REPORT OF THE CHIRIKIOKU (METEOROLOGICAL DEPARTMENT) IN TOKIO ON SEISMOMETRICAL OBSERVATION MADE IN JAPAN DURING THE YEAR 1888.

CONTENTS.

1.—SEISMIC DISTURBANCES AND THEIR FREQUENCY.

During the year 1888, the total number of earthquakes which occurred in this country was 630. A glance at the map shows the distribution of these earthquakes throughout the country.

Among the areas shown by deep colours in the map the following provinces were most frequently disturbed,—Musashi,* Shimozuke, Satsuma, Kazusa, Hitachi, Shimosa, Iwaki, Bungo, Rikuzen, Sagami, Mino, Iwashiro, Nemuro, Kushiro, Kii, Shinano, Mutsu, Owari, Kai, Mikawa, Kōzuke, Bizen, Bitchiu, Suruga, Aki, Mimasaka, Yechigo, Awa, Iwami,

* In Tōkyō, Musashi, we had 101 earthquakes this year. Such an enormous seismic frequency in Tōkyō is partly due to the fact that even very feeble earthquakes were clearly observed by means of delicate instruments set up in the Meteorological Central Observatory. Similarly in any other province which might happen to have similar instruments, we might detect many feeble earthquakes which otherwise might be unrecorded.

Rikuchiu, Hiuga, Oshima, Uzen, Ugo, Iyo, Hōki, Harima, and Iburi.

Each of these provinces had more than five earthquakes during the year. As regards the white parts in the map which include Kitami, Teshio, Yechigo, Yetchiu, Noto, Kaga, Buzen, Chikuzen, Hizen, Higo, Chikugo, Bungo, Iki, Tsushima, Oki, and several islands, we do not hesitate to state that if they were not absolutely free from earthquakes, they were affected very little and the same state of things prevails year after year. It may be noticed that in Satsuma we had a greater frequency, and in Nemuro, a less frequency this year than in 1887. On the whole, the provinces along the Pacific were very often visited by earthquakes, while those along the Japan Sea, were comparatively free from them; and the central mountain range starting from Mutsu and running S.W. afforded, as during preceding years, a remarkable line of demarkation with regard to the distribution of seismic activity in this country.

2.—Number of Earthquakes in each Season.

The following table gives the number of earthquakes recorded during each month of the year 1888 :—

Months.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	Average.
Frequency.	53	77	46	42	69	40	40	34	42	47	85	55	630	52.5

Thus the total number of earthquakes this year was 630. The maximum frequency occurred in November, while the minimum was in August. The following table gives the frequency in each season :—

Seasons.	Spring March, April, May.	Summer June, July, August.	Autumn Sept., Oct., Nov.	Winter Dec., Jan., Feb.	Total.	Average.
Frequency	157	114	174	185	630	157.5

The maximum seismic frequency occurred in winter, while the minimum was in summer. If we divide a year into the hot and cold seasons we have :—

Season.	Hot (from April to Sept. inclusive).	Cold (from Oct. to March inclusive).	Total.	Average.
Frequency	267	363	630	315.0

3.—Number of Earthquakes in each Hour.

The following table shows earthquake frequency in each hour:—

Months.	Hours.	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11 12	Total.
		Fore noon.												After noon.												
January	...	3	...	2	...	3	...	4	...	1	...	2	—	—	...	3	...	1	...	1	...	2	...	1	...	1	...	3	...	2	...	4	...	6	...	3	...	2	...	3	...	3	...	53
February	...	2	...	5	...	3	...	2	...	2	...	1	...	4	—	...	2	...	2	...	4	...	5	...	4	...	4	...	3	11	...	2	...	3	...	4	—	...	2	...	5	...	1	...	6	...	77
March	...	—	...	1	...	1	...	3	...	3	—	...	4	...	1	...	1	—	...	1	...	5	...	2	—	...	3	...	5	—	...	3	...	2	...	5	...	3	...	2	...	1	...	0	...	46
April	.....	1	—	...	1	...	2	—	...	4	...	3	...	5	...	1	—	...	2	...	2	...	1	...	3	...	5	...	2	...	3	...	1	—	...	1	—	...	1	...	2	...	2	...	42
May	.....	2	...	4	...	2	...	2	...	2	10	...	2	...	1	...	3	...	1	...	3	...	5	...	1	...	1	—	...	2	...	2	...	1	...	3	...	3	...	5	...	4	...	6	...	4	...	2	...	69
June	.....	2	—	...	2	...	1	—	—	...	4	...	5	—	...	1	...	1	...	1	...	3	...	3	...	3	...	1	...	1	...	1	...	1	—	...	1	...	1	...	5	...	3	...	1	...	40
July	.....	—	—	...	3	—	...	4	...	1	...	2	...	3	...	1	...	1	...	2	...	2	...	3	...	3	...	2	...	3	...	3	...	2	—	...	2	...	1	...	2	...	40
August	...	—	...	2	...	1	...	4	—	...	2	...	1	...	2	...	3	...	3	—	...	3	—	—	...	1	...	1	...	1	...	1	—	...	1	...	1	—	...	6	...	2	—	...	34
September	...	1	...	2	...	2	...	1	...	2	...	5	—	...	2	...	3	...	1	...	4	...	2	...	1	...	2	...	2	...	3	—	...	2	...	1	...	2	...	1	—	...	2	...	1	...	42
October	...	2	...	2	...	3	...	2	...	3	...	3	...	3	...	4	...	1	...	1	...	2	—	...	1	...	1	—	...	2	...	3	...	2	...	1	...	2	...	2	...	4	...	47
November	..	8	...	5	...	5	...	2	...	4	...	4	...	2	...	1	...	3	...	5	...	5	...	1	...	2	...	5	...	4	...	4	—	...	7	...	4	...	3	...	1	...	6	...	1	...	2	...	5	...	85
December	.	3	...	5	...	3	...	4	...	4	...	5	...	1	...	2	...	4	...	1	—	...	1	...	1	...	2	...	2	—	...	4	...	4	—	...	1	...	3	...	2	...	55
Total		24		28		29		27		33		27		24		30		25		19		23		26		22		22		27		35		24		24		23		30		21		33		26		28		630

From the above we see that the greatest number of earthquakes occurred between 3-4 p.m., and the next maximum frequency between 4-5 a.m. and between 9-10 p.m.; whereas the minimum was between 9-10 a.m. and between 8-9 p.m. If we took 6 o'clock as the limit between day and night, we should have at night a greater number of earthquakes than during the day by 26.

