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# RRS CHALLENGER

## Cruise 47/89

## 27 February - 12 March 1989

## North Sea Survey

Principal Scientist

P.S. Liss

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## CRUISE OBJECTIVES

1) To make underway measurements of air/sea fluxes, surface-sampled variables (temperature, salinity, transmittance, fluorescence, irradiances) and Acoustic Doppler current profiles, around a set track covering the southern North Sea.

2) To make CTD stations (recording temperature, conductivity for salinity, transmittance, fluorescence, dissolved oxygen, up- and down-welling irradiance as functions of depth) at about 130 sites along the track, also taking water samples for calibration and productivity measurements.

3) To take zooplankton samples at about 90 of the CTD sites.

4) To recover and redeploy current meter moorings at sites A, B, C, D, E and F.

## NARRATIVE

After problems with securing an after deck hatchcover and an exploding lithium battery had been dealt with, RRS Challenger sailed from Great Yarmouth on time at 13.30 GMT on 27 February 1989. Wind speed was 6-8 and the sea pretty 'lumpy'. After dropping the pilot, logging commenced, the Simrad echo sounder pole was deployed, the ADCP switched 'on' and course was made for the first line of CTD sites (AA-AG).

It had been planned to service the current meters at mooring 'E' and to add a fluorimeter to the rig. However, since these current meters have lithium batteries it was decided to postpone recovery of this rig until later in the cruise, when more information on the batteries would be available from RVS.

CTD station work proceeding satisfactorily with samples being taken at three depths (surface, mid-depth and bottom). At the pre-dawn station a double cast was made to cover immediate depths. This highlights the problem caused by shortage of water bottles for the CTD rosette. There were only four on board, three on the rosette and a single spare. Clearly time is wasted in having to do two dips for the pre-dawn station but more importantly there is clearly little back up if anything happens to the bottles on the rosette.

The CTD was manned by the scientists on a 4 hours 'on' and 8 hours 'off' arrangement. This seemed to work fine; it meant that everyone knew when they are on duty without consulting a rota and it allowed sufficient time for other scientific work, sleep, food, etc.

CTD sites AE to AN were completed on 28 February as were sites AO to AW on 1 March. On the latter day a compressed gas cylinder on the winch deck managed to fall away from the bottle rack and landed on the deck rail. No damage was done and the bottles were made more secure by lashing. The following day the ship's engineers made up some cylinder restraining bars for a more permanent solution to the problem.

On 2 March CTD sites AE to BD were successfully completed. At current meter mooring site 'D' an acoustic search lasting about five hours was made for the rig supposed to be at this location. The search was eventually successful but it was by then too dark for the rig to be recovered. However, the position was relayed to the "Bon Entente" which later recovered the rig. A new current meter array was deployed at this site.

On 3 and 4 March CTD sites BE to BN and BO to BZ, respectively, were successfully completed. The weather was good on both days with calm seas.

CTD sites CA to CK were completed on 5 March. Although the weather was calm, progress in steaming between stations was hampered by mist and fog which reduced our maximum speed to about 8 knots. The westerly passage along 55°33'N was commenced in the afternoon.

At mooring site 'A' an attempt was made, on 6 March, to recover two current meter rigs supposed to be there, but without success. However, a new rig was successfully deployed at this site. We then deviated from the 'normal' cruise track in order to go directly to mooring site 'C'. CTD sites CL to CS were successfully worked on this day.

Mooring site 'C' was reached early on the morning of 7 March and the current meter rig there quickly recovered. CTD sites EE, EF, DM, DL, DK, DJ, DI, DH, DG, DF, DE, DD and DC were successfully completed.

Mooring site 'A' was reoccupied on 8 March and a further acoustic search was made for the two rigs supposedly at this position. Although we could 'hear' the rig layed here two days previously, there was no sign of the other two current meter arrays. CTD sites DB, DA, CZ, CY, CX, CW, CV, CU, CT, ED and EC were successfully worked. At CS the link between the CTD and the data logger was not working and so only the zooplankton net was deployed there. The link was reestablished while steaming between CS and the next station. The wind picked up towards evening with a Force 8 southerly gale. Working CTD stations under these conditions was extremely difficult although, in fact, none had to be abandoned.

The gale force winds continued for most of 9 March, moderating somewhat from late afternoon. At mooring site 'C' the current meter rig recovered at this position two days earlier was successfully redeployed. CTD sites EB, EA, DZ, EH, EG, DM, DN, DO and DP were completed.

On 10 March CTD sites DQ, DR, DS, DT, DU, DV, DW, DX, DY, DZ and EI were successfully worked, with sites EJ, EK, DQ, EL, EM, EN, EO, EP, EQ, AB and AA being worked on 11 March. At mooring site 'E' the RVS current rig was recovered without any problems from the lithium batteries. A new rig was layed here having a fluorimeter and one current meter.

We returned to Great Yarmouth on the mid-day tide on 12 March.

## SCIENTIFIC PERSONNEL

| | | |
|---|---|---|
| P.S. Liss | UEA | Principal Scientist |
| J. Atherton | Cambridge | |
| G. Ballard | POL | |
| B. Grantham | SMBA | |
| G. Knight | RVS | |
| H. Malschaert | NIOZ | |
| J. Merrett | LUDO | |
| D. Mills | UCNW | |
| C. Ottley | Essex | |
| D. Phillips | RVS | |
| J. Stevenson | UEA | |
| S. Turner | UEA | |
| J. Wynar | RVS | |

## SHIP'S OFFICERS

| | |
|---|---|
| P. MacDermott | Master |
| G. Harries | C/O |
| S. Sykes | 2/O |
| J. Morse | 2/O |
| D. Rowlands | C/E |
| A. Adams | 2/E |
| R. Perriam | 3/E |
| W. Groody | E/E |
| G. Pook | Bosun |

## ACKNOWLEDGEMENTS

The scientific party extends warm thanks to the Master, P. McDermott, Officers and Crew of RRS Challenger for their help and cooperation during the cruise, and to RVS, Barry, for its support, all willingly given and vital in making the scientific work possible.

