I.O.S.

R.R.S. DISCOVERY

CRUISE 106

5 – 22 DECEMBER 1979

TRANS-ATLANTIC PASSAGE WITH EQUIPMENT TRIALS AND HIGH RESOLUTION SEISMIC PROFILING

CRUISE REPORT NO 90

1980

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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R.R.S. DISCOVERY

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Institute of Oceanographic Sciences,
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ITINERARY

Departed Tyneside	1979 December 5th Day 339
Arrived San Juan	1979 December 22nd Day 355

SCIENTIFIC PERSONNEL

R.B. Kidd	Principal Scientist	IOS Wormley
J.S.M. Rusby	Mechanical Engineering	IOS Wormley
R.H. Edge	Mechanical Engineering	IOS Wormley
R. Dobson	Mechanical Engineering	IOS Wormley
B.H. Hart	Mechanical Engineering	IOS Wormley
E.P. Collins	Mechanical Engineering	IOS Wormley
G. Lodge	Mechanical Engineering	IOS Wormley
N.I. Timmins	Mechanical Engineering	IOS Wormley
D.G. Bishop	Applied Physics	IOS Wormley
C.H. Hunter	Applied Physics	IOS Wormley
R.G. Rothwell	Geophysics	IOS Wormley
M.R. Saunders	Geophysics	IOS Wormley
R.F. Wallace	Workshop	IOS Wormley
A.W. Gray	Workshop	IOS Wormley
D. Lewis	Computer	RVS Barry
S. Crease	Sedimentology	Chelsea College, London
J.A. Luchford	Micropalaeontology	University College, London

SHIP'S OFFICERS

P. Moran	Master
K. Avery	Chief Officer
M. Putman	Second Officer
T. Harrison	Third Officer
D. Taylor	Radio Officer
R. Morris	Purser/Catering Officer
C. Latter	Chief Engineer
G. Batten	Second Engineer
J. Richardson	Third Engineer
A. Grattidge	Fourth Engineer
G. Gimber	Fifth Engineer
G. Greene	Electrical Engineer
G.A. Carss	Ship's Doctor

CRUISE OBJECTIVES

Cruise 106 was to be a transit leg UK to the Caribbean which was to include reconnaissance sediment sampling and seismic profiling in a mid-Atlantic location for the HLRW research programme, together with testing and modification of various shipboard equipment both on passage and on station during sampling operations.

The time constraint that Discovery was to arrive in Puerto Rico for Christmas meant that the time allowable for deviation southward to the Great Meteor Seamount study area, to meet scientific objectives, was estimated at a maximum of four to five days. Some of the engineering objectives, including renewal and tensioning of winch wires and load telemetry during coring operations, were to be carried out while on station in the study area. Running up and commissioning trials by IOS personnel on the new hydraulic ring main system and tests of crane modifications were to be major engineering objectives of the cruise.

Other engineering objectives were performance tests on the sonar platform and airgun towing depth trials. These were to take place whenever convenient, when the ship's underway speed could be slowed and varied.

A subsidiary cruise objective was the development of a system of shipboard analysis and sampling of sediment cores.

R.B.K.

NARRATIVE

Discovery was originally scheduled to leave the refit port, South Shields, for ship trials and E.M. Log calibration on 30th November (334), to return for explosives loading at North Shields and to sail for Cruise 106 on 1st December (335). In the event, delays caused by repair work on a generator and by scheduling of explosives loading meant that Discovery left the Tyne at 1200/339, the 4th December, four days late.

Discovery sailed north in very good weather, moderate winds and good visibility, towards Blyth for calibration of the E.M. Log over a measured mile. Reversed traverses were done at varying engine revs: 150, 120, 100 and 80 revs. This successfully completed, Discovery sailed southwards for the English Channel and the launch point for the profiling gear in the Western Approaches. During this traverse, Discovery's engines were run-in at a maximum 150 revs and a start was made on developing a system for shipboard analysis and sampling of cores.

At 0800/341 Discovery was south of Start Point and Falmouth, making slow progress at 7 to 8 knots through the English Channel in force 6 to 7 winds.

