I.O.S.

RRS DISCOVERY

CRUISE 159

15 MAY – 25 JUNE 1986

# BIOGEOCHEMICAL FLUX STUDIES IN THE N.E. ATLANTIC – GME 26°N TRANSECT AND TAG HYDROTHERMAL FIELD

CRUISE REPORT NO. 193

1987

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES DEACON LABORATORY

# INSTITUTE OF OCEANOGRAPHIC SCIENCES

## DEACON LABORATORY

---

**Wormley, Godalming,**
**Surrey, GU8 5UB, U.K.**

**Telephone: 0428 79 4141**
**Telex: 858833 OCEANS G**
**Telefax: 0428 79 3066**

Director: Dr. A.S. Laughton FRS

*Natural Environment Research Council*

INSTITUTE OF OCEANOGRAPHIC SCIENCES

DEACON LABORATORY

CRUISE REPORT No.193

RRS DISCOVERY

Cruise 159

15 May - 25 June 1986

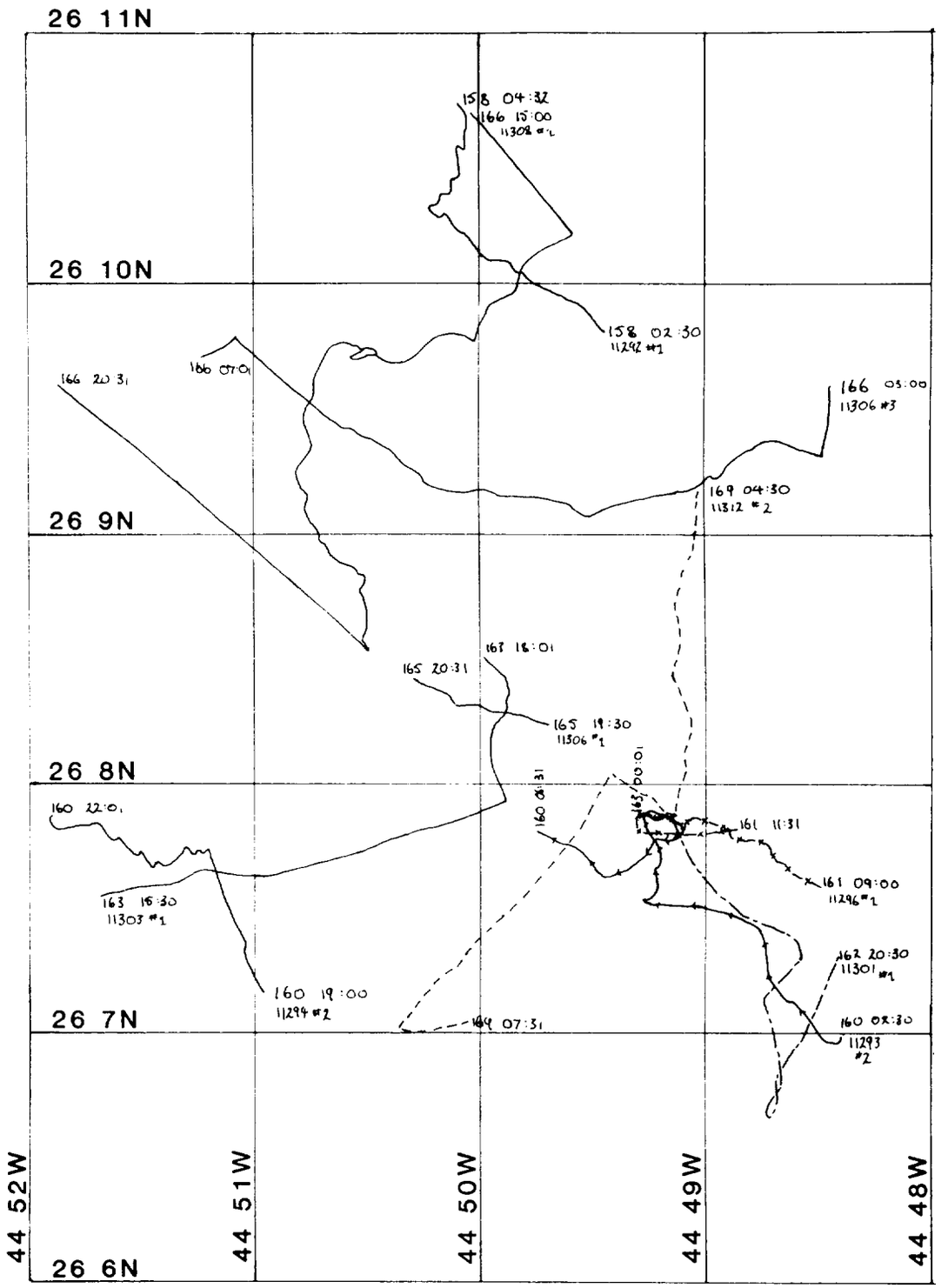
# Biogeochemical flux studies in the N.E. Atlantic - GME 26°N transect and TAG hydrothermal field

Principal Scientist

W.R. Simpson

1987

**FIGURE 7**




C.T.D. TRACKS AROUND T.A.G. AREA

# DOCUMENT DATA SHEET

| | | |
|---|---|---|
| *AUTHOR* | SIMPSON, W.R. *et al* | *PUBLICATION DATE* 1987 |
| *TITLE* | RRS *Discovery* Cruise 159, 15 May - 25 June 1986. Biogeochemical flux studies in the N.E. Atlantic - GME, 26°N transect and TAG hydrothermal field. | |
| *REFERENCE* | Institute of Oceanographic Sciences, Deacon Laboratory, Cruise Report, No. 193, 59pp. | |


*ABSTRACT*

The report describes "Discovery" Cruise 159 conducted in June 1986 in the N.E. Atlantic.

The objectives were:

a) reoccupy a station over the Madeira Abyssal Plain

b) recover and redeploy trap and transmissometer moorings

c) mark a transect for flux studies along 26°N

d) investigate the TAG hydrothermal plumes.

Extensive particulate and dissolved phase chemical sampling, biological and microbiological sampling and studies of particle properties, particle concentration and mass fluxes were carried out.



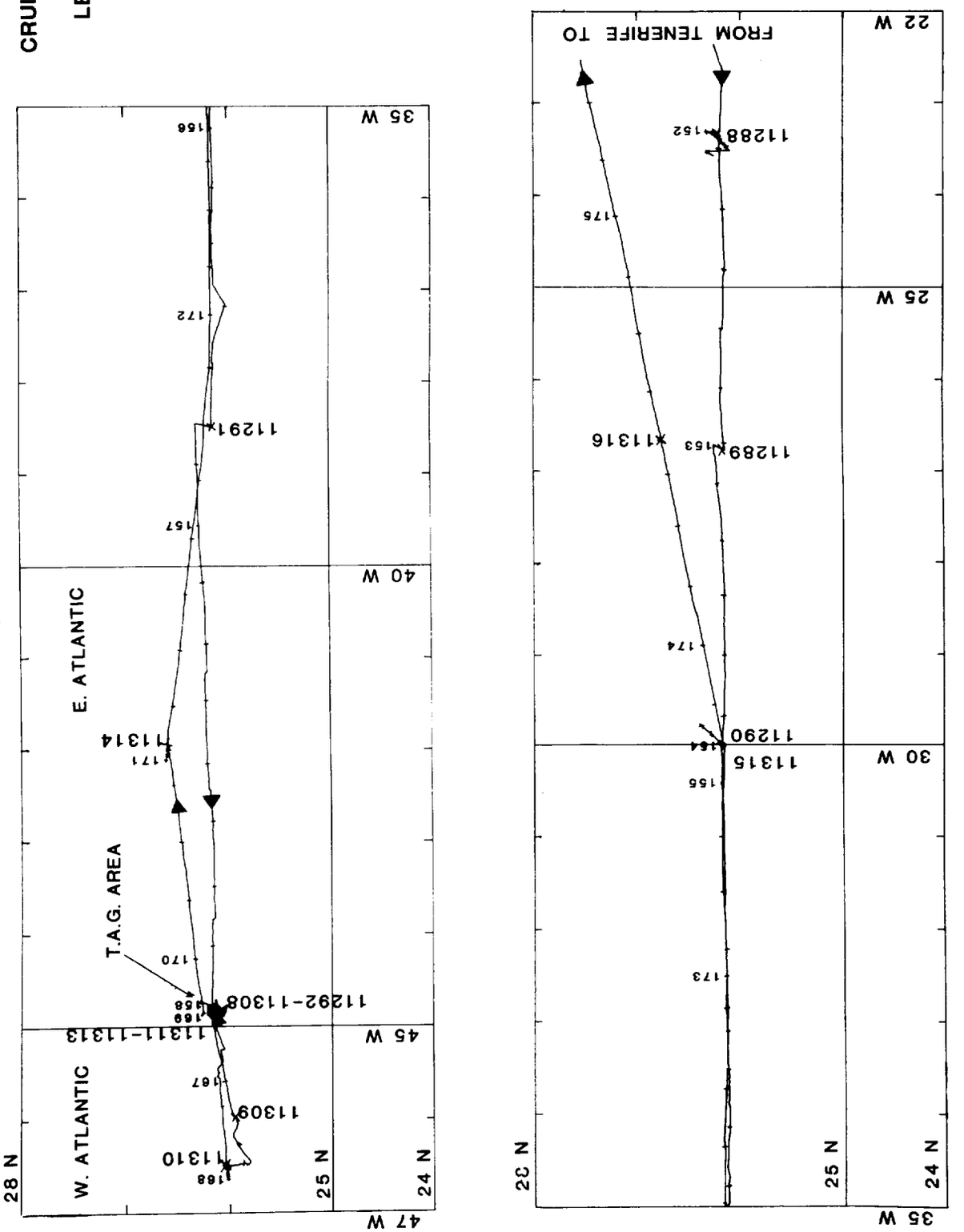
| | | |
|---|---|---|
| *ISSUING ORGANISATION* | Institute of Oceanographic Sciences<br>Deacon Laboratory<br>Wormley, Godalming<br>Surrey GU8 5UB. UK.<br><br>Director: Dr A S Laughton FRS | *TELEPHONE* 0428 79 4141<br>*TELEX* 858833 OCEANS G<br>*TELEFAX* 0428 79 3066 |
| *KEYWORDS*<br>*BIOGEOCHEMICAL CYCLE*<br>*BIOGEOCHEMICAL FLUXES*<br>*CHEMICAL OCEANOGRAPHY*<br>*MARINE BIOLOGY*<br>*MICROBIOLOGY*<br>*WATER COLUMN*<br>*ATLANTIC OCEAN (NE)*<br>*MADEIRA ABYSSAL PLAIN*<br>*TAG HYDROTHERMAL FIELD* | | *CONTRACT*<br>*PROJECT* CO 33<br>*PRICE* £13.00 |

*Copies of this report are available from:*
The Library, Institute of Oceanographic Sciences, Deacon Laboratory.

FIGURE 5

CRUISE 159.

