Ref. JR12

No. 7

CRUISE REPORT

JR12

RRS JAMES CLARK ROSS

R. A. Livermore

Completed: 2nd April, 1996

British Antarctic Survey

Plate I JR12 participants

Ref. JR12 No. 7

RRS *James Clark Ross*
March to April 1996
Cruise JR12

Completed 2/4/96

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RRS *James Clark Ross*
March to April 1996
Cruise JR12

R.A. Livermore

R.A. Livermore, Chief Scientist

2/4/96

M.J.S. Burgan, Master

2/4/96

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Seismic reflection lines

1 Abstract

JR12 completed detailed seismic profiling and rock sampling of segments of the East Scotia Ridge, an active plate boundary mapped in 1995 during cruise JR09a. The prime objective was to evaluate the influence of subduction on seafloor spreading behind (west of) the South Sandwich Arc, by means of detailed geophysical survey and rock sampling. In addition to the four-channel seismic system employed during JR09a, three-component and total field (proton precession) magnetometers, a modified Lacoste-Romberg gravimeter and a new wax corer were also carried. Real-time, differential GPS navigation was used throughout.

The intended seismic survey plan had to be revised, owing to an abnormally high density of icebergs in the northeast Scotia Sea. No seismic work was possible on the so-called 'mermaid's purse' segment (E2), but the IOS-designed Rock Chipper was used to complete a high-density programme of wax core sampling along this part of the ridge. Thirty-seven sites were sampled in seven days at a typical spacing of 1.5 km, with dredge samples on either flank of the axial ridge. A single wax core was recovered from the northernmost segment, E1, along with seismic profiles along the axis, and a single cross line. Although conditions were very poor, and the ridge depth great (> 4000m), valuable seismic data was acquired.

Open water was located eventually at the southern end of the East Scotia Ridge (segment E9). The opportunity was taken to complete a seismic profile along the axis of E9, guided by HAWAII-MR1 bathymetry, plus a series of cross-axis lines at a spacing of 10 km. Additional lines were added across the shallowest point, where a smooth axial ridge, convex in cross-section, was encountered. Although intracrustal reflections were not observed clearly, segment E9 nevertheless appears to experience enhanced melting rather like its northern counterpart.

Technical successes include the operation of the Rock Chipper, BAS-built three-component magnetometer, sonobuoy recording and the use of Racal Skyfix differential GPS navigation. Some problems were encountered with borrowed RVS equipment.

2 List of Personnel

Scientific and Technical

1	Chief Scientist	R.A. Livermore (BAS)	
2	Geochemist	P.T. Leat (BAS)	
3	Geologist	R.V. Dingle (BAS)	
4	Geophysicist	A.M. Reading (BAS)	Seismic Recording
5	Geophysicist	P.C. Jones (BAS)	Navigation, Gravity
6	Geophysicist	J.K. Ferris (BAS)	Gravity
7	Computing	P. Morris (BAS)	Data Manager
8	Engineer	S.F. Bremner (ISG)	Mechanical (airgun/compr.)
9	Engineer	A.M. Tait (ISG)	Mechanical (airgun/compr.)
10	Engineer	N.P. Audley (ISG)	Mechanical (airgun/compr.)
11	Engineer	P.J. Cooper (ISG)	Electronics
12	Computing	G.J. Butcher (ISG)	Computer Support
13	Computing	P. Duncan (RVS)	Logging
19	Engineer	G. White (RVS)	Seismic Recording
20	Ship's Doctor	I. Cunningham	

Ship's Officers

1	Master	M.J.S. Burgan
2	Chief Officer	R. Jackson
3	2nd Officer	G.C. Morgan
4	3rd Officer	J.A.G. Tolson
5	Science Off.	J.W. Summers
6	Radio Officer	C.A. Waddicor
7	Chief Eng.	S.E. Taylor
8	2nd Eng.	C. Smith
9	3rd Eng.	R.S. Jones
10	3rd Eng.	M. Inch
11	Science Eng.	S.A. Wright
12	Electrician	A.K. Rowe
13	Purser	R.K. Walters

Crew

1	CPO Bosun	M. Brookes
2	PO B'n Mate	J.H.W. Williams
3	SG1	R. Graham
4	SG1	D.O. Williams
5	SG1	P.A. Cossey
6	SG1	C.D. Fairbrother
7	SG1	K.S. Beck
8	CPO M'man	D. Bretland
9	M'man	D.R. Summers
10	Chief Cook	R.W. Fox
11	2nd Cook	S.G. Redgen
12	Asst. Cook	D. Greenwood
13	Steward	J.A. Clancey
14	Steward	T.N. Dixon
15	Steward	M.A. Hines

3 Timetable of Events

1996

March

1 Scientific party arrives at FIPASS.
3 Mobilisation commences.
5 Ship sails at 13:45 GMT; following safety and lifeboat drill, leaves Port William and commences first STCM ship compensation manoeuvre at 16:30; total field magnetometer fish streamed at 17:10; course set for way point 1; STCM, Simrad EA500 and gravimeter in operation; first Racal Skyfix DGPS corrections received.
7 STCM compensation manoeuvre; XBT launched; seismic airguns deployed, but two guns do not seal.
8 Seismic gear deployed with leaky port No. 3 gun; two dead channels on hydrophone streamer; commence seismic acquisition on test line BAS 956-S69; first sonobuoy launched successfully; seismic gear recovered.
9 STCM compensation manoeuvre; seismic gear deployed; towed magnetometer deployed; commence line BAS956-S70.
10 STCM compensation manoeuvre; recovered noisy magnetometer.
11 Course changes for icebergs and dead whale.
12 Ice conditions too poor for seismic work, so Rock Chipper is rigged instead; first deployment on axis of East Scotia Ridge at 'mermaid's purse' feature; small fragments of basalt glass recovered; repeat gives similar results.
13 Full-scale wax coring programme underway: larger fragments recovered; some winch problems and some sites missed owing to icebergs having got there first.
14-16 Wax coring continues, with increasing success: multiple hits used to increase chances of recovery.
17 Two dredges attempted on flanks of 'mermaid's purse': very successful.
18-19 Further wax coring to complete sampling of segment E2.
20 Attempt to deploy seismic gear over northern segment (E1) of East Scotia Ridge; line S72 completed satisfactorily, then reversed with sonobuoys; however, many course changes now required as bergs move across the line; finally, gear recovered and a wax core taken on ridge axis.
21 Berg density and strong winds bring a halt to wax coring; eventually recommence coring and, after several tries, recover good sample from 4300m, the deepest achieved on JR12.
22 No information from Cambridge on ice conditions, so head south to find open water on ridge axis; further wax core taken en route.
23 Progress halted owing to storm; finally recover wax core at 58° 36′S, 29° 57′W; wind around 50kts, rough sea.
24 STCM compensation manoeuvre; ice clearing as segment E9 at the southern end of the East Scotia Ridge approached; seismic gear finally deployed at 09:30 and line S77 commenced along ridge axis; sonobuoy deployed; towed magnetometer recovered owing to noise.
25 Seismic recording continues on cross-axis lines; line S79 commenced: two sonobuoys failed, two successful; line S80 commenced: one sonobuoy lost, one transmitting

correctly; magnetometer redeployed.

26 Trimble GPS receiver locked up, but quickly corrected; sonobuoy launched on line S84 successfully; interesting volcanic ridge imaged on seismic profile, further lines added at 1.5 km spacing.

27 Four sonobuoys launched, two unsuccessful; towed magnetometer retrieved owing to noisy record; repaired and redeployed; seismic gear recovered after line S89.

28 STCM compensation manoeuvre; commence fast gravity/magnetics lines; heavy seas degrade data quality.

29 Survey completed at 06:00, course set for the Falkland Islands; Racal Skyfix corrections disabled.

31 STCM compensation manoeuvre.

April

3 Very heavy roll (~46°) causes chaos in UIC room; 11:00 refuel in Mare Harbour; 15:30 arrive FIPASS.

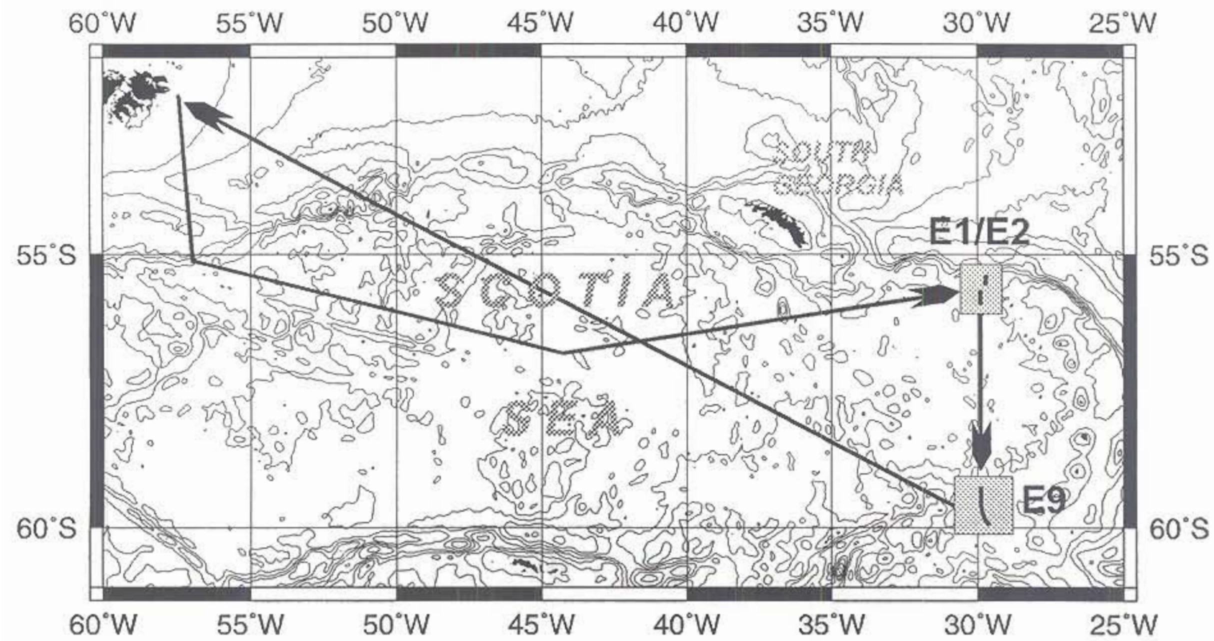


Figure 1: JR12 outline cruise plan

4 Introduction

Cruise JR12 followed up the systematic sonar mapping campaign of JR09a by carrying out detailed geological and geophysical surveys along the axis of the East Scotia Ridge (Fig. 1). The base maps provided by the 1995 HAWAII-MR1 survey allowed very precise targeting of rock sampling and seismic survey lines.

In the event, a very dense swarm of icebergs prevented the geophysical work from being carried out on the chosen segment (E2), although a small amount of data was acquired over E1 and the E2 rock sampling programme was completed successfully. An alternative target was sought in the southeastern Scotia Sea (E9), where the seismic and potential field work was finally completed.

As well as marking the first use by BAS of real-time differential GPS navigation at sea, JR12 was notable for the first deployment of the Rock Chipper, a wax corer purchased from IOS, and the first use of the BAS shipboard three-component magnetometer (STCM).

5 Scientific Objectives

Anomalous behaviour of the northernmost segments of the East Scotia Ridge was indicated by sonar mapping and seismic reflection profiling during cruise JR09a. It appears that this part of the ridge enjoys an enhanced supply of magma, derived from melting of the mantle below, which gives rise to a transition from a rift valley to a narrow topographic high at the ridge axis. A magma pond comparable to those observed elsewhere beneath the mid-ocean ridge system, but of limited lateral extent, was discovered immediately beneath the shallowest section of the ridge.

Cruise JR12 aimed to define the three-dimensional structure of the anomalous region by collecting seismic data along closely-spaced profiles, and by using disposable sonobuoys to determine the extent of the heated 'low-velocity' zone beneath the magma pond. Systematic sampling of fresh volcanic glass was also planned, to investigate small-scale variations in melting and crystallisation, which might reflect processes occurring beneath the ridge, such as the migration of fluids from the adjacent volcanic arc.

6 Achievements

A complete track plot for JR12 is shown in Fig. 2, with times annotated at 24 hour intervals.

Drake Passage

A long magnetic/gravity profile was acquired along a flow line of seafloor spreading through the Drake Passage. Two seismic lines (S69-S70) were shot over the extinct spreading ridge (Fig. 3) and one (S71) across a feature suspected of being a similar feature farther east.

East Scotia Ridge - Segment E1

Despite numerous icebergs, several lines were shot along the axis of the segment (Fig. 4), and one across it. Frequent course changes made it difficult for the ship to stay on the ridge for long enough to obtain worthwhile results. Nevertheless, some interesting data were acquired, showing prominent intracrustal reflections. A single wax core, the deepest attempted, at 4275m, was also obtained.

East Scotia Ridge - Segment E2

Although seismic profiling could not be carried out over this segment, a programme of systematic rock sampling was completed at 37 sites (Fig. 5) with the Rock Chipper and at two sites with the dredge (diamonds in Fig. 5).

East Scotia Ridge - Segment E9

One along-axis seismic line and ten cross-axis lines were recorded (Fig. 6). In addition, 12 sonobuoys were deployed (black and white circles in Fig. 6 denote successful and unsuccessful sonobuoy deployments) and recorded on selected lines. A small number of additional, non-seismic, crossings was also completed.

Technical Achievements

Real-time, differential GPS navigation was used successfully for the first time on a BAS scientific cruise. Although ice conditions frequently made it difficult to exploit the ability to steer very straight lines at constant speed, the effect on gravity data processing was marked.

The Rock Chipper was used to sample a total of 39 sites, with typical recovery of a few grammes of fresh basaltic glass.

The new BAS shipboard three-component magnetometer was operated throughout. Results of seven compensation turns were applied and the resulting data processed to produce X,Y and Z components and total field anomalies. The latter agreed well with proton magnetometer measurements.