The weather moderated overnight and on the morning of 8th December (342) the ship was making 10 knots with the skies clearing. Discovery arrived at the UK Data Buoy at 1200/342 and rendezvoused with RRS John Murray, which was on station conducting experiments. Our original launch point for the profiling gear was a few kilometres to the northwest and so it was decided that here the profiling gear would be deployed. The PES fish was operational by 1230/342 and the 2 kHz receiving array and magnetometer were streamed. Load tests on the array were run as the ship came up to speed, and were projected to reach 230 lbs at 11 knots. Both profiling watches, for the 2 kHz and the PES, were in operation by 1300. Data from the magnetometer were being logged by the IBM 1800 computer from 1500/342 (see Table 1).

At 1600/342 after a profiling run over the shelf edge into deep water, the ship altered course to due south in an attempt to avoid a force 10 gale, forecast to be rapidly approaching from the west. By 2120/342 it became necessary to recover the profiling gear because it was expected that the ship would hove to in order to ride out the storm.

Two days were spent either hove to or in making an erratic 2 to 3 knot passage generally southwards in the Bay of Biscay. By 11th December (345) the weather had improved sufficiently to make 6 to 7 knots, although another gale was forecast. The profiling gear was streamed again at 1000/345 over the Charcot Seamounts. That afternoon Discovery sailed SSE at 13 knots to try to get well south, away from the prevalent storm "trails" before turning west.

At 0700/346 Discovery set a course 240° for the Azores and by 0800 was making 12.5 knots over the Iberia Abyssal Plain in clear skies, but still against a 27 knot headwind and heavy swell. The ship's speed dropped rapidly overnight to average only 8 knots by 0800/347, and wind speeds had risen to 50 knots.

The next day Discovery was back up to 12.5 knots average speed and was within 200 miles of the Azores. The inevitable decision was made to abandon scientific objectives in the Great Meteor Seamount study area and to make a direct run to Puerto Rico, whilst attempting en route to accomplish as many of our engineering objectives as possible. The setting up of a system of shipboard core analysis had gone well and the transatlantic traverse with the 2 kHz profiler would anyway produce a useful test of its potential.

At 1020/348 the PES and 2 kHz profilers were switched off since no clearance for profiling within Azores limits had yet been received.

Periodically between 1330/348 and 1400/349, the wire on the electric winch was reeled off and dumped in lengths over the side while underway, and work continued

on the hydraulic main system. At 1900/349 the PES and 2 kHz profiling systems were switched on again and watches continued.

By 16th December, 0800/350 Discovery had crossed Oceanographer Fracture Zone in good weather and was averaging 13.5 knots. The 2 kHz profiler records improved in response to improved sea conditions and lowering in ship motion and the recorder was displaying its best records yet with recognisable subbottoms to 50 metres below the seabed. That afternoon the wind on the beam unexpectedly began to rise sharply. Sea states 7 to 9 were encountered overnight and through much of the 17th December.

At 1300/351 a lifebelt was sighted and the ship made a series of tight turns to investigate, only to find that the lifebelt was a broken one with no name visible. Between 1850 and 2100 on Day 351 the 2 kHz profiler was off for repairs to the transmitter unit. Torque tests were run on the forward hydro, double barrelled capstan and midships winches while underway, employing deck anchor points.

Days 352, 18th December to 355, 21st December were spent underway at top speed, $13\frac{1}{2}$ knots plus, towards San Juan. During this period new 4 mm wire was reeled on to the starboard electric winch; all commissioning was completed on the hydraulic main system and torque tests were completed on the forward hydro, midships and double-barrelled capstan winches. Also, work was carried out on the transit system for the forward explosives magazine.

Discovery arrived within sight of San Juan at 0700/356, 22nd December. The engines were run at 100 revs for a cooling period. At 0800/356 PES and 2 kHz watches ended and the ship slowed to 4 knots to recover this gear and the magnetometer. At 0830 the sonar platform was deployed for a short period for trials on our port approach. The ship was tied up alongside its berth in San Juan at 1030/356, 22nd December.

R.B.K.

