JR09A:

RRS James Clarke Ross
Scotia Sea and South Atlantic
Bathymetric Swath Mappings
January 1995 - February 1995

RRS James Clark Ross
January to February 1995
Cruise JR09a

R.A. Livemore

RA. Livemore, Chief Scientist

28/5/95

C.R. Elliott, Master

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1 Abstract

JR09a carried out systematic surveys of active plate boundaries in the Scotia Sea and South Atlantic during 48 days in January and February, 1995. The principal tool employed was the HAWAII-MRl towed sonar, which produced bathymetric data with a swath width of 10 - 15 km, together with sidescan imagery with a width of 16-26 km. A small seismic reflection profiling system and a three-component fluxgate magnetometer were also deployed, together with a gravimeter and total field magnetometer.

The survey followed the original plan closely, and all scientific objectives were achieved. The entire length of the east Scotia Sea spreading ridge axis was surveyed, including all crust produced during the past 780,000 years, and in some cases crust as old as 1Ma. Data were processed and plotted on board, revealing a ‘rifted’ axial morphology along most of the central ridge segments, but a very different morphology within 100km of the northern end. Here, sidescan imagery proved crucial in locating the ridge axis, which often lacks a distinctive bathymetric signature. Seismic profiling along part of this newly-identified ridge, imaged a strong reflector -3 km beneath its shallowest point. Following previous observations of similar reflectors in the Pacific Ocean, we interpret this as the upper surface of a melt lens atop a crustal magma chamber. We also mapped a rectangular area NE of Visokoi, Candlemas and Saunders Islands, the part of the forearc where plate convergence is thought to be perpendicular to the trench. Together, these surveys provide valuable site survey information for future experiments.

New data were acquired in the southernmost part of the east Scotia Sea, along the South American - Antarctic Ridge (the South America - Antarctica plate boundary), and up to the Bouvet triple junction. Collaborative work in the latter area is designed to establish the present day and past configurations of the triple junction. The three plate boundaries do not appear to meet at a single point, and there is a pronounced contrast between nearby segments of the South American - Antarctic and African - Antarctic plate boundaries, whereby the former is represented by an oblique rift basin, while the latter exhibits a grossly-inflated ridge.

Technical successes included the successful operation of the three-component magnetometer and logging of its data to the ship’s computers; use of the Ashtech 3D GPS to supply ship attitude information for correcting three-component magnetic data; and satisfactory operation of a new, PC-based, seismic recorder. Some problems were encountered with lack of reliability in equipment borrowed from RVS.

2 List of Personnel

Scientific and Technical

1	Chief Scientist	R.A. Livermore (BAS)	
2	Geophysicist	R.D. Larter (BAS)	
3	Geophysicist	N.C. Mitchell (Durham U)	
4	Geophysicist	R.J. Hunter (BAS)	
5	Geophysicist	A.P. Cunningham (BAS)	Seismic Data Processing
6	Geophysicist	L.E. Vanneste (BAS)	Seismic Data Processing
7	Geophysicist	A.P. Nankivell (Oxford)	CASE Student
8	Geophysicist	Y. Nogi (MRI,Tokyo)	STCM
9	Geophysicist	M. Ligi (Bologna)	Collaborator (Bouvet)
10	Engineer	J.R. Erickson (HMRG)	MR1
11	Computing	F. Martinez (HMRG)	MR1
12	Computing	L.D. Petersen (HMRG)	MR1
13	Computing	D.D. Joseph (HMRG)	MR1
14	Engineer	S.F. Bremner (ISG)	Mechanical (airgun/compr.)
15	Engineer	A.M. Tait (ISG)	Mechanical (airgun/compr.)
16	Engineer	M.O. Preston (ISG)	Electrical (PES/3.5 kHz)
17	Computing	D.J. Richmond (ISG)	Data Logging
18	Computing	G. Butcher (ISG)	Computer Support
19	Engineer	D. Teare (RVS)	SAQ/Gravimeter
20	Ship's Doctor	F. Lenihan	

Ship's Officers

1	Master	C.R. Elliott
2	Chief Officer	J.B. Marshall
3	2nd Officer	S.I. Wallace
4	3rd Officer	A. Gatti
5	Science Off.	J.W. Summers
6	Radio Officer	M.E. Gloistein
7	Chief Eng.	D.J. Cutting
8	2nd Eng.	W.R. Kerswell
9	3rd Eng.	R. Caldwell
10	3rd Eng.	M. Inch
11	Science Eng.	S.A. Wright
12	Electrician	N.E. Thomas
13	Catering Off.	J.S. Gibson

Crew

1	CPO Bosun	G.M. Stewart
2	PO B'n Mate	A. Gill
3	SGl	C.A. Chalk
4	SGl	A.M. Bowen
5	SGl	D.J. Peck
6	SGl	KS. Beck
7	SGl	H.P. Owen
8	CPO M'man	D.R. Summers
9	M'man	A.L. Macaskill
10	Chief Cook	S. Hewitt
11	2nd Cook	M. Davis
12	Steward	J.J. Hanley
13	Steward	J.L.S. Charlton
14	Steward	C.N. Besley-Clark

3 Timetable of Events

1994

December

30 Scientific party arrives at FIPASS
31 Mobilisation commences

1995

January

1 Ship sails at 14:00 GMT; following safety and lifeboat drill, leaves Berkely Sound at 16:OO; STCM ship compensation manoeuvre completed, and total field magnetometer fish streamed at 20:14; course set for way point 1 at 55°s STCM, Simrad EA500, PES and 3.5 kHz profiler in operation.
4 MRl deployed at 09:41; MR1 not receiving data, retrieved at 12:08; airgun (300 cu in) deployed at 16:30; commence line 1 without MRl.
5 STCM compensation manoeuvre; MRl deployed at 18:07, line 3 commenced; PES switched off to avoid noise on MRl.
7 Commence Area B survey; ship loses steering between 05:49-06:00; MRl record becomes noisy; MRl towfish recovered at 10:15, drogue line found to be fouling depressor weight; MRl redeployed at 12:00.
9 MRl recovered owing to noisy record at 21:00.
10 MRl redeployed after repairs; record now much cleaner.
12 Completed Area B survey; commence Area A survey.
20 First part of Area A survey completed; gear recovered; STCM manoeuvre.
21 Arrive Grytvikan.
22 Depart Grytvikan.
23 Deploy gear and commence second half of Area A survey.
28 STCM manoeuvre.
29 Encountered brash ice in southeastern Scotia Sea; magnetometer fish lost in ice.
31 Area A survey terminated at 06:15, and gear recovered for transit around pack ice; MRl deployed at 19:40 for start of Area C survey.

February

5 Area C survey completed; transit to Area D with gear deployed; commence Area D survey.
14 Final way point reached, MRl and towed magnetometer sensor recovered at 03:00; STCM compensation manoeuvre; EA500, STCM and gravimeter run during transit to Capetown.
17 Final STCM compensation manoeuvre completed and newly-overhauled magnetometer towfish streamed.
18 Arrive Capetown.

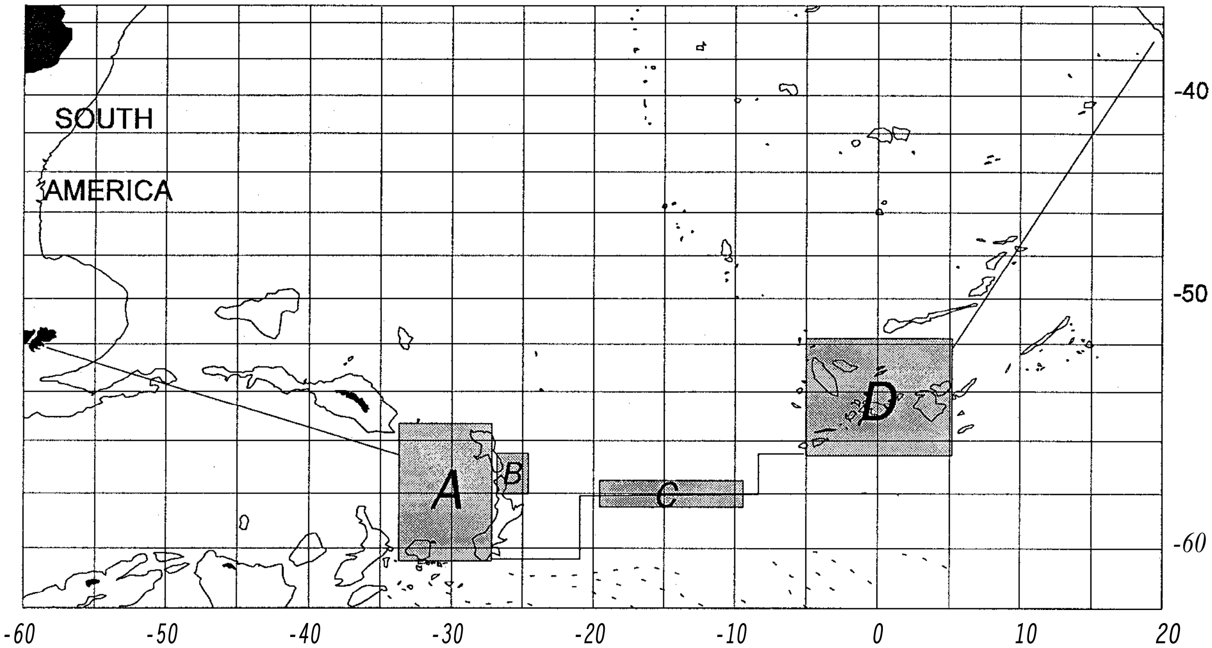

Figure 1   JR09a survey plan

4 Introduction

JR09a was notable in being the first ever BAS cruise to undertake bathymetric swath mapping. As RRS *James Clank Ross* still, unfortunately, lacks a hull-mounted multibeam echo sounder, a towed long-range sonar, HAWAII-MRl, was hired from the School of Ocean and Earth Science and Technology (HMRG), University of Hawaii. This system provides depth measurements across a swath as wide as 3.5 times water depth, and also a 12-25 km swath of sidescan imagery, similar to GLORIA but of higher resolution.

The cruise programme represented the amalgamation of three separate cruise proposals; firstly, a proposal to BRIDGE (Livennore and others, 1992) for multibeam (Simrad EM12) and sidescan (GLORIA) mapping of the East Scotia Ridge axis; secondly, a proposal to NERC (Mitchell and Livennore, 1992) for similar mapping of the Bouvet triple junction in the South Atlantic, and thirdly, a proposed season of GLORIA sidescan imaging in the Scotia Sea and South Shetlands areas (Larter and Livermore). Following withdrawal by NERC of RRS *Charles Darwin* from the first two projects, agreement was reached with BRIDGE and NERC/HEA for the funding of a sonar to be towed from RRS *James Clark Ross* during the BAS Geoscience season 1994/95. Discussions with a variety of operators indicated that the HAWAII-MRl system was the most appropriate to the cruise requirements.

The cruise objectives were ambitious, even for a long (48 day) leg. Large, systematic, surveys were conducted over the east Scotia Sea ridge crest (Area A - see Figure l), northern South Sandwich forearc (Area B), and the Bouvet triple junction and its traces (Area D), plus continuous data acquistion along much of the South American - Antarctic Ridge (Area C). Time had therefore to be strictly limited, and it was fortunate that weather conditions were generally favourable, and technical difficulties confined to the early part of the cruise. Precise targeting of MRl was made possible by high-resolution satellite-derived gravity maps, so that survey plans could be designed to make very economical use of ship time.

Besides MRl, there were three other pieces of equipment on trial: a shipboard three-component magnetometer (STCM), borrowed from the University of Tokyo, with a view to possible permanent installation of a similar instrument in future; a new four-channel seismic recording system, constructed at BAS during 1993, and operated for the first time during this cruise; and an Ashtech 3D GPS system which had been fitted by IOS prior to departure from the UK, and was to be investigated as a possible substitute for the STCM gyros. All three systems performed well.

5 Scientific Objectives

Our prime objectives were to achieve contiguous, high resolution bathymetric coverage and sidescan imaging of four tectonically active areas in the South Atlantic (Fig. 1). These data would permit a much more detailed interpretation of present day tectonics in these areas, and also facilitate detailed planning of future campaigns involving finer scale studies using deep-towed sensors.

The survey in Area A (east Scotia Sea) was designed to provide coverage of the entire ridge axis, including all areas of the ridge flanks younger than 0.8 Ma (Brunhes magnetic polarity epoch). Partial funding for MRl had been agreed under the BRIDGE (British mid-ocean ridge initiative) community programme for this work, in order to characterise its segmentation pattern prior to detailed studies of hydrothermal venting and associated biota on the ridge crest. That is, we aimed to determine the number and dimensions of individual ridge segments, their morphology, and the nature of the offsets between them (transform faults, overlapping spreading centres, etc). This would improve our understanding of how the ridge responds to changes in the depth of the subducting slab, and in the regional stress field along the ridge axis. We also intended to collect some data along longer W-E orientated lines in preparation for a future BAS integrated Geoscience initiative, known as SLICE, which will study many aspects of the South Sandwich arc-backarc system. These lines would serve as a 'site survey' in positioning deep crustal seismic reflection profiles, to be shot as part of the SLICE programme.

In the southern part of the area, the new data would overlap an area imaged previously (RRS *Charles Darwin* cruise CD37) using GLORIA. The combination of data should permit a reasonably firm understanding of the complex processes operating there today and in the recent geological past.

We planned to use the small seismic system to attempt to image any axial magma chambers which may be present, as has been done in the Pacific. Time did not allow a systematic seismic survey, but we hoped that, by shooting a line along the northern part of the axis, which satellite gravity maps suggested was the area in which such a magma chamber was most likely to exist, we could establish the existence of a melt lens, and so target future work on ridge processes,

The part of the South Sandwich forearc (Area B) surveyed was the area where the South America (SAM) - Sandwich (SAN) plate convergence direction is thought to be normal to the trench. In this area we intended to use MRl to map structural features, providing evidence of the strain regime (trench-normal extension or shortening), and to search for any forearc seamounts which might exist. We also intended to use seismic reflection data in combination with the MRl data to estimate the mass balance at the South Sandwich trench (sediment accretion versus tectonic erosion). One further objective was to use the magnetic data to search for linear anomalies between the islands and in the upper forearc, to test the hypothesis that the present volcanic arc is built on ocean floor that was formed at the back-arc spreading centre.

The transit from Area A (Scotia) to Area D

(Bouvet) was to be used to obtain reconnaissance coverage of the plate boundary (shown schematically in Fig. 1 as 'Area C'), in order to characterise its segmentation pattern, and to investigate the structure of its long-offset transforms. Additional coverage was planned at the western end of the Bullard transform, in order to fill gaps in previous GLORIA coverage caused by severe weather (see CD37 cruise report) and differing scientific objectives.

Our original objectives for mapping the Bouvet triple junction (Area D) were heavily modified following a partial survey by a joint Italian-Russian expedition in early 1994, led by Professor Bonatti (Bologna). The time available for this work was much less than we had hoped, so that we limited ourselves to two main objectives. These were, firstly, to obtain MRl data over the older ends of the conjugate Conrad and Bouvet fracture zones, in order to investigate the transition from RRR- to RFF-configuration (see Glossary for explanation of these terms) which created these two transforms. Secondly, we planned to obtain MRl coverage of the present triple junction area, as revealed by the recent Italian-Russian bathymetric mapping. We expected that the MRl sidescan would provide important evidence for neotectonic processes which were not apparent from bathymetry alone. This survey was extended southwards, to map the trace of the triple junction on the Antarctic plate, and included the first, inflated, segment of the Southwest Indian Ridge, known as Spiess Ridge.

We had specific objectives in connection with the STCM. These were i., to attempt direct logging to the ship's system via a Level A interface; ii., to investigate the use of the Ashtech 3D GPS for roll and pitch measurements to replace the dedicated gyrocompasses of the STCM; iii., to investigate the use of the STCM in conditions in which a normal, towed total field instrument could not be deployed, and iv., to evaluate vector and total field anomalies.

6 Achievements

A complete track plot for JR09a is shown in Fig. 2.

Area A: East Scotia Sea

A systematic MRl survey of the East Scotia Ridge was completed (Fig. 3). As planned, continuous bathymetric coverage of the ridge and flanks out to a cmstal age of 0.8 Ma, and to over 1.0 Ma in many places, was obtained over the northern part of the ridge (N of 57° S). Sidescan imagery was obtained over swaths as wide as 16 km or greater, giving total coverage with overlaps of 4-6 km. Our strategy was to map the northern part of ridge axis with W-E orientated tracks at a spacing of 12 km, prior to the mid-cruise break in South Georgia. This pause was then used to identify the precise location of the ridge crest, in order to position a seismic reflection line exactly over the ridge axis to image any shallow lenses of melt, which might be only 1 km wide. The seismic source was changed at this time from a single 300 cu in gun, to a beam of three guns, in an effort to maximise our chances of success. This strategy was successful, and we obtained a clear image of a high-amplitude reflector beneath the shallowest point of the ridge (Fig. 4), the first such observation outside the Pacific basin. Undoubtedly, this area will become a focus for multidisciplinary ridge axis studies in future.

Examples of MRl bathymetry and sidescan along a N-S swath over this ridge segment are shown in Plates I and II. The low speed required for seismic profiling provided an opportunity to acquire sidescan at a low ping rate, and hence achieve maximum swath width. Note that the sidescan swath in Plate II has a total width of over 22 km, half that of GLORIA.

The southern part of the ridge, from 57° to 61° was mapped with an increased line spacing of 15 km, without seismic profiling, to save time (Fig. 3). Nevertheless, excellent results were obtained, and full sidescan coverage achieved. The only slight disappointment was that the ice front was encountered on our penultimate swath, forcing the abandonment of the last line, which it was hoped would shed light on the nature of the boundary between the Sandwich and Antarctic plates.

Area B: South Sandwich Forearc

In the South Sandwich forearc, a systematic survey of the area east of Visokoi, Candlemas and Saunders Islands was achieved (Fig. 5). Most lines were oriented 075° or 225°, approximately at right angles to the trench, and the line spacing was 15 km. Before leaving the area, tie lines were collected along the trench-slope break and along part of the trench. Continuous sidescan coverage across the survey area was obtained, with continuous bathymetric coverage east of the trench-slope break. However, on the upper forearc, west of the trench-slope break, there are gaps between the bathymetric swaths. Within the limited time available, we had to chose between restricting the survey to a smaller area or accepting that there would be gaps between the bathymetric swaths.

Unfortunately the MRl data from this area were affected by some operational problems, which were probably a consequence of it being the first area surveyed during the cruise. About half of the MRl data collected in Area B are contaminated by coherent noise (CN) as a consequence of a wiring malfunction in the towed vehicle (see Section 7.3.1). This noise causes degradation of both bathymetric and sidescan data at far range. HMRG will reprocess these data in Hawaii using techniques not available on the shipboard processing system, to attempt to remove the coherent noise. In water depths greater than 5km, near the trench, the bathymetric data have a poor signal-to-noise ratio, irrespective of whether or not they are affected by the coherent noise. This is probably a consequence of the fact that the system was operated with a short transmission pulse length (2 ms), and on reduced power for part of the survey, while "running in" a new set of transducers.

Area C: South American - Antarctic Ridge

A continuous single track was run along the South American - Antarctic plate boundary from its southwestern termination at the South Sandwich trench, to the first ridge segment to the E of the Bullard transform (Fig. 6). Additional lines at the western end of the Bullard, including the ridge-transform intersection, were acquired, enabling the completion of a sidescan mosaic (GLORIA plus MRl) covering the entire transform and margins.

Area D: Bouvet Triple Junction

A successful survey of the western trace beyond the Conrad FZ was made (Fig. 7). This crust is older than that of most of the other areas surveyed, and consequently carried a greater thickness of sediments. The sonar returns are therefore more attenuated, resulting in sidescan imagery with a narrower range of pixel values than obtained over active spreading centres. Nevertheless, the trends of earlier FZs can be discerned, providing constraints on triple junction behaviour.

A decision was made to concentrate the maximum amount of the remaining time on the triple junction area and the southern trace, resulting in the acquisition of a bathymetric and sidescan dataset which show clearly the contrasts between the SAAR and SWIR, both spreading at low rates, as they approach the triple junction. While the SAAR terminates in a deep, rhomb-shaped graben, the SWIR becomes extremely shallow (-750m) and smooth.

STCM

The STCM trials were thoroughly successful. It proved possible to operate the system using the ship-mounted Ashtech 3D GPS, dispensing with the need for additional gyms, and to log output via a Level A. High-quality total field data derived from component measurements agreed very well with the results from the Varian V75 proton magnetometer. It would be possible, therefore, to construct a similar device for pennanant installation on RRS *Jam es Clark Ross (see* section 9, Recommendations).

7 Equipment Performance

A complete summary of equipment operation is shown diagrammatically in Fig. 8.

7.1 Navigation

Navigational data from the following instruments were logged via the 'ABC' system:

Trimble 4000 GPS locator
Gyro
EM log
Doppler Log
Ashtech 3D GPS
TSS300 HPR

As on previous cruises, fixes from the Trimble 4000 GPS locator were logged every 10 seconds, together with gym heading, and stored in the data streams (files) **gps_trim** and gym. Speed data from the EM log were logged every 2 seconds and stored in the stream em-log, whilst speed data from the doppler log were logged every second into the stream **dop_log.**

The problem of spurious accelerations resulting from Selective Availability, and their propagation into Eötvös corrections and hence free-air gravity anomalies from the Lacoste-Romberg meter, recurred. Using the technique applied on JR04, involving the relaxation of ship's positions obtained from gym heading and speed log between GPS fixes sampled at 15 minute intervals, speed-made-good (smg) was calculated for a test section of navigation data (Fig. 10). The result indicated that spurious jumps in speed resulted from this procedure, as the average speed changed between 15 minute windows. Moreover, very large jumps in smg were observed at major turns. Comparison of motion data recorded over a period of several days from both logs with ground speed calculated from GPS indicated that the recalibrated doppler log now appeared to give better agreement with the speeds calculated from GPS than the EM log, the converse of what was observed during JR04. The large spikes at turns were traced to the averaging of gym headings prior to combination with speed log values in the Level C program **relmov.** However, the 15 minute jumps remained.

GPS fixes were averaged over a 4.5 minute window then subsampled to 15 minute intervals (Fig 9). Data from the doppler log were averaged over a 4 minute window and then interpolated at 30 second intervals. This was then combined with gym data using the Level C routine **relmov.** The Level C routine **bestnav** uses the relative motion data to dead reckon the ship's track between the GPS fixes 15 minutes apart, and outputs positions at 30 second intervals. This operation was used routinely to post-process the navigation data every 12 hours, and a copy of the final navigation data was then made available to the HMRG group after each processing mn.

Voyage Management System (RJH/RA L)

A second GPS receiver, a Shipmate 5000 system, is used by the ship's officers during the day to day navigation of the ship. This is directly linked to the PC-based Voyage Management System (VMS). Waypoints were routinely entered into the VMS before and during each survey. A PC repeater showing the ship's position and proposed track form part of the equipment in the UIC room. Apart from one incident when the touch sensitive computer screen on the bridge failed and the whole system had to be shut down for a few hours, this performed well. However, it was noted that the Shipmate receiver was more prone to losing fixes than the Trimble 4000. The navigation officer has suggested than in the future we may look at connecting the VMS to the Trimble via its spare output port.

The VMS proved to be a valuable source of information on survey progress, wind conditions etc., and was referred to constantly. During cruises such as this, involving numerous parallel lines, it provides a convenient overview of progress within the current cruise plan, including altered way points, and time to next way point. Since cruise track planning had been undertaken previously using a Fortran program

CRUZPLAN written by RAL, it would have been most efficient if the resulting way points, which might number over 50 for a medium-sized survey, could have been input to the VMS directly from the network or even from a floppy disc. This appeared not to be possible with the present version of the VMS software, however, and so manual entry by ship's officers had to be undertaken.

Ashtech GPS (MOP)

The Ashtech GPS system is a four-antenna system designed to give not only position information but heading, heave, roll and pitch. It does this by comparing the position of the four antennae in near real-time, knowing the antenna geometry, from which it calculates the attitude of the ship. The system is relatively complex and relies on a large number of parameters to configure it. It was expected that the system would be set up ready to go, needing very little configuring. However, this proved not to be the case.

The unit was already powered up prior to mobilisation, but was giving wildly inaccurate position information (somewhere in the northern hemisphere). The manual was consulted and a reset performed. This produced a *Flash Board error* and the unit still failed to perform correctly. At this point, a call for help was e-mailed to Brian King at IOS.Help was immediate and cured most of the problems. However, it became obvious that the manual and equipment did not agree. This was due to several software upgrades in the machine and none for the manual. One mote iteration of questions and answers was needed before the desired quality of attitude data was achieved. To make things a little easier for anyone else unfamiliar with this system, the required parameters that constitute a good starting point are listed in Appendix 1.

