

49. *Frequency-distribution of the Itô
Earthquake Swarm of 1930.*

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Introduction.

1. Itô, a town noted for its many hot springs, lies on the eastern shore of the Idu Peninsula, about 100 km SW of Tôkyô. On Feb. 13, 1930, the townspeople began to feel a number of small quick shocks accompanied with detonating sounds like that of distant gun firing, such as is heard there occasionally through war-ships at target practice some distance out to sea. These shocks daily increased in frequency and strength. The shock felt on March 4, 5 h 11 m was so strong that it was felt in the southern part of Kwantô district, while the one that occurred on March 9, 19 h 54 m was violent enough to be recorded by almost every seismograph in Japan. The observations made at the Seismological Institute, Tokyo Imperial University, of the conspicuous Itô earthquakes are shown in Table I. The worst of these was the one that came on March 22. Although it was "strong" according to the Japanese intensity scale, damage to the town was slight. It merely shock down roof tiles, overturned stone walls, and threw down objects from shelves. The unusual small damage notwithstanding the violence of the shocks felt by the inhabitants, might have been due to the short duration of the principal part of the earthquake motion, or else the principal motion was too short to cause the houses to vibrate with it. The violence felt, however, was because the period of the vibrations was 0.5 second—the period to which man is most sensible.¹⁾

After April 12 the shocks diminished in frequency, although about thirty days later, on May 8, they became again active. The inhabitants, however, took care to surpress all outward signs of fear and apprehension lest the visitors to the spas upon getting alarmed might forsake the town, which would be detrimental to the town's main business.

1) M. ISHIMOTO et M. OOTUKA, *Bull. Earthq. Res. Inst.* 11 (1933), 113~121.

Table I.

Arrival-time of <i>P</i> (Tôkyô)				<i>S-P</i>	total duration	Maximum double amplitude				
						NS	EW	Resul.	<i>T</i>	
1930		h	m	s	s	m	μ	μ	μ	s
February	21,	8	37	15.4	13.9	11	120	120	170	0.57
	22,	20	21	12.0	13.7	14	143	126	191	0.66
	28,	18	31	13.2	13.7	5	110	135	174	0.7
March	4,	3	50	53.2	13.8	7	64	89	109	0.7
	4,	5	11	17.3	13.8	12	350	360	500	1.1
	9,	4	39	53.0	14.0	7	182	130	224	0.7
	9,	19	54	48.7	13.7	16	400	361	538	0.85
	13,	4	29	44.7	13.5	12	100	79	128	1.1
	14,	14	18	41.3	13.3	7	79	48	93	1.1
	14,	21	05	30.0	12.5	3	30	26	40	0.56
	15,	18	34	3.7	12.6	9	175	130	218	0.7
	19,	10	16	57.1	13.7	8	136	159	207	1.3
	21,	23	4	23.6	13.4	9	148	92	170	1.1
	22,	17	50	51.7	13.8	20	1000	800	1280	1.0
	26,	14	22	58.5	14.0	20	280	316	422	1.5
	27,	1	41	47.1	13.8	20	267	340	433	1.2
	30,	0	5	36.7	13.7	8	55	46	72	1.3
April	1,	23	4	43.8	13.9	12	179	164	248	1.1
May	9,	12	52	49.7	13.3	15	108	113	159	1.1
	12,	21	27	0.2	14.2	18	464	226	535	1.3
	14,	8	57	2.5	13.4	13	172	146	225	0.9
	15,	15	58	19.4	14.2	13	82	100	129	1.0
	17,	5	14	23.6	13.8	30	560	667	871	1.1
August	15,	11	43	24.3	13.0	10	62	40	74	0.5

Since June no earthquake was felt until the one that occurred on Nov. 7 of the same year, excepting the moderate one of Aug. 15, about 10 km south of Itô. On Nov. 7 seismic activity revived, culminating in the Idu earthquake that came in the early morning of Nov. 26. There were many after-shocks, but they diminished until they ceased in March, the following year.

Since the seismic activity varied as just said, the accessory shocks of the Idu earthquake might have had some relation to the Itô earthquake swarm. In the present paper, however, only the frequency-distribution of the earthquake swarm is investigated in detail,²⁾ the

2) The preliminary investigations were published in the following papers:
A. IMAMURA, N. NASU, F. KISHINOUE and C. YASUDA, *Proc. Imp. Acad.*, 6 (1930), 190~193; A. IMAMURA and others, *Disin* 2 (1930), 215~220 and 281~300; F. KISHINOUE, *Disin*, 2 (1930), 502~503.

object being to ascertain the characteristics of earthquake swarms.

Idu Earthquakes before 1930.³⁾

2. Since the XII century earthquake records were kept in the Province of Idu, but when they are compared with the records of neighbouring provinces, the earthquakes suffered by Idu are surprisingly few. In the "Materials for the Earthquake History of Japan"⁴⁾ only one earthquake is recorded for Idu. This one occurred on July 30, 841, but the position of the epicentre is not definitely known.

3. In September 1882, a local shock occurred at Atami, a famous watering town about 13 km N of Itô, and was reported shortly after by T. Dan,⁵⁾ who states that the duration of the shock seemed very short, probably a few seconds. Damage to houses due to the earthquake were slight, but many retaining walls of terraces were thrown down and tombstones overturned or rotated, judging from which the mode of the earth motion might have been like that of the Itô earthquake swarm.

4. Besides these recorded earthquakes, the writer was told by old residents that swarm earthquake occurred in the Meidi Era (1868~1911), but of which no historical records could be traced. According to inquiries made by the late E. Makino, the time of those earthquakes was 1870.

5. In another case, in June 1905, earthquakes were experienced near the Island of Oosima, Idu, about 40 km SE of Itô.⁶⁾

From data, the writer deduced that the epicentre of the earthquakes lay under the sea between Oosima and the Idu peninsula, slightly south of the Itô earthquakes. According to N. Fukuchi⁷⁾ the origin of the earthquakes might be under the sea bed NW of Oosima. Seismic activity began on May 28, 1905, and on June 5 more than one hundred earthquakes were felt followed by nearly twenty of them the next day.⁸⁾ His opinion is that there were not so many earthquakes, but only ten

3) On this subject, the writer wrote in detail: F. KISHINOUE, *Disin*, 8 (1936), 116~120.

4) *Rep, Earthq. Inv. Comm.*, 46 (1904).

5) T. DAN, Notes on the Earthquake at Atami, in the Province of Idzu, on September 28, 1882. *Trans. Seism. Soc. Japan*, 5 (1883), 95.

6) F. OMORI, *Bull, Earthq. Inv. Comm.*, 2 (1908), 39~100 and *Rep, Earthq. Inv. Comm.*, 68 (1910), 31~38.

7) N. FUKUCHI, On the geological Aspect of the Oosima (Idu) Earthquake of June 1905. *Rep. Imp. Earthq. Inv. Comm.*, 53 (1906), 87~95.

8) See also "Miscellaneous Reports on the Oosima (Idu) Earthquakes." *Rep. Imp. Earthq. Inv. Comm.* 53 (1906), 96~97.

or twenty of very long duration. These activities ended by the middle of June.

In the writer's opinion, these earthquakes might have been an earthquake swarm like the one that visited Itô lying NW of it. Seeing that they had the following characteristics of swarm earthquakes: (i) Swarm earthquakes occurred repeatedly in the region as just mentioned.⁹⁾ (ii) The earthquakes were crowded into a few hours of the day. (iii) The duration of each shock was very short, and its motion quick. (iv) No earthquake of destructive intensity occurred. (v) The active volcano Miharayama nearby was not affected in the least.

Seismological observation of the Itô swarm earthquakes.

6. The earthquake swarm began as already mentioned on Feb. 13, 1930, and its frequency increased gradually as shown in fig. 1. On March 10, five seismographs were set up temporarily, one each at Itô, Usami, Aziro, Kawana and Hasima, surrounding the epicentral region under the supervision of Dr. Imamura. The space distribution of the origins of the earthquakes have been reported already by Dr. N. Nasu¹⁰⁾. As these temporary stations were closed in April the same year, the period of observation might have been too short for investigating the whole course of earthquake activities, which lasted nearly four months. At Misaki and Kamakura, both about 50 km ENE of Itô (Kamakura is about 20 km NNW of Misaki), seismographs have kept working continuously from the records of which the writer studied these seismic activities. The constants of the instruments at the two stations used for this investigation are shown in Table II.

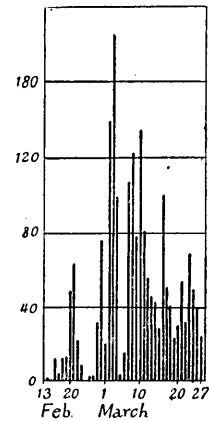


Fig. 1. Frequency-distribution of earthquakes felt at Itô

Table II.

Station	Seismograph	<i>M</i>	<i>V</i>	<i>T</i>	<i>v</i>	Speed of drum
Misaki	Omori-Imamura portable horiz. seismograph	kg 12	120	sec 4	1.5	mm/min ca. 50
Kamakura	Imamura portable horiz. seismograph	7	50	7	1.5	ca. 50

9) The Vogtland swarm earthquakes also occurred repeatedly in 1897, 1900, 1901, 1903 and 1908. E. TAMS, *Zeits. f. angew. Geophys.*, **1** (1922~1925), 194.

10) N. NASU, *Bull. Earthq. Res. Inst.*, **13** (1935), 400~416.

7. Very slight shocks of the earthquake swarm were of course not recorded at these stations as the distance between the stations and the epicentres was about 50 km, and although the epicentral distances of Misaki and Kamakura are nearly equal, the seismograms obtained at Misaki were mainly used for the present investigation, because the magnification of the seismograph there was greater than that of the instrument at Kamakura. (When the observation at Misaki failed to function, those at Kamakura were availed of to fill the deficiency, but when both instruments failed, the data of felt earthquakes at Itô registered by E. Makino¹¹⁾ were adopted.) Most of the earthquakes felt by him (fig. 1) are believed to have been recorded by the seismograph at Misaki, seeing that the daily frequencies reported by him are almost the same as those recorded at Misaki (fig. 2). The lowest limit of

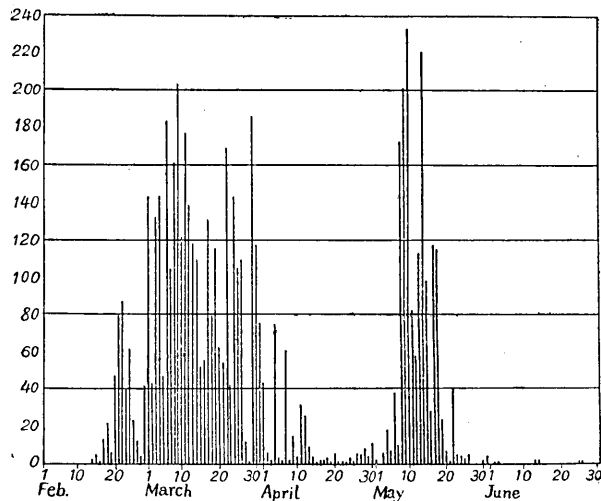


Fig. 2. Frequency-distribution of the Itô earthquakes in 1930 as observed at Misaki.

sensibility of the earthquakes on seismograms at Misaki was 0.2 mm for double amplitude.

8. The arrival times of the earthquakes at Misaki are shown in Table III in which the date, hour and minute of arrival are shown, the total number of earthquakes observed being 5735. When a certain minute is repeated in the table, it means that as many number of earthquakes as are repeated occurred in a minute interval. As the clock for the time-marks on the seismograms was not accurate at that time,

11) E. MAKINO zealously undertook the observation of the earthquakes at Itô with an Imamura seismograph since March 1930 until his untimely death in May 1934.

although the times were checked with those of large earthquakes that were observed at other stations, the range of error in the table may be one minute.

In the next table (IV) the hourly and daily frequencies of the earthquakes are shown. The maximum daily frequency was 233 on May 10, and the maximum of the hourly frequency 74 during 0~1 h on March 6.

The frequencies at Misaki, compared with the daily frequencies reported in the Kisyô-Yôran, published by the Central Meteorological Observatory of Japan, are shown in fig. 3.

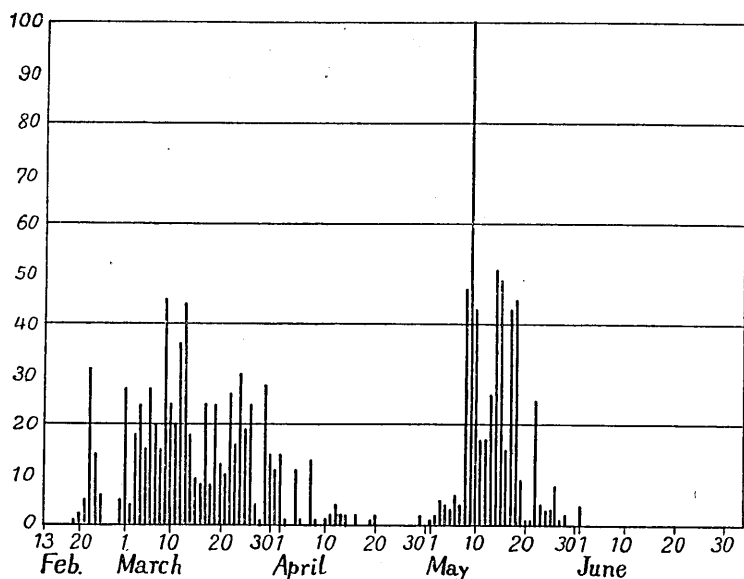


Fig. 3. Frequency-distribution of the Itô earthquakes as observed at local meteorological stations.

Relation between the seismic energy and the frequency of swarm earthquakes.

9. Assuming the energy of an earthquake to be proportional to the square of the amplitude of the seismic wave, the writer summed up the squares of the amplitudes of the first S-wave in the NS component as recorded at Misaki for each day (fig. 4). In this study, the EW component was neglected, because the type of the earthquakes as shown on the seismograms was so similar for every earthquake, (shown in fig. 5, Pl. LVIII) that the relative variation in seismic energy could be obtained by merely measuring one component motion. If fig. 4 were compared with the frequency-distribution in fig. 2, it will be

clear that the two diagrams are on the whole similar, whence it may be concluded that the frequency was closely connected with the occur-

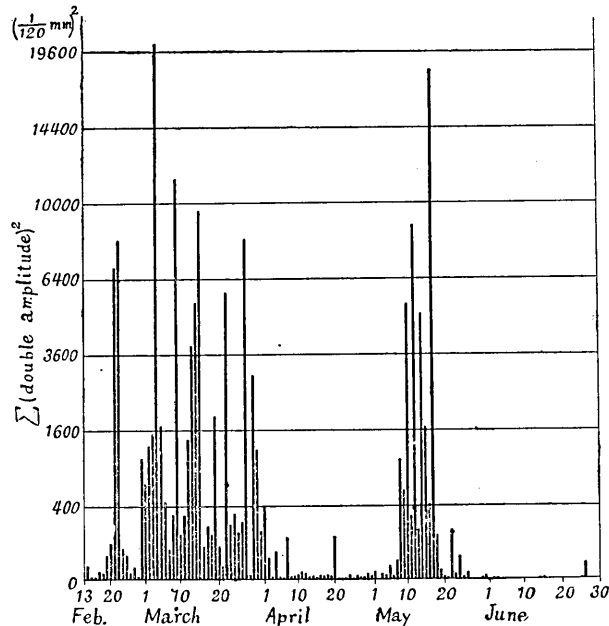


Fig. 4. Variation of seismic energy of Itô earthquakes.

rence of large earthquakes, and that although the number of slight earthquakes was many, they did not play an important role in the time variation in seismic energy. On the other hand, it seems that the large earthquakes occurred when the earthquakes frequency was great.¹²⁾

Relation between earthquake frequency and tidal height and the periodicity of frequency.

