

CHAPTER V. FREQUENCY OF THE ERUPTIONS (THE
ERUPTIONS AND EARTHQUAKES OF THE ASAMA-YAMA VI
[Notes on the Eruptive and Seismic
Disturbances, 1911-1917])

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Date.	2a	Time of Occurrence.	Successive Time Difference.	Date.	2a	Time of Occurrence.	Successive Time Difference.
			m s				m s
X 5, 1916.	μ			X 6, 1916.	μ		
	2*	15.16 A.M.	17		7*	9.25.59 A.M.	13
	4*	55.33	2 45		209	26.12	17
	7*	58.18	10 6		45*	26.29	17
	45.	7.08.21	1 24		95	26.46	
	5*	09.48					
	⋮	⋮					
	8*	36.48	2 12				
	21	39.00	2 14		4*	10.40.24	
3*	41.14						

* indicates an unfelt shock.

CHAPTER V. FREQUENCY OF THE ERUPTIONS.

15. Occurrence of stronger explosion. The dates of the stronger Asama-yama explosions during the 24 years, 1894–1917, are shown in Table XI; the outbursts which occurred in quick succession and evidently formed a group being indicated by a bracket. The intervals between the successive eruptions, or the commencements of the different eruption groups, are shown in Table XII. With the exception of July 1894 to Feb. 1899, and Sept. 1902 to Dec. 1907, when the eruptions were very few, the intervals in question varied between 4 and 179 days, being, as shown in Table XIII, most frequently 4 to 11 days, with the mean of 7 days. This is nearly similar to the result mentioned in § 16 with respect to the recurrence of the maximum frequency of the small outbursts in 1913. Further, the stronger eruptions indicates amongst the others an interval of 167 to 179, with the mean of 170 days.

16. Time interval between successive maximum frequency groups of eruptions, in 1913. The dates of commencement of the different maximum frequency groups of the Asama-yama eruptions in 1913 are as follows :—

Date.	Daily Frequency.	Date.	Daily Frequency.
May 13th.	9	Aug. 3rd.	269
25th.	2	8th.	32
June 2nd.	3	12th.	158
21st.	168	17th.	58
July 1st.	12	21st.	23
5th.	475	27th.	269
10th.	6	Sept. 1st.	255
18th.	5	Oct. 15th.	693
26th.	7		

The intervals between the successive dates under consideration were mostly from 4 to 8 days, with the mean of 6 days, as follows :—

Time Interval.	Number of Cases.	Time Interval.	Number of Cases.
4 days	3	10 days	1
5	4	12	1
6	1	19	1
8	4	44	1

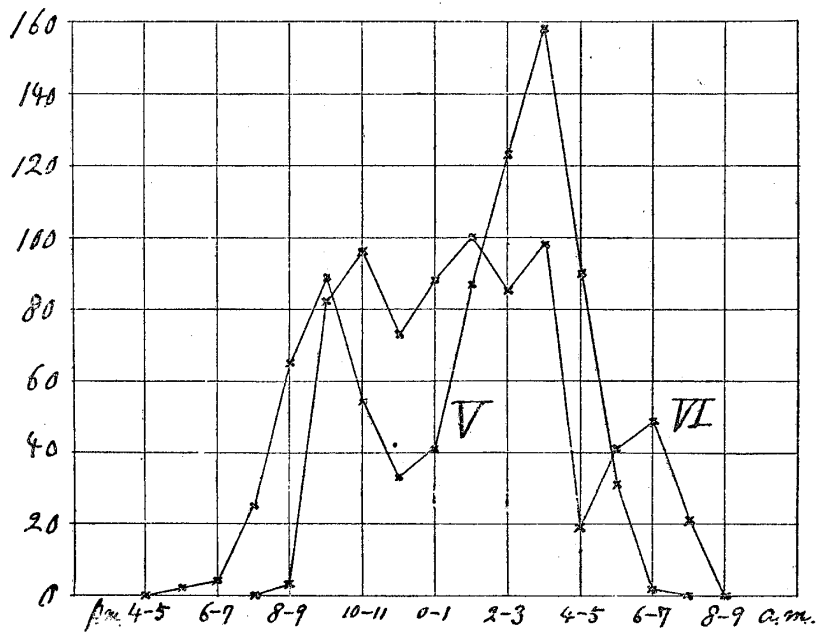
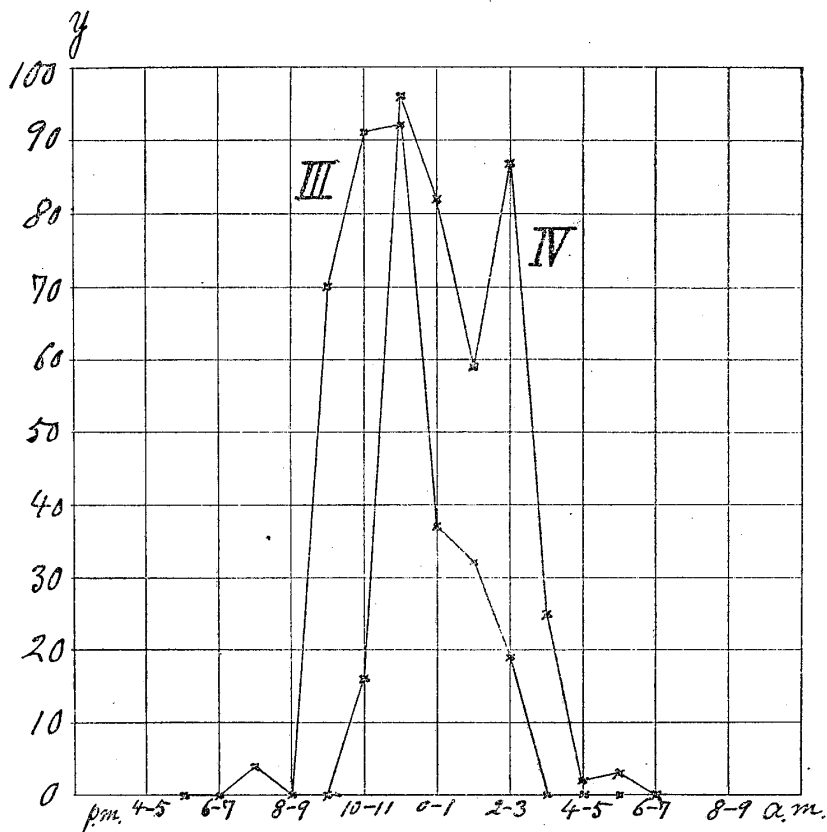
17. Variation in hourly frequency of eruptions. In the observations during the year 1913 at the Asama-yama stations several unbroken sets of closely succeeding volcanic outbursts have been completely registered, their hourly distribution for the interval between May 1st and Oct. 31st being shown in Table XXII. Amongst the others there were nine well marked eruption groups, as follows :

