

17. *The Oti Graben in Southern Noto Peninsula, Japan.* (Part I)

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(Read March 20, 1934.—Received Dec. 20, 1934.)

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1. Introduction.

The Noto peninsula, a flat low-relieved land projecting into the Japan Sea from North Central Japan, consists of andesite, Neogene Tertiary, and Pleistocene terrace deposits on the basal granite and gneiss. At the isthmus of this peninsula, a low depressed land, in which the south bay of Nanao (七尾) and the Oti (奥知) lagoon are situated, runs about N 60°E, and cut the structural connection between the peninsula and the Japanese mainland. This low depressed land has been called by Prof. T. Ogawa¹⁾, the "Oti tectonic valley."

In this paper, the writer studies the stratigraphy of southern Noto and discusses the geotectonic development of this depressed lowland. This study will make it possible to form an idea of the geotectonic development of the Sado island and Yamato submarine bank, both of

1) T. OGAWA, *Expl. Text. Geol. Map, Japan*, "Wajima" sheet, 1:200,000, (1908).

which lie in the Japan sea, parallel to the Japanese island arc, under the assumption that these island and submarine bank have geologic structural characteristic similar to those of the Noto peninsula.

As to the topography and geology of southern Noto, many investigators, such as the late N. Yamasaki²⁾, T. Ogawa, T. Tsujimura³⁾, J. Makiyama⁴⁾ and K. Mochizuki⁵⁾ have published the results of their studies, while M. Yokoyama has published his palaeontological results. But in these studies no tectonic characteristics and its history have been discussed thoroughly.

On Sept. 21st, 1933, a destructive earthquake⁷⁾ occurred near Nanao, its origin being determined as in the southern part of South Nanao Bay, which makes it necessary to study the geologic structure of this region from the standpoint of seismological geology.

2. Topography.

For convenience the writer divides this region into four parts, namely, (a) the bottom of the Oti graben, (b) the northwest part of the graben, (c) the southeast part of the Oti graben, and (d) other localities.

a. *The bottom of the Oti graben.* As shown in Fig. 1, the southeast part of a topographic line connecting Zike-Itinomiya (氏家一宮) in Hagui (羽咋)-gori, through Tizi (千路), Notobe (能登部), Yosikawa (良川), Sirouma (白馬) with the town of Nanao, shows very contrasting topographic features to its northwest part. That is, the southeast part of this topographic line is a very flat lowland, while the opposite side of this line is a very steep dissected slope.

And again, the two side of a topographic line connecting Siho (子浦) through Suginoya, Iiyama (飯山), Takabatake (高畠), Kotake (小竹), with Sano (佐野) in Higasiminato-mura (東湊村), shows also a contrasted topography as remarked above. On this line, its southeast side is a very steep slope, while the opposite side is a low flat surface, which is the same plain as that on the southeast side of the former topographic line.

The bottom of the Oti graben is the area between these two topographic lines. These two topographic lines are almost parallel to each

2) N. YAMASAKI, *Jour. Geol. Soc., Tokyo*, (1908), (in Japanese).

3) T. TSUJIMURA, *Nippon-Tikeisi* (Geomorphology of Japan), (1932), (in Japanese).

4) J. MAKIYAMA, *Chikyû*, 14 (1930), (in Japanese).

5) K. MOCHIZUKI, *Geogr., Rev. Japan*, 4 (1928); *Jour. Geol., Tokyo*, 39 (1932); *Geography, Japan*, 2 (1934), (in Japanese).

6) M. YOKOYAMA, *Jour. Geol. Soc., Tokyo*, 33 (1926); *Imp. Geol. Surv. Japan, Rep. No.* 101 (1928); No. 104 (1929).

7) T. SUZUKI, *Bull. Earthq. Res. Inst.*, 12 (1934), 44, (in Japanese).

other, and outside of them are very steep slopes like fault scarps, as just stated. Japanese writers, therefore, called this flat elongated depressed lowland, the "Oti graben" or "Oti tectonic valley". Fig. 1 is a map of this region, shaded or hatchured for every twenty meters height, and on which these two topographic boundary lines are clearly shown. EF and GH in Fig. 1, which are transverse profiles of this depressed lowland, show these topographic boundaries in elevation.

The contour lines of the graben bottom, those in the southwest part, are very simple, occupied by the Oti lagoon, whence this graben derives its name. This southwestern part of the bottom of Oti graben is an Alluvial plain, the southwestern end of which is fringed by sand dunes 30~40 m. above the level of the Japan sea. This sand dune, which continues to the southwest shore of the Japan sea falls in height near the southwest end of the Oti graben, as shown in Fig. 1. That is the 20~40 m. (hatchured) areas in the part of Oti graben decreases relatively to the other part of the sand dune.

While the northeastern half of the bottom of the Oti graben does not show so simple contour lines as those of the southwestern half of the bottom of the graben, it is dissected by many small valleys. This topographic irregularity suggests that the southwestern half of the bottom is relatively lower in height than the northwestern half of the bottom. To verify this suggestion, the writer has projected topographic profiles of the bottom of the graben as shown in Fig. 1, AB, CD. By these two figures the asymmetric reliefs of the graben bottom is clearly brought out. The graben bottom gradually decreases in height toward the southwest, but toward the northeast it rises, although it is dissected near the town of Nanao. On the land surface of the dissected northeastern part of the graben bottom are basal rocks, while Alluvial deposits now fill the dissected valley. The town of Nanao occupies the lowland that was newly formed in the dissected valley in the northeastern part of the graben bottom.

Prof. T. Tsujimura⁸⁾ has called attention to the poor development of fanglomeratic deposits derived from the walls of the graben on the southwestern half of the bottom, and explained it by the relative subsidence of the southwestern half of the graben bottom.

The southern bay of Nanao is believed to be a continuation of the graben bottom, but the bottom surface of the bay does not represent the true characteristics of the graben bottom. The island of Onna(-zima) (女島), O(-sima) (雄島), Tera(-sima) (寺島), Karasu(-zima) (烏島), etc., which are elevated reliefs of the graben bottom consist of Tertiary rocks.

8) T. TSUJIMURA, *op. cit.* (1932).

The topographic boundary line, running from Kooda (向田) in Notozima (能登島) to the east of Sanami (佐波) in nearly SSW direction, is considered the northeastern extension of the northwest side of the graben bottom, while the topographic boundary line running from Entunagi (縁繋) to Sobogaura (祖母ヶ浦) in Notozima, is supposed to be the northeastern extension of the southeast boundary line of the graben bottom.

The Tokuda terrace, so called in this paper, is a flat surfaced terrace in the graben bottom about 30~40 m. above sea-level, developed near Tokuda (徳田). Going southwestward, this terrace lying northwest of the railway between Tokuda and Nanao station, is covered with Ninomiya (二宮) Alluvial fan, and disappears in the southwest part of its fan.

b. The northwest part of the Oti graben. The northwest part of the Oti graben is divided into three terraces and an Alluvial plain, the plain being the lowest in height. The second lowest is the Tumuki terrace, 35~30 m. above sea-level, which develops at the back of Tumuki (津向) village, northwest of the town of Nanao. The terrace next above the Takasina terrace or hill, about 80~50 m. above sea-level, is a dissected low relief hill developed in Takasina-mura (高階村) and its environs. The topographic characteristics of Takasina hill resemble those of Tama hill near Tôkyô, namely the writer's D1 terrace.

