

*REPORT OF THE COMMITTEE ON A SYSTEM
OF EARTHQUAKE OBSERVATIONS.*

[READ AND DISCUSSED JUNE 1ST 1883.]

One of the main objects of the Seismological Society from the commencement was to invoke as soon as possible the assistance of the Imperial Japanese Government in carrying out a system of observations after a definite plan, as it was evident that one of the first aims of seismometry, the location of centres or lines of disturbance, could not be arrived at without such aid.

Hitherto this assistance has not been nor could have been asked for, by the Seismological Society, on account of the difficulties and doubts attending the adoption of any one instrument for a number of stations. Many instruments have been constructed and tried by our members and have given indications, but whether and how far the latter are reliable, has not been thoroughly tested yet. Dr. Wagener, who pointed out the necessity of such a test, formulated the same as follows: If two instruments built on exactly the same principle, but differing in size, in the proportion of the various parts and in azimuth, while being set up near to each other, give for the same earthquake the same indications, there is good reason to believe that such instrument is reliable.

This test has to the best of our knowledge not yet been applied, and thus, while acknowledging that great ingenuity has been displayed by several members in inventing new and improving old instruments, the Committee is nevertheless of the opinion, taking into consideration the cost, the simplicity of observation and the experience gained hitherto, that the only observations which can at present be safely recommended for a number of stations and which can be made independent of the above test, are those of "Time" only, at the Telegraph Offices; namely, that time of an earthquake when the motion of the earth reaches a certain amplitude.

The objection that may be urged against this plan is that the times when the vibrations reach a certain definite amplitude, even supposing this could be accurately observed, may not refer to the same wave or phase of the earthquake vibration. Your Committee frankly acknowledge this to be true, but claim that this time of reaching a certain definite amplitude is the only definite time that can be observed by simple apparatus, and that this method offers the readiest means of determining the center or line of disturbance and the average velocity of transmission of this disturbance through the ground, and therefore offer of the following—

RECOMMENDATIONS

AS TO PLAN OF SEISMOLOGICAL OBSERVATION.

1. Observations, at different places throughout Japan, of the instants at which the ground reaches a certain amplitude of vibration.

2. Establishment of at least 10 stations at some selected telegraph offices, fitted with simple apparatus.

3. At each of these stations a post should be set firmly in the ground, and on the post should be mounted a clock and some arrangement for stopping it at the instant the motion of the ground reaches a certain amplitude of vibration.

4. These stations should be in a room of the telegraph offices so that the clock can be compared each noon with the signals which are sent simultaneously over all the telegraph lines.

5. The clocks should have second-hands, wooden pendulum rods, the pendulum $\frac{1}{2}$, $\frac{2}{3}$ or $\frac{3}{4}$ second, and, if they are wound every day, their daily rates should never differ by more than 1^s from a uniform daily rate for one week. They must have a maintaining spring to keep them going while winding. They should be thoroughly examined before purchasing, both for uniformity of rate extending over at least 10 periods of winding, and also for periodic errors which complete their cycle while the clock runs down once, and also for periodic error in the reading of the second-hand. Clocks which are

wound daily would, on the whole, probably be the most satisfactory.

6. The arrangement for stopping the pendulum should do this with as little shock as possible, and so as to cause no torsion on the suspending spring.

7. Since it will be perhaps impossible on account of the cost to provide each station with a second clock (for comparison if the first one is stopped and afterwards set going again) and also difficult to provide other signals than the regular noon signal, only one accurate time observation will be possible in 24 hours; but this will be sufficient for a commencement, and experience will show whether it is more advisable afterwards to give the first 10 stations a second clock or to increase the number of stations.

8. Observation books to be provided for the telegraph operators, in which they should enter in duplicate all the regular daily comparisons of clocks with the noon signal, and one of these sets should be weekly torn out and sent by mail to the Seismological Society. By this method the Society can keep a close watch upon the performance of the clocks. Separate books should also be provided in which to enter, also in duplicate, the records whenever the clock is stopped by any cause whatever. These records should comprise the reading of the clock face when found stopped, this to the nearest $\frac{1}{2}$ second; the time by a second clock (whole minute) when the first clock is started again and then the comparison of the two clocks with each other to the nearest half second; and any remarks as to intensity of shock, etc., if the observer noticed it. One of these records should be immediately torn out and sent by mail to the Seismological Society as soon as the record is completed.

[Here it is assumed that the telegraph office is provided with two good clocks like that described above, one to be kept going all the time, and the other fitted with the apparatus to stop it at the time of an earthquake. At stations thus provided with two clocks, they should both be compared daily with the noon signals]

9. The Seismological Society should appoint a permanent

committee to receive and thoroughly discuss these records when sent in, and from time to time prepare reports embodying the results of these observations and their discussion, these reports to be printed in the Transactions of the Seismological Society.

If the Society approve of the above recommendations for this class of observations, the committee recommend the appointment of a committee of two foreign and two Japanese members of the Society, to make the following examinations and investigations, and report to the Society as soon as possible:

1. To see whether the Telegraph Department will cooperate with the Society to the extent indicated in the above recommendations, and to ascertain the location of suitable offices, what kind of clocks they are furnished with, whether it will be possible to mount the necessary apparatus in one of these rooms, etc.

2. To ascertain if clocks which will satisfy the conditions specified above can be purchased either in Tokio or Yokohama, what such clocks will cost, and whether they can be obtained for one month's trial at an astronomical observatory, with the option of purchasing them or not to depend upon the results of the one month's examination.

3. To examine the different forms of apparatus for stopping a clock when a vibration of the ground occurs, and select the one which seems best adapted to the purpose, and also decide upon what degree of sensitiveness it seems best to give the apparatus, and how much such an attachment will cost.

4. To ascertain the probable cost of an accurate determination of the latitudes and longitudes of the different stations, and also the probable degree of accuracy of the present maps or determinations already available.

E. KNIPPING.

H. M. PAUL.

Note. A long discussion followed the reading of this report. The respective advantages of employing a clock from which the time could be automatically recorded without stopping the same, as compared with a clock which was stopped, were considered. Suggestions were made as to the advisability of employing some simple seismograph in conjunction with the clock. The plan adopted by the society will appear in a subsequent report.