JR04:

RRS James Clarke Ross
Scotia and Bellingshausen Seas
Marine Geology and Geophysics
February 1993 - March 1993

Natural Environment Research Council

British Antarctic Survey

Cruise Report

RRS *James Clark Ross*

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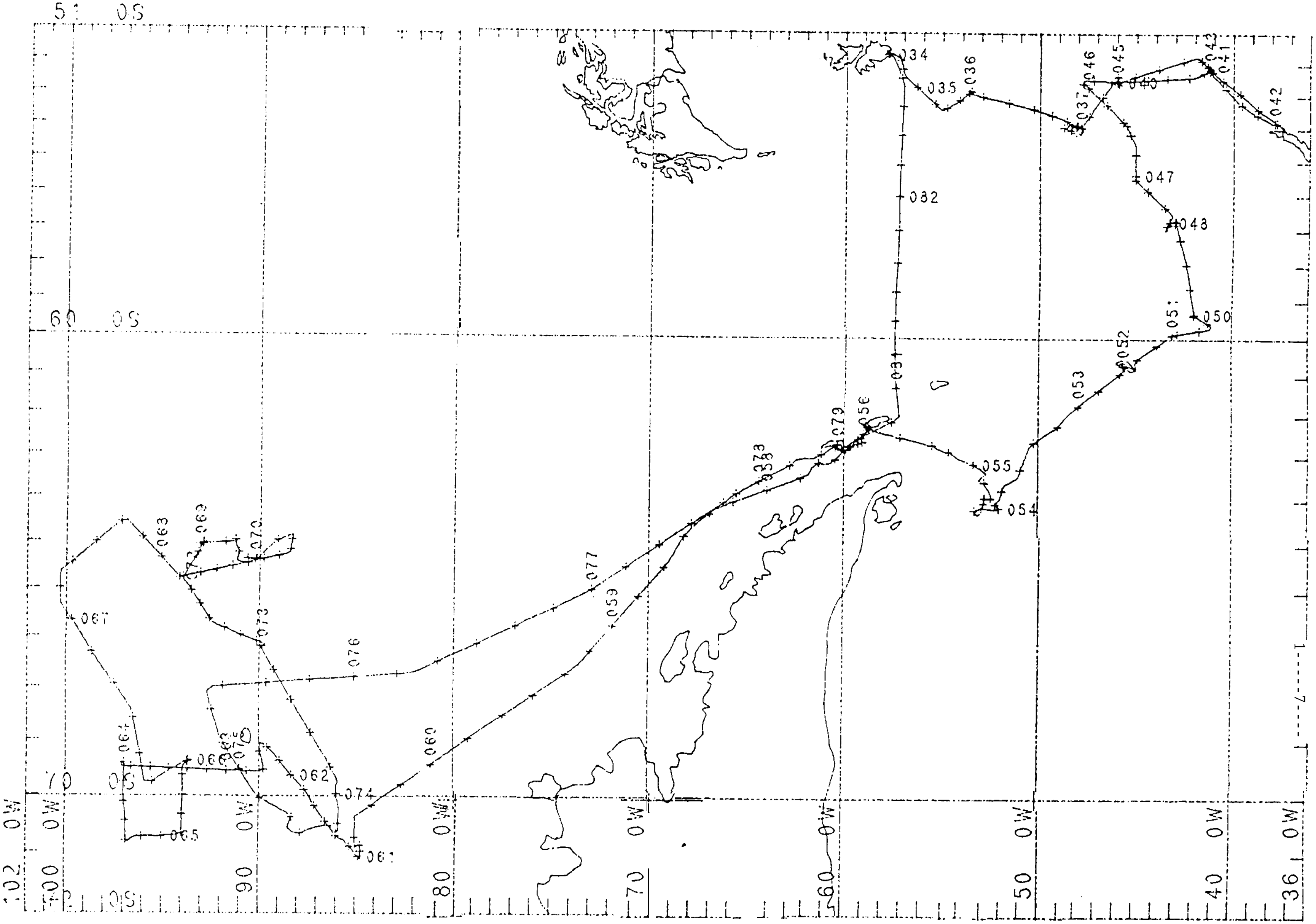

Figure 1. Summary track chart for Cruise JCR04. For greater detail, see fold-out chart at back.

SUMMARY (PFB)

Cruise JCR04 sailed from Port Stanley on 3rd February 1993 (day 034) and returned on 23rd March (day 082). Its main tasks (all essentially achieved) were:

i. 3 weeks of coring in the Falkland Trough, Central Scotia Sea and NW Weddell Sea, to study glacial/interglacial circulation changes,

ii. a similar period of marine geophysical investigation of the Bellingshausen Sea basin around Peter I Island,

iii. a short period of dredging along the axis of Bransfield Strait, for geochemical analysis

iv. en passant, refuelling the Signy Island Station and recovering 2 geological field parties from S Shetland Island sites.

A summary track chart is shown opposite: a more detailed version forms a fold-out at the back of this Report.

The coring was moderately successful: a total of 110m of core was recovered from 29 stations, which should reveal the variation of Antarctic Circumpolar Current flow through the last glacial cycle. However, two RVS Driscoll corers were lost because of failures of an Aramid warp used on a borrowed deck-mounted coring winch. In association with the coring programme, six CTD stations were occupied, three current meter moorings were deployed and 600km of single-channel seismic data acquired.

The Bellingshausen Sea study was very successful: it collected 1520 km of high quality multichannel seismic profile, plus a greater amount of magnetic and gravity data, a little single-channel seismic data and some dredged rocks, in pursuit of an important problem of regional tectonic evolution, bearing on the oldest ridge crest-trench collision, New Zealand-West Antarctic separation and the origin of the N-S lineation through Peter I Island, recently detected on Geosat images.

Virtually all of the activities of the cruise were new to RRS James Clark *Ross,* and some (dredging and coring in particular) were undertaken using jury rigs because the ship's Main Winch could not be used. Some loss of time, data and sample quality and, sadly, equipment must be attributed to this constraint, but the success of the cruise owes everything to the hard work put in by all on board. When she is finished . . . .

1. INTRODUCTION (PFB)

Cruise JCR04 represented a significant step forward for BAS Marine Geoscience. For the first time it would be possible to exploit the major geoscience facilities of the ship (for coring and for multichannel seismic profiling) to accomplish work that could not have been done from any (UK-owned) platform previously available. In the event, continued failure of the Main Winch to reach its specified performance on Sea Trials denied us the ship's full coring potential, but overall the cruise remained the first opportunity since 1988-9 to acquire a substantial body of high-quality data and samples to pursue central marine geoscience objectives.

<u>1.1. Coring under the ACC.</u> The central objective of the first part of the cruise (to Signy Island) was to examine the glacial/interglacial variability of the Antarctic Circumpolar Current (ACC), an extension of previous work on Weddell Sea Bottom Water under Project B6151 (Pudsey et al, 1988; Pudsey, 1992). The ACC is high-energy and extremely variable: it has energetic eddies, and its axis is known to have migrated north-south through time. To establish its behaviour during the late Quaternary, therefore, would not be a simple matter, and would require an extensive core collection from several areas, of sedimentary sequences that include at least one complete glacial/interglacial cycle. The cores should sample sites of both terrigenous and biogenic sedimentation, where deposition today is influenced by the ACC. Data from three moorings (which will, we hope, be recovered in 1993-4) would help quantify that influence. CTDs (with transmissivity profiles) and single-channel seismic data would further define the oceanographic and depositional context of the core sites.

<u>1.2. Bellingshausen Sea Tectonics.</u> Tine second major target concerned the tectonic evolution of the Antarctic margin between about 85° and lOO°W, and the adjacent floor of the Bellingshausen Sea to the north. This section of margin includes probably the oldest of the series of ridge crest-trench collisions that subsequently migrated NE along the Antarctic Peninsula margin through the Cenozoic, and has been extensively studied by BAS Marine Geoscience (eg Barker, 1982; Larter and Barker, 199 la,b), and possibly the boundary between that and the section of margin formed by the separation of New Zealand in the mid-Cretaceous. The ocean floor fabric associated with both collision and separation appears to be oriented NW-SE. Apparently superimposed on this, and revealed clearly by Geosat data (McAdoo and Marks 1992), is a ridge extending north from the margin at about 94°W and linked to a north-south trough extending to 64°S. Associated with the trough are Peter I Island, a young volcano (Prestvik et al. 1990), and several seamounts, including in particular the two large De Gerlache Seamounts near 65°5, 92°W. We attempted to answer questions like:

(a) Where is the boundary between collisional and extensional margins?

(b) What is the age of the oldest collision?

(c) What are the ages and origins of the north-south ridge and trough, and the De Gerlache Seamounts?

(d) What relation do any other young features have to alkalic volcanism on Peter I Island and onshore in the Jones Mountains?

This required a mixture of multichannel seismic (MCS) survey to examine structure and stratigraphy, fast magnetic survey to date the ocean floor, and dredging to permit the De Gerlache Seamounts to be dated and characterised geochemically. The dominant uncertainty was the sea ice distribution, which would restrict the range of MCS survey and, in particular, might deny access to the continental shelf and margin.

1.3. Bransfield Strait Dredging We were committed to a short programme of dredging seamounts along the axis of Bransfield Strait, for Dr J Smellie of BAS (Project B1213) and in collaboration with Dr L A Lawver's cruise aboard RV ***Nathaniel B Palmer,*** which had a similar commitment to Dr L Fisk (OSU). This would be interposed between the two major programmes, being on the way from one to the other, but could be supplemented at cruise end, as the ship had to revisit the area to recover two geological field parties.

1.4. Other Coring Of a number of short contingency activities, two (both involving coring) proved feasible. The first took advantage of unusually good ice conditions to visit a sediment body discovered during the 1984-5 cruise of RRS ***Discovery,*** on the slope near the eastern tip of the Antarctic Peninsula shelf, in the northwest Weddell Sea,. This sediment accumulation seemed likely to contain a proximal record of Weddell Sea Bottom Water production through a glacial cycle, that would complement our own studies of hemipelagic deposition farther east (Project B615 1: e.g. Pudsey, 1992). The second involved a single core on the Antarctic Peninsula outer shelf off Anvers Island, in front of a till tongue mapped by deep-tow boomer survey during JCR0l, to improve constraints on the extent of grounded ice cover of the shelf, at and during retreat from the last glacial maximum (part of Project B6152).

The ship's scientific complement comprised 6 BAS Geoscience Division scientists, with technical and engineering support from 7 BAS staff (ship and ISG) and 5 from RVS. The cruise promised to be exceptionally challenging, in that virtually every activity would be new to the ship and to most of those on board. Also, two crucial activities in particular, coring and dredging, were to be accomplished using jury rigs, since the intended facility (the Main Winch) was unavailable. The cruise was not without setbacks, in the event, but did achieve many of its objectives, and in some style, thanks to the hard work and commitment of all on board.

2. SCIENTIFIC NARRATIVE (PFB)

Mobilisation. Usually, a Cruise narrative starts "RRS James *Clark Ross* left Port Stanley at XXX on YYY, heading . . . . . " However, to do so in the case of JCR04 would omit mention of the considerable effort of the previous five days in completely refitting the ship for Geoscience after two successive Life Science cruises.

The ship arrived at FlPASS (Port Stanley) late on 28th January (day 028), having fuelled that morning at East Cove. Thanks to MLSD and ship personnel, the equipment used during the previous cruise was packed ready to be put ashore the following morning (thence ultimately to the forward hold), and loading of Geoscience gear started in the afternoon of day 029.

Loading, securing and fitting out, though intricate and time-consuming, proved straightforward for the most part The heavy equipment (BGS coring winch, airgun umbilical winches, Long Piston Corer handling gear, Driscoll, box and Kasten corers, single-channel streamer winch, magnetometer drums, sheave plate) was set in place first, so that hydraulic lines could be rigged and testing begun. The UIC Room was fitted out for single- and multichannel seismic, magnetic and 10kHz and 3.5kHz sounding, and the Main Lab for core handling and seismic processing. The Rough Workshop was turned over to airgun assembly and servicing, and a wide range of other tasks. The Water Bottle Annexe housed the corer rigging equipment and CTD. The Wet Lab became occupied by current meter mooring gear. The gravimeter was run up and a base station tie obtained.

Top priority was given to preparation for the initial activities of the Cruise - coring and single-channel seismic profiling. Other preparations, notably rigging the airgun beams and "cherry-picker" extensions to the Effer cranes for multichannel seismic operations, could be completed after sailing.

There were snags. The RVS core head bucket appeared likely to foul the adjacent bulwark during operation, and its "handraulic" control was inadequate at the extremes of its travel. It was replaced by the BAS LPC swivel/clamp, using the BAS-built corer neck adaptor to accommodate the Driscoll corer. The new CTD frame lacked a series of crucial holes in the rosette base plate, that were difficult to drill. Arranging a complete electrical power and control system for the BGS winch took longer than anticipated.

We were scheduled to sail on 2nd February (Day 033), but delayed to 6pm for air freight and subsequently overnight at ship's request, because BGS winch installation was barely complete and those working on it would otherwise have had to resume sea duties too soon after working long hours alongside. However, to be sailing am/034, ready to begin the science programme, after arriving late pm/028, was a considerable achievement: the entire ship's company worked hard and intelligently throughout.

Departure for Falkland Trough. RRS James *Clark Ross* left Port Stanley at 0800 on day 034 heading SSW for the start of a SCS profile along the Falkland Trough. On the way the ship slowed and turned head to wind for 4 hours to stream the new 5OOOm of 16mm braided Aramid rope that would be used for coring, and wind it on to the BGS winch.

As described in the Introduction, the central objective of the first part of the cruise (to Signy) was to examine the glacial/interglacial variability of the Antarctic Circumpolar Current

(ACC). The ACC is high-energy and extremely variable, so to establish its behaviour during the late Quaternary required an extensive core collection from several areas, supplemented by current meter, CTD and nephelometer data and water samples, and acoustic profiles, to allow core sites to be optimally located and to define precisely their oceanographic and depositional context.

The SCS streamer and a single airgun were deployed at 02/035 for a 70-mile line along the Falkland Trough axis to map a sediient drift that was also the object of our first core (GC062, a 2-barrel gravity core). We took the coring station slowly and carefully, since this particular rig was new to everyone. A CTD station on the same site was used also as a wire test for the first pair of mooring releases.

The ship then headed east across the North Scotia Ridge into the Scotia Sea, for the first area of more focussed activity. "Area E" contained a drift deposited apparently in the slacker water SE of the main deep pathway of the ACC through the North Scotia Ridge. An initial SCS/3.5kHz survey (days 036/7) to help select core sites was followed by a piston core, CTD, a kasten and two more piston cores and a mooring deployment (IX), over the next 36 hours (037/8). The order in which sites were occupied was dictated by time: sites were so close together that it was quicker to revisit a site to (for example) deploy a CTD or mooring than to wait on site while a corer was re-rigged.

Loss of Corer. The next transect lay north-south across the ACC axis in the Falkland Trough, directly east of the gap in the North Scotia Ridge already mentioned, and north of Aurora Bank, on a large sediment drift. A CTD dip (plus wire test) and piston core (PC068) were obtained at the northern margin of the drift, and a second piston core attempted about 15km to the south. On this core the warp parted on pullout (see coring report), within 4-5m of the termination. It was thought at the time that the warp may have tangled around part of the corer, such as the trigger arm.

With the corer (head, 4 barrels, trigger) we had lost also the BAS neck adaptor, so could no longer use the BAS LPC swivel/clamp device for deployment. It would be necessary to find sheltered water to exchange this for the RVS "bucket", which would also have to be re-rigged to overcome its control deficiencies. After an additional wire test the ship headed east towards South Georgia.

Coring priorities were re-assessed. It was decided to try to accomplish the more near-axis Falkland Trough transects thoroughly, at the expense of some of the more off-axis and less well-defined Scotia Sea targets. Accordingly, the ship diverted slightly to obtain a SCS profile across the northern margin of the eastern end of the Falkland Trough ("Area D") on Day 040, in preparation for coring, before heading for Rosita Harbour in worsening weather.

The afternoon of Day 041 was spent transferring and rigging the corer handling gear and spare core head. The RVS bucket was now driven from the ship's hydraulics, by means of control gear borrowed from an airgun beam "cherry-picker", and the barrel supports were re-positioned on the deck socket matrix. A 6m steel wire pennant was interposed between the aramid warp and the corer, and the eye splice remade. Before use, the new eye splice on the aramid warp was tested to 3.3 tonnes, the pull of the BGS winch at maximum diameter.

Coring Continued: Areas D and C. The ship headed back for Area "D" after 7 hours in shelter, into the remains of the bad weather. The SCS profile in Area “D” appeared to show the northwestward (upslope) migration of a boundary between distal (turbidite and hemipelagic) deposition on the flat basin floor and current-controlled deposition on the flank of the eastern Falkland Plateau. Four sites were selected, along a 20-km length, for a mix of kasten and piston cores, plus a mooring (X) deployment and CTD. All this was achieved, in 36hrs from noon/042, but not all of the cores were of good quality. The aramid behaved apparently as a very weak spring, with a recoil on trigger release unable even to extract the trigger corer. Our pennants were being made systematically too long, leading to late movement of the piston up the barrel and, probably, loss of the uppermost sediment. This was more noticeable in weak, fine-grained sediments such as were being sampled in Area “D” than at higher-energy sites as in Area “E”.

From Area “D” the ship returned westward, slowly at first because of fog, to complete coring in Area “C”, north of Aurora Bank. Mid-morning on Day 044 the ship experienced a complete power failure, caused by the explosive disintegration of the exciter of one of the main generators. Power was quickly restored, but the long-term result was that, for the remainder of the season, the ship would be able to use only 1 main and 2 auxiliary generators for all purposes. The practical effects on the cruise were an understandable reluctance to have the propulsion power exceed 2000kW (12kts downhill) and a need to stop work briefly at intervals to permit inspection and service of the remaining main generator.

Coring in Area “C” was completed early on Day 045 and the SCS gear was streamed for an east-west transect of the sediment drift, linking two existing MCS lines and defining the drift’s western “nose”. An attempt next to constrain the age of the drift, by coring what underlies it where it reaches the seabed to the west of the nose, was unsuccessful. The kasten corer wouid not penetrate what we took to be a carapace of glacial erratics and/or winnowed sand.

Scotia Sea Coring. The original cruise plan included a transect of 13 cores across the Scotia Sea: groups of 3 cores (in the north) and 4 in the south constituted depth transects to study nepheloid distribution and the effects of biogenic silica dissolution. It seemed possible to salvage a few of these cores, including a short transect (with mooring) near 57°S (Area “K”), before arriving at Signy Island to refuel the Base on Day 050. The first core of this transect (PC077) was the longest to date (10.5m) and it seemed we had learned to use the aramid.

However, the next core was short, and we found that an extra catcher ring, unnoticed during rigging, had jammed the piston. On re-deploying at the same site, the bottom 3 barrels slipped off when the corer was rotated to the vertical, but were held by the piston and, after 2 hours of careful manipulation, were brought back on deck and disentangled. The grubscrews in one collar, which did not have to be fully screwed down lest they pinch the liner and jam the piston, had in this case not been correctly located. We resolved to tighten up corer rigging procedures, which had probably been relaxed in the interests of speed.

