I.O.S.

SIZEWELL – DUNWICH BANK PROJECT

by

B. J. LEES

Progress report for the period
January 1975 to December 1976

Report No 38

1977

NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE OF OCEANOGRAPHIC SCIENCES

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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This project is supported financially
by the Department of the Environment

Institute of Oceanographic Sciences
Crossway
Taunton
Somerset

CONTENTS

1. INTRODUCTION

This is the first formal Progress Report covering work undertaken in the Sizewell Dunwich (East Coast) area since the inception of the project in January 1975. Preliminary work for the project, involving field reconnaissance and some historical study, was carried out during 1974.

The Sizewell-Dunwich Bank was selected since it fulfilled the following criteria. The bank is relatively simple in form, apparently stable, reasonably isolated from other banks, and submerged at all times. Other requirements were that it should be accessible yet away from busy shipping lanes and that the site should not be subject to estuarine effects. A further factor in the choice was that the study is likely to shed some light on two important practical problems: the erosion of the adjacent coastline and the effects of the dredging of gravel from the seabed nearby.

For convenience in the text the bank will be referred to as two separate entities, the Sizewell Bank and the Dunwich Bank, although morphologically they form an elongated structure with a central constriction. They extend from 52° 11'N to 52° 17' N and the crests are approximately 2 km offshore, parallel to the Suffolk coast (Fig 1).

A brief study of the geology of this part of Suffolk reveals that the coastline of the Sizewell-Dunwich area comprises Pliocene and Pleistocene Crags, a term used locally for any shelly sand, overlain by beds of glacial origin. The Coralline Crag of Pliocene age outcrops in the south of the area near Aldeburgh whilst further north the character of the Crag changes to beds of sand, laminated clays and pebbly gravels. These deposits are known as the Norwich Crag and are probably of Pleistocene age (Chatwin 1961).

The glacial deposits which overly the Norwich Crag comprise the Westleton Beds, which consist of pebbly or sandy gravel and are exposed at Dunwich. Overlying these are beds of weathered boulder clay known as the Norwich Brickearth. Offshore it is thought that the bedrock is Norwich Crag and that it is overlain by Recent deposits of gravels, sands, silts and clays. Recent coastline changes include the development of a small ness at Thorpeness from accumulations of sand and shingle whilst Dunwich was well known until the last year or so as an area of acute erosion.

2. AIMS

The Sizewell-Dunwich Bank project comprises a multi-disciplinary study with the aim of resolving the sediment transport system of a representative offshore bank. It is necessary that the understanding generated is of sufficient rigour and sufficiently fundamental to be used ultimately for prediction purposes. This includes being able to provide information of direct use to those concerned with environmental problems such as offshore dredging, coastal erosion and the building of sea defences.

To do this all influencing factors, such as seafloor topography, substrate composition, sediment budget, tidal currents and waves, should if possible be recognised, measured, and their interrelationships analysed. The requirements are being tackled in two ways. One is the Field Study covered by this report, and based on the classic methods of physical oceanography and sedimentological analysis. The other involves numerical analysis of the sediment transport system, and thus investigation into the feasibility of constructing a mathematical model. This comprises a separate project (S33).

In the initial stages the effort has been at a comparatively low-level (equivalent to approximately two people working full-time). Priority has been given to obtaining the information required for the mathematical modelling programme; to a qualitative description of the topography and sedimentology of the area; and to acquiring data (such as wave records)which are needed over an extended period.

3. PROGRESS to 31 DECEMBER 1976

After a brief preliminary historical and cartographic survey, the fieldwork began in January 1975 and is still continuing.

In order to identify the sediments present and estimate the quantity of potentially mobile material (ie unconsolidated sediment) geophysical techniques were used. These were supplemented by grab sampling and box coring. To investigate both tidal currents and waves, to which sediment movement is closely related, current meters were deployed at a total of twenty two stations during the two years and three pressure recorders were installed to provide wave data.

Monitoring of seabed variation with time commenced in the second year by undertaking repeat bathymetric surveys and sediment tracer work.

3.1 Geological Sampling

A seabed grab sampling programme (Fig 2) was commenced during the cruise which took place in April and May 1975. Fieldwork cruises are listed in Table I. The first phase was limited by the draught of the vessel which prevented any work in the shallower water over and inshore from the banks. Nine box core samples were also obtained. In September 1975 the grab sampling programme was completed except in certain limited areas near the Sizewell Power Station where the Central Electricity Generating Board had current meter rigs moored. It had been hoped to continue the box coring programme initiated in 1975, but severe weather conditions at the time of the August to September 1976 cruise meant that this was not possible. Additional geological information was, however, obtained over a limited area around the northern end of the Dunwich Bank. This was from the sticky sampling cards used to detect the fluorescent tracer (see 3.7 Tracer work).

Fig 3 shows the 1975 distribution of the four main sediment types in the study area.

(a) The blue-grey clay has a plastic consistency and contains lenses of silt and also black, slightly oily patches, probably of organic origin. There is frequently a thin veneer of brownish sand and silt, and the clay itself becomes darker with depth.

(b) The sand forming the banks appears to be compact and clean and varies in colour from brownish to yellowish. Some samples contain comminuted shell or laminae of entire and fragmented shell. Two of these samples analysed for grain size distribution have means of 3.17 ϕ (0.12mm) and 2.56 ϕ (0.17 mm) with both standard deviations less than 0.55 ϕ (0.04 mm) indicating well sorted sediments. (Phi (ϕ) is defined as $-\log_2$ grain diameter in mm (Krumbein 1934)). The distributions are negatively skewed (ie towards the coarse fractions of the samples) and there is little material smaller than 3.75 ϕ (0.08 mm). The shapes of the cumulative curves (for an example see Fig 4) indicate that a single statistical population is involved in each case. The orangey-yellow colouring of the sands located by grab sampling nearshore to the north of the power station and also towards Thorpeness (Fig 1) is similar to that of sands comprising Minsmere Cliffs. There may be some relationship between them, although of course colour is not necessarily a diagnostic feature.

(c) A third sediment type consists of intercalated sands, silts and clays, usually grey in colour, becoming darker with depth, and of rather fluid consistency. Owenia fusiformis, a tube worm, was present in large numbers in the samples.

(d) The last type of sediment is gravel, comprising mainly flints, either rounded, or rounded to angular. These are orange-brown in colour, and have a maximum length of 80 mm. Quartzites, quartz and a small number of other types are also present. The indigenous fauna is mainly sessile. Often the gravel forms a veneer and the van Veen grab penetrated to the sands or clays beneath, resulting in the inclusion of very fine or medium sands with whole, fragmented and comminuted shell, or silts and clays.

Each of the sticky sampling cards used to detect the fluorescent tracer, and mentioned above, had a thin layer of sediment adhering to it. These layers came from small areas of seafloor each 120 mm x 250 mm. The substrate could therefore be readily identified as sand, clay or gravel. Such information when compared with the original grab sampling survey indicates that the clay/sand and sand/gravel boundaries at the northern end of the Dunwich Bank have migrated to the east, although by how much it is difficult at this stage to quantify. This is because of the errors inherent in using the Decca Main Chain Navigating System (see section 3.8). This system was used in the initial grab sampling survey.

Unlike grab samples, box cores are essentially undisturbed and therefore suitable for more detailed analysis. At least two x-ray photographs, mutually at right angles, were taken of subsamples from each core. A thickness of approximately 20 mm was found to be the optimum for the radiography, and this thickness was attained by trimming away surplus material. The nine box cores were taken in the intercalated sands, silts and clays. The x-ray technique, besides demonstrating the various depositional laminae shows also considerable bioturbation, such as worm burrows and sea urchin feeding trails.

3.2 Geophysics

The basic geophysical programme carried out in January and February 1975 involved sidescan sonar and sub-bottom profiling with boomer and pinger. A pattern was followed with zig-zag lines, one immediately offshore, a second across the banks, and a third outside the banks. Tie-lines traversing these were run parallel to the coast. It was acknowledged at the time that there were gaps in the record and that some data were substandard. Therefore, it was necessary to try to improve the quality with subsequent work. This was undertaken during the cruise in April and May of the same year.

Examination of the sub-bottom profiling records reveals the presence of at least four types of surface layer which can be correlated with the sediments identified in the grab samples. These are:

(a) Good reflector. Very little acoustic penetration. Probably gravel.

(b) Good reflector, good penetration. Thickness of this sediment type can usually be determined. Probably fairly clean sand. In the southern part of the area the top of the reflector shows some surface structure, with what may be sandwaves and ridges. There is also some indication of this on the sidescan sonar records.

(c) Good reflector. Very little structure apparent below the surface. Probably to be correlated with the firm blue-grey clay.

(d) Relatively poor reflector. Probably softer sediment. Some penetration, but there are many irregularities. This could be the mixed sands, silts and clays.

The isopachyte map (Fig 5) shows the thickness of the good reflector (b) above, probably the sand. Its base is easily recognised beneath the crest of the Dunwich Bank, but becomes more difficult to distinguish in the southern part of the study area. Material deposited above this horizon shows horizontal bedding and has a maximum thickness of 9.5 m over the Dunwich Bank and probably more than 6 m over the Sizewell Bank. These sediments form a zone with a mean width of 2.5 km, broadening to 3 km opposite Minsmere and Dunwich Cliffs. They are almost certainly unconsolidated. The geophysical work was done in February 1975 and the grab sampling in September the same year and comparison of the two sets of data suggests that the sand could possibly be lying closer inshore in February. This phenomenon of variable distance of the banks from the shore, similar to that noted when comparing sediment samples, has also been observed by the Central Electricity Generating Board (personal communication).

The material beneath the sand in the north is likely to be the firm blue-grey clay, while further south the sands and clays appear to be mixed. Intermittent horizons also show below the sands and clays, but these are probably in consolidated sediment (Norwich Crag? - see 1. Introduction) and therefore not relevant to the present study.

There are no hints as to the thickness of the gravel to the east of the banks, although pockets therein may be filled with sand.

Records obtained east of Southwold show many buried channels, which may be due to the geophysical lines traversing a former meandering stream or streams. This could be the old course of the present River Blyth now reaching the sea at Southwold.

The sidescan sonar records resulting from runs over the banks are difficult to analyse because of the effects of the shallow water which gives rise to acoustic response from the ship's wake, especially marked at each turn. Physical features on the seabed are therefore masked.

3.3 Wave and wind data

Frequency modulated pressure recorders, linked by armoured cable to a shore-based magnetic tape data logger, were installed at three offshore stations, one in January and two in April 1975. The first and second were offshore from Southwold and Dunwich respectively in an approximate mean depth of 8 m water, while the third was off Aldeburgh in just over 6m water. The situation of the recorder at Southwold is such that it measures wave periods and heights which may well be similar to those seaward of the bank. The Dunwich recorder is situated inshore and therefore is reached by waves which have traversed the bank, whilst the third one is in an area south of the Sizewell and Dunwich Banks (Fig 1).

During the first year of monitoring the largest waves recorded were at Aldeburgh with H_s = 3 m. H_s is defined as the significant wave height or the mean height of the highest one third of the waves in the record (Draper 1966). There were more waves with a period $>$11.0 secs reaching Dunwich than the other two sites and waves with periods of between 5.0 secs and 7.0 secs were more frequent at

Southwold and Aldeburgh. At all three sites these shorter period waves ranged up to heights of 2.4 m. The largest waves at each site had periods between 7.0 secs and 8.0 secs.

A summary of one year's data is presented in Figs 6, 7 and 8 for Dunwich, Southwold and Aldeburgh respectively. Fig (a) for each area consists of a wave scatter diagram relating significant wave height to the wave period (as defined by the zero crossing period) expressed in occurrences per thousand (Draper 1966). Fig (b) depicts H_s and H_{max} and (c) the percentage occurrence of zero crossing wave periods for the same three sites. It was hoped that these diagrams would demonstrate whether the bank has any sheltering effect at the Dunwich site, compared with the exposed sites at Southwold and Aldeburgh. Such an effect would be demonstrated by attenuation of H_s, perhaps with waves from certain directions only. However, it is apparent that detailed computation is necessary to identify significant differences. It is hoped to undertake this in 1977.

For data on wave direction, reliance has had to be placed upon the monitoring of wind direction by the coastguard at Aldeburgh, and an assumption made that the wind and wave direction offshore are closely related. The short fetch in this area makes such an assumption reasonable.

Preliminary wave ray-path diagrams have been plotted using one of a series of Hydraulics Research Station wave refraction programs, adapted for a PDP11 computer, in conjunction with seabed topography (water depths) taken from Admiralty survey charts. An example is shown in Fig 9. It is also part of the present work to use one of the related programs which predicts the inshore significant wave heights and zero crossing periods.