TSS3OO Heave, Pitch and Roll Sensor (MOP)

This equipment was fitted during ship construction, but has never been used. It consists of a sensor on the tweendeck and an active junction box in the UIC. Twenty seven frames of data are transmitted each second, consisting of heave, roll, pitch, vertical and horizontal acceleration, in the form of an RS232 ASCII string. DJR configured a Level-A interface to accept this data, but, owing to the quantity of data and transmission speed limitations in the Level-A, data logging was only possible every two seconds.

Comparing the the heave, pitch and roll data for the TSS300 and Ashtech showed surprising differences, the most striking of which is the large period (90s) component superimposed on the TSS data (Fig. 11). Futher investigation is required to find the source of this long wavelength component, if the data from this instrument is to be used.

7.2 Bathymetry

7.2.1 Depths from MR1 towed swath sonar (NCM)

The altitude of the sonar fish above seafloor was determined by detecting the seafloor echo in one of the sidescan sonar channels (using a constant water sound speed of 1500 m/s). These altitudes were processed by the HMRG group to remove outliers. In order to account for the offset of the towfish from the vessel, these ping times were adjusted for the approximate time taken for the ship to travel the length of the towing cable. A script was written to extract these altitudes, towfish depths and ping times from MR1 binary files using a HMRG MR1 program **mdasc** and the Unix function **grep.** Times were converted into minutes from start of the year and uncorrected depths were computed from towfish depths and altitudes. These times and depths were averaged over 2 minutes (simple arithmetic mean) and output for the ABC system in the forn "year Julian-day hour:minute:second depth 50". As quality values were unavailable from the MR1 software, a constant value of 50 was given for each record.

7.2.2 Simrad EA500 (MOP)

It was requested by the Principal Scientist to run the bridge Simrad echo sounder as a second source of bathymetry. It soon became obvious that the Simrad transmit pulse was corrupting MR1 data to an unacceptable level, since the two instruments operated asynchronously but on similar frequencies. The Simrad has the facility to be either the source of a sync pulse or to sync on an external pulse. This feature has been used before to enable two echo sounders to be synchronised to avoid interference. It was suggested that with the correct delay the same technique might be employed with MR1. To this end the Simrad ***external pulse in*** connection (already prepared and available on the bridge) was connected through the ships uncommitted scientific co-axial cabling to the UIC. The synchronisation worked well, but second and third bottom multiple signals from the Simrad still interfered with the MR1. The Simrad was then turned off during MR1 data acquisition.

The exercise did highlight, however the shortage of data connections on the bridge. Most of the bridge instruments are on the central 'island' (Ashtech, Simrad, Trimble, etc). There are only two data ports in this area, both in use. To get around this, a cable had to be fastened across the deck head with sticky back pads to enable connection to one of the spare ports adjacent to the port bridge-wing door. This was done with the Master's consent, but is obviously a highly inadequate solution, especially since the sticky pads would occasionally fail, allowing the cable to trail across the deck.

7.2.3 3.5 KHz Echo Sounder (MOP)

Attention is drawn to previous JCR marine cruise reports. This equipment still performs just as it did 4 years ago: it is badly designed, the documentation is extremely poor, as is the build quality. The 3.5 kHz system is actually constructed from three distinct parts, 1) Raytheon line scan recorder, 2) Ocean Data Equipment power transceiver, and 3) IOS correlator, annotator and interface equipment.

The problems encountered this year:

The Raytheon line-scan recorder suffers intermittently from what appears to be a loss of synchronisation by the main drive motor. Despite many hours spent trying to trace the cause of the fault, its precise nature and remedy remain elusive. The unit has been sent to Raytheon on two occasions, only to be returned with the diagnosis of "no fault found". The loss of synchronisation sometimes happens once every 30 seconds for a few minutes, then not again for several hours. The only way to reset the recorder is switch the power off.

The power of the output pulse is controlled from the transceiver which is marked -03 -24 -18 -12 -6 and 0 dB. If the output power is increased above -6 dB then the unit shuts down, showing a transducer impedance mismatch. This problem seems to come and go annually and for no good reason. Two things are possible: the preset level at which the shutdown occurs might have drifted with time, or there might be a genuine transducer problem. The documentation for the power transceiver does not detail how to set up the mismatch circuit and that the manufacturer seems to have stopped trading. Also, the IOS documentation does not specify the DC resistance of the transducers so it is difficult to ascertain if there is a problem there.

7.2.4 10 KHz Echo Sounder (MOP)

All the comments levelled at the 3.5 kHz also apply this sounder, only more so! This equipment has more controls and is more illogical and quirky. Apart from the usual comments on build quality, documentation, spares, maintainability etc, this equipment provided no problems for the few hours that it was used. Like the Simrad, it produced unacceptable noise on the MR1 record, and so was switched off.

7.2.5 Ocean Logger (MOP)

Although using the Ocean logger on this cruise was not strictly necessary, the instrument was run for interest. It was referred to regularly for water temperature information which might affect the passage of sound through the water column.

During the 45 days that the equipment was running several problems occurred. The display driver ‘crashed’, so that all that would be visible on the screen were horizontal thin red lines moving as they would on a television that had lost line and frame sync. The only effective remedy was to switch off the power. On one occasion it was noticed that the Ocean Logger Level A clock was not incrementing at the usual one second rate. All the instruments, thermosalinograph, barometer etc, were turned off one at a time and in doing so it was found that the PAR sensor seemed to be the cause of the problem. Once it was switched off in the instrument setup, the clock worked correctly. Switching off the power supply to the foremast Rhopoint modules and back on again cured the problem.

On two separate occasions it was noticed that the Level A clock on the PC had stopped completely. It was assumed initially, since the Level B was not showing either DEAD or IDLE for the Ocean Logger, that it was merely the display that had died again. On examining Level B data for this instrument, it was found that no data was being transmitted either, because the PC had crashed. Why this did not trigger an alarm on Level B is a mystery. Timeouts for the Ocean Logger on the Level B were set correctly.

7.2.6 *CTD (MOP)*

This system was not required at all during this leg of the cruise. Time was taken however to prepare it for work on JR09B. Earlier in the year problems with the conductivity cell were reported. An attempt to change the sensor for a borrowed spare were thwarted since the two sensors (the one on the instrument and the borrowed spare) were not of the same size. It appeared that later manufacture conductivity cells were made with a larger base than earlier sensors. Instructions supplied by the manufacturer showed how the sensor head could be modified to accept the larger sensor this was to be done by enlarging a particular hole.

The sensor head was disassembled and removed according to the instructions. This was done with the exception that three wires that were to be disconnected from some components inside the sensor head were cut rather than de-soldered. This was viewed as being a safer option since it was less easy to make a mistake or damage the components. Later when the wires were joined, they were soldered and then covered with heat shrink sleeving and a small blob of glue.

The hole in the sensor head was enlarged to the correct size by Mr. Bremner who also inspected the ‘0’ ring seals. Silicon grease was used in the reassembly. The cell was then tested by using water from the uncontaminated sea water supply. All appeared to function correctly.

7.3 HAWAII-MR1

7.3. I *Engineering (JRE)*

This section describes the performance of the MR1 towfish and acquisition system, including factors influencing data collection. This is the first time that the system has been towed through pack ice. In addition, we recorded the first images of ice bergs, which show up as noise in the sidescan. Overall, the system performed well after some initial telemetry problems.

It was found that running the system using the MR1 hydraulic power pack, as installed in Grimsby, caused the winches to run too slowly to afford safe operation. The ship's hydraulic power supplies were used in preference, employing three of the four available hydraulic pumps.

First deployment was at 004/11:00. The telemetry soon stopped working and the fish was onboard by 005/12:08. After warming up on the bench, the telemetry began to work: the failure seemed to be temperature-related. After adjusting the telemetry with the towfish electronics in a cold room, we redeployed the system at 005/18:07. The telemetry was still giving several "Downloading Parameter" error messages an hour, but this did not seem to affect the data.

At 007/08:39 the ship lost steering control and made a very small radius turn at as it slowed from 8 kts to 2-3 kts. The towfish reached a depth of 172 meters. The steering problem was corrected after about 12 minutes. After returning to 8 kts the towfish began pitching making data collection impossible. Recovering the depressor we found the middle of the drogue line fouled on the tow wire. This was cleared and the drogue streamed without recovering the towfish. Data collection resumed and returned to normal.

Six hours later, at 007/14:15, the port side stopped collecting data. Adjusting the topside telemetry threshold solved the problem. However, a pathology known as Coherent Noise (CN) appeared. Apparently the pressure cycling caused by the steering problem produced a fault in the inter-can cable in the towfish. The inter-can cable carries power, telemetry, and attitude data between the port and starboard electronics pressure cases. The fault allowed telemetry signals to radiate electromagnetically into the water. The CN noise then coupled into the array cables and was superimposed on the acoustic signals. CN noise is characterized by track-parallel striping in the sidescan, and by a constant slope down and away in the bathymetry, starting at about the first multiple.

When the CN noise appeared the weather conditions precluded a safe towfish recovery so data collection continued for another 60 hours until the towfish could be recovered. This was achieved at 009/21:00, the inter-can cable was replaced with a spare and the electrical splice remade to the umbilical in the nose of the towfish. The towfish was redeployed at 010/01:40, when the data were found to be free of CN noise. The telemetry error rate was much lower, since the adjustment made to compensate for the fault in the inter-can cable aligned the telemetry better.

By this time a clear correlation between ship board radio transmission and telemetry errors became evident. The ship's Radio Officer was most helpful in determining which frequencies were the worst offenders and tried to minimize interference. It appears that FSK type transmissions cause the most interference. At this point almost all of the telemetry errors can be attributed to radio interference, aside from those at the beginning of the cruise.

When collecting seismic data in conjunction with MR1 we synchronized the two systems such that the seismic shot was fired about 1 second prior to the MR 1 ping. The MR 1 was the master using the Sun Sparcstation's time base. The ship's 10 kHz depth sounder and correlated 3.5 kHz sounder had to be turned of to avoid interfering with the MR-1 data. No depth sounders were running in conjunction with the MR 1.

7.3.2 MR1 Bathymetry Processing (DDJ)

The processing procedure is illustrated in Fig. 12. Raw data files, collected and transferred from the logging computer hard disk to Exabyte tape on a 12-hour basis, are processed using **btyp,** an interactive program which creates MR1 files from the raw data. This program takes a "cell width" parameter which determines the cross-track width in metres over which the calculation of a single bathymetty value is attempted. The cell width was set at 10 m for the JR09a cruise. The output bathymetty data are stored in MR1 file format.

During **btyp,** a bottom detect (bd) file is generated, then edited and applied to each 1-hour raw data file. Port and starboard flat bottom tables and several other parameters (e.g. median filters) are also applied to MR1 file generation. The flat bottom tables are calculated by stacking the electrical versus acoustic angle data for several hour files to characterize the sound velocity structure of a particular water column (Figs. 13a,b). The success of bathymetry processing is largely dependent upon the applicability of the tables to the water column temperature/salinity structure for the survey area.

The flat bottom tables for JR09a were created using stacked data from the initial transit into Area A (hour files 005/18:00 through 006/14:00). The extremely flat, featureless seafloor, as well as the non-stratified, homogeneous nature of the water column temperature profile, proved ideal for producing the tables, which have worked well in water depths ranging from 1500 meters to over 7000 meters in the four survey areas, with the following exceptions:

1. The extremely shallow area at 007/08:35 through 007/11: 18 in the early part of the forearc survey (Area B) shows some track-parallel banding on the starboard side. A special flat bottom table for very shallow water has not yet been generated successfully. However, these files were collected shortly after the ship lost steering, causing fouling of the drogue line in the tow cable and subsequent towfish pitching. It is doubtful that data stacked from these hour files would be useful in table generation.

2. The very flat regions on the transit between survey Areas A and B comprising 007/00:00 through 007/12:00 and 012/19:00 through 012/23:00 show a great deal of noise mixed in with the signal through most of the starboard side of the swath, with a large amount of edge noise on the portside swath. This is not specifically a 'table problem', but can be partially corrected by slight modification of the existing tables. This is currently in progress.

The occurrance of CN in the bathymetry data for the early part of the forearc survey (007/14:13 through 009/20:40) has caused a 1.5 to 2 km loss of swath on the starboard side. Port side has retained most of its swath width, but is generally noisy at high angles. The CN signal causes an edge striping indicating an extreme downward slope on the swath edge. This edge can be merely "trimmed" off but these data will be reprocessed at the Univeristy of Hawaii when the necessary algorithms are written to remove the noise signal from the data.

When final navigation becomes available, the mrnav program merges the navigation information with the bathymetric data producing a new MR1 file whose ping headers contain location and course values. These files have an "n" appended to their suffix names (e.g. MR195005.00.btypbn).

The bathymetty collected by MR1 during cruise JR09a is generally of very high quality. The slight amount of noise in the data is easily read through and does not hinder interpretation. The data has purposely not been trimmed to allow the user to determine the data edge. Because there are no further processing programs for reducing the random noise in the bathymetric data, we are using GMT programs for final processing, and for producing publication-quality figures. An example of processed bathymetry data is shown in Plate II.

Raw Data File input:

btyp ------------.btypb (processed bathy)
Step 1 ---------------------------
(edit bd's) ------------.btyps (first-processed sidescan)

.btypb **mmavm** --------.btypbn ---> GMT
Step 2 --------------------------------------
.btyps (merge with navigation) --------.btypsn ---> sidescan processing

mrgrid
Step 3 .btypbn -------------- .bty.cswr (and control file)

mrovl
Step 4 .bty.cswr (and control files) --------------- .ras

Fig. **12** MR1 Bathymetry processing steps; program names are shown in bold type.

7.3.3 Sidescan Processing (LP)

The MR1 System collected more than 280,000 km² of sidescan sonar imagery during 36 days of surveying aboard the RRS *James Clark Ross.* Full swath width varied from 15 km when using a 12 second ping rate in 3000 meters water depth to 26 km when using a 20 second ping rate in 7000 meters of water.

Sidescan was generated in MR1-format 'hour files' (each containing one hour of data) immediately after raw data tapes were removed from the logging system and bottom detects were edited. The hour files were then merged with navigation from **bestnav.** All sidescan has been processed through a minimum of 5 programs to reduce the effects of artifacts caused by our system and interference from other systems. These programs include:

1. **mrdespeckle - rescales** anomolously high- and low-value pixels
2. **mrdestripe -** replaces noisy striped pings by comparing them with neighbouring pings and rescaling their values
3. **mrmicrodestripe -** replaces small segments of ping noise by interpolating the values from neighbouring pings
4. **mrtrim -** removes filler values beyond the end of the ping
5. **mravg -** equalizes parallel-to-track gain variations by multiplying values by a correction factor

The first four programs were run in one job, and the output files given the suffix '.nd4t'. Gain correction was done with **mrscale as** the next step, and those output files have the suffix '.nd4ta'. Other programs used on sidescan include **mrscale,** to raise/lower the grey levels of poorer quality sidescan such as that collected when the system was operating at 3/4 power, and **mrfill,** to trim noisy swath edge to specified widths on those survey lines that overlie previous tracks.

Once the sidescan has been processed, it is gridded at scales and projections requested by the Chief Scientist, and plotted on a Raytheon TDU-850 thermal printer for mosaicking.

A rea A : East Scotia Ridge

Three different types of sidescan data were collected in the east Scotia Sea Ridge survey:

3/4 Power, 5 msec pulse:
from 006/09:00 - 007/01:20
Full Power, 5 msec pulse:
from 012/18:35 - 020/17:27
023/13:32 - 023/15:56
Full Power, 10 msec pulse:
from 023/15:56 - 030/06: 11

An angle-varying-gain (avg) correction file was made for each type of sidescan. **mrscale was** used to equalized the grey levels between the 3 types of sidescan (3/4 power was too light, CN-affected data was too dark). Sidescan was gridded on a Mercator projection at a scale of 1:500,000 (at the equator). After gridding, separate histogram- equalized contrast maps were created for the north and south parts of the ridge survey. Two versions of the 2 mosaics in the north part of the survey were made - one showing the north-south line along the ridge axis overlying the east-west lines, and the other showing the east-west lines on top. One sidescan mosaic was made for each of the 3 plotting sheets in the south part of the ridge. A sample of gridded final sidescan along the east Scotia Sea ridge is shown in Plate II.

Area B: South Sandwich Forearc

Three different types of sidescan data were collected in the Forearc Survey:

3/4 power, 5 ms pulse
from 007/05:30 - 007/13:55
Full Power, 2ms pulse, CN
from 007/14:41 - 009/20:40
Full Power, 5 ms pulse, no CN
from 010/02:01 - 012/13:59.

An avg correction file was made for each type of sidescan. The 3/4 power data were too light relative to the full power, so **mrscale** was used to boost those values. Similarly, the sidescan containing cns was too dark and was scaled to lighten it. After gridding, a histogram equalized, global contrast map was applied to all sidescan. Two final shipboard mosaics were made at the 1:250,000 scale, Mercator projection, true scale latitude of 57°s. No attempt was made at sea to remove the CN, as defining the noise and determining parameters to remove it requites more time than is available at sea. This will be done at HMRG.

Area C: South America - Antarctic Ridge

Only one type of sidescan data was collected in the survey along the fracture zone:

Full Power, 10 msec
from 031/2009 - 037/0259

One avg file was created for these data. The data were then gridded at the 1: l,000,000 scale, Lambert Conic Conformal projection. Two final shipboard mosaics were made.

Area D: Bouvet Triple Junction

Only one type of sidescan data was collected at the Bouvet Triple Junction:

Full Power, 10 msec pulse:
from 037/02:59 to 044/18:30.

One avg file was created for these data. The data were then gridded at the 1:1,000,000 scale, Mercator projection with a true scale latitude at the equator, and then pixel-replicated by a factor of 2 to produce 7 final shipboard mosaics at the 1:500,000 scale. One histogram-equalized contrast map was generated and applied to the entire survey.

7.3.4 ***Postprocessing (FM)***

The processing of the bathymetric data is divided into two steps. MR1 programs calculate the bathymetry from the phase and time delay information and merge it with navigation (section 7.3.2). GMT processing decimates the data to appropriate densities for gridding, filters the data, interpolates across small gaps, and produces geographically registered grid files which can be output as PostScript contour, color, shaded relief, and perspective plots.The program **mr2gmt** converts the bathymetry data in these MR1 files into ASCII longitude, latitude, depth suitable for processing using the GMT package. Detailed descriptions of the MR1 and GMT programs can be found in their respective man pages'.

7.4 Gravity (RAL/DT)

Gravity meter S84 was supplied by RVS, as on JR04. The gravity base station at the landward end of the FIPASS bridge was employed, as in previous cruises (see R.R.S. *James Clark Ross* Cruise JR04 Report). No difficulties were encountered during operation.

Gravity Base Ties

Gravity meter: S84
Meter calibration constant:

FIPASS gravity base tie, day 951001

Time:	95/001/10:00
Meter reading:	12464.5
Spring tension:	12464.8

With the ship moored near the western end of FIPASS, measurements suggested that the meter was 2.06 m below the FIPASS base station, which was assumed to be 200m from the ship (see R.R.S. *James Clark Ross* Cruise JR04 Report, p.43). Corrections were made as follows:

Free-air correction (FA)
FA = 0.3086 x 2.06 = 0.63 mGal

Latitude correction (LA)*
LA = -0.79 x 0.2 = -0.16 mGal

Estimated gravity at ship's meter (g)
g = base reading + FA + LA
= 981227.63 + 0.63 - 0.16
= 981228.10 mGal

FIPASS gravity base tie, day 951075

Time:	95/075/19:30
Meter reading:	12460.4
Spring tension:	12460

Estimated height of meter above base station -0.81m.

Free-air correction (FA)
FA = 0.3086 x 0.8128 = 0.25 mGa1

Latitude correction (LA)
LA = -0.16 mGa1

Estimated gravity at ship's meter(g)
g = base reading + FA + LA
= 981227.63 + 0.25 - 0.16
= 981227.72 mGa1

Difference is -0.38 mGa1 in 74 days, 9.5 hours (1785Sh). Mean drift rate -0.000213 mGa1 h^{-1}.

7.5 Magnetics

7.5.1 *Varian* V75 *Total Field Magnetometer (RAL)*

One of the two sensors supplied by RVS was deployed soon after leaving the Falkland Islands, via the aft port boom. This produced a trace with short-period noise giving a jitter with amplitude of about 5 nT. Various possible sources of this noise were investigated, and a slight improvement was achieved by switching off the ship's cathodic protection system briefly. Shortly afterwards, the opportunity was taken to change sensors whilst MR1 was being recovered. The replacement gave much less noise, but it remained impossible to raise the signal level above 2, which may be a result of the inadequate cable length (200m). Furthermore, it was not possible to log the data owing to a fault in the Level A interface. Since this was a specially-adapted Mk I type, a replacement Level A could not be used. The fault required several days to put right, during which time the Servoscribe record was digitized and input to Level C manually.

Acquisition proceeded normally, except for several large jumps from typical field values of approximately 30,000 nT, to values of approximately 60,000 nT, for periods of about ten minutes, in addition to the usual interruptions caused by radio transmissions. On day 029, the ship entered an area of brash ice near the edge of the ice front in the southern part of the east Scotia Sea. As the ice increased in density, it was decided to retrieve the sensor, but before this could be accomplished, it became caught on a "growler" and the cable separated at the ship end. By this time, it had become clear that the STCM was capable of providing an acceptable alternative source of total field information, and so the spare towed sensor was not deployed until the ship entered completely open water, and then from directly beneath the stem gantry.

When redeployed, the spare sensor once again gave noisy results, interspersed with periods of cleaner data acquistion. Some contamination of the kerosene within the bottle was suspected, and so the sensor was recovered during the transit to Cape Town, so that it could be checked, cleaned and refilled. When opened, a significant volume of water was found inside the sensor bottle. The bottle was cleaned and refilled with normal kerosene, and a test deployment made prior to arrival in Cape Town. The results were satisfactory, bearing in mind the short cable length.

7.5.2 *Shipboard Three-Component Magnetometer (Y N/RA L)*

This was the first time that a vector field magnetometer had been used aboard RRS *James Clark Ross.* As it is proposed that a similar system be operated in future by BAS, a full description of the system, and reports on its installation and operation are given below.

Vector measurements of the geomagnetic field provide more detailed information than total intensity for understanding the magnetic structure of oceanic crust. A shipboard three-component magnetometer was developed recently and used to measure geomagnetic field vectors (Isezaki, 1986).

Magnetic anomaly lineations in the ocean are an important key to understanding the evolution of mid-ocean ridges. The strike of two-dimensional magnetic structures, such as magnetic anomaly lineations at reversal boundaries, can be obtained from a single ship track using geomagnetic field vectors (Isezaki, 1986; Seama et al., 1993). Moreover, the STCM is easy to operate, because the sensors of this system are simply fixed to the ship's deck. Thus, the STCM is especially useful for understanding areas where data are sparse, and where sea ice prevents the deployment of towed sensors, such as the remote Southern Ocean.

The components of the STCM system were as follows.

(1) Flux-gate magnetic sensors

Three orthogonal flux-gate type magnetic sensors, which were fixed on the deck above the bridge, provide the magnetic field signals.

(2) Magnetometer

The magnetometer consists of two sub-systems: the signal detector and the CPU interface. The former takes the signals from the flux-gate magnetic sensors and provides analogue output to the CPU interface. The CPU converts it to a 16-bit binary digital signal, which is latched and transmitted to the PC via a PIO interface.

(3) Horizontal gyrocompass

This provides the ship's yaw. Analogue output from the horizontal gyrocompass is transmitted to the CPU interface of the flux-gate magnetometer and also converted to 16-bit binary format. These data are sent to the PC via the PIO board.

(4) Vertical gyrocompass

The vertical gyrocompass gives the ship's roll and pitch, which are transmitted to the PC via an RS232C interface.

(5) NEC-PC

The NEC-PC controls sampling and transmits the data to the ship's Level A interface. The PC sends the latch command to the CPU interface of the flux-gate magnetometer and obtains the three magnetic field components, together with yaw, roll and pitch from the gyrocompasses. These data are stored on the hard disk of the PC, and, during JR09, were also transmitted to ship's Level A interface at 1s intervals.

