

## 15. Hôjô Trough.

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(With 1 Text-Figure and 1 Plate.)

The Bôsô Peninsula, which is one of the major geotectonic divisions of the Kwantô Region,<sup>1)</sup> consists of seven parts, each trending east-west and geotectonically as well as physiographically distinct from the other.<sup>2)</sup> Counted from the north they are (Figure 1)

1. Kimitsu tilted block, sloping northwards with its tilt-edge along the Nokogiri-Kiyozumi ridge.
2. Kamogawa graben, with the valley of Hoda-gawa on the western prolongation, the real nature of which is still unknown.
3. Mineoka horst.
4. Soro-Iwai fault-line valley.
5. Middle Awa (or Chûbô) plateau, sloping southwards.
6. Hôjô trough.
7. South Awa (or Nanbô) plateau, sloping northwestwards.

Of these seven parts, the Hôjô trough only is dealt with in the present article, while certain features of the Middle and South Awa plateaux are taken into consideration.

The depressed zone lying between the Middle Awa plateau and the South Awa plateau was often called the "Hôjô graben"<sup>3)</sup> or "Kagami-gaura graben" on account of its graben-like aspect; it was found, however, that the depression in its greater length is a trough and not

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1) H. YABE and R. AOKI, "The Great Kwantô Earthquake of September 1, 1923, Geologically Considered", *Ann. Rep. Saitô Gratitude Foundation*, No. 1 (1926), 70 et seq.

2) H. YABE, "Bôsô Peninsula", *Gendai no Kagaku (Science Gazette)*, Vol. II, No. 4 (1914), (in Japanese). In this paper is given my first notion about the block-structure of the peninsula, which is essentially the same as our present view at least as to the major divisions.

3) For instance, H. YABE and R. TAYAMA, "On Some Remarkable Examples of Drowned Valleys found around the Japanese Islands", *Rec. Oceanogr. Wks.*, Japan, II (1929), 12: It is the "depression of Tateyama" or "depressed zone of Tateyama" of the late Professor Yamasaki: "Physiographical Studies of the Great Earthquake of the Kwantô District, 1923", *Jour. Fac. Sci., Imp. Univ., Tôkyô*, Ser. II, Vol. 1 (1926).

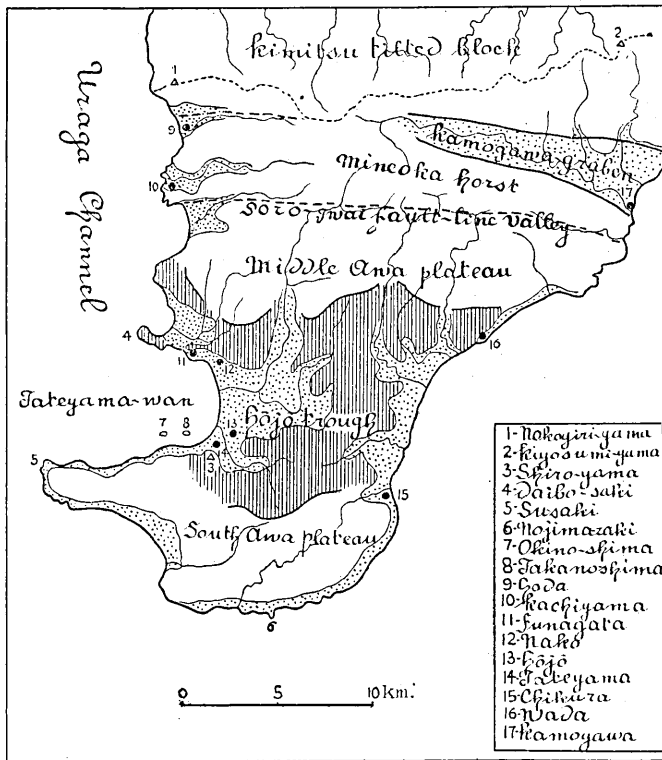


Fig. 1.

embayment open at the north-west and west; it is shallow, being 30 m. or less in depth, and has a straight furrow of an east-west trend, 327-662 m. deep along its median line. Its northern and southern coasts are as a whole straight, running approximately east-west; in a distant view there is a long series of escarpments, 100-120 m. high on both coasts, and these escarpments are so topographically attractive that several authors, including Yabe, regarded them as fault-scarps. Concerning them, the late Professor N. Yamazaki stated in his "Physiographical Studies of the Great Kwantô Earthquake of the Kwantô District, 1923," that "the northern wall of this zone is well marked by the scarp which extends from the cliffy promontory of Daibozaki farther eastward, passing by the bluff of Nako, where stands the well-known temple of Kannon, while the hills to the east of Cape Susaki form the southern boundary. Between these fault-lines extends the beautiful bay of Tate-

4) Also sometimes called Kagamigaura.

a graben, and the name Hôjô trough is preferred to Hôjô graben.

