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RRS DISCOVERY

CRUISE 160

30 JUNE – 25 JULY 1986

GEOCHEMICAL SAMPLING OVER THE MADEIRA AND PORCUPINE ABYSSAL PLAINS

CRUISE REPORT NO. 187

1986

INSTITUTE OF OCEANOGRAPHIC SCIENCES

NATURAL ENVIRONMENT RESEARCH COUNCIL

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WORMLEY

RRS DISCOVERY

Cruise 160

30 June - 25 July 1986

Geochemical sampling over the Madeira and Porcupine Abyssal Plains

Principal Scientist

J. Thomson

CRUISE REPORT NO. 187

1986

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C.J. Phillips	Third Engineer
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D.C. Wiseman	Bosun

ITINERARY

Departed:	Santa Cruz, Tenerife	30 June 1986
Arrived:	Falmouth, UK	25 July 1986

OBJECTIVES

The main purpose of this cruise was to obtain samples of sediment and sediment pore waters for geochemical research. The major part of the cruise was funded by the Department of the Environment as part of its radioactive waste management research programme (objectives i-v). This programme required work in the area of the Madeira Abyssal Plain east of the Great Meteor Seamount (the "GME area"). Rescheduling of the ship's programme allowed inclusion of a minor component of Science Vote work (objectives vi and vii).

The primary objectives in order of priority were:

(i) to sample the sediments in the 10 km x 10 km abyssal plain area centred on 31°17'N, 25°24'W (the "DOE box") to obtain solid phase and pore water material for geochemical characterisation of the sediment column;

(ii) to investigate possible pore water advection in the area proximal to the 100 km^2 area by sampling where the abyssal plain laps on to local relief;

(iii) to sample an area of the plain where the uppermost turbidite is missing (approximately 31°30'N, 24°26'W) for further investigation of the oxidation front phenomenon previously identified;

(iv) to undertake a number of activities related to non-geochemical programmes: piston coring, bottom photography, sediment pore pressure work and a sediment trap recovery/redeployment;

(v) to sample the small manganese nodule field close northeast of the area in (i);

(vi) to sample the sediments of the Porcupine Abyssal Plain for further investigation of the geochemical processes responsible for formation of a metal-rich band at the Holocene/glacial boundary;

(vii) to undertake a seawater collection for the Standard Seawater Service on a "ship-of-opportunity" basis.

In the event, good progress was made on all these objectives except (v), which was abandoned through lack of time in the GME area.

NARRATIVE

Discovery was alongside at Santa Cruz, Tenerife, having completed Cruise 159. The scientific party for Cruise 160 were on board assembling and preparing scientific equipment on 27 and 28 June, but did not embark until 0900z on Sunday 29 June. Breakdowns on Cruise 159 meant that the ship was awaiting replacement bearings from RVS for one of the ship's three main engines, and a replacement solenoid from IOS for the aft crane. Although these parts had arrived in Tenerife from the UK on the same flight during the weekend, sailing had to be delayed from the morning to the afternoon of Monday 30 June while the agent arranged customs clearance and transport to the ship. The solenoid could not be located, however, and it was decided to sail without it. This caused a minor problem later because the crane's engine had to be started using a shorting wire.

Discovery sailed at 1430z on Monday 30 June and proceeded to the GME area. The 10 kHz PES and 3.5 kHz fish were deployed at 0830z on Tuesday 1 July, and scientific watches commenced at 1900z. The first station worked (11317) commenced at 0818z on Wednesday 2 July.

The primary requirement at Station 11317 was deployment of a PUPPI device with a 6 m probe, but the opportunity was taken to collect seawater from depth for various geochemical purposes, using the ship's deep-water sampling rosette rigged with eleven 2.5 litre "Go-flo" bottles (Station 11317#1-#4). This work also served to test the midships hydraulic winch repair which had been made in Tenerife. A deep-water wire test (Station 11317#5) of the electronic packages of the two PUPPI devices on board was accomplished successfully, following which the 6 m PUPPI was deployed (Station 11317#6). The station was completed at 2206z.

Work in the area of the 10 km x 10 km "DOE box" began at 0318z on Thursday 3 June (Station 11318) when the Kastenlot corer (11318#1), pore water sampler (11318#2) and the box corer (11318#3) were run, with the station completed at 1712z. The time necessary to process sediment for geochemical purposes and to prepare the processing equipment for the next station meant that a strategy of spacing work in the DOE box with other work in the wider GME area was adopted. In view of the short distances involved, however, this still gave little respite to personnel.

Station 11319 began at 2236z on 3 July and comprised a wire test of a corer acoustic release and the WASP camera and electronics, and two runs of the piston corer. The first piston corer run (11319#2) failed because a retractor pin was

prevented from travel by a misaligned securing tape. This was remedied and the second run (11319#3) operated satisfactorily. The station was completed at 1042z on Friday 4 July.

On return to the DOE area, Station 11320 began at 1506z, when the box corer (11320#1 and #4), pore water sampler (11320#2) and the Kastenlot corer (11320#3) were run. The full WASP system was wire tested at shallow depth (11320#5). A second PUPPI was then laid slightly to the north of the DOE area (Station 11320#6), with work on Station 11320 completed at 1514z on Saturday 5 July. The WASP system was deployed to run over a small topographic high to the south of the DOE box at Station 11321. The system was deployed at 1525z on 5 July and ran until it ceased to take photographs. The system was secured inboard at 0418z on Sunday 6 July and Discovery proceeded to Station 10322 where a further piston core was taken, with the station completed at 1418z.

