29. *The Geomorphology and Geology of Northern Idu Peninsula, the Earthquake Fissures of Nov. 26, 1930, and the Pre- and Post-Seismic Crust Deformations.*

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Contents.

Introduction.

Since the severe Northern Idu seismic disturbance of Nov. 26, 1930, the writer has been engaged chiefly in the geological survey of the disturbed region, in studying the earthquake fissures of Nov. 26, 1930, and the pre- and post-seismic crust deformations from the viewpoints of geomorphology, to the ground disturbances, and to the pre- and post-seismic crust deformations. Studies on somewhat similar lines have also been made, geologically, by Ihara and Ishii, and Tayama and Niino,[1] and geomorphologically by Prof. Tsujimura and Okayama.[2]

The megatectonical position of Northern Idu was dealt with by the writer in brief in an earlier paper,[3] namely, that northern Idu is a geotectonic unit, situated in the southern part of the "Fossa Magna," a weak transversal geotectonic zone in the central part of the main Japanese island formed during the Neogene, and by which the Kwanto mountainland and Northeast Japan are

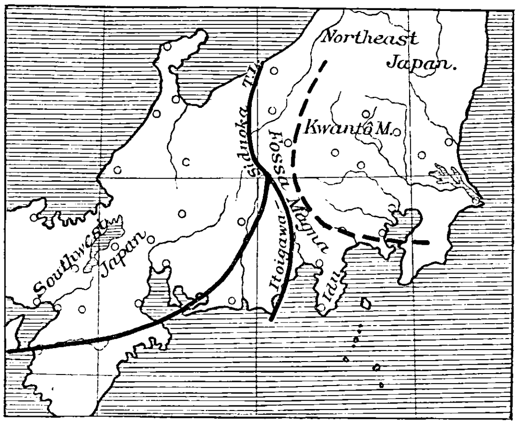

Fig. 1. The central part of Japan.

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1) K. IHARA and K. ISHII, *Imp. Geol. Survey Japan*, Rep., 112 (1932).
R. TAYAMA, *Report of Saitô Hôonkwai*, 11 (1931).
R. TAYAMA and H. NIINO, *Report of Saitô Hôonkwai*, 13 (1931).
2) T. TSUJIMURA and T. OKAYAMA, *Jour. Geol. Soc., Tokyo*, 38 (1931).
T. TSUJIMURA, Collection of papers in Ootuka Tirigakukwai, 1 (1932).
3) Y. ÔTUKA, *Bull. Earthq. Res. Inst.*, 11 (1932).

Table I.

Stratigraphic sequence of Idu[4] Peninsula according to Tayama and Niino, (1931).

Quaternary.	Alluvium.	Recent deposits.
		PL-Terrace gravel beds.
	Upper Diluviu, Diluvium.	Loam.
		M- Terrace beds.
		T- Terrace beds.
	Lower Diluvium.	Atami group.
		Zyo group.
Tertiary.	Simoda series.	Matuzaki group.
		Sirahama group.
		Tateiwa group.
		Aoiti group.
	Yugasima series.	Yugasima group.

Table II.

Stratigraphic sequence of north Idu Peninsula according to Ishii and Ihara,[5] (1932).

Alluvial deposits.	
Diluvium.	Terrace deposits.
	Talus and boulder deposits.
	Kasiwatoge beds.
	Ajiro beds.
	Zyo beds.
Tertiary.	

Table III.

Stratigraphic sequence proposed by the present writer.

a.	Kanogawa Alluvial deposits.	
	Misima fan.	
du.	Hirai terrace deposits.	
	Hatake terrace deposits.	
	Kasiwanokubo terrace deposits.	
dlII.	Darumayama volc. deposits	Hakone volc. deposits.
		Yugahara volc. deposits.
		Tanakayama volc. deposits.
dlI.	Zyo beds.	Simotanna beds.
		(Hata beds of Kuno).
Idu old Neogene Tertiary.		

4) R. TAYAMA and H. NIINO, *op. cit.*, (1931).

5) K. IHARA and K. ISHII, *op. cit.*, (1932).

seperated from the Outer and Inner zone of Southwest Japan (Fig. 1). For convenience, the writer has divided Northern Idu into the following eight geologic provinces.

1. The Kano-gawa Alluvial plain.
2. The western slope of Mt. Hakone.
3. The Tanakayama forest.
4. The Simotanna province.
5. The Tanna fault zone.
6. The Simoômi slope.
7. The Darumayama slope.
8. The Wasidu mountainland.

The post-Tertiary geology and geomorphology of the geologic provinces above listed follow.

The stratigraphy of Idu Peninsula was studied by R. Tayama and

Table IV.

Stratigraphic sequence proposed by H. Kuno.

dlII.		Old somma of Volc. Hakone, (Oliv. 2-pyr. and.; 2-pyr. and.)	
		↑ Volc. Yugawara.	
		↑ Quartz andesite.	
		↑ Volc. Taga.	
		↑ Volc. Usami, (2-pyr. and.)	
dlI.	Simotanna beds, (shale, dacite pumice.)	↑ Aziro beds, (Usami beds,) (Oliv. aug. bas; Oliv. 2-pyr. and.)	
	↑ Hata beds, (Hyp. bear. aug. oliv. bas.)		
		Quartz and. dyke, (Hyp. dacite.)	Hayakawa tuffite, (tuff brec,) (mu?)
		Tensyôzan beds, (Aug. oliv. bas. 2-pyr. and.)	
		Mikasayama beds, (Oliv. 2-pyr. and.)	
		↑ Ainohara beds, (2-pyr and.)	
	Nonaka beds, (dacite tuff.)	↑	Inamura beds, (2-pyr and.)
	↑	Quartz gabbro.	↑
ml.	Sogayama beds, (Tuff breccia.)	———	Hirogawara beds, (Tuff breccia, shale.)

H. Niino and by Ishii and Ihara before the occurrence of the Idu earthquake, the preliminary reports of the former two having appeared in the Report of Saitô Hôonkwai and those of the latter two in the "Journal of Geography in Japan, or Imp. Geol. Surv. Japan, Report."

The following tables show the succession of the strata as deduced by the above authors (Tab. I, II.) The present writer's conclusion regarding the stratigraphy as based on his field observation differs but little from the above tables. But in the division of the older formations, the writer reserves comments as the field surveyed by him was not wide enough. In this paper therefore the writer treats these old formations as one under the name of "the Idu old Neogene." The stratigraphic division of the last-named writers is given in Table II, which shows some advances in the division of igneous rocks as compared with that of the first-named. The stratigraphic succession used by the writer is shown in table III in descending order. Recently the following stratigraphic sequence was proposed by H. Kuno (Table IV.)

Geology and geomorphology of Northern Idu Peninsula.

I. Region of the Kanogawa Alluvial Plain (Fig. 2).

1) The lagoonal deposits of Ukisimagahara[6] and the fluviatile deposits near Daiba,[7] which fill the old valleys formed by early Alluvial erosion are here the youngest formations of all. The chronologic relation of these deposits to the Misima[8] fan was described in an earlier paper by the writer.

From well-sinkings made in the city of Numadu,[9] which is situated on the Alluvial plain, silt, sand, and gravel beds underlie the surface soils, the gravels usually occupying the lower horizon. Although the late Ishiwara[10] described the marine condition in the early Alluvial geologic history of Numadu, his conclusions must be accepted with reserve since they are not based upon any conclusive evidence. However the upheaval of the land which he also pointed out may be true, seeing that the present Kanogawa (river) has a depth of about 10m. below the land surface.

The low ridge, 5m. or more above sea level, bordering the northeast shoreline of Suruga bay, is a sand-dune protecting the lagoonal

6) 浮島ヶ原. 7) 大場. 8) 三島. 9). 沼津.

10) H. Ishiwara, *Jour. Geol. Soc., Tokyo*, 17 (1898).

11) 川西村. 12) 守山. 13) 北條. 14) 塚山.

deposits of Ukisimagahara from the sea. AIIu* in Fig. 2 shows the lowland of Ukishimagahara and AIIs the sand-dune. AIId* in Fig. 2, representing the Alluvial plain near Daiba previously discussed by the writer, is almost contemporaneous with the Ukisimagahara (AIIu and AIIs).

The loose brown sand beds exposed on the shore of the Kano in Kawanisi-mura[11] correspond to all (d.) The isolated mountain, Mori-yama,[12] near Hôzyo,[13] a small hill in Tukayama,[14] consist of Neogene rocks. They are relic peaks of basal Neogene rocks, which the deposits of aII could not completely cover owing to the relatively great height of the former, which was increased during early Alluvial epoch.

The Alluvial beds of the Tanna and Tasiro basins will be described in a later chapter.

2) AI. Misima fan. As already described in an earlier paper of the writer the Misima fan is a fan-spread skirt of Mt. Huzi. On the river wall and floor of the Kise and Sakai, dissecting the fan, may be seen exposed the lava of Huzi. The lava is similar to that cropping out on the surface of the fan near the Ri-o, hostelyn. This means that the early ejecta of volcano Huzi had flowed down through the "Susoaidani" (meaning valley between the foot of two mountains) between Mount Hakone and Mount Asitaka, which were already in existence, and spread out to form the beautiful fan shaped topography near Misima, after which the basal lava of Huzi overflowed the surface of the fan. This overflow may antedate the formation of the present Huzi volcanic cone and may be comtemporaneous with or later than the dissection of the western slope of Mount Hakone, for the materials composing the Misima fan are deposited in the dissected valleys of Mt. Hakone. Although there is no palaeontological evidence, the age of the Misima fan may be lowest Alluvium.

According to Prof. Hirabayashi[15] and the late Ishiwara,[16] the lava exposed on the Misima fan is the basal part of the Huzi lava flows, which is composed of Olivine basalt. The distribution of the lava flow on the Misima fan is shown as " al " in Fig. 2. Similar lava is exposed in the valley from Yosida[17] to Ootuki[18] and Saruhasi,[19] all of which are situated on the northeastern foot of Mt. Huzi, and on the southern foot nr. Oomiya.[20]

15) T. Hirabayashi, *Rep. Imp. Earthq. Invest. Comit.*, 16 (1896), (in Japanese).
16) H. Ishiwara, *op. cit.*, (1898).
17) 吉田. 18) 大月. 19) 猿橋. 20) 大宮.
* In Fig. 2, AIIu and AIId are erroneously represented by symbol AII.

Other deposits contemporaneous with the Misima fan are found developed in some of the tributal valleys in this province, but their ages have not yet been definitely determined.

3) Hirai terrace. duIIh. The Hirai terrace, thus called by the present writer, is about 50m. above sea level, and situated east of Daiba. The small village of Hirai,[21] from which the name is derived, is on the eastern corner of the terrace, which slopes down gently toward the Kanogawa Alluvial plain, being only about 20m. above sea-level at Nitta. The materials forming the terrace are horizontally stratified beds of dark reddish brown volcanic ash and yellow pumice, all pointing to the subaqueous origin of these beds. Fig. 3 is a geologic sketch map of this terrace. The western and northern limits of this terrace are bounded by the Raikogawa(river),[22] a tributary of the Kano, by which the Tasiro basin is drained. The south part of the terrace is dissected by the Kakizawa river and its tributaries. The low ridge of the Simotanna province, between the rivers Kakizawa[23] and Raiko, orientated in a S. N. direction, borders the eastern limit of the terrace. On the south-east part of Kasiya,[24] the bordering ridge diminishes in height, being covered by pumiceous materials that compose the Hirai terrace, while the high peaks of the ridge project like isolated hills above the surface of Hirai terrace.

4) Hatake terrace duIIt. Similar terraces are scattered about the east corner of the Kanogawa Alluvial plain from the Hatake[25] Hot springs to Nakoya.[26] They are about 30–40 metres high above sea-level and are long narrow ridges projecting into the Alluvial plain and lying between the lower courses of the valleys that drain the Tanakayama forest to be described later. But the beds composing these terraces are roughly stratified, the size of the pumice being larger than that of Hirai, whose pumiceous beds are underlain by these irregularly stratified pumiceous beds as may be seen on a cutting wall between Hatake and Daiba, in loc. A in Fig. 3. Fig. 4 is a sketch of this wall. The Hirai beds may therefore be younger than that of the Hatake terrace, but their heights are so nearly alike that the surface of these terraces appear as though they were formed during the same geologic age.

Rock terrace of the same height as the Hirai terrace is developed near Nirayama,[27] which consists of Miocene andesite. Near Narutaki,[28] Naka,[29] and Dai,[30] terraces develop in the same way, rising to heights

21) 平井. 22) 來光. 23) 柿澤. 24) 柏屋. 25) 畑毛.
26) 奈古谷. 27) 韮山. 28) 鳴瀧. 29) 中. 30). 臺.

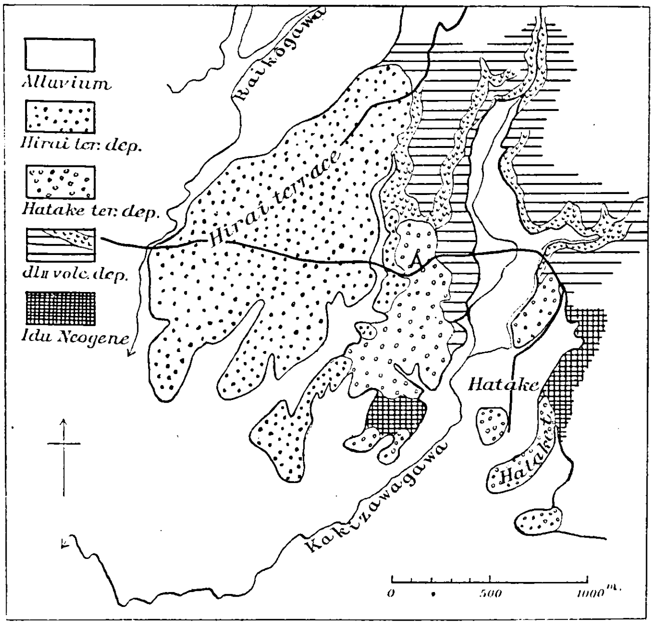

Fig. 3. Geologic sketch map of region near Hatake. (gawa=river).

of 30–35 metres above sea-level.

A similar terrace about 30m. high may also be seen at Ema-mura,[31] on the west side of the Kano. The low hill, about 30–35m. high, on the way from Hora[32] to the southern limit of Uzyo,[33] on the west part (back) of the Nagaoka hot springs is another terrace. The pumice bed composing this terrace crops out on the cutting wall in Uzyo along the highway from Nagaoka to Mito. These pumiceous materials closely resemble those forming the terrace in Hatake. Ishii and Ihara regard these two pumiceous beds in widely seperated localities to be of the same age.

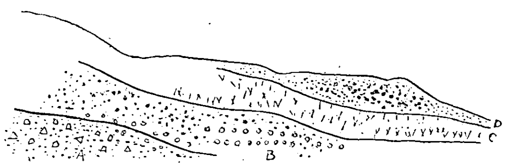

Fig. 4. The exposure of the south wall of excavation on the highway between Hatake and Daiba. (Loc A in Fig. 3.)

A. Andesite and breccia bearing pumiceous sand and gravel. B. Pumiceous sand and gravel.	Hatake t. d.
C. Yellow pumiceous bed. D. Brown volcanic ash.	Hirai t. d.

31) 江間村. 32) 洞. 33) 有城. 34) 長岡. 35) 三津.

At Bessyo,[36] in Kawanisi-mura, another similar terrace is observed. The terrace near Mihuku,[37] on the southern part of the Kanogawa Alluvial plain, is about 40m. high. Exposures near Takyo[38] along the Simoda highway show that the terrace is composed also of pumiceous

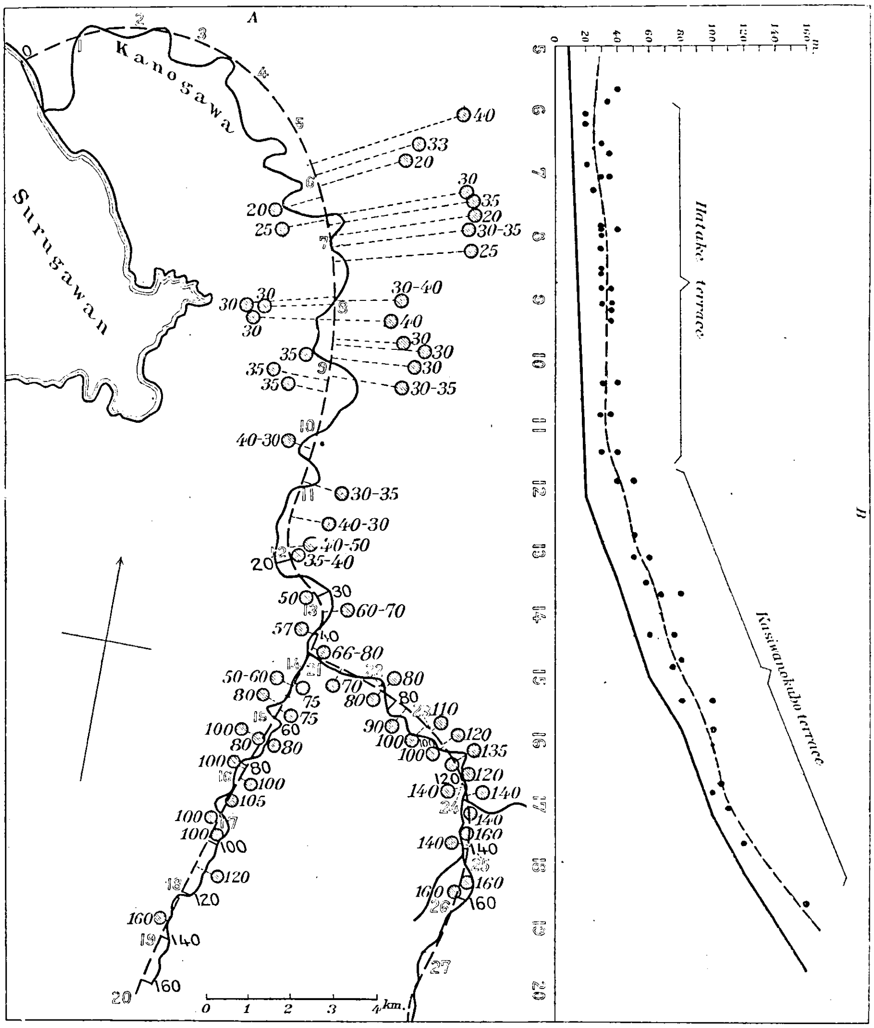

Fig. 16. A. Map shows the areal distribution of Hirai, Hatake and Kasiwanokubo terrace. (Numerals in ordinally type show the heights of terrace. Numerals gothic type show the heights of river floor).
B. Numerals show the vertical distribution of these terraces along the Kanogawa. Full line shows the heights of river floor.

