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Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

BGS cruise to Rockall-Hatton-Faroes region Project 06/02 RRS Charles Darwin CD180 Operations Report

Marine Coastal and Hydrocarbons Programme

Internal Report IR/06/076



BRITISH GEOLOGICAL SURVEY

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RRS Charles Darwin, Village Bay, St Kilda.

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Foreword

This report covers the operation of last scientific cruise for NERC of the RRS Charles Darwin, CD180, BGS Project 06/02, a regional marine geophysical survey west of Scotland, carried out from 20th May to 9th June 2006. This field operation continues the regional geological mapping in this area that was initiated in 1992 as part of the BGS Rockall Continental Margin Project, but also concentrated on certain specific structures and target areas, which had been identified from previously collected data. The cruise was funded through the BGS Science Budget programme.

Acknowledgements

As with any offshore work programme, this project was 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 Appendix 1 and their contribution to the success of the operation is hereby acknowledged. Grateful thanks are also due to Captain Peter Sarjeant, the other officers and crew of the RRS Charles Darwin, the technical support provided by Gareth Knight and colleagues of UKORS and Andy Louch and colleagues of the RSU logistical support, for their efforts and assistance to make this an efficient and smooth operation. Thanks also to Ken Hitchen and for the report review.

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Summary

This report describes the operation for BGS Project 06/02 (Charles Darwin CD180), from the mobilisation on the 18th May, the regional marine geophysical survey west of Scotland, 24th May to 7th June and demobilisation on 9th June.

The operational aims of the survey project were:

- To carry out a planned programme of 1900 km of marine geophysical surveying to link into existing data

The survey was designed to address several geological objectives including:

- Define size/shape of basalt window;
- Identify and/or constrain compressional folds/faults/thrusts
- Investigate the seismo-stratigraphy of the Faroe-Bank Channel with a view to identifying suitable potential borehole location(s).

The above work was completed ahead of schedule, thus allowing high-resolution seismic reflection lines to be run just south of St Kilda and Stanton Bank.

The geophysical techniques employed were high-resolution single channel seismic reflection, (Airgun and Sparker), gravitational field, magnetic field and multibeam bathymetry. All systems were digitally recorded, and in addition, airgun was digitally processed on line.

The vessel utilised was the RRS Charles Darwin Cruise CD180. The vessel provided an excellent platform for the work involved with good laboratory space, working deck space, general facilities and experienced officers and crew.

The main mobilisation took place between the 18th – 19th May 2006, in Falmouth, Cornwall. Operations were conducted over a 15-day period and demobilisation took place on the 9th June in Fairlie on the Clyde Estuary. Weather conditions varied; there were very few excellent days. There was one day lost to weather and lower quality data was accepted for some of the lines.

The survey was extremely productive with the entire planned programme being completed in 11 days. Additional lines were run just south of St Kilda and Stanton Bank, totalling 30 lines and 2183 km of data.

1 Introduction

The British Geological Survey Project 06/02 was a marine geophysical survey (seismic reflection, gravitational field, magnetic field, multibeam bathymetry) covering areas from Rockall, Hatton Bank, the banks south west of the Faroe Islands and the Faroe Bank Channel. The survey was designed to address several geological objectives including:

- Rockall to Hatton Bank: Multibeam only to get full picture from sea-bed to depth (line is coincident with existing BGS seismic collected in 2000 which shows a variety of interesting features).
- Small area on Hatton Bank: Lines across basalt window to define size and shape of window and orientation of fold axes in Mesozoic.
- NW edge of Hatton Bank: Lines across SEA7 sites where video of coral obtained. Lines to investigate if there is relationship between coral growth and geological structure.
- NW edge of Hatton Bank: Lines anticipated to image geological structures some of which might be compressional in origin. Lines cross sea-bed ridges imaged by Spanish 2005 multibeam survey. Origin of ridges unknown (yet).
- Various banks south west of Faroe Islands: Lines designed to investigate the structure of major banks and Wyville-Thomson and Ymir ridges. One line crosses 'Alpin Dome' between Rosemary Bank and Bill Bailey's Bank
- Faroe Bank Channel: Lines mainly to investigate seismic stratigraphy and sediment patterns in Faroe Bank Channel. Also to look for possible future borehole location(s).
- St Kilda: Short high resolution lines were run just south of St Kilda to tie in an existing piston core to existing BGS Deep Tow Boomer line.
- Stanton Bank: High resolution seismic reflection line were run for the MESH project to compliment previously acquired data in 2005 on project BGS 05/05 (CD174).

2 Narrative

2.1 MOBILISATION

The mobilisation of the RRS Charles Darwin started on 18th May in Falmouth and went according to plan apart from damage to the sparkarray power cable that occurred whilst the 10ft bangbox container was unloaded from the lorry.

2.2 SURVEY

Saturday 20th May

The vessel sailed at 10:00 for the final NERC scientific cruise of the RRS Charles Darwin. The prevailing poor weather, and the forecast received, dictated that the best course for the vessel to reach the starting point of the work programme, Rockall, would be through the Irish Sea. Even by taking this course instead of the Atlantic side of Ireland the sea state was poor and uncomfortable for all. Total power loss to the vessel was experienced at 23:00, cause at the time unknown. Power was restored within 15mins.

Tuesday 23rd

Despite the uncomfortable ride the vessel made good progress arriving SE of Rockall Bank at 07:00. The speed of sound was checked with a sound velocity probe (SVP) to provide a speed of sound through the water column for the multibeam system. This was followed by running lines to check the calibration of the multibeam, heading west up the slope of Rockall Bank. Unfortunately due to the sea state the vessel could not run the reciprocal line down the slope. However a line reciprocal to the down slope line was run back up the slope. Unfortunately the vessel lost total power for the second time in 18 hours, this corrupted the multibeam data and so the check could not be made. By this time the vessel could not make headway due to the increase in swell and wind. The vessel was weathered off. On advice from Gareth Knight, it was decided that further checks would not be attempted to the multibeam, as the calibration was unlikely to be affected from the previous time the multibeam was used.

Wednesday 24th

By dawn the sea state and wind speed had improved and allowed line 1, a multibeam only line, to start at the designated point approximately 15 miles south of Rockall. Initially the line was run at a speed of 4 knots due to the sea state. The speed was progressively increased throughout the day to the optimum 8 knots.

Thursday 25th

Line 1 was completed in the morning. The airgun, sparker and magnetometer systems were deployed and up and running in an hour and a half in good sea conditions. Lines 2 to 5 were completed meeting the requirement to image a window within the basalt of Hatton Bank. Problems with compressor 2 overheating did not affect the data collection.

Friday 26th

Transit to second area of interest on Hatton Bank, lines looking at areas of cold-water coral reefs and geological structures. Lines 6 to 8 are a line running in a generally northerly direction, with small course alterations. On line 10 the vessel had to slow for a time to allow a fishing vessel to pass. By the end of the day part of line 11 had been completed.

Saturday 27th

Continue on line 11 until completed and all equipment recovered just after 07:00. This completed the area around Hatton Bank. The vessel steamed at 10 knots to the start of a transit line across Lousy, Bill Bailey and Faroe Banks collecting additional multibeam on the way. Note data was collected at 10 knots and not the optimal 8 knots. No line number was given to this opportunist line. The vessel stopped 2 miles before the start of line 12 to perform a SVP deployment followed by deployment of the seismic equipment. Line 12 was started at 20:47.