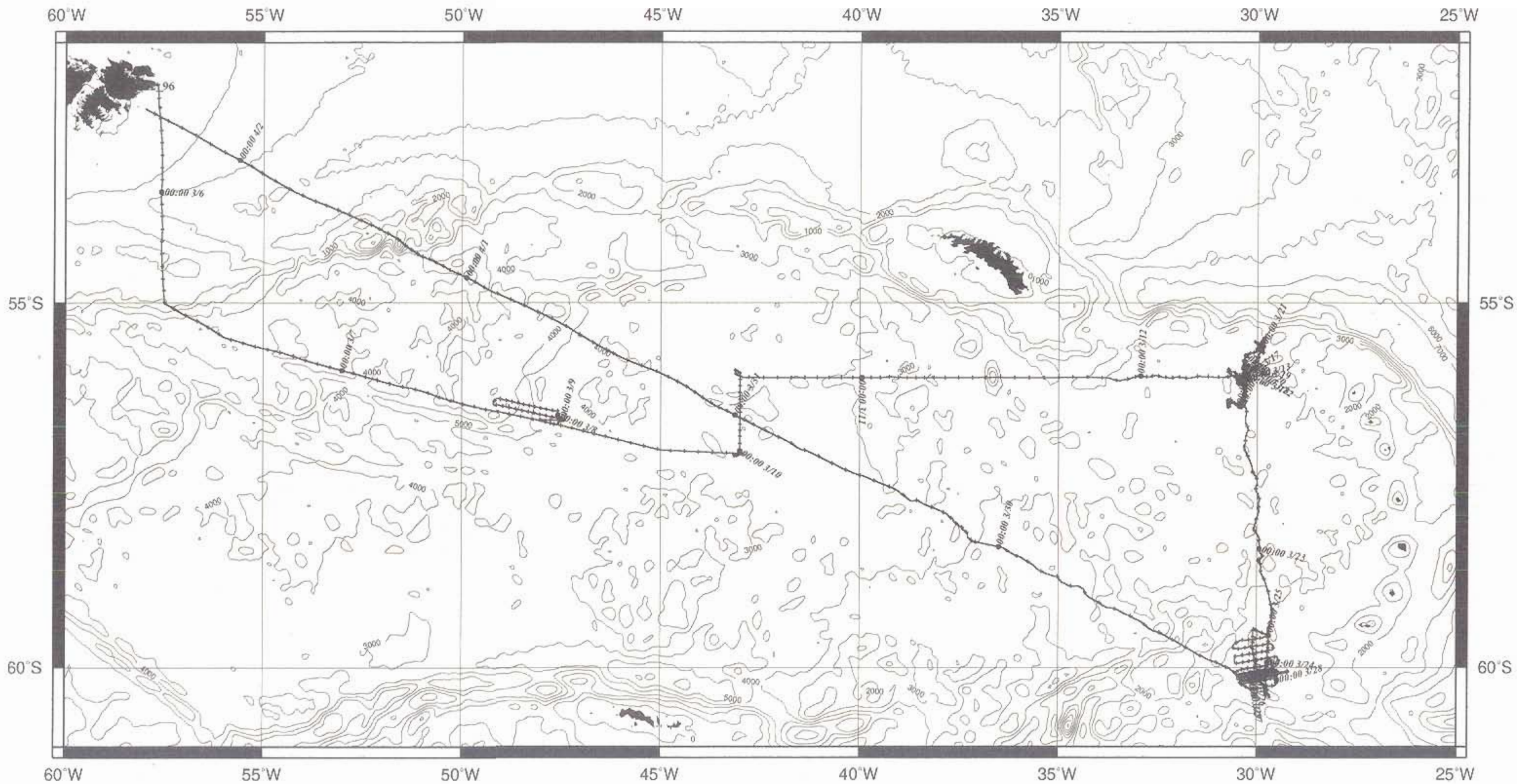


Fig. 2 JR12 Track Summary

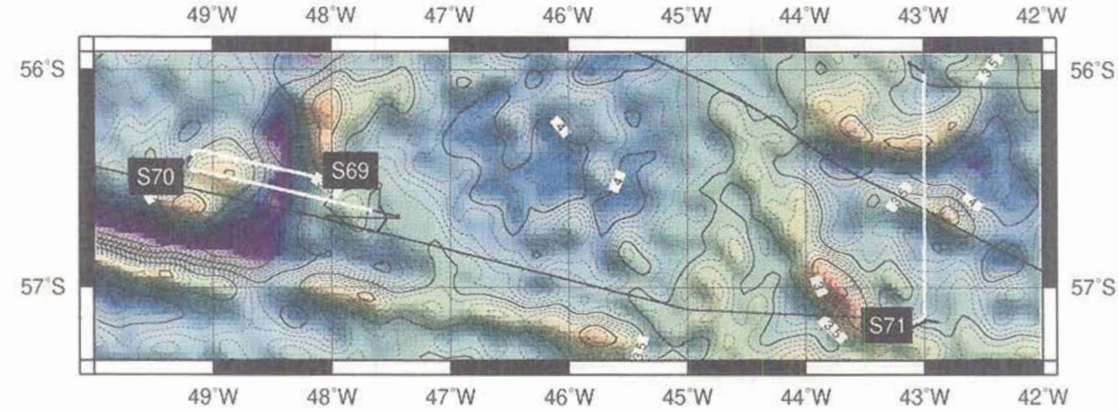


Fig. 3 Drake Passage seismic profiles (white lines); depth contours in km

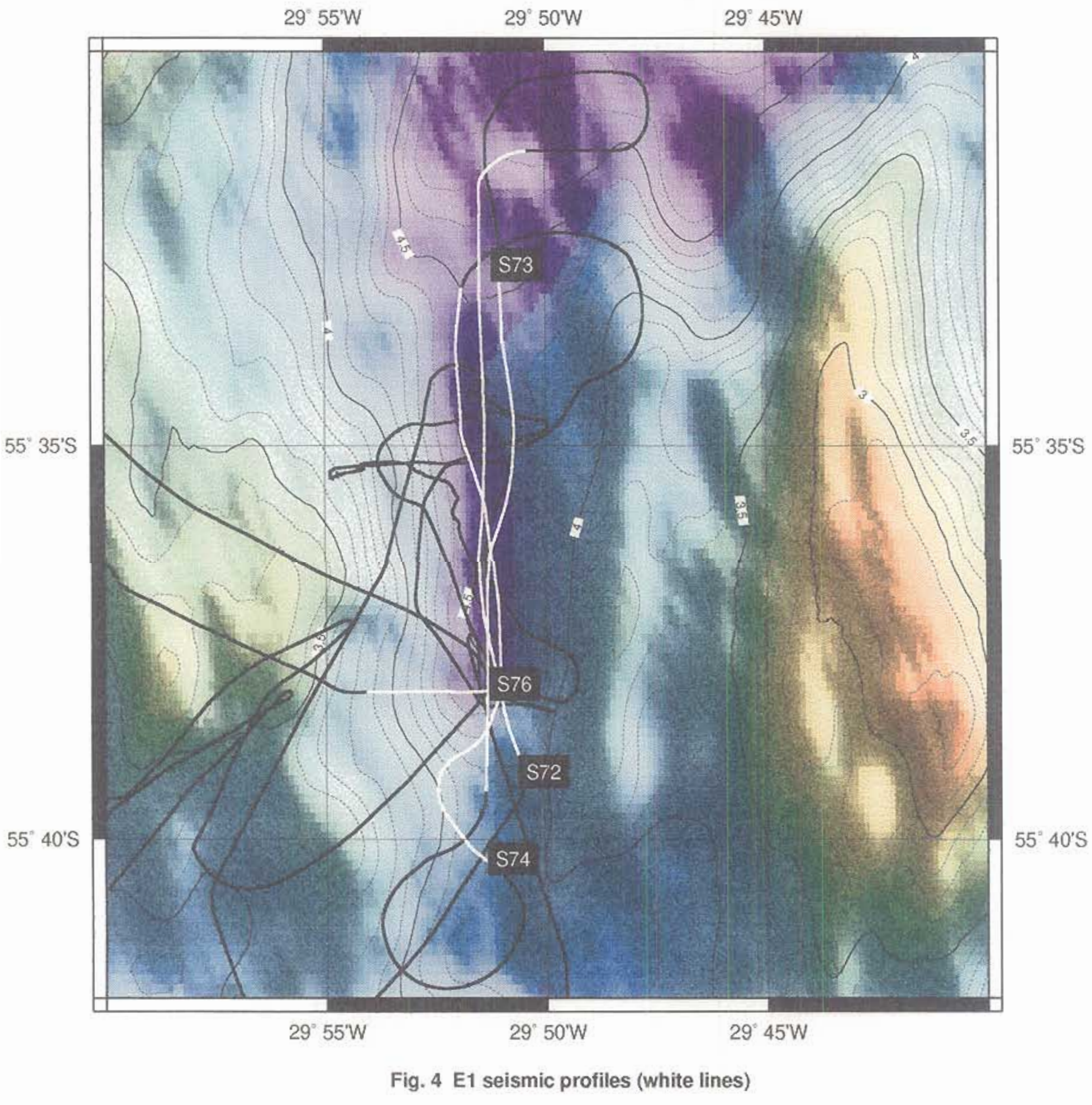


Fig. 4 E1 seismic profiles (white lines)

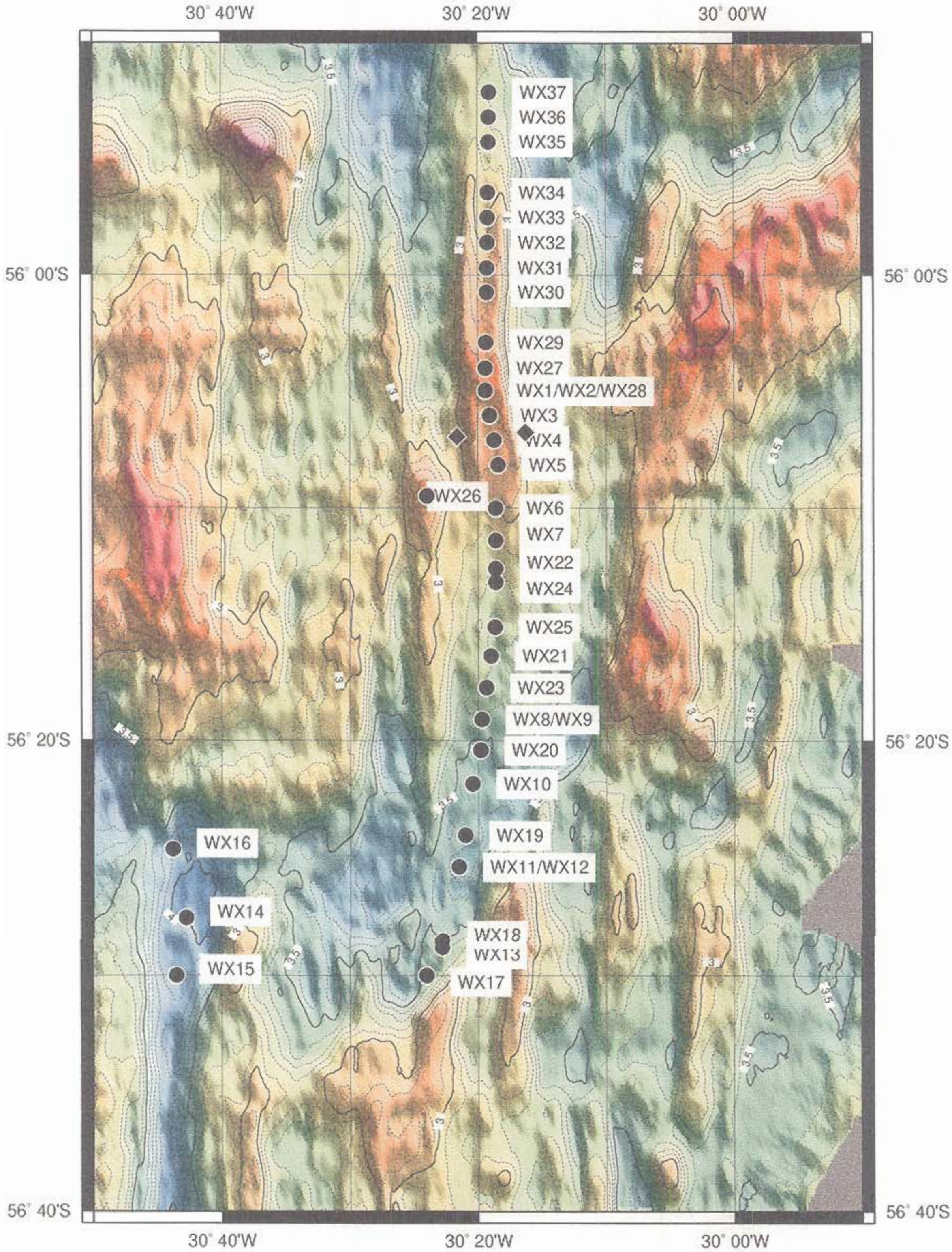


Fig. 5 Mermaid's Purse sampling

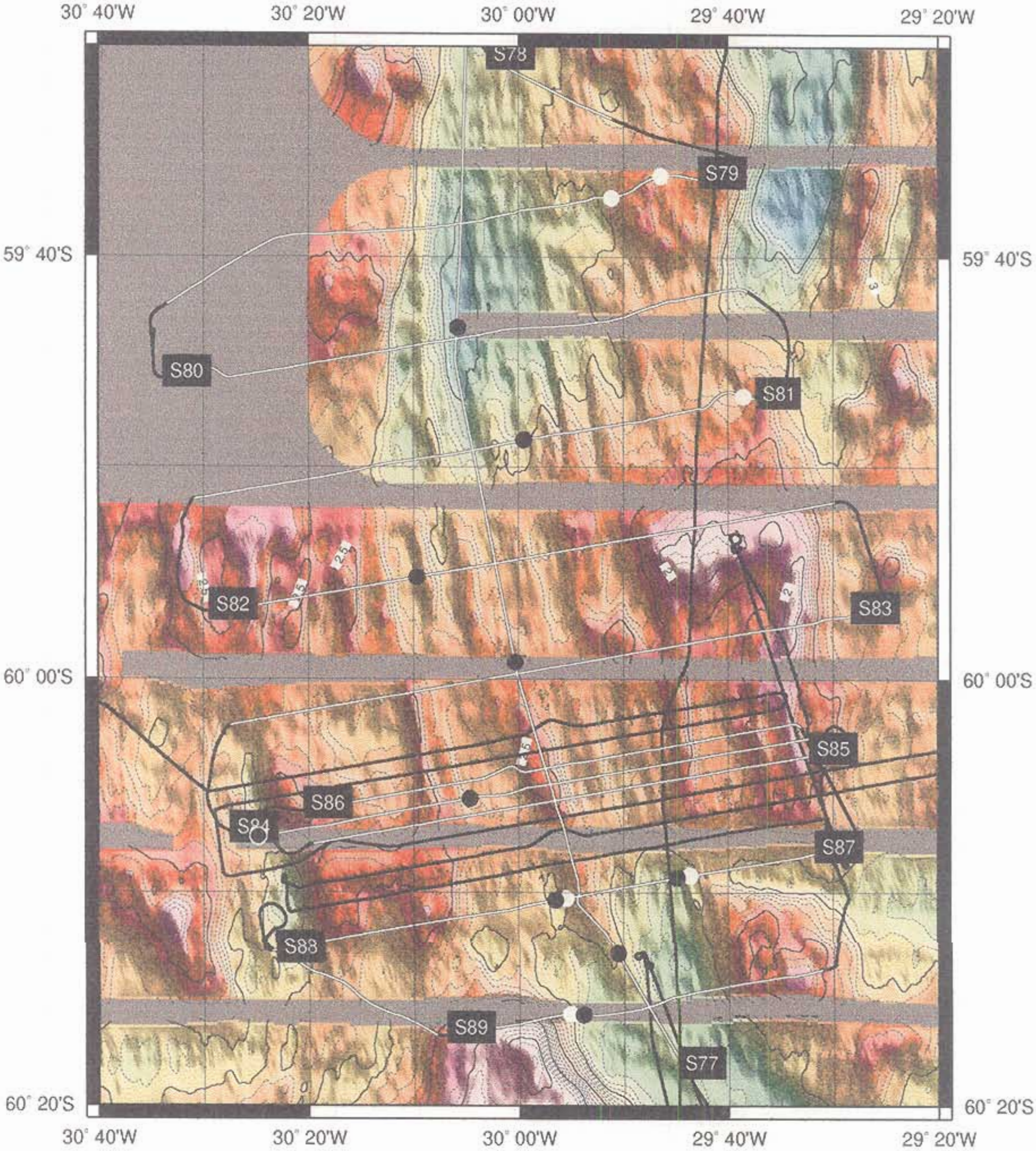
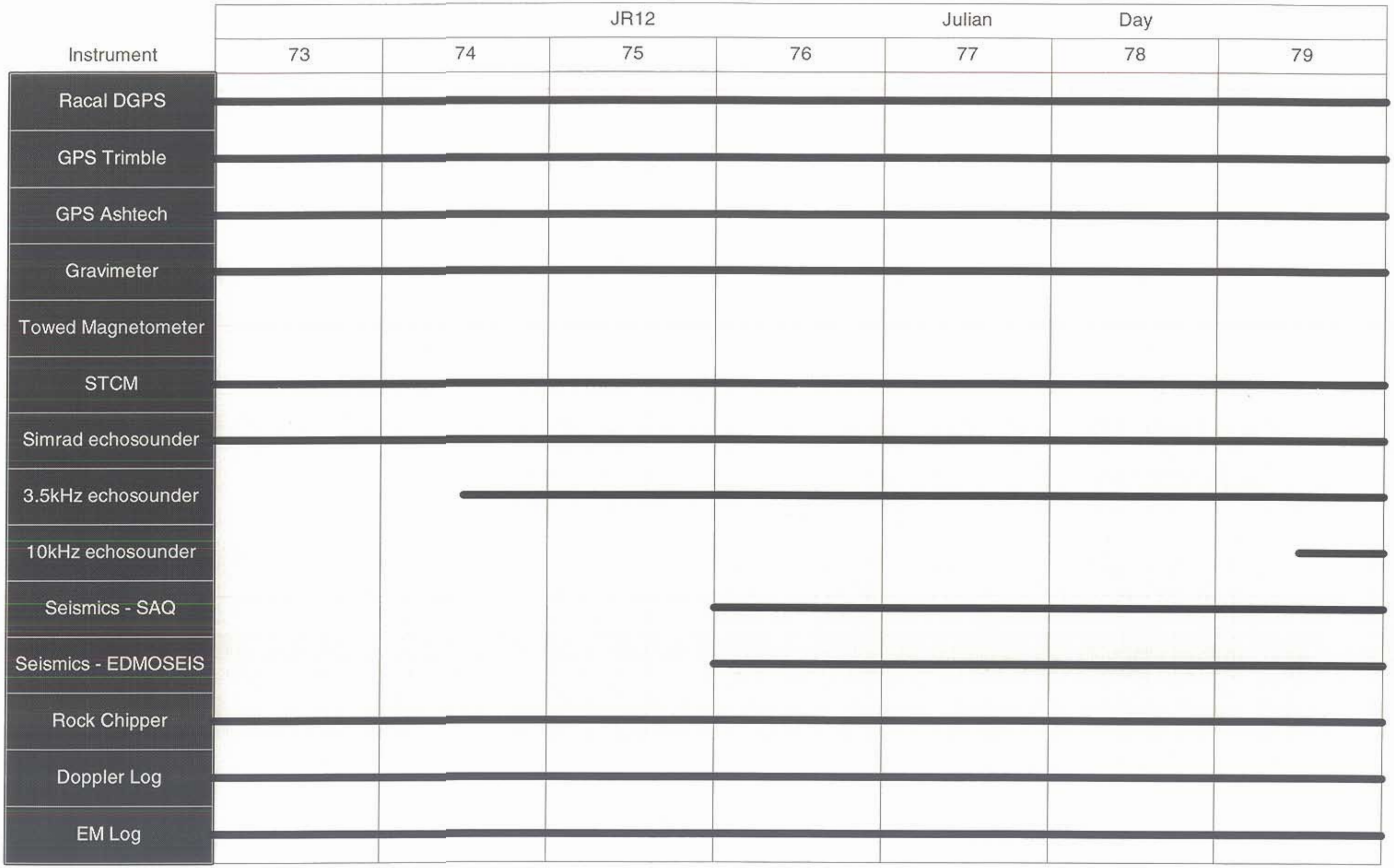
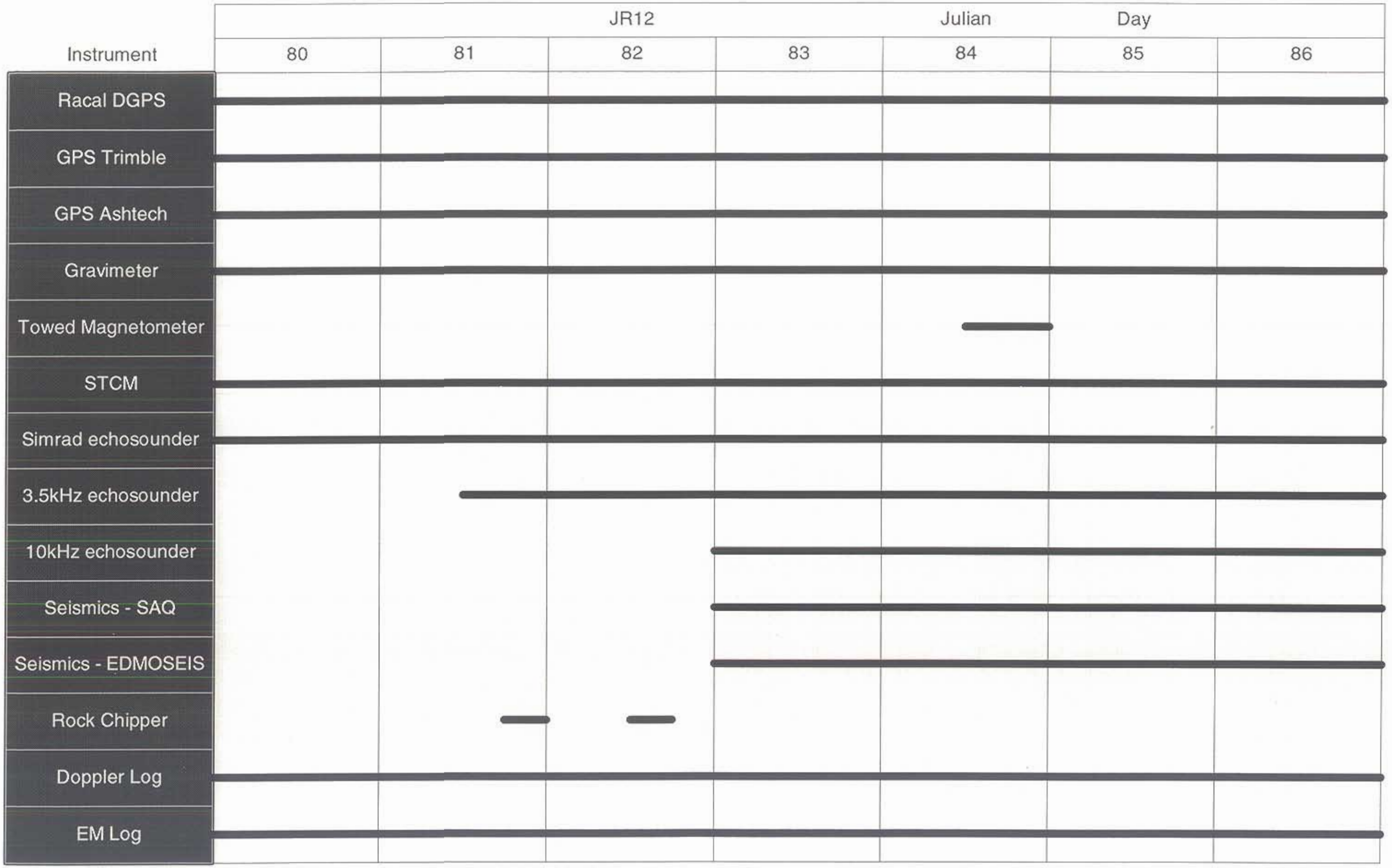


