DR. M.T. JONES.
I.O.S. (POLYTON)

I.O.S.

RRS DISCOVERY

CRUISE 139

12 JULY - 3 AUGUST 1983

BOTTOM BOUNDARY MIXING AND THE DEEP CIRCULATION IN THE EAST ATLANTIC

CRUISE REPORT NO. 148

1983

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

INSTITUTE OF OCEANOGRAPHIC SCIENCES

Wormley, Godalming,
Surrey, GU8 5UB.
(0428 - 79 - 4141)

(Director: Dr. A.S. Laughton FRS)

Bidston Observatory,
Birkenhead,
Merseyside, L43 7RA.
(051 - 653 - 8633)

(Assistant Director: Dr. D.E. Cartwright)

Crossway,
Taunton,
Somerset, TA1 2DW.
(0823 - 86211)

(Assistant Director: M.J. Tucker)

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INSTITUTE OF OCEANOGRAPHIC SCIENCES

WORMLEY

RRS DISCOVERY

Cruise 139

12 July - 3 August 1983

Bottom boundary mixing and the deep circulation in the east Atlantic

Principal Scientist

A.J. Elliott

CRUISE REPORT NO. 148

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Arrive Dakar 3 August 1983

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C.H. Clayson	IOS, Wormley	
A.J. Elliott	IOS, Wormley	- Principal Scientist
G. Griffiths	IOS, Wormley	
T.J. Hamlyn	IOS, Wormley	
N.W. Millard	IOS, Wormley	
J.A. Moorey	IOS, Wormley	
I.P. Rouse	IOS, Wormley	
B.R. Stanton	IOS, Wormley	
J.C. Swallow	IOS, Wormley	
D.L. Weddell	IOS, Wormley	
P. Foden	IOS, Bidston	
D. Jones	RVS, Barry	
G.C. Knight	RVS, Barry	

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OBJECTIVES

The first goal of Cruise 139 was to make a near-bottom float dispersion experiment at a depth of around 4,500 m on the continental slope 160 miles to the west of Madeira. The float observations were to be supplemented by CTD stations and by a bathymetric survey of the area. In addition, some near bottom instruments were to be deployed. These included a VACM/camera tripod, Bencat (an instrument to measure Benthic Currents And Temperatures) and a Bidston tide gauge. A second aim of the cruise was to study the deep circulation of the E. Atlantic by making a N-S hydrographic section between 29°N, 24°W and 24°N, 24°W, and to collect hydrographic data along a section running up the continental slope between 24°N, 24°W and 15°N, 17°W. All of these objectives were achieved.

NARRATIVE

RRS Discovery sailed from Funchal, Madeira, at 0830 on July 12 (Day 193) and headed on a course of 263° towards the moored array that had been laid near 32°20.5'N, 20°11.0'W during the previous cruise (Cruise 138). (See Figure 1). The weather was good with a slight swell from the NW. At 1300 the ship hove to and the fish for the precision echo sounder and the float interrogator were put into the water. At 1406 the interrogator fish was recovered to investigate a fault caused by water in the cable. This was repaired and the fish was put back into the water at 1940. Passage continued towards the first CTD station (10825) which was located 30 miles to the east of the array (0210/194). (See Figure 2 and Table 1). The ship then proceeded to the centre of the moored array and the VACM/camera tripod was deployed (0846/194) one mile north west of the central mooring. (See Figure 3 and Table 2). Following this, the ship moved 6 miles to the south and launched a remote interrogator (R/I) and 3 Mark II near-bottom floats (See Table 3). While the floats were sinking to depth, a CTD station was made near to the eastern mooring (1601/194). At the end of this the ship returned to the float area and an interrogation was made (1956/194). Unfortunately, the remote interrogator did not respond so two additional fixes were made to determine the float locations. The ship then moved 15 miles to the south and a CTD cast was made (10828,0037/195). A Bidston tide gauge was then laid in 4,955 m at a position 20 miles to the west of the central mooring (0851/195) following a bathymetric survey of the area. A CTD cast (10830) was also made at the same site.

The ship returned to the float area and a new R/I was launched (1621/195). Bencat was then deployed about 1 mile to the west of the central mooring (1810/195).

Following this, the float positions were checked using the new R/I. The ship then steamed 50 miles to the SW and started a line of three CTD stations that ran towards the NE. During the most easterly of the stations (10834) there were problems with loss of signal from the CTD (1940/196).

Three additional floats (1 Mark III, 2 Mark II) were launched near the central mooring position and a CTD station (10835) was made close to the Bencat site on day 197. Unfortunately, the Mark III float settled onto the bottom and had to be recovered later in the day (1820/197). While additional floats were being prepared, an echo sounder survey was made of the region to the SE of the central mooring. During the early hours of July 17 (Day 198) two Mark III floats were launched, but it was found that no signals could be received from the R/I - which was suspected of having released and risen to the surface. A number of hours were spent trying to locate the R/I, which could only be detected intermittently. During the afternoon of day 198 (1459/198) Bencat was recovered after its first 3 day deployment. More time was then devoted to trying to locate the R/I, and a Mark II float was lowered to 1500 m on the hydrographic wire in an attempt to improve the acoustic transmission (1748/198). The search was abandoned at dusk, and fixes were made on the Mark II floats. At this time only one of the Mark III floats was still functioning (No. 4) and its depth was determined by navigating the ship directly above its position. Although the float was at 300 m above the sea bed, no signal was being received from its near bottom echo sounder (0100/199). During the remainder of the night a CTD station was made 20 miles to the east (10837,0629/199), after which the ship returned to the float area. At this stage (1200/199) no signal was being received from the R/I, which was assumed to be on the surface and drifting towards the SW. No further attempts were made to locate this R/I. The ship next steamed 14 miles to the east of the array centre and launched a Mark III float. Unfortunately, this float stopped transmitting shortly after being put into the water and had to be recovered (1543/199). The ship then returned to the vicinity of the central mooring and Bencat was launched for a second deployment (1911/199). The position was navigated using the release pinger, after which the ship steamed 10 miles to the east and a final Mark III float was launched (2040/199). While this float was sinking to depth, a repeat CTD station was made close to the central mooring and the Bencat position (10839, 2334/199). Two float fixes were made following the CTD cast, but it was not possible to receive a signal from the recently launched Mark III float.