Sunday 28th

In the early hours the wind picked up to 25 knots creating a large following swell, which at times broke onto the deck. The sparker was recovered at 05:30 due to poor data and risk to the equipment, the line continued, without break, with airgun. Although the airgun data quality was affected, the vessel was currently on the top of Lousy Bank with little penetration through the basalt. By 10:00 the wind had eased to 13 knots, though still with a large following swell. The swell had diminished enough by 12:30 to re-deploy the sparker, though the data is not of optimum quality. At 14:46 the deepest (1240m) part of the line between the Lousy and Bill Banks was reached. By 16:30 the wind had quickly moved 180 degrees, directly ahead of the vessel and increased to 30 knots. This caused speed fluctuations with the vessel and poor sparker data due to confused sea. The sparker was recovered. Various weather-induced problems followed, magnetometer cable caught on airgun frame, airgun hydrophone noisy, recovered and checked and the vessel found it hard to maintain the required constant speed. The line continued throughout with short loss of airgun data, while the hydrophone was checked and no sparker data for the times it was recovered to deck.

Monday 29th

Sparker re-deployed in the early hours. At 08:46 the shallowest (88m) part of the Faroe Bank on this line was reached, wind still blowing 16 knots from the north. The line was completed at 20:03 and all equipment was recovered. An SVP was deployed whilst several airguns were changed out, the airgun frame welded up and the sparker trimmed.

Tuesday 30th

By midnight all equipment had been re-deployed and the vessel was turning onto the next line, running SW across the Faroe Bank Channel. Problems with the airgun hydrophone being entangled with the airgun frame resulted in the vessel circling the line. Line 13 was started at 01:54. Wind reduced to 10-15 knots throughout the day, the swell slowly followed. An emergency drill practice was undertaken mid-morning and included a safety quiz. By midnight line 14 was two-thirds completed.

Wednesday 30th

The day started with excellent weather, but by midday the wind had picked up to 17 knots from the south. The day ended approximately two-thirds along line 15 with the wind 15 knots from the southwest.

Thursday 1st

Line 15 continued, just after midnight a loss of air pressure to the airguns was traced to gun 1. This was isolated. Line 16 started late morning, with the wind and swell on the port stern quarter, 20+ knot winds were recorded throughout the day. The data were acceptable though not excellent with the sparker suffering the most.

Friday 2nd

Line 16 continued, the wind moving slowly around to west-southwest and varying in speed with squalls up to 25 knots. The vessel began to suffer from increased rolling throughout the day and consequently degradation in the data quality similar to the previous day. Line 16 finished at around 19:00, the sparker was recovered for trimming and re-deployed, line 17 started in an easterly direction, the swell directly astern.

Saturday 3rd

From midnight the wind ameliorated and the swell followed. During the night it was noticed that the on line airgun printer was failing to print all the shots. This problem continued intermittently for the rest of the survey and could not be specifically traced to either the printer or the CODA system that was sending the data. Line 17 finished at 06:03 and line 18 started immediately after a 45 deg course alteration. The CODA recording system lost the easting navigation input for 3 hours during the morning and the GPS signal produced apparent large jumps in position for an hour in the afternoon. The position recorded on each ping recorded on the CODA cannot be relied upon for this line. Line 18 finished at 15:53 and line 19 started half an hour later in a northerly direction.

Sunday 4th

Line 19 and 20 were completed and line 21 started all in excellent sea conditions.

Monday 5th

Line 21 was completed at 16:18, this completing the original survey plan. All equipment was recovered and the vessel steamed towards a position just south of St Kilda.

Tuesday 6th

Additional time allowed a short excursion around the world heritage site of St Kilda. To use the surplus time available two further work areas were proposed.

- An area just south of St Kilda to run seismic reflection lines across an existing piston core location to tie this into previously run BGS Deep Tow Boomer lines.
- Stanton Bank: To fill in data collected in 2005.

Both these areas required high resolution seismic. Unfortunately no surface tow boomer was on board. The sparker system was adapted to optimise it for high resolution. All tips were made into a line for uniform depth, the power per tip was reduced, flotation was added to try to maintain a tow depth of 0.25 m, the vessel speed was reduced to increase the number of shots per km, the firing interval was reduced from 6 sec to 0.6 sec and the sampling rate and filter frequencies increased.

Work started at the St Kilda area 18:00 and 5 lines (22-26) were completed by 22:00. The equipment run was sparker, PES, pinger and multibeam. The pinger gave good results until the sparker was switched on and obliterated the pinger record. Upon completion all equipment was recovered and the vessel steamed to the next work area at Stanton Bank.

Wednesday 7th

07:30 arrived at Stanton Bank work area. After a short delay waiting for a fishing boat to move away, the first line, 27, was started at 07:54. Four lines (27-30) were completed by 22:00. All equipment was recovered and the vessel steamed towards Fairlie. This concluded the survey.

Thursday 8th

Steaming to Fairlie

Friday 9th

Arrived Fairlie 11:30. Allowed gravity meter to settle before switching off. 14:00 Demob equipment and depart the vessel and travel to Edinburgh.

3 Equipment used

3.1 AIRGUN SYSTEM

Source: An array of 5 x 40 cu inch Bolt 600B airguns with waveshape kits and time break solenoids was utilised as the airgun source. Routinely, up to four guns were fired simultaneously, keeping the fifth gun as a ready spare. The number of guns used varied with water depth, with a minimum of 1 being used in the shallower areas. The firing rate varied from 6 – 7 seconds depending on water depth. The airgun array firing synchronisation was achieved by monitoring the time break solenoids and manually adjusting each airgun's trigger as required. This introduces a short time delay into the system of between 25 and 38 milliseconds and thus the sea-bed return time is not an absolute measurement of depth. A 20ft compressor container belonging to BGS containing two CompAir Reavell type VHP36 compressors supplied the high-pressure air for the airguns. Air was fed from the compressors through the vessel's internal pipe-work to the aft deck and connected into the BGS airgun control panel.



Plate 1 Deployment of Airguns and 30m-hydrophone streamer

Hydrophone: A 4 channel SIG hydrophone summed to give a single channel 32m active length was utilised as the receiver for the airgun source.

Recording: The BGS CODA DA200, software version 3.9.11.5L(3360) 2005 four-channel digital recording and processing system was utilised to record the raw data. The data were recorded to Flipdisks in CODA format with a sampling frequency of 3kHz, record length of 4 seconds and bandpass filter of 25-800 Hz. 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 vessels Trimble DGPS system, and logged position, time and date for each shot.

