

REPORT UPON EARTHQUAKES OBSERVED IN JAPAN 1889.

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I.—GENERAL OBSERVATIONS.

SEISMIC DISTURBANCES AND THEIR FREQUENCY—The number of earthquakes which occurred in this country during the year

1889 amounted to 930 disturbances. Map 1 shows the distribution of these earthquakes.

The country is divided into the following six areas according to the number of earthquakes which took place during the year :—

1. Most frequently shaken area, viz., Higo and Musashi.*
2. Very frequently shaken area, viz., Shimozuke, Hitachi, Shimōsa, Nemuro, Iwaki, and Sagami.
3. Frequently shaken area, viz., Bungo, Kazusa, Satsuma, Kushiro, Kōzuke, Awa, Oshima, and Rikuzen.
4. Less frequently shaken area, viz., Iwashiro, Kai, Mino, Rikuchiu, Mikawa, Mutsu, Kii, Owari, Suruga, Shinano, Ugo, Chishima, Hiuga, Izu, Ise, Bichiu, Aki, Suo, Hitaka, Tōtomi, Yechigo, Iyo, Osumi, and Hizen.
5. Least frequently shaken area, viz., the remaining provinces which are coloured in the map, the seismic frequency being generally less than 5 in the year.
6. Area free from earthquakes, viz., the parts which are not coloured in the map, consisting of Sado, Noto, Inaba, Oki, Tsushima, Teshio, western parts of Tajima, northern parts of Mimasaka, nearly whole of Hoki, northern parts of Izumo, north and southern parts of Shiribeshi, western parts of Iburī, northern parts of Ishikari and Kushiro, central parts of Kitami, and many islands.

The last area might be considered for the present as free from earthquakes as no report of disturbances have been received from this area. In fact, it would not be too much to

* Hitherto the former province had only 3 or 4 earthquakes every year. But the well known terrible earthquake which affected this province and others on the night of July 28th, was followed by repeated shocks, thus giving rise in the year to 281 shocks. In addition to this, 62 shocks were felt on the next 29th and 30th, but the exact time of their occurrence being unknown, they are omitted in the above figures. If we take them into calculation, we should have 343 shocks instead of 281. This frequency of shocks in Higo is the reason for the sudden increase in the total number of earthquakes in this country for the year.

The great frequency of shocks in Musashi namely 115, is due to the fact that at Tokyo in this province careful observations are made with seismometers.

say that the area is but little affected by, if not absolutely free from earthquakes, since earthquakes are never reported either from there or from neighbouring parts.

In fine, there is reason to suppose that the central mountain chains traversing the Empire from Hokkaido to Kiushiu form a remarkable line of demarkation as regards the seismic frequency, the provinces along the coast of the Pacific being frequently shaken whilst those along the Japan Sea are but little affected.

NUMBER OF EARTHQUAKES IN EACH SEASON.—The number of earthquakes observed every month from January to December, 1889, is given in the following table :—

Months.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	Aver- age.
Number of Earthquakes,	53	57	63	67	60	39	65	192	79	103	82	72	930	77.5

From the above table it will be seen that we have the maximum frequency in August and the minimum in June. The general increase in frequency is due to repeated shocks after the terrible earthquake in Higo already referred to.

The frequency in each season may be deduced from the above table, thus :—

Seasons.	Spring.	Summer.	Autumn.	Winter.	Total.	Average.
Number of Earthquakes.	190	296	264	180	930	232.5

From the preceding Table we see that the average frequency per season was 232.5, and also that the maximum frequency was in Summer and the minimum in Winter.

If we call six months from April to October the hot season and those from October to April the cold season, we have :

Seasons.	Hot.	Cold.	Total.	Average.
Number of Earthquakes	502	428	930	465

Thus the average frequency of the two seasons was 465, and the earthquakes occurred more frequently during the hot season than in the cold one.

NUMBER OF EARTHQUAKES IN EACH HOUR.

The occurrence of Earthquakes according to the hours of the day and night is shown in the following table:—

Months, Hours.	FORENOON.												AFTERNOON.											
	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	
January	—	—	3	2	4	4	5	2	4	—	—	3	4	3	1	2	2	4	4	4	—	—		
February	—	—	1	1	2	4	2	5	3	2	2	1	3	4	4	2	1	—	3	1	6	4		
March	2	1	3	2	—	2	5	2	2	4	2	3	2	2	4	3	3	4	3	6	1	2		
April	4	3	3	5	2	1	1	5	1	1	1	1	5	7	6	3	5	4	—	3	3	2		
May	3	1	1	5	—	5	7	1	4	5	3	3	4	2	2	1	—	3	3	2	—	2		
June	—	2	1	3	—	1	3	3	1	1	4	1	1	4	3	1	—	2	2	1	—	4		
July	4	4	8	5	5	1	5	3	2	—	3	2	3	2	1	1	2	1	1	2	2	4		
August	6	8	12	15	10	9	7	9	8	5	7	6	11	10	10	9	11	8	6	6	4	5		
September	1	5	6	3	3	3	3	6	3	2	8	3	5	3	3	1	4	1	1	4	1	2		
October	1	6	6	4	2	6	6	3	3	1	3	3	6	4	3	2	7	3	7	5	5	2		
November	3	1	5	1	3	2	2	4	5	8	1	4	7	3	4	5	2	3	—	1	5	4		
December	1	4	4	2	2	2	1	1	3	3	4	6	5	4	4	1	2	3	—	5	3	1		
Total	25	35	53	48	29	45	42	45	35	38	40	34	151	48	47	32	41	36	23	40	29	39		
													42	33	930									

From the above table we see that the maximum frequencies occurred between 2-3 a.m. and 0-1 p.m., whereas the minimum frequencies, an between 6-7 p.m. and 0-1 a.m.

AREA OF SEISMIC DISTURBANCES.—The area shaken by the earthquakes varied with their intensity from a mere local tract up to several thousand square *ri*. The following table is a classification of the earthquakes according to the area disturbed ;

Areas.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Aver- age.
More than 1,000 square <i>ri</i> .	5	5	7	6	3	4	1	3	3	5	3	1	46	3.8
From 1,000 down to 100 square <i>ri</i>	10	9	5	16	13	9	14	8	7	9	8	9	117	9.8
Less than 100 square <i>ri</i> ...	38	43	51	45	44	26	50	181	69	89	71	60	767	63.9
Total.....	53	57	63	67	60	39	65	192	79	103	82	70	930	77.5

From the above table we see that 767 earthquakes out of the total number of 930 disturbed areas less than 100 sq. *ri*, 117 areas between 100 and 1,000 sq. *ri*, and 46 areas greater than 1,000 sq. *ri*. We may add that one earthquake shook an area of nearly 6,000 sq. *ri*, whilst another shook an area of about 9000 sq. *ri*.

INTENSITY OF EARTHQUAKES.—During the year 1889, as we have seen, the total number of earthquakes was 930, of which 51 were of a severe character, 290 of moderate, and the remaining 589 were slight shocks. Thus, severe ones were of 6% of the total number of earthquakes, moderates ones 31%, and slight ones 63%.

The provinces shaken by these severe earthquakes were :—

	Times.
Hitachi	12
Musashi	10
Sagami	9
Shimōsa and Shimozuke	7
Kazusa	6
Suruga and Rikuchiu.....	5
Kōzuke, Izu, Iwaki, and Awa	4
Rikuzen, Oshima, Kushiro, Owari, Mino, Kii, Iyo, Bungo, and Higo	3

Buzen, Hiuga, Awa, Kai, Ise, Tōlōmi, Yechigo, and Ugo	2
Shinano, Iwashiro, Mutsu, Mikawa, Omi, Wakasa, Yechizen, Settsu, Awaji, Tosa, Nagato, Chiku- zen, Chikugo, Hizen, and Satsuma	1

Of these severe shocks, the most severe one was that which visited both Higo and Chikugo on the 28th of July. The very severe ones were those which occurred in Kantō Feb. 18th, in Mino May 12th, in Izu April 8th, in Mutsu and Oshima Dec. 31th, in Shimozuke Oct. 13th, in Bungo Jan. 18th, and in Yechigo March 18th.

