SECOND INTERNATIONAL CONFERENCE ON
PORT AND OCEAN ENGINEERING UNDER ARCTIC CONDITIONS
UNIVERSITY OF ICELAND
DEPARTMENT OF ENGINEERING AND SCIENCE

TRACER PROJECT
EKOFISK, THE NORTH SEA

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INTRODUCTION

200 lbs of fluorecent tracer was placed on March 15th 1973 at the Phillips platform "Gulf Tide" at the Ekofisk site in the North Sea.

So far samples taken on May 3rd, June 10th and July 12th have been analyzed.

Current and wave measurements from the Gulf Tide are made available by Phillips. Some preliminary results on tracer movements were presented at the conference.

The project will continue and a more comprehensive presentation and report is expected to be presented at the Coastal Engineering Conference in Copenhagen 1974.

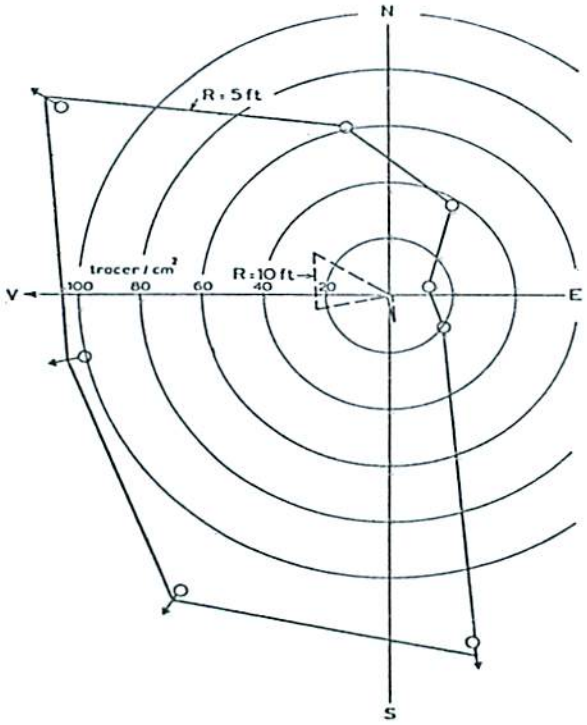
TRACERS AND SAMPLES

The blue fluorecent tracer had a grain size distribution close to the actual distribution of the bottom sediments at the site. The sand is in the fine fraction with a D_{50} around o.12 mm. For practical reasons tracers were placed 30 ft from one of the platform legs.

Sampling is done by divers. At a waterdepth of 70 m the sampling procedure has to be simple to keep the costs at a reasonable level.

RESULTS

Fig. 1 is an example of the result of the sampling on May 3rd. Concentration is given in tracers per square centimeters.



Samples were taken at 5 and 10 ft distances from the tracer source. It may be noted that tracers have mainly moved towards northwest and towards south, the concentration decreasing with distance from the tracer source.

Fig. 1 SAMPLING MAY 3, 1973

WAVES AND CURRENTS

Wave data from the Gulf Tide include the maximum and significant wave heights and the wave periods for four hour intervals. Wave direction is not given and must be evaluated from wind recordings.

Currents are recorded at three depths giving the current directions and velocities. One current meter is positioned 30 ft below the surface, another at 90 ft depth and a third at 190 ft depth or about 12 m above the sea bottom.

At the deepest current meter velocities in the order of ½ knot (ab. 1 ft/sec) were frequently observed. During the winter months from December 1972 to May 1973 current directions at 190 ft depth were mostly from Southeast, which is in agreement with the main tracer movement towards Northwest recorded on May 3rd and shown in Fig. 1.

MOTION OF BOTTOM SEDIMENTS

When hydrodynamic forces by waves and currents exceed a critical value, bottom sediments start moving. The incipient motion is governed by the critical water velocity or the critical shear stress.

Little data exist on combined action of waves and currents. Fig. 2 from ref. (1) shows the results of model tests for incipient motion under wave action compared to critical velocities given for steady flow (2).

