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CITY OF LONDON POLYTECHNIC

Department of Geology
Sir John Cass Faculty of Physical Sciences and Technology
Walburgh House
Bigland Street
London E1 2NG

CRUISE REPORT

RRS CHARLES DARWIN 21/87

10 MARCH - 7 APRIL 1987

SEYCHELLES - MAURITIUS

INDEX

5. Results

6. Acknowledgements

1. INTRODUCTION

Following on from a passage leg from the Oman, cruise 21/87 started from Port Victoria, Seychelles on 10.3.87 and ended on 7.4.87 at Port Louis, Mauritius. Scientific personnel who participated on the cruise are listed in Table 1.

The cruise programme consisted of two major elements. The first of these (9 days duration) was a series of site surveys along the Mascarene Plateau for the closely following (May - July '87) drilling program of the ODP Leg 115. The second element, of 21 days duration, involved a multidisciplinary study of the structure, origins and evolution of the Rodrigues Ridge. The regional setting of both these structures is shown in Fig. 1.

2. ODP SITE SURVEY OPERATIONS

2.1. Background to the Site Survey

Leg 115 of the Ocean Drilling Program has two primary objectives:

(a) To sample the volcanic basement rocks of the Mascarene Plateau - an objective not previously acheived by either dredging or drilling - in order to investigate hotspot associated volcanic lineaments in the Indian Ocean.

(b) To sample the sediments at various depths within a limited equatorial region.

The recovery of the volcanic rocks is important for understanding the

FIG 1. REGIONAL SETTING OF THE MASCARENE PLATEAU AND RODRIGUES RIDGE

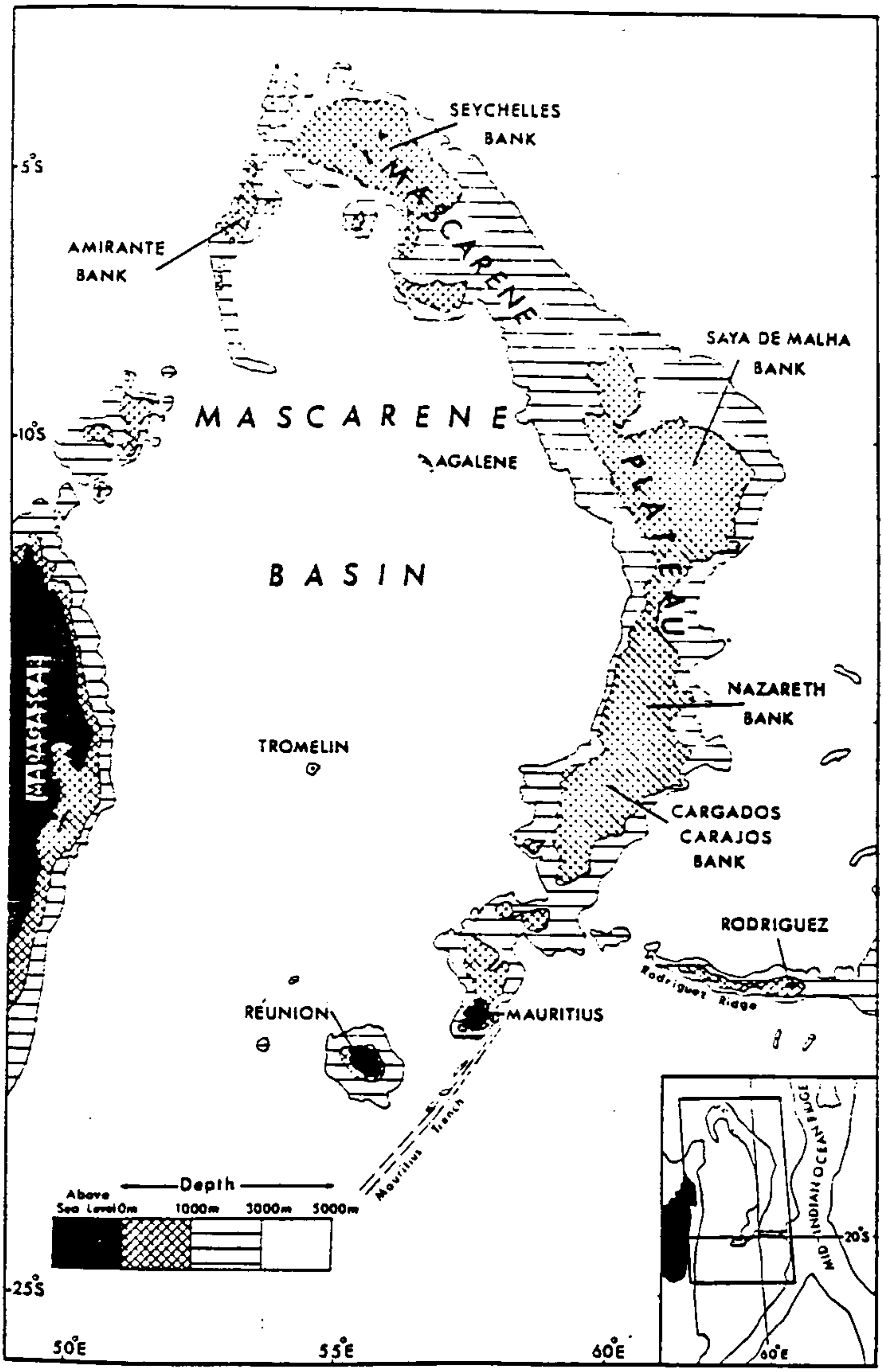


TABLE 1

SCIENTIFIC PERSONNELL ON CRUISE 21/87

A.Baxter (PSO)	City of London Polytechnic
M.Bussell	City of London Polytechnic
D.Davies	RVS
B.De Ribet	Institut de Physique du Globe, Paris
S.Draper	UCNW - Bangor
R.Duncan	College of Oceanography, Oregon State University
G.Evans	RVS
M.Fisk	College of Oceanography, Oregon State University
A.Gale	City of London Polytechnic
G.Heward	University of Hull
R.Lloyd	RVS
H.Pedley	University of Hull
J.Price	RVS
S.Smith	RVS
C.Woodley	RVS

motion of the Indian and African lithospheric plates and for studying the chemistry of the chain of volcanoes that extend from the Deccan Traps of India to Reunion Island in the W. Indian Ocean.

The sediments will be used in a number of palaeo-oceanographic studies, amongst which will be biostratigraphy, sedimentation rates, subsidence rates and equatorial productivity. The results of palaeolatitude estimates from magnetic determinations will be compared with the hotspot position (Reunion island) to determine true polar wander.

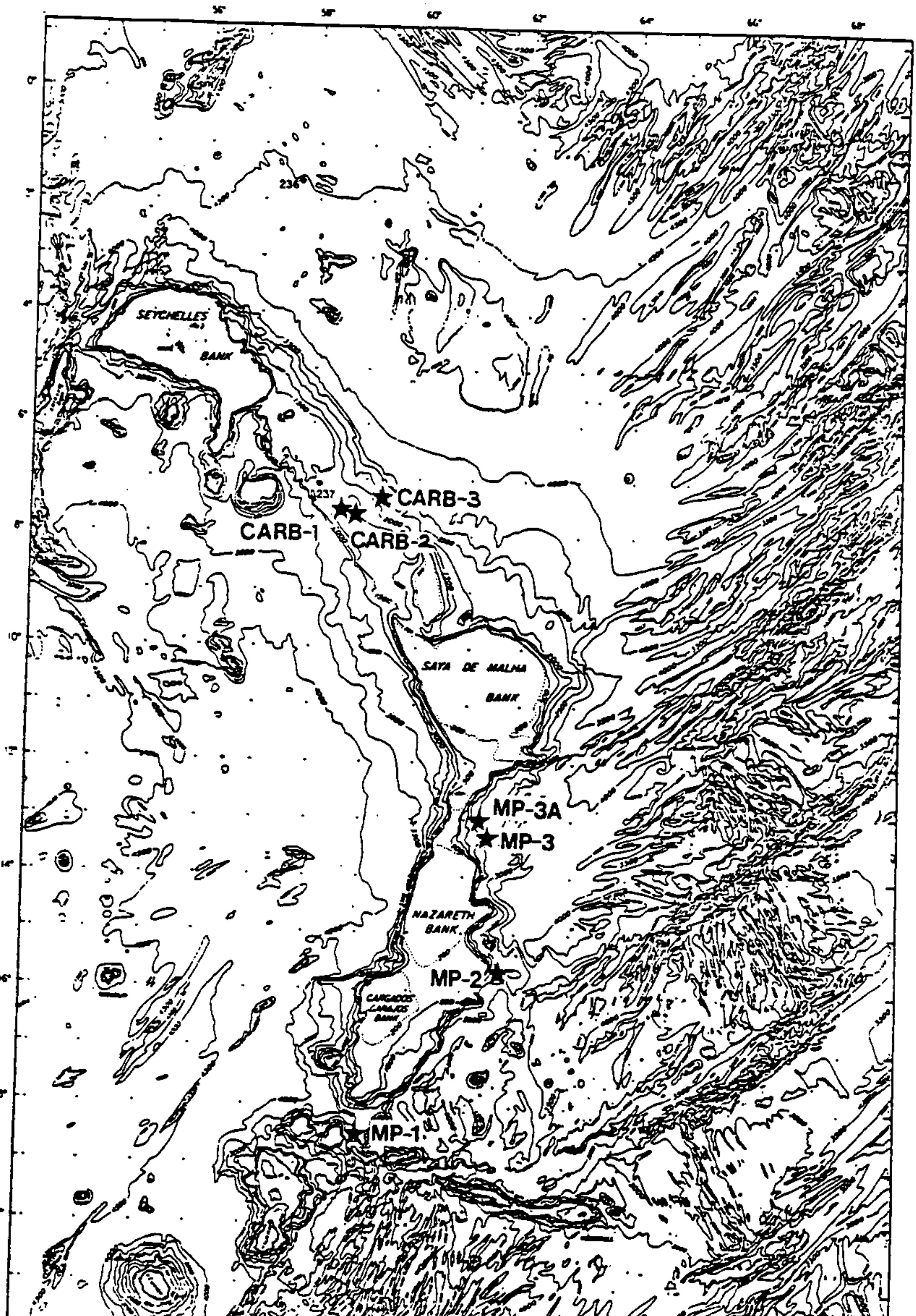
2.2. Methodology

Three primary targets (MP-1,MP-2 and MP-3) for drilling to volcanic basement and one primary target for sampling a complete sedimentary section in relatively shallow water (CARB-1) were to be surveyed. Additionally an MP-2 alternative and two further sediment sites (CARB-2,CARB-3) were targeted.

The CARB sites are located on the northern slope of the Mascarene Plateau, 300nm S.E. of the Seychelles. The MP sites are evenly spaced between the Seychelles and Mauritius, on the eastern side of the Mascarene Plateau (Fig. 2).

The initial target locations for the surveys are listed below in the order in which it was intended to complete them and with the estimated time in hours required:

FIG 2. LOCATION OF ODP LEG 115 DRILLING SITES SURVEYED BY RRS CHARLES DARWIN



SITE	LATITUDE(S)	LONGITUDE(E)	HOURS
CARB-1	7° 37'	58° 48'	18
CARB-2	7° 10'	59° 20'	9
CARB-3	7° 00'	59° 30'	9
MP-3	13° 24'	61° 20'	18
MP-2	15° 30'	61° 45'	18
MP-2A	16° 15'	61° 12'	18
MP-1	18° 30'	59° 12'	18
		TOTAL	108

Total transit time for the surveys was estimated at 111 hours giving a total estimated time requirement of 219 hours. In the event the work was completed in 202 hours, against the 192 originally allotted.

The plan was to proceed south from the Seychelles towards the Rodrigues Ridge, which was the primary target of study of the cruise. Surveys were completed at all sites except MP-2A and an alternative site was added near to MP-3.

For all sites magnetics and gravity were measured, together with single channel seismic reflection stratigraphy, 3.5kHz SRP and 10kHz PES bathymmetry. A Magnavox MX1107 transit satellite navigation system was used throughout the surveys and a Trimble global positioning system (GPS) was used intermittently when satellites were available.

Single channel seismic (SCS) data was recorded unfiltered on magnetic tape and simultaneously a physical record was produced on two or three paper recorders with high and low bandpass filters set at 30Hz and 80Hz respectively. The airgun array and hydrophones were successfully towed at six knots without any signal degradation.

3. SITE SURVEY RESULTS

3.1. CARB-1, CARB-2, CARB-3

These sites were chosen on the basis of three previous intersecting SCS lines (Glomar Challenger 24, Conrad 1707 and Vema 3406). These lines showed that the sediment thickness was 300-400m, so that there was a good possibility of drilling to basement in this region.

The airguns and hydrophones were deployed at 1600 GMT on March 11 to start the survey. CARB-1 was completed at 0700 on March 12 and the ship moved downslope to CARB-2 and CARB-3 in 2500 and 3000m of water respectively. These surveys were completed at 2330 on the same day. Fig 3 (CARB-1, CARB-2) and Fig 4 (CARB-3) show the ship's track for these surveys.

The new seismic data in conjunction with previous seismic lines appear to be more than adequate for selecting a drilling site at CARB-1. Over most of the site the sediment thickness appears to be 0.2-0.3 seconds (2-way travel time). At the western edge of the site the thickness increases to 0.4 seconds over what was interpreted as a fossil reef. Fig. 5 shows part of the Darwin SCS record for the traverse NW-SE across the proposed drilling site CARB-1, with ca. 280m of carbonate oozes and minor volcaniclastics covering the basement. Fig 6 shows part of the W-E SCS record for CARB-2, with ca. 400m of carbonate sediment overlying flat-lying basement at the proposed drilling site. Fig 7 shows the SCS record for the selected CARB-3 site, with

