17. *The Geomorphology of the Kano-gawa Alluvial Plain, the Earthquake Fissures of Nov. 26, 1930, and the Pre- and Post-seismic Crust Deformations.*

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Introduction.

After the seismic disturbance of Nov. 26, 1930, which severely damaged northern Idu and the southern part of Mt. Hakone, a number of papers[1] appeared on the geology and geomorphology of the disturbed region, together with papers on geophysics.[2] Among the host of questions

1) a. Central Meteorological Observatory, "Kita-Idu Disin Gaihô", (Preliminary Report of Northern Idu Earthquake), (1930).

b. Central Meteorological Observatory, "Kita-Idu Disin Hôkoku," (Report of Northern Idu Earthquake), (1930).

c. T. OGAWA, "Idu Disin ni okeru Diban-hendô ni tuite", (Dislocations of the Idu Earthquake, Nov. 26th, 1930), *Cikyû*, 15, 1 (1931).

d. Y. KIMIZUKA, "Idu Disin Tôsaki", (Research Trips to the Regions of the Idu Earthquake), *Cikyû*, 15, 1 (1931).

e. R. TAYAMA, "Kita-Idu Disin to Tisitukôzô to no Kwankei", (Relations between northern Idu earthquake and the geologic structure), *Report of Saitôhôonkwai*, 11 (1931).

f. R. TAYAMA and H. NIINO, "Idu-hantô Tisitu Gaihô", (Preliminary report of the geology of Idu peninsula), *Report of Saitôhôonkwai*, 13 (1931).

g. K. IHARA and K. ISHII, "Kita-Idu Disin Tiiki no Tikei oyobi Tisitu", (On the topography and geology of the meizoseismal area of Idu earthquake), *Tigaku-zassi*, 43 (1931), 513.

h. K. IHARA and K. ISHII, "Kita-Idu Disin Tiiki no Tihen", (Terrestrial disturbances in the meizoseismal area of the Idu earthquake), *Tigaku-zassi*, 43 (1931), 514.

2) a. N. NASU, F. KISHINOUYE, and T. KODAIRA, "Recent Seismic Activities in the Idu Peninsula", *Bull. Earthq. Res. Inst.*, 9, 1 (1931).

b. A. IMAMURA, "Kita-Idu Ôdisin no keisokugakuteki Kenkyû," (Seismometric study of the recent destructive N. Idu earthquake), *Bull. Earthq. Res. Inst.*, 9, 1 (1931).

c. T. TERADA and N. MIYABE, "On Heterogenous Distributions of Houses Destroyed by Earthquake", *Proc. Imp. Acad.*, 7, 4 (1931).

d. C. TSUBOI, "A Note on the Results of the Repeated Precise Levellings across the Itô Earthquake Area," *Bull. Earthq. Res. Inst.*, 9, 2 (1931).

e. C. TSUBOI, "On the Results of Repeated Precise Levellings around Idu Peninsula," *Bull. Earthq. Res. Inst.*, 9, 3 (1931).

that this earthquake has raised, what geologists and geomorphologists would in particular like to have answered are: What are the relations between the earthquake fissures and the geology and geomorphology of this disturbed region? What connections have the earthquake fissures with the crustal displacements as revealed by levellings made both before and after the catastrophe?; and what relations have the crustal displacements that went on during the last 35 years with the present geomorphological features?

From the tectonic point of view, the Idu Peninsula, which projects into Sagami Bay, in the bottom of which Bay were located the epicenters of the great Kwantô earthquake of Sept. 1, 1923, is situated on the southern part of Naumann's *fossa magna*, where the early Pliocene strata were severely disturbed, and between the two geotectonic lines of Itoigawa-Siduoka and Nirasaki-Suntô. Many volcanoes of the Hudi (Fuji) volcanic group which are connected with these geotectonic lines are distributed in this peninsula. Geologically speaking, the basement complex of the peninsula is built up of igneous and also pyroclastic Neogene rocks. After they had been deposited, these pyroclastic formations were deformed into complicated structures by crustal movements during late Tertiary[3] and were sculptured into more or less rugged reliefs by subaerial denudation. After that, these regions suffered in part through transgression of the lowest Peistocene. On these reliefs the early Quaternary volcanoes, such as Atami,[4] Yugawara,[5] Hakone,[6] and Amagi[7] became active, in the order named, with numerous block movements.

Then the basal reliefs that were sculptured in the late Tertiary were thickly covered with the younger volcanic materials (lava and ashes), and were changed into smooth reliefs (e.g., western slope of Tan'na,[8] Tanakayama[9] Forest, etc.) which contrast strongly with the older reliefs, which are destitute of younger volcanic material (e. g., Kanuki-yama,[10] Tokura-yama,[11] Wasidu-yama,[12] etc.). Pl. XXI, Fig. 1.

The recent fluviatile erosion that dissected these two reliefs, both rugged and smooth, made some erosion valleys filled with young fluviatile deposits of the Kano-gawa,[13] the Kise-gawa,[14] and others. The Kano-gawa Alluvial plain is a plain composed of these young fluviatile materials.

It is worth noting that although the severely shaken regions of the

3) Y. ÔTUKA, *Bull. Earthq. Res. Inst.*, 9, 3 (1931).
4) 熱海. 5) 湯河原. 6) 箱根. 7) 天城. 8) 丹那. 9) 田中山. 10) 香貫山.
11) 戸倉山. 12) 鷲頭山. 13) 狩野川. 14) 黄瀬川.

Idu earthquake of 1930 consist of these younger formations, the area of the older reliefs of basement complex were hardly scarred by any marks of disturbance.