Fig. 6 E9 seismic profiles (white lines), depth contours in km

Fig. 7 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.


JR12
Julian
Day
Instrument
65
66
67
68
69
70
72
Racal DGPS
GPS Trimble
GPS Ashtech
Gravimeter
Towed Magnetometer
STCM
Simrad echosounder
3.5kHz echosounder
10kHz echosounder
Seismics - SAQ
Seismics - EDMOSEIS
Rock Chipper
Doppler Log
EM Log


JR12 Julian Day
Instrument
73
74
75
76
77
78
79
Racal DGPS
GPS Trimble
GPS Ashtech
Gravimeter
Towed Magnetometer
STCM
Simrad echosounder
3.5kHz echosounder
10kHz echosounder
Seismics - SAQ
Seismics - EDMOSEIS
Rock Chipper
Doppler Log
EM Log


JR12
Julian
Day
Instrument
80
81
82
83
84
85
86
Racal DGPS
GPS Trimble
GPS Ashtech
Gravimeter
Towed Magnetometer
STCM
Simrad echosounder
3.5kHz echosounder
10kHz echosounder
Seismics - SAQ
Seismics - EDMOSEIS
Rock Chipper
Doppler Log
EM Log


JR12
Julian
Day
Instrument
87
88
89
90
91
92
93
Racal DGPS
GPS Trimble
GPS Ashtech
Gravimeter
Towed Magnetometer
STCM
Simrad echosounder
3.5kHz echosounder
10kHz echosounder
Seismics - SAQ
Seismics - EDMOSEIS
Rock Chipper
Doppler Log
EM Log

7 Equipment Performance

A complete summary of equipment operation is shown diagrammatically in Fig. 7.

7.1 Navigation

7.1.1 GPS Navigation

On previous BAS geophysical cruises, the principle source of navigation data has been autonomous measurements of the Coarse/ Acquisition code (C/A code) using a single-frequency Trimble 4000 DL, GPS receiver. Due to the policy of Selective Availability, which introduces controlled errors into the GPS satellites' C/A code, autonomous position fixes exhibit horizontal position errors of up to 100 m.

By using two receivers, a base station receiver at a known, fixed, location, and a "rover" receiver, position can be calculated to metre-level precision. The base station receiver computes corrections by calculating the differences between its actual and observed ranges to the in-view satellites. These corrections can then be transmitted to the rover receiver using a radio or satellite link. This is known as Real-Time Kinematic (RTK) surveying, and the standard format for transmitting differential GPS corrections is known as RTCM-104. An alternative method to RTK surveying, which yields slightly more accurate position fixes, is to post-process the data from the rover and base station receivers. This calculates a relative position vector between the base and rover stations and thus the errors due to Selective Availability cancel out. For a full explanation of all differential GPS (DGPS) techniques see Hoffman-Wellenhoff (1992). Both methods of DGPS were deployed during JR12.

GPS Receiver Installation

An RTK capability was provided by the Racal Survey UK 'SkyFix' facility. The DGPS corrections from Racal's base station in Port Stanley, were transmitted to the JCR using Inmarsat communications satellites. The location of the survey meant that only this base station could be used. Inmarsat uses a modulation technique to superimpose a binary code onto the radio frequency. In addition, Racal compresses and applies its own coding to the RTCM-104 messages. Therefore, before the uncompressed differential corrections are passed to the GPS receiver, the Inmarsat radio signal is passed through a demodulator and decoder, rented from Racal. The 'SkyFix' demodulator/ decoder box was installed by a Racal engineer in the radio room within 1 m of the Inmarsat receiver.

The RTCM-104 corrections were supplied to port 1 of the Trimble 4000 DL via a serial cable. The receiver is fitted with RTCM version 2 software and in order to receive the corrections a firmware switch, accessed via the control and RTCM-104 menus, needs to be switched to 'ON/AUTO'. When DGPS corrections are being received, the screen only shows corrected position fixes. Similarly, all the information included in output messages, such as NMEA formatted data or cycle print outs, have also been corrected. DGPS corrections are updated by 'SkyFix' at least every 5 seconds and, on average during JR12, once every 3 seconds. If corrections are being received, a box at the bottom of the receiver's screen, accessed via the position sub menu within the status menu, will say 'DIFFERENTIAL'.

Each of the 4 ports on the Trimble receiver was utilised as shown in Table 1.

Port Number	Input /Output/Power	Type of Message	Instrument port is connected to	Baud rate
1	Input	RTCM -104 V 2.0	SkyFix decoder	9600 8-None-1
2	Output	Cycle Printout	Level A	9600 8-None-1
2	Power			
3	Output	NMEA 83 - GLL message	Ship's Voyage Management System (VMS)	4800 8-None-1
4	Output	Compressed Full satellite message	Logging PC in UIC room	9600 8-None-1

Table 1. Trimble port connections

A BAS Trimble 4000 SSI dual-frequency receiver was installed at the Cable and Wireless offices in Port Stanley, and connected to a Racal dual-frequency antenna installed on the site. The antenna is positioned on the top of a 15 m high ariel mast and has an unrestricted all-round view of the horizon. Data was logged at 5 second intervals onto a PC using the Trimble proprietary logging software 'LOGST'. Each day's data were copied at a preset time onto two sets of floppy disks by employees of Cable and Wireless. The installation was quick and easy and the staff at Cable and Wireless were very co-operative. Data from the ship's Trimble 4000 DL were also logged onto an external PC, again using LOGST, and each day's data were downloaded onto a networked disk, again at the preset time. These two data sets will be processed using GPSURVEY II software in Cambridge.

Operation and Results

Differential corrections were enabled by Racal at 13:00 GMT on day 065. The Trimble receiver operated without any problems until day 083. At that time, the ship was a sufficient distance away from Port Stanley (58° 35.4' S, 29° 59.6' W) that for periods of approximately an hour there were insufficient common satellites seen by the base and rover receivers for a differentially corrected position to be calculated. The receiver continued to output the last calculated position and thus produced a fault on the VMS. Each time a similar situation occurred, the receiver was told to ignore the differential corrections and calculate an autonomous position and the fault on VMS was cleared. Differential corrections were restored to the receiver when the common satellite geometry had improved to a sufficient degree that a differentially corrected position could be calculated.

A comparison between differential and non-differential position fixes is shown in Fig. 8. The satellite geometry at the time these results were taken was such that the major part of the error introduced by Selective Availability appeared in measurements of latitude. Fig. 8 clearly shows the spikes and offsets that Selective Availability introduces into GPS-derived navigation. The largest jump in latitude shown is equivalent to approximately 40 m in position. The figure also shows that the offsets in autonomous position fixes not only produce spiky navigational information but also introduce a longer period uncertainty in fixing a position, in this case an error of ±40 m. How such apparent jumps in position are translated into Eötvös corrections is shown in Fig. 9. This shows that the jumps in latitude produce spikes in the Eötvös correction of over 500 mGal. These spikes can easily be removed with a simple despiking technique, although the underlying signal will still suffer errors resulting from the Selective Availability. In previous years, spikes in the Eötvös correction were directly translated into the final calculated free-air anomalies. However, this was caused by a flaw in the methodology employed by the Level C gravity processing program (see JR09a Cruise Report). The accuracy of Eötvös and latitude correction calculations is obviously improved by increasing the accuracy of the navigation data using differential GPS, as Fig. 9 shows.

There are numerous missing data points within the Trimble database logged by the Level A system. It can be seen from the above table that Level A logs the cycle printout output from the Trimble receiver. Although this message type includes all the data variables required, it is also a variable format message, which, it was discovered, occasionally overloaded the system, thus causing the system to drop data samples. A preferable solution is to log the GGA NMEA formatted message, which is of a fixed length. However this involved splitting the data stream that was linked to the VMS and thus halting the ship's navigation system for a considerable length of time. This change to Level A logging was therefore only completed towards the end of JR12.

Reference

HOFFMAN-WELLENHOFF,B., LICHTENEGGER, H. AND COLLINS, J., 1992. GPS theory and practice. New York, Springer Verlag.

7.1.2 Voyage Management System (RAL)

The VMS is now connected to port 3 of the Trimble 4000 (see Section 7.1.1), even though the latter was installed for scientific purposes. The PC repeater in the UIC again provided a valuable source of information on progress, wind conditions, etc. One of the large touch-screen displays on the bridge failed spectacularly on day 084. As suggested in the JR09a Cruise Report, it would be very useful if digital information, including way points and outlines of key features, could be entered from floppy disc or the network.

7.1.3 Ashtech 3D GPS (PJC)

This unit provides accurate heave, roll, pitch, speed over ground (SOG), course over ground (COG) and true heading information. A four Æ array is mounted on the wheelhouse roof. Positional information is derived from Æ#1 (port side outer). All Æs are surveyed and relative (to Æ#1) x, y and z co-ordinates computed. The Ashtech has four separate channels and requires that five identical satellites are tracked by each channel. Calibration is achieved using static or dynamic data sets.

The system was installed by IOS in 1994 to provide attitude data for the Acoustic Doppler Current Profiler (ADCP). Unfortunately the supplied Æ's were designed for use on an aircraft and not of a suitable construction for seaborne applications. Consequently serious corrosion caused one Æ to fail shortly after leaving Stanley at the beginning of JR11. As the system requires four functional channels this made it unservicable, and the ADCP data would be degraded. No spares had been provided and none were available from the ship. By chance, a GPS system was being carried as part of another project and the Æ was donated to get the Ashtech up and running again.

Several days were spent trying to perform a dynamic calibration but without success. Even a static test at Stromness did not yield a good result. The Ashtech data was recorded for the rest of the leg but without a proper calibration it was decided not to feed roll and pitch information directly into the ADCP.

During the JR11 mid-cruise break in Stanley, a series of successful static calibrations were carried out, the best of which was fed into the Ashtech and used for the whole of the next leg. Regular checks on the Ashtech data showed that sensible data was available for sufficient time to be of use to the ADCP. Further checks on the ADCP data confirmed that the information was "valid".

New Æ's were provided at the end of JR11. The ground planes were modified to accept a single hole fixing and the new Æ's installed. Several static calibrations were carried out at FIPASS and once again the best (quietest) result was fed into the Ashtech. This calibration has been used for the whole of JR12.

7.1.4 TSS300 Heave, Roll and Pitch Sensor

This was operated and logged throughout. Daily plots indicated that plausible values were being generated for heave, roll and pitch, although these differed from those produced by the Ashtech 3D GPS.

7.2 Bathymetry

7.2.1 Simrad EA500

Operated throughout, this was logged via Level B. Sound velocity was set to 1500 ms^{-1} to give depths in uncorrected metres. The results contained intermittant gaps where a seabed reflection could not be identified, as well as numerous error spikes. Fortunately, most of the survey was conducted in areas which had been mapped previously with HAWAII-MR1 (see JR09a Cruise Report).

7.2.2 10KHz Precision Echo Sounder (PJC)

The 10KHz PES worked well during the whole of JR12, although it was not employed for depth sounding, the Simrad EA500 being logged instead.

During wax coring operations, a pinger was attached to the cable 100m above the Rock Chipper. The latter was lowered to 200m off the sea-bed, allowed to stabilise, and then driven at 110m/min into the sea bed. The PES was used to monitor the pinger during these manoeuvres and the trace recorded on the Waverley. This paper record may be of use to future operators.

7.2.3 3.5 kHz Echo Sounder (PJC)

The 3.5KHz echo sounder was in operation more or less continuously from the start of JR12. Minor problems were encountered initially, but these can be attributed to lack of experience on the part of the operator. The latest Raytheon switch settings (as detailed in the manual) proved to be correct and reliable.

