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RRS CHALLENGER

CRUISE 26/88

10 MARCH - 29 MARCH 1988

MOORING DEPLOYMENT AND ASSOCIATED WORK AT HEBRIDES SHELF EDGE AND RECOVERIES IN BRISTOL CHANNEL

CRUISE REPORT NO. 1

1988

NATURAL ENVIRONMENT RESEARCH COUNCIL

PROUDMAN OCEANOGRAPHIC LABORATORY

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Mooring deployment and associated work at Hebrides Shelf edge and recoveries in Bristol Channel

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ABSTRACT

This report describes RRS CHALLENGER cruise 26/88, from 10th March to 29th March 1988. Five current meter moorings (three with thermistor chains) were deployed in a section across the Hebrides Shelf edge near 58° 8'N, together with one acoustic doppler current profiler, a bottom pressure recorder at either end of the section, and another mooring 10km further north. Ship-borne acoustic doppler current profiling, surface measurements and depth profiles of conductivity and temperature, box coring, bottom photography and side-scan sonar surveys were carried out intensively in the area. Recoveries of two bottom pressure recorders in the Bristol Channel, and of STABLE, were attempted.

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Acknowledgements

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CRUISE OBJECTIVES

1. Deploy 6 moorings and two bottom pressure recorders at the Hebrides Shelf edge.
2. Deploy 2 acoustic doppler current profilers, and recover after 7 or more days (neap to spring tides).
3. CTD and shipborne acoustic doppler survey across the continental slope (300m to 1850m).
4. Side-scan sonar survey of Hebrides shelf edge near 58°N.
5. Box cores and bottom photographs from the same area.
6. Surface temperature and conductivity continuous sampling underway and on passage.
7. Recover 2 offshore pressure recorders from Bristol Channel.
8. Recover Sediment Transport And Boundary Layer Equipment from Bristol Channel.

NARRATIVE

Troon - Hebrides Shelf Edge - Holyhead

After departing from Troon at 1545 on 10th March (all dates hereafter refer to March) and a brief pause to put out the overside pump for continuous temperature and conductivity sampling (q.v.) course was made for the deployment section near 58° 9'N, 9° 40'W. Upon arriving at 0200 on 12th, a short survey was carried out to check the presence of a suitable location of gentler slope for the planned 950m mooring, between the two known scarps along the continental slope in this area. After wire testing of some mooring acoustics (0400-0800) the planned deployment section was traversed, heading 110° inshore from 1200m to 300m water depth, where the first deployment was made at 1020: a bottom pressure recorder. Following a successful floatation test, one of the P.O.L. acoustic doppler current profilers (POLDOP) (q.v.) was deployed in 400m at 1300hr. Continuing WNW along the section (conveniently characterised by Decca Green lane H46) a current meter mooring was deployed in 450m (1400-1445 hrs) but an intended CTD profile was postponed owing to a winch fault. After further wire testing of acoustics, the 650m mooring was deployed; drifting during the lengthy buoy-first operation necessitated a tow of the nearly-complete mooring around to the correct depth; the whole procedure took about 3 hours (1800-2100).

During the night of 12/13th course was made, via the 450m depth contour with slow steaming to use the acoustic doppler current profiler (ADCP) in bottom-tracking mode, to a deep-water position off the next mooring location for

more wire testing of acoustics. Then the northerly 650m mooring was laid (0940-1140) again involving a tow to bring the mooring to the correct location, on this occasion after excessive allowance for drift during paying out. An alongside CTD dip followed; en route to the next mooring location a CTD dip was performed alongside the previous day's 650m mooring. Then the 560m mooring was deployed (1430-1545; out of sequence because of a fault in its designated acoustic release in an earlier wire test) with a subsequent CTD dip alongside. Finally, the 950m mooring was deployed (1830-2000) and a straight-line course (for the ADCP) set for 2000m water to wire-test the deepest releases.

On the morning of 14th the 1500m mooring was deployed (1020-1245 including a ½hr tow to the right depth). CTD dips were performed alongside this mooring, the 950m mooring of the previous day and the deep pressure recorder site. The recorder itself successfully underwent a floatation test and was laid at 1730 to complete the deployments of the cruise.

It had been intended then to run a side-scan survey along 250m and 350m depth contours in 58°N to 58° 20'N, and indeed the UDI fish was put astern and cable paid out. However, an intermittency in the signal and worsening weather prompted the hauling in of the fish and the intended track was followed with only the ADCP operating.

On return to just north of the deployment section (1400/15th) a temporary fault in the CTD winch led to a second trial of the UDI side-scan. However, this was again unsuccessful (there being no evidence of a transmitted or received signal) despite considerable earlier efforts to secure and dry out all connections (q.v.).

At 1630 (15th) a CTD dip was carried out adjacent to the 450m mooring (thus completing the set of dips adjacent to each mooring). The bottom camera (q.v.) was also lowered successfully here, and later in 750m on the upper scarp where hourly CTD dips followed overnight, until higher seas curtailed the sequence to a span of 10 hours. After more steaming with the ADCP in bottom-tracked mode (16th a.m.) further camera stations were carried out adjacent to the mooring line at 355m, 605m and 863m water depth, with CTD casts also at 350m and 855m. During the night 13 hourly CTD dips were carried out near 600m depth just inshore of the scarp.

Advantage was taken of the calmest weather and seas to date (on 17th) to attempt two box cores, at 340 and 248m depth. Both were shallow (the second hardly penetrating at all on one side) owing to heavy clay just beneath the surface, but the first was sufficiently structured to take some sections. After

also checking the shallower pressure recorder, course was made eastwards for shallower water to again try out the side-scan sonar after two days' overhaul. The bottom was identified in the image after some experimentation; the cable to the fish could then be paid out with confidence, lowering the fish closer to the sea bed and much improving the image. A survey between 58° 5'N and 58° 15'N began, with runs northwards along 8° 45'W, southwestwards at 250m depth and northeastwards along the 350m depth contour. Worsening weather caused deteriorating records, and the survey had to be abandoned and the fish brought inboard when the ship's speed could no longer be guaranteed. RRS Challenger hove to and subsequently sheltered off Lewis, continuing to operate the shipborne ADCP and overside pump for surface CTD sampling (although the latter's logging failed for ½ day). One CTD and a trial of the EG&G 110KHz sidescan were carried out while sheltering. At midnight of 19/20th course was made westwards in improving conditions for the POLDOP position, the acoustic release pinger was switched on and the rig located. CTD and camera stations were carried out nearby, with the intention of obtaining at the same time shipborne ADCP measurements directly comparable with POLDOP (but faulty records with the former may prevent this). POLDOP's release was then triggered and the rig floated to the surface, was immediately spotted 200m to starboard and was recovered without difficulty. CTD and camera stations (the latter with some delay owing to the hydrographic wire running out of a block) were carried out at 600m near the deployment section before 13 hourly CTD dips near 750m were embarked upon overnight.