The writer believes that two distinct aggregations of geologic forces were at work in bringing about that Idu earthquake, one being the forces that were responsible for the formation of the complicated Tertiary structures and the other the forces that were responsible for the distribution of the volcanoes of the Hudi (Fuji) volcanic group. It is unfortunate that hardly any study worthy of the name has been made of this region by Japanese geologists, with the result that there is very little data for the study of the Idu earthquake from the geological side. In these circumstances Professor S. Tsuboi, Ass't Professor H. Tsuya, Mr. H. Kuno, and the writer, all members of the Institute, are now occupied with the geological survey of the region, so that the results of their geologic studies of the Idu earthquake should be available at no distant date.

In this paper will be discussed the tectonic relations of the most recent topography—the Alluvial plain—to the ground disturbances and to the pre- and post-seismic crustal displacements in the Kano-gawa Alluvial plain.

The writer takes this opportunity of thanking the members of the Earthquake Research Institute, the Military Land Survey, the Central Meteorological observatory, Tôkyô, and others for prompt publication of their reports on the Idu earthquake, for by means of these reports his field studies were greatly assisted and facilitated.

Geomorphology of the Kano-gawa Alluvial Plain (Pl. XX)

The Misima fan. The equatorially elongated coastal plain, Ukisima-gahara,[15] that fringes the southern foot of Mt. Hudi and Mt. Asitaka,[16] is a very young plain of deposition, so young in fact that not long while ago it was only a lagoonal region. Therefore this young plain may be young Alluvium, contemporaneous with the Sitamati plain of Tôkyô, i.e., the writer's geomorphological plain A_{II}.[17] In that case it is the young deposit that covers the foot of Mt. Hudi.

The southeastern base of Mt. Hudi converges southward and develops a beautiful fan-shaped slope towards the south as far as Misima[18] and Numadu,[19] through the narrow part where the base of Mt. Hudi and that

15) 浮島ヶ原. 16) 愛鷹山.
17) Y. Ôtuka, "Daisiki" (The Quaternary), *Iwanami Kôza.*
18) 三島. 19) 沼津.

of Mt. Asitaka come close to that of Mt. Hakone. This fan-shaped slope is the "Misima Fan."

The materials composing this fan are mostly wastes derived from Mt. Hudi, such as lava flows, ashes, etc. To the writer, intercalation of lava flows with other materials is of no importance in dealing with the large topography of the fan, for the reason that distribution of lava flows does not point to any geomorphological anomalies. (The destroyed houses in the town of Misima were in alignment with these lava flows).[20] The geologic age of the Misima fan is then contemporaneous with or slightly later than that of the coastal plain, Ukisimagahara, although the boundary of the latter is so concordant that no definite line of demarcation can be drawn between them.

The boundary of the fan may be traced from Higasinôdô[21], in the village of Kaneoka-mura,[22] through the northern foot of Kanuki-yama, where the surface of the fan touches the Wasidu mountainland, with discordant boundaries, to Tanita,[23] south-east of Misima town. The boundaries along which run two rivers, Kise-gawa and Sakai-gawa,[24] from the vertex of the fan to both margins, are topographically discordant with the base of Mt. Asitaka on the west and that of Mt. Hakone on the east.

According to Mr. Murata,[25] the special character of the surface contours of the fan is such that the form of the fan is not likely to be affected by the presence at its front, or toe, of any obstacle, even a mountain. If this is so, then the theory of upwarping of the crust will have to be invoked in order to explain the Misima fan, which has a greater southward convexity of contour line than a normal fan.

Rivers on the Fan. The fan is dissected by incisive meandering rivers having a depth of 10 m. As stated by Mr. Murata, their courses are straight from the vertex to the front of the fan. Two of them, the Sakai-gawa and Tama-gawa,[26] turn southwest-ward in their lower courses, where the slope of the fan disappears. The Kise-gawa meanders incisively and excavates laterally in its lower course. It confluxes with the Kano-gawa at the front of the fan, where the Kano-gawa had

20) T. TERADA and N. MIYABE, *Proc. Imp. Acad.*, 7, 4 (1931), 146.

21) 東能堂. 22) 金岡村. 23) 谷田. 24) 境川.

25) T. MURATA, "Theoretical Consideration on the Forms of Alluvial Fans," *Geogr. Rev.*, Japan, 7, 7 (1931).

T. MURATA, "Relation between the Form of an Alluvial Fan and its Marginal Topography," *Geogr. Rev.*, Japan, 7, 8 (1931).

26) 玉川.

dissected it previously; and where the peculiar southward convexity of the contour lines of the fan are exhibited.

Alluvial plain near Daiba.[27] The Kano-gawa Alluvial plain between the Wasidu mountainland and the Tanaka-yama Forest, as shown in Pl. XX, gradually slopes down northward to the southern part of the Kakizawa river,[28] which drains the Tan'na basin; while on the northern side of the river its slope rises to the north and passes into the Misima fan with a concordant boundary. The meandering Kano river, whose course antedates the Misima fan, runs past the fan along the boundary between the Wasidu mountainland and the Alluvial plain to the northwest in a direction opposite to that shown by the contours of the Alluvial plain.

The Alluvial plain near Daiba and the Hatake[29] Hot Springs are parts of the Kano-gawa that were dammed up by the Misima fan and the Wasidu mountainland, so that geologically it is younger than the Misima fan. The plains near Daiba, especially Misono[30] and Simo,[31] Nakasato-mura,[32] Nirayama-mura,[33] and Oohira-mura,[34] being the lowest parts of this region, are subject to floods during the rainy season, with the result that the crust here is weak due to settling of insufficient deposits. Should, however, the width of the valley be proportional to its depth, then the Alluvial deposits may be thicker than has been supposed, although it is only an inference based on the foregoing assumptions, boring being the only way to decide the point. The incised meander courses, as already shown, may have been caused by the very gentle grade of the river floor.

