R.R.S. SHACKLETON CRUISE

REPORT ON CRUISE 3 1973

April 6 - May 3 1973

R.R.S. Shackleton Cruise 3/73

Geology and geophysics near the Horseshoe Seamounts, 400 miles west of Gibraltar, and in area "Q", 300 miles S.E. of San Miguel (Azores).

Report of Proceedings

(a) Cruise Objectives

Scientific personnel came from the Universities of Cambridge and of East Anglia (Norwich) and from the British Museum (see distribution list at the end of the report).

This was our third and final cruise to the Horseshoe Seamounts where we have worked during Researcher 4/71 and Shackleton 2/72. It was intended to complete the geological sampling of the five seamounts and to complete the present phase of geophysical data collection making particular use of our greatly improved seismic reflection capability. Plans (fig.1) made after detailed discussions with the French group from C.O.B. (Brest) called for a conventional reversed seismic refraction line (CD) at the western end of the Horseshoe Abyssal Plain using recording sonobuoys and geophex, two reflection/refraction lines farther east at J and K using recording sonobuoys and aquaflex, and dredging on Coral Patch, Cromer Seamount and Ormonde Bank. All the tracks between these stations were carefully chosen as seismic reflection lines and we intended to use 6 disposable sonobuoys on them. Plans are detailed on the appended page.

The objective at area "Q" was to try out the reflection/refraction technique in an area of typical ocean crust. We hope to be able to determine the crustal structure down to the Moho by shooting aquaflex lines 15 miles long instead of shooting conventional refraction lines 35 miles long using more costly geophex. Plans called for a pair of crossed lines, orientated parallel and perpendicular to the trend of the Mid-Atlantic Ridge, each shot out to 20 miles from recording sonobuoys using aquaflex on the outward run and the large chambers of the Bolt airgun on the return run. None of these plans were wholly implemented.

(b) Duration

The Cambridge party joined in Gibraltar a.m. on 2nd April and spent four days extracting gear from the hold and setting it up in the lab. The ship sailed a.m. 6th into the Mediterranean and we spent two days in calm weather getting reflection profiling apparatus working. We passed through the Straits into the Atlantic p.m. 7th. The ship entered Ponta Delgada (San Miguel, Azores) a.m. 3rd May.

The weather in the Atlantic was inclement. We experienced almost continuous moderate northerly winds with corresponding sea and swell produced by depressions passing close to the north of us.(The mean of 160 entries of wind speed in the log is $18\frac{1}{2}$ knots.) Although we had one day of calm (conveniently during a refraction line) and were hove-to for less than 12 hours in total, the programme near the Horseshoe Seamounts had to be modified almost out of recognition to take account of the forecasted weather and to avoid steaming beam-on to the sea. We had only one gale which prematurely terminated the work in area "Q".

At 0930 on 12th April when we had just completed laying four recording sonobuoys prior to firing a refraction line we received a signal instructing us to land an officer for compassionate reasons. We recovered the buoys and set course downwind towards Madeira having booked an airflight home through the agent. At 1930, almost halfway to Madeira, we received another signal from Barry ordering us to land the man in Lisbon not in Madeira and by 0730 next morning we were back near the refraction line steaming into the wind and sea bound for Lisbon which was reached at 1600 on the 14th. We sailed again at once and began working on Ormonde Bank at 1400, 15th April.

The total time spent working or on passages within the Horseshoe Seamount area was 14 days (planned: 18 days); in area "Q" we spent 2 days (planned: 3 days). $1\frac{1}{2}$ days were spent in the Med. and 10 days on passage from port to the working areas and between the two areas (planned total: $6\frac{1}{2}$). (A speed of 200 miles per day was used for planning.)

(c) Conduct of operations

The tracks steamed in the Horseshoe Seamount area are shown in Fig.1. The plan for connecting most of the working areas with useful reflection profiles was disrupted by the weather and by returning to Lisbon and it was necessary to forgo profiling and to make many of these short passages at full speed collecting only magnetic and depth measurements. We obtained 435 nautical miles of reflection profile, 120 miles with Lamont airgun, the rest with our Bolt gun using 160 cu in. chamber, all of it of good quality (planned: 845 miles). We shot the two aquaseis lines and the reversed refraction line as planned. We spent $5\frac{1}{2}$ days on reconnaissance and bottom sampling on Ormonde Bank and Cromer Seamount, taking 18 dredge hauls and 9 short cores, instead of the $6\frac{1}{2}$ days planned in three locations. Although we got fewer rocks in these hauls than in 1972 I believe that this was not the fault of gear or technique but merely due to a shortage of suitable outcrops on the bottom. We have now sampled all of the major seamounts in the area. A station list is appended.

