quick movements of T=0.20 sec. For the next 12.3 sec., the vibrations, which were free from the mixture of small movements, were perfectly regular: T=1.07 sec., max. 2a=0.094 mm. During the rest of the principal portion, the motion was much smaller: T=1.03 sec., max. 2a=0.038 mm. [End portion.] The vibrations were very small: T=1.3 sec., max. 2a=0.012 mm.

Comparison of the Longitudinal and Transverse Components. The preliminary small portion lasted 1.6 sec. longer in the transverse than in the other component, so that the 1st displacement of the "initial vibration" was entirely longitudinal: the resultant 2nd displacement (2a=0.019 mm) being directed away from the crater with the westward deviation of 8° from the radius. The maximum motion phase set in 10.0 sec. after the commencement in each component. During the 1st 14.6 sec. of the earthquake, the motion was greater in the longitudinal than in the transverse component. But thereafter vibrations were much more conspicuous in the latter than in the former, the max. 2a's in the two components being in the ratio of 15 to 10.

CHAPTER VIII. VOLCANIC MICRO-TREMORS AND SMALL NON-EXPLOSIVE ERUPTIONS OBSERVED AT YUNO-TAIRA, 1911—1912.*

71. *Volcanic micro-tremors and eruptions on Oct. 2nd, 1912.* *Tromometer Diagram: Longitudinal Component.* (Figs. 57 and 58.) The first 154 eruptions, which occurred between 11. 22. 40 a.m. and 1. 04. 27 p.m., were small and of the simpler type. Thereafter the eruptions, though still of small magnitude, happened in close succession, so that the diagram indicated, for the

* The times of occurrence of the different outbursts considered in this chapter are those registered by the tromometer at Yuno-taira.

next $1^h 59^m\frac{1}{3}$ a continuous series of the volcanic micro-tremors. From about 3. 03. 45 p.m., the shocks, most of which were of complex type, became again individually distinct, some of the greatest occurring at 3. 54. 22 ; 3. 58. 59 ; and 6. 48. 12 p.m. The explosions became gradually fewer, finally ending with the one at 8. 44. 52 p.m. Thus it will be seen that the eruptions on the day in question lasted altogether about $9\frac{1}{3}$ hours.

(**i.**) The elements of motion of the continuous "*volcanic micro-tremors*" were as follows :—

T (sec.)	**2a** (mm)	**T** (sec.)	**2a** (mm)	**T** (sec.)	**2a** (mm)
1.26	0.0037	0.29	0.0025	0.83	0.0044
1.30	42	0.27	17	1.23	56
1.32	42	0.84	60	1.24	67
0.95	31	0.85	47	0.50	47
0.97	34	0.45	21	0.55	36
0.49	17	1.00	27	1.19	39
0.92	37	0.96	33	0.32	09
1.17	89	1.18	42	1.32	47
1.29	68	0.46	14	0.82	49
0.94	55	0.38	09	0.32	17
0.88	57	0.34	17	0.49	41
0.93	67	0.95	46		

(**ii.**) The elements of motion of some of the typical *eruptions in the 1st stage*, or those which occurred previous to the appearance of the micro-tremors were as follows.

Eruption of 11. 59.05 a.m. A very small shock. Total duration =29 sec. [Preliminary portion.] Duration=4.5 sec. [Principal portion.] Duration=9.0 sec. T=0.40 sec., 2a=0.001 mm.

Eruption of 0. 20. 09 p.m. Total duration=28 sec. During the first 4.5 sec. of the principal portion, the vibrations were largest: T=1.32 sec., 2a=0.005 mm. The subsequent portion was made

up of vibrations of T=1.03 sec., mixed with the quicker ones.

Eruption of 0. 21. 02 p.m. [Preliminary portion.] Duration= 4.3 sec. [Principal portion.] Duration=9.4 sec. T=0.46 sec., 2a =0.001 mm; T=0.64 sec., 2a=0.0008 mm.

Eruption of 0. 42. 13 p.m. [Preliminary portion.] Duration= 4.7 sec. T=0.46 sec.; T=0.72 sec., 2a=0.0008 mm. [Principal portion.] Duration=14.4 sec. T=0.36 sec., 2a=0.0026 mm; T= 0.70 sec., 2a=0.005 mm. At first, there were traces of slow movements of T=1.7 sec.