The depressed zone in question consists of four parts of different physiognomy; counted from the west, they are: the Tateyama-wan (bay of Tateyama),<sup>4)</sup> the alluvial plain of Hôjô or Hôjô plain, Kokonoe hills, and the alluvial plain of Chitose or Chitose plain.

The Tateyama-wan is a four kilometers broad rectangular

yama and an adjoining coastal plain where the noted summer resorts of Hôjô and Tateyama are located."<sup>5)</sup>

The two small islets Takanoshima and Okinoshima off Tateyama are on a line nearly parallel to the southern boundary of the bay; these islets are flat topped, being raised wave-cut benches of Neogene rocks. Terraces of the same nature and similar height and lower ones as well as the present sandy beach form a narrow, discontinuous belt along the foot of the escarpments.

The sandy beach which borders the Tateyama-wan at the east runs straight from north to south. The broad alluvial plain of Hôjô which extends from the shore-line eastwards, is drained by the two streams, Heguri-gawa and Shiwoiri-gawa. The main stream of the Heguri-gawa is physiographically very interesting, as it has its lower course extended on a new grown coastal lowland, the middle course cut a consequent valley of a north-south trend through the Middle Awa plateau,<sup>6)</sup> and the upper course lying in the Soro-Iwai fault-line valley of an east-west trend by which the back-side of the plateau is limited. Several streamlets from the Kokonoe hills and an adjoining part of the South Awa plateau coalesce on the plain to form Taki-kawa which is now a tributary of the Heguri. The Shiwoiri-kawa is fed by the water from the South Awa plateau.

The Hôjô plain consists of the bay-head deposits of the Tateyama-wan, overlain by alluvial materials; in a former time it was occupied by the marine water of the bay. The geologically youngest marine formation was uplifted in consequence of a slight emergence of land as shown by the streams intrenched a few meters below the ground surface and sometimes exposing marine deposits lying beneath the alluvia. The earlier history of the lowland is revealed by higher terraces 15-20 m. above the present sea-level, which follow in their distribution almost thoroughly the indented inland boundary of the plain. These 15-20 m. terraces belong to a category of the Post-loam terraces (PL.) of Aoki and Tayama<sup>7)</sup> in the Kwantô region north of the Bôsô peninsula, and are believed by us to be of marine origin; the 20 m. terraces are rock ben-

5) Yamasaki assumed rift valleys for the middle course of the Heguri-gawa and the adjacent middle course of the Maruyama-gawa which are parallel to one another, an opinion which we can not accept Yamasaki, "Physiographical Studies", 89.

6) YAMASAKI, "Physiographical Studies", 89.

7) R. AOKI and R. TAYAMA, "Morphology and Geology of the Kwantô Tectonic Basin, with Special Reference to Its Western Marginal Part", *Saito Gratitude Foundation, Sci. Rep. VIII* (1930), (in Japanese).

ches covered by alluvial or detrial materials while the 15 m. terraces are built of contemporaneous marine sediments. At a post-Pleistocene time, the sea-level of the Tateyama-wan was preceded by a submergence far superior in amount; the present coastal topography still retains the incontestable trace of that submergence of land.

These latest episodes in the geological history are quite the same in the other parts of the Kwantô region as in the present district, as repeatedly pointed out elsewhere by one of us.<sup>8)</sup>

The depression of the Hôjô zone certainly took place prior to this submergence of land.

The hilly land lying between the Hôjô plain and Chitose plain on the Pacific coast is a strongly dissected plateau of Neogene rocks called the Kokonoe hills; it is quite similar in geological and early topographical growth to the Middle and South Awa plateaux. At present it lies below the latter two, or in other words it shows an aspect of having submerged more deeply in alluvia. A fact which merits our special mention in this connection is that there is absolutely no trace of an abrupt topographical break between it and the other two. The highest ridge of the Kokonoe hills, which is hardly 100 m. high and serves as the water-shed between the two streams, one down to the Chitose plain and the other to the Hôjô plain, is extended from north to south and has its crest line uninterruptedly passing to the ground surface of the Middle Awa plateau at the north and to that of the South Awa plateau at the south. Physiographically as well as geologically we could find no trustworthy indication of faults by which the lower Kokonoe hills were suspected to be separated from the two higher plateaux.

