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OBSERVATIONS ABOUT ICE-SHOCKS ON LAKE SÄÄKSJÄRVI

by

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Abstract

In this preliminary paper it has been found that the frequency of ice-shocks is strongly correlated to the fall of the temperature, to the thickness and the absorption of the snow cover and to wind conditions. The distribution of the maximum amplitude has been studied according to the formula of Ishimoto—Iida $N(a)a^m = k$ and m has been found to be equal to 1.55. A dispersion relation has been calculated for the flexural waves.

Introduction

In the Nurmijärvi seismograph station a very sensitive short period Nurmia-type seismograph has registered during many winters weak seismic events, of which some have later been attributed to the cracking of ice on the near-by lake (Miyamura, Luosto, Saastamoinen [2]). The cracking is accompanied by an audible sound wave and in addition by elastic waves in the ice-sheet. To obtain a clearer picture about the phenomena a seismograph was placed on the ice-sheet during the winter 1962—1963 about 200 meters from the shore.

The recording instrument was a Willmore-type seismometer with 1 sec period and magnification was made by a transistorized amplifier designed by Riihimaa [5] with an ink recording pen. The paper speed was usually 2 mm per second and only occasionally 40 mm per second. Temperature was measured by a thermistorized apparatus. An example of the ice records appears in Fig. 4.

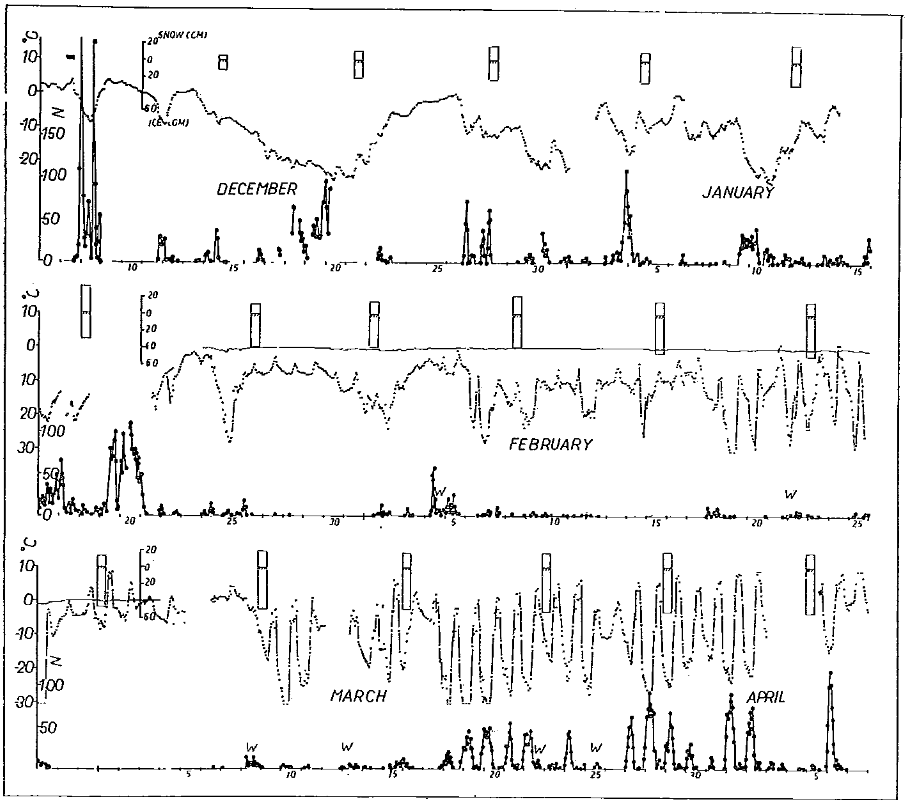

Fig. 1. Ice shock frequency, air temperature and (only in February) ice temperature, thickness of the ice sheet and the snow layer and some observations about the wind.

Results

In Fig. 1 are represented frequency of ice shocks, temperature, thickness of ice and snow, and some observations about wind from Dec. 6, 1962 to Apr. 7, 1963. The diagram is presented in three parts in each of which the lowest is the calculated number of ice shocks per hour. The next one is the air temperature in every full hour. The temperature for December has been obtained from the Finnish Meteorological Office and was measured at the Observatory of Nurmijärvi about ten meters above the surface of the lake. The temperature measurements in 1963 were obtained with the above-mentioned thermistorized system. From Jan. 24 to March 3 the temperature of the surface of the ice has been measured also and the values show only a little deviation from 0°C. The uppermost are the thicknesses of snow and ice measured once a week. As a rule the frequency of ice shocks increases when the temperature is falling. At the beginning of December, when the ice was covered with a little snow, there were plenty of ice shocks even when the temperature was falling only by a small amount. The correlation between the thickness of snow and the frequency of shocks is not quite so clear. There is especially a remarkable lack of shocks during the heavy frosts of February. One can see in the diagram that during this period the temperature of the ice-surface was almost constant. This may result from the good insulation of soft snow and from the fact that ice sank many times during the winter under the weight of snow (Palosuo [4]). One can see during this time some shocks which may be caused by strong wind releasing stresses in the ice. There are some observations about very strong winds during this time represented in the figure by the letter W. From March to April an increase can be seen in the frequency of shocks. At this time the daily variations in temperature are great and due to more intense radiation from the sun the snow cover is denser.

