Cruise Report

RRS *James Clark Ross*

Cruise JR53
September to October 2000

Atlantic Ocean Marine Geophysics

Alex P. Cunningham and Neil C. Mitchell

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CONTENTS

1. SUMMARY

During cruise JR53 (September to October, 2000), scientists from BAS Geological Sciences Division and Cardiff University conducted marine geophysical survey during the southward passage of RRS *James Clark Ross* from Portsmouth to Montevideo. This cruise was the first of a proposed programme of transit surveys using the recently installed Simrad EM 120 multibeam echo sounder and TOPAS sub-bottom profiler. Our main objective this season was to survey an 80-km section of the Mid-Atlantic Ridge near 1°45'S. This work was completed successfully and the new multibeam data show the geomorphology of the ridge in detail. Multibeam data collected on passage between oceanographic stations reveal several areas which might, with future transits, prove fruitful for study including the Southwest Approaches, Bay of Biscay, the margins of Ascension Island, the continental rise bordering the Canary Islands and Africa, and the Brazil Basin.

2. PERSONNEL

Scientific and Technical

A. P. Cunningham	BAS Geological Sciences Division	Geophysicist
N. C. Mitchell	Cardiff University	Geophysicist
A. Barker	BAS ITS	Computer engineer
Vsevelod Avanasyev	BAS ETS	Electronic engineer

Ship's Officers

M.J.S. Burgan	Master
G. Chapman	Chief Officer
J. A. McCarthy	2nd Officer
N. Macleod	3rd Officer
S. J. Mee	Radio Officer
D. E. Anderson	Chief Engineer
C. Smith	2nd Engineer
R. J. Macaskill	3rd Engineer
G. J. Armour	4th Engineer
D. P. Trevett	Deck Engineer
A. K. Rowe	Electrical Engineer
J. S. Gibson	Catering Officer

Crew

C. D. Lang	Bosun
D. J. Peck	Bosun's mate
A. M. Bowen	Seaman
K. E. Chappell	Seaman
K. M. Dickson	Seaman
G. A. Dale	Seaman
L. J. Trussler	Seaman
E. Allan	Motorman
R. Parsley	Motorman
D. K. McManamy	Chief Cook
T. J. Macaskill	2nd Cook
L. Jones	Senior Steward
S. D. Hadgraft	Steward
M. Weirs	Steward
G. Raworth	Steward

3. TIMETABLE OF EVENTS

September

13	Ship departs Portsmouth
14	Start of TOPAS and EM 120 data collection on passage
15	Test deployment of AMS SV^{PLUS} sound velocity profiler (SVP) at station AMT11–03
17	TOPAS data collection stopped due to synchronisation problems
22	EM 120 data collection halted at the limit of Cape Verdes EEZ
23	EM 120 data collection restarted at the limit of Cape Verdes EEZ
27	Start of Mid-Atlantic Ridge multibeam survey, and deployment of SVP at station AMT11–24
29	Completion of Mid-Atlantic Ridge multibeam survey

October

06	STCM compensation manouevre
10	EM 120 data collection halted at the limit of Uruguay EEZ
11	Ship arrives Montevideo

4. INTRODUCTION

Much of our knowledge of slow-spreading mid-ocean ridges is based on data collected during the many cruises in the North Atlantic over the past 30–40 years. However, the character of the Earth's geoid over the North Atlantic, which is dominated by the broad Azores and Icelandic anomalies, is markedly different to that of the South Atlantic, which consists of many, more localised anomalies. Assuming that magmatic and ultimately tectonic ridge processes are in some way affected by mantle temperature and composition reflected in the geoid character, the northern Mid-Atlantic Ridge (MAR) is not necessarily representative of slow-spreading ridges.

Cruise JR53 (track shown in Fig. 1) was the first of a proposed programme of surveys of the southern MAR, using the Simrad EM 120 multibeam echo sounder on passage to and from Antarctica. This new system forms 191 1-degree beams, making it one of the highest resolution hull-mounted deepwater echo sounders available to academic researchers. By deviating our track by a few days during each six-monthly transit, we aim progressively to survey much of the northern section of the MAR in the South Atlantic. Our first season's effort has concentrated on an area south of the Chain Fracture Zone. This area is transitional between the Equatorial Atlantic, which has been proposed to be a region of anomalously cold mantle [*Bonatti*, 1996], and the South Atlantic proper, and hence may provide an early indication of any links between ridge processes and the state of the underlying mantle in this region. To the north, the survey abuts a detailed multibeam survey of the Chain Fracture Zone conducted during joint Italian-Russian cruises (M. Ligi, personal communication, 2000).

In addition to multibeam data, we routinely collected three-component magnetometer data and TOPAS narrow-beam sediment profiler records. As the transit database develops, it will also be used to study sedimentary processes on the UK, Iberian, African and South American margins, and other volcanic and tectonic features.

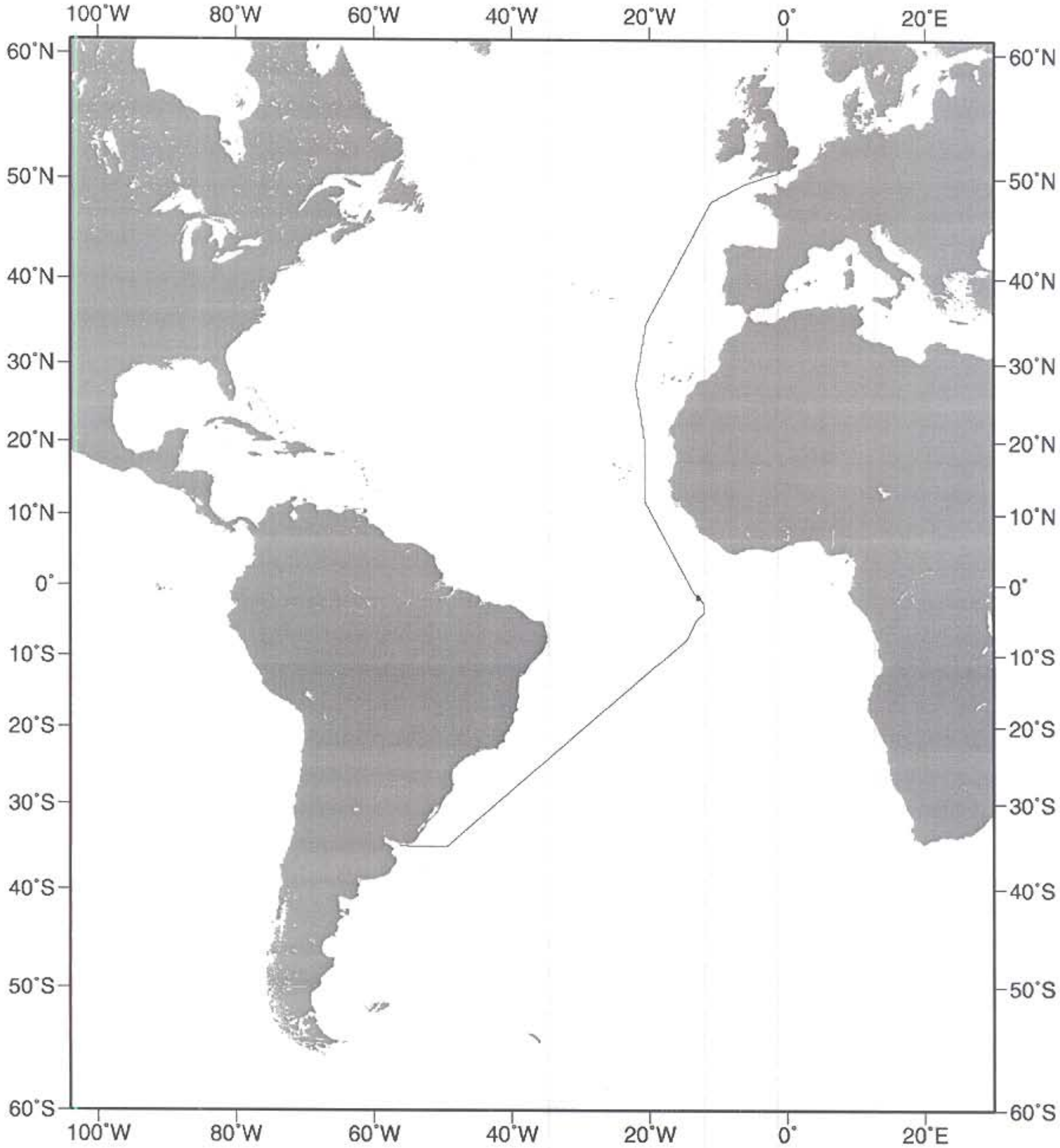


Fig. 1. Track of cruise JR53.

5. SCIENTIFIC HIGHLIGHTS

The results of this first transit cruise revealed a number of regions that could, with future transits, prove fruitful areas for study. Upon leaving the UK, our first scientific target was the continental margin in the Southwest Approaches, where we imaged canyons at the base of the continental slope. Here, the multibeam system provided some exciting new data on shelf edge canyons, showing three orders of geomorphological slope incision (Fig. 2).

