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ON

THE EARTHQUAKES

IN

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GENERAL REVIEW.

FREQUENCY AND DISTRIBUTION OF EARTHQUAKES.

During the year 1900 (Meiji 33rd), the total number of earthquakes observed all over Japan was 1,888, the daily average being 52. Those provinces where 100 shocks and more were felt were Chikuzen, Iwashiro, Hitachi, Iwaki, Musashi, Rikuzen, Shinano, Shimôsa and Rikuchū; and 50–100 shocks were observed in Provinces Kadzusa, Shimotsuke, Mino, Sagami, Satsuma, Kōtsuke, Awa, Settsu, Kai, Ugo, Mutsu, Owari, Yamato, Higo, Hiuga, and Nemuro. The general distribution of earthquakes for this year was as follows : —

The eastern and southeastern coast of Honshū, in general, was quite disturbed. Especially the provinces surrounding the Bay of Tōkyō had much seismic disturbance. During this year at Tokyo there were observed 157 earthquakes which were 60 more than the average.

But most of their origins were situated in the south of Uraga Channel and a comparatively few originated in the Bay of Tokyo ; that is to say, about 30 shocks started off Miura Peninsula or Ōshima Island, and over 20 in the neighborhood of Miyake Island. Many of them were after shocks of the strong earthquake in November of this year which originated near Miyake Island. On the contrary, shocks which originated in the regions of Yokohama, Yokosuka and Haneda, were only 9 ; and 4 felt local shocks originated in the vicinity of Tōkyō. A few local shocks which were quite weak occurred along the coast of the Gulf of Sagami.

The region of seismic origins stretches from Ōshima Island to the boundary of Musashi and Shimôsa passing through the central part of the Bay of Tōkyō. Many shocks originate in this region. During this year seismic activity of this belt, was greater than in the normal year, thus increasing the number of earthquakes in Kwantō District.

Also of late, a belt of region spreading from Mito to Maokamachi in Province Shimotsuke offered many shocks. At Maokamachi 8 and in the neighborhood of Kasama and Ishizuka 12–13 shocks originated. But the earthquakes originated in these regions, in general, were not brisk in nature and their disturbed areas were limited.

As south-western portions of the Provinces Hitachi and Shimotsuke received not only shocks originated in the regions above mentioned, but also those which originated in the Bay of Tōkyō, more shocks were observed in the vicinity of Tsukubasan (A mountain at the south-western Hitachi) than on the coast of the province.

On the 12th of May a strong earthquake occurred in northern Rikuzen. Its shock was violent, and the damage caused by it was considerable.

Many aftershocks accompanied this earthquake, and more than 6 strong and 10 weak shocks came from off Kinkazan and therefore at the meteorological stations of Ishinomaki and Fukushima there were observed respectively 25 and 100 shocks more than the average. At Fukushima however, only one local earthquake was observed. If we compare the accompanying origin and frequency diagrams we will see that there exist some remarkable differences between these two regions, Fukushima and Ishinomaki.

On the coast of Rikuzen, over 40 local shocks originated in the districts Kesen and Higashiheii; also many shocks occurred in the adjacent sea basin. Since the Rikuchu sea, on the other hand, was more free from disturbances than in the normal year, on the eastern coast of Rikuchu and Mutsu the frequency dropped below under its average. At the meteorological station of Miyako, for example, its diminution was observed to be about 70.

In the present year many shocks also originated, under the Strait of Tsugaru. Therefore, the region which extends from northern Mutsu and Ugo as far as southern Oshima was abnormally devastated. The two cities Aomori and Akita were crossed by more shocks than the normal. Whilst eastern Ugo met only a few after shocks of the violent earthquake of the year 1896, all other disturbances were caused by the influence of remote origins. In Hokkaidō the seismic frequency was under the normal; on the coast of Nemuro, for example, its diminution was 20.

In this year the earthquakes which originated in land (except some portions of Shinano and Kōtsuke), were comparatively rare. The diminution of frequency in Shimotsuke, Uzen and Echigo was each over 10. On the other hand, at Matsumoto and Nagano it increased each over 40. Among them 13 shocks originated at Suzaka-machi in Takai county and 11 in the vicinity of Fukushima-machi in county Nishichikuma. From these results the two places appeared to possess independent seismic origins.

In the plain of Mino-Owari, after the great catastrophe of 1892, the frequency decreased year by year, but recently its diminution is becoming slow, that is, it was only 5 shocks less in this year than in the preceding year. But the origins were located in the same region, that is, the central portion of Owari. Especially 2 strong and 3 weak shocks originated at Neoya situated in the central portion of the province; and a few weak or slight shocks occurred at Ōno, Shimoakiu and in the prolonged line from Neoya.

The locality of Sabaye-machi in the province of Echizen was frequently disturbed

by the earthquake of May 22nd and its after shocks. These disturbances, however were not related to those which originated in the plain of Mino-Owari, and the after shocks had always limited devastated area. Even at Fukui (at a distance of 15 km) they were not felt. On the contrary, at Asukechō in Mikawa province (at a distance of about 140 km) 4 of them were observed there existing some geological relations. Also the linear or origin running in the SE–NW direction to the vicinity of Sobaramura in Ise province from the Chita Peninsula in province Owari offered many shocks, but all of them were either weak or slight.

In Kinai, the after shocks of the strong earthquake originated at Arima in the last year gradually declined. But in a tract comprising the Bay of Ōsaka from western Settsu over 20 weak or slight shocks occurred, also southern Tanba, including the vicinity of Kiōtō, offered over 10 shocks. Therefore, frequency at Ōsaka was 57, and that of Kiōtō, Okayama, Tadotsu, and Kōbe was respectively 12–13 above the normal. However, those which were felt at Okayama and Tadotsu were mostly nonlocal shocks, and only 5 or 6 earthquakes occurred in the Inland sea of Seto. And as their origins were scattered here and there their mutual relations could not be found, if any. But it was certain that a number of shocks originated at Niihama in Iyo Province. A region which encircles the boundaries of the three provinces, Bitchū, Bingo and Izumo, had abnormal frequencies of small shakings.

In Kiushū, the northern portion was normal while in the southern an increase of frequency was over 30. The origins were situated in the region extending from the north west point of the Gulf of Kagoshima, the boundary of the Provinces Hiuga and Higo. At Hanto in this region, were observed 21 slight shocks since the weak earthquake of August 4th. Also 18 local shocks originated on the southern coast of Satsuma or under the adjacent sea of the Yaku Island. The linear origin of this region runs parallel to the volcanic chain of Kirishima, and more or less shakings came from this belt in every year, especially the seismic source was active in this year. Again in the sea west of Satsuma over 10 shocks originated; some of these shocks severely devastated Koshiki Island and others the coast of western Satsuma.

Thus the position of the origin was not stationary, but it was found that disturbed areas elongated E–W wise in every case, that they seemed to be intersecting almost perpendicularly with the above mentioned origin. As Kagoshima is so situated to receive influences from the both origins, frequency and intensity were considerable. In detail, since the strong earthquake of May 28th, there were 3 weak and 50 slight shocks observed.

At Amamiōshima Island one out of 37 shocks which were felt originated in the adjacent sea, and some of them strongly threatened the southern Kiushū, but such cases

were quite rare. We can not yet find the relations between them and those from the vicinity of Yaku Island.

In the islands more south of the latter as the Yaeyama or Okinawa Islands, were only a few disturbances felt in this year as usual. Now coming to Formosa, the frequency was the greatest at Taihoku in this year though it was 25 shocks less than in the preceding year. At Tainan, the case was reverse, that is to say, it surpassed the same number. Since the Island had yet no station, the origins of the shocks could not be determined accurately. But it could be conceived from experience that the northern portion, in general, was mostly disturbed in the previous years while in this year, the case was quite different

Their epicentre was situated in the adjacent sea of the Pescadores Islands. Many local shocks also originated in the vicinity of Tainan, and moreover, the eastern sea of the Island was the seats of some seismic origins. Thus Tainan was the most frequented region in the Island. Many of them, however, were of nonfelt nature. Somewhat notable shakings were only 3 or 4 all over the Island.

The number of the local and nonlocal earthquakes observed at several meteorological stations, are given in the following table :—

Stations.	Total number.	Local shocks.			Non-local.	Non-felt.	A.	B.	C.	D.
		a.	b.	Total.	Shocks	Shocks.				
Kagoshima	78	63	7	70	8	22	91	87	28	48
Miyazaki	52	27	14	41	11	21	79	64	40	21
Kumamoto.....	54	35	1	36	18	34	67	67	63	60
Tadotsu.....	28	7	0	7	21	18	25	37	64	33
Ōsaka	65	34	3	37	28	53	57	72	82	70
Wakayama.....	28	17	0	17	11	10	61	74	36	32
Nagoya.....	45	18	1	19	26	31	42	61	69	65
Yokohama.....	93	21	12	33	60	43	35	33	46	42
Tokiō	157	58	6	64	93	106	40	28	67	62
Chōshi	39	14	8	22	17	23	56	41	59	66
Mito	181	59	22	81	100	93	45	58	51	45
Kanayama	49	14	7	21	28	15	43	32	31	9
Ishinomaki	118	58	27	85	33	69	72	74	58	50
Miyako.....	58	24	15	39	19	31	67	63	53	61
Yagi	44	21	1	22	22	32	50	43	73	48
Kioto.....	23	7	4	11	12	6	48	14	26	43
Hikone.....	30	3	4	7	23	17	23	36	57	68
Gifu.....	78	63	5	68	10	51	89	81	65	50
Iida	31	8	2	10	21	18	32	12	58	24
Kōfu	54	6	4	10	44	30	19	32	56	61
Matsumoto	118	79	2	81	37	104	69	49	88	83
Nagano	78	64	1	65	13	73	83	82	94	67

Mayebashi.....	50	27	0	27	23	44	54	22	88	66
Kumagaya.....	67	8	1	9	58	48	13	29	72	77
Utsunomiya	62	8	20	28	34	32	45	30	52	39
Fukushima	200	86	3	89	111	173	44	34	68	73
Fukui	45	21	1	22	23	27	49	41	60	62
Akita	50	17	0	17	33	36	34	58	72	45
Aomori	51	17	4	21	30	36	41	37	71	69
Nemuro.....	55	43	5	48	7	9	87	88	16	28

a. Number of earthquake which were observed at only one meteorological station.

b. Number of earthquakes which were observed at a meteorological station, nearest to the epicentre.

A. Percentage of local shocks.

B. Average of local shocks.

C. Percentage of nonfelt shocks.

D. Average of nonfelt shocks.

From the above table it may be seem that Kagoshima was most frequently visited by local shocks, the percentage being 91 %. Nemuro and Gifu were next each being 81 %. On the other hand, at Kumagaya were observed only 13 % local shocks, and at Kofu 19 %.

As already mentioned, Kagoshima was visited by shocks originated from two different seismic sources. Also Gifu suffered from the shocks which originated at Neoya or in the region along the Kisogawa. There existed a remarkable difference in the frequences of this place and of Nagoya where was observed 42 % of local shocks. Although many shocks were observed at Nemuro which came from the sea off the eastern coast, the region, in fact, was not very near to their origins.

The small percentage of Kumagaya and Kōfu might be ascribed to the rareness of the occurrence of strong earthquakes in their neighborhoods.

Nonfelt earthquakes were mostly observed at Nagano, the percentage being 94 %, Matsumoto and Mayebashi were next each being 88 %. At Nemuro, the percentage was the smallest, being 16 %. (At the Fukuoka meteorological station, 292 disturbances were observed, but as the frequency was entirely abnormal they were omitted in the table and the accompanying plate of the seismic frequency).

HOURLY DISTRIBUTION OF EARTHQUAKES.

The following table contains the hourly distribution of 1888 shocks for this year.

Time. \ Month.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total.	Average.
0–1 a. m.	4	4	10	9	5	4	3	2	4	3	4	5	57	51,5
1–2 ,, ...	3	5	9	9	11	5	6	7	5	7	7	12	86	54,4
2–3 ,, ...	10	8	5	7	25	1	6	7	7	2	6	4	88	61,8
3–4 ,, ...	4	8	5	12	18	3	2	6	5	8	6	9	86	58,6
4–5 ,, ...	5	8	7	8	18	3	5	1	5	8	6	2	76	55,3
5–6 ,, ...	11	5	4	12	6	5	4	8	1	8	7	5	76	61,8
6–7 ,, ...	4	5	4	11	14	5	3	9	4	6	13	4	82	58,9
7–8 ,, ...	6	5	8	5	11	4	6	3	7	2	6	2	65	53,3
8–9 ,, ...	3	3	12	4	6	4	7	7	5	6	4	5	66	56,2
9–10 ,, ...	0	3	8	9	12	5	8	3	8	5	7	7	75	59,5
10–11 ,, ...	5	7	7	11	14	6	7	5	3	12	3	9	89	56.3
11–12 ,, ...	8	13	7	4	10	10	8	8	6	3	8	7	92	56,5
0–1 p. m.	6	3	3	7	6	5	4	1	6	2	6	6	55	52,8
1–2 ,, ...	4	7	7	8	6	3	3	5	8	3	7	12	73	62,5
2–3 ,, ...	5	7	7	8	3	7	4	5	5	8	3	9	71	61,7
3–4 ,, ...	4	4	11	14	13	7	3	7	3	6	11	9	92	57,0
4–5 ,, ...	9	6	9	11	10	7	6	10	6	7	3	8	92	55,4
5–6 ,, ...	8	11	11	11	16	5	8	7	3	6	9	1	96	59,2
6–7 ,, ...	8	11	8	12	12	5	2	3	5	4	6	4	80	59,0
7–8 ,, ...	5	9	8	5	12	7	11	4	1	6	10	6	84	61,8
8–9 ,, ...	5	7	3	4	12	6	5	5	5	8	8	4	72	65,5
9–10 ,, ...	5	6	6	7	12	7	3	2	6	5	15	6	80	69,6
10–11 ,, ...	7	6	7	3	10	9	6	3	2	4	10	5	72	64,2
11–12 ,, ...	10	9	5	15	9	2	8	4	4	2	7	8	83	58,0
Total.....	139	160	171	206	271	125	128	122	114	131	172	149	1,888	1,410,8
Average ...	135,9	98,2	125,1	111.7	104,5	95,7	85,4	117,1	121,7	101,6	187,3	126,7	1410,9	117,6

Thus it is seen that earthquakes were most frequent between 5–6 p.m. (96 times) the next being between 11 a.m.–noon, between 3–4 p.m. and also between 4–5 p.m. (each 92 times); while shocks were least between 0–1 p.m. (55 times), the next being 0–1 a.m (57 times). There were 12 more shocks in afternoon than in morning. If we take 6 o'clock as the boundary between day and night, 8 more shocks were observed during daytime than during night.

