SAND WAVES IN THE NORTH SEA

BY

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Though it has been known for a long time that the bottom of the North Sea in certain areas is covered with sand waves, the vastness of these areas has surprised the modern Netherlands' investigators who recently started comprehensive and detailed surveys of the North Sea farther from their shores than was hitherto the case.

The word "sand wave" is not intended to describe the smaller ripples that grow and decay under the influence of tidal streams, but it is difficult to say when a ripple becomes a sand wave. Quite arbitrarily a ripple of which the range between trough and crest exceeds 10 feet will be called a "mega ripple" or sand wave.

Off the Netherlands' coast sand waves from 10 to 45 feet have been discovered. These sand waves show a marked asymmetry, whereas all of them generally are aligned in the direction WNW-ESE. It has been found that off the Netherlands' coast the NNE side of these mega ripples is much steeper than the SSW side.

This phenomenon of asymmetry gave rise to the question whether these sand waves travel in a NNE direction as it is also known that there generally exists a residual current in that same direction. The results of investigations in this matter have not yet produced significant data from which to decide on the magnitude of an eventual yearly advance.

Annexes 1 to 6 give the 1 : 10.000 fair sheets of a detailed survey of an area west of Hook of Holland where an accurate Decca Survey Chain is available for position fixing. In this area a total number of six surveys has taken place so far, three in spring and three in autumn. Consequently, these surveys cover a period of two and a half years.

During all these surveys the same survey vessel, equipped with the same echo-sounder, steamed along the same lane-fractions during periods of stability in the radiated lane pattern. It can be said that - relative to the seabottom - during all these surveys the ship moved along the same set of sounding lines with a 5% level of uncertainty of within 35 metres for any such line.

This amount of uncertainty was calculated as follows. Lanewidth in the area surveyed is 1280 metres. The standard deviation of the radiated pattern (controlled by a monitor station) is of the order of 0,013 lane which equals 17 metres. Twice the amount of the standard deviation gives a range of values for any particular lane within which 95 out of a 100 observations of that lane would fall.

Position fixing - obtained by reading the intersecting hyperbolae which are of the same accuracy as the ones along which the ship steamed - can be said to have taken place with a 5% level of uncertainty of within 55 metres. The long axis of the position ellipse lies along the bisecting line dividing into equal parts the angle of 48 degrees subtended by the two sets of hyperbolae. The direction of this bisector is NNW-SSE.

Comparison of the surveys given in Annexes 1 to 6 shows that not a single movement of the different crests exceeds the level of significance of about 60 metres even after a time interval of two and a half years. There are, however, a number of smaller shifts in the positions of the crests which, though none of them is significantly large, all - or at least the great majority of them - point in a NNE direction.

It can, therefore, be stated with some confidence that a longer time series will eventually reveal a yearly advance of the mega ripples along the Netherlands' coast. This rate of advance will undoubtedly prove to be slow and probably will be in a NNE direction.

Investigations carried out in other areas, e.g. west of IJmuiden, by the Rijkswaterstaat have shown that mega ripples are covered with

a series of smaller ripples, a phenomenon also to be seen on the echographs of the area west of Hook of Holland. These smaller ripples have a much greater speed of advance under the influence of tidal streams and can be formed when the water velocity exceeds a certain minimum value. This minimum value is a function of the grain size of the material to be transported.

It does not seem to be an unreasonable assumption that during a North-going tide a number of these smaller ripples travel along the rather flat SSW slope of the megaripple and that some, after reaching the crest, will topple over the steep NNE side. It seems also reasonable to assume that these latter small ripples will not appreciably travel in the opposite direction any more during the following South-going tide.

The rest of the small ripples that have not reached the crest of the mega ripple during the North-going tide can be expected to travel in the opposite direction during the following South-going tide over a larger distance than those small ripples that toppled over the steep NNE side. With, generally, a small residual current in a NNE direction, moreover, this might provide the mechanism for the small rate of advance of the sand waves.

Another indication that the above mentioned assumption might prove to be the right one is found in the different heights of the crests as determined during different surveys. These heights differ materially from one survey to the other as can be seen by comparing the fair sheets in the Annexes 1 to 6. The height differences are not all of the same sign along one particular crest. Some parts of a crest are higher, others lower than the same parts of the same crest as determined during foregoing or following surveys.

