

List of Recent Volcanic Eruptions in Japan*.

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With Pls. XI-XIII.

Larger volcanic outbursts in recent years. Among the recent volcanic explosions in Japan, the most notable were the following five:—

- (i) Explosion of Bandai-san. July 15, 1888; 7h 45m a.m.
- (ii) „ Azuma-san (Issaikyo-san). May 19, 1893; 11h 30m a.m.
- (iii) „ Adataras-san (Numashiri-yama). July 17, 1900; 6h 30m p.m.
- (iv) „ Tori-shima. August, probably between the night of 7th and that of 9th, 1902.
- (v) Submarine eruption near the Minami Iwo-jima (South Sulphur Island). About the 5th of December, 1904.

Of these, the first four consisted each of a sudden steam explosion, the most violent being that of the Bandai-san, one of whose peaks was entirely destroyed. The three explosions of the Azuma-san, Adataras-san, and Tori-shima were much smaller, that of the first named mountain being probably the least. A rough idea of the comparative strengths of the explosions may be obtained from

* Translation, with additions, of the present author's paper in the Reports (Japanese) of the Imp. Earthquake Inv. Comm., No. 49, 1904.

the masses blown off on the different occasions*, which were approximately in the ratios of 3400 : 1 : 7 : 56, as follows:—

	(volume of newly formed crater.)	
Bandai-san	1,700,000,000	cubic metres.
Azuma-san	500,000	”
Adatara-san	3,600,000	”
Tori-shima	28,000,000	”

Each of these four volcanic explosions caused a considerable damage, attended by loss of human lives, which was specially striking in the case of the Tori-shima, the total population of the island, about 125 in number, having been entirely wiped away without leaving even a trace.

The explosion of the Adatara-san was central, that is to say, took place from the filled up crater of the original volcano, while those of the Bandai-san, Azuma-san, and Tori-shima, were each an eccentric outburst, having occurred not in the original central crater.

The submarine volcanic outburst, (v), which took place near the Minami Iwo-jima, was very remarkable and consisted in the eruption of molten lava, resulting in the formation of a new island, about 145 metres in height and nearly 5 km in circumference. This island, made up of the loose material, again entirely disappeared about 1 year later.

Of the 5 cases of larger volcanic outbursts mentioned above, the first three occurred in the province of Iwashiro, in the northern part of the Main Island, while the two last occurred in the Pacific and belonged to the Fuji volcanic chain.

* The estimation of the volume of newly opened crater of the Bandai-san was made by the late Professors S. Sekiya and Y. Kikuchi. Those relating to the three other volcanoes are based on the observations of the present author.

List of volcanic outbursts, 1893-1907. During the 14 years between 1893 and 1907, there were in Japan (Kuriles, Lyu-Kyu, and Formosa excepted) over 70 cases of volcanic outbursts, which consisted mostly in the explosions of steam; the mountains most active during this period being the following four:—

Asama-yama (province of Shinano).....	about 31 times
Kirishima-yama (province of Hyuga)	„ 19 „
Aso-san (province of Higo).....	„ 6 „
Shirane-san (province of Kotsuke)	„ 5 „

Besides these, Azuma-san (Issaikyo-san), Adatara-san (Numashiri-yama), Tarumae-san (in Hokkaido), Komaga-take (Do.), Katta-dake (province of Rikuzen), and others were also more or less active; there being also two cases of submarine eruptions off the Pacific coast. The approximate positions of these volcanoes, 14 in number, are as follows.

Volcano.	Latitude (N)	Longitude (E)
Komaga-take.	42° 04'	140° 41'
Tarumae-san.	42 42	141 23
Katta-dake.	38 08	140 27
Azuma-san.	37 44	140 15
Adatara-san.	37 38	140 16
Bandai-san.	37 37	140 04
Shirane-san.	36 38	138 33
Asama-yama.	36 25	138 30
Iwo-dake.	36 15	137 36
Aso-san.	32 54	131 05
Kirishima-yama.	31 56	130 52

Volcano	Latitude (N)	Longitude (E)
Near Bayonnise Rock.	31° 55'	139° 54'
Tori-shima.	30 27	140 07
Eruption near Minami- Iwo-shima. }	24 13	141 29

As a strong volcanic eruption has usually a number of smaller followers, it is often difficult to count the exact number of the outbursts. These small secondary ones have, in so far as they can be identified as such, been excluded from the following list of the volcanic disturbances.

