I.O.S.

RRS DISCOVERY

CRUISE 162

22 SEPTEMBER – 9 OCTOBER

1986

PHYSICAL OCEANOGRAPHIC STUDIES IN THE NORTH-EAST ATLANTIC, 31° – 49°N

CRUISE REPORT NO. 186

1986

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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WORMLEY

RRS DISCOVERY
Cruise 162
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Physical oceanographic studies in the north-east Atlantic, 31° - 49°N

Principal Scientist

P.M. Saunders

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R. Lloyd	"
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I. Waddington	IOS (Wormley)
R. A. Wild	"

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D. Coverdale	Chief Officer
R. Chamberlain	2nd Officer
D. Thompson	3rd Officer
D. Riddle	Radio Officer
I. Bennett	Chief Engineer
N.A. Wilson-Deroze	2nd Engineer
C. Phillips	3rd Engineer
B. Entwhistle	Extra 3rd Engineer
B. Smith	Elect. Officer
Frank Williams	C.P.O. Deck

ACKNOWLEDGEMENTS

It is a pleasure to acknowledge the willing and capable assistance of all of the officers, petty officers and crew of the RRS Discovery on this cruise. We also wish to thank Messrs A.E. Fisher and R.A. Clement for their considerable assistance on arrival in Falmouth.

Cruise Objectives

1. Recovery of 3 current meter moorings at GME ($31^\circ30'$N, 25°W).

2. Recovery of a recording transmissometer mooring, also at GME.

3. Recovery of 4 Autonomous Listening Stations (ALS) and redeployment of northern 3.

4. Working of CTD stations at GME and in the ALS area to the North.

5. Re-calibration of Electromagnetic Log.

Cruise Narrative (see figure 1)

Discovery set sail from Funchal at 1315Z on 22 September 1986 (day 265) with clear skies and light winds and steamed west towards the GME (Great Meteor East) area. En route at 0845Z the following morning the ship was hove to for two hours and a hydrophone lowered to 700m to listen to US Sofar floats: two of the expected three were heard, the most distant at a range of 1000km. The PES fish (echo-sounding) was also put overboard. At 1815Z the ship was hove to for a shallow CTD lowering to 1500m depth: the data was not logged.

On arrival at GME (31 30N 24 45W) and in 5440m of water a moored transmissometer was released, 0654Z on 24 September (day 267), and recovered by means of the double-barrelled winch on the fore-deck. This short mooring was aboard by 0847. A full depth current-meter mooring was then released about 5 miles to the south (0924Z) and by 0955Z the 4' diameter sphere was on the fore-deck. In succession 6 Aanderaa current meters, 1 transponder and 1 acoustic release were also recovered. By 1310Z with the help of the deck crew all gear was aboard and stowed. Discovery then steamed 15 miles west to the location of mooring 399, a 1000m long bottom-mooring with 3 current meters. Nothing was heard from either the beacon or the release on the mooring despite a search within a 3 mile radius of its launch position. The release was presumed to have been faulty and the mooring drifted away at some time during the previous 10 months. Five miles to the west we detected an identical mooring (401), released it and by 1915Z all gear was aboard.

During the night of the 24-25 September two full-depth CTD stations were occupied. The first 11360 was uneventful, starting at 2033Z and ending by 0023Z. On the second, station 11361, during recovery the winch was found very sluggish and with 4700m wire out (approximately) hydraulic power failed. The fault was diagnosed as a stuck command valve; the valve was removed, cleaned and replaced and recovery recommenced. With a further few hundred meters of wire on the drum a sudden pump pressure surge caused the operator to hit the emergency stop on the winch console. This put the console out of action without stopping the pump! Eventually console operation was restored and by 0915Z after five hours the station was concluded.

Immediately the hydrophone was lowered to 700m (on the same midship winch) for a second listen to SOFAR floats. All 3 floats were heard enabling fixes to be made on two of them. This information was forwarded to the RV Endeavor which had already put to sea to work in the area of the floats. By 1100Z the hydrophone was inboard. A third CTD station (11363) was then occupied and a 5200m lowering and recovery made without alarms. On all 3 CTD stations the performance of the multisampler was miserable. At approximately 1715Z (day 268) Discovery left the GME area to work in the Iberian basin to the north.

After a journey of 468 miles steamed at approximately 10.7 kts against light headwinds Discovery arrived at the position of ALS mooring 404 at 1300Z on the 27th September (day 270). The mooring was released and by 1406Z the buoyancy grappled. After the ALS unit was inboard power to the forward winch failed. The second buoyancy of the mooring was lifted aboard by crane and the remainder of the mooring recovered on the anchor capstan. By 1515Z the release was inboard and the ship steamed off.

At 1200Z on the 28th September (day 271) an experiment was performed to check the em-log sensitivity (port instrument) for both the fore and aft and athwartship components. A 10KHz transponder was attached via a 10m line to trawl float (2) buoyancy. The ship ran past it at various speeds logging acoustic range and (visible) bearing. At the end of the operation the ship was then positioned close to the transponder, lying-to, first port side to wind and subsequently starboard side to wind. The wind was never more than 10kts and the skies were clear. The experiment was concluded at 1510Z when the ship steamed off to CTD station 11364 which was accomplished without incident. The station ended at 2147 (day 271).

On the 29th September (day 272) mooring 405 was recovered and relaid as 416 (Stn. 11365) between 0700Z and 1100Z. Mooring 405 was recovered over the bow and 416 laid, buoy first, over the stern. Discovery arrived on site at 0300Z allowing a 'flat area' to be found for the deployment of mooring 416. The winds were very light but there was a light swell running from 280°.

After the successful completion of this work the ship steamed eastward and continued a series of stations along 41 40N towards the third ALS mooring (406). A CTD station (11366) between 2130Z on the 29th and 0100Z on the 30th (day 273) was notable for the water depth, 5600m, which coupled with the rolling of the ship led to a very slow recovery below 4000m. Later the same day CTD station 11367 (1000Z-1430Z) was notable for a 35 min stop with approximately 1500m of wire out whilst the cause of a low pressure torque limit was investigated. A card in the winch control box in the electronics lab. was replaced and normal working restored. Before the final CTD station (11368) on this section was worked (0100Z-0430Z, 1st October d 274), rope stretching and measurement was undertaken.

Mooring 406 was recovered from 5350m of water later the same morning (0645-0945Z) with the oil in the hydrophone to ALS13 emulsified, presumably by a leak of sea water. Starting from the recovery location, mooring 417 was streamed buoyancy first (1030Z) over the stern and at 1213Z the anchor was cut away arriving on the bottom 48 minutes later.