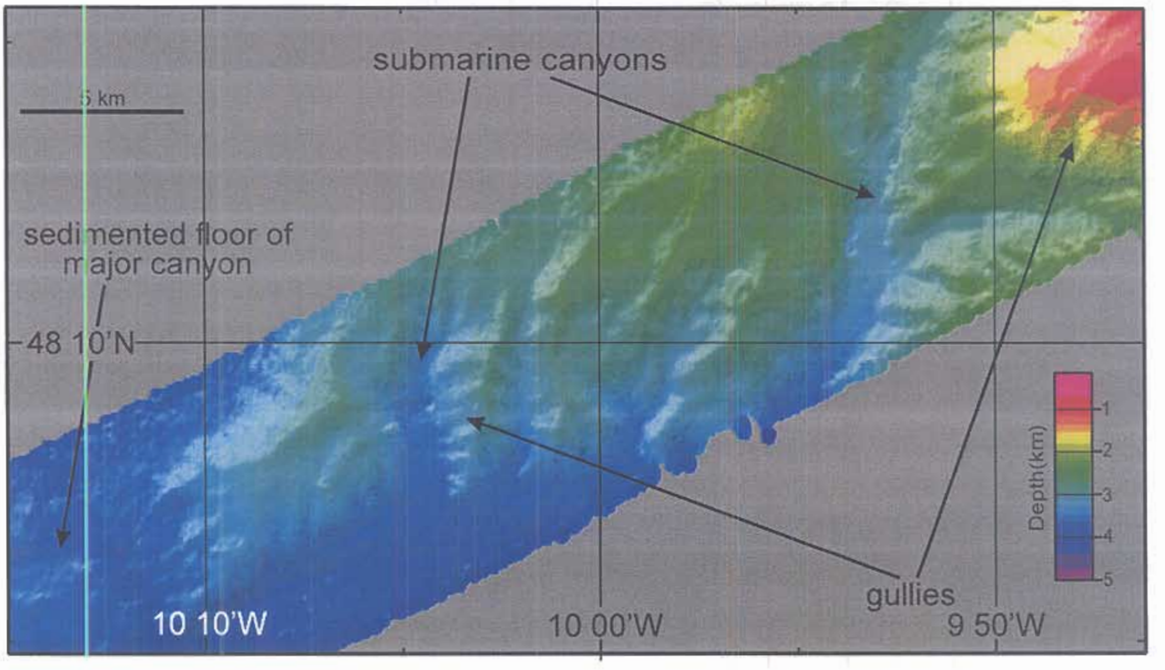


Fig. 2. EM 120 swath bathymetry data showing canyons dissecting the base of the continental slope, Southwest Approaches.

Farther south, we imaged sedimentary structures in the Bay of Biscay and abyssal hills west of Iberia, before crossing the Gloria Fault, the boundary between the Eurasian and African plates. At this time, the TOPAS sediment profiler was turned on again briefly, recovering an image of deformed sediments over, it is hoped, the plate boundary itself.

To the west of the Canary Islands and Africa, we crossed channels shown by previous IOS work to be caused by turbidity currents transporting sediments from the African margin, and subtle topography of the Canary and Saharan debris flow deposits. Following a period without recording within the Cape Verdes 200 nmi EEZ, we collected multibeam data over turbidity current channels south of the islands, shown by Gebco charts to be sourced on the African margin. From there to the MAR survey area, we crossed sea floor that was mostly featureless, with the exception of a number of seamounts on the Sierra Leone Rise.

Within the MAR survey area proper, we first crossed the Romanche Fracture Zone and the active Chain Transform, before beginning our box-shaped survey (Fig. 3a).

(a)

(b)

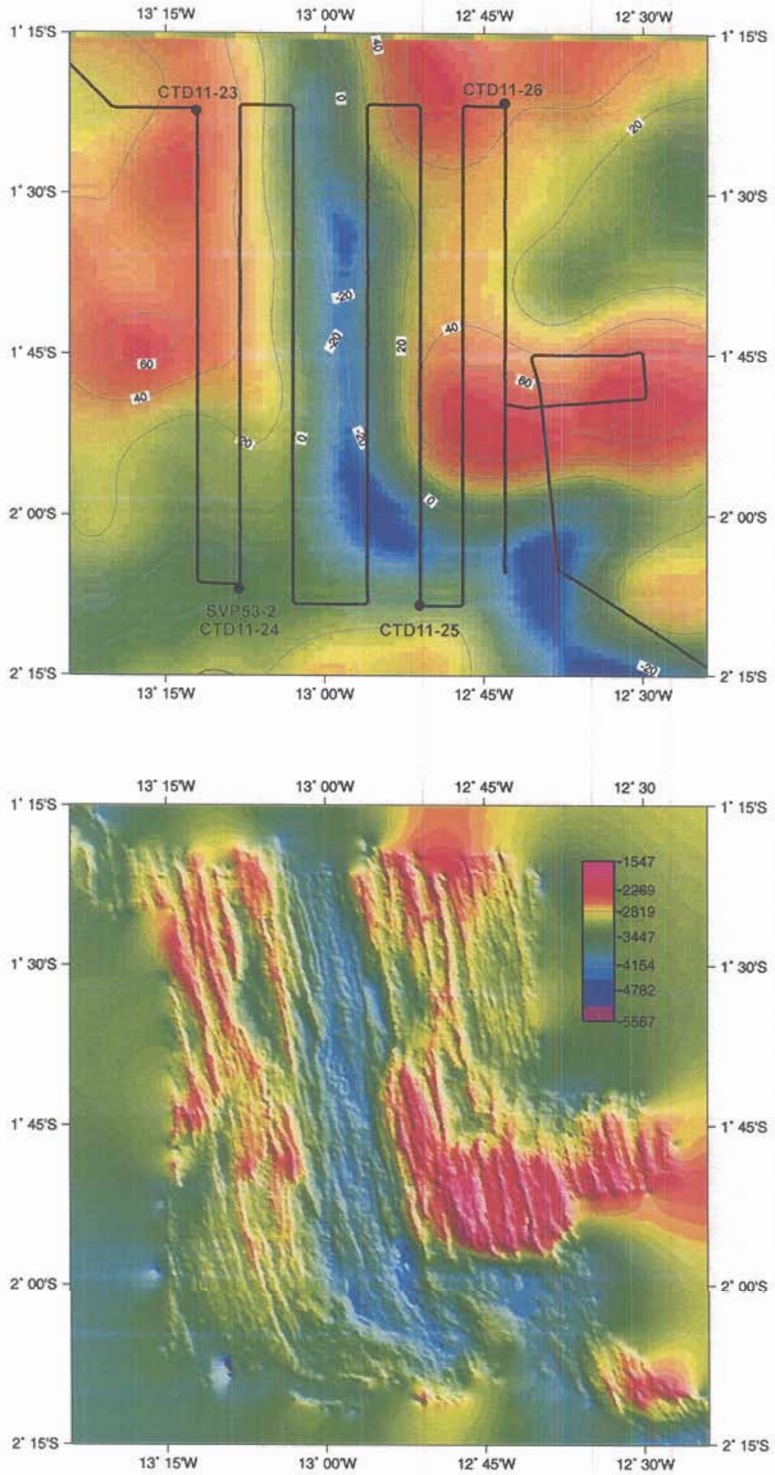


Fig. 3. EM 120 swath bathymetry survey of the Mid-Atlantic Ridge near 1°45'S. **(a)** Survey tracks plotted with free-air gravity anomaly (contour interval: 20 mGal) derived from satellite altimetry measurements [*Sandwell and Smith*, 1997]. CTD and SVP stations described in the text are marked. **(b)** Shaded relief display of swath bathymetry data (illumination from the NE). Scale bar shows sea-floor depth in metres.

The multibeam data (Fig. 3b) cover both sides of the axial rift valley and an inside corner high (a shallow region at the intersection of a rift valley with a short ridge offset to another rift valley).

In contrast to many inside corner highs in the North Atlantic, this one does not show a surface with crenulations oriented parallel to the spreading direction, which have been interpreted as evidence for long-offset detachment faulting. Instead, the inside corner high seems to show a similar fabric to 'normal' sea floor. Upon leaving the box survey, we ran single lines farther down the ridge, covering more southerly sections of rift valley floor and inside-corner highs, again showing no evidence for crenulations.

Upon leaving the MAR survey area, we obtained one opportunistic line across the southwest flank of Ascension Island, crossing a satellite volcano to the main Ascension Island edifice (Fig. 4), while still remaining more than 12 nmi beyond the coastline as required by the MOD. Between Ascension Island and the Brazil Basin to the west, we covered mostly abyssal hill terrain, showing some interesting seamount features. Later, within the Brazil Basin, we crossed fields of abyssal migrating sediment waves.

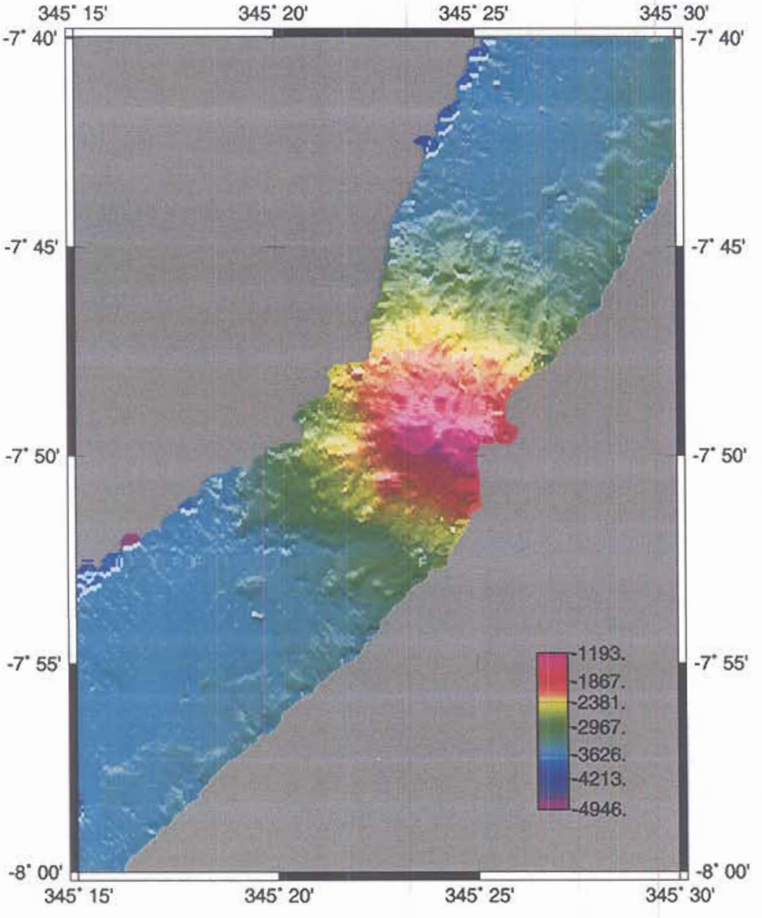


Fig. 4. Swath bathymetry data showing volcano on the southwest flank of Ascension Island. Scale bar shows sea-floor depth in metres.