The crest line of the Kokonoe hills lies nearer to the Pacific shore than to the shore of the Tateyama-wan, its distance from the former being about one half of that from the latter. The hilly land is further asymmetrical in another respect, namely as to the altitude of terraces along its western and eastern borders. The 20-15 m. terraces on the west side are equivalent to the 30-20 m. ones on the east side; likewise the lower or younger terraces hold higher altitudes on the eastern side than on the western. This peculiar feature suggests an asymmetrical emergence of land, the amount being greater on the eastern side than on the western.

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8) H. YABE and R. AOKI, "A Summary of the Stratigraphical and Palaeontological Studies of the Cenozoic of Japan, 1920-1923", *Proc. Pan-Pacific Sci. Congr.*, Australia, (1923), 969.

The inland boundary of the Chitose plain very rich in indentations shows nowhere any sharp topographical and geological breaks reminding us of dislocation lines which seem to have contributed on the origin of the lowland.

By cartographical studies as well as in field observations we could not succeed in tracing any faults or fault-scarps on either side of the Hôjô plain, Kokonoe hills and Chitose plain, as stated above. Actual faults do not exist on either side of these parts of the Hôjô depression and neither in a position as plotted by Yamasaki<sup>9)</sup> and Yabe<sup>10)</sup> independently on their tectonic maps of the Kwantô region, nor elsewhere near any position apt to bring up the idea that the depression is a graben in strict sense; on the contrary, the physiographical relation of the Middle and South Awa plateaux to the depressed zone suggests its origin as a trough rather than a graben, due to a gentle downwarp of the earth's supercrust.

The escarpment on the north and south coasts of the Tateyama-wan are arranged on straight lines, of which the northern one is 5 km. and the southern one 10 km. long. The escarpments on the north coasts are, however, too discontinuous and separated to be safely assumed as the remnants of a once continuous fault scarp. These on the south coasts are more continuous and can be said as still retaining a vestige of an ancient fault scarp, though we have no geological evidence to support this interpretation; we can restore a fault scarp along the line of these escarpments, but it may or may not have existed there actually. Therefore what we can say now at most about the westernmost section of the Hôjô depression is merely that it has a certain evidence, though not a conclusive one, of a graben.

The depressed zone of Hôjô gives us a false impression of a graben; this is due to the remarkable panoramic views from its lowlands to the north and to the south. On both sides of the lowlands there is visible in a distance a series of escarpments which are nothing but the edge of terraces.

The Middle Awa plateau with its ground-surface as a whole is sloping southwards carrying two distinct planes of denudation which are correlated with the Lower Tama terrace ( $T_2$ ) and the Upper Tama terrace ( $T_1$ ) of Aoki and Tayama in the other parts of the Kwantô region. Higher areas above them are the relics of the Pre-Tama land with an

9) YAMASAKI, *op. cit.*, Pl. IX.

10) YABE and AOKI, *op. cit.*, Pl. II.

aspect of a dissected peneplane.

The terminal slope or face of the Upper Tama terrace is fairly continuous and magnificent in a distant view; it is usually 40–80 m. high and its base lies 100–120 m. above the sea level. In a top view, it is interrupted by a few large valleys where it always makes a broad backward bent; hence, the total aspect of the line is a series of curves convex southwards, and their front lies approximately on a line west by south to east by north in extension. By way it must be added that there is no trace of major fault geologically recognised to play an important rôle on the growth of these escarpments.

This upper series of escarpments lies 2 km. north of the restored line of escarpments between Daibôzaki and Nako and of its imaginary eastward prolongation.

In the South Awa plateau the Pre-Tama land-surface is reduced almost to nil and only a small area at the valley-head of the Nagao-gawa close to the southeastern border of the plateau is thought by us with some doubt to be a remnant of it. From the highest part which is about 200 m. high, the ground-surface of the plateau slopes gently to the north-west, with an abrupt break at a height of 100–120 m., where the Upper and Lower Tama terraces are separated by a steep wall 40–80 m. high and facing the depressed zone of Hôjô; the wall is most conspicuous for a distance of 3 km. and has a trend west-south-west to east-north-east. According to F. Ueda, a fault runs parallel to and 1 km. north of the escarpment; it is either a simple escarpment by erosion more or less controlled by an old dislocation line, or a retired fault scarp, according to the pre-Upper Tama or pre-Lower Tama origin of the fault.

The two escarpments along the edge of the Upper Tama terraces on the northern and southern sides of the depressed zone of Hôjô are some nine kilometers apart; they are not only parallel to one another but also parallel to the general trend of the Hôjô zone. This feature is important, because it tells us that the first downwarping of the earth's supercrust along the Hôjô zone was already displayed in the post-Upper Tama time.

