Ref. JR12 No.D1

DRAFT

RRS *James Clark Ross*
January - February 1999
Cruise JR39a

Completed 10/2/99

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RRS *James Clark Ross*
January - February 1999
Cruise JR39a

R.A. Livermore, Chief Scientist
10th February, 1999

C.R. Elliott, Master
10th February, 1999

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1. Abstract

JR39a completed a programme of magnetic and seismic survey in the central and southern Weddell sea which had originally been scheduled for the ill-fated cruise JR07, which was cancelled owing to an engine room fire aboard RRS *Bransfield* in 1993/94. The primary objectives were to date ocean floor flow lines observed on satellite gravity maps by identifying anomalies on magnetic profiles, and to determine the nature of Anomaly T, the abrupt termination of the flow lines near 69°S.

Very good weather and sea conditions were enjoyed for most of the 26 days at sea, and all logistic objectives were met comfortably. The ship penetrated almost to the continental margin in the Weddell Sea, where the sea ice front was encountered at 73°19'S, but not entered.

Preliminary interpretations suggest that Anomaly T is associated with an abrupt change in plate motions at 120-130 Ma, involving a change from moderate SW-NE to slow WSW-ENE spreading, caused by Atlantic opening.

Technically, the revised RVS seismic acquistion system, incorporating short, Teledyne, streamer and new Geometrics seismic recorder, performed well, although it is unlikely that acquisition at speeds greater than 5 knots will be possible, as was done routinely with the old Geomechanique hydrophone cable.

2. List of Personnel

Scientific and Technical

LIVERMORE Roy A	Ch.Scientist	BAS
BRUGUIER Nigel J	Geophysicist	BAS
VANNESTE Lieve E	Geophysicist	BAS
MORRIS Peter	Data Manager	BAS
TAIT Andrew	Mech.Eng	BAS
LENS Peter	Comp.Support	BAS
ROBST Jeremy	Comp.Support	BAS
BOOTH David	Equip. Support	RVS
PAULSON Christopher	Equip. Support	RVS
PHIPPS Richard	Mech.Eng	RVS

Ship's Officers and Crew

ELLIOTT Christopher R	Master
PATERSON Robert C	Ch/Off
KILROY Robin T	2nd/Off
LIDDLE Andrew R	3rd/Off
SUMMERS John	Dk/ Off
HAIGH Thomas	Cadet
WADDICOR Charles C	R/O
CUTTING David J	Ch/Eng
KERSWELL Wiliam R	2nd/Eng
JONES Roger S	3rd/Eng
EADIE Stephen J	4th/Eng
WRIGHT Simon A	Deck Eng
THOMAS Norman E	Elec
GIBSON James S	Cat/Off
BROOKES Martin	Bosun
DODD Jonathon M	Bosun Mate
COSSEY Peter A	SG1
GRAHAM Roderick	SG1
O'SULLIVAN Neil B	SG1
DAVIS Raymond A	SG1
WATSON David N	SG1
SMITH Sidney F	MG1
ROBINSHAW Mark A	MG1
FOX Roy W	Ch Cook
BAILEY David R	2nd Cook
CLANCY John A	2nd Stwd
DIXON Tony N	Stwd
BALDWIN-WHITE L B	Stwd
HADGRAFT Simon D	Stwd

3 Timetable of Events

1999

January

8 Scientific party arrives in Stanley
14 Mobilisation commences, two seismic beams rigged; parts for BAS re-usable sonobuoys delayed at Brize Norton, the rest is transferred to the hold.
15 Ship departs FIPASS at 14:35, following boat drill and safety talk; strong swell, wind 25 knots; magnetometer deployed at 22:35, but noisy record obtained.
16 Magnetometer recovered at 00:30, reserve sensor deployed, now OK.
17 Magnetometer recovered at 18:00, and STCM compensation manouevre completed; 3.5 kHz sounder switched on; commenced seismic gear deployment at 20:00; hydrophone streamer tows deep at front, shallow at rear; recovered to add lead.
18 Airgun problems: starboard 160 cu in. Gun found to lack seals, replacement also lacks seals; beams deployed with two guns shut down; magnetometer deployed; seismic line S90 completed; seismic gear recovered and STCM manouevre completed.
19 Deploy magnetometer and set course for Weddell Sea.
20 Spare magnetometer deployed for testing.
21 Heavy seas; second magnetometer fish recovered.
22 Magnetometer recovered; STCM manouevre; seismic gear deployed and line S91 commenced in area of 'kinked' gravity ridges (area D).
23 Course changes for ice bergs; seismic line S92 commenced.
24 End of line S92; noise in magnetometer and streamer alarms; magnetometer recovered and redeployed; Line S93 completed and seismic gear recovered; STCM manouevre.
25 Magnetometer deployed; heading south.
27 STCM manouevre; deploy seismic gear, 160 cu in. gun not firing; line S94 completed and gear recovered; heading south.
29 reached 73°S; magnetometer recovered for ice; ice edge encountered and followed west; furthest south 73°19'S.
30 Magnetometer deployed and head north to Anomaly T (area E).
31 Magnetometer recovered; STCM manouevre; seismic gear deployed for line S95; 300 cu in. gun not firing; magnetometer deployed; line S96 commenced.

February

1 Magnetometer cable tangled: recovered and redeployed.
2 Line S98 commenced, but very heavy sea causes severe rolling; line abandoned and seismic data acquisition continues on lines S98 and S99 northward into wind and southward back to starting point of line.
3 Last line (now renumbered S100) completed; seismic gear recovered; STCM manouevre; magnetometer deployed.
4 Magnetics line in area D added; continue northward track.
9 Arrived in Stanley.

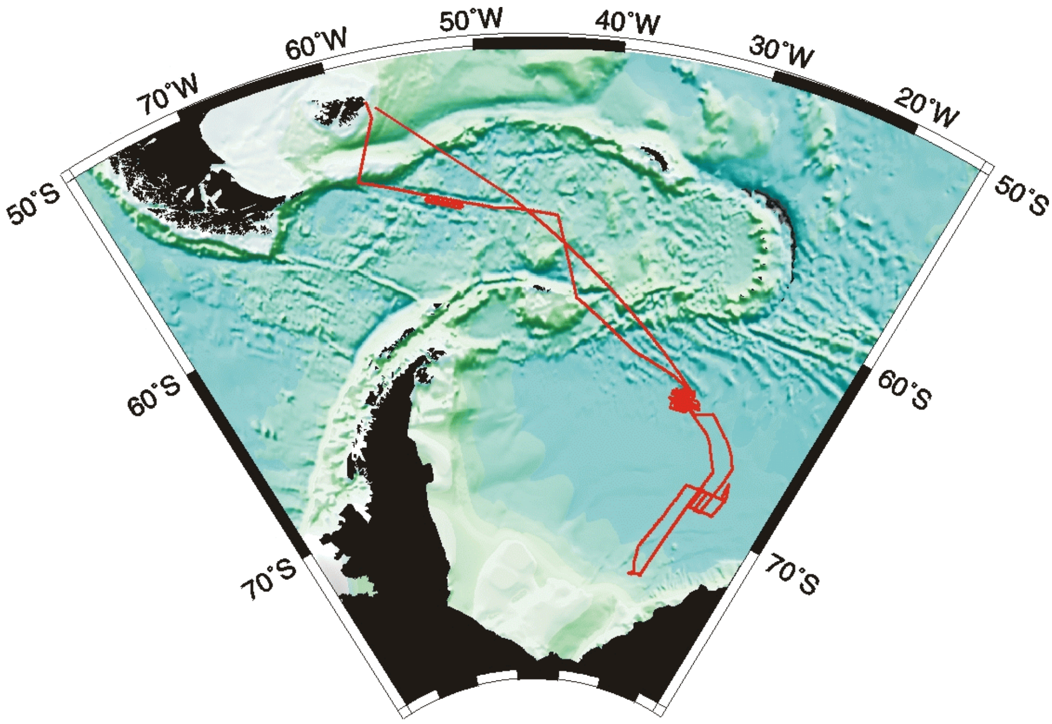

Figure 1 Track of RRS James Clark Ross during cruise JR39a

4 Introduction

Cruise JR39a completed a program of magnetic and seismic survey, designed to 'ground truth' features observed on free-air gravity maps of the Weddell Sea region, believed to represent a record of tectonic plate motions from the time of Gondwana supercontinent break-up in the Jurassic (approximately 170 million years ago) until the Miocene (approximately 20 million years ago). The work was carried over from cruise JR07, which was originally scheduled for 1994, but which was cancelled following an emergency aboard sister ship RRS *Bransfield.*

Following an uncomfortable Scotia Sea crossing, weather and sea conditions were near-ideal for most of the key surveys in the central and southern Weddell Sea, and all scientific objectives were met comfortably. During this leg, the ship crossed the Antarctic Circle and reached the southernmost latitude of her career at 73°19'S (Fig. 1).

