I.O.S.

RRS DISCOVERY
CRUISE 126

4 MARCH — 3 APRIL 1982

GEOLOGICAL AND GEOPHYSICAL STUDIES BETWEEN THE AZORES AND THE CANARIES

CRUISE REPORT NO. 141
1983

NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE OF OCEANOGRAPHIC SCIENCES

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INSTITUTE OCEANOGRAPHIC SCIENCES

WORMLEY

R.R.S. DISCOVERY

Cruise 126*

4 March - 3 April 1982

Geological and geophysical studies between the Azores and the Canaries

Principal Scientist

T.J.G. Francis

I.O.S. Cruise Report No. 141

1983

**This cruise was transferred to, and completed, aboard RRS Shackleton which sailed from Ponta Delgada on March 18.*

CONTENTS

DATES

Discovery Leg	Departed Gibraltar	4th March, 1982	Day 063
	Arrived Ponta Delgada	16th March, 1982	Day 075
Shackleton Leg	Departed Ponta Delgada	18th March, 1982	Day 077
	Arrived Gibraltar	3rd April 1982	Day 093

SCIENTIFIC PERSONNEL

		Discovery Leg	Shackleton Leg
T.J.G. Francis, Principal Scientist	IOS Wormley	X	X
R.J. Babb	IOS Wormley	X	X
A.F. Gray (Alistair)	IOS Wormley	X	X
A.W. Gray (Alan)	IOS Wormley	X	
D.E. Gunn	IOS Wormley	X	X
T.J. Hamlyn	IOS Wormley	X	X
M.J. Harris	IOS Wormley	X	X
Q.J. Huggett	IOS Wormley	X	X
S. Jones	RVS, Barry	X	X
R.B. Kidd	IOS Wormley	X	X
G.V. Lodge	IOS Wormley	X	
P. Mason	RVS Barry	X	
M.J. Noel	IOS Wormley	X	X
Ms M.C. Price	IOS Wormley	X	X
P.J. Schultheiss	IOS Wormley	X	X
R. Simm, Case Student	Univ. Coll. London	X	X
P.P.E. Weaver	IOS Wormley	X	X
A.A. Misab	Moroccan Observer	X	

SHIP'S OFFICERS AND PETTY OFFICERS

	R.R.S. Discovery	R.R.S. Shackleton
Master	S.D. Mayl	M. Harding
Chief Officer	E.M. Bowen	D. Coverdale
Second Officer	B.M. Richardson	P. Oldfield
Third Officer	P. Pepler	A. Brigden
Chief Engineer	A. Coombes	C. Storrier
Second Engineer	D. Hornsby	G. Batten
Third Engineer	R. Cotter	C. Phillips
Fourth Engineer	G. Parker	R. Whitton
Fifth Engineer	K. Sullivan	
Fifth Engineer	T. Comley	
Electrical Officer	P. Sharpe	B. Smith
Radio Officer	R. Townsend Rose	R. Parker
Purser/Catering Officer	R. Overton	R. Morris
Bosun	F. Williams	S. Francis
Carpenter	L. Cromwell	

CRUISE OBJECTIVES

The main objective of the cruise was to study the sediments and sedimentary processes in the Canary Basin - part of the feasibility studies into the ocean disposal of high-level radioactive waste commissioned by the Department of the Environment. Four months prior to the cruise a GLORIA sidescan sonar survey of the area was conducted on Farnella Cruise 3/81, revealing fascinating and hitherto unknown patterns of sediment transport across the lower continental rise off northwest Africa out towards the distal regions of the Madeira and Cape Verde abyssal plains. A principal purpose of this cruise was to conduct near bottom geophysical observations and to obtain core samples from some of the Farnella GLORIA targets. By this means we hoped to "calibrate" the GLORIA data. The work was to be concentrated in three study areas (Great Meteor East, Cape Verde One and Cape Verde Three) and upslope from these areas towards the African margin. It would include Driscoll piston coring, Kastenlot coring, bottom photography, 3.5 kHz profiling from the sea surface and high-resolution near-bottom profiling in the 5-10 kHz band. In order to locate the equipment precisely in relation to GLORIA targets some stations would be acoustically navigated. A further geophysical objective of the cruise was to gather heat flow data, principally along two orthogonal traverses in the Great Meteor East area.

The final objective of the cruise and the first to be carried out was to act as shooting ship in a two-ship multichannel seismic experiment in which the RRS Shackleton would be receiving ship. This work would be in support of the Department of Earth Sciences of the University of Cambridge. The shooting would involve the firing of approximately 3 tonnes of explosives and airgunning with a 1000 in^3 airgun.

A series of problems prevented us from achieving all of the above objectives:

(1) Before the cruise started we learned that Spain would not allow us to work within 200 nm of the Canaries, even though such permission had been granted to the preceding Farnella cruise. Although a disappointment this detracted little from the main objectives of the cruise, since the bulk of our work was well outside the Canaries limit, but it did mean that some of the GLORIA targets nearer the source of sediment supply could not be worked on.

(2) The explosives part of the seismic experiment proceeded smoothly but difficulties with the airgun system, elaborated on in the narrative section,

prevented us from carrying out any airgunning either for the Cambridge seismic experiment or subsequently for seismic reflection profiling.

(3) Finally, a problem developed with the Discovery winch which forced us to terminate the first leg prematurely and transfer the whole operation to the Shackleton in the Azores. It was our good fortune that Shackleton was available and the transfer allowed us to complete some two thirds of the work which we would have achieved in the most favourable circumstances.

NARRATIVE (All times GMT)

Discovery Leg

Repairs to the traction winch were completed at 1300 on March 3rd (Day 062) after which the coring warp was reeved and the winch tested with a 5 ton load. During this time the Agent attempted to make contact with the Moroccan observer in Tangier so that he could fly over to Gibraltar and allow the ship to sail that evening. This proved impossible, so the departure of the ship was delayed 12 hours until 0630 on day 063. At 1000 we arrived off Tangier and the observer, Abdul Aziz Misab, arrived on board by pilot boat at 11.25 in the uniform of a Sub Lieutenant of the Moroccan Navy. During the afternoon the PES, 3.5 kHz and magnetometer fishes were streamed and by 1645 we were heading west at full speed on two engines (10+ knots) to rendezvous with the Cambridge team in RRS Shackleton at $36^{o}09'$N, $23^{o}28'$W (RV1). Minor problems with the PES, 3.5 kHz and the computer logging took the remainder of the day to be sorted out. This was the first trial of the new 3.5 kHz system at sea. That evening radio contact was established with Shackleton, but there was too much interference for voice communication.

Discovery continued on passage in good weather for the next three days. Daily radio schedules were made with Shackleton to discuss the details of the seismic experiment in which Discovery would act as shooting ship. Between 0936/064 and 1115/064 the ship was hove to while the towing arrangements of the 3.5 kHz fish were improved. From 1336/066 we followed a comfortable southerly course for about an hour while explosives were transferred from the forward magazine to the ready use locker on the poop.