Table I. List of Volcanic Outbursts in Japan, 1893-1907.

Volcano.	Date.	Time of Outburst.	REMARKS.
	1894		
Kirishima-yama.	Feb. 25	10 ^h 30 ^m A.M.	Detonations. Ashes thrown out.
"	" 28	8 20 "	Loud detonations.
Aso-san.	March 7	5 — "	Detonations. Ashes thrown out.
	Rumbling sounds also heard at 7.13; 8.46; 9.15; 9.23; 9.40; 10.02 and 10.25 A.M. of the same day, the last being the strongest.		
"	" 13	10 40 A.M.	Detonations and explosion.
Azuma-san (Issaikyo-san).	" 16	—	Detonations. Ashes thrown out.
"	April 4	Noon.	" "
Asama-yama.	" 6	1 — A.M.	" "
"	" 11	9 — P.M.	Loud detonations. Ashes thrown out.
Azuma-san.	" 12	10 — A.M.	Ashes thrown out.
Asama-yama.	" 17	8 — A.M.	Detonations. Ashes thrown out.
"	" 28	6 20 P.M.	Outburst.
"	" 30	0 — A.M.	Loud Detonations. Ashes thrown out

Volcano.	Date.	Time of Outburst.	REMARKS.
Aso-san.	May 24	Midnight.	Detonations. Ashes thrown out.
Asama-yama.	June 14	9 ^h 30 ^m A.M.	Loud detonations. Ashes thrown out in large quantity.
Aso-san.	„ 23	8 — P.M.	Loud detonations. Ashes thrown out.
Tarumae-san.	Aug. 17	6 — P.M.	Smoke emitted.
Aso-san.	„ 30	5 — A.M.	Detonations.
1895			
Katta-dake.	Feb. 15	9 — A.M.	Smoke emitted.
„	„ 19	8 30 A.M.	„
Azuma-san (Issaikyo-san).	March 8	7 32 A.M.	Detonations and emission of smoke.
„	„ „	9 40 P.M.	„ „
Kirishima-yama.	July 16	0 30 P.M.	„ „
Kumaga-take (Katta-dake).	Sept. 27	5 — A.M.	„ „
Kirishima-yama.	Oct. 16	0 30 P.M.	„ „
„	Dec. 18	3 45 P.M.	Loud detonations and emission of smoke.
1896			
Kirishima-yama.	March 15	8 26 A.M.	Explosion, accompanied by emission of smoke and falling of ashes.
„	June 26	1 — A.M.	Detonations and emission of smoke. Ashes thrown out.
„	Dec. 21	1 15 P.M.	Explosion. Ashes thrown out.
1897			
Zo-O-san (Katta-dake)	Jan. 14	0 30 A.M.	Detonations. Smoke emitted.
Aso-san.	{ End of Feb. to the beginning of March.	—	Detonations continued for several days, being strongest on March 3.
Shirane-san.	July 31	5 — A.M.	Detonations and emission of smoke.
Kirishima-yama.	Sept. 4	8 — A.M.	Explosion.

