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PRELIMINARY REPORT  
OF THE  
EARTHQUAKE OF NOVEMBER 1, 1935

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An earthquake, so severe that it was felt over an area of more than 500,000 square miles, occurred shortly after one o'clock in the early morning of November 1, 1935. This report covers the work done to date by the Seismological Division of the Dominion Observatory, Department of the Interior, Ottawa, in determining the epicentre of the disturbance and in preparing for a detailed study of the scientific data which it has made available.

**Preliminary Location of the Epicentre:** The following type-written report was given to the press at 3.30 a. m. November 1:

"A very severe earthquake was registered at the Dominion Observatory this morning. The first preliminary tremors arrived at 1-04-20 a. m., E. S. T. The distance to the epicentre was from 175 to 200 miles. Three of the five seismographs operating at the Observatory were thrown out of commission after the first thirty seconds which makes the work of determining the azimuth rather uncertain. The instruments indicate, as well as may be under the circumstances, that the direction from which the tremors came was north-west, which would put the epicentre in the upper Ottawa valley. It is just possible, however, that the direction is 180° removed from this and that the epicentre is in the vicinity of Lake Champlain, not far from Plattsburg."

The distance was determined from the fact the difference in arrival time of the P and S phases was 34 seconds. The azimuth was indicated by the registered first movements in the north-south and east-west directions as respectively registered on the two components. These showed that the seismograph pier moved south-east.

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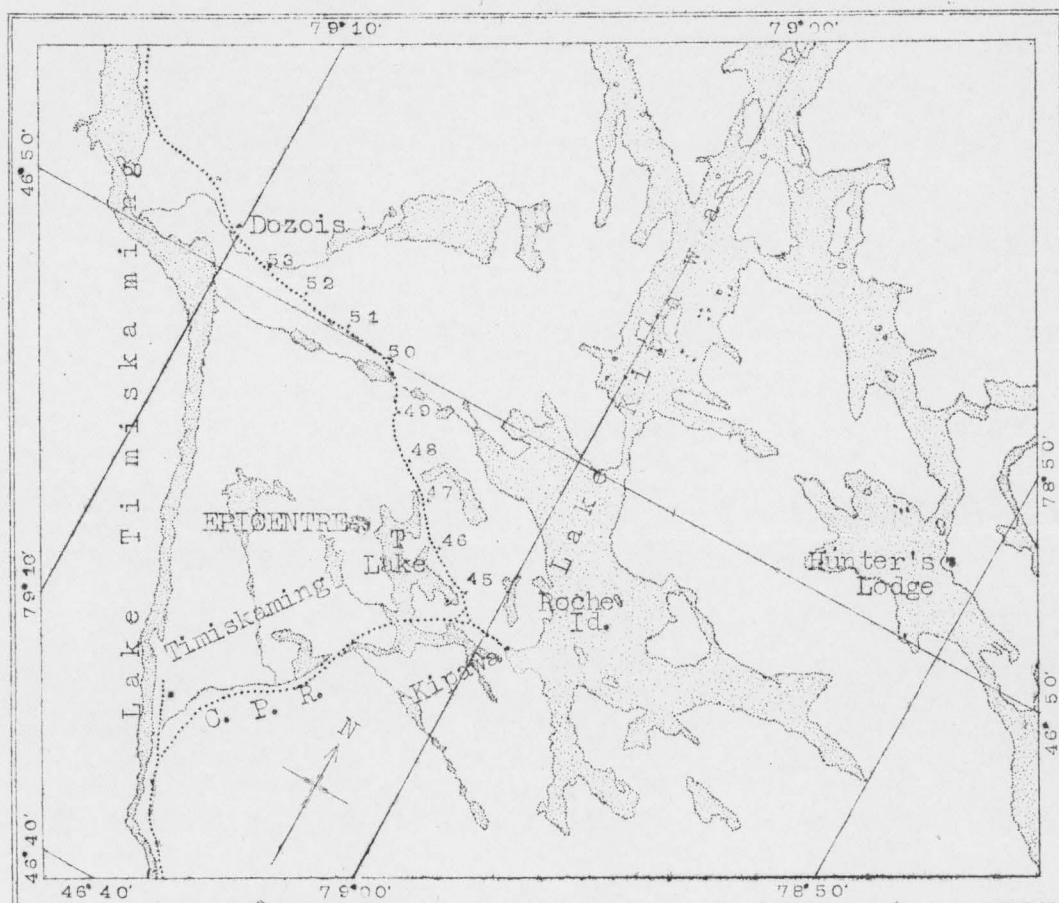
The uncertainty of  $180^\circ$  in the azimuth arises from the fact that only the record of the vertical seismograph can decide whether the first onset was a thrust from an epicentre to the north-west or a pull toward an epicentre to the south-east. The vertical record indicated a thrust, thus placing the epicentre north-west of Ottawa. The acceptance of the vertical indication required that we place the epicentre somewhere around Mattawa or North Bay and no such severe earthquake was ever known to have occurred there. Disregarding the indication of the vertical would have placed the epicentre in the Champlain valley where severe earthquakes would not have been so unexpected.