Group.	Month.	Most Active Epoch.	Duration.
i	June.	21st, 8-9 p.m. . . . 22nd, 0-1 a.m.	5 hours.
ii	„	23rd, 5-6 p.m. . . . 23rd, 10-11 p.m.	6
ix	July.	5th, 4-5 p.m. . . . 6th, 0-1 p.m.	21
vii	August.	3rd, 8-9 p.m. . . . 4th, 10-11 a.m.	15
iii	„	4th, 9-10 p.m. . . . 5th, 2-3 a.m.	6
iv	„	5th, 10-11 p.m. . . . 6th, 3-4 a.m.	6
v	„	27th, 7-8 p.m. . . . 28th, 5-6 a.m.	11
vi	September.	2nd, 8-9 p.m. . . . 3rd, 7-8 a.m.	11
viii	October.	15th, 3-4 a.m. . . . 15th, 1-2 p.m.	11

The duration of the greatest eruptive frequency in these different cases was about 6 hours, 12 hours, and 21 hours respectively for the groups (i) to (iv), (v) to (viii), and (ix). The duration of these three species of the eruptive epochs were thus approximately in the ratios of 1:2:3. This fact will also be seen from Table XIV, which gives the hourly frequency of the eruptions in the nine groups in question. Thus, comparing together all the different cases, we see that the frequency which became first pronounced at about 4 p.m. was reduced more or less distinctly to a minimum at about noon and next at about 8 a.m., suggesting the possibility of the existence of a period of 8-hours length.

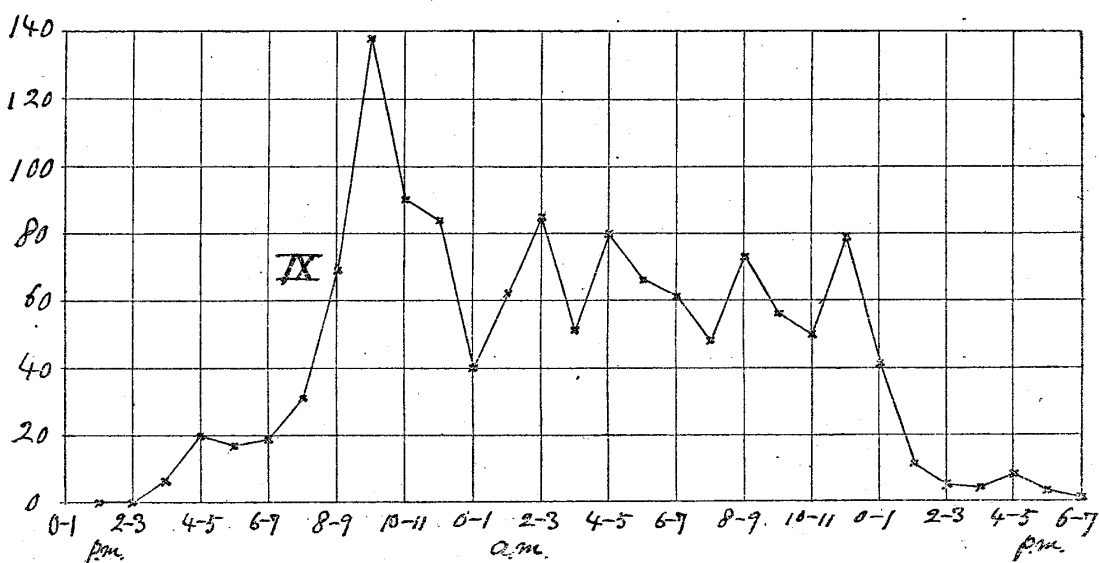
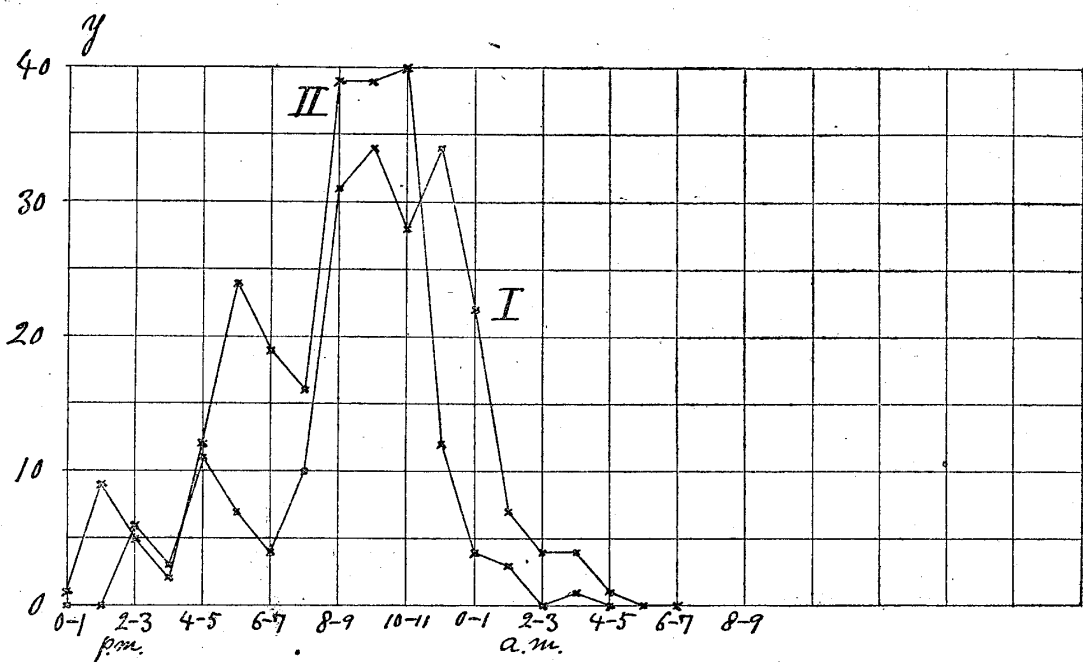
Figs. 11 and 12. Variation in the Hourly Frequency of the Asama-yama Explosions. (y =Hourly Number of Explosions)