36) 別所. 37) 三福. 38) 田京.

beds. From its height and material it may safely be considered a similar terrace to the Hatake terrace. Of the two terraces of unequal height near the town of Oohito,[39] the heigher has the same height as that of Mihuku, while the lower one gradually transits its height to the Kanogawa Alluvial plain, which diminishes in width in this district. The age of the lower one may be contemporaneous with that of Misima fan.

To summarise, all the foregoing terraces have heights from about 30 to 40m., chiefly consisting of pumiceous material or volcanic ash, excepting, however, the rock terraces near Nirayama, which has little or no gravel. It will be noticed that generally the size of the pumice grows larger as we go northward. The pumice composing the slope of Mount Hakone near Misima closely resembles petrographically that of the terrace near Hatake. The writer therefore believes that the above terrrce has some close relation to the slope of Mt. Hakone. Judging from their heights and their constituent materials the terraces then may be contemporaneous with each other. If so, the terraces of Hatake on the east side of the Kano are contemporaneous with that on the opposites side of the river; and it may be inferred that the pumiceous materials flowed down and filled in the old Kano valley from the north, probably from Mount Hakone, and was denuded to a topographic plain (at the leve of the Hatake terrace). The topographic plain of the terrace was then re-excavated by the Kano and left as scattered terraces on both sides of the Kano. The Hirai terrace was no doubt formed in the Hatake terrace during the early stage of this erosion.

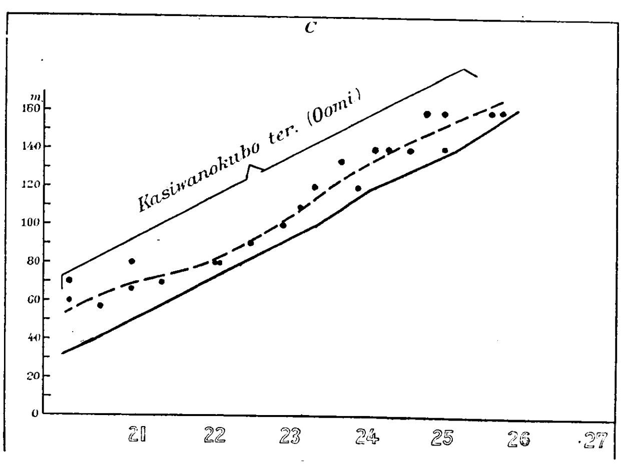

Fig. 16. C. Fig. shows the vertical distribution of the Kasiwanokubo terrace along the Oomi-gawa.

5) The Kasiwanokubo terrace. The Kasiwanokubo terrace is well preserved on the upper course of the Kano, about 80–135m. above

39) 大仁.

sea-level. Near Kumokane[40] and Yugasima[41] on the Kano, they begin to get high, reaching 135m. near Hatuma[42] on the Oomi river. These terraces are composed of gravel beds or Tertiary bed rock. Many river terraces along the tributaries of the Kano and the Oomi may belong to these terraces.

Because of the unevenness and steep inclination of the terrace surface, it is not expected that these terraces could be accurately correlated with each other by referring to their heights, without any other precise data. But these terraces have roughly been traced from Kasiwanokubo to Hatuma along the river Oomi and up to Yugasima along the Kano. Fig. 16 shows the distribution of these terraces.

The chronologic relation between the age of formation of the Kasiwanokubo terrace and the Hatake terrace is not yet definitely known. Measuring their relative heights from the present river floor, they are about 20m. and 30m. respectively (excepting the lower terrace near Oohito). But the relative heights tell nothing of the chronologic relationship between these two terraces. Their chronologic relation must therefore be considered with respect to their absolute heights and their geologic structures.

As just stated, the Hirai terrace which is 30–40m. high, consists of pumiceous material but not of gravels, while the Kasiwanokubo terraces, which are higher than the Hirai, consist of gravels. And the Kano-gawa plain abruptly narrows down near the town of Oohito. Fig. 16 shows the projection of the river course, its tributaries having flowed over the ancient surface of the Kasiwanokubo terrace, which developed towards the north, namely, the area under the pumiceous material composing the Hirai terrace. The northern part of Kasiwanokubo flexed down relatively to the southern part of the town of Oohito. The ejection of pumice might have occurred during this period. The pumice, further, may have flowed down and covered the downwarped area of the Kasiwanokubo terrace.

II. Western slope of Mt. Hakone.

Fig. 5 shows the summit level of Northern Idu Peninsula drawn by Okayama's method in 500m. mesh. On the north side of the line joining Hirai and Tasiro, the contour lines of the summit-level curve very gradually, running toward the northwest, and suggesting the conical slope of a volcano, but on the south side they trend in a meridional direction, sharply, and turning south of the line. The

40) 雲金. 41) 湯ケ島. 42) 八幡.

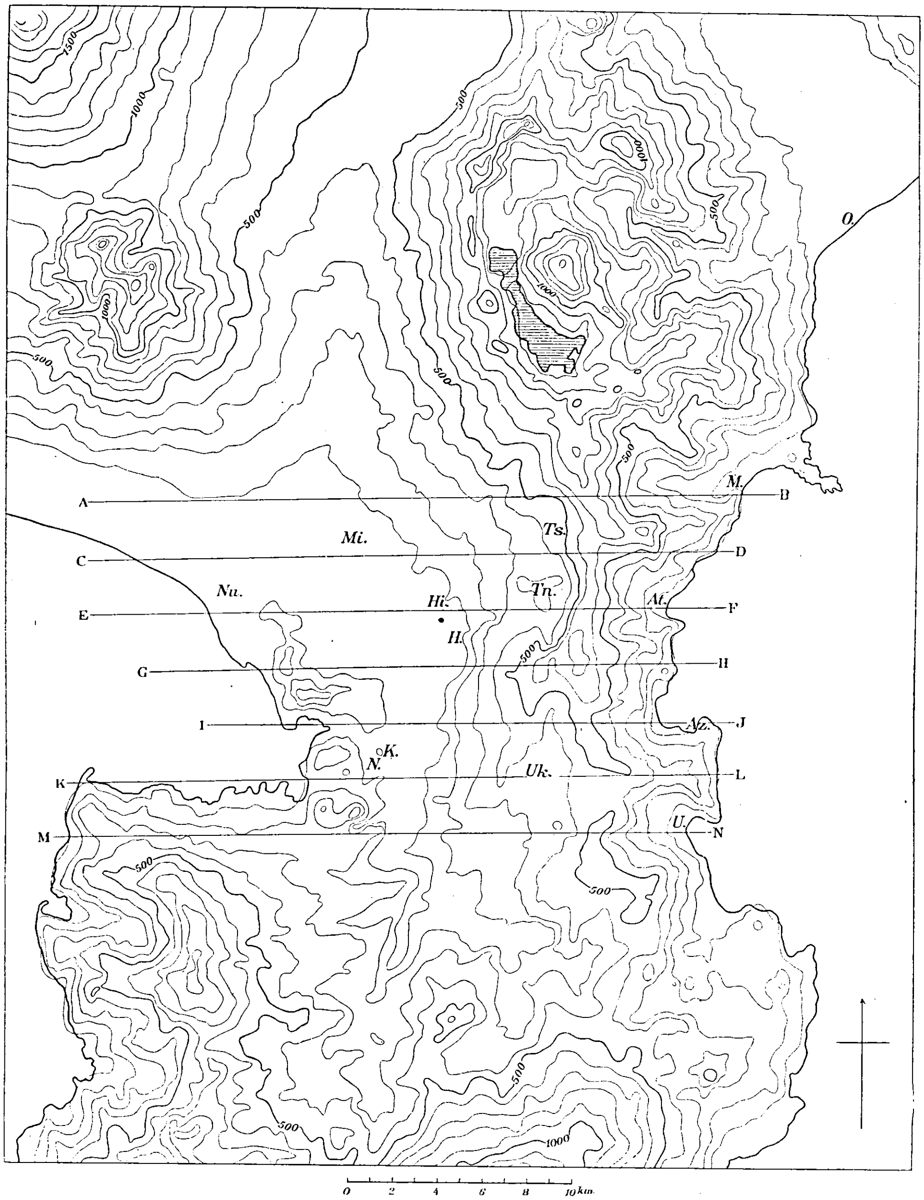

Fig. 5. Summit-level of Northern Idu. (Contour line is referred to the highest points in the 500m. nets. Line AB, CD, EF, GH, IJ, KL, MN show the position of profile which are shown in Fig. 8.)

At. Atami.
Az. Aziro.
H. Hatake.
Hi. Hirai.
K. Kona.
M. Monkawa.
Mi. Misima.
N. Nagaoka.
Nu. Numadu.
O. Odawara.
Tn. Tanna.
Ts. Tasiro.
U. Usami.
Uk. Ukihasi.

northern side of the line differs geomorphologically from the southern. The province forming the western slope of Mt. Hakone, and which is the subject of this section, is the area north of this line. The surface of the summit level of this region resembles the reconstructed low relief surface of Mt. Hakone, the present slope of which is dissected by radial valleys. The ridges between these radial valleys of Mount Hakone in this region are principally pumice flows and lavas, almost parallel to the landsurface. These volcanic materials are exposed along the Tôkaidô highway, and on the deeply dissected radial valley walls on the slope, for example, in the Kakizawa, the Raiko, and the Yamanaka[43] valleys.

The pumiceous flows exposed on the western foot of Mount Hakone along the Tôkaidô highway resemble those of the Hatake terrace. These pumice are sometimes seen as stratified beds, as in the exposure on an excavation at Ako,[44] north of Daiba village, where they show more or less flow structure. The distribution of these pumice beds is limited to this region, although in the higher part of the western slope of Mount Hakone they are scarcely to be found. The pumice flowed from Mt. Hakone during Diluvial times in the same manner as during the eruption of Komagatake in 1930.[45] And the pumiceous materials of the Hirai terrace may be the same eruptive materials or secondary deposits of them. The surface features of the pumiceous beds with more or less flow structure as exposed on the cliff near Ako strongly remind the writer of the Takao beds (pumice beds) in the Ooiso block,[46] which was surveyed by him. The petrographic characters of their constituents however differ slightly. These pumiceous materials might have flowed over the relief at fairly large heights, as the sides of the hills of older Neogene rocks near Hatake are covered by pumice flows, as previously described (Fig. 3). In the southwestern part of this region, the lava flows exposed beneath the pumice flows are buried under the land surface.

In the Yamanaka and Ryûtakuzi[47] valleys, as Prof. Hirabayashi and Ishii and Ihara have pointed out, some lava flows are exposed beneath the pumice flows. These lava flows extend to the shore of lake Asi (Asinoko) on Mt. Hakone.

The following geologic history may then be inferred of this region

43) 山中. 44) 赤王.
45) H. TSUYA, *Bull. Earthq. Res. Inst.*, 8 (1930).
46) Y. OTUKA, *Jonr. Geol. Soc., Tokyo*, 36 (1929).
47) 龍澤寺.

from the evidences above enumerated. First some lava and ash poured down over the southwest slope of Mt. Hakone in a southwest direction. But the extent of these lava flows is limited on the south by a line roughly joining Yanai[48] (a small village northwest of Tasiro) and Hatake. The pumice ejected from Mt. Hakone deposited over this surface.

Small patches of pumice are seen as far the Simotanna region and elsewhere.

The pumiceous material that crops out between Karuizawa[49] and Tanna[50] was distributed probably during this period in the middle or late Diluvial.

The form of the southwest slope shown by the summit level may accord with the original accumulated surface of these pumice beds. During or after their accumulation followed river erosion, deepening the valleys on the slope of Mount Hakone. The pumiceous material which was removed from its original position to the lowlands through the valleys, resettled in the lower levels. Part of the material removed probably formed the Hatake terrace.

The rivers, by continually dissecting the southwest slope of Mount Hakone, would also resettle the pumiceous material. The age of dissection of the Hirai and Hatake terraces may be contemporaneous with this age. The lower courses of these rivers are buried under recent fluviatile materials (deposits aI and aII), and volcanic material from Mount Huzi (e. g., lava of the Misima fan). The Huzi lava flow consequently postdates the dissection of Mount Hakone. Though no fault topographies are observed in this region, its southwest boundary, namely, the line joining Yanai and Hatake, may be a tectonic line as Prof. T. Tsujimura and Okayama[51] conjectured. A brief reference to this line is made in the writer's previous paper. According to H. Kuno, the boundary line between the lava flow of Mt. Hakone and Mt. Yugawara (whose original form is now almost dissected out) roughly coincides with this line in its northeast part.

III. The Tanakayama[52] forest.

Other striking features noticed on the summit-level in fig. 5 are the depressed reliefs and peculiar arrangements of the contour lines near the village of Tanna. These features are characteristic of the region south of the line joining Yanai and Hatake. In the Tanna

48) 柳井. 49). 輕井澤. 50). 丹那.
51) T. Tsujimura and T. Okayama, *op. cit.*, (1931).
52) 田中山.

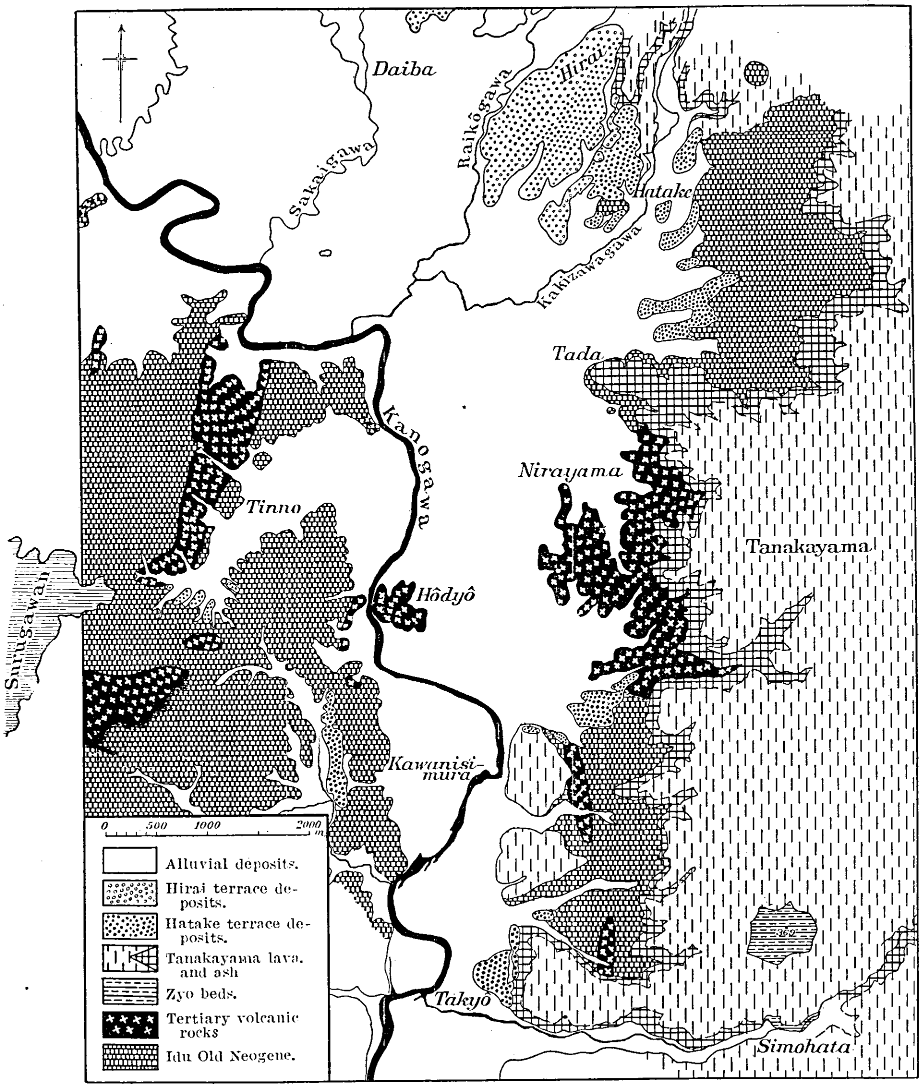

Fig. 6. Geologic map of the western part of Tanakayama forest.

basin, the 300 m. contour line in the summit level is a closed curve The 400, 500, and 600 m. contour lines south of this closed one are constricted and show a saddle shaped surface. Valleys vertically opposite the saddle trend meridionally. The closed or constricted contour lines are due to the depressed zone of the Tanna fault zone which will be described later, the zone in which severe ground disturbances occurred at the time of the Northern Idu earthquake. The area between the Tanna fault zone and the Kano-gawa Alluvial plain is divided into the Simotanna region on the north and the Tanakayama forest on the south by the Kakizawa valley, which runs from the southern corner of the Tanna basin to Hatake village in an E. W. direction. The geomorphologic and geologic characters of one side of the boundary of the Kakizawa valley differ from those on the other. The Tanakayama forest, which is the southern part of the boundary is higher than the opposite part, and has a more simple geologic structure. But as is generally the case, a rigid boundary line can not be drawn between them. It may be called the "boundary zone" or the "transitional zone." The surface of the Tanakayama forest is a low relief surface, and consists of almost horizontal lava flows or pumiceous materials extruded from the early Diluvial volcano Taga. The bedding planes of these volcanic materials are roughly parallel to the surface of the summit-level, while the surface of the summit-level of the Tanakayama forest suggests the fragmental conic surface of a volcano. The surface of the Tanakayama forest may then be the remnant of a slightly dissected volcanic slope. On the eastern limit of this forest, the low relief surface is bounded abruptly by a steep meridional scarp facing the east, which is the western fault scarp of the Tanna fault zone. It therefore follows that the peculiar arrangement of the contour line in the summit-level already mentioned, namely, the depressed topography along the Tanna fault zone, could only have been formed after the surface of the Tanakayama forest was formed. The western limit of this forest, like the eastern, is bounded by a steep slope facing the lowland of the Kano-gawa Alluvial plain. Exposures of the lava flows that have built up the Tanakayama forest may be seen on this steep westerly slope resting upon old Neogene rocks at a height of about 250–300m. above sea-level. They may be seen also on the valley walls of the Hukazawa and Kakizawa, which deeply cut the forest region.