## INDIVIDUAL PROJECT REPORTS

### CTD System (D. Phillips)

The CTD worked well throughout the cruise and 135 casts were made. The only problem was yet again an ingress of water into the rosette pylon through the indicator pin. The pressure was released by removing some of the oil and the 'O' ring seals were cleaned; this cured the problem. On recovery of the CTD at one station the frame caught on the hinges of the gate on the ship's side. This caused the whole frame to tilt and a reversing thermometer (S/N 179) was broken. During the cruise the location beacon was tested and failed to work. The lanyards on the GO-FLO bottles continued to deteriorate to the point where one snapped and had to be replaced. The winch readouts in CTD mode still have an intermittent fault.

### Surface Monitoring Systems (D. Phillips)

Both transmissometers (103D, 99D) worked well throughout the cruise and needed not maintenance. This is also true for the fluorimeter and the light meters, and the thermosalinograph. The major problem with the system is the chart recorders in the lab.

### Moorings B, E, F (D. Phillips)

Before leaving Yarmouth an incident with lithium batteries meant that no S4 would be deployed during the cruise. On leaving Yarmouth rig E was spotted and its position marked. No rigs were laid or recovered at B and F. A mooring was laid on 11-7-88 at E, this consisted of the UCNW fluorimeter in the top S4 position and a replacement MM88 9347. After successfully deploying the new rig, the old one was recovered and the S4 meters moved and stored in a safe place. No data was translated and this will have to be done on return of the current meters to RVS.

**Moorings D, A, C (G. Ballard)**

ST D) An acoustic search eventually located POLDOP 1 but as daylight had run out it couldn't be recovered. The position was relayed to the Bon Entente which recovered it later. POLDOP 2 was deployed at this site.

ST A) An acoustic search failed to locate the rig deployed on CH43. POLDOP 4 was deployed. On a second visit to the site a comprehensive acoustic search was carried out. There was no sign of the lost rig but POLDOP 4 was switched 'on' at a distance of 4 cables.

ST C) POLDOP 3 was recovered very quickly at 'C' and was relayed 2 days later on the second visit to the site.

**Air/Sea Fluxes (J. Merrett)**

Aim: To collect high volume and cascade impactor samples for subsequent trace metal and organic analysis at Liverpool University. Also to help with the collection of Essex University's (Chris Ottley) cascade impactor and high volume samples.

Report: Seven sets of high volume filters each of approximately twenty hours duration were collected over the duration of the cruise. This is despite there being many rain events, when the particulate samples cannot be used for fear of losing some trace elements and compounds into solution. One cascade impactor sample of approximately 55 hours was obtained.

Problems: Two of the high volume samples were damp when taken down to be stored for transit. This was due to the high relative humidity of the air whilst sampling, ie. misty conditions. However this could be used as a guide to the extent of removal of trace elements and compounds in comparison with dry samples. New flexible hosing, leading from the filter plates to the pumps is required for one sampler. Therefore, due to the smaller diameter of the new hosing, pipes leading to the pumps may have to be turned down to achieve a good seal. More sturdy plastic clips are needed to hold the flexible hosing in place whilst sampling.

**Isokinetic Sampling for Large Aerosol Particles (C. Ottley)**

Conventional air sampling equipment general underestimates the particulate content in air. The use of isokinetic sampling reduces the potential error caused in the sampling technique.

The equipment operated satisfactorily and a sample of 50 hours duration obtained. During periods when the wind was out of sector/raining the vacuum pump was overhauled by the ship's engineers.

A 4 on 8 off CTD watch was maintained while a 24hr watch was maintained on the atmospheric sampling.

**Wet Precipitation (J. Merrett, C. Ottley)**

Seven wet precipitation samples were collected throughout the cruise (for A. Rendell, UEA). One of these samples was obtained from fog although this later became rain. During the rough weather the collection of uncontaminated samples proved most difficult since sea spray was seen level with the bridge. However a sample was collected when it was not raining, but spray was still apparent on the bridge wing, and perhaps a contribution of trace metals etc. due to the spray could be found from this. The angled collectors were found to be very useful enabling larger quantities of rain water to be collected.

**Trace Gases (Suzanne Turner and Jane Stevenson)**

Surface water samples were taken at over 90 stations and were analysed for trace gases. It was not possible to sample all the stations, as analysis time was longer than the periods between some stations and it is not possible to store samples. The dissolved trace gases were extracted and concentrated using a cryogenic purge and trap technique and analysed using three Gas Chromatographs (2 FPD and 1 ECD).

Concentrations of dimethyl sulphide (DMS) and its precursor Dimethylsulphoniopropionate (DMSP) were determined, including intra- and extracellular DMSP fractions. About 16 halocarbon compounds were detected, including bromoform, methylchloroform, carbon tetrachloride iodomethane, etc. Chlorophyll samples were frozen for laboratory analysis and photoplankton samples were preserved using Lugol's iodine and formalin.

**Suspended Sediments (J. Atherton)**

Objectives

1) To make surface and water column measurements of beam transmittance.

2) To calibrate the transmittance data in terms of suspended material concentrations by filtration of water samples.

Date Acquisition

Transmittance: Continuous surface profiles of transmittance were obtained along the survey track using two deck mounted transmissometers fed by the ship's non-toxic water supply. Breaks in transmission occurred only when the transmissometers were serviced, this being on a daily basis. Vertical profiles of transmittance were obtained at all CTD stations using a CTD mounted transmissometer. Continuous profiling began at the surface and approached to within 3-5 metres of the sea bed.

Calibration Samples: Water samples were taken at 3 depths (eg. surface, mid-depth and bottom) using the rosette sampler at all the CTD stations (1450-1583), except the following 20 stations:

1513 (CH), 1515 (CJ), 1517 (CL), 1519 (CN), 1522 (CP), 1524 (CR), 1525 (CS), 1533 (DJ), 1539 (DD), 1549 (CU), 1550 (CT), 1553 (EB), 1556 (EH), 1558 (2nd DM), 1564 (DS), 1569 (DX), 1571 (2nd DZ), 1574 (EK), 1582 (2nd AB), 1583 (2nd AA).

