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CHICHIBU

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CHICHIBU

NOTES ON THE GEOLOGY OF THE CHICHIBU DISTRICT

By Denzō Satō and Haruyoshi Fujimoto

The Chichibu district, which occupies the northeastern part of the Kwantō mountainland, is of much interest to our geologists on account of the full development there of various formations known in Japan. The facility of an excursion from Tokyo is a point of advantage.

TOPOGRAPHICAL FEATURES

As a whole, the mountainland extends from SE to NW with several high peaks more than 2,000 m., occurring in the southern part, from which the land gradually descends toward the northeast.

Two rivers, the Ara-kawa and the Kanna-gawa, with their sources in the high peaks above mentioned, run nearly parallel across the mountainland in the general direction from SW to NE, receiving many tributaries. Consequently there occur excellent exposures of various geological formations along these rivers. The Chichibu basin, as it is called, lies nearly in the centre of the district and is roughly square-shaped, extending about 15 km. from east to west and 11 km. from north to south. The basin is filled up for the most part by marine Tertiary deposits, with frequent occurrences of faults between the deposits and the older rocks of the borderland, especially in the eastern half of the basin.

The basin is a flat terrace-land gently inclined to the northeast, with an elevation of 500-600 m. above the sea-level in the southwestern part and of 250-300 m. in the northeastern, while it is 200-300 m. lower than the adjoining mountainland. The Ara-kawa crosses this basin diagonally from SW to NE., forming a narrow flood plain which is about 100 m. lower than the general surface of the basin, so that the upper and lower terraces have been developed along the course of the Ara-kawa and its main tributaries throughout the basin. The lower terrace can be traced outside the basin along the Ara-kawa as well as along the Kanna-gawa.

GEOLOGY

The geological formations developed in the Chichibu district are shown in the accompanying columnar section, divided as follows (ascending order) :

(1) The Sambagawa System (or Crystalline-Schist System).
(2) The Mikabu System.
(3) The Chichibu System.
(4) The Cretaceous System.
(5) The Tertiary System.
(6) The River Terrace Deposits.

1. Sambagawa System

This, the oldest formation of the district, is well developed on the northeastern periphery of the mountainland, and extends about 48 km. from Shimonita in Gunma Prefecture to Tamagawa in Saitama Prefecture with a maximum width of 20 km. It is disconnected between Yorii and Ogawa in the eastern part by younger formations. Concerning the Sambagawa System, there is Professor Kotō's elaborate paper on its petrographical and stratigraphical studies and Professor Yabe's paper published subsequently on the geological structure of the northeastern part of the Kwantō mountainland and on the Sambagawa System, especially on the order of succession. Depending mainly on the data set forth by these authorities, to which have been added the results of our own research, we have classified the Sambagawa System in the following ascending order :—

Lower ; Sericite-schist and graphite-sericite-schist, accompanying piedmontite-schist in its uppermost horizon.

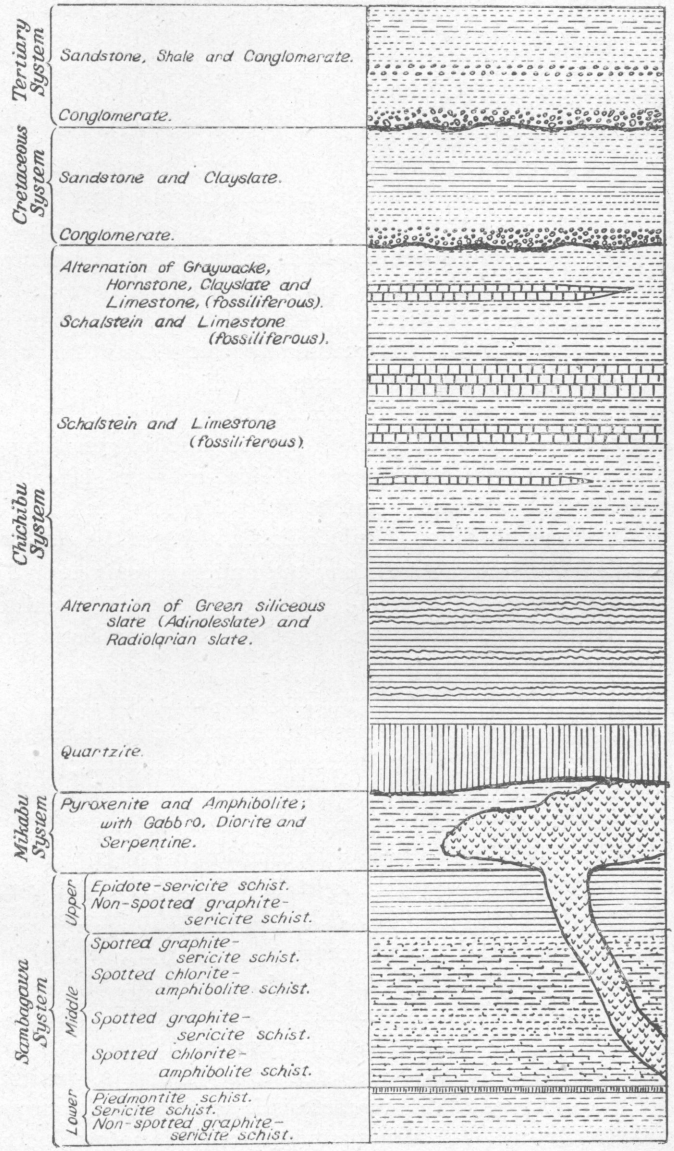
Middle ; Spotted chlorite-amphibole-schist and spotted graphite-sericite-schist, intercalating thin layers of biotite-schist, hæmatite-schist and crystalline limestone.

