 28ms reflected swept pulse to a filtered 1.5 ms, 3.5 kHz output pulse for greater noise immunity. The towfish contains four TR109F Massa transducers wired in a parallel series combination.

2.4 GRAVITYMETER

The gravity meter was a LaCoste and Romberg AIR-SEA system. This consists of a highly damped, zero-length spring type gravity sensor (LaCoste and Romberg S84) mounted on a gyro-stabilised platform, together with associated control and recording electronics. The sensor and control electronics were located two decks below the main laboratory within the Stable Laboratory close to the centre of motion of the vessel.

Gravity was measured continuously and the gravity, spring tension and cross coupling correction values logged, at a one second interval in L&R Long Format, onto the ship's Level ABC logging and processing system. Data were also output to a colour printer for QC purposes. Data were first processed to produce a Free Air anomaly, sub sampled to 10 seconds, edited to remove erroneous data (such as that obtained on turns) and smoothed using a Gaussian filter with a 20-sample window.

2.5 MAGNETOMETER

The system used was a Direct Reading Varian V75 marine proton precession magnetometer with 1 gamma sensitivity. The sensor was towed 200m astern and the system was triggered by the seismic control system such that the sensor was polarising when the sparker fired. This eliminated electrical interference from the sparker discharge. The data were converted from parallel BCD data to serial data within a parallel to serial converter before being logged onto the ship's Level ABC Logging and processing system. Data were processed to produce a magnetic anomaly referenced to IGRF 1990.

2.6 ECHO SOUNDER

This was a Simrad EA500 Hydrographic Echo sounder with a 9 element tow fish operating at 10kHz. Serial data, showing depth in meters and reflected power, were logged on the ship's Level ABC system. Echograms were displayed onto colour monitors during operation and recorded onto a colour printer for QC purposes. Data were processed by editing out erroneous and null values (registered as a Zero depth) and converting to true depth by applying the appropriate Carter corrections to the 1500 m/second data.

2.7 NAVIGATION, PROCESSING AND DATA LOGGING

The process of calculating the position of the ship and thus the navigation of the ship is done using a mixture of dead reckoning and GPS inputs.

The ships gyro and the Chernikeeff log provide the dead reckoning side of the navigation. This is processed to make a relative motion file called relmov. The bestnav program then takes this data along with data from a primary fix file (data from a Trimble GPS_4000DL) and if this is not available from a secondary fix file (data from an Ashtech GG-24 (combined GPS + GLONASS)). The differential corrections for both of these file's are fed from a Sea Star (3000L DGPS set to Eik EMS). In practice the dead reckoning data is almost never used in the final navigation as GPS data is updated at a rate of once every second.

All position data is referenced to the WGS 84 datum.

3 Preliminary Interpretation of Seismic Data

Dan Evans and Ruth Williams

A preliminary on board interpretation was made of the seismic data. To help with this, cross-reference was possible with existing data or interpretations in and around the survey area, including:

- BGS maps of the Cormorant, Miller and Flett sheets
- ENAM airgun data
- GEM and Seabed project reports
- BGS Neogene stratigraphic atlas

Preliminary depth maps at a scale of 1:500 000 have been produced for several horizons; these depths are taken from the airgun record for consistency, although with reference to the sparker data that generally gave good detail in the upper section. The following maps have been produced:

- Intra-Naust O
- Top and isochron of Tampen Formation
- Top Tampen slide deposits
- Top Tampen slide 'parental'
- Top and isochron of Miller Slide deposits
- Top Ferder Formation equivalent
- Intra-Neogene Unconformity (INU)
- Latest Oligocene/earliest Miocene Unconformity (LOEMU)
- Top basalt

3.5 kHz pinger data were also studied, but not used for mapping purposes. The depths to the horizons were also fed into an Excel spreadsheet to produce graphic printouts of the interpretations for each line. Figure 4 shows an example interpretation for Line 14. This is a SW – NE line across the central portion of the North Sea Fan within the study area. Diapiric activity obscures the reflections in the centre of the line, in the area of a volcanic high. The Tampen slide sidewall and Tampen slide deposits are mapped.

Additionally, other features have been mapped including the limit of the North Sea Fan, and the distribution of deep, shallow and surface diapirism, together with the complete limits of the Miller slide deposits north of 62^{o}N, and several other possible slides or slide headwalls/sidewalls, and faults.

The data collected provide a reasonable coverage of the total planned grid, and will provide a good basis for interpretation on the Landmark workstation. On the basis of this work, an improved cruise plan can be proposed for the 2002 survey. In particular, additional lines for more detailed study can be proposed, including further investigation of the Tampen head/sidewall features, the control on diapirism of a basalt high along trend from the Fuglo Ridge and an area of slips and slides along the northern edge of the Fuglo Ridge. Regrettably an onboard plan for a 48-hour survey along the Tampen Slide sidewall could not be carried out due to poor weather at the end of the cruise.

