I.O.S.

R V SARSIA CRUISES 4/76
R V EDWARD FORBES CRUISE 16/76

a. R V SARSIA CRUISE 4/76 27 MARCH – 2 APRIL 1976
b. R V SARSIA CRUISE 4/76 5 – 15 APRIL 1976
c. R V EDWARD FORBES CRUISE 16/76 24 AUGUST – 17 SEPTEMBER 1976

a. SUSPENDED SEDIMENT MEASUREMENTS IN SWANSEA BAY
b. TURBULENCE MEASUREMENTS IN START BAY
c. SIZEWELL – DUNWICH BANK FIELD STUDY

CRUISE REPORT NO 44

1976

NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE OF OCEANOGRAPHIC SCIENCES

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RV SARSIA CRUISES 4/76
RV EDWARD FORBES CRUISE 16/76

a. RV SARSIA CRUISE 4/76 27 MARCH - 2 APRIL 1976
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24 AUGUST - 17 SEPTEMBER 1976

a. Suspended sediment measurements in Swansea Bay
b. Turbulence measurements in Start Bay
c. Sizewell - Dunwich Bank Field Study

Cruise Report No 44

1976

Institute of Oceanographic Sciences
Crossway
Taunton
Somerset

INSTITUTE OF OCEANOGRAPHIC SCIENCES

a) R V SARSIA
CRUISE 4/76

27 March - 2 April 1976

Suspended sediment measurements in Swansea Bay

CRUISE REPORT NO 44
1976

Institute of Oceanographic Sciences
Crossway
Taunton
Somerset

CONTENTS

SCIENTIFIC STAFF

A D Heathershaw (Principal Scientist)	27 March - 2 April
P Hooper	27 March - 31 March
C N Puckett	27 March - 2 April
T Upham	27 March - 2 April
G Yielding	27 March - 31 March

SHIP'S OFFICERS

Captain E Dowell (Master)

C George (1st Mate)

I Jude (Fishing Mate)

OBJECTIVES

The objectives of this cruise were twofold:

1. To test the new Pumped Sampling System (PSS) developed by IOS (Taunton) for measurement of suspended sediment fluxes;
2. To carry out tidal cycle observations of the suspended sediment concentrations and velocity profiles at a number of locations offshore between Port Talbot and Porthcawl (see Fig 1).

These observations form part of a larger study being carried out in the Swansea Bay area, by IOS (Taunton), which is directed towards identifying and possibly quantifying those processes responsible for the erosion of sand from the foreshore between Port Talbot and Porthcawl.

Pumped Sampling (PS) techniques have been introduced to determine the quantities and particle size distributions of material in suspension. It is hoped that simultaneous observations of the velocity profiles near the sea-bed will enable the sediment flux rates to be calculated and that tidal cycle measurements will enable estimates to be made of the net sediment transport rates and directions.

EQUIPMENT AND METHODS

The PSS equipment was designed and built at IOS (Taunton) and is shown schematically in Fig 2. The design was based upon that of similar apparatus at the Hydraulics Research Station, Wallingford. The sea-bed unit consists of a tubular steel frame having a triangular base. The frame also supports an 'instrument post' on which may be mounted up to six 12.5mm bore nozzles, for suspended sediment sampling. Also supported on the post are 4 Braystoke flowmeters for current speed measurements. Further provisions are made for mounting 2 electromagnetic flowmeters (for use in another experiment), the mounting of various electronic units, an underwater television system and an inclinometer. Also mounted on the frame is a solenoid valve unit which enables samples to be taken from any one of the six nozzles and pumped to the surface via a single hose; this is accomplished by energising the appropriate solenoid from the surface.

The underwater unit is lowered to the sea-bed on a single load wire. Separate electrical cables carry electrical power and signals between the solenoids, Braystoke flowmeters, underwater Television and the surface and a 50m, 12.55mm bore PVC hose carries seawater to the surface and the shipboard pump and filtration units.

Alignment of the probe with the mean flow is achieved by a large fin on the rear of the frame. All cables are attached to a bridle which falls to the rear of the frame when the latter is resting on the sea-bed.

Provision is also made on the shipboard pump and filtration units for the simultaneous measurement of suspended sediment fluxes at an intermediate depth with a roving unit. This latter unit consists simply of a nozzle attached to a Braystoke direct reading current meter with a separate 50m PVC hose.

Water samples are pumped, by Jabsco $\frac{1}{4}$HP electrical pumps (one for the sea-bed unit and one for the roving unit if this is being used), through 40 μm polyester gauze filters clamped in Sartorius 142mm PVC pressure filter holders. Total flows and flow rates are monitored with a Neptune rotary piston flow meter. Sediments finer than 40 μm are collected in 250 ml water samples for subsequent concentration measurements by filtering and weighing and by optical techniques (EEL long cell absorptiometer).

Initial measurements were made with nozzles and Braystoke flowmeters set at the following elevations:

Nozzle No.	Height*(m)	Braystoke No.	Height*(m)
1	.07		
2	.12		
3	.22	1	.22
4	.42	2	.42
5	.82	3	.82
6	1.72	4	1.72

*Spacing is roughly logarithmic

Information on the flow rates near the sea bed was obtained (as mentioned previously) with the Braystoke flowmeters. These were monitored continuously on board the surface vessel by interfacing them directly to a PDP8 computer. Thus the number of rotor revolutions at all four elevations were listed routinely, every 60s, on a Teletype. This information requires subsequent conversion to speeds in 'cm.s^{-1}', although rough conversions are possible at the time of collection.

Initial calibrations of the system showed that pump-line velocities of the order of .6 - .7 ms^{-1} could be obtained. These are comparable with the figure of .8 ms^{-1} obtained by the Hydraulics Research Station with similar PSS equipment and should have been great enough to prevent settling of particulate matter in the pump line. It was necessary to know the flushing time when changing from one nozzle to another. For the 50m hose this was of the order of 90s. This time could be measured directly, as the flushing of the line was usually found to be accompanied by the trapping of a small quantity of air in the hose which would cause the pump to 'race' when passing through it.

NOTE: The PSS equipment and methods of collecting and analysing suspended sediment samples are described in more detail in a separate report.

RESULTS

It was hoped to carry out PS observations over 1 tidal cycle at each of 5 locations (Stns. PS1 - PS5 in Fig 1). However, inclement weather conditions severely limited the work that could be carried out and it was decided to concentrate efforts on collecting information from Stn PS2 (approximately mid-way along the length of the foreshore being studied). About 18 hours of data (not continuous) were collected from this station.

A total of 113 filter samples and 113 water samples were collected from the bottom boundary layer during this period.

The amount of sediment that could be collected on a filter was found to be limited by the presence of large quantities of organic material in suspension. The effect of this was to cause the filter to become blocked after about 1 - 4 minutes of pumping. The subsequent build-up of pressure in the pump line could be monitored on a pressure gauge and it was thus possible to by-pass the filter unit before this became completely blocked.

A typical set of data is shown in Table 1 and Figure 3. These indicate the expected variations with height above the sea-bed, the total concentration of material coarser than 40 decreasing from .1g l^{-1} at a height of 10cm above the bed to .001g l^{-1} at a height of about 150cm above the bed. They also confirm that the concentration of coarse material falls off more rapidly than that of the finer material.

No data are yet available on the flow rates at each elevation and the water samples have not yet been analysed for the concentrations of material finer than 40 μm.

EQUIPMENT PERFORMANCE

It became apparent at an early stage in the cruise that a number of modifications to the PSS would be required before any further work is carried out. The major improvements that are required are as follows:

(a) It is necessary to decrease the time taken by the solenoid plungers in opening or closing. This can be achieved by machining grooves in the plungers thereby allowing a freer passage of the oil (in which the solenoids are immersed) between the plungers and the inside of the solenoid coil;
(b) New nozzles of a stronger construction are required and it is proposed to make these from stainless steel. The new nozzles would also be mounted on streamlined spars on the instrument post;
(c) A new manifold (connecting the six nozzles via the solenoid valves to the single hose) of stronger construction is required and it is also proposed to make this from stainless steel;
(d) It is necessary to redesign the pump and filter board to enable the simultaneous operation of two pumps and two filter units. New valves or taps are required which will enable a rapid changeover to be made between the filter lines and the by-pass lines.

Some difficulty was experienced with the focussing of the underwater television camera. However this was adjusted internally on a later cruise and operated satisfactorily. In Swansea Bay it is doubtful whether much could have been achieved with the camera due to extremely poor visibility.

Channel 4 of the Braystoke/PDP8 interface was found intermittently to give count rates which were apparently double the known count rate (when tested with a signal generator and also when in use with a flowmeter).

A fault on the 'line feed' of the teletype was also found to cause preceding lines of information to be 'overwritten' thereby making them unintelligible. It was therefore necessary, when possible, to carry out the 'line feed' manually.

The new rig was found to handle fairly easily and to align itself satisfactorily with the mean flow when suspended just beneath the surface.

However, it was necessary to replace the brackets supporting the ballast weights on the frame when the original supports were damaged beyond repair.

SHIP PERFORMANCE

For the successful operation of the PSS it is necessary to have the surface vessel anchored fore and aft. Experience has shown that a three-point anchoring system is best in this respect with two bow anchors and a single stern anchor. The RV Sarsia has again demonstrated its extreme usefulness for this type of work.

CONCLUSIONS

Given that weather conditions were far from ideal (making handling of the rig extremely hazardous at times) and that this was the first time that the PSS had been deployed, the cruise can be considered reasonably successful. It should be noted here that the rig and the PSS were used on a later cruise on the 'Sarsia' and that good results were obtained.

The results to date from Swansea Bay look promising and it is hoped that detailed measurements at the five locations shown in Figure 1 will be possible in 1977 from the RV Sarsia.

ACKNOWLEDGMENTS

We are grateful to Captain E Dowell and the Officers and Crew of the RV Sarsia for their co-operation throughout this cruise. We are especially grateful to the Chief Engineer for carrying out a number of repairs to our equipment. Finally we would like to thank Captain M Perry for making all the necessary arrangements to use the ship and Dr E Denton, Director of the Marine Biological Laboratory, for permission to carry out this work on the RV Sarsia.

A D Heathershaw
IOS Taunton
November 1976

APPENDIX I

Summary of Senior Scientist's Log

Friday 26.3.76 — IOS Taunton personnel travelled to Plymouth by train and equipment was transported to Plymouth by lorry.

Saturday 27.3.76 — Started loading equipment at 0900 and setting up the PSS. The ship sailed from Plymouth for Swansea Bay at 1600.