The ship then left the area of the floats for a period of about 48 hours while a CTD station was made along a line running to the NW. Four stations were made along this section (10840-10844, 0929/200 to 0503/201). On return to the

float area a near bottom mooring, which supported a remote interrogator 400 m above the sea bed, was laid (1453/201).

A mooring that had been deployed during the previous cruise (Cruise 138) was recovered at 1850/201. This mooring had been laid for the Building Research Establishment and contained blocks of concrete that were being subjected to pressure. Some additional float tracking and a CTD station was done during the night, followed by a CTD (19844) to the east of the moored array and a further repeat CTD station (10845) near the central mooring. The computer logging system went down briefly during station 10844, and again during 10845. After the second crash, it was found that the navigation could not be updated and that satellite fixes were not being accepted by the system. This fault took several hours to correct.

Bencat was released from the sea bed at 1309/202, arriving at the surface at 1500; and the VACM tripod was released at 1529/202 and recovered at 1734. After a period of float fixing, the ship steamed to the most easterly of the CTD stations (10846, 0230/203). There were further problems with the computer during this station and the data were recorded using the Digidata alone during the top 1200 m of the cast. The system then recovered and the data were logged normally for the remainder of the station. As the ship steamed back west towards the float area, the opportunity was taken to repeat a CTD station (10836) that had shown a striking bottom profile (10847, 0701/203). The thin cold bottom layer was found to be present at both stations.

Most of day 203 was spent recovering floats (channels 4, 7 and 10). The final night in the float area was spent making a CTD station (10848, 0125/204) at a location about 20 miles to the west of the floats. The ship then returned to fix the floats and the morning of day 204 was spent recovering the remaining floats (8, 9 and 17) and the moored R/I. This work completed, the ship left the area of the moored array and steamed 20 miles to the west to recover the tide gauge (2009/204). The ship continued westwards, and two CTD stations were made along the latitude of the array centre (10849 at 2358/204 and 10850 at 0729/205). There was a power failure near the end of station 10850 when the CTD was 800 m below the surface. This caused a delay of nearly 2 hours in completing the cast, since the power could not be restored to the winch. This was eventually traced to a relay that had tripped during the power failure. At noon on day 205 the ship left the latitude of the moored array and started to head south on the second phase of the cruise.

While steaming towards the start of the N-S section (see Figure 4), the opportunity was taken to repeat one of the CTD stations that had been made between

the ALS positions during Cruise 138 (10851, 2054/205). The first 3 stations (10852-10854) of the N-S section were made as planned, but an extra CTD station was made at 26°30'N, 23°00'W (10855) so that a moored float could be deployed during daylight hours at station 10856 (26°00'N, 24°00'W). The float mooring was laid, buoyancy first, from the stern of the ship. A bottom echo showed the sound source to be at a depth of about 3,650 m. The two remaining stations of the N-S section (10858 and 10859) were made without incident on day 209.

The final stage of the cruise involved a CTD section while the ship was steaming across the continental slope towards Dakar. It was planned to make 8 stations between 23°00'N, 24°20'W and 20°10'N, 22°00'W with the water depth decreasing from around 5,000 m to 4,000 m. However, since the ship was ahead of schedule (half a day had been allowed for instrumental or engine delays during the steam south from the moored array area) it was possible to include an extra two stations into this slope section. Consequently, stations 10860 to 10869 were made, without incident, between 0030/210 and 1240/212. The ship then continued its course towards Dakar, arriving at 0830 on day 215.

EQUIPMENT AND OBSERVATIONS

Neutrally buoyant floats

These notes should be read in conjunction with Table 3. The objective of the float work on this cruise was to track and observe the dispersion of a cluster of 6 or more floats at about 400 m above the bottom, on a slope in depths of 4,600 to 4,700 m. At the end of the immediately preceding Cruise 138, two floats had been tracked briefly at such depths whilst an array of moored current meters was being set, on the slope to the west of Madeira. They had revealed a northward current, increasing towards the bottom, with speed reaching 7 cm s^{-1} (floats S3 +7 and 7, Table 3).

We had on board seven Mark II floats that had been used several times before and whose load-depth relationship was fairly well known, and four Mark III floats that had been modified and re-weighed since they were last used a year ago. The intention was to measure accurately the spacing of the floats in the cluster, by making one of them a remote interrogator. By this means, ranges could be measured to the other floats from two places almost simultaneously.

Various difficulties were encountered. Soon after arriving in the working area, four floats were laid in a line spaced 5, 3, 2 km across the expected north-going current (floats 1, 8, 7 and 5, Table 3). The first one, the remote interrogator, stopped working soon after it was launched. Another circuit was modified

and launched in a replacement float next day (see Table 3). Three days later, this second interrogator became intermittent and showed signs of having switched its release and come to the surface. A brief search was unsuccessful and no more signals were heard from it. By then, three more floats had been added (10, 4 and 17, Table 3). One of them was a Mark III float. Its load had been adjusted in the light of experience with ballasting the Sofar floats, which use similar glass spheres as buoyancy elements. However, instead of settling at 4250 m as intended, it went slowly to the bottom. It was recovered and re-launched early next day with 34 g less load (equivalent to 600 m less depth for a Mark III float). This time, it settled close to the intended depth (2nd float 4, Table 3). Unfortunately, its near bottom echo sounder did not work, though it should have been well on scale.

