I.O.S.

SWANSEA BAY (SKER) PROJECT

by

A P CARR, A D HEATHERSHAW and M W L BLACKLEY

PROGRESS REPORT FOR THE PERIOD

AUGUST 1976 to JULY 1977

REPORT NO 48

1977

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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Swansea Bay (Sker) : Third Progress Report

1. INTRODUCTION

The First and Second Progress Reports (IOS Reports 20/75 and 26/76) covered the work which had been carried out before the end of July 1975 and between August 1975 and July 1976 respectively. This, the Third and penultimate Report under the present contract with the Department of the Environment, outlines work undertaken between 1 August 1976 and 31 July 1977. The format is similar to the first two and contains three main sections:

1. Report of progress in the 12 months up to 31 July 1977
2. Summary
3. Plans for the future.

The earlier Progress Reports mentioned the intention to produce two parallel Report series, one outlining work undertaken during a specific period of time; the other devoted to specific research Topics as data and analyses became available. The first of the latter, describing long-term changes in the coastline, was completed towards the end of the period covered by this report. It is intended to produce some 8 topic reports, the last of which will attempt to synthesise the results of the individual aspects of the study, being scheduled for late 1978. Appendix 1 provides an outline of the contents of the proposed Topic Reports and the provisional completion dates, although certain of these are unlikely to be met.

The past year has also seen the completion of the first scientific paper based on aspects of the Swansea Bay Study.

Over the timespan covered by this Progress Report there has been progressive transfer of effort from the acquisition of information in the field and field experimentation, to data analysis and collation.

2. PROGRESS ON THE SWANSEA BAY PROJECT TO 31 JULY 1977

2.1 Evidence for longer-term changes based on documentary records

Topic Report : 1 (IOS Report No 42/77), was completed in July 1977. The second, and main, part of this report is devoted to a review of the various documentary sources which help to shed light on changes in Swansea Bay particularly as they affect the eastern shoreline over the longer-term. Certain other information, for example that based upon logs from boreholes commissioned as part of the whole research project, has been incorporated where this helps to clarify the picture.

While the results of the work are less explicit than might have been hoped they nevertheless contribute to the overall picture. The Summary of the first Topic Report includes the following points:

(a) The dune systems along the E side of the Bay do not exceed 6000 years in age. At their maximum extent, before extraction by man, they probably contained about 1.2×10^8 tonnes of sand, most likely derived from earlier dunes located further seaward rather than directly from the sea bed.

(b) The documentary evidence provided by hydrographic charts suggests that the offshore banks have progressively changed their relative position between 1859 and 1974 but that the apparent differences in their volume are not significant.

(c) Maps, dating between the 1840's and early 1960's cover the E coastline of the Bay. They indicate that since the mid-nineteenth century there have been two main areas of change, that around the R Neath and that close to Port Talbot. (For location of all sites mentioned see Figure 1 of this Report). Each site has been associated with civil engineering works; the Neath with a training wall built in the 1870's and the Port Talbot docks with a series of breakwaters begun in 1865 and extended several times thereafter, well before the construction of the present Tidal Harbour. Recession of low water mark is particularly noteworthy, but there have been local areas of accretion of which Crymlyn Burrows is the most important. At least until the 1960's, from Witford as far S as Morfa Mawr the beach gradient has become progressively steeper, but S of that again the position is indeterminate.

(d) The historical evidence from about 1100 AD onwards emphasises the long-term variability of this area of coast both in the context of the flooding and reclamation of the marshes and in the instability of the sand dune systems.

(e) There was disagreement amongst the various consultants prior to, and during, the 1973 Public Inquiry as to the cause of erosion of the beach between Port Talbot and Sker Point. However, its existence was generally accepted. Increasing concern about the problem was shown over time.

(f) Between 1970 and 1976 an average of just over 4×10^5 tonnes of marine dredged sand and gravel was unloaded at Swansea and Briton Ferry each year, mostly derived from Nash Bank. This compares with an annual average of 1.15×10^5 tonnes from the E foreshore of Swansea Bay over the period 1970-73.

(g) Calculations, based on figures for the whole foreshore extraction period (approximately 1934-73) would imply a lowering of the Margam and Kenfig beach by up to 0.25m, assuming uninterrupted longshore drift between Port Talbot and Sker Point, uniform distribution of sand across the beach, and no gain or loss offshore.

(h) Sand-winning from the dunes is of longer standing than that of the foreshore and still continues. It has been of a similar order of magnitude.

(i) Capital dredging for the Port Talbot tidal harbour was 11.2×10^6 tonnes. Estimated maintenance dredging for Port Talbot and Swansea between 1960 and 1976 has been comparable in volume of sediment to that of the capital dredging total.

2.2 Photogrammetry and topographic survey

Fair copies of three photogrammetric surveys covering the area S of Port Talbot tidal harbour to Sker Point have now been completed and the information provided, notably the distribution of peat, clay and lag deposits, will be incorporated in Topic Report: 2.

The displacement of the beach contours between the three aerial surveys was also calculated. Sections were drawn up normal to the beach at 500m intervals, 'K' at the north end and 'Z' near Sker Point. From these, movements of more than 20m landwards or seawards were recorded and a diagrammatic representation of one series of changes can be seen in Fig 2 in plan view.

Between 1968 and 1975 a general retreat of the contours landward, ie a steepening of the beach, is indicated. This is particularly so on the Kenfig Beach towards Sker Point. The limited accretion occurring along the line of section 'R' would appear to be primarily the result of a change in the course of the R Kenfig as it flows across the beach, and this is probably true, in part, of the erosion on section 'S' also.

The monthly topographic surveys of 11 beach sections, begun in September 1975, were terminated in spring 1977, 3 finishing in April and the remainder in May.

Thus there are records from one summer and 2 complete winters. Because of the width and relative flatness of the beach, and the small vertical changes, the profiles do not lend themselves to conventional means of comparison by superimposition of one month's record with another. Instead, a computer program has been used to calculate monthly volume changes within successive 20m compartments down the beach for each section and an example is shown in Appendix 2. It is hoped to demonstrate seasonal and longer-term variations by this means and then to attempt to quantify the apparent amount of sand moving between sections during the survey periods.

Some other levelling has been undertaken. This included the frequent survey of an additional line ('Q'), opposite the Access Ramp, between November 1976 and May 1977. This site was that chosen for 2 beach experiments in which transport of fluorescent labelled sand was compared with hydraulic data for the same site (See 2.3; 2.4; and 2.7 below).

2.3 Wave data

Both the Waverider buoy, located near the Scarweather light vessel, and the sea bed pressure-type wave recorder just S of the Port Talbot tidal harbour have continued to function throughout the period of this Report. At present there is a backlog in the processing of these data.

In addition, 2 self-contained wave recorders have been deployed intermittently along the eastern shore of the Bay (as planned in Report 26/76). The purpose of these was two-fold: to confirm (or disprove) the energy focus suggested by the wave refraction computations, and to provide supplementary wave information during the period of the beach experiments nearby. Unfortunately, when the units were retrieved at the end of the spring 1977 beach experiments, they had failed to operate satisfactorily due to a transducer fault. It is hoped to resolve the wave energy question by the deployment of these self-contained instruments during the autumn and winter of 1977-78 by the University College of Wales, Swansea, acting as agents on behalf of IOS.

It was also noted in the previous Progress Report that the 3.2 cm X-band radar was due to be moved from Mumbles Head to a site on the southern breakwater of the Port Talbot tidal harbour. This operation was carried out in October 1976 and much improved representation of the direction of wave approach has been obtained since that time. Figure 3a shows the radar tower and 3b provides an example of the information which can be obtained by photographing the display at 3-hourly intervals.

2.4 Current Meter data

With the exception of a long term current mooring being maintained at Stn A (see Fig 1) the collection of current meter data is now complete and emphasis has been switched to the interpretation of these records.

To the end of July 1977, 53 meter deployments had been made in the Swansea Bay area using Plessey MO21 and Aanderaa RCM4 recording current meters. Despite initial setbacks and losses of equipment a fairly comprehensive set of measurements under summer and winter conditions has now been obtained.

The bulk of these data are from measurements of the current speed and direction at a height of 2m above the sea bed and, where the depth of water was sufficiently great, at the mid-mean depth level (usually about 10m) as well. Record lengths have been typically 6 - 8 weeks with the flow being sampled every 10 minutes. Details of the current meter data returns are given in Table 1.

A suite of computer programs to perform the preliminary analyses of these data has now been virtually completed and a number of records have been analysed for validation purposes. In particular a detailed analysis has been carried out of the various types of error occurring in records. The conversion of the current meter data from binary format to speed and direction readings now includes a comprehensive set of diagnostic checks as well as producing a graphical line printer output of the record. This will be the primary source for manual editing of the information.

Whereas previous analyses of current meter data at IOS (Taunton) have used a regression direction calibration, the new programs use a 'look-up' table conversion procedure; this has the merit of both being easier to prepare and is computationally more efficient.

One of the problems, which has resulted in a delay in interpreting these records, has been due to the need to write programs for the 3 different types of data format now in use, ie Plessey 4 and 6 channel meters and the Aanderaa 4 channel meter.

An extensive modification to the current meter data analysis programs was also required because of the limited core store on IOS Taunton 's PDP11 computers and the length of the records being handled.

An example of some of the results from the routine analysis of a particular record are shown in Figures 5, 6 and 7; these show unsmoothed and smoothed progressive vector plots, speed and direction time series, speed and direction frequency histograms and a scatter plot from Station C. However it should be stressed here that the more detailed and important aspect of the analyses of these records, in particular the comparison with meteorological data, have yet to be completed.

2.5 Geological sampling

2.5.1 Beach

The sampling of the sand fraction of the beach continued on a bi-monthly basis until April 1977. As previously, the 11 topographic survey lines were used and specimens were obtained from high, mid and low water levels along these. Not all the bi-monthly samples have been analysed as the sediment size distribution remained fairly constant over the face of the beach.

Although there was some variability from survey to survey the following broad trends emerged:-

(a) Between sections C and T (Fig 1) the size of the sand fraction at mid-water level was the same size or coarser than that near high water. This trend was reversed from sections V to Z. Samples on all sections became finer from mid- to low-water.

(b) Trends along the length of the beach were not well defined but there appeared to be a tendency for the material to become finer in the neighbourhood of Sker Point, the R Kenfig and the Port Talbot tidal harbour.

2.5.2 Kenfig Dunes

Since the compilation of the last report the radiocarbon dates have become available for the peats underlying the dunes. These show a value of 5686 ± 45 BP (SRR - 967) for a thin beat band occurring at -3.1m OD in Borehole 4 (Fig 1). This value is closely comparable with those obtained by Godwin and Willis (1961) and suggests that sea level then was about 7m below that of the present day. Another radiocarbon date (Borehole 2) relates to a former extension of Kenfig Pool, now overlain by sand. This was from a height of +6.1m OD and gave a value of 793 ± 40 BP (SRR - 968). Historical evidence for burial of the neighbouring town of Kenfig agrees well with these data.