It was found that setting the transmitter gain, PES gain and attenuation were best performed using a scope. Clipping of the receive pulses occurred well before the attenuator LED started to flash. Once the PES settings are correct, the Raytheon gain and threshold adjustments can be made. This routine was carried out during initial setting up and after each power cycle.

It is not possible to drive the transducer at full power without the mismatch light coming on. The transmitter ran at -12db for the whole cruise and seemed to give acceptable results. On one occasion the trace was lost and replaced with several narrow "noise" bands. The Raytheon and PES were powered down and all was well when the system was re-booted. Several days later, a similar fault appeared and was again rectified by power cycling.

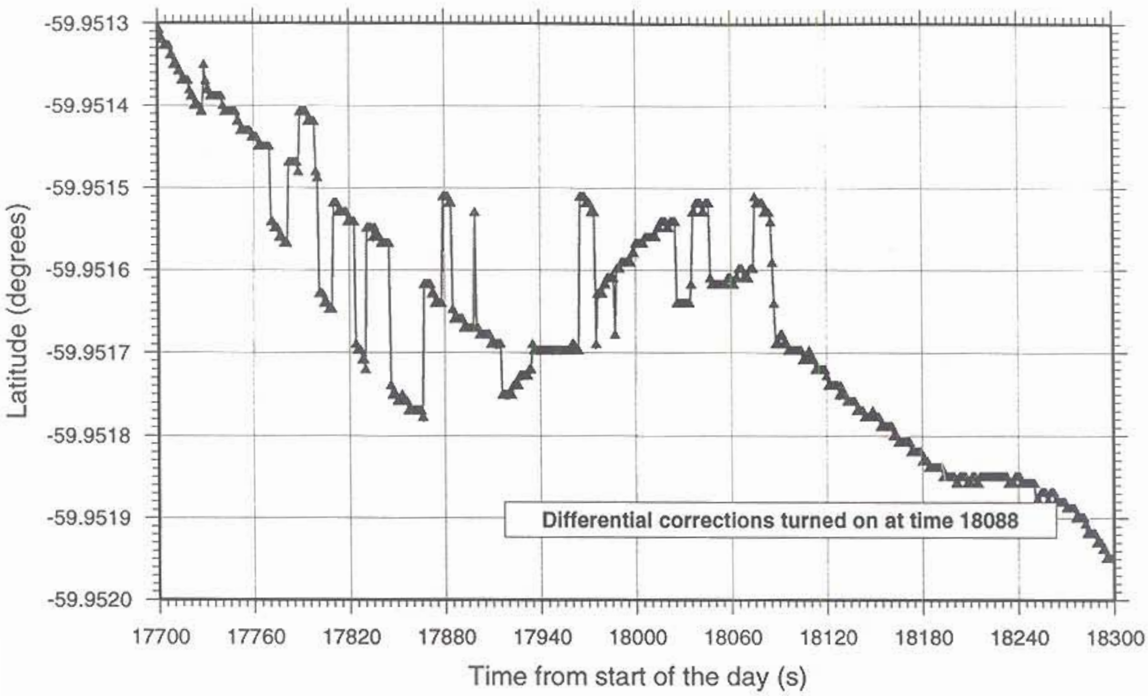


Fig. 8 Ship's latitude from Trimble data

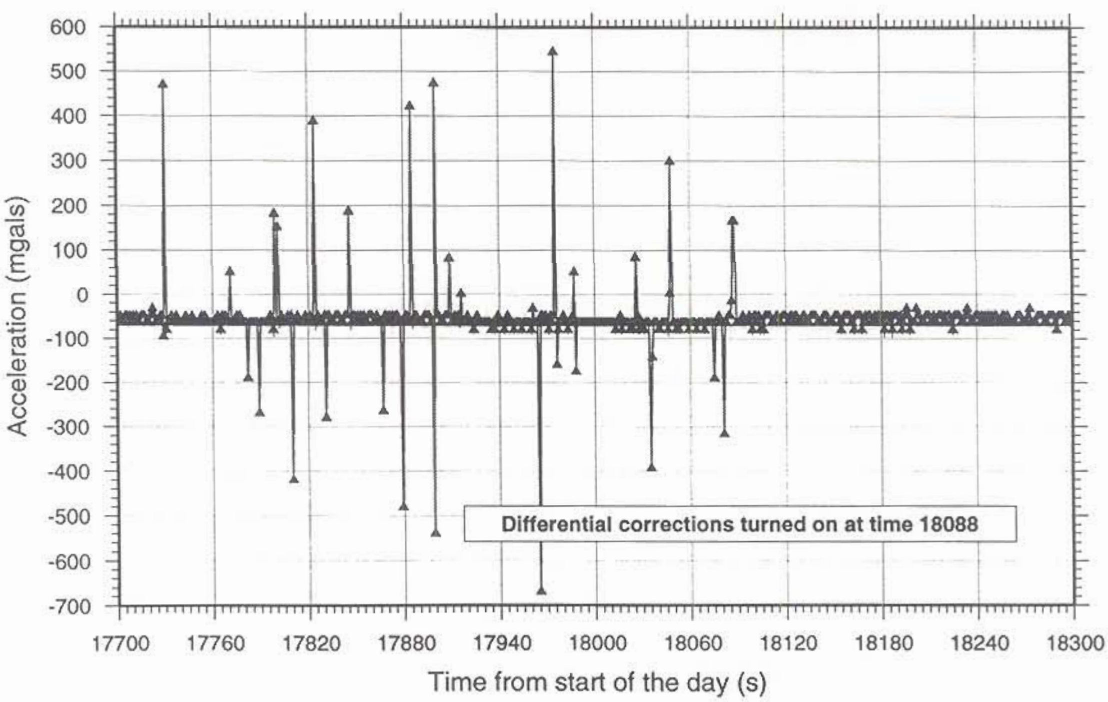


Fig. 9 Eotvos correction calculated from Trimble data

7.3 Gravity

7.3.1 The LaCoste and Romberg Meter S-83 (PCJ)

A LaCoste and Romberg (L+R) air/sea gravimeter, S-83, was deployed on JR12 to measure the gravitational field. This meter has been loaned to BAS by the Hydrographic Office of the Royal Navy, and modified by the Zero Length Spring Corporation (ZLS), primarily for use in an aircraft, but retains the capability of obtaining high quality results at sea. Three important modifications distinguish ZLS modified meters from the commonly used L+R S meter described in numerous papers (e.g. LaCoste, 1967, Valliant, 1992), although similar modifications are included in recent L+R upgrades to their S meters.

The first important modification is to the control system, which has been totally redesigned, all operations of the meter and platform now being controlled by a program running on a personal computer (PC). The PC also records all meter and platform measurements including the outputs from the gyros and accelerometers which form the cross-coupling factors. Instructions from the PC are converted to actions in the platform and meter via a set of electronic circuit boards contained in two units known as the platform control box and the computer interface box. Details of the system can be found in two system guides, LaCoste and Romberg (1977) and ZLS (1994). The raw data recorded on the PC are very lightly filtered using a 200 Hz running-mean filter.

Another modification reduces the sampling interval from 10 seconds to 1 second. This is essential for airborne measurements, since a 10 second sampling interval would induce significant aliasing errors. When measuring gravity at sea, a 1 second sampling interval is not essential, but it is desirable in order to reduce any aliasing effects caused by higher frequency components of the ship's motion. The third major modification is an increase in the slew speed of the spring tension. This is required to keep the beam within the reading range when the meter is subjected to the increased accelerations experienced whilst flying. It is not necessary for ship operations and has the disadvantage of reducing the resolution of spring tension measurements. If S-83 is to be deployed on other cruises, a replacement spring tension motor with a slower slew speed should be purchased, although this would, in addition, require the purchase of a software modification and thus significantly increase the cost.

In order to ensure accurate results, a series of tests and calibrations of the gravimeter need to be undertaken before the start of any survey. A list of the calibrations and the reasoning behind them is given in the aerogravity field report (Jones, 1995). Detailed methodologies for the majority of these tests can be found in various sections of the manuals, LaCoste and Romberg (1977) and ZLS (1994). All these calibrations should be performed in a laboratory on land before the meter is transferred and installed on the ship. Small additional calibrations can be made after the meter has been installed to compensate for any changes that occurred during transportation.

Installation

The gravimeter and platform were mounted in the gravimeter room of the JCR. The platform frame was bolted to a board, consisting of a 10 cm thick slab of vibration-absorbing synthetic rubber, sandwiched between two sheets of plywood. This board acted as a shock absorber filtering out high frequency vibrations generated within the ship. The mounting board and platform were fixed to two steel rails running parallel to the long axis of the vessel. The platform control box was connected via the 1m main cable to the computer and the computer interface box, which were both mounted in their transport case. The computer and computer interface box were powered using the ship's 115V/ 60 Hz power supply. In order to reduce instrumental drift, the meter was connected to the auxiliary heater power supply from the time it was installed in Grimsby in September 1995 until mobilisation of JR12. The auxiliary heater power supply was powered using a 240V/115V transformer.

Operation and Recording

The operating program used throughout JR12 was ZLS_AIR, which started up automatically when the computer was booted. Details of the automatic startup procedure and checks are given in ZLS (1994). The sample rate was 1 second and the platform was left in a 4 minute period throughout the cruise. The typical period and amplitude of the horizontal accelerations induced by the ship's motion are such that a four minute platform period is long enough to obtain accurate measurements. In addition, a four minute platform period is sufficiently short for the transient noise induced by a turn to have dissipated before any target area is reached. See Valliant (1992) and Jones (1995) for a discussion on the advantages and disadvantages of different platform periods.

The gravimeter computer clock can be synchronised to a 1Hz signal generated, for instance, by a GPS receiver. There were difficulties in distributing the 1 Hz signal from the Trimble GPS receiver to the gravimeter. Therefore the gravimeter clock was checked against GPS time every 12 hours and altered accordingly using a procedure described in ZLS (1994). The gravimeter clock only drifted by a fraction of a second per day.

All output signals from the meter and platform are logged to the hard disk of the gravimeter computer in the format given in ZLS (1994). The current hard disk has enough space to log approximately 8 days of data at a 1 Hz sampling rate. Therefore data files had to be purged from time to time. The gravimeter computer runs under the QNX operating system, which is multi-tasking, so that data files can be purged without interrupting acquisition. Details of 'EZFM', the QNX file management program, are given in ZLS (1994). In addition to logging the data onto the gravimeter computer hard disk, the data were recorded on the ship's ABC system. The Level A logged serial data through the gravimeter computer serial port, using a null-modem cable [see ZLS (1994) for a wiring diagram of the null-modem cable and details of the serial port protocol]. Due to the wiring of the null-modem cable, the connection to the serial port of the gravimeter computer should remain intact after serial data have been switched on. The data link is controlled using the configuration menu of the ZLS_AIR program. If this connection is broken, the serial data stream can only be re-established after rebooting the computer. This led to data not being logged to the Level A for a number of hours at the beginning of JR12. However, these data were recorded on the hard disk. Level A successfully recorded all subsequent gravimeter data obtained on JR12. Serial data are initiated at a rate of one per second, but it is likely that there is some delay between initiation and their arrival at the Level A, so the time stamp by the gravimeter computer was used for all subsequent processing.

Data Processing

Standard processing steps were taken to convert raw gravity data to free-air anomalies and are described in greater detail in Swain (1992). This involved making latitude, free-air and Eötvös corrections using software written by Chris Swain and PCJ. Differential, real-time kinematic (RTK) GPS measurements generated by a Trimble 4000 DL receiver were used to calculate all navigational information.

In addition to these standard methods of data processing, corrections were made for gravimeter reading errors caused by the platform tilting when it was subject to horizontal accelerations. These methods are described in Swain (1995) and Peters and Brozena (1995). Also, the cross correlation method of LaCoste (1973) was applied to the measurements. This method is based on the principle that there should be no cross correlation between the observed gravity, corrected for Eötvös effects, and ship motion. The ship motion can be described by a number of independent monitors such as velocity and acceleration and their products, all of which, are recorded in the data stream. The method smooths the observed gravity by adding the fraction of each of the monitors output which is required to give zero correlations. This method has an important added advantage of allowing systematic errors in the platform performance to be detected and then making some sort of correction for them. The mathematical details of implementing the scheme are given LaCoste (1973).

Still Reading

A still reading was taken with S-83 at high tide on 5.3.96, at approximately the same time as G-784 was read. The land meter measurements were made at the closest location to the ship at which a stable land meter reading could be recorded.

The still reading at FIPASS 10:00:00 GMT on 5.3.96 for S-83 = 11433.7 mGal.

The calibration constant for S-83 = 0.9966

Results

Fig. 10 shows the free-air gravity anomaly along seismic line S69. This seismic line was shot as part of the Drake Survey across what is thought to be dead spreading ridge, which can be clearly seen on satellite gravity maps as a prominent negative anomaly. The data in the figure, recorded on a calm day, have been filtered with a low-pass filter with a short, 300 s, cut-off period. This corresponds to a wavelength of 750 m assuming a ship's velocity of 4.9 knots. Although the long-wavelength features have their source in depth or crustal density variations, it is quite probable that the shortest wavelength features are spurious. The distance to the other survey line in the area is too great to check these short wavelength features. A filter with a longer cut-off of 450 s was applied to the data recorded.

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ZERO LENGTH SPRING CORPORATION, 1994. ZLS dynamic gravity meter operating systems, user's guide, version 2, marine system, aeroplane system.

7.3.2 Gravity Tie to Stanley via FIPASS (JKF)

A gravity tie was attempted between the meter S-83 on board the ship to an intermediate gravity base on the closest piece of land to the FIPASS jetty. This gravity base had already been tied with two separated loops, using a Worden gravity meter, to a base station in the BAS offices in Stanley in 1988. A 7-way tie was completed as part of this study, using LaCoste and Romberg gravity meter G874, improving the resolution and the accuracy of the FIPASS base. This showed that observed gravity at the marked base station at FIPASS, Falkland Islands, is 0.91 milligals higher than that at the base station at British Antarctic Survey offices in Stanley.

Hence, absolute value:

Stanley A/B Bassett 1987

	981226.75	(± 0.22)
FIPASS	+ 0.91	(± 0.03)

Absolute value of observed gravity at FIPASS base = 981227.66 (± 0.25) mGal.

±0.22 of this error is that attributed to the BAS offices base by the Directorate of Military Survey, Ministry of Defence, UK, 1986-7. This survey tied the Falkland Islands into the ISGN-71 reference system.

This result compares with a previous estimate made with a Worden gravity meter using two separate ties:

1988 Value 981227.63 mGal (± 0.05)

FIPASS gravity base tie, day 96/065

Gravity meter: S-83
Meter calibration constant: 0.9966

Time: 96/065/10:00
Meter reading: 11433.7

The ship was located 190 metres to the North of the FIPASS base and 190 metres to the West. FIPASS base was measured as 1.5m above sea level at roughly high tide. The shipborne gravity meter was estimated to be 1m above sea level at the same time. It was thus 0.5 metres below the base. No Bouguer or terrain corrections were made.

Latitude correction (LA)
190m at a gradient of -0.79 mGal per km N:
LA = 0.19 * -0.79 = -0.15 mGal

Free-air correction (FA)
FA = 0.5 * 0.3086 = 0.15 mGal

Estimated gravity at ship's meter
g = base gravity + LA + FA
= 981227.66 - 0.15 + 0.15
= 981227.66 mGal

FIPASS gravity base tie, day 96/093

Time: 96/093/20:30
Meter reading: 11430.5

Total drift

11433.7 - 11430.5 = 3.2 mGal over 28.4 days, or 0.11 mGal/day.