The BAS shipboard three-component magnetometer performed well, and demonstrated that, with adequate information from compensation manoeuvres, perfectly acceptable data may be obtained routinely in ocean regions. An RVS total-field instrument was towed for most of the time and, despite its obsolescence, provided valuable data. The recently-acquired RVS Geometrics seismic recording system was operated together with a twelve-channel hydrophone streamer assembled from spare sections of the Teledyne multichannel streamer. This also performed well.

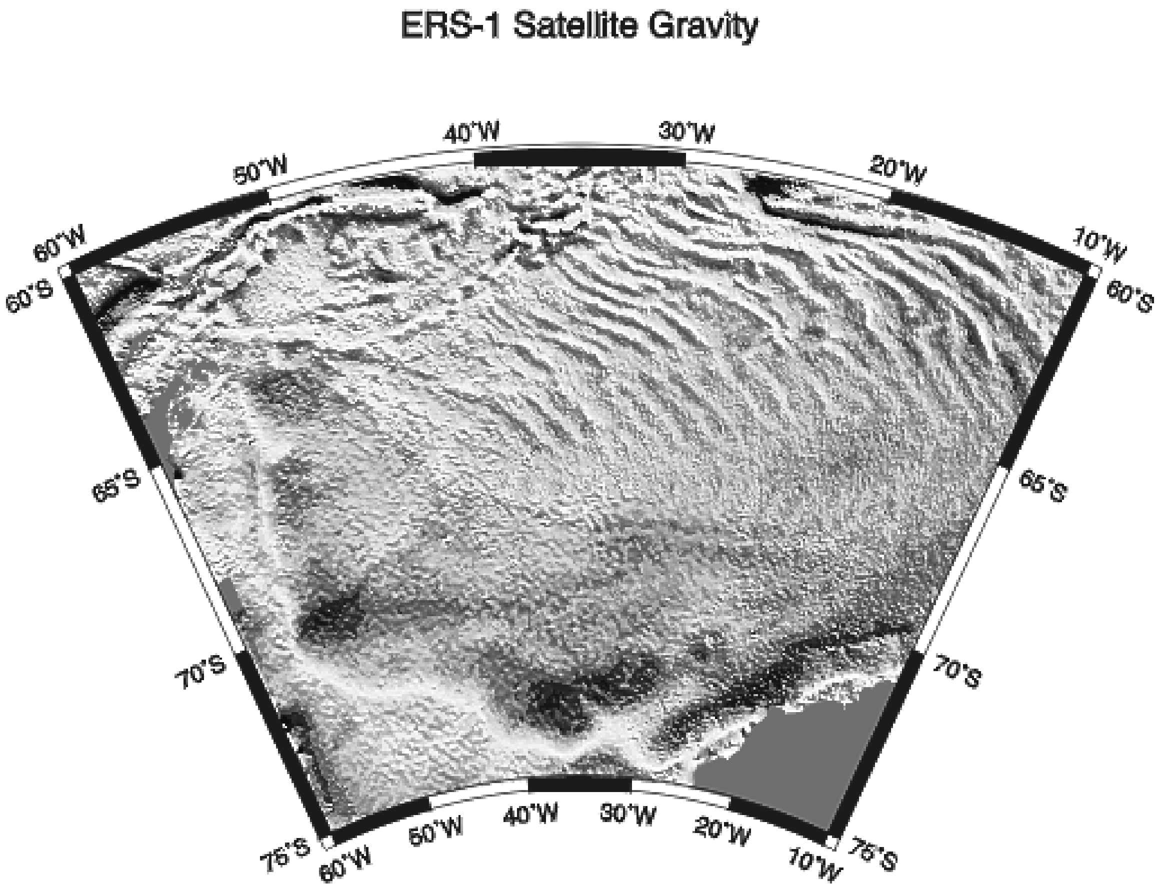

Figure 2 Free-air gravity anomaly map of the Weddell Sea derived from re-tracked ERS-1 and Geosat radar altimetry.

5 Scientific Objectives

The striking 'herring-bone' pattern of gravity ridges and troughs (Fig.2) has fascinated Antarctic geoscientists ever since the release of satellite radar altimetry from the mid-eighties Geosat mission by the US Navy (McAdoo & Marks, 1992). Since then, data coverage has been extended to higher latitudes by the European ERS-1 and ERS-2 satellites, and to ice-covered regions by careful reprocessing of altimetry. The 'herring-bone' pattern constitutes a set of so-called 'flow lines', which are believed to have formed by the process of sea floor spreading, and to represent the trajectory of South America, as it moved away from Antarctica (Livermore & Woollett, 1993). By acquiring, and interpreting, marine magnetic anomaly profiles along these flow lines, it is possible to date this record by reference to a well-known magnetic polarity reversal timescale. This, in turn, allows the calculation of rates of motion, and the timing of significant changes in spreading direction.

The very first scientific cruise of the *James Clark Ross* (see JR01 cruise report) acquired data along tracks in the northern Weddell Sea, designed to follow these gravity ridges as far as 63°S. A second cruise, JR07, was planned to this work to areas further south. Two sections of the record, in particular, were of interest. The first was an apparent disruption of the spreading pattern, referred to informally as the 'kink' (Fig. 2), and the second was the abrupt termination of the ridge-trough pattern near 69°S, known as 'Anomaly-T'. Understanding the nature and significance of these features form the prime objectives for JR39a.

References

Livermore & Woollett, 1993. Earth and Planet. Sci.Lett., 117,475-495.
McAdoo & Marks, 1992. J. Geophys. Res., 97, 3247-3260.

6 Achievements

Drake Passage

A single seismic reflection profile was shot across the extinct axis of the West Scotia Ridge, between the Endurance and Quest fracture zones. This provided a shakedown of the equipment, and also complements a previous survey over the segment to the north of the Endurance Fracture Zone.

Northern Weddell Sea

Magnetic profiles run on both outward and return legs add to the database constraining the later stages of Weddell sea spreading, from the Paleocene to the Miocene, when subduction and spreading were terminated, it is believed, by ridge-trench collisions.

The 'Kink'

One N-S and three W-E seismic profiles were acquired, in order to examine the structure of oceanic basement created during an abrupt change in plate motions. These profiles show a remarkable change in basement structure, from rough and high-relief to the north, to smooth and deeply-buried beneath the kink itself. An extensive magnetic grid was acquired (Fig. 3), which demonstrates that a W-E trend of magnetic isochrons was maintained during the 15 Ma or so duration of the change.

M-series Anomalies

Two complete tracks over Mesozoic magnetic anomalies from C34 to Anomaly T were obtained, plus several short crossings of anomalies adjacent to Anomaly T. These should help to determine the age and spreading rates for this crust.

Anomaly-T

A set of four seismic lines (Fig. 4) was obtained. Two dip lines cross Anomaly T, showing shallow, faulted basement, flanked by smoother basement to the south. Two W-E lines complete the survey, one to the north of Anomaly T, crossing three spreading compartments and the two intevening fracture zones, and one to the south, revealing the more subdued fabric of older crust.

