

NATIONAL INSTITUTE OF OCEANOGRAPHY
Wormley, Godalming, Surrey.

R. R. S. DISCOVERY CRUISE 43 REPORT

October - November, 1971

"GLORIA" IN PEAKE AND FREEN DEEPS,
and
ON THE AZORES-GIBRALTAR RISE

N.I.O. CRUISE REPORT NO. 47
(Issued March, 1972)

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DATES

Leg 1	Leave Barry, S. Wales	7th October	Day 280
	Arrive Southampton	1st November	Day 305
Leg 2	Leave Southampton	4th November	Day 308
	Visit Falmouth	24th November	Day 328
	Arrive Southampton	25th November	Day 329

SCIENTIFIC PERSONNEL

			<u>Leg 1</u>	<u>Leg 2</u>
A. S. Laughton	Principal Scientist		X	X
R. B. Whitmarsh	Geophysics		X	X
N. J. Olliff	"	(Diver)	X	X
J. J. Langford	"		X	
J. H. Hancock	"		X	X
P. Lindsay	"		X	X
M. Wilson	"			X
J. E. Nafe*	"			X
J. S. M. Rusby	GLORIA		X	X
M. L. Somers	"		X	X
J. Revie	"		X	X
R. Dobson	"		X	X
R. H. Edge	"		X	
S. K. Willis	"	(Diver)	X	X
R. Peters	"	(Diver)	X	
G. Mardell	"	(Diver)		X
B. S. McCartney	Seismic Profiling		X	X
D. G. Bishop	"		X	X
C. G. Flewelling	"		X	X
R. M. Bonner	"		X	
T. Turner	"			X
A. J. R. Voss	Data Processing		X	
F. Bilimoria	"		X	X

* Lamont-Doherty Geological Observatory, U. S. A.

SHIP'S OFFICERS

G. L. Howe	Master
M. A. Harding	Chief Officer
M. Bradley	2nd Officer
A. G. Marsh	3rd Officer
J. Phelan	Radio Officer
C. S. Storrier	Chief Engineer Officer
P. Jones	2nd Engineer Officer
C. Phillips	3rd Engineer Officer
P. Maguire	4th Engineer Officer
S. Turton	Junior Engineer Officer
K. R. Elcomb	Junior Engineer Officer
B. Winchester	Chief Electrical Officer
T. McMahan	2nd Electrical Officer

SUMMARY OF CRUISE INTENTIONS

(1) GLORIA

The cruise was planned to make the maximum use of long range side-scan sonar (GLORIA) in the open ocean conditions of the north Atlantic in areas of scientific interest and to establish its capability of operating in worse weather than previously experienced. Two principal areas were chosen for these studies:-

- (a) King's Trough (42°N, 23°W) where previous studies on cruises 4, 11 and 33 have provided well surveyed areas with geological control. In particular, Palmer Ridge dividing Peake and Freen Deeps, presented a steep scarp on which both basaltic basement and a Tertiary sedimentary sequence were exposed. This target area was to be viewed from many angles.
- (b) The western region of the Azores-Gibraltar Ridge, believed to be a major plate boundary with dominant transcurrent faulting. The scale of the features in the area chosen for survey were such that they could be scanned in the 12 mile range of GLORIA. The survey was planned on a regular grid basis to give a series of overlapping sonographs that could be mounted to give a mosaic of an 80 x 80 mile square.

(2) Seismic Reflection Profiling

It was also planned to make maximum use of seismic reflection profiling using new Bolt air-guns and a new N. I. O. hydrophone array. Seismic profiles were planned on passage whenever time allowed a speed of 8 knots or less, and were to be obtained simultaneously with the GLORIA surveys. Chamber sizes from 40 to 1000 cu. in. were available and comparative tests were planned.

(3) PUBS

Two Pop-up Bottom Seismic Recorders (PUBS) were carried in order to experiment with the possibility of replacing explosive sound sources for short range refraction seismics with the 1000 cu. in. air-gun sound source. As a back up project in the event of GLORIA breakdown, seismic refraction lines to study the structure of King's Trough, and also to look for crustal anisotropy were planned and 7½ tons of explosive carried.

(4) Underwater Photography

It was planned, if time was available, to make photographic traverses across targets suggested from GLORIA records, using the towed buoyant mini-camera.

(5) Coring

Short cores were required for organic geochemistry.

(6) Magnetic and Topographic Passage Data

Passage tracks and spare time were planned to fill in areas of poor magnetic and bathymetric coverage of the N. I. O. data collection.