To save time, we got underway after the corer had been recovered, abandoning that site and heading for Area “K”. An initial 3.5kHz survey of the area produced a range of promising sites. The first was cored successfully (PC079) overnight 047/8, despite a clogged fuel filter slowing the BGS winch to half speed during recovery. A CTD station followed, that included a partly successful wire test for the next set of mooring releases; the releases fired, but failed to acknowledge having done so.

Since PC079 showed signs of having penetrated farther than the core length recovered, indicating softer-than-usual sediments, the next core was sited on a more condensed section. Unfortunately, the at-amid again parted on pullout (calculated at 3.2 tonnes, as before). This time, the warp parted within 45cm of the eye. It no longer seemed reasonable to view the earlier failure as caused probably by its catching round part of the corer, since in all other respects the failure was identical to this one, in which the aramid had been protected from catching by a 6m wire pennant. To reinforce this view, another splice, made on board to manufacturer's instructions, failed at 3.1 tonnes under test on deck.

The failure of PC080 involved the loss of a second core head and trigger, and 4 more barrels. One head was left but very few useable barrels and no trigger. BAS permission was sought (and given) to use the ship's Main Winch, for kasten coring with the remaining l-tonne head and kasten adaptor. Core lengths would be limited to 3.25m, which would probably limit sampling to the last 50ka or so; however, this would still allow comparison of modem sedimentation with that at Last Glacial Maximum.

Meanwhile, Mooring XI had been deployed on the site of the lost corer, and a short survey had been run to connect that site to PC079. The Main Winch was used for a kasten core (KC081) on the mooring site, and the ship then headed south for the next site, about 120km away. KC082 was acquired am/O49 and the ship continued south. On station for KC083, a rapid pressure drop and rising swell heralded bad weather, and a planned site on the western flank of Bruce Bank was abandoned in favour of a core and CTD at a deeper site farther west, that would permit arrival at Signy Island early enough in the day for fuelling to commence. This judgement proved correct, and the ship arrived at Signy 0930/051.

Part 1 Summary. The programme aimed at examining the glacial/interglacial variability of the ACC was now complete, in the sense that no time remained to accomplish more. Within it, we had collected one gravity core, 11 piston (plus trigger) cores and five kasten cores. Piston core length averaged 6.6m and kasten core length 2.2m. Core quality was questionable in the softest sediments, and we lost two complete 4-barrel piston corers, We laid three moorings to examine the modem circulation, and occupied six CTD stations. We collected ca. 600km of SCS profile.

The original plan had, quite reasonably, envisaged a greater number of core sites, and longer cores. The loss of the corers, subsequent loss of time (estimated two days) in seeking sheltered waters to re-rig the handling system, and significant reduction of core length and quality, have to be attributed to our use of an aramid warp on the BGS winch. This was a BAS decision, in light of contractual circumstances surrounding use of the Main Winch. In all, however, it seems likely that sufficient cores have been obtained, from a range of carefully selected and documented sites, to allow an initial assessment of the glacial/interglacial variability of the ACC. In that sense, and despite the difficulties externally imposed, this first part of JCR04 must be counted a qualified success.

Northwest Weddell Sea. The Signy call provided an opportunity to walk and to see some wildlife, though the weather could have been better. At 11/052 the ship departed, heading for a sediment accumulation discovered during the 1984-5 cruise of RRS ***Discovery,*** on the slope beneath the eastern tip of the Antarctic Peninsula shelf, in the northwest Weddell Sea. This accumulation seemed likely to contain a proximal record of Weddell Sea Bottom Water production, that would complement our own studies of hemipelagic deposition farther east (eg Pudsey, 1992). Additional oceanographic data had been acquired in this area on a US cruise in 1991 and during JCR0l, but with difficulty because of ice. This year the area was reported to be ice-free, and it seemed possible to achieve an effective coring programme in little more than a day on site.

Compilation of all available data from the area we were approaching had strongly suggested that the margin ran east-west and that the sediment body we planned to core was a vast levee fed from a channel (and perhaps from others) that ran southward downslope. The levee was acoustically opaque to 3.5kHz energy (which suggested coarse-grained and thus proximal sediments) and had a sharp southern boundary with more transparent (finer-grained, distal) sediments. We needed to confirm the slope direction, the continuity and orientation of the channel and the southern facies transition, and to sample both the distal and the proximal sediments.

The ship headed for the southern end of the MCS profile, and attempted to core on either side of the acoustic facies transition. Sampling the fine-grained distal facies was straightforward, but it proved more difficult to sample the dropstone-rich sands of the levee. The southern boundary was traced westward, and further core sites on the levee were chosen along a line upslope parallel to the channel. Only two of four further attempts (KC087-9) were clearly successful. Nevertheless, the levee had been mapped and sampled, and time remained for a short zigzag track to examine the outer shelf above the channel, on passage to Bransfield strait.

<u>Bransfield Strait</u>, After visiting Teniente Rodolfo Marsh Stn to pick up Richard Hunter on Day 055, the ship started the planned dredging programme. This was a BAS contribution to a joint UK/US project to sample the line of seamounts extending along the axis of the central trough of Bransfield Strait, of which Deception and Bridgeman Islands are the only subaerial members, and was being undertaken on behalf of Dr J L Smellie. The BAS contribution would concentrate on the SW half of the trough. Interleaved with the dredging was an essential preparation for the forthcoming Bellingshausen Sea programme: the initial balancing of the MCS streamer for Antarctic seawater temperature and salinity conditions,

Since the ship's Main Winch was unavailable to us, it had been agreed that we could use the starboard warp of the Brattvaag Twin-Warp Trawl winch for dredging. There were difficulties in adopting this method, notably the poor speed control at low speed and lack of a true measure of wire tension, but it appeared viable. The first preparatory step was to familiarise the winch drivers with the mode of operation of the winches, which had not been used since Sea Trials the previous summer, This accomplished, late on Day 055, the ship was given over to streamer balancing for an initial 4 hours. Then dredging began, in less than ideal conditions: Force 6-7 winds blowing along the slope to be dredged, on a NE-SW ridge in VW. This first dredge (DR143) was unsuccessful, the strangler pennant having parted, with loss of a dredge bag. The dredge was repeated (DR144) with the wind moderating, and was successful.

There followed a further 10 hours of MCS streamer balancing, during which the ship moved to the next dredge target, a seamount centred near 62.9°S, 59.9°W. A dredge on the eastern flank recovered 150kg of basaltic rock, and a second farther west (DR146) recovered 50kg. Mindful of suggestions that we seek targets farther to the southwest, we moved on towards a 6Ofm shoal marked on the Admiralty Chart, 15km south of Deception Island. A box survey around this feature failed to find it, so the ship continued to a prominent scarp near 63.2°S, 61.2°W. The first attempt, on the upper slope (DR147), produced an empty bag, and the second (DR148) a small collection of rocks that may not have been in situ. The ship then headed for the only other clear target, a narrow ridge extending NE from the shelf of Low Island, shown on the Tectonic Map (1985) and based on two shoal soundings on the Admiralty Chart. This too, however, could not be found. In the absence of additional clear-cut targets, and with streamer balancing virtually complete, it was time (late on Day 057) to head for the Bellingshausen Sea. A further dredging opportunity would occur on the return passage.

Part 2 Summary. Although brief, the time since the Signy Island call had been productive, yielding four kasten cores (average length only 1.6m, but useful nonetheless) in the NW Weddell Sea and three (possibly four) successful dredges (out of six attempted) in Bransfield Strait, and achieving a balanced MCS streamer, in addition to the passage southwest.

Bellinnshausen Sea: Passage and MCS. The aims of the Bellingshausen Sea survey have been described in the Introduction. They concerned the tectonic evolution of the Antarctic margin between about 85 and lOO°W, and the adjacent sea-floor to the north. This area probably contained the boundary between New Zealand-West Antarctic extensional tectonics in the west and ridge-crest subduction to the east, with additional likely neotectonic complications (Peter I Island and possibly the De Gerlache Seamounts and N-S lineation revealed on Geosat GM images). We aimed to map ocean floor age, use the ship’s considerable MCS capability to examine sea-floor structure and sediment stratigraphy, and sample the seamounts by dredging to determine ages and geochemical affiliations.

In December 1992 and January 1993, a cruise of RV. *Nathaniel B Palmer* led by Dr C Raymond had reconnoitred this area (magnetics, gravity, SCS), then gone on to investigate the New Zealand - West Antarctic separation farther west. Before arriving in the area we had been able to obtain the ship track of that cruise, so that we could avoid duplication. Beside these objectives, any data acquired that related to glacial margins, for example, had to be considered a bonus. In particular, the cruise plan had been constructed originally in the knowledge that sea ice could prevent all access to the shelf and upper slope. As the season progressed, however, ice conditions began to appear quite favourable.

Passage to the SW from Bransfield Strait took a line along the outermost shelf of the Antarctic Peninsula (except between 74” and 80°W), to examine the relation between shelf edge depths and inshore ice drainage basins (see Larter and Cunningham, 1993 for example). The ship arrived at 85°W early on Day 060 and turned south to reconnoitre the extent of ice-free water over the shelf. It would be necessary to acquire MCS data over a significant width of shelf, to allow the deep structure of the margin to be compared with that of known extensional and ridge crest collision margins. This, incidentally, would also allow glacial sedimentation to be examined thoroughly on the outer shelf, slope and rise, for comparison with other parts of the Antarctic margin (see Larter and Barker, 1991b; Larter and Cunningham, 1993).

It took about 14 hours to deploy the MCS gear (for the first time on this ship, essentially, and in unpleasant weather). Meanwhile, during the necessary manoeuvres, the ship reached its farthest south to date (71°07.34’ S). The first MCS line, run NW off the shelf into a basin and towards Peter I Island, commenced early on Day 061. MCS single-channel monitor records showed a complicated glacial sedimentation story on the shelf, and the influence within the basin sediments of debris from Peter I Island to the north. Coming back south to the basin axis, we started the next MCS line early on Day 062. This line ran parallel to the margin to examine the north-south ridge near 95°W. Essentially, this line demonstrated that the ridge was an old feature, devoid of significant neotectonic disturbance.

Late on Day 063 we turned south to run back onto the shelf along 97°W. Ice conditions on the shelf were worse than around 85°W and it was impossible to go very far south. The value of this line in assessing deep margin structure will be difficult to judge until the MCS data are fully processed. The ship made its way east, trying to keep on the shelf despite the pack ice, to examine the prograded wedge on the outer shelf and assess the origin of a prominent GEOSAT gravity anomaly transverse to the margin along an extension of the north-south ridge. This was not entirely successful, but brought the ship early on Day 065 to 94°W, the start of the last MCS line of this session, northward off the margin along the bathymetric axis of the north-south ridge. The aim of this line was to connect shelf and basin sedimentation, but this was largely prevented by the pack-ice distribution on the shelf.

Bellingshausen Sea: Magnetics, Dredging etc. It was time to re-assess priorities for the remaining 9-10 days in the area. The MCS gear was recovered late on Day 065 and the first of two long NW-SE fast lines started. These were intended to supplement existing magnetic data to allow ocean floor within the region to be dated. The ages would also help define the margin origin: essentially. in a collision zone ocean floor would become younger towards the margin, in an extensional zone older.

These lines were run in deteriorating weather, but the wind and sea stayed not far from the beam, making uncomfortable passage but allowing ship speed to be maintained. At the northern end of the line, the ship reached west of l00°W, another BAS record. To save passage time, early on Day 068, the second line was interrupted part way, close to the De Gerlache seamounts, which were primary dredge targets. The line would be continued after dredging, partly as an MCS line and partly in the earlier fast magnetics mode.

The ship crossed the flat top of DGW early on Day 068, heading NE. The first dredge site (DR149) was chosen high on the NE flank, and yielded 8 cobbles, some of which *might be in situ*. The next site was located on what appeared to be a parasitic cone, farther down the NE flank. The dredge snagged right away, and was only freed after much manoeuvring: the dredge bag came on board strangled, and containing only one small erratic. The station was repeated (DR151), and the bag came on board tom and empty. The ship moved around to the upper part of the NW slope for DR152, and gained six small cobbles of similar, probably *in situ* lithology. By now it was late on Day 068 and the results of dredging had been rather meagre. It seemed time to move to the smaller, reversely-magnetised DGC.

DGC was reached early on Day 069, and a site dredged on the NW flank, in about 3200m water depth. It yielded only two manganese-coated subrounded cobbles, probably erratics. It seemed more fruitful to move on to DGE. During the passage a 20mm steel bar was welded to the after bulwark, which the dredge wire had cut into during the last dredge.

As on DGW, a site was chosen on the upper slope of the main body, that for simplicity could be dredged upwind. The bag came up strangled, and containing two obvious erratics and 2 pieces of a freshly-broken semi-indurated conglomerate containing rounded pebbles. Since these could have been erratics also, there was no likely in ***situ*** component. By then, the relative lack of dredging success and the passage of time, were arguing for dredging to be curtailed. It was decided to attempt one more site, on an isolated peak on the ENE flank, seen on the original ***Eltanin 42*** crossing. It was necessary to find the NNW (upwind) slope but a preliminary survey soon made clear that the peak was not isolated, and had no steep NNW slope. It merely appeared so, the ***Eltanin 42*** profile having crossed obliquely a dissected slope open to the south. it was decided to dredge ***along*** slope (upwind), an uncommon strategy but one that might be appropriate on a steep volcano flank, where ash/sediment and outcrop might alternate, as a result of gravitational instability, and where dredging ***upslope*** with only the moderate control that our jury rig allowed led often to higher than necessary dredging speeds and consequent damage. The dredge yielded one large vesicular basaltic block, that might perhaps have been ***in situ.***

The ship headed east to a position downwind of the planned MCS profile crossing DGE and the adjacent section of the north-south trough. The MCS gear was deployed am/070, this time in only 7 hours. DGE was crossed overnight 070/l and the line continued to where the original fast magnetic profile had broken off 3.5 days before. The next 240km of magnetics line was also two MCS lines, that re-crossed the north-south trough in an area remote from seamounts. The data should allow flexural modelling of the trough, as a means of establishing its origin.

The MCS line was ended late on Day 072. Streamer recovery was hampered by a multitude of small oil leaks in two sections, which was attributed to the attentions of killer whales during deployment 3 days before. After recovery, the magnetics line was continued in rapidly worsening weather, with a beam sea that once more caused discomfort rather than a reduction in ship speed. In the time remaining, it seemed possible to link this current line to a final magnetics line by a short dogleg SCS profile that would intersect the earliest, very successful MCS line on the continental shelf, helping to define the geometry of the prograded glacial sequences that had been revealed.

The SCS gear was streamed late on Day 073 and the profile begun. However, over the two weeks since that first MCS line had been run, a southerly wind had shifted large rafts of sea ice northward. In the dark and with limited time remaining it was impossible to do other than play safe and skirt all such rafts to the north, so the SCS profile is likely to have only limited value. The SCS gear was recovered around noon on Day 074 and the final fast magnetics run NW off the margin begun. The final departure point was reached 90 minutes late, at 0730/075, and the ship started the return passage to Bransfield Strait.

<ins>Summarv: Part 3.</ins> The Bellingshausen Sea survey was a success. The ship proved an excellent MCS platform, and the survey conducted will produce a significant advance in our understanding of the structure and origin of the margin, the north-south ridge and the De Gerlache Seamounts. The magnetics were informative and the dredging, though difficult, will with moderate good fortune yield seamount chemistry and ages. The questions posed above can be answered, certainly after MCS processing, magnetics compilation and dredged rock analysis, and with an element of uncertainty right now. As well as the tectonic objectives, the MCS data will allow some comment on the glacial sedimentary history of this section of the Antarctic margin, thanks to a(n initially) favourable pack ice distribution. Very little time was lost to bad weather or equipment breakdown, and only a little to ice when we became too ambitious.

Passage to Port Stanlev, with Diversions. Blessed with a gale-force tailwind, the ship made excellent time NE, back towards Bransfield Strait. There appeared to be ample time for some dredging and a kasten core, in addition to the ship's other duties, before arrival at Mare harbour (Falkland Islands) early on Day 082. We stopped pm/O77 on the outer shelf off Anvers Island and, in marginal weather conditions, obtained a full kasten core in a depression in front of a posited late glacial till tongue, with the intention of dating the tongue to test models of ice sheet extent at glacial maximum. Continuing, we reached False Bay, Livingston Island, where the first of two geological field parties was to be recovered, early on Day 078.

Recovery proved impossible that day, because of the steep swell from the SW breaking along the beach. The ship's company's efforts to accomplish the recovery left it in no state to go out dredging overnight, as had been planned, and we remained at anchor. As conditions were no better next morning, the ship sailed for Potter Cove, where the greater shelter allowed recovery of the second party without difficulty. Departing there 1500/079, we undertook a short test of the LPC trigger unit in 450m of water in Maxwell Bay, then headed back towards False Bay. Since recovery could not now proceed before first light, there was time for one dredge station in Bransfield Strait. Choice was limited because of passage constraints, and it was decided to enhance the existing collection by dredging again close to DR146. About 100kg of very vesicular basalt was recovered (DR156) without difficulty. Much the same could be said for the field party the next morning, and the ship was heading NE along Bransfield Strait, for Port Stanley, by l000/O8O.

The ship needed to average 12.5kts to allow the scientific party to catch the flight out of Mount Pleasant on Day 083. It found no difficulty in achieving this speed, despite contrary winds, and we must be grateful for the magical engineers' extra knots that were found and used on this occasion. The track was virtually a direct line to Cape Pembroke, except for the very northern end, but still managed to fill a gap in existing coverage of Drake Passage and the Falkland Plateau. The ship tied up alongside FIPASS at 1800/082 (March 23rd).

3. CORING: EQUIPMENT, PROCEDURE, STATIONS (CJP, PFB, SB, AT)

The ship's coring capability for this cruise evolved as a series of responses to adversity. planned as a **BAS** Long Piston Corer (LPC) cruise with RVS **Driscoll** corers as back-up, it lost use of the Main Winch and 30-T SuperAramid warp during summer sea trials, when serious winch control problems were revealed. Trials also established that the steel coring warp of the Main Winch would slip on veer at about 5.5 tonnes. LPC use was abandoned and a deck-mounted winch was borrowed from BGS, initially as standby to (restricted) use of the Main Winch coring warp, and an At-amid rope purchased for it. By the time of the cruise, BAS HQ had decided that contractual risks associated with use of the Main Winch required that the BGS winch be the sole means of deployment. The ship sailed with two RVS Driscoll corers and a kasten corer made up of a third Driscoll head and two BAS-owned barrels. Handling gear was mainly BAS LPC equipment, but with a RVS Driscoll head bucket in addition. To rig and operate this diverse mixture of equipment, on a ship that had never cored before, was an achievement in itself.

progress of the coring programme is described in the Scientific Narrative. Core station positions and results are given in Table 1. This section describes equipment and techniques (in detail, for the benefit of future users of JCR), and circumstances surrounding equipment loss.

<u>3.1 BGS Winch</u> BAS borrowed from BGS a portable winch that could be deck-mounted, driven from ship's power and controlled remotely from the Winch Control Room. The winch was shipped to FlPASS aboard RRS ***Bransfield,*** and installed by ship's personnel during JCR04 mobilisation. Installation was a major task, involving deck mounting, electrical and hydraulic plumbing for both power and control, and replacement of the 5000m of 12mm rope (partly damaged) that it carried by 5000m of new 16mm aramid warp.