Southern Weddell Sea

Magnetic lines were extended from Anomaly T southward to the ice edge at 73°19'S. Like previous profiles, these are of reduced amplitude, but should nevertheless assist interpretation, since they are likely to be much closer to the paleospreading direction.

Technical Achievements

A new hydrophone and recording configuration was used for the first time on JR39a. This comprised a short, twelve-channel streamer, formed from spare sections of the Teledyne multichannel cable, and the new, Geometrics, seismic recording system. Apart from minor problems, this system performed well, although acquisition at speeds greater than 5 knots was not attempted.

The second, revised, STCM did not perform well, but will be monitored during JR39b.

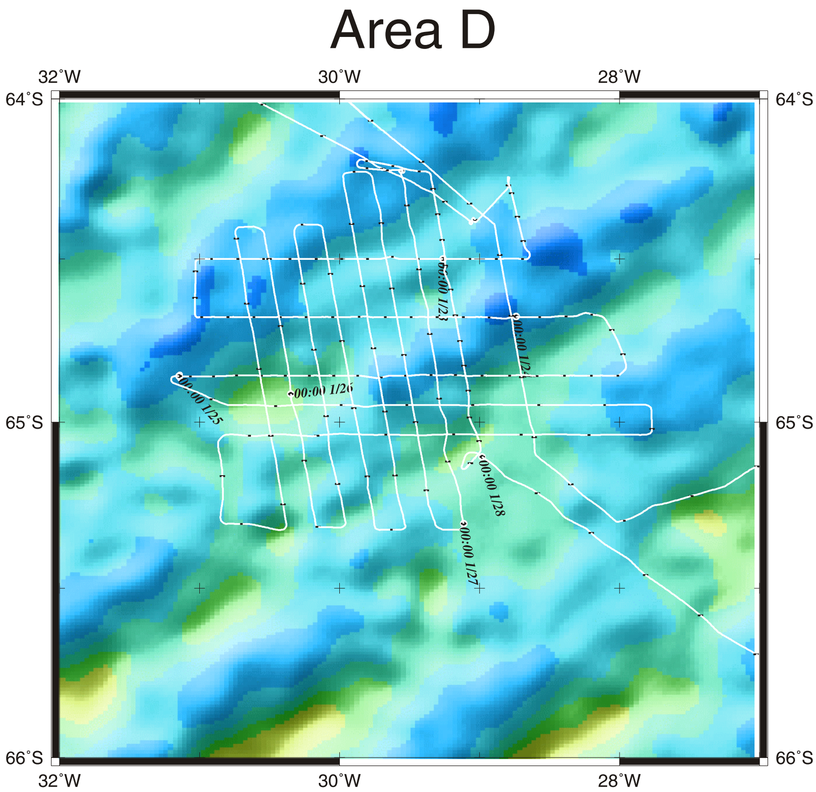

Figure 3   Area D (Kink) tracklines

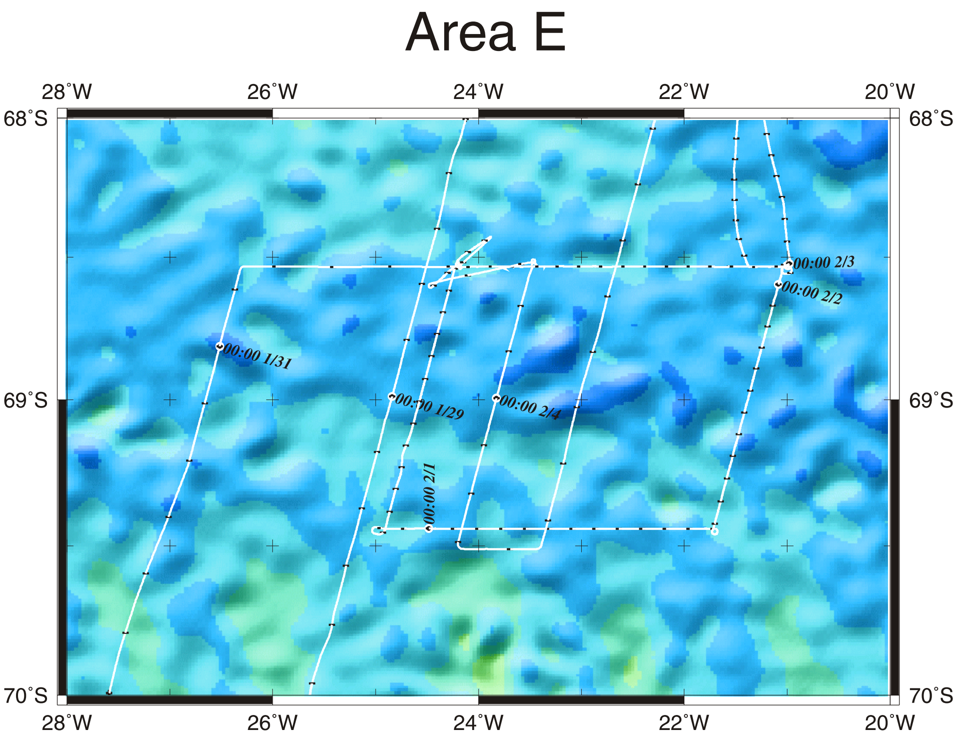

Figure 4   Area E (Anomaly T) tracklines

7 Equipment Performance

A complete summary of equipment operation is shown diagrammatically in Table *.

7.1 Navigation

7.1.1 Trimble

7.1.2 Ashtech 3D GPS / TSS Motion Sensor (PM)

As it is desirable to include roll and pitch information in the correction of STCM data, the performance of these two instruments was monitored. As is normal, the Ashtech only worked intermittently. The TSS instrument has a history of problems. The original model fitted never worked correctly and was replaced in 1997. The new instrument had a tendency to go unstable and introduce 90° rolls. This was returned to the manufacturers for checking in spring 1998. It is obvious from the records obtained this cruise that despite this the problem has still not been solved (Fig. 6a). The true roll signal frequently is contaminated with low frequency noise, and the instrument goes unstable on occasion taking several minutes to recover. By contrast the pitch signal is good and correlates very well with that from the Ashtech (Fig. 6b). The TSS obviously is still in need of some serious repair.

7.2 Bathymetry

7.2.1 Simrad EA500

7.2.2 3.5 kHz Echo Sounder (MP)

This instrument was used only briefly on the way to the first seismic line, early on in the cruise It was with the usual high degree of trepidation that the unit was switched on, this was at the request of the Principal Scientist. The days of carrying instruments that produce huge quantities of ozone and have high voltage parts exposed should, in 1999, surely be over. Siting the recorder under one of the UIC's air extraction vents reduces the nauseating and dangerous ozone to tolerable (although probably still excessive) levels. The echo sounder and recorder did however produce a passable record (using the hull transducers only) until weather and the motion of the ship degraded things to an unusable degree. At this point the echo sounder was turned off and fortunately was not required again.

This machine is, and always was, something of an embarrassment to a modern scientific vessel. It was out of date when it was purchased and is purely a matter of luck, considering the importance sometimes placed on it, that part of an expensive scientific program has not been lost.

It is based on totally out dated technology, poorly documented, un-maintainable and inadequately-spared.

7.3 Magnetics

7.3.1 Varian V75 Proton Precession Magnetometer S/No. 244 (CP)

On deployment of the first magnetometer bottle southwest of the Falkland Islands on Julian Day 015 at 22:40 Z, the precession signal was evidently noisy and a consistent reading proved to be unobtainable. The bottle was recovered and the spare deployed at 00:25 on day 016. A consistent reading was immediately evident and the bottle was used throughout JCR39a with good results, despite some cable damage at the bottle end, where it may have come in contact with the hydrophone or gun arrays. The fault with the first bottle proved to be due to low resistance between the sensor coil and earth at the sensor termination. The sensor was duly re-terminated before arriving in Stanley prior to JR39b.