On return to the DOE area at 1824z, the piston corer was again deployed (Station 10323#1). A mishap occurred on corer entry, when the transmitted shock up the warp of the corer triggering caused a complete collapse of the traction winch accumulator with associated damage to the coring warp. The accumulator assembly was removed and a small block was substituted so that the gear could be recovered. While these repairs were being effected the corer was pulled out by the ship's drift, and on recovery it was found that two of the four barrel sections were bent. Apart from this the core was good and was sectioned for detailed geochemical investigation. The corer was inboard at 0206z on Monday 6 July and the ship remained hove to on station for the rest of the night. Analysis of the problem by the IOS engineering staff suggested that a repair could be made at sea, but the Master required assurance that any repair was properly tested for safety. Accordingly, IOS Wormley was contacted to advise the repairs proposed and to seek advice on a suitable test procedure. Water sampling work (Stations 11324#1, 11325#1) and an overnight 3.5 kHz survey of a previously uncharted area to the southeast of the DOE box were undertaken while repair pieces for the winch were fabricated. Further water sampling (Stations 11326#1 and #2) was carried out while repairs continued on Tuesday 8 July. The repair work on the winch was completed and tested by 1700z, with the proof test witnessed by the Master and Chief Officer. It was not feasible to continue work with the aft winch immediately because of the time worked by the engineering staff, and a further survey to the west of the DOE box was made overnight.

Bottom sampling resumed at 0718z on Wednesday 9 July when a box core

(11327#1) was retrieved, with the trawl warp substituted for the damaged coring warp. This station ended at 1234z. The PUPPI device deployed at Station 11321 was recovered next, and the ship set course for the next station at 1548z. A suite of sampling devices was run at Station 11328 from 2030z: Kastenlot corer (11328#1), pore water sampler (11328#2) and box corer (11328#3). A complete failure of ship's power occurred for a few minutes during pay-out of the box corer at 0958z but no problem ensued. The station was completed at 1342z on Thursday 10 July.

The vessel hove to on station at 1847z for the second deployment of the second PUPPI device (Station 11329#1) at the position of Station 11320#6 and this was accomplished by 2000z. Sampling in the DOE area resumed at 2048z when a water test of the repaired WASP system (Station 11330#1) and a 4.5m gravity core (11330#2) were run. The gravity corer was the trigger corer from the Driscoll piston corer rigged with piston corer barrels, and was used to achieve a deeper penetration than was possible with the Kastenlot corer. The piston corer was no longer usable at the GME water depths because of the damaged coring warp. This station was completed at 0136z on Friday 11 July.

A second WASP run was planned in the north east of the DOE area and the vehicle was deployed at 0945z. It became evident that further faults had developed since the first run and the run was terminated early and completed at 1548z. Discovery then returned to the position occupied as Station 11328, and work began with a pore water sampler run (11332#1) at 1836z. Kastenlot core 11332#2, 4.5 m gravity core 11332#3 and a further pore water sampler deployment (11332#4) were then run. On the second pore water sampler deployment at this station a short pennant had been used because the longer (100 m) pennant used on the trawl warp had made launch and recovery handling hazardous because of the slow response of the auxiliary storage drum brake to control at the Schat davit. The trawl warp is not torque balanced; a severe tangling of warp around the pore water sampler had resulted, with substantial damage to the sampler's mechanical and electronic components. A considerable amount of remedial work was necessary and the sampler was inoperative for several days.

Two further cores (box core 11333#1 and Kastenlot core 11333#2) were collected in the DOE area between 1918z on Saturday 12 July and 0530z on Sunday 13 July. The 6 m PUPPI device deployed at Station 11317#6 was recovered and secured inboard at 1406z. A single box core (11334#1) was taken between 1906z and 2324z on 13 July in a reoccupation of Station 11328. A 1 km sediment trap array mooring laid on Cruise 159 (Discovery Station 11287#11) was located,

released and recovered between 0524z and 0922z on Monday 14 July.

By this stage it was clear that an unexplained persistence of pore water oxygen was present at 2-3 m depth in the sediments in the DOE box, and a major concern of the remainder of the cruise would be elucidation of this phenomenon which might be related to horizontal advection. Two gravity cores (11336#1 and 11337#1) were taken on rising topography immediately to the east of the DOE area between 1121z and 1930z on 14 July. Following this, a further box core (11337#1) was taken in the DOE area and the WASP system was again tested in the water (11337#2). This work was completed at 0457z on Tuesday 15 July.

The second PUPPI device was recovered for the second time between 0544z and 0802z on 15 July. Station 11338 was occupied from 1206z to 1554z on 15 July when the sediment trap array mooring was relaid and observed to the bottom in the same position from which it had been recovered. The WASP system run which had been abandoned earlier was conducted from 1936z until 0730z on Tuesday 15 July (Station 11339).

Two further gravity cores were collected, one in the DOE area (11340#1) from 1436z to 1812z on 15 July, and another at a reoccupation of Station 11328 (11341#1) from 2300z to 0224z on Wednesday 16 July. This concluded work in the GME area and Discovery proceeded north. The ship made good speed (11 knots) throughout Thursday 17 July, but a northerly wind and swell reduced headway to 7-8 knots through Friday 18 July and Saturday 20 July. A planned station on the distal Horseshoe Abyssal Plain was abandoned on Saturday 19 July because of the sea condition and the course was altered towards the final stations in the Porcupine Abyssal Plain. The weather moderated from Sunday 20 July onwards and did not pose any further problems to the ship's speed. An underway collection of seawater was made at approximately 44°N for the Standard Seawater Service between 1642z and 1744z on Monday 21 July and between positions 44°05'N, 13°58'W and 44°16'N, 13°55'W.