The winch was sited as far forward as possible on the after deck, to leave space free for other activities. Its warp was led aft to a diverter sheave (the port diverter sheave of the Twin Warp Trawl Winch) secured to the deck socket matrix between the After Gantry legs, and thence to the sheave atop the spurling pipe serving the Main Winch (and by the normal route to the Midships Gantry). The portable cable metering system designed for the 14mm cable of the Biological Winch was used to measure wire out, wire speed and tension.

The winch's capability matched our needs. It could haul about 3.3 tonnes when fully loaded, and proportionately more with the warp deployed. It could haul at up to 80m/min, which was entirely adequate for coring. It was used for 19 core stations, and abandoned after the loss of a second Driscoll corer. It faltered only twice: on one deployment, the warp ran away briefly during veer, when the winch unaccountably slipped out of gear. On another, haul speed dropped significantly after a hydraulic fluid filter clogged.

<u>3.2 Main Winch</u> After loss of the second piston corer, it was deemed unacceptable to risk the single remaining core head with kasten barrel on the BGS winch. With BAS HQ Permission the ship's Main Winch was used for the remaining cores. Ten successful kasten core stations were occupied. Of these, nine used the steel Coring Warp. Subsequently, the storage winch spooling gear sheave was found to be damaged when dismantled to see why it was not running as freely as it had during initial sea trials. The coring programme was completed using the tapered trawl warp, which employed a different spooling gear. The Main

Winch was run at 36m/min, using 6 driven drums, out to 5-700m, where tension was usually sufficient for the wire to turn the undriven drum when the drive was limited to 5 drums and the speed increased to 60m/min. The deepest deployment was in 4600m of water: no slip was experienced at any site.

3.3 Handling gear

1) MPD Tilt/Transfer unit. It was decided initially to use the BAS LPC corer handling gear with the RVS piston core head and barrels, and a neck adaptor designed to fit the MPD tilt/transfer unit, For this application the tilt/transfer unit proved rather cumbersome but functioned correctly. Manually locking the neck adaptor to the housing of the tilt/transfer unit was time-consuming, and to reach outboard beneath the unit while attaching the chain noose (see below) was very awkward. The portable control box is too heavy (insufficiently portable) for long deployments.
ii) Davits The davits were positioned 7m and llm aft of the midships gantry centre line. The forward one was used to lift a 3-barrel (9m) corer and the after one a 4-barrel (12m) corer. Various obstructions on the deck restrict the range of davit positions. The davits worked well except that the after one was very slow to power up when the hydraulics were switched on. Again the control box is too heavy.
iii) RVS bucket. After the loss of the first piston corer with neck adaptor, the MPD tilt/transfer unit could no longer be used. The RVS coring bucket was mounted in its place below the midships gantry. It was a tight fit on the deck matrix and there was little room for adjustment on the base plate. The coring bucket was converted from “handraulic” to powered operation by C. Rymer, using a control box borrowed from the airgun-beam handling gear. Core handling was easier and quicker using the bucket because the core head is automatically latched in position, and the bucket is less bulky to reach around.

3.4 Piston (Driscoll) Corer Deployment Deployment procedure was as follows.

- Lift barrels clear of supports and swing corer outboard using davit and tilt/transfer unit or bucket (piston/free-fall pennant already coiled in core-head, end attached to slack main warp)
- Lower away on davit until barrels are vertical
- Slack off davit wire, drop chain loop off bottom of barrels and recover davit wire
- Lift trigger into position above core head using wire from 2-T forward auxiliary winch on gantry (FAW wire)
- Hook trigger on to core head, set hydrostatic release and clamp pennant on to trigger; take up slack on main warp, detach FAW wire
- Lift pilot corer and chain on FAW wire, lower away outboard, attach chain to trigger arm, detach FAW wire
- Lift corer out of bucket, move it away from ship’s side using gantry, veer 50m of main warp
- Move warp back within reach of ship’s side, attach pinger
- Veer to seabed and take core.

Recovery procedure was as follows.

- Remove pinger at 50m
- Bring trigger to rail, pick up pilot corer and chain using FAW wire, bring pilot corer inboard and secure on deck
- Attach wire from MPD 10-T auxiliary winch to top of pennant, slack off main warp, remove trigger
- Heave in on auxiliary winch until core head is at rail, re-attach main warp to core head

- Slack off auxiliary winch, lift core head into bucket or neck clamp, latch
- Attach chain noose from davit wire around top of barrels, tape noose open, lower down barrels to just below lowest sleeve
- Heave in on davit wire (break tape, tighten noose) until barrels are horizontal
- Swing corer inboard, lower into barrel supports.

The most awkward part of this operation was attaching and removing the heavy trigger: it required 1 - 2 people working outboard and above the core head. A trigger was bent during one deployment and subsequently straightened.

<u>3.5 Kasten corer deployment</u> The kasten corer used a one-tonne piston core head but was considerably easier to deploy and recover than the piston corer, being much shorter and having no moving parts. The 2m and 3.25m barrels were too short to reach either davit, so to raise and lower the bucket and barrel we used the MPD auxiliary winch wire. This was led over a block on the gantry about lm aft of the main warp position and attached to a lug on the bucket. The kasten core catchers purchased from Cambridge University were too flimsy for some Antarctic sediments (stiff diatom oozes or muds with dropstones). The catchers had to be straightened after most deployments and one external lever eventually broke off. The more robust type of catcher with stronger springs, supplied by RVS, was more suitable. For very coarse sediments (such as in the NW Weddell or the Peninsula shelf) the external levers were removed; otherwise we found that small dropstones could jam in the catcher, preventing the internal flaps from closing.

<u>3.6 Core Lab Processing</u>

i) Piston cores. During corer assembly, 3m liner lengths were marked and aligned, to keep a consistent relative orientation down the whole core for the benefit of magnetic remanence studies. Upon removal from the barrel, each full liner was end-capped and cut into two 1.5m lengths. The top liner, usually less than full, was lashed vertical, the water drained and the liner sawn off at the top of the sediment. Sections were numbered 1 to n from the top down. Not all the liners were exactly 3m long, which resulted in some short (few cm) lengths of sediment at joints between barrels. These were retained so that the complete core length could be reconstructed. End caps were taped on and the liner sections were stored horizontally in the cool store (+4°C).

ii) Kasten cores. Kasten cores had to be processed promptly because there is no liner and the barrel has to be completely emptied, washed and reassembled for the next deployment. The procedure was as follows.
- Detach from core head and manhandle into lab. The barrel is supported in two bench vices.
- Remove core catcher and store vertically
- Remove lid (approx. 60 screws) and support free sediment ends
- Remove screws from false bottom and insert threaded T-bars
- Raise false bottom by approx. 2cm, slice with cheese-wire and discard protruding sediment and clean surface. Do visual description, take photographs, make smear slides.
- Raise false bottom by 5cm and take 3 parallel channel samples using 5cm square plastic electrical conduit (see fig. 2). Channels are numbered 1 and 2 if the core is more than 1.5m long. Adjacent channels are lettered a,b,c. Three short channel samples were usually obtained from the core catcher.
- Raise bottom by lcm and discard protruding sediment. Raise bottom by 3cm and take continuous series of slab samples (10cm long by 15cm wide) downcore. Each slab is cut with

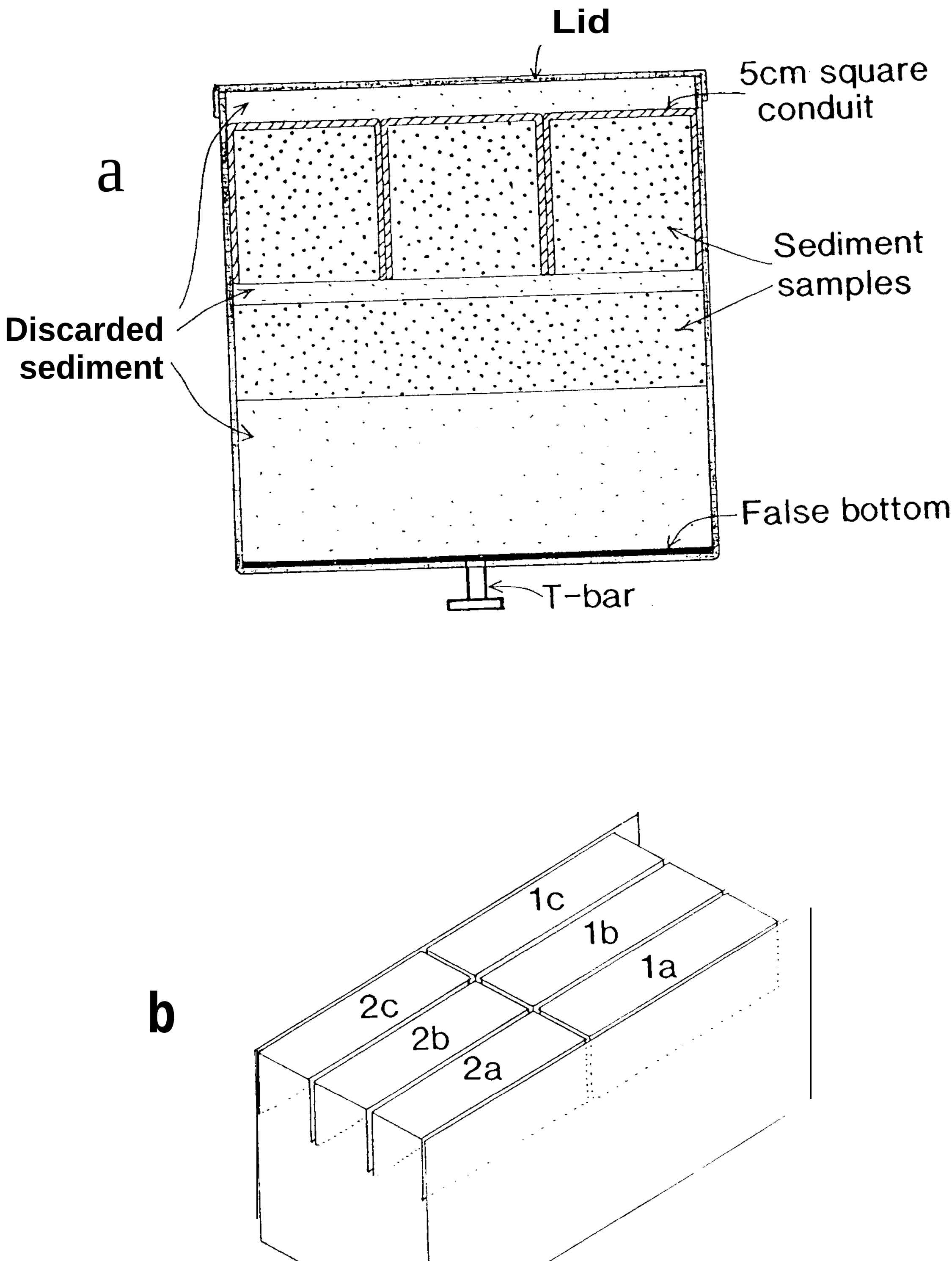

Figure 2 a) Cross-section of Kasten core showing positions of channel and slab samples b) Convention for numbering channel samples: core top is to right.

a cheesewire, encased in clingfilm and stored in a plastic box.
- Discard remaining sediment, wash and re-assemble corer.

3.7 Core Storage Core sections, channel samples and boxes of slab samples were all stowed at +4°C in the Cool Store. The Cool Store racking is ideal for core storage without the steel trays, because core sections can be lashed to horizontal and vertical rails. Also, most of the steel trays are bent and do not fit the racking. Only two trays were found necessary, to accommodate short lengths of core.

3.8 Loss of Driscoll corers - Aramid rope use The BGS winch was loaded with 5000m of 16mm KT3 Aramid rope with braided polyester sheath, from Mar-low Ropes (MR). Its quoted Average Breaking Load is 11.47 tonnes and its elastic response (scaled up from 10mm rope, on MR advice) is shown in Fig. 3. The initial eye-splice termination was MR's, and subsequent splices were to MR instructions.

Tension was monitored on the sensor block normally used for the Biological Winch (14mm conducting cable). Use of this with a 16mm warp should have no effect on wire out and speed measurements, but should show anomalously high wire tension values because of the change in geometry (theoretically, high by 50%, although we could see an effect of only l0-. 20% using known weights, perhaps because the aramid warp flattens around the sheaves).

The corer rigs comprised one 2-barrel gravity core, 13 3- or 4-barrel piston cores and 15 3.25m Kasten cores. All but the last 10 Kasten cores used the BGS winch and 16mm aramid warp. Their static weights were about 1.2 to 1.5 tonnes (3-4 barrel piston) and 1.1 tonnes (kasten). Pull-out force exceeded 2 x weight (on a few occasions) probably because the trigger was arranged to give a 3m free fall before the cutter hit the sediment. This was a compromise between conventional coring practice on steel wires (5-6m free-fall) and STACOR practice (0.5m).

The aramid warp parted on the 7th core (a 4-barrel piston core) and its replacement parted on its 12th core (ditto). On the first occasion, the warp parted within 4m of the splice (ie. could have been closer), and we guessed at the time that it had tangled around the trigger arm and, effectively, been cut. We therefore added a 6-m wire pennant above the piston/free-fall pennant to keep it away from such dangers. The second parted only 40-50cm from the eye, within the length of the splice (which had been made on board, with advice from MR, and tested to 3.3 tonnes). These warps parted during pull-out, at maximum measured tensions of 3.77 tonnes (actually 3.2 tonnes at the eye, allowing 10% warp diameter effect, and subtracting the weight of the warp above the eye). The maximum tension ever observed was 4.6 tonnes (3.95 tonnes at the eye, with the same assumptions), at pullout on PC074. A third eye, made after the failure of the second, was tested on board and failed at 3.1 tonnes.

A spliced eye is generally supposed to be the most effective termination to retain the strength of a warp, and its failure at such low loads is not understood. We now believe all three failures were similar in nature, the first being closer to the splice than at first thought, and not caused by tangling. Mat-low data (Figure 3) show non-linear stretch with load, particularly at low loads. Most of our use was in their low-load range (!) so considerable stretch was expected: the aramid acts as a weak spring. Stretch was in fact limited by the warp's inability to pull out the trigger corer on initial rebound. Thus the warp is likely always to have been moderately taut, with little chance of snagging around (for example) the trigger arm.

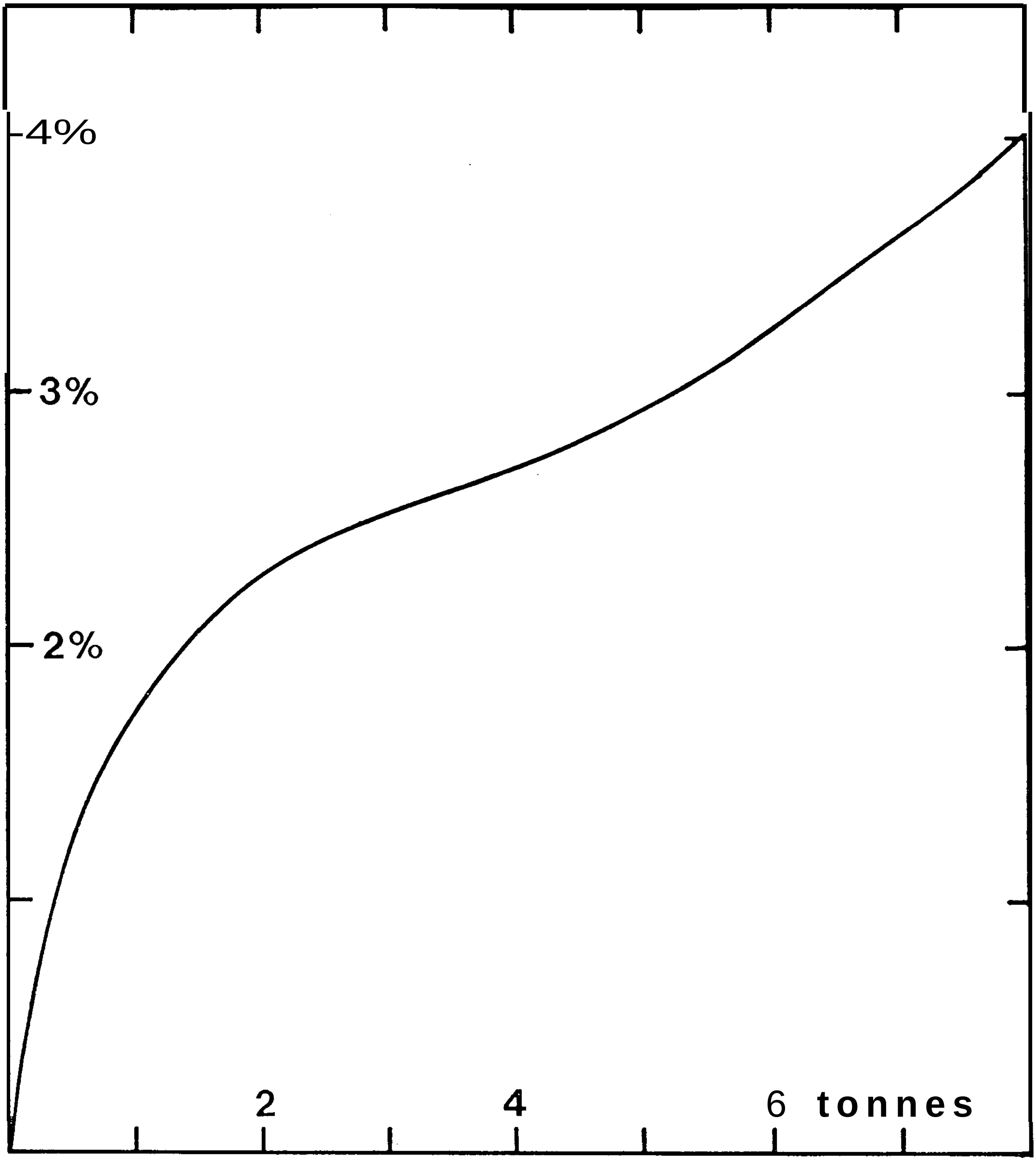

Figure 3. Variation of elastic extension with applied load for KT3 16mm aramid rope (scaled up from 10mm rope data, at Marlow Ropes suggestion), showing non-linear behaviour: rope is a weak spring under low load. Average Breaking Load for 16mm rope is quoted as 11.47 tonnes.

We shall need to seek information from other users of aramid warps, to see if some aspect of our practice is inappropriate. In particular, we have to be concerned about potential use of the ship’s own SuperAramid warp: although that has a solid sheath, and its use on French ships has been relatively trouble-free, there will be a question about its use aboard JCR until we understand the cause of the recent failures.

3.9 Recommended equipment modifications   Among the diverse assemblage of equipment used this year were some components of the BAS Long Piston Corer and handling system. Some modifications are desirable, in light of this season’s experience.

i. Lifting eyes are required, for crane lifting into position, on the tilt/transfer mechanism and barrel davits.

ii. Step plates are required on the tilt/transfer mechanism, to aid pinger and trigger attachment and other wire operations during deployment and recovery.

iii. Additional securing points are required on bulwarks and superstructure around the midships gantry, to assist corer deployment and recovery.

iv. Manual control valves on barrel davits should be relocated to avoid damage.

v. Portable hydraulic control boxes and associated cables are heavy and cumbersome; lighter components should be substituted.