In the village of Takyo, the lava flows down from the Tanakayama forest to the level of the Kano-gawa Alluvial plain through the lower part of erosion reliefs of Neogene rocks. At Tada[53] also the lava flows down to the lower level. Dl in Fig. 2 of the Tanakayama region shows this low relief surface covered with these lava flows and volcanic ash, while the "steep relief" of Fig. 2 shows the steep erosion surface of

53) 多田.

the old Neogene rocks without any covering material.

The 363 m. triangulation point situated 2 km. North of Simohata[54] (Fig. 6), an isolated hill projecting above the low relief surface of the Tanakayama forest, consists of volcanic sandstone that may be seen cropping out on the valley floor near Simohata, and with which the Tanakayama lava flows are underlain. Owing to old surface inequalities in the volcanic sandstone, the lava and volcanic material could not completely cover it. The underlying sandstone will be described later.

The Hukazawa river deeply excavates the Tanakayama forest, on the valley wall of which the Tanakayama lavas show beautiful columnar joints. But the Neogene rocks that crop out on the eastern limit of this region are not exposed in this valley. Fig. 18 shows the columnar joints of the lava flows near Takyo. It seems that the buried relief of the Neogene rocks in the east part of this region has been reduced in height through tectonic movement or some other cause.

Near Simohata, on the Hukazawa velley under the Tanakayama lava flow, may be observed bluish-grey, muddy sandstone containning some fragments of fossil plants, the same sandstone that forms the 363 m. point above mentioned. The Tanakayama lava on the valley wall of Hukazawa, which crops out along the upper course disappears beneoth the land surface near Yasuno, while thick agglomerate and micaceous or ashy beds develop above its lava, which beds we shall call the "Zyo" beds in this paper. The area between the Hukazawa and the Oono-Doodoko[55] valleys, which limits the southern part of this region, is covered also by lava flows and other material, the upper part of which consists of volcanic ash and lava and the lower of conglomerate and pumice beds. The lower pa… is the Zyo beds of Tayama.

Summarising the foregoing, the geologic history of the Tanakayama forest may be inferred as follows:

During or after the deposition of the Zyo beds, subaerial erosion sculptured the land surface to, a relatively great height. The Tanakayama lava and volcanic flows then covered the sculptured reliefs from east to west. Some Tanakayama lava sheets flowed down, as in Takyo and Tada, through the lower part of the highly ragged reliefs towards the ancient Kano-gawa valley. During or after the deposition of these flows, the Tanna fault line became active, and the topographic, that is, the visible Tanna fault zone was formed. The rivers of the forest dis-

54) 下畑. 55) 大野一堂處.

sected the land surface, resulting in the Hukazawa, Kakizawa, and other valleys.

IV. The Simotanna slope.

The geologic province of the Simotanna slope, situated at somewhat lower level north of the Tanakayama forest, has already deen studied by Professor Hirabayashi and T. Watanabe.[56] Recently the complicated underground geologic structure of this province was brought partly to light by the tunnelling work proceeding on the Atami railway line. Professor Tsuya will shortly publish a paper on this complicated geologic structure.

According to him, and to his drawn geologic section along the tunnel wall, the Tanna tunnel consists of Olivine bearing andesite lava and agglomerate in the upper horizon, and alternations of sand, mud, and gravel containning dacitic pumice in the middle horizon. The latter beds, which contain some plant remains (e. g., *Fagus crenata*), are folded, flexed, and thrusted over the younger olivine bearing andesite flows from west to east, forming a low-angled thrust plain (Fig. 7).

This alternative formation may be almost contemporaneous with the beds exposed on the floor of the Hukazawa valley near Simohata, described above, or with the Zyo beds of Tayama.

According to Prof. Tsuya, the petrographic characters of the pumice contained in the alternative formation of Simotanna, which is considered almost identical to the beds exposed on the tunnel wall, perfectly agree with that contained in the writer's Tutizawa beds[57] on the Ooiso block. The Tutizawa beds, according to the author's stratigraphic study, may be lower Pleistocene, judging from their stratigraphic positions and their fossils.

Fig. 7. Schematic geologic sketch of the tunnel wall between stations 6950 ft. and 7350 ft. from the western mouth.

From these considerations, the Tutizawa beds in the Ooiso block, the alternative formations of Simotanna, the beds exposed on the walls of Tanna tunnel, and the Zyo beds of Tayama may all be contempor-

56) T. Hirabayashi and T. Watanabe, "Geological report near Tanna Basin," *Atami Construction Office, Government Railways Japan*, (1924).

57) Y. Otuka, *op. cit.*, (1926).

aneous with one another. They seem to be interesting examples of the post-Pliocene palaeogeography of these regions.

Below the alternative beds of the tunnel wall, the agglomeratic beds, the Simotanna sand, mud, and gravel alternations, and the basic lava flows rest unconformably either upon Neogene tuffite beds or upon agglomeratic beds. In these tuffite beds are contained *Amussiopecten* aff. *praesigne* (Yokoyama), and *Venericardia panda* Yokoyama, which seem to indicate middle Neogene age.

These Neogene rocks crop out in small patches along the valley wall of the Kakizawa, 200m. West of Simotanna and 2000m. North of Hatake-Yuduka, forming sometimes a projecting hill on the low relief land surface of young formation. Although the general height of the land surface of the Simotanna province is somewhat lower than the Tanakayama forest, the former is more dissected than the latter. And some faults, which may be inferred from certain topographic characters, run in a N-S direction in the province near Simotanna and Binnosawa. On the western margin of this forest the underlying basal Neogene rocks are less exposed than that in the Tanakayama forest, as shown in Fig. 6.

The Tanakayama forest and the Simotanna province were dissected by river erosion during late Tertiary, followed by early Pleistocene volcanic activities. During this period the dl_I formation deposited on the rugged land surface of Neogene rocks. After the deposition, the younger lava flows covered the erosion surface of the dl_I formation. During or after the extrusion of the olivine bearing andesite flow, the Simotanna province suffered overthrusts from west to east and other crustal movements, and was seperated from the Tanakayama forest by the boundary zone of the Kakizawa valley. In the later stage of this period appeared the Tanna fault in the eastern limit of this province. This fault may be contemporaneous with the flexing of the Ninomiya shell beds in the eastern slope of Soga-yama on the Ooiso block.

According to H. Kuno, the number of lava sheets on the east side of the Tanna fault zone is larger than that on the west. This difference in the number of lava sheets seems to indicate that it was in times past the wall of a caldera, the east side of the Tanna fault zone having lowered gradually with accumulations of the lava sheet.

As already explained, the Tanakayama lava on the west side of the fault zone flowed from east to west, while some of the lava flowed down to lower levels through the lower part of the ancient reliefs.

After that the Tanna fault resumed activities by which movements the topographic (visible) nuclear fault began to form.

But the northern spread of this topographic character of the Tanna fault zone seems to be obscured by accumulation of new volcanic material from Mt. Hakone; or it may be traversed by the inferred fault line connecting Yanai and Hatake, cutting the northern extension of the Tanna fault. But the writer is unable to say anything definite in these respects. Some writers recognize the northern extension of the Tanna fault as connecting the depressed topography extending from the Hakone pass to the saddle-shaped topography between Mt. Kintoki[58] and Myôzin[59] through lake Asi. But the topographic character of this depressed zone is quite different from that of the Tanna fault zone. The topographic characters of the Tanna fault zone show the narrow graben or ramp[60] form, but that of Hakone merely broadly depressed reliefs. The writer however, while not denying the existence of a fault structure under the lowered reliefs of Mt. Hakone, finds himself unable to recognize what is mentioned above as a fault topography.

V. The Tanna fault zone (Fig. 2).

As already stated, the eastern limit of the Simotanna and the Tanakayama forest is bounded by the steep straight slope to the long narrow depressed land which extends from the north, the Tasiro basin to the south, the Ukihasi basin through the Karuizawa and Tanna basin. This long narrow depressed zone is called the Tanna fault zone in the present paper. The depressed land has the form of an arc with large curvature, convexing to the east. From its form and tectonic characters, the Tanna fault zone reminds one of a kettle fault or a thrust fault topography. On the south part of the Ukihasi basin, this fault zone continues along the Oono valley.

The ridges to the east of this zone form the main divide of the Idu peninsula. This divide extends from Mt. Hakone to Amagi through Mt. Hikane, the Atami pass, and (Mount) Kuro-dake. The summit-level shows the distribution of the height on both side of the depressed Tanna fault zone. The east side is higher than the opposite side. But as stated above, the Tanakayama slope on the west side of it is believed to be the accumulated surface of volcanic materials and lava ejected from a crater that was at one time situated on the east side of the depressed zone. The crest or the slope of the east side should therefore

58) 金時. 59) 明神.
60) B. Willis, *Bull. Geol. Soc. Am.*, **39** (1923).

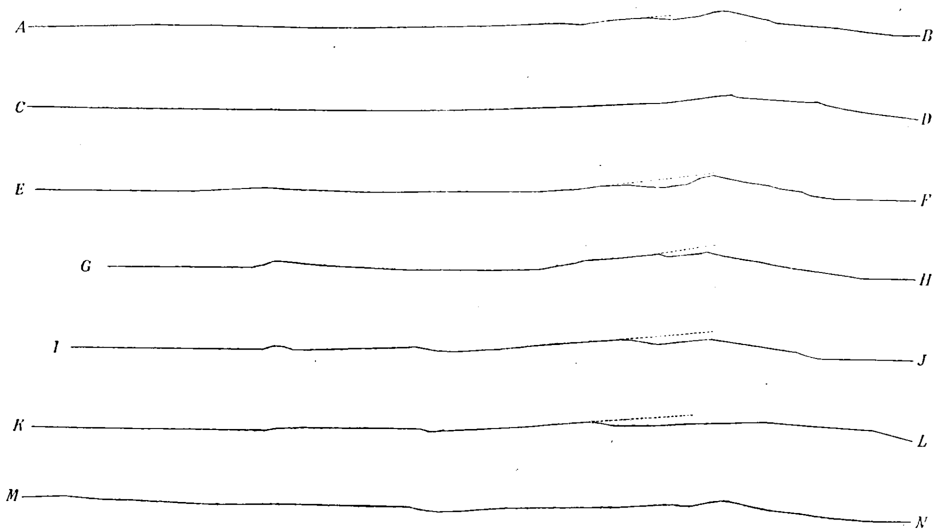

Fig. 8. Profiles of the summit-level (Lines AB, CD, EF, GH, IJ, KL, MN in Fig. 5).

be in the same plane as the surface plain of the Tanakayama forest. The land surface of the east slope of the Ukihasi basin roughly accords with the slope of the bedding plane of the lava flows. Fig. 8 gives profiles of the summit-level intersected in the direction at right angles to the general trend of the depressed fault zone. The larger parts of the straight lines touch the profile lines of the western slope as shown in Fig. 8. But by imagining that these straight lines of the eastern slope were prolonged, then the heights are larger than those of the west, which suggests that the west side of the fault zone had upheaved relatively to the east side, and in which case, if both sides of the fault zone were a continuous plane, the west part should have upheaved relatively to the east. Indeed, according to Prof. Tsuya and Kuno, the lavas forming the eastern slope are parallel to the surface of the summit-level of the east slope, in which case the lava on the eastern slope has not the same slope as the western, so that the eastward convexing curvature of the Tanna fault zone does not suggest a kettle fault.

1) Tasiro basin. Fig. 12 shows the topography of the Tasiro basin and its northern part. The form of the Tasiro basin is an obtuse angled triangle, with the long side parallel to the general trend of the Tanna fault zone on the west.

The west side of the basin is the steepest of all. This steep wall develops from the northeastern corner of the basin and continues through Karuizawa village to the Tanna Primary School, at the northern corner of the Tanna basin. The crest line of this west wall is very even. The Simotanna low relief surface above mentioned is the western side of this line. The windgap like topography west of the 343m. triangulation point in Karuizawa, through which the Atami highway passes and then turns north along the foot of the steep slope, is a good example. A tributary of the Raiko, which drains the Tasiro basin, deepens the steep slope and forms narrow valleys. These facts show that the Simotanna slope and the river systems on its slope had existed before the western steep slope of the Tasiro basin came into existence. That steep slope was formed so quickly that the rivers flowing on both sides of the Tanna fault zone could not deepen their valleys fast enough to follow the upheaval of the steep wall. It is the belief of the author that the steep slope limiting the west side of the Tanna fault zone in these parts is the fault scarp that rises relatively to the basin area, as supposed by the late Prof. Yamasaki.[61]

The Tasiro, the Karuizawa, and the Tanna basins have been formed by local sedimentation of the rivers Raiko and Kakizawa which were dammed up by the quick formation of the steep western fault scarp, from which it follows that the deposits in these basins are quite recent accumulations. The disastrous results of the earthquake in these basins may be understood partly from the fact that these younger materials are loose and not so compact from its having only been recently dammed and also from its tectonic character, as has been shown by borings made in the Tanna basin by the railway authorities.

Normally the beheaded part of the valley, through which passes the Atami highway, should drain the Karuizawa basin and its eastern part, but the dissection of the Kakizawa along the Tanna fault zone, which erodes so easily, was so quick that the upper course of the former was captured by the Kakizawa. The ground disturbances of the 1930 earthquake mostly occurred at the foot of the fault scarps. The outflow of the Tasiro basin was blocked by a fault, resulting in the formation of a small lake at the time of that earthquake.

The steep fault-scarp topography which disappears north of the Tasiro basin is replaced by other kinds of fault topography. Fig. 12 shows this fault topography, which terminates at a point on the north,

61) N. Yamasaki, *Jour. Geol. Soc., Tokyo*, **26** (1919).

602m. above sea level, on which the Yanai and Hatake tectonic line meet the Tanna fault zone. The north-south ridge of 602m., which is one kilometer long, obstructs the streams on the east slope from flowing west, so that the streams turn their courses towards the west and conflux with other streams flowing on the eastern slope around the southern end of the ridge. The eastern slope of this ridge is steep, while topographies similar to it may be seen arranged linearly in accord with the general trend of the Tanna fault, so that if the volcanic slope were generally smooth, these ridges would have been formed by fault activities.

Although in the earthquake of 1930, the earthquake rents or fissures were limited to the northern part of this region, on the western side of the ridge occurred the great landslide of Kobutano and Magano. Consequently the topography in the northern extension of the Tanna fault shows relatively simple but very interesting characters. The only explanation of the fault topography the author can offer is the upheaval of the east side of the fault zone relatively to the opposite side.

2) The Tanna basin, which is subpentagonal in plan, is situated 2km. south of the Tasiro basin. Its west side is not like that of Tasiro. Its east and west sides are more or less steep, while its south and north sides are relatively low. The steep side of the fault scarp west of the Tasiro basin turns westward along the Kakizawa at the Tanna Naga[62] and is cut by the Kakizawa valley. This steep slope does not continue to Okkosi,[63] Sinyama,[64] on the south side of the basin. The flexed boundary zone between the Tanakayama forest and the Simotanna province has affected the trend of the fault scarp. Or it may be considered that they were deformed by the erosive action of the Kakizawa river which denuded parts of the fault scarps and broadened its fluviatile plain. The earthquake fissures of 1930 occurred along the westerly foot of the isolated hill in the central part of the Tanna basin. This isolated hill is about 10m. or so in height, and consists chiefly of coarse-grained pumiceous sand stone beds dipping steeply toward the west. The fault that is inferred from the topographic characters does not however accord strictly with that of the earthquake fissures. In the tunnel under this basin, many parallel, vertical, or steeply inclined faults whose directions are almost meridional cut the Diluvial agglomeratic rocks. One of these parallel faults almost completely blocked the

62) 名賀. 63) 乙越. 64) 新山.

western drain drift of the tunnel.[65]

The writer looked down into the Tanna basin to observe the topographic character of the fault zone from the Ikenoyama pass, situated south of the Tanna basin about 320m. above sea-level and continuous with the floor of the Karuizawa village, which is situated between the Tanna and Tasiro basin about 3m. above the Tanna basin. He believes that the terrace may be an old river floor of the Kakizawa. It was however difficult to verify it geologically as the region consists mostly of Quaternary agglomerates, it being impossible to observe the terrace deposits in a state of good preservation.

As above stated, although the western topography of the Tanna basin is a relatively simple fault topography, the eastern side of the fault zone is somewhat complicated. The following briefly describes the topographic characters of the east side-wall.

3) The Atami pass fault. The narrow indented saddle, through which the Atami highway passes, runs in a N. 45° W. trend, its northwest extension skirting the Atami highway for 1 km., ending at the northern corner of the Tasiro basin, connecting the numerous Kernbut-like topographies. Its southern prolongation extends through Nisiyama in Atami to the northern limit of Atami town, connecting the saddle like topographies which are linearly arranged. These characters may be regarded as fault topography, which according to H. Kuno, may be confirmed geologically at the Atami pass and near Atami town. At the Atami pass, the same lava sheets on both sides of the fault line are dislocated.

4) The Ainohara[66] fault. The linear valley running from Wada[67] in Atami to Ainohara suggests a fault topography. This linear negative topography is traced to the northern part of the Tasiro village across the Atami highway and the north saddle of the 672·2m. point, which lies southwest of Atami pass. This fault has been verified geologically also by H. Kuno as the Ainohara fault.[68] In the earthquake of 1930, the wall of the Atami tunnel was displaced and cracked. These two fault lines above mentioned do not continue westward across the Tanna fault zone.

These faults, arranged obliquely to the general trend of the fault zone, were verified geologically and topographically. Some faults parallel to these two are also observed in this province.

