I.O.S.

R.R.S. DISCOVERY

CRUISE 103

9 – 25 JULY 1979

GEOLOGY AND GEOPHYSICS IN THE GULF OF ADEN AND RED SEA

CRUISE REPORT NO 88

1980

NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE OF OCEANOGRAPHIC SCIENCES

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ITINERARY

Departed Djibouti	1979 July 9th, Day 190
Arrived Suez	1979 July 25th, Day 206

SCIENTIFIC PERSONNEL

R.C. Searle	Principal Scientist	I.O.S. (Wormley)
S.V. Bicknell	Gloria	" "
R.H. Edge	Mechanical engineering	" "
C.G. Flewellen	Seismic reflection	" "
P.M. Hunter	Geophysics	" "
R.D. Peters	Workshop	" "
R.A. Phipps	Workshop	" "
A. Prigmore	Geophysics	" "
J. Revie	Gloria	" "
M.R. Saunders	Geophysics	" "
D. Jones	Computer	R.V.S. (Barry)
D. Lewis	Computer	" "
D. Tamsett	Student (Geophysics)	Newcastle University
T. Cole	Student (Coring)	Imperial College
S. Shearme	Student (Coring)	Imperial College
Izeldin A. Yousif	Observer	Red Sea Commission
Hussein A. Gawad	Observer	Egypt

SHIP'S OFFICERS

M.A. Harding	Master
J.D. Noden	Chief Officer
J.K. Seymour	2nd Officer
C.J. Dixon	3rd Officer
A.E. Coombes	Chief Engineer
N.A. Deroze Wilson	2nd Engineer
F.J. Richards	3rd Engineer
R.G. Whitton	4th Engineer
R. Cotter	5th Engineer
G. Gimber	5th Engineer
L. Wilson	Electrical Engineer
R.M. Morris	Purser Catering Officer
I.K. Catherall	Radio Officer

PETTY OFFICERS

A.A. Zomers	Bosun
D.S. Knox	Bosun's Mate
R.G. Burt	Netman
L. Cromwell	Carpenter

CRUISE OBJECTIVES

The following intentions were established prior to the cruise:

1. To conduct a tectonic study of the Gulf of Aden fracture zones, especially the Alula Fartak trench. This was intended to form the major part of the Ph.D. thesis of one of the cruise participants, D. Tamsett.
2. To investigate any changes in tectonic and volcanic patterns along the Gulf of Aden spreading axis in the vicinity of the Gulf of Tadjourah.
3. To conduct a reconnaissance survey with Gloria in the Red Sea. It was hoped in particular that Gloria would produce new data on the tectonics of the salt deposits there, and the nature of the Pliocene rifting which produced the axial trough.
4. To obtain cores from the Atlantis II Deep area of the Red Sea for geochemical studies at Imperial College.

SUMMARY OF MAJOR PROBLEMS

The cruise was dogged by a series of equipment malfunctions, most of which were potentially serious and could have jeopardised the scientific programme. In fact most of the problems were overcome, and all of the major cruise intentions were achieved. This was partly the result of a very great deal of long and hard work put in by the technical staff, and partly good luck. Most of the problems were attributable to inadequate maintenance or simply the need to replace aging equipment. Detailed reports will be found later, but the major problems are summarised here.

1. Ship's engines

In Djibouti, only one engine was considered to be in really good condition, and for some time it was uncertain whether we would sail at all. Eventually we departed with two engines operational, although one of those was still suspect. This meant we would not be able to work in any bad-weather areas, so there was a real danger that we might have to abandon the Alula Fartak Trench work. In the event, the weather was good and we were not seriously inconvenienced by engine problems.

2. Ship's air-conditioning

It is quite clear that the present air conditioning system is not adequate for tropical conditions. It failed completely on two occasions, rendering the lower accommodation almost uninhabitable. Even when it was working there were quite inadequate supplies of air to some parts of the ship, including the Master's and Principal Scientist's cabins. In addition, the pump driving the Voyager units was extremely noisy, and caused a great deal of discomfort in parts of the accommodation. Although everyone worked willingly, the poor conditions inevitably meant a loss of efficiency, particularly as many people found it very difficult to sleep.

3. Computer

The IBM 1800 gave trouble throughout the cruise, with major faults in the disc drives, plotting office printer and drum plotter. These resulted in loss of data and inability to list, plot or edit data at sea. Moreover, considerable time and effort had to be devoted to preparing high-quality track charts by hand. Most of the computer problems were attributed to insufficient maintenance.

4. Airguns

Major items on the guns failed as a result of age. The workshop staff were just able to keep the guns working, but we had numerous interruptions to our traverses while guns were recovered or deployed, often to fail again soon afterwards. By the end of the cruise virtually all the spares had been used and only one gun was serviceable.

5. Magnetometer

The magnetometer, which should be trouble-free, failed repeatedly. Most problems were in the outboard cables, which clearly need replacing. But some involved the inboard cable, electronics and pen recorder. Faults in the last two items were largely due to overheating. The liquid-ink pen recorder does not seem to be suitable for the environment in which it is used.

NARRATIVE

The ship departed Djibouti at 1013 GMT on day 190 (July 9th). A consignment of air freight containing the new airgun fared cable and streamlined weight for towing trials, together with airgun and air conditioner spares and charts, failed to arrive at Djibouti. We sailed with one engine out of commission, and doubts concerning the state of insulation on both others; however daily tests showed some improvement during the next few days, and we were able to carry out the scientific program as planned. There were also doubts about the condition of the ship's air conditioning system, and indeed this failed on two occasions. Much dedicated work by the ship's engineers rectified these faults and kept the system running most of the time, but it is clear that the existing plant is quite inadequate in tropical conditions. Both personnel and equipment suffered as a result.

