

I.O.S.

**R R S DISCOVERY
CRUISE 123**

5TH AUGUST – 10TH SEPTEMBER 1981

**GEOLOGICAL INVESTIGATIONS ON THE
CONTINENTAL SLOPE TO THE WEST OF
THE BRITISH ISLES AND NORWAY**

**CRUISE REPORT NO 131
1982**

**NATURAL ENVIRONMENT
INSTITUTE OF OCEANOGRAPHIC
SCIENCES
RESEARCH COUNCIL**

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ITINERARY

Departed Barry	1250 GMT	5th August 1981	(Day 217)
Arrived Bergen	0554 GMT	24th August 1981	(Day 236)
Departed Bergen	0800 GMT	26th August 1981	(Day 238)
Arrived Immingham	0728 GMT	10th September 1981	(Day 253)

SCIENTIFIC PERSONNEL

			<u>Leg 1</u>	<u>Leg 2</u>
R.H. Belderson	Geology	IOS Wormley		X
T. Bugge	Geology	IKU Trondheim		X
J.M. Campbell	GLORIA	IOS Wormley	X	X
Mrs G.F. Caston	Geology	IOS Wormley	X	X
N.G.T. Fannin	Geology	IGS Edinburgh	X	
C.G. Flewellen	Profiling	IOS Wormley	X	X
A.W. Gray	Profiling	IOS Wormley	X	X
N.H. Kenyon	Geology	IOS Wormley	X	X
J. Klepsvek	Sidescan	IKU Trondheim		X
P. Mason	Computer	RVS Barry	X	X
C.D. Pelton	Geology	IOS Wormley	X	
J. Revie	GLORIA	IOS Wormley	X	
K.O. Sandvik	Geology	IKU Trondheim		X
M.L. Somers	GLORIA	IOS Wormley	X	X
A.R. Stubbs	Sidescan	IOS Wormley	X	X
R.J. Walker	GLORIA	IOS Wormley		X
Mrs J.M. Weller	Geology	IOS Wormley	X	X
J.B. Wilson	Geology Principal Scientist	IOS Wormley	X	X

SHIP'S OFFICERS

P.H.P. Maw	Master (Leg 1)
P.J. MacDermott	Master (Leg 2)
K.O. Avery	Chief Officer
J.T. Morse	2nd Officer
G.P. Harries	3rd Officer
R.M. Morris	Purser/Catering Officer
G.M. Batten	Chief Engineer
D.A. Anderson	2nd Engineer
H.J.C. Peck	3rd Engineer (Leg 1)
P.P. March	4th Engineer
R.G. Whitton	4th Engineer (Leg 2)
G. Gimber	5th Engineer
T.J. Comeley	5th Engineer
P.J. Parker	Senior Electrical Engineer
R.L. Townsend-Rose	Radio Officer

CRUISE OBJECTIVES

- (1) Investigation of the morphology of the continental slope to the west of the British Isles and Norway with particular reference to the Porcupine Seabight, the slope west and north of Scotland, the Wyville-Thomson Ridge, and the major slump structures at Storegga and south of Bear Island in the Barents Sea.
- (2) Investigation of the morphology of the deep water coral banks on the continental margin to the west of Norway.
- (3) Operational trials of the new digital correlator for the GLORIA system.
- (4) Intercomparison trials of the new 80/90 kHz and 245/255 kHz side-scan sonars.

NARRATIVE

Leg 1 (all times are GMT)

The departure from Barry on 5th August originally scheduled for 0900 was postponed due to faults on the ship's radar. As it was important not to miss the morning tide, Discovery sailed at 1250 from Barry with two Decca engineers still on board completing the repairs to the radar. On leaving the lock at 1324, Discovery anchored in the approaches until the repairs were completed. This was achieved by 1750 when the radar engineers left by pilot boat. The PES fish and side-scan sonar were deployed at 1824 and Discovery sailed down the Bristol Channel. The initial speed of 10½ kts was reduced to 8 kts to improve the quality of the records obtained from the 31/37 kHz and 80/90 kHz side-scan sonars to be used for intercomparison purposes. A fault in the 245/255 kHz system prevented useful results being obtained until the following day when the fault was repaired.

