

R.R.S. DISCOVERY
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Observations in the Rockall Trough
(JASIN 1977)

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CONTENTS

| | Page |
|---------------------------------------|------|
| Scientific Personnel | 1 |
| Introduction | 2 |
| Itinerary | 2 |
| Acknowledgements | 5 |
| Notes on Equipment and Observations: | |
| Batfish | 5 |
| Computing | 6 |
| CTD Work | 7 |
| E.M. Spar | 8 |
| Float Tracking | 9 |
| Moorings | 10 |
| Pitch-Roll Buoy | 11 |
| Radiosondes | 11 |
| Underway Observations and Navigation | 13 |
| Vector-Averaging E.M. Current Meter | 14 |
| Tables: | |
| 1. Station List | 15 |
| 2. Mooring List | 16 |
| 3. Summary of Radiosonde Flights | 19 |
| 4. Batfish Tows | 20 |
| 5. Float Trajectories | 22 |
| 6. Intercomparison of Surface Sensors | 23 |
| Figures: | |
| 1. Track Chart (whole cruise) | |
| 2. Track Chart (JASIN area) | |

SCIENTIFIC PERSONNEL

| | | |
|-------------------|--------------------|---|
| Prof. W.V. Burt | Oregon State Univ. | Moored met. instruments, thermistor chains |
| Mr F. Evans | Oregon State Univ. | Moored met. instruments, thermistor chains |
| Mr B. Moore | Oregon State Univ. | Moored met. instruments, thermistor chains |
| Mr B.A. Hughes | IOS Bidston | Moored current meters, tide gauge |
| Mr J.W. Cherriman | IOS Wormley | Moored current meters |
| Mr R.F. Wallace | IOS Wormley | Moorings, workshop |
| Dr R.T. Pollard | IOS Wormley | Batfish, E.M. shear probe, etc. |
| Mr V.A. Lawford | IOS Wormley | Batfish |
| Mr J.A. Moorey | IOS Wormley | Salinometer, surface T & S |
| Mr J. Smithers | IOS Wormley | CTDs |
| Dr C.H. Clayson | IOS Wormley | E.M. probe, P.R. buoy, VAECM |
| Mr K.G. Birch | IOS Wormley | E.M. probe, P.R. buoy, VAECM |
| Dr P.K. Taylor | IOS Wormley | Radiosondes, LO-CATE |
| Mr A. Osmond | Met. Office | Radiosondes, LO-CATE |
| Miss T. Colvin | IOS Barry | Computing |
| Mr P.R. Hartland | IOS Barry | Computing |
| Mr I. Innes | IOS Barry | Computing |
| Mr M. Butterfield | U. of Southampton | Float tracking |
| Mr N.W. Millard | IOS Wormley | Float tracking |
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| Dr J.C. Swallow | IOS Wormley | Float tracking, Pr. Sci. |

INTRODUCTION

This cruise was part of JASIN 1977. Its purpose was to continue exploration of the JASIN area (roughly 57°-60°N, 10°-14°W) begun earlier in the year by cruises of "Challenger" and "Tydeman", and to evaluate various instruments and observational methods for possible use in the proposed 1978 experiment.

The main items in the scientific programme were

- (1) Setting and recovering four surface moorings carrying meteorological recorders and shallow thermistor chains
- (2) Occupying a pattern of CTD stations, in the form of widely spaced small (15 km) triangles, each triangle being occupied twice in a 12½ hour period
- (3) Acoustic tracking of near-surface floats, including depth-telemetering floats
- (4) Tests of a new batfish and using it for mapping near-surface water structure
- (5) Trials of an electromagnetic shear probe
- (6) Radiosonde tracking, including use of W-3 LO-CATE equipment
- (7) Trials of pitch-roll buoy
- (8) Intercomparison of electromagnetic and rotor-vane vector averaging current meters
- (9) Recovering six current meter moorings and a tide gauge, set by "Challenger" in July
- (10) Surface T and S observations, and bathymetry, on passage when in deep water.

Weather conditions varied, but were mostly good, and work of some kind was always possible. Some progress was made on all the items listed above. All the moorings and the tide gauge were recovered. The e.m. shear probe was lost, but not before some records had been obtained from which its performance could be assessed. More detailed accounts of equipment and observations are given below.

NARRATIVE (see Figs. 1 and 2 for track charts)

'Discovery' sailed from Southampton at 1145/7th September. Three days passage in good weather via the west coast of Ireland brought us to the JASIN area early on the 10th. The first task was to set the four surface moorings, one per day on shallow seamounts,

alternating with overnight CTD or batfish work. The first mooring (U3) was set on Anton Dohrn seamount a.m. 10th. On the way to the second mooring position, on the northern slope of Rockall Bank, a triangular pattern of CTD stations to 1200 m was occupied. We had intended to do six stations, repeating the triangle with 6-hour intervals, but troubles with the CTD delayed the start. The second surface mooring (U4) was set in the afternoon of the 11th, after a fruitless search for B1 mooring nearby. Overnight, another triangle of CTD stations was occupied twice and the third surface mooring (U1) was set on George Bligh bank in the afternoon of the 12th. A batfish run was planned from there to the next mooring site, but it soon had to be recovered (noise in its CTD output) and instead several shallow stations were done with the lowered CTD. Subsurface moorings W4 and W1 were interrogated during the overnight run to Rosemary bank. The weather had deteriorated by the time we arrived there, but the fourth surface mooring (U2) was set in a 40 kt wind, p.m. 13th.

A batfish run was made from there to W3 mooring position, near which another triangle of CTD stations was planned. The weather was not fit for CTDs by then, but W3 was interrogated and the batfish run continued on a northwestward course towards moorings W1 and W4, which were thought to be in a suitable region for float tracking and testing other instruments. On the way, during the 14th, the compensating electric winch was tested working from a lowered pressure transducer, and the gyro housing of the electromagnetic shear probe was lowered for a leak test. Overnight, a triangle of CTD stations was occupied twice, near moorings W1 and W4, and an acoustically tracked surface float was launched on the last station. Wire tests of various instruments (e.m. shear probe housing, bottom transponders, remote interrogators) were done alternately with fixing the surface float. A pressure-telemetering float was launched, but an error in loading made it go too deep, and its release did not work, so the float was lost. Two bottom transponders were laid for acoustic navigation whilst fixing floats. Next day (16th) the electromagnetic shear probe was lowered on the electric winch for a test, but after several hours recording the winch cable broke and the probe was lost. A group of four surface floats was then launched and tracked overnight relative to the bottom transponders and a remote

interrogator, all of which were recovered in the afternoon of the 17th.

The pitch-roll buoy was then launched, with a float and drogue attached, and the batfish was towed repeatedly round a 5-mile triangle, keeping the pitch-roll buoy at one corner, until a.m. 18th when the batfish and pitch-roll buoy were recovered.

By then it was time to start recovering subsurface moorings; W1 and W4 were recovered that day, followed by a batfish run towards W3 position. Arriving there soon after midnight, the triangle of CTD stations (omitted earlier because of weather) was occupied twice, and W3 mooring recovered p.m. 19th. From there, a zig zag batfish course was set towards moorings B2 and W2, and overnight another series of 5-mile triangles was run with the batfish, relative to a surface float. Moorings B2 and W2 were recovered in daylight on the 20th, and another batfish run was made, north-northwestwards to $59^{\circ}30'N$, $13^{\circ}W$, thence via surface buoys U1 and U4 to the neighbourhood of mooring B1 and the tide gauge on the north slope of Rockall bank. Those two items were recovered in the forenoon of the 21st. In the afternoon, the vector-averaging electromagnetic current meter was compared with a conventional VACM by streaming the two instruments under a surface float from the ship whilst lying to, and a further test was made with the remaining pressure-telemetering float.