Press reports received during Friday and Saturday morning confirmed the indication of the vertical seismogram that the epicentre lay to the north and west of Ottawa. The aftershock at 9.33 a. m. Saturday, which was felt at points west of Ottawa, further established the azimuth.

**Location by Means of First Arrival Times:** During the afternoon of Saturday, Science Service, Washington, D. C., in response to our request sent us the first arrival times at Washington, Harvard, Buffalo, Chicago, and Saint Louis. These with the first arrival time as known for Ottawa gave us six onsets most probably correct to within a second. Later in the day we received the seismograms from Shawinigan Falls and determined the onset there.

We define the focus as the point within the earth from which the energy started and the epicentre as the point on the surface vertically above the focus. Until recently no curves were available for earthquakes originating at a deep focus. In January, 1935, a set of curves by George J. Brunner, S.J., were made available. These were used in the present determination.

To use such curves in connection with first arrival times it is necessary to assume the time at the epicentre and the depth of focus. Obviously, many combinations might be tried and in fact they were, but the intersections failed to define



EPICENTRAL REGION OF THE  
TIMISKAMING EARTHQUAKE  
November 1, 1935

a point. Late Sunday afternoon a point focus was determined from the first arrival times at the seven stations mentioned assuming the time at the epicentre to be  $1^h 03^m 40^s$  and the focal depth to be 200 km. (125 miles). The point defined was  $\phi = 46^\circ 45'$ ,  $\lambda = 79^\circ 15'$ . This is about six miles WNW of the town of Timiskaming, Que. Field work could now begin and the writer left Ottawa for North Bay Sunday night.

The Itinerary of the Field Work:

Nov. 4 - 5	North Bay and environs
Nov. 6 - 13	Timiskaming, Kipawa and environs
Nov. 14 - 15	Timiskaming to Ville Marie and return to Kipawa
Nov. 16 - 18	Kipawa and environs
Nov. 19 - 22	Timiskaming and north
Nov. 23	North Bay
Nov. 24	T. N. O. Ry. near Diver, Ont.
Nov. 25	North Bay
Nov. 26	North Bay, Timagami, Cobalt, Haileybury
Nov. 27	New Liskeard, Englehart, Swastika, Kirkland Lake
Nov. 28	Noranda and Rouyn
Nov. 29-Dec. 2	Parent
Dec. 3	Return to Ottawa via Montreal

Field Methods: In field work the following methods are available for determining with more or less precision the position of an epicentre.

- (1) Plotting of isoseismals
- (2) Earthquake sounds
- (3) Earth or rock displacements
- (4) Shifting or fall of heavy well-placed bodies
- (5) Aftershocks
- (6) Telephone or telegraphic connections at the  
time of the earthquake
- (7) Discolouration of bodies of water
- (8) Azimuth of swing of freely suspended bodies
- (9) Negative evidence



**Isoseismals:** Isoseismals (lines through points of equal disturbance) are determined for the entire area over which the earthquake is felt. An isoseismal map is thus made for the disturbed area. There are several scales of intensity available -- the Rossi-Forel or the Wood-Neumann scales are the ones generally used in this country.

To obtain the data to which the scale is to be applied questionnaires were sent to nearly 400 post offices in Canada. These were chosen to cover the area from Manitoba to the Atlantic coast and from the border of the United States to the Arctic. Each letter contained several questionnaires in French or in English with a letter to the postmaster asking that they be distributed to those persons in the community most likely to furnish carefully considered observations. The data so obtained are supplemented from the field work. The great mass of data obtained has not yet been worked up but an isoseismal map for Canada will be constructed. The United States Coast and Geodetic Survey at Washington is preparing a similar map for the United States area affected -- said to be as far south as the Carolinas. This will be furnished to us when completed so that the final map may be made with no interruption at the political boundary.

