I.O.S.

RRS CHALLENGER
CRUISE 8/82

21 MAY - 7 JUNE 1982

INSTRUMENT AND HARDWARE TRIALS IN THE PORCUPINE SEABIGHT

CRUISE REPORT NO. 143
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NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE OF
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SCIENCES

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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INSTITUTE OF OCEANOGRAPHIC SCIENCES

WORMLEY

R.R.S. CHALLENGER
Cruise 8/82

21 May - 7 June 1982

Instrument and hardware trials in the Porcupine Seabight

Principal Scientist

M.J. Harris

CRUISE REPORT NO. 143

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ITINERARY

Depart Falmouth	21st May 1982
Arrive Barry	7th June 1982

SCIENTIFIC PERSONNEL

A.G. Andrews	I.O.S., Wormley	
A.C. Braithwaite	" "	
C.H. Clayson	" "	
J. Crease	" "	
G.K. Doherty	" "	
D. Edge	" "	
M.J. Harris	" "	(Principal Scientist)
M. O'Toole	Irish Observer	
G.R.J. Phillips	I.O.S., Wormley	
R.A. Phipps	" "	

SHIP'S OFFICERS

G. Selby-Smith	Master
J.J. Moran	Chief Officer
P.O. Oldfield	Second Officer
R. Hagley	Third Officer
D. Rowlands	Chief Engineer
C.B.A. Harman	Second Engineer
R.J. Perriam	Third Engineer
R.G. Whitton	Fourth Engineer

SUMMARY OF OBJECTIVES

The main purpose of the cruise was to test new or modified instruments and their associated hardware under realistic open ocean conditions. Between these tests opportunity would be taken to establish the operational boundaries of the two long baseline acoustic transponder sites in the Porcupine Seabight, and where possible, to use these transponders for fixing the position of the ship and moored equipment while carrying out these tests.

The principal instruments and hardware to be tested were: new Benthic Current and Temperature probe frame, Benthic Resistance Thermometer Array (BERTHA), Nautilus Float, near surface transponders, pitch-roll buoys, new pore water sampler, and reeler release. Plans had been made to test some other instruments but these were not available at the time of the cruise.

A calibration of the ship's EM log relative to one of the transponder baselines and a comparison of a TSD with IOS water bottles and a transponder were planned. It was also proposed to pay particular attention to the collection of the bathymetric data during the cruise, as this information was required for the production of a new chart for the Porcupine Seabight.

If enough time was available, a small detour would be made to recover and re-lay bathysnap.

NARRATIVE

The ship left Falmouth on the afternoon of 21st May and proceeded towards position A ($50^{\circ}45'$N $12^{\circ}00'$W). Although there was only a slight swell and light winds, poor visibility made it necessary to reduce the ship's speed. The PES fish was deployed on the morning of 22nd, and with the wind freshening, the ship continued at reduced speed on a heading of 275°. The edge of the continental shelf was reached by the evening and the echo sounding watch was started. Particular attention was paid to the annotation of the E/S record and log.

By the early afternoon of 23rd the ship had reached position A. It was here that the Nautilus Float was subjected to a series of pressure tests to a maximum depth of 1000 m. This was followed by vertical wire tests of four acoustic command releases that were to be used during the course of the cruise.

With the weather improving the ship headed for the shallow water (1250 m) long baseline transponders which are at position B ($51^{\circ}40'$N $13^{\circ}00'$W). On approaching this position on the morning of 24th the ship's speed was reduced to 4 knots to begin the first survey of these transponders. The pitch-roll buoy array was then deployed, but by this time the wind was gusting up to 30 knots. Although this gave the buoys a rough ride, they were safely recovered at the end of the day even though the parachute drogue of the array was lost when it fouled the ship's propeller. By the evening of 25th the near bottom echo sounders (NBES), to be used on the pore water sampler, the reeler release and the BENCAT frame had all been tested. While using the midships hydrographic winch to test the NBES, it was noticed that the winch's meter wheel was drastically out of calibration. This was corrected by changing the gears of the meter wheel. During the following day the complete Nautilus Float system was tested to a depth of 500 m and recovered containing a large quantity of seawater. The BENCAT frame was deployed on the seabed, acoustically released and recovered. The pore water sampler was tested twice and calibration of an STD manufactured by NBA was checked using acoustic transponders and water bottles. The majority of the work at this position took place within acoustic range of the transponders. This made it possible to check the movement of the ship relative to the seabed, a useful aid when testing such instruments as the PWS. It also meant that between instrument tests the ship was conveniently positioned for checking the performance of the baseline transponders. Having completed the work that could usefully be done in this depth of water, the ship proceeded to the bathysnap position (51°04'N 12°53'W).

At first light on the morning of 27th bathysnap had been acoustically released and was safely on board. While this instrument was serviced prior to being redeployed, a bathymetric survey was made of the surrounding area, and showed the bottom topography to be smooth but for a shallow valley to the N.W. of the site. Because of mechanical problems with bathysnap's current meter this survey was more extensive than originally planned. The first attempt to deploy bathysnap was unsuccessful because the weight of the ballast frame was insufficient to provide an acceptable descent rate. After recovering and increasing the ballast weight, bathysnap was satisfactorily redeployed. The PWS was tested again before getting under way to position C (49°47'N 14°07'W).

On 28th the deep water (4000 m) baseline transponders were located on approaching position C. By the time the benthic thermistor chain had been deployed in the early evening the weather had deteriorated to such an extent that the only suitable work was the surveying of the transponders. On the following morning it was still too rough to handle the larger instruments on the main winch so the echo sounders for the PWS and towed survey camera monitor were checked using the hydrographic winch. After this the transponder survey was continued to fill in some of the gaps left by the earlier survey work. As the poor weather conditions made it impractical to continue working in this area, a course was set for position D on the Goban Spur (49°25'N 12°24'W).

The ship arrived at this new position in the early hours of 30th. As predicted by the met. forecasts, the weather conditions were good, and a short bathymetric survey was made prior to starting the instrument tests. During the course of the day the PWS was tried twice and the pitch-roll buoys deployed for 10 hours. While tracking the buoys it was possible to stop the ship long enough to check the performance of the PWS' echo sounder. These repeated tests on the E/S were made in an attempt to identify the acoustic reflection problems of the E/S when mounted on the PWS.

As the met. information indicated an improvement in the weather conditions at position C the ship returned and recovered the thermistor chain on the morning of 31st. This was followed by a calibration of the ship's EM log, using the baseline transponders as reference points. During the afternoon 5 and 10 kHz near surface transponders were wire tested and then deployed attached to surface floats to check their acoustic range. As the PWS was ready, another two tests were made with it prior to returning to the Goban Spur.