In the terrible earthquake in Kumamoto, Higo, houses were levelled, many lives were lost, and domestic animals were killed. On the other hand, in all other cases, even with the most violent the damage was small. The least violent ones caused articles to fall from shelves, clocks to stop, &c.

NUMBER AND INTENSITY OF EARTHQUAKES IN EACH PROVINCE.—The details of the number and intensity of earthquakes in each province during the year 1889 are as follows:—

Provinces.	Number of Earthquakes.	Severe.	Intensity. Moderate.	Slight.
Higo	281	2	33	246
Musashi	115	5	23	87
Shimozuke	85	4	11	70
Hitachi	63	6	39	18
Shimosa	50	2	15	33
Nemuro	48	—	6	42
Iwaki	38	3	13	22
Sagami	31	5	14	12
Bungo	29	2	10	17
Kazusa	26	5	12	9
Satsuma	26	—	4	22
Kushiro	25	1	18	6
Kozuke	23	2	9	12
Awa	22	2	7	13
Oshima	22	2	11	9

Rikuzen	21	4	14	3
Iwashiro	20	—	8	12
Kai	19	2	11	6
Mino	19	2	3	14
Rikuchiu	18	2	9	7
Mikawa	15	1	5	9
Mutsu	13	—	6	7
Kii	13	—	5	8
Owari	12	1	—	11
Suruga	10	4	5	1
Shinano	10	1	1	8
Ugo	10	1	3	6
Hiuga	10	1	4	5
Chishima	10	—	4	6
Idzu	9	3	5	1
Bichiu	9	—	1	8
Ise	9	—	5	4
Hitaka	7	—	4	3
Suo	7	—	4	3
Aki	7	—	3	4
Totomi	6	1	2	3
Yechigo	6	—	4	2
Iyo	6	1	1	4
Osumi	6	—	3	3
Hizen	6	—	4	2
Settsu	5	—	3	2
Awa	5	—	4	1
Tosa	5	1	4	—
Bizen	5	—	5	—
Buzen	5	1	3	1
Chikugo	5	1	4	—
Uzen	4	—	—	4
Omi	4	1	2	1
Awaji	4	1	2	1
Tamba	4	—	1	3

Shima	4	—	I	3
Chikuzen	4	I	I	2
Nagano	3	I	I	I
Iwami	3	—	I	2
Izumo	3	—	2	I
Bingo	3	—	I	2
Harima	3	—	2	I
Sanuki	3	—	2	I
Kaga	3	—	2	I
Yechizen	3	I	—	2
Iburi	3	—	I	2
Ishikari	2	—	2	—
Shiribeshi	2	—	I	I
Wakasa	2	I	—	I
Yamashiro	2	I	—	I
Kawachi	2	—	2	—
Izumi	2	—	2	—
Yamato	2	—	I	I
Iga	2	—	—	2
Iki	2	—	I	I
Mimasaka	I	—	I	—
Tajima	I	—	—	I
Tango	I	—	I	—
Yetchiu	I	—	—	I
Hida	I	—	—	I
Takachi	I	—	—	I

Thus we find that the first six provinces, namely, Higo, Musashi, Shimosuke, Hitachi, Shimōsa, and Nemuro were affected most frequently, while the last six provinces, namely, Mimasaka, Tajima, Tango, Yetchiu, Hida, and Tokachi, least frequently.

TABLE OF EARTHQUAKES (MONTHLY).—We may classify the provinces according to the number of earthquakes in each month, and indicate the provinces visited by violent shocks and and the maximum area shaken, as follows :—

JANUARY.

Seismic Frequency.		Severe Earthquakes.			Most Extensive Earthquake.		
Number of Earthquakes.	Provinces.	No.	Days.	Provinces.	Day.	Area.	Provinces.
10-8	Hitachi, Shimozuke.	1	1st	Shimōsa, Musashi, Sagami, Shimozuke, and Hitachi.	30th	3,640 sq. <i>ri</i> .	Mutsu, Rikuchiu, Rikuzen, Ugo, Uzen, Iwashiro, Iwaki, Shimozuke, Hitachi.
8-6	Kushiro.						
6-4	Bungo, Nemuro, Musashi.	2	18th	Bungo, Buzen, Higo, Hiuga, Iyo.			
4-2	Awa, Shimōsa, Kazusa, Sagami, Iwaki, Rikuzen, Rikuchiu, Mikawa, Satsuma.	3	30th	Rikuzen.			
2-1	Kai, Kii, Mino, Iwashiro, Kōzuke, Yechigo, Shinano, Suruga, Mutsu, Uzen, Ugo, Bizen, Bichiu, Nagato, Aki, Suō, Owari, Mimasaka, Iburi, Ishikari, Hitaka, Buzen, Hizen, Higo, Chikuzen, Chikugo, Hiuga, Osumi, Sanuki, Tosa, Awa.	4	31st	Kushiro.			
FEBRUARY.							
16-14	Musashi.	1	18th	Musashi, Sagami, Awa, Kazusa, Shimōsa, Hitachi, Shimozuke, Kai, Suruga, Izu, Kōzuke.	18th	5,750 sq. <i>ri</i> .	Musashi, Sagami, Awa, Kazusa, Shimōsa, Hitachi, Shimozuke, Kōzuke, Kai, Suruga,
14-12	—						
12-6	—						
6-4	Shimozuke, Sagami.						

Seismic Frequency.		Severe Earthquakes.				Most Extensive Earthquake.		
Number of Earthquakes.	Provinces.	No.	Days.	Provinces.	Day.	Area.	Provinces.	
4-2	Kazusa, Shimōsa, Hitachi, Mutsu, Kai, Kuroshiro, Nemuro, Bungo.	2	18th	Kushiro.			Izu, Tōiōmi, Shimano,	
		3	19th	Tōsa, Awa, Iyo.			Iwashiro, Iwaki, Riku-	
2-1	Kōzuke, Iwaki, Shinano, Suruga, Mino, Aki, Izu, Mikawa, Awa, Yechigo, Iwashiro, Uzen, Rikuzen, Ugo, Owari, Shima, Bizen, Bichiu, Bingo, Iwami, Suō, Oshima, Hitaka, Tōsa, Awa, Iyo, Sanuki, Hiuga, Satsuma.	4	21th	Sagami.			zen, Uzen, Yechigo,	
		5	28th	Owari.			Mikawa, Owari, Mino.	
MARCH.								
12-10	Musashi.	1	1st	Rikuchiu.			Iwaki, Iwashiro, Shi-	
10-8	Shimozuke.	2	3rd	Rikuchiu.	31st	4,340 sq. <i>ri</i> .	mōzuke, Hitachi, Shi-	
8-6	Hitachi.	3	15th	Ugo.			mōsa, Kazusa, Awa,	
6-4	Shimōsa, Kazusa, Awa, Kōzuke, Iwaki, Sagami, Kai.	4	17th	Oshima.			Musashi, Sagami,	
		5	18th	Yechigo.			Kai, Kōzuke, Yechi-	
		6	26th	Awa.			eo, Uzen, Rikuzen,	
4-2	Yechigo, Iwashiro, Kii, Bizen, Suō.	7	28th	Sagami, Musashi, Shimōsa, Hitachi, Shimo			Ugo.	