III....Aug. 4th-5th, 1913. IV....Aug. 5th-6th, 1913.
 V....Aug. 27th-28th, ,, VI .. Sept. 2nd-3rd, ,,



Figs. 13 and 14. Variation in the Hourly Frequency of the Asama-yama Explosions. (y =Hourly Number of Explosions.)

I.....June 21st-22nd, 1913. II....June 23rd-24th, 1913.
 IX....July 5th-6th, „



Figs. 15 and 16. Average Course of the Hourly Frequency Variation of the Asama-yama Explosions. (Table XV.)

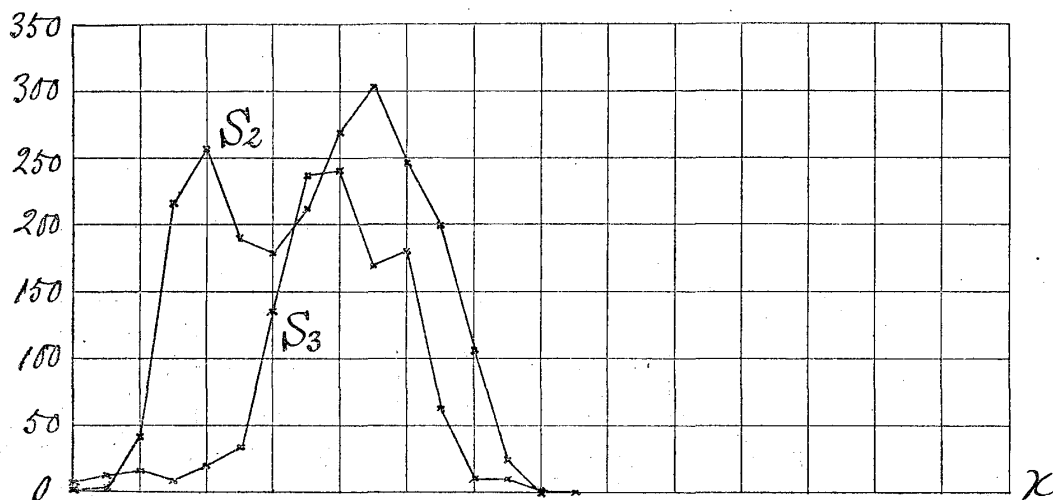
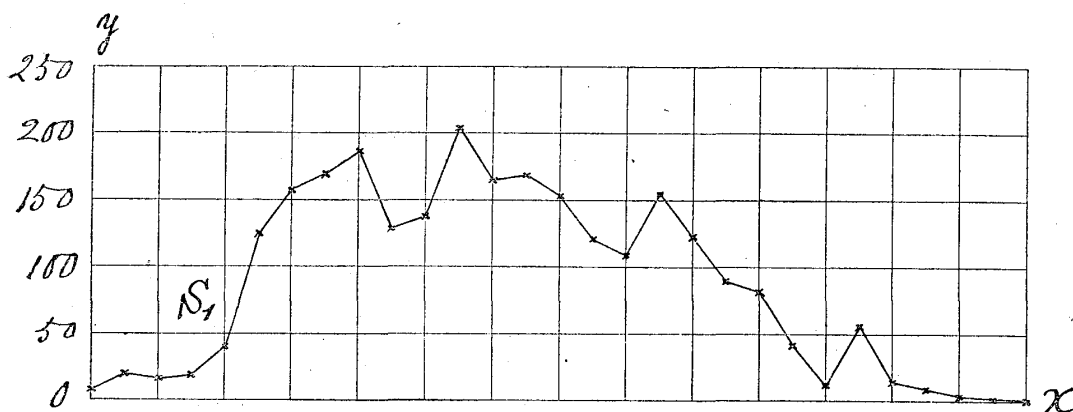
x = Hourly Interval.

y = Hourly Summation Number of Explosions.