4 Personnel

BGS

Colin Brett	Geophysicist, Principal Scientist
Evelyn Campbell	Scientific Watchkeeper
John Derrick	Mechanical Engineer
Dan Evans	Geologist
David Long	Scientific Watchkeeper
Michael Strutt	Scientific Watchkeeper
David Wallis	Electronics Engineer
Ruth Williams	Geologist

SOC UKORS

Chris Paulson	Electronics Engineer, Technical Liaison
Jeff Bicknell	Computing
Paul Duncan	Computing
Jeff Jones	Mechanical Engineer
Alan Sherring	Mechanical Engineer

RRS Discovery

Robin Plumley	Master
Peter Sarjeant	Ch. Officer
Phil Oldfield	2nd Officer
Chris Vrettos	3rd Officer
Ian McGill	Ch. Engineer
Jim Royston	2nd Engineer
Steve Bell	3rd Engineer
Clive Phillips	3rd Engineer
Garry Auld	Electrical Officer
Pete Bennett	Bosun
Greg Lewis	Bosun Mate
Bob Dickinson	Deck
Martin Wyness	Deck
Perry Dollery	Deck
Iain Thomson	Deck
Steve Day	Deck
Terry Stewart	Motorman
Eddie Staite	Catering Manager
Chris Puslik	Chef
Wilmot Isby	Steward
Graham Mingay	Steward
Dennis Young	Steward