10. According to the residents of Itô, the earthquakes came mostly at the time of low tide. Fig. 6 seems to show some relation between frequency and tidal height. The lunar periods of the frequency variation were then studied. The investigation was carried out first for frequencies for every 25 solar hours (an average lunar day being about 24 h 51 m) by the method which was described by J. Bartels¹³⁾, and recently used by Prof. T. Matuzawa¹⁴⁾ and the writer,¹⁵⁾ in investigat-

12) N. Miyabe also noticed the same relation for this earthquake-swarm: N. MIYABE, *Bull. Earthq. Res. Inst.*, **13** (1935), 168.

13) J. BARTELS, *Terr. Magn. a. Atm. Elect.*, **40** (1935), 1~60.

14) T. MATUZAWA, *Bull. Earthq. Res. Inst.*, **14** (1936), 38~67.

15) F. KISHINOUE, *ditto*, **14** (1936), 604~609.

ing the periodicity of earthquake occurrence. The mathematical notations used in the present paper are the same as those used in Prof.

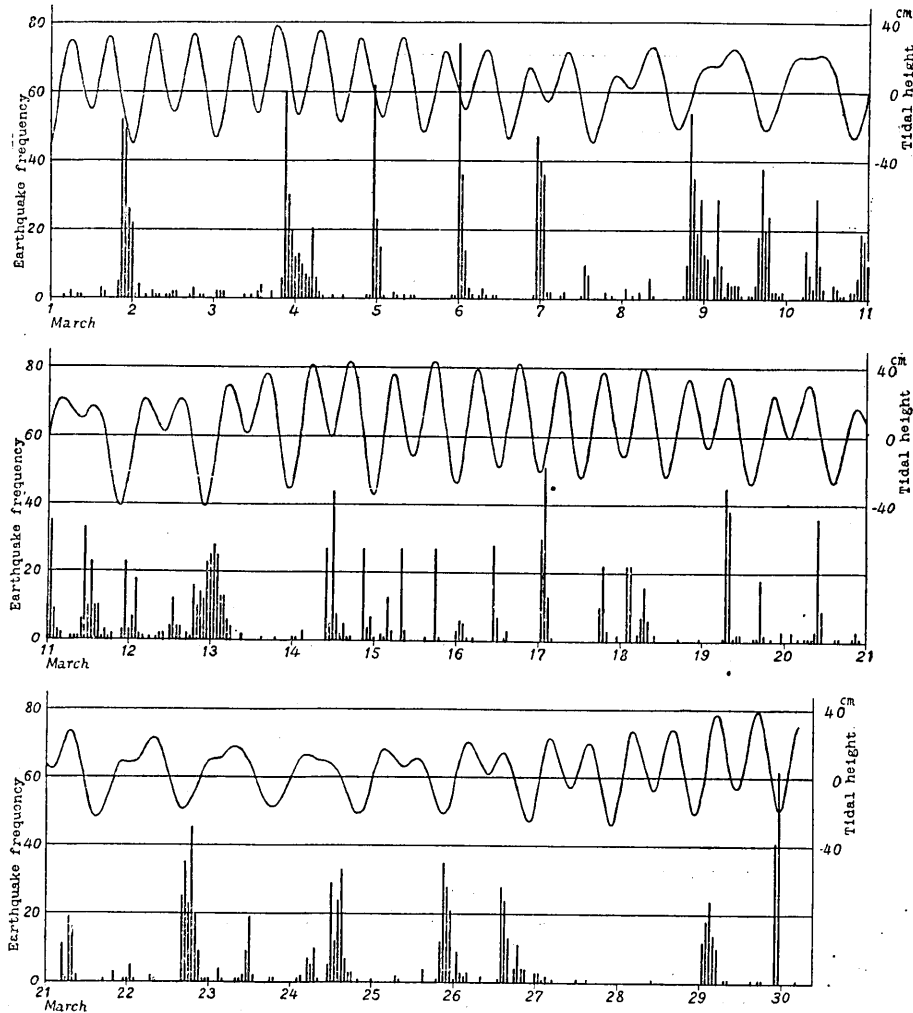


Fig. 6. Tidal height and earthquake frequency observed at Misaki.

Matuzawa's paper, so that an explanation of the method and the notations may be omitted.

11. Tables V and VI give the results of harmonic analysis for about 28 days (ca. 1 lunar month) from 14 h, Feb. 28 to 17 h, March 28 (figs. 7, 8), and from 20 h, April 26 to 23 h, May 24 (figs. 9, 10). In the tables the relative amplitudes c_1 and c_2 for each interval are greater than the corresponding expectancies, but the phase angles have been taken at random, after which the problem of "random walk"

was applied to examine the periodicity of the earthquakes. Obtaining the ratio of the average relative amplitude c_m and the expectancy for the average l_m , the probability $w(k)$ that the average amplitude will exceed the expectancy is mentioned at the foot of the tables, where $w(k) = e^{-k^2}$ and $k = c_m/l_m$. For the data in Table V the ratios of the first and second harmonics were obtained as 2.29 and 0.64 respectively,

Table V.

Interval	n	a_0	a_1/a_0	b_1/a_0	a_2/a_0	b_2/a_0	c_1	φ_1	c_2	φ_2	ε
Feb. 28. 14h ~ March 1, 15h	49	1.96	+0.382	+1.081	-0.983	+0.753	1.146	19.4	1.238	307.4	0.253
March 1, 15 ~ 2, 16	173	6.92	-0.380	+1.622	-1.380	-0.633	1.666	346.4	1.518	245.2	0.135
2, 16 ~ 3, 17	19	0.76	+0.257	+0.013	+0.021	-0.709	0.257	87.1	0.709	178.2	0.407
3, 17 ~ 4, 18	197	7.88	-0.045	+1.414	-0.595	+0.444	1.415	358.1	0.742	306.8	0.126
4, 18 ~ 5, 19	109	4.36	+0.234	+1.795	-1.570	+0.653	1.810	7.5	1.700	292.6	0.170
5, 19 ~ 6, 20	137	5.48	+0.228	+1.816	-1.554	+0.616	1.830	7.0	1.672	291.6	0.151
6, 20 ~ 7, 21	151	6.04	+0.799	+1.170	-0.751	+1.489	1.416	34.3	1.668	333.2	0.144
7, 21 ~ 8, 22	114	4.56	+1.493	-0.614	+1.10	-1.320	1.615	112.4	1.718	141.2	0.166
8, 22 ~ 9, 23	249	9.97	+0.585	-0.212	-0.525	-0.022	0.622	109.9	0.525	267.6	0.112
9, 23 ~ 11, 0	124	4.96	-0.158	-0.004	+0.358	-1.190	0.158	268.5	1.243	163.3	0.159
11, 0 ~ 12, 1	180	7.20	-0.203	-0.025	+1.253	-0.148	0.205	263.0	1.262	96.5	0.132
12, 1 ~ 13, 2	189	7.56	+0.770	-0.770	+0.405	-0.775	1.088	135.0	0.874	152.4	0.129
13, 2 ~ 14, 3	67	2.68	+1.651	+0.500	+1.217	+0.754	1.724	73.1	1.432	58.2	0.217
14, 3 ~ 15, 4	111	4.44	-0.694	+0.297	-0.926	-0.860	0.755	293.2	1.263	227.1	0.168
15, 4 ~ 16, 5	63	2.52	-0.042	-0.584	+0.950	+0.284	0.586	184.1	0.992	73.3	0.223
16, 5 ~ 17, 6	135	5.40	+0.670	-0.646	-1.14	-1.191	0.931	133.9	1.648	223.7	0.153
17, 6 ~ 18, 7	90	3.60	-0.160	-1.037	+1.057	-0.828	1.049	188.7	1.343	126.2	0.187
18, 7 ~ 19, 8	72	2.88	+1.840	-0.250	+1.706	-0.490	1.856	97.7	1.774	106.1	0.209
19, 8 ~ 20, 9	76	3.04	+0.720	+0.332	+0.961	-0.454	0.793	65.2	1.064	115.2	0.203
20, 9 ~ 21, 10	104	4.16	+1.45	+0.332	+0.849	-0.125	1.486	103.6	0.858	98.4	0.174
21, 10 ~ 22, 11	15	0.60	-0.99	-0.513	+3.02	+0.085	1.116	242.6	3.02	88.4	0.458
22, 11 ~ 23, 12	178	7.12	+0.101	+1.560	-1.225	+0.006	1.562	3.7	1.225	270.3	0.133
23, 12 ~ 24, 13	83	3.32	+1.150	-0.744	+0.687	-0.233	1.370	122.8	0.725	251.2	0.195
24, 13 ~ 25, 14	87	3.48	+1.616	+0.701	+1.020	+1.159	1.763	66.8	1.544	41.4	0.190
25, 14 ~ 26, 15	150	6.00	-0.217	+1.11	-0.353	-0.934	1.130	349.0	0.998	200.7	0.145
26, 15 ~ 27, 16	72	2.88	+1.12	+0.730	+0.774	+0.427	1.336	57.3	0.884	61.1	0.209
27, 16 ~ 28, 17	1	0.04	-0.375	+1.973	-1.852	-0.725	2.008	349.3	1.988	248.6	1.772
mean			+0.437	+0.384	+0.094	-0.147					

$$l_1 = 1.318, l_{1m} = 0.254, c_{1m} = 0.582, k_1 = \frac{c_{1m}}{l_{1m}} = 2.29, w(k_1) = 0.005.$$

$$l_2 = 1.413, l_{2m} = 0.272, c_{2m} = 0.174, k_2 = \frac{c_{2m}}{l_{2m}} = 0.64, w(k_2) = 0.66.$$

Table VI.

Interval	n	a_0	a_1/a_0	b_1/a_0	a_2/a_0	b_2/a_0	c_1	φ_1	c_2	φ_2	ϵ
April 26, 20 h ~27, 21 h	6	0.24	+1.466	-0.791	+0.713	+0.709	1.666	108.4	1.004	45.2	0.724
27, 21~28, 22	10	0.40	+0.60	-0.226	-0.522	-0.865	0.641	110.6	1.010	211.1	0.560
28, 22~29, 23	4	0.16	+0.70	-1.56	-0.838	-0.650	1.710	155.9	1.124	232.2	0.886
29, 23~May 1, 0	11	0.44	-1.485	-0.439	+0.889	-0.259	1.548	253.5	0.926	106.3	0.535
May 1, 0~2, 1	2	0.08	+0.375	-1.95	-1.80	-0.725	1.985	169.1	1.940	248.0	1.253
2, 1~3, 2	15	0.60	+0.744	-0.432	+0.12	-1.33	0.860	119.9	1.345	174.7	0.458
3, 2~4, 3	10	0.40	-1.398	+0.45	+1.222	-0.395	1.468	271.9	1.284	108.0	0.561
4, 3~5, 4	8	0.32	+0.388	+0.404	+1.00	+0.238	0.560	40.7	1.028	76.6	0.626
5, 4~6, 5	41	1.64	-0.359	-0.558	+0.366	+0.851	0.663	212.7	0.926	23.2	0.277
6, 5~7, 6	62	2.48	+1.80	-0.571	+1.419	-1.016	1.883	107.6	1.745	125.6	0.225
7, 6~8, 7	246	9.82	+0.762	-0.246	-0.397	-0.613	0.801	108.0	0.730	212.9	0.113
8, 7~9, 8	179	7.16	+0.250	-0.457	-0.511	-0.350	0.521	151.3	0.619	235.6	0.132
9, 8~10, 9	168	6.72	-0.674	+0.112	+0.399	-0.230	0.683	279.5	0.460	120.0	0.137
10, 9~11, 10	74	2.96	+0.253	-0.230	+0.771	+0.645	0.341	132.3	1.005	50.0	0.206
11, 10~12, 11	105	4.20	+0.386	-1.104	-0.397	-0.586	1.170	160.8	0.708	214.1	0.173
12, 11~13, 12	215	8.60	+0.286	-1.30	-0.348	+0.790	1.331	167.6	0.863	336.2	0.121
13, 12~14, 13	93	3.72	-0.270	+0.214	+0.804	-0.678	0.345	306.9	1.051	131.3	0.184
14, 13~15, 14	64	2.56	+0.699	+0.461	-0.566	+0.170	0.837	56.6	0.591	288.3	0.222
15, 14~16, 15	102	4.08	-1.397	+0.658	+0.643	-0.449	1.398	272.4	0.784	138.7	0.174
16, 15~17, 16	134	5.36	+0.143	-0.570	+0.384	-0.386	0.588	166.0	0.544	135.2	0.153
17, 16~18, 17	5	0.20	+0.43	-0.98	+0.35	+4.52	1.070	156.4	4.533	4.4	0.792
18, 17~19, 18	24	0.96	+1.454	+0.735	+0.955	+1.005	1.629	63.2	1.387	43.6	0.362
19, 18~20, 19	4	0.16	+0.40	+1.563	-0.494	+0.888	1.612	14.4	1.015	330.9	0.886
20, 19~21, 20	39	1.56	-1.35	-0.365	+0.369	+0.063	1.399	254.8	0.374	80.3	0.284
21, 20~22, 21	6	0.24	+0.033	-3.97	-0.049	+0.116	3.970	90.5	0.524	337.1	0.724
22, 21~23, 22	4	0.16	-0.813	+1.443	-0.350	-0.713	1.658	330.7	0.794	206.2	0.886
23, 22~24, 23	3	0.12	+0.103	-0.607	-0.748	+1.408	0.616	170.4	1.594	332.1	1.022
mean			+0.131	-0.272	+0.120	+0.094					

$$l_1=1.423, l_{1m}=0.274, c_{1m}=0.302, k_1=1.10, w(k_1)=0.30.$$

$$l_2=1.352, l_{2m}=0.260, c_{2m}=0.152, k_2=0.58, w(k_2)=0.71.$$

while for those in Table VI, the ratios were got as 1.10 and 0.58 respectively. Then, from theory, the lunar periodicity might not be concluded except the first harmonic in the former table. As a whole, when the two cases were combined (the phase difference between the two cases of course taken into account), the ratios for the two harmonics were obtained as 1.55 ($w(k_1)=0.09$) and 0.59 ($w(k_2)=0.71$) respectively. Had change in sea level any correlation with earthquake frequency, the lunar half-daily period or k_2 must be very great. But

since in the above results, the second harmonics were small, the relation between frequency and tidal height might be uncertain for the Itô earthquakes.¹⁶⁾

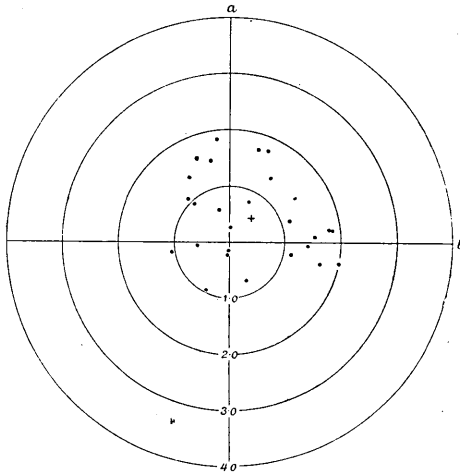


Fig. 7. Harmonic dial of the first harmonic for each of 27 intervals of 25 hours beginning Feb. 28, 14h.

