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# Research Cruise Report
# R.R.S. Charles Darwin
# 7/85

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## SUMMARY

R.R.S. CHARLES DARWIN cruise 7/85 investigated the Mesozoic and early Cenozoic plate motions in the eastern Equatorial Atlantic and examined their relation to crustal structure and the history of sediment deposition. The study involves:

(i) recording seismic reflection profiles to examine the sedimentary cover of the African margin

(ii) delineating the magnetic and bathymetric trends of the region.

(iii) determining the patterns of sediment accumulation at the various stages of Atlantic opening

(iv) using seismic refraction to study the structure of the Guinée Fracture Zone.

The vessel left Funchal, Madeira on August 31 (Day 243) 1985 and remained at sea for 35 days, arriving in Mindelo, Cape Verde Islands on October 5 (Day 278). A track chart is shown overleaf.

The following objectives were achieved:

(i) Over 1000km of seismic reflection profiles were shot off Senegal, Guinée and Sierra Leone.

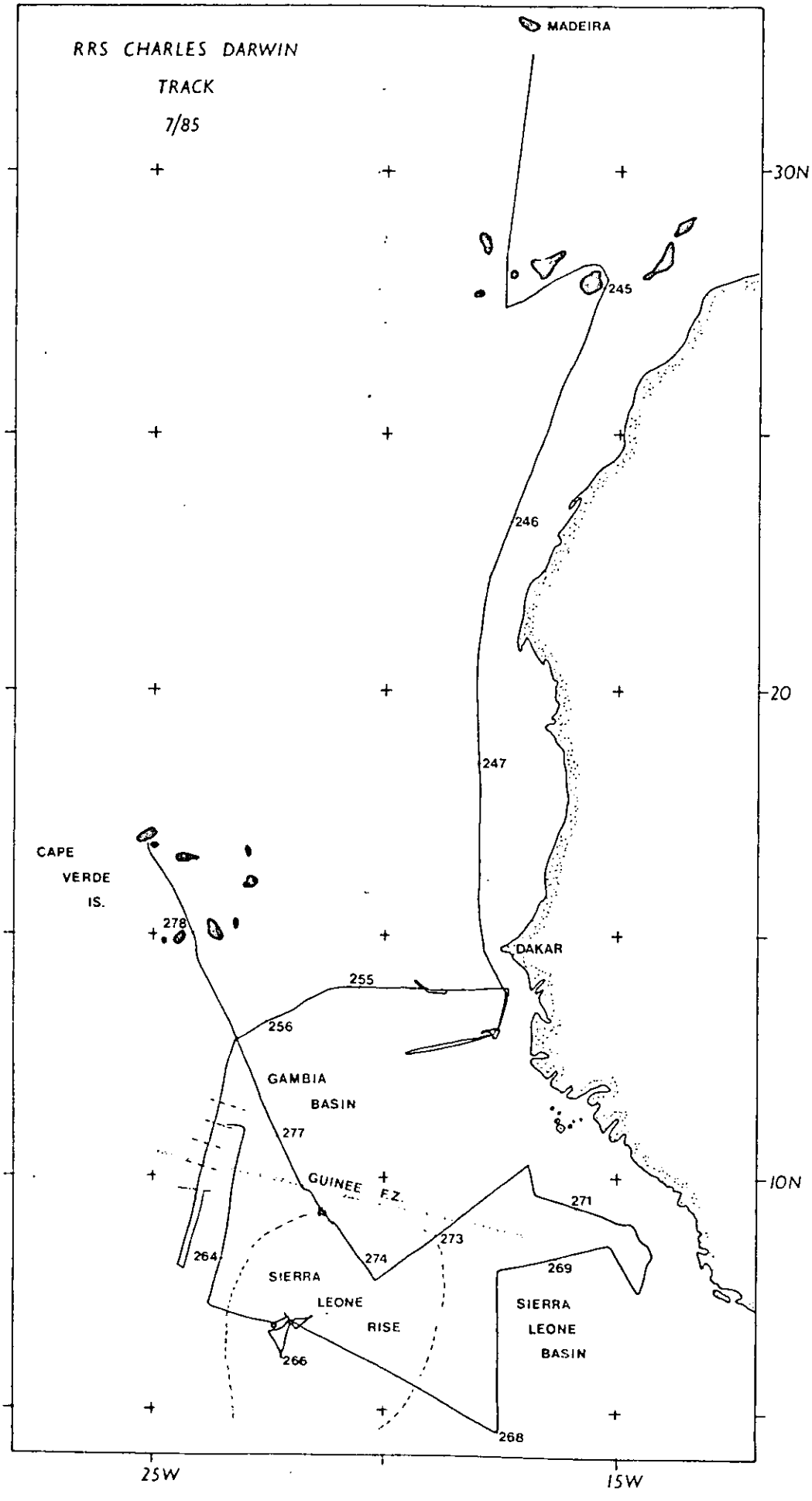
(ii) Seismic stratigraphy has been linked to DSDP well-data in the Gambia Basin.