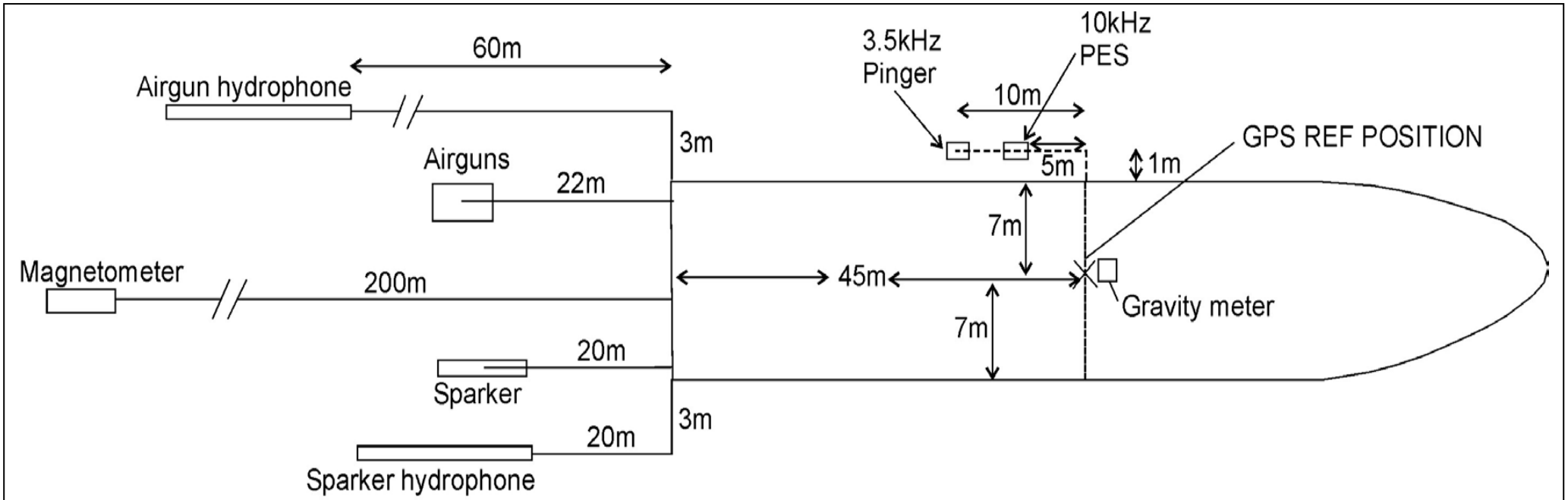

Figure 1. RRS DISCOVERY - LAYBACK DIAGRAM

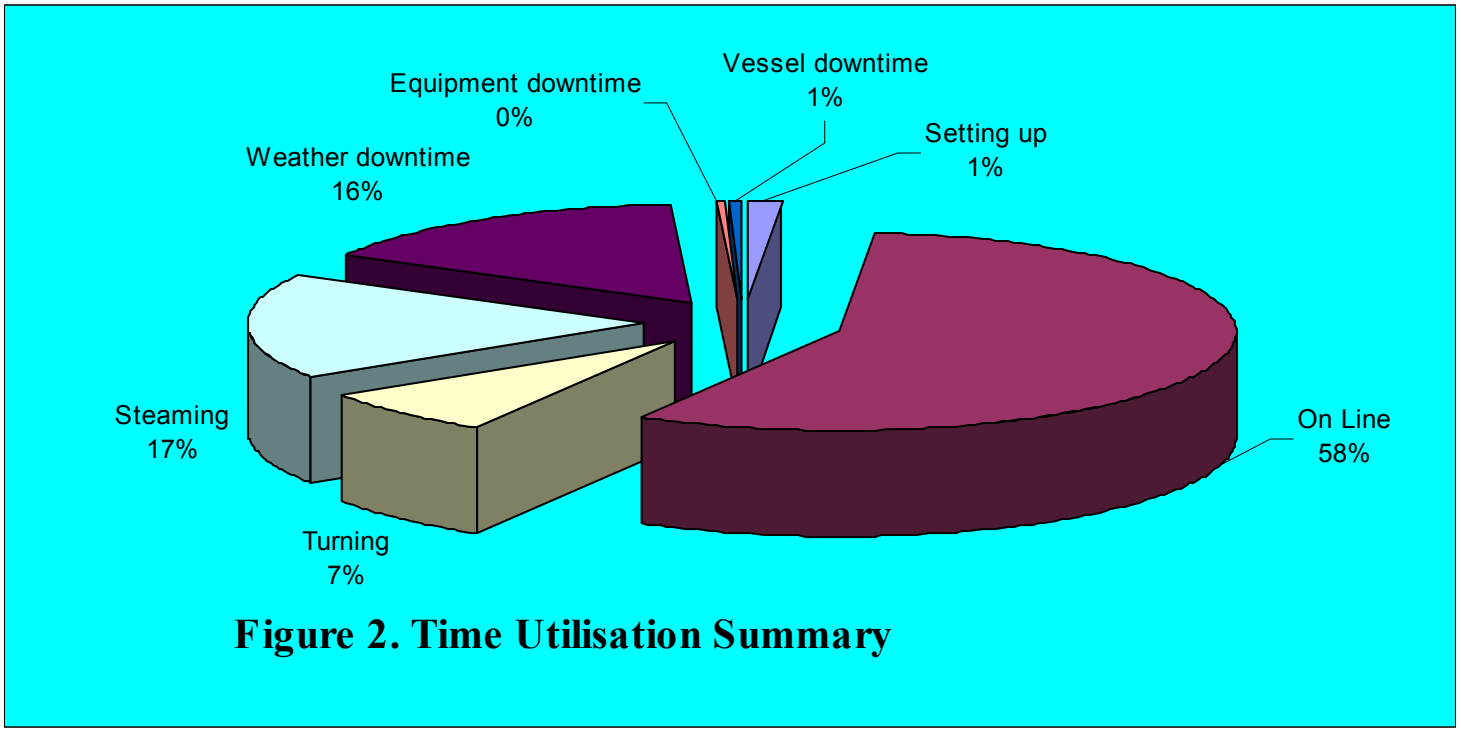

Figure 2. Time Utilisation Summary

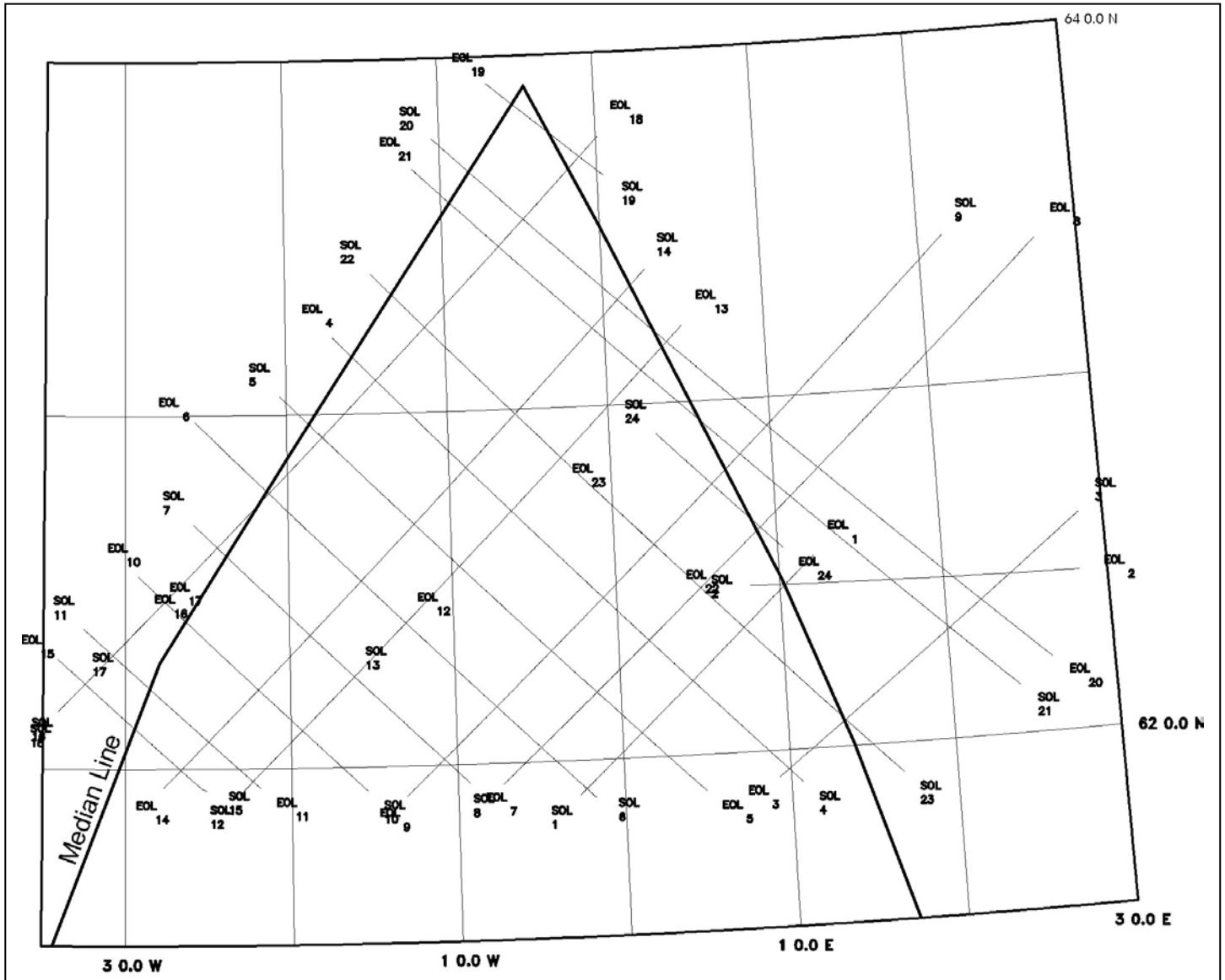

Figure 3. Discovery Cruise D254 - Summary Track Chart.