2-1	Bichiu, Rikuzen, Rikuchi, Ugo, Mutsu, Mikawa, Mino, Bingo, Aki, Suruga, Uzen, Shinano, Owari, Tamba, Bizen, Izumo, Iwami, Kushiro, Oshima, Nemuro, Awa, Tosá, Iyo, Satsuma, Higo.	8 9 10 11 12	28th 28th 30th 31st 31st	zuke. Hitachi, Shimōsa. Hitachi. Bungo, Iyo. Hitachi, Iwaki. Shimozuke, Iwaki.		
APRIL.						
18-16	Musashi.	1	3rd	Yechigo.	18th	3,050 sq. ri. Izu, Suruga, Sagami,
16 14	—	2	3rd	Musashi.		Awa, Kazusa, Shimō-
14-12	Shimozuke.	3	18th	Izu, Suruga, Sagami,		sa, Musashi, Kai, Tō-
12-10	Hitachi, Shimōsa.			Awa.		tōmi, Mikawa, Owari,
10-6	—	4	25th	Mino, Owari.		Mino, Kozuke, Shimo-
6 4	Sagami, Kōzuke, Iwaki.	5	25th	Ise.		zuke, Hitachi.
4 2	Suruga, Kai, Kazusa, Mino, Owari, Mikawa, Rikuzen, Awa, Izu, Hiuga, Oshima, Nemuro.	6	28th	Hitachi.		
		7	29th	Hitachi.		
2-1	Yechigo, Tōtōmi, Settsu, Awaji, Shinano, Tamba, Yamashiro, Mutsu, Oni, Ise, Kii, Bichiu, Bingo, Buzen, Iburi, Kushiro, Shiribeshi.					

MAY.

Seismic frequency.		Severe Earthquakes.			Most Extensive Earthquake.		
Number of Earthquakes.	Provinces	No.	Days.	Provinces.	Day.	Area.	Provinces.
14-12	Musashi.	1	12th	Mino, Owari, Ise, Omi, Iwashiro, Wakasa, Yechizen, Mikawa, Tōtomi, and Suruga.	12th	4,800 sq. ri.	Mino, Owari, Ise, Mikawa, Tōtomi, Iga, Yamashiro, Wakasa, Yechizen, Kaga, Hida, Suruga, Kai, Izu, Sagami, Musashi, Shimosa, Shimozuke, Kōtchiu, Shinano, Yetchiu, Shima, Kii, Yamato, Izumi, Kawachi, Settsu, Tamba, Tango, Awaji, Yajima, Harima, Bizen, Bichiu, Saunuki, Awa.
12-10	—						
10 8	Shimosuke.						
8-6	Nemuro.						
6-4	Hitachi, Shimosa, Iwaki, Bungo.						
4-2	Mitawa, Kazusa, Chishima.						
2-1	Suō, Shinano, Kii, Mino, Ise, Owari, Tōtomi, Sagami, Kōzuke, Settsu, Aki, Iyo, Rikuchiu, Omi, Wakasa, Yamashiro, Yechizen, Suruga, Izu, Kai, Hida, Kaga, Yetchiu, Shima, Yamato, Kawachi, Izumi, Awa, Tamba, Tango, Harima, Awaji, Bizen, Yetchiu, Nagato, Ugo, Iwashiro, Hitaka, Oshima, Shiribeshi, Kushiro.						

JUNE.

8-6	Musashi, Shimozuke.	1	6th	Rikuchiu.	20th	2,340 sq. <i>ri</i> .	Hitachi, Shimōsa, Kazusa, Iwaki, Iwashiro, Shimozuke, Kozuke, Musashi, Sagami, Kai.
6-4	Hitachi.	2	11th	Nagato.			
4-2	Shimōsa, Rikuchiu, Iwaki, Kai.	3	20th	Hitachi, Iwaki.			
		4	24th	Rikuchiu.			
2-1	Iwashiro, Ise, Kazusa, Mitawa, Sagami, Minno, Ugo, Kii, Nagato, Shima, Yechizen, Kaga, Kōzuke, Rikuzen, Mutsu, Suruga, Tōtomi, Izu, Shinano, Bizen, Bichiu, Bingo, Aki, Owari, Kushiro, Nemuro, Chishima, Buzen, Bungo, Satsuma, Awa.	5	27th	Suruga, Tōtomi, Izu.			

JULY.

8-6	Nemuro.	1	28th	Higo, Chikugo, Hizen, Chikuzen, Bungo, Buzen, Satsuma, Huga.	28th	3,590 sq. <i>ri</i> .	Chikuzen, Chikugo, Buzen, Bungo, Hizen, Higo, Huga, Osumi, Satsuma, Iki, Nagato, Suō, Aki, Iwami, Iyo, Tosa.
6-4	Musashi, Shimozuke.						
4-2	Hitachi, Shimōsa, Aki, Chishima, Iyo, Bungo, Hizen.	2	31st	Away, Awaji.			
		3	31st	Awa, Kii.			
2-1	Rikuchiu, Nagato, Rikuzen, Kazusa, Suō, Kii, Shinano, Kōzuke, Tōtomi, Kaga, Yechizen, Kai, Iwami, Iwaki, Mutsu, Ugo						

Seismic Frequency.		Severe Earthquakes.			Most Extensive Earthquake.		
Number of Earthquakes.	Provinces.	No.	Days.	Provinces.	Day.	Area.	Provinces.
	Mikawa, Mino, Ise, Bichiu, Bizen, Harima, Tanba, Buzen, Higo, Chikugo Hiuga, Satsuma, Tosa, Sanuki, Awa, Oshima, Iki.						
AUGUST.							
8-6	Musashi, Iwaki.	1	2nd	Musashi, Kazusa, Shimōsa, Hitachi, Shimozuke, Kōzuke.	2nd	2,850 sq. <i>ri</i> .	Musashi, Shimōsa, Hitachi, Shimozuke, Awa, Sagami, Kai, Shinano, Yechigo, Iwashiro, Iwaki.
6-4	Shimozuke, Shimōsa, Kazusa, Hitachi, Satsume.	2	3rd	Higo.			
4-2	Sagami, Awa, Nemuro.	3	26th	Musashi, Sagami, Kazusa.			
2-1	Suō, Kai, Iwashiro, Mutsu, Rikuzen, Mino, Ise, Kōzuke, Shinano, Yechigo, Owari, Iga, Wakasa, Izumo, Kii, Iwami, Iwashiro, Hiuga, Higo, Bungo, Chikugo, Hizen, Chikuzen, Buzen, Kushiro, Iyo.						

SEPTEMBER.

8-6	Musashi.	1	2nd	Settsu.	8th	2,550 sq. <i>ri</i> .	Mutsu, Rikuchiu, Ugo, Oshima, Shiribeshi, Ishikari, Ihuri, and Hitaka.
6-4	Nemuro, Shimōsa, Satsuma.	2	16th	Kazusa, Musashi, Sagami.			
4-2	Shimozuke, Hitachi.						
2-1	Iwaki, Mutsu, Oni, Mino, Tanba, Ise, Awa, Kazusa, Sagami, Kōzuke, Kai, Mikawa, Owari, Iga, Shima, Yamato, Kawachi, Izumi, Settsu, Harima, Kii, Iwami Iwashiro, Rikuchiu, Ugo, Oshima, Kushiro, Ihuri, Ishikari, Hitaka, Chishima, Hiuga, Chikugo, Osumi.						

OCTOBER.