3.4 Current Meter Data

During the 1975 January and February cruise five Bergen (Aanderaa) self-recording current meters were successfully deployed in 20 m water. Four were buoy-mounted on U-shaped moorings with the meters at midwater level (Fig 10). The fifth instrument was mounted in a bottom frame approximately a metre above the seabed.

A Braystoke direct-reading current meter was used at three stations inshore from the banks to obtain data from varying depths over three successive tidal cycles, one at each station.

In April 1975, six Plessey (MO 21) self-recording current meters were successfully deployed in 12 m of water at stations just seaward of the banks. They were mounted at midwater level on U-shaped moorings which were basically similar to those used for the Bergen meters. A further nine Plessey meter deployments were made in August 1976. The instruments remained in the water for two weeks although it is planned to occupy Station 22 (Fig 1) on a long term basis by changing the mooring every two months. The first change was carried out in November 1976.

Computer programs are available for both Bergen and Plessey meters for processing the data to a standardised format with graphical printouts. Some of these programs were written for deep water measurements and do not necessarily allow for the complexities encountered in shallow coastal waters. Alternative methods of analysis are being examined, for example, where the ebb and flood are assessed separately and vector averages (speed and direction) are calculated for each. Some of these results are shown in Fig 11.

3.5 Water Velocity Profiles

The mathematical modelling programme requires a knowledge of water velocity profiles and it was hoped to use data provided by the Braystoke direct-reading current meter during the January and February 1975 cruise. However, one objection to this is that readings from different depths are not made synchronously and in the minute or so taken to move the current meter to a different depth and note the reading, the currents can change. In September 1976 the Marconi Buoyed System was laid at Station 25 (Fig 1). The equipment consists essentially of a number of current meters, in this case six, that can individually and simultaneously measure current speed and direction, and a data logger which controls the current meters and records the information in an accepted computer compatible format on magnetic tape. The data logger is housed in a seabed mounted sinker with a mooring line to a subsurface buoy. For this experiment the meters were clamped to the line at 1 m intervals. It was hoped to obtain continual readings every ten minutes for one month, but after five and a half days the meter wire was severed. The sub-surface buoy and the two uppermost sensors were lost.

The deployment was partly an exercise to evaluate the Marconi system. No data were returned by the second sensor from the surface, and there were some invalid readings for both direction and speed amongst the other sensor measurements.

Before the results can be successfully analysed the invalid data must be filtered out and this is likely to be a time consuming process.

3.6 Bathymetry

Two groups of echosounding runs using a Kelvin Hughes MS36 echosounder were carried out in September 1976, using a HiFix 6 positioning system where practicable and the Decca Main Chain system where it was not. In each case as much as possible of the study area was covered. The first set was undertaken on the 2, 3 September (during neap tides) and the 7 September (approaching spring tide conditions) after the northerly gales at the end of August had died down. The second set was after SW gales, and took place on the 12 and 13 September, soon after maximum spring tides.

All depths were corrected for tidal and atmospheric pressure variations to Ordnance Datum Newlyn using the pressure transducer at Dunwich to measure water level changes. Co-tidal charts compiled by the International Council for the Exploration of the Sea were also used to assess the correction necessary for the tidal time lag as the flood moved south.

Figs 12 and 13 show the two bathymetries. Although the echosounding lines of the two surveys are not coincident areas covered by both include a line traversing the N end of the Dunwich Bank, and an area 7 km from N to S including the trough and western flank of Dunwich Bank. Further S there are five lines in each survey which cross the banks in the area of the constriction between the two. Finally there is the eastern flank of the Dunwich Bank as far S as latitude 52°14'30"N.

It can be seen by comparing the two surveys that there are no significant differences over the east flank of the Dunwich Bank, or in the area of the inshore trough as far S as latitude 52°15'. One way of measuring any change is to note the displacement of the crest of the banks and also of the trough situated to the W of the crest.

At the N end of Dunwich Bank the earlier survey (carried out 2 September) was positioned using Decca Main Chain, and is thus subject to errors of at least 40 m, (Decca Navigator Data Sheets). Although a displacement of the crest to the NW greater than the inherent surveying error is indicated, no figures are suggested because of these errors. Displacement also occurred at the southern end of the bank, where fixes were obtained by means of HiFix 6. The bank appears to have moved to the E by as much as 250 m in latitude 52°14'0" to 52°14'30". At the southern end of the area covered by both surveys the displacement appears to be minimal. There is no evidence to show how the Sizewell Bank was affected under SW gale conditions.

The Hydrographic Department of the MOD also carried out a limited survey of the banks in July and August 1975, using HiFix 6. In the area of the constriction between the banks, the crest and trough were located in positions intermediate to those identified by the two later IOS surveys. These lateral movements may be responses to wave action. The weather conditions prevailing between the Hydrographic Department and the first IOS survey, and between the two IOS surveys, will be examined.

3.7 Tracer work

Although IOS 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. Fluorescent tracer work was therefore undertaken in September 1976 as a pilot experiment on which to base designs for future 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 the grain size distribution of 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 that 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 cm 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 14), 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. A second injection of 350 kg of the blue tracer was made at the same station at high water slack on 7 September. Lack of time because of adverse weather meant that experiments with the red dyed sand had to be cancelled.

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, which has an area of 0.03 m^2. There could be several reasons for this. In particular the quantity injected could be too small and this was one of the considerations which resulted in the decision to make the second injection considerably larger than the first. It should be noted that other workers have varied the size of injections from 2.7 kg (Jolliffe 1963) to 900 kg (Stuiver and Purpura 1968).

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 rigid sampler. The sampler comprised a greased "Formica" card attached to an iron weight and this would only make contact with the crests of the ripples. 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.

At this stage qualitative results only can be obtained. Fig 14 shows the directions in which the tracer had moved during the first six hours after the injection, and then during the flood part of the tidal cycle immediately following. When the current meter data from stations 16 and 17 are available it will be possible to compare water speed and direction at midwater level nearby with tracer movement on the seabed.

3.8 Position Fixing

During the 1975 cruises position fixing offshore was achieved using the Decca Main Chain system. However, for detailed survey work, this system is not sufficiently accurate.

In the Sizewell–Dunwich area the fixed errors are 0.01 lane to be added to the red pattern readings and a similar amount to be subtracted from the green pattern readings. The variable errors, due to interference between signals, are such that there is a fix repeatability error, not exceeded on 68% of occasions, of approximately 40 m (Decca Navigator Operating Instructions and Marine Data Sheets).

For the grab sampling carried out by mv Concord, Decca HiFix was installed. This system has now been discontinued for the research area by Decca Survey Ltd and replaced by the more advanced HiFix 6 with a fix repeatability error of 5 m. HiFix 6 was used successfully on the 1976 cruise.

4. SUMMARY

As yet it has not been possible to commence the planned beach and cliff surveys or measurements of suspended sediment. Vibrocoring cannot be carried out until a suitable ship is available (March 1978) and the 1976 box coring programme was aborted because of adverse weather.

However, much has been achieved.

Substrate sampling during the first two years has shown that the Banks generally consist of clean, well sorted sands, which are horizontally bedded in some areas, and which attain a maximum thickness of 9.5 m (Fig 5). The sands appear to lie on a platform of blue-grey clay, probably non-marine, in the northern part of the area. Further south the sands and clays become intermixed on both sides of the bank. An area of gravel of indeterminate thickness, because of its high acoustic reflectivity, lies to the east and under normal conditions appears to be stable, as evidenced by the undisturbed state of the pebbles and indigenous sessile fauna. There are indications of buried channels, the remains of former streams, over which the Dunwich Bank now lies.

Two hydrographic surveys, before and after SW gales, apparently show that under these gale conditions the parts of the banks surveyed can move eastwards, as much as 250 m in places. Lateral movement has also been indicated by comparing the most recent Hydrographic Department survey (July/August 1976) with the two IOS echosounding surveys. These movements could well be responses to wave action.

In contrast the pilot experiment with fluorescent tracer has shown that there is a short term displacement of material as a result of tidal action. Overall the tidal flood is to the SSW and the ebb to the NNE, almost parallel to the coast line and long axis of the banks.

A total of 22 current meter stations has been occupied and there have been good data returns from the tapes so far analysed. In particular a modified U-shaped mooring has been designed and successfully deployed in water as shallow as 5.5 m.

Progress has also been made towards an assessment of the velocity profile through the water column at one representative station.

Twenty months almost continual wave data have been obtained from the three pressure transducers.

5. FORWARD LOOK

In the next year or so it is hoped to intensify the effort put into the study. In particular, field work should increase with the commencement of beach and cliff measurement, and the getting underway of the tracer study programme proper. It is planned also to make suspended sediment and bed shear stress measurements, as well as continuing current meter and wave recorder deployments. Hydrographic surveys at more frequent intervals should also be possible now that major position fixing problems appear to have been solved.

In the long term the success of the project depends not only on the understanding achieved from making field measurements as rigorously as possible, but also on the development of the mathematical model (2. Aims). It is intended that this latter shall be a progressive exercise where the model will be continually calibrated against field data as an increasing amount of such data is obtained.