AREA OF SEISMIC DISTURBANCE.

During this year, seismic energy was not strong in general, with an exception of the strong shocks which originated in the adjacent seas of Miyake Island or Etorō. Shocks which had the major axes of the disturbed area stretching over 1200 km occurred only 4 times. But many shocks originated in land or the Inland seas, hence

the total area of devastated land was more extensive than in the normal year, amounting 9,721,600 sq. km. Of this, 168,960 sq. km was violently shaken and 152,240 sq. km only slightly. The earthquake which had the greatest disturbed area occurred on the 25th of December which originated in the sea south east of the coast of Nemuro, devastating 210,720 sq. km. The next was the shock of August 29th which occurred in the Strait of Tsugaru (or Sangar Strait), and was felt over an area of 202,880 sq. km.

The shocks which disturbed more than 20,000 sq. km are given in the following table:—

Date.	Time of occur.	Epicentre.	Axes of disturbed area.		Strong and violent part.	Weak part.	Slight part.	Total area.
			Major.	Miner.				
	h m		km	km	km²	km²	km²	km²
Jan. 1	8.57 a.m.	Off Mutsu.	600	400	—	4,000	28,800	32,800
,, 5	5.48 a.m.	Hiuga sea.	400	240	—	5,440	26,080	31,520
,, 5	11.16 a.m.	Northern Ōsumi.	320	200	—	6,600	29,280	36,480
,, 12	3.03 p.m.	Kumanoura.	320	240	—	2,720	26,080	28,800
,, 13	1.20 a.m.	Kumanoura.	480	360	—	6,400	31,200	37,600
,, 17	0.14 a.m.	Northern Kai.	600	360	10,560	26,500	64,320	101,380
,, 17	5.31 a.m.	Northern Rikuzen.	520	160	—	2,400	28,000	30,400
,, 18	4.46 p.m.	Off Etorō I.	1,400	600	2,240	12,800	60,800	75,840
,, 31	2.38 a.m.	Off Izu.	720	680	320	8,000	51,680	60,000
Feb. 1	4.22 a.m.	Mutsu sea.	1,000	600	2,560	18,560	52,960	74,080
,, 2	11.01 a.m.	Central Hiuga.	360	240	—	5,720	28,800	34,520
,, 2	5.02 p.m.	do.	400	320	—	16,000	20,000	36,000
,, 2	11.10 p.m.	Kitan channel.	280	140	960	10,240	21,280	32,480
,, 3	7.08 p.m.	Northern Rikuzen.	320	120	—	960	22,240	23,200
,, 13	1.28 p.m.	Rikuchū sea.	1,200	720	—	19,680	71,360	91,040
,, 16	10.53 a.m.	Off Chōshi.	560	320	3,680	24,800	74,720	103,200
March 4	11.58 a.m.	Ashio.	440	240	—	5,280	35,840	41,120
,, 4	4.46 p.m.	Iwaki sea.	440	240	—	5,280	35,840	41,120
,, 10	9.19 p.m.	Rikuchū sea.	400	280	—	7,200	24,800	32,000
,, 12	10.34 a.m.	Off Kinkazan.	920	480	9,920	58,400	61,920	130,240
,, 12	7.55 p.m.	Rikuchū sea.	800	520	—	16,480	40,640	57,120
,, 13	10.90 a.m.	Rikuzen.	800	400	3,360	15,040	70,080	88,480
,, 15	6.22 p.m.	Bay of Tokyo.	400	320	—	2,400	36,000	38,400
,, 16	10.20 p.m.	Uraga channel.	440	240	1,120	6,720	64.800	72,640
,, 17	1.39 p.m.	Mutsu sea.	880	520	2,240	19,680	74,560	96,480

Date.	Time of occur.	Epicentre.	Axes of disturbed area.		Strong and violent part.	Weak part.	Slight part.	Total area.
			Major.	Miner.				
	a.m.		km	km	km²	km²	km²	km²
March 21	10.04 p.m.	Off Tokachi.	720	320	—	8,320	26,400	34,720
,, 22	0.55 a.m.	Sabaechō.	800	480	4,160	35,200	88,640	128,000
,, 23	3.36 a.m.	Morioka.	440	240	—	12,800	31,520	44,320
,, 26	5,32 p.m.	Off Chōshi.	400	240	—	2,720	33,760	36,480
,, 26	8.52 p.m.	Bay of Tokyo.	400	200	—	2,080	32,160	34,240
,, 29	4.40 p.m.	Sakashitachō in Iwashiro.	400	280	1,280	11,040	54,880	67,200
April 1	6.34 p.m.	Kōriyama in Iwashiro.	280	120	—	4,160	19,560	22,720
,, 15	7.51 a.m.	Hitachi sea.	520	440	—	13,920	70,080	84,000
,, 16	7.12 p.m.	Rikuchū sea.	640	560	—	15,200	38,720	53,920
May 4	1.13 p.m.	Iwami sea.	480	240	—	10,240	50,560	60.800
,, 5	9.22 a.m.	Utsunomiya.	320	160	—	6,720	22,080	28,800
,, 12	2.25 a.m.	Northern Rikuzen.	1,360	720	41,600	75,200	81,600	198,400
,, 12	11.39 a.m.	do.	710	400	—	4,640	57,440	62.080
,, 15	7.13 a.m.	Northern Kai.	480	360	1,600	22,080	57,760	81,440
,, 15	8.20 p.m.	Off Tainan.	680	uncertain.	—	6,400	29,920	36,320
,, 21	8.29 a.m.	Sagami sea.	240	200	640	8,000	25,600	34,240
,, 22	1.22 p.m.	Shiriya cape, Mutsu.	720	480	—	4.160	47,360	51,520
,, 31	5.43 p.m.	Neoya in Mino.	400	280	3,040	22,560	62,400	88.000
June 1	6.38 a.m.	do.	320	240	1,600	10,080	44,480	56.160
,, 8	5.24 p.m.	Off Tokachi.	1,000	800	800	23,200	57,600	81,600
,, 9	9.11 p.m.	Satsuma sea.	680	280	—	19,200	21,120	40,320
,, 10	7.29 p.m.	Northern western Hitachi.	240	200	—	2,560	21,440	24,000
,, 25	3.47 p.m.	Uraga channel.	560	320	1,120	17,600	46,640	43,520
,, 26	6.58 p.m.	Out of the G. of Sagami.	640	280	—	2,880	32,800	35,680
July 8	11.47 p.m.	Hitachi sea.	520	400	3,360	21,600	46,720	71,680
,, 10	11.44 p.m.	Northern Shimoosa.	360	240	—	10,560	31,520	42,080
,, 16	5.33 p.m.	Kajima sea.	360	280	—	5,120	31,200	36,320
,, 24	9.53 a.m.	Kumanoura.	560	280	—	8,000	34,880	42,880
,, 25	1.08 a.m.	Bay of Owari.	520	320	—	14,720	62,580	77,280
Aug. 5	1.21 p.m.	Iwaki sea.	1,000	800	12,320	80,960	85,120	178,400
,, 5	5.45 p.m.	Strait of Hōyo.	360	160	—	5,760	38,240	44.000
,, 16	2.33 a.m.	Eastern Harima.	320	120	1,600	9.280	26,240	37,120
,, 27	3.01 p.m.	Totsukachō in Sagami.	280	240	2,560	9,760	27,840	40,160
,, 29	11.32 a.m.	Tsugaru strait.	1,600	1,000	23,520	87,520	91,840	202,880

				km	km	km²	km²	km²	km²
Sep.	4	3.03 a.m.	Northern Mino.	280	200	—	11,200	27,040	38,240
,,	15	1.19 p.m.	Off Mishima, Nagato.	800	560	1,760	33,600	76,000	111,360
,,	20	3.23 a.m.	Suō sea.	400	280	—	28,320	39,360	67,680
;	24	0.31 a.m.	Off Rikuchū.	800	640	—	24,040	78,080	102,120
Oct.	3	3 19 a.m.	Out of the Uraga channel.	600	320	—	17,920	67,360	85,280
,,	5	4.17 a.m.	Off Shima.	480	280	—	8,000	27,040	35,040
,,	12	4.04 a.m.	Mitachō in Settsu.	400	160	—	2,400	24,000	26,400
,,	16	0.26 p.m.	Off Kinkazan.	560	240	640	10,080	47,040	57,760
,,	17	8.16 p.m.	Hiuga sea.	520	360	—	16,800	46,420	63,040
,,	19	11.48 a.m.	Kōriyama in Iwashiro.	280	120	—	4,800	16,000	20,800
,,	27	2 46 a.m.	Off Kinkazan.	440	240	320	3,360	25,120	28,800
,,	29	6.35 a.m.	Northern Mikawa.	200	160	—	960	22,240	23,200
Nov.	2	3.04 p.m.	Mutsu sea.	800	320	—	4,480	76,320	80,800
,,	5	2.10 p.m.	Off Oshima.	520	320	—	1,600	43,200	44,800
,,	5	4.42 p.m.	Off Miyake I.	800	560	4,800	19,040	76,160	100,000
,,	5	5.19 p.m.	do.	800	520	160	3,040	69,760	72,960
,,	5	7.39 p.m.	Izu sea.	520	360	—	800	23,200	24,000
,,	6	6.14 p.m.	Off Awa.	480	320	—	1,920	62,880	64,800
,,	7	1.14 a.m.	Boundary of Bitchū & Bingo.	220	200	1,280	11,680	16,960	29,920
,,	10	2.55 a.m.	Iwaki sea.	720	560	1,920	47,520	75,680	125,120
,,	15	6.38 a.m.	Off Hitachi.	1.200	800	—	27,680	124,800	152,480
,,	15	8.06 a.m.	Off Kazusa.	280	160	—	1,600	28,800	30,400
,,	19	4.40 a.m.	Northern Yamato.	520	280	1,760	12,640	29,120	43,520
,,	19	10 59 p.m.	Izu sea.	520	320	—	800	50,460	51,200
,,	24	5.02 p.m.	Southern off Kunishiri I.	1,400	800	—	4,800	35,200	40,000
,,	24	9.04 p.m.	Hōyo channel.	440	240	—	10,400	29,600	40,000
,,	27	9.16 p.m.	Kyōtō.	560	360	3,040	28,000	51,680	82,720
Dec.	4	2.14 a.m.	Hōyo channel.	240	120	—	2,400	18,400	20,080
,,	5	1.15 p.m.	North eastern Mino.	280	200	—	13,280	24,000	37,280
,,	6	2.02 p.m.	Rikuzen sea.	680	360	—	10,720	79,040	89,760
,,	25	2.09 p.m.	South eastern Nemuro.	1,800	1,200	12,000	111,360	87,360	210,720
,,	31	5.40 p.m.	Rikuzen sea.	400	320	—	5,120	32,000	37,120

Thus it can be seen that in 4 cases the area exceeded 150,000 sq. km., in 8 cases it was 100,100 and 150,000 sq. km, and in 30 cases 50,000 and 100,000 sq. km.

INTENSITY OF SHOCKS.

In this year, south-eastern Rikuzen suffered from the strongest shocks amounting to 5 times; next, northern Iwaki and the eastern coast of Mutsu, had each 4 strong shocks. It was also observed that there were 3 each on the coast of Hitachi, the north-eastern coast of Mutsu, the Peninsula of Miura and south-eastern Rikuchū. On the other hand, no marked disturbance originated in the area extending from Kiushū and Shikoku to Formosa.

Of 1,888 shocks during this year, 45 were either violent or strong, 200 weak and the remaining 1,643 slight (As there is yet no fixed standard to determine seismic intensity our classification may be to some extent arbitrary. We have, however, assumed that a shock was strong or weak, when it was coincidently so reported from two or more stations, and its disturbed area can be closely known. If only a single report was obtained as strong or weak, then it was classified into the next class. But a slight or weak shock which was felt over the area of more than 16,000 sq. km or 80,000 sq. km respectively, was classified into the higher intense type).

Taking in percentage, 2,4 % was either violent or strong, 10,6 % weak and the remaining 87 % slight.

