THE

SEISMOLOGICAL BULLETIN

OF

The Central Meteorological Observatory

OF

JAPAN.

Vol. I. No. I.

July 1922.

Published by
The Central Meteorological Observatory,
TOKYO.

PREFACE.

In issuing a series of our new publication under the title of " The Seismological Bulletin," of which the present is the first number a few words as the way of introduction may not be out of place. Hitherto we published the records and their disscussions of earthquakes observed in Japan in Part 2 of the Annual Report of the Central Meteorological Observatory every year. But with increasing activity of seismological researches in home and abroad it became necessary to issue the earthquake records as quickly as possible, so as to furnish the investigators the necessary data. It also became necessary for us to make the prompt publication of short notes and preliminary reports on seismological subjects prepared by the members of this observatory.

We intend therefore to publish the records of current earthquakes and notes on seismological subjects in this new bulletin which may be regarded as the continuation and extention of Part 2 (earthquakes) of the Annual Report of the Central Meteorological Observatory of Japan.

T. Okada,
Acting director.

CONTENTS.

Seismological Observations in Tokyo.

(Jan.—April. 1922)

$\varphi = 35°41''06''$ N $\lambda = 139°45''04''$ E h = 21.3m Underground : Diluvium (loam)

Instruments : Wiechert Astatic Inverted Pendulum.
Ômori Horizontal Pendulum.

		T_0	ε	$\frac{r}{T_0^2}$	V
	AN :	3.0s	3.2	0.0001 cm/sec²	1400
	AE :	3.0	3.2	0.0001	155
Omori	AE :	17.7	—	0.007	20

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude AN μ	AE μ	Δ km.	Remarks
1	1	Jan	iP	4	54	19				89	Local shock. near Tokyo.
			iS		54	31					
			ME		54	31	0.4		−29		
			MN		54	32	0.6	28			
			F		57	55					
2	1		e	20	05	53				6200	Distant earthquake.
			eS		11	27					By Omoir's Pendulum.
			eL		25	24					
			eF	21	17	—					
3	2		e	21	34	50				—	Felt lightly at Isigakizima. By Omori's Pendulum.
4	4		iP	6	32	53				45	Felt at Tokyo, Yokohama,
			iS		32	59					Utunomiya, Mito, Asio
			MN		33	01	0.4	100			and Tukuba-san.
			ME		33	02	0.3		110		
			F		37	20					
5	6		P	12	44	45				45	Epicenter is near the River-
			eS		44	51					Nakagawa (near Mito).
			MN		44	54	0.4	20			Felt at Utunomiya, Mito and
			ME		44	55	0.5		17		neighborhoods.
			F		46	55					
6	6		P	13	06	32				89	Felt at Mito and Tokyo.

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude AN μ	AE μ	Δ km.	Remarks
		Jan	S	13	06	44					Epicenter is near the Lake
			MN		06	47	—	18			Kasumigaura.
			ME		06	47	—		11		
			F		08	54					
7	6		e	15	18	56	—	—	—	—	Very distant Earthquake.
8	8		iP	23	49	59				450	Volcanic earthquake Origi-
			eS		50	45					nated at Asama.
			MN		51	00	2.8	41			Felt at Usuda and Omae
			ME		51	01	2.9		51		(near Asama)
			MN		52	24	2.4	−32			
			ME		53	32	1.8		18		
			F	24	05	40					
9	9		iP	14	03	19				82	Epicenter is near Mito.
			iS		03	27					
			iL		03	30					
			MN		03	31	1.1	14			
			ME		03	32	1.2		−13		
			F		06	25					
10	10		e	8	29	00	—	—	—	—	Time is uncertain for the shock is too faint for use, origin is very distant.
11	14		eP	3	09	07					Asama Volcanic-earthquake.
			F		11	48					
12	14		P	3	14	52				141	Sound-shock of the strong
			L		15	11					Asama-yama explosion.
			M		15	12	—	7	9		
			eF		16	19					
13	14		iP	5	04	09				89	Felt at Mito and Tyosi.
			iS		04	21					
			ME		04	24	0.4		18		
			MN		04	26	0.6	−9			
			F		09	05					
14	17		eP	4	09	36				6140	Record of distant earthquake.
			eS		17	20					
			eL		27	21					
			ME		29	28	?	488			
			ME		31	12	?	3400			
			CE		34	02	?	175			
			eF	5	45	00					

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude AN μ	AE μ	Δ km.	Remarks
15	19	Jan	eP	22	13	06				3390	Distant earthquake.
			eS		18	16					
			eF		48	00					
16	22		eP	3	40	49				12100	Do.
			eS		53	24					
			eF	4	25	00					
17	22		iP	22	05	56				156	Epicenter is off the eastern coast of Iwaki.
			iS		06	17					
			ME		06	19	1.4		850		Felt in Hokkaido and the northern part of Japan.
			CE		13	24	1.3		240		
			F		24	40					
18	24		iP	10	53	07				45	Felt at Tokyo and Yokohama.
			iS		53	13					
			ME		53	13	0.4		38		
			MN		53	15	0.6	24			
			F		56	25					
19	31		P	13	28	22				8340	Distant earthquake.
			S		37	39					(by Omori's pendulum)
			L		47	46					
			ME		50	41	7.1		375		
			ME		56	42	6.8		605		
			ME		59	16	5.7		−400		
			ME	14	03	17	6.0		320		
			ME		05	19	4.9		295		
			CE		07	31	8.8		−250		
			CE		14	03	7.2		−180		
			eF	15	37	00					
20	1	Feb	iP	4	16	35				160	Near the lake Kasumigaura.
			eS		16	46					
			iL		16	57					
			MN		17	26	2.0	−24			
			ME		17	15	1.2		−36		
			F		21	05					
21	4		iP	23	34	23				390	Near the Islet Hatizyo.
			eS		35	06					
			ME		35	32	1.2		28		
			eF		40	45					

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude A_N μ	A_E μ	Δ km.	Remarks
22	5	Feb	eP	22	21	38				289	Near the River Yosino,
			eL		22	17					Sikoku.
			MN		23	01	3.0	−40			
			eF		29	45					
23	6		iP	11	13	12	(first motion {4 to N, 5 to E)			69	Near Tokyo.
			iS		13	16					
			iL		13	22					
			MN		13	28	1.2	−18			
			ME		13	22	0.7		10		
			F		15	35					
24	7		iP	22	30	13	(first motion {8 to N, 4 to E)			276	Near the Islet Hatizyo.
			eS		30	30					
			iL		30	50					
			MN		30	53	0.9	42			
			ME		30	53	0.8		−41		
			F		35	25					
25	9		P	14	54	28				408	Southern part of Yamato.
			eS		55	05					
			eL		55	23					
			MN		56	21	2.8	81			
			ME		56	11	3.3		28		
			eF	15	04	10					
26	9		iP	23	54	27				70	Off the coast of Sagami.
			iS		54	37					
			MN		54	37	0.4	50			
			ME		54	37	0.6		38		
			F		56	55					
27	10		iP	13	38	44				186	Coast of Iwaki.
			iS		38	54					
			iL		39	09					
			MN		39	27	2.1	50			
			ME		39	29	1.0		45		
			MN		40	31	0.9	−35			
			ME		40	37	2.0		32		
			eF		45	55					
28	11		iP	22	29	41	(first motion {31 to N, 23 to W)			53	Near Tokyo.
			S		29	45					
			iL		29	49					

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude A_N μ	A_E μ	Δ km.	Remarks
		Feb	MN		29	49	0.7	−48			
			ME		29	49	0.5		35		
			F		32	55					
29	12		ePS	14	08	51				237	Iwaki.
			eL		09	23					
			MN		09	28	1.7	−28			
			ME		09	30	0.9		29		
			eF		11	25					
30	12		P	22	06	59				108	Near Tokyo.
			S		07	15					
			MN		07	15	—	20			
			ME		07	16	0.3		−14		
			F		09	45					
31	12		iP	22	11	51				298	Do.
			iS		12	31					
			MN		12	39	1.1	21			
			ME		12	36	0.7		−30		
			MN		13	05	1.4	14			
			ME		13	05	1.7		−10		
			eF		18	10					
32	14		iP	0	44	26				217	Near the Islet Hatizyô.
			iS		44	40					
			eL		44	55					
			MN		45	11	1.1	11			
			ME		45	05	1.2		−8		
			MN		46	01	1.3	−7			
			ME		46	33	1.0		5		
			eF		49	45					
33	14		iP	1	07	51	(first motion {1.4 to S / 0.4 to W)			216	Do.
			S		08	09					
			L		08	20					
			MN		09	18	2.4	54			
			ME		09	12	1.9		51		
			eF		25	00					
34	14		iP	11	51	18				85	Near Tukuba.
			iS		51	24					
			iL		51	30					
			MN		51	32	0.4	10			
			ME		51	32	0.9		−8		

No.	Date Day	Month	Phase	h	Time m	s	Period s	Amplitude A_N μ	A_E μ	Δ km.	Remarks
			F		53	57					
35	15	Feb	iP	1	16	39				173	Eastern part of Iwaki.
			iS		16	53					
			iL		17	02					
			MN		17	07	1.4	70			
			ME		17	41	1.6		−63		
			eF		31	00					
36	22		eP	17	21	36				905	Near the Loo-choo Islands.
			eS		—	—					
			eL		23	38					
			MN		25	18	2.8	27			
			eF		28	25					
37	24		eP	0	57	23				56	Eastern part of Iwaki.
			eL		57	31					
			ME		57	32	1.0		30		
			MN		57	32	0.9	−19			
			F		59	59					
38	28		iP	1	41	23				127	Do.
			iS		41	40					
			MN		41	49	1.2	−35			
			ME		41	50	0.4		45		
			eF		46	55					
39	28		iP	13	59	19				76	Near Tukuba.
			eS		59	26					
			iL		59	30					
			MN		59	31	0.4	21			
			ME		59	32	0.9		23		
			eF	14	03	35					
40	3	Mar	iP	21	28	49	(first motion $\begin{cases} 8 & \text{to N} \\ 4.5 & \text{to E} \end{cases}$)			79	Near Tukuba.
			iS		28	52					
			iL		28	59					
			ME		29	00	—		54		
			MN		29	00	—	−50			
			F		31	20					
41	4		P	13	12	34				1770	Southern part of Kamtchatka.
			S		13	45					
			L		15	16					
			ME		16	16	5.4		−1500		

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude AN μ	AE μ	Δ km.	Remarks
41	4	Mar	ME		18	35	4.2		−1110		
			eF		53	20					
42	5		iP	9	51	57	(first motion	{1.1 to N 0.7 to E}		77	Near Tokyo.
			iS		52	07					
			ME		52	08	0.6		−48		
			MN		52	09	0.8	64			
			eF		54	24					
43	5		iP	23	54	01	(first motion	{4.0 to N 1.1 to E}		46	Do.
			iL		54	07					
			MN		54	07	—	7			
			ME		54	08	—		−9		
			F		56	54					
44	5		e	21	25	16				—	Distant earthquake.
			eF		42	00					
45	7		iP	19	03	30	(first motion	{7 to N 4 to E}		78	Near Tukuba.
			iS		03	38					
			MN		03	38	—	7			
			ME		03	38	—		−5		
			F		05	55					
46	10		e	17	03	01				1450	Distant earthquake.
			eS		05	43					
			eF		32	25					
47	13		e	20	17	42	—	—	—	—	Do.
			eF		23	25					
48	16		iP	18	32	57				231	Off the coast of Hitati.
			iS		33	28					
			MN		33	36	3.8	448			
			ME		33	45	2.1		−83		
			eF		56	35					
49	18		eP	6	43	34				200	Distant earthquake.
			eL		44	01					
			F		46	18					
50	18		P	8	45	35				590	Near the Islet of Hatizyo.
			S		46	40					
			ME		46	47	1.8		142		
			F		47	59					

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude A_N μ	A_E μ	Δ km.	Remarks
51	18	Mar	iP	8	58	33				115	Near Utunomiya.
			S		58	39					
			iL		58	49					
			ME		58	50	—		110		
			F	9	06	39					
52	26		iP	14	38	34	(first motion {4.4 to N, 5.8 to E)			53	
			S		38	43					
			iL		38	52					
			MN		38	53	1.4	−58			
			ME		38	59	1.8		61		
			eF	15	04	10					
53	27		iP	10	54	31	(first motion {4 to S, 3 to W)			92	Near the lake Kasumigaura.
			iS		54	42					
			iL		54	46					
			MN		54	58	0.8	−43			
			ME		56	02	0.7		34		
			eF		—						
54	1	April	iP	5	42	22				90	Near Tukuba.
			iS		42	32					
			MN		42	34	—	−14			
			ME		42	35	—		16		
			eF		43	55					
55	2		iP	23	15	39				255	Near the Islet of Hatizyo.
			S		15	58					
			MN		16	14	0.8	−14			
			ME		16	19	1.1		8		
			eF		18	40					
56	4		iP	12	10	37				92	Near Kohu.
			iS		10	47					
			MN		10	47	—	−7			
			ME		10	48	—		9		
			eF		12	50					
57	5		e	9	10	13	—	—	—	—	Distant earthquake.

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude AN μ	AE μ	Δ km.	Remarks
85	9	April	iP	23	42	28				100	Near the lake Kasumigaura.
			iS		42	37					
			MN		42	38	—	−4			
			ME		42	38	—		7		
			F		43	48					
59	10		iP	13	57	30	(first motion {8 to E, 4 to N)			100	Coast of Kugyukuri.
			iS		57	38					
			iL		57	43					
			MN		58	10	2.7	300			
			ME		58	09	3.1		−2480		
			eF	14	18	00					
60	12		eP	8	11	04				1660	Coast of Kusiro.
			eL		13	28					
			eF		22	00					
61	12		iP	13	37	30	(first motion {4.0 to N, 5.5 to E)			50	Near Tukuba.
			S		37	35					
			iL		37	36					
			ME		37	38	—		120		
			MN		38	38	—	121			
			F		43	10					
62	15		iP	00	54	29				134	Southern part of Iwaki.
			iS		54	41					
			MN		54	41	—	10			
			ME		54	41	—		−6		
			eF		56	54					
63	15		iP	16	40	22				37	Near Tokyo.
			iS		40	27					
			MN		40	28	—	−8			
			ME		40	28	—		6		
			F		42	10					
64	16		iP	10	23	56				82	Do.
			S		24	07					
			MN		24	08	—	−4			
			ME		24	09	—		6		
			F		27	10					

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude AN μ	AE μ	AZ μ	Δ km.	Remarks
65	21	April	iP	4	03	04					90	Near Tokyo.
			iS		03	16						
			MN		03	16		—	1340			
			ME		03	16		—		1340		
			F		09	10						
66	21		iP	6	08	42					123	Near Tukuba.
			S		08	57						
			MN		08	57		—	−8			
			ME		09	00		—		11		
			F		11	10						
67	23		iP	5	05	18					194	Eastern part of Iwaki.
			iS		05	44						
			MN		06	11		1.4	−41			
			ME		06	18		1.2		−34		
			F		20	10						
68	24		iP	16	57	41					66	Near Tokyo. (Foreshock o
			iS		57	50						No. 71)
			MN		57	50		—	−8			
			ME		57	51		—		−12		
			eF		58	50						
69	25		iP	4	55	04					72	Near Tukuba.
			iS		55	14						
			MN		55	14		—	−9			
			ME		55	14		—		8		
			F		57	18						
70	25		e	22	28	58		—	—	—	—	Distant earthquake.
71	26		iP	1	11	36					74	Near Tokyo.
			iS		11	46						
			MN		11	47		—	23350			
			ME		11	47		—		24560		
			F		23	45						
72	26		iP	4	03	00					3493	Near Kamtchatka.
			iS		07	08						(By Omori's Pendulum.)
			eL		10	04						
			ME		16	32		4.4		275		
			ME		25	29		5.4		300		
			F	6	14	00						

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude A_N μ	A_E μ	Δ km.	Remarks
73	26	April	iP	2	19	18				74	Aftershock of No. 71.
			iS		19	28					
			MN		19	28	—	−12			
			ME		19	29	—		13		
			F		21	32					
74	26		iP	2	34	54				74	Do.
			iS		35	04					
			MN		35	05	—	26			
			ME		35	04	—		20		
			F		37	10					
75	26		iP	3	36	53				67	Do.
			iS		37	02					
			MN		37	03	—	18			
			ME		37	04	—		−16		
			F		37	43					
76	26		iP	3	40	04				67	Do.
			iS		40	13					
			MN		40	13	—	12			
			ME		40	13	—		11		
			F		41	00					
77	26		iP	4	30	21				74	Do.
			iS		30	31					
			MN		30	31	—	16			
			ME		30	32	—		13		
			F		31	23					
78	28		iP	00	43	39				140	Off the coast of Kasima.
			eS		43	58					
			MN		44	00	1.4	—			
			ME		44	02	0.9		−36		
			F		47	50					
79	26		iP	5	38	04				74	Aftershock of No. 71.
			iS		38	14					
			MN		38	15	—	11			
			ME		38	14	—		−10		
			F		39	11					

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude AN μ	AE μ	Δ km.	Remarks
80	28	April	iP	3	09	40				74	Aftershock of No. 71.
			iS		09	50					
			MN		09	50	—	−9			
			ME		09	50	—		8		
			F		12	14					
81	28		iP	9	16	05				37	Near Tyosi.
			iS		16	10					
			eL		16	21					
			MN		16	34	—	−15			
			ME		16	54	1.3		−49		
			eF		43	07					
82	28		iP	17	04	15				152	Eastern part of Iwaki.
			iS		04	36					
			MN		04	37	1.3	−57			
			ME		04	38	1.8		86		
			F		07	45					
83	28		iP	19	32	09				71	Northern part of Sagami.
			iS		32	19					
			MN		32	20	0.9	−98			
			ME		32	21	1.1		89		
			F		38	08					
84	28		iP	23	45	28				74	Aftershock of No. 71.
			iS		45	38					
			MN		45	39	0.9	−49			
			ME		45	38	—		78		
			F		46	44					
85	29		iP	2	22	59				74	Do.
			iS		23	09					
			MN		23	10	—	−4			
			ME		23	09	—		9		
			F		28	13					
86	29		iP	16	53	07				172	Near the cape of Sioya.
			iS		53	22					
			L		53	30					
			ME		53	36	1.4		−50		
			F		59	55					

Earthquakes in 1921.

The total number of earthquakes observed in Japan in 1921 is 2859, of which 1435 were felt and 1424 unfelt ones. The regions which were most frequently shaken are Central Formosa, Wakayama, Satuma peninsula and Tukubasan. 150 shocks were observed in the central part of Formosa in a single month of July.

Though the volcanic activity was almost subsided, Mt. Asama erupted in January, May and June. Among the eruptions those occurred on the 18th. and 24th. of January, the 16th. of May and the 4th. and 21st. of June were most remarkable, and were accompanied by more or less precipitation of ashes over the neighbouring districts.

A volcanic Islet called Suwanose near Kagoshima also erupted on the 8th. of December.

The following table contains the number of earthquakes observed in each month :—

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Remarkable	1	0	1	1	0	1	1	0	0	1	0	2	8
Rather Remarkable	3	1	3	4	2	2	6	5	4	3	2	4	39
Small Area	16	7	13	6	6	6	7	7	11	6	11	20	116
Local and others	102	87	108	86	95	87	205	94	79	87	115	127	1272
Total Felt	122	95	125	97	103	96	219	106	94	97	128	153	1435
Unfelt	143	103	121	92	117	128	104	105	113	123	145	130	1424
Total	265	198	246	189	220	224	323	211	207	220	273	283	2859

The scale of the magnitude of earthquake is as follows :—

Remarkable : The semi-major axis of the shaken area is more than 300 km.

Rather Remarkable : The semi-major axis of the shaken area is more than 120 km.

Small Area : The semi-major axis of the shaken area is morn than 60 km.

Local : The semi-major axis of the shaken area is less than 60 km.

Some notable Earthquakes occurred near Japan and the Distant Earthquakes observed in Japan in 1921.

I The earthquake of $7^h\ 7^m$ on the 2nd. Jan. The epicenter was off the south coast of Etrof I., having its approximate co-ordinates 148°.5E and 43°.2N. The shock was felt at Nemuro, Kusiro, Hakodate and Mito.