FIG 3. SHIP'S TRACK FOR CARB-1 AND CARB-2 SITE SURVEYS

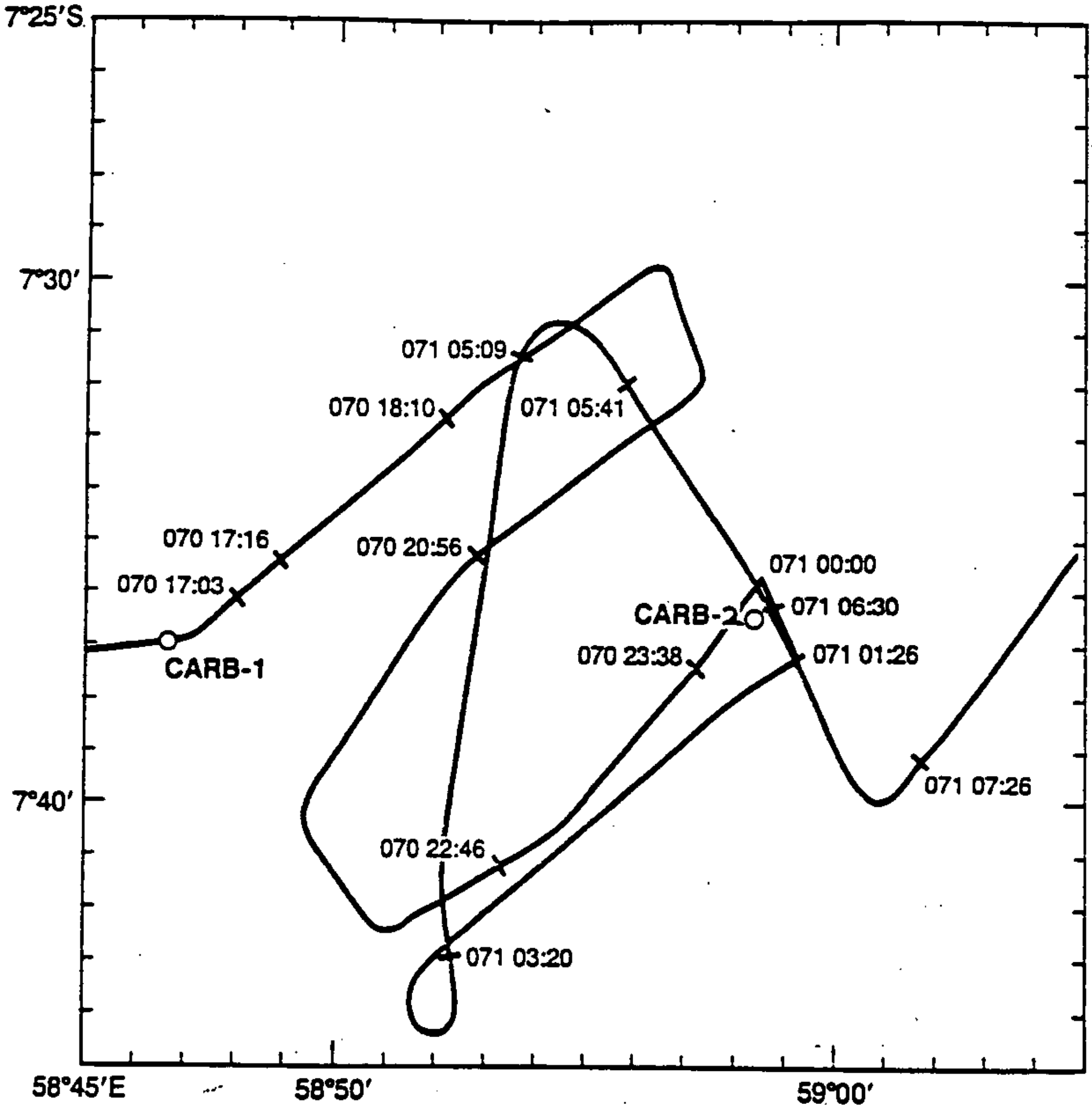


FIG 4. SHIP'S TRACK FOR CARB-3 SITE SURVEY

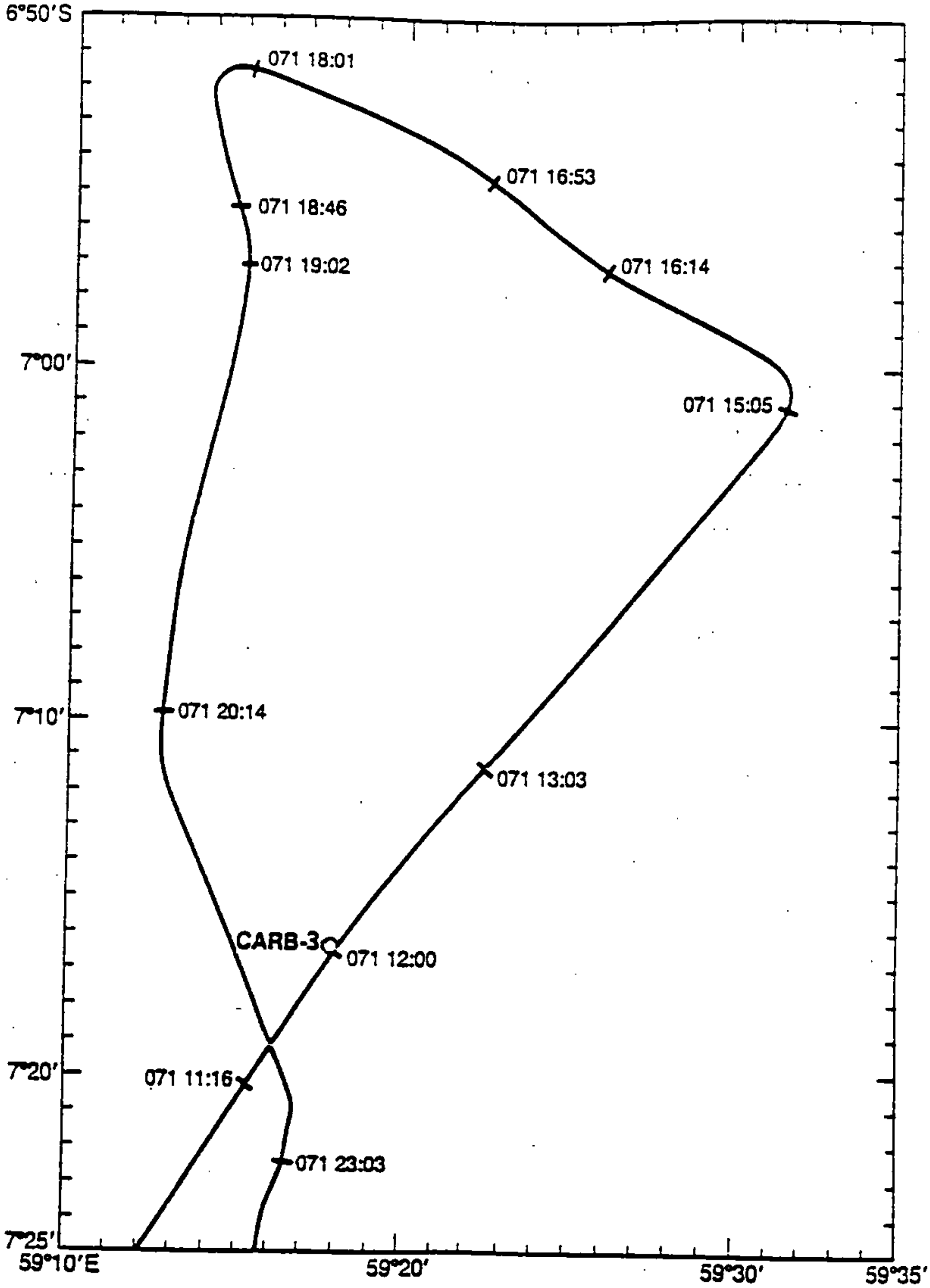


FIG 5. DARWIN SCS LINE ACROSS CARB-1 DRILLING SITE

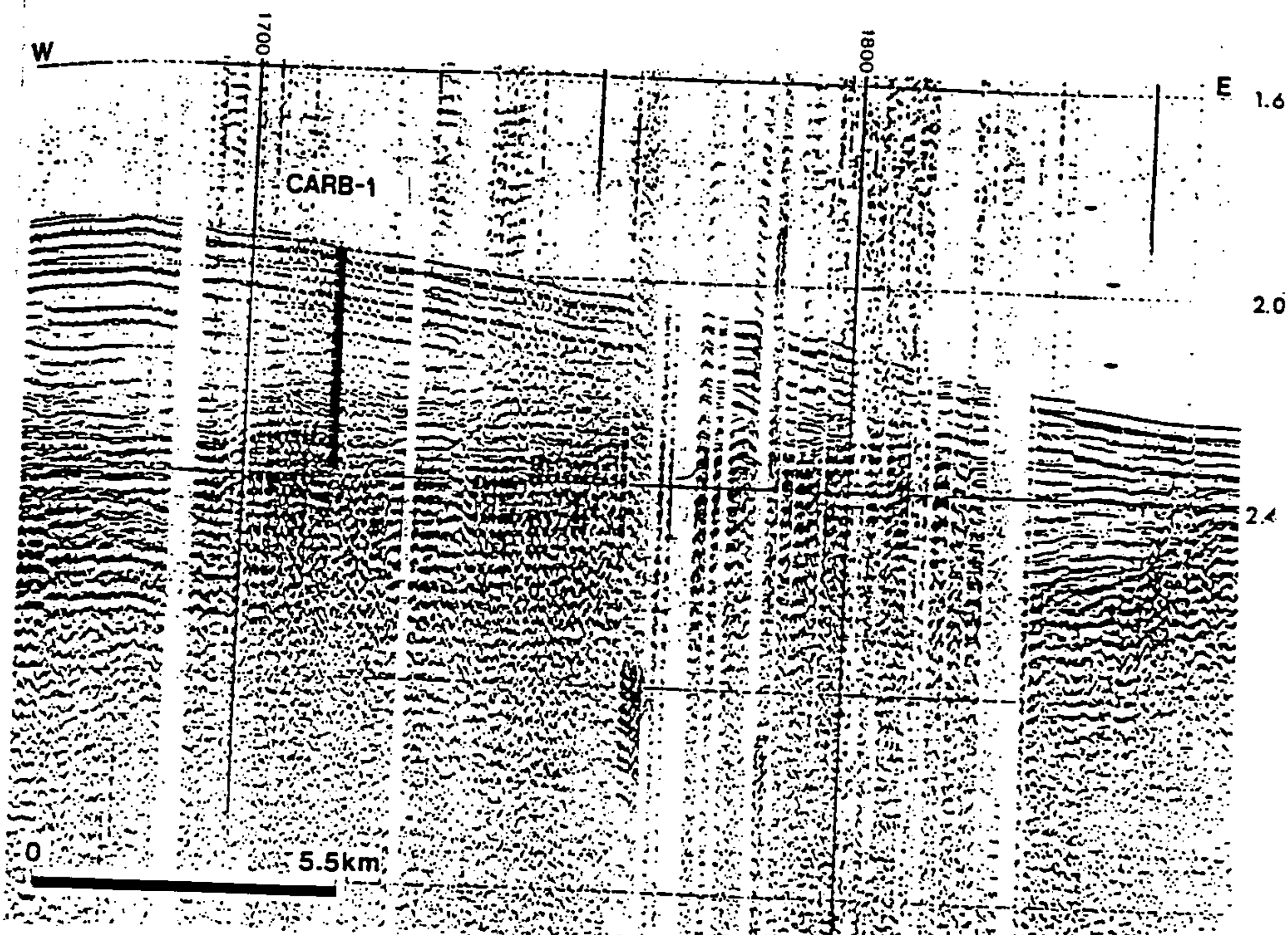
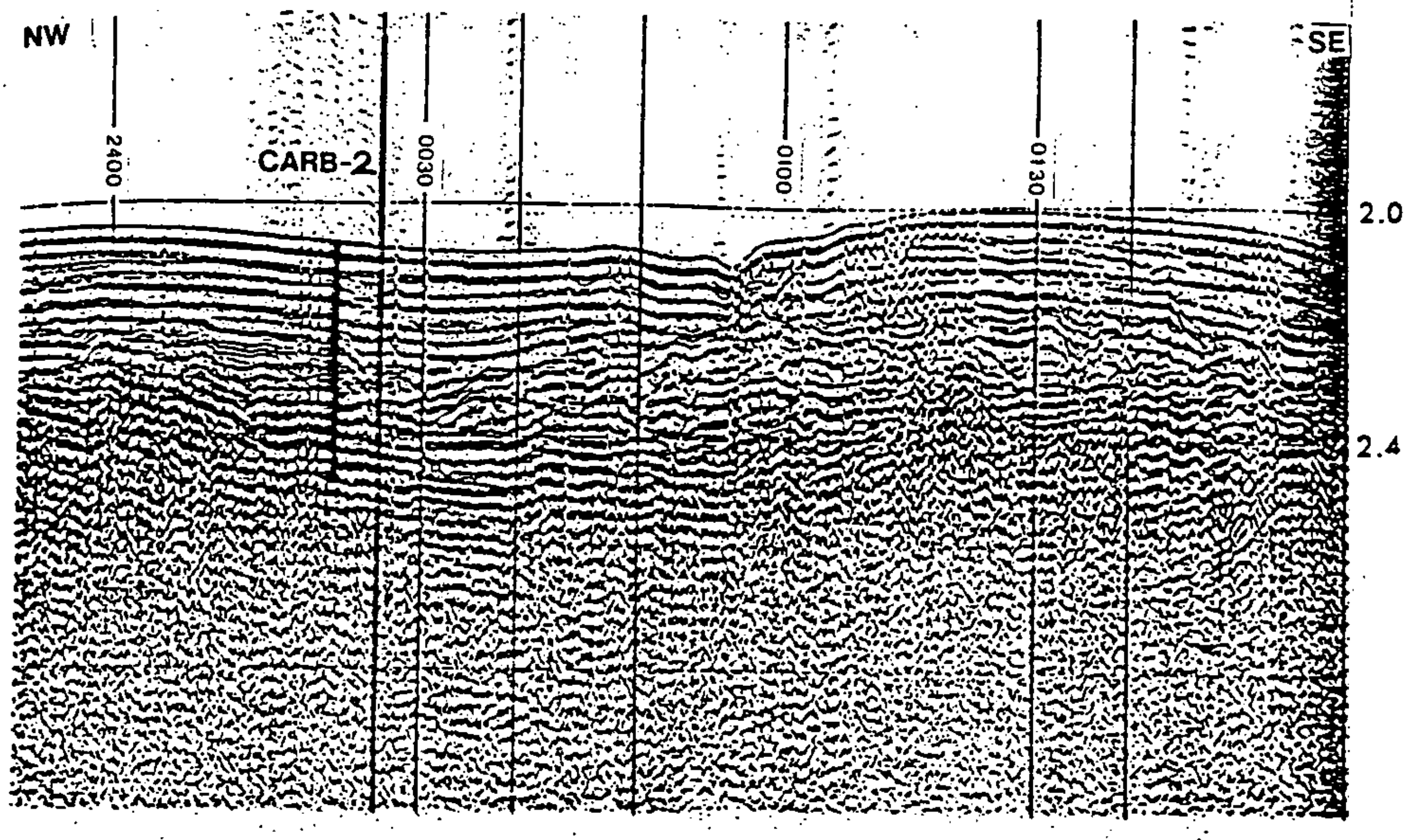


FIG 6. DARWIN SCS LINE ACROSS CARB-2 DRILLING SITE



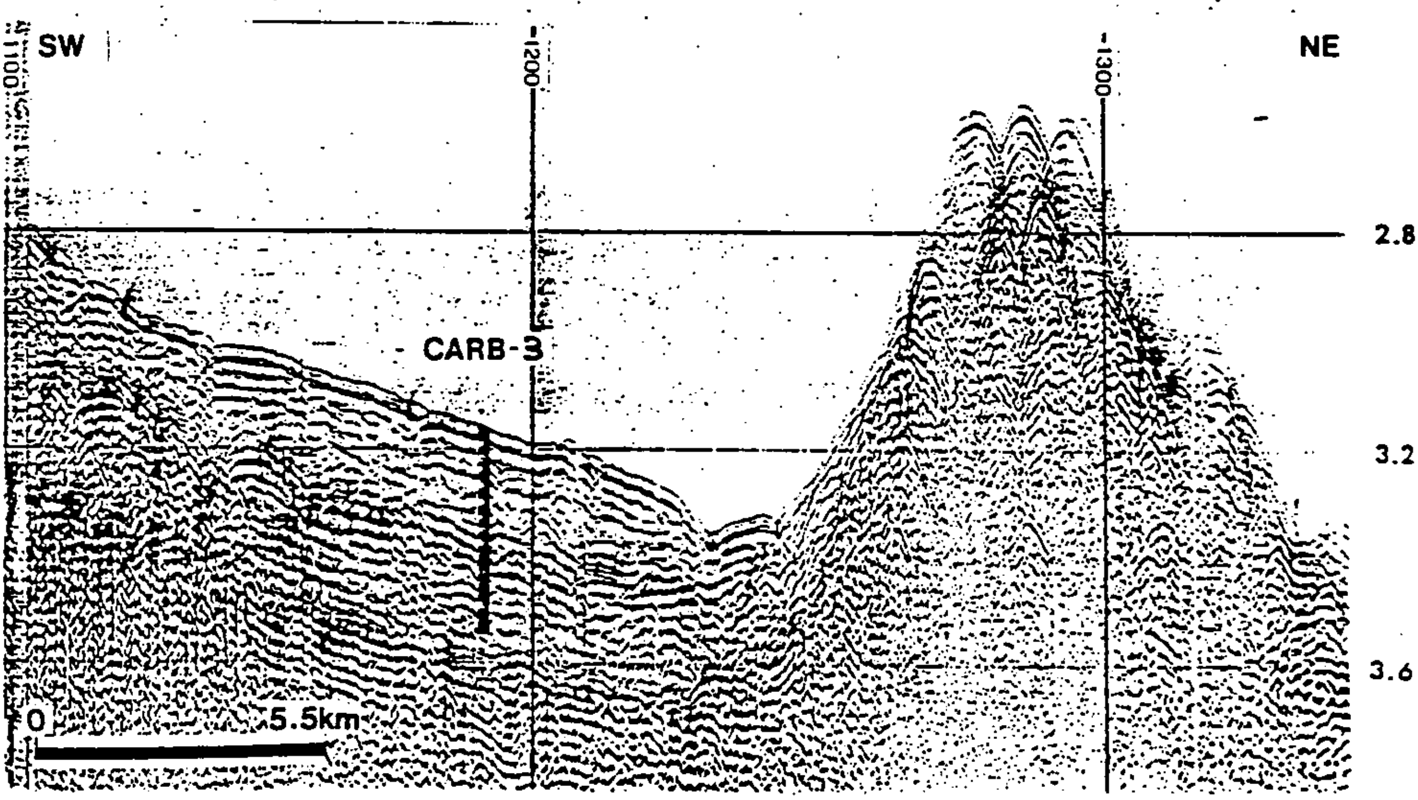


FIG 7. DARWIN SCS LINE ACROSS CARB-3 DRILLING SITE

possibly slumped carbonate sediments ca 410m thick lying above basement at the selected drilling site.

