

THE EARTHQUAKE OF MARCH 21, 1904, IN NOVA SCOTIA.*—

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Early on the morning of March 21st, 1904, a widespread earthquake was felt in New England, New Brunswick, and Nova Scotia. On the whole, its violence was considerably greater in the first named region than farther east. In the Maritime Provinces, it was greatest in certain districts, rather erratically distributed.

Such an earthquake naturally excited much interest, and newspapers gave considerable space to accounts of its effects. The United States Geological Survey began an investigation of it, through Professor Harry Fielding Reid, of Johns Hopkins University, Baltimore, Maryland. For the purpose of compiling all possible information in a systematic manner, a blank sheet is sent to observers whenever an earthquake is to be studied by the Survey. Dr. Reid requested the author to gather such data as could be found for Nova Scotia, and in the pursuit of this task the information was collected which forms the basis of this paper. It is published with Dr. Reid's permission.

It is impossible to thank, individually, all who have been of service in this connection. Especial mention should be made of that given by Dr. A. H. Mackay, Superintendent of Education for Nova Scotia, who very kindly placed the *Journal of Education*, the official organ of the department, at the author's service for distributing questions; and who collected the answers

* Contributions from the Science Laboratories of Dalhousie University.—[Geology and Mineralogy].

wherever possible. Names of many observers will appear in the text. To all these, and to others, many thanks are due. On the phenomena in New Brunswick, a short paper has appeared by Mr. S. W. Kain ("Recent Earthquakes in New Brunswick"; Nat. Hist. Soc. of N. B., bull., vol. V, no. 11, June, 1904; pp. 243-245). It is to be regretted that more notes are not available, especially in the gold districts or region covered by them, between the Atlantic Ocean on the south and the carboniferous rocks on the north. The author will be greatly obliged to any who send him information from such or other places, and it will be used in a supplementary paper later.

For the purpose of serving as a guide to observers on future occasions, the questions sent out are here reproduced. They have been slightly amended from the original, to be better adapted to the local conditions. Most of the information obtained thus far regarding this earthquake is too meagre to permit of classification under the separate answers, and will be given as it was received.

QUESTIONS REGARDING THE EARTHQUAKE OF MARCH 21, 1904.

1. *Location of the Observer.*—County and location in county; township.
2. *Situation of the Observer.*—(a) Indoors (and on what floor of the house) or in open air, on a wharf or boat, in a mine and how deep. (b) Position and occupation at the moment of the shock.
3. *Time* at which shock was felt, eastern standard time.
4. *Nature of the Shock.*—(a) Was any tremulous motion felt before the principal disturbance and for how many seconds? (b) How many principal or prominent disturbances were felt, and for how many seconds did they last? (c) Was any tremulous motion felt after the principal disturbance, and for how many seconds? (d) Did the movement gradually increase in intensity and then die away, or (e) were there two or more maxima of intensity or series of disturbances; and, if so, what was the interval between them and the order of their intensity? (f) Was the principal disturbance strongest near the beginning, the middle, or the end of the series? (g) Was any vertical motion perceptible, and, if so, was the movement first upward and then downward, or vice versa? (h) What was the apparent direction of the movement? (i) In what direction were objects overturned?

5. *Duration of the Shock* in seconds, not including that of the accompanying sound.
6. *Intensity of the Shock*.—Was it strong enough : (a) To make windows, doors, fire-irons, etc., rattle? (b) To cause the chair or bed on which the observer was resting to be perceptibly raised or moved? (c) To make chandeliers, pictures, etc., swing, or to stop clocks? (d) To overthrow ornaments, vases, etc., or cause plaster to fall from the ceilings? (e) To throw down chimneys, or make cracks in the walls of buildings?
7. *Sound Phenomena*.—(a) Was any unusual rumbling sound heard at the time of the shock, and, if so, what did it resemble? (b) Did the beginning of the sound precede, coincide with, or follow, the beginning of the shock, and by how many seconds? (c) Did the end of the sound precede, coincide with, or follow, the end of the shock, and by how many seconds? (d) Did the sound become gradually louder and then die away? (e) Did the instant when the sound was loudest precede, coincide with, or follow, the instant when the disturbance was strongest, and by how many seconds? (f) Did the sound change in character at or about the time when the disturbance was strongest?
8. *Miscellaneous*.—Note any other phenomena which may be related to the earthquake, such as effects on animals, on springs or streams, any change in the wind, (if so, to what direction), permanent displacements of the soil, etc. If the observer was on a boat or wharf state especially the intensity, apparent direction, etc., of shocks and noises.
9. Name and address of observer.