2.5.3 Offshore : vibrocores

The cruise in RV Sarsia, postponed from October 1976, took place in January 1977. It was planned to divide the time available into 2, firstly for vibrocoring and then to extend the suspended sampling and bed shear stress measurements. In the event, weather conditions were very poor and only a part of the vibrocoring and none of the other work, was carried out. However, a further cruise on the same vessel during late March and early April was rather more successful. As a result a total of 29 vibrocores was obtained up to 5m deep (See Fig 4). This number of cores is considered adequate although rather more would have helped to clarify some of the ambiguities which still remain.

Most of the laboratory work related to this coring programme - ie resin impregnation, X-ray photography, etc - has been completed.

2.6 Suspended sediment and bed shear stress measurements

As noted in 2.5.3 above, the continuation of this work, begun in April 1976, was not possible until the end of March 1977. In the intervening period a number of improvements were made to the suspended sediment sampling apparatus which has greatly improved the ease with which these measurements can now be made. (The suspended sediment and velocity profile measuring apparatus is described in IOS Report 26/76 and IOS Cruise Report No 44, 1976).

On the March cruise on RV Sarsia (21 March - 7 April 1977) three stations, PS2, PS3 and PS4, offshore of Port Talbot were occupied, (see Fig 1). Measurements of suspended sediment concentration were made at elevations of .10, .15, .25, .40, .80 and 1.80m above the sea-bed; at the same time the mean flow ($\overline{U}$) was measured at elevations of .15, .40, 1.00 and 1.80m. Concentration measurements were, where possible, made every 0.5 hour and one minute averages of the mean flow were collected automatically from all four elevations on a more or less continuous basis using a PDP8 computer plus interface. These data were output directly onto punched paper tape.

Approximately 63 hours of velocity profile and suspended sediment data were collected. A total of 579 samples of suspended matter (both organic and inorganic), greater than 40μm were obtained for particle size analysis and concentration determinations. Material finer than 40 μm was collected in 250 ml water samples for optical concentration measurements. The analysis of these samples remains to be completed.

It had been hoped that a wider coverage of suspended sediment and velocity profile measurements would have been possible; however inclement weather and difficulties with equipment limited the scope of the programme. Notwithstanding these setbacks it is considered that the data coverage should be adequate for describing the variations in suspended sediment concentration over the tidal cycle, for examining the neap-spring variation and the changes occurring with increasing distance from the shoreline (that is, moving from low to high tidal flow conditions). The velocity profile data should be adequate for calculations of the bed shear stress to be made; these figures will then be compared with the critical shear stress for the indigenous sediments.

2.7 Tracer work

During the period 1 August 1976 to 31 July 1977 tracer work has been carried out both offshore and on the beach. The study offshore was a continuation of that described in IOS Report 26/76 and represented both further surveys of the extent of dispersal of the tracer (Scandium-46) as well as laboratory analysis of the results.

The beach experiments were undertaken in Autumn 1976 and Spring 1977. Sand, labelled with fluorescent tracer, was used as part of an integrated study to compare the recorded hydraulic parameters, and the sand transport calculated from them, with actual sediment movement. These two series of experiments are described in more detail in Section 2.8 below.

IOS Report 26/76 described the injection of tracer, labelled with radioactive Scandium-46, at a site with a depth of water ranging between 16 and 26m, on 29 April 1976. Four complete tracer searches were carried out before 31 July 1976. Further full searches were undertaken on 4-5 September and again between 30 October and 1 November. Because of inclement weather it did not prove possible to have as comprehensive a coverage of complete surveys as during the 1975 radioactive tracer study. However, the general pattern was clear.

Analysis of results has shown several interesting features. Unlike most tracer studies, including that at Kenfig Patches in 1975, the percentage recovery of labelled material (corrected for decay) did not fall off progressively over time. Instead, the last 2 searches indicated an increase in the proportion of tracer that could be accounted for, this rising to no less than 74% on the final complete survey (D + 153 to 155). This gives firm support to the view that, once the tracer becomes in equilibrium with its environment, dispersive losses are low and any apparent drop in recovery may be largely accounted for by burial. In this specific instance subsequent exhumation explains the increase in the proportion accounted for.

Both 1975 and 1976 experiments suggest that initial transport rates are unrepresentative and that as much as a week needs to elapse before the tracer comes into equilibrium with the mobile surface layer.

Typical transport rates of the order of .2 - .4 tonnes $day^{-1}m^{-1}$ have been obtained using a tracer balance method of calculation. Comparison of data from a nearby recording current meter and wave records suggest that net tracer drift in the Kenfig Patches area is approximately 1/1000 of the mass transport velocity attributable to waves and 1/5000 of that based on the observed tidal residual flow.

This work is to be reported more fully in a forthcoming scientific paper and Topic Report : 6.

2.8 Beach experiments

2.8.1 Two series of beach experiments have been carried out, one between 12 and 24 November 1976 and the other from 24 April to 6 May 1977. Both these studies were located at a position somewhat N of a point midway between the southern breakwater of the Port Talbot tidal harbour and Sker Point ('Q' in Fig 1). The location was selected on the basis that it was uniformly sand covered unlike the peat and clay outcrops further north. Nor was it obviously affected by the immediate proximity of the tidal harbour, the SCOW outfall to the N, nor the R Kenfig to the S. In addition, the site was fairly close to that covered by the radar scanner. On each occasion the aim was to compare the movement of sand with observed hydraulic parameters.

2.8.2 Measurements of near-bed wave orbital velocities and the longshore current were made with electromagnetic current meters mounted on a frame at a height of 1m above the beach face. Wave pressure fluctuations were also measured using an FM pressure recorder and all sensors were cabled in (over a distance of some 400m) to recording equipment housed in a Portakabin laboratory ashore.

In addition, for the second beach experiment (24 April - 6 May 1977) 3 Plessey MO21 recording current meters and 2 self contained wave recorders were deployed offshore of the beach experimental area to provide supplementary data on tidal currents and wave climate.

Figure 8 shows the beach rig design while Figures 9 and 13 indicate the relationship of the rig to the beach and the fluorescent tracer injection site: the positions of other recording equipment deployed during the beach experiment are shown in Figure 1.

The four channels of electromagnetic flowmeter data, the pressure signal and a timing signal were recorded on a 7-track Bell and Howell CPR4010 FM tape recorder. Analogue records of velocity and pressure fluctuations were also collected on a Bell and Howell UV chart recorder. During the first beach experiment (12 - 24 November 1976) movement of material on the beach surface was studied using a prototype self-generating noise probe and some of these data were recorded on the CPR4010 tape recorder. Typical velocity and pressure analogue signals are shown in Figure 10 and the data logging system is shown schematically in Figure 11. Magnetic tapes were returned to the laboratory where they have been re-played through low pass filters and digitized at intervals of 0.2s to produce computer-compatible magnetic tape records. The electromagnetic flowmeters were calibrated in the towing tank at IOS (Wormley).

During the second beach experiment a wave staff was set up approximately 10m to the SE of the beach rig. When possible filming of the wave staff was carried out synchronously with the collection of velocity and pressure data. It is hoped that this information will enable the observed velocity and pressure signals to be correlated with wave form.

The objective of these measurements is to relate the observed rates of movement of tracer to the alongshore variations in wave energy and the longshore current. Furthermore the directional characteristics of waves approaching the beach, of relevance to littoral drift calculations, are being studied. The energy spectra, co-spectra and quadrature spectra of the velocity and pressure fluctuations are being used to calculate the directional spectra and mean direction of the waves. The possibility of reflected wave energy is also being studied using this technique and the statistical characteristics of the velocity fluctuations are being examined for other methods of parameterising wave direction. Estimates of the longshore current will also be obtained.

An attractive feature of these measurements is that the tidal range effectively permits an examination of the variation in wave direction characteristics across the beach face assuming a stationary wave climate. It is hoped that eventually a comparison will be made between wave direction estimates from velocity-pressure measurements, from wave refraction techniques and from radar observations.

2.8.3 In each series of experiments fluorescent labelled sand, closely corresponding in size range to that of the actual beach, was used. In the first series 3 colours, red, blue and green, were injected, each injection being of 0.5 tonnes. The initial injection corresponded to neap tides. An excavation 2cm deep was made into the beach surface over an area $3.5m^2$ and the tracer was placed in this, and levelled so that the surface was comparable with the adjacent beach. The tracer was then thoroughly wetted with a solution of detergent in sea water to reduce its surface tension. At spring tides the other 2 colours were deployed, one batch in a similar fashion to the neap's injection; the other as a thin veneer on the beach surface. In the 1977 experiments injections again corresponded to neaps and spring tides and were similar in design but only 2 colours of fluorescent sand were used.

In all cases systematic sampling was employed. Close to the injection site cores were taken but elsewhere surface sampling was used, between 170 and 270 samples being taken at each low water for a total of 16 tides. During periods of darkness maximum travel was determined by an ultra-violet lamp powered by a generator mounted on the back of a Land-Rover. Because tracer did not appear to go offshore in the November experiment, only the exposed beach was sampled in the spring 1977 experiments. A typical recovery pattern is shown in Figure 12.

Analysis of the data obtained during both series of experiments is continuing.

Some preliminary measurements of the compaction of beach sediment (using a core penetrometer) and the variations in the level of the water table in the beach were made during the second experiment. It is hoped that further measurements of this type will be carried out in time for the final topic report.

2.9 Meteorological data

The collection of meteorological data has been continuing as a background activity to the main study for some time. However, with the collection of current meter and wave data now more or less complete, the meteorological information is becoming of increasing importance.

Meteorological records, principally wind speed and direction from Port Talbot and atmospheric pressure data from Rhoose Airport, S Glamorgan, are now being digitised in a format suitable for computer based comparisons with wave and current meter data. Hourly values of wind speed and direction and six-hourly values of the atmospheric pressure are being punched onto paper tape and will eventually enable comparisons to be made over a 2 year period.

All meteorological data have been supplied by the Meteorological Office.

2.10 Data processing and compilation of Topic Reports

As mentioned in the Introduction to this Progress Report, an increasing emphasis is being directed to the analysis of field data and the production of the Topic Reports. The first of the latter is now complete. Appendix 1 gives an outline of the content of the various reports planned, together with the target dates for their completion. The order of the Topic Reports is largely governed by the progress in processing particular areas of data; in the specific expertise of available personnel; and the existence of other, related, commitments.

While it is hoped to keep fairly closely to the proposed timescale, Topic Reports 3, 4 and 8 may present particular difficulty in this respect. These cover Wave Data; Tidal Currents and the Final Report.

2.11 Liaison

Last year's Progress Report stated that: "A high level of liaison is considered essential to the success of the project during the next year". This high level has been achieved. As well as continuing the established contacts with AERE, Harwell, the British Steel Corporation, Hydraulics Research Station, Welsh Office, Welsh National Water Development Authority, relevant local authorities, and other bodies (such as the Marine Biological Association) falling within the overall remit of NERC, additional relationships have been established. For example, IOS have supplied wave data for the contractors (Kier Ltd) who are responsible for the building of the 3.5 km long outfall for the new integrated steelworks at Port Talbot.

The co-operation with the British Transport Docks Board (BTDB) has again been noteworthy, and IOS's radar tower has been erected on the Port Talbot tidal harbour main breakwater with BTDB's agreement. This has enabled much better wave direction records to be obtained under a wide range of conditions (see Section 2.3).

