

ART. X.—*Earthquake of October 20th, in Northeastern America;*  
by ALEX. C. TWINING.

NOTICES of the earthquake of October 20th last, collected from the newspapers and received from other sources, display an area of disturbance extending from New Brunswick in the East, to the State of Iowa in the West, and from the Lakes and the River St. Lawrence in the North, to Cincinnati and Richmond, Va., in the opposite direction. No doubt the actual area of disturbance was far more extended, especially in the East and North; for the manifestations were at least as strong in degree at the utmost bounds of our information in these last directions, as in those parts with which we are most immediately familiar. The same conclusion is confirmed by the circumstance that, even where the motions were most fully developed, they were not obvious to persons not favorably situated for receiving impressions from them. It is easy to believe that they escaped public attention over large regions where they took place sensibly, although but feebly.

At this place—New Haven, Connecticut—the movements, both in the precise time of their occurrence and in the attendant circumstances, were immediately and critically investigated by the writer, from the testimony of many intelligent citizens. Independently, and in their various situations and positions, the witnesses agreed in describing an oscillatory movement, to and fro, in the general direction of N.N.E. to S.S.W.,—not level but rocking. This last sensation is plainly indicative quite as much of a vertical displacement, combining irregularly and oppositely with the horizontal, as of any alternations of inclination in the earth's surface, after the manner of a wave, and a consequent vibratory condition of persons and objects. Still, that the latter did take place is a conclusion that seems to be made inevitable, by the invariable fact that the oscillations were by far the most perceptible in lofty situations,—for example, in the ascent progressively from the lower floors of edifices to the upper stories. In the latter, at least, objects were both felt and seen to be in motion; and suspended objects, as lamps and pictures, were set into vibration, with a range of three or four inches and, when free, in the direction already specified. There were two distinct shocks. In estimating the duration of these and of the interval between them, and also in estimating their component oscillations, these durations and intervals were in no case recorded from mere verbal statements, but means were employed to ascertain the informant's *mental* impressions and recollections, applying to them my own measurement, as to time.

These impressions and recollections would often give durations more than double, in some instances, of the like in other instances. Taking, however, the most trustworthy, and allowing to the others a weight proportioned to their value, under the circumstances, the first shock was found to have continued through about nine seconds, the second through about eleven seconds, and the interval about five,—making, altogether, twenty-six seconds. The time of each double vibration—that is both to and fro—was concluded to approximate to a second and one-third,—although, so far as mere numbers were concerned, the witnesses more generally approved not more than one second, or even less. The precise time of day will be referred to farther on. It is remarkable that motions which were not even noticed, ordinarily, by persons in basement stories or in the streets, should have produced in most of those who felt them nausea or dizziness or other affections, according to the temperament of the individual.

A careful comparison of the various newspaper paragraphs which have come to hand—nearly forty in number—makes it clear that the general phenomena were everywhere the same. Every where there were two shocks experienced of a few seconds each, and a brief interval. These are about as variously stated in duration by the newspapers as the same were stated by different observers at New Haven:—thus, at Troy 15 to 20 seconds in all, at Montpelier 30, at Cleveland 15 to 30, the prevalent authority being for the latter, at Boston 18 to 30, at Brunswick, Me., 30 to 40, at Cincinnati 30 and less, at Hartford 20 to 60, at Cornell University, Ithaca, three shocks of 15 seconds each—the *three* being too exceptional among the mass to be credited, and having but one other parallel, that is, Brooklyn. At Harvard College Observatory the duration of tremor was from 8 to 15 seconds by the estimate of different observers,—two shocks with a continuous tremor between, and the component oscillations 40 in a minute according to observer W. A. Rogers. At East Saginaw, Mich., the first shock is described as 10 seconds, then an equal interval, then a second shock of 10 seconds. A very few of the statements are so abnormal, one or two in their brevity (one or two seconds) and about as many in their length (two or three minutes), that no weight can be accorded to them. On the whole, the entire duration—26 seconds—at New Haven, is confirmed as having been about the duration in all other places observed—a uniformity probable in itself. In one instance the oscillations are spoken of as four or five in a second, and as being like the motions of a boat,—also in one other (at Keene) they are described as having been vertical.