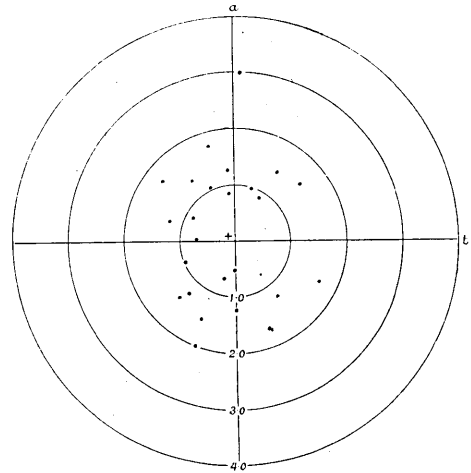


Fig. 8. Harmonic dial of the second harmonic of 25 hours beginning Feb. 28, 14 h.

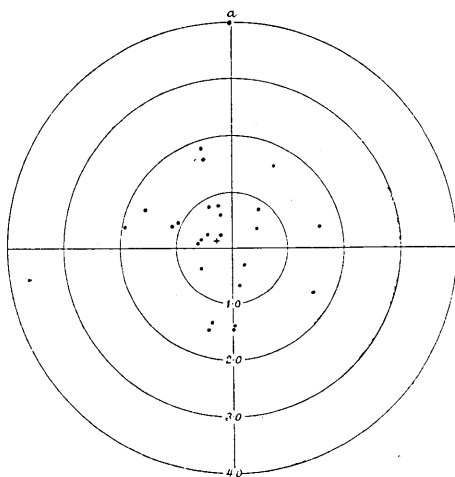


Fig. 9. Harmonic dial of the first harmonic for each of 27 intervals of 25 hours beginning April 26, 20 h.

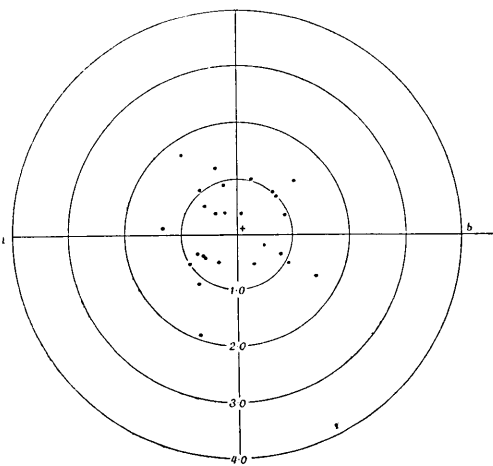


Fig. 10. Harmonic dial of the second harmonic of 25 hours beginning April 26, 20 h.

16) To verify these results, correlation coefficients between hourly frequency and tidal height at Misaki, and hourly frequency and hourly change of tidal height were calculated for March 1~28. The coefficients obtained were $+0.126 \pm 0.025$ (prob. error) and $+0.010 \pm 0.026$ respectively.

12. Except in the first series of earthquakes, the frequencies were correlated with the lunar day. The daily period will be seen from fig. 6, while the solar daily period has been found by a number of investigators.¹⁷⁾ Next the 24 hour period of the frequency was studied. The results obtained similarly as the 25 hour period are shown in Table VII and fig. 11. The value k was 0.89, so the probability was great ($w(k)=0.45$).

Table VII.

Date	n	a_0	a_1/a_0	b_1/a_0	c_1	φ_1	ε
1930							
Feb. 14	2	0.08	+1.00	+1.19	1.55	48.2	1.253
15	4	0.17	+0.750	-1.80	1.95	292.7	0.886
16	1	0.04	+1.00	-1.74	2.01	299.9	1.770
17	13	0.54	-0.79	+1.12	1.370	125.0	0.492
18	21	0.88	+0.834	-1.312	1.554	337.0	0.387
19	6	0.25	-0.293	+0.830	0.880	109.6	0.724
20	49	2.04	-0.426	-1.263	1.333	251.4	0.253
21	79	3.29	+0.098	+0.031	0.103	17.6	0.199
22	87	3.63	-0.833	+0.062	0.838	175.7	0.190
23	39	1.63	+1.260	-0.609	1.40	334.2	0.284
24	61	2.54	-1.290	-0.392	1.348	197.0	0.227
25	23	0.96	+0.228	-0.665	0.703	288.9	0.370
26	12	0.50	+1.054	-0.052	1.057	357.2	0.512
27	4	0.17	-0.022	-0.130	0.132	260.5	0.886
28	42	1.75	-1.680	+0.592	1.782	160.6	0.273
March 1	143	5.96	-0.995	-1.453	1.760	235.6	0.015
2	43	1.79	+0.124	+0.995	1.075	83.0	0.270
3	132	5.50	-0.930	+1.335	1.626	124.8	0.018
4	143	5.96	+0.408	+1.470	1.523	74.5	0.015
5	47	1.96	+0.348	+1.635	1.678	78.0	0.258
6	183	7.63	+0.133	+1.823	1.825	85.8	0.013
7	104	4.33	+0.114	-1.193	1.199	84.5	0.617
8	161	6.71	-1.113	+1.231	1.69	132.1	0.014
9	203	8.46	-0.454	+0.236	0.504	152.5	0.012
10	122	5.08	+0.375	-0.463	0.596	309.0	0.016
11	177	7.38	-0.369	-1.963	1.996	259.4	0.013
12	139	5.79	-0.569	+0.776	0.862	126.2	0.015
13	118	4.92	+0.844	+1.511	1.734	60.9	0.016
14	109	4.54	-0.331	-0.659	0.738	243.3	0.017
15	52	2.17	-0.412	+0.313	0.518	142.8	0.246

(to be continued.)

17) See B. GUTENBERG, *Handb. d. Geophys. Bd.*, 4, §280.

Table VII. (continued.)

Date	n	a_0	a_1/a_0	b_1/a_0	c_1	φ_1	ϵ
1930							
March 16	55	2.29	+0.378	-0.835	0.916	294.3	0.239
17	132	5.50	+0.136	+1.393	1.400	84.4	0.015
18	79	3.29	+1.023	+0.683	1.230	33.7	0.200
19	115	4.79	+0.992	-0.654	1.188	326.6	0.017
20	62	2.58	+0.728	-1.20	1.407	301.2	0.225
21	54	2.25	+1.568	-0.344	1.603	347.5	0.241
22	169	7.04	-1.642	-0.287	1.667	189.9	0.014
23	42	1.75	+0.291	-1.331	1.363	282.2	0.274
24	143	5.96	-0.361	-1.29	1.340	254.4	0.015
25	105	4.38	-1.06	+1.386	1.390	127.4	0.017
26	109	4.54	-0.990	-0.493	1.106	206.5	0.017
27	12	0.50	+0.495	+1.123	1.227	66.3	0.512
28	1	0.04	+1.00	-1.72	2.00	300.2	1.772
29	186	7.75	+1.45	+1.587	1.588	84.8	0.013
30	117	4.88	+1.14	+0.672	1.323	30.5	0.016
31	75	3.13	+0.375	-1.34	1.372	285.6	0.205
April 1	43	1.79	+0.767	-1.474	1.66	297.4	0.270
2	6	0.25	-0.868	+0.50	1.002	150.0	0.723
3	2	0.08	+0.714	-1.730	1.871	292.4	1.253
4	75	3.13	+1.356	+0.844	1.597	31.9	0.204
5	3	0.13	-0.472	-0.472	0.668	225.0	1.023
6	2	0.08	+0.712	+0.712	1.004	45.0	1.252
7	61	2.54	+0.897	-2.51	0.932	70.4	0.227
8	2	0.08	+0.748	+0.976	1.228	52.6	1.252
9	15	0.63	+0.315	+1.236	1.276	75.8	0.457
10	4	0.17	+0.371	-0.485	0.651	305.6	0.885
11	32	1.33	+1.45	-1.09	1.80	323.0	0.313
12	26	1.08	+0.866	-1.70	1.94	296.9	0.348
13	9	0.38	-1.51	-0.032	1.544	181.3	0.591
14	4	0.17	0	0	0	—	0.886
15	1	0.04	-2.00	0	2.00	180.0	1.772
16	2	0.08	-1.725	+0.711	1.866	157.4	1.253
17	2	0.08	+0.976	+0.748	1.228	37.4	1.253
18	3	0.13	+1.98	+0.176	2.06	5.1	1.032
19	1	0.04	+1.00	+1.74	2.00	60.1	1.772
20	5	0.21	+1.04	-0.202	1.24	349.0	0.792
21	1	0.04	0	-1.975	1.975	270.0	1.772
22	1	0.04	-0.524	+1.928	1.998	105.2	1.772
23	1	0.04	0	-1.975	1.975	270.0	1.772
24	3	0.13	+0.826	-1.471	0.951	330.2	1.023

(to be continued.)

Table VII. (continued.)

Date	n	a_0	a_1/a_0	b_1/a_0	c_1	φ_1	ε
1930							
April 25	1	0.04	-1.00	+1.74	2.00	119.9	1.772
26	5	0.21	-1.042	+0.039	1.044	177.9	0.792
27	5	0.21	-1.05	-0.337	1.103	197.7	0.792
28	8	0.33	-0.50	+0.129	0.516	345.5	0.627
29	4	0.17	-1.68	+0.186	0.249	312.1	0.886
30	11	0.46	-0.149	-1.487	1.496	264.3	0.534
May 1	2	0.08	-1.84	+0.760	1.994	337.5	1.253
2	0	0	0	0	0	—	∞
3	6	0.25	+0.072	-0.729	0.734	275.7	0.723
4	18	0.75	-0.464	-0.375	0.597	219.0	0.418
5	7	0.29	+0.373	-0.366	0.523	315.6	0.670
6	38	1.58	-0.476	+0.490	0.683	134.2	0.287
7	10	0.42	+1.083	+0.420	1.612	21.2	0.561
8	173	7.21	+0.655	-0.714	0.991	312.5	0.014
9	201	8.38	+0.770	+0.214	0.799	15.5	0.013
10	233	9.71	+0.143	+0.451	0.474	72.4	0.012
11	82	3.42	+0.618	+0.744	0.967	50.3	0.196
12	58	2.42	-0.083	+0.619	0.625	97.6	0.233
13	113	4.71	+0.859	-0.724	1.123	320.0	0.017
14	221	9.21	+1.094	-0.354	1.150	342.1	0.012
15	98	4.08	-0.424	+0.350	0.550	140.4	0.179
16	28	1.17	+0.307	-0.795	0.852	291.1	0.335
17	117	4.88	+0.607	+0.833	1.029	53.9	0.016
18	115	4.79	+0.306	-0.777	0.835	291.4	0.017
19	23	0.96	-1.497	+0.431	1.560	163.9	0.370
20	7	0.29	+0.013	+0.132	0.135	84.3	0.670
21	1	0.04	+1.93	+0.523	2.00	15.1	1.772
22	40	1.67	+0.780	-0.996	1.264	308.0	0.280
23	5	0.21	0	-0.399	0.399	270.0	0.793
24	4	0.17	+1.62	-0.012	1.62	355.7	0.887
25	3	0.13	+0.504	+0.280	0.577	29.1	1.023
26	5	0.21	-1.08	-0.697	1.285	212.8	0.793
27	0	0	0	0	0	—	∞
28	0	0	0	0	0	—	∞
29	0	0	0	0	0	—	∞
30	2	0.08	+0.506	-1.88	1.946	285.0	1.253
31	4	0.17	+1.98	+0.132	1.986	3.8	0.886
		mean	+0.113	-0.005			

$$l=1.326, l_m=0.128, c_m=0.114, k=0.89, v(k)=0.46.$$

The daily periodicity of the Ito earthquakes however was found questionable from theory.

Frequency variation in short time intervals.

13. As to the conspicuous earthquakes that were felt at Tôkyô (Table I), the frequency variation in slight earthquakes occurred both before and after these moderate ones were investigated. The method of investigation was simple: the frequency for every 20 minutes before and after the principal earthquake was obtained and its time variation studied. In the frequency diagrams (fig. 12), four types of frequency-distribution will be

noticed: (i) The frequency in earthquakes, which increases gradually, diminishes when it reaches maximum (shown schematically in fig. 13-a). The diagram indicates the type of earthquake swarm, and in this case the strongest or principal earthquake usually occurs soon after the culmination of the seismic frequency. (ii) A strong shock occurs alone or accompanying a few earthquakes. (iii) After the strong shock, many small ones occur in succession, and their frequency is maximum at the time of the principal shock, which then diminishes exponentially. (fig. 13-b). The after-shocks of strong earthquakes are generally examples of this case. (iv) Small earthquakes become increasingly frequent, until when near its maximum frequency the principal shock occurs, after which, virtually no more earthquakes occur (fig. 13-c). To take the case of the frequency of volcanic earthquakes, they increase before the eruption, after which it becomes few.¹⁸⁾

In fact the type of frequency-distribution cannot be distinctly classified. Frequently the various types merge into one another, although in the present investigation, the type of frequency-distribution was not affected by changes in the time interval of the frequency.

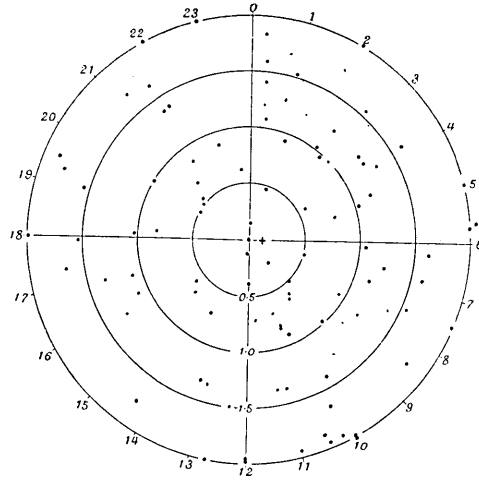


Fig. 11. Harmonic dial of daily variation in earthquake frequency. The numerals in the circumference indicate hours of maximum amplitude.

18) F. OMORI, *Rep. Imp. Earthq. Inv. Comm.*, 87 (1918), 58.

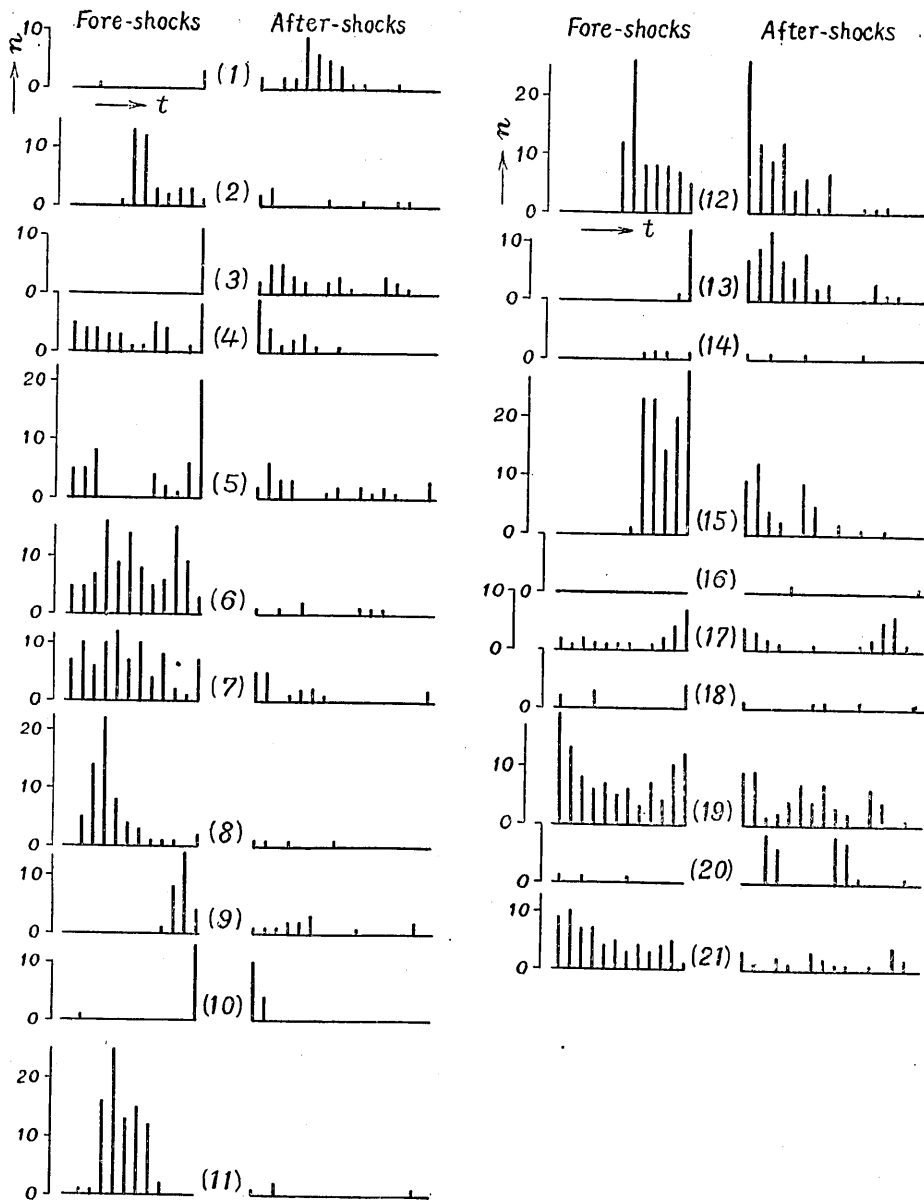


Fig. 12. Earthquake frequency for intervals of 20 minutes before and after the conspicuous earthquakes (in Table I) which occurred at Itô.