Another Mark III float (15) was launched soon afterwards, similarly loaded, but nothing was heard of it at the next fix. The two remaining Mark III floats were launched next day, and both of them also failed. One of them (11) became very weak within a few minutes of being launched, and was recovered immediately. From that it was possible to determine the cause of these Mark III failures, though not before the next one (16) had been launched.

Inspection of the recovered float revealed that a current limiting resistor had burnt out causing complete failure of the power amplifier. However, the primary cause was the failure of two diodes that were intended to protect one of the output transistors from excessive voltage spikes. This failure was, in turn, attributable to an error on the printed circuit board that resulted in an unfair stress being put on the two diodes. These circuits have been used for extended periods in the past without failure. However, since then their pulse lengths have been increased and it would appear that this was enough to overload the diodes.

The only remaining Mark III release circuit was set to a frequency that was too close to that of one of the current meter moorings, so it was not feasible to re-launch the recovered Mark III float after repair.

From midday on day 198 until the afternoon of day 201, the cluster was tracked without the benefit of a remote interrogator. Ranges were taken by the ship from three successive positions to form a fix. There were no floats remaining on board that could be converted into a remote interrogator. However, a moored bottom transponder was modified and set in a short mooring in a suitable position relative to the float cluster. It made accurate tracking possible for the remaining three days of the experiment.

The floats and the temporary mooring were recovered on days 203 and 204. Of

the four floats that were lost, the two Mark IIIs can be explained by the fault found in No. 11. The first Mark II remote interrogator had a corrosion pit on one of its end caps that could possibly have caused it to collapse. The cause of the second remote interrogator's premature release is unknown. There had been no release signal transmitted near its frequency.

The Mark II floats tended to go deeper than expected (see Table 3), one of them 200 m deeper. Depths measured later in the trajectories that lasted 9-10 days tended to be deeper, by about 30 m, than those near the beginning. Possibly both these are indications of creep in the Mark II floats. They are not fitted with pressure gauges and corrodable weights, like the Sofar floats are, so some increase in depth it to be expected.

N.W. Millard
J.C. Swallow

CTD and reversing bottles.

The CTD with oxygen sensor, multisampler and transmissometer were used on 40 stations. At all stations a near bottom echo sounder, which was attached to the CTD frame, was used to take the CTD to 10 m off the bottom. Throughout the cruise no electronic problems were encountered in any of the system components. The cable harness connecting the CTD, multisampler, transmissometer and sea cable gave some problems at depths of 200-350 m early in the cruise. No specific fault was found on deck, but the harness was renewed and use was made of a junction box instead of a complex telecohesive tape joint. The bulkhead connections on both the CTD and multisampler were also replaced. This arrangement worked perfectly for the rest of the cruise.

Comparison of the CTD temperatures with the reversing thermometers showed the CTD to be stable. However, frequent conductivity jumps of .001 PSU were noted in most casts at depths of greater than 4,000 m. No large jumps were found, and the same conductivity cell was used throughout the cruise. The Digidata back up data recording unit worked well with no major problems.

Thermometers

The rosette multisampler was used on every CTD station. The (D.S.R.T. temperature - CTD temperature) was about 0.030°C for deep water and about 0.021° at 9°C. The 10 metre bottle comparisons were very variable. A table of individual (D.S.R.T.°C - CTD°C) was kept for every station, and the average calculated for each individual thermometer. These varied from 0.023°C for

3461 to 0.034°C for 11149, which is rather higher than is usual. The other deep thermometers had averages of 0.027, 0.030, 0.031, 0.034. The CTD "10 metres off the bottom" values were used in conjunction with the P.E.S. reading converted to decibars. This gave an average value of -8.5 db for (calculated db. - CTD db). This value was used to revise the Q values of certain unprotected thermometers, using both the CTD values and trustworthy known unprotected thermometers. A graph was kept of (D.S.R.T. db - CTD db) for all unprotected thermometers. Once a good Q value had been established these (D.S.R.T. db - CTD db) showed very little spread. There was one erratic, U 14904, which appears to have either a non-linear Q or dramatic changes in the mercury break position.

Guildline salinometer

This worked extremely well apart from shifts of 140 digits in the readout; but noting the standby reading it could be determined exactly when the shift re-curred, so no samples were lost through this cause. On Cruise 138 the fault occurred intermittently for about 2 days early in the cruise and then it did not reoccur until the last few days of Cruise 139. It was intermittent for about 20 minutes and then stayed on for about 24 hours. Due to an increase in ambient temperature it was necessary to switch from the 27° to 30° range. When the unit was restandardised, the cell correction had changed from -16 digits (at 27°) to -139 (at 30°) without adjusting the Rs cell trim. The fault then disappeared, and when restandardised gave a cell correction of -14. It is quite remarkable that at 27° it was -16 and at 30° it was -14 without touching the Rs cell trim. This is equivalant to the bath temperature changing by 3.0000°C ± .0003°C, and/ or an extremely well matched set of resistors for the thermistors and cell network. In summary, the Guildline is an extremely good instrument, the fault is a nuisance but it is a constant value and it can be detected immediately by the standby reading.