The NERC research contract with the Department of Oceanography, University College of Wales, Swansea, has ensured close co-operation between members of that Department and IOS, not merely on the specific aspects of the contract, but on joint work, such as that on sea bed drifters. A substantial report, describing progress on the contract, was received by IOS in June 1977.

3. SUMMARY

During the year there was a progressive transfer of staff and resources to the processing and analysis of data from the field and field experimentation. However, both the Waverider buoy and the FM pressure wave recorder have continued to be deployed throughout as have current meters on the long-term mooring. Additionally, 3 major field projects have taken place. These were the deployment and recovery of a further 7 recording current meter rigs (10 current meters) during autumn and early winter 1976; beach experiments in November 1976 and April/May 1977; and 2 cruises on RV Sarsia during parts of January and March/April 1977.

The beach experiments were designed to compare the movement of fluorescent-labelled sand with hydraulic data obtained from electromagnetic flowmeters and an FM pressure head mounted on a rig nearby.

Other instrumentation, including the radar scanner used for determining wave direction, was installed in the general area. Tracer work, in this case an extension of the 1976 experiment using sediment labelled with radioactive Scandium-46, was also carried out offshore. Two further complete searches were made while, as part of both RV Sarsia cruises, cores were taken in the tracer dispersal area to determine depth of burial. The main purpose of the cruises was, however, to obtain vibrocores of the material on the sea bed; to collect suspended sediment samples; and carry out bed shear stress measurements. In spite of very poor weather, especially on the first cruise, a reasonably comprehensive body of data was obtained: this included 29 vibrocores and almost 600 suspended sediment samples with particles $> 40\,\mu m$ alone.

Much of the effort in the area of data analysis has been directed towards producing a suite of computer programs to deal with the recording current meter records. A less sophisticated program has been used to calculate changes on the various beach profiles carried out monthly between Sept/Oct 1975 and April/May 1977. These sections (and the particle-size analyses on the same lines) show relatively little short-term change over the period unlike the documentary records and photogrammetry. Both the latter sources, which cover the periods 1840-1960 and 1968-75 respectively, suggest a continuing steepening of the beach, mainly due to landward retreat of low water mark. The documentary records form the major part of Topic Report: 1 (IOS 42/77) which was completed during the period covered by this Report, while discussion of evidence provided by the beach levelling and photogrammetric surveys will be included in Topic Report: 2.

The year up to 31 July 1977 also marked the completion of the first scientific paper to be based on data gained from the Swansea Bay project.

4. FUTURE WORK

As has been noted earlier in this Report, the Swansea Bay Project has now reached a stage when most effort is being directed into the processing, analysis and interpretation of the field data and samples. However, a limited amount of data collection will continue for some time to come including that from one survey of the beach sections.

4.1 Current meter data

The last deployment of the recording current meters at the long-term mooring ('A' on Fig 1) is due to be completed in November 1977. Thereafter, resources will be concentrated solely on processing and analysis of all the records obtained this far.

4.2 Wave data

It is intended that the Waverider, off the Scarweather lightvessel, and the FM pressure recorder located just S of the Port Talbot tidal harbour, will remain in operation for the 1977-78 winter. The information, together with directional information obtained from the radar at Port Talbot, will be used to extend the present data set and to help place in context the records collected from the self-contained wave recorders due for deployment near the coastline between Morfa Mawr and Sker Point during autumn 1977 (Fig 1).

4.3 Data and sample processing

While the vibrocores have either been impregnated with resin or photographed using an X-ray source (depending upon whether they were of sand or clay) there is a considerable backlog of suspended sediment samples to be processed. These, along with the remainder of the fluorescent tracer samples, will occupy the sedimentation laboratory at IOS, Taunton, for some time.

The methods for standard wave analyses are well established and, unlike the current meter records, are less demanding of computer power and core. Most of the current meter analysis programs are now available. Once all the existing data are run and results tabulated there are two major stages. These are correlation of one factor with another (for example, current residuals against specific meteorological parameters) and the general synthesis of the information which has been gained.

4.4 Compilation of scientific papers and reports

It has already been noted that Topic Report: 1 has been completed. At the time of writing (September 1977) Topic Report: 2 (see Appendix 1) is at an advanced stage. During the next 12 months or so a further 6 reports are scheduled. It is hoped that these, together with other information, will help to provide a basis for scientific papers discussing specific aspects of interest and importance. One of the areas in which a considerable body of evidence is likely to be available as a result of the project is that of comparative data. Already the paper to be presented at the US Coastal Sediments '77 symposium examines sediment transport as observed by radioactive tracers versus that inferred from hydraulic measurements. Similar comparisons should be available in due course for longshore dispersal of beach sand in relation to tidal current and wave data, and between computed wave refraction and recorded wave energy.

Such comparisons should be of real value not only in the specific context of Swansea Bay but in a more widespread context also.

5. ASSESSMENT OF PROGRESS TOWARDS THE OVERALL PROGRESS OF THE PROJECT

Last year's Progress Report (IOS Report 26/76) said:
'The overall aims of the project are to obtain field data from offshore and the foreshore and to use these data, largely within the limits of present scientific knowledge and techniques for interpretation, to produce an integrated assessment of sediment transport. At the same time it is hoped to improve the techniques themselves as they relate to this type of study. These objectives have relevance not only for Swansea Bay but for wider application elsewhere. For the specific area, the aims are to define the overall circulation pattern of sediment transport within the Bay and to attempt to quantify it, especially in respect of the amount of sediment reaching the coastline from offshore.

IOS is confident that the Swansea Bay project will result in an important advance in both local knowledge and in a more general understanding of physical systems in the coastal environment. Nevertheless several problems have arisen or appear likely to arise which cannot be solved in the present context. These will need a different scientific approach - for example, a detailed study of individual small scale phenomena - or the acquisition of comparative data from other sites in order to provide a reasonable chance of their being resolved'.

These comments still apply.

At the three-quarter stage in the present contract for the Swansea Bay Project, the emphasis has changed from the initial desk study, through the data-gathering period of field work and experimentation, to the most crucial phase: that of analysis, compilation and synthesis. This change in emphasis has been apparent throughout the current Report. While the volume of work remaining to be done continues to give cause for concern it is the time scale rather more than the problem itself that is in question. Nevertheless, as was remarked last year, it remains true that it is on the integration of data, and the associated analysis and interpretation that the project will stand or fall.

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TABLE 1

Summary of Current Meter Data returns from Swansea Bay (in period August 1976 to July 1977).

Long term current measurements

Meter No	Meter type*	Station	Height (m)	Deployment periods From	To	Record status
KA244)	P/6	A	10	27.7.76	28.9.76	Complete
669)	P/4	A	2	27.7.76	28.9.76	"
KA 237)	P/6	A	10	28.9.76	1.12.76	"
KA 262)	P/6	A	2	28.9.76	LOST	No data
626)	P/4	A	10	4.12.76	LOST	No data
680)	P/4	A	2	4.12.76	1. 2.77	Complete
KA 244)	P/6	A	10	1. 2.77	LOST	No data
KA 260)	P/6	A	2	1. 2.77	3. 4.77	Complete
629)	P/4	A	10	3. 4.77	1. 6.77	"
560)	P/4	A	2	3. 4.77	1. 6.77	"
667)	P/4	A	10	1. 6.77	26.7.77	"
532)	P/4	A	2	1. 6.77	26.7.77	"
669)	P/4	A	10	26.7.77		
594)	P/4	A	2	26.7.77		
Short term current measurements						
KA 244	P/6	D	12	26.10.76	3.12.76	Complete
KA 267	P/6	D	2	26.10.76	LOST	No data
KA 269	P/6	E	12	26.10.76	3.12.76	Complete
667	P/4	E	2	26.10.76	3.12.76	"
626	P/4	G	2	27.10.76	30.11.76	"
KA 260	P/6	F	10	27.10.76	1.12.76	"
560	P/4	F	2	27.10.76	1.12.76	"
680	P/4	B	2	29.10.76	30.11.76	"
534	P/4	H	2	29.10.76	16.12.76	"
594	P/4	C	2	29.10.76	4.12.76	"
573	P/4	B	2	30.3.77	LOST	"
KA 269	P/6	H	2	29.3.77	31.5.77	"
669	P/4	K	2	29.3.77	31.5.77	"

*Meter Types: P Denotes Plessey MO21 recording current meter
4 and 6 denote number of parameters

Record Status: Complete implies that a record was obtained. This is not a reflection on the quality of the data.

APPENDIX 1

SWANSEA BAY PROJECT : PROVISIONAL LIST OF REPORTS AND TIMESCALE

Progress Reports	Completion date
1. Progress report for the period to March 1975 and subsequent developments. IOS Report No 20, 1975	12/75
2. " " " " " August 1975 to July 1976. IOS Report No 26, 1976	12/76
	Provisional Completion date
3. " " " " " August 1976 to July 1977	10/77
4. " " " " " from August 1977	12/78

Topic Reports		Completion date
1. Swansea Bay: (a) Introduction (b) Long-term changes of the coastline	An outline description of the area; an indication of the research objectives and evidence for long-term change. The latter mainly includes literary and cartographic sources but also borehole data in so far as chronology is provided by C^{14} dating techniques. Sand and gravel extraction and dredging figures are incorporated.	7/77
		Provisional Completion date
2. Swansea Bay : Evidence for beach stability: topographic and photogrammetric measurements.	Essentially a data report incorporating comparisons of 3 aerial photographic surveys and beach sections from September 1975 to April 1977. Some reference to earlier consultants' data will be included, but this would mainly be in synthesis report (8, below).	10/77
3. Swansea Bay: Wave data: observed and computed wave climate.	To include lists of available wave data: comparisons between offshore and nearshore: 12-month wave scatter diagrams for Hs and Tz; extremes etc. Direction as shown by radar pictures (see also 7, below). Computed refraction, including direction and energy.	12/77*
4. Swansea Bay: Tidal currents: observed tidal and residual circulations and their response to meteorological conditions.	This would be an analysis of all the current meter data and meteorological data that has been obtained, plus that from other sources. The timing is related to the Report for the WNWDA/Welsh Office scheduled for 10/77.	12/77*
5. Swansea Bay: Geophysical measurements and sediment characteristics, offshore and onshore.	To include sidescan, CSP, vibrocoring, box coring and grab sampling offshore, beach sediments and borehole logs onshore. The report would seek to identify those areas of potentially mobile material and examine the statistical evidence for the origin of sediments (eg sorting coefficients)	3/78 (Date dependent upon availability of data and processing of samples: ideally Report should be earlier).
6. Swansea Bay: Offshore sediment movement (using radioactive tracer techniques) and its relation to observed tidal current and wave data.	This Report would include the 1975-76 tracer work, including the tracer burial work by AERE Harwell. The movement recorded would be evaluated in the light of related wave and current measurements. The emphasis would be on quantification.	6/78
7. Swansea Bay: Foreshore sediment movement (using fluorescent tracer techniques) and its relation to observed tidal currents and wave climates.	The Report would consist of the data obtained from the 1976 and 1977 beach experiments (tracer movement, e/m flowmeter and wave recorder data) together with other relevant wave and current meter records. Wave refraction studies, wave direction from the radar at Port Talbot tidal harbour and some beach profile and sediment data would be included. Littoral drift estimates would be provided. There would, as in 6 (above) be an emphasis on quantification.	6/78
8. Swansea Bay: Final Report: a study of foreshore erosion and sedimentation processes in the nearshore zone.	A synthesis of 1 - 7 (above). This report will include appendices listing the available data.	9/78*

It is hoped that each Report will include a section on techniques and, where appropriate, on advances in theory and methods. A supplementary report concentrating on data relevant to the needs of the local Coast Protection Authority might also be written (if required) but it would not be IOS's intention to interpret the data's implications.

