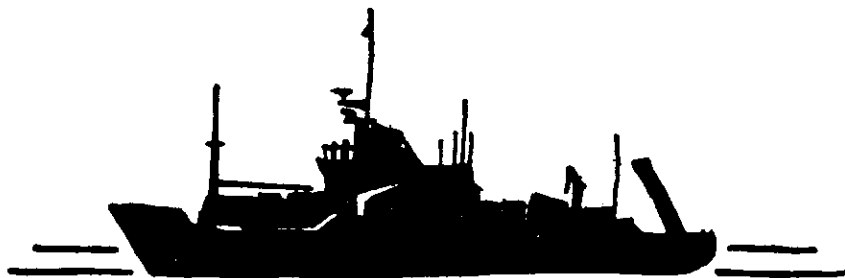


Scottish Marine Biological Association

Dunstaffnage Marine Research Laboratory



CRUISE REPORT

S.M.B.A., P.O. Box No. 3, Oban, Argyll, Scotland.

Dunstaffnage Marine Laboratory

Cruise Report

R.R.S. Challenger
Cruise 52/89
11 May - 24 May 1989

↓ 005

CRUISE REPORT

CRUISE RVS Cruise CH52/89. Sediment Resuspension Experiments - SERE.
This is the second of a series of three cruises studying sediment
resuspension processes as part of the NERC North Sea Project.

VESSEL RRS Challenger

PERIOD 11-24 May, 1989

SCIENTIFIC PERSONNEL	C.R. Griffiths	DML - Principal Scientist
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ACKNOWLEDGEMENT

The excellent services afforded by Capt. P. Maw and his officers and crew throughout this cruise are most gratefully acknowledged.

SCIENTIFIC OBJECTIVES

- (1) To evaluate the hydrodynamic processes controlling the resuspension of sediment and its seasonal variability at two contrasting sites in the North Sea.
- (2) To evaluate the influence of sedimentological characteristics and geotechnical and geophysical properties of the bed on the resuspension of sediment at the two sites.
- (3) To examine the role of benthic and pelagic organisms in sediment resuspension and deposition processes.
- (4) To determine the impact of sediment resuspension on water quality through its influence on trace metal, nutrient and organic contaminant exchange processes.

(5) To develop a detailed model inter-relating vertical current structure and suspended sediment concentration at a point site. To use this model as the basis for constructing a fine-grid, 3-dimensional model incorporating sediment transport to cover the observational areas.

SPECIFIC OBJECTIVES

To make time series observations of physical, sedimentological and biological properties of the sediment, suspended particulate material and water at two sites in the North Sea using a variety of moored instruments. CTD/water bottle casts, pumped sampling and sediment grabs and box cores.

The two sites (Figure 1): are (1) Northern site, $54^{\circ} 35'N$ $04^{\circ} 50'E$, 45 m depth, muddy sand, seasonally stratified water column, and (2) Southern site, $52^{\circ} 40'N$ $3^{\circ} 40'E$, 27 m depth, sand, permanently well-mixed water column.