Upper; Epidote-sericite-phyllite, accompanying sericite-graphite-phyllite in its lower horizon.

The general strike of the series is NW-SE with some foldings and faultings, as shown in the map.

Along the Ara-kawa, especially between Yorii and Kunikami, excellent exposures in full development of these crystalline schists are met with, making this section most notable as an example of the oldest formation in the district and most interesting for a geological trip.

Lower division :—The most essential element of the lower division is a sericite-schist. According to Prof. Kotō, "Normal



sericite-schist is a grayish-white, thick foliated rock with a wavy sweep on the sheeny surface. Slabs show numerous prominences of a yellowish tinge, owing to the presence of epidote crystals. The cleaved face has a silky lustre, due to the parallel arrangement of fibrous scales of sericite. The rock-ingredients are quartz, some feldspars, sericite, calcite, a yellowish-green epidote, iron glance, iron mica and lastly rutile."

In the upper horizon of this division, there is a most remarkable rock, the piedmontite-schist. It occurs generally in thin bands alternating with other thin bands of spotted graphite-sericite-schist, spotted chlorite-amphibole-schist, and is an index bed suggesting the boundary between the middle and lower divisions. This rock is of a purple colour, more compact than the sericite-schist, but easily cleavable into thin plates. On weathered surfaces, beautiful purplish-red prismatic crystals of piedmontite are distinctly visible to the naked eye. The components of this rock, according to Prof. Kotō, are, besides the manganese epidote, quartz, sericite, greenish-yellow garnet, rutile, non-striped feldspar and blood-red iron-glance. Good exposures of this rock are found at several points such as Sueno, Hagure, Oyahana and Honnogami along the valley of the Ara-kawa.

Below the sericite-schist along the anticlinal axis near Sueno, we found spotted as well as non-spotted graphite-sericite-schists and modifications of them. These probably form the lowest horizon of the Sambagawa System.

Middle division :—Upon the piedmontite-schist, we found spotted graphite-sericite-schist alternating with spotted chlorite-amphibole-schist, having a considerable thickness and constituting the main part of the Sambagawa System. Thus the distribution of these schists is very wide and they may be easily observed at several places in the district. Besides the two above mentioned schists, this division often accompanies thin layers of crystalline limestone, quartz-schist, hæmatite-quartz-schist and biotite-schist in various horizons.

The last mentioned schist occurs in thin layers of 2 or 3 m. in several localities, such as Nagatoro, Fukuro, Semba, Shimo-Misawa and the foot of Hodo-san. According to Prof. Kotō's description, "The spotted graphite-sericite-schist is essentially made up of feldspar, sericite, graphite, both varieties of hæmatite, quartz, and ? chlorite, together with the characteristic accessories of tourmaline, garnet and lastly rutile. Its outward appearance is not unlike that of

the *garben-schiefer* of Saxony. The weathered rock has the aspect of a coarse, lamellar, brown mica-schist with prominent black spots. These spots are generally of an inflated disk-shaped form, the face being much blurred by the compression of the rock itself. Under the microscope, these spots or nodules (0.3—0.5 cm.) were found to be of a feldspathic nature. The spotted chlorite-amphibole-schist, the spotted green-schist, is a thick, imperfectly schistose rook of a grass-green colour. It is full of innumerable white spots (0.5—2 m.m.) on a green ground, presenting an aspect quite similar to currants in a pudding. Slides show that each spot is nothing but an individual grain of feldspar, or is composed sometimes of many grains. The general mass of the rock consits of a grass-green, lamellar, fibrous chlorite which encircles the porphyritic feldspar-grains."

