

## REPORT ON EARTHQUAKE OBSERVATIONS MADE IN JAPAN DURING THE YEAR 1889.

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(An Epitome of a Translation with a Prefatory Note and General Observations, by JOHN MILNE.)

[Read May 29th 1890.]

The following paper is practically a translation of a report published by the Meteorological Central Observatory in Tokyo. It was drawn up by Mr. N. Otsuka, under the general superintendence of Mr. Arai Ikunosuke, the Director of the Observatory. The report is based upon records sent by observers in the shaken districts after each shock to the Central Observatory, where a map showing the area over which the disturbance has been recorded is immediately drawn. Altogether there are in Japan more than 650 stations at which observations are made.

For the commencement of this class of observations in Japan, reference may be made to Trans. Seis. Soc., Vol. IV., "The distribution of Seismic Activity in Japan," by J. Milne. Trans. Seis. Soc., Vol. VII., Pt. II., "387 Earthquakes observed during two years (1881-3) in North Japan," by J. Milne. Trans. Seis. Soc., Vol. X., pp. 57-82, "Earthquake Observations of 1885 in Japan," by Professor Seikei Sekiya. Trans. Seis. Soc., Vol. XIII., Pt. I., p. 91, "Report on Earthquake Observations made in Japan during the year 1886."

The two latter papers, like the present, are based upon Reports of the Imperial Meteorological Department. The areas of districts shaken are given in square *ri* (1 square *ri* = 5.95 square miles).

## FREQUENCY OF EARTHQUAKES.

During the year 1887 (Meiji 20th) from January to December the number of earthquakes in this country was 483, being 1 more than in 1885 and 11 more than in 1886.

In 1887 there were 483 shocks, or a daily average of 1.323.

In 1886 there were 472 shocks, or a daily average of 1.293.

In 1885 there were 482 shocks, or a daily average of 1.320.

For the sake of convenience in comparing the frequency in different places, we have added a map for the 482 earthquakes in this year, see Fig. 1, made on the same plan as the maps of previous reports. Most of the earthquakes occurred in Musashi, Shimotsuke, Nemuro (eastern), Shimosa, and Shitachi.

There were 80 in Tokio, the largest number since 1876. Iwashiro, Kazusa, Rikuzen, Mutsu, Sagami, Kii, Satsuma, Kotsuke, Owari, Iwami, Mino, and Iyo stand next; and Iwashiro, Tushima, Echigo, Aki, Hiuga, Kai, Ugo, Ise, Suruga-Mikawa, Totomi, Bizen, Bitchu, Teshio (north-southern), Awa, Shinano, Uzen, Yamashiro, Settsu, Omi, Rikuchu, Tosa, and Izumo, are third. All other places were for the most part shaken less than 5 times. Nemuro (northern), Kitami, Kushiro (northern), Tokachi (northern), Ishikari, Teshio (both north-eastern), Shiribeshi (south and north), Iburi (western), Noto (southern), Etchu (northern), Oki, Iki, Tsushima, Hizen (western), and all the islands in the surrounding seas of the Empire have no colouring; this is due to there being no reports from those places. So we assume that in these places there were no earthquakes. As reported last year, the places from which no reports come, are nearly the same each year: very few earthquakes occur in the districts near them. So though we have no reports, we believe the number of disturbances to be very small.

In the last three years earthquakes have been most frequent on the south-east coast; on the N. W. they have been very few except in San-in Do, San-yo Do. and Nan-kai Do, of which

San-in and San-yo have the same number in the northern and southern parts, and Nan-kai Do has many in its western part. In short, as pointed out last year, it is shown in Fig. 1. of each report, that the mountain ranges which rise and run to the south-west through the middle of the main island, form barriers across which earthquakes do not pass.

RELATION OF EARTHQUAKES TO SEASONS.

The season of earthquakes varies greatly. The following tables of time and frequency, and the average number of earthquakes in each month of the 3 years 1885, 1886, and 1887, are given for convenience in comparison:—

Month.	1885.												Total.	Ave.
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.		
No. of Earth- quakes.	32	44	37	37	51	46	32	30	45	41	47	40	482	40.2
Average for 2 years	38	39	49	38	58	30	36	46	41	33	22	42	472	39.3
No. of Earth- quakes.	41	58	30	29	60	38	38	35	43	20	35	56	483	40.2
More or less.	m	m	l	l	m	o	m	l	o	l	m	m	m	m
Average of 3 years	37.0	47.0	38.7	34.7	56.3	38.0	35.3	37.0	43.0	31.3	34.7	46.0	47.90	39.92

As in the above table, the total for 1887 is 483. The monthly average is 40.3. Five months, Jan., Feb., May, Sept. and Dec. have more than the average number. March, April, June, July, Oct. and Nov. have less. May has the most and Oct. the least.

From the average number during the three years, we must conclude that most occur in May and fewest in Oct.

We arrange the number of occurrences by seasons as follows:—

Season.	Spring.		Summer.		Autumn.		Winter.		Total.	Aver.
	Mar.	Apr.	June.	July.	Sept.	Oct.	Dec.	Jan.		
No. of earth- quakes.	125	108	133	116	482	120.5				
Average for 2 years	135	110	114	117	476	119.0				
No. of earth- quakes.	119	111	98	155	483	120.7				
More or less	l.	m.	l.	m.	m.	m.				
Average for 3 years	129.7	110.3	109.0	130.0	479.0	119.75				

As in the above table, during 1887 the average per season is

120.7. Winter has more than the average, and the other three seasons less. The fewest occur in autumn.

In each of the three years, the season having the greatest number differs, *i.e.* in 1885 autumn, in 1886 spring, in 1887 winter; but the season having the fewest is the same in 1886 and 1887. In 1885 summer has the fewest.

Referring to the average number of disturbances in the three years, we see that in spring and winter, it is greater than the average, and in summer and autumn less; in winter greatest, and in autumn least.

We arrange by two seasons, cold and warm, as follows:—

Season,	Warm, Apr.-Sept.	Cold, Oct.-Mar.	Total.	Average.
No. of earthquakes. 1885 ...	241	241	482	241.0
1886 ...	249	223	472	236.0
Average for 2 years .....	245	232	477	238.5
No. of earthquakes. 1887 ...	243	240	483	241.5
More or less .....	2 l.	8 m.	6 m.	3.0 m.
Average for 3 years.....	244.3	234.7	479.0	239.5

As in the above table, in 1887 the average number of one season is 241.5. In the warm season it is greater than the average, and in the cold less, but the difference is only three.

In 1886 and in 1887 disturbances occurred very often in the warm season and very seldom in the cold season.

In 1885 the number was the same for both seasons.

Referring to the average number, we see that in the warm season there are more, and in the cold less, the difference being 96.

TIME OF EARTHQUAKE OCCURRENCE.