Each sample was filtered at 0.45 microns, rinsed with distilled water, dried in a laminar flow cabinet and stored in petri dishes. Samples were also taken at intervals from the "PPIMS" deck mounted transmissometer.

Problems

Insufficient filter papers led to 20 CTD stations being missed, with regards to calibration of the transmissometer.

**Nutrient Analysis (B. Grantham)**

Water was taken for nutrient analysis from three depths at each of 125 stations. Analyses on the unfiltered water were carried out in triplicate on a Chemlab Autoanalyser measuring Nitrate, Nitrite, Ammonium, Phosphate and Silicate.

Problems were encountered with leaks in the nitrate manifold and malfunction of the chart recorders and turntable sampler. These were not serious enough to cause much loss of data on this cruise but may be an indicator of more serious problems in the future.

**Zooplankton (H. Malschaert)**

During this survey approximately $1.3 \times 10^3$ $m^3$ of seawater were filtered by taking 90 vertical net hauls in order to quantify and identify the pelagic mesozooplankton.

All stations which were planned to be sampled were done. So 90 stations were sampled out of a total of 127 stations. Not even one station was cancelled due to bad weather or damage. The stations were distributed all over the cruise track. Particular attention was paid to taking samples in areas close to the major river mouths.

The zooplankton samples were collected with two different types of nets. One net was equipped with 300µm mesh and had a mouth area of

0.42 $m^2$. A smaller net (0.19 $m^2$) with 50µm mesh was used to catch the eggs and younger juvenile stages of the zooplankton.

**Biology (D. Mills)**

The biologist was responsible for a range of different measurements, outlined below.

CHLOROPHYLL - Samples were collected from 3 depths (surface, mid and bottom) from all CTD stations for determination of extracted chlorophyll.

PHYTOPLANKTON - Surface samples from alternate CTD stations were collected and preserved for future analysis of species composition.

UNDERWAY SURFACE OXYGEN - Dissolved oxygen was measured using a pulsed $O_2$ electrode system. Samples were collected on a daily basis for calibration of the electrode using Winkler titrations.

MOORED FLUORIMETER - A submersible fluorimeter and battery logger unit were deployed at Mooring A.