PROJECT REPORTS

1. Reconnaissance Coring and Profiling on HLRW Study Area

This part of the programme was abandoned when it was found on arrival in the region of the Azores that time was barely available for a direct transit to Puerto Rico, let alone a deviation south to the Study Area. Delays at the refit port and storm conditions off the European Margin had removed any possibility of scientific studies south of the Azores.

R.B.K.

2. 2 kHz High Resolution Profiling

(a) Modifications for Cruise 106

For Discovery Cruise 106, it was decided to begin again with the 2 kHz profiler development and build a completely new correlator with improved resolution, and also to build a hydrophone with a stronger cable termination which could withstand being towed at 13 knots. The new correlator has the same pulse length, because of the noise problem, but has a bandwidth of 1000 Hz giving a resolution of 1 ms and hence an improvement of 2.5 times. At the start of the cruise, after the new hydrophone had been deployed to the full extent of the cable, approximately 450 metres, the strain was taken up by a spring balance and the tension in the cable measured at various speeds up to 10 knots. Figure 2 shows the results obtained. One part of the system which could, and has, reduced the quality of the records in the past is the recorder itself. Although the EPC recorder is reliable, it does suffer badly from stylii pairing which results in regularly spaced gaps in the record and consequently ruins the trace-to-trace correlation. For this reason a Raytheon recorder was purchased and used on this cruise for the first time.

(b) General Performance

All the data was collected at maximum passage speed as governed by the weather conditions at the time. This for the most part meant heavy seas and swell, which are unfortunately not the best profiling conditions. This, therefore, resulted in most of the records being affected by considerable noise. At one stage, the hydrophone had to be pulled in 100 metres to reduce tension and this length was retained for the rest of the cruise.

During some periods, the sea conditions were favourable and the records looked reasonable. Overall the system worked well with only a few breaks in data. These were caused by a minor problem with the take-up spool on the recorder, and the output transitions of one transmitter going short-circuit. Once these faults were corrected the system worked reasonably well.

A separate internal report on the performance of the system by Kidd, Bishop and Rothwell has been prepared. This includes example illustrations of the records obtained during Cruise 106 and comparisons are made, both with previous 2 kHz records obtained from Discovery and with published 3.5 kHz records. Where weather conditions were good the Cruise 106 records are clearly an improvement on previous 2 kHz records. They compare favourably with 3.5 kHz records, giving sediment penetration and recognisable subbottoms to 50 metres plus, despite towing

speeds in excess of 12 to 13 knots.

D.G.B., R.B.K.

3. Shipboard Analysis and Sampling of Sediment Cores

A subsidiary objective of the cruise was to develop a system of handling and analysing cores on board ship. This would provide for the HLRW disposal programme a preliminary analysis and description to serve as a basis for future laboratory studies on subsamples at IOS Wormley, and other laboratories.

To this end, two unsplit sediment cores taken northeast of the Azores on an RRS Shackleton cruise two months previously, were brought along to provide material on which to practice techniques during transit to the study area.

A team of five (RBK, GR, SC, JAL, MAS) set up operations in the aft chemistry laboratory. The cores, each already split into two sections vertically, were split longitudinally using a circular saw and cheesewire. One half, designated 'ARCHIVE', was cleaned, visually described and its lithologies were analysed using smear studies. Core photography was carried out on this archive section. The other half, designated 'WORKING', was subsampled both for shipboard analysis of palaeontology, non-biogenic coarse fractions and carbonate content, and for shorebased X-ray diffraction grain size, LECO carbonate and other studies.

A standard format shipboard report was prepared on the two practice cores employing as illustrative material: visual core description forms, smear slide and coarse fraction descriptions, core summary plots and core photograph mounts.

Although this "DSDP" style system of core description analysis and data presentation was not used in earnest on Cruise 106, valuable experience was gained of the potential for such work on subsequent Discovery cruises in the HLRW programme.

R.B.K.

EQUIPMENT REPORTS

1. Precision Echo Sounder

The echo-sounder fish and Mufax were continuously used during the cruise. Most times, good results were obtained, however, faring slippage on the fish towing cable caused some problems in obtaining a good bottom echo towards the end of the cruise. The same fish, No.3, was towed throughout.

R.G.R.