The following table is one in which the earthquakes in the three years are arranged according to the hours of the day:—

HOURS.	MONTHS.												TOTAL.
	A.M. A.M.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	
12 to 1 ...	3	8	2	4	5	8	4	3	0	2	6	5	50
1 to 2 ...	7	10	3	2	2	7	6	1	6	6	2	6	58
2 to 3 ...	8	5	7	6	10	5	6	13	11	1	4	6	82
3 to 4 ...	5	5	5	5	5	12	1	5	7	6	4	5	65
4 to 5 ...	3	7	0	3	12	4	3	3	6	1	1	2	45
5 to 6 ...	4	4	8	2	16	2	6	5	3	7	4	1	62
6 to 7 ...	4	5	5	3	6	2	5	3	10	4	2	8	57
7 to 8 ...	4	2	4	6	7	5	3	3	1	6	6	4	51
8 to 9 ...	5	5	5	6	8	5	6	4	10	1	3	5	63
9 to 10 ...	5	6	6	5	6	10	2	4	7	6	2	3	62
10 to 11 ...	10	1	3	7	1	2	2	2	3	2	2	6	41
11 to 12 ...	4	5	4	5	8	7	5	2	4	3	4	10	61
P.M. P.M.													
12 to 1 ...	2	3	2	2	5	3	4	3	7	3	8	6	48
1 to 2 ...	2	10	5	6	13	7	4	7	5	6	5	5	75
2 to 3 ...	7	2	9	7	11	5	7	4	4	3	7	5	71
3 to 4 ...	2	7	1	7	6	1	7	6	7	2	6	3	55
4 to 5 ...	3	3	6	2	8	4	2	5	8	1	2	2	46
5 to 6 ...	4	9	5	2	4	7	4	0	4	2	1	1	43
6 to 7 ...	4	4	6	5	4	5	3	5	8	6	5	6	61
7 to 8 ...	6	7	3	4	2	4	5	4	2	5	3	5	50
8 to 9 ...	1	6	5	5	7	3	6	5	5	6	11	11	71
9 to 10 ...	2	6	6	2	5	5	8	6	9	5	5	10	69
10 to 11 ...	10	11	12	5	6	6	1	6	0	6	5	13	81
11 to 12 ...	6	10	4	3	5	6	2	10	3	6	5	10	70
Sum.....	111	141	116	104	169	114	106	111	129	94	104	138	1,437

The greatest number of earthquakes occur between 2 and 3 a.m., and the least between 10 and 11 a.m.

Between 2 and 3 p.m. and between 8 and 9 p.m. there were 71 shocks.

Between 5 and 6 a.m. and 9 and 10 p.m. there were 62 shocks.

Between 11 and 12 a.m. and 6 and 7 p.m. there were 61 shocks.

Between 12 and 1 a.m. and 7 and 8 p.m. there were 50 shocks.

Generally between noon and midnight there have been 43 more shocks than between midnight and noon; or from 6 a.m. to 6 p.m. there have been 91 more shocks than during the remaining 12 hours.

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EARTHQUAKES CLASSIFIED ACCORDING TO THE LAND AREA SHAKEN BY EACH.

In the following table we give the total shaken areas and the average shaken areas of large and of small earthquakes for each month of the three years (1885, 1886 and 1887). The measurements are in sq. *ri* (1 sq. *ri* = 5.95 sq. miles):—

Month,	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
Whole area ... 1885...	10,020	16,980	7,320	4,750	10,380	15,890	9,170
1886...	3,240	5,550	4,810	12,480	15,380	5,080	10,490
Average for 2 years...	6,630	11,265	6,065	8,615	12,880	10,485	9,830
Whole area ... 1887...	23,200	16,270	3,200	12,310	13,220	5,920	13,290
Larger or smaller ... This year.	16,570	5,005	2,865	3,695	340	4,565	3,460
Average for 3 years...	12,153	12,933	5,100	9,847	12,993	8,963	10,983
Average area... 1885...	310	390	200	130	200	370	290
1886...	80	140	100	330	260	170	290
Average for 2 years...	195	265	150	230	230	270	290
Average area... 1888...	570	280	110	420	220	160	350
Larger or smaller ... This year.	375	15	40	190	10	110	60
Average for 3 years...	320	270	137	293	227	233	310

Month.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Average.
Whole area ... 1885...	6,060	14,570	21,340	4,120	11,700	132,300	11,025
1886...	10,820	9,500	3,860	2,480	8,360	92,050	7,671
Average for 2 years...	8,440	12,035	12,600	3,300	10,030	112,175	9,348
Whole area ... 1887...	7,820	14,580	2,680	11,950	9,390	133,830	11,152
Larger or smaller ... This year.	620	2,544	9,920	8,650	640	21,655	1,805
Average for 3 years...	8,233	12,883	9,293	6,183	9,817	119,391	9,949
Average area... 1885...	210	320	520	80	290	3,310	276
1886...	230	230	120	110	200	2,260	189
Average for 2 years...	220	275	320	95	245	2,785	232
Average area... 1887...	220	340	130	340	170	3,310	276
Larger or smaller ... This year.	—	65	190	245	75	525	44
Average for 3 years...	220	297	257	177	220	2,961	247

The whole area in 1887 is..... 133,830 square *ri*.

The monthly average is..... 11,152 square *ri*.

The average per disturbance..... 276 square *ri*.

During 1887 there were 91 disturbances above the average.

The area of disturbance is 41,783 square *ri* more than in 1886, and 15,339 square *ri* more than in 1885.

The number above the average in 1887 is 25 more than in 1886, and 5 less than in 1885.

Year.	Whole area.	The number which were greater than the average area.
1887.....	133,830 square <i>ri</i> .....	91.
1886.....	92,050 square <i>ri</i> .....	63.
1885.....	132,300 square <i>ri</i> .....	96.

The area of the Empire, excepting small islands and the islands of Riuki, is 24,352 square *ri*; therefore the area disturbed in 1887 is five times the area of the Empire.