(iii) Five seismic refraction lines have been shot across the Guinée Fracture Zone to examine lateral variations in deep structure (dotted lines near 25°W: track chart).

(iv) Bottom samples from the vicinity of the Guinée Fracture Zone have been recovered (Sierra Leone Rise region; track chart).

(v) Gravity, magnetic and bathymetric data have been obtained along tracks linking the refraction profiles and bottom sampling stations.

All equipment and cruise data arrived in London from the ship in late January 1986.


RRS CHARLES DARWIN
TRACK
7/85
MADEIRA
30N
20
10N
25W
15W
245
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CAPE
VERDE
IS.
278
DAKAR
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256
GAMBIA
BASIN
277
GUINEE F.Z.
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SIERRA
LEONE
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## SCIENTIFIC PARTY

| | | |
|---|---|---|
| Dr B.R. Clayton | : | UCL |
| A.R. Cumming | : | RVS |
| J.I.C. Docherty | : | UCL |
| G.H. Evans | : | RVS |
| Dr E.J.W. Jones | : | UCL (Principal Scientist) |
| M.C.J. Kennard | : | UCL |
| P.J. Mason | : | RVS |
| I.G. Mitchell | : | UCL |
| I.M.A. Niang | : | University of Dakar |
| R.G. Perry | : | UCL |
| A.C. Pierce | : | UCL |
| J.D. Price | : | RVS |
| A.D. Robinson | : | RVS |
| S.J. Smith | : | RVS |
| S.K. Smith | : | RVS |
| F. Spathopoulos | : | UCL |
| W.J. Whyte | : | Gambia Geological Survey |
| Dr J.L. Wild | : | UCL |

## OFFICERS AND CREW

| | | |
|---|---|---|
| P.H. Warne | : | Master |
| K.O. Avery | : | Chief Officer |
| M.S. Putman | : | Chief Officer |
| B.M. Richardson | : | Ex. Second Officer |
| J.G.L. Baker | : | Radio Officer |
| G.M.Batten | : | Chief Engineer |
| R.E. Hagger | : | Second Engineer |
| A.P.Grattidge | : | Third Engineer |
| P.G. Parker | : | Electrical Officer |
| P.O. Biggs | : | P.O. (Deck) |
| S.C. Francis | : | Seaman 1A |
| A. Quick | : | Seaman 1A |
| G. Crabb | : | Seaman 1B |
| D.G. Buffery | : | Seaman 1B |

| | | |
|---|---|---|
| W. Hawkins | : | Cook/Steward |
| C. Hubbard | : | Ship's Cook |
| J.A. Orsborn | : | Second Steward |
| C. Peters | : | Steward |
| D.A. Chattaway | : | Steward |
| M.H. Williams | : | Motorman 1 |

1. Tuesday 27 - Friday 30 August

Charles Darwin prepares for sea. Funchal, Madeira.

2. Saturday 31 August (243)

We left the dockside in Funchal at 0800 hrs (GMT) as planned and headed south for a point on the continental slope off Cape Vert, Senegal. The PDR fish was deployed to port at 0910 hrs. At 0930 hrs it was necessary to heave to for minor engine room repairs.

