

19. *On the Results of Repeated Precise Levellings around Idu Peninsula.*

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Introduction.

The peninsula of Idu, on the Pacific coast of Central Japan, was recently attacked by three successive seismic disturbances. The first one of them was due to the Kwantô earthquake of Sept. 1, 1923, the second due to the Ito earthquake swarms of 1930, and the third due to the North Idu destructive earthquake of Nov. 26, 1930. With the hope of detecting, if any, of the changes of land levels in the peninsula connected with these seismic disturbances, precise levellings have been repeated three times around the peninsula as well as in its neighbouring regions by the Land Survey Department of the Imperial Army. The results of these measurements were recently placed at our disposal which are the object of the present paper to discuss. The levelling route covered by these surveys is shown in Fig. 1 together with the ordinal numbers of the bench-marks in the route. The first levelling survey was made about 30 years ago, the second one immediately after the occurrence of the Kwantô earthquake of 1923 but before that of the Idu earthquake of 1930, and the third one after the occurrence of the last mentioned earthquake. These three surveys will be referred to in this paper as I, II, and III according as their chronological orders. The changes of heights of the bench-marks on the levelling route as found by means of these levellings are tabulated in the following tables. The changes of heights of the bench marks are graphically shown in Figs. 2, 7, and 10. Generally speaking, the peninsula has been dipping southwards, especially in the interval (III-II). Remarkable changes of heights of bench-marks are found at B.M. 9400 in Fig. 2, B.M. 55.1 in Fig. 7, and B.M. 9337 in Fig. 10. They will be discussed in detail in the following chapters.

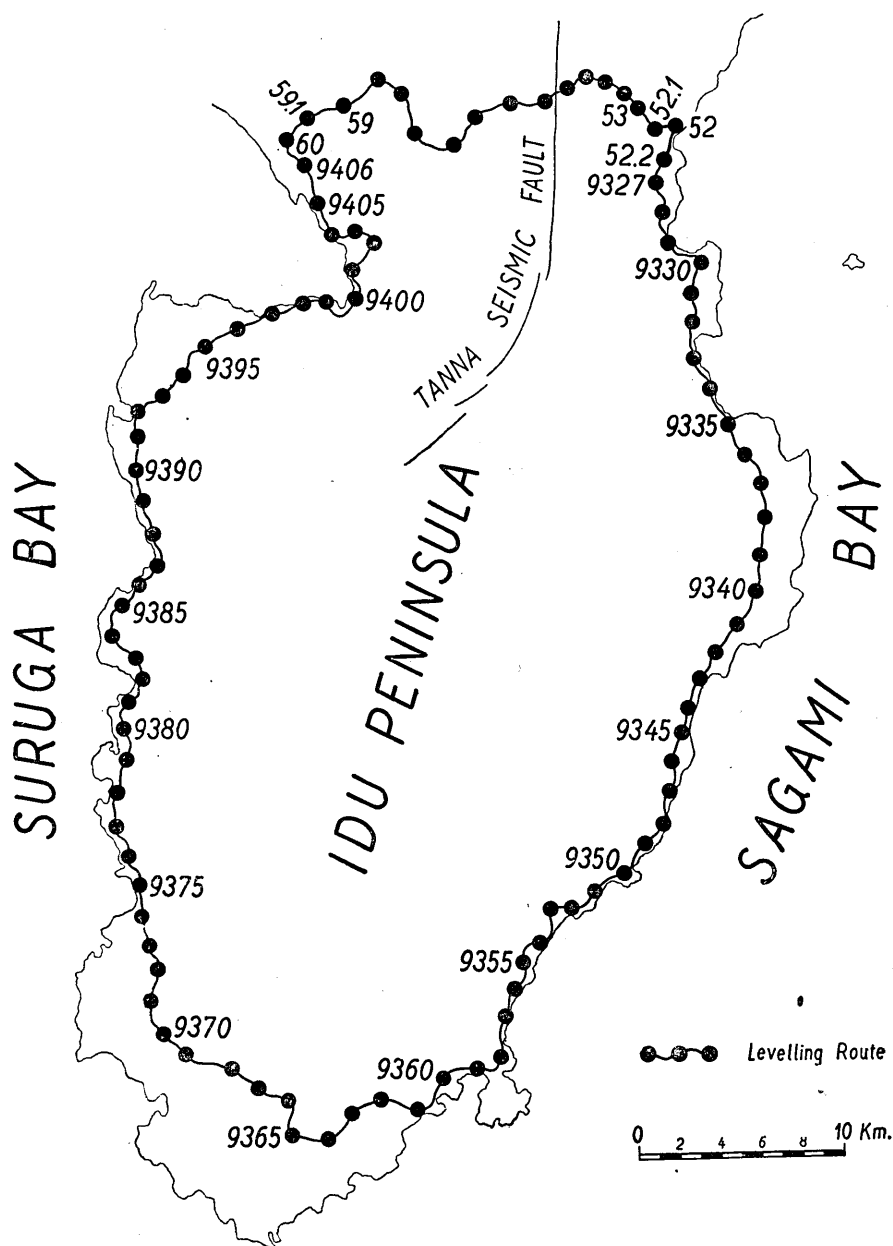


Fig. 1.
Levelling Route Around and Across Idu Peninsula.

Table I.
Change of Heights along the Western Coast of the Peninsula.