Installation and Operation

The three orthogonal sensors were fixed on the rear of the deck above the Bridge Deck, behind the funnel (see Plate III). The magnetometer, personal computer (NEC-PC), horizontal and vertical gyrocompasses were installed in the UIC mom (see Plate IV). The sensors and horizontal gyrocompass were connected to the magnetometer by extension cable. The magnetometer and vertical gyro were connected to the PC by PIO and RS232C respectively. The PC controls sampling of the magnetic field data from the magnetometer, and ship's heading, roll and pitch data. All data were obtained every 1 second. The magnetic field components from the sensors and the ship's heading from the horizontal gyrocompass are latched at the same time and all data are transmitted as 16-bit binary data to the PC by PIO (16 bit I/O). Roll and pitch data from the vertical gyrocompass are also transmitted to the PC synchronously via RS232C. These data were stored on the hard disk of the PC and transmitted to the ship's logging system every 1 second by RS232C.

Vector magnetic data (H_{ob}) were obtained using the three magnetic field components from the sensors together with gyrocompass data to provide ship roll (R), pitch (P) and yaw (Y). The ambient field vector F, is given by:

$$H_{ob} = A*R*P*Y*F+H_P, \qquad (1)$$

where A is a constant matrix including the effects of the sensor's location and the ship's magnetic susceptibility distribution, and H_P is the magnetic field produced by the ship's permanent magnetic moment (Isezaki, 1986). A and H_P (twelve constants) were determined using data at six different locations during the cruise while the ship steered tight circles in both clockwise and anticlockwise directions. The geomagnetic field vectors were calculated from the observed data using eq. (1). The residual field of each component was calculated by first subtracting the IGRF-90 value and then subtracting linear trends from the measured geomagnetic field data. Short wavelength anomalies, which appear to be noise derived from ship motion, were removed using a 25-minute simple moving-average filter.

Measurement during JR09

The STCM system was set up before the cruise and ran throughout almost the entire cruise from the day 001 to 049. Transmission of the data from the PC to the ship's Level A interface was achieved on day 006. Three-component magnetic field data, yaw, roll and pitch were then transmitted every second. There was a problem with the vertical gyrocompass on day 007, and roll data were not available from that time. The cause of the problem was not identified.

To determine the twelve constants related to the ship's permanent and induced magnetic filed, calibrations were conducted on days 001, 005, 020, 023, 028, 031, 045 and 048, while the ship steered a figure-of-eight. Calibration took about 25 minutes at each site except for that on day 028, which took about one hour, because the MR1 was still being towed.

Data processing

Preliminary results were obtained on board the ship. To obtain preliminary results of vector geomagnetic anomaly field data, a temporary set of twelve constants related to the ship's permanent and induced magnetic fields were determined using the calibrations on days 020, 023, 028 and 031, but further post-cruise analysis is required using all calibration data to determine the twelve constants precisely.

The STCM data set in the ship's logging system were transferred to the STCM's standard analysis format. Navigation, yaw and total intensity from the proton magnetometer were combined with STCM data using logging time and put into the STCM's standard analysis format. Since there was a problem with the vertical gyrocompass of the STCM system, roll and pitch information from the ship's TSS300HRP and Ashtech 3D GPS systems were also put into the STCM's standard analysis format. Roll and pitch information from the TSS300HRP were available at Level C from day 022 and from the Ashtech 3D GPS from day 024. Roll and pitch data from the Ashtech 3D GPS are of good quality, but are only available when number of satellites with high angle is greater than four. Variations of roll and pitch data from the TSS300HRP contain unknown long-period changes (> 1 minute) and were not suitable for ship's attitude correction of the STCM in the present state. A full correction for ship's roll and pitch was not made on board the ship. Variations caused by roll and pitch are short period (2-4 seconds) and about 500 nT with respect to a 1-degree change. Such short period of variations were filtered out by simple moving average method on board ship. However, roll and pitch data combined with TSS and Ashtech 3D GPS will be used on post cruise processing to obtain better quality vector geomagnetic anomaly field data.

The geomagnetic field vectors were calculated using the twelve temporary constants which were determined on board ship. The residual field for each component was calculated by first subtracting the IGRF-90 and then subtracting linear trends from the measured geomagnetic field data. Short wavelength anomalies, which derived from ship motion, were removed using a 25-minute simple moving-average filter. Profiles of X (northward), Y (eastward) and Z (vertical) components of the geomagnetic anomaly field were obtained along the ship's track. Total field anomalies were also calculated and compared with those obained from the proton magnetometer. Although there is a slight difference in absolute value, the variations of the total field anomaly are in good agreement (Figure 14).

ISDVs (Intensity of Spatial Differential Vectors - Seama et al., 1993) were also calculated on board the ship. The positions of magnetic boundaries, such as magnetic anomaly lineations and fracture zones, were obtained by searching for peaks in the ISDV. We selected peaks that exceeded a threshold level of 10 nT/km as magnetic boundaries. The boundary vector, which shows the strike of the 2D magnetic source structure, was calculated from the data near each magnetic boundary (data within 10 km on either side of the boundary, or half the distance to the neighbouring boundary if less than 10 km). Strikes of magnetic structures at their boundary positions were obtained and plotted along the ship's track.

References

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Isezaki, N., 1986. A new shipboard three component magnetometer, Geophysics, v. 5 1, 1992-1998.
Seama, N., Nogi, Y. and Isezaki, N., 1993. A new method for precise determination of the position and strike of magnetic boundaries using vector data of the geomagnetic anomaly field, Geophys. J. Int., v. 113, 155164.

7.6 Seismic Profiling

4779 km of 4-channel seismic reflection data were collected during the cruise, in the South Sandwich forearc and northeastern Scotia Sea (Appendix 2). Most of these data (4445 km) were collected between days 004 and 020, using a single 4.9 1 (300 cu. in) airgun as the source and at a towing speed of 8 kts. An additional 334 km were collected between days 023 and 025 while towing three airguns on a beam at 6 kts. In many places, the seismic data reveal aspects of the structure and stratigraphy beneath the sea floor which will complement the surface images produced from MR1 data.

Most of the components of the small seismic system were borrowed from RVS (airguns, single airgun umbilical, short hydrophone streamer, amplifiers, filters, SAQ digital recording system and EPC recorder). The beam, umbilical and winch used to deploy three airguns on days 023-025 are part of the ship's equipment, and are maintained by BAS Instrumentation and Systems group. The Waverley recorder, used to display an additional singlechannel monitor record for most lines, is part of the ship's scientific echo sounding system. A prototype 4-channel digital recording system, built at BAS by Ed Mowse, was taken on the cruise, and proved very successful. After the first trial recording period it was used in preference to the SAQ system, and the latter was only used when data recorded on the BAS system were being backed up. Having a small seismic system on board enabled us to collect digital seismic reflection data simultaneously with MR1 data at a towing speed of up to 8 kts.

7.6.1 *Seismic Recoding (RDL)*

Equipment:

BAS 4-channel PC-based digital recording system
Carrack SAQ PC-based digital recording system
Bell-Howell amplifiers
2 x Krohn-hite analogue filters
EPC crystal delay unit
Key pulse generator
EPC recorder (single channel monitor)
Waverley recorder (single channel monitor)

This instrumentation was set up in the UIC Room before departing from Port Stanley. On the first line, the new BAS digital recording system and the SAQ system were set up to record in parallel. The inputs to the SAQ system were passed through the Bell and Howell amplifiers, whereas inputs to the BAS system, which has adequate amplifiers built into its signal processing unit, were taken directly from the deck unit. The inputs to the EPC and Waverley recorders were taken from the SAQ inputs after amplification (usually channel l), and were bandpass filtered using one of the Krohn-hite filter units. Initially trigger signals, conditioned by the key pulse generator, were taken from the EPC crystal delay unit. When this developed a fault it was replaced by a signal generator borrowed from the Electronics Lab. From the start of line BAS945-S34 onward a trigger signal was taken from the MR1 acquisition system, to prevent the airgun direct wave from interfering with the MR1 data. The MR1 trigger signal was delayed by the repaired EPC crystal delay unit so that the airgun fired at the end of the MR1 listening window, before the next transmission pulse.

The SAQ system, loaned from RVS, is designed to record directly to magnetic tape. Last year the original system PC, which was a 286 machine, was replaced by a 386 PC. The software did not function correctly with the faster processor, and the system was returned to Bullard Laboratories for Tim Owen, who designed it, to rectify this problem. Tim delivered the system PC (with modified software) and signal processing unit to BAS in September and they were loaded on the ship in Grimsby. At the time we thought that the tape drive had been delivered to the ship with the other RVS equipment. It was not until mid-December that Tim discovered the tape drive had been sent to Bullard Laboratories together with the test of the system. He forwarded the tape drive to BAS, but it arrived just too late to be included in the last consignment of air freight for the cruise. The SAQ software includes an option to record data to the PC hard disk, but this option is not fully implemented on the version of the system owned by RVS.

To enable us to use the disk recording option, Tim Owen provided an updated version of the software specifically for use on this cruise. On the first seismic line, the SAQ system recorded data normally at first, but soon started recording only alternate shots, and after about 7 hours it was recording only one shot in three. This problem was found to result from a mistake during installation of the updated software which caused the system to run the RVS version. When the updated software was subsequently installed correctly, attempting to run it caused the PC to hang up (i.e. no further response could be obtained until it was rebooted). Inspection of the SAQ source code revealed that the PC was hanging up when a function intended to measure its clock speed was called. The source code was modified to allow the user to input the clock speed interactively, then recompiled and reinstalled. Subsequently the SAQ system functioned satisfactorily, except that channel 2 was recorded with inverse polarity. One further problem was that the updated version of the software was designed for use with a version of the hardware which only has 64 Hz and 500 Hz anti-alias filters. It would not allow interactive selection of any other anti-alias filter frequency, even though the RVS version of the hardware includes 125 Hz anti-alias filters. This problem was circumvented by creating a configuration file using the RVS version of the software and using it to set the initial recording parameters for the updated version. Unfortunately, having solved these various problems, the usefulness of the SAQ system was limited by the small size of the hard disk on the PC. The 80 Mb disk had been partitioned into two parts, and only about 30 Mb were available on the partition containing the SAQ software. This restricted recording of 4-channel data, with a 2 ms sample interval, 6 s record length and 16 s firing cycle, to less than 5 hours. At the end of each period of data acquisition, the data on the SAQ PC were copied to a tape streamer ("Parallel Stream") device. The data were than transferred from the tape streamer to the MicroMax PC, from which SEG Y format tapes were generated (see section 7.6.4). At the start of the cruise, a network card was installed in the PC, which enabled us to make an additional backup of data files to the network PC server.

When the first two lines recorded on the BAS 4-channel system were read onto the MicroMax, it was discovered that the times recorded in the trace headers had not been incrementing. Inspection of the source code revealed that the trace header time is only updated while the menu which includes the time is displayed on the PC monitor. Thereafter the system was operated with this menu displayed during acquisition, with the alternate menu only being selected temporarily when a change in recording delay was required. This change in practice was introduced part way along line BAS945-S32, so the first 18 hours of data recorded on that line do not have valid times in the trace headers. The signal processing unit on the BAS system has two pre-amp gain levels. The first two lines were recorded using the low gain setting and all later lines were recorded using the high gain setting.

On the first three lines, data from the hydrophone group nearest to the ship were recorded on channel 4, and the channel numbers that data from the other groups were recorded on decreased as the group offset increased. Before shooting line BAS945-S33 the inputs to the signal processing unit were rearranged so that channel number increases with offset on this and all subsequent lines. There were more than 450 Mb of space on the hard disk of the system PC, which allowed continuous recording of 4-channel data, with a 2 ms sample interval, 6 s record length and 16 s firing cycle, for about 3 days. At the start of the cruise a Datatrac tape controller card and a network card were installed in the system PC. These enabled us to backup data to 9-track tape and to the network PC server, respectively. At the end of each period of data acquisition, data were backed up across the network to the server hard disk, or to DAT tape. When the network backup was complete, the hard disk on the PC was parked (C:\DISKPARK), then the PC was switched off and carried down to the Main Lab. There it was connected to the STC2925 tape drive which is part of the MicroMax data processing system, and the data files were backed up to SEG-Y format tape using the batch commands BACKUP and ABACKUP. BACKUP was used to write the first file on each tape, and writes two end-of-file marks. ABACKUP was used to append files to an existing tape. It backspaces over one file mark before starting to write, so the tape was positioned after both end-of-file marks before using this command.

7.6.2 Short ***Streamer (RDL)***

This consisted of (from front):

Tow cable (an estimated 141 m were deployed beyond the stem during lines BAS945-S30 and BAS 923-S31, but the length deployed was reduced to 95 m on all later lines)
25 m stretch section
20 m weight section
25 m stretch section
2 m depth section
5 x 50 m active sections, with 2 m depth section between sections 2 and 3
200 m rope ending in a monkey's fist

This is exactly the same configuration that this streamer had at the end of cruise JR04, and we suspect that it had not been used during the intervening 21 months (in the JR04 cruise report the second stretch section is recorded as being 50 m in length, but we now think that this must have been a mistake). The fifth active section was added to the streamer during JR04 because no spare stretch sections were available. On all lines on this cruise, data were recorded from the front four active sections. As on JR04, the depth sections had not been calibrated before the cruise, so we relied on spectral analyses of data, carried out on the MicroMax, to determine the towing depth of the streamer. Spectral analyses of data from the first two lines suggested that the streamer was towing very deep, even at 8 kts (16-20 m). Readings could only be obtained from the front depth section, but these readings were close to the depth for the nearest hydrophone group derived from spectral analyses.

Before starting line BAS945-S32, the length of tow cable deployed was reduced by 46 m. Spectral analyses and the front depth section indicated that the front of the streamer then towed at a depth of about 12 m, but the spectral analyses also indicated that the depth of the streamer steadily increased with offset to about 17 m on the furthest group (all depths at 8 kts).

On day 015, in rough weather, large amplitude, random noise spikes began to contaminate the seismic data. The problem was traced to the streamer. Nothing further could be done until it was recovered, and as the source of the problem may have taken some time to locate and correct, we decided not to interrupt the survey. At about the same time an intermittent open circuit developed on the front depth section. We did not immediately suspect a connection between these two problems. As the weather improved over the next few days the noise became less severe, but re-emerged when conditions worsened again. By day 020 the front depth section had an open circuit on it most of the time. As it was no longer providing any valid depth information the power supply to it was disconnected prior to the start of line BAS945-S64. The random noise spikes immediately disappeared and it became clear that the two problems were inter-linked. The intermittent opening and closing of the depth section circuit must have been producing cross-talk on the seismic data channels. The remaining lines were shot with the depth section disconnected. Lines BAS945-S65 to BAS945-S68, shot on days 023-025, were free from random noise spikes. However, when the data from these lines were examined on the MicroMax we discovered that the two groups furthest from the ship had been almost completely dead during this last period of recording.

The streamer was dismantled on day 028 to locate the cause of the poor transmission of data from the furthest offset two groups and the problem on the depth section circuit. Some broken wiring was found in the front stretch section, so it was replaced. This appears to have restored connection to the furthest offset groups.

The problems which we encountered with this streamer are probably the inevitable result of the wear and tear it has received over many years. However, the question arises whether BAS should continue to risk compromising scientific results in the future by hiring unreliable equipment of this antiquity from RVS, or whether the JCR should be equipped with a short streamer of its own. A small seismic system is essential equipment, not a luxury, for most BAS Geoscience cruises.

7.6.3 ***Airgun and Compressors (SFB, RDL)***

System Components:

Umbilical Winch
Beam Crane
7 m towed Air-Gun Beam
Single Gun Umbilical
Single Gun Deck Air Manifold
Bolt 1500C Air-guns
2.6, 4.9, 7.6 litre chambers
Towed Hippo Buoy
JCR Gilson Winch (c/w 12mm diameter 7x19 ss wire)
JCR Starboard Effer Crane
JCR Hamworthy compressors

A single Bolt 15OOC airgun with a 4.9 1 (300 cu. in.) chamber was used as the source on lines BAS945-S30 to BAS945S64. It was towed on a simple umbilical consisting of a single air hose, three electrical cables and a towing wire (supplied by RVS). Neither a near-field hydrophone nor a depth sensor were deployed, so only one of the electrical cables was used, for the firing signal. The air hose was connected to a deck air manifold. The towing wire was anchored to a deck matrix bolt near the starboard quarter. The umbilical was towed through the starboard quarter roller block. The length of umbilical deployed beyond the stem was about 40 m. From previous experience of towing a single 4.9 1 airgun in a similar way on cruise JR04, with a depth sensor, it is thought that the airgun towed at about 4 m depth at 8 kts. A wire passing through a block suspended from the articulated arm of the stem gantry, and connected to one of the Gilson winches mounted on the boat deck aft of the UIC room, was used to deploy and recover the airgun. This wire was left slack while towing. Preliminary charging of the gun to 35 bar was carried out with the gun just below the bulwark, immediately before lowering into the water. After sealing, the gun was lowered into the water, simultaneously paying out both the Gilson wire and the umbilical.

The hydrophone streamer was deployed immediately afterwards over the stem, beneath the aft gantry, and fed over a roller block mounted on the bulwark. Recovery was the reverse of deployment, with the gun being vented down to 35 bar before leaving the water. Final air bleeding was completed just below the bulwark to ensure that the gun was completely discharged before returning to the deck.

On all the single airgun lines, the firing signal to the airgun was provided by a small, 19" rack-mounted airgun firing unit, loaned from RVS. It performed satisfactorily on these lines. Some firing problems were encountered during the later stages of the first deployment. This was rectified on several occasions by reducing air pressure to the gun until firing recommenced. The technique for this was to shut down the compressors and vent the system to atmosphere until firing restarted, this normally occurred at approximately 80 bar. This proved to be a recurring problem and at the next opportunity the gun was replaced. The replacement gun continued to fire for the remainder of the survey (ca 12 days 2hrs) without further problems.

On lines BAS945-S65 to BAS945-S68 (days 023 to 025) three airguns were towed on a 7 m -long beam. The airguns used were: 4,9 l(300 cu. in.) at the front of the beam, 2.6 1 (160 cu. in.) in the centre, and 7.6 1 (466 cu. in.) aft. The system was assembled for use on leaving South Georgia. The distances between the airgun ports measured on deck were 2.35 m between the front and centre, and 3.3 m between the centre and aft. The system was positioned on the starboard side of the aft deck for deployment over the starboard quarter. Near-field hydrophones were mounted on the beam above each airgun. The signals from the near field hydrophones were compared on a digital storage oscilloscope and the airguns were tuned manually.

The beam was deployed in the usual manner using the beam crane connected to the starboard aft Effer crane. The beam was raised over the bulwark, a hippo buoy was attached to the aft end of the beam by 8 m of 24 mm polypropylene rope, then the guns primed to 35 bar. After this, the beam was lowered into the water by means of the winch mounted on the beam crane, simultaneously paying out the umbilical. The umbilical, which was towed through a fairlead on the tip of the starboard boom, was paid out until there were only three turns left on the winch drum. An estimated 60 m of umbilical were deployed beyond the stem. Wire on the beam crane winch was paid out until slack and then tied off on the bulwark. The strain was taken on the umbilical and the guns charged to 135 bar. No depth sensors were used, but a similar towing arrangement on cruise JR04 resulted in the front of the beam towing at about 12 m depth and the tail at about 9 m depth, at 5 kts. As the beam was towed at about 6 kts on this cruise, the towing depths were probably slightly less than those measured on JR04. Allowing for the angle of the umbilical running down to the front of the beam, and the length of the beam itself, the centre of the source was located about 62 m astern.

Recovery would normally be the reverse of deployment but, unfortunately, this was not possible here. During the recovery procedure the beam crane failed on haul. A visual inspection of the pipework indicated that the most likely cause was a blockage of the hydraulic supply to the crossover valve on the winch, restricting flow to the pressure side of the valve. The valve was removed for closer examination and cleaning. Having found no evidence of a blockage, the valve was refitted. This however, did not solve the problem and after other obvious causes were eliminated, it was decided to recover the beam by other means.

The chosen method was to stop off the winch wire and unwind it from its existing drum and rewind it onto the Gilson winch via the block on the aft gantry. The beam could then be lifted over the bulwark between the gantry. This manoeuvre proved successful and was achieved without causing any further damage to the equipment. The guns were then removed and the beam stowed. Further fault diagnostics will be carried out on the beam crane winch in due course.

During deployment there were a number of gun sealing problems:

Gun 1 (fwd) 4.9 litre.

During priming the gun appeared to be leaking at the supply hose from the beam. On inspection the hose was damaged at the swaged coupling. The hose was replaced and the gun primed successfully.

Gun 2 (ctr) 2.6 litre.

This gun failed to seal after several attempts to prime it. The gun was stripped down and inspected. The fault was traced to a missing seal. A seal was fitted and the gun reassembled and primed successfully.

Gun 3 (aft) 7.6 litre.

The gun sealed first time with no problems.

The 2.6 1 airgun stopped firing during line

BAS945-S65. At the end of the line, the other two airguns were sealed and switched off, and the air pressure to the 2.6 1 airgun was bled down to about 40 bar. The 2.6 1 airgun started firing again, but when the other airguns were reconnected, the 7.6 1 one would not fire. The same procedure was repeated several times as problems with one airgun or another persisted throughout most of line BAS945-S66. Towards the end of the line it was concluded that two of the channels on the RVS airgun control unit were firing alternately, or sometimes not at all. It appeared that only one channel was providing an effective firing signal. We found that it was possible to trigger two guns from this channel, and a decision was taken to continue shooting with just the 4.9 1 and 7.6 1 airguns. At the start of the last line, BAS945-S68, the airgun control unit was replaced by a spare unit, also loaned from RVS, which had previously been used by BAS on RRS *Discovery* cruise 154 in 1985. All three airguns were brought back on line, but there were problems with erratic firing of the 4.9 1 airgun Eventually it was switched off. Towards the end of the line the 2.6 1 airgun failed, so the last part of the line was collected with only the 7.6 1 airgun still firing. During routine gun servicing, the 4.9 1 and 2.6 1 guns were inspected for possible faults. In both cases, the problems were attributed to faulty solenoids. The 4.9 1 gun solenoid had seized and the 2.6 1 gun solenoid had a broken core.

The amount of air required to fire even the three airguns on the beam could be supplied by one compressor, so the compressors were not severely tested during this cruise. The low pressure alarm in the UIC Room sounded every time the air pressure was bled down to try and restart a stalled airgun. Perversely, the only time it failed to sound was when the compressor in use stalled without warning on day 005.

7.6.4 ***Seismic Data Ptrocessing (A PC,RDL,LEV)***

The MicroMax seismic processing system was assembled prior to leaving Stanley and consisted of the following:

- Compaq 386/33Mhz CPU
- Wyse high-resolution monitor
- StorageTek 2925 tape drive
- Exabyte helical scan cartridge drive
- Epson LQl050 dot matrix printer
- Jilutech 60Mb parallel stream device

The MicroMax system was principally used to generate SEG-Y seismic tapes and process seismic reflection data acquired during the cruise.

Recovery and Transcription of Seismic Reflection Data

Seismic reflection data recorded during surveys across the east Scotia Sea and South Sandwich Forearc were initially transcribed to standard format SEG-Y field tapes. Data acquired using the BAS marine seismograph were written to SEG-Y by connecting the acquisition PC directly to the StorageTek 2925 tape drive and using the BACKUP and ABACKUP batch files (see section 7.6.1). Data recorded using the Carrack SAQ system were initially transferred to the MicroMax PC using the Jilutech parallel stream device. Individual DOS files were then concatenated using the DOS "copy/b" command and written to SEG-Y tape using the Datatrac tape handling software provided with the MicroMax system. Completed SEG-Y field tapes were verified by running tape analyses and reading a small number of traces back to disk. Both acquisition systems were connected to the ship's PC network and raw seismic reflection records were also copied to DAT tape either via the network server or directly using "Windows Agent" software. All SEG-Y field tapes generated during the cruise were copied to highdensity 8mm cartridges for archival purposes.

Seismic Reflection Data Processing

Seismic reflection data processing principally involved data testing, the generation of filtered near-trace gathers and the development of a strategy for the processing of common-mid-point (CMP) data. These activities are described below.

Raw shot gathers were initially read from the SEG-Y field tapes and examined on the MicroMax to enable an assessment of the quality and content of data acquired on each channel. All data recorded during the cruise were initially sampled at 2 ms and this sampling interval was preserved on processed seismic records acquired in the east Scotia Sea. However, some profiles acquired in very deep water had total trace lengths of 14 s after the restoration of recording delays (7000 samples at 2 ms sampling). It was necessary to resample these longer records to 4 ms due to restrictions on the maximum number of samples handled by the MicroMax system. Analyses of raw shot records showed that data quality varied significantly between individual channels and successive seismic lines as a result of instrumental problems described elsewhere in this report. The four data channels recorded on the Carrack SAQ system were improperly ordered on some lines and channel 2 appears to have been recorded with inverse polarity in all SAQ files. A fault that developed in the short streamer during acquisition also resulted in a contamination of lines BAS945-S51 to BAS945-S64 with random noise spikes as a result of cross talk from the depth section circuit. Efforts were made to manually remove spikes prior to the processing of some of these lines. A streamer fault also resulted in the loss of channels 3 and 4 on lines BAS945-S65 to BAS945-S68.

