MRS. P. EDWARDS.

I.O.S.

RRS DISCOVERY

CRUISE 131

12 AUGUST (224) – 23 SEPTEMBER (266) 1982

GEOLOGY AND GEOPHYSICS OF THE CHARLIE-GIBBS FRACTURE ZONE, NORTH ATLANTIC OCEAN

CRUISE REPORT NO 137

1982

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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INSTITUTE OF OCEANOGRAPHIC SCIENCES

WORMLEY

R.R.S DISCOVERY

Cruise 131

12 August (224) - 23 September (266) 1982

Geology and geophysics of the Charlie-Gibbs Fracture Zone, North Atlantic Ocean

Principal Scientist

R.B. Whitmarsh

I.O.S. Cruise Report No. 137

1982

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ITINERARY

Leg 1

12th August (224) 1982	Departed Gibraltar
1st September (244) 1982	Arrived St. John's, Newfoundland

Leg 2

9th September (252) 1982	Departed St. John's, Newfoundland
23rd September (266) 1982	Arrived Falmouth, U.K.

CRUISE OBJECTIVES AND BACKGROUND

Major objectives of the cruise were to follow up an earlier underway survey of the Charlie-Gibbs Fracture Zone with geological and geophysical station work and to sample and to make near-bottom observations of the Northwest Atlantic Mid-Ocean Canyon. The Charlie-Gibbs Fracture Zone station work was to include dredging, recordings of microseismicity and seismic refraction profiles. En route to the fracture zone a short seismic reflection profiling survey was also planned in the Iberia Abyssal Plain.

Considerable difficulty was had in achieving most of these objectives. Throughout the cruise the main winch, or the hydraulic power pack which drives the winch, gave incessant trouble. Eventually the system broke down completely during Leg 2. Thus it was impossible to core (except once), dredge or tow a benthic camera during Leg 2. A second problem was industrial action taken by the crew on two occasions. The first strike, in St. John's, caused the whole Mid-Ocean Canyon project to be cancelled. Lastly the weather was often marginal for the station work. For just over half the time the average wind speed exceeded 20 knots and 10 per cent of the time it was over 30 knots. We were lucky to just avoid hurricane Debby during Leg 2.

The remote location of the main study area caused us to steam over 4000 miles and also meant that over 40 per cent of the cruise was spent on passage. However, the two working periods spent at Charlie-Gibbs Fracture Zone were intensely busy.

ACKNOWLEDGMENT

The scientific work carried out on this cruise could not have been done without the support and professionalism of the Master, Officers and Petty Officers. We thank them most warmly for their assistance in our endeavours.

NARRATIVE

Leg 1

The ship sailed from the North Mole, Gibraltar to the South Mole at 0640/224* to load detonators and five tons of explosives. The loading was completed by 1300 but sailing was then delayed by repairs to the Sperry gyro and by medical treatment to one of the officers. We finally cast off from the South Mole at 1654. At 1900 the PES and 3.5 kHz fishes were streamed and we set course to the west. From 1245/225 until 1930 a test of the 3.5 kHz profiling system was carried out while traversing the Gulf of Cadiz and a fault, later traced to a broken lead on deck, was discovered which produced noisy records. Cape Sao Vicente was rounded at 1800/225 and course was set for the western Iberia Abyssal Plain. At 1100/226 the 3.5 kHz fish was recovered for inspection and the magnetometer streamed.

At 1220 the next day the point at which to begin a seismic reflection profiling survey of the western Iberia Abyssal Plain was reached. This was carried out at about 8 knots along three legs using a 300 ins^3 gun (mainly at a 12-second firing rate), the array and the 3.5 kHz profiling system. On recovering the airgun and array at 0020/229 we set course for the site of a heatflow station at about 45°N, 22°30'W en route to Charlie-Gibbs Fracture Zone. This site was reached at 0430/230 but handling difficulties in 2.5m seas and 30-knot winds soon led to the abandonment of the station (10600).

Course was resumed until 1200 when we stopped for the first wire-test of the PUPPI (pop-up pore-pressure instrument) in much improved conditions. The PUPPI was lowered at 0.5m s^{-1} on the trawl warp to about 900m of wire-out. At this stage it was noted that the near-bottom echo-sounder trace did not react to changes in winch speed. It was concluded therefore that it had become detached from the wire. On recovery this proved to be the case. It was further demonstrated that the detached part was slowly sinking and eventually at 1706 the PUPPI was abandoned. Course was then set to a revised position for the heat flow station, previously abandoned, which was reached at 2000. This station (10601) proved successful, except that loose turns on the trawl warp storage drum caused some difficulty and delay, and continued until 0450/231 when we again got underway to Charlie-Gibbs Fracture Zone (CGFZ).

*GMT is used throughout this narrative.

The Eastern Median Valley of the CGFZ was reached at 2200/232 but plans to deploy an array of four ocean-bottom seismographs (PUBS) were thwarted by 30-knot winds and high seas. A bathymetric survey of the valley was, therefore, carried out during the night and conditions had sufficiently improved by 0700 next day to begin deploying four PUBS (10602). This was completed by 1315. A single 1000 ins^3 airgun was then used in a four-hour survey to determine the dimensions of the PUBS array.

The transponder interrogator fish and magnetometer were subsequently deployed for a short passage to the Central Median Valley. This was reached by 0200/234 when a bathymetric survey of the axial valley was begun. The survey ended about first light and, after recovering the magnetometer, we deployed the two 5-kHz navigational transponders (10603) on top of the hills west of the valley. Two dredge stations (10604, 10605) were then carried out over a low ridge in the floor of the axial valley. During the second station, however, the winch traversing gear and its drive mechanism became inoperative. With considerable difficulty the dredge was eventually brought on deck 13.5 hours after it had gone over the side. Rocks were obtained at both stations.

To avoid using the coring winch temporarily, and to obtain a respite, we steamed east to occupy a heat-flow station (10606). This was begun at 1530/235 using the trawl warp. While some loose turns on the traction winch were being removed, when the heat-flow probe was actually in the bottom, a turn of wire caught around the pinger 100m above the probe. Thereupon the station was aborted and the probe was brought on deck at 0130/236.

The ship then sailed south to carry out an east-west reversed seismic refraction line (10607) on the hills south of the southern transform valley and west of the ridge axis. This was carried out with two PUBS, a 1000 ins^3 airgun and two series of explosive shots and ended at 1635/237. On picking up the second and last PUBS we then steamed to the Eastern Median Valley to resume dredging, the coring winch problems having been overcome. The first dredge station (10608) began at 1600/238. In spite of two hold-ups, both times to repair broken couplings on the traversing gear, the station was successfully completed by 2321. A second station (10609) was begun at about 0100/239 and proceeded without incident, ending at 0530. Rocks were obtained at both stations.

A few hours later the deployment of a second microearthquake array of four PUBS was begun (10610). This activity was completed by 1337. There was then a delay while an engine-room problem was solved. Afterwards a 1000 ins^3 airgun survey was begun to enable the array to be surveyed in. During this operation an on-deck hose coupling was damaged and broke. Although a temporary repair was made the airgun by now was flooded and would not restart shooting. Since the temporary repair could not be re-made if the gun was brought on deck again, air-gunning had to be abandoned at 2040/239.

The ship then got underway under the threat of imminent bad weather and the magnetometer was streamed. During late evening the bad weather struck and by early the next morning 45-knot winds brought the ship practically dead in the water. The magnetometer was recovered. Only very slow progress was made to the west in the next 24 hours. By the morning of Day 241 conditions had sufficiently improved for the magnetometer to be restreamed and scientific activities recommenced. Later in the morning the third engine was brought on line and Discovery headed southwest, to avoid a second depression, and then west-southwest for St. John's.

Scientific watchkeeping ended at 1730/243, 200 miles offshore. The ship experienced two complete failures of propulsion in the next 24 hours, the second time just off the Newfoundland coast, but eventually St. John's Harbour was reached. The first line went ashore at the Esso bunker berth at 1806/244.