3.2. MP-3, MP-3A

After surveying the CARB sites, the Darwin steamed south to the basement objective site MP-3. This target was chosen because a Wilkes SCS line (728) passed across the middle of the Mascarene Plateau here, and the sediement thickness and water depth appeared appropriate for drilling operations. This target however proved to be on a relatively steep slope and a much more gradual slope at the same water depth was located only 15nm to the south.

The quality of the SCS records obtained at the CARB sites gave the shipboard party sufficient confidence that they would not have to rely on the original Wilkes SCS line to locate the drilling site. Consequently the original MP-3 site was designated as the alternate, MP-3A and the new southerly site was identified as the primary target MP-3.

An abbreviated survey was carried out at MP-3A (see Fig 8 for ships track). A portion of the Darwins SCS record NW-SE across the chosen location of MP-3A is shown in Fig 9. Approximately 280m of carbonate sediment and possible minor volcaniclastics lie above the presumed basement.

The Darwin arrived at MP-3A at 1000GMT on March 14 and the airguns and hydrophone were deployed. After minor problems with the airguns, the survey commenced at 1138 GMT. The survey of both MP-3A and MP-3 was completed and the gear recovered at 1220 on March 15, after collecting 142nm of gravity, magnetic, SCS, 3.5kHz SRP and 10kHz PES bathymmetry. The ships track for the MP-3 survey and a portion of the N-S SCS line across the selected drilling

FIG 8. SHIP'S TRACK FOR MP-3A SITE SURVEY

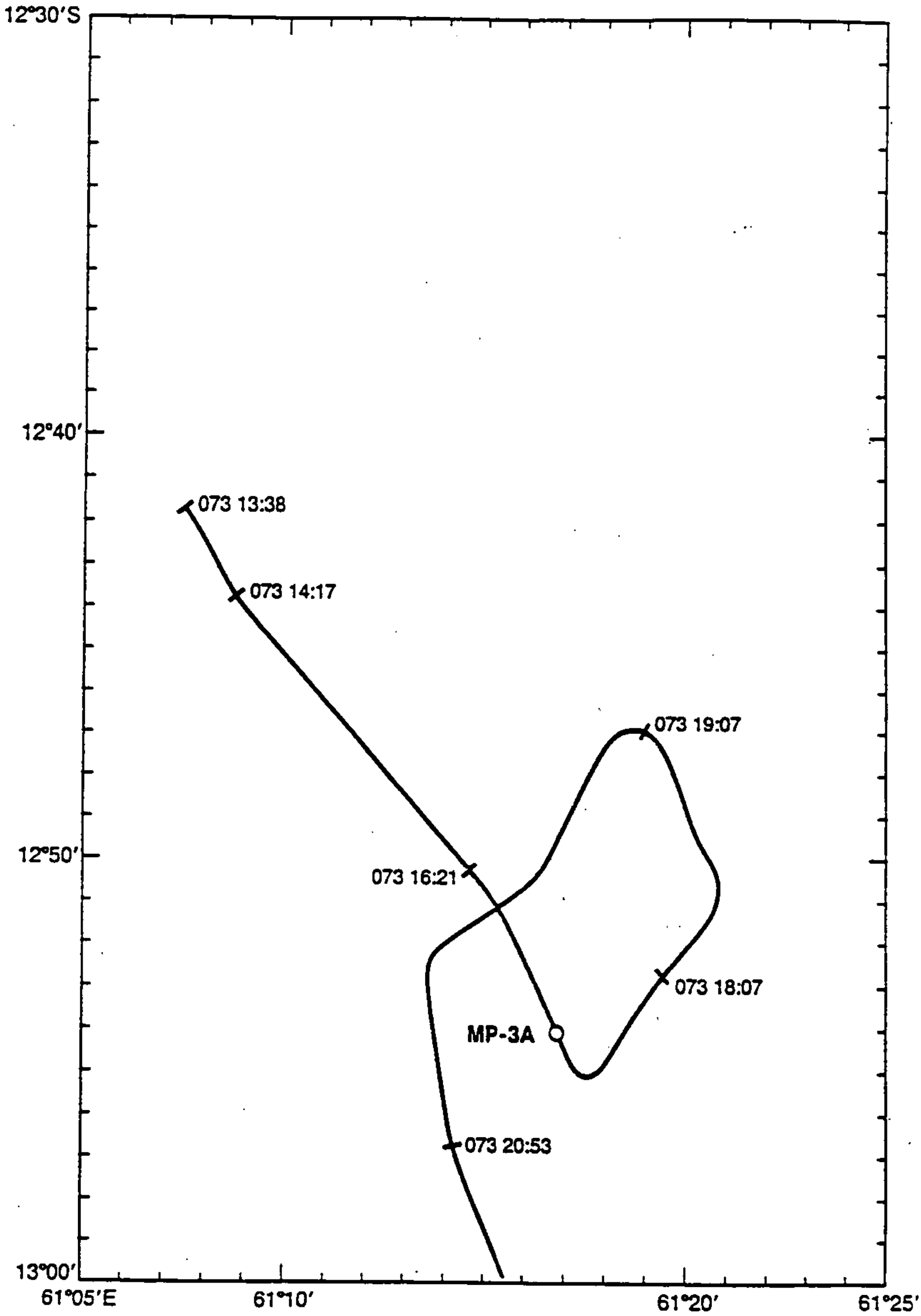
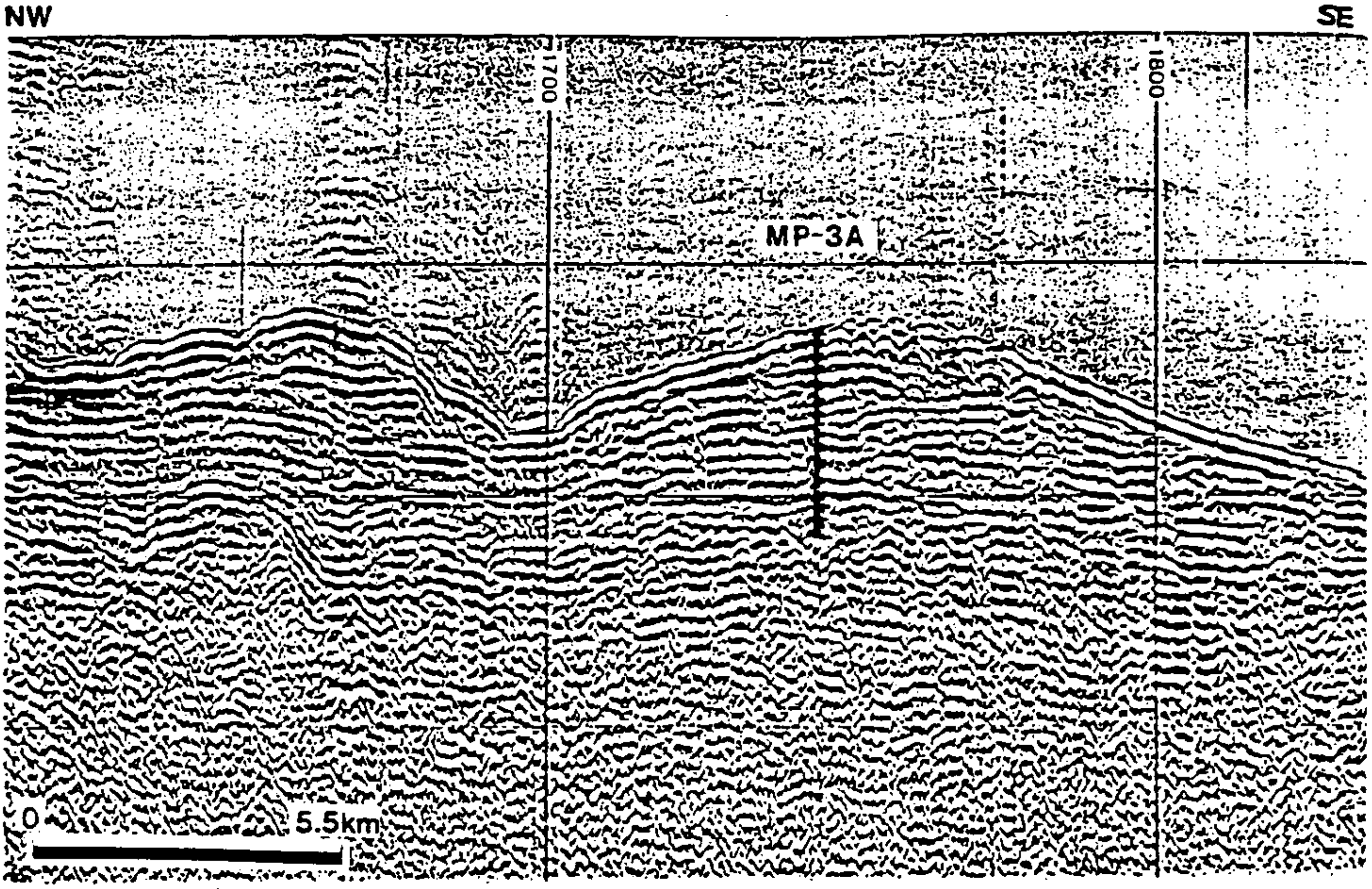


FIG 9. DARWIN SCS LINE ACROSS MP-3A DRILLING SITE



site for MP-3 are shown in Figs 10 and 11 respectively.

MP-3A has ca. 250m of relief caused apparently by erosional channels running off the Mascarene Plateau, that strike 030 degrees. There may also be a fault with similar trend which controls the channel development. At MP-3 erosional channels strike approximately E-W and appear to reach basement in some locations (see Fig 11). Sediment thickness at the selected drilling site is ca. 280m.

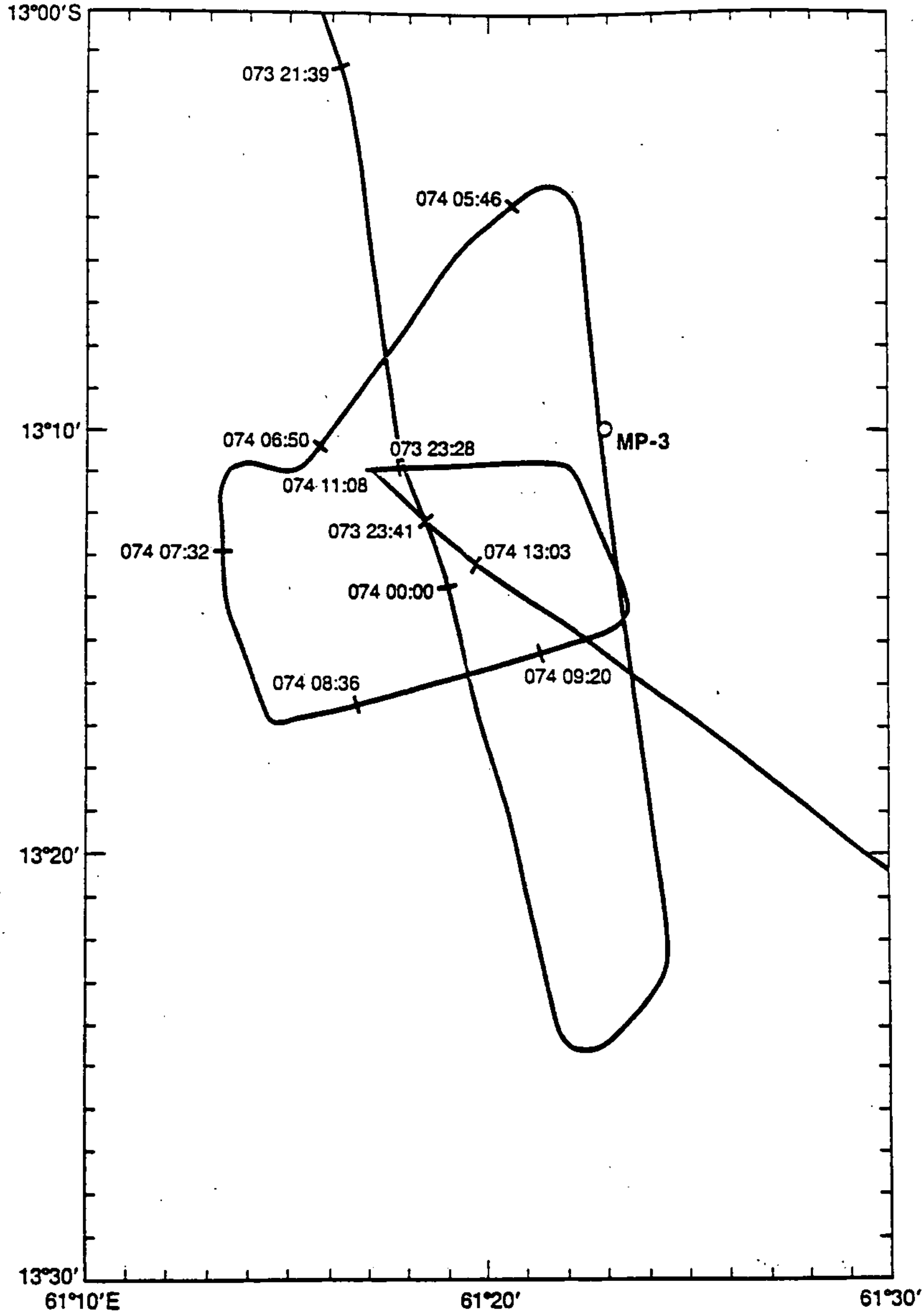
3.3 MP-2

From MP-3 the Charles Darwin steamed south to MP-2. Location MP-2A was not surveyed due to lack of time. The ship arrived at MP-2 at 0450 GMT on March 16 and deployed the SCS gear. The existing bathymmetric maps proved inaccurate but the team located a basin in 2600m of water that was 6 X 3 nm in extent, with a uniform sediment cover and smooth basement. The sediment had no strong reflectors and at the selected drilling site was ca. 250m thick, apparently consisting of carbonate ooze. The ships track across MP-2 is given in Fig 12 and part of Darwin's W-E SCS line across the selected site is shown in Fig 13. The survey was completed at 1750 GMT on March 16.

