29. *Recent Seismic Activities in the Idu Peninsula.* (*Part 2.*)

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The earthquakes that shook so often the Idu district during the period from Feb. 1930 to January 1931, have already been described in an earlier report,[1] in which also were mentioned the distributions of the seismic foci of the Itô earthquake-swarm and the after-shocks of the Idu destructive earthquake of Nov. 26, 1930.

Since then, the method of determining the seismic foci has been improved to such an extent that it is possible now to obtain more accurate results than heretofore of the stereometrical distribution of the seismic foci. I shall now describe the new result of the improved method as applied to Itô earthquakes.

Strong Earthquake of March 22, 1930. Although this Itô earthquake brought no causalities in its train, the particular shock that occurred at 17 h 50 m, March 22 (Japanese standard time) was the strongest of the large number that originated under the Itô Bay. In this paper the distribution of the seismic foci of the shocks that occurred during a few days before and after this strong earthquake will receive special attention in our study of the change in the position of the seismically active centre that probably took place after this strong earthquake.

Network of Seismological Stations. During the few days that preceded the strong earthquake just mentioned, observations were carried out by the network of five stations, namely, Kawana, Itô, Usami, Aziro and Hasima (Fig. 1).

These stations were chosen for the network as they would cover the seismically active centre that lay under Itô Bay. Although Usami was discontinued immediately after the strong earthquake of March 22, the network consisting of the remaining four stations covered most of the seismic foci of the shocks that occurred afterwards.

1) N. NASU, F. KISHINOUE and T. KODAIRA, "Recent Seismic Activities in the Idu Peninsula. (Part 1.)", *Bull. Earthq. Res. Inst.*, 9 (1931), 22~35.

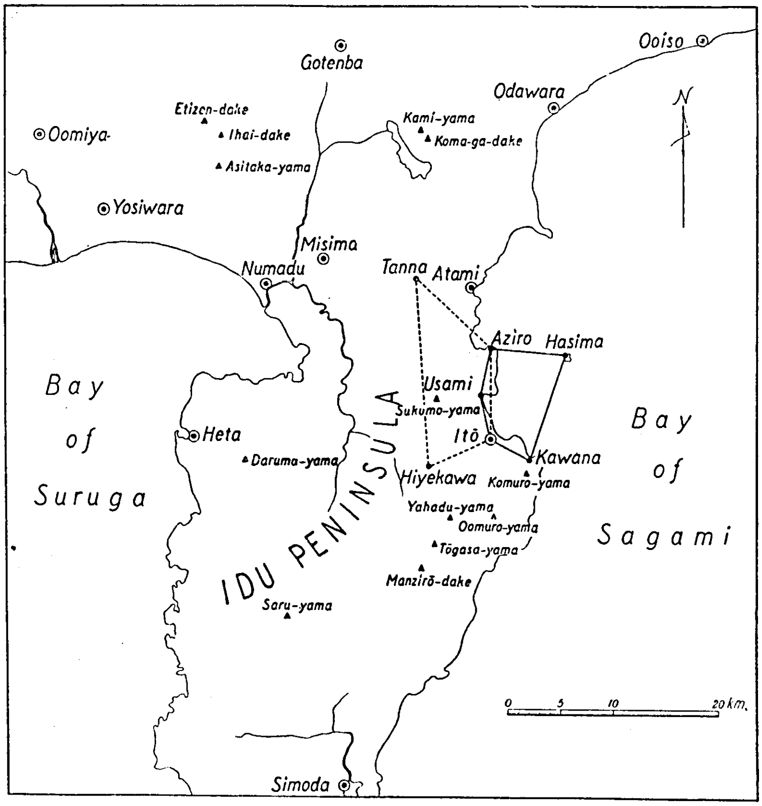

Fig. 1. Map showing the networks of seismological stations.
—— network for the Itô earthquakes.
-------- network for the Idu after-shocks.

Method of determining the Seismic Foci. Owing to its being the most convenient method for determining the seismic foci of shocks that occurred in shollow places, the graphical method was used for the Itô earthquakes.

Formula for computing the Focal Distance by means of the Duration of the Preliminary Tremors. As has been stated elsewhere,[2] the constant factor k in the formnla, $D=kt$, which shows the relation between the duration of the preliminary tremors (t) and the focal distance (D), must first be determined, because k varies with the locality in which the earthquake occurs. The value of k that would apply to

2) N. NASU, "Observations of the Tango after-shocks." *Bull. Earthq. Res. Inst.*, **6** (1929), 24～332; **7** (1929), 133～152.

N. NASU, "A Stereometrical Study of the Aftershocks of the Great Tango Earthquake, etc." *Journ. Fac. Sc.*, [ii], **3** (1929), 29～129.

the Itô earthquakes was specially determined in the manner now to be explained.

Determination of k. Generally speaking, in order to determine k, we require the durations of the preliminary tremors as obtained from four stations. In the case of the earthquakes that occurred during the few days that preceded the very strong shock of March 22, referred to in our previous report, notwithstanding that our network consisted of five stations only four were availed of and only one value of k was determined for each earthquake. But our further studies in connection with this value k brought out the fact that, since in determining k, the duration of the preliminary termors as obtained at four stations are required, by availing of the fact that five combinations of four stations are possible from the five stations we have, there is at our disposal five sets of k values for every earthquake, with consequent increased accuracy in the k determined.

