FOREWORD

This report contains the bare details of a month's cruise west of Ireland during May/June 1968. The survey was carried out under the leadership of Dr. Clive McCann and its success was very largely due to him. While the scientific observations were seriously hampered by bad weather and instrumental breakdowns, something like 1000 profile miles of sub-bottom information were obtained as well as about 2000 miles of total field magnetic recording. In addition, sea-surface wave records were taken and vertical water structure observations made.

One of the major factors contributing to the success of this cruise was the efficient assistance provided by the officers and crew of the R.V. PRINCE MADOG under its Master, Capt. T. Donovan. As indicated in the main body of the report this small research vessel was capable of operating in extremely adverse weather conditions without greatly impairing scientific efficiency.

The survey was supported by a grant-in-aid from the Natural Environment Research Council, awarded to the undernamed, covering salaries and instrument running costs. All the scientific equipment and the total running costs of the research vessel were provided by the University College of North Wales.

D. Taylor Smith
Marine Geology
Department of Oceanography.

August 1968.


PRINCE MADOG

CONTENTS

-o-o-

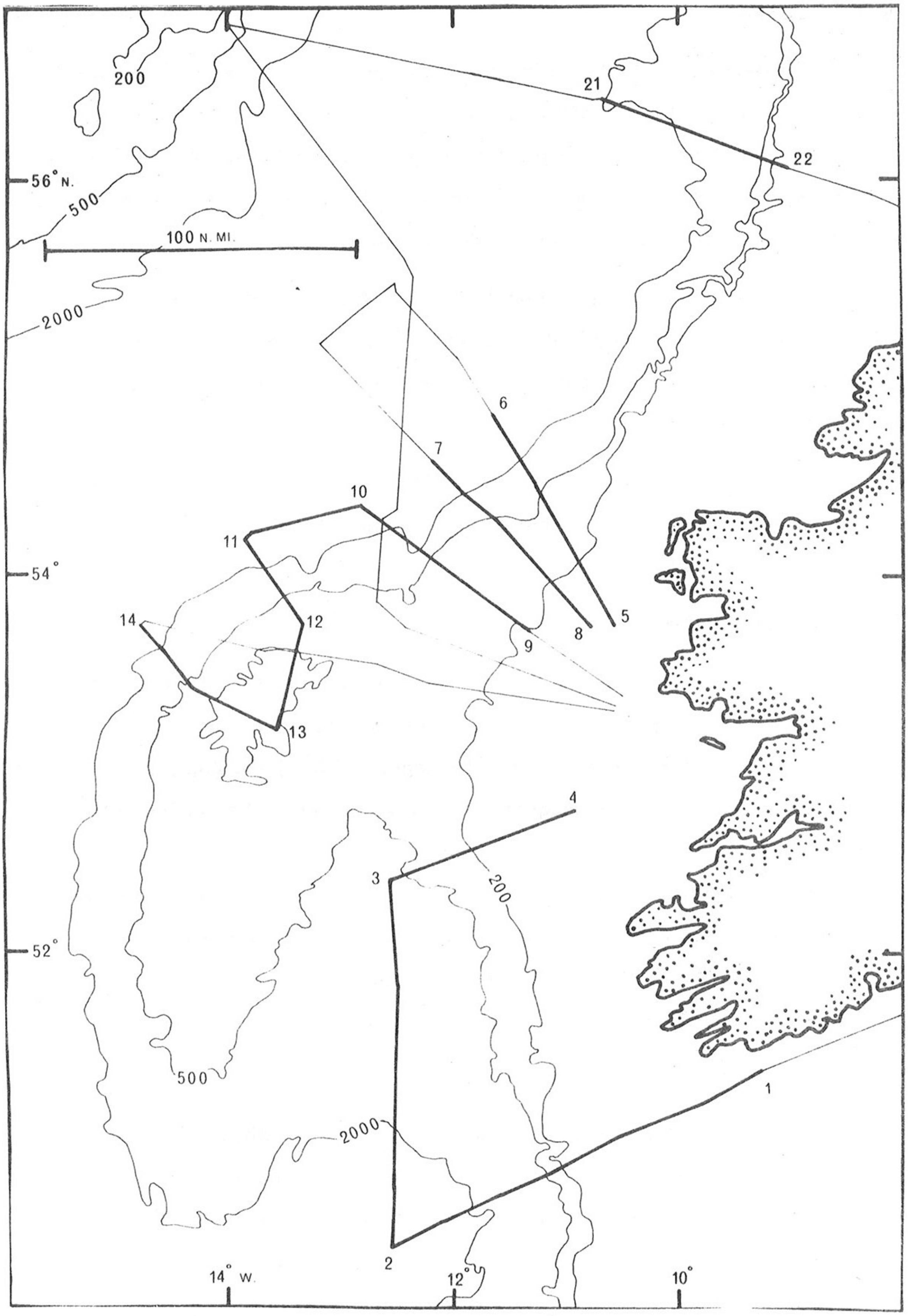
Figure 1

Western Approaches, PRINCE MADOG Cruise No. 32/68, May - June 1968.

