I.O.S.

RRS DISCOVERY CRUISE 63

GEOCHEMICAL AND BENTHIC BIOLOGICAL SAMPLING ON THE NORTH WEST AFRICAN CONTINENTAL MARGIN

12 JUNE – 14 JULY 1974

CRUISE REPORT NO. 12

1974

INSTITUTE OF OCEANOGRAPHIC SCIENCES
NATURAL ENVIRONMENT RESEARCH COUNCIL

RRS DISCOVERY CRUISE 63

12 June - 14 July 1974

Geochemical and Benthic Biological Sampling on the North West African Continental Margin.

Cruise Report No. 12

1974

Institute of Oceanographic Sciences,
Wormley,
Godalming,
Surrey.

CONTENTS

Itinerary

Leg 1

Leave Barry 12 June 1974
Arrive Santa Cruz, Tenerife 20 June 1974

Leg 2

Leave Santa Cruz, Tenerife 22 June 1974
Arrive Freetown, Sierra Leone 14 July 1974.

Scientific Personnel

R.G. Aldred
M.V. Angel (first leg only)
R. Bentley
J.D. Burton (Southampton University)
S.E. Calvert (Principal Scientist)
T. Coyle (Southampton University)
F. Culkin
A.W. Gray
I. Innes
D. Lewis
M.J. McCartney
C.I. Measures (Southampton University)
N.W. Millard
C.D. Pelton
A.L. Rice (Second leg only)
M.H. Thurston

Objectives of the Cruise

The main objectives of the cruise were as follows:

1) To obtain a series of large-volume water samples, for studies of the trace element composition and particulate matter geochemistry of some of the water masses of the north Atlantic.

2) To obtain a series of sediment core samples, for geochemical studies, along selected profiles off the North West African margin.

3) To obtain samples of the benthos at 3000-4000m depth off the North West African margin.

4) To obtain a 24-hour seris of biological samples from 300-600m depth at a single station off northern Spain.

5) To obtain side scan sonar and telesounde r coverage of the African continental shelf.

Narrative

Discovery sailed from Barry at 1000 on 12 June 1974. The 10 kHz echo-sounder fish was launched at 0915/13 June at the shelf break south west of Land's End and normal watches were started.

We proceeded at 12 knots to a station at 44°N, 13°W to carry out a series of midwater plankton and nekton collections using the RMT 1+8 nets. This started at 0900/14 June and was completed at 0643/15 June. The operation of some of the large volume water bottles was tested using the forward steam winch in the time available between hauls. Wind speeds were between 16 and 27 knots on the station.

The ship then proceeded on a southerly course to carry out a topographic survey of a small abyssal hill on the Iberian Abyssal Plain at 41°20'N, 13°58'W. We were to check the position and the detailed shape of the feature, previously surveyed in 1959, and to provide extra coverage for a forthcoming current-measuring experiment by W.J. Gould (IOS). The feature was located after a 1-hour search and 9 traverses were made across it. The survey was completed at 0620/16 June.

Discovery then steamed to 34°00'N, 12°02'W, arriving at 1804/17 June, where a 24-hour hydrographic station was occupied. Normal hydrographic casts, using 1 litre NIO sampling bottles, were made from the surface to 4400m and large-volume sampling bottles, both 8 litre NIO and 30 litre Niskin types, were used in various combinations to obtain large volume samples over this depth range. A total of 17 casts was made. A gravity core sample was attempted but failed owing to problems with rigging and a bottom catcher valve jamming in the open position on retrieval. Wind speeds were 12 to 18 knots and the station was completed at 2040/18 June.

We then proceeded directly to Santa Cruz, Tenerife, retrieving the echo-sounder fish at 0700/20 June, and picking up a pilot at 0921. After anchoring off the harbour overnight, Discovery tied up alongside the following morning.

We sailed from Santa Cruz at 0800/22 June, streamed the echo-sounder fish at 0930, and proceeded to a shallow station at 24°02'N, 17°00'W. A series

of tests of the equipment to be used extensively on the forthcoming profile lines was carried out. A modified catcher valve on the gravity corer was tested, together with a leaf-spring valve made up on board. Both worked, the former allowing recovery of a small sample. Reversing thermometer assemblies and the tripping mechanisms on large-volume bottles were tested and some samples were taken to test a new laboratory pressure filtration system for the trace element and particulate sampling programme. A new bottom net, with a pinger to monitor attitude, was launched and successfully fished in 1000m depth. Winds were 20-22 knots. The station was completed at 2145/23 June and we proceeded to the start of the first sampling profile.

