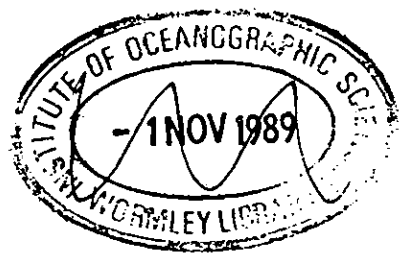
RRS CHALLENGER

FINAL REPORT CRUISE 60/89
6 - 19 SEPTEMBER 1989

Dr Martin R. Preston
Oceanography Laboratories
Earth Sciences Department
Liverpool University



RRS CHALLENGER CRUISE 60/89

6 - 19 September 1989

Overall Scientific Aims:

To undertake the last in a series of three studies of sediment resuspension at two sites in the southern North Sea. This project is part of the process study objectives of the NERC North Sea Project.

Scientific Personnel

M R Preston	LUDO - Principal Scientist
A J Bale	PML
R J M Howland	PML
A Rowden	PML
D Flatt	POL
J Humphrey	POL
D Leighton	POL
C Jago	UCNW
S Jones	UCNW
D Boon	UCNW
R Wilton	UCNW
J Jackson	MARC
G Knight	RVS
D Phillips	RVS

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 sedimentalogical characteristics and geotechnical, geochemical 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 develop a detailed model interrelating 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, chemical, sedimentalogical 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 grab and box cores.

The two sites (Figure 1) are 1) Northern site, 54°35'N 04°50'E, 45m depth, muddy sand, seasonally stratified water column and 2) Southern site, 52°40'N 03°40'E, 27m depth, sand, permanently well-mixed water column.

Summary narrative

Challenger left Gt. Yarmouth at 12.15 hours on 6 September 1989 and sailed directly to the northern study site at 54°35'N 04°50'E. On

arrival a total of 11 moorings were deployed and a twelve hour tidal cycle study involving CTD casts and settling velocity tube (SVT) deployments was carried out. In later tidal cycle studies pumped sampling from different depths for zooplankton collection was also performed.

On leaving the northern site Challenger proceeded to the southern study site at 52°40'N, 03°40'E. On arrival bad weather interrupted scientific activities for about 24 hours. When conditions improved three moorings were deployed and Day grab samples from a 25 point grid centred on the study position were collected. A small number of box cores were collected for benthic, geophysical and chemical measurements and a 12 hour tidal cycle study was worked.

For the remainder of the cruise Challenger steamed between sites working tidal cycle stations at each site and collecting grab and box core samples and camera pictures around a 25 point grid centred on the site. A large volume sediment trap was deployed before, and recovered after, nearly all tidal cycle studies.

At the end of the cruise all moorings were recovered with the exception of a Waverider buoy which went missing after only a few days deployment.

Despite interruptions of the programme by occasional bad weather all the principal objectives of the cruise were achieved and the cruise as a whole can therefore be counted as being very successful. Challenger docked at Gt. Yarmouth at 03.00 hours on Tuesday, 19 September 1989.

Narrative

5 Sept 1500 Scientific personnel embark at Great Yarmouth. Loading, servicing and commissioning of equipment.

6 Sept 1215 Leave Great Yarmouth and steam directly to northern site.

7 Sept Arrive northern site 0715 and deploy rigs 6,5,10,1,9 and 11. Moorings completed at 1847. Overnight tidal cycle study started deploying CTD and settling velocity tubes.

8 Sept 0745 tidal cycle completed. 0809 rig 11 recovered. 0836-1100 bottom camera deployed whilst ADCP mooring prepared. 1131 ADCP (Rig 8) deployed followed by rigs 2,3,4 and 7. Steam to southern site overnight.

9 Sept 0432 arrive southern site. 0744 transmissometer calibration completed but bad weather conditions prevented any other scientific activities all day.

10 Sept 0803 deploy rigs 1,2 and 3. Day grab samples collected at all points on the southern 5 x 5 station grid. 1804 tidal cycle study begun with SVT deployment. Submersible pump sampling performed.