G. Griffiths
J.A. Moorey

VACM/camera tripod

The VACM/camera tripod was launched near the central mooring at 0846 on Day 194. After falling at about 0.85 m/sec it reached the bottom at 1018, and its position was fixed as being at 32°21.4'N, 20°13.0'W, putting it about 1½ miles to the NW of the central mooring in water 4690 m deep. The current meter was set to a 15 minute data cycle, and the camera fired at 32 minute intervals. The package

was recovered at 1529 on Day 202 after 8 days on the bottom. The tilt/compass indicator showed that the rig had been sitting on a level bottom with the camera directed towards the NE.

This was the first trial of the new tripod, which is no longer constructed from aluminium tubing but instead uses an open conical base that attaches directly to the rotor cage studs of the VACM. The compactness of the new design enabled the tripod and its buoyancy to be lifted directly by the aft crane in a single hoist over the stern.

A.J. Elliott

Bencat

BENCAT was deployed twice, in each case for a period of three days; this period was the limit imposed by the logger tape capacity due to the intensive sampling routine specified for this cruise (one hour sampling every 3 hours). The first deployment was in a depth of 4691 m at a position 32°20.7'N, 20°13.1'W, near the VACM tripod mooring. The mooring was in position from 1955 hrs, 14 July 1983 until 1459 hrs, 17 July 1983. Descent rate was 0.80 m/s and ascent rate estimated at 0.65 m/s although the latter figure is uncertain due to failure of the release beacon batteries on the way up.

The second deployment was in a depth of 4675 m at a position 32°21.1'N, 20°12.4'W, again near the VACM tripod. The mooring was in position from 1911 hrs, 18 July 1983 until 1310 hrs, 21 July 1983. The measured descent and ascent rates were 0.77 m/s and 0.75 m/s. These figures differ to a surprising degree from those measured on Cruise 132 for a nearly identical configuration.

A new temperature sensor of improved resolution and with faster response was used. The sensor was mounted in two different positions in the frame for the two deployments to assess which was the more acceptable compromise between the conflicting requirements of minimum flow disturbance and of good correlation with the current sensors.

A useful preliminary examination of the data recorded was possible by replaying short sections of the record into a COSMAC microcomputer, using DMA to cope with the high data rate from the Sea Data reader.

C.H. Clayson
A.J. Elliott

Tide gauge

The Mark IV tide gauge consists of a Sea Data logger unit housed, together

with the batteries, in an aluminium pressure case. There are four external sensors fitted, three for pressure and one for temperature. The logger unit fits in a frame which free falls to the bottom and can be released by means of an acoustic release. The tide gauge was deployed on 14 July (Day 195) at position 32°19.3'N, 20°41.3'W; 4938 metres deep and recovered on 23 July. Data from the first part of the record were listed using the Sea Data translator coupled to the COSMAC microcomputer, showing that data were present on the tape.

The logger tube and sensor cases are made from thicker and harder aluminium than previous Mark IV's so that they can be deployed at depths >5,000 m. This was the heavier tube's first deployment and the extra weight made the unit rise at a slightly slower rate. (0.86 m/s instead of 1 m/s).

Sensors fitted to the logger included two strain gauges, one fitted with a Phase-locked loop to improve resolution by multiplying the frequency, and the other without a P.L.L. set up for minimum current consumpton. The third sensor was a Digiquartz pressure sensor, which developed an internal fault that could not be repaired, so the tide-gauge was deployed without it. The temperature sensor was a platinum resistance probe conncected to an A.C. bridge. Signals from all the sensors were recorded onto a compact cassette in the Sea Data logger.

P. Foden

Building Research Establishment mooring

During the previous cruise (no. 138) a near bottom mooring had been laid for the Building Research Establishment. Beneath its buoyancy spheres this mooring supported two buoyancy 'hard hats' that had been filled with concrete samples. The samples were held in individual compartments within the hard hats. The mooring had been laid near 32°23.9'N, 20°20.9'W in water of depth 4712 m, and was released from the sea bed at 1823/201 and recovered from the surface at 2022/201. The samples were removed from the buoyancy package and kept soaked in sea water while being stored in sealed plastic containers.

A.J. Elliott

Shipborne computing

During the second week of the cruise a major but intermittent hardware fault developed on the computer system used for CTD/Navigation logging and processing. The system would halt but with no indication as to what had caused the halt. When

this fault had developed to the extent of seriously affecting the performance of the machine, a convenient break in CTD work occured. This enabled the identical computer, used for extra data processing and backup, to be physically exchanged with the faulty machine, though the exchange of computers took longer than anticipated due to the failure of the camac interface power supply. It did eventually prove to be entirely successful, in that no further problems were encountered the logging system. The fault was found using engineering diagnostic programs and no CTD stations were missed. The floating point processor board, which handles all high accuracy arithmetic, was found to be the cause of the trouble. Unfortunately, the second computer system could not be used for the remainder of the cruise due to this fault.

Apart from the hardware problems, the data acquisition computer worked well. At the beginning of the cruise, some software modifications were made to the operating and processing systems to bring them in line with the definitive versions at R.V.S., Barry. The two systems were compared to make sure nothing had been omitted from the latest set-up, which was then successfully tested during the run to the first CTD station. Some data were lost during one of the CTD dips due to noise affecting the transmission circuit. Once it had been reset, normal logging resumed. There were some data gaps in the navigation as a result of the processor halts, and the dead-reckoning was not updated between the satellites either side of the break.

While analysing the CTD archive tapes it was found that almost all of one CTD cast (No. 10847) had failed to archive. During the dip it had been noticed that the data were not being archived, even though the archive system had almost certainly been initiated. When this was noticed the archive was restarted - but, instead of beginning at the start of the cast as is normal, it apparently began at the current record.