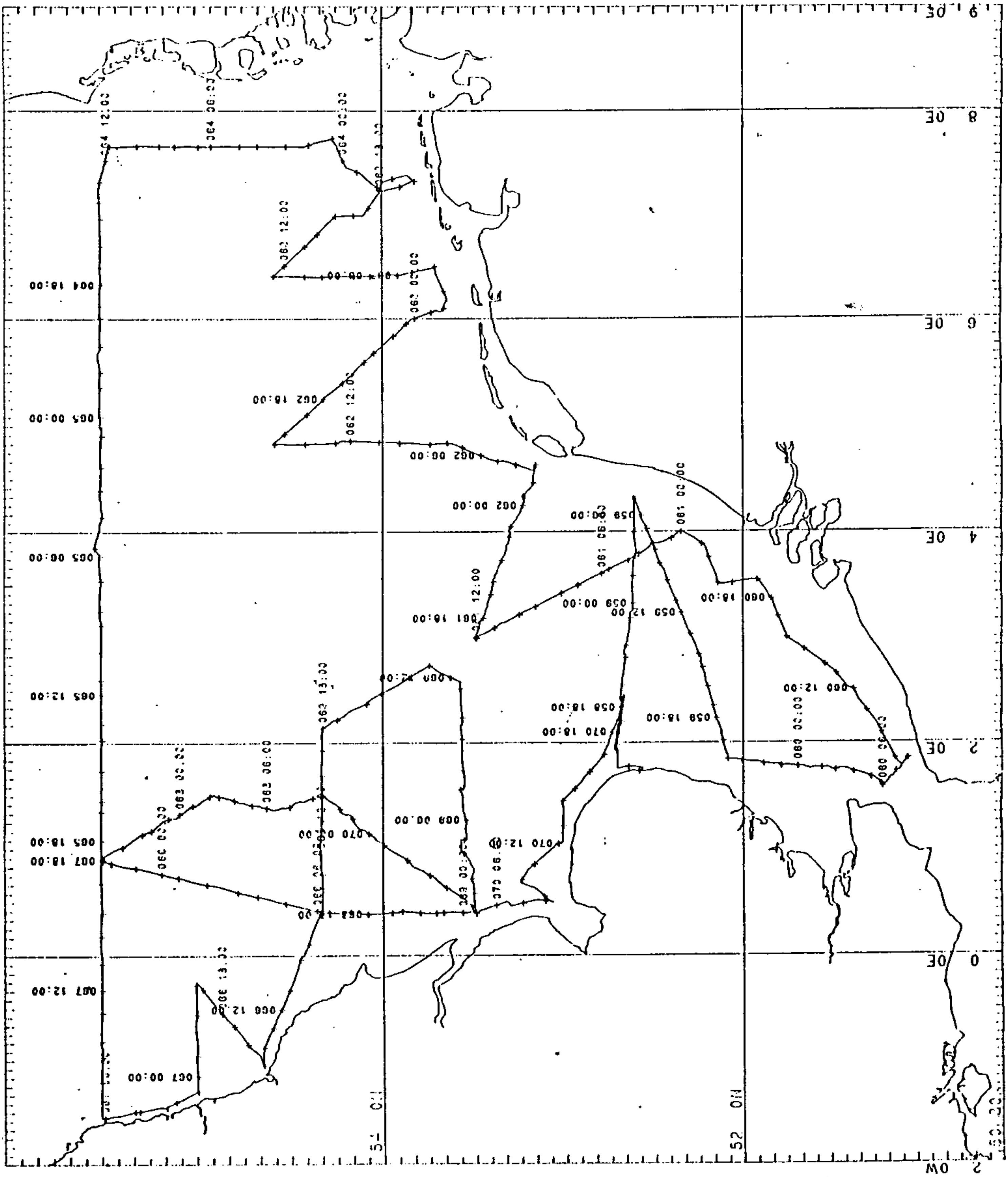
## CTD Station List

| Stn No. | Code | Yr | Day | Time | Start Latitude | Longitude | Depth | Day | Time | End Latitude | Longitude | Depth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1450 | AAA | 89 | 058 | 16.10 | 52 43.1N | 1 55.9E | 29 | 058 | 16.17 | 52 43.4N | 1 55.6E | 11 |
| 1451 | ABB | 89 | 058 | 18.51 | 52 41.4N | 2 24.7E | 52 | 058 | 18.59 | 52 41.6N | 2 24.7E | 53 |
| 1452 | ACB | 89 | 058 | 21.28 | 52 40.3N | 2 50.4E | 45 | 058 | 21.35 | 52 40.3N | 2 50.5E | 46 |
| 1453 | ADB | 89 | 058 | 23.19 | 52 37.9N | 3 15.0E | 37 | 058 | 23.24 | 52 37.8N | 3 15.0E | 15 |
| 1454 | AEA | 89 | 059 | 01.52 | 52 36.8N | 3 45.9E | 10 | 059 | 01.57 | 52 36.6N | 3 46.0E | 30 |
| 1455 | AFA | 89 | 059 | 03.07 | 52 36.9N | 3 60.0E | 27 | 059 | 03.11 | 52 36.7N | 3 59.9E | 61 |
| 1456 | AGA | 89 | 059 | 04.41 | 52 36.9N | 4 20.0E | 21 | 059 | 04.46 | 52 36.9N | 4 20.0E | 21 |
| 1457 | AHB | 89 | 059 | 05.56 | 52 34.6N | 4 9.1E | 26 | 059 | 06.01 | 52 34.7N | 4 9.1E | 29 |
| 1458 | AIB | 89 | 059 | 08.55 | 52 28.2N | 3 42.0E | 28 | 059 | 09.01 | 52 28.3N | 3 42.0E | 11 |
| 1459 | AJB | 89 | 059 | 11.33 | 52 21.4N | 3 15.6E | 40 | 059 | 11.39 | 52 21.4N | 3 15.6E | 21 |
| 1460 | AKB | 89 | 059 | 14.12 | 52 14.9N | 2 50.1E | 21 | 059 | 14.17 | 52 14.8N | 2 50.0E | 42 |
| 1461 | ALB | 89 | 059 | 17.08 | 52 10.0N | 2 20.2E | 51 | 059 | 17.15 | 52 10.2N | 2 20.2E | 54 |
| 1462 | AMB | 89 | 059 | 20.08 | 52 5.4N | 1 50.2E | 30 | 059 | 20.14 | 52 5.4N | 1 50.2E | 10 |
| 1463 | ANB | 89 | 059 | 22.55 | 51 46.9N | 1 46.4E | 92 | 059 | 23.00 | 51 47.0N | 1 46.4E | 45 |
| 1464 | AOA | 89 | 060 | 01.31 | 51 29.7N | 1 44.8E | 96 | 060 | 01.36 | 51 29.7N | 1 44.5E | 36 |
| 1465 | APA | 89 | 060 | 05.28 | 51 11.4N | 1 34.5E | 92 | 060 | 05.33 | 51 11.5N | 1 34.5E | 51 |
| 1466 | APA | 89 | 060 | 05.47 | 51 11.8N | 1 34.9E | 53 | 060 | 05.52 | 51 11.9N | 1 34.9E | 52 |
| 1467 | AQB | 89 | 060 | 07.51 | 51 3.0N | 1 50.4E | 11 | 060 | 07.56 | 51 3.0N | 1 50.6E | 11 |
| 1468 | ARB | 89 | 060 | 13.17 | 51 27.9N | 2 39.9E | 14 | 060 | 13.22 | 51 27.9N | 2 39.9E | 13 |
| 1469 | ASB | 89 | 060 | 15.55 | 51 45.0N | 3 0.1E | 36 | 060 | 16.01 | 51 45.0N | 3 0.2E | 36 |
| 1470 | ATB | 89 | 060 | 17.59 | 51 50.2N | 3 22.0E | 55 | 060 | 18.04 | 51 50.2N | 3 22.1E | 12 |
| 1471 | AUB | 89 | 060 | 20.37 | 52 8.1N | 3 29.8E | 10 | 060 | 20.44 | 52 8.2N | 3 29.8E | 14 |
| 1472 | AVB | 89 | 060 | 22.43 | 52 13.1N | 3 52.0E | 26 | 060 | 22.48 | 52 13.1N | 3 52.0E | 28 |
| 1473 | AWB | 89 | 061 | 00.03 | 52 21.0N | 3 59.8E | 5 | 061 | 00.09 | 52 21.0N | 3 59.8E | 62 |
| 1474 | AEA | 89 | 061 | 03.32 | 52 36.9N | 3 45.6E | 13 | 061 | 03.38 | 52 36.8N | 3 45.6E | 11 |
| 1475 | AYA | 89 | 061 | 05.26 | 52 47.0N | 3 36.9E | 12 | 061 | 05.31 | 52 47.0N | 3 36.7E | 13 |
| 1476 | AYA | 89 | 061 | 05.43 | 52 46.9N | 3 36.6E | 11 | 061 | 05.48 | 52 46.8N | 3 36.6E | 11 |
| 1477 | AZB | 89 | 061 | 07.38 | 53 0.1N | 3 25.9E | 28 | 061 | 07.43 | 53 0.2N | 3 25.9E | 27 |
| 1478 | BAB | 89 | 061 | 09.31 | 53 12.2N | 3 15.9E | 27 | 061 | 09.37 | 53 12.4N | 3 15.8E | 27 |
| 1479 | BBB | 89 | 061 | 12.01 | 53 29.8N | 3 0.6E | 13 | 061 | 12.06 | 53 29.9N | 3 0.7E | 13 |
| 1480 | BCB | 89 | 061 | 19.27 | 53 24.4N | 3 27.1E | 29 | 061 | 19.32 | 53 24.4N | 3 27.3E | 29 |
| 1481 | BDB | 89 | 061 | 22.26 | 53 18.5N | 3 59.9E | 69 | 061 | 22.32 | 53 18.7N | 3 59.9E | 28 |
