82. *On the Observations of Slow Earthquake Motions.*

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The present author communicated at the last November meeting a paper concerning his new horizontal pendulum seismograph which can be so adjusted as to have a free vibration period as long as 3.5 minutes.¹⁾ Till then, the number of earthquakes actually observed with this instrument were only a few, but since then he has obtained other examples, of which some are especially interesting as they originated within a few hundred kilometers from Tokyo and showed the existence of such an extraordinary slow earth's movement as previously experienced in the case of distant earthquakes. The result of these observations with some remarks on two Chile destructive earthquakes constitutes the contents of the present paper.

The new instrument is so installed as to register EW component with a pointer magnification of 5 times and is almost perfectly damped. Its free vibration period T_0 ranged during the observations here cited from 140 sec. to 107 sec. The result is as follows :

(1) The earthquake of Oct. 26, 1926, originated probably near New Guinea. Fig. 1 is a reproduction of the original register reduced into two-fifth size. The most conspicuous feature of the seismogram is the existence of extraordinary slow and large waves A and B with the periods 53 and 94 sec. and westward displacements 6 and 2.5 mm. respectively. These waves are traceable in Fig. 2 and 3, which are the reproductions of the diagrams due to the same earthquake and obtained with the Mainka instruments at the Central Meteorological Observatory, Tokyo.

(2) The earthquake of Nov. 11, 1926, originated off the coast of Iwaki at 377 km. to NE of Tokyo (Fig. 4). The most remarkable feature is the appearance of four long waves A ($T=75$ s., $a=0.3$ mm.), B ($T=102$ s., $a=0.3$ mm.), C ($T=123$ s., $a=0.4$ mm.) and D ($T=150$ s., $a=0.3$ mm.). The waves, of which T is near T_0 , i.e. 140 s., may be

1) Proceedings Imp. Academy, 2, No. 9.

doubted as due to instrumental error, but it must be remarked that another diagram (Fig. 5), which is a reproduction reduced into one-third size from the register obtained with an Omori H.P. seismograph, of which T_0 , V and ν are respectively 62 s., 15 and 3.7:1, shows also traces of such long waves.

(3) The earthquake of Jan. 18, 1927, originated near N coast of Iwaki at 272 km. to NNE of Tokyo (Fig. 6). The pendulum ($T_0 = 107$ s.) registered three long waves A ($T=88$ s., $a=0.5$ mm.), B ($T=99$ s., $a=0.6$ mm.) and C ($T=220$ s., $a=0.6$ mm.).

(4) The earthquake of Feb. 16, 1927, originated probably off the Kurile Is. at 1830 km. from Tokyo. The pendulum ($T_0=109$ s.) registered P ($T=9$ s., $a=0.08$ mm.) at 10 h 39.0 m, S ($T=10$ s., $a=0.06$ mm.) at 10 h 42.1 m. and long waves A ($T=91$ s., $a=0.4$ mm.) at 10 h 42.9 m and B ($T=95$ s., $a=0.3$ mm.) at 10 h 44.4 m.

(5) The earthquake of March 3, 1927, originated probably near Mindanao Is. at 3420 km. from Tokyo. The pendulum ($T_0=109$ s.) registered eP at 10 h 14.0 m, S ($T=10$ s., $a=0.03$ mm.) at 10 h 19.2 m and long waves A ($T=55$ s., $a=0.5$ mm.) at 10 h 23.6 m, B ($T=35$ s., $a=0.4$ mm.) at 10 h 32.7 m and C ($T=78$ s., $a=0.6$ mm.) at 10 h 38.7 m.

Now, reviewing the Tokyo observation of the Atacama Earthquake of Nov. 11, 1922 (Fig. 7), and the Osaka observation of the Valparaiso Earthquake of Aug. 17, 1906 (Fig. 8),¹⁾ several series of extraordinary long waves predominating here and there in the whole course of the earthquake motion are noticed as follows :

The Atacama Earthquake $\left\{ \begin{array}{l} \text{Time of occurrence at the origin} = 4\text{h } 32.6\text{m.} \\ \Delta \text{ (arcual distance from Tokyo)} = 153^\circ. \end{array} \right.$

	A ₁	A ₂	B ₁	B ₂	B ₃	C	D ₁	D ₂	E
Time from P' (in min.)	16		38			57	84		126
T (in s.)	80	82	95	134	82	170	163	163	107
2a (in mm.)	0.1	0.2	0.36	0.4	0.6	0.6	0.3	0.4	0.2

The Valparaiso Earthquake $\left\{ \begin{array}{l} \text{Time of occurrence at the origin} = 0\text{h } 41\text{m.} \\ \Delta \text{ (arcual distance from Osaka)} = 156^\circ. \end{array} \right.$

	A ₁	A ₂	A ₃
Time from P' (in min.)	15.8		
T (in s.)	180	105	133
a (in mm.)	0.1	0.04	0.05

1) Bull. Imp. Earthq. Inv. Comm., I, 2.

Granted that P' corresponds to the dilatational waves propagated across the central core of the earth, the waves of A series appear to correspond to S' , the distortional waves propagated along the same route.¹⁾

The observations of the slow earth's movements due to earthquakes originated in various distances may be useful for solving certain geophysical problems ; the author, who is now endeavouring to set up a similar pendulum for another component, much hopes to know about the results of observation in other places.

1) Similar results have been obtained from the Tokyo observation of the Chile earthquakes of Aug. 6, 1913, Dec. 4, 1918, and April 14, 1927.