The drainage system of the Takasina hill is very asymmetric, the main divide being near the southeastern margin of this hill extending from Tumuki through Kuramayama (鞍馬山) to Sirouma and Hidume (廿三日). This partial existence of the divide suggests that the valley heads of the drainage system in this hilly country was cut by the topographic boundary line of the Oti graben, which is represented by a straight valley between the graben bottom and Takasina hill.

The highest terrace is about 200 m. above sea-level. It is here called the Akakura mountainland. This mountainland is in the west of Takasina hill, bordered by a meridional topographic boundary. The Akakura mountainland, which is a dissected mountainland of andesite, of which Mt. Akakura (赤藏) is the highest mountain. The topographic boundary of the Akakura mountainland and Takasina hill runs from Taduruhamma (田鶴濱) in Wakura-mati (和倉町) to Haruki (春木) and Kurozihukazawa (黒氏深澤) in Toya-mura (鳥屋村). This topographic boundary is not represented in the Oti graben bottom. Fig. 2 shows a sketch of this topographic boundary as seen from the southeast corner of the graben bottom near Kosidi.

As already stated the boundary line between this mountainland and the graben bottom is a steep slope. K. Mochizuki⁹⁾ called this

9) K. MOCHIZUKI, *op. cit.* (1934).

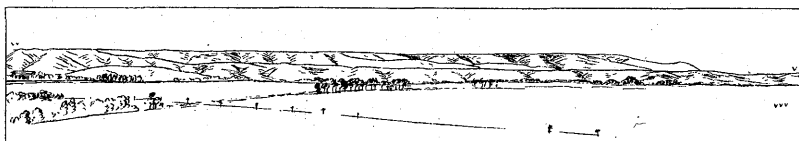


Fig. 2. Schematic sketch of the topographic boundary of the northwest part of the Oti graben seen from southeast corner of the Oti graben bottom near Takebe (武部). vv=Akakura mountainland, v=Takasina hill, vvv=Oti graben bottom.

steep topography the Bizyôsan (眉丈山) fault scarp. The back slope of Bizyosan fault scarp is a dissected low relief surface.

c. *The southeast part of the Oti graben.* Since the mountainland southwest of the Oti graben is higher than the northwest part of the Oti graben, the height of the fault scarp is greater than in the one northwest. On the ridge of the mountainland many peaks with heights of 460~390 m. are aligned in a N 60°E in direction, the mountainland gradually dropping in height toward the west shore of the bay of Toyama.

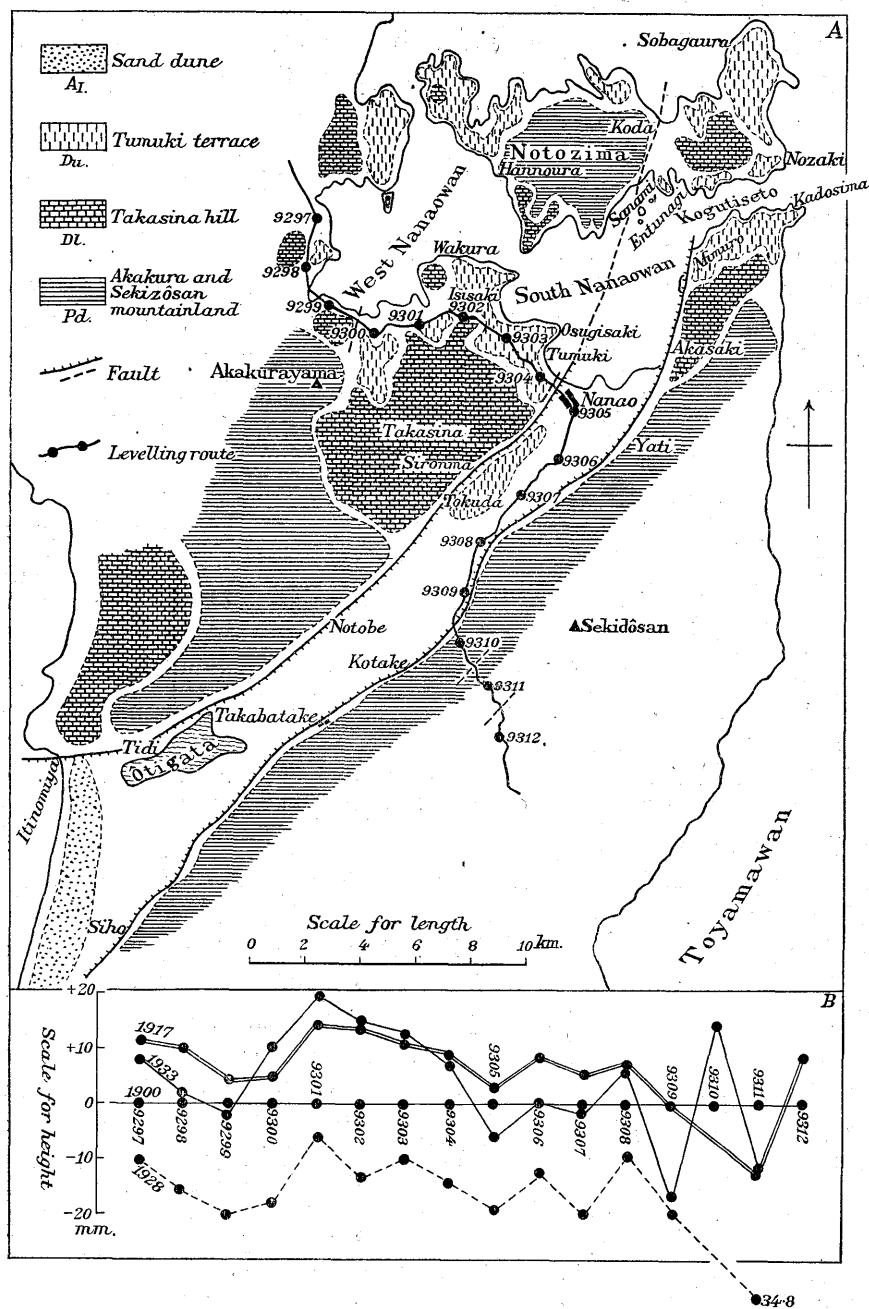
The Sekidosan (石動山) fault scarp of Mochizuki¹⁰⁾ is the northwest scarp of this mountainland and the southeast steep slope of the graben. Fig. 7 shows the Sekidosan fault scarp seen from the east shore of the southern bay of Nanao. The Northeastern extension of this fault scarp gradually becomes indistinct and finally disappears near Kogutiseto (小口瀬戸). The writer expected a northeastern extension of the fault scarp on the topographic boundary between Entunagi and Sobogaura in Notozima but here geologic evidences are against this expectation, as will be explained later.