11 Sept 0724 tidal cycle study completed. 0747 rig 3 recovered. 0845 box coring until 1218 then steam to northern site. Repairs to box corer undertaken during passage.

12 Sept 0640 arrive northern site. 0737 commence box coring and grab sampling. All sampling completed at 1742 and rig 11 deployed at 1756. Visual check of rigs revealed that the waverider mooring appeared to be missing.Tidal cycle study begun at 1907 with CTD cast.

13 Sept 0735 tidal cycle completed. 0758 rig 11 recovered. 0848 Z boat deployed to replace batteries in rig 10 lights. Whilst Z boat away bottom camera was deployed at selected stations. 0958 Z boat recovered. Camera stations completed 1315. 1536 rig 11 deployed. 1734 tidal cycle study begun with CTD cast.

14 Sept 0735 tidal cycle completed. Looked for waverider mooring but nothing found. 0828 rig 11 recovered. 0911 rig 3 recovered. 0922 leave for southern site.

15 Sept 0000 arrive southern site. 0019 - 0533 deploy bottom camera at grid stations. 0616 - 1016 deploy camera and box corer. Recover rigs 1,2 and 3. 1510 commence echo sounding survey of grid steaming at 5 knots. 1654 complete echo sounding. 1737 begin tidal cycle study with CTD cast. Tidal cycle work stopped at 2318 on advice of master about deteriorating weather conditions. Steam to northern site.

16 Sept Arrive northern site and recover rigs 4,8,9 and 2. 1931 commence tidal cycle study.

17 Sept 0631 tidal cycle study completed. Recover rigs 10,1,5 and 6. Bowthruster failed during recovery of one mooring but was repaired fairly quickly. Waverider buoy confirmed as missing. 1359 steam to southern site.

18 Sept 0328 arrive southern site and immediately begin tidal cycle study with CTD cast. 1605 tidal cycle completed and steam to Great Yarmouth arriving alongside at 0300.

Report on Scientific Results:

Moorings: The numerous moorings deployed included STABLE, Aanderaa and S4 current meters, transmissometers, sequential and large volume sediment traps, a tide gauge, the ETA rig, a Waverider buoy and a MET buoy. All were recovered safely except the Waverider (lost), 1 transmissometer (leaked) and a spar buoy (probably pinched). Good data was recovered from all systems except the met buoy and 1 S4 (1308). The met buoy failed to respond to the data retrieval programme but may still give up good data. The S4 failed to record any data but worked when tested on the ship after recovery. The other three S4s all had records shortened by a few scans due to being reset brfore the 'Q' command had been given.

The UCNW transmissometers were successfully calibrated before and after deployments and, with the exception noted above, worked well. Preliminary findings indicate significant variations in suspended matter loadings due to tidal resuspension. A number of larger resuspension

events superimposed on the background were noted. These are possibly associated with changes in weather conditions during the deployment period.

UCNW measurements of geophysical properties and collection of samples for porosity measurements and lacquer impregnation were also successfully achieved from box cores.

Settling Velocity Tubes: These were of a new design by UCNW and after some initial minor setting up problems worked very successfully and were deployed in conditions of up to about force 8.

Benthos: Once the box corer had been sufficiently repaired to function a total of 10 box cores were taken for examination of the macrobenthos. Five replicate cores (10cm diameter) to the maximum depth obtainable were taken from each box core to assess what species were present and their abundance. These were pre-sieved on board through a 0.5mm mesh and preserved using formalin.

One core (6.5cm diameter) was taken from each core sample to a mimimum depth of 20cms. This was frozen and returned to the laboratory for sectioning. The water content, organic carbon content and grain size will be determined for each section.

One sediment core (4cm diameter) was taken to a depth of 5cms and frozen for return to the laboratory. The mucus content of this will be determined when a suitable method has been devised.

A small surface sample was collected from each box core. This was frozen and returned to the laboratory for measurement of the pigment content.