En route, trials of a side scan sonar system, modified for use as a telesounder, were made on the shelf off Spanish Sahara. Weather conditions were generally poor for this application.

Six stations (numbers 8520 to 8525) were occupied on the first profile, from 0515/25 to 1910/29 June, running from 20°46'N, 18°00'W to 20°45'N, 24°00'W. Wind speeds varied between 15 and 25 knots, decreasing westwards. Hydrographic casts, between 2 and 5 on each station, plus gravity core attempts, were completed on each station. In addition, replicate trawls with the bottom net were made on stations 8521 and 8524, in 3070 and 4414m depth, respectively.

On station 8525, 1000m of new 4mm wire was added to the forward steam winch to make up for some loosely-laid wire at 4400m. We were then able to use the winch for the deep stations on the later profiles.

On the second profile, five stations (8526 to 8530) were occupied, from 1705/30 June to 1150/3 July, between 17°38'N, 22°00'W and 17°44'N, 16°44'W. Wind speeds decreased from 20 to 10 knots along the profile. A gravity core was collected on each station and the bottom net was fished on station 8528 in 3150m depth.

A sample of the sea-surface microlayer was collected on station 8528 from an inflatable boat upwind from the ship.

On route to the next profile, the side scan sonar/telesounder was operated on a small area of the shelf south of Cap Verde. The records were somewhat better than those obtained farther north because of smaller waves and lower wind speeds.

The third sampling profile consisted of six stations (8531 to 8536), from 1503/04 to 1010/08 July, between 13°59'N, 17°37'W and 12°45'N, 23°30'W. Wind speeds were between 6 and 10 knots along the profile. The station work repeated that on the first profile, hydrographic casts and a gravity core sample being completed on each station and the bottom net fished at 3000m depth on station 8532.

The final profile (stations 8537 to 8542), from 0230/09 to 1400/11 July, between 10°38'N, 22°04'W and 11°19'N, 17°23'W, repeated the sampling on the second profile. A gravity core sample was collected on each station and the bottom net was fished on station 8540 in 4000m depth. A further bottom net station, in 3000m depth, was planned, but a suitably smooth bottom could not be found after some searching and it was abandoned.

We then proceeded on various courses on the shelf off Guinea and Sierra Leone at 6 knots operating the sidescan sonar/telesounder. Weather conditions

were good on this section; the survey lasted from 1400/11 to 2330/13 July. Echo-sounding watches were secured at this point and Discovery proceeded to Freetown. The sonar and echo-sounder were recovered at 0700/14 July, we picked up a pilot at 0915 and were berthed at 1000/14 July.

Reports of Projects

1) Hydrographic Work

a) The Casts

A total of 12 hydrographic stations were occupied on the cruise and 57 separate casts were made (Table 1 and Figs. 1 &2). This work was carried out for selected dissolved trace element work and for a preliminary study of the geochemistry of suspended particulate material. The normal strategy on each station was to take between 2 and 5 casts, the shallow or an intermediate one first and the deepest one last, the latter using a pinger to position the lower bottle 10-20m off the bottom. Combinations of 1, 8 and 30 litre sampling bottles were used, a 1 litre bottle always being placed 10m above a large-volume bottle. Additional 1 litre bottles were also used to provide additional hydrographic detail.

The large-volume bottles were used without reversing thermometers, their depths being derived from the thermometric depths determined using the 1 litre bottles. Salinity, oxygen and reactive silicate were determined on samples from the 1 litre bottles, while the entire contents of the large volume bottles, whose volumes were known, were used for the particulate sampling.

In making up casts with a variety of sampling bottles, it was necessary to modify the available messengers. Normal messengers were provided with plastic lanyards to be released from Niskin bottles and totrip NIO bottles positioned below. General Oceanics "go-devil" messengers were used on the NIO bottles, without the lanyards provided, totrip Niskin bottles below.

b) Laboratory Work

Salinity was determined on all 1 litre samples using an Auto-Lab salinometer. Dissolved oxygen was determined on the same samples using the standard Winkler technique modified for use with a micrometer burette (2ml capcaity). Reactive silicate was likewise determined spectrophotometrically using standard procedures.

Large volume water samples were collected in high density polythene cans and pressure-filtered through 0.4μ pore size, 47mm diameter Nuclepore membrane filters, using compressed air or nitrogen at 15 psi. Attempts were made to filter the entire contents of the large volume bottles through single filters. This was possible with mid-water samples, but the membranes became clogged with some near-surface and near-bottom samples and a smaller volume was used. The filters were washed after filtration with three aliquots of 0.5M ammonium formate (isotonic with seawater) to remove residual sea salt and stored in lucite petri dishes.