We proceeded west along the Gulf of Tadjourah to launch the PES fish, SRP gear, magnetometer and Gloria near its western end. All except the SRP hydrophone were deployed by 190/1335. Gloria recording commenced at 1855 after initial checks of the system. The hydrophone array was snagged on the capstan while being paid out and several conductors severed. Recording of magnetic field began at 190/1822 using the 'A' cable and fish, but the results were rather noisy. The hull-mounted sidescan was recorded from 190/1640, after initial trouble setting up because the direction indicators did not correspond to the true orientations of the asdic plates. The correct settings were eventually found by trial and error, but for several days we could only use the port beam. In the early part of the cruise the hydraulic motor on the asdic was run continuously while we adjusted the beam angles for best operation; but this caused a loss of about 20 litres per day of oil, so the motor was eventually switched off and the plates fixed at 45° each side. Except for a short period in the central Red Sea they were left thus for the rest of the cruise. The SRP array was repaired and eventually deployed at 191/0919. The 2 kHz profiler was then switched on (receiving through the SRP array) and airgunning with a 40 cu. in. gun began at 191/1000.

After deploying the gear we steamed eastwards along the axis of the Gulf of Aden toward the Alula Fartak Trench. A shallow zigzag was made across the Tadjourah Trench until 191/1550. Then for the next day and a half we followed a straight track, crossing the alternate spreading sections and fracture zones of the West Sheba Ridge.

At 192/0125 the first of a long series of airgun problems occurred. The gun was found to be leaking, was recovered and replaced. During the recovery the block on the A-frame jammed, a hydraulic hose to the capstan burst under the extra load, and the oil was lost. The hose was repaired, and the new airgun launched at 192/0600.

The same evening (192/2000) the magnetometer finally failed to produce any useful signal. Tests indicated that the fish or cable were faulty so these were recovered and replaced by the RVS ones. (A second IOS set, in the hold, was believed to have been discarded as faulty on Cruise 101).

A series of course alterations in the morning of day 193 brought us to the south end of Alula Fartak Trench, and we altered course at 0544 to make a very shallow oblique crossing of it with Gloria. At 0641 we changed the airgun to one with a 160 cu. in. chamber, anticipating thick sediments to the northwest of the Alula Fartak Trench. This gun failed to seal, but eventually a gun was got working by 0850. The side-scan was switched off at 0920 as no useful signals were being received in the deep water. At 1249 the airgun failed and was recovered. A replacement was launched at 1541, and fired successfully.

At 193/1633 we were approaching the junction of the Alula Fartak Trench with the East Sheba Ridge axis, and altered course to view the junction obliquely with Gloria. After crossing the ridge axis we turned onto a southerly course to cross a transverse ridge(possibly a minor fracture zone) parallel to and east of the Alula Fartak Trench.

During the night of 193/194 the wind rose to force 6, the strongest experienced in the cruise. This was accompanied by a heavy swell from the south, into which the ship could not maintain more than 6 knots. At 194/0420 we altered course to begin the first of two long profiles across the Alula Fartak Trench. The gravimeter total compensation circuit tripped out (possibly as a result of heavy pitching) and the beam went off-scale at the end of the turn. It was reset at 0752 just before crossing the trench. The remainder of this line produced excellent gravity and SRP profiles, with acoustic basement being traced to a depth of 2¼ seconds before being lost in the surface multiple. At 194/1239 the side-scan was switched on again, and gave strong signals.

The second profile perpendicular to the trench commenced at 194/2018, with an airgun change at 2202. The second part of the profile was carried out at a speed of 4 kts while an engine room cooling fan was being repaired. The profile was ended at 195/0616; we then turned and followed the inactive part of the Alula Fartak Fracture Zone to the SW until its trace vanished on Gloria. At 195/1927 we headed NW toward the Gulf of Aden axis.

We proceeded along the axis, parallel to our outward track, except for a zigzag south to follow one of the fracture ridges near 49°E. The remainder of the westward passage was uneventful except for the appearance of a 'Red Tide' plankton bloom starting at about 1100 on day 197. (It had previously been observed about the same position on cruise 102, but on our eastward track we had passed this area at night and not seen it). Some samples were taken about 1400. It was still present at sunset (1600) and the characteristic smell persisted throughout the evening. It was gone next morning.

At 0340 on day 198 we recovered the streamed gear prior to the passage of Bab-el-Mandeb. The passage was made at full speed (2 engines) with PES, side-scan and gravimeter running. Another 'Red Tide' was seen north of the straits in the afternoon.

At 198/1550 we relaunched Gloria and SRP gear, but towed Gloria on a short

(400 feet) cable until 2000, when it was veered to its full 1200 feet. Recording began at 2040, and we commenced a series of shallow zigzags crossing the Red Sea axial trough.

On day 199 at 0738 there was a complete failure of ship's electrical power lasting 10 minutes. The ship did not completely loose way, but slowed to about 4 kts. Gloria went to a depth of 250 feet. Computer sampling stopped, and after the restoration of power no computed navigation was available until the next satellite fix, at 1038. At 0830 we altered course to return to the point of the power failure, and eventually continued the line from there at 1012. Between 1030 and 1800 the airguns failed three times.

During the night of 199/2000, the computer failed due to a breakdown of the computer room air conditioning. Following this it was impossible to recover recently logged data for the period 199/0734 to 200/0550. Again on day 200 the airgun failed, and it took three attempts to get one working again.

Early on day 201 we passed to the east of the Atlantis II Deep, insonifying it with Gloria. Then at 201/0828 we recovered the streamed gear in preparation for coring.