Leg 2

Due to an unofficial strike by the crew the ship was delayed 5 days 50 minutes in port beyond the scheduled sailing date. However at last we departed from St. John's at 1320/252. Once clear of the area of floating ice the PES, 3.5 kHz and magnetometer fishes were deployed. Thence, a passage direct to Charlie-Gibbs Fracture Zone was begun. The planned three days' work over the Mid-Ocean Canyon had to be cancelled due to the late departure from St. John's and to the fact that the array of ocean-bottom seismographs (PUBS), deployed in the fracture zone area at the end of Leg 1, was due to pop-up from 1200/256 onwards.

Discovery arrived in the western part of the fracture zone at 1200/255 but the strong 30-knot winds and high seas precluded taking two cores there. We therefore continued eastwards to the vicinity of the PUBS array. Fortunately, the weather moderated and all four PUBS were successfully recovered by 0915/256. The ship then got underway to a second coring site near the intersection of the Central Median Valley and the northern fracture zone valley. This station (10611) was executed successfully. A 7.3m core was obtained with the Driscoll piston corer as well as a 2.5m core in the trigger corer. A short time later, at 1[illegible]09/256, a PUBS was deployed to carry out recordings of the signals from a bottom-impacting 1.5 ton weight lowered on the coring warp. However, while the weight was being lowered, squeaks developed in the traction winch, the investigation of which delayed the arrival of the weight at the sea-bed. There was only time for 11 impacts before it was necessary to begin hauling in the weight because the PUBS was due to release itself from the sea-bed. After hauling in about 600m of wire the weight fell off the warp. A pump problem then developed which restricted the hauling speed to about 0.2m s^{-1}. Consequently, the PUBS surfaced about 45 minutes before the warp and chain were recovered at 0350/257. The weight had been lost due to failure of the "10-ton" weak link at a load not in excess of five tons.

Due to the winch problem, plans to dredge and to tow the benthic camera in the Central Median Valley now had to be aborted. Instead a velocimeter dip (10613) was carried out which was initially delayed by earthing problems connected with the unusual positive earth system of the velocimeter. In order to save time, the two navigational 5-kHz transponders were now popped up in the remaining daylight (the original plan was to recover them next day at first light but the winch problem meant it was likely to be unprofitable to wait that long). Both transponders were recovered by 1940 and the towed interrogator fish was also brought inboard.

The ship then returned to the location of the station 10611 core site to carry out a high-resolution sub-bottom profiler traverse. This station (10614) was begun at 2150 but had to be aborted shortly afterwards when the power supply to the equipment caught fire in the electronics laboratory. To fill in the remaining night hours, before beginning a seismic refraction station at dawn, a 3.5 kHz and PES survey was carried out of the east-west ridge north of the northern fracture zone between 30° and 31°20'W.

At 0858/258 the first of two PUBS was laid (10615) in the axis of the southern fracture zone valley. An unreversed profile was shot to the east with two 1000 ins^3 airguns and shots of 25, 50 and 150 kg. A second PUBS was deployed at 1837 at the east end of the line and the shooting procedure repeated from east to west. Shot firing ended at 0152/259 and the two PUBS had been recovered by 1225.

Meanwhile the winch problems had not been solved in spite of the strenuous efforts of the scientific and ship's engineering staff. Therefore it was decided to do what could be done with the equipment available. Thus we steamed north to the area of a proposed IPOD site scheduled to be drilled in 1983. A good deal of time was lost in getting a 40 ins^3 airgun to operate to enable a reflection profiling survey of the site to be carried out. Eventually this was achieved by 2000 hours and the site was reached at midnight. Shortly afterwards the high-resolution sub-bottom seismic profiler was deployed (10616) but it was faulty. As time was running out before the start of the next seismic refraction line the station was abandoned and we steamed southwest to the north end of the final north-south refraction line.

The first PUBS was laid at 0655/260 (10617). A message was then received from RVS that shooting should be delayed by two hours to enable the safe departure of a Soviet submarine from the area. Meanwhile two more PUBS were laid at the southern end of the line and explosive was brought from the magazine to the after-deck. Shotfiring began at 1603 and continued for the next five hours. The ship then returned northwards towards the northern PUBS firing a single 1000 ins^3 airgun (the pump problems in the hydraulic power pack precluded deploying two 1000 ins^3 guns). This PUBS was recovered at 0345/261 and we then set off south at full speed with the threat of the approaching hurricane Debby, then gusting at 160 knots over the Grand Banks, hanging over us. The airgun was fired between the two southern PUBS which were recovered by 1518 hours. As the last PUBS was brought on board and the magnetometer was streamed the wind was already freshening and within a few hours had reached an average speed of 30 knots with the barometer falling very sharply.

The ship made a rapid departure to the southeast to avoid the worst of the oncoming weather. At latitude 50°N course was altered to 090° to pass over a second proposed IPOD site further east. However at 1450/262, a few hours before reaching this site, it was clear that conditions were too bad to carry out seismic reflection or high-resolution sub-bottom profiling and the course was changed to southeast once again. This decision was fortunate because, instead of heading north of east, the deep depression into which hurricane Debby had now developed was heading due east. By 0830/263 the ship had reached latitude 48°10'N and an easterly course was resumed. The expected storm did not materialise on the evening of Day 263 although there were 30-knot winds all that night. By dawn next day atmospheric pressure was rising and the weather improved. At 0930 we hove to, to conduct a high-resolution sub-bottom profiler station (10618) over the lower continental rise off Goban Spur. This proved successful and at 1350 the ship resumed its passage. Later the same day a further high-resolution sub-bottom profiler station (10619) was carried out close to IPOD Site 548 near the top of Goban Spur. The profiler was brought inboard at 0036/265.

By 0700/265 the ship was well onto the continental shelf and scientific watchkeeping ended. An hour later the 3.5 kHz and PES fishes were brought inboard. The ship then resumed its passage to Falmouth where the first line went ashore at 0708/266.

PROJECT AND EQUIPMENT REPORTS

DREDGING

The objectives of dredging in the Charlie-Gibbs Fracture Zone were as follows:

1. To recover fresh basalts from the Mid-Atlantic Ridge axis immediately north and south of, and within, the fracture zone. It was hoped that major and trace element analysis of these rocks would provide information on magma chamber processes near to fracture zones and on the nature of mantle heterogeneity in the North Atlantic.
2. To recover oceanic hydrothermal deposits (e.g. sulphides or umbers) by dredging on the highest part of the ridge in the floor of the central median valley, a situation in which such deposits are most commonly found.

On the first leg, dredging was carried out at four stations in the central median valley but hydrothermal deposits were not recovered. Loss of time, through breakdown of the winch and bad weather, prevented dredging in the western median valley. On the second leg, dredging was cancelled due to a total breakdown of the winch, preventing recovery of rocks from the eastern median valley.

The equipment used was identical at each station, with a weighted rock dredge attached to the main 21-mm coring warp by 30m of chain and a 200m-long 20mm trace wire. Two weak links, of 2.5 tons and 5 tons respectively, were inserted into the line directly above the dredge and were separated by a shackle to which a throttling line was attached. Five-ton hammer lock swivels were attached between the dredge and chain (i.e. above the weak links) and between the trace wire and main warp. A 10° tilt pinger was deployed between the chain and trace and was used successfully to guide the dredge onto the sea-floor.

Navigation throughout the dredging operations was performed using two 5-kHz transponders laid just above the sea-floor and the ship's position was plotted every 10 mins. At the first dredge station, a remote interrogator was inserted in the line between the trace wire and the main warp to monitor the position of the dredge. However, the positions of the ship and the dredge were found to be indistinguishable on the scale of the plot (5 cm to 1 km). As the interrogator fish also complicated deployment of the equipment it was removed on subsequent stations and the dredge position was crudely calculated from the water depth and the length of the wire out. A dynamometer record was kept at all stations but it was found that only very large 'bites' could be distinguished from the effect of the ship's heave.

Rocks were recovered at all four stations. At all but the first (10604) the 2.5-ton weak link had broken and the bag was throttled. The contents of each haul are now briefly described:

Station 10604

Rocks were recovered from the flanks of a small hill at 52°22'N, 31°43'W over a distance of about 750m. The haul consisted of 10 fragments (boulders and cobbles) of basaltic pillow lava, with beautifully developed glassy chilled margins and radial cooling joints. The rocks were remarkably fresh, although showing slight signs of ocean floor weathering, and were almost certainly in situ. One rounded gabbro cobble is probably an erratic.