In the other parts of the Kwantô region, the Upper and Lower Tama terraces are succeeded by the next lower Musashino terraces, and these in their turn by the Post-loam terraces. As a matter of fact, the Musashino terraces are developed very poorly, if any at all, in the Hôjô zone; a narrow terrace on the mid-slope of a small hill called Shiro-

yama near Tateyama is thought by us with some doubt to be one example of them and all others are similarly very limited in extension and of doubtful nature. The Shiroyama has a broad belt of the Post-loam terraces around its base, 20 m. above the sea-level.

In p. 4 we have already stated that the downwarping of the Hôjô zone in the present state is an earlier event than the submergence of land which preceded the building of 15-20 m. terraces. Further, that the building of the Lower Tama terraces anteceded the downwarping is quite evident from the distribution and topographical features of the Lower and Upper Tama terraces given above. Now the question arises whether the downwarping is older than the building of the Musashino terraces or younger? Any sound discrimination of the pre-Musashino (terrace) or post-Musashino (terrace) date of the crustal movement is rendered difficult by the very scanty development of the Musashino terraces in the district; but we hold the view that the district was primarily destitute of the Musashino terraces in any significant extension and the downwarping took place there after the building of the Musashino terraces in other places and before the submergence of land which preceded the building of the 15-20 m. terraces, for, otherwise, the Musashino terraces must be found in more extended distribution.

Summary: The depressed zone of Hôjô is probably not a graben, but a trough in its greater length; the possibility of its being a graben can be still maintained at most only in its westernmost section, the Tateyama-wan. The downwarping of the earth's supercrust took place most vividly at a time later than the building of the Musashino terraces and earlier than the submergence of land which preceded the emergence of the 15-20 m. terraces. The similar trough-making process seems to have been once active on the same line after the building of the Upper Tama terraces and before that of the Lower Tama.

Finally it remains to be added that there are two other troughs on the South Awa plateau, which are more or less similar in nature to, but much smaller in size than the Hôjô trough. One of them is 4 km. by 2 km., elongated from west to east, transversal to the eastern border of the plateau, and drained by the Kawajiri-gawa which has its mouth near Chikura on the Pacific coast. It is recognisable as a trough of the Lower Tama terraces by restoration, along the border of which the Musashino terraces are scarcely tracable.

The other trough of a more topographical interest is situated close

to the southern border of the South Awa plateau which is limited in the south by a bold escarpment, 60-100 m. high, facing the sea; it is elongated from east-north-east to west-south-west and 3.5 km. by 6 km. in extension. In front of the escarpment which is a fault scarp (Shirahama fault) is a lowland, a kilometer broad and consisting of 20-30 m., 12-20 m. and lower terraces, including rock benches elevated at the occasion of Kwantô earthquake of Genroku era (1703)<sup>11)</sup> and that of 1923. This trough is now provisionally called Nagao-gawa trough, as it is drained by the stream of that name.

The Nagao-gawa trough is a trough of the Upper and Lower Tama terraces, with the almost horizontal Musashino terraces well developed over the sunken area and still preserved rather fresh. The Musashino terraces have an elevation of 50-80 m. above the sea-level; through them the main stream and large tributaries of the Nagao-gawa makes their incised meander. Hence the Nagao-gawa trough is a product of super-crustal deformation at a date before the building of the Musashino terraces and after that of the Lower Tama terraces.

The Nagao-gawa cuts a narrow gorge just before its debouch from the plateau-border to the coastal lowland, thereby enclosing a small basin some 30 m. high near a village of the name Hongô; the basin traversed by the incised meander course of the main stream of the Nagao-gawa is due to the northward tilting of the very marginal part of the border of the South Awa plateau since the building of the Musashino terraces.

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11) A. IMAMURA, "Change of the Coast Line in Bôsô Peninsula", *Rep. Imp. Earthq. Inv. Comm.*, No. 100, B (1925), 91, (in Japanese).



## 15. 北 條 凹 地 帯

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在來房總半島南部に於て所謂「北條地溝帯」「館山灣地溝帯」と稱せられたるものは地溝と稱すべきに十分なる斷層を兩側に缺き寧ろ凹地帯と見做すを適當とすべし。唯館山灣南側の多少一直線狀に配列する急崖の列は斷層崖を想起せしめざるにあらざるも實際は然らず。地形上著しき兩側の急崖は  $T_1$ ,  $T_2$  兩段丘の境にありて、北側にあつては北より南に、南側にあつては南より北に傾き殊に  $T_2$  面は北條凹地帯内の九重丘陵地の表面に連る。