Please answer as many questions as possible ; number and letter the answers to correspond with the questions and forward to :

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Observations on the earthquake follow. For convenience, one or two are given from New Brunswick.

Moncton, N. B.—(Halifax Herald, Mch. 21). “A severe shock of earthquake was felt here ten minutes after two this morning. Houses trembled and furniture rocked, awakening many people from sleep. The vibration continued ten or fifteen seconds, but no damage was done.”

Some dishes are said to have been broken in *St. John*. At *Fredericton*, many people rushed out, and lamps and dishes were broken. At *Woodstock* also the shock was severe.

Yarmouth, N. S.—(Halifax Chronicle, Mch. 22). “Many people were awakened early this morning by the shock of earthquake. It was of short duration, but was plainly felt in different parts of the town and country about two o’clock.”

Shelburne.—Replies to questions were condensed into the following, numbers referring to question blank.

(2b) Lying in bed at the time, and awakened by the trembling motion.

(3) About 1.15 a. m.

(4) Lasted about 15 seconds.

(6a) No rattling.

(6b) Bed moved.

(6c) No pictures disturbed.

(6d) No moveable articles overthrown.

(7) No sound.

[C. S. Bruce.]

It was evidently not felt at *Liverpool*.

Lunenburg.—(Lunenburg Progress-Enterprise, Mch. 23). “At *Kentville* and all through the valley it was felt, and in some places the dishes rattled in the cupboards. The vibrations were distinctly felt at *Bridgewater* and as far south as *Lunenburg*, where several of our citizens, among whom were Mr. Fenwick Zwickler and Mr. George Miller, were awakened by the rattling of dishes, and a sensation that something unusual was happening. The vacillation lasted several seconds, and in every place was five minutes past one on Monday morning.”

No other place on the south shore has yet reported the occurrence except *Mahone Bay*, where a slight shock was noted by a teacher.

It has been impossible to get information of a positive nature from *Halifax*, the only data being contained in the following

by Mr. John MacAloney. His house is at Fairview, immediately north of the Halifax city limits. "I was in bed at the time; know it was after midnight, as I heard the clock strike twelve before going to sleep. Was awakened by feeling the house jar, at the same time hearing a faint sound that I took to be distant thunder. I attached so little importance to it that, had I not seen the notice of an earthquake in the papers, I would not have thought of the matter again." He explained verbally that the house felt the jar of every train, and he was very familiar with that sensation. Neither the trembling nor the sound could have been produced by a train. The house is bedded on solid rock.

To date, no note of the occurrence has been received from the country covered by the gold-bearing rocks, east of Halifax.

The most western locality on the north, from which data come, is *Digby*.—(Halifax Herald, Mch. 21). "A slight shock of earthquake was felt here, and all through the country, about two o'clock this morning, quickly followed by another of short duration. No damage whatever resulted beyond the alarm occasioned some people. In some instances in the country districts, people fled from the houses for fear they would fall."

At *Bear River*, a few miles south of Digby, and on the edge of the old rocks, the shock was distinct and heavy, sufficient to twist a bed perceptibly in at least one instance. The occupant, a wakeful invalid, knew it was tight against both end and side walls when he first went to sleep; and it was more than an inch away from the side wall, but still against the end wall, after the shock. Two periods of vibration were felt, and the attitude of the bed suggested west to east motion, which suggestion was emphasized by the sensation caused by the trembling.

Bridgetown, Annapolis Co.—(Halifax Herald, Mch. 21). "There was a very distinct shock of an earthquake felt here at just two o'clock this morning. Several persons were awakened by the trembling motion of the earth, which lasted probably about ten seconds. No damage is reported."

(Weekly Monitor, Bridgetown, Mch. 23). "The earthquake shock felt here on Monday morning The time varies from 1.05 a. m. in parts of Maine to 2.05, the time it occurred here." Mention is made also of a shock at *Belledale*, "between two and three o'clock," severe enough to wake up many.

A teacher reports the shock at *Paradise West*, and another at *North Williamstown* in the same county.