As already stated, the five stations now under consideration are Kawana, Itô, Usami, Aziro and Hasima. For brevity, we shall denote these stations by K, I, U, A, and H, respectively. If we take four out of these five stations, we have five different combinations of stations, namely, (K, I, A, H), (K, I, U, A), (H, K, U, A), (H, I, U, A), and (K, I, U, H). This enables a division of the network of five stations into five networks of four stations as shown by the full-lines in Fig. 2.

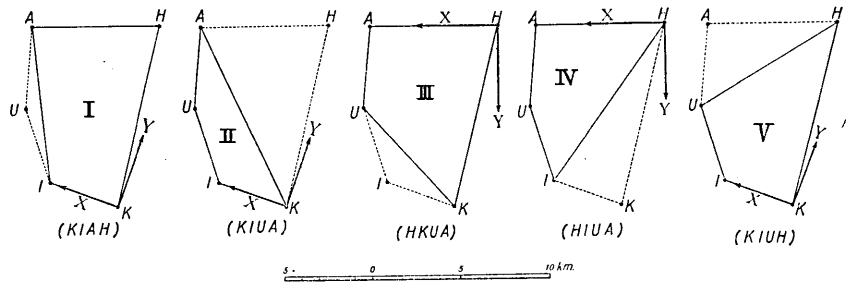

Fig. 2. Networks of four stations.

Since the value of k can be determined by means of the whole networks of four stations just mentioned, we get five different values of k for one earthquake.

It is worth while to examine within what limits the value of k can be determined in the way just mentioned. The answer to this question will undoubtedly be an excellent datum of reference in connection with future observations of local earthquake.

As the general method of determining k by means of the durations of the preliminary termors at four stations has already been given in the report of the observations of the Tango after-shocks,[1] only a brief explanation of it will be made.

Assuming that all the stations lie on the same horizontal plane, $Z=0$, let the origin of coordinates be at one of the stations, and the X axis on the line joining the origin of coordinates with any other station. Let the coordinates of the four stations be $(0, 0, 0)$, $(x_1, 0, 0)$, $(x_2, y_2, 0)$, and $(x_3, y_3, 0)$ respectively, and the durations of the preliminary tremors at these stations t_0, t_1, t_2 and t_3. We can then evaluate k by the formula

$$k=\sqrt{\frac{(x_3y_2-x_2y_3)d_1^2-(d_3^2y_2-d_2^2y_3)d_1}{(x_3y_2-x_2y_3)\tau_1+(y_3\tau_2-y_2\tau_3)d_1}}, \tag{1}$$

where d_1, d_2, d_3 are the respective distances of the stations lying at points $(x_1, 0, 0)$, $(x_2, y_2, 0)$, $(x_3, y_3, 0)$ from the origin of coordinates, $(0, 0, 0)$, and $\tau_1=t_1^2-t_0^2$, $\tau_2=t_2^2-t_0^2$, $\tau_3=t_3^2-t_0^2$.

Formula (1) was applied to the five networks of stations (Fig. 2); the directions of the X and Y axes having been taken as shown by the arrows in Fig. 2. Upon inserting the numerical values of x, y, and d, the formulas for k that are applicable to the five network of stations become as follows:

(I) Network (KIAH).

t_0(Kawana), t_1(Itô), t_2(Aziro), t_3(Hasima).

$$\begin{cases} d_1=\text{distance between Kawana and Itô}=4{\cdot}0\text{ km.} \\ d_2=\text{distance between Kawana and Aziro}=11{\cdot}2\text{ km.} \\ d_3=\text{distance between Kawana and Hasima}=10{\cdot}4\text{ km.} \end{cases}$$

$$\begin{cases} x_1=d_1=4{\cdot}0\text{ km. (Coordinates of Itô.)} \\ x_2=7{\cdot}64\text{ km},\ y_2=7{\cdot}90\text{ km. (Coordinates of Aziro.)} \\ x_3=1{\cdot}20\text{ km},\ y_3=10{\cdot}33\text{ km. (Coordinates of Hasima.)} \end{cases}$$

$$k=\sqrt{\frac{604{\cdot}6816}{62{\cdot}82\,t_0^2-72{\cdot}54\,t_1^2+41{\cdot}32\,t_2^2-31{\cdot}60\,t_3^2}}. \tag{1, I}$$

(II) Network (KIUA).

t_0(Kawana), t_1(Itô), t_2(Usami), t_3(Aziro).

$$\begin{cases} d_1=\text{distance between Kawana and Itô}=4{\cdot}0\text{ km.} \\ d_2=\text{distance between Kawana and Usami}=7{\cdot}6\text{ km.} \\ d_3=\text{distance between Kawana and Aziro}=11{\cdot}2\text{ km.} \end{cases}$$

$$\begin{cases} x_1=d_1=4{\cdot}0\text{ km. (Coordinates of Itô.)} \\ x_2=6{\cdot}75\text{ km},\ y_2=3{\cdot}50\text{ km. (Coordinates of Usami.)} \\ x_3=7{\cdot}94\text{ km},\ y_3=7{\cdot}90\text{ km. (Coordinates of Aziro.)} \end{cases}$$

$$k=\sqrt{\frac{339\cdot504}{-7\cdot94\,t_0^2+25\cdot54\,t_1^2-31\cdot60\,t_2^2+14\cdot00\,t_3^2}}. \qquad (1, \mathrm{II})$$

(III) Network (HKUA).

t_0(Hasima), t_1(Aziro), t_2(Kawana), t_3(Usami).