B. M.		I	II-I	II	III-II	III
			mm		mm	
60	Numadu	1903	- 84.3	1924	+ 17.0	Dec. 21, 25, 1930
9406		"	- 91.9	"	+ 14.2	" 20, 21
9405	Sisigahama	"	- 89.7	"	+ 20.2	" 20
9404		"	-114.2	1929	+ 27.8	" 18
9403		"	-109.0	"	+ 46.1	" 17, 18
9402		"	-110.1	"	+ 64.3	" 17, 19
9401		"	-106.9	"	+ 64.9	" 11, 12
9400	Mito	"	- 94.4	"	+ 74.6	" 12, 16
9399		"	-104.8	"	+ 61.6	" 14
9398		"	-113.6	"	+ 51.2	" 9, 10
9397	Kou	"	-126.0	"	+ 34.2	" 10, 12
9396		"	-125.7	"	+ 30.8	" 12, 14
9395		"	-101.7	"	+ 21.4	" 14, 18
9394		"	- 98.6	"	+ 19.2	" 20, 26
9393		"	-113.6	"	+ 12.5	" 17, 20
9392	Hata	"	-132.5	"	- 3.0	" 21, 23
9391		"	-114.3	"	+ 4.9	(Dec. 27, 1930,
9390		"	-125.1	"	- 1.8	Jan. 10, 1931
9389		"	-102.2	"	- 3.4	Jan. 4, 1931,
9388	Tohi	"	-113.7	"	- 12.3	" 2, 4
9387		"	-126.1	"	- 23.0	" 5
9386		"	-102.4	"	- 11.9	" 7
9385	Kosimoda	"	-101.4	"	- 8.8	" 8, 12
9384		"	- 99.2	"	- 8.3	" 12, 13
9383		"	- 96.0	"	- 4.5	" 14, 15
9382	Ukusu	"	- 84.5	"	- 15.7	" 16, 22
9381		"	- 91.6	"	- 14.2	" 18, 19
9380		"	- 88.1	"	- 10.0	" 18, 22
9379		"	- 79.5	"	- 10.4	" 14, 15
9378	Tago	"	- 76.0	"	- 13.3	" 11, 13
9377		"	- 86.6	"	- 14.8	" 15, 16
9376		"	- 80.8	"	- 17.3	" 17
9375		"	-110.3	"	- 19.9	" 5
9374	Matuzaki	"	- 92.5	"	- 20.5	" 2
9373	Iwasina	"	- 90.8	"	- 22.1	Dec. 28, 31, 1930
9372		"	- 83.5	"	- 23.4	" 28, 31
9371		"	- 72.8	"	- 29.8	Jan. 3, 7, 1931
9370	Zyaisi	"	- 78.6	"	- 28.7	Dec. 24, 26, 1930

Table II.
Change of Heights across the Tanna Seismic Fault.

B. M.		I	II-I	II	III-II	III
52	Atami	1896	mm + 43.5	1924	mm + 92.1	Dec. 10, 12, 1930
52.1			- 40.0		+ 89.1	
53			- 6.1		+101.4	
53.1			- 39.9		+ 94.5	
54			- 48.3		-	
54.1	Karuizawa	"	- 55.6	"	+ 47.7	" 23, 25
55			-		-132.8	" 26, 26
55.1			- 80.8		-197.8	" 26, 37
56			- 95.5		- 52.5	" 27, 31
56.1			- 77.9		- 7.7	Jan. 3, 1931
57	Hirai	"	- 74.0	"	+ 36.1	" 2, 5
57.1	Daiba	"	-125.6	"	- 0.6	" 2, 5
58	Misima	"	-110.1	"	- 10.6	" 7,
58.1		"	- 96.4	"	- 6.1	" 9,
59		"	- 88.6	"	+ 6.5	" 10, 11
59.1	Numadu	"	- 80.7	"	+ 19.5	" 12,
60			- 84.3		+ 17.0	

Table III.
Change of Heights along the Eastern Coast of the Peninsula.

B. M.		I	II-I	II	III-II	III
52	Atami	1903	mm + 43.5	1923	mm + 92.1	Dec. 9, 10, 1930
52.2			- 25.5		+ 72.7	
9327			+ 18.8		+ 58.0	
9328	Kamitaga	"	- 9.6	"	+ 69.0	" 12, 15
9329			- 33.2		+ 50.7	" 19, 20
9330			+ 88.0		+ 77.6	" 19, 20
9331	Azero	"	+ 57.5	"	+ 93.8	" 21, 25
9332			+ 52.0		+134.4	" 22, 24
						" 26, 27

(to be continued.)

Table III. (*continued.*)

B. M.		I	II-I	II	III-II	III
			mm		mm	
9333		1903	+ 31.5	1923	+ 168.0	Dec. 26, 27
9334		"	—	"	+ 210.5	" 26, 27
9335	Itô	"	— 6.8	"	+ 259.7	Dec. 28, 1930.
9336		"	— 9.6	"	+ 288.3	Jan. 2, 1931.
9337	Yosida	"	— 29.1	"	+ 292.5	Dec. 28, 31
9338		"	— 44.0	1924	+ 250.8	" 30, 31
9339	Sakihara	"	— 69.4	"	+ 193.0	Jan. 3, 15 1931
9340		"	— 63.1	"	+ 140.7	" 3, 15
9341	Yawatano	"	— 57.8	"	+ 97.2	" 4, 16
9342		"	— 51.8	"	+ 68.0	" 4, 13
9343		"	— 40.7	"	+ 54.3	" 5, 13
9344	Ookawa	"	— 34.3	"	+ 33.2	" 10, 11
9345		"	— 33.4	"	+ 30.2	" 17, 18
9346		"	— 33.4	"	+ 24.7	" 15, 18
9347	Katase	"	— 33.5	"	+ 16.9	" 11, 18
9348		"	— 36.1	"	+ 17.2	" 12, 13
9349	Inatori	"	— 31.5	"	+ 16.8	" 9, 12
9350		"	— 24.4	"	+ 11.1	" 5, 10
9351		"	— 26.5	"	+ 11.0	Dec. 30, 31, 1930
9352		"	— 25.6	"	+ 3.9	{ Dec. 28, 1930,
9353	Kôduhama	"	— 36.4	"	+ 0.6	{ Jan. 2, 1931
9354		"	— 42.3	"	+ 4.5	Dec. 27, 28, 1930
9355		"	— 35.8	"	+ 2.1	Dec. 26, 27, 1930
9356		"	— 32.4	"	+ 0.5	" 23, 26
9357	Sirahama	"	— 37.1	"	— 2.8	" 19, 22
9358		"	— 47.0	"	— 0.3	" 16, 17
9359	Simoda	"	—	"	— 5.7	" 14, 15
9360		"	— 47.4	1929	— 5.1	" 11, 13
9361		"	— 46.9	"	— 10.0	" 10
9362		"	— 48.6	"	— 12.3	" 10, 12
9363	Simogamo	"	— 51.1	"	— 17.5	" 12
9364		"	— 61.6	"	— 17.9	" 13
9365		"	— 67.9	"	— 21.9	" 13
9366		"	— 61.7	"	— 21.9	" 15
9367	Simoono	"	— 63.3	"	— 20.6	" 16, 18
9368		"	— 64.4	"	— 20.8	" 17
9369		"	— 69.2	"	— 30.0	" 17
9370	Zyaisi	"	— 78.6	"	— 28.7	" 18