Summarising now what has been said, the Misima fan is a peculiar fan, being intercalated with lava flows. Its topographic characters, however, agree well with the results of Murata's study. One peculiarity that never fails to strike the observer is the greater convexity of its contour lines near the course of the Kise-gawa. The Alluvial plain near Nakasato-mura and Nirayama-mura is a younger plain than the surface of the Misima fan, with a weak crust.

Ground Disturbances of the Alluvial Plain.

For convenience the ground disturbances of the Alluvial plain have been grouped by locality as follows: (1) Matoba, Simidu-mura[35];

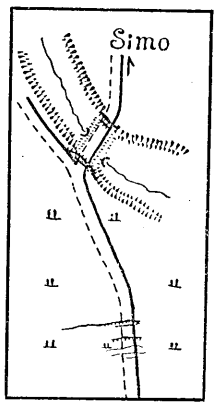
27) 大場. 28) 柿澤川. 29) 畑毛. 30) 御園. 31) 下. 32) 中郷村.
33) 韮山村. 34) 大平村. 35) 清水村的場.

Nagahusi and Simo, Nakasato-mura ;[36] (2) Nitta, Kan'nami-mura ;[37] (3) Yatumizo and Akô, Nakasato-mura ;[38] (4) Idunagaoka railway station, Nirayama-mura,[39] and Kona, Kawanisi-mura.[40]

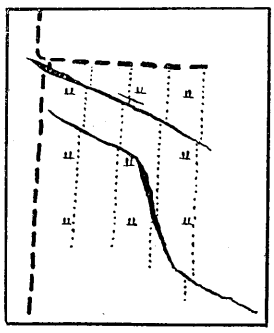
(1). Matoba, Simidu-mura, and Nagahusi and Simo, Nakasato-mura. Nagahusi and Matoba were severely damaged but no trace of any ground disturbances could be found except near Matoba, where water spurted from a small earthquake fissure. Southeast of these villages many earthquake fissures were noticed on the Alluvial plain. The sense of these fissures seemed to agree with those of the crust deformations that were measured after the earthquake. Fig. 1, Pl. XXI, shows their distribution.

(a). Across a small road connecting Simo and Misono, small parallel fissures ran N. 80°E. The largest one measured 120 m. in length (Pl. XXII, Fig. 2). Its horizontal and vertical displacements were small. A little north of these fissures were many small ones at the junction of the bed rock and a bank of soil, where the road crosses a small valley. These fissures, or *rifts* as they will be called, must be distinguished from true earthquake fissures. It is notable, as will be seen later, that these rifts occur at the junction of two or more formations having different crust strengths (text fig. a).

(b). A group of large rifts (text fig. b and Pl. XXII, Fig. 4) appears 100 m. east of locality (a), where a path 1 metre wide, and crossed by these rifts, has been displaced 1/3 metre horizontally, but not vertically. This group consists of two large ones and some smaller ones, the larger one of which is traceable for about 200 m. in a N. 65°W.-N. 20° W.-N. 65° W. direction, having the shape of the letter "Z", but with the stem of the letter slanting in the opposite direction. The ground on the southern side of this rift had shifted 1/3 m. westward, relatively to its northern side (Pl. XXIII, Fig. 5). The shorter rift runs N. 60° W. Its displacement is in the same sense as that of the larger rift just mentioned. Paddy



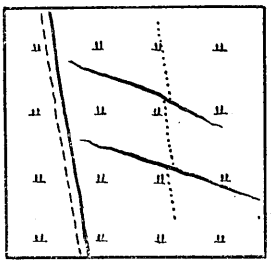
Text fig. a.


Text fig. b.

36) 中郷村長伏、下. 37) 函南村仁田. 38) 中郷村八満、赤王. 39) 韮山村伊豆長岡.
40) 河西村古奈.

field dykes that were formerly straight and ran parallel, N-S, were severed and thrown out of alignment about 1/3 m. by the earthquake rifts, the southern side towards the west and the northern side towards the east.

(c). In a dry rice-field along the road just mentioned, and 200 m. south of locality (b), we also find earthquake rifts, which however do not extend as far as the road but run N. 60° W. across the rice-field dykes. Their displacements are the same as those last mentioned (text fig. c, Fig. 3, Pl. XXII). These three groups of earthquake rifts show very small displacements, vertically or laterally.



Text fig. c.

(2). Nitta, Kan'nami-mura. On the Sundu Railway line,[41] about 800 m. north of Idunitta station, appears a group of parallel rifts. These rifts, which ran roughly N. 70° E., had bent and even cut the track rails. The ground between these parallel rifts, which were broken and discontinuous lines, had subsided and tilted like a small *graben*, or a small fault angle basin. To a slight extent horizontal shiftings occurred in all directions. Fig. 6, Pl. XXIII shows the rifts with their positions in line with the direction of the said horizontal displacement, while Figs. 7–10 show other examples.