It was decided to revert to the coring warp for work on the Porcupine Abyssal Plain, although the damage sustained by this warp meant that only depths less than 5 km could be worked. Station 11342 on the Armorican Plateau was worked from 0700z to 1842z on Tuesday 22 July when a Kastenlot core (11342#1), a pore water sampler deployment (11342#2) and a box core (11342#3) were run. The final station (11343) was located in international waters at the mouth of the Porcupine Sea Bight. This station was undertaken between 1248z on Wednesday 23 July and 0254z on Thursday 24 July. The devices utilised were the Kastenlot corer (11343#1), the pore water sampler (11343#2), the box corer (11343#3) and

the pore water sampler (11343#4).

Scientific watches were concluded on completion of Station 11343 and Discovery set course for Falmouth. The PES and 3.5 kHz fish were recovered at 0800z on Thursday 24 July, having run approximately 2700 nautical miles on this cruise. The vessel was secured alongside at Falmouth at 1240z on Friday 25 July.

PROJECT AND EQUIPMENT REPORTS

(i) BOX CORE PHOTOGRAPHY

When the box cores first arrived on deck and the shrouds removed, a camera bracket was attached from which photographs of the sediment surface could be taken. The bracket was slotted so that the camera could be moved for stereophotography. The light source was a 240 v (AC) hand-held 800 w spotlamp. This was chosen in preference to a fixed lighting system as one could reduce pooling and glare from the sediment surface more easily with a hand-held device.

These photographs were taken with two aims in mind:

1. To enable the surface roughness to be assessed for geophysical purposes using photogrammetry.
2. To obtain a photographic record of the sediment surface.

Box coring for geochemical purposes is a process fraught with the fear of oxygen contamination of the surface layer. I would like to thank the assembled chemists for their patience in allowing me to carry out my work ahead of their subsampling procedure.

Q.J. Huggett

(ii) CORING OPERATIONS

Box, Kastenlot and piston cores were required to provide progressively deeper samples for shipboard pore water extraction and subsequent solid phase analysis. The box and Kastenlot corers provided material which overlapped the depths of the in-situ pore water sampler (up to 1 m) while the piston corer sampled down to 10 m. Following the damage to the coring warp, depths greater than 2 m were achieved using the piston corer trigger corer as described below.

Box Coring

The IOS box corer was used on this cruise with a new release system designed by Mr. R.H. Edge (Ocean Engineering Group, IOS). This release is actuated by a modified retractor fired by an IOS 10 kHz acoustic control system. The acoustic system is modified to fire on command with a short delay, and a pressure switch is fitted to prevent pre-firing in air (see IOS Cruise Report No. 184).

The first box corer run on the cruise (Station 11318#3) failed to fire, and the charging time of the relay-firing capacitor was decreased. Following this modification nine box cores were collected without problems. The modification to the corer thus appears highly successful, allowing faster veer speeds on the winch without pre-trip problems.

Kastenlot Coring

Seven Kastenlot cores were retrieved on this cruise using a 2.3 m stainless steel barrel. No difficulties were encountered. The modified catcher system developed at IOS therefore continues to solve the catcher door closure problem encountered on Discovery Cruise 135 (IOS Cruise Report No. 169).

A handling method using the Hiab crane mounted on the Schat davit was evolved when difficulties were encountered with the ship's aft crane. The problem was that a solenoid failure meant that the crane's diesel engine had to be started by hand using a shorting wire. If the engine cut out during corer handling, therefore, a dangerous situation could develop. Launching and recovery by the Hiab crane was somewhat slower than by the ship's crane, but the lack of pendulum effect meant that handling was easier and safer.

Piston Coring

Three piston cores were taken with the IOS Driscoll piston corer with a 10 m barrel. This corer uses an acoustically-released safety pin, which was retracted with the corer some 20-30 m above the seafloor. This technique has proved very successful on recent cruises in preventing pre-triggering of the corer.

During the third corer run (Station 11323#1), the traction winch inboard accumulator arm failed as the corer triggered into the seafloor. While the winch was being repaired, the corer was pulled out of the seafloor by the ship's drift and appeared to have been dragged some distance. This bent two of the core barrel sections slightly. Apart from this the core seemed very similar to

the previous two although it was roughly 3 m shorter. The damage to the coring warp resulting from the accumulator arm collapse prevented any further piston coring on this cruise because no work in shallower water was required.

Gravity Coring

An improvised 4.5 m gravity corer was constructed using the trigger corer from the piston corer modified by the attachment of a longer barrel. Although the cores recovered were considerably shorter than those obtained by piston coring they could be logged with the p-wave logger and subsampled using the same techniques as used on piston cores.

In total six gravity cores were taken, all of which were 3-3.2 m long. Using more weight on the corer head and increasing the run-in velocity were tried without any increase in core length.

D.E. Gunn G.A. Lake
H.E. Sutherland J. Thomson
R.F. Wallace A.T. Webb D. White

(iii) ENGINEERING REPORT

A new hydraulic pump was installed in the forward ring main which powers the midships winch. The system was tested in Tenerife and the repair found to be satisfactory. The winch was used to full water column depth (~ 5400 m) during the cruise and no problems were encountered.

The accumulator of the aft traction winch failed during corer triggering on piston core Station 11323#1. The weld on one arm sheared and the whole accumulator assembly twisted round to tear off the other arm. The accumulator collapsed forwards towards the winch control room and landed between the winch and the warp spurling pipe, tearing off the forward pinch roller and damaging the sheave. One strand of the three-strand coring warp was badly damaged in two places (5527 m and 5532 m wire out indicated). The accumulator arm was disassembled and laid aside, and a small snatch block was rigged and the warp and gear were recovered at 0.3 m/s.