Volcano.	Date.	Time of Outburst.	REMARKS.
1898			
Kirishima-yama.	Feb. 8	1 ^h — ^m A.M.	Detonations and emission of smoke.
„	March 11	7 — P.M.	Loud detonations and explosion.
„	Dec. 30	11 — P.M.	„ „ „
1899			
Asama-yama.	March 10	1 — P.M.	Detonations and explosion.
„	July 10	Night	Explosions, continuing for several days.
„	„ 15	11 — A.M.	Loud detonations and explosion.
Kirishima-yama.	„ 28	1 30 A.M.	„ „ „
Asama-yama.	Aug. 7	7 — P.M.	„ „ „ Ashes fell for several days.
Adatara-san.	„ 24	11 30 P.M.	Explosion.
Kirishima-yama.	Sept. 12	Morning	Detonations and explosion.
„	Oct. 13	3 05 A.M.	„ „
„	Nov. 7	Morning	„ „
Adatara-san.	„ 12	7 30 P.M.	Explosion.
1900			
Adatara-san.	Jan. 22	7 — A.M.	Detonations and explosion.
„	Feb. 7	6 — P.M.	„ „
Kirishima-yama.	„ 16	9 — A.M.	„ „
Asama-yama.	„ 19	5 — P.M.	Loud detonations and explosion.
„	March 1	{ From morning to noon.	„ „ „
„	„ 22	Midnight	Detonations, followed by several others.
„	„ 31	3 10 P.M.	Loud detonations and explosion.
Adatara-san.	July 17	6 30 P.M.	Great explosion. (See the 1st §)
Asama-yama.	„ 21	—	Explosion.
Shirane-san.	Oct. 1	3 — A.M.	Feeble detonations and explosion.
Asama-yama.	Nov. 19	4 30 P.M.	Explosion.

Volcano.	Date.	Time of Outburst.	REMARKS.
Asama-yama.	Dec. 14	4 ^h — ^m A.M.	Feeble shaking and explosion.
1901			
Asama-yama.	April 20	0 25-5 00 P.M.	Explosion.
"	" 21	10 30 A.M.	Emission of smoke.
"	May 25	10 50 A.M.	" "
"	" 26	2 00 P.M.	" "
"	July 21	Evening	Explosions continued for several days.
"	Aug. 6-8	—	(Ashes fell also on 9th and 10th.)
1902			
Asama-yama.	Aug. 5	1 — P.M.	Detonations. Ashes thrown out.
Tori-shima.	Aug. { (probably between evening of 7th and that of 9th)		Great explosion. (See the 1st §)
Shirane-san.	Sept. 5	Evening	Small explosion.
"	" 17	1 — P.M.	" "
1903			
Kirishima-yama.	Aug. 29	2 30 P.M.	Detonations and explosion.
"	Nov. 25	9 — A.M.	Great detonations and explosion.
1904			
Asama-yama.	Aug. 4	Noon	Smoke emitted, and ashes thrown out.
Near the Minami Iwo-jima.	(About Nov. 28)	—	A great submarine eruption, resulting in the formation of a new island.
1905			
Komaga-take.	Aug. 20	11 — P.M.	Explosion. Ashes continued to be thrown out till the end of the year.
Shirane-san.	Oct. 24(?)	—	Smoke emitted, and ashes thrown out.
1906			
Asama-yama.	April 6	Early morning	Smoke emitted.
In the vicinity of Bayonnaise Rock, to the SE of Aogashima.	April (probably between 7 and 13)	—	A submarine eruption, which continued probably for about one week. A great quantity of pumice was found floating on the sea surface.

Volcano.	Date.	Time of Outburst.	REMARKS.
Aso-san.	June 8	5 ^h — P.M.	Detonations, followed by an explosion. A new crater, about 50 ft in length and 24 ft in width was formed.
	1907		
Asama-yama.	Jan. 18	Continued from the evening of 18th to the morning of 19th	Smoke emitted.
„	March 28		6 — A.M.
„	Aug. 24	Early morning	„ „
Iwo-dake. (in Shinano)	Dec. 11	—	Explosion. Ashes were thrown out.

Annual variation of the frequency of the volcanic outbursts. The distribution in the 12 months of the year of the 80 cases of volcanic disturbances contained in the list given in the preceding § is shown in the 2nd column of the following table; the figures in the 3rd column, taken from the late Mr. Ogashima's work, "Nippon Saiishi," (*A compendium of unusual events in Japan*), being the annual distribution of the 113 volcanic outbursts, which happened in Japan since the earliest historical times down to 1885*.

Table II. Volcanic Eruptions in Japan.