Station 10605

Only two samples were recovered; they were sub-angular, rounded cobbles with thin manganiferous coatings. One was a pale grey, medium-grained quartzite and the other a fine-grained, dark grey rock, probably basaltic but possibly tuffaceous. On the basis of shape and smoothness both these samples were classed as erratics.

Station 10608

This haul was dredged from an area south of station 10604 and consisted of fine to coarse gravel with a few larger pebbles and cobbles. The haul was sieved and the coarser fraction was separated on lithological grounds into two groups:

1. Thirty-one angular fragments of a dark grey, aphyric, slightly vesicular basalt, some fragments having thin glassy margins. Most of the fragments show evidence of advanced ocean floor weathering in the form of friable crusts of bright orange iron oxides and clays. It is thought that these fragments may have been in situ or were locally derived.
2. Sixty-two rounded and smooth pebbles, some with obvious glacial features (striae and faceting). The following lithological types were recognised: pale grey and green quartzites, porcellaneous limestone, chalk, altered tuffs, micaceous sandstone, shales and basalt. On the basis of shape, roundness, wide variation in lithology and evidence of glacial activity this group was classed as erratics.

Station 10609

This dredge recovered rocks from a col at the north end of the poorly defined central ridge, at 52°21'N, 31°45'W, over about 1.2 km of the sea-floor. The haul consisted of a mixture of gravel, cobbles, and one large boulder in a calcareous sand/silt. Many of the samples showed obvious evidence of glaciation and the majority were rounded or smoothed. The following lithologies were recognised: coarse red sandstone, porcellaneous limestone, banded gneiss, mica schist, grey sandstone, altered tuffs, granite, basalt, cherts and pink quartzite.

The large boulder was a pyroxene-biotite gneiss. On the basis of the varied lithology, shape and evidence of glacial activity this group is thought to consist of erratics.

The sediment was found to be primarily composed of foraminiferal and coccolith debris. Grains of olivine, feldspars and actinolite were also recognised.

C.J.R.

CORING

Operating difficulties with the traction winch limited the coring programme to only one core. This was taken using three 3m barrels on the IOS piston corer in the northern transform valley of the Charlie-Gibbs Fracture Zone. A site was chosen on a terrace above the valley floor where the 3.5 kHz profiler record showed a reasonably thick sedimentary sequence. 7.26m of sediment was recovered in the main core with 2.53m in the trigger core. The core was split aboard ship and showed a sequence of silty and sandy marls with some marly oozes and some diatom-rich horizons. There was no 'flow in' in the core and by comparison with the trigger core it was ascertained that only 15 cm of surface sediment were missing from the piston core. The trigger core had repenetrated several times but the top metre was undisturbed. No problems were encountered in handling the piston corer. The trip-chain length and free-fall distance were taken from the coring manual. The absence of flow in and the empty space between the top of the sediment core and the piston suggests that the piston stopped a couple of metres above the sediment surface during coring. In future deployments it may be beneficial to add one metre to the free-fall distance.

The coring warp was used in this deployment and, as on Discovery Cruise 124, large load oscillations were recorded by the dynamometer. The maximum average load on deck was just over 6 tons although the maximum load recorded, including the dynamic variation, was 10 tons. A 1.5-ton pull-out force was recorded giving a total load of 9.5 tons (less than the maximum load recorded during haul in). The record of the pinger on the core head shows an oscillation amplitude of about 10m while at the surface the swell had a height of about 2m.

P.W.

ACOUSTIC TRANSPONDER NAVIGATION

Two Mk-II 5.1 kHz transponder floats were moored 100m above the sea-bed at two sites 8 km apart overlooking the dredging sites. Several tracks cutting the baseline between the two floats were steered so as to measure accurately the length of the baseline.

To fix the position of the dredge, as well as the ship, a remote interrogator transponder was mounted between the main warp and the dredge. However, after the first dredge station, it was decided to do without the interrogator as it proved to be too time consuming to deploy and retrieve the dredge with this attached.

The two navigational transponder floats were used extensively throughout the dredging operations and provided fixes of the ship's position at approximately ten-minute intervals. With the ship up to 17 km away from the transponders, fixes were received clearly using standard techniques.

Due to bad weather and lack of time, the transponders were left on the sea-bed when the ship departed for St. John's. Both transponders were recovered successfully during Leg 2 after further service supporting coring and seismic weight operations.

I.R.

HEAT FLOW PROBE

The heat flow probe was successfully deployed at two stations which yielded data from a total of ten full penetrations, three of which recorded the decay of a heat pulse for sediment conductivity determinations.

The first station (10601) was located about 220 km north of King's Trough. Initial problems in handling the probe were overcome by employing a triangular arrangement of strops, fixed to points at each end of the head, to ensure the instrument balanced horizontally. A rope to a sliding collar was used to steady the strength member during launch. A 60° tilt pinger was fixed to the trawl warp 100m above the probe to assist in positioning the instrument above the bottom and to gauge the amount of slack wire after penetration. Eight dips were made at this station after some initial delay due to problems with the winch. The acoustic telemetry performed well and provided confirmation of the moment of penetration, the frictional heating and the effects of the heat pulse. Slack wire was maintained while the probe was in the bottom by paying out continuously at a rate of 0.2-0.3m s^{-1}. On recovery, the face seals of the monitor pressure case were found to be badly corroded. The cause was traced to current leakage from sponge pads within the battery pack and the problem was reduced by incorporating further insulation. A faulty switch was also rectified.

The second station (10606) was located on the northern flank of the eastern segment of the Charlie-Gibbs Fracture Zone. Due to a battery pack failure, acoustic telemetry was lost prior to the first penetration and the station was abandoned after the third penetration due to the warp becoming entangled with the pinger. Further problems with the winch also hampered this station.

The magnetic tapes from both stations were decoded and listed aboard ship using an Aandera/PDP11 replay system.

M.N.

POP-UP PORE PRESSURE INSTRUMENT (PUPPI)

PUPPI was designed and built to measure any difference in pressure between sediment pores and normal hydrostatic pressure for a period of up to several days.

Basically, the instrument consists of three sections:

1. A top weight and pinger assembly.
2. The centre section (floats and instrumentation).
3. The disposable bottom section.

The instrument uses two mechanical-acoustic releases, the first separates the top weight and pinger from the centre and bottom sections and the second separates the centre section from the bottom section.

To test the instrumentation (data logger and acoustic telemetry) PUPPI was assembled without the 3-metre long lance and with the mechanical releases made inoperative in order to conserve the retractor detonator for later experiments. Squibs were used in place of the retractor detonator. As an added precaution two safety ropes were attached between the top and centre sections in case of a mechanical failure.

The instrument was attached to the trawl-warp via a 20-metre length of polypropylene rope and a swivel. The instrument was launched and lowered into the water using the stern crane davit. At about 900 metres' water depth (having been lowered at 0.5 m s^{-1}) it was observed that the centre section of the instrument had become detached from the top weight assembly and was descending freely to the bottom at about 0.2 m s^{-1}.

On recovery the top weight and pinger systems were still attached to the warp, the remainder was missing. Although the precise mode of this failure is unknown, it is highly probable that initially the top mechanical release failed and that this was caused by either:

(a) excessive loading (imposed by ship's heave)

(b) the warp becoming entangled with the instrument

(c) vibration.

Dynamic loads of up to ±0.9 tonnes were recorded on the dynamometer prior to failure. A deep gouge on the lead weights and a badly-abraded polypropylene rope suggest that some entanglement occurred around the instrument.

It is estimated that corrosion around the bottom release mechanism will allow the instrument to 'pop-up' in about six months' time (February 1983) from its present position (46°2.3N, 23°13.9W).

P.J.S., B.H.