When the accumulator arm was inspected, the weld on the starboard arm was seen to have been weak for some time as much of the fracture surface was corroded. The accumulator arms were also fabricated in box sections of different thicknesses, 5 mm and 10 mm respectively. The arm with the failing weld was the thinner.

The accumulator sheave shaft was badly bent at one end. Approximately 30 cm of the shaft was cut off and a new piece spigotted and welded on and turned to size. The accumulator arms were shortened by 75 mm to remove the damaged ends. The arms were welded back on to the bottom main shaft with extra gussets added to distribute the load at the points of failure. The repaired accumulator was proof-tested to two tons horizontal pull.

Coring stations recommenced with the trawl warp substituted for the damaged coring warp and the repaired accumulator worked well.

A.C. Braithwaite G.A. Lake
R.F. Wallace A.T. Webb

(iv) POP-UP PORE PRESSURE INSTRUMENT (PUPPI)

PUPPI was developed to measure any pore water advection in the GME study area. Previous deployments (on Discovery Cruise 153, Charles Darwin Cruises 6 and 9B) had indicated no significant pore water advection in the area (< 1 mm per year). The objectives of the cruise for PUPPI were:

(a) To deploy a PUPPI with a 6 m probe. Previous deployments had used 3 m and 4 m lances. It was hoped that the sediment at 6 m depth would be less disturbed by biological activity, and that the instrument sensitivity to pore water advection would be increased by measuring the differential pressure over a greater distance.

(b) To investigate the causes of the tidally-induced pore pressure signal. The aim was to see if the tidal signal was an artefact of the measuring system or was a real effect in the sediment. By making large changes to the compliance of the pressure measuring system it was hoped that the effect of the transducer/pipework could be eliminated. This was to be done by increasing the volume of water in the system by an order of magnitude, using a rigid volume of trapped water, and increasing the length of nylon pipe by a considerable extent.

Station 11317#6

After successful wire tests of the data loggers and acoustic telemetry units (Station 11317#5) the PUPPI with a 6 m lance was deployed on the abyssal plain. The deployment went smoothly and the descent of the instrument did not seem to be adversely affected by the extra length of lance. It penetrated

fully and no tilt was indicated.

Preliminary Results

The instrument functioned well and recorded no significant pore pressure. The pore pressure in the 6 m port had not completely finished decaying when the instrument was recovered and so future deployments should be for an extra one or two days.

Station 11320#6

The main aim of this deployment was to investigate the effect on the system of increasing the volume of trapped water. A rigid brass container containing 500 ml of sea water was "T'ed" into the pipe which connected the port at 4 m depth and the pressure transducer. The port at 2 m was connected as normal. The launch was uneventful and the instrument penetrated fully with no tilt.

Preliminary Results

The data was non-typical for this area, indicating substantial pore water advection and no tidal signal. The logger and transducers were checked carefully for faults and the data studied carefully, but no satisfactory explanation could be found.

Station 11329

Because of the unusual data obtained from deployment 11320#6 it was decided to redeploy a standard PUPPI as close as possible to that position. The original plan to experiment with a longer length of pipe was abandoned. Unfortunately only a single port probe was available, and so one transducer was connected to this port and the other transducer was used to check on the effect of using a completely unbled transducer and pipe (attached to the stray line).

Preliminary Results

The cutter which cuts the pore pressure pipe before lift-off failed to operate, thus the quality of the zero reference was impaired. However, the pressure change which again was seen at cut was much larger than the uncertainty in zero. The transducer connected to the unbled pipe measured no change on cut, indicating that the use of an unbled system does introduce large errors in the measurement of excess pore pressure.

The three deployments in the GME area were highly successful and gave

Pore Water Analysis

Pore water samples from the hydraulic squeezing sytem and the in-situ pore water sampler were subdivided to give two sets of 2 ml samples for the continuous-flow analyser. Samples for the determination of iron, manganese, silicate and phosphate were acidified in a nitrogen atmosphere. Ammonia, nitrate and nitrite were determined on the second set of unacidified samples. Iron values were substantially lower in samples which were acidified in a normal atmosphere. Silicate contamination was encountered from the Nuclepore prefilters when these were used in the second filtering step for "polishing" samples from the hydraulic squeezers. Due to the large dead volume of the Swinnex filter holders used in this step, some samples were also contaminated with distilled water when this was not flushed out prior to collecting the first of the 2 ml samples.

The continuous-flow analyser ran well, the system having been increased from 3 to 7 channels for this cruise. A "Chemlab" system was used with Commodore PET and BBC microcomputers for data reduction.

Specialised analysis for carbonate system components was carried out on selected in-situ pore water samples. Total CO_2 was measured by a titration procedure based on a non-aqueous solvent and pH was determined using a thermostatted microcell and flow-junction reference electrode.

Oxygen was measured directly on core subsamples by gas chromatography of headspace gases after equilibration in a closed container. Over 250 subsamples were processed for this measurement during the cruise.

F. Culkin N.C. Higgs
D.J. Hydes T.R.S. Wilson

(vi) SEDIMENT TRAP HANDLING

An array of four sediment traps, laid on Cruise 159 (Station 11287#11) was recovered on 14 July. Each trap has a closing mechanism actuated by a clock which is set on deployment. In fact, none of the traps were closed on retrieval; one because the timer had been set wrongly, three because the rubber cord effecting closure had stretched. Despite this, samples were obtained in all four receivers and were deep-frozen for return to IOS.