3.4. MP-1

This site lies closest to Mauritius and according to the hotspot model for the genesis of the Mascarene Plateau should have the thinnest sediment cover. Three pre-existing SCS lines run through this area. The most useful, Glomar Challenger 24 crosses a basin at about 18 30'S, 59 06'E. The Darwin's survey concentrated on this basin as the sediments appeared to be less than

FIG 1Ø. SHIP'S TRACK FOR MP-3 SITE SURVEY



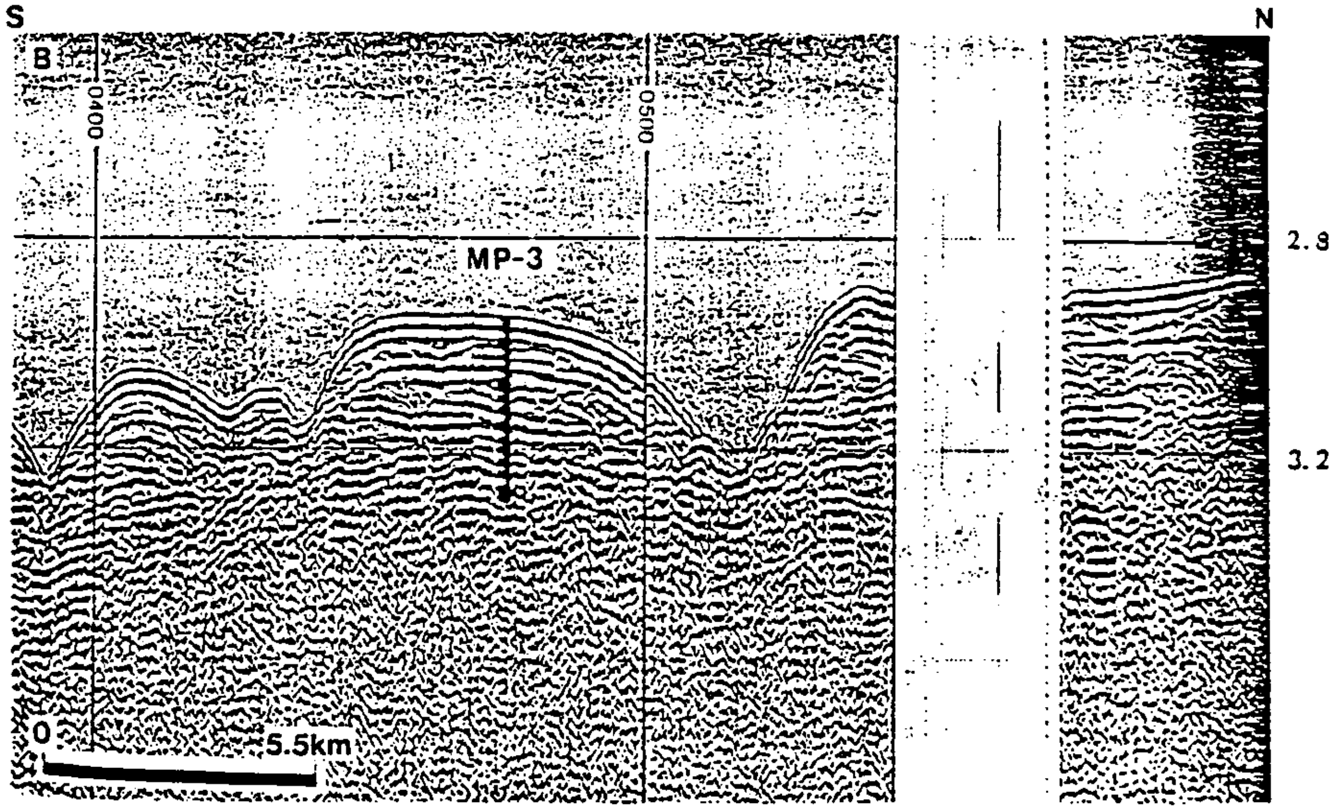


FIG 11. SCS LINE ACROSS MP-3 DRILLING SITE

FIG 12. SHIP'S TRACK FOR MP-2 SITE SURVEY

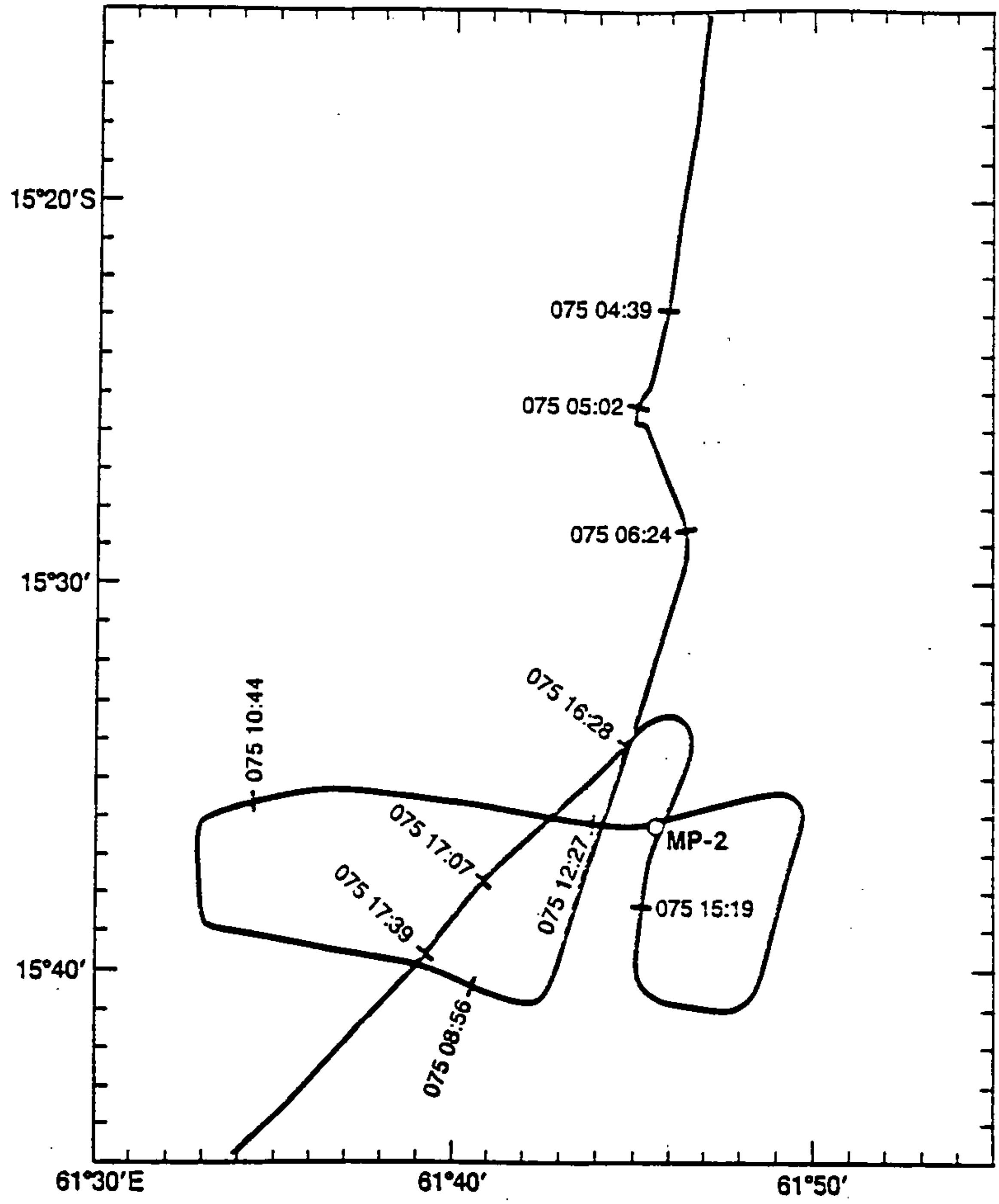


FIG 13. SCS LINE ACROSS MP-2 DRILLING SITE

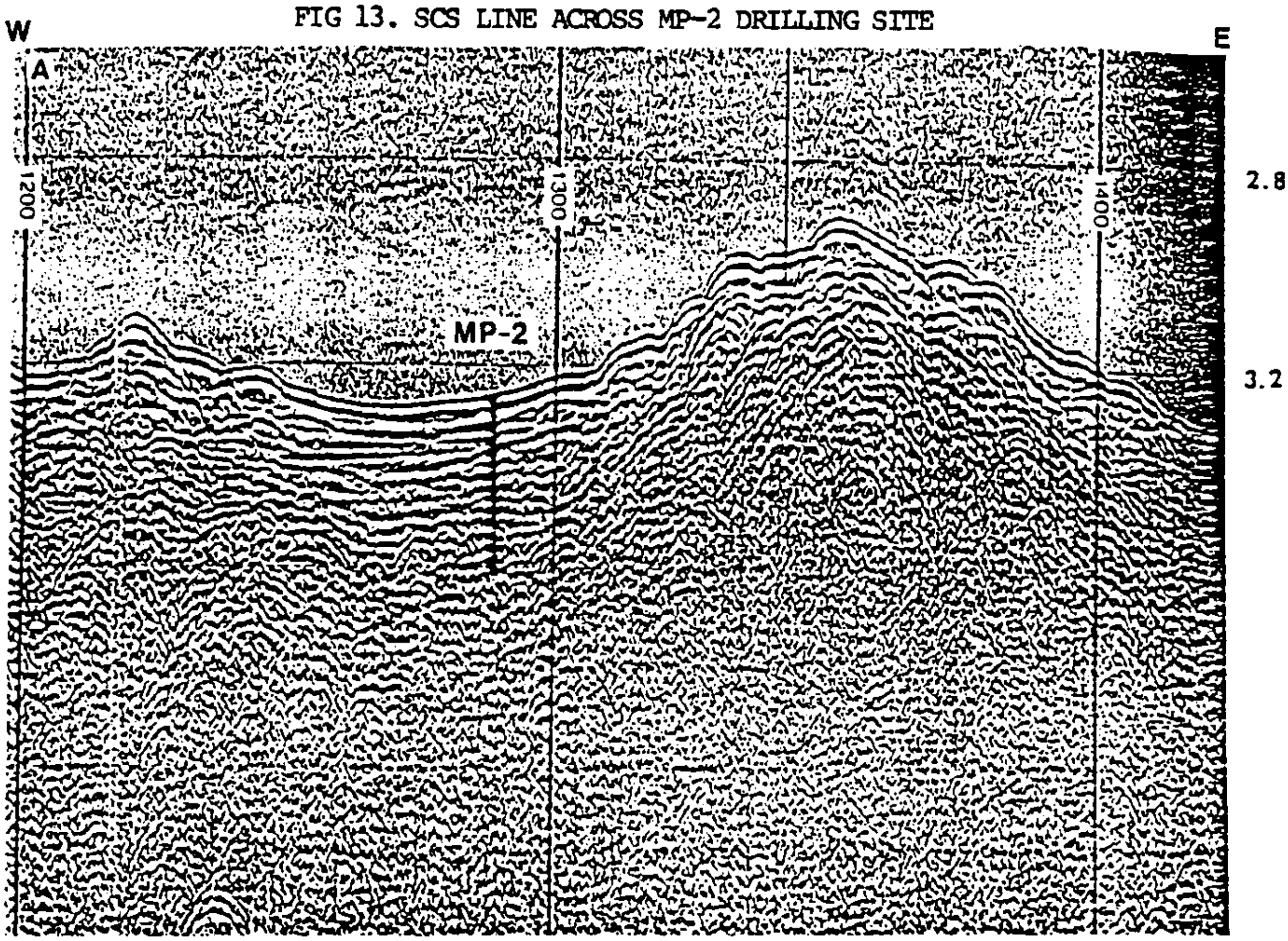


FIG 14. SHIP'S TRACK FOR MP-1 SITE SURVEY

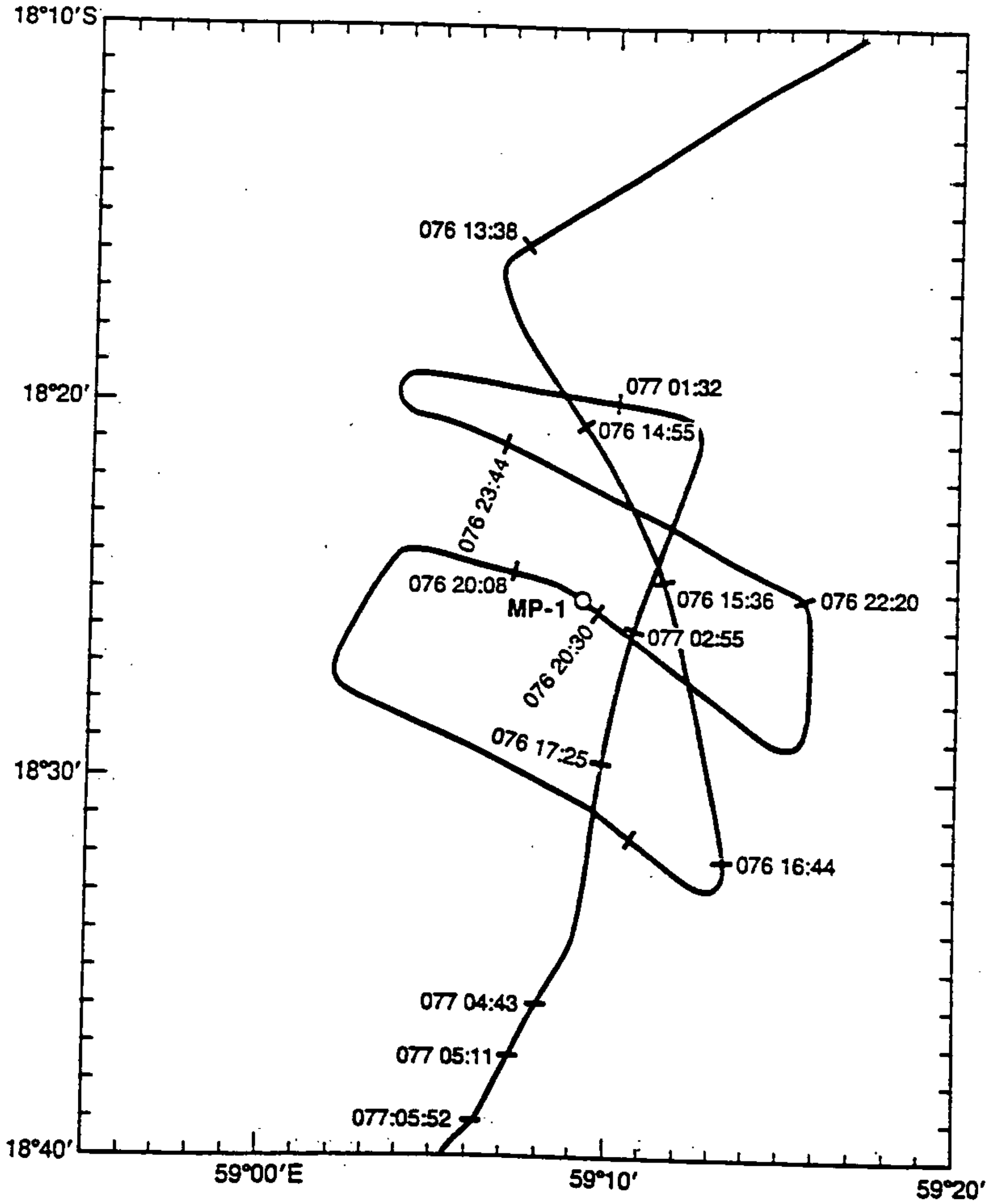
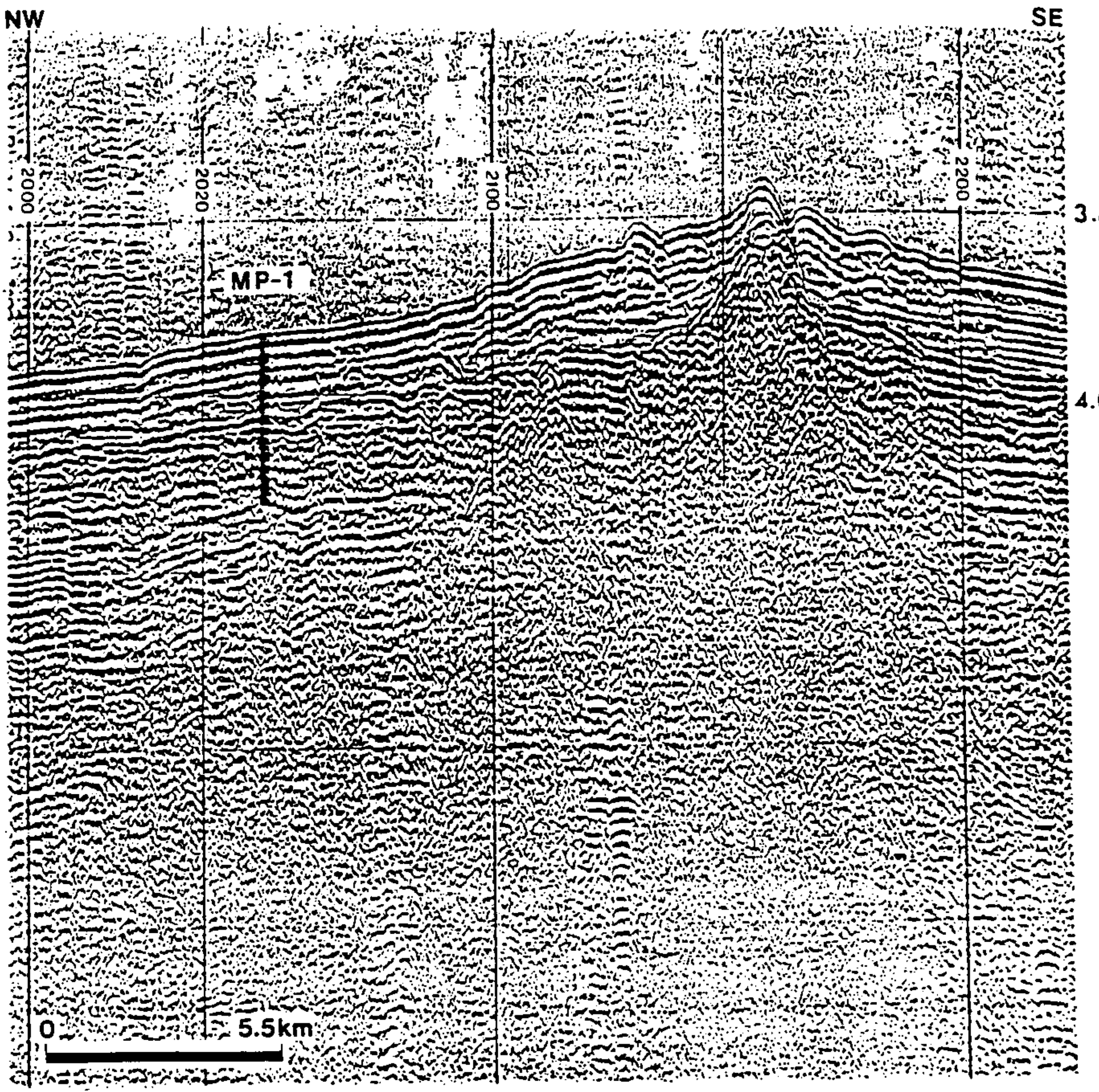


