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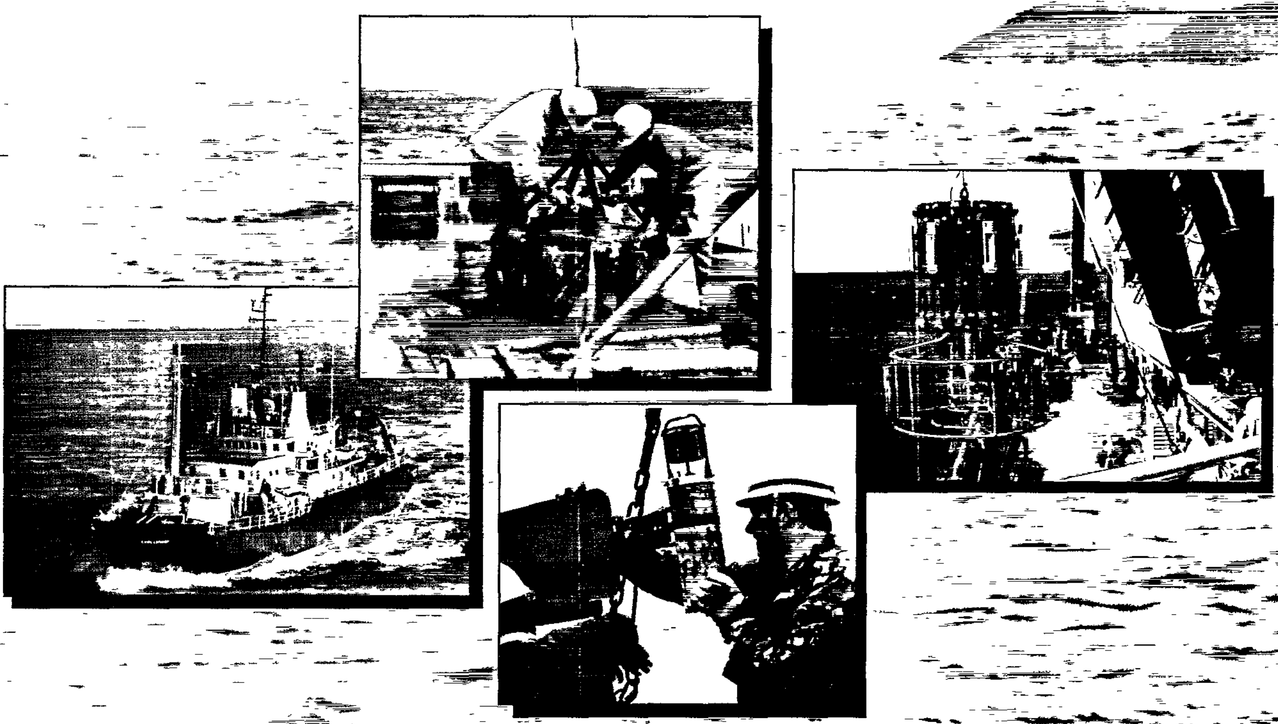
Cruise Report



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SOUTHAMPTON OCEANOGRAPHY CENTRE

CRUISE REPORT No. 27

RRS *DISCOVERY* CRUISE 240
11 MAY - 28 MAY 1999

Ocean Technology Division instrument trials cruise
over the Goban Spur, Pendragon Escarpment and
Porcupine Abyssal Plain

Principal Scientist
I P Rouse

1999

Ocean Technology Division
Southampton Oceanography Centre
University of Southampton
Waterfront Campus
European Way
Southampton
Hants SO14 3ZH
UK

Tel: +44 (0)23 8059 6158
Fax: +44 (0)23 8059 6149
Email: ianr@soc.soton.ac.uk

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AUTHOR

ROUSE, I P et al

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ABSTRACT

The principal objective of the cruise was to test, verify and trial a range of oceanographic instruments developed within SOC in a deep water, free field environment not possible in a land-based laboratory. The instruments included:

1. Mini Profiler Vehicle (MPV)
2. SUMOSS optical spectrometer
3. A profiling CTD mooring system
4. A new design of cable fairing for the SeaSoar vehicle
5. SHRIMP video and camera vehicle
6. Scatterometer profiler system
7. Deep water stills camera

The work area - in the vicinity of the Goban Spur and the Porcupine Abyssal Plain - was chosen with care so as to give a wide range of terrain and water depths, from the continental shelf to abyssal plain, to suit the various instruments testing requirements within a small area.

During the cruise, as well as the deep-water instrument and vehicle trials, there were also elements of training new staff and the development of safe working and handling practices.

This cruise demonstrated the huge advantages of being able to test equipment in a deep-water environment. All the instruments deployed benefited from the results obtained, whether they highlighted unknown problems or confirmed theoretical designs. The cruise also highlighted that trials of this kind rapidly accelerate the speed of development of both equipment and instrumentation and are almost a necessity for new designs prior to their being used in anger on scientific cruises.

KEYWORDS

ADCP, CABLES, CHIRP, CRUISE 240 1999, CTD, DEEP-TOWED VEHICLE, "*DISCOVERY*", FAIRINGS, GOBAN SPUR, INSTRUMENT TRIALS, OCEANOGRAPHIC EQUIPMENT, OPC, MOORING SYSTEM, PENDRAGON ESCARPMENT, PORCUPINE ABYSSAL PLAIN, SCATTEROMETER, SEASOAR, SEDIMENT PROFILER, SHRIMP, SUMOSS, TRIALS CRUISE, UNDERWATER CAMERA, UNDERWATER VEHICLE, UNDERWATER VIDEO, YO-YO MOORING

ISSUING ORGANISATION

Southampton Oceanography Centre
Empress Dock
European Way
Southampton SO14 3ZH UK

Copies of this report are available from: **National Oceanographic Library, SOC** *PRICE*: £7.00
Tel: +44(0)23 80596116 Fax: +44(0)23 80596115 Email: nol@soc.soton.ac.uk

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1. Ships Personnel

R.C. Plumley	Master
J.D. Noden	C/O
S. Sykes	2/O
T.A. Owoso	3/O
I.G. McGill	Chief Engineer
A.F. James	2/E
S.J. Bell	3/E
D. Stewart	ETO
P.G.Parker	Electrical Officer
M. Holt	Extra Chief Engineer
M.J. Drayton	Chief Petty Officer (Deck)
K.R. Luckhurst	Petty Officer (Deck)
R. Johnson	Seaman
S.P. Day	Seaman
J.E.Dale	Seaman
T.R. Edwards	Seaman
G. Cooper	Seaman
K. Pringle	Motorman
E. Staite	Senior Catering Manager
J. Haughton	Chef
A.S. Duncan	Master Steward
W.J. Link	Steward
S.E. Link	Steward

2. Scientific Personnel

I. Rouse (PSO)	SOC – OTD
R. Babb	SOC – OTD
J. Campbell	SOC – OTD
D. Edge	SOC – OTD
C. Flewellen	SOC – OTD
A. Harris	SOC – OTD
M. Hartman	SOC – GDD
I. McDermott	C-CORE, Newfoundland, Canada
D. Matthew	SOC – OTD
J. Smithers	SOC – OTD
I. Waddington	SOC – GDD
R. Wallace	SOC – OTD
S. Whittle	SOC – OTD
J. Wyatt	SOC – OTD
C. Day	SOC – RVSSEG
P. Mason	SOC – RVSSEG
M. Beney	SOC – RVSISG
A. Jones	SOC – RVSSIG
D. Young	SOC – RVSSEG

3. Itinerary

Depart Southampton 11.00 11th May 1999
Arrive Southampton 10.00 28th May 1999

4. Cruise Objectives

The principal objective of the cruise was to test, verify and trial a range of oceanographic instruments developed within SOC in a deep water, free field environment not possible in a land-based laboratory. The instruments included:

8. Mini Profiler Vehicle (MPV)
9. SUMOSS optical spectrometer
10. A profiling CTD mooring system
11. A new design of cable fairing for the SeaSoar vehicle
12. SHRIMP video and camera vehicle
13. Scatterometer profiler system
14. Deep water stills camera

With the exception of the scatterometer all instruments were deployed and tested during the cruise with valuable performance data being gained in all cases. **Fig 1** shows the geographical location of the trials.