Between 2200Z on the 1st and 0130Z on the 4th (day 274-277) five full-depth CTD stations were worked (11370-11374). Both the multisampler sea-unit and deck unit had received considerable refurbishment and a dramatic improvement in performance took place. On these stations tests were made by G. Phillips of the deck unit and sea unit for the next generation of releases. Unfortunately at the beginning of the cruise he had decided that the near bottom echo sounder word for 'close approach' of the CTD had an untrustworthy pressure case so an ordinary 10KHz beacon with increased power was used for this work. Between 1800 and 2000Z on the 3rd (day 276) whilst maintaining a constant heading the ship speed was reduced in stages: this procedure confirmed the estimate made earlier that the em-log port/starboard sensors were misaligned by between 1.5 and 2.0°.

An early arrival at the last ALS mooring (0230Z) on the 1st allowed an echo sounding survey to be carried out to select 'flatfish' terrain for re-deployment. A spot two miles south of the mooring 409 site was chosen. First mooring 409 was recovered forrard; it was released at 0711 with all gear inboard 2 hours later. The deployment of mooring 418 (stn. 11375) buoyancy first over the stern (0954-1130Z) also went smoothly. Unfortunately the release did not time out during descent nor after arrival on the bottom (1214Z) so that, at minimum, a very short life on the sea bed was assured. The mooring was released at 1258, recovered again on the fore deck and a weary crew brought the offending release aboard by 1509Z. A Marsh Marine connector was found to have leaked although the release had been tested on an earlier CTD lowering to considerably greater depth. It also became apparent during recovery that ALS13 was probably malfunctioning since an analysis of the data from the previous deployment had shown it had failed near the start of the deployment period.

Overnight the ship steamed 50miles NNE to CTD station 11376 (1950-2310Z) during the course of which the hydraulic pump motor cut out without evident cause. By this time it was not an infrequent occurrence so that later the next day R. Wild and B. Smith gave it a thorough check out. On return to the ALS site, mooring 419 was laid very smoothly 0726-0858Z on the 5th October (day 278). The mooring was identical with 418 save that of the ALS and release. Both instruments appeared to be functioning correctly when the anchor bottomed out so Discovery headed off to the NE on its way to 3 shelf moorings and Falmouth. A swell was running from the SW.

On arrival at the next CTD station the forward ring main cut out before the CTD was off the deck. A leak was discovered, an accumulator replaced; no hydraulic fluid could be seen in the sight glass and it took about 30 gallons before the level in the supply tank was restored. The station was abandoned but the system was run for an hour normally. At the next station (11378) on 6th October (day 279) considerable care was exercised: the site level was monitored and frequent hauling tests were made during the cast (0551-0911Z) but the system performed satisfactorily. The last of the deep CTD stations (11379) was occupied (1537-1842) without incident before the ship headed on to the shelf to recover 3 shallow moorings.

A search was made for mooring 413 which was adrift but located by ARGOS transmissions. It started about 0500Z on the 7th October (day 280) when the radio signals were first detected (expected range 1.5mi). After numerous course changes the mooring was detected both on radar and visually and grappled at 0926. The mooring which had been cut above a 34" diameter sphere was inboard at 0939. En route for the second mooring which was also adrift, Discovery passed the spar buoy mooring 415 on its station. A search was made for mooring 414 and shortly after it was heard at 1510Z the mooring was sighted and by 1609Z was inboard. (This mooring was recovered cut below the 34" sphere). Overnight an experiment was performed to measure the tidal currents at this part of the shelf using the ship's acoustic doppler profiler. For one tidal cycle a square racetrack side 8mi was steamed around the spar mooring locations. The experiment began at 1753Z and concluded at about 0710Z on the 8th October (day 281).

Immediately a series of seven CTD stations was started (11380): each lasted only a few minutes but was separated by between 4 and 6 miles. The pattern was broken off at 1018Z in order to recover the spar. It became evident that ours was not the first attempt, surface buoyancy (10 plastic polo spheres) and all stray lines to the spar had been cut away. This made recovery difficult despite light winds and low seas. Eventually (1125Z) a line wrapped around the upper part of the spar raised it sufficiently for a working party in the rubber boat to attach a line to an eye bolt. The spar was lifted on the forward crane and part of the mooring buoyed off using plastic jerry cans. The instrumentation below the spar, 3 VAECMs, an acoustic doppler profiler and a pressure-temperature recorder were recovered by 1200Z. At 1215 the second part of the mooring was grappled and by 1245 the anchor was stowed on the foredeck.

The scientific programme was concluded by raising the PES fish (1259Z) and completing four more shallow lowerings. The last was completed by 1548Z when all scientific logging was ended. The ship steamed to Falmouth and docked at 1030Z on the 9th October (day 282) after a very successful cruise which enjoyed amazingly good weather throughout.

INDIVIDUAL PROJECT REPORTS

Mooring Work (Waddington, Goy, Phillips, Wild)

1. Current meter moorings at GME (2 recoveries, 1 missing)

All recoveries were made on the foredeck using the starboard A frame, double-barrelled winch and crane (as required). See Table 1 for a summary.

M400, a 1 year full-depth mooring with 6 Aanderaa current meters (Figure 2), was a composite of steel wire and man-made fibre with the buoyancy in the form of a 1.3m diameter steel sphere. On release the bottom echo rose 143m (at 1.3m/s) in 5444m of water: on recovery the measured mooring lengths totalled 5265m, putting the sphere at 179m depth or 36m deeper than observed. The steel sphere showed weed and barnacle growth, samples of which were preserved; growth was also observed on the covered wire to a depth of about 600m below the sphere.

M401, a 1 year near-bottom (1000m length) mooring with 3 Aanderaa current meters, was released in 5055m of water and rose at 1.1m/s. On the surface its yellow Benthos buoyancy spheres were seen only with difficulty. Recovery was uneventful.

M400 was similar to M401 but could not be located despite a 2-hour long search. It was presumed to have pre-released, surfaced and drifted away.

2. ALS moorings in the Iberian Basin

Five ALS moorings were recovered (404, 405, 406, 409, 418) and four were deployed (416, 417, 418, 419). All recoveries were forward and deployments were, buoyancy first, aft. The design was common to all nine moorings and is illustrated in figure 3. Buoyancy in the form of glass spheres, was positioned both above and below the ALS unit and 10m long hydrophone. This ensured that both during deployment and recovery only modest loads were put onto the hydrophone. (On recovery once the ALS unit is raised to the A frame, the hydrophone can be man-handled inboard, to be stopped off at its lower end). Only a few minor problems were encountered during the five recoveries:- on mooring 404 the winch became incapacitated briefly (see narrative); on mooring 405 there was tangling of mooring lines at the lower buoyancy unit; on mooring 406 there was a delay in recovery due to jamming of the recovery line in the grapnel! Multiplait was suggested for future work.