The monthy distribution of these shocks is as follows :—

Month. / Intensity.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total.
Violent or strong....	4	7	8	1	8	3	2	4	1	3	6	1	48
Weak.	18	15	25	13	23	19	15	12	11	10	21	15	197
Slight.	117	138	138	192	240	103	111	106	102	118	145	133	1,643
Total.....	139	160	171	206	271	125	128	122	114	131	172	146	1,888

Thus violent or strong shocks were most frequent in March and May, occurring 8 times each, while weak shocks were most felt in March (25) and weaker ones in May (23). The marked increase of frequencies, in these months might be due to the strong earthquake of Sabaechō in Echizen on March 22nd and the violent shock of northern Rikuzen on May 12th, and their many aftershocks. Especially in May the total number of disturbances was 271.

Strong shocks were observed at the following stations :—

Ishinomaki and Yokohama (4 times at each), Mito and Kanayama (3 times at each), Miyako, Aomori and Tokachi (twice at each), Kiōto, Kōfu, Nagatsuro, Kumagaya, Mera, Fukushima, Yamagata, Akita, Wajima, Niigata, Ōshima, Kagoshima, Hakodate and Kushiro (once at each).

Weak shocks were felt at Ishinomaki (17 times), Yokohama and Hakodate (16 times at each), Chōshi (13 times), Mito and Tōkiō (12 times at each), Utsunomiya (11 times) and Mera (10 times).

Notable shocks in this year were the violent earthquake of the northern part of Rikuzen on May 12th, and the strong shocks, that occurred off the Island of Miyake on November 5th, at Sabaechō in the province of Echizen on March 22nd, off the coast of Nemuro on December 25th, in the Strait of Tsugaru on August 29th, off Kinkazan on March 12th, at Neoya in the province of Mino on May 31st, at Kōfu in the province of Kai on January 17th, in the Iwaki Sea on August 5th, in the Izu Sea on November 10th, at Kyōto on November 27th, off Mishima in the province of Nagato on September 15th.

DESCRIPTIONS OF SPECIAL EARTHQUAKES.

We shall now give here general accounts of some of the most striking earthquakes during 1900.

Earthquake of January 17th, 0^h 14^m a.m. (See Pl. III. No. 1).

This was a strong earthquake originated in the vicinity of Kōfu in the province of Kai. Near the epicentre clocks stopped, and articles were shaken down from shelves, but no building was not damaged. The total area of disturbance was 101,440 sq. km., having the longest and shortest axis of 400 km and 360 km respectively. The regions which were strongly shaken were northwestern Kai and southeastern Shinano forming an irregular egg-shape, and the area was 10,560 sq. km. Slight shocks were felt in the region extending to the middle portions of provinces Echigo and Iwashiro on the northeast, and Tsu in the province of Ise on the west

This earthquake was one of the after shocks of the earthquake on April 3rd, 1898, originated at Mutsuai-mura (about 52 km., south of Kōfu) having the linear origin in the direction NE–SW. The most devastated region in 1898, was the southern portion of this province, while in this year, the shock occurred in the opposite portion. Therefore, at the meteorological station of Hamamatsu in the province of Tōtōmi, even a slight shock was not felt, although in the previous year this region was severely disturbed.

The most damaged region by this earthquake was Yokone in Toyooka-mura Minamikoma county. There were felt severe vertical shocks, and most of articles were shaken down from shelves. The village was at about the southern boundary of the epicentre. (In the previous year (1898) this village was also situated in the most disturbed area at the northern limit of the epicentre. On that occasion many fissures were produced on the ground and many houses were injured; and at Kajikazawa (about 20 km, south of Kōfu), many clock pendulums stopped.)

Northwards from this place the intensity rapidly declined, therefore at the boundary of the provinces of Kai and Shinano only slight shocks were felt.

Kōfu.—Houses were violently shaken, but nothing was damaged.

The following table gives the results of instrumental observation at several stations :—

Stations.	Time of commencement.	Duration.	M. Horizontal Motion.				M. Vertical Motion.			Intensity.	Remarks.
			Direction.	Period.	Range.	Time from beginning.	Period.	Range.	Time from beginning.		
	h. m. s.	m. s.		s.	mm.	s.					
Kōfu.....	0 14 14 a.m.	1 18	WNW-ESE	0.7	0.9	2	—	—	—	Strong. (rather weak.)	
Iida.....	0 12 25 a.m.	1 0	SW-NE	1.9	1.3	—	0.8	0.8	—	Weak. (rather weak.)	Accompanied no sound.
Takayama.	0 15 0 a.m.	0 20	S-N	uncertain.	0.2	—	—	—	—	,,	,,
Matsumoto	0 12 48 a.m.	1 14	WNW-ESE	0.9	1.3	—	—	—	—	Slight.	—
Tokyo.....	0 14 11 a.m.	2 25	ENE-WSW	0.5	0.7	—	0.4	0.2	—	,,	—

Earthquake of March 12th, 10^h 34^m a.m. (See pl. III. No. 2).

This earthquake occurred off Kinkazan. The total disturbed area was 120,240 sq. km., the major and minor axes being 920 km, and 480 km respectively. The regions in which most violent shocks were felt were the whole of the province of Rikuzen and some portions of provinces of Iwaki and Rikuchū, covering an area of 9,920 sq. km. The isoseismal area of 61,920 sq. km. in which slight shocks were observed extended to the middle of Sado Island on the north, and its western portion was limited by a line passing through the eastern portions of the provinces of Echigo and Shinano and Suruga Bay.

Earthquakes which were felt at Ishinomaki previously, had always their origin either in the bay of Ishinomaki or in northern Rikuzen, and covered great areas. But the epicentre of this earthquake was located at the sea-bed 40 km east of Ojika Peninsula.

On the pacific coast of Rikuzen severe shocks were very rarely felt. At the light house of Kinkazan the clock stopped, but nothing else was damaged. At Ishinomaki, shocks were brisk and many fractures were produced in the walls of warehouses. From this fact it is apparent that the origin seemed to have been situated on the shore and Ishinomaki was nearest to it.

A French steamer reported that she was alarmed by the sudden vertical shocks about 10^h 36^m a.m. at sea about 50 km off in the direction N 63° E from Kinkazan Island. As it is not a rare case that by sailing ships an earthquake is felt, we cannot of course, hastily assume that the place is the epicentre.

It is no doubt, however, that the above mentioned sea surface was more disturbed than any other places on land. From the instrumental observations of the direction of the maximum horizontal motion at the meteorological stations of Miyako and Ishinomaki, and also from the shape of the isoseismal area in which strong shocks were felt, we may assume that this earthquake originated beneath the sea-basin of Ishinomaki Tiles fell down from roofs, walls of houses were fractured by the shocks. At Kakuta and Nagamachi in the neighbonrhood of the place, clock pendulums were stopped and liquid splashed out of buckets.

Miyako.—During the severest vibrations, the needle of the instrument ran out of the mercury cup.

Results of the instrumental observation at several stations are given in the following table :—

Station.	Time of commencement.	Duration.	M. Horizontal Motion.				M. Vertical Motion.			Intensity.	Remarks.
			Direction.	Period.	Range.	Time from beginning.	Period.	Range.	Time from beginning		
	h. m. s.	m. s.		s.	mm.	s.	s.	mm.	s.		
Ishinomaki	10 33 46 a.m.	3 0	NW-SE	uncertain.	9.2	—	uncertain.	1.9	—	Strong.	Slow, tiles did down from roof, walls fractured.
Miyako ...	10 34 30 a.m.	2 03	NE-SW	2.6	4.7	10	0.9	1.4	14	Strong. (rather weak.)	—
Fukushima	10 35 21 a.m.	1 14	NW-SE	0.6	6.5	—	0.4	5.0	—	Weak.	—
Yamagata .	10 35 0 a.m.	0 50	NW-SE	2.0	1.8	—	—	—	—	,,	Door etc cracked.
Kōfu	10 35 30 a.m.	3 19	SE-NW	0.8	0.4	—	—	—	—	,,	—
Yokohama.	10 35 32 a.m.	4 12	NNW-SSE	1.4	2.7	—	—	—	—	,,	Slow.
Akita.....	10 34 36 a.m.	4 01	NW-SE	1.5	5.4	—	0.5	0.5	—	Weak. (rather slight.)	Brisk.
Mito.....	10 34 57 a.m.	2 47	SSE-NNW	1.0	0.7	—	0.8	0.2	—	,,	Slow.
Nagano	10 35 26 a.m.	2 33	NE-SW	1.3	1.2	—	—	—	—	Slight. (non felt.)	,,
Mayebashi	10 36 47 a.m.	2 40	S-N	1.0	0.5	—	—	—	—	,,	,,

Earthquake of March 22nd, 0^{h} 55^{m} a.m. (See pl III. No. 3)

This was a strong earthquake which originated in the vicinity of Sabaechō in Echizen. The total land area of the disturbance was 108,000 sq. km, the longest and shortest axes being respectively 800 km and 480 km. The most severely devastated region was two counties, Imadachi and Nibu, in the province, and also in

the western portion of the same province and eastern Wakasa, covering a total area of 4,160 sq. km. Slightly disturbed area extended as far as Southern Shinano and Mito on the east, Bingo and Tajima on the west and Kaga on the north, the Inland Sea of Seto forming the southern boundary.

Sabayechō.—The shock began at $0^h\ 54^m\ 30^s$ a.m. At first, tremendous sounds were heard in the south-west and then were followed by both intense horizontal and vertical motions. But the intensity very rapidly declined. As the shocks were very brisk damage was rather considerable, in spite of the short duration. Numbers of houses and ware houses were destructed, and demolitions of stone-walls and embankments were numerous. Six persons were wounded. The devastated area was limited within a few kilometre along Hino River Nibu county. The damage in this county was next to that of Sabayechō. Especially at Yoshida, a house was partly and a store house entirely destructed. Walls of a ware house were fractured, articles in the rooms were totaly demolished, and liquer at breweries was splashed out of buckets. But destructions of stone-walls, roads, and embankments were almost limited within the low swampy region neighboring Inadachi county.

Takeochō, Nanjō County.—This small town is situated at 4 km south of Sabayechō. Only a few clock pendulums were stopped here and nothing else was damaged. Thus the disturbed area was very limited, that is to say, this earthquake was local. After-shocks were observed at the following places :—

Sabayechō.—After the initial shock there were observed two strong shakings in a few minutes, and 7 of weak or slight shocks until sunrise.

Yoshida.—The initial shock was followed by 5 strong and 40 weak shocks, but slight shocks occurring continuously, could not be accurately determined. Even after a few days, notable sounds were occasionally heard on the east and many slight shakings were felt.

Takeochō.—4 weak and 10 slight shocks were observed.

Ōnomachi, Ono County.—3 slight shocks were felt and earth sound was heard once.

Fukui.—No after-shock was observed. The damage in Fukui Prefecture was sa follows :—

Totally destructed houses	2
Partly destructed houses	10
Injured houses	488
Totally destructed warehouse	1
Injured ware houses	24
Damaged stone-walls	98
Overturned gravestones, Torii, stone lanterns	33

Fissures on farms and rice fields	4
Fissures on roads	6
(Total length).....	41.2 m.
Injured embankments	2
(Their total length)	171 0 m.
Fissures in Embankment	30
(Total length).....	11.0
Landslip of mountain	1
Other damaged places	69

This earthquake had the same nature with the disturbances which had frequently occurred in the central portion of the province of Echizen. As a rule they had been slightly felt on the plain of Owari-Mino; while this earthquake severely disturbed the plain; even in southern Mino, slight shocks were observed. At Asukechō in the province of Mikawa, 4 after shocks were recorded, although no such records were obtained at places near the epicentre, as Gifu and Nagoya, and even at Fukui nearest to the epicentre Though this fact might be closely related to the geological formation, we can think that there existed some relations between this earthquake and the fault line which had been caused by the great devastation of 1892 and which passed through the vicinity of Asukechō.

The next table gives results of the instrumental observation at several stations :—

Station.	Time of commencement.	Duration.	Maximum H. Motion.				Max. Vertical Motion.			Intensity.	Remarks.
			Direction.	Period.	Range.	Time from beginning.	Period.	Range.	Time from beginning.		
	h. m. s.	m. s.		s.	mm.		s.	mm.			
Fukui.....	0 54 37 a.m.	1 20	S-N	1.2	26.1	—	0.3	3.0	—	Weak.	Clock. stopped.
Kiōtō	0 55 30 a.m.	1 19	E-W	0.7	0.4	—	0.4	0.1	—	Weak (rather slight.)	Slow.
Yagi	0 56 17 a.m.	0 37	NE-SW	1.0	0.8	—	—	—	—	,,	—
Kanazawa.	0 58 50 a.m.	2 04	S-N	1.0	1.7	—	—	—	—	Slight. (non felt.)	—
Nagano	1 0 22 a.m.	1 06	WNW-ESE	1.2	4.4	—	—	—	—	,,	—

Earthquake of May 12th, 2^h 32^m a.m. (See pl. III. No. 4)

This earthquake originated in northern Rikuzen.—Its total disturbed land area extended over 210,800 sq. km. that is, about a half area of the whole Japan. Its major and minor axes were respectively 1360 km, and of 20 km. The most disturbed regions were the provinces of Rikuzen, Rikuchū, Iwaki, eastern Iwashiro, north

eastern Uzen, southern Ugo, southern Mutsu and north-eastern Hitachi covering an area of 41,600 sq. km. The land comprising 4,000 sq. km was more or less damaged.

As the isoseismal area in which slight shocks were felt extended as far as Kinai on the west and the central portion of Hokkaido on the north, thus covering 81,600 sq. km. The Province of Rikuzen, since ancient times, was one of the most frequentlv disturbed region in Japan. Recently, however, the activity has declined, and such as the earthquake of 1897 and this one were rarely observed in the region.