A topographic boundary, a branch of the Sekidosan fault scarp at Yati (谷地) in Higasiminato-mura runs in a N 45°E direction to Oonoki (大野木) on the west shore of the bay of Toyama. The west side of this topographic boundary line is a dissected terrace, less than 110 m. above sea-level, while the east side of this boundary line is a relatively high mountainland, about 300~250 m. above sea-level. This topographic boundary line is clearly shown in Fig. 1, and Fig. 3.

Fig. 3 is a distribution map of these topographic divisions. The Tumuki terrace in this province, about 50 m. above sea-level, broadly develops near Mimuro (三室) and Kadosima (鹿渡島) on the peninsula between the south bay of Nanao and bay of Toyama.

The mountainland which is the back slope of the Sekidôsan fault scarp has relatively low relief surface, which gradually drops in height toward the bay of Toyama, as seen in the summit level in Fig. 4. As Mt. Sekidôsan abruptly rises about 100 m. above this low relief sur-

10) K. MOCHIZUKI, *op. cit.* (1934).



face, Mochizuki¹¹⁾ thinks that Mt. Sekidô(san) may be a monadnock on the low relief surface.

Takasina hill, about 90~120 m. above sea-level in this province, is poorly developed on the peninsula between the bay of Nanao and Toyama.

d. Other locality. In addition to those three provinces, the writer briefly describes the topographic characteristics of Noto(-zima) island and Noto peninsula.

The island of Noto(-zima) which is a large island in the bay of Nanao is topographically divided into four parts, namely, Alluvial plain, coastal terrace, and high and low hill lands, all of which have similar topographic characteristics respectively with those of the province in the northwest part of the Oti graben. Fig. 3 shows the distribution map of these topographic divisions in the Noto(-zima) island.

Noto peninsula, topographically, consists of the Noto peneplain, and Hiradoko, Matunami and other coastal terraces, and the Alluvial plain. The Noto peneplain, to which attention was called by T. Ogawa¹²⁾, is a low relieved surface, on which Hôdatu(-san) (寶立山) (a mountain in the northeast part of Noto) and other mountains stands as "monadnocks." Fig. 8 shows the low relieved surface of the Noto peneplain seen from the bay of Toyama.

In the northwestern part of the Noto peninsula, the discrimination of Takasina hill from Noto peneplain itself is difficult. Fig. 4 shows a summit level of Noto peninsula, in which the peninsula is clearly divisible into two parts, the southeast and north part of the Oti graben. The north part of Oti graben gradually decreases in height toward the southeast, while the northwestern margin of this province abruptly does the same toward the Japan sea. In this way, the general surface of the summit level of northern Noto peninsula inclines southeastward, while the main divide of Noto peninsula is situated at the southeast margin of northern Noto peninsula. Regarding these topographic characteristics, the present writer is inclined to the opinion that the Noto peninsula flexuously tilted southeastward after the formation of the so-called Noto peneplain surface. The river systems that were formed during the formation of the Noto peneplain remained on the peneplain surface during its deformation, later draining the present deformed peneplain surface which is represented by the summit level of Noto peninsula (Fig. 4).

11) K. MOCHIZUKI, *op. cit.* (1934).

12) T. OGAWA, *op. cit.* (1909).

3. Coastal terraces along the east of Noto peninsula.

It was previously noted by Prof. T. Ogawa¹³⁾ and Mochizuki¹⁴⁾ that many coastal terraces, 30~40 m. above sea-level, are broadly distributed along the east coast of Noto peninsula. The three main terraces, Tumuki, Hiradoko, and Matunami will now be described. Fig. 5 shows

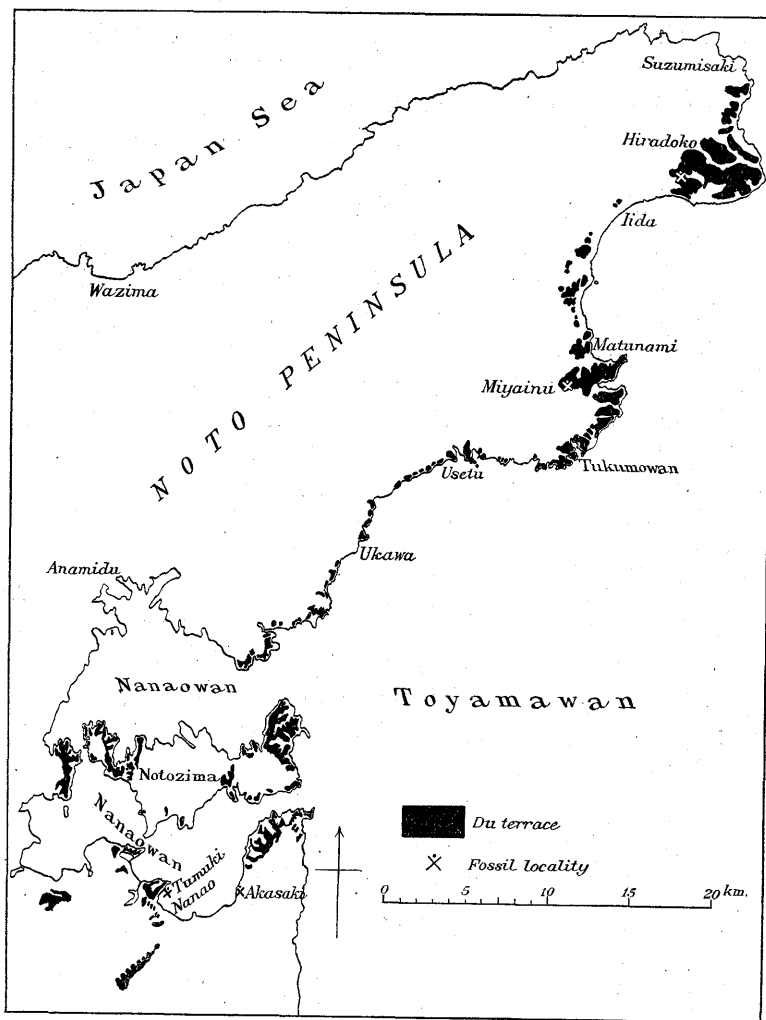


Fig. 5. Distribution map of Du coastal terrace on the east coast of Noto peninsula.

the distribution of these terraces in Noto.

a. *Tumuki terrace.* As already stated, Tumuki terrace lies back of

13) T. OGAWA, *op. cit.* (1909).

14) K. MOCHIZUKI, *op. cit.* (1932)

Tumuki village, northwest of the town of Nanao. Its height is 30~40 m. above sea-level. The surface of the terrace is flat and consists of erosion surfaces of Tertiary bed rock and deposition surfaces of sand and mud beds underlain by Tertiary bed rock with unconformity. At Osugizaki (大杉崎), the south end of this terrace, there is an exposure of a bluish-gray shell-bearing bed with which a valley of Tertiary bed rock is buried. The height of the floor of this buried valley as exposed is about 10 m. above sea-level. This bluish-gray shell-bearing sand bed gradually changes into mud. *Raeta pulchella* (Adams et Reeve), *Ringicula doliaris* Gould are found in this mud, the thickness of which is more than 4 m. Above this mud bed rest reddish brown sandy surface soils.

The fossil shells from the bluish-gray shell-bearing sand are listed in Table I (col. 2).