NARRATIVE

Leg 1

R. R. S. 'Discovery' sailed from Barry Docks at 1100/280 in very calm weather, heading directly towards King's Trough. Echo sounder and magnetometer watches were started at 1530/281 before crossing the continental shelf edge. Once in deep water, the new main trawl warp was streamed at 2 kts. in order to tension it on the winch. A total of 8610m was paid out, out of a total of 9248 m. At 8589 m out the wire jumped off a sheave and jammed between the sheave and the support, and minor damage was done to the wire, but it was not appreciably weakened.

On passage to King's Trough, some trials were made of the new seismic profiling system using Bolt air-guns. On arrival at King's Trough, the GLORIA system was not quite ready to launch, so a velocimeter station (7749) was made and an unsuccessful camera station (7750) across Palmer Ridge was carried out. The subsequent survey of the Peake-Freen Deeps is described in the project reports. The GLORIA vehicle was launched in calm weather on day 287 and produced sonograph records until 1010/290 when the area was left.

The track up the axis of King's Trough looking starboard at the 12 n. m. range was interrupted by an electrical failure in the towing cable of the vehicle which meant that both sonar circuits and control circuits were out of action. As it was blowing force 5 and there was appreciable swell, it was not possible to recover the vehicle in the open ocean so course was altered to San Miguel in the Azores in order to get a good lee. We arrived there at 0700/293, having run a seismic reflection profile the whole way, and recovered the vehicle.

While the cable damage was being examined and repairs attempted, we steamed ENE to some deep water to test a possible seismic refraction technique used a bottom seismic recorder (PUBS) and a 1000 cu. in air-gun sound source, interspersed with explosive charges up to 50 lb.

Two core stations (7753, 7754) and a velocimeter station were then made (day 295).

It was clear by now that the GLORIA cable was not repairable on board and that the only chance of operating GLORIA on Leg 2 was to return to Southampton, instead of visiting Madeira, and to replace the cable with an older part-used one. During the remainder of Leg 2, long reflection seismic, topographic and magnetic profiles were made across the Azores-Gibraltar Ridge in order to set the stage for Leg 2.

A second PUBS experiment (7756) was carried out on the way back to Southampton, in the Iberian Basin. Thereafter the passage back was at maximum speed except for a 30 hour period when a seismic reflection profile was obtained at 6 kts using a 160 cu. in. air-gun across the Bay of Biscay north of the Biscay seamounts.

The ship arrived at Southampton in thick fog on day 305. The replacement GLORIA cable was fitted and various repairs were made to the vehicle.

Leg 2

The ship sailed from Southampton at 1500/308, with some change of scientific

personnel and shortly ran into heavy head seas. The passage directly to the area chosen for detailed survey on the Azores-Gibraltar Ridge was made at maximum speed without seismic profiling. The gale force winds gradually veered to the starboard quarter and after three days died away. On day 312 we arrived at the survey area and made a velocimeter station (7757) to establish the acoustic ray paths for the coming survey. It was, however, too rough to launch GLORIA there, so we ran to the lee of San Miguel Is., Azores, for launching on day 313.

We arrived at the survey area at 1633/314 and left it at 0818/321 on passage back to Santa Maria for recovery. Throughout the survey the wind and sea had been constantly from the NE usually force 5 or 6 but at times up to gale force 8, (see project report).

The return passage for recovery of the GLORIA vehicle at Santa Maria Is. showed a linear feature on the sonograph. After recovery on day 322, and some experiments with air-gun and hydrophone, we examined the feature with a set of seven crossings with seismic profiling. The feature showed up to be a narrow valley indicative of an extensive E-W fault.

On completion of this examination, we steamed directly back to U. K. mostly at the maximum speed which continual gale force winds from ahead would allow. We arrived at Falmouth at 1630/328 to discharge unused explosives and proceeded to Southampton arriving at 1000/329.

PROJECT REPORTS

(1) Peake and Freen Deeps Survey (fig. 2)

Due to the cable failure to the GLORIA vehicle, only the Peake and Freen Deeps were surveyed in the King's Trough region.

Prior to the launching of the sonar vehicle, a seismic reflection survey was made (day 285 - 287) of an area SE of Freen Deep where it is crossed by the Azores-Biscay Rise. The existence of this rise was confirmed and the E-W trending ridges were found on top of it.

A velocimeter station (7749) to 2000 m. gave the data to plot by computer a ray path diagram in order to optimise the sonar operations.