65) R. Takahasi, *Bull. Earthq. Res. Inst.*, 9 (1931), 435–475.

66) 相原. 67) 和田.

68) Y. Ôtuka and H. Kuno, *Bull. Earthq. Res. Inst.*, 10 (1932), 472–475.

5) Of the parallel are shaped fault topographies east of Karuizawa, one runs from the 250m. point east of Tasiro to Takizawa[69] of the Tanna basin, while the other is situated parallel to the east one. If the surface of these ridges bounded by these fault topographies are the fragments of a contemporaneous topographic plain, this feature should be considered as a step fault topography with the downthrow side on the west. The Tanna fault zone may be a new variant of the graben or Willis' "ramp," bounded by a reversed fault on the west and by a normal stepped fault on the east.

The southern part of the east side-wall of the Tanna basin is more or less steep, but there the step-fault topography is not clearly observable. The isolated hill in the Tanna basin mentioned above may be the top of a block thrown down step fashion by the faults.

6) In previous paragraphs it was stated that the arc-shaped trough-like zone, running from Okkosi to Ukihasi[70] and Tawarano[71] across the Ikenoyama[72] pass along the Hukazawa valley, is a fault topography. The gentle slope of the Tanakayama forest is abruptly limited by this zone, having a surface inclined steeply to the floor of this trough as in the case of the western wall of the Tasiro basin. But it differs from the west wall of Tasiro in the existence of an isolated hill clinging to the steep surface. The isolated hill north of Ukihasi, especially, may be regarded as a "kernbut" and "kernkol" topography. The earthquake faults of 1930 appeared on the "Kernbut" part as shown in Fig. 37. The southern part of the west side of the Tanna fault zone generally has high steep walls, while the eastern slope inclines very gently westward. The parallel step fault topographies as seen in the Tanna basin disappear in this slope.

7) The Yamabusi[73] fault. Near the Yamabusi pass is observed a faults system lying N. 60° W. In the northeast part of it, other fault topography suggesting a kettle fault are developed as shown in Fig. 2. The NE side of this fault is depressed relatively to the opposite side.

8) The Yasuno[74] fault. The northern valley of Yasuno, 1500m. north of Tawarano, suggests a hinge fault topography, its west wall being steep, while its east side is gentle. The difference in height of the two sides is fairly large—about 100m. or so—decreasing as one goes northward. The writer has illustrated the topographic fault in Fig. 2.

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69) 瀧澤. 70) 浮橋. 71) 田原野. 72) 池ノ山. 73) 山伏.
74) 安野.

No geological evidences were obtained.

9) Southern extension of the Tanna fault. As to this question, topographic evidences of the extension are obtained along the Oono valley. It is not correct that the southern extensions are topographically observed between Warabo-Hiekawa[75] as generally stated, but as will be explained later, geological evidences may exist in the valley of the Hiekawa.

But ground disturbances occurred in the earthquake of 1930, and the many geologic faults that cut the Zyô beds in Oono valley seem to support the idea that the Ono valley is a fault valley.

10) Distribution of the river pattern on both side of the Tanna fault. Fig. 9 shows the distribution of river pattern on both side of the Tanna fault. As shown in Fig. 9, the valleys on the west side of the Tanna fault correspond roughly with those on the opposite side, as if they had been continuous valleys at one time before the activity of the Tanna fault zone.

But it must be noticed that the pattern of the western valleys must have been displaced north along the Tanna fault zone about 4km. or so in order to correspond accurately with the eastern. That is to say, the corresponding eastern valleys are situated always relatively north to those on the west. The streams on the east slope turn their courses southward along the Tanna fault zone, and then readjust themselves westward to the western valleys.

The earthquake faults of 1930, dislocated the western block horizontally, southward, about 3m. or so relatively to the eastern along the Tanna fault zone. The characteristic topographies of the river pattern above mentioned may therefore have been formed by repeated horizantal dislocation.

Consequently the Tanna fault zone is a young topographic fault zone consisting of some distributed minor parallel faults. The west side of it is generally thrust on the east side with steep fault planes. But careful observations show that the lowland of the fault zone is the depressed zone bounded on the west side by reverse fault planes, and on the east side by normal fault planes.

The river pattern on both side of the Tanna fault zone suggest that the horizontal dislocations were repeated during faulting, and had shifted the west side of the fault zone to the north relativelly to the

75) 原保一冷川.

east side in the same sense as those in the earthquake faults of 1930.

VI. The Simoômi province.

The southeast side of the valley which drains the Tawarano basin is a geologic and topographic province. As seen in the summit-level, this province gently slopes southwestward. The finely stratified volcanic sands cover but thinly, but they dip so steeply that the writer doubted if the crustal disturbances had occurred after the deposition of the ashes. But this steeply dipping stratification may be the usual condition of the volcanic sand as is seen easily in a volcanic region.

The gentle relief shown by the summit-level is dissected into narrow spurs by streams flowing southwest and confluxing with the Kano. On the walls and floors of the valleys the lava flows are exposed beneath the volcanic ashes, while in places mud and conglomerate alternately appear under these lava flows.

These alternative beds which are typically developed near Zyo, Simoômi-mura, were called Zyo beds by Tayama and Niino.[73] In the type locality, the Zyo beds are alternations of mud, sand, and pumice.

The Zyo beds consist of brown sand at the lowest horizon, followed by thinly altered pumice or tuff bearing beds and more or less hard, grey mud beds containning some fossil shells and foraminifera. Northern exposures of this mud bed contain some fossil leafs, e. g., *Fagus crenata*, etc. The species of fossil mollusca and foraminifera from the Yokoyama fossil zone in the lower part of the Zyo beds are *Limopsis tokaiensis* Yokoyama and *Glycymeris pilsbry* (Yokoyama), and many other species now living in the open seas. Table 5 shows these fossil mollusca and foraminifera. The faunal characters of these beds differ little from the living fauna of Suruga bay. The writer believes these beds to belong to the uppermost Pliocene or lowest Pleistocene, most probably to his dlI. (Fig. 10).

According to Prof. Tsuya, the fossil bearing Zyo beds may be related to the mud alternations of Simotanna, the former occupying a slightly lower horizon. The petrographic characters of the pumice indicate that the Simotanna beds are contemporaneous with the Tutizawa beds of the Ooiso block, and that the horizon is slightly higher than the Ninomiya bed of the Ooiso block which is overlain by the Tutizawa beds, while the Ninomiya beds may be upper Pliocene in view of its palaeontological character and sedimentation cycle.[74] The stratigraphic correlation schemed

73) R. TAYAMA and H. NIINO, *op. cit.*, (1931).
74) OTUKA, *Geogr. Rev.*, Japan, 8 (1932).

Table V.

List of fossil foraminifera and mollusca collected from Zyo beds which crop out Yokoyama, near Zyo.

Foraminifera

Baggina zyoensis Otuka M. S.
Bolivina robusta Brady.
Bolivinita quadrilatera (Schwager).
Bulimina sp. (*aculeata* var.?) no. 2.
Cassidulina orientale Cushman.
Cassidulina subglobosa var.
Cibicides lobatulus (Walker et Jacob),
Cibicides lobatulus var.
Cibicides sp. 4.
Cibicides wuellerstorfi Schwager.
Elphidium crispum (Linné.)
Eponides praecincta Karrer.
Eponides sp.
Frondicularia sp.
Globigerina bulloides d'Orbigny.
Globigerina dubia Egger.
Globigerina inflata d'Orbigny.
Globorotalia tumida (H. B. Brady.)
Globorotalia aff. *oblonga* (Williamson).
Globorotalia truncatulinoides (d'Orbigny).
Guttulina sp. no. 1.
Gyroidina soldanii d'Orbigny.
Lagena strumosa Reuss.
Lagena sp. no· 1.
Lenticulina sp. no. 6.
Lenticulina sp. no. 7.
Lenticulina ? sp.
Lenticulina sp.
Loxostomum karreiana (H. B. Brady).
"*Nodosaria.?*" sp.
Nodosaria (*Dentalina*) *consobrina emaciata* (Reuss).
Nodosaria sp. no. 1.
Nodosaria (*Glandulina*) *rotundata* (Reuss).
Nodosaria scalaris (Batsch).
Nonion boueana d'Orbigny.
Nonion sp.
Nonionella sp.
Orbulina universa d'Orbigny.
Pattellina aff. *corrugata* Williamson.
Patellina opercularis d'Orbigny.
Pseudopolymorphina sp.
Pyrgo vespertilio Schlumberger.
Pyrgo denticulata ? (H. B. Brady).
Pyrgo sp. 4.
Pyrgo aff. *elongata* (d'Orbigny).
Quinqeloculina sp. 4.
Quinqueloculina disparilis d'Orbigny.
Quinqueloculina sp. 10.
Quinqueloculina sp.
Quinqueloculina sp.
Rectobolivina bifrons (H. B. Brady).
Rotalia sp.
Robulus sp.
Sigmoidella sp. nov.
Spiroloculina grata Terquem var.
Spiroloculina sp. no. 1.
Textularia conica d'Orbigny.
Textularia aff. *sagittula* Defrance.
Triloculina tricarinata (d'Orbigny).
Triloculina trigonula (Lamarck).
Uvigerina pygmae d'Orbigny.

Mollusca

Cylichna sibaensis Yokoyama.
Erato callosa Adams.
Fusinus nipponicus ? Smith.
"*Pleurotoma*" *braunsi* (Yokoyama).
Inquisitor sp.
Lora yokoyamai Onoyama
Bela sp.
Natica sp.
Typhis arcuatus Hinds.
Leptothyra rubra Dunker.
Dentalium totomiensis Makiyama.
Patellina sp.
Haliotis ?. sp.
Yoldia ninomiyaensis Otuka M. S.
Glycymeris pilsbry (Yokoyama).
Limopsis tokaiensis Yokoyama.
Limopsis adamsiana Yokoyama.
Lima quantoana Yokoyama.
Lima subauriculata (Montagu).
Pecten laqueatus Gould.
Chlamys sp. (irregularis ?)
Anomia sp.

Tellina sp.	*Lucina acutilineata* Conrad
Venericardia ferruginosa A. Adams et Reeve.	*Volsella* sp.(Fragmental).
Myadora fluctuosa Gould.	*Brachiopoda* sp. (fragmental).

by Prof. Tsuya has been confirmed palaeontologically. The continuation of the Zyo beds are exposed on the dissected valley floor of the Simotanna slope.

The Zyo beds are flexed, faulted, and reversely faulted, and in places intruded by andesite dykes. The muddy sand of the Zyo beds exposed near Simotanna and Simohata are covered with Tanakayama lava as already stated. But the only fossil remains obtained here were fragments of fossil plants. From this geologic structure of the Zyo beds, it may be concluded that the southern extension of the Tanna fault zone once extended southward.

The Zyo beds exposed near Oono, which is an alternation of sand and conglomerate, is overlain by lava flows, and unconformably underlain by the Simosiraiwa beds of Tayama of the Older Neogene. In these

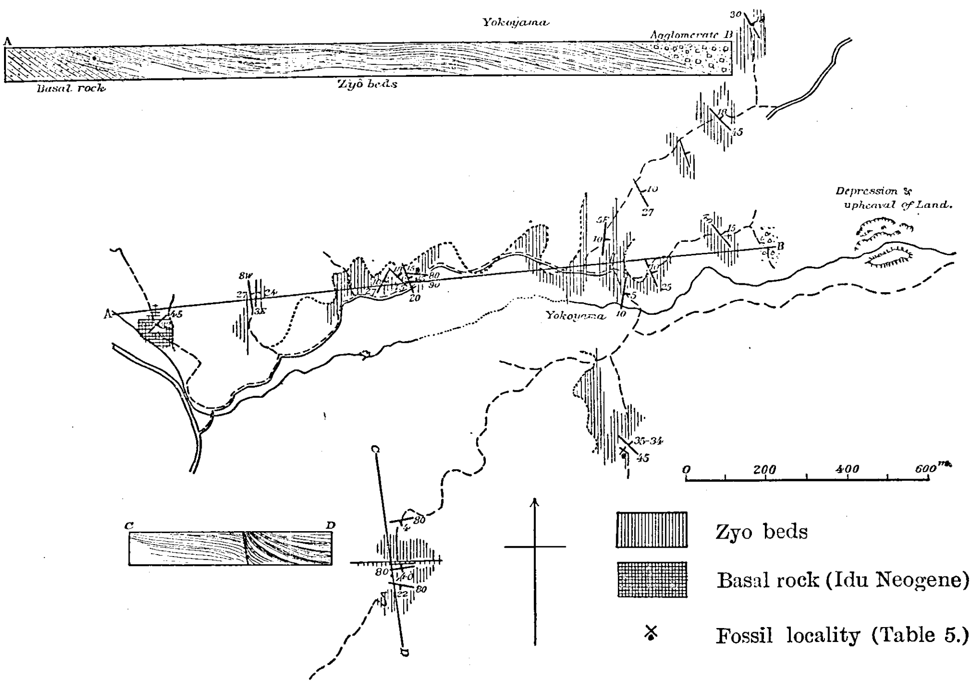

Fig. 10. Geologic route map near Zyô.

Oono valleys, the Zyo beds are severely disturbed by faulting parallel to the general trend of the Oono valley, suggesting that early Pleistocene tectonic movements occurred in this Oono valley. These exposures are seen on the northwest valley wall near Oono. Fig. 11 is a sketch of these faults exposed at Oono.

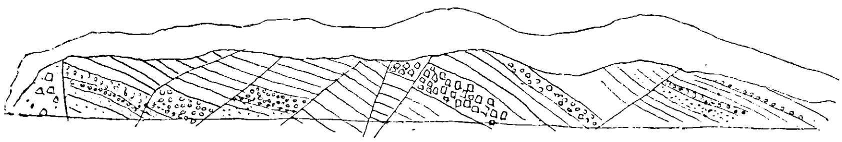

Fig. 11. The faults exposed on the cutting near Oono

The Zyo beds are exposed in the upstreams of the Tosikawa[75] valley in the same way as in the Oono valley. The beds here consist of pumiceous muddy sand and conglomerate, dragged and flexed at the southeast limit of the exposures as a result of faulting.

The sand and gravel alternation of the upper courses of the Kamisiraiwa[76] may belong also to the Zyo beds, covered by the Sukumo[77] lava. The alternation is' horizontally in the large exposures of the eastern valley of Kamisiraiwa, but flexed upward in the southern limit of the exposure. The underlying Neogene rock exposed at the mouth of the Simosiraiwa valley contains many foråminifera. Hanzawa[78] has reported from these beds *Lepidocyclina* (*Amphilepidina*) *nipponica* Hanzawa, *Lepidocyclina* (*Amphilepidina*) *angulosa* Provale, etc.

VII. The Darumayama[79] province.

As the writer has not yet fully surveyed this province, only a few observed facts will be treated here. Darumayama, which is a Diluvial volcano like Taga, erupted on the southern part of the Wasidu[80] mountainland. Although the volcano lacks its western half, its broad skirts extend to the bay of Mito and Suruga and to the Kanogawa valley. Recent river erosion has dissected these skirts, sculpturing many radial valleys. These slopes consist of thick two-pyroxene andesite agglomerates covering Neogene agglomerate. This stratigraphic relation may be seen near Bentenzima, Omusu village, on the shore of Mito bay. Some lenticular conglometrate and sand beds exposed between the Darumayama volcanic materials and Neogene agglomerate is considered by Tayama to be the same as the Zyo beds. But in the writer's opinion they may be younger

75) 年川. 76). 上白岩. 77) 巣雲. 79) 達摩山. 80). 鷲頭.

78) S. Hanzawa, *Sci. Rep. Tohoku Imp. Univ.*, Sendai, Geplogy, **13** (1932).

than the Zyo beds, judging from its constituent materials and stratification.

The northeastern part of the Darumayama slope is divided by the high Hottanzyo-yama in the Wasidu mountainland into two slopes, the northern (Mito bay) and eastern (the Kanogawa valley). The eastern slope is well observed on the upper course of the Syuzenzi valley.

The geologic history as deduced from the foregoing is that this province was denuded and dissected after the late Tertiary crustal movement. The reliefs as shown in the Wasidu mountainland, which will be described later, were covered by volcanic materials ejected from the Darumayama. But the reliefs near Mt. Hottanzyo and Wasidu are often so high and steep that the materials did not cover these provinces. the activity of the Darumayama was then followed by the dissection of the volcanic slope and many radial valleys were sculptured, e. g. Kioi, Osumi, Syuzenzi valley, etc.

The submarine topography of Suruga bay (Fig. 2 and 17), which shows the drowned valleys extending from the mouth of the numerous land valleys to the sea, suggests that this area subsided after the formation of these radial valleys. These radial valleys therefore were formed in pre-Alluvial time or before the formation of Misima fan, which fills a similar valley in the Hakone slope.

VIII. The Wasidu mountainland.

As shown in Fig. 2, the west side of the Kanogawa Alluvial plain is a steep relief region, the Wasidu mountainland, which is higher than the regions referred to so far, the difference of height in an area of nearly 4 sq. km. being about 350m.

This mountainland consists of Neogene pyroclastic sedimentary rocks and igneous rocks, all lower Pliocene or lower Miocene. Fig. 6 is a geologic sketch map of this province. In the province treated thus far the old erosion surface of Neogene rock is covered thickly by younger volcanic detritus and sediments, while in this mountainland no covering strata are seen. Whether the Wasidu mountainland was covered once by young formations, and they have been removed by recent erosions, or whether from the beginning of the Diluvium young formations have not covered this mountainland, there is no young formation there now. The structural relation of the young formations to the old erosion surface of the Neogene rock observed in the other provinces previously dealt with, suggests that the latter case is more probable than the former, seeing that the high peaks of Hottanzyoyama (or Katuragisan), which consist of Neogene rock (see Fig. 2), rises above the projected slope of Darumayama. It can therefore only be concluded that the old erosion surface of the fairly high old Neogene rocks were in existence in these provinces before the volcanic detritus of the Darumayama had accumulated. The stratigraphic relation of the Tanakayama lava flows to the Neogene bed rocks suggests that the mountainland of Neogene rocks were in existence at the time of the pre-Tanakayama lava. The Wasidu mountainland may therefore be a ruined topography of late Tertiary land surface, deformed by recent erosive action.