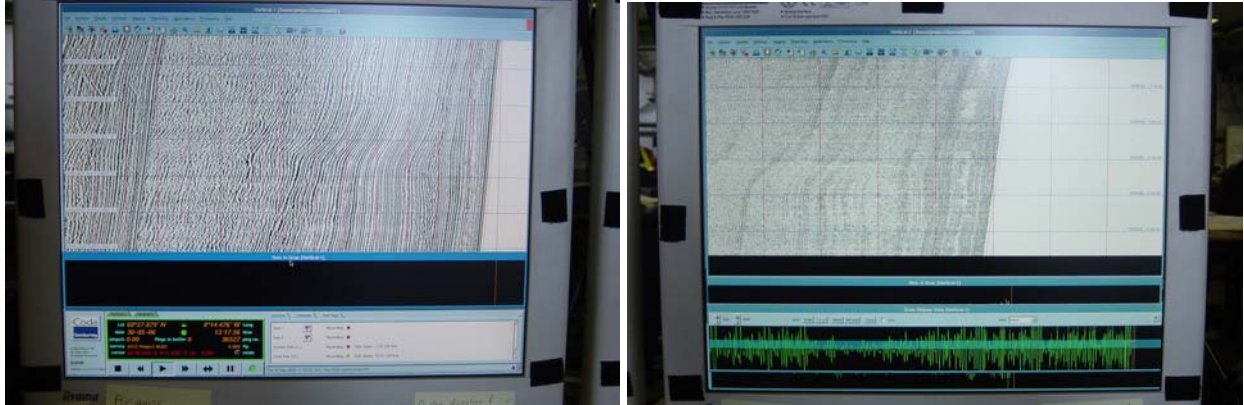


Plate 2 Screen images of Airgun and Sparker data

On line processing: In addition to the recording described above, the CODA system was also used to process the data on-line and produce a real time hard copy output on an Ultra 120 thermal printer. Processes applied were time varied gain (TVG), time varied filtering (TVF) and trace mixing and, in extremely large amplitude sea swell situations, a swell filter. Both TVG and TVF were applied from the sea-bed, which was tracked automatically. A 1.5 sec record length was used for the on-line hard copy, with a delay adjusted to give an optimum record for the water depth.



Plate 3 Seismic reflection recording layout and hardcopy printer

3.2 SPARKER SYSTEM

Source: EG&G, nine candle, multi-tip sparkarray with 135 tips was utilised as the sparker source.

High Voltage Power Supply: An Applied Acoustic Engineering CSP2200 capacitor charging unit. This is a single unit, powered from the ship's 240VAC supply incorporating switchable output energy up to a maximum of 2200 J. Apart from lines 2-5 (1800J) the whole survey was conducted at an output of 2200 J.



Plate 4 Sparkarray and hydrophone 10m hydrophone streamer on an exceptional calm day

Hydrophone: A seven channel Teledyne 10m hydrophone, summing on the most part, all channels to give a single output, was utilised as the receiver for the sparker source.

Recording: This utilised the same CODA DA200 four-channel digital recording and processing system as the airgun, with the data recorded on the same file to Flipdisk in CODA format. The data were recorded with a sampling frequency of 5kHz, record length of 1.9 seconds and a bandpass filter of 100-1730 Hz. The start of recording was delayed in deep water to permit a minimum of 1 second of data below the seabed. As with the airgun, position, time and date were recorded with every shot.

On-line processing: The sparker data was processed on line for QA purposes of the recorded data. Processes applied were time varied gain (TVG), time varied filtering (TVF), swell filter (occasionally), and trace mixing. Both TVG and TVF were applied from the sea-bed, which was tracked automatically. A hardcopy output could not be obtained on line as the BGS only has one thermal printer that will operate with the CODA. During long transits and weather downtime hard copies were generated. A 700msec record length was used for the hard copy, with a delay adjusted to give an optimum record in the prevailing water depth. Ideally a second printer would be beneficial on these projects to obtain the on line hardcopies required and as a backup for the only printer.

3.3 GRAVITY METER

The gravity meter used was a ZLS Corporation UltraSys controlled LaCoste and Romberg sensor serial No. S75 system. This consists of a highly damped, zero-length spring type gravity sensor mounted on a gyro-stabilised platform, together with associated control and recording electronics. The sensor and control electronics were located in the 'Controlled Temperature Laboratory' adjacent to the 'Main Laboratory', this allowed easy access for observation. It was impractical to mobilise the meter in the vessel's 'Gravity Room' due to access restrictions for

both equipment and cables to main lab. Gravity was measured continuously and the gravity, spring tension and cross coupling correction values were logged at a one second interval in L&R Long Format onto the ship's logging and processing system and internally in the gravity control computer. Additional backup data storage was achieved through utilising the zip drive incorporated with the gravity control computer. Data were also output to a colour printer for QC purposes. No data processing was carried out on the vessel.

The vessel suffered two complete blackouts during the transit to the work area. This resulted in the meter losing power and having to be clamped and kept on heat using a battery powered, power supply. At the time of writing it is unknown if these two power blackouts have had an affect on the data, although this felt unlikely. However it was observed that the internal pressure within the meter varied with atmospheric pressure and this should be corrected for using the approximation of 1mGal for every 4Hpa of pressure change. This fault should be repaired before the next cruise.



Plate 5 Gravity meter and recording PC

3.4 MAGNETOMETER

The system used was a Barringer proton precession magnetometer with a 1 gamma sensitivity. The sensor was towed 200 m astern to minimise the effects of the vessel's steel hull on the local magnetic field. 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 Binary Coded Decimal (BCD) data to serial data within a BCD to serial converter before being logged onto the ship's logging and processing system.

This very elderly system performed as well as can be expected, though suffered from noise on some lines. Consideration should be given to the replacing this ageing system, to a system that is higher resolution and easier to interface and record the data, both hard copy and digital as paper and pens are becoming expensive and difficult to source.



Plate 6 Deployment of marine magnetometer

3.5 MULTIBEAM

The vessel has an elderly deep water Simrad EM12 multibeam system, which was used throughout the survey. Checks of the multibeam calibration were made when the vessel arrived at Rockall Bank. Lines were run up the bank and down on a reciprocal course. Unfortunately the weather was too severe for the vessel to run an accurate reciprocal course. A further line was run back up the slope, however the data was lost when the vessel had a complete blackout. After half a day of attempting to check the calibration of the multibeam system without success, coupled with the poor weather conditions, it was decided, with advice from the multibeam operator on board that no further attempts would be made. The vessel was weathered off for next 12 hours.

Note: The calibration of the multibeam historically has proven to be stable and as such no recalibration was deemed necessary or was planned for this project. The attempted checks of the multibeam calibration were just that, checks.

Several sound velocity profiles were made throughout the survey, Rockall Bank, before the start of line 12 and the Faroe Bank Channel. It was noted that the Faroe Bank Channel had fresh water close to the seabed.



Plate 7 Simrad EM12 multibeam recording and processing

3.6 PINGER

The 3.5kHz pinger is a transducer mounted in a tow fish and was towed over the starboard side. This was controlled by an IOS transceiver with the data recorded on a CodaOctopus360 acquisition system and was part of the standard shipboard equipment. The pinger gave poor sub-bottom records compared with the sparker system and was affected by the sparker especially in the St Kilda and Stanton Bank areas where the sparker was fired at the higher rate of 0.6 sec.



Plate 8 Recovery of PES (port) and Pinger (Starboard)

3.7 PRECISION ECHOSOUNDER

The Precision Echosounder (PES) is a 10kHz IOS transducer mounted in a tow fish and deployed off the port side close to amidships. This is controlled by a Simrad EA500 transceiver and display and was compensated for fish height with the depth recorded centrally. Paper printout was only collected for the lines around St Kilda and Stanton Bank.

