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I.O.S.

**GEOLOGICAL INVESTIGATION IN
THE EQUATORIAL ATLANTIC**

21 November - 4 December 1978

M. I. A. S.
17 JAN 1979

**R.R.S. DISCOVERY
CRUISE 96**

CRUISE REPORT NO. 79

1979

**NATURAL ENVIRONMENT
INSTITUTE OF OCEANOGRAPHIC
SCIENCES
RESEARCH COUNCIL**

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CRUISE 96

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Institute of Oceanographic Sciences,
Brook Road, Wormley, Godalming,
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ITINERARY

Sailed from Recife a.m. 21st November, 1978

Arrived Recife a.m. 4th December, 1978

SCIENTIFIC STAFF

R.H. Belderson	(I.O.S. Wormley)	Principal Scientist
S.V. Bicknell	(I.O.S. Wormley)	Gloria
D.G. Bishop	(I.O.S. Wormley)	In charge of profilers
G.F. Caston	(I.O.S. Wormley)	Geology
R.H. Edge	(I.O.S. Wormley)	Senior engineer
D. Flatt	(I.O.S. Bidston)	Tidal measurements
P. Foden	(I.O.S. Bidston)	Tidal measurements
A.W. Gray	(I.O.S. Wormley)	Compressors
P. Hartland	(R.V.S. Barry)	Computer
B. Hughes	(I.O.S. Bidston)	Tidal measurements
N.H. Kenyon	(I.O.S. Wormley)	Geology
C.D. Pelton	(I.O.S. Wormley)	Geology
R.D. Peters	(I.O.S. Wormley)	Compressors
J.B. Rae	(I.O.S. Bidston)	Tidal measurements
J. Revie	(I.O.S. Wormley)	In charge of Gloria
R. Rizzo	(Univ. Sao Paulo)	Observer

SHIP'S OFFICERS

J.J. Moran	Master
J.D. Noden	Chief Officer
J.K. Seymour	2nd Officer
C.J. Dixon	3rd Officer
C.P. Tottle	Chief Engineer
N. de Rose Wilson	2nd Engineer

OBJECTIVES

The original main objective - the exploration of the morphology of the Brazilian continental slope and rise to the east of Recife using Gloria Mk II - had to be abandoned when the Brazilian authorities refused us permission to carry out this work. Consequently an alternative programme of work outside the 200 mile limit was accomplished. This comprised surveys of the eastern end of the Equatorial Atlantic Mid-Ocean Canyon and of much of the Romanche Fracture Zone, with a linking track between these two main features of interest.

Three secondary objectives were: (1) the laying and recovering of an experimental tide gauge (T6) for I.O.S. Bidston; (2) trials of the new I.O.S. 2 kHz reflection profiler; and (3) running in of three new air-gun compressors.

MAIN EQUIPMENT USED

Gloria Mk II; air-guns; 31 kHz narrow beam echo sounder; P.E.S.; 2 kHz reflection profiler.

NARRATIVE

DISCOVERY sailed from Recife at 1330Z (1030 local time) on 21st November, 1978. A NE course was set towards a flattish area on the continental slope at about 2800 m water depth selected as a likely site for the mooring of tide gauge T6. At 1620Z the ship was hove to briefly for a tide gauge flotation test, the P.E.S. fish being launched at the same time. The sonar pod was deployed at 1900Z and the 2 kHz reflection profiler switched on briefly to test transmission. The nature of the noise generated by the latter equipment was so potentially wearing on the ship's company that it was agreed with the Captain to restrict its use to between the hours of 1200 and 1900.