Having recovered all the subsurface moorings, a start was made next day on the surface moorings, which were recovered in the reverse order. Mooring U2 on Rosemary bank was recovered a.m. 22nd, after an overnight batfish run from near U4. From U2's position, another batfish run was made via $60^{\circ}N$, $11^{\circ}W$ to U1 on George Bligh bank. It was recovered a.m. 23rd and, with the prospect of worsening weather, an attempt was made to recover U4 late that afternoon. That had to be abandoned after several tries, resulting only in damaging the meteorological instruments on the buoy. Overnight, surface T and S were recorded along a track returning to U4's position, using the batfish on deck connected to a sea-water hose. Next day (24th) the weather was not fit for mooring recovery. The pressure-telemetering float was launched and recovered several times with different loads, and was tracked overnight until a.m. 25th. Mooring U4 was then recovered in better weather, and the batfish was towed on a track

ending near U3 mooring a.m. 26th. Again, the weather was not fit for recovering the mooring (wind 43 knots and heavy swell). The pressure-telemetering float was launched and tracked until late afternoon, when the weather had improved sufficiently for U3 mooring to be recovered. After a further intercomparison of the vector-averaging electromagnetic current meter and a VACM, a batfish run was made ending at the southernmost triangle of CTD stations, which had been occupied only once at the beginning of the cruise. That triangle was worked twice during 27th September, after which 'Discovery' set course for Barry, arriving there via the Irish Sea at 0900/30th September.

ACKNOWLEDGEMENTS

It is a pleasure to acknowledge the continuing contribution made by the master, Captain M. Harding, and the officers and crew of the R.R.S. 'Discovery', to the success of the scientific work. Particular acknowledgement is due for the efforts of the boat's crew who went out to repair instruments and attach extra recovery lines to the surface buoys, sometimes in poor weather.

J.C. Swallow

NOTES ON EQUIPMENT AND OBSERVATIONS

BATFISH (staff concerned: Lawford, Pollard, Smithers)

The new IOS Batfish was successfully launched and recovered 12 times, completing 126 hours of data collection (Table 4). The normal cycle was from 10 m to 85 m depth, with a period of between 3 min and 5 min, using approximately 160 m of faired cable. Several servo-controlled horizontal runs were made at various depths between 15 m and 90 m. One run was made servoing along the 11.5°C isotherm. The cycling mode tended to be irregular in the depths attained at the top and bottom due to a tendency of the vehicle to shear off to one side or the other of the ship. Cable angles reached 45°, generally to port. It was not found possible to correct this fault during the cruise. Variations in depth during the horizontal tows decreased considerably the deeper the tow, until at 90 m depth variations of less than 2 m peak to peak were obtained. Isothermal towing proved to be a practical proposition as long as the water was reasonably stratified. On three occasions the batfish CTD was run

on deck, being supplied with water from the ship's fire main. The hose was connected to a fitting clamped directly to the CTD sensor head. As the fitting was made from perspex it was possible to observe the flow of water about the sensors. No aeration was observed, the water velocity across the sensors being approximately 6 m sec^{-1} . Throughout the cruise a number of fastenings on the vehicle came loose and it was necessary, to mechanically lock as many as possible. On recovering the vehicle after the first run it was found that the towing bridle had become slightly bent downwards; during the last run this bend became considerable, precluding any further use of the vehicle. Two runs had to be aborted due to slight leakage of water into the CTD core and one through loss of a core in the towing cable. The new IOS-built hydraulic unit performed excellently throughout, less than 3 ml of water being found in the outer chamber at any time. Much of the credit for this performance must be due to Mr R.E. Potter who built the unit.

V.A. Lawford

COMPUTING (T. Colvin, P.R. Hartland, I. Innes)

Besides accurate navigation the computer system was used extensively to provide profiles, listings and track charts etc. for the convenience of the main participants of the cruise.

Subjective analysis of the navigational data on a daily basis was made to correct obvious anomalies arising from poor quality fixes. Meteorological, surface salinity and temperature profile data were similarly treated to eliminate known sources of interference. Bathymetric data was logged at six minute intervals.

At all times the prime navigational aid was satellite navigation with Loran-C fixes being calculated for cross reference only. Poor reception of one slave station was experienced throughout and this affected the overall performance of hyperbolic navigation.

Interleaved with the above, which constituted the main bulk of the activity related to the computing facility, user programmes were run as required by the cruise participants. These were in the main related to the calibration of equipment in connection with CTD data and water bottle thermometers. Off-line inputting and processing of

data associated with the E.M. shear probe was also carried out.

T. Colvin

CTD WORK (P.M. Saunders, J. Smithers)

42 stations (the first station 9576, the last 9623) were occupied using the Neil Brown CTD during the cruise. Both this instrument and the Hewlett Packard 2100 computer on which the data was logged performed well. A Calcomp plotter normally a peripheral for the ship's IBM 1800 computer was moved into the clean room alongside the HP 2100 and displayed the temperature-salinity data during each cast. The proximity of the plotter to the CTD operator was a great convenience and it is hoped that this move can be repeated in future.

CTD failure occurred only on station 9600 (lowering 1) due to the open circuiting of the main electrical cable to the instrument at 730 m, and on station 9582 whilst being raised due to the failure of the deck unit (because of a short circuit). Both faults were quickly rectified. The first four casts (station 9576 and 9577 lowerings 1-3) were all plagued by erratic behaviour of the conductivity sensor. After it was replaced by a spare, no further major problems were encountered. The multisampler performed extremely reliably providing salinities at 2 to 4 depths and temperatures at 1-3 depths on each cast. The salinity values determined on board yielded estimates of the CTD cell factor which varied during the cruise between 1.0013 and 1.0026. The multisampler thermometer measurements quickly demonstrated large differences from those made with the CTD platinum resistance thermometer: the discrepancy was traced to a change in an amplifier board in the CTD made shortly before departure. An approximate calibration good to $\pm 0.01^{\circ}\text{C}$ was made on the cruise and a more exact determination will be made on return to Wormley.

The observational program for the CTD centred on efforts to measure the mesoscale geostrophic shear at four locations (approximately $57^{\circ}30'\text{N}$, $58^{\circ}30'\text{N}$ and $59^{\circ}30'\text{N}$, all close to 12°W , and near $58^{\circ}30'\text{N}$, $10^{\circ}30'\text{W}$). At each location stations were made to a depth of 1200 m at the vertices of a triangle of side 15 km. In order to reduce the 'noise' due to the semi-diurnal tide each station was occupied twice separated by approximately 6 hours. Pair averages may be expected to

contain considerably reduced 'noise' from tides. At the time of writing only the eastern location has yielded geostrophic shear from 200-1100 db in excess of 10 cm/s.

Other CTD observations were as follows:- Lowerings to 120 m were made in the vicinity of each of the four surface moorings 235-238 for intercomparison with thermistor chain data. En route between 59°N, 13°45'W and 59°15'N, 10°W (approximately), 120 m casts were made at 15 km separation. Near 59°30'N and 12°W repeated shallow lowerings were made at 5 minute intervals for a duration of approximately 2½ hours. These latter measurements revealed the complex spatial and temporal variations of the upper ocean probably better described by the Batfish observations.