Table 1 **JCR 04 Core Station List**

Core No.	Latitude	Longitude	Depth	Length	Time/date
923 GC 062	52°55.5'	53°41.0'	3000m	3.4m	1700-2100/035
TC 063	53°56.0'	48°02.6'	3956m	1.2m	1100-1800/037
PC 063	"	"	"	6.5m	"
KC 064	53°52.1'	48°20.3'	4304m	3.2m	0030-0330/038
TC 065	54°04.2'	48°23.2'	4200m	1.2m	0530-1100/038
PC 065	"	"	"	6.5m	"
TC 066	53°59.1'	47’50.8’	4129m	1.0m	1650-2150/038
PC 066	"	"	"	8.5m	"
TC 067	52°22.1'	45°59.8'	3571m	0.9m	1330-1735/039
PC 067	"	"	"	8.0m	"
PC 068	52°31.2'	45°58.0'	3364m	Corer lost	1855/039-0000/040
KC 069	52°02.9'	41°17.6'	3720m	1.9m	1740-2255/042 *
TC 070	52°08.3’	41°09.2'	3763m	0.3m	0020-0600/043
PC 070	"	"	"	5.3m	"
TC 071	52°03.9’	41°16.6'	3748m	0.7m	1010-1435/043
PC071	"	"	"	3.0m	"

TC 072	52°06.4'	41°12.	3773m	0.3m	1820-2215/043
PC 072	"	"	"	8.6m	"
KC 073	52°09.2'	41°10.7'	3760m	2.9m	2245/043-0200/044
TC 074	52°31.0'	45°57.9'	3373m	0.6m	23 15/044-0335/045+
PC 074	"	"	"	4.0m	"
KC 075	52°40.7'	45°57.6'	3388m	2.9m	0450-0730/045
KC 076	52°35.5'	47°43.6'	3766m	0.15m	20 l0-2240/045
TC 077	53°55.0'	45°28.0'	3774m	0.7m	0930-1345/046
PC 077	"	"	"	10.5m	"
TC 078	55°33.0'	45°00.9'	3840m	0.6m	0135-08551047*+
PC 078	"	"	"	4.2m	"
TC 079	56°45.0'	43°16.9’	3733m	0.3m	2330/047-0330/048+
PC 079	"	"	"	8.0m	"
PC 080	56°44.3’	42°58.0'	3663m	Corer lost	1300- 1550/048
KC 081	56°44.3’	42°58.1'	3662m	3.2m	01 l0-0445/049
KC 082	57°57.0’	42°24.0'	3110m	l.0m	1230-1605/049
KC 083	59°22.2'	41°57.9’	39OOm	2.3m	0030-0445/050
KC 084	59°53.2'	43°04.5'	4597m	1.8m	2020/050-0045/05
KC 085	64°05.1'	52°08.7’	2374m	0.9m	1830-2055/053
KC 086	64°10.5’	51°57.8'	2664m	2.9m	2145/053-0030/054
KC 087	64°04.3'	52°44.0'	1997m	trace	0730-1010/054
KC 088	63°57.0’	52°42.0'	1441m	1.8m	1100-1500/054 *
KC 089	63°55.3’	52°20.0'	1449m	0.7m	1625- 1 805/054
KC 090	63°52.5'	65°30.8’	476m	2.8m	1840-2045/077

Notes * repeated station
+ recovered core length is less than depth of penetration (i.e. core head covered in mud)

4. CURRENT METER MOORINGS (CW, UP)

Three moorings were deployed, each having two acoustic releases, two Anderaa RCM8 current meters and one sediment trap (fig. 4). The moorings were deployed using the Gilson winches and the After Gantry. Each deployment took approximately 2 - 3 hours (Table 2).

All six acoustic releases were wire-tested before deployment on the moorings. The IOS CR200 releases were fitted with test pyros (puffers) and attached to the CTD frame, which was then lowered to near the sea bed **(i.e. same as the** mooring depth). The first test was successful with both puffers having fired. However tests on the other two showed that only one puffer was firing. It was found that the batteries in the releases which generate the pyro firing voltage were incorrectly wired. This fault was rectified and subsequent tests were successful.

The Oceano releases were also tested at their proposed working depth and all released without any problem. It is sometimes difficult to obtain accurate ranges from the Oceano releases, even when a weight is attached to the transducer and the ship's thrusters are stopped. Further investigation of this problem is required.

In previous Antarctic deployments, loss of data from Aanderaa current meters with solid-state DSU's had been a serious problem. Some meters recorded virtually no data, and may have switched off recording before even reaching the seabed. Others recorded only 1 year's data instead of the anticipated 2. Investigation by RVS indicated the most likely cause to have been battery failure in the very low temperatures experienced both in the water and on deck immediately before deployment. Also the backup battery in the standard DSU, which is designed to retain data already collected, had a life expectancy of only one year. Accordingly the current meters deployed this year have had two alterations made: the main battery unit has an additional cell fitted in parallel to increase its capacity, and the new Aanderaa DSU's have a permanently-fitted battery with a life expectancy of seven years. It is hoped that these modifications will ensure a better data return.

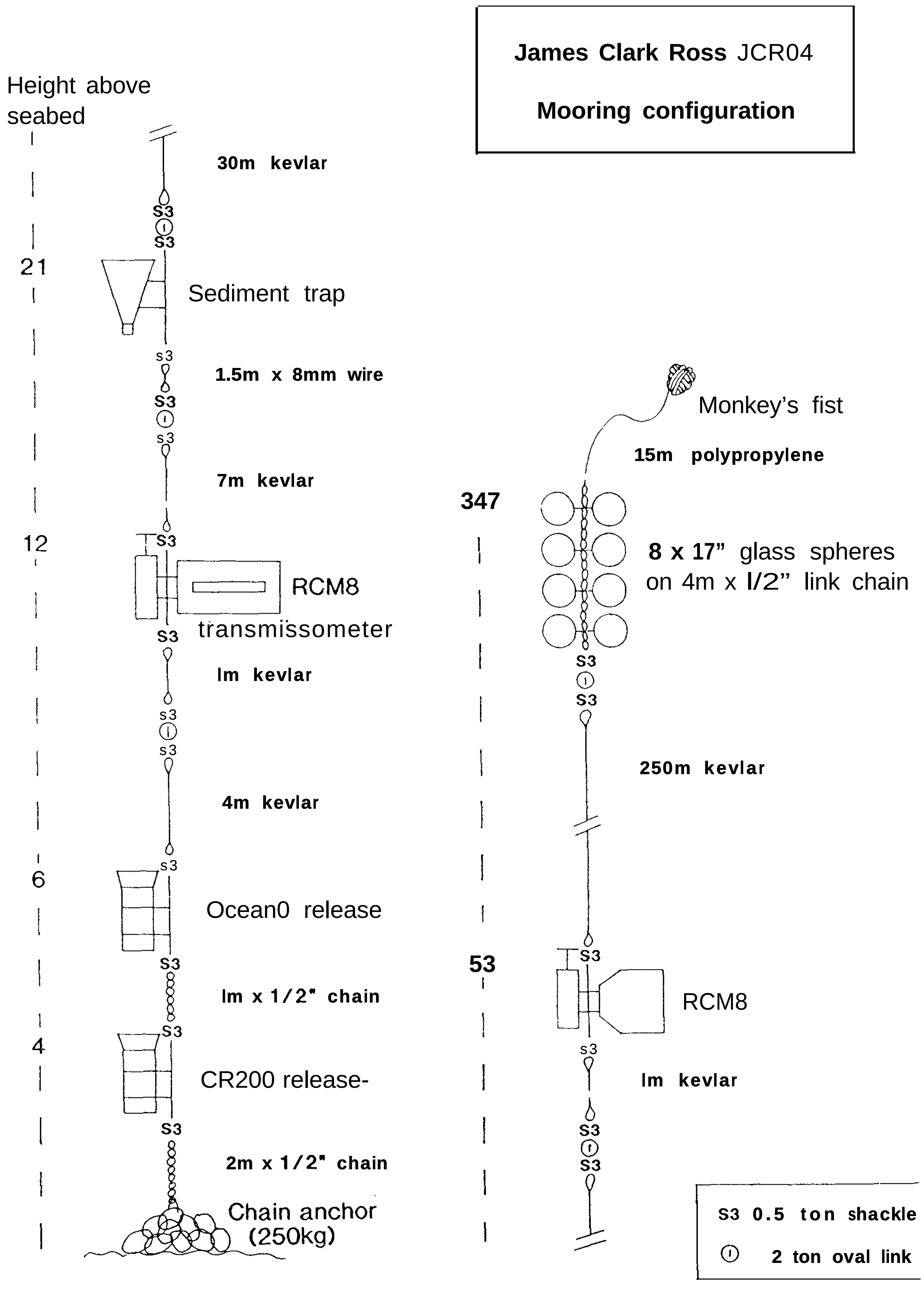
James Clark Ross JCR04
Mooring configuration
Height above seabed
21
12
6
4
30m kevlar
S3
S3
Sediment trap
s3
1.5m x 8mm wire
S3
s3
7m kevlar
S3
RCM8
transmissometer
S3
lm kevlar
s3
s3
4m kevlar
s3
Ocean0 release
S3
lm x 1/2" chain
S3
CR200 release-
S3
2m x 1/2" chain
Chain anchor
(250kg)
Monkey's fist
15m polypropylene
347
8 x 17" glass spheres
on 4m x l/2" link chain
S3
S3
250m kevlar
53
S3
RCM8
s3
lm kevlar
S3
S3
S3 0.5 ton shackle
2 ton oval link

Figure 4

Table 2 **JCR 04 Mooring deployments**

Mooring IX

Top meter RCM 9909 First record 2000/034
Bottom meter RCM 9904 + transmissometer First record 1300/035
Ocean0 release 118
IOS CR200 release 2497

Ship on station 1210/038 Water depth 3956m
Mooring cut free 1422/038 53°56.0'S 48°03.1' W
On bottom 1503/038
Timed out 1522/038

Mooring X

Top meter RCM 9419 First record 2300/038
Bottom meter RCM 9418 + transmissometer First record 2300/038
Ocean0 release 119
IOS CR200 release 249

Ship on station 1540/043 Water depth 3763m
Mooring cut free 1658/043 520°8.3' S 41°09.2' W
On bottom 1733/043
Timed out 1748/043

Mooring XI

Top meter RCM 9911 First record 1700/044
Bottom meter RCM 9903 + transmissometer First record 1400/046
Ocean0 release 120
IOS CR200 release 25 10

Ship on station 1610/048 Water depth 3657m
Mooring cut free 1703/048 56°44.5' S 42°58.2' W
On bottom 1741/048
Timed out 1810/048

5. CTD STATIONS AND EQUIPMENT (UP, MP)

The purpose of this season's CTD stations was to obtain temperature and transmissivity profiles at selected core sites, and to obtain water bottle samples for the study of suspended sediment. The main water masses (AABW, CPDW) are well defined, and it was not considered necessary to calibrate temperature and salinity data (in contrast to JCR 01 where the CTD profiles were used for estimates of geostrophic flow). Six stations were occupied (Table 3), including one at each mooring site.

Instrument frame: the new stainless steel instrument frame is a great improvement on the old wire frame. It is larger, heavier (so additional weights no longer have to be used) and easier to secure, and the instruments and water bottles are protected from impact against the ship's side or pieces of ice. There is space to attach additional instruments such as transmissometer, pinger and acoustic releases. The frame was supplied without a bracket to carry the CTD instrument. S. Bremner fabricated a bracket from steel angle on board, but a proper stainless bracket will be required in future.

Sensors: the pressure/temperature/conductivity instrument is the same as has been used on many previous cruises, and worked faultlessly. A transmissometer was used, connected to one of the spare analogue channels, a connecting waterproof cable having been made last year. Transmissivity values (voltage output) are uncalibrated, and there was some drift during the period of use. The transmissometer was removed after the fifth CTD drop because it was required for one of the current meters on the final mooring.

Deck unit and computer: no faults arose in the deck unit, and all the data for the down and up casts were logged by the EG&G software. The only minor problem was that the transmissivity data could not be monitored on the PC screen on three of the drops. This was traced to a calibration file error: the Cal-file had been changed to accommodate the extra (transmissivity) display, but the PC reverted to the default Cal-file after a re-start. This problem was eventually corrected. Data for all six casts were backed up from the PC at the end of the cruise:CTD data were also logged on the ABC system.

Water bottle sampling: casts were made to within 10m of the seabed (measured as pinger-bottom separation) and bottle samples were taken at several depths within the lowest 100m. Only stations 079 and 080 had a nepheloid layer. A mid-water sample was also taken at 2000 or 1000m depth (measured using wire-out). In most casts only 6 of the 10 available bottles were used; there were no leaks, but on one cast a bottle failed to close properly because the bottom end fouled the CTD frame. The water samples were filtered through nuclepore polycarbonate membranes of 0.4 micron pore size to examine the suspended sediment content.
~~to the 10-tonne winch control system.~~

Table 3 JCR04 CTD Station List

No.	Lat. S	Long. W	Depth	Time
923 CTD 077	52°55.5'	53°41.2'	3000m	2300/035 -0 130/036
078	53°55.1'	48°02.6'	3956m	1850- 2245/037
079	52°22.8'	45°59.4'	3543m	0920 - 1245/039
080	52°08.2'	41°08.8'	3770m	0620 - 0920/043
081	56°44.8'	43°16.5'	3733m	0330 - 0850/048
082	59°53.1'	43°04.6'	4596m	1650 - 2020/050

Notes. Stations 077, 078, 079 and 081 included wire tests of acoustic releases. Time on station at 081 also included repairs to the lo-tonne winch control system.

6. SMALL SEISMIC SYSTEM (RDL)

810 km of 2- and 4-channel seismic reflection data were collected during the cruise (Table 4). Most of these-data (595 km) were collected in the Falkland Trough and northern Scotia Sea between days 035 and 045. An additional 215 km were collected in the Bellingshausen Sea on days 073-074. -Almost all of these data were collected at 8 kts. The Falkland Trough and northern Scotia Sea lines were mostly fast reconnaissance survey used for selecting core sites. These lines will also be useful in studies of the longer term history of sediment deposition under the influence of the Antarctic Circumpolar Current. In the Bellingshausen Sea the system was used to collect data in ice conditions which precluded use of the MCS streamer.

The small -seismic system was assembled from components borrowed from RVS (airgun, umbilical, short hydrophone streamer, amplifiers, filters and EPC recorders) and Cambridge University (digital recording equipment). Having this-system on board gave us the flexibility to collect digital seismic reflection data without incurring the large time overhead of deploying and recovering the MCS streamer and air-gun beams (deployment and recovery of the small system each took less than 1 hour). It also allowed us to collect data at 8 kts and to operate among patches of brash ice and stringers of pack.

<u>6.1.1. Seismic Recording and Monitoring Instrumentation</u> This consisted of:

- Car-rack SAQ (PC-based digital recording system)
- Bell-Howell amplifiers
- 2 x Krohn-hite analogue filters
- 2 x EPC recorders (single channel monitors)

It was set up in the UIC Room before departing from Port Stanley. The Cat-rack SAQ system performed well until the last day of data acquisition, when it stopped recording in the middle of a line for no apparent reason. The system stores data on hard disk, which means data acquisition has to be stopped when the disk is full and can not restart until the recorded data have been copied to another device and cleared from the disk. This proved to be a limitation because of the relatively small size of the hard disk (80 Mb) on the PC. On many lines we recorded only 2 channels instead of 4, to have adequate recording time to complete the line, and on others we used a lower sampling rate or shorter record length than we would have preferred. At the end of each period of data acquisition, the data were copied to a tape streamer ("Parallel Stream"), device. The data were then transferred from the tape streamer to the MicroMax PC, from which SEG Y format tapes were generated (see MicroMax Report). Another limitation resulted from the fact that the SAQ system only has a choice of 64 Hz or 500 Hz anti-alias filters. To record "high resolution" 2 ms or 1 ms sampled data it was necessary to filter data using the Krohn-hite filters before it was written to the SAQ system. Since only two filter units were available it was only possible to record 2 channels of high-resolution data. One of the filter units malfunctioned on day 045 (Line BAS 923-S26), producing a severely distorted output signal. Fortunately this line was recorded with a 4 ms sample interval using the SAQ 64 Hz anti-alias filter, and the Krohn-hite filter was only being used to condition the signal for one of the EPCs. A temporary repair was carried out so that the filter unit was available for use on the latter part of the cruise.

<u>6.1.2. Short Streamer</u> For Lines BAS 923-S21 to BAS 923-S25 this consisted of (from front):

Tow cable (an estimated 143 m were deployed beyond the stem during Lines BAS 923-S21 to BAS 923-S24)
25 m stretch section
20 m weight section
2 m depth section
4 x 50 m active sections, with 2 m depth section between sections 2 and 3
50 m stretch section
>lOO m rope ending in a monkey's fist

The depth sections on this streamer had not been calibrated before the cruise, so we relied on spectral analyses of data, carried out on the MicroMax, to determine the towing depth of the streamer. Spectral analyses of data from the first four lines suggested that the streamer was towing very deep, even at 8 kts (15-19 m). Depth section readings were actually within the range derived from these spectral analyses. For Line BAS 923-S25, the length of tow cable deployed was reduced by 41 m. Spectral analyses and the depth sections indicated that the streamer then towed at a depth of about 10 m (at 8 kts). In deteriorating weather conditions, however, the data on this line were rather noisy. While the ship was at anchor in Rosita Harbour the steamer was reconfigured in an attempt to overcome this noise problem. The stretch section from the tail of the streamer was inserted after the weight section, and a spare active section was put in its place at the tail of the streamer. The same length of tow cable was deployed on Line BAS 923-S26 as on Line BAS 923-S25 (an estimated 102 m deployed beyond the stern). The amount of tow cable deployed was reduced again on Lines BAS 923-S27 to BAS 923-S29, an estimated 81 m being deployed beyond the stem. This reduced the streamer towing depth to about 8 m (at 8 kts).

On Lines BAS 923-S21 to BAS 923-S24, data from active sections 3 and 4 were recorded on the SAQ system. On Line BAS 923-S25 active section 2 was recorded instead of section 4 after the first 60 shots, because of a noise problem. Four channels of data were recorded on Line BAS 923-S26, from the first 4 active sections. Lines BAS 923-S27 to BAS 923-S29 were shot on the continental shelf and upper slope in the southern Bellingshausen Sea. To obtain near-normal incidence reflection data in this relatively shallow water area, active sections 1 and 2 were recorded on the SAQ system.

