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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

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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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

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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 ¼HP 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.

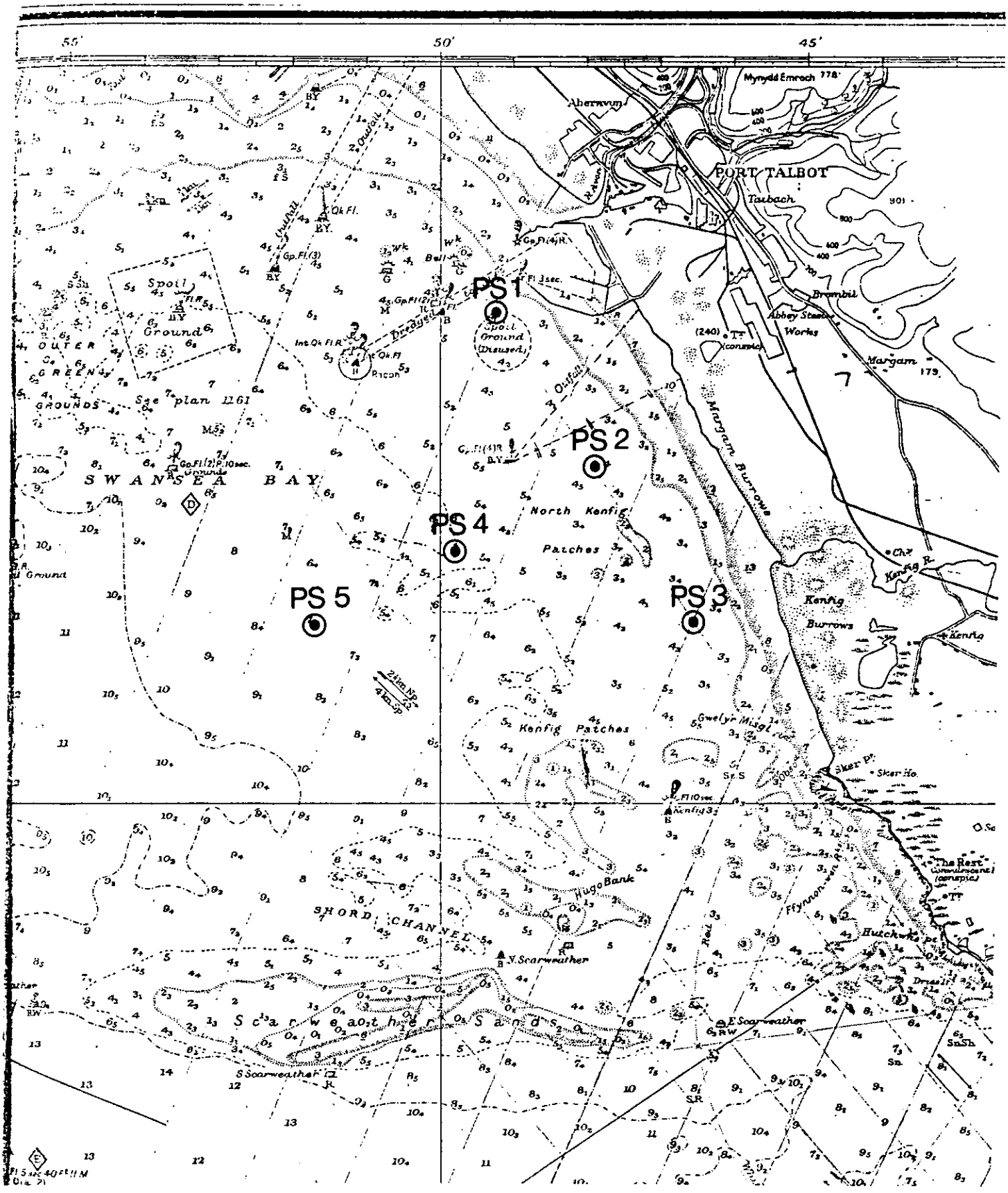
Friday 2.4.76 Unloaded scientific equipment not required on following cruise, and IOS personnel, with equipment, returned to Taunton.