GLORIA was launched in very calm weather on day 287 and three runs of about 70 n. m. each were made viewing the area between the deeps (Palmer Ridge):-

- (a) from the north at close range (NO)
- (b) from the south (PQ)
- (c) from the north at a greater range (RS)

All runs were made viewing to starboard to the 12 n. m. range. Tracks NO and RS were 8 n. m. apart and the sonographs could therefore be correlated. A zig-zag run (STUVW) was made across Palmer Ridge viewing to starboard to the 7 n. m. range with the purpose of examining targets at a different angle of insonification.

Failure of the rudder control circuits unfortunately resulted in excessive yaw of the vehicle and a loss of angular resolution of the targets.

On leg PQ and subsequent legs, seismic reflection profiles were obtained together with the sonographs and these greatly helped the interpretation of features which were first seen to one side and then crossed beneath the ship's track. The additional bathymetric and magnetic surveys have led to some revision of the bathymetric and magnetic contour charts of Peake and Freen Deeps.

A. S. L.

(2) Azores-Gibraltar Ridge Survey (Figs. 1 and 3)

The Azores-Gibraltar Ridge was studied on two scales. In the latter part of Leg 1, four N-S traverses of bathymetry and magnetics were made between 16° and 23°W, and a fifth on Leg 2. On three of these, seismic reflection profiles were also obtained. Between 21° and 25°W, five E-W tracks, four with seismic reflection profiles, were made on passage to the Azores. On two or them, GLORIA was in operation viewing to the south to a 12 n. m. range. Together with the results of the box survey described below which filled in the gap between 19° and 21°W, and with other data not obtained on this cruise, the data has enabled the bathymetry, basement structure and magnetic anomaly pattern of the western half of the Azores-Gibraltar Ridge to be well established. A particularly interesting feature, the Gloria Fault, was discovered running E-W along 37°N almost continuously from 20° to 25° W (Laughton et al - in press).

A box survey with 80 n. m. sides near 37½°N, 27½°W, was designed to examine with side-scan sonar the topographic trends in a region believed to be dominated by E-W ridges and valleys. The track orientation of SW-NE was chosen so that these trends would cross the sonograph records obliquely. Viewing was always to the south-east out to a range of 12 n. m. , and tracks were spaced by 8 n. m. so that sonographs could be fitted together as a mosaic, and so that there was bathymetric control over the central region of the sonograph of the previous track. Eleven such tracks formed the box. Three more tracks in the form of a Z crossed the box viewing to a 7 n. m. range, in order to provide cross ties and to examine targets from another angle and with higher resolution. Navigation for the first part of the survey was by satellite, but the receiver subsequently failed. After that navigation was by Loran A (by day) and celestial observations, by correlation of GLORIA targets, and by the crossovers of bathymetry and magnetics. This gave rise to the irregularity in the SE half of the survey pattern.

Throughout the survey, seismic reflection, bathymetric and magnetic profiles were also obtained.

A. S. L.

(3) GLORIA Operations

The sonar vehicle was first launched on this cruise a. m. on the 14th October in calm conditions near Freen Deep. The vehicle was towed at a depth of about 350 feet at 6 kts. in the region of this deep, initially using the 12 mile range and later changing to the 7 mile range for a closer inspection of Palmer Ridge. The linear correlator was used throughout the tow, transmitting a 4 second FM pulse with a 100 Hz bandwidth.

A certain amount of trouble was experienced from the start; the sonar receiver

channel was noisier than usual, and an earth fault on transmission caused interlock interference. The yaw of the vehicle was found to be greater than normal, with a period of about 6 minutes. It was found later that this yaw was aggravated by the rudders which suggested damage to the system. Later it was found impossible to alter the beam angle due to an earth fault. Fortunately the beam was at a reasonable angle, 12° to starboard, and all subsequent runs were carried out at this position.

By p. m. on day 290 it was clear that a major fault had developed in the towing cable, resulting in the loss of most vehicle controls. It was decided to abandon further work in the survey area and steam south for a lee off San Miguel to recover the vehicle. At the time it seemed possible that all discharge valve circuits would be lost and we might have to lift the dead vehicle to the surface. Fortunately, it was found that sufficient cores remained in action to surface the vehicle normally. On inspection it was found that the faults were due to brittle fracture of copper conductors and to fatigue in the polythene sheath of the main cable in the vehicle under the ball joint. This had allowed sea water to circulate around the control quad cores. The cable had been used in 1970 as well as for the two previous cruises in 1971, fatigue being caused by the bending introduced when the towing arm is swung fore and aft.

Plans were made to replace the defective cable at Southampton on the 1st November, if electrical tests under load showed that the only remaining length in store was satisfactory. On arrival at Southampton this replacement length was tested under load on the quayside and was found acceptable. Due to its short length (560 feet, used in 1969) the cores were spliced on to a short length of the remaining ship cable which was in good condition.