On arrival in the vicinity of the proposed tide gauge station time was spent between midnight and 0230Z/22nd on surveying for a suitable spot, or hove to waiting on satellite fixes. The tide gauge was released at 0243Z and arrived on bottom at 0342Z in a depth of 2825m at a position $6^{\circ}45.27S$, $34^{\circ}18.05W$. Discovery then resumed a NE course with the intention of launching Gloria at dawn. At 0545Z/22nd a communication was received from R.V.S. that no work was to be done within 200 n.m. of the Brazilian coast (which includes the island of Fernando de Noronha) until permission had been granted. The sonar pod was retracted and narrow-beam echo-sounding discontinued. The ship was held to the same course, as the ground being covered was considered to be of secondary interest. A further message was received from R.V.S. at 0912Z/23rd requiring us to heave to and await instructions. After 30 hours spent hove to, we were permitted at 1530Z/24th to proceed towards the 200 n.m. limit and start work. A new programme of work

having been decided upon, including surveys of the south eastern end of the Equatorial Atlantic Mid-Ocean Canyon and the Romanche Fracture Zone, Discovery headed at full speed towards 4°S , 29°W to begin the canyon survey.

Commencing at 0023Z/25th the sonar pod and echo sounder fish were deployed, Gloria launched and the air-gun and hydrophone streamed. By 0200Z recording was underway on all these systems as Discovery ran parallel to the canyon at 8 knots. The survey was concluded at 1326Z/25th and the ship then turned on a course of 036°T at $8\frac{1}{2}$ knots towards the Romanche Fracture Zone. The Romanche Fracture Zone survey commenced at 2112Z/26th on an easterly course along the northern side of the fracture zone at a speed of 9 knots. The most easterly point reached was at $0^{\circ}01'\text{S}$, $18^{\circ}22'\text{W}$, when at 2200Z/28th, after making allowance for the need to recover the tide gauge in daylight, it became necessary to turn back. The ship was headed south for an hour and a half and then westwards along the southern side of the fracture zone. At 1830Z on December 1st the hydrophone and air-gun were recovered, followed, shortly before sunset, by Gloria. The sonar pod was retracted and course set for the tide gauge station. Echo-sounding was discontinued at the 200 n.m. limit. The tide gauge station was reached at 1200Z/3rd, the gauge released at 1232Z and brought on board at 1349Z. DISCOVERY Cruise 96 was concluded when she docked alongside at Recife at 1254Z on 4th December, 1978.

REPORTS ON PROJECTS AND EQUIPMENT

Geological results

The Gloria Mk II produced good records along 2,600 km of track. A 100 km length of the eastern end of the Equatorial Atlantic Mid-Ocean Canyon was viewed. The sinuous channel, with indications of secondary bed features on its floor, was seen to terminate adjacent to the Fernando de Noronha Fracture Zone. Along the linking track between the Canyon Survey and the Romanche Fracture Zone Survey a number of fracture zones were viewed on oblique crossings. The survey of the Romanche Fracture Zone provided a wealth of detail concerning this, the largest and most dramatic of the Atlantic fracture zones, including a delineation of what is probably the presently active transform fault.

The air-gun sub-bottom profiler gave good records through to oceanic basement wherever there was a sufficient thickness of sediments. The records from both the 31 kHz narrow-beam echo sounder and 2 kHz sub-bottom profiler suffered in quality through the great depth of water during much of the cruise.

R.H. Belderson

Gloria Mk II

The Gloria Mk II was launched in good weather conditions at 0030Z on day 329. In the next seven days some 1400 n.m. of track length were covered at an average speed of 8.6 knots. Recovery was at 1930Z on day 335, again in fairly good conditions, although the long period swell was estimated as 12 ft high. Both launch and recovery were carried out at 5 knots with the swell on the beam. The towing arm on the vehicle was in the clamped position and during recovery the nose of the vehicle did not touch the gantry until about the midway point. Towing conditions were favourable throughout and the cable showed no signs of damage. The 40 sec pulse repetition period was used and the 4 sec FM pulse was transmitted on three sections each side. All six sections each side were used for reception and the receive beam was stabilised in the direction perpendicular to the smoothed vehicle heading. There were no Gloria equipment faults during the period of the survey and all four channels were successfully replayed from the 21 tapes recorded. The Gloria equipment was the same as for Cruise 91 except for the successful use of the new anamorphic camera designed and built at I.O.S.