4.—Area of Seismic Disturbances and Intensity.

The area shaken by an earthquake varied from a mere local tract up to an area of several thousand sq. *ri*, depending chiefly on the intensity of the shock. In the following table, the number of earthquakes during the year has been classified according to the size of the area disturbed :—One square *ri*=5.9 sq. miles

Area.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Average.
Over 1,000 square *ri*	2	6	3	8	5	3	2	1	2	1	7	4	44	3.7
1,000-100 square *ri*	8	15	7	2	16	9	10	8	4	6	9	10	104	8.7
Under 100 square *ri*.....	43	56	36	32	48	28	28	25	36	40	69	41	482	40.2
Total.....	53	77	46	42	69	40	40	31	42	47	85	55	630	52.5

From the above we see that out of 630 earthquakes, 482 only disturbed areas less than 100 sq. *ri*, 104, areas of 100—1,000 sq. *ri*, and the remaining 44, areas of over 1,000 sq. *ri*. Among the last 44 earthquakes, 2 shook an area of over 5,000 sq. *ri* or about one-fifth of the empire, and another shook over 9,000 sq. *ri* or about three-eighths of the empire. It may be here mentioned that the last earthquake shook a greater area than any that have been recorded since the commencement of these observations in Japan in 1884.

5.—Number and Intensity of Earthquakes in each Province.

The number and intensity of earthquakes in each province during the year 1888 were as follows:—

Provinces.	Frequency.	Severe.	Moderate.	Feeble.
Musashi	101	5	19	77
Shimozuke	56	2	3	51

Provinces.	Frequency.	Severe.	Moderate.	Feeble.
Satsuma	48	1	7	40
Kazusa	39	—	5	34
Hitachi	35	5	13	17
Shimosa	33	6	16	11
Iwaki	30	—	13	17
Bungo	24	1	5	18
Sagami	22	1	19	12
Rikuzen	22	2	11	9
Mino	19	1	14	14
Iwashiro	16	1	11	4
Nemuro	16	—	2	14
Kushiro	16	—	11	5
Kii	15	1	5	9
Shinano	15	1	12	2
Mutsu	15	1	7	7
Owari	14	—	8	6
Kai	13	2	11	—
Mikawa	11	—	4	7
Kozuke	11	1	8	2
Bizen	10	—	8	2
Bichiu	10	1	7	2
Suruga	9	1	6	2
Aki	9	—	7	2
Mimasaka	9	1	4	4
Yechigo	9	—	4	5
Awa	8	1	3	4
Iwami	8	—	4	4
Rikuchiu	8	4	3	1
Hiuga	8	—	7	1
Oshima	7	3	3	1
Ugo	7	—	6	1
Uzen	7	—	5	2
Iyo	6	—	3	3
Hoki	6	—	3	3
Harima	6	2	4	—

Provinces.	Frequency.	Severe.	Moderate.	Feeble.
Iburi	6	1	3	2
Iga	5	—	—	5
Yamashiro	5	—	3	2
Tamba	5	—	3	2
Ise	5	1	3	1
Tajima	5	1	—	4
Idzu	5	1	3	1
Higo	5	1	1	3
Osumi	5	—	4	1
Suo	5	—	1	4
Hizen	4	—	3	1
Bingo	4	—	3	1
Inaba	4	—	2	2
Tango	4	1	2	1
Totomi	4	—	1	3
Hitaka	4	1	2	1
Izumi	3	—	2	1
Hida	3	—	2	1
Ishikari	3	1	2	—
Kitami	3	—	3	—
Settsu	2	—	1	1
Yechizen	2	1	1	—
Wakasa	2	—	1	1
Yamato	2	—	2	—
Awa	2	—	2	—
Sado	2	—	1	1
Nagato	2	—	2	—
Izumo	2	1	1	—
Tosa	2	—	2	—
Shiribeshi	2	—	1	2
Omi	1	—	1	—
Kaga	1	—	1	—
Shima	1	—	—	—
Kawachi	1	—	—	1
Yetchiu	1	—	—	1

Provinces.	Frequency.	Severe.	Moderate.	Feeble.
Awaji	1	—	—	1
Chikugo	1	—	—	—

Thus Musashi had 101, Shimozuke, 56, and Satsuma, 48 earthquakes this year, while Omi, Kaga, Shima, Kawachi, Yetchiu, Awaji, Buzen, and Chikugo had each of them only one earthquake respectively.

6.—Intensity of Earthquakes.

Of the 630 earthquakes in the year 1888, severe earthquakes numbered 58, moderate ones 264, and feeble ones 308. Thus 9% of the total number of earthquakes in the year was severe, 42% moderate, and 49% feeble. The provinces shaken by severe shocks were as follows:—

No. of Earthquakes.	Provinces.
8.....	Rikuzen;
7.....	Musashi, Hitachi, Shimosa;
5.....	Iwaki, Rikuchiu, Kai;
3.....	Shimozuki, Sagami, Izu, Shinano, Iwashiro, Oshima;
2.....	Suruga, Kozuke, Uzen, Hida, Ise, Harima, Iyo, Iwami, Hiuga;
1.....	Kazusa, Awa, Ugo, Mutsu, Ishikari, Iburi, Hitaka, Yechigo, Yechizen, Mino, Owari, Omi, Kii, Tango, Bichiu, Mimasaka, Izumo, Bungo, Hizen, and Satsuma.

Among the most severe earthquakes, we may count the one which occurred in Iwashiro and its neighbourhood on July 15th, the one in Hida and its neighbourhood on November 10th, the one in Iwaki and its neighbourhood on October 12th, the one in Mino and its neighbourhood on July 7th, the one in Hitachi and its neighbourhood on February 2nd, the one in Mutsu and its neighbourhood on the 5th of February, the one in Kanto on April 24th, the one in Kazusa and its neighbourhood on November 3rd, the one in Hitachi and its

neighbourhood on April 5th, and lastly the one in Shimosa, and its neighbourhood on May 22nd. During these earthquakes, houses and buildings were damaged, stone lanterns and tombstones overthrown, articles on shelves thrown down, and pendulum clocks stopped.