The GLORIA launch procedure was commenced 0416 on 7th August at the edge of the continental shelf south-west of Ireland. During the launch the cable came off the drum and was damaged. On testing it was found to be necessary to change the cable. GLORIA was recovered at 0539 and work commenced on changing the cable and also changing two array harnesses which were found to be faulty. During this time the hydrophone was deployed and topped up with oil. A survey of the heads of some of the canyons in the Porcupine Seabight was undertaken using the 31/37 kHz sidescan sonar. Repairs to GLORIA were completed at 1830 and the new launch scheduled for the morning of 8th August. The hydrophone was recovered at 0440 and GLORIA was successfully launched at 0452. The hydrophone was redeployed

at 0600 and the air gun at 0619. Recording was begun at 0628.

Investigations into the morphology of the Porcupine Seabight were conducted along a series of approximately east to west and west to east traverses followed by a south-east to north-west passage towards the top of the Seabight. On completion of the return leg of this traverse at 0900 on 11th August GLORIA transmission was switched off and the change to the digital correlator was made. During this time Discovery steamed over the Slyne Ridge at the northern end of the Porcupine Seabight towards the continental margin west of Co. Mayo, Donegal Bay and Co. Donegal. Work was completed on the introduction of the digital correlator and the subsequent modifications to the post correlator amplifiers by 1215 on 12th August and recording using the digital system was commenced.

The survey proceeded northwards across the Donegal Fan towards the Hebrides Terrace Seamount and across the Barra Fan onto the continental slope west of St Kilda where good GLORIA records were obtained across the slump described by Stride, Curray, Moore & Belderson (1969). At 1500 on 14th August the course was altered to cross the southern flank of the Wyville-Thomson Ridge. Very good records of iceberg plough marks were obtained with the 31/37 kHz side-scan sonar across the east end of the Ridge. We proceeded north towards the slide on the continental slope north-west of Foula first discovered on IGS profiles. Good GLORIA records of the slide were obtained. We continued north until 1515 on 15th August ($61^{\circ}25.5'N$ $02^{\circ}6.0'W$) when we turned west to go down the slope and then south at 2015 on a course parallel to the slope but at about 1100 m water depth. Some fairly severe refraction problems were encountered due to the cold Norwegian overflow water flowing south at the bottom of the Faeroe-Shetland Channel.

On 16th August it was discovered that header tank for the sonar platform had no oil in it. The pressure was reduced to 400 psi and the azimuth motor was blocked off. This reduced the rate of oil loss to about 1 litre per hour. Further investigation on 17th August showed that the leak affected the port transducer pod which was then blocked off.

A survey of the Wyville-Thomson Ridge was undertaken on 17th August on completion of which we continued south on the continental slope west of Lewis. Speed was reduced to prevent snatching of the GLORIA cable in the heavy swell. A survey of the portion of the continental slope west of the Hebrides Terrace Seamount was then completed and at 0351 on 19th August we turned north again at $56^{\circ}36.5'N$ $09^{\circ}13.6'W$ to traverse the continental slope towards the Wyville-Thomson

Ridge. At 1156 on 20th August we altered course to 282° to run a second survey along the Wyville-Thomson Ridge returning along the north side of the Ridge into the Faeroe Bank Channel and hence across to the continental slope west of Shetland.

We continued north-eastwards along the continental slope north of Shetland and crossed the Greenwich Meridian at $62^{\circ}33.24'N$ at 0400 on 23rd August. The air gun, hydrophone and GLORIA were recovered between 0845 and 0944 on 23rd August. The PES fish was recovered at 1000 and echo-sounding continued using the hull transducer. A side-scan sonar line largely following the 300 m isobath was run over the west side of the Norwegian Trough in response to a request from Statoil. Unfortunately the sonar platform became skewed soon after GLORIA was recovered and this affected the usefulness of the records. The side-scan pod was retracted at 2118 on 23rd August. Discovery docked in Bergen at 0554 on 24th August.