MADE IN JAPAN DURING THE YEAR 1889. 105

AREA.	YEAR.	MONTHS												TOTAL	AVER- AGE.			
		JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.					
More than 7,000 square <i>ri</i> .	1885.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1886.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1887.....	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	0.1
Between 6,000 and 7,000 square <i>ri</i> .	1885.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1886.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1887.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Between 5,000 and 6,000 square <i>ri</i> .	1885.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1886.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1887.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Between 4,000 and 5,000 square <i>ri</i> .	1885.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1886.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1887.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Between 3,000 and 4,000 square <i>ri</i> .	1885.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1886.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1887.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Between 2,000 and 3,000 square <i>ri</i> .	1885.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1886.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1887.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Between 1,000 and 2,000 square <i>ri</i> .	1885.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1886.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	1887.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sum ...No. in 1885 & 1886.	1	5	1	4	6	5	4	3	8	7	1	4	49	4.1				
Average for 2 years	—	2	—	2	3	2	2	1	4	3	—	2	21	1.7				
Sum ..... No. in 1887.	7	5	—	3	2	1	4	3	4	—	5	3	37	3.1				
More or less.....	This year.	7m.	3m.	—	1m.	1l.	1l.	2m.	2m.	—	3l.	5m.	1m.	16m.	1.4m.			
Between 750 and 1,000 square <i>ri</i> .	1885.....	2	1	1	—	—	2	1	1	2	—	—	2	12	1.0			
	1886.....	—	1	2	1	2	1	—	2	—	1	—	2	12	1.0			
	1887.....	1	1	—	—	1	1	1	2	1	—	—	—	9	0.8			
Between 500 and 750 square <i>ri</i> .	1885.....	5	4	1	1	—	1	—	2	1	2	—	—	17	1.4			
	1886.....	1	1	—	2	—	—	—	1	2	2	—	4	13	1.1			
	1887.....	—	2	1	—	6	1	1	—	1	1	3	2	18	1.5			
Between 300 and 500 square <i>ri</i> .	1885.....	2	1	—	2	4	1	2	1	—	6	1	4	24	2.0			
	1886.....	2	2	2	1	3	4	1	1	—	2	1	1	20	1.7			
	1887.....	2	4	4	2	1	3	2	1	3	1	—	2	25	2.1			
Between 200 and 300 square <i>ri</i> .	1885.....	—	1	2	1	4	—	4	1	2	9	2	27	2.2				
	1886.....	2	—	4	1	4	2	2	2	1	—	2	20	1.7				
	1887.....	2	2	—	1	2	2	1	2	2	1	2	4	21	1.7			
Between 100 and 200 square <i>ri</i> .	1885.....	3	6	5	6	16	7	4	2	4	—	5	5	63	5.2			
	1886.....	5	3	2	3	4	4	1	5	4	3	1	4	39	3.2			
	1887.....	3	1	2	3	4	2	2	—	2	2	1	2	24	2.0			
Sum ...No. in 1885 & 1886.	22	20	19	18	34	26	11	21	15	18	17	26	247	20.5				
Average for 2 years	—	11	10	9	9	17	13	5	10	7	9	8	13	12.1	10.1			
Sum ..... 1887.	8	10	7	6	14	9	7	4	10	6	6	10	97	8.1				
More or less.....	3l.	—	2l.	3l.	3l.	4l.	2m.	6l.	3m.	3l.	2l.	3l.	24l.	2.0l.				
Less than 100 square <i>ri</i> .	1885.....	19	27	27	26	28	27	23	19	33	24	32	24	300	25.7			
	1886.....	28	31	39	27	41	18	30	33	30	25	19	28	349	29.1			
	1887.....	26	43	23	20	44	28	27	28	29	14	24	43	349	29.1			
Sum ...No. in 1885 & 1886.	47	58	66	53	69	45	53	52	63	49	51	52	658	54.8				
Average for 2 years	—	23	29	33	26	34.	22	26	26	31.	24.	25	26	325	27.1			
Sum ..... 1887.	26	43	23	20	44	28	28	27	29	14	24	43	349	29.1				
More or less.....	3m.	14m.	10l.	6l.	10m.	6m.	1m.	2m.	2l.	10l.	11l.	17m.	24m.	2.0m.				
Whole sum.....	Whole No. in 1885 & 1886.	70	83	86	75	109	76	68	76	86	74	69	82	954	79.5			
Average for 2 years	—	35	41	43	37	54	38	34	38	43	37	34	41	475	39.6			
Sum ..... 1887.	41	58	30	29	60	38	38	35	43	20	35	56	483	40.2				
More or less.....	6m.	17m.	13l.	8l.	6m.	—	4m.	3l.	—	17l.	1m.	15m.	8m.	0.7m.				

From the above table, we see that in 1887 there were :—

349	which disturbed less than.....	100 square <i>ri</i> .
79	which disturbed between .....	100 and 1,000 square <i>ri</i> .
37	which disturbed between .....	1,000 and 5,000 square <i>ri</i> .
2	which disturbed between .....	5,000 and 7,000 square <i>ri</i> .
		and only one over 7,000 square <i>ri</i> .

Of earthquakes whose area of disturbance is less than 100 square *ri*, there were 24 more in 1887 than in 1885 and 1886.

#### DISTURBED PLACES.

In every year, the places which have been shaken are nearly the same: namely, in order of frequency of disturbances, Musashi, Shimotsuke, Kazusa, and Shitachi; Nemuro; Iwaki, Kazusa, and Rikuzen; Mutsu, Sagami, and Kii.

In Musashi, Shimotsuke, Kazusa, and Shitachi there were 50 disturbances; in Tokyo 80. In these provinces, the origins and areas are nearly the same each year. In Nemuro there were 28, which shook about the same area; and in Kii and Satsuma many.

A detailed account of districts shaken is given in the following table :—

Name of Province.	Year.	No. of Earth- quakes.	Intensity.		
			Strong.	Weak.	Small.
Musashi .....	1885.....	68 ...	2 ...	18 ...	48
	1886.....	54 ...	1 ...	15 ...	38
	1887.....	80 ...	2 ...	15 ...	63
Shimotsuke .....	1885.....	58 ...	1 ...	18 ...	39
	1886.....	61 ...	1 ...	5 ...	55
	1887.....	42 ...	0 ...	6 ...	36
Nemuro .....	1885.....	33 ...	4 ...	22 ...	7
	1886.....	43 ...	1 ...	15 ...	27
	1887.....	35 ...	2 ...	2 ...	31
Shimōsa .....	1885.....	40 ...	0 ...	15 ...	25
	1886.....	28 ...	0 ...	17 ...	11
	1887.....	29 ...	2 ...	15 ...	12
Shitachi .....	1885.....	36 ...	0 ...	8 ...	28
	1886.....	33 ...	1 ...	23 ...	9
	1887.....	27 ...	0 ...	8 ...	19



Iwaki	1885	19	1	13	5
	1886	19	0	16	3
	1887	25	0	7	18
Kazusa	1885	22	0	4	18
	1886	14	0	4	10
	1887	22	1	3	18
Rikuzen	1885	16	0	11	5
	1886	12	3	5	4
	1887	21	2	7	12
Mutsu	1885	26	2	8	16
	1886	15	0	6	9
	1887	18	1	9	8
Sagami	1885	15	1	13	1
	1886	8	1	3	4
	1887	15	1	9	5
Izu	1885	5	2	2	1
	1886	1	1	0	0
	1887	5	1	3	1
Hoki	1885	2	0	2	0
	1886	—	—	—	—
	1887	5	0	2	3
Suō	1885	5	0	1	4
	1886	3	0	3	0
	1887	5	0	0	5
Hizen	1885	3	0	2	1
	1886	4	0	0	4
	1887	4	0	4	0
Osumi	1885	9	2	5	2
	1886	3	0	1	2
	1887	4	1	1	2
Higo	1885	4	0	3	1
	1886	2	0	2	0
	1887	4	0	3	1
Kaga	1885	—	—	—	—
	1886	—	—	—	—
	1887	4	0	3	1
Kushiro	1885	15	1	8	6
	1886	23	4	13	6
	1887	4	1	3	0

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Kawachi	1885	2	0	2	0
	1886	3	1	1	1
	1887	3	0	1	2
Hida	1885	3	0	1	2
	1886	1	1	0	0
	1887	3	0	1	2
Kii	1885	18	0	7	11
	1886	22	1	6	15
	1887	15	0	8	7
Satsuma	1885	10	1	4	5
	1886	10	0	6	4
	1887	14	0	9	5
Kotsuke	1885	11	0	10	1
	1886	11	2	6	3
	1887	13	3	6	4
Owari	1885	8	0	2	6
	1886	3	0	2	1
	1887	12	1	5	6
Aki	1885	5	0	2	3
	1886	5	0	1	4
	1887	10	0	5	5
Iwami	1885	2	0	2	0
	1886	6	0	1	5
	1887	11	0	5	6
Mino	1885	13	3	8	2
	1886	6	0	4	2
	1887	11	1	3	7
Iyo	1885	3	0	2	1
	1886	10	3	6	1
	1887	11	0	9	2
Iwashiro	1885	5	0	3	2
	1886	9	0	6	3
	1887	10	1	4	5
Toshima	1885	9	2	5	2
	1886	3	0	1	2
	1887	10	2	7	1
Sado	1885	—	—	—	—
	1886	1	0	1	0
	1887	3	0	1	2