The array was relaid on 15 July (Station 11338#1) using 180 kg of chain as ballast and with the four traps at 10 m, 116 m, 1111 m and 1143 m respectively above the seafloor. The timers were individually checked and confirmed to be

interesting and unexpected results. The results of Stations 11320#6 and 11329#1 were so untypical that the system will have to be checked out very carefully and further deployments made in the same location before it can be shown whether or not there is pore water advection in the area.

D.E. Gunn S.D. McPhail

(v) PORE WATER SAMPLING

In-Situ Pore Water Sampler

The IOS Mk III in-situ sampler was deployed on eight occasions. Successful operation of the system occurred in all deployments except two: at Station 11332#4 the trawl warp (which was substituted after damage to the coring warp) tangled with the frame, resulting in considerable superficial damage. At Station 11343#2 a modification intended to slow the initial rate of descent of the probe was found to prevent the probe from descending altogether. After removal of this modification, correct operation and sampling was achieved at this station (11343#4).

The prototype in-situ porosity probe was also successful at Station 11343#4 after problems at earlier stations.

A.C. Braithwaite D.J. Hydes
G.A. Lake S.D. McPhail T.R.S. Wilson

Pore Water Extraction from Cores

Approximately 400 pore water samples were produced from 18 cores (Kastenlot, box, piston and gravity) using hydraulic squeezing in a low temperature (4°C) container. Core cutting and sample preparation were carried out in a nitrogen atmosphere in an inflatable glove bag which was manufactured for this specific purpose as a variant of the Perspex glove box previously used. The bag system proved to be very successful and was used throughout the cruise. A number of subsamples of pore water were collected into special air-tight vials for carbon isotopic analysis at University College London (J. McArthur).

A further two box cores were processed by centrifugation for the analysis of rare earth elements at Cambridge University (B. Dickie).

S. Colley B. Dickie Q. Huggett
J. McArthur A. McDonald C. Stumpp

working and were set to close the traps in 14 weeks time, i.e. midnight on 22 October 1986. The rubber cords were shortened by 2" in an attempt to ensure that the traps would close.

This deployment used release CR2314, command frequency 320 Hz, release frequency 342 Hz, period 1.02 sec.

D.J. Hydes G.A. Lake
H.E. Sutherland R.F. Wallace A.T. Webb

(vii) WIDE AREA SURVEY PHOTOGRAPHY

The WASP camera system was deployed on three occasions giving two successful camera runs. The system is identical to that used on Discovery Cruise 153 (IOS Report No. 172).

Station 11321#1

The WASP system was loaded with 61 m of 400 ASA film with an aperture of f3.5-4 and programmed to cycle at 16-second intervals whilst in photographic range of the seafloor (8-18 m).

The target for this run was a small "outcrop" of pelagic sediments protruding through the flat turbidites of the abyssal plain. This "outcrop" or knoll was only 2-3 miles across and so the 10 kHz beacons established in the area on a previous cruise proved invaluable in directing the WASP system over the target.

The WASP system was launched at 1525z (5/vii) and started taking photographs at 1842z. The system ran well until 0054z (6/vii) when the signals abruptly weakened. Fearing an entanglement with the seafloor, the WASP was immediately retrieved and was back on deck by 0400z (6/vii). The WASP system was undamaged and the poor signal strength attributed to an internal instrument failure.

The film from this run was processed on board and it revealed that although the run was curtailed the knoll had been successfully traversed.

Station 11331#1

The WASP system was prepared as for the previous station except that the monitor was substituted for the back-up system as the fault which caused signal failure had not been located.

The target for this run was a hill in the east of the GME region around which turbidity currents had taken material into the abyssal plain. In order to enable close correlation with GLORIA side scan sonographs (taken on a Farnella cruise in 1982) the hill was to be used as a reference point. Acoustic navigation was not available for this run which was navigated using transit satellites only.

The WASP system was launched at 0947z (11/vii) and reached the seafloor at 1300z (11/vii). It appeared that no photographs were being taken and so the system was retrieved and the station abandoned. It appeared that a high-pressure leak in the wiring harness had caused the flash units to fail; the harness was therefore replaced.

Station 11337#2 (15/vii)

This was a test dip to check that the high-pressure leak had been cured. The first monitor (as used on 11321#1) had been repaired and was substituted for the back-up system.

The WASP was lowered to 3500 m and appeared to function correctly. It was then retrieved and prepared for a repeat attempt at the target for Station 11331#1.

Station 11339#1

This was the second attempt at photographing the target specified for Station 11331. The WASP system was launched at 2005z (15/vii) and started taking photographs at 2322z. The system ran well and at 0450 (16/vii) it was hauled in and was back on deck by 0730 (16/vii).

The film from this run was developed on board and it revealed that the WASP had successfully crossed from the hill out onto the abyssal plain as planned.

Despite the problems encountered with the WASP system the two main objectives were fulfilled.

Q.J. Huggett S.D. McPhail

SUMMARY AND ACKNOWLEDGEMENTS

This cruise was successful in collecting the materials and data to meet its objectives. Good pore water data were collected for the "DOE box" area, which was essential for comparison with earlier work at GME and to guide solid phase and more specialised pore water investigations. Although much of the

interpretation must await further shore-based analysis, of particular scientific interest were:

(i) the finding in the GME area of a widespread zone where residual oxygen was present below post-oxic conditions in the top of the turbidite b;

(ii) the unexplained pore pressure data obtained at Stations 11320#6 and 11329#1, and

(iii) the indurated iron-rich band found at Station 11342, for which cores comprehensive pore water data were obtained.