On reaching the Spur on the morning of 1st May, a second set of range trials was completed with the 5 and 10 kHz transponders; on this occasion they were set at the greater depth of 250 m. The ship then moved out to deeper water in order to redeploy the thermistor chain. While on passage one of the pressure cases belonging to the thermistor chain was found to be damaged. This was quickly repaired and pressure tested on the hydrographic winch before laying the thermistor chain. Overnight another section of the bathymetric survey was completed and during the 2nd a series of tests were made with the Nautilus Float and PWS. The night was used to continue the bathymetric survey. The PWS was tested during the morning, and the thermistor chain recovered before the deteriorating weather made this impossible. There was just time for one more test of the float before the weather limited the work to the completion of the survey on the Goban Spur.

On the morning of 4th the ship was set on a course of 060° to move into quieter water for the run to the work site for the pitch-roll buoy/radar intercomparison experiment. The last test of the Nautilus Float was delayed to obtain better weather conditions, but was completed before reaching the continental shelf. The pitch-roll buoy radar intercomparison which was the last scientific experiment, took place at midday on 6th. The ship then proceeded to Barry, arriving on the morning of 7th.

PROJECT REPORTS

1. Bathysnap

Bathysnap is a bottom mounted instrument package designed to take a time series of photographs of a small patch of the seabed (~3 metres square) to study the rate of production and dispersal of the many animal tracks on the seabed. It also carries a current meter measuring current speed, direction, and temperature. This was laid at the end of Challenger Cruise 5/82 and as the planned track for this cruise passed close by it was sensible to recover it, to renew the film and tape and to re-lay it for its eventual recovery from Challenger in July.

The acoustic beacon was switched on, release effected, and Bathysnap brought inboard without difficulty. The camera and flash unit were changed and the current meter removed; on dismantling it was found that although over half a tape full of good data had been recovered, the battery was totally discharged. On further investigation the motor drive was found to have jammed; it was progressively stripped and checked; when removing the gearbox the motor freed itself; there was no obvious damage or cause of jamming so the unit was cleaned, oiled and reassembled. It then operated properly for one hour, so it was prepared for the re-lay.

The first lay attempt was aborted as the sink rate was less than 0.2 metres/second. Twenty pounds of ballast were added to each of the three legs of the spare ballast frame; it then sank at 0.8 metres/second.

The new lay position was fixed by a satellite at launch,

Lat. N 51.04.772
Long. W 12.54.386.

G.R.J. Phillips.

2. Benthic Current and Temperature Measuring System (BENCAT Mk 2)

The new framework was lowered on the trawl warp to test the release mechanism. The tripod ballast frame was retained by short strops so that it was not lost when the release operated. A free-fall deployment was made in 1220 m depth. The measured descent and ascent rates of 0.77 and 1.03 m/s, respectively, showed that the drag was lower than predicted. On the basis of these figures, the calculated descent and ascent rates for the instrument with its full instrumental payload are 0.94 and 0.72 m/s respectively, which are satisfactory.

C.H. Clayson.

3. Benthic Resistance Thermometer Array (BERTHA)

Two deployments of the chain were made in depths of 4024 m and 1726 m. For the first deployment, the sensors were strapped together in a bundle so as to provide an intercomparison of the individual platinum resistance and thermistor sensor elements. The array was launched buoy first, using the Bencat buoyancy module and, although this operation occupied a large amount of deck space during preparation, the technique worked very satisfactorily. The descent rate was 1.76 m/s with approximately 600 lb anchor chain. An additional 17 inch glass float was attached just above the main instrument housing so that this would not sink too deep whilst the mooring was being paid out on the surface. After recovery, it was found that the Sea Data motor drive card had failed after a few hours. After repair and testing of the drive, together with leak testing of the main housing which had sustained damage to an O-ring seating face, the chain was redeployed in the same configuration and a two day record was successfully obtained. On this occasion approximately 420 lb of chain was used, giving a descent rate of 1.44 m/s. The second site was on a slope and quite large (±0.25°C) temperature fluctuations were present, allowing correlation of the sensors over a range in addition to the temperature profiles observed during descent and ascent.

Recovery of the chain was accomplished easily and rapidly using the eyes at 4 m intervals along the strain bearing wire. These were alternately attached to snap hooks on the two auxiliary winches.

C.H. Clayson.

4. Bottom Transponder Systems

Two sites in the Porcupine Sea Bight have been acoustically marked by long life transponders in order to evaluate quantitative benthic sampling techniques. The transponders were deployed in September 1981 in 'long base line' pairs at depths of 1200 and 4000 metres and have a potential battery life of 14 years. The base line length and orientation were accurately determined at the time of lay but the true position on the Geoid requires iteration from the accumulation of a large number of satellite fixes (30 or so). Additionally the area of accurate fixing can be maximised by knowledge of the bathymetry when single transponder ranges can be used with the depth to position the ship. The purpose of this cruise was to evaluate new instruments during which the ship's position was not critically important. It was therefore decided to operate when convenient at these two sites, collecting further satellite data to survey-in the networks and providing bathymetric surveying as a bad weather and fill-in exercise.

The shallow site (Figure 6) was navigated entirely acoustically. The extremes were fixed using single transponder ranges but by maintaining the same course as through the two range region then making a single course alteration, we were always brought back into the two range region. The satellite and 'dead reckoned' tracks have been included and well demonstrate the problems of working accurately in real time without benefit of acoustics. The grid has been fixed using 15 satellites accumulated over the four cruises to date and is accurate to within a few hundred metres (base line length is known to better than 20 metres and orientation to better than 5°).

The deep site (Figure 7) poses considerably more problems than the shallow one; the base line length is nearer the limit of obtainable range so the two transponder coverage is a smaller proportion of the required working area; the bottom topography is more ambiguous; and the interpretation of the records is more difficult. This site was navigated using a combination of acoustics, dead reckoning, and hindsight. As can be seen the planned neat grid became considerably distorted, demonstrating the problems of non acoustic navigation. However, now the bathymetry is better known totally acoustic navigation is possible.

The third figure (Figure 8) highlights the problem of station keeping in a variety of weathers. The first track (Day 144) was plotted while maintaining station during a wave measuring experiment; this shows the effect of the cross wind drift. The second track (Day 145 - station keeping experiment) was an investigation of the problem; we returned to a suitable position from outside the area and 'hove to' to the best of our abilities; we noted the drift and then tried a variety of propeller, rudder, bow thrust combinations to compensate and as can be seen failed to improve. During the third track (Day 145 - awaiting better weather) to make life easier for the bridge officers we had some way on (the normal bad weather situation). The fourth track (Day 146) was in considerably better weather and as can be seen the ship's movement over the ground was considerably slower.

G.R.J. Phillips.

