OBERVATION OF THE NATURE (MODALITÄT) OF THE EARTHQUAKE OF JULY 25th 1880

BY MEANS OF

DR. G. WAGENER'S SEISMOMETER.

(READ JAN. 27TH, 1881)

(A Translation from the Mittheilungen der Deutschen Gesellschaft für Natur-und Völkerkunde Ostasien's.)

In the "Anleitungen zu wissenschaftlichen Beobachtungen auf Reisen, Erdbebenkunde," p. 311, it is said:

"Nature of movement.—The motion of the earth consists, "as indicated already by the name earthquake, always in a " series of quickly repeated shakings, which are recognised in " by far the most cases as an undulating up-and down-and side- " ways motion. Happily only very rarely the motion appears " as a thrusting one or even similar to that of a projectile " launched from a gun. Only in very slight cases the un- " dulating motion appears as a trembling of the same degree " throughout, but usually one or more stronger shakings can be " distinguished during the whole phenomenon, which are then " mentioned usually as single shocks."

Any one who has had frequent occasion to observe earthquakes will concede, that K. von Seebach has in the above lines characterised plainly the different kinds of earthquakes. But the observer, after answering the most important questions (see vol. 20, page 442) has another problem before him, viz. to measure if possible in each earthquake also carefully as much of the nature of the same as possible. It must be settled, whether proper apparatus gives the same or approximately the same results with regard to the nature of the shock as the feelings,—

whether in the observations, made till now as it seems without apparatus, the observer has not been deceived by his senses. I will here only mention the frequent difference as to the direction attributed to the same earthquake in the same place; the uncertainty which an observer often experiences, whether the earthquake is continuing, or whether it has ceased and the building only in which the observer dwells is still oscillating; and finally the notion of some observers, that many earthquakes last often only fractions of a second.

The complete solution of the problem, i. e. exact measurement of the nature of the motion by means of graphic representation (at first of the horizontal component) will be tried by Dr. Wagener's drum apparatus, which is not yet put up; the principle was indicated in vol. 15 of the "Mittheilungen" and the apparatus fully described in the Japan Gazette of July 10th 1880. But a preliminary answer to the question how the nature of an earthquake is in any single case observed by means of the apparatus for horizontal motion might already be of interest in several respects. For firstly the observation mentioned below is a proof that the theory of the apparatus is correct for the case in question and that the instrument is practical and reliable, and secondly, as far as I know, it is the first time pretty reliable data in absolute measure for the nature of an earthquake have been obtained.

On the 25th of July at 2^h 3.1^m p. m. mean Tokio time a pretty long earthquake commenced. About 0.3 m. after the commencement I stood before the seismometer and had for the first time a chance to observe how the same works *during* an earthquake, and at the same time the horizontal motion of the earth magnified 24 times.

The lower end of the indicating pendulum (see vol 14) and the hand immediately below it occupied my whole attention. The indicating pendulum went, while the hand stood at about 20° (corresponding motion 0.5 mm), in convulsive motions from side to side, till at 2 h. 3.6 m. a stronger shock came, moving the hand to 40° (1 mm.); after that the indicating pendulum went again from side to side, but without disturbing the hand any more, till at 2 h. 4.4 m. a still stronger shock came, moving the hand to 75° (1.67 mm.); after this (the strongest) shock the indicator pendulum still went for about 40 seconds from side to side, in convulsive, non quite regular ticks, without further moving the hand, till toward 2 h. 5.1 m. the earthquake ended and the indicating pendulum came almost instantaneously to rest.

The end of the earthquake according to the feeling—I stood the whole time on the ground before the apparatus—took place almost exactly at the same time, when the indicating pendulum came to rest. The whole motion and of course particularly the 2 last strong shocks (see figure) I felt quite plainly. Only the time of the first shock, when I was still in the house, is less certain. The ticks of the end of the indicating pendulum between the shocks were as far as I could judge of the same amplitude. I am quite sure that after the two last shocks no regular gradual decrease of the amplitude took place as with an ordinary pendulum, which is put in motion and left to itself.

For a better understanding of the preceding the following may be remarked: The framework, on which the apparatus is fixed, forms a heavy wooden foursided pyramid, strongly bound with iron bands, resting with the lower half of its base in the ground, and which can only get into motion if the earth moves. With such a framework there is obviously no possibility of independent oscillations.

If the indicating pendulum is brought into the 3 positions, which correspond to the above mentioned 3 shocks (horizontal motion 0.5, 1.0 and 1.67 mm.) it comes to rest in 1, 1,2 and 2,2 seconds respectively; in an earthquake it must come to rest far quicker still, the circumstances being much more favorable: (1)

From the adduced observation the following conclusions result:

1) The motion of the earth continued without interruption fully 2 minutes; because, if there had been an interrup-

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(1) *In the experiment the heavy ball (25 Kg.) is moved from the vertical line, while in an earthquake, as above, the heavy ball remains nearly in its absolute position in space.*

tion of even only 2 seconds, the same would doubtless have been recognised on the indicating pendulum.

2) During the motion of the earth 3 stronger shocks occurred, in time and in a progressing series 0.5, 1.0 and 1.67 mm strong. These measures represent:

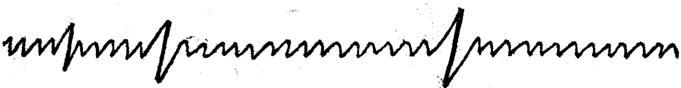
3) The exact absolute quantity of the greatest horizontal displacement of a point in the earth's surface, measured from its place while at rest, for the 3 shocks, because all other motions were weaker.

4) The apparatus was free from after oscillations, which might have impaired the indications.

5) As the time of one half oscillation of the earth's surface amounted to about 0.8 to 1 second, there were in this earthquake from 75 to 60 whole oscillations.

Tokio, the 26th September. E. Knipping.

Earthquake of July 25th 1880.



2 h. 3.1m., p. m. 3.6 m. 4.4 m. 5.1 m.