This work was completed by day 308 and the ship left for the Azores to undertake the second part of the cruise, a survey of part of the Azores-Gibraltar Ridge.

The vehicle was launched near San Miguel on day 313, and a course laid for the 80 mile square survey area about 200 miles to the east. On arrival the speed was increased to 7½ kts. which provided a nearly true scale plan view of the sea floor using the 12 mile range. Most of the survey was carried out without vehicle rudder control, which was lost early on. A jury rig was used successfully for a short time but that had to be closed down later due to further earth faults in the steering meter circuits.

The survey was completed on day 321 and the vehicle recovered a. m. on day 322 off Santa Maria.

Successful sonographs were obtained over a period of 9 days while the vehicle was in the water in spite of winds of up to 35 kts. and corresponding sea and swell conditions. Variations in towing tension did not exceed 40% of steady loading although the speed had to be reduced to 6 kts. in conditions of pitching into head seas. Launch and recovery are, however, still restricted to relatively calm conditions without swell.

During both surveys it was found possible to tow the seismic profiling system and the magnetometer while the sonar was deployed. No pellet floats or guard's van float were used on this cruise, so that the water surface

aft of the ship was basically clear for cables, etc., to be streamed. It was also valuable to find that a faster ship's speed could be used, than has been used hitherto.

J. S. M. R.

(4) Seismic Reflection Profiling System (SRP)

The SRP system was operated satisfactorily for a total of over 560 hours covering over 3,684 n. m. of track (6800 km) at between 6 and 8 kts. The system was operated whilst GLORIA was deployed without any difficulty or mutual interference.

In its present form the SRP system consists of:-

- (i) Bolt Par 1500C air-guns with chamber sizes of 40 or 160 cu. in., generally operated once every 10 seconds at a pressure between 1000 and 1800 p. s. i. from air supplied by the Williams and James 30 cu. ft. /min. compressor;
- (ii) An N. I. O. hydrophone array, consisting of a 100 ft. spring section joined to four 50 ft. sensor sections and a 50 ft. tail section, all nearly neutrally buoyant and towed on an 8 core weighted cable 500 yds. long, with an elastic strop connected to the towing boom to prevent surging;
- (iii) A receiving console including amplifiers and filters, displaying on an 18" Mufax paper recorder at 2 second or 4 second sweep period with adjustable delay;
- (iv) A Bell and Howell VR 3360 tape machine, recording at 1 7/8 i. p. s., with playback speeds available from 1 7/8 i. p. s. to 60 i. p. s.

The new air-guns proved to be most reliable and in one instance operated continuously for 7½ days. On the four occasions when a gun ceased to work whilst profiling, in three cases the cause was found to be pieces of broken sealing springs embedded in the face of the plastic piston seat; on the other occasion a seal was ineffective due to dirt. It was possible to launch and recover the gun without reducing speed, which was essential when the SRP system was operated whilst GLORIA was deployed. It was well worthwhile having a second air-gun standing by in the event of failures to reduce the track distance without profile and to allow careful repair of the faulty gun at a comfortable speed. Maintenance at the end of all runs was also well justified by the subsequent reliability.

A second standby hydrophone was not required since the first one worked the whole cruise without fault. Background noises with this hydrophone depend upon the ship speed and course relative to sea and swell and on passing ships within a range of about 10 miles. Depth sensors in the hydrophone were damaged when the ship lost way on one occasion, but were recalibrated subsequently.

Minor problems with the system now concern:-

- (i) the Williams and James compressor which developed several minor faults, all of which were repaired, whilst the lower capacity Reavell compressor acted as standby;

- (ii) the gun towing assembly which has rather high drag and in which the electrical trigger cable was once damaged;
- (iii) the high pressure hose whose outer sheath blistered and burst in many places and which subsequently became very leaky;
- (iv) after recording 30 reels of tape each 13 hours 20 mins. long, the capstan drive belt of the tape recorder broke; this was spliced several times and a further 15 reels were recorded.

For most of the profiling in the King's Trough and Azores-Gibraltar surveys, a 40 cu. in. chamber with a relatively shallow tow (20 ft.) was employed at a pressure of 1500 p. s. i., giving adequate energy to penetrate the rather thin sediments (less than 1 sec.) and giving sufficient high frequency components to resolve some sedimentary layers. For the profile in the Bay of Biscay a 160 cu. in. chamber was used at 850 p. s. i. and 35 ft. to achieve a greater penetration of about 3 seconds. A 1000 cu. in. chamber operated at 1500 p. s. i. once every 120 seconds was tried as a sound source for two PUBS seismic refraction lines and ground waves were observed at the fundamental bubble frequency of the gun (about 10Hz).