S_1 Aug. 3rd-4th; and 5th-6th, 1913.

S_2 Sept. 1st-2nd; Oct. 15th; and Aug. 27th-28th, 1913.

S_3 Aug. 5th-6th and 4th-5th; and June 21st-22nd, and 23rd-24th, 1913.



From Table XIV and from the diagrams in figs. 11 to 14 it will be seen that the groups (i) to (ix) show among themselves certain similarities in the time of occurrence and the course of the frequency variation, such that, in Table XV, (S_2), i, ii, iii, and iv; (S_2), v, vi, and vii; and (S_1), viii and ix, have been respectively taken together. The results of the summation are illustrated in figs. 15 and 16. In S_2 and S_3 , whose duration was short, the increase and decrease of the eruptive frequency were quick; the principal portion of the variation indicating a mean rate of 55 to 85 per hour. In S_1 , which is complex and lengthy in duration, the variation was slow: the increase was at first in the rate of 34 per hour, while the average decrease rate was about 15 per hour.

18. 10-minutes frequency of eruptions. In Table XVI is indicated the 10-minutes frequency of the Asama-yama eruptions during the following 7 epochs in 1913, when the disturbances occurred in close succession:—

- | | |
|--------------------------|--------------------------|
| (i) June, 21st to 24th. | (v) Aug., 27th and 28th. |
| (ii) July 5th and 6th. | (vi) Sept. 1st and 2nd. |
| (iii) Aug., 3rd to 6th. | (vii) Oct. 15th. |
| (iv) Aug., 12th to 15th. | |

The maximum frequency during the epochs in question was 40, and gave the average quickest rate of one eruption in every $1\frac{1}{2}$ minutes. This interval is much longer than the successive time difference in the case of the A-type, or non-eruptive, seismic disturbances (§ 12).

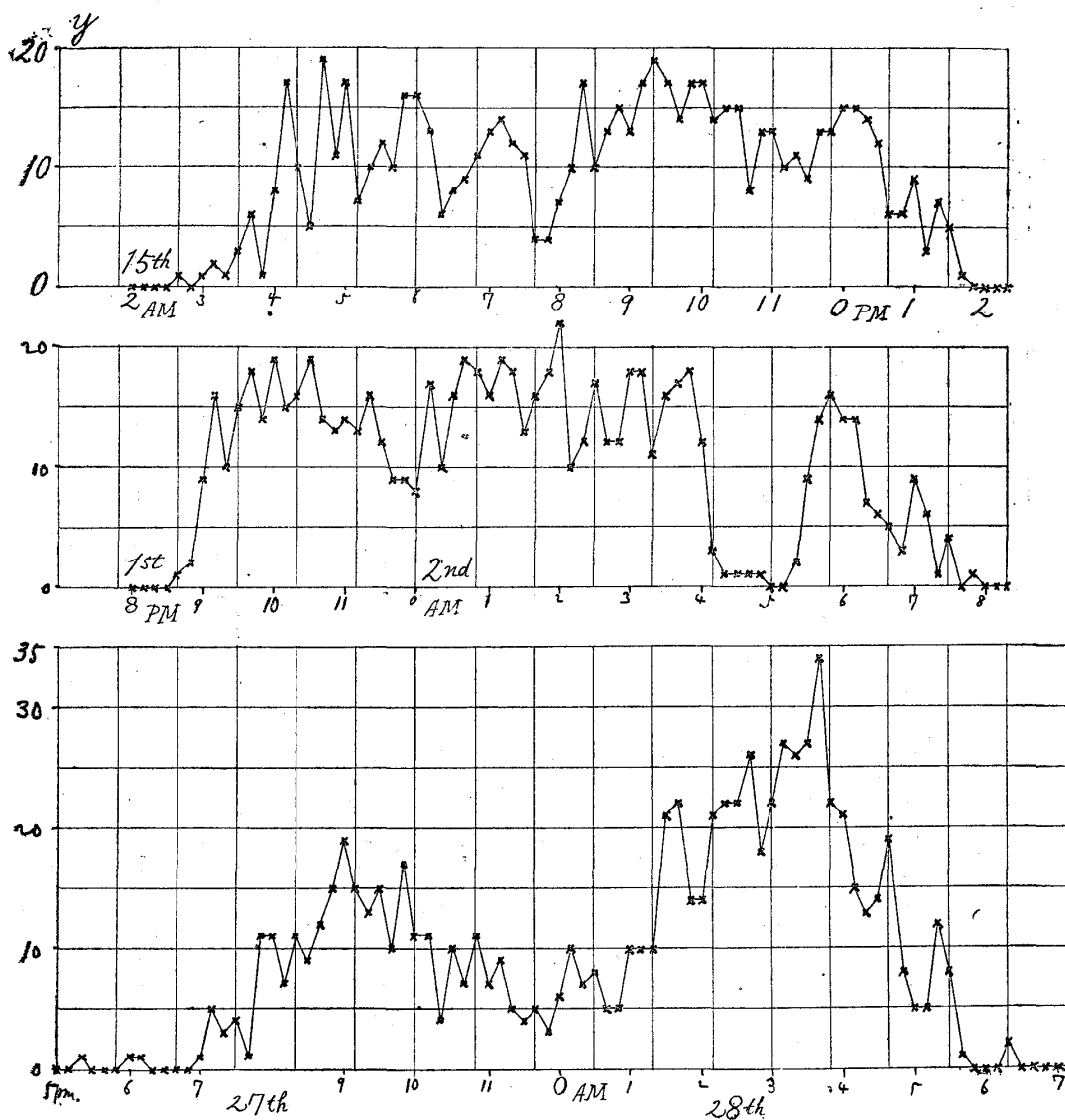
From the graphical representations in figs. 17, 18, and 19, it will be seen that the three activity epochs on Aug. 27th–28th,