We were underway again at 1030 hrs and made good southward progress for the remainder of the day, averaging 12 knots. Normal watchkeeping duties in the scientific plot were carried out. Preparations for deploying 2 airgun arrays began, together with further wiring of equipment in the aft laboratory and scientific plot. By midnight we had reached 29 37N, 17 17W.

3. Sunday 1 September (244)

Continuing southwards, we passed between the islands of Gomera and Hierro in the Canaries at 0700 hrs. It was soon afterwards that the fine start to our cruise was marred by a most unfortunate accident. While working on the afterdeck during the morning the bosun, Bob Macdonald, severed the top of a finger on his left hand. A reel of steel wire was being lifted using a metal pole when his finger became caught. He clearly required hospital treatment so we altered course at 1015 hrs for Las Palmas.

Charles Darwin maintained a steady 10 knots with the wind and swell against us. Normal scientific watches were maintained.

A Las Palmas launch met us at 2150 hrs. After transfer of the bosun was completed we set course for Cape Blanc.

Throughout the day the preparations continued for our multichannel seismic lines; streamer sections were checked and the two arrays of airguns made up.

4. Monday 2 September (245)

We made good progress on our southerly passage, reaching 23 29N 17 15W by 2300hrs.

Faults in the hydrophone streamer connections were corrected and the hoses were prepared for a deployment of 4 airguns. We also began preparing our sonobuoys for the forthcoming refraction profiles.

5. Tuesday 3 September (246)

Our average speed southwards during the day was 12.1 knots. Wind and swell were slight. By midnight we reached 18 31N, 18 00W.

Cable and airgun pressure hoses were taped on deck. Depth controllers for the hydrophone array were tested and made ready for deployment. Seismic recording gear was wired up in the scientific plot. Data logging is proceeding very satisfactorily.

6. Wednesday 4 September (247)

Averaging 12 knots, we were within sight of Dakar at 1900 hrs. Six hours previously we had streamed the magnetometer. Still heading southwards, we began at 2340 hrs to record bathymetric, gravity and magnetic data along a track parallel to the shelf break and some 6 km from it. This line, which lies off Senegambia near 13 30N, had been chosen for recording our first multichannel seismic .profile. It was necessary to check that the water is everywhere deep enough for towing the multichannel streamer.

7. Thursday 5 September (248)

The passage along our intended multichannel line was completed at 0314 hrs, confirming that the water depths are everywhere greater than 85m. We then altered course for a point on the middle part of the continental slope, well off the coastal shipping route, for balancing the streamer. The magnetometer was recovered at 0520 hrs. Streamer repair and balancing operations began at 0815 hrs, continuing for the remainder of the day under the direction of John Price and Tony Cumming. By midnight two sections (2 and 17) had been replaced and repairs made to section 23. Standard tests were successfully carried out on depth sensors and depth control birds.

8. Friday 6 September (249)

All sections of the 48channel array were streamed at the normal 5 knot speed. After 2 hours we were able to maintain a depth of 37-41 feet (approx. 13 m) at each of the six depth sensors. Deployment of the airgun array (1000, 300 and 160 cu.in.) proved protracted owing to the leakage of air from the 160 cu. in. unit.

9. Saturday 7 September (250)

The start of our first multichannel seismic line was further delayed by airgun and compressor breakdowns. Loose hose connections, burst hoses and a sticky compressor valve had to be repaired. At approximately 1500 hrs section 37 on the streamer became very noisy as a result of intermittent shorting. By 2300 hrs the airguns were working well, firing at 20 second repetition rate and a pressure of 1850 p.s.i. Watchkeepers were becoming well used to tape changes and logging the necessary parameters (test tapes only).