(1) Feb. 21.	(8) March 14, 14 h.	(15) March 30.
(2) " 22.	(9) " 14, 21 h.	(16) April 1.
(3) " 28.	(10) " 15.	(17) May 9.
(4) March 4,	(11) " 19.	(18) " 12.
(5) " 9, 4 h.	(12) " 22.	(19) " 14.
(6) " 9, 19 h.	(13) " 26.	(20) " 15.
(7) " 13.	(14) " 27.	(21) " 17.

An experiment in fracture.¹⁹⁾

14. Generally speaking the causes of these earthquakes are believed to be as follows: A part of the earth's crust is gradually strained by some unknown stress, which when it exceeds the ultimate strength of that part of the earth's crust, an earthquake takes place. A part fracture or a rapid dynamic deformation of the earth's crust follows, at the same time propagating elastic, or seismic waves. Presuming that it is fracturing of the earth's crust that generates an earthquake, the writer carried out a simple experiment in fracture to solve the problem of time distribution of earthquakes.

15. Studies of cracks due to fracture have been made by a number of investigators.²⁰⁾ The present writer investigated the time process of fracture, by recording the sounds or rapid vibrations of thin wooden boards resulting from fracturing them.

As material for experiment, thin wooden boards ($35 \times 3 \times 0.5 \sim 0.8$ cm) of regular grains were employed. Wood, being heterogeneous and somewhat brittle, was selected as the most suitable material for studying the fracturing of the earth's crust.

16. The apparatus for the experiment was simple as shown in fig. 14. A pick-up *a* of an electric gramophone, divested of its supporting arm, was set on a wooden board *d*, with a steel needle *b*, which was thrust into the upper side of the board. Being supported at *c* and *c'* the board was bent by the weight of a circular cylinder *e*. The cylinder was moved with a wire *f* which was pulled as the screwed rod was rotated by wheel *h*, the wheel being turned by an electric motor. The velocity of pull could be altered by changing the velocity of the motor or gear-ratio.

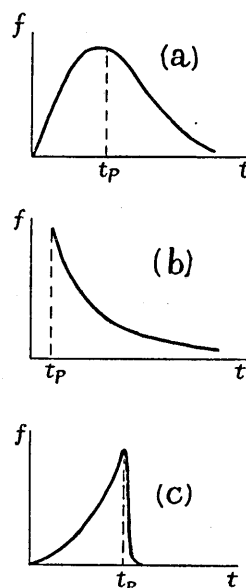


Fig. 13. Schematic diagrams of types of frequency-distribution.
t, time; t_p , occurrence time of principal shock; *f*, frequency of earthquakes.

19) Preliminary report on this experiment was read on Nov. 21, 1933 at the monthly meeting of the Earthquake Research Institute, and published in *Disin*, 6 (1934), 25~31.

20) There is considerable literature covering this problem, for example:—

G. NISHIMURA and T. TAKAYAMA, *Bull. Earthq. Res. Inst.*, 10 (1932), 476~489.

Force was applied to the middle point of the board when fracture occurred at that point. Force of this kind was applied merely for convenience of experiment to record the vibration of the board with the pick-up. When the board cracked, electric current was generated in the coil of the pick-up, the current being amplified with an amplifier, which forms a part of the Haeno radio-seismograph.²¹⁾ The current was recorded with an oscillograph on cinematographic films (see middle line, fig. 15. in Pl. LVIII). The displacement every 5 mm of the board at the middle was marked on the film (lower line in fig. 15) by an electric circuit made when metal plate *l* touched the fine copper wires fixed to the bed of the apparatus. Time marks were put on the film (upper line in figure) at intervals of 1/5 second with a synchronous motor made by the writer.²²⁾

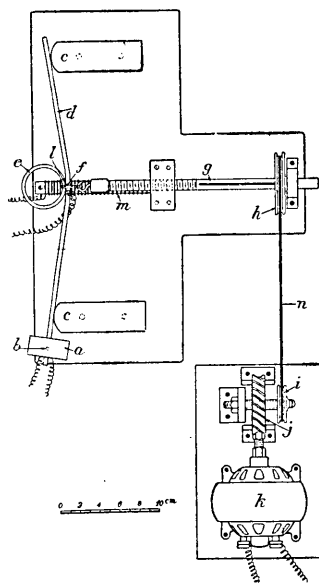


Fig. 14. Apparatus of experiment of fracture.

Results of the experiment.

17. As the bending proceeded, cracking sounds were heard, while the oscillograms recorded many inaudible vibrations. The process of fracture varied with the velocity of bending, the kind of wood, the grain of the board, and the moisture content of the wooden board. As material for the board, cedar, pine, and Japanese cypress were used. (The writer intended also to experiment with rock, instead of the wooden board, but nothing suitable was available.) Fig. 15 in Pl. LVIII is a part of an oscillogram. In the figure are shown many rapid inaudible vibrations and cracking sounds.

When the materials were the same and the velocity of bending equal, the board broke with nearly equal deformation. The velocity was not so great, from about 1 to 2.5 mm per sec at the middle of the board. When deformation proceeded slowly, occasionally loud creaking sounds were heard owing to rupture of the grains, and low silent vibrations were found on the oscillogram. This mode of fracture resembles the mode of occurrence of an earthquake swarm, a group of small

21) S. HAENO, *Jap. Journ. Astron. Geophys.*, 8 (1930), 39~50.

22) F. KISHINOUE, *Bull. Earthq. Res. Inst.*, 10 (1932), 189.

earthquakes and a few larger ones.

When the board was bent quickly, complete fracture occurred with loud cracking sounds following greater deformation than in the case previously mentioned. In this case, sometimes the board broke all at once, but in most cases many small vibrations followed the main breaking. This mode of fracture is believed to be similar to that of after-shocks that follow most great earthquakes.

The Number of vibrations or sounds every 5 sec are shown in fig. 16. They greatly resemble the frequency diagrams in fig. 12.

18. As it is known that the strength of wood in large measure depends on its moisture content, some of the boards were placed in damp situation or immersed in water several days before the experiment. In such cases fracturing occurred slowly, almost without any quick vibrations.

It was found that the process of fracture is affected considerably by the condition of the experimented material and the particular way in which the force acts.

19. On the assumption that the type of frequency-distribution of earthquakes is due to the mode of fracture of the earth's crust, the writer will now attempt to explain the differences in the type of frequency-distribution.

Recently in the epicentral regions of many great earthquakes and swarm earthquakes, the topographical changes that occurred were found by means of precise levellings and triangulations,²³⁾ and most great earthquakes the depths of which are believed to be shallow, are generally accompanied with many after-shocks, whereas small earthquakes and deep-seated earthquakes, the energy of which might be as great as some destructive earthquakes, occur without accessory shocks, and no crustal deformations have been known to follow such earthquakes. From this the writer deduced that the occurrence of many small earthquakes in succession, such as swarm earthquakes (the origins of the Itô earthquakes were also shallow in depth²⁴⁾) or after-shocks may be due to fracturing of the upper crust of the earth caused by certain slow deformations. The surface of the earth is free from traction, and the materials that compose the upper layer of the earth may be more brittle than those at depths subjected to high pressure and high temperature, so that upper layer may be liable to be fractured in the manner that a wooden board was broken in the model experiments here

23) See for instance, A. IMAMURA, *Publ. Imp. Earthq. Inv. Comm.*, 25 (1930) and C. TSUBOI, *Jap. Journ. Astron. Geophys.*, 10 (1933), 93~248.

24) N. NASU, *Bull. Earthq. Res. Inst.*, 13 (1935), 400~416.

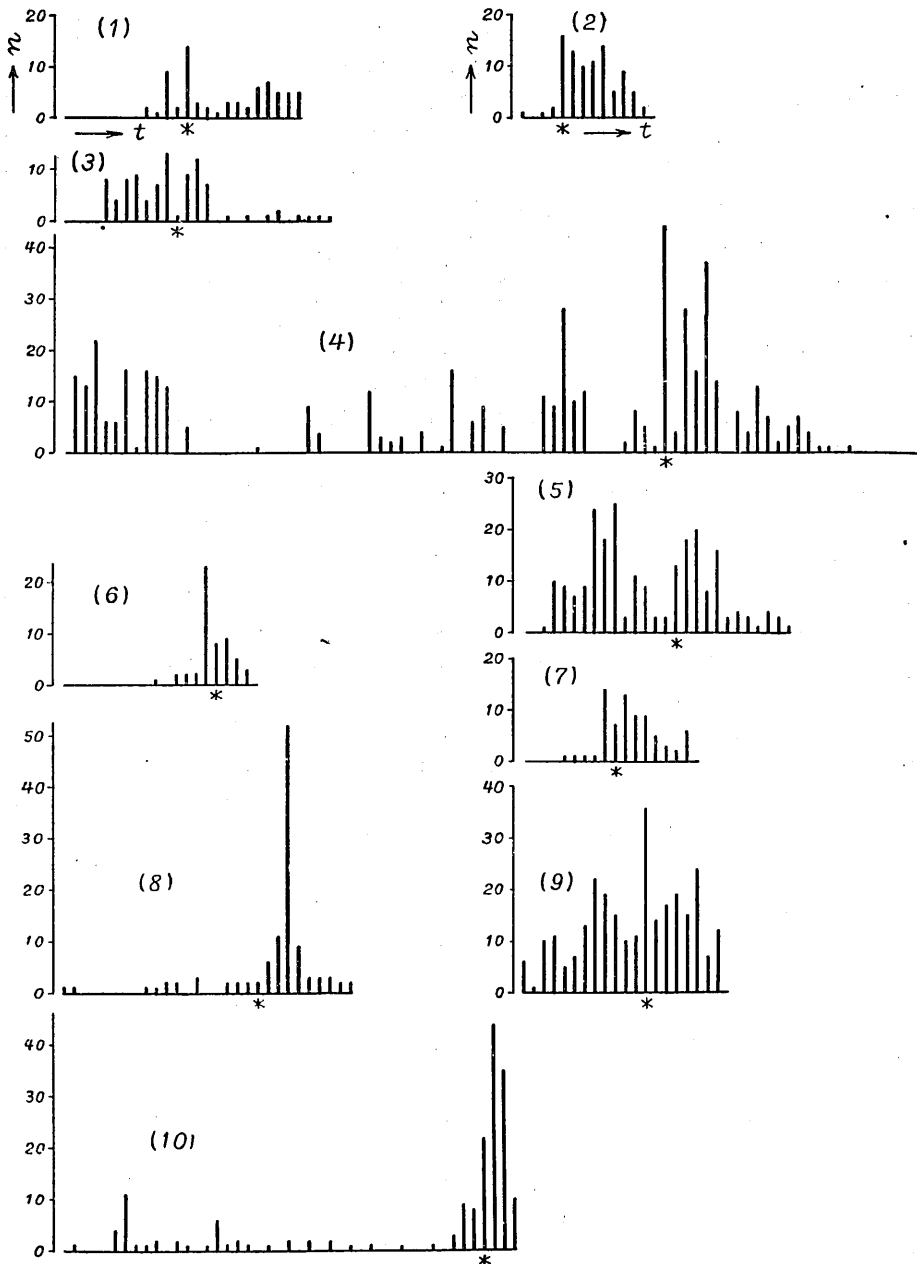


Fig. 16. Experiments in fracture.

n , number of shocks

t , time (5 sec interval)

star, time of shock of maximum amplitude.

described. In other words, since the upper crust is brittle, small cracks may appear in it through crustal deformation, when the vibrations due to the cracking may be regarded as the earthquake motion. It would therefore not be strange if slight earthquakes and deep-seated earthquakes are not followed by accessory shocks, as they do not cause any crustal deformations that could be observed.

20. Small earthquakes that occur near volcanoes may also be caused by crustal deformations resulting from changes in the state of the magma. Moreover, the frequent occurrence of volcanic earthquakes may in some cases be regarded as forerunners of volcanic eruptions, as is generally supposed.

21. Seismic tunamis are believed to be the result of a large deformation of the sea bottom, while the earthquakes caused by tunami usually accompany a large number of after-shocks. If the above mentioned relation between frequent occurrence of earthquakes and crustal deformation is true, tunami may be expected when many earthquakes occur under the sea bed, and one such earthquake is as strong as the earthquakes that generated the tunami. Of course, although the earthquake may be strong the tunami may be small, should the deformation be large in horizontal component and small in vertical, as was the case in the crustal deformation of the Californian earthquake in 1906.

A mathematical expression of frequency-distribution of earthquakes.

22. About forty years ago, F. Omori²⁵⁾ obtained a mathematical expression for the frequency-distribution of after-shocks. He assumed frequency f to be proportional to the strain in the earth's crust, say S , namely,

$$f = \alpha S, \quad (1)$$

where α is a positive constant, while the diminishing rate of the strain at a certain time is supposed to be proportional to the earthquake frequency at the time:

$$\frac{dS}{dt} = -\beta f, \quad (2)$$

where β is the other positive constant. Then

$$\frac{df}{dt} = -\alpha\beta f,$$

25) F. OMORI, *Rep. Imp. Earthq. Inv. Comm.*, 2 (1894), 103~139.

and we have

$$f = f_0 e^{-\lambda t} \quad (\lambda = \alpha \cdot \beta \text{ and } f_0 \text{ is the value of } f \text{ at } t=0).$$

This formula fairly expresses the frequency-distribution of after-shocks, and is used still at times. M. Enya²⁶⁾ and S. Kusakabe²⁷⁾ afterwards extended the above consideration and explained the decrease of frequency.

23. Suppose that an earthquake occurs when a part of the earth's crust has been fractured and the origin of the swarm earthquakes is in a finite region, then the region to be fractured may diminish, or the earthquake-generating power may decrease, while the total number of earthquakes that have occurred until that time is increased, whence the writer developed the above relation (2) adding two terms to it, namely,

$$\frac{dS}{dt} = -\beta f - \gamma \int_0^t f dt + \delta, \quad (3)$$

where $f=0$ at $t=0$, and γ is a positive constant, and δ another constant to be determined by the initial condition. This equation may be changed to the form,

$$\frac{d^2 f}{dt^2} + \beta' \frac{df}{dt} + \gamma' f = 0. \quad (4)$$

This is the same as the equation of free-vibration of a pendulum with damper, and is an equation well-known to seismologists.