$\begin{cases} d_1=\text{distance between Hasima and Aziro}=7\cdot1\text{ km.} \\ d_2=\text{distance between Hasima and Kawana}=10\cdot4\text{ km.} \\ d_3=\text{distance between Hasima and Usami}=8\cdot8\text{ km.} \end{cases}$

$\begin{cases} x_1=d_1=7\cdot1\text{ km. (Coordinates of Aziro.)} \\ x_2=2\cdot5\text{ km, } y_2=10\cdot09\text{ km. (Coordinates of Kawana.)} \\ x_3=7\cdot56\text{ km, } y_3=4\cdot50\text{ km. (Coordinates of Usami.)} \end{cases}$

$$k=\sqrt{\frac{1186\cdot1703}{-25\cdot34\,t_0^2+65\cdot03\,t_1^2+31\cdot95\,t_2^2-71.64\,t_3^2}}. \qquad (1, \mathrm{III})$$

(IV) Network (HIUA).

t_0(Hasima), t_1(Aziro), t_2(Itô), t_3(Usami).

$\begin{cases} d_1=\text{distance between Hasima and Aziro}=7\cdot1\text{ km.} \\ d_2=\text{distance between Hasima and Itô}=10\cdot7\text{ km.} \\ d_3=\text{distance between Hasima and Usami}=8\cdot8\text{ km.} \end{cases}$

$\begin{cases} x_1=d_1=7\cdot1\text{ km.} \\ x_2=6\cdot23\text{ km, } y_2=8\cdot70\text{ km. (Coordinates of Itô.)} \\ x_3=7\cdot56\text{ km, } y_3=4\cdot50\text{ km. (Coordinates of Usami.)} \end{cases}$

$$k=\sqrt{\frac{776\cdot8089}{-7\cdot92\,t_0^2+37\cdot74\,t_1^2+31\cdot95\,t_2^2-61\cdot77\,t_3^2}}. \qquad (1, \mathrm{IV})$$

(V) Network (KIUH).

t_0(Kawana), t_1(Itô), t_2(Usami), t_3(Hasima).

$\begin{cases} d_1=\text{distance between Kawana and Itô}=4\cdot0\text{ km.} \\ d_2=\text{distance between Kawana and Usami}=7\cdot6\text{ km.} \\ d_3=\text{distance between Kawana and Hasima}=11\cdot2\text{ km.} \end{cases}$

$\begin{cases} x_1=d_1=4\cdot0\text{ km. (Coordinates of Itô.)} \\ x_2=6\cdot75\text{ km, } y_2=3\cdot50\text{ km. (Coordinates of Usami.)} \\ x_3=1\cdot20\text{ km, } y_3=10\cdot33\text{ km. (Coordinates of Hasima.)} \end{cases}$

$$k=\sqrt{\frac{176\cdot0368}{-38\cdot21\,t_0^2+65\cdot53\,t_1^2+41\cdot32\,t_2^2+14\cdot00\,t_3^2}}. \qquad (1, \mathrm{V})$$

A few words should be added here in regard to the nature of the Itô earthquake-swarms, the seismic activity of which, beginning generally with a slight earthquake, is followed almost without intermission during the next few hours by a countless number of shocks. During this time we actually see the tremors being continuously recorded on the seismograms. These continuous tremors often hindered accurate determination of the duration of the preliminary tremors. In the circumstances, notwithstanding the countless number of shocks recorded by instruments, in only a small per cent of them could we accurately determine the duration of the preliminary tremors. There were, however, 38 earthquakes during the few days both before and after the strong earthquake of March 22, in which accurate determination of the duration of the preliminary tremors was possible. The durations at five stations were determined in 10 of these 38 earthquakes, while for the remaining 28 earthquakes the durations were determined at four stations.

Table I shows the values of k and the networks of stations (Fig. 2) that were used in determining k.

Table I. Durations of the Preliminary Tremors and k.

No.	Time of occurrence	Duration of the preliminary tremors.					Net-work	k
		Kawana	Itô	Aziro	Hasima	Usami		
		sec.	sec.	sec.	sec.	sec.		km./sec.
1	III 17, $18^h 45^m$		1·45	2·00	1·85	1·60	IV	4·859
2	18, 2 11		1·50	1·95	1·85	1·55	〃	4·413
3	2 20		1·70	2·00	1·75	1·75	〃	5·100
4	2 46		1·55	2·05	1·95	1·70	〃	5·391
5	7 45		1·50	2·10	2·05	1·70	〃	5·412
6	19, 7 29		1·55	1·90	1·85	1·60	〃	5·290
7	7 34		1·55	1·90	1·85	1·60	〃	5·290
8	7 45		1·55	2·00	1·85	1·65	〃	4·893
9	8 00		1·55	1·90	1·85	1·55	〃	4·552
10	10 16	1·75	1·80	2·00	1·80	1·80	I	4·736
							II	5·308
							III	5·207
							IV	5·204
							V	5·095
11	17 12	1·60	1·60	1·90	1·80	1·60	I	5·255
							II	4·806
							III	4·820
							IV	4·763
							V	4·300
12	20, 10 30	1·55	1·70	2·30	2·10	1·90	I	5·430
							II	4·803
							III	4·851
							IV	4·776
							V	4·163
13	11 03	1·50	1·80	2·30	1·80		I	5·182

(to be continued.)

