CRUISE REPORT

CRUISE: RVS Cruise CH78/91; Sediment Resuspension Group (SERE) Cruise IV

VESSEL: RRS *CHALLENGER*

PERIOD: 23 April to 09 May, 1991

PERSONNEL:

A W Morris	PML - Senior Scientist
A J Bale	PML
A Fern	RVS
D Flatt	POL
A J Harrison	POL
R J M Howland	PML
J Humphery	POL
S Jones	UCNW
A Nield	UCNW
R Palin	POL
D Phillips	RVS
A A Rowden	PML
P G Watson	PML

ACKNOWLEDGEMENTS:
The excellent services afforded by Captain Geoff Long and his officers and crew are most gratefully recorded.

OBJECTIVES:
1, To evaluate the hydrodynamic processes controlling the resuspension of sediment at a muddy coastal site in the Irish Sea.
2. To evaluate the influence of sedimentological characteristics and geotechnical and geophysical properties of the bed on resuspension.
3. To examine the role of benthic organisms in sediment resuspension and deposition processes.
4. To determine the impact of sediment resuspension on water quality through its influence on trace metal and nutrient exchange processes.
5. To develop a detailed model interrelating vertical current structure and suspended sedimnet concentration at a point site and to use this model as the basis for constructing a fine grid, three dimensional model of the observational area.

ITINERARY: All times BST. Figure 1 shows the positions of the main experimental site with its grid of nine stations (WP11 to WP19) and the more extensive grid of stations (30 to 59) forming the wider surveyed region.

Sat, 20 April
POL party arrive Barry and commence loading and commissioning of equipment on board.

Mon, 22 April
UCNW equipment delivered and loaded aboard am. PML party arrive Barry