References

Bonatti, E., Long-lived oceanic transform boundaries formed above mantle thermal minima, *Geology*, *24*, 803–806, 1996.

Sandwell, D.T., and W. H. F. Smith, Marine gravity-anomaly from Geosat and ERS–1 satellite altimetry, *J. Geophys. Res.*, *102*, 10039–10054, 1997.

6. EQUIPMENT PERFORMANCE

6.1 NOAA Scientific Computer System (SCS)

The NOAA Scientific Computer System (SCS) was used to log data from several instruments on JR53. The SCS performed well, with the exception of one failure on the 10th October which was attributed to a memory allocation problem in the NT operating system.

6.2 Trimble 4000 DS

The Trimble 4000 DS was the principal source of navigation data during JR53. The instrument was used in differential location mode, with corrections supplied via Inmarsat feed from a Racal *Skyfix* unit, and applied in real time by the GPS receiver. The data were logged to the SCS. In general, GPS data were of high quality, although close inspection during navigation data processing showed that fixes jumped erratically for short periods of time, causing small deviations from the presumed track of the ship. These errors may have been due in part to the choice of base station, as the differential solution is computed using satellites viewed by both the base station and the shipboard system. For the first part of the cruise, differential corrections were obtained from a base station in Aberdeen, but this was later changed to a station in South America.

6.3 Ashtech GPS/GLONASS GG24

This system provided a secondary source of navigation data, and it performed well throughout the cruise. Ashtech/GLONASS data were logged on the SCS.

6.4 Ashtech G12

This dual GPS unit provides data for dynamic positioning and was not used on cruise JR53.

6.5 Leica MX 400

The Leica MX 400 was the primary GPS navigation system used by the officer on watch, and data obtained from it were logged on a PC on the bridge.

6.6 Ashtech 3D GPS and TSSHRP

The Ashtech 3D GPS and TSSHRP provided position and attitude data. Both systems performed well throughout the cruise, and the data were logged on the SCS.

6.7 Doppler Log

The doppler log did not function reliably during JR53, and eventually stopped working on 19th September.

6.8 EM Log

The EM log functioned well throughout JR53 and was logged on the SCS.

6.9 Shipboard three component magnetometer (STCM)

During JR53, three-component magnetic data were collected using both shipboard three component magnetometers (STCMs). These devices logged continuously without fault during the cruise. Data from the old system were logged on the SCS, whereas data from the new system were logged separately using a Java program written by Andrew Barker. Calibration turns were carried out in the Brazil Basin north of the Rio Grande Rise during 6th October (between 1335 and 1400 GMT). Before undertaking the calibration manouevre, the STCM data were checked to ensure that the area had comparatively subdued magnetic anomalies.

6.10 Simrad EA 500 echo sounder

During JR53, EA 500 soundings were contaminated with transmission noise from the EM 120 which resulted in erroneous bottom detections. This was due to problems encountered with the Simrad Synchronisation Unit (SSU, described below). In future, we recommend that the EA 500 is switched off during periods of multibeam survey. In the absence of reliable EA 500 data, centre-beam depths from the EM 120 (computed at 1500 $m.s^{-1}$) were exported for use by the Hydrographic Office.

6.11 Simrad EM 120 multibeam echo sounder

The Simrad EM 120 multibeam echo sounder performed well throughout the cruise. Shipboard processing showed that the multibeam data were of high quality. However, we experienced complications during JR53 which were not reported during the initial acceptance trials cruise JR50.

After some initial experimentation, the multibeam aperture was set to 110° for the transit and 120° for the MAR survey (survey parameters listed in Appendix A). These parameters were selected for the following reasons: (1) to ensure that the seabed was sampled adequately along track at the transit speed of 11½ knots (the ping rate must be high enough to ensure that the along-track distance between successive pings is not significantly greater than one centre-beam width); and (2) to prevent data loss where the system rejected pings with very poor bottom detection, which occurred frequently with wider apertures. During multibeam survey, the Bridge was instructed to conduct turns at 30 $deg.minute^{-1}$, cutting the corners at waypoints to avoid sharp turns which might affect the Seatex Seapath motion reference unit.

During JR53, the EM 120 suffered interference from the other echo sounders and TOPAS, due to problems with the setup of the SSU. In particular, the TOPAS system would frequently transmit within the listening window of the EM 120, leading to sounding errors along parallel tracks in both port and starboard data. Consequently, we decided the TOPAS system should be turned off until the problem could be rectified. This decision was taken for the following reasons: (1) we decided that EM 120 data should take priority, as TOPAS data could be collected on later transits, or supplemented with existing 3.5 kHz profiler records; (2) TOPAS recording slowed the EM 120 ping rate down to such an extent that it was not sampling along-track adequately; (3) the quality of the TOPAS data was highly variable; (4) noise from the TOPAS transmission would cause significant problems when EM 120 data were post-processed and merged with data collected during later transit legs.

A further possible interference problem with the EA 500 was also identified. This appeared as bursts of bad soundings within the swath, possibly caused by transmission of the EA 500 during the EM 120 recording window.

During the trials cruise JR50, sea water velocity data obtained with the SVP were imported from the SVP PC to the EM 120 console via a serial cable using *Procomm* software. However, owing to operational difficulties, this method was considered unsatisfactory during JR53. Our first direct loading of an expendable bathythermograph (XBT) profile (T7–01059 on the 21st September) via the serial port was successful: the profile appeared in the Simrad SVP editor and was extrapolated to full ocean depth. However, the method that the Simrad SVP editor uses to extrapolate the SVP to full ocean depth is not explained in the Simrad manuals, and some discrepancy with the recorded SVP data suggested possible errors in the mid-depth part of the profile. We chose to edit the extrapolated profiles, and also to process the sounding data a second time using velocities calculated ourselves from the formula described in the EM 120 manual, but with temperature data from a published deep temperature profile. This was done using a C program *xbt2svp* written by Neil Mitchell (Appendix B). Later in the cruise, the serial connection to the EM 120 console failed consistently, yielding the error 'input error serial port not recognised. To enable new input, you must reset the last selected input function'. Repeated attempts to load the velocity data led to gaps in data recording since logging must be stopped before the SVP data are imported. Since *Neptune* software allows for processing of data with an updated sound velocity profile, and since updating of sound velocity profiles proved necessary anyway, we decided to develop a system of processing velocity profiles on a Sun workstation and copying them to the EM 120 console when necessary. Data obtained using XBTs and the SVP were reformatted into the Simrad .asvp text format, and read directly from disk into the SVP editor on the EM 120 console and in *Neptune* software. XBT data were reformatted using the program *xbt2svp*. SVP data were reformatted simply by adding a header from an existing Simrad .asvp file and adjusting the number of samples specified within it.

Data logging

EM 120 data were written to the /data1/raw, /data1/proc and /data1/shared sub-directories on workstation *em120–101*. Data written to these directories were copied every minute into equivalent directories on the hard disk array attached to workstation *em120–102* (*Neptune* post processing workstation) using a crontab routine setup by Jeremy Robst. This enabled older data files stored on the internal disk on the logging workstation to be cleared to prevent it filling to capacity. Daily tape backups were made of the file system on the hard disk array.

During the cruise, we identified some problems concerned with data logging. The EM 120 was configured to create a new raw data file every 30 minutes. Occasionally however, the system would fail to close a file after this time, and would continue to log to the same file for several days. In future, this could result in significant data loss if one of these large files were to become corrupted. Furthermore, on 8th October, logging stopped when the /data1 partition on the *em120–101* workstation filled to capacity. On this occasion, the EM 120 console display froze, and gave no prior warning of a lack of disk space. In order to remedy this, we deleted data files in the /data1/proc directory that were more than three days old and re-booted the system.

Multibeam data processing

During JR53, multibeam bathymetry data were processed using *Neptune* software. Appendix C includes a sample processing log which describes a typical processing sequence. The data were processed in batches containing multibeam soundings collected over 2 days or less. Depth corrections were applied to each batch using a single sea water velocity function, obtained either from SVP or XBT measurements. The size of each data batch was dictated by the variation in the speed of sound in sea water at the hull during acquisition (monitored using the Java program *speed* written by Andrew Barker): if this parameter varied by > 2 m.s^{-1}, the sound speed profile used for depth correction was updated.

During JR53, the speed of sound in sea water was determined from the following: (1) underway data computed by the program *speed*, (2) XBT data, (3) SVP data, and (4) CTD data. Depth corrections were applied using data from XBT or SVP deployments.

Noise problems

As part of the onboard processing sequence, multibeam bathymetry data obtained in deep water were gridded with a 25 m cell size using *GMT* software. Plots of the gridded data were produced routinely to check the quality and resolution of the soundings. This revealed problems typical of multibeam echo sounder data, including weak bottom detections on the outer beams, and broad cross-track curvature in the bathymetry due to sound velocity errors ('smile' or 'sadness'). However, other problems were identified which appear to be specific to the multibeam system on RRS *James Clark Ross*:

(1) Outer parts of the swath show a 'railway sleeper' pattern. This noise was most clearly apparent when data showing a flat sea floor were gridded at 25 m intervals, and illuminated using the shaded relief facility in *GMT* (Fig. 5). It appears as a fine-scale variation in cross-track depth on the outer beams. The noise starts abruptly at a discrete beam number on both sides, possibly

coinciding with outer transmit sectors. The source of the noise is uncertain. It could be caused by roll-meter error, although errors in roll attitude should create an error which progressively increases from the centre beam outwards. Another possible explanation is that the noise is caused by interference from another echo sounder. We believe it occurred while the EA 500 was transmitting in advance of the EM 120 transmission, although we cannot be absolutely certain of this because the EA 500 changed transmit priority spontaneously throughout the cruise. Alternatively, it might be caused by a low backscatter signal in the outer sectors. The real-time ping display on the EM 120 console shows low backscatter intensity (decreasing outwards) in beams 1–40 and 160–191, even when sector automatic gain control is turned on (menu MBES>filtering>sector tracking). This might be due to acoustic attenuation of the signal within the titanium windows fitted on RRS *James Clark Ross*, causing reduced signal level relative to the normal EM 120 design. Therefore, it might be rectified if the power of the recorded signal on the outer sectors could be increased. The effect on the data can be removed by smoothing, although this of course reduces the effective spatial resolution of the system.