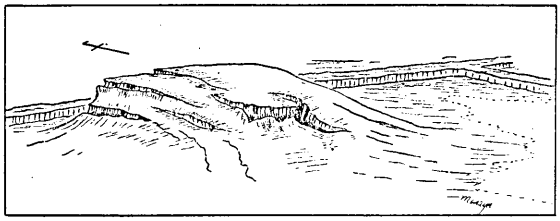
(3). Yatumizo and Akô, Nakasato-mura The mouth of the Akô valley was disturbed in such a way as to appear that the Alluvial deposits which filled this valley had slid down south- or south-westwards. On the southern side of the small spur of the valley that pushes out westwards (Fig. 2, Pl. XXII), the Alluvial deposits slid down southward carrying the railway track about 1 m. south-ward with it, while the ground on the eastern side of the part that had slid was raised relatively about 1/3 m. by a local rift in a N-S direction, (Fig. 11, 12, Pl. XXIV) and formed a meridionally elongated depression between an elongated swell, or elevation, in the same direction and the western slope of the spur (Fig. 2, Pl. XXI). These features resembles that of the landslide in Niigata Prefecture as described by Mr. T. Tokuda.[42]

At *d* in Fig. 2, Pl. XXI, will be seen two domed swells in the rice fields, 300 m. S.S.E. of *a* in Fig. 2, Pl. XXI. (Fig. 13, 14, Pl. XXV). These elevations have a diameter of about 5 m., with a depression between

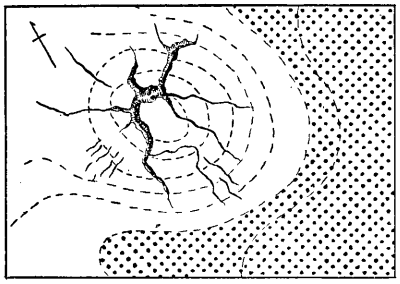
41) 駿豆鐵道.

42) T. Tokuda, *Geogr. Rev.*, Japan, 3, 5 (1927), 371–381.

them in which water has accumulated. The slope of the dome on the north-east is gentle on its south-western side but steep on the side opposite to it. It appears as if the ground had thrusted from the south-west. See text fig. *d*. The dome to the south-south-east, which is elliptical, has not the steep slope of the one just described, as shown in plan in text fig. *e*. These swells are about 1 m. high.



Text fig. d.



Text fig. e.
(Drowned area is dotted.)

(4). Nagaoka railway station, Nirayama-mura, and Kona, Kawanisi-mura. The earthquake rifts near Nagaoka station on the Sundu railway are on a small scale. Ground water spurted out from a few of them. Their trends are N. 60°W. or N. 40°W. According to Mr. Tanahashi,[43] who studied these earthquake rifts in detail, those near Nanzyô[44] and Kona run N. 40° E. and may be traced for about 100 m.

The conclusion from the foregoing is that the distribution of disturbances indicates the presence of a tectonic zone as marked by a group of rifts on the way from Simo through Nitta and Yatumizo to Akô. It is possible that there are other tectonic centers of earthquake rifts near Nagaoka railway station besides the zone just mentioned.

The foregoing practically covers all the earthquake rifts on the Alluvial plain that were observed by the writer. As to the possible objection that some rifts might have escaped detection, the writer is confident that even should this objection turn out to be not unfounded, it will not adversely affect any future studies that may be based on the inferences stated in the preceding pages.

Disturbances on the Alluvial Plain. The disturbances on the Alluvial plain are divided as follows:

(1). Disturbances caused by differential "strength of crust"; e.g., Kona, Nirayama Matiya,[45] Nanzyô, Hatake, and Tada.[46]

43) TANAHASHI, *Umi to Sora*, 11, 3 (1931).
44) 南條. 45) 町屋. 46) 多田.

(2). Disturbances caused by differential strength of rocks in the Alluvium; e.g., Misima-mati.

(3). Disturbances caused by the terrestrially disturbed zone; Daiba, Matoba, Nagabusi, Yatumizo, Idunagaoka station.

(4). Disturbances the causes of which are still unknown.

Ground Disturbances and Crust Deformations, Pre- and post-Seismic Disturbances associated with the earthquake of Nov. 1930, and the Geomorphology of the Alluvial Plain.

Soon after the Idu earthquake of 1930, precise levellings and triangulations were repeated by the Military Land Survey (Fig. 15). The results of these measurements were recently discussed by Mr. C. Tsuboi[47]

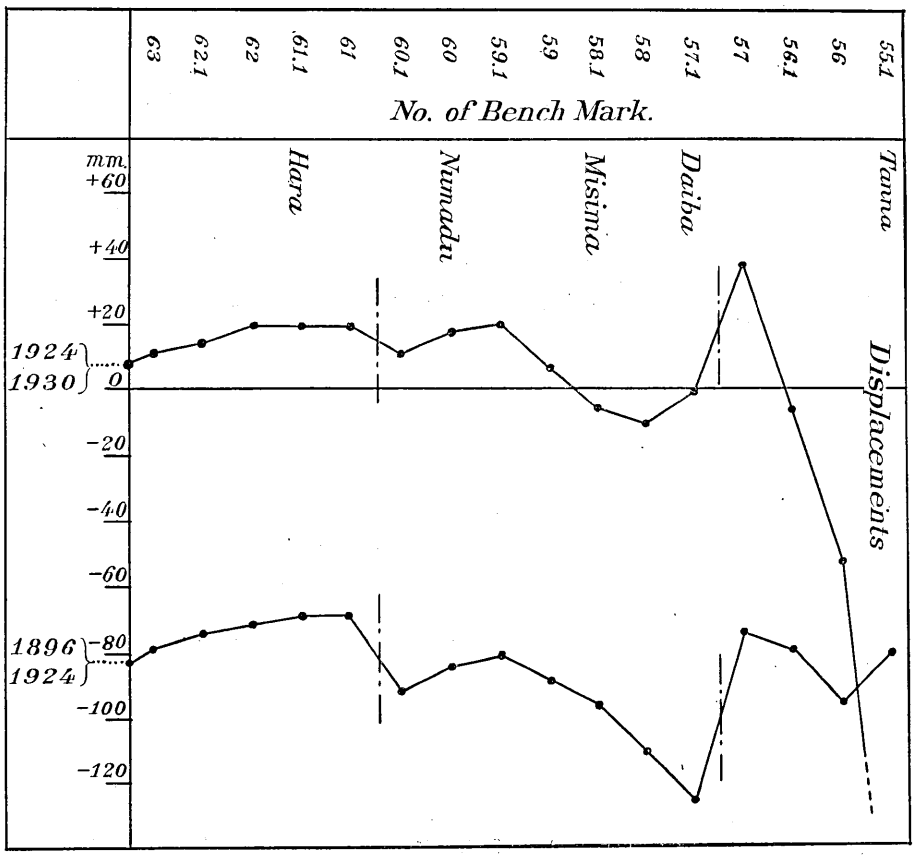


Fig. 15.