The MicroMax system was also used to check time information written to the seismic trace headers. Trace headers were examined to ensure that times were being recorded correctly as this information provides a means of generating UKOOA shotpoint navigation files when registered against geodetic position. Analysis of trace headers generated by the BAS marine seismograph during lines BAS945-S30 and BAS945-S31 showed that shot times did not increment correctly. Subsequent examination of the acquisition software source code revealed that the shot time is only updated when the menu which includes time is displayed on the PC monitor (see section 7.6.1). Examination of trace header times also revealed that trigger pulses taken from both the Electronics Lab signal generator and the MR1 acquisition system did not repeat at the precise cycle period intended. The Electronics Lab signal generator was set to generate trigger pulses at about 15 s intervals. However, analyses of seismic trace headers indicated an actual cycle time of approximately 15.15 s. Similar analyses also revealed that the MR1 acquisition system provided an imprecise trigger pulse with a cycle time approximately equal to 16.03 s when set to a 16 s cycle. These timing errors should be considered when generating shotpoint navigation data if mis-ties are to be avoided.

Spectral analyses were carried out on seismic traces taken from profiles BAS945-S30 and BAS945-S31 to determine the frequency characteristics of noise apparent in the water column. A power spectrum was computed using a 2 s window above the seafloor reflection which shows a peak in the water layer noise at approximately 7 Hz (Fig. 15). Low frequency noise of this kind is apparent on all data acquired at 8 knots and is attributed to a combination of swell and towing noise. Figure 15 also shows prominent spikes in the power spectrum at 51 Hz and 102 Hz. These spikes have been observed during previous cruises and are associated with the ship's cathodic protection system (RRS *James Clark Ross* Cruise JR04 Report, pp. 36). Spectral analyses were also carried out to determine the towing depth of the Geomechanique streamer by examination of the notch in the power spectrum associated with free-surface cancellation. Initial tests on traces taken from BAS945-S30 and BAS945-S31 indicated that towing depths increased along the streamer from 16 m (near channel) to 20 m (far channel), at a towing speed of 8 kts. This resulted in a reduction in seismic bandwidth and a noticeable stretching of the seabed wavelet with increasing offset. The towing depths estimated for lines BAS945-S30 and BAS945-S3 1 were considered unacceptably large and the streamer tow cable was shortened during subsequent deployments. Additional analyses carried out on line BAS945-S36 indicated that towing depths (at 8 kts) were reduced to 12 m (near channel) to 17 m (far channel).

Seismic data testing continued with the generation of test panels to determine an appropriate trace binning strategy. Seismic data were generally acquired in deep water (> 3km) and consequently the seabed wavelet showed little moveout with increasing offset in areas of subdued bathymetry. However, seafloor wavelets were offset in areas with appreciable in-line bathymetric relief and it was necessary to devise an appropriate binning strategy for these data. Test panels were generated consisting of near trace gathers, four-fold shot stacks (bin size set to 75 m) and two-fold CMP stacks (bin size set to 35 m). The four-fold shot stacks showed an appreciable enhancement of primary reflectors but also a loss of vertical resolution in the near surface which resulted from the summation of traces within a comparatively large bin (75 m). The two-fold CMP stack also showed an enhancement of primary reflectors but retained a greater vertical resolution than the shot stacks. A reduction in bin size also resulted in increased spatial sampling and an accompanying improvement in the performance of the Stolt F-K imaging algorithm applied after stack. The two-fold stack was therefore chosen as an acceptable compromise between the enhancement of signal-to-noise by stacking adjacent traces and the apparent reduction in seismic resolution with increasing bin size. The majority of the stacked data processed during the cruise have been binned in this way.

Tests were also carried out to determine an appropriate low-cut filter to suppress the low frequency noise apparent in the water layer. A series of filter panels were produced using low-cut filters with comer frequencies ranging from 7 to 19 Hz. These tests indicated that a low-cut filter with a corner frequency at 13 Hz (eliminating all energy below 8 Hz) partially suppressed the noise in the water column without adversely affecting primary reflectors apparent at depth and this filter has been comprehensively applied to data processed during the cruise.
Testing was also undertaken to determine appropriate deconvolution parameters. Autocorrelations were computed using traces taken from BAS945-S36 to identify periodicities associated with airgun bubble pulse reverberations. The first and second bubble pulse reverberations were apparent in the autocorrelations as prominent periodicities with lags of approximately 120 ms and 240 ms. A series of deconvolution test panels were then produced to determine an operator which most effectively suppressed the reverberations and these tests showed that statistical deconvolution before stack (DBS) partially suppressed airgun bubble reverberations throughout the seismic record. Operator design windows included the seabed reflection and near surface geology where primary reflectivity was most apparent. The operator considered most effective had a length = 300 ms, gap = 24 ms and 1.0% whitening and this has been applied to all stack data processed during the cruise.

Filtered near trace gathers were produced for all seismic reflection profiles following the completion of the pre-stack testing described above. Near traces were read from the SEG-Y field tapes and the original recording delays were restored. A bandpass filter (8-13-150-250 Hz) and a three-fold weighted trace mix (trace weights = 1,2,1) were then applied to the gathers which were typically plotted with 1 dB/s gain recovery. The filtered near trace gathers provided a quick and informative view of the subsurface shortly after acquisition. Two-fold CMP stack records were also produced for a number of seismic reflection profiles and merged CMP stacks were usually written to tape without display processing. However, time variant bandpass filters and a three-fold weighted trace mix (trace weights=1,2,1) were applied to some profiles after stack to enhance shallow-dipping crustal reflectors.

CMP stacked profiles BAS945-S32, BAS945-S36 and BAS945-s44 were also subject to post-stack imaging using a Stolt F-K time migration algorithm. Migrations were performed on overlapping CMP stacked sections which were trimmed and merged to remove ringing from the edge of the section. It was also necessary to remove noisy traces prior to performing the migration. Migrated time sections were initially generated using a uniform velocity field (1500 m/s) in the absence of reliable estimates of seismic velocity. This proved a simple and effective method of imaging seafloor topography and near-surface structures. Simple layered velocity models were also constructed to reflect an increase in seismic velocity with depth and time migrations were performed on profile BAS945-S32 using these models. Tests showed that the Stolt F-K algorithm commonly over-migrated events when using 100% RMS velocities calculated from a geologically reasonable interval velocity model and the velocities used in later models were lowered accordingly. Tests were also carried out to determine an appropriate value for the "W" parameter used by the Stolt algorithm and this parameter was generally set to 0.7 during subsequent migrations.

A summary of the processing procedures typically applied to CMP stack data generated during the cruise is listed below:

1. Recovery of 4-fold shot gathers from SEG-Y tape, resampled and edited as necessary.
2. Geometry assignment, station locations determined from trace header times, 66m shot interval, 33m CMP interval.
3. Restoration of recording delays.
4. Partial gain recovery (proportional to time).
5. Bandpass filter 8-13-150-250 Hz.
6. Statistical deconvolution before stack.
   operator length = 300ms
   operator gap = 24ms
   whitening = 1%
7. Common mid point sort and stack, 2-fold, 33m bins.
8. Stolt F-K time migration, using seawater velocity or simple layered velocity fields.
9. Time variant bandpass filter.
10. 3-fold weighted trace mix, 1,2,1 trace scalars.

Equipment Performance

In general, the MicroMax processing system performed well throughout the cruise. The Wyse high-resolution monitor failed during day 003 and this was replaced with a VGA monitor available as a spare for the Mk 4 Precision Echo Sounder. The C: hard disk on the MicroMax CPU became corrupted on day 010 after files were copied to the PC using the Jilutech parallel stream device. The machine was unable to reboot on the C: drive and it was necessary to gain access to the system by rebooting from the MicroMax field support diskette. The C: drive was then reformatted and the system was restored from a previous backup using the Datatrac tape handling software. The system then functioned normally for the time remaining. Corruption of this hard disk also occurred during a previous cruise (R.R.S. *James Clark Ross* Cruise JR04 Report, pp. 37) and we consider similar problems likely in the future unless the hard disk is replaced.

7.7 Data Logging

Underway Data Processing (RJH)

7.7.1 Bathymetry

Before MR1 was deployed on day 006, along-track bathymetry data was obtained from both the Simrad EA500 echo sounder and the IOS 10 Khz PES system. Simrad data was logged by the ABC logging system every 8 seconds. PES data were not logged directly, although a written record was made every 5 minutes into the bathymetry log-book. The Level B repeater in the UIC room was used by watchkeepers to check the Simrad data as it was collected. It was noted that there were periods of several minutes when the Simrad would lose contact with the sea bed and no data would be logged. Large scale variations of tens of metres were also noted between successive records. A typical record of the Simrad data over a two day period (003-005) is shown in Fig. 16. The poor quality of this data meant that for the initial transit period (days 002 - 006) the final bathymetry file would be made up of the 5-minute interval, manually-recorded data taken from the PES. As on previous cruises, these data were entered manually into the ABC logging system using the Level C routine **mandep,** and later interpolated onto a 2 minute interval using the Level C routine **interp.**

Soon after the initial deployment of MR1 on day 006 it was found (perhaps fortunately) that the EA500 signal showed up as interference on the sidescan sonar record as did that of the 10 kHz PES. Along-track bathymetry is recorded automatically by MR1. These data were interpolated at 2 minute intervals and entered into the ABC logging system (see section 7.2.1). Spikes in the data were edited out (i.e. given a 'suspect' status) using the graphical editor in Level C. Once edited, a Carter Area correction was applied to the raw depth data using the level C routine **prodep.**

As a backup, the depth to sea bed was recorded routinely every 5 minutes into the watchkeeper's bathymetry log book.

7.7.2 *Proton Magnetometer Data*

Data from the Varian magnetometer was logged into the stream **magnet** every 6 seconds. The raw total field data was routinely edited using the level C graphical editor to remove spikes by giving them a 'reject' status. It was noted that on steep magnetic gradients the magnetometer's Level A had given data a 'suspect' status. When this occurred a 'Change too big' error was displayed on the UIC level B monitor. We were not able to reconfigure the Level A with a higher threshold for differences between successive data samples. As a result, all the raw data had to be given a 'good' status, using the Level C routine edstats, before using the graphical editor. After editing the total field data were converted to magnetic anomaly using the level C routine **promag90.**

7.7.3 Gravity Data

A more detailed description of gravity processing is given in section 7.4. It was realised on JR04 that the effect of selective availablity of GPS data was to produce large errors in the calculated Eötvös correction. To correct for this GPS data was averaged over a four minute interval and subsampled every 15 minutes. Relative motion data from the gyro and Doppler log were then used to dead reckon the ship's track between this 15 minute 'fixes' (see section on Navigation 7.1). This produced a marked improvement in the quality of the free-air anomaly data. On a previous Birmingham University cruise, the scientific party had attempted to improve the free-air data by averaging the Eötvös correction, using a moving 5-minute window. However, when this technique was tried, using their routine, it found that the correction was slightly out of phase with the actual motion of the ship. We believe this may be the result of placing the averaged Eötvös correction values at the end of each window rather than at the centre. We did not have the time to alter the code of this averaging routine, so went back to using the tried and tested method from JRO4.

Back-processing of these data was done at various stages throughout the cruise. The Level

C routine **prograv** normally expects to calculate a Bouguer Anomaly using the data from the processed depth stream **prodep**. However, as these data were not available until the latter stages of the cruise, pmgrav was reconfigured so that Bouguer anomalies would not be calculated.

7.7.4 *Level C Data Processing*

RVS were contacted on two occasions. The first was about their new MGD77 file utility, which was producing output which deviated from the MGD77 standard by putting data in the wrong columns. This made it impossible to pass to the post-processing software.

They were also contacted about the gravity processing program **prograv**, where it was felt that the Eötvös correction was being applied at the wrong point.

Some UNIX shell scripts were written to avoid repetitive typing of commands and to speed up plotting. Examples are given in Appendix 3.

7.8 **Computing** (GB)

Initial problems

After a delayed arrival on the JCR, it was discovered that there were outstanding computing problems to be solved :

1. The ArcServe PC backup software had been disabled by people travelling back to Stanley from bases.
2. The VAX startup sequence had been altered, giving no LAT networking without manual intervention
3. The NFS software for mounting VAX files on the UNIX file system had been overwritten during an upgrade in the summer
4. Most printers were not working. Some had been hard wired to PCs by people travelling back from bases.
5. WordPerfect Office was not forwarding e-mail to sendmsg. Also some directories were set up for a Cambridge configuration - the database file was not being located by the software.
6. Vista exceed was not working as in Cambridge.
7. Some level C software needed attention before being acceptable by the users - navigation and MGD77 utilities.
8. Utilities written on previous cruises (shell scripts) had been deleted.
9. The export of the Geophysics database was not compatible with the ship's version of Oracle.
10. Some files were missing from the new GKS drivers brought from Cambridge.
11. The export of the Chief Scientist's files was incomplete.
12. The Captain wished to see ALL outgoing messages (except personal), not just the ones sent to him for releasing.

Most of these problems were resolved during the Cruise.

Security

The newly installed PC networking software, Netware, allowed backups of PCs to be made directly to tape for the first time (over the network). This helped during the early part of the cruise where seismic data were being collected in large quantities by PCs. The networking software allowed speedy backups to be made before data was deleted from disk.

Also for the first time, user's PC files could be brought from Cambridge and loaded on the ship's Server. This was a very useful and popular service but could lead to a shortage of disk space if everyone required all their files at the same time.

The 3 communal PCs were backed up on a daily basis - internal C: drives, were done when not being used and network (server) drives every night. A Parent - Child strategy was used - child tapes being recycled after one week and parent's after 3 weeks. This allowed recovery of accidentally deleted files by 3 methods - Microsoft "undelete", Netware “salvage” and backup tapes (for up to 3 weeks). Virus checking and disk integrity were continually monitored.

The ABC logging and processing System was covered by archiving of all level B tapes plus “tars” of pro-data and raw-data.

VAX files were backed up using a Parent - Child strategy of 3 and 2 weeks respectively. No additional backups of Oracle were made as the Geophysics database (loaded from an archive) was not being written to. Single user, (standalone) backups of the VAX System disk were carried out once a week.

Network

The unfortunate discovery (a few days before the ship left Grimsby) that both Netware versions 3 and 2 were required, led to the ship being split into two physical networks - the Officer’s and the Scientists. As the Chief Scientist’s cabin is on the Bridge deck, he was limited to terminal server access to the main scientific and messaging computing resources.

The Radio Officer and the Catering Officer also had their PCs cut off from the main PC network during reconfiguration. During the Cruise, however it was possible to re-install their link and issue them with WordPerfect Office and full printing services.

This main PC network, along with printing services are now dependent on the Sun Sparc 20 and the Novel Server being kept running (which is not usually the case when there are no Scientists on board). A policy for providing non-Scientific shipbome computing needs to be thought through to avoid the situation where people in transit do not have to hard wire to printers and change settings.

One big disappointment of the new installations was the ArcServe PC backup software. There are two major problems with the current version (v5.0). When a restore (from tape to server) is made the PC network becomes unusable. This is a serious problem as PCs now rely heavily on the network for most applications and file space. The other problem with ArcServe is with its database. The database is used for keeping a record of the contents of all tapes and save-sets - information is not held on the tapes themselves. The database appears to corrupt itself after few days use. The same problem, apparently occurs in Cambridge. ArcServe should therefore be upgraded or replaced as soon as possible.

Another aspect of networking that has changed this year is that the ship is now (indirectly) connected to the Internet (and potentially in excess of 30 million users). The BAS policy of Airletters, circulation of messages at HQ and Releasing Officers needs urgent reviewing.

The U_GEOPHYS VAX files and directories were mounted on all 3 (non-logging) UNIX tile Systems giving easier access to files across platforms.

The HP650c Plotter has proved a great success although at the moment it is necessary to manually specify the plotting language (HPGL, HPGL2 or Postscript) from the front panel. The automatic mode does not work with the level C HPGL filters, although this might be remedied later. The amount of memory, 20 Mbytes was sufficient for most work although on a couple of occasions it was not enough. The nesting function (ability to plot several x/y graphs alongside each other) proved a useful feature.

The new Sun Newsprint A3 colour inkjet printer gave considerably more problems with the manufacturer admitting that it will not perform as specified until new software is written.

8 Recommendations

Major Items

1. It was agreed unanimously by scientists and engineers that the RRS *James Clark Ross* is an outstanding research vessel, operated to high professional standards. It is regrettable that she lacks her own geophysical equipment, as she would otherwise rank amongst the most desirable platforms for academic marine geophysics in the world. The major omission is, of course, the absence of a modem, wide-swath, multibeam echo sounder, which could be used routinely during all scientific cruises, and on passage, to provide continuous improvements in bathymetric base maps. These maps, in turn, would provide the foundation for tectonic studies and for detailed planning of future projects. All possible avenues for the funding of such a system should be explored.

2. The seismic reflection profiling element of the cruise suffered badly from the poor condition of RVS-supplied equipment, resulting in the loss of data over crucial parts of the survey, leading eventually to a decision to curtail seismic work early in the cruise. The establishment of a complete BAS-owned small seismic system would have great benefit. A new, BAS-built seismic recording system was proven during JR09, and this could be combined with a selection of airguns of modem design, streamer and gun control electronics, to produce a self-contained system at modest cost. Alternatively, sources of hired equipment other than RVS should be explored. The value of ship time lost as a result of inadequate instrumentation, as happened on JR09, should be included in any costings.

3. Similarly, the RVS-supplied magnetometer was very elderly, and was supplied with a cable too short for the ship (200m as against 300m necessary to avoid ship's noise), one noisy sensor and a defective Level A, which prevented automatic logging until day 005 of our cruise. Purchase of a new total field magnetic gradiometer, together with spare sensor and cable/winch should be investigated by BAS.

4. The results of our operation of the STCM demonstrated that construction and fitting of such a device to BAS ships would be cost-effective, in smuch as it would allow the collection of data from all cruises and transits, in all ice conditions, without the need to deploy towed gear. It is recommended that construction of a system, based on the Japanese STCM, be commenced forthwith.

Seismic A cquisition

1. Having pre-serviced guns available enabled a quick changeover between breakdowns, giving a cycle time of approximately 30 minutes from recovery to recommencement of the firing. The estimated time to strip down and service a faulty gun can be between 2 to 3 hours, assuming no further resealing problems occur during redeployment. One spare gun for every beam in operation is recommended.

2. The beam wiring and air hose arrangement needs to be improved. At present, the system is extremely labour intensive to set up and causes long delays when problems occur. Beam setup and breakdown times could be dramatically reduced if the system was easier to dismantle, and would result in a reduction in the use of expensive consumables. The current umbilical/beam interface could also be improved. The present design is arranged so that the polyurethane fairing is clamped into the end of the beam. The cables and hoses from the umbilical must then be connected up to mating hoses running along the inside of the beam, an intricate and time-consuming operation. The design also offers very little strain relief to the individual hoses and cables, which often migrate up the inside of the umbilical outer skin. The proposal is to modify the beam, so that the beam end is permanently attached to the umbilical fairing. This could then be very quickly bolted to the rest of the beam during mobilisation or breakdowns, and would also offer strain relief to the hoses and cables, as well as preventing them from migrating inside the umbilical outer skin.

Computing

1. The working conditions in the data-prep room are now very crowded and it is perhaps time for a full re-think on the layout. This also applies to the computing office. At the moment, too much space is given to printers and machines that do not require it such as file and mail servers. These machines could possibly be stacked on shelves to make more user space.

2. Three communal PCs (albeit 66MHz 486s) for all Scientists, Administrators and Designers is grossly inadequate for a ship of the JCR's size.

3. A new, faster, black and white, A4 laser printer would be particularly useful, especially if it could automatically determine printing language. A laserjet 4 as in Cambridge would fit the bill as this would have the added advantage of not requiring a VAX or Sun server (if fitted with a network card).

4. The HP650c Plotter was such a success that it would now be difficult to manage without it. A full set of spares should therefore be carried in case of breakdown during a cruise.

The following 5 points were included in the last cruise report (JR06 - Predator / Prey) but are still relevant, especially the first two.

5. More time needs to be allowed for people supporting cruises to set up; in addition, if the same people were made responsible for satisfying the requirements of the cruise, accountability would be simplified.

6. Formal handover - A lot of the early problems were caused by lack of information about what happened on the previous cruises and transits.

7. More disk space - requirements for disk space are increasing almost as quickly as requirements for more processing power. This applies to all platforms.

8. Better management of individual user accounts on Suns - at present it appears that new users on the VAX are better catered for in terms account management.

9. The shortage of network ports in the UIC room should be addressed immediately - if necessary using the short term solution of a "Black Box" expander device. There is also a shortage of suitable AUI drop cables on the ship.

10. Printer drivers for WordPerfect should be provided with PC installation as they give much better results than the general purpose Windows drivers. This would allow selective double-sided printing and save paper.