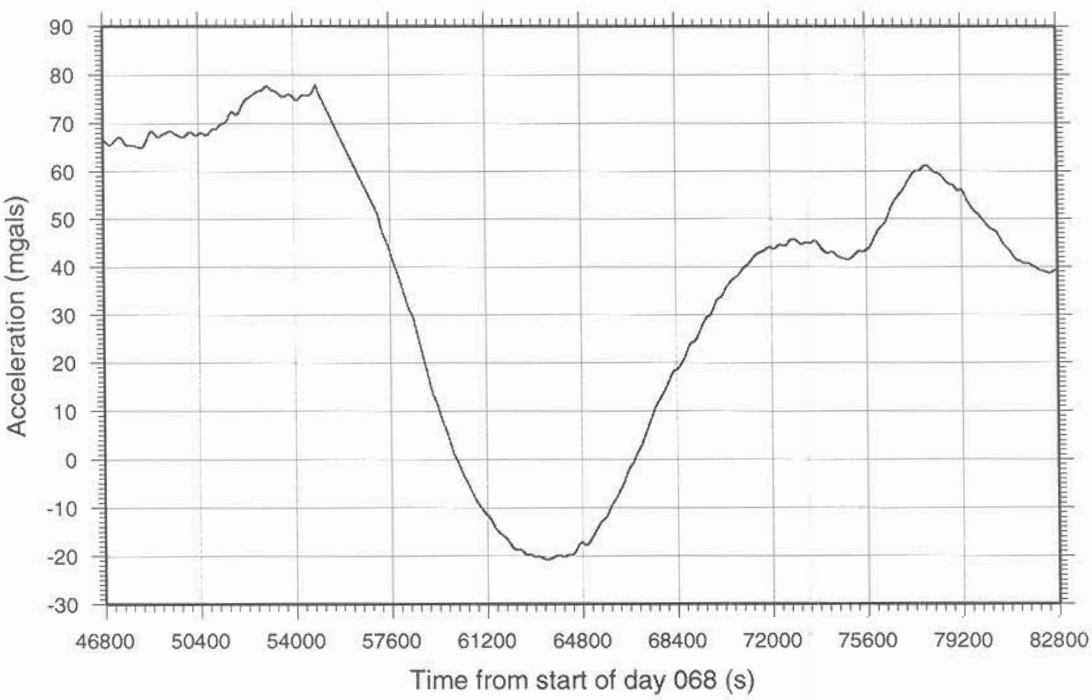

Fig. 10 Free-air anomaly along line S69 filtered with 300s low-pass

7.4 Magnetics

7.4.1 Varian V75 Total Field Magnetometer (GW)

One of the two sensors supplied by RVS was deployed soon after leaving the Falkland Islands, but gave a very noisy signal. The fish was recovered on day 067, and the connectors cleaned, but this did not clear the problem. The fish and cable were then replaced with the spares on day 070, which improved the signal quality dramatically. Later, the signal again became very noisy, so that the sensor was recovered at the next convenient opportunity. Water was found in the deck connector. This was cleaned, to give a good signal once more. On day 084, the signal was lost completely when the amplifier and pre-amplifier in the Varian failed, perhaps caused by a voltage spike from the ship's mains. The boards were replaced, giving a clean signal. On day 087, a particularly heavy (~30°) roll of the ship caused a massive voltage spike which blew the 10 A fuse in the power supply. This was replaced, and the magnetometer continued to operate satisfactorily back to the Falkland Islands.

7.4.2 Shipboard Three-Component Magnetometer (RAL/PM)

The principles of STCM operation, and its advantages compared to conventional towed, total field magnetometers, were discussed in the JR09a Cruise Report, and technical details may be found in Isezaki (1986), Seama et al. (1993) and Korenaga (1995).

This was the first time that the new BAS-built STCM had been operated. Its design, although based on the same principles as the Japanese instrument operated during JR09, had been considerably simplified by Paul Woodroffe of ISG, doing away with gyrocompasses entirely, and using the Ashtech 3D GPS and TSS300HRP attitude sensor for heave, roll and pitch information. The STCM was operated throughout JR12, and was found to be very satisfactory.

Bartington MAG-S03 three-axis fluxgate sensors had been mounted during JR10 on the railings aft of the ship's funnel (Plate II), close to the position occupied previously by the Japanese instrument. These were connected to a control box on the Boat Deck below, containing power supply and analogue-to-digital converters for each of the three sensors. From there, cabling ran down to the UIC, where a dedicated PC running Lab Windows was used to monitor the signals and transmit them to the ship's logging system at 1s intervals. The sensors are mounted so that the three components measured are X: fore-and-aft, Y: athwartships, Z: upward.

Apart from a minor bug, which caused the PC to log times offset by a day, the system operated very well. All three components plus the total field are displayed as they are acquired, and all that is required from watchkeepers is occasional adjustment of the display scale (although this does not affect recording). Compensation manouevres were executed in 'figure-of-eight' loops in the same manner as for JR09a at 7 locations (Table 2), when the three components were seen varying sinusoidally.

Data Processing

Processing of the data was carried out with programs provided by Y.Nogi on cruise JR09a. As his program directories contained several nearly-identical copies of each program including various experimental, non-working, versions, there was some initial difficulty in choosing which to use. Some minor modifications were then required to input the JR12 data. The processing sequence is as follows.

1. Determine calibration constants from ship calibration loops
2. Apply these constants to the STCM data
3. Filter using a low pass filter (25 minute moving average in the present case)
4. Remove any residual trends
5. Find gradients and peaks in data
6. Calculate strike of 2D source.

On long straight runs the instrument worked extremely well and the calculated total field is quite close to that derived from the towed magnetometer. From time to time, when sailing in particular directions, or when shooting seismics, marked level shifts of several hundred nT are present. The reason for this is as yet unclear and requires further study. Some extra directional corrections seem to be required.

Pitch and Roll

The calibration and correction of the data involves the use of pitch and roll information derived either from the Ashtech GPS or the TSSHRP. As the two instruments can give considerably different readings, and the Ashtech was limited to a range of ±5° it is difficult to decide which is the more appropriate. Calibration constants for the STCM were calculated separately using pitch and roll information from the two instruments and also without any pitch and roll data at all. When the data was reduced with the three different sets of coefficients it was found that the Ashtech coefficients produced the worst fit to the proton magnetometer, the TSSHRP coefficients were better, but on average the coefficients calculated without pitch and roll were the best (Fig 11). It seems probable that the short period variations due to the pitch and roll have been removed by the long period (25 min) averaging. Filters of this length are unlikely to seriously degrade the data when operating in deep water where high frequency anomalies from shallow sources are not present. It seems as if it should be possible to dispense with the pitch and roll data for most BAS operations.

Results

A comparison was made between the total field anomalies derived from the STCM and those from the towed magnetometer over the area of the main seismic programme. It was found that when using the calibration constants derived from the first five calibration loops that there was an average level shift of about 325 nT between the proton and STCM on eastward lines and an average shift of about 750 nT on westward lines. When these bulk shifts were applied to the STCM data, the agreement between the two datasets was excellent (Fig 12). The proton magnetometer was not available on the northernmost three lines in this survey area but it is clear that the STCM profiles provide a reliable alternative. Application of level shifts derived from the north-south tie line through the middle of the area will improve the data still further. Vector plots have been produced for a number of line segments but little analysis has yet been attempted.

Thus, the BAS STCM can provide total field magnetic anomaly data with a resolution comparable to a standard proton magnetometer when operating in deep water areas. In addition, it can provide vector information which should be of value for the determination of strike of two-dimensional bodies.

The process of compensating for the ships magnetic moment remains something of a black art. Choosing different sets of calibration loops when calculating calibration coefficients can make radical changes to the overall base levels of the STCM anomalies. This is an area where considerably more study is called for. Unless compensation can be improved drastically, STCM data will probably only be of real use when recorded on straight tracks of more than about three hours duration.

Recommendations

1. Although the sensor and control housings and cables survived JR12 admirably, it would be better if the control box and cabling from there to the UIC were routed internally. A more rigid and permanent fixing for the sensors would also be desirable.

2. Minor modifications to the Lab Windows software would include a switch from μT to nT, the more usual unit in magnetic surveying, a fix for the date bug referred to above, and, perhaps, an additional display, showing magnetic anomalies after removal of the ship's field, based on previous compensation data. An input for a towed magnetometer (total field only) might also prove useful.

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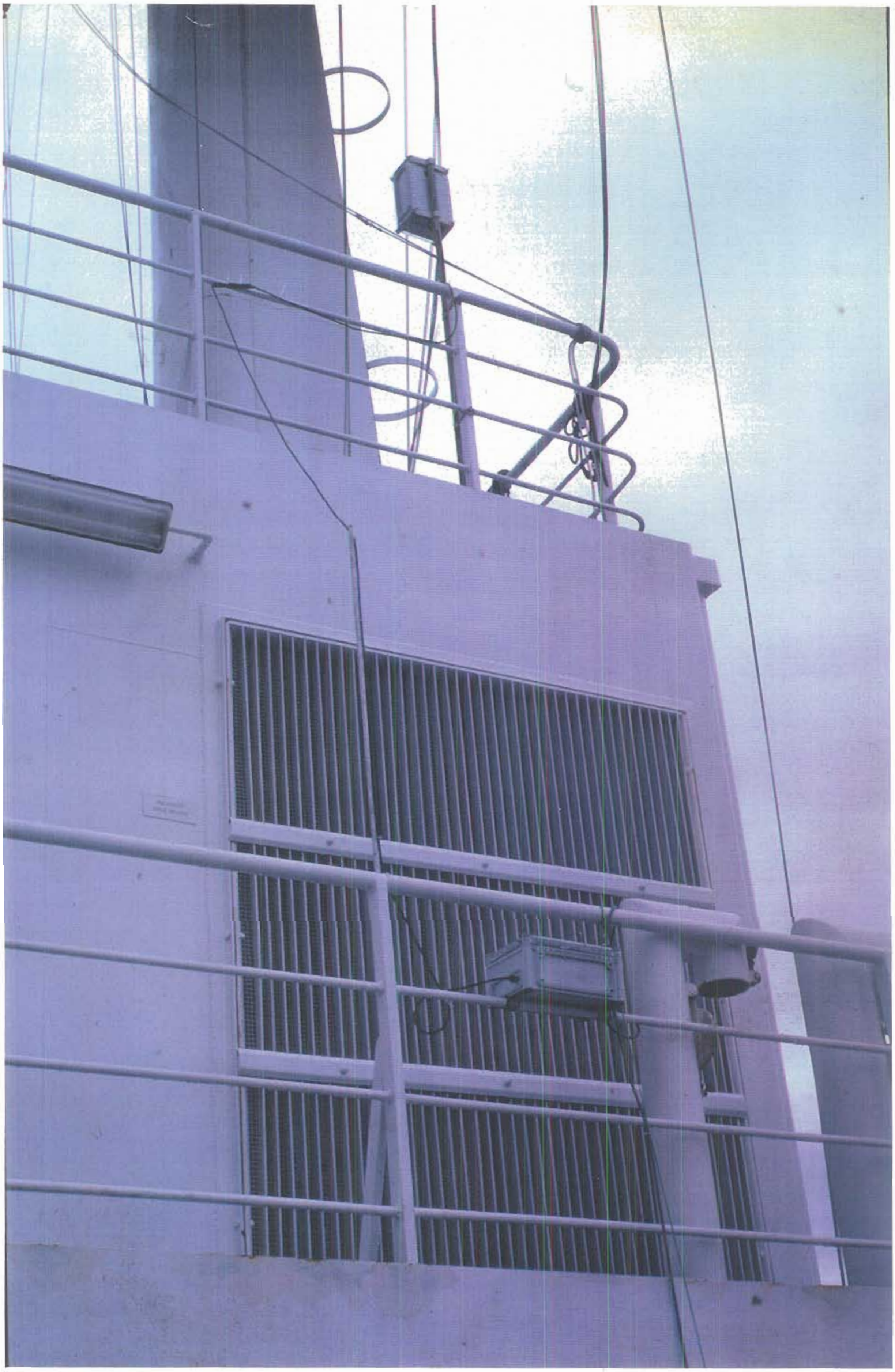
NO	DAY	START TIME	LATITUDE	LONGITUDE
1	65	16:33	-52.0108	-57.6394
2	67	17:42	-56.7400	-47.6850
3	69	00:11	-55.6773	-47.4430
4	70	13:11	-55.9675	-43.1176
5	84	08:06	-60.2258	-29.7982
6	88	08:35	-59.8902	-29.6622
7	91	12:20	-55.6961	-46.3108