Sept. 1st–2nd, and on Oct. 15th, were of an equal length, namely, about 11 hours. On the two occasions of July 5th–6th and of Aug. 3rd–4th, the duration was a little longer. (See figs. 20 and 21.) Again, in the eruptions on Aug. 27th–28th, the increase to a maximum and the decrease therefrom of the frequency were quite gradual, but in the other cases illustrated in figs. 18 and 19, the increase in the number of the eruptions took place quickly, sometimes in only about 40 to 80 minutes; the frequency, subject to fluctuations, remaining on the whole constant for a considerable portion of the subsequent stage.

Figs. 17 to 21 show more or less distinctly the periodic fluctuations in the frequency variation, with the average lengths of about 6, 2, and 1 hours, as follows:—

300 ^{min.}	100 ^{min.}	60 ^{min.}
320	120	65
360	127	<hr/> mean, 62
360	<hr/> mean, 116	
360		
380		
<hr/> mean, 250		

Figs. 17, 18, and 19. Variation in the 10 Minutes Frequency of the Asama-yama Explosions.



y = 10 Minutes Number of Explosions.

Fig. 17. Oct. 15th, 1913.

Fig. 18. Sept. 1st-2nd, 1913.

Fig. 19. Aug. 27th-28th, 1913.

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Figs. 20 and 21. Variation in the 10 Minutes Frequency of the Asama-yama Explosions.

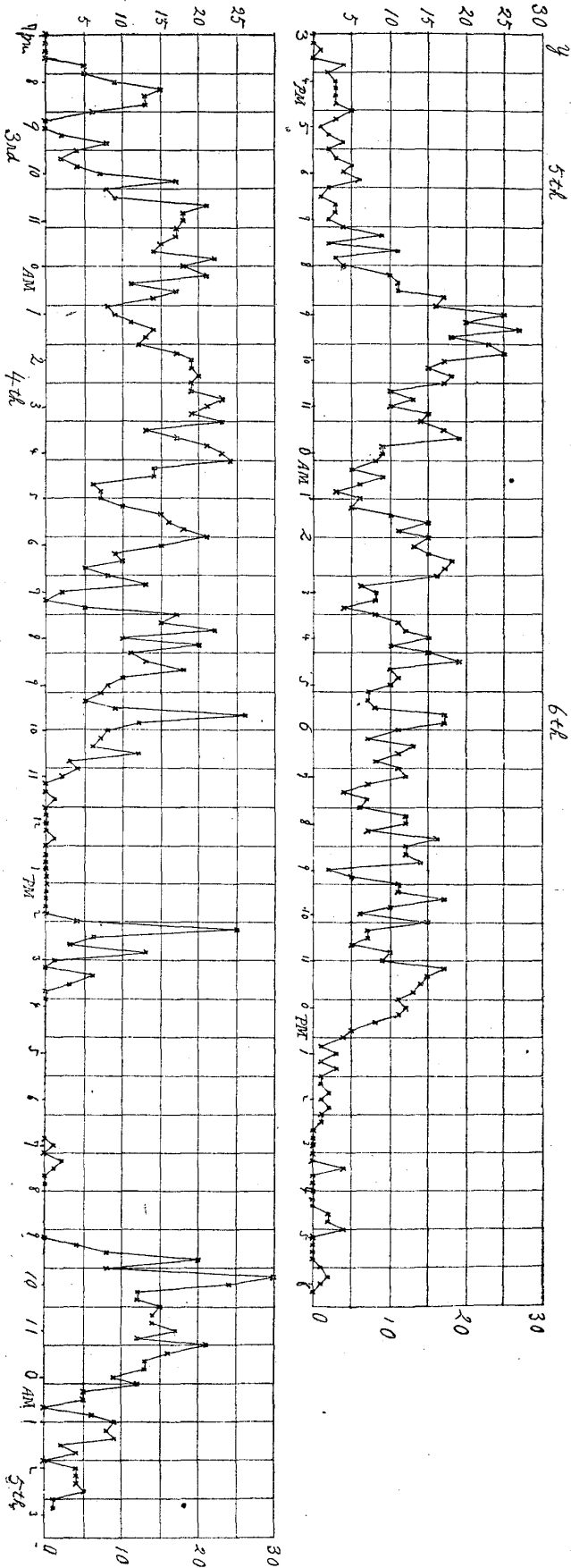


Fig. 20. July 5th-6th, 1913.

y = 10 Minutes Number of Explosions.

Fig. 21. Aug. 3rd-4th, 1913.