10-8	Oshima.	1	2nd	Mino.	26th	3,700 sq. <i>ri</i> .	Rikuzen, Iwaki, Iwashiro, Uzen, Mutsu, Oshima, Hitaka.
8-6	Musashi.	2	7th	Oshima.			
6-4	Shimozuke, Rikuzen, Rikuchiu, Hitachi, Mutsu, Satsuma.	3	13th	Shimozuke, Hitachi, Shimōsa, Kōzuke, Musashi.			
4-2	Iwashiro, Ise, Shimōsa, Sagami, Awa, Iwaki, Mino, Ugo, Nemuro.	4	25th	Kii.			
2-1	Suruga, Izu, Mikawa, Owari, Kōzuke, Kii.	5	26th	Rikuzen.			
		6	28th	Sagami, Izu, Suruga, Kai, Musashi, Kazusa.			

Hitachi, Kazusa, Shimōsa, Awa, Musashi, Sagami, Izu, Suruga, Kai, Shinano, Oshima, Iburi, Hitaka, Ishikari, Tokachi, Kitami, Kushiro, Nemuro.

Musashi, Sagami, Kōzuke, Shimozuke, Iwashiro, Oshima, Kushiro.

2-1 Kazusa, Shimosa, Sagami, Kōzuke, Shinano, Rikuchiu, Uzen, Awa, Kai, Suruga, Izu, Yechigo, Mino, Mikawa, Ugo, Mutsu, Wakada, Kii, Bichiu, Izumo, Hizen, Osumi, Chikuzen, Chikugo, Bungo, Hiuga, Oshima, Hitaka, Tokachi Iburi.

II.—SPECIAL OBSERVATIONS.

NOTABLE EARTHQUAKES.—Here we give short accounts of certain notable earthquakes:—

1. The earthquake on the 18th of February occurred at 9 minutes past 6 a.m.:—This earthquake consisted of five successive shocks. The first shock took place at 6h. 9m. a.m.; the 2nd one, at 6.27 a.m.; the 3rd one, at 7h. 48m. 52sec. a.m.; the fourth one, at 8.2 a.m.; a.m.; and the fifth one, at 10h. 10m. 56sec. a.m. The first one shook 21 provinces—Musashi, Sagami, Awa, Kazusa, Shimōsa, Hitachi, Shimozuke, Kōzuke, Kai, Suruga, Izu, Tōtōmi, Shinano, Iwashiro, Iwaki, Rikuzen, Uzen, Yechigo, Mikawa, Owari, and Mino covering an area of 5,750 square *ri*. Out of these 21 provinces, 11, viz., Musashi, Sagami, Izu, Awa, Kazusa, Shimōsa, Hitachi, Shimozuke, Kōzuke, Kai, and Suruga, covering an area of 1,690 square *ri*, were moderately shaken. The severely shaken area consisted of five provinces, —Sagami, Musashi, Shimōsa, Kazusa (nearly the whole), and Awa, covering an area of 300 square *ri*. In the last areas there was a little damage to buildings, &c.

In Tōkyō, here and there, walls were cracked or shattered, tombstones and stone lanterns were overthrown, articles fell from shelves, clocks stopped, li-

quids flowed over, &c. As might be expected, edges of cliffs and the low ground suffered more than other parts.

In Yokohama houses were a little damaged.

In Sagami, Aiko-gori, rents were observed in the walls of warehouses. Near the seashore at Kensaki, houses suffered more or less.

In Awa and Kazusa, the overflow of water from buckets or vessels, the displacement of walls, the falling down of articles, and the alarm of the people indicated that the shocks were pretty severe.

In Shimozuke, rents in walls, the falling down of vases, the stopping of clocks, and the overflow of liquids were observed.

In Kai, Naka-gori, articles were upset.

It may be presumed that not only in the tract of land which was shaken severely, but also in the area moderately shaken, somewhat similar phenomena must have taken place.

The origin of this earthquake seems to have been somewhere in the Gulf of Tokyo. Often we have had earthquakes which, originating in the gulf, disturbed a similar area. But since seismic observations were begun in the year 1884, we have met, for the first time, an earthquake from this quarter which not only propagated itself far to the coast of Yechigo, but also travelled through great distances both to the north and west.

Before leaving the description of this earthquake, it would be proper to say a few words about its direction. In the severely shaken area, the prevalent direction of the earthquake, as for the parts to the west of the gulf, was either from S.E. to N.W., or E. and W. In the parts to the east of the gulf, it was E. and W., or from S.E. to N.W. In the parts to the north of the gulf, it was N. and S. As we recede, however, from this area, the direction of motion becomes much modified, and nothing can be definitely determined.

The second shock extended over ten provinces:—Musashi, Sagami, Kazusa, Shimosa, Hitachi, Shimozuke, Kozuke, Shi-

nano, Kai, and Suruga, covering an area of 1,320 square *ri*. The shock was rather slight.

The third shook disturbed an area nearly equal to that of the second. It was also slight.

The fourth only disturbed the neighbourhood of Tokyo.

The fifth had greater linear extension to the north and south, and affected eight provinces:—Musashi (nearly the whole), Sagami, Kai, Kozuke, Shimozuke, Hitachi, Shimosa, and Kazusa, disturbing an area of 1,050 square *ri*. The shock was slight.

2. Earthquake on the 12th of May which occurred at 10.40 a.m.—Since the winter, 1883, the district of Chiugoku had never such an extensive earthquake as this one. Altogether 37 provinces were shaken:—Mino, Owari, Iso, Mikawa, Totomi, Omi, Iga, Yamashiro, Wakasa, Yechizen, Kaga, Hida, Suruga, Kai, Izu, Sagami, Musashi (nearly the whole), Shimosa, Shimozuke, Kozuke, Shinano, Yetchiu, Shima, Kii, Yamato, Izumi, Kawachi, Settsu, Tanba, Tango, Awaji, Tajima, Harima, Bizen (nearly the whole), Bichiu, Sanuki, and Awa, disturbing an area of 4,800 square *ri*. Of these provinces. Mino, Owari, Mikawa, Totomi, Suruga, Shinano, Ise, Iga, Omi, Yamashiro, Tanba, Wakasa, Yechizen, and Hida covering an area of 1500 square *ri*, were moderately shaken. The severely shaken area consisted of Mino and Owari occupying 220 square *ri*.

In the provinces, Yechizen, Kaga, Hida, Shinano, Suruga, Kai, Shima, Ise, Kii, Yamato, Kawachi, Izumi, Yamashiro, Settsu, Tanba, Wakasa, and Tango the earthquake was clearly felt; whereas, in the provinces, Kaga, Yechiu, Hida, Shinano, Kōzuke, Shimozuke, Shimōsa, Musashi (nearly the whole), Sagami, Izu, Suruga, Kai, Kii, Izumi, Awaji, Settsu, Tanba, Tango, Tajima, Harima, Bizen, Bichiu, Sanuki, and Awa, occupying an area of 1,670 square *ri*, the shock was so slight that it was hardly perceived.

In the neighbourhood of Gifu, people were thrown into a state of alarm. The banks of the Nagara river were rent for some distance. There were much damages to porcelain, wine-bottles, &c. Pendulum-clocks, especially those facing towards the south or north, were stopped. According to the observations of the Gifu Observatory, the duration of the earthquake was about 2m. 30s. The movement, which was very slight at first, was followed 3 minutes after by a violent shaking, and at the 5th second, the range of motion to the north and south was 4 *bu* 4 *rin*. But, from the moment at which the east and west motion came into play, the intensity was so much increased that the two leaden cylinders of the seismometer, together with the index, were over thrown, which put an end to the observations. The maximum range, however, seems to have been about 7 *bu*.

In Mino, Haguri-gori, the water in some rice-fields became muddy during the earthquake. In Motosu-gori, Mushiki-gori, Kako-gori, Kamo-gori (Mino) and Aichi (Owari), clocks facing north and south were stopped, walls were cracked, liquids overflowed, &c.