Otomari			
	h	m	s
P	7	08	18
L		09	11
M		10	05
C		15	29
F		21	28

Hakodate			
	h	m	s
P	7	08	36
L		10	1
ME		11	14
MN		10	9
F		21	41

Mito			
	h	m	s
P	7	09	12
L		11	0
F		32	24

Tyosi			
	h	m	s
P	7	09	15
L		11	10
MN		12	5
ME		11	15
FN		45	9
FE		48	0

Tokyo			
	h	m	s
P	7	09	9
S		10	9
L		11	19
F		22	55

Nagoya			
	h	m	s
P	7	09	50
L		12	35
MN		13	15
C		15	33
F		20	16

Osaka			
	h	m	s
P	7	11	8
L		14	11
ME		15	18
MN		14	59
FE		39	13
FN		40	3

Kobe			
	h	m	s
P	7	10	8
L		13	9
ME		14	27
MN		13	40
CE		16	57
CN		15	39
FE		23	13
FN		29	49

Hukuoka			
	h	m	s
P	7	11	1
L		14	30
F		46	55

II The Earthquake of $9^h\ 47^m$ on 7th. Jan. This may be one of the strongest after-shockes of the great earthquake in Kansu, North China on the 16th. December, 1920.

Hukuoka			
	h	m	s
P	9	46	49
S		50	47
L		52	49

Osaka			
	h	m	s
P	9	47	47
MN		59	52
F	10	19	52

Tokyo			
	h	m	s
P	9	52	54
eS		56	23
eL		58	44
ME_1		58	59
ME_2	10	2	24
CE		4	59
F		11	12

III The earthquake of $14^h\ 53^m$ on the 12th. Jan. The epicenter was in Straite of Bungo. Its coordinates were 131°.9 E. and 33°.5 N.

Hukuoka			
	h	m	s
P	14	53	38
L		53	54
MN		53	55

Osaka			
	h	m	s
P	14	53	51
L		54	39
MN		55	27

Gihu			
	h	m	s
P	14	54	22
L		55	12
F		58	0

Matuyama			
	h	m	s
iP	14	53	36
iL		53	46
M		53	59
F		55	43

IV The earthquake of $21^h\ 50^m$ on the 13th. Jan. The epicenter was near the northern part of the Philippine Islands.

Taihoku

	h	m	s
e	21	59	54
L	22	0	13
F		17	—

Hukuoka

	h	m	s
eP	21	59	10
L	22	1	50
ME		32	20
F		57	6

V The earthquake of $10^h\ 28^m$ on 25th. Jan. The epicenter was off the cap of Esan, Hokkaido. Its co-ordinates are 142°.1 E. and 41°.9 N.

Hakodate

	h	m	s
eP	10	28	10
L		28	27
ME		28	39
MN		28	33
CE		30	16
CN		30	6
F		35	59

Mito

	h	m	s
P	10	29	7
L		30	16
F		32	40

Tyosi

	h	m	s
P	10	29	15
L		30	31
MN		30	34
ME		30	31
CN		33	43
F		34	39

Tokyo

	h	m	s
P	10	29	17
eL		29	48
MN		29	50
ME		29	51
F		21	4

VI The earthquake of $4^h\ 30^m$ on the 6th. Feb. The epicenter was probably near Kamtchatka.

Otomari

	h	m	s
P	4	30	10
L		32	17
F		49	2

Hakodate

	h	m	s
eP	4	31	13
F		38	30

VII The earthquake of $23^h\ 58^m$ on the 10th. Feb. The epicenter was near the Mariana Islands.

Taihoku

	h	m	s
e	23	59	28
L	0	3	25
F		55	—

Hukuoka

	h	m	s
P	23	57	48
L	0	1	40
ME		2	13
F		40	47

Osaka

	h	m	s
P	23	58	21
L	0	1	42
MN		4	1
ME		2	49
FN	1	36	51
FE		35	21

Tyosi

	h	m	s
P	23	58	5
L	0	1	28
MN		2	42
ME		1	46
FN	1	22	25
FE		42	25

Mito

	h	m	s
P	23	58	14
L	0	1	50
F		40	50

Midusawa

	h	m	s
P	23	48	40
L	0	2	34
ME		3	1
MN		2	46
FE		17	—
FN		23	—

Zinsen

	h	m	s
ePN	23	59	26
SN	0	3	47
MN		9	41
FN		20	11

Hakodate

	h	m	s
P	23	59	37
ME	0	0	21
MN		4	30
F		13	52

VIII The earthquake of $1^h\ 6^m$ on the 14th. Feb. The epicenter was off the eastern coast of the Philippine Islands.

Osaka				Midusawa				Hakodate			
	h	m	s		h	m	s		h	m	s
P	1	8	6	P	1	8	6	eP	1	8	24
MN		16	24	S		13	44	S?		14	16
ME		14	58					F		18	16
FN		37	36								
FE		39	26								

IX The earthquake of 3^h0^m on the 14th. Feb. The epicenter was in the eastern districts of Yamanasi prefecture. Its co-ordinates were 139°.0 E. and 35°.5 N. An area of about 15000 sq. km. was strongly shaken and the shock was felt in an area of about 79000 sq. km. This earthquake seems to be accompanied by the following fore and after-shocks :

Fore-shocks				After-shocks			
	15^h	0^m	13th.		3^h	22^m	14th.
	22	45	13th.		8	27	14th.
					8	59	14th.
					16	56	14th.

Tokyo				Mito				Tyosi				Nagoya			
	h	m	s		h	m	s		h	m	s		h	m	s
P	3	0	39	P	2	59	53	P	3	0	51	P	3	0	51
L		0	53	L	3	0	11	L		1	13	LE		1	11
MN_1		0	54	MN		0	16	ME		1	17	LN		1	18
ME_1		0	54	ME		0	21	MN		1	29	MN		1	36
MN_2		1	44	F		12	15	FE		13	28	ME		1	39
ME_2		1	41					FN		14	14	C		4	54
F		8	20									F		13	39

Kobe				Hukuoka				Osaka			
	h	m	s		h	m	s		h	m	s
P	3	1	15	P	3	0	36	P	3	1	27
L		2	4	L		4	14	L		2	10
ME		2	15	MN		4	41	MN		2	20
MN		2	23	ME		4	44	ME		3	3
CE		7	45	F		33	39	FN		23	55
CN		5	32					FE		24	21
FE		18	48								
FN		12	37								

X The earthquake of $14^h\ 38^m$ on the 19th. Feb. This is one of the aftershocks of the Great earthquake in North China.

Zinsen			
	h	m	s
eP	14	38	46
S		42	33
M		47	13
F	15	12	28

Taihoku			
	h	m	s
eP	14	39	56
eS		44	12
L		45	15
M		46	6
F	15	34	—

Fukuoka			
	h	m	s
eP	14	40	49
L		46	30
M		48	41
F	15	37	0

Osaka			
	h	m	s
P	14	41	37
MN		52	18
ME		50	32
FN	15	17	58
FE		16	7

Tyosi			
	h	m	s
eP	14	42	26
L		49	14
MN		51	19
ME		49	27
FN	15	15	49
FE		16	4

Mito			
	h	m	s
P	14	41	15
S		46	53
L		52	7
F	15	11	30

Otomari			
	h	m	s
P	14	44	41
L		49	43
F	15	13	55

XI The earthquake of $18^h\ 21^m$ on the 19th. Feb. This is another aftershock of the great earthquake in North China.

Zinsen			
	h	m	s
P	18	22	21
eS		26	34
M		32	1
F		52	25

Taihoku			
	h	m	s
eP	18	21	9
eS		26	10
L		28	46
M_1		29	0
M_2		29	56
M_3		31	45
M_4		33	30
F	19	34	—

Hukuoka			
	h	m	s
P	18	21	6
L		27	25
M_1		30	42
M_2		33	35
F	19	37	36

Kobe			
	h	m	s
P	18	21	48
S		27	9
L		32	4
ME		32	7
MN		34	22
CE		55	20
CN		45	59
FE	19	1	59
FN		1	59

Osaka			
	h	m	s
P	18	20	54
MN		32	18
ME		34	42
FN	19	14	14
FE		14	24

Tokyo			
	h	m	s
P	18	21	18
S		21	29
L		21	35
ME		21	36
MN		21	37
F		23	50

Tyosi			
	h	m	s
eP	18	21	58
S		27	43
L		31	6

Mito			
	h	m	s
P	18	21	56
S		27	57
L		31	36
M		32	37
F	19	35	10

Midusawa			
	h	m	s
P	18	22	22
S		28	35
ME		38	12
MN		35	52
FE		55	—
FN	19	14	—

Otomari			
	h	m	s
P	18	23	54
L		30	47
F		47	48

XII The earthquake of $18^h\ 35^m$ on the 27th. Feb. The epicentre was at a distance of about 8000 km. from Tokyo.

Otomari				Hakodate				Midusawa				Mito				Tyosi			
	h	m	s		h	m	s		h	m	s		h	m	s		h	m	s
PN	18	35	24	eP	18	35	5	P	18	35	0	P	18	34	54	P	18	35	11
L		45	4	ME		36	24	S		44	22	S		44	6	S		44	25
ME	19	3	37	MN		36	24	ME		58	44	L		52	39	L		56	35
FN		13	20	F		50	57	MN		58	44	MN		53	20	M		57	55
								FE	19	19	—	ME		55	12	F	19	27	50
								FN		49	—	F		54	10				

Tokyo				Osaka				Kobe				Hukuoka				Taihoku			
	h	m	s		h	m	s		h	m	s		h	m	s		h	m	s
P	18	34	52	P	18	35	8	P	18	35	0	P	18	35	11	P	18	45	25
S		44	9	S		44	32	S		44	21	S		45	6	S		50	36
ME		46	14	L		53	42	L		54	0	L		57	58	L		56	33
MN		46	9	MN		59	23	M_1		58	53	M	19	0	48	M_1	19	2	10
F	19	44	—	ME		58	59	M_2	19	6	43	F	20	2	11	M_2		5	53
				FN	19	45	5	C		16	28					F	20	19	—
				FE		46	8	F		31	0								

XIII The earthquake of $3^h\ 2^m$ on the 3rd. March. The epicenter was in the eastern part of Hukusima prefecture, having its co-ordinates 140.9 E and 37°.5 N. An area of 25000 sq. km. was strongly shaken, the shock was felt over an area of 630000 sq. km.

Mito				Tyosi				Tokyo				Midusawa				Hakodate			
	h	m	s		h	m	s		h	m	s		h	m	s		h	m	s
P	3	2	53	P	3	2	55	P	3	2	57	P	3	2	47	P	3	3	29
L		3	12	L		3	21	L		3	23	L		3	12	L		4	17
MN		3	53	ME		3	48	F		—	—	F		52	—	ME		5	47
ME		3	53	MN		4	0									MN		5	41
F		36	15													CE		10	55
																CN		10	55
																F		29	5

Osaka				Kobe				Otomari				Hukuoka			
	h	m	s		h	m	s		h	m	s		h	m	s
P	3	3	52	iP	3	3	51	P	3	4	12	P	3	4	37
L		5	28	S		4	28	L		6	8	L		7	4
MN		5	47	L		5	21	M		8	43	MN		8	10
ME		6	33	ME_1		6	50	C		14	32	ME		8	42
FN		53	44	ME_2		8	29	F		34	16	F		52	1
FE		52	27	MN_1		6	15								
				MN_2		7	31								
				CE_1		11	46								
				CE_2		15	32								
				CN_1		11	28								
				CN_2		14	59								
				F		44	3								

XIV The earthquake of $8^h\ 27^m$ on the 3rd. March. The epicenter was near New Guinea.

Taihoku				Osaka				Midusawa			
	h	m	s		h	m	s		h	m	s
eP	8	28	0	P	8	29	18	P	8	30	26
eS		29	21	L		36	53	S		38	9
L		36	18	MN		39	10	FE	9	4	—
F	9	6	—	F	9	2	53	FN		6	—

XV The earthquake of $6^h 33^m$ on the 5th. March. The epicenter was near New Guinea.

Osaka				Kobe			
	h	m	s		h	m	s
P	6	33	7	eP	6	42	55
MN		58	2	L		51	32
ME		37	11	C	7	2	10
FN	7	28	2	F		13	54
ME		27	37				

XVI The earthquake of $1^h\ 34^m$ on the 24th. March. The position of the epicenter is near the Caroline Islands.

Nagano				Osaka			
	h	m	s		h	m	s
iP	1	33	39	P	1	33	30
iS		40	18	L		39	45
				MN		41	50
				F	2	4	53

XVII The earthquake of $14^h\ 46^m$ on the 24th. March. The epicenter was near Kamtchatka.

Otomari				Hakodate				Midusawa				Mito				Tyosi			
	h	m	s		h	m	s		h	m	s		h	m	s		h	m	s
PN	14	44	23	eP	14	45	42	P	14	45	54	P	14	46	24	P	14	46	17
L		46	38	ME		46	19	L		49	3	L		49	57	L		49	53
MN		47	27	MN		49	2	ME		51	29	F	16	2	15	MN		50	34
ME		48	17	F	15	2	6	MN		51	46					ME		50	10
C		50	19					FE	15	26	—					FN	16	10	12
F	15	30	5					FN		25	—					FE	15	26	56

Tokyo				Osaka				Kobe				Hukuoka				Nagasaki			
	h	m	s		h	m	s		h	m	s		h	m	s		h	m	s
P	14	47	? —	P	14	47	1	P	14	47	0	P	14	47	27	P	14	47	45
S		49	7	L		51	15	LE		51	29	L		53	37	L		53	20
L		51	5	MN		52	1	LN		51	13	F	15	49	51	F	15	18	56
MN_1		51	16	ME		53	32	ME		52	9								
ME_1		51	32	FN	16	7	31	MN		51	20								
MN_2		52	27	FE		8	31	CE	15	4	36								
ME_2		52	41					CN		4	58								
MN_3		53	50					FE		28	5								
ME_3		55	48					FN		22	51								
ME_4		55	59																
F	15	57	—																

XVIII The earthquake of 22^h14^m on the 29th. March. The epicenter was near Kamtchatka.

Otomari				Hakodate				Midusawa				Tokyo			
	h	m	s		h	m	s		h	m	s		h	m	s
PN	22	14	38	eP	22	14	4	P	22	14	9	P	22	14	6
L		16	24	eL		16	8	L		18	50	eL		19	28
ME		17	29	ME		16	42	ME		19	4	F		58	—
MN		18	22	F		28	4	MN		19	31				
C		27	21					FE	23	0	—				
F		54	23					FN		27	—				

Osaka				Kobe				Hukuoka			
	h	m	s		h	m	s		h	m	s
P	22	15	52	eP	22	14	37	P	22	16	22
S		19	19	LE		20	44	L		23	1
L		21	32	LN		20	50	M		26	10
MN		22	54	ME		21	14	F	23	21	30
ME		22	20	CE	23	4	8				
FN	23	30	17	CN	22	42	14				
FE		27	4	FE	23	34	2				
				FN		12	45				

XIX The earthquake of $15^h\ 10^m$ on the 30th. March. The epicenter was near New Guinea.

Taihoku				Hukuoka				Zinsen				Osaka			
	h	m	s		h	m	s		h	m	s		h	m	s
e	15	9	34	PE	15	9	44	PN	15	10	10	P	15	10	5
L		13	32	S		15	45	S		14	29	S		16	14
F	16	0	—	L		18	55	M		20	27	MN		19	45
				M		21	21	F		51	50	FN		49	35
				F	16	7	55					FE		48	15

Tyosi

	h	m	s
P	15	10	11
L		16	33

Midusawa

	h	m	s
P	15	10	37
S		17	21
MN		28	0
FE		50	—
FN		50	—

Hakodate

	h	m	s
eP	15	10	18
F		17	26

XX The earthquake of $4^h\ 16^m$ on the 1st. April. The epicenter was near the Mariana Islands.

Taihoku

	h	m	s
e	4	18	19
S		21	19
L		25	53
M_1		24?	30
M_2		30	9
F	5	14	—

Hukuoka

	h	m	s
P	4	16	58
L		27	30
M_1		30	21
M_2		36	6
F	5	26	47

Osaka

	h	m	s
P	4	16	17
S		25	47
L		33	47
M		38	6
F		44	12

Zinsen

	h	m	s
P	4	14	41
S		24	3
M		32	1
F	5	24	24

Tokyo

	h	m	s
eP	4	15	59
S		26	45
L		36	47
ME_1		37	38
ME_2		41	33
ME_3		42	13
ME_4		44	32
ME_5		45	4
CE_1		48	49
CE_2		51	41
CE_3		54	49
CE_4		57	1
F	5	20	—

Midusawa

	h	m	s
P	4	16	1
eS		23	13
ME		43	24
MN		36	41
FE	5	12	—
FN		12	—

Otomari

	h	m	s
P	4	32	46
S		36	8
L		39	22
M		41	27
C		46	46
F	5	0	20

Kobe

	h	m	s
P	4	15	35
L		30	54
ME_1		35	49
ME_2		39	54
MN		33	20
CN		47	48
CE		8	44
FE		36	36
FN		53	54

XXI The earthquake of $12^h\ 9^m$ on the 1st April. The epicenter was about 6000 km. from Japan.

Midusawa

	h	m	s
P	12	10	0
eS		17	37
MN		28	35
FN	13	9	—

Tokyo

	h	m	s
P	12	9	44
iS		15	19
L		24	15
ME_1		26	38
ME_2		30	12
CE		37	31
F	13	14	—

Osaka

	h	m	s
P	12	10	7
S		17	39
L		24	47
M		27	20
F		12	5

Kobe

	h	m	s
P	12	9	54
S		17	29
LE		20	36
LN		21	48
CE		30	43
CN		36	46
FE		51	16
FN		55	23

XXII The earthquake of $9^h\ 36^m$ on the 2nd. April. The epicenter was far off the east coast of Formosa, having its co-ordinates 123°.4 E. and 22°.6 N. The shaken area was about 180000 sq. km.

Taihoku				Nagasaki				Kobe				Tokyo				Tyosi			
	h	m	s		h	m	s		h	m	s		h	m	s		h	m	s
P	9	37	54	P	9	39	34	P	9	40	17	P	9	40	59	P	9	41	5
L		38	49	L		42	55	SE		42	4	S		43	25	L		44	38
M		39	50	M		45	25	SN		43	5	L		44	24	FN	10	22	19
F	10	13	—	F	10	6	26	LE		46	36	ME_1		44	54	FE		46	24
								LN		46	14	ME_2		45	35				
								ME		47	29	ME_3		46	33				
								MN		47	13	MN_1		44	42				
								FE	10	33	16	MN_2		45	19				
								FN		19	46	MN_3		46	1				
												MN_4		46	27				
												CE_1		47	22				
												CE_2		48	42				
												CN_1		47	18				
												CN_2		47	43				
												CN_3		48	10				
												FE	10	5	—				
												FN		3	—				

Mito				Midusawa				Hakodate				Otomari			
	h	m	s		h	m	s		h	m	s		h	m	s
P	9	41	7	P	9	41	27	eP	9	41	54	P	9	42	33
L		44	33	L		45	14	L?		46	4	S		47	10
MN		47	10	ME		51	51	ME		46	36	L		49	39
F	10	12	20	MN		50	55	F		55	21	M		53	59
				FE	10	12	—					C	10	7	13
				FN		24	—					F		18	31

XXIII The earthquake of $9^h\ 45^m$ on the 12th. April. The epicenter was in North China.

Taihoku				Zinsen				Osaka			
	h	m	s		h	m	s		h	m	s
e	9	44	40	P	9	40	22	P	6	46	14
L		47	12	S		43	57	MN		52	47
F	10	7	—	L		46	27	ME		53	50
				F	10	4	10	FN		12	36
								FE		17	0

XX IV The earthquake of $17^h\ 59^m$ on the 18th. Aprli. The epicenter was near

Oita, having its co-ordinates 131°.9 E and 32°.7 N. An area of about 25000 sq. km. was shaken weakly, and the total shaken area was about 60000 sq. km.

A landslip was occurred by the shock along the railway from Oita to Saegi, as the earthquake occurred after rainy days. Unfortunately a train, which arrived there two and half hours later, overturned and two engineers were wounded.