Captain Maw was relieved by Captain MacDermott and Mr Peck who was injured was replaced by Mr Whitton. Dr N.G.T. Fannin (I.G.S.) also returned to the U.K., having participated in Leg 1. Our Norwegian colleagues, Dr K.O. Sandvik and Messrs T. Bugge and J. Klepsvek joined the ship that evening. The Decca representative in Bergen came on board to do further work on the radar and to repair the Decca Navigator which had given trouble from time to time throughout the first leg.

Leg 2

Discovery sailed from Bergen at 0800 on 26th August. The PES fish and side-scan sonar pod were deployed at 1300 and a repeat side-scan sonar line along the west side of the Norwegian Trough close to the line undertaken at the end of Leg 1 was run at a depth just over 300 m to look for pock marks. GLORIA, the air gun and hydrophone were streamed by 1738. As the water depth was only just over 300 m GLORIA was deployed with a shortened cable. It was hoped to examine some of the pock mark ground using GLORIA. The side-scan sonar and GLORIA survey for Statoil on the west side of the Norwegian Trough was completed at 0335 on 27th August and Discovery proceeded across the mouth of the Trough towards the east side.

A fault on the No. 2 air compressor turned out to be a broken piston. This compressor could not therefore be used further on the cruise. Some necessary service work was completed on No. 1 compressor which functioned well for the duration of the leg. Once into deeper water at 1251 on 27th August, the GLORIA cable was paid out to full range. We proceeded northwards along the steep face of a probable slump north of the mouth of the Norwegian Trough. The course was

adjusted from time to time to maintain an acceptable water depth for GLORIA operations in these waters.

We crossed the top of the Storegga Slide and at 0054 on 28th August changed course to proceed down the slope and cross the slide again further to the west on course 222° . Further traverses were made across the Storegga Slide on 28th and 29th August and a final line from the most westerly point on the slide reached ($64^{\circ}36.7'N$ $00^{\circ}36.6'E$) eastwards up the slide towards the top. This line was terminated at 1250 on 30th August when the course was changed to 0° to cross the south-eastern edge of the Vøring Plateau.

Discovery crossed the Arctic Circle at 1337 on 31st August and proceeded north-eastwards across the Vøring Plateau towards the continental margin west of the Lofoten Islands where some good results were obtained with GLORIA on the steeply gullied continental slope. Following this, we set course for the continental slope at the western end of the Barents Sea and proceeded northwards towards the slide south of Bear Island. We reached the northern end of the slide at 1816 at $72^{\circ}31.27'N$ $15^{\circ}30.08'E$ on 2nd September and then altered course to 253° .

The weather deteriorated rapidly with gale force westerly winds. Course 253° was the only suitable course to tow GLORIA so this was maintained until a turn to the south could be made. This was achieved at 0508 on 3rd September and further course changes were made as the weather eased to bring the ship back on course towards the probable slide feature on the north-east corner of the Vøring Plateau. By 1720 the weather deteriorated and as there was no chance of maintaining the course towards the Vøring Plateau it was decided to steam towards the lee of the Lofoten Islands in order to recover GLORIA. The hydrophone was recovered at 1830. At 0243 on 5th September the GLORIA cable was shortened to 250 m and passage was made towards the lee of Rostoy Island at the southern end of the Lofoten Islands. GLORIA was successfully recovered at 0730 on 5th September. Some useful results were taped from the short range side-scan sonars in the shallower waters off Rostoy Island.

A south-westerly course was then set but weather conditions deteriorated and speed was reduced. The weather continued to deteriorate and by the morning of 6th September conditions were such that the PES and side-scan sonars had to be shut down. The wind and sea states were up to 10 or 11 by this stage. A wave recorder station was run from 0630 to 0658 at $65^{\circ}55.3'N$ $09^{\circ}11.3'E$ (Station No. 10398). As there was no sign of an improvement in the weather it was decided to run for Trondheim Fjord as soon as conditions permitted to pick up two pilots and

to make passage for Stavanger on the lee side of the islands.