Respecting the relative amount of disturbance at different places, the sensations experienced by individuals would be but

a fallacious test, because so much influenced by temperament, as well as by situations and positions. Persons sitting, for example, were far more sensitive than persons standing. Again, while operatives in upper rooms often rushed down—as here at New Haven—in a panic, persons standing or walking in the immediate vicinity below, did not even perceive the phenomenon. The same remark applies to the reported swaying of walls and buildings ten inches to a foot, which is no doubt exaggerated in amount. But a vague conclusion may be derived from specific occurrences, such as the displacement of objects, the cracking of window panes or of ceilings, and the falling of chimneys, as well as from the degree of public notice which the event excited. All that, in the present instance, can be rationally deduced from such indications would seem to be that the amount of disturbance at New York, at Cleveland, at Milwaukee and Detroit was about the same as at New Haven; that it was greater at Boston, at Brunswick, at Montreal and at Quebec; that it was less at Cincinnati, at Chicago, and at Dubuque, and was but just distinctly perceptible at Richmond, Va. In other words, the movement was more remarkable in the East and North, and less in the West and particularly in the South. It is also believed that no like occurrence comparable in the aggregate with this one has been experienced in New England during the present century, nor since November 18, 1755—supposing the newspaper quotation, relative to that event, made by a Boston correspondent, from “a book published in 1786” to be correct and authentic.

It only remains to compare the times noted at the various places concerning which our information is sufficiently authentic. At this place there were two among the observers who separately noted the time by reference to standard time-pieces. By each the same time of beginning was given, within a few seconds;—that is, 11<sup>h</sup> 19<sup>m</sup> 46<sup>s</sup>. The average of three other observations by time-pieces whose errors could not be ascertained except on the day after, proved to be very nearly the same. The same conclusion was farther confirmed, with sufficient exactness, by the average of three clocks which had stopped, as observed upon their dials. Prof. C. Smallwood of Montreal Observ’y has obligingly furnished observations of local time in the Canadas which are entitled to confidence, viz., at Quebec, Montreal and Owen’s Sound, and also at St. Johns, N. B. These will be found in their place in the table below. The time at Boston, taken by Mr. Farmer with care, is communicated by Prof. Newton, together with most of the newspaper notices herein referred to. That at Harvard College Observatory has been obligingly furnished to the writer by Assistant Arthur Searle, together with the other facts herein stated as observed at that locality. The

time at Cleveland, Ohio, is the average of three clocks that were stopped, and is confirmed essentially by Col. Whittlesey, but without an actual reference of either to a standard time-keeper. From these combined the following table is composed; of which column 1 gives the place of observation; column 2, the latitude; column 3, the difference of local time from New Haven corresponding to the longitude; column 4, gives the respective local times corresponding to  $11^h 19^m 46^s$ —the beginning at New Haven; column 5, is an empirical scale of progress proportioned to the differences of longitude and the presumed differences of absolute time at St Johns and Chicago; column 6, gives the observed times of the earthquake; column 7 is comparative of the two preceding, and shows the presumed error of observation, whether too late or too early at each of the places respectively. It would obviously only obscure the discussion to take account in the table, of times which do not purport in the notices themselves to be near approximations, or which are adopted from the railroad time-pieces without supplying the proper correction, or which are found by comparison with the mass of observations to be grossly in error. To one or the other of these categories belong the notices from Brunswick and Portland, Me., Burlington, Vt., Warrensburg, Saratoga, Cooperstown, Cornell University, and Auburn, N. Y., Scranton and Titusville, Pa. The notice from Cincinnati, Ohio, is retained on account of the extreme position.