Conditions were now good and 21st March continued with a camera station nearby (780m) and CTD and camera stations near 890m (the latter had to be repeated when no pictures were obtained at the first attempt). Box cores were then taken at 810m, 672m and 605m, before resuming the side-scan sonar survey with a short run along the 350m contour, continuing with runs along the contours for 420m, 510m, 610m and 750m approximately, between 58° 5'N and 58° 15'N. Continuing the latter (22nd, p.m.) with a cross-shelf run along 58°N in to 400m depth, the fish grounded and was hauled in, fortunately revealing only minor superficial damage. A final box core, at 450m to complete the depth sequence, was enabled by the return of a calm sea.

Overnight (22/23rd), a sequence of bathymetric sections across the slope was commenced, with CTD stations at either end and at some locations between. Fine weather permitted this work to continue through 23rd, including some further wire tests of acoustic releases. The tenth section being completed at

0300 (24th) in worsening weather, course was made for The Minch (around the Butt of Lewis) and a relatively sheltered passage to Holyhead, arriving 0830 on 26th (the shipborne ADCP and surface temperature and salinity sampling continued under way, the latter ceasing with pump failure in The Minch).

Holyhead - Bristol Channel

After exchanging scientific personnel and loading diving equipment by small boat at Holyhead during the morning of 26th, Challenger put to sea at 1100 hrs and headed south for the Bristol Channel area.

At 0515 hours the following morning, 27th March, Station BCS 2 was occupied and attempts were made to locate the pop-up pressure recorder at this site but without success. After carrying out an acoustic/visual search 1/4 mile around the station position the ship left the station at 0850 hours and headed for Station BCS 1, eventually arriving at 1420 hours. Again, no contact was made with the pop-up pressure recorder so at 1537 hours an attempt was made to drag for the mooring, but after several passes the drag line parted under a load of 2 tons, most likely due to the uneven sea bed. At 1635 hours the acoustic search area was widened to 1/4 mile, then $\frac{1}{2}$ mile radius around the position but no contact was made, so at 1752 hours the ship left the station and headed for the STABLE site west of Lundy. At 2222 hours the STABLE site was occupied and the pinger on the rig activated at the expected position.

At 0600 the following morning (28th) and with the promise of improving weather later in the day, a survey was started to fix the location of the rig accurately enough for divers to find it on the sea bed. Use of the EG&G side-scan sonar failed to produce any positive targets so navigation was dependent on acoustic tracking and Decca plotting. This continued throughout the morning until 1005 hours when the frayed end of the pellet line attached to the STABLE rig was sighted floating on the sea surface. A small boat was launched and an extra length of line plus pellets was attached to the free end to provide a visible marker. Two other marker floats were placed in close proximity either side of the rig position on weighted lines.

Although the weather had improved considerably during the morning, with the wind falling away to 10-15 knots, the swell still remained too high for diving during the slack water period at 1500 hours, so at 1400 hours the ship left the STABLE station and proceeded to BSC 1 arriving at 1815 hours for another attempt to locate the missing pressure recorder. An acoustic search was made along a line west to east for a distance of 4 miles each side of the position but nothing was found. The ship docked at Barry at 0500 hours on 29th March.

INDIVIDUAL PROJECT REPORTS

Deployment of Moorings (D.L. Leighton)

6 current meter arrays were deployed (three with thermistor chains incorporated) in depths of 1500m, 950, 650 (2), 550 and 450m. Owing to a combination of circumstances these rigs had to be deployed buoy first. The two deeper moorings used Kevlar rope extensively to reduce weight, being designed to allow for 5% stretching. The 950m mooring's thermistor logger was at its design depth for pressure on the case. All arrays were deployed successfully, but on occasions the whole array had to be towed for quite a distance, to obtain the correct depth, because drift during deployment could not be estimated accurately a priori.

Perhaps the most worrying feature of this operation, was the number of fishing vessels working in the vicinity of the line of moorings.

Pressure Recorders (A.J. Harrison)

For measurement of pressure differences along the survey section a Teleost pop-up pressure recording system was deployed at each end of the section. At the easterly station, BP 300, two independent recording instruments were used, together with release acoustics CR 2474C which has the Bell ceramic ring transducer. TG 289 is fitted with a Digiquartz pressure transducer while TG 281 has a Bell & Howell strain gauge pressure sensor.

At the westerly station, BP 1800, three recording instruments together with CR 233 release acoustics unit and transponder T7 were fitted to the same frame and, after carrying out a buoyancy test, one extra 10" DIA glass float was attached in addition to the four 17" DIA units to give an extra safety margin in the event of an instrument flooding. TG 283 and TG 293 both employ the Kulite silicon strain gauge pressure transducer while TG 292 has the Digiquartz pressure transducer.

Each instrument has a temperature sensor as well as the pressure sensor and was set to sample both channels every 15 minutes throughout the deployment period, except for TG 292 which was set at 30 minutes sampling. Continuous integration of the sensor output is employed on each instrument.

At each station the deployment was carried out as planned and the instruments allowed to free-fall onto a flat sea-bed to rest on the 135Kg ballast frame at a descent rate of about 1 m/sec.

Acoustic Doppler Current Profiler (POLDOP) (D. Flatt)

A 260KHz ADCP, serial number POLDOP01, was deployed on a modified Teleost frame with the usual acoustics and release systems. The instrument was set up

on the ship as follows:-

10 minutes sampling
Tx pulse 8 msec
1st cell 18 metres from sea bed
cell length 11 metres vertically
24 cells
150 pings per sample

At recovery (after eight days) the rig ascended the 400m to the surface in eight minutes and was on board ½ hour later.