* At the time of writing it is becoming increasingly obvious that because of data processing difficulties, these Reports are likely to be completed considerably behind schedule.

APPENDIX 2

Section C: Comparison of surveys in January and February in order to determine change in area.

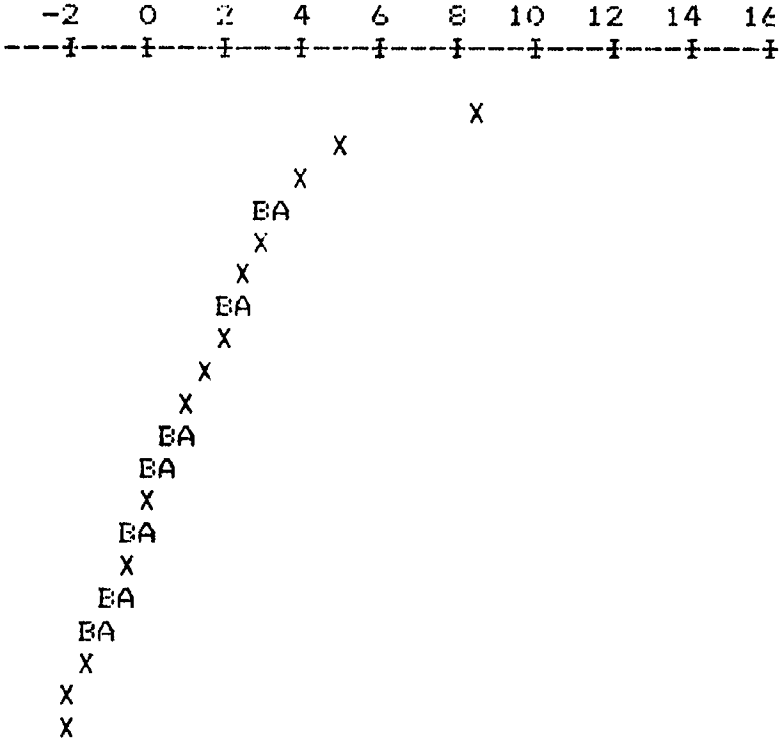
JANUARY 1977

32.000	34.500	35.000	36.500	39.500	41.500	45.000	49.500	62.000	75.000
11.750	11.615	11.555	10.695	8.920	7.890	7.355	5.980	4.870	4.265
107.500	152.000	183.000	225.500	272.000	312.000	365.000	394.500	434.000	490.000
3.400	2.640	2.125	1.310	0.450	-0.355	-1.510	-2 035	-2.600	-3.240

FEBRUARY 1977

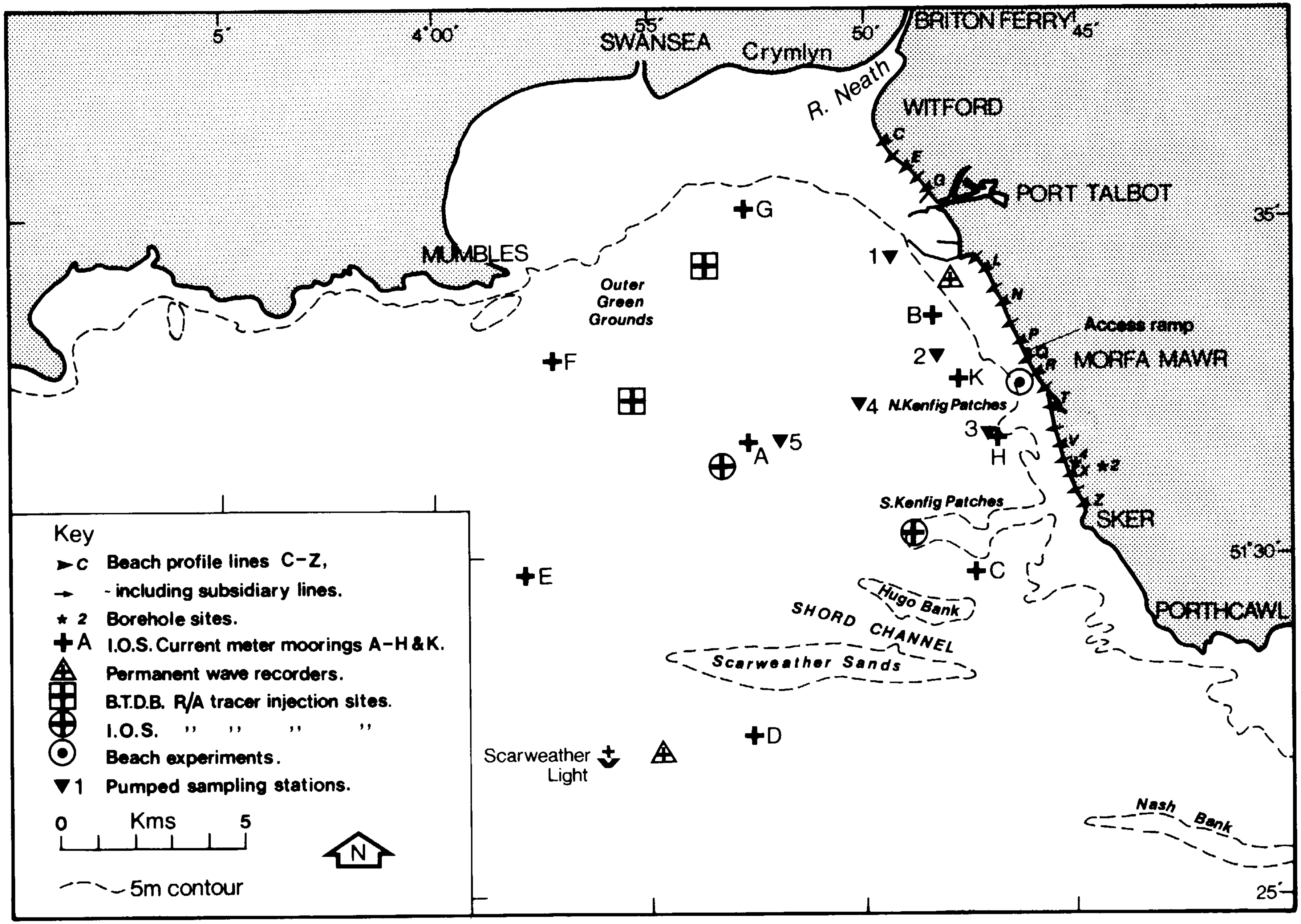
32.000	35.000	36.000	41.000	43.000	47.000	49.000	89.000	147.500	185.500
11.820	11.435	10.735	8.350	7.125	6.335	5.840	3.655	2.585	2.020
234.000	245.500	295.500	353.500	380.500	438.000				
1.130	0.455	-0.475	-1.400	-1.895	-2.740				

PROFILE



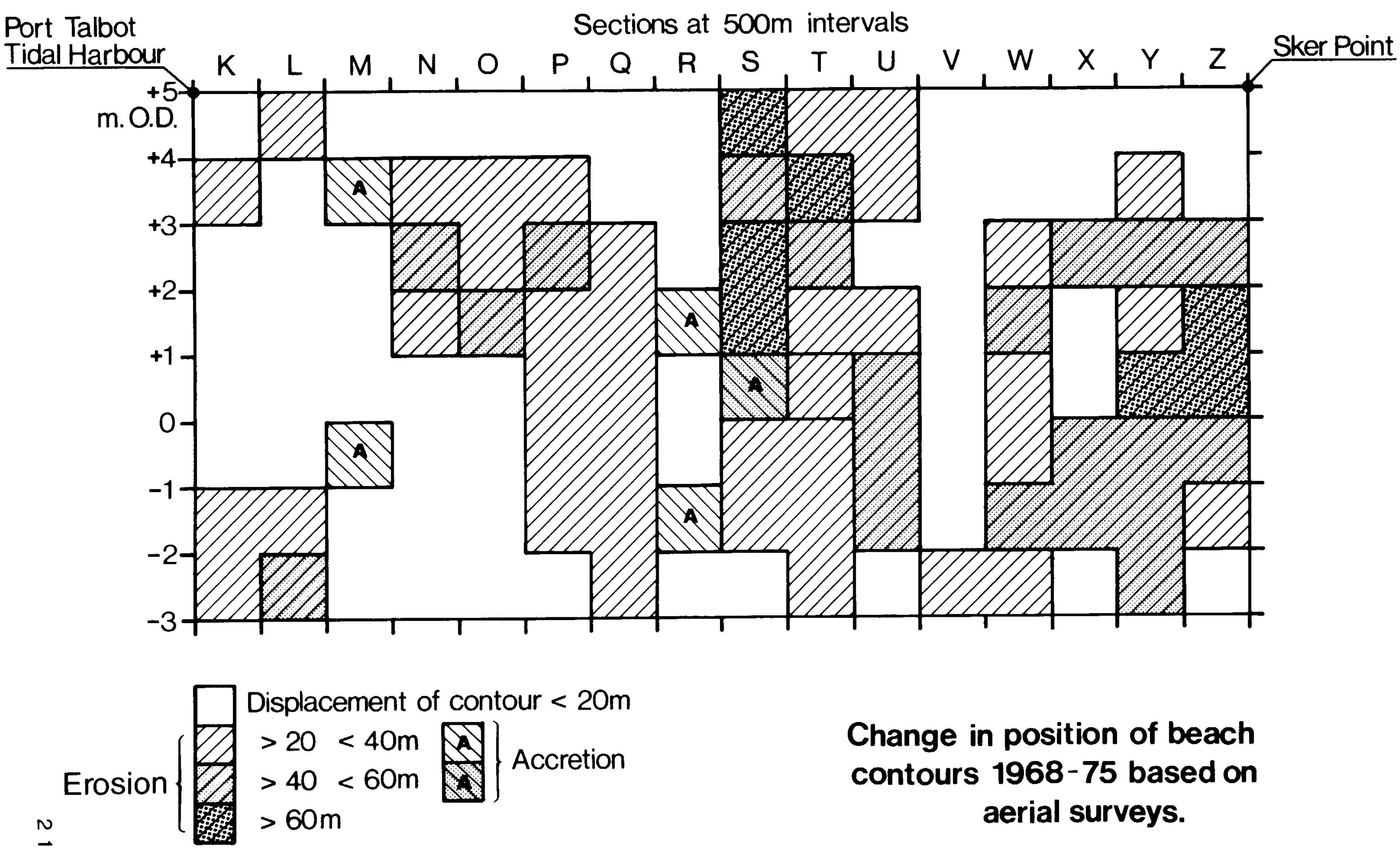
DISTANCE (METERS)	FIRST HEIGHT (METERS)	SECOND HEIGHT (METERS)	CHANGE IN AREA (SQ. M.)	TOTAL (SQ. M.)
40.0	8.663	8.827	0.000	0.000
60.0	5.048	5.239	3.560	3.560
80.0	4.132	4.147	2.062	5.623
100.0	3.600	3.454	-1.311	4.311
120.0	3.187	3 088	-2.443	1.868
140.0	2.845	2.722	-2.213	-0.345
160.0	2.507	2.399	-2.307	-2.652
180.0	2.175	2.102	-1.810	-4.462
200.0	1.799	1.754	-1.181	-5.644
220.0	1.415	1.387	-0.736	-6.380
240.0	1.042	0.778	-2.926	-9.306
260.0	0.672	0.185	-7.506	-16.812
280.0	0.289	-0.187	-9.623	-26.435
300.0	-0.114	-0.547	-9.090	-35.525
320.0	-0.529	-0.866	-7.697	-43.222
340.0	-0.965	-1.185	-5.559	-48.781
360.0	-1.401	-1.519	-3.376	-52.157
380.0	-1.777	-1.886	-2.270	-54.427
400.0	-2.114	-2.182	-1.768	-56.195
420.0	-2.400	-2.475	-1.436	-57.631