Moorings 416, 417, 419 (Figure 2) were deployed by positioning the ship 1.5-2.0 miles downwind from the drop-point and streaming buoyancy, instrumentation and line over the stern whilst steaming 0.5-1.5kts. The Hiab crane, which was mounted on the Schat crane davit, was employed to lift over buoyancy (using a no-load release) and to act as a variable position sheave; the ship's capstan was used to deploy mooring line through the divertor sheave; the ship's aft crane was used to lift over the hydrophone. The crane was also used lift the anchor chain clump to the transome where it was tied up prior to being cut away at the time when the entire mooring was deployed and the ship was in the correct location. 4000m - average descent rates of about 1.8m/s were experienced. The aft-deck area was severely constricted due to the presence of Gloria. With careful rehearsal of the operation and in the good conditions encountered the deployments went quite smoothly.

3. Shelf-moorings in the Western Approaches

Three moorings were recovered, (413, 414, 415); two were drifting and one was moored. All were tracked via the ARGOS satellite location system via IMMARSAT and STUTTGART; approximately 4 hour-old position fixes could be obtained on the ship. Within 1.5 miles the HANDAR test set on the ship would receive signals directly: visual sighting of all the moorings was difficult because of their small freeboard.

M413, Figure 4, was recovered from the ship's waist using a bamboo pole with snaphook. A line was passed forward to the A frame and the discus buoy and VACM brought onto the foredeck. The mooring line was found to have been cut through 0.5m above the subsurface buoy.

M414, a very similar mooring was recovered in an identical fashion. In this case the mooring was cut approximately 5m above the anchor (trawled?) allowing the 0.9m diameter steel sphere to surface. In heavy weather the clashing between the sphere and the plastic discus buoy had caused considerable damage to the latter.

M415, Figure 5, was a complex mooring consisting of a spar buoy carrying considerable instrumentation (including ADCP, an Acoustic Doppler Current Profiler) tethered via surface buoyancy to a subsurface sphere anchored in 165m of water. On inspection it became apparent that all surface lines had been cut and the surface buoyancy removed. The line from the spar to the subsurface sphere was nowhere shallower than 5m! A rubber boat was launched alongside the ship to use as a platform: a noose was drawn around the upper (fragile) section of the spar and a line passed to the ship. The spar was then lifted by two of the scientific party sufficiently high so that the upper flange emerged and a snap-hook fastened to an eye-bolt then by the rubber boat crew. The line was then passed forward to the A frame and recovery commenced on the fore-deck. With the spar lifted out of the water, the tether could be severed and thrown overboard with plastic jerry can buoyancy. Thus separated the two parts of M415 could then be recovered without difficulty. The duration of the entire recovery was about $2^1/_2$ hours and without good weather, skilful ship handling and a determined rubber-boat party would not have been successful.

ALS Recoveries and Deployments (N. Millard)

Four automatic listening stations (ALS) moorings were recovered (404, 405, 406, 409) and three were relaid (416, 417, 419). The ALS data from the recoveries were translated at sea on a Sea Data Decoder and transferred to half-inch computer tapes. The data were then plotted using a BBC microcomputer-based analysis program. This revealed that ALS 15 and ALS 17 (see Mooring list for locations) yielded good records but that ALS 13 had none and ALS 16 had only 4 days of data. This was disappointing. ALS 13 was found to have a broken wire at the back of the connector on the lead to the hydrophone, presumed to be broken on launch. On ALS 16 the correlator had failed. On the moorings relaid ALS 14, 15 and 17 were used (again see Mooring list). Time checks on the ALS clocks were made against a satellite clock locked to the GOES WEST satellite. These checks revealed that clock errors were as follows:-

ALS 13	lost	-1.3ms day^{-1}
ALS 15	gained	1.58ms day^{-1}
ALS 16	gained	8.508ms day^{-1}
ALS 17	lost	-10.48ms day^{-1}

They showed little correspondence with the drifts measured on earlier deployments of the same instruments!

A hydrophone was lowered on the midships winch to 700m depth to listen to U.S. channel 5 floats at 1100m in the Madeira Basin. On the first station (11358 at 32 02.3N, 20 58.7W) two floats were heard as follows

No. 148 at 09 50 19 and 09 58 11Z on day 266

No. 150 at 10 31 07 and 10 33 53Z

On the second station (11362 at 31 31.2N, 24 45.9W) three floats were heard:-

No. 148 at 09 46 14 and 09 54 08Z on day 268

149	10 06 33	10 10 03Z
150	10 29 32	not seen

This information was relayed to the RV Endeavor, which was at sea, via INMARSAT.

10 KHz Acoustics (G. Phillips)

GME - The first two moorings to be recovered were from a tight group of four. Four of the five acoustic sea units were turned on with a single blast of the common command channel transmitted through the towed fish single element at a ship's speed of 11.5kts. One of the transmissometer mooring sea units was isolated and fired without difficulty; its second unit was fired as the mooring was rising to avoid the potential hazard of recovery of a live 'pyrolease'. The Bathysnap and sediment trap mooring acoustics were both checked satisfactorily - recovery should be on Discovery Cruise 163. The acoustic release on mooring 400 was then turned on, isolated, and after manoeuvering the ship to a suitable position for recovery released normally. Mooring 399 failed to respond during initial approach or a two hour search pattern: this mooring contained two totally independent acoustic units; the first, a transponder, would respond directly to the echosounder; the second, a standard acoustic release unit, should respond to standard commands; my conclusion is that the mooring has moved well away from its original location having parted company with its anchor for an unknown reason. Mooring 401 was similarly equipped to 399: the transponder was located at a range of 9km at a ship's speed of 11kts; the release unit was turned on, isolated, and fired without difficulty.

ALS - On passage to and between moorings two CTD stations were used to fully test 4 standard acoustic release units for use on the 3 ALS moorings to be replaced; all 4 had been thoroughly overhauled and deployed on short term (6 to 10 week) moorings in 1986. The 4 ALS moorings were located and released normally. Moorings 416 and 417 were deployed and monitored acoustically as usual and without incident although initial descent rates were measured in excess of 3 metres per second. Mooring 418 had to be recovered: during the initial descent the beacon lost synchronisation on several occasions (indicating high vibration at the relay); the beacon did not time itself out after 35 minutes unlike all its previous trials; the most likely reason for this is a leak somewhere between the switching relay and one of the pyroleases which can bypass the beacon switching circuit; the only possible course of action in this situation is to recover the mooring as the minimum long term result would be loss of location beacon and one of the recovery devices; on recovery an underwater connector was found to have let in about 20ccs of sea water - it was already badly corroded as was the rest of the electrical path (mushroom transducer, tube, and end cap); there was no obvious reason for the leak but after careful cleaning and reassembly to a very small pressure case the connector was tested to greater than 4,500m pressure on a CTD cast - it again leaked - it was acting rather like a sponge. The mooring was relaid the following day with the fourth tested release unit as Mooring 419; this unit contained extra sensors for tilt (15°and 60°) and leak sensing; the mooring behaved normally; the acoustic unit timed out, was reset, and when it timed out the second time indicated that it was vertical, in position, and dry.