The last sixteen hourly samples were printed out from the cache memory. The data showed that the rig had been in an upright position, the backscatter strength was low and the correct number of samples had been recorded. The TVG and backscatter strength indicated that the first eight cells could provide usable data, a range of 100 meters. Plots of the Doppler data were made showing the tidal cycle and current direction.

A second rig was not deployed owing to an electronics fault.

Acoustics (P. Foden)

Acoustic wire tests began on 12th March. The ship is equipped with a Mufax and PES and both of them were used with POL's MK IV deck unit and a Nagrafax.

It is possible to switch the output from the PES fish from eight elements (standard PES mode) to single element. The single element provides a tight beam downwards and was the mode used for all the wire tests. The single element is equivalent to the tadpole or hand-held overside transducers used at POL.

Problems were encountered with the Nagrafax and so the spare unit had to be employed. The symptom was no output at the stylii and has been experienced with this unit before.

Six units were wire tested on the 12th March to a depth of 500m using the hydrographic winch. All units fired their test fuses and release times were in the range 7-8 x 10 secs. The next wire test was carried out at 600m with similar results, all fired their fuses with release times of 8-10 x 10 secs.

The deeper wire tests took place on 13th March at 950m and 650m. Difficulty was experienced with unit 2472c (ceramic ring). This unit started pinging in beacon mode before a 320 Hz transmission was made. It was put to one side for repair and later retest. The other unit worked satisfactorily with a release time of 9x10 secs. At 650m just one unit was tested which operated successfully with a release time of 8x10 secs, one of the fuses did not fire, but did so when tried again in the lab later. A new lead was fitted to the unit

(2421) in case the contact resistance was too high.

On 14th March a further wire test was carried out at 1800m. Both units fired their fuses and had release times of 10-11x10 secs. After this time the deployments were carried out and surveying began. On the 22/23rd March a further six units were wire tested at 1000m.

All six units operated successfully and fired their fuses. 2472c had been modified to make it less sensitive and functioned satisfactorily. Release times varied from 6x10 secs to 19x10 secs (the high time for 2472c is probably because it is a shallow unit and not designed to operate with the single element).

Only one recovery was made and that was 1AD400 on 20th March. This was successful and the rig popped up only 200 metres away from the ship. One recommendation for further trips is a switch box, to change over the tracker unit and the PES without disconnecting the Plessey plug at the rear of the Mufax.

Summary of acoustic units and sites

Site	Unit
BP 300	2474c
CM 450	229c
CM 560	2421m
CM 650N	2326m
CM 650S	2327m
* CM 950	236m
CM 1500	2166m
BP 1850	233m

* This mooring was trawled almost immediately, recovering the acoustic unit (and one current meter).

On the 27th March the recovery of BCS2 and BCS1 was attempted. There was no acoustic response at either of these sites.

On the same day the search for the STABLE site was started. The rig was fitted with a ceramic ring acoustic beacon and a spherical pinger. The beacon frequency was transmitted when we were approaching the site and only the ceramic ring beacon responded. The beacon was left to time out pending daybreak.

On 28th several attempts were made to get close to the site by using the Decca. This brought the ship close to the site but not over the top. Both towed Dolphins were deployed and a manual switch was used to switch between Port and Starboard sides. (The Dolphins were fitted with ceramic rings and matching chokes.) The Mufax was used to give a clearer display of progress. It was easy

to see the path difference between sides and easy to make modifications to the ship's heading.

On the first pass of the site the STABLE pinger was very close on the starboard bow; at the same instant a rope was seen floating in the water on the starboard side. On the second pass the ship was guided very close to the site and the rope was clearly visible again. Subsequently the rope was found to be the original pellet float line.

This exercise shows the importance of using at least two acoustic beacons to mark seabed moorings.

Ship-borne Acoustic Doppler Current Profiler (ADCP) (D. Teare)

The ADCP was started on 12th and ran for 13 days until approaching Holyhead (26th). During this time there were three system failures. Two can be attributed to the I.B.M. P.C.; the other to the ADCP electronics. The cause of these failures has not been established, but the mains supply must be suspected, as this has caused problems on other equipment in the past. A first course of action would be to either fit a mains conditioning unit or connect the equipment to the ship's "clean" computer supply.

Whenever possible the ADCP was run in the "bottom tracking" mode, which was useful in water depths of up to 500m, the maximum range of current profiling being 350m. In water depths up to 350m the profiling range was approximately 85% of the water depth, the shortfall being due to the side lobe effects of the transducer beam. In water depths over 500m "Mean" mode was used to give a shear current display. There are two possible ways of achieving this; the first is to re-program the ADCP to "mean" mode, the second being to allow the system to default to "mean" when the bottom tracking is lost. The first method gives greater accuracy but requires that recording is stopped while the mode is changed. The second method does not require recording interruption, but accuracy is reduced due to the lower number of pings/ensemble in the "bottom tracking" default mode.

A check was also kept on the I.B.M. clock which is known to drift, and was re-set twice when the recording disc was changed.

A floppy disc recording of the "ADCP set up" and "log list" parameters was also made; this proved very useful on system failures and time resets by reducing the time spent "button punching". It may be worth noting that the "ADCP set up" and "log list" can be saved as the default program on I.B.M. hard disc.

CTD and Surface Sampling (R.I.R. Palin)

The surface sampling hardware was essentially the same as on previous cruises, except that the overside pump housing was strengthend to resist the extra strain imposed by the increased speed of the Challenger.

The system worked without mechanical failure until 24th when the pump failed. This was entirely to be expected; the life of the pump in service is known to be about a fortnight. Since the cruise was all but over, it was decided that it was unnecessary to fit the spare pump.

The logging of the surface data and CTD dips is now carried out by a dedicated micro computer, interfaced to an Amstrad PC 1640. The logging of the dips was carried out very successfully, with the system able to be used by all personnel with no more than a few minutes training, thus meeting its prime design objective. The surface sampling, however, was to begin with less than perfect, and some work was necessary to bring it to an acceptable state, but it is now in a fully usable state, including logging of latitude and longitude from the Mark 53 Decca on the bridge. Dips and surface tracks can be plotted on the A3 plotter which is part of the system.

It would be useful if the PES system gave an RS232 output of depth for this and other logging systems; the saving of man hours when depth surveys are carried out would be enormous, and building the interface would be trivial.

Box Corer (J.D. Humphery)

A Reineck box corer was used to provide sedimentological information along the section to 810m. It had not been used since the IOS (Taunton) closure, and very little expertise in its use was available. Advice was obtained before departure.