The gear was inboard by 0944, and after some initial difficulty in locating the required site over Atlantis II Deep we hove to at 1135 for the first core (station 10094). The 1000 lb gravity corer, lowered at 1 ms^{-1}, completely buried itself in the soft sediment and came up with the tail fin full of hot mud. During the next station the ship drifted over the edge of the sediment basin and only a few pieces of gypsum were recovered. The following two stations successfully sampled the uppermost sediments of the Deep as required.

We then moved away to the northeast, and completed a line of six cores (10098-10103) up the flank of the Axial Trough.

The last core was on board by 202/0756; by 1003 all the underway gear had once more been deployed, and we set off on another series of zigzags toward the Gulf of Suez. At 1600 one of the IBM 1800 disc drives failed, and the computer was switched off for several hours to refurbish the drive. It came on again at 2018. Navigation points for the down period were recovered after the cruise, but no data were logged.

At 1200 on day 203 the computer disc drive failed once more. All sampling was stopped until 204/0546. This time no data were logged and it proved impossible to recover the navigation later. Fortunately the HP2100 satellite navigation computer continued to function, and tracks were plotted by hand using the satellite fixes available.

By day 204 we had a little time in hand, and decided to use some of it in making a near coast-to-coast magnetic profile along a seafloor-spreading flowline. At 0900 we altered course to 035° at 26° 06'N, 34°47'E. The profile was completed by 1700, but unfortunately the magnetometer had failed for nearly three hours during the middle of the traverse. It was not thought worthwhile returning to recover the lost section.

By 0136 on day 205 we had reached the northern end of the Red Sea, and altered course to 028° for a run along the SE coast of Sinai. This was to enable Gloria to look at the southern end of the Jordan-Aquaba transform fault, but the fault did not show up very clearly. After running past the southern side of the straits of Tiran, we turned onto 225° at 0650 and began to recover all the streamed gear for the last time.

By 0821 all gear except the airgun was inboard, and we headed for the Gulf of Suez. Computer sampling was stopped at 0920. Some trials on the towing characteristics of the airgun were then carried out at various ship speeds, before recovering the gun at 1140. We entered the Gulf of Suez at 1345, and kept the hull-mounted side-scan running until 1810, but it detected no features on the floor of the Gulf. We dropped anchor in Suez Bay at 0642 on day 206, July 25th.

R.C.S.

PROJECT REPORTS

1. Gulf of Aden Studies

The objective of this leg of the cruise was to investigate the seafloor spreading centres and fracture zones in the western Gulf of Aden from the Gulf of Tadjourah to the Alula Fartak Trench using Gloria as the principal instrument for this purpose. Most tracks were planned on the basis of existing bathymetry to provide the most useful Gloria coverage; the exceptions were two long profiles perpendicular to the Alula Fartak Trench where gravity (and SRP) were of prime concern.

The survey included a 2½ day eastward journey from Djibouti to the Alula Fartak Trench, and a 2½ day journey westwards to the Red Sea.

The eastward journey from Djibouti was a fairly direct track. Gloria operated successfully from the mouth of the Gulf of Tadjourah, the track following the Tadjourah trench and the general trend of the spreading axis and inferred offsets in the same. For most of the eastward journey 20 second pulse repetition period (15 km range) Gloria insonifications were obtained, the range being severely limited to usually 10 km or so, sometimes to as little as 5 km due mainly to the intially very steep velocity/depth profile of the water. This situation improved as we approached the Alula Fartak Trench whereupon the full range (40 second pulse repetition period) was adopted.

The survey of the Alula Fartak Trench consisted of a track running the length of the trench, the spreading centres at each end also being insonified. Two long profiles for the purpose of interpretation of the gravity anomalies over the trench were obtained, one across the deepest part of the trench, the second across the double valley structure at the southern end of the trench. A short section of the scarps of the continental crust in the African plate corresponding to the zone of shear in the initial rifting of the African and Arabian plates giving rise to the Alula Fartak Transform was insonified. The westward journey essentially followed a line some 15 kms south of the eastward journey providing Gloria insonifications from opposite directions for a strip of the ocean floor. The 20 second pulse repetition period was reinstated at the point at which it gave way to the 40 second swathes during the eastward journey.

(a) Observations

As in other areas of mid-ocean Gloria studies, the main targets appear to be fault scarps associated with various manifestation of the spreading axis and fracture zones.

Scarps closely corresponding to the coastline to the NW of the Tadjourah trench were seen. Some 20 small volcanoes about 2 km in diameter were seen in the Tadjourah trench from 43°30'E to 45°30'E. There are no obvious transform faults here though possibly hints of such can be seen. The density of fault scarps in the Tadjourah trench is much less than seen elsewhere. From 45°30'E to the Alula Fartak trench there are 8 or 9 more obvious transform faults.

(b) Spreading axis

Much of the spreading axis zone in the Gulf of Aden is oblique to the spreading direction, though the individual scarps comprising the tectonic fabric of the spreading axis zone are in general perpendicular to the spreading direction. Thus the scarps are disposed en echelon to the trend of the spreading axis zone. Some sections of the spreading axis zone are, in general trend, perpendicular to the spreading direction. Examples are the section near the SW end of the Alula Fartak Trench (apart from the immediate intersection area), and two short sections at each end of a clearly delineated transform fault at the eastern side of the 1° square (Laughton, Whitmarsh & Jones, 1970).

(c) Fracture zones

This transform at the eastern side of the 1° square has a pair of straight tramline-like targets a few kms apart, running along a flow line. This well delineated transform fault corresponds to well developed conjugate scarps of shear in the continental shelf of the spreading plates. However it appears by eye, that the most recent spreading has been along a flow line, different by a small angle ($\sim 10^{\circ}$) from the flow line of the finite pole of opening as deduced from a visual fit of the coastlines.