Observations were made on each core, and notes taken about such things as the RPD layer, sediment structure, dead faunal remains, surface topography and the presence and numbers of conspicuous animals.

After collection of the sub-samples noted above the remainder of the sediment in the box was sieved through a 2mm mesh to obtain improved abundance estimates of the larger and lower density macrofauna in particular Echinocardium cordatum and Callianassa subterrenea.

An additional core was taken for resin casting which was quite successful with a significant fraction of the burrow system yielding casts.

Sediment Traps: Both sequential and large volume sediment traps were deployed and good samples were obtained from each system. At the northern site a Parflux trap and a PML trap were deployed on the same mooring to allow comparisons to be made of collection efficiencies.

The only problems encountered were with the acoustic releases which proved to be unreliable and which were therefore not included in the moorings as had originally been intended. This meant that had the surface markers had been lost it would have been very difficult to locate and recover these moorings. In the event no such disaster occurred and the traps were recovered without problems.

The samples were sub-divided for distribution to different laboratories where both chemical and biological examinations will be made.

Pumped sampling: Samples from three depths were obtained from each deployment of the pumping system (every two hours approximately during

most tidal cycle studies: a total of 114 samples i.e. 38 profiles x 3 depths). Samples were filtered to permit estimation of the total particulate loading and further samples were collected for estimates of the chlorophyll concentrations and for the identification of phytoplankton species.

Zooplankton sampling was performed by pumping large volumes of water through 200um mesh. Samples were preserved with dilute formalin and returned to the laboratory for taxonomic investigations.

Samples for taxonomy and biomass measurements were taken at three depths every two hours from the Go-Flo bottles on the CTD rosette.

Chemistry: 38 grab samples and 5 box core samples were obtained for chemical analysis. Suspended particulate and dissolved samples were obtained from 4 tidal cycles. Nutrient and dissolved aluminium analysis was performed on board on all water bottle samples. A number (19) of samples for subsequent trace metal analysis were collected, eight during a tidal cycle at neaps and eleven during a tidal cycle at springs. Problems with getting the ultra-clean Go-Flo bottles from Southampton University into workin order limited the number of samples collected at neaps.

A number of kinetic experiments were performed in which sections of a sediment core form the northern site were resuspended in sea water. The results consistently show a release of both aluminium and nutrients from the sediment during the resuspension process.

A total of 84 CTD casts were made over the two study sites.

Scientific Equipment:

Before departure the shipboard Atlas crane, which had previously been giving problems was serviced but due to the short time available only rather temporary repairs were made. Although functional during the cruise this crane gave occasional minor problems and should be given a proper overhaul at the refit, if not before.

The wire-out indicator on the CTD/hydro winch gave occasional problems with the readings sometimes jumping causing the winch driver to lose track of the instrument depth.

The RVS supplied box corer was found to be practically unusable as supplied because of a very poor seal between the box and knife. A repair of sorts was effected using ship's stores of rubber sheet and glue but this should be regarded as temporary. It was also found necessary to make two additional locking pins to prevent slumping of the box when tension was released from the suspension wire. The box itself is rather distorted and overall the system needs a major service before reuse.

There were also problems with the RVS supplied acoustic releases and after one had opened prematurely on the deck during the final stages of a mooring preparation it was decided that it would be safer not to use them at all despite the risk of being unable to retrieve rigs whose surface markers had been lost.

The ultra-clean Go-Flo bottles supplied by Southampton University were also found to be unusable as supplied. None of the bottles had complete lanyard sets and although two bottles were made functional using RVS spares there were not enough spare lanyards to repair all the bottles.

The CTD generally behaved well but exhibited erratic behaviour when confronted with a sharp thermocline which caused loss of some data in this zone. The wire to CTD connection was remade but the problem persisted. It was not possible to identify whether this was a hardware or software problem. It will be necessary to check the data from any stratified regions as soon as possible after collection.