After passing Shackleton during the night Discovery was near RV1 at 0825/067 when test firing commenced. Three 2.1 kg shots were fired at 3 minute intervals and successfully received by Shackleton's 24-channel array. We then manoeuvred so as to be going eastwards along the line of Expanded Spread Profile No. 1 (ESP 1), with Shackleton going westwards, each ship at 5 kt, and to pass abeam of each other at the RV1 position. Shooting of ESP 1 began at 1000 and the two ships were abeam to port 100 yards apart at 1004. A total of 65 shots were fired (15x2.1 kg, 15x12.5 kg, 15x25 kg, 20x50 kg) with no misfires, the last shot going off at 1348.

Discovery then returned at full speed on two engines to rendezvous with Shackleton before nightfall and make a transfer of minor items of equipment and food by inflatable boat. The next line was to be a Constant Offset Profile with Discovery firing a 1000 cu. in. airgun every 40 sec. The airgun was launched at 2230/067, seated satisfactorily, but the valve board did not function properly. While this was being adjusted an explosion occurred in the valve board and the adjacent hose on deck blew. No one was injured, but the explosion was clearly an ignition and it was not clear where oil had got into the compressed air system. The prudent thing to do was to abandon the airgunning and to head for $36^{o}32'$N, $23^{o}23'$W (RV 3) to shoot ESP 2 the next day.

During the forenoon of day 068 we manoeuvred slowly in the vicinity of Shackleton, allowing Bob White and Kevin Smith to transfer from Shackleton so that the latter could examine the valve board. However, repairing the board would have taken too long, as Shackleton was all this time proceeding north at 2½ kt with her array streamed, and doubts remained about the safety of the compressed air system. The Shackleton personnel returned to their ship and Discovery manoeuvred into position for ESP 2. Firing started at 1400 on a course of 190^{o} at 5½ kt. The same suite of charges were fired as on ESP 1 with the 65th charge detonating at 1748. At 1750 the remaining unused explosives were fired. Out of the total of 131 charges there were no misfires, a tribute to the expertise of our shotfirers Steve Jones and Peter Schultheiss.

The magnetometer was streamed and switched on at 1805/068 and we headed south for our first station with the traction winch. At 0823/069 the magnetometer was switched off, the fish was recovered and by 0830 we were hove to for station 10405 with the Heat Flow Probe. The 3.5 kHz profiler was also switched off to minimise acoustic interference with the pinger telemetry from the probe. This being the first use of this particular instrument its assembly took longer than it should and it was not until 1224 that the instrument was launched. Eight penetrations were made between 1431 and 1834 and the instrument was back inboard at 2040. Recovery of the instrument proved to be an awkward operation and a better handling method needs to be devised. Following the Heat Flow station an hour was spent in handling trials of the Kastenlot corer before setting off at 2158 on passage to the first Kastenlot Core station.

At 0416/070 the ship was hove to for station 10406 with the Kastenlot corer. Launching was achieved by running the corer out horizontally through the stern rail, its weight being taken by the crane. Once outboard the load was transferred so that it hung vertically from the crane davit on the 21 mm coring warp. The station proceeded satisfactorily until 0839 when with 3853m of wire out and the corer coming up an ominous clicking started in the forward drum of the traction winch. A recurrence of the problem which afflicted cruise 125 was with us. The hauling speed was reduced and a 3.4m core recovered at 1145. During the night Petty Officer Knox, one of the crew, had seriously injured a finger in a steel door, so on completion of the station at 1145 we set course for Funchal to drop him off for medical treatment.

Between 1100 and 1600 scientific activities ceased while we lay off Funchal to land the injured seaman. Meanwhile R/T communication was established with Director IOS and it was decided that the scientific party should transfer to the Shackleton in Ponta Delgada on March 16 (075) to continue the cruise in that ship. On completion of the Cambridge cruise Shackleton was scheduled to dead head back to the UK for refit, so we were exceptionally fortunate that a replacement ship was available, nearby and equipped with a suitable deep sea winch. Four days remained until the transfer, giving us time to conduct a few stations with the High Resolution Deep Profiler on Discovery's CTD wire before arriving in Ponta Delgada. On leaving Funchal course was set for the Great Meteor East area.

By the evening of day 072 we reached the area of the earlier Farnella cruise and, after running 3.5 kHz profiler tracks over some of the GLORIA targets, stopped at midnight for station 10407 with the High Resolution Deep Profiler. After some initial difficulties had been overcome, we succeeded in towing the instrument some 7 n.m. over the bottom. A maximum of 6250m of wire was used in 5225m water depth. Maximum tension on the wire was 3700 lb. The station was completed at 1453/073 and we headed for Ponta Delgada, acquiring on the way some useful 3.5 kHz profiles over the Farnella GLORIA coverage.

In fine weather and with three engines operating we made excellent progress at more than 12 knots so that by the afternoon of day 074 there was time to conduct another High Resolution Deep Profiler station and still arrive at Ponta Delgada by mid-day on 075. At 1454 we were hove to for station 10408 over a small sedimented pond between abyssal hills. Excellent sub-bottom reflections were obtained, the strongest of which corresponded with those seen on the 3.5 kHz. The station was completed at 1902/074 and we continued on passage. Scientific watchkeeping was concluded at 1000/075 and the magnetometer, 3.5 kHz and PES fishes were recovered in the ensuing half hour. At 1300 we tied up alongside Shackleton which was berthed facing west near the outer end of the Ponta Delgada mole. Discovery faced east in order to facilitate the transfer of scientific gear from her poop to Shackleton's well deck.

Shackleton Leg

Transfer of gear to Shackleton continued through the forenoon of day 076 and at mid-day Discovery sailed to return to the UK for winch repairs. Limitations of space and equipment precluded the complete transfer of people and equipment. Fourteen of the scientific party transferred, the remaining three returning to the UK with Discovery and the Moroccan observer disembarking. Coring from Shackleton would be confined to gravity and Kastenlot corers since the ship was not equipped to handle the heavier Driscoll piston corer. Shackleton's main winch carried 7200m of non-tapered 13mm steel warp at the start of our cruise.

At 1120/077 Shackleton sailed from Ponta Delgada and headed south towards the Great Meteor East area. At 1600 we stopped to deploy the PES and 3.5 kHz fish, the latter being achieved with the main warp and "A" frame since there was no suitable towing boom as in Discovery. By 1715 we were underway with the magnetometer fish also streamed. At 0600/079 we hove for station S126/1 with the Kastenlot corer in the Great Meteor East area. Before starting the core station the 3.5 kHz fish had to be recovered. The PES record indicated an almost transparent layer 5m thick beneath which sub-bottom reflectors appeared to a depth of 15m. Clearly the sediment we planned to core was soft and fine grained. However, the core collected at S126/1 fell out of the barrel due to a catcher door failure and it took another station S126/2 to recover a core successfully.

At the conclusion of the second station we proceeded eastwards for a couple of hours towards the intersection of two Dutch 3.5 kHz lines which we had chosen for the site of station S126/3 with the Heat Flow Probe. This station commenced at 1905/079 and half an hour later the probe was on the way down. Three penetrations of the bottom were made, but the conductivity pulse failed to work so the probe was retrieved earlier than planned for modifications to be made. While this was being done a further Kastenlot core was obtained at station S126/4.