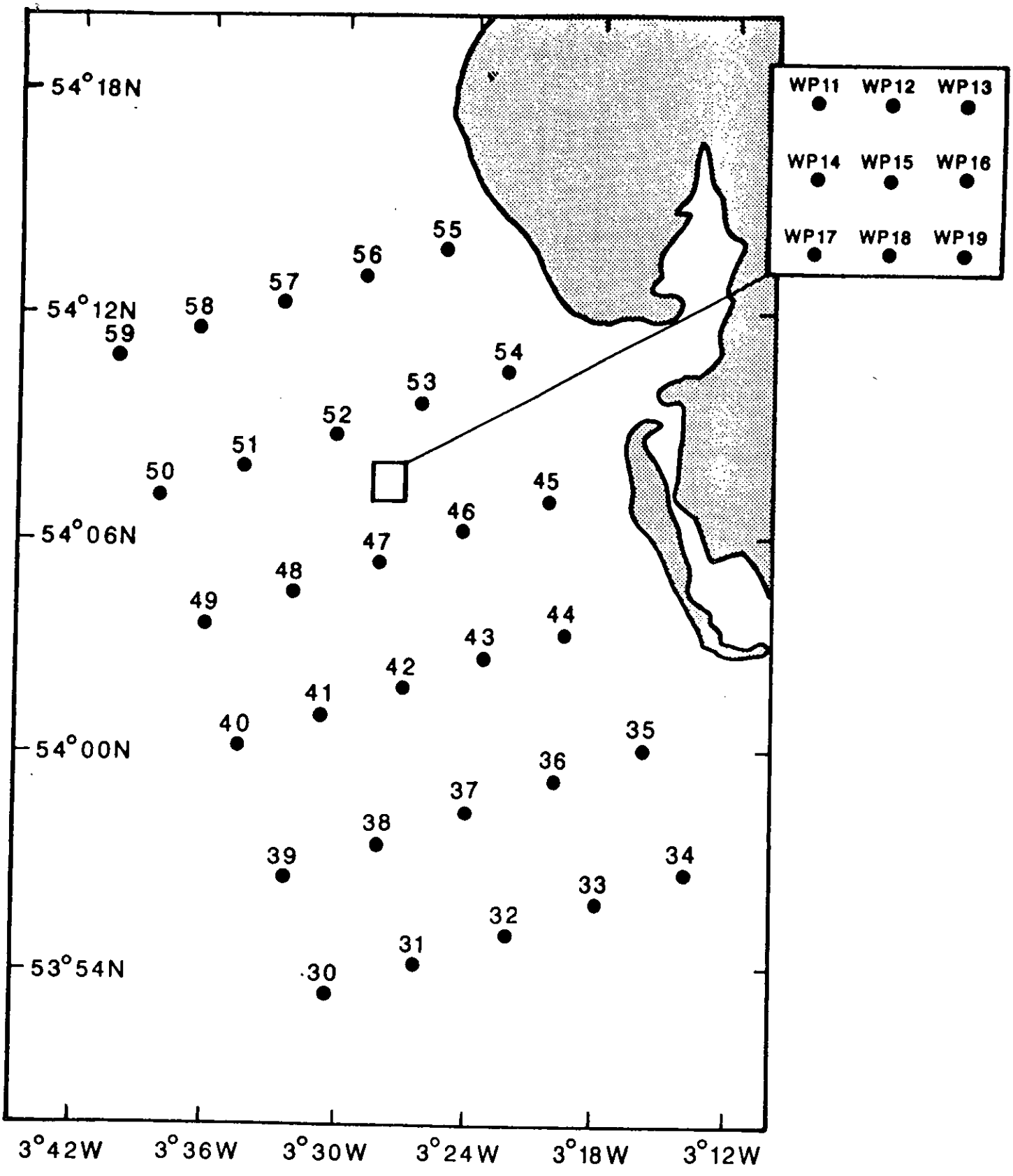


Figure 1. The experimental site in the NE Irish Sea.

1400, unload equipment onto vessel and commence commissioning. UCNW party arrive Barry 2100.

Tues, 23 April

Depart Barry 1300 and proceed directly to experimental site in NE Irish Sea (Approx. 1 mile square centred on 03° 27.2'W, 54° 07.5'N). Continue preparation of scientific equipment. Lifeboat drill 1630.

Wed, 24 April

Arrive at experimental site 1500. Immediately commence deployment of moored rigs. Metereological data buoy (Rig B) deployed approx. 1 mile to southwest of experimental station grid 1525. CTD drop for calibration of rig transmissometers, 1555-1615. Rig G deployed within experimental station grid 1645. Rig H deployed 10 miles south of station grid 1910. Return to station grid zone (2130) and commence overnight series of hourly CTD profiles at central grid station (WP15) alternated with circuits around grid zone with continuous monitoring of surface salinity, temperature, transmittance and fluorescence to quantify basic characteristcs of experimental site.

Thur, 25 April

CTD series completed 0730. Recommence rig deployments. Rig I (U shape, 2xS4) deployed at 54° 06.0'N, 3° 26.6'W, 0945. Rig J (ETA) deployed at 54° 08.9'N, 3°28.06'W, 1317. Rig C (ADCP pop-up) deployed at 54° 09.02'N, 3° 26.51'W, 1522.Rig D (ADCP L-rig) deployed at 54° 06.78'N, 3° 37.37'W, 1822. Transit to site of Rig H and commence overnight series of CTD profiling at 2000. Prepare Rig A (STABLE) overnight.

Fri, 26 April

CTD series completed 0700. Deploy Rig A (STABLE) at 54° 07.41'N, 3° 27.49'W, 0915. Deploy sediment trap 1010 at 54° 07.7'N, 3° 27.7'W for overnight sampling. Recieve VHF radio call 1000 from MAFF research ship *Cirolana* concerning deploying TETRAPOD in close proximity to STABLE: advise them of position of STABLE and other moorings. Rubber dinghy visit to STABLE to verify performance 1115 to 1215. Some problems noted, but not acute. Commence box coring at Stations WP11, 13, 15, 17,and 19 at 1330 to collect samples for on-board incubations for measuring sediment/water diffusive fluxes, to take samples for pore-water analysis and for subsequent laboratory analysis of metal content. Final box core taken at 1900. *Cirolana* sighted ca. 1700 near STABLE site.