Nagasaki				Hukuoka				Kagosima				Kobe			
	h	m	s		h	m	s		h	m	s		h	m	s
P	17	59	9	P	17	59	21	P	17	59	18	P	18	0	3
L		59	24	L		59	42	L		59	38	SE		0	24
M		59	40	MN		59	53	M	18	0	28	SN		0	27
F	18	2	58	F	18	7	9	C		0	38	LE		0	40
								F		8	52	LN		0	48
												ME		0	47
												MN		0	49
												CE		3	51
												CN		4	34
												FE		9	42
												FN		10	40

Osaka				Tokyo				Midusawa			
	h	m	s		h	m	s		h	m	s
P	18	0	3	P	18	0	50	P	17	3	42
L		0	46	S		1	16	L		4	8
MN		1	15	L		1	26	ME		4	12
ME		1	22	MN		1	48	MN		4	12
FN		12	47	F		3	50	FE		7	—
FE		13	28								

XXV The earthquake of 7^h 10^m on the 25th. April. The epicenter was in the Bungo strait, having its co-ordinates 131°.9 E and 35°.7 N. The shock was felt over an area of about 68000 sq. km.

Hukuoka			Nagasaki			Kobe			Osaka		
	h	m	s	h	m	s	h	m	s	h	m	s
P	7	11	15	P	7	11	17	P	7	11	44	P	7	12	17
L		11	28	L		11	36	L		12	13	MN		14	41
MN		11	30	F		13	42	ME		12	31	ME		14	41
F		14	16					MN		12	29	FN		26	12
								C		13	37	FE		26	52
								F		15	30				

XXVI The earthquake of 12^h 29^m on the 11th. May. The epicenter was in the eastern part of Hukusima prefecture, having its co-ordinates 141°.1 E and 37°.5 N.

An area of about 19000 sq. km. was shaken weakly and the total shaken area was about 90000 sq. km.

Midusawa				Mito				Tyosi				Tokyo			
	h	m	s		h	m	s		h	m	s		h	m	s
eP	12	29	58	P	12	29	59	P	12	30	6	P	12	29	54
L		30	15	L		30	18	L		30	30	S		30	8
ME		30	16	MN		30	19	M		30	39	L		30	22
MN		30	22	F		31	21	FN		32	31	ME_1		30	23
FE		36	—					FE		32	56	ME_2		30	34
FN		34	—									CE		31	00
												F		33	10

XXVII The earthquake of $11^h\ 53^m$ on the 13th. May. The epicenter was central Sagami, having its co-ordinates 139°.5 E. and 35°.4 N. The total shaken area was about 19000 sq. km.

Tokyo				Mito				Tyosi				Osaka			
	h	m	s		h	m	s		h	m	s		h	m	s
P	11	53	30	P	11	53	41	P	11	53	43	P	11	54	13
L		53	37	L		53	55	L		53	57	L		54	49
ME_1		53	37	MN		54	5	MN		54	11	MN		55	25
ME_2		54	2	F		57	28	ME		54	16	F	12	3	3
F		59	15					FN		56	22				
								FE		56	47				

XXVIII The earthquake of $8^h\ 45^m$ on the 21st. May. The epicenter was far off the east coast of the Philippine Islands.

Taihoku				Hukuoka				Osaka				Tokyo				Zinsen			
	h	m	s		h	m	s		h	m	s		h	m	s		h	m	s
e	8	45	24	P	8	46	58	P	8	47	22	P	8	48	0	P	8	48	26
L		47	41	S		50	58	S		51	29	S		53	20	S		52	53
M		51	21	L		53	30	MN	9	3	25	eL		57	28	M	9	1	43
F	10	16	—	ME		57	19	ME		0	29	MN_1		58	0	F		28	43
				F	9	55	45	FN	10	2	26	ME_1		58	17				
								FE		3	32	MN_2		59	43				
												ME_2		59	47				
												MN_3	9	0	23				
												ME_3		0	37				
												MN_4		1	24				
												ME_4		3	9				
												CE_1		6	24				
												CN_1		3	40				
												CE_2		7	41				
												CE_3		12	40				
												CE_4		16	38				
												F		55	—				

XXIX The earthquake of $22^h\ 29^m$ on the 21st. May. The epicenter was near the Kurile Islands. The shock was recorded at nearly all the stations in Japan, but it was felt nowhere.

Hakodate

	h	m	s
P	22	29	9
S		29	35
L		32	50
MN		33	23
CN		34	55
F		45	35

Mito

	h	m	s
P	22	30	57
L		33	14
MN_1		35	26
MN_2		38	29
ME		37	59
F	0	30	18

Tokyo

	h	m	s
P	22	30	1
L		33	20
LE		35	13
F	0	25	—

Osaka

	h	m	s
P	22	30	36
S		34	36
MN		40	55
ME		39	34
FN	23	42	29
FE		42	29

Kobe

	h	m	s
eP	22	30	33
L		37	27
C		45	15
F	23	7	4

Hukuoka

	h	m	s
P	22	31	1
S		35	26
L		38	16
ME		43	21
F	23	52	4

Zinsen

	h	m	s
P	22	32	8
S		36	36
M		42	50
M		45	36
F	23	11	36

Otomari

	h	m	s
P	22	28	7
L		30	18
MN		31	9
ME		31	30
C		40	9
F	23	1	4

XXX The earthquake of $4^h\ 47^m$ on the 14th. June. The epicenter was on the coast of Iwaki, having its co-ordinates 141°.0 E. and 37°.2 N. The shiken area was about 60000 sq. km.

Mito

	h	m	s
P	4	47	26
L		47	40
MN		48	1
ME		47	59
F		58	22

Tokyo

	h	m	s
P	4	47	41
S		48	8
L		48	32
MN_1		48	35
MN_2		50	19
CN_1		52	37
CN_2		54	1
F	5	0	—

Numadu

	h	m	s
eP	4	47	58
L		48	42
F		56	41

Hakodate

	h	m	s
P	4	49	19
S		49	48
L		50	8
ME		50	24
MN		50	33
CE		52	55
F		57	24

Osaka

	h	m	s
P	4	49	23
L		50	18
MN		51	6
F	5	1	33

Midusawa

	h	m	s
P	4	47	32
L		47	58
ME		48	24
MN		48	15
FE		58	—
FN		56	—

XXXI The earthquake of 11^h23^m on the 22nd. June. The epicenter was to the south of Cape of Erimo, having its co-ordinates 143°.0 E. and 41°.3 N. The total shaken area was 226000 sq. km.

Hakodate

	h	m	s
P	11	23	15
L		23	44
ME		23	51
MN		23	51
F		39	54

Midusawa

	h	m	s
PE	11	24	16
L		25	3
ME		26	9
MN		25	57
FE		42	—
FN		40	—

Otomari

	h	m	s
P	11	24	16
L		24	43
C		28	36
F		35	58

Mito

	h	m	s
P	11	24	55
L		26	12
F		38	15

Tyosi

	h	m	s
P	11	25	10
L		26	26
M		27	33
FN		37	23

Tokyo

	h	m	s
P	11	24	52
S		25	36
L		26	50
ME_1		27	12
ME_2		28	7
ME_3		30	4
CE		32	57
F		56	—

Osaka

	h	m	s
P	11	26	47
L		28	30
MN		29	25
ME		29	40
FN		51	45
FE		49	17

XXXII The earthquake of $14^h\ 20^m$ on the 4th. July. The epicenter was far off the coast of Vladivostok, having its co-ordinates 133°.4 E. and 41°.2 N. Though it was recorded in seismograms at nearly all the stations in Japan, it was slightly felt only at Mito, Hukusima and Hakodate.

Otomari

	h	m	s
P	14	22	48
L		26	32
M_1		26	36
M_2		26	49
C		31	0
F		46	13

Hakodate

	h	m	s
P?	14	21	30
S?		23	30
F		35	59

Midusawa

	h	m	s
P	14	21	21
L		24	1
ME		24	2
MN		24	7

Mito

	h	m	s
P	14	20	42
L		22	22
MN		22	57
F		51	19

Tyosi

	h	m	s
P	14	20	39
L		22	25
MN		22	34
ME		22	38
FN		47	0
FE		50	4

Tokyo

	h	m	s
P	14	20	31
S		22	23
L		23	32
ME_1		23	41
MN_1		23	50
MN_2		25	52
MN_3		28	1
ME_2		28	29
MN_4		29	13
CN		34	51
F		52	20

Osaka

	h	m	s
P	14	20	56
L		22	58
MN		23	22
ME		23	0
FN	15	16	21
FE		14	21

Kobe

	h	m	s
P	14	20	44
L		22	43
M		22	50
C		36	16
F		48	31

Hukuoka

	h	m	s
P	14	21	3
L		23	12
ME		23	35
MN		23	42
F	15	13	26

Nagasaki

	h	m	s
P	14	21	13
L		23	28
M		23	33
F		33	32

Taihoku

	h	m	s
P	14	22	12
L		25	23
F		49	—

XXXIII The earthquake of $18^h\ 11^m$ on the 15th. July. The epicenter was fa off the east coast of the Philippine Islands.

Taihoku

	h	m	s
P	18	11	23
L		15	29
F		43	—

Osaka

	h	m	s
P	18	12	53
MN		21	0
ME		19	18
FN		48	23
FE		53	58

Tokyo

	h	m	s
eP	18	13	15
MN_1		19	38
ME		22	34
MN_2		24	6
F		55	20

Mito

	h	m	s
P	18	13	37
L		18	31
F		40	23

Midusawa

	h	m	s
P	18	13	35
S		19	21
FE		32	—

Hakodate

	h	m	s
P	18	13	5
S		19	24
ME		20	3
F		26	24

XXXIV The earthquake of $15^h\ 4^m$ on the 29th. July. The epicenter was off the south east coast of Formosa. The probable shaken area was about 63000 sq. km

Taihoku

	h	m	s
e	15	5	31
L		6	11
M		6	13
F		18	—

XXXV The earthquake of $10^h\ 38^m$ on the 9th. August. The epicenter was off cape of Erimo, having its co-ordinates 144°.2 E. and 41°.5 N. The shaken area was about 120000 sq. km.

Otomari

	h	m	s
P	10	39	7
F		52	36

Hakodate

	h	m	s
P	10	39	18
L		40	8
ME		40	21
MN		41	4
CE		44	28
CN		44	37
F		54	38

Akita

	h	m	s
P	10	39	29
L		40	50
F		48	2

Niigata

	h	m	s
P	10	40	0
S		40	52
L		41	50
ME_1		42	37
MN_1		42	51
ME_2		43	19
ME_3		43	49
MN_2		44	58
F		56	23

Mito				Tokyo				Osaka				Midusawa			
	h	m	s		h	m	s		h	m	s		h	m	s
P	10	40	6	P	10	40	9	P	10	41	27	PE	10	39	30
L		41	28	S		40	59	L		46	2	LE		40	29
F	11	3	10	L		41	43	MN		48	24	ME		40	34
				MN_1		44	29	ME		46	39	FE		57	—
				ME		43	4	FN	11	7	27				
				MN_2		44	39	FE		9	42				
				MN_3		45	2								
				F	11	20	25								

XXXVI The earthquake of $20^h\ 18^m$ on the 27th. August. The epicenter was off the coast of Hidaka, Hokkaido, having its co-ordinates 142°.6 E. and 41°.5 N. The shaken area was about 120000 sq. km.

Hakodate				Mito				Tyosi				Tokyo			
	h	m	s		h	m	s		h	m	s		h	m	s
P	20	18	41	P	20	19	12	P	20	20	3	P	20	20	20
L		19	5	L		20	11	L		21	9	S		20	50
ME		19	29	F		28	15	M		22	3	L		21	27
MN		19	14									ME		22	4
CE		21	2									MN		22	36
CN		20	52									F		28	50
F		29	59												

XXXVII The earthquake of $11^h\ 21^m$ on the 28th. August. The epicenter was the same as that of the earthquake of $20^h\ 18^m$. The shaken area was 120000 sq. km. and the area weakly shaken was 60000 sq. km.

Hakodate				Midusawa				Tyosi				Tokyo			
	h	m	s		h	m	s		h	m	s		h	m	s
P	11	23	44	P	11	24	20	eP	11	21	49	eP	11	25	42
L		24	1	L		24	51	L		22	59	eL		26	13
ME		24	38	ME		24	58	M		23	37	eMN		27	43
MN		24	19	MN		25	0					eME		27	19
F		31	23	FE		33	—					eF		30	10
				FN		31	—								

XXXVIII The earthquake of $12^n\ 28^m$ on the 5th september. The epicenter was to the west of the cape of Erimo. The shaken area covered the southern half of Hokkaido.

Hakodate				Sapporo				Midusawa			
	h	m	s		h	m	s		h	m	s
eP	12	29	33	iP	12	29	58	P	12	29	52
L		29	56	iS		30	4	L		30	36
ME		30	4	LE		34	11	ME		30	59
MN		30	9	F		34	1	MN		31	5
F		34	45					F		34	—

XXXIX The sea-shock felt near the Kurile Islands. The following is an abstruct from the Report of Nemuro Observatory on the sea-shock felt near the Kurile Islands :—

" Captain E. Usawa of the " ss. Uruppu-maru " visited the observatory and told of a sea-shock felt on board the steamer. " s.s. Uruppu-maru " left the port of Nemuro on the 17th. of August and returned there on the 10th. of September. At $5^h\ 10^m$ am. all the crews were astonished by a shock as if the ship struck on a bank, when she was sailing to Broughton bay from Ketoy Island, and was just at a point 152°. 19′ E and 47° 14′.5 N. The depth of sea was 200 f. Nearly all oil lamps fell down, the filaments of electric lamps were broken and a lid of a kettle was turned back.

The coast of Ketoy and Sinsiri islands were covered by the dark dust and the out line of the islands could not observed. For a while it become so dusty that it was unable to keep eyes open. At the north-western end of Sinsiri island a large landslip was observed.

The captain observed an unusually large amount of smoke ejected from the crater of Sinsiri Island, before the shock was felt After the first shock was felt 7 others were felt on board before the ship entered the bay, and at 6^h15^m am. 4 shocks were felt in the bay. It was told that at Sinsiri Island also an unusually violent shock was felt this morning.

Uruppu-maru sailed from the bay and no more shocks were felt."

XC The earthquake of $4^h\ 9^m$ on the 11th. Sept. The epicenter was near Batavia ?

Taihoku				Nagasaki				Hukuoka				Osaka				Tokyo			
	h	m	s		h	m	s		h	m	s		h	m	s		h	m	s
eP	4	9	0	P	4	10	10	P	4	10	28	P	4	10	48	P	4	11	3
S		14	59	S		17	1	S		16	50	S		17	51	S		17	23
L		21	22	L		20	49	L		24	3	L		24	46	L		24	29
M		24	12	ME_1		21	8	ME		30	5	MN		31	7	ME_1		27	2
F	7	35	—	MN_1		21	19	MN		34	44	ME		32	11	ME_2		33	51
				MN_2		29	36	F	6	5	1	FN	5	57	57	ME_3		41	24
				ME_2		32	2					FE		59	46	ME_4		44	59
				MN_3		34	6									F	7	38	—
				ME_3		34	44												
				F	6	12	40												

Mito				Midusawa				Hakodate				Otomari				Zinsen			
	h	m	s		h	m	s		h	m	s		h	m	s		h	m	s
P	4	11	2	eP	4	11	25	eP	4	11	44	P	4	12	10	P	4	7	34
S		18	32	S		19	13	L?		19	57	L		20	41	S		14	44
L		25	1	MN		35	25	ME		20	21	M		42	17	L		21	44
ME		33	45	F	5	56	—	MN		20	26	C	5	5	15	M		30	44
F	6	26	32					F	5	3	7	F		37	47	F		30	0

XCI The earthquake of $2^h\ 12^m$ on the 10th. Oct. The epicenter was near the western part of New Guinea.

Taihoku				Hukuoka				Kobe				Osaka				Hakodate			
	h	m	s		h	m	s		h	m	s		h	m	s		h	m	s
e	2	12	41	P	2	13	24	eP	2	1	12	P	2	13	18	eP	7	13	32
L		17	45	M		21	59	LE		17	11	MN		23	52	F		20	39
F	3	20	—	F		49	17	LN		17	13	ME		21	56				
								FE		40	6	FN		58	28				
								FN		43	16	FE	3	3	23				

XCII The earthquake of $7^h\ 52^m$ on the 12th. Oct. The epicenter was far off the east coast of Hokkaido, having its co-ordinates 146°.5 E. and 42°.2 N. The shaken area was about 500000 sq. km.

Otomari				Hakodate				Midusawa				Mito			
	h	m	s		h	m	s		h	m	s		h	m	s
P	7	53	23	eP	7	53	54	P	7	54	17	P	7	55	11
L		54	10	L		55	5	L		55	51	L		57	33
MN		54	17	ME		56	6	ME		56	7	MN		58	31
ME		54	24	MN		55	50	MN		56	24	F	8	7	15
C		59	20	F	8	7	1	FE	8	11	—				
FN	8	7	55					FN		13	—				
FE		8	40												

Tyosi				Tokyo				Osaka				Hukuoka			
	h	m	s		h	m	s		h	m	s		h	m	s
P	7	55	0	P	7	55	17	P	7	56	34	P	7	56	27
L		56	57	eS		55	54	MN		59	31	M	8	0	6
MN		58	29	eL		57	5	ME		59	36	F		6	36
ME		57	22	MN_1		58	19	FN	8	16	44				
FN	8	5	1	ME		58	28	FE		17	19				
FE		4	0	MN_2		59	38								
				MN_3	8	1	6								
				C		2	55								
				F		6	32								

XCIII The earthquake of $5^h\ 7^m$ on the 15th. Oct. The epicenter was near New Caledonia.

Taihoku

	h	m	s
e	5	8	12
L		16	28
F	6	40	—

Nagasaki

	h	m	s
P	5	8	5
S		16	14
L		22	55
F	6	8	21

Hukuoka

	h	m	s
P	5	8	28
S		16	40
L		23	15
M		28	34
F	6	22	41

Osaka

	h	m	s
P	5	8	5
S		15	57
L		24	33
MN		27	57
ME		29	28
FN	6	12	30
FE		15	15

Tokyo

	h	m	s
iP	5	3	27
eS		10	29
eL		18	33
ME		20	1
MN		22	27
CE		36	6
CE		40	14
F	6	12	—

Midusawa

	h	m	s
P	5	7	53
S		16	6
M		25	41
F		27	—

Hakodate

	h	m	s
eP	7	8	58
ME		10	17
F		22	24

XCIV The earthquake of $16^h\ 4^m$ on the 7th. Nov. The epicenter was near Mindanao Island. The Observatory at Batavia reported that the tidal waves occurred on the coast of Great Sangir Island.

Taihoku

	h	m	s
e	16	4	0
L		7	10
F	17	26	—

Hukuoka

	h	m	s
P	16	5	41
L		11	11
F		42	47

Osaka

	h	m	s
P	16	6	15
MN		13	38
ME		15	10
FN	17	2	37
FE	16	59	0

Tyosi

	h	m	s
eP	16	6	12
eL		14	51
M		15	10
F		47	7

Mito

	h	m	s
P	16	4	50
L		12	46
M		15	45
F		40	27

Midusawa

	h	m	s
P	16	6	32
S		11	43
M		16	53
F		36	—

XCV The earthquake of $18^h\ 40^m$ on the 11th. Nov. The epicenter was near Mindanao Island.

Taihoku

	h	m	s
P	18	40	26
S		43	56
L		46	32
M		51	24
F	20	50	—

Nagasaki

	h	m	s
P	18	41	40
L		46	28
ME		47	53
F	20	7	46

Hukuoka

	h	m	s
PE	18	41	57
SE		47	23
LE		55	33
ME_1	19	0	41
ME_2		5	20
ME_3		8	7
FE	20	21	50

Kobe

	h	m	s
P	18	42	5
S		46	53
L		50	46
ME_1		50	39
MN_1		54	28
ME_2		55	48
MN_2		56	6
MN_3		57	23
MN_4		59	23
CE_1	19	1	51
CN_1		4	14
CE_2		7	47
CN_2		7	40
FE		57	52
FN	20	2	54

Osaka

	h	m	s
P	18	42	18
S		47	35
L		52	33
MN		55	55
ME		53	2
FN	20	10	16
FE		14	13

Tokyo

	h	m	s
iP	18	42	33
S		43	7
L		43	55
MN		44	57
ME		44	41
F	19	32	—

Tyosi

	h	m	s
P	18	42	48
S		49	59
L		59	52
MN	19	0	30
ME	18	59	16
FN	20	5	20
FE		21	34

Mito

	h	m	s
P	18	42	37
L		49	47
MN		53	52
ME	19	0	0
F	20	20	48

Midusawa

	h	m	s
P	18	42	58
S		48	32
ME		54	14
MN	19	2	6
FE		28	—
FN		9	—

Hakodate

	h	m	s
eP	18	43	19
MN		45	6
ME		46	45

Otomari

	h	m	s
P	18	43	48
L		50	2
M	19	4	3
C		19	12
F		45	31

XCVI The earthquake of $13^h\ 54^m$ on the 13th. Nov. The epicenter was near the Mariana Islands.