| 1.                    | 2.             | 3.                         | 4.                        | 5.               | 6.              | 7.                   |
|-----------------------|----------------|----------------------------|---------------------------|------------------|-----------------|----------------------|
| Place of Observation. | Lat. of place. | Time diff. from New Haven. | Simultaneous local Times. | Empirical Times. | Observed Times. | Diff. early or late. |
|                       | ° ' "          | m. s.                      | h. m. s.                  | h. m. s.         | h. m.           | m. s.                |
| St. Johns, N. Bruns.  | 45 9           | + 27 34                    | 11 47 20                  | 11 45 5          | 11 45           | 0 5 early.           |
| Bangor, Me.           | 44 48          | + 16 34                    | 11 36 20                  | 11 34 55         | 11 35           | 0 5 do.              |
| Lewiston, Me.         | 44 5           | + 10 46                    | 11 30 32                  | 11 29 33         | 11 30           | 0 27 late.           |
| Boston, Mass.         | 42 21          | + 7 28                     | 11 27 14                  | 11 26 30         | 11 25½          | 1 1 early.           |
| Harv. Coll. Obs'y.    | 42 23          | + 7 11                     | 11 26 57                  | 11 26 14         | 11 25½          | + 0 25 do.           |
| Quebec, L. C.         | 46 49          | + 6 38                     | 11 26 24                  | 11 25 44         | 11 27           | 1 16 late.           |
| Providence, R. I.     | 41 50          | + 6 7                      | 11 25 53                  | 11 25 15         | 11 26           | 0 45 do.             |
| Norwich, Conn.        | 41 33          | + 3 14                     | 11 22 50                  | 11 22 25         | 11 20           | 2 25 early.          |
| Montpelier, Vt.       | 44 17          | + 1 18                     | 11 21 4                   | 11 20 48         | 11 24           | 3 12 late.           |
| Hartford, Conn.       | 41 46          | + 0 59                     | 11 20 45                  | 11 20 30         | 11 20½          | + 0 4 do.            |
| New Haven, Conn.      | 41 18          | 0 0                        | 11 19 46                  | 11 19 36         | 11 19½          | + 0 10 do.           |
| Montreal, L. C.       | 45 31          | — 2 38                     | 11 17 8                   | 11 17 7          | 11 17           | 0 7 early.           |
| Dudley Obs., N. Y.    | 42 40          | — 3 20                     | 11 16 26                  | 11 16 31         | 11 15           | — 1 16 + do.         |
| Hudson, N. Y.         | 42 14          | — 3 22                     | 11 16 24                  | 11 16 29         | 11 14           | 2 29 do.             |
| Schenectady, N. Y.    | 42 48          | — 4 0                      | 11 15 46                  | 11 15 54         | 11 15           | 0 54 do.             |
| New York.             | 40 43          | — 4 20                     | 11 15 26                  | 11 15 35         | 11 15           | 0 35 do.             |
| Warsaw, N. Y.         | 42 43          | — 20 58                    | 10 58 48                  | 11 0 13          | 11 0            | 0 13 do.             |
| Toronto, U. C.        | 42 40          | — 25 44                    | 10 54 2                   | 10 55 48         | 10 55           | 0 48 do.             |
| Owen Sound, U. C.     | 44 44          | — 32 2                     | 10 47 44                  | 10 49 58         | 10 52           | 2 2 late.            |
| Cleveland, Ohio.      | 41 30          | — 35 10                    | 10 44 36                  | 10 47 5          | 10 44½          | 2 25 early.          |
| Cincinnati, Ohio.     | 39 6           | — 46 6                     | 10 33 40                  | 10 37 8          | 10 30           | 7 38 do.             |
| Chicago, Ill.         | 42 0           | — 58 38                    | 10 21 8                   | 10 25 23         | 10 25           | 0 23 do.             |

From all observed times of the *end*, if expressly so given, twenty-six seconds has been deducted for the *beginning*, as above. Wherever no mention is made of the period in the shock to which the observation applies, the times stated in the notices respectively have been inserted in the table without change, as being the presumed time of the beginning.

An inspection of this table discloses no considerable north-and-south movement. A nearly east-and-west progress is that which appears most consistent with the aggregate of times. Indeed it presents itself as the only one at all consistent with a uniform and regular progress. Nor is there discovered in the table any decisive indication of a change of direction as between the east and the west of the Alleghanies; but the various accounts, so far as they go, indicate the very reverse. Thus the direction of N.E. and S.W., noted at Brunswick, was accurately N.  $10^{\circ}$  E. at Harvard Observatory, while it was N.N.E. at New Haven, and almost identically the latter also at Chicago. But at Cleveland and Detroit it is described as E. and W., and at Burlington, Vt., N. and S. One account from Boston makes it, incorrectly, N.W. and S.E., and another from Hartford the same at the latter place.

The best approximate result appears to be that the earthquake made progress from about E.  $6^{\circ}$  N. to about W.  $6^{\circ}$  S., *at the rate of one hundred and sixty miles a minute*, being six minutes and a half from St. Johns to Chicago; *while surprisingly, the ordinary direction of the subordinate undulation was about N. by E.* But there was not absolute regularity of rate in any single direction. The times at Cambridge, at Albany and at New Haven compared together, disclose appreciable deviations from the general *regimen* of the table; and the same is probably true with respect to the Cleveland observation. Unfortunately the latter was not checked by comparison with a standard time-piece,—neither, as is probable, was the Owen's Sound observation. That at Cincinnati does not purport to be more than a loose approximation.

It appears by observations of Prof. Hough at Dudley Observatory, obligingly furnished me by him, that the principal shock was observed at 11<sup>h</sup> 15<sup>m</sup>, being a few seconds in duration, but that a tremor continued for at least a minute. No doubt there exist, at various localities not heard from, many observations recorded or distinctly remembered. It is desirable yet to have them communicated to this place, or to some one elsewhere, by whom they will be made available.