Upper division :—The Upper division, overlying conformably the Middle division, consists mainly of epidote-sericite-phyllite (the epidote-sericite-gneiss of Prof. Kotō) and various modifications of it, alternating with non-spotted graphite-sericite-phyllite. The most characteristic feature of the epidote-sericite-schist is a platy structure which is thicker in the lower horizon, but passes into a very thin, stiff and papery structure in the upper.

According to Prof. Kotō, " Beginning now with the lower étage, the thick-platy, grayish-white variety easily cleaves off into slabs of more than 0.5 cm. in thickness. The upper and lower surfaces of the slabs are covered by a thin skin of grayish-green, soft, talcose lamellae which shine with a glittering lustre. It is the presence of this layer which allows of the rock being so easily taken off. A newly fractured surface presents layers of a snowy-white, saccharoidal mass, consisting of a fine admixture of quartz and feldspar grains, the presence of the latter being shown by their pearly lustre. On the whole, the feldspar seems to be the predominating constituent, and usually more porphyritic in its habitus than the quartz-grains. A very characteristic feature of the rocks of the Upper Sambagawa is their papery structure, and also their richness in sericite scales. Thus the weathered exposures of the rock in any road cutting present a more or less advanced stage of disintegration, and are finally resolved into tough, slippery, silver-white splinters —— a peculiar aspect of the road which, if once seen, can not be easily forgotten."

2. Mikabu System

The Mikabu System, which overlies the Sambagawa System, occurs to the south of the latter, forming a belt from Shimonita to Jūshi, about 18 km. long and 3 km. wide, and dipping generally to the southwest. It is also found near the town of Yorii along the Arakawa; at the southern part of the Mino-yama region toward the east of the Chichibu basin, occurring as a small wedge-shaped mass; it also forms Kasa-yama and Dōdaira-yama. The name "Mikabu" was derived from Mikabu-san, which is a prominent peak to the north of the Kanna-gawa, consisting of rocks of this system.

The Mikabu System consists of pyroxenites and amphibolites, with intercalations of thin quartzite, phyllite, and crystalline limestone. The pyroxenites and amphibolites occur in numerous varieties, some massive, some schistose; and they often contain glaucophane. According to Prof. Kotō, "These pyroxenites and amphibolites seem to be altered crystal tuff, originally composed solely (excepting some few cases) of one mineral —— pyroxene, which had been thrown up from eruptive vents, just as in the case of ejectamenta of modern volcanoes, and then deposited at the bottom of the one universal ocean of the past, when dry land was comparatively rare. The writer thinks it advantageous to apply the names of clasto-pyroxenite and clastoamphibolite respectively to our rocks, thereby signifying their tuffaceous origin."

Although the Middle Sambagawa System is often overlaid directly by the Mikabu System, lacking the Upper Sambagawa System, the Mikabu and Sambagawa Systems seem to be conformable, both systems showing quite continuous beds with the same strike and dip.

3. Chichibu System

The Chichibu System, overlying the Mikabu, is well developed and occupies an extensive area in the southwestern half of this terrain. It is characterized by several foldings and strike-faults, generally running NW-SE, parallel to those of the lower two systems. The Kanna-gawa, which flows from SWW to NEE across these geological formations, has many fine exposures at different points throughout the total length of the valley. This Kanna-gawa district is the locality where the order of succession of the Chichibu System was first studied in 1887 by Dr. Ōtsuka. Recently the writers carried on an investiga-

tion on this subject and divided the complex into the following ascending order :—

(1) Quartzite with thin limestone and sandstone lenses.
(2) Alternation of green siliceous slate (adinole-slate) and radiolarian slate (chert).
(3) Schalstein intercalating many fossiliferous limestone lenses.
(4) Alternation of hornstone, graywacke and clayslate.