The next Heat Flow station, S126/5, started at 0530/080 in much the same place as the previous one. Unfortunately the conductivity pulse still failed to work, so after three penetrations, in which only temperatures were recorded, the probe was again prematurely recovered. On completion of the station the 3.5 kHz fish was streamed and at 1107 we got underway for the next station, our track being chosen to cross a number of conspicuous features of the Farnella GLORIA coverage. At 1708 we hove to for a survey camera run, station S126/6, across a series of fan-shaped lineaments identified on the side scan records. For this station the 3.5 kHz fish was not recovered but was transferred to the davit on the forward starboard corner of the superstructure in order to save time. After various problems with the camera had been overcome it was in the water at 1855 and was photographing the bottom from 2144 to 0223/081. While heaving in the camera the warp snagged the 3.5 kHz fish and damaged its faired cable, so our efforts to save time proved to be a case of more hasteless speed. Nevertheless the system was still operational and at 0603/081 we got underway to run a number of zig-zag tracks across the Farnella GLORIA coverage with PES and 3.5 kHz (see Figure).

The survey continued throughout the next day and until 0046/083 when we hove to for the first core station on the Farnella GLORIA coverage, S126/7. Some maintenance was necessary to the deck winch control before we could recover the 3.5 kHz fish, so it was not until 0145 that the station itself commenced. A 1.7m gravity core containing some very coarse sand was recovered and inboard at 0630. The next station was only a short distance away and by 0710 we were hove to in position. Before shooting the core station the (blue) Acoustic Navigation fish was deployed on the main warp and then transferred with the crane to hang off the starboard fo'castle bollard. This was completed by 0800/083 and station S126/8, combining acoustic beacon tests with the gravity corer, began. Acoustic beacons were attached to the main warp 500 and 550m above the corer. The beacons transponded satisfactorily to the signals from the blue fish, but the S/N ratio on the EPC recorder was poor. A 1.6m core was recovered, again containing some very coarse material. On examining the acoustic beacons after recovery both puffers were found to have fired so it was decided to proceed with a series of stations, at approximately 30°50'N, 22°50'W, acoustically navigated by the two beacons.

Because of the prevailing NE wind it was decided to move to the northerly acoustic beacon position first and at 1838 we hove to at 30°54'N, 22°50'W. A long time was then spent waiting for a good satellite fix on which to drop the beacon. It was eventually launched at 2219, though the satellite fix was only moderate. The blue fish was then launched and suspended from the starboard forecastle bollard. Moving south, we planned to drop the second acoustic beacon at 30°50'N, 22°49'W. Reception of the first beacon was so poor, however, at 9 km horizontal range that we decided to abandon the launch of the second beacon and with it our efforts at acoustic navigation on this cruise. Instead we moved west a little to conduct a camera station.

Station S126/9 began at 0230/084. By 0524 the camera was near the bottom. Unfortunately the Near Bottom Echo Sounder (NBES) failed to operate, so the camera was hauled back and inboard at 0750. At 0800 we got underway and moved north a couple of miles to take a Kastenlot core on the "layered facies" identified on the 3.5 kHz records south of the channel. S126/10 began at 0900 This station was also unsuccessful, probably because the corer fell over on the bottom due to coarse sediment close to the surface. The station was repeated, as S126/11, with a triggered gravity corer and was successful in obtaining a 0.7m core, the bottom of which was sand.

The next station, also with the gravity corer, was to be on the axis of the channel. Before starting the station we observed the channel with the PES on a south to north traverse. Then lowering the corer to 200m above the bottom we moved back south at 1 kt, stopping just on the southern edge of this roughly 0.5 mile wide feature. After allowing the wire angle to steepen for nearly half an hour the corer was lowered into the bottom. Taking into account what the PES was telling us, the wire out and the wire angle, and a satellite fix at the time of penetration we were confident that the corer bottomed in the channel. A 0.9m core was recovered, again with lots of sand.

On completion of the core station we moved south to make another attempt to run the survey camera NNE across the GLORIA features. Station S126/13 began at 2355/084 but we were again frustrated by problems with the NBES. On completing this station at 0545/085 we moved south to core a feature interpreted as a debris flow on the 3.5 kHz records. A triggered Kastenlot core was used for this. However, station S126/14 only succeeded in retrieving some mud in the catcher, whose doors had closed. The dynamometer record of the station suggested that the corer pre-triggered.

At 1020/085 we got underway and moved north to recover the acoustic beacon. This was on board at 1324, following which the blue fish was recovered and the (red) 3.5 kHz fish deployed on the main warp. At 1430 we were underway once more, heading for the "black hole" on the GLORIA coverage, interpreted as an area of pelagic sedimentation shielded from terrigenous input by a basement high. At 2100 we reached the coring site. The red fish was transferred to the starboard fo'castle bollard, but before the coring could commence some 20m of main warp which had bird-caged had to be removed and a new swaged hard eye fitted. This completed, the Kastenlot corer was over the side at 2233. This station, S126/15, was successfully completed at 0130/086, the 2.2 m core obtained confirming the GLORIA interpretation. Passage was then made for the next core site, located on a "distal lobe" of the GLORIA coverage, but by the time it was reached at 0649/086 the weather had deteriorated and it was decided to continue on to the position of S126/5 for a repeat of that Heat Flow Station. However, the weather deteriorated even further and eventually it was decided not to proceed with this station either. Around midnight the 3.5 kHz ceased operating because, it transpired later, water had got into the junction box on deck. This problem could not be sorted out until the weather moderated.

Throughout the day 087 we remained hove to in Force 8 to 10 winds and heavy seas, progressing only 60 n.m. in a N by W direction. On day 088 the weather moderated and our speed was increased to 5 or 6 kt. The following day we were informed that the cruise would end at Gibraltar in order to drop equipment for Discovery which would now be sailing before we could reach the UK. At 0835/089 course was altered to 085^{o} for Gibraltar. Scientific watchkeeping was concluded at 0830/090 and the PES and 3.5 kHz fish were recovered.

T.J.G.F.

PROJECT AND EQUIPMENT REPORTS

3.5 kHz Profiler: Instrumentation

This system has been developed at IOS to obtain a continuous acoustic record of the sea-bed sediments while the ship is underway. During the cruise it proved capable of penetrating the sediment to a depth of 94 metres.

The system comprises a deck control unit, power amplifier with a booster, EPC recorder and a towed acoustic transducer array. The deck control unit contains the electronics that provide the swept frequency transmission pulses, and the receiver and correlator that amplify and process the return echo signals. An Edo Western power amplifier and booster provide the necessary amplification and impedance matching for the acoustic transmission of the pulses by the transducer array. This array has four transducers that are series parallel connected and mounted in a fish that is towed alongside the ship.

The acoustic transmission pulse has a duration of 28 milliseconds and within this time span the carrier frequency is swept from 3.0 kHz to 4.0 kHz. The return echo signal is received by the transducer array and fed through the preamp, optional AGC and matched filters for display on an EPC recorder. During this cruise better results were obtained without the use of the optional AGC.