Month.	80 Vol. Outbursts in recent years. 1893-1907	113 Vol. Outbursts recorded in history. 685-1886	Sum. (193 Outbursts).
I	3	6	9
II	9	20	29
III	12	13	25

* For accounts of historical volcanic outbursts in Japan, the reader is also referred to Prof. John Milne's paper, "the volcanoes of Japan," in the Trans. Seism. Soc. Japan, Vol. IX.

Month.	80 Vol. Outbursts in recent years. 1893-1907	113 Vol. Outbursts recorded in history. 685-1886	<i>Sum.</i> (193 Outbursts).
IV	11	14	25
V	3	8	11
VI	4	4	8
VII	8	7	15
VIII	11	14	25
IX	5	9	14
X	4	3	7
XI	5	9	14
XII	5	6	11

The annual variations of the recent volcanic outbursts and of those which occurred in the historical times are, as illustrated in Figs. 1 and 2 (Pl. XI), mutually alike, each showing two distinct maxima of the frequency. The monthly distribution of the two sets of eruptions taken together is given in the last column of the above table and illustrated in Fig. 3. From the latter it will be seen that the absolutely greatest frequency (29) of eruptions occurred in February; the three months of February, March, and April together forming the 1st, or principal epoch of volcanic activity, followed by the principal minimum in June. The 2nd, or smaller, maximum frequency (25) occurred in August.

Comparison with the annual variation of seismic frequency. To compare the annual variation of the frequency of the volcanic eruptions with that of the seismic frequency, I give, in Table III, the mean monthly percentage numbers of earthquakes observed instrumentally at the meteorological observatories of

Nagoya, Gifu, and Kumamoto, which places are shaken mostly by seismic disturbances of inland origin; the figures having been deduced from the data given in the "Publications of the Imp. Earthquake Inv. Comm.", No. 8.

Table III. Mean Monthly Percentage Numbers of Earthquakes at Nagoya, Gifu, and Kumamoto.

Month...	Nagoya.	Gifu.	Kumamoto.	<i>Average.</i>
I	13.3	10.7	10.9	11.6
II	7.5	8.2	9.3	8.3
III	13.0	9.9	9.9	10.9
IV	9.6	13.9	9.5	11.0
V	9.0	9.2	10.5	9.6
VI	6.3	6.9	9.6	7.6
VII	6.0	6.0	4.9	5.6
VIII	11.2	5.5	7.5	8.1
IX	6.6	6.5	7.5	6.9
X	6.9	8.2	8.8	8.0
XI	4.8	8.6	6.1	6.5
XII	5.8	6.5	5.5	5.9

According to the average values of the monthly seismic frequency, which are given in the last column of Table III, and which are graphically illustrated in Fig. 4, the annual variation of the frequency of the earthquakes of inland origin shows the epoch of the principal maximum (=11) in March and April, with the principal minimum (=5.6) in July; there being an epoch of a secondary maximum (=8) in the months of August to October. The variation in question may thus be regarded as

being on the whole approximately similar to that of the frequency of the volcanic eruptions.

With respect to the cause of the frequency variations of these two phenomena, it is to be remarked that the earthquakes of inland origin are much affected by the atmospheric pressure, as discussed in the *Publications*, No. 8; the 1st, or principal, seismic maximum above mentioned being due probably to the barometric maximum in the annual variation. The 2nd, or smaller, seismic maximum may possibly be due to the more extensive or stronger among the earthquakes of inland origin taken into consideration; the annual variation of large and small shocks being in general opposite to one another. The cause for the two maxima in the frequency variation of the volcanic eruptions is probably the same as in the case of those of the earthquakes. It is needless to add that further and more strict investigations in these connections are necessary, especially for the explanation of the secondary maximum in the frequency of volcanic eruptions*.

Seasonal numbers of volcanic eruptions. The following table gives the distribution in the four seasons of the year of the 193 volcanic eruptions (Table II) and of the percentage numbers of the earthquakes observed at Nagoya, Gifu, and Kumamoto based on the data given in Table III.

