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RV EDWARD FORBES CRUISE 16/75

21 AUGUST – 8 SEPTEMBER 1975

SANDWAVE RESEARCH IN START BAY AND THE OUTER THAMES ESTUARY

CRUISE REPORT NO 41

1975

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

RV EDWARD FORBES CRUISE 16/75

21 August–8 September 1975

Sandwave Research
in Start Bay and the Outer Thames Estuary

Cruise Report No 41

1975

Institute of Oceanographic Sciences
Crossway
Taunton Somerset

CONTENTS

SCIENTIFIC STAFF

D N Langhorne	(Senior Scientist)	22 August–5 September
P J Hooper		21 August–5 September
R H Wilkinson		22 August–25 August
E J Moore		23 August–3 September
J Humphery		23 August–25 August (accommodated
J O Malcolm		23 August–25 August (on
D Hill		23 August–25 August (shore and 3 September
R L Cloet		4–5 September
A J Marks		4–5 September

EXTERNAL STAFF

Contract Divers (for search for lost transducer):	
C Massie-Taylor	27 August
R Sargent	27 August
Decca Survey Ltd (Differential HiFix):	
A Holmes	29 August
Maintenance of Hifix monitor at Landguard Point:	
R Rowland (Harwich Port Authority)	29–31 August

SHIP's OFFICERS

B A Chapman	(Captain)
J T Morse	(1st Officer)
J Price	(2nd Officer)
R Perriam	(Engineer)

OBJECTIVES

1. To establish an area in Start Bay for the detailed study of sandwaves and associated dune bed forms.

2. To lay a wave rider buoy for subsequent dune studies.

3. To carry out trials with a prototype 'non-trawl' transponder sinker.

4. To carry out sonar trials (a) with various objects to establish their suitability for use as passive acoustic reflectors, (b) in a vertical tow mode.

5. To carry out acceptance trails of the Decca Tracer Buoy, and continue the development of the concept of Differential HiFix.

6. Survey the Port of London Authority trial dredged channel within the sandwave field using Differential HiFix.

7. To carry out field trials with Rangemaster relative position fixing system.

ITINERARY

Wednesday, 20 August
D N Langhorne, P J Hooper and D Joyce delivered the IOS (T) equipment to Barry
11.45 arrived Barry. (DNL sprained his ankle and was taken to Cardiff Royal Infirmary by RVB staff) PH and DJ unloaded equipment and set it up on board.
18.30 DNL and DJ returned to Taunton.

Thursday, 21 August
09.45 Sailed from Barry.
Carried out a drag sweep for lost Cambridge University equipment off Minehead.

Friday, 22 August
On passage.
DNL and RH Wilkinson drove to Dartmouth.
12.00 meeting with J Hutchins (crabber) to discuss fishing interests in Start Bay.
19.30 EDWARD FORBES arrived at Dartmouth (No 6 Buoy). DNL & RHW joined the ship.
Originally planned ETA 14.00 (delay due to poor weather).

Saturday, 23 August
E J Moore, J Humphery, J O Malcolm and D Hill joined the ship.
Sonar and echo sounding survey of the area SW of the Skerries Bank.
Trials with sonar in vertical tow mode.
Trials with sonar Automatic Gain control.
20.30 Returned to Dartmouth. Visited MV WILDORA (possible charter vessel).

Sunday, 24 August
Continued sonar and E/S survey.
Laid wave rider buoy.
Carried out trials with 'non-trawl' transponder sinker.
Carried out trials with sonar reflectors.
20.00 Returned to Dartmouth. DH was taken to hospital with an ear infection.
Mr Venebles visited the ship to repair MS 36 echo sounder.

Monday, 25 August
Continued sonar trials.
Relayed transponder sinker at base of a sandwave.
Diver observations on the lee slopeof sandwave.
19.30 Returned to Dartmouth. JOM, JH, RHW, DH left the ship.

Tuesday, 26 August
Continued sonar and E/S survey on Skerries Bank.
17.20 Sonar transducer lost.
19.30 Returned to Dartmouth to make arrangements for divers to search for the lost transducer. (Original programme of sailing for the Thames deferred.)

Wednesday, 27 August
10.15 Sailed from Dartmouth with contract divers.
12.15-14.30 Divers searched for the lost transducer.
16.00 Returned to Dartmouth.
17.20 Sailed for Harwich.