7.—Table of Earthquakes (Monthly).

In the following table, provinces are classified according to the frequency of earthquakes in each month. The days of occurrence and areas of severe earthquakes together with the day, area, and provinces visited by the earthquake which shook the most extensive area in each month are given :—

JANUARY.

Seismic Frequency.		Severe Earthquakes.			Most Extensive Earthquake.		
Number of Earthquakes.	Provinces.	No.	Days.	Provinces.	Day.	Area.	Provinces.
6-5	Kazusa, Satsuma.	1	30th	Satsuma.	11th	1,480 sq. *ri.*	Hitachi, Shimōsa, Kazusa, Iwaki, Shimozuke, Kōzuke, Musashi, Sagami.
4-3	Hitachi, Shimozuke, Musashi, Iwaki.						
2-1	Mutsu, Iwashiro, Shimosa, Sagami, Yechigo, Shimane, Yamashiro, Kii, Iwami, Ugo, Kōzuke, Suruga, Mino, Mikawa, Owari, Tamba, Hoki, Bingo, Aki, Suō, Iyo, Tosa, Bingo, Kushiro, Oshima.						

FEBRUARY.

16-15	Musashi.	1	2nd	Hitachi, Shimōsa, Musashi.	5th	9,670 sq. *ri.*	Mutsu, Rikuchiu, Rikuzen, Uzen, Ugo, Iwaki, Iwashiro, Shimozuke, Hitachi, Musashi, Kazusa, Shimōsa, Oshima, Shiribeshi, Ishikari, Kitami, Iburi, Tokachi, Hitaka, Kushiro, Nemuro.
14-11	—	2					
10-9	Shimōsa, Satsuma.	3	2nd	Hitachi, Shimōsa.			
8-7	Hitachi.	4	5th	Mutsu, Oshima, Iburi, Hitaka.			
6-5	Shimozuke, Rikuzen, Mutsu, Iwaki, Iwashiro, Kazusa.	5	6th	Rikuchi.			
			22nd	Rikuzen, Iwaki, Rikuchiu.			
			24th				

FEBRUARY.

Seismic Frequency.		Severe Earthquakes.			Most Extensive Earthquake.		
Number of Earthquakes.	Provinces.	No.	Days.	Provinces.	Day.	Area.	Provinces.
4-3	Bizen, Mimasaka, Rikuchiu, Mino, Inaba, Harima, Bichiu, Kushiro, Ishikari, Nemuro.	6	24th	Ishikari.			
		7	24th	Shimōsa.			
		8		Iwaki.			
2-1	Hitaka, Kitami, Teshio, Tokachi, Iburi, Shiribeshi, Oshima, Uzen, Ugo, Sagami, Awa, Kōzuke, Owari, Yamashiro, Kii, Tango, Tajima, Iwami, Suruga, Mikawa, Hida, Izumi, Tanba, Hoki, Iyo, Hiuga.						

MARCH.

8-7	Musashi.	1	16th	Sagami, Musashi, Suruga.	16th	1,990 sq. *ri.*	Sagami, Suruga, Izu, Kai, Shinano, Musashi, Kōzuke, Shimozuke, Hitachi, Shimōsa, Kazusa, Awa.
6-5	Shimozuke, Satsuma.						
4-3	Nemuro, Awa, Sagami, Hitachi, Shimōsa, Kazusa, Kai.						
2-1	Kushiro, Iwaki, Izu, Shinano, Suruga, Mutsu, Ugo, Kōzuke, Ye-						

	chigo, Totomi, Mikawa, Owari, Tamba, Tajima, Harima, Inaba, Mimasaka, Bizen, Iwami, Iyo, Tosa, Higo, Hiuga.					
			APRIL.			
8-7	Musashi.	1	3rd	Shinano.	29th	5,080 sq. *ri.* Musashi, Sagami, Izu, Suruga, Kai, Kōzuke, Shimozuke, Hitachi, Shimōsa, Kazusa, Awa, Iwaki, Iwashiro, Rikuzen, Uzen, Yechigo, Shinano, Totomi, Mikawa, Mino.
6-5	Satsuma, Shimozuke.	2	5th	Hitachi, Shimosa, Musashi, Shizuoka, Kōzuke.		
4-3	Iwaki, Kai, Rikuzen, Kozuke, Hitachi, Shimōsa, Sagami, Izu, Shinano.	3	5th	Izu.		
		4	11th	Tango.		
		5	11th	Rikuchiu.		
2-1	Mutsu, Rikuchiu, Ugo, Uzen, Iwashiro, Kazusa, Awa, Suruga, Yechigo, Tōtōmi, Mikawa, Mino, Owari, Iga, Yamato, Kawachi, Izumi, Kii, Yechizen, Omi, Yamashiro, Wakasa, Settsu, Tamba, Tango, Tajima, Inaba, Harima, Mimasaka, Bizen, Bichiu, Bingo, Aki, Hoki, Izumo, Iwami, Suo, Iyo, Bungo, Higo, Hiuga, Osumi, Kushiro, Kitami, Nemuro.	6	29th	Musashi, Sagami, Izu, Suruga, Kai, Shinano, Kozuke, Shimozuke, Hitachi, Shimosa, Awa.		
		7	30th	Ugo.		

MAY.