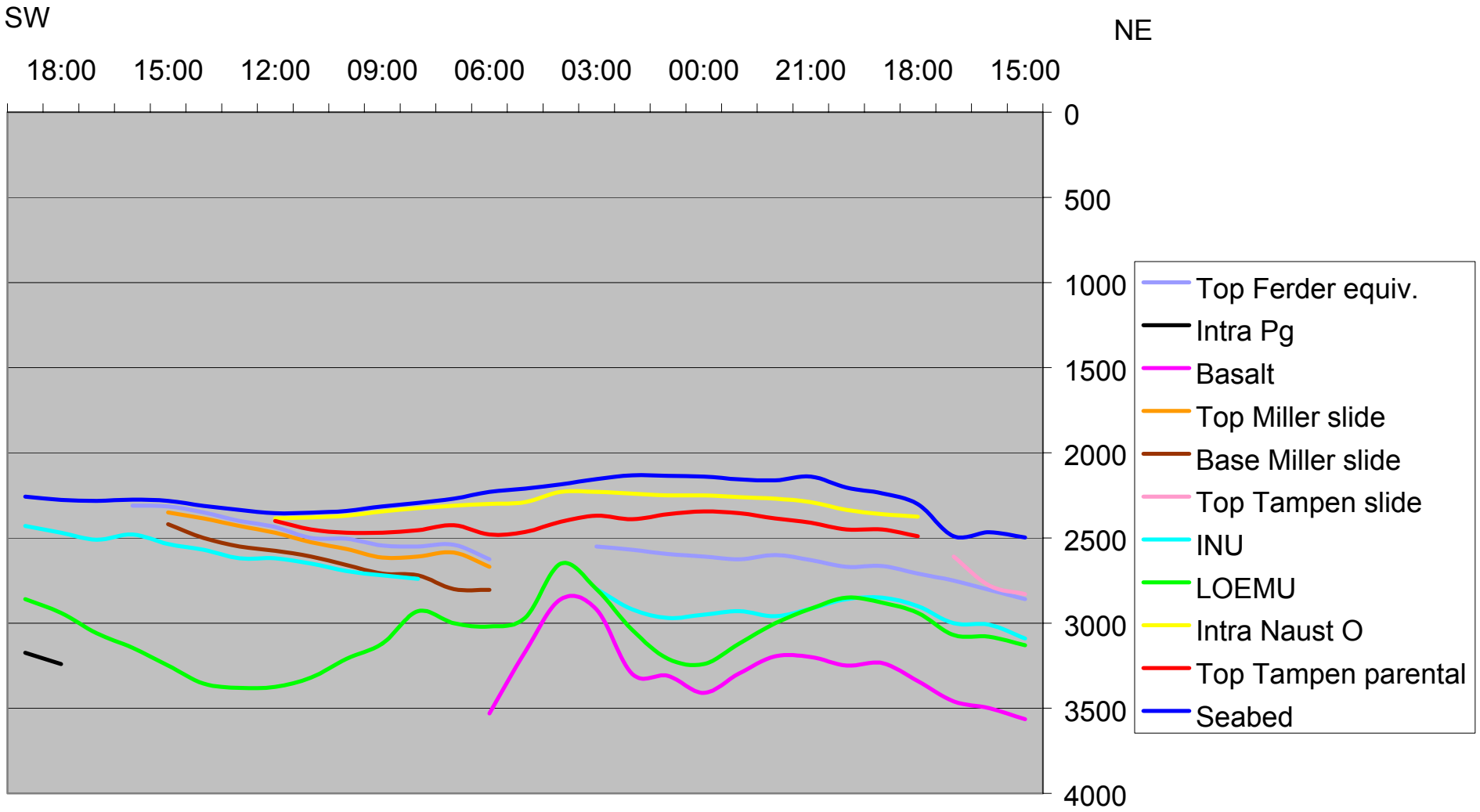

Figure 4. Example Interpretation - Line 14

Appendix 1 Summary Daily log

Summary Daily Log

Date: 25 June J Day 176

Time
08:00 Arrived at vessel at Govan to start mobilisation
Mobilsation in progress all day
Gravity base tie established in the evening

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	0.0
On line	0.0	0.0
Turning	0.0	0.0
Steaming	0.0	0.0
Weather downtime	0.0	0.0
Equipment downtime	0.0	0.0
Vessel downtime	0.0	0.0
Port	0.0	0.0

Summary Daily Log

Date: 26 June J Day 177

Time
08:00 Sailed Govan
Heading for the survey area, preparing equipment en route
Boat drill carried out pm

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	0.0
On line	0.0	0.0
Turning	0.0	0.0
Steaming	16.0	16.0
Weather downtime	0.0	0.0
Equipment downtime	0.0	0.0
Vessel downtime	0.0	0.0
Port	0.0	0.0

Summary Daily Log

Date: 27 June J Day 178

Time

On passage to the survey area throughout

Total km of completed lines:

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	0.0
On line	0.0	0.0
Turning	0.0	0.0
Steaming	24.0	40.0
Weather downtime	0.0	0.0
Equipment downtime	0.0	0.0
Vessel downtime	0.0	0.0
Port	0.0	0.0