Two closely spaced transform faults appear to be similar to the Kurchatov & Famous area fracture zones (Searle & Laughton 1977, Whitmarsh & Laughton 1976), that is, they are represented by zones of oblique spreading.

Briefly, one might describe the remaining half dozen small-offset transform faults as appearing as fairly cleanly offset spreading centres. They have few targets parallel to the spreading direction but exhibit a curvature of spreading axis scarps when approaching within a few kilometres of the transform.

(d) Alula Fartak Trench

On travelling along the axis of the Alula Fartak Trench the trace of the transform fault was seen over much of its length. In addition broad targets were seen on either side of the trench possibly corresponding to an uplifted ridge, though on crossing the trench for the sake of the gravity profiles it was seen that the trend of finer structure was more akin to that at the spreading centre. The severity of the topography requires a correction for the slant range distortion before making reliable estimates of the trend of the scarps. Of interest is that both of the valleys of the double valley structure at the southern end of the trench showed scarp orientations apparently related more to ridge crest processes than subsequent uplift. This has possible implications for the formation of the double valley.

The seismic reflection profile across the deepest part of the trench showed a surprisingly thin sediment thickness, about $\frac{1}{2}$ sec. To the west however a very thick sedimentary blanket was revealed, the trench being protected from a deluge of sedimentation by a severe ridge rising just above the sediments at its apex.

The fault scarps in the spreading axis at the southern end of the transform fault begin to curve towards the Alula Fartak transform fault some 30 km from it. On reaching the Alula Fartak Trench they are at an angle of about 45° with the axis of the trench.

(e) Concluding remarks

It seems likely that the Gulf of Aden represents an immature ocean in the sense that its transforms and spreading centres may be undergoing adjustment; that what we see at the spreading axis zone constituting the last few million years may be somewhat different to earlier modes of spreading and offsets in the spreading axis. The situation is further complicated by a likely change in the character of seafloor spreading manifestations as one approaches the Afar junction.

D.T.

2. Red Sea underway studies

Gloria produced a wealth of fascinating new data in the Red Sea. In the Southern Red Sea, the familar fault-scarps produced by the seafloor-spreading process were seen on the floor of the axial trough, and an impressive field of seafloor volcanoes was seen between 15^{0} and 16^{0}N. The scarps bounding the axial trough were seen to be composed of arcuate segments, particularly in the south. It is thought that this structure may be a result of post-Miocene salt flow.

The sonograph covering the Atlantis II Deep area confirms that the basins there are bounded by fault scarps identical to those seen elsewhere on spreading axes.

No clear evidence of any major transform faults was seen anywhere in the Red Sea, although in several places the spreading axis suffers minor offsets, possibly accomplished by localised areas of oblique spreading.

In the central Red Sea, where the axial trough breaks up into isolated basins, the areas between the basins were seen to have continuous sediment cover across the sea's axis. Strongly reflecting fault scarps were only seen on the floors of the basins.

In the northern Red Sea, north of about 23^{0}N, the axial trough and associated axial fault scarps are almost completely absent. There are few areas of sea-floor not covered by sediment. The sediments display a complex variety of morphological patterns, including numerous small basins and channels. The sedimentary structures may be related to extensive tectonism of the underlying salt, but they display only weak signs of control by seafloor spreading tectonism.

Perhaps the most surprising result of the work in the Red Sea was the absence of any strong feature associated with the expected position of the active Jordan-Aquaba transform fault. The southeastern margin of Sinai displays a series of en echelon scarps, but none of them appears geomorphologically young.

R.C.S.

3. Coring

The general intention was to investigate the mineralogical controls exerted on the geochemistry of hydrothermal sediments in the Red Sea. It was hoped at the outset that fresh sediments of known hydrothermal origin could be collected for detailed mineralogical analyses in order to compare these results with the already existing extensive geochemical data on similar material. Of particular interest in this investigation are the silicate clay minerals (mainly Fe-smectites) which are thought to play a significant role in the elemental mass balances of these hydrothermal sediments and are therefore likely to be the main controlling mineral phases.

The SW Basin of Atlantis II Deep (approximately 21 °N) was chosen for sampling where hot metal-rich brine is currently discharging and where Fe-silicates are currently precipitating from the brine to form the uppermost sediment layer.

(a) Core Stations 10094-10097

A single-barrel gravity corer with 1000 lb head-weight was used. The SW Basin of the Deep was located after some initial difficulties, using a combination of the bathymetric map of the area (Bäcker & Richter), the echosoundings and our DR position.

The first core, lowered onto the bottom at 1 m s^{-1}, returned filled (277 cm) with black sulphidic mud interlayered with some orange material. The corer fin was also packed with the black mud indicating that the whole corer had sunk well into the sediment and therefore the corer had retained no surface sample as hoped. On insertion of an arm into the mud retained in the fin it was found to be still hot! Subsequent cores in the Deep were lowered onto the bottom at 0.5 m s^{-1}.

During the second core station, the echosoundings showed that the ship was drifting away from the Deep up over an escarpment. The core barrel hit gypsum basement on the side of the Deep and returned with a few crystals of this mineral in the catcher.

The last two cores were taken both at the same site in the S.W. Basin very close to where the metal-rich brine is thought to be vented. Both returned containing black mud; the former was about half full (125 cm) therefore representing a true surface sediment sample while the latter was a full core similar to the very first station (10094). This last core, however, showed no signs of the fin having entered the sediment and therefore probably was fairly representative of the sediment surface.

The three successful cores were stored in the ship's constant temperature room.

T.C.

(b) Core Stations 10098-10103

Six cores were taken to the North East of the Atlantis II Deep in water depths of 700-900m. The same gear was used as for the earlier stations.