Seismic Frequency.		Severe Earthquakes.			Most Extensive Earthquake,		
Number of Earthquakes.	Provinces.	No.	Days.	Provinces.	Day.	Area.	Provinces.
12-11	Musashi.	1	11th	Iyo.	22nd	3,650 sq. *ri*	Hitachi, Shimosa, Musashi, Kazusa, Sagami, Izu, Suruga, Kai, Shinano, Kozuke, Shimozuke, Yechigo, Iwaki, Iwashiro, Uzen.
10-7	—	2	15th	Shinano.			
6 5	Rikuzen, Iwaki, Shimozuke, Kii.	3	22nd	Shimosa, Hitachi, Musashi.			
4-3	Mutsu, Hitachi, Shimōsa, Kazusa, Sagami Shinano, Kai, Mino, Hizen.	4	23rd	Harima.			
		5	27th	Kai.			
2-1	Kushiro, Nemuro, Tokachi, Hitaka, Iburi, Rikuchiu, Ugo, Uzen, Iwashiro, Kōzuke, Yechigo, Suruga, Izu, Tōtōmi, Mikawa, Owari, Omi, Iga, Yamashiro, Yamato, Kawachi, Izumi, Settsu, Harima, Tamba, Tango, Tajima, Bizen, Inaba, Mimasaka, Bitchiu, Bingo, Aki, Suō, Iyo, Tosa, Bungo, Higo, Satsuma.						

			JUNE.				
10-9	Musashi.	1	8th	Izu.	3rd	1,700 sq. *ri.*	Hitachi, Shimosa, Kazusa, Musashi, Sagami, Kōzuke, Shimozuke, Iwaki.
8-7	—	2	12th	Harima.			
6-5	Hitachi, Sagami.	3	15th	Mimasaka.			
4-3	Shimozuke, Iwaki, Kai, Suruga.	4	15th	Kai.			
		5	18th	Sagami, Kai.			
2-1	Nemuro, Kushiro, Mutsu, Iwashiro, Shimōsa, Kazusa, Kōzuke, Izu, Shinano, Mino, Tōtōmi, Mikawa, Owari, Kii, Settsu, Harima, Inabe, Hōki, Mimasaka, Bizen, Bichiu, Bingo, Aki, Izumo, Suō, Tosa, Satsuma.	6	26th	Bitchiu.			
			JULY.				
10-9	Musashi.	1	7th	Mino, Owari, Omi, Yechizen.	7th	3,970 sq. *ri.*	Mino, Owari, Yechizen, Omi, Wakasa, Tango, Tamba, Yamashiro, Yamato, Kawachi, Izumi, Settsu, Kii, Iga, Ise, Shima, Mikawa, Tōtōmi, Suruga, Sagami, Musashi, Kai, Shinano, Hida, Kaga.
8-5	—	2	11th				
4-3	Shimozuke, Hitachi, Kazusa, Mikawa Mino.	3	12th	Yechigo.			
		4	15th	Uzen.			
2-1	Nemuro, Mutsu, Rikuchiu, Rikuzen, Ugo, Uzen, Iwaki, Iwashiro, Yechigo, Shimōsa, Sagami, Izu, Kai, Kōzuke, Suruga, Shinano, Hida, Owari,	5	17th	Iwashiro. Rikuzen.			

JULY.

Seismic Frequeucy.		Severe Earthquakes.			Most Extensive Earthquake.		
Number of Earthq akes.	Provinces.	No.	Days.	Provinces.	Day.	Area.	Provinces.
	Tōtōmi, Ise, Shima, Kii, Yamato, Izumi, Kawachi, Iga, Yamashiro, Omi, Yechizen, Kaga, Wakasa, Tamba, Tango, Settsu, Tajima, Nagato, Osumi, Sado.						

AUGUSI.

8-7	Musashi.	1	11th	Iwaki, Iwashiro, Rikuzen, Uzen, Shimozuke.	12th	3,130 sq. *ri.*	Iwaki, Rikuzen, Uzen, Iwashiro, Ugo, Rikuchiu, Shimozuke, Hitachi, Shimōsa, Musashi.
6-5	—						
4-3	Rikuzen, Shimozuke, Yechigo, Hitachi, Shimōsa, Bungo.			Hitachi.			
		2	17th	Ise.			
		3	27th				
2-1	Nemuro, Kushiro, Rikuchiu, Ugo, Uzen, Iwaki, Iwashiro, Kazusa, Kōzuke, Shinano, Mikawa, Mino, Owari, Ise, Kii, Yamato, Settsu, Wakasa, Tango, Iwami, Tosa, Hiuga, Satsuma.						

12-11	Musashi.					
10-5	—					
4-3	Owari Mino, Bungo, Satsuma.					
2-1	Kushiro, Nemuro, Hitaka, Iburi, Oshima, Mutsu, Iwaki, Iwashiro, Yechigo, Shimozuke, Hitachi, Shimōsa, Kazusa, Sagami, Suruga, Kai, Tōtōmi, Mikawa, Shinano, Ise, Kii, Iwami, Nagato, Iyo, Hiuga, Osumi, Higo.					
		SEPTEMBER.				
		1	10th	Kai.	10th	1,610 sq. *ri.*	Kai, Musashi, Sagami, Suruga, Tōtōmi, Mikawa, Shinano, Mino, Owari.
		2	11th	Musashi.			
		3	12th	Iwami.			
		4	20th	Hiuga.			
		5	27th	Oshima.			
		OCTOBER.				
10-9	Satsuma.	1	20th	Hitachi.	20th	2,210 sq. *ri.*	Hitachi, Shimōsa, Kazusa, Sagami, Musashi, Kōzuke, Shimōzuke, Iwashiro, Iwaki, Rikuzen.
8-7	Shimozuke.					
6-5	—					
4-3	Hitachi, Kazusa, Musashi, Mino, Kii.					
2-1	Nemuro, Oshima, Iburi, Shirebeshi, Mutsu, Rikuzen, Iwaki, Iwashiro, Kōzuke, Shimōsa, Sagami, Mikawa, Tanba, Settsu, Bizen, Bichiu, Bingo, Hōki, Aki, Bungo, Osumi, Hiuga.					

NOVEMBER.