M.J.H.

3.5 kHz Profiler Records

The 3.5 kHz system performed exceedingly well over a wide range of sea-floor environments and water depths and during a variety of sea states and ship conditions. Down-time was confined to a period when the deck junction box flooded during a storm. The only poor records were obtained immediately after the transfer from Discovery to Shackleton while on passage south from the Azores. This was traced to incorrect connections into the correlator, from which point high quality records similar to those recorded earlier on Discovery were obtained. Clearly this is a system which can be transferred easily from ship to ship with no loss of performance. Tests were made of signal quality on Shackleton at varying ship speeds: 4, 6, 8 knots and full cruising speed. Only a slight increase in sub-bottom penetration was observed at the slower speeds and the system loses little in record quality at full cruising speed. Sea state and weather conditions affected the records adversely only when they became extreme. Ship pitching during bad weather (gale force 8-9 and 45 kt. winds) caused a loss of sharpness and breaks in the trace-to-trace correlation. Despite this there were few occasions when the records became of little use in interpretation.

The interpretive value of high resolution seismic profiling lies in its ability to characterise changes in the style of sedimentation on the deep sea-floor through changes in echo-character. Because of the relatively low frequency of the 3.5 kHz system when compared with the standard PES echo-sounder, it is capable of penetrating the upper parts of the 100 metres (70 to 90 metres of sub-bottom penetration was common on the distal abyssal plains crossed during this cruise) revealing stratification and its orientation. Echo character mapping using 3.5 kHz systems has been extensively employed since the 1960s by U.S. oceanographic institutions as a tool in examining sedimentary environments and processes on the deep sea-floor. Over the years, these maps have been 'calibrated' through sediment sampling, bottom-photography and other near-bottom techniques and the sediment types have been correlated with particular echo-characteristics. During this cruise we planned to use the 3.5 kHz profiling, along with bottom photography, sampling and near-bottom seismic profiling, to examine the causes of changes in back-scattering detected by GLORIA on the 'Farnella' cruise in October 1981.

A high degree of correspondence has been found between the backscattering changes on the GLORIA sonographs and the changes in echo-character observed by the 3.5 kHz profiling. Five main 'sediment facies' are interpreted from the profiler records.

1) *Transparent* wedges (5 to 10 m thick) or infill layers which overlap other facies.

2) *Thin stratified* sequences (up to 30 m thick) which can be traced laterally into:-

3) *Channels* - topographic indentations into the sea-floor with a relief of around 20 metres and which show no sub-bottom traces.

4) *Pelagic drape* over, or onlapping onto, basement topographic features (including seamounts).

5) *Thick stratified* sequences over the abyssal plain regions, which show

remarkably extensive horizontal continuity and have a 'ponded' relationship to basement features.

Each of these has a distinct backscattering signal on the GLORIA sonographs. The combination of the two techniques clearly forms a powerful mapping tool with which to examine complex sedimentary processes in abyssal regions.

R.B.K.

Stratigraphic Coring

We planned to take a series of 12m-long piston cores for stratigraphic purposes, but the failure of the Discovery winch prevented any use of the Driscoll piston corer. We therefore resorted to using the Kastenlot box corer with 2 and 4m-long boxes, and on RRS Shackleton we also used a triggered Barry gravity corer with a 3.6m barrel. All the cores were opened at sea - the osmotic knife providing excellent unsmeared surfaces for descriptions and photography both of which were completed at sea. Smear slides and nannoplankton slides were made at sea and the smear slides were described on board. Samples were also taken for later analyses of calcium carbonate content, grain size and X-ray mineralogy.

The only core taken on RRS Discovery (D10406) was sited in the eastern part of the Madeira abyssal plain in a water depth of 5628m. It was taken with the Kastenlot corer and produced 3.4m of interbedded marls, pelagic clay, tephra rich layers and volcaniclastic sands. Seven individual graded units were found in this core indicating frequent turbidity currents in this area.

Two cores were taken in the Great Meteor East study area. S126/2 from the western part of the area was taken in 5446m water depth and revealed 4.15m of soft fine-grained sediment. This sediment is interpreted as representing two turbidites separated by 30 cm of pelagic sedimentation. The base of the lower turbidite was not penetrated but the recovered section of this turbidite was 327 cm thick with the lowest 20 cm consisting of laminated silt. Core S126/4 was taken in the central part of the study area in 5446m water depth. It consists of 3.83 m of sediment, again with the lower 3.16m consisting of a thick turbidite - this turbidite may be laterally equivalent to the lower turbidite in S126/2. Above the turbidite there are a series of marls and a possible second turbidite which has a striking green coloured base.

A number of cores were taken over the distal parts of the Spanish Saharan submarine sediment slide in an effort to calibrate the GLORIA sonograph coverage obtained from R.V. Farnella. The sites were carefully located with the aid of the 3.5 kHz profiler records and one of them was to have involved a transect of bottom transponder-navigated cores. Despite the failure of the transponder-navigation the cores obtained were sufficiently well located to characterise the major GLORIA backscattering/3.5 kHz echo-character changes as planned.

At the first location, referred to as the "boundary site", two cores were taken with the Barry corer. The first, S126/7, recovered a 1.66m core in which a graded volcaniclastic sand to marly ooze unit in the upper 8.5 cm and trigger core, overlies a sequence of 20 to 30 cm thick "flow units" within which nannofossil and marly oozes, pelagic clays and variegated marls are generally flowed and disturbed. The second, S126/8, is 1.57 cm long and comprises an 11 cm thick marl overlying a series of intensely deformed "flow units", 12 to 60 cm thick. These units contain rounded patches of black volcaniclastic sand, white nannofossil ooze and marls, often flowed into near vertical orientation, along with 1 to 3 cm size clasts of basalt rock and green tephra. The flowed lithologies are interpreted as primary fabrics (i.e. not coring disturbance) and are indicative of debris flows. At the "boundary site" the bright backscattering zone of the sonographs appears to represent a debris flow lobe and the dark speckled zone a place where turbidites have onlapped the surface of a further lobe.

The second location, the "transponder site", was to have been the site for acoustically navigated coring. Three coring attempts were made, one with the 4m barrel Kastenlot corer, which failed to penetrate, and two successfully with the 3m barrel Barry gravity corer. S126/11 was taken over an area characterised as "dark-speckled" on GLORIA and "thinly stratified" on 3.5 kHz profiles. The core comprises 0.68m of graded volcaniclastic sand to marl units and the location is interpreted as an "overbank" area for the channel to the north. This 20m deep channel is a clear topographic target on GLORIA sonographs, and features as having no penetration on 3.5 kHz records. S126/12 was taken in its axis. Again coarse sands with marls were encountered this time massive and ungraded and containing rounded pebbles up to 3 cm long. Both cores are suspected of having repenetrated but, with the great difficulty in penetrating through these very coarse sands that we experienced here, it appears that we were fortunate to have any recovery at all.