If we compare these two shocks, we may see that the epicentre of the present earthquake was in the neighbourhood of Koushida-mura in Tōda county, while that of the previous year was in the vicinity of Sendai. The details of this earthquake are given in the following pages :—

Time of commencement.

Since this earthquake was of brisk nature from its beginning exhibiting a few prominent vibrations, the time of its occurrence could be easily determined ; but in fact, there existed an extra-ordinary disagreement on the times of commencement observed at several stations which we could not comprehend. The following may be believed as trustworthy

Ishinomaki	2^h	23^m	10^s	a.m.
Kanayama	2	23	38	,,
Mayebashi	2	24	17	,,
Gifu	2	25	9	,,
Nagoya	2	25	15	,,
Fukushima	2	23	38	,,
Tōkiō	2	24	10	,,
Yokohama	2	24	28	,,
Aomori	2	25	10	,,
Tsu	2	25	28	,,

If we assume that the epicentre was situated in the vicinity of Ishinomaki, we have 4.3 km/see. as the mean velocity of the propagasion of the seismic wave computing from differences between the times of occurrence at different stations.

Direction of the maximum horizontal motion

Although the direction of the displacement of bodies on the ground, in general, is related to that of the origin of shocks from the position of the body, there are some cases which were rather controlled by the topographical features. By this shock we can determined the direction of the motion either by that of convulsion of

liquids or of displacement of houses or of overturn of gravestones, stone-walls, chimneys. But surrounding conditions should be fully investigated.

For example, if a grave stone rests on a quite horizontal foundation it will take a strong seismic intensity to overturn it. Many grave stones overturned by this earthquake were somewhat inclined, or had some defects with them. Moreover, cross sections of many gravestones were not square, and therefore they had more tendency to turn in the one direction than in the other. In such a case, it is the easiest and the most convenient to determine the direction of motion by that of convulsion of liquid. We examined this at 46 places and reached a satisfactory result. We must not, however, decide the intensity of a shock by the amount of liquid which was splashed out ; because it measures more quantity by the vibration of a large range and slow nature than by that of a small range and brisk nature. As this shock had brisk nature and a short duration, the amount of liquid splashed out was comparatively small.

At Kitaura in Tōda county, a Shōyu (a kind of sauce) manufacturer built up two brick chimneys, one in 1897 and the other in 1899. They were injured by the shock. The areas of the top and the base of the former were about .65 and 1.2 sq. km. respectively and the thickness of the top measured were .7 of the breadth of a brick and that of the base 1.5 of it. The height measured about 13 metres, and the underground work was 1.2 metres. The upper portion as far down as 2.4 metres from the top was broken down by the shock and overturned westward. The remaining portion received many fissures. The cement was not good, so that every piece of bricks could be separated along their faces and pieces themselves were perfect. The second chimney had a top and base of about .91 and 1.8 square metres respectively with thickness of 1 and 2 bricks breadths respectively. The height was 18,5 metre. The foundation was concreted at the depth of 1.5 metres. Its upper portion measuring some 4.5 metres fell down, facing E 10° N, and it destroyed the roof of a store-house. In this house was stored some backets which measured 1.8 metre in height and diameter, and which were filled up with the raw material of shoyu. By brisk shocks, the liquid was splashed out either eastward or westward. But other tumbled objects did not show any definite direction. As we could not find the meridional displacement of any house which had solid foundations, the motion of the ground seemed to have been east-west wise.

Wakayagichō.—A brick chimney which was 10 metres high, with a top and base of .8 and 1.3 square metres respectively, was broken down from its middle facing to N 40° W.

Another was about 9 metres high, its top and base measuring respectively .5 and 1 square metre. This one was broken off at about 5 metres above the ground, and the broken portion was displaced about 6 centimetres, facing to N 10° W. Moreover cement was disjointed at the lower portion in .3 metres from this fracture, and that portion also turned towards the same direction. We examined 6 overturned stone lanterns having solid foundations, and we found that N 50° W was the mean direction of the motion of the ground. This agreed with the direction of convulsion of liquid.

Koushida, Tōda County.—Many store-houses of corns which were built up with thick boards and solid foundations were a few centimetres displaced. As this village is a low swampy place lying along the Eaigawa, and has a special topographical feature, the direction of shock was quite regular, being SE–NW.

The following table gives the determinations of the direction of motion at several places :—

County.	Town, Village &c.	Direction of Motion.	County.	Town, Village &c.	Direction of Motion.
Shida.	Matsuyama-chō.	N 75°E–S 75° W	Tome.	Yoneyama.	N 70° W–S 70° E
,,	Furukawa-cho.	N 80°E–S 80° W	,,	Hirawaku.	N 70° W–S 70° E
,,	Noda-mura.	N 55°W–S 55° E	Kuribara.	Wakayagi-chō.	N 50° W–S 50° E
,,	Aou-mura.	N 50°E–S 50° W	Momou.	Terasaki.	E–W
Tōda.	Kitaura.	N 85°W–S 85°E	,,	Nobiru.	N 70° W–S 70° E
,,	Koushida.	N 70°W–S 80° E	Miyagi.	Shikamata.	N 70° E–S 70° W
,,	Minami-Koushida.	N 80°W–S 80° E	,,	Shiogama-chō.	N 60° E–S 60° W
,,	Wakiya-chō.	E–W	,,	Sendai.	NW–SE
Tome.	Sanuma-chō.	N 10°W–S 10° E	,,	Ishinomaki.	N 60° W–S 60° E
Nishiiwai.	Ichinoseki-chō.	N80° W–S 80° E	Ojika.		

Nature of the shock.

This earthquake was one with brisk nature, exhibiting only horizontal motion Even at the villages of Koushida and Yoneyama where many houses were destroyed the vertical motion was felt very slightly. So the calamities were due to the horizontal shaking with large amplitudes. By examinations of the damage we found that even houses which were thatched with reeds and were comparatively heavy on their upper parts suffered a little damage and only few overturned entirely. The chief damage consisted of break-down of pillars and declination toward either front or rear and right or left. All of totally destructed houses were roughly built.

At the most disturbed regions, as Koushida, Matsuyamachō, etc., the total range of the maximum horizontal motion reached about 10 mm The duration was observed

to have been 7–8 minutes at distant places, while in the neighbourhood of the epicentre, it was only 3 minutes or less. Before shocks at many places, rumbling sounds were heard from beneath the ground, also after the initial shock slight ones and sounds occurred intermittingly. Especially at the flank of Sobayama in Momou county, 63 after shocks were felt until 7 o'clock a.m.

The area in which rumbling sounds were heard formed a ellipse elongating meridionally, and it extended over Morioka on the north, Taira on the west and Shinjō on the west. It covered about 28,800 sq. km.

Features of damage.

Next, we will give some accounts of the damage.

Matsuyamachō, Shida County.—There were felt brisk horizontal shocks with tremendous sounds at about half past 2 o'clock in the morning. Walls of some warehouses were peeled off, some old houses partly destructed, and even houses which were built on solid foundations were 6 centimetres displaced in the S 10° E direction. In the buddhist temple of Sekiunji, frames were bent, and many gravestones were over turned. Six of them which measured 7.9 cm. in height and 8.5 sq. cm. in cross section were about 0.7 cm. displaced towards S 80° W. As the southern part of the town lies along hill sides the damages were comparatively small.

Noda-mura.—This was a small village along the south bank of the Naruse river, having only 7 houses. Here 6 houses were injured, their pillars were broken off and walls peeled off.

Umenoki-mura.—This is situated on the opposite bank of Noda. A stable was destroyed. The roads in the vicinity of these villages received a few small fractures, running N 20° E–S 20° W.

Kitaura, Koushida-mura, Tōda county.—As the soil here was not rigid, seeming to have been a swampy region in ancient times, the calamities were numerous. A firmely founded house was deprived of its roof on the north side. Also, some store houses were overturned, the walls peeled off, and the foundations themselves were about 9 cm. displaced toward N 60° W. Moreover there were destruction of brick chimneys, convulsion of liquid, etc.

Minami-Koushida.—This village was most severely devastated, and 45 out of 64 houses were damaged. Houses in this region were generally built up on solid foundations and thatched with reeds. Pillars broke down, or houses became inclined to one side, but some of houses were entirely overturned either eastward or westward. It is a prevailing custom in this locality that all buildings which belong to one owner are connected each other from an agricultural necessity. Different-sized buildings have different amplitudes of vibration; but as they are forced to swing simultaneously the damages were rather increased

On the banks of the Itomagawa at the eastern foot of Heragatake damage was severe; especially, at Hirawaku-mura it was the severest. The calamities were of about the same extent at Minamikoushida.

Yoneyama-mura.—A few houses were partly or totally destroyed. Two persons were injured.

Sanumachō.—Five houses were destroyed, and many were injured. A person was wounded.

Wakayagichō, Kuribara County.--Totally destroyed houses were 5; partly destroyed 2; injured buildings 41.—The embankment of the Itomagawa along the road leading from Sanumachō to Wakayagichō was cracked and crushed in many places. Especially, the fissures were prominent in two places measuring 76 metres in length. A fissure extending over 27 metres appeared in the road.

Shikamata-mura. Momou county—A few houses were damaged.

Ishinomakichō.—Shocks were slight at Minatomachi on the opposite coast, and some number of houses were slightly damaged. At Inai-mura 7 and at Tonami-mura 9 houses were injured.

Higashina, Ōtsuka-mura.—An embankment of 2 metres in height and 1.8 metres in breadth was partly buried in the ground, amounting to 106 m. in length, and partly destructed, amounting to 66 m.

Kamioka-mura.—This is situated on the opposite coast of Higashina. An embankment was buried in the ground, in three places, and its total length measured 222 metres.

In the vicinity of these villages, huge blocks of rocks were detached from Daibutsusan.

Shiogamachō.—At many places, fractures of the ground, demolitions of brick chimneys, etc. occurred, and all the walls of ware-houses were cracked.

Sendai.--Shocks were slight, only a few fissures were produced in the walls of houses. Here, only a special case was the destruction of a wine-store.

The next table gives the total damage caused by this shock and examined by the Miyagi Police station.

District.	Kurokawa.	Natori	Igu.	Ojika.	Momoo.	Tome.	Toda.	Shida.	Tamatsukuri.	Kuribara.	Total.
No. of persons dead & wounded.....	—	—	—	1	1	2	11	2	—	—	17
Totally destroyed	—	—	—	2	6	7	21	7	—	1	44
partly ..... ,, ...	—	—	—	2	5	4	33	4	—	—	48

No. of houses	Damaged	9	3	16	25	257	190	570	400	1	3	1,474
	Total	9	3	16	29	267	201	624	411	1	4	1,566
Wrecked roads embankments &c.	(No.)	—	—	—	—	18	—	—	—	—	2	20
	(Length$^{(m)}$)	—	—	—	—	67	—	—	—	—	78	145
Fissured roads embankments &c.	(No.)	3	—	—	—	8	—	6	—	—	1	18
	(Length$^{(m)}$)	81	—	—	—	20	—	32	—	—	27	87
Bridges wrecked (No.)		—	—	—	—	5	—	2	—	—	—	7
Walls wrecked (No)		—	—	—	—	—	—	2	1	—	—	3

Iwate Prefecture.

Ichinosekicho. Shocks were most severely felt in Nishiiwai county. Some walls of ware-houses were wrecked, tiles slid down from roofs, holes were produced in roads and the convulsion of liquid at breweries and apothecaries etc. took place.

No building, however was, injured. Even Hanamaki and Mizusawa in the north of the town received more or less damages.

Fukushima Prefecture.

Shocks in general, were more slight than those of 1897.

Kōriyamacho, Azumi county. Some houses were bent to one direction, and the walls were wrecked.

Yumotocho, Ishiki county. Clock pendulums were stopped, and liquid was splashed out of backets.

Origin.

This earthquake originated in province of Rikuzen as the shock of February 2nd, 1897. In the previous year such mountaneous villages as Murata, Shiraishi, and others in the west of Sendai, were parts of the epicentre. On the other hand, the origin of this earthquake was situated more north at Koushida, Tōda county and Yoneyama, Tome county. Although these villages stand on the soft ground, and the calamities were increased comparing to other villages, the regions have, up to this date, no example of great catastrophes caused by those shocks which occurred in the province or under the adjacent sea. Moreover, the record of the Ayukawa tideguage showed that this earthquake did not accompany the *Tsunami* (though the record was not complete.) From these results we conclude that the origin was not situated beneath sea basin. By tracing the most severely devastated regions we see that the line is parallel to the Kitakami mountain range running meridionally. At Sanumacho and Yoneyama-mura the damage was great as mentioned, and at Kosato and Ōnuki at the foot of Heragatake a few houses were injured, and many small fissures running N-S were produced in roads. These villages certainly suffered

more than Sakuragaoka and Terasaki on the west. Beyond Heragatake, the most situated Koushida, the most disturbed place by this shock. In the main road which lead to Wakidani a somewhat remarkable fissure was caused running N10°E—S10°W. Tracing this fissure line we found many small fractures in the field at a distance of about 10 km. and muddy sand was ejected. Going southward, at Fudōdō and Kinomadzuka along the Naruse river, some houses were destroyed and an embankment was wrecked. Southward from this place the intensity decreased more and more. But as already mentioned from Daibutsusan on the coast of the Bay of Matsushima, blocks of rocks were detached and at Higashina an embankment was buried in the ground.

Thus we conclude that these regions were the epicentre of this earthquake and the origin was a fault that occurred in a great depth.

