I.O.S.

R R S DISCOVERY
CRUISE 109

10 MARCH - 19 APRIL 1980

GEOLOGICAL AND GEOPHYSICAL STUDIES OF THE ANTILLES REGION

CRUISE REPORT NO 98

1980

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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SCIENTIFIC PERSONNEL

	10-25 March	25 March to 19 April
Mr. B.J. Barrow (Applied Physics)	x	-
Mr. R.H. Belderson (Geology)	x	x
Mr. M.G. Beney (Computing)	x	x
Mr. S. Bicknell (Applied Physics)	-	x
Mrs. G.F. Caston (Geology)	x	x
Miss T. Colvin (Computing)	x	-
Mr. A.W. Gray (Workshop)	x	x
Mr. N.H. Kenyon (Geology)	x	x
Mr. G. Knight (Computing)	-	x
Mr. P. Mason (Computing)	x	-
Dr. J.H. Peacock (Durham University)	-	x
Mr. C.D. Pelton (Geology)	x	x
Mr. M. Poulter (Durham University)	-	x
Mr. J. Revie (Applied Physics)	x	x
Mr. M. Smith (Durham University)	-	x
Dr. A.H. Stride (Geology) - Principal Scientist	x	x
Mr. A.R. Stubbs (Applied Physics)	x	x
Dr. G.K. Westbrook (Durham University)	x	x
Totals	13	15

OBJECTIVES

1. The main intention was to determine the nature of the deformation that has affected the sediments along the boundary zone between Atlantic and Caribbean sea floors and to seek its origins. Details of the relief, and interpretation of it as structural trends, are largely lacking, despite attention by British, French and American workers.

The approach was to make the first broad regional survey of the structural trends in plan view with GLORIA long range side-scan sonar and high resolution echo-sounder, looking especially for folds, faults and slumps. In the second part of the cruise crucial profiles were explored in association with a small Durham University geophysics team, using a multi-channel seismic profiling system, to obtain the structure of the underlying sediments.

2. Sonar platform - speed trials

3. Lucas hydraulic pump - noise tests

4. Pollution monitoring

NARRATIVE

The ship fitting of Gloria at San Juan, Puerto Rico, was commenced on 3rd March and was finished in time for departure. The ship sailed at 1000 on 10th March. Speed trials of the short range side-scan pod were held outside the 3 mile limit and the echo-sounder fish and Gloria fish were then launched further seaward. The intended courses north of Puerto Rico were aborted because of an urgent request to keep clear of a missile range. The subsequent courses were mainly along the band of deformed sediments to the east of the Lesser Antilles. This work was interrupted by the need to land two seamen at Barbados on 23rd March. The ship then made its mid-cruise port call at Bridgetown on Tuesday 25th March. Scientific equipment was brought aboard for the Durham workers on that day. The sailing date of 27th March had to be extended by a day to allow missing items of that equipment to reach the ship.

Discovery sailed on its second leg on 28th March. The four-gun array was not assembled until after dark so its first trial was delayed until the following morning. Its use continued until the evening of 9th April. Retrieval of guns and Geomechanique streamer took two hours. The run to Panama then commenced, every opportunity being taken to examine the band of deformed ground fringing the northern side of South America.

Gloria and the P.E.S. fish were brought inboard on the late afternoon of 16th April. The Geomechanique streamer was streamed to find the source of the oil leak. It was then wound on again at low tension.

The night run to port was made with P.E.S. and side-scan sonar. The ship anchored at Colon on the morning of 17th April for the necessary formalities preceding passage through the Panama Canal. The ship was tied up at Balboa, Panama on 19th April.

NOTES ON EQUIPMENT

1. Sonar Platform (A.R. Stubbs)

(a) Speed trials

After leaving Puerto Rico the pod was deployed, put to Mode 1 (i.e. hydraulically locked in azimuth) and the hydraulic pressure set to 600 p.s.i. The ship's speed was increased to 6 knots and then the helm put hard over to port, the effect on the platform being noted. This was repeated to starboard and followed by similar tests at 8 and 10 knots.

There was no noticeable movement of the pod in the azimuth direction throughout the trials.

(b) Pod retraction

After leaving Puerto Rico the pod was deployed and retracted twice to check that it was operating correctly. Before docking at Barbados, however, repeated attempts to retract the pod only achieved partial recovery. Accordingly, a diver was engaged in Bridgetown to examine the gear. He reported that there was no fouling but that the shaft might be bent, there being a bright spot half way up on the port side. Attempts to retract the pod were then continued. Full retraction was achieved after about 30 attempts, the pod rising a small additional amount each time. In view of this difficulty it was decided that the pod would remain housed for the remainder of the cruise.

(c) Work with the pod

On leg 1 there was no restriction on the use of the pod, the system being changed from side-scanning to echo-sounder as required, depending on the water depth. Good results were obtained.