Summary Daily Log

Date: 28 June J Day 179

Time
07:50 Slowed to deploy equipment, starting with pinger and PES fish
08:30 Towfish deployment complete, starting to deploy seismic equipment
09:10 Two hydrophones and sparker deployed successfully.
09:20 Airguns deployed, but several problems encountered
09:40 Airguns recovered to sort out problems - gun not sealing, sheaves on A-frame
seized, winch wire not long enough, hoses towing over tow rope
12:45 Airguns deployed, now OK
13:00 Running up systems and adjusting tow set-up
13:20 All seismic systems running - turning towards start of first line
14:00 Deployed magnetometer - signal noisy
15:25 Recovered magnetometer and deployed second bottle
17:15 Turning on to line
17:22 SOL 1
19:43 A/C to avoid fishing floats
20:04 Back on track
22:10 Sparker pulse poor
22:30 Sparker recovered to investigate - earth wire connection broken on frame
22:41 Sparker redeployed and working correctly
24:00:00 Running Line 1

Total km of completed lines: 0

	Today (hours)	Total (hours)
Mob/demob, setting up	9.3	9.3
On line	6.7	6.7
Turning	0.0	0.0
Steaming	8.0	48.0
Weather downtime	0.0	0.0
Equipment downtime	0.0	0.0
Vessel downtime	0.0	0.0
Port	0.0	0.0

Summary Daily Log

Date: 29 June J Day 180

Time	
00:00	Running Line 1
03:26	Sparker stopped - faulty relay box
03:30	Sparker back on
03:50	Sparker record very noisy - investigating
04:30	Changed sparker hydrophone deck lead - sparker fine
05:20	EOL 1 - turning to next line
08:30	SOL 2
10:00	Observed pinger interference on airgun - re-routed cable in lab
10:30	Gun 2 firing inconsistent - changed for gun 3
19:35	EOL 2
19:40	Sparker recovered for trimming
20:05	Sparker re-deployed
22:15	Aigun hydrophone noisy - changed for spare
22:43	SOL 3
24:00:00	Running Line 3

Total km of completed lines: 205km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	17.7	24.4
Turning	6.3	6.3
Steaming	0.0	48.0
Weather downtime	0.0	0.0
Equipment downtime	0.0	0.0
Vessel downtime	0.0	0.0
Port	0.0	0.0

Summary Daily Log

Date: 30 June J Day 181

Time
00:00 Running Line 3
02:02 Sparker stopped firing - sparker recovered
02:47 Sparker re - deployed fault still under investigation
03:26 Sparker operational - fault in power supply trigger board
10:30 Lead weight added to the front of the original airgun hydrophone
11:00 Airgun hydrophone changed for original - better response
15:10 EOL 3
15:20 Sparker recovered for trimming and re-deployed
17:01 SOL 4
18:04 Tried Gun 2 -still inconsistent firing
21:45 Intermittent noise on airgun hydrophone - source unidentified
23:59 Running Line 4

Total km of completed lines: 332km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	22.1	46.5
Turning	1.9	8.2
Steaming	0.0	48.0
Weather downtime	0.0	0.0
Equipment downtime	0.0	0.0
Vessel downtime	0.0	0.0
Port	0.0	0.0

Summary Daily Log

Date: 1 July J. Day 182

Time	
00:00	Running Line 4
00:27	Sparker stopped firing - flat battery in relay bax?
09:30	Sparker power increased to 2200J
09:50	Firing cycle inceased to 7 seconds - deeper water
09:50	Number of guns increased to four
11:05	Sparker trigger failure - relay box?
11:30	Intermittent sparker triggering problem traced to seismic control unit
15:05	Firing cycle slowed to 8 seconds
18:03	EOL 4
18:10	Sparker recovered for trimming
19:30	Both CODA's rebooted after problems resetting fix-marks
20:30	Sparker re-deployed
20:51	SOL 5
23:59	Running Line 5

Total km of completed lines: 536km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	21.9	68.4
Turning	2.1	10.3
Steaming	0.0	48.0
Weather downtime	0.0	0.0
Equipment downtime	0.0	0.0
Vessel downtime	0.0	0.0
Port	0.0	0.0

Summary Daily Log

Date: 2 July J. Day 183

Time	
00:00	Running Line 5
03:01	Firing cycle reduced to 7 secs
08:08	Firing cycle reduced to 6 secs
08:14	Sparker power reduced to 1600J
17:41	EOL 5 - turning to next line
18:00	Sparker recovered for trimming - one candle holder changed
21:15	Sparker re-deployed
22:12	SOL 6

Total km of completed lines: 719km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	19.5	87.9
Turning	4.5	14.8
Steaming	0.0	48.0
Weather downtime	0.0	0.0
Equipment downtime	0.0	0.0
Vessel downtime	0.0	0.0
Port	0.0	0.0

Summary Daily Log

Date: 3 July J. Day 184

Time	
00:00	Running Line 6
05:36	Low frequency interference on airgun - gun 3 added
06:20	Airgun low cut filter increased to 25 Hz
06:50	Airgun low cut filter reset to 20Hz
09:30	Noise reduced on record by adjustment of threshold
17:42	EOL 6 - turning to next line
18:14	Sparker and airguns recovered for maintenance
18:15	Speed increased to 5.5knots for transit
20:34	Slowed to survey speed, deployed sparker and airguns
21:29	SOL 7 - firing 3 guns
23:59	Running Line 7

Total km of completed lines: 892Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	20.1	108.0
Turning	3.9	18.7
Steaming	0.0	48.0
Weather downtime	0.0	0.0
Equipment downtime	0.0	0.0
Vessel downtime	0.0	0.0
Port	0.0	0.0