Appendix 1 Ship's complement

BGS		RRS Charles Darwin	
Dave Smith	<i>Electronic Engineer-Principal Scientist</i>	Peter Sarjeant	<i>Master</i>
Davie Baxter	<i>Mechanical Engineer</i>	Peter Newton	<i>Chief Officer</i>
Iain Pheasant	<i>Mechanical Engineer</i>	Kieron Hailes	<i>2nd Officer</i>
Heather Stewart	<i>Marine Geologist</i>	Katie Rumbold	<i>3rd Officer</i>
Adrian Tuitt	<i>Student Geologist</i>	John Holt	<i>Chief Engineer</i>
Dave Wallis	<i>Electronic Engineer</i>	Glynn Collard	<i>2nd Engineer</i>
Michael Wilson	<i>Electronic Engineer</i>	John Harnett	<i>3rd Engineer</i>
		David Ardern	<i>3rd Engineer</i>
		John Smyth	<i>Engine Room Petty Officer</i>
		David Holdsworth	<i>Electrical Officer</i>
UKORS, NOC		Michael Minnock	<i>Chief Petty Officer scientific</i>
Gareth Knight	<i>IT Support</i>	Michael Drayton	<i>Chief Petty Officer Deck</i>
		Philip Allison	<i>Petty Officer Deck</i>
		Gerald Cooper	<i>Seaman</i>
		Stewart Barrett	<i>Seaman</i>
		Joseph Lambert	<i>Seaman</i>
		Ford Prefect	<i>Seaman</i>
University of Malaga Instituto Espanol Oceanographie		Paul Lucas	<i>Ship Catering Manager</i>
Miriam Sayago-Gil	<i>Marine Geologist</i>	Darren Caines	<i>Chef</i>
		Wilmot Isby	<i>Assistant Chef</i>
		Jacqueline Paterson	<i>Steward</i>
Guardline			
Len Phillips	Supernumery		

Appendix 2 Summary Daily Log

All times quoted are GMT

Summary Daily Log

Date: Thursday 18th May 2006

Time

08:30 Arrive vessel, County Warf, Falmouth, start mobilisation
 Sparker power cable damaged when 10ft container lifted off lorry

16:45 Depart vessel

Total km of completed lines: 0

	Today (hours)	Total (hours)
Mob/demob, setting up	8.25	8.25
On line	0.00	0.00
Turning	0.00	0.00
Steaming	0.00	0.00
Weather downtime	0.00	0.00
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	7.25	7.25

Summary Daily Log

Date: Friday 19th May 2006

Time

08:00 Join vessel, continue mobilisation

12:45 Gravity base-tie at half tide 11811.2 PC

Total km of completed lines: 0

	Today (hours)	Total (hours)
Mob/demob, setting up	10.00	18.25
On line	0.00	0.00
Turning	0.00	0.00
Steaming	0.00	0.00
Weather downtime	0.00	0.00
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	14.00	21.25

Summary Daily Log

Date: Saturday 20th May 2006

Time

09:00 RRS Charles Darwin departs Falmouth for her last scientific cruise for NERC
Weather poor, head up the Irish Sea

15:15 Emergency drill

Total km of completed lines: 0

	Today (hours)	Total (hours)
Mob/demob, setting up	0.00	18.25
On line	0.00	0.00
Turning	0.00	0.00
Steaming	14.00	14.00
Weather downtime	0.00	0.00
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	10.00	31.25

Summary Daily Log

Date: Sunday 21st May 2006

Time

09:30 Scientific briefing

13:00 SIG hydrophone oil topped up
Sparker finally repaired

Total km of completed lines: 0

	Today (hours)	Total (hours)
Mob/demob, setting up	0.00	18.25
On line	0.00	0.00
Turning	0.00	0.00
Steaming	24.00	38.00
Weather downtime	0.00	0.00
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	31.25

Summary Daily Log

Date: Monday 22nd May 2006

Time

00:00 Vessel passing Dumfries & Galloway, heading for Rockall
 13:00 Multibeam switched on
 23:00 Total ship power failure, gravity meter clamped and on backup heater supply
 23:30 Restart Gravity meter
 23:50 Gravity meter running

Weather poor throughout the day, vessel rolling and pitching

Total km of completed lines: 0

	Today (hours)	Total (hours)
Mob/demob, setting up	0.00	18.25
On line	0.00	0.00
Turning	0.00	0.00
Steaming	24.00	62.00
Weather downtime	0.00	0.00
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	31.25

Summary Daily Log

Date: Tuesday 23rd May 2006

Time

00:00 On passage to survey area
 07:15 Hove to and deploy SV probe to obtain sound velocity profile for multibeam
 Water depth 2066, winching very slow, due to lightweight.
 10:43 SV probe on deck
 11:50 Run multibeam up slope towards Rockall Bank, dir NW, to check alignment
 Deploy pinger, weather deteriorating
 14:40 Turn vessel and reciprocal line, vessel cannot maintain course due to weather
 15:45 Run line back up slope on reciprocal course to previous line, dir NW
 Wind now gusting 35 knots from NW
 16:26 Total ship power failure, vessel pushed beam on, gravity meter clamped
 16:32 Vessel power restored, multibeam calibration data lost
 Vessel cannot make headway in present sea conditions, decide not to rerun checks
 16:50 Gravity meter operating
 23:59 Vessel heading towards start of first line, but is effectively hove to due to weather
 conditions

Total km of completed lines: 0

	Today (hours)	Total (hours)
Mob/demob, setting up	8.75	27.00
On line	0.00	0.00
Turning	0.00	0.00
Steaming	7.25	69.25
Weather downtime	8.00	8.00
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	31.25

Summary Daily Log

Date: Wednesday 24th May 2006

Time

00:00 Vessel proceeding slowly (2 knots) towards start of K1, sea state poor, 35 knot wind
 06:32 SOL1, Dir NW, multibeam, PES only
 23:59 On line 1

Total km of completed lines: 0

	Today (hours)	Total (hours)
Mob/demob, setting up	0.00	27.00
On line	17.50	17.50
Turning	0.00	0.00
Steaming	0.00	69.25
Weather downtime	6.50	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	31.25

Summary Daily Log

Date: Thursday 25th May

Time

00:00 On line 1
 02:08 Course alteration for final section of line, Dir W-NW deg
 03:00 Wind 10 knots, westerly, old swell prevailing
 06:53 EOL 1
 07:30 Start to deploy airguns
 09:00 Airguns, sparker and magnetometer systems deployed
 10:09 SOL 2, Dir SE
 12:33 EOL 2
 13:02 SOL 3, Dir NW
 15:10 EOL 3, Air compressor 2 overheating
 17:08 SOL 4, Dir SW
 17:24 Airgun hydrophone deployed further to maintain depth
 19:00 EOL 4
 19:17 Compressor 2 shut down, air leak into cooling system
 20:26 SOL 5, Dir NE
 21:00 Increase in magnetometer noise
 22:28 EOL 5, recover sparker for trimming