The purpose of collecting these cores was to try to extend knowledge of a manganese dispersion halo around the Deep. Manganese values in the sediments decrease with increasing distance away from the Deep, but are still above a background value for normal Red Sea sediments at a distance of 10 km. Using these new cores, it is hoped to be able to demonstrate a further progressive decrease in manganese concentrations further away from the deep.

The maximum length of the cores was 45 cm, and the sediment, in all cases, consisted of pale brown mud.

Free-fall techniques were used to collect the last four cores, but the core barrel failed to penetrate harder bands below the soft surface sediment.

S.S.

EQUIPMENT REPORTS

1. Gloria

All the equipment in use was the same as for the last few cruises except the main towing cable which was one of the new 400m lengths.

The vehicle was launched, in water depth of about 250m, 3½ hours after leaving Djibouti and 700 ft of cable veered. During the next five hours, while the ship steamed into deeper water, a number of faults were cleared up which allowed regular transmission on three amplifiers each side. The rest of the cable was then veered and recording started in what has become the normal manner. At this time there was no heading information coming up from the vehicle but since the results were very good it was decided to continue through the night and decide in the morning whether to recover and investigate the heading fault. In the morning the towing conditions were still good and in the absence of any obvious effects on the records which could be attributed to vehicle yaw, it was decided to carry on without heading information, and therefore receive beam steering, for the time being. In fact good results were obtained in the Gulf of Aden for the next seven days and until the vehicle had to be recovered for the passage through the Straits of Bab-el-Mandeb into the Red Sea. Advantage was then taken of the 14 hours the vehicle was inboard to sort out the heading fault in the gyro box. The vehicle was re-launched with all systems functioning. Recording continued successfully for a further 3½ days until it was necessary to recover the gear for coring operations. The vehicle was re-launched 24 hours later and 3 more days recording completed before final recovery at the northern end of the Red Sea near the island of Tiran.

All three launches and recoveries were executed with no problems in near calm conditions and at the end the cable showed no sign of wear and tests indicated no change from new condition. The Gloria track length was 2580 n.m. and covered a total period of 312 hours. The 4 sec. F.M. pulse transmitted at 40 sec pulse repetition period was used for most of the time but in the shallower parts of the Gulf of Aden the 2 sec. F.M. pulse was transmitted at 20 sec. intervals.

The recorded tapes were replayed as normal except for the first 3 hours which had a synchronising fault.

J.R.

2. Compressors

Because the spare parts had not arrived at Djibouti at the time of sailing, relief valves and pressure maintaining valves were taken from the No.3 compressor (container DC) and fitted to the No.1 AC compressor.

The No.1 compressor functioned extremely well throughout the cruise, logging up a total of some 230 hours. The compressor room ambient temperatures never exceeded 35 °C and this was achieved by keeping the door of the main aft hatch open and by use of the efficient extractor fan. However high sea temperatures up to 34 °C were recorded which pushed the compressor to near its maximum high pressure air temperatures of 68 °C to 70 °C. This was recorded when using a 160 cu in gun firing every 10 seconds. Increasing the firing time to 12 seconds reduced the high pressure air temperature 2 to 3 °C which allowed the compressor to cope more comfortably. Humidity was high and regular draining of the air reservoirs was necessary.

Trouble developed at the beginning of the cruise with the No.2 compressor which had to be stopped because the fresh water cooling temperature rose to 53 °C indicating some sort of blockage. The centrefugal pump and thermostatic water flow valve were removed, dismantled and re-calibrated etc., and all was found correct. The second stage suction-delivery valve was removed and found to be well carboned up. A new one was fitted. Also the first stage valve was removed and examined and found to be okay. Third and fourth stage valves inspected and new 'o' ring fitted on 4th stage.

R.H.E.

3. Airguns

The general condition of the 3 airguns at the beginning of the cruise was far from satisfactory, and a great deal of trouble and time was spent in order to keep the airguns functioning.

Major items failed such as: Top chamber cracked around clamp groove P15/05; Main Housing Ph.Br. cracked around clamp groove P15/04; and solenoid housing disintegrated. Also main 'o' ring surfaces on some items were scored and there was continual failure of 'o' rings. All this indicates the necessity for a return to works and major overhaul. Many parts were replaced with new ones and therefore new spare parts will be required. Perhaps in the long term it might be advisable to order new airguns.

R.H.E.

4. Hydrophone winch

At the start of the cruise the winch was removed from its storage place on the foredeck and positioned on the poop deck. The lead screw drive pulleys were siezed solid, the drive belt was removed and the lead screw assembly was not used (this requires finally a new design). One of the hydraulic hoses fractured and was replaced, otherwise it worked perfectly well.

R.H.E.

5. Hull-mounted sidescan (asdic)

The asdic was used continually throughout the cruise except for the hydraulic power-pack which because of the high leakage rate of oil at the hydraulic motor end was used only occasionally to align the plates. A check was kept on the leakage of oil; the rate was found to be approximately 20 litres per day. No leakage occured in the static position. A puzzling phenomenon, which caused considerable time to be wasted in setting up the equipment, was that the angle indicators in the laboratory and the asdic compartment were out of phase with each other and with the true values. Eventually the correct settings were found by trial and error. The acoustic side worked well.

R.H.E., R.C.S.

6. P.E.S.

The PES was towed throughout and behaved perfectly well. No vibration was felt at any time and strut wear was minimal.

R.H.E.

7. SRP system

The electronics gave no trouble, except for one occurrence of bad stacking on the CPR 4010 tape recorder and a loose fuse-holder in the Wormley EPC recorder. The hydrophone was unfortunately snagged on the first time out and as the strain-bearing core was okay it was decided to repair the broken conductors rather than change cables. Stopping off the hydrophone during the repair caused a break at the forward end of the spring section; although this was repaired, oil was lost and none could be found to replace it.