A large horizontal frame, approximately 2.5m x 1.5m, supports a gimballed piston with a throw of 500mm. An open-ended stainless steel box, 280mm x 200mm x 450mm high, is pushed into the seabed by the weight of the piston. A knife closes the bottom of the box before withdrawal. All-up weight is approximately 800kg and cores to the depth of the box can be obtained in soft sediments. Wedges were used to lock the gimbals while the apparatus was on deck; a pinger was fitted to provide precise information on height above bottom, using the PES. Lessons regarding corer use were learned very quickly.

The corer was used once at each of six locations - limitations on time precluded further work. Six cores were obtained varying from very good to poor. Weather was (necessarily) good, but a fair swell was running on each occasion.

Up to four sub samples measuring 300 x 200 x 50mm could be obtained from

each box. Four sub samples were taken from the first, third, fourth and fifth cores, three from the sixth, and only one from the second. Generally, the cores were of sand overlying clay, the clay being softer from deeper water. Box penetration was poor in shallow water. Surface stones and bioturbation were generally present. One sub sample was taken at right angles to the others. Sample orientation relative to North is unknown. The sub-samples were numbered, photographed and and wrapped in polythene for transport, and were stored horizontally.

Longer sub-sample boxes, (perhaps of plastic for x-radiography) could be used with advantage in soft sediments.

Camera (J.D. Humphery)

A camera was used to photograph the sea bed around the current meter sites. The photographs are used in conjunction with the sidescan records and box cores to provide information on bed material and bedforms.

The camera is a 35mm, full-frame, optically corrected, flash illuminated survey camera, mounted in a simple rectangular frame. It was manufactured by Underwater and Marine Equipment Ltd., (no longer in business). The flash unit is mounted at the bottom of the frame, looking outwards and slightly downwards to provide maximum contrast of bedforms. The camera is mounted as high as possible (to maximise coverage and minimise backscatter) and looks at the centre of the flash field. Lens to subject distance is about 2m. The system is actuated by a bottom contact switch; a compass is included in the photoframe to show the orientation of bedforms.

It was deployed successfully on nine occasions. At each site, a 36 exposure FP4 black and white cassette was used, providing up to 26 useful shots. Note however that many were lost due to pre-triggering and for other reasons.

A total of 160 bottom shots was obtained: most were of good quality. 35 frames were printed at sea (no more paper was available). Generally a silty surface with numerous pebbles is revealed, with considerable biological presence and activity. Some sand ripples, ridges and scour patterns were also recorded. A broken compass and unreliable camera performance were caused by a heavy blow against the ship's side during recovery of the seventh deployment.

Shipboard processing facilities were not ideal; poor quality equipment, rusty water supplies containing particles, and ship movement were some of the problems encountered.

Side-Scan Sonar (J.D. Humphery and C.C. Graham)

A 50KHz sidescan sonar system, manufactured by UDI of Aberdeen, was used to map bottom relief and sedimentary structures along bathymetric contours around the current measurement site.

The system comprised five main parts:

a) The towfish was of twin-boom construction, bridged by a depressor with a single towpoint. Each boom carried an outward-looking transducer array, transmitter electronics and receiver pre-amplifier. The unit was borrowed on trial from BGS Edinburgh.

b) The tow cable, winch and power pack were hired from UDI for £125/day. The cable was 2100m of 10mm, double armoured wire containing seven conductors, which ended in a massive strain relief termination. All wire was paid out at times. The winch drum was driven hydraulically from the power pack; the two units, mounted side by side, formed a package about 2.5m x 2m x 2m high, weighing 5.2 tonnes. The winch had electric starting, was reliable (apart from the slip rings), proved very easy to use, but was a little slow.

c) The deck unit was housed in the plot and connected to the winch by a deck cable. It was a simple device to use - internal microprocessors were controlled by push buttons on the front panel. The unit provided outputs for the EPC paper recorder, black and white monitor, colour monitor and RS232 for computer interfacing. A spare unit was supplied by UDI - hire charge was £45/day.

d) A black and white monitor provided a waterfall display of the sidescan image. It was most useful when setting the gain controls manually. It was supplied by UDI.

e) An EPC 3200 recorder, obtained from RVS, was used to provide a permanent (negative) image of the sidescan record.

The whole system was set up and tested by Mr. Ian Robertson of UDI while the ship was in Troon harbour. He gave a wet-test demonstration and instructions to scientific personnel. However, when the system was first tried at sea there were many problems. Water in the winch slip rings appeared to cause problems with both deck units - the slip rigs were completely dismantled, dried and reassembled, and a working deck unit made from parts of both systems. Misleading results were obtained by using the auto-tuning device - only when manual tuning was used was a satisfactory record taken.

Over 200km of side-scan data were collected, of which approximately 70% provided useful information on bottom conditions. Most of the good sections of data were obtained from a series of lines (each of approximately 25km in

length), which were run parallel to the bathymetric contours on the outer shelf and slope, in water depths of between 140 and 737m.

The overall quality of the EPC 3200 records was fair to poor. There was a 'grainy' quality to the data, and it lacked definition. It was noticeable that the amount of available data, as seen on the monitor screen, was not being reproduced faithfully on the paper records. A system for recording the incoming signals for subsequent processing and display (e.g. a computer disc system) may be a useful addition.

The working range of the survey was set at 200m per channel, which yielded about 100m of useful data per channel, with the fish 20m to 40m off the bottom. When the fish was towed less than 10m above the sea bed, the bottom return was lost. Across-track resolution was of the order of 0.75m, and the along track resolution varied between about 3m to over 10m.

The main observations resulting from the survey were:-

a) the relative scarcity of iceberg ploughmarks in this area;

b) the coarse nature of the sea bed sediment in the deep water area;

c) the common occurrence of longitudinal bedforms (probably narrow sand ribbons) on the slope, which run almost parallel to the bathymetric contours, and which become better developed and more pronounced with depth;

d) the evidence for downslope movement in the deep water region;

e) the frequency of linear, furrow like features, which may be trawl marks.