Table 2 STCM compensation loops

Plate II STCM sensor installation



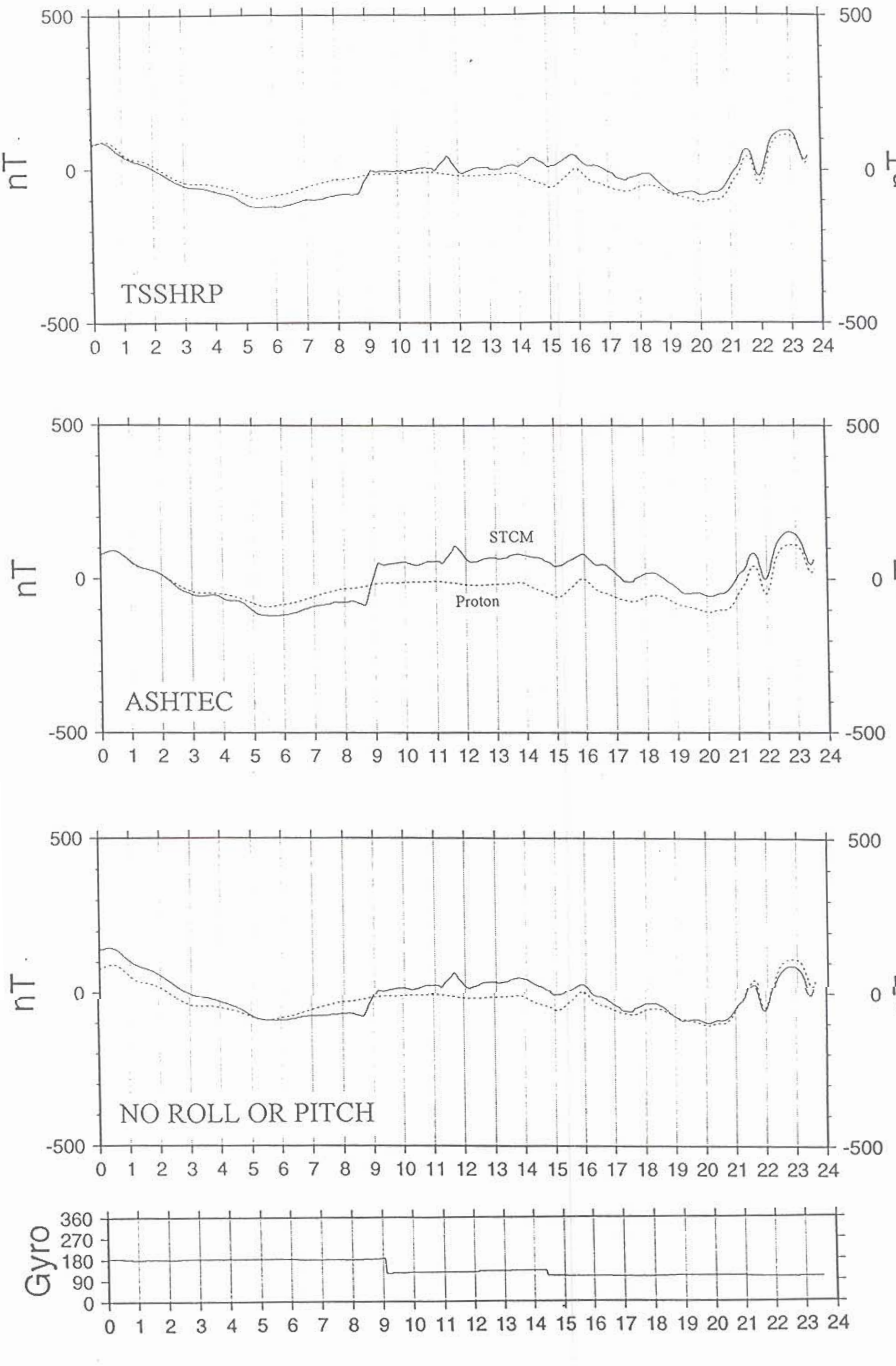


Fig 11 STCM calibrated using different roll and pitch data

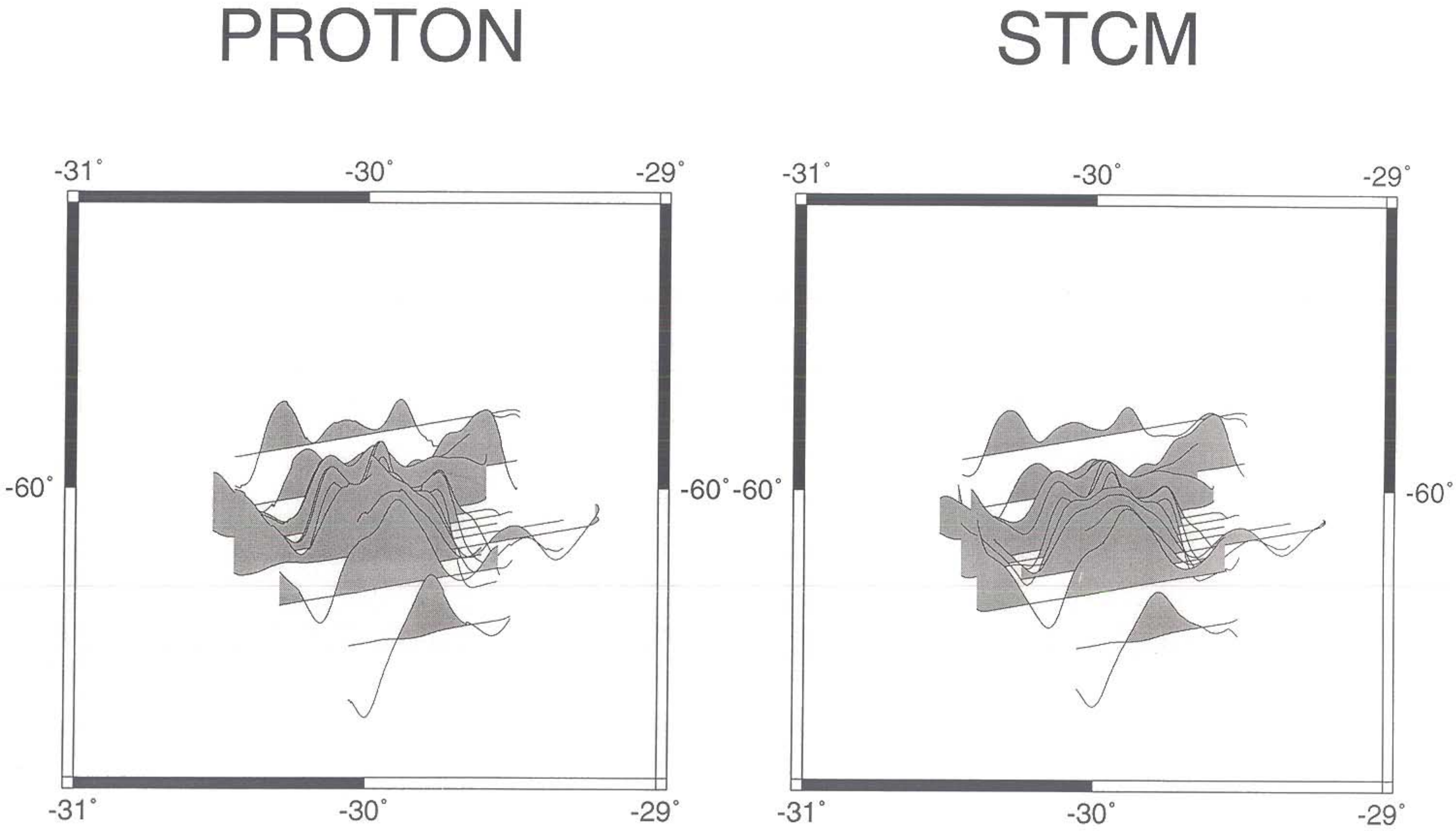


Fig 12 comparison between STCM and proton precession magnetometers

7.5 Seismic Operations

Seismic profiling formed the major part of the cruise plan for JR12. An unusual and extensive swarm of icebergs prevented deployment over the prime target, the E2 "mermaid's purse" segment of the East Scotia Ridge, and only a few, very irregular, profiles were obtained on segment E1 to the north. Following systematic rock sampling of the E2 segment, operations were switched to the southernmost segment, E9, where one along-axis and ten cross-axis profiles were acquired, many with sonobuoy data (see Fig. 6).

A total of 1006 km of 4-channel seismic reflection data were collected on 21 lines, consisting of 3 test lines over extinct tectonic elements in the Central Scotia Sea, collected between days 068 and 070, and 18 lines over segments of the East Scotia Ridge collected between days 080 and 087. The details are given in the Appendix.

An array of 6 airguns with a total capacity of 30.2 l, mounted on two beams, was used. The lines acquired were shot at 20 second intervals if sonobuoy data was to be acquired on the same line, otherwise a 12 second firing interval was used. Towing speeds of 4.9 kts and 4.0 kts were used, resulting in two- and four-fold stacks respectively.

7.5.1 Airgun System (SFB)

The seismic system was installed on the RRS James Clark Ross while alongside at FIPASS (Port Stanley, FI) between 2nd and 5th March 1996. The following equipment was required.

Equipment

RVS 4-channel seismic system
BAS airgun handling system

System Components

umbilical winch (x2)
beam crane (x2)
7 m towed airgun beam (x2)
Bolt 1500c Airguns:
160 (2), 300 (2), 466 (2) cubic inch chambers
towed Hippo buoy (x2)
JCR Gilson winch (c/w 12mm diameter 7x19 ss wire)
JCR port and starboard Effer Cranes
Reftek 43A airgun firing system
Hamworthy air compressors
ship's hydraulic system

Installation

Preliminary installation went well with most of the equipment in position and bolted down by the end of the first day. Containerisation of the equipment was a great success and ensured that we were in a good position to start building up the air-gun system the following day. Hydraulics were plumbed in and testing was completed successfully. There were some outstanding repairs to be completed before testing of the system could commence. The repairs were necessary due to damage caused during loading in Grimsby docks. In future, the equipment will be shipped down on a custom-built container flat. The bulk of the installation was completed on schedule with only one or two minor faults in the system. These were rectified and the system was fully tested. Outstanding items were completed while underway.

Beam-mounted airgun system

The handling system was supplied from the BAS Geoscience equipment pool. The airguns and hydrophone streamer were supplied by RVS. The two BAS umbilical winches were positioned on either side of the aft deck with one of the beam deployed over each quarter. Each beam was assembled with the same gun configuration. Arranged from forward to aft on the beam, the chamber sizes of the guns were 300 cu inch (4.91 litre) , 160 cu inch (2.61 litre) and 466 cu inch (7.61 litre). Shot 'phones were positioned directly above each gun, inside the beam. Depth sensors were also placed inside the beam and positioned at each end.

Deployment and Recovery

The beams were deployed in the usual manner, using the beam winches connected to the aft port and starboard Effer cranes, the starboard beam being deployed first. The basic procedure was as follows:

The beam was raised over the bulwark. The Hippo buoy was connected to the aft end of the beam by 8 metres of 36 mm polypropylene rope. Each gun was then primed to 200 PSI (ca. 14 bar). The beam was lowered into the water by means of the winch mounted on the beam crane, whilst simultaneously paying out the umbilical. The umbilical, which was towed through a fairlead fixed to the end of the starboard airgun boom, was paid out until there were only three turns left on the winch drum. This leaves approximately 60 metres of umbilical deployed beyond the stern.Wire on the beam crane winch was paid out until slack and then tied off on the bulwark, to enable the strain to be taken on the umbilical. The guns are then charged to 2000 PSI (ca 138 bar). The port side deployment is carried out in the same way. Recovery is the reverse of deployment.

Operational Problems

During the first deployment there were a number of gun sealing problems: gun 2 (centre, 160 cu in) on the starboard beam suffered an air leak at the top housing joint. Replacement of seals (P1524, P1554, P640) and top housing sleeve failed to rectify the problem, and the gun was replaced with a spare. Gun 3 (aft, 466 cu in) also suffered an air leak at top housing joint, but was corrected by replacement of seals.

On the port beam, gun 1 (fwd, 300 cu in) had a rapid hammering of the shuttle, and would not seal. It was stripped down and the fault traced to missing operating seal P1524. This was fitted, and the gun sealed on low pressure test. The guns then operated satisfactorily until line S72 (day 083), when ice formed on the shuttles of both 160 cu in guns, causing rapid hammering. The ice was removed, and the guns then operated satisfactorily.

7.5.2 Seismic Air Compressors (SAW)

The *James Clark Ross* is equipped with four air compressors for seismic operations. These are Hamworthy four-stage water cooled machines, controlled in cascade to generate compressed air over the range 138 - 155 bar. This is supplied to the guns from the common reservoirs via a regulating valve which governs the supply pressure to 135 bar (2000 psi). The requirements of this cruise required two machines to be run during 20 second firing rate periods and three during 12 second periods. In both cases the final machine in the sequence was only on load for a short periods of time.

7.5.3 Seismic Recording (AMR)

Equipment:

Geomechanique Type 3 hydrophone streamer
BAS 4-channel PC-based digital recording system
RefTek 43a gun controller and depth monitor
PM 5715 Philips pulse generator
Bell-Howell amplifiers
EPC crystal delay unit
Key pulse generator
Waverley thermal linescan recorder

The streamer was secured to the centre of the after deck by means of matrix bolts. The remaining items above were installed in the UIC room before departing from Stanley.

On initial testing, it was found that the trigger pulse from the RVS RefTek gun controller was of insufficient amplitude to trigger the BAS seismograph. The trigger was therefore passed through the Philips pulse generator to produce a suitable 5 V trigger. The machine used is part of the on-board ISG test kit which is needed for trouble-shooting underway. If similar RefTek gun controllers are to be used on future cruises, it is essential that a dedicated pulse generator be included as part of the seismic acquisition freight. It is also common practise in seismic recording to synchronise the gun controller directly with the ship's master clock (not done by BAS at present). This would allow for better combination of seismic data with navigation and potential field data being recorded along the same lines.

From the deck unit, the seismic signals were passed through a Bell-Howell amplifier (gain of 1) for ease of cabling. They were then taken across the UIC room via 4 co-axial cables replacing the four short twisted pairs used previously. Gains on the BAS seismograph were set at 'high' throughout (all four pairs of dip switches to 'off').

The BAS seismograph includes a network card and Datatrac tape controller. This allowed recorded data to be backed up first to the network where further copies were made, and also in SEG-Y form to the StorageTek open reel tape recorder. Each line was written to a separate tape.

Prior to the start of seismic recording, a calibration check was carried out on the programmable gain amplifiers (PGAs) within the BAS 4-channel seismograph (as suggested by the designer and builder, Edmund A. Mowse). The drift in the calibration of the signal strength was found to be less than 4% for all channels, well within the maximum acceptable range of 10%. During most of the lines, all channels were operated with the PGAs set at gains of 4. Over the E9 segment of the East Scotia Ridge, the part of the recorded signal corresponding to the highly reflective sea-floor caused saturation of the seismograph and a change to gain 2 was made on some lines.

In general, the seismograph (known as *EDMOSEIS*) performed very well. Despite being built as a prototype, it has been operated successfully on both JR09a and JR12. Development to a higher number of channels is strongly recommended.

Short Streamer (AMR)

After re-configuration, this consisted (from the front) of :

tow cable (95 m)
25 m stretch section
20 m weight section
25 m stretch section
2 m weight section
2 x 50 m active sections
2 m weight section
2 x 50 m active sections
1 inactive 50m section
Rope ending in monkey's fist (100 m appx.)

The configuration used was the same as that used during JR09a. Spectral analysis was carried out in order to ascertain the towing depth from the notch in the signal spectrum. At 4.9 knots, it towed at around 13 m.

The first two lines were shot using the streamer as supplied by RVS. It was found that only three channels were recording, so the streamer was brought in to trace the dead channel. It was found that the active sections were, from front to back, 1,2 and 5. Broken wires were discovered in the tow cable and second stretch section; these were not repairable at sea, so spare units were substituted. The streamer was redeployed with sections 1,2,3 and 4 active and operational.

Most lines experienced at least some navigation problems owing to the many ice-bergs in the east Scotia Sea during the time of the experiment. However, the versatility of the small seismic system in such difficult operating conditions was proved beyond doubt. It is strongly recommended that BAS see this acquisition technique as both contributing in its own right and providing a flexible back-up system should conditions similar to those encountered during this cruise prevent planned acquisition of future marine MCS data.

7.5.4 Seismic Data Processing (AMR)

As on previous cruises, the MicroMax seismic processing system was assembled prior to leaving Stanley. It consists of:

Compaq 386/33 MHz CPU
StorageTek 2925 tape drive
Epson LQ1050 dot matrix printer

An NEC MultiSync 3D monitor was borrowed from the ship. Recorded data was written in SEG-Y format to the tape drive direct from the BAS seismograph. Data quality was checked by reading data from the SEG-Y tape into the MicroMax and displaying it on screen and as printed hard-copy. Spectral analyses were carried out using the MicroMax. In contrast to previous years, the MicroMax was positioned close to the StorageTek tape drive used to write the SEG-Y tapes. This arrangement could be further improved by adding a switch box with two 37-pin in/outputs.

The MicroMax software compatibility with the obsolete DOS 3.0 provides networking problems and an alternative should be found for future use (e.g. Unix/ProMax). The use of open reel tapes no longer makes sense with more compact forms of data storage available. Exabyte or DAT tape drives would be compatible with a Unix based ProMax replacement.

Data processing on board was used in both quality control and the production of raw stacked sections for key parts of the E. Scotia ridge. Noise due to the ships 9 MHz radio transmission contaminated a few traces every day, however, the Radio Officer was extremely helpful in avoiding transmission at key parts of seismic lines.

The ProMax software available at BAS Cambridge will be used for further processing and display.

7.5.5 Sonobuoys (RAL)

The system consisted of:

Dowty Ultra SSQ906F sonobuoys (x18)
VHF aerials (x3)
ICOM IC R7000 Receivers (x2)
Eddystone 990R Receiver
Racal-Dana 9082 signal generator
Krohn-Hite 3550 filters
Bell+Howell amplifiers
Store 4D tape recorder
Carrick SAQ digital recording system
EPC crystal delay units
EPC chart recorder (x3)

Disposable sonobuoys provide a quick and effective way of obtaining information on seismic velocities in the crust and upper mantle, without having to set up land or ocean bottom stations. Operation is simple: the buoy detects energy from the airgun array using a hydrophone suspended at a predetermined depth (140 ft was used for JR12), and transmits a signal via VHF radio to the ship, where the resulting 'wiggle trace' is filtered, digitized and recorded. The range of the buoy is calculated using the direct (or water) wave and, if several are deployed simultaneously, the best-fitting drift may be calculated.

VHF antennae were purchased in Cambridge, and installed on the main mast during mobilisation in Stanley. These were connected by coaxial cable to three receivers supplied by RVS, and installed in the UIC room. The output from these receivers was band-pass filtered 3-100 Hz using Krohn-Hite analogue filters and amplified with a gain of 50 applied by the Bell and Howell differential amplifiers. It was then passed through a 125 Hz anti-alias filter, before being recorded digitally by the Carrack SAQ (SAQ = 'seismic acquisition'!) system, also supplied by RVS. EPC printers were connected to each of the three recording channels for quality control. A backup analogue recording facility was provided by an RVS Store4 tape recorder.

Following installation in Stanley, no problems were experienced with the antennae, external cabling or connections. The two ICOM VHF receivers provided by RVS functioned satisfactorily, but the older, Eddystone, receiver was noisy and is in need of replacement. The newly-upgraded version of the PC-based SAQ system used on previous BAS cruises (e.g. JR09a) functioned satisfactorily, although the user interface was felt to be rather obscure and lacking in both online and paper documentation. After acquisition, the SEG-Y format data files were transferred to the Micromax for quality control, and also written to Exabyte tape cartridge for archiving. An example plot of sonobuoy data is shown in Fig. 13. Owing to the limitations of the Micromax software and the networking software installed on the PCs, it was necessary to transfer data via the Sun workstation to the EDMOSEIS PC, from where a 9-track tape could be written for input to the Micromax and for archival purposes. It had been recommended by colleagues at Bullard Labs that a coded clock signal be recorded on the fourth channel on the SAQ system. However, the ship's radiocode clock proved unsuitable for this purpose.

The Dowty SSQ906F sonobuoys used were only 30 cm long and easily deployed by hand from the Boat Deck or wheelhouse roof. The flipper plates were removed and parachutes left in place. Maximum depth (140 ft) and transmitting time were selected. Of eighteen launches, twelve recorded satisfactorily for 2 hours or more. The failures were believed to have been caused by airgun damage soon after launch, except for one which apparently did not deploy its hydrophone. A list of deployments is given in Table 3.

Expendable bathythermographs were deployed at four sites, in order to obtain information on the sound velocity structure of the ocean. A summary of these may be found in Table 4.