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)					Total weights (g)	Total concentrations (mg l^{-1})
		Particle size ranges (μm)						
		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

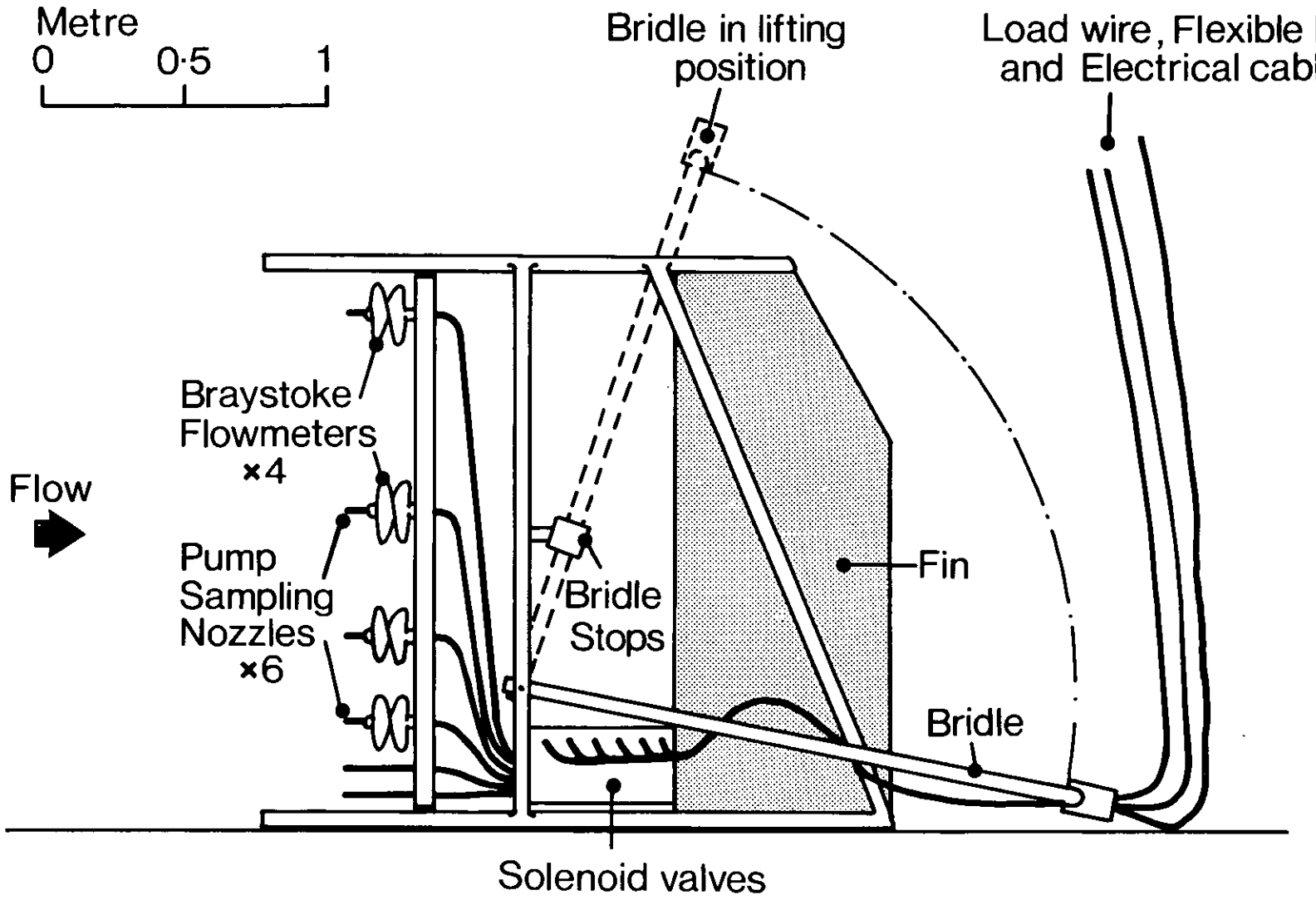
Suspended sediment concentrations in various particle size ranges from six elevations above the sea bed at Station PS2 (see Fig 1). The mean flow at the surface was approximately .5 ms^{-1}.



◉ Pumped Sampling Stations

Pumped Sampling Stations

Fig.1



Schematic diagram of Pumped Sampling Apparatus.