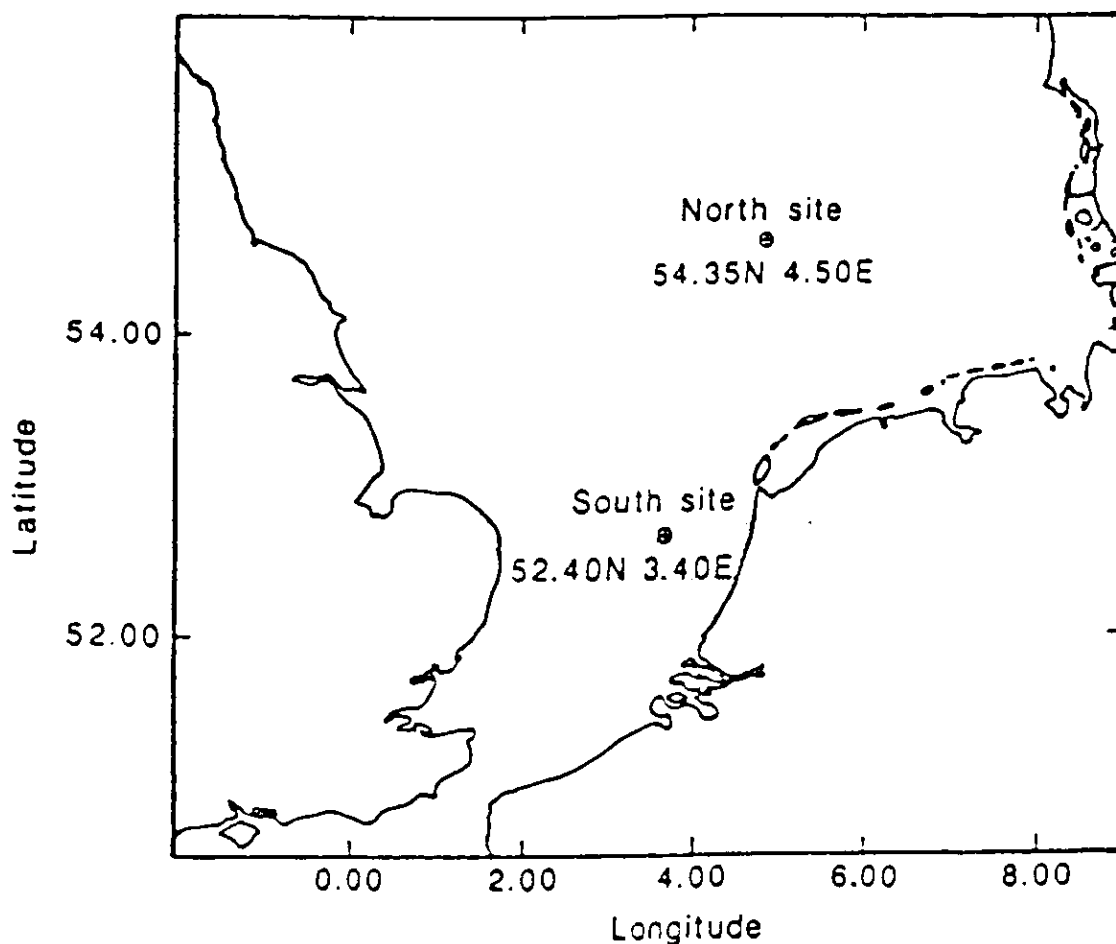


Figure 1. Location of the two experimental sites in the southern North Sea.

SUMMARY

R.R.S. Challenger sailed from Gt. Yarmouth at 1420Z hours on 11th May 1989 and proceeded toward the southern site at $N52^{\circ} 40' E3^{\circ} 40'$. A Simrad survey was worked through the night in order to identify the sand wave studied by Dr. D.A. Huntley on Challenger 46/88. During the following day, 8 moorings were deployed before starting a tidal cycle. A typical tidal cycle spanned 18 hours. This consisted of hourly CTD casts using the RVS package (Neil Brown Mk IV CTD including dissolved oxygen, Sea Tech Transmissometer, Chelsea Instrument Fluorometer and up/down welling irradiance), water samples were taken from surface, mid and bottom layers with each cast. Alternating on the half hour, settling velocity tubes were deployed, or samples were taken from three depths using the large volume pumping system. A large volume sediment trap was deployed for the duration of each tidal cycle.

At the northern site $N54^{\circ} 35' E4^{\circ} 50'$ 4 moorings were deployed before starting a tidal cycle. Details of all the moorings are included in Table 1.

At each site, sediment samples were taken at regular station intervals within a nautical square mile grid ($5 \times 5 = 25$ stations). In total 9 box cores and 16 day grabs were obtained. A photographic survey was worked over the same grid.