The Results of the Levelling along the Western Coast of Idu Peninsula.¹⁾

The changes of heights of the bench-marks along the western coast of the peninsula are shown in Fig. 2. The curve (II-I) shows the

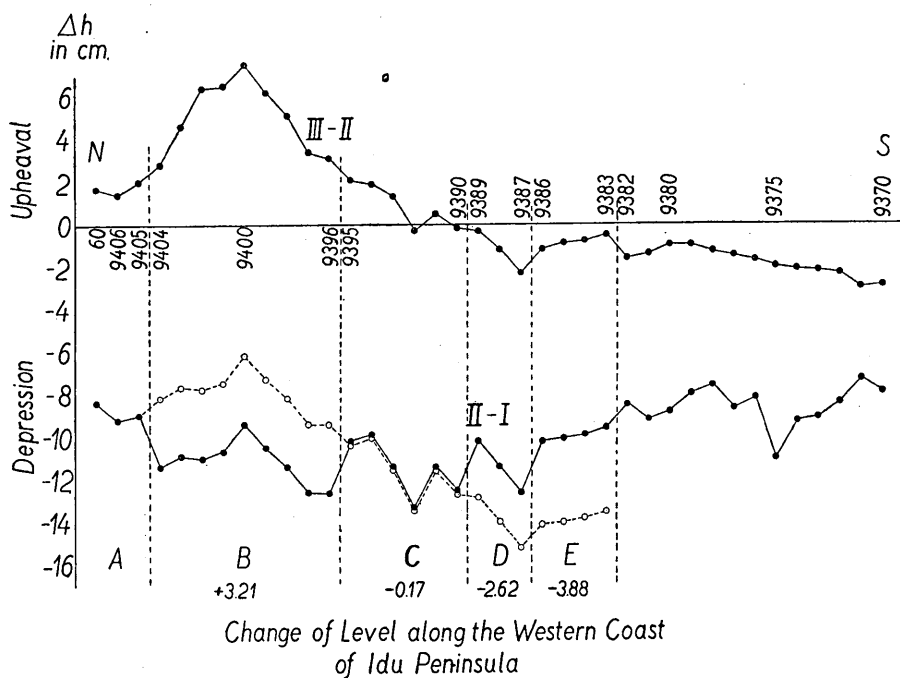


Fig. 2.

changes in the interval between II and I, while the curve (III-II) those in the interval between III and II. The former changes are to be regarded as mainly due to the effect of the earthquake of 1923 and the latter ones to that of the earthquake of 1930. If we compare these two curves, we find that a number of segments or portions such as A, B, C, D, and E that are quite similar in their forms for both curves are commonly involved in them. For the segment B, the form of the curve is very much characteristic. The levelling route from B.M. 9404 to B.M. 9396 corresponding to the segment B is not straight but goes winding as may be seen in Fig. 1, thus the peculiar form of the curves of Fig. 2 corresponding to the segment B may be produced purely as a geometrical effect even if the land

1) C. TSUBOI, *Proc. Imp. Acad.*, 7 (1931), 158.

between B.M. 9404 and B.M. 9396 is subjected to a single tilting as a whole. For the purpose of determining whether this is actually the case or not, the method due to my colleague Mr. N. Miyabe²⁾ is exclusively effective. If the land between B.M. 9404 and B.M. 9396 is assumed to have undergone a single tilting, then the difference of changes in heights of any two points lying on this land whose distance is of a unit length, must be a sinusoidal function of the directional azimuth of the line connecting these two points with respect to a definite reference direction, say E. The difference per unit distance of changes in heights in different azimuths may be obtained by dividing the difference of changes of heights of any two of the bench-marks between B.M. 9404 and B.M. 9396 by the distance between these marks. In Table IV will be given these quotients obtained for (II-I) and (III-II) together with the corresponding azimuths, distances, and differences in height changes.

2) N. MIYABE, *Proc. Imp. Acad.*, 7 (1931), 150.

Table IV.

Section B. Bench-Marks 9396; 9397; 9398; 9399; 9400; 9401; 9402;
9403; 9404.
Azimuth

From \ To	9396	9397	9398	9399	9400	9401	9402	9403	9404
9396	—	+25°	+23°	+15°	+12°	+27°	+32°	+41°	+46°
9397	-155°	—	+22°	+9°	+7°	+27°	+33°	+45°	+53°
9398	-157°	-158°	—	-4°	-1°	+30°	+37°	+53°	+64°
9399	-165°	-171°	+176°	—	+2°	+55°	+53°	+71°	+87°
9400	-168°	-173°	-179°	-178°	—	+94°	+72°	+90°	+107°
9401	-153°	-153°	-150°	-125°	-86°	—	+50°	+88°	+117°
9402	-148°	-147°	-143°	-127°	-108°	-130°	—	+139°	+162°
9403	-139°	-135°	-127°	-109°	-96°	-92°	-41°	—	-169°
9404	-134°	-127°	-16°	-93°	-73°	-63°	-18°	+11°	—

Distance in km.