ACCRETION = 5.623 Sq m
EROSION = -63.254 Sq m



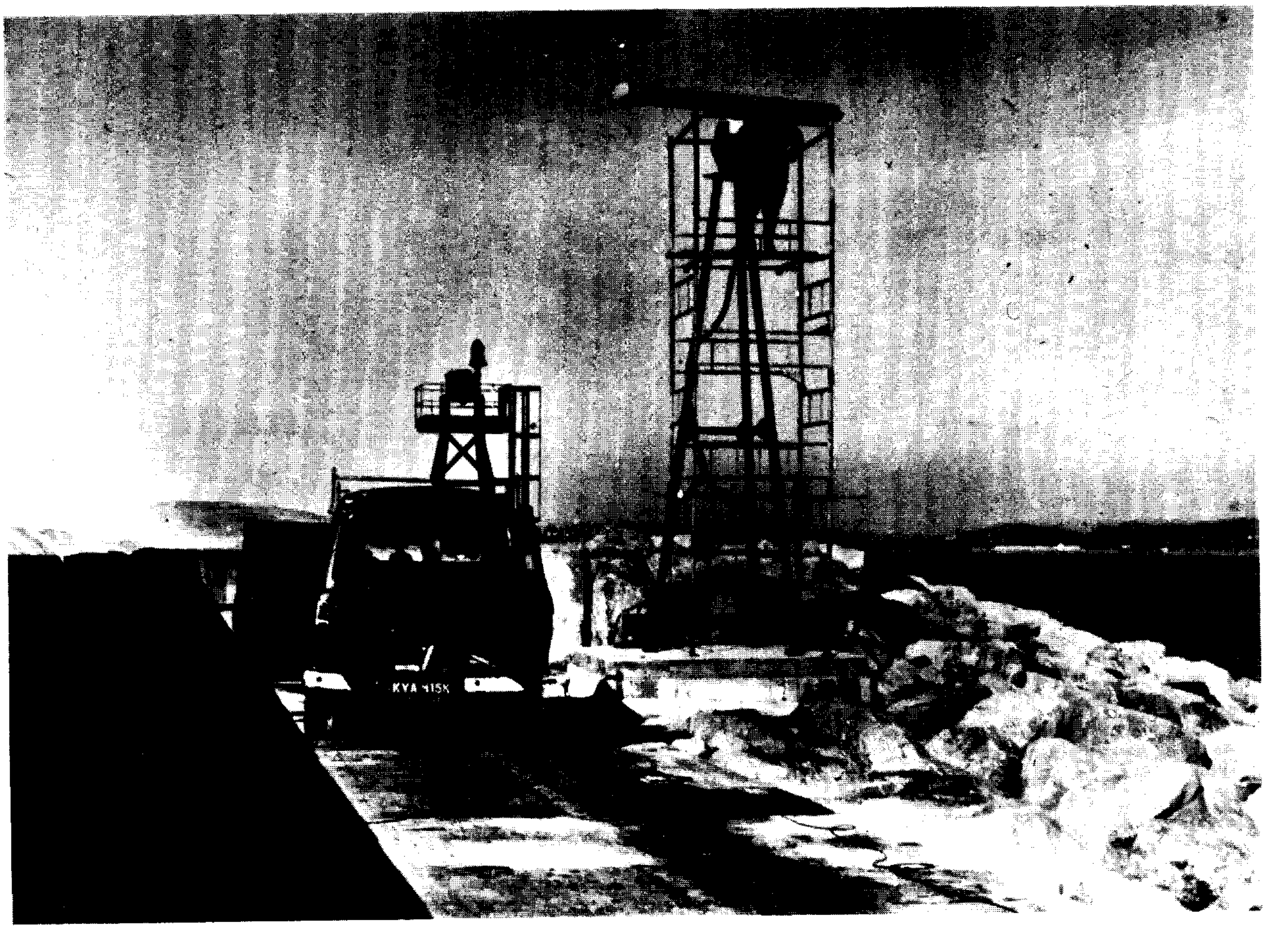
5'
4°00'
55'
SWANSEA
Crymlyn
50'
BRITON FERRY
45'
R. Neath
WITFORD
PORT TALBOT
35'
MUMBLES
Outer Green Grounds
G
F
1
B
2
K
Access ramp
MORFA MAWR
4
N.Kenfig Patches
3
H
A
5
S.Kenfig Patches
SKER
51°30'
C
E
Hugo Bank
SHORD CHANNEL
Scarweather Sands
PORTHCAWL
D
Scarweather Light
Nash Bank
25'
Key
C Beach profile lines C–Z,
- including subsidiary lines.
2 Borehole sites.
A I.O.S. Current meter moorings A–H & K.
Permanent wave recorders.
B.T.D.B. R/A tracer injection sites.
I.O.S. ,, ,, ,, ,,
Beach experiments.
1 Pumped sampling stations.
0 Kms 5
N
5m contour

Fig.1



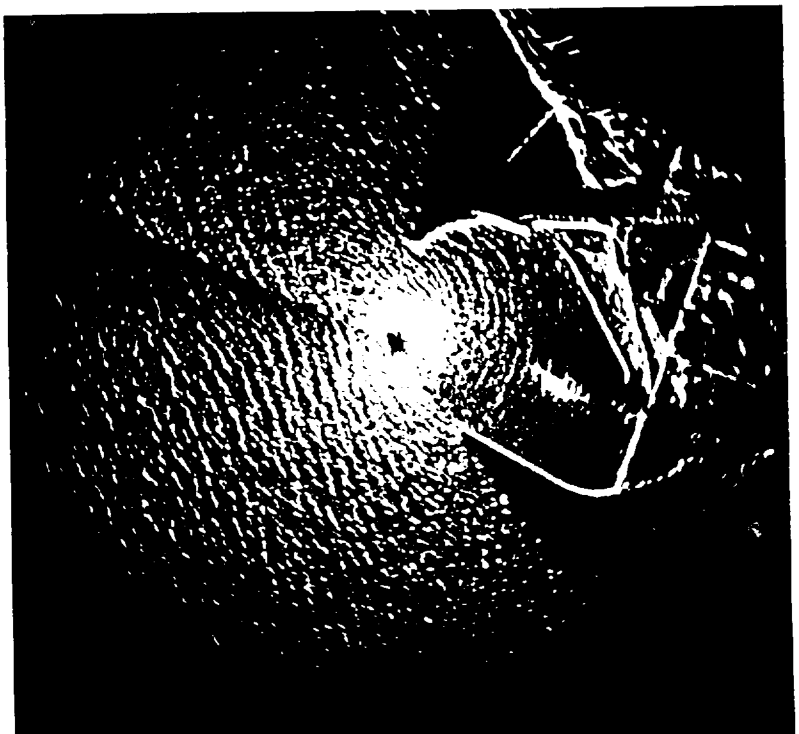
Change in position of beach contours 1968-75 based on aerial surveys.

Fig. 2



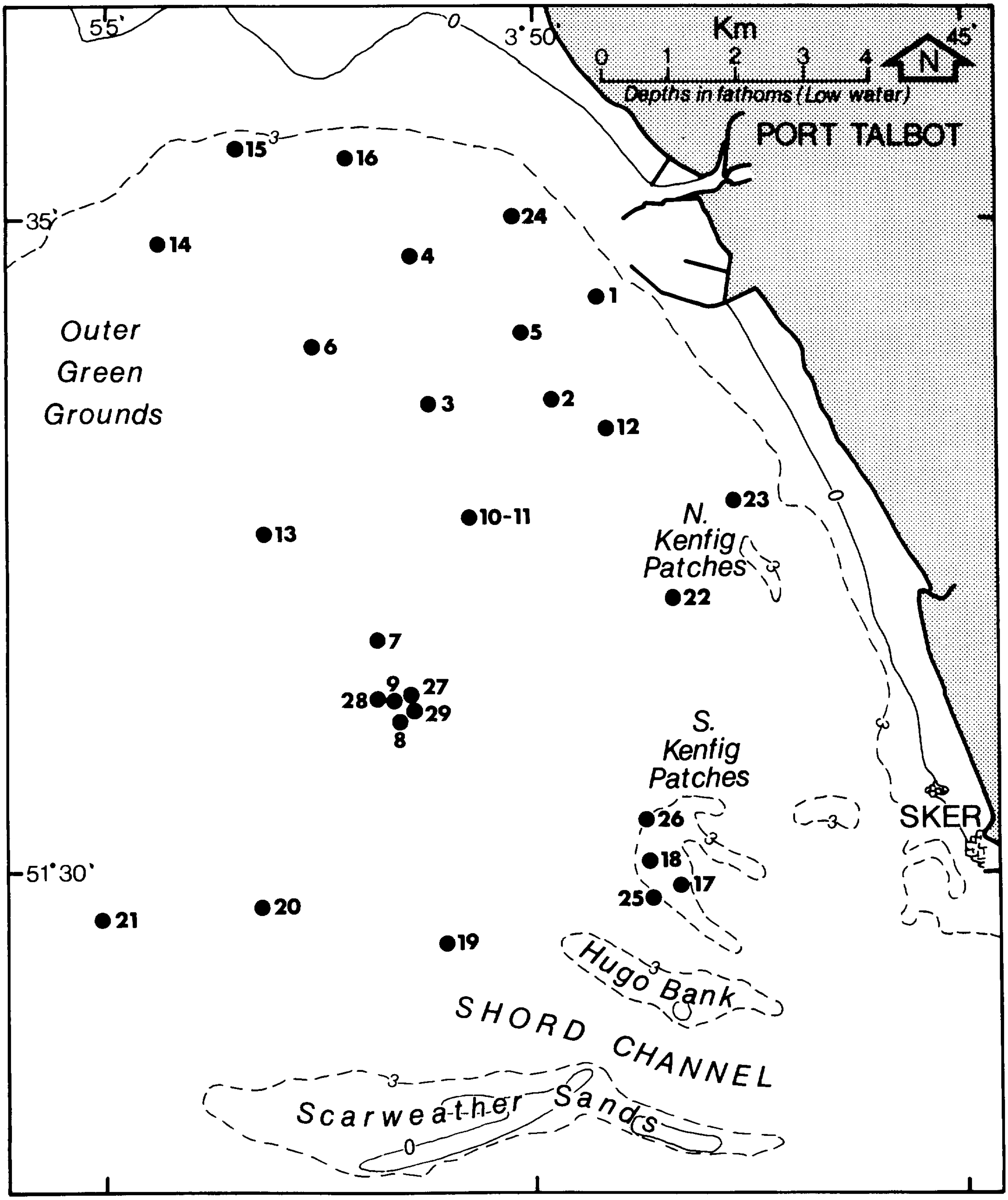
Erection of radar tower and scanner.