The filtrates from the large volume bottles were split into 3 subsamples, one of which was acidified and stored for trace metal analysis at Wormley, the other two being used for the preliminary concentration of Mo and V on board. The metals were coprecipitated with the hydrous oxidesof manganese and iron, respectively, collected on membrane filters and

stored in glass vials. Final analyses of these samples will be completed at Southampton University.

J.D. Burton, S.E. Calvert, T. Coyle,
F. Culkin, M.J. McCartney, C.I. Measures

2) Sediment Sampling

A stainless steel gravity corer, equipped with 10cm diameter barrels, 1 and 2 m in length, was used to collect the sediment samples. A pinger was used 100m above the corer in order to determine the amount of wire to lay out. Positions and details of the cores collected are shown in Table 1 and Figs 1 and 2. Failures were due to faulty flap valves or sediment washing past leaf-spring valves in the catcher assembly.

S.E. Calvert
A.W. Gray

3) Benthos

The benthic programme had four main objectives; to test a new and previously untried bottom net and also a shaker for handling the samples, to compare at different latitudes the fauna close to the continental slope/rise junction if this could be identified, to repeat hauls as nearly as possible over the same ground in order to establish the confidence which can be placed in single samples as representative of samples in the general area, and to make some deep hauls for comparison with the shallower ones.

a) The gear

The bottom net BN 1.5

The new bottom trawl consists of a net with a mouth area of about 1.5 square metres attached to the back of a sledge with skids about 7' (2.15m) apart. In mid-water the mouth of the net is occluded by a simple blind attached to two heavy "feet" hanging beneath the sledge, while in the fishing position these feet are raised by the sea-bed and the blind is drawn back. A pinger registersboth the opening of the net and the adoption of a horizontal attitude by the sledge on the bottom rather than the nose up position assumed during shooting and hauling.

After some initial slight problems, including confusion in the identification of the pinger traces, it was possible to determine very accurately the times when the net began and ceased fishing and extremely steep wire angles were achieved, the ratios between wire out and depth on first contact with the bottom usually being within the range 1.2 - 1.4:1.

The weak link at the main towing swivel parted twice and one or other of the weak links at the ends of the lower net bar on several occasions, but in general the net worked very efficiently and no abortive hauls were made.

The use of the mini underwater camera mounted on the sledge confirmed the effectiveness of the blind in closing the mouth of the net and also provided some pictures of the bottom.

The "benthic shaker"

One of the main problems in handling deep sea benthic samples is the separation of small animals from large quantities of fine sediment. The benthic shaker, being a cross between a go-go girl and a collander, is an attempt to overcome this difficulty by providing a moving riddle. It consists of a stack

of three 4' x 2' trays with stainless steel mesh bottoms, mounted on a frame which can be shaken back and forth with a total pitch of ¼, ½ or 1" and at a continuously variable frequency up to 200/minute. In practice, the shaker was usually used with 8mm, 1mm and 0.5mm mesh trays and was shaken through a ½" stroke.

Though the shaking mechanism was not used for all the samples, it proved invaluable on several occasions, reducing even the largest samples containing upwards of 100 litres of mud to quantities which could be handled comfortably with hand sieves within 20-30 minutes.

b) Slope/rise samples (Table 2 and Fig. 2)

The original intention was that on each of the profiles to be covered during the cruise the slope/rise change in declivity would be recognised on the echo sounder record and a haul would then be made along the isobaths on the rise side of this change. In the event no obvious change was noticed on the southernmost profile as it crossed the very steep rise to the continental shelf off Portuguese Guinea and the area was so dissected by canyons that no reasonably flat ground suitable for bottom trawling could be found. However, a clear change in slope was found on each of the more northerly profiles and successful hauls were made.

Considerable differences between the catches in these three profiles were found. At the northerly station (8521) the sediment was a globigerina ooze and the fauna was dominated by large quantities of glass sponges; the other macroscopic animals taken included a large macrurid, several striking galatheid decapods, and scaphopod and bivalve molluscs. Annelids were fairly common, but the peracarid crustaceans were poorly represented.

On the next profile (station 8528) the sediment still had a large globigerina component but there was also a considerable admixture of pteropod remains. The fauna was rather restricted in both numbers of species and numbers of individuals. No trace of the siliceous sponges in the previous sample was found and the dominant macroscopic animals included asteroids, bivalves and scaphopods. Annelids were not abundant but the sample did contain considerable quantities of very fresh looking eel-grass which must have been transported from neighbouring shallow-water areas very rapidly.