Magnetic and bathymetric data obtained on all lines ; sub-bottom data only obtained on thick lines.

Leg 1	-	Includes 1 - 4
Leg 2	-	Includes 5 - 8
Leg 3	-	Includes 9 - 14
Leg 4	-	Includes 21, 22.

Figure 1


200
56° N.
500
100 N. MI.
2000
21
22
6
7
10
11
54°
5
8
9
12
14
13
4
3
200
52°
500
2000
1
2
14° W.
12°
10°

INTRODUCTION

This report describes a preliminary geophysical survey of the Porcupine Bank and the adjacent continental margin west of Ireland, carried out by the Marine Geology Group of the Department of Physical Oceanography (University College of North Wales, Bangor). The purpose of the cruise was to obtain magnetometer, sub-bottom profiler and depth records.

The area of the survey is roughly 50°-57° N, 10°-16° W ; Fig. 1 shows the lines of the geophysical traverses. Surveying was carried out also on the outward run south of Ireland and the homeward run via the Rockall Bank and the North Channel.

The survey lasted from 28th May, 1968 to 20th June, 1968. Galway harbour was a convenient port for bunkering, equipment maintenance and exchange of personnel.

SHIP AND PERSONNEL

The University College of North Wales Research Vessel "Prince Madog" was used exclusively for the geophysical survey. Despite her small size (Length Overall: 93 ft. Beam: 23 ft. Tonnage: 300 tons) the ship proved to be an excellent sea boat, and magnetometer surveying could be carried out in sea conditions associated with winds Force 6-7 and a heavy swell. The ship was manned by a master, Capt. T. Donovan, three officers, four crew and two cook-stewards. The scientific personnel who took part in the cruise were Dr. R.J. Bailey, Mr. S. Buchan, Dr. R.H. Clarke, Mr. F.C. Dewes, Mr. N. Kenolty, Dr. C. McCann, Mr. D. Taylor Smith and Mr. V. Truesdale.

AIMS AND METHODS

The original intention of the survey was to obtain bathymetric, magnetic and sub-bottom profiles across the Porcupine Bank and the adjacent continental margin. A number of scattered sub-bottom profiles have been made in this area, notably by Curray, Moore, Belderson and Stride (1966) and Lagaay and Collette (1967) only one of which (Lagaay and Collette) has so far been published.

A detailed magnetic survey of the area south of latitude 54°N and out to 18°W has been carried out by Bott and Gray (to be published), as well as a detailed survey of a part of the Porcupine Bank by Allan (to be published).

The poor weather conditions encountered throughout the survey often made it difficult to obtain satisfactory sub-bottom profiles and greater emphasis was placed on the magnetometer and bathymetric survey north of latitude 53°N and out to 13°W.

POSITION FIXING AND NAVIGATION

Positions of all geophysical lines were fixed using simultaneously two Chains (North-West British and South-West British) of the Decca Navigator System. Although the survey was in the fringe area of both Chains, satisfactory bearings were obtained during daylight hours and it was only during the few hours of darkness (0000-0300) that instability occasionally occurred. The four bearings obtained enabled the ship's position to be plotted correct to $\pm$ 1 nautical mile. The course was plotted on a 1:1,000,000 Two Chain Decca Chart, taking deccometer readings at 30 minute intervals.

A Loran "C" receiver was also carried but this was inoperative throughout the survey.

Simultaneous 10 minute fiducial marks were registered on the records of the magnetometer, sub-bottom profiler (SBP) and precision depth recorder (PDR).

SCIENTIFIC POWER SUPPLIES

The ship was very adequately provisioned with power supplies. The high voltage power supplies for the SBP were fed from an 18 kVA, 230 v 50 Hz, rotary converter driven by the ship's main engine. All other electronic equipment was fed from a separate 18 kVA rotary converter. Three 500VA, 110v, transformers were used to drive the PDR and the appropriate circuits in the SBP. A six volt supply was installed to drive an Earth Alarm System (Fig.2).

INBOARD INSTALLATIONS

The Electronics Laboratory permanently housed the PDR and the high-voltage generating and triggering equipment of the SBP. The SBP recorder and the Varian magnetometer were temporarily installed in the General Laboratory together with various items of servicing equipment (Oscilloscope, oscillator, transistor tester, etc.).

OUTBOARD INSTALLATIONS

When working in water of greater depth than 100 metres, the E.G. & G Type 264, 6-element, array hydrophone was towed 100 metres astern of the ship. At this distance there was negligible pick-up of the ship's noise. For shallow water surveying the E.G. & G Type 262-G single element hydrophone was towed from a boom over the ship's stern quarter.

The Varian magnetometer sensor was also towed behind the ship at a distance of 150 metres. For slow speed, shallow water surveying where the sensor was likely to drag on the sea bed, it was attached to a buoy and the towing strain taken partly on the cable and partly on a rope attached to the buoy.

Both the hydrophone and magnetometer cable reels were mounted on castors. Each reel was then rotated horizontally about a vertical steel rod screwed into the ship's deck, to take in or pay out the cable. Both cables were hauled in by hand as they were too stiff to wrap around a winch end without fear of eventual breakage of the conductors.