The new camera uses the same principle as its predecessor. A continuous flow 35 mm camera photographs the moving object through a narrow slit. The anamorphic ratio is determined by the ratio of film speed to object speed. In the new system the Muirhead K300 print is mounted on a drum which eliminates the time-consuming job of sticking each print on black card. The drum is driven by an electric motor and a proportion of the tacho output from this motor is used to drive the film drive motor. The ratio of film speed to object speed can be adjusted as required by varying the proportion of tacho voltage picked off. The 35 mm flow camera, slit and illumination were incorporated from the old system.

J. Revie

Air-gun sub-bottom profiler

Approximately 1400 n.m. of data was collected using the IOS two channel array and a 160 or 300 cubic inch air-gun firing at a repetition rate of 10 secs and 1500 psi. Apart from a fracture in the main housing of one air-gun, the equipment worked well despite the high ambient temperatures. The towing speed was 8 kts initially and shortly after increased to 9 kts without any increase in noise level or deterioration of the signal. The data was displayed on 2 EPC recorders, one set at 10-100 Hz and the second at 40-100 Hz. With sediment thickness only reaching a maximum of $1\frac{1}{2}$ seconds, the basement was still visible

on the 40-100 Hz record.

All data was recorded on tape at $15/16$ "/sec and FM.

D.G. Bishop

2 kHz sub-bottom profiler

This is an experimental system and was tried for the first time on this cruise. The equipment is almost identical to that of Gloria but operates at 2 kHz instead of 6.5 kHz. It comprises:-

- (1) 3 transducers, each with its own water cooled transmitters and sited in the water filled double bottom of the forward hold. Transmit power is of the order 300 watts/transducer.
- (2) Drum correlator with a selection of swept transmit signals ranging from 100 Hz/ $\frac{1}{2}$ sec to 400 Hz/2 sec and repetition rates of 2.5, 5, and 10 secs.
- (3) Playback/transmit amplifiers and filters.
- (4) Input processor including preamplifiers and filters.
- (5) Short towed line array made up of 11 weighted transducers and summing preamplifier.

Initially, the short array was deployed in place of the SRP array and a 200 Hz/ $\frac{1}{2}$ sec pulse transmitted every 5 secs. It became obvious straight away that the EPC was not the best recorder for displaying the data, due to the slow sweep speeds over-compressing the signals. Increase of sweep speed only increased the vertical exaggeration and so making it worse.

In order that there should be no loss of SRP data whilst testing out the 2 kHz profiler, the transmit repetition rate was reduced to 10 secs and used to trigger the air-gun. The signal received on the first channel of the SRP array was simultaneously filtered from 1.6-2.6 kHz and used in place of that originally received from the short array. This proved to be very successful.

Owing to the depth of water being in excess of 4000m for most of the time, penetration was shallow, and so the transmit pulse was increased to 400 Hz/2 sec. This gave a slight improvement and a penetration of 150 m in 5000 m of water was achieved. It was unfortunate that the system could not have been tested in shallower water.

Because of the high signal levels heard within the ship on transmission, the use of the 2 kHz profiler was limited to between the hours of 1200 and 1900.

D.G. Bishop

VHP 36 Reavell Compair Compressors

The compressors were installed and test run at South Shields in September/October 1978, and were used to run air-guns for the first time on Cruise 96.

They were run each in turn, first using a 160 cu. in. air-gun and latterly a 300 cu. in. air-gun. During this period some minor problems developed in the form of air leaks from pipes, gauges, relief valves and the pressure controller. However these were quickly repaired. It was found necessary to set up the pressure switches each time for different sizes of air-guns used, in order to prevent the overrun timer cutting in and stopping the compressor each time (when switched to auto).

The compressors were run in fairly high temperatures and high humidity conditions. Regular watch-keeping was carried out and all information was logged at regular intervals, as is considered very necessary.

It is interesting to note that one compressor working hard could deliver air at 1750 psi for a 300 cu. in. air-gun fired every 10 secs.