Total km of completed lines: 367

	Today (hours)	Total (hours)
Mob/demob, setting up	1.50	28.50
On line	15.50	33.00
Turning	5.00	5.00
Steaming	2.00	71.25
Weather downtime	0.00	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	31.25

Summary Daily Log

Date: Friday 26th May

Time

00:00 On transit to next line
 01:00 Re-deploy sparker
 01:05 Sparker set to 2200J
 01:44 SOL 6, Dir N
 06:10 EOL 6
 06:12 SOL 7, Dir N, course change from line 6
 08:35 EOL 7
 08:38 SOL 8, Dir N, course change from line 7
 11:14 EOL 8
 12:00 SOL 9, Dir SE
 15:28 EOL 9
 15:53 SOL 10, Dir NE
 18:27 Slowing to 3 knots for fishing boat
 18:38 Magnetometer switched off, hauled closer to vessel in response to proximity of fishing vessel
 18:58 Magnetometer deployed to full length and switched ON
 20:26 EOL 10
 21:18 SOL 11, Dir E
 23:59 On line 11

Total km of completed lines: 499

	Today (hours)	Total (hours)
Mob/demob, setting up	0.00	28.50
On line	21.25	54.25
Turning	1.00	6.00
Steaming	1.75	73.00
Weather downtime	0.00	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	31.25

Summary Daily Log

Date: Saturday 27th May

Time

00:00 On line 11
 06:32 EOL 11,
 07:14 All seismic equipment and magnetometer recovered to deck
 Steam to next survey area, north-east of Hatton Bank
 Repair sparker, one candle not firing, replace candle holder
 Drain air compressor storage tank and clean air filter/scrubber
 15:30 Arrive 2 miles before next line, recover pinger
 15:38 Deploy SVP for multibeam calibration
 16:53 SVP on deck
 17:00 Pinger deployed
 17:05 Power to compressors switched ON, waiting for pressure to build up
 (cannot operate at the same time as winch)
 18:20 Airguns, sparker and magnetometer deployed
 18:47 SOL 12, Dir NE
 23:59 On line 12

Total km of completed lines: 569

	Today (hours)	Total (hours)
Mob/demob, setting up	3.75	32.25
On line	11.75	66.00
Turning	0.25	6.25
Steaming	8.25	81.25
Weather downtime	0.00	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	31.25

Summary Daily Log

Date: Sunday 28th May

Time

00:00 On line 12
 04:00 Wind 20 knots, sea state 4-5, swell behind vessel
 05:00 Wind 25 knots, sea state 5, swell building following sea
 05:30 Swell very large breaking on after deck
 05:37 Switch off sparker
 05:47 Sparker and hydrophone recovered, airgun data suffering, but currently on top of Lousy Bank
 09:23 Wind 13 knots, still large following sea, occasionally breaking over stern
 12:40 Deployed sparker, slight reduction in sea state, now in trough between Lousy and Bill Bailey Bank
 16:30 Wind moved around 180 degrees to be ahead of vessel and increased to 30 knots quickly, resulting in opposing swells and confused sea ship movement increased, sparker data poor
 17:24 Sparker recovered, seastate poor
 22:03 Vessel struggling to keep on course, current and sea condition resulting in crabbing and magnetometer, cable tangled in airgun frame,
 22:08 Recover magnetometer and airgun hydrophone to inspect.
 22:16 Re-deploy airgun hydrophone
 23:59 On line 12

Total km of completed lines: 569

	Today (hours)	Total (hours)
Mob/demob, setting up	0.00	32.25
On line	24.00	90.00
Turning	0.00	6.25
Steaming	0.00	81.25
Weather downtime	0.00	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	31.25

Summary Daily Log

Date: Monday 29th May

Time

00:00 On line 12
 01:59 Sparker deployed
 02:06 Magnetometer deployed
 08:46 Shallowest part of Faros Bank, 88m
 Wind N, 16 knots, cold, vessel 60m off-track to starboard
 10:50 Vessel off-track 86m to starboard
 20:03 EOL 12
 20:35 All equipment recovered
 Deploy SVP
 SVP on deck
 Transit to next line
 Slow to deploy geophysics equipment

Total km of completed lines: 944

	Today (hours)	Total (hours)
Mob/demob, setting up	3.00	35.25
On line	20.00	110.00
Turning	0.00	6.25
Steaming	1.00	82.25
Weather downtime	0.00	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	31.25

Summary Daily Log

Date: Tuesday 30th May

Time

00:00 Airgun, sparker and magnetometer deployed
 00:23 Airgun hydrophone noisy, hydrophone rope tangled in airgun frame
 Vessel loops around to restart line
 01:54 SOL 13, dir SW
 09:30 Emergency drill practice
 10:30 Turn for dog leg part of line
 16:23 EOL 13
 17:03 SOL 14, Dir NE, seastate good
 23:59 On line 14

Total km of completed lines: 1010

	Today (hours)	Total (hours)
Mob/demob, setting up	2.00	37.25
On line	21.25	131.25
Turning	0.75	7.00
Steaming	0.00	82.25
Weather downtime	0.00	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	31.25

Summary Daily Log

Date: Wednesday 31st May

Time

00:00 On line 14
 03:45 EOL 14
 03:26 Sparker recovered for trimming
 03:44 Sparker deployed
 04:46 SOL 15, Dir SW, sea-state good
 13:15 Wind increasing, 17 knots, Dir 190, port quarter
 15:47 Wind increasing, 23 knots, Dir 190, port quarter, swell increasing
 16:40 Vessel finding it difficult to maintain set speed, hydrophones changing depths
 17:48 Wind speed falling, 18 knots, swell
 20:09 Wind speed falling, 15 knots, swell
 23:59 On line 15

Total km of completed lines: 1070

	Today (hours)	Total (hours)
Mob/demob, setting up	0.00	37.25
On line	23.00	154.25
Turning	1.00	8.00
Steaming	0.00	82.25
Weather downtime	0.00	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	31.25

Summary Daily Log

Date: Thursday 1st June

Time

00:00 On line 15
 00:21 Loss of pressure on airguns, shut off pressure to airgun 1
 04:00 Wind increasing, 16 knots, Dir SW, dead ahead
 06:13 Wind increasing, 20 knots, Dir SW, dead ahead, vessel pitching and finds it
 Difficult to maintain set speed
 09:00 21 knot wind, Dir SW, dead ahead, data quality poor
 10:17 EOL 15, recover sparker for trimming
 11:02 Wind speed 19 knots, Dir W-SW deg
 11:22 SOL 16, Dir N
 11:35 Swell on port stern quarter, move sparker hydrophone to end of boom
 15:36 Wind Speed 16.5 knots, Dir W-SW
 21:40 Wind Speed 19.5 knots
 23:59 On line 16

Total km of completed lines: 1300

	Today (hours)	Total (hours)
Mob/demob, setting up	0.00	37.25
On line	23.00	177.25
Turning	1.00	9.00
Steaming	0.00	82.25
Weather downtime	0.00	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	31.25