The air conditioning fan is the clean chemistry container appears to have failed resulting in uncomfortably high working temperatures.

The "constant temperature laboratory" is neither constant nor cool unless an additional seawater supply is diverted from the deck washing system.

Acknowledgements

I should like to take this opportunity to express my gratitude to Captain Peter Maw, his officers and crew for helping to make this a most successful cruise.

Martin Preston.

Martin Preston
Principal Scientist.

28 September 1989

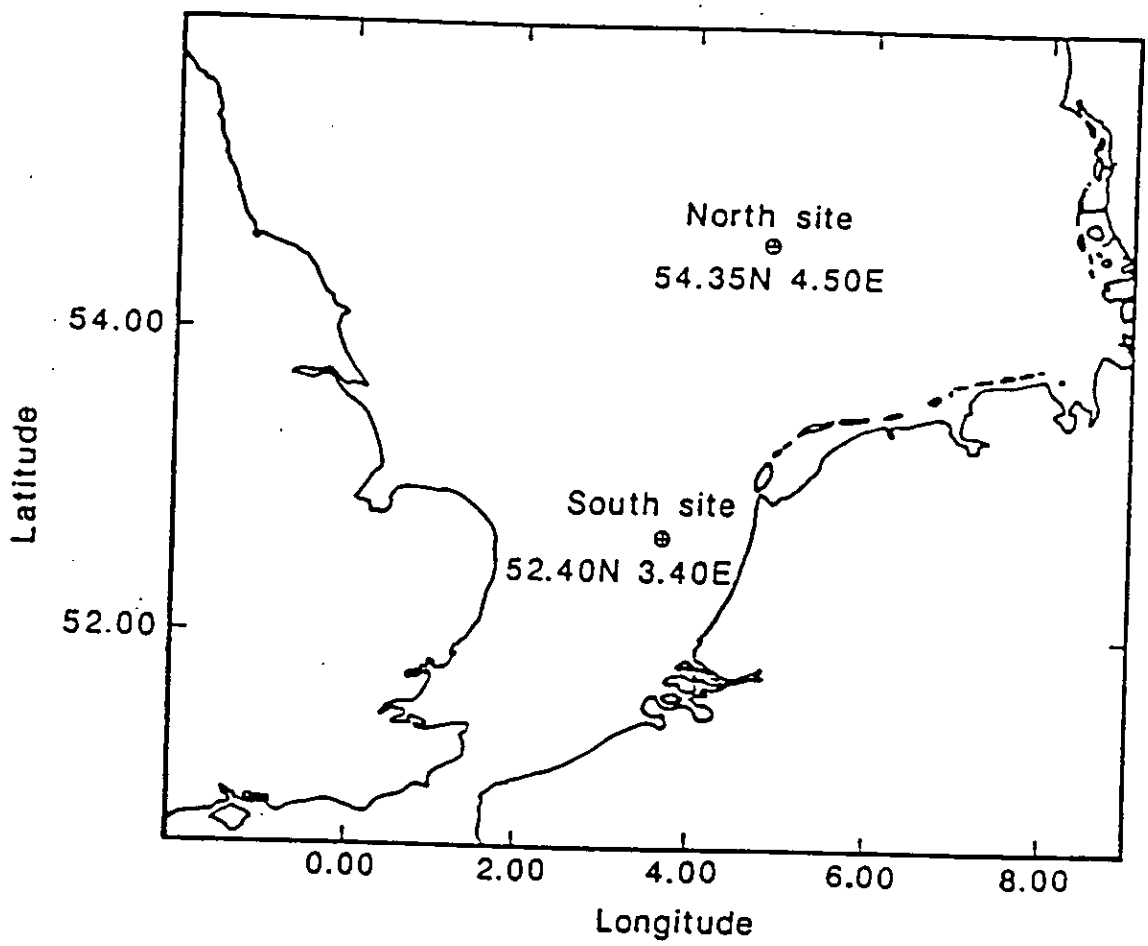


Figure 1. Location of the two experimental sites in the southern North Sea.