Tidal cycles were then worked at both sites before the recovery of the various rigs. Four tidal cycles were obtained at the southern site and 3 at the northern site. All instruments were recovered safely with one exception.

For the duration of the cruise the ship mounted ADCP was in operation.

NARRATIVE (all times G.M.T.)

- | | |
|--------|---|
| 10 May | 1400 Scientific personnel embark at Gt. Yarmouth, loading, servicing and commissioning of equipment. |
| 11 May | 1220 Set sail and steam directly to southern site $N52^{\circ} 40' E3^{\circ} 40'$. 2350 on station, simrad survey through the night. |
| 12 May | 0521 Met buoy and wave rider deployed. 0730 continue mapping sand waves as STABLE was assembled. 1340 STABLE deployed. 1652 Rig 1 deployed after wire test. 1817 ETA buoy deployed. 1859 large volume sediment trap deployed (LVT). 2000 begin tidal cycle. |
| 13 May | 0540 Deploy PML dual sediment trap rig, continue tidal cycle. 1549 ADCP deployed. 1635 LVT recovered. 1800 set course for northern site $N54^{\circ} 35' E4^{\circ} 50'$. |

14 May 0628 Arrive northern site. 0750 deploy thermistor rig. 1000 c/m rig deployed. 1142 LVT deployed. 1301 begin tidal cycle. 1537 ADCP deployed, continue with tidal cycle through the night.

15 May 0545 LVT recovered. 0714 begin box core/grab survey. 1818 proceed to southern site.

16 May 0746 Arrive southern site. 0815 deploy LVT. 0900 begin tidal cycle.

17 May 0544 Finish tidal cycle and recover LVT. 0723 begin box core/grab survey. 1913 mapping run of sand waves. 2344 begin camera survey.

18 May 0536 LVT deployed. 0603 begin tidal cycle. 1912 finish tidal cycle and recover LVT. 1930 proceed to northern site.

19 May 0841 Arrive northern site, deploy LVT and begin tidal cycle.

20 May 0740 Finish tidal cycle and recover LVT, thermistor rig and c/m rig. 0950 recover ADCP and set course for southern site. 2339 begin tidal cycle.

21 May 0543 Deploy LVT and continue with tidal cycle. 1446 Recover ADCP, Met buoy, ETA, Wave Rider, Tidal Gauge and LVT. Continue tidal cycle through the night.

22 May 0409 Recover PML dual sediment trap rig, Rig 1 and STABLE. 0732 set course for northern site. 2330 arrive northern site and begin tidal cycle.

23 May 1341 Finish tidal cycle and return to Gt. Yarmouth, alongside the following morning at 1000.

REPORT ON SCIENTIFIC PROCEDURES

Sediment Traps

Sediment trapping was undertaken in two modes:

1. Automated sequentially sampling traps were deployed at both sites for the duration of the survey (6 or 8 days).
2. Large volume traps were deployed concurrent with each tidal cycle (15-20 hours) to allow bulk samples to be obtained for a range of analyses.

1. Sequential Traps.

At the northern site one Parflux trap, capable of taking 12 samples, was deployed at a height of 5 m above the bed using a single point mooring fitted with an acoustic beacon. At the southern site, a second Parflux trap was deployed along with a PML sequential trap, both traps sampled at 5 m above the sea bed.

Southern Site (both traps)

Position	N52° 39.1' E3° 39.8'
Deployment	0601Z 13.5.89
Start sampling	1230Z 13.5.89 (slack water)
Sampling interval	24 hrs 50 mins
Recovery/Stop sampling	0420Z 22.5.89
Samples taken	8.6

Northern Site

Position	N54° 35.2' E4° 50.5'
Deployment	1030Z 14.5.89
Start sampling	1300Z 14.5.89 (slack water)
Sampling interval	12 hrs 25 mins
Recovery/Stop sampling	0630Z 20.5.89
Samples taken	10.1

The Parflux trap at the northern site appeared to have caught a consistent series of samples in which the amount of particles increased with time. At the southern site the Parflux also took a sensible looking set of samples. However, the PML trap, which is capable of taking replicates, looked as though it will give little information. This is mainly due to the very high load of Phaeocystis in the water column which dominated the trap catches at this site.