HIGH-RESOLUTION SUB-BOTTOM PROFILER

The main objective of the experiments with this instrument was to try to obtain an acoustic record and a core, whose acoustic properties could be subsequently measured, from the same site. The first attempt, at the site where we had taken the Driscoll core, was abandoned when the system's 250v power supply caught fire. The second attempt, at an IPOD drill site, was abandoned because the acoustic receiver became unstable when the instrument entered the water. This fault was eventually traced to an unsuitable termination on the CTD wire and the system operated correctly on the third attempt. The fourth and final attempt was at IPOD Site 548. The instrument operated correctly and a good acoustic record, of a different character from that usually produced by the instrument, was obtained. This record showed four major sub-bottom reflectors, but much less fine structure than usual. The travel times of these reflections seem to correlate well with 3.5 kHz profiler records from the same site and we hope that it will be possible to correlate the acoustic record with physical measurements on hydraulic piston cores taken during the IPOD programme.

R.J.B.

MICROEARTHQUAKE OBSERVATIONS

The prime objectives of this work were to determine the hypocentres and the focal mechanisms of microearthquakes which occur beneath the crests of slow-spreading ridges. In addition, the observation of earthquakes on a ridge crest adjacent to its junction with a major fracture zone may indicate how stress changes from a region of tension to one of horizontal shear.

Two arrays of four ocean-bottom seismographs (PUBS) were deployed. Each array formed an approximately equilateral triangle of side 12 km with an instrument at each of the vertices and the fourth instrument at the centre. This configuration gives a good uniform hypocentre resolution over an area roughly twice the array dimensions. Since accurate location of the instruments is important they were laid, when possible, at the times of good satellite fixes. In addition, 1000 in^3 airgun surveys were made subsequently so that sound ranging can be used to fix accurately the relative locations of the PUBS on the sea-bed. Co-ordinates for both the arrays are given in Table 2.

The first array straddled the median valley of the Mid-Atlantic Ridge some 20 km south of its junction with the eastern end of the Charlie-Gibbs Fracture Zone. This array should have detected events typical of a ridge crest environment and also those events occurring near the junction to the north. All instruments were recovered successfully after approximately 4.5 days' recording; all tapes ran and recorded data. Preliminary examination of the tapes, using audio-monitoring of a fast replay, indicates that over 200 microearthquakes were detected. In addition, shots fired on refraction line 10607 were also recorded.

The second array was deployed on the suspected short spreading centre which separates the north and south active transform faults of the fracture zone. Observations in this region, which should be strongly influenced by the thermal and stress regimes of the transform faults to the north and south, will provide an interesting contrast to the results from the first array which was on a ridge crest with the same spreading rate. The array was left to record while Discovery made the mid-cruise port call at St. John's, Newfoundland and all instruments were recovered successfully on the second leg. All tapes ran for the full 200 hours possible and over 150 events were recorded.

R.C.L.

CONTROLLED SOURCE SEISMIC EXPERIMENTS

The sole objective of the seismic refraction profiles shot on this cruise was to determine the thickness of the crust beneath one of the transform fault valleys of the Charlie-Gibbs Fracture Zone and the rate at which the crustal thickness changes in a direction normal to the valley.

Therefore three profiles were shot: (a) parallel to the valley on the hills south of the southern transform fault (station 10607); (b) along and within the same transform fault valley (station 10615); and (c) along a line normal to the fault and roughly centred over it (station 10617). Five tons of Geophex were fired to give 96 shots varying in size from 25 to 150 kg out to ranges of 95 km. In the range zero to 25 km, one or two 1000 ins^3 (16 l) airguns were fired every two minutes.

The above three stations involved the deployment of seven ocean-bottom seismographs (PUBS). All seven were recovered and they all recorded successfully the shots fired to them. A number of extraneous events, some possibly of biological origin, were also detected.

A novel experiment was carried out at station 10612. A 1.5-ton steel and concrete weight, containing a precision pinger, was lowered on the coring warp and impacted on the sea-bed 11 times while paying out the warp at 1m s^{-1}. The weight was designed to entrain about 1 ton of water so that on impact the moving mass was 2.5 tons. The surface waves and other seismic signals produced by this device were recorded on the sea-bed by PUBS at ranges out to 1300m. This source is not quite as effective as the free-falling 1-ton weights used on a previous cruise but nevertheless appears to generate useful signals from which it is hoped to derive sediment shear-wave velocity/depth models. Unfortunately, during its recovery, the weight was lost due to the failure of a 10-ton weak link under cyclic loading caused by the heave of the ship.

R.B.W.

POP-UP BOTTOM SEISMOGRAPHS (PUBS)

During the past year PUBS development has continued with the fitting of new hydrophones and new radio beacons and with tape-deck modifications. A new PUBS was also built during this period bringing the number of instruments available to six.

An Aandera current meter compass has been interfaced to the new PUBS clock formatter. The compass reading is sampled and digitised once every hour and stored. Each minute this stored valve is added to the time code word and recorded on tape.

In the course of the cruise PUBS were used to record microearthquakes and the signals from refraction lines (explosives and air-guns) and from a bottom source. This source was a concrete and steel weight, attached to the end of the coring warp, which was repeatedly impacted onto the sea-bed to generate surface waves.

Eight PUBS were deployed in two earthquake recording arrays. Seven other deployments were made during three refraction lines. These lines were shot parallel to, along the axis of, and across the southern transform valley of the Charlie Gibbs Fracture Zone. A specially modified PUBS with three 1-Hz geophones (Teledyne Geotech S500) was deployed to record surface waves generated by the bottom source. Moored transponder buoys were used as a navigational aid during this experiment.

Failure of the forward crane early in the cruise meant that all subsequent deployments and recoveries were carried out using the forward 'A' frame and capstan winch. This proved to be a very safe and controllable method of handling the PUBS inboard and outboard and, in fact, worked better than using the crane.

All PUBS were recovered successfully; acoustics and recovery beacons performing well. The new hydrophones gave good results. However the performance of the 1-Hz geophones is more difficult to assess as they were only used on one deployment.

Modifications to the tape recorders have been effective in preventing wheel slip in the direct drive system. This has eliminated a major source of noise and enhanced the reliability of the tape-recorders.

The digital compass was checked against a jelly bottle compass during one deployment. The two readings differed by 22° but, in view of the many possible sources of error in this comparison, we have no reason to suppose that the new compass was not functioning properly.

To summarise the PUBS performed well, proved reliable in operation and in excess of 1400 hours of ocean-bottom recordings were obtained.

R.E.K.

SHOTFIRING

Explosive charges were used as seismic sources for three refraction lines using ocean-bottom seismographs as receivers. A total of 5000 kg of ICI 'Geophex' in 12.5 kg sticks, together with 100 No. 8 star plain detonators, made up with 1m and 2m underwater safety fuse, were loaded in Gibraltar for these experiments. The table below summarises the charge sizes, fuse lengths, flight times, calculated shock factors and number of charges used for each refraction line. A total of 100 charges was laid without any misfires.

Charge size (kg)	25	50	150	
Fuse Length (cm)	60	75	150	
Flight time (s)	48	54	94	
Shock factor	0.006	0.009	0.007	
No. of) Line 1	20	12	4	
) Line 2	20	10	2	
charges) Line 3	0	23	4	
Total No.	40	45	10	= 95 charges
Total weight (kg)	1000	2250	1500	= 4750 kg

In addition to these charges 3 x 12.5 kg and 2 x 37.5 kg charges were detonated to destroy the contaminated plastic bags in which the explosive had been packaged. The remaining surplus of 137.5 kg of 'Geophex' was dumped overboard. Three test burns in air established a fuse burn rate of 136s m^{-1}. The shock factor was calculated for a speed of 10 knots using the relationship defined in Chapter 5 of NERC: Handling Explosives in Research Vessels, 1980. While the 'Geophex' was in general found to be in good condition, one box contained a few oily drops which may have contained some nitroglycerine. This box was immediately dumped overboard.

P.J.S.

AIRGUNS AND COMPRESSORS

Leg 1

Airguns were used for reflection and refraction profiles. A 300 in^3 gun was fired for 33 hours during a reflection profiling survey. Due to the winch problems, only one 1000 in^3 gun could be deployed at a time, although it had been planned that two 1000 in^3 guns would be used for seismic refraction work, because the technicians did not have time to rig up the system for using two guns at the same time as working on the winch system. A 1000 in^3 was used on four occasions at 4.5 knots.