APPENDIX 1 DETAILS OF MOORINGS

	Rig No	Name
		Northern site
R410	1	✓ Current meters and transmissometers Rig 1
R411	2	✓ S4 current meters 2 × 543 Rig 2
R412	3	✓ ETA rig 2×545
R413	4	✓ Bottom current meters and tide gauge
R414	5	✓ STABLE
R415	6	✓ Met buoy
R416	7	✓ Waverider buoy
R417	8	✓ ADCP (#4.)
R418	9	✓ Thermister chain
	10	Sequential sediment traps
	11	Large aperture sediment trap * /S4
		Southern site
R420	1	✓ Current meters and transmissometers
	2	Sequential sediment trap
	3	Large aperture sediment trap*
R419	4	✓ ADCP (#7)

* The large aperture trap was deployed only over the period of tidal cycle studies (weather permitting). On some occasions it was also fitted with a near-surface array of S4 current meters

Appendix 2 Positions and results of moorings

	Rig No	Position	Comments
RU10	1 ✓	54°34.7'N 04°49.2'E	Deployed 1615:7/9/89 Recovered 0929: 17/9/89 Good data except from bottom transmissometer which had leaked causing total failure CM + xmiss
RU11	2 ✓	54°34.91'N 04°50.23'E	Deployed 1224:8/9/89 Recovered 1733:16/9/89 Good data though some records shortened by a few scans due to being reset before the 'Q'command had been given 2 × S4
RU12	3 ✓	54°34.59'N 04°50.23'E	Deployed 1335:8/9/89 Recovered 0911:14/9/89 Good data except for 1 S4 which failed to record though appeared to work properly after recovery CTA
RU13	4	54°35.75'N 04°50.85'E	Deployed 1543:8/9/89 Recovered 1432:16/9/89 Good data - spar buoy lost Bottom, TG/Cm
RU14 ✓	5 ✓	54°35.40'N 04°50.73'E	Deployed 1114:7/9/89 Recovered 1135:17/9/89 Data not examined on board STABLO
RU15 ✓	6 ✓	54°34.7'N 04°49.2'E	Deployed 0741:7/9/89 Recovered 1357:17/9/89 Unable to retrieve data from buoy at sea but data may be retrievable at POL Met buoy
RU16 ✓	7 ✓	54°34.59'N 04°48.60E	Deployed 1644:8/9/89 Lost Waverider
RU17 ✓	8 ✓	54°35.16'N 04°50.74'E	Deployed 1131:8/9/89 Recovered 1459:16/9/89 Good data ADCP
RU18 ✓	9 ✓	54°35.21'N 04°48.59'E	Deployed 1801:7/9/89 Recovered 1610:16/9/89 Good data Th. Ch
✓	10 ✓	54°35.43'N 04°50.00'E	Deployed 1333:7/9/89 Recovered 0750:17/9/89 Good samples Sed trap
✓	11 ✓	54°35.13N 04°49.34E	Deployed 1845:7/9/89 Recovered 0817:8/9/89 Sed trap

			Good sample
	11	54°35.15'N 04°49.37'E	Deployed 1756:12/9/89 Recovered 0758:13/9/89 Good sample Sed trap
	11	54°34.96'N 04°48.35'E	Deployed 1539:13/9/89 Recovered 0828/14/9/89 Good sample Sed trap
	Southern site		
R4'20	1	52°40.2'N 03°40.8'E	Deployed 0803:10/9/89 Recovered 1340:15/9/89 Good data CM + X mtr
	2	52°40.57'N 03°40.39'E	Deployed 0907:10/9/89 Recovered 1145:15/9/89 Sed trap Good sample
	3	52°40.19'N 03°39.30'E	Deployed 1522:10/9/89 Recovered 0747:11/9/89 Good sample Sed trap
R4'17	4	52°40.17'N 03°39.19E	Deployed 1508:10/9/89 Recovered 1253:15/9/89 Good data ADCP