On the whole, these layers form a continuous succession. The lower half consists of various sorts of siliceous rocks often containing radiolarian remains ; while the upper half, on the contrary, is of a dark green or dark red schalstein, intercalating many limestone lenses and others. The schalstein is the most characteristic rock in this complex, plainly showing its derivation from volcanic tuff and intercalating many fossiliferous limestones. The fossils from the limestones in the schalstein, and also those often found in a higher horizon than the schalstein, comprise certain species of *Fusulinidae*, *corals*, *crinoid stems*, and *calcareous algae*. These fossiliferous limestones are found extensively in the Kanna-gawa district as well as in many other places, but the preservation of the fossils is not good on account of the crystalline nature of the rocks. The most conspicuous fossils obtained are as follows :

Schwagerina princeps Ehrenberg (Uppermost Carboniferous)
Fusulina cfr. ambigua Deprat } (Upper horizon of Lower
Fusulina cfr. Kraffti Schellwien } Carboniferous)
Fusulina complicata ? (Uppermost Carboniferous ?)
Neoschwagerina (*Yabeina*) *globosa* Yabe } (Lower horizon of Upper
Neoschwagerina Margarita Deprat } Permian)
Fusulina ambigua Deprat }
Doliolina lepida Schwager } (Upper horizon of Lower Permian)

From these fossils, it may be inferred that the Chichibu system represents formations from the Carboniferous as far as the lower horizon of the Upper Permian, or at least as far as the upper horizon of the Lower Permian.

Concerning the relation between the Mikabu and Chichibu Systems, we have not yet positive data sufficient to settle the question whether they are unconformable or conformable.

4. Cretaceous System

One of the most remarkable geological structures of the Kwantō mountainland is the so-called "Sanchū-graben" which was first noticed by the late Dr. Harada. This graben, which is about 40 km. long and 2-5 km. wide, extends in the direction NWW, from west of Ogano, a small town in the Chichibu basin, as far as Ohinata in Nagano Prefecture and is entirely filled up by Cretaceous deposits which consist of clay slate, sandstone and conglomerate. The sandstone and clay slate yield many fossils such as plants and fresh-water molluscas in the lower horizon, and *Trigonia* and *Ammonites* in the upper horizon. Those in the lower strata have been pronounced to be the Lower Cretaceous (the so-called Ryōseki series) in Japan, while those in the upper strata belong to the Middle Cretaceous (the so-called *Trigonia* sandstone), which has an extensive distribution in Japan. Their strike is generally NWW-SEE or NW-SE, coinciding with that of the Chichibu system and usually dipping SW with steep angles of about 70°-80° or more and sometimes inclined to NE. The Cretaceous deposits are generally separated from the Palaeozoic by faults, but the Tertiary of the basin has no connection with these faults, so that we may safely infer that this graben-depression took so that we may safely infer that this graben-depression took place before the deposition of the Tertiary rocks.

5. Tertiary System

The Tertiary deposits are developed not only in the Chichibu basin, but also on the margin of the Kwantō mountainland. The Tertiary deposits which entirely fill up the basin have generally the strike of NE-SW or NEE-SWW and the dip of SE or SSE 20°-30°, but incline eastward near the western boundary. Consequently the lowest horizon develops on the western part and the uppermost horizon overlaps toward the east. The deposits are mostly marine and yield *Thyasira-phacoides* fauna (the characteristic common fauna in the Miocene marine deposits of Japan), *Terebratulina japonica* Soub, *Lythothamnium*, *Myogypsina*, etc. Professor Yabe states that the deposits were probably open sea sediments and that they bear a relation to the Miocene marine deposits widely developed in Japan.

From his studies on large numbers of mollusca collected from this basin. Dr. Yokoyama has recently come to the conclusion that

the Tertiary strata, as a whole, belong to the Pliocene Epoch. The boundary between the Tertiary and the pre-Tertiary formations of the borderland, is mostly faults, which can best be seen in the north-eastern and southern parts of the basin. These faults seem to be closely related to the formation of the basin. Since that time, the greater part of the Tertiary strata on the adjoining mountainland has been eroded away, the isolated patch of the Tertiary at Jūshi being a remnant. The Tertiary strata on the margin of the mountainland have also close connections with those of the basin, and they may be correlated to the upper horizon of the basin by their lithological character and mode of occurrence. They do not yield as many fossils as the strata in the basin.