Sunday 28.3.76 — On passage to Swansea Bay. Anchored fore and aft at Stn.PS1 at 1230. Wind Force 4/5 - S/SW. Fairly heavy swell, about 2m high, running into Swansea Bay from SW. Conditions not ideal. Set up Braystoke flowmeters. Tried rig over side but abandoned attempts due to swell making handling very difficult. Checked air tightness of connections to manifold and flowmeters (on filter board) and located a number of small leaks. Weighed anchor at about 1430 and moved offshore to Stn PS5 to see if conditions were any better there. In the area of Stns PS4 and PS5 at about 1530. Conditions still too bad to work. Decided to seek shelter in Oxwich Bay until conditions improved. Anchored in Oxwich Bay at 1645. Carried out repairs to pump sampling equipment. Tried out equipment (over side only) at 1830 but still having trouble with leaks. Carried out calibrations on pumps to determine line velocities. Remained at anchor overnight.

Monday 29.3.76 — Forecast - 0635 Lundy: W 4-6 increasing 7 in N. No improvement in the situation, still a heavy swell running; decided to remain at anchor until mid-day to see if weather improved. No improvement by mid-day. Decided to remain at anchor in Oxwich Bay. Carried out various tests on the roving unit and pump and filter units.
Forecast - 1755 Lundy/Fastnet: W - NW 5-6 locally 7. Decided to remain at anchor in Oxwich Bay overnight. Conditions still too bad to handle rig with reasonable safety.

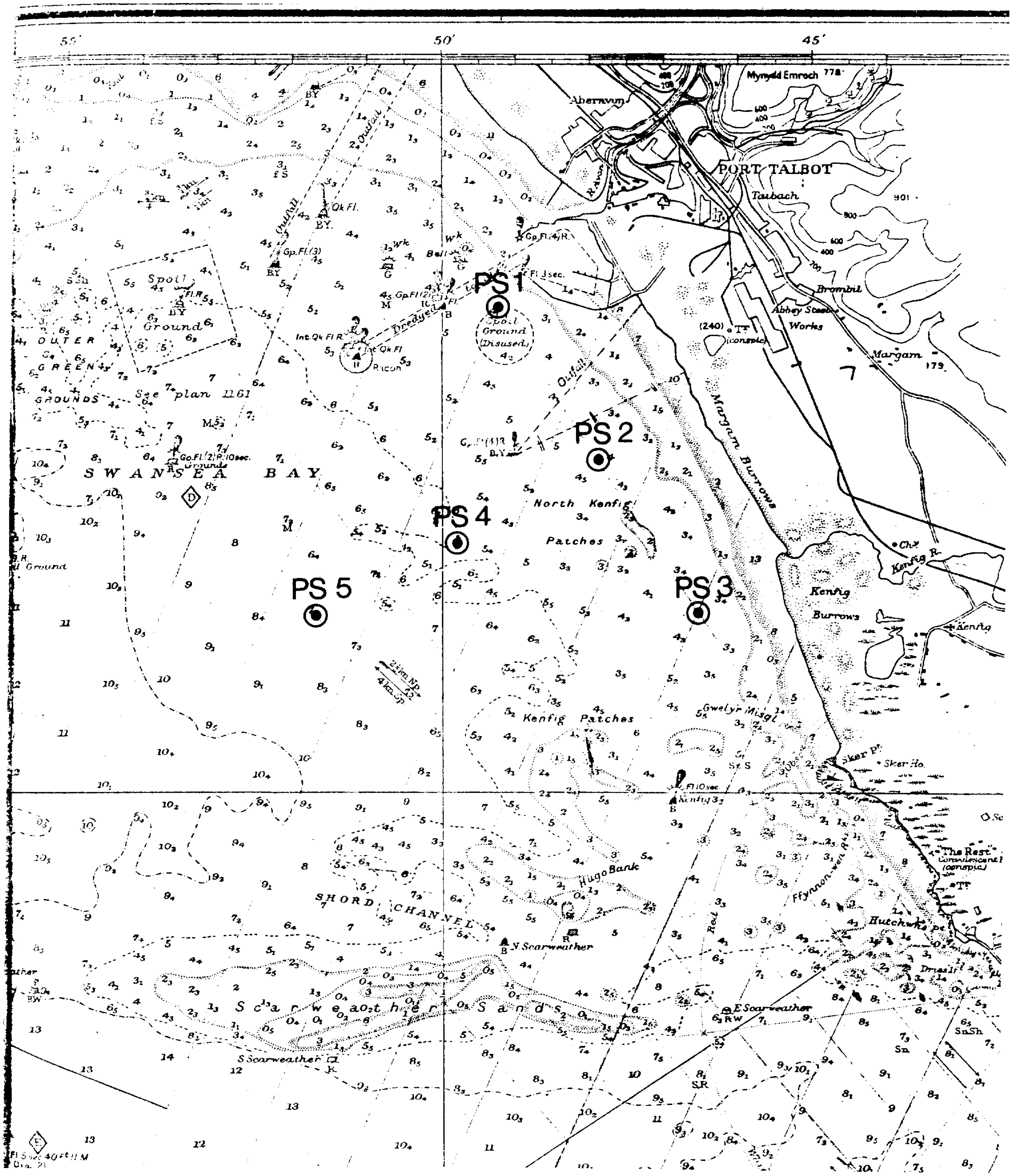
Tuesday 30.3.76	Forecast - 0635 Lundy: NW backing to SW 4-5 locally 6 later. Decided to attempt measurements at Stn PS2 although conditions not ideal. Anchored fore and aft on Stn PS2 at 0930. Started profile measurements at 1010. Lifted rig on board 1440. One Braystoke rotor and spindle missing. Replaced Braystoke parts. Launched rig again at 1530. Braystoke flowmeters still giving trouble. Lifted rig at 1945 and replaced Braystoke rotors at levels 1 and 2. Rotor at level 3 still causing trouble. Launched rig again at 2050 and commenced profile measurements at 2120. Continued profile measurements until 0315 (31.3.76) when difficulty was experienced with operating the solenoids. Lifted rig and found electrical cable to solenoids partially severed, underwater television lights damaged and brackets for ballast weights broken. Decided at 0400 to suspend any further work until daylight.
Wednesday 31.3.76	Forecast - 0635 Lundy: W 4-5. Proceeded to Swansea to put G Yielding and P Hooper ashore. 0800 anchored off Swansea waiting for a Pilot. 0930 alongside outer jetty Swansea G Yielding and P Hooper put ashore at 1100 and sailed from Swansea. Anchored under Mumbles Head at 1130 to repair equipment and wait for improvement in the weather. Forecast - 1755 Lundy: W - NW 4-6 locally 7 at first. At 1845 decided to abandon any further work due to deteriorating weather conditions and returned to Plymouth.
Thursday 1.4.76	On passage. Berthed at West Wharf, Plymouth at 1530. Moved into inner basin 1800.
Friday 2.4.76	Unloaded scientific equipment not required on following cruise, and IOS personnel, with equipment, returned to Taunton.

TABLE 1

Profile measurement No 7, Stn. PS2: Started 1610/30/3/76. Finished 1633/30/3/76

Sample No	Elevation (m)	Weights of inorganic material (g) Particle size ranges (μm)					Total weights (g)	Total concentrations (mg l^{-1})
		150	150-106	106-75	75 - 63	63 - 40		
37	.07	.0087	.0447	.1865	.1132	.2739	.6270	160.36
38	.12	.0107	.0300	.1251	.0990	.2800	.5448	92.18
39	.22	.0062	.0064	.0504	.0476	.1438	.2544	55.96
40	.42	.0026	.0040	.0386	.0534	.1587	.2573	36.05
41	.82	.0035	.0042	.0128	.0167	.1002	.1374	7.91
42	1.72	.0008	.0009	.0056	.0038	.0768	.0279	0.71

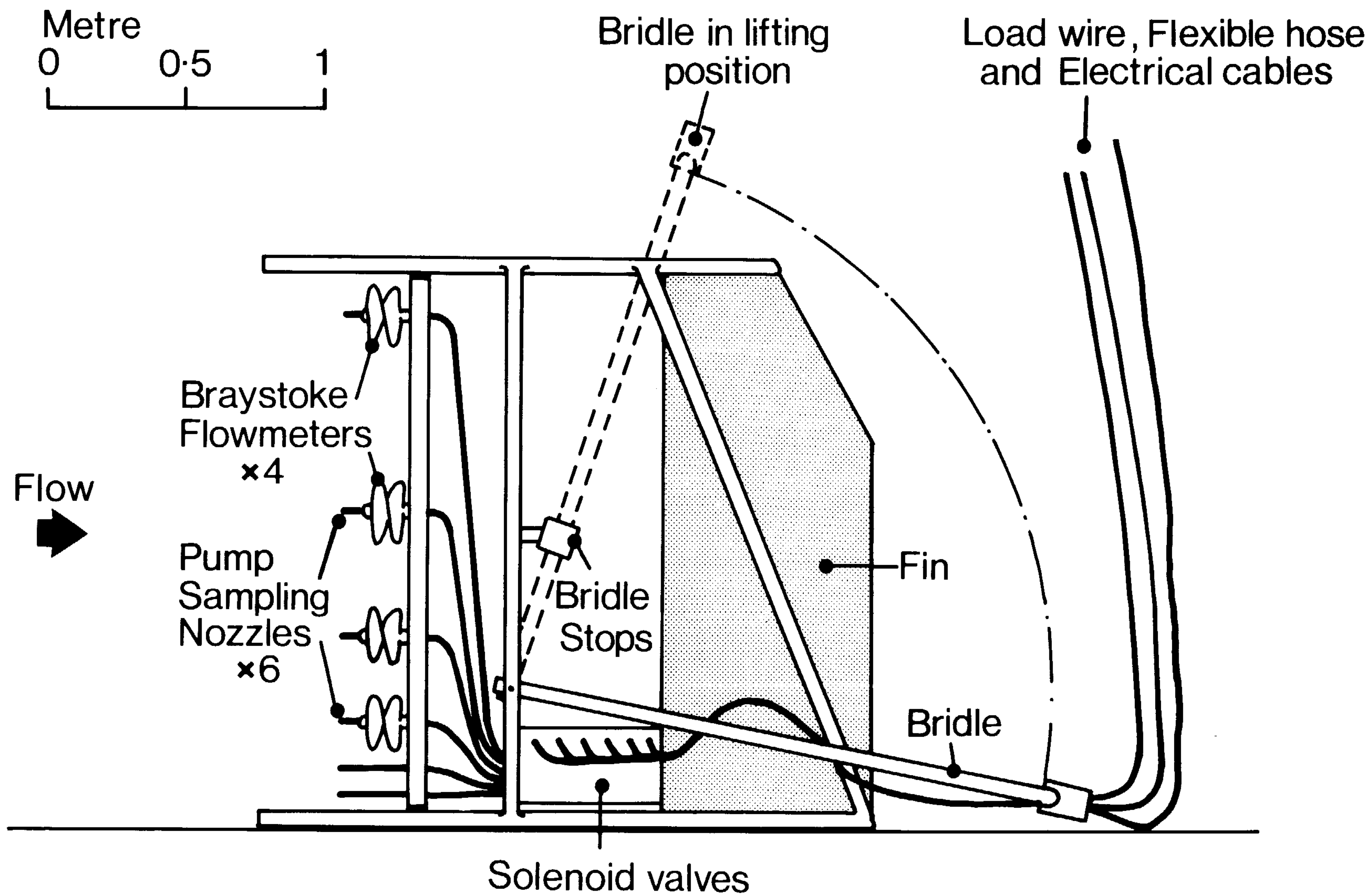
Suspended sediment concentrations in various particle size ranges from six elevations above the sea bed at Station PS2 (see Fig 1). The mean flow at the surface was approximately .5 ms^{-1}.