Eruption of 0. 42. 35 p.m. [Preliminary portion.] Duration= 5.4 sec. T=0.82 sec., 2a=0.0008 mm. [Principal portion.] Duration =11.6 sec. T=1.35 sec., 2a=0.009 mm; T=0.57 sec., 2a=0.004 mm., mixed with some quicker movements. [End portion.] T=1.27 sec., 2a=0.0033 mm; T=0.40 sec., 2a=0.0017 mm.

Eruption of 1. 02. 36 p.m. [Preliminary portion.] Duration= 5.6 sec. T=1.06 sec., T=0.52 sec., 2a=0.0004 mm. [Principal portion.] Duration=8.4 sec. T=1.39 sec., 2a=0.005 mm; mixed with small vibrations of T=0.42 sec. [End portion.] T=0.56 sec., 2a=0.0014 mm.

(**iii.**) The elements of motion of some of the typical *eruptions in the 3rd stage*, or those which occurred subsequent to the appearance of the micro-tremors, were as follows.

Eruption of 3. 32. 27 p.m. [Principal portion.] Duration=9.0 sec. T=1.27 sec., max. 2a=0.018 mm (2nd vibration), mixed with quick movements of T=0.40 sec.

Eruption of 3. 33. 33 p.m. [Preliminary portion.] Duration= 4.2 sec. [Principal portion.] Duration=18.6 sec. In the 1st 5.5 sec., the motion was simple and made up of 5 slow vibrations of T=1.10 sec., 2a=0.0068 mm, the superposed movements being insignificant. In the remaining part of this phase, the motion

consisted of the vibrations of T=1.04 sec., 2a=0.011 mm, mixed with quick ones of T=0.35 sec., 2a=0.0041 mm. [End portion.] T=0.58 sec., mixed with slower movements.

Eruption of 3. 54. 22 p.m. This was the largest disturbance which occurred on Oct. 2nd. [Preliminary portion.] Duration=5.6 sec. T=0.56 sec., 2a=0.0012 mm. [Principal portion.] Duration=9.0 sec. In the 1st 3.8 sec., there were three slow vibrations of T=1.27 sec. of gradually increasing amplitude, the 3rd having the max. 2a of 0.027 mm. In the remaining 5.2 sec. of this phase, the motion was made up of well defined quick vibrations of T=0.52 sec., the 1st two of which had the greatest 2a's respectively of 0.0246 and 0.0241 mm. [End portion.] T=0.53 sec., 2a=0.0049 mm; T=0.92 sec., 2a=0.0041 mm.

Eruptions of 3. 55. 03 and 3. 55. 18 p.m. In the principal portion of these two successive shocks, lasting together 23.2 sec., the motion was composed chiefly of the following vibrations:

T (sec)	2a (mm)	T (sec.)	2a (mm)	T (sec.)	2a (mm)
0.33	0.0081	0.58	0.010	1.04	0.0076
0.31	0.0078	0.47	0.011		

Eruption of 3. 55. 39 p.m. [Principal portion.] Duration=8.1 sec. T=0.36 sec., 2a=0.013 mm; T=0.89 sec. (2a small).

Eruption of 3. 55. 52 p.m. [Principal portion.] Duration=10.6 sec. T=0.92 sec., 2a=0.013 mm; T=0.41 sec., 2a=0.0068 mm.

Eruption of 3. 56. 06 p.m. [Principal portion.] Duration=8.0 sec. The motion was composed chiefly of well defined quick vibrations of T=0.36 sec., 2a=0.013 mm, which were mixed with slower movements.

Eruption of 4. 15. 54 p.m. Total duration=28 sec. [Preliminary portion.] Duration=6.9 sec. T=0.40 sec., 2a=0.0009 mm. [Principal portion.] Duration=5.7 sec. The motion consisted almost

entirely of quick vibrations of T=0.44 sec., 2a=0.01 mm. [End portion.] T=0.46 sec., 2a=0.0030 mm.

Eruption of 4. 18. 56. p.m. Total duration was over 29 sec. [Preliminary portion.] Duration=8.8 sec. T=0.89 sec., 2a=0.0009 mm; mixed with some smaller vibrations. [Principal portion.] T=0.53 sec., 2a=0.003 mm; T=1.1 sec.

Eruption of 5. 00. 37 p.m. Total duration=44 sec. [Preliminary portion.] Duration=7.0 sec. [Principal portion.] For the 1st 6.1 sec., the motion was composed chiefly of the vibrations of T =0.58 sec., 2a=0.004 mm. Thereafter the motion consisted of regular movements of T=0.48 sec., 2a=0.0025 mm, and remained almost uniform in amplitude till the end of the earthquake. The character of motion thus suggests the case of a small but steady smoke eruption which continued for some 30 or 40 seconds. The two following earthquakes were of the same type.

