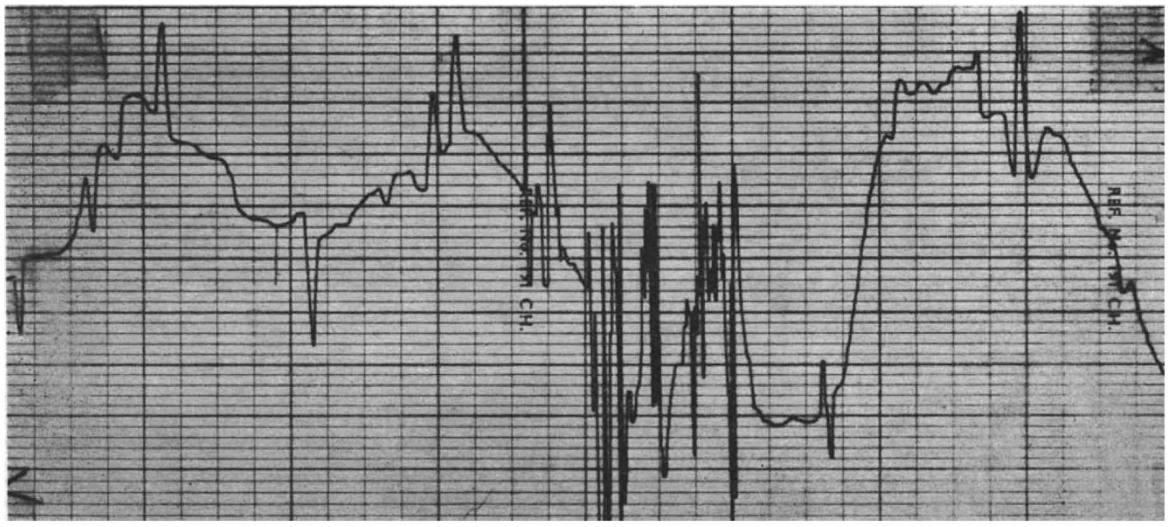


Fig. 1

The beat frequency record for April 13, 1963, is reproduced in Fig. 1.

It is of interest to compare these results with those reported in *Nature*[1,2] for somewhat similar signals received on 16 kc/s.

The U.S. National Bureau of Standards, Boulder Laboratories, did not observe anything unusual on 18 kc/s on the dates given. The U.S. Naval Observatory, Washington, have stated their stations were not scheduled to transmit simultaneously on 18 kc/s in April 1963. Their records show no indication of any interfering signal on the dates indicated but we are confident that it was not a local effect.

If very-low-frequency transmissions are to be used for navigation and standard frequency purposes, it is disturbing to think that the signals may suffer from interference so close to the nominal frequencies.

A. H. Allan

Dominion Physical Laboratory,
Lower Hutt, New Zealand.

[1] Rohan, P., Anderson, L. L., and Cooke, D. J., *Nature*, **197**, 783 (1963).
[2] Allan, A. H., *Nature*, **198**, 582 (1963).

## PHYSICS

### Effect of Tidal Range, Temperature and Fresh Water on the Amount of Silt in Suspension in an Estuary

The British Transport Docks Board Research Station has designed and made instruments which continuously record the concentration of silt in suspension. One of these instruments has been recording this information for several years in the Humber Estuary at King George Dock, Hull.

Using these records for the period July 1961–June 1962 a regression analysis was performed with the average silt in suspension over a tide as the dependent variable and tidal range, river temperature and fresh water entering the estuary as the independent variables. Significance testing was included in the computer programme so that the relative importance of each of the independent variables on the silt concentration could be assessed.

First the assumed form of the equation was taken to be:

$$S = A + BT + CQ + DQ^2 + ER$$

where $S$ is the average concentration of silt in suspension over a tide measured in milligrams of dry solids per litre of estuary water; $T$ is the river temperature (deg. F); $Q$ is the combined fresh water entering the Humber from the Rivers Ouse and Trent in thousands of cubic ft. per sec on the day in question; $R$ is the tidal range (ft.).

The regression coefficients so obtained gave the following formula for silt concentration:

$$S = 850 - 17{\cdot}74\,T + 13{\cdot}46Q - 0{\cdot}25\,Q^2 + 26{\cdot}55\,R$$

The $Q^2$ term is insignificant at a probability-level of 0·1 per cent when the relationship becomes:

$$S = 907 - 18{\cdot}21\,T + 6{\cdot}04\,Q + 26{\cdot}67\,R \qquad (1)$$

For a second regression the terms for the products $RT$ and $RQ$ were introduced and this gave the formula:

$$S = 325 - 4{\cdot}85\,T + 1{\cdot}71\,Q - 0{\cdot}25\,Q^2 + 58{\cdot}1\,R - 0{\cdot}76\,RT + 0{\cdot}59\,RQ$$

At a probability-level of 0·1 per cent this reduces to

$$S = 81 + R(75{\cdot}15 - 1{\cdot}06\,T + 0{\cdot}27\,Q) \qquad (2)$$

As there is little difference in the residual error terms in the analysis of variance corresponding to the 0·1 per cent probability-level (111 in the first regression and 107 in the second) there is little to choose between the two forms. These errors are in both cases about 20 per cent of the average value of silt in suspension for the year. In both expressions the relative importance of range and temperature is greater than that of the fresh water. The fact that temperature should have such a large influence on the concentration of silt in suspension in an estuary is particularly interesting.

The records taken during the unusually prolonged period of low temperature and low fresh-water flow which persisted for three months during the winter of 1962/1963 confirmed the influence of temperature on the amount of silt in suspension in the River Humber. If during this period the silt content had depended more on fresh water than on temperature it would have been as low as in a normal summer, whereas it was found to be high as in the previous and wetter winter.

These formulæ apply to the Humber Estuary outside King George Dock, Hull. The value of the constants would presumably alter from place to place and the relative importance of temperature and fresh water could also be different. This is at present being investigated, and continuous siltmeter records are being taken at other places in the Estuary.

W. H. Jackson

Research Station,
British Transport Docks Board,
Hayes Road, Southall, Middlesex.