A further change was found in the samples on the next profile (station 8532 *1 and *6). These catches, which were made respectively on the seaward and landward sides of the slope/rise break, were similar, the sediment containing large quantities of a fine brown mud and small amounts of a stiff blue-grey mud. Few large animals were taken in either haul, the macroscopic fraction consisting of a large natant decapod, some holothurians and asteroids and a few bivlave molluscs and annelids.

From a cursory examination of these few samples it seems that the physical feature of a change in slope at approximately the same depth does not impose much uniformity on the bottom fauna over the range of latitude sampled; it is likely that the nature of the sediment is much more important in determining the make-up of the bottom community.

c) The deep hauls

Three hauls were obtained in 4000m or more, two at about 21°N (station 8524 *1 and *6) and one at 11°N (station 8540 *1). At the first of these stations the sediment was a red clay, though most of this was winnowed from the net during hauling leaving a mainly globigerina ooze, while at the more southerly station the catch contained a very large number of rust-coloured worm tubes in a soft brown mud. All three samples contained few macroscopic

forms, though those from station 8524 included some striking purple-coloured soft holothurians.

d) Replicate samples

Where replicate hauls were made the pairs of samples appear on first examination to be very similar indeed.

R.G. Aldred
A.L. Rice
M.H. Thurston

4) Mid-Water Biology (Table 3)

The eighth in the series of hauls taken to study the growth rates of organisms and the rate of community change in the shallow mesopelagic fauna (300-600m) at 44°N 13°W was completed. No night sample at 300-400m was taken because of the shortage of time. Considerable changes had occurred in the fauna since the seventh series taken on 11/12th May during Cruise 61. The daytime 300-400m RMT 8 haul was dominated by Pleurobrachia. The abundant siphonophores which had previously dominated this depth had been displaced downwards to 400-500m. Argyropelecus hemigymnus, Nematoscelis boopis, small Benthosema glaciale and Cyclothone sp. were also abundant at 400-500m. Similarly the 600-500m haul included many species previously in the 400-500m range. The surface water was more transparent and the sea colour was blue, in contrast to being turbid and greeny during cruise 61. Whether the downward displacement of the mesopelagic fauna is a result of the downward displacement of the isolumes, or the interpolation of the large Pleurobrachia population will need investigating.

M.V. Angel

5) Side Scan Sonar and Telesounder Surveys

A combination of two Kelvin Hughes MS47 transducers fitted to the port side hull of the ship enabled the side-scan system to be used in the telesounding mode. By disconnecting one of the transducers, the system could also be used for conventional side-scan sounding. The system has an optimum scanning depth of about 50m and was only used on the shelf.

Side-scan and telesounder records were obtained along portions of the track, as shown in Fig. 2, at speeds of 6 to 8 knots. It was mainly used in the side-scan mode, but telesounding was done wherever there was some relief. The work was concentrated off Guinea and Sierra Leone where a series of buried Pleistocene deltas and associated shoreline features are preserved in the mid-shelf position.

The records obtained were only of moderate quality, due to the use of unstabilised transducers and to the presence of a strong thermocline.

C.D. Pelton
N.W. Millard

6) Meteorological Observations

Daily meteorological observations were made in order to check the accuracy of the data automatically logged by the ship's computer.

The calibration constant for the solarimeter was changed during the cruise on advice from IOS Wormley.

South of 20°N, more detailed observations were made and coded on WMO forms for the GATE exercise.

C.D. Pelton

7) Ornithology

Routine ornithological observations were made throughout the voyage. An average of seven ten-minute periods per day were spent scanning, identifying and counting birds. Casual observations outside these periods were also made.

Twenty-two species of sea birds and six land birds were seen, but only three, Cory's shearwater (Calonectris diomedea), Wilson's storm petrel (Oceanites oceanicus) and Herring gull (Larus argentatus), were at all numerous.

For the first two days of the cruise while still over the continental shelf, the birds seen were typical northern maritime species such as Fulmar (Fulmarus glacialis), Manx shearwater (Puffinus puffinus), Gannet (Moris bassanus), kittiwake (Rissa tridactyla), Herring gull and Lesser black-backed gull (Larus fuscus). These species disappeared abruptly when deeper water was reached and very few birds were seen until 17 June (36°N 13°W) when Wilson's storm petrel became a regular feature of the observations. With the exception of a flock of Cory's shearwaters at 35°N 12°W, there was little evidence of the warm temperate and subtropical species, until 19 June (32°N 14°W) when Cory's shearwater, Bulwer's petrel (Bulweria bulwerii), Madeiran storm petrel (Oceanodroma castro) and white-faced storm petrel (Pelagodroma marina) were seen fairly regularly.

