9|37|70

R.R.S. JOHN MURRAY

CRUISE REPORT 3/70

UNIVERSITY OF BIRMINGHAM

Celtic Sea

CONTENTS

Scientific Objectives

The main purpose of the cruise was to survey by seismic, gravity and magnetic methods the area to the south west of Ireland leading across the shelf to the Porcupine Seabight and the Continental margin. The structure of the Porcupine Seabight and its relationship to the structure of the continental shelf and the margin are little understood, yet these may well give valuable evidence of the evolution of this region of the western margin of Europe and of the structural history of the British Isles. The previous Birmingham cruise, 7/69, had included a crustal seismic experiment with a line of shots out to the Porcupine Seabight and detailed survey in the region was also required to provide information about near-surface geological structures to enhance interpretation of the deeper ones. For this purpose, in particular, seismic refraction lines were required at points along the original crustal line to give velocity information of the shallower layers. The survey was also designed to link with that across the Nymphe Bank, south of Ireland, made during cruises 4/67 and 7/69 so that a continuous tract of sea from Wales to the margin should be covered.

Additional experiments were planned as follows:-

1. The evaluation of a vertical hydrophone array for use in water of oceanic depths to obtain seismic reflections from deep crustal boundaries.
2. Evaluation of aquaflex as a seismic source for refraction measurements at sea using sonobuoys.
3. Geophysical traverses across the Nymphe Bank and Bristol Channel approaches during transit to and from the main survey area to improve the track density in critical areas.
4. A gravity traverse into Carmarthen Bay, to assist research being carried out at University College, Swansea.
5. Evaluation of effect of ship's magnetic field on proton magnetometer towed at various lengths and headings.
6. Bottom sampling for foraminifera and ostracoda in the River Shannon estuary to extend the range already sampled by Mr. I. Hoskin, University College, London.

Narrative

(a) First Leg: Barry to Cork, 23rd March to 1st April

R.R.S. John Murray sailed from Barry at 11.30 B.S.T. on 23rd March and made direct for Carmarthen Bay. A 1000J Sparker/ magnetic/gravity traverse, 70/1, was commenced at 13.30 off the Scarweather Lightship, and after making a dogleg course into Carmarthen Bay to take gravity readings requested by University College, Swansea, we traversed south to Lundy before heading west. Traverse 70/1 was suspended temporarily during the afternoon of 24th March to conduct trials with the magnetometer to ascertain the effect of the ship's field at various headings and various lengths of towing cable, an experiment suggested by Prof. T. Murphy, Institute of Advanced Studies, Dublin. Traverse 70/1 was continued northwards to the Irish coast and along to Cobh where D. J. Blundell joined ship. On leaving Cobh, Sparker/magnetic/gravity traverse 70/2 was commenced at 18.00 on 25th March, to fill in gaps left in the survey of cruise 7/69 whilst making our way westwards beyond Fastnet, and was completed by 11.00 on 26th March. During the rest of the day, trials were held to establish the method of firing aquaflex charges with the ship hove to, in preparation for the experiment using a vertical hydrophone array. On successful completion of these trials, at 16.00, Traverse 70/3 was commenced with gravimeter and magnetometer recording. At 18.00 the sparker was also used and, as the water depth increased, power was gradually increased to 10,000J. Unfortunately, in water depths greater than 1000 fthm, signal strengths in the short hydrophone array, that was the only one available, were weak and sub-bottom reflections were not clearly visible. The sparker was stopped at 23.30 and the traverse was continued with gravimeter and magnetometer until 05.20 on 27th March, by which time the ship was on station to commence seismic experiments. First, a dahn buoy was laid to serve as a local reference point. The vertical hydrophone array (eight hydrophones on 1000 ft. of cable) was put overboard and buoyed at its upper end, with 1500 ft. of cable then leading to the ship. In order to trail the charges of aquaflex 300 ft. clear of the ship it was then necessary to shuttle forward and astern, paying out or pulling in the hydrophone lead cable as necessary. This proved to be a difficult operation to perform without dragging the hydrophone array from its vertical position. Five charges of 200 ft. aquaflex were successfully fired and recorded but in preparing for the next charge the ship going astern overran the