Sat, 27 April

Successfully retrieve sediment trap 0630 and commence box coring at stations WP11 to 19, inclusive, for macrofaunal analysis and measurement of geotechnical properties of the sediment. Coring completed successfully 1700. Commence overnight hourly CTD profiling at site of rig H.

Sun, 28 April

Terminate CTD profiling 0600 and proceed to Bar Light off Liverpool to rendezvous with pilot vessel. A Harrison transferred to pilot as arranged 1000. A Bale also sent ashore with pilot for medical treatment. Return to experimental area 1300 and commence cicuit round larger grid (Stations 30 to 59) for characterising regional hydrography near spring tides. CTD dips at all stations with water bottle sampling (clean conditions) at every other station for particulate trace metal analysis.

Mon, 29 April

Circuit completed 0600. Proceed to grid centre and commence (0730) 24+ hour serial observations examining semi-diurnal spring tide variability in water column with CTD profiling at hourly intervals, interspersed with settling column deployments and trials of prototype near-bottom water column profiler.

Tues, 30 April

Anchor station completed 0630. Proceed to Liverpool Bar Light to pick up A Harrison and A Bale. Return to main experimental site 1330. Deploy sediment trap (with acoustic ranger attached for testing). Deploy experimental ADCP (rig E). Carry out ranging tests and trials of near-bed water column sampler. Return to grid centre and commence overnight CTD profiling with settling tube measurements and clean water bottle sampling for particulate metal analysis.

Wed, 1 May

Recover sediment trap and experimental ADCP rig successfully 0800. Commence sea bed photography around all stations WP11 to WP19 to 1300. Carry out serial observations using near-bed water column sampler 1000 to 1700. Redeploy sediment trap and experimental ADCP rig, 1900. Check moorings: all present and operating satisfactorily except wave rider light inoperative.

Thur. 2 May

Small boat to check STABLE performance 0830. Retrieve sediment trap and experimental ADCP rig by 1100. Return to WP15 and carry out tidal time series of deployments of near-bed water column profiler for nutrient chemistry and suspended solid load measurements with coresponding CTD profiling. Proceed to southern site and commence (1700) overnight series of hourly CTD casts with interspersed settling tube measurements.

Fri, 3 May

Overnight serial observations complete at 0800. Return to main experimental site and commence box coring. Samples at WP19, 15 and 11 taken for on-board incubation for measurement of sediment/water chemical diffusion fluxes, pore water profiles, chemical and biological sediment characterisation. Four additional cores taken at WP11 for collection of biological samples for laboratory experimentation. Deploy sediment trap 1600. Commence neap-tide repeat of survey around larger grid (Stations 30 to 59, but 45 omitted due to weather and proximity to coast).

Sat, 4 May

Larger grid circuit completed at 0915. Sediment trap retrieved 1045. Start 24+ hour neap tide anchor station at WP15 at 1200 with hourly CTD profiling, two-hourly settling tube deployments, sampling for particulate trace metal analysis at two-hourly intervals from 1900.

Sun, 5 May

Serial sampling at WP15 continued throughout the day, including near-bed profiler deployments pm. Serial observations terminated 1800.

Mon, 6 May

Collection of rigs started 0600. Successful recoveries of rigs I (at 0634), Rig J at 0720, Rig D at 0911, Rig c at 1045, Rig F at 1125 and Rig A at 1730.

Tues, 7 May

Repeat camera survey of inner grid stations (WP11 to 19) started 0900, finished 1130. Rig G recovered 1350 following close CTD deployment. Rig H recovered 1500 following close CTD deployment. Intercalibration of rig and CTD transmissometers completed 1650. Proceed to final rig (met. buoy, Rig B) retrieval at 1850. Depart for Barry.

Wed, 8 May

In transit. Scientific party decommission and pack equipment. Make good ship's laboratories.

Thur, 9 May

Dock at Barry, early am. Unload equipment and depart for home laboratories.