6. Igneous rocks

Gabbro, diorite and diabase occur sporadically in the Chichibu district as dykes or often in the form of laccoliths, the first two especially having an intimate connection with serpentines. They are found mostly in the Crystralline-Schist and Mikabu Systems, where they seem to have intruded after the deposition of these systems. An excellent exposure of gabbro (diorite) and serpentine may be observed on the cliff at Kanasaki along the Ara-kawa. Prof. Kotō writes concerning this rocks:—"Gabbro-diorite is a whitish-gray, hypidiomorphic, granular rock of originally massive structure, but has now become more or less imperfectly schistose. The grayish mass is speckled with dark-brownish, satiny patches of a lamellar texture. Under the microscope these patches consist, for the great part, of a long, flaky, almost colourless or bluish green variety of amphibole, a part of which has already changed into a light green confused mass of serpentine. There the rock passes insensibly into serpentine which occurs as dykes in the graphite-sericite-schist ; and the higher part of the cliffs is entirely covered by a mass of the serpentine."

ROUTE BETWEEN YORII AND KUNIKAMI ALONG THE ARA-KAWA

Between Yorii and Kunikami along the Ara-kawa, the crystralline schists are fully developed, showing excellent exposures on both banks and presenting beautiful picturesque scenery, almost continuously for about 20 km. On arriving at Yorii, which is a town situated on the north bank of the Ara-kawa, we see southward through the

window of the train, two distinct terraces along the river, the upper and the lower, the former being 50 or 60 m. higher than the latter. A general view of the topographical features of the district can also be obtained over the terraces, the older rocks forming prominent mountains, while the hilly range in front consists of Tertiary strata. Going on westward about 1.5 km. from Yorii, the train runs very close to the river, which at this point is well known as Zō-ga-hana ("Elephant's nose") and is noted as one of the most beautiful spots along the Ara-kawa. At this point, a fault running N-S is observed across the river, its west side consisting of graphite-schist with a strike NEE and a dip SSE 20°, while the east side is composed of pyroxenite with a strike N 50°W. Between Sueno and Hagure, the river flows through a narrow gorge where is found a typical exposure of the lower division of the Crystalline Schists on the cliffs of both banks. The strata form a symmetrical anticline with its axis in the direction of E-W, the graphite-sericite-schist (often spotted) being developed in the lower horizon. The most typical development of sericite-schist is found near Sueno in the southern wing of the anticline, where it is quarried for building stone.

The succession of the lower and middle divisions is most favorably observed near Hagure station, where piedmontite-schist in the upper horizon of the lower division is regularly overlaid by spotted chlorite-amphibole-schist of the middle division. Toward the north from this point, the middle division is developed and further northward over the Ōtsuki or Enoki pass, the upper division occurs in turn.

From Hagure the train, turning to the west, passes along the northern bank of the river; and a beautiful view of exposures of crystalline schists, which belong to the middle division, may be obtained from the window of the train for a distance of about 4 km. Passing Higuchi station, the train turns to the south and runs parallel to the river course as far as Oyahana, a distance of about 5 km. This district is a flood plain about 1 or 1.5 km. wide, bounded by steep walls on both sides, which seem to be a fault scarp, especially on the eastern side. Now we get off the train at Nagatoro station, from which only a short walk will take us to Nagatoro, the terminal point of this excursion.

Since the opening of the Jyōbu railway, Nagatoro, literally, "Long stagnancy of the river water," which is located very near Nagatoro station, has become noted for its beautiful scenery, especi-

ally for its scarlet maple leaves in the autumn. On the right bank, a fault scarp rises, forming a perpendicular cliff about 50 or 60 m. above the river water, while on the opposite side, the low rocky banks, eroded by the river, present an interesting view as wall as a fine exposure of the middle division of the Crystalline Schists. The fault line on the right bank can be traced further southward about 10 km. in the strike direction as far as Tochiya on the eastern margin of the Chichibu basin. At Nagatoro and in its environs, besides spotted chlorite-amphibole-schist and spotted graphite-sericite-schist, there are found various modifications such as non-spotted graphite-sericite-schist, amphibole-schist, hæmatite-quartz-schist, biotite-schist, sericite-schist, quartz-schist and crystalline limestone.