5. Calibration of E.M. Log

Two double runs on 060° and 240° were made at 100 revs and 150 revs, as nearly as possible over the 4000 m deep transponder site. This transponder base line, which is 6 km long, allowed accurate fixing of the ship's relative position to within a few metres. The analogue output from the E.M. log and the logging of the Magnavox D.R. were recorded every 2 minutes and also the wind speed and direction. The results suggested the analogue output read 9% low on true speed. With a setting on the Magnavox of 11500 pulses per nautical mile, which was in use at the time, the Magnavox speed reading was 4½% low, so a setting of 11000 is more appropriate and suggested for future use. With this setting the Magnavox and Simrad systems agree. The wind speed was relatively low so calibration of drift was probably accurate, but it suggested that the fore and aft effect of wind and waves amount to an incremental speed of $\frac{1}{15}$ of the wind speed. This agrees fairly well with the results obtained from the station keeping experiment.

The thwartships component of the E.M. log was not calibrated.

M.J. Harris.

6. Nautilus Float

Prior to this cruise the float had been tested in a Scottish loch; however, since that time the mechanical hardware and electronics for the buoyancy control had been modified and prepared in prototype form for testing at the full operational depth of the float.

During the course of the cruise three different aspects of performance of the float were checked. These were the ability of the float to withstand the hydrostatic pressures at its operational depth, the effectiveness of the acoustic command/telemetry link, and the reliability of the buoyancy control system. All of these were investigated by attaching the float to the ship's main warp and lowering it to the required depth.

Initially, with the electronics removed, the float was lowered in four successive steps to a depth of 1000 m. As the float had not leaked, the electronics were installed and connected to the appropriate transducers and the buoyancy control system. During the next test the acoustic command and telemetry systems were checked and found to be working properly. However, the float was recovered when the telemetry link began to malfunction. The fault on the telemetry link had been caused by a severe sea water leak from a pipe in the buoyancy control system. This had occurred because the fail safe and differential pressure valves had failed to seal properly. Unfortunately the damage caused to the electronics prevented the telemetry link providing the normal leak indication. Because of the damage to the float's electronics it was necessary to replace these with a self contained I.O.S. command monitor. After some minor modifications of the buoyancy control system, following tests proved that the system would operate correctly to a depth of 350 m. The failure of the system beyond this depth was due to leakage in the differential pressure valve; the remainder of the system was still operating correctly.

This series of tests proved the basic principles of operation of the float to be sound, but revealed the weakness in the valves and pipework of the buoyancy control.

M.J. Harris.

7. Near Surface Transponders

A requirement exists for acoustic relocation of surface drifting buoys. A standard I.O.S. 10 kHz transponder was modified to run at the maximum power handleable by its transducer and to improve its detectability by increasing its pulse length. It was suspended 100 metres beneath a free drifting surface buoy and interrogated by several standard shipborne transducers and receiver systems which were interfaced with the PES Mufax display. The experiment was then repeated with a unit having similar power levels but running at 5 kHz. This was monitored using a 5 kHz towed transducer and a modified 10 kHz transceiving system interfaced to the PES Mufax display. Both experiments were then repeated with the transponders moored 250 metres below the surface buoy. Maximum ranges obtained were 3 and 3.4 km for the best 10 kHz arrangement and 2.6 km (normal power) and 3.9 km (high power) for the 5 Hz system. The experiment also provided useful information about the working limits of system components.

G.R.J. Phillips.

8. Pitch Roll Buoy Array

The array of three buoys in line, with 40 m and 80 m spacings was deployed twice. On the first occasion, the wind speed was 30 kts from 225° and a heavy swell, estimated at 4 m crest to trough, 8 seconds period, was arriving from 210°. No difficulty was experienced in launching the array under these conditions and the buoys streamed in line downwind of their parachute drogue satisfactorily. On recovery, however, the parachute was caught around the propeller and lost but, fortunately, the rope connecting this to the array parted and the array was subsequently recovered without further problems. Upon examination of the buoy records, it was found that the radio synchronisation system had not worked reliably and that one recorder had jammed half way through the deployment period. The radio system was modified so as to transmit a time code which was recorded by the slave buoys and this worked successfully on the second deployment. On the second 9 hour deployment a very long crested swell of approximately 3 m crest to trough was arriving from 280°. The swell period was approximately 12-13 seconds and it was clearly visible on the radar, which allowed independent measurements of direction, wavelength and phase velocity. Unfortunately only two out of the three buoys worked correctly due to a connector coming loose on one buoy. On this deployment a roller blind drogue was used to provide a sea anchor for the array: this had been constructed on board out of the limited range of materials available. Although the drogue deployed successfully, its furling rope became entangled during the deployment so that it could not be furled before recovery: apart from this it worked well.

C.H. Clayson.

9. Pitch Roll Buoy - Radar Intercomparison

The passage back to Barry was broken to allow measurements with a single pitch roll buoy in the vicinity of an h.f. radar installation, near Milford Haven, operated by the University of Birmingham Electronic and Electrical Engineering Department. The radar measures the Doppler spectra on Bragg scattered dekametric radar waves, allowing estimation of wave height/direction and surface current speed/direction.

A two hour record was obtained at near slack water so as to avoid the complication of frequency translation due to buoy drift with the current. Measurements of current were made using the ship's electromagnetic log together with Decca fixes.

C.H. Clayson.

10. Pore Water Sampler Mk III (P.W.S.)

P.W.S. Mk III was deployed a total of 12 times during this its maiden cruise. The first and second deployments were the only sea bed tests carried out. No samples were taken and on test no. 2 the sampler was dragged over after 12 mins resulting in the main frame being bent at the control arm pivot point. The remaining tests were carried out in midwater, i.e. at approximately 500 m, this being achieved with modified electronics timed to switch the unit to the S.I.P. (sampling in progress) mode 28 mins after deployment.

After valve firing problems during the third and fourth deployments, the circuit responsible was replaced with the old pattern circuit using iron cored relays and deployments 5,8,9,10,11 and 12 proved very successful giving samples from 41 to 87½% of the total possible, depending on the position of the reed switch setting.

Deployment No. 6 was used to check the operation of the near bottom echo sounder (N.B.E.S.) when mounted on the P.W.S. frame. Previous independent tests of the echo sounder proved it to be working correctly, but on the sampler, acoustic reflections within the frame gave spurious readings for the height off the seabed. This problem was resolved by mounting the echo sounder's transducer outside the sampler's main frame.

Deployment No. 7 failed due to a break in the main power cable.

The 10 kHz acoustic telemetry system used with the sampler was mounted on the side of the main frame and housed the electronics for monitoring and transmitting the sampler's attitude in the water and height off the seabed as well as the sampling time. This system worked correctly throughout the series of tests.

The P.W.S. was prepared for a final seabed deployment but this was ruled out due to bad weather conditions.

A.G. Andrews.

11. Reeler Release

The reeler comprised a barrel of rope through the centre of which ran a steel bar. The top of the bar was connected to a standard acoustic command release. One end of the rope was connected to the mooring line at the top of the release. The other end of the rope was connected through the bottom of the barrel to the lower section of mooring. The release when activated dropped the steel bar allowing the mooring buoyancy to pull it to the surface drawing the rope from the barrel. The mooring could then be recovered complete with any bottom mounted equipment, thus obviating the need to drop ballast or carry excessive buoyancy on heavy bottom mounted instruments.