SUMMARY:

A highly successful cruise, no major problems were encountered and all objectives were achieved. All moored rigs were successfully deployed and recovered. Weather at no time interfered with work but was sufficiently windy at times to generate sediment resuspension events; *i.e.* optimum conditions were fortunately encountered. The results obtained have confirmed that this selected Irish Sea site is ideal for field investigations of both tidal and storm sediment resuspension and of their interactions. All data collected has been deposited in the BODC North Sea Data Base at Bidston to facilitate comparisons with the parallel North Sea observations carried out during the NERC North Sea CRP studies (RVS Cruises 44/89, 52/89 and 60/89).

RESULTS:

Physical measurements

Details of all moored instrument operations are listed in Table 1 and a siting plan is given in Figure 2. All moored equipment was successfully deployed and recovered and good quality data were recorded excepting one Aanderaa current meter (flooded) and the ADCP at the western position.

The moorings were deployed in time for spring tides on 28 April (average spring range) and were recovered at neap tides(slightly smaller than average neap range). The tidal current at the centre site did not exceed 0.6m/s and the currents rotated anti-clockwise round an ellipse whose major axis was orientated nothwest/southeast, parallel to the coast. At the southern site, tidal currents were stronger (variance twice that at main site), the ellipse was narrower and was orientated east/west.

Three small storms were experienced with winds gusting to 30 knots on 29/30 April, 1 May and 3/4 May. However the winds were generally offshore and consequently the maximium significant wave height was less than 1.3m.

The density field exhibited more small scale variability than anticipated. To determine temperature and salinity gradients (horizontally, vertically and in time), the CTD system was operated in two complementary strategies: hourly profiles with depth through 13 or 25 hours at the mooring sites and coverage of a spatial grid. The spatial grid of 30 stations took 16 hours to complete and was covered twice, on 28/29 April and on 3/4 May. Overall 189 CTD casts were recorded.

Water temperatures were around 8^{o}C as the sea warmed during spring. Some stratification in both temperature (up to 0.6^{o}C) and salinity (up to 1 psu) was recorded. The most plausible interpretation was that stratification at this time was controlled by tides; it was minimal along the southern grid line where tidal currents were strongest, along the grid line nearest the coast and at spring tide.

station	rig	instrument	position	deployed	recovered	depth
A	STABLE	stable	54:07:41N 3:27:59W	0814 26/4/91	1626 06/5/91	27m
		sparbuoy 4	54:07:45N 3:27:42W	0824 26/4/91		
B	MET. BUOY		54:05:93N 3:29:93W	1425 24/4/91	1750 07/5/91	24.5m
C	ADCP pop-up	poldop 4a frame D3	54:09:02N 3:26:51W	1422 25/4/91	0945 06/5/91	20m
D	ADCP "L-rig"	poldop 2a WLR 500 sparbuoy 3	54:06:78N 3:37:37W 54:06:73N 3:37:43W	1722 25/4/91 1718 25/4/91	0811 06/5/91	
E	ADCP single pt.	POLDOP 9a frame D5 acoustic 2B 1 ping	54:09:00N 3:26:51W	1441 30/4/91	0827 01/5/91	23m
	ADCP	POLDOP 9a EDO Tran. 275 pings	54:08:87N 3:26:49W	1805 1/5/91	1017 02/5/91	
F	WAVERIDER		54:05:99N 3:28:07W	0952 25/4/91	1025 06/5/91	
G	U shape	RCM4 6443 TRANSMISS.1 RCM4 4387 TRANSMISS.4 subsur. 18 torroid 9	54:07:69N 3:27:04W 54:07:60N 3:27:06W	1538 24/4/91 1538 1540 1540 1541 1546	1250 07/5/91	
H	U shape	RCM4 568 RCM4 9643 TRANSMISS.2 subsur. ? torroid 10	53:57:17N 3:19:49W 53:57:11N 3:19:39W	1801 24/4/91 1805 1805 1806 1809	1447 07/5/91	
I	U shape	S4 1644 S4 1196 subsur. 49 torroid 3	54:06:00N 3:26:6W 54:06:00N 3:26:7W	0840 25/4/91 0841 0843 0850	0534 06/5/91	
J	ETA rig	S4 1258 S4 1112 Transponder subsur. 9	54:08:90N 3:28:06W	1211 25/4/91 1211 1211 1217	0620 06/5/91	24m
sed trap			54:07:7 N 3:27:7 W	0910 26/4/91	0630 27/4/91	
		benthos	54:09:36N 3:26:08W	1457 30/4/91	0804 01/5/91	
		s4 1308 benthos	54:08:63N 3:27:20W	1746 01/5/91	0955 02/5/91	23m
		benthos	54:07:82N 3:28:06W	1425 03/5/91	0945 04/5/91	22m

