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CHAPTER VII. NON-EXPLOSIVE ERUPTIONS OBSERVED AT YUNO-TAIRA AND THE ASAMA PASTURE GROUND(THE ERUPTIONS AND EARTHQUAKES OF THE ASAMA-YAMA IV [Strong Asama-yama Outbursts, Dec. 1912 to May 1914])

journal or publication title	Bulletin of the Imperial Earthquake Investigation Committee
volume	7
number	1
page range	114-121
year	1914-08-23
URL	http://hdl.handle.net/2261/16052

The maximum and 1st well-defined transverse vibration occurred 1.8 sec. later than the longitudinal "initial vibration."

CHAPTER VII. NON-EXPLOSIVE ERUPTIONS OBSERVED AT YUNO-TAIRA AND THE ASAMA PASTURE GROUND.*

64. *Eruption of June 24th*, 1913, *at* 11. 34. 17 *p.m.* At Yuno-taira, there was perceived some sound, accompanied by the slight shakings of the building. As the mountain was shrouded in thick mists, the condition of the crater could not be ascertained.

Yuno-taira Tromometer Diagram: *Longitudinal Component.* Total duration=88 sec.

[Preliminary and principal portion: duration=21.1 sec.] Unlike the diagrams in the usual cases, the motion began with a very small "initial vibration," of T=2.7 sec., composed of the 1st, or inward, displacement of 0.001 mm, and the 2nd, or outward, one of 0.0034 mm. For the next 6.2 sec., the motion was largest, being composed of the 4 nearly equal vibrations of the average T=1.55 sec., max. 2a=0.0305 mm, mixed with the quick movements of T=0.30 sec., 2a=0.0164 mm; the quivering of the writing pointer due to the sound shock, occurring 5.5 sec. after the end of the 1st displacement of the "initial vibration." During the next 4.5 sec., the motion was smaller and consisted of vibrations of T=1.0 sec., 2a=0.016 mm, mixed with those of T=0.45 sec., 2a=0.0085 mm. During the remaining 7.6 sec. of the principal portion, the vibrations were small: T=0.9 sec., max. 2a=0.0077 mm. [End portion.] The motion was regular: T=0.64 sec., max. 2a=0.0039 mm.

65. *Eruption of July 1st*, 1913, *at* 0. 17. 01 *p.m.* At Yuno-

* The times of occurrence of the eruptions considered in this chapter are those registered at Yuno-taira, with the exception of the last case, for which the observation was made only at the Asama Pasture Ground.

taira, the eruption was announced by very faint sounds like those of distant thunders, causing the building to be shaken gently. At the same time, black smokes were just appearing upon the top of the Maikake-yama, this time moment being 14 sec. later than the commencement of the earthquake motion as registered by the tromometer. 2 or 3 sec. after there were heard the noises caused by the falling of the lava fragments on the upper part of the somma. A picture of this eruption seen from Yuno-taira is given in Fig. 4.

(i) *Yuno-taira Tromometer Diagram* : *Longitudinal Component.* (Fig. 56.) Total duration=150 sec.

The diagram indicates a well defined preliminary tremor, and consists, unlike those due to the explosions, of the slow vibrations mixed with a comparatively slight amount of the quicker movements. [Preliminary tremor.] Duration=2.3 sec. The motion was composed of small regular vibrations of T=0.31 sec., 2a=0.0004 mm, mixed with slow ones of T=0.99 sec., 2a=0.001 mm. [Principal portion.] Duration=13.4 sec. The "initial vibration" was composed of the 1st, or inward, and the 2nd, or outward, displacements respectively of 0.0097 and 0.043 mm, the period being 2.0 sec. The next vibration was small: T=1.23 sec., 2a=0.023 mm. The 3rd vibration was again much larger; T=1.54 sec., 2a=0.048 mm. So far there was practically no superposition of quick movements. These latter became, however, prominent (max. 2a=0.022 mm, T=0.27 sec.) during the next 4.8 sec., which interval may be regarded as forming the most active part of motion, and which began with a marked (slow period) displacement of 0.044 mm directed toward the origin. During the remaining 4.03 sec. of the principal portion, the motion was much smaller, being composed of slow vibrations of T=1.19 sec., 2a=0.013 mm, with slight

superpositions of small movements. The effect due to the sound shock was not clearly indicated. [End portion.] The motion was made up of slow vibrations of T=1.24 sec., max. 2a=0.0041 mm, mixed with small movements of T=0.44 sec., and T=0.58 sec. (max. 2a=0.0015 mm).