Taihoku

	h	m	s
e	13	56	9
L	14	0	15
F		30	—

Nagasaki

	h	m	s
P	13	55	22
L		58	43
ME		58	45
F	14	17	44

Hukuoka

	h	m	s
PN	13	55	29
LN		58	51
MN		58	59
FN	14	7	18

Kobe

	h	m	s
P	13	55	7
L		58	9
ME		58	15
MN		58	14
ME		59	52
MN		59	6
FE	14	11	2
FN		12	47

Osaka

	h	m	
P	13	58	8
L		58	1
MN		58	8
ME		59	22
FN	14	32	18
FE		30	7

Tokyo

	h	m	s
iP	13	54	57
S		55	58
L		57	26
ME		57	39
MN		57	41
MN		59	20
ME		59	2
CE	14	2	32
F		28	—

Tyosi

	h	m	s
P	13	54	52
S?		57	31
F	14	31	43

Mito

	h	m	s
P	13	55	0
L		58	0
MN		58	16
F	14	26	37

Midusawa

	h	m	s
P	13	55	32
L		58	52
ME		59	41
MN		59	23
FE	14	9	—
FN	13	44	—

Otomari

	h	m	
P	13	56	38
L	14	0	50
F		16	0

XCVII The earthquake of $4^h\ 50^m$ on the 15th. Nov. The epicenter was near the strait of Tusina, having its co-ordinates 131°.2 E. and 35°.3 N. The shaken area was about 75000 sq. km. Another shock from the same origin, followed this shock at 13^h50^m.

Hukuoka				Nagasaki				Kobe				Osaka				Kyoto			
	h	m	s		h	m	s		h	m	s		h	m	s		h	m	s
P	4	50	10	P	4	50	42	iP	4	50	59	P	4	51	5	eP	4	51	6
L		50	31	L		51	28	L		51	42	L		51	53	L		52	8
MN		50	57	F		57	32	ME		52	43	MN		54	46	MN		52	10
F		57	12					MN		51	56	ME		53	43	ME		52	21
								FE	5	3	20	FN	5	10	35	FE		55	18
								FN		3	51	FE		11	40	FN		55	27

XCVIII The earthquake of $20^h\ 43^m$ on the 15th. Nov. The epicenter was near New Guinea?

Taihoku				Nagasaki				Hukuoka				Kobe				Osaka			
	h	m	s		h	m	s		h	m	s		h	m	s		h	m	s
P	20	44	35	P	20	44	59	P	20	45	2	P	20	35	24	P	20	45	30
F	21	50	—	F	21	48	25	S		51	55	ME		44	49	S		53	54
								L		55	54	FE	21	14	23	L	21	1	34
								ME		57	2	FN		13	39	MN		6	31
								F	23	0	29					ME		8	9
																FN	22	10	33
																FE		3	21

Tokyo				Tyosi				Midusawa				Hakodate				Otomari			
	h	m	s		h	m	s		h	m	s		h	m	s		h	m	s
iP	20	45	42	P	20	45	52	P	20	45	46	P	20	45	33	P	20	45	36
MN		47	38	S?		53	41	S		53	4	MN		45	41	F	21	37	12
ME		52	7	F	21	15	41	ME		59	33	ME		45	42				
F	21	23	—					MN		59	30	FN	21	7	10				
								FE	21	25	—	FE		5	10				
								FN		40	—								

XCIX The earthquake of $17^h\ 51^m$ on the 1st. Dec. The epicenter was to the west of Isigakizima, having its co-ordinates 123°.0 and 24°.8 N. The shaken area was about 75000 sq. km.

Taihoku			
	h	m	s
P	17	53	46
L		54	8
M		54	26
F	18	5	3

C The earthquake of $12^h\ 31^m$ on the 8th. Dec. The epicenter was near Tokyo, having its co-ordinates 139.°8 E. and 35°.8 N. The total shaken area was 600000 sq. km., weakly shaken area 200000 sq. km. and strongly shaken area 75000 sq. km. In the epicentral area, plastered walls and tiles were shattered and tombstones, stone lanterns in shrines and other unstable subjects were overturned. Fifty or more after-shocks were observed.

Mr. Ushiyama's paper "on the destructive earthquake near Tokyo on 8th. December 1921" is refered to on the details of this earthquake. The followings are the abstracts from the reports from the observatories.

Tokyo	h	m	s
iP	12	31	39
eL		31	45

Tyosi	h	m	s
P	12	31	42
L		31	52
CE		37	38
CN		38	0
F		47	13

Mito	h	m	s
P	12	31	40
L		31	48
F		54	13

Tukubasan	h	m	s
P	12	31	39
ME_1		31	45
ME_2		33	36
ME_3		34	49
ME_4		36	3
CE_1		36	39
CE_2		37	32
CE_3		38	16
CE_4		39	14
F		56	33

Maebasi	h	m	s
P	12	32	11
L		32	21
F	13	1	42

Numadu	h	m	s
iP	12	31	54
S		31	59
L		32	7
C_1		41	46
C_2		42	21
F		55	41

Midusawa	h	m	s
P	12	32	23
L		33	5
MN		33	53

Akita	h	m	s
P	12	32	24
L		33	21
F		53	52

Gihu	h	m	s
P	12	32	26
L		32	53
M_1		36	19
M_2		37	45
F		51	1

Kyoto	h	m	s
eP	12	33	19
L		34	1
MN		34	25
ME		34	28
FE		47	37

Osaka	h	m	s
P	12	32	43
L		33	53
MN		34	17
ME		34	27
FN	13	37	3
FE		37	3

Kobe	h	m	s
P	12	32	46
L		34	0
ME		34	7
MN		34	25
CE		44	49
CN		44	57
FE	13	10	27
FN	12	52	17

Hakodate	h	m	s
P	12	33	7
L		34	22
ME		34	55
MN		35	22
CE		41	26
F		57	17

Sapporo	h	m	s
iP	12	33	9
iLN		34	51
iLE		34	45
MN_1		35	24
MN_2		35	51
MN_3		36	16
MN_4		36	29
ME_1		35	33
ME_2		36	8
ME_3		36	34
ME_4		37	10
CN_1		40	43
CN_2		41	44
CE_1		40	41
CE_2		42	5
FN		51	33
FE		51	33

Hukuoka	h	m	s
P	12	33	37
S		35	7
L		35	48
ME		36	10
MN		36	23
F	13	25	19

Otomari	h	m	s
P	12	34	12
L		36	3
ME		38	3
MN		39	12
C		49	34
F	13	9	51

Taihoku	h	m	s
e	12	35	51
L		39	48
F	13	4	34

Zinsen	h	m	s
P	12	31	13
S		33	18
L		35	45
MN		36	13
F		49	0

CI The earthquake of 11^h2^m on the 12th. Dec. The epicenter was off the coast of North Japan, having its co-ordinates 142°.3 E. and 41°.0 N. The shaken area was 100000 sq. km.

Midusawa				Mito				Tyosi				Hakodate				Sapporo			
	h	m	s		h	m	s		h	m	s		h	m	s		h	m	s
P	11	2	35	P	11	3	12	eP	11	3	20	eP	11	2	39	iP	11	2	36
L		2	58	L		4	10	L		4	35	L		2	40	iSN		2	47
ME		3	15	MN		4	32	MN		5	2	ME		3	11	iSE		2	46
MN		3	4	F		7	5	F		9	16	MN		3	8	iLN		3	7
FE		12	—									F		8	14	iLE		3	5
FN		12	—													F		9	25

CII The earthquake of $15^h\ 47^m$ on the 18th. Dec. The epicenter was near Kamtchatka.

Hakodate				Tokyo				Osaka				Kobe				Hukuoka			
	h	m	s		h	m	s		h	m	s		h	m	s		h	m	s
e	15	47	4	P	15	47	31	P	15	47	50	iP	15	47	33	P	15	47	53
F		57	16	S		50	46	MN	16	9	2	L		47	58	S		50	1
				L		52	18	F	17	39	15	ME		51	19	L		52	48
				ME		53	29					MN		52	44	F	16	39	48
				F	16	36	35					FE	16	21	18				
												FN		25	0				

CIII The earthquake of $8^h\ 4^m$ on the 20th. Dec. The epicenter was near Nasu, Hukusima, having its co-ordinates 140°.1 E. and 37°.0 N. The shaken area was 200000 sq. km. and an area of 75000 sq. km. was weakly shaken.

Mito				Tukubasan				Tokyo				Midusawa			
	h	m	s		h	m	s		h	m	s		h	m	s
P	8	4	36	P	8	4	35	iP	8	4	48	P	8	4	51
L		4	47	L		4	39	L		5	9	L		5	15
MN		4	48	ME_1		4	44	F		17	0	ME		5	31
ME		19	54	ME_2		5	29					MN		5	38
F		19	54	CE_1		6	9					FE		22	—
				CE_2		6	35					FN		23	—
				CE_3		7	40								
				F		10	15								

Kyoto				Kobe				Nagasaki			
	h	m	s		h	m	s		h	m	s
eP	8	6	36	P	8	6	42	P	8	8	23
L		7	46	L		7	18	L		9	11
ME		7	55	ME		7	25	F		14	15
MN		8	0	MN		7	58				
FE		11	2	CE		10	54				
FN		13	24	CN		11	28				
				FE		17	27				
				FN		17	34				

On the Destructive Earthquake near Tokyo on the night of 8th. December 1921.

By T. USHIYAMA.

On the night of 8th. December 1921 Tokyo and the neighbouring districts were violently shaken by an earthquake. In the epicentral region the shock was so severe that the small fissures along wayside, cracks on the plasted walls and the small landslipes were produced.

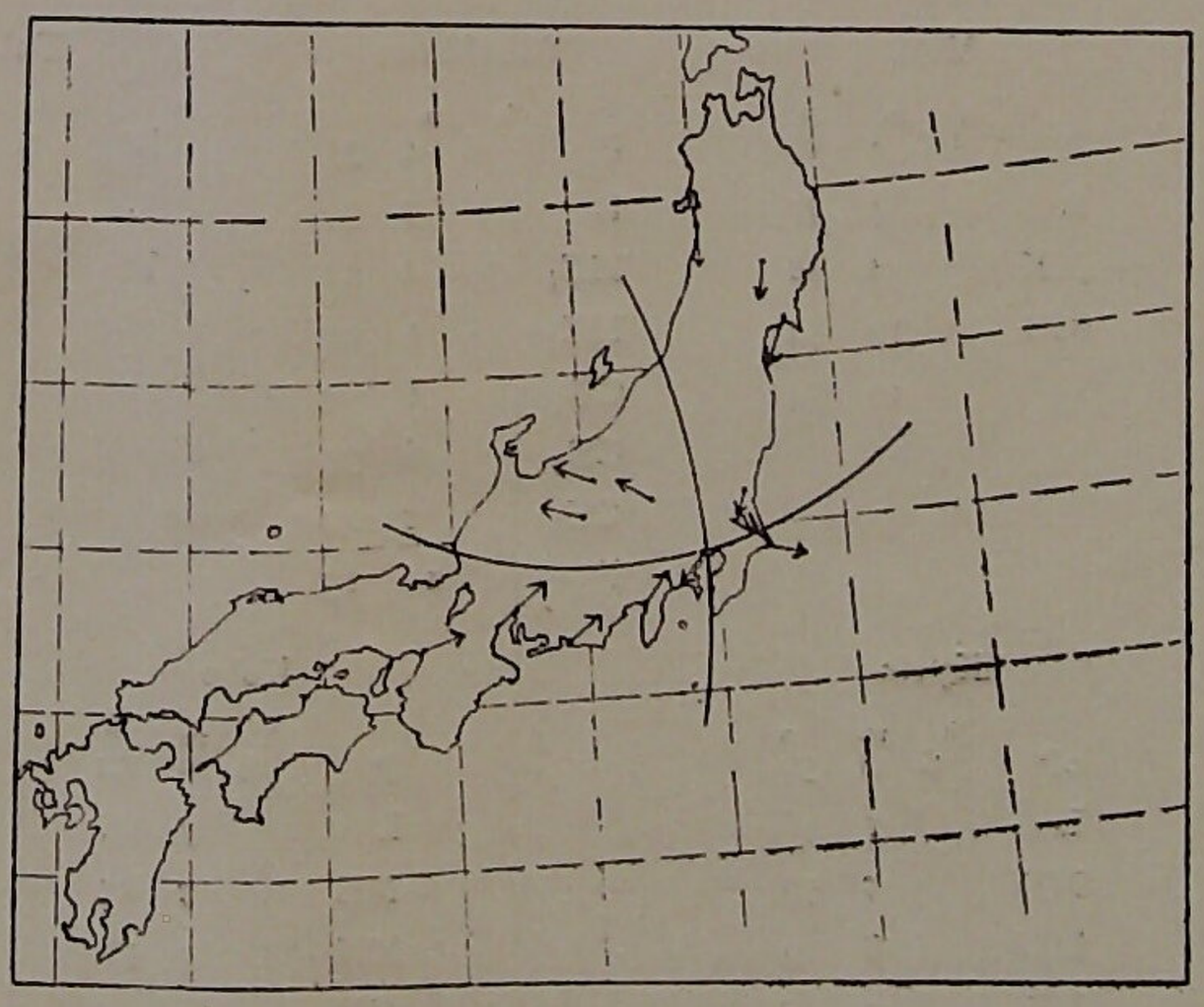
In Tokyo the time of emergence was 9^h31^m 38.9 pm. (12^h 31^m 38.9^s G M.T.)

Epicenter: The focus deduced from the seismograms at various stations specially examined by myself lies under the lake district about 30 km. to the north-east of Tokyo.

In this case the ordinal method of the plane geometrical construction for finding the epicenter by the direction of the first movement and the duration of the preliminary tremor gives no consistent result, because of the focal depth and of the complex geological structures of the earth-crust.

The Direction of the first Movement: The first movement of the shock was outwards from the epicenter on the southeastern and northwestern sides of the epicenter, and inwards to the epicenter on the northeastern and south-western sides as shown in Fig. 1.

Fig. 1.



Geographical Considerations: The distribution of the direction of the first movement suggest us some knowledge of the cause of the earthquake. The northern part of the main land of Japan runs nearly from north to south and the southern part of it from west to east. These two parts are joined together at the district where the present earthquake occurred.

Moreover the distribution of the first movements has a close relation to this geographical feature of Japan. In the directions parallel to the main land the first movements were "pull" to the epicenter and in the direction perpendicular to it the movements were "push." This close relation between the distribution of the first movements and the geograpical feature of Japan leads us to suppose a enormous pressure acting along the Mainland. If the supposition of such a pressure acting along the direction parallel to the main land is true, we may easily explain that the main land is widest at the joining point of its northern and southern (or western) parts and that at the joining point the greatest volcanic zone in Japan or the Fuji Volcanic zone runs across the main land.

Seismographical data : The followings are the seismographical data and the intensities of the shock estimated at several stations.

Station	Intensity*	Duration of Preliminary tremore	Direction of First Movement
Tokyo	IV	6.2	SW
Tyosi	IV	9.8	ESE
Mito	IV	8.0	S
Tukubasan	III	6.0	—
Utunomiya	IV	—	—
Maebasi	III	10.0	WNW
Kohu	III	—	—
Numadu	V	13.0	NE
Yokohama	IV	—	—
Yokosuka	IV	—	—
Matumoto	II	19.0	SSW
Nagano	II	20.6	WNW
Kumagaya	IV	3.9	—
Niigata	II	24.0	—
Asio	III	—	—
Iida	V	—	—
Tu	II	52.0	—
Midusawa	II	42.0	SSW
Gihu	I	26.8	E
Hikone	I	48.0	SSE
Osaka	I	70.0	ENE
Nagoya	I	16.0	ENE

* I slight, II weak (rather slight), III weak, IV strong (rather weak), V Strong

Determination of the epicenter : Though the duration of the preliminary tremore is one of the best data to determine the position of the epicenter, it is affected by the

nature of the rocks consisting the earth-crust and also by the depth of the seismic focus. The relation between the duration of the preliminary tremor and the epicentral distance is not unique, but it varies as the position of the epicenter differs. The relation must be given one for every earthquake, as the depth of the focus, and the physical properties of rocks differ in each cases.

If in the simplest of cases the duration of the preliminary tremor be assumed to be proportional to the focal distance of the station, then the problem is simplifised. If the preliminary tremors are observed at two stations, the epicenter must lay on the locus of the points, the distances to which from the stations are proportional to the duration of the preliminary tremor at each stations. Such a locus is a circle and may easily be drawn. If the observations are done at more than three stations, we get more than two such loci, and thus the epicenter is located as the intersection of the loci. This method is quite easily applied in practical cases and gives a consistent result as shown in fig. 2. If we may choose some couples of stations having nearly same duration of the preliminary tremor, the result is much better. By this procedure the position of epicenter of the present earthquake is located at 139°.8 E and 35°.8 N.

Fig. 2.

On the Destructive Earthquake occurred near Tokyo on the 26th. April 1922.

By SAEMONTARO NAKAMURA

On the morning of the 26th. April 1922 an earthquake occurred on the south-eastern coast of the Bay of Tokyo. Unfortunately the strongly shaken area covered the region most thickly populated in Japan, including Tokyo, Yokohama and Yokosuka. The shock was strongest in the region along the coast of the bay, and a few persons were injured or killed in Tokyo. Some stone buildings in Tokyo, Yokohama and other towns were damaged. Tiles and Plastered walls were shattered. Tombstones, brick walls and stone lanterns overturned. Some of the brick chimneyes were cracked and twisted at Hojo snd Minato. Light-houses at Kwannonzaki, Jogashima and Kenzaki were damaged. The trains temporally stoped on the line along the south-eastern coast of the bay, as the rails sunk at Minato station and other points nearby. Some of embankments in Tokyo and Yokosuka sliped down. At the Chinese town in Yokohama two brick buildings were nearly ruined.

This earthquake accompanied by a foreshock about twenty hours and quarter before and followed by aftershocks. The followings are the time of emergence of those shocks observed in Tokyo.