The work in the GME area was particularly demanding because the short distances involved meant that there was a very short recovery time for personnel and equipment. I should like to acknowledge the considerable efforts of the scientific party which ensured the success of the cruise, recognising in particular that the collection of quality pore water data on a continuous basis requires both skill and relentless effort.

It is a pleasure to record the thanks of the scientific party to Discovery's officers and crew for their assistance on this cruise. In particular, the deck crew gave invaluable help with all gear handling and with driving the aft traction winch.

Several mishaps on this cruise could have been catastrophic for the scientific programme, most notably the damage to the aft winch and the pore water sampler. I wish to acknowledge the expertise and application of the members of the IOS Applied Physics and Ocean Engineering groups in keeping systems running and their improvisational skills in undertaking such work at sea.

J.Thomson

TABLE 1 - Details of Work Performed on Cruise 160

Station Number	Date	Latitude (N)	Longitude (W)	Equipment	Water Depth (uncorr. m)	Times (z)	Notes
11317#1	2/vii	30°44.2'	24°29.4'	CTD	-	0821-0907	Electronic problems; aborted.
11317#1	2/vii	30°44.8'	24°29.6'	CTD	-	1043-1126	Failed to fire bottles.
11317#3	2/vii	30°44.9'	24°29.7'	CTD	-	1132-1140	Successful firing at 10 m.
11317#4	2/vii	30°45.3'	24°29.9'	CTD	-	1207-1248	11 x 2.5 litre bottles fired at 1000 m.
11317#5	2/vii	-	-	Electronics	-	1305-1627	Wire test to 5300 m for PUPPI acoustics packages.
11317#6	2/vii	30°43.5'	24°29.3'	PUPPI	-	2048-2206	Deployment; 6 m probe.
11318#1	3/vii	31°18.4'	25°25.3'	Kastenlot	5375	0341-0731	
11318#2	3/vii	31°18.6'	25°23.1'	PWS	5375	0814-1236	
11318#3	3/vii	31°17.7'	25°22.8'	Box	5375	1309-1712	No core.
11319#1	3/vii	30°54.0'	24°32.2'	Electronics	-	2244-2317	Acoustics wire test.
11319#2	4/vii	30°55.0'	24°34.0'	Piston	5366	0024-0506	No core.
11319#3	4/vii	30°56.5'	24°36.0'	Piston	5366	0528-1042	

TABLE 1 - Continued (2)

Station Number	Date	Latitude (N)	Longitude (W)	Equipment	Water Depth (uncorr. m)	Times (z)	Notes
11320#1	4/vii	31°18.2'	25°23.6'	Box	5375	1528-1915	Large rhizopod protozoan on core surface.
11320#2	4/vii 5/vii	31°17.7'	25°23.7'	PWS	5375	1955- 0004	
11320#3	5/vii	31°19.6'	25°23.6'	Kastenlot	5370	0025-0355	Core for palaeomagnetic studies.
11320#4	5/vii	31°17.4'	25°25.1'	Box	5375	0433-0814	Core for rare earth element studies.
11320#5	5/vii	-	-	WASP	-	0945-0958	WASP system wire test.
11320#6	5/vii	31°21.8'	25°24.6'	PUPPI	-	1155-1514	Deployment; 4 m probe.
11321#1	5/vii 6/vii	31°10.8' 31°13.8'	25°30.7' 25°25.4'	WASP	-	1525- 0403	Run terminated due to equipment failure.
11322#1	6/vii	31°10.9'	24°35.0'	Piston	5365	0941-1358	
11323#1	6/vii 7/vii	31°17.7'	25°25.8'	Piston	5375	1907- 0206	Traction winch accumulator failure: recovered corer at slow speed.

TABLE 1 - Continued (3)

Station Number	Date	Latitude (N)	Longitude (W)	Equipment	Water Depth (uncorr. m)	Times (z)	Notes
11324#1	7/vii	31°19.2'	25°37.6'	CTD	-	1242-1324	Cast to 1000 m.
11325#1	7/vii	31°18.7'	25°23.3'	CTD	5375	1519-1842	Deep cast to 5365 m.
11326#1	8/vii	31°16.7'	25°24.2'	CTD	-	0808-0830	Cast to 1000 m.
11326#2	8/vii	31°17.0'	25°24.2'	CTD	-	0907-1018	Cast to 1500 m.
11327#1	9/vii	31°18.3'	25°23.4'	Box	5380	0722-1234	
(11320#6)	9/vii	-	-	PUPPI	-	1329-1548	Recovery.
11328#1	9/vii 10/vii	31°29.3'	24°26.5'	Kastenlot	5375	2048- 0105	
11328#2	10/vii	31°31.4'	24°27.0'	PWS	5375	0232-0714	
11328#3	10/vii	31°29.9'	24°28.1'	Box	5375	0755-1317	
11329#1	10/vii	31°21.8'	25°25.0'	PUPPI	-	1859-2000	Deployment; 4 m probe.

TABLE 1 - Continued (4)

Station Number	Date	Latitude (N)	Longitude (W)	Equipment	Water Depth (uncorr. m)	Times (z)	Notes
11330#1	10/vii	31°17.1'	25°24.0'	WASP	-	2057-2106	WASP system wire test.
11330#2	10/vii 11/vii	31°18.0'	25°26.1'	Gravity	5380	2118-0136	
11331#1	11/vii	-	-	WASP	-	0945-1532	Run aborted due to system failure.
11332#1	11/vii	31°29.7'	24°26.3'	PWS	5375	1844-2348	
11332#2	12/vii	31°29.6'	24°26.4'	Kastenlot	5375	0024-0430	
11332#3	12/vii	31°30.6'	24°26.1'	Gravity	5375	0505-0901	
11332#4	12/vii	31°30.1'	24°26.2'	PWS	5375	0946-1413	Device damaged by warp entanglement.
11333#1	12/vii 13/vii	31°17.9'	25°24.4'	Box	5375	1922-0006	
11333#2	13/vii	31°17.7'	25°25.3'	Kastenlot	5377	0051-0506	
(11317#6)	13/vii			PUPPI	-	1149-1400	Recovery.