* In the Reports (Japanese) of the Imp. Earthquake Inv. Comm., No. 56, I have stated the view that the secondary maximum in the frequency of the volcanic eruptions may be due to the pressure of the sea water at the bottom. The supposition stated in the present paragraph seems to be the more likely one.

Table IV. Seasonal Distribution of the Volcanic Eruptions and the Percentage Numbers of the Earthquakes.

Season.	Volcanic Eruptions. (193)	Seismic Frequency.			
		Nagoya.	Gifu.	Kumamoto.	Mean.
Spring (March, April, May.)	61	31.6	33.0	30.3	31.6
Summer (June, July, August.)	48	23.5	18.4	22.3	21.4
Autumn (Sept., Oct., Nov.)	35	18.4	23.2	22.7	21.4
Winter (Dec., Jan., Feb.)	49	26.5	25.4	24.7	25.5

Thus, for the volcanic eruptions, the greatest seasonal number of 61 occurred in Spring, being 1.7 times greater than the least number, which occurred in Autumn. For the mean frequency of the earthquakes, the greatest percentage number of 31.6 occurred also in Spring, being about 1.5 times greater than the least number of 21.4, which occurred in Summer and Autumn. The curves graphically representing the variations of the seasonal frequencies of the eruptions and the earthquakes, given in Figs. 5 and 6, (Pl. XII), will be seen to be on the whole similar to one another.

Numbers of volcanic eruptions in the successive years. Table V gives the number of the volcanic eruptions for each of the years 1894 to 1907, and for the sake of comparison, the total numbers of earthquakes (exclusive of teleseismic disturbances) observed in Japan during the successive years.

Table V. Yearly Numbers of Volcanic Eruptions and Earthquakes in Japan. 1894-1907.

Year.	Number of Volcanic Eruptions.	Number of Earthquakes*.
1894	17	2,729
1895	8	1,417
1896	3	1,906
1897	4	1,727
1898	3	1,561
1899	10	1,682
1900	12	1,831
1901	6	1,615
1902	4	1,401
1903	2	1,242
1904	2	1,142
1905	2	1,901
1906	3	1,551
1907	4	1,642

(* Formosa excluded)

From Figs. 7 and 8 (Pl. XIII), which graphically illustrate the results contained in Table V, it will be seen that the relations to time of the numbers of the eruptions and the earthquakes are rather alike to each other; in each case the absolutely greatest number occurring in 1894, and a maximum in 1900.

From what has been said in the foregoing §§, the volcanic activity in Japan seems to follow approximately that of earthquakes. This is in accordance with the fact that large volcanic eruptions and destructive earthquakes often take place in nearly the same epoch in different parts of a great seismic zone.

Annual Variation of the Volcanic Eruptions and Earthquakes in Japan.

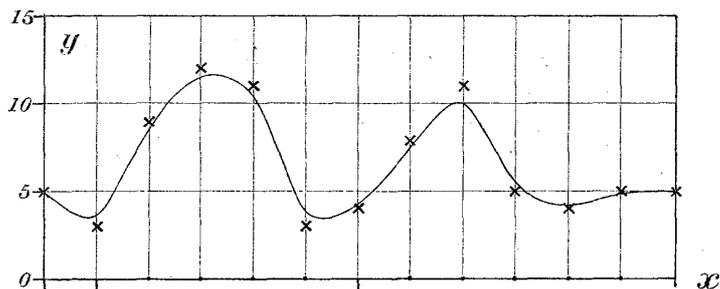


Fig. 1. 80 recent Volcanic Eruptions.

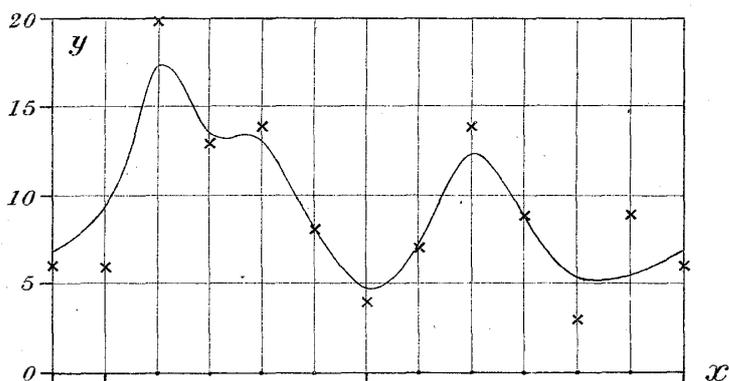


Fig. 2. 113 historical Volcanic Eruptions.