The experiment at "Q" was disrupted by the failure of I.C.I. Aquaflex to explode. We had aquaflex on board in three lengths: 200 shots of 50 ft, 350 shots of 100 ft and 75 shots of 200 ft. During the aquaseis line at K in the Horseshoe Plain we fired 95 of the 50 ft lengths and had only one miss-fire, but we fired 15 of the 100 ft lengths and had 9 miss-fires. Most of the aquaflex set aside for work at Q was in 100 ft lengths. We were compelled to abandon the first line fired there because of the long gaps in the firing schedule caused by miss-fires and we were able to fire only one of two planned lines, abandoning the faulty 100 ft lengths completely and concentrating all the 200 ft lengths (and fifty 100m lengths of Geoflex) on achieving this one line only. The 160 cu in. airgun was used while returning to the buoys after this line. We intended to shoot the cross line using the 300 cu in Bolt airgun as a sound source but a gale came up and prevented us. Details of the performance of the aquaflex are appended. On almost all of the missed shots the detonator was heard to explode and in my opinion the problem was caused by defective explosives and not by poor technique.

After the gale had moderated we spent 8 hours on another reflection/refraction experiment using the 300 cu in airgun in an area 35 miles S.E. from Santa Maria. The place was much less suitable than "Q" and results were poor. Tracks between working areas are shown in Fig.3.

(d) Equipment (Cruises 3/73 and 4/73)

(i) Cambridge

Cruise 3/73 was remarkable for the reliability of the Cambridge gear after it had been set up in the Mediterranean. The prototype firing clock jumped each time it was used to fire aquaflex (we had to fire this in local control) and the Oscillomink (a jet-pen recorder used for seismic refraction) ink pump had to be cleaned out; there were no other failures. The battery case of the newly built radar transponder buoy leaked during trials in Gibraltar but was found to be strained by its holding down bolts; when these were slightly slacked off no further difficulty was encountered. (Two identical buoys have been supplied to R.V.B.) The buoy was used for three periods of several days each and gave good results (see next paragraph).

On cruise 4/73 the gear also worked well but the complete failure of one sonobuoy light caused a great deal of frustration on two occasions when recovering the buoys during the Middle watch.

(ii) R.V.B.

Minor difficulties with R.V.B. equipment were very quickly and efficiently dealt with by Derek Lewis. U.M.E.L. pingers and the magnetometer worked excellently. The Kelvin Hughes precision echo sounder suffered frequent minor faults which might have become serious in the absence of Mr. Lewis. This apparatus is getting old. The towed fish was damaged by colliding with a floating log during Cruise 4. The lab crystal clock system was kept going during Cruise 3 but broke down completely during Cruise 4 and had to be replaced, rather inadequately by a Cambridge crystal clock. The steel head of the aquaflex firing cable is almost worn out and should be replaced. The provision of a dynamometer remote readout in the lab is very welcome but it should be resited to clear the chart table, preferably near the echo sounder whence dredge stations are controlled when using a pinger. (The Decca navigator, which was not used on this cruise, is sited over the light table in a position where it cannot conveniently be read or set up.) The British built Omega receiver did not work at all, which very fortunately did not matter because the satellite navigator kept working but which might well have forced us to abandon the work in the Horseshoe Seamounts area where celestial navigation would not now be sufficiently accurate. I recall that a French, Sercel, Omega receiver hired for Researcher during 1971 worked perfectly in this area.

The Flexotir array winch, mounted on the statboard quarter, was kept going only by the devotion of the Chief Engineer. Before it could be used the diesel had to be stripped, then the outer bearing seized up on the first few turns and the brake had to be adjusted. It had been sent for overhaul to Barry just before the ship sailed but the overhaul appears to have consisted solely of spraying the whole winch (and the upper turns of the array) with green paint. Money spent on this overhaul was entirely wasted. The winch requires minor modification to enable the lead to the array to be connected from the inboard side rather than the outboard side and the drum must be fitted with a locking bar to prevent it turning while this connection is being made or broken prior to recovery of the array. The brake slipped on two occasions and once again it was pure luck that no-one lost an arm or was thrown over the ship's side.