◉ Pumped Sampling Stations

Pumped Sampling Stations

Fig.1



Schematic diagram of Pumped Sampling Apparatus.

Fig. 2

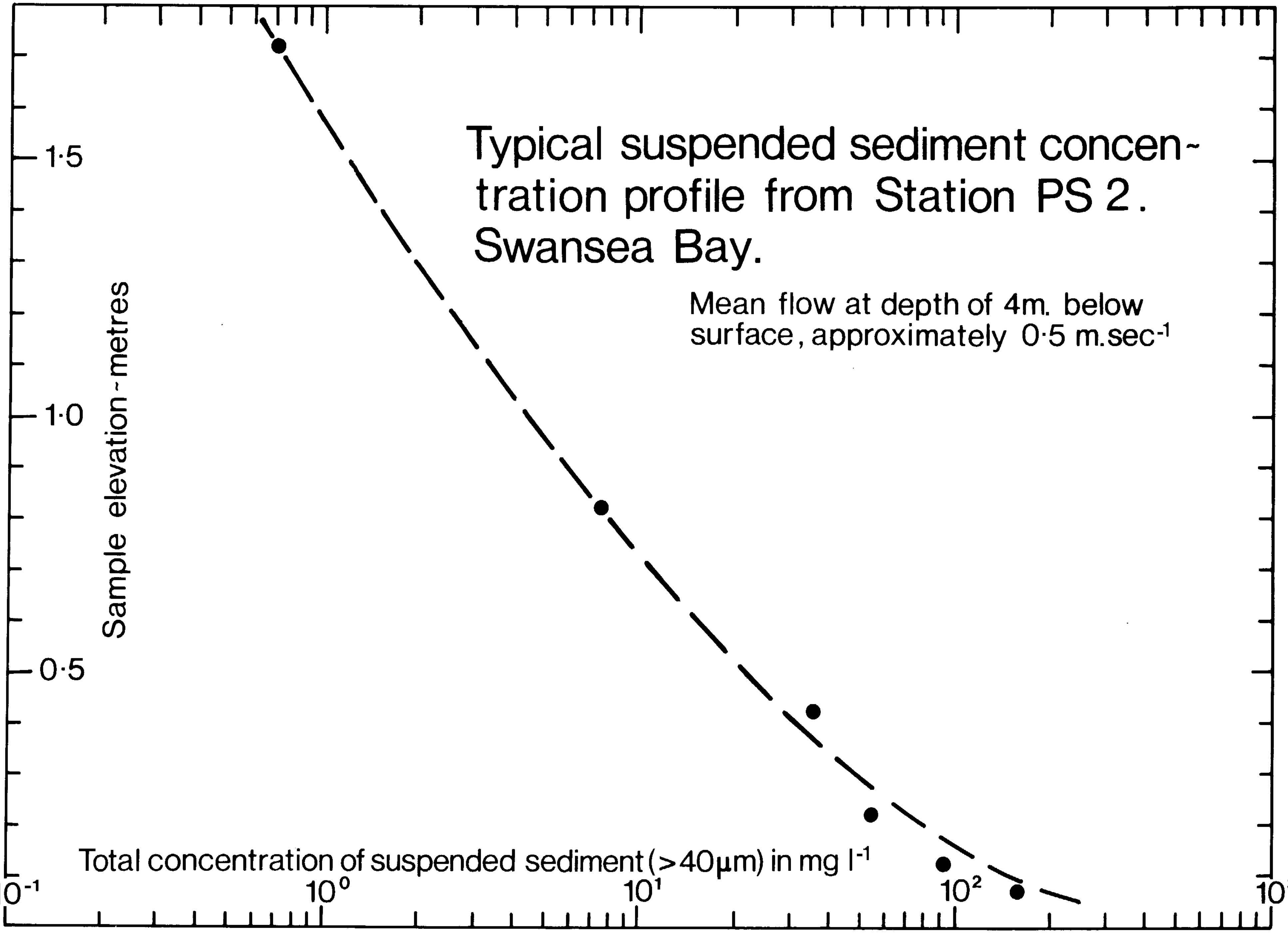

Typical suspended sediment concentration profile from Station PS 2. Swansea Bay.
Mean flow at depth of 4m. below surface, approximately 0·5 m.sec-1
Sample elevation - metres
1·5
1·0
0·5
Total concentration of suspended sediment (>40μm) in mg l-1
10-1
100
101
102
103

Fig. 3

INSTITUTE OF OCEANOGRAPHIC SCIENCES

(b) R. V. SARSIA
Cruise 4/76

5-15 April, 1976

Turbulence measurements in Start Bay

CRUISE REPORT NO. 44

1976

Institute of Oceanographic Sciences
Crossway
Taunton
Somerset

CONTENTS

SCIENTIFIC STAFF

R L Soulsby (Principal Scientist)	5 - 15 April
Dr A P Salkield	5 - 10 April
Dr A G Davies	5 - 9 April
M R Lees	5 - 15 April
M A S Moore	5 - 10 April
Dr K R Dyer	10 - 14 April
G P LeGood	10 - 15 April
E J Moore	9 April
C N Puckett	9 April

SHIP'S OFFICERS

Captain E Dowell (Master)

C George (1st Mate)

I Jude (Fishing Mate)

R Young (Chief Engineer)

G Parker (2nd Engineer)

J Taylor (3rd Engineer)

OBJECTIVES

The aim of this cruise was to continue and extend the measurements being made of sediment transport by turbulent tidal streams. A rig was deployed on the seabed, carrying instruments to measure the currents and monitor the sediment movement. Three experiments were planned, two to investigate the turbulent structure of the boundary layer and the third to investigate the suspended sediment concentrations.

Five sites were chosen within Start Bay to give a range of conditions for the experiments. The first two experiments needed to be performed in areas of no sediment movement, whereas the third experiment required as much movement as possible. All the work needed strong tidal currents, shelter from wind, waves and swell, and a flat bed. Depths, holding and currents must be compatible with good anchoring. It was not possible to meet all these conditions simultaneously, but the sites chosen gave a good compromise.

MEASUREMENTS

The three experiments performed were:

(1) Measurement of the vertical and horizontal structure of the intermittent bursts of turbulent momentum flux observed on previous cruises. This entailed using two E/M flowmeters, one held at a reference height of 35cm, while the other was placed successively at 15, 35 and 175 cm. For horizontal work the flowmeters were placed 50cm apart in the cross-stream direction, at a height of 35cm. This work was planned to give information about the size, 'shape' and strength of the burst-like events.

(2) Simultaneous measurement of U, V and W (downstream, cross-stream and vertical components of current). Normally only U and W are measured, and it is essential to find out what is entailed in ignoring the V-component. The two flowmeters were mounted with their stems at right angles to each other, and the heads close together, at 45° and -45° to the vertical respectively. Thus the upper flowmeter measured U and $\frac{1}{\sqrt{2}}(W + V)$, and the lower measured U and $\frac{1}{\sqrt{2}}(W - V)$.

(3) Pumped sampling to give a time series of suspended sediment concentration, while simultaneously making current measurements. This will give a quantitative measure of the sediment transport to be correlated with the measurements of bed shear stress and Reynolds Stress. The underwater TV monitored the performance

of the sampling system, as well as giving an independent indication of sediment movement. Time series were made at different heights, while occasional vertical profiles gave total suspended sediment transport rates.

Background information was obtained throughout the experiments:

(i) Tidal velocities and directions were measured at half-hourly intervals with a direct-reading Braystoke directional current meter at 5m depth.

(ii) A T-S bridge was used to take temperature and salinity profiles to ensure there was no density stratification.

(iii) Water depth was read periodically on the ship's echo sounder.

(iv) The attitude of the rig on the sea bed was monitored by an inclinometer indicating pitch and roll. A pivoted flag mounted about 20cm above the bed was visible on the TV, and indicated the flow direction at that point to assist with aligning the rig with the flow. A compass was also visible, showing the azimuth of the rig's axis.

(v) An EG & G sidescan sonar was used at sites 2 and 5. The sonar was towed from the ship's boat and viewed the position of the rig relative to the surrounding topography.

(vi) Echo-sounder arrays were made at each site, consisting of three runs parallel to the tide direction, spaced 2.8 cables apart, and each of length 5.6 cables.

(vii) Grab samples at each site will be taken on a later cruise in mid-May.

INSTRUMENTATION

A new underwater rig was used on this cruise. This was designed in conjunction with the Inshore Sedimentation Team for pumped sampling, and/or turbulence measurements. Most of the instruments were carried on an angle iron vertical post near the front of the rig. A high-aspect ratio fin aligned the rig with the flow, being mounted well behind the suspension point to give a large turning moment. The lifting and electric cables were attached to a swinging bridle, which was upright when the rig was lifted, but fell to the horizontal when the rig was on the bed so as to carry the cables away from the rig and minimise overturning moments.

Two types of current meter were used simultaneously: Braystoke rotor current meters were mounted in a vertical array at four heights from 12cm to 177cm from the bed, giving velocity profiles from which bed shear stresses could be calculated; and electromagnetic flowmeters mounted at two heights giving a faster response (4 Hz), two-component measure of the currents for calculation of Reynolds stresses. Sediment motion was observed with an underwater TV system. In addition a pumped sampling system was used, allowing sediment-laden water drawn from one of six nozzles at different heights on the rig to be pumped and filtered on deck to give suspended sediment concentration. A cable connected the rig to the ship, where all the information was monitored.