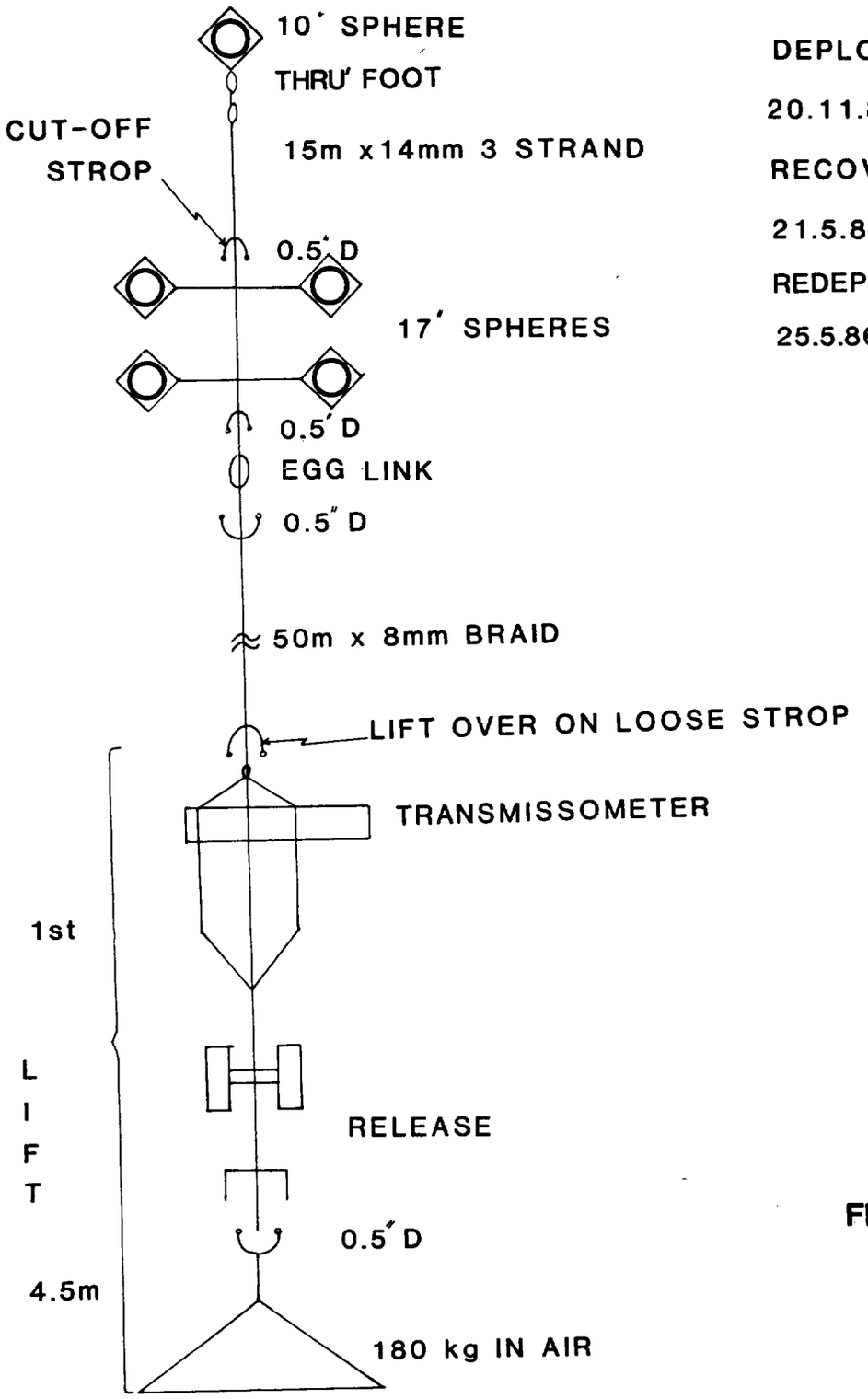
LEG 2



CONTENTS

MOORING 402 TO RECOVER AND LAY

31° 33.6' N
24° 43.4' W



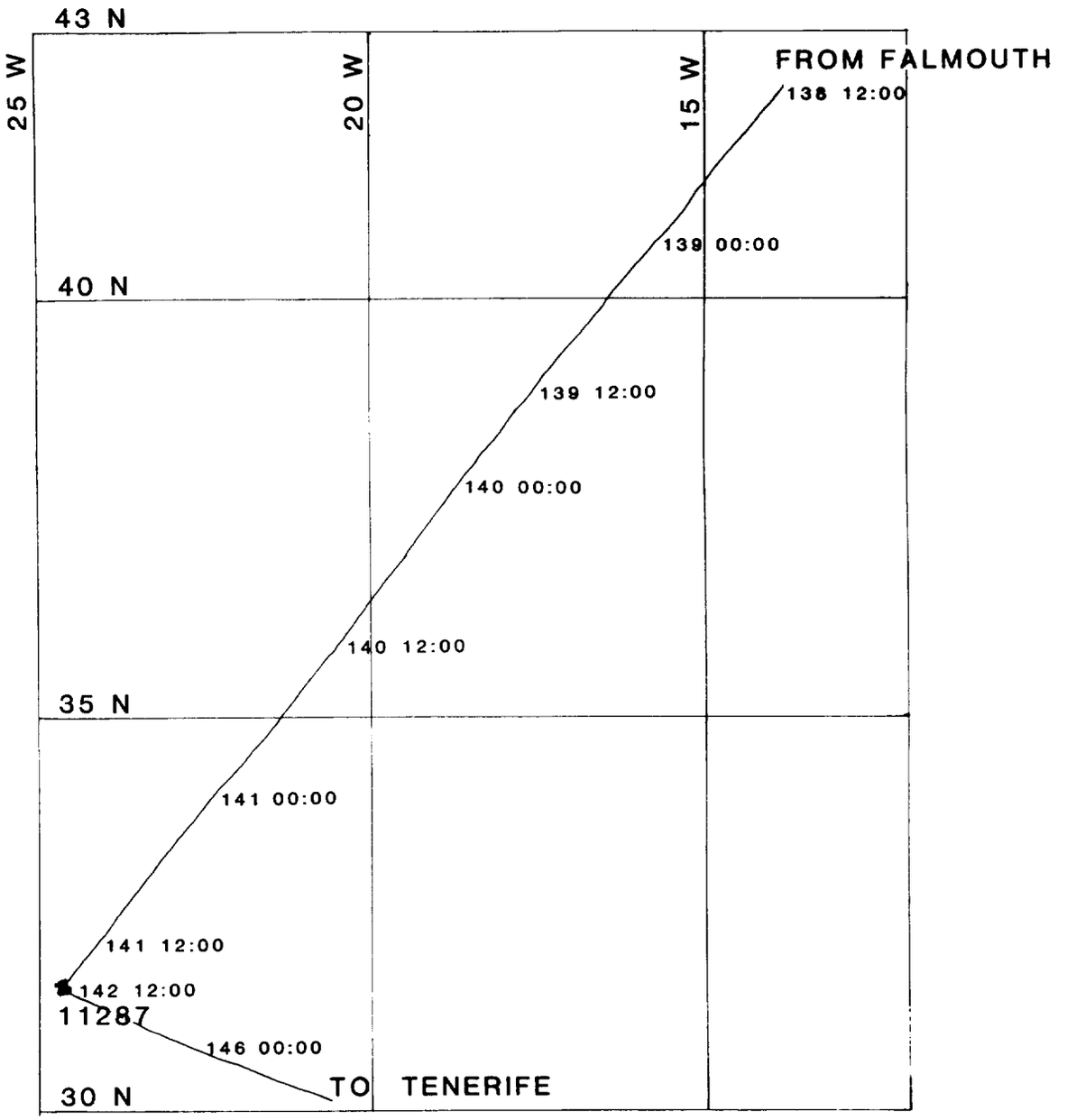

DEPLOYED (5440m)
20.11.85
RECOVERED
21.5.86
REDEPLOYED
25.5.86

FIGURE 3

SCIENTIFIC PERSONNEL - Leg 2

| | | |
|---|---|---|
| R.G. Aldred | IOS | Biology |
| S.M. Boswell | Cambridge | Earth Sciences |
| P.A. Domanski | IOS | Biology |
| C.R. German | Cambridge | Earth Sciences |
| T.J.G. Gwilliam | IOS | Applied Physics |
| P.J. Herring | IOS | Biology |
| N.J. Hooker | IOS | Applied Physics |
| A.G. Howard | Southampton | Chemistry |
| D.J. Hydes | IOS | Geochemistry |
| A.E. Isley | Rhode Island | Oceanography |
| D.A. Jones | RVS | Computing |
| R.W. Jordan | Surrey | Microbiology |
| P.P. Newton | East Anglia | Environmental Sciences |
| J.W. Patching | University College, Galway | Microbiology |
| R.M. Sherrell | MIT | Earth, Atmospheric & Planetary Sciences |
| W.R. Simpson | IOS | Principal Scientist |
| A.R. Staszkiewicz | IOS | Engineering |
| R.F. Wallace | IOS | Engineering |
| D. White | IOS | Applied Physics |
| L.H. Wright | IOS | Engineering |

**FIGURE 1**




CRUISE 159 LEG 1 GREAT METEOR EAST

ITINERARY

| | | |
|---|---|---|
| Leg 1 | Falmouth to Tenerife | 15 May to 27 May 1986 |
| Leg 2 | Tenerife to Tenerife | 29 May to 25 June 1986 |

OBJECTIVES

1. To return to Great Meteor East (GME) on the Madeira Abyssal Plain to carry out follow-up studies of biogeochemical fluxes over the proposed radioactive waste disposal site.
2. To recover, service and redeploy sediment trap and transmissometer moorings at GME and make comparisons of pumped particle data with trap samples (mass fluxes, metals and organics).
3. To complete a transect of stations along 26°N taking particle and water samples for chemical analysis to estimate fluxes.
4. To locate and sample plumes produced by hydrothermal venting from the TAG field on the mid-Atlantic ridge. The programme was to include studies on water and particle chemistry, microbiology and general biology (nekton).

NARRATIVE

Discovery set sail from Falmouth on May 15th for the twelve-day leg to the Canary Islands. The only bad weather during the cruise was encountered in Biscay on the second day out. A short shakedown station to test equipment was run at 38°N 18°W in readiness for commissioned work over the Madeira Abyssal Plain. The work at GME involved the re-occupation of a station in the vicinity of the proposed radioactive disposal site as part of the Department of Environment investigations.

In the early afternoon of May 21st, the search commenced for the transmissometer tide-gauge mooring and sediment trap mooring laid from Darwin (Cruise 9A) on 21 November 1985; both were successfully recovered within five hours. Although there were some problems with the closing mechanisms on the traps, the samples were unaffected. The data collected by the transmissometer appeared to be good but full evaluation was to be carried out at a later date at

TABLE 2 - SAMPLE LOG - (c) Filter samples

| STATION | DEPTH | VOL. | TYPE | LAB. |
|---|---|---|---|---|
| 11287 | 118 | 753 | N | U |
| | 118 | 818 | G & M | B & C |
| | 250 | 1706 | G & M | B & C |
| | 750 | 1741 | G & M | B & C |
| | 750 | 1708 | G | B |
| | 2300 | 1252 | N | U |
| | 2300 | 1284 | N | E |
| | 2300 | 1225 | N | U |
| | 4365 | 1324 | G & M | B & C |
| | 5265 | 1123 | G & M | B & C |
| | 5350 | 1237 | G & M | B & C |
| | 5360 | 1263 | G & M | B & C |
| | 4523 | 1292 | N | U |
| | 5364 | 1198 | N | U |
| | 5441 | 1335 | N | U |
| | 5449 | 1270 | N | U |
| 11288 | BLANK | - | N | U |
| | BLANK | - | N | U |
| | 140 | 272 | N | I |
| | 750 | 1253 | N | E & I |
| | + 1000 | 1161 | N | I |
| | + 100 | 1637 | (N) | - |
| | + 15 | 1565 | N | I |
| | + 4 | 1719 | N | I |
| 11290 | 1000 | 361 | N | M |
| | + 10 | 1400 | N | U & E |
| | BLANK | - | N | M |
| | 20 | 370 | N | U & E |
| | 50 | 827 | N | U & E |
| | 150 | 965 | N | U & E |
| | 1000 | 1230 | N | U & E |
| 11293 | BLANK | - | N | U |
| | 3390 | 83 | N | U |
| | 3290 | 240 | N | M |
| 11294 | 3290 | 428 | N | M |
| | 3346 | 1450 | N | C |
| | 3346 | 1115 | N | E |

samples on this station were taken for subsequent Pu and Am analysis by the IAEA at Monaco, filling in the sampling missed at GME. The biologists who joined in Tenerife trawled the RMT 1 + 8 nets to 230 m and from 650 to 415 m and, on passage to Station 11290, from 485 to 800 m. Filters were also taken on this and other stations for particle mobility studies (UEA).

On Station 11290, some problems were encountered with equipment. There were power supply problems to both filter and particle cell pumps on FIDO and the net monitor failed. However, the MIT pump (nicknamed FIFI) was tried successfully for the first time, it being clamped on the wire 50 m above the CTD-rosette. After a second FIFI cast, FIDO was run to 1000 m after correction of the power supply problems. Four filter samples were taken.

The nets were trawled to 1300 m (Station 11291) on the way to the TAG area on the ridge. Contact was made with Atlantis II that was finishing work with Alvin on the vent field. Peter Rona, Principal Scientist on Atlantis II, told us of very strong venting activity and they kindly laid a transponder on the hydrothermal mound to aid our navigation to the vents. However, we were unable to activate the transponder because we could not transmit on the frequency required.

A preliminary N/S bathymetric survey was run along the median valley. The plan was to lay three transponders to form an approximate equilateral triangle with the base running N/S down the valley axis with the vents to the left of centre of this base and the third at the top of the triangle, west of the vent field. The first transponder to the north of TAG failed to work, the second to the south operated successfully but was later found to be partially hidden behind a small, formerly uncharted, hummock (see Bathymetry, Figure 6) and the third to the west was laid close to the valley axis. Thus we were left with two working transponders, one of which was partially obscured. The precise position of the transponders was determined by satellite fixes over the duration of our stay over the median valley.

The first cast with FIDO located the plume, there being a strong particle signal obtained in the transmissometer read-out with maximum attenuation at 3340 m. Samples were taken in the plume. FIFI was placed 100 m above FIDO on this cast. The CTD-rosette was run after returning to the adjudged correct position. During this passage the neuston net was fished.

Holding position over the vent was found to be problematic on this and all subsequent stations. The wind (15-20 kts) came steadily from the E/SE with strong surface currents. The ship's drift during casts is exemplified by the

TABLE 2 - SAMPLE LOG - (a) Surface Sea Water "Pole" Sampling

| SAMPLE NUMBER | DATE | TIME | LATITUDE N | LONGITUDE W | 250 ml | 1000 ml |
|---|---|---|---|---|---|---|
| 1 | 30.5.86 | 21.20 | 26°11.8' | 23°19.9' | 1 | - |
| 2 | 1.6.86 | 12.00 | 26°08.7' | 24°48.5' | 2 | - |
| 3 | 1.6.86 | 18.30 | 26°10.8' | 26°10.8' | 2 | - |
| 4 | 2.6.86 | 01.50 | 26°14.7' | 26°54.5' | 2 | - |
| 5 | 2.6.86 | 08.50 | 26°09.5' | 28°19.8' | 2 | - |
| 6 | 2.6.86 | 15.15 | 26°09.8' | 29°41.7' | 2 | - |
| 7 | 4.6.86 | 00.20 | 26°10.7' | 30°27.4' | 2 | - |
| 8 | 4.6.86 | 04.30 | 26°10.9' | 31°16.3' | 2 | 1 |
| 9 | 4.6.86 | 07.20 | 26°09.7' | 31°52.0' | 2 | 1 |
| 10 | 4.6.86 | 10.40 | 26°09.1' | 32°33.7' | 2 | - |
| 11 | 4.6.86 | 14.10 | 26°08.2' | 33°19.4' | 2 | - |
| 12 | 4.6.86 | 16.50 | 26°08.1' | 33°52.8' | 2 | - |
| 13 | 4.6.86 | 20.20 | 26°08.3' | 34°37.9' | 2 | 1 |
| 14 | 4.6.86 | 22.50 | 26°08.5' | 34°59.8' | 2 | - |
| 15 | 5.6.86 | 01.45 | 26°08.5' | 35°37.0' | 2 | - |
| 16 | 5.6.86 | 04.20 | 26°08.5' | 36°05.9' | - | - |
| 17 | 5.6.86 | 16.00 | 26°11.3' | 38°27.8' | 2 | 1 |
| 18 | 5.6.86 | 18.40 | 26°15.1' | 38°25.4' | 2 | - |
| 19 | 6.6.86 | 01.20 | 26°15.8' | 39°50.3' | 2 | - |
| 20 | 6.6.86 | 07.30 | 26°12.8' | 41°09.9' | 2 | - |
| 21 | 6.6.86 | 13.25 | 26°11.2' | 42°26.7' | 2 | - |
| 22 | 6.6.86 | 19.40 | 26°09.5' | 43°50.7' | 2 | - |
| 23 | 7.6.86 | 01.10 | 26°07.3' | 44°50.5' | 2 | 1 |
| 24 | 16.6.86 | 10.20 | 26°00.7' | 46°29.1' | 2 | - |
| 25 | 16.6.86 | 14.10 | 26°01.2' | 46°32.3' | 3 | - |
| 26 | 16.6.86 | 10.50 | 26°16.0' | 45°30.1' | 2 | - |
| 27 | 18.6.86 | 20.40 | 26°16.0' | 44°51.2' | 2 | - |
| 28 | 19.6.86 | 23.50 | 26°37.3' | 42°06.4' | 2 | - |
| 29 | 20.6.86 | 21.25 | 26°09.7' | 37°44.6' | 2 | - |
| 30 | 20.6.86 | 21.30 | 26°09.7' | 37°44.6' | 2 | - |
| 31 | 21.6.86 | 00.10 | 26°09.6' | 37°14.4' | 2 | - |
| 32 | 21.6.86 | 00.15 | 26°09.6' | 37°14.4' | 2 | - |
| 33 | 21.6.86 | 02.55 | 26°09.8' | 36°44.4' | 2 | - |
| 34 | 21.6.86 | 06.10 | 26°10.0' | 36°06.9' | 2 | - |
| 35 | 21.6.86 | 06.15 | 26°10.0' | 36°06.9' | 2 | - |
| 36 | 21.6.86 | 08.50 | 26°10.2' | 35°36.8' | 2 | - |

and transmissometer) north of TAG, a strong particle plume suggested the presence of a second vent field.

Before leaving TAG to take up a station west of the ridge, the nets were trawled open to 2000 m and a CTD-transmissometer-FIFI cast run to 3333 m.

The station west of the ridge was worked at 26°01'N, 46°36'W at the end of a minor transform fault; the idea was to compare this water column with that of TAG and to investigate the possibility of material transport along the fault from the valley. Water samples were taken throughout the water column and two FIFI samples obtained at 2000 m.

By the end of Station 11310 the net monitors were repaired. However, while it was necessary to use the davit for launching and recovery there was insufficient height for the full monitor-RMT 8 + 1 arrangement, therefore the RMT1 net was removed. The RMT8 caught many interesting specimens. Also the DODO filtration unit was ready and, on return to the TAG area, a cast with the instrument showed the possible existence of a third vent field at 26°09.40'N, 44°50.21'W (Station 11311). This cast, and two further casts on Station 11312, were run to 3400-3500 m and alternated with rosette sampling. The aft crane was repaired which allowed the first and last long deep trawl along the median valley over TAG. The nets were opened at 2930 m and closed at 3460 m. From this trawl, estimated to be 200 m above the vents, was obtained a specimen of R. chacei found previously in samples collected on the vents by the submersible Alvin.