47) C. Tsuboi, *Bull. Earthq. Res. Inst.*, 9 (1931), 271-290.

in this bulletin. According to him, in the Kano-gawa Alluvial plain there are block boundaries between bench-marks Nos. 57 and 57.1, between Nos. 59 and 59.1, and between Nos. 9404 and 9405. The mean displacement that occured between bench marks Nos. 57 and 57.1 during the period between 1896 and 1924, as measured in 1924, is smaller than that for the period between 1924 and 1931, during which last period occurred the Idu earthquake. This means that if the pre-seismic change had occurred at a uniform rate, then it is equivalent to the acute changes associated with the 1930 earthquakes. The inferred tectonic zone as previously described, crosses the levelling route between bench-marks No. 57 and No. 57.1, where Mr. C. Tsuboi has marked the boundary line of blocks.

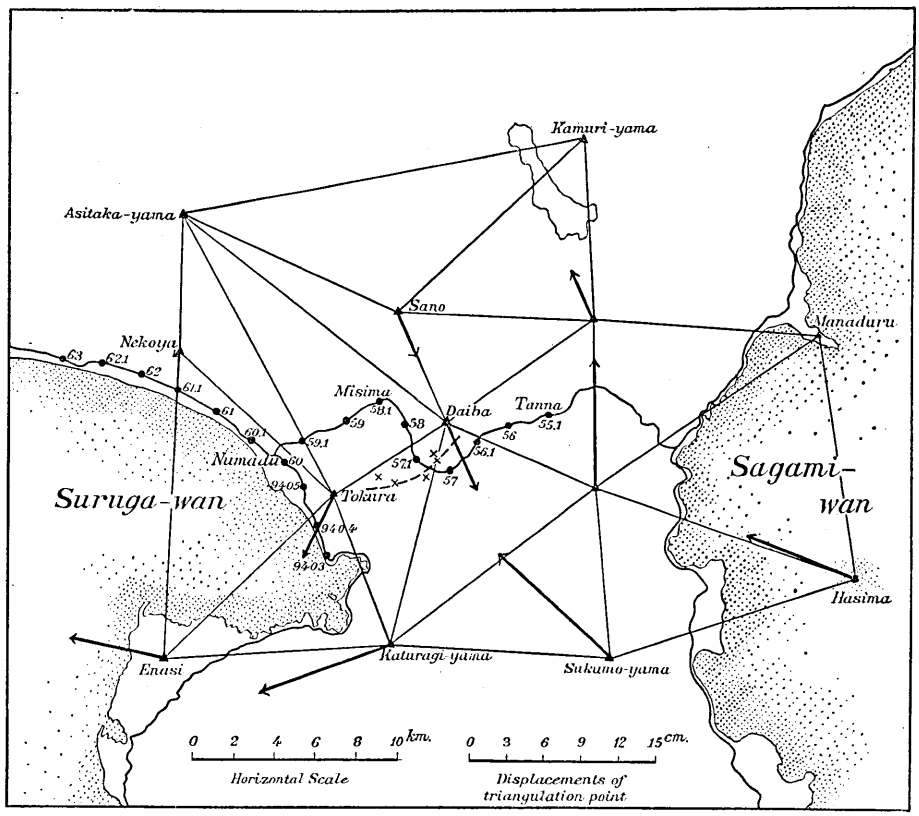


Fig. 16. Levelling route and displacements of triangulation point.

According to the same investigator, post-seismic displacements of bench-marks between No. 57.1 and No. 58 show tilting of the block towards N. 50° E. This tilting is not inconsistent with the ground disturbances near Akô, referred to above. Record of displacements for the past 35 years show tilting of the block farther to the southeast, and it is seen to enhance the grade of the Misima fan. The displacements during 36 years of bench-marks Nos. 57.1, and 58, 58.1, 59, 59.1, and 60 show an anticlinal warping. This is not inconsistent with the sense shown by the peculiar convexity of the contour line of the Misima fan. According to Mr. C. Tsuboi again, there is a block boundary between bench-mark Nos. 59.1 and 60, but it may be regarded as an earth flexure.

From these considerations it will be seen that on the Kano-gawa Alluvial plain, at any rate, the topography, and the pre- and post-seismic crust deformations and the ground disturbances associated with the Idu earthquake 1930 are closely related to one another.

As for the triangulation points indicate distortions of the Alluvial plain. The displacements of the earthquake rifts may be explained by shear action owing to the distortion (Fig. 16).

Conclusions.

As has been stated, the geomorphology of the Kano-gawa Alluvial plain and the pre- and post-seismic crustal displacements as revealed by surveys, and also the ground disturbances associated with the Idu earthquake of Nov. 30, 1930 are all closely connected with one another. The slight anomalies that have been encountered in studying these problems from the standpoint of geomorphology may safely be interpreted as manifestations of the action of certain hidden forces at work under the earth's crust. Several ground disturbances of the Alluvial plain which are apt to be ignored are closely related to the results that were brought to light by precise levelling and triangulations.