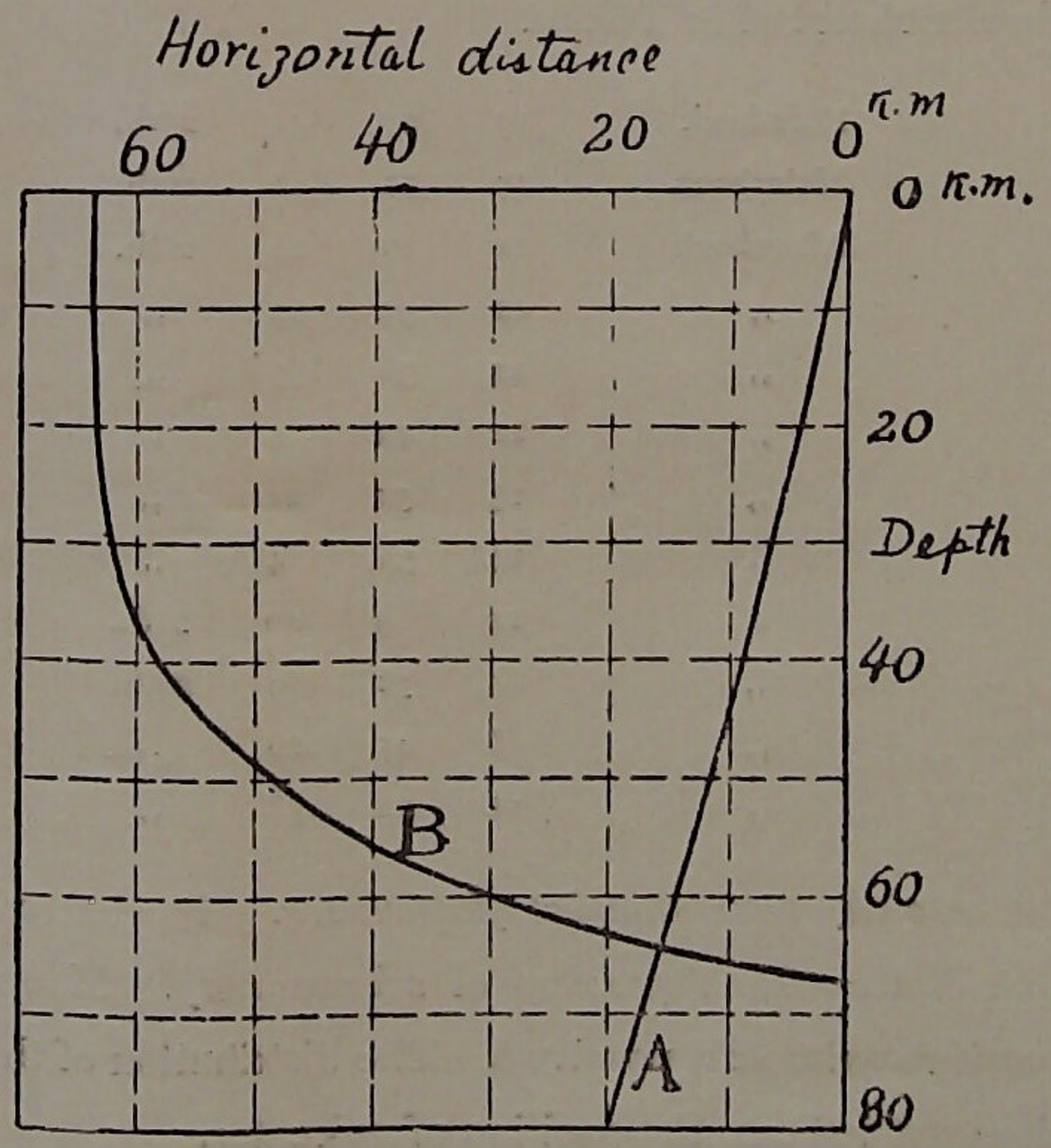
Eoreshock	13	57	41	25th.	(unfelt)	P—S	9.6
Mainshock	10	11	36	26th.	(strong)	,,	9.6
Aftershock	11	19	18	26th.	(unfelt)	,,	9.7
,,	11	34	54	,,	(,,)	,,	9.9
,,	12	36	53	,,	(,,)	,,	9.3
,,	12	40	4	,,	(,,)	,,	9.1
,,	13	30	21	,,	(,,)	,,	10.0
,,	14	38	4	,,	(,,)	,,	9.5
,,	12	9	40	28th.	(slight)	,,	9.6
,,	4	32	9	29th.	(weak)	,,	9.5
,,	8	45	28	,,	(slight)	,,	10.0
,,	11	22	58	,,	(unfelt)	,,	9.5

On the determination of epicenter. To determine the position of seismic focus is one of the oldest problem of seismometry. Many authorities written on this subject but it remains still unsolved. The distribution of the apparent intensity of the shock does not indicate the position of epicenter.

It is affected by the geological and geographical conditions of the location where the shock is observed. Moreover in some cases, rather in general, the intensity of shock is not greatest in epicentral region, according to the mode of vibration at focus. The well known method to find the epicenter by combining the observations of the direction of the first impulse and of the duration of the preliminary tremor is good for distant earthquake but not for the near earthquake, especially when it is observed in its epicentral region. In the epicentral region the direction of the first movement would not indicate the direction from which the shock comes and the duration of the preliminary tremor would not give the epicentral nor focal depth. The depth of the focus, and the dimention of the origin would affect the observed values of those quantities. It is not so simple to formulate the relations between the position of the focus and these quantities. As the wave length of the seismic waves is of the order of 10 km. the observation in a region within some 100 km- from the epicenter must specially be treated. In Tokyo the duration of the first preliminary tremor is always more than a few seconds even in the cases, in which the epicenter located by the date of the observations at other stations is quite near Tokyo. If the epicenter is determined by the single observation at Tokyo, it is always located at some point far from Tokyo.

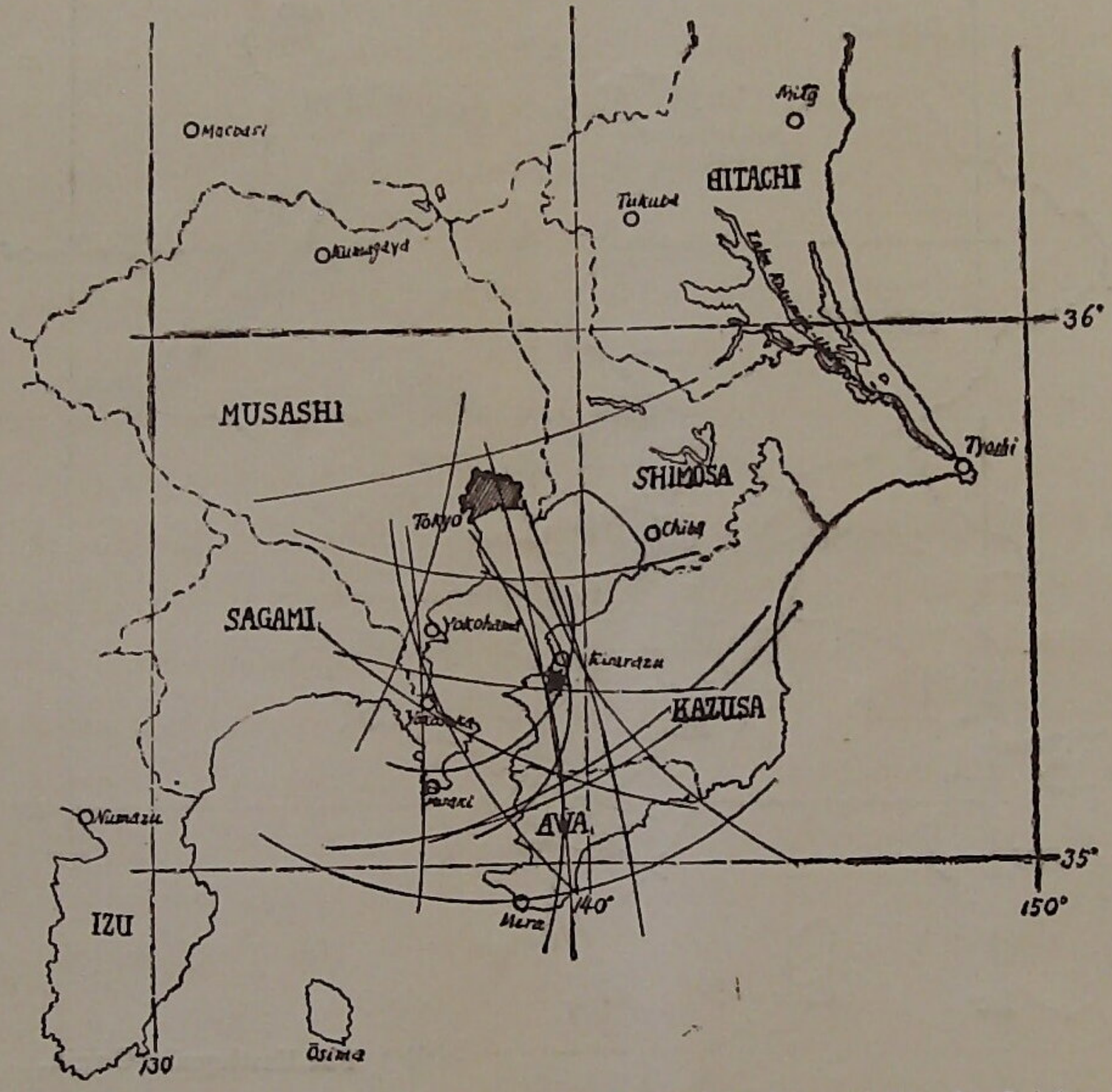
The lateral deflection of the seismic rays would have some influence on the determination of the epicenter in Japan. In general the horizontal refraction of the rays may be very small, but in our case the observations are done at the margin of continent, where the velosities of propergation of the seismic waves must be vary in the direction perpendicular to the boundary line of the continent and the ocean. Hence the seismic rays must be deflected horizontally as well as vertically. As the velocity of propergation of the wave may be large beneath the ocean than in continent, the rays would curve to the continental side.

Fig. 1.



The distribution of the intensity, direction of the first movement and the duration of the preliminary tremor do not give any conclusive result on the position of epicenter.

Fig. 2.



(✸) The Eahthquake Origin.

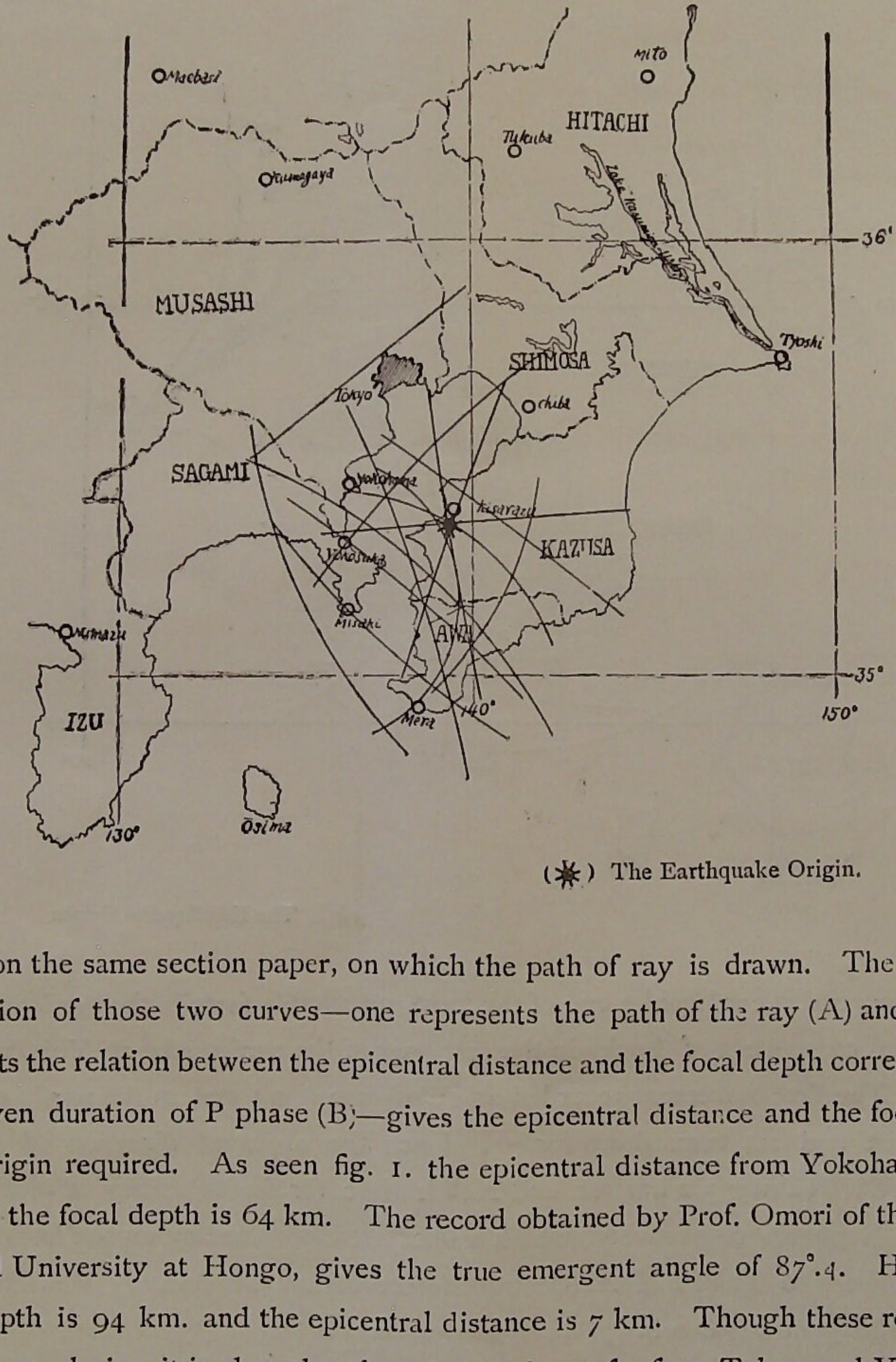
In the present earthquake one of the most remarkable facts is the predominence of the vertical component of shocks in the first part of the earthquake at Yokohama and Tokyo. The first movement recorded at Yokohama is 0.1 mm. to the north, 0.58 mm. to the east and 1.4 mm. downwards. Hence the apparent direction of emergent angle is 76°. Taking 3.2 km/sec. and 2.46 km/sec. for the velocities of propergation of P and S phases respectively, which values were obtained by myself from the data in Japan, (see the Bulletin of the Central Meteorological Observatory Vol. III. No. 1) the true emergent angle is 80°.7.

The path of the ray, whose emergent angle is 80°.7, many be drawn on a section paper, taking account the refraction as shown in fig. 1.

As the duration of P phase may be given as a function of the epicentral distance

and the focal depth, for a given value of the duration of P phase the epicental distance and the focal depth have a definite functional relation. This functional relation is also

Fig. 3.



(✱) The Earthquake Origin.

plotted on the same section paper, on which the path of ray is drawn. The point of intersection of those two curves—one represents the path of the ray (A) and another represents the relation between the epicentral distance and the focal depth corresponding to a given duration of P phase (B)—gives the epicentral distance and the focal depth of the origin required. As seen fig. 1. the epicentral distance from Yokohama is 15 km. and the focal depth is 64 km. The record obtained by Prof. Omori of the Tokyo Imperial University at Hongo, gives the true emergent angle of 87°.4. Hence the focal depth is 94 km. and the epicentral distance is 7 km. Though these results are not very conclusive, it is clear that the epicenter is not far from Tokyo and Yokohama and the focal depth is 60 km. or more. Assuming the focal depth be 60 km. the epicentral distances from several stations are obtained as follows :

Station	Duration of P Phase	Epicentral Distance
	s	km.
Osaka	42.7	415
Nagoya	26.6	250
Yamagata	33.0	330
Utunomiya	13.0	115
Mito	16.0	145
Niigata	26.6	250
Yokohama	6.3	30
Yokosuka	6.3	30
Tokyo	9.2	85
Kumagaya	14.0	125
Numazu	11.2	100
Hamamatu	23.6	220
Maebasi	17.6	160
Tyosi	10.4	90
Takayama	23.8	225

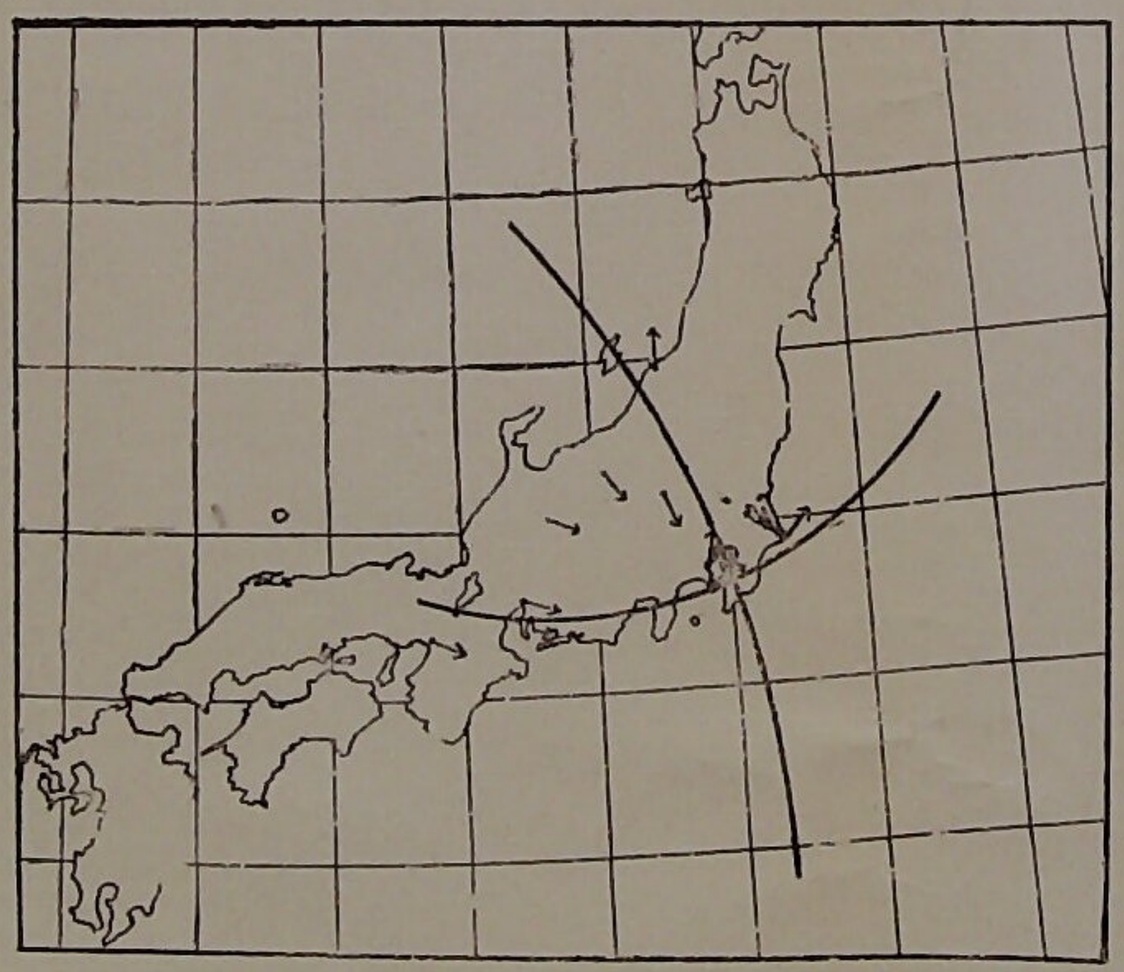
From these data the epicenter is located near Kisaradu on the south-eastern coast of the bay of Tokyo. The approximate coordinates are 139°.9 E. and 35°.4 N. (see Fig. 2.)

Applying Ushiyama's method for finding the epicenter by the ratio of the duration of the P phase we get also the same point as the epicenter as shown in Fig. 3. The directions of the first movements at each stations are :

First Movement is outwards

Station	First Movement N : E
Nagoya	2 : −6
Osaka	3 : −8
Hamamatu	−1 : −25
Numazu	1.4 : −10.6
Tyosi	18.5 : 22.9
Niigata	5.7 : 0

Fig. 4.



First Movement is inwards

Station	First Movement N : E
Tokyo (University)	−10 : 2
Tokyo (Observatory) N 18 W : N 72 E	−18 : 2.5
Maebasi	−5.0 : 2.7
Nagano	−13.1 : 9.2
Takayama	−6 : 17
Yokohama	1.4 : 3.0

The distribution of these directions of the first movements is shown in fig 4. which is quite country to that in the case of the earthquake on the 8th. Dec. 1921. The boundary lines separating the regions, in one of which the movement is inwards and in the other it is outwards, is curved, and cross at an angle distinctly differ from the

right angles. Some effect of the horizontal refraction of the seismic ray is also seen. The direction of the movement deflects more and more northwards as the epicentral distance increases.

The vibration which gives such a distribution of the first movement must be in a nearly horizontal plane. While the movement of the earthcrust which is caused by horizontal inequalities in the earth's interior between the continental and oceanic areas must be an eddy movement with a horizontal axis, the earthquake motion detected by the seismometer seems to be in a horizontal plane with vertical axis.

This phenomena has a possibility to be an example for the principle of tendency of the vortical motion towards symmetry suggested by Dr. S. Fijiwhara.

大正十一年九月十五日印刷
大正十一年九月二十日發行

中央氣象臺

編纂兼發行者　東京市京橋區宗十郎町十五番地　中島丑之助

印刷者　東京市京橋區宗十郎町十五番地　合資會社東京國文社

THE SEISMOLOGICAL BULLETIN

OF

The Central Meteorological Observatory

OF

JAPAN.