24. When $\beta^2 > 4\gamma^2$, the solution may be give as

$$f = f'_0 e^{-\mu_1 t} + f''_0 e^{-\mu_2 t}, \quad (5)$$

where μ_1 , μ_2 , f'_0 and f''_0 are constants, when the equation (4) may include the result obtained by F. Omori as a special case.

25. When $\beta^2 = 4\gamma^2$, or in other words γ becomes as great as β , the solution becomes

$$f = \left(\frac{df}{dt} \right)_{t=0} t e^{-\nu t}.$$

This expresses the relation between f and t as shown in fig. 13-a, and may explain the frequency-distribution of earthquake swarms in certain cases.

26) M. ENYA, *Ditto*, 35 (1901), 35~56, 57 (1907), 85~98, and 61 (1908), 63~70.

27) S. KUSAKABE, *Publ. Imp. Earthq. Inv. Comm.* 17 (1904).

26. Moreover if δ is a function of time the equation (4) is transformed into

$$\frac{d^2f}{dt^2} + \beta' \frac{df}{dt} + \gamma' f = \delta',$$

where δ' is obtained by the initial condition. If δ' be given as the function of t as shown by the dotted line in fig. 17, then the solution may be obtained as the curve in the full line on the same diagram, which may be in better accord with the result of the earthquake swarm described above.²⁸⁾

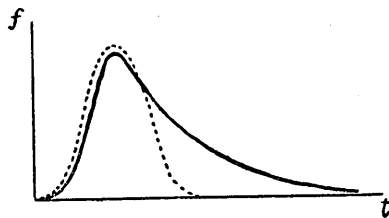


Fig. 17.

At all events, the frequency-distribution of earthquakes may depend upon the plastic property of the earth's upper crust, and the manner in which the earthquake generating force acts. In the writer's opinion, there is no essential difference between the frequency-distributions of after-shocks and earthquake swarms.

28) Another explanation of the frequency-distribution in fig. 17 may be obtained, when the conditions $f_0' = -f_0''$ and $\mu_2 > \mu_1$ are put in the expression (5). But the consideration in the text may be better in respect of physical meaning than that stated here.

Table III.

Arrival times of the Itô earthquakes at Misaki.

Date	hour	minute	Date	hour	minute	Date	hour	minute
1930 Feb.			20	18	17, 49	22	3	16, 16, 41, 45
14	2	08, 08		19	10		4	32
15	10	50, 51, 51		21	55		5	26, 31, 33, 48
	12	56		22	58		6	02, 04, 20, 21,
16	10	22		23	32, 35, 39, 59			24, 26, 45, 49,
17	10	24, 38	21	0	06			58
	21	16, 18, 43		1	56		7	05
	22	02, 04, 07, 08, 08, 09, 26, 35		2	14, 15, 32, 33, 49		8	04, 22, 31, 31, 31, 33, 41, 54,
18	0	43		3	06, 36, 40			57
	5	00		5	29		9	10, 12, 18, 36,
	6	18		8	36, 37, 37, 38,			40
	7	09			40		12	49, 49, 51
	8	10, 29, 39		9	29, 37, 55, 56,		14	47, 49
	10	47, 49, 51, 54, 56, 58			58		17	45
	11	01, 03, 07, 22, 23, 50		10	00, 03, 03, 05, 08, 11, 12, 13, 21, 24, 33, 35,		18	00, 04, 06, 08, 09, 09, 12, 13, 13, 15, 18, 20, 21, 22, 24, 25, 25, 26, 28, 30, 32, 33, 33, 35, 40, 45, 46, 54
	15	58			36, 36, 43, 44, 50, 50, 55, 55,			09, 25, 32, 33, 49, 52, 59
	21	42					19	
19	1	34		11	05, 06, 08, 35, 50		20	17, 21, 37, 42
	10	48					21	37, 42, 42
	16	46		12	50		22	30
	23	15, 25, 55		17	31, 35		23	26
20	10	37, 59		21	03, 06, 07, 08, 09, 10, 10, 11, 11, 13, 13, 13, 14, 15, 15, 16, 18, 18, 21, 29, 36, 50, 52, 54		0	41, 51
	11	06, 25, 28, 30, 39, 48, 49					6	06
	12	05, 11, 26, 28, 30, 32, 38, 44, 44, 45, 49, 50, 51, 55		22	10, 10, 10, 10, 20	23	7	06, 21, 22, 23, 23, 26, 27, 29, 31, 31, 32, 35, 43, 44, 45, 47, 47, 50, 50, 55,
	13	08, 18, 24, 26, 27, 29, 42, 43		23	53			12, 14, 18, 19,
	14	23, 30, 49					8	22, 30
	15	20, 24, 31, 32, 33	22	0	38, 54			
	17	09		1	22			
				2	02			

(to be continued.)

Table III. (*continued.*)

Date	hour	minute	Date	hour	minute	Date	hour	minute
1930 Feb. 23			25	19	49	1	21	36, 36, 36, 37,
	9	57		21	07			38, 38, 38, 38,
	10	21, 28, 28, 29	26	3	14			39, 39, 40, 41,
	14	18, 39		4	41, 42			41, 42, 42, 42,
	17	39, 42		5	22			43, 43, 44, 44,
	21	35		6	34, 49			45, 45, 46, 46,
24	0	41		8	05			47, 47, 47, 48,
	1	48		9	19, 48			48, 49, 50, 50,
	5	00, 12, 13, 54		10	21			50, 52, 53, 54
	10	43, 44		18	55		22	00, 01, 01, 02,
	11	06		20	49			02, 03, 04, 05.
	12	18, 38	27	1	53			05, 06, 07, 08,
	14	58		2	38			08, 08, 08, 09,
	15	04		14	08			10, 10, 11, 14,
	16	26, 28, 28, 30,		15	12			20, 24, 25, 27,
		31, 34, 40, 41,	28	5	15			27, 28, 28, 29,
		41, 44, 49, 50,		18	14, 21, 22, 23,			30, 30, 34, 34.
		53, 54, 56, 56,			23, 26, 28, 28,			34, 35, 37, 38,
		58, 59			29, 30, 31, 32,			38, 38, 40, 41,
	17	03, 03, 06, 07,			38, 49, 56, 56,			41, 43, 46, 47,
		07, 08, 09, 13,			56			48, 50, 52, 53,
		16, 20, 23, 23,		19	08, 11, 19, 20,			57, 59
		29, 30			23, 27, 27, 37,		23	00, 02, 02, 02,
	18	03, 14, 22, 27,			37, 45, 58			03, 03, 04, 05,
		39, 53, 53		20	07, 41, 46, 59			06, 06, 06, 07,
	19	03, 14, 17, 49,		21	10, 12, 16			08, 09, 20, 20,
		49, 50		22	20, 31, 32, 40,			20, 24, 51, 52.
	21	33, 33			52, 59			53, 54, 55, 56,
	23	40	March	3	03			58, 58
25	0	17	1	5	01, 02	2	0	00, 00, 01, 01,
	2	21		7	17			02, 02, 03, 03,
	3	02, 08		8	45			04, 05, 06, 08,
	5	24, 47		14	44, 47, 53			08, 09, 10, 12,
	10	48, 52, 52, 53,		15	03, 25			12, 18, 29, 52,
		56		20	55			53, 55
	11	00, 00, 01, 23,		21	20, 20, 21, 21,		1	09
		54			24, 25, 25, 27,		2	09, 10, 15, 53
	14	44			28, 28, 29, 29,		4	11
	15	08, 40, 56			31, 31, 33, 34,		6	50, 57
	17	17			34, 34, 35, 36,		7	51

(to be continued.)

Table III. (*continued.*)

Date	hour	minute	Date	hour	minute	Date	hour	minute				
1930 March 2	8	35	3	22	33, 34, 49, 49,	4	23	18, 18, 19, 19,				
	10	23			52, 52, 55, 57,			22, 24, 24, 24,				
	11	23			57, 59			26, 28, 28, 29,				
	12	27, 28			23			02, 05, 07, 08,	32, 35, 36, 37,			
	13	37, 38						13, 15, 18, 18,	37, 38, 39, 40,			
	17	59						18, 19, 21, 22,	40, 41, 41, 41,			
	18	59, 59						22, 25, 59, 44,	42, 43, 45, 47,			
	20	37			4			0	47, 56, 57, 58	47, 48, 53, 53,		
	21	49							08, 16, 24, 33,	53, 54, 56, 56,		
	3	1			06, 49			4	1	34, 34, 35, 37,	5	0
		2	49, 57	38, 40, 44, 58	57, 58							
		3	00, 17	01, 01, 05, 11,	01, 02, 03, 05,							
		9	49	15, 15, 16, 20,	08, 12, 19, 28,							
		11	50	30, 40, 45, 45,	30, 30, 31, 35,							
		13	06, 37	59	38, 39, 42, 44,							
		14	43, 43, 43, 47	2	00, 00, 00, 10,	44, 50, 53, 53,						
		17	09, 35		18, 20, 36, 38,	53, 54, 57						
		20	37, 42, 54, 55,	3	3	43, 54	1			00, 03, 04, 08,		
		21	56, 59			14, 30, 44, 44,	08, 08, 11, 11,					
		22	00, 01, 01, 02, 02, 03, 04, 05, 05, 06, 06, 08, 13, 14, 17, 20, 20, 22, 22, 22, 22, 23, 24, 26, 27, 27, 28, 29, 29, 30, 30, 30, 31, 32, 33, 34, 34, 35, 38, 39, 40, 40, 40, 42, 42, 43, 45, 45, 46, 49, 51, 51, 52, 52, 53, 53, 55, 56, 58, 59, 00, 05, 10, 12, 14, 15, 17, 18, 18, 19, 21, 21, 25, 27, 28, 28, 28, 30, 32, 33,	02, 25, 59, 44, 47, 56, 57, 58	4	4	03, 03, 04, 44,	6	0	24, 25, 53		
							50, 53,			2	40	
							02, 02, 03, 04,			5	33, 38	
04, 05, 08, 09,							6			6	10	
09, 10, 10, 11,										8	33	
15, 17, 17, 27,							6			10	40	
38, 42, 45, 45,										11	47	
04, 12, 12, 32,							7			22	10	
32, 41	23									38		
02, 30	8						0			06, 08, 12, 12,		
14										13, 18, 19, 21,		
50	11						0			21, 22, 22, 22,		
36										23, 23, 23, 23,		
00	21						0			24, 25, 25, 25,		
47										25, 25, 26, 29,		
02, 05, 07, 08,	22						0			29, 30, 31, 31,		
09, 11, 11, 12,										31, 31, 31, 32,		
12, 13, 13, 14,	23						0			33, 33, 34, 34,		
14, 14, 15, 15,		34, 35, 36, 36,										
15, 15, 16, 17,	23	0	37, 37, 38, 38,									

(to be continued.)

Table III. (continued.)

Date	hour	minute	Date	hour	minute	Date	hour	minute						
1930 March 6	0	39, 40, 40, 41,	6	23	47, 51, 52, 53,	8	19	48, 49, 50, 52,						
		41, 41, 43, 43,			54, 55, 57, 59			53, 56, 57, 57,						
		44, 45, 46, 47,			00, 03, 04, 04,			57, 59						
		48, 48, 49, 49,			06, 07, 11, 13,			20	01, 03, 04, 05,					
		50, 50, 51, 51,			14, 15, 16, 17,			07, 08, 08, 08,						
		52, 53, 54, 54,			18, 19, 20, 20,			10, 11, 11, 12,						
	55, 55, 56, 58,	21, 21, 21, 24,	12, 13, 13, 14,											
	58, 59	25, 25, 26, 26,	15, 15, 16, 17,											
	1	1	00, 01, 01, 02,	7	0		27, 28, 30, 30,	20	21, 23, 23, 23,					
			05, 05, 07, 09,				31, 32, 32, 34,		27, 28, 29, 31,					
			10, 11, 11, 11,				35, 36, 37, 37,		31, 32, 32, 33,					
			12, 12, 13, 13,				41, 43, 50, 54,		35, 35, 38, 39,					
			15, 18, 19, 27,				1		00, 01, 03, 04,	41, 43, 45, 47,				
			27, 30, 32, 33,						09, 09, 12, 13,	47, 47, 48, 50,				
			34, 35, 39, 40,						21, 21, 22, 23,	51, 51, 51, 52,				
			43, 47, 48, 48,						23, 23, 24, 24,	53, 53, 56, 57,				
			49, 50, 51, 57						25, 25, 26, 27,	58, 59				
			2						2	03, 03, 09, 14,	2	1	27, 27, 27, 28,	21
	15, 18, 18, 20,	28, 28, 30, 30,		07, 08, 14, 19,										
	21, 29, 32, 43,	30, 31, 32, 32,		21, 24, 26, 26,										
	52, 58	33, 33, 41, 55		26, 27, 28, 28,										
	3	3		01, 15, 21	2			2		01, 15			21	
				4			4			6				
	6	6	7		38, 45			21	43, 44, 45, 46,					
				7			7		12	03	21	48, 50, 50, 53,		
	8	8	13		32, 35, 43, 43,			22				54, 57, 57		
				10			10		14	44, 45, 46, 48,	22	11, 11, 11, 14,		
	11	11	14		48, 49			22				15, 15, 17, 17,		
				22			22		14	05, 09, 10, 17,	22	17, 17, 18, 19,		
	23	23	19		20, 55, 56			22				20, 22, 24, 35,		
				23			23		19	39, 40	23	35, 36, 46		
	23	23	21		25			23				00, 03, 05, 06,		
				23			23		8	25, 26, 37	23	06, 06, 08, 11,		
	23	23	3		08			23				12, 12, 14, 14,		
				23			23		5	45, 46	23	15, 16, 16, 16,		
	23	23	8		19, 54, 54, 54,			23				18, 21, 27, 30,		
23				23		9	55, 55		23	31, 33, 34, 35,				
	23	23	18		14			9		40, 41, 47, 52,				
23				23		18	48		9	59				
	23	23	18		48			9		02, 12, 13, 27,				

(to be continued.)

Table III. (continued.)

Date	hour	minute	Date	hour	minute	Date	hour	minute			
1930 March 9	0	28, 30, 30, 30,	9	17	34, 37, 38, 40,	10	14	54, 56, 58, 59			
		43, 50, 51, 55,			40, 40, 41, 42,			15	08, 23, 23		
		56			45, 46, 46, 47,			16	36		
	1	01, 01, 03, 08,		49, 52, 54, 57,	18		18	58, 59	17	33	
		16, 16, 16, 19,		04, 06, 12, 13,				19	11, 11		
		27, 28, 29, 31		13, 16, 18, 23,				20	32, 35		
	3	05, 06, 06, 17,		32, 34, 35, 38,	19		19	49, 49, 53, 54,	21	51, 51, 51, 52,	
		37, 39, 59		55, 57, 57, 58				22	52, 53		
		4		00, 04, 08, 13,				00, 01, 02, 03,	20	20	12, 12, 12, 13,
	16, 16, 21, 26,			04, 04, 05, 07,	15, 15, 20, 21,		12, 12, 12, 13,				
	27, 29, 29, 29,			07, 08, 11, 17,	39, 41, 44, 51,		54, 56, 57				
	5	30, 30, 31, 31,		17, 20, 21, 22,	21		21	23, 26, 31, 32,	11	0	03, 05, 06, 07,
		32, 32, 33, 33,		36, 40, 44, 54				07, 12, 16, 17,			17, 20, 29, 32,
		34, 35, 36, 37,		11, 41				34, 40, 43, 44,			57
	6	38, 38, 39, 47,		20, 20	10		23	31, 47	6	1	44, 46, 48, 51,
		48		5				23			57, 58
		7		00, 05, 08, 16,				6			06, 08, 20, 22,
	16, 18, 30, 33,		6	37, 41, 43, 44,	10, 12, 14, 15,						
	33, 55, 56, 58		7	48, 48, 48, 52,	15, 17, 17, 19,						
	8	56	7	54, 55	8	8	9	10	25, 27, 31, 33,		
		9	00, 00, 23, 55,	7					07, 09, 11, 17,	33, 35, 36, 40,	
			56	8					36, 42, 48	41, 43, 47, 49,	
	10		12, 21, 21, 51	8	47, 51, 58	9	9	10	11	59	
		50, 53, 56, 56	9	01, 02, 02, 03,	01, 02, 02, 05,						
		03, 04, 18, 41	9	03, 04, 04, 04,	05, 12, 14, 17,						
	11	13	10	04, 04, 05, 05,	10	10	11	11	57		
		13	50	06, 06, 06, 07,					3	11, 14, 22	
			14	45					08, 08, 09, 11,	4	51, 54
	15			12, 54, 56, 57	12, 14, 15, 15,	7	57				
		16		10, 10, 22, 24,	16, 21, 25, 49,	8	01				
			32, 33, 34, 39,	50	9	37					
	39, 41, 47, 48,		10	00, 09, 12, 13,	10	18, 35, 53, 56,					
17	52, 53, 56, 56,	11	16, 27, 32, 40,	11	11	11	11	57, 58			
	57, 59	11	43, 43					01, 01, 05, 09,			
	01, 03, 04, 04,	11	01, 07, 27					11, 15, 17, 20.			
		07, 08, 08, 09,									
		11, 12, 12, 13,									
		15, 23, 26, 27,									
		31, 31, 32, 33,									

(to be continued.)