NARRATIVE

The movements of the ship, the experiments being performed, and the individual run numbers are shown on a day-by-day basis in Figure 1.

It was necessary to re-anchor the ship at Position 5 on 7 April so as to face into the (stronger) ebb tide.

9 April was given over to D N Langhorne for lifting of three current meter rigs on the Skerries Bank. Operations were directed by J Moore and C N Puckett.

On 10 April, the crew rest-day, Mr A E Soleman of the Academy of Scientific Research and Technology, Cairo, was given a demonstration of the equipment.

On 12 April, the stern anchor cable fouled the rig as the ship swung, necessitating re-anchoring.

The three sites occupied were surveyed by echo-sounder on 14 April, before sailing for Plymouth.

INSTRUMENT PERFORMANCE

It was unfortunate that this cruise immediately followed three others using the same instruments and instrumentation personnel, putting a heavy strain on both. This resulted in the TV and Braystoke systems being out of action at the start of the cruise, and the EM flowmeters not having a (successful) prior calibration.

However, through the efforts of the instrumentation team all the instruments were back in working order by the second half of the cruise, and the EM flowmeters were brought back to Taunton intact, allowing a post-cruise calibration to be made.

Underwater Rig

This performed satisfactorily. The fin aligned the rig positively with the flow, and it showed no tendency to 'fall off' the current direction on touchdown. At one stage in the first week the TV camera and a light were faced backwards to observe the bridle, lifting cable and electric cables. This showed that the bridle was effective in lifting when the cable became tight, and that a surprising amount of slack had to be paid out to prevent the bridle lifting at all. The 200 kg of ballast seemed quite adequate to keep the rig stable under most conditions. The rig was pulled over forwards on one occasion, its most vulnerable position for the instruments, but, apart from the loss of the compass and flag, the only damage was two bent Braystoke spindles. The protection for the instruments seemed adequate in general, though when the EM flowmeters are mounted at their highest position they are in some danger of striking the ship's side on deployment and recovery. A box section might be more rigid than the angle iron for the instrument mounting post.

Electromagnetic flowmeters

These behaved very much more reliably than in the past.

The 5cm heads used previously had been replaced by 10cm ones (Heads A and D) as it was thought these might be more reliable. In fact this was the first cruise of the series in which it was not necessary to change the heads at all. In addition the underwater electronics did not need attention. All the problems which occurred could be attributed to earthing, but an infallible noise-free earthing system has still not been discovered. Tension in the cable and misalignment of the rig also upsets the flowmeters, but this can usually be cured by re-positioning the rig.

Braystoke flowmeters

The PDP-8 and Braystoke interface were both out of action at the start of the cruise. After replacing the PDP-8L by the PDP-8F and repairing the interface they gave no trouble. The rotor spindles were frequently bent due to a number of causes, but easily straightened or replaced. As always there was some fouling of rotors by seaweed and grit.

TV system

At the start of the cruise the camera would not focus. This was corrected on 7 April and gave no further trouble.

Pumped sampling system

This was only the second time this system had been used, and none of the scientists on this cruise had experience of it. There was some difficulty priming the pump, probably mainly due to a leak in the manifold on the rig.

However, in use there were few problems. Filter changing could be accomplished in 1 min, and this could be reduced in future by using a change-over tap in place of the pairs of tubing clips.

Inclinometer, Compass and Flag

The inclinometer gave no trouble after being repaired on 7 April. The compass and flag behaved well until they were lost on 13 April.

Braystoke Direct Reading Current Meter and T-S Bridge

These both performed well.

EG & G Side-scan Sonar

This performed well, but at times could not be used due to weather conditions.

SHIP PERFORMANCE

Again the three-point anchoring capability of Sarsia proved invaluable. On one occasion only was there any problem, when the ship swung the wrong way at the turn of the tide, causing the stern anchor to foul the port bow anchor, and also the rig. This was quickly sorted out with minimal damage.

The new platform on the fore-deck for the rig to sit on was a big improvement on the previous arrangement, when the rig had to balance on the taut stern anchor cables.

A new scientific supply generator had been installed and this proved much less troublesome than the old shared power supply.

RESULTS

Overall, the cruise was very successful, especially the second week. All three experiments were satisfactorily completed.

An hour-by-hour record of the data collected and an estimate of its quality is shown in Figs 2 - 5.

Vertical and Horizontal Structure Experiment

Although there were instrument problems during this work, they did not seriously affect the quality of the results, as only the EM flowmeters were essential, and these were working. Data was obtained at all four head heights in the vertical structure work, hopefully in usable quantities. The horizontal structure work was reduced to three hours, and during this time the X2 channel was giving trouble, so this may be less successful.

The choice of site was not ideal, due to the presence of sandwaves.

UVW experiment

The heads were first placed at a mean height of 65cm and measurements taken over 15 hours. The quality of the data was generally good. However, when the heads were moved to a mean height of 145cm, eight hours of work was marred by a bad tape on the 7-track tape recorder.

Pumped Sampling Experiment

Three ebb tides were worked, taking sediment concentration time series at heights of 12, 7, 52 and 17 cm. The quality of the data was generally good.

STATIONS OCCUPIED

Start Bay Position	Latitude	Longitude	Decca Red	Decca Purple	Bottom	Depth (m)	Max Currents at 5m
1	50°14.27'N	3°37.88'W	B04.25	A75.33	Medium sand Highly mobile	13	82cm/sec
2	50°15.58'N	3°34.12'W	B11.13	B56.05	Very coarse sand & shell Not mobile	42	130cm/sec
5	50°17.45'N	3°32.25'W	B13.30	B65.27	Medium sand Not mobile	34	79cm/sec

ACKNOWLEDGMENTS

We are grateful to Dr E Denton, Director of the Marine Biological Association, Plymouth, for making RV Sarsia available to us. Captain E Dowell and the Officers and crew of Sarsia gave us every assistance with the work, and helped make the cruise an enjoyable and successful one. Captain M Perry assisted throughout with the organisation of the cruise.

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RV Sarsia Cruise 5/75, 25 May - 6 June 1975. Turbulence measurements on the seabed carried out in Start Bay, SW England. IOS Cruise Report No 30, 1975.

RV Sarsia Cruise 10/75. 26 August - 11 September 1975. Turbulence measurements on the seabed off Southern England. IOS Cruise Report No 38, 1975.