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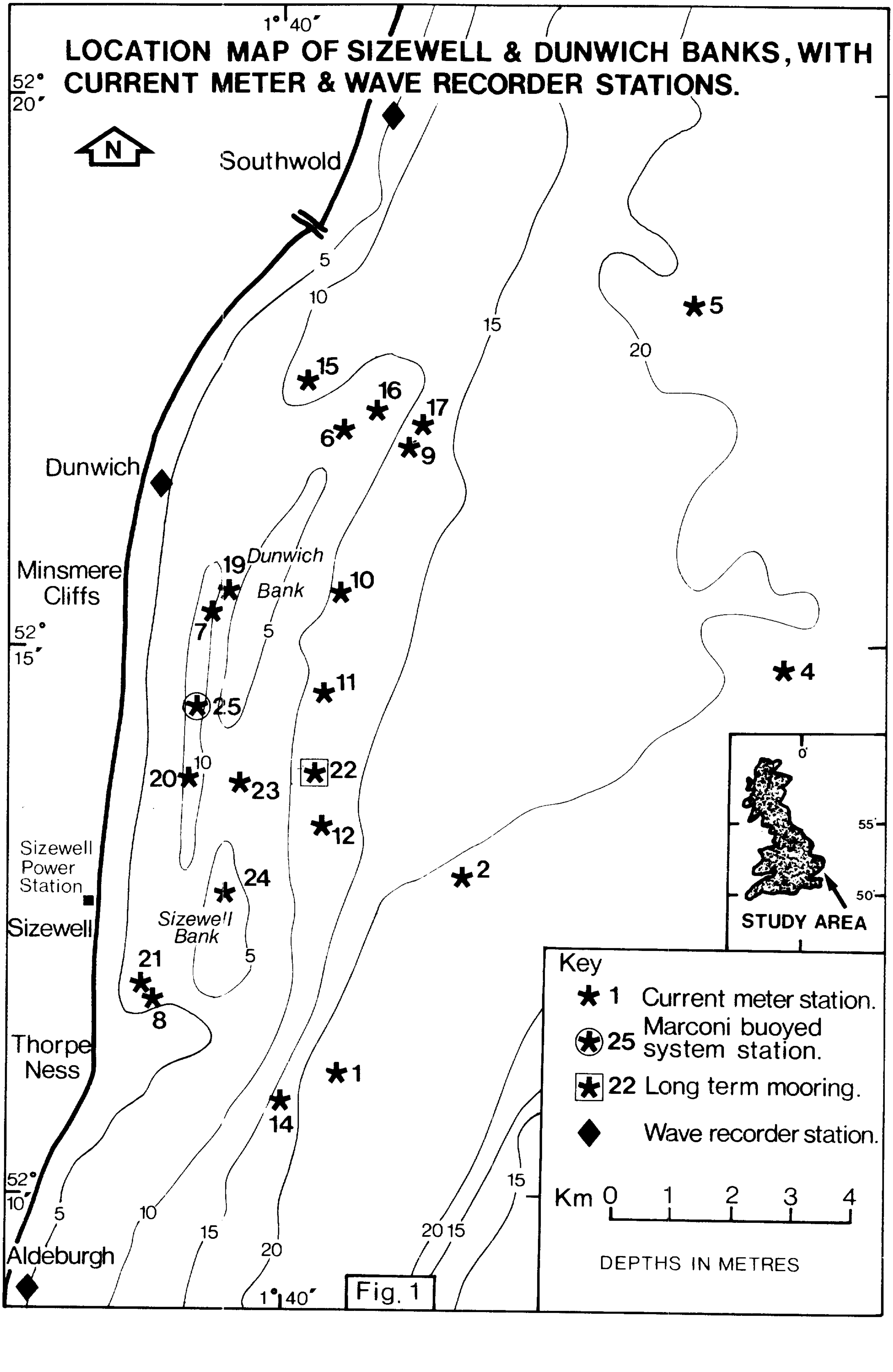
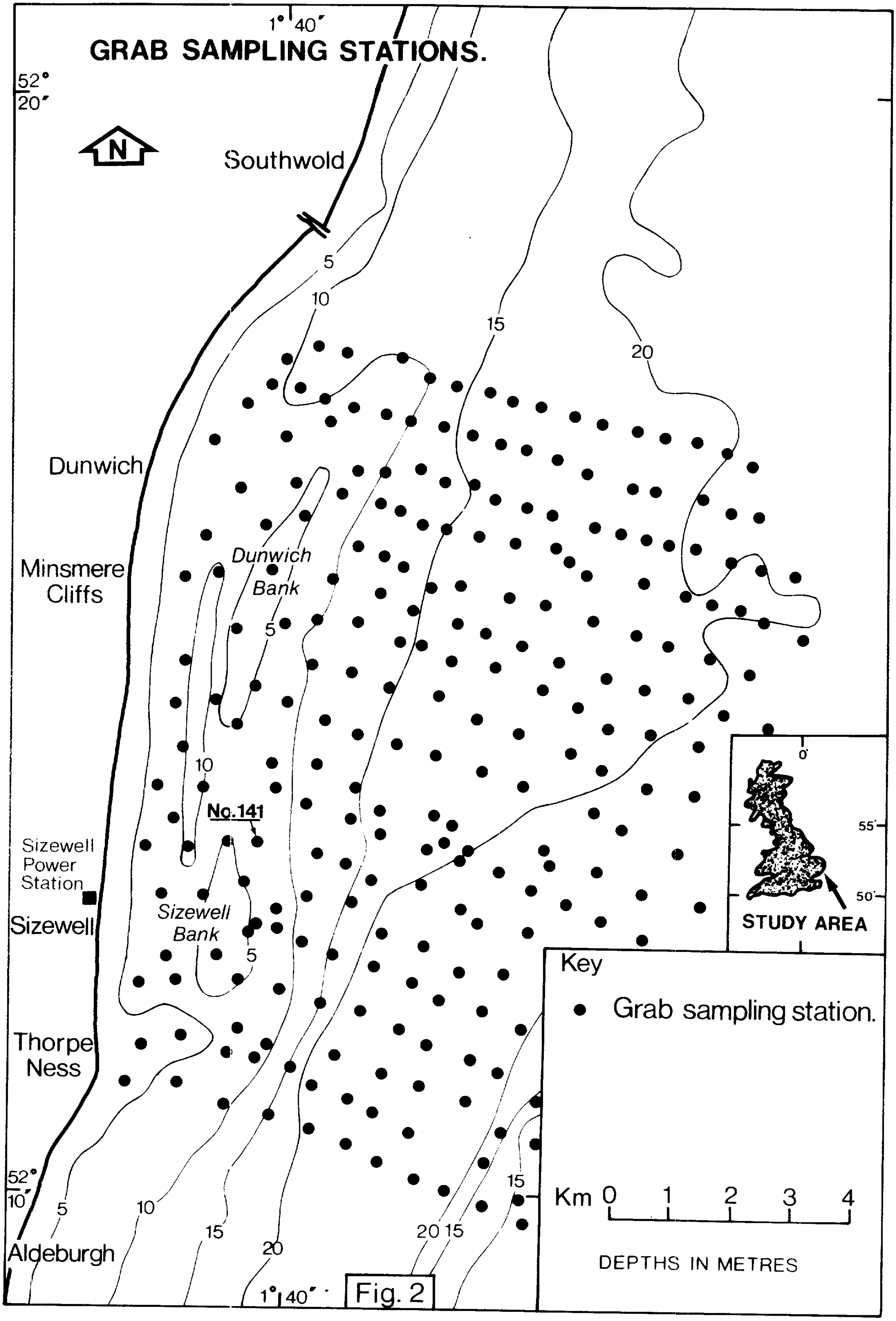
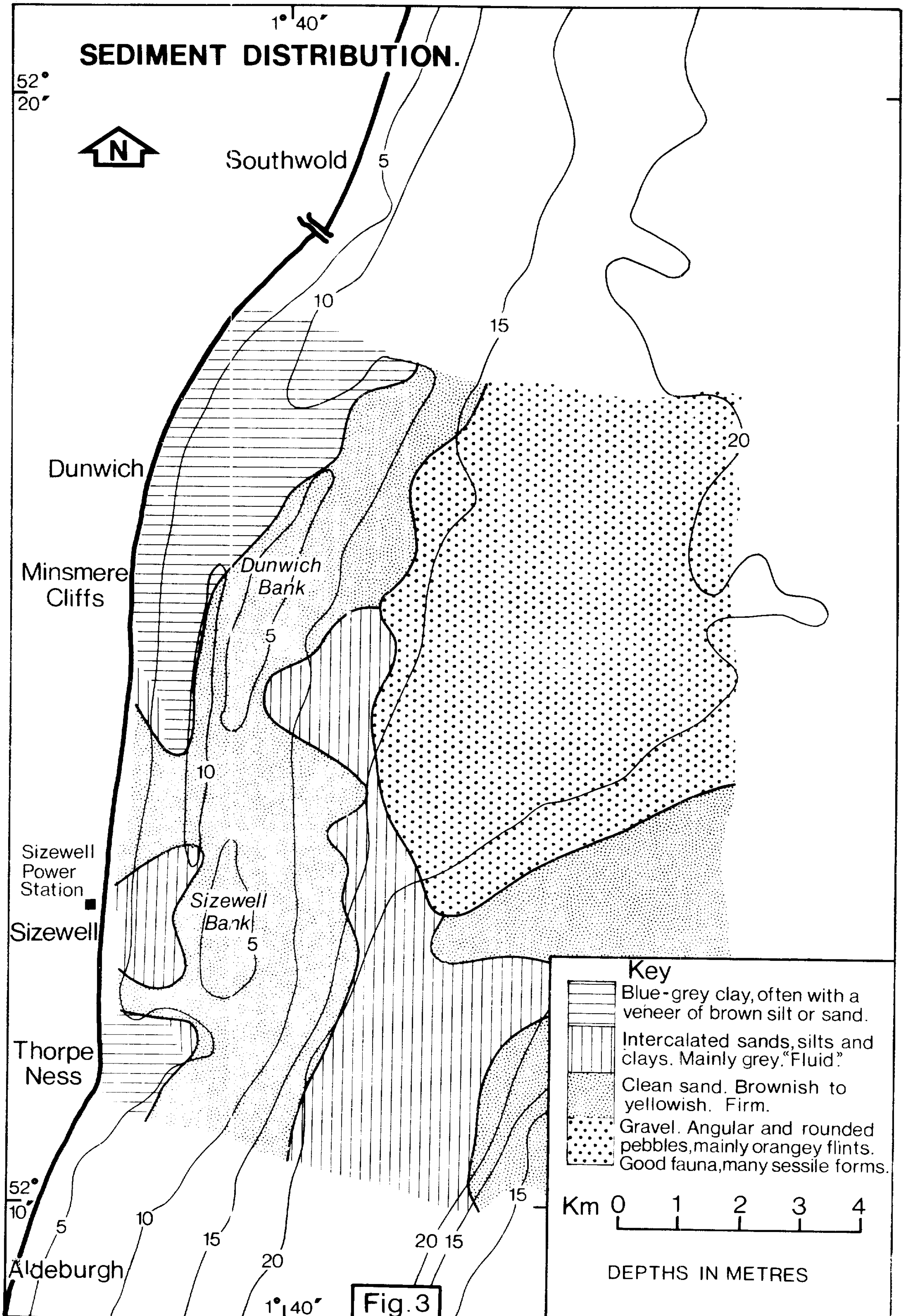
7. LIST OF FIGURES

TABLE I

Dates	Vessel	Work undertaken
8–22 February 1975	RV Edward Forbes	Geophysical survey. Current meter deployments. Tidal stream readings.
18 April to 3 May 1975	RRS John Murray	Geophysical survey. Current meter deployments, diver inspection of rigs. Grab and box core sediment sampling
6–7 September 1975	MV Concord	Grab sampling
29 August to 13 September 1976	RV Edward Forbes	Current meter deployments. Bathymetric surveys Fluorescent tracer pilot experiment. Water velocity profile measurements

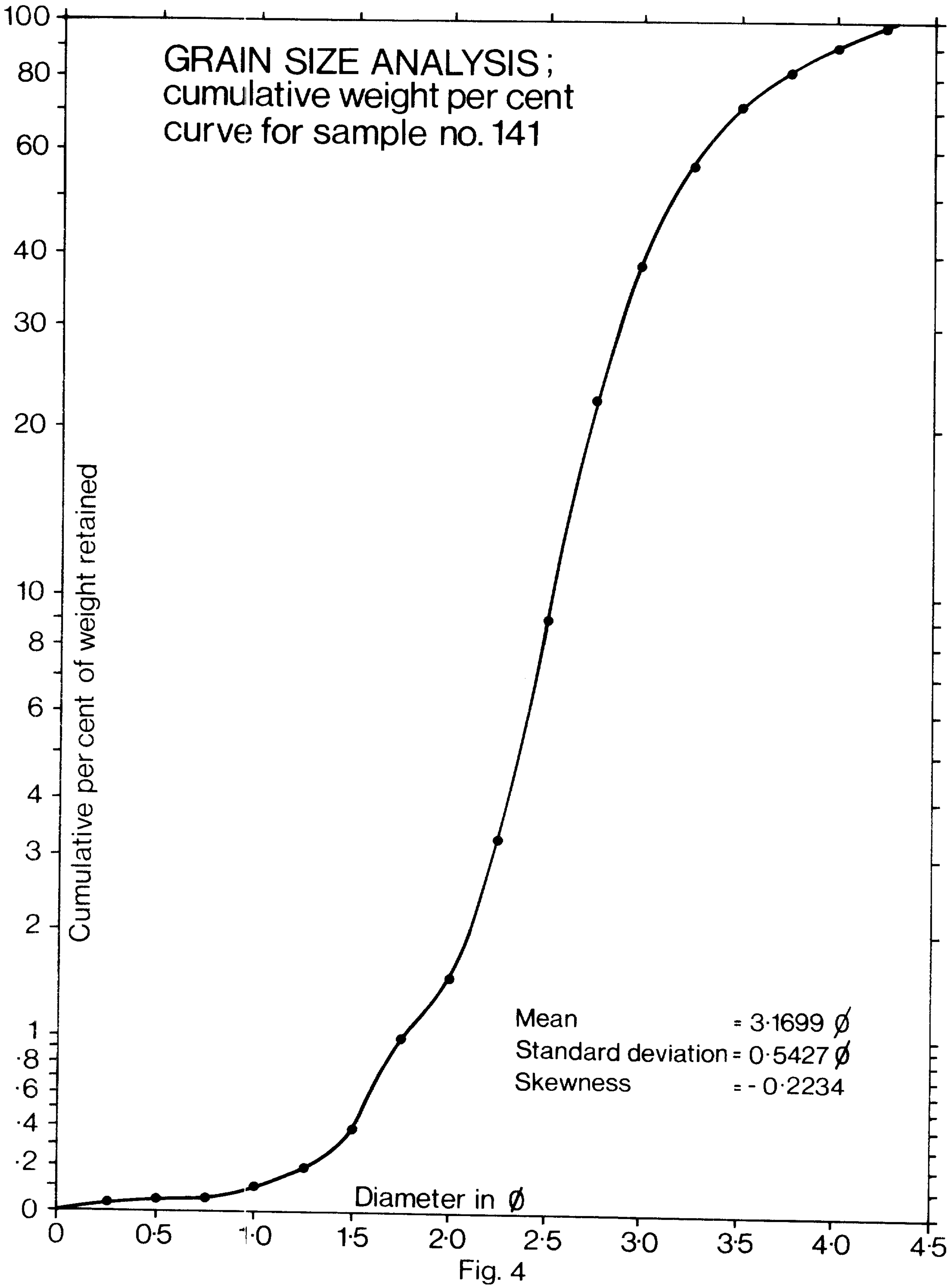

1° 40´
LOCATION MAP OF SIZEWELL & DUNWICH BANKS, WITH CURRENT METER & WAVE RECORDER STATIONS.
52° 20´
N
Southwold
Dunwich
Minsmere Cliffs
52° 15´
Dunwich Bank
Sizewell Power Station
Sizewell
Sizewell Bank
Thorpe Ness
52° 10´
Aldeburgh
1° 40´
STUDY AREA
Key
1 Current meter station.
25 Marconi buoyed system station.
22 Long term mooring.
Wave recorder station.
Km 0 1 2 3 4
DEPTHS IN METRES
Fig. 1