From \ To	9396	9397	9398	9399	9400	9401	9402	9403	9404
9396	—	1.65	3.10	4.45	5.65	6.10	7.70	7.25	6.40
9397	1.65	—	1.50	2.85	4.05	4.40	5.90	5.70	4.90
9398	3.10	1.50	—	1.45	2.70	3.00	4.45	4.35	3.70
9399	4.45	2.85	1.45	—	1.25	1.95	3.50	3.75	3.40
9400	5.65	4.05	2.70	1.25	—	1.55	2.85	3.50	3.50
9401	6.10	4.40	3.00	1.95	1.55	—	1.50	1.95	2.00
9402	7.70	5.90	4.45	3.50	2.85	1.50	—	1.20	2.00
9403	7.25	5.70	4.35	3.75	3.50	1.95	1.20	—	2.00
9404	6.40	4.90	3.70	3.40	3.50	2.00	2.00	2.00	—

Difference of Change of Height for (II-I) in mm.

From \ To	9396	9397	9398	9399	9400	9401	9402	9403	9404
9396	—	+0.3	+12.1	+20.9	+31.3	+18.8	+15.6	+16.7	+11.5
9397	-0.3	—	+12.4	+21.2	+31.6	+19.1	+15.9	+17.0	+11.8
9398	-12.1	-12.4	—	+8.8	+19.2	+6.7	+3.5	+4.6	-0.6
9399	-20.9	-21.2	-8.8	—	+10.4	-2.1	-7.3	-4.2	-9.4
9400	-31.3	-31.6	-19.2	-10.4	—	-12.5	-15.7	-14.6	-19.8
9401	-18.8	-19.1	-6.7	+2.1	+12.5	—	-3.2	-2.1	-7.3
9402	-15.6	-15.9	-3.5	+7.3	+15.7	+3.2	—	+1.1	-4.1
9403	-16.7	-17.0	-4.6	+4.2	+14.6	+2.1	-1.1	—	-5.2
9404	-11.5	-11.8	+0.6	+9.4	+19.8	+7.3	+4.1	+5.2	—

Table IV.

Inclination for (II-I) in 10^{-6}

From \ To	9396	9397	9398	9399	9400	9401	9402	9403	9404
9396	—	+0.2	+3.9	+4.7	+5.5	+3.1	+2.0	+2.3	+1.8
9397	-0.2	—	+8.3	+7.4	+7.8	+4.3	+2.7	+3.0	+2.4
9398	-3.9	-8.3	—	+6.1	+7.1	+2.2	+0.8	+1.1	-0.2
9399	-4.7	-7.4	-6.1	—	+8.3	-1.1	-2.1	-1.1	-2.8
9400	-5.5	-7.8	-7.1	-8.3	—	-8.1	-5.5	-4.2	-5.7
9401	-3.1	-4.3	-2.2	+1.1	+8.1	—	-2.1	-1.1	-3.7
9402	-2.0	-2.7	-0.8	+2.1	+5.5	+2.1	—	+0.9	-2.1
9403	-2.3	-3.0	-1.1	+1.1	+4.2	+1.1	-0.9	—	-2.6
9404	-1.8	-2.4	+0.2	+2.8	+5.7	+3.7	+2.1	+2.6	—

Difference of Change of Height for (III-II) in mm.

From \ To	9396	9397	9398	9399	9400	9401	9402	9403	9404
9396	—	+ 3.4	+20.4	+30.8	+43.8	+34.1	+33.5	+15.3	- 3.0
9397	- 3.4	—	+17.0	+27.4	+40.4	+30.7	+30.1	+11.9	- 6.4
9398	-20.4	-17.0	—	+10.4	+23.4	+13.7	+13.1	- 5.1	-23.4
9399	-30.8	-27.4	-10.4	—	+13.0	+ 3.3	+ 2.7	-15.5	-33.8
9400	-43.8	-40.4	-23.4	-13.0	—	- 9.7	-10.3	-18.5	-46.8
9401	-34.1	-30.7	-13.7	- 3.3	+ 9.7	—	- 0.6	-18.8	-17.1
9402	-33.5	-30.1	-13.1	- 2.7	+10.3	+ 0.6	—	-18.2	-36.5
9403	-15.3	-11.9	+ 5.1	+15.5	+18.5	+18.8	+18.2	—	-18.3
9404	+ 3.0	+ 6.4	+23.4	+33.8	+46.8	+17.1	+36.5	+18.3	—

Inclination for (III-II) in 10^{-6}

From \ To	9396	9397	9398	9399	9400	9401	9402	9403	9404
9396	—	+ 2.0	+ 6.6	+ 7.0	+ 7.8	+ 5.6	+ 4.4	+ 2.2	- 0.4
9397	- 2.0	—	+11.4	+ 9.6	+10.0	+ 7.0	+ 5.0	+ 2.0	- 1.4
9398	- 6.6	-11.4	—	+ 7.2	+ 8.6	+ 4.6	+ 3.0	- 1.2	- 6.4
9399	- 7.0	- 9.6	- 7.2	—	+10.4	+ 1.6	+ 0.8	- 4.2	-10.0
9400	- 7.8	-10.0	- 8.6	-10.4	—	- 6.0	- 3.6	- 5.2	-13.4
9401	- 5.6	- 7.0	- 4.6	- 1.6	+ 6.0	—	- 0.4	- 9.6	- 8.6
9402	- 4.4	- 5.0	- 3.0	- 0.8	+ 3.6	+ 0.4	—	-15.2	-18.2
9403	- 2.2	- 2.0	+ 1.2	+ 4.2	+ 5.2	+ 9.6	+15.2	—	- 9.2
9404	+ 0.4	+ 1.4	+ 6.4	+10.0	+13.4	+ 8.6	+18.2	+ 9.2	—