Eruption of 5. 06. 36 p.m. Total duration=35 sec. [Preliminary portion.] Duration=6.6 sec. apprx. [Principal portion.] Duration =15.0 sec. In the 1st 3.8 sec., the motion was comparatively small: T=0.36 sec., 2a=0.0034 mm. In the remaining 11.2 sec., the vibrations were perfectly regular: T=0.48 sec., 2a=0.009 mm. [End portion.] T=0.46 sec.

Eruption of 5. 07. 08 p.m. [Principal portion.] Duration=12.8 sec. T=0.47 sec., 2a=0.004 mm.

Eruption of 6. 48. 12 p.m. Total duration=50 sec., apprx. [Preliminary portion.] Duration=3.5 sec. [Principal portion.] Duration=10.4 sec. In the 1st 8.2 sec., the motion was made up of 6 slow vibrations, which gradually increased in amplitude till the 5th one: T=1.37 sec., max. 2a=0.03 mm. Thereafter the vibrations were: T=0.55 sec., 2a=0.0125 mm. [End portion.] T= 1.01 sec.

72. *Eruption of July 1st, 1911, at 11. 32. 08 a.m.* Total duration=60 sec. *Longitudinal Component.* [Prelim. portion.] Duration=6.0 sec. T=0.83 sec., 2a=0.0014 mm. [Principal portion.] Duration=15.0 sec. T=0.80 sec., 2a=0.01 mm. [End portion.] T=0.78 sec., 2a=0.0031 mm. *Transverse Component.* [Prelim. portion.] Duration=4.8 sec., 2a=0.004 mm, T=1.2 sec. apprx. [Principal portion.] Duration=14.6 sec. The motion consisted of vibrations of T=1.25 sec., 2a=0.014 mm, mixed with quicker movements of T=0.54 sec. [End portion.] T=0.67 sec., 2a=0.0042 mm.

73. *Eruption of July 2nd, 1911, at 2. 18. 23 p.m.* Total duration=40 sec. *Longitudinal Component.* [Prelim. portion.] Duration=3.7 sec. [Principal portion.] Duration=14.6 sec. The motion consisted of comparatively slow vibrations of T=0.90 sec., 2a=0.015 mm, mixed with quick movements of T=0.38 sec. [End portion]. The vibrations were regular: T=0.82 sec., 2a=0.0023 mm, there being at first also small quick movements of T=0.40 sec. Toward the very end, there were some traces of slow movements of T=2.6 sec. *Transverse Component.* [Prelim. portion.] Duration=5.3 sec. [Principal portion.] Duration=12.8 sec. The motion was regular: T=0.80 sec., 2a=0.012 mm. [End portion.] T=0.88 sec., 2a=0.005 mm.

74. *Eruption of July 8th, 1911, at 10. 16. 04 a.m.* Total duration=50 sec. *Longitudinal Component.* [Preliminary portion.] Duration=5.5 sec. [Principal portion.] Duration=11.5 sec. T=0.75 sec., max. 2a=0.031 mm. [End portion.] T=0.74 sec., 2a=0.007 mm. *Transverse Component.* [Preliminary portion.] Duration=4.2 sec. [Principal portion.] Duration=8.8 sec. T=0.77 sec., 2a=0.03 mm. [End portion.] T=0.72 sec., 2a=0.006 mm.

75. *Eruption of July 14th, 1911, at 4. 32. 26 a.m.* *Longitudinal Component.* Total duration=60 sec. [Preliminary portion.] Du-

ration=5.5 sec. : 2a=0.0009 mm, T=0.92 sec., T=1.4 sec. [Principal portion.] Duration=9.5 sec. Motion was regular, max. 2a=0.015 mm, T=0.95 sec. [End portion.] Motion gradually decreased : max. 2a=0.0036 mm, T=0.74 sec. *Transverse Component.* [Preliminary portion.] Duration=18.2 sec., 2a=0.0033 mm, T=1.4 sec. Principal portion.] Duration=8.7 sec. Motion was regular : max. 2a=0.02 mm, T=0.79 sec. [End portion.] T=1.0 sec.