This shell bed, which was first found by K. Mochizuki¹⁵⁾ in 1928 in the Nanao Cement Compounds at Tumuki, is called the Tumuki shell bed. M. Yokoyama¹⁶⁾ later described many fossil shells from this bed.

Although the writer from its geologic occurrence, first believed that the Tumuki shell bed has been formed after the formation of the Tumuki terrace, since the shell bed forms the surface of the terrace near Osugizaki as just stated, the inference was error. The Tumuki shell bed may therefore be a pre-Tumuki terrace deposits, and the formation of the surface of Tumuki terrace contemporaneous with or closely related to the formation of the shell bed. That is, the surface of the Tumuki terrace was formed by the abrasion and deposition of the Tumuki shell bed in the dissected valley that was formed during the pre-Tumuki stage. Fig. 9 shows the Tumuki terrace near Osugisaki.

Going south, similar terraces develop near the public park of Nanao and near Tokuda village. The terrace near Tokuda, called Tokuda terrace by the writer, has been described in a previous line. The materials composing Tokuda terrace, which resemble those of Tumuki, is exposed on a cliff south of Hosoguti (細口). The upper part of this exposure is a brown soil that gradually changes into yellow, reddish-brown, or bluish-gray mud. This bluish-gray mud contains ill-preserved fragments of fossil plants, but no marine shells. This mud is underlain by a creamy, grayish sand bed which consists of fine weathered granitic sand. The writer found in it a cast *Batillaria* aff. *fluvialis* (Potiez et Michaud). This occurrence of marine shell points to an invasion of the sea in the Oti graben bottom during the Tumuki stage. As already stated the Tokuda terrace is geologically and topographically similar to

15) K. MOCHIZUKI, *op. cit.*, (1928).

16) M. YOKOYAMA, *op. cit.*, (1928).

the Tumuki terrace, for which reason the writer is convinced that these two terraces may be contemporaneous with each other.

It may be added that the sand and mud beds forming the Tokuda terrace rest unconformably on the Neogene formation east of Hosoguti and Kokubu (國分).

The coarse grained sand and gravel beds forming the Tumuki terrace surface of Iwaya (岩屋) and Kozima (小島), near Nanao may be contemporaneous with the Tumuki shell bed. These coarse grained sand and gravel beds are underlain by the Kozima and Nanao beds to be described later.

The Tumuki terrace is also distributed in Isizaki (石崎), Sobogaura in Notozima, Sakiyama-mura (崎山村), near the mouth of the south part of the bay of Nanao.

The narrow terrace at the mouth of Akasaki (赤崎) valley in Higashiminato-mura, consists of coarse grained sand and a dark greyish shell-bearing mud bed, underlain by the Neogene Tertiary with unconformity. This shell-bearing mud is exposed on the road between Nanao and Mimuro, about 5 m. above sea-level. The fossil shells of this mud bed are listed in Table I col. 1. A coarse grained granitic sand lies on the shell-bearing mud. The surface of the terrace here is poorly preserved. The writer could not find any stratigraphical relation between these terrace forming beds and the Tumuki terrace.

The Tumuki terrace in Sakiyama-mura is well dissected. The writer failed to find any shell-bearing beds in this province, although he noticed a coarse-grained granitic sand forming the surface of the terrace.

b. *Hiradoko terrace.* The Hiradoko terrace which was studied by K. Mochizuki¹⁷⁾ is near Iida (飯田), in the northeast part of Noto peninsula. This terrace, 40~25 m. above sea-level, lies southeast of a line connecting Syôin (正院), east of Iida, and Awadu (粟津) northeast of Syôin. On a cut wall, south of Hiradoko, Mochizuki found a shell-bearing sand mud forming the surface of the Hiradoko terrace. These shell-bearing beds, called the Hiradoko shell bed by K. Mochizuki, is underlain by the Iiduka (飯塚) beds with unconformity. As will be seen from Fig. 10, the exposure on the cut wall near Hiradoko is a depressed relief of Tertiary bed rock, filled with the Hiradoko beds. Fossil shells are found in the upper half of this bed, from which Mochizuki reported 55 species. The fourth column of Table I shows the fossil shells collected here by the writer.

The rock succession of the Hiradoko bed differs slightly from the Tumuki bed in the absence of the upper dark grayish mud. The writer agrees with Mochizuki's opinion, however, that the Hiradoko bed is

17) K. MOCHIZUKI, *op. cit.*, (1932).

contemporaneous with the Tumuki bed.

c. *Matunami terrace.* The coastal region of eastern Noto from Matunami (松波), south of Iida, to Tukumo-wan (九十九灣), is a broad flat terrace, 30~40 m. above sea-level. The width of the terrace sometimes attains to 500~2000 m., the surface being very flat. These topographic characteristics closely resemble those of the Tumuki and Hiradoko terrace, just described. The writer calls this the Matunami terrace. Its width near Akasaki (赤崎) and Miyainu (宮犬) is about 4000 m. On the highway between Usetu (宇出津) and Matunami, a shell bearing mud¹⁸⁾ is exposed at Miyainu, the thickness of which is about 5 m., resting on the Tertiary bed rock with unconformity. This stratigraphical relation clearly resembles that of Hiradoko. The fossil shells collected from these mud beds are listed in column 3 in Table I. The faunal characteristics are very similar to those of Hiradoko.

As previously stated, the coastal terraces along the east shore of Noto peninsula, namely, Hiradoko, Matunami, Tumuki, and Tokuda, are 30~40 m. above sea-level and consist of marine beds. Similar terraces are therefore expected to exist between these terraces. So far as the writer knows, there are many prolongations of the Hiradoko terrace near Ugai (鵜飼) between Matunami and Iida etc. Between Tumuki and Matunami, a narrow belt of the Matunami terrace fringes the sea-shore from Usetu to Ukawa. These terraces being virtually of the same height, the writer concludes that the east shore of Noto peninsula was uplifted 30~40 m. (or the sea-level lowered 30~40 m.) after the deposition of the Hiradoko and other shell beds. Evidence of this movement is also seen in the Tokuda terrace in the Oti graben. It will thus be seen that the northeast part of the graben developed, physiographically similar to the Tumuki, Matunami, and Hiradoko terraces. Fig. 5 shows the distribution of these terraces along the east shore of Noto peninsula.

d. *Conclusion.* The geologic age of these shell-bearing terrace deposits deserves careful study. Most of the fossil shells collected from these beds are now living in our seas washed by the warm Kuroshio current, some of the warm current species of which now live only in the southern Japan, only a few of such species being found in the lower Pleistocene deposits of Central Japan. The warm current which washes the sea shore on the northwest side of the Japanese islands flows through the Korean straits into the Japan Sea. The occurrence of these warm current fauna in the Pleistocene deposits of this region suggests that the warm current flows into the Japan Sea through the Korean straits.

18) T. OGAWA, *Expl. Text. Geol. Map, Japan*, "Suzumisaki" sheet, 1:200,000, (1907). In this expl. text., T. Ogawa considers these terrace deposits the Younger Tertiary (dt of Ogawa).

Table I. (1=Akasaki; 2=Tumuki; 3=Matunami; 4=Hiradoko).