CTD Station List

Stn No.	Time	Date	Lat. N.	Long. W.	Water Depth m	Samples T	Samples S
1	1200	13/3/88	58° 13.87'	9° 34.41'	657	1	1
2	1330	13/3/88	58° 8.95'	9° 38.37'	672	0	0
3	1630	13/3/88	58° 7.70'	9° 32.99'	527	1	1
4	1320	14/3/88	58° 8.56'	9° 43.01'	1375	1	1
5	1430	14/3/88	58° 7.90'	9° 40.94'	910	0	0
6	1600	14/3/88	58° 9.05'	9° 47.95'	1843	1	1
7	1630	15/3/88	58° 7.89'	9° 30.36'	483	1	1
8	1917	15/3/88	58° 10.10'	9° 38.10'	722	0	0
9	2100	15/3/88	58° 11.92'	9° 36.86'	770	0	0
10	2200	15/3/88	58° 12.97'	9° 36.75'	790	0	0
11	2300	15/3/88	58° 10.44'	9° 37.13'	720	1	1
12	0000	16/3/88	58° 10.64'	9° 37.84'	750	0	0
13	0100	16/3/88	58° 11.12'	9° 38.55'	800	0	0
14	0200	16/3/88	58° 10.56'	9° 37.97'	760	0	0
15	0320	16/3/88	58° 10.36'	9° 38.41'	740	1	1
16	0400	16/3/88	58° 11.12'	9° 37.72'	755	0	0
17	0520	16/3/88	58° 12.31'	9° 37.18'	675	0	0
18	1530	16/3/88	58° 6.24'	9° 23.24'	350	1	1
19	1840	16/3/88	58° 8.45'	9° 40.84'	855	0	0
20	2045	16/3/88	58° 8.07'	9° 35.14'	600	0	0
21	2140	16/3/88	58° 8.77'	9° 35.26'	610	0	0
22	2240	16/3/88	58° 8.51'	9° 34.89'	595	0	0
23	2340	16/3/88	58° 8.10'	9° 35.06'	590	1	1
25	0045	17/3/88	58° 8.33'	9° 34.97'	590	0	0
26	0140	17/3/88	58° 8.34'	9° 35.86'	615	0	0
27	0240	17/3/88	58° 8.20'	9° 35.30'	610	0	0
28	0340	17/3/88	58° 7.98'	9° 35.45'	600	1	1
29	0445	17/3/88	58° 8.08'	9° 34.25'	580	0	0
30	0540	17/3/88	58° 8.22'	9° 35.11'	590	0	0
31	0640	17/3/88	58° 8.24'	9° 33.83'	555	0	0
32	0740	17/3/88	58° 8.23'	9° 36.24'	610	1	1
33	0840	17/3/88	58° 8.30'	9° 36.07'	580	0	0

34	1230	19/3/88	58° 19.00'	6° 54.58'	61	0	0
35	1350	20/3/88	58° 6.03'	9° 27.00'	400	0	0
37	1800	20/3/88	58° 6.75'	9° 36.10'	584	1	1
38	2040	20/3/88	58° 6.85'	9° 39.81'	695	0	0
39	2140	20/3/88	58° 7.31'	9° 39.15'	695	0	0
40	2240	20/3/88	58° 7.39'	9° 39.21'	755	1	1
41	2340	20/3/88	58° 7.48'	9° 39.19'	730	0	0
42	0040	21/3/88	58° 7.61'	9° 38.80'	780	0	0
43	0140	21/3/88	58° 7.28'	9° 39.31'	720	0	0
44	0240	21/3/88	58° 7.34'	9° 39.25'	740	1	1
45	0340	21/3/88	58° 7.22'	9° 39.55'	790	0	0
46	0440	21/3/88	58° 6.98'	9° 38.93'	660	0	0
47	0540	21/3/88	58° 7.59'	9° 40.04'	820	0	0
48	0640	21/3/88	58° 7.38'	9° 39.29'	735	0	0
49	0740	21/3/88	58° 7.00'	9° 40.31'	820	1	1
50	0840	21/3/88	58° 7.46'	9° 39.18'	745	0	0
51	1100	21/3/88	58° 7.48'	9° 40.85'	892	0	0
52	2040	22/3/88	58° 4.77'	9° 38.00'	612	0	0
53	2230	22/3/88	58° 5.17'	9° 49.79'	1812	0	0
54	0200	23/3/88	58° 6.67'	9° 49.56'	1845	0	0
55	0330	23/3/88	58° 6.85'	9° 45.32'	1520	0	0
56	0430	23/3/88	58° 6.69'	9° 42.21'	830	1	1
57	0540	23/3/88	58° 6.81'	9° 36.06'	590	0	0
58	0650	23/3/88	58° 9.78'	9° 34.98'	610	0	0
59	0740	23/3/88	58° 9.68'	9° 40.77'	970	0	0
60	0840	23/3/88	58° 9.69'	9° 43.71'	1606	1	1
61	1000	23/3/88	58° 9.36'	9° 47.85'	1843	0	0
62	1130	23/3/88	58° 12.58'	9° 47.38'	1870	0	0
63	1330	23/3/88	58° 12.78'	9° 33.00'	610	0	0
64	1430	23/3/88	58° 14.75'	9° 31.10'	605	0	0
65	1600	23/3/88	58° 14.95'	9° 46.00'	1840	0	0
66	1710	23/3/88	58° 17.26'	9° 47.06'	1895	0	0
67	2040	23/3/88	58° 16.77'	9° 26.22'	600	0	0

Camera Station List

Stn. No.	Date	Begin Time	Begin Lat. N	Begin Long. W	Begin Water Depth m	End Time	End Lat. N	End Long. W	End Water Depth m	Comments
1	15/3/88	1719	58° 8.14'	9° 29.46'	470	1733	58° 8.19'	9° 29.29'	455	
2	15/3/88	1959	58° 11.02'	9° 37.83'	748	2016	58° 11.29'	9° 37.60'	750	
3	16/3/88	1446	58° 6.26'	9° 23.40'	355	1502	58° 6.24'	9° 23.36'	355	
4	16/3/88	1649	58° 8.24'	9° 34.40'	605	1710	58° 8.87'	9° 34.29'	600	
5	16/3/88	1918	58° 8.99'	9° 39.83'	863	1942	58° 9.09'	9° 39.80'	840	
6	20/3/88	1435	58° 6.19'	9° 28.17'	390	1455	58° 5.93'	9° 28.46'	400	
7	20/3/88	1910	58° 6.08'	9° 36.48'	600	1940	58° 6.26'	9° 36.46'	597	
8	21/3/88	0956	58° 7.32'	9° 39.30'	775	1012	58° 7.75'	9° 39.32'	786	
9(1)	21/3/88	1134	58° 7.50'	9° 40.50'	860	1151	58° 7.50'	9° 40.25'	815	No pictures
9(2)	21/3/88	1302	58° 7.33'	9° 40.49'	875	1320	58° 7.40'	9° 40.35'	900	