TABLE 1 -Continued (5)

Station Number	Date	Latitude (N)	Longitude (W)	Equipment	Water Depth (uncorr. m)	Times (z)	Notes
11334#1	13/vii	31°30.8'	24°25.2'	Box	5375	1908-2324	
(11287#1)	14/vii	31°32.4'	24°41.6'	Sediment Traps	-	0524-0800	Recovery of array laid on Cruise 159.
11335#1	14/vii	31°22.7'	25°16.9'	Gravity	5365	1122-1456	
11336#1	14/vii	31°22.3'	25°20.1'	Gravity	5375	1600-1930	
11337#1	14/vii 15/vii	31°17.7'	25°25.3'	Box	5380	2032-0032	Core for rare earth element studies
11337#2	15/vii	-	-	WASP	-	0134-1457	WASP system electronics test to 3500 m.
(11329#1)	15/vii	-	-	PUPPI	-	0544-0802	Recovery.
11338#1	15/vii	31°33.2'	24°40.0'	Sediment Traps	-	1212-1554	Deployment: to be recovered on Cruise 163.

TABLE 1 - Continued (6)

Station Number	Date	Latitude (N)	Longitude (W)	Equipment	Water Depth (uncorr. m)	Times (z)	Notes
11339#1	15/vii 16/vii	31°41.3'	24°00.0'	WASP	-	2005- 0730	
11340#1	16/vii	31°15.4'	25°22.8'	Gravity	5380	1446-1812	
11341#1	16/vii 17/vii	31°29.3'	24°25.8'	Gravity	5375	2302- 0218	
11342#1	22/vii	46°37.7'	13°15.6'	Kastenlot	4525	0740-1046	
11342#2	22/vii	46°36.5'	13°14.9'	PWS	4525	1103-1430	
11342#3	22/vii	46°38.97	13°14.8'	Box	4526	1505-1755	
11343#1	23/vii	49°41.8'	14°41.5'	Kastenlot	4365	1250-1531	
11343#2	23/vii	49°42.7'	14°41.0'	PWS	4365	1608-1913	No samples.
11343#3	23/vii	49°42.9'	14°41.6'	Box	4365	1933-2227	
11343#4	23/vii 24/vii	49°42.4'	14°39.6'	PWS	4365	2337- 0254	

Abbreviations:

Box	- IOS box corer
CTD	- Conductivity, temperature, depth probe with attached water sampling rosette
Gravity	- Gravity corer with 4.5 m barrel
Kastenlot	- Box section gravity corer with 2.3 m barrel
Piston	- Driscoll piston corer with 10 m barrel
PUPPI	- Pop-up Pore Pressure Instrument
PWS	- In-situ sediment pore water sampler (IOS Mk III)
WASP	- Wide Area Survey Photography system