76. *Eruption of July 21st, 1911, at 10. 47. 40 p.m.* Total duration=35 sec. *Longitudinal Component.* [Preliminary portion.] Duration=2.3 sec. T=0.8 sec. [Principal portion.] Duration=18.6 sec. During the 1st 11.2 sec., the motion consisted of comparatively slow vibrations of T=1.32 sec., 2a=0.023 mm, mixed with those of half period. During the rest of this phase, there predominated quick movements of T=0.43 sec., 2a=0.0095 mm, mixed with slower ones of T=1.03 sec. [End portion.] T=0.76 sec., 2a=0.0036 mm. *Transverse Component.* [Preliminary portion.] Duration=3.4 sec., T=0.78 sec., 2a=0.0035 mm. [Principal portion.] Duration=15.0 sec. The motion was composed of the vibrations of T=0.72 sec., 2a=0.016 mm, mixed with some slower ones. [End portion.] T=0.91 sec., 2a=0.0036 mm ; T=0.58 sec.

77. *Eruption of Aug. 15th, 1911, at 4. 42. 50 a.m.* This was a small outburst, which projected out stones and killed one police constable and an American missionary who were then sitting at the crater edge.* From Fig. 61, which is a photographic enlargement (magnification=630) of the longitudinal component of the tremor-recorder diagram, the eruption seems to have been followed at close intervals by at least three minor ones, making up the total duration of about 1^m 40^s. In the principal, or first, eruption the preliminary portion lasted 2.8 sec. During the

* See the Bulletin, Vol. VI, No. 1, p. 32.

first 8.8 sec. of the principal portion, the motion consisted of vibrations of T=1.5 sec., 2a=0.013 mm, divided into those of half period. During the remaining 10.4 sec. of the same phase, the motion was principally as follows:—T=1.1 sec., 2a=0.025 mm. The period of the regular vibrations in the end portion of the series of the different shocks was about 0.80 sec. In the preliminary portion and at the commencement of the principal portion, there were sometimes superpositions of the quick movements of period of about 0.4 sec.

78. *Eruption of Aug. 20th*, 1911, *at* 3. 38. 59 *a.m.* Total duration=37 sec. *Longitudinal Component.* [Preliminary tremor.] Duration=5.8 sec. T=0.86 sec., 2a=0.0036 mm. [Principal portion.] Duration=18.3 sec. During the 1st 5.4 sec., the motion consisted chiefly of slow vibrations: T=1.2 sec., 2a=0.019 mm. During the remaining 12.9 sec. of this phase, the motion was composed of nearly uniform quick vibrations of T=0.40 sec., 2a=0.017 mm, mixed with those of period of double length, T=0.80 sec. [End portion.] T=0.72 sec., 2a=0.0025 mm. *Transverse Component.* [Preliminary portion.] Duration=6.1 sec. 2a=0.0062 mm, T=1.0 sec. [Principal portion.] Duration=15.8 sec. T=0.53 sec., 2a=0.019 mm. [End portion.] T=0.65 sec., 2a=0.0018 mm.

79. *Eruption of Aug. 29th*, 1911, *at* 8. 35. 55 *p.m.* Total duration=62 sec. In the longitudinal component, recorded by the tromometer, the preliminary portion lasted 2.8 sec., followed by the principal portion which lasted 14 sec. and consisted of 13 nearly regular vibrations of T=1.08 sec., 2a=0.007 mm. In the end portion, the motion consisted of vibrations of T=0.66 sec., mixed with those of T=1.5 sec.

80. *Eruptions of Sept. 9th*, 1911, *at* 11. 49. 21 *and at* 11. 49. 59. *a.m.* These two small outbursts occurred in succession, together

lasting 1^m 31^s. In the longitudinal component of the 1st eruption the preliminary tremor lasted about 2.1 sec., and the principal portion began with 4 slow movements of T=1.6 sec., 2a=0.006 mm; the subsequent portion being made up of the following two series of vibrations:—T=0.87 sec., 2a=0.002 mm; T=1.4 sec., 2a 0.002 mm, mixed with smaller ones of T=0.6 sec. In the 2nd eruption, the principal portion lasted 13.2 sec. and consisted of 14 regular vibrations of T=0.94 sec., 2a=0.003 mm; the subsequent motion being made up of vibrations of T=0.91 sec. mixed with some quick movements. Again, in the earlier and end portions of the two disturbances there were superposition of minute tremors of T=0.35 sec.