M 面は發達不十分なれど  $PL_1$ ,  $PL_2$  面は北條平野と千歳平野の周縁に發達す。この  $PL_1$  面は千歳平野に於ては北條平野に於けるものより多く隆起す。

北條凹地帯の形成は既に  $T_2$  面形成後に始り最新の著しき運動は恐らく M-面形成後なるべし。而して  $PL_1$  面形成後東西兩側に於て非對稱的の上昇を示す。

尙この以外に長尾川と川尻川の兩凹地帯あり前者は半島の南端白濱斷層に接し恐らく M 面形成後の地盤彎曲に歸するものなるべし。

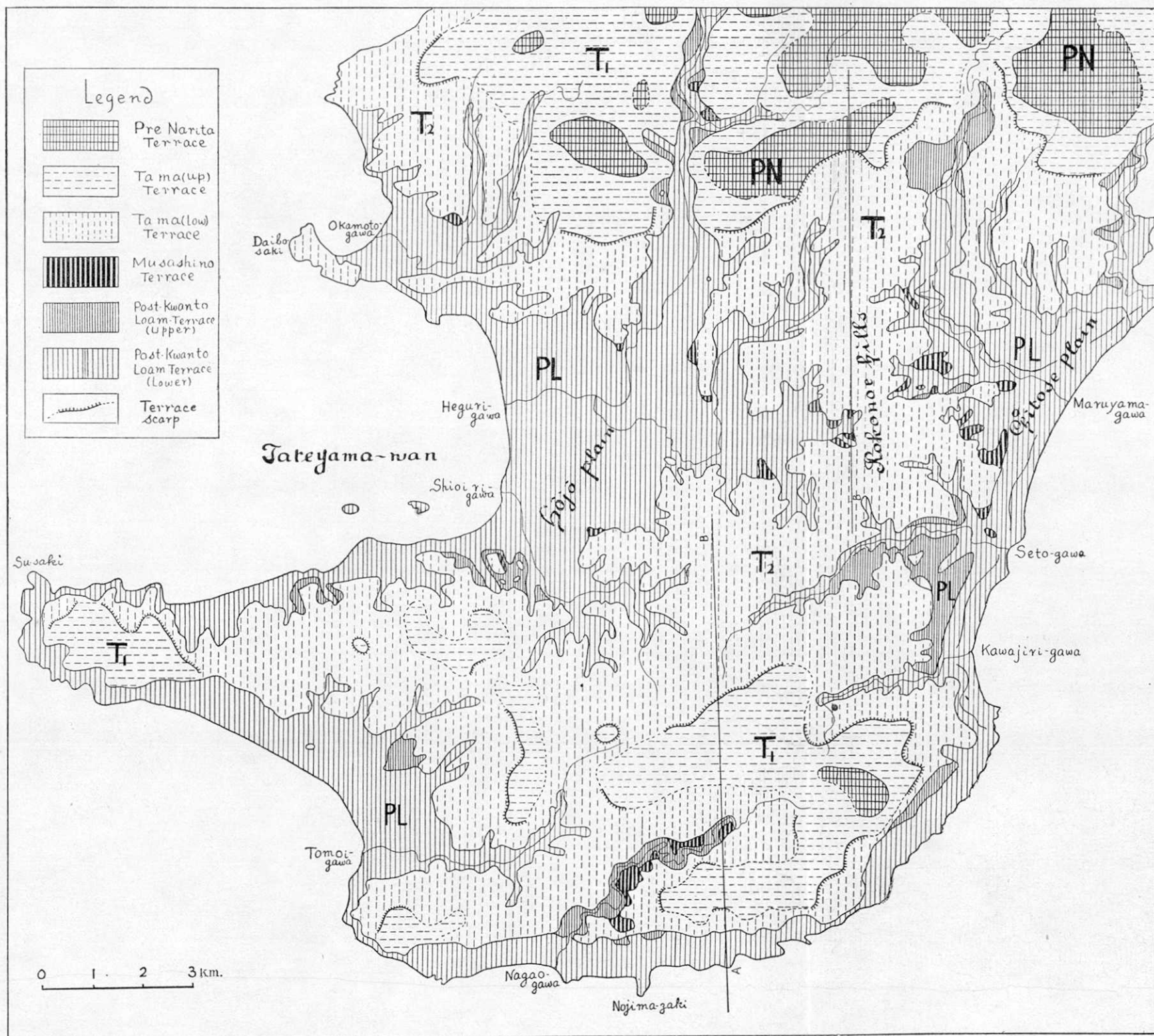


Fig. 2. Terrace Map of the Middle and Southern Parts of Eōsō Peninsula. (Originally it accompanies two profiles along the lines A-B and C-D; but these are excluded from the present paper).