The SBP acoustic source consisted of two E.G. & G. Sparkarrays bolted together and towed from a derrick projecting about 10 feet over the starboard side of the ship. This system was made necessary by the short length of cable supplied with the arrays (70ft), but was not satisfactory in rough seas as the arrays jumped out of the water thus limiting the weather conditions under which surveying could be carried out. It is intended for future work to extend the cables and tow the Sparkarrays further astern of the ship.

Edgerton, Germeshausen and Grier SBP ("Sparker")

The E.G. & G Sparker System was of a nominal 10,000 joules power operating at 3.5 kV and consisting of:-

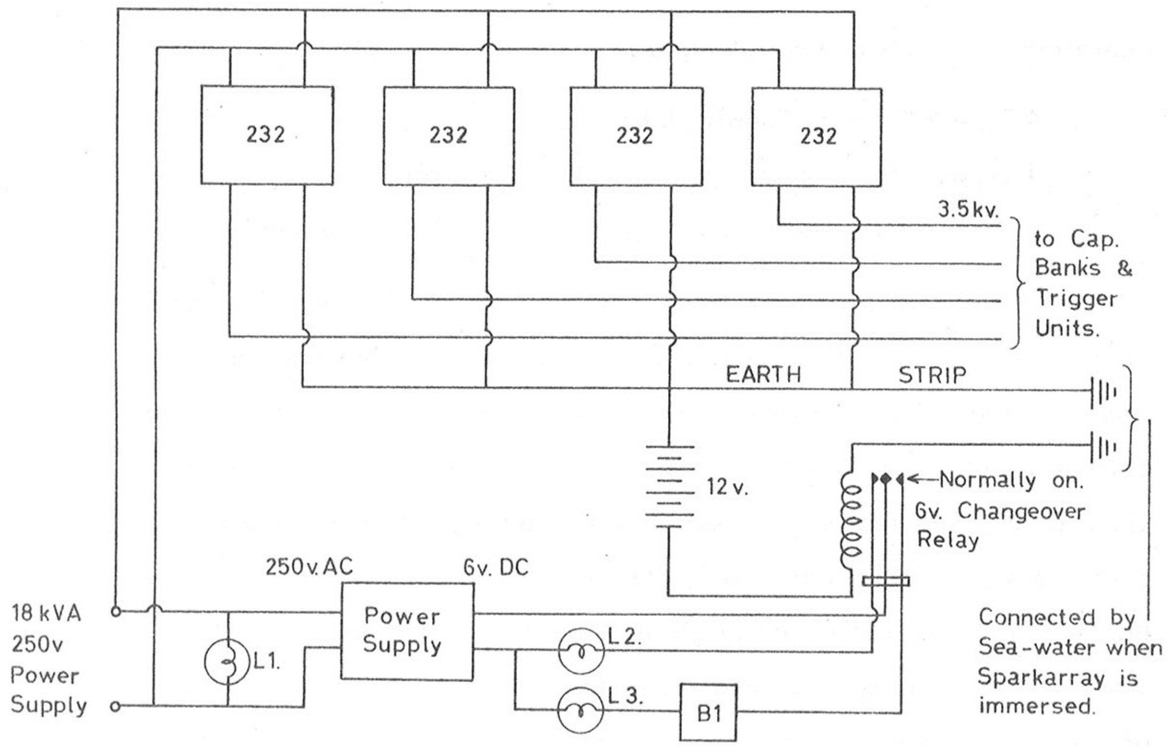
4 Type 232 Power Supply Units

4 Type 233 Capacitor Banks (2,000 joules each)

2 Type 231 Capacitor and Trigger Units (1,000 joules each)

This set-up gave a minimum repetition period of 4 seconds. Due to the failure of one of the Type 232 Power Supplies on the first leg of the survey, a reduction in power was necessary. Most of the SBP traverses were carried out at 3,000 joules at a repetition period of 2 seconds. The E.G. & G. Type 254 Recorder can be operated over a range of sweep speeds, continuously variable from 1 to 1,000 r.p.m. of the helix blade as well as having a switched helix control giving a number of fixed sweep speeds. To simplify interpretation the fixed sweep speeds only were used and the majority of the records were taken on 1 second sweep; the variable sweeps/key switch enabled the Sparker to be triggered once every 2 seconds and the received pulse was printed on the 1st or 2nd sweep depending on the depth of the sea bed and the sub-bottom strata. A useful additional facility on this recorder would be a centre triggering position, as on the Precision Depth Recorder.

The high voltage and high power of the Sparker made earthing of prime importance. Two separate earths were used: firstly, all the equipment frames were grounded to the ship's hull. Secondly, a 100 amp earth wire was run side by side with the high-voltage cables, and soldered to a copper strip which was lashed to the cables near the Sparkarray. Thus the equipment was earthed directly to the sea while the array was in the water. An insulated, low current cable was run out side by side with the earthing cable, and earthed to the sea water close to the earthing strip. There was thus electrical connection between the earth strip and the low current cable so long as they were both in the water. The circuit of Fig. 2 was used to give an alarm when the earth strip came out of the water. A warning was thus given to the watchkeeper if the Sparkarray came out of the water either due to violent wave motion or to interference by unauthorised personnel.