10. Sunday 8 September (251)

On the approach track to multichannel line 1 the airgun system failed again due to a burst hose, so at 0130 hrs we veered off line for repairs. Another attempt to start the line also did not succeed due to a loose hose connection on the 1000 cu. in. airgun (0500 hrs). We then decided to change the towing configuration, streaming the 1000 cu. in., two 300 cu. in. airguns and the 160 cu. in. airgun on separate lines. All was ready for the approach to line 1 at 1250 hrs. Shooting along line 1 began at 1420 hrs. From the outset the recording, tape filing and logging went smoothly in the plot - the result of several practice runs beforehand.

Beginning 1635 hrs we lost power on the Sercel due to overheating. The temperature control in one of the air conditioners in the plot had been inadvertently turned up earlier and this failed to cope with the increased heat output from the Sercel (approx. 6KW). Fuse replacement and turning the air conditioner to minimum temperature led to no further down-time on the recorder for the rest of the day. At 2120 hrs the airgun array pressure began to fall rapidly, from a leak in the 300 cu. in. unit. This was closed down and isolated while shooting continued. The galvanometer monitor recorder indicated good signal :noise during the line, except on channel 26 which showed signs of intermittent shorting.

11. Monday 9 September (252)

Shooting along line 1 was completed at 0014 hrs (1727 records, including noise records at beginning and end). We made a slow turn to the west to begin shooting line 2, which crosses the Senegal continental margin at 14 55N. Recording began at 0223 hrs. Small speed changes were necessary near the start of the line owing to heavy traffic. Once we were west of the main shipping lane the magnetometer was deployed. Recording went

remarkably smoothly, with high signal:noise on the galvanometer and EPC monitor recorders. At 1720 hrs intermittent signal failure began to be observed on the far traces. They became so persistent that at 1850 hrs we decided to recover the streamer for examination and repair. By then we had reached 18 56W. Repairs to the streamer were still being carried out at midnight.

12. Tuesday 10 September (253)

The day was devoted to streamer repairs. Two sections had suffered ? shark bites. It was possible to heat seal the hole in one but the other had to be replaced by a spare. Inter-section electrical connections also needed attention. The hydrophones were fully streamed at 2340 hrs with the birds 13-14m deep. A frustrating day considering that the multichannel line had started so well.

13. Wednesday 11 September (254)

The magnetometer was deployed at 0410 hrs and we rejoined the MCS line after minor airgun failure at 0557 hrs when shooting commenced once again (line 3). The streamer was then towing at 12-13m. At 0950 hrs section 90 was switched out because of intermittent shorting. Airgun pressures began to decrease at 1250 hrs due to leakage from the 300cu. in. unit. This was isolated but did not result in a trouble-free source system, for the 1000 cu. in. airgun stopped at 1720 hrs and had to be recovered. By 1930 hrs we had 2 * 300 cu. in. and 1 * 160 cu. in. airguns working. Repairs to the 1000 cu. in. took longer. This was not operational until 2105 hrs. By midnight we had reached 20 32W on our east-west traverse along 13 55N.

14. Thursday 12 September (255)

We completed line 3 at 0250 hrs continuing westwards on 270 degrees to record a single channel profile (using the second streamer section) and part of the M-sequence magnetic anomalies. At 0550 hrs we started a slow (2 degrees/minute) turn to the southwest and headed for our next multichannel track (line 4) across the Guinée Fracture Zone. During the day the four airguns were rigged to tow on separate lines, each at depth of 12m. The single-channel record quality during the afternoon was excellent. Our midnight position was 13 13N, 22 34W.

15. Friday 13 September (256)

At 0754 hrs we started a slow turn to approach the start of the MCS line 4 across the southern Gambia basin. Digital recording began at 1020 hrs. A malfunction in the auto-tape change unit soon after the start of the line resulted in the loss of 40 records. Apart from this early problem recording continued without interruption during the day. Some difficulties were experienced keeping the speed down to 5 knots with the current and swell now with us. The midnight position was 11 16N, 23 38W.