The line that connects the ground disturbances of Simo, Nitta, Yatumizo, and Akô may be a tectonic line hidden under the surface. It is worth noting that the south-western end of a tectonic line, regarding which Assistant Professor T. Tsujimura and Mr. Okayama had a discussion at the last annual meeting of the Geological Society of Tôkyô, coincides with the north-eastern end of this tectonic line at Akô.

As for the ground disturbances near the Idunagaoka railway station, the writer has no explanation to offer; and in the circumstances earnestly hopes for the speedy laying of a levelling route over the Simoda highway through Nirayama-mura.

17. 狩野川沖積層地域の地形と昭和五年十一月二十六日伊豆地震の際にその地域に生じた地變及び地殻變形との關係

地震研究所 大 塚 彌 之 助

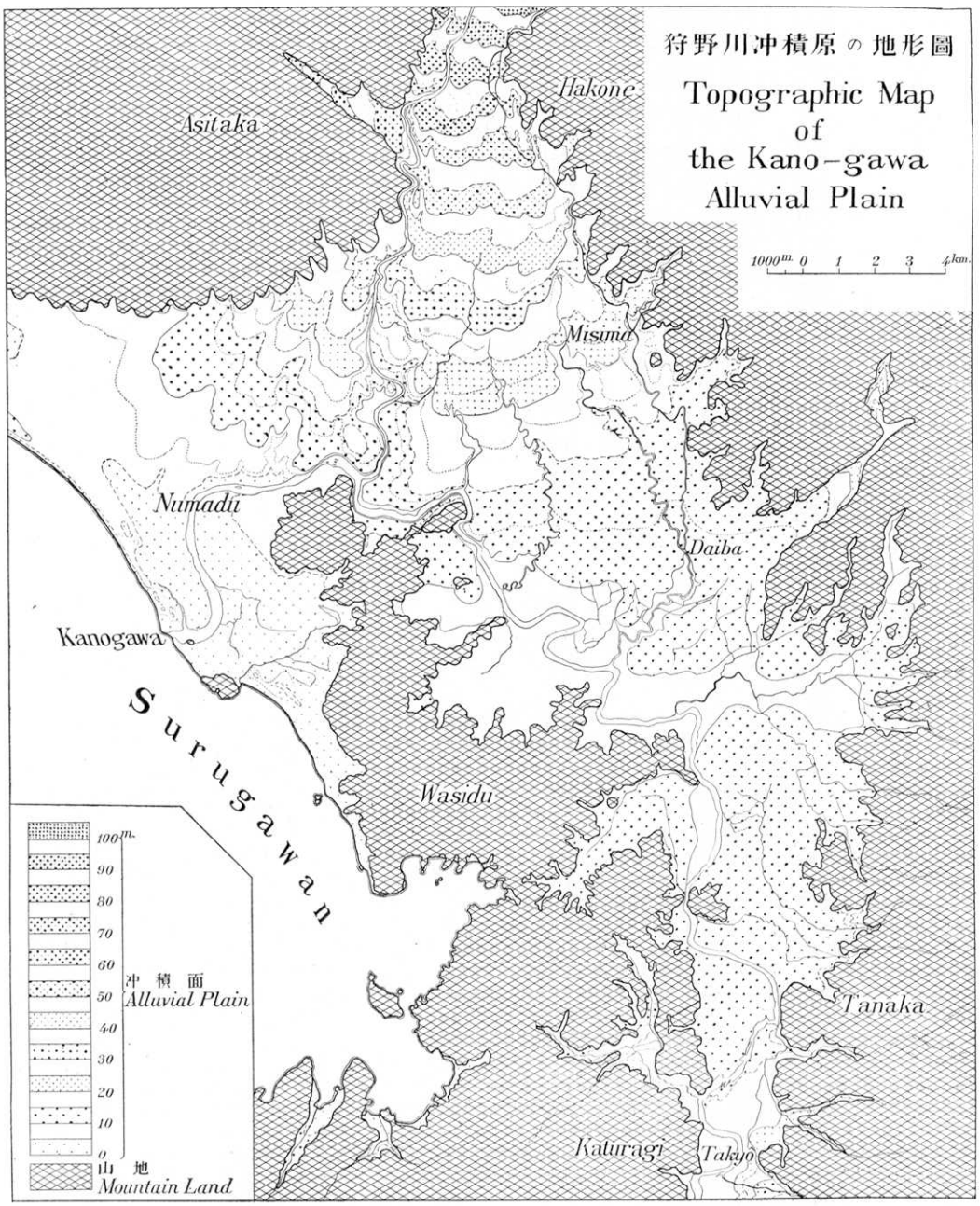
最も新しい地質時代に出來たと考へられる沖積層堆積地域の地形、卽ち三島扇狀地及び狩野川沖積地の地形、とその地表面にできた伊豆地震の際の地變と、伊豆地震の前後に行はれた一等水準點檢測の結果及び伊豆地震前後の一等三角點檢測の結果とはかなり關係があるやうに見える。