Faults in the lab radar were swiftly repaired by Derek Lewis and the Radio Officer. The changed R.V.B. policy, encouraging the ship's staff to keep this vital piece of equipment working at sea, is appreciated. It is important that the box of spares be kept full (we used the spare klystron) and most important that complete circuit diagrams be obtained and kept on board for both the display unit and the transceiver. Both Alpine radar transponder units worked, one better than the other. We obtained usable fixes out to 18 miles range which is unusually good for this system. The best unit shorted and burned out its internal wiring during Cruise 4, damaging the batteries of the transponder buoy. Although this unit was repaired and used again, I suggest that both might be sent back to Alpine so that the performance of the less good one can be checked.

(e) Ship's equipment and fittings

Both the diesel and the electric compressor were overhauled by the Chief Engineer before we joined the ship and were kept running by him throughout the voyage. We were never prevented from using the air guns when we needed them. Trials established the following firing rates:

Electric (Reavell) compressor alone:-

*Lamont gun	30 cu in chamber at	2300 psi every	9 seconds
*Bolt	160	1300	20
Bolt	300	1400	40

Diesel (Hamworthy) compressor alone:-

Bolt gun 300 cu in chamber at 1100 psi every 60 seconds.

Both compressors together:-

*Bolt gun 300 cu in chamber at 1750 psi every 30 seconds.

Here an asterisk indicates the systems used for extensive periods of firing.

The ratemeter and the meter showing total wire over the side on the ship's main coring and dredging winch once again proved to be unreliable due to pulses of electrical noise in the system and to wiring failures. This incommoded the dredging programme and was a considerable nuisance to the Electrical Officer and Mr. Lewis who had to mend it in the middle of the night. It is important that a backup direct mechanical counter be installed at the meter sheave in the Winch Room (Lower hold) like the cyclometer that we installed there in 1972.

The Engineer and Bosun regard the crane aft as being insufficiently firmly secured to the deck and would also like to have a small winch installed on deck aft of the hatch cover on the forward well deck for handling light objects over the A-frame. I agree with both these suggestions provided that the winch is quiet (electric not diesel).

The accommodation for all scientists except the Senior Scientist is very poor, particularly when women are on board. Three suggestions are offered in order of expense and I regard the first of these as imperative.

(i) Each bunk should have half a washing gear cupboard, a towel rail, a toothglass holder and access to a mirror. In the list below a tick indicates that it has and a cross marks a missing item.

cabin	cupboard	rail	glass	mirror
S4	✓	✓x	xx	✓
S5	✓	✓x	xx	✓
S6	xx	✓xx	xxx	x
S7	✓	✓✓	✓x	✓
S8	✓	✓x	✓x	✓
S9	✓	✓x	✓x	✓

(ii) By the lab is a compartment with two lavatories (the only ones available to the 13 scientists) and two showers. The showers are seldom used because when they are the lavatories are not available. So

a) the starboard of the two showers should be changed into a washbasin,
b) a heavy curtain or a sliding door should be installed to separate the two halves of the compartment so that the inner part has a shower and a lavatory and the outer part a lavatory and a basin for the watchkeeper and others to use. This would double the number of washbasins available to the 7 occupants of cabins S4, S5 and S6 who at present compete for one shower/washbasin in the port passage.

(iii) It would be possible, if the ship's watertight subdivision allows it, to install a washbasin in cabin S6 at the head of the single bunk just inside the door as an extension from the basin in the Chief Steward's cabin next door.

(f) Comment

The unexpectedly poor weather made this cruise less fun than was anticipated. However, 70% of the programme was achieved and there were no equipment failures. The cheerful and active cooperation of everyone on board, Captain, Officers and Crew was appreciated. In particular we should like to thank Les Haggis, the Bosun, who has built up a team which every effort should be made to keep together, and Bob Johnson, the Chief Engineer, whose forethought and cheerful presence at all hours of day and night prevented the scientific programme from being held up by winch, compressor or engine problems.

D.H. Matthews
29.6.73.