Vol. I. No. 2.

December 1922.

Contents.

Published by

The Central Meteorological Observatory,

TOKYO.

Seismological Observations in Tokyo.

(April.—Augst. 1922)

$\varphi = 35°41''06$ $\lambda = 139°45''04''$ h = 21.3m Underground : Diluvium (loam)

Instruments : Wiechert Astatic Inverted Pendulum.

Ômori Horizontal Pendulum.

	T_0	ε	$\frac{r}{T_0^2}$	V
AN :	3.0	3.2	0.0001	145
AE :	3.0	3.2	0.0001	155
AE :	17.7	—	0.007	20

No.	Date Day	Date Month	Phase	Time h	Time m	Time s	Period s	Amplitude AN μ	Amplitude AE μ	Δ km.	Remarks
87	30	April	iP	18	46	31				49	Felt at Tokyo and
			iS		46	38					Yokohama
			ME		46	38	—		130		
			F		48	10					
88	1	May	iP	10	52	00					Near the Islet Hatizyo.
			eS		53	03					
			eL		54	46					
			MN	11	03	38	3.4	125			
			F		27	55					
89	2		e	11	27	28				2310	Near the Mariana Islands.
			eS		29	29					
			eL		31	31					
			ME		31	49	4.6	75			
			F		55	25					
90	3		iP	9	44	51				87	Near Tyosi.
			iS		45	03					
			MN		45	03	1.4		— 10		
			ME		45	04	0.9	18			
			F		48	35					
91	4		eP	9	16	23				3454	Epicenter was off the east
			eS		19	10					coast of the Kuril Islands.

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude AN μ	AE μ	Δ km.	Remarks
	4	May	eL	9	23	22					
			eME_1		25	18	7.6		700		
			ME_2		37	22	6.0		350		
			ME_3		44	38	5.0		450		
			ME_4		53	32	5.4		435		
			ME_5	10	05	28	5.8		540		
			CE_1		11	35	5.0		400		
			CE_2		16	48	4.5		205		
			CE_3		22	16	5.0		110		
			F	11	55	15					
92	4		P	21	26	49				385	Near the Islet Hatizyo.
			S		27	14					
			L		27	40					
			F		37	55					
93	5		eP	0	23	49				809	
			eS		24	48					
			eL		25	38					
			F		59	46					
94	6		iP	10	59	05	(first motion {4.1 to N, 1.5 to E)			122	Near Mito.
			iS		59	13					
			iL		59	22					
			MN		59	24	0.9	−18			
			ME		59	25	1.4		0		
			eF	11	04	36					
95	6		P	12	26	31				653	Near the Taskalora-Deep.
			S		27	09					
			eL		27	59					
			eF	13	18	—					
96	6		iP	20	46	09	(first motion {8 to N, 3 to E)			180	Felt at Tokyo.
			iS		46	19					Near the Islet Osima.
			iL		46	33					
			MN		46	35	0.7	34			
			ME		46	36	0.8		−40		
			F		49	50					

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude AN μ	AE μ	Δ km.	Remarks
97	7	May	iP	14	31	19				92	Near Tukubasan.
			iS		31	25					
			iL		31	31					
			MN		31	32	0.8	8			
			ME		31	43	0.6		11		
			eF		34	25					
98	7		iP	19	29	30				184	Felt at Mito and Tokyo.
			S		29	55					
			MN		29	59	1.5	18			
			ME		29	59	1.4		—17		
			F		35	25					
99	8		iP	16	39	13				22	Felt at Mito.
			iS		39	16					
			MN		39	17	—	3			
			ME		39	16	—		4		
			F		40	05					
100	9		iP	3	29	03	(first motion {7.0 to N, 0.2 to E)			59	Near Tokyo, Felt at
			iS		29	11					Kanazawa, Tukubasan,
			MN		29	12	—	5800			Mito, Tokyo, Yokosuka,
			ME		29	11	—		4720		Yokohama, Maebasi,
			F		34	00					Kumagaya, Numazu, Kohu, Niigata, Gihu, Hukusima, Nagoya, Akita, Utunomiya.
101	10		iP	11	04	02				29	Felt Mito and Tukubasan.
			iS		04	15					Near Tukubasan.
			MN		04	15	—	-8			
			ME		04	16	—		6		
			F		06	20					
102	10		iP	16	33	18				67	Off the coast of the Bonin
			iS		33	27					Is.
			MN		33	27	—	4			
			ME		33	30	—		—4		
			F		(in next)						
103	10		iP	16	34	59				69	Do.
			iS		35	08					
			MN		35	11	—	14			
			ME		35	12	—		-10		
			F		37	45					

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude AN μ	AE μ	Δ km.	Remarks
104	14	May	iP	18	04	33				134	Near Mito. Felt at Mito,
			iS		04	51					Hukushima and Tukuba-
			MN		04	52	2.4	-10			san.
			ME		04	52	1.6		9		
			F		07	45					
105	15		iP	6	37	47	(first motion {1.8 to N, 0.9 to E)			67	Off the coast of the Isinomaki.
			iS		37	56					Felt at Isinomaki.
			MN		37	57	—	-8			Kanayama and Akita.
			ME		37	58	—		-7		
			F		39	26					
106	15		iP	9	24	06	(first motion {4 to S, 3 to W)			84	Near Islet Osima, felt at
			iS		24	17					Numazu, and Osima.
			MN		24	18	—	-38			
			ME		24	17	—		40		
			F		26	28					
107	15		iP	20	23	00	(first motion {2.0 to N, 0.5 to W)			520	Epicenter was on the east
			iS		23	19					coast of Iwate (143°. 5 E.
			iL		24	10					40° N)
			eMN		24	15	2.0	153			Felt at Yamagata, Obihiro,
			eME		24	17	1.7		-240		Akita, Midusawa, Hakodate,
			eF		45	25					Kusiro, Mito, Nemuro, Isinomaki, Tukubasan, Tokyo, Hukusima, Kohu, Utunomiya, Hatizyo and Yokohama.
108	16		iP	7	28	54	(first motion {8 to N, 5 to E)			134	Near Mito.
			eS		29	00					Felt at Mito, Tukuba-san,
			eL		29	08					Hukusima and Utunomiya.
			MN		29	09	—	18			
			ME		29	10	—		-15		
			F		30	11					
109	16		iP	8	12	03				2126	Far off the south-west coast
			eS		13	35					of Formosa.
			eL		15	38					
			ME		16	42	3.4		-42		
			F		21	35					
110	16		iP	23	35	24	(first motion {6.0 to N, 4.5 to E)			76	Near the lake Kasumigaura.
			iS		35	34					Felt at Tukuba-san and
			MN		35	35	0.5	-1.4			Mito.

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude AN μ	AE μ	Δ km.	Remarks
	16	May	ME		35	35	0.4		9		
			F		37	50					
111	19		eP	13	27	07				100	Near Mito. Felt at Mito and
			eS		27	18					Tukuba-san.
			MN		27	21	—	-10			
			ME		27	24	—		9		
			F		28	44					
112	20		iP	22	51	12	(first motion $\begin{cases}4 \text{ to S}\\1 \text{ to W}\end{cases}$)			67	Near Tukuba. Felt at
			iS		51	21					Tukuba-san, Yokosuka,
			MN		51	21	—	-34			and Yokohama.
			ME		51	21	—		48		
			F		55	35					
113	21		e	19	12	24					Distant earthquake.
			eF		44	28					
114	22		e	2	56	22					Distant earthquake.
			eME	3	01	21	4.5		80		
			eF		42	27					
115	24		iP	8	29	35				69	Near Tokyo,
			iS		29	44					
			MN		29	45	—	-8			
			ME		29	45	—		11		
			F		31	15					
116	24		iP	10	17	24				72	Near Tokyo.
			iS		17	34					
			MN		17	34	—	11			
			ME		17	36	—		-8		
			F		18	44					
117	25		iP	3	21	08	(first motion $\begin{cases}4.8 \text{ to S}\\2.0 \text{ to E}\end{cases}$)			378	Near Tyosi.
			iS		21	17					
			MN		21	17	—	14			
			ME		21	17	—		8		
			F		25	35					
118	25		iP	9	58	58				84	Near Tukuba-san. Felt at
			iS		59	09					Tukuba and neighbor-
			MN		59	10	—	7			hoods.

No.	Date Day	Date Month	Phase	Time h	Time m	Time s	Period s	Amplitude A_N μ	Amplitude A_E μ	Δ km.	Remarks
	25	May	ME		59	11	—		-6		
			F	10	02	04					
119	28		iP	12	09	21	(first motion {4 to N, 2 to E)			104	Near Siobara (co-ordinates 139.8 N and 36.8 E). Felt at Isinomaki, Kanayama, Tukuba-san, Kohu, Mito Maebasi, Tokyo, Kumagaya Hukusima, Yokohama Yokosuka, Akita, Utunomiya and Mizusawa.
			iS		09	35					
			MN		09	35	1.3	544			
			ME		09	35	1.1		614		
			F		25	25					
120	30		iP	02	08	22	(first motion {8.0 to N, 3.5 to E)			74	Near Tokyo.
			iS		08	32					
			MN		08	35	—	4			
			ME		08	33	—		-8		
			F		09	25					
121	31		iP	8	23	43	(first motion {7.0 to N, 3.4 to E)			78	Felt at Tokyo.
			iS		23	54					
			MN		23	54	—	-48			
			ME		23	55	0.4		36		
			F		25	55					
122	1	June	iP	21	31	58	(first motion {3 to N, 4 to E)			169	
			iS		32	21					
			MN		32	24	1.1	-38			
			ME		32	25	0.9		51		
			F		34	45					
123	2		iP	15	58	20	(first motion {4 to N, 3 to E)			63	Near Tyosi.
			iS		58	28					
			MN		58	29	0.7	38			
			ME		58	30	0.5		41		
			F	16	02	—					
124	2		P	20	19	16	(first motion {14 to E, 4 to N)			2940	Near the Mindanao Islands.
			eS		22	06					
			eL		24	55					
			eF	21	23	—					
125	3		iP	4	56	55	(first motion {7.8 to S, 2.5 to E)			61	Eastern districts of Hukushima prefecture,
			S		57	14					

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude AN μ	AE μ	Δ km.	Remarks
	3	June	L		—	—					Felt at Mito, Maebasi, Akita,
			M		—	—					Numadu, Midusawa,
			eF	5	27	20					Yokohama, Kohu, Yamagata, Isinomaki, Tukuba, Hukusima and Utunomiya.
126	5		eP	14	01	39				957	Off the coast of Kusiro (Hokkaido). Felt at Kusiro and Nemuro.
			eL		03	48					
			eMN		03	51	1.8	38			
			eME		03	54	1.9		-41		
			F		42	20					
127	5		eP	15	45	38				601	Do, Felt at Kusiro only.
			eL		46	59					
			MN		47	02	0.4	34			
			ME		47	03	0.3		58		
			F		59	50					
128	7		iP	17	53	22	(first motion {4 to S, 2 to W)			178	Off the coast of Kasima,
			iS		53	33					Felt at Mito, Utunomiya,
			iL		53	56					Fukusima and Tukubasan,
			MN		53	58	0.4	-56			
			ME		53	59	0.6		48		
			F	18	05	45					
129	8		eP	6	52	00				115	Coast of Kusiro (Hokkaido).
			eL		52	15					Felt at Obihiro, Kusiro
			MN		52	17	—	14			and Nemuro.
			ME		52	18	—		-8		
			eF		54	40					
130	15		iP	7	07	54	(first motion {1.1 to S, 1.3 to W)			51	Near Tukubasan.
			iS		08	01					
			MN		08	02	0.7	38			
			ME		08	02	0.5		40		
			F		09	45					
131	15		iP	19	23	15				148	Coast of Fukushima
			S		23	35					prefecture.
			MN		23	36	—	4			
			ME		23	37	—		-6		
			F		25	25					

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude AN μ	AE μ	Δ km.	Remarks
132	18	June	P	12	17	59				349	Off the coast of Toba (137.°0
			eL		18	36					E. 33.°1 N),Felt at Hikone,
			MN		19	06	1.4	-14			Maiduru, Tu, Hukui,
			ME		19	08	1.8		20		Nagoya, Hamamatu, Yagi,
			eF		(in next earthquake)						Turuga,Tokusima, Miyadu,
											Wakayama, Iida and Oka-
											yama
133	18		eP	12	20	59					Do.
			L		21	36					
			MN		21	38	1.6	-38			
			ME		21	39	1.9		-41		
			F		37	44					
134	21		iP	13	48	48	(first motion	{2.4 to N, 1.2 to E)		260	Near Mito. Felt at Mito.
			iS		49	07					
			iL		49	23					
			MN		49	26	0.8	45			
			ME		49	27	1.6		-36		
			F		55	46					
135	22		iP	10	18	55	(first motion	{1.8 to N, 0.8 to E)		85	Near Hakone.
			eS		19	07					Felt at Numazu.
			MN		19	07	0.4	31			
			ME		19	08	1.1		-25		
			F		22	10					
136	22		iP	15	10	09	(first motion	{1.5 to S, 11 to W)		122	Near Tukuba. Felt at Mito
			iS		10	25					Tukuba-san and Utuno-
			MN		10	35	0.7	36			miya.
			ME		10	35	0.5		-28		
			F		13	16					
137	22		iP	19	49	39				263	Do.
			iL		50	14					
			MN		50	15	0.4	31			
			ME		50	15	1.1		-25		
			eF		53	25					
138	23		iP	1	51	59	(first motion	{2.8 to N, 0.9 to W)		134	Felt at Utunomiya, Tukuba,
			iS		51	17					Mito, Tokyo Maebasi and
			iL		51	27					Hukusima. Epicenter was
			MN		51	28	0.7	-82			near Tukuba.
			ME		51	28	0.4		65		
			F		59	24					

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude A_N μ	A_E μ	Δ km.	Remarks
139	25	June	iP	18	41	36	(first motion	{3 to N, 4 to E)		59	Near Lake-Kasumigaura.
			iS		41	43					Felt at Yokosuka, Tukuba
			iL		41	44					san, Yokohama, Tokyo,
			MN		41	45	—	—			Kumagai, Utunomiya and
			ME		41	46	0.4		248		Mito.
			F		48	16					
140	27		eP	14	36	38				4930	Distant earthquake.
			eS		43	10					
			eL		47	29					
			eF		54	—					
141	29		iP	4	51	10				2368	Distant earthquake.
			eL		55	22					
			eF	5	17	—					
142	1	July	iP	2	28	01	(first motion	{1.4 to N, 2.9 to W)		62	Near Tukuba-san.
			iS		28	10					
			ME		28	10	—	48			
			MN		28	11	—		39		
			F		30	25					
143	2		eP	8	08	30				126	Near Tokyo.
			eS		08	37					
			eL		08	47					
			MN		08	49	2.0	-58			
			ME		08	51	1.1		46		
			eF		14	58					
144	2		P	8	27	05	(first motion	{4 to W, N-S ?)		426	Near Islet Hatizyo.
			eS		27	30					
			L		28	02					
			ME		28	28	1.2		37		
			MN		29	00	2.4	-84			
			MN		34	57	1.1	-28			
			ME		34	21	1.3		19		
			eF		48	25					
145	2		eP	13	44	59					Distant earthquake.
			eS		51	33					
			eL		58	03					
			eF	14	59	—					

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude AN μ	AE μ	Δ km.	Remarks
146	2	July	eP	21	24	27				100	Off the coast of Kasima
			eS		24	42					(near Mito.)
			F		26	45					
147	3		P	2	24	02				2050	
			eS		25	34					
			eL		27	25					
			ME		28	32	2.4		124		
			ME		29	29	3.0		-97		
			F		37	15					
148	5		iP	18	37	34				68	Near Tokyo, Felt at
			iS		37	43					Urayasu.
			MN		37	44	—	-31			
			ME		37	44	—		34		
			F		39	25					
149	5		iP	20	21	20	(first motion	{2.0 to N 3.7 to E)		425	Epicenter was near
			S		21	49					Kinkazan (142.0 E. 38.5
			L		22	18					N). Felt at Kusiro, Isino-
			ME		22	21	2.1		438		maki, Midusawa, Hukusima,
			F		40	47					Akita, Mito, Nigata, Hako-
											date, Maebasi, Tukuba-san,
											Yokohama, Kohu, Yoko-
											suka, Numazu, Yamagata,
											and Utunomiya.
150	7		iP	17	22	40				209	Off the coast of Mito. Felt
			L		22	58					at Mito.
			MN		23	24	1.1	-41			
			ME		23	24	1.6		28		
			MN		25	08	1.3	-19			
			ME		24	46	1.6		10		
			F		29	48					
151	7		iP	17	41	52	(first motion	{2.4 to S 1.8 to E)		209	Off the coast of Mito,
			L		42	20					Felt at Mito.
			MN		42	44	1.1	39			
			ME		42	46	1.4		39		
			F		49	25					
152	7		iP	17	58	22	(first motion	{2.4 to N 1.1 to E)		178	Off the coast of Mito.
			L		58	46					

No.	Date Day	Date Month	Phase	Time h	Time m	Time s	Period s	Amplitude AN μ	Amplitude AE μ	Δ km.	Remarks
	7	July	MN		59	28	1.4	-48			
			ME		59	49	1.2		-53		
			MN	18	01	56	1.3	-34			
			ME		01	58	1.6		-29		
			F		14	15					
153	7		P	19	14	53				208	Do.
			eL		15	10					
			MN		15	58	1.0	-8			
			ME		15	59	0.8		-4		
			F		17	04					
154	8		iP	2	14	35	(first motion {0.9 to E, 1.4 to S)			180	Off the coast of Kasima (141. N. 36.3 E). Felt at Mito, 4 Tukuba and Hukusima.
			iS		14	55					
			MN		15	11	1.2	-58			
			ME		15	13	1.7		48		
			F		20	55					
155	8		iP	2	34	44	(first moton {0.9 to N, 1.2 to E)			185	Do, Felt at Mito.
			iS		35	06					
			MN		35	11	1.4	40			
			ME		35	13	1.3		-32		
			F		41	25					
156	11		eP	14	17	03	(first motion {N-S ?, 1.4 to E)			1800	Near the Bonin Is.
			eL		19	48					Felt at Titizima (Bonin)
			MN		20	02	2.3	-45			
			ME		20	02	2.8		36		
			MN		21	39	1.9	-21			
			F		29	25					
157	12		iP	9	11	55	(first motion {1.1 to N, 0.7 to E)			75	Near Tukuba.
			iS		12	00					
			MN		12	01	0.5	-34			
			ME		12	02	0.9		43		
			F		15	02					
158	13		iP		05	05				2800	Near the Caroline Is.
			eL		11	01					
			ME		15	21	4.8		-39		
			F		43	50					

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude A_N μ	A_E μ	Δ km.	Remarks
159	14		iP	9	21	48	(first motion	{1.8 to N, 0.4 to W)		230	Near the Bonin Is.
			iL		22	20					
			MN		22	38	1.0	58			
			ME		22	42	0.5		-46		
			F		30	58					
160	14		P	11	10	59				292	Felt at Hakodate (Hokkaido), Epicenter was off the coast of Aomari prefecture.
			eS		11	39					
			MN		11	41	1.4	-31			
			ME		11	42	1.8		-20		
			F		16	50					
161	17		iP	13	42	32				63	Near Tukuba.
			iS		42	41					
			MN		42	41	—	-10			
			ME		42	41	—		8		
			F		44	15					
162	19		e	12	58	12					Near Karenko (Formosa)
			eF	13	21	46					122.3 N. 24.2 E. Felt at Taityu Taihoku and Islet-Isigaki.
163	26		iP	22	59	32				61	Eastern districts of Yamanasi prefecture.
			iS		59	40					
			MN		59	41	—	18			
			F	23	01	18					
164	28		iP	9	22	34	(first motion	{2.7 to S, 3.4 to E)		136	Near Tyosi.
			iS		22	52					
			MN		22	58	0.4	-24			
			ME		22	59	0.6		18		
			F		26	24					
165	28		e	11	36	34					Distant earthquake.
			eF		49	—					
166	29		iP	3	46	15	(first motion	{0.4 to E, 1.8 to S)		150	Near Tokyo Felt at Tokyo and Yokosuka.
			iS		46	24					
			iL		46	35					
			MN		46	36	0.5	51			
			ME		46	36	0.3		-64		
			eF		49	28					