L1.:	Red Lamp in General Laboratory.	Lit when power supplied to Sparker Power Supplies.
L2.:	Green Lamp in Electronics Laboratory.	Indicates Sparkarray and Earth Strip in water.
L3.:	Red Lamp in Electronics Laboratory)	Indicate Sparkarray and Earth Strip out of water.
B1.:	Bell in General Laboratory)	

Fig. 2. Sparker Alarm System

As indicated above the array hydrophone was towed behind the ship. Noise on the record came mainly from two sources. Firstly, that generated by the hydrophone itself travelling through the water and secondly, the surface wave noise. During Leg 1, when surveying at six knots in an exceptionally calm sea, penetration of over 600 metres of sediment was obtained. Six knots was the normal speed for Sparker surveying but when travelling across the Continental Slope speeds as low as three knots were used in order to obtain maximum penetration. During Leg 3, sea water entered the nose of the hydrophone and partially shorted the output socket. This resulted in a considerable decrease in sensitivity and emphasis was switched to the magnetometer survey for the final week of the survey.

Gifft PDR

The Gifft PDR is a versatile, programmable, depth recorder using electro-sensitive paper. Generally, as with the SBP Recorder, a 1 second sweep was used and an appropriate programme used in each water-depth to obtain the maximum data density (Table 1).

The transducer was rigidly mounted beneath the ship's bow. During rough weather a poor record was obtained due to excessive ship's motion. There was some evidence that the poor record was partly due to a random jitter of the triggering pulse, but this was not proved. Over much of the period of the survey, a great deal of information was lost due to the poor quality of the record.

Sweep speed	Programme	Keying	Water Depth (Seconds)
1 second	C	Edge	Recorded Depth
"	T R	Centre	0.5sec. + Recorded Depth
"	T R	Edge	1.0sec. + Recorded Depth
"	T G R	Centre	1.5sec. + Recorded Depth
"	T G R	Edge	2.0sec. + Recorded Depth
"	T R	Centre	2.5sec. + Recorded Depth
"	T R	Edge	3.0sec. + Recorded Depth
"	T G G G R)	Centre	3.5sec. + Recorded Depth
"	or T T G G R R)	Edge	4.0sec. + Recorded Depth
"	T R	Centre	4.5sec. + Recorded Depth

Table 1. Set of Programmes for Gifft P.D.R.

Varian magnetometer

The Varian magnetometer automatically measured the earth's total magnetic field at a position about 450 ft. behind the ship at intervals of 20 seconds. The reading in gammas (10^{-5} Oersted) was displayed on the instrument and an analog record of the last two (0 - 99γ) or the last three (0 - 999γ) figures was plotted on a paper chart recorder. The instrument operated continuously without malfunction during the whole period of the survey. No interference was experienced between the Sparker and the magnetometer when they were run simultaneously.

C. McCann

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Curray, J.R., Moore, D.G., Belderson, R.H., and Stride, A.H., (1966) Continental Margin of Western Europe: Slope Progradation and Erosion, Science 154 265-266.

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APPENDIX I

SYNOPSIS OF DAILY LOG (Times in G.M.T.)

LEG 1

May 28, 1968	Ship sailed from Portdinorwic at 10.00 hrs. 1230 hr. Streamed Magnetometer at 10 knots. 1900 hr. Reduced speed to 6 kno ts and Streamed Sparker.
29	Continued Sparker and Magnetometer Survey at 6 knots.
30	Continued Sparker and Magnetometer Survey at 6 knots. Weather deteriorated. Poor Sparker Recorder late in the day.
31	Weather eased 0000-1300 hr. then deteriorated. Continued Sparker and Magnetometer Survey until 1930 hr. when ceased due to bad weather and proceeded to Galway.
Work carried out:-	437 nautical miles of Sparker Survey 523 nautical miles of Magnetometer Survey.

LEG 2

June 4	Commenced Sparker and Magnetometer Survey at 6 knots at 1640 hr. Wea ther deteriorated. Ceased Survey at 1710 hr. Sheltered behind Inishboffin Island.
5	Weather poor. Proceeded to Killary Bay.
6	Geophysical Survey of Killary Bay.
7	Sailed from Killary Bay, 0500 hr. Commenced Sparker and Magnetometer Survey at 6 knots at 0830 hr.
8	Continued Sparker and Magnetometer Survey at 6 knots. 2000 hr. Reduced to 4 knots to Survey Continental Slope.

June 8	2315 hr. Recommenced Survey at 6 knots.
9	0000-0600 hr. Continued Sparker and Magnetometer Survey at 6 knots.
	0600-1140 hr. Magnetometer Survey at 10 knots. Proceeded to Galway.
Work carried out:	275 nautical miles of Sparker Survey.
	292 nautical miles of Magnetometer Survey.