No headway was made with SRP digital logging probably due to the effect of the heat on the digital tape recorders.

The 2 kHz high resolution profiling system's plumbing was blocked with algae but has worked well since this was cleared out. The intermittent triggering was eliminated, but the record still leaves something to be desired due to incorrect correlation.

C.F.

8. Shipboard Computer System

The system was used to log cruise data, provide navigation, plots and listings.

Early in the cruise, the plotting office printer failed. When attempting to use the bridge printer as the auxilliary, this also failed due to paper jamming and damaging the printer. It was several days before the plotting office printer could be made to work satisfactorily.

The drum plotter made frequent, small, random shifts in the drum rotation during plotting, which when they first started occuring were irritating. However, the problem worsened progressively throughout the cruise and eventually made the plotting of large scale charts impossible.

Several disk problems occured during the cruise, the first one following a general ship power failure on day 199. An 'end leg' was performed to preserve the data already collected. But, next day a second drive 1 failure made the drive 1 disk unusable. The data for this period should be recoverable on the land system.

The second copy of the system drive 1 disk was used following the second disk failure. A third failure on day 202 made the system log file corrupt and as the disk heads had to be changed a data gap of 6 hours was caused. Logging and processing continued for one day, then on days 203 to 204, 18 hours of data was overwritten due to a corruption of Inskel Common.

The following day, persistent seek errors on drive 1 made work very difficult, but logging continued until the end of the leg. This fault was eventually traced to misalignment of the disk-head accessing circuitry.

Plotting continued for the next 24 hours following the rectification of this fault until persistent plotter errors made further work impossible.

D.J., D.L.

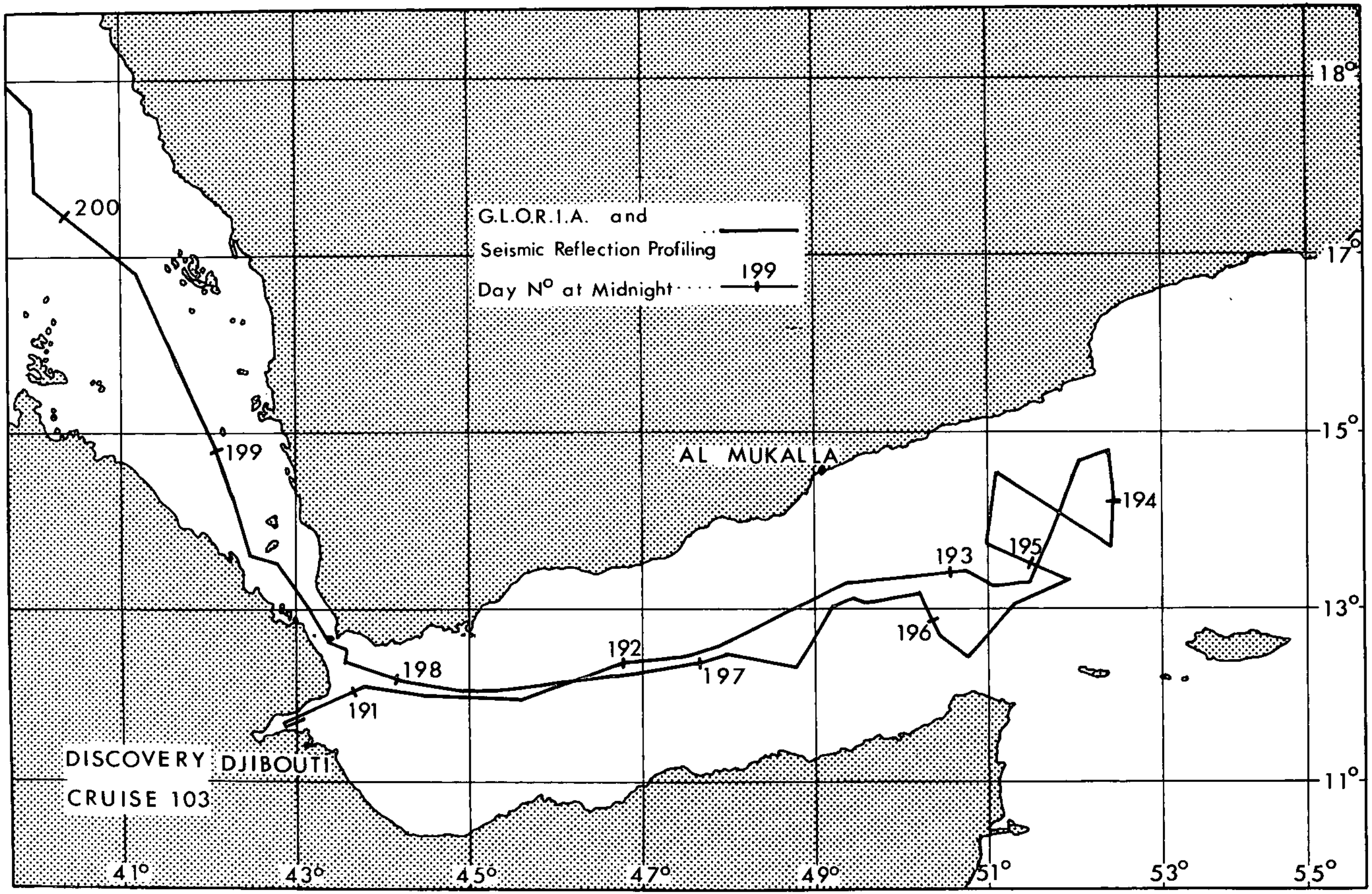
Table 1: Underway Geophysical Observations