Log calibrations

A transponder was used suspended a few metres under a free floating surface mooring to provide a navigation reference for calibration of various ship's speed logs. The type of transducer used (mushroom) was not really suitable for this purpose but using the beam steering unit with the PES fish ranges to 1500 metres were achieved and useful results obtained.

Ship's acoustics

PES Mk III - Mufax FN3 quickly showed signs of serious motor problems as well as electrical faults; it was treated as the reserve and returned to Wormley for overhaul at the end of the cruise. Mufax FN8 was mechanically noisy but performed satisfactorily. One towed fish was used completely satisfactorily throughout the trip. Both hull transducers were satisfactory but only used for test purposes.

10KHz bottom finding pingers - the near bottom echosounder (NBES) was unuseable due to a corroded tube; there was no spare. One of the standard pingers was modified to increase its power output to cope with the soft GME sediments (a simple modification catered for in original design); this was fitted to the CTD assembly and used satisfactorily on all casts; it did however limit closest approach to the seabed to 10 metres and was not as easy to use for real time control as the NBES. The NBES was returned to Wormley at the end of the cruise for fitting of a new tube. Of the other two pingers one was fully modernized and ready to go (although not used), the other set is suitable only for spares.

Experimental Command System

Some of the CTD casts were used to evaluate a new (to IOS) command technique in deep water. This technique could greatly increase the number and flexibility of command channels if adopted for the IOS command system. The instrumentation was developed to suit IOS requirements by Marine Acoustics Ltd from their normally higher frequency 'intelligent transponder'. The technique was proved to be totally suitable for deep ocean use. Due to instrumental failures no trial was completely successful but from about 2,500 interrogations there were no false interpretations and only about 100 failures to respond; of the 100 failures 95 occurred during trials of a marginal implementation of the technique and represented about 15% of interrogations. The instrumentation will be modified for shallow water trials and if as successful could form the basis of the next generation IOS command system.

Ships Acoustic Doppler Current Profiler (G. Griffiths)

Following the installation of the RD Instruments Acoustic Doppler Current Profiler (ACDP) at Falmouth during August the system was run throughout the cruise.

The 150kHz JANUS transducer array was mounted in the ASDIC pod with a heading offset of +45 degrees. Although capable of being deployed beyond the bubble layer beneath the ship, for this cruise the pod was operated in its retracted position which put the transducer faces within the line of the ship's hull. The cable from the transducers ran to the Plot where the ADCP electronics package and the IBM PC-AT Data Acquisition System was located.

The system software had been installed on the hard disk of the PC-AT at Falmouth prior to Cruise 161 and worked correctly on power up. Following the delivery of a prototype interface board from RDI to enable the ADCP to accept heading input from the ship's stepper gyrocompass (rather than their usual synchro gyro input) wiring changes were made to the deck unit and the interface was installed. However RDI had failed to supply an updated EPROM for the deck unit and thus the cruise was limited to recording current components relative to the ship's heading. A stepper gyro simulator was built so that testing of the interface could be done whilst the ship was at port once the new EPROM had been received.

A control box for the Colnbrook Instrument Development Vertical Reference Gyro was built to enable the pitch and roll to be used by the ADCP to correct the data for shipmotion. Although the gyro uses synchro output as required by the ADCP, changes in the interface board to handle the stepper gyro meant that the pitch/roll compensation could not be used.

The RS232 serial output from the PC-AT was used to send the ensemble data to the PDP11/34 computer installed on board to enable further processing. Data was logged on the PC-AT hard disk, with a backup of data files to 1/2Mbyte diskettes daily. No disk errors were encountered from either the hard or floppy disks. The accuracy of the PC-AT system clock was poor, on average losing 30 seconds per day - this required a daily update.

Instrument performance

A very brief trial of the bottom tracking mode of the ADCP was possible on the very narrow Madeiran Shelf. The range possible was in excess of 400 metres. Only a few ensembles were obtained, which made interpretation of the currents difficult. At sea the operating range of the instrument was generally between 130 to 300 metres, depending on scattering. This varied on a diurnal basis, with the rise and fall of the scattering layer seen clearly on most days. Occasionally, large patches of scattering were encountered notably between 150 and 250 metres. The traces could generally be correlated with those on the 10kHz PES although the ADCP usually showed the scatterers to be some tens of metres shallower. During the cruise the data acceptance parameters were tuned to reject the data from depth cells affected by active scatterers yet allowing for the normal fluctuations in strength and Doppler shift. An increase in range is anticipated when the ASDIC pod is fully deployed. Whilst on station some interference in the upper 30 metres was seen from wires over the side of the ship, and the use of the bow propellor drastically reduced the quantity of good data.

The ADCP was checked for transducer misalignment and velocity calibration at the same time as the EM LOG calibration (qv.)

Prior to the recovery of the spar buoy mooring (with current meters) near the shelf edge at a depth of 160 metres, a box pattern with sides of 8 miles was steamed for 12 hours. By keeping to cardinal headings the interpretation of the ADCP velocity data was simplified. As bottom tracking was in operation and some GPS based navigation was available a further check on the ADCP calibration will be worked up.

Calibration of the Port Electromagnetic Log (J. Swallow, R. Pollard)

On 28 September, calibration runs were made for a period of just over three hours. A transponder was laid under a float at a depth of 10m, and four runs past it were made at speeds of 2, 4, 6 and 8 knots. Then Discovery lay to for about 15 minutes with the light wind on each of the port and starboard beams to calibrate the athwartships component. Transponder range was less than 1500m, so a run at 11 knots was not attempted.

Both log components had only nominal calibrations initially;- 4knot/volt with zero misalignment angle. It was found that the true foreaft velocity Vfa(true) was related to the computer logged value Vfa(est) by

Vfa(tru) = 0.1955 + Vfa(est) * 0.93145 (knots)

from the least squared fit to the 4 runs. The RMS error (true - observed) was only 0.4cm/sec. The port starboard component was less well fitted from the two drift runs, giving

Vsp(true) = -0.015 + Vsp(est) * 0.962 (knots)

with an error of about 2cm/sec.

Tests were also done on the accuracy of logged gyro values. The four runs gave misalignment angles which varied with ship speed, namely 1.83 degrees (clockwise rotation of log) at 10 knots, 1.78 at 8 knots, 1.68 at 6 knots, 1.26 at 4 knots, and rotation in the opposite sense at 2 knots! The cause of the variation is not understood, but a mean value of

1.7 degrees

allows less than 2cm/sec error in Vsp correlated with Vfa at all speeds. Fasham's (1976) correlation technique was also used, but gave dubious answers given the variation of apparent angle with speed.