Summary Daily Log

Date: 4 July J. Day 185

Time	
00:00	Running Line 7
04:07	Gun 5 off - poor timing, Gun 1 on
07:23	Gun 1 stopped - leaking badly causing noise on sparker record
	Gun 5 on
09:34	Gun 5 off as water depth shallows
09:51	Sparker power reduced to 1600J
10:56	EOL 7 - turning towards next line
11:08	Sparker and airguns recovered for maintenance
11:09	Speed reduced to give time for maintenance on turn
12:10	Back to survey speed. Sparker and airguns deployed
12:15	Still problems with guns 2 and 5
12:38	SOL 8
12:40	Plugs cleaned on airgun trigger leads - all guns working
17:50	Added 3rd gun
21:00	Gun 2 auto firing, gun 1 on
21:25	Gun 1 leaking, turned off - running guns 3, 4, 5 only good guns
22:22	Gun 3 off after intermittent missfiring
23:59	Running Line 8

Total km of completed lines: 1012Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	22.3	130.3
Turning	1.7	20.4
Steaming	0.0	48.0
Weather downtime	0.0	0.0
Equipment downtime	0.0	0.0
Vessel downtime	0.0	0.0
Port	0.0	0.0

Summary Daily Log

Date: 5 July J. Day 186

Time	
00:00	Running Line 8
10:55	Airgun printer earthed after intermittent problems
15:53	EOL 8 - turning towards next line
16:20	Sparker and airguns in for maintenance
18:47	Sarker and airguns deployed - all guns good
19:15	SOL 9 - using 3 guns
20:05	Large low frequency noise on airgun hydrophone
23:59	Running Line 9

Total km of completed lines: 1252Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	20.7	151.0
Turning	3.3	23.7
Steaming	0.0	48.0
Weather downtime	0.0	0.0
Equipment downtime	0.0	0.0
Vessel downtime	0.0	0.0
Port	0.0	0.0

Summary Daily Log

Date: 6 July J. Day 187

Time
00:00 Running Line 9
04:34 Airgun printer stopped by CODA system - reset and restarted
23:59 Running Line 9

Total km of completed lines: 1252Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	24.0	175.0
Turning	0.0	23.7
Steaming	0.0	48.0
Weather downtime	0.0	0.0
Equipment downtime	0.0	0.0
Vessel downtime	0.0	0.0
Port	0.0	0.0

Summary Daily Log

Date: 7 July J. Day 188

Time	
00:00	Running Line 9
00:36	EOL 9 - turning towards next line
00:41	Sparker inboard for trimming
01:00	Sparker re-deployed
02:12	SOL 10
07:36	Airgun printer stopped - power re-routed
14:35	EOL 10 - turning towards next line
14:55	Sparker and airguns recovered for maintenance
17:08	Sparker and airguns re-deployed
17:45	SOL 11 - firing 2 guns
18:30	Guns towing too shallow - let out more deployment wire
18:41	Added 3rd gun
23:59	Running Line 11

Total km of completed lines: 1595Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	19.3	194.3
Turning	4.7	28.4
Steaming	0.0	48.0
Weather downtime	0.0	0.0
Equipment downtime	0.0	0.0
Vessel downtime	0.0	0.0
Port	0.0	0.0

Summary Daily Log

Date: 8 July J. Day 189

Time	
00:00	Running Line 11
03:37	EOL 11
03:40	Sparker recovered fro trimming and re-deployed
05:03	SOL 12
14:54	Complete, instant ship's power failure - EOL 12
15:08	All towed gear inboard except airguns
15:45	Limited ship's power available
15:55	Airguns recovered
16:01	Ship's power restored on two generators- starting systems up
18:20	Full ship's power now available - all four generators operational
18:20	Commencing to deploy equipment
19:15	SOL 13 - with overlap of end od Line 12
23:59	Running Line 13

Total km of completed lines: 1744Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	18.1	212.4
Turning	1.6	30.0
Steaming	0.0	48.0
Weather downtime	0.0	0.0
Equipment downtime	0.0	0.0
Vessel downtime	4.3	4.3
Port	0.0	0.0

Summary Daily Log

Date: 9 July J. Day 190

Time	
00:00	Running Line 13
11:27	EOL 13 - turning to next line
11:40	Sparker inboard for trimming - speed increase between lines
14:00	Slowed and deployed sparker
14:30	SOL 14
23:59	Running Line 14

Total km of completed lines: 1877Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	21.0	233.4
Turning	3.0	33.0
Steaming	0.0	48.0
Weather downtime	0.0	0.0
Equipment downtime	0.0	0.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Summary Daily Log

Date: 10 July J. Day 191

Time	
00:00	Running Line 14
19:04	EOL 14 - turning to next line
19:11	Guns switched off - sparker recovered for trimming
19:20	Airgun tow rope badly frayed - attached to wire strop
20:15	Sparker re-deployed
21:28	SOL 15
23:59	Running Line 15

Total km of completed lines: 2100Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	21.6	255.0
Turning	2.4	35.4
Steaming	0.0	48.0
Weather downtime	0.0	0.0
Equipment downtime	0.0	0.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Summary Daily Log

Date: 11 July J. Day 192

Time
00:00 Running Line 15
03:51 EOL 15
03:55 Sparker inboard for trimming and re-deployed
07:49 Noise on airgun hydrophone - under investigation
10:00 Noise still poor but intermittent - weather deteriorating
11:02 EOL 16 - Line aborted to repair airgun hydrophone
11:06 Circling while repairing airgun hydrophone - rewiring plug
12:35 Airgun hydrophone now fine
13:00 SOL 17 - weather conditions still deterirating
13:05 Noise returned to airgun hydrophone - exchanged for spare
14:20 Weather conditions still deteriorating
14:42 EOL 17 - aborted due to weather
15:18 All towed gear recovered - W.O.W. Airgun hydrophone pre-amp replaced.
23:59 W.O.W.