そして地形から知られる僅な異常も地殻に絕えず作用してゐる或る力の或る表現とも解することができる。

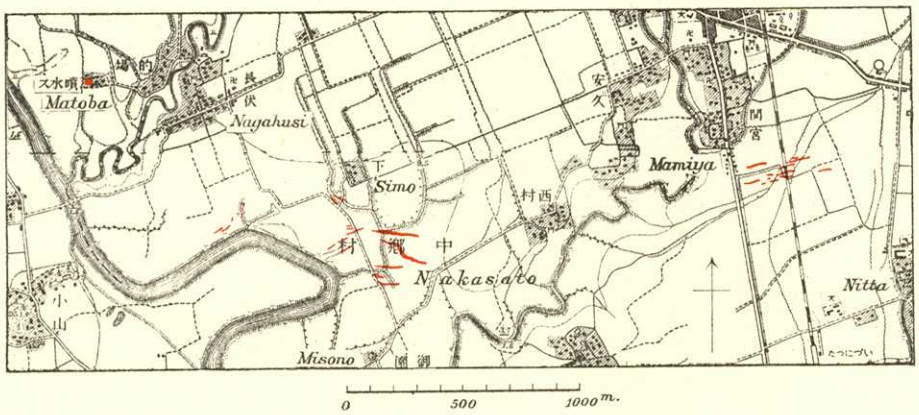
又一般に輕視されがちな沖積地の種々な地變も水準點の檢測の結果や、三角點の檢測の結果やと比べると密接な關係が生じてくる。

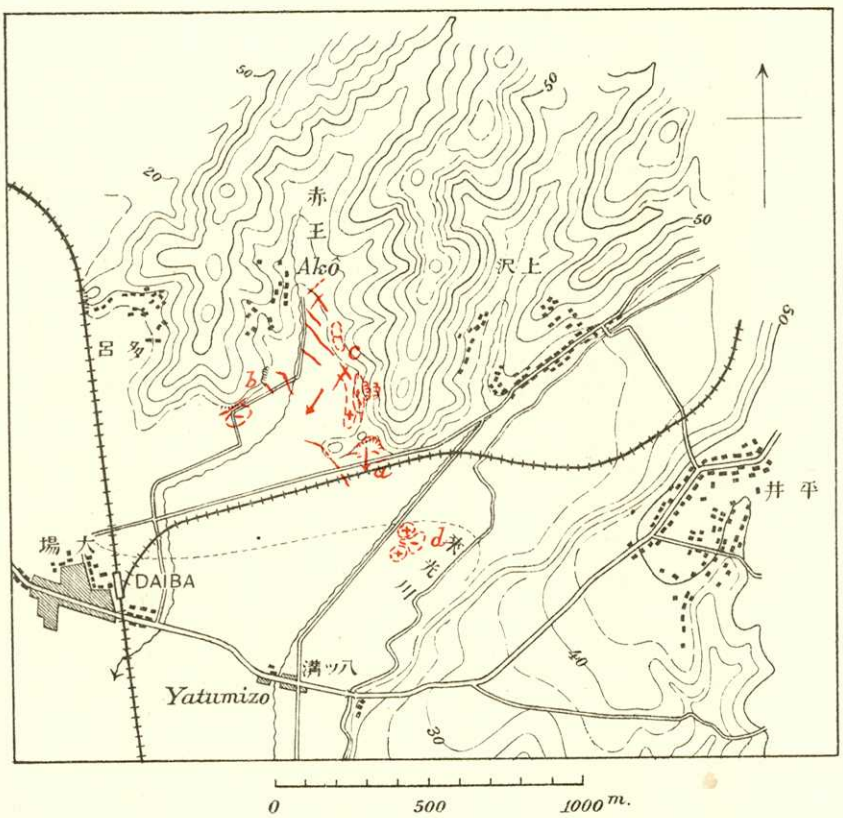
地震の被害もよく吟味してみると地質學的に意味のあるところに分布されてゐるやうであるが、試錐を要する地域では原因不明の被害が相當ある。

中郷村下から伊豆仁田、八ツ溝を經て赤王に至る地域には地質構造上特異な線、恐らく斷層線が存在するのであらうが、沖積層下に隱れて知られない。唯だ 1931 年の東京地質學會總會の席上に於て辻村助教授、岡山學士によりて注意された山中新田の東南側を走る地形學的異常線の南端が赤王附近に達してゐることは今後の研究の際に注意する必要があると思ふ。



（震研彙報、第十號、圖版、大塚）





（震研彙報、第十號、圖版、大塚）

Fig. 1. Kano-gawa Alluvial Plain and Wasidu Mountainland.

Fig. 2. Earthquake rift nr. Simo

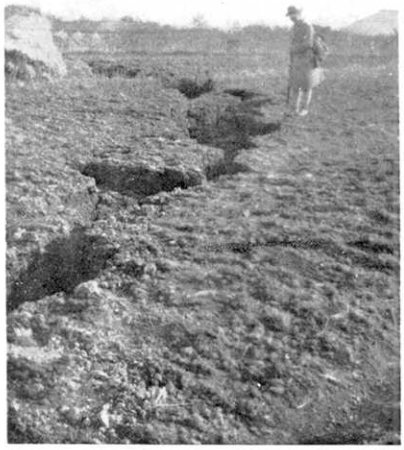


Fig. 4. Earthquake rift nr. Simo.

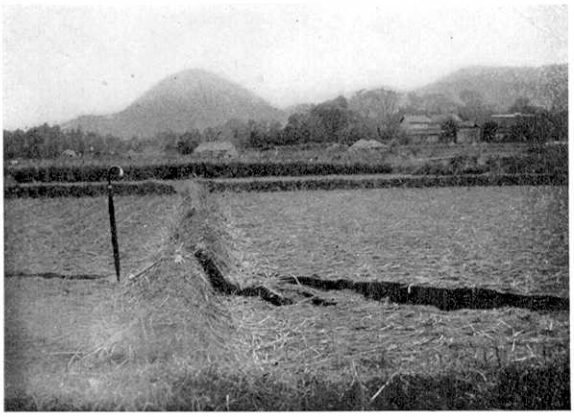


Fig. 3. Earthquake rift nr. Simo. Fig. shows the displacement of a rice-field dyke.