lead cable which fouled the propellers and parted. The ship immediately put about to recover the hydrophone array by retrieving the buoy only to find the buoy broken and drifting a mile away, no longer attached to the array. The damage to the buoy cannot be attributed in any way to the accident when the cable parted and must have occurred some time earlier, but does explain how the ship came to overrun the cable which by that time had been pulled down by the weight of the array. The damage to the buoy cannot have been caused by the ship backing up on previous occasions as constant watch was kept from the stern. No other shipping was present at the time which could have fouled the buoy and only speculative explanations can be given; possibly the buoy was attacked by a shark or it may have been dragged under by the weight of the array and imploded. The area was searched for any sign of the array, but as it was not buoyant, there was little chance of finding it. Eventually, the search was abandoned and gravity/magnetic traverse 70/4 was commenced at 17.45 westwards to 14°W Long. and returning on a near-parallel track to the dahn buoy by 08.00 on 28th March. A seismic refraction line, firing to two sonobuoys one mile apart was then undertaken, using charges of up to 100 lb. of geophex at ranges out to 17 miles. An attempt later to use an air-gun source in conjunction with the sonobuoys to obtain reflection data was thwarted by a fault in the Mufax recording equipment. At 17.50, gravity/magnetometer traverse 70/5 was commenced, again to 14°W Long. but to the south of traverse 70/4, returning to the dahn buoy by 06.30 on 29th March. A second refraction line was fired to reverse the previous day's line, using the same technique. On completion of the line, in worsening weather conditions, the ship made to retrieve the dahn buoy but after a lengthy search without finding it the buoy had to be abandoned. At 22.00 gravity/magnetic traverse 70/6 was commenced, travelling eastwards and then southeast but as the weather worsened further it became necessary to turn about and head for shelter in Bantry Bay, reached early on 31st March. Gale force winds continued all day and it was evident that no further useful work could be accomplished west of Ireland during the first leg. On 1st April we headed out of Bantry Bay, conducting trials for firing aquaflex charges with a single wire firing cable and a high voltage blaster whilst still in sheltered water. Gravity/magnetic traverse 70/8 was recorded between Mizzen Head and Cobh and the first leg of the cruise was completed on reaching Cork at 18.00.

(b) Second leg: Cork to Barry, 4th to 13th April.

Having departed from Cork at 09.30 on 4th April, gravity/magnetic traverse 70/9 was commenced south of Cobh at 12.00, leading westwards to a position at 11°W Long. where further sonobuoy seismic refraction lines were required. Three lines were completed on 5th April, the first using geophex charges, fuse fired to a range of 9 miles. This line was then repeated exactly, using aquaflex charges which with 400 ft. lengths of cord, were successfully recorded to a range of 8 miles. The third line was fired in the opposite direction from the sonobuoy to give a partial reversal of the refractors. On completing the seismic work, gravity/magnetic traverse 70/10 was commenced at 17.30 towards the River Shannon but with winds increasing rapidly to gale force, gravity data became poor and the line was abandoned at 06.40 on 6th April. D. J. Blundell and I. Hoskin were put ashore by launch near Foynes Harbour, after which a series of 10 sample stations for Mr. Hoskin (U.C.L.) were worked, including shipek grab for bottom sampling, sea water samples at 30 ft. above the sea bed, and plankton sampling. Gravity/magnetic traverse 70/11 was started at 10.00 on 7th April along a dogleg course, heading generally southwest. From 23.30 the sparker was also recorded, until 13.00 on 8th April. Traverse 70/12 was then begun, recording gravity and magnetic data only. This was continued as far as 14°W Long. and then a succession of dogleg tracks was followed, returning eastwards. During the course of 9th April the two chain decca system, on which navigation had been based hitherto, began malfunctioning and navigation had to rely on dead reckoning.

Traverse 70/12 was completed by 14.00 on 10th April, by which time Decca readings could again be obtained but fixes were poor. Gravity/magnetic traverse 70/13 was commenced along a parallel course back westwards as far as 13° 20'W Long. and completed by 09.00 on 11th April. On a return, parallel track, south of 70/13, traverse 70/14 was recorded using sparker as well as gravimeter and magnetometer, continuing until 03.00 on 12th April when the sparker was brought inboard. Traverse 70/15 along a continuing track, by now south of Ireland, was recorded with gravimeter and

magnetometer until 14.00. The sparker was again put overboard and all three instruments were recorded along traverse 70/16 until 22.00 by which time, with wind increasing to gale force, the traverse was abandoned. R.R.S. John Murray returned to Barry at 10.30 on 13th April.

P.D.R. recordings were made continuously throughout both legs of the cruise. Apart from the period mentioned, position fixing was obtained through readings of Decca chains LD1 and LD3 at ten minute intervals. In addition to continuous paper trace recordings, all instruments were read and recorded at 10 minute intervals on all traverses.

Project Reports

A map showing the ships tracks and stations occupied and indicating the nature of the observations recorded is attached to this report.