Table I. (*continued.*)

No.	Time of occurrence	Duration of the preliminary tremors.					Net-work	*k*
		Kawana	Itô	Aziro	Hasima	Usami		
	h m	sec.	sec.	sec.	sec.	sec.		km./sec.
14	16 45	1·60	1·60	1·90	1·80	1·60	I	5·255
							II	4·806
							III	4·820
							IV	4·763
							V	4·300
15	22 21	1·50	1·60	2·10	1·80	1·70	I	4·128
							II	4·351
							III	4·130
							IV	4·198
							V	4·773
16	21, 5 33	1·30	1·50	2·15	1·80	1·70	I	4·312
							II	4·413
							III	4·257
							IV	4·292
							V	4·470
17	8 40	1·50	1·50	2·20	2·20	1·70	I	4·901
							II	4·601
							III	4·564
							IV	3·531
							V	4·235
18	22 48	1·50	1·60	1·90	1·60	1·60	I	5·029
							II	4·448
							III	4·508
							IV	4·428
							V	3·902
19	23 24	1·60	1·60	2·20	2·10	1·75	I	4·113
							II	4·601
							III	4·259
							IV	4·387
							V	5·854
20	23 34	1·40		2·10	1·80	1·70	III	4·437
21	22, 16 20	1·40	1·40	1·80	1·70	1·40	I	5·072
							II	4·353
							III	4·470
							IV	4·356

(*to be continued.*)

Table I. (*continued.*)

No.	Time of occurrence	Duration of the preliminary tremors.					Net-work	k
		Kawana	Itô	Aziro	Hasima	Usami		
		sec.	sec.	sec.	sec.	sec.		km./sec.
21							V	3·677
22	22, 17 h 02 m	1·10	1·10	1·70	1·60	1·20	I	4·754
							II	4·571
							III	4·501
							IV	4·492
							V	4·328
23	17 03	1·30	1·40	1·70		1·40	II	4·732
24	18 30	1·50	1·55	1·80		1·55	II	5·123
25	23, 3 02	1·60	1·50	1·90		1·50	II	4·525
26	3 46	1·20	1·45	1·80		1·50	II	4·533
27	12 20	1·30	1·50	1·90		1·60	II	4·980
28	13 00	1·30	1·50	1·75		1·50	II	4·634
29	13 08	1·20	1·45	1·80		1·50	II	4·533
30	29, 3 50	1·30	1·50	2·00	1·65		I	5·219
31	4 04	1·55	1·70	1·80	1·65		I	4·969
32	4 07	1·40	1·45	1·80	1·60		I	5·063
33	5 10	1·30	1·40	1·80	1·60		I	5·970
34	30, 0 06	1·00	1·20	2·00	1·80		I	5·333
35	5 40	1·30	1·50	2·00	1·65		I	5·219
36	31, 11 14	1·35	1·40	1·90	1·75		I	4·948
37	IV 1, 12 17	1·30	1·40	2·20	1·90		I	4·338
38	23 04	1·35	1·50	1·90	1·85		I	5·128

It will be seen from this Table that k varies considerably with the particular network selected for its determination. In the 10 earthquakes in which the observations were made at five stations, k becomes 5·85 at maximum and 3·53 at minimum, while the differences between the values of k determined for each earthquake range between 0·21 and 1·74. All the values of k in Table I lie between 5·90 and 3·53.

An attempt was made to ascertain the relation between the focal depth and the values of k, but without success; no clear relation between these quantities could be found. It seems in order to state that there is no perceptible change in k within the limits of the focal depths now under consideration, and that the mean of the 85 values of k in Table I is applicable to the seismic triangulation of the Itô earthquakes now in question.

Seismic Triangulation of the Itô Earthquakes. As the mean of the 85 values of k shown in Table I came out as 4·70, we used the formula

$$D=4{\cdot}70\,t \tag{2}$$

for computing the focal distance.

In the case of a network of five stations there are ten different combinations of three stations, while in that of four stations there are four combinations. Thus, in the 10 earthquakes that were observed at five stations, 10 different positions of the seismic foci could be determined for each earthquake, and four different positions of the seismic foci for each of the earthquakes that were observed at four stations.

In determining the seismic foci, maps of scale 1/100,000 were used, on which the positions of the seismic foci are shown by the coordinates X', Y', Z; X', Y' being the coordinates of the epicentre and Z the focal depth. The directions of the X' and Y' axes are shown in Fig. 3. The coordinates of the seismic foci determined by the seismic triangulation are shown in Table II. (Triangles: *1*=KIU, *2*=KIA, *3*=KIH, *4*=KUA, *5*=KUH, *6*=KAH, *7*=IUA, *8*=IUH, *9*=IAH, *10*=UAH).

Table II. Seismic Foci of the Itô Earthquakes.