Seismic Frequency.		Severe Earthquakes.			Most Extensive Earthquake.		
Number of Earthquakes.	Provinces.	No.	Days.	Provinces.	Days.	Area.	Provinces.
14-13	Musashi, Kazusa.	1	2nd	Musashi.	24th	5,240 sq. *ri.*	Mutsu, Rikuchiu, Rikuzen, Iwaki, Iwashiro, Shimozuke, Hitachi, Shimōsa, Kazusa, Musashi, Sagami, Oshima, Iburi, Hitaka, Tokachi, Kushiro.
12-11	—	2	3rd	Kazusa, Shimosa.			
10-9	—	3	7th	Rikuzen.			
8-7	Shimozuke, Hitachi, Shimosa.	4	10th	Hida.			
		5	12th	Kii.			
6-5	Rikuzen, Iwaki, Iwashiro.	6	20th	Rikuzen, Iwaki, Yamashiro.			
4-3	Kitami, Kushiro, Mutsu, Sagami, Mikawa, Bungo.	7	23rd	Kikuzen.			
		8	24th	Rikuzen, Iwaki.			
		9	27th	Izumo, Iwami.			
2-1	Nemuro, Tokachi, Hitaka, Iburi, Oshima, Ugo, Uzen, Rikuchiu, Kōzuke, Kai, Suruga, Tōtōmi, Shinano, Hida, Mino, Owari, Ise, Iga, Omi, Yamashiro, Yamato, Kii, Settsu, Harima, Tango, Bizen, Mimasaka, Hōki, Izumo, Bitchiu, Bingo, Aki, Suō, Iwami, Awa, Sanuki, Satsuma.	10	27th	Ise.			

DECEMBER.

6-5	Bungo, Satsuma, Hiuga, Shimozuke.	1	4th	Hida.	6th	3,350 sq. *ri.*	Rikuchiu, Rikuzen, Ugo, Uzen, Iwaki, Iwashiro, Shimozuke, Hitachi, Shimōsa, Musashi.
4-3	Rikuzen, Iwaki, Hitachi, Musashi, Shimano, Mino, Owari. Mikawa, Higo, Osumi.	2	6th	Rikuzen, Rikuchiu.			
		3	10th	Rikuchiu.			
		4	10th	Hiuga.			
		5	27th	Iyo, Bungo, Higo.			
		6	30th	Oshima.			
2-1	Nemuro, Iburi, Oshima, Mutsu, Ugo, Uzen, Rikuchiu, Iwashiro, Kazusa, Shimōsa, Hida, Yetchiu, Kii, Harima, Inaba, Bizen, Bichiu, Bingo, Izumo, Aki, Suō, Nagato, Iyo, Sanuki, Tosa, Awa, Buzen, Chikugo, Awaji.						

8.—Notes on Special Earthquakes.

The following short accounts only refer to the most notable earthquakes or to a series of successive shocks which disturbed the same quarter. The times of occurrence of these seismic disturbances were found by a careful comparison of times indicated by several clocks of the affected area. It should be remembered, however, that in an extensive earthquake, the time of occurrence varied, as it ought to do, from place to place.

1. The earthquake on February 5th, occurred at 1 a.m. The area affected on the day was very wide, extending from Hokkaido in the north, to Musashi and Kazusa in the south. The area therefore included a great number of provinces—Oshima, Shiribeshi, Iburi, Hitaka, Tokachi, Kushiro, Nemuro, Ishikari,* Kitami (5, S.E.),† Teshio (southern corner), Mutsu, Rikuchiu, Ugo, Uzen, Rikuzen, Iwaki, Hitachi, Shimōsa, Iwashiro (8, E.), Shimozuke (2, S.E.), Musashi (4, E.), Kazusa (8, N.) covering an area of 9,670 square *ri*. Among the rest, Mutsu (6, N.E.), Oshima, (3, E.), Iburi (2, S.E.), Hitaka (9, S.) and Tokachi (1, S.W.) were most severely disturbed. However, they suffered no great damage. In fact, this quarter has often had extensive earthquakes, but it must be said that an area of over 9,000 square *ri* was shaken for the first time since the commencement of Seismometric Observations in 1884.

2. Earthquake on April 11th, which occurred at 3 a.m.—On this day the earthquake was felt in 23 provinces, Tango, Tanba, Settsu, Yamashiro, Omi, Yechizen, Wakasa, Harima, Inaba, Tajima, Mimasaka, Bizen, Bitchiu, Hōki, Kawachi (9, N.), Izumi (6, N.), Yamato (2, N.), Iga (3, N.W.), Ise (1, N.), Mino (3, W.), Izumo (2, E.), Bingo (8, E.), and Aki (1, E.) occupying an area of 2,190 square *ri*. Among the others, Tango (8, W.) was most severely affected, but not

* When the name of a province is mentioned the whole or nearly the whole of the province is meant.

† By the notation (5, S.E.) is meant 5 parts out of 10 or half a province to the South-east. When a similar notation is used a similar thing is meant.

much damage was done. In Tango and Tanba this was followed soon after by a very feeble shock.

3. Earthquake on April 29th, which occurred at 10 a.m.—This earthquake disturbed Rikuzen, Uzen, and Yechigo to the north, Shinano, Mino, and Mikawa to the west, and the Pacific Coast to the south-east. It was therefore felt throughout the provinces Musashi, Sagami, Izu, Suruga, Tōtōmi, Kai, Kōzuke, Shimozuke, Hitachi, Shimōsa, Kazusa, Awa, Iwaki, Iwashiro, Shinano, Rikuzen (3, S.), Uzen (southern corner), Yechigo (6, central), Mikawa (7, E.), and Mino (2, E.) occupying an area of 5,080 square *ri*. Among the severely shaken areas may be mentioned Musashi, Sagami, Izu, Suruga (6, E.), Kai (8, E.), Shinano (eastern corner), Kōzuke (7, S.E.), Shimozuke (7, S.), Hitachi (7, S.), Shimōsa (8, W.), Kazusa (3, W.), and Awa (7, W.) amounting to 1,930 square *ri*. It is said that during this earthquake, river banks in Nasugōri, Shimozuke gave way, rents were made in walls in Utsunomiya and Shimo-Tsuga-gōri, Shimozuke, articles were knocked over in Tōkyō and Saitama-gōri, Musashi, of liquids in Kuraki-gōri, Musashi; in Minami-Saku-gōri, Shinano; in Izu; and in Haga-gōri, Shimozuke, pendulum clocks were stopped in Minami-Saku-gōri, Shinano, and in Izu. As to the nature of the motion, we had reports saying a little up and down motion was felt in each of the shaken areas, but, it seems, it was generally a horizontal motion. It is satisfactory to record that in spite of the extraordinary extension of the shaken area, only a few places suffered any damage.