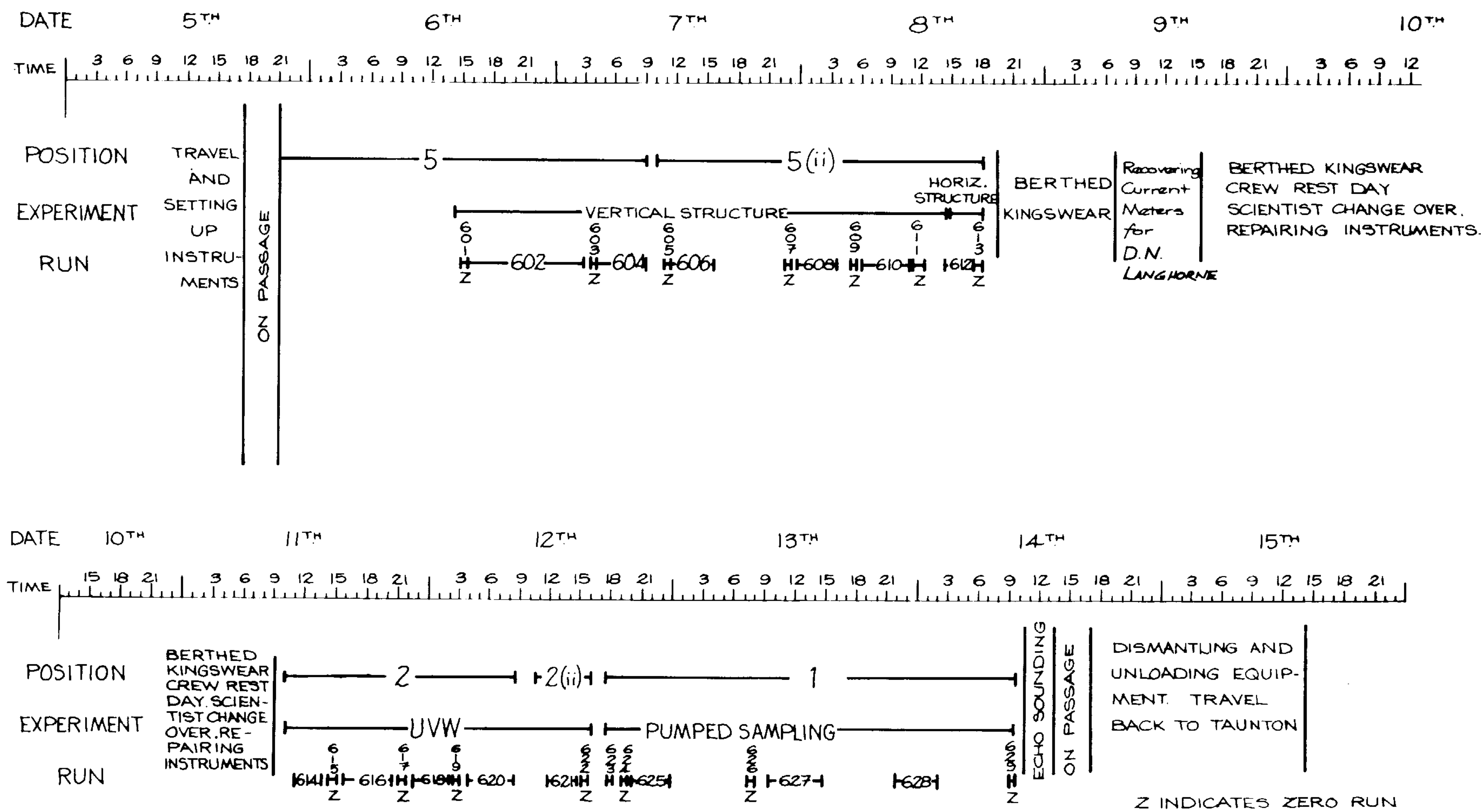

Figure 1: Day-by-day summary of experiments and events

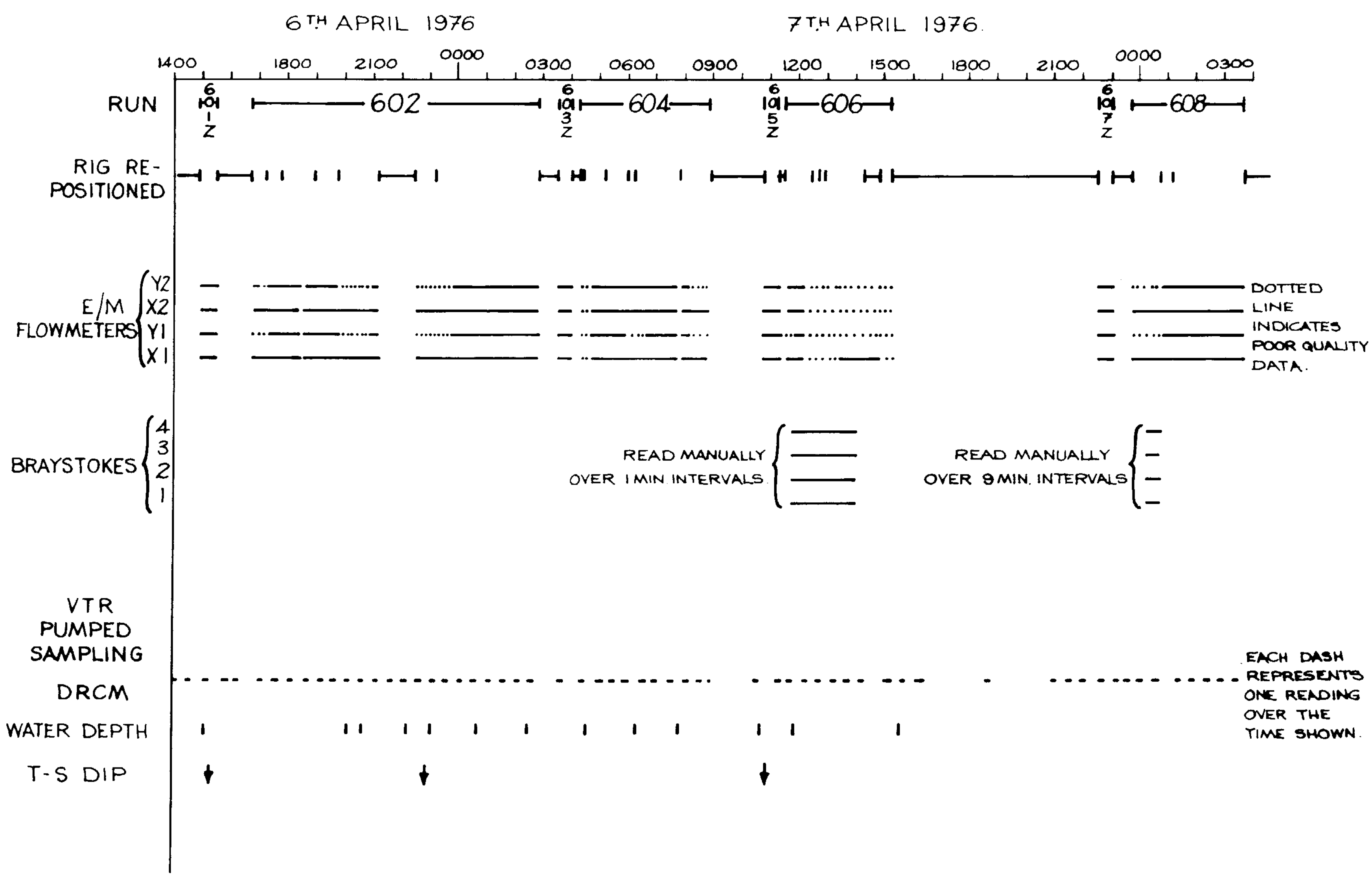

Figure 2: Summary of measurements taken 6 - 7 April

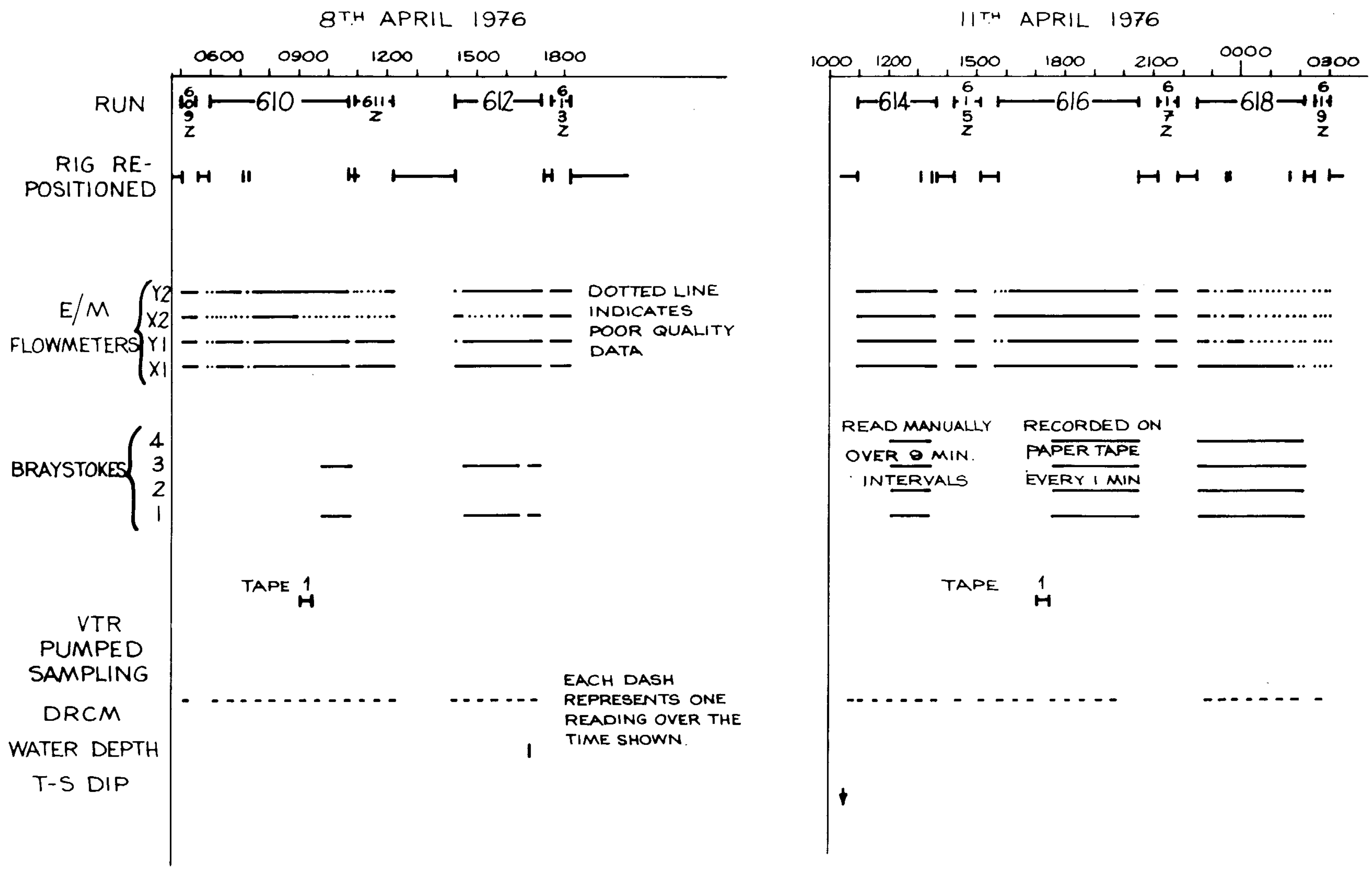

Figure 3: Summary of measurements taken 8 and 11 April.

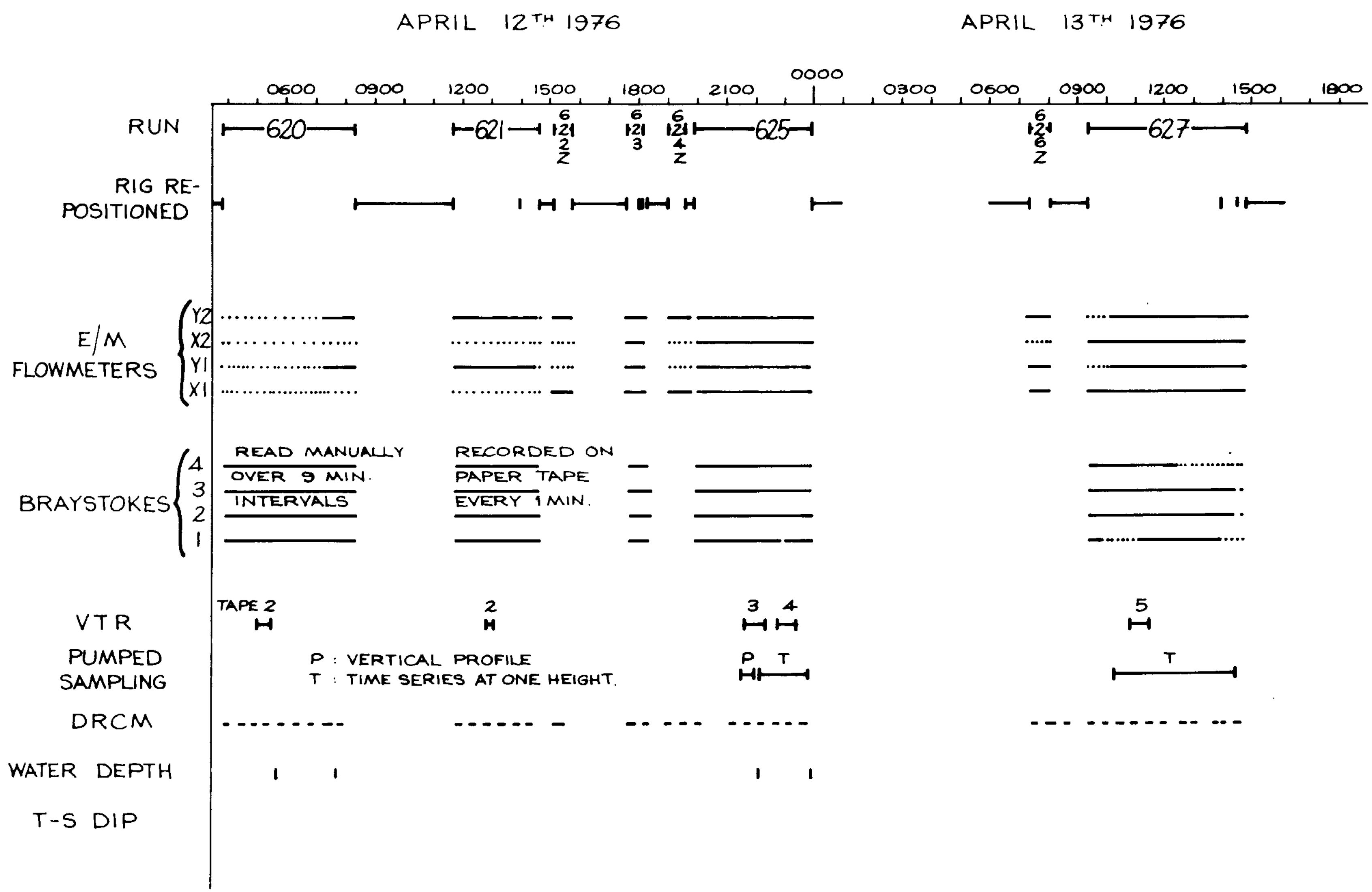

Figure 4: Summary of measurements taken 12 and 13 April.