South of the Canary Islands, the trends in numbers and distribution was longitudinal rather than latitudinal. The number of individuals recorded was markedly higher at the eastern end of each profile although the number of species was not significantly different. Only within twenty to thirty kilometres of the coast were terns encountered giving a greater diversity. Profile B was a partial exception to the longitudinal varia in numbers as small numbers of Madeiran and Leach's storm petrels (Oceanodroma leucorhoa) were seen north-east of the Cape Verde Islands.

The presence of Pomarine skuas (Stercorarius pomarinus) between latitudes 27°N and 11°N and Leach's storm petrel between 21°N and 11°N indicate that a juvenile or non-breeding element of the population does not migrate, and remains in winter quarters.

Most Wilson's storm petrels seen during the first part of the cruise were in the early stages of moult; the wing outline frequently appearing notched due to the loss of one or more inner primaries. A Leach's storm petrel captured at 13°N 21°W on 6 July was also moulting.

Three Leach's stom petrels and one Wilson's storm petrel were found on the ship and were ringed before release.

The data obtained during this cruise contrast sharply with those from previous cruises made in 1969 and 1972, and demonstrate a very marked seasonal variation in numbers and distributions.

M.H. Thurston

8) Computing

The computer and associated hardware performed well throughout the cruise. Problems arose with failure in the air conditioning system which on one occasion resulted in the internal clock, and hence the sampling, stopping. A malfunctioning paper-tape reader made the backing-up of the data disks difficult, and finally a fault on writing the ship's position to disk (which happened 3 times during the cruise) resulted in the navigation jumping several tens of miles. This was quickly noticed (automatic checks after each satellite fix) and was easily corrected without loss of information i.e. it was possible to calculate the correct position during the time the navigation was in error.

The alpha-numeric terminal was used for data entry by the biologists for recording net hauls and calculating distance travelled over the sea-floor.

The tektronix 611 was frequently used for Live Track Plots, in particular for surveying geological features and for positioning the ship over the same ground for replicate bottom trawls.

The program SMERC (track plots) was used to provide permanent records of the position at each station for various projects.

At the end of the cruise the ship's power system failed before the vital indexes could be dumped to the corresponding data disks. However, switching the computer on again after the power was restored showed that the information had not been lost and that the cruise files could be ended normally.

Overall the system now appears to be over-loaded. The system disks are full of programs and data files, while the CPU is constantly executing programs, especially the new navigation suite.

R. Bentley
I. Innes
D. Lewis

TABLE 1. Station List

Station No.	Date 1974	Position N. Lat	Position W. Long	Depth Corr. Metres	Equipment/ Sampling	Results
8517	14.vi- 15.vi	43°50.4' - 44°28.9' - 43°50.8'	12°24.8' - 12°51.7' - 12°26.2'		TSD RMT 1+8	0-1000m see Table 3
8518	17.vi	34°00.1' - 33°55.1'	12°01.3' - 12°06.4'	4449	HC GC	17 casts to 4100m Small amt. foram ooze.
8519	23.vi	24°01.4' - 24°02.5'	16°59.8' - 16°58.4'	1061	HC GC BN	4 casts to 935m 76cm green mud See Table 2
8520	25.vi	20°46.5'	18°00.7'	1237	HC GC	2 casts to 1080m 94cm green mud.
8521	25.vi- 26.vi	20°46.9' - 20°48.6'	18°53.4' - 18°53.4'	3066	HC GC BN	3 casts to 3005m 120cm grey-green clay see Table 2
8522	26.vi	20°48.9' - 20°47.8'	19°59.1' - 19°59.8'	3745	HC GC	3 casts to 3722m 222cm grey clay
8523	27.vi	20°45.9' - 20°43.7'	21°22.0' - 21°22.6'	4152	HC GC	3 casts to 4114m 103cm buff clay.
8524	27.vi- 28.vi	20°42.7' - 20°46.6'	22°44.6' - 22°41.8'	4432	HC GC BN	3 casts to 4201m 103cm pink clay see Table 2
8525	29.vi	20°45.3' - 20°44.1'	23°59.9' - 24°00.5'	4674	HC GC	5 casts to 4618m 105cm buff clay
8526	30.vi	17°38.2'	21°59.3'	3338	GC	162cm brown clay
8527	1.vii	17°39.9'	20°16.9'	3199	GC	No core
8528	2.vii	17°41.1' - 17°32.6'	18°40.2' - 18°42.1'	3153	GC BN SF	28cm grey clay See Table 2
8529	3.vii	17°42.6'	17°23.3'	2325	GC	124cm grey clay
8530	3.vii	17°43.7'	16°44.1'	647	GC	76cm green mud
8531	4.vii	13°58.6'	17°37.0'	936	HC GC	2 casts to 803m 88cm green mud
8532	4.vii- 5.vii	13°49.2' - 13°46.0'	18°18.8' - 18°07.5'	3240	HC GC BN	3 casts to 3169m 43cm grey-green clay see Table 2
8533	5.vii	13°39.0'	18°19.6'	4095	HC GC	3 casts to 3959m 188cm grey-green clay
8534	6.vii	13°18.9'	20°39.5'	4568	HC GC	3 casts to 3741m 147cm grey clay
8535	7.vii	13°02.8' - 13°00.9'	22°08.5' - 22°08.9'	4735	HC GC	3 casts to 4638m No core