Summary Daily Log

Date: Friday 2nd June

Time

00:00 On line 16
 00:48 Wind speed 20 knots, Dir 250 deg
 02:10 Wind speed 18 knots, Dir 270 deg
 03:49 Sparker recovered on top of Bill Bailey's Bank and trimmed
 04:14 Problems with oil filter of air compressor 2, shut down and reduce number of guns firing
 05:10 Compressor back up and running
 07:14 Wind speed 20 knots, Dir 265 deg
 11:33 Wind speed 18 knots, Dir 282 deg
 14:06 Wind speed 21 knots, Dir 280 deg
 18:50 Wind speed 18 knots, Dir 290 deg
 18:58 EOL 16, recover sparker for trimming
 19:24 Sparker deployed
 19:44 SOL 17, Dir E
 20:20 Bridge position making large jumps
 20:31 Ship back on line
 22:56 Wind speed 13 knots, Dir 280 deg
 23:59 On line 17

Total km of completed lines: 1545

	Today (hours)	Total (hours)
Mob/demob, setting up	0.00	37.25
On line	22.25	199.50
Turning	1.75	10.75
Steaming	0.00	82.25
Weather downtime	0.00	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	31.25

Summary Daily Log

Date: Saturday 3rd June

Time

00:00 On line 17
 02:22 On line printer not printing data correctly, missing pings
 03:45 Wind speed 13 knots, Dir 307 deg
 04:00 Wind speed 11 knots, Dir 307 deg
 05:58 Sparker OFF and recovered for trimming
 06:01 Start to alter course to next line
 06:03 EOL 17
 06:16 SOL 18, Dir SE, course alteration complete
 06:25 Sparker deployed and ON, Printer not printing correctly
 08:40 08:40 to 11:38, lost easting on CODA NAV.
 14:50 GPS signal poor, large variations in apparent position
 15:20 GPS position stable
 15:53 EOL 18, Sparker recovered for trimming
 16:13 Sparker deployed
 16:21 SOL 19, Dir N
 23:59 On line 19

Total km of completed lines: 1712

	Today (hours)	Total (hours)
Mob/demob, setting up	0.00	37.25
On line	23.50	223.00
Turning	0.50	11.25
Steaming	0.00	82.25
Weather downtime	0.00	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	31.25

Summary Daily Log

Date: Sunday 4th June

Time

00:00 On line 19
 01:46 EOL 19, recover sparker for trimming
 02:10 Deploy Sparker
 02:28 SOL 20, Dir SW
 20:05 Sparker recovered for trimming
 20:21 EOL 20, deploy sparker
 20:22 SOL 21, Dir SW
 22:20 On line printer missing pings
 23:59 On line 21

Total km of completed lines: 1913

	Today (hours)	Total (hours)
Mob/demob, setting up	0.00	37.25
On line	0.00	223.00
Turning	23.25	34.50
Steaming	0.75	83.00
Weather downtime	0.00	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	31.25

Summary Daily Log

Date: Monday 5th June

Time

00:00 On line 21
 10:26 Wind 11 knots, Dir 176 deg
 16:00 Wind 11.6 knots, Dir 185 deg
 16:18 EOL 21
 16:45 All gear recovered, steam toward St Kilda work area
 Start to replay data

Total km of completed lines: 2073

	Today (hours)	Total (hours)
Mob/demob, setting up	0.00	37.25
On line	16.25	239.25
Turning	0.00	34.50
Steaming	7.75	90.75
Weather downtime	0.00	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	31.25

Summary Daily Log

Date: Tuesday 6th June

Time

00:00 On transit
 10:30 Arrive Village Bay, St Kilda
 16:00 Leave St Kilda
 18:00 Arrive at St Kilda work area and deploy sparker and hydrophone
 18:40 SOL 22, Dir NE
 19:06 Cross piston core location, vessel off-track 10m SE of proposed line
 19:24 EOL 22
 19:50 SOL 23, Dir S
 19:58 Cross piston core location, vessel off-track 6.3m W of proposed line
 20:11 EOL 23
 20:18 SOL 24, Dir N
 20:41 EOL 24
 20:50 SOL 25, Dir S
 21:14 EOL 25
 21:44 SOL 26 Dir E
 21:56 Cross piston core location, vessel off-track 0.73m N of proposed line
 22:04 EOL 26, recover sparker and hydrophone and transit to Stanton Bank
 23:59 On transit

Total km of completed lines: 2089

	Today (hours)	Total (hours)
Mob/demob, setting up	0.50	37.75
On line	6.25	245.50
Turning	1.25	35.75
Steaming	14.00	104.75
Weather downtime	0.00	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	2.00	33.25

Summary Daily Log

Date: Wednesday 7th June

Time

00:00 Steaming to Stanton Bank
 07:30 On site waiting for fishing vessel
 Deploy Sparker and hydrophone
 07:54 SOL 27, Dir SW
 10:18 EOL 27
 10:50 SOL 28, Dir NE
 12:57 EOL28
 13:22 SOL 29, Dir SE
 15:10 EOL 29
 15:39 SOL 30
 22:04 EOL 30, end of survey, recover all equipment
 22:20 All equipment recovered, transit to Fairlie

Total km of completed lines: 2183

	Today (hours)	Total (hours)
Mob/demob, setting up	0.50	38.25
On line	13.00	258.50
Turning	1.50	37.25
Steaming	9.00	113.75
Weather downtime	0.00	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	33.25

Summary Daily Log

Date: Thursday 8th June

Time

00:00 Transit to Fairlie

23:59 Transit to Fairlie

Total km of completed lines: 2183

	Today (hours)	Total (hours)
Mob/demob, setting up	0.00	38.25
On line	0.00	258.50
Turning	0.00	37.25
Steaming	24.00	137.75
Weather downtime	0.00	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	33.25

Summary Daily Log

Date: Friday 9th June

Time

00:00


10:30 Alongside Fairlie

13:00 Clear of vessel

Total km of completed lines: 2183

	Today (hours)	Total (hours)
Mob/demob, setting up	2.50	40.75
On line	0.00	258.50
Turning	0.00	37.25
Steaming	10.50	148.25
Weather downtime	0.00	14.50
Equipment downtime	0.00	0.00
Vessel downtime	0.00	0.00
Port	0.00	33.25