Fig. 3a



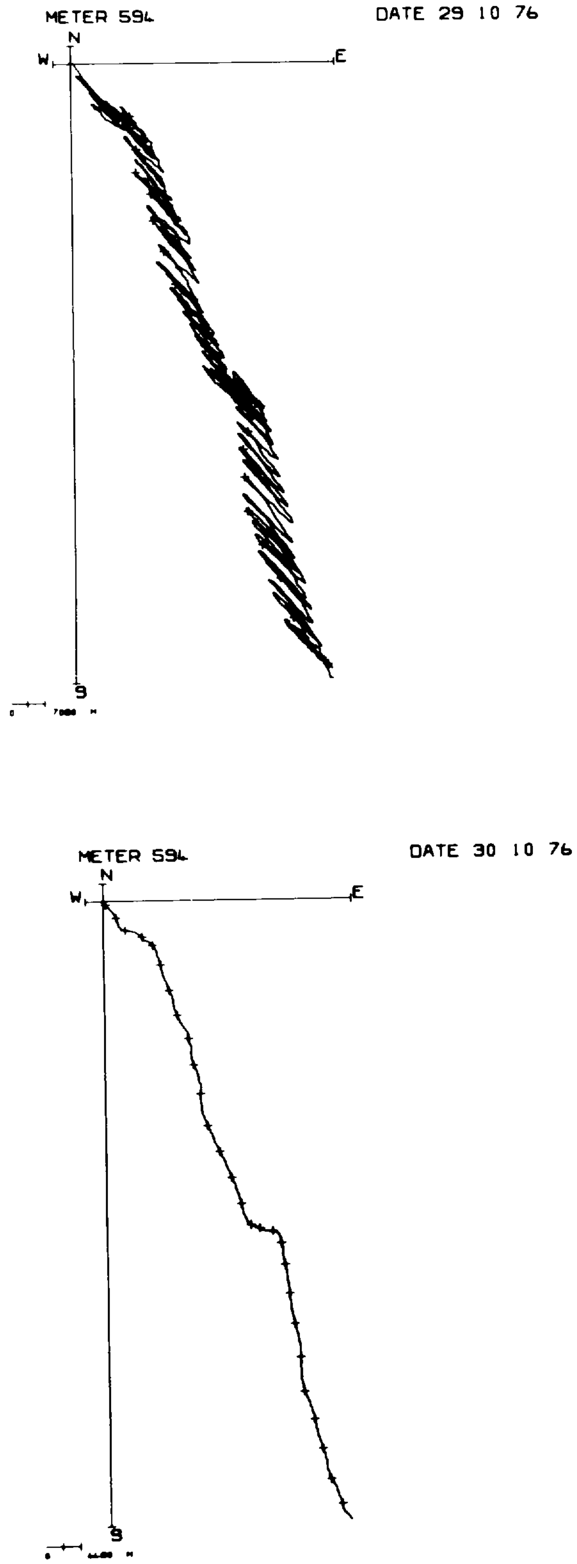
Typical photograph of radar display of sea waves.

Fig. 3b



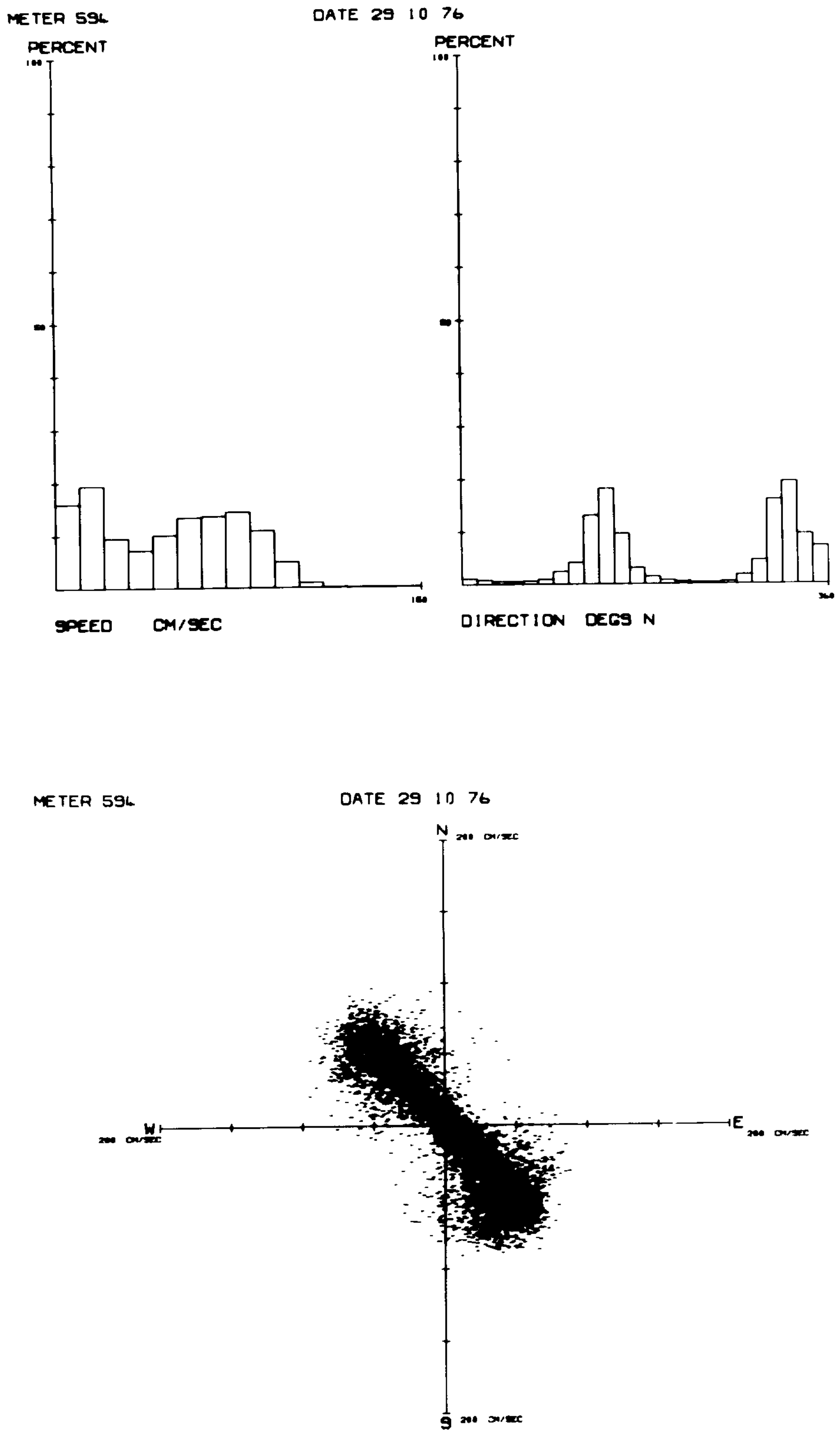
Vibrocore positions: Nos. 1 - 16 Sarsia Cruise January 1977
17- 29 ,, ,, March 1977

Fig. 4



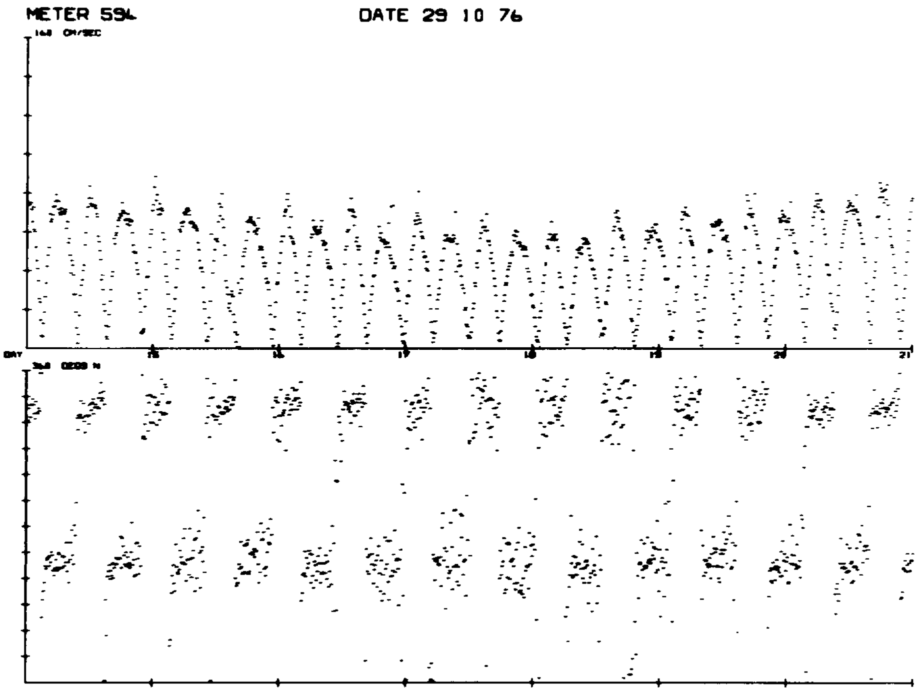
Showing unsmoothed (top) and smoothed progressive vector plots from meter no. 594, stn C, Swansea Bay, measured over a period of approximately 30 days.

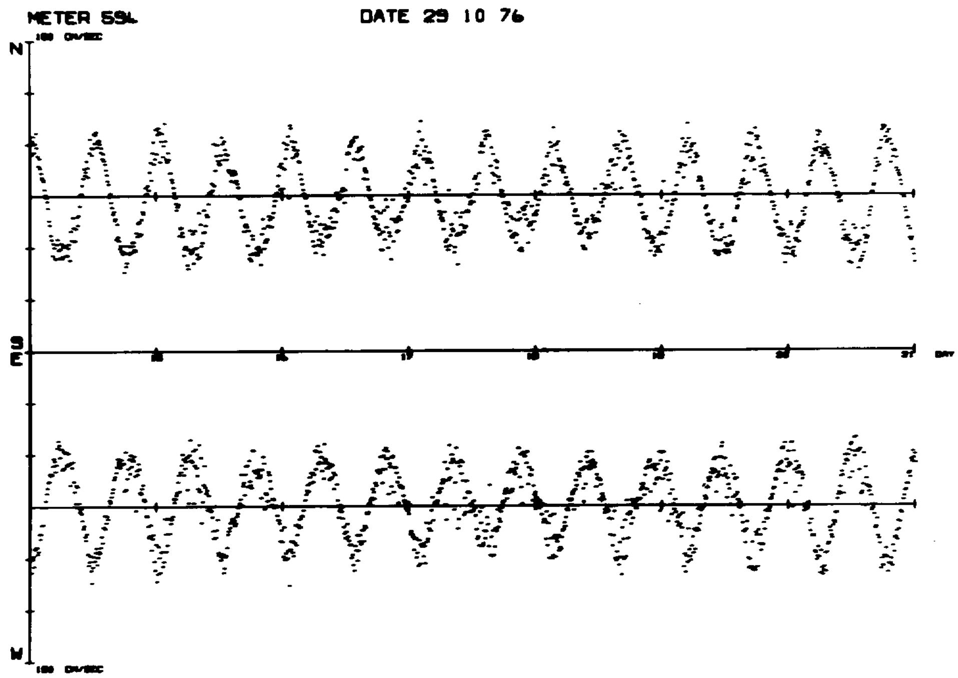
Fig. 5



Showing speed and direction frequency histograms (top) and current speed scatter plot (bottom) from meter no. 594, stn C, Swansea Bay, measured over a period of approximately 30 days.