From 22 star sights, the bridge gyro repeater was found to read 0.86 degrees high, but the computer logged values were 0.87 degrees low compared with the bridge repeater. Therefore the logged gyro values are unbiassed, but should be increased by 1.7 degrees to allow for the log misalignment.

Currents calculated from the corrected log values had no athwartships bias, but were found to have a persistent component in the same sense as the ship heading at 11 knots passage speed. To remove correlated values, the log Vfa at 11 knots would need to be increased by about 4%, comparable with amount it had been reduced after the calibration runs. Is the log calibration non-linear at speeds above 8 knots?

CTD Stations (P.M. Saunders, N. Millard, G. Griffiths, J. Read, J. Moorey)

17 stations were occupied utilising a NBIS CTD which was lowered from the hydraulicly powered midship winch on a large frame. The CTD was interfaced with a 1m Transmissometer (SN 035) from Sea Tech. In support of the CTD, samples were taken for salinity and dissolved oxygen utilising a General Oceanics Multisampler; samples were taken at pre-selected levels on the up coast (stopped). A 10kHz pinger was used to measure height above bottom; the near bottom echo-sounder generally employed for this purpose had a corroded pressure case which was deemed unsafe. Releases were tested on early stations (11363, 11364) and on later stations (11372 onwards) trials were made of the next generation releases.

The performance of the CTD was flawless, aprt from a steady drift of the conductivity sensor amounting over the cruise to a change of 0.01 PSU. The multisampler worked poorly over several stations and two refurbishments were made, involving both the sea and deck units. By mid-cruise its performance was excellent.

The hydraulic winch system was troublesome; on six stations the lowering/recovery was interrupted and the motor restarted generally without knowing why it had cut-out (never under maximum load!). A leak developed on station 11378 causing the loss of most of the hydraulic fluid (into the bilges of the bow-thruster forward space); its replacement involved carrying Tellus the length of the ship in 5 gallon containers. Although the seas were generally flat, some swell was encountered; this generated loads of 2000kg when over 5000m of wire was off the drum and not only were hauling speed very low, 0.2-0.5m/s, but sometimes the winch all but stalled.

Logging of the CTD data was achieved on the ship's ABC level system and graphs and lists of provisionally calibrated data were furnished. Due to the collapse of the CTD level A station 11366 was not logged nor was one-third of the down cast of station 11367. Station 11359 was not logged either. The back-up system of Digidata tape deck had initial difficulties but subsequently proved reliable.

Salinometer, Thermometers and Dissolved Oxygen (J. Moorey)

It was decided to run the Guildline salinometer bath at 24°C as the lab temperature was often about 22°; however some afternoons the lab went up to over 25° and the thermostat lost control of the bath temp. This usually meant that samples oculd only be measured early morning or late at night. Near the end of the cruise, on the 6th of October, the salinometer became faulty. This was eventually traced to operational amplifier A19 which was replaced. The last few samples measured (on stations 11376, 11378, 11380) gave bad duplicates. Why? At the time of measurement the lab temperature had dropped to 18° but the salinometer was operated with a bath temperature of 24°C. Obviously 21° would have been better but there is always the time factor to consider when resetting bath temperature.

Apart from trouble associated with the multisampler not always operating at the required depth there were no problems with the reversing thermometers.

For the oxygen titrations the new (French) oxygen bottles were used for the first time. One advantage is that when the stopper is removed prior to fitration there is plenty of room for the titration liquid. Another advantage is the funnel shape surrounding the tops of the stoppers, which allows a bottle/stopper water seal without the use of a cyclinder as used on our usual bottles. However if the funnel of the bottle is filled to the brim there is sometimes a tendency for the stopper to float and release the seal. Only a small amount of water is needed, just sufficient to keep the bottle/stopper junction wet enough to provide a seal. The

French bottles seem more vulnerable to breakages should the weather be rough. An adequate fiddle needs to be made.

Ship's Central Computing (C. Jackson, R. Lloyd)

For this cruise there were two independent computer systems. The standard ABC system and an additional PDP11 for Dr R Pollard to run his PSTAR programs.

ABC system

Navigation (gyro, em-log, satellite navigator, gps receiver) and CTD were logged.

Navigation processing was based on TRANSIT satellites with log and gyro based intermediate positions at 2 minute intervals. GPS data was collected intermittently (available only for short periods twice a day and not accurate if the receiver had not been initialised with an approximate position just before the reception period). Track plots were produced daily at a scale of 1:1000000 (Mercator projection). The logs were re-calibrated and the new values used from day 277 00:00 onwards.

CTD processing made use of UNESCO approved routines (1983). During dips the processed data was displayed live on a screen and then plotted on the multipen HP flatbed plotter. For each dip a listing of processed data at 20 second intervals was also produced.

All data collected was archived to tape in GF3 format. The archive tapes contain text files with calibration details as well as the data.

ABC performance

Level A (8085 based).
100% availability of micro based sampling interfaces.
GPS fixes missed because of change in receiver parameters on bridge.
GPS interface was modified to reduce time between dummy messages by 5 seconds so that level B did not raise DEAD alarms.
Gyro encoder (ex IBM 1800) failed but was repaired after 12 hours - unfortunately we were sailing constant course or on station during this period.

Level A (8086 based - CTD).
15 out of 16 CTD stations logged.
Initial difficulty with downloading instrument details. Successful after 12 hours ready for second station 11360.
Station 11361 required re-starts during dip - some data gaps.
Station 11366 the level A would not start - not logged.
Station 11367 onwards - new level A built using spare Cambridge ring chassis and interface worked perfectly from then on.

Level B
100% availability

Level C
2 megabytes of memory installed. After two days horrendous crash occurred. Telex communication obtained fresh details for 2M memory from manufacturers via Barry. Data reprocessed from level B tapes. After this performance was excellent.

Level C was reading the data from Level B via the Cambridge ring, parsing, raw data filing, navigation processing (both live and corrected to fixes). CTD calibration and processing, CTD live plotting, CTD hard copy plotting and GF3 archiving. This was done simultaneously keeping up with raw data input and without the need to restrict casual use (eg. programming or the transfer of data to PDP).

On day 281 the Level C displayed ring error messages.
We switched to RS232 B to C link but noticed a backlog build up during CTD dips. The CTD dips were so short (200 metres) that we could not estimate the magnitude of the slower B-C transfer.
The paper sensor light bulb failed on the Calcomp 1039 drum plotter and an alternative assembly had to be made to take an ordinary bulb.

PDP11/34A - RVS involvement only

The hardware had been tested before cruise 161 but on arrival the magtape would not work. Work was done on this during the night to allow engineering diagnostics to be run. Eventually after 3 days it was made to work on 800 bpi only. Thus tapes from Barry could not be read nor data from the ABC system. So Robert Lloyd wrote transfer programs by RS232 link from Level C to the PDP.