FIG 15. SCS LINE ACROSS MP-1 DRILLING SITE



200m thick and also because it is on the margin of the Mascarene Plateau at about 2500m water depth.

The SCS gear was deployed at 1430 on March 17 and the survey completed at 0400 on March 18. 84nm of geophysical data was collected in the basin and most of the area proved suitable for drilling. The sediment was almost uniformly less than 200m thick and appeared to consist of carbonate ooze with only one strong internal reflector, possibly an ash layer. The basement was relatively smooth, with no faults visible. the ships track for the survey is shown in Fig 14 and part of Darwin's SCS line running NW-SE across the selected drilling site is shown in Fig 15.

3.5. Summary

In total, 82 hours of geophysical data was collected over 470nm of ground. The primary sites for drilling were selected at four sites and these are listed below:

Site	Lat(S)	Long(E)	Water Depth(m)	Sediment Thickness(m)
CARB-1	7°36.0'	58°58.5'	1496	280
MP-3	13°10.0'	61°23.0'	2240	280
MP-2	15°36.5'	61°45.5'	2650	250
MP-1	18°25.5'	59°09.0'	2714	170

Few and only minor problems with equipment were encountered and the site surveying operations were successfully completed, having attained virtually all objectives.

4. RODRIGUES RIDGE INVESTIGATION

4.1. Background

The original objectives of the Rodrigues Ridge study were as follows:

(a) To determine the nature of the ridge structure and its component rocks.

(b) To establish the relationship of the ridge to the basaltic volcanism of Rodrigues island, which lies on the eastern end of the structure.

(c) To establish the nature and form of the Rodrigues Ridge - Mascarene Plateau intersection.

(d) To establish the spatial and temporal distribution and sedimentary history of carbonates from the ridge crest and flanks.

These primary objectives were supplemented by an investigation of the geotechnical properties of carbonate sediments from the ridge flanks, micro-palaeontological studies and an investigation of fossil and living echinoid populations.

4.2. Methodology

To minimise time losses due to deploying and retrieving the air gun and MCDAS arrays, seismic reflection profiling of the ridge was conducted in a single, continuous operation lasting seven days. A continuous sequence of linked cross-ridge traverses was run, starting from the western end of the ridge at its intersection with the Mascarene Plateau, and terminating east of Rodrigues island.

Magnetometer, gravimeter, 3.6kHz SRP and 10kHz PES data were also continuously acquired in this operational phase, during which potential sites for subseqent dredging, coring and agassiz sampling. The physical sampling operations were carried out on the return east to west pass along the ridge, with additional magnetic, gravity, 3.5kHz and 10kHz data collected between these sampling stations.

Fig 16 details the major movements of the RRS Charles Darwin during the Rodrigues Ridge study. In Fig 16 the MCDAS traverse line is emboldened. Approximately 730 nm of MCDAS data was acquired and a total 1250nm of magnetic, gravity, 3.5kHz and 10kHz data.

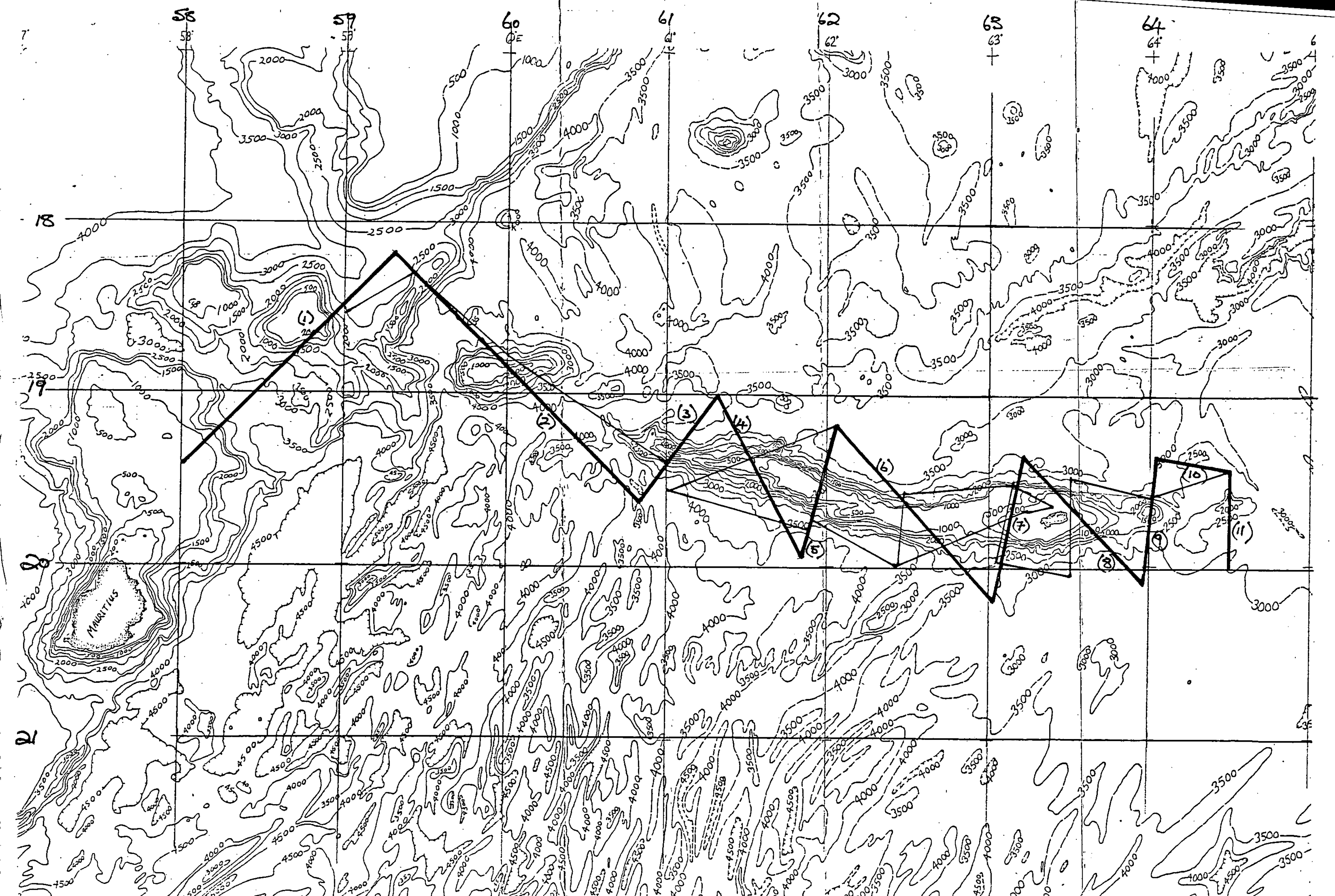
A total of 26 rock dredging operations were carried out at 15 major sites along the ridge. 7 piston coring runs were made and 13 attempts using the gravity corer. The Agassiz trawl was deployed on 3 occasions. The location of major sampling sites is shown in Fig 17, with full details given in Table 2.

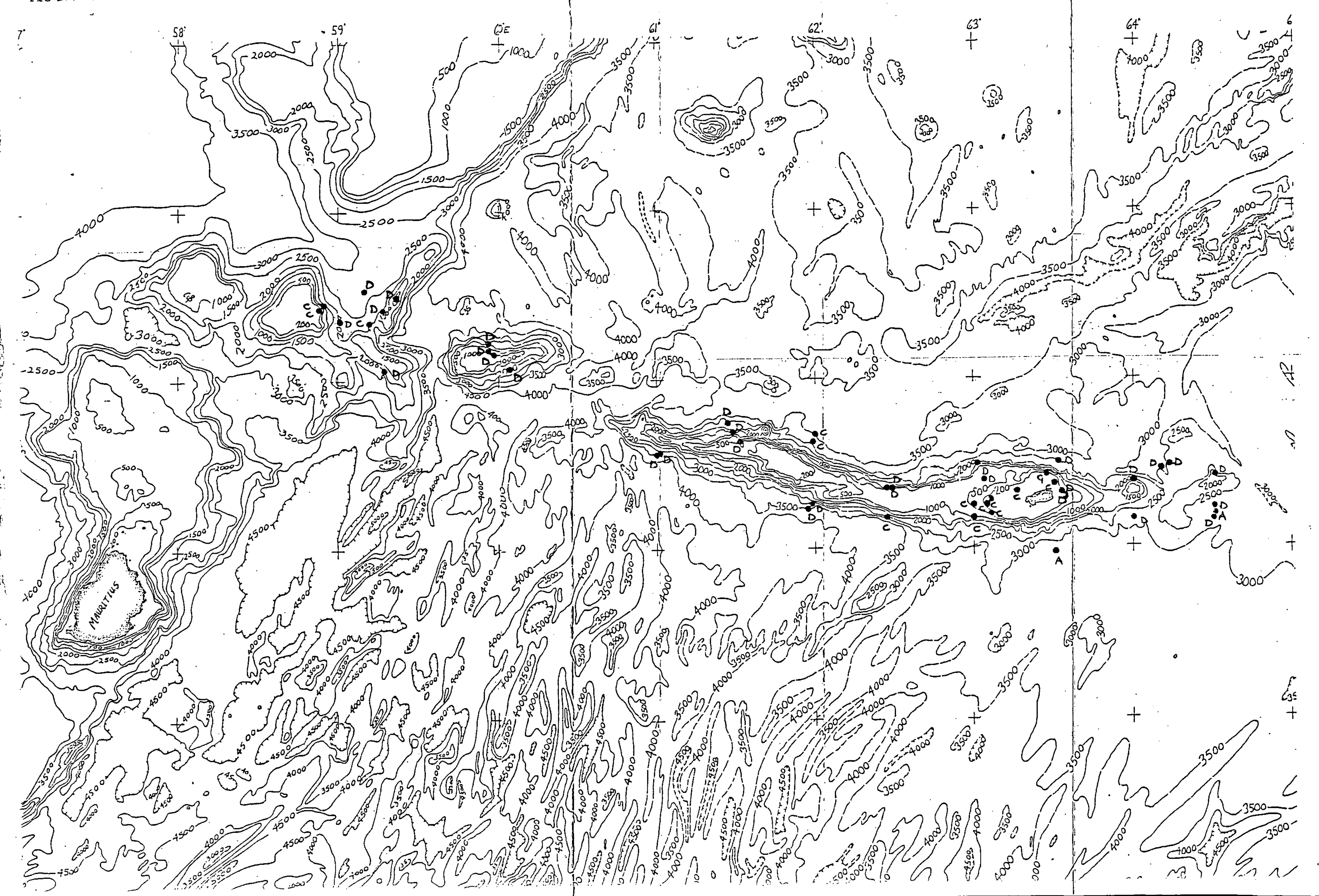
4.3. MCDAS Operations

The MCDAS array was first streamed at 2240 GMT on 18 March, and operations terminated at 2259 GMT on 25 March. In this period 730 nm of data was acquired.