The remaining location, the "black hole" site, was planned as an attempt to characterise the patches of solid black detected by GLORIA around basement structures. Our 3.5 kHz profiles showed these to have a draped style and they are interpreted as pelagic sedimented areas. The 4m barrel Kastenlot corer recovered 2.2m of sediment at station 126/15. This indeed comprises a dominantly pelagic sequence of horizontally bedded and bioturbated, marly oozes, marls and pelagic clays. Also present are laminated silty marl layers whose content of detrital material suggests they may be distal turbidite units unconnected with the volcaniclastic turbidites of the side channel area.

RBK, PPEW

Physical Properties

The main objective of the physical properties programme was to obtain sediment samples from appropriate sites for analysis at Wormley and other laboratories. All the samples were obtained using the 15 cm x 15 cm square section Kastenlot corer. Although 2, 4 and 6 metre length barrels were available, the 6m barrel was not used because of the foreshortened cruise programme. However, the 4m barrel was used successfully, for the first time allowing high quality samples to be obtained beyond 2 metres.

On the first leg only one core was obtained (D10406). This was taken at the same site as the "weight drop experiment" on Discovery Cruise 118 (D10303) which provided <u>in situ</u> shear wave velocity measurements. During the ascent of this core the gearbox on Discovery's new traction winch was damaged which prevented its further use. The recovered core (3.4 m) consisted of oozes, marls and turbidites and was subsampled primarily for triaxial strength testing and consolidation analysis. A substantial amount of washout down one side of the core (possibly due to the long recovery time and a slight gap between the cutter and the barrel) made it impossible to transfer complete 1m lengths into the specially designed transportation boxes. Consequently the triaxial samples were obtained by sub-sampling using polycarbonate tubing.

Coring from RRS Shackleton began with a 2m barrel and 6 weights (S126/1). This core was lost on recovery at the surface because the catcher doors had not closed. A 4m barrel with 12 weights was used on the same site (S126/2) and a full core was recovered consisting mainly of a thick turbidite. At station S126/4 a 3.85 m core was obtained (mainly turbidite) again using the 4m barrel and 12 weights.

This configuration failed to work at S126/10 where it is suspected that a hard sand layer near the surface prevented any penetration. For the next station S126/14 the Kastenlot corer was rigged with a trigger arm and pilot corer as trigger weight allowing a 6m free-fall for the 2m barrel and 12 weights. Somewhat surprisingly this returned empty; the dynamometer record shows an anomaly which was interpreted as a pre-trigger in mid-water which would explain the lack of any penetration. A heavier trigger weight should be used in the future to prevent this re-occurring. The last core S126/15 was taken in worsening weather using the 4m barrel and 12 weights. A 2.2m core was recovered consisting of oozes, marls and turbidites.

Samples were taken from these cores as follows:-

(a) One corner of each core was cut away into a V-trough for archive purposes.

(b) Approximately, 40 PVC and stainless steel ring samples (20 mm high, 75 mm dia) were taken for consolidation and permeability testing at Wormley, Oxford University and the University College of North Wales.

(c) Eleven polycarbonate cylinders (120 mm long, 65 mm dia) were taken, primarily for triaxial testing at City University. Three of these samples were taken to examine bioturbation features.

(d) More than 50 samples of approximately 20 cc were taken using a syringe as a mini piston corer for bulk density determination.

(e) Thirty-six samples of approximately 200g were taken at regular intervals for the first 2m, in cores S126/2 and S126/4 for chemical analysis at Wormley.

(f) A 1m length from S126/2 was transferred to a stainless steel box for transportation to Wormley. This will enable larger undisturbed samples to be obtained should they be required.

On two of the cores, D10406 and S126/4, transducers were inserted into the sediment to measure the shear wave velocity. Signal quality was not always good, but a series of values ranging from 10 m/s to 65 m/s were recorded in the different lithologies.

P.J.S.

High Resolution Near-Bottom Profiler

The instrument used on this cruise is acoustically similar to that used on Cruise 118 last year, but with additional facilities for depth measurement and heave compensation. An absolute pressure sensor of the type developed for IOS tide gauges is fitted for depth measurement, together with a vertical accelerometer and double integrator which indicates short term vertical motions of the instrument. It was hoped to use the accelerometer output to measure the depth resolution capability of the pressure sensor.

Two stations were carried out, D10407 and D10408. Unfortunately the pressure sensor and accelerometer circuitry failed to operate correctly, apparently because of interference from the acoustic signal arising in the frequency multiplex system used to transmit the signals up the single core CTD wire. There was insufficient time between the two stations to make any useful modifications.

One of the objectives of the first station was to move the ship slowly over a system of sedimented channels. It proved possible to tow the instrument at 1 knot in 5210 m water depth without the CTD wire tension becoming excessive, albeit in extremely calm weather. However, so much wire has to be paid out that it is very difficult to avoid continual variations in the height of the instrument above the bottom, making interpretation of the records very difficult. As the pressure sensor heave-compensation failed to work, it is hoped to apply bottom-locked heave compensation to the tape recorded signals.

The acoustic results were fairly satisfactory, again showing a great deal of fine structure, and penetration to 30m. The second station was a sediment-filled pond, and the penetration performance was better than at the first station where the sediments are belived to be harder. At both stations there was a very marked horizontal variation in the observed profiles.

R.J.B.

Heat Flow

Considerable experience was gained in operating the new heat flow probe which was deployed at three stations during this cruise. The increased weight of the instrument led to some problems in operating it aboard Discovery, particularly during the recovery. Using the Cambridge/RVS trackway on Shackleton, however, launching and recovery were simpler and safer.

After rectifying some initial faults in the acoustic telemetry the probe was deployed at Station 10405 ($33^{o}30'N$, $22^{o}59'W$; water depth 5410m). A porous nose cone, differential pressure transducer and associated electronics were attached to measure _in situ_ pore pressures. A total of eight penetrations were made along a 4 n.m. linear traverse. The telemetered data gave a clear indication of frictional heating on penetration and pullout together with the probe tilt (typically 5^{o} or less). Unfortunately, no heat pulses were triggered and no clear evidence for a pore pressure pulse on inserting the probe were seen (0-30 psi range). On recovering the probe the thermistor string was found to be broken; the evidence suggesting a rotational pullout as the cause (Dip 6?). The differential pressure transducer and its electronics were also missing (Dip 7?).

A modification was made to the tensioning mechanism to give more free play to the string while changes were also made to the heat pulse circuitry. The probe was then deployed at two further stations at each of which three penetrations were obtained along approximately E-W linear traverses (S126/3: $31^{o}31'N$, $24^{o}28'W$; S126/5: $31^{o}30'N$, $24^{o}28'W$). The instrument still failed to produce heat pulses whilst in the sediment for reasons that remain unclear but good records of _in situ_ temperatures were obtained.

Needle probe measurements of thermal conductivity were made on Kastenlot Core 10406. The probe was used to measure the conductivity in transverse and vertical planes at 27 points in the core and the data combined to estimate the degree of thermal conductivity anisotropy. All measurements were compared to a jelly standard. Anisotropies were in the range 0-32%.

M.J.N.