5. Narrative

The ship sailed from Empress Dock, Southampton at 11.00 on Monday 11th May (Julian day 137). After clearing the Needles Channel the ship was slowed to 8 knots over the ground and the shipboard ADCP (Acoustic Doppler Current Profiler) run to collect bottom locked data for analysis prior to cruise D242. At 23.00 the recording was stopped and the ship brought back up to full speed and course made for the profiling CTD mooring site.

The mooring site was reached at 11.00/139 and the echo sounder fish launched. The depth of the water was checked and deployment of the mooring commenced. The anchor of the mooring was released at 15.14/139 at 49° 00.7N 13° 22.76W in 3633m of water. The SUMOSS instrument was then made ready for its first launch over the stern of the ship at 16.30 but this had to be abandoned when the cable was damaged in a rigging block.

At 19.16/139 Seasoar was launched and towed overnight at 8 knots in a clockwise box survey starting at 49° 00.0N 13° 30.0W. **Fig 2** shows the track followed. Seasoar was recovered at 11.50/140. At 13.00

SUMOSS had its second launch, this time successfully at 49° 00.0N 13° 29.0W. The instrument was recovered at 16.00/140.

The ship was then repositioned to commence a SHRIMP deployment from the amidships 'A' frame using the 0.68" armoured conducting cable. For this deployment the vehicle also had the new stills camera mounted on the frame. SHRIMP was deployed at 20.20/140 at position 49° 00.3N 13° 59.8W. During recovery from this trial a broken armouring strand was found on the main cable. The strand had to be cut away and taped up before slow recovery of SHRIMP could commence. The vehicle was finally on deck at 02.16/141.

The conducting cable was streamed at 10.55/141 with the TOBI depressor weight as load. The cable was visually inspected and extra precautions taken with the broken strand before the cable was rewound and the depressor brought back aboard at 16.30/141. The ship was repositioned overnight prior to the first MPV deployment.

The MPV was launched from the stern of the ship on the conducting cable and also using the TOBI umbilical and depressor weight at 11.25/142 in 1130m of water at position 49° 29.6N 11° 57.8W. The vehicle was towed on a generally westerly course at a speed of between 2 to 3 knots. **Fig. 3** shows the tracks for this and the second successful MPV run. The MPV was recovered at 13.37/143 at position 49° 29.0N 13° 22.3W.

SHRIMP was then deployed at 17.00/143 in position 49° 29.7N 13° 22.2W for a video survey. The vehicle was recovered at 20.30/143 after a successful run. At 23.45/143 the MPV was re-deployed with a hydrophone line array attached to be used as a receiver. The vehicle was recovered at 01.00/144 due to no signals being received by the line array.

Whilst the MPV was undergoing modifications SUMOSS was deployed twice between 11.00/144 and 16.30/144 at positions 49° 06.4N 13° 36.1W and 49° 06.7N 13° 40.0W. The modified MPV was deployed at 20.00/144 at position 49° 08.5N 13° 41.9W in 4500m of water and the vehicle taken down to within 400m of the seafloor. Only extremely feint signals were observed. The vehicle was recovered at 07.22/145 and more modifications made prior to a re-launch at 09.45/145. The receiver was found to be oscillating and the vehicle recovered promptly at 10.15/145.

The ship was then repositioned to recover the profiling CTD mooring. The mooring was grappled at 14.20/145 and fully on board by 15.30/145. During this time the MPV had been restored to its original configuration and was deployed for a second successful run (see fig. 3) at 19.00/145 at position 49° 00.0N 13° 45.2W in 4500m of water. The short run was finished at 03.17/146, position 49° 02.8N 14° 01.0W when the vehicle was safely brought aboard. The PES fish was also brought inboard and passage made back to Southampton.

The cruise ended with the ship docking alongside at SOC at 10.00 on 28th May (Julian Day 148).

6. Risk Assessments

At the beginning of the cruise risk assessments were carried out for each piece of equipment to be used during the trip. Those people responsible for each instrument completed pro forma assessments. These were then reviewed and additional comments added at a meeting with the PSO, Master, C/O and the senior RVS technicians. It was hoped that these documents would provide a basis for defining operational and safety procedures for these scientific instruments for use on all ships. Video footage taken during the cruise would also be of great use for incorporation into training programmes on the launch and recovery of the various pieces of equipment at sea.

7. Training

An important feature of a trials cruise should be training and experience given to new staff. On this cruise were two staff on their first NERC Research Ship cruise, Darren Young from SOC – RVSSEG and Jim Wyatt from SOC – OTD drawing office.

Darren received 'on the job' training from the SEG engineers on the specialist winch and deck handling gear they are responsible for as well as on safety issues and administration of the quality control standards employed. Jim gained experience from seeing deployment and recovery of instruments on a moving platform: the importance of robust designs that are easy to handle. He also benefited from the safety instruction given as well as standing watches and assisting the SEG and OTD engineers.

8. Individual Instrument Reports

8.1 Mini Profiler Vehicle (MPV)

Trial Objectives

1) To trial and verify the operation of the new Mini Profiler Vehicle (MPV)

2) To verify the use of the HI-DAPT as the digital data acquisition and processing system for the MPV.

Trial Results

It took 4 days to steam to and from the trial site. During the first week of the trials the chirp sonar and telemetry system, which was to be used on the MPV, was assembled and bench tested. An additional buoyancy sphere was added to the MPV on board ship in order to make it slightly positively buoyant. During this period, the HI-DAPT underwent minor repair for damage sustained during transit to the UK. The HI-DAPT was also configured to accept the navigational data available on the RRS Discovery, was wired to accept the chirp trigger signal and underwent testing to ensure compatible operation with the MPV. A second logging system – an Octopus Marine Systems 360 unit was parallel wired with the HI-DAPT for comparison during the cruise. The MPV was deployed on 5 occasions, details of which follows.