Appendix 1

ASHTECH 3D GPS SETUP

Screen 4

Alt known	N
Ranger	0
Unhealthy SV's	N
Rec int	001
Min N°SV	2
Elev mask	10

Att'd Control

Max MRMS	010mm
Search Ratio	0.5
3 SV search	N
One Second update	Y

Kalman filter	Tau	To	Q	R
Heading	999	000	$1.0e^{-2}$	$1.0e^{-2}$
Pitch	20	000	$4.0e^{-2}$	$1.0e^{-2}$
Roll	20	000	$4.0e^{-2}$	$1.0e^{-2}$

Att'd setup

1-2 vector	+2.943	+4.745	+O.OOO
1-3 vector	+11.493	+4.793	-0.006
1-4 vector	+13.222	+o.ooo	+o.ooo
offset	0	0	Ø
Max cycle	0.2		
Smoothing	N		
Max Magnitude	0.080		
Max angle	20		

Port A setup

NMEA	off
Real Time	off
Baud rate	9600

Port B setup

NMEA	off		
Real Time	off		
Baud rate	4800		
	Options	PAT	on
		Update 1s	

Appendix 2

4-CHANNEL SEISMIC REFLECTION LINES

LINE	TIME (GMT)	LATITUDE	LONGITUDE	DIST. (KM)
945-S30	17241004	56°30.0' S	36°00.0' W	123
	0219/005	56°30.0' S	34° 00.0 w	
945-S31	05 13/005	56° 51.0'S	34°00.0' w	122
	12491005	56°51.0'S	36°00.0' W	
945-S32	19541005	57°04.2' S	36°00.0' W	485
	0320/007	57°04.2' S	28°00.0' W	89
	1015/007	56°52.5' S	26° 34.9' w	
945-S33	16381007	56°53.6' S	26°48.8' W	16
	17491007	~~57° 23.9' S~~ 56:8593	26°55.45 W	
945-S34	15 131008	57°23.9' S	24°41.4' W	99
	2131/008	57°39.0' S	26°16.5' W	
945-S35	22391008	57° 31.2'S	26°20.4' W	155
	0823/009	57°09.6' S	23° 51.2'W	
945-S36	09241009	57°01.8' S	23°55.1' W	155
	20071009	57°23.4' S	26°23.7' W	
945-S37	0335/010	57°07.8' S	26°31.4' W	150
	1414/010	56°46.9' S	24°08.6' W	
945-S38	1525/010	56°39.1' S	24°12.4' W	150
	0101/011	57°00.0' S	26°34.7' W	
945-S39	0135/011	57°00.0' S	26°34.7' W	30
	03221011	56°44.4' S	26°42.4' W	
945-S40	032210 11	56°44.4' S	26°42.4' W	65
	0745/0 11	56°35.3' S	25°41 .0' W	
945-S41	0745/011	56°35.3' S	25°41.0' W	128
	1621/011	57°32.0' S	24°28.0' W	
945-S42	1645/O 11	57°32.0' S	24°28.0' W	31
	1852/011	57°27.0' S	23°58.0' W	
TOTAL THIS PAGE				1798

LINE	TIME (GMT)	LATITUDE	LONGITUDE	DIST. (KM)
945-S43	1900/011	57°27.0' S	23° 58.0' W	60
	23261011	56°56.5' S	24° 18.5' W	
945-S44	23451011	56° 56.5' S	24° 18.5' W	237
	16351012	57° 30.0' s	28° 06.0' W	233
	1020/013	57° 30.0' s	32° 00.0' W	
945-S45	1117/013	57° 23.5' S	32° 00.0' W	140
	2108/013	57° 23.5' S	29° 40.3' W	
945-S46	2210/013	57° 17.1'S	29° 40.3' W	80
	0406/014	57° 17.1'S	30° 59.9' w	
945-S47	0515/014	57°10.6' S	30° 59.9' w	80
	1059/014	57°10.6' S	29° 40.5' W	
945-S48	12561014	56°57.7' S	29° 40.5' W	100
	2017/014	56°57.7' S	31° 19.2' W	
945-S49	21031014	56° 51.2'S	31° 19.2' W	80
	02431015	56°51.2'S	30° 00.5' w	
945-S50	03471015	56° 44.7' S	30° 00.5' w	80
	1039/015	56° 44.7' S	31° 18.9'W	
945-S5 1	1147/015	56° 38.3'S	31° 18.9' W	80
	1751/015	56°38.3' S	30° 00.7' w	
945-S52	1920/0 15	56° 31.8'S	30° 00.7' w	80
	0113/016	56° 31.8'S	31° 18.7' W	
945-S53	020510 16	56°25.3' S	31° 18.7' W	80
	0841/016	56°25.3' S	30° 00.9' w	
945-S54	1007/016	56° 18.9' S	30° 00.9' w	80
	1547/0 16	56° 18.9'S	31° 18.5' W	
945-S55	1652/016	56°12.4' S	31°18.5' W	100
	23571016	56°12.4' S	29° 41.8' W	
945-S56	0054/017	56°06.0' S	29° 41.8' W	100
	0818/017	56°06.0' S	31° 18.2' W	
TOTAL THIS PAGE				1610

LINE	TIME (GMT)	LATITUDE	LONGITUDE	DIST. (KM)
945-S57	0910/017	55° 59.5' s	31° 18.2' W	120
	1757/017	55° 59.5' s	29° 22.9' W	
945-S58	1903/0 17	55° 53.0' s	29° 22.9' W	120
	03491018	55° 53.0' s	31° 17.9' w	
945-S59	0447/018	55°46.5' S	31° 17.9' w	145
	1508/018	55° 46.5' S	29° 00.0' W	
945-S60	1609/0 18	55° 40.1' s	29° 00.0' W	145
	02361019	55° 40.1' s	31° 17.6' W	
945-S61	03331019	55° 33.6' S	31° 17.6' W	145
	1415/019	55° 33.6' S	28° 59.7' W	
945-S62	1515/019	55° 27.1' S	28° 59.7' W	145
	0120/020	55° 27.1'S	31° 17.2' W	
945-S63	02 1 l/020	55° 20.7' S	31° 17.2' W	145
	1142/020	55°20.7' S	29° 00.1' W	
945-S64	12371020	55° 13.8' S	29° 00.1' W	72
	16401020	55° 15.0' s	30° 08.4' W	
945-S65	18 15/023	55° 10.8' S	29° 48.4' W	58
	23201023	55° 10.8' S	28° 54.0' W	
945-S66	0030/024	55° 17.3' s	28° 54.0' W	38
	04 11/024	55° 17.4' s	29° 30.0' W	31
	0705/024	55° 29.5' S	29° 50.1' W	22
	09 1 0/024	55° 41.6' S	29° 51.3' W	
945-S67	09 1 0/024	55° 41.6' S	29° 51.3' W	30
	1200/024	55° 45.5' s	30° 19.0' w	
945-S68	12001024	55° 45.5' s	30° 19.0' w	71
	18431024	56°24.0' S	30° 22.5' W	21
	20351024	56°24.5' S	30° 43.0' w	63
	02281025	56°58.0' S	30° 42.8' W	
TOTAL THIS PAGE				1371
TOTAL				4779

Appendix 3

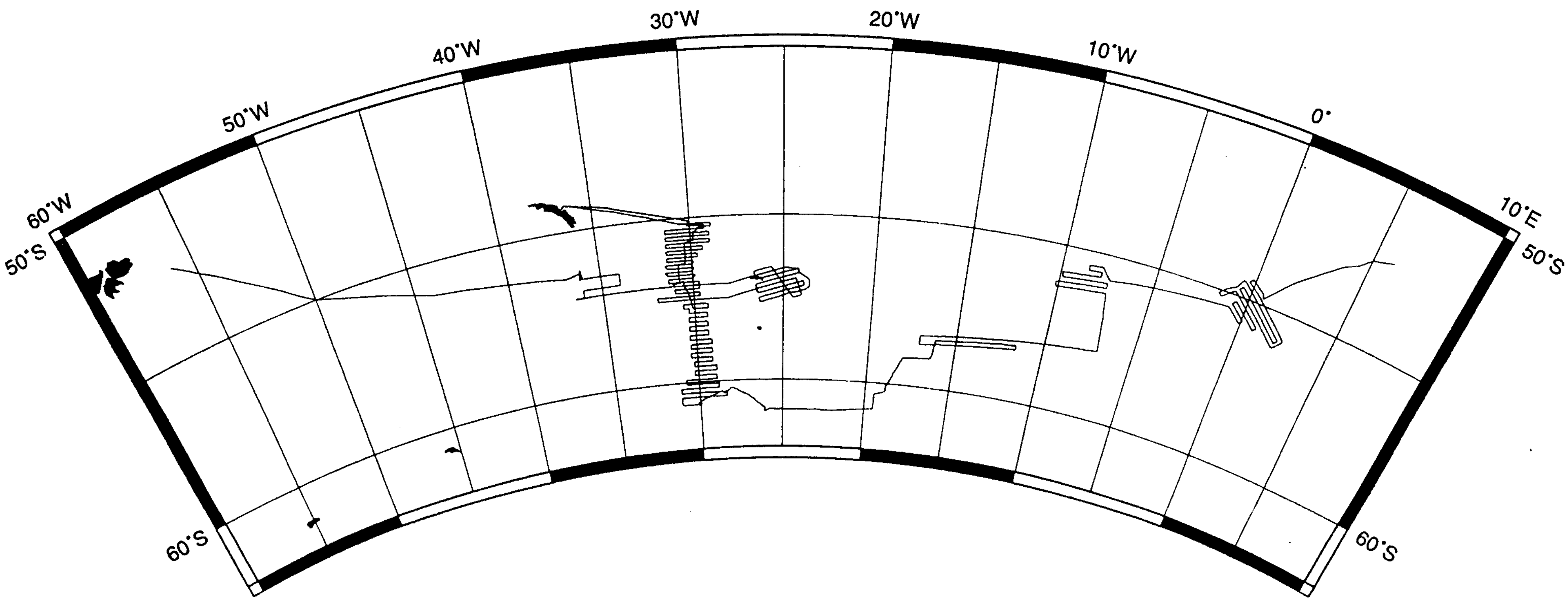
SHELL SCRIPTS

Example I

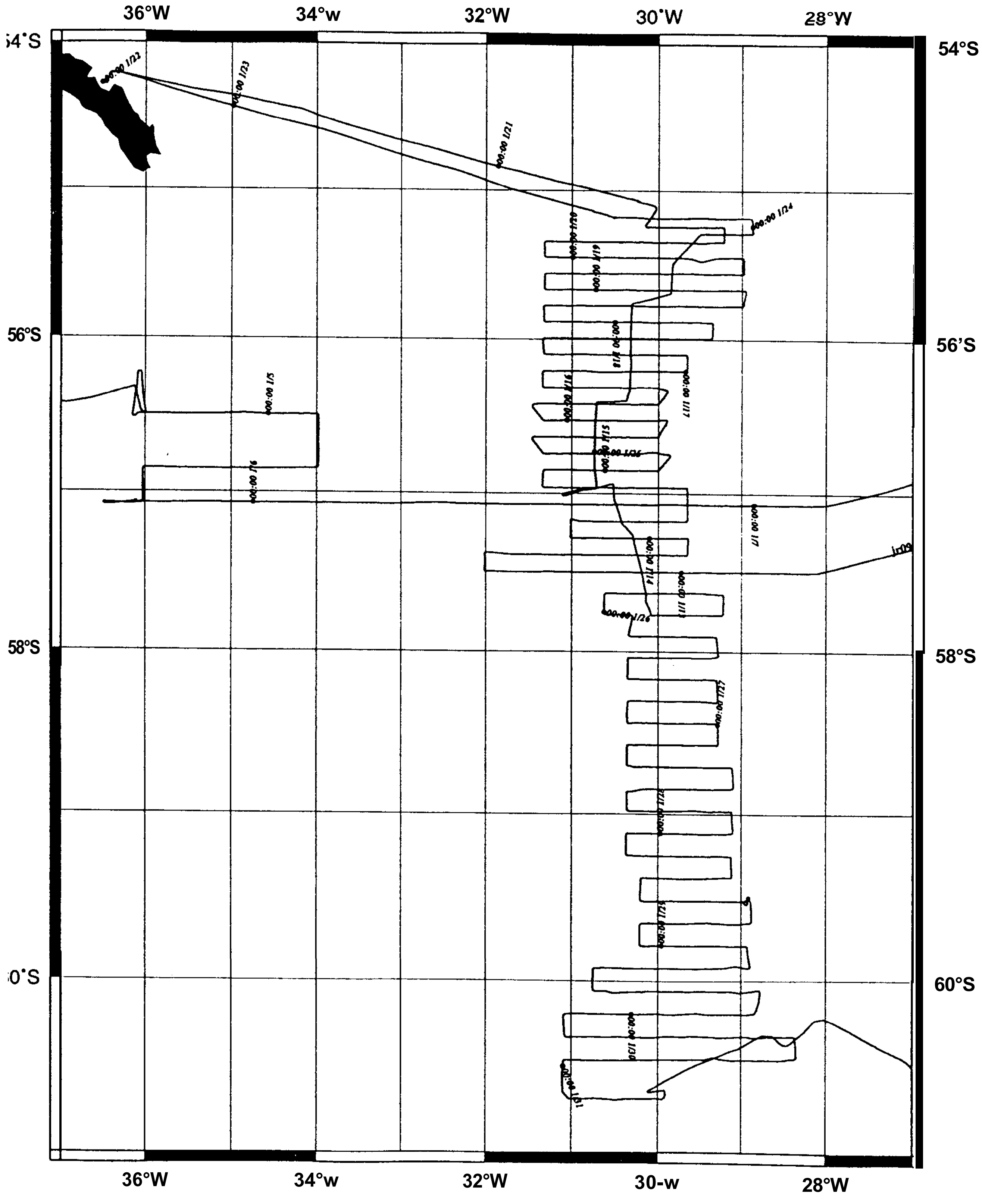
```
##################################################################
#
# Name :          nest
# Purpose :       Designed to make daily plotting of Gravity, Motion
#                 and Magnetics on the HP650c Plotter easier.
# Author :        Graham Butcher
# Date :           15th Jan 1995
# Updates :       None - original code
# Files required (3 of):
#
#  1.             name.grav.xy
#  2.             name.motion.xy
#  3.             name.mag.xy
#
# Produces a 4th, 5th & 6th files :
#
#  4.             name.grav.xy.dip
#  5.             name.motion.xy.dip
#  6.             name.mag.xy.dip
#
# Then goes ahead and "cat"s the 3 files through an hpgl filter
#   to give 3 more files :
#
#  7.             name.grav.hpgl
#  8.             name.motion.hpgl
#  9.             name.mag.hpgl
#
# These are finaly sent to the plotter for "nested" plotting
#   ie the 3 plots are plotted in a line. NB The plotter must
#   be set to nested plotting for this to happen.
#
#################################################################
#
tplot  ($1}.grav.xy > ($1).grav.xy.dip
tplot  {$1}.motion.xy > ($1).motion.xy.dip
tplot  {$1}.mag.xy > ($1).mag.xy.dip
cat  ($1).grav.xy.dip| hpgl  > ($I).grav.hpgl
cat  ($1).motion.xy.dip | hpgl  > ($1).motion.hpgl
cat  ($1).mag.xy.dip| hpgl  > ($1).mag.hpgl
lpr  -Php650c ($1).grav.hpgl
lpr -Php650c  ($1).motion.hpgl
lpr  -Php650c ($1).mag.hpgl
#
echo ""
echo "The 3 plots - $1 gravity, motion and magnetics are on their"
echo ' way to the HP650c  Plotter"
echo ""
exit
#
#################################################################
```

Example II

```
########################################
#
# Name :            trackplt
# Purpose :        Designed to make Ship's track plotting easier
# Author :         Graham Butcher
# Date :            16th Jan 1995
# Updates :        None - original code
# Files required (2 of):
#
#  1.              name.grd
#  2.              name.trk
#
# Produces a 3rd and 4th files :
#
#  3.              name.grd.dip
#  4.              name.trk.dip
#
# Then combines them and "cat"s the result to the hp650c Plotter
#
#################################################################
#
gridplot {$1).grd > {$1}.grd.dip
trackplot {$1}.grd {$1}.trk > {$1}.trk.dip
cat {$1}.grd.dip {$1}.trk.dip| hpgl > {$1}.trk.hpgl
lpr -Php650c {$1}.trk.hpgl
#
echo ""
echo "Plot $1 is on its way to the hp650c Plotter."
echo ""
exit
#
##########################I+############
```



GMT May 15 15:34 **Figure 2 JR09a Track Summary**



May 15 15:35 Figure 3 Area A tracks. Time is shown every 24 hours

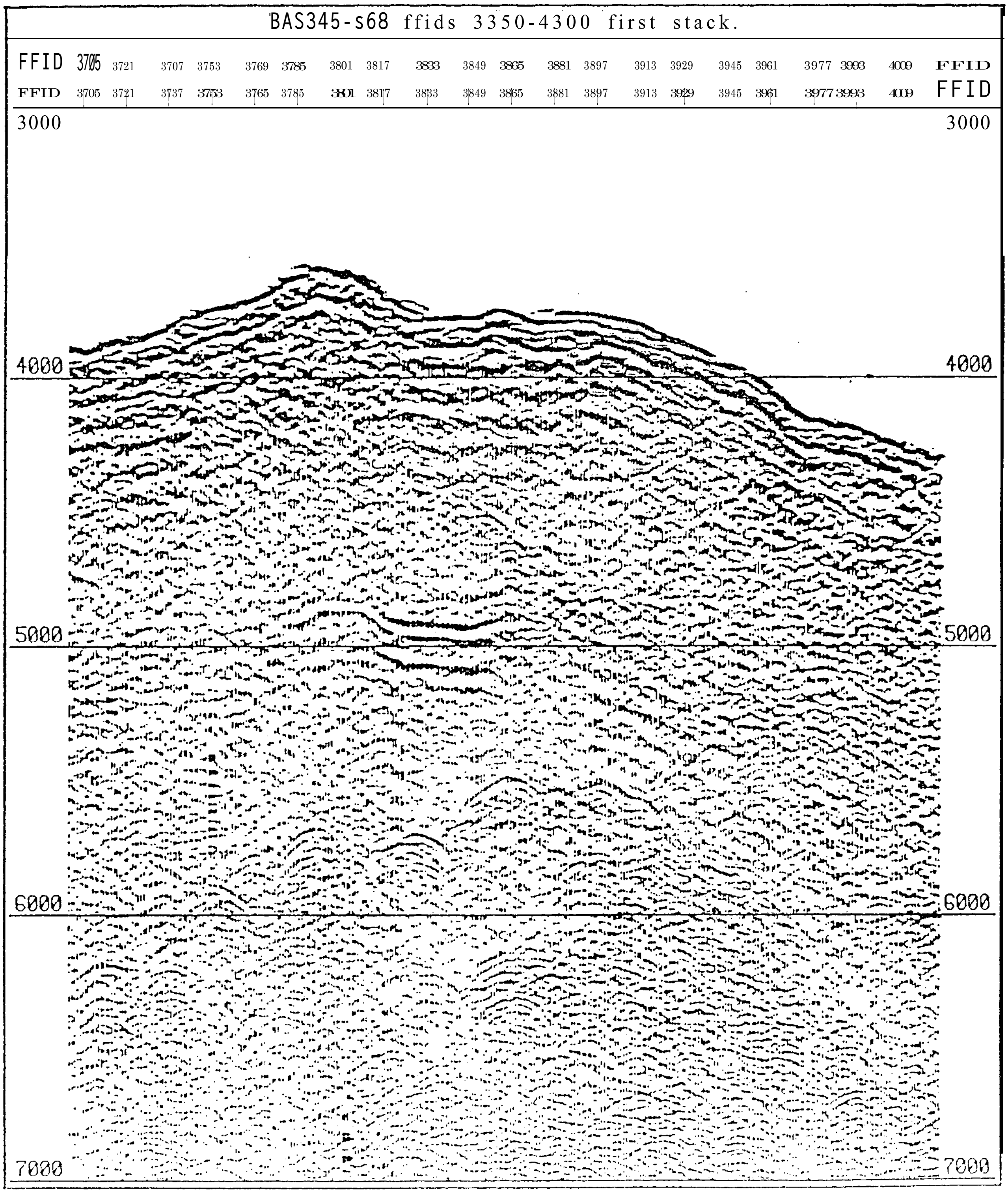
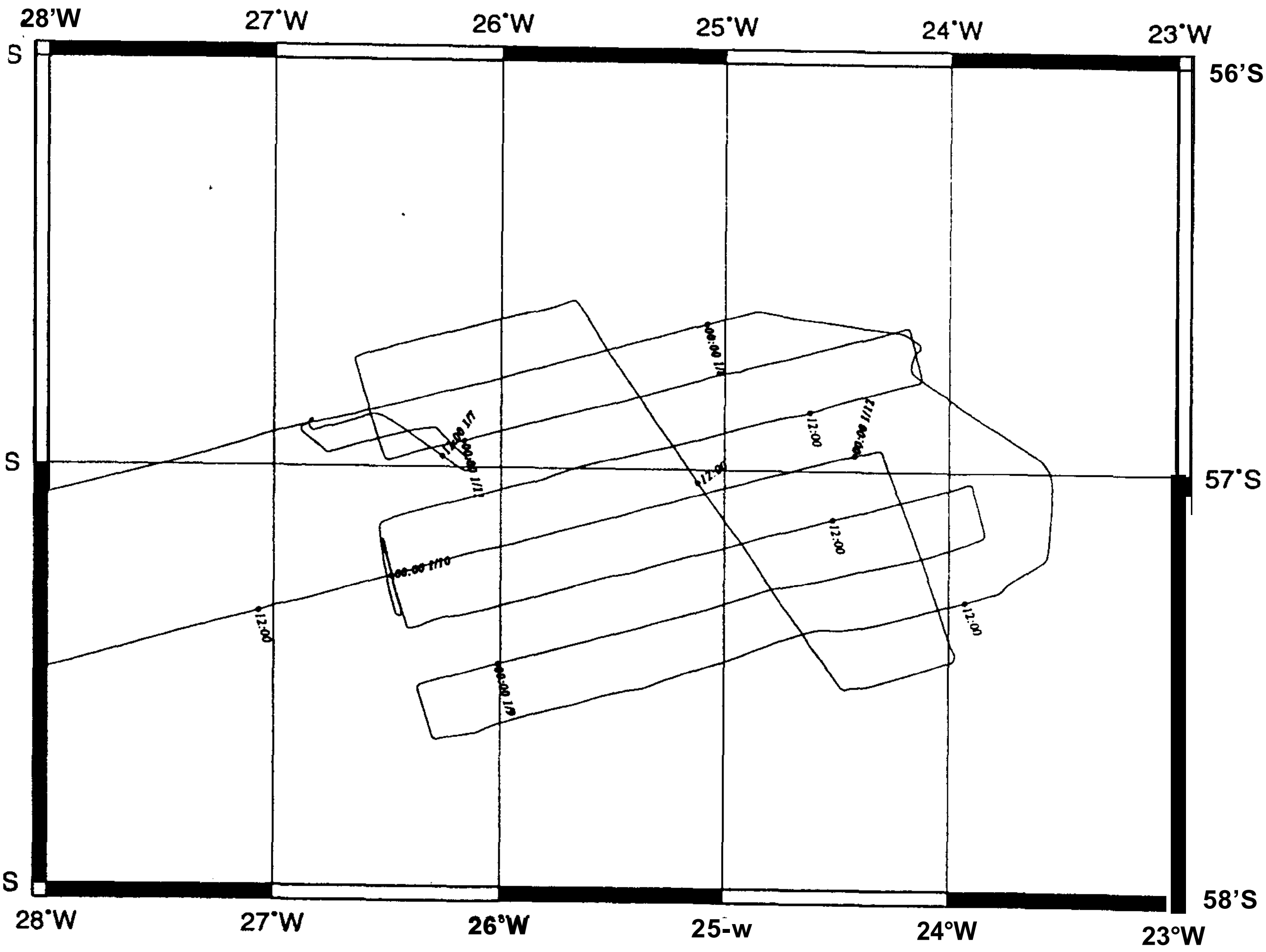


Figure 4 Section of seismic reflection profile along northern East Scotia ridge axis.



ly 15 15:42 **Figure 5 Area B tracks**

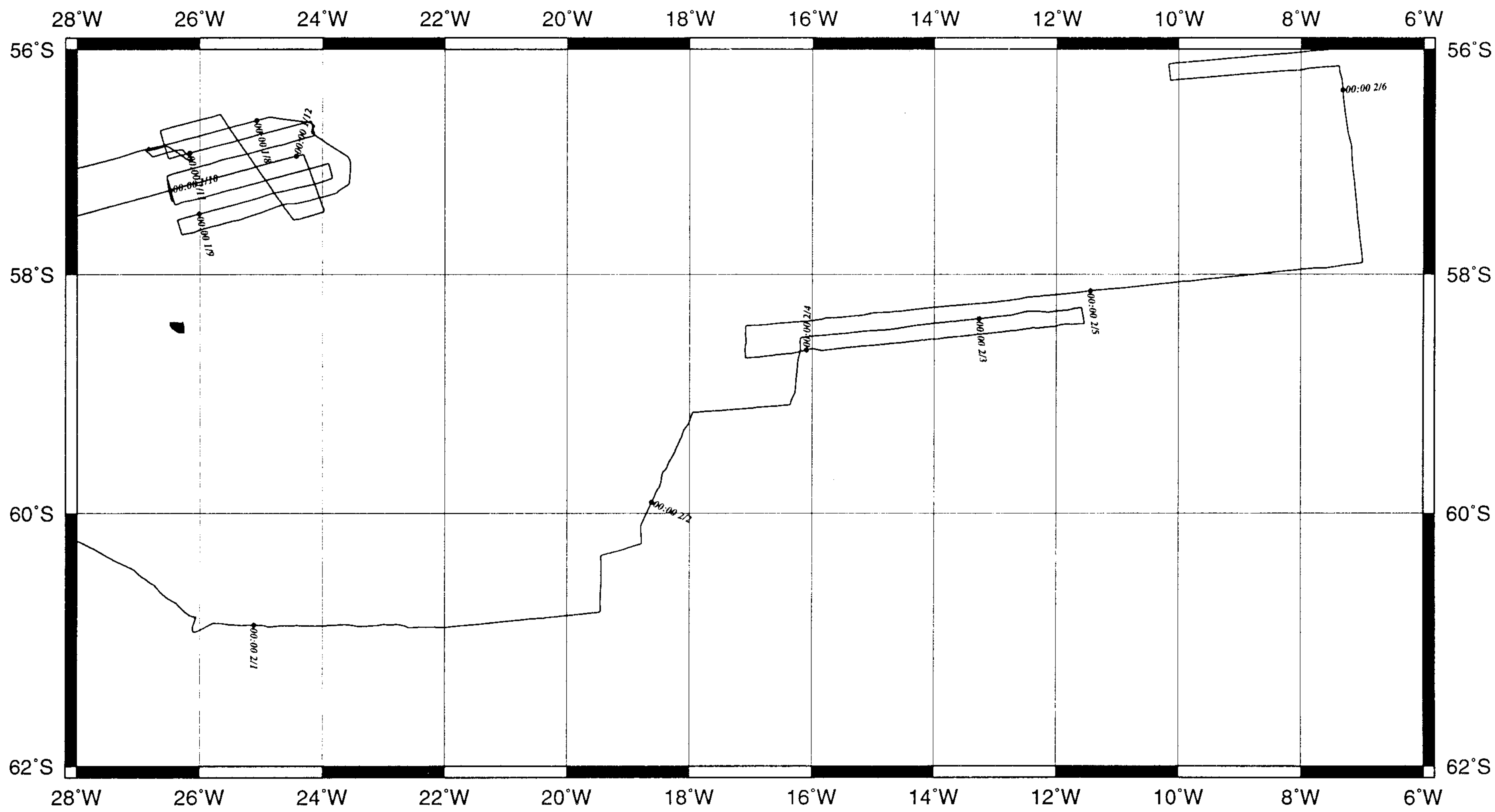


Figure 6 Area B (South Sandwich Forearc) and Area C (South American - Antarctic Ridge) surveys