Box Core Station List

Stn No.	Date	Time			Water Depth m	Comments
1	17/3/88	1040	58° 6.16'	9° 22.60'	340	Sand - 10cm sample
2	17/3/88	1220	58° 4.51'	9° 13.80'	258	Clay - shallow lopsided sample
3	21/3/88	1430	58° 7.28'	9° 38.98'	810	good sample - 3/4 full
4	21/3/88	1710	58° 8.00'	9° 38.57'	672	good sample - 3/4 full
5	21/3/88	1900	58° 7.4'	9° 36.80'	605	lop-sided sample
6	22/3/88	1900	57° 59.37'	9° 33.47'	460	good sample

Table

Moorings and Bottom Mounted Instruments

Mooring	Latitude N	Longitude W	Decca 8E Green	Decca 8E Purple	Water Depth m	time/date Laid	time/date Recovered	Instrument	Depth m
BP300	58° 4.89'	9° 19.27'	H46.22	C58.95	297	1022 12/3/88		TG 281 TG 289	297
1AD400	58° 6.28'	9° 26.95'	H46.20	C64.08	400	1303 12/3/88	1601 20/3/88	POLDOP 01	400
CM450	58° 6.63'	9° 30.95'	H46.05	C66.44	465	1444 12/3/88		1509 6941 5913	115 290 445
CM650S	58° 7.56'	9° 37.81'	H46.16	C71.60	650	2050 12/3/88		6275 3368 4388 logger 6, chain 774 4968	100 300 500 570 625
CM650N	58° 13.81'	9° 34.81'	I37.53	C64.16	658	1135 13/3/88		5522 7389 2672 5521	108 308 508 633
CM560	58° 7.24'	9° 34.21'	H46.12	C68.37	560	1548 13/3/88		3950 logger 3, chain 688 6440 5915 6753	110 115 310 510 535

Table (continued)

Mooring	Latitude N	Longitude W	Decca 8E Green	Decca 8E Purple	Water Depth m	time/date Laid	time/date Recovered	Instrument	Depth m
CM950	58° 8.10'	9° 41.28'	H46.60	C72.28	917	2000 13/3/88		6720	62
								5526	362
								6443	712
								logger 4, chain 759	762
								6938	817
CM1500	58° 8.71'	9° 43.73'	H46.40	C74.08	1530	1226 14/3/88		7570	130
								3559	530
								4387	930
								8243	1430
BP1850	58° 9.44'	9° 46.71'	H46.86	C75.32	1795	1750 14/3/88		TG 283	
								TG 292	1795
								TG 293	

Logger and chain numbers are given where moorings included 50m thermistor chains of 11 sensors below the logger.
Serial numbers prefaced TG are for pressure recorders.
POLDOP 01 is an acoustic doppler current profiler (q.v.). Otherwise serial numbers are for Aanderaa RCM4 current meters.

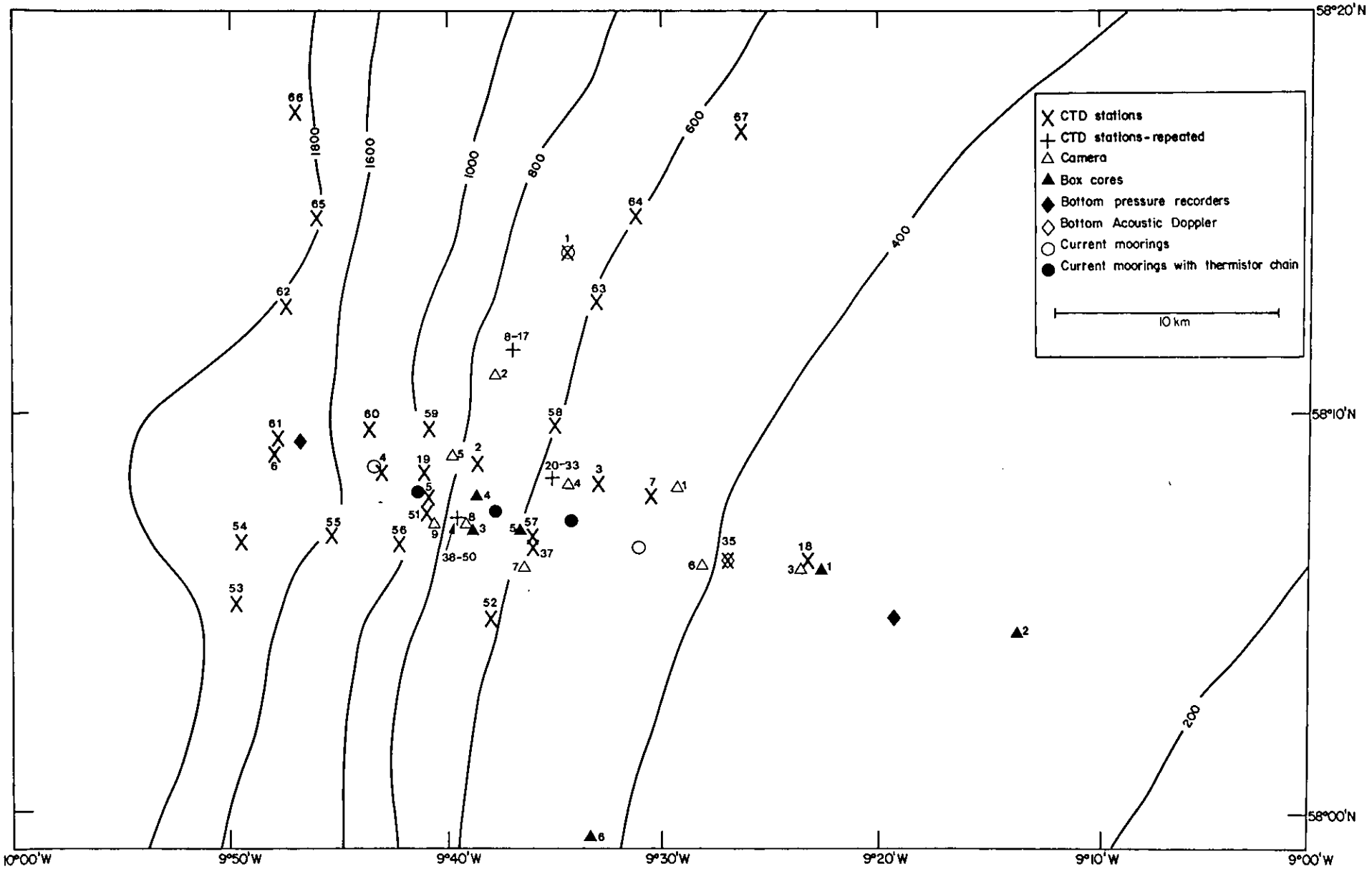

Figure 1. Stations and positions of moorings and bottom-mounted instruments, Hebrides Shelf