Initial trials were carried out on the main warp with 300 lbs of ballast hung below the reeler. The first deployment used 185 metres of normal 3 strand 18 mm rope flaked carefully into the barrel and taped to the release bar just above the point of release; the release operated normally but on recovery the rope was found to have picked up a bight and jammed in the exit hole at about 90 metres; recovery was effected without incident. It was decided that the rope was too stiff so the next deployment used 200 metres of more pliant 18 mm multiplatt flaked in as before but through an oversight the rope was not taped; the release operated normally but on recovery it was found that 5 metres or so of rope had floated out of the barrel and was tightly twisted around the warp; during recovery the rope had sawn itself completely through either on the release mechanism or tube support clamps (most likely); the barrel, rope, and ballast weight were lost.

G.R.J. Phillips.

ACKNOWLEDGEMENTS

It is a pleasure to thank the Master, Officers and Crew in all departments for their untiring efforts and assistance throughout the cruise; assistance from RVS (Barry) before and after the cruise is also gratefully acknowledged.

LIST OF TEST SITES

Date	Site	Lat. N	Long. W	Gear
May 23	A	50°45'	12°00'	Acoustic command release Nautilus float
May 24-26	B	51°40'	13°00'	Bencat frame Long baseline transponders Nautilus float Pitch-roll buoy array Pore water sampler Reeler release STD
May 27		51°04'	12°53'	Bathysnap Pore water sampler
May 28,29,31	C	49°47'	14°07'	Benthic thermistor chain E.M. log Long baseline transponders Nautilus float Near bottom echo sounder 5 & 10 kHz near surface transponders Pore water sampler
May 30, June 1-3	D	49°25'	12°24'	Benthic thermistor chain Nautilus float 5 & 10 kHz near surface transponders Pitch-roll buoy array Pore water sampler
June 6	E	51°31'	5°38'	Pitch-roll buoy