<u>LEG 3</u>

June 11	0745-1400 hr. Magnetometer Survey at 10 knots.
	1400-1930 hr. Magnetometer and Sparker Survey at 6 knots.
	1930-0000 hr. Magnetometer and Sparker Survey over Continental Slope at $3\frac{1}{2}$ knots.
12	0000-0300 hr. Continued Survey at $3\frac{1}{2}$ knots.
	0300-0715 hr. Magnetometer Survey at 10 knots.
	0715-0820 hr. Magnetometer and Sparker Survey at 5 knots.
	0820-1110 hr. Hove to due to bad weather.
	1110-1818 hr. Magnetometer and Sparker Survey at 4 knots.
	1818-0000 hr. Increased speed to 6 knots.
13	0000-1000 hr. Sparker and Magnetometer brought inboard. Plankton sample taken.
	1000-1300 hr. Hove to for repairs to hydrophone.
	1300-1645 hr. Magnetometer Survey at 10 knots.
	1645-1730 hr. Ship's Main Engine Stopped. Magnetometer inboard.
	1730-2040 hr. Recommenced Magnetometer Survey at 10 knots.
	2040-0010 hr. Magnetometer and Sparker Survey at 6 knots.

June 14	0010-0835 hr. Hydrophone brought inboard for further repairs. Magnetometer survey at 10 knots. 0835 hr. Magnetometer inboard. Proceeded to Galway.
Work carried out:-	187 nautical miles of Sparker Survey. 428 nautical miles of Magnetometer Survey. Plankton Haul for University College, Galway.

<u>LEG 4</u>

June 17	1750 hr. Magnetometer Survey at 10 knots.
18	0800-0950 hr. Hove to due to bad weather. Water Bottle station to 1750 m. Bathythermograph to 150 m. 1120-0000 hr. Magnetometer Survey at 10 knots.
19	0000-1420 hr. Continued Magnetometer Survey at 10 knots. 1420 hr. Bathythermograph and Water Bottle Station. 1510-1804 hr. Magnetometer Survey at 10 knots. 1804-0000 hr. Sparker and Magnetometer Survey at 6 knots.
20	0000-0400 hr. Continued Sparker and Magnetometer Survey at 6 knots. 0400-1907 hr. Magnetometer Survey at 10 knots. 1907-2300 hr. Magnetometer and Sparker Survey at 6 knots. 2300 hr. All gear taken on board. Proceeded at 10 knots to Menai Bridge.
Work carried out:-	81 nautical miles of Sparker Survey. 633 nautical miles of Magnetometer Survey. 3 days at Wave Recordings (1x20 minute Record each 3 hours) 2 Water Bottle and Bathythermograph Stations. 6 Surface Water Samples taken.

APPENDIX II

Preliminary results of the magnetic survey

by

C. McCann

Introduction

From the profiles obtained in the survey it is possible to draw a contour map of the Earth's total field only for the middle portion of the area (Figure 3). This map is contoured at 100 gamma intervals. Single line, uncrossed, profiles were also recorded on the outward and homeward journeys, and in the Ireland Trough out to the Rockall Bank. The high frequency, short wavelength portions of the profiles have been removed by the digitising process in the reproduction of the profiles from the magnetograms.

No corrections have been made to the magnetic data as presented in Figure 3 either for temporal variations of the Earth's field or for regional effects. For the former, Valentia magnetograms, provided by Dr. R. Riddihough, show that the maximum variation over the whole survey is less than 100 gammas. For the latter, two regional fields were computed for this area : the first, after Bullard, Hill and Mason (1962), and the second after that proposed by McQuillin (1966). Neither of these regional computations gave a good fit in this area.