G.C. Knight
D. Jones.

COSMAC microcomputer

An RCA COSMAC microcomputer was taken on the cruise for hardware and software familiarization. As a Sea Data decoder was available it was decided to construct an interface for the reader and microcomputer. This provided a 'quick look' check of the Bencat, tide gauge and tripod VACM data tapes. The data were transferred from the decoder to the micro using the COSMAC direct memory access facility, and up to 8192 characters could be stored and then inspected.

G. Griffiths

Acoustics

Acoustic command release (CR 200 series):

All units used during the cruise worked well. Most of them had been wire tested on the previous cruise, leaving only one to require wire testing. This was done by attaching the release to the side of the multisampler frame of the CTD - a technique that worked well and saved considerable time. Six recoveries were made during the cruise : Tripod, Bencat (twice), moored remote interrrogator, the Building Research mooring and the Bidston tide gauge (the tide gauge used a modified version of the CR 200 series release).

Precision echo sounder Mark III (Fish and Mufax No. 12):

These two units and their cabling worked well all trip.

Acoustic command Deck Control Unit (Mark III):

The unit (No. 25) worked well and required no attention.

Near Bottom Echo Sounder (NBES):

Forty CTD stations were occupied while using the NBES; of these, all but 5 were completely successful. At the beginning of the cruise the unit was used that had been working well on Cruise 138. However, this unit broke down (accounting for four of the faulty dips) and was changed for a replacement unit. This worked well for the rest of the cruise except for one dip when the battery failed.

M.G. Sawkins

TABLE 1 CTD Station Positions

Station	Day	Time	Lat(N)	Long(W)	Depth(m)
10825	194	0210	32°19.5'	19°39.1'	4046
10827	194	1601	32°18.9'	20°07.2'	4559
10828	195	0037	32°00.0'	20°09.7'	4681
10830	195	1106	32°18.9'	20°41.0'	4935
10832	196	0506	31°30.0'	20°39.7'	4839
10833	196	1301	31°40.5'	20°08.3'	4702
10834	196	2049	31°49.8'	19°40.4'	4162
10835	197	0848	32°21.4'	20°14.1'	4698
10836	198	0741	32°35.2'	19°40.4'	4158
10837	199	0629	32°17.0'	19°53.8'	4306
10839	199	2334	32°20.5'	20°13.3'	4690
10840	200	0929	32°50.2'	19°40.2'	4024
10841	200	1453	32°51.5'	19°45.6'	4572
10842	200	2125	32°57.9'	20°30.0'	5026
10843	201	0503	33°04.3'	21°07.9'	5262
10844	202	0153	32°34.1'	19°54.1'	4410
10845	202	0954	32°20.9'	20°13.7'	4694
10846	203	0230	32°36.1'	19°28.4'	3945
10847	203	0701	32°36.0'	19°39.6'	4145
10848	204	0125	32°35.9'	20°26.7'	4805
10849	204	2358	32°18.0'	20°58.7'	4977
10850	205	0729	32°19.1'	21°13.9'	5073
10851	205	2050	31°39.3'	22°35.3'	5204
10852	206	1948	28°59.8'	24°00.2'	5190
10853	207	0548	28°05.0'	24°00.7'	5137
10854	207	1702	26°59.7'	23°59.7'	5111
10855	208	0339	26°29.0'	23°02.0'	4969
10856	208	1351	26°00.1'	24°00.1'	5097
10858	209	0257	25°00.0'	24°00.1'	5101
10859	209	1343	24°00.1'	24°00.3'	5071
10860	210	0030	23°01.6'	24°17.7'	5105
10861	210	0858	22°30.5'	24°00.4'	5026

TABLE 1 CTD Station Positions (continued)

Station	Day	Time	Lat(N)	Long(W)	Depth(m)
10862	201	1639	22°03.7'	23°41.8'	4937
10863	201	2303	21°47.6'	23°26.1'	4849
10864	211	0602	21°30.9'	23°07.3'	4740
10865	211	1226	21°12.1'	22°54.4'	4619
10866	211	1824	20°59.7'	22°41.6'	4518
10867	212	0023	20°43.8'	22°29.5'	4353
10868	212	0642	20°27.7'	22°10.6'	4156
10869	212	1240	20°10.3'	22°00.6'	3961

TABLE 2 Mooring positions

Mooring No.	Station No.	Lat(N)	Long(W)	Depth (m)	Description
351	10826	32°21.4'	20°13.3'	4690	VACM tripod
352	10829	32°19.3'	20°41.3'	4955	Tide gauge
353	10831	32°20.7'	20°13.1'	4691	Bencat Drop 1
354	10838	32°20.6'	20°11.8'	4675	Bencat Drop 2
355	10857	26°00.6'	24°00.0'	5097	Moored sound source