Table III. (*continued.*)

Date	hour	minute	Date	hour	minute	Date	hour	minute
1930 March 11	11	21, 22, 25, 25,	12	2	30, 31, 42, 43,	13	0	31, 33, 39, 41,
		27, 28, 30, 31,			47, 58			42, 53, 57, 57,
		32, 32, 32, 33,		3	13, 30			57, 58
		34, 35, 37, 37,		4	53		1	01, 02, 03, 05,
		39, 43, 44, 48,		6	08			05, 07, 08, 08,
		52, 55, 57, 57,		8	22			11, 14, 23, 25,
		59		9	32, 37			29, 30, 35, 35,
				10	17, 46			39, 40, 41, 42,
				12	17, 44, 46, 53			44, 46, 48, 50,
				13	00, 16, 17, 20,			50, 51, 52, 57
	12	13	01, 06, 08, 25,		23, 24, 27, 31,	2	01, 02, 03, 05,	
			27, 29, 31, 34,		35, 39, 50		05, 06, 11, 15,	
			35, 36, 37, 37,	14	02, 04, 33, 39		15, 22, 24, 24,	
			38, 39, 40, 41,	15	00, 02, 02, 04		27, 30, 32, 37,	
			43, 48, 49, 53,	17	29, 30		38, 42, 43, 43,	
			55, 55, 58	18	58		45, 46, 47, 54,	
				19	03, 03, 14, 14,		54	
					14, 17, 25, 26,		02, 04, 10, 10,	
					39, 41, 42, 43,		17, 18, 18, 19,	
					44, 47, 51, 54		20, 21, 28, 46,	
	14	15	07, 13, 16, 17,		00, 00, 01, 01,		48	
			18, 22, 31, 32,	20	09, 11, 12, 21,	4	10, 11, 12, 17,	
			36, 50		22, 57		20, 23, 25, 27,	
			21	06, 09, 12, 13,		30, 38, 40, 45,		
				14, 20, 29, 29,		45		
				42, 45, 46, 47,	5	00, 04, 17, 17,		
				56, 59		19, 57		
			22	07, 11, 15, 16,	6	13, 18, 33, 34,		
				22, 29, 31, 32,	9	32, 33		
				38, 40, 43, 44	15	39		
15	16	14, 15, 15, 18,		01, 02, 14, 17,	19	10		
		19, 21, 24, 24,	23	19, 20, 22, 28,	0	31		
		28, 30, 30, 34,		29, 30, 33, 34,	14	1		
		34, 36, 36, 41,		35, 35, 36, 39,	3	17, 45, 54		
		43, 43, 44, 46,		43, 44, 45, 46,	10	41, 41, 44, 54,		
		54, 54, 59		48, 54, 54		55		
			0	02, 02, 09, 10,	11	01, 03, 05, 06,		
			1	13, 14, 15, 16,		06, 07, 07, 09,		
			2	21, 21, 22, 22,		11, 12, 12, 15,		
				25, 26, 28, 29,		15, 16, 19, 19,		

(to be continued.)

Table III. (continued.)

Date	hour	minute	Date	hour	minute	Date	hour	minute
1930 March 14	11	21, 21, 21, 21,	15	18	45, 45, 47, 50,	17	2	41, 41, 43, 47,
		21, 22, 23, 23,			55, 57, 57			53, 58, 59
		23, 24, 24, 25,			07			05, 09, 18, 18,
		25, 25, 28, 29,	16	0	11, 11, 11			18, 18, 19, 19,
		29, 30, 31, 38,		1	37, 40, 43, 49,			19, 20, 23, 32,
		39, 40, 40, 43,	2	54, 57	36			
		45, 52, 52, 55	3	03, 04, 26, 27,	4			51
		07, 08, 15, 15,	5	27	18			15, 28, 31, 33,
		22, 23, 37, 53	11	05	19			34, 46, 46, 46,
		00, 33	11	34				46, 58
		06, 16, 18, 35,		10, 11, 11, 11,				01, 07, 07, 08,
	13		12, 15, 15, 15,		10, 10, 11, 12,			
	14		15, 16, 18, 19,		12, 17, 22, 24,			
	21		22, 24, 25, 29,		24, 24, 25, 25,			
	15		29, 30, 38, 38,		26, 27, 28, 31,			
	16		39, 41, 45, 48,		44, 45			
	20		48, 52, 53, 59		20	02, 06, 06		
			25, 27, 28, 29,	12	02, 03, 28, 32,	23	25, 44	
			29, 30, 30, 31,		38, 50, 54	2	32, 36, 36, 37,	
			33, 34, 37, 40,	14	21		38, 38, 40, 41,	
			41, 43, 45, 49,	15	03, 03, 03	18	42, 42, 42, 48,	
		57, 58, 58	1	25, 39, 39, 40,		49, 49, 50, 50,		
		05, 23, 39, 47	17	40, 42, 44, 46,		50, 51, 54, 55,		
	21	15, 18, 30, 45,			47, 48, 48, 49,		57, 58	
	22	59, 59, 59		50, 51, 51, 52,		3	04, 04, 04, 04,	
		21		52, 53, 53, 54,			05, 06, 06, 06,	
15	0	03, 03		54, 54, 55, 56,			07, 10, 11, 12,	
	2	05		56, 57, 57, 57,			13, 15, 16, 17,	
	3	01, 01, 02, 04,		58, 58			21, 22, 22, 25,	
	4	04, 05, 06, 07,		2	00, 00, 00, 00,		33, 53	
		07, 08, 15, 15,			01, 01, 01, 02,	5	32, 57	
		22			04, 04, 04, 05,	6	11, 25, 42, 49,	
		37, 37, 52			06, 06, 07, 07,		54, 54, 55	
	5	01, 10, 21			08, 08, 09, 10,	7	08, 11, 12, 24,	
	9	08			11, 11, 12, 12,		26, 28, 29, 33,	
	15	17, 23, 24, 25,			13, 13, 14, 14,		35, 36, 43, 46,	
	18	26, 26, 28, 30,			14, 14, 15, 16,		47, 47, 50, 50	
		31, 33, 33, 33,			17, 18, 20, 20,	8	40, 40, 44, 46,	
		34, 34, 39, 40,			20, 21, 23, 23,		47, 48	
		41, 41, 43, 44,			24, 25, 26, 41.	10	05, 07	

(to be continued.)

Table III. (continued.)

Date	hour	minute	Date	hour	minute	Date	hour	minute
1930 March			20	4	34	22	1	00, 01, 23, 30,
	18	17 56		6	22			40
				7	45		2	12
	19	6 44		8	55		7	06, 08
		7 00, 22, 28, 29,		9	08, 08, 08		8	58
		29, 30, 31, 31,		10	03, 04, 05, 05,		15	41, 43, 43, 44,
		32, 32, 32, 32,			05, 07, 08, 10,			44, 46, 47, 48,
		33, 33, 33, 34,			10, 12, 14, 16,			48, 48, 49, 50,
		35, 36, 36, 37,			16, 17, 17, 18,			51, 52, 52, 53,
		39, 39, 40, 42,			18, 18, 19, 20.			53, 54, 55, 56,
		43, 43, 44, 45,			20, 21, 22, 22,			57, 57, 57, 58,
		45, 46, 46, 47,			23, 23, 25, 28,			59
		48, 49, 49, 49,			28, 28, 30, 30,		16	02, 04, 05, 05,
		50, 50, 51, 51,			31, 32, 37, 51			06, 06, 07, 07,
		52, 55, 56, 56,		11	03, 04, 07, 10,			08, 09, 09, 10,
		57			10, 16, 24, 25,			10, 11, 13, 14,
	8	00, 00, 07, 08,			59			14, 16, 16, 18,
		11, 13, 13, 14,		15	12			18, 31, 32, 35,
		15, 15, 16, 17,		16	46			38, 39, 40, 46,
		17, 18, 19, 20,		20	49			46, 54, 55, 55,
		21, 25, 26, 26,		21	06, 13, 21			56, 57, 59
		27, 28, 31, 33,		22	58		17	00, 09, 15, 15,
		35, 37, 38, 38,	21	5	17, 25, 26, 28.			24, 25, 28, 30,
		30, 42, 44, 44,			32, 33, 34, 39,			30, 31, 33, 40,
		46, 47, 49, 51,			40, 42, 47, 47			42, 45, 50, 56,
		52, 56		6	58			56, 57, 57, 53,
	9	08		7	04, 15, 17, 21,			59, 59, 59
	10	15, 21			22, 25, 28, 28,		18	00, 01, 02, 02,
	11	02, 03			29, 30, 33, 38.			03, 03, 03, 04,
	15	03			38, 40, 41, 47,			05, 05, 06, 06,
	16	35			52, 53, 57			08, 09, 09, 09,
	17	07, 08, 08, 11,		8	02, 02, 03, 05,			10, 10, 13, 15,
		11, 12, 12, 13,			12, 13, 16, 16,			16, 19, 20, 21,
		14, 18, 27, 29,			18, 21, 34, 34,			24, 24, 26, 26,
		30, 36, 37, 40,			36, 46, 51, 51			28, 29, 32, 33,
		40, 41		9	06, 45			37, 39, 40, 40,
	18	56, 56		17	41			45, 46, 50, 51,
	20	03		20	06, 16, 17			51, 53, 53, 56,
20	23	54, 55, 55		23	04			57
	2	48, 48, 48	22	0	59		19	06, 07, 09, 10,

(to be continued.)

Table III. (continued.)

Date	hour	minute	Date	hour	minute	Date	hour	minute				
1930 March 22	19	10, 10, 13, 15,	24	12	06, 11, 13, 14,	25		17, 20, 20, 21,				
		17, 25, 31, 34,			16, 19, 20, 23,			21, 22, 25, 25,				
		35, 38, 50, 50,			24, 25, 28, 29,			26, 26, 29, 30,				
	20	53, 53, 56, 57		30, 33, 34, 35,	39, 43, 43, 45,			30, 32, 33, 35,				
		05, 28, 33, 35,		45, 45, 54, 54,	57			37, 37, 38, 42,				
		36, 37, 37, 38,		57	52, 54, 54, 57,			58, 59, 59				
	21	49		49	13			02, 03, 04, 04,	22	01, 01, 03, 04,		
		32		32	13			06, 12, 19, 20,	22	08, 09, 10, 11,		
		02		02	13			21, 22, 55, 56	22	15, 15, 16, 20,		
	23	0		24	14			14	01, 02, 05, 09,	23		21, 21, 22, 22,
				02, 03, 46, 51					16, 16, 18, 19,			23, 25, 26, 30,
		3		39				28, 30, 33, 35,	30, 39, 40, 42,			
4			36, 37, 39, 40,	43, 44, 46, 47								
8		53	43, 46, 47, 49,	04, 07, 09, 09,								
		9	30	51, 53, 56, 58		10, 11, 11, 11,						
10		29, 29	15	15		00, 01, 04, 04,	12, 20, 22, 25,					
		32, 34, 35, 37,				05, 08, 09, 10,	26, 29, 31, 31,					
		54, 55, 56, 58,				10, 14, 15, 15,	33, 35, 39, 46,					
12		00, 02, 03, 06,	12	12		17, 18, 19, 19,	59					
	10, 13, 13, 14,				20, 20, 21, 23,							
	16, 17, 17, 18,	24, 25, 27, 27,										
	20, 22, 27, 28,	30, 34, 34, 39,										
	29, 30, 46	44, 46, 49, 51,										
13	04, 04	16	16	56	26	0	51					
	18			50	05, 19, 23, 26,	3	15, 29					
				19	56	27, 46, 55	4	41, 51, 58				
24	2	29	25	17	09, 09, 41	26		8				
		3			20, 37			18	23, 27, 49	8	28, 28	
	5	23, 44, 47, 49,		20	20			42	13	59		
		49, 55, 59						0		03, 06, 10, 11,		
	6	03, 03, 18, 22,		7	7			04	14	15, 16, 16, 17,		
		52						15, 45		18, 19, 19, 20,		
	7	09, 13, 17, 20,		15	15			05	15	21, 31, 32, 35,		
		24, 25, 25, 26,						23, 24, 35, 56		36, 36, 37, 40,		
		27, 28						56		43, 44, 46, 47,		
	8	19		19	19			00, 02, 06, 15,	15	52, 54, 57, 58		
		19						19, 22, 23, 25,		00, 04, 06, 08,		
	11	48, 52, 56, 56,		21	21			26, 30, 32, 45	15	09, 10, 10, 10,		
59		02, 08, 11, 11,	12, 12, 13, 15,									
12	01, 02, 03, 04,			12, 13, 13, 17,		21, 26, 29, 30,						

(to be continued.)

Table III. (continued.)