2. Large volume traps (LVT)

The large volume traps were deployed twice at the northern site and four times at the southern site. At the southern site one trap was placed 5 m off the bed, and at the northern site traps were placed at 5 m and 35 m above the sea bed.

Southern Site (30 m)

Deployed	Recovered	Sampling duration
1900Z 12.5.89	1630Z 13.5.89	21.5 hrs
0810Z 16.5.89	0550Z 17.5.89	21.7 hrs
0540Z 18.5.89	1930Z 18.5.89	13.8 hrs
0550Z 21.5.89	1905Z 21.5.89	13.3 hrs

Northern Site (48 m)

Deployed		Recovered		Sampling duration
1150Z	14.5.89	0550Z	15.5.89	18.0 hrs
1110Z	19.5.89	0455Z	20.5.89	17.8 hrs

Samples at the southern site appeared to be dominated by Phaeocystis and large quantities of particles were taken. At the northern site much smaller catches, though possibly of more inorganic composition, were obtained at 5 m compared to the southern site. Virtually no material was taken from the trap 35 m above the sea bed. Portions of this material were filtered to provide samples for quantification of the 'catch' in ghm and carbon and nitrogen.

PARTICLE CHARACTERISATION

Suspended particle concentrations

Samples were taken by pumping large volumes of water with a Flygt subsurface pump (190 l/min). The pump was lowered to just below the surface and the attached hose was weighted and lowered to the required pumping depth using the hydrographic wire. The samples were filtered on tared paper to determine the particulate load. Samples were taken at three depths every two hours during a tidal cycle, in total 171 samples were taken (57 x 3 depths).

Particle sizing

Particle sizing was carried out with a coulter TAPII multichannel particle counter using 280 μm and 70 μm aperture tubes. Water samples were taken at three depths with the CTD Go-Flo bottles and analysed with both tubes. Counts were performed every two hours during the tidal cycles.

Chlorophyll and phytoplankton

Samples from the pumping system were taken at the same frequency as for suspended particles to assess the phytoplankton density in terms of their chlorophyll. Known volumes of the samples were filtered for subsequent acetone extraction and determination of the chlorophyll pigment. Samples were taken in parallel with the chlorophyll filtration and preserved with iodine to allow subsequent identification of the phytoplankton if required.

Zooplankton

Samples for taxonomy and biomass were collected from the pumping system at the same frequency as for suspended particles. The water was filtered through 200 μm mesh zooplankton nets with removable ends, suspended in water

to avoid damage to the animals. Taxonomy samples were preserved in dilute buffered formalin. Biomass samples were resuspended in a small volume of filtered sea water, subsampled if dense, and filtered through pre-weighed ashed GF/C filters before being frozen.

MOORINGS

A total of eight instrumented moorings were deployed at the southern site and three at the northern site. The instrument types and numbers are listed in Table 1, along with mooring positions and times of deployment and recovery. No problems were encountered with deployment or recovery. However, the limited deck space due to the presence of a large container on the aft deck prevented more than one rig being made ready at one time, resulting in the mooring work taking an extra half day on deployment and recovery. One instrument was damaged during the deployment/recovery. The Valeport RCM had a bent spindle and chipped rotor, the rest of the equipment was O.K.

ADCPs

The ADCP at the southern site had an experimental set-up to try and get more cells in the shallow depth (28-30 m). Unfortunately, the backscatter return with the 2 m/sec transmit pulse used was not enough and no useful current data was obtained.

The ADCP at the northern site was a new instrument on a test deployment which suffered a transmitter failure. The ship mounted ADCP returned good data for the duration of the cruise.