| 1482 | BEB | 89 | 062 | 00.59 | 53 14.1N | 4 20.2E | 61 | 062 | 01.04 | 53 13.9N | 4 20.5E | 11 |
| 1483 | BFB | 89 | 062 | 02.47 | 53 9.7N | 4 37.3E | 78 | 062 | 02.53 | 53 9.9N | 4 37.6E | 78 |
| 1484 | BGA | 89 | 062 | 07.54 | 53 39.0N | 4 50.1E | 11 | 062 | 07.59 | 53 39.0N | 4 50.1E | 11 |
| 1485 | BGA | 89 | 062 | 08.12 | 53 39.0N | 4 50.1E | 10 | 062 | 08.17 | 53 39.0N | 4 50.1E | 11 |
| 1486 | BHA | 89 | 062 | 10.13 | 53 55.1N | 4 50.6E | 21 | 062 | 10.19 | 53 55.2N | 4 50.7E | 21 |
| 1487 | BIB | 89 | 062 | 12.38 | 54 15.0N | 4 50.3E | 43 | 062 | 12.44 | 54 15.1N | 4 50.4E | 44 |
| 1488 | BKB | 89 | 062 | 15.25 | 54 34.7N | 4 50.9E | 44 | 062 | 15.31 | 54 34.7N | 4 50.9E | 43 |
| 1489 | BJB | 89 | 062 | 17.55 | 54 19.0N | 5 15.2E | 45 | 062 | 18.00 | 54 19.1N | 5 15.1E | 44 |
| 1490 | BLB | 89 | 062 | 20.49 | 54 2.9N | 5 39.9E | 38 | 062 | 20.55 | 54 3.0N | 5 39.9E | 38 |
| 1491 | BMB | 89 | 062 | 22.06 | 53 56.2N | 5 50.0E | 13 | 062 | 22.11 | 53 56.2N | 5 49.9E | 13 |
| 1492 | BNB | 89 | 062 | 23.38 | 53 49.7N | 5 59.7E | 28 | 062 | 23.43 | 53 49.7N | 5 59.7E | 28 |
| 1493 | BOB | 89 | 063 | 02.25 | 53 38.9N | 6 10.0E | 6 | 063 | 02.30 | 53 38.8N | 6 10.0E | 5 |
| 1494 | BPA | 89 | 063 | 04.00 | 53 42.9N | 6 30.5E | 3 | 063 | 04.05 | 53 42.9N | 6 30.4E | 3 |
| 1495 | BQA | 89 | 063 | 05.41 | 53 54.9N | 6 25.1E | 28 | 063 | 05.46 | 53 54.9N | 6 25.2E | 28 |
| 1496 | BQA | 89 | 063 | 05.58 | 53 54.9N | 6 25.5E | 28 | 063 | 06.04 | 53 54.9N | 6 25.5E | 28 |
| 1497 | BRA | 89 | 063 | 07.30 | 54 6.0N | 6 25.2E | 15 | 063 | 07.36 | 54 5.9N | 6 25.2E | 15 |
| 1498 | BSB | 89 | 063 | 09.08 | 54 20.1N | 6 24.6E | 39 | 063 | 09.14 | 54 20.1N | 6 24.5E | 39 |
| 1499 | BTB | 89 | 063 | 11.15 | 54 35.1N | 6 25.1E | 39 | 063 | 11.20 | 54 35.1N | 6 25.1E | 39 |
| 1500 | BUB | 89 | 063 | 13.05 | 54 24.9N | 6 42.3E | 37 | 063 | 13.12 | 54 24.9N | 6 42.2E | 37 |
| 1501 | BVB | 89 | 063 | 15.09 | 54 15.1N | 7 0.1E | 37 | 063 | 15.14 | 54 15.1N | 7 0.1E | 37 |
| 1502 | BWB | 89 | 063 | 16.27 | 54 6.0N | 7 0.1E | 15 | 063 | 16.33 | 54 6.0N | 7 0.3E | 16 |
| 1503 | BXB | 89 | 063 | 17.54 | 54 0.7N | 7 14.6E | 12 | 063 | 17.59 | 54 0.7N | 7 14.8E | 13 |
| 1504 | BYB | 89 | 063 | 19.57 | 53 49.5N | 7 20.2E | 6 | 063 | 20.02 | 53 49.4N | 7 20.4E | 26 |
| 1505 | BZB | 89 | 063 | 23.30 | 54 11.4N | 7 28.1E | 39 | 063 | 23.36 | 54 11.4N | 7 28.0E | 39 |
| 1506 | CAA | 89 | 064 | 00.59 | 54 15.9N | 7 44.7E | 28 | 064 | 01.06 | 54 15.8N | 7 44.5E | 30 |
| 1507 | CBA | 89 | 064 | 02.13 | 54 24.9N | 7 39.9E | 26 | 064 | 02.17 | 54 24.9N | 7 39.8E | 29 |
| 1508 | CCB | 89 | 064 | 04.02 | 54 40.0N | 7 40.0E | 22 | 064 | 04.07 | 54 40.0N | 7 40.0E | 22 |
| 1509 | CDA | 89 | 064 | 06.14 | 54 54.9N | 7 40.1E | 22 | 064 | 06.18 | 54 54.9N | 7 40.1E | 22 |
| 1510 | CEB | 89 | 064 | 08.35 | 55 9.9N | 7 40.0E | 26 | 064 | 08.40 | 55 9.9N | 7 40.0E | 26 |
| 1511 | CFB | 89 | 064 | 11.18 | 55 27.1N | 7 39.5E | 26 | 064 | 11.23 | 55 27.2N | 7 39.4E | 26 |
| 1512 | CGB | 89 | 064 | 12.54 | 55 30.1N | 7 19.8E | 29 | 064 | 12.59 | 55 30.1N | 7 19.8E | 30 |
| 1513 | CHB | 89 | 064 | 14.45 | 55 30.1N | 7 0.0E | 29 | 064 | 14.50 | 55 30.1N | 7 0.0E | 29 |
| 1514 | CIB | 89 | 064 | 16.52 | 55 30.1N | 6 30.0E | 43 | 064 | 16.58 | 55 30.1N | 6 30.2E | 43 |
| 1515 | CJB | 89 | 064 | 19.46 | 55 29.8N | 6 0.5E | 50 | 064 | 19.53 | 55 29.9N | 6 0.5E | 51 |
| 1516 | CKB | 89 | 064 | 22.00 | 55 30.0N | 5 30.0E | 52 | 064 | 22.10 | 55 30.0N | 5 30.0E | 53 |