4. The earthquake on July 15th, which occurred at 7½ a.m. The area affected was Iwashiro, Iwaki (1, W.) and Yechigo (eastern corner), thus describing an elipse like a figure whose major axis had an east and west direction, and covered an area of 600 square *ri*. In all probability, this earthquake was due to the eruption of Bandai-san. On the same day, Inashiro-machi at the foot of the mountain (at a distance of 60 *chō* to the S.E.) felt a feeble earthquake at 8 a.m., which, be-

coming more and more severe, reached its climax at 8½ a.m. Just at the same moment, the eruption of Bandai-san took place with a deafening thundering noise. During the last shock, the surface of the water of the Lake of Inawashiro was so greatly agitated that it overflowed. In Wakamatsu, Kita-Aizu-gōri, subterraneau waves came from the N.E. at 33 minutes past 7 a.m.; and the up and down motion lasted about 7 seconds. This was followed by a feeble shaking, lasting 30 seconds. During the last shock, sounds of distant thunder were heard.

From the above reports it is evident that two shocks took place before the eruption, and the most severe shock was just at the moment of eruption.

Earthquake Observations made at the Meteorological Central Observatory, Tokyo.

During the year 1888, the number of earthquakes observed at the Meteorological Central Observatory was 101. The following table shows at a glance the date, direction, intensity, &c., of these earthquakes :—

9.—Table of Earthquakes observed in Tokyo during the Year 1888.

Date.	Time of Occurrence.	Duration.	Horizontal Motion.				Vertical Motion.
			Direction.	Max. range in mm.	Max. Vel. per Sec. in mm.	Max. Accel. per Sec. in mm.	Max. Amplitude in mm.
Jan.	h. m. s.	m, s.					
1st	3 31 38 p.m.	—	—	little	—	—	—
11th	8 50 36 a.m.	5	S.E.E. to N.W.W.	0.4	0.7	2.4	—
14th	5 31 55 p.m.	15	E.W.	little	—	—	little
27th	10 5 33 p.m.	10	S.W.	little	—	—	—
Feb.							
2nd	1 15 15 p.m.	3 48	N.W.W. to S.E.E.	13.0	11.0	18.6	little
2nd	2 23 46 p.m.	1 49	E.W.	0.7	1.6	7.3	—
2nd	3 0 14 p.m.	—	—	little	—	—	—
2nd	3 41 27 p.m.	4 5	S.W.W. to N.E.E.	3.8	5.0	13.1	—
5th	0 50 56 a.m.	1	S.W. to N.E.	1.6	2.4	7.2	—
10th	3 26 55 p.m.	10	N.E. to S.W.	little	—	—	—

Date.	Time of Occurrence.	Duration.	Horizontal Motion.				Vertical Motion.
			Direction.	Max. range in mm.	Max. Vel. per Sec. in mm.	Max. Accel. per Sec. in mm.	Max. Amplitude in mm.
Feb.	h. m. s.	m. s.					
10th	6 38 7 p.m.	12	E.W.	little	—	—	—
11th	3 38 56 p.m.	—	—	little	—	—	—
13th	11 33 44 a.m.	25	S. to N.	little	—	—	—
15th	3 43 38 p.m.	30	E. to W.	little	—	—	—
17th	0 16 17 p.m.	50	E. to W.	little	—	—	—
18th	6 13 45 p.m.	15	E. to W.	little	—	—	—
22nd	10 24 43 a.m.	1 30	E. to W.	0.7	0.7	1.4	—
23rd	11 10 50 p.m.	10	S. to N.	little	—	—	—
24th	2 7 6 a.m.	—	E. to W.	little	—	—	—
Mar.							
1st	3 30 15 p.m.	1 15	S.W.W. to N.E.E.	little	—	—	—
1st	9 54 12 p.m.	30	S. to N.	little	—	—	—
9th	4 54 16 a.m.	25	N.N.W. to S S.E.	0.4	6.3	198.4	little
9th	10 17 1 p.m.	—	—	little	—	—	—
16th	5 58 2 a.m.	30	S.E. to N.W.	0.2	0.9	8.1	—
16th	6 43 32 a.m.	2 50	S.E. to N.W.	0.4	1.6	12.8	—
17th	7 55 36 p.m.	—	—	little	—	—	—
April							
1st	6 17 8 a.m.	—	—	little	—	—	—
5th	2 30 29 p.m.	2	S.E. to N.W.	1.2	5.4	48.6	0.5
8th	2 22 32 p.m.	—	—	little	—	—	—
16th	11 6 43 p.m.	—	—	little	—	—	—
27th	8 34 34 a.m.	2	S.E. to N.W.	0.2	0.4	1.6	—
29th	10 0 33 a.m.	8	S.E. to N.W.	5.6	22.0	172.8	1.5
30th	5 44 38 a.m.	—	E. to W.	little	—	—	—
May							
5th	8 52 24 p.m.	—	—	little	—	—	—
8th	4 7 56 a.m.	—	—	little	—	—	—
8th	4 51 41 a.m.	—	—	little	—	—	—
10th	10 12 0 a.m.	—	—	little	—	—	—
13th	4 51 52 a.m.	abt. 10	N.W. to S.E.	0.2	1.3	16.9	—
13th	11 17 41 p.m.	—	—	little	—	—	—
22nd	6 9 20 p.m.	4 30	S.E.E. to N.W.W.	1.5	1.8	4.3	0.2
24th	9 35 37 a.m.	1	E. to W.	little	—	—	—
24th	11 45 5 a.m.	—	—	little	—	—	—
26th	6 17 14 p.m.	—	—	little	—	—	—
27th	7 5 9 p.m.	—	—	little	—	—	—
June							
3rd	7 53 8 a.m.	3	N.W.W. to S.E.E.	1.5	3.6	17.3	—
12th	9 6 27 p.m	abt. 20	N.N.W. to S.S.E.	0.4	1.0	5.0	—
15th	0 21 25 a.m.	—	—	little	—	—	—
18th	2 20 31 p.m.	1 40	S.E. to N.W.	0.3	1.2	9.6	—
18th	3 17 6 p.m.	—	—	little	—	—	—