Thursday, 28 August
On passage.

Friday, 29 August
07.00 Arrived at Harwich (Trinity Pier).
08.00 A Holmes (Decca) arrived on board.
08.15 R Shaw (Decca HiFix engineer) came on board.
11.12 Sailed for Harwich to set up HiFix monitor (buoy) on Great Sunk Beacon.
Carried out differential HiFix trials.
20.30 Returned to Harwich. Set up HiFix monitor (analogue) at Landguard Point.

Saturday, 30 August
Carried out monitored survey of PLA trial dredged channel.

Sunday 31 August
Static trials of Differential HiFix.

Monday, 1 September
Range and bearing trials of Monitor buoy's directional aerial.
17.15 Abandoned attempts to recover HiFix monitor equipment from Great Sunk Beacon, due to poor sea conditions. Sailed for Dartmouth.

Tuesday, 2 September
On passage.

Wednesday, 3 September

07.15 Arrived at Dartmouth.

08.00 Sailed from Dartmouth with IOS (T) divers to search for the lost sonar transducer. Carried out bathymetric studies of large sandwaves to east of the Skerries.

Thursday, 4 September

R L Cloet and A J Marks joined the ship.

Carried out trials with Rangemaster relative positioning system using four sea bed transponders.

Friday, 5 September

06.00 Sailed from Dartmouth to continue ranging trials with sea bed transponders. Recovered transponders and non-trawl sinker module.

pm IOS (T) staff returned to Taunton.

RV EDWARD FORBES sailed for Barry.

pm Contract divers (no longer under contract) recovered the lost sonar transducer.

NARRATIVE

1. To establish an area in Start Bay for detailed studies of sandwaves and associated dune bed forms:

The first sonar and E/S survey was conducted on the SW end of the Skerries Bank. Predetermined tracks were run across the Bank in the direction considered most likely to be parallel to the sandwave crests. In this area difficulty was experienced in maintaining a steady course on account of the strong cross tide and the multitude of crab pot floats.

A later survey was carried out using a line orientation of 080°–260° in the middle part of the Bank. The extent of the survey was limited by the area of deeper water on the bank between patches of shallower water. Excellent sonar records were obtained indicating a featureless gravel area in the east in deep water, with an abrupt change to dune forms of sand. With progression onto the Bank (with loss of water depth, lower flow velocities and decrease in grain size) a progressive increase in dune wave length occurred.

A diver (J O Malcolm) made a preliminary inspection of the lee slope (N facing) of a major sandwave in the area (ht 10 m). See diver report – Appendix 2b.

2. Wave Rider Buoy
Under the direction of J Humphery, the wave rider buoy was successfully laid off the Skerries Bank in Start Bay; negotiations being in progress to set up the recorder at Start Point Lighthouse.

3. Trials with the prototype 'non-trawl' transponder sinker.
Only minor problems were experienced in handling the sinker module (weight 8 cwt approx) on board ship. The module was initially laid in shallow water (10 m) off Slapton Beach. Divers reported that the legs sank into the sea bed some 15 cms under the weight of the frame, as required. Using compressed air it was possible to jet the legs in until the flat railway wheel was supported by the sea bed. Divers observed that whilst a sideways pull was put on the module using the ship's winch, it tilted, rotated and again settled upright on the sea bed.

The module was later laid in the trough between two large sandwaves (up to 12m amplitude) as close as possible to the foot of the lee slope. Divers were used to release the lowering wire. The first attempt failed when strain came on the lowering wire before it was disconnected thus causing the module to turn over. The second attempt was successful. The module was left in position with a ground wire (to be used as recovery wire) and marker float, together with both Rangemaster and Rangemeter transponders. Tests with Rangemeter confirmed that measured ranges could be obtained.

The module was recovered on 5 September without difficulty. Prior to recovery (3 September) the divers inspected the sinker module and reported no apparent change: that is no further settling had occurred nor erosion or siltation around the legs.

4. EG & G Sonar Trials: until the loss of the towed transducer (see Appendix 1) the sonar performed satisfactorily.

(a) In order to make studies of the temporal variability of dunes using sidescan sonar a requirement exists for fixed control points to be established on the sea bed. Various objects were tested to determine their suitability for use as passive acoustic reflectors for this purpose.