Fig. 5. Earthquake rift nr. Simo. Fig. shows the displacements of troughs.

Fig 6. Earthquake rifts nr. Nitta.

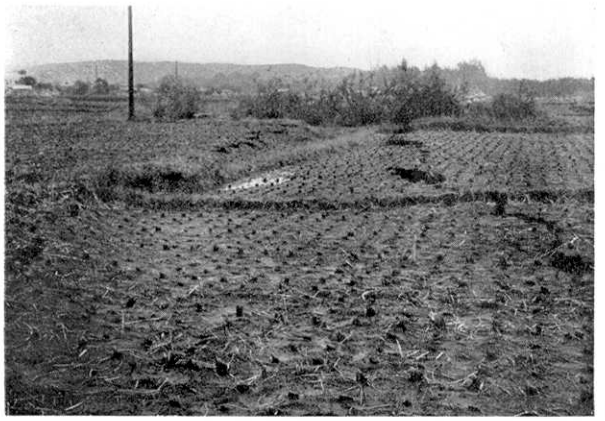


Fig. 7. Earthquake rift nr. Nitta.

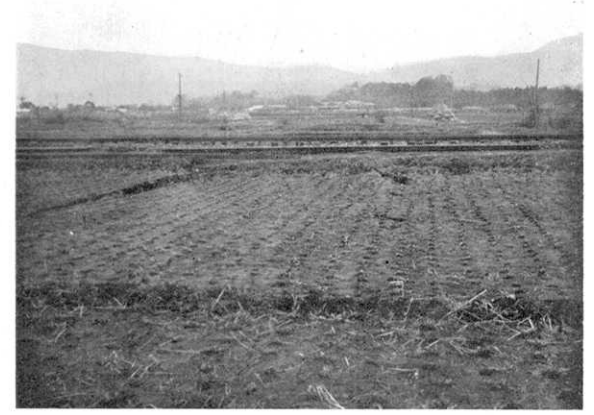


Fig. 8. Earthquake rift nr. Nitta.

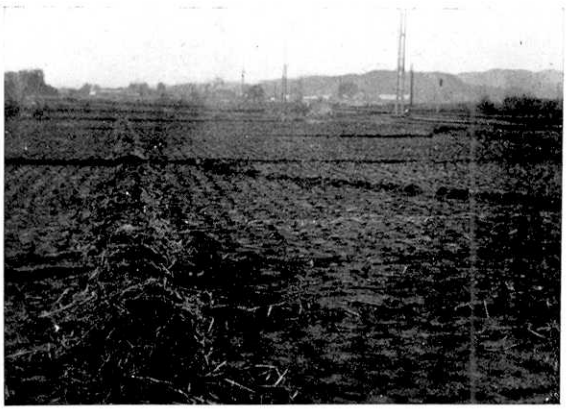


Fig. 9. Earthquake rift nr. Nitta.

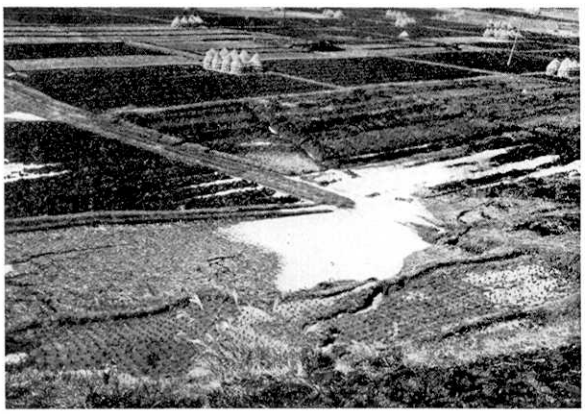


Fig. 11. Earthquake rift nr. Akô.

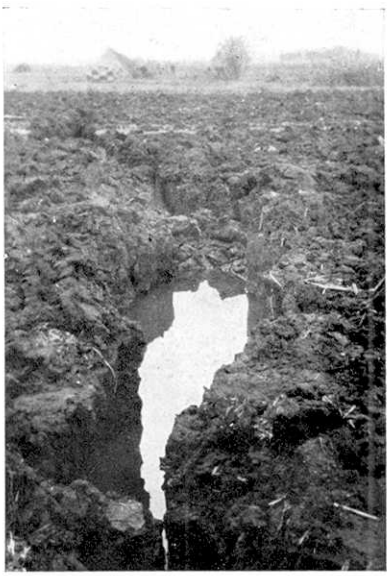


Fig. 10. Earthquake rift nr. nitta.

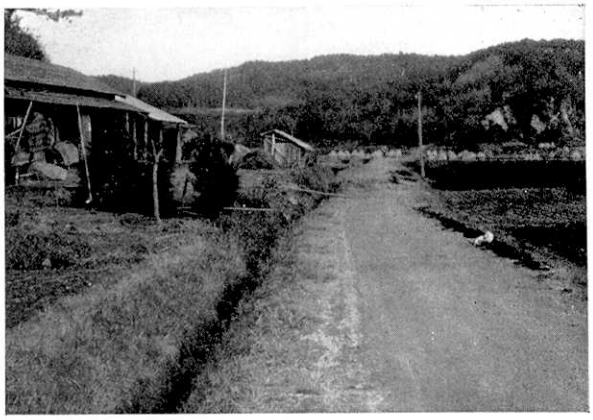


Fig. 12. Earthquake rift nr. Akô.

Fig. 13. Earthquake swell nr. Yatumizo.

Fig. 14. Earthquake swell nr. Yatumizo.