S4s

Data was obtained from three of the four POL/DML S4s. The fourth (0258) had its X and Y settings set wrongly and gave no usable data. The two SMBA S4's returned good data, though only one was deployed in burst mode due to the failure of a clock battery. These two instruments were deployed from a surface tail attached to the sequential trap mooring at the southern site.

Aanderaa & Valeport RCM's and thermistor loggers

The Valeport RCM was slightly damaged on recovery, there had also been a battery failure beforehand, limiting the recovered data to 29 hours. All the other instruments worked well and gave good data.

Met Buoy and Wave Rider

The fine weather during the cruise proved no test for the met buoy and wave rider. Both worked and gave good data.

STABLE

The Sediment Transport and Boundary Layer Equipment was deployed on 'Crest 25' as identified by Dr. D.A. Huntley on CH46/89. Despite lively conditions for both deployment and recovery, all sensors remained intact. The data is still to be worked up.

Transmissometers

All the moored transmissometers were calibrated against the instrument on the CTD before and after deployment. In addition to the moored instruments, one was included on the STABLE rig. On recovery, three of the instruments had leaked through the interconnecting cable plug (487, 852, 853) and one instrument had sustained interconnecting cable damage (834). The deck mounted PML transmissometer was maintained for the duration of the cruise.

SEDIMENT SAMPLING

At each site, 14 day grabs and 9 box cores were obtained using the 5 x 5 station grid. Samples were taken for textured analysis. Replicate measurements of electrical resistivity, acoustic s-wave velocity and sediment porosity were made on each of the box cores. The box cores at the northern site were generally good with relatively undisturbed surface features. No surface features were observed at the southern site.

McCAVE SETTLING VELOCITY TUBES (MSVT)

To measure the settling velocity distribution of undisturbed samples of suspended particulates at 1 m above the bed, MSVT were deployed at 2 hourly intervals during a tidal cycle. Deployments at the northern site were generally successful with 3 tidal cycles monitored. Planktonic material clogged up the filters at the southern site, reducing the total number of samples taken to 10.

CAMERA SURVEY

A UMEL 35 mm camera, with dedicated flash, was used to obtain black and white photographs of the sea bed at both sites on the standard 5 x 5 station grid. In conjunction with the camera survey a detailed echo sounder record was maintained. Five exposures were made at each of the chosen grid points, 14 grid points were selected from the southern station grid and 3 from the northern station grid. The films were developed on board soon after exposure. The camera survey at the northern site was abandoned when it was demonstrated that due to high turbidity there was little benefit in continuing it.

CHEMISTRY

Samples for nitrate, nitrite, ammonia, silicate and phosphate were taken from all CTD casts during the tidal cycles at both sites. Aluminium samples were taken on all but one of the tidal cycles and two kinetics experiments carried out in which surficial sediment from a box core at the northern site was resuspended in surface water from the same site. Particulate and dissolved metal samples were taken hourly on two of the tidal cycles, one at each site.

In order to investigate the solid state speciation of trace metals in resuspended and down-column flux particulate material, the following samples were collected:

1. Down Column Flux Particulates. Water samples were collected in Go-Flo bottles during "tidal cycles"; the suspended particulates were filtered out. The total trace metal content of this down-column flux material will be estimated, and will provide a "base-line" for subsequent work.
2. Trapped Resuspended Material. "Sequential" (SEQ), and "large-volume" (LVT) sedimentation traps were deployed to collect particulate material over several selected tidal cycles. The large volumes of material collected by these deployed "rigs" will be suitable for investigating the speciation of trace metals within the chemically-defined fractions that compose this material. Using the "total-metal" data from 1), above, and comparing it against the partitioning of the metals (as mentioned) it should be possible to assess the effect of resuspension events on the trace metal/particulate budget.
3. Sediment Cores. Sediment material was collected using the box-corer. The relatively undisturbed sediments will be used in investigations of the effects of recent sediment resuspension on trace metal behaviour. Also, the effects of early diagenesis will be studied on the more stable "northern" sediment cores.
4. Atmospheric Particulates. Atmospherically transported particulates were collected using large-volume air pumps (located on the fore-castle). These samples should provide data on inputs of trace metals from atmospheric sources.