It must be noted that the console used was originally purchased in 1979 before being used on board RRS *Bransfield*, and the magnetometer sensors were originally purchased prior to the 1971 Antarctic season for use on board RRS *Shackleton* by the

University of Birmingham. The electronics, spares and sensors are no longer available and the manufacturing company have long ceased to trade or support magnetometers.

7.3.2 BAS Shipboard Three-component Fluxgate Magnetometer (PM)

Two three component magnetometers were in operation during JR39. The first is the original BAS instrument which has been run on all geoscience cruises since JR12 in 1996. The sensor mounting and outdoor electronic package for this STCM were improved for the 1997 - 8 season and have not been changed since. The second instrument is one of a batch constructed by BAS in 1998 and was installed on the JCR in Stanley immediately before sailing on JR39a.

Magnetometer 1

Behaved impeccably during the cruise, the data are by far the best acquired to date. Fig. 4 shows a typical example.

Magnetometer 2

This never worked properly at all. At first it was mounted on the aft rail of the Navigation Bridge Deck. It produced noisy data seemingly unrelated to the towed proton magnetometer record. To check that the mounting location was not inherently noisy the sensor was moved to a new site further along the same deck rail, but now immediately below the sensor of magnetometer 1 (Fig 5). There was little obvious improvement in the record. The new STCM was then moved adjacent to the old one on the same rail behind the funnel and will be monitored in that position during cruise JR39b. As an experiment, the sensors of STCMs 1 and 2 were interchanged. As the new sensor in the old instrument then gave a quiet record whilst the old sensor in the in the new instrument gave a noisy record it seems probable that the problem is not due to the new sensor itself but lies elsewhere.

Seven calibration turns were carried out during JR39a,. As the sensor exchange experiment was carried at about 1600 hour on day 20, the first two calibrations are invalid after that time.

Table 1: Calibrations:

1	17/1/99 18:07:44 - 18:38:35	56.59S	51.94W
2	18/1/99 23:27:07 - 19:00:08	56.30S	54.69W
3	22/1/99 15:36:20 - 16:14:30	64.38S	29.05W
4	24/1/99 23:21:32 - 24:35:58	64.86S	31.14W
5	27/1/99 05:38:35 - 06:19:28	64.23S	29.56W
6	31/1/99 05:16:18 - 05:53:38	68.53S	24.19W
7	03/2/99 20:13:00 - 20:52:20	68.52S	23.47W

Table 2: Logged data streams

Instrument	Measurement	Mnemonic	Streams logged	Recording Interval
GPS (Trimble) (differential gps)	position	gps_nmea	lat lon gq svc hdop dage dbase	1 sec
GPS (Glonas)	position	gps_glos	lat lon utc type svc alt cmg smg vvel pdop hdop vdop tdop	1 sec
GPS (Ashtech) (3D gps)	position,roll,pitch	gps_ash	lat lon roll pitch sec hdg mrms brms attf	1 sec
Gyro	heading	gyro	heading	1 sec
Simrad 500	water depth	sim500	uncdepth rpow angfa angps	~9sec
TSS	roll,pitch,heave	tss	roll pitch heave hacc vacc	1 sec
Proton magnetometer	magnetic field	proton	magfld	5 sec
Old STCM	magnetic field components	stcm	X Y Z	1 sec
New STCM	magnetic field components	new_stcm	X Y Z	1 sec
Seismic system	shotpoint	shot	shot_no	20 sec