After initial problems, the system worked quite well over the 8 day per-

FIG 16. RRS CHARLES DARWIN SURVEY LINES ON THE RODRIGUES RIDGE. MCDAS TRAVERSE LINE EMBOLDENED





58°
59°
60°E
61°
62°
63°
64°
MAURITIUS
1000
1500
2000
2500
3000
3500
4000
4500

TABLE 2

COORDINATES OF ALL PHYSICAL SAMPLING SITES

SITE	LAT(S)	LONG(E)	DEPTH(m)	NATURE	RESULT
RR1	19°44'	64°31	2740	rock+pipe dredge	basalt,carbs,Mn nods
RR2	19°35'	64°26'	900	...	...
RR3	19°43'	64°00'	2400	...	...
RR4	19°31'	63°27'	1500	...	...
/87b	19°34'	63°31'	1200	Day grab	sparse corals
/87c	19°35'	63°32'	80	gravity corer	rhodoliths, carbonates
/87d	19°39'	63°32'	73	...	bioclastic carbonates
/87e	19°43'	63°33'	65	...	coralline algae
/87f	19°43'	63°33'	65	rock+pipe dredge	corals,carbonate debris
S3	20°04'	63°26'	3140	Agassiz	Asteroidea, pumice etc.
RR5	19°30'	63°02'	1850	rock+pipe dredge	Warp lost at 16 tons
/87u	19°39'	63°10'	150	...	dredge + some warp lost
/87r	19°40'	63°05'	500	gravity corer	nil
/87v	19°39'	63°32'	70	...	corals,carbonate seds
/87x	19°45'	63°15'	60	...	shell debris
/87z	19°47'	63°09'	65	...	foram rich coarse sands
/87zz	19°48'	63°06'	80	...	...
/87I	19°51'	63°03'	500	...	coral,coarse carb sands
RR6	19°38'	62°31'	1900	rock+pipe dredge	Mn nods,carb sands
RR6A	19°37'	62°31'	1900	...	dredge lost on 6 tonsl
SIII	19°44'	62°35'	605	gravity core	pelagic ooze
RR7	19°41'	61°59'	2360	rock+pipe dredge	nil, bag inverted
RR8	19°39'	61°58'	1590	...	basalt, carbonate
SD1	19°24'	61°59'	2190	gravity core	1.23m carb ooze
SD1A	19°26'	61°59'	2200	...	0.15m ..+ basalt frag
SD1B	19°26'	61°59'	2350	...	nil
SD2	19°21'	61°53'	2650	...	0.03m ...
RR9	19°18'	61°27'	1880	rock+pipe dredge	basalt,carbs,Mn nods
RR9b	19°20'	61°28'	1450	...	...
RR9c	19°17'	61°29'	1890	...	...
RR10	19°19'	61°02'	1105	...	...
RR11	19°21'	61°00'	2010	...	nil
RR12A	18°54'	59°57'	1200	...	basalt,carbonates
RR12B	18°54'	59°57'	1540	...	carbs + corals
RR12C	18°54'	59°57'	2135	...	basalt,carbs,Mn nods
RR12D	18°54'	60°04'	1210	...	basalt,carbonate
RR13A	18°28'	59°18'	1460	...	... + Mn nods
RR13B	18°30'	59°20'	2050	...	nil
RR13C	18°31'	59°23'	1620	...	basalt,carbs,Mn nods
RR14	18°39'	59°00'	2245	...	nil
RR15	18°53'	59°23'	1630	...	dredge lost
SD3	18°31'	59°04'	2667	piston corer	3.28m carb,0.99m pilot
SD4	18°30'	59°04'	2675	...	4.15m carb ooze
SD4B	18°31'	59°02'	2500	...	carb ooze
S4	19°45'	64°29'	2600	Agassiz	Asteroidea,pumice etc
S5	19°53'	64°31'	2600	...	...

iod. Approximately 1.5 days were spent in initially deploying and repairing the hydrophone sections before continuous operations could begin. The main problems were associated with splitting of the plastic sleeving of the hydrophone sections, and the consequential oil leakage. Relining of several sections of the sleeving would appear to be necessary to avoid this problem recurring. Sporadic but minor problems occurred due to leaking electrical junctions in the hydrophone array.

Overall the air gun system worked well and reliably. A six gun array was used throughout, often with the configuration and characteristics shown in Fig 18. In practice one and occasionally two guns failed after several hours continuous operation, but without a major loss of signal performance. In these circumstances repairs to the air guns were made on the turns in and out of the traverse lines. The RefTek system performed extremely well throughout seismic operations.

The Sercel system generally worked well, although the tape decks often signalled H32 errors. The tape deck appears to be the weakest element of the Sercel system used on the Darwin. If possible, upgrading of the decks to e.g. 6250 bpi density capability, combined with a larger diameter reel capability would transform the logisics of operating the system.

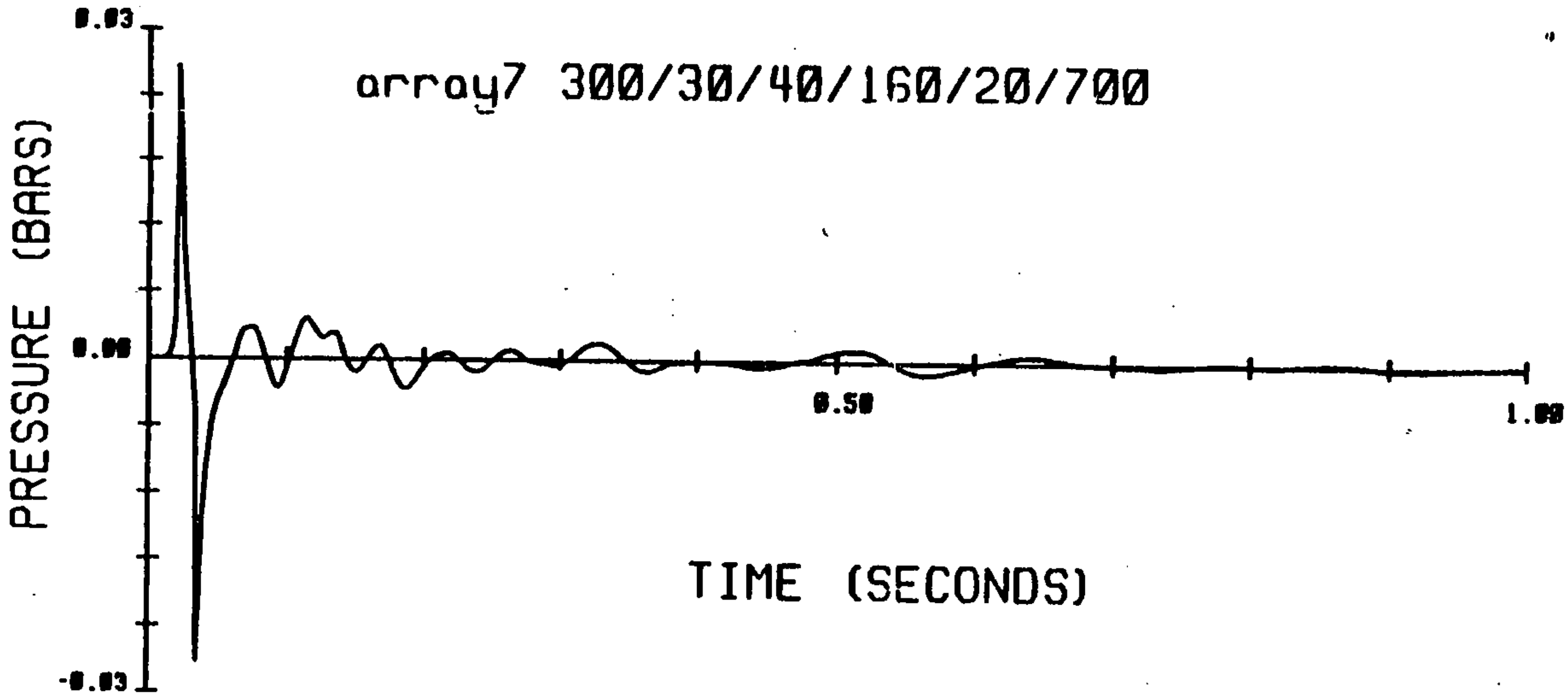
One channel of the MCDAS record was output on spark recorders, with filters set at 30 and 80Hz. This channel's output was also recorded unfiltered on magnetic tape. This SCS physical record was used to monitor the system, to initially assess the gross characteristics of the ridge e.g. lithologic structure, sediment thickness and to assist in selecting sites for later physical sampling.

FIG 18. TYPICAL SIGNATURE OF 6-GUN ARRAY AS USED ON CRUISE 21/87

$\sum v_i$ = 1250 mi

primary/bubble : 18 dB

peak - peak Amplitude : 0.054 bars



4.4. Magnetometer

1250nm of magnetometer data was collected in this study. No significant problems were encountered with the system. Data was output via the chicken printer every six minutes and a manual entry made in the log every thirty minutes.

The fish was typically towed at ca. 6 knots with no difficulties. Even at 10-12 knots there was little significant deterioration of the signal.

4.5. Gravimeter

The gravimter was run continuously and ca. 1250nm of data collected. No significant problems were encountered with the gravimeter. The output pen recorder required occasional recalibrating and there were sporadic difficulties with sticking of the spring tension servo.

4.6. 10kHz PES and 3.5kHz SRP

The PES system was operated throughout the Rodrigues Ridge study. No major faults developed, although the helix on the recorders required daily or more frequent cleaning due to the accumulation of chemicals. This could have been exacerbated by the humidity and temperature. On one occasion the helix required changing.

The 3.5kHz system performed execellently throughout the cruise, with no problems of any type. Its availability allowed high-quality discrimination of sediment characteristics such as slumps, bed forms etc. in the carbonate oozes. High quality resolution was often possible at up to 50m below the sediment surface.

4.7. Rock Dredging

26 rock dredging attempts were made at 15 major sites. The locations of these stations are given in Fig 17 and full details in Table 2. At all of the sites a 12" diameter pipe dredge was deployed behind the rock dredge. A sketch of the typical linkages used to couple the dredgee to the main warp is shown in Fig 19.

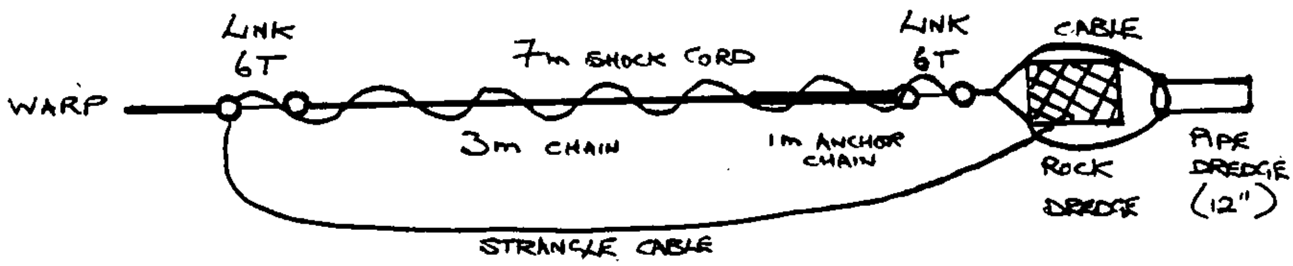
Rock dredging proved hazardous on what was found to be extremely rugged bottom conditions, whether trying to sample the volcanic basement exposed on the ridge flanks, or the carbonates of the ridge crest. Upslope, downslope and along contour dredging techniques were all attempted, with little practical difference in avoiding snagging on the sea bed.

All four rock dredges were ultimately lost and on two occasions snagging of the main warp on the sea bed led to the loss of a total of 2.5km of towing cable.

Bearing in mind the small relative size of the rock and pipe dredges, it would be helpful if more of these could be routinely carried on board for cruises with an identified dredging programme.

Complex maneuvering of the vessel, awareness of warp tension and rapid reactions on the part of the officer on duty were often required to successfully free the dredge and/or main warp when snagged on the sea bed. The provision of a warp tension meter on the ship's bridge, repeating the infor-

FIG 19. TYPICAL ROCK/PIPE DREDGE LINKAGES



mation coming to the main laboratory where the scientific team and mechanics are controlling the operation might considerably ease this task and facilitate lab/bridge communications.

Despite these difficulties the rock dredging programme successfully achieved all of its major aims, retrieving basaltic and other volcanics from 11 sites along the strike length of the ridge. Carbonate sediments were sampled at these and 15 further sites around Rodrigues Island. These samples form the basis for detailed petrological, geochemical, sedimentological and micropalaeontological studies.

4.8. Agassiz Trawl

The Agassiz trawl was deployed three times (see Fig 17 and Table 2 for locations). On each occasion this was done on the smooth carbonate ooze plains adjacent to the Rodrigues Ridge. The primary target of these trawls was deep-water echinoids. No problems were encountered with the equipment, which was typically towed at 0.5 - 1.0 knots for up to six hours on any one trawl. Samples were successfully recovered at each site.

4.9. Coring Operations

Two phases of coring operations were carried out in this study:

(a) At 12 sites on the relatively shallow platform (average 70m depth) around Rodrigues Island (see Fig 17) utilising the 600lb gravity corer.

(b) At 4 sites on the flanks of the central and western portions of the ridge (Fig 17)

(a) Rodrigues Island Platform

Attempts with the Day grab to recover what proved to be coarse bioclastic carbonates on the platform were unsuccessful. The 600lb gravity corer fitted with a 1.5m core barrel was however successfully employed, although recovery was inevitably poor in this type of material. 12 sites were sampled, with typically three attempts made at each.

(b) Rodrigues Ridge Flanks

Four sites were sampled on the flanks of the ridge in variably disturbed, unconsolidated carbonate oozes. All were in relatively deep water, although by this stage operating depths were limited to ca. 2800m through losses to the main warp during dredging operations.

Site SD1 lay in 2200m of water. The 600lb gravity corer was used as the bed slope angle (9.5°) appeared unsuitable for piston coring. 1.23m of core was recovered.

Site SD2 in 2650m was also gravity cored, but retrieved only 0.06m of carbonate ooze.

SD3 (2460m) yielded a 0.30m long gravity core and then 3.28m of coccolith ooze by piston coring, out of a possible 5.10m (64% recovery). The associated 1m trigger core yielded 0.99m of carbonates.

SD4, in apparently undisturbed flat-lying (0.73° bed slope) carbonate ooze at 2608m water depth, yielded 4.15m by piston coring i.e. (81%) recovery.

4.10. Navigation

The Magnavox system was used throughout this study, with intermittent fixes from the GPS system when satellites were available. No significant problems were encountered with the Magnavox. On the shallow platform around Rodrigues Island ship positioning was aided by radar fixing.

4.11. Computing

No problems were encountered with the scientific computing facilities, which worked well throughout the cruise. Data plotting facilities were good and these greatly facilitated the evaluation and selection of physical sampling sites, while the profile plots of magnetic, gravity and bathymmetric data aided initial interpretations.

4.12. Other Features

(1) Ships Log. It was noticed that some of the daily radio transmissions from the Darwin appeared to interfere with the value for the ship's speed as recorded in the ships log in the main laboratory.

(2) Bow Thrusters. It appeared on a number of occasions that the bow thrusters were unable to run continuously for any significant length of time. In some situations, this restricted the ship's maneuverability, particularly when trying to free snagged dredges.

5. RESULTS

Little detailed interpretation of the seismic or gravity data has yet been made. The single channel record is being used to select one or perhaps two cross-ridge traverses for full multi-channel processing and to determine the gross structure of the ridge. Magnetic records for the cross-ridge traverses appear to indicate the presence of a marked ridge-parallel series of reversals.

Bathymmetric, magnetic, bouguer and free-air profiles for the major cross-ridge traverses are presented in Figs 20-28. Table 3 lists the starting and finishing points for each of these traverses. These plots serve to illustrate some of the main features of the Rodrigues Ridge.

Over 200 specimens of predominantly basaltic pillow fragments were recovered from the ridge. Many of these carry well preserved, fresh glassy margins. Of the specimens so far investigated the majority are fine-grained porphyritic olivine basalts. Typically these contain less than 5% olivine phenocrysts, with less common plagioclase and rare clinopyroxene phenocrysts. Locally on the ridge, highly porphyritic facies occur, with up to 30% modal olivine. Preliminary analysis show the basalts to be mildly alkaline, with up to 18% MgO.

Some segments of the ridge have clearly had a protracted sub-aerial volcanic history and dredge hauls here include differentiates petrographically identified as hawaiites - trachytes. No geochemical data is yet available for these samples.

Lithified volcaniclastics, primarily water-lain bedded tuffs predominate at the Mascarene Plateau end of the ridge, and obscure the basaltic basement.