Float No.	Launch		First Fix				Last Fix				Nominal Depth	Obsd. Depth	Duration	Displacement	Mean velocity		
	Day	Time	Day	Time	Lat(N)	Long(W)	Day	Time	Lat(N)	Long(W)	m	m	hrs	km	cm s^{-1}	°T	Notes
S3 +7	186	0845	186	1500	32 20.7	20 08.9	187	0550	32 21.3	20 08.3	3500	3333	14.8	1.3	2.4	040	(a) (b)
7	187	1007	187	1236	32 19.4	20 10.6	189	1030	32 25.6	20 08.7	4200	4203	45.9	11.8	7.1	014	(a)
1	194	1145	not heard beyond 1 hr after launching														
8	194	1217	194	2042	32 16.0	20 16.5	204	0603	32 42.6	20 08.3	4250	4310	225	51.0	6.3	014	
7	194	1241	194	2042	32 16.0	20 15.0	203	1204	32 40.9	20 07.0	4250	4277	207	47.9	6.4	014	
5	194	1303	194	2042	32 16.0	20 13.6	204	0604	32 42.5	20 05.9	4250	4202	225	50.5	6.2	014	
1	195	1624	195	2117	32 19.4	20 18.6	198	0106	32 23.3	20 16.9	4250	4315	51.8	7.8	4.2	019	(c)
10	197	0404	197	1212	32 20.1	20 12.6	203	1204	32 37.3	20 08.0	4250	4451	144	33.0	6.4	012	
4	197	0444	197	1212	32 20.4	20 10.3	On bottom 197 1612. Recovered										(d)
17	197	0515	197	1212	32 22.2	20 09.0	204	0604	32 38.0	20 04.6	4250	4415	162	30.5	5.2	012	
4	198	0016	198	1350	32 21.6	20 10.8	203	1204	32 34.9	20 09.9	4250	4286	118	25.1	5.9	004	(d)
15	198	0112	not heard beyond ½ hr after launching.														(d)
11	199	1520	became weak immediately after launch, recovered.														(d)
16	199	2040	not heard, beyond ½ hr after launching.														(d)

Notes: (a) done in same area in Cruise 138. (b) combined Sofar + Mk II float. (c) remote interrogator. (d) Mk III floats; others were Mk II.

Table 3. Neutrally buoyant floats.

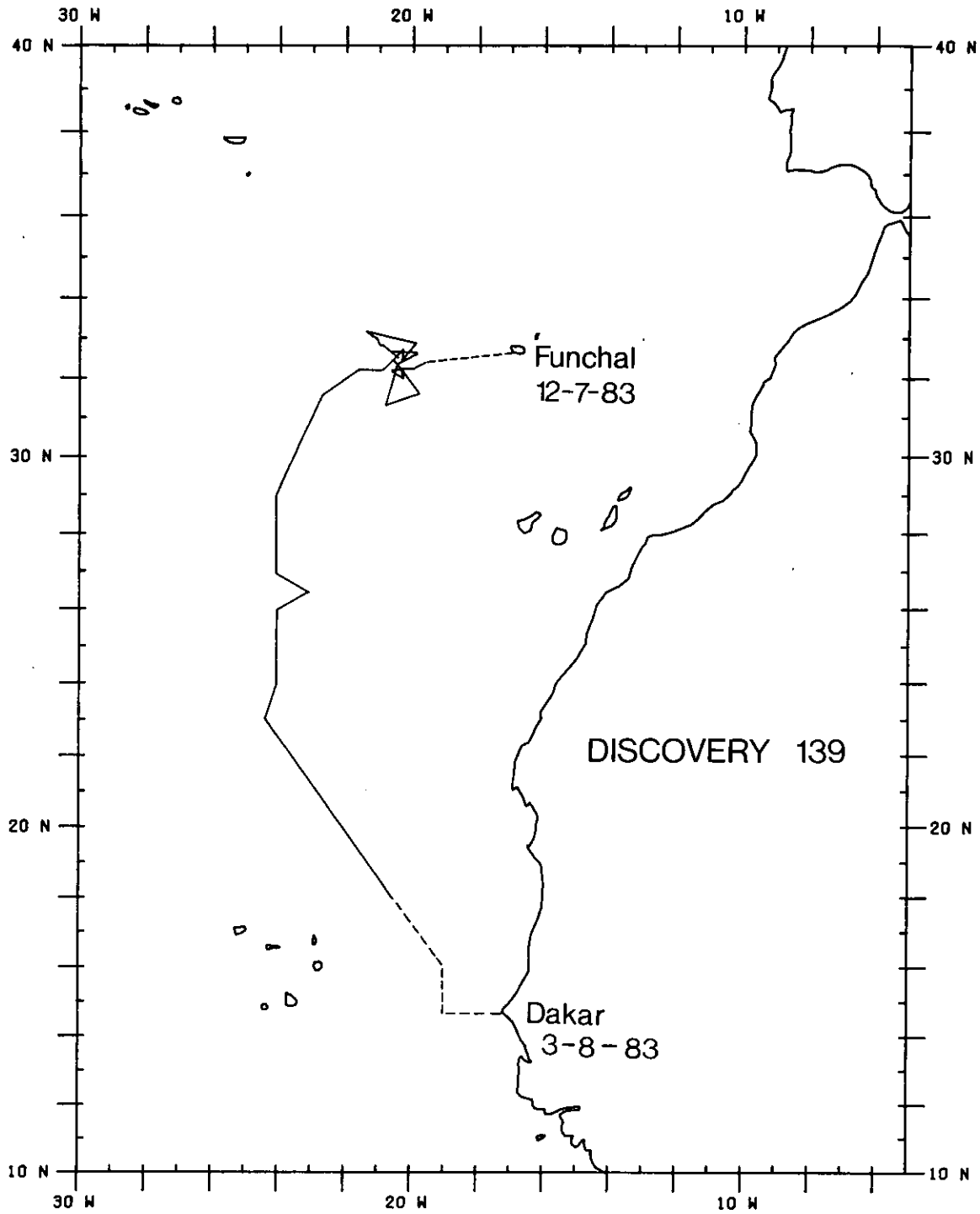

Figure 1. Track chart for Discovery Cruise 139, July 12 - August 3, 1983.