Time and Date: 21:10:40 3/17/96
TITLE: JR12S14 Sonobuoy 14 (Ch.1)

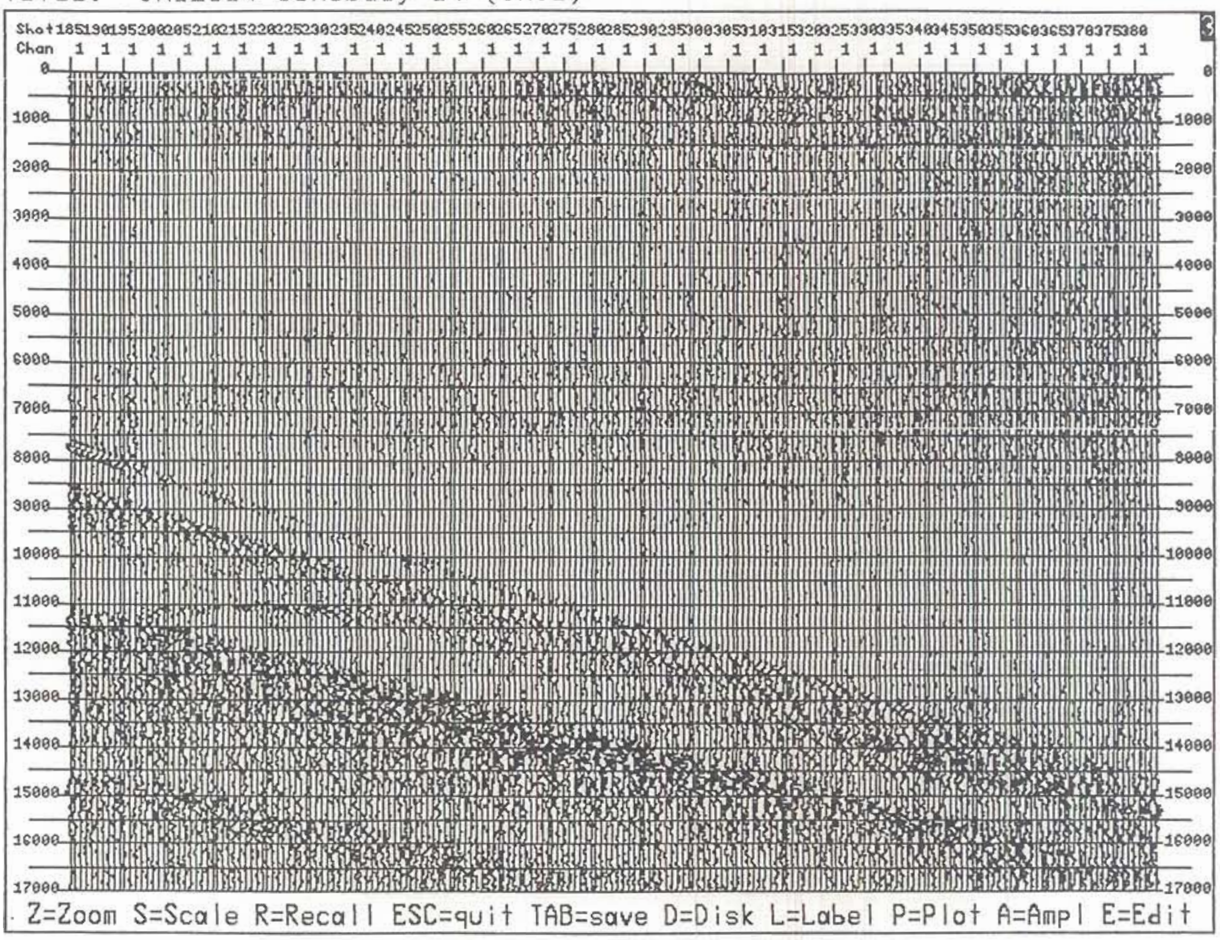


Fig. 13 Example sonobuoy record from segment E9

Table 3: Disposable Sonobuoys

No	Type	Serial	Chan	Frequency MHz	Depth m	Rec No	Deployment Time	Latitude	Longitude	Comments
1	SSQ906F	00119	43	140.125	140	2	96/068/16:23:54	56° 32.08′S	48° 34.70′W	Recorded 2.5 hrs
2	SSQ906F	00118	43	140.125	140	2	96/080/14:09:33	55° 34.13′S	29° 50.83′W	Recorded > 3 hrs
3	SSQ906F	00120	51	143.125	140	2	96/084/11:49:02	60° 12.87′S	29° 50.59′W	Recorded > 3 hrs
4	SSQ906F	00110	31	173.125	140	1	96/084/14:57:57	59° 59.21′S	30° 0.33′W	Recorded > 4 hrs
5	SSQ906F	00111	38	138.250	140	2	96/084/18:34:14	59° 43.36′S	30° 5.77′W	Recorded > 3 hrs
6	SSQ906F	00109	31	173.125	140	2	96/085/01:09:46	59° 36.15′S	29° 46.40′W	Failed
7	SSQ906F	00117	42	139.750	140	2	96/085/01:40:14	59° 37.19′S	29° 51.09′W	Failed
8	SSQ906F	00112	39	138.625	140	1	96/085/14:40:31	59° 46.62′S	29° 38.49′W	Failed
9	SSQ906F	00107	26	169.375	140	1	96/085/16:55:34	59° 48.72′S	29° 59.48′W	Recorded > 3 hrs
10	SSQ906F	00106	25	168.625	140	1	96/085/22:58:57	59° 55.22′S	30° 9.64′W	Recorded > 3 hrs
11	SSQ906F	00116	42	139.750	140	2	96/086/13:00:18	60° 7.41′S	30° 24.79′W	Recorded > 3 hrs
12	SSQ906F	00113	39	138.625	140	1	96/086/15:05:05	60° 5.64′S	30° 4.62′W	Recorded > 3 hrs
13	SSQ906F	00115	41	139.375	140	1	96/087/11:34:00	60° 9.23′S	29° 43.61′W	Failed
14	SSQ906F	00108	30	172.375	140	1	96/087/11:40:25	60° 9.34′S	29° 44.82′W	Recorded >
15	SSQ906F	00105	25	168.625	140	2	96/087/12:32:01	60° 10.29′S	29° 55.41′W	Failed

Table 3: Disposable Sonobuoys

No	Type	Serial	Chan	Frequency MHz	Depth m	Rec No	Deployment Time	Latitude	Longitude	Comments
16	SSQ906F	00101	19	164.125	140	2	96/087/12:43:21	60° 10.38′S	29° 56.44′W	Recorded > 4 hrs
17	SSQ906F	00194	25	168.625	140	1	96/087/20:13:50	60° 15.71′S	29° 55.07′W	Failed
18	SSQ906F	00114	40	139.000	140	1	96/087/20:19.28	60° 15.74′S	29° 53.86′W	Recorded > 3 hrs

Table 4: XBT Sites

No	*Date*	*Time (GMT)*	*Latitude*		*Longitude*		*Depth (m)*	*Comments*
XBT1	96/067	18:11	56°	44′S	42°	41′W	757	
XBT2	084	15:25	59°	57′S	30°	00′W	167	Probable contact with ship
XBT3	084	21:56	59°	30′S	30°	02′W	460	
XBT4	088	14:00	60°	10′S	30°	21′W	180	

7.6 Rock Sampling

7.6.1 Rock Chipper

Wax coring is a very simple technique dating from the HMS *Challenger* voyage of 1872-76, when weighted wax blocks were used to recover rock samples from the sea bed. The Rock Chipper is a wax corer developed by IOS and manufactured by Ocean Scientific International, an IOS "spin-off" company. It consists of a weighted 2m steel column (Plate III) with a cutting head containing five detachable hardened steel cups, into which cold water (surfing) wax is poured. The Rock Chipper is simply dropped onto the bare rock surface, in the hope that some the resulting rock chips adhere to the wax.

Operation (RAL)

A deck frame is supplied, into which the Rock Chipper can be fitted for changing heads or stowage. This was fixed to the deck outside the water bottle annexe on the starboard side of the vessel, by means of matrix bolts.

The Rock Chipper was brought into operation earlier than planned, owing to the high density of icebergs in the working area, which precluded seismic operations. It was deployed by means of the midships gantry on the 16.8 mm steel coring warp on the 30t traction winch. Although the recommended method is by hydro wire, it was decided to use the coring warp for safety. After fitting the prepared head and a 10 kHz pinger, the Rock Chipper was lowered at a rate of 80m/min until 200m from the seabed, as indicated by the PES. It was then left to stabilise for a few minutes before dropping at a rate of 110m/min until impact, after which it was withdrawn either to the surface or to 200m for a further drop. Experimentation with multiple drops indicated that this might increase the yield of rock fragments, although the variability between hauls, even at the same site, was great. This, however, increases the risk of sampling multiple flow units. In deeper water (> 3000m), multiple drops were adopted as the norm.

The first two deployments were on the crest of the mermaid's purse feature (Fig. 5). Both produced small amounts of small, glassy particles plus a fine residue. For these deployments, the recommendations of IOS were followed, and holes were made in the wax in each cup, in order to trap sediment behind the wax. Following problems with dislodged or lost wax, the hole was dispensed with, the cups were completely filled and a shallow indentation or cross was cut in the wax surface, to try to retain fragments. Thirty-four sites were successfully cored on segment E2 (mermaid's purse), one on E1 and three on E3 (Fig. 5; Table 5). Good recovery was achieved on the majority of deployments (Plate IV), although a few failed to recover any worthwhile samples. The major problem was the high density of icebergs, which caused some sites to be missed and others to be altered or abandoned. Nevertheless, a fairly continuous sequence of samples along axis was achieved.

Following deployment and recovery, the cutter head was detatched and immediately replaced ready for redeployment. The head was then taken to the Preparation Laboratory, where the larger fragments were removed from the wax with tweezers, bottled and numbered. In those cases where significant amounts of coherent mud were returned, this was also bottled and labelled. Cups containing fine material were placed into glass beakers which were then filled with water. These were placed in a microwave oven (kindly lent by the ship's Catering Officer and installed by SW in the Biological Laboratory) for two minutes to melt the wax, and then removed to the Prep. Lab. oven, which was maintained at 73°. Rock chips enclosed in the wax were released into the water when the wax melted. The beaker was then cooled and the wax removed. The rock sample was then washed and dried in the oven.

Winch Operations (SAW)

Equipment used:

Thirty Tonne Traction Winch
Steel Coring Warp -
⌀16.8 mm [3 x 19(9/9/1) 1960 RH ORD]
Midships Gantry

Although the thirty tonne winch and a cable of this size may appear to be excessive for the package being deployed, it supplied the best flexibility of operation.

The Chipper was attached to the warp via a swivel, and deployed with the winch in six driven sheaves mode to provide the best control at the ship's side. The wire-out was zeroed at the surface and deployed initially to 50 m (later 100 m) before attaching the pinger. From this point four driven sheaves were used with the speed being regulated to 80-85 m/min until 200 m from the sea bed. The final 200 m were operated at the winch's maximum speed of 110 m/min. The winch was brought to a halt at a wire out value decided before the final high speed decent.

The main problems experienced with the system were in the early stages of the cruise. The first chipping operation brought failure of the storage drum breaks to release after running down to the bottom. This resulted in the chipper being on the bottom for just over an hour before the brakes were released and recovery commenced. This fault was never experienced again and no obvious cause could be found. At the same time, a leak developed on the midships gantry when a blanking plug failed. A repair was caried out after recovery. This delayed the start of the next station by one and a half hours.

The only repeated fault was the failure of the traction winch system to initialise properly on start-up. This only occurred at the beginning of a day's operations and delays varied from a couple of minutes to a maximum of half an hour. This fault is still under investigation.

Recommendations

Several suggestions can be made for improvements to this equipment.

i the use of a larger, heavier sampling head, with more cups,

ii. the use of tapered cups, to prevent wax slipping out during recovery,

iii. safety gate on the deck frame, to prevent the Chipper swinging back into the frame during deployment, and then uprooting the frame from the deck,

iv. fitting deck frame on edge of deck, so that the chipper moves directly out over the water, and does not pass over the heads of people on deck,

v. fitting of additional cups on rods around the stem, to collect samples as it falls over.

7.6.2 Dredging

Dredges were taken on both of the steep (>20°) slopes flanking the "mermaid's purse" (see Fig. 5). The technique adopted (see below) proved effective, and two excellent hauls were recovered (Table 6). Although a small proportion of glacial erratics were found in each, the majority of samples consisted of basaltic rocks and rock fragments, many with a fresh appearance. Large samples were numbered and stored in boxes, while smaller fragments were bagged and labelled.

Winch Operations (SAW)

Equipment used:
Thirty Tonne Traction Winch
Steel Coring Warp -
⌀ 16.8 mm [1 x 19(9/9/1) 1960 RH ORD]
Stern Gantry
Starboard Gilson Winch

This was the first time that *James Clark Ross* had been required to dredge since the thirty tonne traction winch had been accepted into full operations. Previously this had done using a single warp from the Brattvagg trawling equipment. Hence the deployment procedure was under test and the final arrangement is shown in Fig. 14. This only varies from the initial rig in the fact that the changeover from the 42 m pennant to the main warp was done directly rather than stoppering off first. The stoppering off was initially done to avoid the previous problems experienced when linking devices had jamming together. This was not a problem on this occasion.

Fig. 15 shows the actual rigging arrangement of the dredge itself as attached to the ships main warp. The two dredges performed with this rig were both successful.

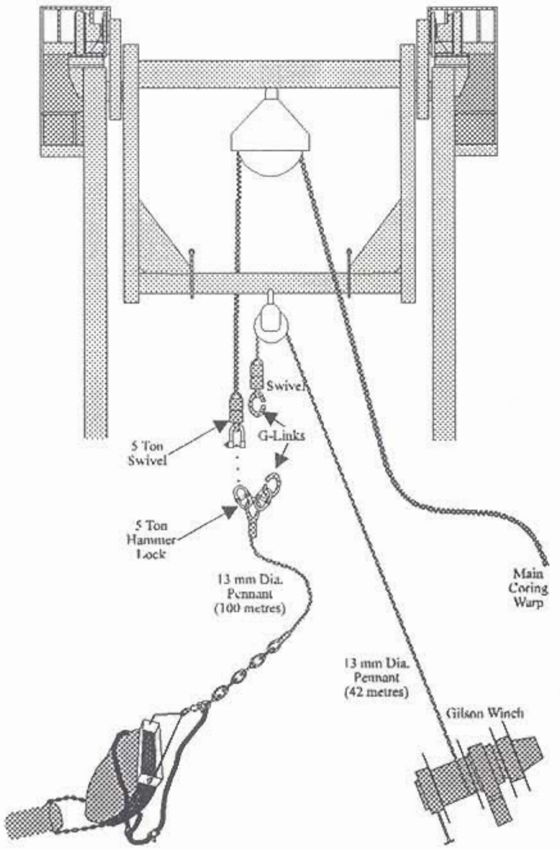


Fig. 14 Dredge configuration

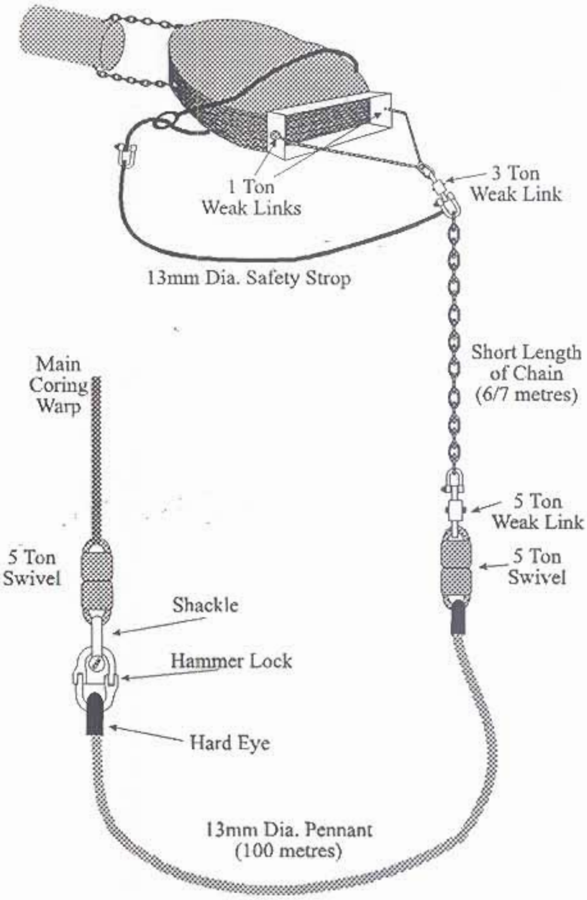


Fig. 15 Dredge rigging

Plate III Rock Chipper

Plate IV   Rock Chipper recovery

Table 5: Wax Core Sites

No	*Date*	*Time (GMT)*	*Latitude*	*Longitude*	*Depth (m)*	*Comments*
WX1	96/072	14:45	56° 5.27′S	30° 17.93′W	2569	One drop, small fragments only
WX2	072	17:00	56° 5.20′S	30° 17.20′W	2686	One drop, fair recovery
WX3	072	19:50	56° 6.01′S	30° 19.06′W	2685	One drop, good recovery
WX4	072	21:49	56° 7.08′S	30° 18.76′W	2749	One drop, good recovery
WX5	073	02:40	56° 8.16′S	30° 18.42′W	2727	One drop, good recovery
WX6	073	04:47	56° 9.98′S	30° 18.50′W	2930	One drop, good recovery
WX7	073	07:05	56° 11.39′S	30° 18.61′W	3106	One drop, poor recovery
WX8	073	10:01	56° 19.09′S	30° 19.68′W	3427	One drop, poor recovery
WX9	073	12:30	56° 19.11′S	30° 19.70′W	3363	One drop, good recovery
WX10	073	14:06	56° 21.81′S	30° 20.39′W	3476	One drop, fair recovery
WX11	073	17:52	56° 25.34′S	30° 21.49′W	3603	Two drops, poor recovery
WX12	073	20:17	56° 26.36′S	30° 21.48′W	3603	Two drops, poor recovery
WX13	073	22:54	56° 28.80′S	30° 22.79′W	3392	Two drops, sediment only
WX14	074	13:28	56° 27.54′S	30° 42.77′W	4023	Three drops, fair recovery
WX15	074	16:56	56° 29.95′S	30° 43.52′W	3965	Three drops, good recovery