P.M. Saunders

E.M. SPAR (K.G. Birch, C.H. Clayson, R.T. Pollard)

A newly developed version of the E.M. spar was used to make measurements of vertical and horizontal flow. This version incorporated a vertical gyroscope to measure the orientation of the sensors. Two of the current meter heads were of the recently developed open construction which is not subject to the stalling problem experienced with the solid heads at high flow angles. A number of records were made to compare the performance of the open and solid heads. A pressure sensor was also included in the new configuration with the objects of monitoring and controlling the vertical motion of the spar relative to the water particle motion, by applying feedback to the servo-controlled electric winch. This pressure feedback system had been tested earlier in the cruise with only the pressure sensor and a weight on the end of the wire. After adjustment to stabilise the system, about a 90% reduction of the pressure fluctuations measured by the transducer was achieved in conditions in which the ship's heave was above 3 m. When the pressure feedback was tried again with the sensor on the spar, the high drag of the sphere on the spar resulted in slack wire when the compensation was not perfect. Unfortunately a turn of wire was caught up on the winch under these conditions with the result that the wire broke and the spar was lost. Since the pressure housing was only adequate for 200 m and the water depth was over 1 km, dragging

was not attempted.

The hard work put into the construction of this instrument by both the IOS workshop (R.F. Wallace) and instrument laboratory (A.C. Braithwaite, S.K. Willis) is gratefully acknowledged.

Preliminary analysis showed vertical velocities due to ship motion of up to 1.5 m/sec. Severe stalling on one closed head was induced. Pitch and roll angles were less than 3° , but were nevertheless clearly correlated with "horizontal" velocities uncorrected for tilt showing the gyroscope to be necessary if horizontal currents and current-shear are to be determined.

C.H. Clayson, R.T. Pollard

FLOAT TRACKING (M. Butterfield, N.W. Millard, P.M. Saunders,
J.C. Swallow)

Our objectives were to assess the feasibility of acoustic tracking of near-surface floats in the JASIN area, to track a group of closely spaced floats (tens of metres apart) relative to bottom transponders, and to test a pressure-telemetering float loaded to stay in the mixed layer and fitted with extra drag against vertical relative motion.

It was found possible to detect a surface float (transducer at 4 m depth) at ranges up to 10 km with the ship moving at speeds up to 8 knots. For accurate range measurement (.01 sec travel time or better) 5 km range and 3 knots speed are more realistic limits. Four surface floats were released simultaneously, spaced approximately 10 m apart across wind, and were tracked relative to bottom transponders and a remote interrogator for 21 hours. Problems were encountered, with one bottom transponder moving significantly during the experiment, and frequently arrivals via acoustic paths involving the remote interrogator could not be detected. But, although the full accuracy of the intended tracking method could not be achieved, it was possible to observe the dispersion of the group of floats, and a short test using a free-floating remote interrogator at the surface gave promising results.

The first test of a pressure-telemetering float was disastrous. A gross error in loading (the buoyancy of the extra drag plate had been counted twice in calculating the load) made it sink quickly beyond

the intended depth, and several attempts to release it had no effect. It went to the bottom and thereafter gave us a lower-limit measure of mean near-bottom current, averaged over 67 hours. The second pressure-telemetering float behaved more satisfactorily. After two adjustments to its calculated load it was possible to place it in or near the bottom of the mixed layer, and some striking changes of pressure were observed with it in winds of 30-40 knots during 26th September.

Starting and end times and provisional positions for float tracks are listed in Table 5.

J.C. Swallow

MOORINGS (W.V. Burt, J.W. Cherriman, F. Evans, B.A. Hughes, B. Moore, R.F. Wallace, J.C. Swallow)

Four surface moorings were set and recovered during the cruise, and six subsurface moorings set by 'Challenger' in July were recovered. A tide gauge, set by 'Challenger' in July, was also recovered.

Recovery of the subsurface moorings and tide gauge was straightforward, except that some concern was felt that during interrogations earlier in the cruise it was not possible to switch the command pinger on, and with the shallowest mooring (B1, in 220 m depth) some time had to be spent searching for the mooring before recovery. These observations suggest that the transducers on the command (and release) pingers look upwards into a relatively narrow cone, necessitating a very close approach (a few hundred metres) before a shallow pinger can be switched successfully.

With the less familiar surface moorings, several lessons were learned. Launching the moorings went satisfactorily, but on attempting recovery in all four cases the recovery lines had become tangled round the lower part of the buoy framework, necessitating boat trips to disentangle the lines or to fit extra ones. In future it would be better to have recovery lines leading up from the attachment points on the lower framework, to suitable points on the upper instrument ring and thence hanging down to water level attached to a trawl float and short stray line. A heavy lifting strop should also be fitted, running from the upper end of the mooring wire below the buoy

to some convenient point on the upper instrument ring, so that the weight of the mooring can easily be taken on the trawl winch as soon as possible after the buoy has been lifted by the crane. Loosening of seized shackles caused part of the chain and sinkers to be lost on two moorings, and might have caused more serious losses if the buoys had been left out much longer; shackles secured with nuts and split pins would be much preferable.

Times, positions, types and depths of instruments and some preliminary notes on their performance are listed in Table 2. For further details about the results, consult Professor W.V. Burt (O.S.U.) regarding meteorological and thermistor chain records, Dr R.T. Pollard (IOS Wormley) about current meter records, Dr D.E. Cartwright (IOS Bidston) about the tide gauge record.

J.C. Swallow

PITCH-ROLL BUOY (K.G. Birch, C.H. Clayson)

Two trials of a self contained version of the pitch-roll buoy were carried out. In the first of these the buoy was tethered to a drogue and to a transponder and allowed to drift free overnight during a series of triangular runs made with the Batfish. In the second, the buoy was launched so as to record during the first of the VACM inter-comparisons referred to above.

C.H. Clayson

RADIOSONDES (P.K. Taylor, A. Osmond)

The radiosonde work during this cruise was in preparation for the JASIN 1978 experiment. It included instrument trials, and the evaluation of Loran-C tracking capabilities in the proposed JASIN area. It had also been hoped to obtain a series of radiosonde flights through a secondary front during a cold air outbreak, a weather situation amenable to study from a single ship. Although such an event did not occur, on several occasions radiosonde soundings from an array of ships, as planned for 1978, would have been of interest.

The major instrument trial was the evaluation of the LO-CATE W3 radiosonde tracking system when used with Loran-C. This system, which provides computer-compatible logging of data from the fast

sampling VIZ 1223 radiosonde, is considered the primary choice for 1978. Delay in obtaining necessary repairs had resulted in the set being put on the ship in a partially working condition and changes to the electronics were necessary before and during the cruise. In particular the set was operated on a temporary reference oscillator constructed at IOS by Mr John Bunting. VIZ 1223 sondes were tracked to give chart recorder and magnetic tape logging of pressure, temperature and relative humidity and both the 1223 and the slow sampling 1205 sondes, were tracked to give wind data. However interference between the 'meteorological' and the wind data caused sudden loss of tracking during all flights for which logging of both types of data was attempted. A low 40 MHz clock signal was considered the probable reason for this but correction at sea did not prove possible.

The WL-2 LO-CATE system, used on previous cruises, was operated with an IOS constructed data logging system and performed reliably. This set is considered the back-up system for the 1978 experiment. To compare their performance the WL-2 and W3 sets were used simultaneously both to track radiosonde flights, and to measure the ship's velocity using signals from a 1223 sonde fixed to the aft mast.