Now we shall pass to the moderately shaken areas. First of all, in Omi, Kanzaki-gori, clocks were stopped. In Ise, Yenge-gōri, people ran out of doors, but no articles were upset. In Wakasa, Oii-gōri, liquids overflowed, articles were overthrown, &c.; and it is said that people there had not experienced for a long time an earthquake of so long duration. In Kaga, Yenuma-gōri, and in Tōtōmi, Sano-gōri, it was regarded as an earthquake rarely met with. In Suruga, Ariwatari-gōri, the water in some wells was so much disturbed as to give rise to sounds of splashing.

From the above facts we have reason to believe that the origin of the earthquake was somewhere in the southern parts of Mino or northern parts of Owari.

In the severely shaken area an up-and-down motion was perceived in a few places, while all other parts were subjected to

horizontal motion. In the slightly shaken area, it was generally horizontal motion.

3. EARTHQUAKE ON THE 28TH OF JULY.—The earthquake, which occurred at 40 minutes past 11 p.m., having Higo for its focus shook the whole of Kiushiu as well as the western parts of Shikoku and Chiugoku. The area disturbed amounted to 6,520 square *ri*. We may classify the provinces according to the intensity of shock:—

1.—MOST SEVERELY SHAKEN AREA.

AREA—100 SQ. RI.

Province.

Higo 4 parts out of 10, western.

2.—VERY SEVERELY SHAKEN AREA.

Higo 3 parts out of 10, N., E., and S.

Chikugo 5 parts out of 10, S. the adjoining seas.

3.—SEVERAL SHAKEN AREA.

AREA—1,360 SQ. RI.

Higo 3 parts out of 10, extreme E. and S.

Chikugo 5 parts out of 10, N.

Hizen 4 parts out of 10, E.

Chikuzen 6 parts out of 10, S.E.

Buzen 9 parts out of 10, E.

Bungo whole.

Hiuga 8 parts out of 10, N.

Osumi 1 part out of 10, N.

Satsuma 1 part out of 10, N. the adjoining seas.

4.—MODERATELY AND SLIGHTLY SHAKEN AREA.

AREA—4,870 SQ. RI.

Chikuzen 4 parts out of 10, N.W.

Hizen 6 parts out of 10, W.

Buzen 1 part out of 10, W.

Nagato whole.

Suō whole.

Iwami 5 parts out of 10, S.W.

Aki 5 parts out of 10, W.

Iyo 8 parts out of 10, W.

Tosa 4 parts out of 10, W.

Hiuga 2 parts out of 10, S.

Osumi 9 parts out of 10, S.

Satsuma 9 parts out of 10, S. the adjoining seas.

We here give a table showing the intensity of the earthquake in the most severely shaken area, especially in Kumamoto and its neighbourhood.

Gun and Shi.	Number of Houses Ruined.	Number of Houses Shattered.	Number of Lives Lost.	Number of Persons Wounded.	Number of Bridges Destroyed.	Number of Bridges Damaged
Kumamoto-shi.....	31	17	3	5	6	0
Akuta-gōri	149	174	15	34	12	21
Takuma-gōri	4	6	0	0	0	0
Kami-Masuki-gōri .	14	0	0	0	0	0
Shimo-Masuki-gōri	2	1	0	0	1	0
Tamana-gōri	0	2	2	35	0	0
Total	200	200	20	74	19	21

Thus we see that 200 houses were levelled, 200 houses were half-levelled, 20 lives lost, and 74 persons wounded, &c. Moreover, here and there, the ground was rent or cracked. River banks gave way at once. Even the Castle of Kumamoto, well known for its unparalleled fortification, had its walls of masonry more or less damaged. But Kumamoto-shi, Akuta-gōri (3 parts out of 10, western), and Tamana-gōri suffered more than the others. We shall not dwell further on the general description of the area, but pass into detailed accounts about each *shi* (town) and *gun*.

I.—KUMAMOTO-SHI.—When the terrible earthquake took place, many people in the town were asleep. Awakened at the first shock, they rushed out of doors. It was a struggle for life, and successive shocks followed one after another. The idea of returning home did not even flash across the minds of the people. They lodged generally on road-sides or in their gardens day and night. All they did was to pray for cessation of the earthquakes. Thus it continued until August 3rd, when they were startled by another severe shock. Their terror was intensified by the rumour that the focus must have been somewhere in Komaga-dake within about 2 *ri* from the town. The next day, they set off to seek a shelter at some distance on the south-east side of the town.

In a few days, however, the disturbance was over. They felt relieved and returned home.

In the town, 15 rents or gaps were formed which, when added together, would have a total length of about 817 *ken*, the widest part being about 3 *sun* across. These fissures had a direction north and south, with a few exceptions, which ran to the east and west. The houses generally fell down towards the south. The water in some wells became milky muddy or reddish.

There was little damage in the walls of the Kencho; but the masonry gate of the Kencho and the warehouses belonging to the Keisatsusho suffered severely. As for the Kumamoto-chindai, 243 buildings were damaged; fences and earthen walls which had a total length of 725 *ken* fell down; and stone walls gave way at 15 points. The Shishin-Saibansho had eaves knocked away, walls were rent, and roofs damaged.

II.—AKUTA-GORI.—In Akuta-gori, the intensity of the earthquake was about the same as that in Kumamoto, 612 fissures were formed in the ground, the largest one being 250 *ken* long and 3 *ken* wide, and the smallest one 5 *ken* long and 3 or 4 *bu* wide. They had not any definite course, but the majority ran to the south-east. A piece of ground with an area of 2 *cho* 3 *tan* was permanently upheaved or depressed. Some of the fissures ejected sand. Stone walls and edges of cliffs gave way at 1707 places, and they generally fell towards the south-east. Details respecting houses, lives, and bridges are given in the preceding table. The houses fell towards the south-east.

At the foot of Nishiyama to the west of Kumamoto, the water in 15 wells began to increase, while that in one well diminished, at about 6 p.m. on the 28th; 84 wells became muddy and some other wells reddish. A thermal spring at Funatsumura became muddy during the earthquake. In the neighbourhood of Nishiyama articles fell down from shelves. Dyers' indigo solutions and water in buckets was generally washed

out towards the south-east. These phenomena were not so pronounced as a distance from Nishiyama.

In 24 hours after the 1st shock, 37 smaller shocks were felt and sounds were heard 33 times. After this, shocks gradually diminished until the 2nd. A very severe shock occurred at 10 minutes past 2 a.m. on the 3rd of August. On the same day, 21 moderate shocks were felt and sounds were heard 13 times. For several days afterwards 5 or 6 shocks and sounds were felt every day.

III.—TAKUMA-GORI.—Here shocks were less severe than those in Akuta-gori. In Oyemura and Motoyama-mura, situated on the Shira-river, several houses were overthrown and roads cracked. Other parts only suffered a little.

IV.—TAMANA-GORI.—In Tamana-gōri, the waves propagated from the south-east, gave rise to pretty severe shocks. Sounds were heard 4 or 5 times. There were many shocks. People were in confusion. A temple in Igura-machi fell down, killing two beggars. Here and there, gaps were formed in the ground; the lengths of these varied from 650 *ken* to 50, and the widths, from 5 *sun* to 3 or 4 *bu*. Walls of houses mostly fell towards the south or north.

V.—KAMI-MASUKI-GORI.—In Kami-Masuki-gōri no lives were lost or people wounded. The gaps in the ground, which generally ran to north and south, varied from 15 *ken* to 2 in length and from 5 *bu* to 3 in width. The banks of the Midori-river here and there gave way. In Kiyama-machi, houses were destroyed. In Akitsu-mura, reddish muddy water gushed out of the gaps, but it was in small quantity and stopped in a few minutes. The water of the Gokono-river along Ofuna-machi became muddy after the earthquake. In Okawa-machi and Ofuna-machi, liquids were spilled towards the south and east. After the first shock repeated shocks and sounds were felt both day and night. The shock which occurred at 2 a.m. on the 3rd of August was moderately strong. After the 5th the shocks and sounds greatly diminished. From the above facts,

it will be seen that the disturbances in Kami-Masuki-gōri were much less severe than those in Kumamoto.