	1	2	3	4
<i>Emarginula crassicosata</i> Sowerby	—	—	—	3
<i>Diodora sieboldii</i> (Reeve)	—	—	1	—
<i>Patelloida saccharina</i> (Linné)*	—	—	1	—
<i>Patelloida conulus</i> (Dunker)	—	—	3	8
<i>Euchelus foveolatus</i> (A. Adams)	—	—	—	5
<i>Solariella</i> aff. <i>angulata</i> (Tokunaga)	—	—	—	2
<i>Tegula</i> (<i>Chlorostoma</i>) <i>rustica</i> (Gmelin)*	—	1	—	—
<i>Skenea nipponica</i> ? Yokoyama	2	—	—	—
<i>Turbo coronatus coreensis</i> Récluz*	3	5	1	—
<i>Astraea</i> (<i>Calcar</i>) <i>haematraga</i> (Menke)*	—	—	13	3
<i>Iravadia annulata</i> (Dunker)	—	—	3	3
<i>Cingula</i> (<i>Pseudosetia</i>) <i>paludinoidea</i> (Yokoyama)	—	—	—	5
<i>Amphithalamus</i> sp.	—	—	—	2
<i>Alvania concinna</i> A. Adams	—	2	8	—
<i>Rissoina</i> (<i>Phosinella</i>) <i>media</i> Schwartz*	—	—	1	—
<i>Rissoina</i> (<i>Rissoina</i>) <i>laevicostulata</i> Pilsbry*	3	40	2	13
<i>Rissoina</i> (<i>Zebinella</i>) <i>yendoii</i> Yokoyama	—	—	3	—
<i>Pseudoliotia micans</i> (A. Adams)*	—	—	2	—
<i>Turritella fascialis</i> Menke	—	—	20	5
<i>Lemintina imbricata</i> (Dunker)*	2	2	1	—
<i>Siliquaria cumingi</i> (Mörch)*	—	—	—	1
<i>Batillaria multiformis</i> (Lischke)*	—	1	—	—
<i>Obtortio septentrionalis</i> (Tokunaga)	10	40	—	—
<i>Obtortio orientalis</i> (Yokoyama)	2	20	40	30
<i>Obtortio perpupoides</i> (Yokoyama)	3	6	1	40
<i>Scaliola bella</i> A. Adams	—	2	2	16
<i>Diala varia</i> A. Adams	—	2	20	1
<i>Bittium perpusillum</i> Tryon*	5	30	60	6
<i>Bittium numamuranum</i> Yokoyama	—	—	40	30
<i>Cerithium</i> (<i>Proclava</i>) <i>kochi</i> (Philippi)*	1	4	—	3
<i>Gourmya</i> (<i>Contumax</i>) <i>sordidula</i> (Gould)	6	37	—	—
<i>Gourmya</i> (<i>Contumax</i>) <i>kobelti</i> (Dunker)*	1	1	35	—
<i>Triphora</i> (<i>Inella</i>) <i>tricincta</i> (Dunker)*	—	1	1	1
<i>Triphora</i> sp.	—	2	12	6
<i>Epitonium</i> (<i>Turbiniscala</i>) sp.	—	—	2	—
<i>Strombiformis</i> (<i>Leiostraca</i>) <i>shibana</i> (Yokoyama)	—	—	—	3
<i>Chrysallida</i> (<i>Miralda</i>) <i>gemma</i> (A. Adams)	—	—	—	5

(to be continued.)

Table I. (continued.)

	1	2	3	4
<i>Chrysallida (Babella) caelata</i> (A. Adams)	—	—	—	4
<i>Chrysallida (Pyrgulina) densecostulata</i> (Garrett)	—	1	11	1
<i>Menestho</i> sp.	—	—	1	—
<i>Menestho lectissimoides</i> (Yokoyama)	—	—	1	—
<i>Odostomia limpida</i> Dall et Bartsch	—	—	1	11
<i>Syrnola cinctella</i> ? A. Adams	—	1	—	—
<i>Cingulina triarata</i> Pilsbry*	—	—	—	1
<i>Turbonilla imbana</i> Yokoyama	—	—	11	—
<i>Turbonilla hiradokoensis</i> Otuka n. sp.	—	—	—	1
<i>Turbonilla</i> sp.	—	1	—	—
<i>Turbonilla (Strioturbonilla) nihona</i> Otuka n. sp.	—	1	1	3
<i>Turbonilla (Pyrgiscus) matunamiensis</i> Otuka n. sp.	—	—	1	—
<i>Turbonilla (Pyrgiscus)</i> sp.	—	1	—	—
<i>Turbonilla (Mormula)</i> sp.	—	—	1	—
<i>Strombus (Labiostrombus) japonicus</i> Reeve*	—	3	4	42
<i>Polinices didyma</i> (Bolten)*	—	1	—	—
<i>Polinices sagamiensis</i> Pilsbry*	—	—	—	3
<i>Natica concinna</i> Dunker	—	3	—	5
<i>Sinum (Eunaticina) papillum</i> (Gmelin)*	—	—	—	1
<i>Erato callosa</i> (Adams et Reeve)*	—	—	—	2
<i>Erronea japonica</i> (Schilder)	—	—	5	—
<i>Bursa (Gyrineum) natator</i> ("Bolten" Röding)	—	—	3	—
<i>Trophon (Bedeva ?) birileffi</i> Lischke*	—	5	7	3
<i>Thais (Mancinella) bronni</i> (Dunker)*	1	7	1	1
<i>Pyrene (Mitrella) varians</i> (Dunker)*	—	5	30	5
<i>Pyrene (Zafra) pumila</i> (Dunker)*	2	2	5	2
<i>Siphonalia cassideriæformis ornata</i> A. Ad.	—	—	—	2
<i>Engina menkeana</i> (Dunker)*	—	—	—	2
<i>Nassarius (Hinia) festivus</i> (Powys)*	—	3	—	1
<i>Nassarius (Tritonella) japonicus</i> (A. Adams)*	—	1	20	—
<i>Nassarius (Alectrion) balteatus</i> (Lischke)*	—	—	—	1
<i>Nassarius (Zeuxis) caelatus</i> (A. Adams)	—	—	1	—
<i>Nassarius (Niotha) gemmulatus</i> (Lamarck)*	—	—	—	2
<i>Nassarius (Niotha) livescens</i> (Philippi)*	—	12	59	—
<i>Fusinus perplexus</i> (A. Adams)*	—	1	—	—
<i>Oliva mustelina</i> Lamarck*	—	—	—	1
<i>Mitra</i> sp.	—	—	—	1

(to be continued.)

Table I. (continued.)