WLR water level recorder,RCM4&7 Aanderaa current meter,S4 inter-ocean current meter, ADCP Acoustic Doppler Current Profiler.

Table 1. Summary of mooring operations during Cruise CR78.91.

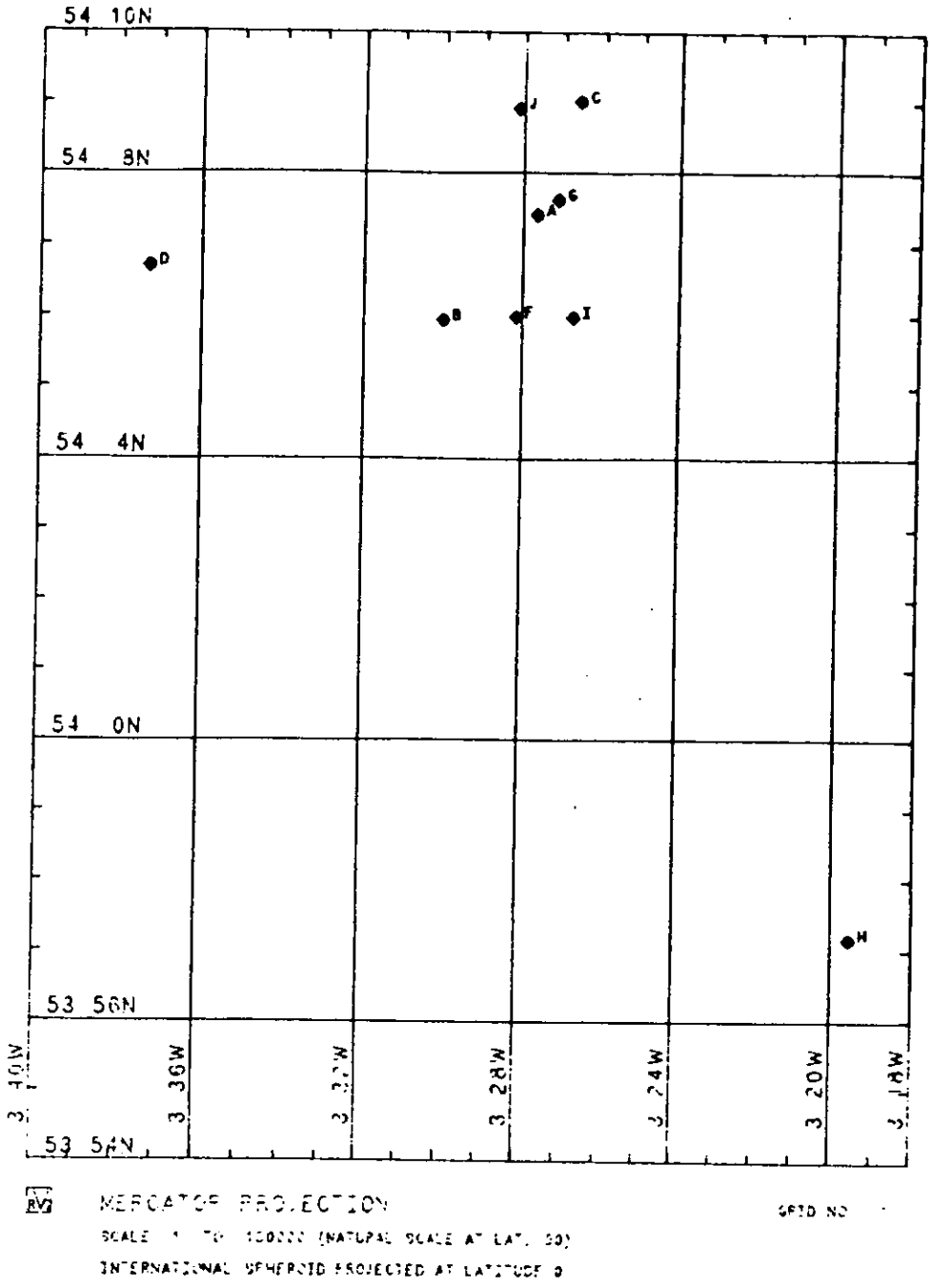
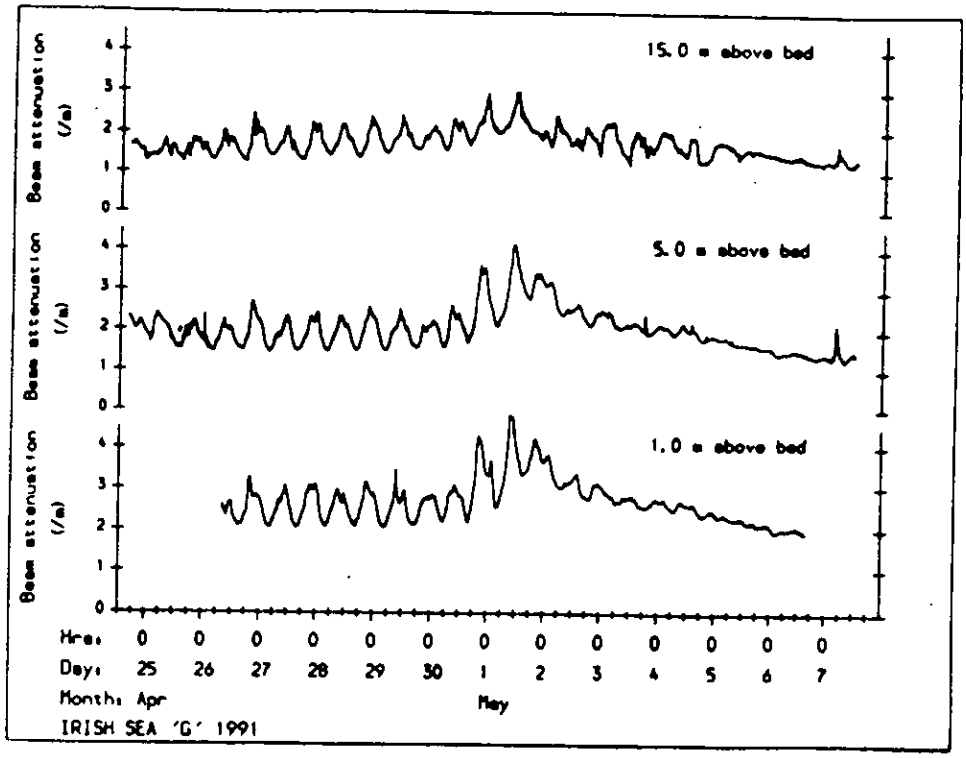


Figure 2. Positions of mooring rigs during Cruise CR78.91.