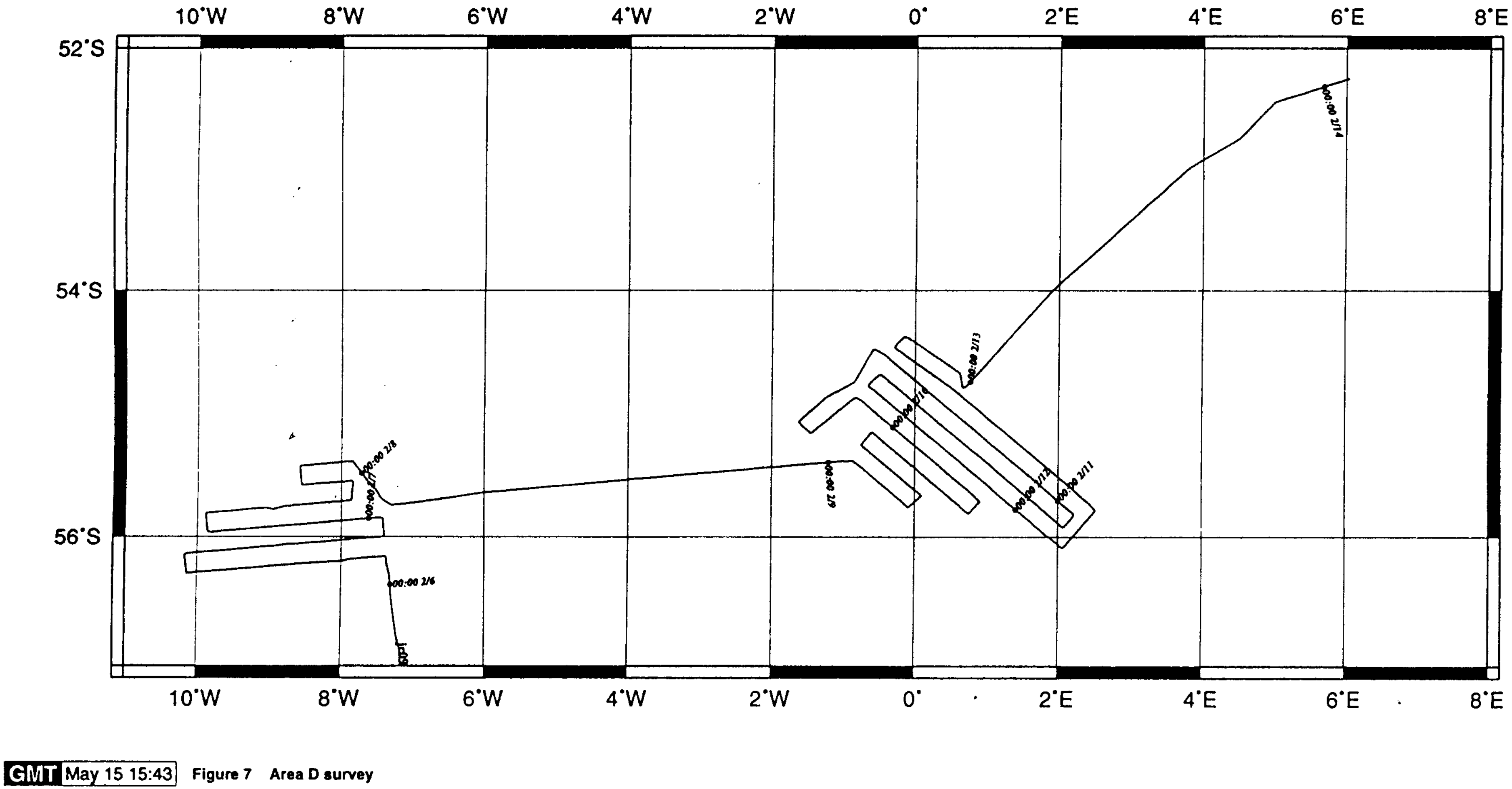
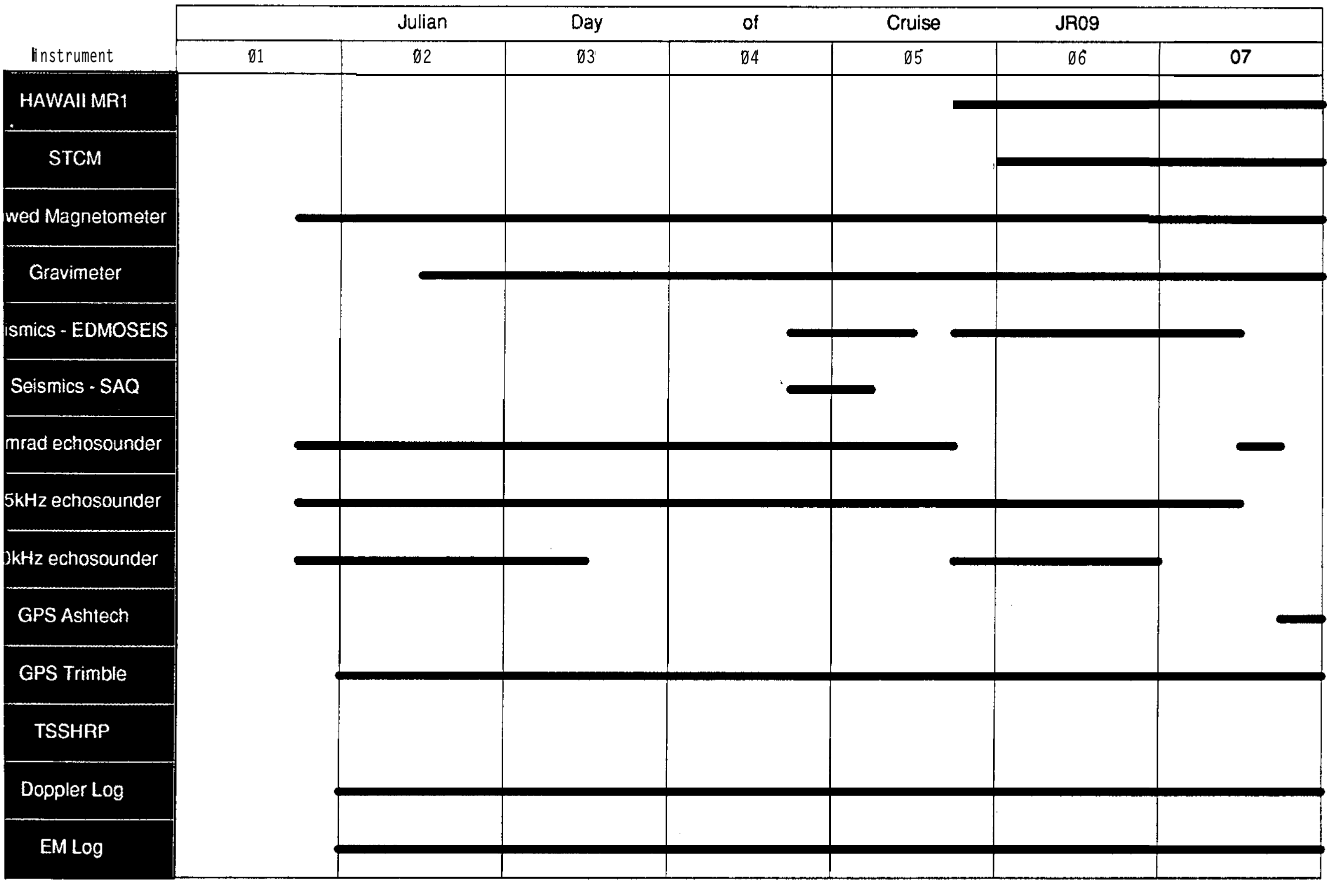


Figure 7 Area D survey

Figure 8 Equipment operation summary - each day is separated into quarters, and a line appears on the chart where an instrument was operating for the majority of the six-hour period. At the end of the chart, total operating time is given for each instrument.


Julian Day of Cruise JR09
Instrument
01
02
03
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06
07
HAWAII MR1
STCM
wed Magnetometer
Gravimeter
ismics - EDMOSEIS
Seismics - SAQ
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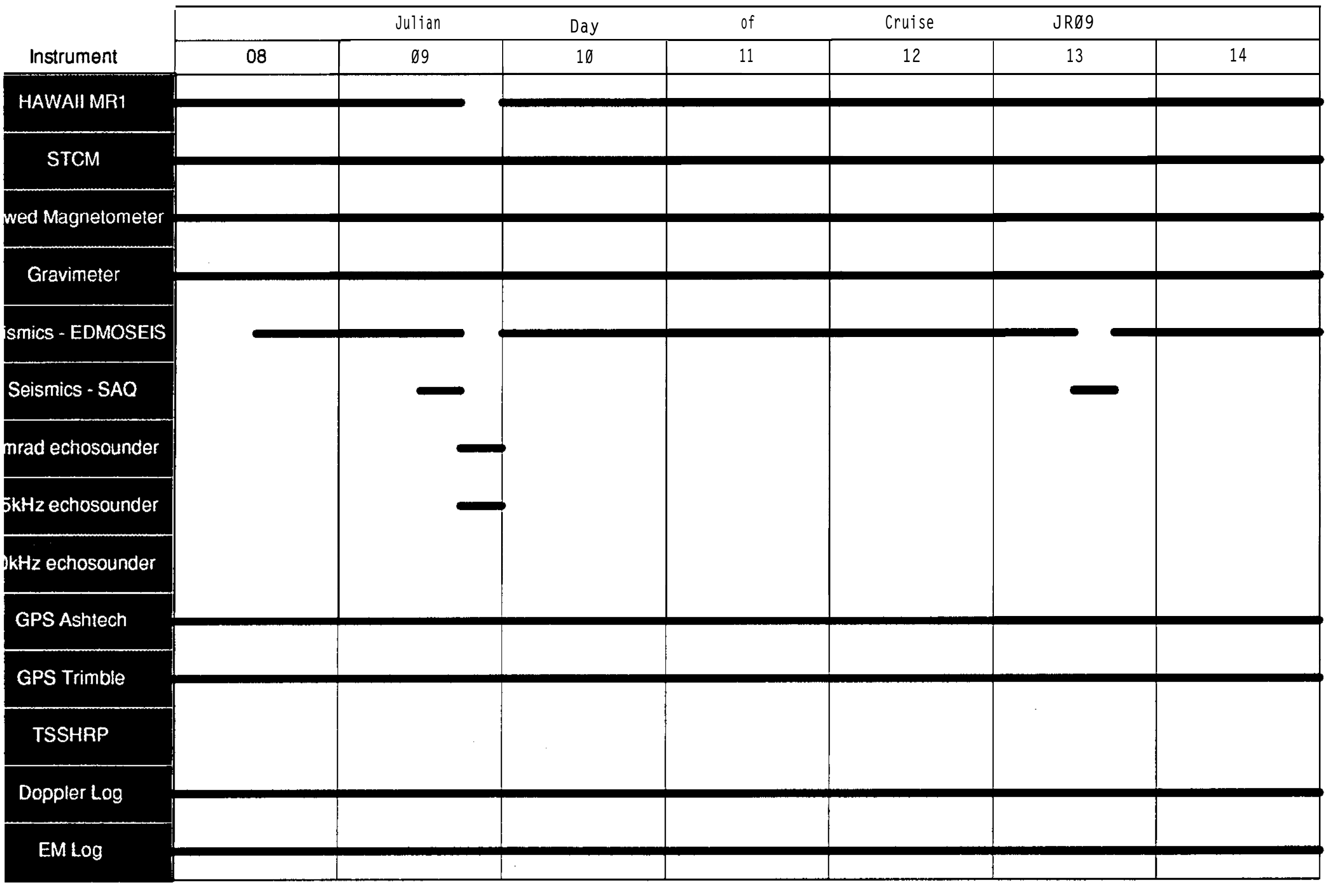
)kHz echosounder
GPS Ashtech
GPS Trimble
TSSHRP
Doppler Log
EM Log


Julian Day of Cruise JR09
Instrument
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HAWAII MR1
STCM
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ismics - EDMOSEIS
Seismics - SAQ
mrad echosounder
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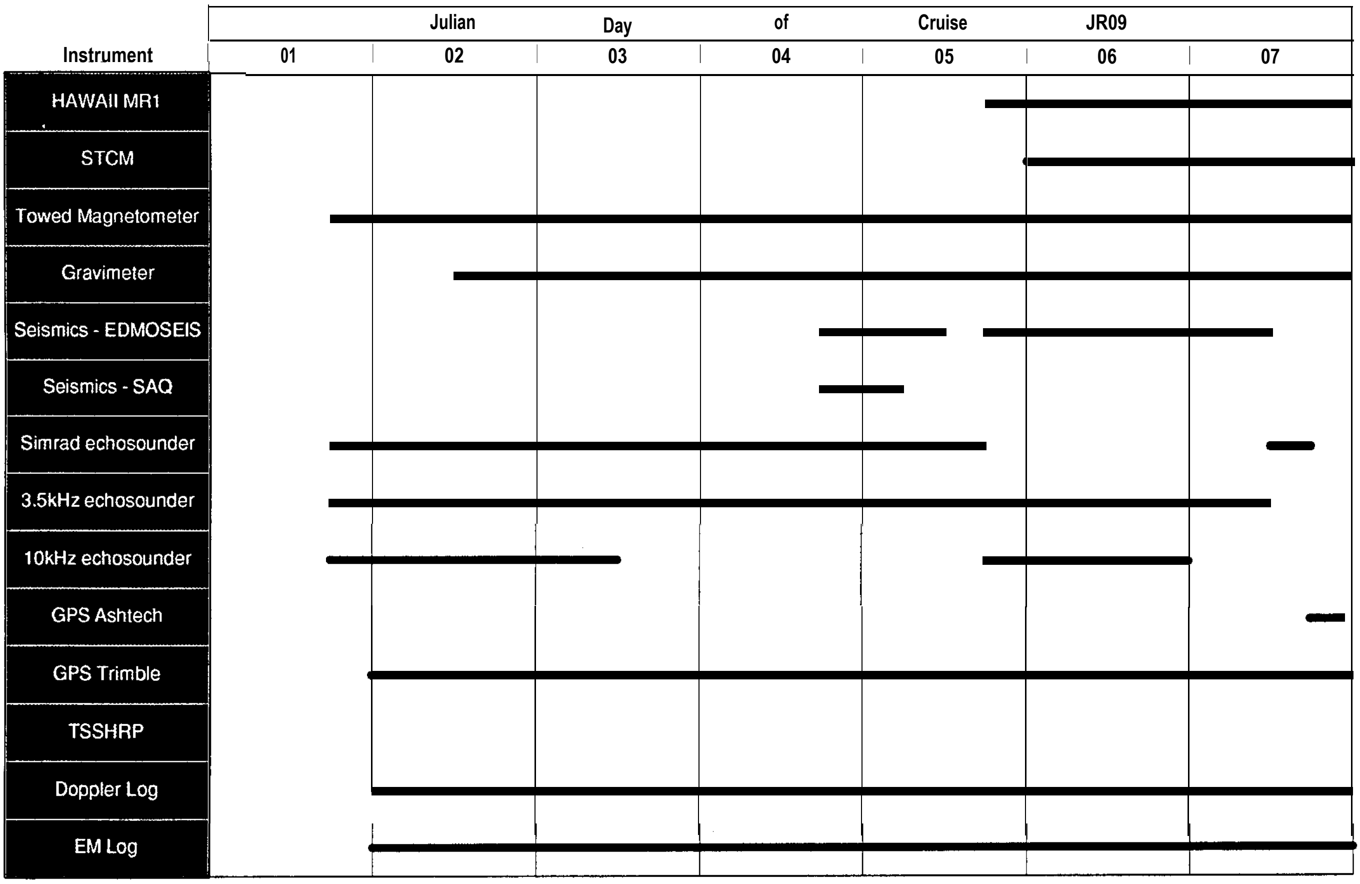
GPS Ashtech
GPS Trimble
TSSHRP
Doppler Log
EM Log


Julian Day of Cruise JR09
Instrument
01
02
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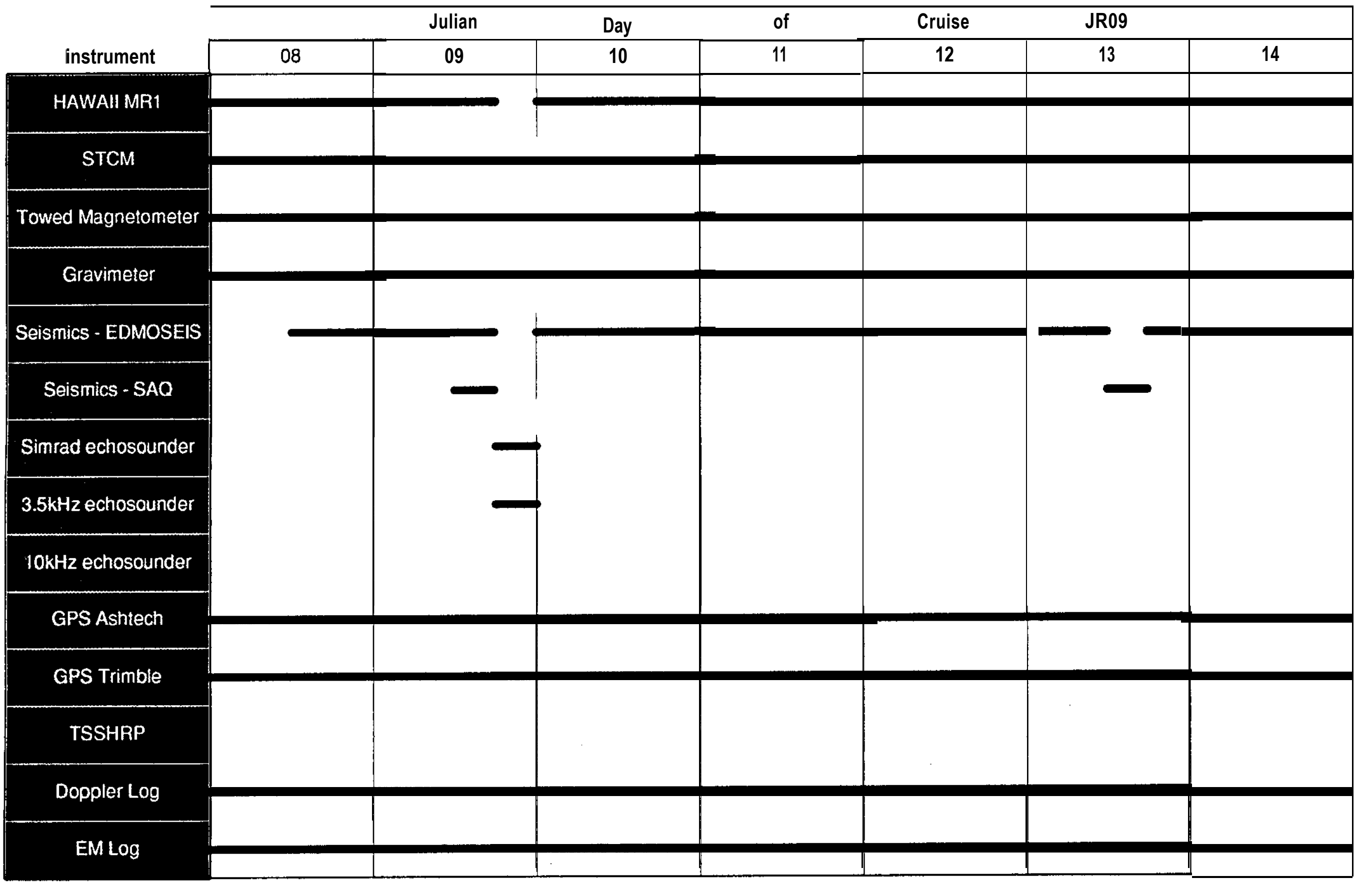
07
HAWAII MR1
STCM
Towed Magnetometer
Gravimeter
Seismics - EDMOSEIS
Seismics - SAQ
Simrad echosounder
3.5kHz echosounder
10kHz echosounder
GPS Ashtech
GPS Trimble
TSSHRP
Doppler Log
EM Log


Julian Day of Cruise JR09
instrument
08
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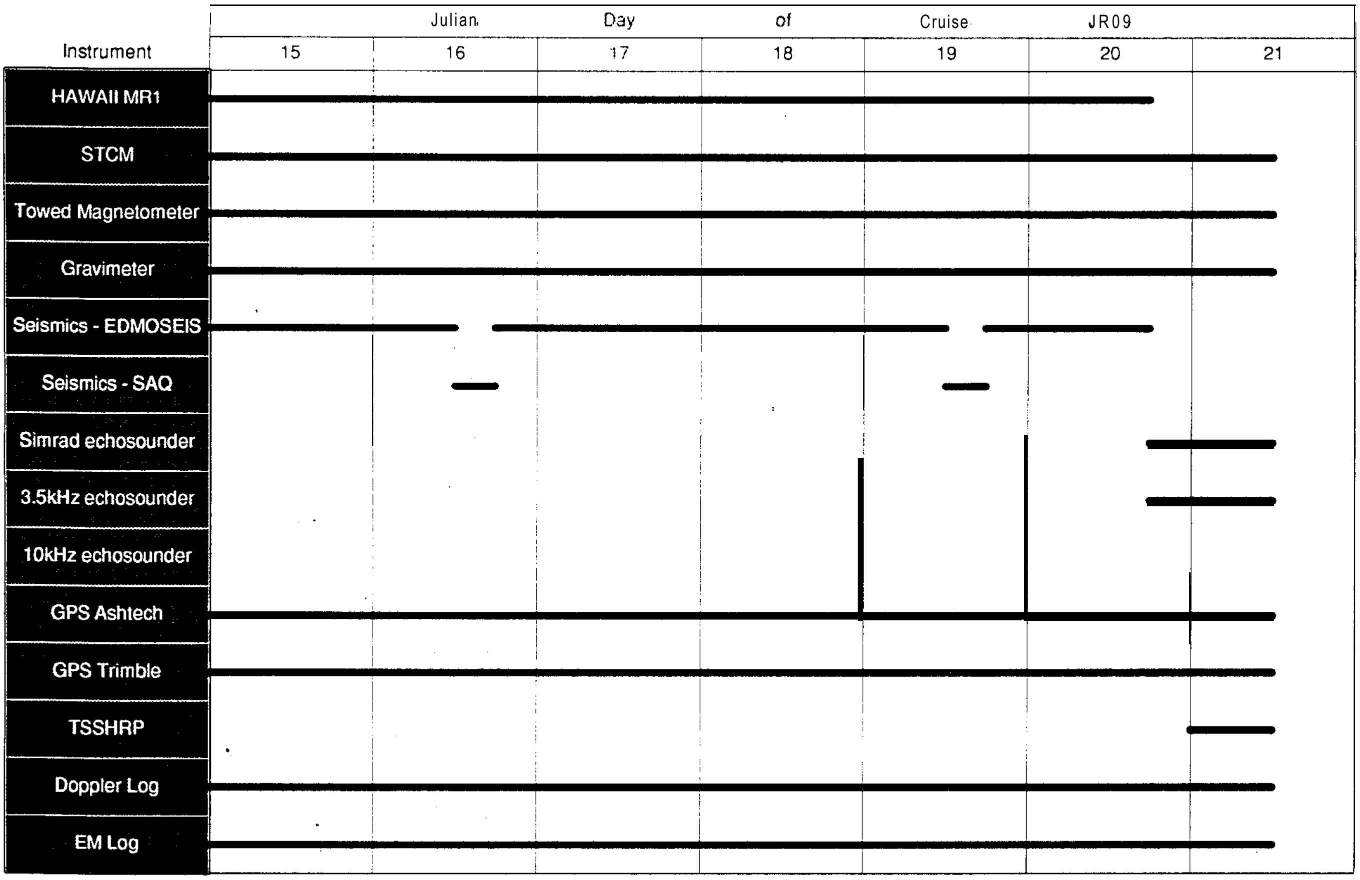
14
HAWAII MR1
STCM
Towed Magnetometer
Gravimeter
Seismics - EDMOSEIS
Seismics - SAQ
Simrad echosounder
3.5kHz echosounder
10kHz echosounder
GPS Ashtech
GPS Trimble
TSSHRP
Doppler Log
EM Log