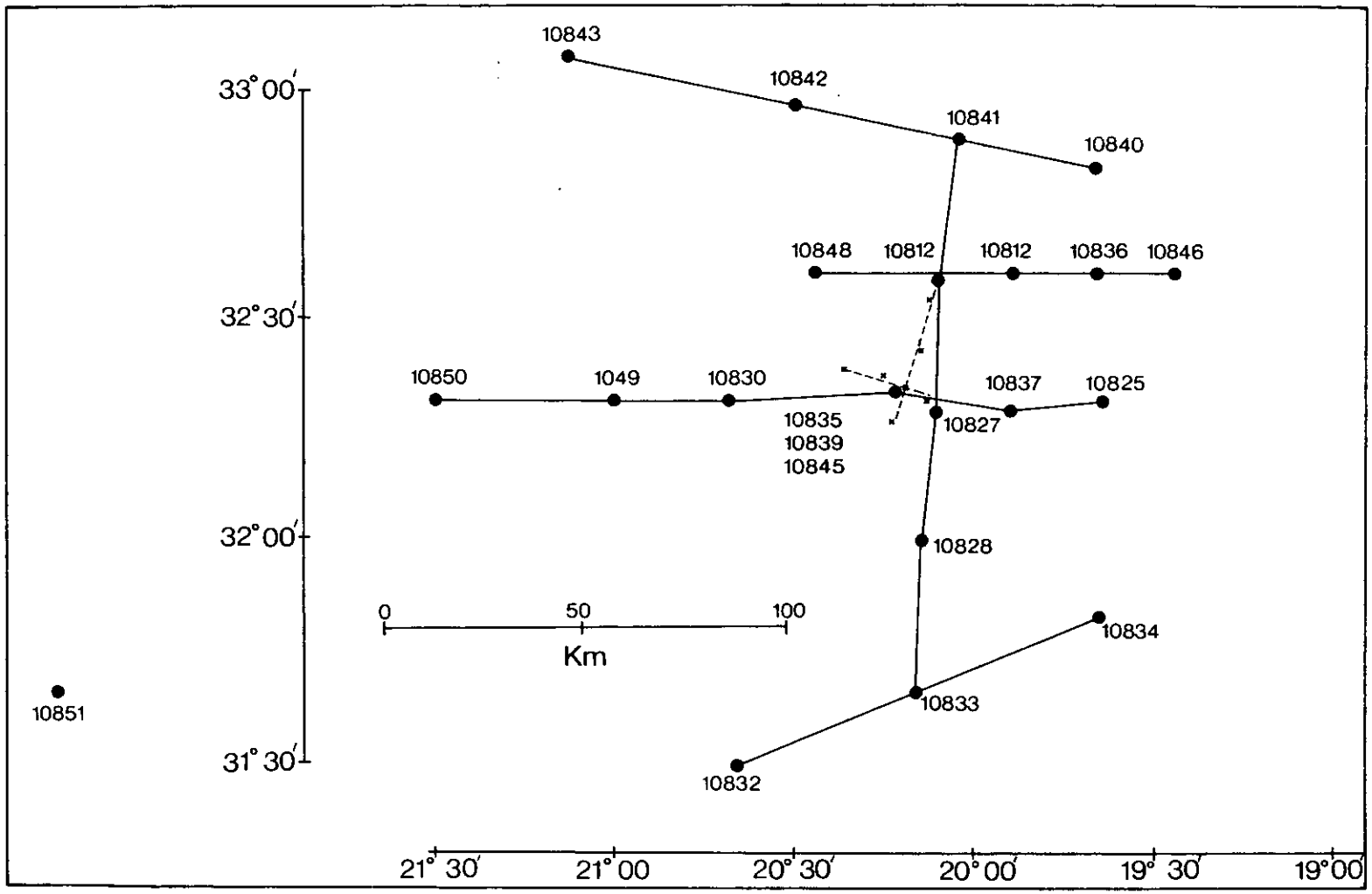

Figure 2. CTD stations in the vicinity of the moored array.