(ii) *Yuno-taira Tremor-recorder Diagram: Transverse Component.* The principal portion lasted 13.2 sec. and consisted of 9 regular vibrations of T=1.4 sec., the maximum (absolute) motion of 0.044 mm occurring 3.8 sec. after the commencement of this phase. In the end portion the vibrations of T=1.35 sec. (2a=0.004 mm) were mixed with those of T=0.62 sec.

66. *Eruption of Aug. 13th*, 1913, *at* 4. 01. 19 *p.m.* The rushing sounds of the eruption were heard at Yuno-taira for about 15 minutes. Throughout the day strong winds continued to blow, and the mountain was enclosed in thick mists.

Yuno-taira Tromometer Diagram: Longitudinal Component. Total duration=80 sec.

[Premonitary Eruption.] At 4. 01. 05 p.m. there took place a small earthquake caused by a premonitary eruption. After the preliminary portion of 1.5 sec. duration, there set in, for the next 3.7 sec., three well-defined vibrations of T=1.2 sec., max. 2a=0.0027 mm, mixed with minute movements of T=0.23 sec. For the next 3.6 sec., the motion was smaller: T=0.77 sec., 2a=0.0017 mm. For the next 5.0 sec., the motion became still smaller, indicating traces of oscillations of T=0.94 sec. Then took place the preliminary portion of the [Main Eruption], which lasted 3.2 sec. and consisted of small regular vibrations of T=0.23 sec., max. 2a=0.0013 mm. The principal portion, which lasted 13.1 sec., and consisted of slow movements with only insignificant mixture of quick tremors, was introduced by a vibration of T=1.08 sec.

composed of the two displacement of 0.0052 and 0.012 mm respectively. The next vibration, whose period was 1.45 sec., had the maximum (absolute) 2a of 0.023 mm. For the next 3.2 sec., there were 4 smaller vibrations of T=0.8 sec., max. 2a=0.015 mm, grouped into those of double period. During the remaining 7.6 sec. of the principal portion, there were 7 vibrations of T=1.1 sec., a max. 2a of 0.021 mm occurring at the commencement of this phase. Thereafter the motion became much smaller and was composed chiefly of two sets of vibrations whose mean periods were as follows:—

T=0.76 sec. (2a=0.0059 mm)	T=1.08 sec. (2a=0.0037 mm)
0.82	1.35 (2a=0.0021 „)
0.77	1.50

The period of the superposed small movements were 0.23 and 0.36 sec. The total duration of the two disturbances was over 80 sec.

67. *Eruption of Aug. 15th, 1913, at 9. 59. 11 a.m.* This eruption as well as the two others in the afternoon consisted in a very powerful emission of black smokes, which were seen also from the city of Nagano. On these occasions small platy lava fragments, of maximum weight of 16 grams were precipitated in great abundance at the base of the Ko-Asama. In the 2nd and 3rd eruptions, the sounds like those of billows of sea were heard at Yuno-taira for a few minutes. In Fig. 6 is given a view of the eruption in the morning taken from the Yuno-taira observatory.

Yuno-taira Tromometer Diagram: Longitudinal Component. The eruption was preceded by a volcanic earthquake, the total duration of the premonitary non-eruptive earthquake and the eruption effect being 3 min. The earthquake began, at 9. 59. 11 a.m. with a short preliminary tremor composed of a single small vibration of 0.0014 mm and of duration of 0.44 sec. The principal portion lasted 1.8 sec., and was made up entirely of very quick vibrations

of max. 2a=0.0497 mm. The subsequent motion was very small and composed of the vibrations of T=0.91 sec., mixed with those of T=0.35 sec.

For 6^m 28^s before the above-mentioned earthquake, the ground was making small slow vibrations of T=1.3 sec., max. 2a=0.0005 mm.

For 23.8 sec. after the earthquake, there were slight vibrations similar to those which existed previous to the latter. For the next 26.6 sec., the movements became more marked: T=1.2 sec., max. 2a=0.0008 mm, mixed with the tremors of T=0.39 sec. These probably formed the precursors of the eruption whose earthquake effects became larger during the next 30.0 sec., the motion consisting of vibrations of T=1.35 sec., max. 2a=0.004 mm, mixed with the smaller ones of T=0.73 sec., and still shorter ones. Then the motion bocame suddenly large, and there were, during the next 3.4 sec., an outward displacement of 0.009 mm, followed by 2 nearly equal conspicuous vibrations of T=1.34 sec., max. 2a=0.021 mm. Thereafter the motion decreased and, for the next 40.2 sec., was composed of the vibrations of T=1.18 sec., max. 2a =0.009 mm, mixed with some smaller ones. The subsequent vibrations were much smaller: T=1.27 sec. Till 10^h 10^m p.m. the ground continued to execute a sort of minute movements similar to those which existed before the premonitary earthquake.