6.1.3. Airgun A single Bolt 1500C airgun with a 4.9 1 (300 cu. in.) chamber was used as the seismic source on all of the 2- and 4-channel lines. It was towed on a simple umbilical consisting of a single air hose, three electrical cables (for trigger, near-field hydrophone and depth sensor) and a towing wire. The towing wire was anchored to a deck matrix bolt, usually near the starboard quarter. During the last three lines in the Bellingshausen Sea the towing point was changed to a deck bolt between the uprights of the stem gantry, so that the umbilical and airgun were less vulnerable to growlers. On all deployments the length of umbilical deployed beyond the stem was about 45 m. A depth sensor was taped to the umbilical about 1 m in front of the airgun This sensor indicated that the airgun towed at 4 m depth when towed at 8 kts and 8 m depth when towed at 6 kts. A wire passing through a block suspended from the articulated arm of the stern gantry, and connected to one of the Gilson winches, was used
to recover the airgun. This wire was left slack while towing.

Table 4: 2- AND 4-CHANNEL SEISMIC REFLECTION LINES

LINE	TIME (GMT)	LATITUDE	LONGITUDE	DIST. (KM)
923-s21	0607/035	53° 27.2' S	55° 06.8' W	
	1 540/035	52° 52.8' S	53° 34.5 w	121
923-s22	1449/036	53° 33.9' s	49° 36.0' W	
	0043/037	54° 01.5' s	47° 44.6' W	132
923-S23	0043/037	54° 01.5' s	47° 44.6' W	
	0240/037	54° 12.0' s	47° 53.1' w	22
923-S24	0240/037	54° 12.0' s	47° 53.1' w	
	073 l/O37	53° 59.5' s	48° 42.3' W	58
923-S25	1505/040	51° 46.8' S	41° 47.8' W	
	23 13/040	52° 30.4' S	40° 32.4' W	118
923-S26	09 19/045	52° 32.5' S	45" 44.4' w	
	1830/045	52° 30.7' S	47° 43.4' w	134
	19 16/045	52° 35.8' S	47° 43.7' w	10
923-S27	2258/073	69° 49.6' S	86° 03.1' w	
	0530/074	70° 40.9' s	85° 56.3' W	95
	0550/074	70° 40.5' s	86° 03.0' W	4
	0635/074	70° 35.9' s	85° 52.7' W	11
923-S28	0635/074	70° 35.9' s	85° 52.7' W	
	0727/074	70° 31.6' S	86° 04.8' W	11
	0918/074	70° 31.9' s	86° 48.6' W	27
	1054/074	70° 36.4' S	87° 25.0' W	24
923-S29	1230/074	70° 40.1' s	8 8 ° 03.0' w	
	134oio74	70° 36.9' S	88° 29.4' W	17
	1500/074	70° 25.6' S	88° 23.2' W	21
	1532/074	70° 24.1' S	88° 17.4' w	5
			TOTAL	810

7. MULTICHANNEL SEISMIC SYSTEM (RDL, AC)

1522 line-km of multichannel (MCS) seismic data were collected in the Bellingshausen Sea between days 061 and 072 (Table 5). These include the only MCS crossings of the continental margin to-date between 80° and 150°W. The MCS streamer and airguns were first deployed on day 061, on the continental shelf at about 71°S.85°W. During the following 4½ days data collection was interrupted only once, about half an hour being required for compressor maintenance. The streamer and airguns were deployed for a second time on day 070, in the vicinity of the De Gerlache Seamounts, and data collection proceeded without interruption for more than 2 days. Such trouble-free data acquisition reflects the thorough preparation and testing of all components of the system by the RVS and BAS staff supporting this project, who are to be congratulated.

The following sections describe the configuration and performance of the component parts of the MCS system.

7.1.1. Seismic Recording and Monitoring Instrumentation. This consisted of:

- Sercel SN358 48-channel recording system
- 3 x Sercel 1600 bpi tape drives
- DSSV pre-amplifier and trace mixing unit
- PC (controlling triggering and generating extended header and log file)
- SIE Oscillograph ("camera")
- 2 x EPC recorders (single channel monitors)

Some of the above equipment was installed in the UIC room in September 1992, before the ship left the UK. Installation was completed in Port Stanley and the whole system was thoroughly tested during the first part of the cruise, even to the extent of writing test tapes on each of the Sercel tape drives and reading these on the MicroMAX processing system. Despite these preparations, Drive B generated a series of parity errors when we first tried to write a data tape to it. It was replaced by Drive C for the first 2½ days of recording. The fault was traced to an open cicuit potentiometer in the write head circuitry. This was replaced and Drive B was used in conjunction with Drive A from the start of Line BAS 923-25 onward. There was also a minor problem on Drive C: during the tape loading procedure (at the end of the rewind to beginning of tape operation) it frequently lost tension on the tape and powered-down. When this happened the tape was retensioned by hand and then powered up again before writing the "burst". Once Drive B had been repaired and proved to be working satisfactorily, the set-up procedures were repeated on Drive C. This appears to have solved the tape loading problem, but no further data were recorded on this drive. Fortunately, the tape drive problems experienced on this cruise resulted in minimal loss of data, but they add to the already substantial body of evidence that these drives are unreliable and long-overdue for replacement by more dependable, higher density recording devices.

In general, the first shot on each tape is unreadable on the MicroMAX. Tape analyses reveal that the SEG B data block is present, but the shot header is absent or corrupted. The only exceptions are the first tapes on lines where the initial "burst" was written using "Mode 44" on the SN358. This suggests that the problem results from the burst written from the tape change-over unit, and that this is in some way different from the burst written by Mode 44. The same problem occurs on tapes written on RRS Discovery cruise 172, so it has probably persisted for several years. The data from these shots could probably be recovered from tape, at some cost, by a specialist data transcription service company. For most purposes, however, such shots must be considered as lost data, and represent a loss of about 2% of the data on a typical MCS reflection profile. This problem should be investigated as soon as possible to avoid such data loss on future cruises.

The DSSV sensitivity was set to 50 µV/µbar for most of the recording time. In some relatively shallow water areas, however, the SN358 gave overscaling warnings. On these occassions the sensitivity was reduced to 25 µV/µbar.

Dave Booth has recently adapted the “Sercel” control program on the PC to write selected extended header parameters, including position number and time, to an ASCII log file on floppy disk, This will greatly facilitate the generation of UKOOA format navigation files.

The SIE oscillograph (“camera”) needed regular attention to keep it working. This archaic piece of equipment, which uses large quantities of an environmentally unfriendly solvent, should be replaced with a modern thermal paper device as soon as possible.

All MCS data were recorded with a sampling interval of 4 ms, and with 25 m streamer groups summed in pairs to make effective 50 m groups. It had been intended that all MCS data would be recorded to a two-way time of 12 s. However, 700 shots on Line BAS 923-28, across one of the De Gerlache Seamounts, were recorded to only 11 s. Shots were fired on a regular cycle time of 18 or 19 s. Both the cycle time and the ship speed were adjusted occasionally to try and achieve 50 m shot spacing. The level C program “dview” was left running continuously on the PC in the UIC room, showing the most recent speed-made-good values from “bestnav” (see Navigation Report). This was very helpful in assessing ground speed. Selective availability makes the “hvel” values from GPS highly variable and useless for this purpose. However, the Shipmate GPS on the bridge displays speed-made-good calculated between GPS positions several minutes apart, and gave similar values to those calculated by “bestnav”.

7.1.2. Streamer and Depth Control System This consisted of (from front):

- 150 m tow cable (an estimated 88 m were deployed beyond the stern)
- 2 m adaptor section
- 3 x 50 m stretch sections (length increases by about 15% when towing)
- 1 m water-break hydrophone
- 1 m depth section
- 24 x 100 m active sections, with 1 m depth sections in front of sections 4, 8, 11, 15, 18, 22 & 24
- 50 m stretch section
- > 100 m rope
- Tail buoy

Thirteen depth controllers (“birds”) were used to control the streamer towing depth. One was placed at the front of the first active section and one every 2 sections (200 m) beyond that. Eight “retrievers” were attached to the streamer to ensure that if any part of it had become detached it would not have sunk. Assuming that the stretch sections extend in length by about 15% while towing, the above distances mean that the front of the first active section was towed about 265 m behind the stern.

Before this cruise the multichannel streamer was last used south of Iceland, on RRS ***Charles Darwin*** in July 1992. Since the main factor affecting streamer balance is thermal expansion/contraction of the hydrophone oil (Isopar M), it was known that the streamer would be heavy for use in Antarctic waters. Streamer balancing was carried out in Bransfield Strait on days 055-056. The work was carried out in 2 sessions, and took a total of about 14 hours. In the first session the retriever floats were used to find out empirically how much extra buoyancy was required. These floats provide 2.3 kg buoyancy each. In normal use they counteract the weight of the retrievers themselves, but on this occasion they were used on their own. One float was attached to each of the last 6 active sections (i.e. 1 per 100 m), and two floats were attached to the tail stretch section. Several more sections were paid out and the last three depth sections were monitored. When the ship slowed to 3 kts the streamer started to sink, indicating that the additional buoyancy required to make the streamer neutrally buoyant was greater than 2.3 kg per 100 m section. The amount of additional oil required was calculated assuming the following parameters:

Surface water temperature	=	0°C
Surface water density	=	1.027 g/cc
Isopar M density (at 15°C)	=	0.786 g/cc
Isopar M thermal expansion coefficient	=	72 x 10^{-5}

The thermal expansion coefficient is the value we have used in the past for Isopar L, since we did not have any information on board about this parameter for Isopar M. Using the above parameters:

Isopar M density at 0°C	=	0.794 g/cc		
Buoyancy per litre of Isopar M in Antarctic surface water	=	1.027 - 0.794	=	0.233 kg

Therefore an additional 2.3 kg of buoyancy per section should result from adding approximately 10 1 of Isopar M. As our experiment on day 055 had shown that the streamer would still be slightly heavy with this amount of extra oil, we decided to pump 20 l of Isopar M into each active section and 10 1 into each stretch section. This was done during the second streamer balancing session on day 056. It is estimated that each active section, except for those which have been punctured (see below), now contains 255 l of oil. Based on our previous experiment, pumping in this much oil could have made the streamer light by up to 2.3 kg per section, but we thought that the birds would be able to overcome this amount of positive buoyancy. In practice the streamer appears to have been only slightly positively buoyant. It towed well at 5 kts without over-working the birds. A copper earth wire was towed from one of the deck matrix bolts to provide an earth return path for commands to the birds (the ship has a cathodic protection system and is not earthed to the sea).

Once balancing was complete, channels 24 and 45 were found to be noisy. The noise on channel 24 was traced to an earth fault on streamer group 47. This was switched out, so all data recorded on channel 24 are entirely from streamer group 48. The noise on channel 45 occurred intermittently on both of the component groups (89 and 90), but did not appear to be bad enough to justify switching them out. At the start of Line BAS 923-28 on day 070, streamer groups 8 and 40 were found to have developed earth faults and were switched out. During this line, faults developed on streamer groups 20, 22 and 23, and these were also switched out for the remainder of the line and subsequent lines. Fortunately none of these resulted in loss of a pair of streamer groups being recorded on the same data channel on the SN358. Also during Lines BAS 923-28 to BAS 923-30, the streamer became more difficult to control, with depth section 2 consistently showing the greatest depth. When the streamer was recovered on day 072, three active sections were found to be damaged. Two of these sections will require re-skinning. This damage was probably the cause of the new earth faults which developed on day 070 and the towing problems. There were more than a dozen killer whales around the ship when the streamer was deployed on day 070: is it possible that they could have attacked the streamer? Another possibility is that the streamer may have snagged on one of the buoys supporting the airgun beams during deployment.

The airgun beams were deployed before the streamer on both MCS deployments (days 061 and 070). The procedure employed for recovery was to surface the birds and recover most of the streamer tow cable before slowing to about 3 kts to recover the airgun beams. Once the airgun beams were secure on deck the rest of the streamer was recovered. During MCS lines the magnetometer bottle was towed over a small block which was clamped to the top of the bulwark between the legs of the stem gantry. Fortunately MCS deployment and recovery operations were mostly carried out in daylight on this cruise. Deployment and recovery during the hours of darkness would be facilitated by improved lighting over the quarters and the stem. This could be achieved by adding two floodlights to the outside of the stem gantry, wired in parallel with the inner two, and fitting one or two floodlights on top of the trawl posts, looking aft.

Between the two deployments of the MCS gear the deck department decided to paint the tail buoy a rather fetching shade of luminous pink, ostensibly to improve its visibility.

7.1.3. Airguns and Compressors The seismic source for MCS work consisted of an array of 9 Bolt 15OOC airguns with a total volume of 55.9 1 (3412 cu. ins). Three airguns were suspended from each of three 7m-long beams. One beam was towed from each of the booms and one was towed from the starboard quarter. The arrangement of chamber sizes within the array was as set out below:

Towing point:	Port Boom	Starboard Quarter	Starboard Boom
Front	300	466	300
Centre	160	160	160
Aft	700	466	700

The spacing between the ports of the 300 and 160 cu. in. airguns on the outer beams was 3.25 m. All of the other airgun spacings were 3.05 m. Computer modelling of this array using software written by Nick Hardy at Birmingham University indicates that, when towed at a depth of 10 m, it should produce a far-field signature with a peak-to-peak amplitude of 61 bar-metres and a peak-to-bubble ratio of 5.2:l (calculated over 0 to 500 Hz).

When first deployed on day 061 the aft end of the port beam was supported from a hippo buoy by 12 m of 24 mm polypropylene rope. At 5 kts, with the umbilical fully deployed, the beam towed level at a depth of about 13 m. This is quite possible since the buoy tows very low in the water and the rope will stretch significantly under tension. Our preferred towing depth for the beams was 9 m, which would place the airguns at about 10 m. One way in which the beams could have been made to tow shallower would have been to leave several turns of the umbilicals on the winch drums. This practice has resulted in the towing wire sawing through air hoses on previous cruises, so it is not recommended. However, these problems occurred with the old style umbilicals. With the new umbilicals, in which the towing wire is isolated inside a plastic tube, it might be possible to leave turns on the winch without risking damage to air hoses and electrical leads. We decided not to chance this, and took the alternative approach of shortening the ropes on the hippo buoys to 8 m. This caused the beams to tow nose-down at 5 kts, with their tails at about 9 m and their front ends at about 12 m. There was little difference between the towing depths of the 3 beams, despite the different lengths of umbilical eventually deployed (see below). Although this towing arrangement was far from ideal, there seemed to be no way of improving on it in the short term. In the longer term, RVS and BAS mechanical sections should investigate ways in which these beams can be made to tow level through the range of towing depths which will be required for different MCS experiments (say 7 to 14 m).

In 7 days of towing no hippo buoys were lost on this cruise. This contrasts with recent RVS experience. One possible explanation for this is that use of longer lengths of rope on the buoys may allow the ropes to become slack and shock loading to occur as the buoys ride over swells, whereas the lengths used on this cruise probably maintained tension in the ropes at all times.

The beam towed from the starboard quarter was deployed before the one towed from the starboard boom. When the latter was deployed it was found to tow alongside the other beam, despite the fact that the length of umbilical between winch and stem-line is about 7 m longer for the outer beam. This is probably a consequence of the different styles of construction of these two umbilicals (which both belong to the ship). The umbilical towed over the starboard quarter and the one on the port side (borrowed from RVS) were both rebuilt last year to a new design in which the the air hoses and electrical leads are wound helically around a plastic tube containing the towing wire. This results in the umbilical as a whole being shorter than the old type, in which hoses, leads and towing wire were simply gathered into a bundle and enclosed in a polyurethane skin. The two starboard beams also towed very close to one another as a consequence of the pattern of water flow astern of the ship. To reduce the risk of collision between the beams, several turns were left on the umbilical winch for the outer beam, despite concern that towing with turns of umbilical on the winch might eventually damage the umbilical. In retrospect it would have been better to have taken in turns on the newer, more robust umbilical towing the inner beam. However, the arrangement of umbilical winches and beams on deck for this cruise meant that it was necessary to deploy the inner beam first, and thus to tow this one nearer the ship would have meant sliding the two beams past one another in the water. Fortunately, there is no evidence of any damage to the old-style umbilical resulting from use on this cruise. However, the new design is clearly more robust and, if funds are available, this old umbilical should be stripped down and rebuilt.

The length of each umbilical deployed was estimated by measuring the diameters of the winch drums, counting turns wound off/on during deployment/recovery, and allowing for the change in diameter with each successive layer of turns on the drum. The umbilicals to the port and inner starboard beams were fully deployed, and the lengths of umbilical beyond the stem are estimated to have been 74.6 m and 82.1 m respectively. Thirteen turns of the umbilical to the outer starboard beam were paid out, and the length beyond the stem is estimated to have been 56.7 m. Allowing for the angle of the umbilicals running down to the front of each beam at about 12 m depth and the length of the beams themselves, the centre of the airgun array was located about 72 m astern.

During the 7 days of shooting there were only two airgun failures. The near-field hydrophone signal from the 300 cu. in. gun at the front of the port beam was weak from quite early on the first line, but this was thought to result from a faulty near-field hydrophone. At the end of Line BAS 923-24 we had to seal off the guns to allow work on a compressor problem. Sealing off the guns revealed an air leak on the port 300 cu. in. gun. This gun did start firing again when the airguns were switched back on, but still produced a weak near-field signature with a short bubble pulse period. It was eventually switched off shortly after the start of Line BAS 923-25. Near the end of Line BAS 923-27 the 700 cu. in gun at the back of the outer starboard beam developed an air leak and was switched off for the remainder of the line. The airguns and streamer were recovered at the end of this line. The 300 cu. in. gun was found to have leaked around the solenoid and the leak on the 700 cu. in. gun resulted from damage to the short air hose linking the gun to the umbilical.

Each of the 4 Hamworthy compressors on the ship has a capacity of 555 m^3/hr (327 cu. ft./min). One compressor should be able to supply an airgun array of up to 25 1 (1530 cu. ins) on an 18 s firing cycle at 135 bar (2000 psi). The airgun array on this cruise slightly exceeded a full load for 2 compressors. This meant that one compressor could be down for maintenance without stopping shooting. There were 5 separate occasions while we were shooting MCS lines when the pressure dropped to 100 bar or less as a result of compressor problems. On each occasion the problem was only temporary and the pressure started to recover after a few minutes, so we were not forced to stop shooting. These problems were caused either by compressors tripping out or, on two occasions, by their blowing out the fusible release valves which are designed to vent the high pressure air in the event of a fire. The most serious compressor problem occurred on day 063, when a high pressure flexible hose on compressor no. 4 started to bulge and had to be replaced. One end of the hose had seized onto the fitting and could not be removed without risking damage to the high pressure pipework. Thus this maintenance work could not be carried out until we stopped shooting. Fortunately there were no other compressor problems before we reached the planned end of Line BAS 923-24, at which point the hose was replaced in about half an hour.

<u>7.2 MicroMax Seismic Processing System</u> (APC)

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

Compaq 386/33Mhz CPU
STC 2925 tape drive
Exabyte helical scan cartridge drive
Epson LQ1050 dot matrix printer
Jilutech 60Mb “Parallel Stream” device

For the duration of the cruise the MicroMax system was principally used to process seismic reflection data and as a diagnostic tool to identify any shortcomings in the recording instrumentation and methods.