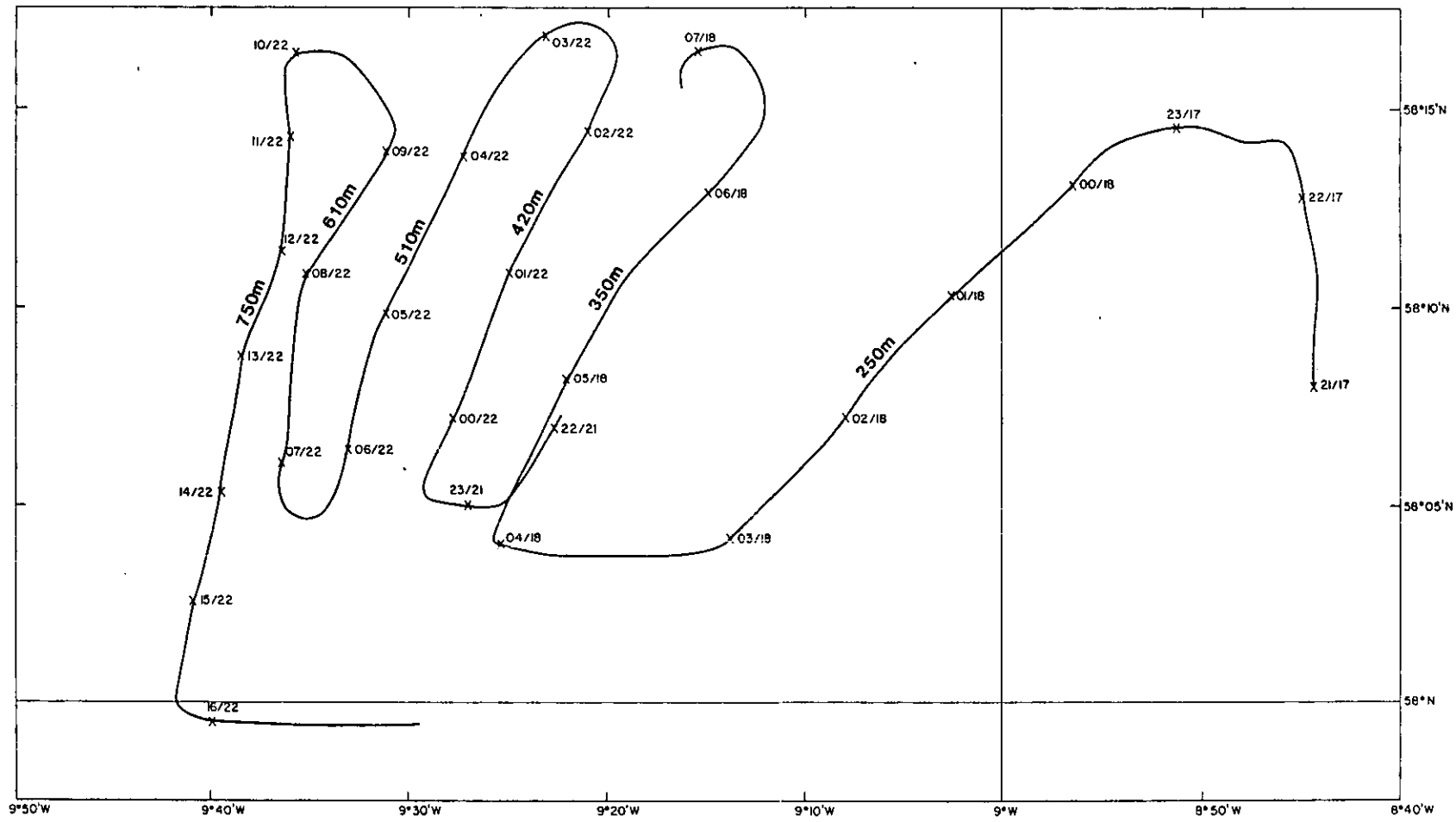

Figure 2. Side-scan sonar track

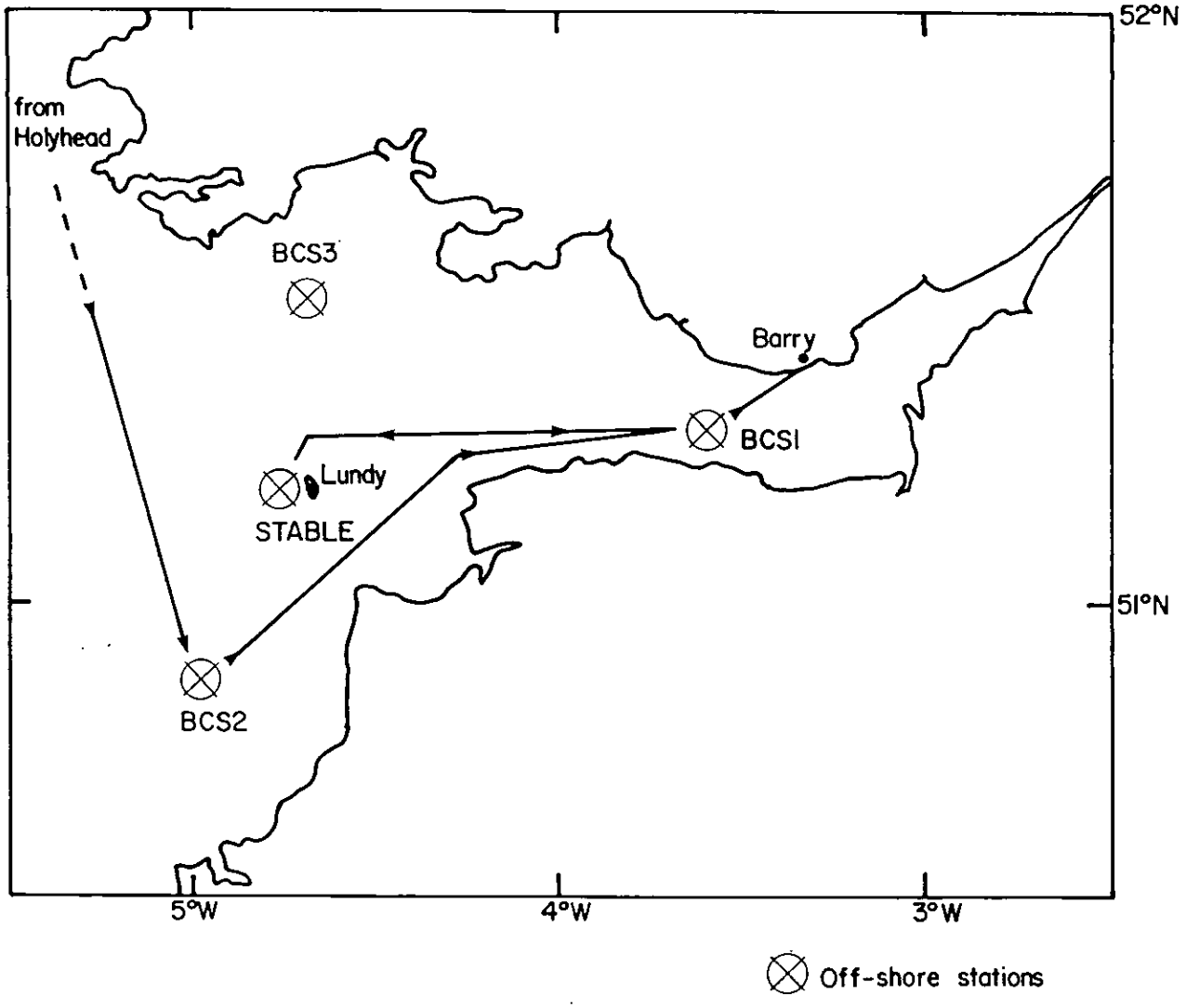