On leg 2 because the pod was not deployed, full range side-scanning was not possible in shallow water. Tilt angles were restricted to between 55° and 90° .

Whilst in the echo-sounder mode a careful check was kept on the response over very deep water. The maximum depths recorded were in the region of 5750 m with a ship's speed of 5 knots in good sea conditions.

2. Lucas hydraulic pump - noise tests (A.R. Stubbs)

During leg 1 opportunity was taken to measure the noise spectrum of the pump that had been installed to serve the new hydraulic ring main. The noise received in a number of adjacent compartments was also measured together with the corresponding ambient figures. Some ambient levels were also noted elsewhere in the ship.

3. Gloria II (J. Revie)

The Gloria II equipment was re-fitted in the ship at San Juan, where it had been stored since November 1979. The vehicle was deployed throughout both legs of the cruise, except for a break of 20 hours on the penultimate day of the first leg (when the ship had to make an unscheduled call to Bridgetown) and a break of 8 hours on the second day of the second leg (while airgun deployment tests were completed). All four vehicle launches and recoveries were carried out in good weather conditions without incident and the same cable was used as on the last cruise with still no signs of deterioration.

Towing speed was 8 knots for the first leg, then about 5 knots while the airguns were in use on the second leg and mainly 9 knots for the remainder of the cruise.

There were no changes in the equipment from recent cruises. For most of the time a 4 second 100 Hz FM pulse was transmitted at 40 second repetition period. As usual the pulse was transmitted on three sections on each side, while all six sections each side were used for reception, with the receive beam stabilised with respect to the smoothed vehicle heading. The range attained was often restricted by poor sound propagation conditions and patterns caused by refraction effects were visible on the sonographs on a number of occasions. Nevertheless a lot of good results were obtained, including records showing textural changes on an abyssal plain. A total of 99 tapes were recorded and the equipment was in use for about 780 hours. No time was lost due to equipment failure but for most of the first leg, the port side array was reduced to 4 sections. The problem was a short to sea on section 3. This was therefore disconnected, together with section 4, which shares a signal return with it. When the vehicle was recovered for the first visit to Bridgetown, investigations revealed a small quantity of water in the aftermost block in

section 3. It could have entered under a failed paint film on one of the transducers. This transducer was replaced but until a more detailed examination can be carried out, this block was disconnected from the system leaving section 3 with four pairs of transducers on both sides. The fault caused no significant loss of data.

4. Gravimeter (G.K. Westbrook)

Although the gravity field is reasonably well known in the cruise area, gravity was measured for the whole of the cruise so as to improve the density of gravity observations. The gravimeter performed well. The chart drive motor failed on 29 March, but this was quickly replaced.

From a previous tie at Barbados and the value obtained at Barbados midway through the cruise the drift of the gravimeter was calculated as 0.133 mgal per day, but calculating from San Juan to Barbados the drift appeared to be about 1.0 mgal per day. Examination of the crossover errors between leg 1 tracks based on San Juan and leg 2 tracks based on Bridgetown showed there to be an average 15 mgal difference. It is thought that the base value given for San Juan was based upon the old Potsdam value whereas that for Bridgetown is related to IGSN71. This would explain the discrepancy. IGSN71 bases are just over 14 mgal less than the old values. With this taken into account the gravity data are consistant and the drift rates low, as would be expected if the meter was working correctly.

5. VHP 36 REVELL Compressors (A.W. Gray)

The compressors again proved to be reliable, although problems arose because of the high ambient temperatures. For the first three days it proved possible to use two 300 in^3 and one 160 in^3 airguns together, with a firing interval of 20 seconds (running on No. 1 and No. 3 compressors). However, when the ambient temperatures ranged between 31° and 37° C, the final air temperature ranged from 60-70° C. Thus, both compressors were running far too close to their cut out temperature. It was therefore decided to reduce the air demand by using only one 300 in^3 gun and one 160 in^3 gun and firing at 20 second intervals. This reduced the final air temperature to 55-63° C and so was continued until the end of the work.

6. Seismic reflection profiler equipment (G.K. Westbrook)

The aims of the seismic reflection work were to determine the internal structure of the deformed sediments of the Barbados Ridge Complex east of the Lesser Antilles, particularly at the margins of the complex where deformation commences, and to determine the depth and shape of the oceanic basement beneath the sediments, which are particularly thick in the southern and western parts of the area surveyed. In order to provide enough seismic energy to penetrate the sediments and yet retain sufficient high frequencies in the signal to be able to resolve the internal structures well, it was proposed to use an array of four airguns firing simultaneously. A twelve channel seismic streamer was used to receive the signals, which were recorded digitally on magnetic tape.

(a) Airguns

Four Bolt 1500C airguns were used to provide the seismic source for the reflection profiling. Two were provided by RVS Barry, one came from Cambridge University and one came from IOS Wormley. The four guns were attached by chains to a single towing bar which was towed on the main trawl warp from the starboard A-frame. Two guns were fitted with 300 in^3 firing chambers, and the other two had 160 in^3 chambers.