As above stated, no young formations exist in this province, where the writer failed to find any landslides or other ground disturbances caused by earthqnakes on account of the unconsolidated nature of the materials.

Brief summary of the post-Neogene geologic history of Northern Idu.

From the foregoing geologic and geomorphologic studies of these provinces, the following geologic history is inferred:

I. The formation of the erosion reliefs of the Neogene rocks.

The stratigraphic relation of the Neogene rock to the young lava flows and igneous materials in these provinces is the clear unconformity as seen in the western limit of the Tanakayama forest or the northerly limit of the Darumayama slope. Moreover the boundary surface of the unconformity has very irregular reliefs in the large relative heights, while the boundary plane between the Simotanna (plant) beds (Zyo beds) and the overhanging young volcanic rocks is not so irregular as that between the Neogene and the young volcanic rock. From these evidences, it is inferred that during late Neogene, the land surface of these provinces were dissected into fairly great relative heights.

II. Transgression of the waters that formed the marine and lacustrine Zyo beds.

As above stated, the distribution of the marine Zyo bed is limited to near the village of Zyo, Simoômi province. Although volcanic materials from Amagi volcano cover this marine deposit on its eastern limit of distribution, no marine deposits are seen in its western part, their places having been taken by young lava flows and old Neogene rocks. Consequently the sea, which deposited the marine Zyo beds, invaded this province, probably from the southeast, where it is covered by volcanic materials from Amagi. During the same age the fossil plant bearing sedimentary rocks below the Tanakayama lava, together with that of Simotanna, were deposited in the depressed meridional zone. This depressed zone is cut diagonally by the topographic fault of Oono during post-Tanakayama lava. Since the Neogene the volcanoes maintained their activities. The period of Prof. H. Tsuya's[81] dacite tuff activity may correspond to the same period.

It is probable that at this stage, neither the Wasidu mountainland the west half of the Tanakayama forest and the Simotanna province, nor the Darumayama province were covered with any young formations.

According to Prof. Tsuya, complicated overthrust structures were formed in the Simotanna province. Old Simotanna sand and mud alternation beds thrust from the west over young lava flows. But the land surface of the complicated structures had been denuded, leaving no visible evidences on the land surface.

III. Extrusion of the lava flows forming a gentle surface.

In the Tanakayama forest, which is the south part of the complicated region, the Tanakayama lava-flows from Taga volcano cover these complicated structures with unconformity, so that the overthrust structure of Simotanna antedates the Tanakayama lava flow. The flexed structure of the Zyo beds may be traced also to this period. After the flexing and overthrusting, the Tanakayama lava overflowed this province. By this time the ancient lowland of the Kanogawa had already formed at the same place as that of the recent Kanogawa alluvial plain, while the south ends of the Tanakayama lava that extends to the lowland through the lower part of the mountain ridge also existed during this period.

IV. The formation of the Tanna fault zone.

After the extrusion of the Tanakayama and the Yugawara lavas, the Tanna fault zone began to make its appearance. The west part of the fault zone overhangs the depressed blocks and is shifted repeatedly toward the south compared with the east side. At this period were formed the diagonal fault of Atami pass and other faults. The imaginary tectonic line joining Yanai and Hatake was probably formed during this stage, when the southwestern slope of Mount Hakone, north of the line, was lowered slightly to the southern side. The Hakone volcanic materials then accumulated on the lower northeast side. The surfaces of the Kasiwanokubo and the Hatake terraces were formed at this stage. The flexual movement that divided the Kasiwanokubo from the

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81) H. Tsuya, *Bull. Earthq. Res. Inst.*, 9 (1931).

Hatake probably occurred in the early stage of this period, followed successively by late Diluvial dissections, the formation of the Misima fan and the accumulation of the Alluvial deposits. More recently the land near Numadu upheaves. 10 m. or so.

The Ground Disturbances of Nov. 26, 1930:

The ground disturbances of Nov. 26, 1930, will now be described in the order of the eight geologic provinces that were affected.

I. The Kano-gawa Alluvial plain. As the ground disturbances of the Kano-gawa Alluvial plain have been described by the writer in a previous paper, their description will be omitted here, except of one example which occurrad on the Hirai terrace. At Hirai, Kannami-mura, a small village along the Atami highway, which suffered heavily from the earthquake, small parallel earthquake cracks running N. S. were noticed; an example of the fact that the boundaries between two beds having differerent physical properties are liable to suffer from severe ground disturbances. Here, the village of Hirai is situated on the geologic boundary of the Hirai terrace and the Simotanna slope.

II. The Southwestern slope of Mount Hakone.

The ground disturbances in this province occurred in its eastern part. The Tôkaidô highway, repaired just before the seismic disturbances, was shaken so severely that the piled up loose soil of the new highway broke off and slipped down along the steep slopes. Parallel meridional fissures were observed near the Yamanakasinden,[82] while on the southern slope of the village of Yamanakasinden a heavy land slide occurred, completely burying seven persons. Near the top of The Hakone pass many earthquake fissure formed on the volcanic cinder slope. Buts these fissures being merely manifestations of some underground tectonic activity, require no special mention. The Hakone station of the Central Meteorological Observatory was damaged and the anemograph tower tilted.

The present writer believes these earthquake fissures were formed by the action of gravity, the loosely accumulated ashy volcanic materials sliding down on account of the violent earthquake vibrations—materials materials that were poised in a state of unstable equilibrium on the upper part of the steep slope formed by recent river erosion.

II. The Tanakayama forest.

Ground disturbances in this province are rare, only some minor

82) 山中新田.

depressions, landslides, and earthquake fissures having been observed. According to Ihara and Ishii,[83] a depression cccurred on a gentle slope about 1km. west of Yasuno. The ground, which consisted of volcanic ash and gravels was depressed for about 5 to 7 m. and surrounded by a horseshoe-shaped scarp of about 110 m. length. On the 278 m. ridge about 1500 m. east of Nirayama, some earthquake rents were observed by the writer (Fig. 19). They caused a horizontal displacement of 20cm. N.60°W. in a path a metre wide. The southwest side of all the rents were depressed 5cm.

In the eastern limit of this forest many earthquake fissures were formed. Their distribution is shown in Fig. 12 and 13. The west side of these fissures however was depressed relatively to the opposite side. Fig. 20, 21, 22 also show the distribution of these fissures.

IV. The Simotanna province.

On the Atami highway, about 400 m. west of Binnosawa village, an earthquake rent ran across the highway in direction almost N.30°W. The vertical displacement was about 30 cm., relative to the west side block. The horizontal displacement is very small. Near Simotanna village, the many earthquake fissures formed are of no special interest.

Seismic disturbances in the Atami tunnel, joining Atami and Ootake[83], have been reported by the government Railways. According to this report, written by Prof. R. Takahasi[84]; "faults and fissures appeared in the tunnel. At a point between bench marks Nos. 3 and 4 on the west side of the tunnel, a vertical dislocation of about 40 cm. was measured. The most remarkable fault in the tunnel appeared near the heading of the third south drain-drift on the west side. The displacement, which was nearly in a horizontal direction, was as much as 270 cm., so that the drain tunnel was completely closed by a fresh slickenside. . . . ."

V. The Tanna fault zone.

The ground disturbances on the Tanna fault zone are very interesting both geologically and geomorphologically. The present writer, for convenience, divides the Tanna fault zone into subregions.

a. Tasiro basin (Fig. 12).

In the Tasiro basin, situated on the northern limit of the Tanna fault zone, earthquake faults run N.-S. at the foot of the steep west slope (Fig. 29, 33, 34). Fig. 34 shows the torii (which was partly broken

83) K. IHARA and K. ISHII, *op. cit.*, (1932).

84) R. TAKAHASI, *op. cit.*, (1931).

by the earthquake) displaced toward the right (north) about 1.5m. relative to the stone steps on the west slope by the earthquake fault which runs between the torii and the stone steps at the same foot. It is visible in a field on the southwest corner of the basin, forming small parallel fissures arranged *en echélon*, and crosses the head of the valley which drains the basin. At the mouth of the basin, the ground surface was depressed and the water dammed (Fig. 28). The displacement of the fault is about 1m. horizontally and 30-60cm. vertically. The west side of this rent was depressed.

The northern extension of this rent goes N. 20° W. from the mouth of the basin to a point 500m. southwest of point 604. 5m. and creeps up the west scarp. The earthquake rents appear discontinuously, *en echélon*, gradually decreasing in number as they go northward (Fig. 25, 26). In the kernkol and kernbut topography on the northern end of the Tanna fault zone referred to in previous sections, minor earthquake fissures with small diaplacements run N. 20° W. But on the western slope of the kern-kol, landslide (Fig. 23) occurred on a large scale, and mole-track and ploughshared like ground disturbances (Fig. 24, 27, 30) were formed above the land slide. The distribution of the ground disturbances is shown in Fig. 12.

b. Karuizawa and Tanna (Fig. 12.)

The earthquake fault runs from Tasiro basin through the western portion of the village of Karuizawa to Tanna basin, along the foot of the steep west scarp of the Tanna fault zone. The earthquake fault cuts the weathered agglomerate materials on the west wall of the Atami highway, west of Karuizawa village. The displacement of the fault here amounts to 60cm. vertically and 1m. horizontally, shifting the west side block of the earthquake fault southward and downward. North of Karuizawa, the earthquake fault runs through the base of the reservoir and has shifted a fence about 1m. or so horizontally (Fig. 31). Its displacement is in the same sense as the one previously mentioned.

The fault extends half way up the spur of point 405m. and then descends to the Tanna basin plain across the river Kakizawa at Naga.

In the Tanna basin, the earthquake fault leaves the western scarp and runs N. 10° W. from the western limit of Naga village to Okkosi, through the western foot of the hill (Kawaguti no Mori).

The small road that joins Tanna Nisikata and Takizawa and crossed by an earthquake fault running N. 20° W., has been displaced 1–0·7m. horizontally (Fig. 32). The fault here is continued by short earthquake fissures running N. 45° W. and arranged *en échelon*.

In the rice field, west of Kawaguti no Mori,[85] the faults are continued. The western block here was shifted 1m. horizontally, southward relatively to the eastern block.

Near Okkosi, the earthquake fault shows the largest displacement of all, amounting to 2–2·6m. horizontally in the same sense as previously mentioned. The distribution of the earthquake fault in the Tanna basin is shown in Fig. 12.

c. Ikenoyama pass (Fig. 13).

The Ikenoyama pass between Tanna basin and the Ukihasi basin was disturbed by an earthquake fault in such a way as to make it appear that the west side of the pass had shifted 1m. southward relatively to the opposite side, along the topographic fault line. An earthquake fault runs N. 20° E. in the northern valley of the pass and another one N.10°W. in the southern part.

The earthquake fissures running E.-W., resulting from the earthquake fault, traverse a road joining Ukihasi and Ikenoyama near the north margin of the pond at Ikenoyama.

On the northern slope of the Ikenoyama pass, a meridional earthquake fault is cut abruptly by the earthquake fissures running E.-W. These fissures were observed on the southeastern slope of the Tanna basin. It seems that these fissures are intimately related to the boundary zone of the Tanakayama forest and the Simotanna province already mentioned.

On the kernbut topography of the steep east slope of the Tanakayama, appeared a group of small parallel earthquake faults (Fig. 36, 37). The west side of each fissure had shifted southward about 30cm. It may therefore be said that this fault topography was traced by means of this earthquake. Fig. 37 shows the group of small parallel earthquakes faults just mentioned.

d. Ukihasi basin (Fig. 13).

According to Ishii and Ihara, the ground disturbances of the Idu earthquake may be grouped into the Ukihasi east earthquake fault, the Ukihashi central earthquake fault, and the Ukihasi west earthquake fault.

The Ukihasi east earthquake fault (not observed by the writer) displaced the road that connects Yamabusi and Ukihasi, horizontally in the same sense as in the Tanna fault zone.

The Ukihasi central earthquake fault is the southern prolongation

85) 川口の森.

of the Tanna earthquake fault. It traversed the western part of the Ukihasi basin, cutting through the low ridge between this basin and the Tawarano basin.

The eastern block here subsided about 1m., in opposite sense to that in the northern part of this fault zone. The horizontal displacements here are about 1-2m. in the same sense as those already mentioned (Fig. 38).

The houses and rice fields on this fault line were severely damaged.

The Ukihasi west earthquake fault, referred to by Ihara and Ishii, may be the same earthquake fissure that appeared on the kernkol topography on the steep slope of Tanakayama forest. According to these writers the south part of this earthquake fault reappeared in the west part of the Ukihasi basin and shifted the west side block southward 1.5m.

e. The Tawarano basin. (Fig. 13).

The Tanna earthquake fault extends to this basin, but disappears in the southern corner of it, where another diagonal fault appears with direction N. 70° W. Fig. 40. shows a displaced rice-field dyke cut by the diagonal earthquake fault.

f. The Oono fault.

The earthquake fault in the Oono valley extends from Oono to Kadono across the Oomi valley. Appearing first in the sunken topography in the hills back of Oono village, it gradually descends to the valley floor of Oono. The horizontal and vertical displacement here is small. But the northwest side of the fault has shifted southwestwards relatively to the southeast side.

Near Doodoko, Oono-mura, an earthquake fault which runs N. 45° E. has shifted nearly 1m. horizontally and depressed the northwest block 60cm.

On the back surface of the ridge, southeast of Doodoko, a group of earthquake fissures appeared parallel to the Oono valley, shifting the west side of the slope 0·6m. southward. This earthquake fault runs across the Oono valley and appears on the Oomi valley near Kadono.

Across the saddle-like part of the spur between the Oomi valley and the Oono valley, the earthquake fault runs N. 10° E. See Fig. 14. These displacements are in the same sense as those last mentioned. The horizontal displacements here are about 1m. N., on the east side of the fault. The Itô-Syuzenzi higaway was displaced in the same sense as that in the Oono valley. This earthquake fault which extends from the Tanna earthquake fault line disappears in the hill back of Kadono.

VI. The Simoômi province.

As the writer could not make a thorough survey of this province, only a short description is here made.

a. The Himenoyu[86] earthquake fault appears discontinuously from Warabo to Kumokane valley through Himenoyu valley, the displacements of the fissure at the top of this valley being 0·3 m. horizontally, while on the south side of Himenoyu earthquake fault is shifted to northwestward.

b. Depression and upheaval of the ground at Zyo.

On the southern part of the spur, in Zyo-mura, 230–250m. above sea-level and 200m east from Yokoyama, an elliptical area with its longer axis about 180 m. and its shorter axis about 80 m., sank about 10–20m., while a long narrow hill about 150m. long and 15 m. wide was upheaved about 5m. above the land surface. Fig. 10 is a sketch map of these areas. Houses on the upheaved area were so little affected that the furnitures and utensils retained their positions with not even the spilling over of liquids, facts indicating that the landslide occurred very slowly.

These areas consist of volcanic ash like the Kwantô loam, with Zyo beds and Sukumo lava exposed around them, as shown in Fig. 10. Between the upheaval land and the depressed grounds a stream is deepening its floor. From these facts the present writer concludes that these upheavals and depressions of the land may have been caused by a sort of landslide which moved slowly by gravity, whereas the upheaved and depressed parts were set in motion by the vibrations of the earthquake, and in slipping down broke into a number of small blocks.

c. Kaziyama,[87] Simokano-mura. The surface soil at the head of a small valley between Sano and Kaziyama, or the western slope of Okunoyama (406m.), slipped down through this valley. Portions of the moving soil were thrown across the Kano-gawa to Sano on the opposite side of the river.

VII. The Darumayama province.

VIII. The Wasidu mountainland.

In these two provinces, the effect of the ground disturbances of Nov. 26, 1930, was so slight that it does not call for any mention.

The bank of the reservoir at the Syuzenzi hot springs was broken by the earthquake shock, resulting in the dammed water inundating

86) 姫ノ湯. 87) 梶山.

he lower part of the spa. In a quarry at Enoura, Enoura bay, northeast of Suruga bay, some boulders were shaken down by the earthquake.

Summary of the ground disturbances of Nov. 26, 1930.

From the foregoing observations, the ground disturbances in these provinces may be divided into the following four groups:

1) Slipping of fissured land surface due to gravity and set in motion by the earthquake.

2) Landslides.

3) Fissures formed by the shearing stress of the earth's crustal distortion.

4) Ground disturbances occurring along old tectonic lines.

1) The first type of earthquake fissure is observed in all these provinces. It occurred on the surface of loose material, such as on the slopes of volcanic ash, Alluvial plains, and soils piled on the road.

But the slopes of volcanoes in these provinces being dissected deeply by river erosion, volcanic materials accumulated on high cliffs are situated in unstable equilibrium, subject to the action of gravity. Violent earthquake shocks shake down these loosely held material, resulting in many fissures on the land surface caused by the slipping, examples of which may easily be seen in the western slope of Mount Hakone, the Tanakayama forest, Simoômi, and Darumayama. Most of these land surface are covered densely with grass and bushes. It seems that the slipping was effectually prevented by the vegetation.

2) The second type of landslide is an extreme form of the first type. Here gravity exceeds the resistence of the accumulated soil and vegetation, thus limiting these landslides to steep slopes where gravity easily exceeds the resistance and causes the landslide. Examples are the steep southwest slope of Yamanaka-sinden, Kobutano and Magano, Oono, Kaziyama, and Zyo. The landslides of Zyo however move much slower than the others.

3) The third type is to be seen in the Alluvial plain, as the writer has referred to in connection with the Kano-gawa Alluvial plain.

4) The fourth type of ground disturbance, which is the most important, occurred along the old tectonic line. The Tanna earthquake fault occurred in the fault zone which was established geologically.

These displacements were in the same sense as the foregoing, as inferred by the arrangements of river pattern.

These southward shiftings of all the western blocks is the outstanding feature with the earthquake fissures and faults that took place Nov. 26, 1930.

As stated by the writer in an earlier paper, the Idu peninsula is situated on the southern part of the Fossa Magna, which dates to the Neogene. According to Professor H. Yabe,[88] Southwest Japan is cut off by the Itoigawa-Siduoka line, which is the west side of the Fossa Magna.