These differences reach values of sometimes more than 2 feet and can be considered to be significant. Under normal circumstances the Kelvin-Hughes MS 26 echosounder used has a standard deviation of not more than 0,5 foot in a depth of approximately 15 fathoms. The influence of swell, even on days with no wind, may influence this standard deviation unfavourably but the methods used on board to determine recorded depths from echographs by averaging out the swell, if any, together with the knowledge that really calm days were used for these surveys allow us to assume that the standard deviation of the echosounder depths will not exceed 0,7 foot.

Apart from the problems of the rate of advance of mega ripples and its mechanism, there is the question of their origin. Why are they formed and how are they formed. The fact that sand waves are present in sea areas of different average depth but seem to become less frequent further north in the North Sea does not simplify our insight in the mechanism of their inception.

Perhaps the solution of the former problems might lead to the answers to the latter questions. It is not impossible that a different regime of tidal currents in the North Sea north of approximately 53° North, combined with lower velocities is responsible for this fact of gradually disappearing mega ripples further north.

If mega ripples not only would derive their possible rate of advance from the smaller ripples superimposed upon them but also would be formed, and consequently be kept up, by such smaller ripples then it might be possible to find a transitional area in the North Sea somewhere at a lattitude of approximately 53° North where the water velocities near the bottom are high enough during springtides to form the smaller and therefore also the megaripples, but where the currents are too weak during neap tides to do the same and might probably be responsible for a certain amount of decay of the mega ripples already formed, if any.

This thought was first expressed by Mr. A. H. B. Stride of the National Institute of Oceanography in the United Kingdom, during informal talks on this subject at the third conference of the North Sea Hydrographic Commission, held in London in January 1965. In order to prove or disprove the validity of his hypothesis the Netherlands' Survey Vessel "Zeefakkel" carried out investigations in such a supposed transition zone during August 1965. The results of this survey have not yet been evaluated completely and will be reported in a later issue of the Hydrographic Newsletter.