Echizen	1885	4	0	2	2
	1886	3	0	1	2
	1887	3	0	2	1
Tango	1885	1	0	0	1
	1886	1	0	1	0
	1887	3	0	1	2
Bingo	1885	1	0	0	1
	1886	1	0	0	1
	1887	3	0	3	0
Awa	1885	7	0	2	5
	1886	2	0	2	0
	1887	3	0	2	1
Ishikari	1885	4	1	2	1
	1886	1	1	0	0
	1887	3	0	0	3
Iburi	1885	7	1	4	2
	1886	2	0	1	1
	1887	3	1	1	1
Awaji	1885	2	0	1	1
	1886	1	0	1	0
	1887	2	0	1	1
Shima	1885	4	0	2	2
	1886	—	—	—	—
	1887	2	1	1	0
Etchu	1885	—	—	—	—
	1886	2	0	0	2
	1887	2	0	0	2
Echigo	1885	3	1	1	1
	1886	31	3	7	21
	1887	10	0	4	6
Huga	1885	5	0	1	4
	1886	6	0	3	3
	1887	10	1	4	5
Kai	1885	21	6	6	9
	1886	11	2	4	5
	1887	9	3	3	3
Ugo	1885	3	0	3	0
	1886	8	2	2	4
	1887	9	0	3	6

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Ise	1885	7	0	3	4
	1886	5	0	3	2
	1887	9	2	4	3
Suruga	1885	8	1	2	5
	1886	2	0	1	1
	1887	8	1	3	4
Mikawa	1885	10	0	3	7
	1886	4	0	1	3
	1887	8	1	4	3
Totomi	1885	5	0	4	1
	1886	2	0	0	2
	1887	8	0	1	7
Bizen	1885	1	0	0	1
	1886	2	0	0	2
	1887	8	0	8	0
Bitchu	1885	2	0	0	2
	1886	1	0	0	1
	1887	8	1	5	2
Yamato	1885	5	0	4	1
	1886	2	0	2	0
	1887	2	0	2	0
Tamba	1885	7	0	4	3
	1886	4	0	3	1
	1887	2	1	1	0
Harima	1885	2	0	1	1
	1886	3	0	2	1
	1887	2	0	2	0
Nagato	1885	5	0	3	2
	1886	3	0	2	1
	1887	2	0	2	0
Mimasaka	1885	1	0	1	0
	1886	—	—	—	—
	1887	2	0	2	0
Buzen	1885	1	0	1	0
	1886	3	1	1	1
	1887	2	0	1	1
Hidaka	1885	3	1	2	0
	1886	—	—	—	—
	1887	2	0	2	0

MADE IN JAPAN DURING THE YEAR 1889. III

Shiribeshi	1885	2	0	2	0
	1886	1	0	1	0
	1887	1	0	1	0
Noto	1885	—	—	—	—
	1886	3	1	2	0
	1887	1	0	0	1
Wakasa	1885	3	0	0	3
	1886	1	0	0	1
	1887	1	0	1	0
Teshio	1885	2	1	1	0
	1886	—	—	—	—
	1887	8	1	7	0
Awa (Boshu)	1885	9	1	8	0
	1886	3	0	3	0
	1887	7	2	2	3
Settsu	1885	5	0	1	4
	1886	3	0	1	2
	1887	7	0	3	4
Bungo	1885	2	0	2	0
	1886	6	1	2	3
	1887	7	0	3	4
Shinano	1885	9	0	5	4
	1886	10	2	14	3
	1887	6	3	1	2
Uzen	1885	7	0	6	1
	1886	5	1	3	1
	1887	6	1	4	1
Yamashiro	1885	5	0	4	1
	1886	2	0	0	2
	1887	6	0	5	1
Omi	1885	6	0	1	5
	1886	2	0	0	2
	1887	6	0	1	5
Rikuchu	1885	9	4	4	1
	1886	10	0	6	4
	1887	6	0	5	1
Tosa	1885	3	1	2	0
	1886	5	2	3	0
	1887	6	2	2	2

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Iga	1885	3	0	2	1
	1886	3	0	0	3
	1887	1	0	1	0
Izumi	1885	2	0	1	1
	1886	1	0	1	0
	1887	1	0	1	0
Inaba	1885	—	—	—	—
	1886	—	—	—	—
	1887	1	0	0	1
Tajima	1885	—	—	—	—
	1886	—	—	—	—
	1887	1	0	0	1
Sanuki	1885	—	—	—	—
	1886	—	—	—	—
	1887	1	0	1	0
Chikuzen	1885	1	0	1	0
	1886	6	0	4	2
	1887	1	0	1	0
Chikugo	1885	1	0	0	1
	1886	1	0	1	0
	1887	1	0	1	0
Chishima	1885	6	2	1	3
	1886	2	1	0	1
	1887	—	—	—	—
Iki	1885	—	—	—	—
	1886	1	0	0	1
	1887	—	—	—	—
Izumo	1885	4	0	2	2
	1886	7	0	5	2
	1887	6	2	2	2
Whole sum	1885	659	40	294	325
	1886	596	38	253	305
	1887	683	45	268	370
Average for the three years		646	41	272	333

INTENSITY OF EARTHQUAKES.

The intensity is not accurately determinable. The places which were shaken severely were Shitachi (4 times), Shimoso, Kozuke, Shimotsuke, Sagami, Shinano, Rikuzen, Mutsu, Ne-

muro, and Iyo (each 3 times). Kazusa, Awa, Musashi, Kai, Mino, Ise, Tosa, Iwami, Bungo, Toshima, Izu, Suruga, Echigo, Iwaki, Uzen, Rikuchu, Iburi, Teshio, Mikawa, Owari, Shima, Omi, Tanba, Izumo, Awa (阿波), Higo, Hiuga, and Osumi were severely shaken once or twice.

The most severe was that which shook Echigo on the 22nd of July. The next one was that which shook Musashi and Sagami, on January 15th: that in Shimosa on September 5th was the next; and then that in Owari on February 2nd. Of these the most serious one opened the ground and threw down or damaged houses. Slighter ones made cracks in the walls, damaged furniture, or caused liquor to overflow from vessels, etc.

#### APPROXIMATE POSITION OF SEISMIC ORIGINS.

Fig. II. at the end of the report refers to the 483 disturbances in 1887, and indicates the origin of each disturbance. But as stated last year, it is very difficult to determine the origin of seismic disturbances with accuracy and therefore we only approximately indicate it by a small circle. The number which is inserted in the circles denotes the number of seismic disturbances which we assume to have originated within the area it encloses. But though the origins of disturbances which occurred on land are somewhat trustworthy, it is impossible to know whether the origins of those which occurred in the sea are within the circle or some miles outside them.

We will now give a general sketch of the year 1887 from Fig. II. In Honshu, most of the origins are to the east of Kai, Shinano, and Echigo, and to the south of Rikuchu. In Hokkaido, most of them are in the sea towards the east, and in the western part of Hokkaido it is likely that they are near the coast. West of Chugoku, most of them are in the Bay of Kagoshima, next to it in the Strait of Kii, and next to it in the Bay of Owari. In general, the origins are numerous in the Southern and

Eastern Seas and near the coast. But few occur in the Japan Sea and near its coast.