According to the writer's geologic study of the southwestern part of the Fossa Magna, it is inferred that many thrust faults occurred during post-Tertiary, and that the western blocks of those faults moved southward, relatively.

It may then be said that the displacements of tectonic lines in this megatectonic zone are repetitions of similar shiftings that have been taking place since the late Tertiary. In view of the foregoing, the Idu peninsula probably suffered always from megatectonic shearing stresses as above stated. Incidentally the North Idu earthquake of Nov. 26, 1930, stimulated local release of this stress, the region having been relieved of this stress by the horizontal shifting along the old fault plane.

Ground disturbances and crust deformations, pre- and post-seismic disturbances associated with the earthquake of Nov. 1930, and the geomorphology of these regions.

Soon after the Idu earthquake of 1930, precise levellings and triangulations were repeated by the Military Land Survey. The results of these measurements have been treated by Prof. C. Tsuboi[89] in this bulletin.

According to him, there is a block boundary between bench marks Nos. 54 and 56. The displacement that occurred between bench marks Nos 54 and 55·1, is about 360·6 mm., the two last-named bench marks being in the Tanna fault zone. The earthquake fault, as previously described, crosses the levelling route between bench marks Nos. 54 and 55·1. The bench marks in the Tanna fault zone are much depressed relatively to other bench marks.

According to the same investigator, post- seismic displacements of bench marks between Nos. 57, 56·1, 56, and 55·1 show tilting of the block towards N. 50°E. This tilting is not inconsistent with conditions relating to the ground disturbances of the Tanna fault zone.

88) Y. OTUKA, *Bull Earthq. Res. Inst.*, 9 (1931), 340, foot note.

89) C. Tsuboi, *Bull. Farthq. Res. Inst.*, 9 (1931), 271-290.

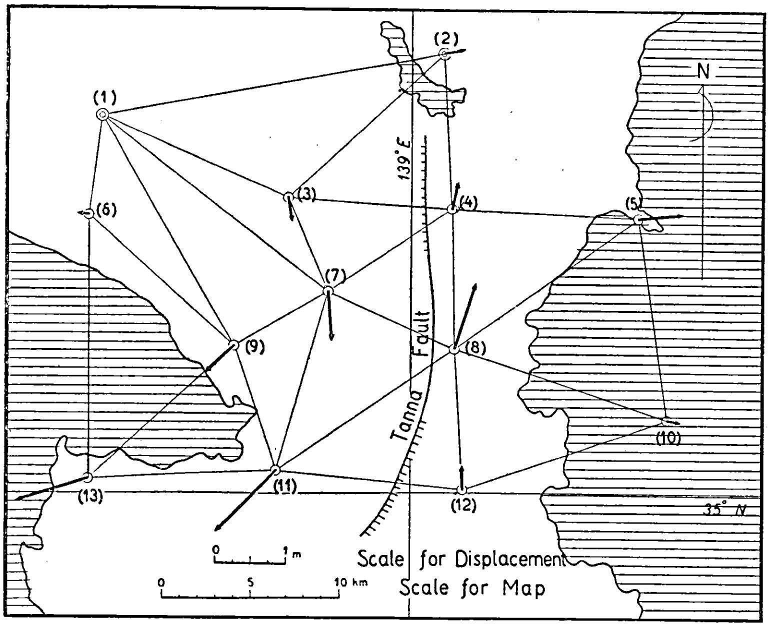

Fig. 15. Map showing the displacement of triangulation point in Northern Idu (after C. Tsuboi).

The movements of triangulation points indicate the distortion of Northern Idu. The displacements of the earthquake faults may be explained by shear action due to the distortion (Fig. 15). These horizontal displacements of triangulation points are in the same sense as that of the earthquake faults and the geomorphologic faults (Fig. 2).

Concluding remarks.

As stated in the foregoing, the geologic structure of Northern Idu, the pre- and post-seismic crust deformations as revealed by surveys, and the ground disturbances associated with the Idu earthquake of Nov. 30, 1930, are all closely connected with one another. The conclusions from this study may be stated as follows:

The post-Tertiary geologic history of Idu peninsula as shown in table VI.

Volcanic activities in this region were most marked during the post Tertiary. The topographic Tanna fault zone came into existence after the Tanakayama lava. The Tanna fault zone is graben or a ramp, the western limit of which is the reversed fault, the eastern limit of which may be normal. The river patterns on both sides of the fault zone

Table VI. Post-Tertiary geologic history of Northern Idu Peninsula. (1933).

<table>
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</table>

suggest that the west side had shifted to the south, relatively.

2. The ground disturbances of the earthquake are divided into 4 groups.

a. Slipping of fissured land surfaces due to gravity and set in motion by the earthquake shock. Example—the south western slope of Mt. Hakone.

b. Fissures formed by the shearing stress of the earth's crust distortion. Example—the Kanogawa Alluvial plain.

c. Ground disturbances occurring along old tectonic lines. Example—The Tanna fault zone.

d. Landslides. Examples—Kaziyama, Yamanaka-sinden, Zyo, etc.

The ground disturbances seem to have been caused by gravity slipping, set in motion by the violent shocks. Even the earthquake fault itself may be the phenomenon by which the long accumulated megatectonic shearing stresses were released by violent earthquake shocks. The sense of the horizontal displacements of the earthquake faults agree in direction with that of the fault zone as inferred topographically. But the vertical displacements of the bench marks do not agree in sense with those inferred geologically, but do so with that of the earthquake fault.

A noteworthy fact is that the many faults in these provinces that were recognized by geological means alone failed to show any visible displacements at the time of the earthquake of 1930, whereas those recognized through geomorphologic features were active during that earthquake. All the earthquake faults recorded in Japan belong in the latter class of geologic faults.

From the foregoing considerations, the fundamental problem concerning the ground disturbances of the earthquake is to determine what is the prime agency that causes these disturbances; in what particular manner does the megatectonic agency affect the earth's crust in Japan; and what kind of tectonic line of weakness is easily affected by the earthquake shocks. To answer these questions it would be necessary to study the geologic and geomorphologic structures of the earthquake region of Japan as well as the megatectonic condition of the Japanese islands during post-Tertiary age.

29. 北伊豆の地形及び地質構造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殼變形との關係

地震研究所 大塚彌之助

最初に北伊豆地方の鮮新世以後の地史を考究した．この地方は鮮新世末頃一度海進を受けた．之に前後してこの地方は洪積世と同様に著しい火山活動の時代であつた．多賀火山，湯河原火山等がそれらから噴出物を出してこの地方の海成堆積物を被ふやうになつたのはこの後である．

丹那斷層はこの火山噴出物に被はれる以前に上記の海進時代の地層を複雜化してゐるやうであるが，現在地形的に明なものができたのは多賀火山の熔岩流出の後である．丹那斷層の性質は一種の地溝で，平行な斷層線の集合のやうに見え，西側は逆斷層，東側は正斷層の形式のやうに見える．この斷層線の兩側の河流の平面型は斷層の兩側で喰違つてゐて，一見西側が南へ移動してゐるやうに見える．斷層線の北限は箱根山地方では不明瞭になつてゐる．之は箱根火山の新しい噴出物で被はれたためか，又は山中新田から畑毛の方へ續く斷層線で切られてゐるためかである．

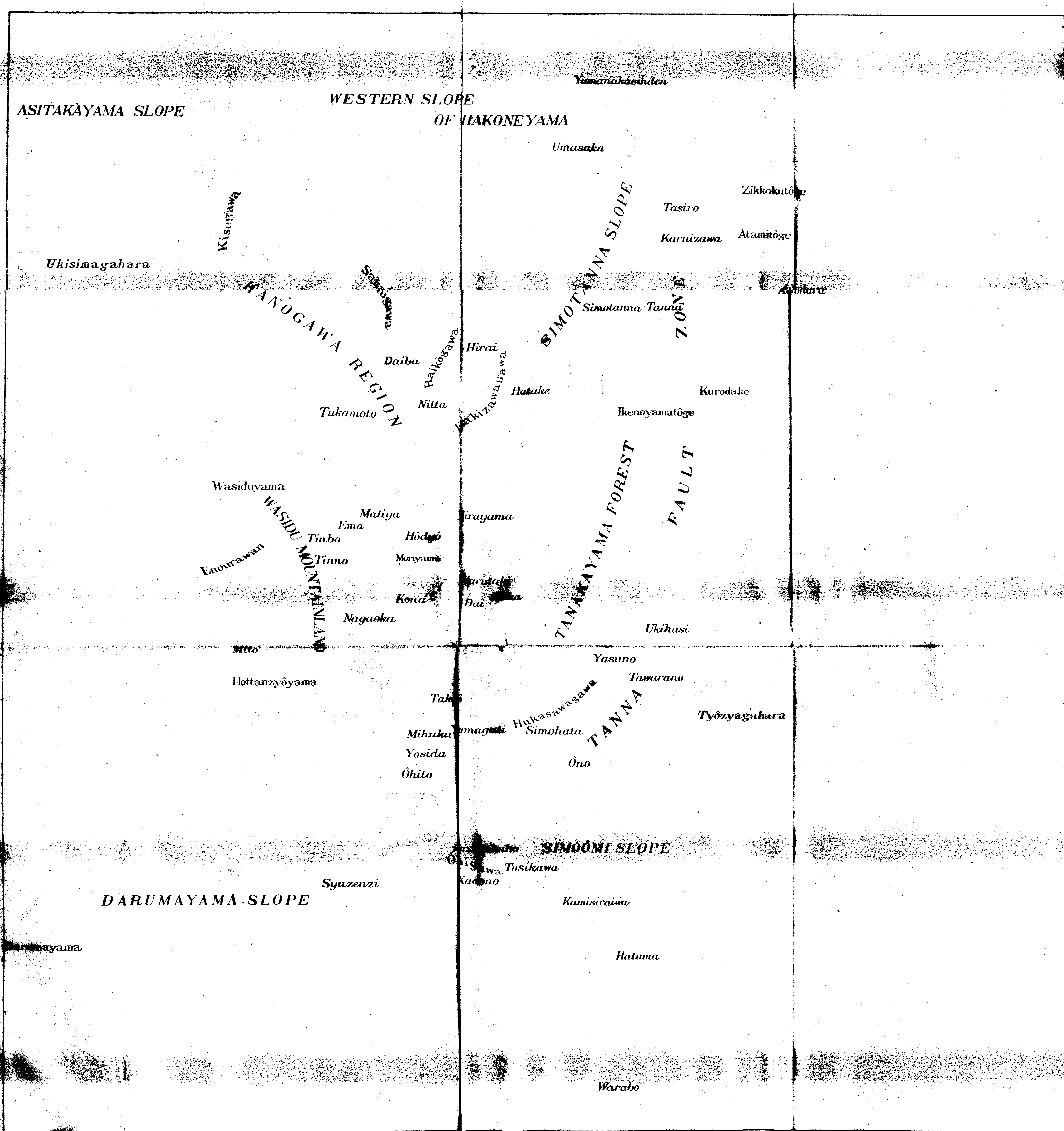
洪積世末期の開析作用はこれらの地方を開析して，冲積世の堆積物は之等の開析谷を埋めてゐる．

鷲頭山地はこれらの新しい火山物質に被はれない古い岩石からなる地方である．

伊豆地震の地變は主としてこの新しい火山物質に被はれてゐる地方に見られる．之等の地方では最近の開析作用で深められた谷に向つて重力に基く地辷りを起してゐるものも少くない．

地變の他の一つは斷層線に沿うてゐるもので，その移動の意味が地形地質から推定されるものと一致するのは面白い．

最後に水準點，三角點の改測の結果と比較し，地震地變と密接な關係にあることがよく認められた．



ASITAKAYAMA SLOPE
WESTERN SLOPE OF HAKONEYAMA
Umasaka
Zikkokutôge
Tasiro
Karuizawa
Atamitôge
Kisegawa
Ukisimagahara
KANOGAWA REGION
SIMOTANNA SLOPE
Simotanna
Tanna
ZONE
Hirai
Raikôgawa
Daiba
Nitta
Tukamoto
Hatake
Kurodake
Ikenoyamatôge
TANAKAYAMA FOREST
FAULT
Wasiduyama
WASIDU MOUNTAINLAND
Matiya
Ema
Tinba
Tinno
Enourawan
Nagaoka
Ukihasi
Yasuno
Tawarano
Hottanzyôyama
Tyôzyagahara
TANNA
Hukasawagawa
Simohata
Mihuku
Yosida
Ôhito
Ôno
SIMOÔMI SLOPE
Tosikawa
Syuzenzi
DARUMAYAMA SLOPE
Kamisiraiwa
Hatuma
Warabo