A data program was written to accept acoustic doppler current profiler data from the IBM PC and to file it on the PDP.

Routines were written for the PDP to translate IBM PC internal floating point numbers to DEC PDP internal floating point numbers.

An eavesdropping program was written to take the output from the CTD level A to its local terminal and to put it into a PDP file for Dr Pollard's PSTAR programs.

003.A.jmj

TABLE 1

MOORING LIST

Mooring	Deploy/ Recover	Date 1986	Day	Lat N	Lon W	Water Depth m	Notes
399	Attempt R	Sep 24	267	31 32.4	25 01.0	5444	Not located. 3 Aanderaas lost.
400	R	Sep 24	267	31 28.8	24 43.8	5444	GME Plain. 6 Aanderaas, figure 2
401	R	Sep 24	267	31 29.4	25 08.5	5055	GME Hill. 3 Aanderaas 10, 100m, 1000m above bottom
404	R	Sep 27	270	37 18.1	18 37.8	3720	ALS 16. 10 day record only
405	R	Sep 29	272	42 44.6	18 56.3	3900	ALS 17
416	D	Sep 29	272	42 46.1	19 01.1	4002	ALS 14. See figure 3
406	R	Oct 1	274	41 28.8	13 27.9	5352	ALS 13. Broken connection - no data
417	D	Oct 1	274	41 28.9	13 28.9	5349	ALS 17. See figure 3
409	R	Oct 4	277	44 48.8	15 09.2	4347	ALS 15. See figure 3
418	D	Oct 4	277	44 46.3	15 09.0	4742	ALS 13. Release faulty (see accomp account)
418	R	Oct 4	277	44 46.3	15 09.0	4742	ALS 13 also faulty
419	D	Oct 5	278	44 45.9	15 09.0	4725	ALS 15. See figure 3
413	R	Oct 7	280	48 57.6	09 20.0	<200m	Adrift. Traced from its Argos transmissions. See figure 4
414	R	Oct 7	280	48 23.0	08 46.1	<200m	Adrift. Traced from its Argos transmissions.
415	R	Oct 8	281	48 45.2	08 57.6	165	Tethered Spar. See figure 5.

P20,jmj

TABLE 2

STATION LIST

Stn No.	Date 1986	Day	Time Down, Z	Lat, N	Lon, °W	Water Depth m	Ht Above bottom	Remarks
11359	Sep 23	266	1903	31 48.8	22 29.8	CTD to 1500m		Test, no data logged
11360	24	267	2217	31 32.7	25 24.1	5440	17	
11361	25	268	0533	31 30.2	24 45.5	5439	20	GME Plain
11363	25	268	1522	31 25.4	25 10.8	5187	30	on hill
11364	28	271	1947	41 50.4	18 50.1	4961	13	Multisampler perf. miserable
11366	29	272	2309	41 44.8	17 15.2	5600	15	Not logged level A
11367	30	273	1240	41 40.6	15 16.9	5349	15	Start logging level A 1500m
11368	Oct 1	274	0227	41 33.2	13 27.8	5349	8	Near mooring 406
11370	1	274	2324	42 35.2	14 49.4	5324	7	Improved multisampler perf.
11371	2	275	1035	42 48.4	16 35.5	5130	10	
11372	2	275	2118	44 01.3	15 50.5	5505	20	Multisampler OK
11373	3	276	0932	43 16.8	14 05.0	5206	12	
11374	3	276	2318	44 38.6	15 07.1	5249	12	Near mooring 409
11376	4	277	2104	45 18.4	14 09.6	4826	11	
11378	6	279	0728	46 11.5	11 35.9	4812	10	1st after hydraulics leak and repair
11379	6	279	1652	47 05.2	10 29.2	4626	10	

TABLE 2 (Continued)

STATION LIST

Stn No.	Date 1986	Day	Time Down, Z	Lat, N	Lon, °W	Water Depth m	Ht Above bottom	Remarks
11380	8	281						Series of shallow
lowering 1			0731	48 41.6	08 50.2	168	8	lowerings around spar
2			0817	48 45.3	08 49.6	160	10	mooring 415 no bottles
3			0905	48 49.3	08 49.0	160	7	
4			1256	48 45.2	08 57.2	170	10	
5			1355	48 41.0	09 03.0	158	10	
6			1449	48 44.9	09 03.0	155	10	
7			1536	48 49.0	09 03.0	159	7	