Appendix 3 Line Summary Log Sheet

British Geological Survey Marine Operations								Line Summary Log Sheet 1 of 1								Vessel: RRS Charles Darwin CD180	
PROJECT		BGS06/02		Area: Rockall-Hatton-Faroes				Type: Geophysical Survey				 British Geological Survey <small>NATURAL ENVIRONMENT RESEARCH COUNCIL</small>					
Line		Start		End		Length	Total	Equipment run							Comments		
No.	Dir	Date	Time	Date	Time	(km)	(km)	Airgun	Sparker	Maggy	Gravity	Pinger	PES	Multi-beam			
1	NW	24.05.06	06:32	25.05.06	06:53	308.00	308.00				X	X	X	X	Seastate poor at SOL, good at EOL		
2	SE	25.05.06	10:09	25.05.06	12:33	15.00	323.00	X	X	X	X	X	X	X	Seastate good, ocean swell		
3	NW	25.05.06	13:02	25.05.06	15:10	15.00	338.00	X	X	X	X	X	X	X	Seastate good, ocean swell		
4	SW	25.05.06	17:08	25.05.06	19:00	15.00	353.00	X	X	X	X	X	X	X	Seastate moderate to good, ocean swell		
5	NE	25.05.06	20:26	25.05.06	22:28	14.00	367.00	X	X	X	X	X	X	X	Seastate moderate to good, ocean swell		
6	N	26.05.06	01:44	26.05.06	06:10	33.50	400.50	X	X	X	X	X	X	X	Seastate moderate to good, ocean swell		
7	N	26.05.06	06:12	26.05.06	08:35	19.00	419.50	X	X	X	X	X	X	X	Seastate moderate to good, ocean swell		
8	N	26.05.06	08:38	26.05.06	11:14	19.00	438.50	X	X	X	X	X	X	X	Seastate moderate to good, ocean swell		
9	SE	26.05.06	12:00	26.05.06	15:28	26.00	464.50	X	X	X	X	X	X	X	Seastate moderate to good, ocean swell		
10	N	26.05.06	15:53	26.05.06	20:26	35.00	499.50	X	X	X	X	X	X	X	Seastate good, ocean swell		
11	E	26.05.06	21:18	27.05.06	06:32	70.00	569.50	X	X	X	X	X	X	X	Seastate good, ocean swell		
12	NE	27.05.06	18:47	29.05.06	20:03	375.00	944.50	X	X	X	X	X	X	X	Seastate variable, moderate to poor		
13	SW	30.05.06	01:54	30.05.06	16:23	66.00	1010.50	X	X	X	X	X	X	X	Seastate variable, moderate, improving		
14	NE	30.05.06	17:03	31.05.06	03:25	60.00	1070.50	X	X	X	X	X	X	X	Seastate good, ocean swell		
15	SW	31.05.06	04:46	01.06.06	10:17	230.00	1300.50	X	X	X	X	X	X	X	Seastate good, ocean swell		
16	N	01.06.06	11:22	02.06.06	18:58	245.00	1545.50	X	X	X	X	X	X	X	Seastate poor, ocean swell deteriorating		
17	E	02.06.06	19:44	03.06.06	06:03	87.00	1632.50	X	X	X	X	X	X	X	Seastate poor, ocean swell improving		
18	SE	03.06.06	06:16	03.06.06	15:53	80.00	1712.50	X	X	X	X	X	X	X	Seastate reasonable, ocean swell, improving		
19	N	03.06.06	16:21	04.06.06	01:46	70.00	1782.50	X	X	X	X	X	X	X	Seastate good, ocean swell		
20	SW	04.06.06	02:28	04.06.06	20:22	131.00	1913.50	X	X	X	X	X	X	X	Seastate good, ocean swell		
21	SW	04.06.06	20:22	05.06.06	16:18	160.00	2073.50	X	X	X	X	X	X	X	Seastate good, little ocean swell		
22	NE	06.06.06	18:40	06.06.06	19:24	5.10	2078.60		X		X	X	X	X	Seastate good, little ocean swell		
23	S	06.06.06	19:50	06.06.06	20:11	2.70	2081.30		X		X	X	X	X	Seastate good, little ocean swell		
24	N	06.06.06	20:18	06.06.06	20:41	2.70	2084.00		X		X	X	X	X	Seastate good, little ocean swell		
25	S	06.06.06	20:50	06.06.06	21:14	2.70	2086.70		X		X	X	X	X	Seastate good, little ocean swell		
26	E	06.06.06	21:44	06.06.06	22:04	2.50	2089.20		X		X	X	X	X	Seastate good, little ocean swell		
27	SE	07.06.06	07:54	07.06.06	10:18	15.30	2104.50		X		X	X	X	X	Seastate good, little ocean swell		
28	SW	07.06.06	10:50	07.06.06	12:57	14.50	2119.00		X		X	X	X	X	Seastate good, little ocean swell		
29	NE	07.06.06	13:22	07.06.06	15:10	14.50	2133.50		X		X	X	X	X	Seastate good, little ocean swell		
30	SE	07.06.06	15:39	07.06.06	22:04	50	2183.50		X		X	X	X	X	Seastate good, little ocean swell		

Appendix 4 Gravity Base Ties

Date	Location	Corrected Ship Base (mgals)	Still Meter Reading	Corrected Meter Value (0.9911 x meter Reading, mgals)
18 th May 2006	Falmouth	981089.8	11811.2	11706.1
9 th June 2006	Fairlie	981581.0	12305.5	12196.0

	Falmouth (mgals)	Fairlie (mgals)	Difference between locations (mgals)
Corrected Ship Base	981089.8	981581.0	-491.2
Corrected Meter Value	11706.1	12196.0	-489.1
Calculated Drift	-	-	+2.1

Notes:

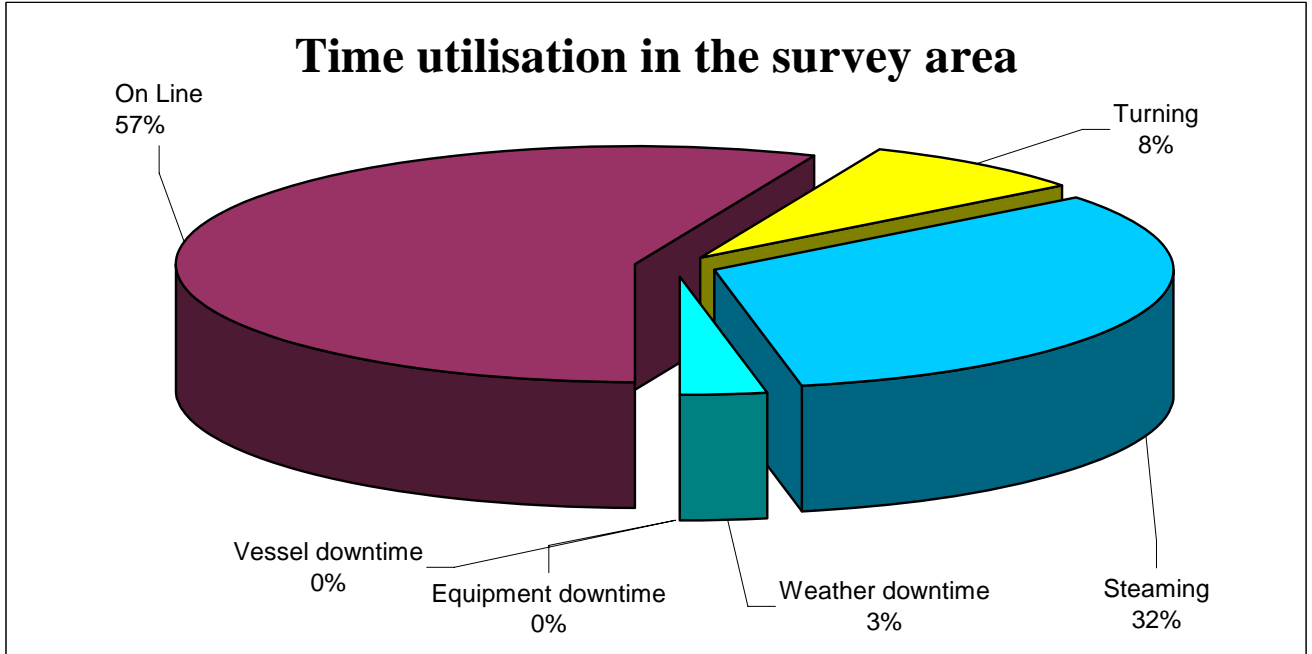
The vessel had two complete blackouts during the cruise and hence loss of electrical power to the gravity meter system. Observations at the time indicated that this did not affect the gravity readings and hence no 'tear' at this point.