In fact while this article is in press, I am furnished through the favor of H. Paton, Esq., of the Montreal Telegraph Co. at Quebec, with the following important statements by Mr. Robert McCord, the operator who made inquiries immediately after

the cessation of the earthquake at that office, and received replies from Montreal. His condensed statements are: "All perceptible motion was over here by the time I had finished telegraphing to Montreal—*do you feel earthquake*. It would take about eight seconds to telegraph the words used. The operator's immediate reply was—*no*. About fifteen seconds after, he said—*here it is*. The gentleman at Montreal afterward explained that, although he said *no*, he did experience a slight movement at the time, but was not aware that it was caused by an earthquake. He telegraphed—*here it is*—on the instant that the shock became sensibly evident. He cannot say how long the vibration lasted after that period, accurately, but is of opinion it continued for nine or ten seconds. The following further particulars be may of interest. The shock passed over this district from a northerly direction,—a rumbling sound accompanied the shock, resembling that produced by ponderous machinery,—noise and motion increased steadily for some seconds, and gradually passed away. Buildings were violently shaken. Our office being in the upper part of a high brick building, the trembling was powerfully felt—the clock in the office was stopped by it at 11:25, but am not certain if the time by it previous to the shock was correct. Some observers say the shock was first felt here a few seconds before 11:24, and lasted forty seconds—others state fifty or sixty seconds. I am of opinion it lasted sixty seconds. No two opinions agree as to the commencement and duration."

"At Bay St. Paul and Les Eboulements—places about ninety or one hundred miles northeast of Quebec—the ground opened in several places, and water was thrown up. Slight elevations of land in some places were produced. The country in the vicinity of St. Paul's Bay is of volcanic formation, and slight shocks are of frequent occurrence. A gentleman from that vicinity informs me that they had twenty or thirty slight shocks within the past two weeks. The shock on the 20th, here, did not appear to have an undulating, upheaving motion, but to partake of a tremulous nature."

"The operator at Richmond, a place ninety miles southwest of here, says the shock was just passing away there at the period when I made the inquiry of Montreal."

Mr. McCord does not refer to specific authority for the convulsive effects at Baie St. Paul and Les Eboulements, some 55 to 62 miles in a direct line from Quebec; but they are in general conformity to what has long been known to British geologists respecting the volcanic character of the region specified. They, in fact, recall and confirm the representations made at page 236, vol. xxx of this Journal, 1836, in a paper by Capt. R. H. Bonycastle, R. En. In that region, very probably, lay the initial

spot of the disturbance. The subject, in this view of it, merits a more extended investigation, and it is hoped that the statement here brought out will induce new communications relative to the facts.

The interpretation of Mr. McCord's interesting statements relative to the telegraphic communication, seems to be as follows: He occupied the last eight seconds of the motion at Quebec with a question put to Montreal. That question, together with the answer "no," I find by careful trial at the American Telegraph office, require not less than eighteen seconds for transmission and reception. Then there are estimated fifteen seconds of interval. Then there was the second reply of not less than eight seconds; then there were nine or ten seconds to the end of the vibrations. In other words, there transpired not less than forty-two seconds between the end of the message and of the tremors at Quebec, and the end of the same at Montreal, ninety-six miles distant in longitude, and one hundred and fifty-nine in a line N.  $51^{\circ}$  E., and which in the table above had been and still remains credited with the empirical interval of thirty-nine seconds,—showing a near accordance between these and the other facts, and 137 miles per minute of east-and-west progress.

Again, the Montreal "no" was given just as the tremors there began, and after—say six seconds after—the end of the shock at Quebec; that is to say, the beginning traversed from city to city in some six seconds more than the duration of the shock. Consequently the latter, in consistency with the above, must have continued about thirty-six seconds, in place of the twenty-six seconds ascertained at New Haven. Still again, the shock at Montreal began with the "no," which may have occupied four seconds. Then there were fifteen seconds of interval; then eight of reply; then nine to ten of estimated continuance; in all thirty-six or thirty-seven seconds for the duration of the shock. The principal movement at Montreal did not come till at least fifteen seconds after the beginning; and the testimony of the Richmond operator shows that the violence of the shock there had passed, while the tremors at Quebec were still in faint continuance. Finally, it will be observed that the time of occurrence stated by Mr. McCord and others—although not confirmed by his comparison with any standard time-piece—*tends* to represent the actual occurrence at Quebec to have been before the empirical time of column 5 in the table, instead of  $1^m\ 16^s$  later, as shown in column 7.