The radiosonde flights were normally single balloon flights to a chosen pressure level at which the sonde was released and descended by parachute. Two release types were used, each being essentially a box, the parts of which were kept together provided a pressure difference existed between the outside and inside. The IOS release performed reliably to the required 500 mb level. The Max-Planck-Institut für Meteorologie, Hamburg, release required a modification to reach 500 mb but then performed reliably. It is cheaper and easier to set than the IOS release and is recommended for the 1978 experiment. Two radiosonde parachute designs were used, one provided by the Meteorological Office and one by the Deutscher Wetterdienst Seewetteramt, Hamburg. Since both types are normally used in a different manner from that required in JASIN, evaluation trials were necessary. The Meteorological Office parachute proved the more reliable and gave an acceptable rate of descent. The accuracy of this parachute in sensing the mean wind will be evaluated from the flight data.

The VIZ 1223 radiosondes for use with the W3 equipment proved unreliable. All ten sondes showed oscillation of the Loran-C receiver, a similar failure to that experienced with VIZ 1220 radiosondes during JASIN 1972. Although a simple remedy was devised and tested both time and data had already been lost.

Loran-C signal quality in the JASIN area was monitored during the cruise. The SL3W (Sylt) signal was very low in amplitude and manual locking of the W3 set was sometimes necessary. However preliminary inspection of the ship velocity comparisons suggested that the W3 one minute winds should be of the required accuracy (better than ± 0.3 m/s) although the quarter minute winds were not. The W3 appeared less susceptible to propagation errors than the WL2 although night time tracking errors of about 1 m/s in one minute 'winds' were observed.

The radiosonde flights are summarized in Table 3.

P.K. Taylor

UNDERWAY OBSERVATIONS AND NAVIGATION

The echo-sounder was operated and logged manually at 6 min intervals whenever the ship was underway in deep water (100 fm). By convention, Matthews' table for Area 9 was used for correcting soundings all over the JASIN area.

At the beginning of the cruise, Loran-C fixes were logged by the computer in addition to satellite fixes (the primary navigation aid) but the weakness of one Loran-C signal (Sylt) and consequent frequent loss of lock caused them to be abandoned after a few days.

J.C. Swallow

The S-T profiler was towed almost continuously throughout the cruise, giving analogue records of near-surface temperature and salinity and being logged simultaneously by the computer. It suffered some shifts of calibration, and frequent checks were made against bucket observations. An intercomparison of various sensors including the S-T profiler was made on two CTD stations, as described below.

- (1) S-T Profiler When hove to on station the fish sinks to about 7 m, during these comparisons the fish was first at 7 m and

then raised to about 1 m. Water temperature and salinity appeared to be well mixed between these two limits.

- (2) R.A.S.T.U.S. sea surface sensor mounted on the hull, temperature is a digital visual readout.
- (3) Hull temperature, an IOS sensor mounted on the hull, 10 minute temperature values are printed on the 1053 printer.
- (4) S-T Profiler bucket, an ordinary rubber bucket with a line attached, the temperature is measured using two IOS surface thermometers. Salinity samples were taken from the bucket on the Autolab.
- (5) Crawford bucket, this has a mercury in glass thermometer permanently fitted.
- (6) The CTD was held at 10 m and two water bottles fired (there were no reversing thermometers on these bottles), the salinity samples were measured on the Autolab. Results of these inter-comparisons are listed in Table 6.

J. Moorey

VECTOR-AVERAGING ELECTROMAGNETIC CURRENT METER (J.W. Cherriman,
C.H. Clayson)

Two trials of a prototype VAECM, recently constructed at IOS, Wormley by T.J.P. Gwilliam, were carried out. The performance of the new current meter was compared with that of an AMF VACM with both current meters suspended from a cluster of surface floats which were tethered to the ship by 100 m of polypropylene rope. The ship lay to during the measurements so that the current meters were towed at between $\frac{3}{4}$ and $1\frac{1}{2}$ knots. The current meters were at 30 m depth with their sensors vertically separated by 1 m: current shear should have been small as the mixed layer depth was about 70 m. The second trial was carried out in seas of about 4 m wave height and was, thus, a severe test of the instruments' response.

C.H. Clayson

TABLE 1. STATION LIST

| Station No. | Date | Time | | Position | | Gear Used, Comments |
|-------------|-------|--------------------------|--------|-----------------|------------------|------------------------------------|
| | | Start (all times GMT) | End | Lat.N. ° ' " | Long.W. ° ' " | |
| 9575 | 10 | 1024 | 1200 | 57 23.1 | 11 10.3 | Mooring 235 (U3) set |
| 9576 | | 1252 | 1257 | 57 23.3 | 11 10.2 | CTD 1 (100m) |
| 9577 | 11 | 0012 | 0052 | 57 27.3 | 11 56.6 | CTD 2 (1200m) |
| 9578 | | 0204 | 0259 | 57 22.1 | 12 09.5 | CTD 3 (1200m) |
| 9579 | | 0406 | 0453 | 57 29.4 | 12 09.7 | CTD 4 (1200m) |
| 9580 | | 1311 | 1420 | 58 04.3 | 13 49.2 | Mooring 236 (U4) set |
| 9581 | | 1436 | 1442 | 58 04.1 | 13 49.5 | CTD 5 (110m) |
| 9582 | | 2142 | 2238 | 58 34.9 | 12 12.5 | CTD 6 (1200m) |
| 9583 | 12 | 0102 | 0148 | 58 38.2 | 12 01.5 | CTD 7 (1200m) |
| 9584 | | 0254 | 0354 | 58 42.7 | 12 12.2 | CTD 8 (1200m) |
| 9585 | | 0454 | 0556 | 58 35.8 | 12 14.7 | CTD 9 (1200m) |
| 9586 | | 0705 | 0803 | 58 39.9 | 12 01.4 | CTD 10 (1200m) |
| 9587 | | 0945 | 1036 | 58 44.4 | 12 16.4 | CTD 11 (1200m) |
| 9588 | | 1614 | 1705 | 58 58.0 | 13 42.6 | Mooring 237 (U1) set |
| 9589 | | 1719 | 1729 | 58 57.6 | 13 43.3 | CTD 12 (110m) |
| 9590 | | 2139 | 2147 | 59 02.6 | 13 16.2 | CTD 13 (110m) |
| 9591 | | 2318 | 2324 | 59 08.8 | 12 52.3 | CTD 14 (110m) |
| 9592 | 13 | 0058 | 0106 | 59 13.7 | 12 25.3 | CTD 15 (110m) |
| 9593 | | 0238 | 0248 | 59 23.6 | 12 12.6 | CTD 16 (130m) |
| 9594 | | 0451 | 0502 | 59 26.0 | 11 49.3 | CTD 17 (130m) |
| 9595 | | 0645 | 0655 | 59 21.9 | 11 22.1 | CTD 18 (130m) |
| 9596 | | 0842 | 0850 | 59 18.2 | 10 51.5 | CTD 19 (150m) |
| 9597 | | 1017 | 1023 | 59 15.4 | 10 25.8 | CTD 20 (130m) |
| 9598 | | 1353 | 1510 | 59 14.1 | 10 12.4 | Mooring 238 (U2) set |
| 9599 | | 1520 | 1533 | 59 14.0 | 10 12.6 | CTD 21 (130m) |
| 9600 | 14 | 2147 | 2234 | 59 25.6 | 12 14.0 | CTD 22 (1200m) |
| 9601 | 14-15 | 2344 | 0034 | 59 33.6 | 12 14.6 | CTD 23 (1200m) |
| 9602 | 15 | 0137 | 0228 | 59 29.6 | 12 02.0 | CTD 24 (1200m) |
| 9603 | | 0332 | 0423 | 59 26.7 | 12 16.3 | CTD 25 (1200m) |
| 9604 | | 0555 | 0643 | 59 34.1 | 12 14.6 | CTD 26 (1200m) |
| 9605 | | 0755 | 0843 | 59 29.3 | 12 01.0 | CTD 27 (1200m) |
| 9606 | | 1253 | 1256 ? | 59 27.9 | 12 03.5 | CTD 28 (1200m) |
| 9607 | | 1311 | 1336 | 59 28.0 | 12 03.8 | CTD 28/1 (5 dips, 30-100m) |
| 9608 | | 1436 | 1551 | 59 27.6 | 12 04.8 | CTD 28/2 (19 dips, mostly 50-110m) |
| 9609 | | 2208 | 2300 | 59 27.1 | 12 04.2 | CTD 29 (6 dips, 10-120m) |
| 9610 | 16 | 1027 | 1041 | 59 27.2 | 12 04.2 | CTD 30 (120m) |
| 9611 | | 1108 | 1540 | 59 25.5 | 12 04.3 | E.M. shear spar |
| 9612 | 19 | 0047 | 0137 | 58 23.0 | 10 36.2 | CTD 31 (1200m) |
| 9613 | | 0236 | 0327 | 58 19.4 | 10 24.6 | CTD 32 (1200m) |
| 9614 | | 0432 | 0529 | 58 15.4 | 10 38.3 | CTD 33 (1200m) |
| 9615 | | 0642 | 0752 | 58 24.4 | 10 36.9 | CTD 34 (1200m) |
| 9616 | | 0904 | 0942 | 58 19.6 | 10 23.4 | CTD 35 (1200m) |
| 9617 | | 1050 | 1134 | 58 15.3 | 10 37.5 | CTD 36 (1200m) |
| 9618 | 27 | 0750 | 0841 | 57 30.4 | 12 09.1 | CTD 37 (1200m) |
| 9619 | | 0958 | 1043 | 57 22.0 | 12 08.7 | CTD 38 (1200m) |
| 9620 | | 1140 | 1230 | 57 27.8 | 11 58.3 | CTD 39 (1200m) |
| 9621 | | 1330 | 1412 | 57 29.7 | 12 09.3 | CTD 40 (1200m) |
| 9622 | | 1523 | 1616 | 57 22.6 | 12 05.0 | CTD 41 (1200m) |
| 9623 | | 1728 | 1808 | 57 27.6 | 11 57.1 | CTD 42 (1200m) |