19. Explosion Frequency on 12th-15th, August, 1913. In the interval between the 12th and the 15th, August, the number of the volcanic outbursts was maximum at frequent epochs (fig. 22), as follows:

Date.	Maximum 10-Minutes Frequency.	Time of Maximum.	Successive Time Interval.
12th.	5	5 30 a.m.	7 ^h 50 ^m
"	12	1 20 p.m.	10 20
"	34	11 40 p.m.	9 40
13th.	25	9 20 a.m.	8 30
"	40	5 50 p.m.	6 00
"	12	11 50 p.m.	7 50
14th.	24	7 40 a.m.	6 40
"	22	2 20 p.m.	19 40
15th.	16	10 00 a.m.	7 00
"	24	7 00 p.m.	

Thus the successive maximum frequencies occurred at the intervals of 6^h00^m to 10^h20^m, with the exception of one case, the mean value being 8^h00^m. This result is in accord with that inferred from Table XIV.

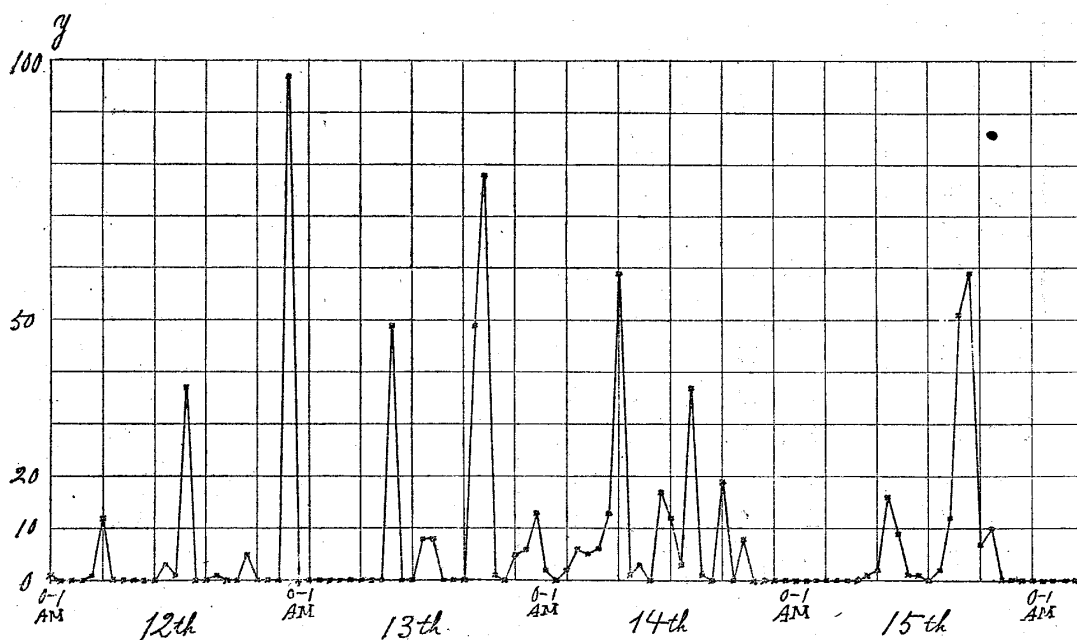


Fig. 22. Variation in the Hourly Frequency of the Asama-yama Explosions, Aug. 12th-15th, 1913. (y =Hourly Number of Explosions.)

TABLE XI. DATES OF THE STRONGER ASAMA-YAMA EXPLOSIONS.
1894—1919.

1894	1901	1909	1911	1913	1913
IV, 6	V, 25	V, 31	{ II, 4	{ IV, 18	XI, 14
" 11	VI, 10	VII, 6	{ " 6	{ " 21	" 20
" 17	" 15	VIII, 21	{ " 10	V, 16	1914
{ " 28	VII, 21	XI, 10	{ " 13	{ " 27	{ I, 11
{ " 30	VIII, 6	XII, 7	{ III, 21	{ " 29	{ " 12
V, 5	" 15	1910	{ " 21	VI, 13	{ " 26
" 13	" 20	II, 12	{ " 22	{ " 17	{ " 27
" 25	X, 13	V, 2	{ " 24	{ " 18	{ " 27
VI, 14	1902	VII, 5	{ " 25	{ " 20	{ " 28
[No outburst till 1899.]	II, 7	" 11	{ IV, 2	{ " 24	{ " 29
1899	VIII, 5	X, 21	{ " 2	{ " 26	II, 14
III, 11	1903	XI, 7	{ " 3	{ " 26	{ " 24
VII, 10	V, 28	XII, 2	{ " 4	VII, 1	{ " 27
" 15	VI, 30	{ " 15	{ " 7	{ " 7	III, 3
VIII, 7	1904	{ " 16	{ " 8	{ " 7	{ " 14
1900	VIII, 4	" 25	{ " 9	{ " 8	{ " 15
I, 22	1905	1911	{ " 11	" 13	{ " 23
" 31	X, 21	{ I, 3	{ " 13	{ " 18	{ " 25
{ II, 7	1906	{ " 6	{ " 16	{ " 19	" 30
{ " 9	IV, 6	" 16	V, 8	VIII, 12	{ IV, 6
" 14	" 20	" 17	X, 22	{ " 12	{ " 9
{ " 19	V, 7	" 17	XII, 3	{ " 15	V, 5
{ " 21	1907	" 18	1912	{ " 15	" 9
III, 1	I, 18	" 18	I, 28	" 15	" 19
{ " 18	III, 28	" 18	II, 13	IX, 21	VI, 24
{ " 21	VIII, 24	" 19	" 22	{ X, 15	{ XI, 12
" 31	1908	" 19	IV, 9	{ " 17	{ " 12
IV, 6	II, 13	" 19	" 15	" 26	{ " 15
VIII, 30	" 19	" 20	{ X, 2	{ XI, 3	{ " 16
XI, 19	VIII, 5	" 21	{ " 3	" 3	{ XII, 14
XII, 14	" 16	" 21	{ " 7	" 4	{ " 15
" 21	IX, 21	" 22	{ " 9	" 5	{ " 16
1901	1909	" 23	XII, 13	" 5	[No outburst till the commence- ment of 1919.]
III, 11	I, 29	" 23	1913	" 6	1919
IV, 20	II, 2	" 23	II, 11	" 6	III, 14
	IV, 2			" 6	