GRAB SAMPLING STATIONS.
1° 40′
52° 20′
N
Southwold
Dunwich
Minsmere Cliffs
Dunwich Bank
Sizewell Power Station
Sizewell
No.141
Sizewell Bank
Thorpe Ness
52° 10′
Aldeburgh
5
10
15
20
20 15
0′
55′
50′
STUDY AREA
Key
Grab sampling station.
Km 0 1 2 3 4
DEPTHS IN METRES
Fig. 2



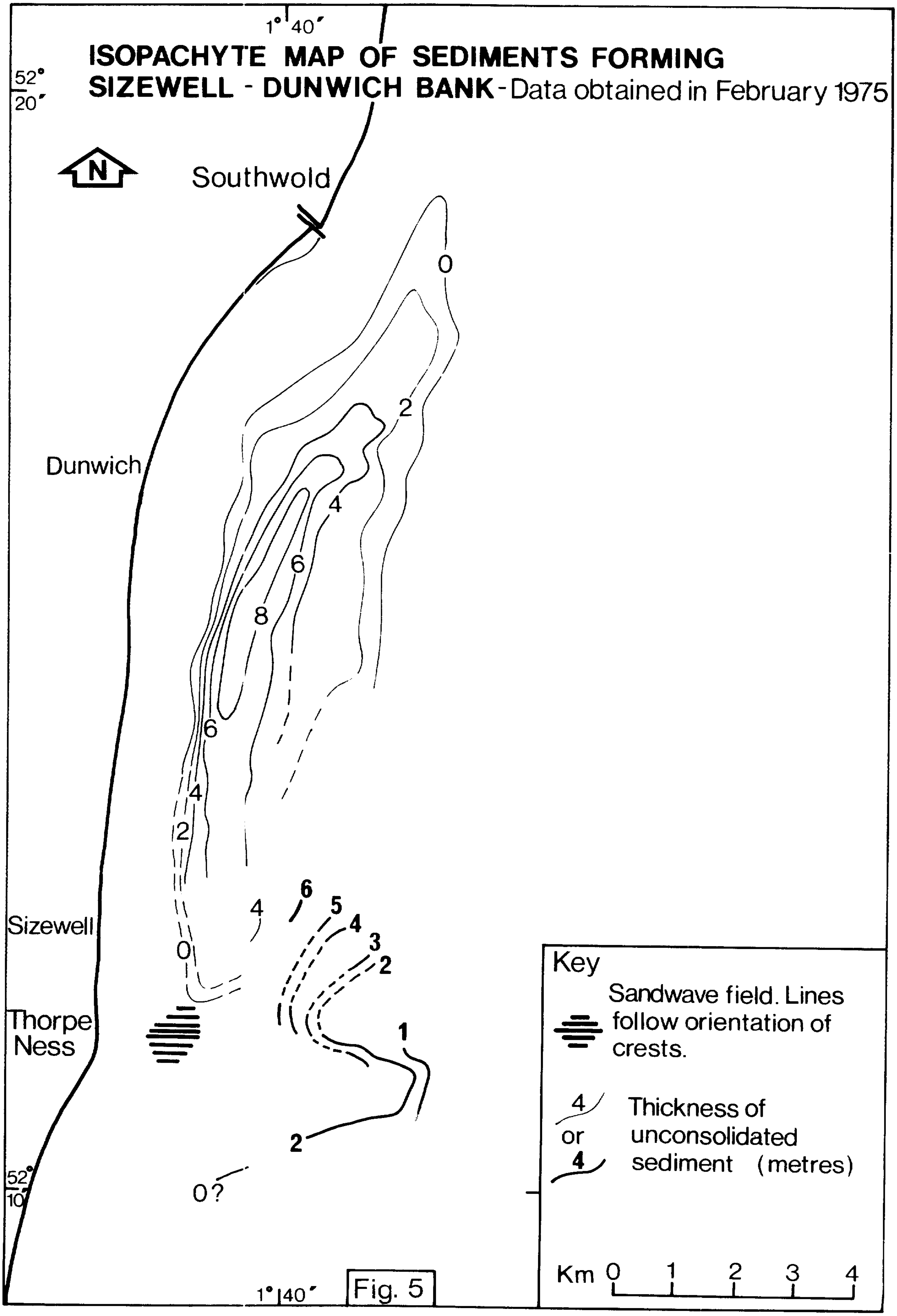
SEDIMENT DISTRIBUTION.
1° 40′
52° 20′
N
Southwold
5
10
15
20
Dunwich
Minsmere Cliffs
Dunwich Bank
5
10
Sizewell Power Station
Sizewell
Sizewell Bank
5
Thorpe Ness
52° 10′
5
10
15
20
20 15
15
Aldeburgh
1° 40′
Key
Blue-grey clay, often with a veneer of brown silt or sand.
Intercalated sands, silts and clays. Mainly grey. "Fluid."
Clean sand. Brownish to yellowish. Firm.
Gravel. Angular and rounded pebbles, mainly orangey flints. Good fauna, many sessile forms.
Km 0 1 2 3 4
DEPTHS IN METRES

Fig. 3



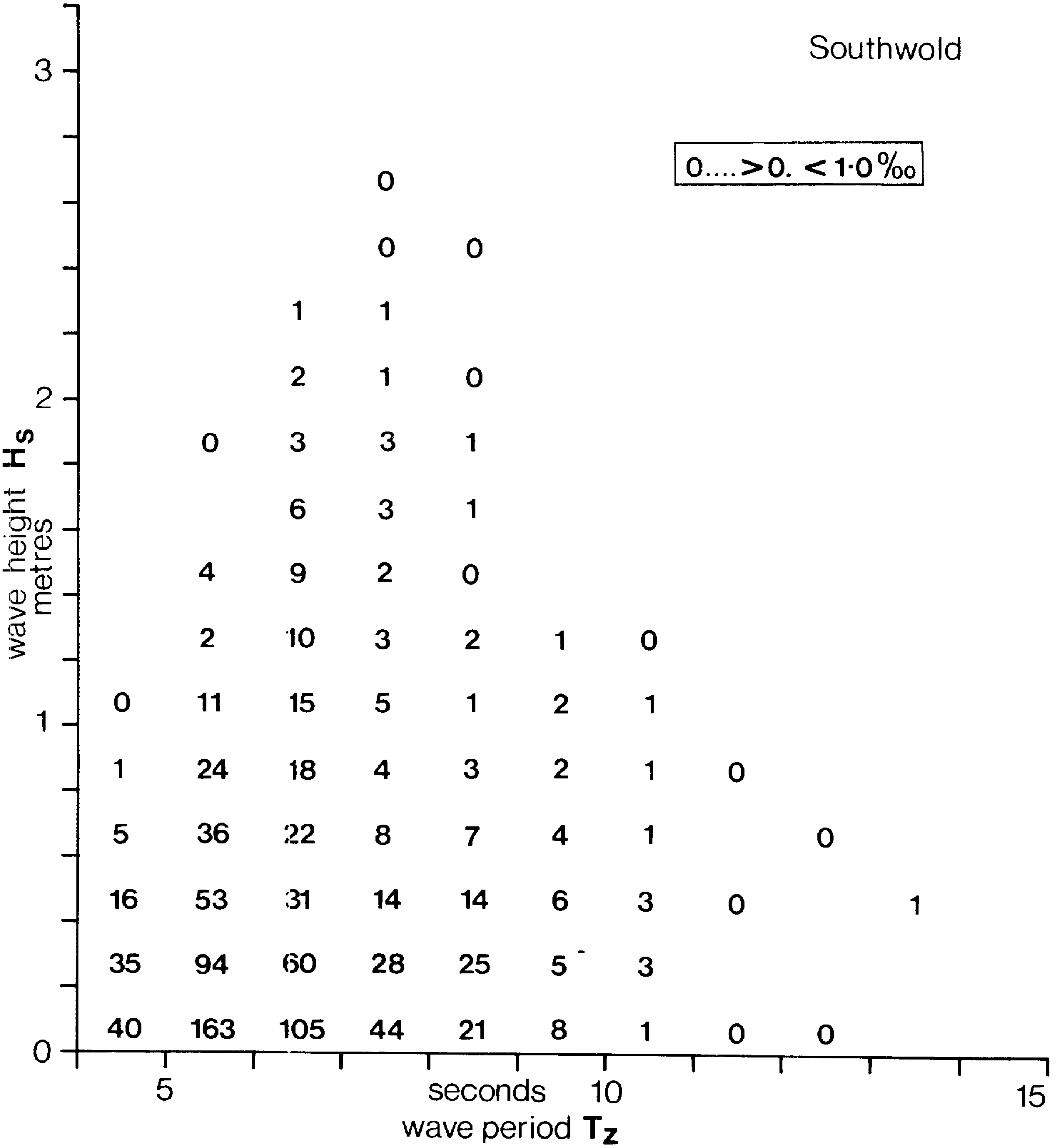
GRAIN SIZE ANALYSIS ;
cumulative weight per cent
curve for sample no. 141
Cumulative per cent of weight retained
100
80
60
40
30
20
10
8
6
4
3
2
1
·8
·6
·4
·2
0
Mean = 3·1699 Ø
Standard deviation = 0·5427 Ø
Skewness = - 0·2234
Diameter in Ø
0
0·5
1·0
1·5
2·0
2·5
3·0
3·5
4·0
4·5

Fig. 4



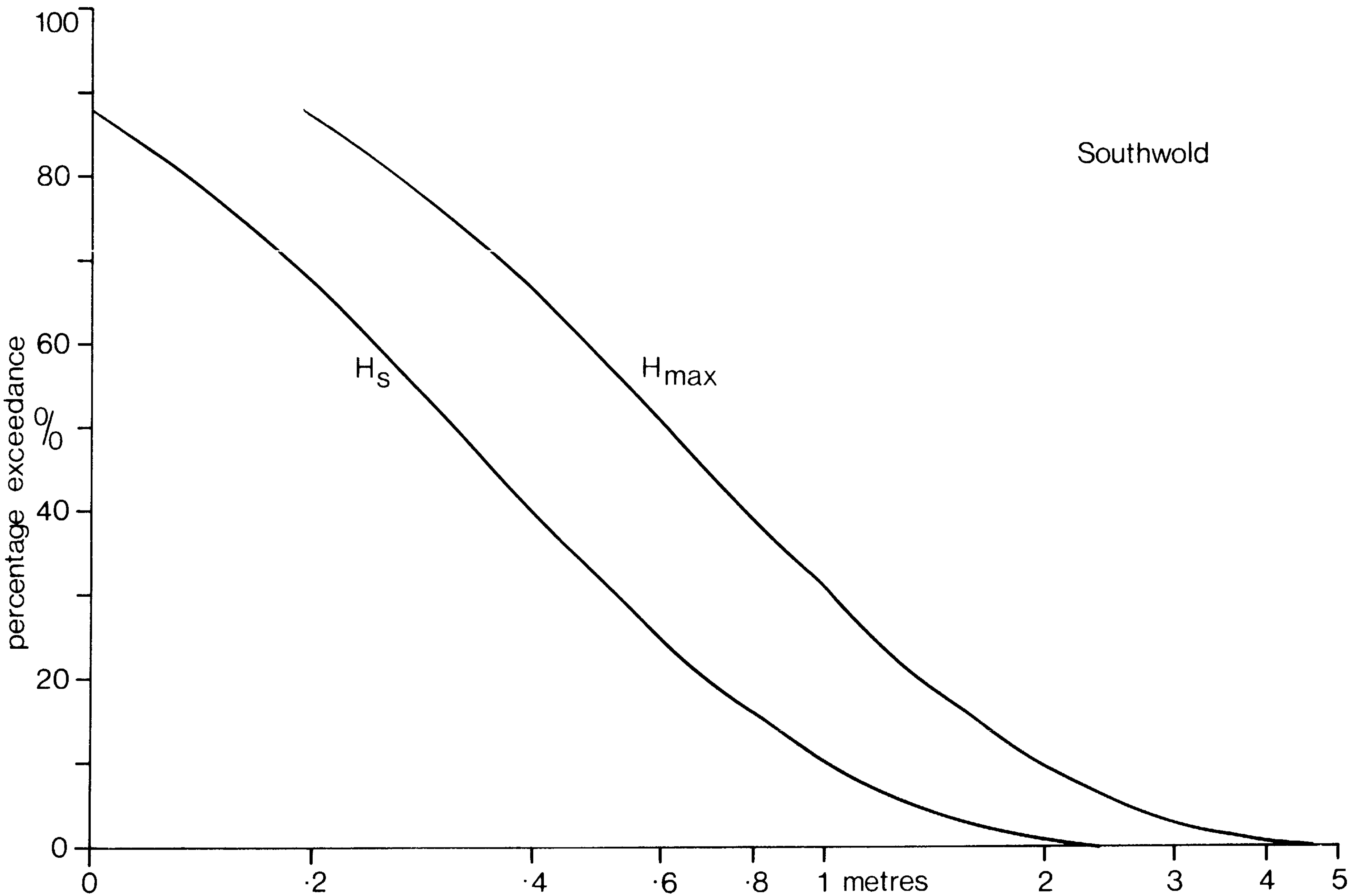
ISOPACHYTE MAP OF SEDIMENTS FORMING
SIZEWELL - DUNWICH BANK - Data obtained in February 1975
1° 40′
52° 20′
N
Southwold
Dunwich
Sizewell
Thorpe Ness
52° 10′
0
2
4
6
8
6
4
2
0
4
6
5
4
3
2
1
2
0?
Key
Sandwave field. Lines follow orientation of crests.
4 or 4 Thickness of unconsolidated sediment (metres)
Km 0 1 2 3 4
1° 40′