Distribution

Matthews (2) Limond Mason Claydon Purdy (2) Miss Lort Miss Fowler	Cambridge
Cann Miss Wilkinson	U.E.A.
George	BM (NH)
Lewis	R.V.B.
Capt. Stobie (4)	R.V.B.
Capt. (Harding) Ch.Eng. (Johnson) Bosun (Haggis)	R.R.S. Shackleton
Prof. Bott	Durham
Dr. Barker	Birmingham
Dr. Bonnin	Paris
Dr. Olivet	Brest
Dr. Laughton	I.O.S.
Dr. Francis	A.W.R.E.
Owen	Cambridge
Spare (3)	

FIG. 3 (a)

R R S Shackleton

Cruise 3/73

6 April - 3 May 1973

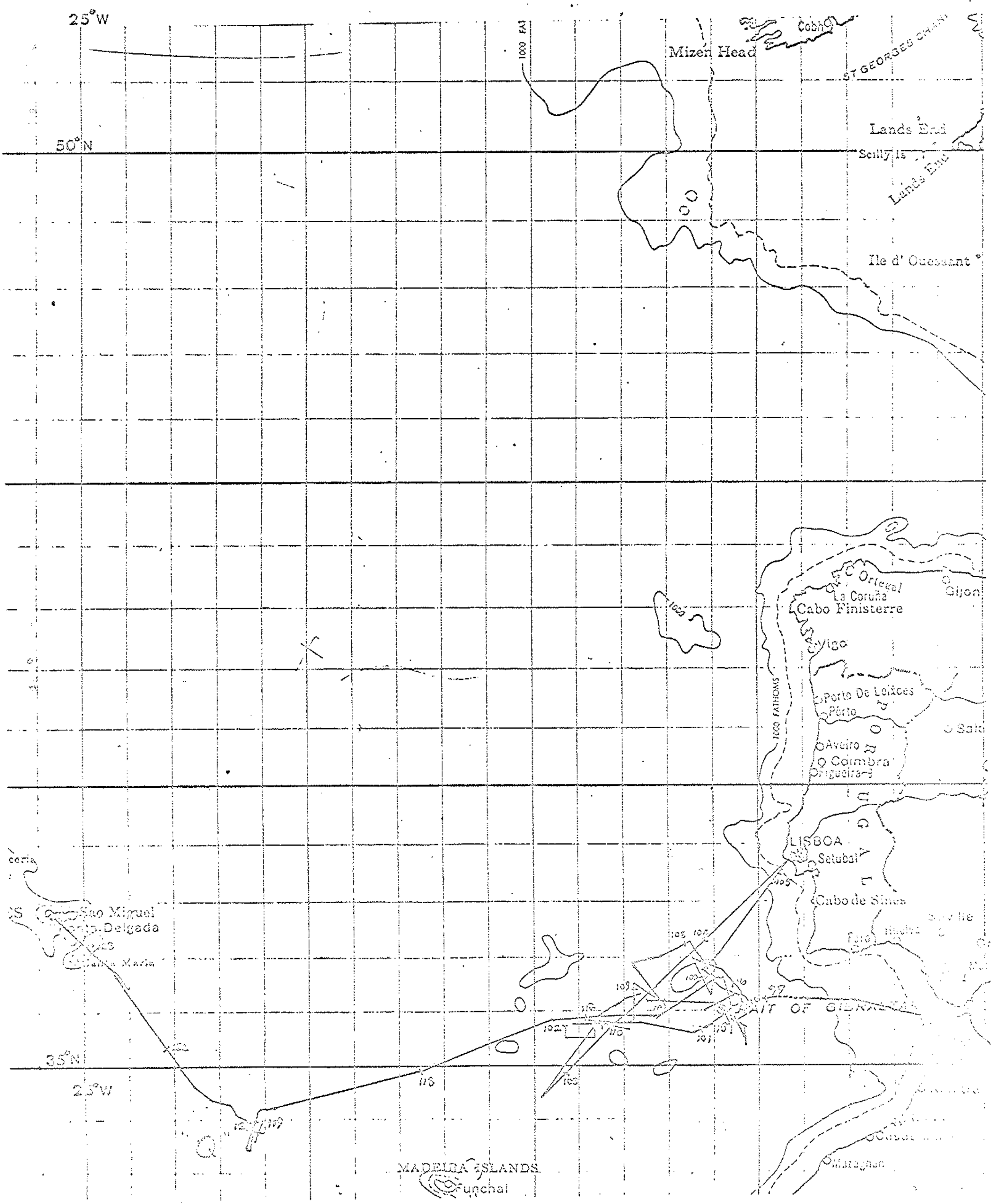
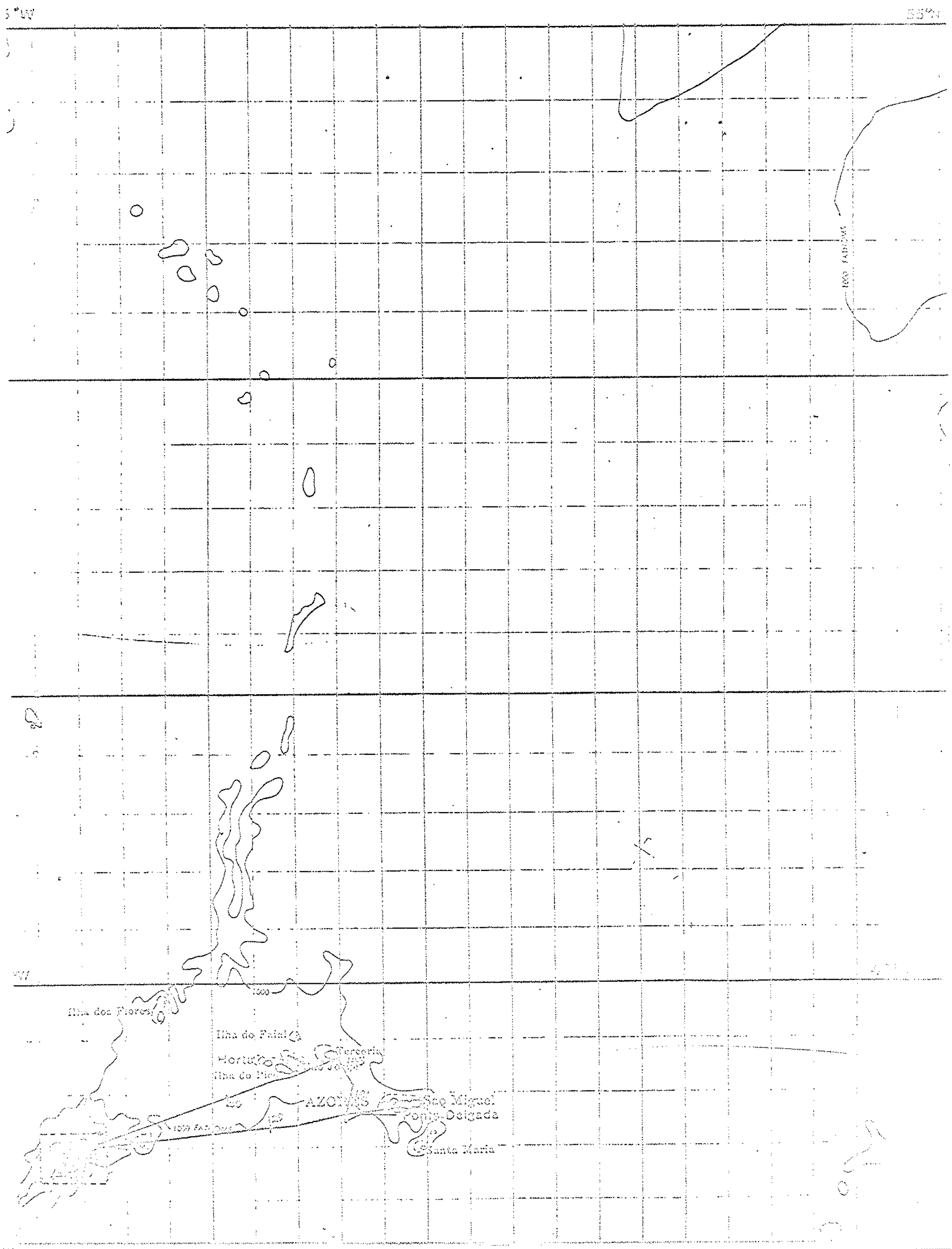