TABLE XII. INTERVAL BETWEEN THE SUCCESSIVE STRONGER ASAMA-YAMA EXPLOSIONS. 1894-1919.

(1894)	5 days.	(1901)	9 days.	(1910)	64 days.	(1913)	4 days.
	6		5		6		7
	11		54		102		7
	7		117		17		6
	8	(1902)	179		25		6
	12	(1903)	296		13		5
	21		33		10		25
[No outburst till 1899]		(1904)	401		9		40
(1899)	5	(1905)	443	(1911)	13		24
	23	(1906)	167		19		11
(1900)	168		14		6		8
	9		17		39		11
	7		255		12		6
	7	(1907)	69		5	(1914)	52
	5		149		31		15
	10		173		167		19
	17	(1908)	6		42		10
	13		168		56		7
	6		11	(1912)	16		11
	146		36		9		9
	81		130		47		7
	25	(1909)	4		6		7
	7		59		170		29
(1901)	80		59		5		4
	40		36		67		10
	35		46		60		36
	16		81	(1913)	66		141
	5		27		28		32
	36		67		11		
	16	(1910)	79		17		

TABLE XIII. VARIATION IN THE INTERVAL BETWEEN THE DATES
OF THE SUCCESSIVE STRONGER ASAMA-YAMA EXPLOSIONS,
1894—1914.

Successive Interval.	Number of Cases.	Successive Interval.	Number of Cases.
4 days.	3	47 days.	1
5	8	52	1
6	10	54	1
7	10	56	1
8	2	59	2
9	5	60	1
10	4	64	1
11	5	66	1
		67	2
12	2	69	1
13	3	79	1
14	1	80	1
15	1	81	2
16	3	102	1
17	3	117	1
19	2	130	1
21	1	141	1
23	1	146	1
24	1	149	1
25	3		
27	1	167	2
28	1	168	2
29	1	170	1
31	1	173	1
32	2	179	1
33	1		
35	1	255	1
36	4	296	1
39	1	401	1
40	2	443	1
42	1		
46	1		

TABLE XVI. 10-MINUTES FREQUENCY OF THE ASAMA-YAMA EXPLOSIONS DURING THE EPOCHS OF MAXIMUM ERUPTIVE ACTIVITY IN 1913.

Hour.	Minute.						Hour.	Minute.					
	0-10	10-20	20-30	30-40	40-50	50-60		0-10	10-20	20-30	30-40	40-50	50-60
(i) June 21st to 24th, 1913.							(ii) July 5th and 9th, 1913.						
21st; 2 p.m.	1	2	—	1	—	2	5th; 3 p.m.	—	—	1	0	4	2
3	—	1	—	—	1	1	4	3	3	3	3	5	3
4	—	2	—	—	6	3	5	1	2	4	2	3	5
5	4	2	—	1	—	—	6	4	6	2	1	3	3
6	—	1	—	1	1	1	7	2	4	9	2	11	3
7	—	1	1	3	3	2	8	4	10	11	11	17	16
8	2	3	6	6	6	8	9	25	20	27	18	23	25
9	2	7	5	8	8	4	10	17	15	18	17	10	13
10	3	1	5	4	7	8	11	10	15	14	17	19	9
11	3	7	9	6	5	4	6th; 0 a.m.	9	8	5	9	6	3
22nd; 0 a.m.	3	6	6	2	2	3	1	6	5	10	15	11	15
1	1	2	1	1	1	1	2	13	15	18	17	16	6
2	—	—	1	3	—	—	3	8	8	4	8	11	12
3	—	—	3	1	—	—	4	15	10	15	19	10	11
4	1	—	—	—	—	—	5	10	7	7	8	17	17
23rd; 0 p.m.	1	—	—	—	—	—	6	11	7	13	11	8	11
1	2	1	1	5	—	—	7	12	7	4	7	6	12
2	1	—	—	1	2	1	8	12	7	16	12	12	14
3	—	—	—	1	1	—	9	2	5	11	11	17	10
4	1	—	2	3	3	3	10	6	15	7	7	5	10
5	7	2	4	1	3	7	11	9	17	15	14	13	11
6	5	6	1	4	3	—	0 p.m.	12	11	8	5	4	1
7	2	—	2	1	3	8	1	3	1	3	1	1	2
8	12	6	6	3	6	6	2	1	2	1	1	—	—
9	3	10	9	4	4	9	3	—	—	—	4	—	—
10	7	7	6	8	7	5	4	—	—	—	2	2	4
11	3	1	5	2	1	—	5	—	—	—	—	1	2
24th; 0 a.m.	2	—	2	—	—	—	6	1	—	—	—	—	—
1	1	—	—	2	—	—							