The results given in Table IV are shown graphically in Figs. 3 and 4. As a matter of fact, the points in the figures are distributed approximately on a sine-curve whose equations are

$$y = 1.''8 \sin (50^\circ - \alpha) \quad \text{for (II—I)}$$

$$y = 3.''5 \sin (50^\circ - \alpha) \quad \text{for (III—II)}$$

(II—I)

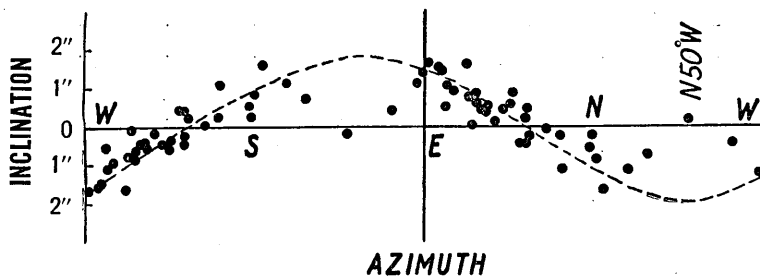


Fig. 3.

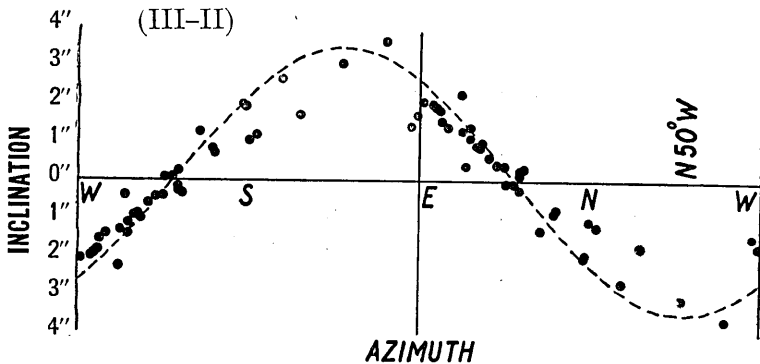


Fig. 4.

This is evidently a proof that the land between B.M. 9404 and B.M. 9396 underwent for both intervals (II—I) and (III—II), a tilting as a whole making a movement what we call a block movement. The tilting was evidently down towards N 50° W for both cases and it was about 2'' and 3.5'' in its amount for the former and latter intervals respectively. It is interesting that the directions of the tiltings were just the same for both of the intervals. For other sections of the levelling routes, such as A, C, D, and E, the tiltings were similarly calculated. The results of these calculations are summarised in Tables V, VI, VII, VIII and some of them are graphically shown in Figs. 5 and 6.

Table V.

Section A. Bench Marks, 60; 9405; 9406.

Azimuth

From \ To	9405	9406	60
9405	—	111°	116°
9406	—69°	—	122°
60	—64°	—58°	—

Inclination for (II-I) in 10^{-6}

From \ To	9405	9406	60
9405	—	— 1.2	+ 1.5
9406	+ 1.2	—	+ 4.8
60	— 1.5	— 4.8	—

Direction of Tilting: N 70° E

Magnitude of Tilting: 4"

Inclination for (III-II) in 10^{-6}

From \ To	9405	9406	60
9405	—	— 3.2	— 0.9
9406	+ 3.2	—	+ 1.8
60	+ 0.9	— 1.8	—

Direction of Tilting: N 60° E

Magnitude of Tilting: 4"

Table VI.

Section C. Bench Marks, 9390; 9391; 9392; 9393; 9394; 9395.

Azimuth

From \ To	9390	9391	9392	9393	9394	9395
9390	—	84°	89°	66°	60°	59°
9391	— 96°	—	95°	54°	50°	51°
9392	— 91°	— 85°	—	26°	33°	41°
9393	—114°	—126°	—154°	—	43°	50°
9394	—120°	—130°	—147°	—137°	—	55°
9395	—121°	—129°	—139°	—130°	—125°	—

Table VI.

Inclination for (II-I) in 10^{-6}

From \ To	9390	9391	9392	9393	9394	9395
9390	—	+ 6.8	— 2.6	+ 2.9	+ 5.1	+ 3.4
9391	— 6.8	—	— 14.6	+ 0.3	+ 4.2	+ 2.3
9392	+ 2.6	+ 14.6	—	+ 9.5	+ 10.9	+ 6.4
9393	— 2.9	— 0.3	— 9.5	—	+ 10.7	+ 3.8
9394	— 5.1	— 4.2	— 10.9	— 10.7	—	— 1.7
9395	— 3.4	— 2.3	— 6.4	— 3.8	+ 1.7	—

Direction of Tilting N 60° W, Magnitude of Tilting 4.5°

Inclination for (III-II) in 10^{-6}

From \ To	9390	9391	9392	9393	9394	9395
9390	—	+ 4.2	— 0.4	+ 3.6	+ 4.0	+ 3.3
9391	— 4.2	—	— 6.3	+ 3.1	+ 3.6	+ 2.9
9392	+ 0.4	+ 6.3	—	+ 7.9	+ 7.2	+ 5.1
9393	— 3.6	— 3.1	— 7.9	—	+ 4.8	+ 2.8
9394	— 4.0	— 3.6	— 7.2	— 4.8	—	+ 1.2
9395	— 3.3	— 2.9	— 5.1	— 2.8	— 1.2	—

Direction of Tilting N 70° W, Magnitude of Tilting 2.75°

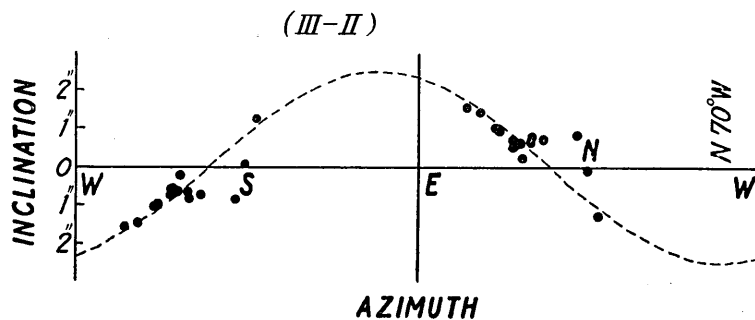


Fig. 5.