16. Saturday 14 September (257)

Our passage along MCS line 4 continued throughout the day. 19 shots on the Sercel were missed soon after 0930 when switch over occurred prematurely and went unnoticed by the tape watchkeeper. (An alarm circuit should be included to let the watchkeeper know if a scheduled shot is not recorded.) At 1441 hrs we reduced speed to maintain our 5 knot passage over the ground. Monitor records are giving data of excellent quality. By midnight we reached 9 05N, 24 11W.

17. Sunday 15 September (258)

We continued on our southerly course recording multichannel seismic data until 1216 hrs, having taped 8912 shots. Most of the afternoon was spent spooling in the streamer. Six sections were damaged, mostly by small ? shark bites. Some of the holes were repaired on the spot by heat treatment. At 1722 hrs we started a magnetometer traverse to head for the first refraction profile designed to fix basement velocities on the earlier MCS line. Our midnight position was 9 11N, 24 00W.

18. Monday 16 September (259)

We arrived at the position of the first refraction line (A) at 0530 hrs. Because of low carrier levels from the sonobuoys after several tests in the water we were unable to leave the first buoy position until 0930 hrs. When we lost the carrier at 1015 hrs steaming on 100 degrees we deployed an expendable sonobuoy. We reached the second buoy position just after midday. Further instrument problems delayed the deployment of the sonobuoy until 1430 hrs. We passed it again at 1505 hrs on track for the first dahn/sonobuoy. Shooting commenced at 1510 hrs. A second expendable buoy was deployed at 1526 hrs. Shooting was completed at 1810 hrs after 24 shots. Winds of 5-6 and choppy seas made reception conditions far from ideal but, nevertheless, strong ground waves were recorded at ranges of more than 10 miles. The first sonobuoy laid was recovered at 2130 hrs, the delay being due to poor visibility. We then steamed eastwards to retrieve the second sonobuoy.

19. Tuesday 17 September (260)

The last sonobuoy was recovered at 0020 hrs. We

then headed northwards for the next seismic refraction line (Line B) with the magnetometer streamed. After bringing in the magnetometer at 0730 hrs we began to lay our first sonobuoy. Problems with power supplies and low hydrophone responses delayed our departure for the next deployment until 1200 hrs. A second sonobuoy was laid at 1510 hrs and shooting began at 1614 hrs. A total of 34 charges was shot on this 45 km reversed line. The first buoy was recovered at 1915 hrs and the second at 2150 hrs. The magnetometer was streamed for a short E-W traverse along a fracture zone ridge and a passage to the next seismic line. During the evening Tony Cumming made modifications to the U.C.L. sonobuoys to achieve greater sensitivities.

20. Wednesday 18 September (261)

We arrived at the position for laying our first sonobuoy on refraction line C at 0900 hrs. The carrier wave was eventually lost after steaming eastwards for nearly 25 miles. A second (expendable) sonobuoy was launched and shooting started at 1426 hrs, finishing at 1709 hrs after 35 shots. Excellent high-velocity ground waves were observed, especially from the first buoy. The latter was retrieved at 1750 hrs. We then proceeded northwards for the next refraction line.

21. Thursday 19 September (262)

Two refraction lines were shot during the day, high quality recordings being obtained on both. The first buoy on line D was laid at 0540 hrs before we moved eastwards to deploy an expendable buoy. Shooting began at 0849 hrs with 2.1 kg charges. 25 charges were fired before we recovered the first buoy. Allowance for buoy drift was carried out remarkably accurately by the officers of the watch. We were heading directly for the buoy at the last close-range shot.

Line E lies approximately 28 miles south of line D. Shooting began at 1714 hrs ending at 1927 hrs. 28 shots up to 50 kg in size were fired. High amplitude ground waves were observed on both buoys simultaneously. Later in the day (2000 hrs) we began moving along a southerly track to the western side of the Sierra Leone Rise.

22. Friday 20 September (263)

We continued along our southerly track at 11 knots until 1400 hrs when we recovered the magnetometer for a velocimeter dip (station CD 7/85/1). A sound velocity profile to 4200m was recorded. Difficulties with spooling the conducting cable caused considerable delays in bringing up the velocimeter, which was finally recovered at 2239 hrs. The measurements should certainly have been completed in less than half the time it actually took (8 hours). We were underway again at 2300 hrs, reaching 8 09N, 23 33W at midnight.