2. Magnetometer

Operation of the Varian V-75 Proton Magnetometer was continuous throughout the cruise, except during storm conditions when the fish was brought inboard (from 2116/342 to 1000/345). Data spikes were thought to be caused by water in the RVS Barry fish, but continued after the fluid had been changed. The analogue chart recorder was not used; all data being logged on the shipboard computer.

M.R.S.

3. Shipboard Computer

The IBM 1800 computer system was used throughout the cruise to log bathymetric, magnetic and meteorological data. In conjunction with the Magnavox satellite navigation system, it provided satellite-corrected dead-reckoning. Track charts were produced on a daily basis and also on this cruise an attempt was made to produce track charts in Admiralty Plotting Sheet format on Mylar sheet. After initial problems with ink pens this was accomplished successfully. Initially an attempt was made to use pressurized ball pens, but it was found that their ink smeared very easily.

An E.M. log calibration was carried out at the beginning of the cruise and the appropriate new computer calibration constants were determined.

Carter depth correction areas were used for the first time on the computer during this cruise.

D.L.

4. Electro-magnetic Logs

Immediately after leaving South Shields, the two Electro-magnetic logs were calibrated over the measured mile at Blyth. One of these had just been fitted during the refit, while the other was of somewhat earlier fitting, both being of the new automatically deployable electro-hydraulic design by Colnbrooke Instruments Ltd.

As soon as the ship put to sea it was found that one pair of components were reversed on each log, in one case the Fore/Aft, and in the other the Port/Starboard. This was corrected by a wiring change and, with the logs switched to the calibration mode, all the repeater stations were adjusted to read the same.

On the measured mile we were able to do four pairs of runs at various speeds from 5 to 11 knots, corresponding to engine revolutions per minute of 150, 130, 100 and 80. Lack of time in the programme did not permit more than this. From

these runs, ground speeds were computed, and after making corrections for derived tidal currents, a factor was obtained for each E.M. log against the true velocity relative to the water mass. The means were taken of these factors for each log and new calibration constants applied to the computer. The digital readouts were also adjusted to read correctly. The data from which these factors was derived is shown in Tables 2 and 3 for each log.in condensed form.

Hydraulic controls

When first deployed on leaving South Shields the E.M. log controls in the engine room cofferdam space were used, so as to allow the operation of the hydraulic rams to be closely observed. Once the correct operation had been verified, control was switched over to the bridge. About a week after putting to sea, the engine room reported that all the E.M. log lights had gone out on the port log control box overnight. Investigation of the cause showed that the log could not be raised due to the circuits being locked out, water having gotten into the limit switches on the sea valve. In an attempt to regain control, this part of the circuit was linked out by hard-wiring across in the control box. This still had no effect and it was found that the limit switch at the bottom of the hydraulic ram was also affected by water ingress.

A dummy control box, consisting of toggle switches wired to the appropriate connector plug, was made up. By unplugging the cable from the control box, which served the limit switches, and replacing it with the simulator it proved to be a simple matter to raise the log by correct sequence of operation of the switches. Since no replacements were available for the limit switches aboard the ship, this log was left in a raised condition and operations continued using the Starboard log.

C.A.H.

5. Photography of Cores and Records

Tests were run to gain experience of core photography aboard ship. These were aimed at providing an accurate record of core lithology to supplement future shipboard core descriptions. The 'Archive' half-sections of cores were photographed after smear slide sampling, using a 'Polaroid' MP-4 land camera and copying stand. It was essential that the sections be photographed as soon as possible after splitting; before there had been any serious colour changes in the core lithology. The MP-4 camera used was fitted with a Tominon 135 mm lens which resolved fine detail. Illumination was provided by four 150w tungsten lamps. Some problems were caused by some sections rapidly drying out under the

lamps.

Each print measured 9 x 11 cms and covered 40 cms of core with overlap.

Laboratory tests had previously shown that Polaroid Type 52/Polaplan 4 x 5 land film was the most suitable of the Polaroid range in producing an accurate rendition of core lithology. Type 52/Polaplan film is a panchromatic, medium-contrast film having type B sensitisation and provides high quality prints. The correct exposure was determined using the Polaroid exposure guide but in some cases an adjustment of one stop was necessary. The optimum exposure was found to be a shutter speed of 1/125 sec at f8½. Print processing time was set at 15-20 seconds at 70 °F as recommended by the manufacturers.