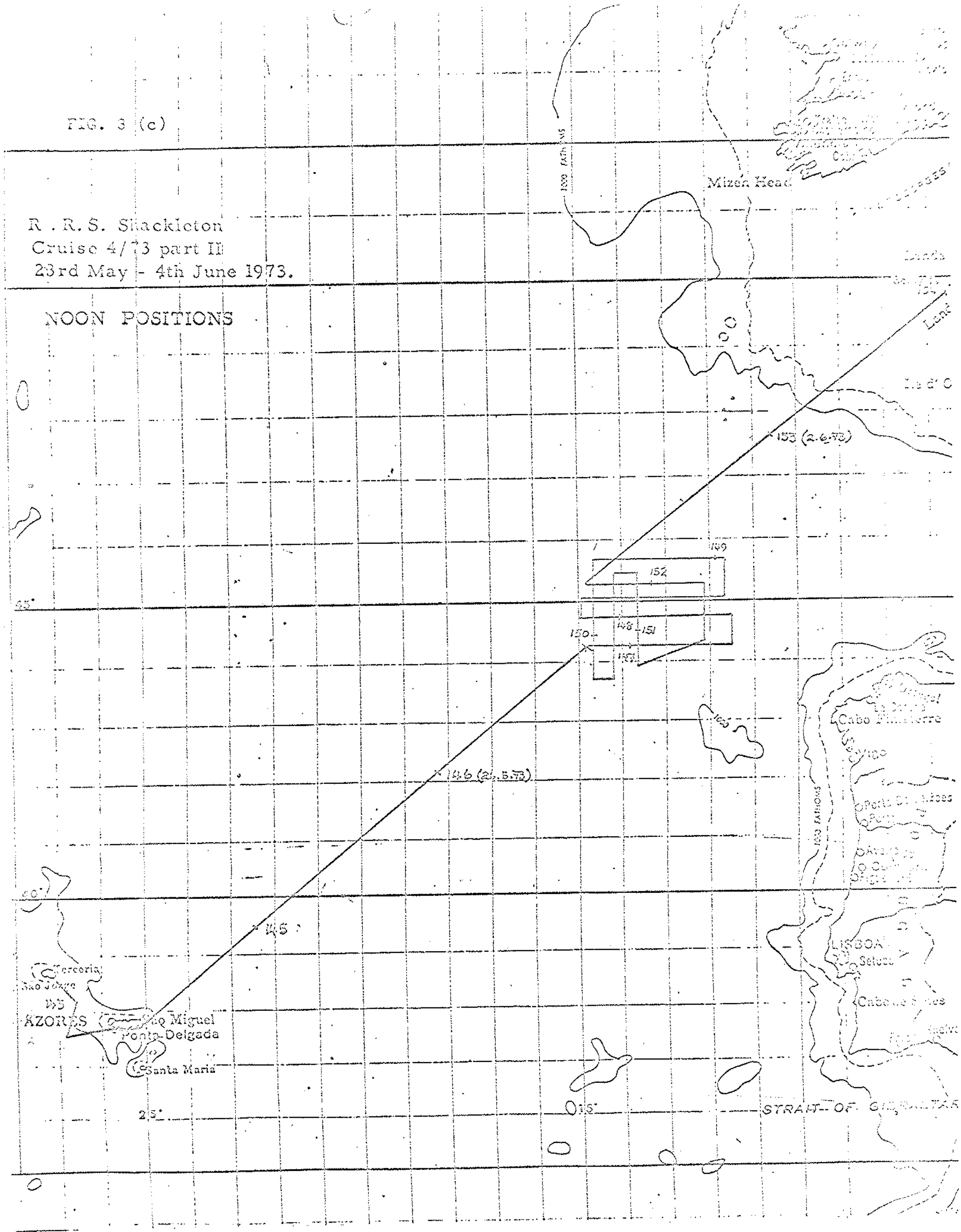
FIG. 3 (b)