68. *Eruption of Aug. 15th, 1913, at 3. 58. 46 p.m.* *Yunotaira Tromometer Diagram: Longitudinal Component.* Total Duration=3^m 25^s. The motion began gradually and consisted, for the 1st 47.7 sec., of regular vibrations of T=1.3 sec., max. 2a=0.0024 mm mixed with small movements of T=0.42 sec., and T=0.61 sec., max. 2a=0.0023 mm. Thereafter the motion became larger and nearly free from the superposition of the latter, being, for the next 28.7 sec., composed of the vibrations of T=1.9 sec., max. 2a=

0.0067 mm mixed with smaller ones. The subsequent motion was gentle and gradually decreased: T=1.8 sec., max. 2a=0.0019 mm, mixed occasionally with the small ones of T=0.97 sec.

69. *Eruption of Aug. 15th, 1913, at 5. 08. 54 p.m.* *Yunotaira Tromometer Diagram*: *Longitudinal Component.* Total duration=60 sec. apprx. The preliminary motion lasted about 2.0 sec. and was very small. The principal portion, which lasted 25 sec., began with the slow "initial vibration" of T=2.1 sec., composed of the 2 displacements of 0.010 and 0.034 mm (absolute maximum) respectively. During the next 9.1 sec., there were 8 vibrations of T=1.14 sec., whose 2a gradually decreased from 0.026 to 0.0038 mm; of these the 1st two only being mixed with small movements (T=0.24 sec. apprx., 2a=0.011 mm). During the remaining 13.8 sec. of the principal portion, the amplitude remained on the whole constant, the motion being composed of the vibrations of T=0.71 sec., max. 2a=0.0033 mm, grouped into the slower ones of T=1.27 sec., max. 2a=0.0047 mm. Thereafter the motion became much smaller, and consisted for the next 37.1 sec. of the vibrations of T=0.67 sec., T=1.04 sec., and T=1.25 sec., mixed with tremors of T=0.27 sec. Then the vibrations again gradually increased up to 2a of 0.0036 mm, on account of the renewed eruptive activity. The ground executed minute vibrations almost continuously till about 5.21 p.m.

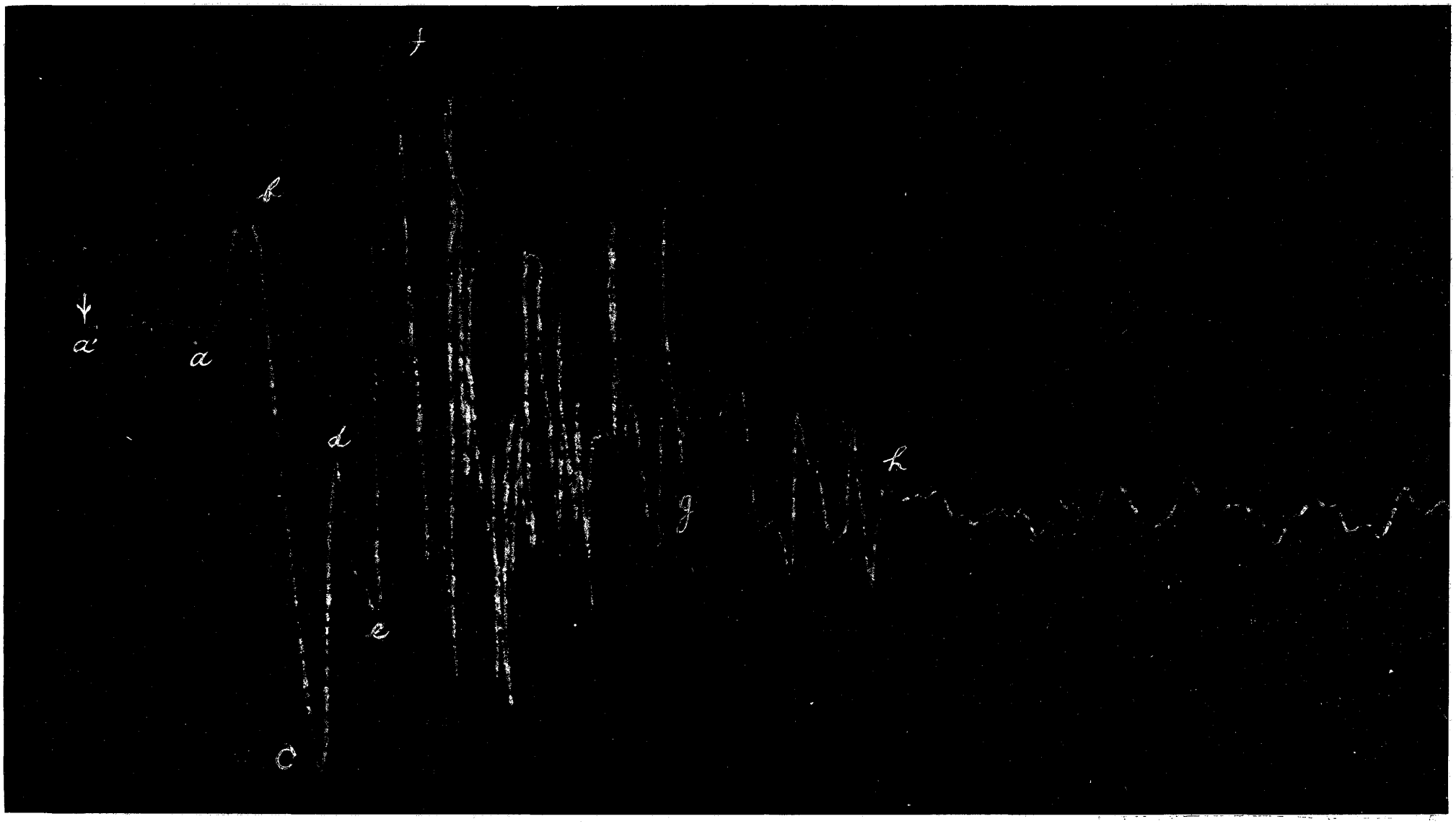
70. *Eruption of Nov. 20th, 1913, at 3. 40. 35 p.m.* (Fig. 50.) *Tremor-recorder Diagram at the Asama Pasture Ground.* Total duration=110 sec.