Total km of completed lines: 2210Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	9.9	264.9
Turning	2.8	38.2
Steaming	0.0	48.0
Weather downtime	9.3	9.3
Equipment downtime	2.0	2.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Summary Daily Log

Date: 12 July J. Day 193

Time
00:00 W.O.W
22:40 Commence deploying equipment - back to original airgun hydrophone
23:15 All gear deployed
23:42 SOL 18 - starting to re-run Lines 16 and 17
23:59 Running Line 18

Total km of completed lines: 2210Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	0.3	265.2
Turning	0.0	38.2
Steaming	0.0	48.0
Weather downtime	23.7	33.0
Equipment downtime	0.0	2.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Summary Daily Log

Date: 13 July J. Day 194

Time	
00:00	Running Line 18
14:40	Sighted 'Pelagia'
23:59	Running Line 18

Total km of completed lines: 2210Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	24.0	289.2
Turning	0.0	38.2
Steaming	0.0	48.0
Weather downtime	0.0	33.0
Equipment downtime	0.0	2.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Summary Daily Log

Date: 14 July J. Day 195

Time	
00:00	Running Line 18
07:18	EOL 18 - sparker and airguns recovered for maintenance
07:35	Turning to run to next line
09:20	Sparker and airguns deployed
10:15	SOL 19 - airguns only, too deep for sparker
16:50	EOL 19 - turning to next line
20:05	SOL 20 - airgun only at start, too deep for sparker
22:53	Sparker on
23:59	Running Line 20

Total km of completed lines: 2509Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	17.9	307.1
Turning	6.1	44.3
Steaming	0.0	48.0
Weather downtime	0.0	33.0
Equipment downtime	0.0	2.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Summary Daily Log

Date: 15 July J. Day 196

Time	
00:00	Running Line 20
	Running line throughout the day
18:09	Sparker CODA error in filters - reset
23:59	Running Line 20

Total km of completed lines: 2509Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	24.0	331.1
Turning	0.0	44.3
Steaming	0.0	48.0
Weather downtime	0.0	33.0
Equipment downtime	0.0	2.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Summary Daily Log

Date: 16 July J. Day 197

Time	
00:00	Running Line 20
02:10	EOL 20 -turning to next line
02:25	Sparker inboard for trimming
02:35	Sparker re-deployed
04:19	SOL 21
23:59	Running Line 21

Total km of completed lines: 2764Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	21.9	353.0
Turning	2.1	46.4
Steaming	0.0	48.0
Weather downtime	0.0	33.0
Equipment downtime	0.0	2.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Summary Daily Log

Date: 17 July J. Day 198

Time	
00:00	Running Line 21
09:30	Boat drill carried out
10:27	Saprker switched off - water too deep
12:25	EOL 21
12:40	Airguns, sparker and hydrophones recovered
12:45	Heading for next line at full speed
14:15	Slowing to deploy equipment
14:38	All gear deployed - turning onto ;ine
15:24	SOL 22
21:45	Airgun deployment wire out further
23:59	Running Line 22 - in steadily deteriorating weather conditions

Total km of completed lines: 3016Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	21.0	374.0
Turning	3.0	49.4
Steaming	0.0	48.0
Weather downtime	0.0	33.0
Equipment downtime	0.0	2.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Summary Daily Log

Date: 18 July J. Day 199

Time
00:00 Running Line 22 in steadily deteriorating weather conditions
04:00 Weather conditions continuing to deteriorate steadily - wind Force 6-7
09:06 EOL 22 - abandoned due to weather - wind now Force 7
09:40 All stern towed equipment inboard - Waiting on weather

Total km of completed lines: 3147Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	9.1	383.1
Turning	0.0	49.4
Steaming	0.0	48.0
Weather downtime	14.9	47.9
Equipment downtime	0.0	2.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Summary Daily Log

Date: 19 July J. Day 200

Time	
00:00	Waiting on weather - Force7/8 northerly
14:00	Turned to head south towards southern end of line
21:00	Vessel turned and hove to near southern end of line
23:59	Waiting on weather - still Force 7/8 northerly

Total km of completed lines: 3147Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	0.0	383.1
Turning	0.0	49.4
Steaming	0.0	48.0
Weather downtime	24.0	71.9
Equipment downtime	0.0	2.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Summary Daily Log

Date: 20 July J. Day 201

Time	
00:00	Waiting on weather - Force 7/8 northerly
23:59	Waiting on weather - Force 7/8 northerly

Total km of completed lines: 3147Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	0.0	383.1
Turning	0.0	49.4
Steaming	0.0	48.0
Weather downtime	24.0	95.9
Equipment downtime	0.0	2.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Summary Daily Log

Date: 21 July J. Day202

Time
00:00 Waiting on weather - Force 7/8 northerly
11:40 Turning to head back to proposed SOL - wind reducing slightly
14:00 Wind dropping quickly
15:50 Slowed to deploy equipment
16:10 All equipment deployed - heading to start of line
17:17 SOL 23
23:59 Running Line 23