Date	hour	minute	Date	hour	minute	Date	hour	minute			
1930 March 26			29	5	24, 24, 25, 41,	30	0	38, 41, 44, 51,			
		32, 33, 34, 37,			42, 55				52, 56, 57		
		42, 44, 51, 55			7		30		1	06, 25, 46, 46,	
	16	02, 03, 06, 08,			8		22			47, 54	
		12, 12, 16, 17,			15		52		2	01, 02, 03, 03,	
		28, 32, 46, 54,			17		51			03, 06, 06, 07,	
		57			18		22			10, 13	
	18	14, 15, 19, 34			22		19, 27, 28, 28,		3	10, 11, 52	
	19	44, 44, 46, 48,					32, 33, 34, 34,		4	22	
		48, 49, 50, 50,					35, 36, 36, 37,		5	30, 40, 45, 46,	
		51, 52, 53					37, 38, 39, 39,			54	
	20	04, 05, 59, 59					40, 40, 41, 42,		6	04, 07, 07, 08,	
	21	00, 03, 05, 10					42, 43, 44, 45,			12, 14, 16, 19,	
	27	0		14, 34, 52				46, 48, 49, 49,			23, 23, 27, 27,
		1		37, 41, 49				49, 50, 52, 53,			29, 38, 41, 42,
		2		22				53, 53, 54, 54,			44, 46, 46, 47,
		3		30, 31				55, 55, 58, 59,			48, 49, 51, 51,
		5		14				59			52, 53, 54, 54,
		12		11			23	00, 00, 01, 02,			54, 56, 59, 59,
		15		35				03, 04, 06, 06,			59
		28		10	15			07, 07, 09, 11,		7	00, 01, 02, 03,
29		1	04, 07, 11, 16,			12, 14, 15, 18,			04, 04, 05, 07,		
			21, 33, 33, 36,			19, 22, 23, 23,			07, 11, 12, 13,		
	40, 41, 46, 50				29, 30, 30, 30,			17, 17, 18, 20,			
	2	05, 16, 17, 28,			33, 34, 34, 35,			21, 26, 26, 30,			
		31, 33, 37, 44,			37, 37, 40, 41,			32, 56			
		45, 45, 47, 47,			41, 42, 42, 42,		8	21			
		49, 53, 54, 56,			43, 44, 45, 45,		13	16			
	3	57, 59			46, 47, 48, 49,		14	17, 17, 32			
		00, 04, 06, 07,			49, 49, 50, 51,		17	28			
		13, 14, 15, 15,			51, 52, 54, 54,	31	4	49			
		15, 16, 17, 19,			55, 56, 56, 57,		9	37, 38, 48, 57,			
		24, 28, 35, 38,			57, 58, 58, 59,			57, 58, 59			
	4	38, 41, 44, 44,			59, 59		10	02, 03, 04, 04,			
		47, 54, 55, 56		30	0			05, 06, 06, 07,			
		01, 02, 07, 11,						08, 11, 14, 17,			
		12, 13, 14, 14,						17, 20, 22, 25,			
		15, 17, 17, 19,						26, 31, 33, 36,			
19, 33							36, 37, 41, 43,				
5		04, 10, 10, 12,					45, 45, 54, 56,				

(to be continued.)

Table III. (continued.)

Date	hour	minute	Date	hour	minute	Date	hour	minute	
1930 March 31	10	57, 58, 59	4	3	21, 21, 21, 23, 24, 27, 29, 31,	7	7	36, 38	
	11	02, 03, 10, 12, 13, 15, 20, 24, 40, 43, 45, 54			33, 34, 34, 34, 36, 37, 38, 39, 44, 49, 49, 50, 51, 55		8	31	
	12	03, 03, 06, 07, 11, 11, 17, 20, 22, 25, 29		4	27, 28, 29, 29, 30, 30, 34, 34, 35, 36, 37, 38, 39, 41, 41, 45, 52	8	6	59	
	13	27, 29					23	38	
	16	27, 40, 44, 46, 53, 57, 57, 59				9	0	22, 25, 27, 30, 35, 40, 45, 56, 57, 57	
	17	04, 05		5	00, 02, 11, 12		6	15, 15	
	19	21		7	13, 48		7	40	
	19	6	02, 03, 44, 53	11	04, 10, 16, 25, 28, 32, 38	10	11	00	
	April 1	7	35					20	10
		8	08		12	15		6	45
9		29, 30, 31, 31, 51, 51, 52, 53, 55	5	7	06, 07, 07		10	40	
10		02, 04, 06, 10, 23, 23, 27, 45		16	22		13	37	
11		04, 19, 33, 34, 38, 41, 49	6	7	54		22	36	
12		05, 08, 13, 15, 17, 39, 47, 47, 50	7	1	31, 38, 40, 41, 42, 42, 43, 43, 43, 44, 44, 44, 46, 47, 48, 50, 51, 51, 56	11	8	13, 19, 24, 25, 27, 28, 29, 29, 31, 32, 33, 34, 36, 39, 40, 41, 41, 43, 43, 45, 50, 52, 52, 53, 54, 54, 58	
13		07, 33					9	00, 05	
14		55					14	41, 42	
23		04		2	00, 02, 02, 04, 06, 07, 08, 09, 09, 11, 11, 12, 17, 17, 24, 24, 25, 31, 33, 35, 35, 39, 39, 40, 41, 42, 43, 45, 46, 47, 47, 50, 51	12	9	45, 46, 49, 50	
2		0	28					10	01, 03, 23, 27, 29, 30, 32, 34, 37, 38, 42, 46, 52, 54, 58, 58
	4	05					11	00, 17, 19, 20, 32	
	16	29, 59					16	03	
	20	24, 25					13	3	
3	9	19					17	41, 46, 52, 57, 58, 59	
	12	17					18	14	
4	3	02, 04, 05, 06, 06, 07, 07, 08, 08, 09, 11, 12, 13, 14, 14, 17, 18, 19, 20, 20,		3	00, 12, 18		21	27	
				4	37		14	6	
				5	21			04	

(to be continued.)

Table III. (*continued.*)

Date	hour	minute	Date	hour	minute	Date	hour	minute
1930 April			30	11	09, 14, 15, 36,	6	22	09, 46, 46, 51
14	10	19			49, 50		23	38
	18	29		12	40	7	0	06
	22	14		16	04		1	38
15	18	50		18	25, 40		4	39, 51
16	18	51	May 1	19	07		5	30
	21	50		20	02		6	41
17	0	35	3	9	43		7	49
	7	09		10	03, 27		10	45, 47
18	5	51		13	49		22	06
	6	32, 54		19	05	8	5	17, 22, 24, 26,
19	2	23		23	01			32, 33, 34, 34,
20	4	34	4	0	04, 05, 18, 22,			35, 35, 37, 40,
	6	28			27			40, 44, 45, 46,
	8	10*, 37		1	54			52, 54, 55, 56
	18	34		2	14, 22, 24	6		00, 02, 03, 05,
21	12	35		14	27, 31, 41, 43,			08, 11, 13, 14,
22	23	31			44, 46			17, 17, 18, 21,
23	12	19		17	35			24, 25, 26, 27,
24	1	30		18	19			31, 34, 34, 37,
	9	59		19	28			38, 38, 39, 39,
	11	23	5	3	14*			41, 43, 45, 46,
25	22	15		5	06*			47, 49, 49, 50,
26	9	45		7	59			51, 54, 57, 58,
	15	52		8	08			59
	20	15, 31, 31		13	55	7		02, 02, 03, 08,
27	12	49		17	06, 10			09, 14, 18, 20,
	15	06, 18	6	4	54, 56			22, 25, 31, 36,
	21	33		5†	02, 13, 25			43, 44, 48, 56,
	22	49		6†	13, 18, 29, 57			58
28	4	20		7	36	8		07, 07, 08, 11,
	5	09, 09		10	18			12, 13, 16, 20,
	16	12, 27		12	14, 14, 50			22
	18	11, 16		17	47, 59	9		05, 17, 20, 52,
	20	31		19	14, 15, 47, 58			55
29	16	13		20	03, 04, 04, 05,	10		00, 05, 09, 12
	18	28, 28			10, 14, 20, 21,	11		23
	22	39			24, 26, 29, 37	12		35, 40, 52
30	10	54		21	07	13		02, 02, 05, 06,

* Not recorded at Misaki, then Data of Kamakura were adopted.

† Time-keeping was bad.

(to be continued.)

Table III. (continued.)

Date	hour	minute	Date	hour	minute	Date	hour	minute	
1930 May 8			9	4	52, 53, 54, 55, 56, 57, 57	9	19	19, 19, 21, 21, 23, 26, 28, 30, 34, 41	
		07, 07, 08, 08, 11, 12, 12, 14, 14, 15, 15, 16, 17, 18, 18, 20, 20, 21, 23, 25, 27, 28, 29, 31, 32, 32, 33, 34, 34, 37, 38, 40, 40, 41, 42, 43, 45, 47, 49, 52, 54		5	01, 03, 03, 04, 05, 09, 10, 11, 13, 13, 13, 14, 15, 17, 18, 19, 19, 20, 22, 22, 23, 24, 24, 26, 26, 27, 29, 29, 30, 35, 35, 37, 39, 42, 42, 44, 44, 45, 45, 45, 47, 50, 51, 55, 55, 57, 58		20	24, 30	
		14	02, 03, 04, 05, 06, 06, 08, 08, 12, 19, 20, 27, 38, 44		6	00, 01, 02, 04, 06, 09, 11, 13, 17, 19, 22, 26, 27, 28, 29, 29, 31, 33, 34, 35, 37		21	01, 04, 55, 57
		15	31		7	11		0	15, 17, 28, 30, 58, 58
		16	59		9	00, 11, 14, 53, 53		1	32, 33
		17	02, 41, 47		10	00, 31, 38**		2	07
		18	30		11	08, 50		3	21, 23, 26, 26, 26, 27, 28, 31, 32, 33, 33, 35, 35, 35, 36, 37, 38, 41, 41, 41, 43, 43, 44, 45, 46, 47, 47, 48, 49, 51, 52, 52, 53, 53, 53, 54, 55, 56, 56, 58, 58, 59, 59
		21	34, 34		12	01, 04, 17, 18, 18, 19, 34, 36, 36, 37, 41, 51, 51, 53		4	01, 01, 02, 03, 06, 07, 09, 10, 11, 12, 13, 14, 14, 15, 15, 16, 18, 18, 19, 23, 25, 27, 30, 30, 31, 34, 42, 50, 59
		22	30, 47, 48, 49, 53, 55		13	02, 09, 10, 13, 24, 26, 32, 36, 52		5	01
		23	04, 25, 26, 48		14	00, 59		6	09
	9	0	37, 40, 41, 42, 43, 50, 52		16	24, 37, 48		7	32, 48, 54
		1	00, 01, 04, 07, 09, 53		17	08, 10, 11, 13, 13, 15, 15, 16**		8	09, 13, 16, 16, 17, 18, 19, 22, 22, 30, 31, 32, 42, 43, 44, 47, 48, 53, 54, 56, 57, 58
		2	17, 27, 37		18	21		9	02, 02, 04, 05, 06, 08, 10, 11,
		3	31, 41, 42, 47, 49, 57		19	03, 16, 17, 18,			
		4	00, 02, 02, 03, 03, 04, 06, 08, 11, 11, 13, 14, 14, 16, 18, 22, 24, 25, 26, 27, 30, 33, 35, 36, 37, 43, 44, 44, 45, 48, 51, 52,						

** 39 earthquakes from May 9, 10 h 38 m to 17 h 16 m were due to Mr. Makino's record.

(to be continued.)

Table III. (*continued.*)

Date	hour	minute	Date	hour	minute	Date	hour	minute			
1930 May 10	9	12, 13, 15, 19, 20, 22, 39, 54, 54 18, 54	11	3	21, 21, 24, 25, 28, 30, 32, 33, 33, 34, 35, 37, 37, 37, 38, 38, 39, 51, 56, 59,	12	17	38			
		08, 22, 57, 58,			4			03, 10	13	0	07
		11			08, 13			7	34, 42, 43	1	06
		12			31, 42, 44, 45,			8	05, 21	2	46
		15			45, 45, 46, 47, 47, 47, 49, 53, 53, 54, 55, 57 08, 13, 28, 33,			10	16, 20, 29, 29, 44, 48	3	14, 17, 18, 21, 22, 26, 27, 27, 30, 34, 44, 44, 45, 46, 48, 52
		16			41 24, 31, 35, 38,			11	03, 03, 04, 05, 10, 12, 14, 16, 16, 17, 19, 30, 31, 32, 32, 35,	4	01, 07
		19			40, 41, 43, 43, 45, 47, 50, 58, 59			12	47	7	33, 37, 39, 41, 42, 43, 44, 46, 47, 50, 55, 59
		20			00, 00, 01, 04, 04, 05, 06, 09, 10, 12, 13, 15, 15, 15, 16, 19, 22, 24, 29, 35, 36, 36, 38, 39, 40, 44, 45, 45, 46, 46, 46, 47, 47, 48, 49, 50, 50, 51, 53, 53, 54, 54, 56 00, 03, 04, 04,			14	21, 21, 22, 24	8	02, 03, 04, 05, 05, 11, 12, 14, 15, 17, 29, 31, 34, 37, 39, 40, 44, 45, 46, 47, 49, 50, 52, 53, 55, 59
	21	06, 44, 45, 46, 55	18	15, 39	9	00, 02, 05, 08, 09, 11, 17, 26, 50					
	22	07, 08, 37, 37, 38, 42, 43, 44, 46, 47	19	45, 53, 55	2	00, 14, 17, 21, 44	10	05, 32			
	23	05, 08, 09, 19	21	07	3	56, 57	11	18, 22, 37, 38, 39, 41, 50, 53, 53, 55, 56, 59			
	11	0	01, 35, 37, 38, 46, 47, 47	22	27, 38, 40	4	07, 35	12	03, 04, 09, 25, 26, 28, 29, 33, 37, 43, 48, 53, 54, 55, 59		
		1	38	0	02, 31	5	46	13	45, 48		
		3	03, 09, 10, 10, 14, 14, 17, 19,	1	13, 15, 18, 19, 25, 26, 27, 27, 29, 29, 30, 36, 44, 54, 58	8	52	15	28, 36, 37, 39, 40, 40, 41, 42		
				2	00, 14, 17, 21, 44	9	11, 18, 18, 23, 28, 41	16	04, 06		
				3	56, 57	10	10	20	54		
			4	07, 35	13	46	22	56			
			5	46	14	29					
			8	52	16	25, 47					
			9	11, 18, 18, 23, 28, 41	17	01, 05, 06, 07, 14, 19, 20, 33,					

(to be continued.)

Table III. (continued.)

Date	hour	minute	Date	hour	minute	Date	hour	minute	
1930 May 13 14			14	9	21, 22, 28, 28,	15	12	00, 55	
	23	36, 45			33, 34, 39, 58		14	15	
	1	14		10	14, 25, 26, 28,		15	58	
	3	23, 24, 25			29, 47, 51, 52,		16	41, 43, 45, 45, 47, 47, 50, 51,	
	4	18, 27, 28, 32, 33, 33, 34, 35, 36, 37, 39, 41, 42, 43, 46, 47, 48, 48, 48, 50, 51, 53, 54, 55, 57, 57		11	01, 01, 05, 15, 20, 21, 21, 22, 27, 32, 34, 37, 46, 46		17	02, 03, 05, 08, 09	
	5	01, 03, 03, 04, 06, 07, 07, 08, 08, 10, 10, 12, 13, 13, 14, 15, 16, 17, 18, 18, 18, 19, 20, 21, 23, 26, 28, 29, 29, 34, 37, 42, 47, 48, 49, 51, 52, 52, 59		12	01, 11, 38, 51, 51, 52, 55, 56, 57		18	47, 49, 49, 50, 52, 54, 55, 56, 59	
	6	00, 00, 04, 05, 08, 19, 20, 21, 22, 31, 33, 84, 42, 43, 48, 52, 56		13	00, 01, 12, 40		19	02, 03, 05, 10, 13, 14, 27	
	7	01, 05, 10, 10, 13, 14, 17, 24, 27, 40, 44, 45, 45, 48, 48, 52		14	25, 30, 39, 40, 41, 47, 50, 51		20	55	
	8	14, 14, 15, 16, 21, 25, 26, 27, 29, 30, 31, 32, 33, 34, 38, 39, 40, 41, 42, 43, 45, 46, 47, 47, 50, 51, 56		15	04, 19, 31, 43 59		21	55, 59	
	9	02, 02, 05, 06, 08, 09, 09, 13, 15, 17, 19, 21,		16	05, 09, 10, 24 20 42 07, 09, 09, 11, 13, 14, 14, 15, 18, 21, 24, 31, 34 44		22	02, 26, 28, 35, 50	
				17	05, 09, 10, 24 20 42 07, 09, 09, 11, 13, 14, 14, 15, 18, 21, 24, 31, 34 44		23	30, 35	
				15	0	11. 45, 48, 52, 52, 58, 58, 58	16	0	46
					1	02, 02, 05, 07, 12, 15, 15, 16, 17, 18, 18, 19, 19, 20, 22, 24, 29, 31, 33, 45, 49, 56, 58		3	01
					2	00, 02, 06, 58		6	03, 33
					6	15		8	44
					10	27, 27		10	44
					11	11, 13, 16, 17, 19, 27, 28, 29, 29, 44, 45, 47, 49, 51, 54, 58		11	09, 10, 11, 12, 13, 15, 16, 21, 21, 26, 42
								19	31, 34
								22	29, 29, 34, 47
							17	0	59
								1	02, 08, 12, 13, 13, 15, 18, 23, 24, 24, 25, 25, 26, 28, 35, 37, 38, 39, 44, 45, 49, 49, 52, 53, 55, 59
								2	02, 05, 08, 08, 11, 21, 21, 22, 25, 28, 29, 33, 43, 51, 52, 52

(to be continued.)