| 1517 | CLA | 89 | 065 | 00.29 | 55 29.7N | 4 59.4E | 44 | 065 | 00.35 | 55 29.5N | 4 59.5E | 44 |
| 1518 | CMA | 89 | 065 | 02.23 | 55 30.0N | 4 31.2E | 12 | 065 | 02.29 | 55 29.8N | 4 31.5E | 13 |
| 1519 | CNA | 89 | 065 | 05.32 | 55 30.1N | 3 35.1E | 15 | 065 | 05.38 | 55 30.1N | 3 35.1E | 14 |
| 1520 | CNA | 89 | 065 | 05.49 | 55 30.1N | 3 35.1E | 14 | 065 | 05.54 | 55 30.1N | 3 35.1E | 14 |
| 1521 | COB | 89 | 065 | 08.28 | 55 29.9N | 3 10.3E | 36 | 065 | 08.35 | 55 29.9N | 3 10.5E | 37 |
| 1522 | CPB | 89 | 065 | 11.23 | 55 30.0N | 2 35.0E | 43 | 065 | 11.29 | 55 30.0N | 2 35.0E | 42 |
| 1523 | CQB | 89 | 065 | 13.38 | 55 29.8N | 2 2.0E | 69 | 065 | 13.44 | 55 29.8N | 2 2.0E | 68 |
| 1524 | CRB | 89 | 065 | 16.29 | 55 29.9N | 1 25.3E | 60 | 065 | 16.38 | 55 29.8N | 1 25.5E | 61 |
| 1525 | CSA | 89 | 065 | 19.02 | 55 29.6N | 0 53.8E | 61 | 065 | 19.11 | 55 29.7N | 0 53.9E | 62 |
| 1526 | CSB | 89 | 065 | 19.28 | 55 29.7N | 0 54.0E | 82 | 065 | 19.35 | 55 29.7N | 0 54.1E | 83 |
| 1527 | EEB | 89 | 066 | 00.54 | 55 5.7N | 0 44.0E | 78 | 066 | 01.01 | 55 5.7N | 0 44.0E | 77 |
| 1528 | EFB | 89 | 066 | 03.41 | 54 40.8N | 0 33.0E | 77 | 066 | 03.48 | 54 40.8N | 0 33.1E | 77 |
| 1529 | DMB | 89 | 066 | 06.31 | 54 20.0N | 0 23.8E | 43 | 066 | 06.38 | 54 20.0N | 0 23.8E | 43 |
| 1530 | DMA | 89 | 066 | 06.52 | 54 20.0N | 0 24.2E | 56 | 066 | 06.58 | 54 20.2N | 0 23.8E | 60 |
| 1531 | DLB | 89 | 066 | 09.30 | 54 26.2N | 0 0.5W | 55 | 066 | 09.37 | 54 26.3N | 0 0.6W | 55 |
| 1532 | DKA | 89 | 066 | 11.11 | 54 31.1N | 0 21.1W | 36 | 066 | 11.20 | 54 31.1N | 0 21.0W | 54 |
| 1533 | DJA | 89 | 066 | 12.33 | 54 34.9N | 0 37.0W | 54 | 066 | 12.39 | 54 34.9N | 0 36.9W | 54 |
| 1534 | DIA | 89 | 066 | 13.56 | 54 38.9N | 0 52.9W | 44 | 066 | 14.03 | 54 38.9N | 0 52.9W | 43 |
| 1535 | DHA | 89 | 066 | 14.55 | 54 38.9N | 1 3.0W | 28 | 066 | 15.00 | 54 38.8N | 1 2.8W | 30 |
| 1536 | DGA | 89 | 066 | 16.01 | 54 43.9N | 0 50.9W | 55 | 066 | 16.10 | 54 43.8N | 0 50.7W | 55 |
| 1537 | DFB | 89 | 066 | 17.40 | 54 52.0N | 0 32.8W | 66 | 066 | 17.47 | 54 52.0N | 0 32.8W | 46 |
| 1538 | DEB | 89 | 066 | 19.40 | 55 0.2N | 0 14.9W | 86 | 066 | 19.50 | 55 0.3N | 0 14.7W | 91 |
| 1539 | DDB | 89 | 066 | 21.15 | 55 0.2N | 0 36.1W | 69 | 066 | 21.23 | 55 0.2N | 0 36.2W | 70 |
| 1540 | DCB | 89 | 066 | 23.07 | 55 0.2N | 0 57.1W | 82 | 066 | 23.16 | 55 0.3N | 0 57.1W | 83 |
| 1541 | DBB | 89 | 067 | 00.40 | 54 59.9N | 1 18.1W | 42 | 067 | 00.46 | 54 60.0N | 1 17.9W | 43 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1542 | DAB | 89 | 067 | 02.46 | 55 9.5N | 1 27.1W | 14 | 067 | 02.51 | 55 9.4N | 1 27.2W | 13 |
| 1543 | CZA | 89 | 067 | 04.22 | 55 19.8N | 1 29.9W | 44 | 067 | 04.29 | 55 19.6N | 1 29.8W | 45 |
| 1544 | CZB | 89 | 067 | 04.42 | 55 19.5N | 1 29.6W | 45 | 067 | 04.47 | 55 19.5N | 1 29.5W | 45 |
| 1545 | CYB | 89 | 067 | 06.19 | 55 30.3N | 1 33.1W | 14 | 067 | 06.24 | 55 30.4N | 1 32.9W | 36 |
| 1546 | CXB | 89 | 067 | 07.46 | 55 30.1N | 1 12.0W | 83 | 067 | 07.54 | 55 30.1N | 1 12.0W | 83 |
| 1547 | CWB | 89 | 067 | 09.38 | 55 30.2N | 0 52.2W | 94 | 067 | 09.46 | 55 30.3N | 0 52.2W | 95 |
| 1548 | CVA | 89 | 067 | 11.04 | 55 29.9N | 0 32.2W | 43 | 067 | 11.10 | 55 30.0N | 0 32.2W | 45 |
| 1549 | CUA | 89 | 067 | 12.58 | 55 29.9N | 0 4.1W | 76 | 067 | 13.05 | 55 29.8N | 0 4.1W | 56 |