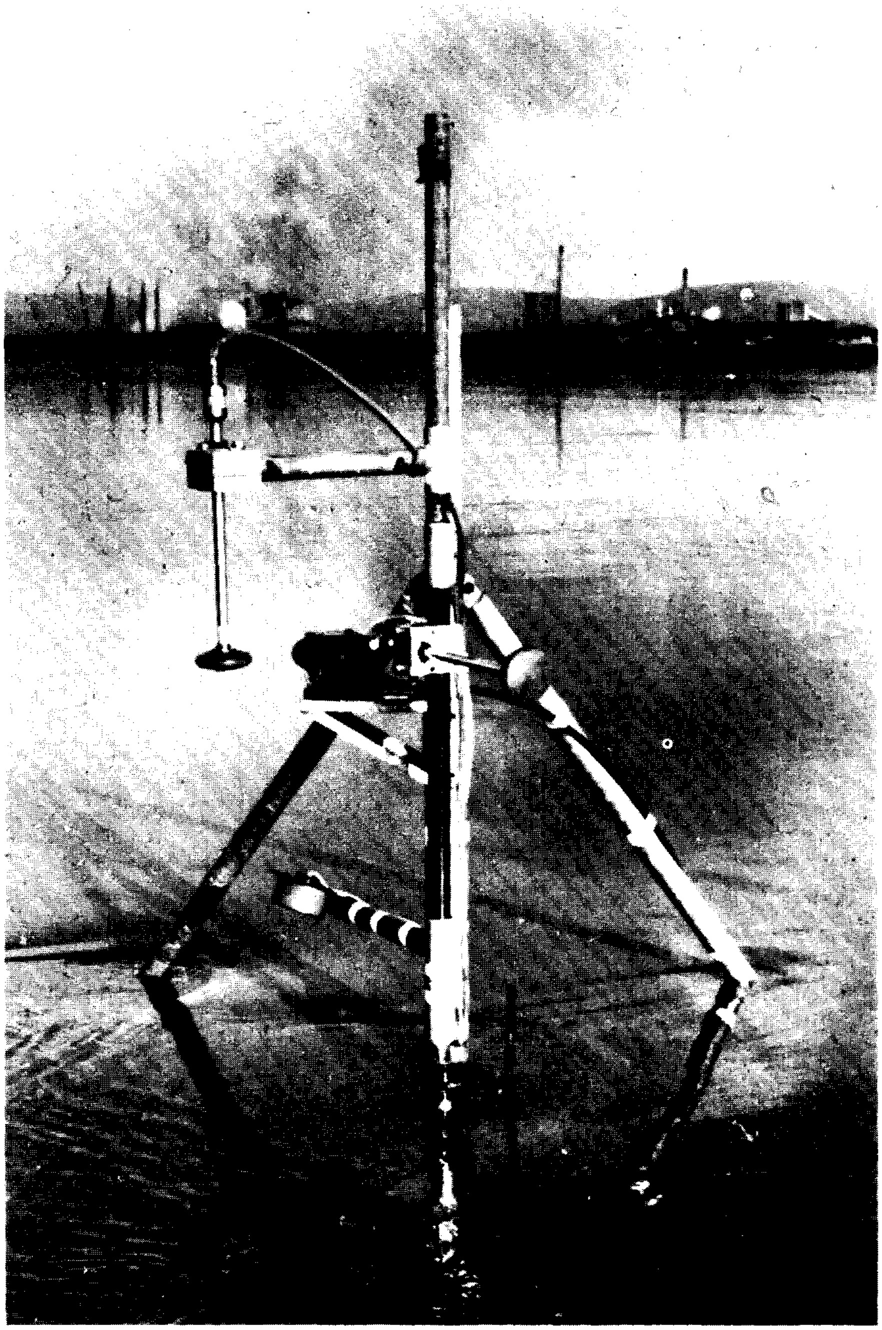
Fig. 6





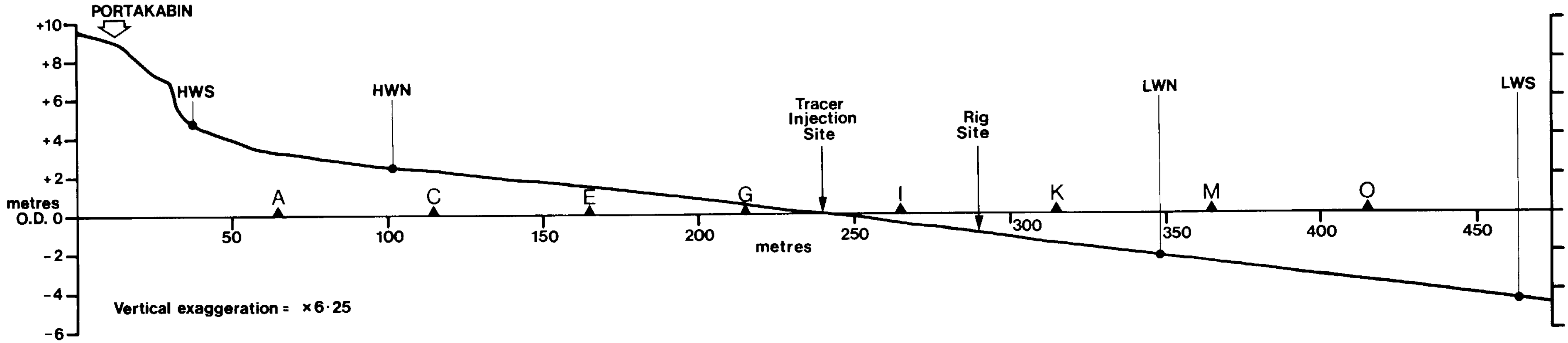
Showing time series of current speed and direction values and resolved speed values from meter no. 594, stn C, Swansea Bay, (shown for 7 days data only).

Fig. 7



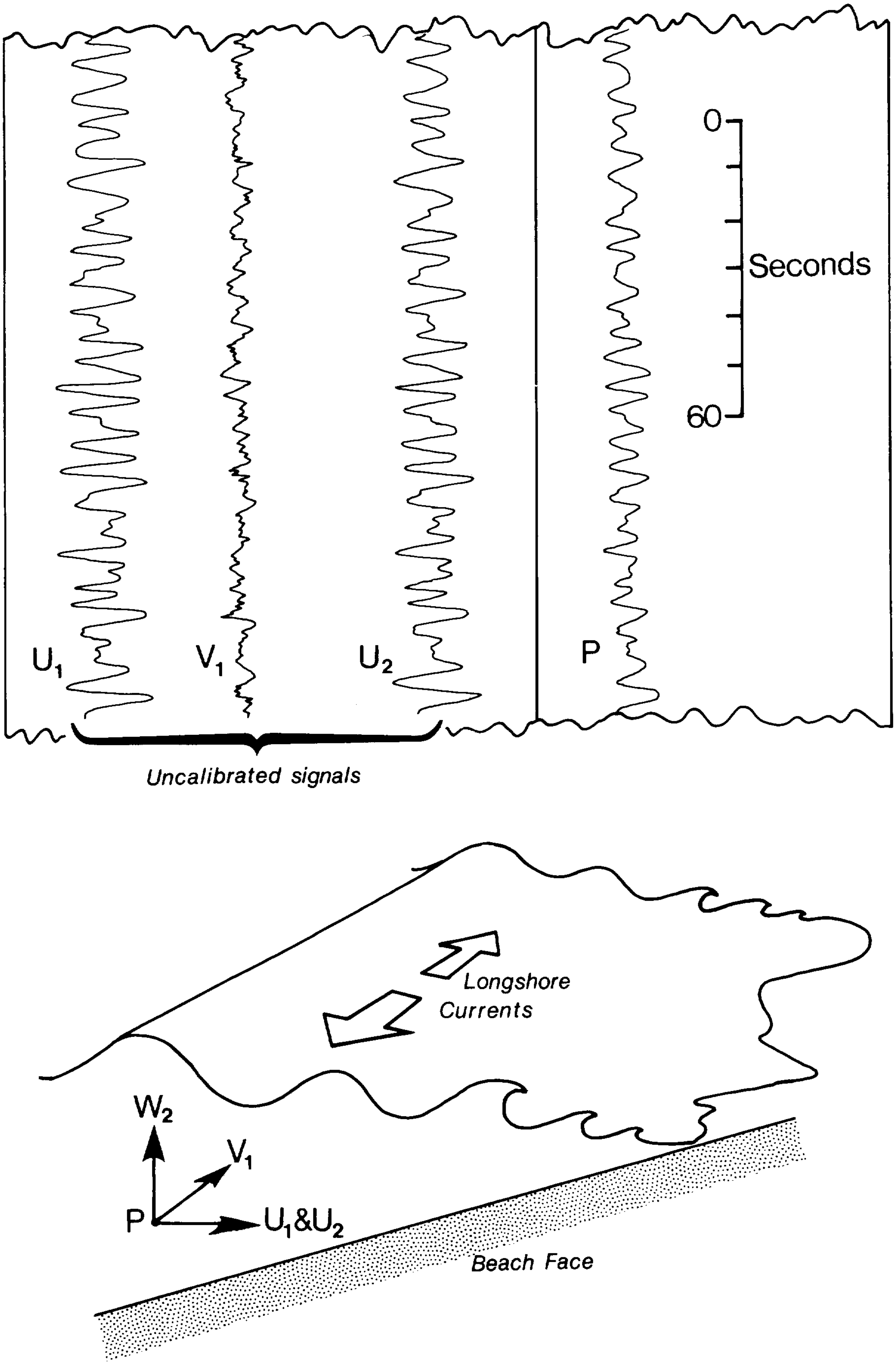
Beach rig showing electromagnetic flowmeters and F.M. pressure wave recorder.