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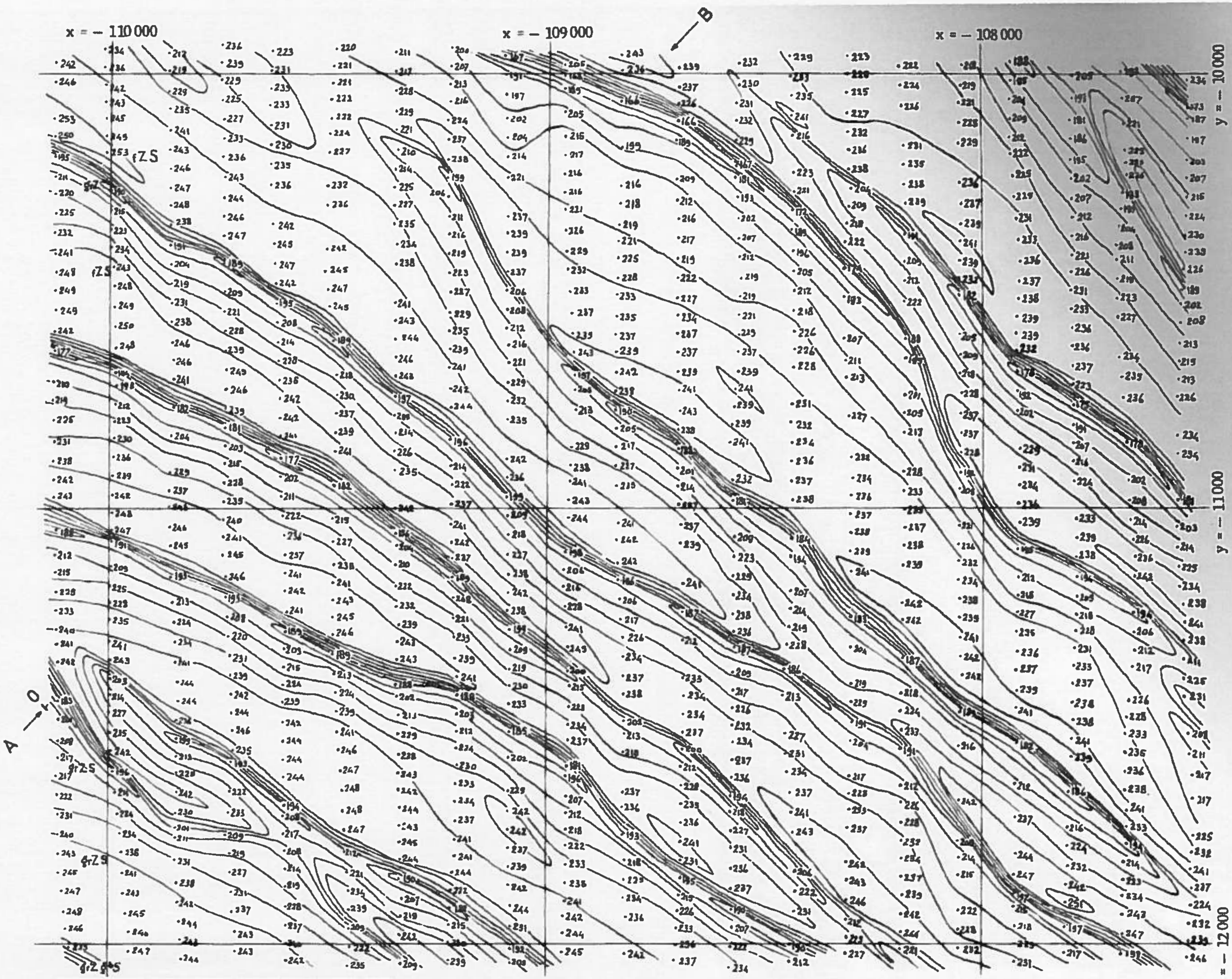