(2) Bursts of bad soundings, often too shallow, close to the centre beam. This is probably caused by the bottom detection algorithms locating the EA 500 transmit pulse or its bottom echo. It is caused by insufficient frequency discrimination, and may be partly rectified when the SSU is fixed. However, we cannot dismiss the possibility of interference between the EM 120 and EA 500 even when they are transmitting concurrently, because the EA 500 echo may sometimes be strong enough to cause false detections. We suggest that, in future, the EA 500 is turned off during multibeam surveying, and that the bridge is provided with a profile plot from the EM 120 for navigation purposes. The EM 120 console shows that there is a single-beam output, so it might be possible to link up a logger and display to show a running profile on the bridge. Alternatively, effort should be made to improve frequency discrimination. This error does not cause a critical problem with the data, but bursts of bad soundings require manual editing since they cannot be removed by *Neptune* software.

(3) Bad detection in beams adjacent to hill slopes. This noise is especially evident when running parallel to a hill with low backscatter sediment in valleys. It appears that the reception sidelobe levels are too high, causing leakage of off-beam backscattering: the bottom echo detector records the travel time of the off-beam interference rather than the echo from the beam centre. The error manifests itself as a trench running parallel to abyssal hills, often forming an artificial dip at the base of fault scarps, or it can form artificial ridges. The bad detections require manual editing.

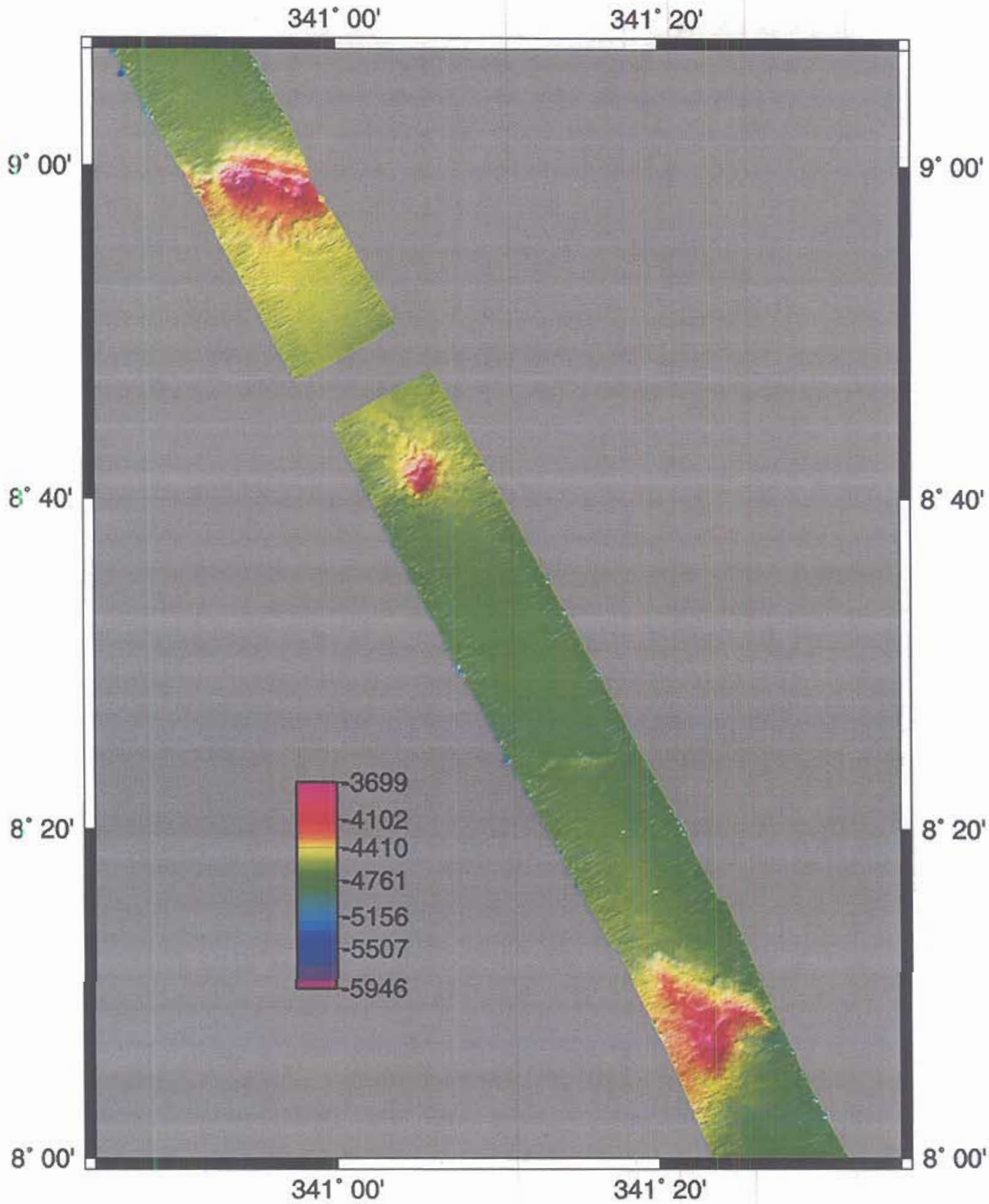


Fig. 5. Swath bathymetry data showing noise on the outermost beams.

6.12 Seatex Seapath motion reference unit

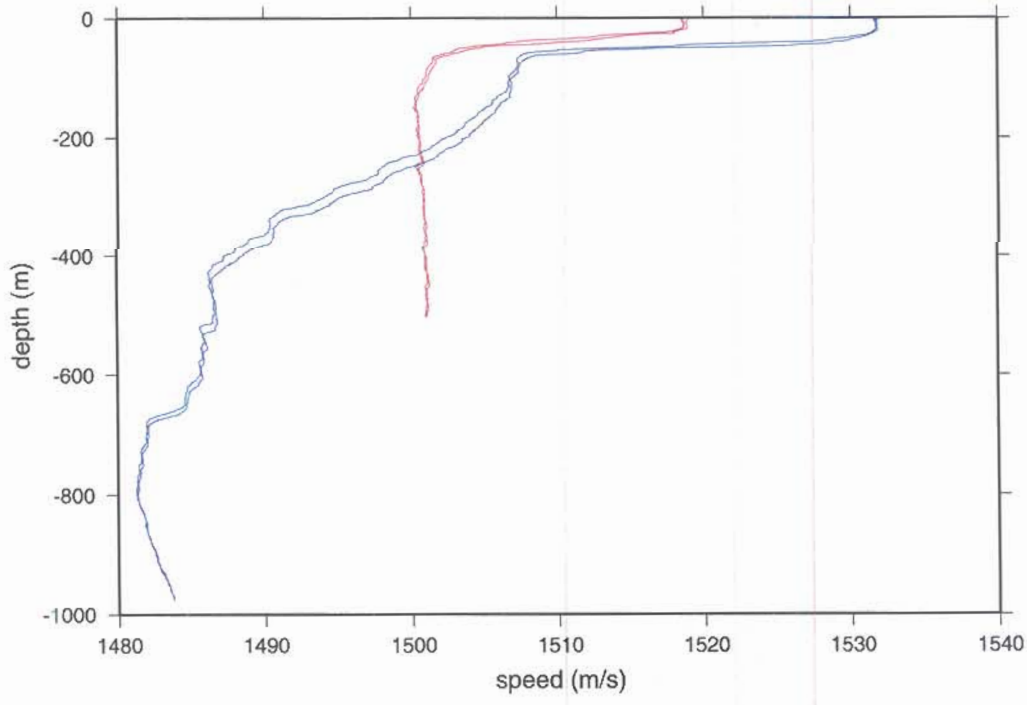
The Seatex Seapath unit provides the EM 120 with real-time position and attitude data. It combines GPS data with attitude data supplied by the motion reference unit (MRU) located in the gravity meter room. In general, the Seapath unit functioned well during the cruise. However, it failed spontaneously for short periods on three separate occasions. On each occasion, it appears that the MRU lost power. When the unit failed for the third time, we discovered that the loss of power was caused by the fuse in the MRU junction box working loose (located on the bulkhead directly above the instrument). Occasionally, the Seapath unit reported bad heading data due to poor GPS coverage, although this reduction in data quality was usually short lived.

6.13 Applied Microsystems Ltd SV^{PLUS} profiling system

The SVP was used to measure the speed of sound in sea water at stations JR53–SVP1 and JR53–SVP2 (Appendix D, data shown in Fig. 7). Prior to the start of the cruise, the port-side midships winch was modified for use with the SVP, and these modifications were accepted by BAS ETS engineers after a test deployment on passage between Grimsby and Portsmouth on the 11th September.

As part of the these modifications, inboard cables were installed to enable scientists to interrogate the instrument whilst on deck. Initial attempts to do this showed that the cables were improperly configured, but this problem was quickly rectified by ETS engineers. The first deployment of the SVP occurred at station JR53–SVP1 (at 1045 GMT on the 15th September, immediately after AMT11–03 CTD). On this occasion, the sensor was lowered to just 500 m, as the winch had not been tested in deep water at that time. This deployment was successful (red curve, Fig. 7a). The SVP was also deployed at station JR53–SVP2 (at 0940 GMT on the 27th September, immediately before AMT11–24 CTD) in the MAR survey area (Fig. 3a). This deployment to 975 m was also successful (blue curve, Fig. 7a) and the data were used to apply depth corrections for the entire MAR survey area.