Table VII.

Section D. Bench Marks, 9389 ; 9388 ; 9387.

Azimuth

From \ To	9389	9388	9387
9389	—	—74°	—77°
9388	106°	—	—81°
9387	103°	99°	—

Inclination for (II-I) in 10^{-6}

From \ To	9389	9388	9387
9389	—	—7.2	—7.6
9388	+7.2	—	—7.8
9387	+7.6	+7.8	—

Direction of Tilting: S 20° W

Magnitude of Tilting: 2'

Inclination for (III-II) in 10^{-6}

From \ To	9389	9388	9387
9389	—	—5.6	—6.2
9388	+5.6	—	—6.7
9387	+6.2	+6.7	—

Direction of Tilting: S 40° W

Magnitude of Tilting: 2'

Table VIII.

Section E. Bench Marks, 9386 ; 9385 ; 9384 ; 9383.

Azimuth

From \ To	9386	9385	9384	9383
9386	—	—132°	—120°	— 96°
9385	48°	—	—109°	— 77°
9384	60°	71°	—	— 46°
9383	84°	103°	134°	—

Table VIII.

Inclination for (II-I) in 10^{-6}

From \ To	9386	9385	9384	9383
9386	—	+ 0.7	+ 1.1	+ 1.8
9385	— 0.7	—	+ 1.4	+ 2.1
9384	— 1.1	— 1.4	—	+ 2.1
9383	— 1.8	— 2.1	— 2.1	—

Direction of Tilting: N 30° WMagnitude of Tilting: 0.4

(II-I)

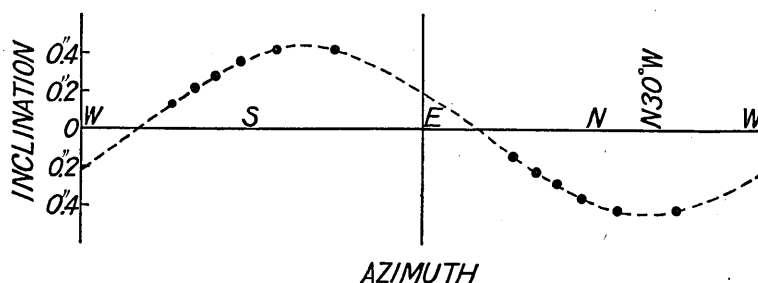


Fig. 6.

Inclination for (III-II) in 10^{-6}

From \ To	9386	9385	9384	9383
9386	—	+ 2.1	+ 1.2	+ 2.0
9385	— 2.1	—	+ 0.3	+ 1.7
9384	— 1.2	— 0.3	—	+ 2.5
9383	— 2.0	— 1.7	— 2.5	—

Direction of Tilting N 30° WMagnitude of Tilting 0.5

We have now determined the extents of land blocks which respectively underwent a tilting as a whole. We can find another evidence of the existence of such more or less rigid land blocks in the results of the repeated levellings here. If we displace in Fig. 2, the sections B, C, D, and E in the lower curve (II—I) along the vertical axis by 3.21 cm., -0.17 cm., -2.62 cm., and -3.88 cm. respectively, we have the curve in Fig. 2 that is shown in dotted lines. The curve obtained in this way is evidently

similar to the upper curve (III—II) in its form. Thus it is concluded that these land blocks were subjected to independent vertical movements simultaneously with the tilting movements. The facimile of such movements may be visualised by an aggregate of wooden blocks floating side by side on a disturbing water surface. From B.M. 9382 south down, no evidence of block movements is apparent and this is rather a striking contrast with the structure of the northern part of the levelling route, on which the evidence of block movements is so pronounced.

Results of the Levelling across the Tanna Seismic Faults.

The change of land levels along this route is shown in Fig. 7. At the time of the earthquake of Nov. 26, 1930, a system of remarkable seismic faults was produced in the northern part of the peninsula in approximately NS trend. The fault was about 30 km. in length and crossed the levelling route from B.M. 52 to B.M. 60 between the bench-marks 55 and 55.1. The land to the east of the fault was displaced northwards relative to the land to the west of it, the amount of the dislocation being about 100 cm. as measured on the surface of the ground. The new seismic fault was right along the well-known Tanna tectonic line. The vertical movement along the recent seismic fault was not simple but of a type of a hinge, the western block, relative to the eastern one being depressed at the northern part of the fault whereas elevated at the southern part. The movement in the neighbourhood of the fault was, so far as the levelling is concerned, of a V-shaped depression. It is to be noted that a movement somewhat similar to the recent one may be found in the neighbourhood of the fault in the interval between the first and second levellings which includes in it the event of the Kwantô earthquake of 1923. Prof. A. Imamura has long emphasised