Fig. 5



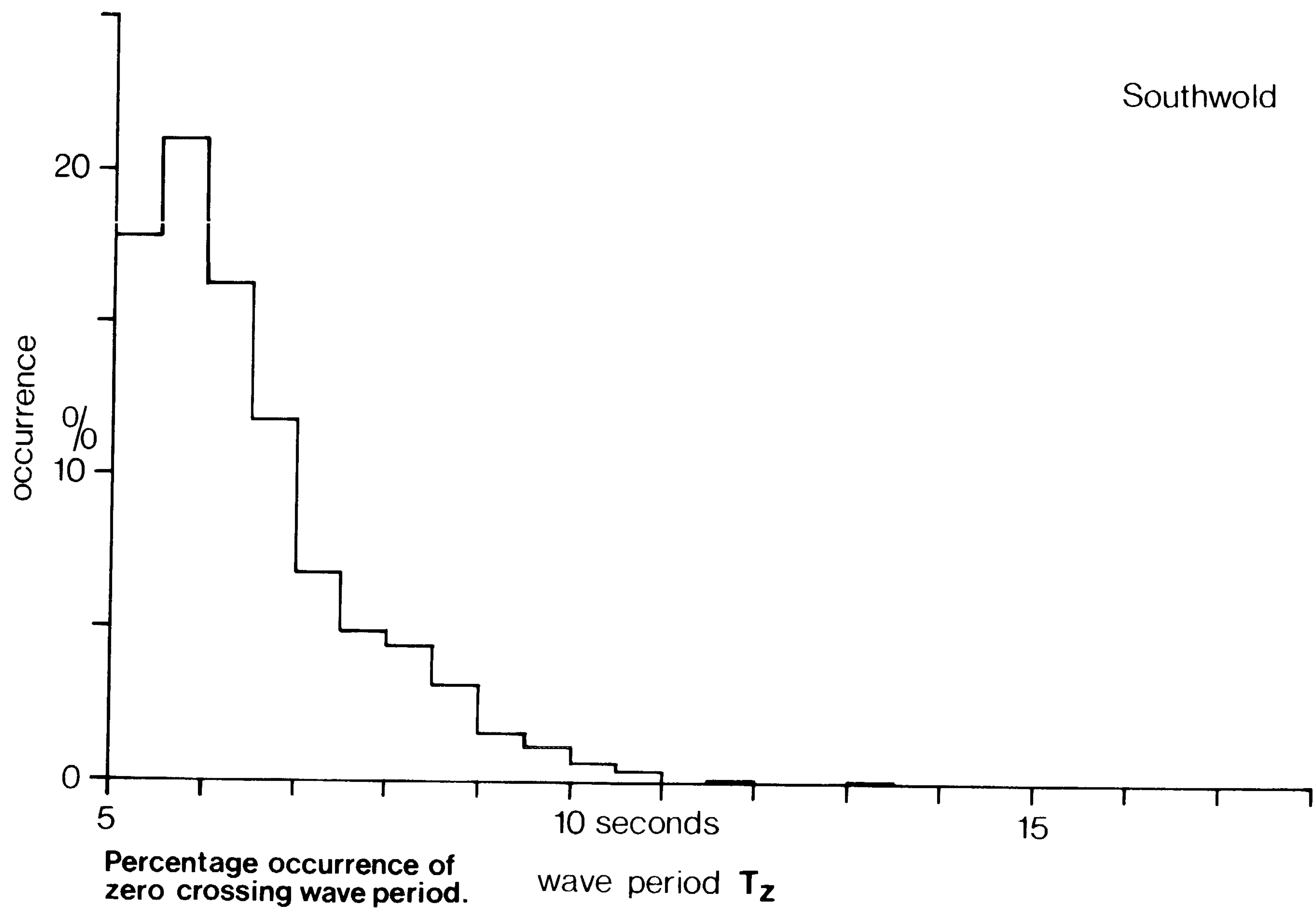
Wave scatter diagram, with occurrences shown per thousand.

Fig. 6a



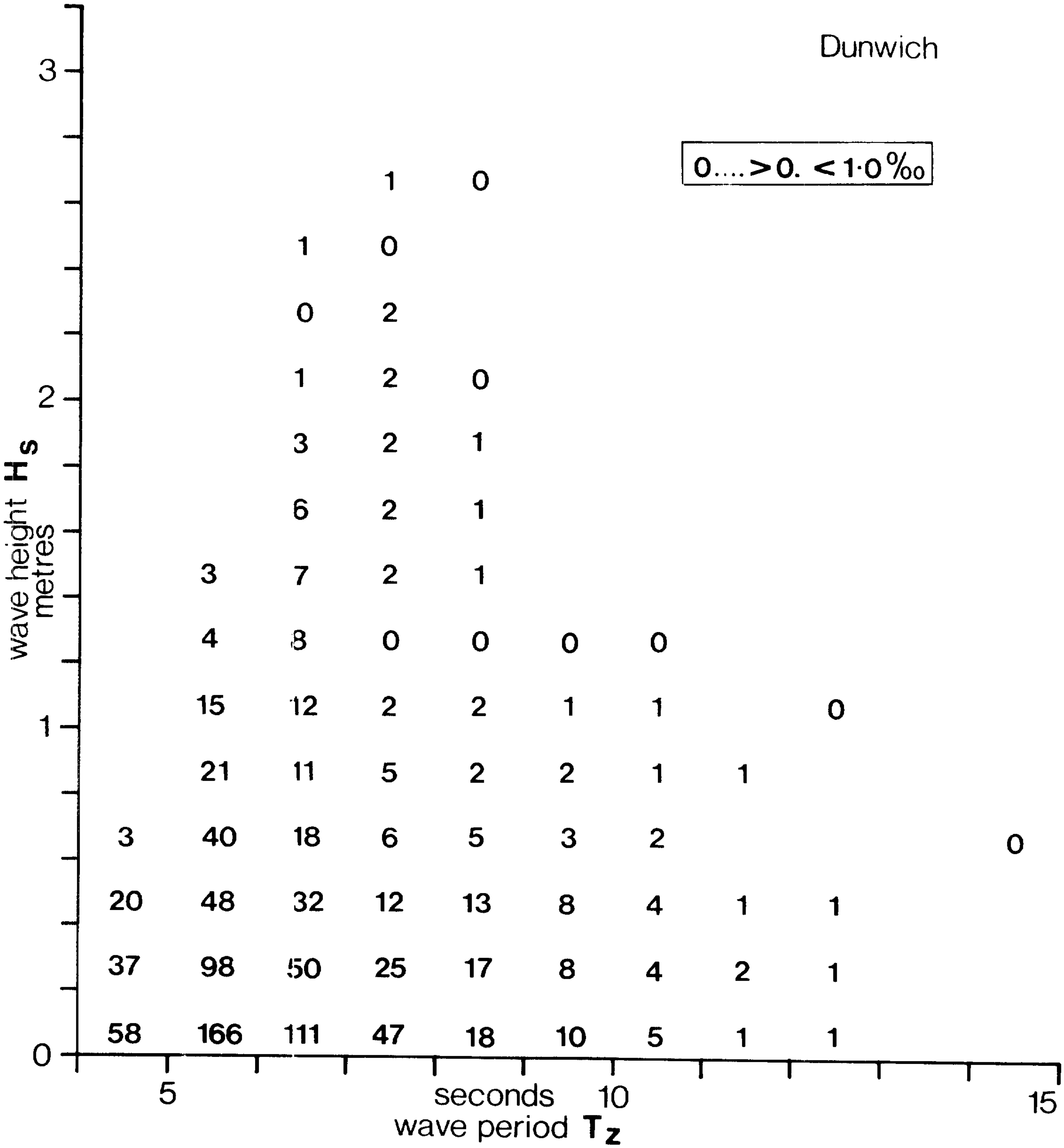
Significant and maximum predicted wave height.

Fig. 6b



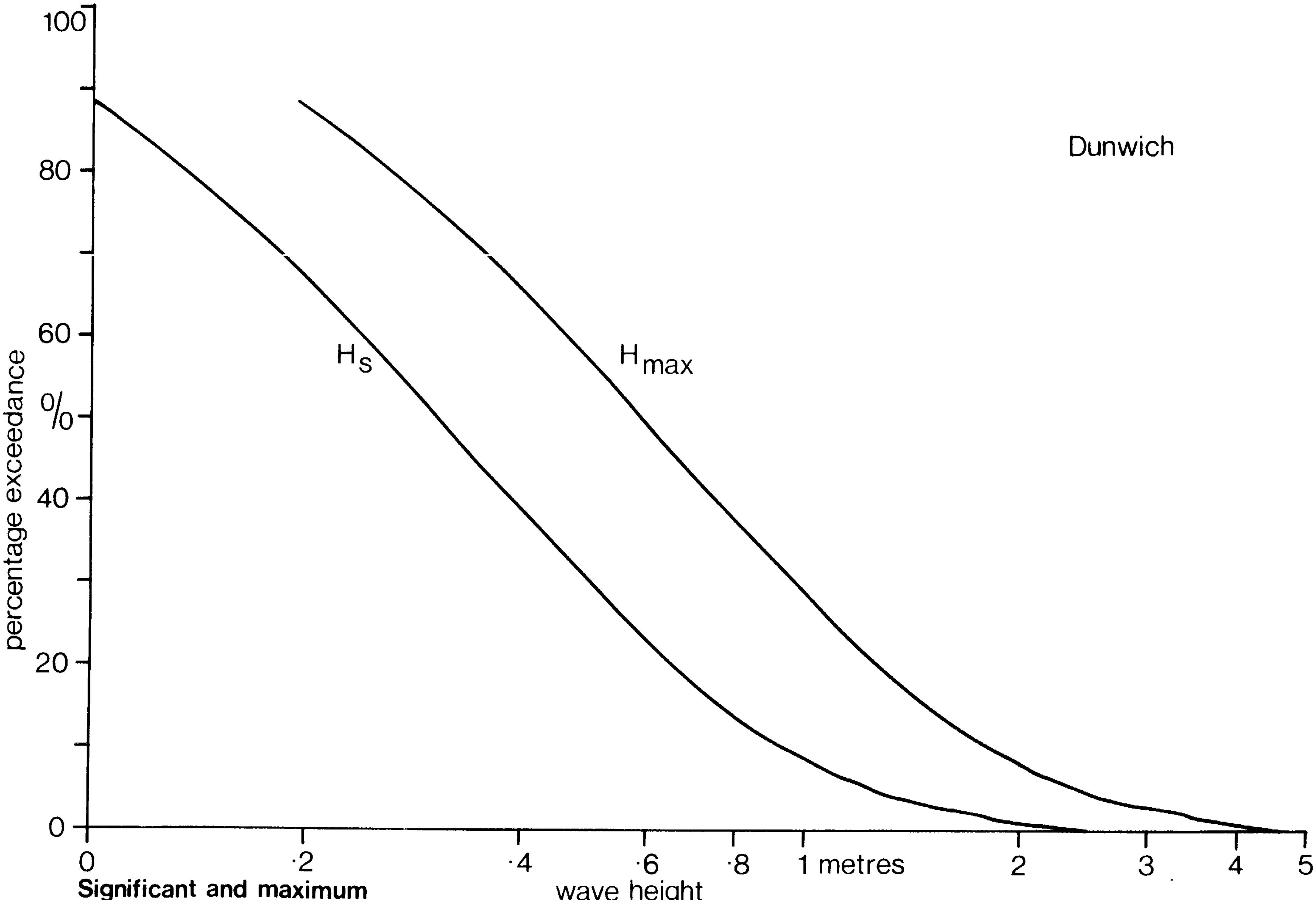
Percentage occurrence of zero crossing wave period.