No.	Time of occurrence	Net-work	Seismic focus.			
			X'	Y'	Z	Mean X' Y' Z
			km.	km.	km.	km.
1	III 17, $18^h 45^m$	*7*	1·0	3·8	4·8	
		8	1·4	3·5	5·3	1·43
		10	1·7	3·6	5·5	3·60
		9	1·6	3·5	5·3	5·22
2	18, 2 11	*7*	2·7	3·4	6·1	
		8	2·2	3·8	5·7	2·20
		10	1·9	3·6	5·4	3·63
		9	2·0	3·7	5·6	5·70
3	2 20	*7*	0·1	5·4	4·4	
		8	1·1	4·5	5·8	1·05
		10	1·6	4·9	6·2	4·85
		9	1·4	4·6	5·9	5·58
4	2 46	*7*	0·1	4·4	4·2	
		8	1·4	3·3	5·9	1·38
		10	2·1	3·9	6·4	3·75
		9	1·9	3·5	6·0	5·63
5	7 45	*7*	0·1	3·9	4·3	
		8	1·5	2·8	6·0	1·45
		10	2·2	3·3	6·5	3·23
		9	2·0	2·9	6·1	5·73

(*to be continued.*)

Table II. (*continued.*)

No.	Time of occurrence	Net-work	Seismic focus. X′	Y′	Z	Mean X′ Y′ Z
	h m		km.	km.	km.	km.
6	19, 7 29	*7*	0·8	4·9	4·3	
		8	2·0	3·9	5·8	1·95
		10	2·6	4·4	6·2	4·30
		9	2·4	4·0	5·9	5·50
7	7 34	*7*	0·8	4·9	4·3	
		8	2·0	3·9	5·8	1·95
		10	2·6	4·4	6·2	4·30
		9	2·4	4·0	5·9	5·50
8	7 45	*7*	0·8	4·3	4·8	
		8	1·5	3·8	5·7	1·45
		10	1·8	4·0	5·9	3·98
		9	1·7	3·8	5·7	5·53
9	8 00	*7*	2·5	4·0	5·9	
		8	2·4	4·1	5·8	2·45
		10	2·4	4·1	5·8	4·08
		9	2·5	4·1	5·8	5·83
10	10 16	*1*	1·6	4·7	6·6	
		2	1·6	5·1	6·3	
		3	1·6	4·9	6·4	
		4	1·2	5·5	6·0	
		5	1·5	4·9	6·4	
		6	1·9	4·9	6·4	
		7	0·4	5·7	5·1	
		8	1·4	4·9	6·4	1·51
		9	1·9	5·0	6·5	5·09
		10	2·0	5·3	6·7	6·28
11	19, 17 12	*1*	2·0	4·3	5·8	
		2	2·0	4·5	5·7	
		3	2·0	4·3	5·9	
		4	2·0	4·6	5·7	
		5	2·1	4·3	5·8	
		6	2·2	4·3	5·8	
		7	1·7	4·7	5·4	
		8	2·0	4·3	5·9	2·05
		9	2·2	4·4	5·9	4·42
		10	2·3	4·5	6·0	5·79
12	20, 10 30	*1*	0·6	3·1	6·5	
		2	0·7	3·2	6·5	
		3	0·7	3·0	6·6	
		4	0·6	3·3	6·4	
		5	0·8	3·0	6·6	
		6	1·0	3·0	6·6	
		7	0·3	3·4	6·2	
		8	1·0	3·1	6·7	0·74
		9	1·0	3·1	6·7	3·14
		10	1·0	3·2	6·8	6·56
13	11 03	*2*	−0·7	4·4	5·5	
		3	−0·6	4·3	5·6	−0·58
		6	−0·5	4·3	5·6	4·33
		9	−0·5	4·3	5·7	5·79

(*to be continued.*)

Table II. (*continued.*)

No.	Time of occurrence	Net-work	Seismic focus. X'	Y'	Z	Mean X' Y' Z
	h m		km.	km.	km.	km.
14	20, 16 45	*1*	2·0	4·3	5·8	
		2	2·0	4·5	5·7	
		3	2·0	4·3	5·9	
		4	2·0	4·6	5·7	
		5	2·1	4·3	5·8	
		6	2·2	4·3	5·8	
		7	1·7	4·7	5·4	
		8	2·0	4·3	5·9	2·05
		9	2·2	4·4	5·9	4·42
		10	2·3	4·5	6·0	5·79
15	22 21	*1*	1·2	4·1	5·7	
		2	1·2	3·8	5·9	
		3	1·1	4·1	5·7	
		4	1·4	3·5	6·0	
		5	1·1	4·1	5·6	
		6	0·9	4·1	5·7	
		7	2·1	3·3	6·5	
		8	1·1	4·1	5·6	1·16
		9	0·8	4·0	5·5	3·88
		10	0·7	3·7	5·2	5·70
16	21, 5 33	*1*	0·5	3·6	5·0	
		2	0·4	3·5	5·0	
		3	0·4	3·6	4·9	
		4	0·6	3·2	5·1	
		5	0·5	3·5	5·0	
		6	0·4	3·5	5·0	
		7	1·1	3·1	5·7	
		8	0·5	3·6	4·9	0·50
		9	0·3	3·5	4·9	3·44
		10	0·3	3·3	4·7	5·02
17	8 40	*1*	2·0	2·3	6·3	
		2	2·0	2·3	6·3	
		3	2·0	2·2	6·4	
		4	2·1	2·3	6·4	
		5	2·1	2·2	6·4	
		6	2·1	2·2	6·3	
		7	2·3	2·2	6·5	
		8	2·2	2·3	6·4	2·09
		9	2·1	2·3	6·4	2·25
		10	2·1	2·3	6·3	6·30
19	22 48	*1*	1·1	5·1	4·8	
		2	1·1	4·9	4·9	
		3	1·1	4·8	5·1	
		4	1·3	4·8	5·0	
		5	1·3	4·8	5·0	
		6	1·3	4·8	5·0	
		7	1·8	4·6	5·5	
		8	1·4	4·8	5·1	1·30
		9	1·3	4·8	5·1	4·81
		10	1·3	4·7	5·0	5·05