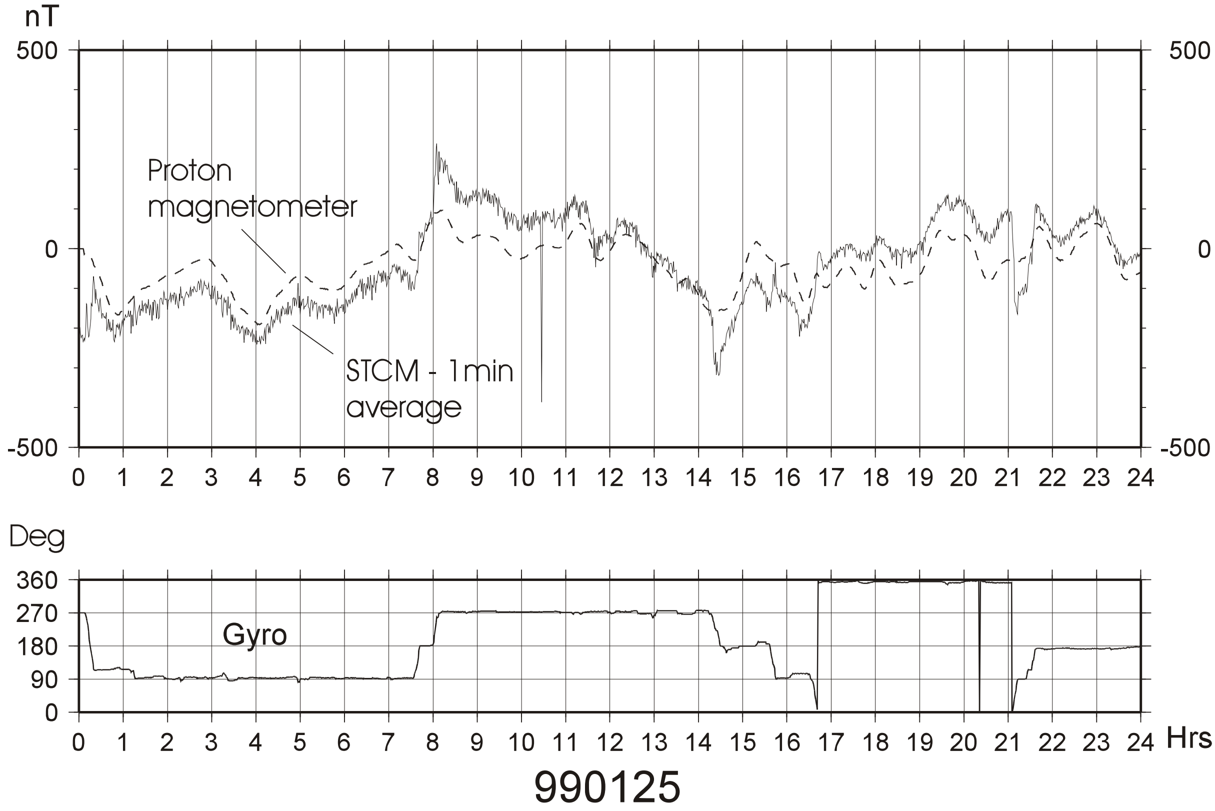

Figure 5: Well compensated record - old STCM

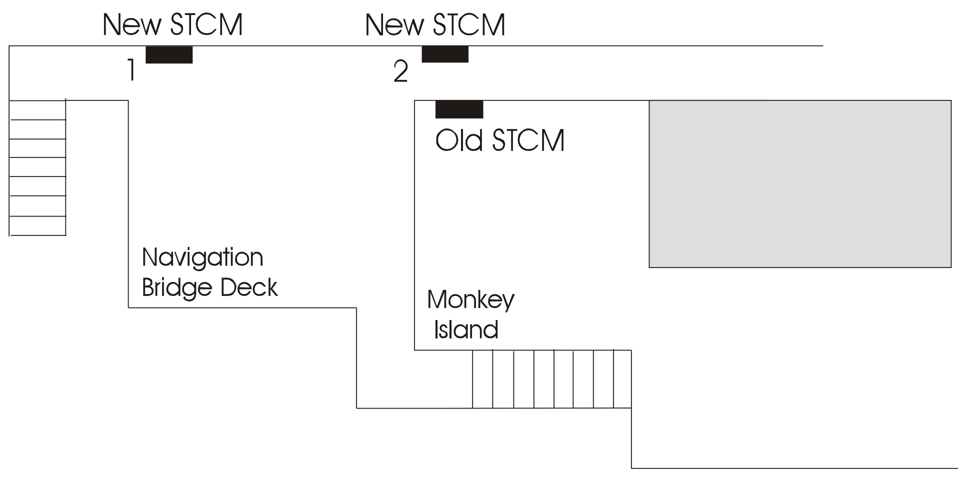

Figure 6: STCM locations on the upper decks

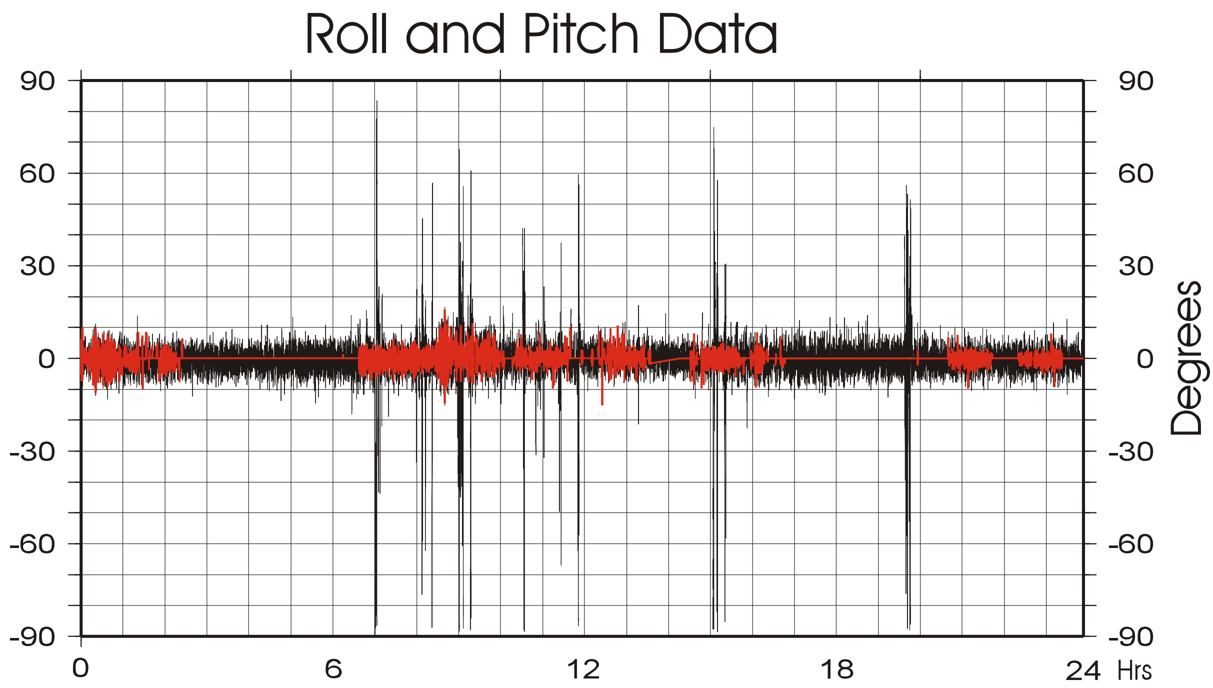

Figure 7a Roll record 19/1/99 Red - Ashtech Black - TSS

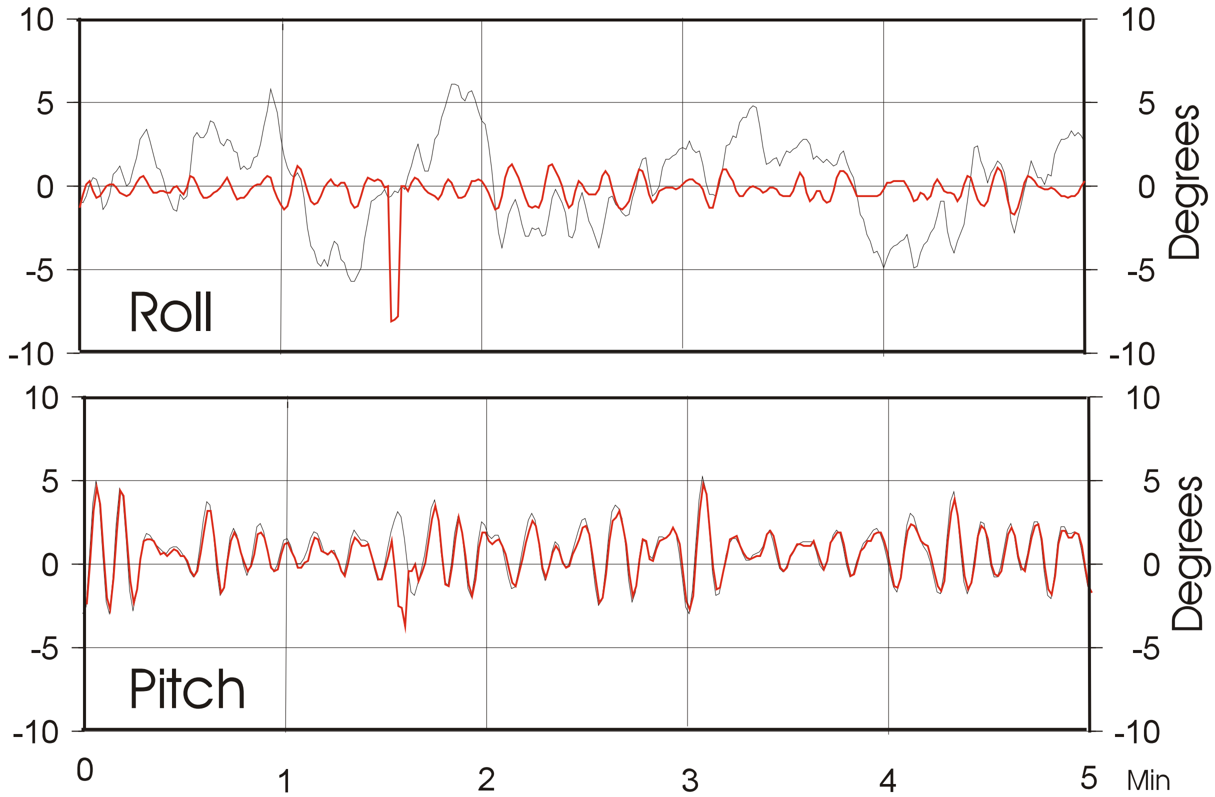

Figure 7b Detailed Roll and Pitch records

7.4 Seismic Reflection

7.4.1 Airguns (AMT)

The seismic system was installed while alongside at FIPASS between 12th January 1999 and 15th January 1999. The following equipment was required.

RVS 4 Channel Seismic System.
BAS Airgun handling System.

System Components:

Umbilical Winch (3 off)
Beam Crane (2 off)
7 m towed Air-Gun Beam (3 off)
Bolt 1500 c Air-guns with the following chamber sizes (in cubic inches):
120 (1 off), 160 (2 off), 300 (2 off), 400 (2 off), 466 (4 off) and 600 (1 off),
Towed Hippo Buoy (3 off)
JCR Gilson Winch (c/w 12mm diameter 7x19 ss wire)
JCR Port & Starboard Effer Cranes

Recording and Firing system:

Reftek Gun Controller
Geometrics Strataview RX96 acquisition system

JCR fixed equipment:

Hamworthy air compressors
Ship hydraulic system

7.4.1.1 Installation

Preliminary installation went well with most of the equipment in position and bolted down by the end of the first day. The ISG Mechanical equipment container was in position (prior to our arrival) on the aft deck. The manufacture of a double aluminium ramp to improve access to the Rough workshop was a great improvement. This allowed the transport of equipment from the container to the workshop to be carried out much more safely and easily than before.

The bulk of the installation was completed on schedule with only one or two minor faults in the system. These were rectified and the system was fully tested satisfactorily. The ship sailed at 17:45 on Monday 15th January 1999. Both the stbd beams were completed at sea. The inner beams were fully assembled in time for the shake down trial on the 17th Jan.