M06 ↓

TABLE 1
B25, M02, M90, M06 (SOUTH OF 20°N)
H, G.

TABLE 1 CONTD.

Station No.	Date 1974	Position N. Lat	Position W. Long	Depth Corr. Metres	Equipment/ Sampling	Results
8536	8.vii	12°44.9'	23°30.5'	4866	HC	3 casts to 4824m
		12°46.0'	23°29.8'		GC	243cm pink clay
8537	9.vii	10°37.3'	22°03.8'	5128	GC	67cm green-grey clay
8538	9.vii	10°46.7'	20°39.9'	4955	GC	202cm grey clay
8539	10.vii	10°54.7'	19°31.7'	4604	GC	111cm grey clay
8540	10.vii	11°15.9'	18°23.0'	4017	GC	160cm grey clay
		11°11.7'	18°24.6'		BN	see Table 2
8541	11.vii	11°06.3'	17°43.2'	3121	GC	248cm green grey clay
8542	11.vii	11°19.3'	17°23.6'	627	GC	55cm green mud

Abbreviations:

HC	Hydrographic casts
GC	Gravity corer
BN	Bottom net; 1.5sq m.
SF	Surface film sample
RMT	Rectangular midwater trawl; 1 and 8 sq. m.

STN.	DATE 1974	POSITION LAT N	POSITION LONG W	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
8519	23/ 6	24 2.2	16 59.2	BN1.5/5C	997-1037	1744-1831		+00
# 7		24 2.5	16 58.4			DAY		
8521	25/ 6	20 46.9	18 53.4	BN1.5/5C	3053-3058	1644-1720		+00
# 1		20 47.6	18 53.5			DAY		
8521	26/ 6	20 47.9	18 53.4	BN1.5/5C	3064-3070	0507-0538		+00
# 6		20 48.6	18 53.4			NIGHT		
8524	28/ 6	20 45.5	22 42.5	BN1.5/5C	4412-4412	0316-0454		+00
# 1		20 46.6	22 42.0			NIGHT		
8524	28/ 6	20 44.3	22 44.4	BN1.5/5C	4414-4416	1955-2111		+00
# 6		20 44.9	22 44.3			DUSK		
8528	2/ 7	17 38.7	18 35.8	BN1.5/5C	3150-3155	0553-0626		+00
# 1		17 38.3	18 34.9			NIGHT		
8532	5/ 7	13 48.2	18 8.0	BN1.5/5C	2952-2958	1322-1416		+00
# 6		13 47.6	18 7.5			DAY		
8532	5/ 7	13 47.8	18 14.0	BN1.5/5C	3113-3119	0027-0106		+00
# 1		13 48.0	18 14.8			NIGHT		
8540	10/ 7	11 15.9	18 23.0	BN1.5/5C	3994-4005	1712-1749		+00
# 1		11 15.2	18 23.2			DAY		

TABLE 2. Bottom Net Station details

BENTHOS B18, B25

STN.	DATE 1974	POSITION LAT N	POSITION LONG W	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
8517 # 1	14/ 6	44 28.9 44 23.7	12 51.7 12 51.4	RMT 1 RMT 8	400- 500	0944-1144 DAY	FLOWMETER FAILED	+00
8517 # 2	14/ 6	44 21.8 44 17.3	12 50.5 12 48.4	RMT 1 RMT 8	300- 400	1237-1437 DAY	NO FLOW	+00
8517 # 3	14/ 6	44 15.3 44 10.9	12 46.5 12 44.4	RMT 1 RMT 8	500- 600	1534-1734 DAY	FLOW DIST. 6.93 KM.	+00
8517 # 4	14/ 6	44 9.9 44 6.8	12 43.9 12 41.4	RMT 1 RMT 8	0-1000	1803-1921 DAY	FLOW DIST. 3.92 KM.	+00
8517 # 5	14/ 6	44 2.7 43 58.4	12 40.0 12 36.2	RMT 1 RMT 8	500- 600	2145-2345 NIGHT	FLOW DIST. 7.42 KM.	+00
8517 # 6	15/ 6	43 54.6 43 50.8	12 30.8 12 26.2	RMT 1 RMT 8	400- 503	0205-0405 NIGHT	FLOW DIST. 7.63 KM.	+00