Once developed, all prints were coated to prevent scratching and fading. When dry the prints were cut and montaged to provide continuous sections and then mounted on standard formatcore photograph forms.

Originally, it had been intended to photograph each section with black and white FP4 and colour Kodachrome 64 35 mm film by fitting two 35 mm rangefinder cameras to a modified universal head, which would replace the MP-4 land camera on the copying stand. However the light-meter batteries in both cameras were "flat" making them unusable. Additionally, serious parallax errors were encountered. It was concluded that range finder cameras are unsuitable for this type of work and should be replacedby the single- lens reflex variety.

Sixteen selected sections of 2 kHz high resolution profiler record, including some 3.5 kHz comparison records were photographed to provide illustrations for a separate internal report on the 2 kHz profiler system.

The prints were produced using the Polaroid MP-4 Land Camera fitted to the copying stand. Previous work had shown that, in this case, Polaroid Type 51/High Contrast film is particularly suited to photographing profiler records. Lab tests confirmed this view. Type 51 film is sensitive to blue light only and this made necessary the reannotation of the records where they had previously been annotated in blue ink. The film yields black and white only with little intermediate grey tones. Hence, is well suited to this type of work. As with all high contrast film, the exposure latitude of type 51 film is limited and determination of optimum exposure values varied with subject type. With the 2 kHz records, an exposure of f8 at 1/60 sec, generally produced good results.

R.G.R.

6. Hydraulic main

During the cruise a considerable amount of work was carried out on this newly installed system:

(a) There were initial filtration problems which caused the pressure relief valve across the Lucas pump to block, so that fall line pressure of 3000 psi could not be reached. This was traced to an incorrectly installed filter element.

(b) Leaks were found in two braised joints in the high pressure line, due to faulty workmanship. Each joint was cut out and replaced by an Hiduran coupling.

(c) The recommended safety system start-up was fitted to the forward hydrographic winch, but had to be removed because of unsuitable valve pressures. It should be noted that with the existing system when the pump is started, full power is applied to all winches.

(d) A centrifugal pump has been installed which requires a head to deck level to prime and start. It is planned to replace this with a displacement pump. The heat exchanger system is inadequate, so that in use the winches may only be run for $\frac{3}{4}$ hour before the oil temperature at the flow control valves exceeds 80 °C.

(e) All units in the system were exercised: the double-barrelled capstan plus reeler, the forward A-frame and hydrographic winch, and the midships hydrographic winch. The double-barrelled capstan had a stationary pull of 3400 lbs, the reeler 120 lbs (after raising the applied pressure to 700 lbs), and the forward winch initially 5000 lbs, but this was subsequently derated to 3400 lbs.

(f) Noise levels from the pump room were found to be unacceptably high in certain spaces. No significant noise came from the lines to the midships winch.

J.S.M.R.

7. Air Compressors

During the refit the two Reavell compressors and ancillary equipment were removed so that the after tank space could be renovated. After these had been installed, there was a considerable amount of commissioning work to do which continued during the early part of the cruise. In addition, No. 2 compressor received a 500 hour overhaul which included replacing valves on the second, third and fourth stages. New filters were fitted to both compressors, and No. 1 compressor was drained to determine the cause of low pressure. This was found to be due to loose oil lines.

J.S.M.R.

8. Conveyor system for explosives

The Conveyor System comprises of a deck roller conveyor which runs from under the loading hatch at the forward end of the Hold to the entrance of the Magazine Store and is fixed to the deck. There is a removable section, which extends the conveyor through the path of the outward opening Magazine door to just over its threshold, and a further removable section which extends a short way into the Magazine Store. A purpose designed wooden pallet runs on this conveyor to transport the 300 Kg. drums of Tovex plastic explosive, which are lowered by crane into the Hold, to just inside the Magazine.

From here each drum is lifted up with a compact hand-operated hoist, which is attached to the carriage of an overhead track conveyor. This conveyor has 3 turntables to rotate the carriage approximately 98^{o} in the horizontal plane and so allow the drums to be loaded into the Magazine in 3 rows and stacked 2 high. Total capacity of the Magazine Store is 28 drums.