As a result of the trial deployment it was obvious that not all the guns had been serviced or built correctly. It was therefore necessary to service all the air-guns, which resulted in the stbd outboard beam only just being complete by the second deployment on the 22nd Jan.

Beam mounted air-gun system.

The majority of the handling system was supplied from the BAS Geoscience equipment pool. The air-guns, hydrophone streamer and one umbilical winch were supplied by RVS. The three umbilical winches were positioned with two on the stbd and one on the port side of the aft deck. This allowed the stbd inboard and outboard beams to be deployed over the stern quarters and aft side rails, the port beam being deployed from the port stern quarter. Each beam was assembled with the following gun configurations:

Beam	Fwd	Centre	Aft
Stbd Inboard	300	160	466
Stbd Outboard	400	120	466
Port Inboard	300	160	466

Shotphones were positioned directly above each gun, inside the beam. It was advised by RVS that guns below 160 cu in. should have their shotphones connected directly on the guns. As the sound generated by the smaller gun are masked by that of the larger guns, thus preventing them from being synchronised with the rest of the array. This was not possible at the time, as the clamps designed to hold the guns had not been supplied. Depth sensors were also placed inside the beams and positioned at each end of the beams.

7.4.1.2 Deployment and Recovery.

The beams were deployed in the usual manner using the beam cranes connected to the aft port and starboard Effer cranes. The starboard inboard beam being deployed first, followed by the outboard beam, this was then repeated for the port beam in the same manner.

The basic procedure was as follows:

The beam was raised over the bulwark. The Hippo buoy was connected to the aft end of the beam by 11 metres of 24 mm polypropylene rope. Each gun was then primed to 200 PSI (ca 14 bar). The beam was lowered into the water by means of the winch mounted on the beam crane, whilst simultaneously paying out the umbilical.

The umbilical, which was towed through a fairlead, fixed to the end of the starboard air-gun boom (for the outboard beam and over the stern quarter for the inboard beams) was payed out until there were only three turns left on the winch drum. This leaves approximately 50 and 60 metres respectively of umbilical deployed beyond the stern. Wire on the beam crane winch was payed out until slack, was then tied off on the bulwark, to enable the strain to be taken on the umbilical. The remaining strain wire was then removed from the beam crane (for the inboard beam) and a new wire was wound on and connected to the outboard beam for its deployment in the same way. The guns were then charged to 2000 PSI (ca 138 bar). The port side deployment was carried out in the same way. Recovery in both cases was the reverse of the deployment.

7.4.1.3 Operational Problems.

Only the inboard beams were used in this deployment as the Stbd outboard beam was still being built. On the stbd beam both the 300 cu" and 466 cu" guns sealed on low pressure. The 160 cu" failed to seal and was brought back on deck, after the charged guns were bled down.

On inspection the gun was missing five seals, these were replaced and the beam was moved outboard again. The gun again failed to seal and was brought back on deck. The gun was replaced and lifted outboard were it failed to seal again, it was brought back aboard where it was stripped down, where the problem was found to be missing a metal spacer ring. This was replaced and again the gun was lifted outboard for testing, where it failed to seal.

It was decided to test the guns on the port beam and if successful, deployment would continue without the use of the Stbd 160 cu" gun. The port beam was lifted outboard of the ship and the guns tested. All the guns sealed, except the 466 cu" gun. The guns were bled down and brought back aboard where the 466 cu" gun was Stripped down. On inspection, the firing seal was damaged, this was replaced and the guns tested. All guns sealed and the two beams were deployed.

Later, the original 160 cu" gun was stripped down and the top housing sleeve was found to be worn (this was replaced). The second 160 cu" gun fitted to the Stbd beam was stripped down and found to have had the wrong size operating seal fitted.

Stbd Beam

The starboard 300 cu" gun stopped firing, and was isolated at 3am 18th Jan, when there was no request to have it restarted. The gun was restarted prior to its recovery by reducing its air pressure to 1200PS. It was run for a short time on full pressure without any problems arising. On recovery no fault was found.

Recovery

All beams were recovered successfully.

Second deployment 22nd - 24th Jan 99

Pre-deployment:

All guns were tested on deck at low pressure in the morning before the evening deployment.

The stbd outboard beam 400 cu" gun was found to auto-fire. On inspection of the gun an o-ring seal was missing from the solenoid. This was replaced and the problem resolved.

On the port beam, both the 466 cu" and 160 cu" guns failed to seal. The guns were stripped down and although no obvious faults could be found. It was apparent that the guns had been assemble without lubrication. The guns were lubricated reassembled and then test on low pressure air where upon they sealed.

Deployment

All three beams were used in this deployment and were deployed without problem.
Once deployed the 300 cu" Stbd inboard beam gun failed to fire. The pressure was reduced to 1100 PSI where upon it commenced firing. It was brought back to full pressure without problems.

Stbd Beam *(23rd Jan 99 13:20 GMT)*

Gun 300 cu" stopped firing. Gun restarted on low pressure but fired intermittently and on occasions would auto-fire. Gun was turned off. Later inspection revealed that the shaft seal was solid on the shaft (this was replaced) and a cut was found in the solenoid seal (this too was replaced).

Recovery

Stbd outboard Beam.

The lifting cable was caught around the front gun - the cable was freed with the use of a boat hook and the beam recovered as normal.

Port Beam.

All the guns were flipped over the beam and the umbilical was twisted around the lifting wire. The tail buoy was removed and the umbilical passed around the beam to untangle it, before recovering it as normal. Once aboard the guns were individually lifted back in to position using the beam crane.

Stbd inboard Beam.

This was recovered without incident.

Third Deployment 27th Jan 99

Deployment

Both inboard beams were deployed without problems. The 120 cu" gun on the Stbd outboard beam failed to seal and was brought back in where the shuttle assemble was striped down and rebuilt. This did not cure the sealing problem, so the gun was isolated in order that the deployment could continue without delay.

At the commencement of firing, the 300 cu" gun on the inboard stbd beam would not fire. Dropping the pressure to the gun failed to start it. The gun was isolated for the duration of the deployment.

Recovery

All beams were recovered successfully.

Later Inspection

The 120 cu" gun on the Stbd outboard beam was stripped down and no specific faults could be found. The gun was retested on deck and found to only seal when struck sharply - this may be caused by the fitment of new o-rings which need to be run in before reliable sealing on low pressure air can be achieved.

The 300 cu" gun on the inboard stbd beam when stripped down, this revealed some damage around the o-ring vent orifice. This gun was replaced in its entirety.

Fourth Deployment 31st Jan - 3rd Feb 99

Deployment

The stbd inboard beam was deployed without any problems. The 466 cu" gun on the port beam required a sharp blow on the end of its chamber to seal it, after which it was deployed with no further problems.

The 120 cu" and 466 cu" guns on the outboard stbd beam both required sharp blows to seal them. Once sealed they were deployed as normal. Once again a problem occurred trying to fire the newly replaced 300 cu" gun on the stbd inboard beam. The gun pressure was dropped which allowed the gun to fire. It ran for 15 minutes before failing, the gun could not be restarted and was isolated for the duration of the deployment.

Recovery

Stbd outboard Beam.

The lifting cable was caught around the front gun - the cable was freed with the use of a boat hook and the beam recovered as normal.

Port Beam.

All the guns were flipped over beam and the tail buoy was twisted around the lifting wire. The beam was brought along the ships side, where tail buoy was untangled and removed. The beam was then recovered as normal and the guns were individually lifted back in to position using the beam crane.

Stbd inboard Beam.

This was recovered without incident.

Comments and Recommendations

1) All the air-guns which were supplied for the cruise were marked up as serviced. It was evident from the problems encountered with the guns that this was not so. A number of guns came with missing and or incorrect seals or parts. Many of the guns had not been lubricated, which directly contributed to their poor sealing or premature failure.
Due to their unknown serviceable state, it was necessary to strip and service all the guns. This was a time consuming process which could have significantly effected the full deployment of the gun array.