| 1550 | CTA | 89 | 067 | 14.51 | 55 29.9N | 0 24.0E | 76 | 067 | 14.59 | 55 29.7N | 0 24.0E | 77 |
| 1551 | EDB | 89 | 067 | 21.21 | 55 15.1N | 1 9.9E | 67 | 067 | 21.30 | 55 15.2N | 1 9.7E | 67 |
| 1552 | ECB | 89 | 067 | 23.55 | 55 5.1N | 1 19.8E | 33 | 068 | 00.00 | 55 5.2N | 1 19.8E | 34 |
| 1553 | EBA | 89 | 068 | 02.06 | 54 55.3N | 1 30.6E | 27 | 068 | 02.10 | 54 55.3N | 1 30.6E | 73 |
| 1554 | EAA | 89 | 068 | 05.40 | 54 38.8N | 1 23.5E | 86 | 068 | 05.45 | 54 38.7N | 1 23.5E | 39 |
| 1555 | DZA | 89 | 068 | 08.29 | 54 20.0N | 1 30.0E | 50 | 068 | 08.36 | 54 19.9N | 1 30.1E | 50 |
| 1556 | EHB | 89 | 068 | 10.42 | 54 20.1N | 1 8.0E | 53 | 068 | 10.49 | 54 20.2N | 1 7.8E | 83 |
| 1557 | EGB | 89 | 068 | 13.10 | 54 19.9N | 0 45.5E | 43 | 068 | 13.16 | 54 19.9N | 0 45.5E | 42 |
| 1558 | DMA | 89 | 068 | 15.23 | 54 19.7N | 0 23.8E | 93 | 068 | 15.30 | 54 19.5N | 0 23.9E | 52 |
| 1559 | DNB | 89 | 068 | 17.11 | 54 9.7N | 0 24.4E | 61 | 068 | 17.18 | 54 9.5N | 0 24.5E | 60 |
| 1560 | DOB | 89 | 068 | 19.30 | 53 55.3N | 0 24.2E | 3 | 068 | 19.36 | 53 55.2N | 0 24.3E | 51 |
| 1561 | DPB | 89 | 068 | 22.39 | 53 40.2N | 0 23.9E | 15 | 068 | 22.44 | 53 40.3N | 0 23.9E | 14 |
| 1562 | DQB | 89 | 069 | 01.01 | 53 30.0N | 0 23.6E | 13 | 069 | 01.05 | 53 30.1N | 0 23.6E | 13 |
| 1563 | DRB | 89 | 069 | 02.27 | 53 31.1N | 0 41.1E | 93 | 069 | 02.37 | 53 31.3N | 0 41.5E | 90 |
| 1564 | DSB | 89 | 069 | 04.46 | 53 34.4N | 1 4.9E | 56 | 069 | 04.51 | 53 34.2N | 1 5.0E | 56 |
| 1565 | DTB | 89 | 069 | 07.07 | 53 34.3N | 1 33.8E | 43 | 069 | 07.13 | 53 34.0N | 1 33.9E | 20 |
| 1566 | DUA | 89 | 069 | 09.37 | 53 34.5N | 2 10.1E | 95 | 069 | 09.41 | 53 34.3N | 2 10.2E | 95 |
| 1567 | DVA | 89 | 069 | 11.22 | 53 34.8N | 2 34.9E | 27 | 069 | 11.26 | 53 34.8N | 2 34.9E | 27 |
| 1568 | DWB | 89 | 069 | 12.56 | 53 45.0N | 2 44.5E | 15 | 069 | 13.01 | 53 45.0N | 2 44.5E | 15 |
| 1569 | DXB | 89 | 069 | 15.43 | 54 4.7N | 2 22.9E | 70 | 069 | 15.50 | 54 4.6N | 2 22.9E | 50 |
| 1570 | DYB | 89 | 069 | 17.54 | 54 19.6N | 2 8.1E | 38 | 069 | 18.00 | 54 19.6N | 2 8.1E | 38 |
| 1571 | DZB | 89 | 069 | 20.59 | 54 19.8N | 1 30.1E | 55 | 069 | 21.07 | 54 19.6N | 1 30.4E | 55 |
| 1572 | EIB | 89 | 069 | 22.43 | 54 10.0N | 1 16.7E | 45 | 069 | 22.51 | 54 10.0N | 1 16.8E | 45 |
| 1573 | EJA | 89 | 070 | 00.47 | 53 59.8N | 1 2.5E | 21 | 070 | 00.52 | 53 59.9N | 1 2.3E | 20 |
| 1574 | EKA | 89 | 070 | 03.22 | 53 43.1N | 0 42.9E | 30 | 070 | 03.27 | 53 43.1N | 0 42.8E | 30 |
| 1575 | DOA | 89 | 070 | 05.20 | 53 29.8N | 0 24.0E | 13 | 070 | 05.24 | 53 29.6N | 0 24.0E | 13 |
| 1576 | ELA | 89 | 070 | 06.22 | 53 19.8N | 0 30.0E | 14 | 070 | 06.26 | 53 19.7N | 0 30.0E | 14 |
| 1577 | EMB | 89 | 070 | 07.32 | 53 9.8N | 0 31.0E | 3 | 070 | 07.35 | 53 9.7N | 0 31.0E | 3 |
| 1578 | ENB | 89 | 070 | 08.27 | 53 4.5N | 0 29.4E | 38 | 070 | 08.32 | 53 4.4N | 0 29.4E | 38 |
| 1579 | EOB | 89 | 070 | 10.24 | 53 12.9N | 0 47.4E | 4 | 070 | 10.30 | 53 12.9N | 0 47.7E | 4 |
| 1580 | EPB | 89 | 070 | 12.22 | 53 1.0N | 1 4.0E | 13 | 070 | 12.26 | 53 1.0N | 1 4.1E | 13 |
| 1581 | EQB | 89 | 070 | 14.01 | 53 1.1N | 1 26.9E | 28 | 070 | 14.06 | 53 1.1N | 1 26.8E | 27 |
| 1582 | ABA | 89 | 070 | 19.23 | 52 41.0N | 2 25.2E | 54 | 070 | 19.29 | 52 41.1N | 2 25.3E | 54 |
| 1583 | ABB | 89 | 070 | 20.35 | 52 40.7N | 2 25.2E | 53 | 070 | 20.43 | 52 40.5N | 2 25.3E | 53 |
| 1584 | AAB | 89 | 070 | 23.25 | 52 42.9N | 1 56.4E | 14 | 070 | 23.29 | 52 42.8N | 1 56.4E | 36 |