Some tapes have been replayed with various filter settings to improve displayed resolution or penetration, or to alter the vertical exaggeration of the record. A new sampled data filter has been tried (off-line) and shown to work as predicted. The filter coefficients can be adjusted to optimise penetration or resolution and the former was easily programmed. However, the attempts to apply spiking filters using a simplified, truncated inverse Z transform of the bottom echo waveform were not very satisfactory. It would appear that a more complicated method such as that of Ziolkowski is required to compress in time the non-minimum phase air-gun waveform. The latter was measured by a hydrophone lowered to a depth of 1000 metres for a range of air-gun depths and pressures.

B. S. M.

(5) Pop-up Bottom Seismic Recorders (PUBS)

Two experiments were carried out using the 1000 cu. in. air-gun and a PUBS (stations 7752 and 7756). The purpose of these experiments was to determine to what extent the large air-gun can replace the use of explosive in conventional seismic refraction shooting. Both experiments consisted of lines 40 kms. long with the gun being fired precisely every 2 mins. at ship's speed of 4 or 6 kts. Critically refracted arrivals were observed out to a range of 15 kms. although it is hoped to extend this range by digital processing ashore and by stacking of the records.

The vibration of the tape-recorder motors was identified as the source of a 50 Hz noise which had been limiting the signal-to-noise ratio of the system. Attempts to decouple the seismic hydrophone from the tape-recorder for the second experiment were partly successful and future elimination of this problem should be possible. An improved ballast release device has now increased the depth from which PUBS can be released to 5000 metres.

R. B. W.

(6) Underwater Photography

Only one station was attempted, prior to launching GLORIA in Freen Deep. A seven mile tow across the south facing scarp of Palmer Ridge was made at 1 kt. using the buoyant minicamera towed on a 15 ft. tether to a ground chain. Towards the end of the station, the pinger failed and some damage was done to the camera on the steep cliffs. A flash failure prevented any pictures being taken. No other opportunity arose to take photographs of targets seen by GLORIA.

A. S. L.

(7) Coring

Three core stations were made in order to obtain near surface sediment for biochemical studies of lipids in the sediments. A 4" diameter, 4 ft. long gravity corer, (on loan from Southampton University) of stainless steel was used with a plastic liner. Organic contamination was reduced to a minimum and the cores stored in the deep freeze. All three cores were globigerina coze with a considerable volcanic ash content presumably from the Azores.

A. S. L.

(8) Topographic and Magnetic Data

Soundings were obtained from the new Mk III N. I. O. Precision Echo-Sounder, using a towed fish with the new GLORIA type transducers. Some improvements to the system were made during the cruise. In the latter part, the fish was towed from a boom at the forward end of the shelter deck to try to reduce screw noise. Soundings were manually entered into the data logger every 5 mins. and were plotted on board on the Calcomp plotter at the same scale as the track charts.

A Varian magnetometer was towed throughout the cruise and readings processed and stored by the data logger. Magnetic anomalies were plotted and profiles drawn by the Calcomp plotter.

On passage, tracks were chosen to fill in areas where data was sparse in order to further the analysis of the NE Atlantic geological history.

A. S. L.

(9) Meteorological Data

The following parameters were logged automatically:-

- Wet and dry thermistor temperatures (Port and Starboard)
- Sea temperature
- Relative wind speed
- Solar radiation

The solarimeter failed during the latter part of the cruise. In addition, the bridge submitted routine meteorological reports by radio to the Meteorological Office.

Wave statistics were gathered while the ship was on station, and spectral analyses made.

J. H. H.

(10) Navigation

For all of Leg 1, and half of Leg 2 the prime navigational aid was the Magnavox 702 satellite navigator. However, on day 316, the power supplies to the receiver failed and it was not possible to repair it. This occurred in the middle of the Azores-Gibraltar Ridge survey. Subsequent navigation was by Loran A, which was usable only between about 1000 and 1700 hours, giving an accuracy of about 1 mile, and by celestial observations whenever available. However, it was found possible to continue the survey linking consecutive legs by the comparison of targets seen by GLORIA on both legs. This method turned out to be accurate to a few cables, although rather tedious. Some navigational ties were made by bathymetric comparisons at cross-over points.

A fault on the shaft encoder of the digital gyro compass was present during the track to Santa Maria after the box survey. This fault was apparently restricted to a course of 264 degrees. The encoder was subsequently replaced in Southampton.

On the passage home, Loran A was carried northwards to the Bay of Biscay, and thereafter Decca was used.

No anchored danbuoys were used.