Name of Ship: RRS Charles Darwin Place: Fairlie, Clyde		Date: 9 June 2006 Julian Day: 160																																					
<p>WATERLINE ABOVE MEAN SEA LEVEL</p> <p>Land meter read here for ship base</p>		Gravity Meter Observation Harbour Base Connection																																					
<p>WATERLINE BELOW MEAN SEA LEVEL</p>		<table border="1"> <thead> <tr> <th>Time(GMT)</th> <th>Place</th> <th>Reading</th> </tr> </thead> <tbody> <tr> <td colspan="3">Vessel tied up at Fairlie Jetty. Base Station established 02/09/02 for D265</td> </tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> </tbody> </table>		Time(GMT)	Place	Reading	Vessel tied up at Fairlie Jetty. Base Station established 02/09/02 for D265																																
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Interval from High Water	1H10	Uncorrected ship base value	981579.89																																				
All heights in metres		Free air correction = 0.31 X a (Add)	1.12																																				
Height of preceding HW or LW	3m0	Ship base corrected for FA	981581.01																																				
Height of Succeeding HW or LW	0m8	Bouguer correction for water slab. Pier=0.04b, Wall=0.02b. (Subtract)	-0.02																																				
Predicted Tide Range (d)	2m2	Corrected ship base value	981581.0																																				
Factor for time interval (from curve for standard port).		Ship borne Meter Harbour Reading																																					
Height of Tide above LW (c)	1m9	Ship meter cal factor (k)	0.9911																																				
Half Tide Range d/2	1m1	Time (GMT)	1130																																				
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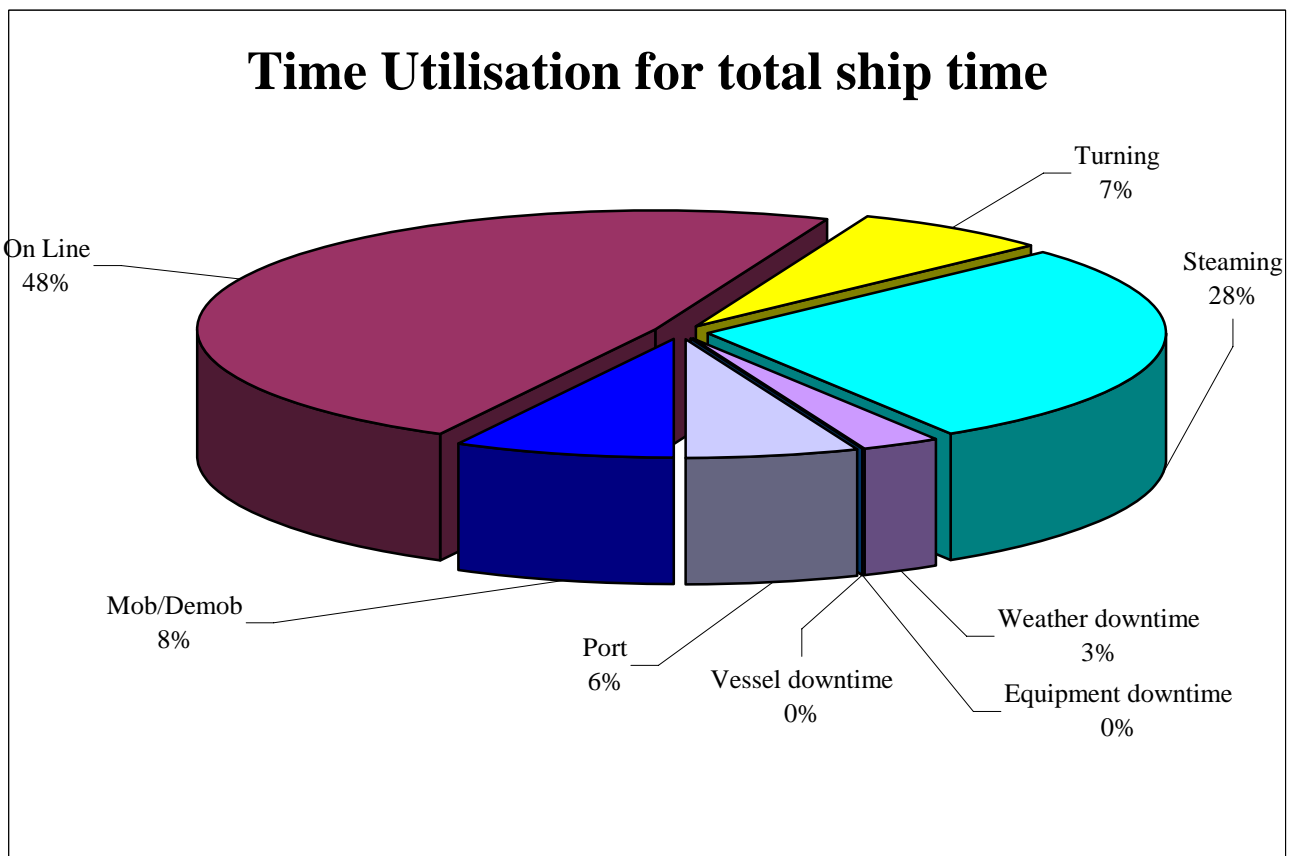
Name of Ship: RRS Charles Darwin		Date: 9 June 2006																																					
Place: Fairlie, Clyde		Julian Day: 160																																					
<p>WATERLINE ABOVE MEAN SEA LEVEL</p> <p>Land meter read here for ship base</p> <p>WATERLINE BELOW MEAN SEA LEVEL</p>		<p>Gravity Meter Observation Harbour Base Connection</p> <table border="1"> <thead> <tr> <th>Time(GMT)</th> <th>Place</th> <th>Reading</th> </tr> </thead> <tbody> <tr> <td colspan="3">Vessel tied up at Fairlie Jetty. Base Station established 02/09/02 for D265</td> </tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> </tbody> </table>		Time(GMT)	Place	Reading	Vessel tied up at Fairlie Jetty. Base Station established 02/09/02 for D265																																
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Appendix 5 Time Utilisation Diagrams

TIME UTILISATION IN THE SURVEY AREA



TIME UTILISATION FOR TOTAL SHIP TIME



Abbreviations

<i>BCD</i>	Binary Coded Decimal
<i>BGS</i>	British Geological Survey
<i>EOL</i>	End of line
<i>ETS</i>	Electronic and Technical Support
<i>GMT</i>	Greenwich Mean Time
<i>IT</i>	Information Technology
<i>NOC</i>	National Oceanographic Centre
<i>PES</i>	Precision Echosounder
<i>RSU</i>	Research Ship Unit
<i>SVP</i>	Sound Velocity Probe
<i>SOL</i>	Start of line
<i>TVF</i>	Time Varied Filter
<i>TVG</i>	Time Varied Gain
<i>UKORS</i>	United Kingdom Ocean Research Services