TABLE 2. MOORING LIST

Notes:

- (1) For subsurface moorings (W,B...) the listed recovery time is the time that the acoustic release was fired. For surface moorings (u...) it is the time that the crane was hooked on, to start lifting the surface buoy.
- (2) Abbreviations: ACM - Aanderaa current meter
 MDL - Meteorological data logger
 TL/TC - Thermistor logger/thermistor chain
 VACM - Vector-averaging current meter.

The meteorological data loggers, thermistor loggers and thermistor chains were also manufactured by Aanderaa.

- (3) Meteorological and other sensors on the surface buoys, recorded by the meteorological data logger, comprised the following:
1. wind speed (cup anemometer)
 2. wind direction (relative to buoy)
 3. air pressure (static head + quartz sensor)
 4. buoy orientation (magnetic compass)
 5. wet bulb air temperature
 6. dry bulb air temperature
 7. solarimeter
 - 8 and 9. thermistors at 0.5m and 2m depth.

Mooring No. 229 (W3), set 1702Z 14.7.77, 58°15.7'N, 10°42.8'W, 1970m.
 recovered 1218Z 19.9.77, 58°16.0'N, 10°42.7'W.

| | | | |
|-------|----------------|------------|--------------------------|
| VACM | ser.no. V0130, | depth 19m, | record no. 22901 |
| TL/TC | T178 | 20,21(5)66 | 02 |
| ACM | 940 | 66 | 03 |
| ACM | 302 | 185 | 04 short record (leaked) |
| ACM | 2106 | 490 | 05 |
| ACM | 423 | 1000 | 06 |

Mooring No. 230 (W1), set 1414Z 15.7.77, 59°29.1'N, 12°11.5'W, 1426m.
 recovered 1124Z 18.9.77, 59°28.9'N, 12°11.2'W.

| | | | |
|-------|----------------|------------|-------------------------------|
| VACM | ser.no. V0159, | depth 27m, | record no. 23001 |
| TL/TC | T245 | 28,30(5)75 | 02 |
| ACM | 469 | 75 | 03 |
| ACM | 2109 | 197 | 04 |
| ACM | 420 | 504 | 05 rotor stuck after 12 days. |
| ACM | 2449 | 1017 | 06 |

Mooring No. 231 (W4), set 2145Z 15.7.77, 59°18.1'N, 12°15.3'W, 1519m.
recovered 1413Z 18.9.77, 59°18.1'N, 12°15.2'W.

| | | | |
|-------|----------------|------------|---------------------------|
| VACM | ser.no. V0156, | depth 36m, | record no. 23101 |
| TL/TC | T44 | 37,38(5)83 | 02 |
| ACM | 1620 | 83 | 03 no data, flat battery. |
| ACM | 2110 | 205 | 04 |
| ACM | 794 | 510 | 05 no rotor |
| ACM | 2450 | 1019 | 06 |

Mooring No. 232 (W2), set 1540Z, 16.7.77, 58°38.3'N, 12°21.4'W, 1647m.
recovered 1201Z, 20.9.77, 58°38.6'N, 12°21.4'W.

| | | | |
|-------|----------------|------------|------------------|
| VACM | ser.no. V0132, | depth 39m, | record no. 23201 |
| TL/TC | T206 | 40,42(5)87 | 02 |
| ACM | 1623 | 87 | 03 |
| ACM | 468 | 208 | 04 |
| ACM | 1622 | 311 | 05 |

Mooring No. 233 (B2), set 1457Z, 18.7.77, 58°34.6'N, 12°22.8'W, 1639m.
recovered 1015Z, 20.9.77, 58°34.6'N, 12°22.5'W.

| | | | |
|-----|---------------|-------------|------------------|
| ACM | ser.no. 1867, | depth 297m, | record no. 23301 |
| ACM | 2575 | 501 | 02 |
| ACM | 1506 | 754 | 03 |
| ACM | 1746 | 959 | 04 |
| ACM | 1750 | 1217 | 05 |
| ACM | 2573 | 1475 | 06 |

Mooring No. 234 (B1), set 0857Z, 19.7.77, 58°06.0'N, 13°49.2'W, 228m.
recovered 0926Z, 21.9.77, 58°05.9'N, 13°49.5'W.

| | | | |
|-----|--------------|------------|------------------|
| ACM | ser.no. 570, | depth 88m, | record no. 23401 |
| | 2576 | 194 | 02 |

Mooring No. 235 (U3), set 1200Z, 10.9.77, 57°23.1'N, 11°10.3'W, 639m
recovered 1825Z, 26.9.77, 57°24.6'N, 11°09.8'W.

| | | | |
|-------|------------------------|------------------|-----------------------------------|
| MDL | ser.no. D221 (surface) | record no. 23500 | wind dir. failed, (time unknown). |
| VACM | V0155, depth 10m | 01 | |
| TL/TC | T265/290 | 11(3)41 | 02 |
| TL/TC | TC9/76 | 46(5)91 | 03 |

Mooring No. 236 (U4), set 1420Z, 11.9.77, 58°04.3'N, 13°49.2'W, 222m.
recovered 0938Z, 25.9.77, 58°04.3'N, 13°49.1'W.

| | | |
|-------|------------------------|---------------------------|
| MDL | ser.no. D222 (surface) | record no. 23600* |
| TL/TC | T269/291 | 11(3)41m 01 |
| TL/TC | TC6/77 | 46(5)91 02 battery leaked |

*Most meteorological sensors damaged in recovery attempts 1650-1755Z 23.9.77.