23. Saturday 21 September (264)

At 0517 hrs we began to head east towards the western flank of the Sierra Leone Rise for sampling operations with the large U.C.L. grab, modified during the last few days by Stan Smith who added a box sampler to the mouth area in order to retain any soft sedimentary material that would otherwise be washed out on the way to the surface. Before the sampling work began, the U.C.L. glass sphere for housing our near-bottom instrument package was successfully pressure tested to 1450m, with a pinger 100m above the sphere (CD 7/85/2).

Grab sampling began at 1800 hrs in a water depth of 1600m. On the first lowering (pinger at 100m) it

failed to close (CD 7/85/3). A second lowering (CD 7/85/4) was more successful, the grab closing and retaining sediments in the spring-loaded box sampler. At 2200 hrs we began a magnetics/gravtiy survey of the western Sierra Leone Rise.

24. Sunday 22 September (265)

After recovery of the magnetometer at 0830 hrs we began a series of large-grab stations in water depths varying from 750-1250m (CD 7/85/5 - CD 7/85/10). Small rock and sediment samples were recovered but no large rock hauls. At 2000 hrs we continued with a magnetic/ gravity survey in the vicinity of our sampling area.

25. Monday 23 September (266)

We hove to at 0820 hrs to deploy the U.C.L. bottom instrument package on the CTD wire in a water depth of 1200m. The package was recovered at 1419 hrs when we headed upslope for further large-grab sampling on the western side of the Sierra Leone Rise. Five sites were occupied and a variety of manganese-coated rocks and sediments was recovered. Excellent winch and ship handling together with careful monitoring of the pinger on the echo-sounder resulted in grab closure at each station (CD 7/85/12 - CD 7/85/16). The magnetometer was streamed at 2220hrs for a passage at full speed towards the African margin.

26. Tuesday 24 September (267)

We remained on our easterly track for the entire day. In preparation for our next multichannel line on

the African margin work continued, somewhat hampered by heavy rain in the morning, on repairing the leaks in the streamer. By the late evening 17 sections had been repaired after spooling on to the deck. The ship's position at 2330 hrs was 4 34N, 17 38W.

27. Wednesday 25 September (268)

Just after midnight (0006 hrs) we moved on to a northerly course to record much-needed magnetic and gravity data near the western side of the Sierra Leone Basin where structural trends are poorly defined. We remained on the course until 1750 hrs then headed on 080 to the starting position of our next multichannel seismic line. Throughout the day repairs were made to the multichannel streamer. Approximately 1100m were spooled on to the afterdeck for work on sections 13, 18, 19 and 23. The end spring section had to be replaced. Our midnight position was 8 18N, 16 20W.

28. Thursday 26 September (269)

During the night a short traverse running parallel to the continental slope off Sierra Leone was completed. We reached a point approximately 20 miles south of our next multichannel line (line 5; on the Sierra Leone margin) at midday, recovered the magnetometer and began to deploy the streamer. It was fully outboard at 1530 hrs. Leaking airgun hoses caused one hour's delay in starting our line. The first record on the Sercel was obtained at 1903 hrs. Thereafter the recording operations were trouble-free. Only the magnetometer developed a fault which we traced to the polarizing current circuit. This was rectified at 2100 hrs with the loss of 90 minutes of recording time.

29. Friday 27 September (270)

We moved northwards along seismic line 5 during the night, several course alterations to port being necessary in order to keep in water depths of more than 50m. The line was terminated at 0950 hrs in a region of strong westerly currents. Seismic line 6, a profile running along the outer continental shelf off Guinée, began at 1055 hrs (course 287°) and shooting continued for the remainder of the day. Maintaining a constant ground speed was not always straightforward because of highly variable currents. At 2205 hrs one compressor had to be shut down due to a leaking interstage valve. Our midnight position was 9°21'N., 15°52'W.