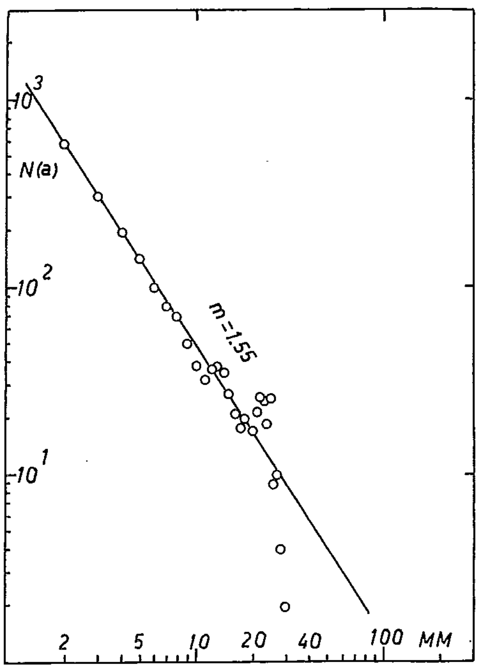

Fig. 2. Frequency distribution of the maximum trace amplitude of the ice shocks.

From the frequency distribution of the maximum amplitude of earthquakes a formula has been achieved by ISHIMOTO and IIDA [1]

$$N(a)\,a^m = k\,,$$

where a is the maximum trace amplitude, $N(a)$ the number of earthquakes whose maximum trace amplitudes range from a to $a \pm da$ and m and k are constants. In Fig. 2 is represented the distribution for about 2 000 shocks between 18 March and 7 April. In this case we can get from the slope of the line in Fig. 2 the value 1.55 for m. When a is big, there is a great deviation from the line that is caused by the limited range of the pen. The values of m for earthquakes lie between 1.8 and 1.9 and OMOTE's [3] value for ice shocks is 1.8. The difference probably arises from variations in absorption coefficient when the ice gets older and thicker and also from the fact that the amplitudes in our case are from the long period flexural wave.

Small charges of dynamite has been blasted to determine the velocities of elastic waves but we have not yet been able to obtain body wave velocities accurately enough. We have, however, obtained the group velocity of flexural waves from two experiments represented in Fig. 3.

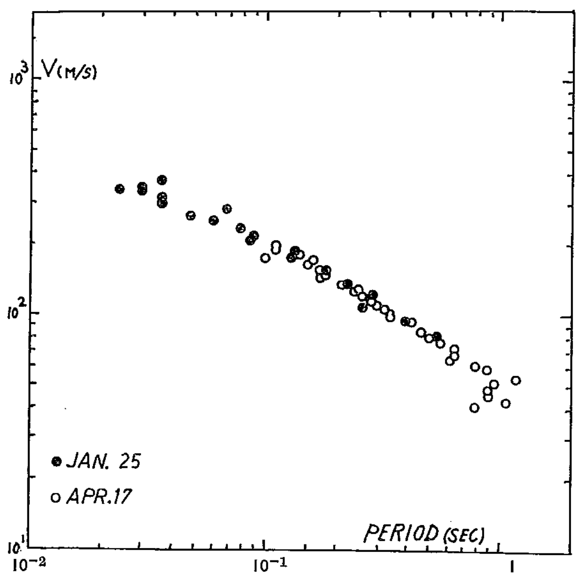

Fig. 3. Group velocity against period of the flexural waves calculated from two blasting experiments.