	1	2	3	4
<i>Cancellaria (Narona) spengleriana</i> Deshayes*	2	—	—	1
<i>Clavatula consimilis</i> (Smith)	—	1	—	—
<i>Brachytoma jeffreysii</i> (Smith)*	—	—	2	—
<i>Asthenotoma nivea</i> (Philippi)*	—	—	—	1
<i>Mangelia (Bela)</i> sp.	—	—	1	—
<i>Mangelia (Bela)</i> sp.	—	—	—	5
<i>Pseudorhaphitoma naganumensis</i> Otuka n. sp.	—	—	—	2
<i>Philbertia leuckarti</i> (Dunker)*	—	—	—	1
<i>Asperdaphne subzonata</i> (Smith)	—	1	—	—
<i>Terebra (Punctoterebra) lischkeana</i> Dunker*	—	—	—	1
<i>Pupa strigosa</i> (Gould)*	—	2	—	2
<i>Ringicula (Ringiculina) doliaris</i> Gould	—	3	9	1
<i>Ringicula (Ringiculina) yokoyamai</i> Takeyama	3	—	4	3
<i>Acteocina exilis</i> (Dunker)	—	—	—	15
<i>Retusa minima</i> Yamakawa	—	1	9	20
<i>Rhizorus artiaperta</i> (Yamakawa)	—	2	—	2
<i>Cylichna yamakawai</i> Yokoyama	2	3	—	1
<i>Philina japonica</i> Lischke*	—	—	—	1
<i>Dentalium (Dentalium) hexagonum</i> Gould*	—	5	20	12
<i>Dentalium (Antalis) motidukii</i> Otuka n. sp.	—	—	—	1
<i>Siphonodentalium (Pulsellum) ozawai</i> Yokoyama	—	—	—	1
<i>Nucula</i> sp.	—	—	—	1
<i>Limopsis multistriata</i> (Forsk.)*	—	—	—	29
<i>Navicula ocellata</i> (Reeve)*	—	4	24	10
<i>Navicula boucardi</i> (Jousseaume)*	—	—	1	—
<i>Barbatia obtusoides</i> (Nyst)*	—	10	—	—
<i>Barbatia stearnsi</i> (Pilsbry)*	—	—	1	40
<i>Barbatia symmetrica</i> (Reeve)*	3	—	20	40
<i>Barbatia divaricata</i> (Sowerby)	—	—	—	40
<i>Barbatia decussata</i> (Sowerby)	—	2	29	—
<i>Arca subcrenata</i> Lischke*	—	—	1	—
<i>Arca inflata</i> Reeve*	—	3	—	—
<i>Bathyarca uwaensis</i> (Yokoyama)	—	—	—	1
<i>Trichomusculus divaricatus</i> (Philippi)	—	—	7	5
<i>Ostrea denselamellosa</i> Lischke*	—	—	1	—
<i>Ostrea gigas</i> Thunberg*	—	4	—	—
<i>Plicatula horrida</i> Dunker	—	—	—	10

(to be continued.)

Table I. (continued.)

	1	2	3	4
<i>Chlamys irregularis</i> (Sowerby)*	—	—	—	3
<i>Chlamys nipponensis</i> Kuroda*	2	4	—	1
<i>Pecten laqueatus</i> Sowerby*	—	1	4	20
<i>Spondylus cruentus</i> Lischke*	—	4	4	—
<i>Lima lischkei</i> Lamy	—	—	15	30
<i>Lima basilanica</i> Adams et Reeve*	—	1	—	3
<i>Crassatellites namus</i> (Adams et Reeve)	—	—	—	4
<i>Begonia japonica</i> (Pilsbry)*	—	1	—	—
<i>Cardita cumingiana</i> Dunker*	—	2	14	10
<i>Basterotia gouldii</i> (A. Adams)	—	—	—	4
<i>Lucina (Myrtea) acutilineata</i> Conrad	—	—	—	20
<i>Lucina contraria</i> Dunker	—	7	—	—
<i>Pillucina pisidium</i> (Dunker)	2	6	15	—
<i>Anodonta bialata</i> (Pilsbry)	—	10	1	—
<i>Codakia divergens</i> (Philippi)	—	1	9	1
<i>Taras lunaris</i> (Yokoyama)	—	—	—	4
<i>Kellia notoensis</i> Yokoyama	—	1	—	—
<i>Scintilla nipponica</i> Yokoyama	—	—	1	—
<i>Jousseauimella crassa</i> (Yokoyama)	—	—	—	1
<i>Mysella oblongata</i> (Yokoyama)	—	—	—	1
<i>Chama aspersa</i> Reeve*	1	4	40	20
<i>Cardium (Fulvia) muticum</i> Reeve*	1	1	1	2
<i>Cardium (Fulvia) hungerfordi</i> Sowerby	—	—	—	15
<i>Cardium (Trachycardium) ebaranum</i> Yokoyama	—	—	1	2
<i>Gafrarium divaricatum</i> (Gmelin)*	4	6	—	—
<i>Gafrarium (Circe) scriptum stutzeri</i> (Donovan)*	4	15	—	—
<i>Pitar pellucida</i> Lamarck	4	8	1	2
<i>Callista pacifica</i> (Dillwyn)*	—	—	1	20
<i>Chamaeformis meretrix</i> (Linné)*	—	—	—	30?
<i>Dosinia japonica</i> Reeve*	1	2	—	—
<i>Protothaca jedoensis</i> (Lischke)*	—	4	7	—
<i>Paphia euglypta</i> (Philippi)*	—	—	—	4
<i>Paphia undulata</i> (Born)*	—	—	12	—
<i>Petricola japonica</i> Dunker	2	2	—	—
<i>Raeta pulchella</i> Adams et Reeve	—	2	—	—
<i>Lutraria arcuata</i> Reeve	—	—	—	7
<i>Macoma tokyoensis</i> Makiyama	—	2	2	—

(to be continued.)

Table I. (continued.)

	1	2	3	4
<i>Macoma truncata</i> Jonas	—	—	3	—
<i>Tellina (Merisca) diaphana</i> Deshayes	—	—	—	1
<i>Tellina (Angulus) iridella</i> v. Martens*	—	—	—	2
<i>Tellina miyatensis</i> Yokoyama	—	—	6	7
<i>Tellina</i> sp.	—	—	—	1
<i>Sanguinolaria (Nuttallia) olivacea</i> (Jay)*	—	1	—	—
<i>Theora (Endopleura) lubrica</i> Gould	—	2	—	—
<i>Solen</i> sp.	—	—	—	2
<i>Aloidis venusta</i> (Gould)	—	—	2	1
<i>Aloidis substriata</i> (Yokoyama)	—	—	—	4
<i>Cryptomya busoensis</i> Yokoyama	—	1	—	—
<i>Mya arenaria japonica</i> Jay*	2	4	—	—
<i>Barnea fragilis</i> (Sowerby)*	1	2	—	—
<i>Barnea dilatata</i> (Souleyet)	—	—	3	2
<i>Pholadidea penita tokyoensis</i> (Yokoyama)	—	2	—	—

According to K. Kikuchi¹⁹⁾, the recent faunal characteristics of the bay of Toyama are of the Kuroshio type. Living species in the bay of Toyama and on the coast of Hukui prefecture²⁰⁾ are marked * in Table I.

On the other hand, during early Pleistocene, probably the writer's dl stage²¹⁾, continental mammals, e. g., *Stegodon orientalis* Owen²²⁾, *Elephas namadicus naumanni* Makiyama, *Elephas trogontheri* Pohlig²³⁾, lived in the Japanese island, so that the must have been connected with Asiatic continent during late Pliocene or early Pleistocene. If these mammals had migrated from the Asiatic continent through the landbridge of Korea during early Pleistocene or late Pliocene, the geologic age of the Tumuki, Miyainu and Hiradoko shell beds must be post early Pleistocene or post late Pliocene, since believed that the warm current flows through the Korean strait into the Japan sea. The condition in which these shell beds are deposited on the Tertiary bed rock is similar to the case of the Dl beds on the Pacific coast, e. g., the

19) K. KIKUCHI, Catal. Mar. Shells Bay of Toyama, (1931).