Instrument	From	To	Total hours	Total miles, at 8.25 kt average
PES	190/1200	205/0716	355.3	2931
Gloria	190/1855	198/0340	176.8	
	198/2040	201/0820	59.7	
	202/1024	205/0650	68.4	
			304.9	2515
Magnetometer	190/1822	190/1928	1.1	
	191/0122	191/1028	9.1	
	191/1428	191/1544	1.3	
	191/2016	192/1916	23.0	
	192/2308	194/1702	41.9	
	195/2058	198/0336	54.6	
	198/1650	201/0826	63.6	
	202/0938	204/1102	49.4	
	204/1450	205/0648	16.0	
			260.0	2145
Gravity	190/1154	194/0454	89.0	
	194/0752	201/1028	170.6	
	202/0934	205/0920	71.8	
			331.4	2734
SRP	191/1000	191/2220	12.3	
	192/0710	193/0630	23.3	
	193/0910	193/1220	3.2	
	193/1600	196/1050	66.8	
	196/1300	198/0330	38.5	
	198/1810	199/0950	15.7	
	199/1420	199/1520	1.0	
	199/1800	200/1010	16.2	
	200/1450	201/0150	11.0	
	202/1000	202/2400	14.0	
	203/0630	205/0650	48.3	
			250.3	2065
Hull-mounted side-scan	190/1639	193/0920	64.7	
	194/1239	201/0658	162.3	
	201/0658	203/0501	46.1	
	203/0501	205/1810	61.2	
			334.2	2757
2 kHz	191/0900	193/0031	39.5	
	193/1643	198/0342	107.0	
	198/1646	201/0848	64.0	
	202/0930	205/0650	69.3	
			279.8	2308

Table 2 Stations

Station	Type	Start time	End time	Position*		Water-depth* corrected metres	Comments
10094	Gravity core	201/1146	201/1313	21°20'.8N	38°05'.7E	2065	Corer buried itself. 3m of hot, black mud recovered
10095	Gravity core	201/1516	201/1646	21°19'.8N	38°06'.2E	1975	A few pieces of gypsum.
10096	Gravity core	201/1734	201/1906	21°20'.6N	38°05'.4E	2140	1.5m dark sediment
10097	Gravity core	201/1940	201/2106	21°20'.1N	38°05'.5E	2146	Full 3m of core recovered
10098	Gravity core	201/2239	201/2333	21°27'.2N	38°13'.9E	958	30 cm pale brown mud.
10099	Gravity core	201/2353	202/0038	21°28'.2N	38°15'.2E	802	Several decimetres pale brown mud
10100	Gravity core	202/0056	202/0139	21°28'.9N	38°16'.6E	799	" " " " "
10101	Gravity core	202/0236	202/0315	21°29'.8N	38°18'.2E	771	" " " " "
10102	Gravity core	202/0456	202/0542	21°28'.6N	38°15'.7E	755	" " " " "
10103	Gravity core	202/0652	202/0812	21°26'.5N	38°12'.7E	1088	" " " " "

* Position of ship and depth for time corer hit the bottom



G.L.O.R.I.A. and
Seismic Reflection Profiling
Day N° at Midnight
199
200
199
198
197
196
195
194
193
192
191
AL MUKALLA
DJIBOUTI
DISCOVERY
CRUISE 103
18°
17°
15°
13°
11°
41°
43°
45°
47°
49°
51°
53°
55°