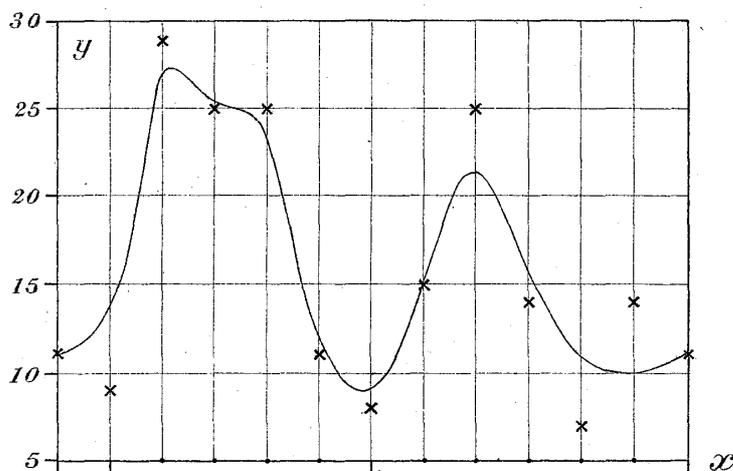


Fig. 3. 193 recent and historical Volcanic Eruptions.

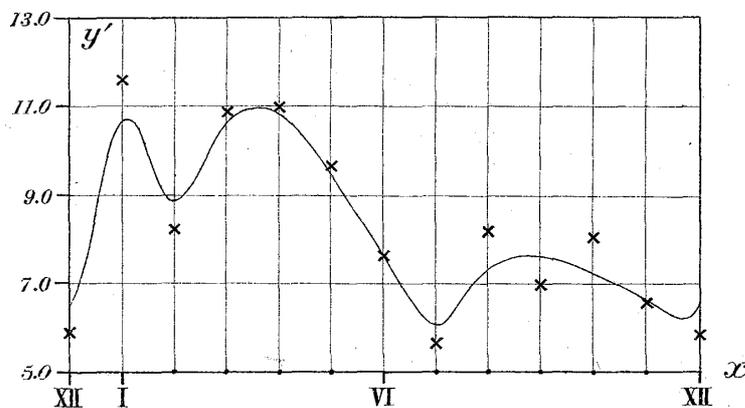


Fig. 4. Earthquakes of Inland Origin.

x = Time, in months.
 y = Monthly number of volcanic eruptions in Japan.
 y' = Mean monthly percentage number of earthquakes of inland origin.

Seasonal Distributions of the
Volcanic Eruptions and Earthquakes in Japan.

Fig. 5. 193 Volcanic Eruptions.