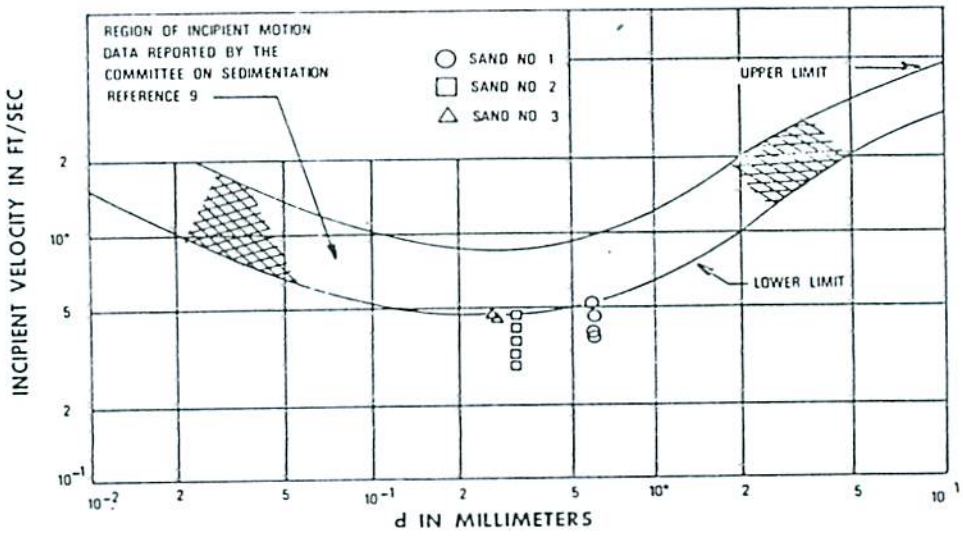


Fig. 2 INCIPIENT VELOCITY AS A FUNCTION OF GRAIN SIZE
From ref. (1)

Here the velocity U was defined as the calculated maximum water particle velocity at the bed according to Stokes third order wave theory. The incipent motion for a mean particle diameter of 0.12 mm corresponding to the bottom sediments at the Ekofisk site accordingly should start moving for a velocity of about 0.15 m/s.

From linear wave theory the maximum horizontal particle velocity at the sea bottom is given as:

$$U_{max} = \frac{\pi H}{T} \frac{1}{\sinh 2\pi h/L}$$

where

H = wave height
T = wave period
L = wave length
h = water depth

Fig. 3 gives U_{max} as a function of wave length for different wave heights. The maximum wave steepness, H/L, is roughly around 0.1. This curve is also shown in Fig. 3.

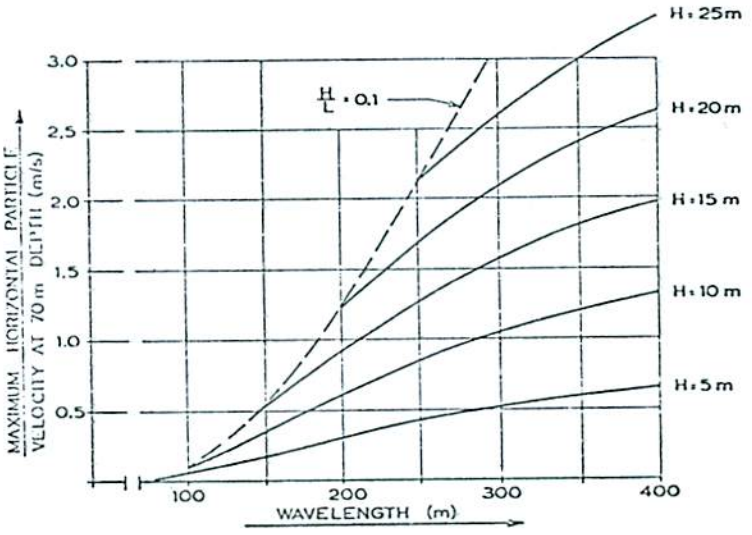


Fig. 3 MAXIMUM HORIZONTAL PARTICLE VELOCITY AT BOTTOM AS FUNCTION OF WAVE LENGTH

Comparing Fig. 3 with a critical velocity of 0.15 m/s it may be seen that waves longer than about 110 m (T = 8.5 sec) are able to move bottom material at the Ekofisk site. As the wavelength increases waveheights may decrease still causing critical velocities. A wave length of 150 m (T ≈ 10 sec) should for instance give incipient motion for a wave height of 5 m. Wave conditions worse than these are certainly occurring in the North Sea frequently.

SUMMARY AND CONCLUSIONS

The preliminary results from this tracer project clearly demonstrate that the bottom sediments in the North Sea at 70 m waterdepth are moved by waves and/or currents. As shown this should also be expected based on the size of bottom particles and occurring wave and current conditions.

When bottom material moves possibilities for scour and for formation of sand waves exist particularly when man-made structures are placed into the environment.

This project will be continued in an attempt to correlate the tracer movement with the wave and current conditions at the site.

ACKNOWLEDGEMENT

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REFERENCES

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