Station 11314 was worked east of the ridge (26°35'N, 42°02'W°) (four hydrocasts and three filter samples) after which the heading was set for Tenerife. A stop was made for DODO casts on the re-occupation of Station 11290 to fill in gaps in the filter sampling. A short near-surface trawl was made at 26°46'N, 26°40'W (Station 11316).

The ship produced one more eventful afternoon when the cam sleeves on the third engine seized during run-up. We docked in Santa Cruz at 1500 on June 15th.

The cruise was not without incident but, despite mishaps, was scientifically successful and was both productive and enjoyable for everyone involved. It was a particular pleasure to have a large proportion of willing and enthusiastic Ph.D. students on board.

All the scientific party are deeply indebted to the officers and crew of Discovery for all their efforts, especially for skilled navigation over TAG and the help freely given when Murphy's Law came into operation. Particular thanks

| Day | Time | Series | SAT. Lat (N) | Long (W) | Gear | Cast | P.E.S. | O/B-I/B | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | **STATION 11313** | | | | | | |
| | 1340 | 1 | (26.00.37) | | 44.50.79) | RMT 1+8 | | Outboard | Crane fixed. Not fully operational. |
| | 1648 | | | | | 2930 | | Open | Fished across Tag at 200m off bottom. |
| | 1848 | | | | | 3460 | | Closed | |
| | 2106 | | (26.16.85 | 44.51.40) | | | | Inboard | Proceeding to 26°35'N 42°W. |
| | | | **STATION 11314** - EAST OF RIDGE | | | | | | |
| 170 | 1106 | 1 | | | CTDR | 3605 | | Outboard | |
| | 1201 | | 26.35.07 | 41.59.95 | | | | At depth | |
| | 1328 | | | | | | | Inboard | |
| | 1340 | 2 | | | DODO+ | 2000 | | Outboard | Loop of warp wound around |
| | | | 26.35.67 | 42.01.07 | FIFI | | | Filter on | FIFI |
| | | | | | | | | Filter off | |
| | 1706 | | | | | | | Inboard | |
| | 1727 | 3 | | | CTDR | 500 | | Outboard | |
| | 1737 | | 26.36.07 | 42.02.49 | | | | At depth | |
| | 1808 | | | | | | | Inboard | |
| | 1834 | 4 | | | R+ | 3300 | | Outboard | |
| | 2118 | | 26.36.35 | 42.03.03 | FIFI | | | Inboard | |
| | 2226 | 5 | (26.37.0 | 42.05.8) | CTDR | 2000 | | Outboard | |
| | 2300 | | | | | | | At depth | |
| | 2352 | | | | | | | Inboard | |

(c) Mooring 402 - Long-term Transmissometer Mooring

This mooring was laid on Cruise 9a/85 from RRS Charles Darwin, Day 322. It was recovered on this cruise on Day 141 for data tape replacement, battery pack renewal and transmissometer change. The mooring was redeployed on Day 145.

| | |
|---|---|
| Time in water | 09-11-30 GMT |
| Water depth | 5370 metres |
| Position | 31°-33.6°N, 24°-43.4°W |

The transmissometer which was recovered from this mooring was then incorporated into the FIDO system for the remainder of the cruise.

(d) Sediment Trap Mooring

This was recovered on Day 141 from GME. Samples were obtained from all four traps on the string. There were some problems with trap closure but these were resolved before relaying the mooring on Day 145. Time on bottom, 1255 GMT.

T.J.G. Gwilliam D. White

APPLIED PHYSICS - LEG 2

(a) FIFI

A prototype pump for in-situ filtration of suspended particulate material (dubbed FIFI) was given its first thorough sea trials on this cruise. The pump is a battery-powered, self-contained unit designed to be attached to a hydrowire at any point along its length, and to "weathervane" in ambient relative current so that the sampling port is always "upstream" of metal contamination from the wire and instrument. An HP-41CX computer and CMT-200 interface control the pre-set pumping interval and record flow rate versus time data. Performance was very good; in fifteen deployments, a single broken filter and two minor pressure-case leaks were the only problems.

R.M. Sherrell

| Day | Time | Series | SAT. Lat (N) | Long (W) | Gear | Cast | P.E.S. | O/B-I/B | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | **STATION 11310** | | | | | | |
| | 1124 | 1 | 26.01.09 | 46.30.60 | CTDR | 1000 | | Outboard | |
| | 1147 | | | | | | | At depth | |
| | 1230 | | | | | | | Inboard | |
| | 1308 | 2 | | | FIFI | 2000 | | Outboard | Pump alone |
| | 1618 | | | | | | | Inboard | |
| | 1706 | 3 | 26.01.07 | 46.34.38 | R | 3596 | | Outboard | Rosette alone. Wire out depths. |
| | 2026 | | | | | | | Inboard | |
| | 2112 | 4 | 26.00.71 | 46.36.16 | FIFI | 2000 | | Outboard | |
| | 2325 | | 26.00.73 | 46.37.11 | | | | Inboard | |
| | 2342 | 5 | (26.00.72 | 46.37.57) | R | 3600 | | Outboard | Wire out depths. |
| 168 | 0216 | | | | | | | Inboard | |
| | 0240 | 6 | | | RMT8 | 800 | | Outboard | Monitor fixed. RMT1 removed |
| | 0340 | | (26.01.47 | 46.35.63) | | | | Open | to allow davit lift. |
| | 0500 | | (26.02.06 | 46.31.51) | | | | Closed | |
| | 0533 | | | | | | | Inboard | Proceeding to TAG |

Although this meant a reduction in the amount of filtration, it did result in the majority of the work being completed. All FIDO data was recorded on audio-magnetic tape and Digidata. However, problems with the shipboard computer system did not allow full use of the plotting routines and the logging of data was also suspect.

| | |
|---|---|
| Station 11288#1 | 750 metres - cast time 2 hours 40 minutes |
| Station 11288#3 | 5043 metres - cast time 9 hours 15 minutes |
| Station 11290#1 | 5496 metres - cast time 8 hours 30 minutes |
| Station 11290#6 | 1000 metres - cast time 4 hours 46 minutes |
| Station 11293#1 | 3624 metres - cast time 4 hours |
| Station 11294#1 | 3700 metres - cast time 5 hours 30 minutes |
| Station 11296#2 | 3600 metres - cast time 5 hours 30 minutes |
| Station 11298#1 | 3370 metres - cast time 5 hours 15 minutes |
| Station 11299#2 | 3370 metres - cast time 5 hours |
| Station 11301#2 | 3273 metres - cast time 3 hours |
| Station 11304#1 | 3657 metres - cast time 18 hours 45 minutes |

The mini-pumping system (DODO) was deployed five times at various depths using the electric winch. Total volume pumped was 2649 litres.

| | |
|---|---|
| Station 11311#1 | Volume pumped - 202 litres |
| Station 11312#1 | Volume pumped - 556 litres |
| Station 11313#1 | Volume pumped - 726 litres |
| Station 11314#2 | Volume pumped - 653 litres |
| Station 11314#4 | Volume pumped - 512 litres |

(d) CTD and Rosette

| | |
|---|---|
| Station 11288#6 | Day 152 |
| Station 11290#2 | Day 153 |
| Station 11290#4 | Day 154 |
| Station 11292#1 | Day 158 |
| Station 11293#2 | Day 160 |
| Station 11296#6 | Day 161 |
| Station 11301#1 | Day 163 |

| Day | Time | Series | SAT. Lat (N) Long (W) | Gear | Cast | P.E.S. | O/B-I/B | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | **STATION 11304** | | | | | |
| | 2230 | 1 | (26.07.79 44.48.40) | FIDO | 3340 | 3670 | Outboard | Particle cell down. First cast attempt aborted. |
| | 2342 | | 26.08.23 44.49.47 | FIFI | 3290 | | At depth | |
| | | | 26.07.85 44.50.28 | | | | Filters on | 3 good filters and 1Mn scavenger. |
| 164 | | | | | | | Filters off | 2 fixes during filtration. |
| | 0230 | | | | 3153 | | Breakdown | Main pump on midships winch broke down. Gear recovered using forward crane to haul Position in median valley maintained by steaming astern N to S, S to N. NEUSTON Net 2235 to 2325. |
| | 1530 | | 26.03.91 44.52.86 | | | | Inboard | |
| | | | **STATION 11305** | | | | | |
| 165 | 1430 | 1 | (26.05.95 44.56.09) | RMT 1+8 | 0-2000 | | Outboard | Aft crane starter motor u/s and net monitors. Nets launched on capstan/davit, and fished open. 4 fixes. |
| | 1830 | | (26.07.60 44.47.76) | (Open) | wire out | | Inboard | |
| | | | **STATION 11306** | | | | | |
| | 1928 | 1 | (26.08.25 44.49.43) | CTDR+T | 500 | | Outboard | Casts subsequently run on 6.4mm cable (electric winch). CTD + Oxygen and transmissometer used. |
| | 1940 | | | | | | At depth | |
| | 2031 | | 26.08.2 44.49.4 | | | | Inboard | |

The subsequent repair of the crane provided a last chance to attempt a deep trawl over the TAG area with the complete net system. The net was fished for a two-hour period to a maximum depth of 3460 m (11313#1), using the calculated horizontal range of the net from the ship and the dead reckoning ship positions to "aim" the net at the vent area. The catches were very small but that of the RMT8 included four specimens of an unusual shrimp (perhaps an alpheid) that had not been encountered previously.

It is clear from the experience of this tow that it will remain very difficult in any future programme to achieve accurately-located, near-bottom tows in the area without additional navigational aids, allowing precise real-time positioning of the net itself relative to the bottom topography. When fully deployed (7274 m.w.o.) the net was at a horizontal range of approximately 6.5 km from the ship with no information about its lateral position relative to the ship's path. The bottom transponders could not be utilised as the net monitor pulses produced multiple triggering. This uncertainty about the position of the net, combined with the near-bottom currents and the small target area of the vents, renders such tows both hazardous and uncertain as to whether they achieve their objective.

Net catches in general were of low biomass, typical of other central gyre regions (e.g. GME). Unusual organisms included a giant leptocephalus larva, a stomiatoid fish with an unusually elongate barbel, and two specimens of the squid Selenoteuthis. Observations were made on the luminescence of several species of copepod and some material was collected for trace metal analysis.

R.A. Aldred P.A. Domanski P.J. Herring

COMPUTING - Leg 1

Logging of navigational data into the shipboard computing system commenced on May 18th (138: 11.06 Z). Breakdown of the CTD Level A was repaired and connected into the computing system on May 17th.

During the cruise two faults occurred, one being a memory board in the Level C computer failing; this was soon rectified by replacing it with a spare board. The other problem encountered was the electrostatic top on the flatbed plotter became detached around the edges and could only be repaired effectively be removing the static top completely and fixing it down with double-sided tape.

Difficulty was experienced in the logging of FIDO data due to the quantity

| Day | Time | Series | SAT. Lat (N) Long(W) | Gear | Cast | P.E.S. | O/B-I/B | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | **STATION 11296** | | | | | |
| | 0901 | 1 | 26.07.64 44.48.60 | CTDR | 25m a.b. | 3650 | Outboard | Bad conductivity data. |
| | 1005 | | 26.07.81 44.49.12 | | | | At depth | 2 fixes. |
| | 1116 | | | | | | In board | |
| | 1152 | 2 | (26.07.82 44.48.32) | FIDO | 3340 | 3680 | Outboard | One of the two Nuc. ripped. GFC O.K. |
| | 1315 | | 26.08.06 44.48.76 | FIFI | 3290 | | At depth | 2 fixes. |
| | 1317 | | | | | | Filters on | |
| | 1620 | | 26.09.01 44.49.44 | | | | Filters off | |
| | 1718 | | (26.09.09 44.50.87) | | | | Inboard | |
| | | | **STATION 11297** | | | | | |
| | 1948 | 1 | 26.10.78 44.51.04 | Net | 500 | | | Did not open. |
| | 2054 | | | | | | | |
| | | | **STATION 11298** | | | | | |
| | 2244 | | 26.07.39 44.49.11 | | | | | Check on conductivity cell. O.K. |
| 162 | 00.02 | | 26.07.03 44.47.22 | | | | Outboard | Passed too far north |
| | 0518 | 1 | (26.06.78 44.48.33) | FIDO | 20m a.b. | 3350 | Outboard | therefore restarted at 0518. |
| | 0728 | | 26.07.16 44.48.57 | FIFI | 70m a.b. | | Filter on | Two out of three filters |
| | 0818 | | 26.07.00 44.49.37 | | | | Filter off | ripped. One good and in the plume. |
| | 1005 | | 26.07.49 44.49.35 | | | | Inboard | |

real progress was made. However, if the computer was working hard, the gaps seemed to become more numerous. This meant that no software development or editing could be done during a FIDO station. This hampered the debugging of another major program in the FIDO processing suite to the extent that it was never completed. The processing of the FIDO data will be finalised at RVS.

As a safety precaution, ASCII tapes were made of the raw FIDO data.

For each CTD station, the pressure temperature and salinity data were listed at bottle sample times for calibration purposes.

Modifications to existing software include:

1. Altering ctdplot s.th. It plots one variable at a time, cutting out the pen changes which normally occur every eighth of an inch of plot.
2. Altering grid s.th. It will draw one-second tick marks - necessary when the work area is only a few minutes of latitude and longitude wide.
3. Altering trackplot s.th. It will annotate only the start and end of a line when using a small plotting scale.
4. Increasing the buffer sizes of subroutines which send to and receive data from the Cambridge ring.

D. Jones

ENGINEERING

Several engineering problems were encountered on this cruise. The forward ring-main pump failed on one station. Fortunately, the wire was all inboard. There was complete loss of pressure on the pump, due to a leak from high to low pressure. Also, the head of the split pin was found in the drain line. It was decided to remove the pump. This was done in about one-and-a-half days with the help of the chief engineer and ship's electrician and IOS technicians. The new pump was fitted and tested successfully.

After sailing from Tenerife, the pump ran for about sixty hours then failed due to an internal fault. There were 3500 m of wire out with FIDO and FIFI on the wire. There was not time to fully investigate the fault on the pump so it was decided to connect the forward crane hydraulics to the midships winch for recovery. The wire was hauled back at 0.5 m/sec and FIDO and FIFI were brought back with comparative ease. The pump was investigated and found to be very noisy and to have a high drain-flow thus needing replacement in Tenerife.

The aft crane starter motor failed at the beginning of a net station.

| Day | Time | Series | SAT. Lat (N) | Long (W) | Gear | Cast | P.E.S. | O/B-I/B | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | 1606 | 5 | | | W.B.<br>FIFI | | | | Test dip of water bottle<br>7 - u/s. FIFI O.K. |
| | 1650 | 6 | (26.10.7 | 29.59.3) | FIDO | 1000 | | Outboard | Good filters. All Nuc. |
| | 1708 | | | | | | | At depth | |
| | 2136 | | 26.10.3 | 29.58.4 | | | | Inboard | |
| | 2140 | | **STATION END** | | | | | | Heading to TAG. |
| | | | **STATION 11291** | | | | | | |
| 156 | 1508 | 1 | | | RMT 1+8 | | | Outboard | |
| | 1525 | | 26.10.2 | 38.28.5 | | 180 | | Open | |
| | 1800 | | (26.14.2 | 38.29.9) | | 1300 | | Closed | |
| | 1855 | | | | | | | Inboard | |
| | | | **TAG** | | | | | | |
| | | | **STATION 11292** | | | | | | Unable to receive signal from NOAA transponder. |
| 158 | 0201 | | (26.09.4 | 44.49.3) | CTDR | 20m a.b. | 3715 | Outboard | 3 fixes. Hf/Zr samples. |
| | 0308 | | (26.09.6 | 44.49.1) | | | | At depth | |
| | 0428 | | 26.10.6 | 44.50.1 | | | | Inboard | Transponders deployed. From first, no response. |
| | | | **STATION 11293** | | | | | | All sampling carried out during drift. |
| | 2130 | 1 | (26.07.50 | 44.48.96) | FIDO | 3340 | 3670 | Outboard | In plume at 3340dp (3544m w.o.) No floor indication. |

(a) CTD measurements

All rosette casts, up until the terminal failure of the midships winch, were accompanied by CTD measurements of the water-column structure. Whilst this was generally highly successful and permitted accurate selection of the water sampling positions, several aspects of shipboard utilisation of the system became evident; in particular, problems with the new Plessey computer system.