Deployment 1 – Chirp Profiler and standard ring array
Configuration - Transmit and receive on ring array.
70db pre-amplifier on TOBI profiler receiver card.
Deployment in 1300 – 1400m water depth (49 29.47N, 11 58.75W)

Results
Duration of run: 20 hours
Strong surface echo detected on the way down.
Good signal returns bottom and sub-bottom multiple layers over sandy terrain.
Decaying oscillations noted (oscilloscope monitored and on profiler hard copy), starting 50ms after transmit pulse. Origin of these is unknown and will require further investigation. For normal TOBI applications, typical altitudes 300 – 400m, it does not obscure the data of interest. It will be a problem in shallower water applications, the sub 200m region.

Deployment 2 – Chirp Profiler and hydrophone streamer
Transmit on ring array, receive on hydrophone streamer
40db gain on streamer pre-amplifier.
Deployment in 1300 – 1400m water depth (49 00.00N, 13 30.00W)

Results
With the vehicle powered up on deck general background noise was picked up. This disappeared on entering the water. No surface echo could be detected on the way down.
After 1 hours run time, allowing for time to get to a sensible flying height (300 – 400m), no bottom echo was detected at any time. The vehicle was then recovered.

Further Ship-based Tests

A series of tests were conducted to determine the signal levels coming through the system.

The general background noise detected on deck previously was still there. This was also the case when the streamer array was held off the deck. Disconnecting the streamer hydrophone eliminated the noise. So the noise was not being created in the streamer's pre-amplifier.

A test box (battery operated) was constructed using a modified chirp transmitter circuit and an attenuator box (1 – 80db). The chirp signal ($10V_{pkpk}$ through attenuator box 1 – 80db attenuation) was injected into streamer pre-amp, allowing signals down to $1mV_{pkpk}$.

With 40db pre-amplifier streamer signals down to 10mV (–60db of $10V_{pkpk}$ source generator) were detectable on the output of the TOBI deck unit.

With 40db pre-amplifier streamer and 70db TOBI profiler receiver card (110db total) signals down to – 70 -> -80db (3 ->1mV) were detectable.

Measurements on streamer capacitance gave figure in correct range, 300pF (approx.).

With the hydrophone streamer attached and pre-amplifier setting of 40 + 70db (streamer pre-amplifier + TOBI profiler receiver card), the profiler graphical output showed a large amount of background noise. A compromise of 10 + 70db was set giving a reduced amount of background noise. The idea being that this would disappear when in the water.

Deployment 3 – Chirp Profiler and hydrophone streamer
Transmit on ring array, receive on hydrophone streamer
80db total on receiver pre-amplifier (10db streamer pre-amp + 70db TOBI receiver card)
Background noise on profiler records with vehicle on deck
Deployment in 4000m (approx.) water depth (49 09.00N, 13 42.20W)

Results

Background noise disappeared in water and a faint surface echo was detected on the profiler record. This disappeared rapidly before the 200m depth range. The surface echo on the standard configuration (transmit and receive in the rings) is detectable to at least 800m depth range.

Vehicle taken down but no visible trace of the bottom on the profiler record. The vehicle continued down to a wire out of 5000m in approximately 4000m of water, no bottom reflection was acquired at all. The vehicle was then recovered.

Deployment 4 – Chirp Profiler and hydrophone streamer
Transmit on ring array, receive on hydrophone streamer
It was decided to increase the overall pre-amplifier gain to the maximum of 110db total (40db streamer pre-amp + 70db TOBI receiver card). This gave the larger background noise as observe before on deck, with the idea that it would disappear in the water as before.
Deployment in similar area to deployment 3.

Results

On deployment the noise got so much greater, in the water, that it saturated the profiler record. It was immediately decided to recover the vehicle.

Further detailed measurements on the configuration of vehicle with hydrophone streamer in the laboratory are recommended.

Deployment 5 – Chirp Profiler and standard ring array
A final deployment of the MPV to test the chirp profiler, with standard ring array and 70db TOBI profiler receiver card pre-amp, over the start of the abyssal plain was planed. This area contains more soft sediment allowing a test of the chirp profiler's potential for penetration and resolution.
Deployment in 4500m water depth (49 00.20N 13 45.80W)

Results
With the vehicle on the surface the bottom echo was clearly detected. On diving a good surface echo down to 800m was detectable. The vehicle was flown at around 300m from the bottom. Fine multi layers in the upper strata were resolvable which would be smeared out in the original continuous wave (CW) mode of operation used on TOBI. Multiple layers are visible deeper down (15-20m) and a layer at 30 –35m is visible. Excellent sub-bottom data was obtained allowing penetration depths of around 30 metres to be achieved. Highly detailed sediment stratigraphy was observed in the sub-bottom profile record.

Small Scale Vehicle Oscillatory Motions

Analysing the HI-DAPT sub-bottom profile data it became apparent that the vehicle was also undergoing a small-scale saw tooth motion. The period of this motion is around 30 seconds. The amplitude of this motion is around 0.7 metres. This oscillation may have several causes and may be due to:

i) the addition of the extra buoyancy sphere to the front of the MPV, which has made the vehicle unstable;

ii) an impulsive snatch-and-flight action as the MPV is momentarily caught by the tow wire and rapidly propelled forward which is then followed by a downward glide until it is once more propelled forward by the tow wire;

iii) the TOBI depressor weight and umbilical may be too large for the MPV, which makes for an unstable flight path.

The motion appears to be highly repetitive and looks like it could be removed by data processing at a later stage. However, it is considered more desirable to remove this small-scale oscillatory motion by modification to the vehicle.

Conclusion

As a first trial of a new system, the results have been extremely encouraging. The new materials used in the vehicle construction have withstood the knocks of deployment and recovery and has given us confidence in the manufacturing techniques. The sonar data is of high quality and will be of considerable interest to scientists and commercial companies alike.

I. Rouse/I. McDermott/D. Matthew/R. Babb

8.2 SHRIMP (Seabed High Resolution IMaging Platform)

Introduction

A few weeks previous to this trials cruise SHRIMP returned from its first mission on board the RRS James Clark Ross cruise J39B, to survey the East Scotia ridge. The one scheduled deployment of SHRIMP was successful although the video data showed the underwater lighting would require a wider flood arrangement to match the field of view of the video cameras. Failure of a cable linking the photographic camera to the flash unit prompted a review and change of connectors associated with these components.

Objectives

The main objectives for this trials cruise were: -

- Verify suitability of new wide flood lamp reflectors.
- Test the integrity of new video recorder pressure housing.
- Prove replacement connector performance.
- Provide further operation of SHRIMP in deep water for development analysis purposes.
- Provide a platform to attach an additional SOC-OTD developed photographic camera and flash unit.

Actions

Two deployments of SHRIMP were completed both of which had attached the SOC-OTD camera and flash unit. All operations were conducted from the mid-ships winch using the electrical coaxial (TOBI) cable.

The first deployment involved lowering the vehicle in 4500m water depth to an altitude of 2m above the seabed. The vehicle was operated at this height for a period of approximately 1/2 hr to provide a seabed target for the SOC-OTD camera system. The video recorder components and SHRIMP photographic camera were removed from their pressure housings for the purpose of this test.

The second deployment was conducted in approximately 2000m water depth on the Goban Spur. This time all system components were in place. The vehicle was lowered to a few metres above the seabed. And operated at this altitude for approximately 2 hours to obtain seabed video footage and test the photographic systems.