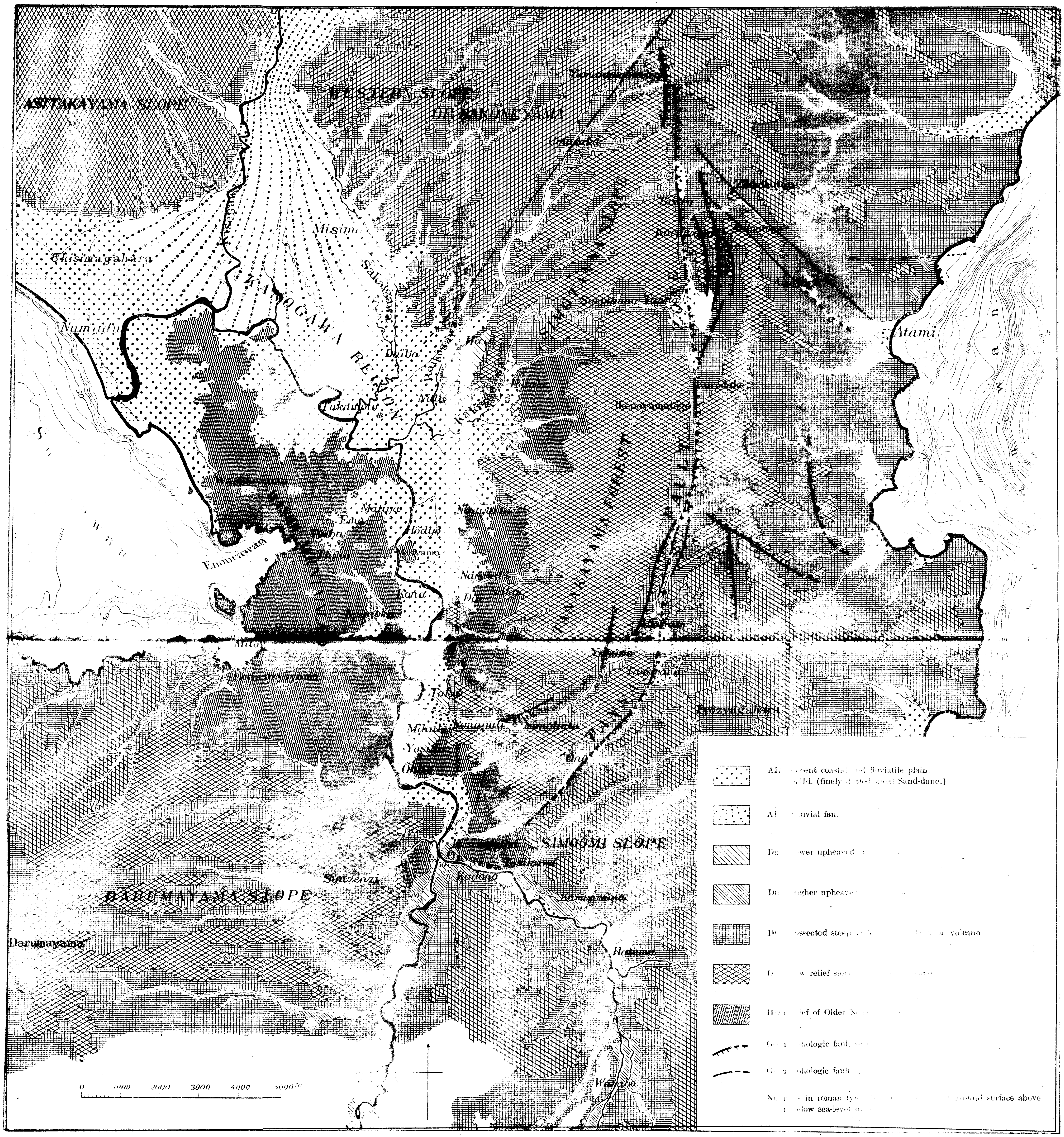


Fig. 2 Geomorphologic Map of Northern Idu

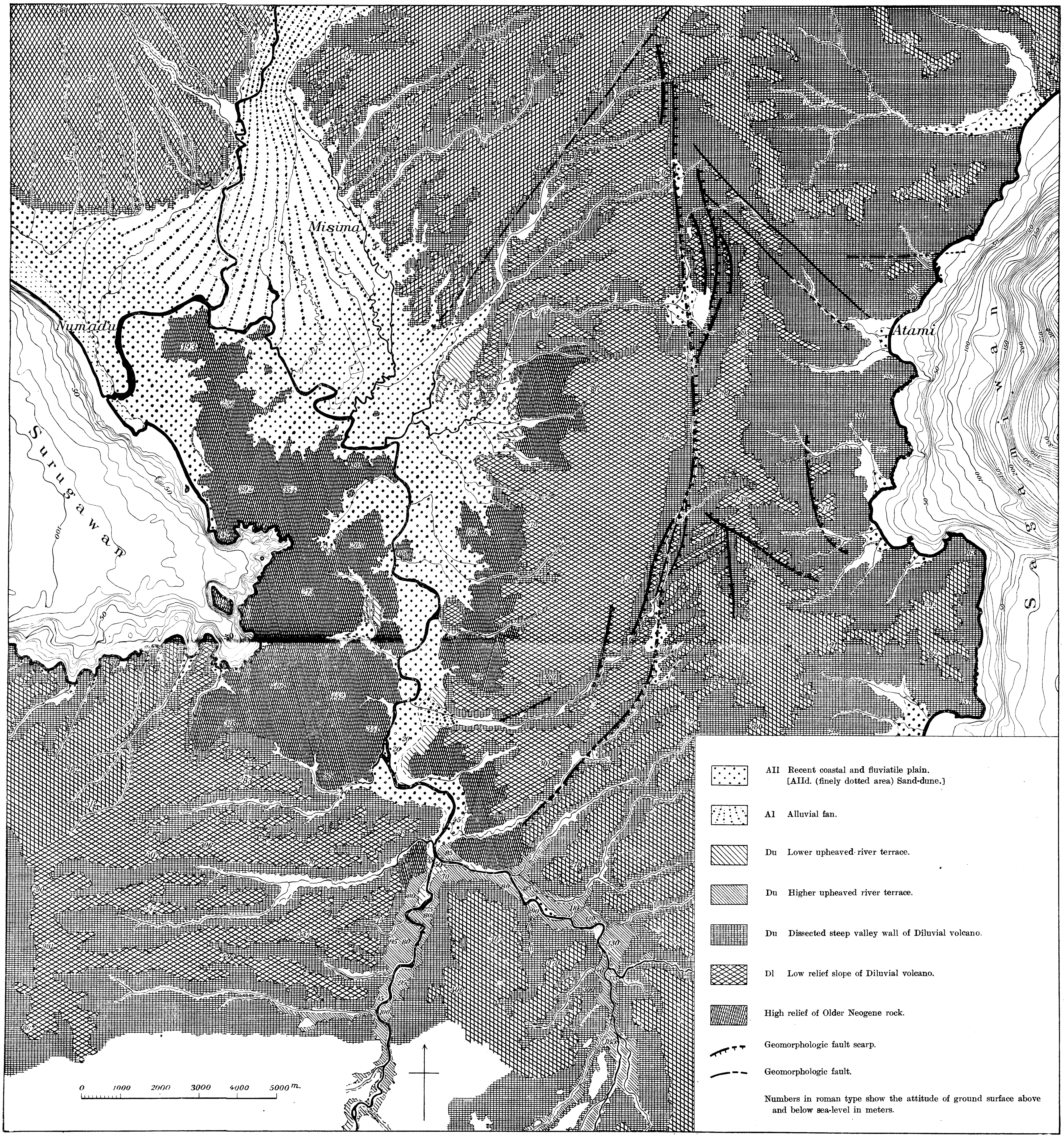


Fig. 2. Geomorphologic Map of Northern Idu

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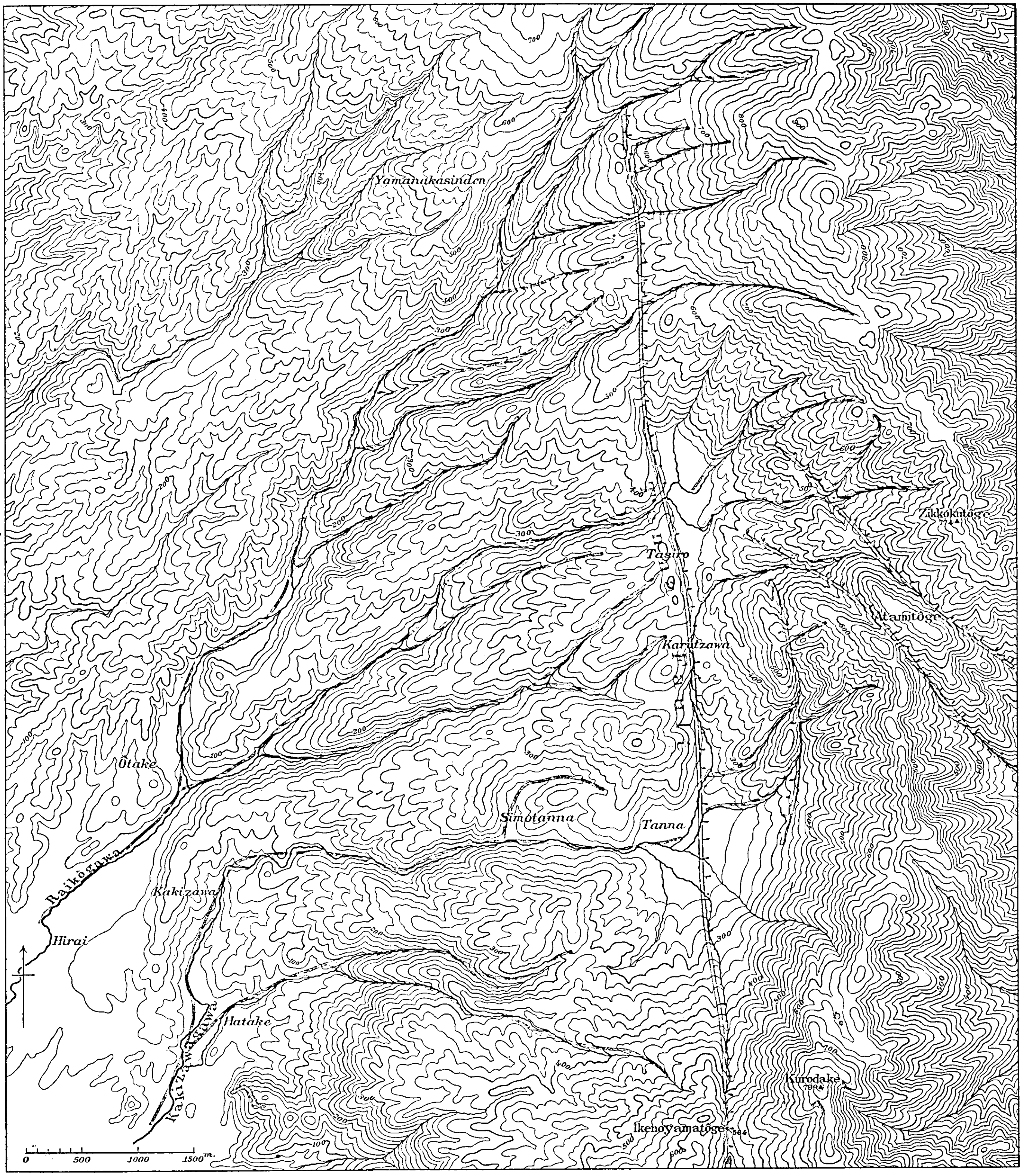

Fig. 9. Map showing the river system near Tanna fault zone.

(震研彙報、第十一號、圖版、大塚)

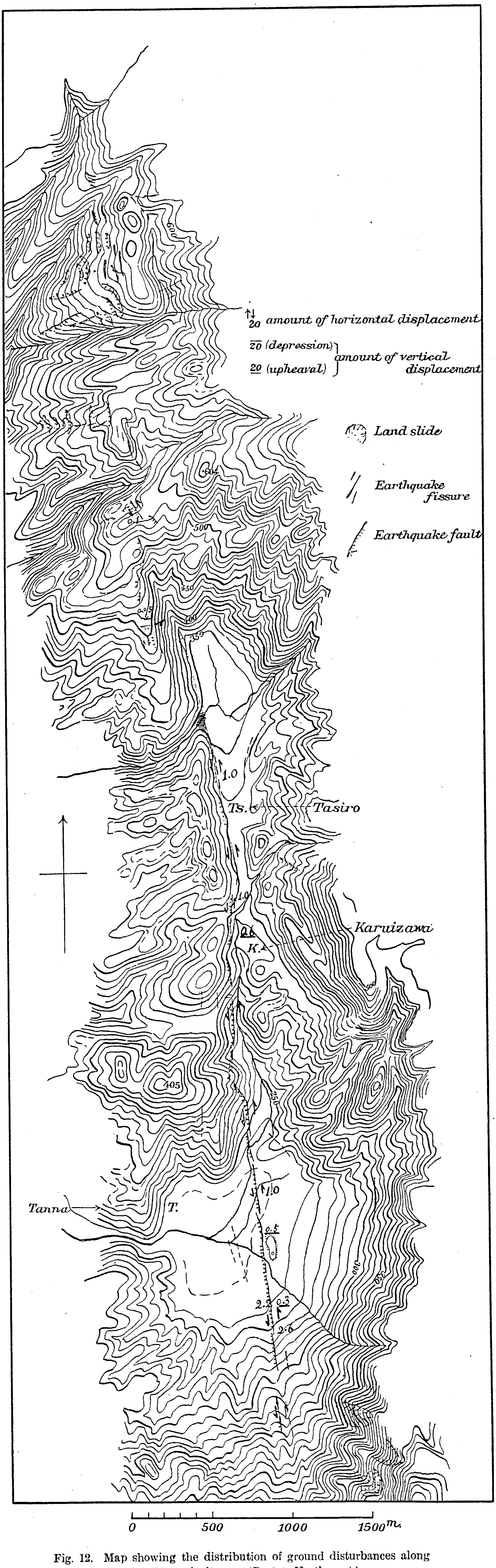

Fig. 12. Map showing the distribution of ground disturbances along the Tanna fault zone (Part 1. North part.)

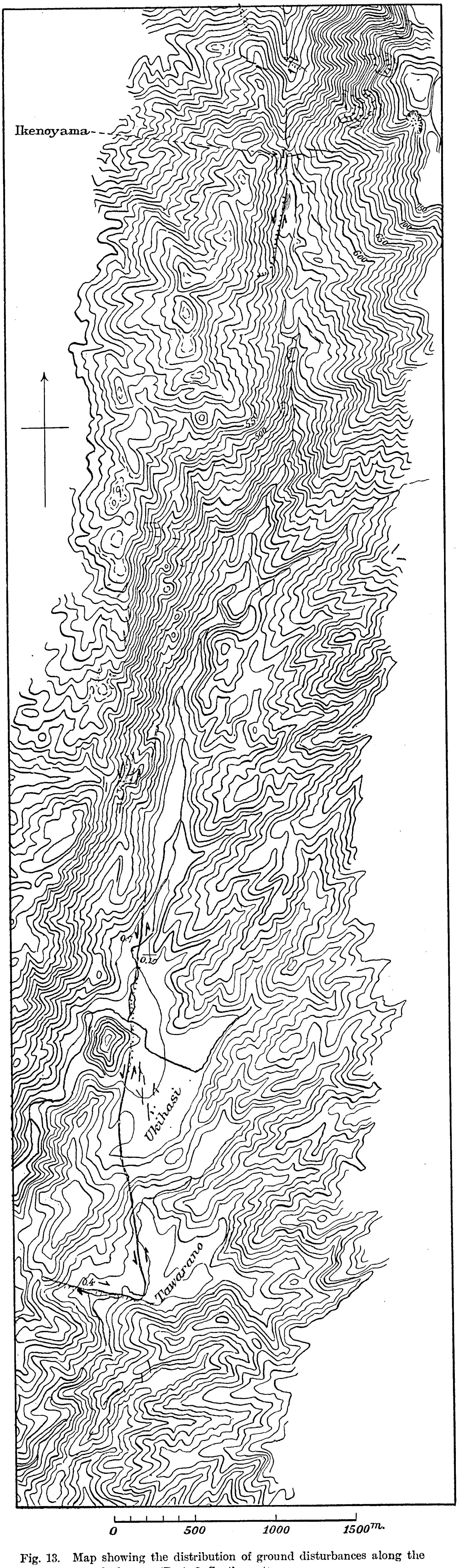

Fig. 13. Map showing the distribution of ground disturbances along the Tanna fault zone (Part. 2. South part).
See Fig. 12.

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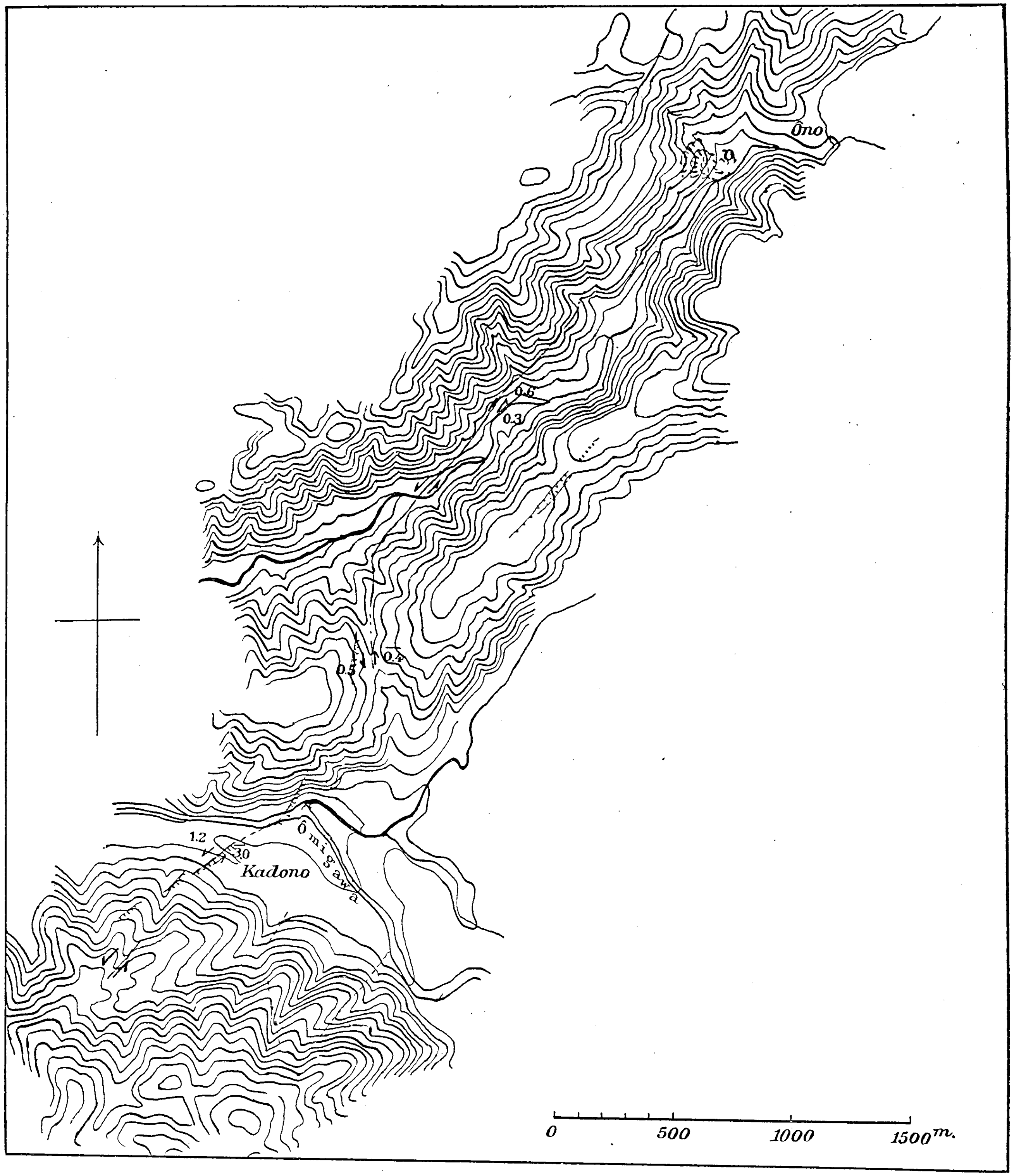

Fig. 14. Map showing the distribution of ground disturbances near Kadono and Oono. See Fig. 12.

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Fig. 17. Drowned coast of Mito bay, seen from Wasidu-yama.

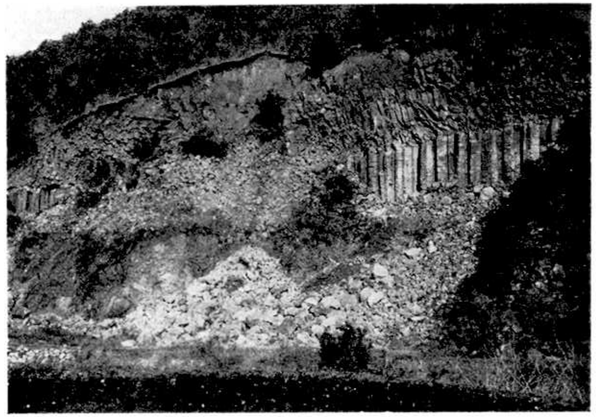

Fig. 18. Columnar joint of Tanakayama lava, nr. Takyo.

Fig. 19. Earthquake rents on the 278 m. ridge about 1500 m. E. of Nirayama.

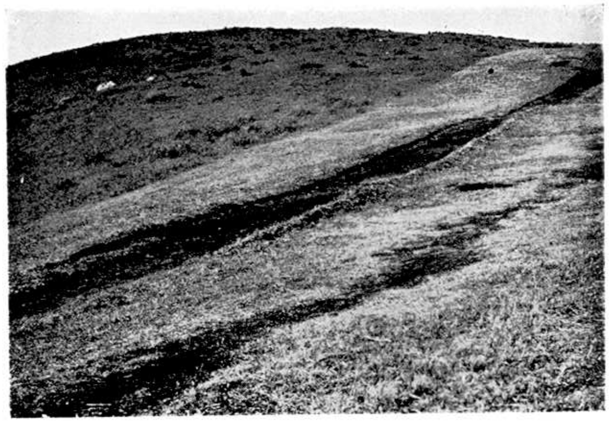

Fig. 20. Earthquake fissures on the eastern limit of Tanakayama forest.

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Fig. 21. Earthquake fissures in Tanakayama forest (few hundred m. S. of Fig 20.)

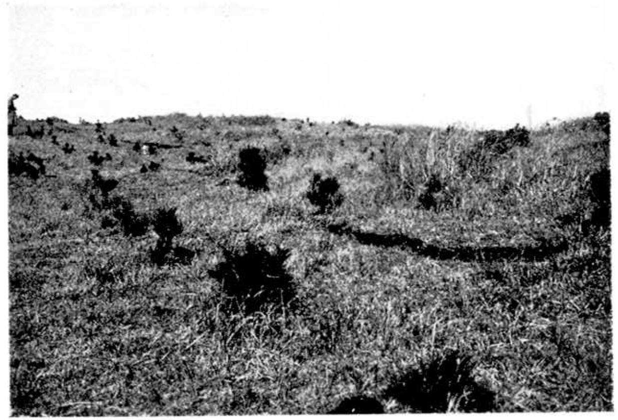

Fig. 22. Earthquake fissures arranged en echélon, few hundred m. S. of Fig. 21.