VI.—SHIMO-MASUKI-GORI.—Here the largest fissure which was 10 *ken* long and 7 *sun* wide, appeared on a road which was serving as a bank of a river. The direction of the gap was west and east. This gap, however, shut again as soon as the earthquake was over. In Sugiai-mura a bridge fell.

We here give a few short accounts about other localities in the very severely shaken area.

In the northern parts of Higo, the fissures in the ground numbered 43, and the largest one appeared at Yamaka-gōri, Yone-no-dake-mura. It was 125 *ken* in length and on an average 5 *bu* in width, the direction being N.E. In Yamamoto-gōri, there were 3 fissures, one of which, 50 *ken* by 1 *sun* had north and south direction in Tawara-mura; one of the remaining two in Sakurai-mura was 20 *ken* by 3 *sun*, the other 6 *ken* by 1½ *sun* both of which also ran north and south. The depth of these fissures seems to have varied from 1 to 6ft. In Kikuchi-gōri, the first shock was the most violent one; this was followed by moderate shocks at intervals of 5 minutes or half-an-hour. Thus the shocks numbered 20 or more. Each was preceded or followed by sounds as of rolling waggons.

In these parts, the houses which fell numbered 20, and the half-ruined houses 10, Yamaga-gōri and Yamamoto-gōri suffered more severely than Kikuchi-gōri and Gasshi-gōri. The houses did not fall in any definite direction, but articles fell towards the west.

In Chikugo, Miike-gori, and its neighbourhood, fissures and gaps varied from 5 to 1 *ken* in length and were sufficiently wide to admit a finger. Those which took place in wet rice fields, often erupted earthy or sandy stuff. Two or three bad houses were much damaged. Liquids were spilled. Dams of masonry along the sea-shore gave way for a length of about 250 *ken*. From the first shock on the 28th to the 3rd of August two or three shocks were felt every day.

In Higo, Takagi-gōri, both shocks and sounds were pretty severe. Mount Mayu, a greater part of which had been overthrown during the earthquake in the 4th year of Kansei, in many places gave way during the first shock. Although the disturbance was over in four minutes, 6 moderate shocks followed one after another before next morning. People lodged out of door and did not sleep. In the following shocks, the movement was so slight that people walking did not feel them. The shock on the 3rd of August was also a severe one. Its direction was the same as the 1st on the 28th.

In Chikugo, Migiwa-gori, clocks facing towards the east were stopped. Stone fences and stone lanterns were overthrown. By 2 a.m. on the 29th, 13 successive moderate shocks were felt at intervals of from 3 to 10 minutes. From 6 to 6.40 a.m. on the same day, 3 moderate shocks were felt; thus making 16 shocks. Old or bad houses only were destroyed or damaged. There was great confusion and tumult.

In Hizen, Kanzaki-gori, the shock was severe, and sounds like distant thunder were heard. By 6 a.m. on the 29th, 5 moderate shocks were felt.

In the central parts of Chikuzen, articles were overthrown; liquids slopped over, and sounds as of a cannon were heard. In the eastern parts, 5 moderate shocks were felt by 6 a.m. on the 29th.

In eastern parts of Buzen the noise of creaking houses was so great, that people rushed out. Besides there was more or less spilling of liquids.

In the northern and eastern parts of Bungo, clocks were stopped by the earthquake. According to the observations at the Oita Observatory, the details of the shock were as follows:

The earthquake took place at 40 min. past 11 p.m., July 28th.
 Duration70 seconds or more.
 Directionfrom S.S.W. towards N.N.E.
 Maximum range.....12.4 mm.
 Period2.7 seconds.
 Natureslow.

The earthquake consisted of 74 complete oscillations, the first of which had a N.W. direction. In the first 10 seconds 15 oscillations took place from S.W. towards N.E., from S.E. to N.W. or E. and W. In the 2nd 10 seconds, 13 oscillations from S.S.E. towards N.N.W. or from S.E. to N.W. ; and from the 15th second, they became more and more perceptible. In the 3rd ten second 12 oscillations, from S.S.E. towards N.N.W. or from S.E. to N.W. In the 4th, 9 oscillations took place. But at the 33rd second, we had the greatest undulatory movement whose direction, maximum range, period, and nature are given in the preceding table. In the 5th, 8 oscillations having longer and longer periods occurred from S.W. towards N.E. or in E. and W. In the 6th, 7 oscillations, from S.S.E. towards N.N.W. or from S.E. towards N.W. In the 7th and last 10 seconds, 10 oscillations took place in N. and S., from S.S.W. to N.N.E. or from S.S.E. towards N.N.W. Thus the disturbance was rapid and slight, but it became slow and moderate by degrees, until the greatest movement took place with a very long period at the 33rd second.

In Higo, Aso-gori, sounds like distant thunder were heard to proceed from Aso-san for several days before the earthquake, especially in the morning. On the other hand, the quantity of smoke evolved from the crater remained as usual or rather a little diminished. In Yatsushiro-gori, sounds in the sea were heard during the earthquake. In Kiuma-gori, only one shock was felt after the severe shock.

The Northern parts of Satsuma had not felt such a severe shock for a long time.

In the severely shaken area, the direction of the shocks greatly varied. Thus in the parts to the west of the very severely shaken area, it was north and south ; to the north, it was north and south or from S.E. towards N.W. ; to the east, it was E. and W. or from S.W. towards N.E. ; to the south, it was from N.W. towards S.E. The nature of the earthquake was generally a combination of vertical and horizontal motions.

In the moderately or slightly shaken area, people were awakened by the shock and sounds were heard. Only one or two shocks after the first one were perceived. The movement was horizontal.

4. EARTHQUAKE ON THE 31ST OF DECEMBER.—The earthquake which took place at 1 p.m. affected the southern parts of Hokkaidō to the north, the seas along Awa and Kazusa to the south, Kai, Shinano, and Yechigo to the west, and the Pacific to the east, or over an area of 9,210 square *ri*. This area included the 28 provinces of Mutsu, Rikuchiu, Ugo, Uzen, Rikuzen, Iwaki, Iwashiro, Shimozuke, Hitachi, Shimōsa, Kazusa, Awa, Musashi, Sagami, Izu, Suruga (2 parts out of 10, E.), Kai (5, E.), Shinano (1, E.), Kōzuke (nearly the whole), Yechigo (1, S.), Oshima (9, S.E.), Iburi (6, E.), Hitaka, Tokachi, Ishikari (a little S.), Kushiro (9, S.E.), Nemuro (9, S.), and Kitami (a little S.E.) The moderately shaken area consisted of Mutsu (7, E.), Ugo (6, E.), Rikuchiu, Rikuzen, Iwaki, Hitachi, Shimōsa, Kazusa, Musashi (5, E.), Sagami (2, N.E.), Kōzuke (a little, S.E.), Shimozuke (7, E.), Iwashiro (3, E.), and Kushiro (3, S.) In the latter area, the duration was 5 minutes or more. But the remaining parts felt a slight shock of short duration.

According to the observations at the Hakodate Observatory, after 1 m. 40 sec. there was a change in the direction of movement. At the same time the intensity was increased so that a pendulum clock went out of order and time was altered one minute.

In Mutsu, Shimo-Kita-gori, the shock was slight, but it was of long duration.

In Rikuchiu, Miyako Observatory, it shook uniformly for 3 minutes.

In Iwashiro, Yama-gōri, it was considered as long and severe.

In Kazusa, Omaba-gōri, some clocks facing the north were stopped. In Sujun-gori, it was slight and long.