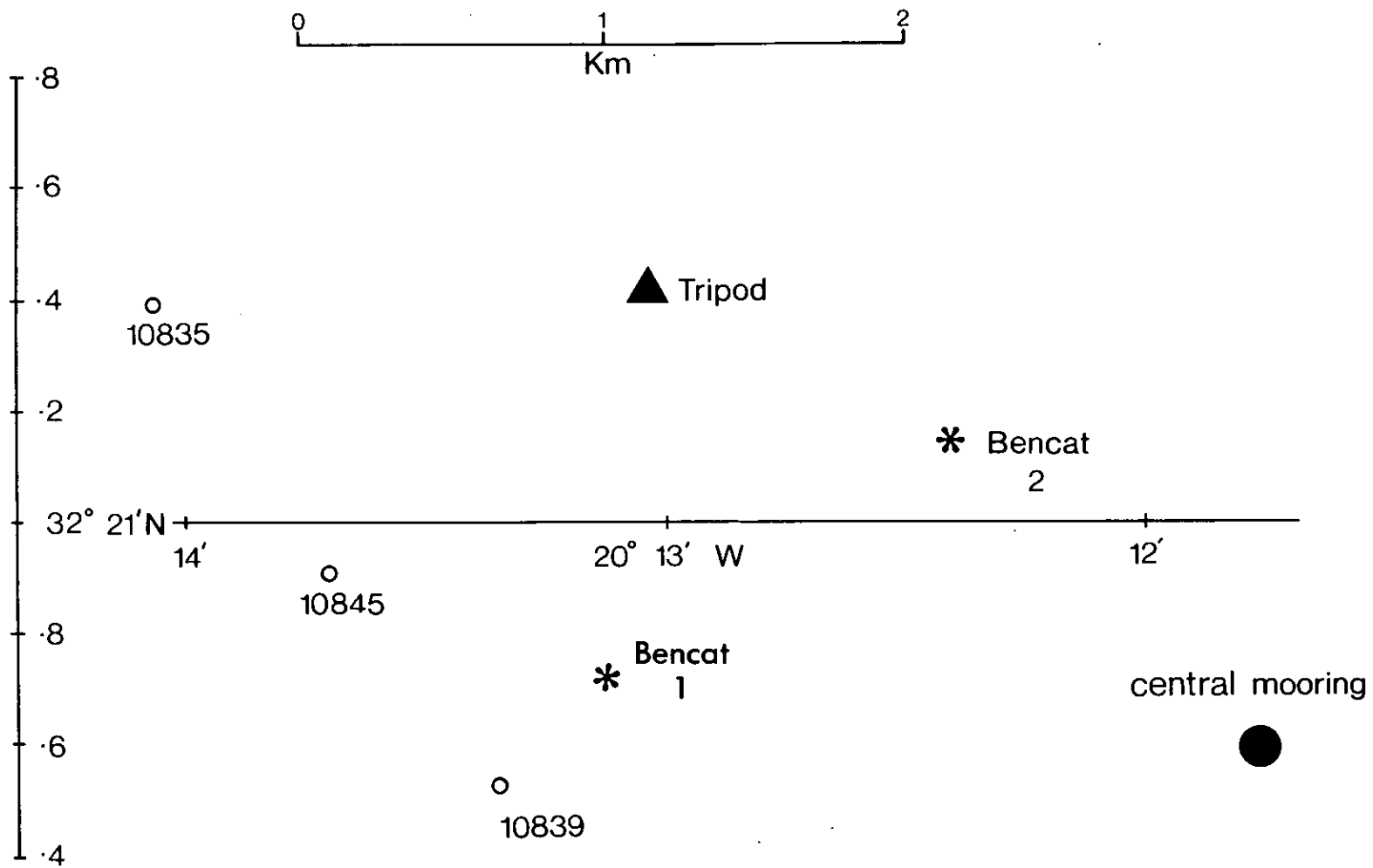

Figure 3. The Bencat and Tripod positions shown in relation to the central mooring, nearby CTD stations are also shown.

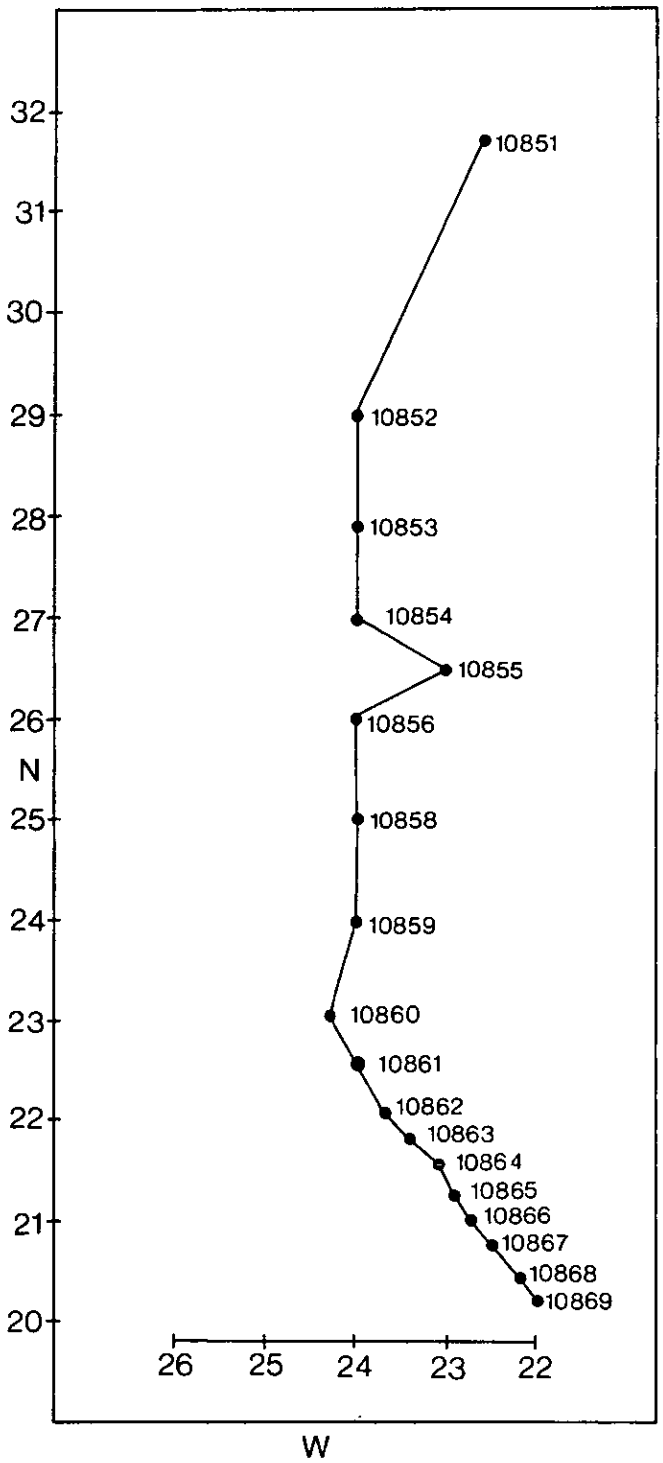

Figure 4. CTD stations made along 24°W and along a section towards Dakar.