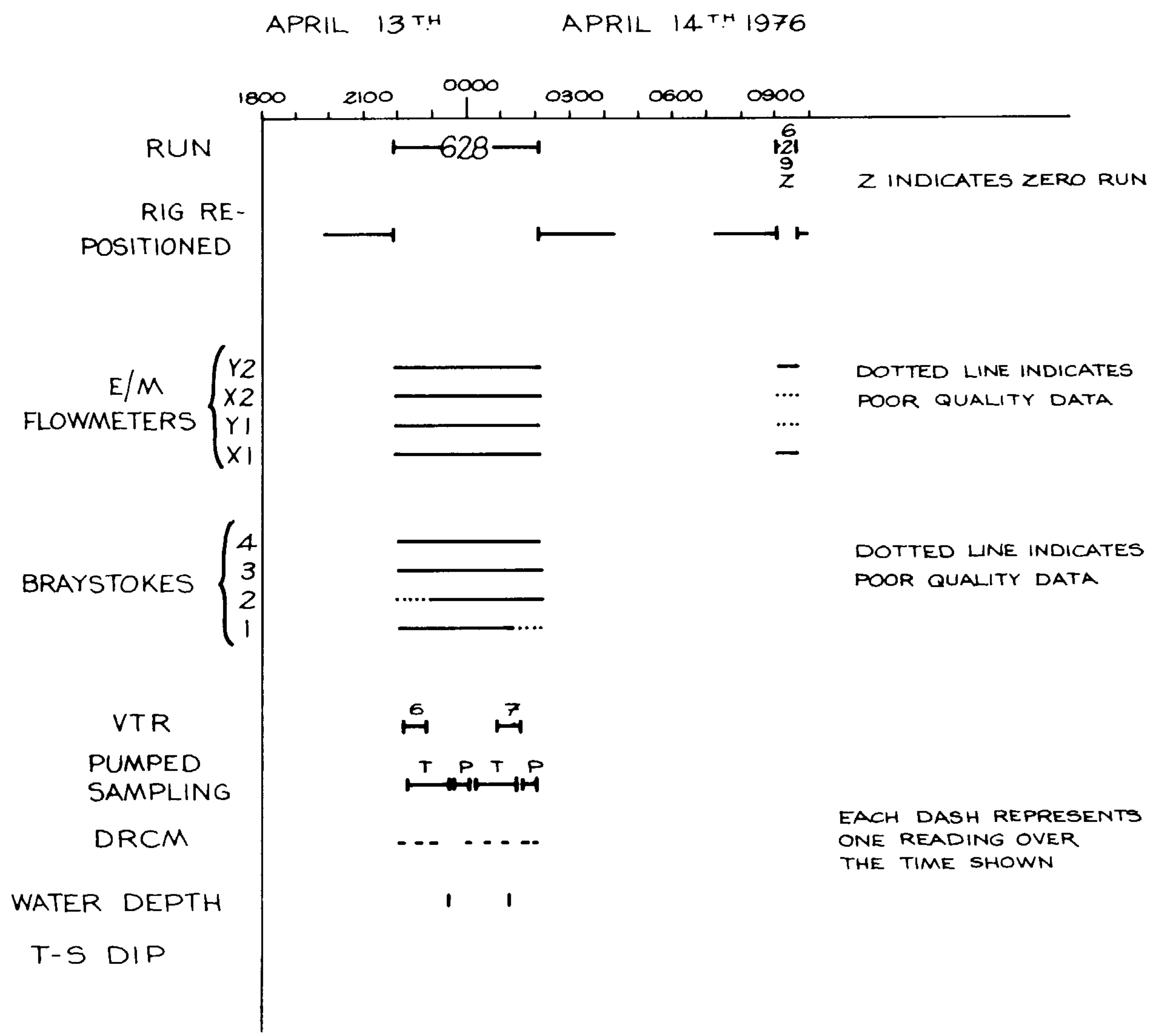

Figure 5: Summary of measurements taken 13 and 14 April.

(c) RV EDWARD FORBES CRUISE 16/76

24 August - 17 September 1976

SIZEWELL - DUNWICH BANK FIELD STUDY

Cruise Report No 44

1976

Institute of Oceanographic Sciences
Crossway
Taunton
Somerset

CONTENTS

SCIENTIFIC PERSONNEL

IOS (Taunton)

Mrs B J Lees (Principal Scientist)	27 August - 14 September
J O Malcolm	31 August - 2 September
D N Langhorne	4 September - 6 September
P J Hardcastle	5 September
E J Moore	5 September
M A S Moore	5 September
T Upham	8 - 11 September
Dr A D Heathershaw	11 - 14 September

IOS (Barry)

W G J Miller	(27 August - 1 September (11 September - 17 September
P Taylor	27 August - 17 September

SHIP'S OFFICERS

P Tilbury (Master)

D Pye (1st Officer)

G Price (2nd Officer)

C Phillips (Chief Engineer)

OBJECTIVES

1. To lay ten Plessey self-recording current meter rigs, seven of conventional design and three designed for shallow water of a mean depth of 5 - 6m. Fig 1 shows their stations and all other locations mentioned in the text. To recover the moorings at the end of the cruise, leaving the long term mooring at Station 22 to be changed at the end of two months, ie the end of October, 1976. The sites have been chosen for three reasons. Firstly to provide data from areas where none or very little existed previously, secondly to monitor current speed and direction at the north and south boundaries of the study area. This information is primarily for input to the mathematical model, ProjectS32B. Thirdly, one station has been sited to assess

the long term current conditions, initially over one year.

2. To lay the Marconi buoyed system at Station 25 in a mean depth of 12m water, the rig to include a string of six sensors, spaced at 1m intervals. The purpose of the deployment is to evaluate the system and measure velocity profiles through the water column.

3. To undertake pilot tracer experiments with fluorescent dyed sand in two colours, blue and red, using a Decca HiFix 6 position fixing system for location. To decide whether this method of position fixing is adequate for the Sizewell-Dunwich study requirements.

4. To conduct a box coring programme in the area of the banks and their environs. The fluorescent tracer sampler is designed to detect the whereabouts of the dyed sand on the seabed surface. In order to detect the tracer at depth it is intended to take box core samples in areas where the tracer is found. The box cores will also be analysed using X-ray and impregnation techniques to give information on sedimentation.

5. To conduct echosounding surveys across the Sizewell-Dunwich banks as time and conditions permit, again using HiFix 6 for position fixing.

EQUIPMENT AND METHODS

Current Meter Moorings

Of the ten planned moorings, nine were successfully deployed. One site, at Station 22 outside the banks, is to be continuously occupied for at least a year, the current meter being changed every two months. The first change took place in late October 1976. The other eight were recovered at the end of the cruise. The tenth mooring was one of three rigs modified for shallow water deployment (but not less than 5.5m depth) and was the first of this design to be laid. Because the basic U-shape of the mooring is retained, the subsurface buoy, A-frame and weight (in this instance c. 350 kgs lead) were necessarily as close together as possible. It was decided to attempt to lay this rig the reverse way from usual, ie meter end last. This was in order to avoid tangling between the meter and the ground line. During the final stages of deployment the ship's propeller and subsurface buoy accidentally came into contact, fortunately causing no damage to the former. However, the subsurface buoy was severed from the mooring and was picked up by inflatable boat. Three days later the rest of the mooring was recovered except for the lead weight. The meter was still attached to a rather distorted A-frame and appeared to have suffered little damage. It was still recording, although the data would have been suspect because of a bent rotor.

After this accident the other two shallow water rigs were laid as normal. meter end first. The inflatable boat and pellet line were used to pull the subsurface buoy and meter line away from the ground line. The method proved to be successful.

Marconi Buoyed Current Meter System (Station 25)

D N Langhorne was responsible for the deployment of this system. There were important differences compared with the conventional method for laying U-shaped moorings. Before deployment began the vessel was anchored with four and a half shackles of chain out, and the engine declutched. She was allowed to stabilise, lying with the tide. With calm seas and this length of anchor chain the vessel was very unlikely to drag her mooring. The inflatable boat was launched and the pellet line from the subsurface buoy held by its crew. The subsurface buoy, the meter line with six sensors clamped at intervals of 1m, and the data logger were assembled and placed at the stern of the vessel. The subsurface float was lowered into the water by the A-frame and held clear of the stern by the crew of the inflatable. The ground line to the data logger was leading from the main winch. As the logger was lowered by paying out the ground line the subsurface buoy was towed as hard as possible away from the vessel by the inflatable boat in order to prevent the impellers from hitting the taut lowering wire. Once the logger reached the seabed the anchor chain was hauled in and the rope holding the subsurface buoy was released (see Fig 2). Effectively the ship moved towards the anchor along a line formed by the anchor chain and ground line. When the whole of the ground line had been paid out the remainder of the mooring was laid in the usual manner.

The system was due to remain moored at this station for approximately one month. It was recovered on 29 October 1976, although the meter wire had been severed, possibly by a trawler, resulting in the loss of the subsurface buoy and two sensors. The rotors of the remaining four sensors were missing. Preliminary examination of the tapes indicates that data have been recorded.