In the next table we give the results of observation obtained at several meteorological stations :

Station.	Time of commencement.	Duration.	M. horizontal Motion.				M. Vertical Mortion.				Intensity.	Remarks.
			Direction.	Period.	Range.	Time from Beginning.	Period.	Range.	Time from Beginning.			
	h. m. s.	m. s.		s.	mm.	s.	s.	mm.	s.			
Ishinomaki...	2 23 10 a.m.	3 19	NW-SE	0.5	49.6	0.8	0.5	7.2	0.8		Strong.	Walls fissured, houses injured.
Fukushima...	2 23 38 a.m.	2 32	WNW-ESE	0.8	8.2	1.8	0.5	0.5	1.7		,,	No sound accompanied.
Mito.....	2 23 15 a.m.	5 23	SE-NW	1.9	13.4	--	1.2	1 1	—		,, (rather weak.)	Brisk. Houses swang.
Aomori.....	2 24 16 a.m.	5 13	SE-NW	1.5	45,5	—	—	—	—		,,	Slow. No sound accompanied.
Yokohama....	2 24 18 a.m.	6 00	WNW-ESE	2.3	22.6	—	1.2	2.5	—		,,	Clocks stopped.
Utsunomiya..	2 23 45 a.m.	4 30	SSE-NNW	2.2	12.7	—	1.4	4.5	—		weak.	Slow.
Tōkiō	2 24 10 a.m.	4 10	NE-SW	0.8	2.4	—	—	—	—		,,	Slow. Clocks stopped.
Mayebashi...	2 24 17 a.m.	2 01	W-E	1.3	8.8	—	0.7	0.9	—		,, (rather slight.)	Brisk. No sound accompanied.
Chōshi.....	2 25 00 a.m.	3 00	E-W	2.1	11.5	—	0.6	0.6	—		,,	Slow.
Kōfu	2 20 57 a.m.	1 45	NW-SE	1.4	1.4	—	—	—	—		Slight.	Slow.
Matsumoto...	2 24 52 a.m.	5 35	SSW-NNE	1.2	2.6	—	—	—	—		,,	Slow. No sound accompanied.

Earthquake of May 31st 5^{h} 43^{m} p.m. (See pl. W. No. 1.) This earthquake occurred in the vicinity of Neoya in the province of Mino, and covered an area of

88,000 sq. km. The three counties, Motosu, Ōno and Ikeda in the province received the most powerful shocks. Slight shocks were felt in the region extending to Tokio and Nagano on the east, and to the middle portions of Izumi, Yamato, and the western portions of Tango, Tanba and Settsu on the west.

Neoya had been a portion of the epicentre of the earthquake of 1892, which offered great calamities in Mino and Owari districts. Many after shocks visited the region, and they were sometimes of weak or slight nature. Lately the number of shocks became rather small and the intensities also declined: but the present earthquake was somewhat remarkable.

At Neoya blocks of rock were detached from mountains, and 6 or 7 after shocks occurred continuously. The damage was restricted in a small area, and at some remote places shocks were slightly felt.

According to the report of the meteorological station of Gifu the principal feature of the shock was as follows:—

The time of occurrence was 5^h **34**^{m} 20^s p.m. It began with vertical motion. After 3 seconds horizontal motion appeared, the range increasing abruptly. The maximum horizontal motion had a range 1,6 mm. in the derection SSW—NNE with the period of 1.0 s. The maximum vertical motion had period of 0.5^s and the range of 0.5 mm. The total duration was 1^m 11^s

Kyōto meteorological station reported that the shock began at 5^h 74^m 10^s with slow tremor the maximum horizontal motion having a period of $0,5^s$, a range of 0,2 mm. and with direction E—W. and that the motion continued for 50 seconds. According to the observation of Matsumoto meteorological station, the shock began at 5^h 44^m 47^s p.m. The maximum horizontal motion had a range of 24 mm. in the direction S—N. with a period of 1.3^s. Total duration was 31 seconds.

Earthquake of August 5th, 1^h 21^m p.m. (See pl. IV. No. 2.) This shock was severely felt along the coast of the provinces of Iwaki and Hitachi. The origin was located far off the coast of Iwaki and its dirturbed area covered 124,4000 sq. km, its major and minor axes being 1000 km and 200 km respectively.

The violent shock was felt throughout an area of 12,320 sq. km covering the province of Iwaki, northern Hitachi, eastern Iwashiro, eastern Shimotsuke and South eastern Rikuzen. Slight shocks were felt at Oshima on the north and in Wakasa, Ōmi and Ise on the west.

Up to this time, earthquakes which came from the Iwaki Sea had, in general, large disturbed areas, but those which gave any calamities were very rare and disturbances observed even in the most strongly shaken regions were nothing more than stopping of clock pendulums, the convulsion of liquid, etc. This general rule, was also followed by the present earthquake. Damages everywhere along the coast were in

the same degree. At Kanayama, Tomioka, Taira, Ōkawara, Sendai and Kinkazan, clock pendulums were stopped. There was an exception of the light house of Shioya cape in Iwaki province, where a great amount of mercury was splashed out of its vessel.

The next table gives the results of observation at several stations.

Station.	Time of commencement.	Duration.	M. horizontal Mortion.				M. Vertical Motion.			Intensity.	Remarks.
			Direction.	Period.	Range.	Time from Beginning.	Period.	Range.	Time from Beginning.		
	h. m. s.	m. s.		s.	mm.	s.	s.	mm.	s.		
Ishinomaki...	1 19 46 p.m.	1 46	SSE-NNW	1.0	10.0	12	0.7	0.8	1.2	Strong.	
Mito.....	1 19 25 p.m.	1 52	SE-NW	3.3	6.2	—	0.4	6.3	—	Strong (rather weak.)	Slow.
Kumagaya ...	1 21 18 p.m.	3 05	SW-NE	1.5	1.9	—	0.6	0.2	—	Weak.	,,
Yokohama ...	1 21 21 p.m.	4 13	SE-NW	2.1	10.9	—	—	—	—	,,	
Kōfu.....	1 21 26 p.m.	2 30	WNW-ESE	1.8	0.4	—	1.1	0.04	—	,,	,,
Aomori.....	1 22 12 p.m.	4 00	NW-SE	2.0	29.0	—	2.0	3.0	—	,,	
Fukushima ...	1 22 45 p.m.	1 41	E-W	0.5	6.3	1	0.3	1.9	1.4	,,	
Tōkiō.....	1 21 00 p.m.	4 00	NNE-SSW	0.7	1.1	—	—	—	—	Strong (rather slight.)	,,
Mayebashi....	1 21 06 p.m.	2 25	SSE-NNW	0.6	1.0	—	1.1	0.2	—	Slight. (unfelt.)	,,
Matsumoto ...	1 22 30 p.m.	3 34	SW-NE	1.0	0.5	—	—	—	—	,,	

Earthquake of August 29th, 11^h 32^m a.m. (See pl. IV. No. 3.) This was a strong earthquake which originated off the coast of the province of Mutsu. As regards the disturbed land area, this shock occupied the second rank in this year, the space covering 202.880 sq. km. Its major and minor axes were respectively 1.600 km and 1.000 km. An area of 22.520 sq. km, covering eastern Mutsu, north-eastern Rikuchū, southern Oshima, south-eastern Hitaka, southern Tokachi, southern Kushiro and southern Nemuro was devastated most severely. The isoseismal area in which slight shocks were felt included the northern portion of Ishikari and the central portion of Kitami on the north, and Fukui and Iida on the west (Etchu, Noto, Sado and western Echigo were outside this area). This area measured 91.840 sq. km.

Next, we will give general features of shocks in the most severely disturbed regions. At Hakodate, articles were shaken down from shelves but buildings were not injured. On the coasts of Mutsu and Oshima, many clock pendulums were stopped. In

Aomori, this was the strongest shock since the establishment of the meteorological station. Hanging articles were lively swung. The needle of the seismograph was often deviated out of the cylinder. As the nature of the shock was slow and its range was large, a great amount of liquid was splashed out of the bucket. The total duration of vibration was 7 minutes.

The results of instrumental observation at several stations are given in the following table :—

Station.	Time of commencement.	Duration.	M. horizontal Motion.				M. Vertical Motion.			Intensity.	Remarks.
			Direction.	Period.	Range.	Time from Beginning.	Period.	Range.	Time from Beginning.		
	h. m. s.	m. s.		s.	mm.	s.	s.	mm.	s.		
Miyako	11 30 16 a.m.	2 34	NNW-SSE	0.8	1.6	5.4	0.8	0.2	54	Weak.	No sound accompanied.
Ishinomaki...	11 34 20 a.m.	2 04	NW-SE	0.7	1.7	5.7	—	—	—	Weak	
Akita	11 35 35 a.m.	3 29	NNE-SSW	2.0	7.6	—	1.5	0.5	—	Weak	No sound accompanied.
Fukushima...	11 32 20 a.m.	1 55	S-N	0.8	1.1	—	—	—	—	Weak (rather slight.)	Slow. No sound accompanied.
Chōshi.....	11 35 44 a.m.	3 13	NW-SE	0.6	0.7	—	—	—	—	,,	Slow.
Kumagaya....	11 34 25 a.m.	3 08	NNW-SSE	1.4	1.1	—	—	—	—	Slight.	,,
Yokohama....	11 34 42 a.m.	3 47	NNW-SSE	1.3	2.5	—	—	—	—	,,	,,
Mito.....	11 35 36 a.m.	4 15	S-N	1.5	1.6	—	1.5	0.3	—	,,	
Kōfu	11 34 38 a.m.	3 56	NW-SE	0.7	0.5	—	—	—	—	Slight (nonfelt.)	,,

Earthquake of September 15th, 1,^{h} 19^{m} p.m. (See pl. IV. No. 4). This was a strong shock which originated under the sea north of the province of Nagato. A solitary island Mishima was most severely disturbed. Its total disturbed area was 111,360 sq. km. having the longest and shortest area of 800 km and 500 km respectively. In the counties of Abu, Otsu and Toyoura, in the province, strong shocks were observed. The isoseismal area in which slight shocks were felt extended as far as the central portion of Higo and Hiuga on the south-west, Fukui and Wajima on the east.

There lies a remarkable origin of disturbance under the sea off Mishima I. From this seismic source many strong shock occurred at that place in every year, and threatened people on the coast of the provinces of Nagato and Suō. Since the strong

earthquake of April 3rd in the year 1898, the activity became more and more brisk.

The present earthquake also belonged to this class, and the form of the disturbed area was similar, but as regards the intensity, this shock was much inferior to the preceding shocks. At a few places only, clock pendulums were stopped.

The results of observation at several stations are given in the following Table :—

Stations.	Time of commencement.	Duration.	M. Horizontal Mortion.				M. Vertical Motion.			Intensity.	Remarks.
			Direction.	Period.	Range.	Time from beginning.	Period.	Range.	Time from Beginning.		
	h. m. s.	m. s.		s.	mm.	s.	s.	mm.	s.		
Fukuoka.....	1 19 20 p.m.	0 35	W-E	0.2	0.4	7	0.2	0.4	7	Weak.	Slow.
Nagasaki.....	1 21 19 p.m.	0 25	NW-SE	1.0	0.5	—	—	—	—	Slight.	Slow no sound accompanied.
Tadotsu.....	1 18 43 p.m.	2 39	SSE-NNW	1.2	0.7	20	0.6	0.1	18	slight (unfelt.)	,,
Kumamoto ...	1 20 17 p.m.	2 36	NW-SE	0.7	0.8	—	—	—	—	,,	Slow.
Miyazaki.....	1 21 03 p.m.	1 10	W-E	0.5	0.5	—	—	—	—	,,	,,

Earthquake of November 5th, 4^h 42^m p.m. (See pl. V. No. 1.) Miyake Island belong to the volcanic belt of Fujisan, and its adjacent sea was considered as a seat of seismic activity. The earthquakes of this source have often shaken both Izu and Bōsō peninsulas.

The earthquake of November 5th, occurred also under the western sea of the island. The islands of Miyake and Mikura received severe damages. Its total disturbed area occupied 200.000 sq. km the longest and shortest axes being respectively 800 km and 560 km. Izu Islands, Awa province, south-western Kazusa, south-eastern Izu and southern Sagami were severely disturbed, and the area covered 4,500 sq. km. The area of slight shocks was Ishinomaki on the north and Matsuyama on the west.

Miyake Island. A weak shock occurred at about 8 o'clock a.m. on the preceding day. Until the afternoon of the 5th, a few slight or weak disturbances were observed. At about 4^h 40^m p.m. came suddenly vertical brisk shocks from the south, east. Many houses and stone-walls were damaged, and roads were injured here and there. At Itazakigahama, along coast, a huge mass which measured 10 m. in length and 7.3 m. in breadth was detached from the cliff. At Higashiyama blocks of rock fell down by which 6 stone-walls were wrecked. In the road which led to Tsubotamura from this place two great fractures were produced. One of them measured 36,4 m. in length and .45 m. in breadth, and the other 5,5 m. in length and 15 cm. in

breadth. At Tsubota-mura 4 stone-walls were destroyed. Small cracks produced in the ground were numerous. Hundreds of after-shocks were observed; among them there were 11 weak shocks until midnight and 6 in the next day. Slight shocks did not disappear even on the 19th

Mikura Island. At 6 o'clock in the morning a slight shock was felt, after which either weak or slight shocks occurred frequently in intervals of 5 or 10 minutes. Among them, those at 2 and 3 o'clock in the afternoon were somewhat notable. At 4^h 40^m p.m. a very violent shock came at last and it continued for about 5 minutes. All articles in houses were thrown down. The ground was fractured here at several places and some of them measured 10-13 m. in length.