In addition to the main objectives I pursued to demonstrate the system capabilities for bioluminescence detection. During recovery the SIT (Silicon Intensified Target) camera and video recorder were turned on in mid-water without illumination. This particular test complemented my previous work in developing a similar lander mounted instrument required by Dr. Peter Herring of the SOC- George Deacon Division.

Results

After **the first deployment** recovery the SHRIMP components were inspected and all pressure housings were found secure from water ingress. One hand made cable joint had leaked so was remade. After **the second deployment** recovery the videotapes were reviewed. Both video recorders had operated correctly and contained both seabed and mid-water colour CCD and monochrome SIT camera images. The wider flood reflectors were an improvement but inadequate to cope with the SIT camera field of view. Observations confirmed correct operation of SHRIMP's photographic camera and flash and operations of the SOC-OTD camera system. The speculative mid-water bioluminescence test proved fruitful with spectacular light trails observed.

Conclusion

All objectives were achieved. The video illumination still requires improvement however it is intended that these D.C. lights are to be replaced by superior A.C. gas discharge lights demoting them to a backup role. The new video recorder pressure housing and Titan series connectors stood up to the tests well. The SHRIMP system provided a most suitable method for testing the SOC-OTD developed camera and flash. The system demonstrated its capability for bioluminescence profiling.
This trials cruise has provided a good opportunity to progress unhindered the development of SHRIMP.

D. Edge

8.3 D240 ADCP calibration

The ADCP configuration file D240scu.cnf was loaded into the DAS software and run whilst the ship was over the continental shelf so that bottom tracking data could be combined with navigation data from differential GPS and enable calibration of the transducer pointing angle and amplitude factor. The ship was steaming at 8 knots speed made good on a steady course throughout the run which commenced 17th May 1999 day 137 1330 and ended 137 2300. ADCP data were however logged until 138 1200. A second calibration run was made heading East on day 146 from 1640 for 3 hours again at 8 knots although the calm conditions seemed to provided good data while the PC was running DAS from 1610 to 0730 on day 147. Tables below document the ADCP PC clock drift for the 2 runs. Navigation data is available throughout the cruise.

Ship clock time GMT	ADCP clock time	GMT - ADCP
137 14:39:26	14:39:31	-5
137 15:57:25	15:57:32	-7
137 17:37:22	17:37:32	-10
137 20:11:18	20:11:32	-14
138 06:57:04	06:57:31	-27
138 09:01:03	09:01:32	-29

146 16:12:08	16:15:22	-194
146 18:50:05	18:53:23	-198
146 19:22:03	19:25:21	-198
146 19:52:04	19:55:21	-197
146 20:58:02	21:01:22	-200
146 02:07:55	02:11:22	-207

M. Hartman, M. Beney, A. Jones

8.4 CTD Proflier Mooring – RRS Discovery station number 13629

The profiling CTD is a neutrally buoyant, autonomous vehicle that uses a traction drive to propel itself up and down 6mm jacketed mooring line. It makes precision CTD measurements throughout the depth range that is programmed into it prior to its deployment. The objectives of the trial are to test our ability to deploy such a mooring in the deep ocean and to determine the feasibility of profiling the upper ocean whilst on a deep mooring. This will give information on instrument duration and performance whilst profiling a substantial density gradient. **Fig.** 4 shows details of the mooring.

To this end a winch system comprising the GDD Double barrel winch fitted with modified storage drum & counter sheaf was developed to provide an increased capacity storage reeler for long continuous wires. This was achieved by modifying the former IOS Camera Sledge umbilical cable winch to perform as a reeler winch. After 2 hours running during the mooring deployment the hydraulic oil temperature rose to 57 ° C and cooling water had to be turned on. Operating the DBC winch control too quickly from stop to either haul or pay out resulted in a slight lag in reeler operation. This lag did not prove to be a problem to the mooring operation.

The Buoy first deployment of the mooring commenced at 11:30 19th May 1999 and was completed by 14:30. It was dropped onto a plateau situated on the Pendragon Escarpment of the Goban Spur at a depth of 3633 metres uncorrected, whilst steaming to the NW. The ship's position at the time the anchor was cut away was 49 02.69N 13 22.76W and slant ranges between 2430m and 2600m were obtained while hove to at 49 03.05N 13 23.52W. Interrogation of the MORS acoustic release units was performed using a MORS deck unit attached to an over side dunking transducer positioned amidships. The ship's EA500 echo-sounder set to a 2 second repeat rate showed a steady trace from the release indicating that the mooring had stopped falling. Subsequently the Gonio direction finder mounted on the bridge was checked periodically for signals from the buoy's 2 ARGOS transmitters, none were noted.

The CTD was set to profile the topmost 1000m of the mooring with a 5-minute rest at the top and at the bottom stop. The sampling interval was set to 10 seconds with pressure checks made every 180 seconds. Three current meters were also mounted on the mooring, two of these were placed above the profilers top stop; An Aanderaa RCM8 with conductivity, temperature and pressure sensors was situated directly beneath a Falmouth Scientific 3D current meter that incorporates an high accuracy CTD. The FSI current meter below the profiler bottom stop also measures pressure. The 2 ARGOS transmitters; one atop the steel buoyancy and the other prototype beacon on the buoyancy at 1000m depth provide positions via satellite when the mooring surfaces and also allow the rig's bearing to be determined via the Gonio DF.

The mooring was recovered on 25th May 1999 from calm seas apart from a slightly awkward swell. While the ship was hove to at 12:32 one of the acoustic releases was interrogated, it responded to one of deck units but showed a fault in the spare. At 12:55 the mooring was released. Both buoyancy packages and the deep ARGOS Beacon were visibly on the surface but only the DF signal from the main buoyancy was received, the reason for the lack of signal from the deep unit is yet undetermined. The Double Barrel winch system was used to haul and store the mooring line and all was inboard by 14:26. The operation went smoothly apart from a tangle in the bottom of the line that appears to have occurred upon release of the mooring.

The profiling CTD motor was still running when recovered and its records show that it profiled successfully throughout the deployment between approximately 100 and 1100 metres, further investigation of the retrieved data will be made later. Detailed analysis of the mooring performance from the instrumental data will be carried out at SOC where Aanderaa calibrated data, not available onboard, can be compared to the FSI data. The full current meter records on two of the instruments do indicate that the mooring performed as was required, the range of current speeds, however, may be too small to give a good indication of its overall behavioural characteristics.

I.Waddington M.Hartman

8.5 SUMOSS2 and Optical Plankton Counter (OPC)

Aims

In approximate order of priority, it was hoped to carry out the following tests during this cruise:-

1. Operate SUMOSS2 down to its maximum design depth using a slip-ring winch.
2. Collect some data with the newly purchased OPC and measure the effect of using a concentrating funnel on the intake.
3. Modify the SUMOSS2 software to allow near-continuous sampling of the spectrometer whilst hauling or veering on the winch, thus obtaining optical profiles.

4. Compare the attenuance data produced by the OPC with measurements from the SUMOSS2 transmissometer.

Detailed SUMOSS Narrative

Day 139

The first attempt to deploy SUMOSS2 was at 1600 on day 139. To ensure that the SUMOSS2 cable did not jump over the shallow cheeks on the winch drum, it was decided to lead the cable through a diverter block on the deck before passing it through the large OTD sheave hanging off the port after crane. Unfortunately, the only block available with a sufficiently large diameter to accommodate the minimum bend radius of the cable was not suitable for this task, and shortly after SUMOSS was lifted off the deck, the cable slipped over the edge of the sheave in this block and was torn on the sheave edge. The deployment was abandoned while the cable was repaired.