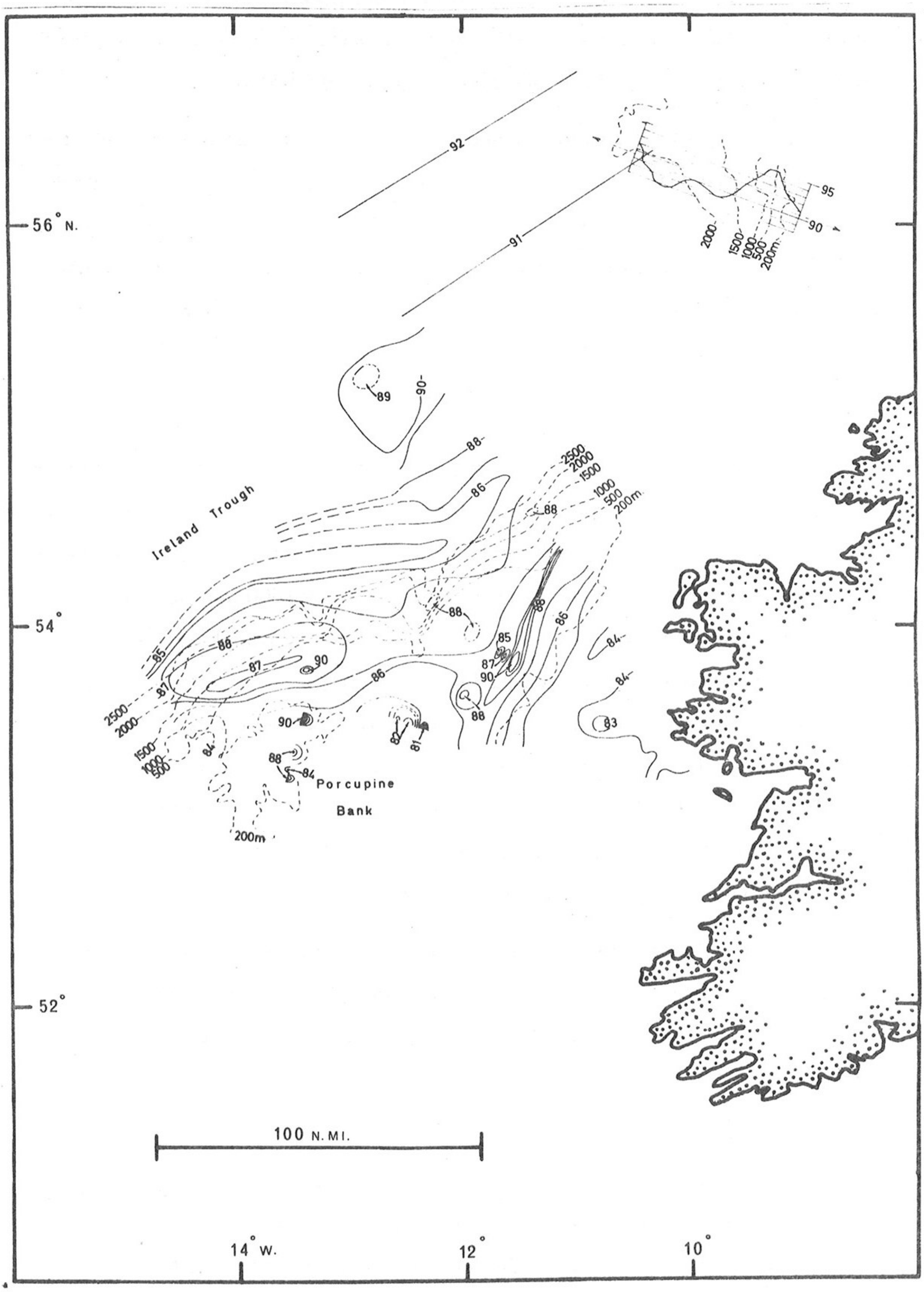
Features of the Magnetic Field Map

A belt of magnetic high values runs from 53°30' N, 15°W to 54°30' N, 11°W parallel to the upper part of the continental slope. At the foot of the slope, and parallel to it, runs a belt of magnetic low values. The total range of values from peak to trough is about 300 gammas; the peak and trough are separated by a distance of about 56 kilometres. Both the high and low belts run right across the area of the survey for a distance of about 230 km.

The single profile across the continental slope, from 56°23' N, 10°46' W to 56°3' N, 9°2' W shows exactly the same feature as the large area to the south. The peak to trough values in this case is 700 gammas, while the separation is again about 56 km.

Figure 3

Preliminary total field magnetic map and bathymetry. Isobaths, dotted, drawn at 500 metre intervals, except that the 200 metre depth contour is also drawn. Isograms, closed lines except where tentatively extended drawn at 100 gamma intervals. (Note: 88 isogam means 48800 gamma total field contour). A single magnetic profile is drawn at about 56°N, 10°W.



56° N.
54°
52°
14° W.
12°
10°
92
91
95
90
2000
1500
1000
500
200m
89
90
88
86
Ireland Trough
2500
2000
1500
1000
500
200m.
88
88
85
87
90
86
84
84
83
88
85
87
88
87
90
86
2500
2000
1500
1000
500
84
90
88
84
Porcupine
Bank
82
81
200m
100 N. MI.

A further belt of magnetic high values runs parallel to, and slightly to the west of, the 200 metre isobath. This is a linear feature of maximum amplitude about 500 gammas, of width about 30 km, and length 100 km.

The profiles in the Ireland Trough indicate that it is an area of very low magnetic relief. The profiles in the shallowest region of the Porcupine Bank indicate that it is an area of high magnetic relief. In this region there are near-surface features giving rise to magnetic anomalies of maximum amplitude about 600 gammas and crest-to-crest distances of about 9 km. The region between the 200 metre isobath and the Irish coast is one of low magnetic relief.

Discussion

The belts of high and low values parallel to the continental slope and extending up to the northernmost line of the survey are qualitatively similar to those described by Fenwick et al (1968) for the continental margin of Newfoundland, although their anomaly pattern is of greater amplitude (800 gammas, peak to trough) and larger spatial dimensions (110 km., peak to trough). Fenwick et al consider that their residual anomalies are created by a thick magnetic continental crust abutting against a thin magnetic oceanic crust. Given that this explanation is possible in the area west of Ireland, although other possibilities undoubtedly arise for the magnetic pattern, it would appear that the smaller range of values than that off Newfoundland indicates a smaller range in crustal thicknesses between the continent and the ocean.