Survey Camera

The survey camera was deployed on three occasions. The camera frame had been slightly modified to incorporate the IOS stereo camera to conduct some filtering experiments on backscattered light whilst the survey camera was in operation. The acoustic monitoring system included a near-bottom echo-sounder (NBES) which indicated the height of the frame off the sea-floor in the range 9m to 150 m.

Remote command frequencies (480 Hz and 500 Hz) were available for switching on and off the NBES and cameras respectively. It was decided that the optimum height for survey photography was in the range 8 to 14m (10m height gives coverage of 6.25x9.25m). The camera was set to cycle every 15 seconds to ensure overlap.

Station 126/6

This station was carried out in 5423m of water over a GLORIA target at 31°11'N, 23°47'W. The survey camera was mounted at the rear end of the frame pointing vertically downwards. Six flash units were mounted at the front all pointing 9½° aft giving a mean camera flash separation of 2m. The camera was loaded with 60m of 400 ASA black and white surveillance film and the aperture set at f3.5. The maximum number of exposures available was therefore 1600. The stereo camera was mounted forward of and adjacent to the survey camera and was triggered from the same circuit. It was loaded with 30m of 400 ASA surveillance film and a Wratten 38A colour filter placed in front of one of the lenses (set a f3.5). The other lens was set at f5.6 and left clear to act as a control).

The system was lowered at 50m/min on the main warp with the ship travelling at 0.35 knots. Problems with the acoustic telemetry meant that the camera operation could not be monitored. A 500 Hz signal was therefore transmitted to ensure that the camera was running whilst it was on the sea-floor.

The camera was on the bottom for four and a half hours, after which the signals became faint (due to the range) and the frame was hauled in. The weather for the station was good and control of the height above the bottom was easily maintained by paying out and hauling in the warp in 2 metre lengths. Approximately 3 miles of sea-floor were covered.

Owing to the limitations of processing facilities on Shackleton only 30 frames were developed on board. These indicate that all the flash guns had operated correctly and that the light was evenly distributed.

Station S126/9

This station was run over a GLORIA target at 30°50'N, 22°53'W in 5238m of water. The arrangement within the frame was the same as for Station S126/6.

When the camera reached the sea-floor the NBES traces were not clear and bottom echoes from the monitor indicated that the frame had touched down. The station was abandoned and the camera recovered undamaged.

A short length of film had run and the sea-floor photographed.

Station S126/13

For this station the system was the same as for S126/6 except that the sensitivity of the NBES had been increased. The NBES again failed to operate correctly and the station was abandoned before the camera reached the sea-floor.

Q.J.H.

5.1 kHz Transponder System Cruise 126

In order to improve the accuracy of positioning subsurface equipment it was proposed to use the 5 kHz transponder system. Two transponders were to be placed approximately 8 km apart and the interrogating transponder attached to the equipment that required positioning. With this configuration it is possible to establish the position of the equipment to within $\pm$ 10 metres relative to the base-line transponders.

Before deploying the transponders they were both attached to the main warp and lowered close to the sea-floor, the overall depth of water being in excess of 5000m. In this position their acoustic release systems were successfully operated. Throughout this "wire test" the acoustic reply pulses from the transponder were only just discernible in the general noise background on the EPC record. One of the transponders was then deployed in a water depth of 5300 metres, and the ship moved to the proposed site of the second transponder which was 9.5 km away. As it was not possible to detect any reply pulses from the transponder at this range the second instrument was not deployed. At a later stage when the ship passed over the transponder site it was only possible to obtain an operational range of 1.5 km. Shortly after this the transponder was acoustically released from its anchor and recovered. During recovery the reply pulses from the transponder were not detected. This was partly due to the increase in noise from the ship's main propellor while hove to, and because the transponder's transmission pulse had correctly shortened in length once it had been released from its anchor.

Although the deck control unit, towed fish and transponders appeared to be operating correctly throughout this period, in general the signal to noise ratio was unacceptably low.

M.J.H.

Table 1: Station List, Discovery Leg

Station	Type	Start Time	End Time	Position Latitude	Position Longitude	Water Depth Corr. metres	Comments
10405	Heat Flow	0830/069	2040/069	$33^{o}30'N$	$22^{o}59'W$*	5410	Differential pressure transducer attached to measure pressure between tip and head. Overside at 1224. Eight successful heat flow penetrations between 1431 and 1834 but pressure sensor not successful. Inboard at 2040. On recovery bottom end of themistor string found broken free and differential pressure electronics case lost.
10406	Kastenlot Core	0416/070	1145/070	$32^{o}34.7'N$	$22^{o}27.3'W$+	5268	4m box fitted with 12 weights. 3.4 m core recovered. Problem developed with traction winch at 3853m wire out when heaving in.
10407	High Res. Deep Profiler	0000/073	1453/073	$30^{o}51'N$	$22^{o}52'W$*	5225	Instrument towed 7 n.m. across features on proximal Madeira abyssal plain previously mapped by GLORIA.
10408	High Res. Deep Profiler	1454/074	1902/074	$34^{o}46'N$	$24^{o}48'W$*	4999	Instrument lowered over small sediment pond between abyssal hills. Major reflectors corresponded well with those of 3.5 kHz profile from sea surface.

* Mean position for station and corresponding depth

\+ Position of ship and depth at time instrument reached bottom.

Table 2: Station List, Shackleton Leg

Station	Type	Start Time	End Time	Position Latitude	Position Longitude	Water Depth Corr. metres	Comments
S126/1	Kastenlot Core	0600/079	1115/079	$31^{o}33.1'$N	$24^{o}49.7'$W+	5444	Fitted with 2m box and 6 weights. Core fell out on surfacing due to failure of one catcher door to close.
S126/2	Kastenlot Core	1330/079	1640/079	$31^{o}33.2'$N	$24^{o}50.5'$W+	5446	Fitted with 4m box and 12 weights. 4.15m core recovered.
S126/3	Heat Flow Probe	1905/079	2345/079	$31^{o}31'$N	$24^{o}28'$W*	5447	Only 3 dips as heat pulse would not operate.
S126/4	Kastenlot Core	0035/080	0455/080	$31^{o}31.7'$N	$24^{o}25.3'$W+	5446	Fitted with 4m box and 12 weights. 3.8m core recovered.
S126/5	Heat Flow Probe	0530/080	1020/080	$31^{o}30'$N	$24^{o}28.5'$W*	5444	Only 3 dips as heat pulse would not operate.
S126/6	Survey Camera	1708/080	0600/081	$31^{o}11'$N	$23^{o}47'$W*	5423	Benthos 372 camera with thin-base film, IOS stereo camera part filtered, 6 flash tubes. Successful
S126/7	Gravity Core	0145/083	0630/083	$30^{o}37.7'$N	$22^{o}17.2'$W+	5095	Triggered with 3m barrel. 1.7m core recovered.
S126/8	Gravity Core + Acoustic Test	0800/083	1445/083	$30^{o}36.8'$N	$22^{o}24.4'$W+	5116	Triggered with 3m barrel. Acoustic beacons attached at 500 & 550m up wire for acoustic testing. 1.6m core recovered.
S126/9	Survey Camera	0230/084	0800/084	$30^{o}50'$N	$22^{o}53'$W*	5238	Unsuccessful. Near Bottom Echo Sounder failed to operate correctly.
S126/10	Kastenlot Core	0900/084	1235/084	$30^{o}51.0'$N	$22^{o}51.9'$W+	5223	Fitted with 4m box and 12 weights. No pull-out observed. Corer probably fell over on bottom. One catcher door closed. No core recovered.

continued.........