(b) Aluminium determinations

During Discovery Cruise 149 (May 1984) a single station was occupied over the Mid-Atlantic Ridge (MAR) at 43°N. Below 2500 m depth the water at that station was in an enclosed valley. In the valley, elevated concentrations of aluminium were observed. These corresponded to elevated concentrations of manganese which were probably of hydrothermal origin.

The stations occupied during Cruise 159 have enabled us to study the possible input of dissolved aluminium to ocean waters resulting from reactions between seawater and hot rock at the MAR, at a site of known hydrothermal venting.

A total of 242 samples was processed for the determination of dissolved aluminium, from stations on and off the Ridge. At the TAG site, aluminium concentrations are enhanced at depths below 3000 m by some 15 and 30 per cent with respect to off-ridge crest stations to the west and east respectively.

(c) Nutrient determinations

Dissolved silicon, phosphate and nitrate were determined on some 250 samples by continuous-flow analysis using the IOS ChemLab analyser system. During the cruise a data collection and reduction system based on an Acorn-BBC micro-computer was set up.

D.J. Hydes

(d) Oxygen

Water samples from the CTD-rosette casts were analysed for D.O. using the Winkler Method. The minimum was generally noted at 900 m. Surface waters tended to be depleted relative to deeper waters and more variability was noted in samples shallower than 900 m.

S. Boswell

| Day | Time | Series | SAT. Lat. (N) | Long (W) | Gear | Cast | P.E.S. | O/B-I/B | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 149 | 1100 | | **LEG 2 CRUISE 159** | | | | | | Sailed from Tenerife (29th May 1986) On passage to 26°12'N 23°20'W Transect station. |
| | | | **STATION 11288** | | | | | | |
| 150 | 2110 | 1 | 26.11.8 | 23.19.9 | FIDO | 750 | | Outboard | Nuc filters (2 only). |
| | 2138 | | | | | and | | At depth | Problem with filter motor. |
| | 2345 | | 26.11.5 | 23.19.6 | | 140 | | Inboard | Samples for IAEA, Monaco. |
| 151 | 0115 | 2 | 26.10.9 | 23.20.0 | CTDR | 750 | | Outboard | CTD dipped to wash and check |
| | 0146 | | | | | | | At depth | timing before cast. |
| | 0220 | | | | | | | Inboard | |
| | 0807 | 3 | | | RMT 1+8 | 230 | | Outboard | On first trawl net failed to |
| | 0824 | | 26.24.7 | 23.18.1 | | To | | Open | open. |
| | 0848 | | | | | 240 | | Closed | |
| | 0910 | | 26.14.2 | 23.19.7 | | | | Inboard | |
| | 1138 | 4 | 26.12.0 | 23.20.8 | FIDO | 4m a.b. | 4975 | Outboard | 4 Nuc. 100m a.b. filter |
| | 1320 | | 26.12.1 | 23.20.9 | | | | At depth | ripped. 1, 10 and 1000m for |
| | 2100 | | 26.14.5 | 23.20.9 | | | | Inboard | IAEA, Monaco. |
| | 2120 | 5 | | | RMT 1+8 | 650 | | Outboard | |
| | 2146 | | (26.17.3 | 23.18.8) | | To | | Opened | |
| | 2346 | | 26.20.5 | 23.16.2. | | 415 | | Closed | |
| 152 | 0008 | | | | | | | Inboard | |

(f) Pb and Pb-210 in Eastern North Atlantic surface water

Surface water samples were collected throughout the cruise using the "pole sampling" technique. This method avoids metal contamination from the vessel hull by sampling in bottles on the end of a non-metallic pole while the ship is steaming at 2 knots. Sampling interval was about every degree of longitude, but was twice as dense in the Beta Triangle region. Samples will be analysed by E. Boyle (MIT) for Pb and by M. Bacon (WHOI) for Pb-210 as part of an investigation of the concentration and spatial variability of Pb in the surface ocean. The expected ban in use of Pb additives in Europe in fuels will lead to decreased atmospheric Pb input to this study area over the next decade. Measurements from this cruise will make possible the quantification of the response rate of the surface ocean to this decreased input. The overall objective is to understand the cycling dynamics for the removal of this fairly reactive trace metal to the deep ocean.

The accompanying table provides a summary of the samples.

R.M. Sherrell

(g) Zirconium and Hafnium

Two types of sampling were used for Zr/Hf, water and cartridges. The water samples (11 x 2.5 litres) were taken using the CTD and Rosette across a plume, which had been located using transmissometer data. These samples were filtered using 0.4 μm Nuclepore filters. These are for IDMS work.

The cartridge samples are $MnO_2$ coated polypropylene filters which were put downflow of FIDO filter stacks through which the water passed. The $MnO_2$ scavenged dissolved trace metals from the water. The large volumes sampled will, it is hoped, give sufficient sample size for Hf isotope ratio measurements.

S.M. Boswell

| Day | Time | Series | SAT. Lat (N) | Long (W) | Gear | Cast | P.E.S. | O/B-I/B | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | **STATION 11287 GREAT METEOR EAST** | | | | | | |
| | 2210 | 1 | 31.33.1 | 24.35.1 | FIDO | 750 | | Outboard | 22.20 cell on, 2232 at depth. |
| 142 | 0326 | | 31.33.9 | 24.36.6 | | | | Inboard | G.F.C. filters (x3), Nuc, 3Mn Scavengers. All Good. Weak particle max. 118 m. |
| | 0420 | 2 | | | CTDR | 750 | | Outboard | 0440 at depth. |
| | 0542 | | | | | | | Inboard | |
| | 0742 | 3 | 31.32.4 | 24.35.2 | FIDO | 2300 | | Outboard | 0821 at depth. 1 G.F.C., |
| | 1327 | | 31.32.1 | 24.34.5 | | | | Inboard | 3 Nuc + 2Mn Scavengers. A Nuc at 2300 ruptured. |
| | 1516 | 4 | 31.32.9 | 24.35.1 | CTDR | 18m a.b. | 5365 | Outboard | 1717 at depth. |
| | 1904 | | 31.33.2 | 24.35.1 | | | | Inboard | |
| | 2050 | 5 | 31.32.9 | 24.35.2 | FIDO | 5m a.b. | 5365 | Outboard | All Nuc. 2100 cell on 2234 at |
| 143 | 0440 | | 31.34.1 | 24.35.7 | | | | Inboard | depth. All good. |
| | 0805 | 6 | 31.33.1 | 24.35.4 | FIDO | 5-10m a.b. | 5365 | Outboard | All Nuc. Pressure transducer |
| | 1520 | | 31.34.5 | 24.34.7 | | | | Inboard | on filter flow sensor flooded 0808 cell on, 0944 at depth. |
| | 1555 | 7 | 31.33.0 | 24.35.1 | CTDR | 4000 | | Outboard | Midwater sampling. 1602 cast |
| | 1834 | | 31.33.0 | 24.35.1 | | | | Inboard | began. 1704 at depth. |

remained above the filter (0.4 μm porosity, 47 mm diameter). About 10 ml of this "soup" was then transferred to sterile culture tubes, each containing 5 ml of Erd-Schreiber medium, and then placed in an illuminated incubator (16 h/8 h light/dark periodicity) set at 20°C. The filters were washed with distilled water, air-dried and stored in Petrislides for later analysis by Scanning Electron Microscopy.

On a few of the deep CTD casts, "soups" were collected and placed in sterile test-tubes and about 0.2 ml of concentrated glutaraldehyde (25%) added to make a 1% solution. The tubes were stored in the fridge at 4°C and will be analysed later by Professor Manton of Leeds University for benthic amoebo-flagellates similar to those found on Cruise 156.

During the RMT net trawls the neuston net was deployed for thirty minutes. Five-millilitre water samples were taken from each catch and added to 5 ml of Erd-Schreiber medium in sterile culture tubes. These were then placed in the illuminated incubator as before (to be analysed as above).

R.W. Jordan

PARTICLE SAMPLING

(a) Inorganic Geochemistry

On Discovery Cruise 159, large volume pumping-filtration systems (FIDO, FIFI and DODO) allowed collection of mg-size samples of suspended particulate matter throughout the water column at several Eastern North Atlantic and Mid-Atlantic Ridge stations. These samples will be analysed at the Graduate School of Oceanography, University of Rhode Island, by instrumental neutron activation (INAA) and scanning electron microscopy-X-ray diffraction/electron microprobe (SEM-XRD/EMP) techniques and by atomic adsorption spectrometry at MIT. Such analyses should provide information on the concentration of a number of elements (specifically, particulate Al, V, Ba, Ca, Si, Fe, Mn, Mg, As, Cu, Cr, Zn, Ti) and a suite of rare earth elements (REEs), as well as the mineralogical composition and degree of weathering of detrital (specifically, clay) materials. This data base will be used to examine the following:

1. The flux of materials through the water column from surface waters, particularly those associated with biogenically-derived particles.
2. The flux of materials through the water column from the sea floor

included House Martin/Delichon urbanica and Swallow/Hirudo rustica. Up to four of the former were seen resting on board at any one time, a favourite place being the PSO's cabin. A single female Blackcap/Sylvia attricapilla and a single Turtle Dove/Strep. turtur were seen on board at the same time. One Swallow was seen as far as 720 miles WNW of the Cape Verde Islands. A solitary Lanner Falcon/Falco biarmicus was seen on the day the ship sailed from Tenerife.

A. Louch

filtered from 2.5 litre General Oceanics GOFLO bottles. (For further details, see R. Jordan's report).

After cooling, filters will be re-analysed for REEs in the UK. Other samples will be re-analysed using ICPMS techniques for many of the same elements listed above. Furthermore, SEM-XRD work will be completed on a series of small-volume filtration samples at IOS. Such work will provide external validation of all data gained in this study and may serve as an opportunity for intercalibration of independent techniques of analysis.

A. Isley R.M. Sherrell W.R. Simpson

(b) Sampling for Zr and Hf

For rare earth elements, a suite of five samples of suspended particulate material from hydrothermal plumes in the TAG area of the Mid-Atlantic Rift Valley were taken. The samples were collected using FIDO and subsequently DODO; details of the samples are given below. The samples taken are to be analysed to investigate the behaviour of the REE in association with Fe and Mn, under potentially varying redox conditions.

C.R. German

(c) Organic Geochemistry

A total of ten samples was collected by filtration of water through pre-cleaned GF/C filters for lipid analysis. During the shakedown two samples were collected from the particle maximum (45 m). Although one filter was torn which reduced the sample collection volume, the remaining filter was intact and had a distinctive green appearance and "algal" odour.

At GME a total of eight FIDO samples was collected from the depths shown below:

5 m above bottom
10 m above bottom
100 m above bottom
1000 m above bottom

re-immersed in unfiltered sea water collected by CTD-rosette at the filtration depth, and the particles resuspended by low power sonication. The mean electrophoretic mobility of each particle sample was determined within twenty-four hours of resuspension using a Rank Mark II micro-electrophoresis apparatus. Particles were also resuspended and oxidised by ultraviolet irradiation for twenty-four hours (1 kw Hg) and the mobilities determined. These experiments were repeated, resuspending both natural and oxidisesd particles in 0.01 M NaCl.

This determination of particle mobilities represents an investigation of particle surfaces from the open and deep ocean, particularly the influence of adsorbed natural organic material. Ultra-violet irradiation is intended to oxidise, and hence remove, organic matter. 0.01 M NaCl serves as a simple "inert" electrolyte, i.e. no Ca/Mg ions which, along with adsorbed organic matter, are important in controlling the mobility of suspended particles in fresh estuarine and coastal surface waters.

P.P. Newton

(f) Sediment traps

On recovery of the sediment traps, the samples bottles were removed and deep frozen for transport to IOS. Only one of the retractors worked correctly and the other three valves were turned manually. However, this did not appear to have any marked effect on sampling efficiency. The traps were redeployed in the order 2, 3, 4, 1 with a honeycombed baffle mounted in the top trap (1). To each sample cup was added 10 ml of HPLC grade chlororoform and 250 ml of filtered sea water. The traps were to be recovered on Cruise 160.

H.R. Jones

SKY CAMERA

The Geography Department of the University of Liverpool provided a fish-eye lens camera for recording cloud cover which, coupled with meteorological data,

re-immersed in unfiltered sea water collected by CTD-rosette at the filtration depth, and the particles resuspended by low power sonication. The mean electrophoretic mobility of each particle sample was determined within twenty-four hours of resuspension using a Rank Mark II micro-electrophoresis apparatus. Particles were also resuspended and oxidised by ultraviolet irradiation for twenty-four hours (1 kw Hg) and the mobilities determined. These experiments were repeated, resuspending both natural and oxidisesd particles in 0.01 M NaCl.

This determination of particle mobilities represents an investigation of particle surfaces from the open and deep ocean, particularly the influence of adsorbed natural organic material. Ultra-violet irradiation is intended to oxidise, and hence remove, organic matter. 0.01 M NaCl serves as a simple "inert" electrolyte, i.e. no Ca/Mg ions which, along with adsorbed organic matter, are important in controlling the mobility of suspended particles in fresh estuarine and coastal surface waters.

P.P. Newton

(f) Sediment traps

On recovery of the sediment traps, the samples bottles were removed and deep frozen for transport to IOS. Only one of the retractors worked correctly and the other three valves were turned manually. However, this did not appear to have any marked effect on sampling efficiency. The traps were redeployed in the order 2, 3, 4, 1 with a honeycombed baffle mounted in the top trap (1). To each sample cup was added 10 ml of HPLC grade chlororoform and 250 ml of filtered sea water. The traps were to be recovered on Cruise 160.

H.R. Jones

SKY CAMERA

The Geography Department of the University of Liverpool provided a fish-eye lens camera for recording cloud cover which, coupled with meteorological data,

filtered from 2.5 litre General Oceanics GOFLO bottles. (For further details, see R. Jordan's report).

After cooling, filters will be re-analysed for REEs in the UK. Other samples will be re-analysed using ICPMS techniques for many of the same elements listed above. Furthermore, SEM-XRD work will be completed on a series of small-volume filtration samples at IOS. Such work will provide external validation of all data gained in this study and may serve as an opportunity for intercalibration of independent techniques of analysis.

A. Isley R.M. Sherrell W.R. Simpson

(b) Sampling for Zr and Hf

For rare earth elements, a suite of five samples of suspended particulate material from hydrothermal plumes in the TAG area of the Mid-Atlantic Rift Valley were taken. The samples were collected using FIDO and subsequently DODO; details of the samples are given below. The samples taken are to be analysed to investigate the behaviour of the REE in association with Fe and Mn, under potentially varying redox conditions.