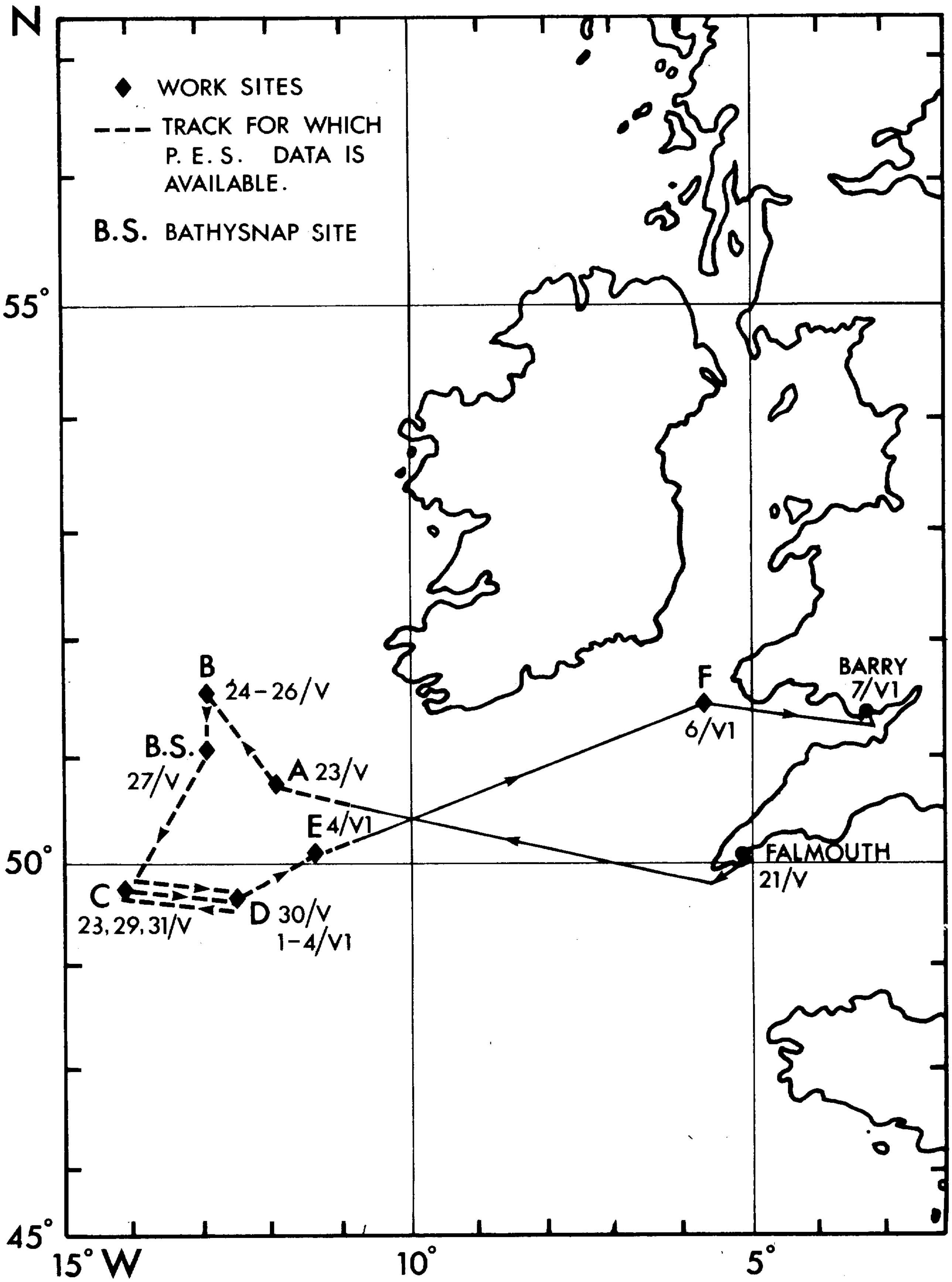

FIG.1 TRACK CHART – CHALLENGER CRUISE 8/82

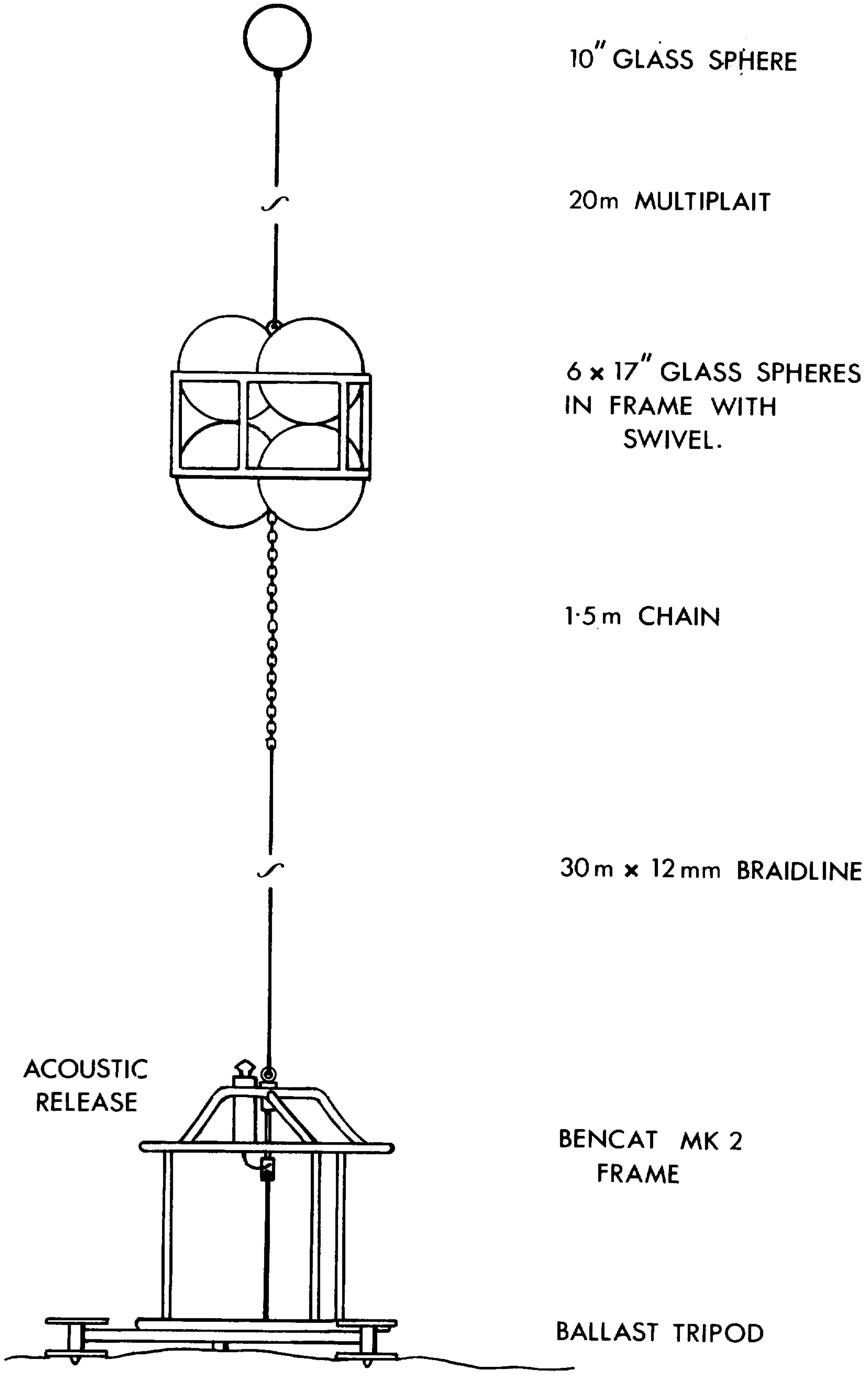

FIG. 2 BENCAT MK 2

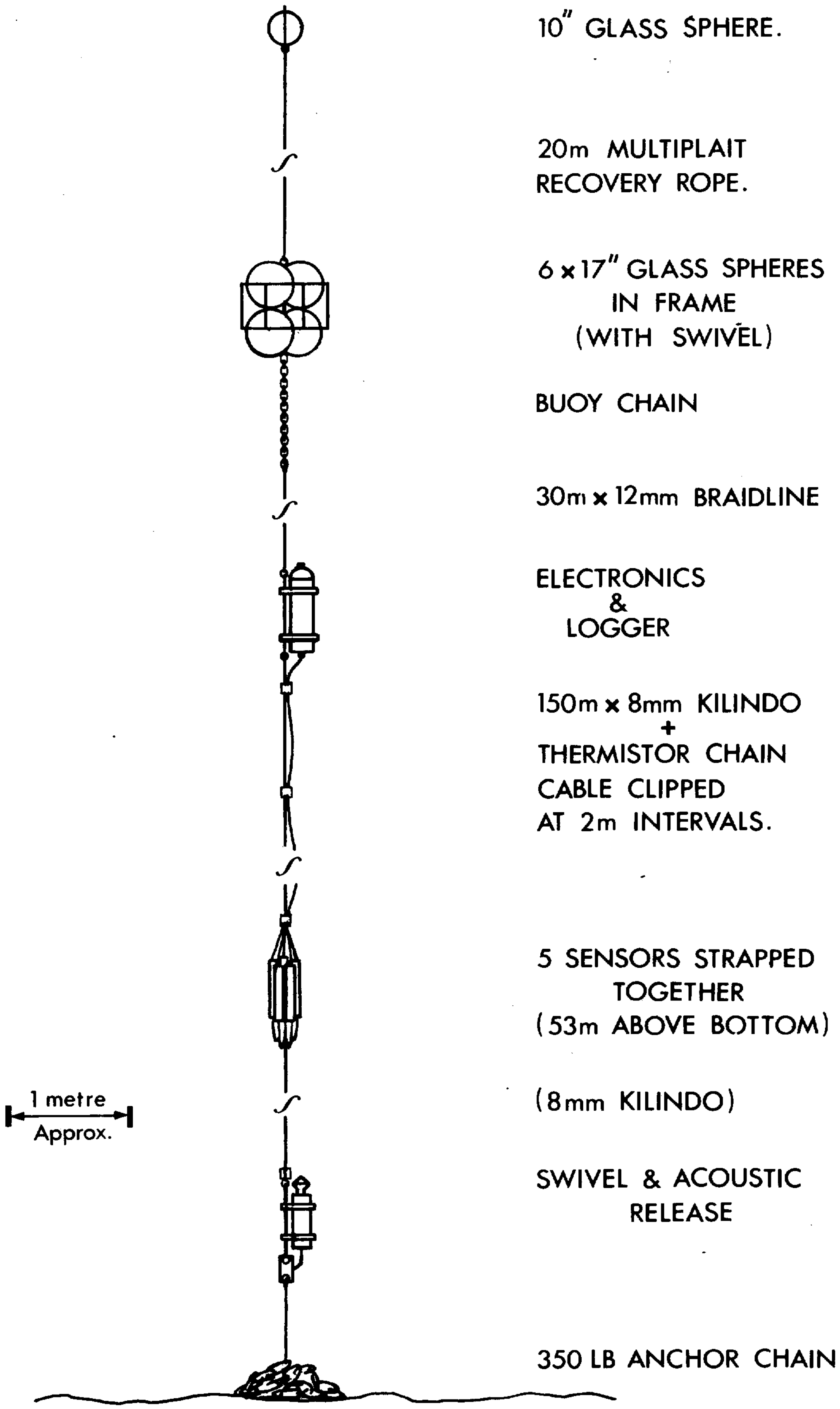

FIG. 3 BENTHIC RESISTANCE THERMOMETER ARRAY