(*to be continued.*)

Table II. (*continued.*)

No.	Time of occurrence	Net-work	Seismic focus.			
			X′	Y′	Z	Mean X′ Y′ Z
	h m		km.	km.	km.	km.
19	23 24	*1*	2·0	2·8	6·7	
		2	2·0	2·8	6·7	
		3	2·0	2·8	6·7	
		4	2·0	2·7	6·7	
		5	1·9	3·0	6·6	
		6	1·7	3·1	6·7	
		7	2·0	2·7	6·7	
		8	1·8	2·9	6·6	1·86
		9	1·6	2·9	6·5	2·85
		10	1·6	2·8	6·4	6·63
20	23 34	*4*	0·9	3·6	5·4	
		5	0·8	3·8	5·3	0·78
		10	0·7	3·7	5·2	3·73
		6	0·7	3·8	5·3	5·30
21	22, 16 20	*1*	2·0	4·4	4·4	
		2	2·0	4·1	4·7	
		3	2·0	4·0	4·8	
		4	2·3	3·9	4·8	
		5	2·2	4·0	4·8	
		6	2·2	4·0	4·8	
		7	3·0	3·7	5·4	
		8	2·4	4·1	4·9	2·23
		9	2·1	4·1	4·8	4·02
		10	2·1	3·9	4·6	4·80
22	17 02	*1*	2·0	3·6	3·1	
		2	2·0	3·6	3·2	
		3	2·0	3·6	3·2	
		4	2·1	3·5	3·2	
		5	2·1	3·6	3·1	
		6	2·0	3·6	3·2	
		7	2·4	3·4	3·5	
		8	2·1	3·6	3·2	2·07
		9	2·0	3·6	3·1	3·56
		10	2·0	3·5	3·0	3·18
23	17 03	*1*	1·3	5·0	2·3	
		2	1·3	5·0	3·3	1·25
		4	1·2	5·1	3·2	5·05
		7	1·2	5·1	3·0	2·95
24	18 30	*1*	1·6	4·7	5·0	
		2	1·6	5·0	4·7	1·33
		4	1·4	5·3	4·5	5·10
		7	0·7	5·4	3·5	4·43
25	23, 3 02	*1*	2·8	3·7	5·9	
		2	2·9	3·6	5·9	3·03
		4	3·0	3·4	6·0	3·50
		7	3·4	3·3	6·2	6·00
26	3 46	*1*	0·2	5·4	1·7	
		2	0·2	5·3	2·0	0·40
		4	0·4	5·1	2·5	5·20
		7	0·8	5·0	3·4	2·40

(*to be continued.*)

Table II. (*continued.*)

No.	Time of occurrence	Net-work	Seismic focus. X'	Seismic focus. Y'	Seismic focus. Z	Mean X' Y' Z
	h m		km.	km.	km.	km.
27	12 20	*1*	0·4	4·7	3·8	
		2	0·4	4·8	3·7	0·28
		4	0·4	4·9	3·6	4·85
		7	−0·1	5·0	2·7	3·45
28	13 00	*1*	0·5	5·6	2·3	
		2	0·4	5·5	2·6	0·58
		4	0·6	5·5	2·6	5·50
		7	0·8	5·4	3·1	2·65
29	13 08	*1*	0·5	5·6	2·3	
		2	0·4	5·5	2·6	0·58
		4	0·6	5·5	2·6	5·50
		7	0·8	5·4	3·1	2·65
30	29, 3 50	*2*	0·8	4·2	4·7	
		3	0·7	4·1	4·5	0·60
		6	0·4	4·1	4·5	4·17
		9	0·5	4·3	4·3	4·50
31	4 04	*2*	0·7	6·1	4·0	
		3	0·7	4·8	5·5	1·50
		6	2·2	4·6	5·2	5·20
		9	2·4	5·3	5·8	5·13
32	4 07	*2*	1·6	4·6	4·5	
		3	1·6	4·4	4·6	1·70
		6	1·8	4·4	4·6	4·47
		9	1·8	4·5	4·6	4·58
33	5 10	*2*	1·3	4·5	3·9	
		3	1·3	4·2	4·3	1·53
		6	1·7	4·1	4·2	4·28
		9	1·8	4·3	4·4	4·20
34	30, 0 06	*2*	0·8	3·0	3·5	
		3	0·8	2·7	3·7	0·93
		6	1·0	2·7	3·7	2·80
		9	1·1	2·8	3·9	3·70
35	5 40	*2*	0·5	4·3	4·4	
		3	0·5	4·1	4·5	0·60
		6	0·7	4·1	4·5	4·18
		9	0·7	4·2	4·6	4·50
36	31, 11 14	*2*	1·7	3·8	4·8	
		3	1·6	3·7	4·9	1·70
		6	1·7	3·7	4·9	3·75
		9	1·8	3·8	4·9	4·88
37	IV 1, 12 17	*2*	1·3	2·3	5·5	
		3	1·3	3·0	5·2	0·83
		6	0·4	3·1	5·2	2·80
		9	0·3	2·8	4·7	5·15
38	23 04	*2*	0·9	4·6	4·3	
		3	0·9	3·4	5·2	1·60
		6	2·2	3·3	5·0	3·78
		9	2·4	3·8	5·6	5·03