TABLE 3

START AND FINISH COORDINATES FOR SELECTED TRAVERSES ACROSS THE RODRIGUES RIDGE

	START		FINISH	
TRAVERSE	LAT(S)	LONG(E)	LAT(S)	LONG(E)
1	58°00'	19°24'	59°17'	18°11'
2	59°25'	18°14'	60°49'	19°35'
3	60°49'	19°35'	61°27'	19°10'
4	61°27'	19°10'	61°50'	19°58'
5	61°50'	19°58'	62°02'	19°15'
7	63°00'	20°05'	63°18'	19°20'
8	63°18'	19°20'	63°58'	20°00'
9	63°58	20°00'	64°08'	19°30'
11	64°25'	20°05'	64°32'	19°55'

For each numbered traverse the figures show, from top to bottom:

Depth

Magnetic Profile

Bouguer Anomaly

Free Air Anomaly

Scale bars are as follows:

Depth	1cm=1000m
Magnetic	1cm=100nT
Bouguer Anomaly	1cm=100 milligals
Free Air Anomaly	1cm=100 milligals

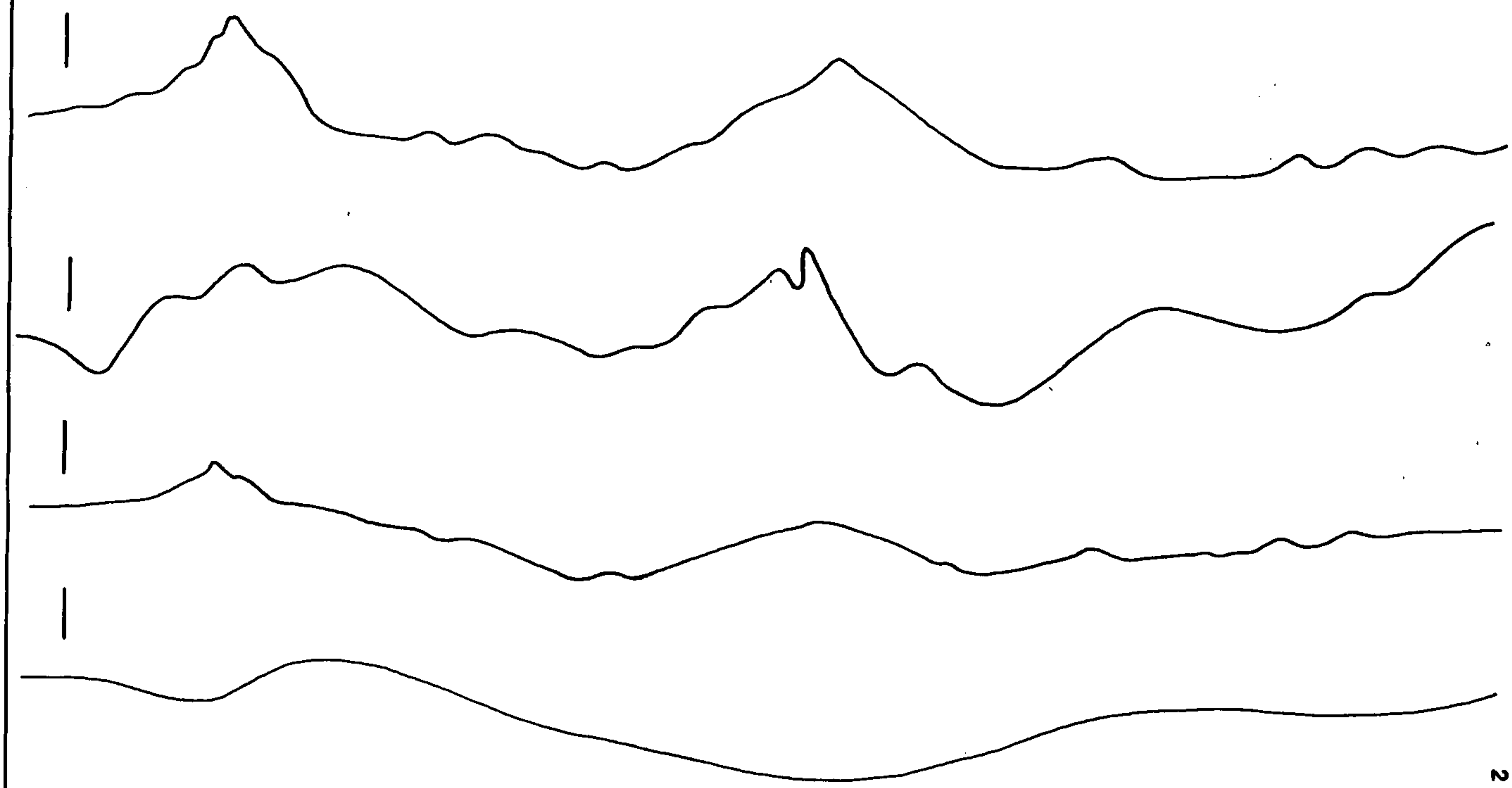


FIG 20. BATHYMETRIC, MAGNETIC, BOUGUER & FREE-AIR GRAVITY PROFILES FOR LINE 2

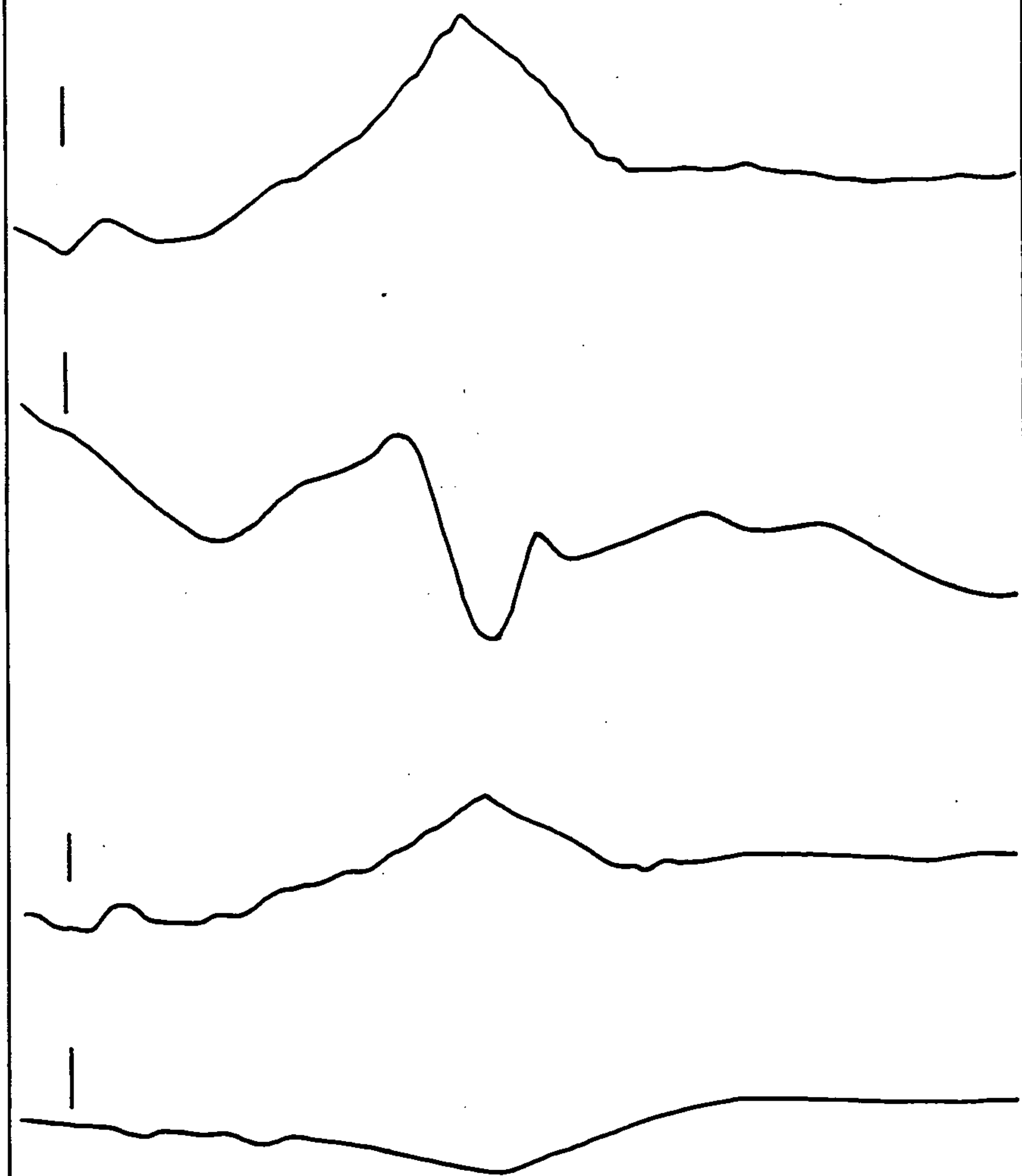


FIG 21. BATHYMETRIC, MAGNETIC, BOUGUER & FREE-AIR GRAVITY PROFILES FOR LINE 3

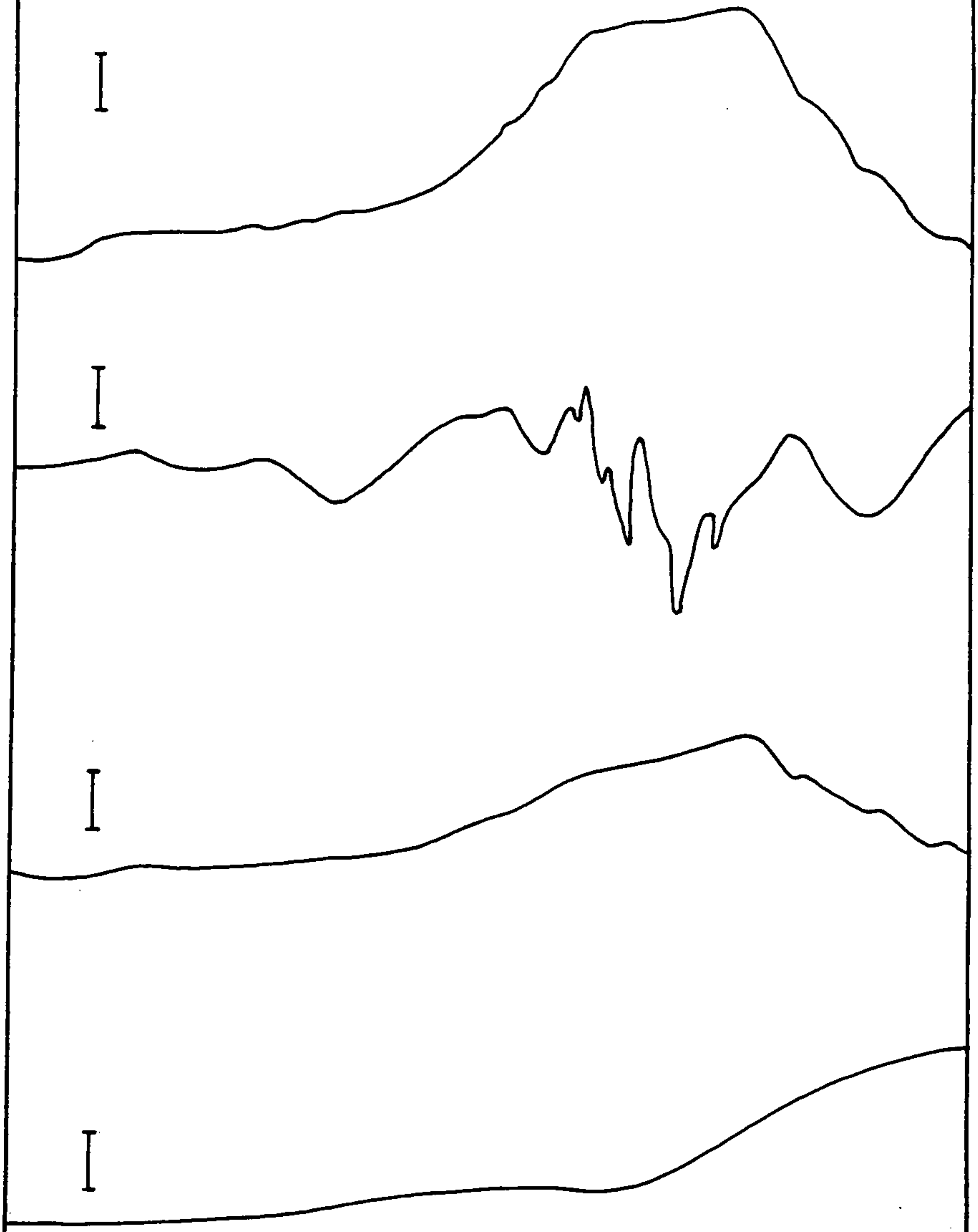


FIG 22. BATHYMETRIC,MAGNETIC,BOUGUER & FREE-AIR GRAVITY PROFILES FOR LINE 4

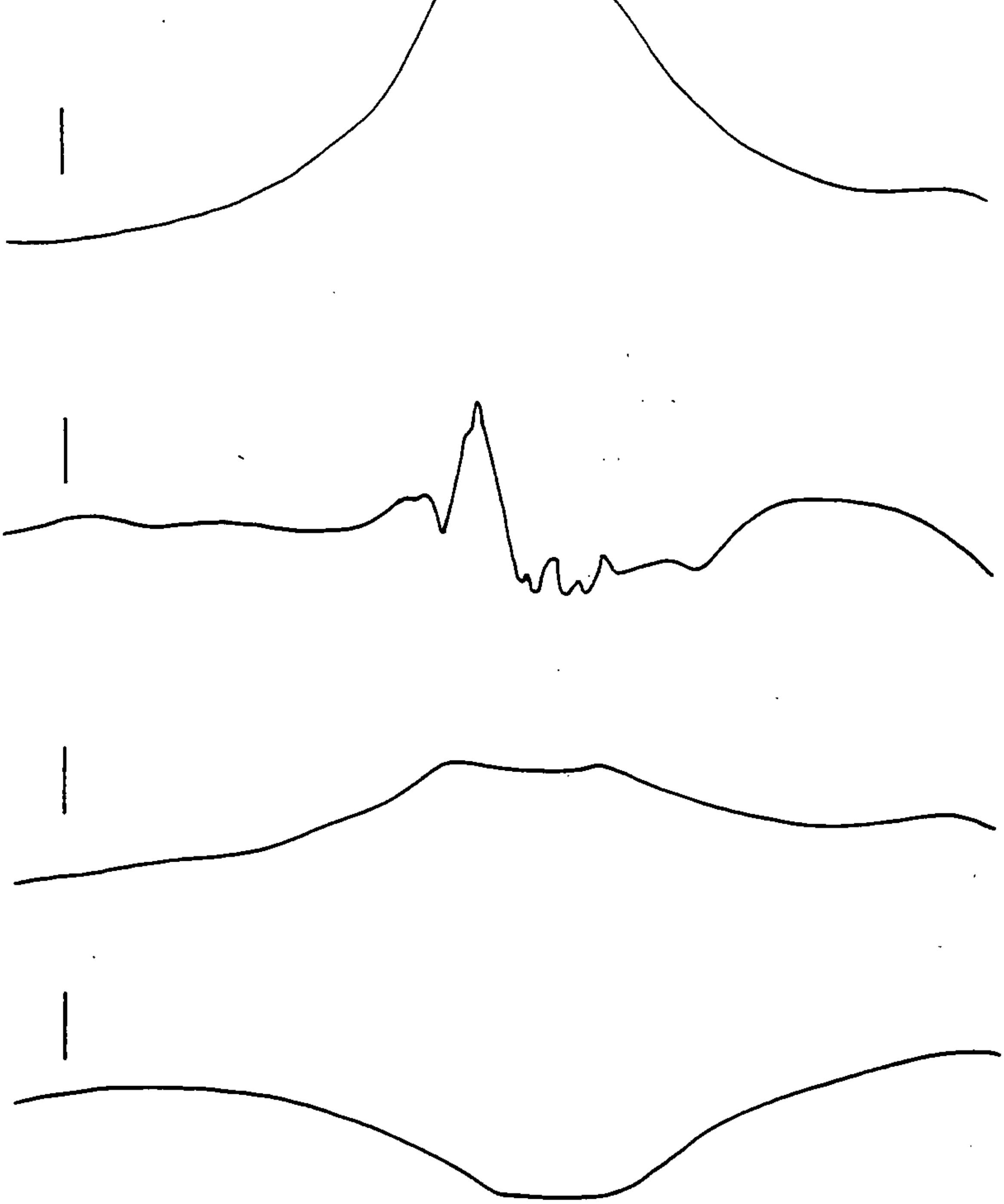


FIG 23. BATHYMETRIC,MAGNETIC,BOUGUER & FREE-AIR GRAVITY PROFILES FOR LINE 5

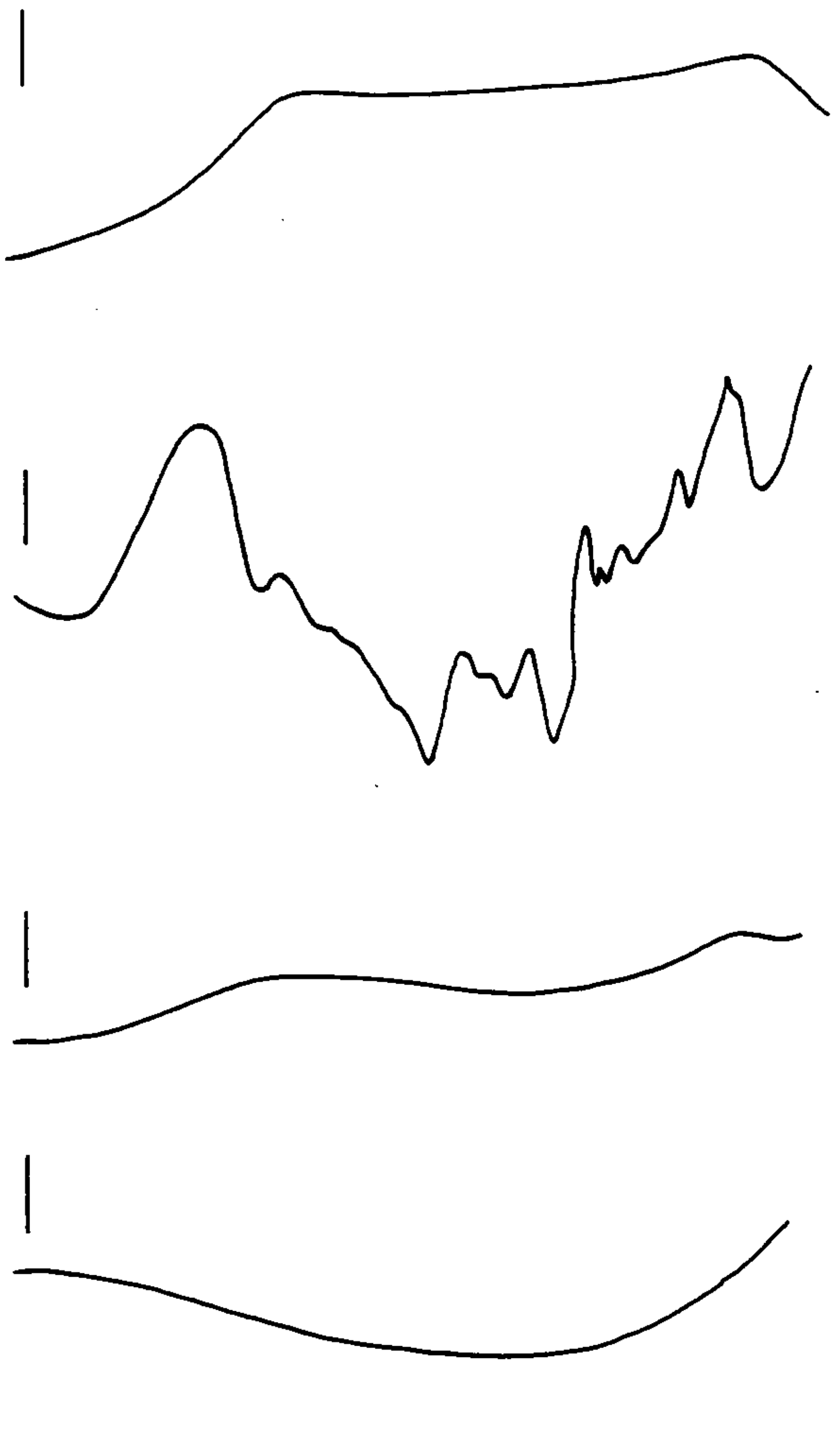


FIG 24. BATHYMETRIC, MAGNETIC, BOUGUER & FREE-AIR GRAVITY PROFILES FOR LINE 7

FIG 25. BATHYMETRIC,MAGNETIC,BOUGUER & FREE-AIR GRAVITY PROFILES FOR LINE 8

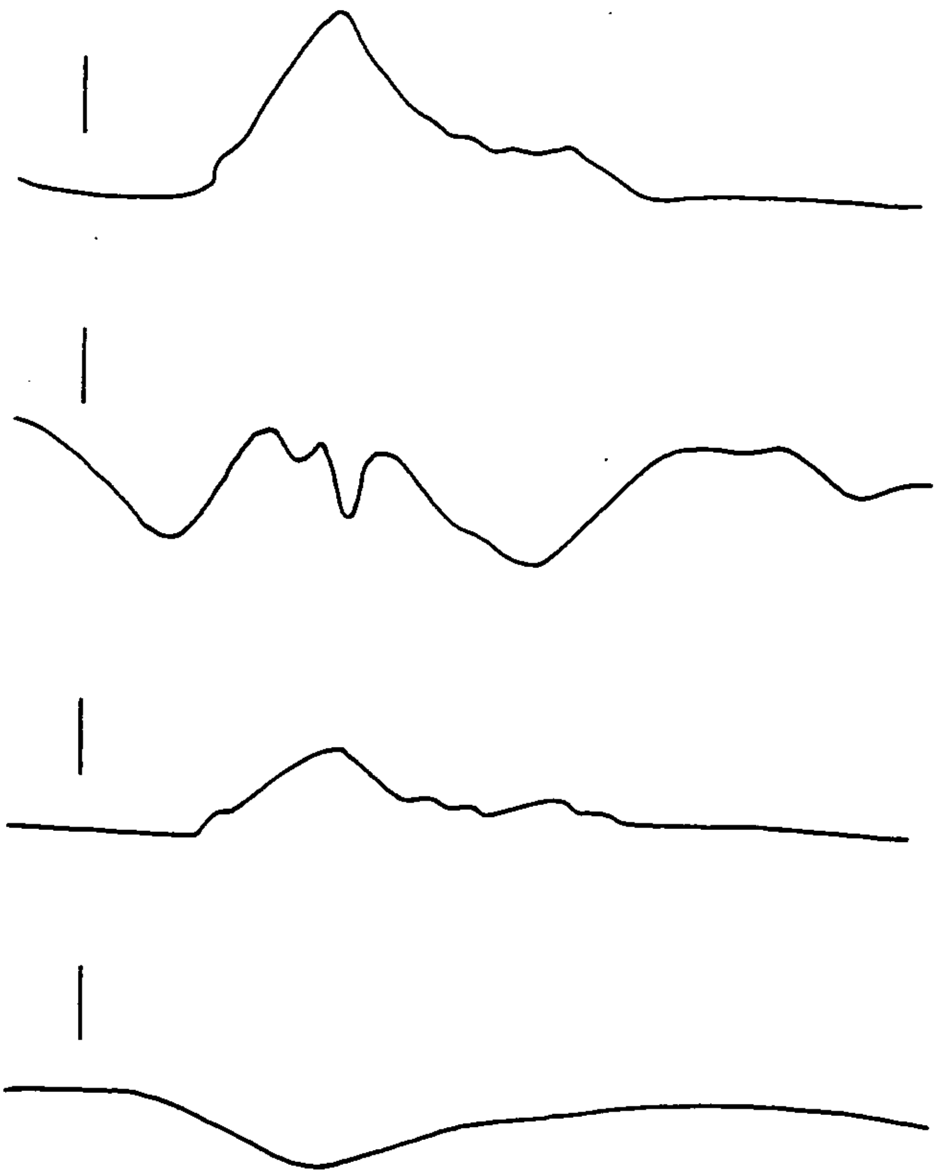


FIG 26. BATHYMETRIC,MAGNETIC,BOUGUER & FREE-AIR GRAVITY PROFILES FOR LINE 9

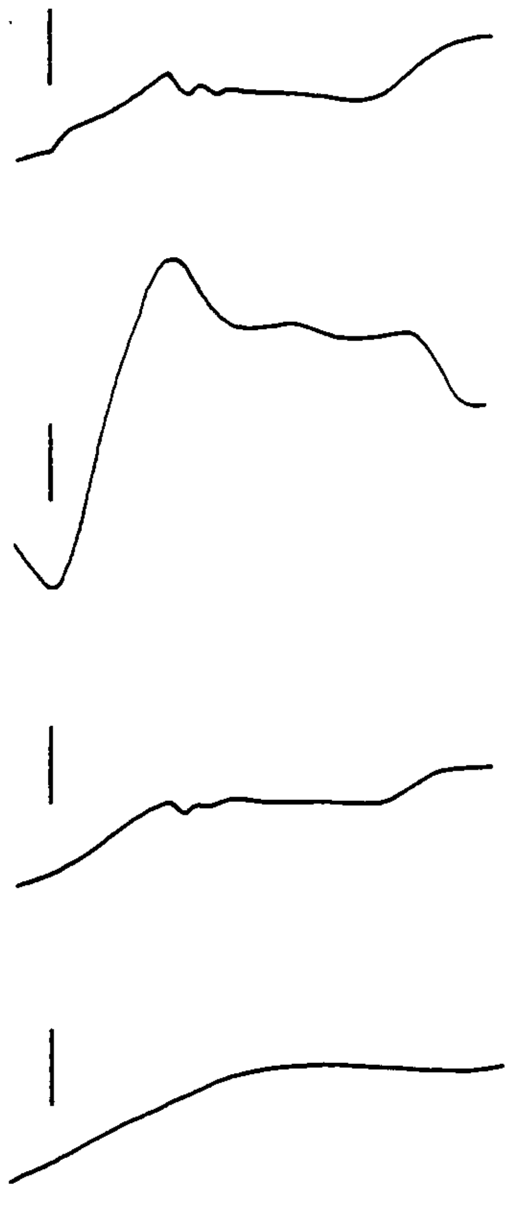


FIG 27. BATHYMETRIC,MAGNETIC,BOUGUER & FREE-AIR GRAVITY PROFILES FOR LINE 1Ø

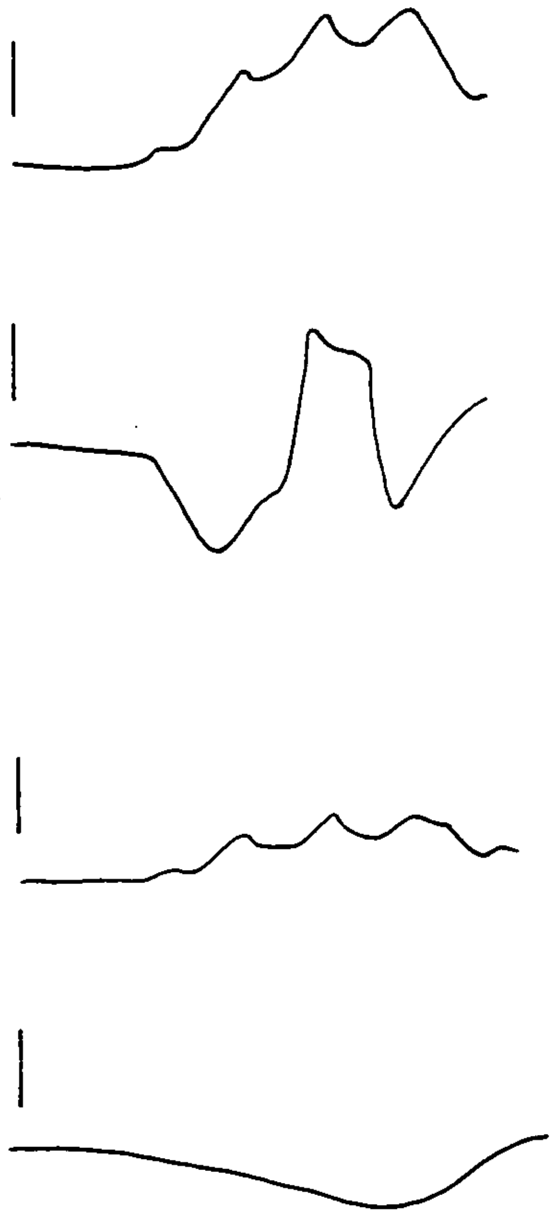


FIG 28. BATHYMETRIC,MAGNETIC,BOUGUER & FREE-AIR GRAVITY PROFILES FOR LINE 11

These tuffs contain occasional fresh olivine basalt clasts, which may yield Ar/Ar or K/Ar ages.

Microprobe analysis of glasses from the pillow margins, to establish liquid compositions, and of matrix and phenocryst phases in the basalts are in progress (M.Fisk and A.Baxter). Major, trace, and rare earth element analysis of the basalts and differentiates has begun (M.Bussell and A.Baxter). K/Ar, Ar/Ar dating of the ridge volcanism will shortly be completed (R.Duncan). Pb, Sr and Nd isotopic studies are planned (W.M.White).

Dredging and coring of the 70m deep shelf around Rodrigues Island showed it to consist of a coralline algal and giant foraminiferal association above a probable Pleistocene planation surface. Variations in foraminiferal distribution occur in this environment and are related to substrate and sediment type. Two broad categories of substrate occur, phytal and sediment. Phytal faunas are charactersied a high proportion of encrusting and grazing rotaliids and thin-shelled miliolids. Faunas from sediment substrates are dominated by globular or thick-shelled amphisteginids and robust miliolids. Dredge hauls from this shelf also retrieved abundant dead coral heads and molluscan material and confirmed the relict nature of much of the planation surface cover.