The old Gloria alternator supplies the AC power to run No. 1 and No. 2 compressors plus the fan unit and seawater pump. The two AC compressors could not be run together because the power supply was inadequate.

The DC compressor was run for six hours on the last operating day of the cruise prior to recovery of gear. Retensioning the belt drive was necessary, otherwise it ran well.

The sonar pod was deployed and recovered twice during the cruise without trouble. The azimuth control was not used.

R.H. Edge

Offshore Tidal Pressure Recorder

As part of the programme of tidal pressure measurements in the Tropical and Southern Atlantic, undertaken during Cruises 95, 97 and 98, it was also possible to deploy and recover an offshore tide gauge during Cruise 96. This gauge (T6) was deployed in a depth of 2825 metres at position $6^{\circ}45.27S$, $34^{\circ}18.05W$, about 90 miles from the coast of Brazil. The gauge was deployed at 0242Z on day 326 and recovered at 1349Z on day 337, giving a record of 11.5 days.

The pressure recording system used was an integrated pressure and temperature sensor with frequency modulated signals being integrated every fifteen minutes and recorded on a modified Aanderaa data logger, all contained in a deep sea current meter housing. This gauge, together with a standard acoustic release unit and a deep sea current meter, was mounted within a small aluminium instrument

frame, which was rigidly attached to a ballast frame by a pyrotechnic release mechanism. Buoyancy was provided by four Corning glass spheres held together in a circular frame and attached to the instrument frame by a three metre length of nylon rope. This arrangement was found very easy to prepare, deploy and recover, and had a fall rate of 1.26 metres/sec and a rise rate of 0.86 metres/sec. The tidal record provided by this gauge has proved to be of good quality and has also provided very useful information for the evaluation of this type of tide gauge and of the sensor arrangement used.

J.B. Rae

Computer Engineering/Processing

Plots at 9.44"/nm were performed each day covering the previous 24 hours. Subsequent Satellite Fix editing and evaluation took place based on quality control parameters and visual examination of both track, log, gyro and corrected course. The track was then redrawn for use on Gloria photography.

Radio interference caused numerous dips in the E.M. log readings and appeared to be especially bad on this cruise, due to the extensive use of the radio. Bathymetry listing and plotting at 1:1M was performed.

Two days before arrival in Recife a sudden drop in various analogue channels, including the E.M. log, was noted. Other channels appeared to have increased in value. This did not affect the track due to the unusually good fixes and constant course.

Gloria was brought in a few hours later.