The SUMOSS2 cable has a soft, polyurethane outer jacket, a kevlar strain-bearing braid and a polythene inner sleeve covering the electrical cores. All of the three outer layers were damaged, but the electrical cores were intact and it was therefore a simple task to make a waterproof repair. Since some of the kevlar strands had been cut (maybe 10 to 20% of the total), it was decided to tape a 4mm wire to the outside of the cable as an insurance policy.

Day 140

SUMOSS2 was successfully deployed at 1200 on day 140, running the cable straight from the winch through the large sheave hanging on the crane and thence over the stern. This scheme requires at least 4 people; one driving the crane, one the winch, one or two steadying SUMOSS2 itself, and one holding on to the cable as it comes off the winch making sure it can't fall off the edge of the winch drum. When deployed, the cable leads directly aft over the transom, which has the drawback that it is hidden from the bridge's view.

A total of 4 complete profile cycles were taken, the first two with the OPC funnel fitted and the second two with it removed.

SUMOSS2 was back on deck by 1515.

Day 144

The second deployment began at 1000 on day 144. New optical profiling software was tried, continuously recording signals from the 5 irradiance sensors down to 100m and back to the surface. An OPC profile (without funnel) was taken and further tests carried out with the optical profiling program, before SUMOSS2 was recovered at around 1230 to fit the funnel. During this recovery, SUMOSS2 was allowed to remain in the water as the crane traversed forward to land it on deck. While this was happening, SUMOSS2 swung against the side of the ship, snapping the main sensor mast and bending some of the struts. Once back on deck, repairs were effected by shortening the mast slightly and adjusting the struts accordingly.

SUMOSS2 was re-deployed at 1330 with the OPC funnel fitted. Just before deployment the tip of the scalar irradiance sensor was accidentally knocked off, exposing the fibre-optic ferrule. Two further OPC profiles were taken, along with irradiance and scatterance profiles before SUMOSS2 was returned to the deck at 1520.

Results

Mechanical and handling

The RVS SR3 slip-ring winch proved very suitable for deploying SUMOSS2 and performed without problem throughout. Its suitability could be further enhanced by fitting deeper cheek plates on the winch drum, adding some sort of traversing gear and maybe a "notched" speed controller valve.

The mishap with the diverter block highlighted the vulnerability of the current dunking cable to mechanical damage. If this cable is ever replaced, it might be worth considering something like a Seasoar cable with some armouring. In the meantime, care should be taken to use only suitable blocks, and that may entail having one specially made if the system is to be used off a crane in the future.

The main sensor mast snapped close to the attachment point (and was repaired) even before its first deployment, and broke in the same place during the second deployment. This is an obvious design flaw which must be rectified before the system is used again. Because of this fragile mast and SUMOSS2's desire to act as a pendulum, it is essential that it is held as close to the lifting block as possible whilst airborne.

Some means of protecting the fragile irradiance sensor heads while on deck would also be a good idea.

The basket arrangement that SUMOSS2 sits on proved to be a great asset when manhandling the system on the deck and in the air, and also served as a convenient structure for attaching other instruments such as the OPC.

The optical sensors, external fibre-optic cables, transmissometer housings and the main pressure housing all performed without problems down to 175m, which was the maximum depth attainable with this cable and deployment arrangement.

Optical measurements

The 5 irradiance sensors produced good results down to around 80m. Just before the cruise began, the scalar sensor input had been moved from channel 4 to channel 10, thus allowing all 5 irradiance channels to be recorded simultaneously. Despite the fact that the scalar sensor has a 400 micron fibre, whilst channel 10 is a 200 micron input, this arrangement proved a great success, having the added bonus of reducing the amount of stray light getting into the scatterance channel.

Other last minute pre-cruise adjustments proved less successful however, and alterations made to try and improve signal levels in the transmissometer by changing the ND filtering, actually made things worse and rendered it virtually unusable. This means that the planned comparison with the OPC attenuance data is not possible.

Modifications to the CCD logging program carried out during the cruise successfully enabled continuous optical profiling measurements to made with a fixed exposure time. It would have been particularly interesting to have tried this with the transmissometer, but in any case a number of irradiance and scatterance profiles were taken which should be sufficient "proof of concept".

It was noted that the output from the scalar irradiance sensor extended down to almost 300nm at the blue end of the spectrum, whilst the other irradiance sensors were struggling to get much below 400nm. This suggests that the perspex windows and diffusers used in the vector sensors have a far higher attenuation in the 300-400nm range then the PTFE used for the tip of the scalar sensor. It was also interesting to note that the accidental removal of the PTFE tip produced no noticeable change in the output from the scalar sensor.

OPC

The Focal Technologies OPC-2T plankton counter was purchased under the MAST YOYO2001 autonomous profiler project. Since it is due to have its first trial on the YOYO in a few months time, the opportunity was taken to gain some experience with the instrument on this trials cruise. The OPC was bolted onto the basket under SUMOSS2, and a new version of the sensor logging program was developed to incorporate the stream of serial data from the OPC. A detachable funnel had also been built just prior to departure, in order to experiment with concentrating the flow of particles through the OPC's tunnel. This was done as the YOYO profiler is expected to travel up and down at velocities in the range 10 to 30 cm/s, which is somewhat slower than the OPC is designed to operate at. Although the OPC that was purchased was specially modified by Focal to operate at low flow rates down to 10 cm/s, some experimentation was deemed desirable.

Seven complete down-then-up profiles were logged during the two deployments, and powering and recording data from the OPC presented no problems. However, it was quickly apparent that this type of "dunking" deployment from a heaving ship is a far from ideal way of using the OPC, which is designed to operate with a reasonably constant flow of water through the tunnel. Instead, under these circumstances the flow direction actually reverses every time the ship heaves up and settles back. The output from the depth gauge confirms a sawtooth motion with an amplitude of several metres. This makes it virtually impossible to make much sense of the particle data recorded, although work is underway to try and extract the data recorded during upward motion only, and then make comparisons see the effect of having the concentrating funnel in place. This task is hampered by the lack of synchronisation between the OPC data stream and the output from the depth gauge.

Attenuance data from the OPC were also recorded but showed very little variation with depth, or between the two deployment sites.

Conclusions

This trials cruise has successfully demonstrated the viability of using a slip-ring winch to take optical profiles with SUMOSS2, and proved the ability of the whole system to operate down to 175m. The experience gained with this type of deployment will be very useful in planning further cruises. The cruise also highlighted a weakness in the design of the sensor mast, and showed the necessity of treating the dunking cable with care to avoid damage.

The experiments carried out with the OPC were a little disappointing because of the inability to get a steady flow through the instrument. This problem would have been ameliorated by calmer conditions, but should have been identified before the cruise. However, basic operation of the OPC was verified and experience gained with logging the data stream it produces.