In Tōkyō, the duration was 5' 20"; the direction from S.E.E. towards N.W.W.; horizontal movement; maximum range was 2.1 mm., the period being 2.8 sec.; maximum amplitude very little; the nature was slight and slow pulsations.

At the Numazu Observatory, in the slightly shaken area, the movement was very slow and slight, and only 3 or 4 undulations were distinctly perceived.

The origin of this earthquake must have been somewhere in the deep depression of the Pacific to the south-east of the shaken area. If it had been in inland or in a sea-bed adjoining the land, the shocks would have been far more severe and destructive.

III.—SEISMOMETRICAL OBSERVATIONS MADE AT THE METEOROLOGICAL CENTRAL OBSERVATORY, TOKYO.

TABLES RELATING TO OBSERVATIONS OF EARTHQUAKES DURING THE YEAR 1889.—The number of earthquakes observed at the Meteorological Central Observatory during the year 1889 was 113. The following table will show their date, time, direction and intensity:—

TABLE RELATING TO SEISMIC OBSERVATIONS DURING THE YEAR 1889.

Date.	Time of Occurrence.	Duration.	Horizontal Movement.			Vertical Movement.	
			Direction.	Maximum Range in mm.	Maximum Velocity in mm. per Sec.		Maximum Acceleration in mm. per Sec. per Sec.
Jan. 1st	h. m. s. 3 4 50 p.m.	m. s. 12	S.W. and N.E.	0.5	5.2	108.2	extremely little
1st	7 5 30 p.m.	1 55	S.W. and N.E.	1.1	23.0	961.8	0.5
3rd	7 58 6 a.m.	2	E. and W.	0.8	1.7	7.2	—
12th	8 34 3 p.m.	—	—	extremely little	—	—	—
27th	2 28 47 p.m.	—	—	ditto	—	—	—

Date.	Time of Occurrence.	Duration.	Horizontal Movement.				Vertical Movement.
			Direction.	Maximum Range in mm.	Maximum Velocity in mm. per Sec.	Maximum Acceleration in mm. per Sec. Sq.	
Feb. 5th	2 27 39 p.m.	5	N. and S.	little	—	—	—
6th	3 20 5 p.m.	2	E. and W.	little	—	—	—
9th	7 41 38 a.m.	10	N. and S.	extremely little	—	—	—
15th	5 14 3 p.m.	—	—	little	—	—	—
18th	6 9 32 a.m.	6 12	N.W. and S.E.	20.3	29.0	82.9	3.7
18th	6 27 45 a.m.	2	S.W. and N.E.	0.2	—	—	—
18th	7 48 52 a.m.	2	E. and W.	little	—	—	—
18th	8 2 a.m.	—	—	extremely little	—	—	—
18th	10 10 56 a.m.	30	S.E. and N.W.	little	—	—	—
19th	2 57 43 p.m.	15	N. and S.	little	—	—	—
20th	9 19 37 p.m.	—	—	extremely little	—	—	—
21st	5 52 21 a.m.	15	E. and W.	little	—	—	—
21st	8 19 23 a.m.	20	N. and S.	little	—	—	—
21st	11 1 4 a.m.	30	—	extremely little	—	—	—
21st	9 27 52 p.m.	15	N. and S.	little	—	—	—
23rd	11 27 21 p.m.	13	N. and S.	little	—	—	—
Mar. 3rd	4 35 19 p.m.	30	E. and W.	0.2	—	—	—
4th	7 24 25 a.m.	—	—	little	—	—	—
18th	6 41 12 a.m.	—	N. and S.	—	—	—	—
21st	6 9 23 p.m.	—	—	—	—	—	—
26th	2 41 48 p.m.	—	—	—	—	—	—
28th	1 20 10 a.m.	1 30	E.S.E.-W.N.W.	4.1	21.5	230.4	0.6
28th	10 22 55 a.m.	1 15	S.E.-N.W.	0.5	3.1	38.4	0.1
28th	7 18 23 p.m.	20	E. and W.	0.2	3.1	96.1	—
31st	6 42 15 a.m.	4	S.S.E.-N.N.W.	3.8	4.8	12.1	0.2
31st	8 13 3 a.m.	—	—	extremely little	—	—	—
31st	5 59 42 p.m.	2	S.W.-N.E.	1.2	5.4	84.6	extremely little
April 3rd	4 27 21 p.m.	1 30	S.E.-N.W.	1.5	6.7	59.9	0.2

Date.	Time of Occurrence.	Duration.	Horizontal Movement.				Vertical Movement.
			Direction.	Maximum Range in mm.	Maximum Velocity in mm. per Sec.	Maximum Acceleration in mm. per Sec. per Sec.	
April 3rd	h. m. s. 4 40 51 p.m.	m. s. —	—	extremely little	—	—	—
6th	7 40 13 a.m.	50	S.W.-N.E.	0.3	1.9	24.0	extremely little
8th	0 48 0 p.m.	—	—	extremely little	—	—	—
14th	5 22 54 a.m.	—	—	ditto	—	—	—
17th	9 41 43 p.m.	—	—	ditto	—	—	—
18th	2 7 42 p.m.	—	ESE.-WNW.	0.8	2.5	15.6	0.2
18th	2 54 11 p.m.	—	—	extremely little	—	—	—
18th	3 39 8 p.m.	—	SE.-NW.	0.3	1.0	6.7	—
18th	4 0 1 p.m.	—	—	extremely little	—	—	—
19th	0 18 46 a.m.	—	—	ditto	—	—	—
19th	2 29 19 a.m.	—	—	ditto	—	—	—
19th	3 0 27 p.m.	50	SW.-NE.	0.2	1.0	10.0	—
19th	5 50 39 p.m.	1 30	E. and W.	0.2	1.0	10.0	—
19th	10 53 55 p.m.	—	—	extremely little	—	—	—
20th	4 50 33 p.m.	—	—	ditto	—	—	—
28th	3 7 43 a.m.	30	E. and W.	little	—	—	extremely little
29th	1 56 28 a.m.	20	E. and W.	little	—	—	ditto
May 6th	11 48 41 p.m.	1	SSW.-NNE.	0.4	2.5	31.2	ditto
8th	5 5 34 a.m.	30	S. and N.	little	—	—	ditto
8th	0 24 7 p.m.	—	—	extremely little	—	—	—
12th	10 42 11 a.m.	2	SSE.-NNE.	0.6	0.9	2.7	—
17th	6 39 15 a.m.	—	—	extremely little	—	—	—
17th	8 34 25 a.m.	—	—	ditto	—	—	—