Shimotsuke, Shitachi, Shimosa, and Musashi had the greatest number of origins. Here there were 58. Next to this is Tokyo Bay with 37; next to that the eastern sea of Nemuro with 30. None of the others had over 16.

About the disturbances which had their origin in the sea and wide areas, 1 had its origin in the Sea of Shikoku and Kiushu (this disturbance had the greatest area); 1 in the Bay of Owari; 8 in the sea of Shitachi and Iwaki; 3 in the sea of Shimosa and Shitachi; 1 in the sea of Rikuzen, and Rikuchū, while in the Strait of Tsugaru, in the eastern sea of Nemuro, and in Tokyo Bay, taken together there are 22.

As to the disturbances which had their origins beneath the land, 2 occurred in Sagami, 1 in Shimotsuke and Iwaki, 1 in Echigo, in Musashi, and in Izumo; total 6.

Thirteen of those which occurred in the sea and on the seashore were severe. Of those which occurred on land 14 were severe, 2 especially, which occurred in Echigo and Sagami, were very severe. Thus we see that the number of disturbances is less than that of 1886.

Besides these, as we see in Fig. II., the origins of the disturbances are dispersed in many places. As it is useless trouble to give them exactly, we will here satisfy ourselves with comparing their number with that of 1886 in the following table:—



	Year.	Whole No.	Large Disturbances.	Moderate Disturbances.	Small Disturbances.	Total Sum.
Those which occurred beneath the sea or along the coast.	1886	228	15	50	163	228
	1887	302	36	76	190	302
Those which occurred on land.	1886	244	11	70	163	244
	1887	181	14	34	133	181
Total sum.	1886	472	26	120	326	472
	1887	483	50	110	323	483
		M.	M.	L.	L.	M.
More or Less.	This year.	11	24	10	3	11



From the above table, we see that large disturbances were more numerous in 1887 than in 1886, and moderate disturbances were less.

#### RELATION OF EARTHQUAKES TO VOLCANOES.

In considering the relationship of earthquakes to volcanoes, we see as was pointed out last year, provinces which are many miles distant from volcanic ranges, such as Musashi, Kazusa, Shimosa, Kotsuke, Shimotsuke, and Shitachi, have many earthquakes every year. Of the provinces which have volcanoes within them, those which are shaken by many earthquakes are the eastern parts of Mutsu, and the central part of Satsuma. Of the provinces which are far off from volcanoes, those which have many earthquakes are the south-eastern part of Nemuro, the western parts of Kii and Iyo, the central part of Aki, and the eastern parts of Iwami, Mikawa, and Owari. Besides, it seems that, in the provinces surrounded by volcanoes, earthquakes are equally scarce every year. The central part of Echigo and Sagami, which are near to volcanoes, each became the origin of strong and serious disturbances, creating damage. (See Fig. III. No. 4, and the report of June 22nd). In short, in some places though there are many volcanoes, earthquakes seldom occur. In others, both earthquakes and volcanoes are few. And there are some places where there are volcanoes, but the disturbances do not spread and are limited to a particular spot.

The sign  in Fig. I. at the end of the report denotes volcanoes which are active. The sign  denotes those which show no sign of activity.

#### MONTHLY REVIEW OF EARTHQUAKES.

##### JANUARY.

The whole number of earthquakes in January was 41; or on the average one for every 18 hours 9 minutes.

Nemuro in Hokkaido; Rikuzen, Rikuchu, Mutsu, Ugo, Iwaki, Iwashiro, the 8 provinces of Kanto, Echigo, Shinano, Kai,

Suruga, Izu, Totomi, Mikawa, Owari, Mino, Hida, Ise, Kii, Mimasaku, Bizen, Bitchu, Bingo, Hoki, Izumo, Iwami, Aki, Suo and Nagato in Honshu, the whole of Shikoku; and Buzen, Bungo, Hizen, Higo, Hiuga, Osumi, and Satsuma in Kiushu were more or less affected by large and small disturbances.

The places which were most shaken were Shimosa, Musashi, Shitachi, Iwaki, Kazusa, and Shimotsuke. They were shaken from 5 to 9 times. Next to them are Kai, Shinano, Awa, Izu, Sagami, Suruga, Kozuke, Totomi, Mino, Aki, Hiuga, Osumi, and Satsuma, shaken 3 or 4 times. All the rest were not disturbed more than twice.

Of 41 disturbances, 6 were strong; that is 1 through Tosa, Iyo, and Bungo; 1 through Sagami, Musashi, Kazusa, Shimosa, Kotsuke, Shinano, Kai, Suruga, Izu, and Awa; 1 through Sagami and Shinano; 1 in Higo, Iyo, and Rikuzen. The rest were all faint and slight.

The sum of the areas of the disturbed places is 23,200 square *ri*. Of all the disturbances, those which had an area of between 100 and 1,000 square *ri* are 8; those which had an area between 1,000 and 500 square *ri* are 7; and the one which shook the greatest area was that of the 15th. It shook 21 provinces *viz.*, Iwaki, Iwashi, Rikuzen, Echigo, Shinano, Kai, Suruga, Izu, Totomi, Mikawa, Owari, Mino, and Hida). In Sagami and the south-eastern corner of Musashi, houses were damaged. The area shaken was 5,360 sq. *ri*.

#### FEBRUARY.

The whole number of earthquakes in February was 58, that is at the rate of 1 per 11 hours 35 minutes.

Nemuro and Toshima in Hokkaido; Rikuzen, Uzen, Iwashi, Iwaki, Shitachi, Kazusa, Shimosa, Kotsuke, Shimotsuke, Shinano, Etchu, Musashi, Sagami, Izu, Suruga, Kai, Totomi, Mikawa, Owari, Mino, Ise, Shima, Iga, Omi, Echizen, Kaga, Yamashiro, Yamato, Settsu, Izumi, Kawachi, Kii, Tamba,

Tango, Tajima, Inaba, Harima, Mimasaka, Hoki, Bizen, and Aki in Honshu; Iyo and the Island of Awaji in Shikoku; Hiuga, Satsuma, Chikuzen, and Hizen in Kyushu were more or less affected by disturbances.

The places which were shaken most were Iyo, Mino, Owari, Mikawa, Ise, Shimotsuke, Omi, and Shitachi. They were disturbed from 5 to 8 times. Next to them were Musashi, Iwaki, Rikuzen, Yamato, Yamashiro, Wakasa, Tamba, Tango, Settsu, and Kii, which were shaken 3 or 4 times. The others were shaken not more than twice.

Of 58 disturbances, only 1 which was felt throughout Owari, Mikawa, Mino, Ise, Omi, Shima, Totomi, Shinano, and Iga, was strong. The others were slight.

The sum of the areas of the disturbed places is 16,270 sq. *ri*. Of all the disturbances during this month, the areas of 10 exceeded 100 sq. *ri*. Five exceeded 1,000 sq. *ri*.

The one which disturbed the greatest area was that of the 2nd. It was felt through Musashi and Shinano in the east; through Kii, Awaji, Bizen, and Hoki in the west; through the provinces from Kii to Musashi in the south; and through the provinces from Kaga to Hoki in the north. Its area was 5,930 sq. *ri*.