Annapolis.—(Halifax Chronicle, Mch. 22). "About two o'clock this morning (the 21st), a shock of earthquake was distinctly felt, shaking the furniture and arousing many from their slumbers. The vibrations lasted several seconds."

Cornwallis, Kings Co.—(1) Center of Cornwallis valley, equidistant from North and South Mountains.

- (2) In a house, second story; awakened from sleep by shock.
- (3) About 2.00 a. m.
- (4) Three distinct shocks.
- (5) About twenty seconds.
- (6) Pictures were displaced on the wall. Some doors were opened.
- (7) Rumbling sounds. [Miss Bessie Cochran, Church St., Cornwallis.]

At *Middleton* and surrounding villages, including *Nictaux Falls*, a few miles south, the shock was severe, frightening women and children. Here a bed shook violently sideways, but the occupants were too agitated to tell the direction of motion. No upward motion was felt. Total duration of disturbance may have been five minutes. There were two principal periods of vibration, with maxima only a few seconds apart.

It was reported from *North Kingston*, Kings Co., by a teacher, as also from *Wolfville*. No report was received from *Windsor*, within a few miles of the latter place, however.

At *Truro*, only one person has reported the shock.

- (2) In bed, awake.
- (3) Between two and three o'clock a. m.
- (3a) No.
- (3b) Two principal disturbances, lasting about ten seconds each, with about five seconds intervening.
- (3c) Yes.
- (3d) From west to east, distinctly.
- (3e) No objects overturned.
- (5) About 25 seconds.
- (6) "It seemed as though someone took hold of side of bed and shook it violently, lifting it up and down; as though it were taken hold of on the west side. Everything was still, and then in a few seconds the same thing happened again. It woke a person in this house and another in the next house."
- (7) No sound noticed. [Mrs. S. V. Mack, Park St., *Truro*].

It appears not to have been felt at Westville, Stellarton, or New Glasgow, in the Pictou carboniferous basin. Inquiry shows it not to have been felt at Pictou. At one time there was expectation of receiving data from one locality in Prince Edward Island, but none have come, and it is probable that the shock was not felt there. I have heard a statement, as yet unverified, that it was detected at *Springhill*. It was not felt, I believe, along the Chignecto shore from Joggins Mines to Apple River.

At *Middle Musquodoboit*, at the home of Mr. Robert Kaulback, the table in the hall shook, and a bed. The motion was from the side, and appeared to come from the west.

The Halifax and Sydney papers gave circumstantial accounts of the shock in the Sydney district; but careful inquiry at Sydney, North Sydney, Sydney Mines and Glace Bay indicates that there was no basis for the story.

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Too few data are available for much discussion of the geological aspects of the earthquake; but enough are at hand to indicate a few points of interest. Further consideration must await the accumulation of information from a larger number of sources.

(1) The variations of time are to be accounted for by the differences between the two standard times, between the standard and local times, or errors of time-pieces. The correct time is 1.04 to 1.05 a. m., eastern standard, or 2.04 to 2.05 a. m., maritime time.

(2) The shock appears to have consisted of two periods of disturbance, of perhaps ten seconds, separated by five seconds interval; but there may have been some little variation in different places.

(3) The shock travelled from west to east, roughly. This is not only away from the region of greatest intensity, in the United States, but is parallel to the general strike of the geological formations in Nova Scotia affected.

(4) It was felt with special severity along the line of the triassic estuary.

(5) It was more effective along the strike than across it. It was felt on the south coast, and again on the north side of the gold-bearing series for a long distance; while there is no information of its occurrence in the inland zone between.

(6) Its intensity apparently decreased eastward.

(7) There appears to be a close relation between intensity and the presence of intrusives. The zone of greatest disturbance is a long and very narrow east and west belt, from Yarmouth to about Kentville. This zone is occupied largely by triassic sediments, and bounded on the south by the plateau composed of siluro-devonian and gold-bearing strata, probably pre-cambrian. On the north is the triassic trap of North Mountain; and the old rocks to the south have, near the

escarpment of the plateau, the northern edge of the great western granite massif, which runs from near Windsor to a point a short distance east of Yarmouth.

(8) The line of disturbance on the south shore of the province remains unaccounted for. Additional data may show the back country to have been affected, or they may not.

(9) No information whatever has been given by observers underground or on the water. It is particularly desirable that data should be collected from these two sources, with a view to establishing direction and relative intensity of shock, and character of sensation, as compared with observations in houses.