It follows, therefore, that if such an explanation is tenable then the Porcupine Bank is of continental structure although of a crustal thickness intermediate between that of "normal" oceanic and continental values.

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APPENDIX III

Preliminary results of the sub-bottom Profiler survey

by

R. J. Bailey and R. H. Clarke

The survey began with a profile which skirted the southern coast of Ireland and ran WSW to the axial region of the Porcupine Seabight (Fig. 1 and Fig. 4, profile 2-1). Towards the Seabight the surface of the folded "bedrock" encountered at the seabed south of Ireland (near 1) inclines gently westwards beneath an increasing thickness of younger sediments. Within these latter an upper and lower series of westward dipping reflectors can be detected (near X), suggesting the presence of an upper and a lower series of prograding strata. The upper series extends to the present shelf edge where it steepens in concordance with the submarine slope. The general concordance of the seabed and sub-bottom reflectors is maintained in the deeper waters of the Seabight, where the bottom is cut by channels (near 2). The south-north profile 2-3 follows the axis of the Seabight. The reflectors maintain their parallelism with the sea bed; and towards 3 they can be detected to a depth of more than 600m below the seabed. Near 3, the pattern of reflectors is disrupted by a cross-cutting structure.

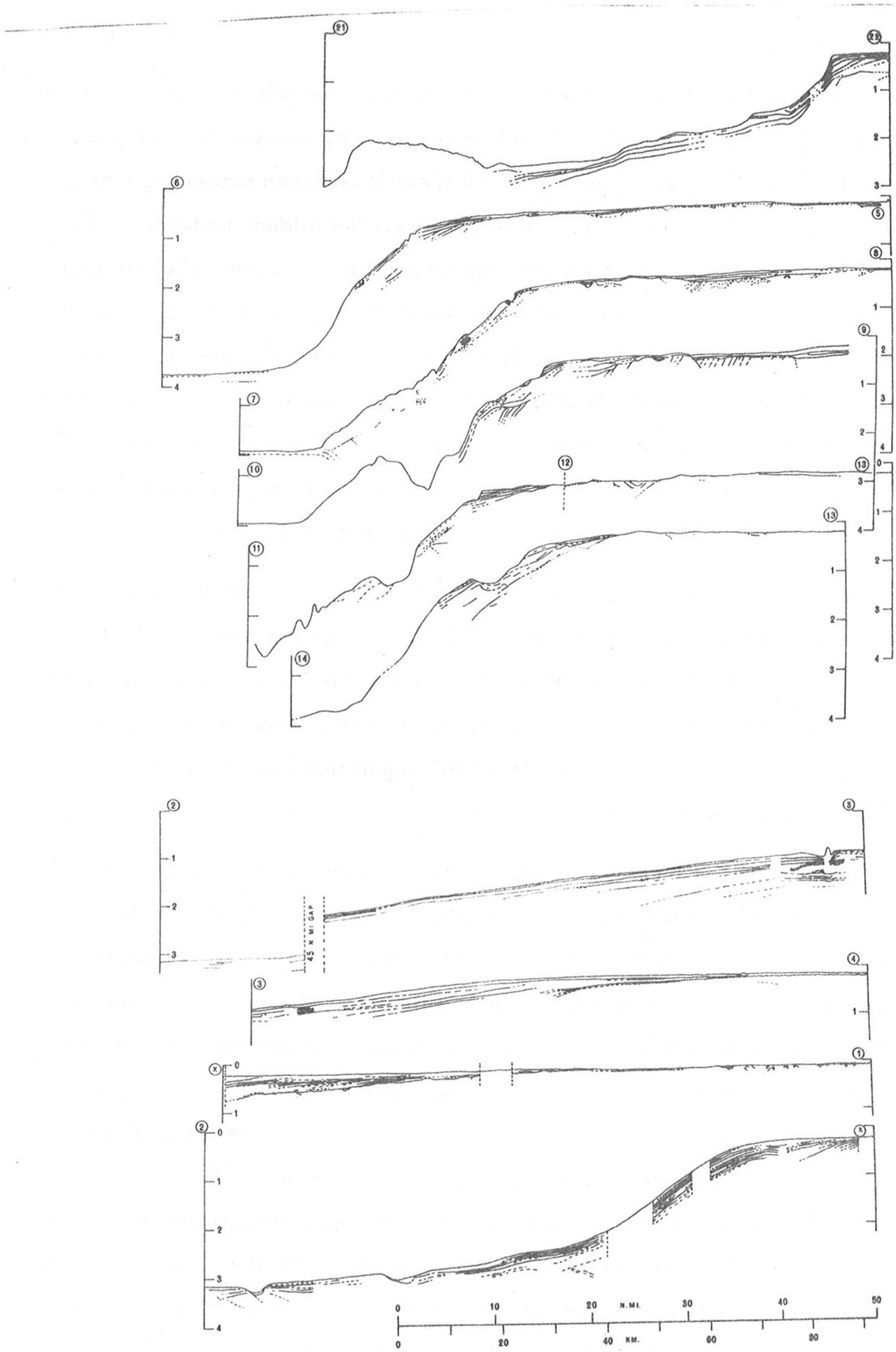
Profile 3-4 shows the more gentle marginal slope found near the northern closure of the Seabight. Folding of buried strata is suggested by the reflectors near 3, and this may be the result of mass downslope movement. However, at this western end of the profile the reflectors remain essentially parallel to the seabed. Mid-way along the profile the reflectors seem to suggest the presence of an older series of strata with steeper westward dip. These rest on "bedrock"; and the remainder of the profile to the East is characterised by the gradual rise of the buried "bedrock" surface and concomitant thinning of the sedimentary cover.