#### MARCH.

The whole number of earthquakes during this month was 30, that is at the rate of 1 per 24 hours 48 minutes.

Ishikari in Hokkaido; Rikuchu, Ugo, Rikuzen, Iwaki, Iwashi, Shimotsuke, Kazusa, Shimosa, Musashi, Sagami, Kai, Echigo, Shinano, Mikawa, Kii, Bizen, Bitchu, Bingo, Aki, Iwami, and Suo in Honshu; Tosa and Iyo in Shikoku; and Hiuga, Satsuma, Higo and Hizen in Kyushu, were more or less affected by disturbances.

The places which had most disturbances were Musashi and Echigo. The number of disturbances was 3. The other places were not disturbed more than twice.

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Of 30 disturbances, 2 were strong, one in Ishikari and one in Iwami. All the rest were slight.

The sum of areas of the disturbed places was 3,200 sq. *ri*; 7 of them shook over 100 sq. *ri*; and none more than 1,000 sq. *ri*.

The greatest area was shaken on the 21st. It was felt throughout Bitchu, Bingo, Iwami, Aki, and Suo. Its area was 620 sq. *ri*.

### APRIL.

The whole number of disturbances in this month was 29, that is 1 per 24 h. 50 m.

Nemuro and Kushiro in Hokkaido; Mutsu, Ugo, Rikuzen, Iwashiro, Iwaki, Kotsuke, Shimotsuke, Musashi, Sagami, Kazusa, Shimosa, Awa, Shinano, Totomi, Mikawa, Mino, Kaga, Echizen, Owari, Shima, Ise, Iga, Omi, Wakasa, Yamashiro, Yamato, Settsu, Izumi, Kawachi in Honshu; the whole of Nankai Do; the whole of San-in Do (Oki excepted); the whole of San-yo Do and of Kyushu were affected by disturbances.

Of these disturbances, 8 were in Musashi, 3 in Iwaki, Shimotsuke, Kii, and in Bitchu; in all other places not more than two disturbances were recorded.

Only one was severe. It was felt throughout Tosa, Iyo, Bungo, Huga, and Osumi. The rest were slight.

The sum of the areas of the disturbed places was 12,310 square *ri*. The disturbances which had areas between 100 and 1,000 square *ri* numbered 6; those which had areas of more than 1,000 square *ri*, 3.

The disturbance which had the greatest area was that which occurred on 29th through Yamashiro, Yamato, Izumi, Settsu, Kawachi, San-in Do (Oki excepted), San-yo Do, Nankai Do, Kyushu, Wakasa, Echizen, Omi, Mino, Kaga, Owari; Iga, Ise and Shima. The area shaken was 7,860 square *ri*. Its intensity was strongest in the eastern parts of Kyushu, and

south-western parts of Shikoku, though not so intense as to damage furniture. This is the greatest area we have noticed ever since the reports of seismometrical observations in the Empire were commenced.

## MAY.

The whole number of earthquakes experienced during this month was 60, that is at the rate of 1 per 12 hours 24 minutes.

Nemuro, Kushiro, Hidaka, Iburi, and Toshima in Hokkaido; Rikuzen, Rikuchu, Mutsu, Uzen, Ugo, Iwaki, Iwashiro, the 8 provinces of Kanto, Kai, Echigo, Mikawa, Mino, Owari, Ise, Kawachi, Kii, Harima, and Ise in Honshu; Awa and Iyo in Shikoku; the whole Island of Awaji. In Kyushu only Hiuga was affected.

The place which had most disturbances was Musashi (10); next to it Nemuro, Mutsu, and Rikuzen (each 6 or 7); and next to them were Iwaki, Shimotsuke, Ugo, and Shimosa (each from 3 to 5). The other places had no more than 2.

Of all the disturbances, 6 were strong; that is, 1 in Rikuchu; 1 through Nemuro and Kushiro; 2 through Mutsu and Toshima; 1 in Shimotsuke; 1 through Rikuzen, Uzen, Shimotsuke, and Shitachi. The rest were slight.

The sum of the areas of the disturbed places was together 13,220 square *ri*. Fourteen shook areas between 100 and 1,000 square *ri*; two more than 1,000 square *ri*. The earthquake on the 29th shook the greatest area. It reached to Mutsu in the north, and to Awa, Musashi, and Kai in the south. The area shaken was 4,360 square *ri*.

## JUNE.

The whole number of earthquakes this month was 38, that is at the rate of 1 per 18 hours 57 minutes.

Nemuro in Hokkaido; Mutsu, Rikuzen, Iwaki, Iwashiro, Shitachi, Kazusa, Shimosa, Kotsuke, Shimotsuke, Musashi, Echigo, Shinano, Mikawa, Owari, Mino, Kaga, Echizen, Shima, Ise, Kii, Settsu, Kawachi, Yamashiro, Tanba, Hoki,

Izumo, and Aki in Honshu; Tosa and Iyo in Shikoku; and Bungo, Higo, Hiuga, and Osumi in Kyushu were affected by disturbances.

The places which had most disturbances were Musashi and Shimotsuke (from 5 to 7). All other places did not feel more than 2.

Of the 38 disturbances 2 were strong; that is, 1 in Tanba and 1 in Ise. The rest were all slight.

The sum of the areas of the disturbed places was 5,920 square *ri*. Nine shocks were felt over areas from 100 square *ri* to 1,000 square *ri*. One extended over more than 1,000 square *ri*. It occurred on the 20th, and the shock was felt over an area of 1,470 square *ri*.

It was felt as far as Rikuzen and Iwaki in the north to Musashi, Shimosa in the south, to Kotsuke in the west, and to the sea in the east.

#### JULY.

The whole number of earthquakes this month was 38, that is at the rate of 1 per 19 hours 35 minutes.

Nemuro, Hidaka, Iburi, Teshiro, Shirieshi, and Toshima in Hokkaido; Mutsu, Rikuzen, Uzen, Ugo, Sado, Echigo, Iwashiro, Iwaki, the 8 provinces of Kanto, Kai, Izu, Shinano, Etchu, Noto, Hida, Kii, Bizen, and Iwami in Honshu; Hiuga, Satsuma, and Hizen in Kyushu were affected more or less by disturbances. There were no reports from Shikoku.

The places affected by most disturbances were Teshiro, Nemuro, and Iwami (each from 5 to 7); next to them Shitachi, Musashi, Shimotsuke, Iwaki, and Kii (each 3 or 4); and others not more than 2.

Four of the disturbances were strong, that is, 1 in Kii, 1 through Mutsu and Iburi, 1 in Teshiro and in Echigo. The rest were slight.

The sum of the areas of the disturbed places was 13,290

square *ri*; seven shook areas from 100 to 1,000 square *ri*, and 4 of them more than 1,000 square *ri*.

The greatest shock occurred on the 22nd. It reached to Ugo in the north; to Musashi in the south; to the Pacific and Nippon Sea in the west and east. The area was 4,200 square *ri*. In the central part of Echigo houses were thrown down and the ground was cracked.

## AUGUST.

The whole number of earthquakes this month was 35, that is at the rate of 1 per 21 hours 15 minutes.