(a) Gravity survey

The La Coste gravimeter functioned well throughout the cruise and was recorded along all tracks made. Weather conditions affected readings at times whenever wind speeds rose above force 6 and three times during the cruise, traverses had to be abandoned because of gales and high seas. Despite this, more than 4500 km of traverse have been recorded and it should be possible to produce a detailed gravity map across the whole of the area surveyed, linking with existing surveys to the east. The main problem anticipated relates to errors of navigation which become significant particularly in the western part of the area.

The traverse into Carmarthen Bay requested by University College, Swansea, was successfully completed.

(b) Magnetic survey

The magnetometer also functioned well throughout the cruise apart from minor difficulties with the chart paper drive. Being less affected by the weather than the gravimeter, magnetic recording is good on all ships tracks. Strong anomalies have been observed within the area and the magnetic map when completed should be of considerable value.

(c) Sparker seismic profiler survey

During the first leg of the cruise only a short hydrophone array was available which, whilst extremely good for recording across the continental shelf, proved inadequate in the deeper waters of the Porcupine seabight in other than calm weather. A longer array was used during the second leg but this proved to be unreliable in performance. Consequently fewer sparker profiles were made than had originally been planned, though three crossings from shallow to deep water in the Seabight were completed.

Additional traverses across the Nymphe Bank have usefully filled certain gaps, though unfortunately the final traverse on return to Barry had to be abandoned early due to bad weather and a gap still remains in the survey of the Bristol Channel Approaches.

(d) Sonobuoy refraction lines

Two long refraction lines, giving reversed coverage, were completed in Porcupine Seabight near 13°W Long. and gave moderately good information. Signals were recorded on magnetic tape and some improvement of quality can be expected on replay. Three lines were also completed across the shelf region at approximately 11°W longitude, giving excellent results. During these lines comparisons were made between geophex and aquaflex as seismic sources. Aquaflex proved to be most promising and although not giving as much advantage as in reflection work, nevertheless resulted in a substantial saving, 400 ft. of cord being roughly equivalent to 25 lb. of geophex. The firing process using a single wire cable (sea earth return) and high voltage blaster proved to be simple, safe and reliable, allowing charges to be fired comfortably at one minute intervals if so required.

(e) Evaluation of vertical hydrophone array

The method of firing charges and recording from the hydrophone array and the eventual end to the experiment have already been described. The array system had originally been designed for use with two ships, one firing and the other recording, and initial trials had been made this way in Antarctic waters a year before. It was appreciated beforehand that operating from one ship could be hazardous and the technique of shuttling the ship to fire charges was arrived at in full knowledge of the risk of severing the cables. However, in practice, the method worked well, although, in fairness, the sea was very calm. I think it would have continued to work well had the buoy not been damaged and cut adrift from the array. I think this accident, for which I have no real explanation, probably occurred an hour or so before the cable was fouled, during which time the entire array and lead cable slowly sank to a near vertical position. It is then understandable how the ship came to overrun the cable and sever it. Fortunately at least some worthwhile data was recorded before the experiment was cut short and preliminary assessment of records from the five shots is promising. 200 ft. lengths of Aquaflex cord were used as a source, weighted to be at

60 ft. depth at one end and 30 ft. the other to give a vertically downward travelling wave. A twin firing cable was used to detonate the charges, which could be fired at approximately 15 minute intervals.

(f) Effects of towing proton magnetometer at various distances astern and at various headings.

The experiment was conducted at about 51°N Lat., 70°W Long. in a region clear of magnetic anomalies, with field increasing east to west at approximately 1γ per 2500 feet. Steaming in along a square course at 5 knots, the towing cable was altered in length, measured from the stern rail, with the results given in Fig. 1. With cable lengths greater than 400 ft., no change in reading with ships heading could be observed but with cable lengths less than 100 ft. readings were not consistent to within ± 10γ. We recommend that the magnetometer should always be towed 500 ft. astern.

(g) Sampling stations in River Shannon estuary.

Ten stations were occupied and at each bottom samples were successfully obtained using a shipek grab. Water samples at 30 ft. above sea bed were also collected for subsequent measurements of salinity. Plankton tows were also made at each station. All the stations requested by Mr. Hoskin were completed.