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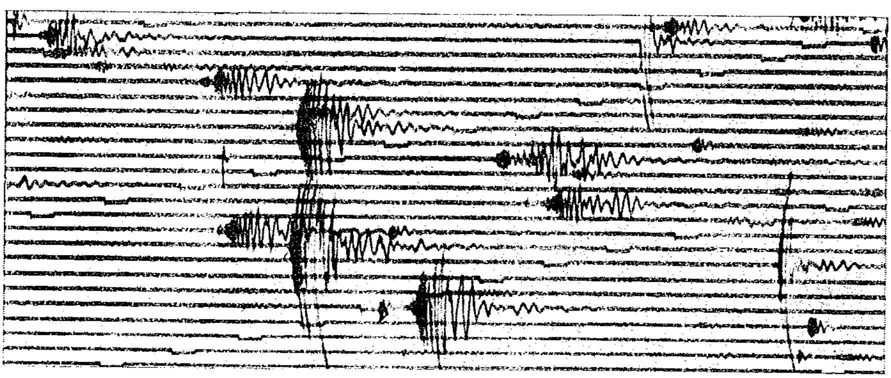

Fig. 4. A record of ice shocks.

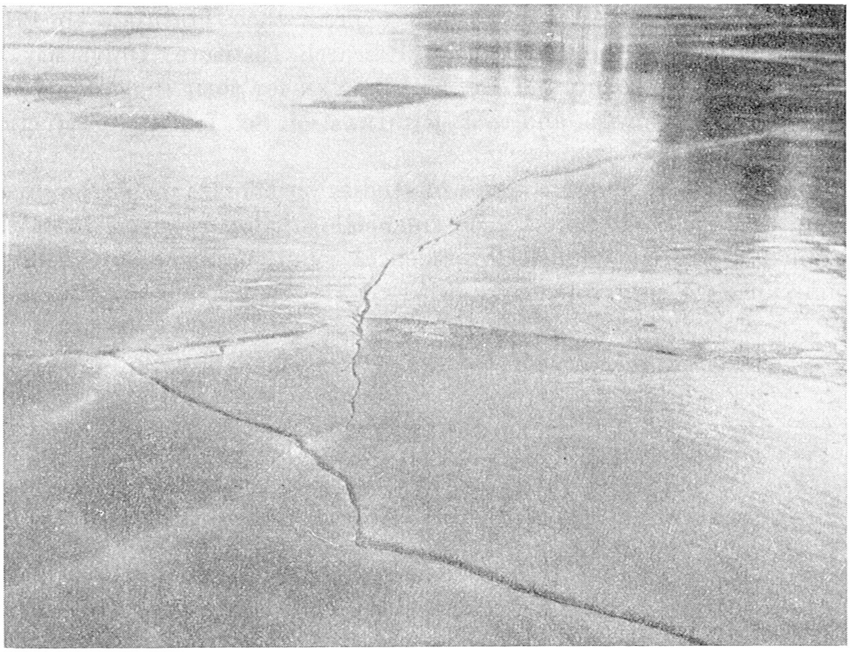

Fig. 5.

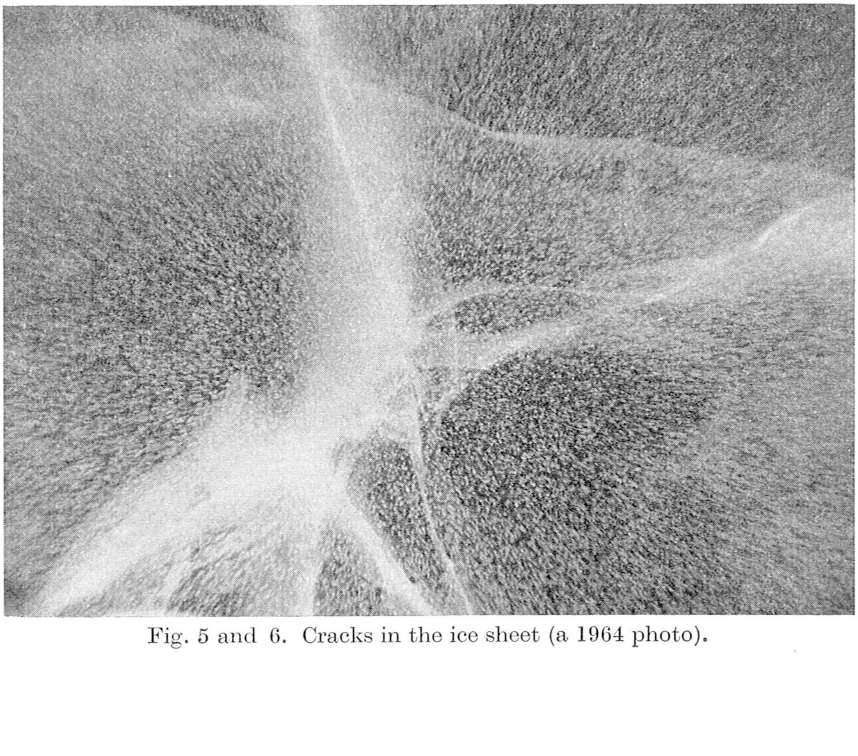

Fig. 5 and 6. Cracks in the ice sheet (a 1964 photo).