C.R. German

(c) Organic Geochemistry

A total of ten samples was collected by filtration of water through pre-cleaned GF/C filters for lipid analysis. During the shakedown two samples were collected from the particle maximum (45 m). Although one filter was torn which reduced the sample collection volume, the remaining filter was intact and had a distinctive green appearance and "algal" odour.

At GME a total of eight FIDO samples was collected from the depths shown below:

5 m above bottom
10 m above bottom
100 m above bottom
1000 m above bottom

included House Martin/Delichon urbanica and Swallow/Hirudo rustica. Up to four of the former were seen resting on board at any one time, a favourite place being the PSO's cabin. A single female Blackcap/Sylvia attricapilla and a single Turtle Dove/Strep. turtur were seen on board at the same time. One Swallow was seen as far as 720 miles WNW of the Cape Verde Islands. A solitary Lanner Falcon/Falco biarmicus was seen on the day the ship sailed from Tenerife.

A. Louch

remained above the filter (0.4 μm porosity, 47 mm diameter). About 10 ml of this "soup" was then transferred to sterile culture tubes, each containing 5 ml of Erd-Schreiber medium, and then placed in an illuminated incubator (16 h/8 h light/dark periodicity) set at 20°C. The filters were washed with distilled water, air-dried and stored in Petrislides for later analysis by Scanning Electron Microscopy.

On a few of the deep CTD casts, "soups" were collected and placed in sterile test-tubes and about 0.2 ml of concentrated glutaraldehyde (25%) added to make a 1% solution. The tubes were stored in the fridge at 4°C and will be analysed later by Professor Manton of Leeds University for benthic amoebo-flagellates similar to those found on Cruise 156.

During the RMT net trawls the neuston net was deployed for thirty minutes. Five-millilitre water samples were taken from each catch and added to 5 ml of Erd-Schreiber medium in sterile culture tubes. These were then placed in the illuminated incubator as before (to be analysed as above).

R.W. Jordan

PARTICLE SAMPLING

(a) Inorganic Geochemistry

On Discovery Cruise 159, large volume pumping-filtration systems (FIDO, FIFI and DODO) allowed collection of mg-size samples of suspended particulate matter throughout the water column at several Eastern North Atlantic and Mid-Atlantic Ridge stations. These samples will be analysed at the Graduate School of Oceanography, University of Rhode Island, by instrumental neutron activation (INAA) and scanning electron microscopy-X-ray diffraction/electron microprobe (SEM-XRD/EMP) techniques and by atomic adsorption spectrometry at MIT. Such analyses should provide information on the concentration of a number of elements (specifically, particulate Al, V, Ba, Ca, Si, Fe, Mn, Mg, As, Cu, Cr, Zn, Ti) and a suite of rare earth elements (REEs), as well as the mineralogical composition and degree of weathering of detrital (specifically, clay) materials. This data base will be used to examine the following:

1. The flux of materials through the water column from surface waters, particularly those associated with biogenically-derived particles.
2. The flux of materials through the water column from the sea floor

| Day | Time | Series | SAT. Lat (N) | Long (W) | Gear | Cast | P.E.S. | O/B-I/B | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | **STATION 11287 GREAT METEOR EAST** | | | | | | |
| | 2210 | 1 | 31.33.1 | 24.35.1 | FIDO | 750 | | Outboard | 22.20 cell on, 2232 at depth. |
| 142 | 0326 | | 31.33.9 | 24.36.6 | | | | Inboard | G.F.C. filters (x3), Nuc, 3Mn Scavengers. All Good. Weak particle max. 118 m. |
| | 0420 | 2 | | | CTDR | 750 | | Outboard | 0440 at depth. |
| | 0542 | | | | | | | Inboard | |
| | 0742 | 3 | 31.32.4 | 24.35.2 | FIDO | 2300 | | Outboard | 0821 at depth. 1 G.F.C., |
| | 1327 | | 31.32.1 | 24.34.5 | | | | Inboard | 3 Nuc + 2Mn Scavengers. A Nuc at 2300 ruptured. |
| | 1516 | 4 | 31.32.9 | 24.35.1 | CTDR | 18m a.b. | 5365 | Outboard | 1717 at depth. |
| | 1904 | | 31.33.2 | 24.35.1 | | | | Inboard | |
| | 2050 | 5 | 31.32.9 | 24.35.2 | FIDO | 5m a.b. | 5365 | Outboard | All Nuc. 2100 cell on 2234 at |
| 143 | 0440 | | 31.34.1 | 24 35.7 | | | | Inboard | depth. All good. |
| | 0805 | 6 | 31.33.1 | 24.35.4 | FIDO | 5-10m a.b. | 5365 | Outboard | All Nuc. Pressure transducer |
| | 1520 | | 31.34.5 | 24.34.7 | | | | Inboard | on filter flow sensor flooded 0808 cell on, 0944 at depth. |
| | 1555 | 7 | 31.33.0 | 24.35.1 | CTDR | 4000 | | Outboard | Midwater sampling. 1602 cast |
| | 1834 | | 31.33.0 | 24.35.1 | | | | Inboard | began. 1704 at depth. |

(f) Pb and Pb-210 in Eastern North Atlantic surface water

Surface water samples were collected throughout the cruise using the "pole sampling" technique. This method avoids metal contamination from the vessel hull by sampling in bottles on the end of a non-metallic pole while the ship is steaming at 2 knots. Sampling interval was about every degree of longitude, but was twice as dense in the Beta Triangle region. Samples will be analysed by E. Boyle (MIT) for Pb and by M. Bacon (WHOI) for Pb-210 as part of an investigation of the concentration and spatial variability of Pb in the surface ocean. The expected ban in use of Pb additives in Europe in fuels will lead to decreased atmospheric Pb input to this study area over the next decade. Measurements from this cruise will make possible the quantification of the response rate of the surface ocean to this decreased input. The overall objective is to understand the cycling dynamics for the removal of this fairly reactive trace metal to the deep ocean.

The accompanying table provides a summary of the samples.

R.M. Sherrell

(g) Zirconium and Hafnium

Two types of sampling were used for Zr/Hf, water and cartridges. The water samples (11 x 2.5 litres) were taken using the CTD and Rosette across a plume, which had been located using transmissometer data. These samples were filtered using 0.4 μm Nuclepore filters. These are for IDMS work.

The cartridge samples are $MnO_2$ coated polypropylene filters which were put downflow of FIDO filter stacks through which the water passed. The $MnO_2$ scavenged dissolved trace metals from the water. The large volumes sampled will, it is hoped, give sufficient sample size for Hf isotope ratio measurements.

S.M. Boswell

| Day | Time | Series | SAT. Lat. (N) | Long (W) | Gear | Cast | P.E.S. | O/B-I/B | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 149 | 1100 | | **LEG 2 CRUISE 159** | | | | | | Sailed from Tenerife (29th May 1986) On passage to 26°12'N 23°20'W Transect station. |
| | | | **STATION 11288** | | | | | | |
| 150 | 2110 | 1 | 26.11.8 | 23.19.9 | FIDO | 750 | | Outboard | Nuc filters (2 only). |
| | 2138 | | | | | and | | At depth | Problem with filter motor. |
| | 2345 | | 26.11.5 | 23.19.6 | | 140 | | Inboard | Samples for IAEA, Monaco. |
| 151 | 0115 | 2 | 26.10.9 | 23.20.0 | CTDR | 750 | | Outboard | CTD dipped to wash and check |
| | 0146 | | | | | | | At depth | timing before cast. |
| | 0220 | | | | | | | Inboard | |
| | 0807 | 3 | | | RMT 1+8 | 230 | | Outboard | On first trawl net failed to |
| | 0824 | | 26.24.7 | 23.18.1 | | To | | Open | open. |
| | 0848 | | | | | 240 | | Closed | |
| | 0910 | | 26.14.2 | 23.19.7 | | | | Inboard | |
| | 1138 | 4 | 26.12.0 | 23.20.8 | FIDO | 4m a.b. | 4975 | Outboard | 4 Nuc. 100m a.b. filter |
| | 1320 | | 26.12.1 | 23.20.9 | | | | At depth | ripped. 1, 10 and 1000m for |
| | 2100 | | 26.14.5 | 23.20.9 | | | | Inboard | IAEA, Monaco. |
| | 2120 | 5 | | | RMT 1+8 | 650 | | Outboard | |
| | 2146 | | (26.17.3 | 23.18.8) | | To | | Opened | |
| | 2346 | | 26.20.5 | 23.16.2. | | 415 | | Closed | |
| 152 | 0008 | | | | | | | Inboard | |

(a) CTD measurements

All rosette casts, up until the terminal failure of the midships winch, were accompanied by CTD measurements of the water-column structure. Whilst this was generally highly successful and permitted accurate selection of the water sampling positions, several aspects of shipboard utilisation of the system became evident; in particular, problems with the new Plessey computer system.

(b) Aluminium determinations

During Discovery Cruise 149 (May 1984) a single station was occupied over the Mid-Atlantic Ridge (MAR) at 43°N. Below 2500 m depth the water at that station was in an enclosed valley. In the valley, elevated concentrations of aluminium were observed. These corresponded to elevated concentrations of manganese which were probably of hydrothermal origin.

The stations occupied during Cruise 159 have enabled us to study the possible input of dissolved aluminium to ocean waters resulting from reactions between seawater and hot rock at the MAR, at a site of known hydrothermal venting.

A total of 242 samples was processed for the determination of dissolved aluminium, from stations on and off the Ridge. At the TAG site, aluminium concentrations are enhanced at depths below 3000 m by some 15 and 30 per cent with respect to off-ridge crest stations to the west and east respectively.

(c) Nutrient determinations

Dissolved silicon, phosphate and nitrate were determined on some 250 samples by continuous-flow analysis using the IOS ChemLab analyser system. During the cruise a data collection and reduction system based on an Acorn-BBC micro-computer was set up.

D.J. Hydes

(d) Oxygen

Water samples from the CTD-rosette casts were analysed for D.O. using the Winkler Method. The minimum was generally noted at 900 m. Surface waters tended to be depleted relative to deeper waters and more variability was noted in samples shallower than 900 m.

S. Boswell

| Day | Time | Series | SAT. Lat (N) | Long (W) | Gear | Cast | P.E.S. | O/B-I/B | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | 1606 | 5 | | | W.B.<br>FIFI | | | | Test dip of water bottle<br>7 - u/s. FIFI O.K. |
| | 1650 | 6 | (26.10.7 | 29.59.3) | FIDO | 1000 | | Outboard | Good filters. All Nuc. |
| | 1708 | | | | | | | At depth | |
| | 2136 | | 26.10.3 | 29.58.4 | | | | Inboard | |
| | 2140 | | **STATION END** | | | | | | Heading to TAG. |
| | | | **STATION 11291** | | | | | | |
| 156 | 1508 | 1 | | | RMT 1+8 | | | Outboard | |
| | 1525 | | 26.10.2 | 38.28.5 | | 180 | | Open | |
| | 1800 | | (26.14.2 | 38.29.9) | | 1300 | | Closed | |
| | 1855 | | | | | | | Inboard | |
| | | | **TAG** | | | | | | |
| | | | **STATION 11292** | | | | | | Unable to receive signal from NOAA transponder. |
| 158 | 0201 | | (26.09.4 | 44.49.3) | CTDR | 20m a.b. | 3715 | Outboard | 3 fixes. Hf/Zr samples. |
| | 0308 | | (26.09.6 | 44.49.1) | | | | At depth | |
| | 0428 | | 26.10.6 | 44.50.1 | | | | Inboard | Transponders deployed. From first, no response. |
| | | | **STATION 11293** | | | | | | All sampling carried out during drift. |
| | 2130 | 1 | (26.07.50 | 44.48.96) | FIDO | 3340 | 3670 | Outboard | In plume at 3340dp (3544m w.o.) No floor indication. |

real progress was made. However, if the computer was working hard, the gaps seemed to become more numerous. This meant that no software development or editing could be done during a FIDO station. This hampered the debugging of another major program in the FIDO processing suite to the extent that it was never completed. The processing of the FIDO data will be finalised at RVS.

As a safety precaution, ASCII tapes were made of the raw FIDO data.

For each CTD station, the pressure temperature and salinity data were listed at bottle sample times for calibration purposes.

Modifications to existing software include:

1. Altering ctdplot s.th. It plots one variable at a time, cutting out the pen changes which normally occur every eighth of an inch of plot.
2. Altering grid s.th. It will draw one-second tick marks - necessary when the work area is only a few minutes of latitude and longitude wide.
3. Altering trackplot s.th. It will annotate only the start and end of a line when using a small plotting scale.
4. Increasing the buffer sizes of subroutines which send to and receive data from the Cambridge ring.

D. Jones

ENGINEERING

Several engineering problems were encountered on this cruise. The forward ring-main pump failed on one station. Fortunately, the wire was all inboard. There was complete loss of pressure on the pump, due to a leak from high to low pressure. Also, the head of the split pin was found in the drain line. It was decided to remove the pump. This was done in about one-and-a-half days with the help of the chief engineer and ship's electrician and IOS technicians. The new pump was fitted and tested successfully.

After sailing from Tenerife, the pump ran for about sixty hours then failed due to an internal fault. There were 3500 m of wire out with FIDO and FIFI on the wire. There was not time to fully investigate the fault on the pump so it was decided to connect the forward crane hydraulics to the midships winch for recovery. The wire was hauled back at 0.5 m/sec and FIDO and FIFI were brought back with comparative ease. The pump was investigated and found to be very noisy and to have a high drain-flow thus needing replacement in Tenerife.

The aft crane starter motor failed at the beginning of a net station.

| Day | Time | Series | SAT. Lat (N) Long(W) | Gear | Cast | P.E.S. | O/B-I/B | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | **STATION 11296** | | | | | |
| | 0901 | 1 | 26.07.64 44.48.60 | CTDR | 25m a.b. | 3650 | Outboard | Bad conductivity data. |
| | 1005 | | 26.07.81 44.49.12 | | | | At depth | 2 fixes. |
| | 1116 | | | | | | In board | |
| | 1152 | 2 | (26.07.82 44.48.32) | FIDO | 3340 | 3680 | Outboard | One of the two Nuc. ripped. GFC O.K. |
| | 1315 | | 26.08.06 44.48.76 | FIFI | 3290 | | At depth | 2 fixes. |
| | 1317 | | | | | | Filters on | |
| | 1620 | | 26.09.01 44.49.44 | | | | Filters off | |
| | 1718 | | (26.09.09 44.50.87) | | | | Inboard | |
| | | | **STATION 11297** | | | | | |
| | 1948 | 1 | 26.10.78 44.51.04 | Net | 500 | | | Did not open. |
| | 2054 | | | | | | | |
| | | | **STATION 11298** | | | | | |
| | 2244 | | 26.07.39 44.49.11 | | | | | Check on conductivity cell. O.K. |
| 162 | 00.02 | | 26.07.03 44.47.22 | | | | Outboard | Passed too far north |
| | 0518 | 1 | (26.06.78 44.48.33) | FIDO | 20m a.b. | 3350 | Outboard | therefore restarted at 0518. |
| | 0728 | | 26.07.16 44.48.57 | FIFI | 70m a.b. | | Filter on | Two out of three filters |
| | 0818 | | 26.07.00 44.49.37 | | | | Filter off | ripped. One good and in the plume. |
| | 1005 | | 26.07.49 44.49.35 | | | | Inboard | |

The subsequent repair of the crane provided a last chance to attempt a deep trawl over the TAG area with the complete net system. The net was fished for a two-hour period to a maximum depth of 3460 m (11313#1), using the calculated horizontal range of the net from the ship and the dead reckoning ship positions to "aim" the net at the vent area. The catches were very small but that of the RMT8 included four specimens of an unusual shrimp (perhaps an alpheid) that had not been encountered previously.