Julian Day of Cruise JR09
Instrument
15
16
17
18
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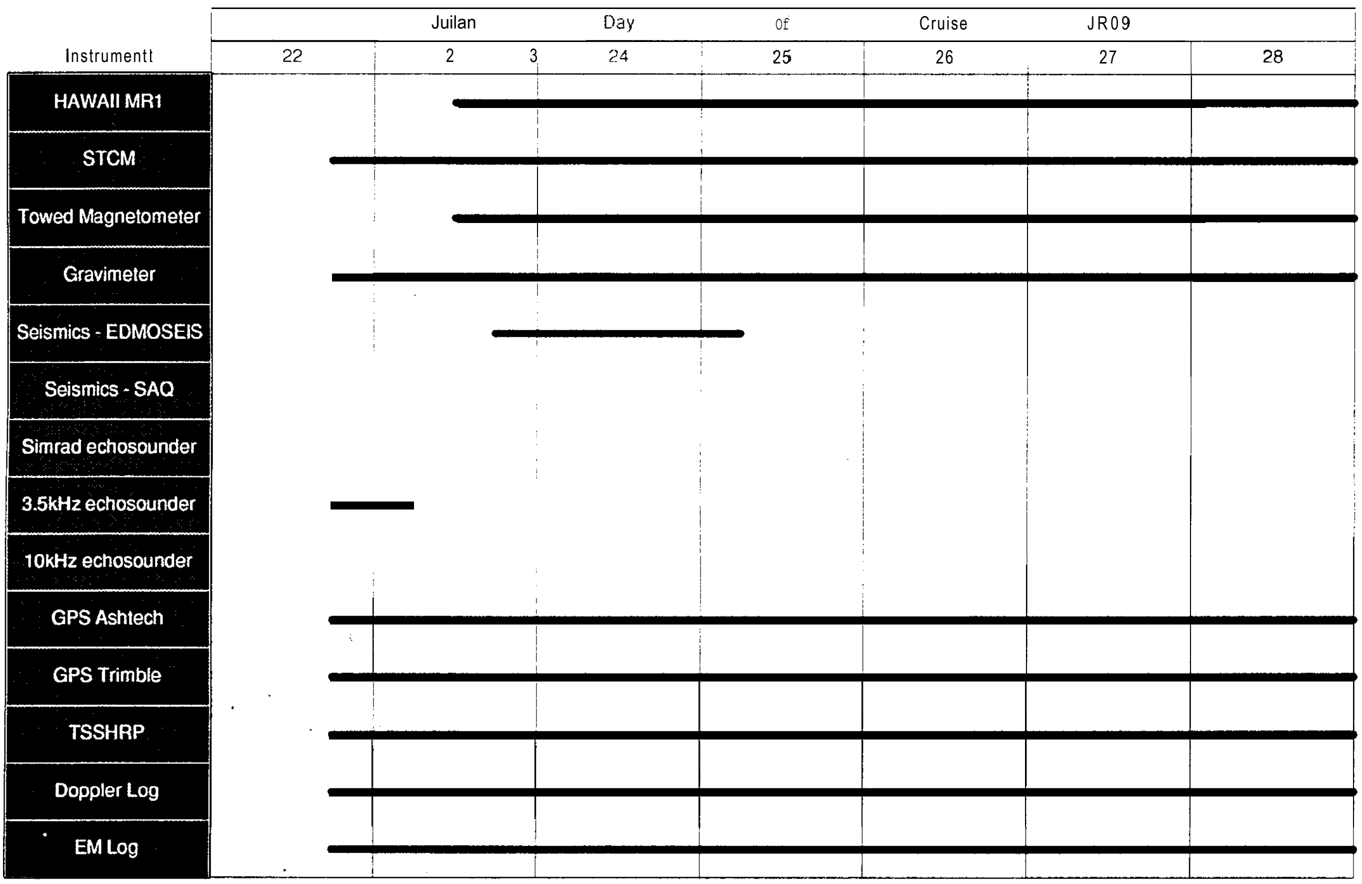
21
HAWAII MR1
STCM
Towed Magnetometer
Gravimeter
Seismics - EDMOSEIS
Seismics - SAQ
Simrad echosounder
3.5kHz echosounder
10kHz echosounder
GPS Ashtech
GPS Trimble
TSSHRP
Doppler Log
EM Log


Julian Day of Cruise JR09
Instrumentt
22
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3
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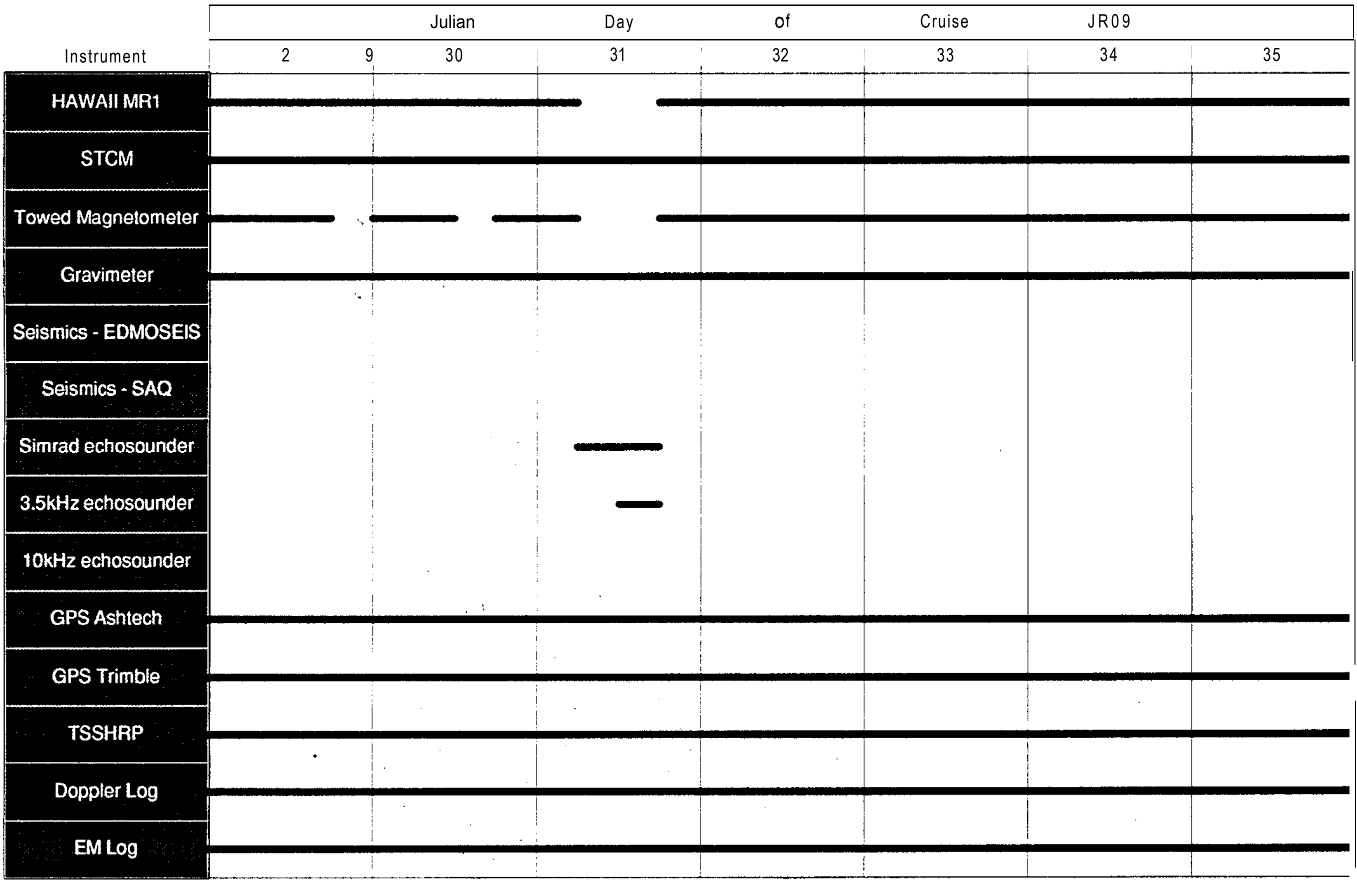
25
26
27
28
HAWAII MR1
STCM
Towed Magnetometer
Gravimeter
Seismics - EDMOSEIS
Seismics - SAQ
Simrad echosounder
3.5kHz echosounder
10kHz echosounder
GPS Ashtech
GPS Trimble
TSSHRP
Doppler Log
EM Log



Julian Day of Cruise JR09
Instrument
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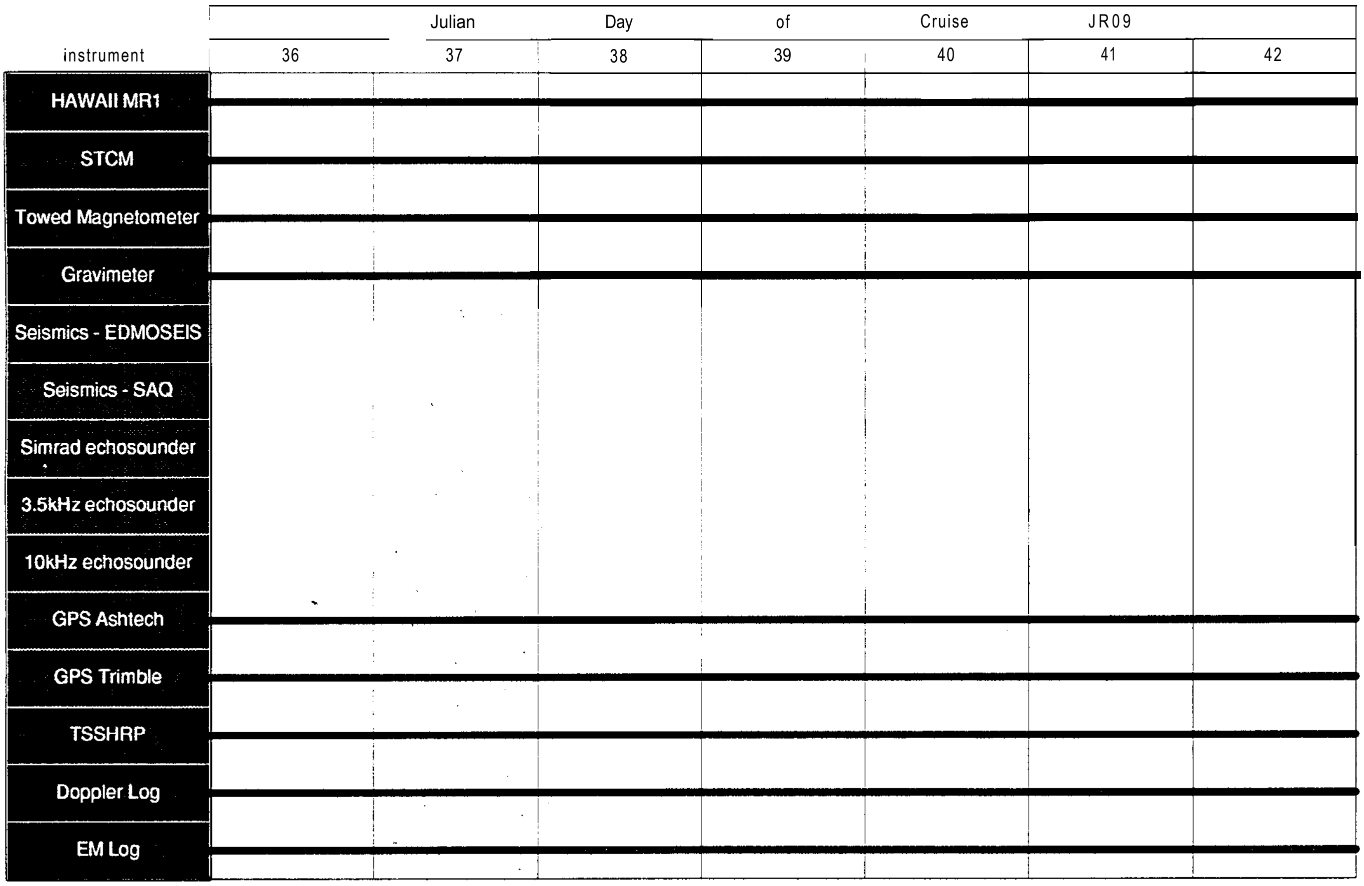
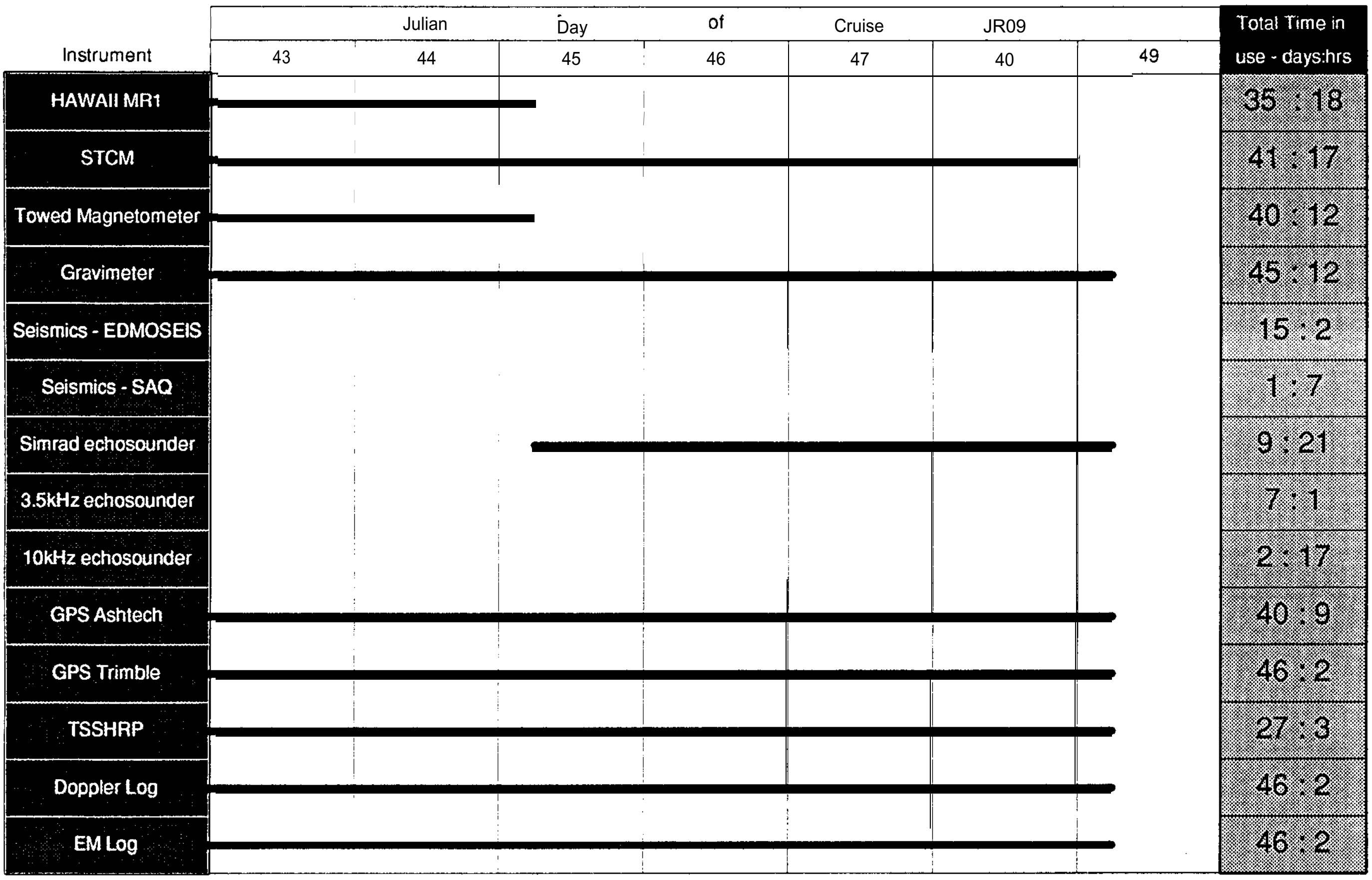
30
31
32
33
34
35
HAWAII MR1
STCM
Towed Magnetometer
Gravimeter
Seismics - EDMOSEIS
Seismics - SAQ
Simrad echosounder
3.5kHz echosounder
10kHz echosounder
GPS Ashtech
GPS Trimble
TSSHRP
Doppler Log
EM Log



Julian Day of Cruise JR09
instrument
36
37
38
39
40
41
42
HAWAII MR1
STCM
Towed Magnetometer
Gravimeter
Seismics - EDMOSEIS
Seismics - SAQ
Simrad echosounder
3.5kHz echosounder
10kHz echosounder
GPS Ashtech
GPS Trimble
TSSHRP
Doppler Log
EM Log


Instrument
Julian Day of Cruise JR09
43
44
45
46
47
40
49
Total Time in use - days:hrs
HAWAII MR1
35 : 18
STCM
41 : 17
Towed Magnetometer
40 : 12
Gravimeter
45 : 12
Seismics - EDMOSEIS
15 : 2
Seismics - SAQ
1 : 7
Simrad echosounder
9 : 21
3.5kHz echosounder
7 : 1
10kHz echosounder
2 : 17
GPS Ashtech
40 : 9
GPS Trimble
46 : 2
TSSHRP
27 : 3
Doppler Log
46 : 2
EM Log
46 : 2

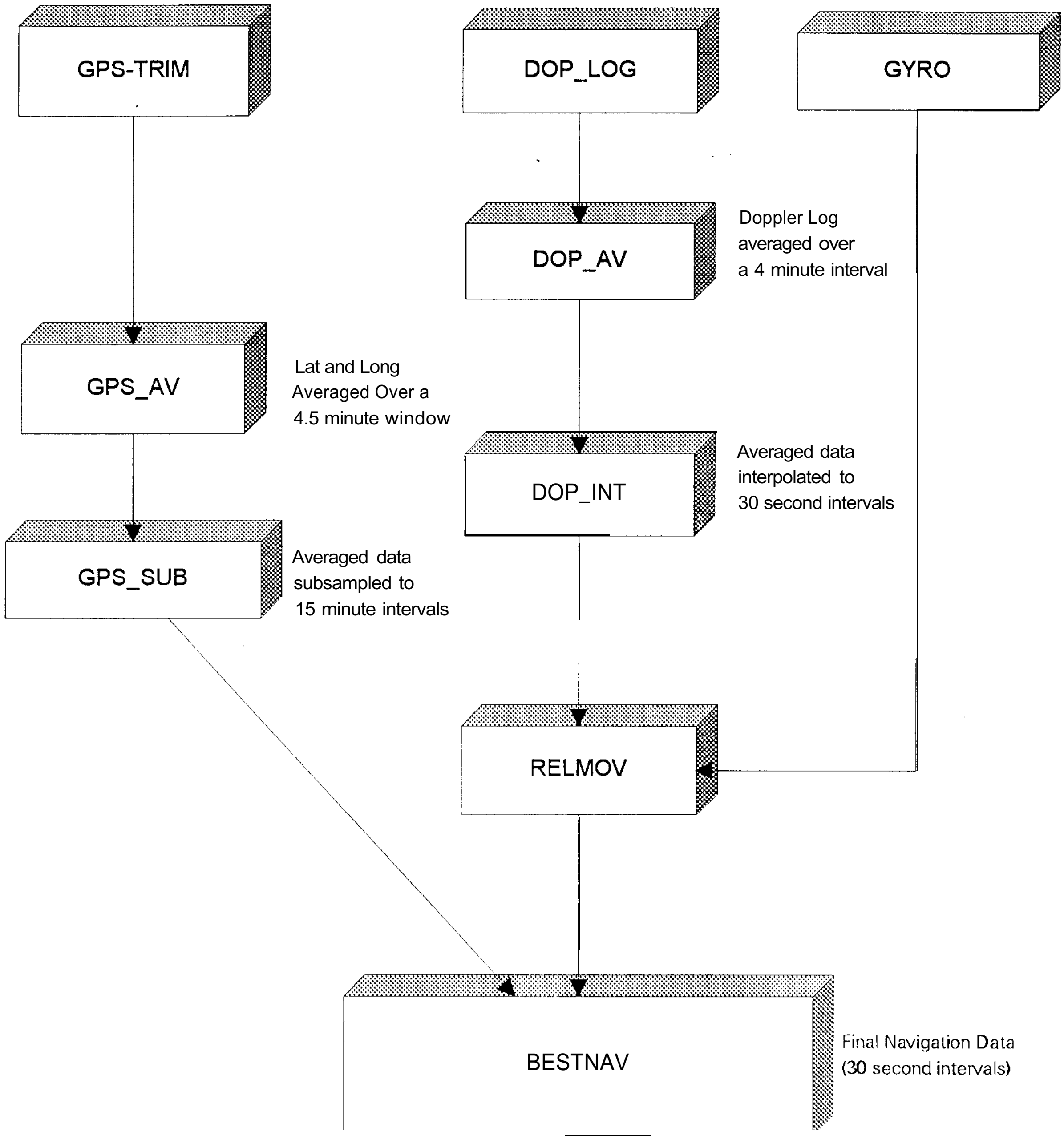


Figure 9. Navigation Data Processing

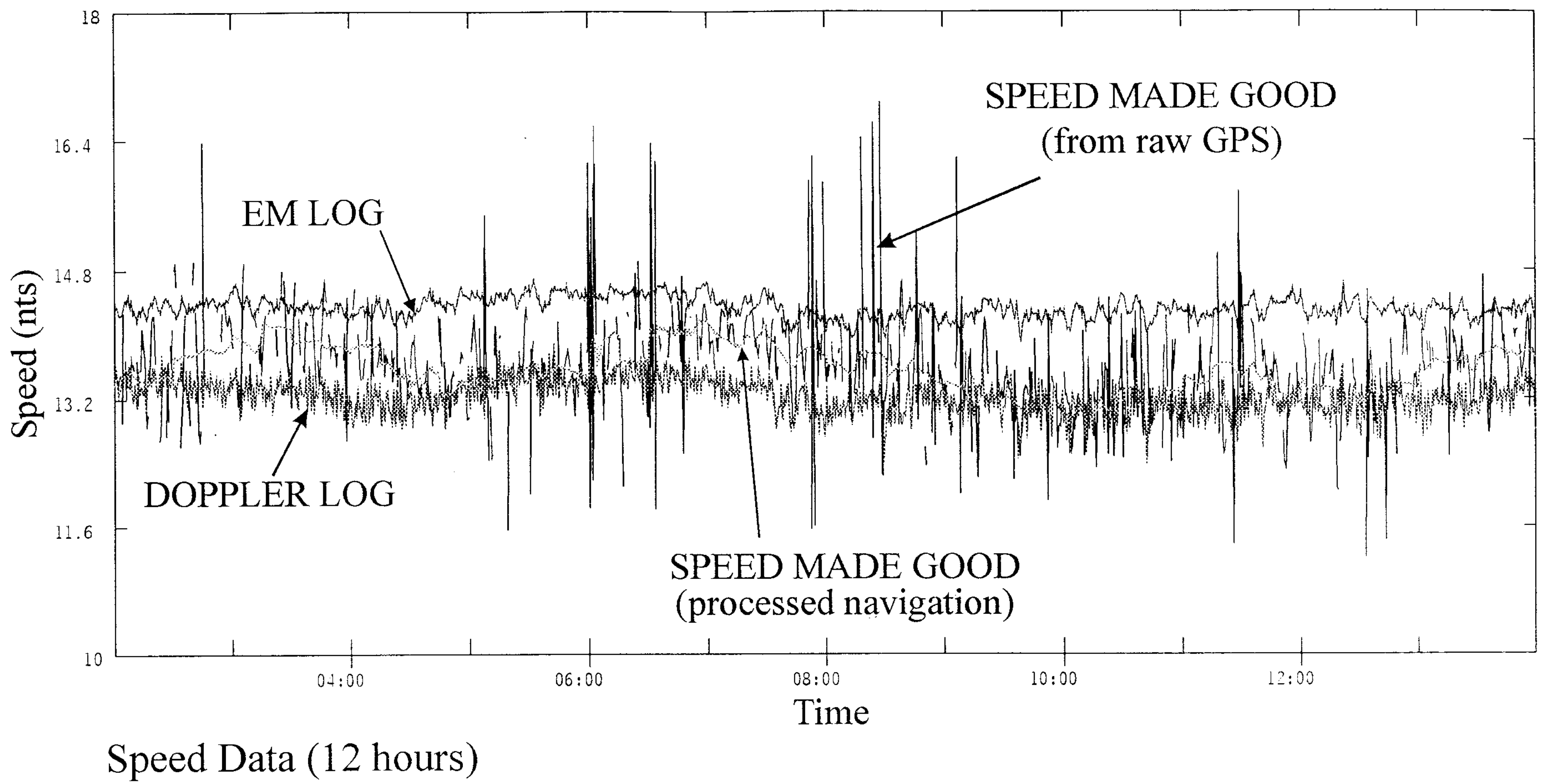


Figure 10 Comparison of speed made good computed from raw GPS fixes with results using processed navigation.