An examination of this Table shows that, even in the same earthquake, the positions of the seismic foci differ slightly from each other according to the triangle chosen in determining the seismic foci. The maximum difference in one direction component according to this Table is 1·9 km, whereas in most earthquakes the difference in the coordinates of the seismic foci does not exceed 1·0 km.

We determined the positions of the seismic foci at points, the coordinates of which have mean values X′, Y′, and Z as determined for each earthquake.

Stereometrical Distribution of the Seismic Foci. The distribution of the epicentres is shown in Fig. 3. In this Figure all the epicentres are seen grouped within a comparatively small area (6 km²). The centre of this area lies about 4 km north of Kawana.

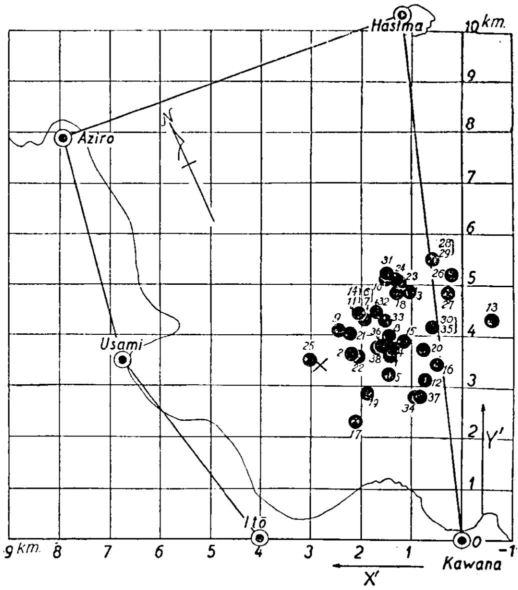

Fig. 3. Distribution of the epicentres of the Itô earthquakes for the period March 19～March 31, 1930.

Upon projecting all the foci on two vertical planes, one parallel to the Y' axis and the other to the X' axis, we get Figs.

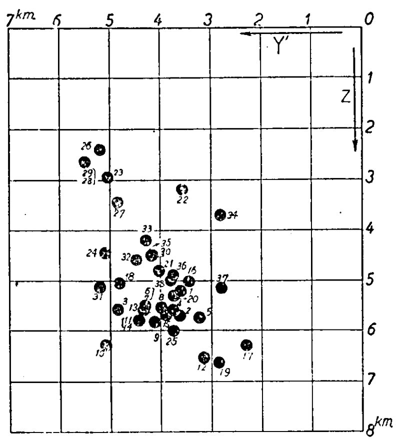

Fig. 4. Distribution of seismic foci on the $Y'Z$ plane.

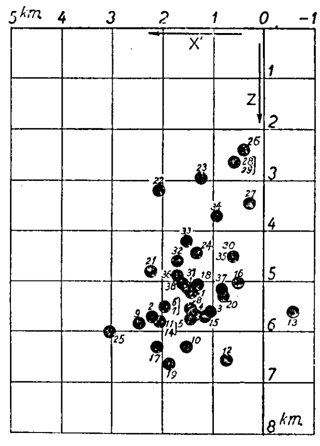

Fig. 5. Distribution of seismic foci on the $X'Z$ plane.

4 and 5. Roughly speaking, the seismic foci of the Itô earthquakes that occurred during the period now in question may be seen to be grouped on both side of a line dipping SW.

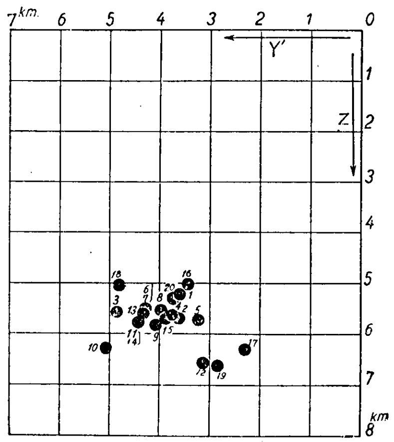

Fig. 6. Distribution on plane Y′Z.

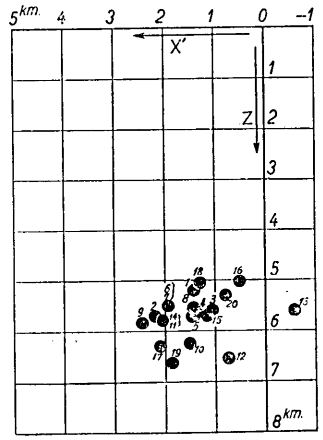

Fig. 7. Distribution on plane X′Z.

Distribution of the seismic foci of the shocks that occurred during the period March 19~March 22, 1930.