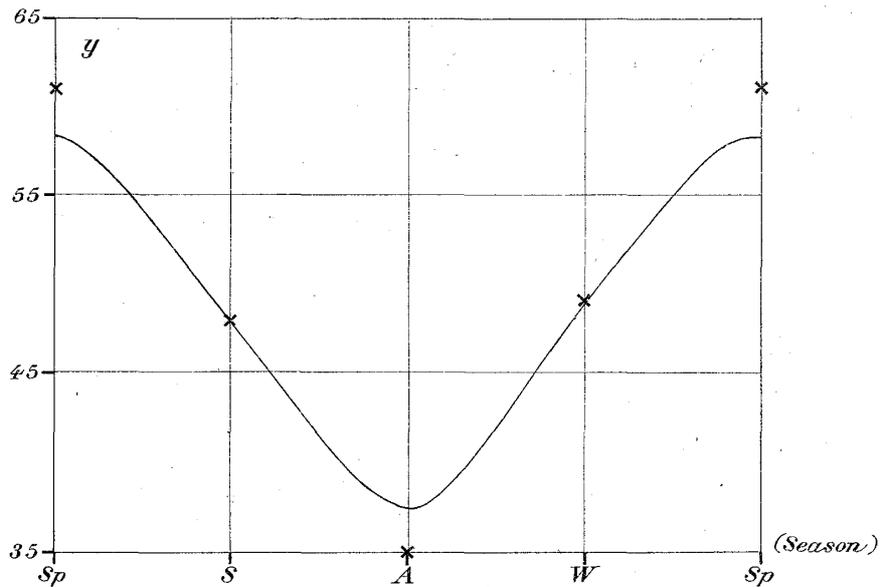
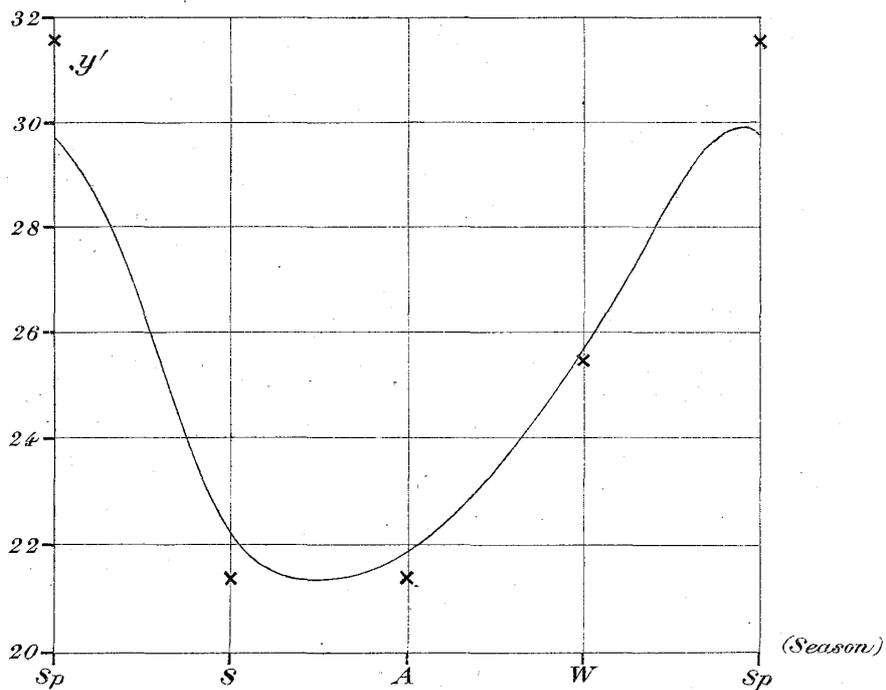


Fig. 6. Earthquakes of Inland Origin.



$\left\{ \begin{array}{l} y = \text{Monthly number of volcanic eruptions in Japan.} \\ y' = \text{Mean monthly percentage number of earthquakes} \\ \text{of inland origin.} \end{array} \right.$

Variations of the Yearly Numbers of the Volcanic Eruptions and Earthquakes in Japan.

Fig. 7. Volcanic Eruptions.