When the first gun was deployed the connecting hose leaked due to a cracked fitting at one end. The gun was depressurised and the hose renewed. The second gun was deployed a few days later after first having had a new solenoid fitted. When this gun was brought inboard the hose had a large blister in the outer layer; this hose was also changed.

During the last deployment work was being carried out on the after hydraulic system and, for an unexplained reason, the airgun capstan spun round and broke the quick-fit coupling causing air to rush from the gun. This deployment was aborted and new quick-fits were sent to St. John's.

Leg 2

On two occasions, two 1000 in^3 guns were deployed together using a 230-kg depressor weight and the auxiliary winch. These guns were towed at 4.5 knots. Both guns fired successfully and no problems were encountered.

However, as more problems developed on the aft hydraulic system, the auxiliary winch could not be used so only one 1000 in^3 gun was deployed at a time using the airgun capstan for the last two occasions.

A seismic reflection survey was carried out over a proposed Glomar Challenger drill site. Before the drill site was reached the 40 in^3 gun was firing intermittently due to a faulty solenoid and firing cable. The gun was brought inboard, the solenoid was changed, the towing cable was removed from the capstan and a new one fitted and the survey was continued with no further problems.

After initial overheating problems, the compressors worked very well. The overheating seemed to be caused by an air-lock in the system. The only other problem was the pilot unloading valve on the No. 1 compressor which had to be re-wired as all the wires had vibrated out of their sockets.

B.K., R.P.

QUANTITATIVE UNDERWAY GEOPHYSICAL OBSERVATIONS

Depths, measured with an assumed sounding velocity of 1500m s^{-1}, were corrected using Carter's Tables.

Magnetic anomalies were calculated with respect to the 1980 International Geomagnetic Reference Field.

During Leg 1, free-air gravity anomalies were calculated using the 1967 International Gravity Formula in the Potsdam system. Leg 2 anomalies were all calculated with respect to the 1971 International Gravity Standardisation Network (IGSN 71). 14.9 mGal should be subtracted from Leg 1 values logged on board to obtain IGSN 71 anomalies.

Satellite fixes were used as the prime navigational aid at all times.

R.B.W.

PRECISION ECHO-SOUNDER

The fish behaved well in spite of being towed at over 11 knots for several days during Leg 1 and for nearly all the passage time during Leg 2.

Some interference between the 3.5 kHz profiling system and the 10 kHz PES was noticed. The 3.5 kHz system gave rise to ghost transmissions, scattering layers and sea bottoms on the echo-sounder record. The PES time-marks were not slaved to the Watesta clock during this cruise.

R.B.W.

VARIAN MAGNETOMETER

The magnetometer operated satisfactorily throughout the cruise. Ingress of salt water into the ouboard cable at the connector end caused some degradation of signal in the latter stages of the cruise causing the occasional spike on the analogue recorder.

C.P.

LACOSTE AND ROMBERG GRAVIMETER

The gravimeter (Serial No. S40) was installed in Gibraltar after being in store for one month after being shipped from Barry. The only fault which occurred during the cruise was the failure of an optic bulb in the gravimeter unit which resulted in the loss of five hours of data. Two 60-Hz power supply failures occurred during the first leg due to a circuit breaker "trip" during explosive runs, but data loss was minimal.

The gravimeter drifted by 1.6 mGal between Gibraltar and St. John's and by 1.2 mGal between St. John's and Falmouth, a rate which can be considered reasonable considering the "off heat" period prior to installation. Due to a discrepancy in the IGSN 71 base value supplied for Gibraltar the gravity anomalies for Leg 1 were calculated in the Potsdam system. 14.9 mGal should be subtracted from these anomalies to convert them to the IGSN 71 system.

C.P., R.B.W.

3.5 KHZ PROFILER

The IOS-designed 3.5 kHz high-resolution seismic profiling system was used almost continuously during this cruise over a wide range of sea-floor environments. It provided both useful information on sediment type and distribution and valuable operator experience in the interpretation of the echo-character detected by this particular system.

The towed fish, a modified IOS PES fish housing four Raytheon transducers, behaved extremely well. However, bad weather, or speeds in excess of 12 knots, made the records somewhat noisy especially during the Leg 2 operations in the Charlie-Gibbs Fracture Zone (CGFZ), although only rarely did they become difficult to interpret. The Raytheon programmable recorder used on this cruise led to increased flexibility and to less stylus maintenance.

Two particularly successful uses of the records produced by the system were, firstly, in locating and examining horizontal sediment continuity around a coring site and, secondly, in running the system over the same ground as the deep-towed high-resolution sub-bottom profiler for a direct comparison of resolution capability. At station 10619 the 3.5 kHz profiler detected four reflectors in the upper 25 metres of sediment. The deep-towed profiler also detected four main reflectors but many additional minor reflecting horizons were seen as well. The maximum penetration of both systems was about 25 metres sub-bottom. Principal objectives for which the system was used to study sedimentary processes were (in chronological order):

(1) Canyon interfluves in the northwestern Gulf of Cadiz to look for evidence of large-scale slope instability.

(2) Profiling across and around parts of the North West Atlantic Mid-Ocean Canyon (NWAMOC); four crossings of the channel were made. Its width off the Grand Banks Rise is around 3.7 km and its depth below the surrounding sea-floor is 115 to 135 metres.

(3) Survey of sediment distribution on the basement ridge north of the CGFZ northern transform fault.

R.B.K.

SEISMIC REFLECTION PROFILING

A two-channel Géomechanique hydrophone array was used. The resultant outputs were summed and filtered using two Kemo bandpass filters set to 5-120 Hz and to 40-120 Hz. The outputs were displayed on two EPC recorders. The 300 in^3 gun used in the Iberia Abyssal Plain was fired every 12 seconds for three hours and the 40 in^3 gun used for the IPOD drill site survey was fired every eight seconds for three hours. Good results were obtained on both occasions once initial problems with compressors and airguns were overcome.

One or two 1000 in^3 airguns were fired every two minutes for refraction purposes using a counter triggered by the one-second pulses from the Watesta clock.

C.P.

SHIPBOARD COMPUTING AND DATA LOGGING

The IBM 1800 computing system sampled data successfully for the duration of the cruise, with the exception of three occasions when sampling had to be halted.

The first failure was caused by a disk drive malfunction resulting in the processor hanging up. As a result, approximately 12 hours of data were lost or corrupted. The second failure occurred when the data filtering program became corrupted and sampling had to be halted for several hours in order to rebuild the program. The third failure occurred when a program used for course updating became corrupted. There was not room on disk to rebuild the program and so a new program disk was required. The second leg was terminated at that point in order to save the previous two-and-a-half days' data. About five hours of data was lost between the end of the second leg and the start of the "third leg".

None of the above failures had any major effect on the objectives of the cruise as all occurred while the ship was underway between stations.

Minor problems in the data sampling and processing were brought about by the following equipment failures:

The 1816 system console failed on two occasions, once when the carriage return contacts failed to make and a second time when the main cord snapped. The pen drive cord on the 1627 drum plotter parted. A loss of 5v in the clock interface was noted but the voltage reappeared before the fault could be isolated. An integrated circuit failed in the magnetometer interface and an integrated circuit failed in the Sat Nav to 1800 interface.

The EM log interface failed early in the cruise and there was no spare on board. A temporary circuit was built which functioned satisfactorily for the remainder of the cruise.

All other equipment worked successfully and without giving any problems.

P.M.

MAIN WINCH AND AFTER HYDRAULIC RING MAIN

Very many problems were encountered. These involved almost all the main components of the Main Winch system. Fault finding on the electro-hydraulic system was hindered by a lack of people on board familiar with the system. Repairs were hindered by a lack of spare parts.

Crane Davit/Driscoll Corer Handling Gear

The davit performed very well with no problems but handling of the Driscoll corer may only be manageable in good to moderate seas with a wind strength not exceeding 20 knots.

Traction Winch

The maximum speed seems to be limited to 1m s^{-1} in high gear while using the coring warp. Once the load exceeds about 5t low gear must be selected and the pay out speed limited to 0.5m s^{-1} (this happens at about 2000m wire out).

When using the trawl warp the same limit applies but, since the warp is lighter, more wire can be deployed before the limiting load of 5t is reached.