Fluorescent Tracer Experiment

Although IOS (Taunton) has used fluorescent dyed sand as a tracer in beach experiments (Blackley, Carr and Gleason, 1972, Internal Report), it is not commonly used by the Institute as an offshore technique. This work was therefore undertaken as a pilot experiment on which to base designs for future tracer work. Useful sediment movement data obtained would be a bonus. The actual injection technique employed was a modified form of that described by de Vries (1971). The two colours of dyed sand used in the experiment matched as nearly as possible in grain size distribution sand found on the Dunwich Bank. Before the experiment began, a sample of sand from the Dunwich Bank was irradiated with ultra violet light to ensure there would be no background material fluorescing with the same two colours as the dyed sand. 120 kg of the blue dyed sand were wetted and frozen in 'tiles' some 10 cms thick. The 'tiles' were enclosed in a coarse meshed net and released at the injection site on the NW side of the Dunwich Bank (Fig 1), at high water slack on 3 September during neap tides. The freezing method enabled the material to reach the seabed and spread from there without losing any significant quantity to the water column. The sample stations were located at the intersections between lines every 0.5 red lane and 0.2 green lane on the Decca Main Chain chart. The HiFix 6 coordinates were noted for each sample station.

The sampler consisted of a 24 kg iron weight with a steel plate 25 x 12 cms screwed to its base. 'Formica' sample cards of the same size were coated with MS_4 silicon grease and fixed to the plate with elastic bands. Each greased card was irradiated with ultra violet light to ensure it was free of contamination before being lowered to the seabed. On recovery it was placed immediately in a transparent polythene bag which was then sealed. The sample could thus still be irradiated to detect fluorescent grains.

A second injection of 350 kg of the blue tracer was made at the same station at high water slack on 7 September. This quantity exceeded the capacity of the freezer and therefore the sand was placed at the stern and wetted whilst in the thick paper bags. Again a net was used to keep the sand together, and during the injection the ship's engine was declutched to minimise turbulence. It was expected that the bags would disintegrate soon after reaching the seabed. The sampling intensity was doubled at first, but later time constraints forced a return to the original sampling grid.

Lack of time because of bad weather meant that experiments with the red dyed sand had to be cancelled.

Sonar surveys.

The MS36 echosounder together with HiFix 6 positioning were used during runs normal to the shore across the Sizewell-Dunwich Banks. The first runs were after the northerly gales of 27 and 28 August and part of 2 September had subsided. They were in two groups, firstly on the 2 and 3 September and secondly on 7 September. A second set of lines was followed on the 12 and 13 September after SW gales on the 11 September. Correction data for tidal height was provided by the pressure transducer located offshore from Dunwich, installed in April 1975. The recorder was modified for the duration of the cruise to sample continuously instead of at the normal three hourly intervals.

Box coring programme.

The weather conditions prevented any use of the box corer during the two periods set aside for the purpose.

RESULTS

All the data obtained during this cruise need some form of processing and analysis before the results are apparent. Therefore it is not possible to include them in a report at this stage. This includes data from the hydrographic surveys, the current meters and the tracer grain counts. However, continuous data were obtained from the eight recording meters deployed for the duration of the cruise, and it is hoped that these will prove satisfactory when validation is carried out. It is not yet known whether the long term current meter mooring or the Marconi sensors gave satisfactory data.

Some useful pointers have emerged from the pilot tracer experiment which will be borne in mind during the design of future experiments. After the first injection of fluorescent dyed sand very few grains were recovered, usually no more than twenty on one card. There could be several reasons for this. Firstly the quantity injected could be too small. Other workers have varied the size of injections from 6 lbs (Jolliffe 1963) to 2000 lbs (Stuiver and Purpura 1968). Therefore it seemed reasonable to make the second injection considerably larger than the first.

A second reason for the paucity of recovered grains could be that many were lying in the troughs of ripples and were therefore missed by the sampler (see under 'Equipment Performance'). Thirdly, the tracer could have been quickly buried. Without the box coring no evidence was obtained on this point. Fourthly, the sampling grid may have been too coarse for the amount of movement undergone by the tracer. This was difficult to assess on board ship, but counts made in the laboratory since the cruise seem to indicate that this may be so.

EQUIPMENT PERFORMANCE

IOS Barry (MSES) Equipment

The Kelvin Hughes MS36 echosounder operated satisfactorily.

Eight current meter moorings were successfully recovered and preliminary examination of the meters indicated that they functioned throughout their deployment.

IOS Taunton Equipment

It was found during the fluorescent tracer experiment that the greased cards, whilst successfully obtaining a seabed surface sample a grain or two thick where contact with the sand was made, were straddling the ripples on the banks. Thus any fluorescent grains in the troughs between were not detected. It may be possible to design a flexible sampler, or alternatively a much smaller one. The latter solution would mean greater difficulty in detecting a significant number of grains.

The performance of the Marconi equipment is currently being evaluated.

Decca HiFix 6 Equipment

After the early replacement of a faulty receiver the HiFix 6 equipment functioned satisfactorily. The set was locked in as the vessel passed through Lowestoft harbour entrance and checked at the same spot on the vessel's return. The only loss of lock was when the ship was away from Lowestoft overnight. The change was found to occur during the night with a maximum value of one lane and on one pattern only. According to Decca Survey Ltd the repeatability in this area is within 5m. It proved possible to return to the fluorescent tracer injection site, using HiFix 6.

SHIP PERFORMANCE

The performance of the RV Edward Forbes was satisfactory throughout. The only worktime lost was approximately half an hour when the brushes in the generator for the domestic supply were replaced.

CONCLUSIONS

The main disappointment was of course in the weather conditions. Of nineteen potential working days, seven were lost because of gales or near gales, and perhaps even more frustrating, a further day of good weather was lost because of faults in the Lowestoft harbour bridge lifting mechanism. 58% of the potential worktime remained.

Because of this, the scientific programme was considerably curtailed. The tracer experiment with the red dyed sand was cancelled, and no box coring at all took place. This, as mentioned earlier, also meant that there was no information as to the depth to which the fluorescent tracer became mixed.

One positive aspect of the bad weather is that with sonar surveys having been undertaken following gales from both the N and SW there should be an indication of how these gales have affected the shapes of the banks. Nine out of ten planned current meter moorings were successfully deployed and all eight short-term moorings recovered. The Marconi buoyed system was also laid successfully and the HiFix 6 method of position fixing proved satisfactory.

ACKNOWLEDGEMENTS

It is a pleasure to thank the Master, Officers and crew of the RV Edward Forbes who, in addition to their normal cheerful cooperation, showed resource in the face of various difficulties outside our control. We should like to thank particularly the staff at IOS Barry involved with current meter deployment. Our thanks go also to Captain Sellers, the Marine Superintendent at MAFF, Lowestoft, who was most helpful in allowing us the use of many facilities, and to Mr Mutimer of the British Transport Docks Board.

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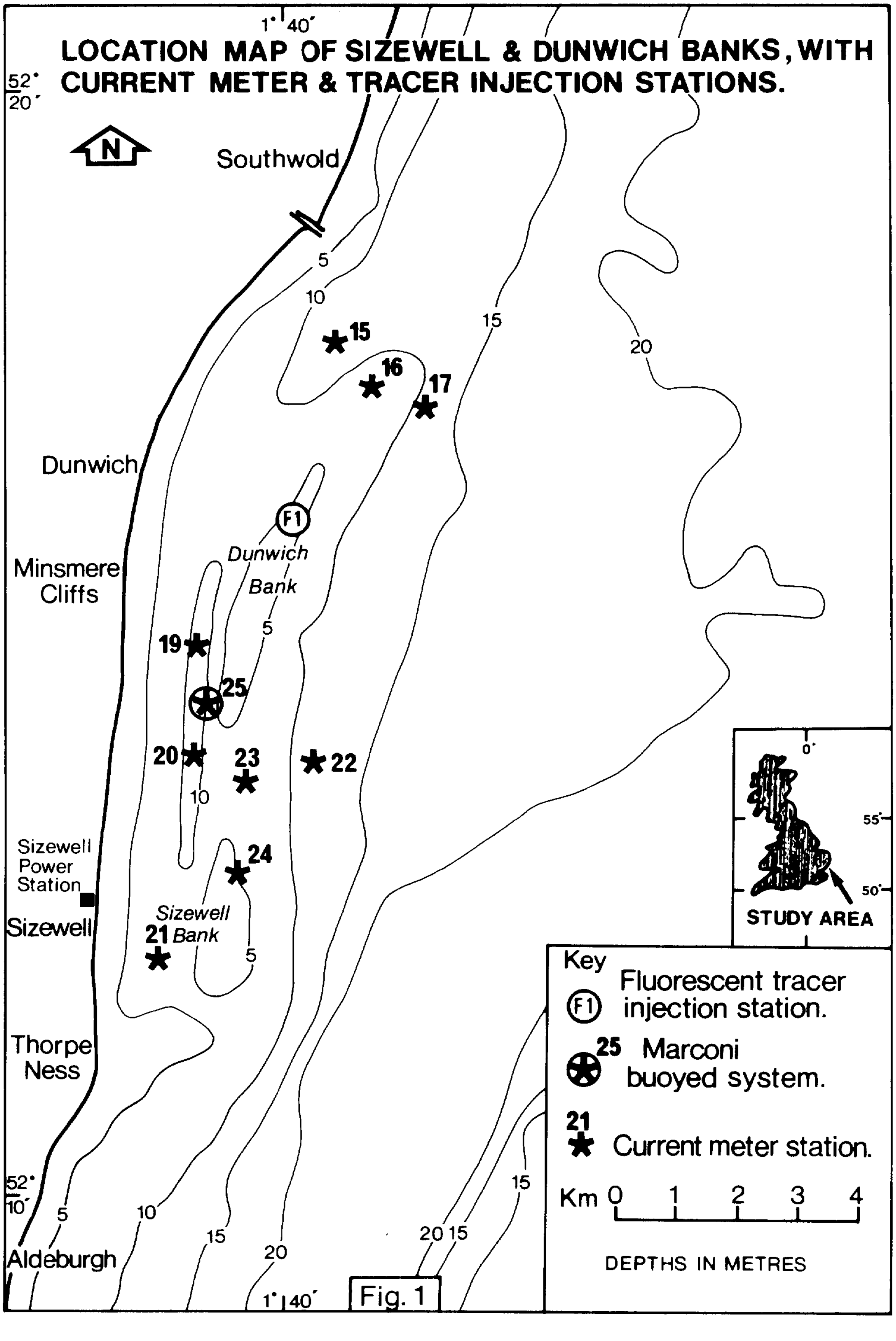
APPENDIX 1