20) T. KURODA, Catal. Mar. Shells Hukui Pref., (1933).

21) Y. OTUKA, "Dai Si-ki," Iwanami Kôza (1931) (in Japanese); *Proc. Pan-Pacific Sci. Congr., Canada* (1933), 1589-1592.

22) H. MATSUMOTO, *Sci. Rep. Tôhoku Imp. Univ., Geology*, 10 (1926).

23) J. MAKIYAMA, *Jap. Jour. Geol. Geogr.*, 3 (1924); *Mem. Coll. Sci. Kyoto Imp. Univ.*, [B], 1 (1924).

Sakisima²⁴⁾ beds, the Atumi shell beds²⁵⁾ and the Huruya shell bed²⁶⁾.

The extent of dissection of the Hiradoko terrace agrees with that of the Du terrace along the Pacific side. Fig. 6a, b show the extent to which dissection has proceeded in the Hiradoko terrace and in the Simosa terrace as calculated by Tayama's method.²⁷⁾ This similarity in dissection in these two remote terraces may justify the writer in concluding that these two terraces underwent similar dissection since their surface was uplifted.

The east coast of Noto peninsula is now

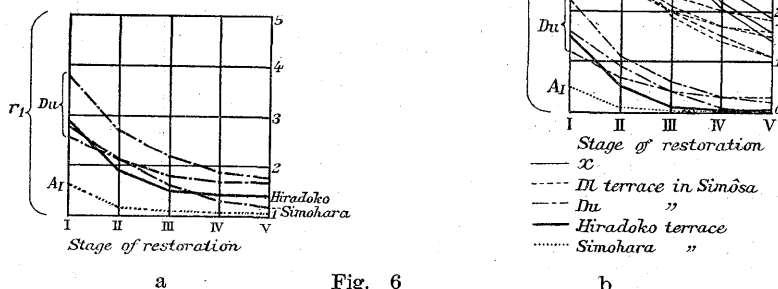


Fig. 6

very irregular in outline. Nanao bay, Usetu harbour, Tukumo-wan, and Anamidu-wan are drowned valley topographies. Seeing that these drowned valleys dissect the surface of Hiradoko, Tumuki and Matunami terrace and Alluvial plains are formed in all the valley head of these drowned valleys, the early Alluvial or later Diluvial subsidence, a predominant feature of Japanese islands²⁸⁾, is seen in this province also.

It will be seen from the foregoing that the surface of the Hiradoko, Tumuki, and Matunami terraces may be the Du of the writer, and the shell beds of Tumuki, Miyainu, and Hiradoko either duI or dIII. The Tumuki shell bed originally believed by the writer from its faunal characteristics and its geologic occurrences, to be "aI" (early Holocene), or "duII" (latest Pleistocene), seems to be an error. Warm current fauna is a common characteristic of "dIII" (lower Pleistocene shell beds) on the Pacific coast of southwestern Japan, as pointed out by

24) Y. OTUKA, *Geogr. Rev. Jap.*, 4 (1928) (in Japanese); OIMIKADO, *Chikyû*, 19 (1933), (in Japanese).

25) OIMIKADO, *Chikyû*, 20 (1933), (in Japanese).

26) J. MAKIYAMA, *Chikyû*, 12 (1929), (in Japanese).

27) R. TAYAMA, *Sci. Rep. Saito-hoonkai*, 9 (1930), (in Japanese).

28) Y. OTUKA, *Proc. Imp. Acad., Japan*, 10 (1934).

Kuroda²⁹⁾, Matsushita³⁰⁾, Oimikado³¹⁾, and Makiyama³²⁾. The occurrence of a warm fauna therefore does not affect the conclusion that the Hiradoko, Tūmuki, and the Matunami shell beds were deposited during the earlier half of the Pleistocene. The age of these shell-bearing deposits of Noto have, however, to be discussed with great care, particularly as any conclusions with respect to the age of these shell-bearing deposits will be closely related to interpretations regarding the Pleistocene crustal movement of the Japanese island. That is, if the Pleistocene shell-bearing beds on the Pacific and Japan Sea side were contemporaneous with each other, the Japanese islands would be moved by similar crustal movement as one block; whereas if these beds were different in age, the Japanese island would be moved by differential crustal movements on Pacific and Japan sea sides. (to be continued).

17. 能登半島南部邑知地溝 (1)

地震研究所 大塚彌之助

この論文は能登半島の南部を N60°E の方向に横ぎる邑知地溝の地質構造発達史の一部の研究である。全章を 8 項に分ち地形・層序・地質構造の順に説明し、最後の章はこの研究の一資料となつた貝化石類の記載に充てた。

緒論に於ては、この地方を研究された先輩諸兄の論文を擧げてゐる。

地形の項は邑知地溝の地溝底・兩側山地の地形區分に終始し、最後に能登半島の切峯面に就いて言及した。

能登半島東岸の海岸段丘の項に於いては、能登半島東岸の海岸段丘を記載し、各段丘層の性質を述べ、徳田・津向・松波・平床各段丘の形成の時代を論じてゐる。種々考察の結果は平床その他各段丘面の形成された時代は從來考察された如く洪積世末期又は沖積世初期と考へるには層位學上・地形學上稍々説明困難な點がある。これらの段丘面は恐らく洪積世中期又は後半の形成にかゝるものらしく、段丘層は從來考察された如く鮮新世末期と考へるには、今日の處、古生物學上矛盾がある。

層位・構造その他に關しては第 2 に之を譲つた。

29) S. NAKAMURA and T. KURODA, *Chikyū*, 1 (1925), (in Japanese).

30) S. MATSUSHITA, *Chikyū*, 18 (1932), (in Japanese).

31) OIMIKADO, *op. cit.*, (1933).

32) MAKIYAMA, *op. cit.*, (1924, 1929).