81. *Eruption of Aug. 3rd, 1912, at 7. 51. 03 p.m.* *Tromometer Diagram*: *Longitudinal Component.* Total duration=40 sec. The commencement was very gradual and the preliminary tremor lasted 2.0 sec. The principal portion, which lasted 11.3 sec., consisted essentially of 7 slow vibrations of T=1.6 sec., 2a=0.0063 mm; the first being composed of the two displacements of 0.0014 and 0.0052 mm respectively toward, and away from, the crater. The end portion consisted of well-defined vibrations of T=0.65 sec., 2a=0.0026 mm, mixed with traces of the slow vibrations which predominated in the principal portion.

I mention next a few cases of the volcanic manifestations directly observed.

82. *Eruption of July 1st, 1912, at 5. 33. 40 p.m.* The present author, staying at the time in the Yuno-taira observatory, perceived the faint rumbling noise, with no simultaneous emission of black smoke from the crater. This was evidently one of those volcanic sounds which occur so frequently, as, for instance, on Dec. 24th, 1911, and each of which accompanies a small outburst throwing

out some rock fragments, but causing no special emission of black smoke. According to the tromometer diagram, the longitudinal component lasted 29 sec. and began with the preliminary portion of about 0.6 sec., followed by the principal portion, 4.6 sec. in duration, consisting of 4 vibrations of max. $2a=0.007$ mm, $T=1.2$ sec. In the end portion, which lasted 49 sec., the motion was as follows: $T=1.2$ sec., $2a=0.002$ mm; $T=0.9$ sec., $2a=0.001$ mm. The time of commencement of this extremely small shock, which was of course insensible, was according to the tromometer record, 5. 33. 39 p.m., or 11 seconds earlier than the moment when the sound was perceived at the observatory.

83. *Eruption of July 2nd, 1912, at 5. 29. 21 a.m.* (See § 4.) The black smokes were observed from Yuno-taira to appear over the top of the Maikake-yama first at about 5. 29. 50 a.m., or some 30 sec. after the outburst.

In Fig. 60 is reproduced a photographic enlargement of the tromometer diagram (longitudinal component). The total earthquake duration was about 1 min., and the preliminary portion lasted 6 sec., the movements in the principal portion of the two components being as follows:—

Longitudinal Component.... Max. $2a=0.0025$ mm, $T=1.4$ sec.
Transverse „ .... Max. $2a=0.001$ „ , $T=1.7$ „

84. *Eruption of Aug. 3rd, 1912, at 7. 20. 58 p.m.* (Fig. 59.) This consisted in an emission of a large quantity of dense gray smokes, whose appearance was first noticed at 7. 23. 10 p.m., by Mr. T. Toyoda at the Yuno-taira observatory. *Tromometer Diagram*: *Longitudinal Component.* Total duration=21 sec. The commencement of the motion was very gradual and uncertain, the preliminary portion lasting about 3.0 sec. The principal portion, whose duration was 10.0 sec., consisted during the first 4.7 sec. of $3\frac{1}{2}$

slow vibrations of T=1.35 sec., 2a=0.0046 mm, mixed with micro-tremors of T=0.26 sec.; the remaining part being composed of the smaller movements of T=0.82 sec.. T=0.37 sec. In the end portion, the motion was very small.

85. *Eruption of August 7th*, 1912, *at* 8.12.18 *a.m.* The smoke emission of this eruption was witnessed by Mr. T. Toyoda at 8.16 a.m. from the observatory. *Tromometer Diagram*: *Longitudinal Component.* Total duration=25 sec. There was apparently no preliminary tremor, and the motion was active during the first 5.4 sec., the maximum 2a of 0.0028 mm occurring 2.3 sec. after the commencement. The principal portion, in which the T was 0.47 sec., terminated with a conspicuous vibration of 2a=0.002 mm. In the end portion, the motion was very small: T=0.44 sec. This eruption was preceded by a very small one by an interval of 13.8 sec.

86. *Eruption of Aug. 7th*, 1912, *at* 9.41.03 *a.m.* Mr. Toyoda observed the smoke emission of this outburst at 9.49 a.m. from the foot of the Maikake-yama. *Tromometer Diagram*: *Longitudinal Component.* Total duration=55 sec. The commencement was fairly well marked, the preliminary portion (max. 2a=0.0005 mm) lasting 5.1 sec. The principal portion, which lasted 19.8 sec., was as follows:—(i), During the first 9.3 sec., the motion consisted of 6 slow vibrations of T=1.6 sec., 2a=0.002 mm mixed with quick movements of T=0.47 sec., 2a=0.0013 mm; (ii), during the remaining 10.5 sec., the motion became larger and quicker, being composed of the vibrations of T=0.93 sec. (2a=0.0026 mm), T=0.63 sec. (2a=0.0013 mm), mixed with still quicker movements. In the end portion, the vibrations were small: T=0.71 sec. (2a=0.0006 mm).