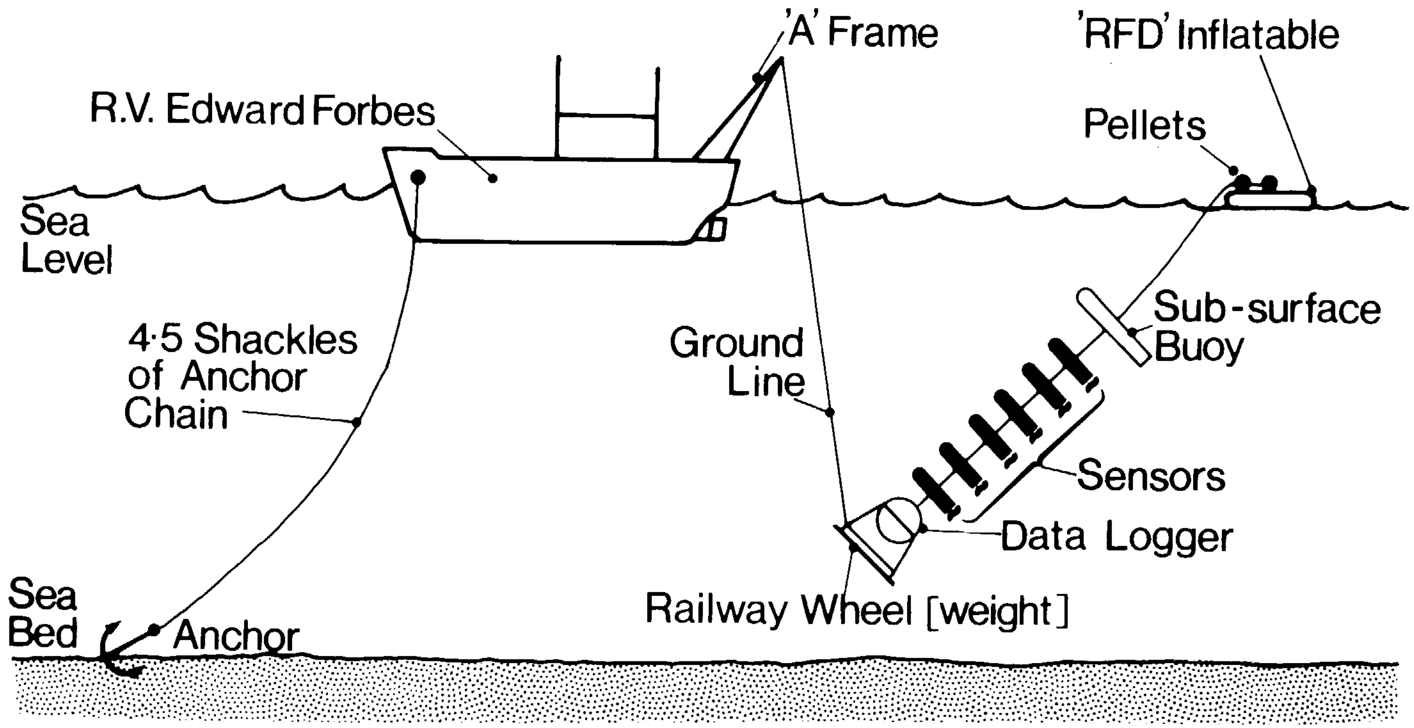
NARRATIVE

Friday 27 August	B J Lees, G W J Miller, P Taylor aboard. Remained in port due to gale force winds and rough seas.
Sunday 29 August	Wind force 3-4 N. Successfully deployed three Plessey self-recording current meter rigs at stations 15 (Decca Main Chain Red J 13.12 Green C 34.10); 16 (Red 12.12, Green 34.70); and 17 (R 12.04, G 35.13). Unsuccessful attempt to deploy shallow water rig at station 18. Problems due to new type of rig designed for shallow water. Subsurface buoy recovered, remainder of rig still on seabed, to be recovered later in cruise. NB: Similar rigs deployed successfully 1 September.
Monday 30 August	Wind force 2-3 NNE. Successfully deployed four current meter rigs at stations 19 (R 5.70, G 35.37); 20 (R 3.17, G 36.22); 21 (R 22.52, G 37.70) and 22 (R 4.12, G 37.10).
Tuesday 31 August	Wind force 4-5 NNE increasing. Conditions in study area proved too rough to work and vessel returned to Lowestoft. Visit from Mr P Martin, Fisheries Officer, MAFF. He reported the possibility of Dunwich fisherman having lost small trawl on rig at station 20. Assured him we would inspect rig as soon as weather permitted.
Wednesday 1 September	Wind force 2 W. Successfully deployed current meter rigs at stations 23 (R 3.31, G 36.80) and 24 (R 1.21, G 37.42). Remainder of rig at station 18 recovered. Rig at station 20 recovered, thoroughly inspected and relaid. No evidence of having snagged trawl. No apparent interruption in meter recording. WGJM put ashore at Southwold, JOM came aboard by inflatable boat. Anchored for night.
Thursday 2 September	Commenced by echosounding across Dunwich Bank, working from N to S. Weather deteriorating, sea roughening, wind gale force 8 N imminent. Vessel returned to Lowestoft. JOM returned to Taunton.

Friday 3 September	Wind force 5-6 locally 8 NW. Delayed sailing until 1430 hours. Echosounding across Dunwich Bank continued until high water slack. 120 kgs wetted and frozen blue fluorescent tracer sand injected on NW of Dunwich Bank (Station F1, see Fig 1). HiFix 6 Pattern 1, 2148.00, Pattern 2, 610.00. Sampled with greased cards on grid constructed at 0.5 Red Decca Main Chain lane and 0.2 Green Decca Main Chain lane intervals, positioning each sampling station with HiFix 6. Sampling continued until no more tracer showed on cards when irradiated with UV light. Anchored 0200 hours Saturday.
Saturday 4 September	0800 to 1720 hours sampled for fluorescent tracer. 1930 Berthed at Lowestoft. HLK, DNL came aboard.
Sunday 5 September	Wind force 3-4 NE. PJH, EJM, MASM joined vessel for day. Marconi buoyed system (with U-shaped rig) successfully deployed inside Sizewell-Dunwich Banks. DNL responsible. See 'Equipment and Methods' for details of method. 1630 berthed at at Lowestoft. PJH, EJM, MASM departed.
Monday 6 September	DNL departed. Vessel unable to leave port all day because harbour bridge jammed. Finally repaired early hours of Tuesday morning.
Tuesday 7 September	0900 to 1100 hours. Conducted echosounding survey until high water slack. 1115 hours injected c. 350 kg wetted blue fluorescent tracer at site F1 as before. Engine declutched to minimise turbulence. Sampling as before on similar grid pattern. 2400 hours anchored.
Wednesday 8 September	Sampling for fluorescent tracer sand continued.
Thursday 9 September Friday 10 September Saturday 11 September	Gale force winds, mainly SW, prevented work.

Sunday 12 September	Current meter rigs from stations 15, 17, 16, 19, 20 and 21 safely recovered. Echosounding carried out over Sizewell Bank. Anchored overnight.
Monday 13 September	Echosounding continued over Dunwich Bank. Returned to Lowestoft and offloaded current meter gear. HiFix 6 equipment removed by Decca engineers.
Tuesday 14 September	Current meter rigs safely recovered from Stations 23 and 24. Toroidal buoy at Station 22 (long-term mooring) righted. 1245 hours sailed for Barry.


LOCATION MAP OF SIZEWELL & DUNWICH BANKS, WITH CURRENT METER & TRACER INJECTION STATIONS.
1° 40′
52° 20′
N
Southwold
Dunwich
Minsmere Cliffs
Dunwich Bank
Sizewell Power Station
Sizewell
Sizewell Bank
Thorpe Ness
Aldeburgh
52° 10′
F1
15
16
17
19
25
20
23
22
24
21
5
10
15
20
STUDY AREA
0°
55°
50°
Key
Fluorescent tracer injection station.
Marconi buoyed system.
Current meter station.
Km 0 1 2 3 4
DEPTHS IN METRES
Fig. 1



DEPLOYMENT OF MARCONI BUOYED CURRENT METER SYSTEM

Fig. 2

CRUISE REPORTS

CRUISE No. and/or DATE	REPORT No.
R.R.S. "CHALLENGER"	
August - September 1974	IOS CR 22
R.V. "EDWARD FORBES"	
October 1974	IOS CR 15*
January - February 1975	IOS CR 19
April 1975	IOS CR 23
May 1975	IOS CR 32
May - June 1975	IOS CR 28
July 1975	IOS CR 31
July - August 1975	IOS CR 36
August - September 1975	IOS CR 41
R.R.S. "JOHN MURRAY"	
April - May 1972	NIO CR 51
September 1973	IOS CR 7
March - April 1974	IOS CR 9
October-November & December 1974	IOS CR 21
April - May 1975	IOS CR 25
April 1975	IOS CR 39
October - November 1975	IOS CR 40
August - October 1975	IOS CR 42
N.C. "MARCEL BAYARD"	
February - April 1971	NIO CR 44
M.V. "RESEARCHER"	
August - September 1972	NIO CR 60
R.V. "SARSIA"	
May - June 1975	IOS CR 30
August - September 1975	IOS CR 38
R.R.S. "SHACKLETON"	
August - September 1973	IOS CR 3
January - February 1975	IOS CR 18
March - May 1975	IOS CR 24
February - March 1975	IOS CR 29
July - August 1975	IOS CR 37
June - July 1976	IOS CR 45
M.V. "SURVEYOR"	
February - April 1971	NIO CR 38
June 1971	NIO CR 39*
August 1971	NIO CR 42*

*not distributed

CRUISE REPORTS

CRUISE No. and/or DATE	REPORT No.
D.E. "VICKERS VOYAGER" AND "PISCES III"	
June - July 1973	IOS CR 1
R.R.S. "DISCOVERY"	
1 (International) 2 (Indian Ocean) 3 (Expedition)	Published and distributed by the Royal Society
	NIO CR[1]
4 February - March 1965	4
37 November - December 1970	37
38 January - April 1971	41
39 April - June 1971	40
40 June - July 1971	48
41 August - September 1971	45
42 September 1971	49
43 October - November 1971	47
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46 April - May 1972	55
47 June - July 1972	52
48 July - August 1972	53
49 August - October 1972	57
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	IOS CR[2]
54 June - August 1973	2
55 September - October 1973	5
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57 November - December 1973	6
58 December 1973	4
59 February 1974	14
60 February - March 1974	8
61 March - May 1974	10
62 May - June 1974	11
63 June - July 1974	12
64 July - August 1974	13
65 August 1974	17
66 August - September 1974	20
68 November - December 1974	16
73 July - August 1975	34
74 Leg 2) Sept.Oct. 1975	33
74 Leg 1 & 3) Sept.Oct. 1975	35
75 October - November 1975	43

[1] NIO CR — National Institute of Oceanography, Cruise Report
[2] IOS CR — Institute of Oceanographic Sciences, Cruise Report