J. Campbell

8.6 Seasoar Fairing Trials.

This trial was to test the performance of the fairing fitted with modified segment links.
The new links are of a stiffer material, deeper and have one locating slot replaced by a hole.
The winch carries 500 metres of faired cable.
For the trial the vehicle carried a Shallow MkIIIb/c Neil Brown CTD to provide the pressure signal to log and control the vehicle's path.

The vehicle was deployed in calm seas 18th May at 1730 BST with the full length of cable and a 10 tonne strain gauge installed between the winch drum and the ship's deck to measure cable loads.
The ship's track for this trial was a box having approximately 4 hour legs. This gave the opportunity to fly the vehicle with varying directions of current shear if any.

Track Waypoints.
49 0.0 N 13 30.0 W
49 30.0 N 13 30.0 W
49 30.0 N 12 45.0 W
49 0.0 N 12 45.0 W
49 0.0 N 13 30.0 W

The range of depth obtainable was still short of that hoped but was an improvement from previous trials.
The vehicle was towed at 7 knots for the first half hour of the trial and the speed increased to 8 knots for the remainder of the trial.
Cable tensions ranged from 300 - 1100 KGs during a complete cycle, this is well within normal working limits.
The range of depths achieved during the first leg was 40 to 260 metres and was maintained through the first turn.
Performance gradually deteriorated with a range of 50 - 250 metres.
After the second turn performance once again deteriorated with a range of 40 - 165 metres.
This remained constant until the vehicle was recovered at 1100 BST on the following day.

The condition of the fairing on recovery was good with no damage or displacement of segments.
There were no spirals in the top 400 metres of fairing but the lower 100 metres had a large number of spirals in the 3 metre lengths. This causes higher drag with lower performance.

Visual inspection of the segments indicates that the trailing surfaces of some have a slight concave cross section due maybe to moulding/shrinkage problems. The trailing edge is also quite thick and the concavity tends to be greater on one face and always the same one. This fault in the cross sectional shape could well mar the performance expected and explain the reason for spiralling of the fairing.

J. Smithers

8.7 Stills Camera - OCEANCAM 6000S

During the transit, the camera was powered from a bench supply and tested a number of times with exposed film.

A problem developed; a relay that switched auxiliary supplies became frozen on. This would have caused excessive energy consumption over a long deployment but would not be a problem for a two to three hour test on SHRIMP. The relay was subsequently replaced by a power transistor. Suitable locations for battery pack, camera and flash were found on SHRIMP and the instruments were clamped in place.

1st deployment. The camera was programmed to start after a 5 minute delay, take a shot every 20 seconds for 10 minutes and then wait for an hour and three quarters before shooting every 20 seconds until the film was used up. When plugged in on deck, the camera went through its diagnostics and reported no errors by firing the flash once. SHRIMP was deployed. After recovery, the film was removed in the darkroom and it was clear that only a little of it had been used. When the camera was powered up again in the lab it reported that it had taken 45 shots and stopped with error #20. (Alarm time passed). The cause, the power connector had been badly mated and had corroded away. The alarm had tried to wake the processor after 45 shots but there was no power.

While the battery was re-charging we were able to replace the power socket with a new one, that had arrived just before the cruise, and adapt the plug to mate with it.

2nd deployment. Our modifications survived, but not all the film was shot due to the limited time that SHRIMP was in the water. We saw a number of flashes on the video signal and the developed film had a few frames, slightly out of focus, taken while the vehicle was on the sea floor. The rest of the film was over exposed on deck, under exposed in the water column and over exposed while the vehicle was on the bottom and the video lights were on. We performed some low temperature tests in a deep freeze cabinet, but this was not a good idea as water condensed on the film made it sticky and eventually jammed the camera.

Conclusions:

Expensive, though they are, stainless steel connectors with firm key-ways are essential. The camera should be flushed with dry nitrogen, or at least should have a packet of silica gel in it. Power switching relays should be replaced by transistors. The mechanics and software control worked perfectly.

C. Flewellen/A. Harris

8.8 Scatterometer

Because of the late return of the TOBI vehicle from its previous cruise due to logistical reasons – the main one being the conflict in Yugoslavia – the large amount of modifications, both mechanical and electronic needed to incorporate the scatterometer into TOBI could not be completed in time for a deployment on the cruise. In the light of the experience gained with the MPV it would be easier to make this vehicle the test frame for the scatterometer in the future.

I. Rouse

9. Summary

The success of the cruise was helped to a large extent by having a wide range of instruments available. This made for flexible planning of the ships time on station, minimising any 'dead' time between tests, and gave plenty of options if equipment required more development or setting up time before its allotted test window. Also the work area was chosen with care to give a wide range of terrain and water depths, from the continental shelf to abyssal plain, to suit the various instruments testing requirements within a small area.

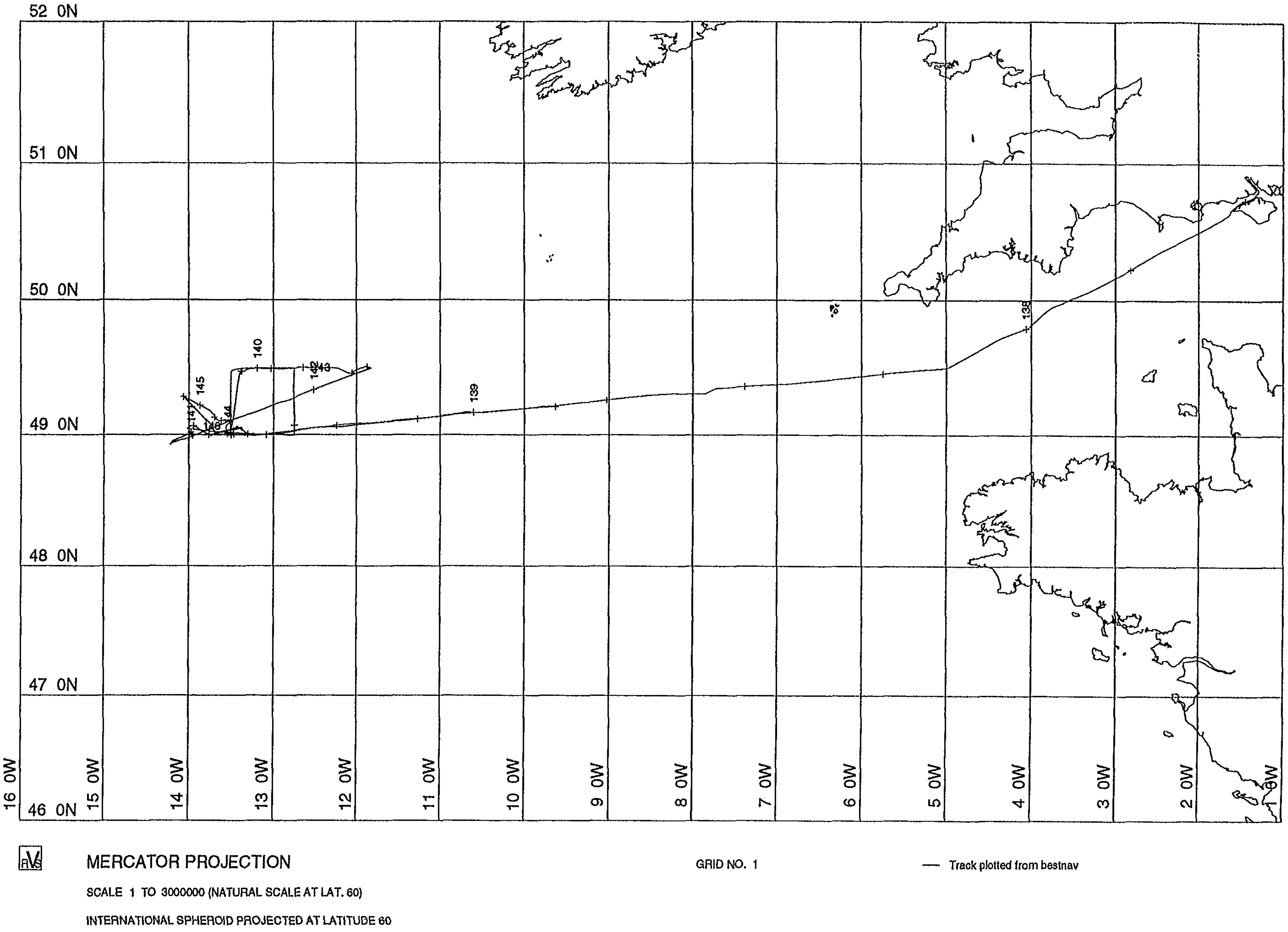
Training should be an important part of a trials cruise. The new staff taken on the cruise benefited hugely from the experience and this will obviously reflect well in their future work. For future trials cruises this area should be expanded.