Cable Terminations

A new type of termination was fitted to the coring warp but it failed after four dredge stations and one Driscoll corer station. The maximum load did not exceed 10t. 5m of warp was removed and a new termination was fitted. As there was only one further station with this warp it is not possible to determine whether the termination design is faulty.

Storage Drum 'A' (Coring Warp)

Problems were experienced with the reeving carriage limit switches and with the scroll shaft.

Limit Switches

The limit switch actuator arms are of too light construction and, due to vibration and movement, they failed to operate the electrical switches. This fault is common to both the carriage switches and the end limit switches.

Scroll Shaft

The scroll shaft is manufactured in three sections: (a) centre scroll, (b) end driven/bearing unit and (c) end bearing unit.

Both end portions contain the last "knuckle" or portion of scroll gear.

While recovering the rock dredge from a depth of 3400m on Day 234 the end-driven portion of the scroll shaft rotated with respect to the centre scroll gear. This caused the knife follower to fail, not returning on reaching the end of the shaft, and to jam in place. The resultant shock loading caused the coupling between the differential gear box and the electric motor to shatter. As no spare couplings were available, the coupling from storage drum 'B' (trawl warp) was used.

The three portions of scroll shaft are joined together with either a press or a heat shrink fit. Very luckily, the driven end of the scroll shaft "picked up" and we were able to recover the warp by removing and repositioning the knife follower at each end of the lay thereby preventing the follower from reaching the damaged portion of the scroll gear. During the following two days we were able to remove the scroll shaft, realign it and key the part together. This was entirely due to the assistance of the ship's engineers.

To stop this problem recurring both sets of scroll gear must be removed and a key way, or some other form of positive drive, must be fitted.

Reeving Carriage

This is fitted with top and side rollers and is carried on a separate shaft from the scroll shaft. Due to warp movements and tensions the carriage is being lifted by between 3 mm to 6 mm while hauling and veering the warp. This, in turn, is causing the scroll shaft to flex and carry unacceptable loads. Therefore, it appears that the reeling carriage must be fitted with additional rollers to stop upwards movement.

Storage Drum 'B' (Trawl Warp)

This drum suffers from the same problems as the other storage drum and will require the same corrective action.

It is suggested that any equipment used on the trawl warp must have at least an 8m strop, with a swivel at each end, in order to stop induced torque in the warp as this may be a factor in the bad reeling of the drum.

Auxiliary Winch

The operation of this winch would be much simpler and easier with the addition of a hydraulic brake.

Hydraulic Power Pack

While recovering the seismic weight on Day 257, with about 2000m of coring warp out, a fault developed on No. 2 hydraulic pump. The warp was recovered at a rate of 0.2/0.3m s^{-1} using No. 1 pump only. The problem with the No. 2 pump was eventually diagnosed as a blocked high-pressure relief valve.

After stripping, cleaning and reassembling the relief valve the power pack was restarted and both pumps were checked by hauling and veering the warp on the traction winch against the ship's capstan for a period of about 45 minutes. The system functioned correctly.

The following morning, when about to deploy air guns on the auxiliary winch, pump No. 2 "saw" a mains pressure of about 4000 psi which then dropped off to zero. Both the boost and pilot pressure were normal. Pump No. 1 behaved similarly but the pressure stabilised at about 1500 psi.

Investigation revealed that pump No. 2 had a damaged fork on the swash plate controller and could not be removed at sea. It was not possible to find the basic problem with pump No. 1, in spite of extensive checks. From Day 259 until the end of the cruise the aft winch system was unserviceable due to the above pump problems.

Sundries

Pump No. 3, which controls the storage drum pressure, tripped out due to a thermal overload during the first leg. This caused slack wire to develop on the low tension side and allowed wire to come off the traction winch. The cause of the thermal overload is not known. Perhaps a safety interlock should be added to make sure the problem does not recur.

A MOOG control switch failed and was replaced by a spare.

G.V.L.

SCIENTIFIC PERSONNEL

		Leg 1	Leg 2
R.B. Whitmarsh, Principal Scientist	IOS, Wormley	X	X
R. Babb	IOS, Wormley		X
Ms. S. Drake	IOS, Wormley	X	X
E.G. Garcia	Spanish Observer	X	
M. Geoghegan	Irish Geol. Survey	X	
B. Hart	IOS, Wormley	X	
Q. Huggett	IOS, Wormley	X	X
C. Jacobs	IOS, Wormley	X	X
R.B. Kidd	IOS, Wormley		X
R.E. Kirk	IOS, Wormley	X	X
B. Knowles	IOS, Wormley	X	X
R.C. Lilwall	IOS, Wormley	X	X
G.V. Lodge	IOS, Wormley	X	X
S. McPhail	IOS, Wormley	X	X
P. Mason	RVS, Barry	X	X
Ms. E. Murrell	IOS, Bidston	X	
M. Noel	IOS, Wormley	X	
C. Paulson	RVS, Barry	X	X
K. Peal	IOS, Wormley		X
R. Phipps	IOS, Wormley	X	X
I. Poutiers	Univ. Bordeaux		X
Ms. M.C. Price	IOS, Wormley		X
C.G. Richardson	Univ. Newcastle	X	X
I. Rouse	IOS, Wormley	X	
P.J. Schultheiss	IOS, Wormley	X	X
P. Weaver	IOS, Wormley		X

SHIP'S PERSONNEL

	Leg 1	Leg 2
Master	S.D. Mayl	S.D. Mayl
Chief Officer	S. Jackson	E.M. Bowen
2nd Officer	T.C. Harrison	S. Jackson
3rd Officer	P.G. Pepler	T.C. Harrison
Chief Engineer	A.E. Coombes	A.E. Coombes
2nd Engineer	N.A. Wilson-Deroze	R. Cotter
3rd Engineer	D. Hornsby	C.J. Phillips
4th Engineer	P.F. March	P.F. March
5th Engineer	T.J. Comely	N. Davenport
5th Engineer	K.T. Sullivan	K.T. Sullivan
Electrical Engineer	P.F. Sharpe	B.A. Smith
Radio Officer	C.S. Currie	C.S. Currie
Purser/Catering Officer	R.M. Morris	R.M. Morris
Chief Petty Officer	F.S. Williams	F.S. Williams
Petty Officer	L. Cromwell	L. Cromwell
Petty Officer	D. Knox	D. Knox
Seamen	S.J. Allison, J. Davies, A.B. Nogan, B.J. Lamb, A.G. Hennah, M.H.S. Johnson, G.R. Leonard	
Chief Cook	C. Hubbard	A. Santos
2nd Cook	J.R. Bussey	J.R. Bussey
2nd Steward	M.A. Craig	B. Clapp
Stewards	M. Harvey	M. Harvey
	W.H. Emery	W.H. Emery
	C.J. Elliott	M.A. Craig
	J. Tucker	J. Tucker
	R.D. Whitcombe	R.D. Whitcombe
Motormen	J.R. Cooper, F.G.S. Leonard, M. Muthawa	

TABLE 1 - STATION LIST

STATION NUMBER	TYPE	POSITION Latitude °N	POSITION Longitude °W	DEPTH (ucm)	TIME (GMT) Start	TIME (GMT) End	COMMENTS
10600	Heatflow	45°13'	22°24'	-	0430/230	0530/230	Station abandoned due to handling difficulties.
10601	Heatflow	46°30'	23°28'	4015	2000/230	0450/231	8 bottom penetrations, 3 conductivity measurements.
10602	Micro-seismicity	51°50'-51°58'	29°53'-30°06'	2655-3375	0717/233	0838/238	4 PUBS deployed, 1000 ins^3 airgun survey.
10603	Acoustic transponders	52°26.4' 52°22.1'	31°50.9' 31°50.7'	2760 3125	0845/234	1940/257	Transponders used to navigate dredges and PUBS.
10604	Dredge	52°22'	31°43'	3060-3300	1300/234	1736/234	Fresh basalts and 1 gabbro recovered.
10605	Dredge	52°21'	31°42'	3000-3300	1800/234	0730/235	2 erratic cobbles.
10606	Heatflow	52°21'	30°00'	4150	1530/235	0136/236	2 bottom penetrations, premature termination due to winch fault.
10607	Seismic refraction	51°58' 51°53'	31°51' to 30°10'	1640-2790	0600/236	1635/237	38 shots, 1000 ins^3 airgun fired, 2 PUBS laid.
10608	Dredge	52°20'	31°41'	3090-3370	1600/238	2321/238	Cobbles and gravel, basalt and erratics.
10609	Dredge	52°21'	31°46'	3210-3280	0045/239	0530/239	Erratics and sediment
10610	Micro-seismicity	52°19'-52°24'	31°42'-31°49'	3190-3468	0900/239	0915/256	4 PUBS deployed, 1000 ins^3 airgun fired.