Our Norwegian colleagues left Discovery at 1200 on 7th September off the island of Hitra at the mouth of Trondheim Fjord on the pilot cutter and we proceeded at full speed on three engines towards Stavanger. The Stavanger pilot station was reached at 1730 on 8th September and following the departure of the two pilots a course was set across the North Sea towards Immingham. The Humber pilot was picked up at 0436 on 10th September and Discovery was alongside at Immingham by 0728.

The success was due in large measure to the help and cooperation given by Captains Maw and McDermott and the officers and men of RRS Discovery, and to the enthusiasm and hard work of the scientific party. Thanks are also due to IKU Trondheim for their support and help with preparations for the cruise and for participating in the work off Norway.

J.B.W.

SUMMARY OF RESULTS

Leg 1

The intention of the first leg of Cruise 123 was to survey the morphology of the continental slope from south-west of Ireland to the northern end of the Faeroe-Shetland Channel; a distance of 1500 km. Nearly complete cover of the slope was achieved despite sound propagation problems due to thermal stratification of the water. The range was severely restricted over the upper slope and in the Faeroe-Shetland Channel. For most of the cruise GLORIA was used at the medium range of 15 km to each side, but in places less than 8 km could be seen. Spurious effects due to the internal stratification make the interpretation of the GLORIA sonographs more difficult than usual.

A number of features were detected that may indicate slope failure. Supposed slump folds are present north of the Shetland Islands and in the Porcupine Seabight and there are 180 km long faults running along the upper slope west of St Kilda. Parallel grooves aligned up and down the slope west of the Shetland Islands have an as yet unknown significance.

The 31/37 kHz sidescan produced evidence of current formed bedforms on the upper slope, on the Wyville-Thomson Ridge and in the Faeroe-Shetland Channel. Unfortunately it was not possible to get as much data as we would have wished, because of the dangers of towing the GLORIA fish in depths of less than the length of the cable.

The distribution of iceberg plough marks was extended to include the most southerly that we know of at 51°N and also the deepest that we know of in 700 m of water on the Wyville-Thomson Ridge.

N.H.K.

Leg 2

The purpose of the survey was to study the huge Storegga Slide, to search for further signs of slope instability on the Norwegian Continental Slope, and to observe any other morphological features.

The range obtained with the long range side-scan sonar (GLORIA) was restricted to a variable extent by the thermal structure of the water. However, the results confirmed that the whole continental slope from $62^{\circ}30'\text{N}$ to $64^{\circ}30'\text{N}$ (a distance of 250 km) is disturbed by sliding. There were further indications of sliding further north, most notably in a newly discovered large slide north-west of the Traena Bank. At the furthest north point reached, south-west of Bear Island, a further large, but probably older, slide was observed.

The short range side-scan sonar provided good detail of the extremely rough surface of the Storegga Slide, as well as good records of iceberg plough marks, pock marks and indications of sediment transport by bottom currents. The air gun worked well throughout, giving information on sub-bottom structure useful to the interpretation of the side-scan sonar results.

R.H.B.

Experience gained in locating patches of deep-water coral on sonographs from the continental margin west of the British Isles and on Rockall Bank suggests that similar patches are present at several locations west of Norway. The patches were observed on sonographs obtained with the 31/37 kHz side-scan sonar.

J.B.W.

EQUIPMENT REPORTS

GLORIA

The vehicle was first launched on Day 219 but had to be recovered at once as the cable sustained damage during the launch. There is always a period when the vehicle has just left the cradle when a snatch can be followed by slack cable which does not lead fair from the winch drum. On this occasion the trouble occurred with the cable at the end of a layer and the slack jumped the drum flange. The cable was sufficiently damaged to require replacement. In tests

after fitting the new cable faults were found in two array harness glands and these were then changed. Subsequently another damaged harness gland was diagnosed but as it presented no immediate threat to the operation of the system replacement was deferred to the end of the first leg.