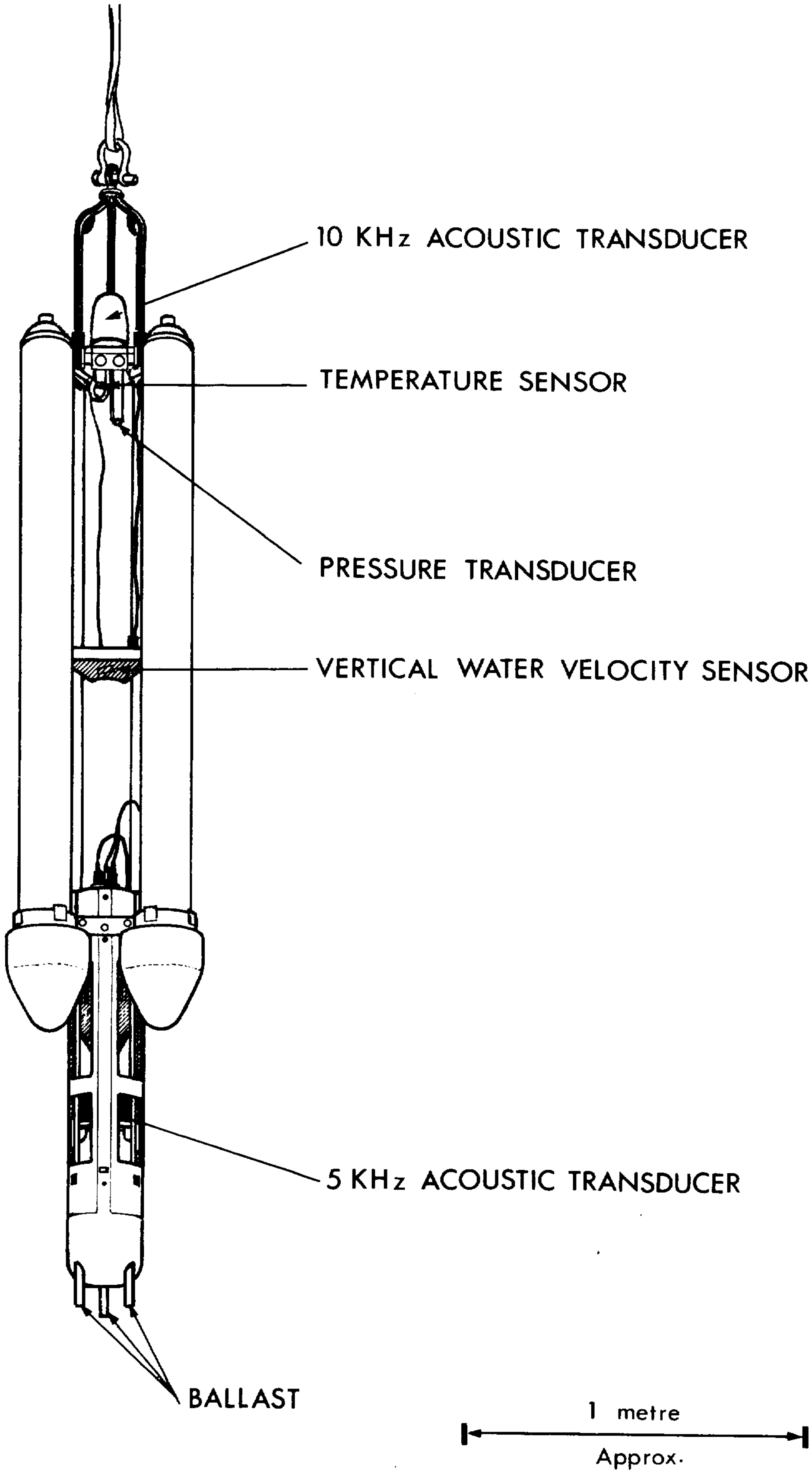

FIG. 4 NAUTILUS FLOAT

1 Main Frame
2 Control Bar
3 Hydraulic Ram
4 Guide Tube
5 Probe (1 of 4)
6 Camera
7 Flash
8 Pinger
9 Control Electronics
10 Battery Pack
11 N. B. E. S. Near Botton Echo Sounder
12 Ballast Weight