Mooring No. 237 (U1), set 1705Z, 12.9.77, 58°58.0'N, 13°42.6'W, 461m.
 recovered 0840Z, 23.9.77, 58°57.6'N, 13°43.7'W.

| | |
|----------------------------|---|
| MDL ser.no. D225 (surface) | record no. 23700 bad tape, cause unknown. |
| VACM V0430, depth 10m | 01 |
| TL/TC T264/289 11(3)41 | 02 |
| TL/TC TC8/78 46(5)91 | 03 |

Mooring No. 238 (U2), set 1510Z, 13.9.77, 59°14.1'N, 10°12.4'W, 468m.
 recovered 0858Z, 22.9.77, 59°14.5'N, 10°10.8'W.

| | |
|----------------------------|------------------|
| MDL ser.no. D226 (surface) | record no. 23800 |
| VACM V0429 depth 10m | 01 |
| TL/TC T268/288 11(3)41 | 02 |
| TL/TC T230/292 46(5)91 | 03 |

Tide Gauge (Mk 4) set 1339Z, 1.7.77, 58°16.1'N, 13°50.9'W, 388 m.
 recovered 1120Z, 21.9.77, 58°15.9'N, 13°51.8'W.

TABLE 3. SUMMARY OF RADIOSONDE FLIGHTS

| Flight No. | Sonde | | Track- ing | | Ascent Rate m/s. | Release | | | Parachute Rate | | Comments | |
|------------|-------|------|------------|----|------------------|---------|-----|--------------|----------------|----|----------|---------------------|
| | 1205 | 1223 | WL2 | W3 | | IOS | MPI | Set Released | DWD | MO | | m/s. |
| D8601 | x | | x | | 4.6 | x | 507 | 519 | | x | 4.6 | |
| D8602 | x | | x | | - | | - | - | | | | Temp. only |
| D8603 | x | | x | | 6.3 | x | 524 | 523 | | x | 9.4 | |
| D8604 | | x | | x | - | | - | - | | x | 3.3 | Only partly tracked |
| D8605 | | x | | x | 5.7 | | - | - | | x | 4.3 | |
| D8606 | x | | x | | 5.7 | x | 480 | 485 | | x | 23.0 | Parachute failed |
| D8607 | x | | x | | 5.5 | x | 481 | 461 | | x | 6.7 | |
| D8608 | x | | x | | 5.6 | x | 481 | 490 | | x | 5.0 | |
| D8609 | x | | x | | 5.6 | x | 481 | 730 | | x | 18.5 | Parachute failed |
| D8610 | x | | x | | 5.9 | x | 434 | 481 | | x | 4.4 | |
| D8611 | x | | x | | 5.5 | x | 531 | 584 | | x | 5.2 | |
| D8612 | | x | | x | - | | - | - | | x | - | No pressures |
| D8613 | x | | x | | 5.8 | x | 488 | 333 | | x | 4.8 | |
| D8614 | x | | x | | 6.0 | x | 533 | 475 | | x | 9.7 | |
| D8615 | x | | x | | 6.7 | x | ? | 390 | | x | 17.9 | Parachute failed |
| D8616 | | x | | x | 6.6 | | - | - | | x | 4.2 | |
| D8617 | | x | | x | 5.9 | x | 533 | 489 | | x | 3.4 | |
| D8618 | x | | x | x | 5.5 | x | 533 | 517 | | x | 4.1 | |
| D8619 | x | | x | x | 6.7 | x | 534 | 572 | | x | 3.9 | |
| D8620 | x | | x | | 5.2 | x | 484 | 480 | | x | 4.2 | |
| D8621 | x | | x | x | 5.4 | x | 452 | 445 | | x | 4.9 | |
| D8622 | x | | x | | 5.8 | x | 472 | 450 | | x | 5.2 | |
| D8623 | x | | x | x | 5.3 | x | 476 | 454 | | x | 5.4 | |
| D8624 | x | | x | x | - | x | 470 | - | | x | - | Temp. only |
| D8625 | x | | x | x | 5.8 | x | 470 | 550 | | x | 4.6 | |
| D8626 | x | | x | x | 6.0 | x | 463 | 450 | | x | 5.7 | |
| D8627 | x | | x | x | 3.2 | x | 440 | (484) | | x | 2.2 | Balloon leaked |
| D8628 | x | | x | x | 5.6 | x | 496 | 450 | | x | 4.0 | |
| D8629 | x | | x | x | 5.6 | x | 496 | 455 | | x | 15.9 | Parachute failed |
| D8630 | x | | x | x | 5.4 | x | 486 | 470 | | x | 5.7 | |

Release performance

Mean difference between setting and actual release height (neglecting one worst case for each type):

IOS -10mb (range -80 to + 22 mb)

MPI +23mb (range -38 to + 58 mb)

where a negative sign means a release nearer the surface.

Parachute performance (includes tests with water ballast only).

D.W.D. 6 flights, 4 failures

Mean successful descent rate 9.6 m/s.

M.O. 25 flights, 1 failure

Mean descent rate 4.9 ± 0.2 m/s (1205 sonde)

3.8 ± 0.3 m/s (1223 sonde).

TABLE 4.. BATFISH TOWS

| Run | (Sept) Date | Start Time (Z) | Stop Time (Z) | MODE | TRACK | COMMENTS |
|----------|----------------|-------------------|------------------|----------------------|--|--|
| 1 | 12 | 2001 | 2007 | Yoyo 10-70m | Near George Bligh Bank | Aborted, water in CTD |
| 2-6 | 13 | 1616 | | Yoyo 10-80m | From mooring U2 (Rosemary Bank) to mooring W3 | Force 9, ships speed 4-6 kts, batfish response marginal. |
| | 14 | | 0244 | | | |
| 7-8 | 14 | 0255 | 0907 | Horizontal 20m + 10m | From W3 to W1 | No hydraulic control, due to cable failure. |
| 9-15 | 17 18 | 1929 | 0851 | Yoyo 10-90m | Seven runs round triangle 5 miles on a side near moorings W1 and W4. Each triangle began near drogued drifting Pitch Roll buoy | On two occasions, buoy was located by navigating on mixed layer temperature structure. |
| 16 17 | 18 18 | 1621 2000 | 1751 2400 | Yoyo 0-90m | From W4 to W3 | CTD fault caused break between runs 16 and 17. |
| 18 | 19 | 1450 | 1716 | Yoyo 10-90m | Course 247° from W3 | Terminated by CTD deck unit failure. |
| 19-23 | 19 20 | 2308 | 0907 | Yoyo 10-90m | Five runs round triangle 5 miles on a side near moorings W2 and B2. Each triangle began near surface Swallow float. | Float drifted to west at 10-15 cm/sec. |
| 24-33 | 20 21 | 1354 | 0716 | Yoyo 10-90m | From B2 via 59°30'N, 13°W and U1 to B1. | |
| 34-40 | 21 22 | 1931 | 0705 | Yoyo 5-90m | Course 065° from B1 to U2 | |