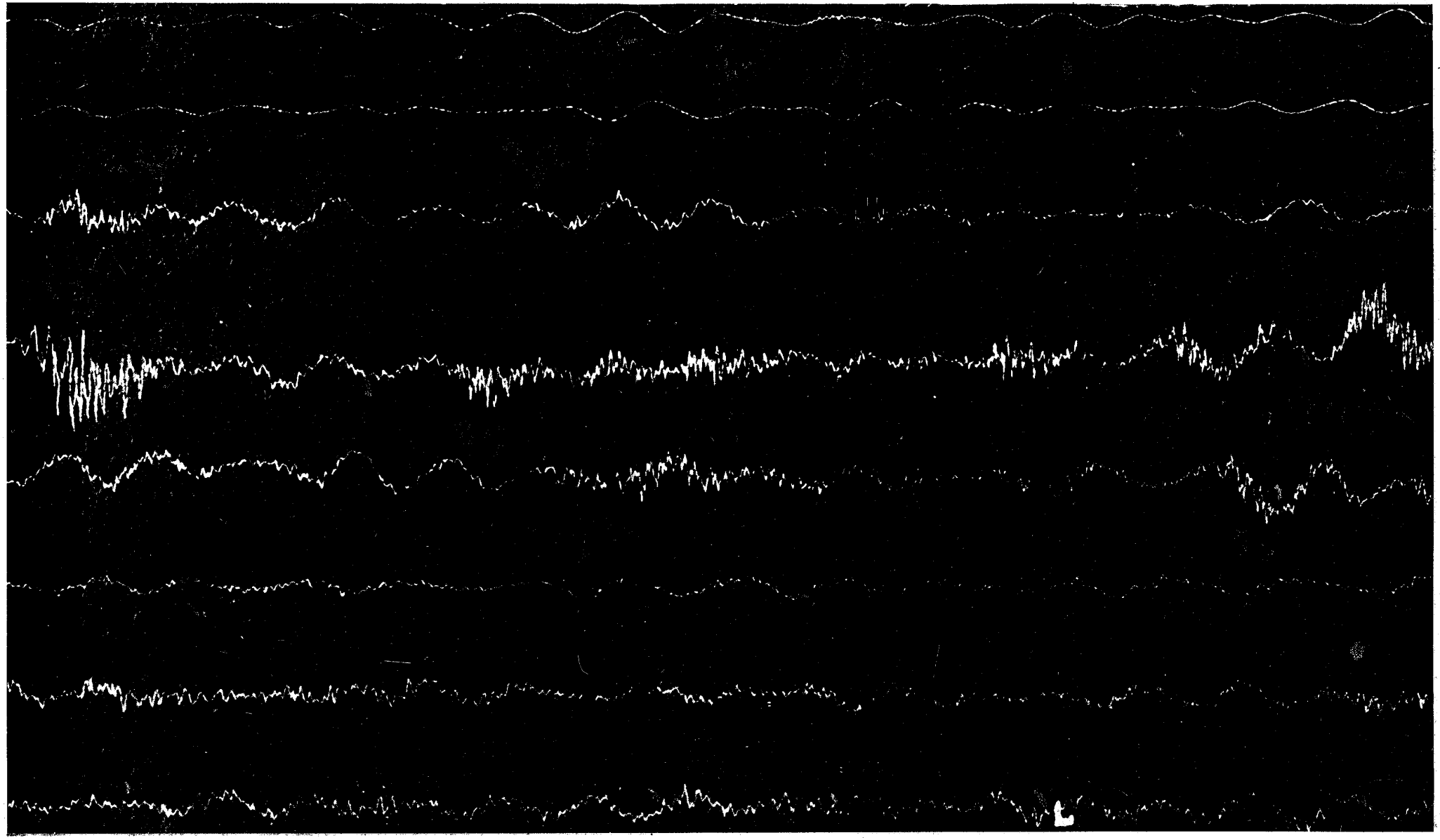
87. *Eruption of Aug. 22nd*, 1912, *at* 5. 23. 01 *a.m.* An

emission of black smoke was observed by the present author at 5. 27. 15 a.m. from the observatory. *Tromometer Diagram*: *Longitudinal Component.* Total duration=37 sec. The motion, which began very gradually, was small for the first 9.8 sec. During the next 9.8 sec., it was most active:—(i), in the first 3.9 sec., T=0.33 sec. (2a=0.001 mm), more or less distinctly grouped into movements of double period; (ii), in the remaining 5.8 sec., T=0.65 sec. (2a=0.0012 mm). In the subsequent part, or end portion, the motion was very small.