Lengths of 25mm and 4mm (internal diameter) air filled polythene tubing were laid on the sea bed to use as sonar targets. 20 lbs weights were attached at intervals to hold the tubes on (or close) to the sea bed. Each end of the tubes was marked with surface floats. A uniform sea bed (sand) in sheltered water of depth 10m was selected for the trials. Running parallel to the tubes both diameters could be clearly detected with the sonar at ranges of up to 77 m. The ease of detection was mainly dependent upon the ship's speed over the ground. The larger diameter tube gave a stronger reflection than the smaller. Running at right angles to the tubes a series of point reflectors were obtained. It is considered that these were probably obtained from the 20 lbs sinkers whilst little reflection came from the continuous air bubble entrapped in the tube except in places where tubes were joined together. 9" Nokalon trawl floats and metal milk bottle crates were also tested as acoustic reflectors. In both cases strong point reflections were obtained which were clearly distinguishable

on a uniform low acoustic return background.

(b) Trials were carried out using the sonar in a vertical tow mode in order that the position of the transducer may be established to a greater accuracy. For these trials the transducer was attached by its nose eye to a vertical wire from the Munro Davit. 200 lbs of lead was used as a sinker attached at the end of the lowering wire. The tail of the fish was guyed to the lowering wire, the cables faired, and a fore guy taken from above the sinker to the bow of the ship. Moderate success was achieved at speeds of up to 4 knots. At these speeds considerable drag forces acted on the system causing vibration, particularly on the fore guy. Normal records were achieved to starboard, whilst reflections off the ship's hull degraded the record to Port. The trials were only carried out in excellent sea conditions and hence the effect of ship motion on the fish was not observed. For the system to be used in an operational mode the utmost consideration should be given to fairing the sinkers and wires, etc.

5. Decca HiFix Tracer Buoy

The Tracer Buoy equipment (Buoy with HiFix aerial, extension cable to directional UHF aerial and cable to external power supplies (2 x 12 volt batteries), UHF receiver, Base converter, 60 ft cable to omnidirectional UHF aerial) was delivered to the ship at Harwich on Friday 29 August by Mr Holmes of Decca. The on-board installation of the omnidirectional UHF aerial was carried out prior to sailing. The Buoy was mounted on Great Sunk Beacon 50 feet above sea level (approximately) and the directional UHF aerial aligned in the direction of Harwich. Despite the distance of 14 nautical miles and obstruction of Harwich Town and docks, etc, it was possible to hold the UHF signal from Great Sunk Beacon to the ship's berth in Trinity Pier in Harwich (14 miles). By logging both the HiFix co-ordinates of the ship's position (tied up alongside) and the HiFix co-ordinates of the buoy (as transmitted by the UHF link) it was possible to record and compare the pattern fluctuations from both an offshore and a shore sited monitor, the latter being a poor land path from the Pattern I slave stations at Allhallows.

Arrangements were made with PLA Gravesend to alter the Goniometer settings at the Pattern I slave station (Allhallows) in steps of 0.02 lanes every 5 minutes to 0.20 lanes and back to the original settings. This was carried out whilst the ship remained stationary alongside in Harwich.

In order to carry out the survey of the dredged channel within the sandwave field at Longsand Head it was necessary to re-align the aerial at Great Sunk Beacon. Throughout the survey both the co-ordinates of the HiFix buoy and the ship were recorded every second (a print out and fix on the echo trace being obtained every 30 seconds).

The claimed beam angle for reception of the directional aerial was 16° on either side of the centre line, the range being governed by UHF line of sight (based on the height of the two UHF aerials) as opposed to signal strength. With the limited time available it could only be established that the beam angle was not less than 60° at 14 miles radius.

Owing to poor sea conditions, it was not possible to recover the equipment from Great Sunk Beacon before leaving the Thames Estuary. The recovery was however successfully carried out by the Port of London Authority at a later date.

A shore side HiFix monitor recording on an analogue recorder was set up on Landguard Point. Daily maintenance and referencing was carried out by Mr Rowland of Harwich Port Authority.

No rainfall occurred during the trial and hence anticipated long period (several hours) pattern fluctuations were not recorded.