Navigational fixes were fed to the computer and the dead reckoning track corrected for the fixes, giving the track interpolated between fixes and the consequent current vectors. Transverse ship's speed through the water was measured by the N. I. O. two component log.

Track charts at 1:1 million, 1:¼ million and ½" to 1 mile were plotted on board by the Calcomp plotter from the processed navigational data stored on disc.

R. B. W.

(11) Shipboard Computer System and Data Logging

The system is essentially the same as that described in N. I. O. Cruise Report No. 33 (issued March 1971). Typewriter outputs of raw and processed navigational, geophysical and meteorological data were available in the plotting office, and of navigational data only, on the bridge. Track charts, plots of soundings and magnetic anomalies were routinely plotted at various scales and some geophysical profiles were plotted. Other offline computations and plots related to acoustic ray path diagrams, studies of seismic profiling pulse shapes and sampled data filters, and the calculation of hyperbolic lattices.

A. J. R. V.

TABLE I
CRUISE 43 - STATION LIST

Stn. No.	Type	Equipment Used	Date	Time (z)/day No.		Lat. N Lat. N to		Depth Range			Comments
				From	To	Long. W	Long. W	UCF	CF	CM	
7749	V	V	11 Oct	2030/284 - 2200/284		42°45.5'N 20°10.3'W		2820	2922	5344	To 2100 m
7750	TC	BMC	11-12 Oct	2342/284 - 0725/285		42°48.0'N 42°55.0'N 20°17.7'W 20°15.0'W		2820	2922	5344	No bottom pictures due to flash failure.
7751	C	SC	14 Oct	0536/287 - 0740/287		42°29.0'N 19°31.0'W		1703	1746	-3193	
7752	S. Refr.	PUBS	21-22 Oct	1605/294 - 0932/295		38°21.2'N 38°42.8'N 22°29.7'W 22°38.6'W		2214	2280	4171	40km line using 1000 cu. in air-gun & 50lb explosive charges. 1 m core.
7753	C	SC	22 Oct	0950/295 - 1155/295		38°21.0'N 22°30.9'W		-2168	-2232	-4083	
7754	C	SC	22 Oct	1155/295 - 1330/295		38°20.5'N 22°28.7'W		2212	2279	4167	Core catcher sample only.
7755	V	V	22 Oct	1330/295 - 1603/295		38°20.0'N 22°27.1'W		2180	2245	4106	
7756	S. Refr.	PUBS	27-28 Oct	2139/300 - 1118/301		40°47.1'N 41°4.8'N 16°17.8'W 16°01.0'W		2180	2245	4106	To 2100 m.
7757	V	V	8 Nov	1210/312 - 1333/312		38°37.3'N 20°02.3'W		2530	2615	4783	
								-2446	-2526	-4621	40km line using 1000 cu. in air-gun.
								2377	2454	4488	To 2000 m.

V = Velocimeter
TC = Towed Camera
BMC = Buoyant Minicamera
C = Core
SC = Southampton Corer

S. Refr. = Seismic Refraction line
PUBS = Pop Up Bottom Seismic Recorder
UCF = Uncorrected fathoms
CF = Corrected fathoms
CM = Corrected Metres

TABLE II
SEISMIC REFLECTION PROFILES

Run No.	Date	Time (z)/Day No.		Airgun cu. in.	Speed kts	Area	Length of profile n.m	Comments
		From	To					
1	10-11 Oct	2200/283 - 0850/284		40	6	Approach to King's Trough	66	
2	11 Oct	1718/284 - 1940/284		40	8	Peake-Freen Deeps	18	
3	12-14 Oct	1025/285 - 0400/287		40	6	Azores-Biscay Rise	272	
4	15-17 Oct	1946/288 - 1610/290		40	6	Peake-Freen Deeps	277	
5	17-20 Oct	2207/290 - 0700/293		40	6	Passage to San Miguel	362	
6	20-21 Oct	2315/293 - 1340/294		40	8	ENE from San Miguel	124	
7	21-22 Oct	1833/294 - 0405/295		1000	4 - 6	ENE from San Miguel	44	PUBS station 7752, firing every 2 mins.
8	23-27 Oct	1736/296 - 1820/300		40	8	Azores-Gibraltar Ridge	785	
9	27-28 Oct	2355/300 - 0500/301		1000	4	W. Iberian Basin	20	PUBS station 7756, firing every 2 mins.
10	29-31 Oct	1944/302 - 0250/304		160	6½	Bay of Biscay	212	
11	9-18 Nov	1621/313 - 0900/322		40	7½	Azores-Gibraltar Ridge	1467	
12	19-20 Nov	0740/323 - 1000/324		40	8	Gloria Fault	217	
TOTAL							3684 n. m	