(a)



(b)

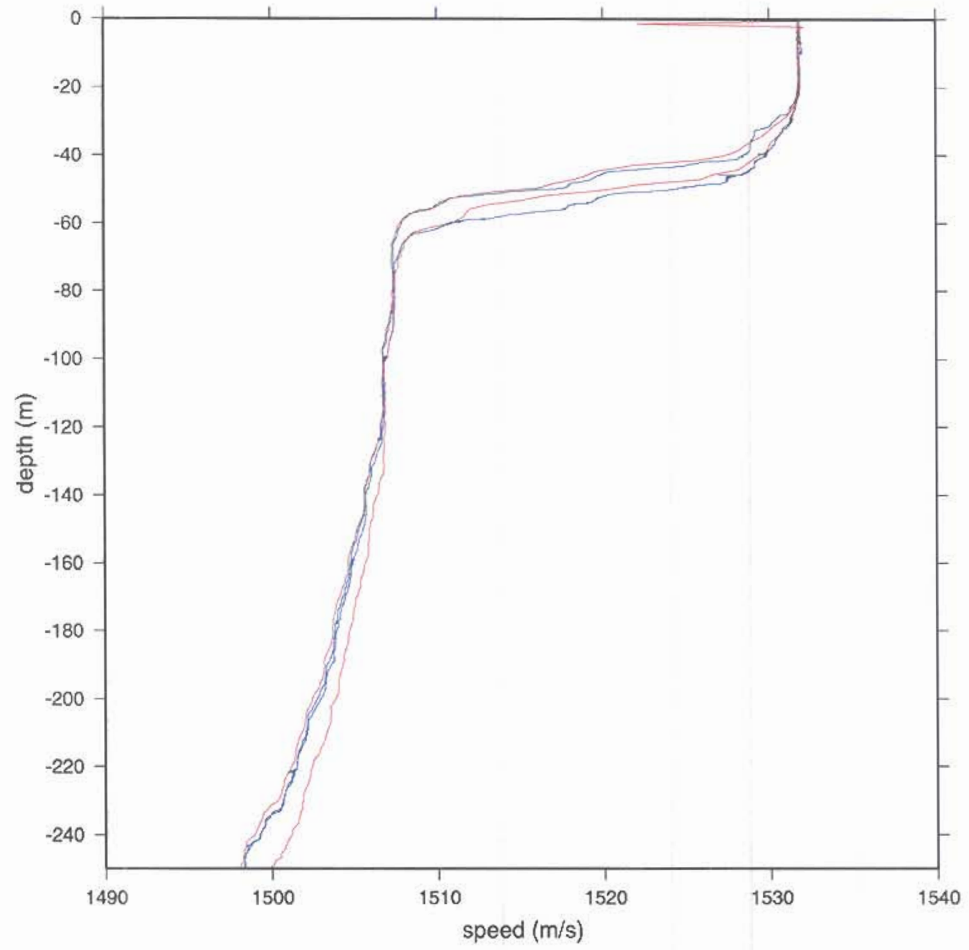


Fig. 7. Variation in the speed of sound in sea water with depth (above and preceding page). **(a)** Profiles obtained using the SVP at sites JR53–SVP1 (red) and JR53–SVP2 (blue). **(b)** Coincident profiles obtained using the SVP (red) and the BAS CTD (blue) at AMT11–24 (located in Fig. 3a).

6.14 Simrad TOPAS sub-bottom profiler

Owing to problems of interference with the EM 120, the TOPAS sub-bottom profiler was only in use for 4 days at the start the cruise. It performed well throughout this time, and provided high quality sub-bottom profiles. The profiler worked particularly well in areas of subdued sea floor, where a strong reflected signal was recorded. However, in areas of rough sea-floor topography, the quality of the TOPAS record varied considerably. We suspect this is due to the beam pattern of the system which is highly directional: most energy reflected out of the plane of section from rough sea-floor topography is not recorded. At the start of JR53, *ProMAX* software was installed on UNIX workstation *jruf* in order to examine TOPAS records. TOPAS data were reformatted to the SEG–Y trace sequential format using the Simrad program *TOPAS2SegY* and then read into *ProMAX*. Figure 8 shows a *ProMAX* plot of TOPAS data obtained using a swept frequency transmission pulse. In this example, the uncorrelated source signature is clearly evident, as the current version of the TOPAS software does not provide a facility to export processed (cross-correlated) traces. Although this procedure can be applied within *ProMAX*, we recommend strongly that future versions of the TOPAS software include a facility to export processed data.

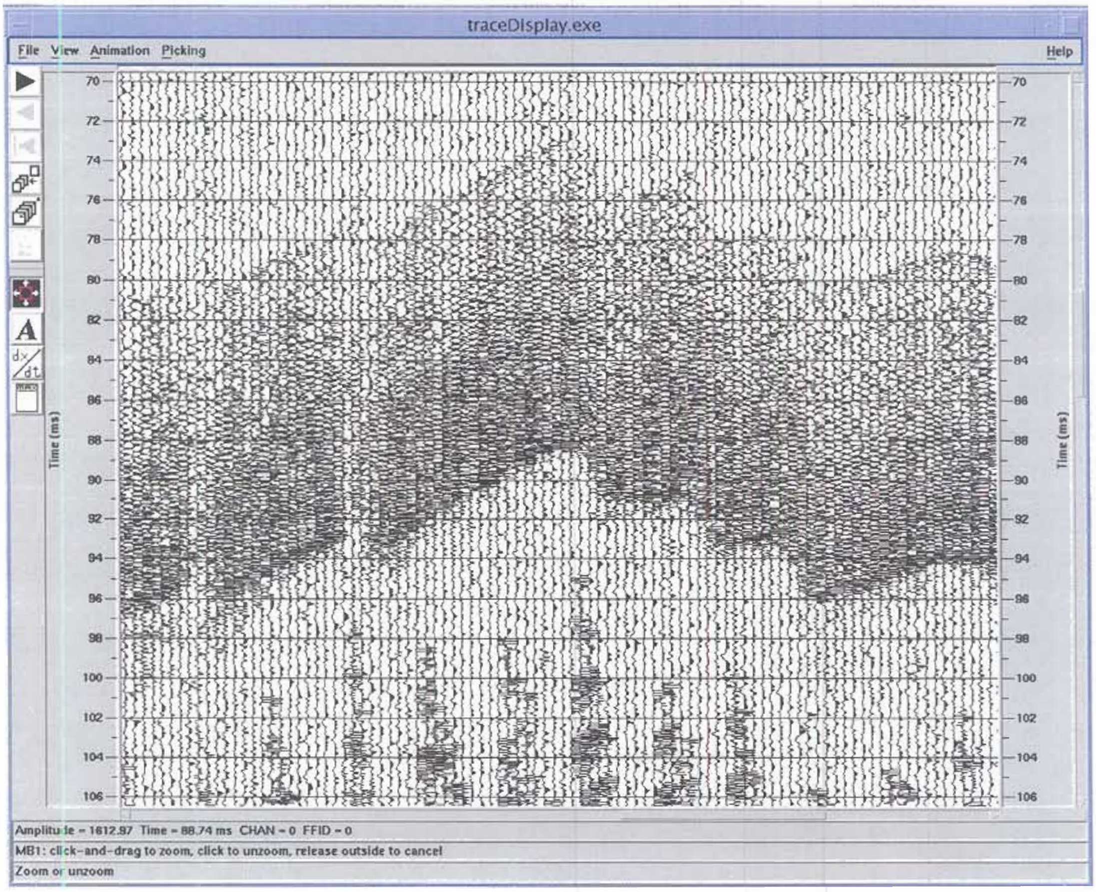


Fig. 8. Uncorrelated TOPAS sub-bottom profiler traces.

6.15 Simrad Synchronization Unit

The SSU is used to synchronise the transmission pulses of the echosounders and TOPAS in order to prevent interference between the instruments. During JR53, we were unable to configure the SSU so that the echosounders were properly synchronised with the TOPAS sub-bottom profiler. Consequently, we decided to switch off TOPAS in order to preserve the quality of the EM 120 data.

At the start of the cruise, we ran the EA 500, EM 120 and TOPAS together, but found that harmonics from the TOPAS transmission interfered with the echosounders, in spite of the fact that it was set in a different group on the SSU. The TOPAS transmission led to bad bottom detections in the EM 120 swath which appeared as two 'tramlines' parallel to the ship track in the mid-range. The TOPAS transmission was also clearly evident on the EK 500 display. When this problem was identified, we checked that the EA 500 and TOPAS were set on external trigger, and made several attempts to adjust the menu settings on the SSU, but without success.

For most of the cruise, we used the EA 500 and EM 120. These instruments are in the same group in the SSU, and were usually synchronised so that the EA 500 transmitted shortly before the EM 120. Occasionally however, the EA 500 cycle slipped, so that it transmitted during the EM 120 listening period. We cannot account for these jumps, which seemed to occur spontaneously, without intervention from the operator. The EA 500 pulse was sometimes apparent in the EM 120 data, causing data spikes parallel to the track in the near-range.

The problems associated with the configuration of the SSU resulted in significant data loss during JR53, and we recommend that the SSU is reconfigured before the next multibeam cruise.

6.16 Sea water velocity monitor

The sea water velocity monitor, developed by Andrew Barker on JR50, computes the speed of sound of sea water beneath the hull of the ship from temperature measurements at the thermosalinograph intake and conductivity from the Oceanlogger.

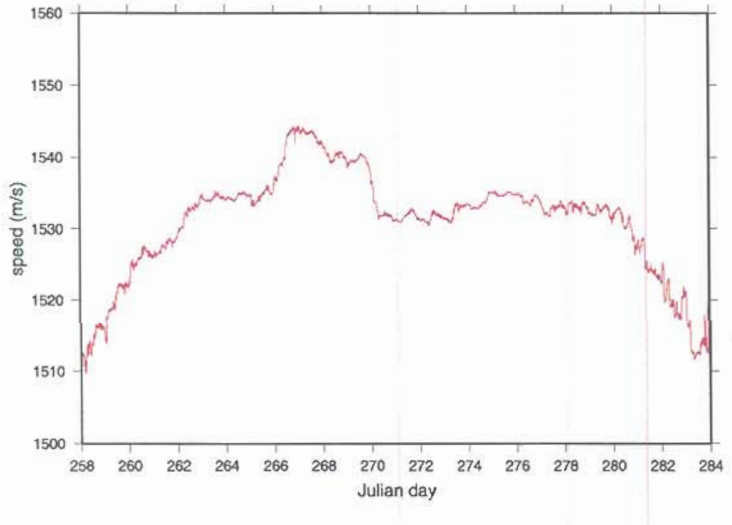


Fig. 9. Speed of sound in sea water at the hull of the ship.