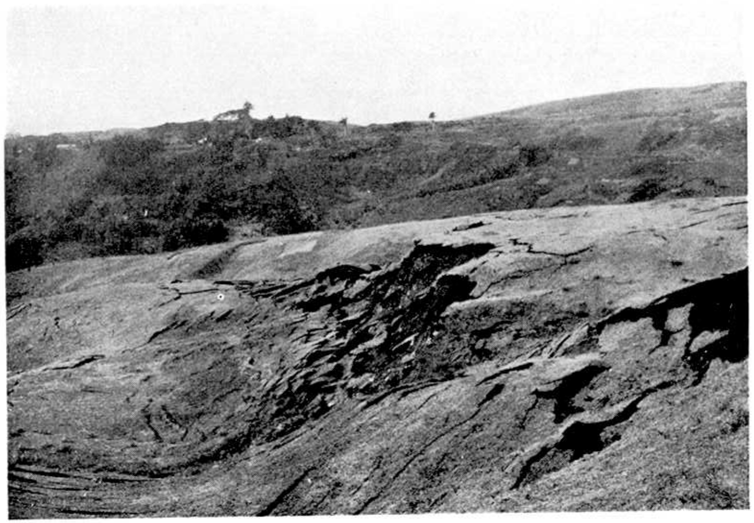

Fig. 23. Landslide on the western slope of Kernkol 850 m. E. of Yamanakasinden. (H. Tsuya.)

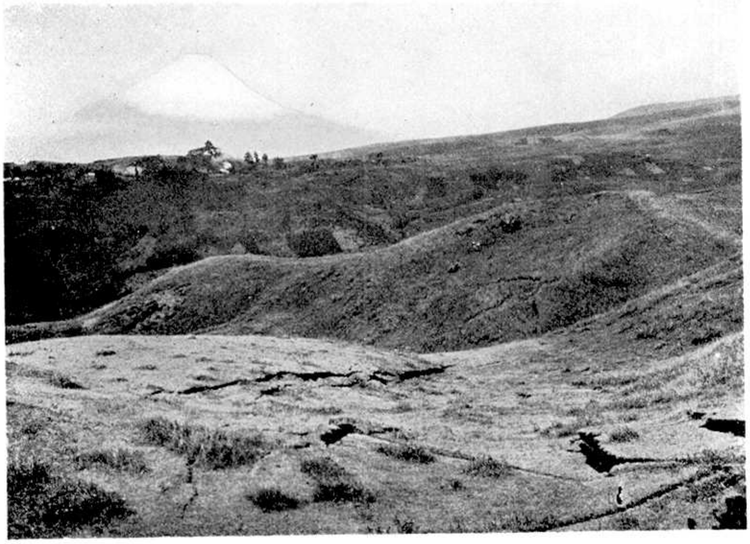

Fig. 24. Earthquake fissures on the eastern slope of a kern-kol. (H. Tsuya.)

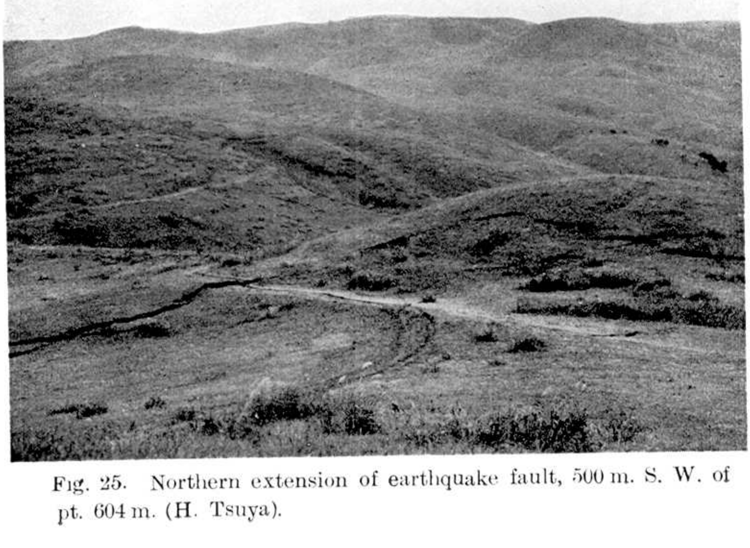

Fig. 25. Northern extension of earthquake fault, 500 m. S. W. of pt. 604 m. (H. Tsuya).

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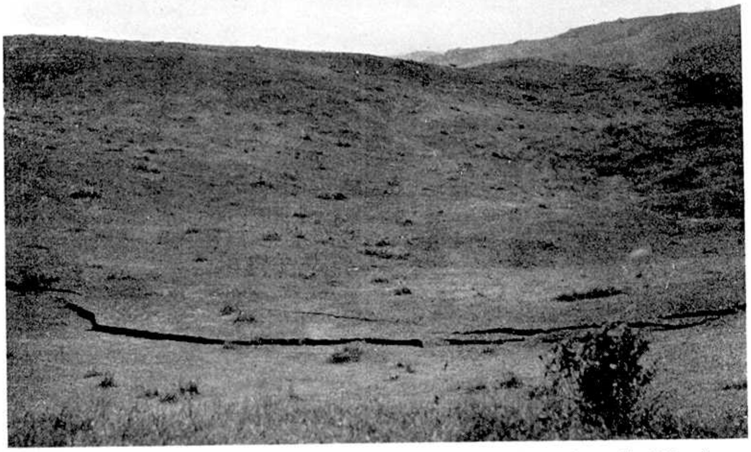

Fig. 26. Northern extension of earthquake fault, 500 m. S. W. of pt. 604 m. left of Fig. 25. (H. Tsuya.)

Fig. 27. Mole-track and plough-shared like ground disturbances on the west slope of the kern-kol 700 m. N. W. W. of pt. 604. (T. Takayama.)

Fig. 28. Water dammed by the earthquake disturbances in Tasiro basin. (H. Tsuya.)

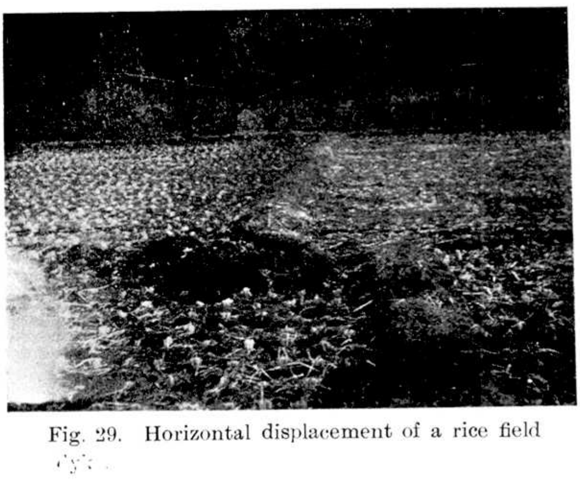

Fig. 29. Horizontal displacement of a rice field

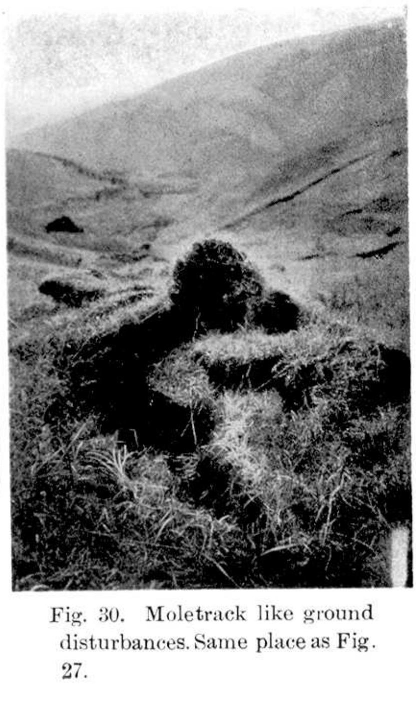

Fig. 30. Moletrack like ground disturbances. Same place as Fig. 27.

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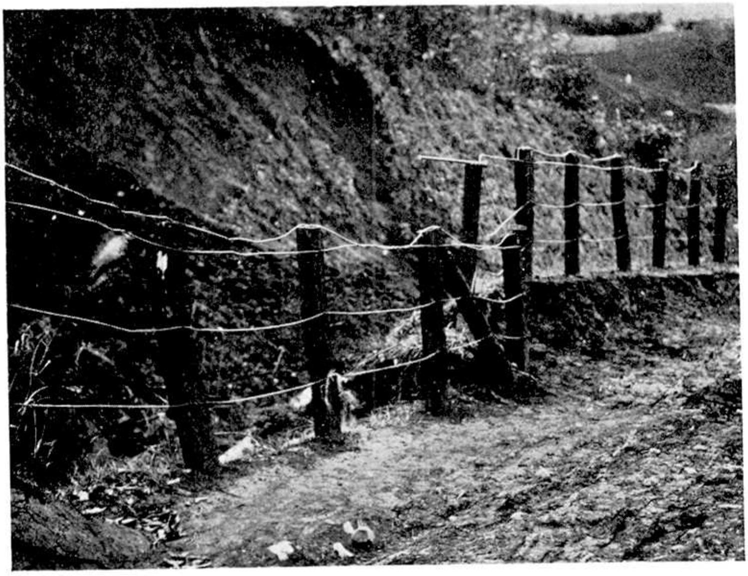

Fig. 31. Displaced fence of Tanna reservoir. (H. Tsuya.)

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Fig. 32. The horizontal displacement of a small road joining Tanna Nisikata and Takizawa. (H. Tsuya.)

Fig. 33. Mole-track like earthquake fault in Tasiro basin.

Fig. 34. Displaced torii in Tasiro basin.

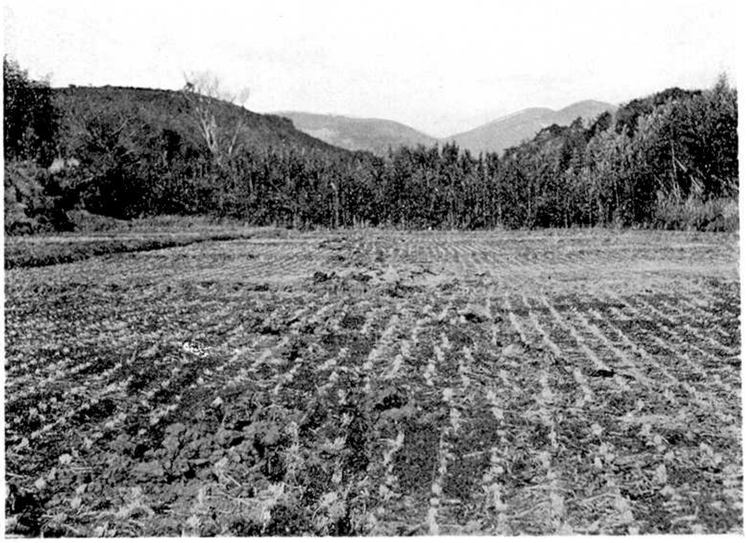

Fig. 35. Ground disturbances in rice fields in Ukihasi basin. (H.Tsuya.)

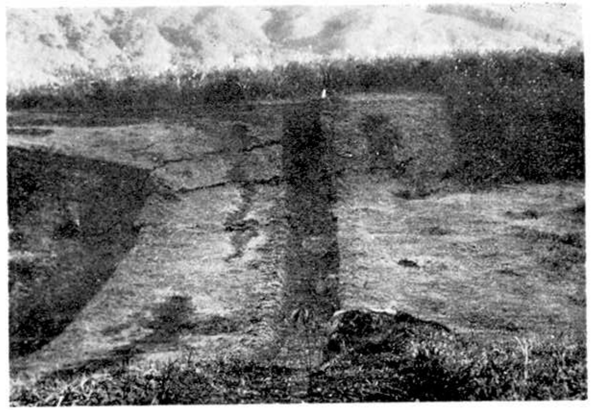

Fig. 36, 37. Earthquake faults in the kernbut topography on the eastern steep wall of Tanakayama forest.

Fig 38. Displacement of a small road in Ukihasi basin, Ukihasi central earthquake fault.

Fig. 39. Landslide at Oono.

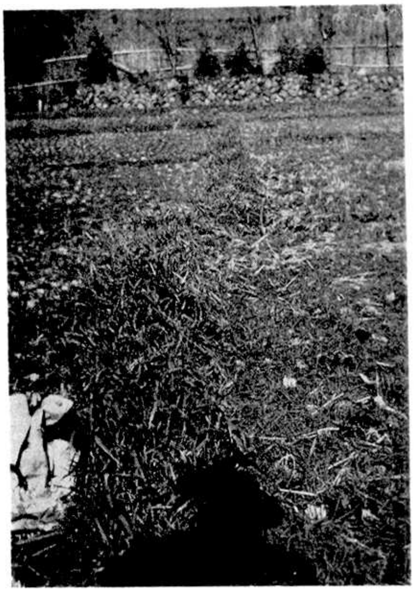

Fig. 40 Displacement of a rice-field dyke in Tawarano basin.

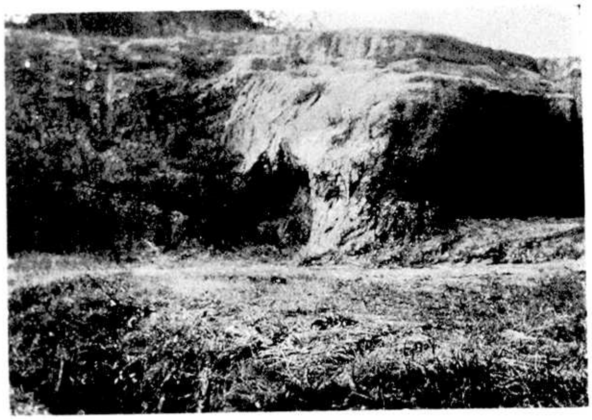

Fig. 41. Stratified pumice beds near Akô.

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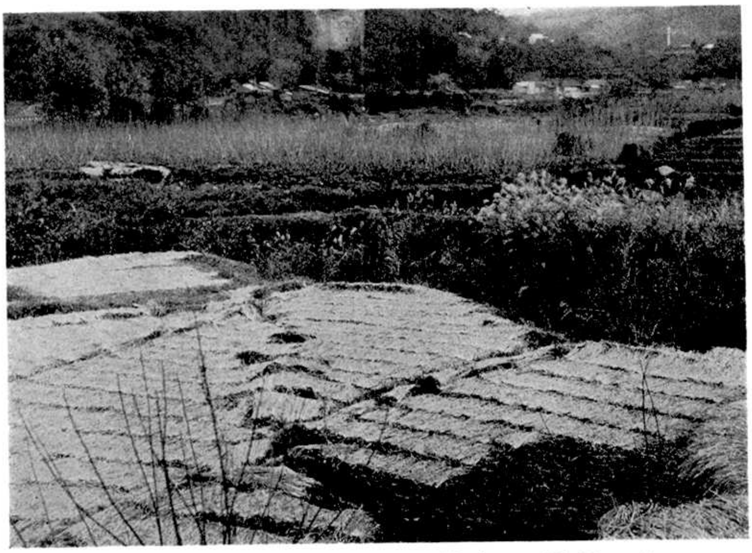

Fig. 42. Earthquake fault nr. Kadono. (H. Tsuya.)

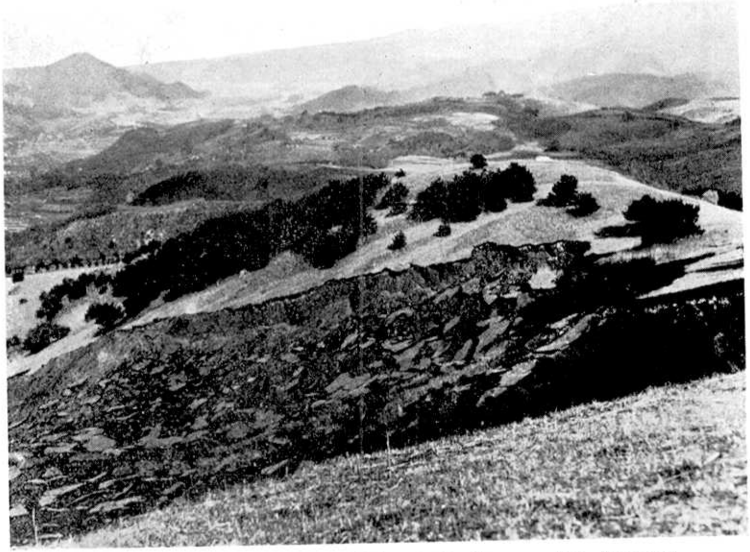

Fig. 43. Head of the landslide at Kadiyama. (H. Tsuya.)

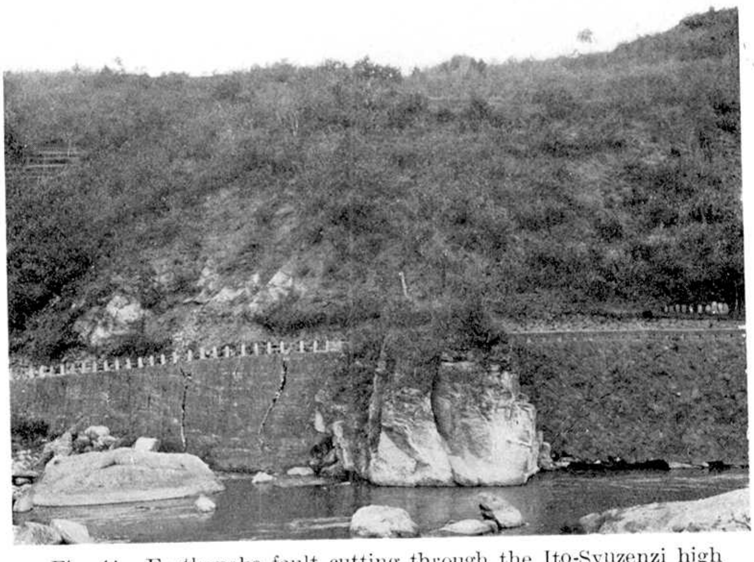

Fig 44. Earthquake fault cutting through the Itō-Syuzenzi high way, along the Oomi river.

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