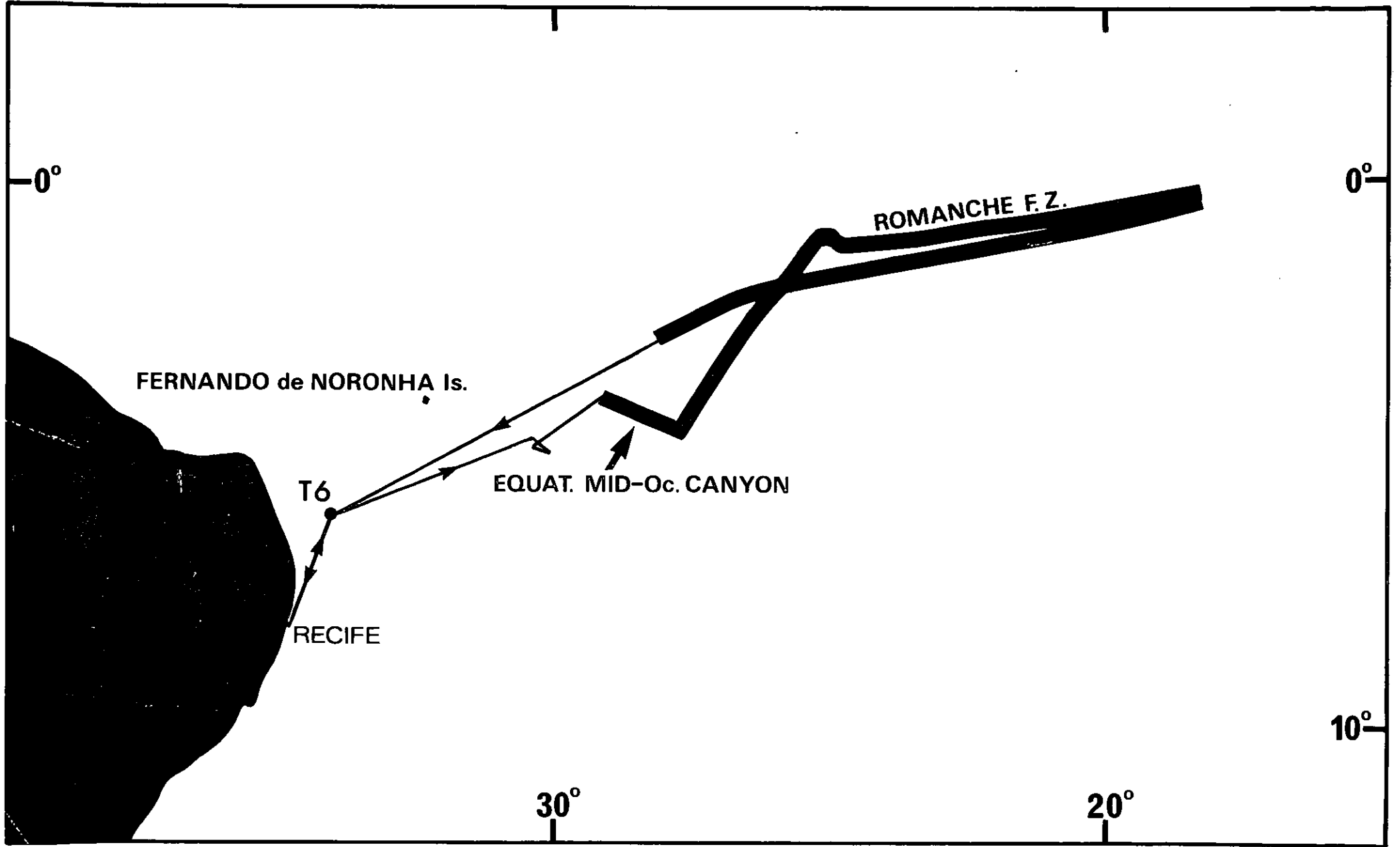
Two days were spent investigating the fault, including the complete A.D.C. calibration. Apart from this fault and the ship's A.C. power, no other significant faults occurred.

P. Hartland

STATION LIST

Station No.	Lat.	Long.	Depth (m)	Name
9925	06°45'S	34°18'W	2825	T6
9926	Recovery of T6 as above			

Track chart showing the location of the long range side scan sonar coverage and
of tide gauge T6



CRUISE REPORTS

RRS DISCOVERY

CRUISE NO

REPORT NO

1	JUN - AUG 1963	1*
2	AUG - DEC 1963	2*
3	DEC 1963 - SEP 1964	3*

NIO CR**

4	FEB - MAR 1965	4
10	TO	10
37	NOV - DEC 1970	37
38	JAN - APR 1971	41
39	APR - JUN 1971	40
40	JUN - JUL 1971	42
41	AUG - SEP 1971	45
42	SEP 1971	40
43	OCT - NOV 1971	47
44	DEC 1971	46
45	FEB - APR 1972	52
46	APR - MAY 1972	55
47	JUN - JUL 1972	52
48	JUL - AUG 1972	53
49	AUG - OCT 1972	57
50	OCT 1972	56
51	NOV - DEC 1972	54
52	FEB - MAR 1973	59
53	APR - JUN 1973	58