Table III. (*continued.*)

Date	hour	minute	Date	hour	minute	Date	hour	minute		
1930 May 17	3	01, 03, 06, 07, 13, 17, 32, 33, 35, 37, 42, 46	18	8	03, 05, 05, 06, 07, 08, 12, 13, 14, 21, 22, 24, 24, 26, 27, 27, 45	22	7	11, 19, 36, 37, 38, 39, 55		
									8	11, 19*, 47
	4	05, 07, 10, 19, 19, 33, 33, 38, 39, 45, 46, 54		9	13, 19, 44	11	28			
								11	27, 45	
	5	06, 14, 20, 24, 27, 45		12	09, 13, 57	12	00, 07, 15, 26, 37, 45, 52			
								13	10	
	6	20, 21, 35		14	20, 28, 30, 36, 44, 47, 50	13	14, 30, 31			
								15	01, 04, 05, 06, 08, 10, 12, 14,	
	7	30, 30, 31, 35, 53, 57		16	04, 07, 19	14	22, 35			
								17	51, 52, 56	
	8	23, 57		17	05, 16	15	08, 24			
								18	43	
	9	37, 45, 49, 54, 55		19	04	23	50			
								20	32, 47	
	10	09, 26, 34, 37	8	04	2	24				
							11	24		
	14	27, 51	10	38	10	01				
							16	54		
	17	00	13	24	12	32				
							18	19, 20, 21, 25, 27, 29, 31, 31, 34, 35, 38, 41, 44, 48, 53		
	19	19, 20, 21, 25, 27, 29, 31, 31, 34, 35, 38, 41, 44, 48, 53	19	06, 07, 12, 19, 44, 45, 47, 47, 48, 49, 53, 54, 55	24	02, 47				
							20	32, 47		
18	17, 17, 47, 48	8	04	3	18					
						2	56, 59			
3	00, 01, 01, 03, 07, 13, 17, 19	20	00, 02, 03, 06, 15	5	22					
						4	04			
5	12	21	03, 14	8	46					
						6	14			
7	47, 47, 48, 49, 50, 51, 51, 52, 53, 53, 53, 54, 54, 54, 55, 56, 56, 57, 57, 58, 59	11	52	9	19					
						20	0			
18	00, 00, 01, 02,	21	53	10	22, 27, 34					
						2	56, 59			
3	00, 01, 01, 03, 07, 13, 17, 19	22	37*	11	18					
						4	04			
5	12	5	18, 52	12	53					
						6	14			
7	47, 47, 48, 49, 50, 51, 51, 52, 53, 53, 53, 54, 54, 54, 55, 56, 56, 57, 57, 58, 59	6	06, 23, 31	13	07					
						8	00, 00, 01, 02,			
20	0	23	21, 23, 55	15	17					
						1	44			
3	17	25	53	16	34					
						11	52			
23	21, 23, 55	26	0	19	10					
						5	53			
2	37*	June	1	19	10					
						5	18, 52			
6	14	3	16	11	43					
						14	2			
15	6	14	17	2	41					
						23	30			
25	13	15	21, 23, 55	6	07					
						26	0			
26	0	25	37*	13	58					
						5	18, 52			
6	06, 23, 31	26	0	19	10					

Table IV. Hourly frequency of the earthquakes
observed at Misaki.

day	hour																								Total in a day	
	0~1	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	12~13	13~14	14~15	15~16	16~17	17~18	18~19	19~20	20~21	21~22	22~23	23~24		
1930 Feb. 14			2																							2
15											3		1													4
16											1															1
17											2															2
18	1					1	1	1	3		6	6				1							3	8	13	
19		1									1											1				21
20											2	7	14	8	3	5										6
21	1	1	5	3		1			5	5	20	5	1					1	2	1		1	1	1	49	
22	2	1	1	4	1	4	9	1	9	5	20	5	1					2			24	5	1	1	79	
23	2						1	20	6	1	4		3		2			1	28	7	4	3	1	1	87	
24	1	1				4					2	1	2		2			2				1			39	
25	1		1	2		2					2	1	2		1	18	14	7	6			2	1	1	61	
26				1	2	1	2		1	2	1				1	3		1		1		1			23	
27		1	1																1						12	
28						1																			4	
March 1				1	2		1	1							3	2			17	11	4	3	6		42	
2	22	1	4		1	2	1	1		1	1	2	2					1	2		5	52	50	26	143	
3		2	2	2					1		1	1	2	2					1	2		1	1		43	
4	12	13	10	7	6	20	6	2	1		1	1			1			2			6	60	30	20	132	
5	23	15	1		2	1	1	1		1	1											1	1	62	143	
6	74	36	14	3	1		1	3	1		1	1											1	1	47	
7	40	36	2	2			1	2					1	10	7								1	47	183	
8		3		1	2				6	1															104	
9	13	12		7	29	10	1	5	4	4	4	1		1	1	4	18	38	20	24	54	35	19	29	161	
10					1	14	7	3	29	10	3										2	2	1	2	203	
11	10	25	9	3	2		1	1	1	6	33	10	23	10	10	1	1	1	2	2	2	6	19	17	122	
12	3	7	18	2	1		1	1	2	2		4	12	4	4			3	1	2		3	23		177	
13	25	28	25	13	13	6	4			2								2	1	16	10	14	12	23	139	
14	1	1		3							5	44	8	2	5	1	1				1				118	
15	1		2	1	13	3				3										27	1				109	
16	3	6	5	1		1						28	7		1	3									52	
17		30	51	13	1															10	22	3			55	
18			22	22		2	7	16	6		2													2	132	
19							1	45	38	1	2	2												1	79	
20			3		1		1	1	1	3	36	9				1	1	18	2		1	3	1		115	
21					11	1	19	16	2												3			1	62	
																								1	54	

(to be continued.)

Table IV. (continued.)

hour day	0~1	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	12~13	13~14	14~15	15~16	16~17	17~18	18~19	19~20	20~21	21~22	22~23	23~0	Total in a day
1930 March 22	1	5	1					2	1							25	35	23	45	20	9	1	1		169
23	1			4	1					1	1	2	9	19	2				1	1					42
24			1	2		7	5	10	1			5	29	12	24	33	7	3	3		1				143
25	1								2	1						4				1	12	35	28	21	105
26	1	9	3	2	3					2				1	28	24	13		4	11	4	4			109
27	3	3	1	2		1							1			1									12
28											1														1
29		12	18	24	14	10		1	1							1		1	1				41	62	186
30	31	6	10	3	1	5	33	22	1					1	3			1							117
31					1					7	31	12	11	2				8	2		1				75
April 1							4	1	1	9	8	7	9	2	1									1	43
2	1				1												2				2				6
3										1			1												2
4				42	17	4		2				7	1	1			1								75
5								1								1				1					3
6								1																1	2
7		19	33	3	1	1		2	1												1				61
8								1																1	2
9	10							2	1			1									1				15
10								1			1			1									1		4
11									27	2					2	1									32
12										4	16	5					1								26
13				1														6	1			1			9
14							1				1								1	1			1		4
15																			1	1					1
16																						1			2
17	1							1																	2
18						1	2																		3
19			1							2										1					1
20					1		1		2																5
21													1												1
22														1										1	1
23													1												1
24		1								1		1													3
25																							1		1
26										1						1					3				5
27													1			2						1	1		5

(to be continued.)

Table IV. (continued.)

day	hour																							Total in a day		
	0~1	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	12~13	13~14	14~15	15~16	16~17	17~18	18~19	19~20	20~21	21~22	22~23		23~0	
1930 April 28					1	2												2		2						8
29																		1		2				1		4
30											1	6	1					1		2						11
May 1																					1	1				2
2																										0
3										1	2			1							1			1		6
4	5	1	3												6				1	1	1					18
5				1		1		1	1					1					2							7
6					2	3	4	1			1		3						2		4	12	1	4	1	38
7	1	1			2	1	1	1			2												1			10
8					20	37	17	9	5	4	1	3	45	14	1	1	3	1				2	6	4		173
9	7	6	3	6	39	47	21	1		5	3	2	14	9	2		3	12	1	14	2	4				201
10	6	2	1	43	29	1	1	3	22	17	2	4	2		16	5				13	43	9	10	4		233
11	7	1		28	2			3	2		6	19	1		4				2	3		1	3			82
12	2	15	5	2	2	1			1	6	1		1	1		2	9	3				6		1		58
13	1	1	1	16	2			12	26	9	2	12	15	2	8	2					1		1	2		113
14		1		3	26	39	17	16	27	20	12	14	9	4	8	4		1	4	1		1	13	1		221
15	8	23	4					1			2	16	2		1	1	9	5	9	7	1	2	5	2		98
16	1			1			2		1		1	16								2						28
17	1	26	16	12	12	6	3	6	2	5	4	1		2		1	1	1	1	15	2			1		117
18	4		2	8	1	1	1	21	21	3		2	3	1	7	35	3	2								115
19									1		1			1						13	5	2				23
20	1	1		1								1												3		7
21						1																				1
22			1			2	3	7	3	7		1	7	3	2	2			1					1		40
23			1								1		1							2						5
24				1					1	1																4
25			1			1									1											3
26									1								3				1					5
27																										0
28																										0
29																										0
30											1		1													2
31						1	3																			4
Total	329	353	284	296	229	231	198	260	262	167	223	291	189	150	155	203	142	162	209	217	225	289	288	375	5727	

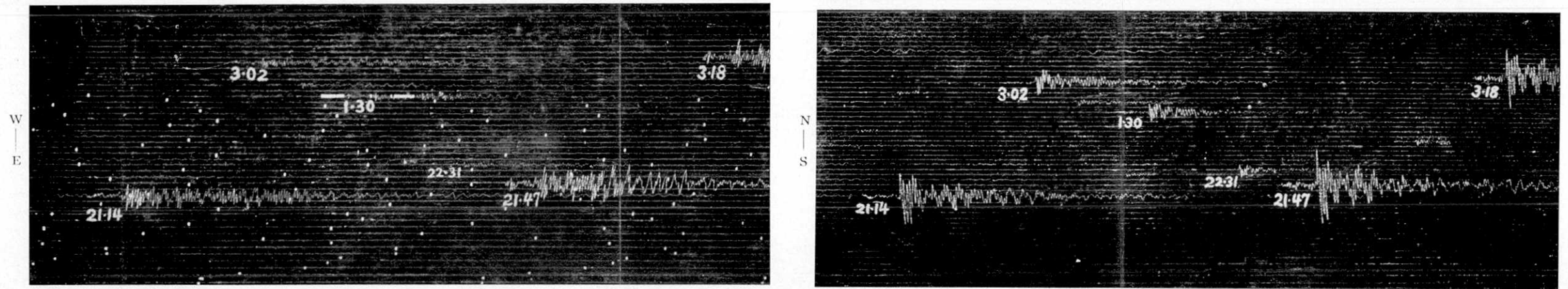


Fig. 5. Parts of seismogram at Misaki, March 11~12, 1930.

(Full size the actual.)

(震研彙報 第十五號 圖版 岸上)

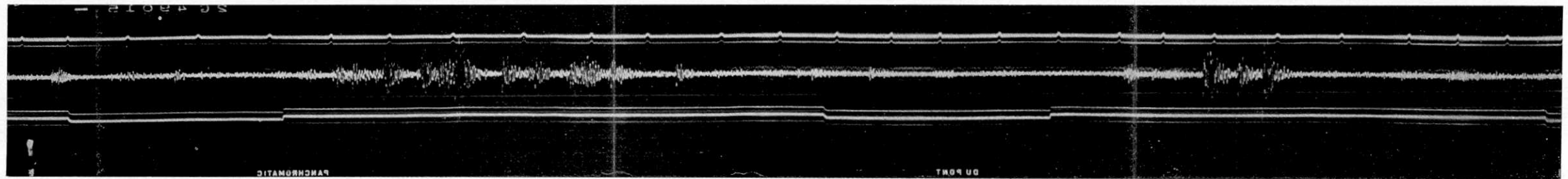


Fig. 15. Part of oscillogram of fracture experiment.

49. 昭和5年伊東地震群の頻度分布

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伊東地震群の活動の消長を調べる爲に三崎臨海實驗所内に据付けられてあつた大森・今村式簡單微動計の記象に表はれた伊東地震の發震時を分の桁まで讀みこつて第3~4表を作つた。又其等の地震は各々記象型が殆ど一定してゐたので南北動のS波の第1動の全振幅の自乗を以て其の地震の勢力を表はすものと假定して、一日毎に各地震の全振幅の自乗の和を求めて第4圖に示した。此は大體に於て毎日の地震頻度を示す第2圖に似てゐるから、強い地震の起つた時は地震の数が多かつたことが判る。或は此から地震の数の多い時は強い地震が起ると云へるかも知れない。又小さな地震は数は多いが地震活動の勢力の變化としては問題にならぬとも考へられる。

次に此の地震は干潮の時に多く起るといはれてゐるので、先づ25時間と12.5時間との週期を2月28日から29日間と3月28日から29日間とについて調べた。其の結果は前の期間の25時間週期の存在することは確率が大きい、後の期間の25時間も兩期間の12.5時間週期も偶然の頻度分布としか考へられない。更に兩期間を位相差を考慮して組合はせると、25時間週期も偶然なことを考へる他は出来なくなつた。若し潮汐と直接關係があれば12.5時間週期の方が確率は大きい筈であるのに問題にならぬ程小さいのであるから、潮汐と地震との關係は無かつたこと考ふべきであらう。

従來地震群の調査に屢々見出されたことのある24時間週期も調べたが、此も確率は小さく、結局此の地震群については1日週期に關しては偶然に起つたこととしか云へない。

地震の頻度分布の期間を20分に短くしても分布の型は大體一定してゐて、地震群型、餘震型等3~4の型に分けられる。地震は地殻の一部の破壊によつて生ずると考へて、此等の頻度分布を説明する爲に木の薄板を曲げて折つてその時に生ずる小振動をオシログラフで記録して見た。其等の振動の5秒間毎の頻度分布を第16圖に示した。此と伊東地震群の場合と比べると似てゐる様に思はれる。

餘震の頻度分布を時に關する函數として表はす數學式は大森・鹽治・日下部の諸氏によつて研究されたが、地震群の場合にも適する様な式を求めた。大森博士等は地震を起すべき地殻内の歪の大きさが地震の數に比例するものと考へ、又歪の減少する割合が地震の頻度に比例するといふ2つの假定から頻度が指數函數によつて減少するといふことを求められた。筆者は地震群の場合には其等の震原が比較的狭い區域に限られてゐるので、その中では地震が起る毎に其の時迄に起つた總數に比例して地震を起すべき區域が減つて行くこと考へて(3)式を假定した。其の様に考へられれば頻度の時に關する式は強い制振器を持つた地震計の運動を示すものと同様になる。そこで地震群の頻度分布曲線は無週期性の振動曲線と見做され、餘震分布も地震群の特別な場合と考へられ、今求めた式の一つの場合として説明が出来る。