88. *Eruption of Aug. 23rd, 1912, at 3.13.53 p.m.* This consisted in the emission of a large quantity of dark gray smokes, succeeded by an abundant issue of white vapours; the eruption, accompanied by no sound, being the greatest which occurred in the day-time on the 23rd. As witnessed from the observatory, the smokes first appeared above the Maikake-yama at 3. 14. 13 p.m., or 12 seconds later than the time moment of the earthquake commencement recorded by the tromometer. After this eruption, some feeble rushing sounds were heard at the observatory probably due to an energetic ejection of the steam. *Tromometer Diagram*: *Longitudinal Component.* Total duration=16 sec. The commencement was well defined and the preliminary portion lasted 9.0 sec., during which the movements of T=0.52 sec. were mixed with those of T=0.3 sec., and the amplitude was uniformly small but for the occurrence of a maximum vibration of 2a=0.0006 mm. 2.9 sec. after the commencement. Then followed a single conspicuous slow oscillation of T=0.87 sec., whose two displacements were 0.0032 and 0.0052 mm and were directed respectively away from, and toward to, the crater; the superposed quick movements of T=0.26 sec. also simultaneously attaining the max. 2a of 0.0009 mm. The motion then rapidly decreased, being continued

Fig. 57. Volcanic Micro-tremors and Eruptive Earthquakes on Oct. 2nd, 1912.

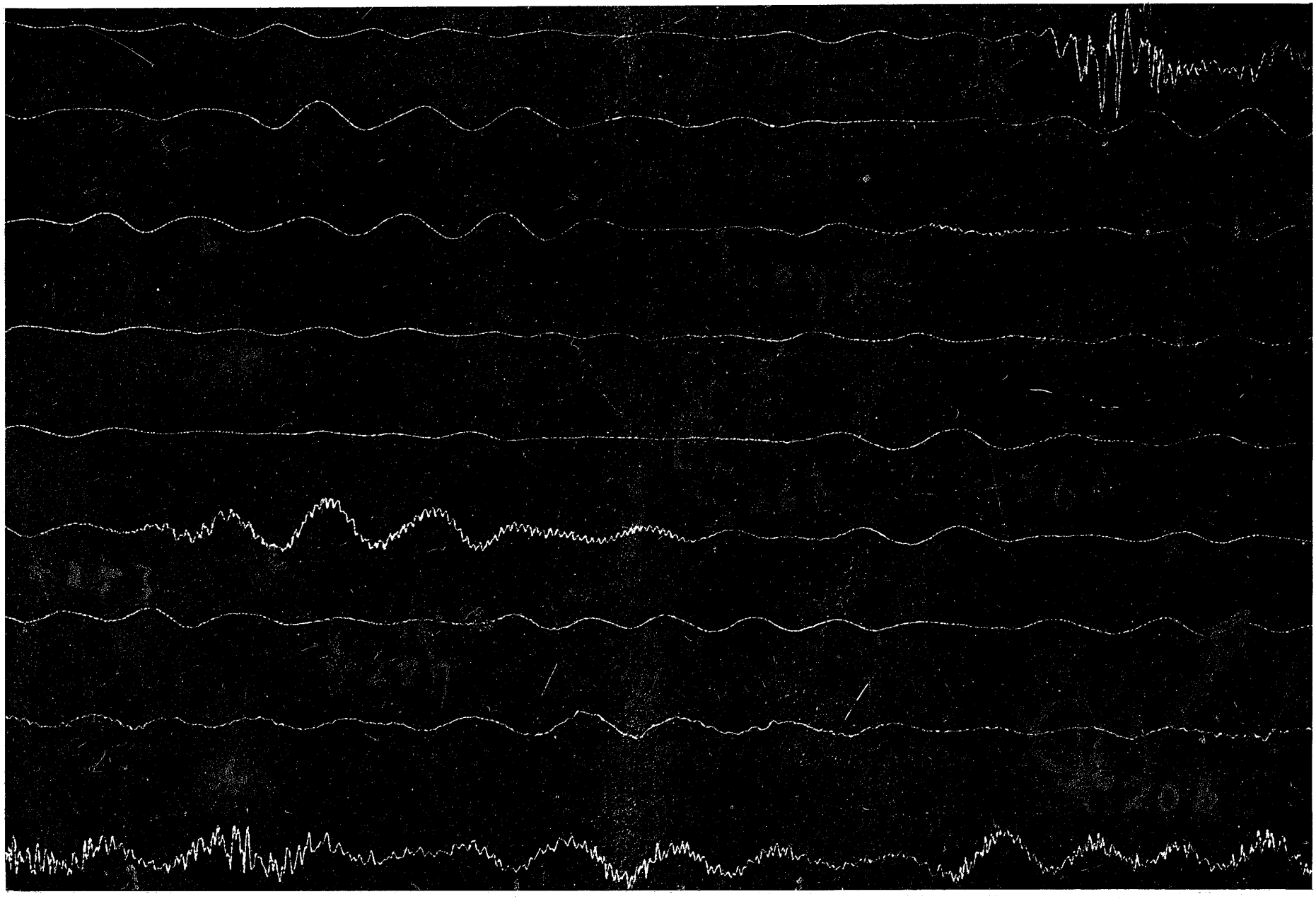
(Part of the Longitudinal Component Tromometer Diagram at Yuno-taira.)