Table 2 continued.......

Station	Type	Start Time	End Time	Position Latitude	Position Longitude	Water Depth Corr. Metres	Comments
S126/11	Gravity Core	1235/084	1610/084	$30^{0}51.1'N$	$22^{0}51.9'W+$	5223	Triggered with 3m barrel. 0.7m core recovered. Bottomed in sand.
S125/12	Gravity Core	1824/084	2246/084	$30^{0}52.5'N$	$22^{0}51.1'W+$	5241	Triggered with 3m barrel. 0.9m core recovered.
S126/13	Survey Camera	2355/084	0545/085	$30^{0}49'N$	$22^{0}53'W$	-	Unsuccessful. Near Bottom Echo Sounder failed to operate correctly. Camera not lowered to bottom.
S126/14	Kastenlot Core	0630/085	1020/085	$30^{0}48.6'N$	$22^{0}53.3'W+$	5237	Triggered with 2m box and 12 weights. No pull-out observed. Some mud in catcher. Probably pre-triggered.
S126/15	Kastenlot Core	2100/085	0130/086	$30^{0}22.0'N$	$23^{0}35.0'W+$	5330	Fitted with 4m box and 12 weights. 2.2m core recovered.

*Mean position for station and corresponding depth

+Position of ship and depth at time instrument reached bottom

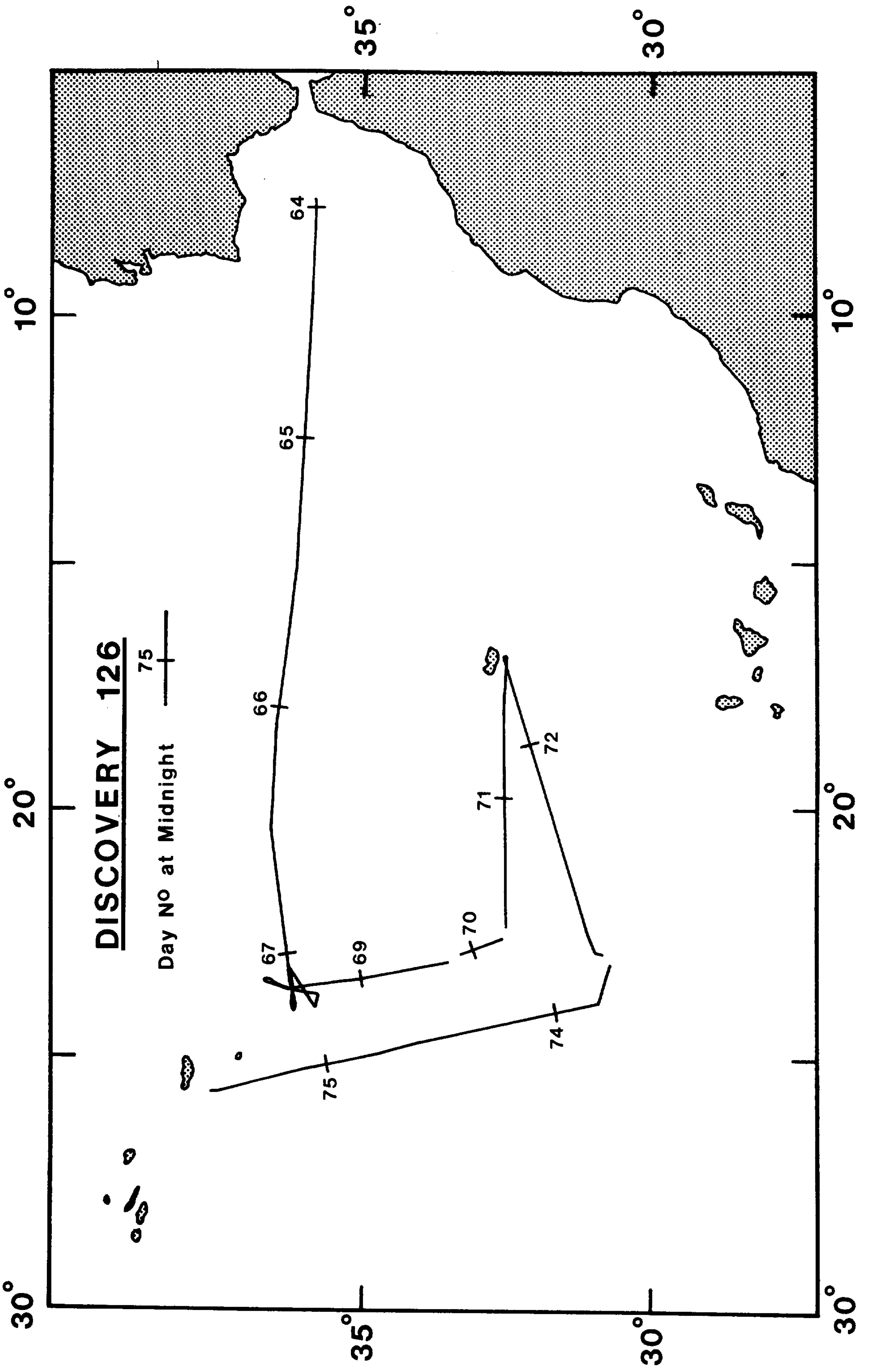
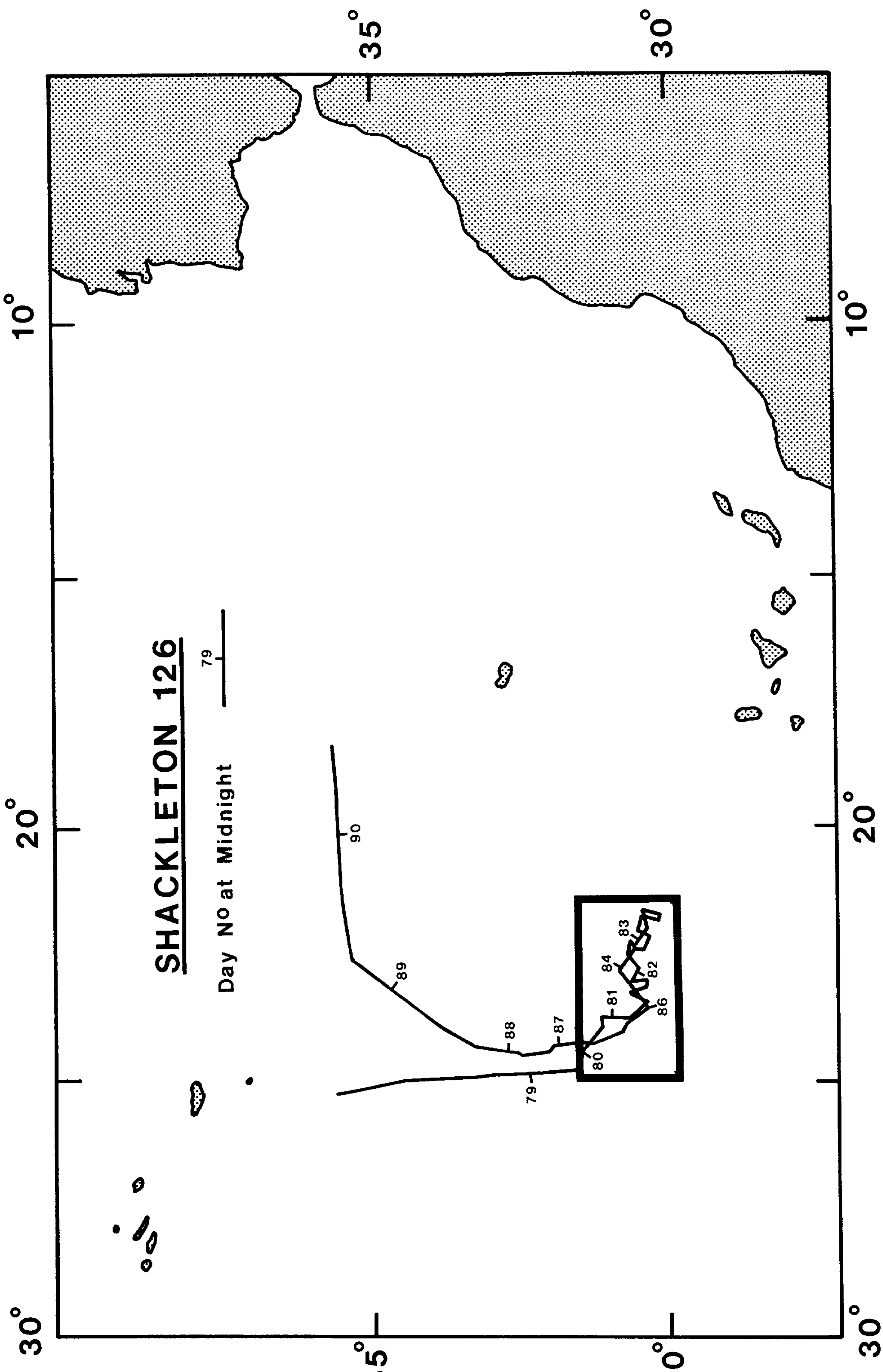