It is clear from the experience of this tow that it will remain very difficult in any future programme to achieve accurately-located, near-bottom tows in the area without additional navigational aids, allowing precise real-time positioning of the net itself relative to the bottom topography. When fully deployed (7274 m.w.o.) the net was at a horizontal range of approximately 6.5 km from the ship with no information about its lateral position relative to the ship's path. The bottom transponders could not be utilised as the net monitor pulses produced multiple triggering. This uncertainty about the position of the net, combined with the near-bottom currents and the small target area of the vents, renders such tows both hazardous and uncertain as to whether they achieve their objective.

Net catches in general were of low biomass, typical of other central gyre regions (e.g. GME). Unusual organisms included a giant leptocephalus larva, a stomiatoid fish with an unusually elongate barbel, and two specimens of the squid Selenoteuthis. Observations were made on the luminescence of several species of copepod and some material was collected for trace metal analysis.

R.A. Aldred P.A. Domanski P.J. Herring

COMPUTING - Leg 1

Logging of navigational data into the shipboard computing system commenced on May 18th (138: 11.06 Z). Breakdown of the CTD Level A was repaired and connected into the computing system on May 17th.

During the cruise two faults occurred, one being a memory board in the Level C computer failing; this was soon rectified by replacing it with a spare board. The other problem encountered was the electrostatic top on the flatbed plotter became detached around the edges and could only be repaired effectively be removing the static top completely and fixing it down with double-sided tape.

Difficulty was experienced in the logging of FIDO data due to the quantity

| Day | Time | Series | SAT. Lat (N) Long (W) | Gear | Cast | P.E.S. | O/B-I/B | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | **STATION 11304** | | | | | |
| | 2230 | 1 | (26.07.79 44.48.40) | FIDO | 3340 | 3670 | Outboard | Particle cell down. First cast attempt aborted. |
| | 2342 | | 26.08.23 44.49.47 | FIFI | 3290 | | At depth | |
| | | | 26.07.85 44.50.28 | | | | Filters on | 3 good filters and 1Mn scavenger. |
| 164 | | | | | | | Filters off | 2 fixes during filtration. |
| | 0230 | | | | 3153 | | Breakdown | Main pump on midships winch broke down. Gear recovered using forward crane to haul Position in median valley maintained by steaming astern N to S, S to N. NEUSTON Net 2235 to 2325. |
| | 1530 | | 26.03.91 44.52.86 | | | | Inboard | |
| | | | **STATION 11305** | | | | | |
| 165 | 1430 | 1 | (26.05.95 44.56.09) | RMT 1+8 | 0-2000 | | Outboard | Aft crane starter motor u/s and net monitors. Nets launched on capstan/davit, and fished open. 4 fixes. |
| | 1830 | | (26.07.60 44.47.76) | (Open) | wire out | | Inboard | |
| | | | **STATION 11306** | | | | | |
| | 1928 | 1 | (26.08.25 44.49.43) | CTDR+T | 500 | | Outboard | Casts subsequently run on 6.4mm cable (electric winch). CTD + Oxygen and transmissometer used. |
| | 1940 | | | | | | At depth | |
| | 2031 | | 26.08.2 44.49.4 | | | | Inboard | |

Although this meant a reduction in the amount of filtration, it did result in the majority of the work being completed. All FIDO data was recorded on audio-magnetic tape and Digidata. However, problems with the shipboard computer system did not allow full use of the plotting routines and the logging of data was also suspect.

| | |
|---|---|
| Station 11288#1 | 750 metres - cast time 2 hours 40 minutes |
| Station 11288#3 | 5043 metres - cast time 9 hours 15 minutes |
| Station 11290#1 | 5496 metres - cast time 8 hours 30 minutes |
| Station 11290#6 | 1000 metres - cast time 4 hours 46 minutes |
| Station 11293#1 | 3624 metres - cast time 4 hours |
| Station 11294#1 | 3700 metres - cast time 5 hours 30 minutes |
| Station 11296#2 | 3600 metres - cast time 5 hours 30 minutes |
| Station 11298#1 | 3370 metres - cast time 5 hours 15 minutes |
| Station 11299#2 | 3370 metres - cast time 5 hours |
| Station 11301#2 | 3273 metres - cast time 3 hours |
| Station 11304#1 | 3657 metres - cast time 18 hours 45 minutes |

The mini-pumping system (DODO) was deployed five times at various depths using the electric winch. Total volume pumped was 2649 litres.

| | |
|---|---|
| Station 11311#1 | Volume pumped - 202 litres |
| Station 11312#1 | Volume pumped - 556 litres |
| Station 11313#1 | Volume pumped - 726 litres |
| Station 11314#2 | Volume pumped - 653 litres |
| Station 11314#4 | Volume pumped - 512 litres |

(d) CTD and Rosette

| | |
|---|---|
| Station 11288#6 | Day 152 |
| Station 11290#2 | Day 153 |
| Station 11290#4 | Day 154 |
| Station 11292#1 | Day 158 |
| Station 11293#2 | Day 160 |
| Station 11296#6 | Day 161 |
| Station 11301#1 | Day 163 |

| Day | Time | Series | SAT. Lat (N) | Long (W) | Gear | Cast | P.E.S. | O/B-I/B | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | **STATION 11310** | | | | | | |
| | 1124 | 1 | 26.01.09 | 46.30.60 | CTDR | 1000 | | Outboard | |
| | 1147 | | | | | | | At depth | |
| | 1230 | | | | | | | Inboard | |
| | 1308 | 2 | | | FIFI | 2000 | | Outboard | Pump alone |
| | 1618 | | | | | | | Inboard | |
| | 1706 | 3 | 26.01.07 | 46.34.38 | R | 3596 | | Outboard | Rosette alone. Wire out depths. |
| | 2026 | | | | | | | Inboard | |
| | 2112 | 4 | 26.00.71 | 46.36.16 | FIFI | 2000 | | Outboard | |
| | 2325 | | 26.00.73 | 46.37.11 | | | | Inboard | |
| | 2342 | 5 | (26.00.72 | 46.37.57) | R | 3600 | | Outboard | Wire out depths. |
| 168 | 0216 | | | | | | | Inboard | |
| | 0240 | 6 | | | RMT8 | 800 | | Outboard | Monitor fixed. RMT1 removed |
| | 0340 | | (26.01.47 | 46.35.63) | | | | Open | to allow davit lift. |
| | 0500 | | (26.02.06 | 46.31.51) | | | | Closed | |
| | 0533 | | | | | | | Inboard | Proceeding to TAG |

(c) Mooring 402 - Long-term Transmissometer Mooring

This mooring was laid on Cruise 9a/85 from RRS Charles Darwin, Day 322. It was recovered on this cruise on Day 141 for data tape replacement, battery pack renewal and transmissometer change. The mooring was redeployed on Day 145.

| | |
|---|---|
| Time in water | 09-11-30 GMT |
| Water depth | 5370 metres |
| Position | 31°-33.6°N, 24°-43.4°W |

The transmissometer which was recovered from this mooring was then incorporated into the FIDO system for the remainder of the cruise.

(d) Sediment Trap Mooring

This was recovered on Day 141 from GME. Samples were obtained from all four traps on the string. There were some problems with trap closure but these were resolved before relaying the mooring on Day 145. Time on bottom, 1255 GMT.

T.J.G. Gwilliam D. White

APPLIED PHYSICS - LEG 2

(a) FIFI

A prototype pump for in-situ filtration of suspended particulate material (dubbed FIFI) was given its first thorough sea trials on this cruise. The pump is a battery-powered, self-contained unit designed to be attached to a hydrowire at any point along its length, and to "weathervane" in ambient relative current so that the sampling port is always "upstream" of metal contamination from the wire and instrument. An HP-41CX computer and CMT-200 interface control the pre-set pumping interval and record flow rate versus time data. Performance was very good; in fifteen deployments, a single broken filter and two minor pressure-case leaks were the only problems.

R.M. Sherrell

| Day | Time | Series | SAT. Lat (N) | Long (W) | Gear | Cast | P.E.S. | O/B-I/B | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | **STATION 11313** | | | | | | |
| | 1340 | 1 | (26.00.37) | | 44.50.79) | RMT 1+8 | | Outboard | Crane fixed. Not fully operational. |
| | 1648 | | | | | 2930 | | Open | Fished across Tag at 200m off bottom. |
| | 1848 | | | | | 3460 | | Closed | |
| | 2106 | | (26.16.85 | 44.51.40) | | | | Inboard | Proceeding to 26°35'N 42°W. |
| | | | **STATION 11314** - EAST OF RIDGE | | | | | | |
| 170 | 1106 | 1 | | | CTDR | 3605 | | Outboard | |
| | 1201 | | 26.35.07 | 41.59.95 | | | | At depth | |
| | 1328 | | | | | | | Inboard | |
| | 1340 | 2 | | | DODO+ | 2000 | | Outboard | Loop of warp wound around |
| | | | 26.35.67 | 42.01.07 | FIFI | | | Filter on | FIFI |
| | | | | | | | | Filter off | |
| | 1706 | | | | | | | Inboard | |
| | 1727 | 3 | | | CTDR | 500 | | Outboard | |
| | 1737 | | 26.36.07 | 42.02.49 | | | | At depth | |
| | 1808 | | | | | | | Inboard | |
| | 1834 | 4 | | | R+ | 3300 | | Outboard | |
| | 2118 | | 26.36.35 | 42.03.03 | FIFI | | | Inboard | |
| | 2226 | 5 | (26.37.0 | 42.05.8) | CTDR | 2000 | | Outboard | |
| | 2300 | | | | | | | At depth | |
| | 2352 | | | | | | | Inboard | |

and transmissometer) north of TAG, a strong particle plume suggested the presence of a second vent field.

Before leaving TAG to take up a station west of the ridge, the nets were trawled open to 2000 m and a CTD-transmissometer-FIFI cast run to 3333 m.

The station west of the ridge was worked at 26°01'N, 46°36'W at the end of a minor transform fault; the idea was to compare this water column with that of TAG and to investigate the possibility of material transport along the fault from the valley. Water samples were taken throughout the water column and two FIFI samples obtained at 2000 m.

By the end of Station 11310 the net monitors were repaired. However, while it was necessary to use the davit for launching and recovery there was insufficient height for the full monitor-RMT 8 + 1 arrangement, therefore the RMT1 net was removed. The RMT8 caught many interesting specimens. Also the DODO filtration unit was ready and, on return to the TAG area, a cast with the instrument showed the possible existence of a third vent field at 26°09.40'N, 44°50.21'W (Station 11311). This cast, and two further casts on Station 11312, were run to 3400-3500 m and alternated with rosette sampling. The aft crane was repaired which allowed the first and last long deep trawl along the median valley over TAG. The nets were opened at 2930 m and closed at 3460 m. From this trawl, estimated to be 200 m above the vents, was obtained a specimen of R. chacei found previously in samples collected on the vents by the submersible Alvin.

Station 11314 was worked east of the ridge (26°35'N, 42°02'W°) (four hydrocasts and three filter samples) after which the heading was set for Tenerife. A stop was made for DODO casts on the re-occupation of Station 11290 to fill in gaps in the filter sampling. A short near-surface trawl was made at 26°46'N, 26°40'W (Station 11316).

The ship produced one more eventful afternoon when the cam sleeves on the third engine seized during run-up. We docked in Santa Cruz at 1500 on June 15th.

The cruise was not without incident but, despite mishaps, was scientifically successful and was both productive and enjoyable for everyone involved. It was a particular pleasure to have a large proportion of willing and enthusiastic Ph.D. students on board.

All the scientific party are deeply indebted to the officers and crew of Discovery for all their efforts, especially for skilled navigation over TAG and the help freely given when Murphy's Law came into operation. Particular thanks

TABLE 2 - SAMPLE LOG - (a) Surface Sea Water "Pole" Sampling

| SAMPLE NUMBER | DATE | TIME | LATITUDE N | LONGITUDE W | 250 ml | 1000 ml |
|---|---|---|---|---|---|---|
| 1 | 30.5.86 | 21.20 | 26°11.8' | 23°19.9' | 1 | - |
| 2 | 1.6.86 | 12.00 | 26°08.7' | 24°48.5' | 2 | - |
| 3 | 1.6.86 | 18.30 | 26°10.8' | 26°10.8' | 2 | - |
| 4 | 2.6.86 | 01.50 | 26°14.7' | 26°54.5' | 2 | - |
| 5 | 2.6.86 | 08.50 | 26°09.5' | 28°19.8' | 2 | - |
| 6 | 2.6.86 | 15.15 | 26°09.8' | 29°41.7' | 2 | - |
| 7 | 4.6.86 | 00.20 | 26°10.7' | 30°27.4' | 2 | - |
| 8 | 4.6.86 | 04.30 | 26°10.9' | 31°16.3' | 2 | 1 |
| 9 | 4.6.86 | 07.20 | 26°09.7' | 31°52.0' | 2 | 1 |
| 10 | 4.6.86 | 10.40 | 26°09.1' | 32°33.7' | 2 | - |
| 11 | 4.6.86 | 14.10 | 26°08.2' | 33°19.4' | 2 | - |
| 12 | 4.6.86 | 16.50 | 26°08.1' | 33°52.8' | 2 | - |
| 13 | 4.6.86 | 20.20 | 26°08.3' | 34°37.9' | 2 | 1 |
| 14 | 4.6.86 | 22.50 | 26°08.5' | 34°59.8' | 2 | - |
| 15 | 5.6.86 | 01.45 | 26°08.5' | 35°37.0' | 2 | - |
| 16 | 5.6.86 | 04.20 | 26°08.5' | 36°05.9' | - | - |
| 17 | 5.6.86 | 16.00 | 26°11.3' | 38°27.8' | 2 | 1 |
| 18 | 5.6.86 | 18.40 | 26°15.1' | 38°25.4' | 2 | - |
| 19 | 6.6.86 | 01.20 | 26°15.8' | 39°50.3' | 2 | - |
| 20 | 6.6.86 | 07.30 | 26°12.8' | 41°09.9' | 2 | - |
| 21 | 6.6.86 | 13.25 | 26°11.2' | 42°26.7' | 2 | - |
| 22 | 6.6.86 | 19.40 | 26°09.5' | 43°50.7' | 2 | - |
| 23 | 7.6.86 | 01.10 | 26°07.3' | 44°50.5' | 2 | 1 |
| 24 | 16.6.86 | 10.20 | 26°00.7' | 46°29.1' | 2 | - |
| 25 | 16.6.86 | 14.10 | 26°01.2' | 46°32.3' | 3 | - |
| 26 | 16.6.86 | 10.50 | 26°16.0' | 45°30.1' | 2 | - |
| 27 | 18.6.86 | 20.40 | 26°16.0' | 44°51.2' | 2 | - |
| 28 | 19.6.86 | 23.50 | 26°37.3' | 42°06.4' | 2 | - |
| 29 | 20.6.86 | 21.25 | 26°09.7' | 37°44.6' | 2 | - |
| 30 | 20.6.86 | 21.30 | 26°09.7' | 37°44.6' | 2 | - |
| 31 | 21.6.86 | 00.10 | 26°09.6' | 37°14.4' | 2 | - |
| 32 | 21.6.86 | 00.15 | 26°09.6' | 37°14.4' | 2 | - |
| 33 | 21.6.86 | 02.55 | 26°09.8' | 36°44.4' | 2 | - |
| 34 | 21.6.86 | 06.10 | 26°10.0' | 36°06.9' | 2 | - |
| 35 | 21.6.86 | 06.15 | 26°10.0' | 36°06.9' | 2 | - |
| 36 | 21.6.86 | 08.50 | 26°10.2' | 35°36.8' | 2 | - |

samples on this station were taken for subsequent Pu and Am analysis by the IAEA at Monaco, filling in the sampling missed at GME. The biologists who joined in Tenerife trawled the RMT 1 + 8 nets to 230 m and from 650 to 415 m and, on passage to Station 11290, from 485 to 800 m. Filters were also taken on this and other stations for particle mobility studies (UEA).