After installation an initial task was to devise a means of generating SEG Y field tapes using the data acquired on the Car-rack SAQ acquisition system. This was necessary to enable these data to be read into the MicroMax itself and for archival purposes. Data were initially transferred from the Carrack SAQ system to the MicroMax PC using the Jilutech “Parallel Stream” device. Individual MS-DOS files consisted of one trace with the accompanying trace header. These were concatenated using the MS-DOS ‘copy /b’ command and the concatenated files were then written to tape with accompanying EBCDIC and binary reel headers using the Datatrac tape handling utilities provided as part of the MicroMax processing system. These tapes conform to the SEG Y standard and can therefore be read by the MicroMax system itself. The commands used to create SEG Y tapes were placed in two MS-DOS batch files. The SEG Y tapes were also copied on to a high capacity Exabyte cartridge for archival purposes.

Instrumental testing began prior to the start of MCS acquisition with the creation of test tapes on the Sercel SN358 MCS acquisition system. Test tapes were written with and without delay on each of the three available tape drives. Tapes written on the Sercel drive ‘A’ were found to be unusually noisy when replayed on the MicroMax and this problem was later attributed to a faulty cable. The cable was adjusted and the drive subsequently performed normally. An additional problem identified at this stage concerns the burst written at the beginning of each Sercel SEG B field tape. In general, the MicroMax was unable to read the first shot on each field tape as the SEG B shot header has been obscured by the initial tape burst. However, the MicroMax did successfully recover the first shot recorded on the first SEG B field tape. The problem therefore appears confined to bursts written from the tape drive switching unit.

Test processing of the seismic reflection data began in earnest with the acquisition of the first 2-channel reflection profile, BAS 923-S21. Provisional processed records were generated for lines BAS 923-S21,-S22,-S23,-S24 and a portion of BAS 923-S26. These records were found to be partly contaminated with noise bursts associated with radio transmissions which were subsequently kept to a minimum during shooting.

Spectral analyses were carried out on traces taken from lines BAS 923-S21 and BAS 923-S22 to determine the towing depth of the Geomechanique streamer by examination of the notch in the power spectrum associated with free-surface cancellation. Records acquired at 6 and 8 knots were analyzed and the actual streamer towing depths were estimated to be within a range of 25-27 metres and 15-19 metres respectively. These depths were considered unacceptably large and the streamer tow cable was shortened during subsequent deployments. Additional analyses carried out on subsequent lines illustrate an increase in bandwidth resulting from these adjustments. Spectral analyses were also performed on noise records acquired at the end of line BAS 923-S24. These records exhibited a power spectrum which decayed smoothly with increasing frequency with the exception of a small spike at 100Hz. Subsequent analyses have shown this spike to be associated with the ship’s cathodic protection system.

During MCS acquisition the MicroMax was principally used to demultiplex the Sercel SEG B field tapes and write the resulting trace sequential data to 9-track tape in the SEG Y format. This continued as a background activity during MCS acquisition and data were transcribed at approximately 20% of the acquisition rate. Lines BAS 923-22 and BAS 923-24 were fully transcribed during the cruise which represents some 38% of the MCS reflection data acquired. In both cases, near traces were recovered from the SEG Y tapes to provide an initial indication of the quality of the data and to check the integrity of the SEG Y tapes. The demultiplexed data were also copied on to an Exabyte cartridge for archival purposes. Spectral analyses carried out on these near traces suggest the MCS airgun source impulse to have a smooth, broad-band power spectrum up to a notch at 64Hz resulting from free-surface cancellation.

In general, the MicroMax system performed well throughout the cruise. The one exception to this occurred during day 053 when one of the hard disk drives (C:) became corrupted and effectively disabled the system. The machine was unable to reboot in the normal way and **it** was necessary to gain access to it by rebooting from an MS-DOS system floppy disk. Existing seismic data files were backed off to tape using the Datatrac tape handling routines which were then copied to a floppy disk. The C: hard disk was then reformatted and the system subsequently restored from a previous backup using the tape handling routines saved to floppy disk. After this restoration the system functioned normally. A full system backup and documentation were taken on the cruise in anticipation of such a failure and it is recommended that the MicroMax field support floppy diskettes, Compaq MS-DOS system diskettes, system backup and appropriate documentation always accompany the system in the future.

Table 5: MULTICHANNEL SEISMIC REFLECTION LINES

LINE	TIME (GMT)	LATITUDE	LONGITUDE	DIST. (KM)
923-22	0405/06 1	70° 53.6' S	85° 19.1' W	
	09551062	69° 03.0' S	89° 55.6' W	270
923-23	0958/062	69° 03.3' S	89° 55.8' W	
	1601/062	69° 32.9' S	89° 44.9' W	55
923-24	1601/062	69° 32.9' S	89° 44.9' W	
	2200/063	69° 29.9' S	97° 03.5' w	284
923-25	23411063	69° 24.2' S	96° 58.0' W	
	1620/064	70° 50.2' s	96° 48.2' W	160
923-26	1620/064	70°50.2 S	96° 48.2' W	
	03481065	70° 41.3' S	93° 59.3' w	104
923-27	0348/065	70° 41.3' S	93° 59.3' w	
	1801/065	69° 29.3' S	93° 54.6' W	134
923-28	17 17/070	65° 14.6' S	88° 29.8' W	
	2008/0 1	65° 46.1' S	93° 59.2' W	260
923-29	2009/07 1	65° 46.1' S	93° 59.4' w	
	0927/072	66° 44.3' S	92° 21.7' W	130
923-30	0927/072	66° 44.3' S	92° 21.7' W	
	2202/072	67° 09.6' S	89° 42.2' W	125
			TOTAL	1522

8. **DREDGING** (PFB)

The ship is intended to dredge using the steel "coring" warp of the 30-T Main Winch, and the After or Midships Gantry. Because the Main Winch had not performed to specification, there were both contractual and practical limitations on its use. As an emergency measure, we used the starboard warp of the Brattvaag Twin-Warp Trawl Winch (TWTW).

Rig and Procedure.

The initial dredge rig was standard: pipe dredge attached by short chains to dredge bag without net, bridle arms secured by 1-T weak links, swivel and 3-T WL by-passed by 12mm bag strangler, 0.5T (15m) of chain, 5-T WL and swivel, 100m of 13mm pennant, 17m of 16mm handling pennant and swivel attached to the TWTW warp. Subsequently, the rig was changed, to reflect the greater strength of the TWTW warp: the 3-T WL became 5-T and the 5-T WL was removed, so that the TWTW warp was protected, essentially, by the 13mm pennant. Also, after the first dredge station, the pipe dredge was removed and the parted 12mm strangler replaced by 16mm wire.

The TWTW warp line inboard was invariant, running aft from a fixed sheave atop the spurling pipe at the break of the superstructure, via a diverter sheave to a block on the after trawl post. The dredge rig had to be deployed through the After Gantry, via a wide-throated block slung from the main crossbeam. To marry these two it was necessary to use 10mm wire on a Gilson winch to lift and lower the dredge rig outboard, and the transfer pennant to transfer the load to the TWTW warp for dredging. A pinger was attached by a single short chain to the TWTW warp 18m above the final swivel (150m above the dredge). On recovery the procedure was reversed.

Results and Critique.

Details of the dredging results are given in table 6. Of 14 dredge attempts, 7 acquired a likely or certain in *situ* sample, and some value might emerge from two others. This represents moderate success, but is not a good measure of successful technique, because it depends heavily on the provinces being dredged. In general, dredging is easier in shallow water and in young volcanic provinces, more difficult in deeper water on older rocks and those that do not fracture easily. Bransfield Strait is thus inherently amenable to dredging, being shallow, young and volcanic. The De Gerlache Seamounts appear much older, making them less amenable, but not impossible. Of the "failed" dredge attempts, two recovered obvious glacial erratics, one came back empty and one lost and one tore the dredge bag. On five occasions the 3-T weak link parted. These results in sum suggest an over-vigorous approach. Why might this be?

We appreciated from the outset that dredging with the TWTW would not be ideal. The main problems were:

i. poor winch speed control at low speeds, which limited the delicacy and precision with which the dredge could be moved over the seabed, and risked damage to the pinger which had to be attached and detached directly outboard of the block on the trawl post.

ii. lack of an unambiguous measure of warp tension: the Brattvaag suggestion of monitoring pressure was only partially successful, since it did not relate to wire tension in a constant or even reproducible manner, reflecting operator actions and system response as well as wire tension. Also, "tension" as displayed by the Brattvaag computer was misleading. It appeared to have been calculated using very simple assumptions, inappropriate to dredging practice and geometry, and was ineffective in that it showed only a slow response. This meant we were dredging with only a partial view of the behaviour of the dredge on the sea bed.

iii. the fixed path of the trawl warp inboard, which made necessary a complicated transfer procedure to bring the dredge in and out via the after gantry. This took time and increased the number of people needed.

In addition, the TWTW tended to overheat at low speeds and, most noticeably with the greater wire length and tension of DR153, the wire cut a deep groove in the after bulwark below the trawl post block.

Against these problems was the fact that the dredge warp SWL had increased by 2-3 times, compared with the Main Winch, with only part of that advantage eroded in deeper water by the dead weight of the warp. In this respect it is important to note that dredging uses the ship itself as an energy source, whether through its engines or through its heave and pitch on a swell. JCR is a bigger ship than RVS ships, which were the models for specification of dredging facilities: JCR can and does apply a bigger force. So far as dredging is concerned therefore, the JCR Main Winch outfit **could** be considered undersized, and a heavier-duty dredging system might not be out of place. Operations this year thus tended to find the weaknesses in a dredge rig that initially was scaled to past RVS ship operation. There would be an advantage to scaling up weak links, as we did for the 3 final dredges of the cruise, and also dredge size, if the TWTW were to be used again.

On JCR04, only one dredge was in water deeper than 2000m, and the majority were shallower than 1000m. In deeper water, the limiting factor is wire drag for motion perpendicular to wire length, which makes it difficult to keep the dredge on the seabed as speed increases. Scaling up then becomes less effective (though some advantage remains).

To overcome the disadvantages of using the TWTW, it would be necessary to

i. improve low-speed controls on winch speed

iii. add an independent (load cell) device to measure tension. Something like the Bio Winch 3-sheave portable system, scaled up, would be appropriate, or perhaps a fixed system sited below decks. It should feed the Seametrix logger.

ii. modify the trawl warp path (add 1 or more extra diverters, strengthen the seating of the existing diverter) to allow direct use of the Main Gantry

Such improvements would be essential for future TWTW dredging, and should be costed, but it would be necessary to weigh the expenditure against the benefits to be gained, compared with using the Main Winch. Also, and very importantly, any adverse consequences for the TWTW of using only a single warp should be identified, before a decision was made.

Almost all dredges were run directly upwind (initially for convenience and finally of necessity because the block on the trawl post was lashed to avoid further grooving of the bulwark). Requested speed was 0.5kt over the ground. It did not prove easy for the Bridge to achieve such a course and speed at times, despite the availability of bow and stem thrusters and use of main engines and rudder. It may be that the ship presents an unusual windage, not yet fully defined. Or, that the effects of thrusters on EM and Doppler log readings, used by the IBNS, or the dither now superimposed on GPS, are not being accounted for. Yet this cannot be the complete story, since station-keeping, for example on core stations, was generally excellent. This needs further thought.

Table 6: Dredge Stations

Dredge	Startlat	Startlon	Startdep	Endlat	Endlon	Endep	Time	Comments
143	62 38.2	59 01.5	1350	62 39.2	59 00.1	1120	9305607	bag lost
144	62 38.3	59 00.6	1300	62 38.7	58 59.9	900	9305612	150kg volcanic
145	62 47.1	59 39.0	1100	62 47.2	59 38.9	1020	9305601	150kg volcanic
146	62 51.2	59 55.3	720	62 51.7	59 54.2	380	9305705	50kg volcanic
147	63 10.0	61 14.9	900	63 09.6	61 15.3	480	93057 14	empty
148	63 10.2	61 13.8	1130	63 09.8	61 14.3	810	93057 16	60kg ?erratic
149	65 02.5	92 56.6	750	65 02.9	92 57.3	370	9306812	30kg mixture
150	65 01.0	92 56.1	1350	65 01.1	92 56.4	1350	9306815	5kg erratic
151	65 01.0	92 56.1	1370	65 01.4	92 56.2	1130	9306818	empty
152	65 02.6	93 07.3	730	65 02.9	93 06.6	400	9306823	20kg volcanic
153	64 57.5	91 16.4	3300	64 57.7	91 16.1	3150	9306909	10kg erratic
154	65 20.9	90 39.3	860	65 21.3	90 39.0	550	9306919	20kg mixture
155	65 20.8	90 12.2	1300	65 21.8	90 09.7	1540	9307003	50kg volcanic
156	62 52.4	59 58.1	875	62 52.9	59 58.2	630	9308003	100kg volcanic

9. OTHER DATA AND EQUIPMENT

9.1 Navigation (RDL)

Navigation data were logged by the ‘ABC’ system from the following instruments:
Trimble 4000 GPS locator
EM log
Doppler log
Gyro

GPS fixes were logged at 25 second intervals for most of the cruise. On most days, however, there were periods with poor GPS constellations when the logging system only accepted one fix every few minutes.

GPS fixes logged while the ship was still alongside FIPASS showed the effect of the “selective availability” applied by the US military on the positional data. These fixes showed a scatter of positions with a standard deviation from the mean of about 100 m. The scatter was not random: the ship’s “track” was a series of loops of varying amplitude and duration. Some of these loops were too long to be averaged out by the 5 minute least squares running average applied to GPS positions in our initial attempt to process navigation data for gravity data reduction. The ground speed calculated from the averaged GPS positions showed unrealistic variations with periods longer than 5 minutes which were not reflected in the EM log or Doppler log data. These variations produced noisy Eötvös corrections which resulted in noisy free-air gravity data. Logging GPS fixes at 1 second and 10 second intervals for periods of several hours confirmed that this was not an aliasing problem resulting from under-sampling the GPS data, but was a genuine effect of selective availability. The problem is that the potential error in ground speeds derived between pairs of fixes which have small uncertainties in their positions increases as the distance and time separation between the fixes decreases.

To overcome this problem, sub-sampled GPS data were combined with relative motion data derived from the EM log and gyro. The EM log data were first averaged over 4 minute intervals and then combined with the gyro data using Level C program RELMOV (a running mean of the EM log data, obtained by moving a 4 minute window along in 1 minute steps, would have been preferred, but this option did not appear to be available in the Level C software). The relative motion data were then used to dead reckon the ship’s track between GPS fixes 15 minutes apart. The combination of relative motion and GPS data was controlled by Level C program BESTNAV. The resulting navigation data produced much smoother Eötvös corrections and free-air gravity data. This navigation data processing method was adopted for all of the cruise navigation data.

The EM log consistently recorded water speeds which were slightly higher than the ground speed indicated by the processed navigation data, suggesting it is slightly out of calibration. However, this instrument proved far more reliable than the Doppler log, the water speeds from which were very considerably different from the ground speeds indicated by the processed navigation data for much of each day.

9.2 Gravity (RDL, APC)

Lacoste and Romberg marine gravity meter S84 (borrowed from RVS) was installed in the Gravity Meter Room in September 1992, before the ship left the UK. The instrument had to be installed with the side which usually faces aft facing forwards because of the proximity of the plinth to the aft bulkhead. The meter had recently been reconditioned by the manufacturers, and the stack of racked electronics which previously accompanied it had been replaced by a new, more compact unit. The meter was interfaced to the 'ABC' logging system via a Compaq 286 PC (IBM compatible).

The gravity meter operated throughout the cruise. Gravity data were smoothed by a 5-minute hardware filter and filtered values were logged by the 'ABC' system at 6 s intervals. Logging was interrupted for half an hour on day 064 (operator error) and again for a similar period on day 074 (PC hard disk full). Clearly this latter interruption was avoidable: in future sufficient space should be cleared on the PC hard disk before a cruise, or during port calls or base visits, to accommodate the files which will be generated during the subsequent leg.

The instrumental drift of the gravity meter was monitored by base ties at Port Stanley before and after the cruise (see below). Unfortunately, base ties at FIPASS, Port Stanley, can not be made in the normal way because FIPASS is a floating structure, precluding use of a land gravity meter on the quayside. Base ties are made by assuming that the local free-air gravity gradient is zero and using the base station at the landward end of the FIPASS bridge, 200 m south of the berths (RRS Discovery Cruise 172 Report). At the start and end of the cruise the ship was berthed in approximately the same place, near the western end of FIPASS, so these base ties should accurately constrain the instrumental drift. There is more uncertainty attached to the absolute values of gravity derived from them, perhaps as much as 1 mgal. However, the low drifts observed on transits from Valparaiso to FIPASS and FIPASS back to Valparaiso on RRS *Charles Darwin* Cruise 37 (-0.20 mGal over 45 days and +0.16 mGal over 27 days) and on the RRS *James Clark Ross* transit to Montevideo after this cruise (+0.3 mGal over 7 days) suggest that FIPASS base ties are more accurate than was originally supposed. Therefore the day 032 and day 082 FIPASS base ties will be used in processing the gravity data from this cruise.

9.2.1 Gravity Base Ties

Gravity meter : S84
Meter calibration constant : 0.9967

Grimsbv gravitv base tie dav *254 (1992)*

Day : *254*
Meter reading (meter units) : 12617.6
g at meter on ship : 981370.6

FIPASS **gravity base tie dav 032**

Day/time : 032/13.30
Meter reading (meter units) : 12460.6

An estimate of the value of gravity at the ship's meter was made by measuring the height difference between the meter and the gravity base station established on the concrete pillar at the west side of the bridge abutment (R.R.S. Discovery Cruise 172 Report). Measurements to the water line suggested the gravity meter to be 1.53 metres below the FIPASS base station (g=981227.63 mGal). The ship was assumed to be moored 200 metres to the north of the base station ***(R.R.S. Discovery*** Cruise 172 Report, pp.43).

Free Air **Correction** (FA)

FA = 0.3085 * 1.53 = 0.47 mGal

Latitude Correction (LA)

Assuming a N/S gravity gradient of 0.79 mGal/km ***(R.R.S. Charles Darwin*** Cruise **37** Report, pp. 29) and a 200 metre N/S separation between meter and base station:

LA = - 0.79 * 0.2 = - 0.158 mGal

Estimated gravity at ship's meter (g)

g = base station (mGA1) + FA + LA

= 981227.63 + 0.47 - 0.158

= 981227.94 mGal

Drift

δg from Grimsby	: -142.66 mGal
Expected meter reading	: 12474.47
Actual reading	: 12460.6
Drift from Grimsby	: -13.87 meter units = (-13.82 mGal)
Drift rate	: -0.096 mGal/day over 144 days

<u>FIPASS **gravity base tie day** 082</u>

Day/time	: 082/19.00
Meter reading (meter units)	: 12458.7

Measurements from the ship and shore to the water line suggest the gravity meter to be **0.85** metres higher than the position during the previous base tie. We may therefore expect the meter reading in mGals to be approximately 0.26 mGals less (0.3085 * 0.85) than the reading taken on day 032. Therefore:

g = 981227.68

Drift

δg from day 032 tie	: **-0.26**
Expected meter reading	: 12460.34
Actual reading	: 12458.7
Drift from day 032	: -1.64 meter units (= -1.63 mGa1)
Drift rate	: -0.033 mGal/day over 50 days

<u>**Montevideo gravity base tie day 089 (start of Cruise JCR05**</u>

Day/time	: 089/14.00
Meter reading (meter units)	: 10972.7
g at base station	: 979745.40 mGal
g at meter on ship	: 979746.28 mGal

Drift

δg from FIPASS (day 082)	: -1481.40 mGal
Expected meter reading	: 10972.40
Actual reading	: 10972.70
Drift from FIPASS	: 0.30 meter units (= +0.30 mGa1)
Drift rate	: +0.043 mGal/day over 7 days

<u>Grimsby gravity base tie day 147</u>

Day/time	: 147/16.00
Meter reading (meter units)	: 12605.3
g at base station	: 981370.40 mGal
g at meter on ship	: 981370.47 mGal

Drift

δg from Montevideo	: +1624.19 **mGal**
Expected meter reading	: 12602.27
Actual reading	: 12605.30
Drift from Montevideo	: 3.03 meter units (= **+3.02** mGal)
Drift rate	: +0.052 mGal/day over 58 days

9.3 Magnetic Survey (PFB)

The magnetometer, a Varian V75 on loan from RVS, was streamed whenever possible, essentially on almost all lines longer than about 40nm. It behaved well, requiring only the occasional cleaning and drying of connectors on deck. It was adversely affected by MF radio transmission, and persistent long-term degradation of the signal towards the end of the cruise was traced to the action of the ship's cathodic protection system. It will be interesting to hear if any long-term damage, to the fish particularly, has been caused in this way.