The cruise superstructure cost was funded by SOC/NERC with individual projects responsible for the manning costs of their equipment. An oversight was that no cruise funding was allocated for mobilisation/demobilisation, extra engineering support and the general running costs of the cruise. It is strongly recommended that such funding be given for future trials cruises.

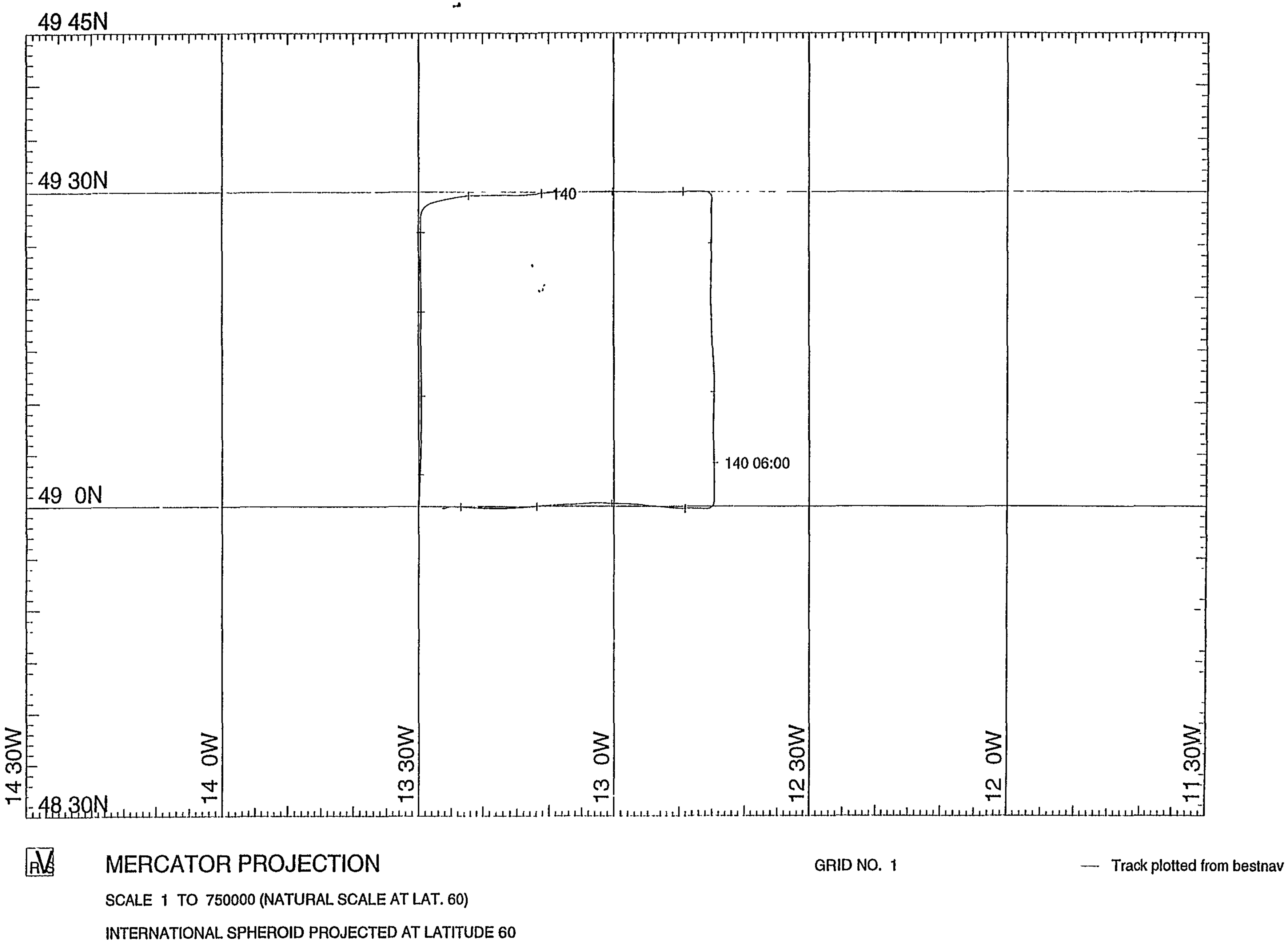
This cruise has shown the huge advantages of being able to test equipment in a deep-water environment. All the instruments deployed have benefited from the results obtained, whether they have highlighted unknown problems or confirmed theoretical designs. The cruise has also shown that trials of this kind rapidly accelerate the speed of development of both equipment and instrumentation and are almost a necessity for new designs prior to their being used in anger on scientific cruises.

10. Acknowledgements

We would like to thank the ship's Master, Robin Plumley, all his crew and our colleagues from RVS for their help and support during the cruise.