TABLE 4. BATFISH TOWS continued...

| Run | (Sept) Date | Start Time (Z) | Stop Time (Z) | MODE | TRACK | COMMENTS |
|-------|-------------|----------------|---------------|--|---|-----------------------|
| 41-51 | 22 23 | 1030 | 0553 | Yoyo 10-90m | From U2 via 60°N, 11°W to U1 | |
| 52 | 23 24 | 1915 | 0710 | On deck, with pumped flow. | From U4 course 053° until 0100/24th, then 240° to re-return to U4. | Too rough to launch |
| 53-60 | 25 26 | 1117 | 0213 | Yoyo 5-90m. | From U4 course 090° to 11°8'W then 180° to U3. | |
| 61-62 | 26 | 0512 | | Yoyos and level tows at 30, 50 and 70m. | Two runs round 4 mile triangle near U3. | Aborted, water in CTD |
| 63 | 26 27 | 2311 | 0133 | Yoyo 10-90m and level tows at 15, 90 and 70m. | Yoyo course 000° from U3, 15m tow on 180° reverse course, 90 and 70m tows on 000° again. | |
| 64-65 | 27 | 0138 | 0643 | Yoyo 10-90m, tow on 11.5°C isotherm, yoyo, level tows at 10, 90 and 60m. | Yoyo course 270°, 11.5°C tow on 090° and 270°, rest of run approx. west to 57°30'N, 12°7'W. | |

TABLE 5. FLOAT TRACKS (Provisional Data)

| Track No | Nominal Depth (m) | Start | | End | | Date (Sept 77) | Date (Sept 77) | GMT | Lat.N. | Long.W. | Lat.N. | Long.W. | Mean Velocity cm/sec | Velocity σ_T | Remarks |
|----------|-------------------|-------|---------|---------|------|----------------|----------------|-----|--------|---------|---------|---------|----------------------|------------------------------------|---------|
| | | GMT | Lat.N. | Long.W. | GMT | | | | | | | | | | |
| 380 | 0 | 0805 | 59 29.4 | 12 00.9 | 0948 | 59 25.6 | 12 07.2 | 16 | 0948 | 59 25.6 | 12 07.2 | 10.0 | 220 | | |
| 381 | 50 | 1301 | 59 27.9 | 12 03.7 | 0820 | 59 22.1 | 12 09.5 | 18 | 0820 | 59 22.1 | 12 09.5 | 5.0 | 208 | Sank, would not release. | |
| 382 | 0 | 1721 | 59 29.2 | 12 04.6 | 1450 | 59 27.2 | 12 02.9 | 17 | 1450 | 59 27.2 | 12 02.9 | 5.2 | 157 | (Minimum mean near-bottom current) | |
| 383 | 0 | 1721 | " | " | 1450 | " | " | 17 | 1450 | " | " | | | | |
| 384 | 0 | 1721 | " | " | 1450 | " | " | 17 | 1450 | " | " | | | | |
| 385 | 0 | 1721 | " | " | 1450 | " | " | 17 | 1450 | " | " | | | | |
| 386 | 0 | 2110 | 58 35.0 | 12 12.7 | 0948 | 58 35.1 | 12 18.0 | 20 | 0948 | 58 35.1 | 12 18.0 | 11.3 | 272 | Marker for bat-fish ran. | |
| 387 | 50 | 0929 | 58 03.9 | 13 48.8 | 1148 | 58 03.8 | 13 49.2 | 24 | 1148 | 58 03.8 | 13 49.2 | | | Pressure tele-meter trial. | |
| 388 | 50 | 1445 | 58 04.2 | 13 48.9 | 1645 | 58 05.1 | 13 50.8 | 24 | 1645 | 58 05.1 | 13 50.8 | | | " " | |
| 389 | 50 | 1757 | 58 04.5 | 13 50.1 | 0850 | 58 08.9 | 13 54.0 | 25 | 0850 | 58 08.9 | 13 54.0 | 16.8 | 335 | At surface from 2010/24 | |
| 390 | 50 | 0832 | 57 22.6 | 11 07.8 | 1644 | 57 24.2 | 11 10.8 | 26 | 1644 | 57 24.2 | 11 10.8 | 14.2 | 315 | Various depths 10-70m. | |

TABLE 6. INTERCOMPARISON OF SURFACE SENSORS

| Station Time | S-T Profiler | | S 1053 | RASTUS | HULL | Crawford bkt. | S-T | Bucket | W/B 10m | T | CTD | S |
|-----------------|--------------|-----------|-----------|--------|-----------|------------------|-------|--------|------------|--------|-----|--------|
| | T Chart | T 1053 | | | | | | | | | | |
| 9619 | | | | | | | | | | | | |
| 1000 | 12.74 | 12.75 | 35.58 | 35.56 | 12.3 | | | | | | | |
| 1010 | 12.74 | 12.75 | 35.57 | 35.54 | 12.1/12.2 | | 12.25 | 35.277 | 35.263 | 11.911 | | 35.262 |
| 1020 | 12.74 | 12.75 | 35.57 | 35.56 | 12.3 | | | | | | | |
| Station 9621 | | | | | | | | | | | | |
| 1330 | 12.22 | 11.93 | 35.53 | 35.54 | 11.9 | | | | | | | |
| 1340 | 12.25 | 12.25 | 35.53 | 35.53 | 11.8 | 11.9 | 11.8 | 35.237 | 35.226 | 11.455 | | 35.220 |
| 1350 | 12.27 | 12.27 | 35.54 | 35.53 | 12.0 | | | | | | | |

Note: "Chart" : analogue record of S-T profiler

"1053" : computer printout of S-T profiler

"RASTUS": Bridge monitor for sea surface temperature.

These temperatures are all raw readings without any correction. The correction to be applied to the CTD temperatures, (as shown by several previous comparisons with reversing thermometer, not used this time) was + 0.35°C.