6. The survey of the Port of London Authority trial dredged channel was carried out on Saturday 30 August. Echo sounding lines were run parallel with Pattern I HiFix lines at an initial spacing of 20 m. It was intended to run interlines but this was not possible as time for the survey was lost realigning the HiFix monitor buoy's aerial at Great Sunk Beacon before and after the survey. Sea conditions were good. Depth was recorded by the ship's MS36 echo sounder and position recorded every second, whilst fix marks and data print out were obtained at 30 seconds intervals. Simultaneous with each fix the co-ordinates of the monitor at Great Sunk Beacon (8 miles SW) were recorded. Tidal data was recorded by PLA automatic tide gauge at Walton whilst further shore sited HiFix monitors recording on analogue recorders were sited at Garrison Point (PLA) and Landguard Point (IOS). Some 20,000 fixes were recorded during the course of the survey.

7. Field trials of Rangemaster relative position fixing system

The objective of the trial was to test the method of deployment and operation of the equipment in a realistic situation.

The Rangemaster trials team (RLC and AJM) joined RV EDWARD FORBES at 0900 on 4 September. A network of four transponders (47, 48, 49 and 50 kHz frequencies) were laid in an approximate square with 500 m sides. At each deployment position a sound velocity profile was recorded. On testing the system it was apparent that the ranges being obtained were becoming erratic and eventually were lost. On checking the 30 m transducer cable it was found to be defective. A second cable (680 m) was connnected. The ship took up stations approximately 500 m away from the central position of each base line and ranges were manually recorded from each transponder as the ship drifted. Spurious readings of a random nature occurred for some 30% of the total data. It was established that this could be reduced to some 5–10% by disconnecting the shaft to the ship's variable pitched propeller. This procedure cannot be adopted as a standard as continuous repetition can cause damage to the ship's transmission. It was found that owing to the noisy environment the automatic range gate tended to lock onto noise and as a result the system was used in the narrow band manual mode. Ranges were obtained up to a distance of 1350 m though no attempt was made to establish a maximum range.

On 5 September RV EDWARD FORBES returned to the transponder range and signals were obtained from three out of the four transponders. The three transponders were recovered and a search made for the fourth. This transponder was ultimately found and recovered some two miles off station.

COMMENTS

WEATHER

Owing to strong NW winds blowing whilst the ship was on passage, from Barry to Start Bay, the ship arrived in Dartmouth at 19.30 (as opposed to 14.00 as originally planned).

For the remainder of the cruise, the sea conditions were mostly abnormally good. On Sunday 31 August winds of force 4-5 northerly prevailed in the Thames Estuary. This was of no consequence as the day was used for static differential HiFix trials and the ship remained alongside in Harwich. The winds persisted on Monday 1 September but failed to upset the research programme (HiFix monitor range/bearing evaluation) except that it was considered dangerous to life and equipment to recover the monitoring equipment set up on Great Sunk Beacon.

SHIP AND EQUIPMENT PERFORMANCE

Whilst working in Start Bay on two occasions some ambiguity occurred with Decca positions, and it could not be established whether the ship's receiver had lost a lane.

MS 36 Echo Sounder (Hull mounted transducers)

This equipment performed satisfactorily at the beginning of the cruise. On Saturday 23 August on switching on, the recorder failed. Attempts to repair the equipment were not successful. On Sunday 24th an electronic engineer (Mr Venebles) was contracted to repair the equipment, which then performed satisfactorily for the remainder of the cruise.

APPENDIX 1

Report on the loss and subsequent finding of the IOS (T) EG & G Sonar Transducer: D N LANGHORNE (Senior Scientist)

CIRCUMSTANCES OF LOSS

At 1720 on Tuesday 26 August the EG & G towed sonar transducer was accidentally snagged on a crab pot float rope. No blame is placed upon the Officer of the watch (2nd officer J Price). At the beginning of the cruise the ship's officers were briefed upon the problems of towing the transducer, in that the length of tow cable often exceeds the depth of water and hence if speed through the water is lost it is in danger of grounding. Secondly whilst working in a cross tide the transducer does not necessarily follow in the wake of the vessel and care has to be taken to avoid obstructions such as crab pots. In the case where the transducer was lost the ship was working at slack low water. The ship passed a crab pot float at an acceptable distance. Unknown to those on board, the float rope was supported by two subsurface floats attached at intervals to the main rope. Being slack low water the surface float was some way from its sinker and the connecting rope was held in mid water.