In future the air-guns need either to be supplied earlier; with time set aside during the mobilisation period for them to be serviced. Or guarantees need to be made that the guns have been fully serviced and checked prior to their dispatch.

2) The two single umbilicals supplied for this cruise were not designed to be used with the air-gun array. They both lacked cabling for the shotphones and depth sensors. As a result it was not possible to run either of the single umbilicals.

3) The design of a multi-purpose hand held tester for shotphones and solenoids would greatly aid the build speed and enhance the fault finding problems associated with the assembly of air-gun beams.

4) Once again a safe method for the removal, transport and servicing of air-guns needs to be undertaken if back injuries are to be avoided.

7.4.1 Practical deployment details (LEV)

Streamer

The amount of tow cable paid out on the streamer, from the point the boot went astern, was 12 turns and 7 spokes of the winch. The winch drum has a circumference of 4 m, and 7 spokes measures 0.5 m. Therefore about 48.5 m of tow cable was paid out. As the streamer is towed at a nominal depth of about 12 m, this means that the horizontal distance to the boot on the streamer is about 47 m. The distance astern to the nearest active section thus measures:

47 m tow cable + 2 m boot + 50 m stretch section +1 m depth section, or about 100 m.

The centre of the winch is about 16 m to port of the starboard bulwark.

Guns

The total length of the umbilicals on the winches is 100 m. For the starboard inboard gun beam and the port gun beam 3 turns remain on the umbilical winches. As each turn measures about

4 m and the distance to the stern is about 7 m, 80 m of umbilical is paid out astern. For the starboard outboard gun beam 4 turns remain on the winch. On this winch a turn measures about 4.5 m and the distance to the outboard boom is about 13 m. This means that for the starboard outboard gun beam about 70 m of umbilical is paid out astern. The gun beams are towed at a nominal depth of about 12 m. The horizontal distance astern to the nearest gun is not significantly different from the amount of umbilical paid out or:

70 m to starboard outboard gun beam
80 m to starboard inboard gun beam
80 m to port inboard gun beam

The average distance astern to the gun beams is 77 m. Each beam has 3 guns suspended from it. The middle gun is about 3 m astern from the umbilical. The gun beams are towed 5 m to starboard, 1 m to port, and 19 m to port of the starboard bulwark respectively. This means that the centre of the gun array is about 80 m astern, and about 5 m to port of the starboard bulwark.

Therefore the minimum offset astern from the centre of the gun array to the nearest active section on the streamer is 20 m, and the perpendicular offset is 11 m. For simplicity the perpendicular offset is ignored in the geometry assignment.

Note: A marker was applied to the steamer tow cable and the umbilicals so that on subsequent deployments the same amount was paid out.

7.4.2 Seismic recording (DB)

The new RVS seismic recoding system uses the *Geometrics* StrataView RX96 as the acquisition system and a PC, running the *Geometrics* Marine Controller Software, to record the data which is stored on a pair of DAT drives. A second pair will automatically take over when the first drives get full. Two Printrex printers provide on-line hard copies of the near field gather and a shot "camera".

The Teledyne hydrophone is directly connected to the Strataview. via an on-line testing unit. The hydrophone was configured to give 12 channels with 25 m spacing. Two depth sensors were also fitted, one to the front of the first active channel and the other to the back of the last channel.

The depth sensors were calibrated on initial deployment. Balancing of the hydrophone was achieved by adjusting the length of the tow cable until the front depth sensor give the required reading. Lead was added to the hydrophone (tapered more at the back - less at the front) until the back sensor also gave the required depth. (Nominal 40 feet). No birds or retrievers were fitted.

The synchronizing of the airguns was achieved by the Reftek firing system The overall fire timing of the system was tied to a 1 pulse per second obtained from an Ashtech G12 receiver. A crystal delay unit provided a time delay which then allowed the next 1pps received to fire the guns, start the seismic recording system and reset the delay unit. The enable pulse also provided the pre-trigger required by the Reftek to digitize the depths of the airguns.

Geometrics Setup Parameter Summary:

Number of Data Channels	12	
Active Spacing	25m	
Active Channel gain	24dB	
Aux Channel 1 gain	24dB	Not Used
Aux Channel 2 gain		Not Used
Aux Channel 3 gain		Not Used
Aux Channel 4 gain		Not Used

Transconductance	34 uv/uba r	
Sample Rate	4mS	
Delay	0S	
Record Length	8 S	Line BAS989-S90
	12 S	Lines BAS989-S91 to S100
Recorded Data Bandwidth	0.3 - 103 Hz	103 Hz is the Anti-alias frequency for a 4mS sampling rate.
Display / Print Bandwidth	10 - 103 Hz	

Hydrophone Configuration:

Tow Cable	48.5 m	Measured from Stern Roller - Max length = 150m
Boot	2m	
Spring	50m	un-stretched
Depth	1m	
Active	100 m	4 x 25m groups
Active	100 m	4 x 25m groups
Active	100 m	4 x 25m groups
Depth	1m	
Spring	50	un-stretched
Rope	100 m	Monkey's fist as drouge

7.4.3 Seismic data processing (LEV)

A simple processing sequence was applied to 10 of the 11 seismic reflection profiles acquired during JR39a (BAS989-s90 has not been processed). Processing was carried out using ProMAX software which was eventually licenced on the 25th of January. Unfortunately the disk holding the data developed disk errors on the 4th of February preventing any further processing while underway. Full details of the processing sequence for the individual seismic lines are documented in the processing log.
The SEGD dat tapes were read onto disk and geometry applied. Given a firing rate of 20 s and an average speed over the ground of 4.86 kts, the nominal shot interval was 50 m. From the configuration of the gun beams and the hydrophone streamer the minimum offset to the near channel was calculated to be 20 m (figure *). The CDP bin size was set to 25 m, which resulted in a 6-fold stack. For all seismic profiles, shot station number 1 ties with CDP number 1000 which leads to a simple conversion from CDP number on the stacked sections to the shot stations logged in the ukooa files.

$$CDP = 2*(\text{shot station} - 1) + 1000$$

The pre-stack processing of the seismic data included 2 steps: bandpass filtering and predictive deconvolution. Spectral analysis of the data as well as bandpass filter tests showed that lines BAS989-s91 through to BAS989-s97 were relatively clean as would be expected since they were collected on calm days. The corner frequencies of the chosen bandpass filter were 8 and 80 Hz, while the cut-off frequencies were 4 and 100 Hz. Although lines BAS989-s97 through to BAS989-s100 were contaminated with swell noise, the same bandpass filter was found to be adequate and would provide consistency throughout the data set. Autocorrelation checks and predictive deconvolution tests suggested that the best results were obtained using an operator length of 350 ms and a prediction lag of 24 ms. The design window was chosen to be about 4 s long and start a few hundred ms above the sea floor.
Velocity files were created assuming a simple

velocity structure and picking the appropriate horizons from the near trace gathers. The interval velocities used were 1480 m/s above the sea floor, 2000 m/s for the sediment, 4000 m/s for the top 1 s of basement material and 6000 m/s for the remainder of the section. Where the basement outcropped the top 0.5 s was assigned an interval velocity of 2000 m/s. The twt-interval velocity pairs for the key CDPs were converted into stacking (RMS) velocity files using the velocity manipulation tool. Velocity files which would be suitable for use by the fk migration tool were created in a similar way. The only difference was an interval velocity of 5000 m/s for the lower part of the section.
The prestack gathers were sorted by CDP, nmo corrected and stacked. Comparison of the prestack and poststack data showed a clear improvement in the signal to noise ratio.
Prior to migrating the data, a bandpass filter removed the higher frequencies (above a corner frequency of 70 Hz and a cut-off frequency of 80 Hz) and a 1,2,1 trace mix smoothed any abrupt lateral variations. The Stolt fk migration tool was then applied to the stacked data.
Any pre-seafloor noise was muted in the preliminary display processed stack. Further display processing may include time variant gain and time variant bandpass filtering, which may favour any low amplitude, low frequency, deep primary reflections such as a Moho reflection.
A SEGY copy of the display processed stack was placed on the disk. A plot of each line was produced using the SU software.