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude AN μ	AE μ	Δ km.	Remarks
167	6	August	PN	0	56	03	(first motion	{0.1 to N / E-W ?}	)	519	Far off the West coast of the
			S		56	28					Idu Is.
			eL		57	13					
			eMN		57	54	3.7	344			
			eCN_1	1	08	44	2.2	−195			
			eCN_2		14	05	1.8	−85			
			eCN_3		17	27	1.9	−56			
			eF		40	14					
168	7		e	12	32	02					Distant earthquake.
			eF	13	13	—					
169	9		iP	9	10	18				67	Near Tukuba, felt at Mito
			iS		10	22					Asio and Tukuba.
			iL		10	27					
			MN		10	35	—	34			
			ME		10	33	—		41		
			F		12	24					
170	11		iP	9	37	33				178	Near Hukusima. Felt at
			iS		37	33					Tukuba-san, Mito and
			MN		38	00	0.5	−34			Hukusima
			ME		37	57	0.7		42		
			eF		41	45					
171	11		e	13	42	00					Distant earthquake.
			eL		48	44					
			eF	14	25	—					
172	13		P	0	22	20				4610	Near the Mariana Islands.
			eL		32	15					
			ME		35	18	3.4	14			
			MN		34	27	2.3		9		
			eF		59	34					
173	14		P	11	45	12				1920	Off the south coast of Kuril
			eS		48	16					Is.
			ME		49	30	2.9		−28		
			CE		53	56	4.1		16		
			eF	12	05	—					

No.	Date Day	Date Month	Phase	Time h	Time m	Time s	Period s	Amplitude AN μ	Amplitude AE μ	Δ km.	Remarks
174	14	Aug.	iP	21	34	50				123	Southern districts of Hukushima prefecture.
			iS		35	04					
			MN		35	07	0.4	16			
			ME		35	09	0.8		-13		
			F		37	55					
175	16		P	16	01	31				2290	Near Kamtchatka.
			eS		03	18					
			eL		05	30					
			MN		06	09	2.8	78			
			ME		05	56	2.4		-81		
			MN		07	47	2.6	68			
			ME		07	51	2.9		-59		
			ME		09	40	2.8		-34		
			MN		10	54	2.7	-41			
			CN		13	11	1.9	18			
			CE		13	19	2.1		11		
			eF		41	24					
176	20		eP	2	17	—				104	Near Tukuba.
			eS		17	14					
			eMN		17	18	—	2			
			eME		17	18			1		
			eF		18	—					
177	20		e	3	19	02					Felt at Islet-Isigakizima.
178	22		iP	7	31	32	(first motion	1.3 to N, 1.0 to E)		110	Near Tukuba. Felt Mito and Tukuba-san.
			iS		31	47					
			MN		31	49	—	8			
			ME		31	50	—		-11		
			F		33	15					
179	24		iP	20	45	35	(motion	7.4 to N, 4.7 to E)		52	
			iS		45	42					
			ME		45	43	0.6		-875		
			MN		—						
			ME		47	28	1.8	156			
			F		50	16					
180	25		e	19	48	37					Distant earthqnake.
			ME		51	56	8.4		50		
			ME		55	38	9.3	47			
			eF	20	06	—					

No.	Date Day	Month	Phase	Time h	m	s	Period s	Amplitude AN μ	AE μ	Δ km.	Remarks
181	28	Augst	iP	8	44	42	(first motion	{1.1 to N, 0.8 to W)		70	Near Tukuba, Felt at Mito and Tukuba.
			iS		44	52					
			ME		44	52	—		18		
			MN		44	52	—	29			
			F		46	38					
182	29		eP	17	08	06				2584	Off the east coast of the Philippine Islands.
			eL		12	51					
			ME		14	44	9.0		−50		
			ME		18	03	6.8		−35		
			CE		24	23	9.3		25		
			eF		46	20					
183	30		iP	0	42	12				370	Off the coast of Kasima (near Mito).
			S		42	47					
			L		43	02					
			MN		43	11	1.0	−23			
			ME		43	13	0.9		18		
			F		48	10					
184	31		iP	20	49	16				222	Felt at Utunomiya, Tukuba-san, Mito and Hukusima. Epicenter was Ibaraki prefecture.
			iS		49	41					
			MN		49	42	0.8	33			
			ME		49	44	0.4		11		
			MN		51	10	1.0	10			
			ME		51	15	0.7		7		
			F		54	24					

On the Destructive Earthquakes in Formosa on the 2nd. and 15th. of September, 1922.*

By SAEMONTARO NAKAMURA.

On the east coast of Formosa, there is one of the greatest seismic zone in Japan. Most of shocks observed in Formosa have their epicenters in the mountainous region in the central part or off the east coast. The strong shocks observed in the northern part of the island on the mornings of the 2nd. and 15th. of September, 1922 had their epicentres in the latter region or off the coast of Dinan-o, near Giran.

The earthquake on the morning of the 2nd. According to Mr. H. Kondo, Director of the Taihoku Observatory, the position of the epicentre of the earthquake on the 2nd. was 122° 15′ E and 24° 30′ N.

By the shock 36 houses were wholly or partly ruined and five persons were killed. All these ruined houses are old ones, built of *sun-dried brick* (Dokaku), and no wooden nor brick buildings were damaged.

The strongest shaken area was limited to Taihoku and Shinchiku provinces. In the southern part of the island the shock was distinctly weak. The abstract of some of the reports from the various parts of the island are given below :—

	Intensity	Direction of Shocks	Remarks
Basshi, Karenko.	weak (rather faint)	E–W	Doors and windows slighly rattled. The shock was felt as if it came from the east.
Kadamura, ,, .	weak	From the direction of the coast.	With a sound like a distant thunder.
Hoppo, ,, .	weak	uncertain.	Accompanied by a sound like a distant thunder. Most of villagers ran out from their houses, having alarmed by the shock. Clocks stoped, water in vessels was markedly swinged, and etc. No damage was done. A few weak or faint shocks were felt till 6 am.
Dainan-o, Karenko.	strong	S–N	Accompanied by a rattling sound like that caused by a carriage passing on a bridge. Some of stone walls were broken. Two strong and more than fifteen weak shocks followed.
Gokotsu, Karenko.	strong (rather weak)	S E	Furnitures were overturned, water flowed, some of stone walls broken, fissures produced on the ground, etc. No sound were heard. 11 shocks on the 2nd, 3 on the 3rd., 12 on the 4th., 2 on the 5th. were felt, of which eight shocks were accompanied by the earth-sound.
So-o-nanto-o	—	—	The report from the harbour works office say that since the 2nd. till 7th. about 150 shocks were felt. On the morning of the 8th. a few shocks were observed in every five minutes.

*Time is refered to the Central Standard Time of Japan in this report, except in the abstracts of original reports of substations in Formosa, in which the Western Standard time is used.

	Intensity	Direction of Shocks	Kemarks
Bon-bonzan	strong	N–S	The duration of the shocks were very long, and their directions were rather uncertain. Some of bottles, canes and others on the shelf were thrown down. A few other shocks followed the main shock.
Giran	strong	SW	Clocks were stoped, brick walls fell down, plastered walls shattered, some of houses were partly ruined and some persons were killed or injured. 7 or 8 shocks were observed after the main shock till the morning, but they were not very strong.
Bitokaku light house	weak	E–W	Horizontal and rapid shocks.
Hokasho light house	weak	N–S	Strongly felt.
Keelung light house	strong (rather weak)	N–S	Some ones ran out, having alarmed by the shock. Clocks were stoped.
Fukikaku light house	faint	E–W	Doors rattled.
Hakusako light house	strong (rather weak)	S–N	Water in a reservoir and mercury in the lantern were overflowed.
Byoritsu	strong	SW	Accompanied by the earthsound. Clocks were stoped.

Though the shock was not so very violent to give damage on the wooden or good brick buildings, the cottages of natives, generally built by the sun-dried bricks and some of them are old and damaged by the white ants were readily ruined by the shocks. According to Mr. Kondo's opinion, If there be no such cottages, no one would be killed by an earthquake with such an intensity. The following table gives statistics of the damage and losses in life.

Taihoku Province.

Localities	Taihoku City	Keelung	Bunzan	Kaizan	Shichisei	Giran	Rato	So-o	Shinsho
killed	1 woman	—	—	—	—	1 man 1 woman	—	—	—
wounded severly	—	—	—	1 man 1 woman	—	1 man	—	—	—
,, slightly	1 man 1 woman	—	—	—	—	1	—	—	—
houses ruined	1	—	—	5	1	2	3	—	1
,, partly ruined	5	1	—	4	3	2	1	4	—
,, broken	4	1	—	28	1	5	20	76	—
brick wall broken	1	—	—	—	—	—	—	—	—
sun-dried constructions broken	—	—	—	—	—	—	1	—	—
chimneys broken	—	—	—	—	—	—	cracked 1 fell down 1		—
killed pige	—	—	1	—	—	1	—	—	—
loss in the wine stores	4,200¥	—	—	150¥	—	—	72 bottles ; 541 litres each contained 848 litres.		—
loss in the china-shops	880¥	35¥	—	—	—	—	1235¥	50¥	—

Shinchiku Province.

Locality	Shinchiku	Toen	Daikei
killed	1 man 1 woman	—	—
Wonnded, severly	—	—	—
,, , slightly	—	—	—
houses ruined	—	—	1
,, partly ruined	1	—	1
,, broken	—	2	2
brick walls broken	—	—	—
sun-dried brick construction broken	—	—	—
chimneys broken	—	—	—
pige killed	—	—	—
loss in the wine stores	—	—	—
loss in tne china-shops	—	—	—

A joint of the main of the water works in Keelung were broken.

The report from Isigakizima observatory says that the shocks were not very strong in the Yaeyama Islands, and that in Hateruma I. clocks were stoped.

This shock was registered at all observatories by the microseismometer. Mr. Ushiyama examined some of the seismograms obtained at the observatories in various parts of Japan, with a special attention on the direction of the first movement and the durations of the preliminary tremors. As the most of seismometers used in Japan are the undamped pendulums, and accordingly the latter parts of the records are not available for the accurate measurements, we must not extend our researches over these parts. The followings are the results obtained, in which the time of the first commencement of the shock is refered to the original reports from the observatories.

Observatory	P	P–S	O	Δ
	h m s	s	h m s	km.
Taihoku	4 16 21	12.2	4 16 9	92
Taityu	16 10	12.5	15 58	93
Isigakizima	16 15	20.2	15 49	191
Taito	16 43	26.2	16 9	239
Naha	17 22	58.2	16 2	575
Kagoshima	18 35	—	16 2	1129
Nagasaki	18 44	m s 2 9	16 6	1177
Hukuoka	18 58	2 15	16 6	1280
Oita	19 5	—	16 6	1328
Huzan	18 54	—	15 54	1345
Kure	19 9	—	15 53	1467
Matuyama	19 22	—	16 6	4169

Observatory	First motion
Taihoku	9.2 to S 6.0 to E
Tainan	0.7 to N 1.0 to E
Taityu	E (one component only)
Taito	to E (one component only)
Kosyun	to E (one component only)
Karenko	10.75 to N 15.95 to E

Observatory	P	P–S	O	Δ	Observatory	First motion
	h m s	m s	h m s	km		
Hirosima	4 19 15	—	4 15 58	1473	Isigakizima	0.25 to N 3.0 to W
Zinsen	19 27	2 43	16 7	1499		
Hamada	19 2	—	15 42	1502	Naha	0.25 to S 2.10 to W
Tadotu	19 13	—	15 47	1554		
Okayama	19 17	—	15 47	1591	Naze	W (one component only)
Dairen	19 28	2 44	15 57	1600		
Sionomisaki	19 26	—	15 50	1643	Kagosima	To S slight in E component.
Kobe	19 45	—	16 3	1682		
Yagi	19 49	—	16 3	1715	Nagasaki	0.5 to S 0.3 to W
Kyoto	19 50	—	16 2	1745		
Tu	19 35	—	15 42	1782	Hukuoka	0.02 to S 0.50 to W
Hamamatu	19 55	—	15 51	1870		
Takayama	20 10	—	15 57	1970	Zinsen	3.7 to S 2.2 to W
Numadu	20 15	—	15 59	1981		
Nagano	20 18	—	15 57	2031	Dairen	5.0 to S 1.5 to W
Maebasi	20 20	—	15 55	2076		
Tokyo	20 23	3 14.2	15 56	2083	Osaka	3.0 to S 3.5 to W
Kumagaya	20 21	—	15 54	2083		
Tukubasan	20 27	—	15 54	2142	Nagoya	to W
Tyosi	—	3 59	—	2172	Tokyo	0.7 to S 1.7 to W
Niigata	20 33	—	15 56	2176		
Mito	20 24	3 39	15 47	2179	Tyosi	to W
Midusawa	20 54	4 47	15 54	2399	Titizima	to W?
Hakodate	21 17	—	15 59	2562		
Sapporo	21 26	5 48	15 55	2697		
Otomari	22 5	—	16 1	3058		

Assuming the co-ordinates of the epicentre determined by Mr. Kondo to be true, the time of occurrence of the earthquake at the origin is determined. The table given in "the large earthquakes of 1913" published by the British association Seismology Commitee is used for this computation. The result is given in the fourth column of the above table. The mean of the time of occurrence at the origin is $4^h\ 15^m\ 57^s$.

It is clear that the time of occurrence at the origin or at the epicentre thus deduced is not accurate, if the depth of the origin be finite or the origin and the epicentre are not considered as the same point. The figures in the fourth column of the above table considerably deviate from the mean value, and the deviations seem to have some regular relation to the epicentral distance. This is partly because of that the depth of the origin is not negligiblly small, and partly of that the time curve used to make the table given by the British association Seismology Commitee does not fit good to the earthquake occurred near Japan. The Velosity of Propagation of the seismic

longitudinal wave in the upper-most layer of the earth-crust seems to be smaller in Japan than that given by German seismologists.[1)]

If the above mean value be not too much differ from the true value, the time of the commencement at Taihoku was 12 seconds too late. But the determination of time at Taihoku is much more acculate to regard this 12 minutes to be an error of observation. The focul depth of this earthquake must be some 100 km. or so to give such a difference in the time of commencement at Taihoku. The time of commencement at Isigakizima is 8 minutes faster, but this is because of the inaccurracy of the determination and keeping of time, as the observatory is in a isolated small islet and have no instrument to determine an accurate time

The shock on the 15th. On the early morning the 15th. of September another earthquake occurred at the nearly same position as that on the 2nd. Though the former was not so strong as the latter, the number of after shocks were exceptionally large, and some of them were considerablly strong on the east coast of Formosa. The strongly shaken area was nearly the same as that in the case of the earthquake on the 2nd. Some of the reports are abstracted as follows :—

Gokotsu, on the 15th, at 3 h. 34 m. am. a strong shock was felt. Its duration was 34 minutes. The general direction of shocks was to the east, though the horizontal and vertical shocks were mixed up. Houses were strongly shaken, stone walls were broken, and furnitures tumbled down. Small fissures were produced on the ground here and there. The earthsound was heared. It was like that due to the continuous discharging of cannons.

A large waterfall on the side of Mt. Nankodaizan was swallowed by a large fissure which appeared on the upstream. Many landslips were occurred on the mountain-side. Number of shocks observed is as follows.

Date	faint shocks	weak shocks	strong shocks	
15	41	30	3	
16	16	7	1	Total 102
17 (till 9 h. am.)	—	3	1	
sum	57	40	5	

Dianan-o. A violent shock lasted about 10 min., which were accompanied by a sound like that caused by a carriage passing on a bridge. 3 dwellings and 2 undwelled cottages were severly damaged. At some places the high-way sliped down. Its total elongation is 43 ken (78 meters). The total elongation of the broken retaining

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1) Saemontaro Nakamura: On the propagation of Seismic Waves in the region near epicentre, Bulletin C. M. O. Vol. III. No. 1.

walls is 46 ken (84 meters). 2 electric poles were broken. Minor shocks are observed still now. (2 pm. 16th. Sept.)

Bonbonzan. The shock was a little stronger than that on the 2nd. Oil cans, tinned foods, bottles of wine and others on a shelf in a store house were thrown down.

Giran. The intensity of the shock was " strong (rather weak)". Clocks were stoped, some of chinas were broken by the shock, and slight damages of houses were done. More than ten shocks were felt till 9 h. am, but they were not very strong.

Hyorin. Clocks stoped. No damages were done. The shock was considerably strong.

Sekitei. Houses were strongly shaken. Some of them, built of the sun-dried bricks, were crucked.

The table of damage and losses in Taihoku province made by the police department of the province based on the reports received till the 21 st. is as follows :—

Name of police office	Minami	Banka	Kita	Shichisei	Tansui	Keelung	Giran	Rato	So-o	Bunzan	Kaizan	Shinsho	Total
Dwellings													
ruined	—	—	—	1	—	1	3	6	6	—	—	—	17
partly ruined	—	—	—	2	—	1	2	3	12	—	—	—	20
broken	8	—	—	4	—	9	37	7	31	—	—	—	96
slightly broken	—	1	2	15	—	13	57	233	111	—	—	—	432
Undwelled cottages													
ruined	—	—	—	3	1	1	3	1	4	—	1	—	14
partly ruined	—	—	—	1	1	—	—	2	2	—	—	—	6
broken	—	—	1	3	—	2	—	17	6	—	—	—	29
slightly ruined	—	—	—	5	—	—	6	24	4	1	—	—	40
Persons													
killed	—	—	—	—	—	—	—	—	—	—	—	—	—
wounded	—	—	—	—	—man 2 woman 1		man 2		man 1	—	—	—	man 5 woman 1
Domestic animals and fowls													
killed	—	—	—	pigs 3	—	—	—	pigs 3 fowls 5	fowls 12	—	—	—	pigs 6 fowls 17
wounded	—	—	—	—	—	—	pigs 1	—	—	—	—	—	pig 1
Goods and others	—	—	—	—	—	chinas 55¥	wine 451 litres	—	wine 685 litres other goods 385¥ chemicals 200¥ 16 wine bottles 256¥	—	—	—	
Roads	—	—	—	—	—	—	—	—	slip down 10 (313 metres) buried 12 (609 metres) crucked 1(an earthen bridge of 14.5 metres)sunk 1	—	—	—	
Miscelaneous													
electric power lines was brocken at 3 points	—	broken tiles 7500	—	—	The main of waterworks broken at a point	—	1 chemney was laied down. 2 walls broken.	1 chemney crucked, 1 wall broken	6 water vase broken 1500 tiles shattered. 3 walls (14.5 metres) broken.	—	—		

The statistics of the damage in the lands of savages are not yet completely made up still now. The total damage since the 2nd. reported till 19th. are tableted as follows :

Damage Province	Taihoku	Shinchiku	Karenko	Total
Japanese killed	—	—	man 2	man 2
Native killed	—	—	man 4	man 4
,, wounded	woman 3	—	man 13	man 13 woman 3
Dwellings ruined	2	1	—	3
,, seriously broken	2	1	—	3
,, slightly broken	1	31	—	32
Cottages ruined	3	—	—	3
,, partly ruined	3	—	—	3
,, seriously broken	6	—	—	6
,, slightly broken	1	1	—	2
Road slipe down Number of points	200	38	17	255
Road slipe down Total length	1452 ken.	64 ken.	117 ken.	1633 ken.
,, buried Number of points	122	9	7	138
,, buried Total length	862 ken.	39 ken.	77 ken.	978 ken.
,, Crucked Number of places	13	—	4	17
,, Crucked Total length	314.5 ken.	—	?	
Bridges seriously damaged Number of places	8	—	2	10
Bridges seriously damaged Total lenghth	83.5 ken	—	?	
,, slightly broken Number of places	49	—	—	49
,, slightly broken Total length	183	—	—	183
Telephon lines broken Number of places	64	—	2	66
,, buried Number of places	2	—	—	2
,, buried Total length	175	—	—	175
Number of Electric Poles broken	6	—	—	6
Ground crucked Number of places	3	—	—	3
Ground crucked Length	32 ken.	—	—	32 ken.
,, sliped Number of places	1	—	—	1
Shelter-Trenchs broken Number of places	19	—	—	19
Shelter-Trenchs broken Total length	219	—	—	219
Wooden Fences broken Number of Places	14	—	—	14
Wooden Fences broken Total Length	670.5 ken.	—	—	670.5 ken.
Stone Walls broken Number of Places	14	—	—	14
Stone Walls broken Total Lenghth	85 ken.	—	—	85 ken.
Water Pipes and Others broken Number of places	8	—	—	8
Water Pipes and Others broken Total Length	48 ken.	—	—	48 ken.