RECOVERY PROCEDURE

On snagging the pot rope the transducer cable (50m) snapped and the sonar record terminated. Position fixes from Navigational Decca were being recorded every second and automatically marked on the sonar record at 30 seconds intervals. Hence the position of the ship (not the transducer) was known accurately at the moment when the power cable parted. Immediately a ready-made up float with rope to sinker was dropped. The inflatable dinghy (which was being towed) left the ship with E J Moore, and P J Hooper, to obtain transits of the estimated position. A second float with heavier sinkers was then laid in the Decca position as recorded by the Mag Log. The float to the crab pot was lifted (property of J Hutchins) until the first of the string of crab pots reached the surface in the hope that the transducer may have been tangled with the rope. At this stage it was noted that two secondary sub surface floats were attached to the rope. With no diving team or equipment on board the vessel returned to Dartmouth.

That evening attempts were made to contact the IOS (T) diving team who were working from RV JANE on the Eddystone. Repeated telephone calls to MBA and

Fort Bovisand etc failed to make contact with the divers who were working late on Waverider replacement. Attempts were then made to arrange divers in Dartmouth. The only success that evening was an offer from a contract salvage organisation (Ocean Diving and Contract Ltd) to dive for one day using one diver for £200. This was rejected.

On Wednesday 27 August attempts to obtain divers from Dartmouth RN College failed as the college was closed for summer leave. However, through the college, contact was made with C Massie-Taylor and R Sargent who agreed to dive from the EDWARD FORBES that day at a rate of £30 per day per man.

In excellent sea conditions with visibility of up to 10m at 30m depth the two divers searched the sea bed until their time permitted at that depth terminated. The start of the search was frustrated by radio information from J Hutchins that he had lifted and relaid his crab pots though he had attempted to relay in the same position. He also passed information that the fishing vessel SUPERBUS had not only recovered the second marker floats but also was lifting the waverider buoy which had been laid on 24 August.

The diver report at the end of the diving period was that the chances of finding the transducer were good provided that the necessary time was made available to make search. The sea bed was rocky without much weed and it was considered that the transducer would not be carried far by the tide.

On the afternoon of 27 August contact by radio was made with RV JANE (J Humphery) and it was arranged that RV JANE would proceed to the area so that the IOS (T) diving team could dive for the transducer that evening. Having passed all information to RV JANE, RV EDWARD FORBES proceeded to the Thames Estuary to continue the research programme.

A major diving programme was arranged for Friday 28 August using the following personnel:

J Humphery	IOS (T)	(The detailed diving
J O Malcolm	IOS (T)	report by J O Malcolm
N Cranham	Fort Bovisand	is attached)
C Massie Taylor	Contract - Dartmouth	
R Sargent	" "	

A final attempt to recover the transducer was made on 3 September. On this occasion the IOS (T) divers J O Malcolm and D Hill dived from RV EDWARD FORBES whilst C Massie-Taylor and R Sargent dived from a private vessel. On each occasion that contract divers were employed financial approval was obtained by telephone from Taunton.

On the evening of 3 September the attempts to recover the transducer were officially terminated. This decision was met with disappointment and certain loss of professional pride.

On 5 September C Massie-Taylor and R Sargent proceeded to the area to continue the search despite no contractual arrangement being made with IOS (T). It was on this occasion that the transducer was found and recovered.

APPENDIX 2a

DIVER REPORT ON THE SEARCH FOR THE EG & G TRANSDUCER

Programme of events:

27 August C Massie-Taylor and R Sargent (Dartmouth) on board RV EDWARD FORBES.

1. Circular search round the best known position buoy.
2. Drift search down tide covering an area approximately 400m x 60m centred on buoy. Visibility 10-12m.

J O Malcolm, J Humphery and N Chanham (Bovisand) on board RV JANE.

1. Drift dive to west of above area, ie approximately over E J Moore's shore transits. One pass only possible due to bad visibility (3m) and low current.

28 August JOM, JH, NC, CM-T AND RS on RV JANE.
Drift dives on W and E sides of original search area covered by CM-T and RS (27 August). Visibility 10m.