The quick action valves on the 4 way air distribution board prepared by RVS caused problems when two of them jammed on the first day on which the guns were tried. Their rubber seatings were replaced by PTFE seatings. During the eleven days for which they were used the guns behaved well overall. Faults which brought about the failure of guns were the abrasion of a trigger lead, the blowing of the fire chamber seal (P-1542), a loose hose connection, and the cracking of the top housing on one gun. This last constitutes serious damage to the gun. A large crack, presumably caused by metal fatigue, opened up around one third of the circumference of the top housing close to the flange, where it joins the main housing.

Deployment and retrieval of the airguns went smoothly, although space was limited on the after deck of Discovery. The guns on their towing bar were lifted by the crane over the ship's side forward of the starboard A-frame and lowered beneath theA-frame where the trawl warp, which was already attached, was brought in to take the weight of the guns so that the

crane could be disconnected. The trawl warp was then run out until the guns were at the desired depth. The whole operation from slowing the ship down to a speed of 3.5 knots to the firing of the guns regularly took only ten to fifteen minutes, due to the good weather. Had the ship been rolling heavily, it would have been difficult to keep control of the guns when they were lifted off the deck by the crane.

(b) Hydrophone streamer

The Geomechanique streamer performed satisfactorily throughout the cruise. 12 active sections, spaced by 12 neutral sections, formed the central part of the streamer. Depth was controlled by two Ashbrook Controllers attached to the heads of the first and seventh active sections. The towing depth was 35 ft.

During retrieval of the streamer it was noticed that oil was leaking from one or more of the near sections after they had been reeled onto the winch. A week later, after GLORIA had been brought inboard, the streamer was put out again and examined to find the leaks. It was found that both the spring sections at the head of the streamer had leaked through holes punctured in the PVC sheath. Unfortunately, during this paying out and recovery operation the weighted section between the two spring sections caught on the edge of the stanshute and also sprang a leak.

(c) Sonobuoys

Twenty ultra type SBGE4 sonobuoys were deployed during the seismic reflection profiling. Their purpose was to give measurements of the seismic velocities in the sedimentary layers overlying the basement. Fourteen of the buoys were successful, in that seismic signals from the buoys were received for a period of about two hours. Of the others, one transmitted the carrier but no signal, one became entangled in the hydrophone streamer, and four stopped transmitting recognisable signal after ten to fifteen minutes.

SCIENTIFIC RESULTS

1. Surface relief of deformed sediments to the east of the Antilles (Gloria)

The main part of the Gloria survey was carried out during the first leg of the cruise on approximately north-south lines, at a speed of about 8.5 knots. Additional coverage was obtained during the second leg of the cruise at lower speeds. Ranges of up to 16 miles were obtained in the deeper water but refraction limited range seriously in shallower water. The overall amount of data collected was most satisfactory and the quality is high.

The Gloria survey revealed marked regional differences in morphology that provide a new edge to study of the tectonic evolution of the ground as a whole. The main tectonic trend lies along the length of the deformed ground, with relatively little sign of any cross trends.

2. Sections through the deformed sediments to the east of the Lesser Antilles (airguns)

Most of the main survey lines were short and ran eastward across the eastern margin of the Barbados Ridge Complex and were joined by north-south lines. Along the main survey lines a speed of 4.75 knots over the ground was aimed for, so as to enable 12 fold common reflection point stacking to be carried out with a gun firing interval of 20 s. The strong and somewhat variable currents made this speed difficult to achieve when there were periods of two to three hours between good satellite fixes. Deviations of up to 0.5 knots occurred on some lines. Some north-south tie lines were run at 5.5 knots and in one case 6.5 knots and were not recorded on magnetic tape although they were displayed on the monitor recorders (E.P.C. and Geospace).

A total of 1222 nautical miles of reflection profile were recorded. Time spent servicing and repairing airguns or compressors amounted to $10\frac{1}{2}$ hours, a possible loss of 50 nautical miles of reflection profile (4% of the total). The work commenced on Day 090 at 1715 GMT and finished on Day 100 at 2150 GMT.

The monitor records (which show the signals recorded from hydrophone channel 3) are encouraging. The oceanic basement is seen well on most of

the records and is greater than 5s reflection time beneath the sea bed on two profiles. The profiles also show clearly the variation in style of deformation of the sedimentary layers above the edge of the Barbados Ridge Complex. This variation is primarily related to variation in sediment thickness.

3. Marine pollution monitoring (CARIBPOL)

A watch was kept for floating oil slicks and floating tar throughout the cruise, in answer to a request from IOCARIBE's cooperative programme. None was observed in the Atlantic region between San Juan, Puerto Rico and the southern end of the Barbados waters, despite the many lines followed there during a period of about one month.

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