Fig. 6c



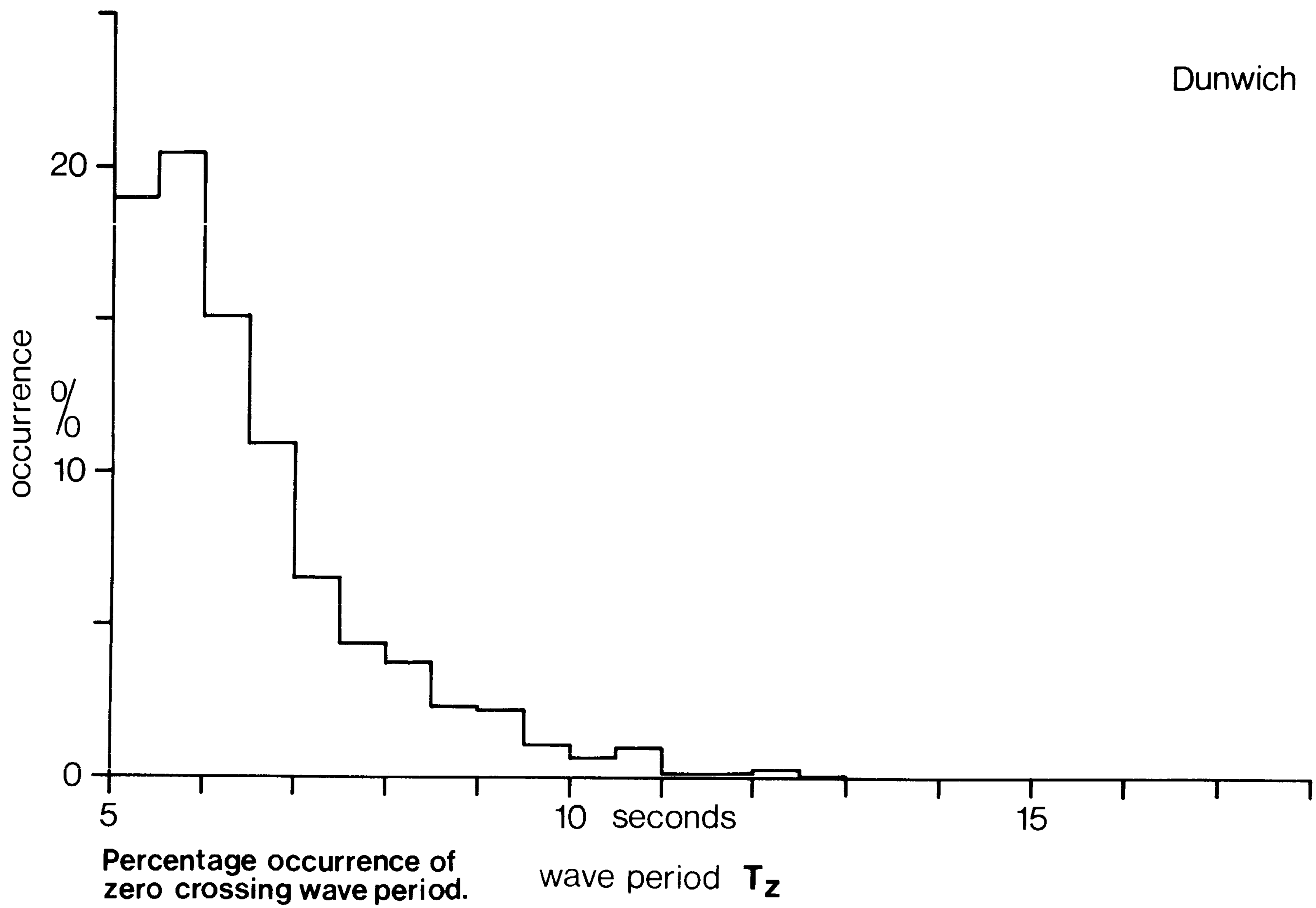
Wave scatter diagram, with occurrences shown per thousand.

Fig. 7a



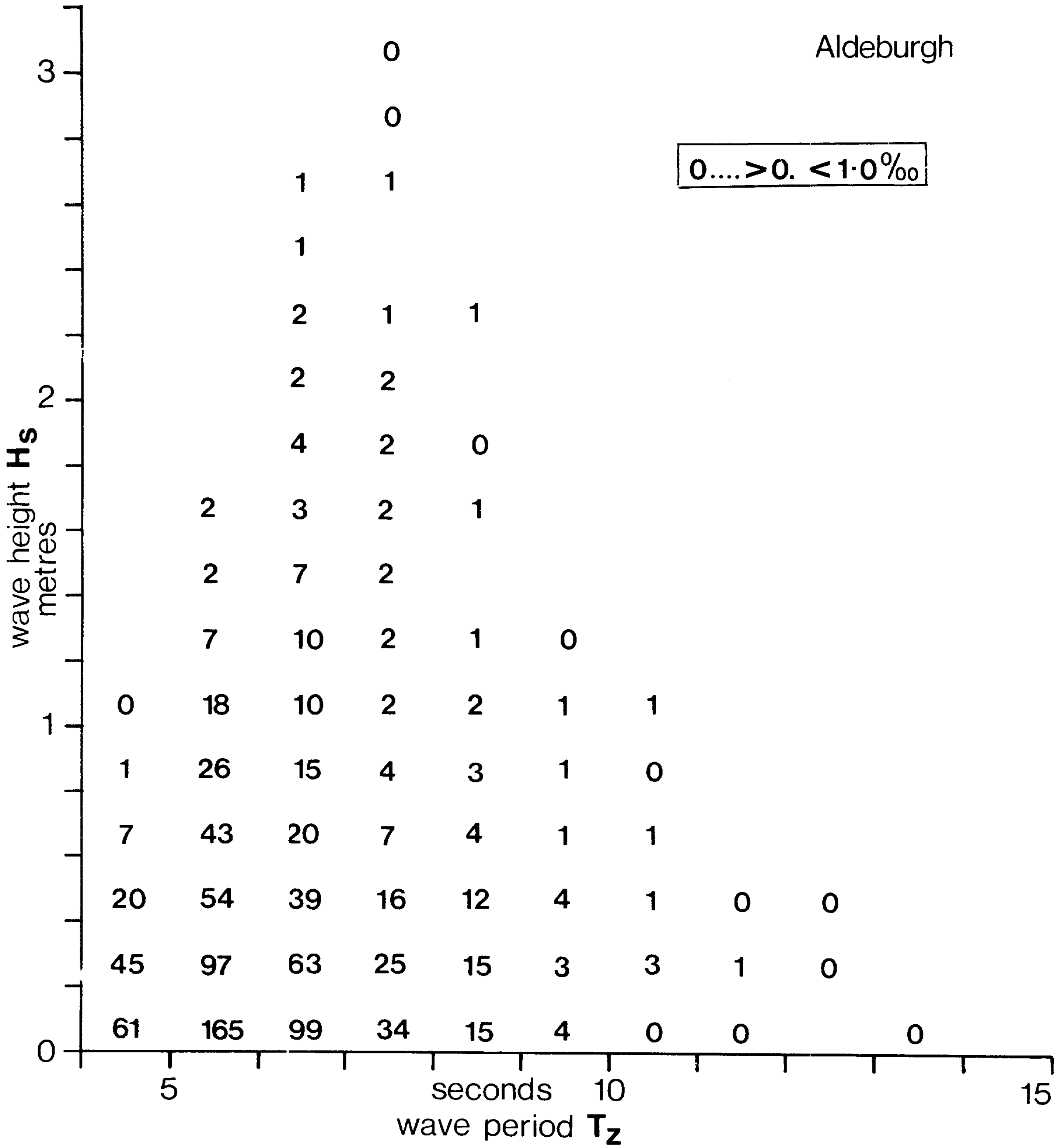
Significant and maximum predicted wave height.

Fig.7b



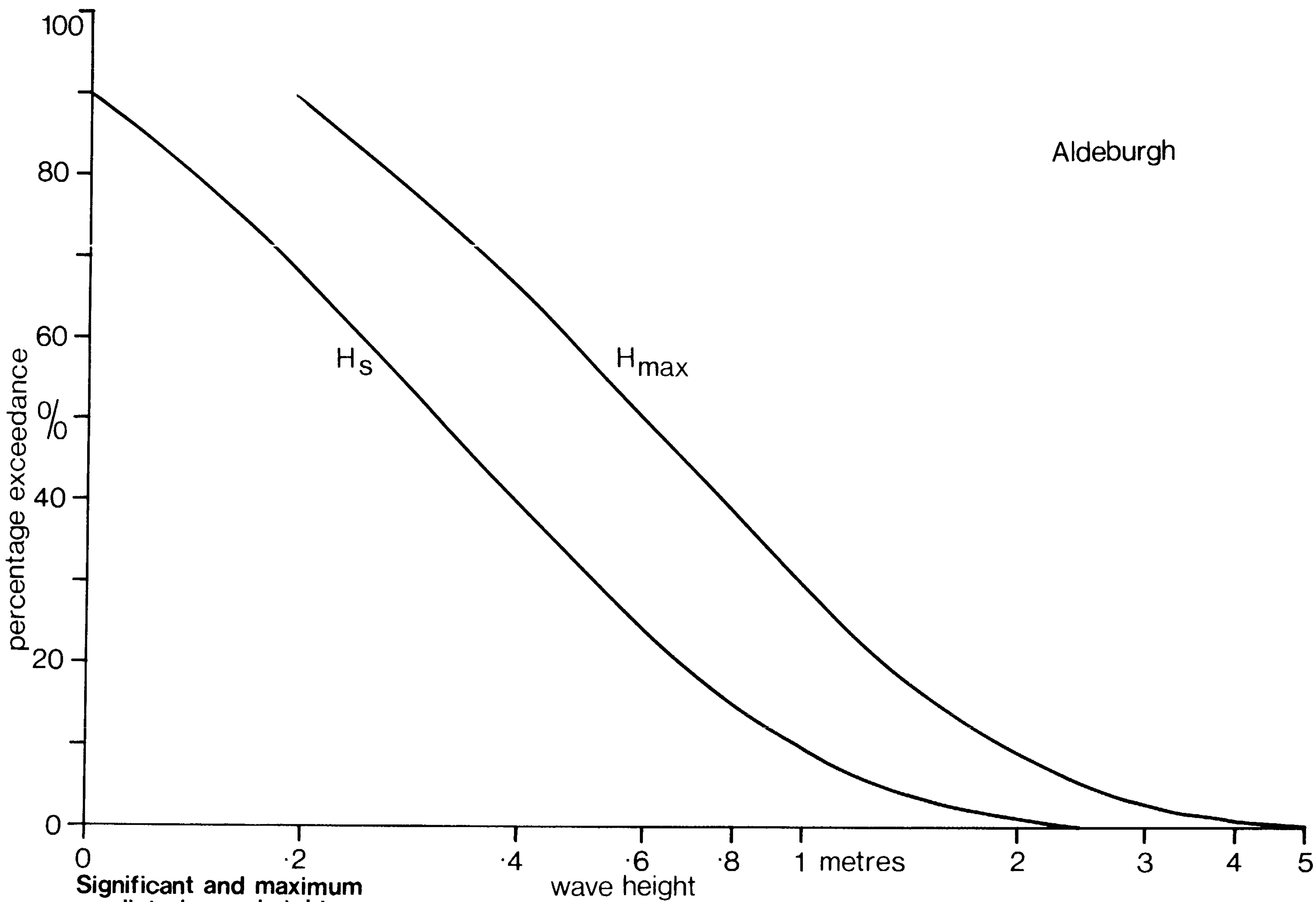
Percentage occurrence of zero crossing wave period.