7.5 Data Processing

Scientific data was recorded during the cruise using the ABC logging system. This performed well with few problems being encountered.

Along-track data was extracted from the differential GPS, Simrad EA500 and proton magnetometer records. Noise was removed from the depth and magnetic data using the Geosoft Oasis editor. The data were then resampled to 1 minute intervals, Carter and IGRF corrections being applied as appropriate, before being merged into a MGD77 format cruise file.

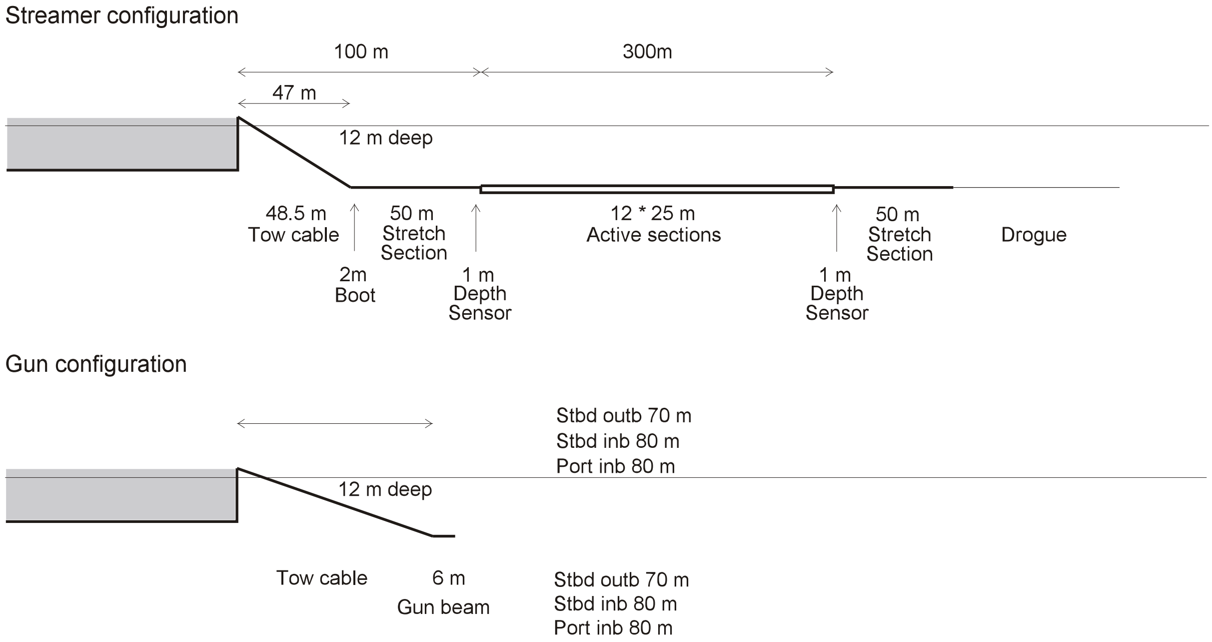

Figure 8 Streamer and gun configuration

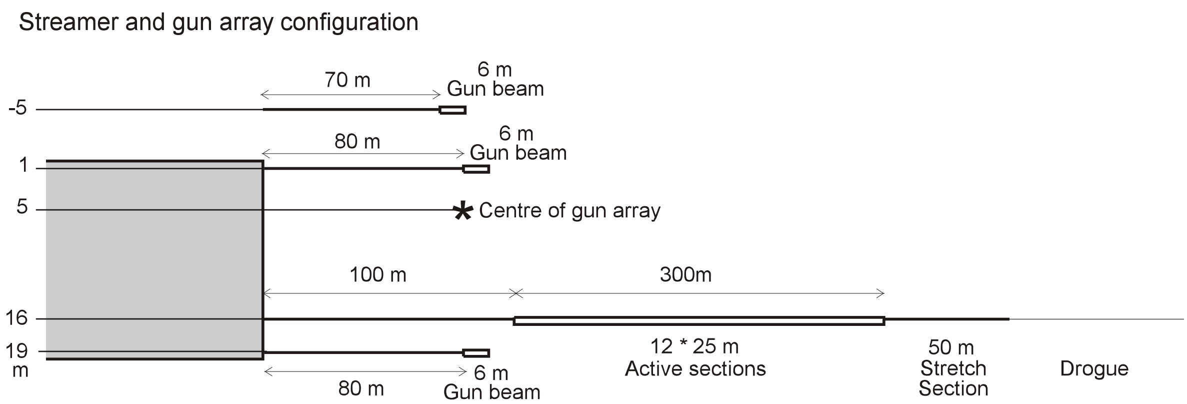

Figure 9 Streamer and gun configuration - plan view

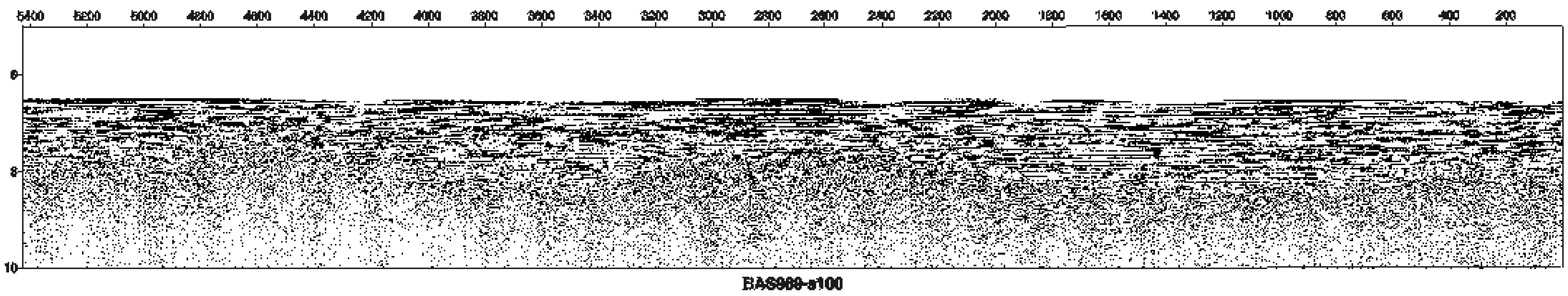

Figure 10 Processed seismic reflection profile S100

8 Recommendations

1 A new towed magnetic gradiometer should be purchased. The existing equipment is obsolete, and cannot be relied on to provide reliable data. To date, we have routinely had to experiment with the two RVS sensors to find one that is capable of giving acceptable results. Some comments from the RVS engineer responsible are reproduced below.

"It must be noted that the console used was originally purchased in 1979 before being used on board RRS *Bransfield*, and the magnetometer sensors were originally purchased prior to the 1971 Antarctic season for use on board RRS *Shackleton* by the University of Birmingham. The electronics, spares and sensors are no longer available and the manufacturing company have long ceased to trade or support magnetometers."

Note that, although an STCM is permanently fitted, a towed magnetometer is used to calibrate this (see report on STCM above), and will be required on future geoscience cruises. Maintenance of such equipment is minimal, and we recommend it remains on the ship permanently.

2 It is recommended that, in future, all airguns be sent to Cambridge prior to shipping, so that they may be prepared by the engineers who will support them at sea. We recognize that this may not always be possible, depending on the commitments of RVS.

3 The 3.5 kHz sounder is unsupportable its recorder is a health hazard, and produces only a paper record. As a matter of urgency, it needs to be replaced if the type of information that it produces is to be required in the future.

4 The TSS motion sensor still does not appear to be producing accurate results, and its effect on the ship's dynamic positioning system must be questioned. Urgent attention by TSS, followed by sea trials is recommended.

Appendix

Summary of Seismic Reflection Lines