TABLE 1 - continued

STATION NUMBER	TYPE	POSITION Latitude °N	POSITION Longitude °W	DEPTH (ucm)	TIME (GMT) Start	TIME (GMT) End	COMMENTS
10611	Piston core	52°31'	31°49'	3750-3890	1205/256	1658/256	7.3m core and 2.5m trigger core.
10612	Seismic weight	52°31'	31°52'	3830	1809/256	0420/257	11 impacts, 1 PUBS deployed. Weight lost due weak link failure.
10613	Velocimeter	52°21'	31°44'	-	1200/257	1520/257	Velocimeter paid out to 2000m.
10614	Sub-bottom profiler	52°34'	31°48'	-	2150/257	0000/258	Abandoned due fire damage to equipment.
10615	Seismic refraction	52°11' 52°06'	31°36' to 30°20'	3830-4520	0858/258	1225/259	32 shots, 2 x 1000 ins^3 airguns fired, 2 PUBS laid.
10616	Sub-bottom profiler	52°50'	30°21'	-	0000/260	0235/260	Station abandoned due transducer problems.
10617	Seismic refraction	52°26' 51°36'	30°49' to 30°56'	1330-4320	0655/260	1519/261	3 PUBS laid, 27 shots, 1000 ins^3 airgun fired.
10618	Sub-bottom profiler	45°45'	14°25'	4520-4540	0940/264	1330/264	Station successful
10619	Sub-bottom profiler	48°54'	12°12'	1220-1320	2223/264	0036/265	Near IPOD Site 258, successful.

TABLE 2 - MOORED EQUIPMENT

STATION NUMBER	GEAR	TIME (GMT)		DEPTH (ucm)	LATITUDE °N	LONGITUDE °W	COMMENTS
		DEPLOYED	RECOVERED				
10602	PUBS 2	0717/233	0300/238	2715	51°53.65'	29°52.94'	
	PUBS 3	1012/233	2338/237	2655	51°50.4'	30°05.55'	
	PUBS 4	1156/233	0838/238	3375	51°57.6'	30°03.91'	
	PUBS 5	1315/233	0548/238	3275	51°54.56'	29°59.10'	
10603	TRANSPONDER 1	0845/234	1940/257	2760	52°26.42'	31°50.87'	
	TRANSPONDER 2	1044/234	1732/257	3125	52°22.12'	31°50.68'	
10607	PUBS 6	0721/236	0600/237	1775	51°53.20'	30°24.72'	
	PUBS 7	1912/236	1635/237	2797	51°57.95'	31°22.51'	No transponder, found by visual search.
10610	PUBS 2	1249/239	0530/256	3190	52°20.82'	31°46.50'	
	PUBS 4	1011/239	2355/255	3285	52°23.9'	31°46.50'	
	PUBS 5	1146/239	0300/256	3468	52°19.04'	31°49.34'	
	PUBS 6	1337/239	0915/256	3340	52°19.31'	31°41.81'	Weak radio, found by visual search.
10612	PUBS 7	1809/256	0420/257	3832	52°31.28'	31°52.96'	Released on back-up clock.
10615	PUBS 2	0858/258	0615/259	4280	52°9.40'	31°14.93'	
	PUBS 6	1837/258	1225/259	4480	52°6.71'	30°32.46'	
10617	PUBS 2	1148/260	1519/261	2623	51°44.12'	30°54.90'	
	PUBS 5	1302/260	1305/261	3255	51°35.77'	30°55.54'	
	PUBS 6	0645/260	0345/261	3870	52°26.32'	30°48.77'	