Fig. 7c



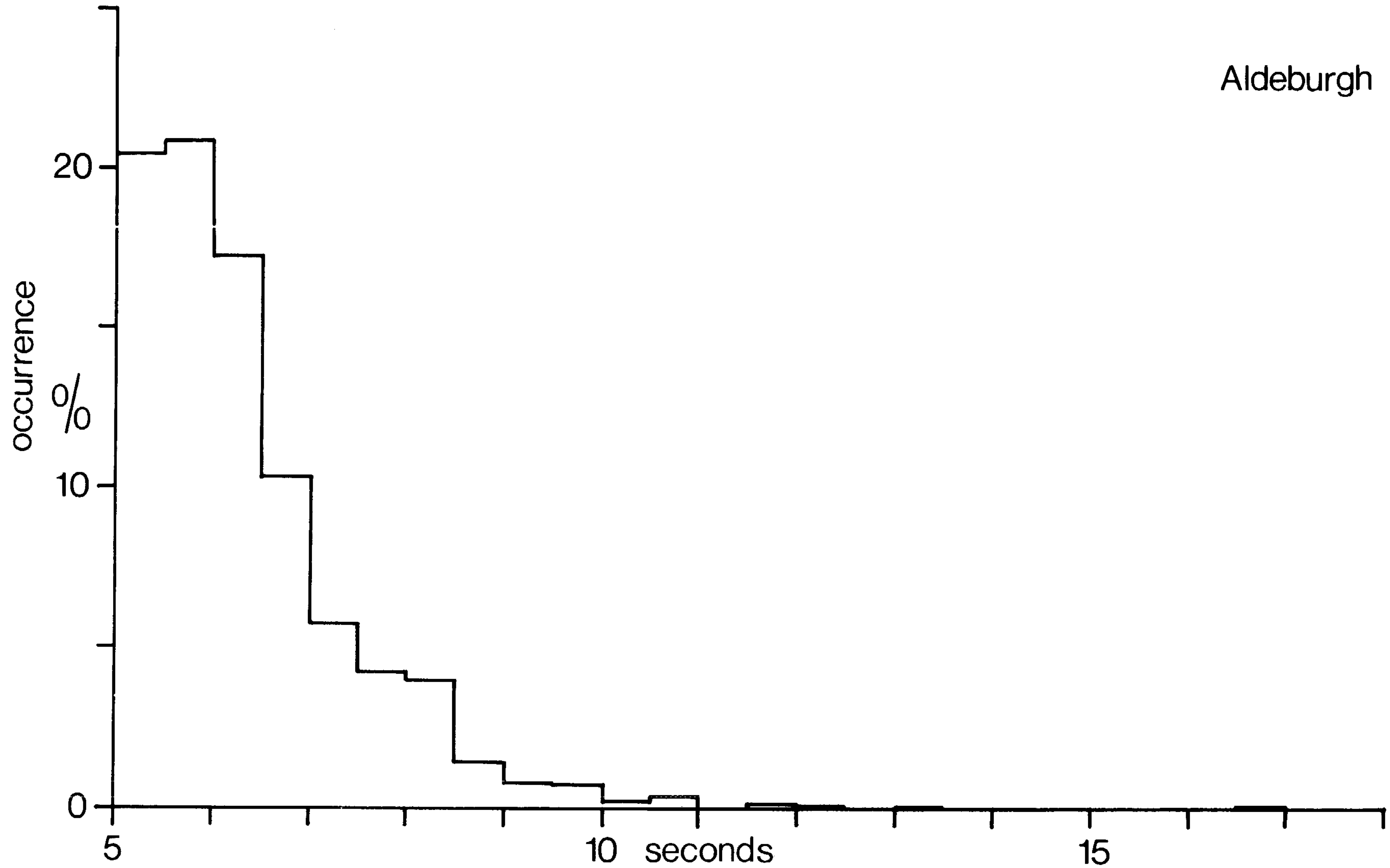
Wave scatter diagram, with occurrences shown per thousand.

Fig. 8a



Significant and maximum predicted wave height.

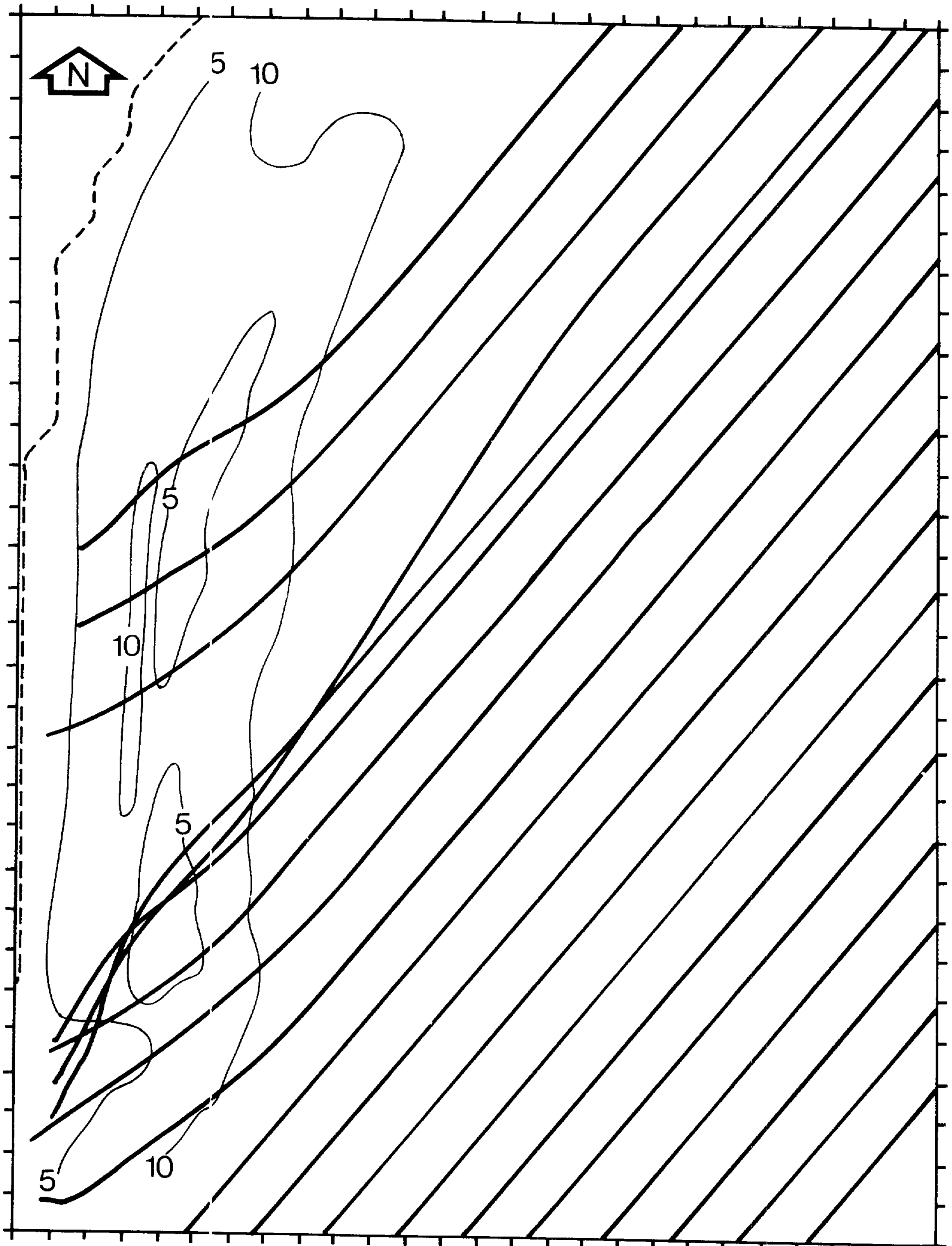
Fig. 8b



Percentage occurrence of zero crossing wave period.

Fig. 8c

RAY PATH DIAGRAM WITH WAVE APPROACH FROM THE NORTH-EAST.



Tide height above Chart Datum = 1 metre.
Bathymetry in metres below chart datum.

Grid size 500 x 500 m.
Wave period 6 secs.

Fig. 9

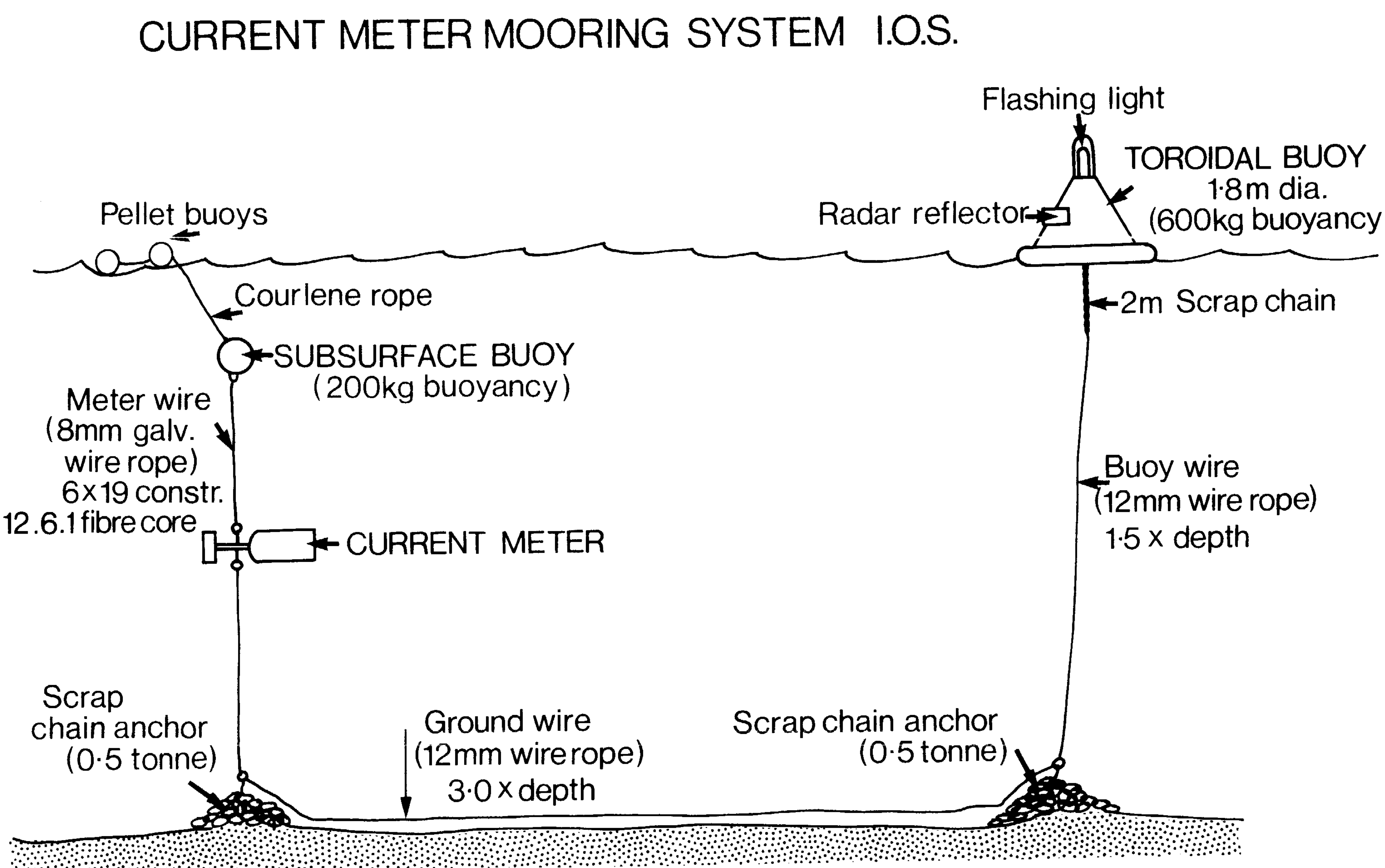

CURRENT METER MOORING SYSTEM I.O.S.
Flashing light
TOROIDAL BUOY
1·8m dia.
(600kg buoyancy)
Radar reflector
Pellet buoys
Courlene rope
2m Scrap chain
SUBSURFACE BUOY
(200kg buoyancy)
Meter wire
(8mm galv.
wire rope)
6x19 constr.
12.6.1 fibre core
CURRENT METER
Buoy wire
(12mm wire rope)
1·5 x depth
Scrap
chain anchor
(0·5 tonne)
Ground wire
(12mm wire rope)
3·0 x depth
Scrap chain anchor
(0·5 tonne)