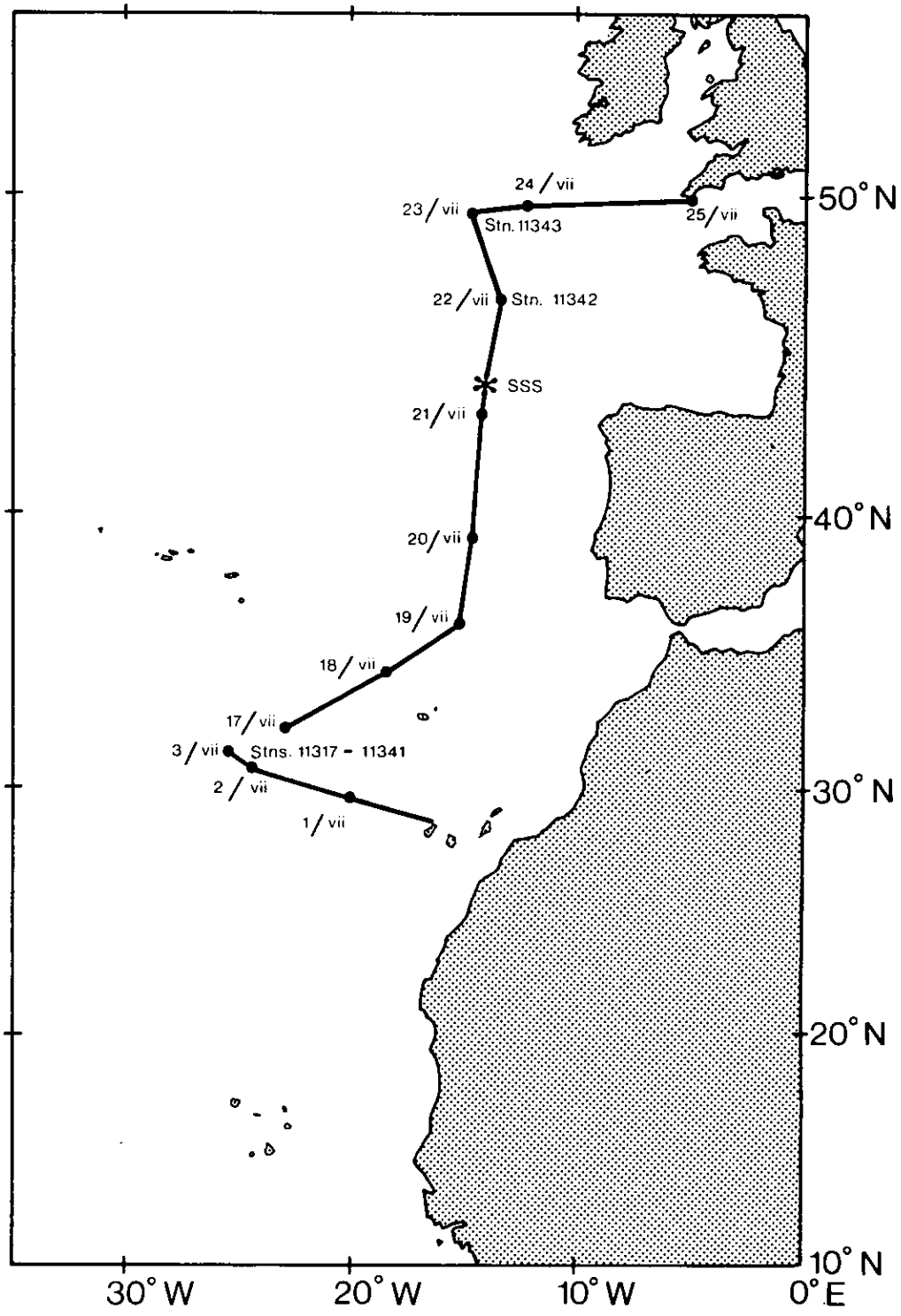

FIGURE 1. "RRS Discovery" Cruise 160: ship's track showing midday positions.
* SSS Collection of seawater for Standard Seawater Service.

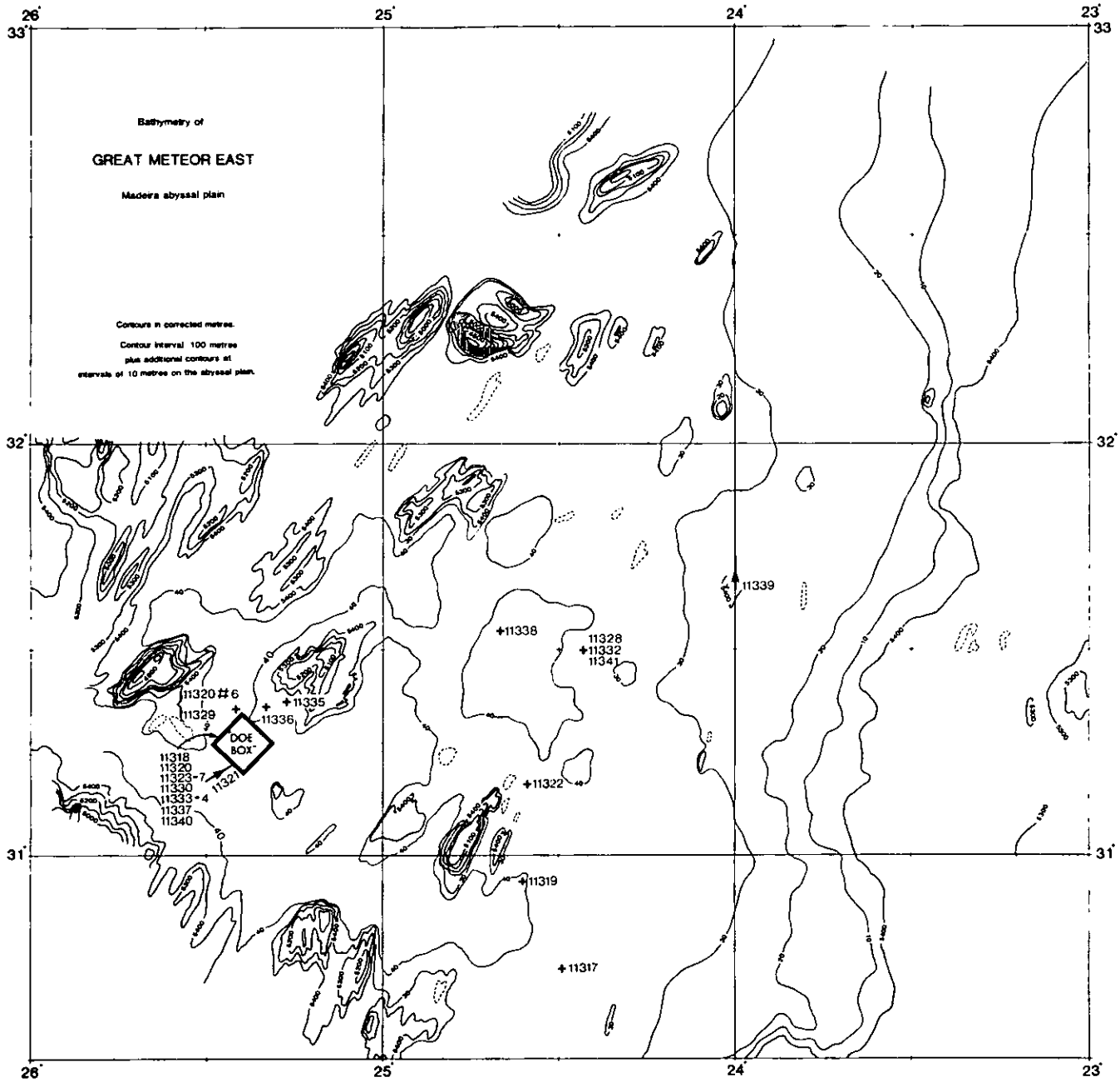

FIGURE 2. "RRS Discovery" Cruise 160: station positions in the GME area, 2 July–17 July.