P20,jmj

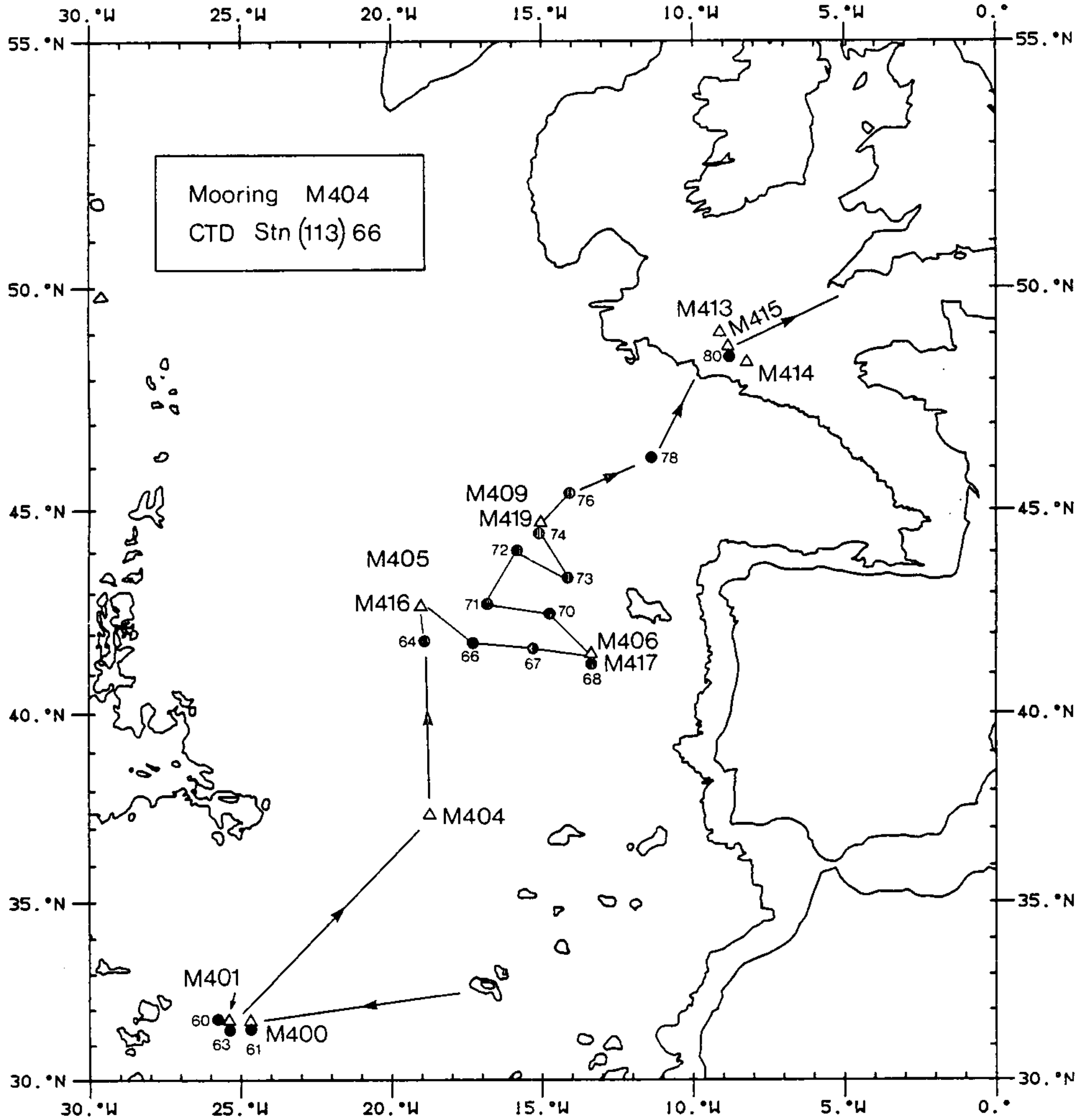
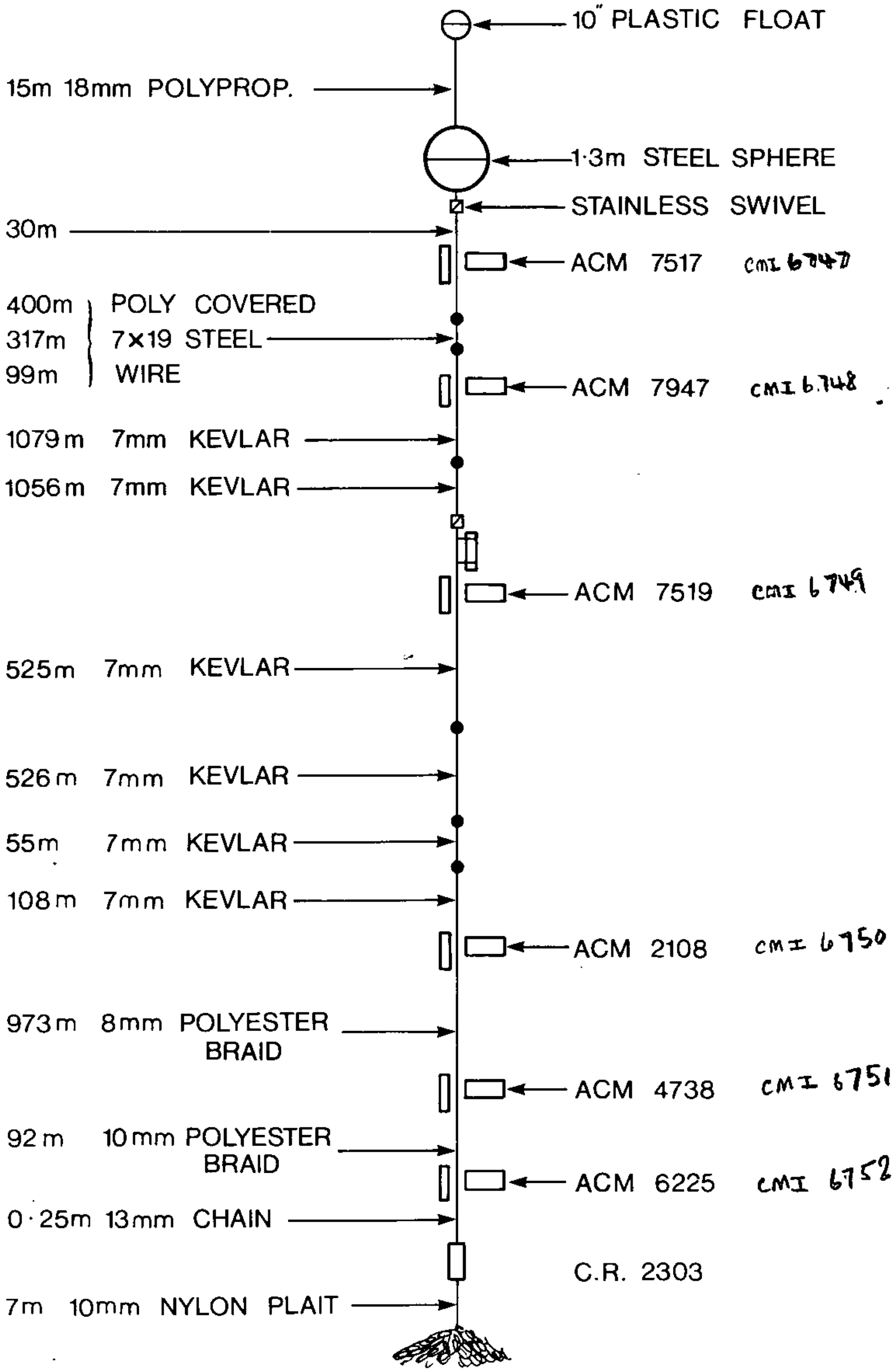
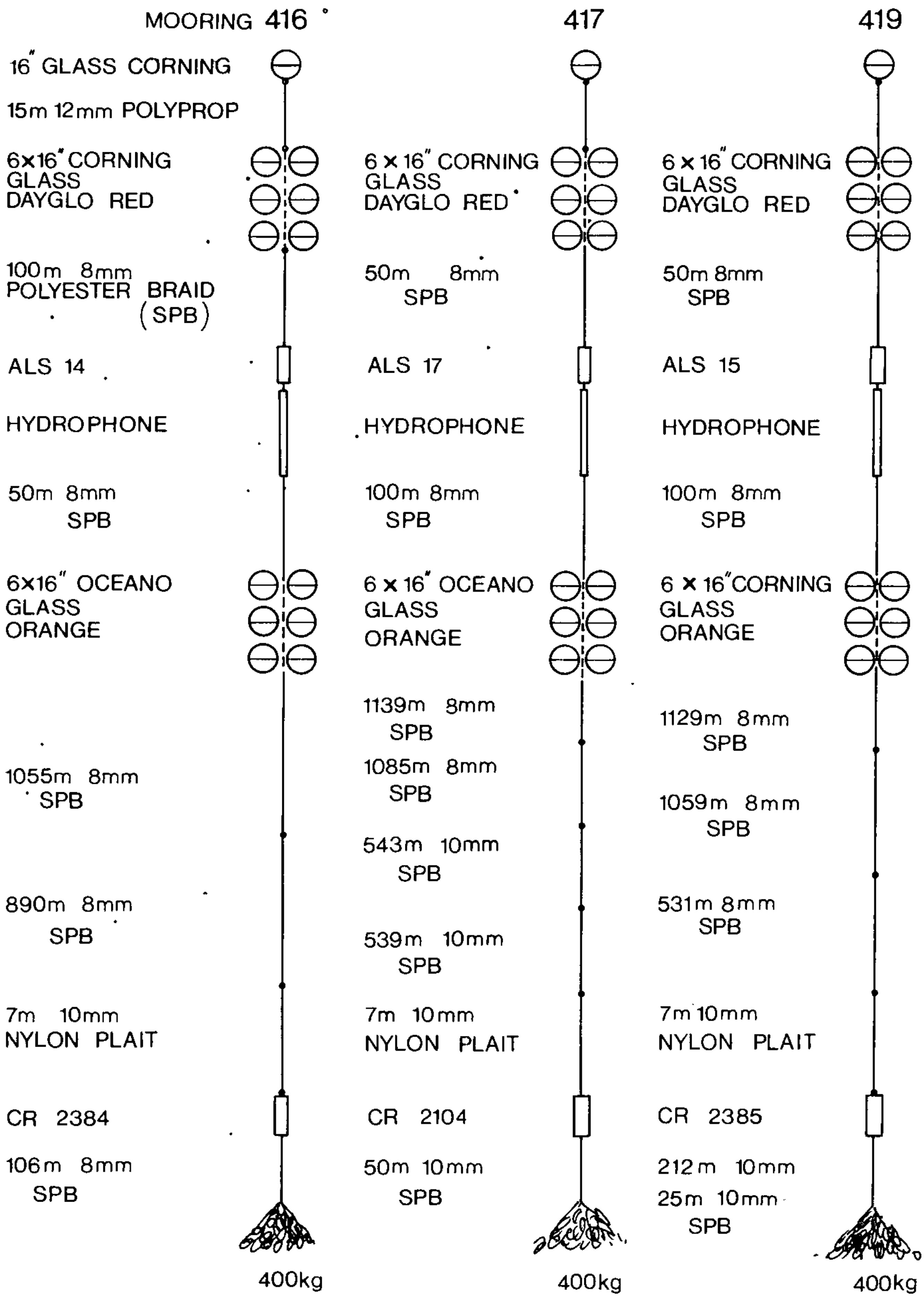