The shore was destructed at more than 120 places. One of them facing to the north-west measured about 220 m. in length. 6 roads which led to the shore were totally destroyed. At a pier 3 stone-houses and 2 ships were destructed. Many high objects were overturned, but fortunately damage on buildings was not so great. One person was wounded by a block which fell from a mountain.

Until the 11th over 40 after shocks per day were observed and then decreased gradually.

Kodzu Island. Tremors occurred at 8^h 10^m a.m. and following them, a number of weak and slight shocks were observed. A strong shock occurred at 4^h 50^m p.m. The motion was vertical at first and the horizontal motion in the direction NE—SW gradually appeared. Articles were shaken down from shelves. Over 60 tombstones were overthrown facing to the south-east. At Kawara a mass which measured 9 m. in length and 2.7 m. in breadth was detached from a cliff. At Dadanuke a tunnel was wrecked to a length of 3.6 m., and an earthen pipe of the aqueduct was wrecked. Fissures of about 3 cm in breadth were numberless. There were 2 totally and 3 partly destroyed houses. Until the 8th inst., 3 or 4 after shocks were observed per day.

From above mentioned results it seemed that this shock originated by a fault under the eastern sea of Miyake I and there was no relation to the volcanic chain passing through the vicinity of the island.

Shocks which started from the adjacent sea basin of Mikura Island have always almost similarly shaped disturbed areas and some of them were felt on the coast of the province of Izu or of Awa.

At Tokiō 3 after shocks of this earthquake were observed.

The following table gives the results of observation at several meteorological stations.

Station.	Time of commencement.	Duration.	M. horizontal Motion.				M. Vertical Motion.			Intensity.	Remarks.
			Direction.	Period.	Range.	Time from Beginning.	Period.	Range.	Time from Beginning.		
	h. m. s.	m. s.		s.	mm.	s.	s.	mm.	s.		
Yokohama....	4 41 41 p.m.	3 30	NW-SE	2.2	19.0	49	1.1	1.2	18	Strong. (rather weak.)	Slow.
Tōkiō	4 41 37 p.m.	3 20	SSE-NNW	1.0	3.3	—	1.0	1.0	—	Weak.	,,
Kiōto	4 43 21 p.m.	1 00	E-W	0.7	0.3	25	—	—	—	Weak (rather slight.)	,,
Kōfu	4 41 40 p.m.	5 56	ENE-WSW	1.5	3.2	—	—	—	—	Slight.	,,
Mito.....	4 41 46 p.m.	1 50	SE-NW	1.8	1.6	—	—	—	—	,,	,,
Mayebashi ...	4 41 57 p.m.	2 28	NNW-SSE	1.5	1.8	—	—	—	—	,,	,,
Matsumoto ...	4 44 44 p.m.	1 14	NW-SE	1.9	1.0	—	—	—	—	Slight (un felt.)	No sound accompanied.

Earthquake of November 10th, 2^h 55^m a.m. (See pl. V. No. 2.) This was a remarkable shock which had the total disturbed area of 125,120 sq. km. The longest and shortest axes measured 720 km and 560 km respectively. Its origin was situated under the Izu Sea, and the southern portions of provinces of Izu and Tōtōmi, covering an area of 1,920 sq. km, were strongly devastated. Slight shocks reached Fukushima on the north, and Fukui and Tadotsu on the north-west.

As we already mentioned, the disturbed area of the earthquake on May 3rd covered the coasts of Awa and Kazusa, so its northern extremity was quite limited. The earthquake of Nov. 10th on the other hand, had its origin in the farther north, and the coasts of Izu and Tōtōmi were severely disturbed. There clocks were stopped and liquids splashed out. Even at Wakasa and Echizen slight shocks were detected; but the calamities were not remarkable.

The following table contains the results of observation obtained at several stations;—

Station.	Time of commencement.	Duration.	M. horizontal Mortion.				M. Vertical Motion.			Intensity.	Remarks.
			Direction.	Period.	Range.	Time from Beginning.	Period.	Range.	Time from Beginning.		
	h. m. s.	m. s.		s.	mm.	s.	s.	mm.	s		
Yokohama....	2 55 21 a.m.	2 54	NW-SE	1.9	9.0	44	0.7	0.3	44	Weak.	Slow.
Kōfu.....	2 55 53 a.m.	3 46	ENE-WSW	1.4	2.6	48	0.7	0.6	40	,,	,,

	h. m.s.	m. s.		s.	mm.	s.	s.	mm.	s.		
Kumagaya ...	2 55 02 a.m.	3 00	S-N	1.2	0.9	—	—	—	—	Weak. (rather slight.)	Slow.
Matsumoto ...	2 57 35 a.m.	1 20	NNE-SSW	1.2	1.0	—	—	—	—	Slight (unfelt).	

Earthquake of November 27th, 9^h 16^m p.m. (See pl. V. No. 3.). From ancient times the vicinity of Kiōto was visited by seismic disturbances very frequently, but the seismic activity was diminished recently. The earthquake of November 27th, however, was one of strong shocks. The area in which strong shocks were felt was of a circular shape covering 3040 sq. km. Slight shocks reached in Kumagaya on the east, and Tadotsu on the west; but they were observed only with the instrument. Although this shock was extraordinarily strong in Kinai, damages were not remarkable. But shocks were very brisk, people felt terribly and ran out of doors.

According to the report of the meteorological station of Kiōto, it began at 9^h 15^m 55^s p.m. After 0.4 second from the beginning, both horizontal and vertical motions of brisk natures came. The maximum horizontal motion had a period of 0.1 second, and a range of 3.6 milimetres. The maximum vertical motion had a period of 0.1 and a range of 0.8 mm. The horizontal motion was prominent for 14 seconds, and it died after 1^m 09^s; while the vertical suddenly declined after 9 seconds, and its total duration was only 19 seconds. The shock was of brisk nature from the beginning to the end, but as the duration was short, people did not receive much damage.

According to the meteorological station of Ōsaka. the beginning of the shock was at 9^h 15^m 47^s p.m. with tremors; after 2 seconds from the beginning tremendous noises were heard on the north, and at the same time slight horizontal and vertical motions were felt; at the 4th second the maximum horizontal motion appeared with a period of 0.2 second and a range of 0.7 milimetre, yet during some seconds slow vibrations were observed in the direction NNE—SSW, and the total duration of the shock was 1^m 30^s.

According to the report of the Tadotsu station, it begans, at 9^h 16^m 0^s p.m. The maximum horizontal motion had a period of 0.4 s and a range of 0.2 mm. Its total duration was 13 seconds.

Earthquake of November 25th, 2^h 07^m p.m. (See pl. V. No. 5.) This earthquake originated in the sea south east of the coast of Nemuro. The total devastated land area covered 210.720 sq. km., the largest and shortest axes being respectively 800 km. and 1200 km. and so far as the area was concerned the shock occupied the first rank in this year. The violent shocks were felt over an area of 13.000 sq. km., including the south-eastern coasts of Nemuro and Kushiro and the eastern coast of Mutsu. The area in which slight shocks were observed covered the central portions of Ishikari and Kitami on the north, and Fukui, Hikone and Wakayama on the west.

The coasts of Nemuro and Kushiro were the most disturbed regions in Japan; many shocks came from off the coast of Nemuro.

At the light house of Ōishi Cape in the province of Nemuro, two glass plates were fractured, and many procelain articles were demolished by their mutual concussions. On the coast of the provinces of Oshima and Mutsu received damages to the same extent; namely, walls of houses were peeled off and window glasses cracked. The eastern coast of Hokkaido, in general, received extraordinarily great calamities in recent years. From these results, it seemed that the origin of the shock was situated in the farther south and covered a larger area than the preceding shocks in the region.

The next table gives the results of observation at several meteorological stations:—

Station.	Time of commencement.	Duration.	M. horizontal Motion.				M. Vertical Motion.			Intensity.	Remarks.
			Direction.	Period.	Range.	Time from Beginning.	Period.	Range.	Time from Beginning.		
	h. m. s.	m. s.	NE-SW	s.	mm.	m. s.	s.	mm.	m. s		
Ishinomaki...	2 07 57 p.m.	3 36		0.7	0.9	2 4	0.4	0.2	2 5	Weak.	Clocks stopped slow.
Fukushima...	2 07 53 p.m.	1 15	NE-SW	0.6	1.5	6	—	—	—	,,	Brisk.
Mito.....	2 07 00 p.m.	4 40	NNE-SSW	0.6	1.6	—	—	—	—	Weak (rather slight.)	Slow.
Yokohama ...	2 08 17 p.m.	5 11	NNW-SSE	1.8	2.6	—	—	—	—	,,	,,
Chōshi	2 10 12 p.m.	3 36	SE-NW	0.9	0.6	—	—	—	—	,,	,,
Kumagaya....	2 06 00 p.m.	4 20	NNE-SSW	1.4	0.9	—	—	—	—	Slight.	,,
Kōfu	2 08 09 p.m.	3 59	NW-SE	0.8	0.1	—	—	—	—	,,	,,
Utsunomiya..	2 10 18 p.m.	3 00	E-W	1.2	1.0	—	—	—	—	,,	,,

SEISMOLOGICAL OBSERVATIONS IN TOKIO.

During this year, 157 earthquakes were observed at the Central Meteorological Observatory. Among them 13 were weak and 144 slight. The following table gives detailed accounts of the time, direction and intensity of each shock:—

Date.	Time of Occurrence.	Duration.	Horizontal Motion.					Vertical Motion.	
			Direction.	Period of max. mo.	Max. range.	Max. velocity.	Max. acceleration.	Period of max. mo.	Max. range.
	h. m. s.	m. s.		s.	mm.	mm./sec	mm./sec²	s.	mm.
Jan. 15	0 33 05 p.	—	—	—	Slight.	—	—	—	—
,, 17	0 14 11 a.	2 25	ENE-WSW	0.5	0.7	4.4	55.2	0.7	0.7
,, 18	4 26 24 p.	—	—	—	Slight.	—	—	—	—
,, 18	4 46 02 p.	—	—	—	,,	—	—	—	—
,, 21	6 29 09 p.	1 30	WNW-ESE	0.3	0.8	8.4	175.1	—	—
,, 27	0 16 13 a.	—	—	—	Slight.	—	—	—	—
,, 31	2 37 45 a.	—	—	—	,,	—	—	—	—
Feb. 1	4 24 10 a.	—	—	—	,,	—	—	—	—
,, 7	9 54 43 a.	—	—	—	,,	—	—	—	—
,, 7	10 10 12 a.	—	—	—	,,	—	—	—	—
,, 9	6 39 0 a.	—	—	—	,,	—	—	—	—
,, 12	7 37 41 a.	—	—	—	,,	—	—	—	—
,, 13	1 28 19 p.	—	—	—	,,	—	—	—	—
,, 15	8 30 36 p.	—	—	—	,,	—	—	—	—
,, 16	9 10 28 a.	—	—	—	,,	—	—	—	—
,, 16	10 53 02 a.	—	—	—	,,	—	—	—	—
,, 16	4 35 04 p.	—	—	—	,,	—	—	—	—
,, 17	0 54 48 p.	1 42	WSW-ENE	0.2	0.3	4.7	147.7	0.1	0.1
,, 18	2 47 02 a.	—	—	—	Slight.	—	—	—	—
,, 18	8 04 30 a.	—	—	—	,,	—	—	—	—
,, 20	11 50 59 p.	—	—	—	,,	—	—	—	—
,, 24	9 21 04 p.	—	—	—	,,	—	—	—	—
,, 26	11 34 24 a.	—	—	—	,,	—	—	—	—
March 1	7 32 07 a.	—	—	—	,,	—	—	—	—
,, 1	8 19 28 a.	—	—	—	,,	—	—	—	—
,, 1	8 25 49 a.	—	—	—	,,	—	—	—	—
,, 1	10 09 00 p.	—	—	—	,,	—	—	—	—
,, 4	11 58 04 a.	3 23	E-W	0.4	0.4	3.1	49.2	—	Slight.
,, 4	3 18 27 p.	—	—	—	Slight.	—	—	—	—
,, 4	4 46 53 p.	—	—	—	,,	—	—	—	—
,, 7	7 16 13 p.	—	—	—	,,	—	—	—	—
,, 8	9 48 55 p.	—	—	—	,,	—	—	—	—
,, 9	6 01 29 p.	—	—	—	,,	—	—	—	—
,, 12	10 35 38 a.	6 50	NE-SW	1.8	2.2	3.8	13.4	—	—