3 September JOM and D Hill on RV EDWARD FORBES
Drift dives mainly downstream (S) of original area.
CM-T and two other divers on MFV.
Drift dives to W of original search area around EJM's transits and further west. Visibility 10m.

5 September CM-T and two other divers on MFV.
Drift dives over EJM's transits. Sidescan fish found 30-40m W of original marker buoy.

SEARCH PROCEDURE

As the point at which the fish was lost was indeterminate due to the length of tow, speed of ship and current velocity it was decided to cover as much ground as possible in the time available to each diver (25 mins at 25 m). To this end the strong current was of great benefit as it meant the divers could use it as the motive power to cover the "ground" quickly with little effort on their part and therefore low air consumption. The mainly good visibility meant that the divers could swim about 5 metres above the bottom and have good lateral visibility. The best method of search used was to put divers down in pairs with individual blob buoys on light lines. The divers stayed in visual contact with

one another and were recalled to the surface when the tender/cox considered they had drifted through the suspected area. The recall took the form of either rope signals or thunderflash.

Search Pattern: It was considered that the current when flowing from N-S was a linear force and could be used to maintain a diver in a constant direction. After an initial circular search around the best known position, the drift diving took place past this to 30m either side from 300m upstream to 300m downstream.

The search area was gradually moved to the west and a large part of the suspect area was swum more than once. Unfortunately the divers were only employed on a day-to-day basis and a proper search pattern was never evolved, the divers merely being put down by distance judgement from the BKP buoy. In the end the fish was found after four days diving. If three to four days had been set aside at the outset then a proper search pattern with surface markers could have been prepared and the divers could have worked in the knowledge that the marked area had been properly searched. As it was, even with the good visibility experienced most of the time, it was possible to miss strips due to lack of overlap or change in current direction. This was evident from the final recovery position which was in an area which had been swum by J O Malcolm, J Humphery and N Craham (Bovisand) in bad visibility (3m), and by C Massie-Taylor (Dartmouth) and his two colleagues in good visibility (10m).

COMMENTS

It was considered by the diving team that with the conditions as they were, ie good weather, good underwater visibility, strong current and a bright yellow objective, there was a very good chance of recovery. The main drawbacks to recovery were depth, and hence time limitations, positional accuracy of point of loss and fishing activity, which would prejudice the laying of marker buoys.

This is the first exercise of this nature carried out by the present active diving team. Although unsuccessful, in that the sidescan fish was not actually recovered by IOS divers, valuable experience was gained in search procedure and given a similar loss in similar conditions there would be a far better chance of a quicker recovery.

APPENDIX 2b

DIVER REPORT ON SANDWAVE OBSERVATIONS - START BAY

24 August 1976

Dive 1 - (off Pilchard Cove - Strete) J O Malcolm and J Humphery 1255-1300.
Bottom at transponder rig 10.5m: visibility 3m: no current: rippled medium sand.
Examined transponder rig to ascertain whether its legs had penetrated the sea bed sufficiently for a trawl wire to pass over the rig without disturbing it.

Dive 2 - JOM and JH 1306-1318.
Used a compressed air feed pipe from a 60 cu ft cylinder to 'jet in' the transponder legs until the railway wheel was flush with the sea bed.

Dive 3 - JOM and JH 1321-1340.
Tested rangemeter and took a bottom sample with scoop.

Dive 4 JOM and JH 1348-1352
Inspected ship's E/M log which was giving trouble due to marine growth.

Dive 5 JOM and JH 1349-1359
Observed the effect of dragging the transponder rig along the bottom using the ship's winch.

Dive 6 JH 1400-1407.
Tested rangemeter with different transponder.

COMMENTS

The object of the rig inspection was to discover (a) whether it was a straightforward rig to lay with no possibility of it becoming inverted if the ship dragged it along the bottom and (b) whether its legs penetrated the seabed sufficiently to avoid snagging a trawl wire.

Both questions were answered satisfactorily by diver inspection and as long as the bottom is relatively soft these rigs could be emplaced without diver inspection if necessary.

Dive 7 (Red 8.25 Purple 51.18) JOM and JH 1745–1812.
Drift dive on blob buoy, bottom 13m: visibility 3m: slight current north: shelly medium sand.

Swam north over five large dunes and took six scoop samples of surface sediment. Checked compaction and avalanche slope angle. Maximum depth 15m.