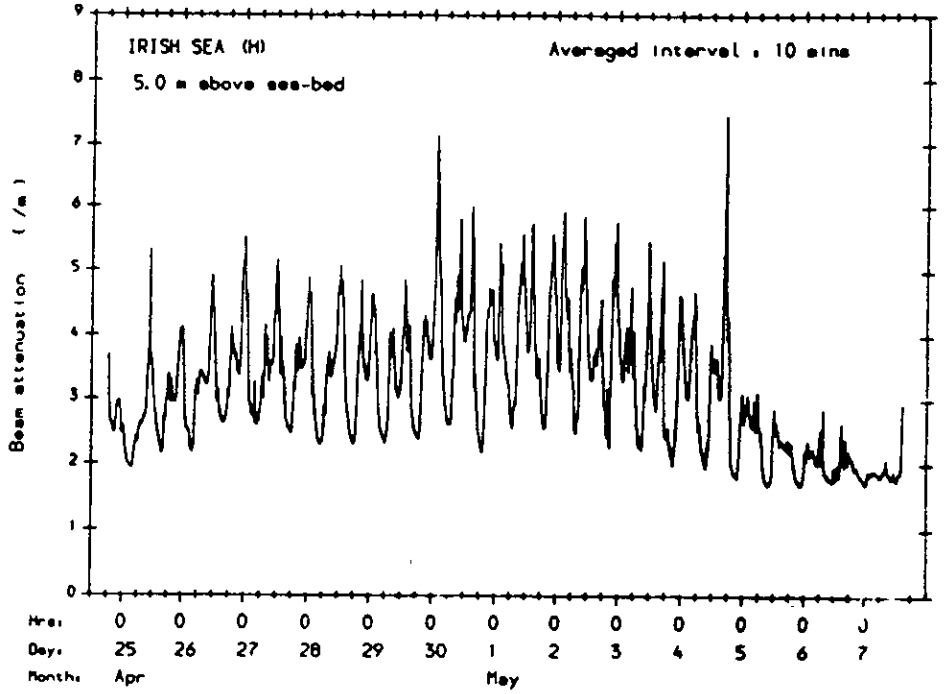


Figure 3. Beam attenuation recorded by moored transmissometers at 1, 5 and 15m above the sea bed at the central observation site (site G, upper plot) and at 5m above the sea bed at the southerly observation site (site H, lower plot).

Sediment resuspension

Figure 3 shows the beam attenuation recorded over 12 days by transmissometers moored at 1, 5 and 15m above the sea bed at the central site (mooring G, Figure 1). Tidal resupensioon around the spring tide of April 28 is evident (peaks approx. every 6h). These are superimposed on the more pronounced cyclic variation (approx. 12h period) due to tidal oscillation of a horizontal suspended sediment gradient across the recording site. A resuspension signal due to the windier weather from 29 April to May 1 is clearly evident. This is shown by enhanced tidally averaged attenuation, particularly at the lowest recording point 1m above the sea bed, gradually reducing over the next few days through settling.

The transmissometer moored at the southerly site (mooring H, Figure 1) shows much more pronounced tidal resuspension and horizontal tidal advection signals in keeping with the stronger tides at this point. A pronounced spring-neap cycle in the resuspension signal is also evident. This is disrupted by 'storm' resupension signals on 30 April and 4 May.

Biological measurements

Nine 0.25m^2 box cores were collected around a regular 1 square mile grid centered on 03°27.2'W, 54°07.5'N. The central station has a depth of 28m and a muddy-sand sediment. The proportion of mud in the sediment increases across the grid towards thw west. The cores have been used for quantification of macrobenthos and for measurements of geotechnical properties.

The macrobenthic community fits the description of an *Amphiura* assemblage similar to that at the northern experimental site in the North Sea. The dominant brittle star *Amphiura filiformis* increased in abundance across the grid towards the muddier western boundary. A good correlation between abundance and sediment compactness (as indicated by ultrasonic pulse velocity) was recorded. This agrees with the hypothesis developed from the North Sea investigations that the presence of *Amphiura* significantly affects the rigidity of near-surface sediment.

The mud shrimp, *Callianassa subterranea*, a major sediment bioturbator was also present. Abundance was about half that recorded at the northern North Sea site. Comparison of sea bed photographs from the two sites illustrates the reduced topographic influence of the smaller numbers at the Irish Sea site.

Report prepared by: 25/11/91

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