TABLE 3. Midwater Biology Station details

ZOOPLANKTON B09, 625

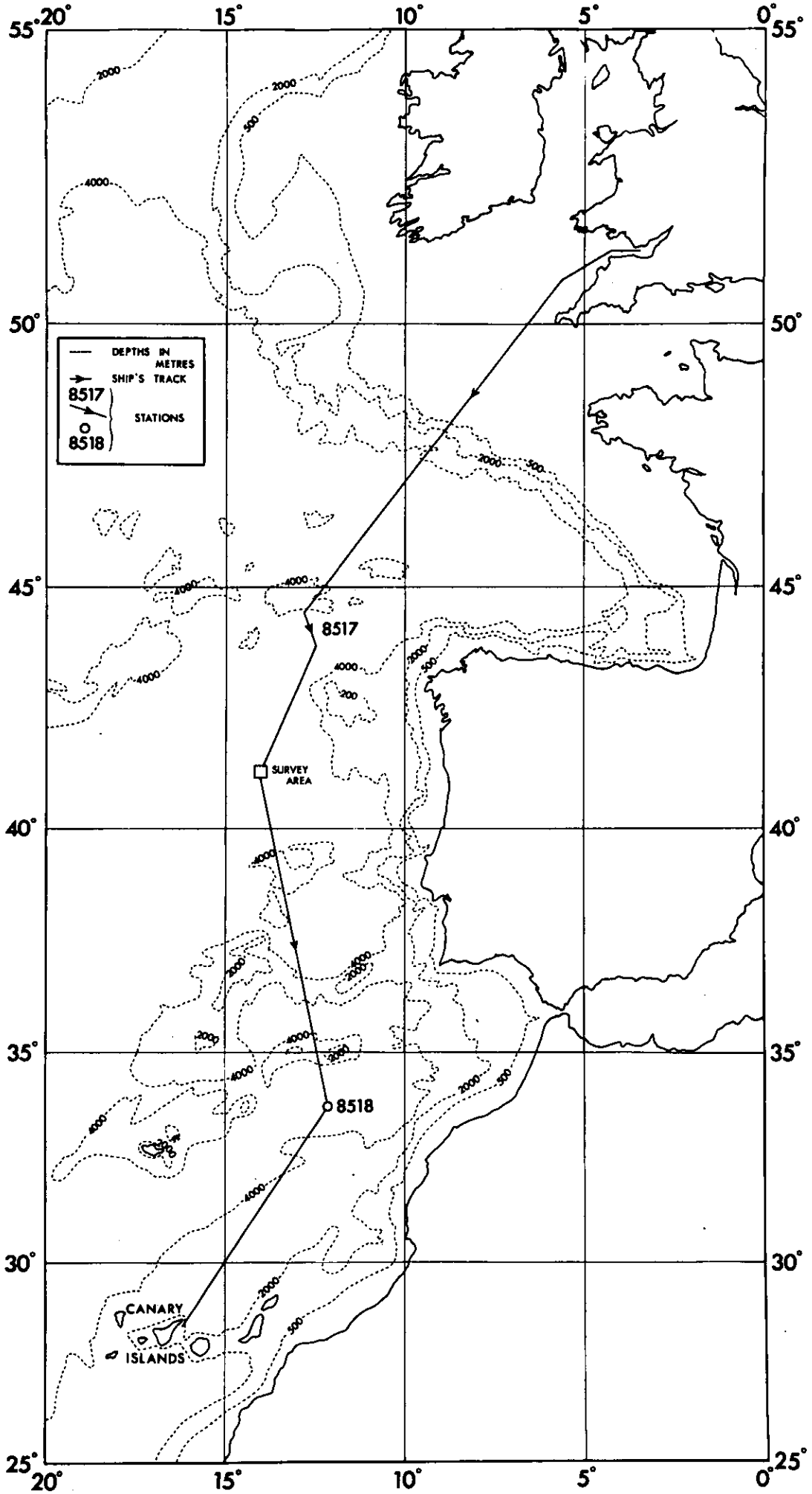
20°
15°
10°
5°
0°
55°
50°
45°
40°
35°
30°
25°
DEPTHS IN METRES
SHIP'S TRACK
8517
8518
STATIONS
SURVEY AREA
CANARY ISLANDS
2000
500
4000
200