Date.	Time of Occurrence.	Duration.	Horizontal Moment.				Vertical Movement.
			Direction.	Maximum Range in mm.	Maximum Velocity in mm. per Sec.	Maximum Acceleration in mm. per Sec. per Sec.	
May 17th	9 20 35 a.m.	—	—	ditto	—	—	—
17th	9 39 37 a.m.	—	—	ditto	—	—	—
17th	1 46 32 p.m.	30	—	little	—	—	—
20th	0 23 30 p.m.	—	—	extremely little	—	—	—
27th	6 22 56 p.m.	12	E. and W.	ditto	—	—	—
28th	5 26 22 a.m.	15	E. and W.	little	—	—	—
30th	10 27 22 p.m.	2	S.E.-N.W.	0.4	1.6	12.8	—
June 1st	6 15 21 p.m.	25	E. and W.	0.2	1.3	16.9	—
3rd	1 51 30 p.m.	—	—	little	—	—	—
14th	0 26 41 p.m.	—	—	little	—	—	—
15th	10 10 2 a.m.	50	—	little	—	—	—
16th	2 31 24 p.m.	30	S.E.-N.W.	little	—	—	—
20th	9 51 10 p.m.	1 30	S.E.-N.W.	0.5	2.6	27.0	—
27th	7 9 17 a.m.	1	E. and W.	0.5	0.6	1.4	—
July 3rd	5 39 58 p.m.	40	E. and W.	0.3	1.9	24.0	extremely little
5th	6 22 31 p.m.	—	—	extremely little	—	—	—
5th	8 57 9 p.m.	—	—	ditto	—	—	—
18th	10 33 18 p.m.	35	N. and S.	little	—	—	—
30th	2 3 40 a.m.	10	E. and W.	little	—	—	—
Aug. 2nd	10 21 6 a.m.	1 30	S.E.-N.W.	1.3	8.2	103.4	0.4
4th	2 36 12 p.m.	—	—	extremely little	—	—	—
5th	7 34 56 a.m.	4 20	E.S.E.-W.N.W.	1.7	4.9	28.2	—
15th	0 6 21 p.m.	—	—	little	—	—	—
20th	5 20 23 p.m.	50	N. and S.	0.3	1.2	9.6	—
21st	1 7 44 p.m.	—	—	little	—	—	—
26th	3 27 13 p.m.	1	E. and W.	1.4	7.3	76.1	0.2
30th	3 6 22 p.m.	3 30	E.S.E.-W.N.W.	0.4	1.3	8.4	—
Sept. 11th	7 14 3 p.m.	—	—	little	—	—	—
15th	2 34 6 a.m.	—	—	little	—	—	—
16th	6 37 30 a.m.	1 30	W.S.W.-E.N.E.	1.3	5.8	51.8	little

Date.	Time of Occurrence.	Duration.	Horizontal Moment.				Vertical Movement.
			Direction.	Maximum Range in mm.	Maximum Velocity in mm. per Sec.	Maximum Acceleration in mm. per Sec. per Sec.	
Sept. 17th	h. m. s. 2 4 28 a.m.	m. s. —	—	extremely little	—	—	—
20th	10 27 1 a.m.	—	—	little	—	—	—
22nd	1 56 33 a.m.	—	—	extremely little	—	—	—
30th Oct.	7 40 27 a.m.	—	—	ditto	—	—	—
1st	6 7 20 a.m.	—	—	ditto	—	—	—
7th	7 41 18 p.m.	—	—	ditto	—	—	—
10th	6 47 27 a.m.	—	—	little	—	—	—
13th	10 50 24 p.m.	2	S.E.-N.W.	2.2	3.5	11.1	0.4
14th	11 8 10 p.m.	1	E. and W.	0.2	1.0	25.6	—
16th	4 10 48 a.m.	—	—	extremely little	—	—	—
25th	11 16 3 a.m.	—	—	ditto	—	—	—
28th	2 16 52 a.m.	2	S.E.-N.W.	1.2	4.2	29.4	little
Nov. 14th	0 30 50 p.m.	—	—	extremely little	—	—	—
15th	8 48 40 p.m.	—	—	little	—	—	—
17th	1 57 56 p.m.	—	—	little	—	—	—
18th	8 31 39 a.m.	—	—	little	—	—	—
18th	1 35 1 p.m.	—	—	extremely little	—	—	—
20th	0 56 34 a.m.	50	N. and S.	0.2	0.7	4.9	—
21st	2 5 32 a.m.	30	N.E.-S.W.	0.2	1.0	10.0	—
21st	1 50 5 p.m.	2 30	—	little	—	—	—
25th	2 34 8 a.m.	16	N.E.-S.W.	0.3	1.9	24.1	—
Dec. 9th	0 3 14 p.m.	15	—	little	—	—	—
11th	5 14 17 a.m.	—	—	extremely little	—	—	—
26th	8 14 11 p.m.	—	—	ditto	—	—	—
28th	17 55 10 p.m.	1 5	E. and W.	0.5	5.2	108.1	—
29th	10 19 11 a.m.	—	—	little	—	—	—
31st	1 5 13 p.m.	5 20	E.S.E.-W.N.W.	2.1	2.4	5.5	little

FREQUENCY OF EARTHQUAKES PER SEASON.—The following table will show the seismic frequency per month:—

Months.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Total.
Number of Earth- quakes	5	16	11	18	13	7	5	8	7	8	9	6	113

From the above table we see that the maximum frequency was in April, while the minimum one was in January and July.

The following table shows the seismic frequency per season:—

Season.	Spring.	Summer.	Autumn.	Winter.	Average.
Number of Earthquakes	42	20	24	27	28

The following table shows the frequency in the hot and cold seasons:—

	October to March.	April to Sept.	Average.
	Cold.	Hot.	
Number of Earthquakes	55	58	56.5

Thus we see that the maximum frequency occurred from 6 to 8 a.m. and from 2 to 3 p.m., whereas the minimum frequency occurred from 3 to 5 a.m.

INTENSITY OF EARTHQUAKES.—We shall give in the following table the intensity of the most severe earthquake which occurred in the year 1889 :—

Date.		Time of Occurrence.		Duration.
February, 18th.		6h. 9m. 32s. a.m.		6m. 12s.
		Horizontal Movement.		Vertical Movement.
Max. Range.	Max. Velocity	Max. Accel.	Max. up and down motion.	
in mm.	in mm.	in mm.	in mm.	
20.3 in 2.2 sec.	29.0 per sec.	83.3 per sec. per sec.	3.7 in 0.6 sec.	

As will be seen from the above table, the disturbance was rapid and severe.

The origin of this earthquake seems to have been somewhere in the Gulf of Tōkyō. In provinces surrounding the gulf, rents or cracks appeared in the walls of dozō (ware houses), and more or less damage was done to buildings; and even in the less severely shaken area, articles were overturned, liquids overflowed, and clocks stopped. No earthquake during the year had a longer duration. After this earthquake we had the earthquake which took place at 1h. 5m. 13s. p.m. on the 31st of December. It had a duration of 5m. 20s. Lastly, we had the earthquake at 7h. 3 4m. 56s. a.m. on the 5th of August, which had a duration of 4m. 20s. All other earthquakes had a duration less than 4 minutes.

There was only one earthquake which had a maximum range greater than 20 mm. No earthquake occurred with a maximum range greater than 10 mm. There were 12 earthquakes with a maximum range greater than 1 mm. and 25 earthquakes less than 1 mm. There were 75 earthquakes whose movement was so slight as to render it impossible to observe the range of oscillation. We therefore had very few severe disturbances during the year, although a large number of earthquakes were recorded.

DIRECTION OF EARTHQUAKES.—The following table shows the number of earthquakes arranged according to direction:—

Directions.	N. to S.	S.S.W. to N.N.E.	S.W. to N.E.	W.S.W. to E.N.E.	E. to W.	E.S.E. to W.N.W.	S.E. to N.W.	S.S.E. to N.N.W.	Uncertain.
No. of Earthquakes	11	1	8	1	18	5	11	2	56

NATURE OF EARTHQUAKES.—The following table shows the number of earthquakes according to the nature of movement:—

Nature.	Months.												Total.
	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
Both vertical and horizontal	2	1	4	6	2	1	1	2	1	2	—	2	24
Horizontal	1	9	2	2	3	4	2	3	—	1	4	—	31
Uncertain	2	6	5	10	8	2	2	3	6	5	5	4	58
Rapid	2	3	3	2	2	2	2	2	1	1	—	1	21
Slow	1	6	3	5	2	3	1	3	—	2	4	1	31
Uncertain	2	7	5	11	9	2	2	3	6	5	5	4	61

From the above we see that the number of earthquakes which were felt as a horizontal movement was greater than those in which horizontal and vertical motions were combined. There were 58 earthquakes the movement of which was indeterminate. As regards the velocity of back and forth motion, 31 out of 113 earthquakes were of slow, 21 were of rapid, and 61 were indeterminate.