Fig.10

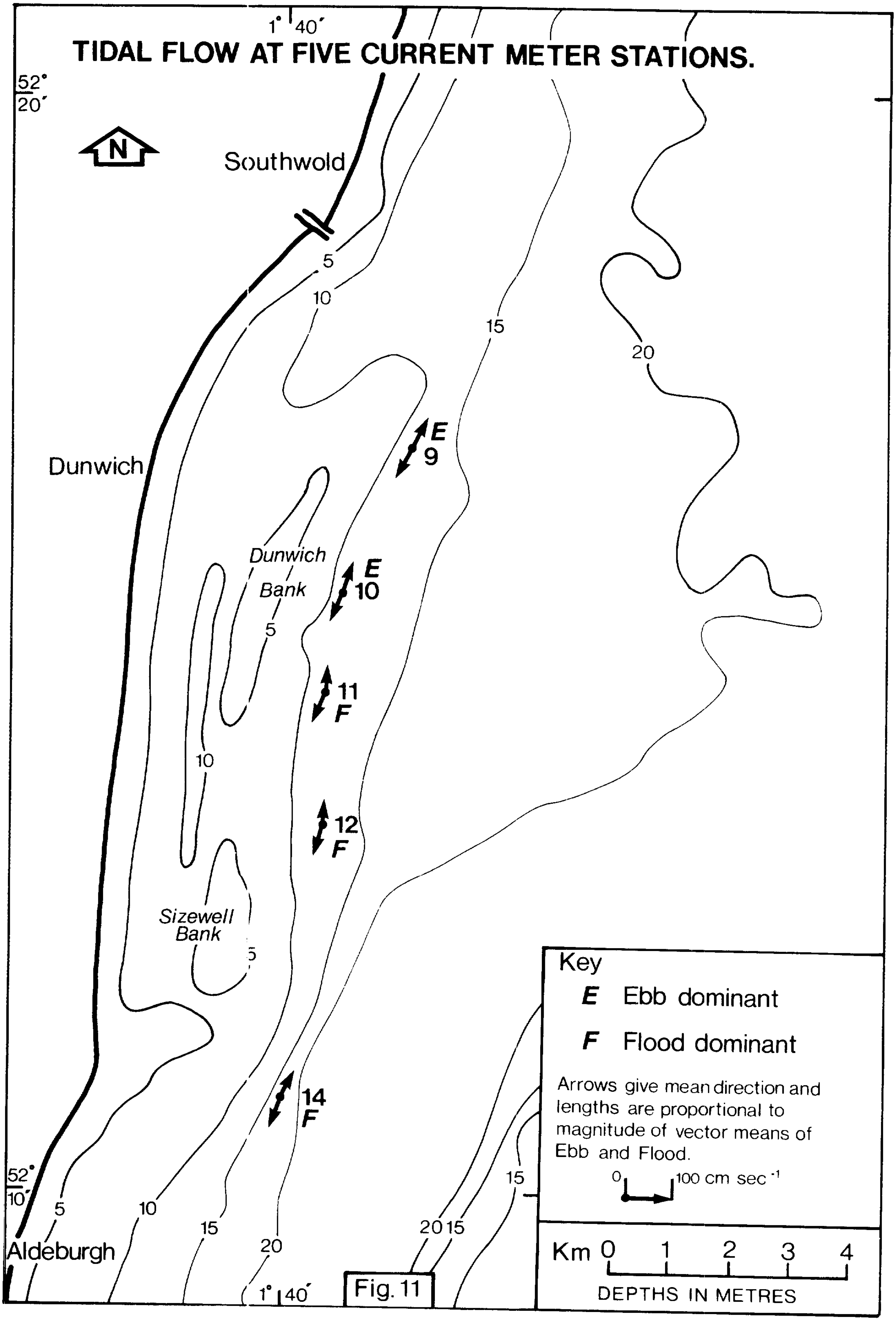
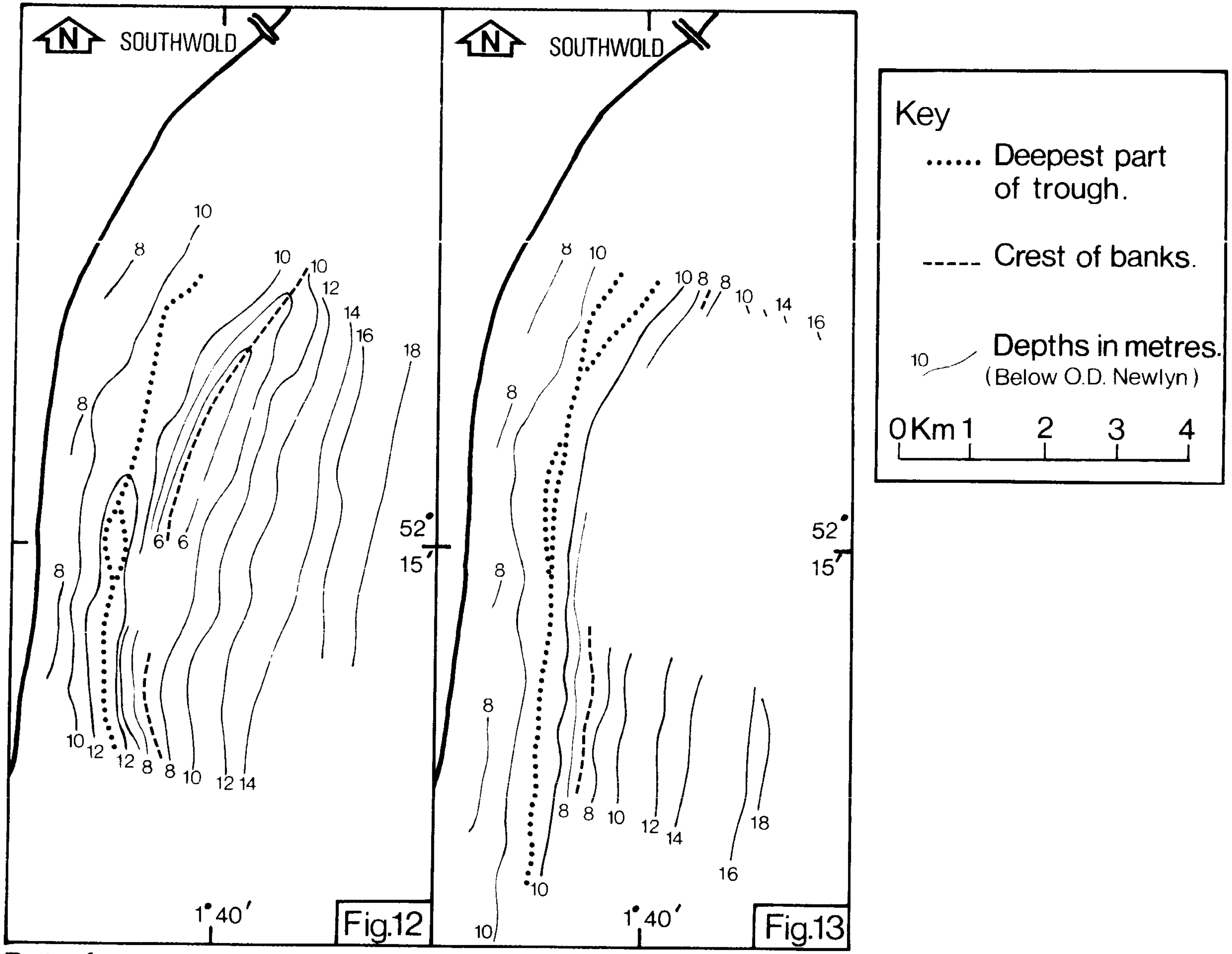

TIDAL FLOW AT FIVE CURRENT METER STATIONS.
1° 40′
52° 20′
N
Southwold
Dunwich
Dunwich Bank
Sizewell Bank
Aldeburgh
52° 10′
E 9
E 10
11 F
12 F
14 F
5
10
15
20
Key
E Ebb dominant
F Flood dominant
Arrows give mean direction and lengths are proportional to magnitude of vector means of Ebb and Flood.
0 100 cm sec -1
Km 0 1 2 3 4
DEPTHS IN METRES

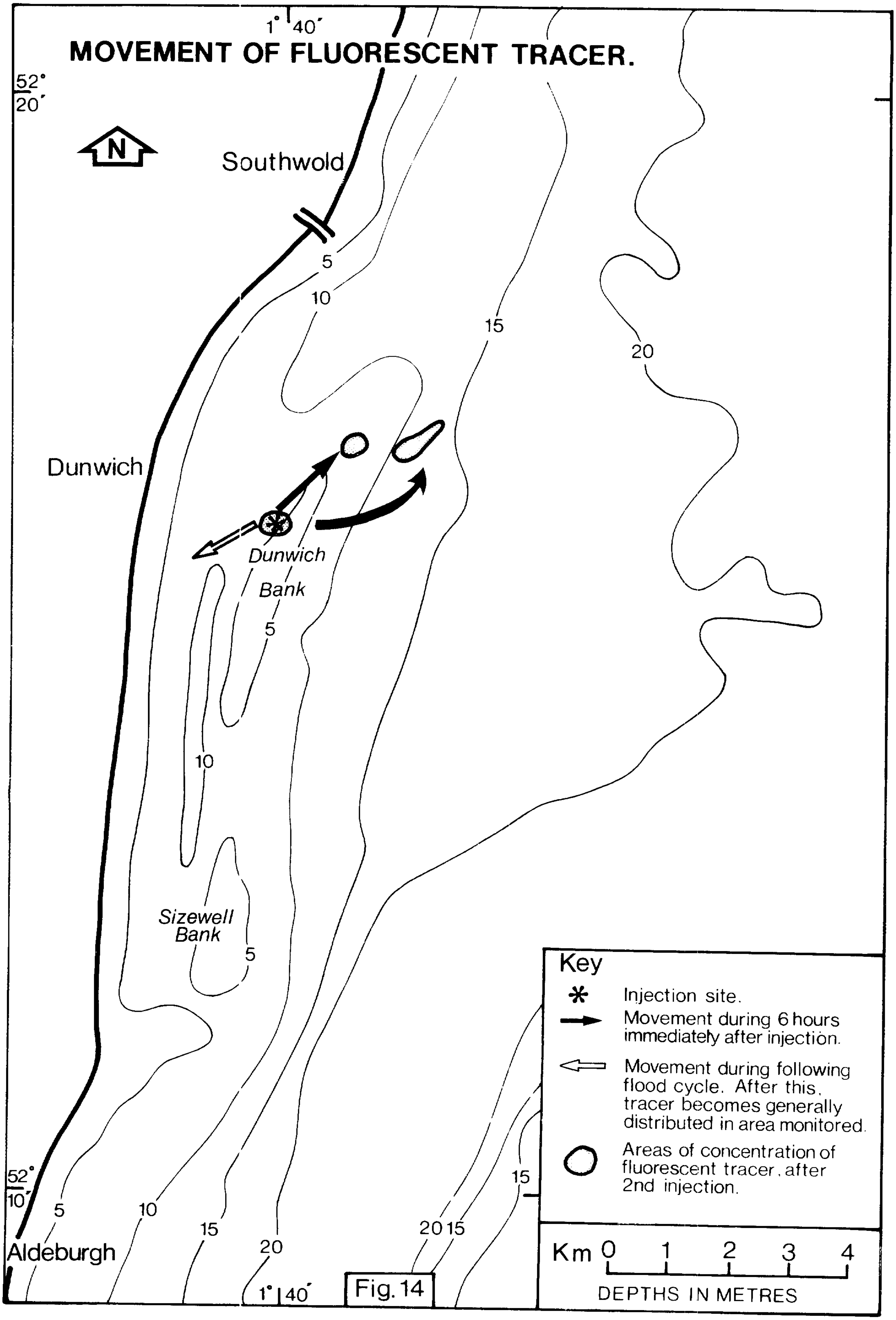
Fig. 11

BATHYMETRY OF SIZEWELL - - DUNWICH AREA.



Data from surveys on 2,3&7 Sept. 1976

Data from surveys on 12&13 Sept. 1976


MOVEMENT OF FLUORESCENT TRACER.
1° 40′
52° 20′
52° 10′
N
Southwold
Dunwich
Dunwich Bank
Sizewell Bank
Aldeburgh
5
10
15
20
20 15
Key
* Injection site.
Movement during 6 hours immediately after injection.
Movement during following flood cycle. After this, tracer becomes generally distributed in area monitored.
Areas of concentration of fluorescent tracer, after 2nd injection.
Km 0 1 2 3 4
DEPTHS IN METRES
Fig. 14