DISCOVERY 126
Day Nº at Midnight
75
64
65
66
67
69
70
71
72
74
75
10°
20°
30°
35°
30°

FIG. 1



SHACKLETON 126
Day Nº at Midnight
79
79
80
81
82
83
84
86
87
88
89
90
30°
35°
30°
10°
20°
30°
35°
30°
10°
20°
30°

FIG. 2

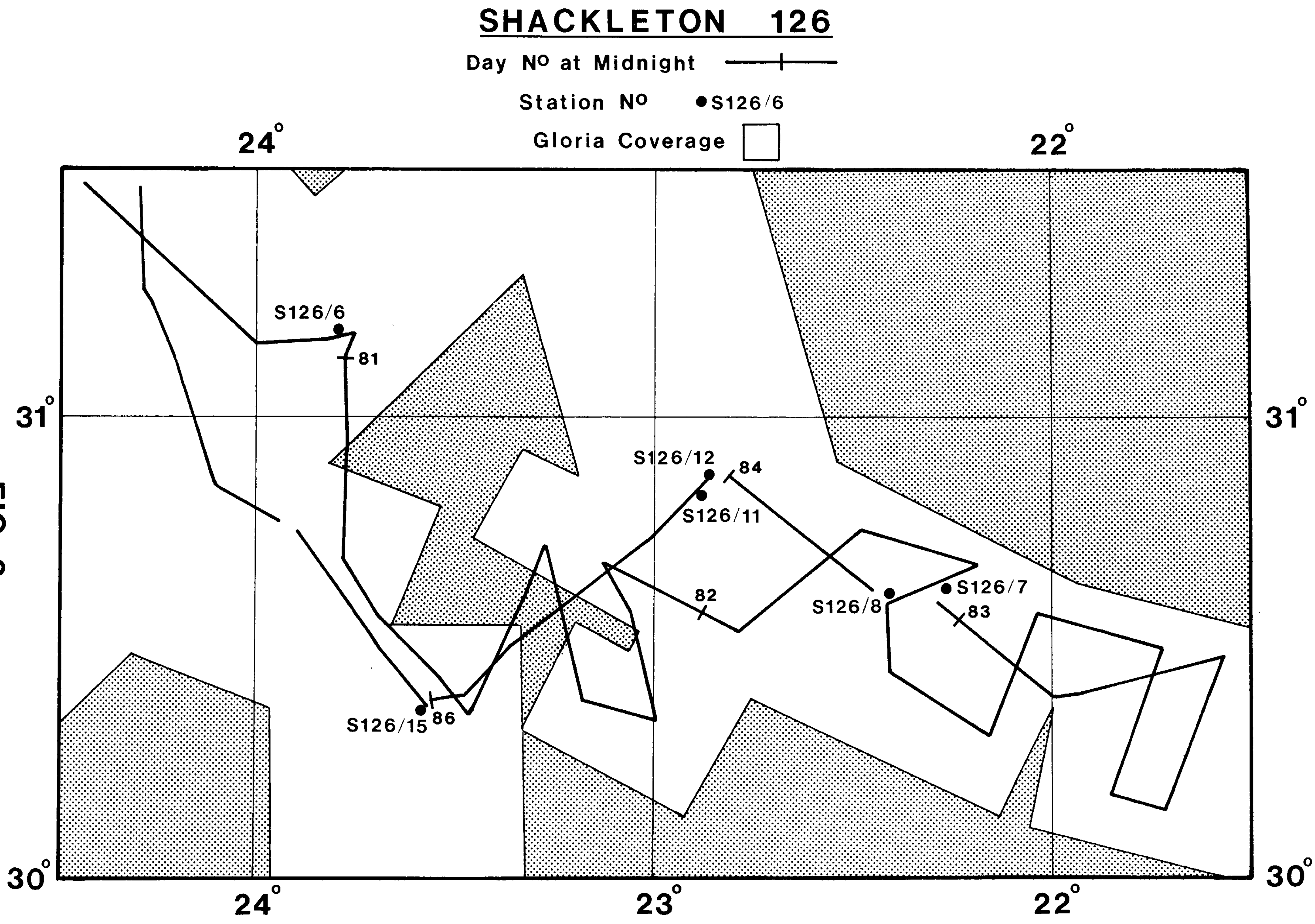

SHACKLETON 126
Day Nº at Midnight
Station Nº
●S126/6
Gloria Coverage
24°
22°
31°
31°
30°
30°
24°
23°
22°
S126/6
81
S126/12
84
S126/11
82
S126/8
S126/7
83
S126/15
86

FIG. 3