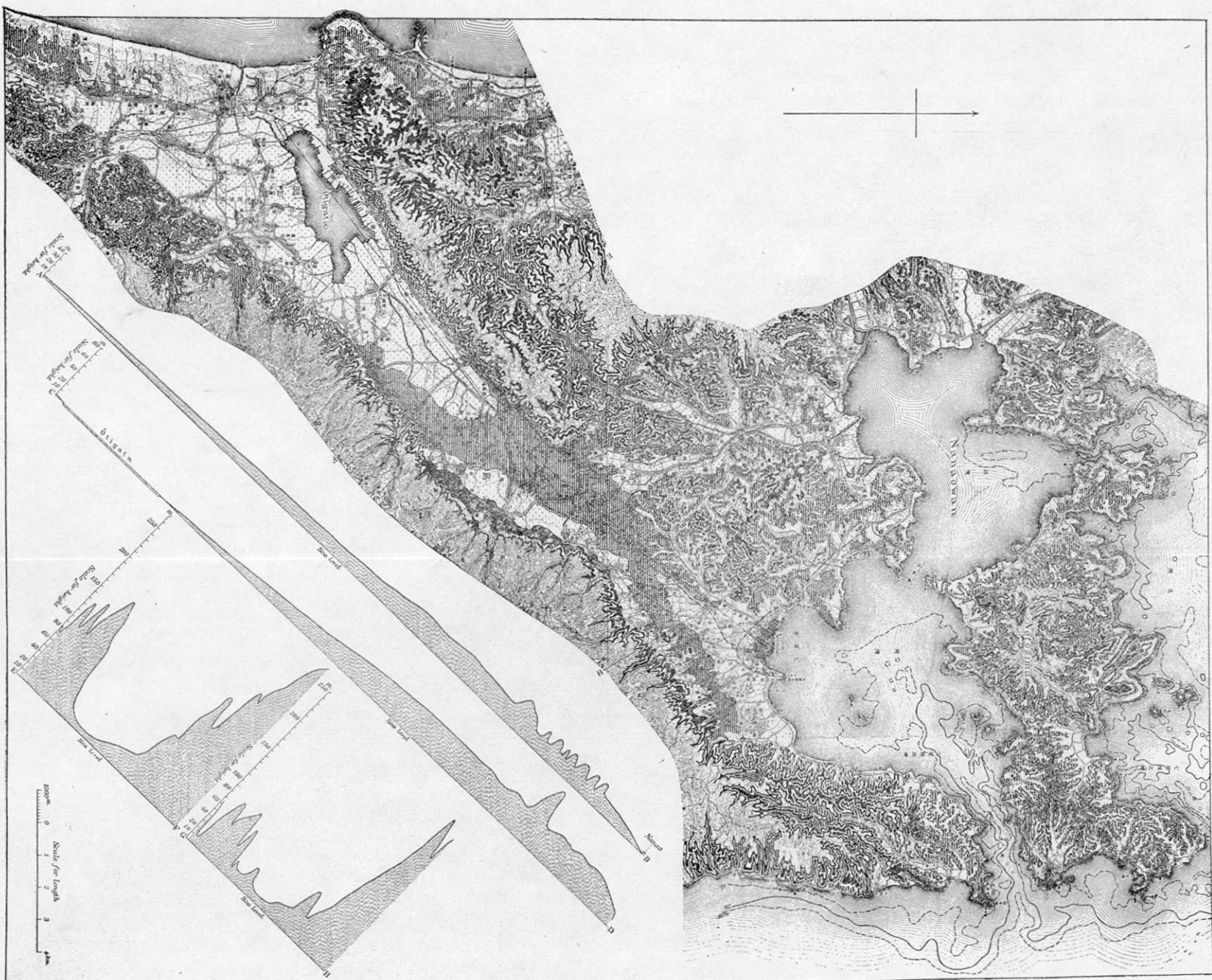


Fig. 1.

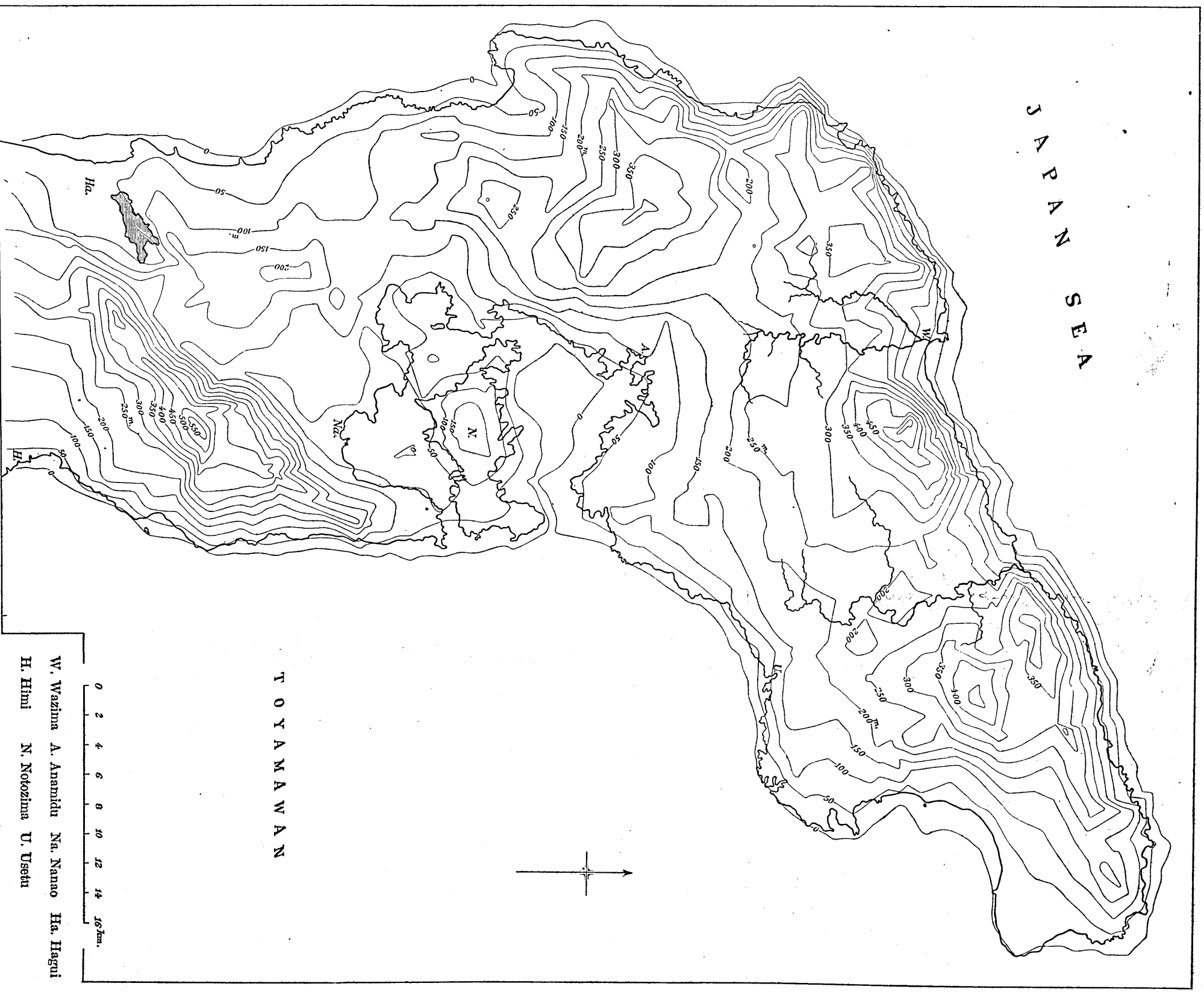


Fig. 4. Summit-level of Noto peninsula. (Contour line is referred to the highest points in the 2 km² nets.)
This summit-level has been drawn by K. Yasumuro.



Fig. 7. Photograph showing the steep fault scarp of southeast side of Oti graben.



Fig. 8. Photograph showing the low relief surface of Noto peninsula.



Fig. 9. Photograph showing the Tumuki terrace near Osugisaki.



Fig. 10. Photograph of Hiradoko shell bed resting on an erosion surface of the Neogene (Iiduka beds) with unconformity.