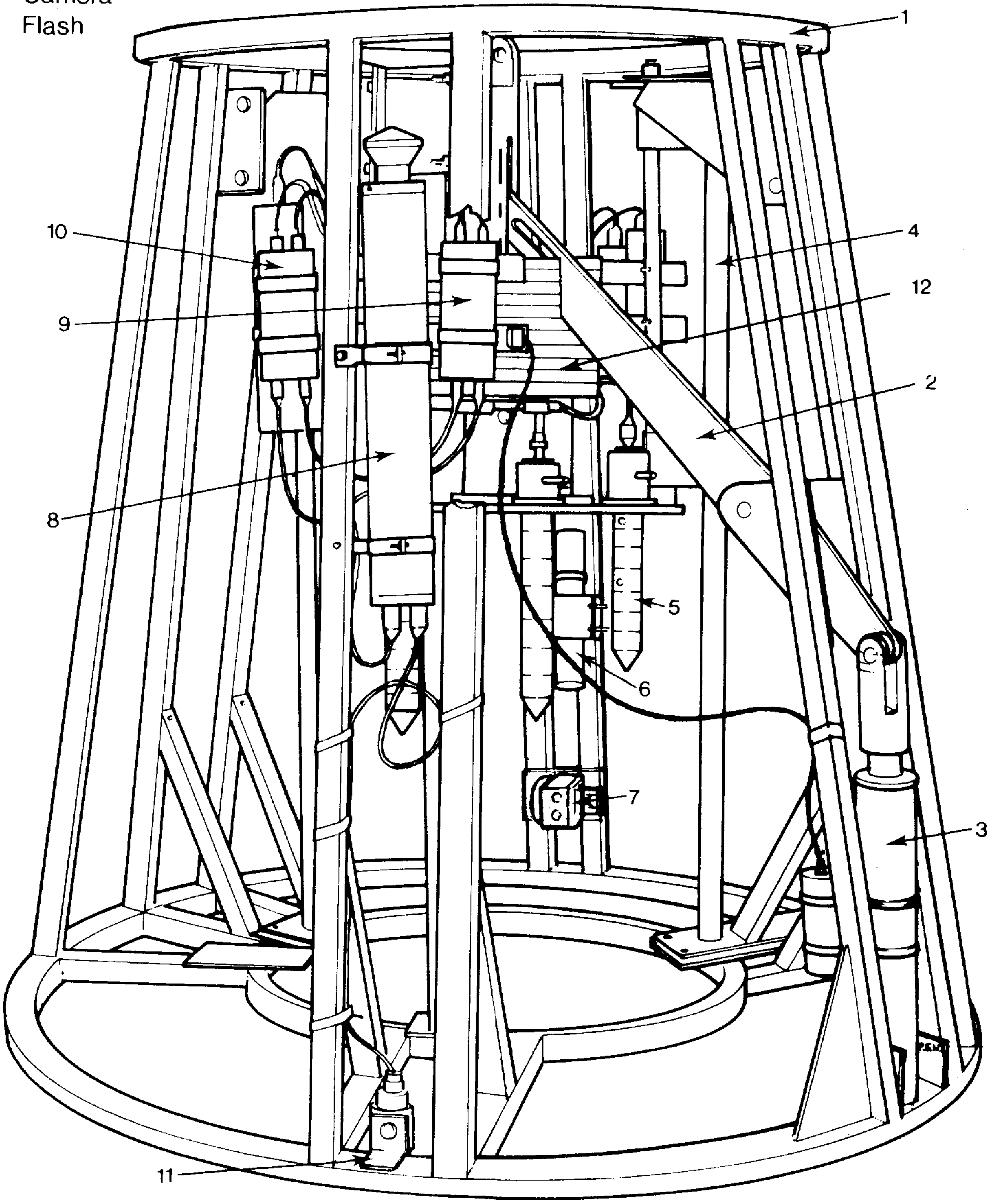

FIG. 5. Pore Water Sampler. MkIII

PORCUPINE SEA BIGHT 1200 METRE TRANSPONDER SITE (LAID SEPT. 1981)

PLOT OF ACOUSTICALLY NAVIGATED BATHYMETRIC SURVEY TRACK AND TRACK ACCORDING TO MAGNAVOX SATELLITES AND DEAD RECKONING ON CHALLENGER CRUISE 8/82

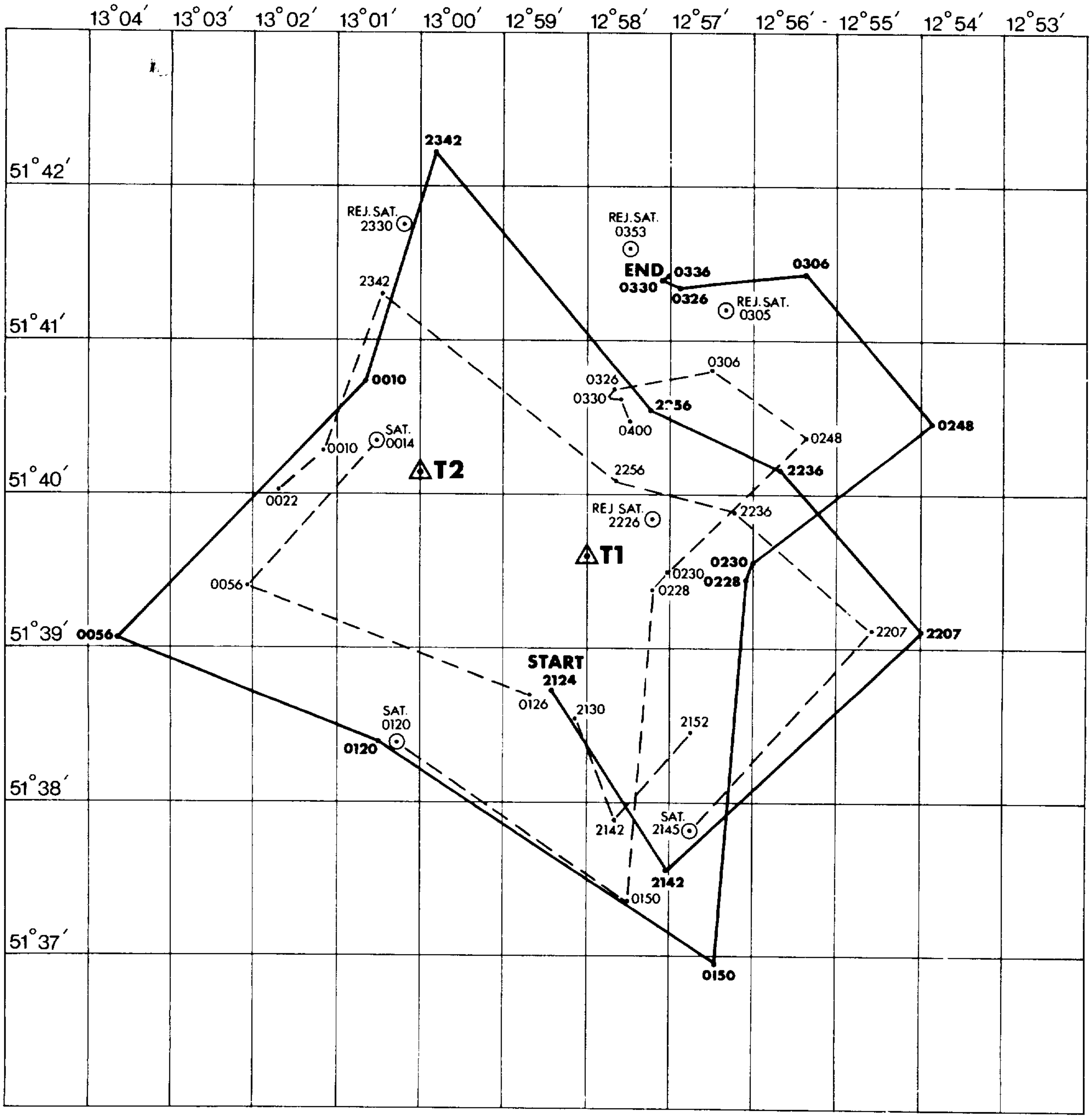

FIG. 6

PORCUPINE SEA BIGHT 4000 METRE TRANSPONDER SITE (LAID SEPT. 1981)