→ Magnification = 810. Time Scale : 1 minute = 144 mm. (Slow regular movements are Pulsatory Oscillations.)

Fig. 58. Volcanic Micro-tremors and Eruptive Earthquakes on Oct. 2nd, 1912.

(Part of the Longitudinal Component Tromometer Diagram at Yuno-taira.)



⟶ Magnification = 810. Time Scale : 1 minute = 144 mm. (Slow regular movements are Pulsatory Oscillations.)

Yuno-taira Seismograms of Smaller Asama-yama Eruptions. [Longitudinal Component.]

Fig. 59. Aug. 3rd, 1912, at 7.23.23 p.m. (Tromometer Diagram). Magnification = 1220. Time Scale : 1 minute. = 380 mm.

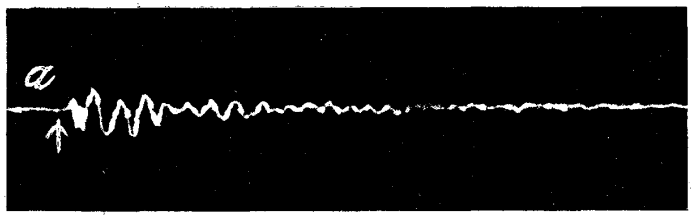


Fig. 60. July 2nd, 1912, at 5.29.21 a.m. (Tromometer Diagram). Magnification = 890. Time Scale : 1 minute = 137 mm.

Fig. 61. Aug. 15th, 1911, at 4.42.50 a.m. (Tremor-recorder Diagram.) Magnification = 630. Time Scale : 1 minute = 148 mm.

for only about 11 sec. after the above-mentioned large movement.

The eruption in question was followed 23.4 sec. after by a very small one of exactly the same character and of the total duration of 14.5 sec. In this second shaking, the time of commencement was 3.14.16 p.m., the motion being small and nearly uniform during the first 9.0 sec. Then there followed a single slow vibration consisting of the two displacements of 0.0007 and 0.0016 mm respectively away from, and toward to, the crater. The subsequent motion was very small.

At 1. 46. 26 p.m., on the same day, there was also a very small earthquake of the same sort; and of the total duration of 30 sec., a single conspicuous vibration (1st motion=0.0006 mm, 2nd motion=0.0009 mm) occurring about 9.5 sec. after the commencement.

CHAPTER IX. REMARKS ON THE SEISMOGRAPHICAL OBSERVATIONS OF THE ASAMA-YAMA ERUPTIONS AT YUNO-TAIRA, ASHINO-TAIRA, AND THE ASAMA PASTURE GROUND.

89. *Duration of motion of explosive Asama-yama eruptions.*

According to Table XV, the total duration of the longitudinal earthquake motion due to the strong Asama-yama explosive eruptions observed at the three stations of Yuno-taira, Ashino-taira, and the Asama Pasture Ground, was on the average roughly 100 to 150 sec., as follows:—

Yuno-taira	50	to 260	sec.;	mean,	118 sec.
Ashino-taira ..	70	„ 116	„ ;	„ ,	96 „
Asama P. G. ..	110	„ 240	„ ;	„ ,	156 „

The average duration of the principal portion was 25 sec. for Yuno-taira, 21 sec. for Ashino-taira, and 29 sec. for the Asama Pasture Ground. Again, the duration of the specially prominent