Discovery 240 **Fig. 1 Cruise track chart and location map.**



Discovery 240 **Fig. 2 SeaSoar fairing trial track.**

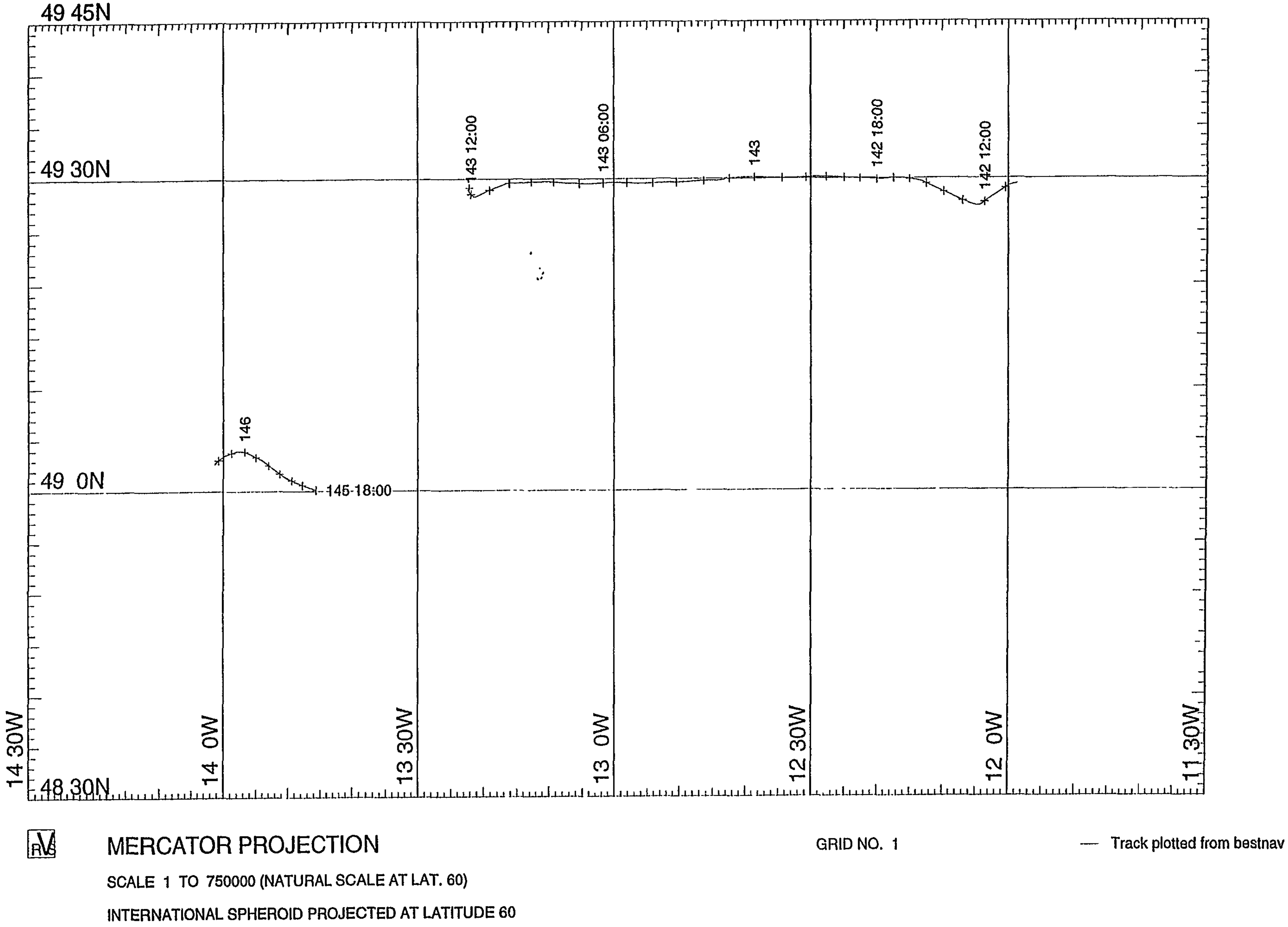


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Fig. 3 MPV deployments track chart.

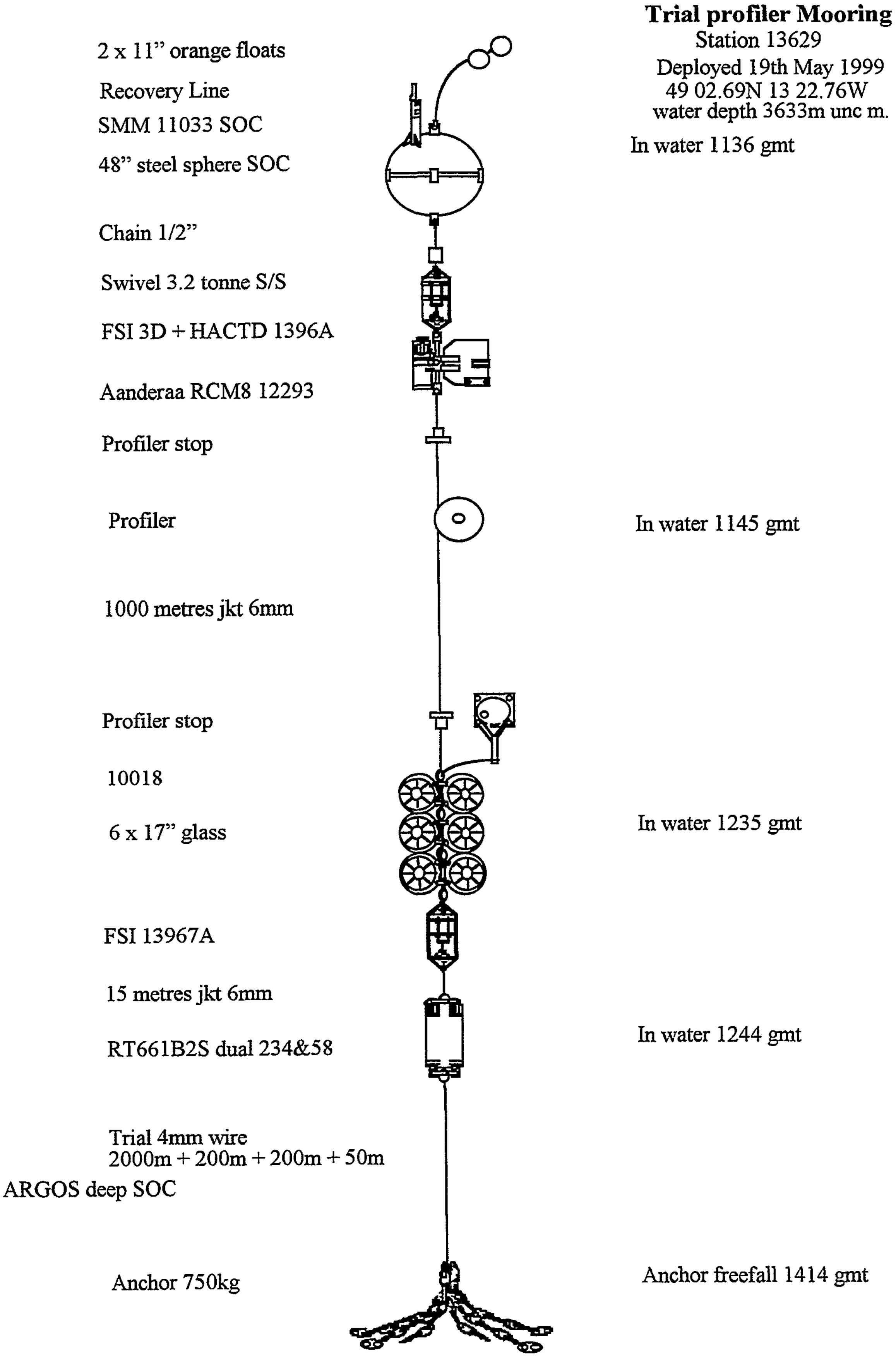

Fig 4. Profiling CTD Mooring

Southampton Oceanography Centre
University of Southampton
Waterfront Campus
European Way
Southampton SO14 3ZH
United Kingdom
Tel: +44(0) 1703 596666
Fax: +44(0) 1703 596667