Fig.8



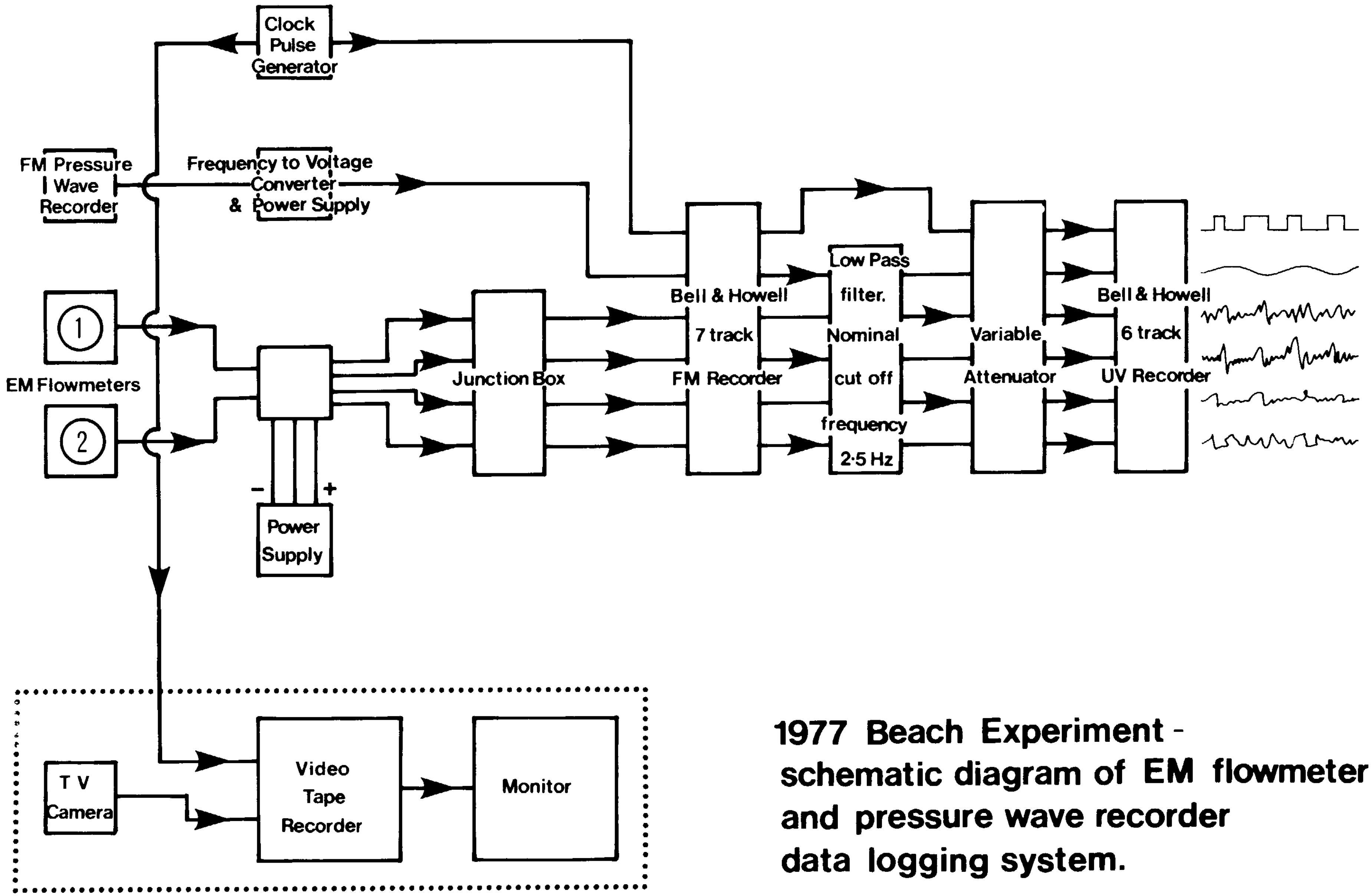
BEACH TRACER EXPERIMENTS: Section (Line Q) showing Rig and Tracer Injection Sites.

Fig. 9



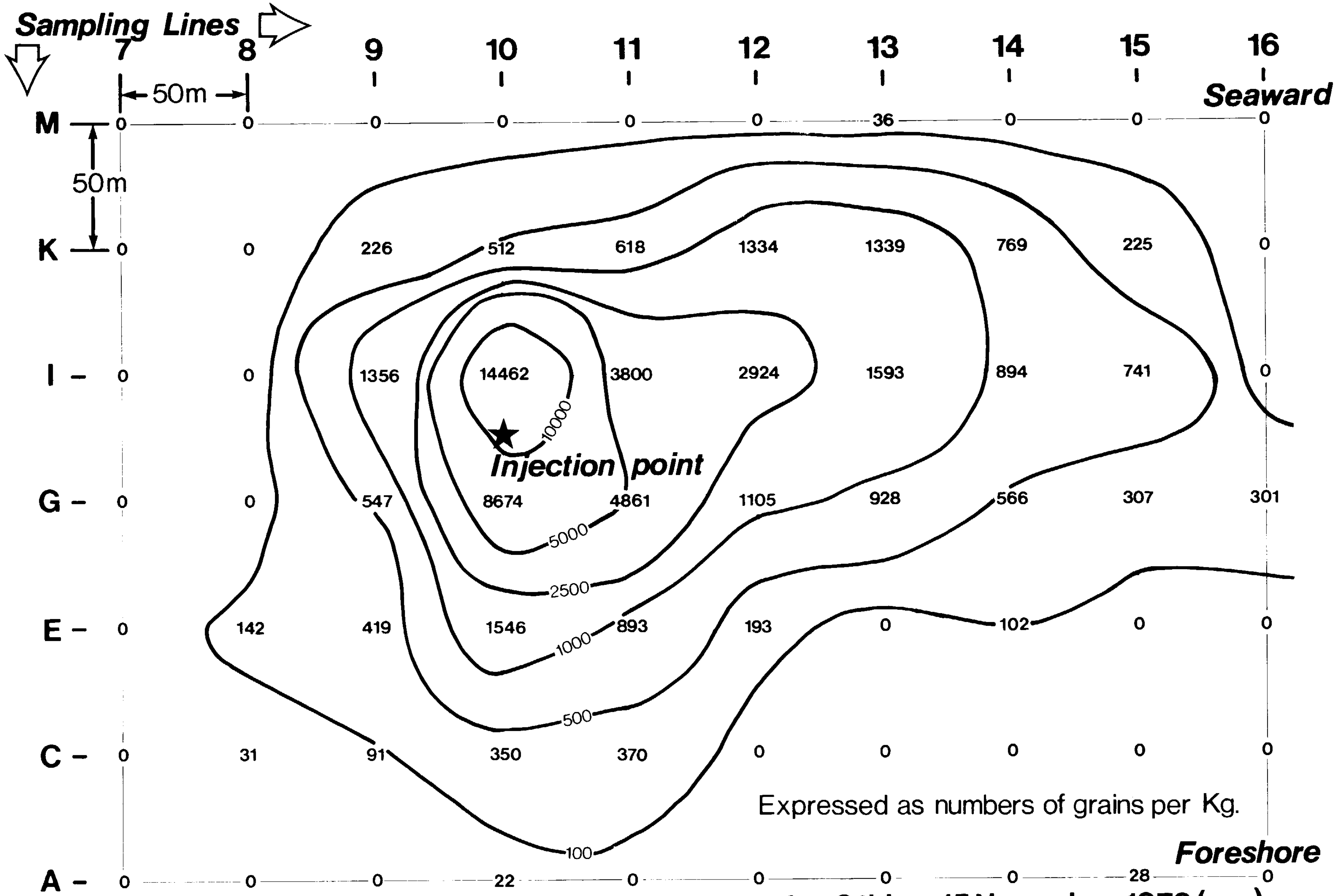
Examples of data from beach rig showing wave induced velocity (U_1, U_2, V_1) and pressure (P) fluctuations (W_2 not shown).

Fig. 10



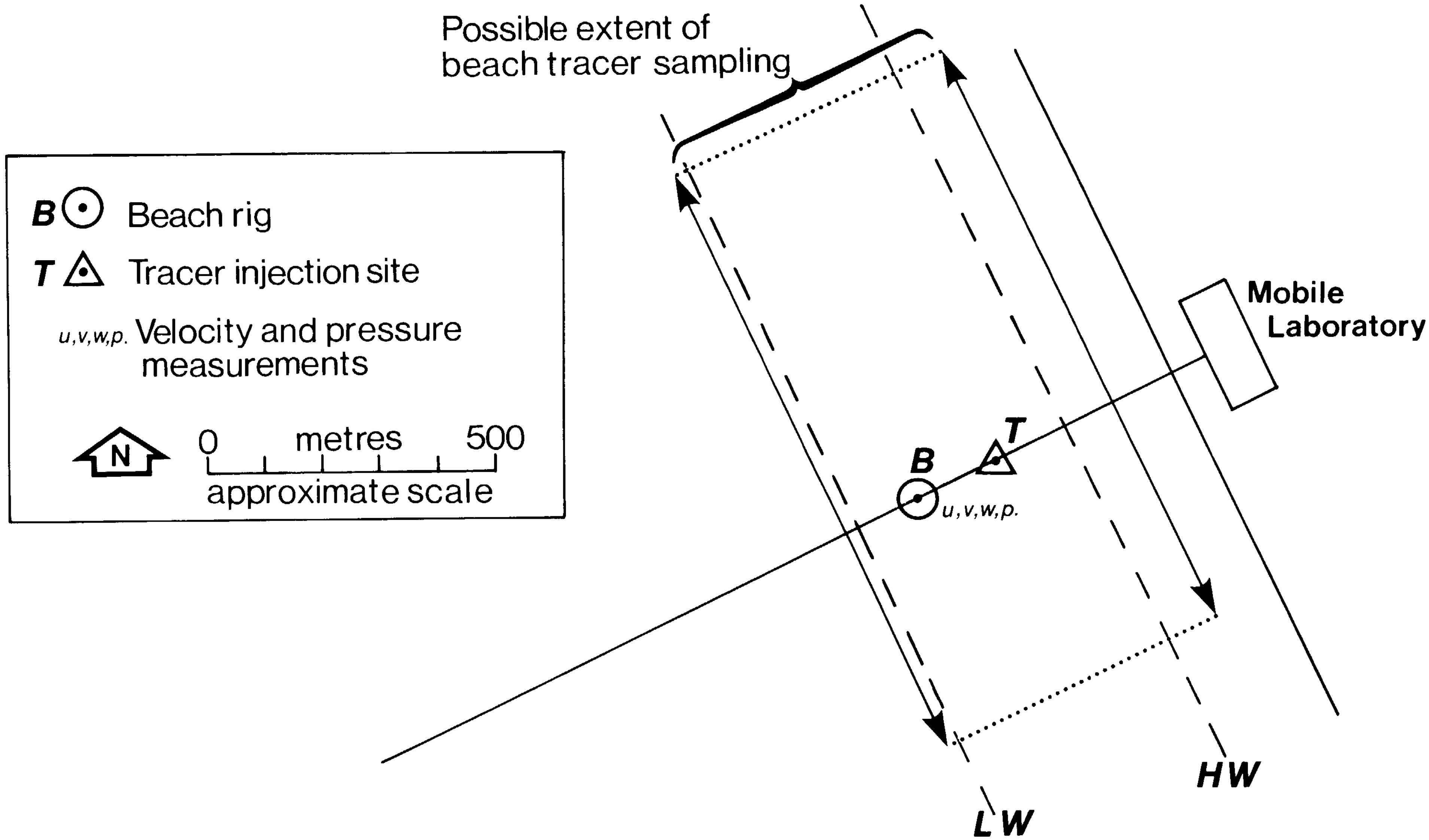
1977 Beach Experiment - schematic diagram of EM flowmeter and pressure wave recorder data logging system.

Fig. 11



Example of fluorescent tracer dispersal pattern: after 3 tides. 15 November 1976 (pm)

Fig. 12



SCHEMATIC DIAGRAM OF BEACH EXPERIMENT

Fig. 13