Date.	Time of Occurrence.	Duration.	Horizontal Motion.				Vertical Motion.
			Direction.	Max. range in mm.	Max. Vel. per Sec. in mm.	Max. Accel. per Sec. in mm.	Max. Amplitude in mm.
June	h. m. s.	m. s.					
18th	9 57 14 p.m.	—	—	little	—	—	—
19th	6 29 57 a.m.	abt. 20	E. to W.	0.2	0.8	6.4	—
22nd	7 6 20 a.m.	—	—	little	—	—	—
24th	11 8 20 p.m.	10	E. to W.	little	—	—	—
July							
2nd	4 51 56 a.m.	—	—	little	—	—	—
7th	9 37 37 a.m.	3	E. to W.	little	—	—	—
7th	5 25 43 p.m.	1	—	little	—	—	—
11th	3 38 35 p.m.	—	—	little	—	—	—
14th	7 31 59 a.m.	—	—	little	—	—	—
14th	4 42 44 p.m.	3	S.S.W. to N.N.E.	0.6	0.8	2.1	—
22nd	2 27 48 a.m.	—	—	little	—	—	—
24th	7 57 43 a.m.	—	—	little	—	—	—
29th	9 48 21 p.m.	1 30	E.W.	0.2	0.6	3.6	little
Aug.							
1st	9 25 18 p.m.	1 30	E.W.	0.2	0.8	6.4	—
11th	9 31 42 a.m.	—	—	little	—	—	—
12th	11 42 27 a.m.	3	S.S.W. to N.N.E.	0.4	1.5	11.2	—
17th	3 49 50 a.m.	1 10	E.W.	0.2	0.6	3.6	—
18th	1 22 0 a.m.	—	—	little	—	—	—
19th	9 19 26 a.m.	—	—	little	—	—	—
19th	11 47 25 a.m.	—	—	little	—	—	—
Sept.							
2nd	5 45 0 a.m.	30	E.W.	little	—	—	—
4th	5 10 0 a.m.	—	—	little	—	—	—
4th	1 36 11 p.m.	—	—	little	—	—	—
5th	0 6 35 a.m.	—	—	little	—	—	—
6th	4 9 25 a.m.	—	—	little	—	—	—
10th	9 22 0 a.m.	—	—	little	—	—	—
11th	8 34 54 a.m.	25	E.W.	0.4	3.1	48.0	little
18th	2 45 39 a.m.	30	E.W.	little	—	—	—
24th	5 24 30 a.m.	20	E.W.	little	—	—	—
24th	5 37 13 p.m.	—	—	little	—	—	—
28th	7 5 21 a.m.	30	E.W.	little	—	—	—
Oct.							
9th	1 7 55 a.m.	—	—	little	—	—	—
10th	4 20 24 p.m.	30	—	little	—	—	—
12th	7 40 56 a.m.	—	—	little	—	—	—
28th	6 15 16 a.m.	2	N.N.E. to S.S.W.	1.2	7.5	93.7	0.5
Nov.							
2nd	1 48 01 p.m.	1	E.W.	0.3	1.2	9.6	—
3rd	0 51 14 a.m.	1 30	E.W.	0.3	1.9	24.1	little
3rd	8 13 33 a.m.	4 30	S.W. to N.E.	1.9	14.9	232.6	0.5

Date.	Time of Occurrence.	Duration.	Horizontal Motion.				Vertical Motion.
			Direction.	Max. range in mm.	Max. Vel. per Sec. in mm.	Max. Accel. per Sec. in mm.	Max. Amplitude in mm.
Nov,	h. m. s.	m. s.					
5th	4 22 55 a.m.	—	—	little	—	—	—
6th	4 38 37 p.m.	3	—	0.2	0.3	0.9	—
7th	10 27 34 p.m.	4	E.W.	0.5	0.4	0.6	—
10th	1 37 44 p.m.	1 30	N.N.W. to S.E.E.	0.3	0.5	1.7	—
16th	0 42 52 a.m.	—	—	little	—	—	—
20th	0 53 29 a.m.	2 30	E.W.	0.2	0.7	4.9	—
22nd	1 27 43 p.m.	—	—	little	—	—	—
23rd	5 13 30 p.m.	—	—	little	—	—	—
24th	2 3 23 a.m.	4	N.W. to S.E.	0.4	0.9	4.5	—
25th	4 50 15 p.m.	15	E.W.	0.2	1.3	16.9	—
Dec.							
3rd	0 24 47 p.m.	2	S.E. to N.W.	0.2	0.4	1.6	—
6th	7 27 42 a.m.	—	—	little	—	—	—
16th	4 19 3 a.m.	20	S.N.	little	—	—	—
28th	3 28 4 a.m.	35	E.W.	0.2	0.4	1.6	—

10.—Earthquake frequency per Month.

During the year 1888, the number of earthquakes in each month was as follows:—

Months.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Frequency	4	15	7	7	11	9	9	7	11	4	13	4	101

From the above it is seen that the maximum frequency occurred in February and the minimum frequency in January, October, and December.

11.—Earthquake frequency per Season.

Year.	Spring.	Summer.	Autumn.	Winter.	Average.
1888	25	25	28	23	25

12.—Frequency during Hot and Cold Periods.

Year.	Hot.	Cold.	Average.
1888	54	47	50

13.—Hourly frequency of Earthquakes.