Date.	Time of Occurrence.	Duration.	Horizontal Motion.					Vertical Motion.	
			Direction.	Period of max. mo.	Max. range.	Max. velocity.	Max. acceleration.	Period of max. mo.	Max. range.
	h. m. s.	m. s.		s.	mm.	mm./sec	mm./sec²	s.	mm.
March 12	1 41 41 p.	—	—	—	Slight.	—	—	—	—
,, 12	7 57 07 p.	—	—	—	,,	—	—	—	—
,, 13	1 10 12 a.	—	—	—	,,	—	—	—	—
,, 13	6 53 32 a.	—	—	—	,,	—	—	—	—
,, 14	11 55 55 p.	—	—	—	,,	—	—	—	—
,, 15	6 23 20 p.	—	—	—	,,	—	—	—	—
,, 16	10 02 21 p.	1 45	NE-SW	1.0	0.4	1.3	7.9	—	—
,, 17	1 39 23 p.	—	—	—	Slight.	—	—	—	—
,, 22	0 56 25 a.	—	—	—	,,	—	—	—	—
,, 26	5 32 21 p.	—	—	—	,,	—	—	—	—
,, 26	8 52 35 p.	—	—	—	,,	—	—	—	—
,, 26	9 33 15 p.	—	—	—	,,	—	—	—	—
April 15	7 50 32 a.	—	—	—	,,	—	—	—	—
,, 20	9 09 23 p.	—	—	—	,,	—	—	—	—
,, 25	8 19 10 a.	—	—	—	,,	—	—	—	—
May 5	9 22 49 a.	—	—	—	,,	—	—	—	—
,, 5	11 45 44 p.	—	—	—	,,	—	—	—	—
,, 12	2 24 10 a.	4 10	NE-SW	0.8	2.4	9.4	73.9	—	Slight.
,, 12	11 45 12 a.	—	—	—	Slight.	—	—	—	—
,, 15	7 13 02 a.	2 10	SW-NE	0.2	0.9	14.1	443.2	—	Slight.
,, 15	9 04 04 p.	—	—	—	Slight.	—	—	—	—
,, 21	8 29 25 a.	—	—	—	,,	—	—	—	—
,, 24	0 13 13 a.	—	—	—	,,	—	—	—	—
,, 31	5 40 39 a.	—	—	—	,,	—	—	—	—
,, 31	5 44 47 p.	—	—	—	,,	—	—	—	—
June 7	1 51 12 a.	—	—	—	,,	—	—	—	—
,, 8	5 27 20 p.	—	—	—	,,	—	—	—	—
,, 8	8 31 03 p.	—	—	—	,,	—	—	—	—
,, 10	7 29 25 p.	—	—	—	,,	—	—	—	—
,, 16	3 14 05 a.	—	—	—	,,	—	—	—	—
,, 20	4 32 00 p.	—	—	—	,,	—	—	—	—
,, 24	3 59 52 p.	—	—	—	,,	—	—	—	—
,, 25	9 24 17 a.	—	—	—	,,	—	—	—	—

Date.	Time of Occurrence.	Duration.	Horizontal Motion.					Vertical Motion.	
			Direction.	Period of max. mo.	Max. range.	Max. velocity.	Max. acceleration.	Period of max. mo.	Max. range.
	h. m. s.	m. s.		s.	mm.	mm./sec	mm./sec²	s.	mm.
June 25	11 56 20 a.	—	—	—	Slight.	—	—	—	—
,, 25	2 39 15 p.	—	—	—	,,	—	—	—	—
,, 25	3 47 15 p.	—	—	—	,,	—	—	—	—
,, 25	9 12 18 p.	—	—	—	,,	—	—	—	—
,, 25	10 28 14 p.	—	—	—	,,	—	—	—	—
,, 25	11 14 24 p.	—	—	—	,,	—	—	—	—
,, 26	5 10 13 a.	—	—	—	,,	—	—	—	—
,, 26	5 24 54 a.	—	—	—	,,	—	—	—	—
,, 26	6 27 00 a.	—	—	—	,,	—	—	—	—
,, 26	10 56 49 a.	—	—	—	,,	—	—	—	—
,, 26	6 58 00 p.	—	—	—	,,	—	—	—	—
,, 26	9 49 42 p.	—	—	—	,,	—	—	—	—
,, 26	10 20 49 p.	—	—	—	,,	—	—	—	—
,, 27	0 54 04 a.	—	—	—	,,	—	—	—	—
,, 27	0 41 47 p.	—	—	—	,,	—	—	—	—
,, 30	2 51 21 p.	—	—	—	,,	—	—	—	—
July 2	5 38 35 p.	—	—	—	,,	—	—	—	—
,, 7	7 15 25 a.	—	—	—	,,	—	—	—	—
,, 8	11 47 14 a.	—	—	—	,,	—	—	—	—
,, 10	11 43 43 p.	—	—	—	,,	—	—	—	—
,, 13	5 00 43 p.	—	—	—	,,	—	—	—	—
,, 13	7 19 52 p.	—	—	—	,,	—	—	—	—
,, 13	10 23 29 p.	—	—	—	,,	—	—	—	—
,, 14	7 20 48 a.	—	—	—	,,	—	—	—	—
,, 14	8 11 41 a.	—	—	—	,,	—	—	—	—
,, 14	8 24 14 a.	—	—	—	,,	—	—	—	—
,, 16	5 32 50 p.	—	—	—	,,	—	—	—	—
,, 17	11 52 04 a.	—	—	—	,,	—	—	—	—
,, 20	4 35 52 p.	—	—	—	,,	—	—	—	—
,, 21	7 30 33 a.	—	—	—	,,	—	—	—	—
,, 24	9 52 40 a.	—	—	—	,,	—	—	—	—
,, 25	1 08 19 a.	—	—	—	,,	—	—	—	—
Aug. 4	1 33 13 p.	—	—	—	,,	—	—	—	—
,, 5	1 21 05 p.	4 00	NNE-SSW	0.7	1.1	4.9	44.2	—	—
,, 8	7 17 26 p.	—	—	—	slight	—	—	—	—
,, 17	6 56 21 a.	—	—	—	,,	—	—	—	—
,, 17	5 27 56 p.	—	—	—	,,	—	—	—	—

Date.	Time of Occurrence.	Dura-tion.	Horizontal Motion.					Vertical Motion.	
			Direc-tion.	Period of max. mo.	Max. range.	Max. velocity.	Max. acce-leration.	Period of max. mo.	Max. range.
	h. m. s.	m. s.		s.	mm.	mm./sec	mm./sec²	s.	mm.
Aug. 25	11 40 19 p.	—	—	—	Slight.	—	—	—	—
,, 27	2 03 12 a.	—	—	—	,,	—	—	—	—
,, 27	3 00 44 p.	0 50	NW-SE	0.2	2.6	37.8	103.5	0.1	0.5
,, 27	4 28 56 p.	—	—	—	Slight.	—	—	—	—
,, 27	4 33 38 p.	—	—	—	,,	—	—	—	—
,, 29	7 00 00 a.	—	—	—	,,	—	—	—	—
,, 29	11 34 41 a.	—	—	—	,,	—	—	—	—
Sep. 1	11 16 32 a.	—	—	—	,,	—	—	—	—
,, 5	6 03 32 p.	—	—	—	,,	—	—	—	—
,, 9	0 31 36 p.	—	—	—	,,	—	—	—	—
,, 10	9 31 34 p.	—	—	—	,,	—	—	—	—
,, 19	4 23 03 p.	—	—	—	,,	—	—	—	—
,, 24	0 36 24 p.	—	—	—	,,	—	—	—	—
Oct. 3	3 19 16 a.	1 48	WNW-ESE	0.7	3.0	13.5	120.4	—	—
,, 3	3 50 36 a.	—	—	—	Slight.	—	—	—	—
,, 4	4 18 32 p.	—	—	—	,,	—	—	—	—
,, 7	4 17 41 a.	—	—	—	,,	—	—	—	—
,, 9	1 41 07 a.	—	—	—	,,	—	—	—	—
,, 12	4 03 53 a.	—	—	—	,,	—	—	—	—
,, 16	0 28 05 p.	—	—	—	,,	—	—	—	—
Nov. 1	9 50 26 a.	—	—	—	,,	—	—	—	—
,, 2	3 04 15 p.	—	—	—	,,	—	—	—	—
,, 5	8 15 13 a.	—	—	—	,,	—	—	—	—
,, 5	2 09 51 p.	—	—	—	,,	—	—	—	—
,, 5	4 41 37 p.	3 20	SSE-NNW	1.0	3.3	10.4	65.0	1.0	1.0
,, 5	5 04 02 p.	—	—	—	Slight.	—	—	—	—
,, 5	5 19 20 p.	—	—	—	,,	—	—	—	—
,, 5	7 38 43 p.	—	—	—	,,	—	—	—	—
,, 5	9 18 10 p.	—	—	—	,,	—	—	—	—
,, 5	9 45 37 p.	—	—	—	,,	—	—	—	—
,, 6	6 13 50 p.	—	—	—	,,	—	—	—	—
,, 9	5 45 33 a.	—	—	—	,,	—	—	—	—
,, 9	11 30 48 a.	—	—	—	,,	—	—	—	—

Date.	Time of Occurrece.	Duration.	Horizontal Motion.					Vertical Motion.	
			Direc-rton.	Period of max. mo.	Max. range.	Max. velocity.	Max. acce-leration.	Period of max. mo.	Max. range.
	h. m. s.	m. s.	NNE-SSW	s.	mm.	mm./sec	mm./sec²	s.	mm.
Nov. 10	2 55 26 a.	2 40		0.9	1.6	5.6	38.9	—	—
,, 13	6 15 12 a.	—	—	—	—	Slight.	—	—	—
,, 13	6 32 07 a.	—	—	—	—	,,	—	—	—
,, 15	6 37 54 a.	—	—	—	—	,,	—	—	—
,, 15	8 06 07 a.	—	—	—	—	,,	—	—	—
,, 15	10 53 41 p.	—	—	—	—	,,	—	—	—
,, 17	7 01 07 a.	—	—	—	—	,,	—	—	—
,, 19	4 56 06 p.	—	—	—	—	,,	—	—	—
,, 19	10 58 40 p.	—	—	—	—	,,	—	—	—
,, 24	5 02 08 p.	—	—	—	—	,,	—	—	—
,, 28	2 43 45 a.	—	—	—	—	,,	—	—	—
Dec. 1	0 33 39 p.	—	—	—	—	,,	—	—	—
,, 2	5 29 13 a.	—	—	—	—	,,	—	—	—
,, 4	10 11 18 a.	—	—	—	—	,,	—	—	—
,, 6	2 02 03 p.	—	—	—	—	,,	—	—	—
,, 9	0 42 42 p.	—	—	—	—	,,	—	—	—
,, 17	9 27 57 a.	—	—	—	—	,,	—	—	—
,, 19	9 27 18 p.	—	—	—	—	,,	—	—	—
,, 25	2 09 26 p.	—	—	—	—	,,	—	—	—
,, 30	0 24 54 a.	—	—	—	—	,,	—	—	—

Among these shocks, the strongest was the earthquake of November 5th $4^h\ 41^m\ 37^s$ p. m. The origin was located in the sea of Miyake Island. It began with a preliminary tremor. After 22 seconds from the beginning, the range of motion increased suddenly. At the next second it reached the climax. The range of horizontal motion was 3.3 mm. in the direction SSE–NNW with a period of 1.0 second; the vertical motion had then a range of 1.0 mm. a period of 1.0 second. The total duration was $1^m\ 40^s$. In spite of the large amplitude, the damages were not large, the nature of vibration being slow and weak.

The next shock occurred on May 12th at $2^h\ 24^m\ 10^s$ a.m. After 33 seconds the maximum horizontal motion was observed. Its range was 2,4 mm. its period 0.8 sec. and its direction NE–SW. The vibration continued for $4^m\ 10^s$. This earthquake caused a great catastrophe in the northern portion of Rikuzen; at Tokio the shock was not strong, but some clock pendulums were stopped.

Among others, the earthquake of October 3rd $3^h\ 19^m\ 16^s$ a.m. was somewhat conspicuous. After 9 seconds the maximum horizontal motion appeared having a range

of 30 mm. a period of 0.7 sec. and in the direction WNW–ESE. After 1ᵐ 48ˢ the vibration ceased entirely.

FREQUENCY AND SEASON.

In the present year, the total number of observed earthquakes was 157 which was 65 more than the normal. This could be mainly due to many strong and weak earthquakes which originated under the adjacent seas of Miyake and Ōshima Island. Local shocks in the vicinage of Tokio were only 6.

The following table gives the distribution of earthquakes for each month.

Month.	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total.
Frequency	7	16	23	3	10	24	16	12	6	7	24	9	157

We see from this table that earthquakes were most frequent in June and September amounting to 24, and next in March being 23 times, while they were least in April (4).

The following table gives the distribution of earthquakes for four seasons in percentage :—

Spring.	Summer.	Autumn.	Winter.	Mean.
22.9	33.1	23.6	20.4	25-0

The summer had the greatest number of shocks, and the winter the least, the difference being 12.7. Such greater frequency in the summer was abnormal.

If we divide the year into the cold and hot seasons, 86 shocks occurred in the cold season and 71 in the hot season, the ratio being 1.2 : 1.

TIME OF OCCURRENCE.

The greatest number of shocks observed was 12 in 4–5 p.m.; the next 10 in 5–6 p.m. and 9–10 p.m.; the least in 3–4 a.m., 4–5 a.m. and 8–9 p.m., each being 3. The morning number was 9 shocks more than the afternoon. Again if we take 6 o'clock as the boundary of day and night, then at daytime 27 more shocks than night were observed.