On Station 11290, some problems were encountered with equipment. There were power supply problems to both filter and particle cell pumps on FIDO and the net monitor failed. However, the MIT pump (nicknamed FIFI) was tried successfully for the first time, it being clamped on the wire 50 m above the CTD-rosette. After a second FIFI cast, FIDO was run to 1000 m after correction of the power supply problems. Four filter samples were taken.

The nets were trawled to 1300 m (Station 11291) on the way to the TAG area on the ridge. Contact was made with Atlantis II that was finishing work with Alvin on the vent field. Peter Rona, Principal Scientist on Atlantis II, told us of very strong venting activity and they kindly laid a transponder on the hydrothermal mound to aid our navigation to the vents. However, we were unable to activate the transponder because we could not transmit on the frequency required.

A preliminary N/S bathymetric survey was run along the median valley. The plan was to lay three transponders to form an approximate equilateral triangle with the base running N/S down the valley axis with the vents to the left of centre of this base and the third at the top of the triangle, west of the vent field. The first transponder to the north of TAG failed to work, the second to the south operated successfully but was later found to be partially hidden behind a small, formerly uncharted, hummock (see Bathymetry, Figure 6) and the third to the west was laid close to the valley axis. Thus we were left with two working transponders, one of which was partially obscured. The precise position of the transponders was determined by satellite fixes over the duration of our stay over the median valley.

The first cast with FIDO located the plume, there being a strong particle signal obtained in the transmissometer read-out with maximum attenuation at 3340 m. Samples were taken in the plume. FIFI was placed 100 m above FIDO on this cast. The CTD-rosette was run after returning to the adjudged correct position. During this passage the neuston net was fished.

Holding position over the vent was found to be problematic on this and all subsequent stations. The wind (15-20 kts) came steadily from the E/SE with strong surface currents. The ship's drift during casts is exemplified by the

TABLE 2 - SAMPLE LOG - (c) Filter samples

| STATION | DEPTH | VOL. | TYPE | LAB. |
|---|---|---|---|---|
| 11287 | 118 | 753 | N | U |
| | 118 | 818 | G & M | B & C |
| | 250 | 1706 | G & M | B & C |
| | 750 | 1741 | G & M | B & C |
| | 750 | 1708 | G | B |
| | 2300 | 1252 | N | U |
| | 2300 | 1284 | N | E |
| | 2300 | 1225 | N | U |
| | 4365 | 1324 | G & M | B & C |
| | 5265 | 1123 | G & M | B & C |
| | 5350 | 1237 | G & M | B & C |
| | 5360 | 1263 | G & M | B & C |
| | 4523 | 1292 | N | U |
| | 5364 | 1198 | N | U |
| | 5441 | 1335 | N | U |
| | 5449 | 1270 | N | U |
| 11288 | BLANK | - | N | U |
| | BLANK | - | N | U |
| | 140 | 272 | N | I |
| | 750 | 1253 | N | E & I |
| | + 1000 | 1161 | N | I |
| | + 100 | 1637 | (N) | - |
| | + 15 | 1565 | N | I |
| | + 4 | 1719 | N | I |
| 11290 | 1000 | 361 | N | M |
| | + 10 | 1400 | N | U & E |
| | BLANK | - | N | M |
| | 20 | 370 | N | U & E |
| | 50 | 827 | N | U & E |
| | 150 | 965 | N | U & E |
| | 1000 | 1230 | N | U & E |
| 11293 | BLANK | - | N | U |
| | 3390 | 83 | N | U |
| | 3290 | 240 | N | M |
| 11294 | 3290 | 428 | N | M |
| | 3346 | 1450 | N | C |
| | 3346 | 1115 | N | E |

ITINERARY

| | | |
|---|---|---|
| Leg 1 | Falmouth to Tenerife | 15 May to 27 May 1986 |
| Leg 2 | Tenerife to Tenerife | 29 May to 25 June 1986 |

OBJECTIVES

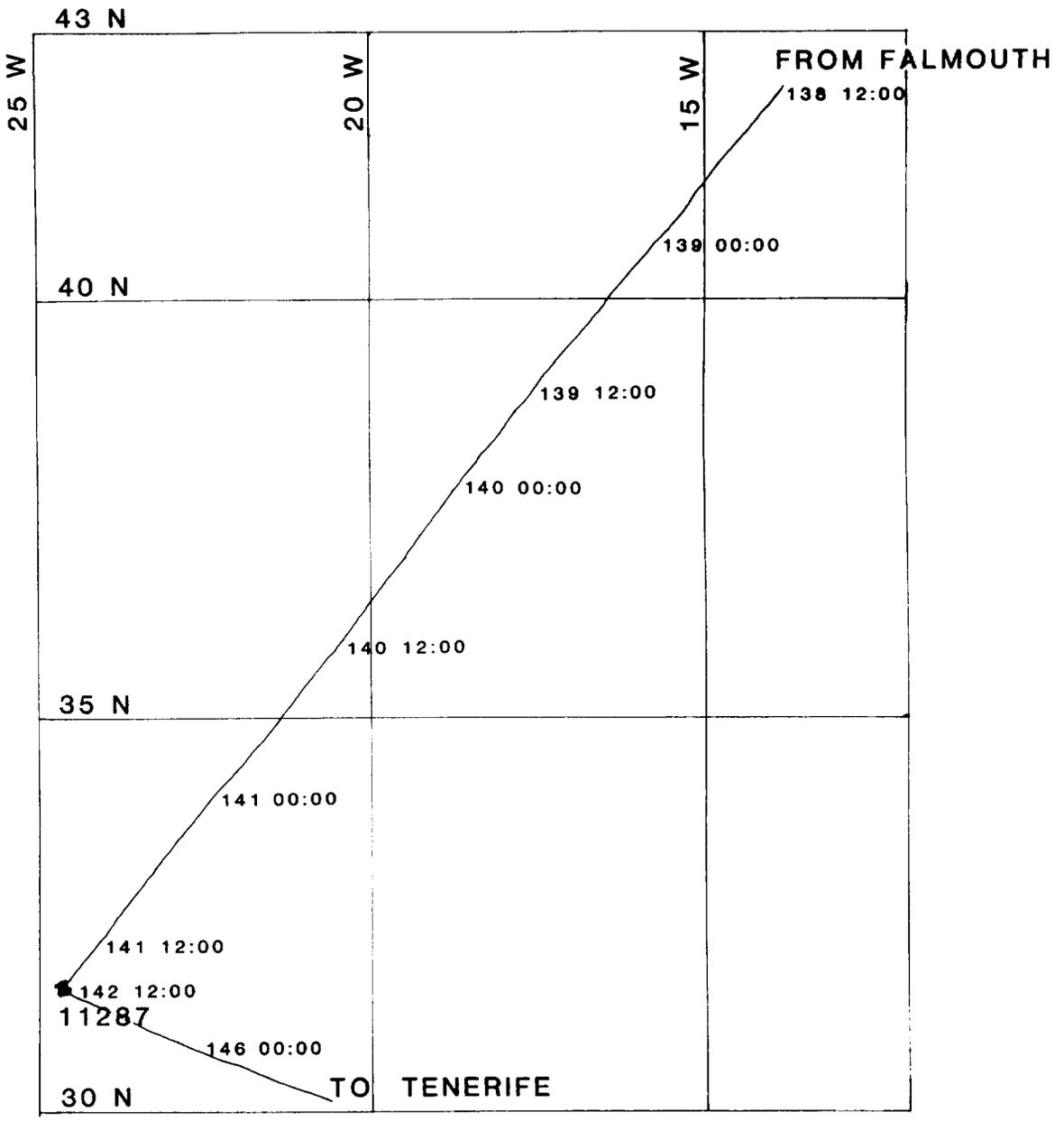
1. To return to Great Meteor East (GME) on the Madeira Abyssal Plain to carry out follow-up studies of biogeochemical fluxes over the proposed radioactive waste disposal site.
2. To recover, service and redeploy sediment trap and transmissometer moorings at GME and make comparisons of pumped particle data with trap samples (mass fluxes, metals and organics).
3. To complete a transect of stations along 26°N taking particle and water samples for chemical analysis to estimate fluxes.
4. To locate and sample plumes produced by hydrothermal venting from the TAG field on the mid-Atlantic ridge. The programme was to include studies on water and particle chemistry, microbiology and general biology (nekton).

NARRATIVE

Discovery set sail from Falmouth on May 15th for the twelve-day leg to the Canary Islands. The only bad weather during the cruise was encountered in Biscay on the second day out. A short shakedown station to test equipment was run at 38°N 18°W in readiness for commissioned work over the Madeira Abyssal Plain. The work at GME involved the re-occupation of a station in the vicinity of the proposed radioactive disposal site as part of the Department of Environment investigations.

In the early afternoon of May 21st, the search commenced for the transmissometer tide-gauge mooring and sediment trap mooring laid from Darwin (Cruise 9A) on 21 November 1985; both were successfully recovered within five hours. Although there were some problems with the closing mechanisms on the traps, the samples were unaffected. The data collected by the transmissometer appeared to be good but full evaluation was to be carried out at a later date at

**FIGURE 1**



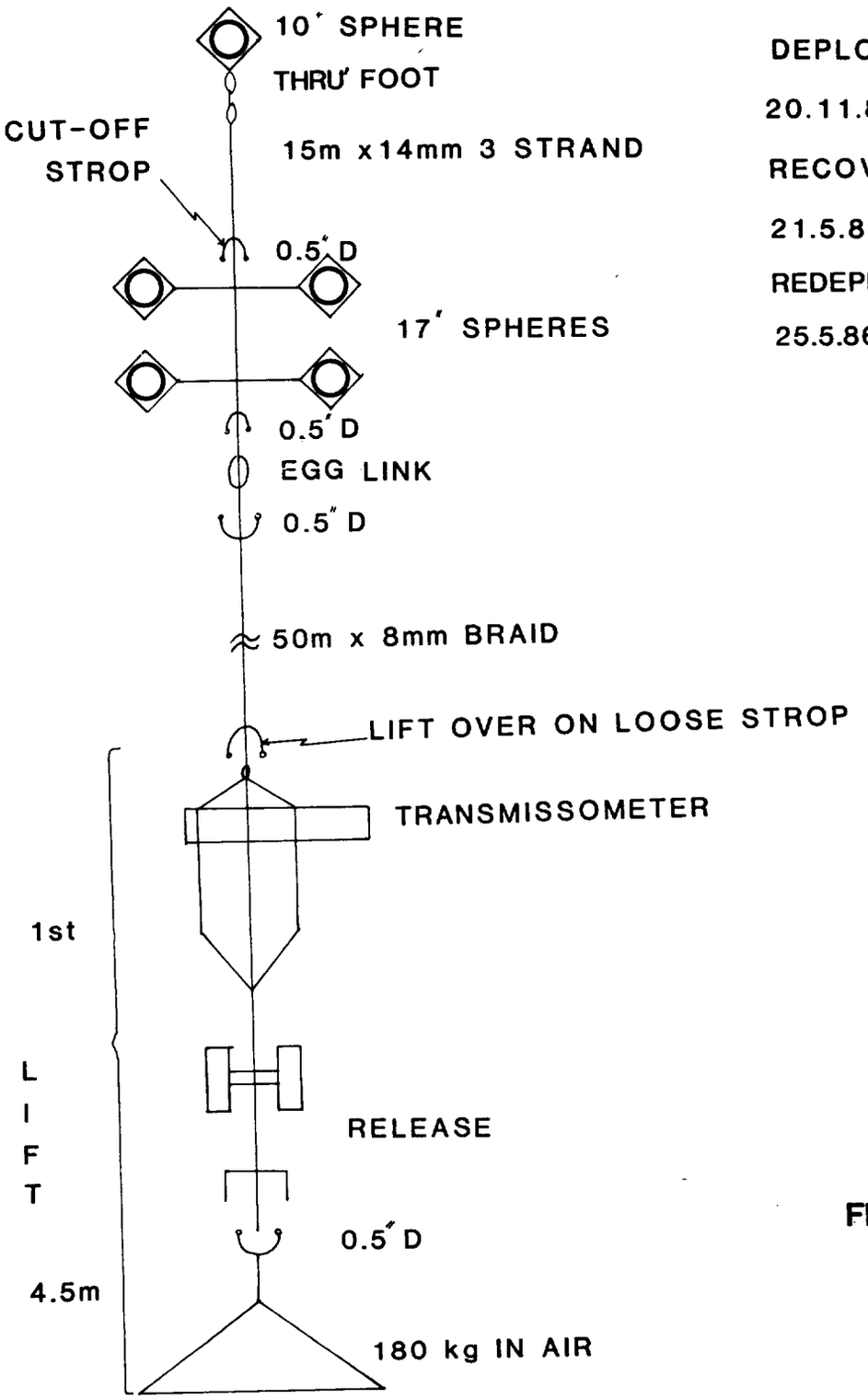

CRUISE 159 LEG 1 GREAT METEOR EAST

SCIENTIFIC PERSONNEL - Leg 2

| | | |
|---|---|---|
| R.G. Aldred | IOS | Biology |
| S.M. Boswell | Cambridge | Earth Sciences |
| P.A. Domanski | IOS | Biology |
| C.R. German | Cambridge | Earth Sciences |
| T.J.G. Gwilliam | IOS | Applied Physics |
| P.J. Herring | IOS | Biology |
| N.J. Hooker | IOS | Applied Physics |
| A.G. Howard | Southampton | Chemistry |
| D.J. Hydes | IOS | Geochemistry |
| A.E. Isley | Rhode Island | Oceanography |
| D.A. Jones | RVS | Computing |
| R.W. Jordan | Surrey | Microbiology |
| P.P. Newton | East Anglia | Environmental Sciences |
| J.W. Patching | University College, Galway | Microbiology |
| R.M. Sherrell | MIT | Earth, Atmospheric & Planetary Sciences |
| W.R. Simpson | IOS | Principal Scientist |
| A.R. Staszkiewicz | IOS | Engineering |
| R.F. Wallace | IOS | Engineering |
| D. White | IOS | Applied Physics |
| L.H. Wright | IOS | Engineering |