Gravity cores taken from the ridge crest, away from Rodrigues Island in 200-500m water depth yielded fine-coarse carbonate sands of outer shelf aspect. No living fauna was found in these facies, and it is concluded that these strata are either relict deposits from a previous lowstand of world sea level or are associated with later tectonic subsidence.

Pelagic carbonates flank both sides of the ridge, typically occurring in the rock redge as lithified and manganese coated blocks and as loose sediment in the pipe dredge. The lithified facies consist of wackestone and packstone lithologies dominated by planktonic foraminifera. The blocks have suffered a prolongued history of lithification which has involved an early development of burrows (still unfilled) followed by later widening of the burrow apertures and final encrustation by thick manganese coatings. These hardgrounds lack a typical encrusting and boring fauna and at this stage are imperfectly understood. They occur today at water depths of 1500 - 3800m. Investigation is initially focussed on SEM, microprobe and thin-section studies (M.Pedley) in an attempt to reconstruct their history. The contained microfaunas may yield information on water depths at the time of their formation and their age. Preliminary data indicates a L. Burdighalian (Late mid-Miocene) age for these carbonates at the west end of the ridge.

Piston cores from the distal north and south flanks of the ridge, furthest from the crest are apparently all slumps or turbidites formed of coccolith and foraminiferal oozes. Consolidation tests revealed disturbances of 27-67% with all samples showing overconsolidation - common in such cores and generally attributed to the sampling method. Grain size distributions are polymodal, with each mode attributable to a particular biogenic component. Typically this consists first of a foraminifera-dominated sand fraction which shows a truncated coarse-tailed distribution, secondly a well-graded silt fraction believed to be a matrix of broken biogenic debris, and thirdly a clay-grade coccolith fraction which forms 20-40% of the sediment.

Two M.Sc. theses based on material collected on this cruise have been completed:

(1) "Recent foraminifera from the waters around the island of Rodrigues, southern Indian Ocean". 1987. G.Heward. University of Hull.

(2) "The geotechnical properties of biogenic carbonate ooze from the Rodrigues Ridge, western Indian Ocean". 1988. S.Draper. UCNW - Bangor.

One Ph.D. thesis (G.Heward) is currently in progress, with the provisional title:

"The sedimentology and micropalaeontology of the Rodrigues Ridge and its surroundings".

The supervisors for this are Dr.M.Pedley and Dr.M.D.Brasier, University of Hull.

6. ACKNOWLEDGMENTS

The scientific party on cruise 21/87 of the Darwin owe an immense debt to the administrative, scientific and technical staff of the Research Vessel Services, Barry. The extent of support, advice and assistance given, prior to and during the cruise was outstanding and is a testimony to the professionalism of the RVS organisation. The PSO is indebted for the level of planning, operational and logistical aid given to him, which resulted in the successful conclusion of the cruise.