Profiles 14-13, 11-12, 10-9, 7-8 and 6-5 traverse the north of Porcupine Bank and the adjacent continental shelf-edge. The Bank has a variable sedimentary

Figure 4

Sparker profiles west of Ireland. The vertical scale is 2-way time in seconds. The encircled numbers refer to the course change numbers on the tracks indicated in Figure 1.

Figure 4



cover, and there appear to be large areas in which gently-folded "bedrock" strata are exposed at the seabed or are only thinly veneered by younger flat-lying sediments. In the east of profiles 10-9 and 7-8 there is evidence suggesting that a relatively thick series of flat-lying sediments covers the folded "bedrock". On profile 7-8 the disposition of reflectors suggests that the sediments thin both eastwards and westwards. They have not been detected on profile 6-5, to the north. Thus, they may represent the "feather-edge" of a north-south sedimentary basin which apparently occupies the Seabight. Towards the eastern end of profile 10-9 the abrupt steepening and disappearance of the "bedrock" reflector coincides with the thickening of the flat-lying sediments, suggesting that the postulated "feather-edge" of the Seabight basin may here be fault-bounded on the west.

Profiles 14-13 and 11-12 show the shallowest part of the Bank. The notable scarcity of sub-bottom reflectors away from the Bank edge suggests that "bedrock" is present at, or close to, the seabed. Near 12 there is a suggestion of synclinical folding of the "bedrock" strata. The presence of folded "bedrock" strata on the Bank proper would be consistent with McCann's suggestion (see above) that it is continental rather than oceanic in character.

Profiles 14-13, 11-12, 10-9, 7-8 and 6-5 suggest that towards the edge of the Bank, and of the continental shelf immediately to the north, the "bedrock" inclines northwestward beneath a wedge of more recent sediment. On profile 11-12 the disposition of the reflectors suggests that the sediment wedge consists of a conformable sequence thickening - and prograding? - westwards. However, on the remaining profiles, e.g. 6-5, the wedge appears to comprise an upper and lower series differing in the amount of their westerly dip. These are analogous to the upper and lower series of prograding strata detected in profile 2-1. On all the profiles in the vicinity of the Bank, the steep slope marking the Bank and continental shelf edge seems to be an erosional feature, with the strata comprising the wedge outcropping on the upper part of the slope. It would seem that recently there has been no appreciable accumulation of sediment along the edge of the Porcupine Bank and the adjacent continental margin. Either the area is starved of sediment or the sediment deposited at the top of the slope is continually removed to the Ireland Trough by mass gravity movements. In any case, the situation here is in marked contrast to that encountered on the remaining profiles (2-1, 21-22) where the shelf edge appears to be essentially "depositional" in character.

Below the Bank edge and the adjacent shelf margin the reflectors are more or less concordant with the slope, though locally they appear to outcrop as a result of erosion of the slope face. The somewhat irregular and predominantly convex lower slope on profile 7-8 is consistent with the presence of a major gravity slide complex at the foot of the slope.

On profile 10-9 and perhaps on the profiles to the north and south (7-8, 11-12) there is evidence of discordance between the reflectors forming the present Bank edge and those beneath. On profile 10-9 the plane of discordance is itself a prominent reflector which shows a relatively shallow northwesterly dip, towards the Ireland Trough. The reflectors beneath the plane of discordance show a steeper dip in the same direction; and the relationship is consistent with the presence of an ancient, buried, Bank edge formed by sediments prograding towards the Ireland Trough. It may be significant that the supposed former Bank edge coincides with a marked steepening of the submarine slope at a depth below sea level of around 1200m.

The Ireland Trough has the character of an abyssal plain. The flat bottom surface shows occasional abrupt steps of the order of 30m in height. Profiles so far obtained indicate the presence of sub-horizontal strata. On profiles 14-13, 11-12, 90-9, 7-8 and 6-5 the Porcupine Bank rises steeply from the floor of the Trough, with no suggestion of a continental rise or corresponding sediment apron.

Profile 21-22 crosses the continental shelf edge due west of Jura. The shelf edge is predominantly a progradational feature, the later prograding sets of strata presumably marking successive positions of the shelf edge. The deepest, relatively flat-lying reflector seems to represent the surface over which the prograding series advanced. At 22 there is a suggestion that this surface may define the upper limit of a still older prograding series. If this is the case the history of the development of the shelf edge here has a complexity comparable to that of the Porcupine Bank edge.