The successful launch was on Day 220, and the system was started up with the drum correlators. Preliminary tests on the new digital correlators were carried out on Day 223. The receiver end correlation circuitry worked exactly as expected but it was necessary to modify the post-correlator amplifiers to match the distribution of correlator output signals to the available dynamic range of the tape recorders. The digital system took over again at 1200 on Day 224 and ran for the rest of the cruise. Tapes 1-13 were drum signals and Tapes 14-69 were digitally correlated. The recording was stopped and the vehicle was recovered on Day 235 to proceed to Bergen. During this passage the faulty harness gland was isolated and replaced, and no more insulation problems occurred during the cruise.

After Bergen the vehicle was launched on Day 238 in a rather lumpy sea left after a blow of Force 5 to 6 from the NW. Again the cable went slack and seemed to get into trouble, but subsequent tests revealed no damage, and the system operated continuously until recovery on Day 248 in the shelter (from the south) of the outer Lofoten Islands. The sea conditions were among the worst in which recovery has been made.

Owing to the propagation conditions and depth of water the system worked at 20 seconds pulse repetition period throughout, so the digital correlators have not been tried at 40 seconds pulse repetition period.

M.L.S.

Short Range Side-Scan Sonar Systems

In addition to the usual 31/37 kHz side-scan sonars two other double sided systems were used at 245/255 kHz and 80/90 kHz, this being the first trials of the latter. All three systems were used during the first three days of the cruise across the continental shelf. Excellent results were obtained on the 31/37 kHz and 80/90 kHz systems. The 90 kHz and 245/255 kHz systems suffered from mains interference; this was eliminated later in the cruise. Most of the cruise was in fairly deep water, down to 3000 m, and the 31/37 kHz systems were used to good effect throughout.

Tape Recordings: At the beginning of the cruise tape recordings were attempted of the signals from all systems, the object being to compare the information

obtained from the three systems on each side that was "looking" at the same ground and hence to investigate the effect of frequency. However, a number of technical faults made the results unusable. A further attempt was made in shallow water at the southern end of the Lofoten Islands and these appear to be successful.

Platform Control System: Early in the cruise the reservoir tank for the high pressure hydraulics was found to be empty. Investigations indicated there was a leak in the Port roll system of about 1 litre/hour. For the rest of the cruise the pipes to this side were blanked off and the relevant control electronics disconnected, the Port plate being fixed at 45° . Otherwise the whole system worked well throughout the cruise.

A.R.S.

Seismic Reflection Profiling

The IOS two channel streamer with 2 kHz sections was towed at 8 kts until near the end of Leg 2 when speed was increased to $8\frac{1}{2}$ kts.

A direct hydrophone signal was filtered between 20 and 80 Hz and displayed on one EPC. A second EPC displayed the average of the two channels after digitisation (essentially 0-100 Hz) until it was realised that the two channels were out of phase (a switch had been knocked down) after which only one channel was monitored.

The Micro-Nova computer performed faultlessly but there were a number of hardware faults on both tape decks. It is hoped that a change of the signal terminating arrangement in transport 1 plus some additions to the software will have removed these faults. A hurried software alteration before the cruise meant that the tape header information at the beginning of each of the recorded tapes was not updated before but after the start of tape. Most of the tapes are thus labelled one less than their correct number.

C.G.F.

Compressors and Air Guns

Two brand new air guns were used. After the initial problems of getting them to fire they worked well, with no further trouble.

No. 2 compressor failed with a cracked first stage piston; this was shown up by high crank case pressure. No 1 compressor was checked and serviced and was used for the rest of the cruise with no further problems.

A.W.G.

FIGURES

Figure 1 GLORIA coverage west and north of the British Isles.
The track in the Bristol Channel and Celtic Sea before the deployment of GLORIA and in the northern North Sea after GLORIA was recovered show additional coverage obtained with the short range side-scan sonar (mostly 31/37 kHz).

Figure 2 GLORIA coverage west of Norway.
The track south of the Lofoten Islands after the recovery of GLORIA shows additional coverage obtained with the short range side-scan sonar (mostly 31/37 kHz). The wave recorder station (No. 10398) is located at the southern end of the line. Track towards Hitra is shown as a broken line.