Hour. \ Month.	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Sum.
0–1 a. m..	2	—	1	—	1	1	—	—	—	—	—	1	6
1–2 ,,	—	—	1	—	—	1	1	—	—	1	—	—	4
2–3 ,,	1	1	—	—	1	—	—	1	—	—	2	—	6
3–4 ,,	—	—	—	—	—	1	—	—	—	2	—	—	3
4–5 ,,	—	1	—	—	—	—	—	—	—	2	—	—	3
5–6 ,,	—	—	—	—	1	2	—	—	—	—	1	1	5
6–7 ,,	—	1	1	—	—	1	—	1	—	—	3	—	7
7–8 ,,	—	1	1	1	1	—	3	1	—	—	1	—	9
8–9 ,,	—	1	2	1	1	—	2	—	—	—	2	—	9
9–10 ,,	—	2	1	—	1	1	1	--	—	—	1	1	8
10–11 ,,	—	2	1	—	—	1	—	—	—	—	—	1	5
11–noon.	—	1	1	—	1	1	2	1	1	—	1	—	9
0–1 p. m.	1	1	—	—	—	1	—	—	2	1	—	2	8
1–2 ,,	—	1	2	—	—	—	—	2	—	—	—	—	5
2–3 ,,	—	—	—	—	—	2	—	—	—	—	1	2	5
3–4 ,,	—	—	1	—	—	2	—	1	—	—	1	—	5
4–5 ,,	2	1	1	—	—	1	1	2	1	1	2	—	12
5–6 ,,	—	—	1	—	1	1	3	1	—	—	3	—	10
6–7 ,,	1	—	2	—	—	1	—	—	1	—	1	—	6
7–8 ,,	—	—	2	—	—	1	1	1	—	—	1	—	6
8–9 ,,	—	1	1	—	—	1	—	—	—	—	—	—	3
9–10 ,,	—	1	1	1	1	2	—	—	1	—	2	1	10
10–11 ,,	—	—	2	—	—	2	1	—	—	—	2	—	7
11–.Midnight ..	—	1	1	—	1	1	1	1	—	—	—	—	6
Total	7	16	23	3	10	24	16	12	6	7	24	9	157

DIRECTION OF MOTION.

In only 13 out of 157 shocks, the direction of motion was determined. The direction most frequently observed was SW-NE (4 cases) ; and no shocks had N–S direction. Six earthquakes pointed towards their origins strictly, three made an angle of $22\frac{1}{2}^\circ$ with their origins, one 45° and three $67\frac{1}{2}^\circ$.

The next table shows the direction of their maximum ranges :—

Directoin.....	S-N	SSW-NNE	SW-NE	WSW-ENE	E-W	ESE-WNW	SE-NW	SSE-NNW	Un-certain.	Sum.
Frequency.....	—	2	4	2	1	2	1	1	144	157

NATURE OF SHOCKS.

During this year, at Tōkiō, 8 shocks were brisk, 6 slow and 143 uncertain. In many cases the horizontal motion was observed only ; and in 3 cases both vertical and horizontal motion appeared.

When the mean period of the complete vibration was less than 1 second, the shock was taken as quick, and when greater as slow.

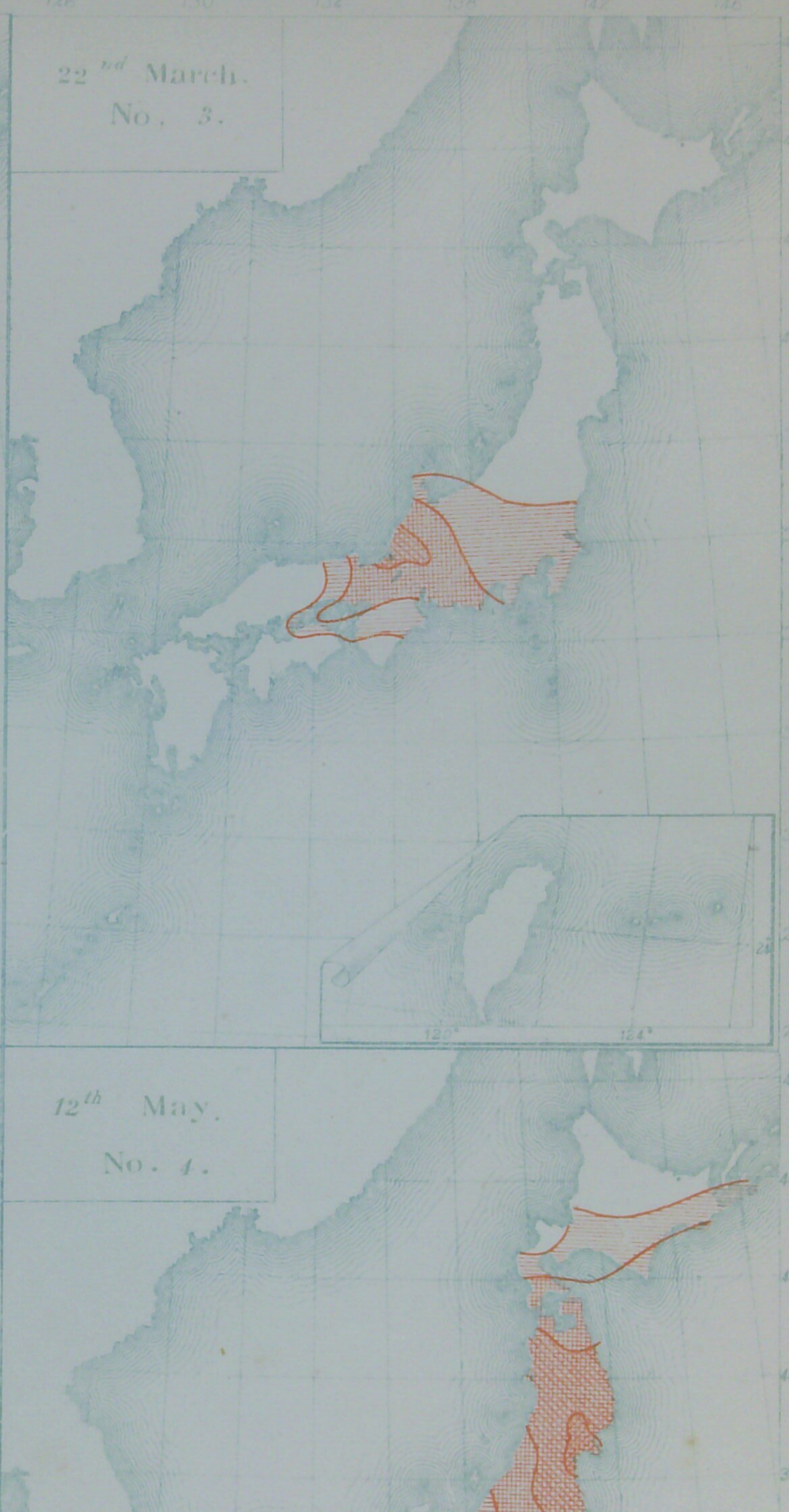
Thus 157 shocks are classified as follows :—

Nature. \ Month.	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Sum.
Vertical & Horizontal.....	1	1	—	—	—	—	—	1	—	—	—	—	3
Horizontal.....	1	—	3	—	2	—	—	1	—	1	3	—	11
Quick.....	2	1	2	—	1	—	—	1	—	1	—	—	8
Slow.....	—	—	1	—	1	—	—	1	—	—	3	—	6
Uncertain.....	5	15	20	3	8	24	16	10	6	6	21	9	143

PRINCIPAL EARTHQUAKES 1900.

17th January.
No. 1.

22nd March.
No. 3.



12th March.
No. 2.

12th May.
No. 4.

12th March. No. 2.

12th May. No. 4.

Slight · Weak · Strong · Violent

PRINCIPAL EARTHQUAKES 1900.

5th August.
No. 2.

15th September.
No. 4.

Slight

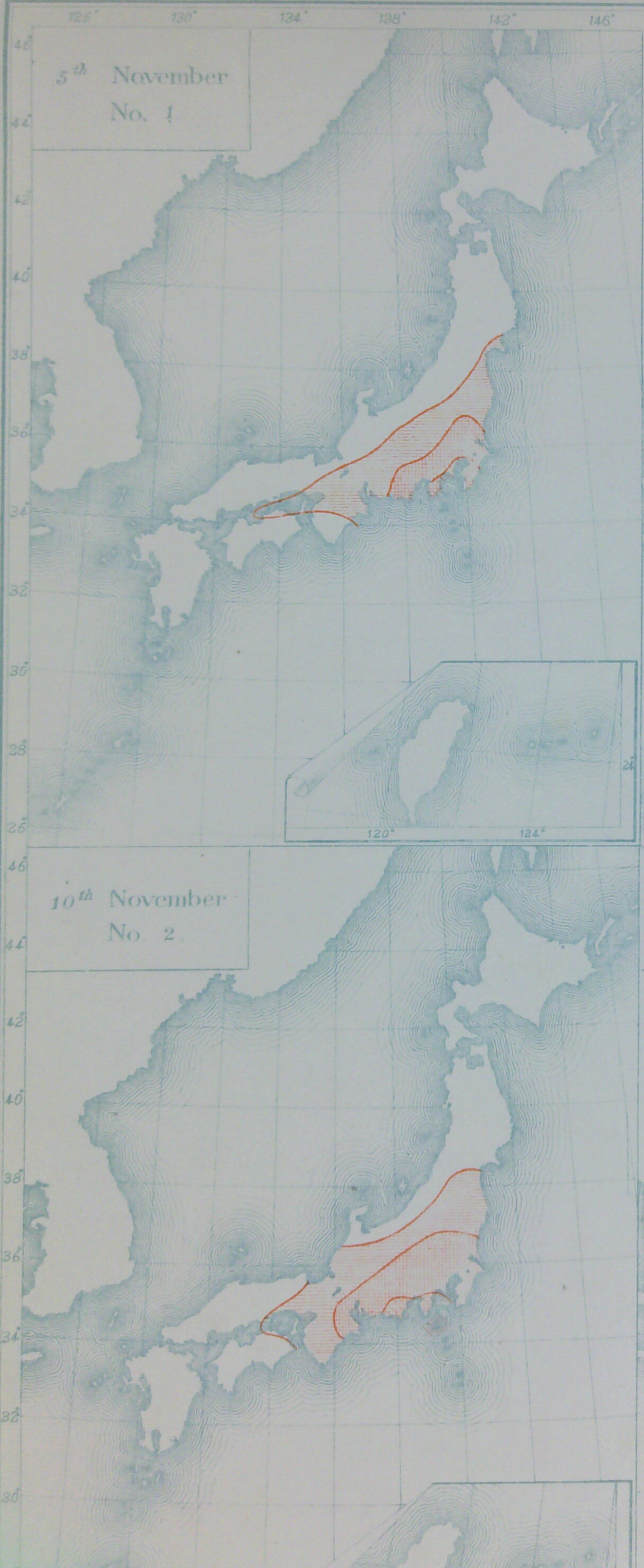
Weak

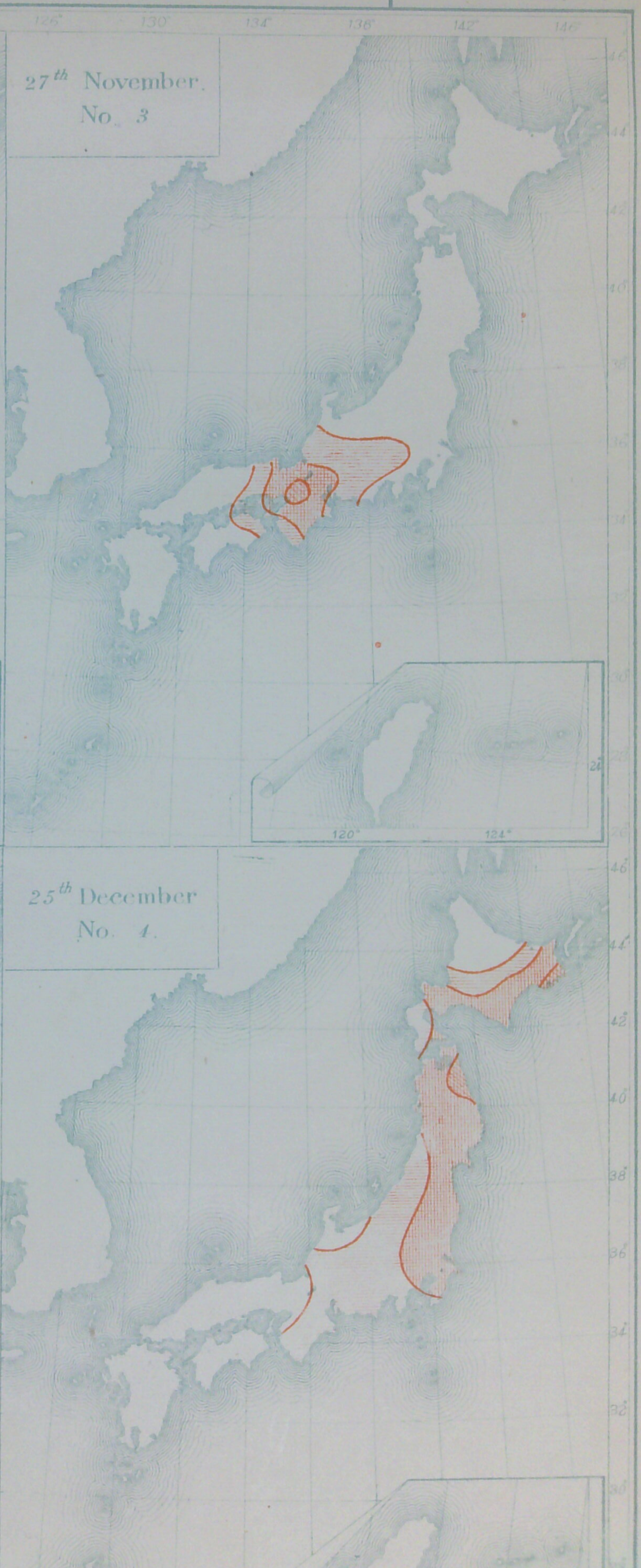
Strong

Violent

PRINCIPAL EARTHQUAKES 1900.

PLATE V.





10th November
No. 2.

25th December
No. 1.

Slight

Weak

Strong

Violent

明治四十二年十一月廿五日印刷
明治四十二年十一月三十日發行

中央氣象臺

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