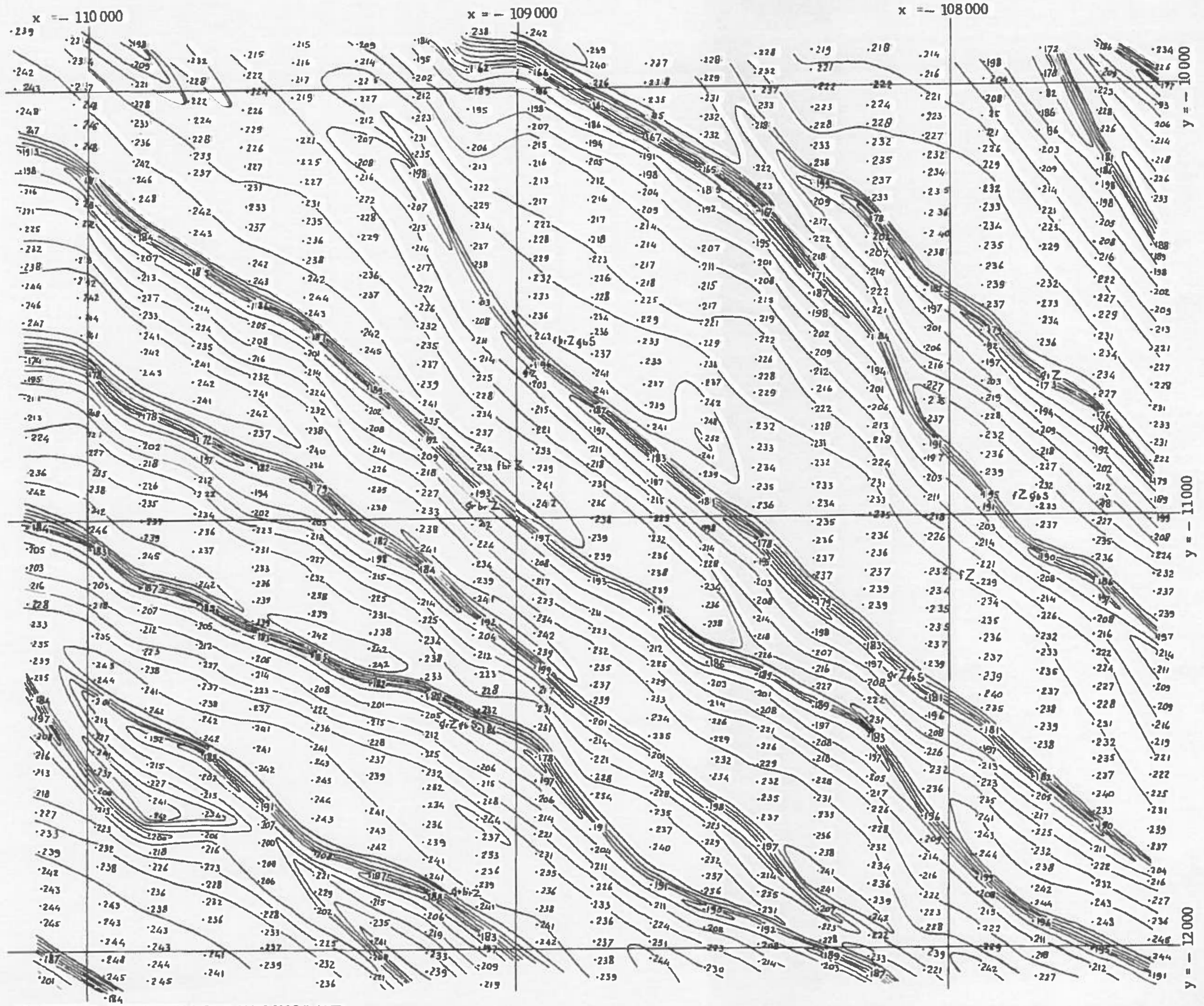
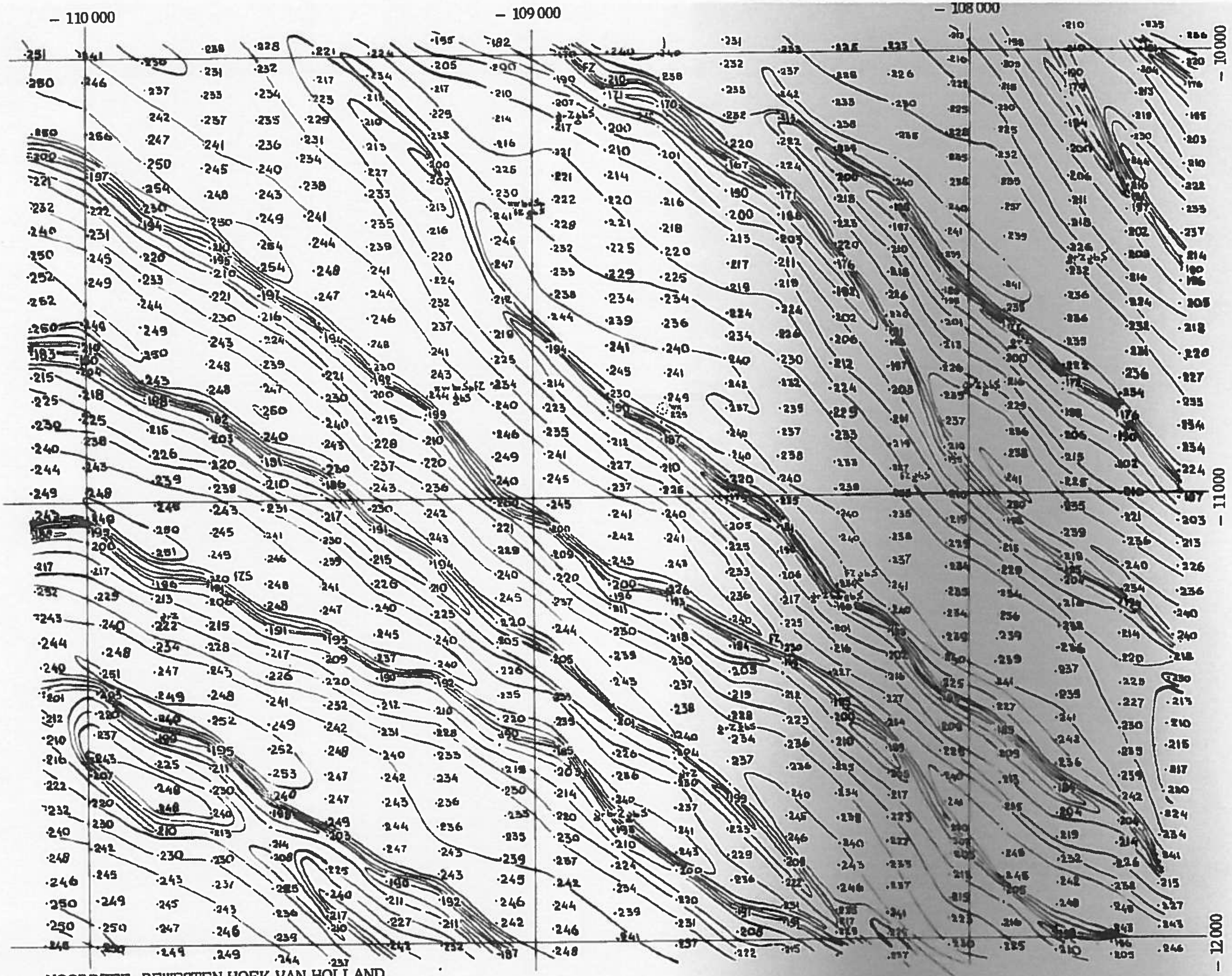