IOG CR***

54	JUN - AUG 1973	2
55	SEP - OCT 1973	5
56	OCT - NOV 1973	4
57	NOV - DEC 1973	6
58	DEC 1973	4
59	FEB 1974	14
60	FEB - MAR 1974	5
61	MAR - MAY 1974	10
62	MAY - JUN 1974	11
63	JUN - JUL 1974	12
64	JUL - AUG 1974	13
65	AUG 1974	17
66	AUG - SEP 1974	20
68	NOV - DEC 1974	16
69	JAN - MAR 1975	51
73	JUL - AUG 1975	34
74/1+3		35
74/2	SEP - OCT 1975	33
75	OCT - NOV 1975	43
77	JUL - AUG 1976	46
78	SEP - OCT 1976	52
79	OCT - NOV 1976	54
80	MAR - MAY 1977	59
83	MAY - JUN 1977	61
84	JUN - JUL 1977	50
86	SEP 1977	57
87	OCT 1977	58
88	OCT - NOV 1977	55
89	NOV - DEC 1977	67
90	JAN - MAR 1978	68
91	MAR 1978	69
92	APR - MAY 1978	73
93	MAY - JULY 1978	71
94	JULY - SEPT 1978	74
95	OCT - NOV 1978	77
97	DECEMBER 1978	77
98	DEC 1978 - JAN 1979	75
99	JANUARY 1979	78

* REPORTS 1 TO 3 WERE PUBLISHED AND DISTRIBUTED BY THE ROYAL SOCIETY FOLLOWING THE INTERNATIONAL INDIAN OCEAN EXPEDITION

** NIO CR: NATIONAL INSTITUTE OF OCEANOGRAPHY, CRUISE REPORT

*** IOG CR: INSTITUTE OF OCEANOGRAPHIC SCIENCES, CRUISE REPORT

CRUISE REPORTS

CRUISE DATES	REPORT NO
RRS "CHALLENGER"	
AUG - SEP 1974	108 CR 22
MAR - APR 1976	108 CR 47
MAR - MAY 1978	108 CR 72
MV "CRISCILLA"	
NOV - DEC 1978	108 CR 73
RV "EDWARD FORBES"	
OCT 1974	108 CR 15 X
JAN - FEB 1975	108 CR 19
APR 1975	108 CR 23
MAY 1975	108 CR 32
MAY - JUN 1975	108 CR 28
JUL 1975	108 CR 31
JUL - AUG 1975	108 CR 36
AUG - SEP 1975	108 CR 41
AUG - SEP 1975	108 CR 44
FEB - APR 1976	108 CR 48
APR - JUN 1976	108 CR 50
MAY 1976	108 CR 53
AUG - SEP 1977	108 CR 64
RRS "JOHN MURRAY"	
APR - MAY 1972	NIO CR 51
SEP 1973	108 CR 7
MAY - APR 1974	108 CR 9
OCT - NOV	
& DEC 1974	108 CR 21
APR - MAY 1975	108 CR 25
APR 1975	108 CR 39
OCT - NOV 1975	108 CR 40
AUG - OCT 1975	108 CR 42
OCT - NOV 1976	108 CR 53
MAR - APR 1977	108 CR 66
JULY - SEP 1978	108 CR 76
NC "MARCEL RAYARD"	
FEB - APR 1971	NIO CR 44
MV "RESEARCHER"	
AUG - SEP 1972	NIO CR 60
RV "SARSTA"	
MAY - JUN 1976	108 CR 30
AUG - SEP 1976	108 CR 30
MAR - APR 1976	108 CR 44
MARCH 1977	108 CR 63
RRS "SHACKLETON"	
AUG - SEP 1973	108 CR 3
JAN - FEB 1975	108 CR 18
MAR - MAY 1975	108 CR 24
FEB - MAR 1975	108 CR 29
JUL - AUG 1975	108 CR 37
JUN - JUL 1976	108 CR 45
OCT - NOV 1976	108 CR 49
JUL 1977	108 CR 62
MV "SURVEYOR"	
FEB - APR 1971	NIO CR 38
JUN 1971	NIO CR 39 X
AUG 1971	NIO CR 42 X
DE "VICKERS VOYAGER" AND "PISCES III"	
JUN - JUL 1973	108 CR 1