FIG. 1

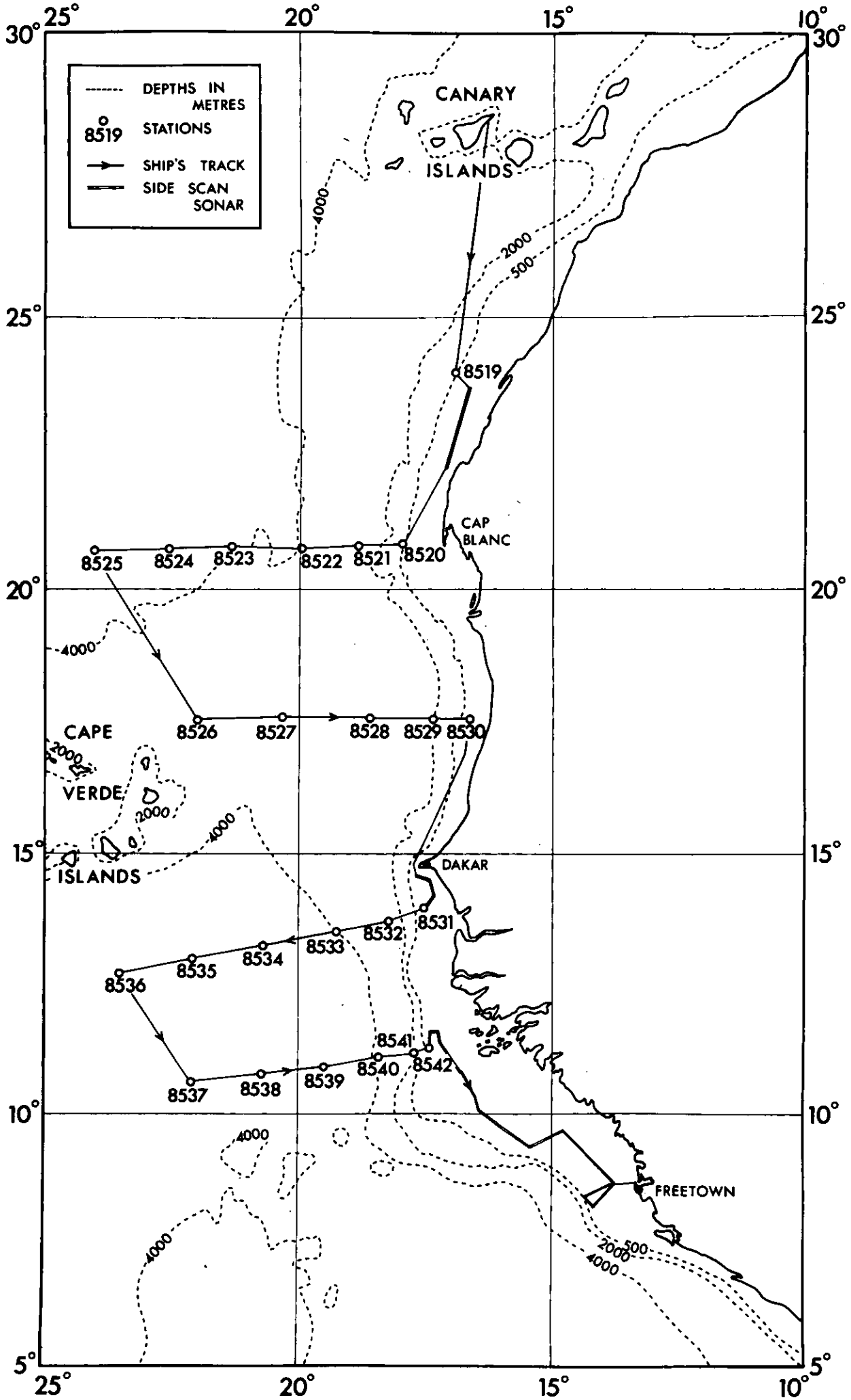
DEPTHS IN METRES
8519 STATIONS
SHIP'S TRACK
SIDE SCAN SONAR
CANARY ISLANDS
CAP BLANC
CAPE VERDE ISLANDS
DAKAR
FREETOWN
8519
8520
8521
8522
8523
8524
8525
8526
8527
8528
8529
8530
8531
8532
8533
8534
8535
8536
8537
8538
8539
8540
8541
8542
4000
2000
500
0
30°
25°
20°
15°
10°
5°

FIG. 2