Scales of intensity are based on such items as sounds heard, tremors felt, and destruction caused by an earthquake. They divide these effects into a scale of ten. The division is not scientifically accurate and the resulting map is not of much value for by the time it is made the epicentre is usually known. Moreover, so many factors enter into the analysis, not the least being the psychological one, that the isoseismals mean little. The destruction is affected by such conditions as the nature of the soil, character of the buildings, angle of emergence of the tremors, etc. Field work in the vicinity of the epicentre is necessary if the inner isoseismals are to be of any value in supporting the epicentre location. Much of the field work was of this nature, all relevant material noticed being included in the notes and photographs taken. For the purposes of this report it may suffice to say that the field evidence of this character agreed with the deduction recorded in the concluding paragraph.

**Earthquake Sounds:** In the vicinity of the epicentre most earthquakes are preceded, accompanied, and followed by a roar or rumble variously described as resembling "a fire in a flue," "an approaching tornado," "a train crossing a trestle," "a forest fire," etc. This earthquake was preceded by a most pronounced and, in the vicinity of the epicentre, terrifying roar which was to be heard some seconds before the tremors began. It is generally held that the direction from which an earthquake is approaching can not be determined from earthquake sounds. The experience of the writer in the case of the earthquake of 1925 and again in this case lead him to believe that this indication of direction is of greater value than is generally conceded. Certain it is that, with certain exceptions, some minor, some notable but constituting only a small part of the total of such observations noted, the earthquake sounds for both the main shock and many of the aftershocks indicated in a general way the direction from which the tremors were proceeding and that they were in agreement with the adopted epicentre and focus.

**Earth or Rock Displacements:** The terrain in the vicinity of the epicentre is mostly rocky and covered with small timber. Exceptions occur in the gravel deposits along the shores of lakes Timiskaming and Kipawa and in a few other scattered deposits. No cracks in bed rock were found at any point. Cracks in gravel and sand occurred but only in positions where they had steep relief to one side. About four miles north of Timiskaming and about twenty-five feet in from the east shore of the lake is a series of cracks totalling some 200 feet in length. A week after the earthquake it was possible to insert a stick three feet into one of these. Cracks were found in the gravel bank about lake Kipawa especially in the vicinity of Kipawa. A small island, Roche's island, about half a mile from Kipawa was the most disturbed piece of ground found but it was surrounded by very deep water and covered for the most part by very deep gravelly soil as well as being within less than ten miles of the epicentre. A crack in sand was reported to have been found near Mattawa but the ground was covered with snow before it was possible to get down to see it and the description given indicated that it is a crack in water-soaked sand beside a creek. Such cracks might be

found even farther away than is Mattawa from the epicentre. The effect at Parent, Que., is noted in a separate paragraph below.

Rocks were not displaced at any point unless they were on a slight slope. The majority of such displacements, as found in rock cuts on the roads and railways and in some places about lake Kipawa, were confined to points within a radius of ten to fifteen miles of the epicentre determined.

**Shifting or Fall of Heavy, Well-placed Bodies:** It is usual to look for such well-placed heavy bodies among the newer monuments in cemeteries. However, no cemetery was to be found within thirty miles of the epicentre in which monuments of any kind had been placed. The evidence of this kind to be found in the town of Timiskaming was carefully examined. Heavy tool boxes on a level bench in the machine shop of the mill shifted roughly north-east. So also did a heavy pile of nestled aluminium trays in a cafeteria. In the case of the trays a further observation made known the fact that these fell at the onset of the first heavy shock, -the initial P phase. A man working in a room about 120 feet above ground on a steel tower about 170 feet high stated that the first he noticed was a roar and general trembling of the tower which emerged gradually, so to speak, above the noise usual in this tower. Then at the first sharp shock the tower leaned over in a direction approximately north. After two shocks of this nature it swayed violently at right angles to this direction. This evidence points to an epicentre north and somewhat east of Timiskaming.

Between Kipawa and Dozois the railway runs approximately north-west. At Kipawa the mileage is 43, at Dozois it is 54. At mileages 45 - 54 spare rails are mounted on heavy wooden standards. These have not been displaced for about two years and have left rust marks on the trestles to mark their position, while the parts of the rails in contact with the trestles have not rusted. It was thus possible to determine whether they had shifted. It was found that these at mileages 45, 47, 48, and 49 had shifted. Those at 46 were on trestles which were not level and which leaned in such a way that the rails

were hindered from slipping in a direction conforming to those at adjacent mileages. The rails at mileages 50 - 54 had not shifted at all. These rails are 33 feet long and weigh 935 pounds. They are well placed except as noted. Their evidence can not be disputed that the epicentre lay to the south and west side of the Kipawa-Dozois track.