Nemuro, Kushiro, Tokachi, Hidaka and Toshima in Hokkaido; Mutsu, Rikuzen, Uzen, Iwashiro, Iwaki, Kotsuke, Shimotsuke, Shitachi, Kazusa, Shimosa, Musashi, Echigo, Mino, Mikawa, Kii, Harima, Inaba, Bizen, Mimasaka, Bitchu, Bingo, Hoki, Izumo, Aki, Iwami, and Suo; Tosa in Shikoku; and Bungo, in Kyushu were affected by disturbances.

The place which felt most disturbances was Nemuro (5); next to it was Bizen (3); all other places not more than 2.

Two of the disturbances were strong; one through Shimotruke and Iwaki, one through Izumo and Iwami. All the others were slight.

The sum of the disturbed place was 7,820 square *ri*. The disturbances which had an area of more than 100 *ri* were 4; those which had more than 1,000 square *ri* were 3. The disturbance of the greatest area was that of the 15th, 2,270 square *ri*; it was felt in Iwaki, Kotsuke, Shimonoseki, Kazusa, Shimosa, Shitachi, Musashi, Iwashiro, Uzen, and Rikuzen.

## SEPTEMBER.

The whole number of earthquakes this month was 43, that is at the rate of 1 per 16 hours 45 minutes.

Nemuro and Teshio in Hokkaido; Mutsu, Rikuzen, Rikuchu, Uzen, Ugo, Iwaki, Iwashiro, the 8 provinces of Kanto, Izu, Suruga, Kai, Shinano, Echigo, Mikawa, Owari, Omi,

Yamashiro, Yamato; Izumi, Kawachi, Settsu, Kii, Iwami, Aki, and Nagato; Tosa and Iyo in Shikoku; and Hiuga, Higo and Bingo in Kyushu were affected by disturbances.

The places which were affected most were Musashi, Kazusa, Shimosa and Shimotsuke (each from 6 to 9); next to them come Shitachi, Iwaki, Rikuzen, Sagami, Kotsuke, Iwashiro and Kii (each from 3 to 5); other places not more than twice.

Two of the disturbances were strong: one through Kazusa, Shimosa, Shitachi, Awa, Musashi, Kotsuke, Shimotsuke, and Sagami; the other through Shimosa and Shitachi. The others were slight.

The sum of the area of the disturbed places was 14,580 sq. *ri*. Ten of the disturbances were felt over areas of from 100 to 1,000 sq. *ri*; 4 were felt over an area of more than 1,000 sq. *ri*. The disturbance of greatest area occurred on the 5th and shook 5,500 sq. *ri*. It was felt through Suruga, Kai, Izu, the 8 provinces of Kanto, Shinano, Iwashiro, Iwaki, Echigo, Uzen, Ugo, Rikuzen, and Rikuchu. The eastern part of Shimosa was most severely shaken.

## OCTOBER.

The whole number of the disturbances during this month was 20, that is at the rate of 1 per 37 hours 12 minutes.

Nemuro and Kushiro in Hokkaido; Iwaki, Shitachi, Totomi, Mino, Yamashiro, Hoki, Bingo, Aki, and Suo; also Iyo and Tosa in Shikoku were affected by disturbances. There were no disturbances in Kyushu. In no other month were the places of disturbance so few.

The places which were disturbed most were Shitachi and Shimotsuke (each 3), other places not more than twice.

All the disturbances were slight.

The sum of the areas of the disturbed places was 2,680 square *ri*; 6 of the disturbances extended over areas of more than 100 square *ri*; and none of them over more than 1,000 square *ri*. The greatest area of disturbance was that of the 27th.



(820 square *ri*). It disturbed Shitachi, Shimosa, Shimotsuke, and Iwaki.

## NOVEMBER.

The whole number of the earthquakes this month was 35, that is at the rate of 1 per 20 hours 34 minutes.

Nemuro, Kushiro, and Toshima in Hokkaido; Mutsu, Iwaki, Iwashiro, the 8 provinces of Kanto, Suruga, Kai, Shinano, Mikawa, Ise, Kii, Izumi, Settsu, Harima, Inaba, Bizen, Bitchu, Bingo, Aki, Mimasaka, Hoki, Izumo, Iwami, and Suo; the whole of Shikoku (Awaji included), Buzen, Bungo, Higo, Hiuga, and Satsuma in Kyushu were affected by disturbances.

The places which were affected most, were Musashi, Shimosa, and Shimotsuke (5 or 4); next to them Shitachi and Iwami (3); other places not more than twice.

The strongest disturbance was one which occurred in Nemuro. The others were slight.

The area of the disturbed places was 11,950 sq. *ri*. The areas of 6 of the disturbances were between 100 and 1,000 sq. *ri*. Three exceeded 1,000 sq. *ri*. The earthquake which shook the greatest area was that of the 16th. It was felt through Kii, Izumi, Settsu, Harima, Inaba, Mimasaka, Hoki, Bizen, Bitchu, Bingo, Izumo, Aki, Imami, Suo, Awaji, the whole of Shikoku, and Bungo. The disturbed area was 2,790 square *ri*.

## DECEMBER.

The whole number of the earthquakes this month was 56, that is at the rate of 1 per 13 hours 17 minutes.

Nemuro and Kushiro in Hokkaido; Mutsu, Rikuzen, Rikuchu, Ugo, Iwaki, Shitachi, Kazusa, Shimosa, Musashi, Kotsuke, Kai, Sagami, Shinano, Echigo, Owari, Mino, Omi, Ise, Kii, Suo, Iwami, and Nagato in Honshu; Buzen, Hiuga, and Satsuma in Kyushu were affected.

The places which were affected by most disturbances during this month were as follows Musashi (14); next Shimotsuke, Mutsu, Kazusa (each 5 or 6); next to them Shitachi, Kazusa,

Ugo, Iwaki, and Satsuma (each 3 or 4); and other places not more than 2.

Of all the disturbances only 1, in Mino, was strong; the others were slight.

The sum of the disturbed areas was 9,390 square *ri*; ten of the disturbances were felt over areas of between 100 and 1,000 square *ri* each; 3 over more than 1,000 square *ri*; the greatest shaken area was that of the disturbance of the 16th (2,260 square *ri*). It was felt through Musashi, Kazusa, Shimosa, Shitachi, Iwaki, Kotsuke, Shimotsuke, Kai, and Sagami.

#### TYPICAL EARTHQUAKES.

The following are disturbances requiring special notes.

1 a.m., January 28th.

A slight shock in the central part of Satsuma (Kagoshima Gori). The shaken area was 10 square *ri*. There were 11 disturbances in this place during the year.

4 p.m., February 5th.

Felt through Owari, Mikawa, Mino (southern part), Ise, Omi (eastern part), and Shima. Shaken area, 830 square *ri*. Slight disturbance. The origin seemed to be in the Bay of Owari. There were more than 10 disturbances in the same district during this year.

11 a.m., April 29th.

The places which were most severely affected were the eastern parts of Shikoku. The area was nearly 7,860 square *ri*. In other places there were but slight disturbances. As no report has come of the damage to houses or even to furniture from any place, we see that the disturbance was not of great severity, though there has been no other disturbance which had so great an area, since seismometrical observations were begun. The origin of this disturbance seems to have been far off in the sea of Shikoku and Kyushu.

8.30 p.m., July 22nd.