The carriage has a fail-safe hand-operated brake which is applied automatically, immediately a downward pull is removed, by 4 strong springs.

During the cruise, work was completed on this system for handling explosives in the forward hold. The deck conveyor system leading to the Magazine was fitted and the overhead track inside the Magazine was aligned and stops fitted to the turntable. The overhead trolley was modified to ensure smooth running and to enable drums to be double-stacked.

N.T., J.S.M.R.

9. Corer compass

A recording compass unit was fitted to the RVS corer, the control unit was modified and the system satisfactorily tested in the laboratory. Testing on the corer awaits sampling operations on a subsequent cruise.

J.S.M.R.

10. Sonar platform

After leaving South Shields work continued on recommissioning the sonar platform. The azimuth realignment motor was modified to bring it into line with the response rate of the azimuth drive motor. All cables from the azimuth junction box to the control console were renewed to enable a dust cover to be fitted over the control console. Certain wiring faults in the warning light system were corrected, and cables in the Electronics laboratory were remade to give greater flexibility in the layout of the laboratory display and control units. When

nearing San Juan the platform was deployed and tests of the azimuth response were made at speeds up to 11 knots. From these very brief trials it is clear that more time is needed to equalise the response to port and starboard and ensure that the speed of rotation is adequate.

J.S.M.R.

11. Meteorological observations

Meteorological observations were logged automatically by the computer and manual checks were made each day at 12.00 from the following instruments:

(a) Bridge screen thermometers (port and starboard)

(b) Bridge barometer

(c) M.O. sea temperature (R.A.S.T.U.S.)

(d) M.O. anemometer (relative wind)

(e) Ship's speed and course.

These readings and the corresponding data produced by the computer were recorded in a meteorological log to provide a running comparison. This, on analysis, showed a good correlation, indicating that the readings obtained were of good quality.

Data were obtained throughout the cruise. All scientific instruments functioned well, requiring only general servicing.

M.R.S.

TABLE 1 Periods during which Underway Equipment was used

Instrument	From	To
Echosounding fish	1218/342	1018/348
	1900/349	0800/356
Magnetometer	1542/342	2116/342
	1000/345	0800/356
2 kHz profiler	1800/342	2118/342
	1000/345	1022/348
	1909/349	1850/351
	2245/351	1401/352
	1511/352	0800/356

TABLE 2

E.M. STARBOARD LOG

RUN	T MIN: SECS	V_G	Cur. V_T	$\bar{V}_L$	V_G'	$\alpha = \frac{V_G}{V_G'}$
1A	5:28	10.975)	0.433	10.423	9.990	1.0987
1B	5:04	11.842)		10.546	10.979	1.0786
2A	6:11	9.704)	0.442	9.426	8.984	1.0801
2B	5:40	10.588)		9.241	9.683	1.0935
3A	8:25	7.129)	0.593	7.190	6.597	1.0806
3B	7:13	8.314)		6.884	7.437	1:1179
4A	11:03	5.430)	0.794	5.767	4.973	1.0919
4B	8:33	7.018)		5.243	6.037	1.1625
					MEAN	1.1005

Original cal voltage 8.45
∴ new voltage set to 9.299

TABLE 3

E.M. PORT LOG

RUN	T MIN: SECS	V_G	Cur. V_T	$\bar{V}_L$	V_G'	α $\frac{V_{G_1}}{V_G}$
1A	5:28	10.976)	0.433	11.077	10.644	1.0312
1B	5:04	11.842)		11.318	11.751	1.0077
2A	6:11	9.704)	0.422	10.135	9.693	1.0011
2B	5:40	10.588)		9.928	10.370	1.0210
3A	8:25	7.129)	0.593	7.632	7.039	1.0128
3B	7:13	8.314)		7.351	7.944	1.0466
4A	11:03	5.430)	0.794	6.126	5.332	1.0184
4B	8:33	7.018)		5.969	6.763	1.0377
					MEAN	1.0221