NOORDZEE, BEWESTEN HOEK VAN HOLLAND
Opgenomen door R.O.V. „Zeefakkel", 7 mei 1963
Diepten in dm, herleid tot gem. L.L.W.S.



NOORDZEE, BEWESTEN HOEK VAN HOLLAND
Opgenomen door R.O.V. „Zeefakkel", 11 september 1963
Diepten in dm, herleid tot gem. LLWS



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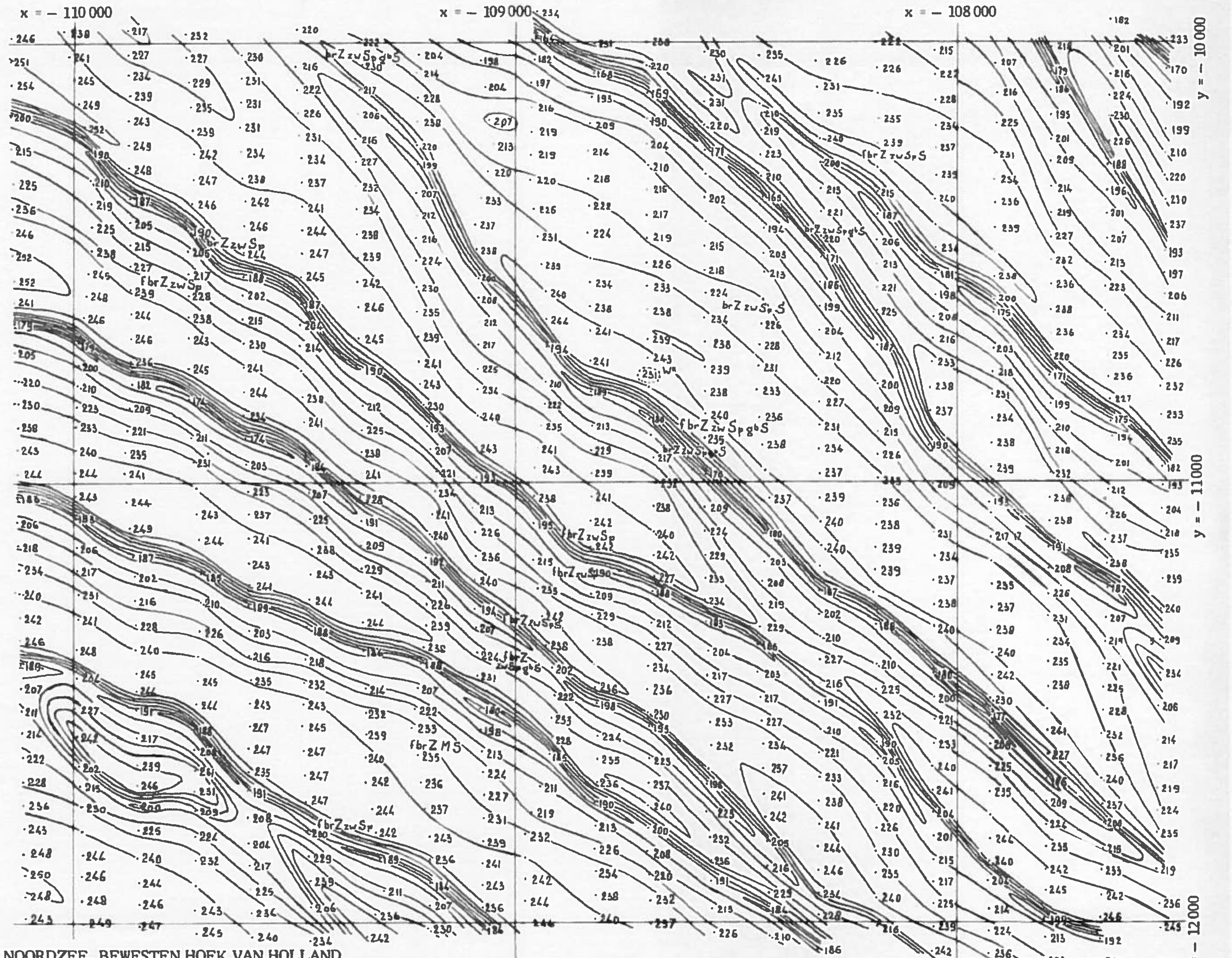