Longitudinal Component. [Preliminary and principal portions: duration=61 sec.] The motion was very small during the 1st 0.9 sec., after which took place the "initial vibration" of T=2.5 sec., composed of the 1st and 2nd displacements of 0.005 and

0.019 mm respectively. For the next 6.6 sec., there were two oscillations of nearly equal amplitude (max. $2a=0.053$ mm) of $T=3.3$ sec.; the moment of appearance of the superposed quick vibrations ($T=0.26$ sec., max. $2a=0.032$ mm) being 5.6 sec. after the earthquake commencement, or 3.6 sec. after the end of the 1st displacement of the "initial vibration," and coinciding with the occurrence of the eruptive phase which gave rise to the barometric disturbance. (See Chapter XIII.) For the next 4.8 sec., there were 2 large oscillations of $T=2.4$ sec., the max. (absolute) displacement of 0.21 mm occurring 12.3 sec. after the commencement. During the next 10.7 sec., the motion was smaller and composed of the vibrations of $T=0.82$ sec., max. $2a=0.062$ mm, mixed as before with quick vibrations. Thereafter the latter almost entirely disappeared, and the motion remained nearly constant during the remaining 36 sec. of the principal portion, being composed of the vibrations of $T=1.06$ sec., max. $2a=0.048$ mm, mixed more or less distinctly with slow oscillations of $T=3.3$ sec. [End portion.] The vibrations were small: $T=1.2$ sec., max. $2a=0.011$ mm.

Transverse Component. [Preliminary and principal portions: duration=72 sec.] The motion was practically *nil* during the 1st 2.5 sec., after which a small left-hand side displacement of 0.0028 mm took place, followed by a vibration of $T=2.2$ sec., $2a=0.040$ mm. For the next 4.3 sec., the motion was also small (max. $2a=0.051$ mm, $T=1.4$ sec.); there appearing, however, the superposition of quick movements of $T=0.18$ sec., max. $2a=0.011$ mm. Then took place a large oscillation of $T=1.84$ sec., whose 2nd displacement had the max. (absolute) $2a$ of 0.146 mm, and occurred 10.9 sec. after the earthquake commencement. For the next 5.6 sec., the motion was active and composed of 6 vibrations of $T=0.93$ sec., max. $2a=0.10$ mm, with the superposition of

Fig. 56. Non-detonative Eruption of Asama-yama on July 1st, 1913, observed at Yuno-taira.



Longitudinal Component. Magfn = 2000. Time Scale: 1 min. = 455 mm. a'....Commencement. a'a....Preliminary portion. eg....Most active part. ah....Principal portion. ab.... 1st displacement of the "initial vibration," abc, directed toward the crater.

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.