RRS Shackleton

Cruise 4/73 part I

8 May- 22 May 1973.





Shackleton left Terceira at 1230 on 23rd May 1973 (Day 143) and arrived back in Barr at 0700 on 4th June 1973 (Day 155). Passage time was $6\frac{1}{2}$ days, leaving 5 working days which were spent doing a magnetic survey for C. A. Williams across the proposed Biscay triple junction. The magnetometer, satellite navigator and echo-sounder worked well and magnetic measurements and soundings were taken throughout the cruise.

PLANS FOR R.R.S. SHACKLETON CRUISE 3 1973

6th April - 3rd May Gibraltar to Ponta Delgada

Depart Gibraltar to carry out trials with reflection-profiling gear .... a.m. 6th April

Return to Gibraltar to land Owen following successful completion of trials and again sail from Gibraltar probably around .... p.m. 7th April

Steam at full speed A (200 n.m.) arriving .... p.m. 8th April

Launch reflection gear and proceed to D (via B and C) at 5 knots (225 miles), recover reflection gear, arriving at D .... p.m. 10th April

Carry out 40 nm long reversed refraction line using Geophex explosive and Bradley sonobuoys. Completion .... p.m. 12th April

Steam at full speed north to 'Cromer' Seamount, lay transponder buoy, carry out bathymetric survey and dredging operations. Completion .... a.m. 14th April

Steam at full speed to E, launch reflection gear and proceed at 5 knots to F, recover gear and steam at full speed to Coral Patch (80 nm @ 10k, 170 nm @ 5k). Arriving at Coral Patch .... a.m. 16th April

Launch transponder buoy, carry out bathymetric survey and dredging operations on Coral Patch. Completion .... a.m. 17th April

Steam at full speed to G, launch reflection gear, proceed at 5k to I (via H) (20 nm @ 10k, 210 nm @ 5k). Arriving I (Ormonde Bank) .... a.m. 19th April

Launch transponder buoy, carry out bathymetric survey, and dredging operations on Ormonde Bank. Completion .... a.m. 21st April

Depending on results of this bathymetric survey either carry out wide-angle reflection line on southern flanks of Ormonde Bank using 'Aquaseis' explosive and Bradley sonobuoys or proceed at full speed to J and then to K carrying out one such line in each location, both approximately 20 miles long and trending roughly NE-SW. Then steam and full speed to L, launch reflection gear, and proceed at 5k to M. Recover reflection gear and steam at full speed back to Ormonde Bank dredging area, arriving .... p.m. 23rd April

Launch transponder buoy, carry out bathymetric survey and dredging operations. Completion .... p.m. 25th April

Stream reflection gear and proceed at 5k to N, O and P (120 nm) arriving .... p.m. 26th April

Recover reflection gear, steam at full speed to Q arriving .... p.m. 28th April

Carry out reflection-refraction experiments completion .... p.m. 1st May

Steam at full speed to Ponta Delgada arriving .... a.m. 3rd May.

G.M. Purdy
27.3.73.

ORMONDE SEAMOUNT

Transponder buoy I			
	1320/105 - 0700/106	36°33.5'N	11°04.9'W
	0700/106 - 1400/106	moving 215°	0.25 kt
	1400/106 - 2100/106	36°32.1'N	11°06.3'W
	2100/106 - 0630/107	moving 215°	0.27 kt
	0630/107 picked up at	36°30.1'N	11°07.9'W

Dredge Stations

No.	Time	Start	Finish	corr fm	corr m.	Result
151	1540 - 1940/105	36°33.4'N 11°08.8'W	36°34.4'N 11°08.9'W	1546 - 1326	2827 - 2426	animals
152	2040/105 - 0110/106	36°35.7'N 11°04.1'W	36°37.2'N 11°05.3'W	1253 - 925	2292 - 1691	animals
153	0210 - 0410/106	36°39.0'N 11°07.9'W	36°39.7'N 11°08.1'W	476 - 355	871 - 650	lst, basalt animals
154	0510 - 1000/106	36°33.8'N 11°06.5'W	36°35.4'N 11°06.9'W	1618 - 1064	2959 - 1946	limestones and serpentinite
155	1040 - 1525/106	36°33.8'N 11°06.1'W	36°34.8'N 11°06.9'W	1477 - 1212	2701 - 2217	animals
156	1640 - 1900/106	36°39.2'N 11°06.2'W	36°39.9'N 11°05.8'W	509 - 452	931 - 826	lst and animals
157	2210/106 - 0130/107	36°39.9'N 11°02.2'W	36°40.8'N 11°03.1'W	884 - 621	1616 - 1136	all gone
158	0235 - 0410/107	36°41.6'N 11°02.0'W	36°41.7'N 11°02.0'W	489	894	coral
159 - 168	1400 - 1900	Inadequately fixed but all on top of Ormonde Bank	$<$ 100 fm			