**Aftershocks:** At Timiskaming and Kipawa the earthquake recurred at intervals all night succeeding the heavy shock at one a. m. Aftershocks were occurring on an average of once a day up until the time the writer left on Nov. 22. A sharp one occurred on Nov. 25. It is likely that these will continue at greater intervals for some weeks. After each sharp shock telegrams were sent from Timiskaming to the telegraph operators at stations thirty to forty miles distant asking if a shock had been felt. In general, the aftershocks were confined to the vicinity of Timiskaming and Kipawa though some were felt as far away as Widdifield a few miles north of North Bay. The evidence of the aftershocks is in agreement with the location adopted.

A continued attempt was made to determine the time elapsing between an aftershock felt at Timiskaming and recorded at Ottawa. The procedure adopted was to note at Timiskaming the time as felt on a watch of good rate. The time was wired to Ottawa and arrangements made to get the time beats from the Observatory to check the error of the watch. In spite of several attempts of this kind no successful determination was obtained - none of the shocks investigated having been registered at Ottawa.

**Telephone or Telegraphic Connections at the Time of the Earthquake:**

Useful data of this kind were impossible due to the services available. The only cases found were a continuous connection from North Bay to Sudbury to Chapleau. It was felt and remarked by the operator at North Bay before it was felt at Sudbury and by Sudbury before it was felt at Chapleau. This is in agreement with the epicentre determined but does not contribute to the precision of the location.



**Discolouration of Bodies of Water:** Lake Timiskaming was not discoloured by the earthquake. Lake Kipawa gradually showed muddy water at the outlet and a tour of the lake showed some parts near clay or gravel banks noticeably whitened but other parts of the lake quite clear. T-lake near Kipawa is known as being deep and clear. From most reliable sources it was learned that this lake has always been clear. Its banks are rocky. It was not under observation the day of the earthquake but the next day it was found to be the colour of café au lait and it was thus discoloured up to the date when last seen by the writer. The epicentre is believed to be at the north-west corner of this lake. Other bodies of water examined were distinctly not affected, being remarkably clear.

**Azimuth of Swing of Freely Suspended Bodies:** At Timiskaming the first shocks of the earthquake closed the relays which cut off the generators and the town was in darkness. No swings were observed. At Kipawa they have their own lighting system which was not affected but no swings were observed. The only evidence of this kind was that of a lantern hanging on a nail in a cabin about 14 miles north of Timiskaming. This was said to have been swinging violently in an east-west direction. This does not directly agree with or contradict the location adopted. Until the azimuth can be checked, it means nothing and a single observation of this kind is of little value. However, the writer learned by experiment that the lantern as suspended was apparently equally free to swing in any direction.

**Negative Evidence:** The best cases of negative evidence observed were at Ville Marie and at North Bay. At these places cemeteries were found with large well-placed stones. These were not shifted in any case. They are respectively about forty miles north and thirty-five miles south-west of the epicentre as located. At Parent, Que., there were many rock cuts and in some of them the rocks were on the point of moving and could be moved by hand yet they did not move with the earthquake, in spite of the fact that over 200 feet of the right of way slid into a small lake.

**The Parent Slide:** The officials of the Canadian National

Railways obtained photographs of this slide before it was repaired and sent them to us with a report. The writer visited the place on Nov. 30 and Dec. 1, at which time snow had not yet covered the ground. It is quite evident from the negative evidence offered by the rock cuts, from the nature of the terrain at this point, and from the fact that it lies more than 200 miles from the epicentre that this slide must have been on the point of slipping into the small lake beside the fill. Fortunately, no accident occurred and a trestle was built to resume traffic by Tuesday morning, November 5. It may be said that this slide was caused by the earthquake but that it was on the point of going anyway. It was fortunate that it went out due to the tremors and not due to a passing train.

**Further Studies Contemplated:** Requests have been sent to all the seismograph stations of the world asking for the loan of their records of this earthquake. Some of them have been received. The earthquake was well registered, for example, as far away as Central Europe. There has not yet been time to hear from more remote stations. Presumably the tremors were noted on seismographs to the very antipodes. The great mass of information which is accumulating will require months to study. The scientific value of this earthquake is unusually great. It is believed that the epicentre is already located within, at most, three or four miles. Further study will not shift the adopted position by more than this amount.

**Conclusion:** The epicentre is tentatively located at  $\phi = 46^{\circ}47'$  N.,  $\lambda = 79^{\circ}04'$  W. This lies about four miles north and a little east of Timiskaming, Que. The focus is believed to be approximately 200 km. (125 miles) below the epicentre. The epicentral time was about  $1^{\text{h}} 03^{\text{m}} 40^{\text{s}}$  though this will be subject to correction on further study. The epicentral time adopted may require to be changed by as much as fifteen seconds plus or minus.

Dominion Observatory,  
Department of the Interior,  
Ottawa, December 14, 1935.

Ernest A. Hodgson,  
Seismologist.