9.4 3.5kHz and 10kHz Echo Sounders (CJP,MP)

Both echo sounders performed reliably throughout the cruise. They were run all the time except when the ship was moored in Rosita Harbour, at Signy Station and in the South Shetland Islands. The 10kHz PES was used in acoustic command mode for release testing and during mooring deployment, in addition to routine echo sounding and for monitoring pinger depth.

Both fish were deployed near the Falkland Islands on day 034 and recovered near Signy on day 051. The 3.5kHz was switched to the hull transducer for 3 l/2 hours on day 041 because the ship was rolling and the fish was at times towing very shallow, giving a noisy record. From Signy to Bransfield Strait the hull transducers were used, because of the anticipated danger of ice damaging the fish tow cables. The PES fish was deployed in Bransfield Strait and for the passage SW to the Bellingshausen Sea, but on day 059 the fish was recovered since it was giving an increasingly noisy signal. This was traced to the presence of seawater in the connector mating the fish junction box to the fish transducer array. Subsequently all connectors were treated with water-repellent contact grease. The PES fish was redeployed on day 067 and recovered on day 074 (again, because of brash ice). The hull transducers were used thereafter, to save deployment and recovery time.

Both fish suffered damage to the cable fairings. When each fish is deployed there is a tendency for the fairing to be trapped in the groove of the davit sheave, so as to strain the fairing and break the plastic clips under the weight of the fish. Spare clips and fairing lengths were taken from spare cables.

Both Waverley and Raytheon chart recorders worked well, requiring only routine maintenance (e.g. stylus needle replacement on the Raytheon). The take-up spool on the Waverley still has a slight tendency to make the paper spiral, but this fault slowly cured itself during the cruise.

The Simrad EK500 Bridge echo sounder was logged directly onto the Level ABC system for short periods through the cruise. This compared well with the PES data input manually at 5-min intervals, but was not sufficiently reliable (in deep water during all but the calmest weather) to be an acceptable replacement for manual input.

9.5 **Ocean Logger/Met Logger (CJP,** PFB)

The Ocean Logger was run for the whole cruise but the thermosalinograph and fluorometer were not switched on until 0010/065. Two problems arose: (i) at 1200/073 the fresh water supply to these instruments was inadvertently turned on (bv whom?), not only giving incorrect values for salinity and fluorescence, but also introducing tiny black particles into the instruments from the ship's fresh water supply. This was cured by flushing the instruments with fresh and salt water, draining and refilling them. This was not done until 2300/073, by which time several tons of fresh water had run to waste. (ii) early on day 075 the fluorescence values became very spiky. This was again cured by flushing and draining the fluorometer.

The normal fluorescence value was about 4 units. This increased to 8-12 when passing through plankton blooms.

There was some comment during JCR04 on the display software of the Ocean Logger, which was considered to lack flexibility. Current values of several parameters are displayed, but only three parameters (fluorescence, sea temperature(s) and salinity) can be displayed in time sequence. It would be useful to allow other parameters to be displayed instead, that might be of greater significance to a different cruise or experiment. Also, the time extent of the display is not shown; the clarity and convenience of the display software in other respects make this a prominent omission.

It is convenient to mention here the function of meteorological sensors. At the start of JCR04 we were told that neither Bridge nor scientific wind speed direction indicators, nor anemometers, were working. The bulk of the damage was put down to an incident involving a flag raised for the Governor FI during a visit to the ship over Christmas. It is unfortunate that no attempt was made to seek replacement sensors for JCR04; it can be extremely useful, particularly on station and during slow-speed manoeuvring, to know wind speed and direction, and to have logged them so that events not understood at the time can be explained afterwards. Also, if the sensors are so vulnerable to accidental damage of this kind, then either they or the flag halyard should be moved elsewhere.

9.6 **Surface Water Samples (CJP)**

The opportunistic study of near-surface plankton was continued during JCR04 by filtering samples drawn from the uncontaminated seawater supply in the Prep. Lab. Seawater pump no. 2 was run continuously, with the hull intake in the Mid position (i.e. flush with the ship's hull). No problems were experienced with air-locks in the system, after the installation of air vents last year (see JCR 01 cruise report). This year most of the samples were taken in the Bellingshausen Sea (including the continental shelf, near the ice edge) and on the return passage to Bransfield Strait (Table 7). Each sample of up to 5 1 was filtered through a pre-weighed nuclepore polycarbonate filter of 0.4 micron pore size, using a vacuum pump. In some cases the filter clogged and the flow rate became unacceptably slow before the whole sample had been filtered. The filters were rinsed using fresh water from the (prefiltered) ship's darkroom supply. No problems were experienced with the filtering equipment.

In addition a smaller number of plankton samples were taken in an attempt to obtain foraminifera (Neogloboquadrina pachyderma) for Dr. K. Darling (Ediiburgh University). Only the >lOO micron fraction was required. In the absence of a 100 micron net, a 125 micron stainless steel sieve was placed under the fluorometer outflow pipe. After each sampling period (usually 2 hours: Table 8) the material retained in the sieve was washed with clean seawater into a small container, resuspended and allowed to settle for a few minutes. A tiny sub-sample was spread on a microscope slide to check for the presence of forams. As much water as possible was then pipetted off, the remaining sample was transferred to a small polythene bottle and immediately frozen at -60°C. Forams were nowhere abundant, but were present in the western Bellingshausen Sea samples. Tiny coiled pteropods were the most abundant group of plankton; diatoms, radiolarians and crustaceans were also common. It was noted that blooms (detected as inceased fluorescence) were quite varied in composition, some being dominantly crustaceans, some siliceous zooplankton and some diatoms.

Table 7 **JCR04 Surface Water samples**

Number	Lat. S	Long. W	Water depth	Quantity filtered	Time
JCR4/ USW/ 1	52 04.3'	41 18.8'	3719m	3.11	1655/042
2	70 52.3'	84 44.6'	621m	2.51	1515/060
3	71 07.2'	84 41.3'	614m	2.51	22451060
4	70 23.8'	86 41.3'	624m	2.51	1255/061
5	69 37.1'	88 24.0'	3146m	3.01	0025/062
6	69 15.4'	89 54.8'	3803m	2.01	1228/062
7	69 33.4'	92 12.5'	4114m	3.51	0206/063
8	69 31.5'	95 00.7'	4206m	3.51	1335/063
9	69 39.8'	96 58.2'	4334m	3.51	0247/064
10	70 25.5'	96 50.9'	3307m	3.51	1140/064
11	70 39.4'	96 49.1'	438m	4.91	1420/064
12	70 49.8'	96 42.0'	403m	3.01	1645/064

13	70 44.3’	95 09.4’	531m	4.01	23 16/064
14	70 42.6’	94 08.4’	474m	4.01	03 l0/O65
15	70 35.5’	93 55.8’	1849m	5.01	0500/065
16	70 25.2’	93 55.6’	2239m	3.51	0700/065
17	70 06.0’	93 55.1’	3149m	3.51	1050/065
18	69 39.0’	93 55.7’	3609m	3.51	1553/065
19	69 40.9’	95 07.7’	4236m	2.51	03 1 0/066
20	69 25.3’	96 04.0’	4379m	3.01	0700/066
21	68 46.3’	96 24.1’	4470m	3.01	1055/066
22	68 04.2’	97 13.8’	4561m	3.51	1510/066
23	67 23.9’	98 31.5’	4623m	4.01	1930/066
24	66 48.9’	99 29.0’	4720m	5.01	2305/066
25	66 13.7’	100 18.6’	4806m	5.01	0245/067
26	65 06.1’	98 41.9’	4857m	5.01	1112/067
27	64 32.2’	97 04.5’	4885m	5.01	1615/067
28	65 32.7’	94 39.4’	4755m	5.01	0150/068
29	65 20.7’	91 08.5’	4684m	5.01	1315/069
30	65 24.9’	90 15.1’	1833m	5.01	0210/07 1
31	66 16.0’	93 10.5’	4700m	5.01	0305/072
32	66 56.1’	91 09.0’	4591m	5.01	1510/072
33	67 11.3’	89 46.0’	4326m	2.51	2300/072
34	68 06.2’	88 33.4’	4059m	5.01	1110/073
35	70 01.2’	86 00.0’	1118m	3.01	0024/074
36	70 40.2	87 56.7’	480m	3.51	1215/074
37	70 28.6’	88 28.5’	846m	3.01	14351074
38	70 07.6’	89 28.6’	2732m	3.01	1900/074
39	69 23.6’	91 15.4’	4038m	2.51	0107/075
40	67 58.2’	91 42.0’	4361m	4.01	12201075
41	67 52.1’	88 20.3’	4143m	4.01	1820/075
42	67 46.9’	84 59.1’	4148m	3.01	0015/076
43	67 05.4’	78 41.7’	3858m	4.01	1215/076
44	66 29.0’	75 29.9’	3342m	3.51	1845/076
45	65 55.8’	72 45.9’	3141m	4.01	0020/077
46	64 37.8’	68 07.5’	1368m	3.01	1115/077
47	63 52.6’	65 30.9’	478m	1.71	1900/077
48	61 22.0’	57 17.3’	1733m	3.01	2342/080
49	60 10.6’	57 22.8’	3607m	5.01	0500/08 1
50	59 04.5’	57 22.2’	3718m	4.01	1015/081
51	57 39.3’	57 16.3’	3465m	3.51	1710/081
52	56 43.8’	57 12.6’	3229m	3.51	21 l0/081
53	55 33.0’	57 11.9’	4248m	3.01	0200/082
54	53 54.6’	57 06.0	1534m	5.01	0925/082
55	53 02.4’	57 01.2’	1663m	4.01	1320/082

Table 8 **$urface Water Samples > 125 microns**

No.	Start and end positions	Water depth	Time
KD 1	64°41'S, 96°36'W to 64°55'S, 96°05'W	4850m	1800-2000/067
KD 2	65°02'S, 92°56'W to 65°02'S, 93°08'W	935-280- 12OOm	2000-2200/068
KD 3	65°22'S, 90°39'W to 65°24'S, 90°08'W	500-2000m	2005-2250/069
KD 4	65°21'S, 89°37'W to 65°25'S, 90°13'W	4700-2100m	2300/070-0200/071
KD 5	65°5O'S, 93°57'W to 65°58'S, 93°39'W	4750m	2100-2300/07 1
KD 6	67°06'S, 90°03'W to 67°11'S, 89°4O'W	4350m	2025-2220/072
KD 7	67°11'S, 89°41'W to 67°11'S, 89°58'W	4350m	2230/072-0410/073
KD 8	70°38'S, 87°39'W to 70°38'S, 88°24'W	530-440m	1130-1325/074
KD 9	67°58'S, 91°22'W to 67°56'S, 90°08'W	4300-4150m	1255-1505/075

10. DATA LOGGING AND COMPUTING

10.1 Level ABC Data Logging and Processing (DJR & RJH)

Level A Operations The following list shows which instruments were logged and how much data were logged from each of them, using the ABC system, during cruise JCR04. Comments on operations are attached.

INSTRUMENT: Ship's gyro compass.
DATAFILE: gyro
START TIME: 93 033 16:19:04 STOP TIME: 93 082 20:05:40
DATA RECORDS: 428725
VARIABLES: heading
COMMENTS: A 2 degree offset was subtracted to give true heading.

INSTRUMENT: Trimble GPS unit.
DATAFILE: gps_trim
START TIME: 93 033 16:19:05 STOP TIME: 93 082 20:05:40
DATA RECORDS: 299751
VARIABLES: lat lon pdop hvel hdg svc sl s2 s3 s4 s5
COMMENTS: This proved to be somewhat problematic during the first half of the cruise due to faulty Level A software. It appeared that whenever the GPS Level A received a data message from the GPS unit which contained fewer than 5 space vehicle I.D numbers it would pass no further messages until the next time it received a message title block from the GPS unit, which occurs every 10 messages. As we had the GPS unit set to output a fix every 25 seconds this meant that up to 225 (9 times 25) seconds could elapse without a fix being sent to the Level B, this would cause the Level B to indicate that the GPS Level A had gone idle. The Level A also produced some SMP messages which contained incorrect data and times. A corrected version of the software was installed on 27th February and no further difficulties have been encountered since this time.

INSTRUMENT: Ckeanlogger PC attached to various met instruments.
DATAFILE: oceanlog
START TIME: 93 034 15:02:50 STOP TIME: 93 082 20:05:30
DATA RECORDS: 373660
VARIABLES: wspd wdir atemp mstemp sstemp hum par tir fluor flow press sal
COMMENTS: Monitoring of fluor, flow and sal was not started until 5th March 1993 at 23:50 GMT.

INSTRUMENT: Ships electromagnetic speed log.
DATAFILE: em-log
START TIME: 93 034 12:30:03 STOP TIME: 93 082 20:05:41
DATA RECORDS: 428876
VARIABLES: speedfa
COMMENTS: None.

INSTRUMENT: Ships doppler speed log.
DATAFILE: dop_log

START TIME: 93 034 12:24:14 STOP TIME: 93 082 20:05:20
DATA RECORDS: 418948
VARIABLES: speedfa speedps
COMMENTS: None.

INSTRUMENT: PC based winch monitoring system.
DATAFILE: winch
START TIME: 93 035 14:08:03 STOP TIME: 93 048 10:42:25
DATA RECORDS: 16192
VARIABLES: cabltype cablout rate tension btension comp angle
COMMENTS: This system was developed and installed by Seametrix and uses a PC to display and record data gathered by sensors attached to the ship's winches. The data are recorded to floppy disk on the monitoring PC, and also sent to the Level B machine via an RS232 connection. The data from this system are only logged intermittently on the ABC system and an investigation of why this is so had been ongoing. On consultation with some of the RVS personnel it was discovered that RVS were already aware of this problem and that it was caused by an incorrect implementation of the Secure V24 protocol used to send messages via serial line to the LevelB.

INSTRUMENT: Precision Echo Sounder.
DATAFILE: rawdep
START TIME: 93 034 20:00:00 STOP TIME: 93 082 19:25:00
DATA RECORDS: 10645
VARIABLES: uncdepth
COMMENTS: These data were read off the echo sounder by the watchkeeper every five minutes and manually entered into the datafile using mandep.

INSTRUMENT: Neil Brown MkIII CTD.
DATAFILE: bas_ctd
START TIME: 93 035 22:32:57 STOP TIME: 93 050 20:17:11
DATA RECORDS: 70105
VARIABLES: pres temp cond chl deltat
COMMENTS: CTD data were logged for six periods of 3-4 hours each.

INSTRUMENT: RVS magnetometer.
DATAFILE: magnet
START TIME: 93 034 19:42:12 STOP TIME: 93 082 19:51:55
DATA RECORDS: 433032
VARIABLES: magfld
COMMENTS: The LevelA used with this instrument had not been supplied with the correct interface panel for use with the magnetometer. Therefore a Trisponder interface panel was adapted to allow the magnetometer to be logged. However the LevelA still produced values that were ten times too large. The raw values in magnet were divided by ten and copied to a file called calmag before processing each day.

INSTRUMENT: RVS gravity meter S84.
DATAFILE: gravity
START TIME: 93 033 16:29:30 STOP TIME: 93 082 20:00:30

DATA RECORDS: 423330
VARIABLES: g s xcup beam vc al ax ve ax2 xac2 lac2 xac lac
COMMENTS: The gravimeter is logged locally by a PC which also sends SMP messages to a LevelA, The data are time-stamped by the local PC and this at first caused some confusion as the clock on the PC was set to the wrong day and so data messages from the LevelA were arriving at the LevelB with the wrong date whereas other messages from the LevelA were correctly time-stamped. The problem was quickly solved and the data were post-processed to correct time stamps. Operated continually apart from a short period when the hard disk of the controlling PC became full.

INSTRUMENT: Ship's EA500 echo sounder.
DATAFILE: sim500
START TIME: 93 034 10:07:32 STOP TIME: 93 082 20:05:29
DATA RECORDS:
VARIABLES: uncdepth rpow angfa angps
COMMENTS: The last two variables, angfa and angps, are not used as this information is only available if a split beam transducer is being used with the EA500. Speed of sound in water was originally set to 1471 m/s, this was changed to 1500 m/s at 09:30 GMT on 6th February 1993. Therefore, values up to this time need to be scaled by a factor of 1500/1471. Also, the capability of the EA500 automatically to track the bottom varies greatly with the ship's behaviour. In particular, turns, rough weather and aeration from the bow and stem thrusters appear to cause the EA500 to lose the bottom, for extended periods.

Level C Data Processing Underway geophysical and navigational data were processed and displayed regularly using various Level C applications. Of primary interest were: navigation data (eg GPS fixes, course and speed made good etc), magnetic anomaly, free air gravity anomaly and bathymetric data. For details on the processing of navigation data refer to section 9.1 of this report.

Magnetic Field Data Raw total field data were logged every 6 seconds. These data were divided by 10 to adjust for Level A scaling, then the Level C routine **promag90** was used to remove the 1990 IGRF from the adjusted total field data. An examination of the **promag90** code revealed that only the first 80 of the 120 necessary coefficients for correct IGRF calculation were being used. It therefore proved necessary to recalculate the IGRF using BAS-developed software, after the cruise. **Promag90** produces a data file (also called promag90) which contains two variables: **magfield** (total field) and **maganmly** (magnetic anomaly). In order to remove spikes caused by radio transmissions, and other bad data points, this file was edited using the graphical status editor, bad data points being assigned a 'suspect' status. It is worth pointing out that most bad data points occurred immediately after or before turning the magnetometer's level A on or off.

Generally speaking the magnetic field data were processed and edited every 24 hours, along with gravity field and bathymetry. A magnetic anomaly profile was displayed along the ship's track for a 24 hour period (usually starting and ending at 14002) using the Level C routines **prof** and **profplot.** In order to plot the profile as 'positive up' it was necessary to specify an azimuth perpendicular to the ship's track, as the auto azimuth function of **prof** tended to make traces 'positive down'. Anomalies were also displayed as a function of both time and distance run in large 2D profiles along with free air anomaly and bathymetry, using the routines **xyprep, oploth** and **tploth.** Occasionally total field data were plotted against distance-run on one of the SUN workstations using the **liveplot** routine. This produces a real-time plot of the changing field as the ship progresses.