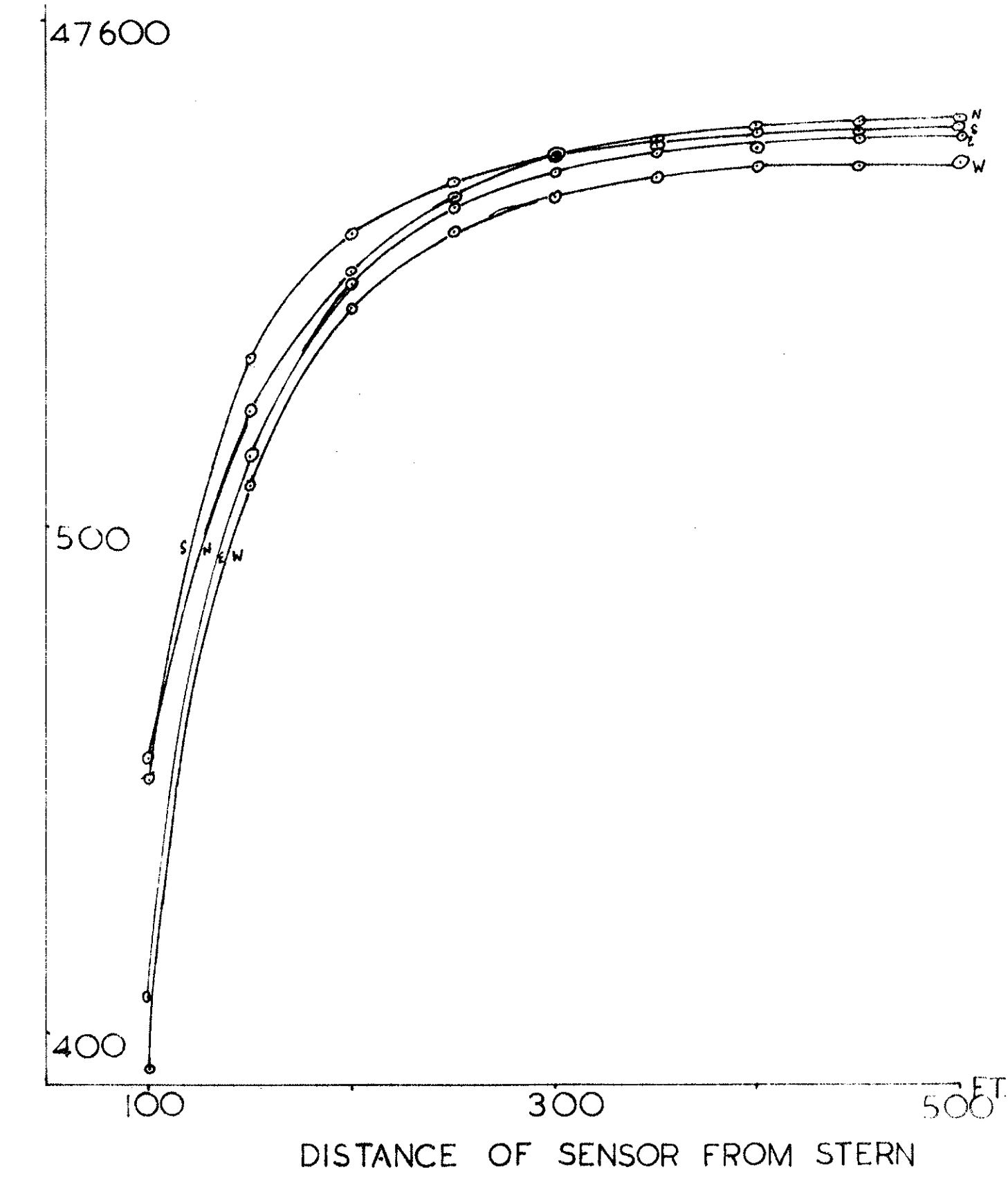
Conclusions

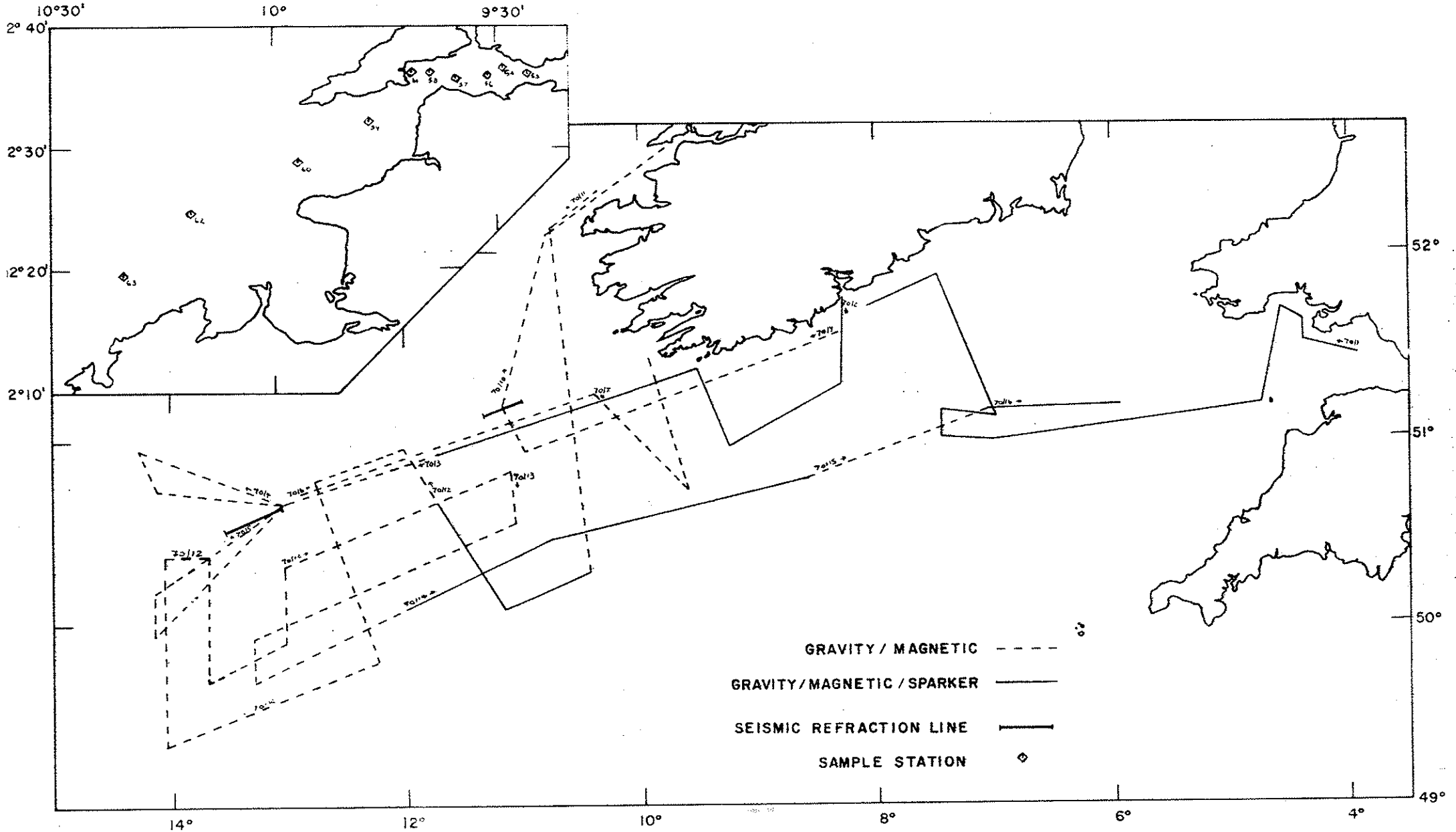
This cruise has completed the series of surveys designed to map a broad strip of sea from the South Irish Sea and the coast of Wales westwards to the continental margin using gravity, magnetic and seismic methods. The area completed now covers in detail the area of the seismic lines fired during the course of a Crustal explosion experiment conducted in September, 1969, and will add substantially to its interpretation.

Although undertaken at a time of year when weather conditions can be severe the cruise was most fortunate to find periods of calm seas between the three gales which blew up during its course, and of the total of 440 hours spent at sea 364 hours were used for scientific work. Consequently, the major part of the survey work was completed, the main losses being in sparker survey, partly due to the malfunctioning of the long hydrophone array needed for work in deep water and the loss of the last section of the final traverse in the Bristol Channel approaches on returning to Barry due to bad weather. The other loss to the cruise programme resulted from the accident to the vertical hydrophone array so that only five of the planned twenty shots were recorded.

I would again like to pay tribute to the fine seamanship of Captain Perry and the crew of R.R.S. John Murray and thank them for their wholehearted support and enthusiasm for the scientific work. We have been greatly assisted by the technical expertise of Mr. King and Mr. Jones of R.V.U., Barry and I wish to thank both them and the staff at Barry for their very considerable help. It has again been a pleasure and a privilege to be on this cruise.

D. J. Blundell,
Department of Geology,
University of Birmingham.


TOTAL
MAGNETIC
FIELD
GAMMA
47600
500
400
S
N
E
W
N
E
W
100
300
500
FT.
DISTANCE OF SENSOR FROM STERN


10°30'
10°
9°30'
2° 40'
2°30'
12°20'
2°10'
52°
51°
50°
49°
14°
12°
10°
8°
6°
4°
GRAVITY / MAGNETIC
GRAVITY/MAGNETIC / SPARKER
SEISMIC REFRACTION LINE
SAMPLE STATION