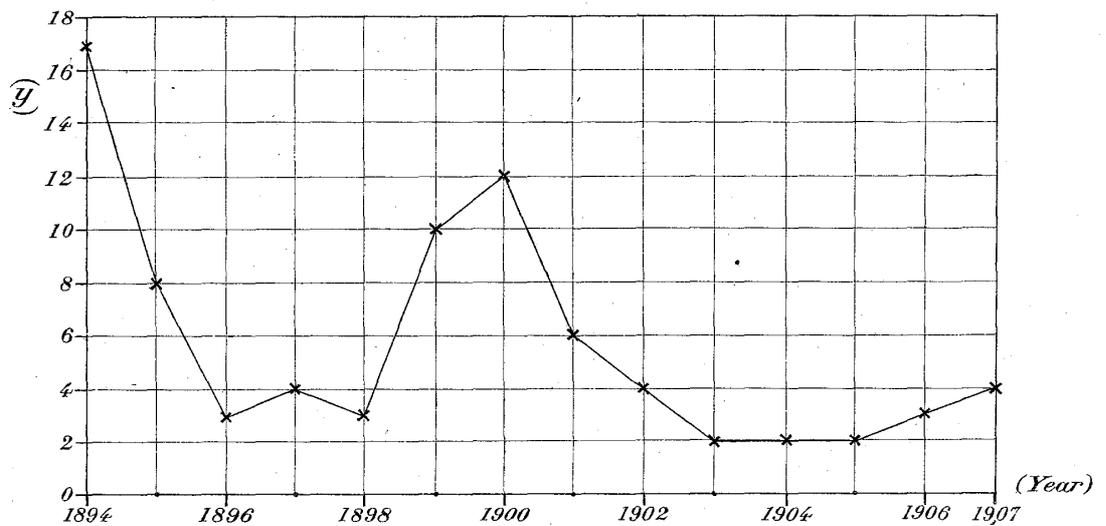
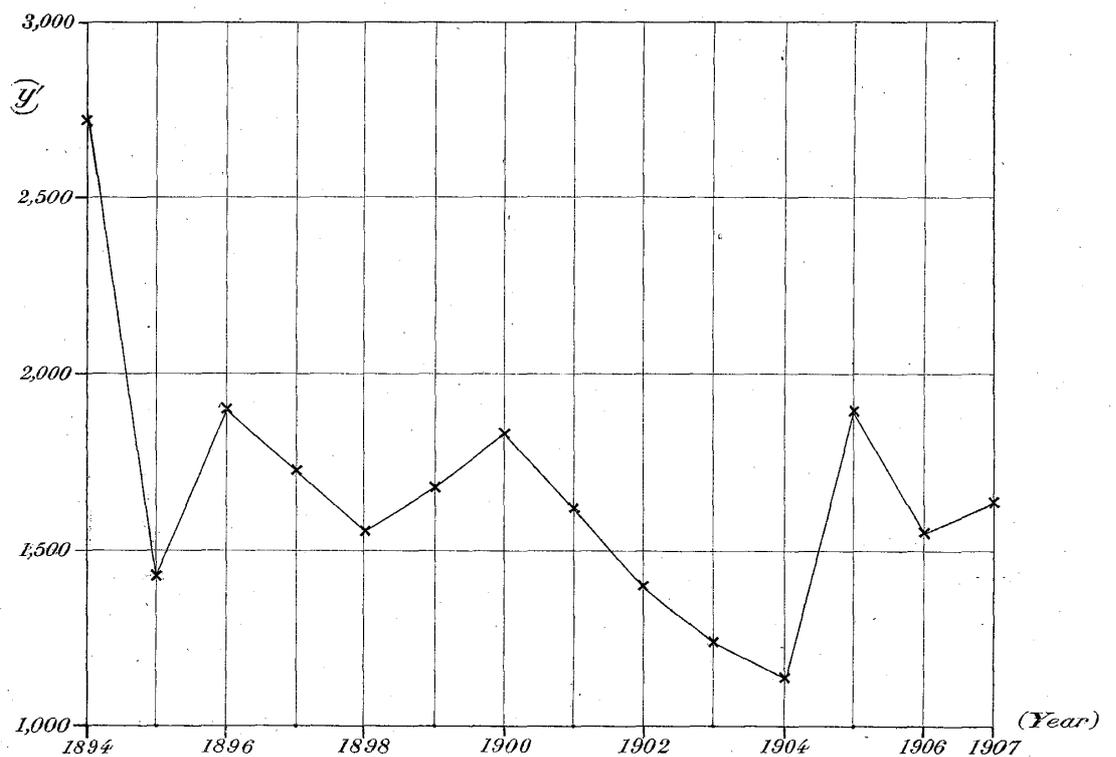


Fig. 8. Earthquakes.



$\left\{ \begin{array}{l} y = \text{Yearly number of volcanic eruptions in Japan.} \\ y' = \text{,, ,, ,, earthquakes in Japan (Formosa excepted).} \end{array} \right.$