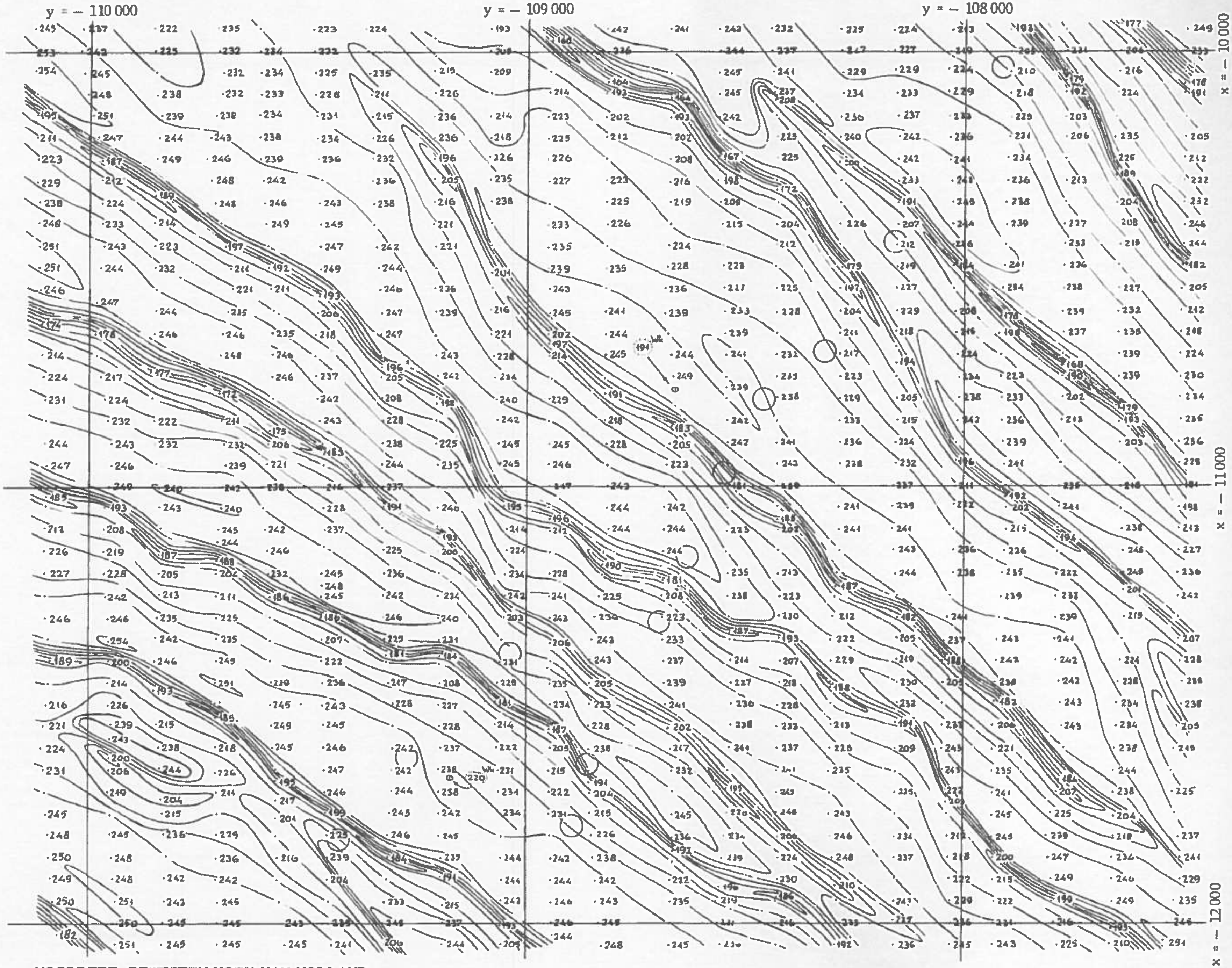
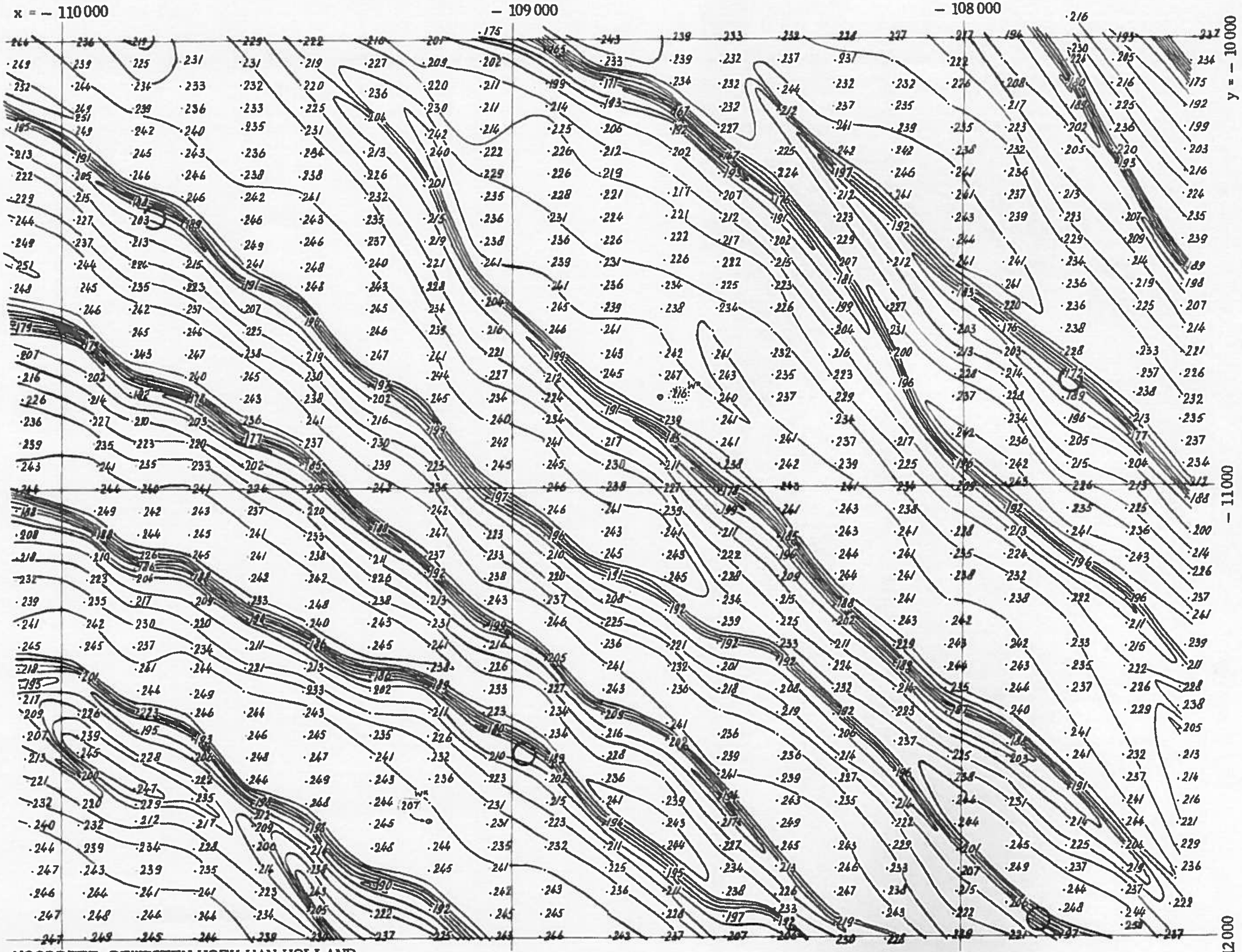
Opgenomen door R.O.V. „Zeefakkel", 12 mei 1964
Diepten in dm, herleid tot gem. L.L.W.S.



NOORDZEE, BEWESTEN HOEK VAN HOLLAND
Opgenomen door R.O.V. „Zeefakkel", 29 september 1964
Diepten in dm, herleid tot gem. L.L.W.S



NOORDZEE, BEWESTEN HOEK VAN HOLLAND
Opgenomen door R.O.V. „Zeefakkel", 11 en 14 juni 1965
Diepten in dm, herleid tot gem. LLWS.



NOORDZEE, BEWESTEN HOEK VAN HOLLAND
Opgenomen door R.O.V. „Zeefakkel", 28 september 1965
Diepten in dm, herleid tot gem. L.L.W.S.