Original Cal. Voltage 8.75

∴ New Voltage should be 8.94

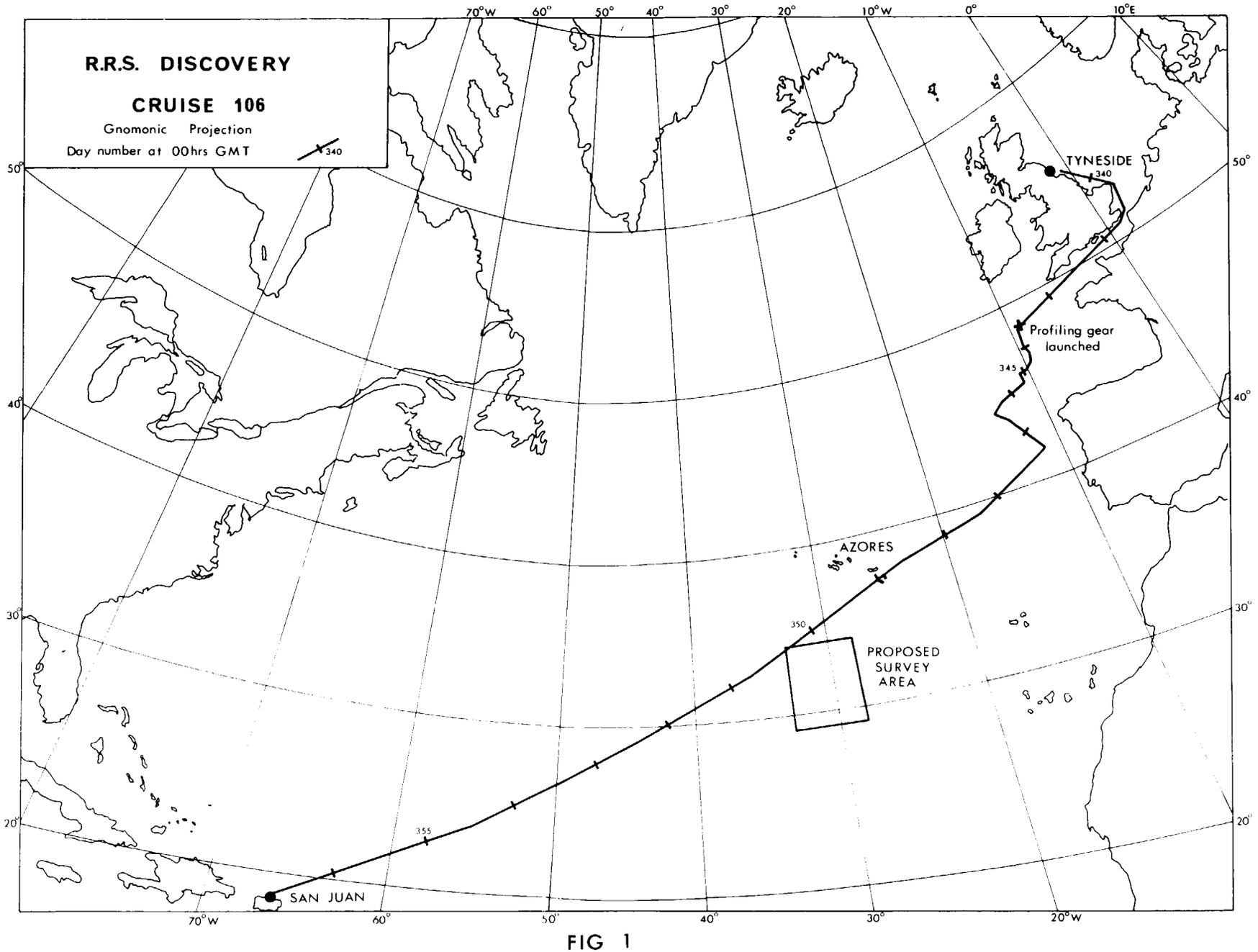
R.R.S. DISCOVERY
CRUISE 106
Gnomonic Projection
Day number at 00hrs GMT
340
TYNESIDE
340
Profiling gear launched
345
AZORES
350
PROPOSED SURVEY AREA
355
SAN JUAN
70°W
60°
50°
40°
30°
20°
10°W
0°
10°E
50°
40°
30°
20°