Gravity Field Data Raw gravity readings collected by the gravity meter Level A were processed regularly (usually every 24 hours) using the Level C routine **prograv.** An account of gravity data acquisition and correction is given in section 9.2 of this report Briefly though, **prograv** converts the raw meter readings to milIiGals then performs the Eotvos and latitude corrections necessary to produce a free-air anomaly. To do this it requires navigational data. It was found that high frequency variations in GPS navigation (due to Selective Availability) had an adverse affect on the Eotvos correction and therefore reduced the quality of the free-air anomaly considerably. To solve this GPS fixes were subsampled every 15 minutes and dead reckoning, using data from the gyro and EM log (averaged over a running 4 minute window) was used to interpolated position between each fix.

The free-air anomaly for a 24 hour period was displayed every day, along with bathymetry and magnetic anomaly on a 2D profile using the Level C routines: **xyprep, oploth** and **tploth.**

Bathymetry Data Soundings taken from the 10khz PES chart recorder every 5 minutes were entered into the system manually at the end of every watch using the **mandep** routine. These data were corrected for variations of sound velocity for the appropriate Carter zone using the **prodep** application. Again this was done routinely every 24 hours and the processed data were displayed as a 2D profile along with magnetic and free air gravity anomalies. An examination of this profile invariably resulted in one or two anomalously deep or shallow readings being noticed. By looking back through the 10 khz PES chart roll the validity of these readings could be determined and, if necessary, corrections made. **Prodep** would then be re-run so that the correct data ended up in the final version of the processed data file.

10.2 Central VAX Computing (PM)

Introduction The main centralised user service was provided by a DEC VAX 4000/300 running VAX/VMS V5.5. This machine is slightly more powerful than the main VAX 6410 (BSVC) in Cambridge. The user operating environment has been set up to emulate the Cambridge system, and Cambridge users should find no difficulty in using the JCR systems.

Application Packages and Compilers Application packages available were: Oracle, SAS, Genstat, UNIRAS, UNIGKS, GRAFIX/GKS, Minitab. Compilers available were: C, Fortran, and Pascal. Versions were as those installed at Cambridge at this time.

Full sets of documentation were available for all packages and compilers.

Printers Three central printers were accessible directly from the VAX.

i. DECLASER 2250 - a high quality monochrome A4 Postscript compatible laser printer. Access to this printer is via two VAX queues, SYS$LASER_PS for Postscript files, and SYS$LASER_ANSI for text files. The system default queue, SYS$LASER, submits through the SYS$LASER_ANSI queue.

ii. HP LASERJET III - a non-Postscript A4 laser printer. Accessed via the VAX queues

SYS$HP_LASER, using the HP printer language **PCL5,** or **HP-GL** graphics.

iii. EPSON LQ1050+ - a 132 character wide dot matrix printer, using fanfold paper. Accessed via the VAX queue SYS$EPSON.

Plotters One colour graph plotter was available.

i. ZETA A0 Colour plotter - an HPGL compatible 6-pen plotter, using roll paper. This is available via the VAX queue SYS$ZETA, and is cabled via a data switch to allow the plotter to be shared with the Sun Level C system. In position 2, the Vax has full control of the plotter, with queueing. Note however that the requirement of the RVS Level C software for the plotter to return to the start of the paper after plotting makes queueing dangerous, as a second plot may overwrite the first.

An HP 6-pen A3/A4 plotter, model 7475, is also available as an eavesdrop device, but was not connected to the system during this cruise.

Accessing the VAX

i. Serial lines - access is via the Emulex terminal servers, using KERMIT or any serial communications package (e.g. Microsoft Terminal from Windows). At the **Serven** prompt, type **c jrva.**

ii. Network connection - access directly through the network card in the PC. On PC-NFS machines, this uses the TELNET command, e.g. **telnet jrva,** while on PATHWORKS machines, the DECNET "sethost" command should be used, e.g. **sethost jrva.**

Disk Space Approximately 350 Megabytes was available for scientific user files, plus an additional 380 Megabytes in the Oracle database, and scratch areas. Usage during the cruise ran at around 75-80% of capacity on both disks.

Connectivity with Sun Workstations VMS/Ultrix Connection is installed, providing TELNET terminal sessions, and FTP file transfer in both directions.

Connectivity with Cambridge The BAS Antarctic Messaging System is installed on the ship, giving message and data transfer facilities between the ship, HQ, and via HQ, all other ships and bases.

Geophysics Cruise Installations This cruise involved the restoration of several user accounts from backup, covering almost 300 Mb of files, plus the import of a large, single-table Oracle database. Setup of user accounts, and the restoration of files was achieved within one day, without problems. The import from the database ran into several problems, detailed below:

i) Reading from tape - importing/exporting directly from/to tape is slow and cumbersome. Oracle may take up to 8 hours to import 300 Mb of data from tape, while an import from disk of the same amount takes less than two hours. All operations should be done on disk files whenever possible, with manual copying to/from tapes where required.

ii) Importing large files - during an import, the new data is read into a temporary area, and only written to the database on successful completion. While this is a sensible precaution in most cases, the Geophysics database is larger than the temporary space available, and so generates an error. To overcome this, it is necessary to use the

COMMIT=Y command line option when importing, to force a periodic write of the imported data, so freeing the temporary space.

iii) Importing from the SYSTEM account - in order to make tables accessible to the original owner, they should be imported under that owner's ID. If this is not feasible due to restrictions on disk space, or tape access, then the OWNER=<username> command line option should be used when importing.

Geophysical Applications The geophysical application software implemented primarily consists of database handling routines, file handling routines, plotting and modelling/interpretation software. Principal applications were recovered during the restoration of the U_GEOPHYS user account. Executable code ran immediately with the exception of graphical applications which were recompiled and linked as necessary. Before leaving Stanley, all principal applications were tested with the marine cruise database and test plots were sent to the ZETA plotter (via the BASl Sun workstation).

During the cruise, alterations were made to the FORTRAN program transfer_mgd77.for and the Level C Mutli control file /rvs/control/fmt/transfer.mfmt which were written to enable the generation of MGD77 records compatible with the marine cruise database ***(R.R.S. James Clark Ross*** scientific equipment trials report, pp.48). These alterations now enable the inclusion of an observed total field gravity measurement (mGal) in the MGD77 record. The Level C multiple listing program 'Mutli' has an additional format definition which includes the observed gravity meter reading (meter units) and is contained in the file /rvs/control/fmt/geophysics.mfmt. An underway geophysical data file generated using this definition was transferred to the VAX using the FTP. The existing file handling program transfer_mgd77.for which uses files produced by 'Mutli' to generate MGD77 records, has been altered (transfer_mgd77_vr2.for) and now calculates an observed gravity (mGals) using the gravity meter reading (meter units), the meter calibration constant (1.0 for S84), and the initial gravity base tie information. The calculated value is then written to the MGD77 record. The modified software was used on a number of occasions to enable recently acquired data to be examined with existing data held in the marine cruise database. A problem associated with spurious total magnetic field measurements which caused the MGD77 conversion program to crash was identified and eliminated at this time.

Hardware Problems No hardware problems were encountered. Service was lost for two hours due to loss of ships power.

11 CRUISE STATISTICS (IG)

Total cruise time, Stanley to Stanley		48.6 days
* Station Time		7.4 days
Coring	4.8 days	
CTD' S	0.8 days	
Current Meter Moorings	0.4 days	
Dredges	1.4 days	
* Seismic Profiling Time		11.0 days
Single-Channel Seismic	3.0 days	
Multi-Channel Seismic	8.0 days	
* Other Survey and Passage Time		26.1 days
To and from Stanley	2.8 days	
Passage between sites	23.3 days	
* Equipment Testing		1.4 days
BGS winch (testing & Kevlar streaming)	0.7 days	
MCS streamer balancing	0.6 days	
LPC trigger test	0.1 days	
* Time At Anchor		2.7 days
Rosita Harbour	0.3 days	
Signy	1.1 days	
Maxwell Bay	0.1 days	
False Bay	1.1 days	
Potter Cove	0.1 days	
Whilst on passage:		
Magnetometer	30.0 days	
3.5 kHz profiler	35.3 days	
10 kHz PES	44.1 days	
Gravity Meter	48.5 days	
Ocean Logger	18.2 days	

12 CREW LIST

Officers: Christopher Elliott Master

John Marshall	Chief Officer	Geoffrey Morgan	2nd Officer
Antonio Gatti	3rd Officer	David Cutting	Chief Engineer
William Kerswell	2nd Engineer	Thomas Ellinson	3rd Engineer
Michael Dixon	4th Engineer	Norman Thomas	Electrical Officer
Simon Wright	Deck Engineer	Charles Waddicor	Radio Officer
Raymond Walters	Purser		

crew: John Summers Scientific CPO

Martin Brookes	Bosun	James Williams	Bosun's Mate
David Peck	Seaman	Albert Bowen	Seaman
Jonathan Dodd	Seaman	Benjamin Riley	Seaman
Barry Wickenden	Seaman	David Bretland	Motorman
Dennis Connell	Motorman	Thomas Sweeney	Chief Cook
David Hunt	2nd Cook	Tony Dixon	Assistant Cook
Mark Jones	2nd Steward	David Greenwood	Steward
James Newall	Steward		

Scientific Party:	Peter Barker	BAS Geoscience	PSO
	Carol Pudsey	-do-	marine geology
	Robert Latter	-do-	marine geophysics
	Alex Cunningham	-do-	-do-
	Richard Hunter[1]	-do-	-do-
	Ian Gilbert	-do-	marine geology
	Paul Murphy	ISG	VAX computing
	Steven Bremner	ISG	mech engineer
	Andrew Tait	ISG	-do-
	Mark Preston	ISG	electronics
	David Richmond	ISG	ABC logging
	Anthony Cumming	RVS	M/SCS electronics
	John Wynar	RVS	-do-
	Bavid Booth	RVS	-do-
	Clive Washington	RVS	moorings
	Chris Rymer	RVS	M/SCS mech engineer
Others:	Jeffrey Barnes	BAS	
	Jonathan Dixon	BAS Doctor	
	Tim Bird[2]	BAS	
	Debbie Armstrong[2]	BAS	
	Rob Willan[3]	BAS	
	Paul Farmer[3]		

[1] picked up Maxwell Bay, Marsh 24th February
[2] picked up Potter Cove, Barton Peninsula 20th March
[3] picked up False Bay, Livingston Island 21st March

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GLOSSARY

AABW	Antarctic Bottom Water
ABC	3-stage shipboard data logger, developed by RVS
ACC	Antarctic Circumpolar Current
BAS	British Antarctic Survey
BGS	British Geological Survey
CPDW	Circumpolar Deep Water
CTD	Conductivity, Temperature, Depth (gear to measure vertical profile of...)
DGC	"the small, central seamount of the De Gerlache Seamount group"
DGE	"the large, eastern seamount of the De Gerlache Seamount group"
DGW	"the large, western seamount of the De Gerlache Seamount group"
DSU	Data storage unit (digital, of Aanderaa current meters)
EBCDIC	Digital data format
EG&G	Edgerton, Germeshausen and Greer (brand of CID logger)
EM	Electromagnetic (ship's log, measures distance & speed through the water)
FAW	Forward auxiliary winch (on midships gantry)
FTP	file transfer protocol (for inter-computer digital data transfer)
FIPASS	Falkland Is. Port and Storage Services: floating jetty complex, Stanley Hr
GPS	Global Positioning System
IBNS	JCR's integrated bridge navigation system
IOS	Institute of Oceanographic Sciences (model acoustic release)
ISG	Instrument and Systems Group of BAS
JCR	RRS ***James Clark Ross***
LPC	Long Piston Corer - BAS development of STACOR, intended for JCR use
MCS	Multichannel seismic (survey, equipment etc)
MLSD	Marine Life Science Division of BAS
OSU	Oregon State University (Corvallis)
PES	Precision echo sounder (IOS design)
RRS	Royal Research Ship
RV	Research Vessel
RVS	Research Vessel Services (of Barry, S Glamorgan)
SCS	Single-channel seismic (survey, etc) - here, digital and 2- or 4-channel
SEG B/Y	MCS magnetic tape formats from Society of Exploration Geophysicists
SWL	Safe working load (of wires & ropes)
TWTW	(Brattvaag) Twin-Warp Trawl Winch - used here for dredging
UICR	Underway Instrumentation and Control Room aboard JCR
VAX	Digital Equipment Corpn computers
WL	(dredging) weak link

14. ACKNOWLEDGEMENTS

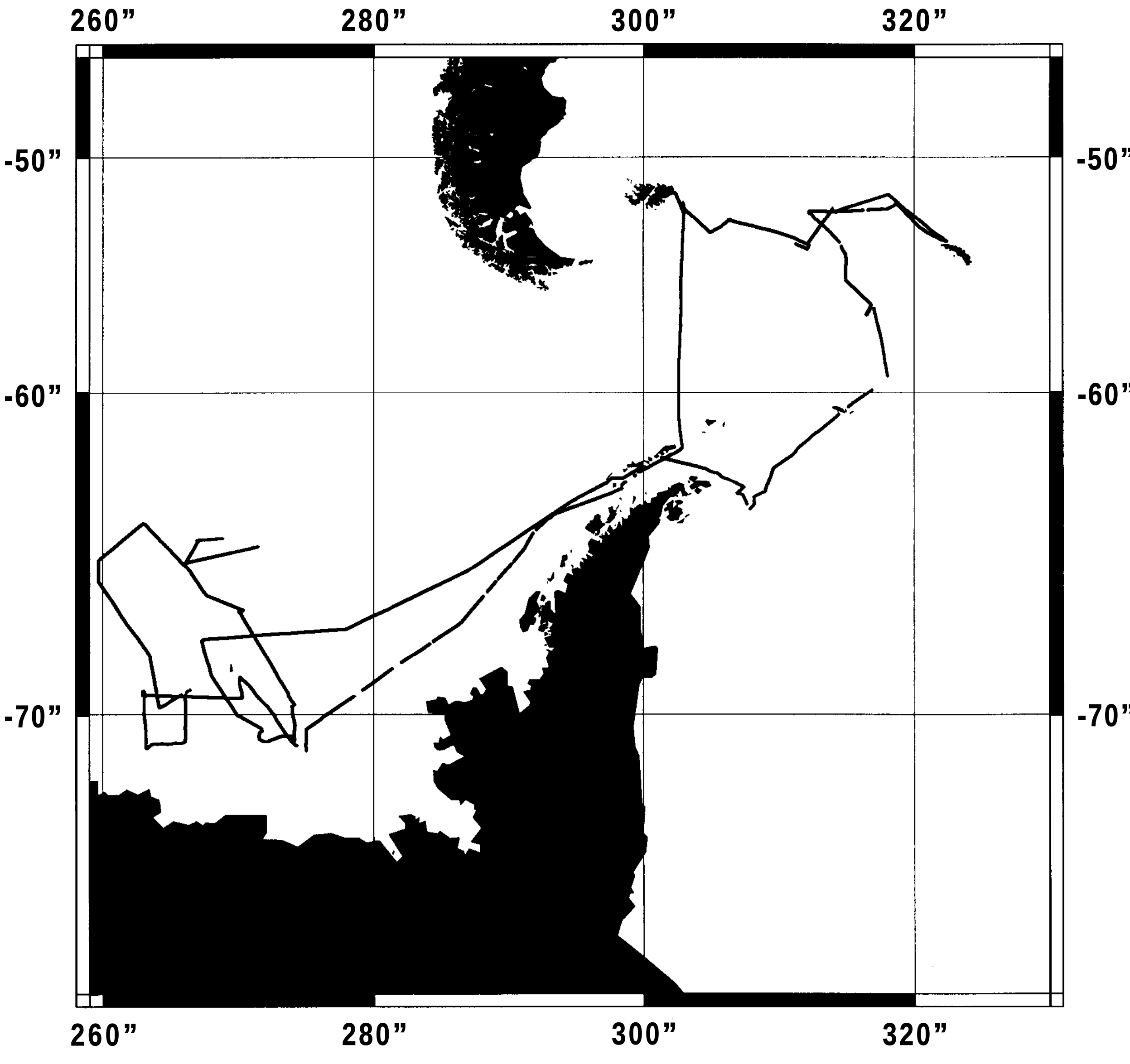
Although this was not a maiden voyage, nor a first marine geoscience cruise, virtually every activity that it comprised was new to the ship and to most people on board. Some activities were carried out using jury-rigged equipment, because the intended, ship-fitted facilities were still not available. In such circumstances, what should be routine procedures must be carefully planned, facilitated and carried out, and much is demanded of ship's crew, scientists and engineering support staff. That the cruise was so successful, therefore, owes much to the commitment, ingenuity and adaptability of those on board. We are grateful to the ship's company, and to RVS and ISG engineers, for their efforts on our behalf.

Director and staff of RVS were particularly helpful in servicing and providing equipment for this cruise. We also thank Jack Pheasant and Director BGS for the generous loan of a deck-mounted winch for coring, when it became clear that the ship's Main Winch would not be performing to specification, and we are grateful to Bob White of Bullard Labs for the loan of his Carrack SAQ digital seismic recorder.

The effort of planning and enabling a season that involved 4 separate and quite different science cruises placed extra strains on those BAS staff normally responsible for the range of BAS logistic support. That the season went so well does them much credit.


JAMES CLARK ROSS 04
TRACK CHART
Key
Bathymetric, 3.5kHz, magnetic and gravity data
Position at 0000(z) Julian day 35
Core
CTD
Mooring
Dredge
Single-channel seismic profile
Multichannel seismic profile
BS
Livingston Island
False Bay
D143,144
D145
D146
D156
D147,148
63°S
61°W
60°
59°
NW
KC088
KC089
KC085
KC087
KC086
64°S
53°W
52°
Port Stanley
Falkland
Trough
North Scotia Ridge
CTD077
GC062
Line 923-S21
Line 923-S26
KC076
PC077
PC078
Rosita Harbour
South Georgia
Scotia Sea
Drake Passage
55°S
60°
C
D
E
K
CTD079
PC067
PC068
PC074
KC075
52°20'S
46°W
KC082
KC083
KC084
CTD082
Signy Island
Maxwell Bay
Bransfield Strait
KC090
Anvers Island
Antarctic Peninsula
Weddell Sea
De Gerlache Seamounts
D149,150,
151,152
D153
D154
D155
Line 923-28
Line 923-29
Line 923-30
Bellingshausen Sea
Peter I Island
Line 923-22
Line 923-23
Line 923-24
Line 923-25
Line 923-26
Line 923-27
923-S27
923-S28
923-S29
65°
70°
2000m
100°W
95°
90°
85°
80°
75°
70°
65°
60°
55°
50°
45°
40°
Line 923-S25
KC069
PC071
PC072
PC070
CTD080
MX
KC073
41°W
52°S
PC079
CTD081
MXI
PC080
KC081
43°W
57°S
Line 923-S22
Line 923-S23
Line 923-S24
KC064
CTD078
PC063
MIX
PC066
PC065
54°S
48°W

JR04_magnetics



JR04_ gravity