TABLE III
GLORIA SONOGRAPHS

Launch	Date	Time (z)/Day No.		Range n. m.	Viewing Side	Speed kts.	Area	Length of track n. m	Comments
		From	To						
1	14-20 Oct	0936/287 - 0100/288		-	-	-	-	-	Sonar not operating
		0100/288 - 1814/289		12	Starboard	6	Peake-Freen Deepes	248	Points M - S
		1814/289 - 1010/290		7	Starboard	6	Peake-Freen Deepes	90	Points S - W
		1010/290 - 1610/290		12	Starboard	6	King's Trough	33	-
		1610/294 - 1200/294		-	-	-	Passage to San Miguel	-	Sonar not operating
2	9-18 Nov	1446/313 - 1900/313		12	Port	7½	Azores	27	-
		1900/313 - 1633/314		12	Starboard	7½	Passage to Survey area	157	-
		1633/314 - 0815/320		12	Alternating Std. and Pt.	7½	Azores-Gibraltar Ridge Survey	930	Points A - V on tracks 045° - 225°
		0815/320 - 0818/321		7	Port	7½	Azores-Gibraltar Ridge Survey	170	Points V - Z on crossing tracks
		0818/321 - 1515/322		12	Port	7½	Passage to Santa Maria	135	-
TOTAL								1790 n. m	