COMMENTS
The large dunes were asymmetrical north, crests trending 110°–290°. The crests were not very obvious, being fairly well rounded. The first dune was sampled: D2, avalanche slope: D3, shell debris as base of avalanche slope: D4, flat bed of trough, finer sand. There was a marked change at the base of the avalanche face both in lithology and angle.

Due to poor visibility and the limit of ground covered it was difficult to decide whether these features were small sandwaves or dunes on a larger sandwave. Height was approximately 1.5m but wavelength was impossible for divers to determine although from the surface approximately 250m was swum and in that distance five dunes were crossed making the wavelength about 50m. Compaction was very variable on the stoss slope, divers being able to work their arms into the sediment up to 40 cm in some places and only 15cm in others. The crests were well rounded with little obvious asymmetry in the smaller dunes but visibility was not good enough to see how straight they were. The last dune crossed, 2–3m in height, was sampled before surfacing: D5, crest, D6, avalanche slope, and D7, trough.

The slope angle was gauged by pushing the writing pad into the slope horizontally and drawing along the sediment surface (34°).

25 August 1975
Dive 1 (Red 8.75 Purple 79.80) JH 1106–1110.
Bottom at winch wire 19m: visibility 5m: slight current to north: medium shelly sand.
Dive to release winch wire from transponder rig and inspect ground wire. Rig was upside down so had to be relaid.

Dive 2 JH 1122–1129
Bottom at winch wire 19m. Rig and ground wire inspected. Max depth 28.5m.

Dive 3 (Red 9.72 Purple 54.12) JOM 1300–1351.
Bottom at shot line 11m: visibility 5m: strong current to south: medium/ coarse shelly sand.
Swam north with difficulty over well defined crest, down a 10m avalanche slope into slack water. Max depth 21m. Continued north over small dunes then turned and drifted back over the same area.

Dive 4 (off Pilchard Cove–Strete) JOM and JH 1740–1745.
Bottom at shot line 10m: visibility 2m: slack water: medium sand, slightly muddy.
Inspected air filled plastic tubes (sonar targets).

Dive 5 1749–1753 " " " "

Dive 6 1758–1805 " " " "