Station numbers are sequential throughout the North Sea Project. Station codes refer to the site (first two letters) and to the observations there (last letter: A - CTD and water bottles; B - CTD, water bottles and plankton trawl; D - CTD, water bottles, plankton trawl and cores). Unless otherwise stated, samples were obtained near-surface, at mid-depth and near-bottom for nutrients, chlorophyll and suspended sediment, and near-bottom also for salinity. The near-bottom temperature was also recorded by reversing thermometers.

## CRUISE TRACK



Cruise Report of Proceedings

Ship..RRS CHALLENGER..... Cruise No .....46 LEG 2.........

Cruise Dates (Inclusive, port to port) ..20 – 26 FEBRUARY 1989........

It is requested that the following aspects [...] this report of proceedings for dispatch or delivery to [...]se, immediately on return to port.

USE AS CRUISE REPORT
CHALLENGER 46 leg2
(MIAS ROSCOP 3425)
DAVID HUNTLEY'S cruise
Use these notes until a Cruise Report is available

a) Main objectives of the cruise.
b) Geographical area. Reference stations [...]ude.
c) Sea and weather conditions encountered
d) Conduct of cruise, main problems encou[...] f the program
e) Equipment performance.
f) Ship performance.
g) Any recommendations.
h) Signature and date.

Brief comments are preferred but if neces[...]eet.

a. Main Objectives.

To measure the flow and sediment movement over sand waves in Southern North Sea, within approx 10 km

b square centred at 52° 39.33 N 3° 40.18 E.

To investigate problems associated with bubbles in the surface transmissometer light paths.

c. Weather and wave climate generally good for February, ranging from almost flat to force 8.

d. On arrival on site, ~~early~~ approx 6 am Day 52, two current meter arrays (RVS), STABLE and three pressure sensors (POL) were deployed. We were very fortunate to have a calm day which enabled all sensors to be deployed, between 0700 and 2010. STABLE was recovered successfully almost exactly 3 days later, as were the current meter arrays. The three pressure sensors were recovered on day 56 during some heavy weather. The ADCP was run throughout the cruise. Other measurements included 13 hourly CTD casts, held very close to the seabed to collect nearbed bottle samples near sand wave crests & troughs, one camera/transmissometer drop, ADCP runs with ship steaming at prescribed speeds and directions, and brief sidescan surveys.

e, f, g. See attached sheet.

D A Huntley 26 February 1989

Comments on RRS Challenger Cruise 46/2 , for Ken Robertson.

On the whole a very successful cruise, with all sensors successfully deployed and recovered, and all indications that data logging worked. Ancilliary measurements generally went well also.

Particular problems:

A. The Shipek Grab fell apart at the weight during a deployment. Fortunately no-one was hurt as it fell to the deck. Operators should be aware that apparently indestructable instruments, especilly old ones, can self destruct without warning. All the older Shipek Grabs should be checked.

B. The Simrad echo sounder still causes problems. Dropouts appear frequently,and not just during rough weather. The analogue chart recorder also requires constant attention, with a particularly annoying tendency for the paper to slip down on the take-up reel and lasserate itself along the bottom edge. The analogue recorder eventually failed completely, causing us to abandon the final hour of our cruise plan.

C. The sidescan fish also gave problems again. An intermittant fault gave, variously, no record, records on both sides and records on one side only. Attempts to get both sides recording reliably were eventually abandoned.

D. The two acoustic releases used on the two current meter moorings had the same frequencies, with the result that the wrong mooring was released during a recovery. This is undoubtedly a consequence of the very limited time between cruises for careful planning and checking.

E. We did not solve the problem of ping rates for the ADCP. Using an identical configuration file to one used on cruise 40 ( we checked that the two config files were the same line by line) we only achieved around 240 pings in two minutes, compared to around 360 during cruise 40. Either the system has changed or our config files differed in a way not revealed by the printouts of the files.

F. On the personnel side, the most important point to make is that RVS personnel have a large burden of work on these cruises. This burden is increasing as the reliability of the heavily-used instruments decreases. I hope that RVS and NERC appreciate the great efforts that are made by their personnel to keep instruments working under difficult condition. The success of these cruises would be greatly effected if their expertise was down-graded or lost.

G. The master, officers and crew were friendly and helpful. The first officer and crew made deplyment of STABLE look deceptively easy, and made recovery of STABLE in marginal conditions possible.

H. The food and service aboard Challenger are excellent.

I. As always the use of the fish lab as a duty mess is incompatible with its use as a scientific lab.

J. The Dark Room cannot be made completely ~~dark~~ dark because of an ill-fitting flap over a cable duct.

K. Problems with an aft deck crane made current meter deployment & recovery more difficult.