Fig. 2

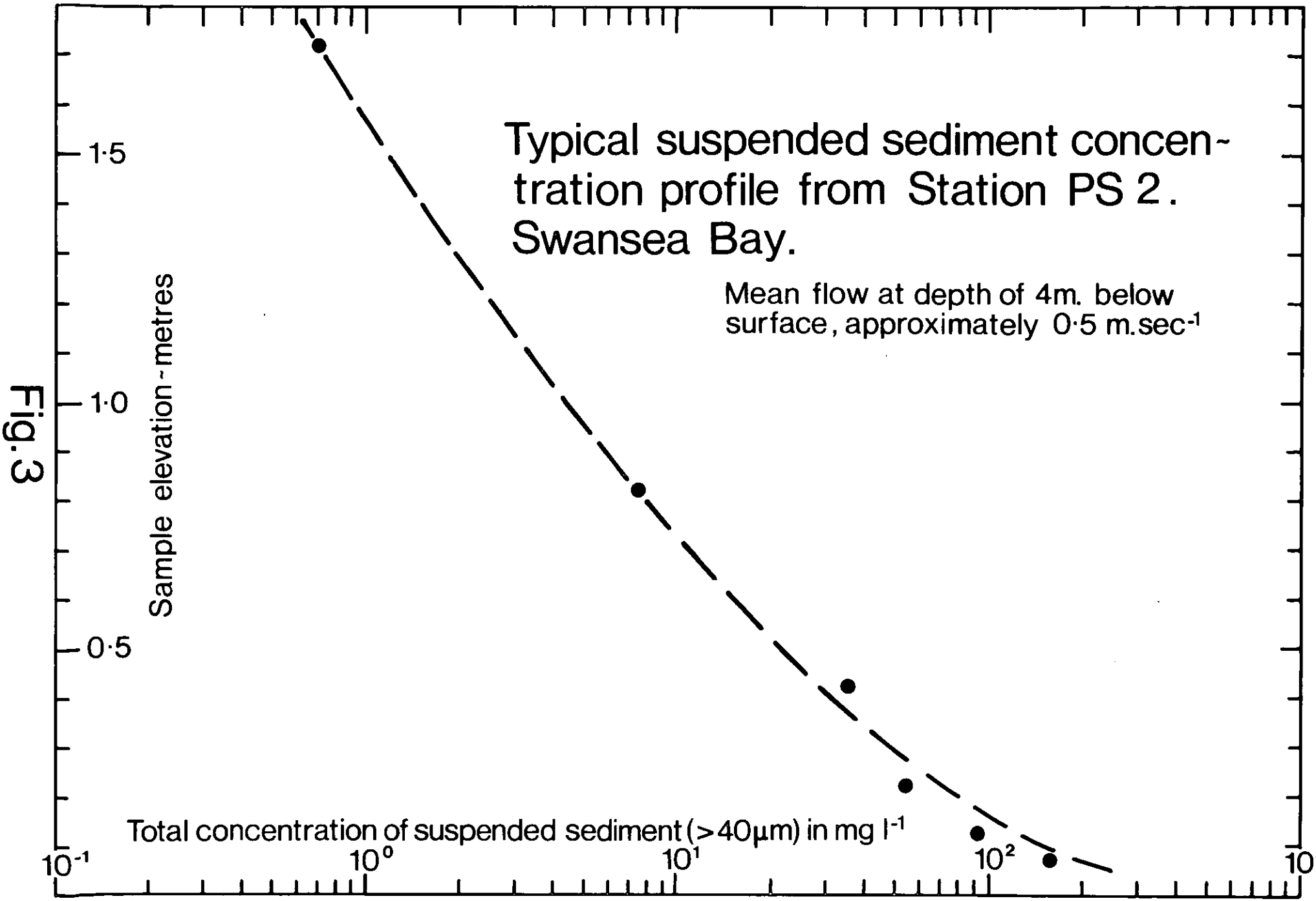

Typical suspended sediment concentration profile from Station PS 2. Swansea Bay.
Mean flow at depth of 4m. below surface, approximately 0·5 m.sec⁻¹
Sample elevation - metres
1·5
1·0
0·5
Total concentration of suspended sediment (>40µm) in mg l⁻¹
10⁻¹
10⁰
10¹
10²
10³

Fig. 3