The monitor worked well throughout the cruise, and the data were logged to a plain text file on a PC in the UIC room. The data (Fig. 9) were monitored in order to identify any significant changes in shallow water structure. During *Neptune* post processing, the sound velocity profile used to compute sea-floor depth was updated if this quantity changed by > 2 m.s^{-1}.

6.17 Expendable Bathythermographs

During JR53, expendable bathythermographs (XBTs) were deployed at 6 hour intervals as part of the AMT–11 science programme. Two types of Sippican XBT were used: T5s with a termination depth of 1800 m, and T7s with a termination depth of 750 m. Figure 10 shows a compilation of XBT data collected during the cruise. The XBT drops are listed in Appendix E. Velocity-depth profiles computed using Sippican software were commonly used to apply depth corrections to the EM 120 swath data.

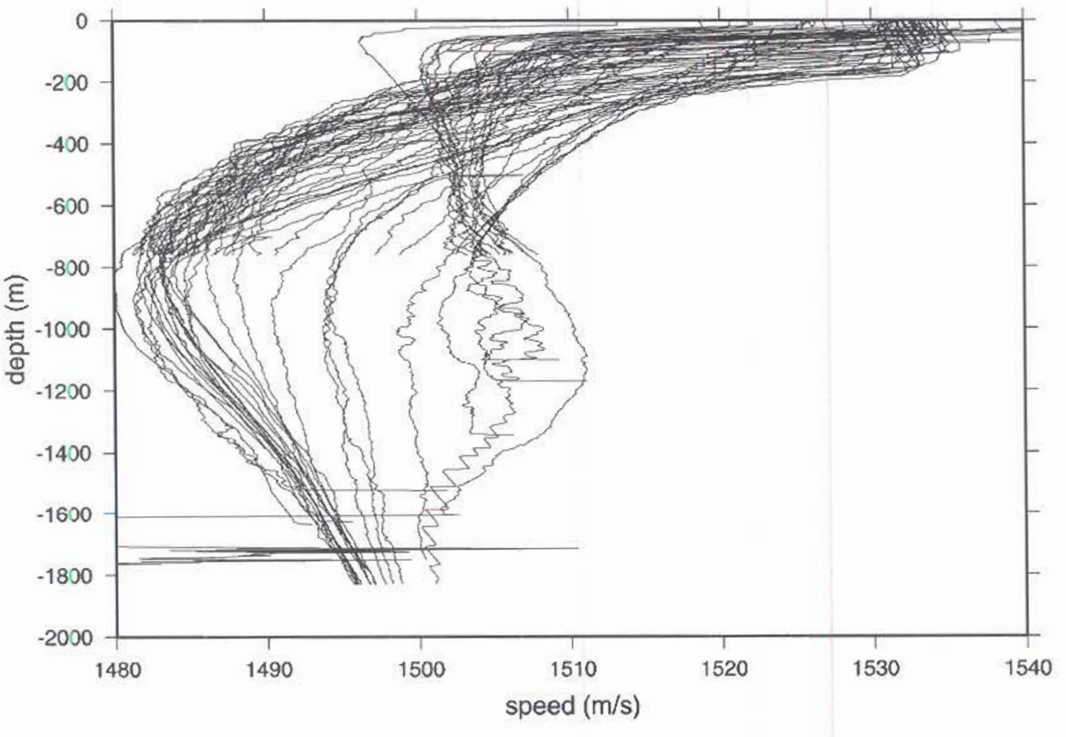


Fig. 10. Compilation of sea water velocity-depth profiles obtained using XBTs.

6.18 Conductivity–Temperature–Depth sensors

During JR53, AMT scientists conducted 46 CTD deployments using the BAS CTD (normally to 250 m). The CTD stations are listed in Appendix F. The AMT–11 cruise report provides a comprehensive account of CTD performance.

7. ACKNOWLEDGEMENTS

This work was planned originally by Rob Larter (BAS Geological Sciences Division). We thank the officers and crew of RRS *James Clark Ross* for their assistance, and engineers and shore-based staff of the BAS Administration and Logistics Division for their support. We also thank Malcolm Woodward for his help in making JR53 a success.

8. APPENDICES

8.1 Appendix A: EM 120 menu settings during the MAR survey

MBES Menu
Ping mode: Auto
Pitch stabilization on
Sector coverage:
  Max port/stbd angle: 60 deg
  Angular coverage: Manual
  Beam spacing: Equidistant
Yaw stabilization
  Mode: Filtered heading
  Heading filter: Slow
  Min depth 100
  Max depth 6000
Sound speed at transducer: from profile
Filtering:
  Spike filter strength: Medium
  Slope filter: on (3 other filters set to off)
  Range gate: Normal
Absorption coefficient: From profile
TVG crossover: 20 deg.

8.2 Appendix B: Program xbt2svp.c

```
/*      xbt2svp.c.c

**** Output data header is guessed based on header of one successful svp file -
it is not
explained in the simrad manuals.
****  Edit the first line to put in yr, mo, day, hour, min of the SVP dip if wan
ted.

                                        N.Mitchell  JCR Sept 2000        */

#define N 2000

#include  <stdio.h>
#include  <math.h>


double  get_sound_speed();


main (argc,argv)

int   argc;
char **argv;
{
        int     i, j, n=0;
        double  S=35.5;
        double  *T;
        double  *ss;
        double  *z;
        int     c;
        int     error=0;
        int     decimate=0;
        int     extrapolated_rows=0;
        int     nheader=35;

        if (((T = (double*) malloc(N * sizeof(double))) == NULL) ||
                ((ss = (double*) malloc(N * sizeof(double))) == NULL) ||
                ((z = (double*) malloc(N * sizeof(double))) == NULL)) {
                fprintf (stderr, "xbt2svp: insufficient memory\n");
                exit(0);
        }

        for (i = 1; i < argc; i++) {
                if (argv[i][0] == '-') {
                        switch (argv[i][1]) {
                                case 'S':
                                case 's':
                                        S = atof (&argv[i][2]);
                                        break;
                                case '5':
                                        nheader = 35;
                                        break;
                                case '7':
                                        nheader = 36;
                                        break;
                                case 'D':
                                case 'd':
                                        decimate = atoi (&argv[i][2]);
                                        break;
```

```
                                case 'h':
                                case 'H':
                                default:
                                        error = 1;
                        }
                }
        }

        if (error){
                fprintf (stderr, "xbt2svp.c usage: xbt2svp -S<salinity> -D<nskip
> -7 -H\n");
                fprintf (stderr, " -S: mean salinity value (default 35.50)\n");
                fprintf (stderr, " -D: number of lines to skip while decimating
(default 0)\n");
                fprintf (stderr, " -7: set if input is from a T7 XBT (default is
 from a T5)\n");
                exit(-1);
        }

        /* skip the header */
        for (i=0; i<nheader;i++) {
                while ((c=fgetc(stdin))!='\n')
                        continue;
        }

        /* Now read 3 columns of depth(m), temperature (degC) and sound speed (m
/s).
                If sound speed is zero, calculate from temperature and salinity
*/

        i=0; j=0;
        while ( fscanf(stdin, "%lf %lf %lf", &z[i], &T[i], &ss[i]) != EOF){

                if (ss[i] == 0.0)
                        extrapolated_rows=1;
                else
                        extrapolated_rows=0;

                if (T[i] != 0.0) {
                        if (ss[i] == 0.0)
                                ss[i] = get_sound_speed(S, T[i], z[i]);
                }
                else {
                        fprintf(stderr, "Warning: Zero temperature reading in in
put.\n");
                        exit(0);
                }
                i++;

                if (decimate && !extrapolated_rows) {
                        if (j==decimate) {
                                j=0;
                        }
                        else {
                                i--;
                                j++;
                        }
                }
```

```
                if (i==N) {
                        fprintf(stderr, "Array too small (N=%d)\n", N);
                        exit(0);
                }
                if (i==1000) {
                        fprintf(stderr, "Warning: nrows in output >1000 (set hig
her decimation number)\n");
                        exit(0);
                }
        }
        n = i;

        /* write file header */
                                /*      yyyymmddhhmm                    nlines
 */
        printf ("( SoundVelocity 1.0 0 200009151347 0 0 -1 0 0 SVP-16  PE %4d )\
n", n);

        for (i=0; i<n; i++) {
                printf ("%.2lf %.2lf\n", z[i], ss[i]);
        }

}

/* sound speed formula taken from Simrad EM120 manual,
referencing Coppens, J. Acoust. Soc. Am, March 1981. */
double  get_sound_speed(S, T, z)
double  S,T,z;
{
        double  ss;

        ss = 1449.05 + T*(4.57 - T*(0.0521 - 0.00023*T));

        ss += (1.333- T*(0.0126 - 0.00009*T))*(S-35.0);

        z/=1000.0; /* convert to km */
        ss += z * (16.3 + z*(0.22 - 0.003*z*sqrt(T+2.0)));

        return(ss);
}
```

8.3 Appendix C: Multibeam echo sounder observers' logs and data processing logs

Multibeam Echo Sounder *Data* Processing Log   Logsheet #:

Cruise JR53   Date :

Check/Replay data

Start file :   End file :
Source directory :
Target directory :
Comments:

Position processing

Setup basic rule ❑
New →Accept →OK ❑
Check statistics ❑
Setup merge/smooth rule ❑
New →Accept →OK ❑
Examine track and flag out turns ❑
File → Save →Rules and Files ❑
Comments:

Depth processing

Setup basic rule to apply SVP ❑
SVP Filename:
New →Accept →OK ❑
Proc. →Depth corr. →Start proc. ❑
Comments:

Calibration

Blocks

In survey control, define block(s)
View→show/hide→enable blocks ❑
Edit →blocks →multiple blocks ❑
File→Save ❑
Comments:

Statistical filtering

Block no	#	#	#	#	#

Logsheet #:

Select block	☐	☐	☐	☐	☐
Proc→data cleaning, View →ShowHide →enable cells					
Create grid	☐	☐	☐	☐	☐
Final cell size	:	:	:	:	:
No points/cell	:	:	:	:	:
Setup basic rule (2 STD)	☐	☐	☐	☐	☐
New →Accept →OK	☐	☐	☐	☐	☐
Check BinStat_#.log	☐	☐	☐	☐	☐
Max % rejected	:	:	:	:	:

Comments:

Correlation

Data Export

Proc→Data cleaning→File →Save

<u>Setup depth data export</u>

Export block	#	#	#	#	#
	☐	☐	☐	☐	☐

Depth data filename 1:
2:
3:
4:
5:

<u>Setup ampl. export</u>

Export block	#	#	#	#	#
	☐	☐	☐	☐	☐

Amp data filename 1:
2:
3:
4:
5:

<u>Setup c/b depth export</u>
(1500 m/s)

Export block	#	#	#	#	#
	☐	☐	☐	☐	☐

CB data filename 1:
2:
3:
4:
5:

Comments:

EM-120 MULTIBEAM ECHO SOUNDER LOG				logsheet #:
RRS *James Clark Ross* cruise : **JR53**	Area:		Logged UNIX filename:	Date:
Pitch offset::	Roll offset:	Heading offset:	Pos. time delay:	Roll delay:	Beam mode:

Ping #	Time	Heading	Speed	Ping (Hz)	Ping mode	Coverage	Water m/s	SVP	Comments

8.4 Appendix D: SVP stations

STATION	DATE	TIME	LAT	LON
JR53–SVP1	15/9/00	1045	47° 08.04'N	11° 35.10'W
JR53–SVP2	27/9/00	0940	2° 06.69'S	13° 08.10'W

8.5 Appendix E: XBT deployments

DATE	GMT	LAT	LON	SST	Salinity	Type	Filename
14/9/00	1126	49°32.78'N	5°47.74'W	17.2	35.27	T7	T7_01029
14/9/00	1700	49°03.17'N	7°22.25'W	18.0	35.25	T7	T7_01030
15/9/00	0520	47°55.22'N	10°44.78'W	18.7	35.61	T7	T7_01034
15/9/00	1119	46°59.21'N	11°42.45'W	19.4	35.66	T5	T5_01035
15/9/00	1632	46°01.99'N	12°12.55'W	19.9	35.71	T5	T5_01036
15/9/00	2158	45°17.15'N	13°02.18'W	20.0	35.64	T7	T7_01037
15/9/00	2204	45°17.15'N	13°02.18'W	20.1	35.64	T7	T7_01038
16/9/00	1123	42°58.22'N	14°45.02'W	21.3	35.79	T5	T5_01039
16/9/00	1206	42°52.38'N	14°49.33'W	21.4	35.77	T7	T7_01040
16/9/00	1909	41°38.31'N	15°46.02'W	21.5	35.85	T7	T7_01041
16/9/00	2340	41°07.39'N	16°08.88'W	21.1	35.95	T7	T7_01042
17/9/00	0530	39°54.45'N	17°01.07'W	21.4	36.21	T7	T7_01043
17/9/00	1122	38°57.49'N	17°42.02'W	21.6	36.42	T5	T5_01044
17/9/00	2345	36°45.53'N	19°12.88'W	22.2	36.32	T7	T7_01045
18/9/00	0638	35°38.79'N	19°57.66'W	22.6	36.47	T7	T7_01046
18/9/00	1112	34°55.81'N	20°27.56'W	23.5	36.85	T5	T5_01047
18/9/00	2340	33°48.99'N	20°43.26'W	24.1	36.84	T7	T7_01049
19/9/00	0600	31°27.53'N	21°12.80'W	23.9	36.95	T7	T7_01050
19/9/00	1121	30°32.43'N	21°23.60'W	24.0	36.93	T5	T5_01051
19/9/00	1718	29°24.48'N	21°37.03'W	24.2	37.15	T7	T7_01052
19/9/00	2344	28°20.82'N	21°49.30'W	23.9	37.01	T7	T7_01053
20/9/00	0613	27°04.10'N	21°56.21'W	23.9	37.16	T7	T7_01055
20/9/00	1117	26°13.09'N	21°47.18'W	23.9	37.16	T5	T5_01056
20/9/00	2340	24°22.95'N	21°26.65'W	24.3	36.64	T7	T7_01058
21/9/00	0604	22°50.44'N	21°10.20'W	24.0	36.36	T7	T7_01059
21/9/00	1127	21°56.52'N	21°00.11'W	24.5	36.24	T5	T5_01061

21/9/00	1622	21°03.71'N	20°51.26'W	24.8	36.28	T5	T5_01064
21/9/00	1956	20°23.97'N	20°44.43'W	24.7	36.23	T5	T5_01066
21/9/00	2342	18°22.23'N	20°36.32'W	25.2	36.24	T5	T5_01067
23/9/00	1122	12°44.47'N	20°39.90'W	28.5	36.07	T5	T5_01068
23/9/00	1715	11°38.84'N	20°33.79'W	28.5	35.52	T7	T7_01069
23/9/00	2345	10°32.40'N	19°56.29'W	28.4	34.93	T7	T7_01070
24/9/00	0809	09°14.61'N	19°13.66'W	27.5	34.07	T7	T7_01071
24/9/00	1120	08°49.00'N	18°58.46'W	27.5	34.36	T5	T5_01072
24/9/00	1732	07°52.92'N	18°28.48'W	27.8	34.58	T7	T7_01073
24/9/00	2342	06°59.18'N	17°59.64'W	27.7	34.26	T7	T7_01074
25/9/00	1122	05°06.06'N	16°55.86'W	27.3	34.95	T5	T5_01075
25/9/00	1741	04°01.59'N	16°21.46'W	27.2	35.53	T7	T7_01076
25/9/00	2353	02°58.22'N	15°47.11'W	26.2	35.55	T7	T7_01077
26/9/00	0602	02°06.00'N	15°19.03'W	24.3	35.56	T7	T7_01078
26/9/00	1122	01°21.15'N	14°52.81'W	23.6	35.81	T5	T5_01079
26/9/00	1754	00°16.17'N	14°18.55'W	23.5	36.00	T7	T7_01080
27/9/00	0529	01°23.65'S	13°12.03'W	23.2	35.87	T7	T7_01081
27/9/00	1036	02°07.24'S	13°08.38'W	23.5	35.89	T5	T5_01082
27/9/00	1735	01°50.87'S	13°02.99'W	23.5	35.87	T7	T7_01083
27/9/00	2350	01°25.20'S	12°55.98'W	23.3	35.87	T7	T7_01084
28/9/00	0504	02°08.55'S	12°48.83'W	23.4	35.82	T7	T7_01085
28/9/00	1008	01°21.78'S	12°43.29'W	23.1	35.77	T5	T5_01086
28/9/00	1736	01°45.00'S	12°37.59'W	23.6	35.85	T5	T5_01087
28/9/00	2352	02°40.63'S	12°12.04'W	23.4	35.82	T7	T7_01088
29/9/00	1123	04°38.40'S	12°38.41'W	23.9	35.87	T5	T5_01089
29/9/00	1730	05°20.22'S	13°21.85'W	24.1	35.96	T5	T5_01090
29/9/00	2345	06°55.79'S	14°08.98'W	24.2	35.90	T7	T7_01091
30/9/00	0545	07°17.17'S	14°20.07'W	24.0	35.85	T7	T7_01092
30/9/00	0910	07°50.04'S	14°36.82'W	24.0	35.82	T5	T5_01093

30/9/00	1125	08°01.75'S	14°51.08'W	24.0	35.82	T5	T5_01094
30/9/00	1748	08°48.33'S	15°45.91'W	24.2	35.89	T5	T5_01095
30/9/00	2341	09°31.90'S	16°37.60'W	24.7	36.19	T7	T7_01096
1/10/00	0630	10°15.86'S	17°29.55'W	24.5	36.43	T7	T7_01097
1/10/00	1225	10°54.30'S	18°15.38'W	24.4	36.60	T5	T5_01098
1/10/00	1817	11°37.40'S	19°06.97'W	24.5	36.64	T7	T7_01099
1/10/00	2345	12°24.41'S	20°03.40'W	24.4	36.67	T7	T7_01100
2/10/00	0727	13°09.20'S	20°56.47'W	23.8	36.99	T7	T7_01101
2/10/00	1225	13°39.87'S	21°34.72'W	23.8	36.87	T5	T5_01102
2/10/00	1229	13°40.31'S	21°35.22'W	23.8	36.87	T5	T5_01103
2/10/00	1825	14°24.10'S	22°27.42'W	24.1	36.95	T5	T5_01105
2/10/00	2319	15°08.55'S	23°21.14'W	23.7	36.99	T7	T7_01106
3/10/00	0610	15°45.43'S	24°05.42'W	23.2	36.97	T7	T7_01107
3/10/00	1244	16°25.70'S	24°54.95'W	23.5	37.04	T5	T5_01108
3/10/00	1823	17°06.47'S	25°44.59'W	23.5	37.08	T5	T5_01109
3/10/00	2347	17°53.38'S	26°42.52'W	23.5	37.06	T7	T7_01110
4/10/00	0615	18°28.00'S	27°25.92'W	23.7	37.11	T7	T7_01111
4/10/00	1230	19°08.23'S	28°15.31'W	23.6	37.17	T5	T5_01112
4/10/00	1822	19°42.17'S	28°57.82'W	23.6	37.13	T5	T5_01113
4/10/00	2345	20°29.24'S	29°48.16'W	23.1	37.07	T7	T7_01114
5/10/00	0614	21°04.22'S	30°40.64'W	23.1	37.07	T7	T7_01115
5/10/00	1234	21°46.29'S	31°32.76'W	23.3	37.05	T5	T5_01116
5/10/00	1831	22°29.02'S	32°26.24'W	23.6	37.06	T5	T5_01117
5/10/00	2347	23°10.16'S	33°18.98'W	23.2	35.08?	T7	T7_01118
6/10/00	0647	23°49.34'S	34°09.14'W	23.4	37.13	T7	T7_01119
6/10/00	1328	24°36.13'S	35°08.91'W	22.4	36.92	T5	T5_01120
6/10/00	1933	25°18.18'S	36°03.36'W	22.0	36.69	T5	T5_01121
6/10/00	2345	26°05.10'S	37°04.40'W	21.8	36.73	T7	T7_01122
7/10/00	0645	26°37.57'S	37°46.43'W	21.9	36.76	T7	T7_01123