FIG. 1

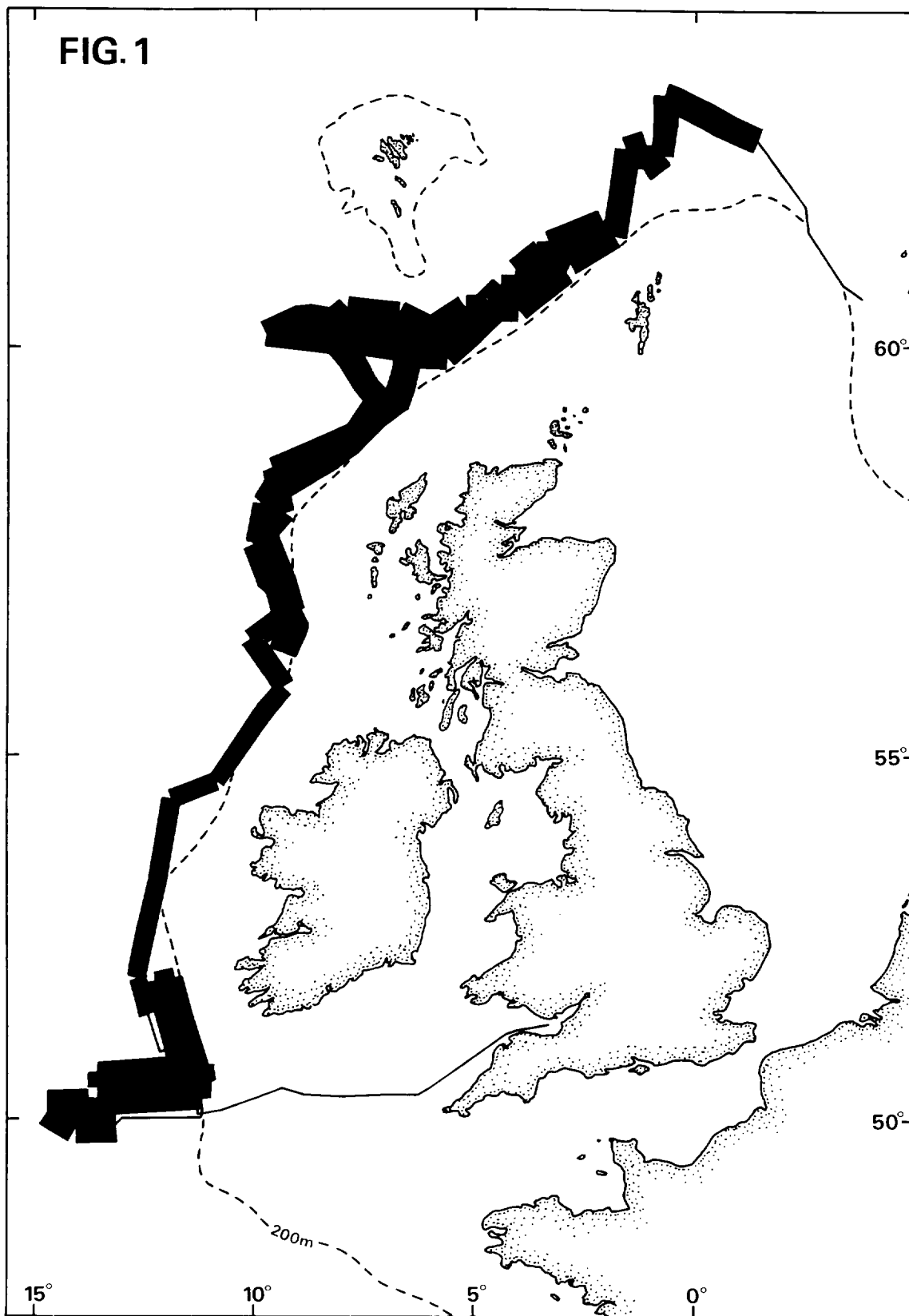


FIG. 2