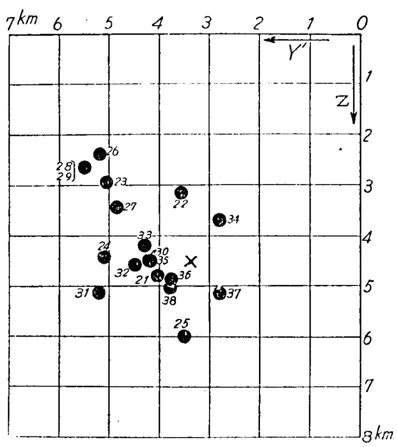

Fig. 8. Distribution on plane $Y'Z$.

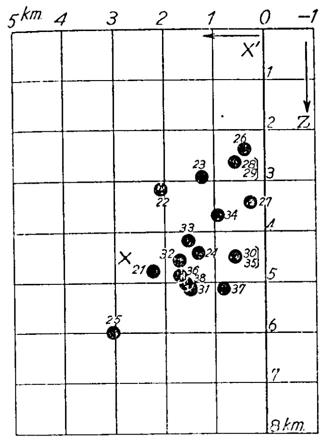

Fig. 9. Distribution on plane $X'Z$.

Distribution of the seismic foci of the shock that occurred during the period March 22~March 31, 1930.
(Cross: the strong earthquake of March 22, 17h 50m.)

To assist in illustrating the migration of the seismically active centre, we divided the seismic foci into two classes according to the time in which the earthquakes occurred. The distribution of seismic foci Nos. 1~20 on the plane $Y'Z$ and $X'Z$ are shown in Figs. 6 and

7, respectively. Although the seismic foci shown in Figs. 6 and 7 are distributed at depths greater than 5 km, upon projecting the foci of the shocks that occurred afterward, we see that all these seismic foci are distributed at depths less than 5·5 km (Figs. 8 and 9). The seismic focus of the strong earthquake of March 22 is indicated by crosses in the latter figures.

The position of this focus is determined with the triangle, Itô-Hasima-Aziro.

Observations of the Strong Earthquake of March 22, 1930.

Itô: Two horizontal components seismograph. The initial earthquake motion was roughly towards West. From the beginning the E. W. component motion was so large that the writing index was thrown out of the smoked paper during the preliminary tremors, whereas the N. S. component motion was smaller than the former and the duration of the preliminary tremors could be determined. But the writing index went out of the paper at the beginning of the main phase.

Initial motion=1,700 μ S, 3,400(?)μ W. Durat. prelim. tremor=1·25 sec.

Aziro: Two horizontal comonents seismograph. Initial motion=360 μ W'., 3,600 μ S'. (N'=N 34°W, E'=N 56°E) Direction of initial motion=S 28·3°E. Durat. prelim. termor=1·80 sec.

Hasima: N. S. component seismograph. As only one component seismograph was installed there, the exact direction of the initial motion could not be determined, but the component of the initial motion was towards the N. Durat. prelim. tremor=1·80 sec.

Usami: E. S. component seismograph. Initial motion was towards the W. Writing index went out of the paper about 0·5 sec. after the beginning.

Kawana: N. S. component seismograph. The writing index was thrown out towards S by the very first motion.

Seismic focus: $X'=2{\cdot}8$ km, $Y'=3{\cdot}4$ km, $Z=4{\cdot}5$ km.

From Figs. 6~9, it may be said that the seismic activity migrated upward immediately before the occurrence of the strong earthquake just mentioned, while after that most of the earthquakes occurred at places shallower than 5 km. If these earthquakes had been caused by the renewed activity of some dormant volcano, which is indeed likely, an upward intrusion of magma into the earth's crust about 5 km below the surface began about two hours before this strong earthquake was felt. The occurrence of this earthquake shifted the volcanic activity to a new region shallower than the old; a procedure quite imaginable in a volcanic eruption.

29. 伊豆半島に於ける最近の地震活動に就いて(第2報)

地震研究所 那 須 信 治

昭和5年2月より翌年1月に至る間の伊豆半島に發生したる群生地震の震原の立體分布に就いては，第1報さして地震研究所彙報第9號に概要を述べて置いた．其後震原決定の方法を改良し伊東地震の震原分布を再調査しその結果を本論文に書いたのである．

震原決定の方法は地震3點觀測の方法であるが距離係數 k は5箇の內より4箇宛の觀測點を組合せ得る場合には1の地震に就いて5通り求め得る．觀測點が4箇の場合には唯1の k の價を決定し得るこさは周知の事柄である．かく一つの地震に就いて求められた k の價には觀測網の選び方により多少差異あるこさを認めた．85 の k の價の平均は 4·70 さなり，これを用ひて3點觀測を行つた．

5箇の觀測點のある場合には3點宛を組合せるこさにより 10 通りの震原位置を1の地震に就いて求めるこさが出來，4箇の場合には4通りの震原位置を求めるこさが出來る．この樣にして求めたる幾通りかの震原位置を示す坐標 X', Y', Z の平均値を取つてその震原さしその分布を圖示した．

3月22日の強震に約2時間先立つて地震活動中心は5粁より淺い所に移り，更にこの強震によつて活動中心が全く淺い所に移動したこさが判明し，通常火山の噴火の經過に於いて想像し得る如き活動中心の上方移動を認めるこさが出來た．