30. Saturday 28 September

Repairs to the compressor were completed at 0150hrs, the source array then operating at full power until the end of seismic line 6 at 1739 hrs. We turned slowly to port for the start of seismic line 7, which runs across the Guinée Plateau on to the Sierra Leone Rise. During the course alteration we took the opportunity of recovering the 1000 cu. in. airgun for minor repairs. For the rest of the evening the streamer was quiet and recording almost trouble-free. Some shots were lost while 3M tapes were in use rather than BASF. We discovered at this time that previously aborted tapes also came from the same 3M batch (2012023), which will now be returned to the manufacturer.

31. Sunday 29 September (272)

We continued on line 7, crossing the northern part of the Sierra Leone Basin west of the outer Guinée Escarpment during the late afternoon. Excellent monitor records were obtained throughout the day. The streamer

towed in a stable configuration and noise levels were low. The midnight position was 8°43'N, 18°54'W.

32. Monday 30 September (273)

Our progression along seismic line 7 continued. The only source of instrumental trouble during the day was a fractured pipe in one of the compressors (third-stage separator) which led to the close-down of the 1000 cu. in. airgun at 1100 hrs. RVS technical staff effected the repairs remarkably quickly, in the most uncomfortable conditions (temperatures exceeding 115°F in the compressor flat), the airguns returning to full power at 1210 hrs. Seismic monitor records remained of high quality throughout the day. The ship's position at midnight was 8°11'N, 20°26'W.

33. Tuesday 1 October (274)

We reached the end of seismic line 7 at 0616 hrs, about one hour after one of the compressors stopped because of overheating. The magnetometer was retrieved at 0645 hrs before we brought in the airguns and began to haul in the streamer. The latter was aboard at 1042 hrs. The magnetometer was then deployed for an hour for a short passage to an area of high relief on the northern part of the Sierra Leone Rise. We spent much of the remainder of the day recovering grab samples from the crest and sides of seamounts associated with the Guinée Fracture Zone, the principal objective being to determine the nature of the basement and its subsidence history. Limestone blocks, up to 50kg in mass, form the main components of the grab hauls. The last station of the day (CD7/85/21 ; 2330 hrs, approx.) was a bottom camera deployment in a region of a particularly successful grab haul.

34. Wednesday 2 October (275)

Following the completion of a series of camera drops, a number of large-grab stations was attempted, the first of which had to be aborted owing to an impaired trawl wire. After a four-hour repair period the grab stations continued until midnight.

35. Thursday 3 October (276)

Following the recovery of the grab at 0020 hrs we completed an earlier bathymetric-magnetic-gravity survey to determine the trend of the Guinée Fracture Zone near 21°20'W longitude. This was terminated at 0900 hrs when we hove to over a particularly steep portion of the slope to deploy a dredge. Unfortunately, at 1125 hrs the dredge became stuck and the weak link parted. We then deployed the large grab at a newly-located shallow part of the Sierra Leone Rise (CD7/85/29 ; depth 260m). Both consolidated and unconsolidated sedimentary material was recovered. At 1300 hrs we headed northwards to shoot a short, unreversed refraction line parallel to the Guinée Fracture Zone (Line 6 ; 1522 hrs, first shot - 1618 hrs, last shot). At the end of the line all remaining detonators were fired. The magnetometer was deployed at 1720 hrs but had to be recovered at 1950 hrs owing to a fault on the ship's main engine (leaking fuel line). The main engine was in operation once again at 2125 hrs and we continued at full speed towards the Cape Verde Islands.

36. Friday 4 October (277)

Increasing noise levels on the magnetometer made it necessary to recover the fish at 0120 hrs and replace it with a spare. The unit was back in operation at 0150 hrs. Throughout the day we continued at full speed towards Mindelo along a track which supplements the survey

around the Cape Verdes to be carried out by Dr Ian Hill's group at Leicester University. Data were logged and plotted for their immediate use in Mindelo. By the early evening we had completed our packing of samples and equipment.

37. Saturday 5 October (278)

Charles Darwin arrived in Mindelo, Cape Verde Islands at 1100 hrs.