(iii) Aug. 3rd to 6th, 1913.							(iii) Continued.						
Minute. Hour.	0-10	10-20	20-30	30-40	40-50	50-60	Minute. Hour.	0-10	10-20	20-30	30-40	40-50	50-60
3rd; 7 p.m.	—	—	—	—	5	5	2 p.m.	—	—	—	—	—	4
8	9	15	13	13	6	—	3	2	6	—	—	—	—
9	—	2	8	4	2	4	4	2	—	—	—	—	—
10	7	17	8	9	21	18	5	5	—	—	—	—	—
11	18	17	17	15	14	22	10	—	—	—	1	2	13
4th; 0 a.m.	18	21	11	17	14	8	11	6	19	19	18	17	17
1	9	11	14	13	12	17	6th; 0 a.m.	12	13	14	12	17	14
2	19	19	20	19	19	23	1	11	6	5	10	11	13
3	21	19	23	13	17	21	2	15	16	19	15	10	12
4	23	24	14	14	6	7	3	8	5	5	4	1	2
5	7	10	15	16	18	21	4	—	—	1	1	—	—
6	15	9	10	5	8	13	5	—	—	3	—	—	—
7	2	—	5	17	15	22	(iv) Aug. 12th to 15th, 1913.						
8	10	20	11	13	18	10	12th; 4 a.m.	—	—	—	—	—	1
9	8	7	5	9	26	12	5	1	—	5	1	5	—
10	8	7	6	12	3	4	11	—	1	—	—	2	—
11	2	—	—	1	—	—	0 p.m.	1	—	—	—	—	—
0 p.m.	—	—	1	—	—	—	1	—	5	12	6	8	6
2	—	4	25	6	3	13	4	1	—	—	—	—	—
3	1	—	6	3	—	—	7	—	—	—	—	5	—
7	1	—	2	1	—	—	11	—	1	17	31	34	14
9	—	4	8	20	8	30	13th; 9 a.m.	—	25	24	—	—	—
10	24	12	12	15	14	14	0 p.m.	—	1	—	5	—	2
11	17	12	21	16	13	13	1	—	—	—	8	—	—
5th; 0 a.m.	9	12	5	5	—	6	5	—	—	—	—	40	9
1	9	8	9	2	4	—	6	24	25	—	3	23	3
2	4	4	4	5	1	1	7	—	—	1	—	—	—
6	—	—	—	2	—	—	9	—	—	—	—	—	5
7	—	—	2	—	1	4	10	—	—	—	1	5	—
8	1	—	2	—	—	—	11	1	—	—	—	—	12
9	1	—	—	—	—	—	14th; 0 a.m.	—	—	1	1	—	—
10	1	—	1	5	3	3	2	—	—	—	—	—	2
11	1	—	—	—	—	—	3	1	1	2	2	—	—

Hour.	Minute.						Hour.	Minute.					
	0-10	10-20	20-30	30-40	40-50	50-60		0-10	10-20	20-30	30-40	40-50	50-60
(iv) <i>Continued.</i>							(v) <i>Continued.</i>						
13th; 4 p.m.	—	2	1	1	1	—	28th; 0 p.m.	6	10	7	8	5	5
5	1	—	—	3	2	1	1	10	10	10	21	22	14
14th; 6 a.m.	2	2	5	1	—	3	2	14	21	22	22	26	18
7	—	1	12	20	24	2	3	22	27	26	27	34	22
8	—	—	—	—	—	1	4	21	15	13	14	19	8
9	—	1	—	1	1	—	5	5	5	12	8	1	—
11	2	—	2	11	2	—	(vi) Sept. 1st and 2nd, 1913.						
0 p.m.	—	9	—	2	—	1	1st; 8 p.m.	—	—	—	—	1	2
1	—	—	—	—	1	2	9	9	16	10	15	18	14
2	6	6	22	3	—	—	10	19	15	16	19	14	13
3	—	—	—	—	1	—	11	14	13	16	12	9	9
5	—	10	3	6	—	—	2nd; 0 a.m.	8	17	10	16	19	18
7	8	—	—	—	—	—	1	16	19	18	13	16	18
15th; 7 a.m.	—	—	—	1	—	—	2	22	10	12	17	12	12
8	2	—	—	—	—	—	3	18	18	11	16	17	18
9	—	—	—	—	—	16	4	12	3	1	1	1	1
10	8	2	—	—	—	—	5	—	—	2	9	14	16
0 p.m.	—	—	—	—	—	1	6	14	14	7	6	5	3
2	—	—	2	—	—	—	7	9	6	1	4	—	1
3	1	—	—	1	2	8	(vii) Oct. 15th, 1913.						
4	20	—	—	2	5	24	15th; 2 a.m.	—	—	—	—	1	—
5	17	23	9	6	2	2	3	1	2	1	3	6	1
6	3	3	—	—	—	1	4	8	17	10	5	19	11
7	—	1	2	3	3	1	5	17	7	10	12	10	16
(v) Aug. 27th and 28th, 1913.							6	16	13	6	8	9	11
27th; 5 p.m.	—	—	1	—	—	—	7	13	14	12	11	4	4
6	1	1	—	—	—	—	8	7	10	17	10	13	15
7	1	5	3	4	1	11	9	13	17	19	17	14	17
8	11	7	11	9	12	15	10	17	14	15	15	8	13
9	19	15	13	15	10	17	11	13	10	11	9	13	13
10	11	11	4	10	7	11	0 p.m.	15	15	14	12	6	6
11	7	9	5	4	5	3	1	9	3	7	5	1	—