PLOT OF ACOUSTICALLY AND MAGNAVOX SATELLITE / DEAD RECKONING NAVIGATED BATHYMETRIC SURVEY TRACK
CHALLENGER CRUISE 8/82

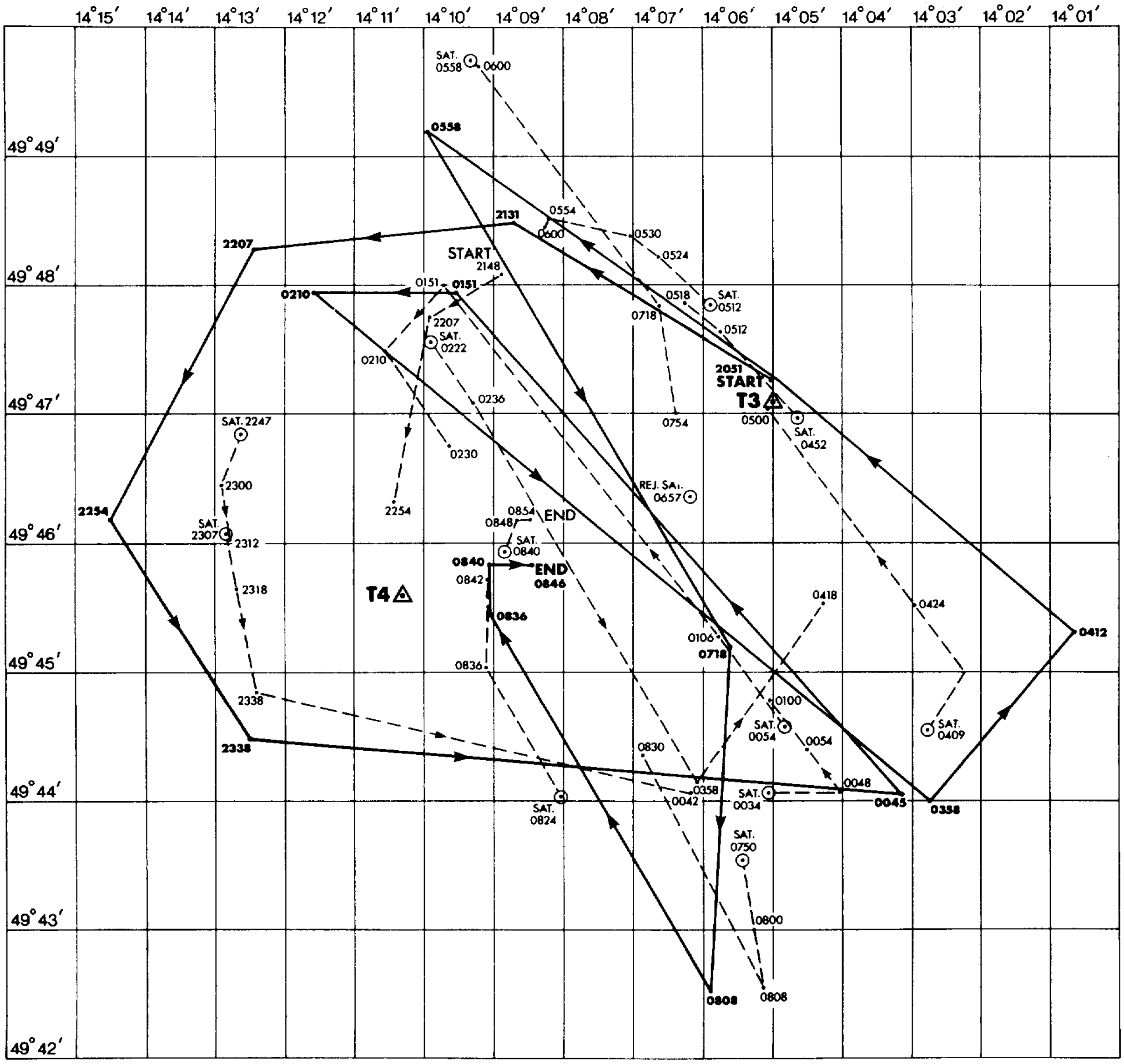

FIG. 7

OBSERVATIONS OF CHALLENGER STATION KEEPING IN A VARIETY OF SEA CONDITIONS, AND AN EXPERIMENT TO STUDY THE EFFECT OF DEPARTING FROM THE STANDARD (HOVE TO) TECHNIQUE. CHALLENGER 8/82

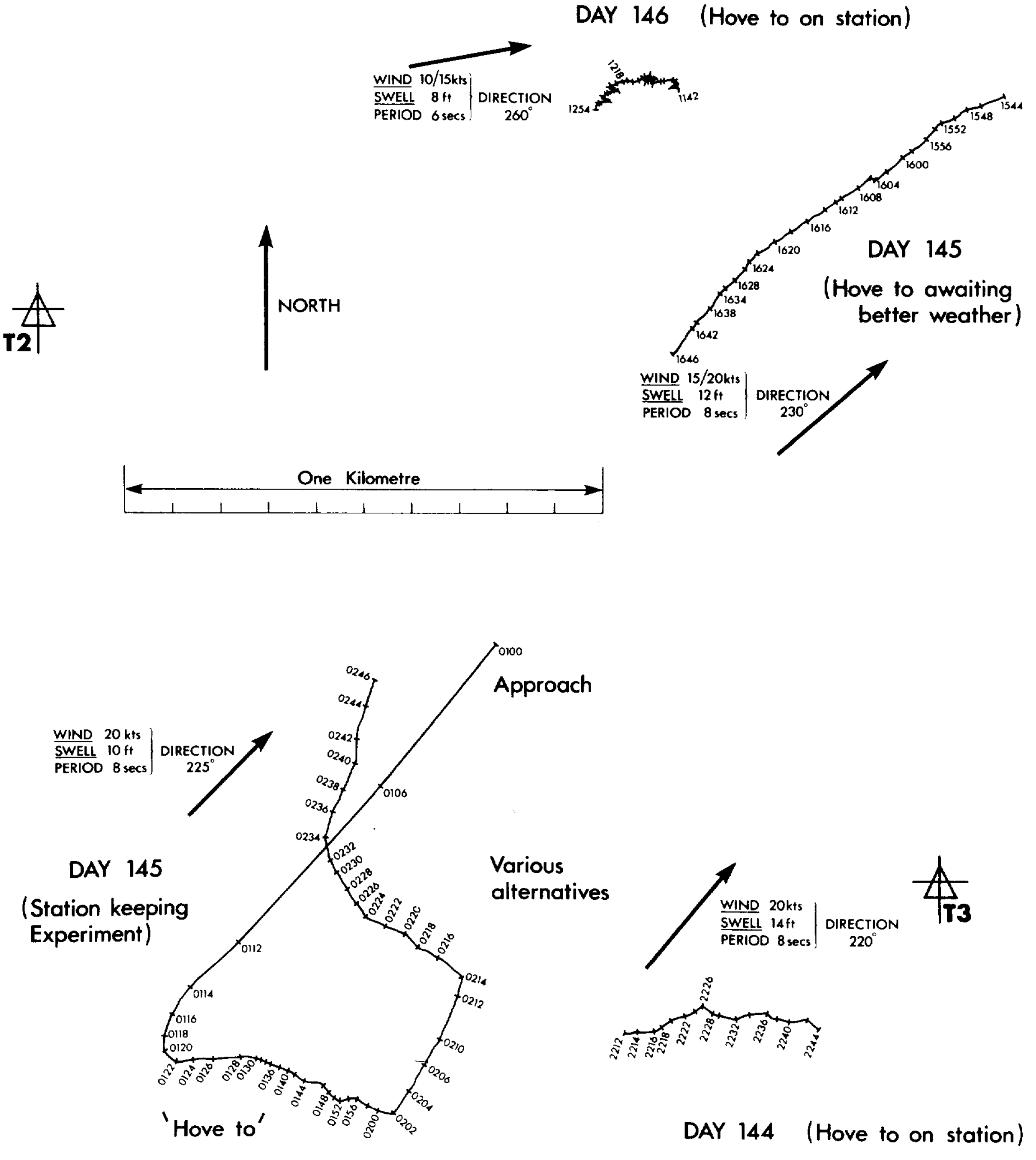

FIG. 8