FIG 1

2 KHZ ARRAY TENSION ∝ SPEED WITH ALL 450 YDS DEPLOYED

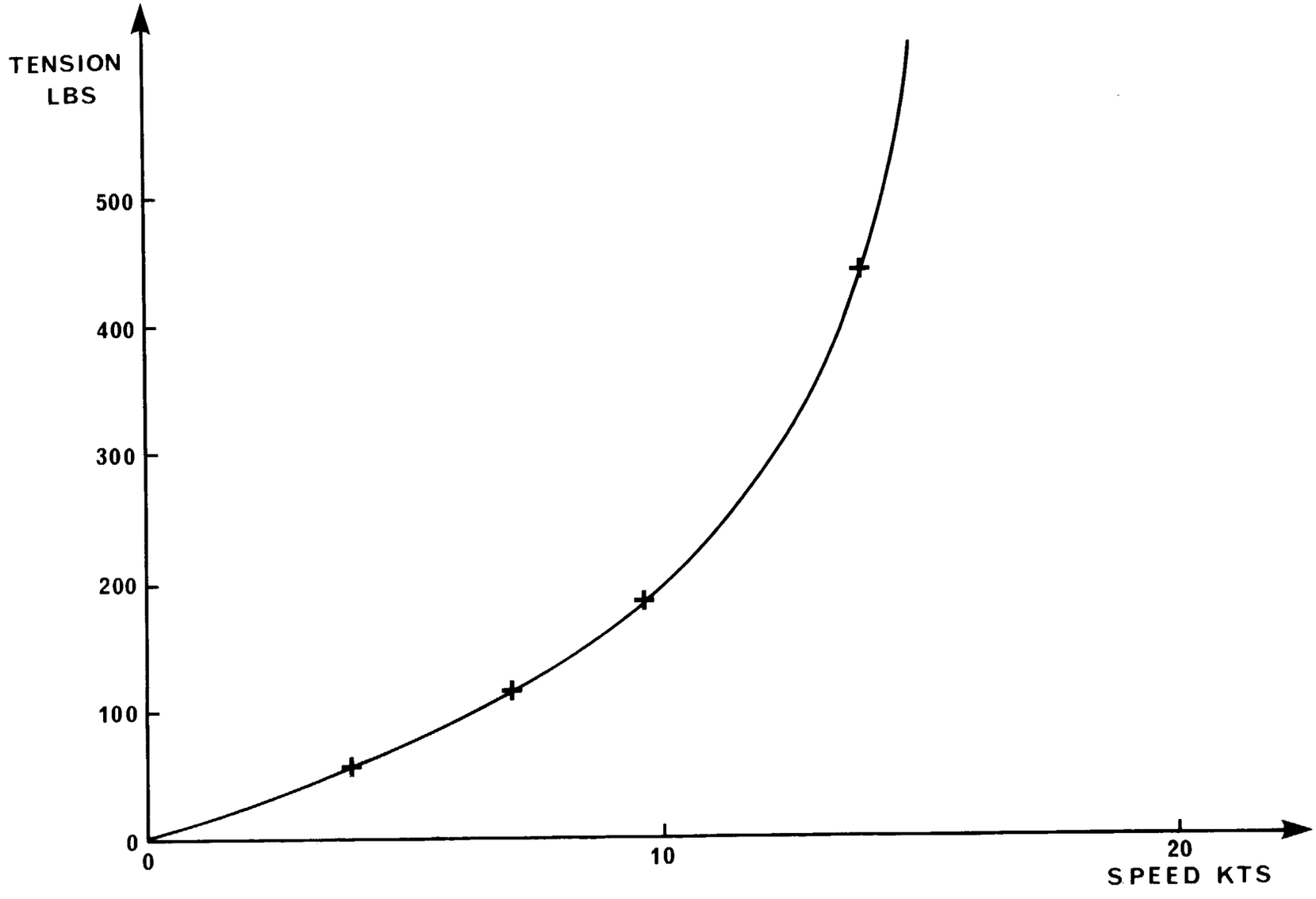

FIG 2