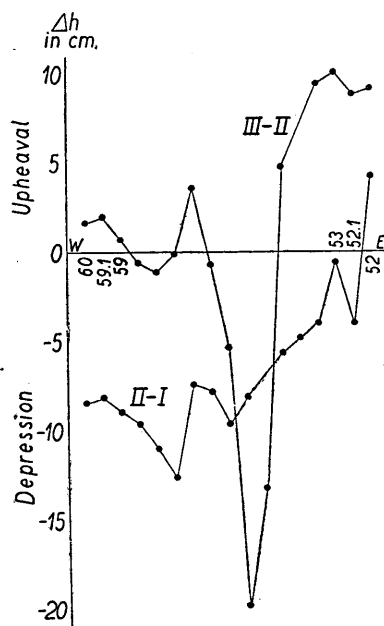


Fig. 7.
Change of Level across the Tanna
Seismic Fault

that there are at least two types in the movement at a fault found by means of levelling, the one he called N-type, and the other V-type, according to the similarity in forms of the profile of the change of land levels to these characters. The present case for the Tanna fault may correspond to the category of V-type. In this route, the tilting of land blocks were also determined similarly as in the preceding chapter. The

Table IX.

Bench Marks 59.1 ; 59 ; 58.1 ; 58 ; 57.1 ;
Azimuth

From \ To	59.1	59	58.1	58	57.1
59.1	—	20°	29°	13°	-9°
59	-160°	—	40°	8°	-23°
58.1	-151°	-120°	—	-35°	-55°
58	-167°	-172°	145°	—	-69°
57.1	-171°	+157°	125°	111°	—

Inclination for (III-II) in 10^{-6}

From \ To	59.1	59	58.1	58	57.1
59.1	—	-6.1	-6.2	-6.1	-3.6
59	+6.1	—	-6.3	-6.1	-1.9
58.1	+6.2	+6.3	—	-3.0	+1.6
58	+6.1	+6.1	+3.0	—	+2.4
57.1	+3.6	+1.9	-1.6	-2.4	—

Direction of Tilting N 50° E

Magnitude of Tilting 1."5

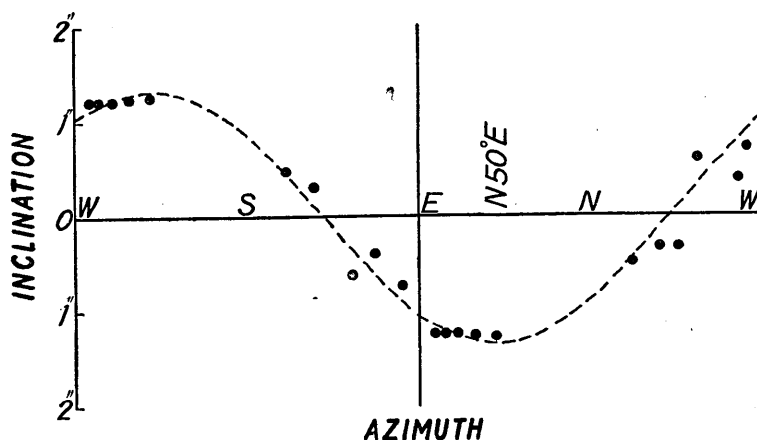


Fig. 8.

Table X.
Bench-Marks 57 ; 56.1 ; 56 ; 55.1.

		Azimuth			
From \ To		57	56.1	56	55.1
57		—	47°	36°	30°
56.1		-133°	—	23°	21°
56		-144°	-157°	—	18°
55.1		-150°	-159°	-162°	—

Inclination for (III-II) in 10^{-6}

From \ To	57	56.1	56	55.1
57	—	-24.4	-25.3	-45.4
56.1	+24.4	—	-27.1	-54.4
56	+25.3	+27.1	—	-78.6
55.1	+45.4	+54.4	+78.6	—

Direction of Tilting S 50° E

Magnitude of Tilting 28"

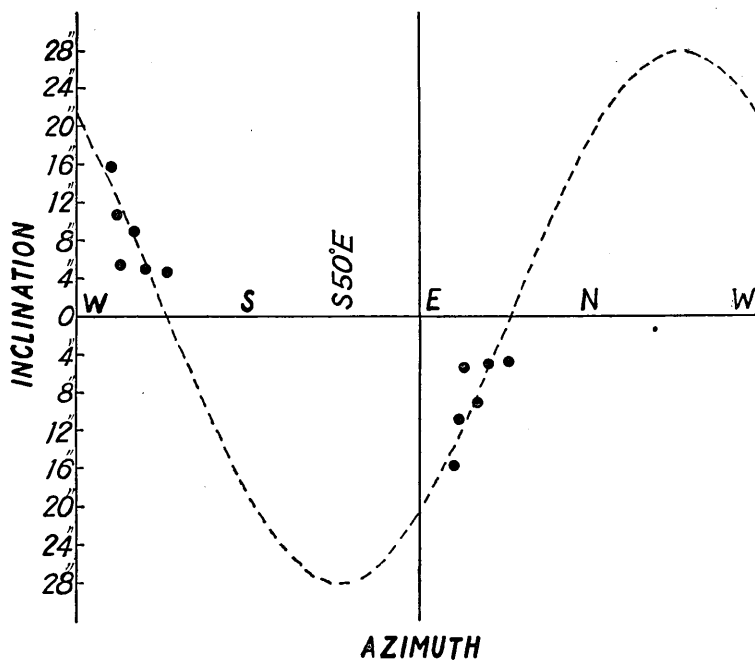


Fig. 9.

results of the calculations are shown in Tables IX and X. The results of these calculations are shown in Figs. 8 and 9.

The Results along the Eastern Coast of the Peninsula.