The disturbance on this day reached to the southern part of Ugo in the north; to the southern part of Musashi in the south; and to the Pacific Ocean and Nippon Sea in the east and west. Its area was about 4,400 square *ri*. The greatest disturbance was in the central part of Echigo (an area, 230 square *ri*), of which 20 or 30 square *ri* in Koshi Gori and the north-western neighbouring districts were reaffected most severely. Especially in Koshi Gori, old and new *dozo* (store houses built of mud), were cracked and many walls fell; some temples and *dozo* were moved from 2 to 5 inches to the south. Some houses were thrown down or greatly damaged, and one person was injured. There were many hundred fissures in the ground, some of which were 3 feet wide, and water and sand were thrown out covering the ground to a depth of about 1 foot. Most of the wells threw out sand so that they were wholly covered, many of them to a depth of 3 feet. Only a few of them were undisturbed. Some of these disturbed wells are now as good as originally, but some are not. In some places, eruptions of water from the cracks in the ground did not stop for over ten days.

Next to Koshi Gori, were Mishi Gori and South Kambara Gori. In Mishima Gori, some *dozo* were moved out of position. The walls of most of the houses and stores were cracked, and many of them were broken. On the bank of the Shinano River there were 7 fissures, some of them 5 inches wide.

In South Kambara Gori, the villages in the neighbourhood of Koshi Gori were most strongly affected, and some buildings were thrown out of position; houses and stores were damaged; and cracks 15 fathoms long and 8 inches wide were formed. There were many small cracks along the banks of the rivers.

In the neighbourhood of Mishima Gori, much furniture was damaged; *dozo* were cracked and a few broken, most houses were thrown out of the perpendicular from 3 to 5 inches.

Some of the fissures were 20 fathoms long, from which blue sand was thrown out.

Of the above places, the villages on the side of the Shinano River seem to have been affected most strongly.

Besides these, in the north (Onuma Gori) *dozo* and house-walls were cracked and furniture was overthrown; in Niigata the *shoji* were thrown out and damaged. On the Shinano River waves were produced and the water became muddy; wells were also rendered muddy. The direction of the waves in the surrounding sea of Niigata, which had been to the north-west, changed to the south-west.

At about 1 a.m., July 23rd last year, there occurred a strong disturbance in the vicinity of East Kubiki Gori in Echigo, Takai Gori, and Minauchi Gori in Shinano. Its area was 1,210 square *ri* less than that of the disturbance of this year, but the violently shaken area was 1,448 square *ri* more. Though it was not so strong as the earthquake of this year, it did some damage.

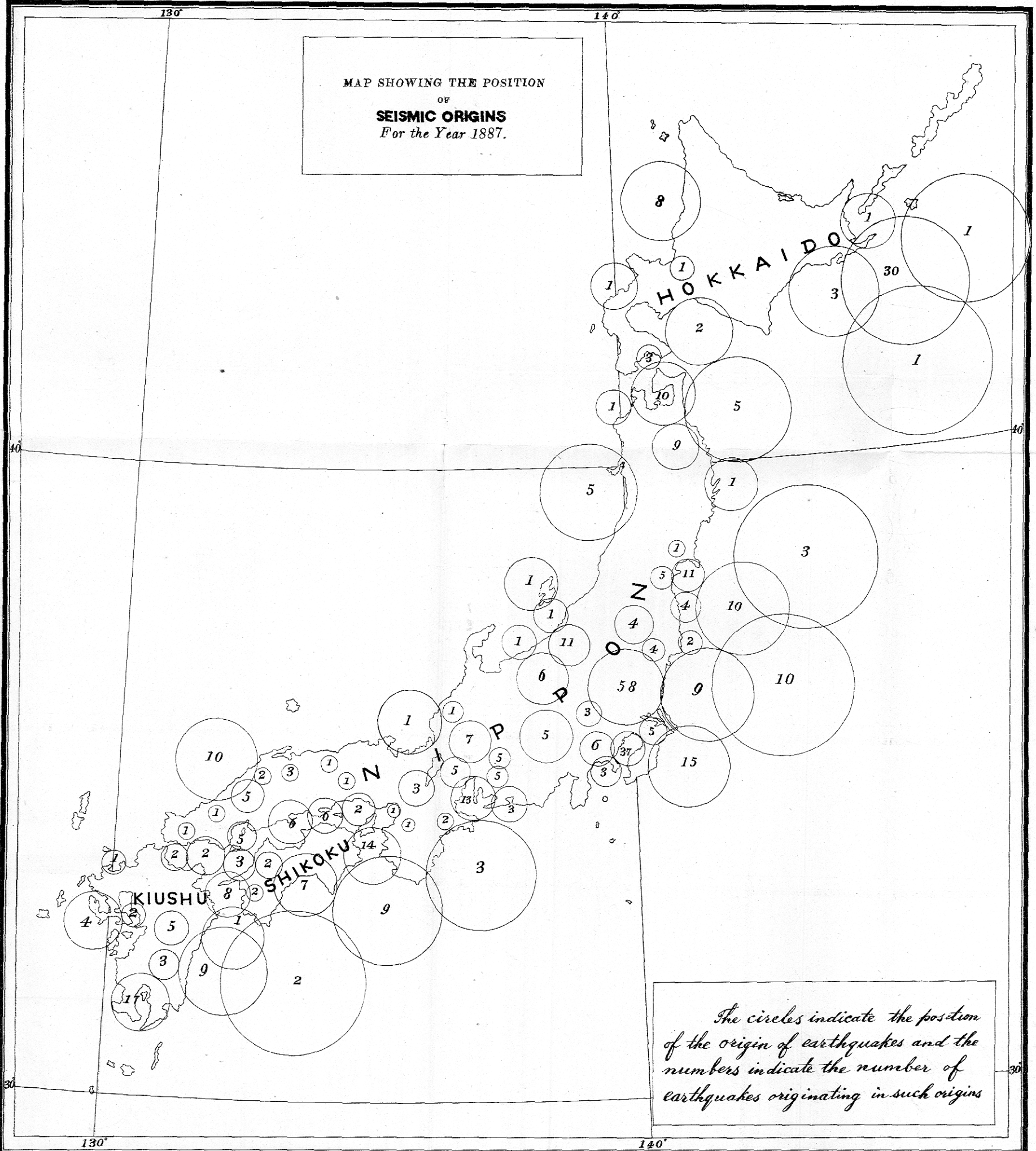
The locations of the most severely shaken districts affected by the two earthquakes were in some respects the same. Moreover, strange to say, the disturbance of this year occurred at 8.30 p.m. July 22nd, and that of last year at about 1 a.m. July 23rd, so the difference of the time of the occurrences was only 5 or 6 hours. It is also strange that in spite of the scarcity of earthquakes in these places, during two succeeding years in the same intensely hot season they experienced such disturbances. It is said that the disturbance of this year was the strongest that has shaken Echigo since the 2nd year of Ansei (1854) or 33 years ago. And, indeed, it is the strongest that ever disturbed the Empire since the 18th year of Meiji (1885).

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PLATE II.

MAP SHOWING THE POSITION  
OF  
**SEISMIC ORIGINS**  
*For the Year 1887.*



*The circles indicate the position  
of the origin of earthquakes and the  
numbers indicate the number of  
earthquakes originating in such origins*

PLATE IV.

MAP SHOWING  
THE FREQUENCY OF EARTHQUAKES  
For the three Years 1885-1887.