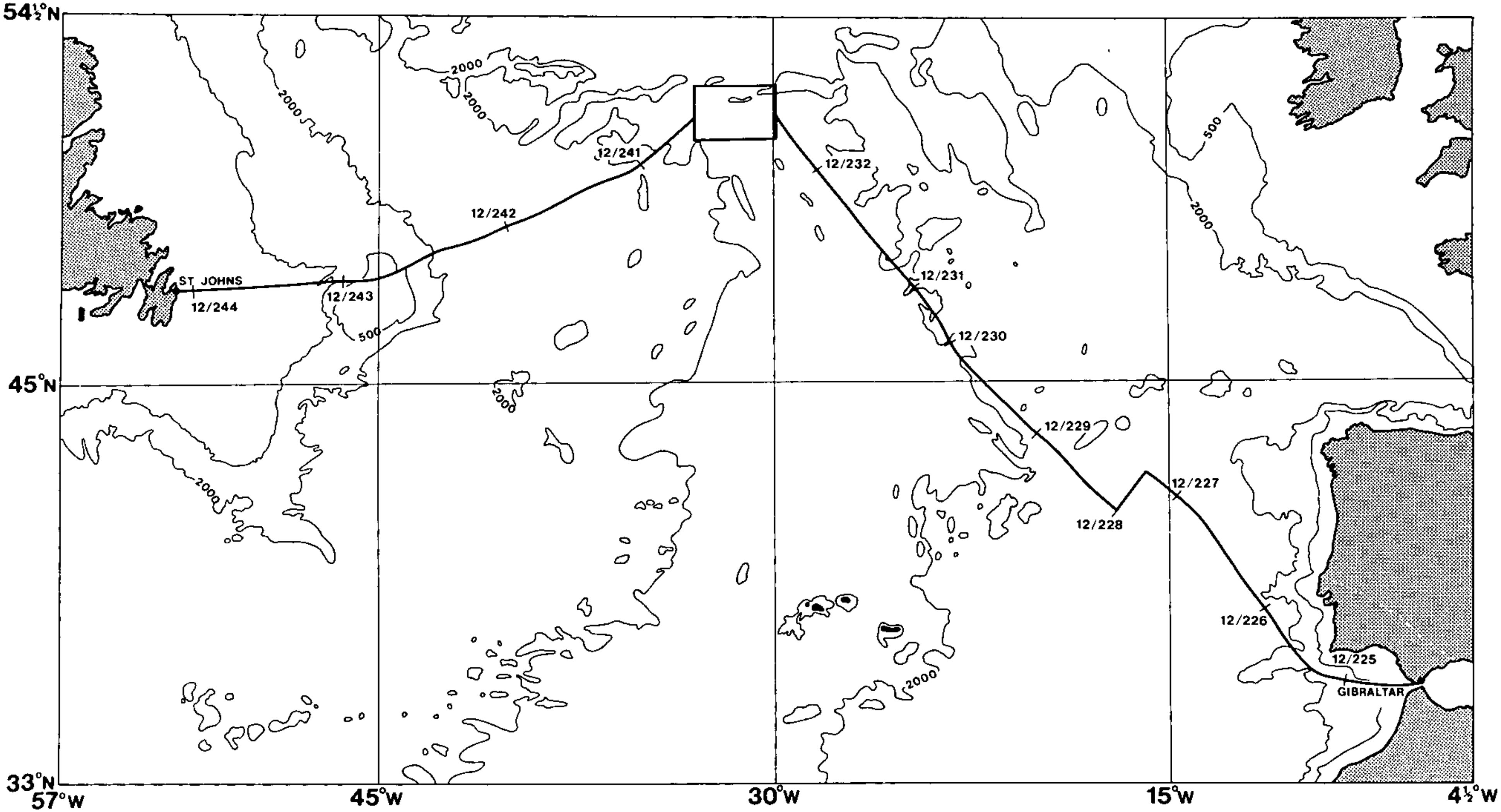
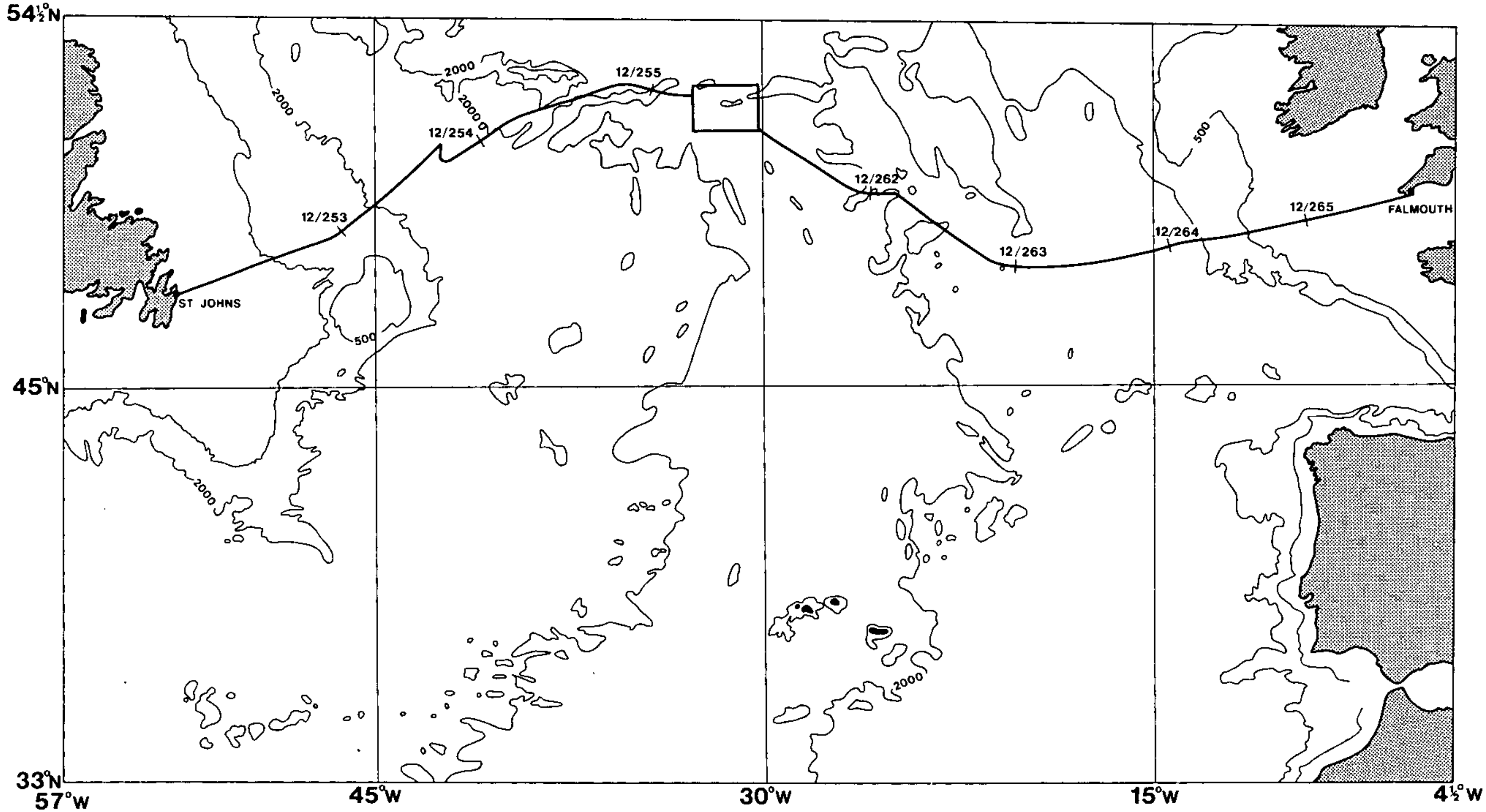
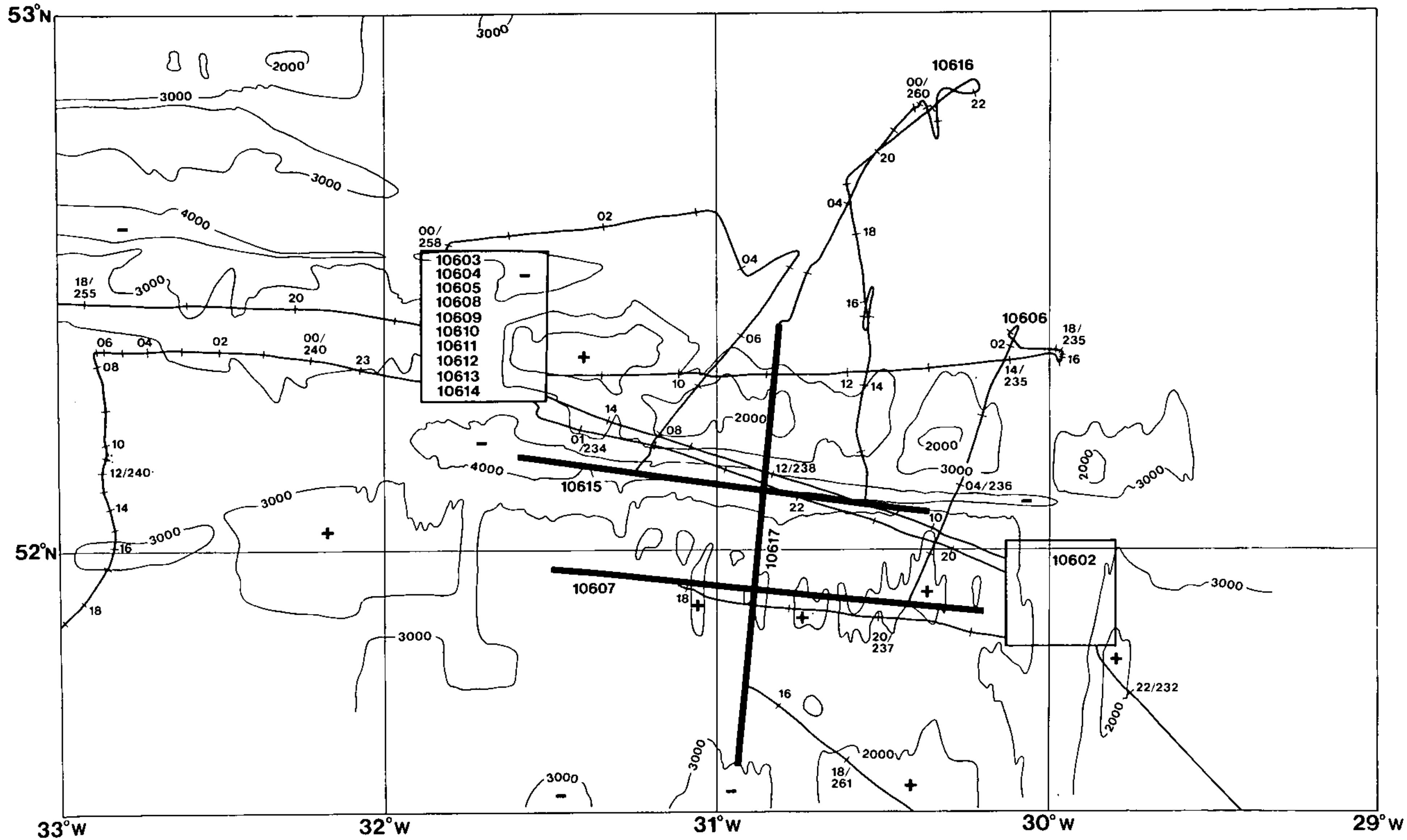

54½°N
45°N
33°N
57°W
45°W
30°W
15°W
4½°W
ST. JOHNS
GIBRALTAR
12/244
12/243
12/242
12/241
12/232
12/231
12/230
12/229
12/228
12/227
12/226
12/225
2000
500

Fig. I


54½°N
45°N
33°N
57°W
45°W
30°W
15°W
4½°W
ST JOHNS
FALMOUTH
12/253
12/254
12/255
12/262
12/263
12/264
12/265
2000
500
Fig.2


53°N
52°N
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31°W
30°W
29°W
10616
10603
10604
10605
10608
10609
10610
10611
10612
10613
10614
10606
10615
10617
10607
10602
3000
2000
4000

Fig.3