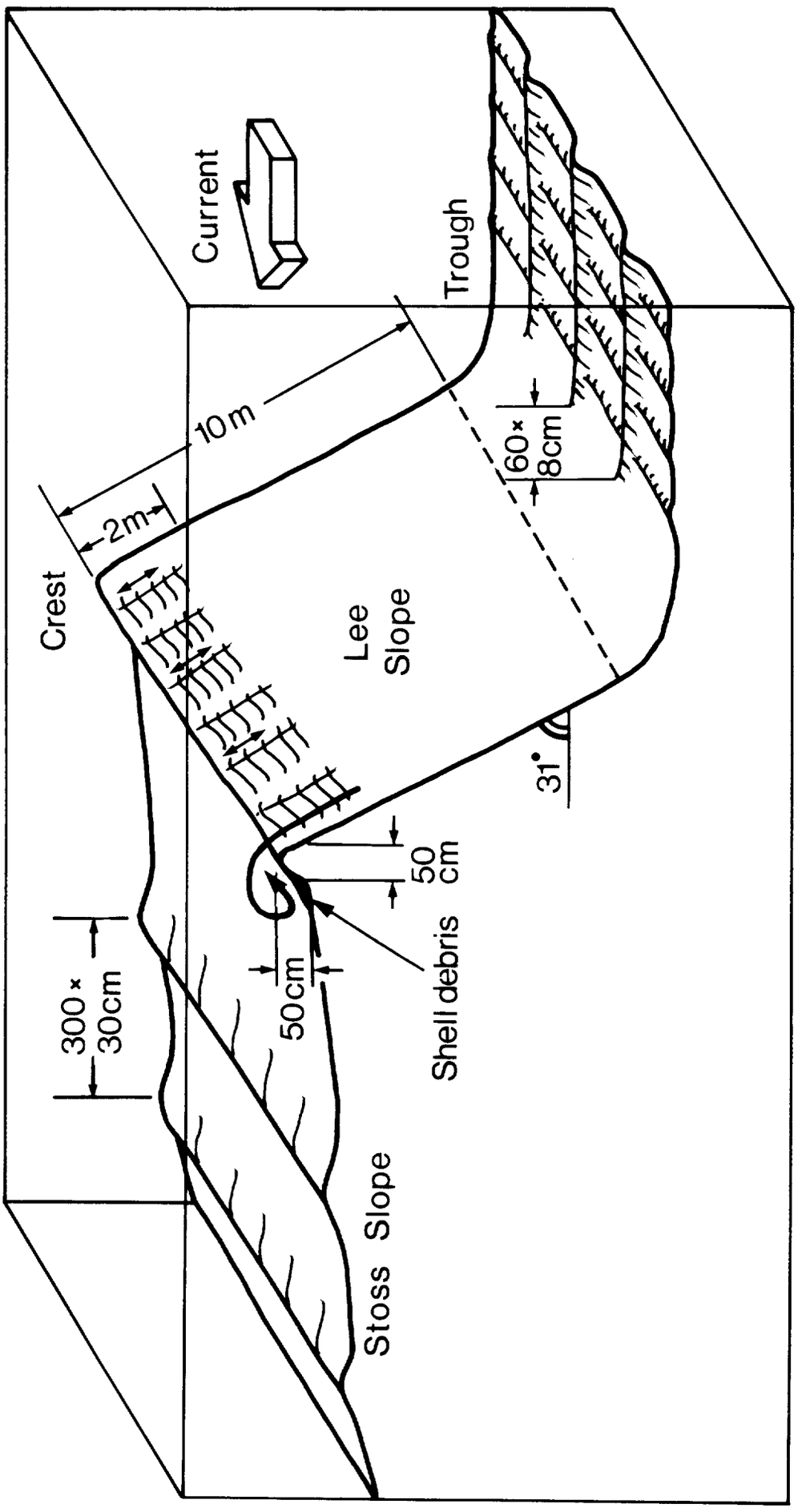
COMMENTS
The transponder rig examined on dives 1 and 2 was to be left for a few days on the bottom to discover whether scour effects would endanger its loss. The sonar targets examined on dives 4, 5 and 6 were lengths of air filled plastic tubing with sealed ends, weighted down at intervals. On the whole, in the poor visibility, the general effect seemed rather haphazard with some tubes partially filled with water and most tubes departing greatly from the intended straight lines. The results on sidescan however appeared promising.

The sandwave on Dive 3 was picked out on the echo sounder as being representative of the general size and shape of sandwaves in that area. The shot–line was dropped exactly on the crest but was pulled south by the diver who had difficulty in getting down against the strong current. The gouge mark made by the shot weight was followed to the crest which again was surmounted with difficulty. Passing down the avalanche slope still water was reached and at the base of this slope there was a gradual levelling off and no obvious change in lithology, unlike that seen and sampled on Dive 7 24 August 1976. Further north (the stoss slope of the next sandwave) the small dunes were asymmetric north.

Drifting back to the south over the same ground it was found that the sample bags had become dislodged during the hard swim against the current. Notes were

taken and a grain size examination showed little variation over the whole area, mostly medium sand with much comminuted shell. The trough had large regular ripples of 60 cm wavelength, 8 cm height trending 030°–210° or at right angles to the main sandwave. Smaller ripples were superimposed on these at 110°–290° trend. Little sediment movement was taking place in the trough. The avalanche slope reached a maximum of 31° and was absolutely planar until approximately 2m below the crest. Patches of broken shell, juvenile echinoid shell etc, were scattered at random over this face. Again little sediment movement was taking place on the slope except where disturbed by the diver. The strong current was attacking the avalanche slope from 2m below the crest producing runnels in which material appeared to be moving both up and down. The slope of this zone was roughly the same as the rest of the avalanche slope. It was possible to stay below this zone and view the current effects but once in it the diver was rapidly carried over the crest. Here it was possible to lie behind the "nipple" on top of the crest, which was about 50 cm high and 50 cm through its base, and watch material being brought over the crest and recirculated to build up the "nipple". Shell material was being deposited at the base of this feature on the downstream side. Dunes were present on the stoss slope of this sandwave of about 3m wavelength 30cm height, (see figure 1).

Fig.1


Current
Trough
10m
2m
Crest
Lee
Slope
60×
8cm
31°
50
cm
Shell debris
50cm
300×
30cm
Stoss Slope