The number of earthquakes in each hour during the year will be found from the following table :—

	Forenoon.												Afternoon.												
M'ths. Hs.	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	Total
Jan. ...	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	4
Feb. ...	1	—	1	—	—	—	—	—	—	—	1	1	1	1	1	5	—	—	2	—	—	—	—	1	15
Mar. ...	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—	1	—	—	—	1	—	1	1	—	7
April ...	—	—	—	—	—	1	1	—	1	—	1	—	—	—	2	—	—	—	—	—	—	—	—	1	7
May ...	—	—	—	—	3	—	—	—	—	1	1	1	—	—	—	—	—	—	2	1	1	—	—	1	11
June ...	1	—	—	—	—	—	1	2	—	—	—	—	—	—	1	1	—	—	—	—	—	2	—	1	9
July ...	—	—	1	—	1	—	—	2	—	1	—	—	—	—	—	1	1	1	—	—	—	1	—	—	9
Aug. ...	—	1	—	1	—	—	—	—	—	2	—	2	—	—	—	—	—	—	—	—	—	1	—	—	7
Sept. ...	1	—	1	—	1	3	—	1	1	2	—	—	—	1	—	—	—	1	—	—	—	—	—	—	11
Oct. ...	—	1	—	—	—	—	1	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	4
Nov. ...	3	—	1	—	1	—	—	—	1	—	—	—	—	3	—	—	2	1	—	—	—	—	1	—	13
Dec. ...	—	—	—	1	1	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	4
Total	6	2	4	2	8	5	4	7	4	6	3	4	2	5	4	8	4	4	4	2	1	5	3	4	101

We see from the above that the maximum frequency was between 3-4 p.m. and 4-5 a.m., and the minimum between 8-9 p.m., 0-1 p.m., 7-8 p.m., 1-2 a.m., and 3-4 a.m.

14.—Intensity of Earthquakes.

Of the 101 earthquakes which took place in Tokyo in the year 1888, we will now describe the most notable earthquakes.

Date.	Time of Occurrence.	Duration.
April, 29th.	10° 0′ 33″ a.m.	... . 8′

	Horizontal Motion.				Vertical Motion.
Date.	Max. Range. in mm.	Max. Velocity in mm.	Max. Accel. in mm.	Direction.	Max. Amplitude in mm.
April 29th.	5.6 in 0.8 sec.	22 in 1.0 sec.	172.8 in 1.0 sec.	S.E. to N.W.	1.5 in 0.6 sec.

The origin of this earthquake must have been somewhere in the Gulf of Tokyo. In the provinces on the gulf, river banks gave way, rents were made in walls, articles fell down, liquids flowed from vessels, clocks were stopped, &c. The duration was long. The next shocks of long duration were those which occurred at 6h. 9′ 20″ p.m. on May 12th, and at 8h. 13′ 33″ on November 3rd, each having a duration of 4½ minutes. All the remaining shocks had a duration of less than 4 minutes. There was only one earthquake which had a range greater than 10 mm., 8 earthquakes which had ranges 1-10 mm., 28 which were less than 1 mm., and the remaining 64 were so feeble that measurement was impossible.

From the preceding facts we may conclude that severe earthquakes were few in number this year, about 90 per cent. of them being feeble.

15.—Direction of Earthquakes.

The principal direction of motion of the 101 earthquakes this year were as follows :—

Year.	S.N.	S.S.W. to N.N.E.	S.W. to N.E.	S.W.W. to N.E.E.	E.W.	S.E.E. to N.W.W.	S.E. to N.W.	S.S.E. to N.N.W.	Unknown.
1888 5	3	4	2	27	5	8	2	45	

Earthquake motion was therefore chiefly E.W., and after that S.E. to N.W. They occurred least in the directions S.S.E. to N.N.W., and S.W.W. to N.E.E., the next being S.S.W. to

N.N.E. Besides these, there were 45 feeble earthquakes having unknown directions.

16.—Nature of Earthquakes.

An earthquake may have a horizontal or vertical motion. And the motion may be rapid or slow. In the following table we show the nature of the earthquakes in 1888 :—

Nature. Months.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Combination of horizontal and vertical motion..	1	1	—	2	1	1	1	—	1	1	2	—	11
Horizontal motion	2	12	7	3	9	8	7	4	5	—	9	3	69
Unknown	1	2	—	2	1	—	1	3	5	3	2	1	21
Rapid	1	2	4	2	1	3	—	1	2	1	4	—	21
Slow	2	10	1	2	1	2	4	2	2	—	5	3	34
Unknown	1	3	2	3	9	4	5	4	7	3	4	1	46

Thus of 101 earthquakes, 69 were horizontal, 11 were combination of horizontal and vertical, and 21 were not definite, being very feeble. The number of slow earthquakes exceeded that of rapid ones by 13, while 46 were so feeble that it was difficult to determine their period of vibration.

MAP SHOWING
THE SEISMIC FREQUENCY
for the year 1888.

TESHIO
KITAMI
ISHIKARI
3
NEMURO
KUSHIRO
9
16
SHIRIBESHI
TOKACHI
IBURI
6
HITAKA
2
OJIMA
7
CHISHIMA
(Kurile Islands)
KOREA
OKI
TSUSHIMA
MUTSU
15
6
RIKUCHU
7
UGO
3
8
RIKUZEN
6
UZEN
SADO
2
4
IWASHIRO
10
25
IWAKI
30
ECHIGO
7
NOTO
ETCHU
KOTSUKE
SHIMOTSUKE
HITACHI
KAGA
3
HIDA
SHINANO
2
2
ECHIZEN
5
MUSASHI
50
SHIMOSA
101
15
25
KAI
10
MINO
19
10
SAGAMI
KAZUSA
10
AWA
OWARI
MIKAWA
5
SURUGA
10
IZU
TOTOMI
12
OMI
5
IGA
YAMASHIRO
KAWACHI
IZUMI
YAMATO
5
ISE
SHIMA
1
AWAJI
HOKI
INABA
TAJIMA
TANGO
WAKASA
IZUMO
8
MIMASAKA
5
TAMBA
8
IWAMI
3
BIZEN
HARIMA
BITCHU
BINGO
6
SETTSU
AKI
10
NAGATO
1
SUWO
SANUKI
2
AWA
15
KII
IKI
CHIKUZEN
BUZEN
IYO
5
TOSA
6
HIZEN
CHIKUGO
BUNGO
24
5
4
HIGO
2
8
SATSUMA
HIUGA
OSUMI
48

Boundary line of Provinces.

▲ Active volcano.

△ Extinct volcano.

This map shows the observations of 630 earthquakes which occurred from January to December 1888 by colors. The dark shade indicates the regions most frequently shaken, the lighter shades less disturbed. Figures are inserted to show the number of earthquake which occurred in different parts of the country during one year.