CROMER SEAMOUNT

Transponder buoy II 36°15.7'N 12°44.7'W

Dredge Stations

No.	Time	Start	Finish	corr fm	corr m.	Result
169	2015/110 - 0035/111	36°17.2'N 12°34.6'W	36°17.9'N 12°35.3'W	2195 - 1895	4015 - 3465	Basalt, ? serpentinite, manganese modules, animals
170	0200 - 0610/111	36°19.8'N 12°33.2'N	36°21.2'N 12°34.7'W	2155 - 1820	3940 - 3330	a few small pebbles, animals
171	0835 - 1310/111	36°17.8'N 12°34.1'W	36°19.3'N 12°35.2'W	2290 - 1860	4190 - 3400	basalt, manganese, limestone, animals
172	1410 - 1840/111	36°19.6'N 12°32.6'W	36°21.3'N 12°34.8'W	2270 - 1810	4150 - 3310	basalt, clinker animals
173	2220/111 - 0520/112	36°20.5'N 12°48.5'W	36°23.2'N 12°49.2'W	1635 - 1430	2990 - 2610	animals
174	0600 - 1340/112	36°19.6'N 12°49.7'W	36°23.7'N 12°50.5'W	1720 - 1310	3140 - 2390	3 pieces of limestone animals
175	1430 - 1820/112	36°20.9'N 12°53.3'W	36°22.8'N 12°53.1'W	1645 - 1210	3010 - 2210	animals
176	2020 - 2330/112	36°26.4'N 12°55.8'W	36°27.6'N 12°56.0'W	1143 - 1130	2090 - 2070	animals
177	0410 - 1100/113	36°00.3'N 12°51.8'W	36°03.5'N 12°53.1'W	2650 - 2465	4850 - 4505	animals
178	1335 - 1915/113	36°00.8'N 12°50.8'W	36°02.9'N 12°51.4'W	2645 - 2455	4840 - 4495	large lump of basalt, manganese nodules, animals

REFRACTION AND REFLECTION

Station No	Time	Approx position of sonobuoys	Work done
Horseshoe Seamounts area			
-	2045/98 - 0400/99 1300/100 - 2300/101	see track chart	E - W reflection profile over Horseshoe Plain Disposable sobobuoy at 1724/101
-	2030/107 - 2000/108	see track chart	Reflection profile over Tagus Plain and Cromer Gettysburg col. 2 disposable sonobuoys at 0120/107 and 0850/108
-	0800/109 - 1720/109 0000/110 - 0917/110	35°45'N 12°50'W 35°48'N 13°45'W	Reversed refraction line using Cambridge sonobuoys and geophex
179	1040/114 - 2050/114	36°07'N 11°00'W	refl. /refra. using Cambridge sonobuoys and aquaflex
180	0020/115 - 1155/115	35°46'N 10°45'W	refl. /refra using Cambridge sonobuoys and aquaflex
-	1900/115 - 0600/116	see track chart	N - S reflection profile across Horseshoe Plain
Area Q			
Transponder buoy III laid 1300/119 at 33°40'N 21°18'W Recovered (adrift) p.m. day 120			
-	2245/118 - 0900/119	see track chart	Reflection profile on course 200° through transponder buoy position. 2 disposable sonobuoys at 0030/119 and 0315/119.
181	1515/119 - 2130/119 2310/119 - 1035/120	33°48'N 21°15'W	refl/refra Cambridge sonobuoys and aquaflex, also disposable sonobuoy and 160 cu in airgun
near Azores			
182	1240/122 - 1940/122	36°35'N 24°25'W	refl/refra using both Cambridge and disposable sonobuoys and 300 cu in airgun

Experience with Aquaseis and Geoflex

Length	No. of shots	No. missfire (det. only)	% missfires
At J, 24 April			
Aq 50 ft	100	10	10%
Aq 100 ft	19	9	47%
At K, 25 April			
Aq 50 ft	94	1	1%
Aq 100 ft	15	9	60%
At Trials, 28 April			
Aq 100 ft	12	7	58%
Aq 200 ft	4	1	-
At line B C, 29 April			
Aq 100 ft	79	40	51%
At line B'C', 30 April			
Aq 200 ft	66	25	38%
Geo 300 ft	48	12	25%
Totals			
Aquaflex 50 ft	194	11	6%
" 100 ft	125	65	52
" 200 ft	70	26	37
Geoflex 100 m	48	12	25

Note

(i) Some of the early failures with 50 ft lengths on 24 April may have been due to throwing the charges perpendicularly out from the ship instead of straight astern.

(ii) The detonator was heard to fire on practically all the shots.

(iii) Tying knots in the charge or binding it with lassovic to prevent it pulling out had no effect. Ships speed was 5 knots and charges were fired every one or every two minutes.

(iv) Some boxes were much worse (all failed) than others. Many of the 100 ft aquaflex reels and some of the 200 ft reels were rusty suggesting that they had been damp for a long time before we received them on board.

(v) Results suggest that the whole consignment apart from the 50 ft reels was old stock.