PRIMARY PRODUCTION

Surface samples obtained from dawn CTD casts were incubated throughout the day in an on-deck incubator. At the end of the day the samples were analysed for changes in dissolved oxygen and carbon ¹⁴ uptake. The light on the incubators was progressively screened to simulate the light conditions in the water column. In addition, 'in situ' measurements of dissolved oxygen were carried out to calibrate the pulsed oxygen system (ENDECO) which is continuously operating on board. Samples were also analysed for chlorophyll a, particulate organic carbon and cell numbers.

BENTHOS

Five box cores were processed out of the nine box cores obtained from the grid survey at each site. The cores received the following treatment:

1. Microfaunal samples - five replicate 10 cm diameter cores to maximum depth possible. Shipboard initial sieving and preservation, stored for laboratory processing.
2. Sediment sample (water content/grain size) - one 6.5 cm diameter core to maximum depth, frozen for laboratory analysis.
3. Sediment sample (mucus content) - one 3.5 cm diameter core to 5 cm depth, frozen for laboratory analysis.
4. Sediment sample (chlorophyll a, phaeophytin content) - one 1.5 cm diameter syringe to 0.5 cm depth, frozen for laboratory analysis.
5. Sediment temperature recorded at 10 cm depth using a digital probe.
6. General observations - note on RPD, feeding traces, rare macrofauna, fecal layer, sediment size changes, surface topography, etc., and where possible photographic records were taken.

Colin Griffiths
Principal Scientist

20th November 1989.

Circulation - North Sea Steering Group (M. Blackley) - 3 copies
- NERC HQ
- RVS (Dr. C. Fay) - 2 copies
- BODC (Dr. M.T. Jones)
- SERE participants

TABLE 1 Details of Moorings

Moorings	Position		Instrument	Depth	Deploy	Recovery
	Lat	Long				
SOUTH SITE			30 m		All times G.M.T.	
R356 Met buoy	52:39.42N	03:40.45E	✓POL-met logger		0521/12.5.89	1516/21.5.89
R357 Wave rider	52:39.36N	03:40.46E	✓		0548/12.5.89	1751/21.5.89
R355 STABLE	52:39.32N	03:40.13E	✓		1340/12.5.89	0627/22.5.89
R351 Rig 1	52:39.16N	03:40.36E	TR ✓852 19m S4 ✓714 ✓17m ✓Valeport ✓12.5 S4 ✓715 ✓11m RCM8 ✓9652 ✓9m RCM8 ✓9680 ✓3m TR ✓853 2m		1652/12.5.89	0522/22.5.89
R353 ETA	52:39.92N	03:40.14E	S4 ✓195 5m S4 ✓258 10m Argos transmitter on buoy		1830/12.5.89	1721/21.5.89
R354 CM/TG	52:39.53N	03:39.88E	RCM ✓1750		0820/13.5.89	1820/21.5.89
R355 ADCP	52:39.36N	03:39.96E	Polydop ✓4		1549/13.5.89	1449/21.5.89
SMBA	52:39.10N	03:39.80E	S4 ✓957 2m S4 ✓858 4m		0900/16.5.89	1400/21.5.89
NORTH SITE			48 m			
R356 Thermistor	54:34.90N	04:49.93E	✓T1146-1685	41m	0750/14.5.89	0843/20.5.89
R357 Cm's	54:34.91N	04:50.38E	✓RCM7 9634 21.5 ✓TR 834 20.5 ✓RCM8 9650 10m ✓TR 487 9m ✓RCM8 9643 5m ✓TR 561 4m		1004/14.5.89	0759/20.5.89
R358 ADCP	54:34:88N	04:51:09E	✓Polydop 9		1537/14.5.89	0953/20.5.89

✓ cm's