Fig. 1. RRS Discovery Cruise 162

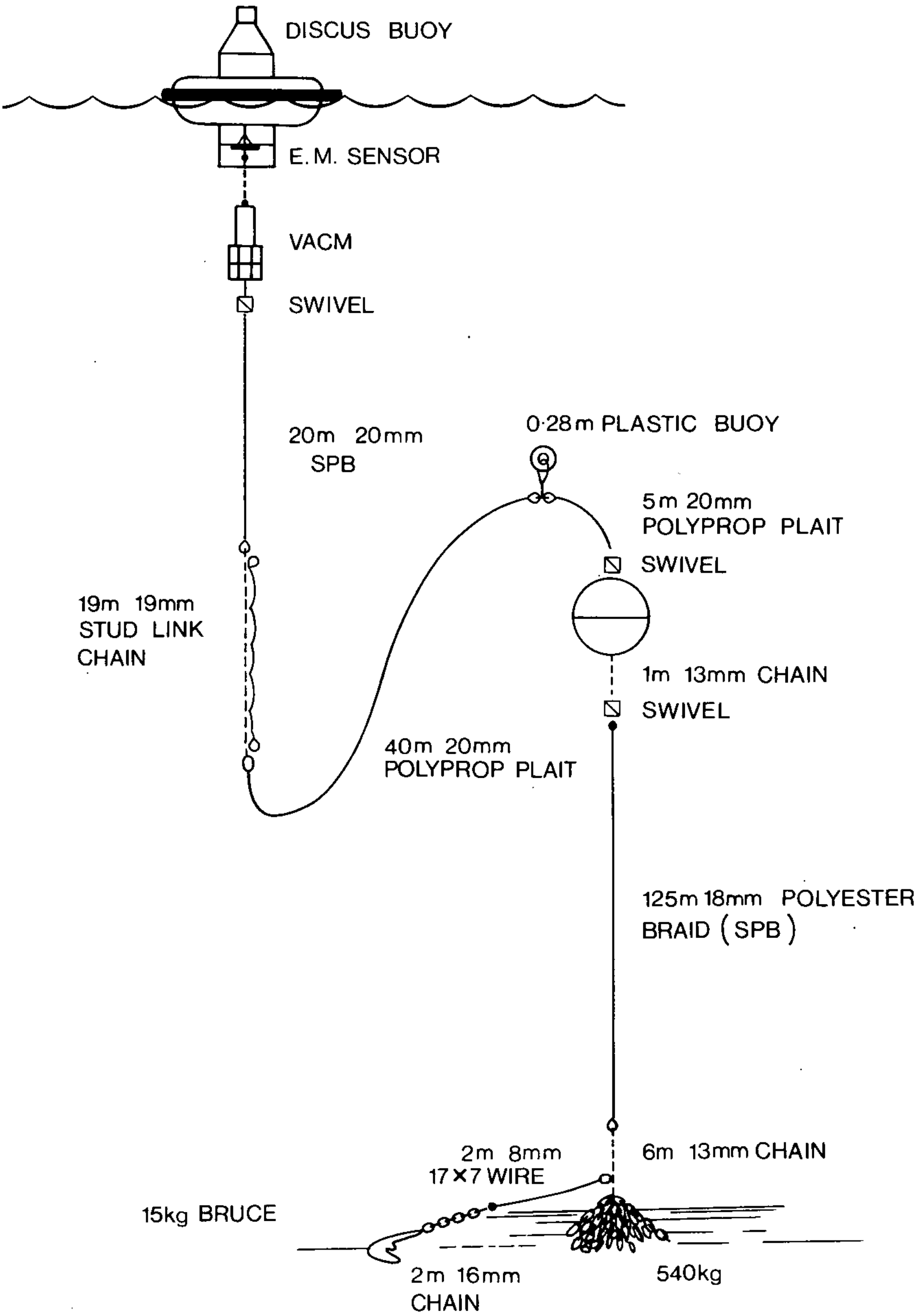
MOORING 400 (Fig. 2)



AUTONOMOUS LISTENING STATIONS (FIG.3)



MOORING 413 (Fig. 4)



MOORING 415 (Fig.5)