Fig 1

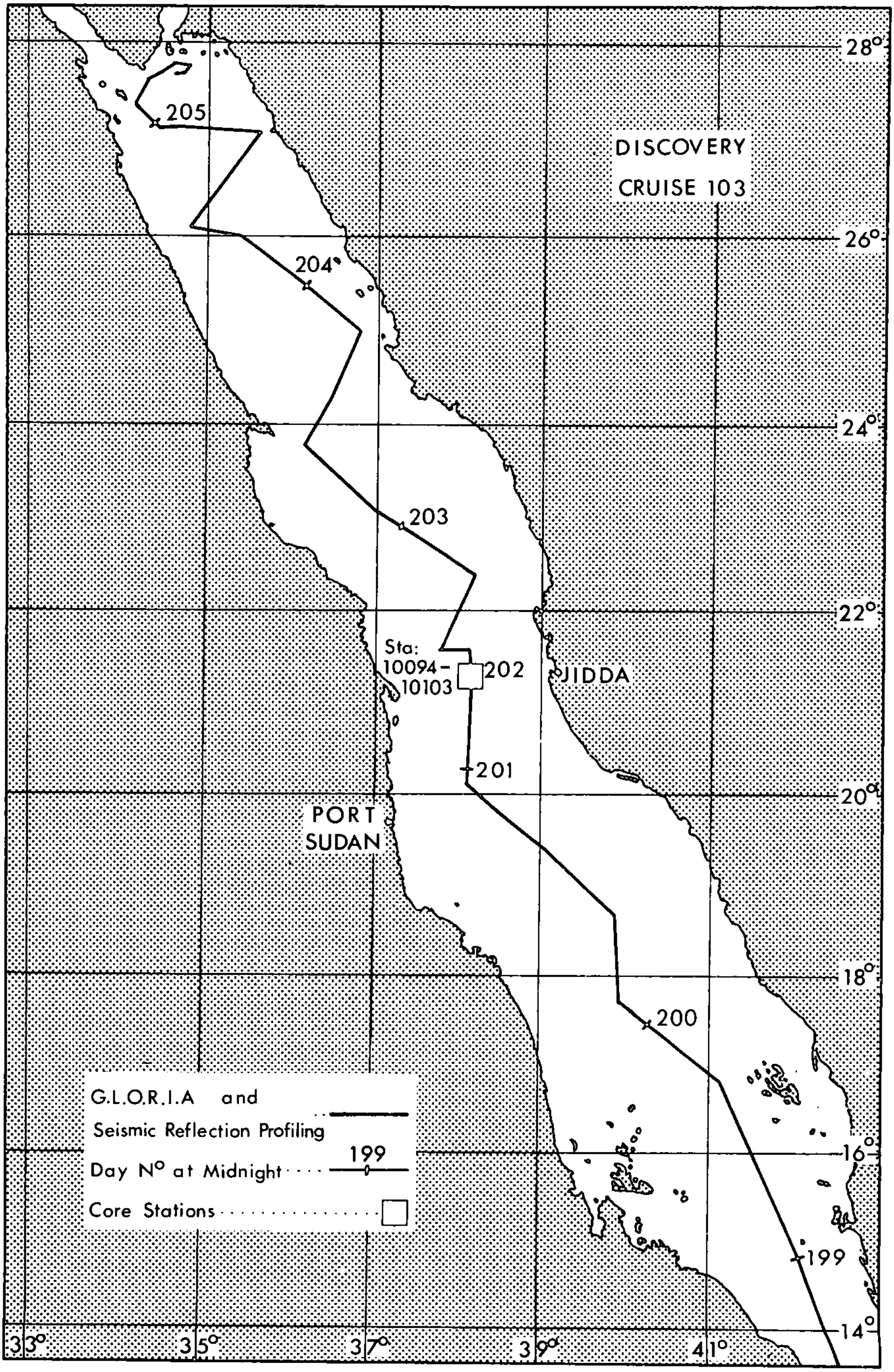

DISCOVERY
CRUISE 103
28°
26°
24°
22°
20°
18°
16°
14°
33°
35°
37°
39°
41°
205
204
203
202
201
200
199
Sta:
10094-
10103
JIDDA
PORT
SUDAN
G.L.O.R.I.A and
Seismic Reflection Profiling
Day N° at Midnight
199
Core Stations

Fig 2

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
TO	TO	TO
37	NOV — DEC 1970	37
38	JAN — APR 1971	41
39	APR — JUN 1971	40
40	JUN — JUL 1971	48
41	AUG — SEP 1971	45
42	SEP 1971	49
43	OCT — NOV 1971	47
44	DEC 1971	46
45	FEB — APR 1972	50
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
		IOS 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	8
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	SEP — OCT 1975	35
74/2	SEP 1975	33
75	OCT — NOV 1975	43
77	JUL — AUG 1976	46
78	SEP — OCT 1976	52
79	OCT — NOV 1976	54
82	MAR — MAY 1977	59
83	MAY — JUN 1977	61
84	JUN — JUL 1977	60
86	SEP 1977	57
87	OCT 1977	58
88	OCT — NOV 1977	65
89	NOV — DEC 1977	67
90	JAN — MAR 1978	68
91	MAR 1978	69
92	APR — MAY 1978	70
93	MAY — JUL 1978	71
94	JUL — SEP 1978	74
95	OCT — NOV 1978	77
96	NOV — DEC 1978	79
97	DEC 1978	77
98	DEC 1978 — JAN 1979	75
99	JAN 1979	78

CRUISE DATES	REPORT NO.
RRS "CHALLENGER"	
AUG — SEP 1974	IOS CR 22
MAR — APR 1976	IOS CR 47
MAR — MAY 1978	IOS CR 72
APR — 1979	IOS CR 81
MV "CRISCILLA"'	
NOV — DEC 1978	IOS CR 73
RV "EDWARD FORBES"	
OCT 1974	IOS CR 15 X
JAN — FEB 1975	IOS CR 19
APR 1975	IOS CR 23
MAY 1975	IOS CR 32
MAY — JUN 1975	IOS CR 28
JUL 1975	IOS CR 31
JUL — AUG 1975	IOS CR 36
AUG — SEP 1975	IOS CR 41
FEB — APR 1976	IOS CR 48
APR — JUN 1976	IOS CR 50
MAY 1976	IOS CR 53
AUG — SEP 1977	IOS CR 64
RRS "JOHN MURRAY"	
APR — MAY 1972	NIO CR 51
SEP 1973	IOS CR 7
MAY — APR 1974	IOS CR 9
OCT — NOV & DEC 1974	IOS CR 21
APR — MAY 1975	IOS CR 25
APR 1975	IOS CR 39
OCT — NOV 1975	IOS CR 40
AUG — OCT 1975	IOS CR 42
OCT — NOV 1976	IOS CR 53
MAR — APR 1977	IOS CR 66
JUL — SEP 1978	IOS CR 76
NC "MARCEL BAYARD"	
FEB — APR 1971	NIO CR 44
MV "RESEARCHER"	
AUG — SEP 1972	NIO CR 60
RV "SARSIA"	
MAY — JUN 1975	IOS CR 30
AUG — SEP 1975	IOS CR 38
MAR — APR 1976	IOS CR 44
MAR 1977	IOS CR 63
RRS "SHACKLETON"	
AUG — SEP 1973	IOS CR 3
JAN — FEB 1975	IOS CR 18
MAR — MAY 1975	IOS CR 24
FEB — MAR 1975	IOS CR 29
JUL — AUG 1975	IOS CR 37
JUN — JUL 1976	IOS CR 45
OCT — NOV 1976	IOS CR 49
JUL 1977	IOS CR 62
JUL 1979	IOS CR 80
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	IOS CR 1

* 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.

*** IOS CR: Institute of Oceanographic Sciences, Cruise Report.

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Printed by NERC/SRC Reprographic Services