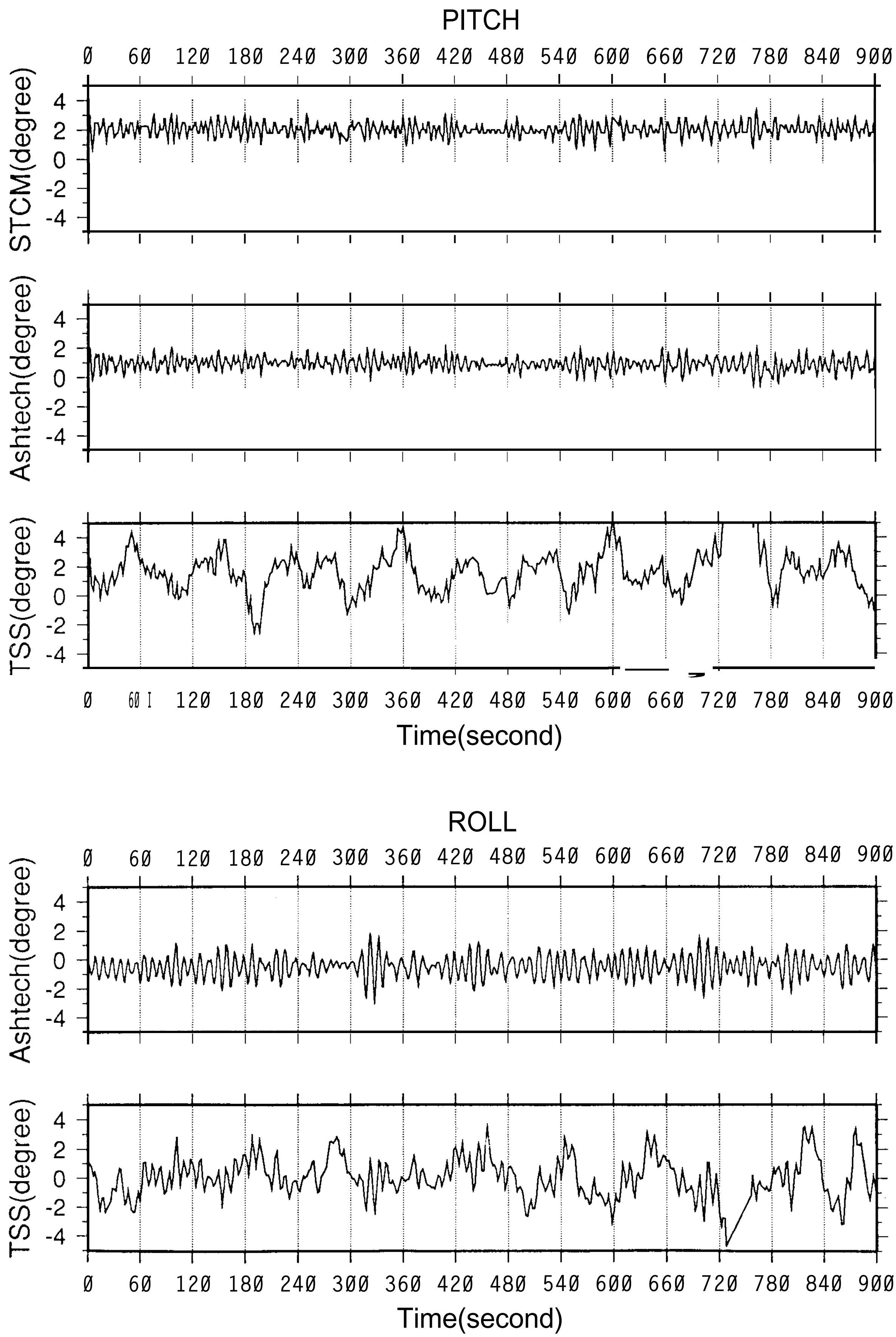
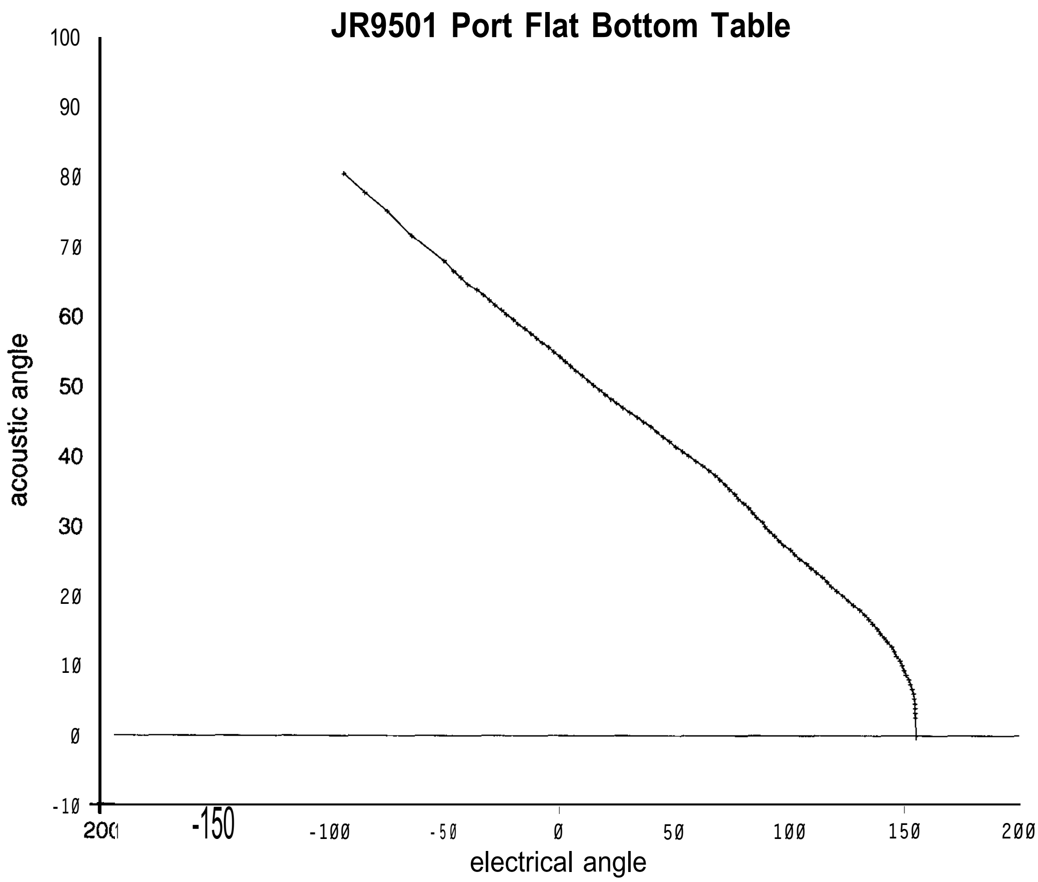


Figure 11 Comparisons of pitch and roll measured by TSS300, Ashtech and STCM gyro.



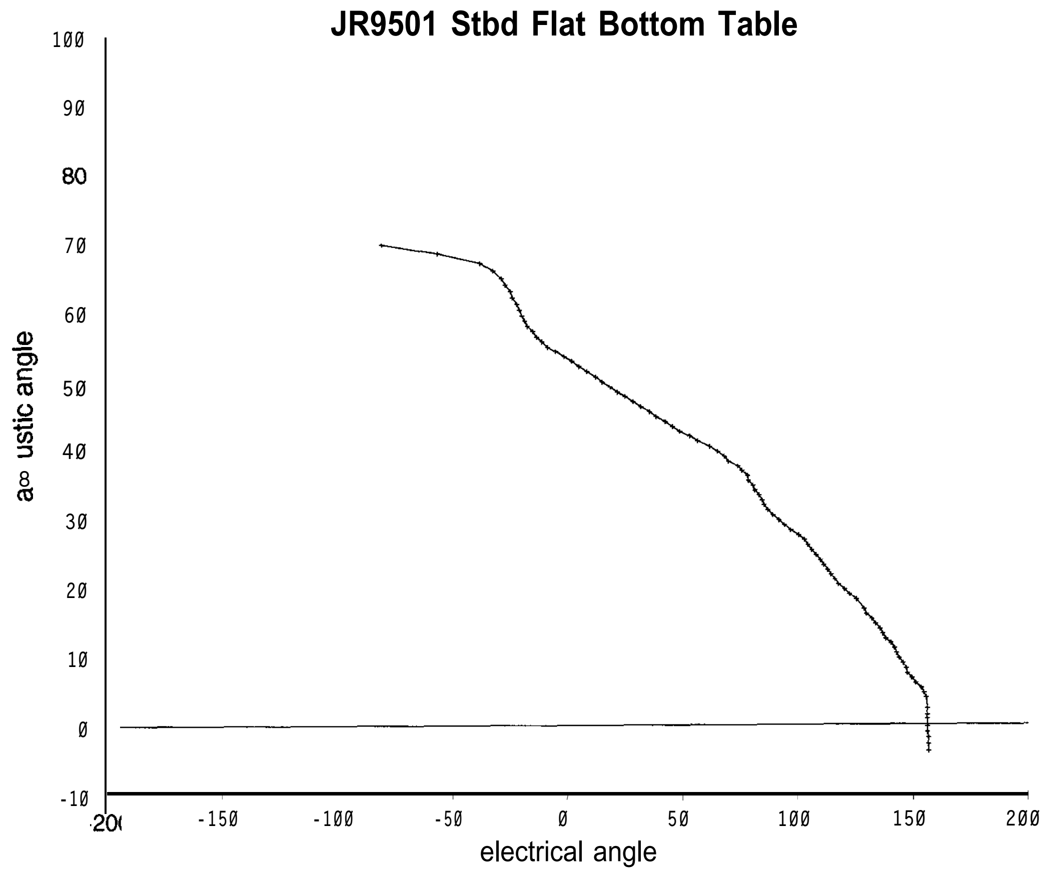


Figure 13 MR1 bottom tables used to map electrical angle to acoustic angle

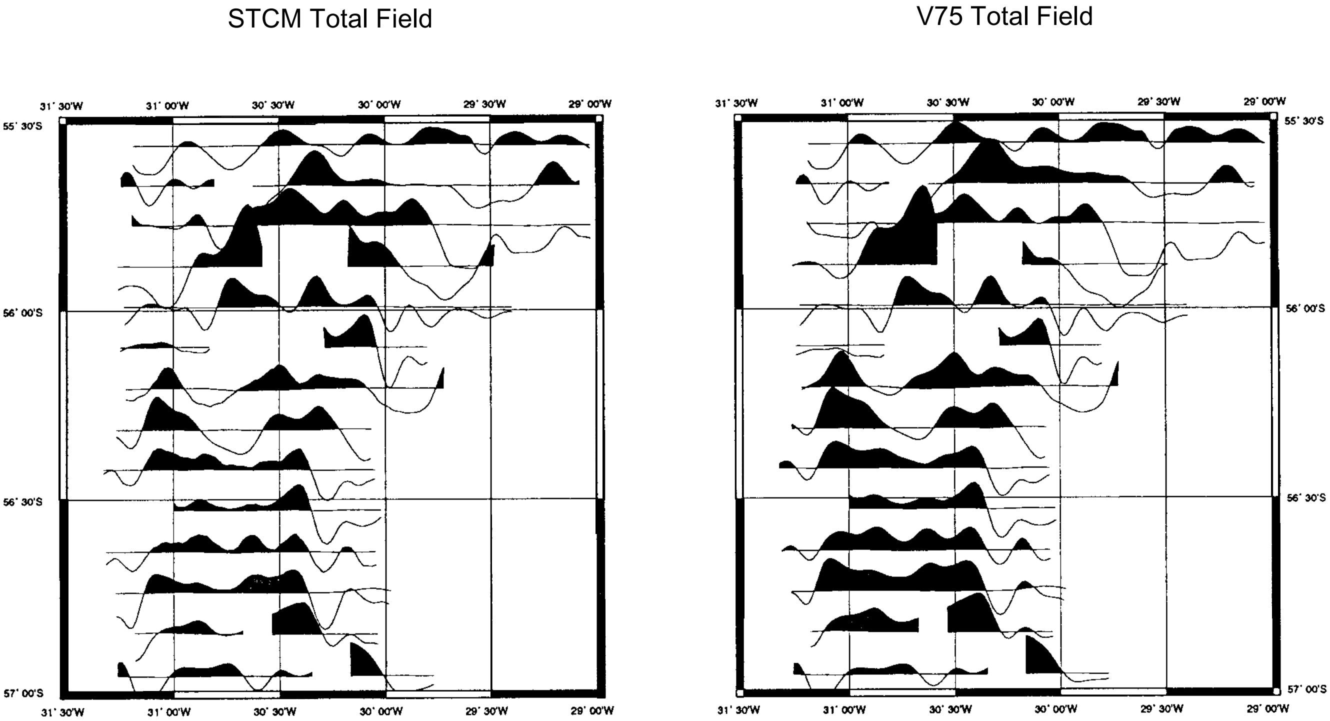


Figure 14 Comparison between total magnetic field anomaly derived from STCM field components and that measured by the Varian towed magnetometer

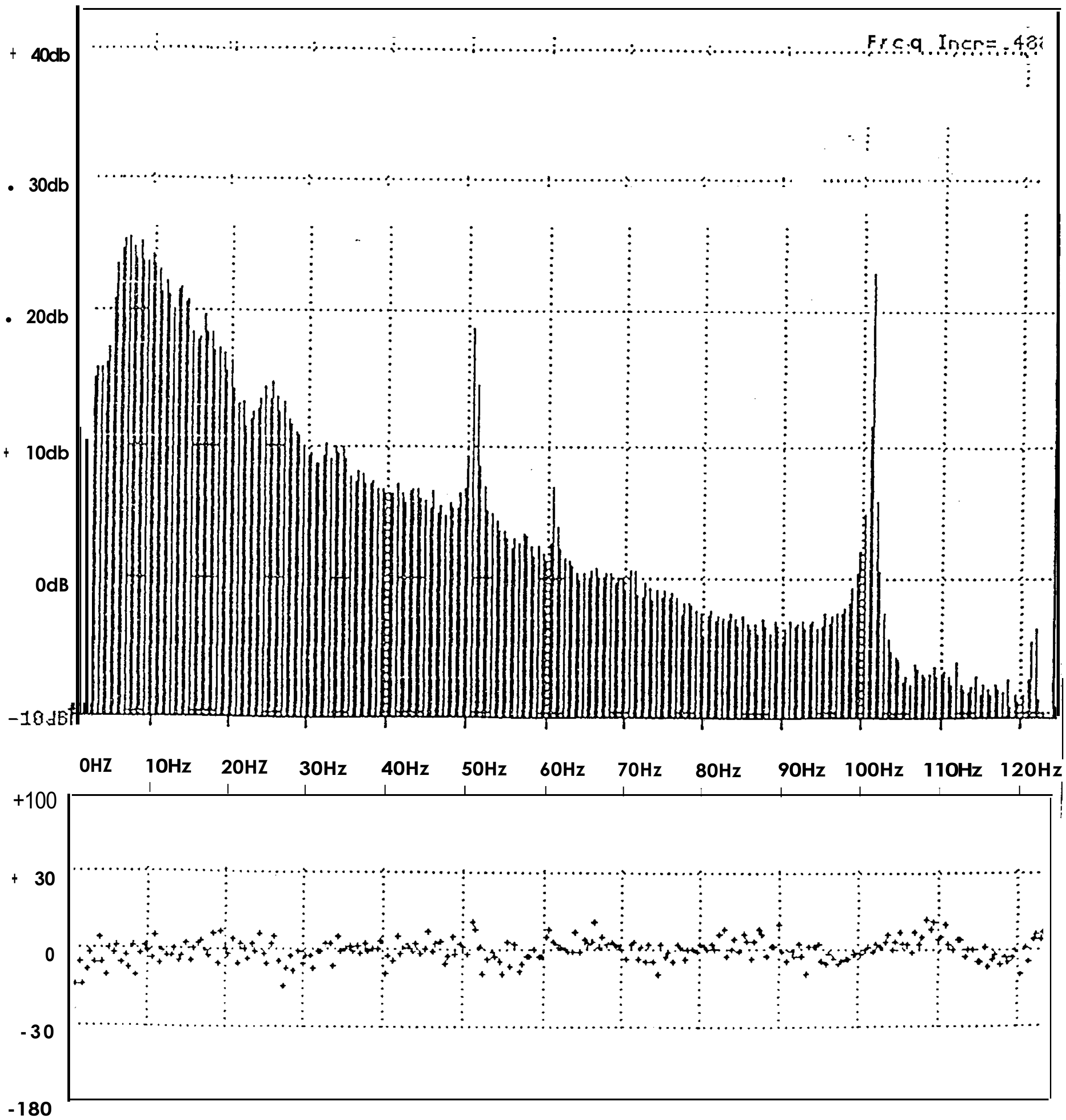


Figure 15 Mean power spectrum of water layer noise computed over 100 traces taken from profile BAS945-S36. The peak at 7 Hz is attributed to swell and towing noise and spikes at 51 and 102 Hz are associated with the ship's cathodic protection system

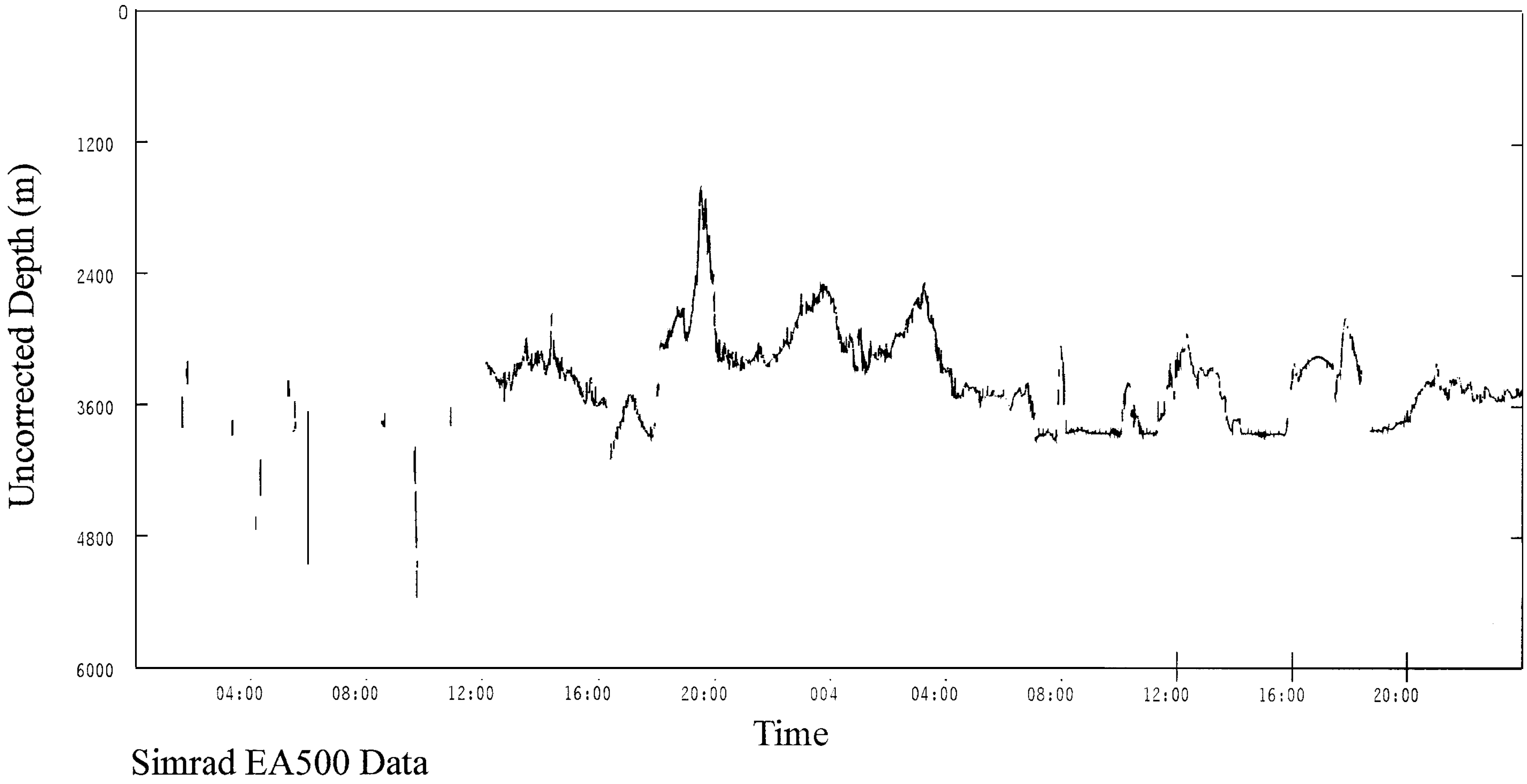


Figure 16 Example Simrad EA500 bathymetric record.


TONNES
LUFFING
S.W.L. 10 TONNES
STATIC

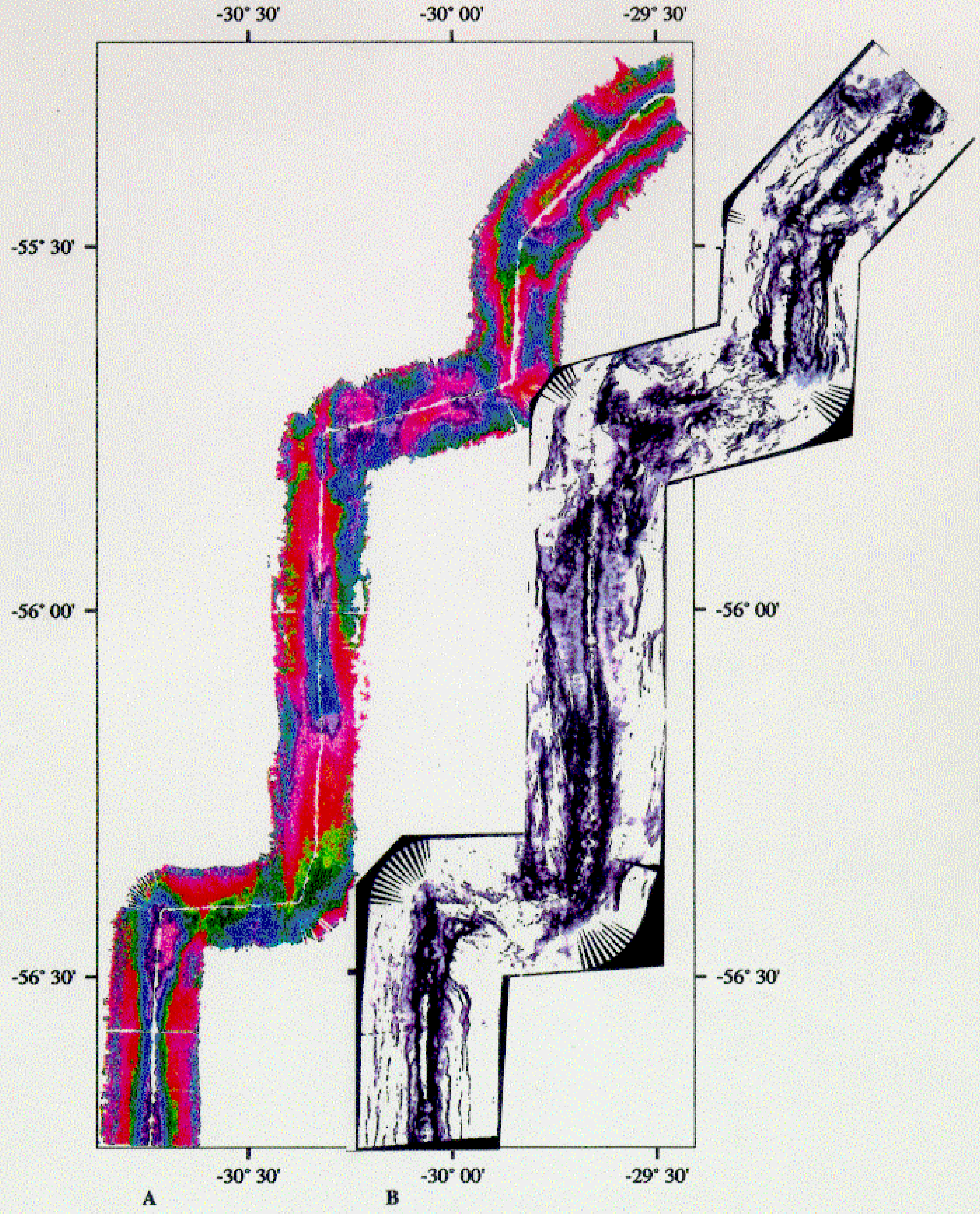


Plate II HAWAII-MR1 bathymetry (A) and sidescan (B) records from the northern part of Area A. The data have been processed and projected onto a Mercator base map. The tracks include the section along which the seismic profile shown in Figure 4 was collected.

Plate III Installation of STCM fluxgate sensors on deck