As the records of this earthquake are now under special examination, I will quote the original reports from the local observatories as a preliminary reports.

The position of epicenter was, according to Mr. H. Kondo, was on the North-West of the former one on the 2nd. Its co-ordinates are 122.° 13′ E and 24° 35′ N.

Observatory	P	O	Observatory	P	O
Taihoku	4 31 48	31 36	Dairen	4 35 2	31 31
Taityu	31 48	31 36	Kobe	35 21	31 39
Tainan	31 46	31 12 ?	Tu	35 27	31 34
Karenko	31 42	31 30 ?	Kyoto	35 27	31 39
Taito	31 24	30 50 ?	Gihu	35 40	31 45 ?
Kosyun	31 40	31 5	Nagoya	35 42	31 47
Hoko	32 10	31 30 ?	Nagano	35 54	31 33
Isigakizima	31 00 ?	30 34 ?	Maebasi	35 58	31 33
Naha	33 10	31 50	Tokyo	35 59	31 32
Kagosima	34 4	31 31	Mito	36 11	31 34
Nagasaki	34 11	31 33	Niigata	36 16	31 39
Oita	34 25	31 26	Kumagaya	36 14	31 47
Hukuoka	34 28	31 36	Hakodate	36 37 ?	31 19 ?
Huzan	34 36	31 36	Otomari	36 24 ?	30 20 ?

The most probable time of occurrence of this earthquuake may be 4h. 31m. 36.9s. ±1.4s. In this case the times of occurrence deduced from the data at different epicentral distances are not very much differ and no regular variation by the difference of the epicentral distance can be detected. Probably the origin was rather shallow.

Characteristics of these earthquakes. The most characteristic phenomena of these Formosan earthquakes are the exceptionally frequent occurrence of the after-shocks. The total number of shocks observed at Taihoku in a single month of September was 1576, which exceeds the double of the mean annual number of shock observed in the observatory and nearly the same as the annual number in whole of Japan. Thus the approximate total monthly number of earthquakes in this month in Japan was 1773, which is 1621 more than the last August, while in other districts except of Formosa the number of earthquakes was less than that in August.

The hourly numhers of the earthquakes observed at Taihoku in September are as follows :

Hours / Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
2	—	—	—	—	2	8	14	6	4	2	3	3	3	3	1	2	2	9	—	—	2	3	2	1	70
3	3	5	1	—	—	1	2	—	1	1	—	—	—	—	—	—	—	1	—	1	—	1	1	1	19
4	2	1	2	—	1	1	2	2	1	—	1	1	1	1	1	—	—	—	—	—	—	4	—	3	24
5	1	1	2	2	4	2	—	—	—	2	3	2	—	—	4	2	3	3	2	2	—	2	—	2	39

Hours / Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
6	1	—	2	—	2	1	3	2	1	4	—	2	—	2	2	—	—	—	—	1	1	—	—	3	27
7	1	1	—	3	—	1	2	3	1	—	—	1	2	1	2	2	—	—	—	1	2	1	1	1	26
8	4	2	1	1	4	4	6	2	1	1	2	2	2	2	1	—	—	5	2	3	—	2	—	—	47
9	—	—	4	1	—	—	—	1	1	—	—	—	1	—	—	1	1	—	2	—	—	—	—	—	12
10	1	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	2	—	—	1	—	6
11	—	1	3	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1
13	—	—	—	1	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	2	—	1	6
14	—	—	—	—	—	—	—	1	1	—	—	—	1	—	—	—	—	—	—	—	1	—	1	2	7
15	—	2	1	1	6	30	29	23	17	12	16	15	15	16	11	10	11	15	11	11	12	7	12	13	296
16	8	9	9	8	8	14	11	3	6	7	3	6	1	2	4	7	4	9	5	9	8	6	5	3	155
17	4	7	3	10	1	6	5	1	2	5	9	12	8	5	9	8	10	8	14	12	13	10	8	11	187
18	12	9	8	13	9	7	8	6	5	3	4	9	2	3	5	7	4	3	4	7	5	4	5	4	146
19	6	7	8	5	4	7	3	—	2	3	1	3	2	5	3	4	3	4	3	2	2	1	0	7	85
20	2	3	3	4	6	5	1	1	—	2	1	—	—	—	1	1	3	—	3	1	2	1	7	1	48
21	—	3?	—	—	3	3	1	2	1	1	3	2	—	1	2	2	1	1	2	1	3	4	2	1	39
22	3	2	—	—	—	2	3	1	1	2	5	—	—	4	1	—	1	3	2	—	—	2	1	3	36
23	1	2	3	3	1	2	2	2	—	—	1	—	—	—	2	—	1	2	—	—	—	—	—	1	23
24	1	1	4	3	6	6	2	3	—	—	2	2	1	3	2	5	2	—	3	2	2	4	1	5	60
25	6	5	6	6	7	1	4	2	2	1	3	1	1	—	3	2	2	3	2	1	2	3	2	3	68
26	2	2	3	1	1	1	1	4	—	—	—	—	—	3	—	1	2	—	1	1	2	1	—	2	28
27	3	3	6	3	3	2	3	2	1	1	—	2	—	1	—	1	3	1	1	2	3	—	2	—	43
28	4	1	3	—	1	1	1	—	1	1	1	—	3	1	—	—	1	—	—	—	—	—	2	—	21
29	—	—	—	—	3	—	1	7	2	1	—	1	1	1	2	2	—	—	1	2	1	—	1	1	27
30	—	1	1	2	1	3	1	2	1	1	—	—	—	2	—	1	3	1	1	—	1	—	—	1	23
Total	65	69	73	67	79	108	105	76	57	50	58	65	44	56	56	58	57	68	59	62	62	58	54	70	1576

Another point to be specially noticed is that the directions of the first movements of the earthquake on the 2nd. recorded at all observatories are towards the epicentre without exception, while in most of cases ever examined the directions were inwards at some observatories, and in others outwards for a single earthquake.

One of the simplest possible explanations of this distribution of the first movements in this Formosan earthquake is that the mass at the origin was suddenly corupsed.

The seismic rays which arrived at most of those observatories now considered will be radiated from the deeper side of the origin as the epicentral distances of the observatories are very large, except that of some observatories in Formosa, if the depth of the origin be not so deep as G.W. Walker[1] considered.

Hence if the cause of this earthquake be a simple depression of the earthcrust, the focal depth must be very large. It may be a simple contraction of mass at origin.[2]

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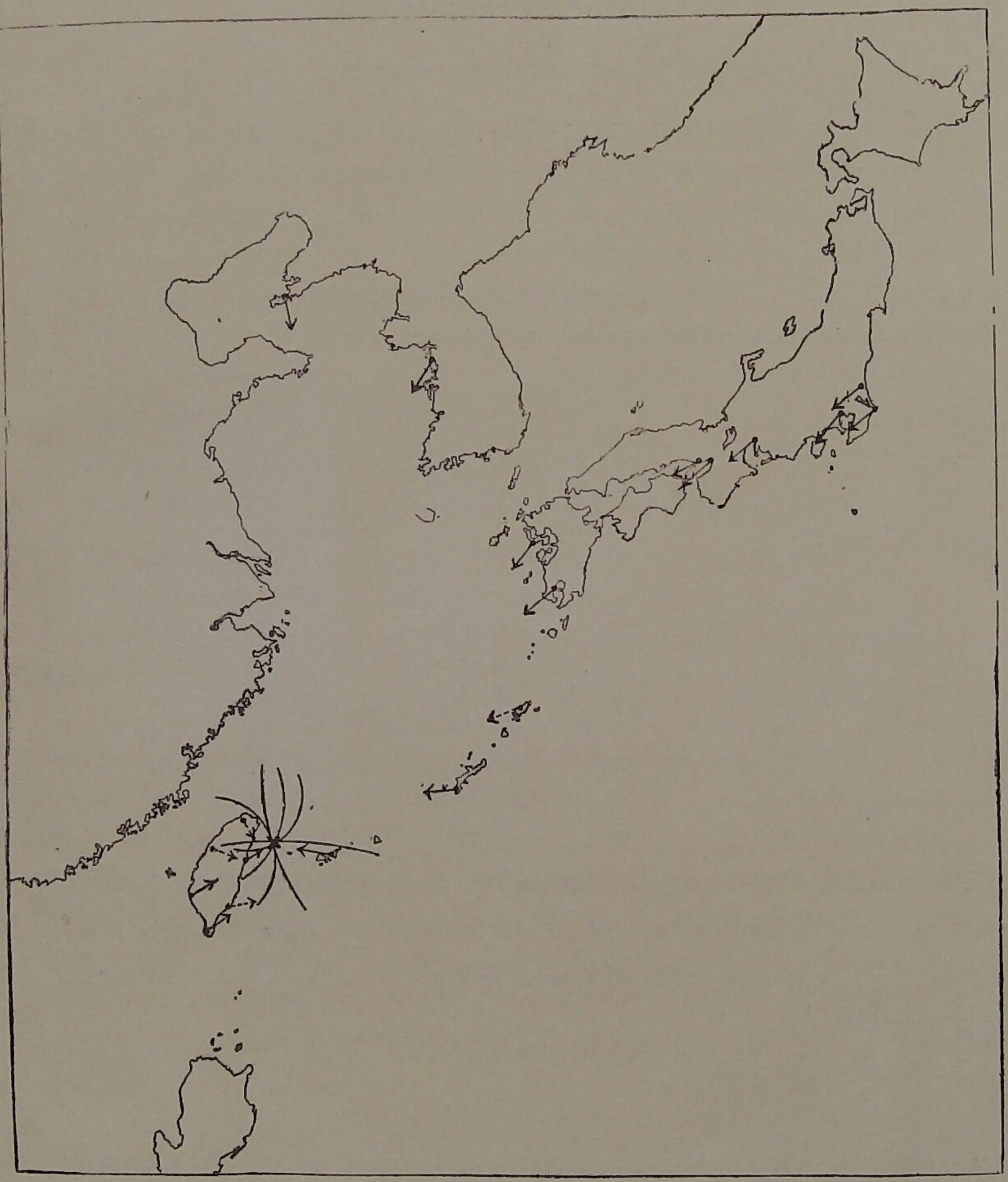
1) G. W. Walker: The problem of Finite focal depth Revealed by Seismometers. phil. Tran. Roy. Soc. London. Ser. A. Vol. 222. Pp. 45-56

2) Saemontaro Nakamura: On the Direction of the first movement of the Earthquake Jour. Met. Soc. Japan. Feb. 1922.

The direction of the first movement.



The record of the Chilean earthquake on the 11th of November, 1922

By SAEMONTARO NAKAMURA.

The earthquake occurred in Chile, south America, was clearly recorded nearly all observatories in Japan. The seismogram at Tokyo recorded many phases due to the reflection of P phase at the earth's surface. The ray reflected along the major arc of the earth's surface was detected rather clearly on the record 11m. 44s. after the commencement of P. The tide-gauge of the observatory at Choshi (Tyosi) recorded the tidal waves due to the earthquake and traveled on the Pacific.[1]

Though the time of commencement of the waves at Chosi is not distinct, the approximate time is the noon of the 12th. Nov. (3h. am. in G.M.T.) The time of occurrence of the earthquake at epicentre may be deduced from the time of commencement of the earthquake recorded at Tokyo. The results of the microseismic observation at Tokyo is as follows :

	h	m	s		h	m	s	T s	AE
P	4	52	34.1	SR_2	5	22	8.0		
PR_1		58	9.6	L		42	57.2		
PR_2	5	1	47.4	ME		48	55	23.2	−150
(PR_3)		4	18.5	CE	6	34	20	16.5	150
S		6	52.1	CE		44	29.5	16.5	50
PS		10	9.0	CE		52	24.9	18.4	−36
eSR_1		18	33.3	F	7	48			

The epicentral distance may be deduced from the above seismologic observation, but it is only an approximate value. More accurate epicentral distance can be computed by the trigonometric culculation after finding the regions where the damages were most serious.

The Japan Gazette said.

(*Kokusai-Associated Press*)

" Santiago, Chile, Nov. 11. The town of Copiapo half way between Valparaiso and Antofagasta has been destroyed by an earthquake. Thirty peoples are so far known to have been killed and sixty at least are injured.

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1) The tide-gauges at Tansui (Formosa), Nagasaki, Kobe and Osaka, also recorded the tidal wares.

Full details of the damage done by the earthquake, which lasted from two to four minutes in different parts of the country, are not yet available. Communication by telegraph is disrupted."

"Buenos Ayres, No. 11,—It is feared that an earthquake last night has caused a tidal wave and a catastrophe at Antofagasta, Chile.

(The town of Copiapo, Chile, is the capital of the province of Atacame, thirteen miles from the sea. The population is about 15,000. It is an important mining centre.

Antofagasta in a seaport of Chile situated on the Bay of Morena. The population is about 25,000.)

"Santiago, Nov. 11.—The value of the houses destroyed is estimated at 5,000,000 pesos. The railway depots at Coquimbo were shaken down and the railway carriages upset, and the tidal wave carried away the greater part of the mole in the harbour."

"The violence of the shocks and their approximate locality were recorded at the Florence Observatory in Italy."

(*Kokusai-Reuter Cable Service*)

"Santiago, Chile, Nov. 12.—According to the latest reports 200 were killed and 400 injured in the earthquake and tidal wave at Coquimbo, La Serena and Copiapo. The waters flooded 300 miles of the shore of Coquimbo and Antofagasta Provinces."

(*Kokusai-Associated Press*)

"Coquimbo, Chile, Nov. 11.—Approximately 100 persons were drowned here, when a tidal wave, following an earthquake, swept in over the seaport with a great roar.

The panic-stricken inhabitants rushed to the hills for safety."

"Valparaiso, Nov. 11.—About 70 persons are reported dead and 50 injured as the result of an earthquake at Coquimbo.

The business district of the seaport was destroyed.

Five thousand people have been rendered homeless by the catastrophe at Ovalle, Illapel, and other towns in the vicinity."

"Antofagasta, Chile, Nov. 11.—More than 100 persons were killed and many injured seriously by an earthquake that overturned many buildings in Copiapo, the capital of the province of Atacama.

The first shocks, which were felt here a few minutes before midnight, were prolonged and sever.

The telegraph lines were broken down. A tidal wave inundated part of the city, flooding scores of buildings close to the beach.

Despatches from the province of Atacama state that the centre of the earthquake was in the area defined by the towns of Copiapo, Ovalo, Vallenar, Chanaral, and San Fernando. Copiapo suffered the most.

In Chanaral a tidal wave swept over the commercial section, wrecking the post-office and other buildings. It is reported the city virtually has been abandoned by the inhabitants.

All the areas affected by the earthquake are badly in need of relief."

(*Kokusai-Reuter Cable Service.*)

"New York, Nov. 11.—Despatches from Hawaii state that a tidal wave swept the bay on Friday evening, washing some craft out to sea, but there were no casualties. A panic occurred among the Japanese living on the waterfront."

The approximate co-ordinates of the epicentre may be assumed as

71° W and 27° S,

from the above descriptions on the catastrophe, which gives the epicentral distances from Tokyo and Choshi. They are 152°.5 and 151°.6 in arc respectively.

As it takes about 1080 seconds or 18 minutes to travel the distance of 152°.5 for the preliminary tremor, the time of occurrence of the earthquake at origin is 4h. 34m 34s am on the 11th. in G.M.T. or 11h. 34m. 34s. on the 19th in the Chilian Mean Time, which has a pretty good agreement with the above description cabled from Antofasta.

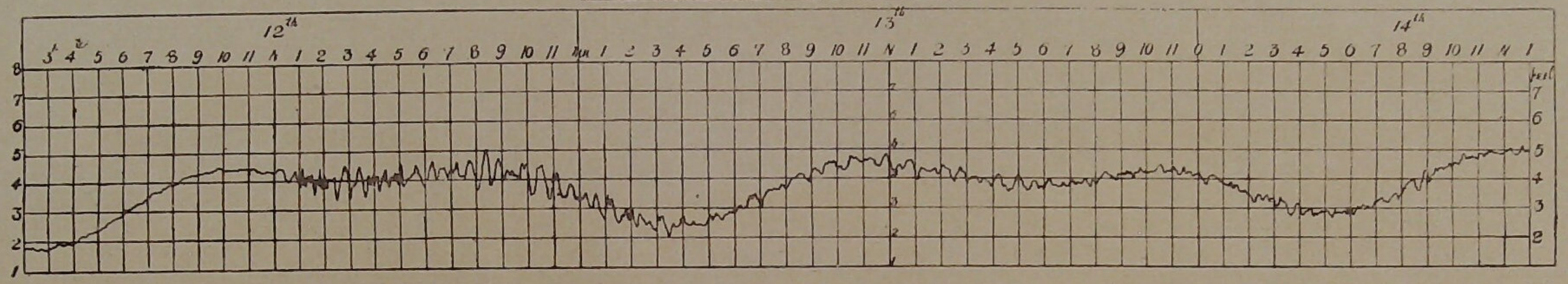
The time taken by the tidal wave to travel from the Chilean coast to Choshi is 22h. 25.4m. and its mean velosity is

$\frac{151.\frac{6}{22.42}}{}$ degrees per hour = 6.744 degrees per hour = 208 metres per sec.

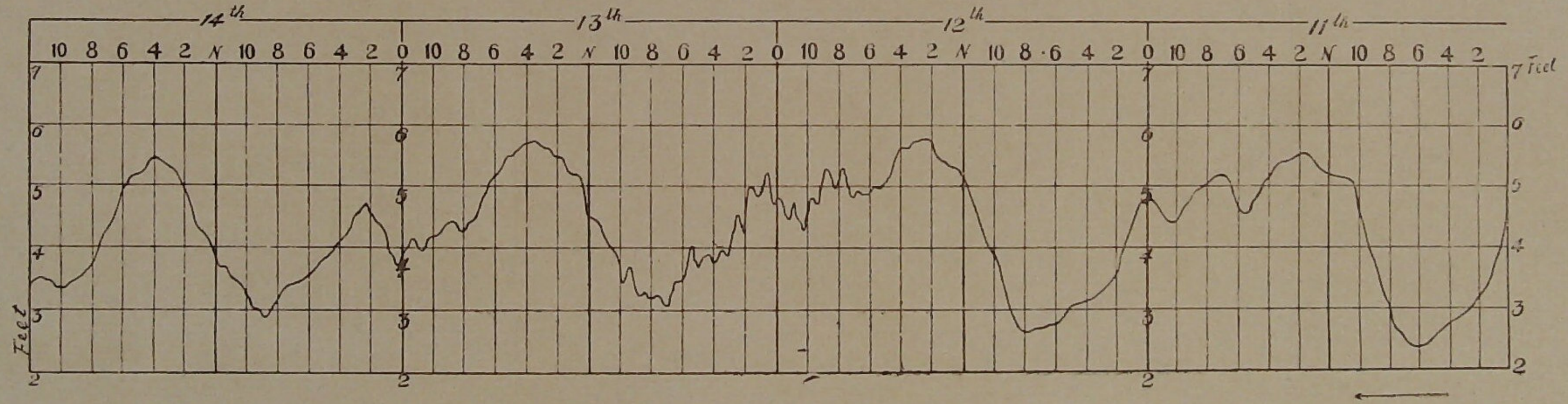
The maximum amplitude of the tidal wave recorded at Choshi is 8.9 inches or 22.7 cm. and its period is about 30 minutes. Hence the wave length is 374 km.

The tide-gauge station of the Tyosi (Choshi) Observatory is perfectly exposed to the open coast of the Pacific and is free from any secondary oscillation of water due to the form of the coast-line.

Mareogram at Choshi



Mareogram at Osaka



大正十二年二月十五日印刷
大正十二年二月二十日發行

編輯兼發行者　東京市京橋區宗十郎町十五番地　中島丑之助

印刷者　東京市京橋區宗十郎町十五番地　合資會社東京國文社

印刷所

中央氣象臺彙報