Table 5: Wax Core Sites

No	*Date*	*Time (GMT)*	*Latitude*	*Longitude*	*Depth (m)*	*Comments*
WX16	096/074	20:25	56° 24.58′S	30° 43.50′W	3941	Three drops, poor recovery
WX17	075	02:00	56° 30.00′S	30° 23.42′W	3445	Three drops, fair recovery
WX18	075	05:04	56° 28.52′S	30° 22.77′W	3416	Three drops, mud only
WX19	075	09:12	56° 24.00′S	30° 20.99′W	3550	Two drops, good recovery
WX20	075	12:08	56° 20.47′S	30° 20.05′W	3497	Three drops, good recovery
WX21	075	15:11	56° 16.37′S	30° 18.98′W	3339	Three drops, poor recovery
WX22	075	18:00	56° 12.79′S	30° 18.58′W	3204	Three drops, fair recovery
WX23	075	21:03	56° 17.71′S	30° 19.33′W	3330	Three drops, good recovery
WX24	096/076	00:26	56° 13.20′S	30° 18.60′W	3210	Three drops, good recovery
WX25	076	19:04	56° 15.11′S	30° 18.66′W	3308	Three drops, good recovery
WX26	076	22:32	56° 9.49′S	30° 23.96′W	2586	Three drops, brown clay with dark grains
WX27	076	11:04	56° 4.01′S	30° 19.38′W	2687	Three drops, good recovery
WX28	096/077	21:55	56° 4.96′S	30° 19.37′W	2607	Three drops, good recovery
WX29	96/078	00:15	56° 2.92′S	30° 19.33′W	2641	Three drops, good recovery
WX30	078	03:33	56° 0.74′S	30° 19.26′W	2779	Three drops, good recovery

Table 5: Wax Core Sites

No	Date	Time (GMT)	Latitude	Longitude	Depth (m)	Comments
WX31	96/078	09:44	55° 59.66′S	30° 19.22′W	2827	Moderate recovery
WX32	078	13:49	55° 58.60′S	30° 19.22′W	2857	Three drops, good recovery
WX33	078	16:51	55° 57.52′S	30° 19.21′W	2920	Moderate recovery
WX34	078	19:09	55° 56.45′S	30° 19.15′W	3015	Good recoverry
WX35	079	09:53	55° 54.29′S	30° 19.14′W	3051	Three drops, good recovery
WX36	079	16:24	55° 53.22′S	30° 19.13′W	3157	Fair recovery
WX37	079	19:23	55° 51.85′S	30° 19.09′W	3237	Good recovery
WX38A	96/081	18:30	55° 34.18′S	29° 51.49′W	4275	E1 segment, three drops, poor sample.
WX38B	96/081	18:30	55° 34.18′S	29° 51.49′W	4275	Three drops, good recovery
WX39	96/082	14:09	57° 24.34′S	30° 6.53′W	3767	Three drops, three large fragments of glass.
WX40	96/083	04:18	58° 36.31′S	29° 57.21′W	3709	Good sample.

Table 6: Dredge Sites

No		*Date*	*Time (GMT)*	*Latitude*	*Longitude*	*Depth (m)*	*Comments*
DR157	Start End	96/077	13:03 15:07	56° 6.89'S 56° 6.76'S	30° 15.91'W 30° 17.42'W	2955 2581	Good recovery. Several large basalt samples (>5 cm); mud filled bucket.
DR158	Start End	077	17:00 18:57	56° 6.93'S 56° 6.93'S	30° 21.59'W 30° 20.43'W	2960 2590	Excellent recovery. Several very large pillow basalt samples (>20 cm); mud filled bucket.

7.7 Data Logging (PD/GJB)

7.7.1 Level A Computers

GPS_ASH

This caused problems early in the cruise because the Level A was taking its time from the Ship's clock and not the GPS receiver. This is usually the best way of doing things, assuming the Ship's clock is synchronised to GPS time. Unfortunately this is not the case on JCR and pairs of records were stamped with identical times. This was partially fixed by modifying the Level A application so that it takes the time from the NMEA message. Unfortunately the NMEA message does not give the date, so there can be problems at midnight which require manual correction of the julian day using the RVS *recno* and *modtime* utilities.

Recommendation: Install equipment to automatically synchronise the Ship's clock to GPS time.

TSSHRP

No problems were encountered with this package, although the data from it needed to be processed into degrees on the Level C by dividing by 200. This was accomplished using the RVS *clop* program. The processed data from this instrument was stored in the *protss* data stream.

EM_LOG

No problems were encountered with this package.

DOP_LOG

No problems were encountered with this package.

GPS_TRIM

This package suffered from the fact that the scientific GPS receiver had been commandeered by bridge staff for use with the Vessel Management System (VMS). The VMS was supplied with the NMEA data while the Level A had to make do with the cycled printout messages. These messages can be very long and frequently cause serial overrun messages on the Level A, together with frequent gaps in the data. A splitter lead was built by Pat Cooper with the idea of connecting the NMEA output to both the VMS and the Level A. At this time all that is required is a lead to go from the splitter lead to the 25 way D type wall socket which is patched through to the Level A.

Recommendation: Enable the sharing of NMEA data from the Trimble GPS receiver by either the splitter lead or an RS-232 buffer box.

MAGNET

No problems were encountered with this package. Data from this instrument was processed on the Level C using the RVS *promag* software with the resulting data being stored in the *promag* data stream. One annoying thing was that the *promag* software gave almost all of the output data records a reject status of '20' instead of the normal good status of '50'. All the data was changed to good status using the RVS *edstatus* utility, before being manually edited using the interactive data editor.

BAS_STCM

This PC based Level A consistently output times one day ahead of what they should have been. This required the use of the RVS *recno* and *modtime* utilities to correct the julian day. This instrument was also found to react to levels of RF of less than 1W, perhaps due to inadequate shielding of the instrument (which is mounted in a plastic box) or the cabling.

Recommendations: Correct the software that it outputs the correct day and improve the shielding of instrument and cable.

BAS_GRAV

Problems were encountered early on in the cruise with the Level A application which needed to be modified, together with the serial cabling. Investigations by Pat Cooper, suggested problems were arising due to the receive data line to gravity meter being unterminated at the other end and these were solved by disconnecting the line. Data from this instrument was processed on the Level C using the RVS *prograv* utility and the processed data was stored in the *prograv* data stream.

SIM500

This package suffered from records with duplicate times when the depth is relatively shallow, but apart from this suffered no problems. Data corrected for Carter Area by the RVS *prodep* program.

Recommendation: Find a way to make the Level A output data only once a second.

GYROSYNC

No problems were encountered with this package.

An attempt was made to log the Seametrix winch system. Unfortunately there is only one data line coming from the Seametrix to the Level B, and no data line from the Level B to the Seametrix, so the Level B cannot transmit its ACK/NACK signals. If new cabling is installed this may fix the problem.

7.7.2 Level B Computer

The Level B generally behaved very well during the cruise, despite a very high data throughput. The ethernet link from the Level B to Level C went down several times for no apparent reason. No data was lost as the backlog was always well below the size of the Level B's disk FIFO's which are currently 67MB in size. No network errors were shown on JRUB's console, although there were sometimes error's on JRUC's console. All power was lost to the computer and data prep rooms on day 088 for a short period of time. The Level B remained up with the Galatrek UPS providing power. It seems that the Level B console is not taking its power from the UPS - this will be corrected after logging is concluded. Several times the Level B output debug messages as follows:

```
1:to_disc DEBUG: cannot write to "FIFO
2" (err=000:225)
```

The error message indicates an "impossible interrupt vector". The disc was then set to BAD by the Level B which then stopped all accesses to it. The OS-9 *dcheck* utility was used to check the integrity of data on the drive, and it reported no problems. The Level B *cb_man* utility was then used to modify the Level B control block, setting the health of the fifo to NO_RD. This action was taken at every occurrence of the disc turning BAD.

Recommendations: Modify the Level B *to_levc* process so that if the link goes down, it automatically tries to re-establish the link every five minutes. Investigate the reasons why the Level B is setting the disc to BAD. Purchase a network analyser for use in seeking out network problems on JCR.

7.7.3 Level C Computer

No major problems were encountered with the Level C. Apart from the processing that has already been mentioned in the Level A section, navigation was processed using the RVS *relmov* and *bestnav* programs with the resulting data stored in the *relmov*, *bestnav* and *bestdrf* data streams.

Plots were produced of Ship's track, together with profile plots of gravity magnetic field and eotvos on sections of Ship's track. Twenty-four hour plots of em_log, dop_log and GPS speeds were produced in order to compare data from the three sources. Six hourly plots were produced of pitch and roll data from the TSS system and the Ashtech GPS system. Eight hourly plots of processed bathymetry data were also produced.

Daily backups were made using the Unix *tar* utility to Exabyte 8mm tape cartridges.

7.8 General Computing and Peripherals (GJB/PD)

The HP650C A0 Plotter suffered a complete failure early on in the Cruise. Despite efforts to locate and rectify the fault, involving contacts with BAS HQ and HP, it proved impossible to restore this service. This was unfortunate as it was critical to planning and decision making.

Some tapes (UNIX) brought from Cambridge did not yield their full contents. It is not clear if this was because of a fault with the tape or with the DAT tape drive on JRUA. Also a copy of JR11 data had been made using the JRUA DAT drive, before the start of JR12 and this failed to restore later (even though it had been verified at the time). Other backups were restored without problems, however.

A directory from the PC server JRNA was mounted as part of the UNIX file System on JRUA and JRUC. This made it easier to transfer hierarchies of files between UNIX and PC platforms. It was particularly useful in accessing the CD ROM on JRUA for PC use.

Extra file space for JRUA was created by mounting the spare drive on JRUC on JRUA. A mount point of /local5 was created.

Recommendations

1. The situation where level A applications are written during mobilisation should be avoided if possible.

2. All tapes brought from Cambridge should be verified there. The "dump" command might be more useful than "tar" as it allows interactive restores and a directory listing as well as being able to use more than one tape per backup. Important files should be brought on a variety of media types eg 4mm DAT, 8mm DAT, CD ROM etc.

3. Because of the ever increasing demand for disk space, it might be more practical in the future, for departments to purchase their own SCSI drives and bring them pre-loaded with applications and data. These could then be plugged into the existing hardware and file systems on the ship.

4. If 3 is not possible the use of CD ROMs should be encouraged and CD ROM drives should be available on all machines. On the PC front, the portable ZIP drives that take 100MB diskettes should be encouraged and be permanently made available on the ship.

5. When bringing copies of PC C: drives on tape it is advisable to bring all files and directories. This is because applications now require files such as registration files as well as profile files to run. There were occasions on this cruise where important files were not brought.

6. If possible original installation disks should be brought for applications. Copies do not always work.

7. A thorough audit of the ship's computing network (copper and fibre optic) should be made on return to the UK. Hopefully this will eliminate the intermittent poor performance experienced.

8. An additional file and application server on the Officer's deck would not require much extra management and would improve the performance of Office Automation Applications.

8 Recommendations

Minor and specific recommendations are given in the relevant sections of this report. The following general recommendations are made.

1. Differential GPS should be considered for all geophysical cruises. The real-time Racal Skyfix system provides a dramatic improvement in navigation, simplifying processing of gravity and seismic data, without the need for additional BAS manpower.

2. The small seismic reflection system provides an excellent method for acquiring important information in difficult conditions. This makes it valuable both as a front-line tool, and as a contingency for multichannel seismic or other operations. Such a system should be carried on all BAS Geoscience cruises, if possible.

3. Use of sonobuoys can provide important information on crustal structure, both for geological interpretation and for seismic data processing, but the disposable types have severe limitations. Construction of larger, re-usable sonobuoys, employing GPS location and seismic (low-frequency) hydrophones, should be investigated.

4. The Rock Chipper proved an outstanding success, and should be carried aboard *James Clark Ross* at all times, so that interesting sites may be sampled whenever convenient. A series of straightforward modifications to the system (see section 7.6) should be completed before re-deployment. Construction of a larger version could also be considered.

5. The STCM should be developed into a more rugged system for continuous operation whenever the ship is at sea. This requires only minor changes to the housings and fixings of sensors and electronics.

Appendix

4-CHANNEL SEISMIC REFLECTION LINES

LINE	TIME (GMT)	LATITUDE	LONGITUDE	SHOT (s)	DIST. (km)
956-S69	0421/068 1156/068	56°30.3'S 56°24.0'S	48°04.6'W 49°10.8'W	20	73
956-S70	1238/068 2233/068	56° 27.7'S 56° 39.1'S	49° 12.1'W 47° 39.2'W	20	103
956-S71	2254/069 1155/070	57°10.4'S 56°01.0'S	43°08.8'W 42°59.9'W	20	137
956-S72	1043/080 1231/080	55° 39.2'S 55° 31.3'S	29° 50.5'W 29° 50.4'W	12	16
956-S73	1354/080 1516/080	55° 32.8'S 55° 39.4'S	29° 51.0'W 29° 51.4'W	20	13
956-S74	1634/080 1801/080	55° 40.3'S 55° 33.0'S	29° 51.2'W 29° 51.9'W	20	15
956-S75	1832/080 2001/080	55° 32.8'S 55° 38.2'S	29° 47.9'W 29° 50.1'W	20	11
956-S76	2008/080 2028/080	55° 38.1'S 55° 38.1'S	29° 51.1'W 29° 54.1'W	12	3
956-S77	1037/084 2120/084	60° 18.3'S 59° 30.0'S	29°44.2'W 30° 05.0W	20	96
956-S78	2144/084 2302/084	59° 30.7'S 59° 33.5'S	30° 02.4'W 29° 51.1'W	20	12
956-S79	0045/085 0625/085	59° 36.3'S 59° 42.3'S	29° 42.1'W 30° 33.4'W	20	52
956-S80	0720/085 1320/085	59° 45.8'S 59° 41.6'S	30° 33.2'W 29° 38.1'W	12	55
956-S81	1430/085 2001/085	59° 46.8'S 59° 51.6'S	29° 36.7'W 30° 30.9'W	20	54
956-S82	2103/085 0315/086	59° 56.8'S 59° 51.6'S	30° 28.7'W 29° 29.7'W	20	58
956-S83	0445/086 1140/086	59° 56.9'S 60° 02.2'S	29° 27.6'W 30° 27.4'W	12	59
956-S84	1251/086 1840/086	60° 07.3'S 60° 02.6'S	30° 26.8'W 29° 30.9'W	20	55
956-S85	1925/086 0119/087	60° 03.5'S 60° 07.8'S	29° 31.6'W 30° 19.5'W	12	47
TOTAL THIS PAGE					859

LINE	TIME (GMT)	LATITUDE	LONGITUDE	SHOT (s)	DIST. (km)
956-S86	0253/087	60° 06.2'S	30° 19.8'W		
	0840/087	60° 02.2'S	29° 33.0'W	12	46
956-S87	1015/087	60° 08.2'S	29° 31.0'W		
	1534/087	60° 12.8'S	30° 23.5'W	20	51
956-S88	1654/087	60° 12.9'S	30° 22.4'W		
	1900/087	60° 16.7'S	30° 07.8'W	12	16
956-S89	1910/087	60° 16.6'S	30° 06.2'W		
	2226/087	60° 13.6'S	29° 31.0'W	20	34
TOTAL THIS PAGE					147
TOTAL					1006