7/10/00	1336	27°19.62'S	38°42.79'W	20.6	36.18	T5	T5_01124
7/10/00	1923	27°58.94'S	3°33.97'W	20.1	36.24	T5	T5_01125
7/10/00	2345	28°44.12'S	40°39.15'W	20.7	36.50	T7	T7_01126
8/10/00	0515	29°21.56'S	41°24.50'W	19.9	36.46	T7	T7_01127
8/10/00	1343	30°05.36'S	42°22.04'W	18.3	36.03	T5	T5_01128
8/10/00	1935	30°48.09'S	43°21.31'W	18.2	36.02	T7	T7_01129
8/10/00	2355	31°40.64'S	44°32.69'W	17.8	35.96	T7	T7_01130
9/10/00	1332	33°09.55'S	46°37.81'W	16.6	35.63	T5	T5_01131
9/10/00	1337	33°09.92'S	46°38.29'W	16.6	35.60	T5	T5_01132
9/10/00	1928	33°57.36'S	47°43.41'W	16.9	35.83	T7	T7_01133

8.6 Appendix F: Table of CTD deployments

STATION	DATE	TIME	LAT	LON
AMT11–01	14/9/00	1053	49° 34.82'N	5° 36.75'W
AMT11–02	15/9/00	0417	47° 57.48'N	10° 38.58'W
AMT11–03	15/9/00	0952	47° 08.04'N	11° 35.10'W
AMT11–04	16/9/00	0434	43° 55.20'N	14° 03.18'W
AMT11–05	16/9/00	1049	42° 58.86'N	14° 45.00'W
AMT11–06	17/9/00	0425	39° 57.48'N	16° 58.74'W
AMT11–07	17/9/00	1044	38° 57.78'N	17° 41.58'W
AMT11–08	18/9/00	0443	35° 52.26'N	19° 48.90'W
AMT11–09	18/9/00	1046	34° 55.98'N	20° 27.24'W
AMT11–10	19/9/00	0449	31° 34.26'N	21° 11.34'W
AMT11–11	19/9/00	1048	30° 33.00'N	21° 23.28'W
AMT11–12	20/9/00	0447	27° 14.70'N	21° 58.08'W
AMT11–13	20/9/00	1048	26° 13.20'N	21° 46.86'W
AMT11–14	21/9/00	0448	22° 57.54'N	21° 11.04'W
AMT11–15	21/9/00	1049	21° 57.18'N	20° 59.88'W
AMT11–16	23/9/00	1049	12° 44.82'N	20° 39.84'W
AMT11–17	24/9/00	0449	9° 42.36'N	19° 28.80'W
AMT11–18	24/9/00	1050	8° 49.20'N	18° 58.86'W
AMT11–19	25/9/00	0449	5° 58.68'N	17° 26.22'W
AMT11–20	25/9/00	1050	5° 06.06'N	16° 55.98'W
AMT11–21	26/9/00	0501	2° 09.42'N	15° 20.70'W
AMT11–22	26/9/00	1051	1° 21.00'N	14° 53.10'W
AMT11–23	27/9/00	0440	1° 22.20'S	13° 12.12'W
AMT11–24	27/9/00	1000	2° 06.96'S	13° 08.10'W
AMT11–25	28/9/00	0415	2° 08.46'S	12° 51.06'W
AMT11–26	28/9/00	0941	1° 21.42'S	12° 43.08'W

AMT11–27	29/9/00	1049	4° 27.90'S	12° 37.80'W
AMT11–28	30/9/00	0450	7° 13.62'S	14° 18.12'W
AMT11–29	30/9/00	1052	8° 01.20'S	14° 50.28'W
AMT11–30	1/10/00	0533	10° 13.92'S	17° 26.82'W
AMT11–31	1/10/00	1149	10° 54.00'S	18° 14.64'W
AMT11–32	2/10/00	0549	13° 01.50'S	20° 46.80'W
AMT11–33	2/10/00	1145	13° 39.90'S	21° 33.90'W
AMT11–34	3/10/00	0534	15° 44.88'S	24° 04.74'W
AMT11–35	3/10/00	1147	16° 25.56'S	24° 54.00'W
AMT11–36	4/10/00	0533	18° 27.36'S	27° 24.60'W
AMT11–37	4/10/00	1147	19° 07.62'S	28° 14.58'W
AMT11–38	5/10/00	0535	21° 03.42'S	30° 39.60'W
AMT11–39	5/10/00	1147	21° 44.64'S	31° 30.60'W
AMT11–40	6/10/00	0604	23° 48.24'S	34° 07.86'W
AMT11–41	6/10/00	1247	24° 35.64'S	35° 08.88'W
AMT11–42	7/10/00	0606	26° 36.66'S	37° 45.54'W
AMT11–43	7/10/00	1247	27° 19.20'S	38° 42.00'W
AMT11–44	8/10/00	0620	29° 18.60'S	41° 20.64'W
AMT11–45	8/10/00	1301	30° 05.16'S	42° 22.20'W
AMT11–46	9/10/00	1247	33° 08.70'S	46° 35.85'W

8.7 Appendix G: Risk assessment

RISK ASSESSMENT RRS *James Clark Ross* Cruise JR53

BAS Geological Sciences Division Atlantic Geophysics

1. General

During cruise JR53, geoscientists from BAS and the Cardiff University will undertake marine geophysical survey using the Simrad EM 120 swath bathymetry and TOPAS profiling systems. This work will involve operation of instrumentation in the UIC laboratory and occasional deployment of XBTs and the AMS SV^{PLUS} sound velocity profiler. Although the cruise requires only a narrow range of activities, the individuals involved will be exposed to hazards associated with marine operations in addition to those associated with work ashore. Hence, participants should maintain constant vigilance regarding actions by themselves and their colleagues in order to minimise the risk of human error putting people or equipment at risk. Documentation on risk minimisation is available on the RRS *James Clark Ross* in the Officer's Lounge; all participants should familiarise themselves with the contents of these papers.

To enable deployment and recovery of scientific equipment to be undertaken safely certain basic principles must be adhered to. Foremost of these is familiarisation with the working practices in operation covering the deployment and recovery of scientific equipment. Many of these are covered as part of the newly instigated ISM (International Safety Management) package and in particular the Marine Standing Instructions. Marine Standing Instructions (MSI/SCI/01) details general principles of scientific operations from BAS vessels and offers guidance on procedures and safety. It should be consulted by all scientific personnel.

At the start of the cruise, ship-side will be made aware of the equipment that will be used during the cruise. Arrangements and procedures for deploying, recovering and handling equipment shall be the subject of discussion between the Master, Chief Officer, scientist in charge and prime users.

2. Hazards

2.1 Travel to and from the vessel

A NERC document relating to travel is currently in preparation. Participants should pay particular regard to fatigue arising from completion of a days work at BAS when outbound or arising from a long journey homeward bound. Guidance notes on driving hours and behaviour (H&S news 2/99, Appendix 5) should be consulted if this is planned as part of an individuals journey.

2.2 Activities on board the vessel

All work at sea must be undertaken in accordance with approved BAS policy and, where necessary, the requirements laid down by the Master.

2.2.1 Handling of scientific stores whilst at sea

Cruise participants will be required to manually handle XBTs and other cargo. All equipment must be handled carefully, paying full regard to avoidance of: potential injury situations, damage to the equipment and hazard to the vessel. Staff should be aware of, and implement, safe lifting techniques. Suitable safety equipment, in accordance with instructions from the Master or Officer of the Watch must be worn at all times.

2.2.2 Deck operations

Cruise participants will be required to deploy XBTs and the sound velocity profiler.

(i) marine standing instructions (MSI/SCI/03) offer guidance on the deployment of overside scientific equipment and should be consulted by all involved in these operations. Participants should also be familiar with general codes of guidance on safe working practices onboard ship as advised by Ships Safety Officer or other nominated person.

(ii) overside operations must be undertaken with approval and guidance from the Officer of the Watch.

(iii) decks are likely to become wet and slippery, consequently precautions need to be taken and appropriate footwear worn at all times.

2.2.3 Laboratory work

Cruise participants will be required to undertake watchkeeping and data analysis in the UIC and computer rooms.

(i) Particular attention should be paid to the safe stowage of equipment. Ship's motion can at times be violent and there are inherent dangers in gear that is not made secure. Laboratories need to be kept in a tidy and seaman-like state at all times.

(ii) All laboratory activities must be in accordance with BAS safe working practice with the added risk that full regard must be taken of vessel motion.

3. Training

Adequate training must be given to all personnel, paying due regard to new techniques and the presence of individuals who have had little or no previous experience on BAS cruises.

4. Review

During the cruise, I will be continually assess risks associated with all aspects of the work and encourage cruise participants to inform me immediately of any activities which provide cause for concern.

5. Overall assessment of risk for cruise JR53

In comparison to previous BAS GSD cruises, JR53 will involve a narrow range of activities. Although some activities (principally deck work) are potentially dangerous, suitable precautions will be taken to reduce the residual risk to a low level.

Overall the Risk Factor for the cruise is assessed at 5 (as scored in NERC Guidance Note: Risk Assessment HS3/95).

Assessment completed by .... Date ....

Assessment approved by .... Date ....