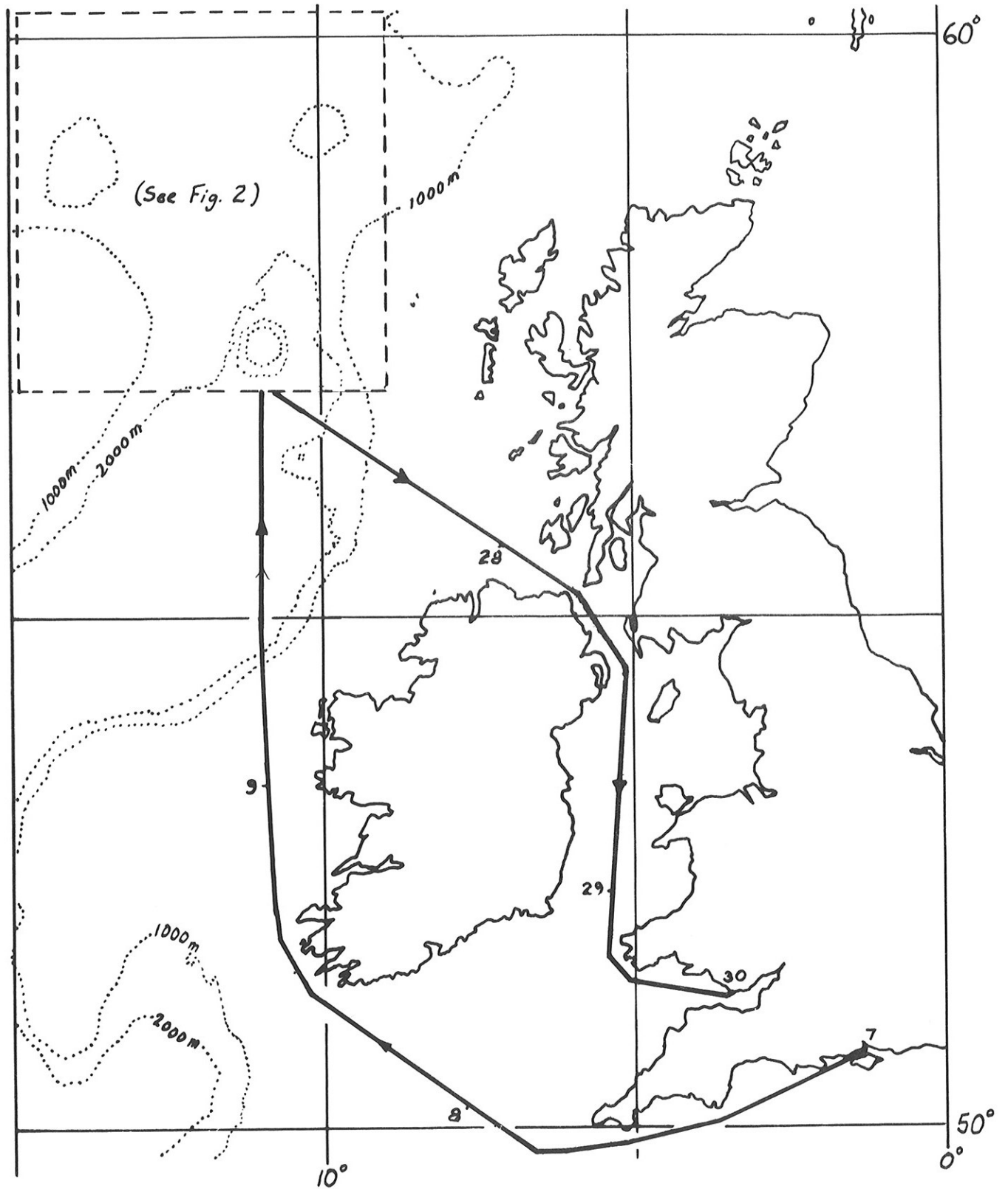


Fig. 1. Discovery Cruise 86 - General Track Chart.

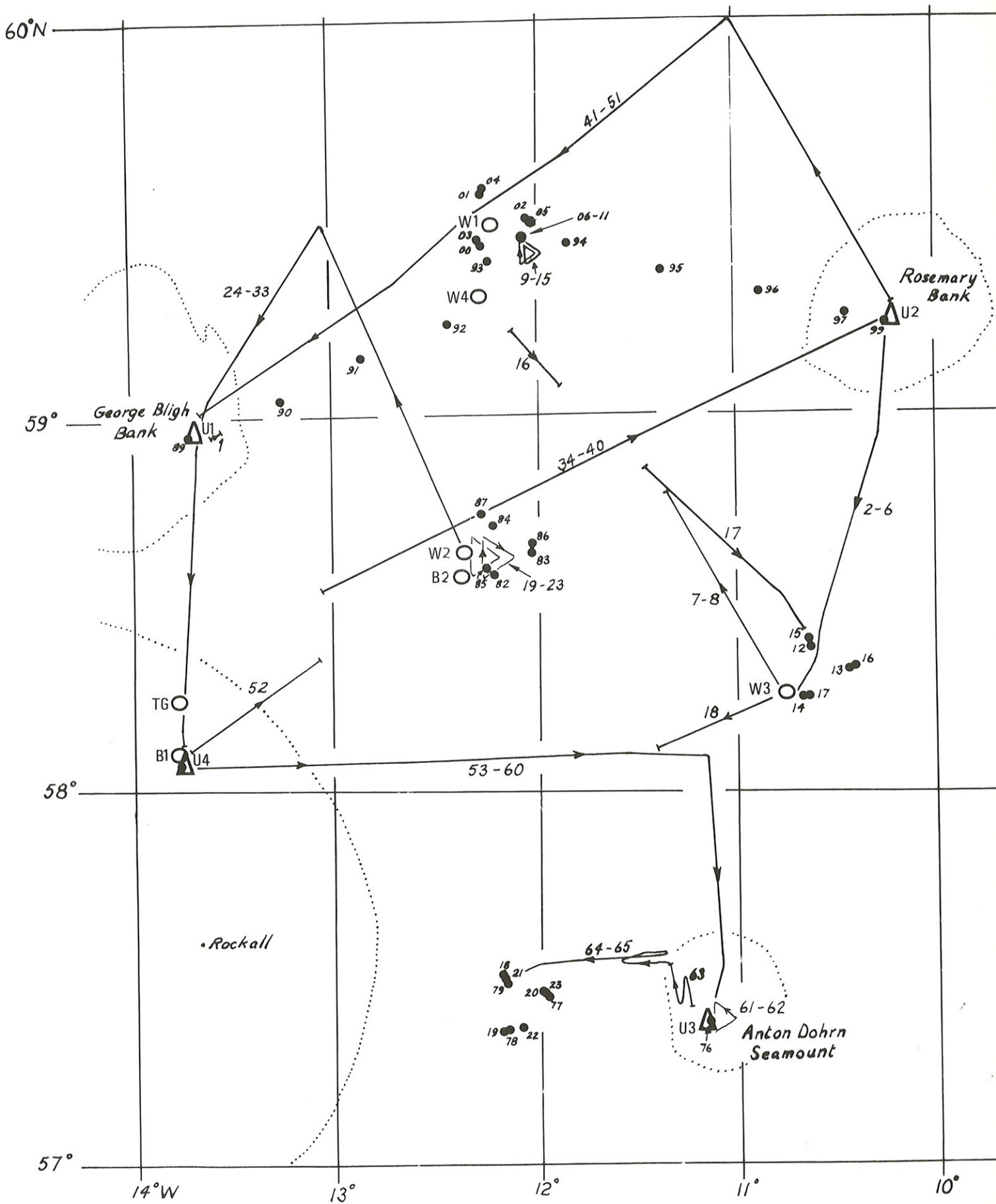


Fig. 2. Discovery Cruise 86 - JASIN Area. Open triangles: surface moorings. Open circles: subsurface moorings. Small solid circles: station positions. Numbered sections of track are batfish runs. Dotted lines are 1000 m bathymetric contours.

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| 44 | December 1971 | 46 |
| 45 | February - April 1972 | 50 |
| 46 | April - May 1972 | 55 |
| 47 | June - July 1972 | 52 |
| 48 | July - August 1972 | 53 |
| 49 | August - October 1972 | 57 |
| 50 | October 1972 | 56 |
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| 61 | March - May 1974 | 10 |
| 62 | May - June 1974 | 11 |
| 63 | June - July 1974 | 12 |
| 64 | July - August 1974 | 13 |
| 65 | August 1974 | 17 |
| 66 | August - September 1974 | 20 |
| 68 | November - December 1974 | 16 |
| 69 | January - March 1975 | 51 |
| 73 | July - August 1975 | 34 |
| 74 | Leg 2 Sept. Oct. 1975 | 33 |
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