The change of land levels along the eastern coast of the peninsula is shown in Fig. 10. The results of the levellings along this route were

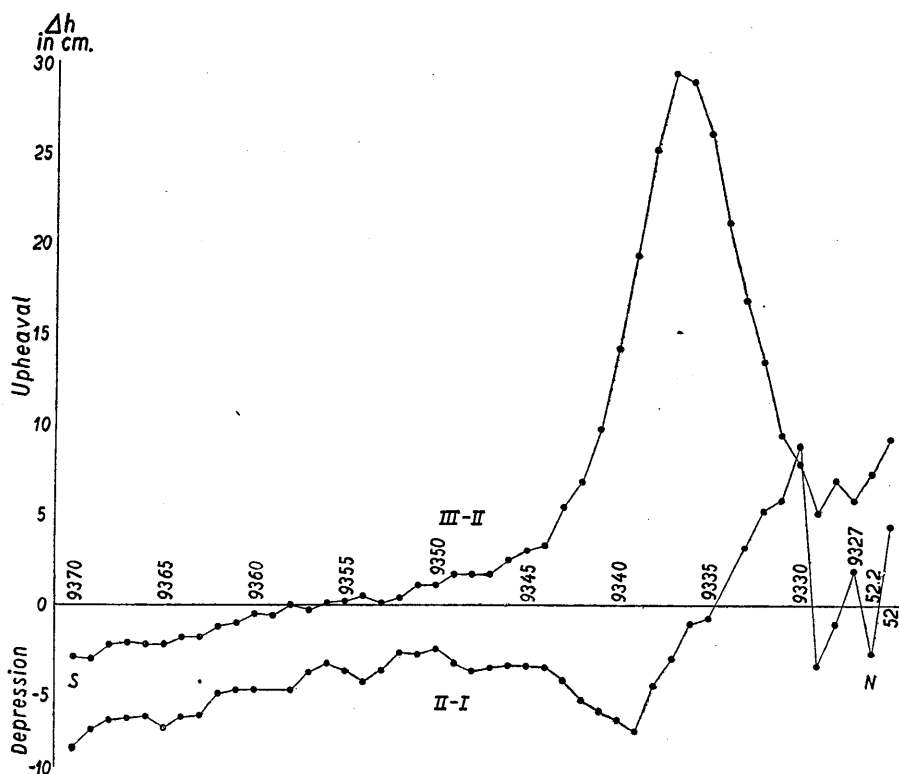


Fig. 10.

Change of Level along the Eastern Coast of Idu Peninsula.

already discussed in the writer's previous papers.³⁾ In this section it is to be noted that the movement of the earth's crust that occurred in the interval between the first and second levellings is decidedly different from what occurred in the interval between the second and third levellings.

3) C. TSUBOI, *Proc. Imp. Acad.*, 7 (1931), 153; *Bull. Earthq. Res. Inst.*, 9 (1931), 151.

Idu Earthquake of 1930 and Tilting of Land Blocks.

The writer has often pointed out⁴ the block-structure of the outer part of the earth's crust especially in earthquake districts. These individual land blocks seem to move apparently independently, yet their movements must be in some order when viewed as a whole. We have here a good example of such a case. We have determined the directions and magnitudes of tilting of land blocks in the northwestern part of the peninsula. They are shown by arrows in Fig. 11. A remarkable feature is at once apparent that the arrows change the directions clockwise as we go from the southern blocks to the northern. This shows that the land as a whole was twisted like a plate. As was described in one of the preceding chapters, the relative vertical displacement along the Tanna seismic fault was of a type of a hinge. This can be regarded now as a natural consequence of the twisting deformation of the earth's crust to the west of the fault.

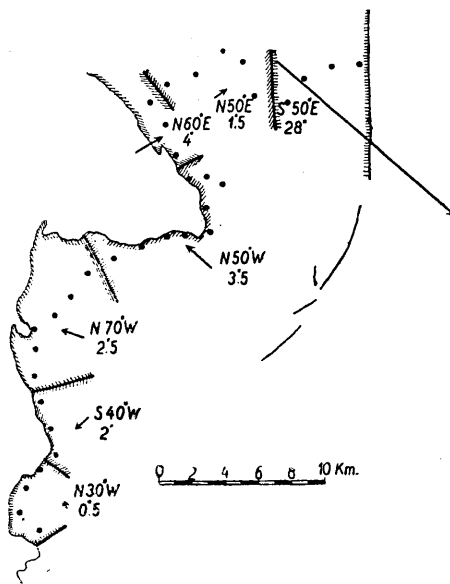


Fig. 11.

In conclusion the writer wishes to express his sincere thanks to Professor T. Terada for his interests in this work and also to Mr. N. Miyabe for his kind advices. Thanks are also due to the Land Survey Department of the Imperial Army for placing the results of the survey at our disposal.

4) C. TSUBOI. *Bull. Earthq. Res. Inst.*, 6 (1929), 71; 7 (1929), 103; 8 (1930), 153; *Proc. Imp. Acad.*, 4 (1928), 529.

19. 伊豆半島に於ける水準測量の結果に就いて

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伊豆半島の周圍に沿つた水準測量は既に三度も繰返されたが、此の論文は夫等の結果に就いて若干の考案を加へたものである。特に昭和五年十一月二十六日の北伊豆地震によつて生じたと信ぜらるゝ垂直變動に就いては稍詳細に吟味をなした。宮部理學士が考案した方法に従つて地塊の大きさ、傾斜の方向、及び其の量等を定めて見た。その内稍大切な結果と思はれるのは次の二點である。即ち第一は、伊豆半島西海岸北部に於いては地塊構造が著しいが、南部には之が認められないと云ふ事である。第二は伊豆半島西海岸北部に於ける地塊を全體から大きい目で見ると、大體に於いて北の方では東下りの傾斜であり、南の方では西下りの傾斜であつて、宛も此の近傍の地殻が振れたかの如き觀を與へる事である。北伊豆地震に關聯した丹那斷層は、北方では西が東に對して相對的に沈降し、南方では反對に上昇してゐると報ぜられたが、之も斷層の西側の地殻の振れを考へると其の自然の結果と看做す事が出来る。