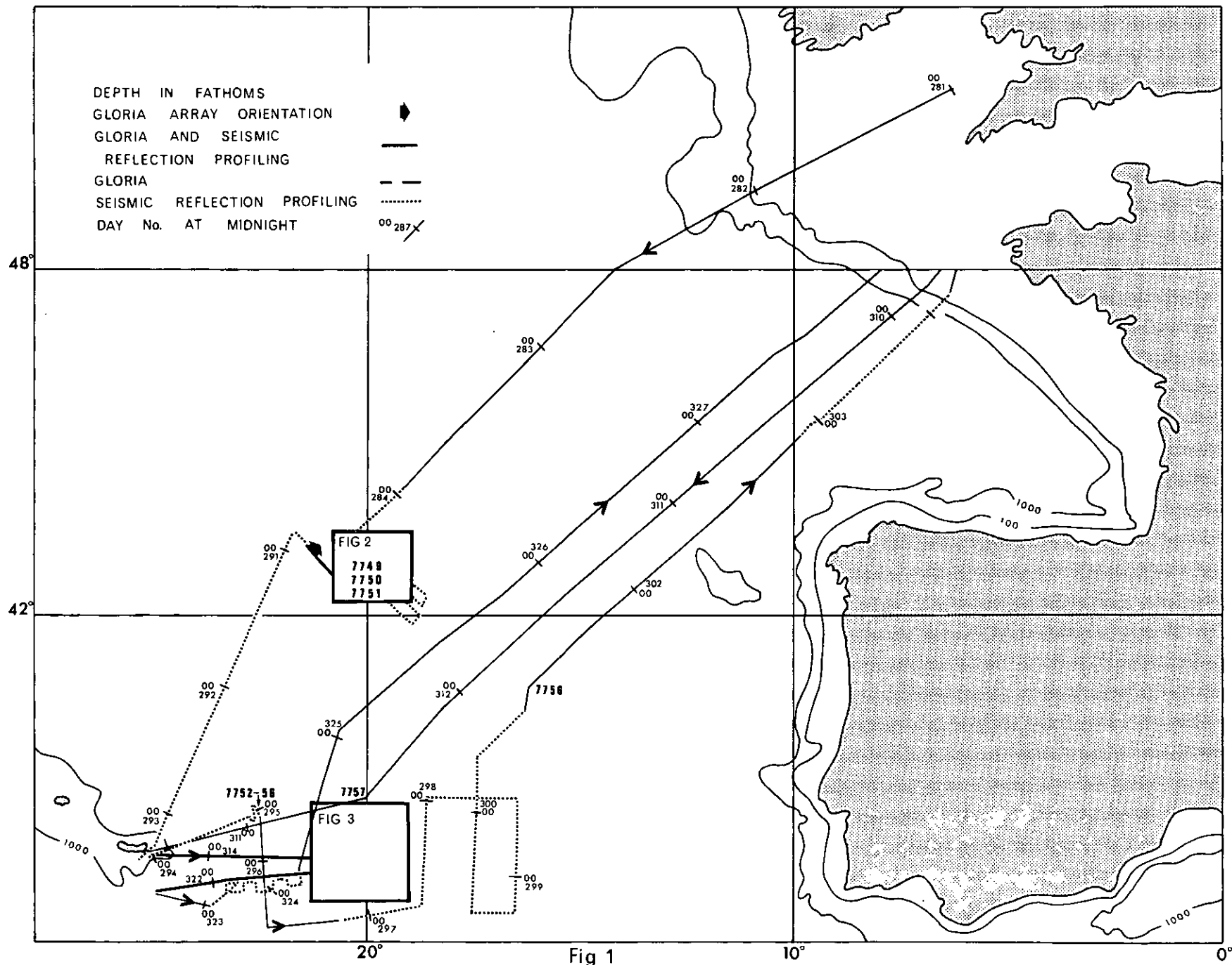


Fig 1

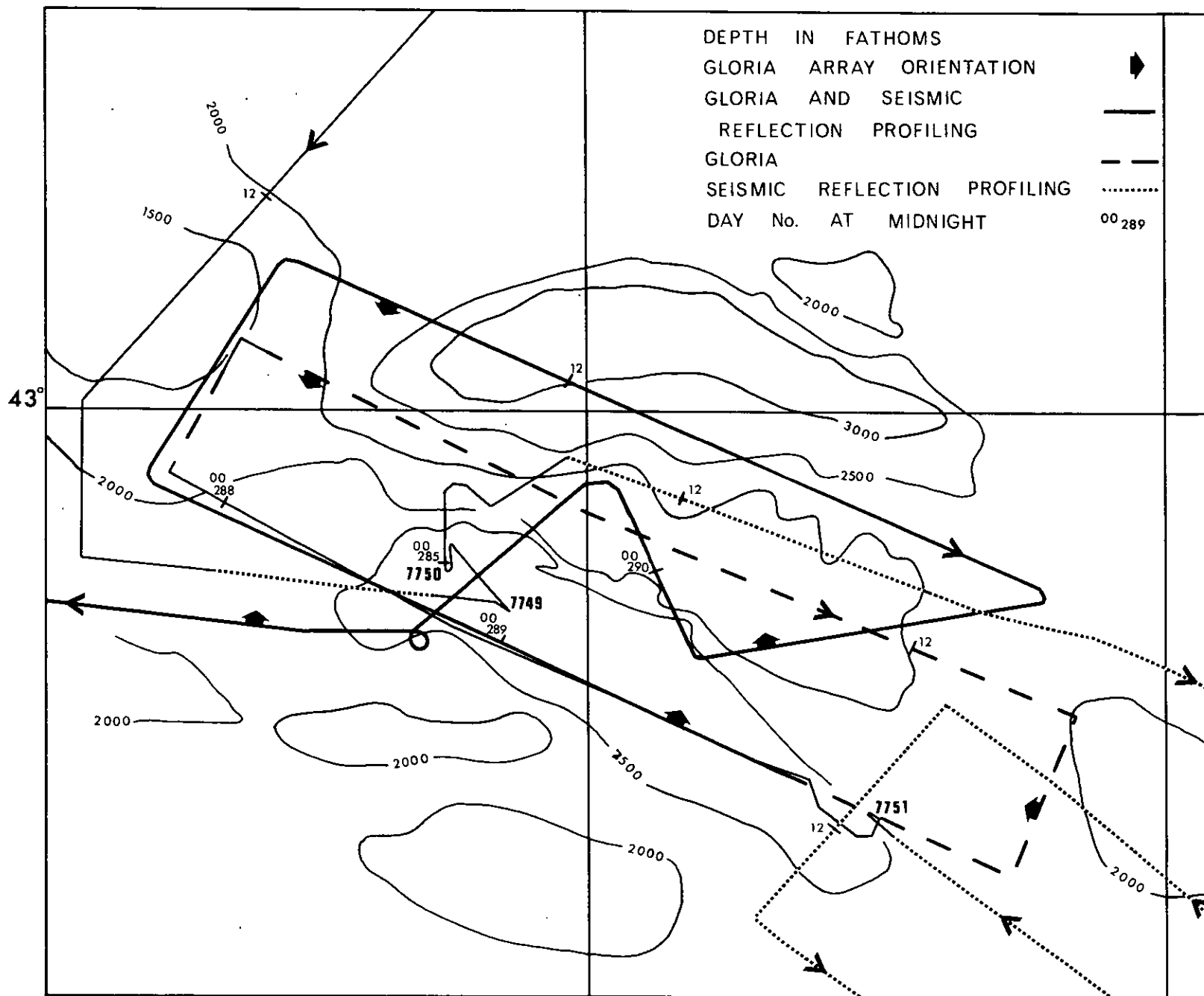


Fig 2