MOORING 402 TO RECOVER AND LAY

31° 33.6' N
24° 43.4' W




DEPLOYED (5440m)
20.11.85
RECOVERED
21.5.86
REDEPLOYED
25.5.86

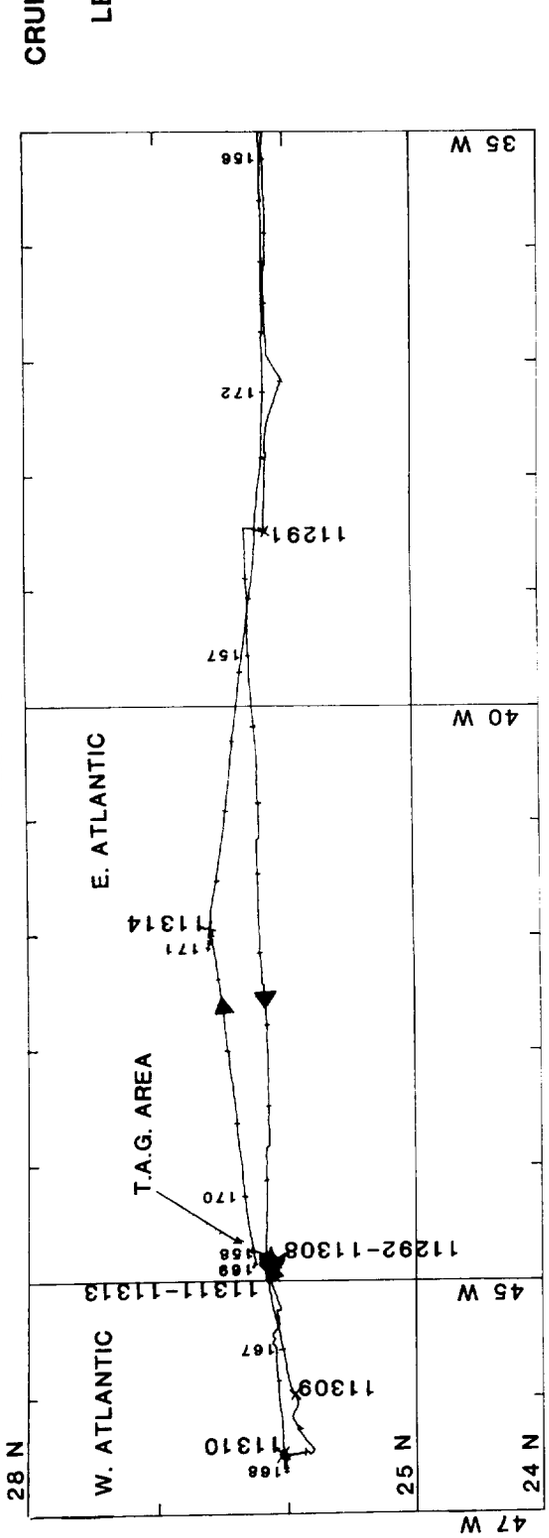
FIGURE 3

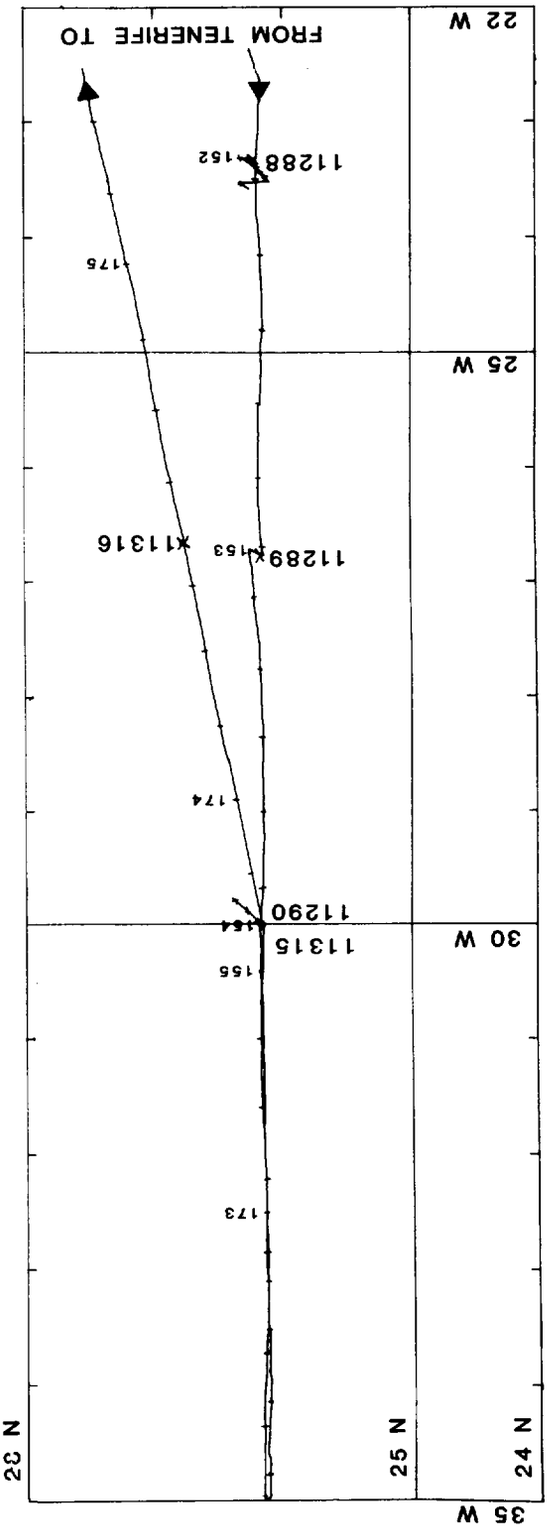
CONTENTS

FIGURE 5

CRUISE 159.

LEG 2



# DOCUMENT DATA SHEET

| | | |
|---|---|---|
| *AUTHOR* | SIMPSON, W.R. *et al* | *PUBLICATION DATE* 1987 |
| *TITLE* | RRS *Discovery* Cruise 159, 15 May - 25 June 1986. Biogeochemical flux studies in the N.E. Atlantic - GME, 26°N transect and TAG hydrothermal field. | |
| *REFERENCE* | Institute of Oceanographic Sciences, Deacon Laboratory, Cruise Report, No. 193, 59pp. | |


*ABSTRACT*

The report describes "Discovery" Cruise 159 conducted in June 1986 in the N.E. Atlantic.

The objectives were:

a) reoccupy a station over the Madeira Abyssal Plain

b) recover and redeploy trap and transmissometer moorings

c) mark a transect for flux studies along 26°N

d) investigate the TAG hydrothermal plumes.

Extensive particulate and dissolved phase chemical sampling, biological and microbiological sampling and studies of particle properties, particle concentration and mass fluxes were carried out.



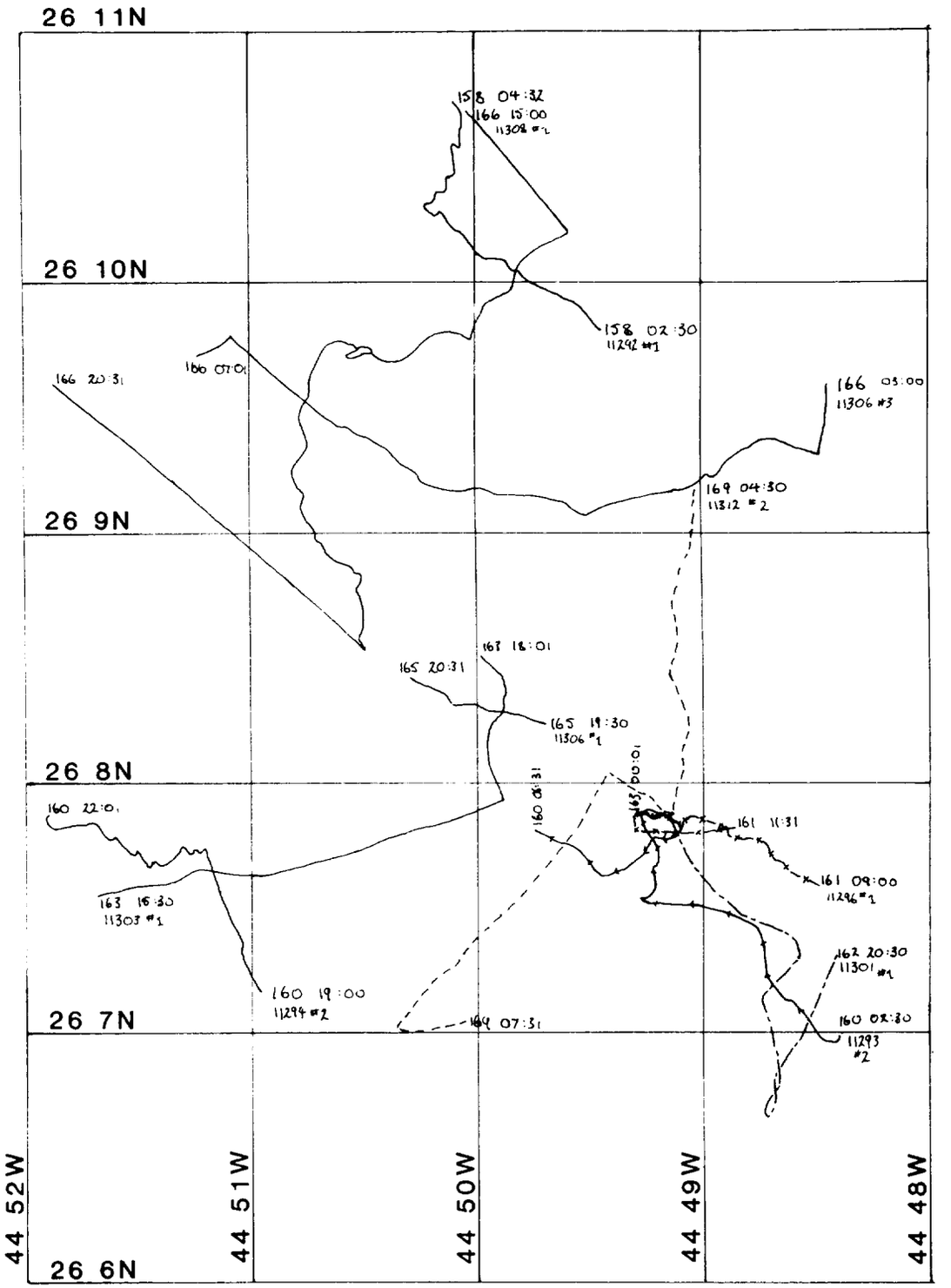
| | | |
|---|---|---|
| *ISSUING ORGANISATION* | Institute of Oceanographic Sciences<br>Deacon Laboratory<br>Wormley, Godalming<br>Surrey GU8 5UB. UK.<br><br>Director: Dr A S Laughton FRS | *TELEPHONE* 0428 79 4141<br>*TELEX* 858833 OCEANS G<br>*TELEFAX* 0428 79 3066 |



| | | |
|---|---|---|
| *KEYWORDS* | *MICROBIOLOGY*<br>*WATER COLUMN*<br>*ATLANTIC OCEAN (NE)*<br>*MADEIRA ABYSSAL PLAIN*<br>*TAG HYDROTHERMAL FIELD* | *CONTRACT*<br>*PROJECT* CO 33<br>*PRICE* £13.00 |
| *BIOGEOCHEMICAL CYCLE*<br>*BIOGEOCHEMICAL FLUXES*<br>*CHEMICAL OCEANOGRAPHY*<br>*MARINE BIOLOGY* | | |

*Copies of this report are available from:*
The Library, Institute of Oceanographic Sciences, Deacon Laboratory.

**FIGURE 7**




C.T.D. TRACKS AROUND T.A.G. AREA

INSTITUTE OF OCEANOGRAPHIC SCIENCES

DEACON LABORATORY

CRUISE REPORT No.193

RRS DISCOVERY

Cruise 159

15 May - 25 June 1986

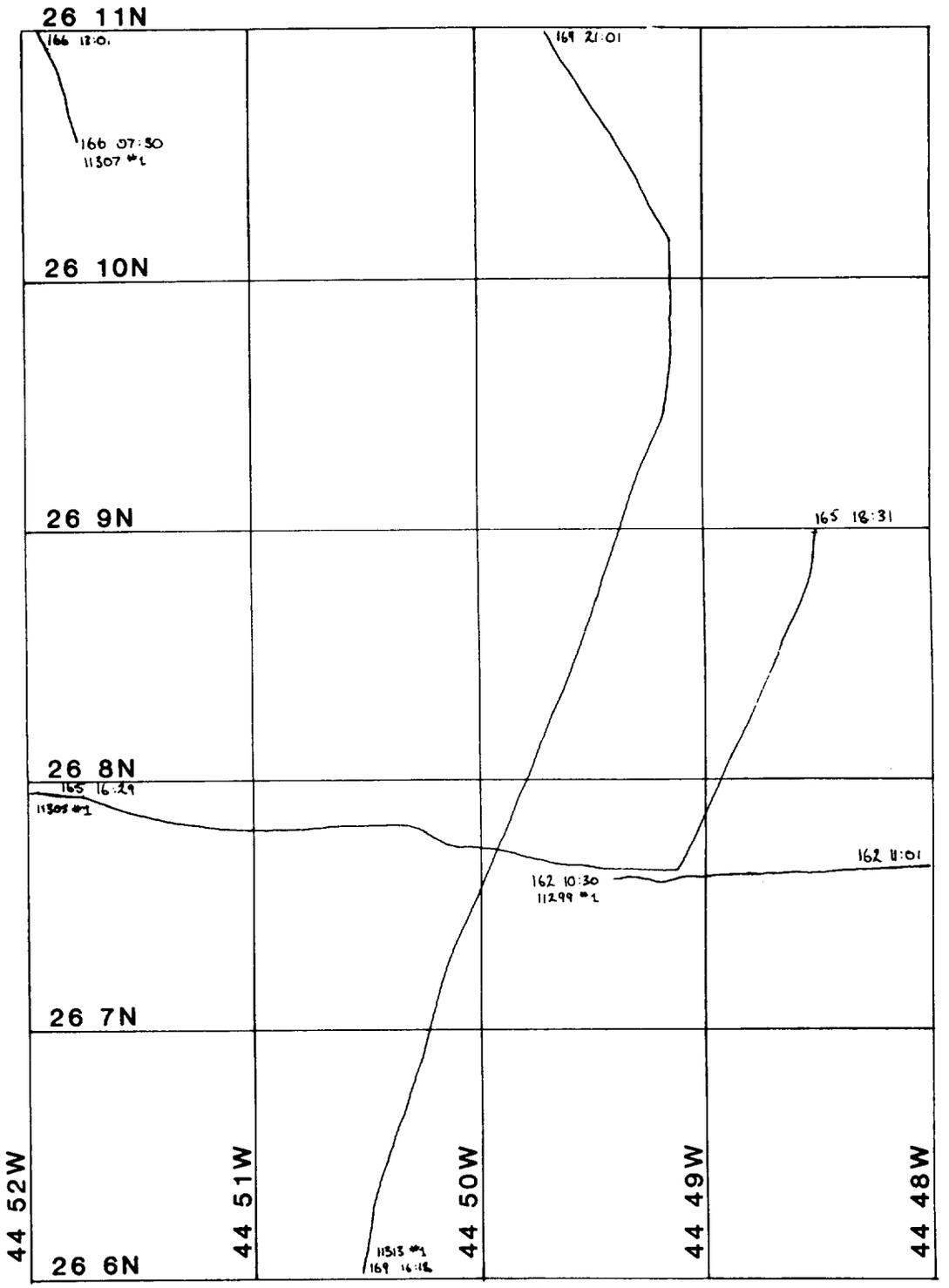
# Biogeochemical flux studies in the N.E. Atlantic - GME 26°N transect and TAG hydrothermal field

Principal Scientist

W.R. Simpson

1987

**FIGURE 9**




NET TRACKS AROUND T.A.G. AREA