Total km of completed lines: 3147Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	6.7	389.8
Turning	0.0	49.4
Steaming	0.0	48.0
Weather downtime	17.3	113.2
Equipment downtime	0.0	2.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Summary Daily Log

Date: 22 July J. Day 203

Time	
00:00	Running Line 23
10:15	EOL 23
10:28	Sparker, airguns and hydrphones recovered - full speed to next line
11:45	Slowed to deploy equipment
12:00	All equipment deployed - turning onto line
13:00	SOL 24
19:46	EOL 24 - End of Survey - End of Discovery Station No 14131
20:14	All stern towed equipment recovered
20:28	PES and pinger towfish recovered
20:30	Commence passage to Southampton
23:59	On passage

Total km of completed lines: 3329Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	17.0	406.8
Turning	3.5	52.9
Steaming	3.5	51.5
Weather downtime	0.0	113.2
Equipment downtime	0.0	2.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Summary Daily Log

Date: 23 July J. Day 204

Time	
00:00	On Passage
23:59	On Passage

Total km of completed lines: 3329Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	0.0	406.8
Turning	0.0	52.9
Steaming	24.0	75.5
Weather downtime	0.0	113.2
Equipment downtime	0.0	2.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Summary Daily Log

Date: 24 July J. Day 205

Time	
00:00	On Passage
23:59	On Passage

Total km of completed lines: 3329Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	0.0	406.8
Turning	0.0	52.9
Steaming	24.0	99.5
Weather downtime	0.0	113.2
Equipment downtime	0.0	2.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Summary Daily Log

Date: 25 July J.Day 206

Time	
00:00	On Passage
23:59	Dock Southampton

Total km of completed lines: 3329Km

	Today (hours)	Total (hours)
Mob/demob, setting up	0.0	9.3
On line	0.0	406.8
Turning	0.0	52.9
Steaming	24.0	123.5
Weather downtime	0.0	113.2
Equipment downtime	0.0	2.0
Vessel downtime	0.0	4.3
Port	0.0	0.0

Appendix ll Line Summary

British Geological Survey Marine Operations Line Summary Log Sheet of

PROJECT 01/01 NORTH OF 62N 2001 GEOPHYSICAL SURVEY **Vessel: RRS Discovery**

Line	Start			End			Length	Total	Equipment Run						Comments
No.	Date	J. Day	Time	Date	J. Day	Time	(km)	(km)	Airgun	Sparker	Gravity	Magnetics	Pinger	E/S	
1	28-Jun	179	17:22	29-Jun	180	5:20	107	107	x	x	x	x	x	x	
2	29-Jun	180	8:30	29-Jun	180	19:35	98	205	x	x	x	x	x	x	
3	29-Jun	180	22:43	30-Jun	181	15:10	127	332	x	x	x	x	x	x	
4	30-Jun	181	17:01	1-Jul	182	18:03	204	536	x	x	x	x	x	x	
5	1-Jul	182	20:51	2-Jul	183	17:41	183	719	x	x	x	x	x	x	
6	2-Jul	183	22:12	3-Jul	184	17:42	173	892	x	x	x	x	x	x	
7	3-Jul	184	21:29	4-Jul	185	10:56	120	1012	x	x	x	x	x	x	
8	4-Jul	185	12:38	5-Jul	186	15:53	240	1252	x	x	x	x	x	x	
9	5-Jul	186	19:15	7-Jul	188	0:36	244	1496	x	x	x	x	x	x	
10	7-Jul	188	2:12	7-Jul	188	14:35	99	1595	x	x	x	x	x	x	
11	7-Jul	188	17:45	8-Jul	189	3:37	75	1670	x	x	x	x	x	x	
12	8-Jul	189	5:03	8-Jul	189	14:54	74	1744	x	x	x	x	x	x	EOL - total ship's power failure
13	8-Jul	189	19:15	9-Jul	190	11:27	133	1877	x	x	x	x	x	x	
14	9-Jul	190	14:30	10-Jul	191	19:04	223	2100	x	x	x	x	x	x	
15	10-Jul	191	21:28	11-Jul	192	3:51	62	2162	x	x	x	x	x	x	
16	11-Jul	192	6:37	11-Jul	192	11:02	35	2197	x	x	x	x	x	x	EOL - airgun hydrophone problem
17	11-Jul	192	13:00	11-Jul	192	14:42	13	2210	x	x	x	x	x	x	EOL - weather - to be re-run
18	12-Jul	193	23:42	14-Jul	195	7:18	252	2462	x	x	x	x	x	x	Incl. re-run of 16 and 17
19	14-Jul	195	10:15	14-Jul	195	16:50	47	2509	x		x	x	x	x	No Sparker - deep water
20	14-Jul	195	20:05	16-Jul	197	2:10	255	2764	x	Part	x	x	x	x	No Sparker at start - deep water
21	16-Jul	197	4:19	17-Jul	198	12:25	252	3016	x	Part	x	x	x	x	No Sparker at end - deep water
22	17-Jul	198	15:24	18-Jul	199	9:06	131	3147	x	x	x	x	x	x	EOL -weather - part to re-run
23	21-Jul	202	17:17	22-Jul	203	10:15	128	3275	x	x	x	x	x	x	
24	22-Jul	203	13:00	22-Jul	203	19:46	54	3329	x	x	x	x	x	x	

Appendix lll Gravity Base Ties

Date	Location	Corrected ship base	Corrected meter reading	Drift mgal
25/06/2001	Govan	981589.47	12810.1	0.0
26/07/2001	Southampton SOC	981115.61	12330.0	-4.6