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Figure 3. Bristol Channel locations

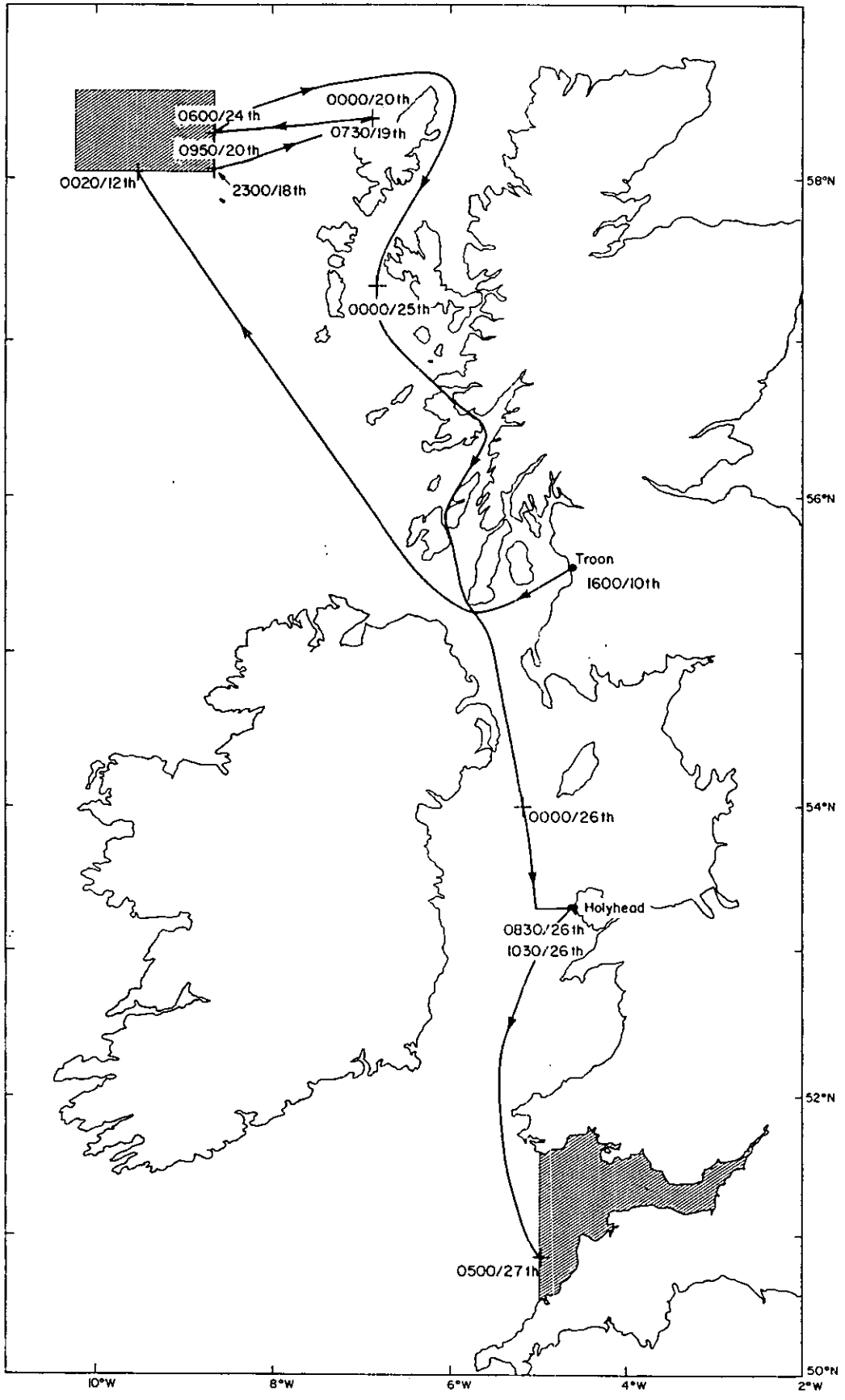

Figure 4. Cruise track