At the southern end of Nagatoro, the river bends again to the west, crossing obliquely the mountain-ranges of the Mino-yama and the Hodo-san, and in this region is found a member of the Lower Sambagawa System, sericite-schist with piedmontite-schist, below the Oyahana bridge. This is only a part of the complex which extends N-S forming an anticlinal structure on the eastern foot of Hodo-san. The eastern boundary between the lower and middle divisions is a fault running N-S, and this may be easily observed on the right bank of the river below the Oyahana bridge. At this point piedmontite-schist and chlorite-schist are exposed respectively on the east and west sides of the fault, having the same strike of N-S and a slow dip to the east.

As already mentioned in the preceding pages, gabbro-diorite occurs about 1 km. west of Kanasaki, as a dyke in the graphite-sericite-schist and gradually passes into serpentine. The ophicalcite in the same region is quarried for ornamental stone. At a short distance westward from here, the older rock formations suddenly disappear and we enter into the Tertiary region, which extends over the whole Chichibu basin. This boundary is a great fault running in the direction of NNW-SSW through Minano and it is probable that a considerable horizontal displacement took place along the fault.

It is noteworthy that to the north of Kunikami, the Tertiary strata occur in a graben-like form occupying an area about 3 km. long and 1 km. wide. They are composed of sandstone, shale and hard conglomerate, yielding some remains of mollusca and *Lithothamnium*, which are found in the calcareons sandstone at Ōdaira, about 2 km. north of Kunikami.

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M. Yokoyama ; Mollusca from the Tertiary Basin of Chichibu. Jour. Fac. Sc. Imp. Univ. Tokyo ; Sect. II. Vol. I. Part 3, 1925.

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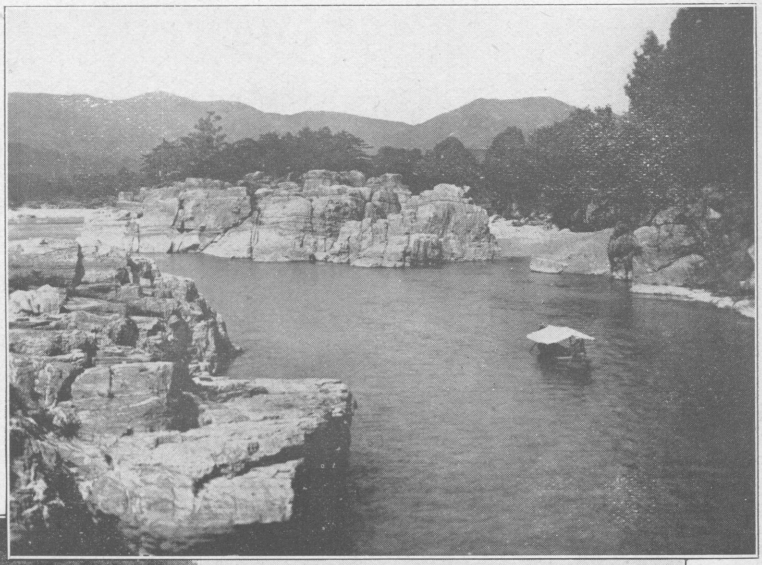
Fig. 2.

SW view from Yorii, showing the upper and lower terrace of the Arakawa.

Fig. 3. Nagatoro.



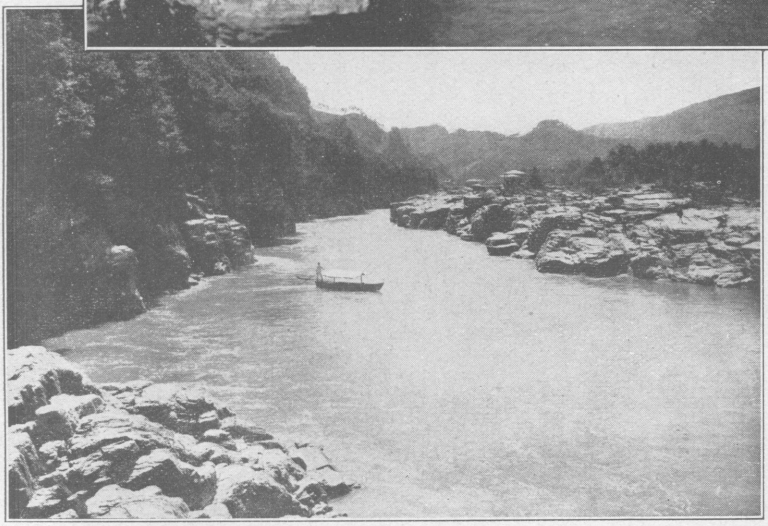
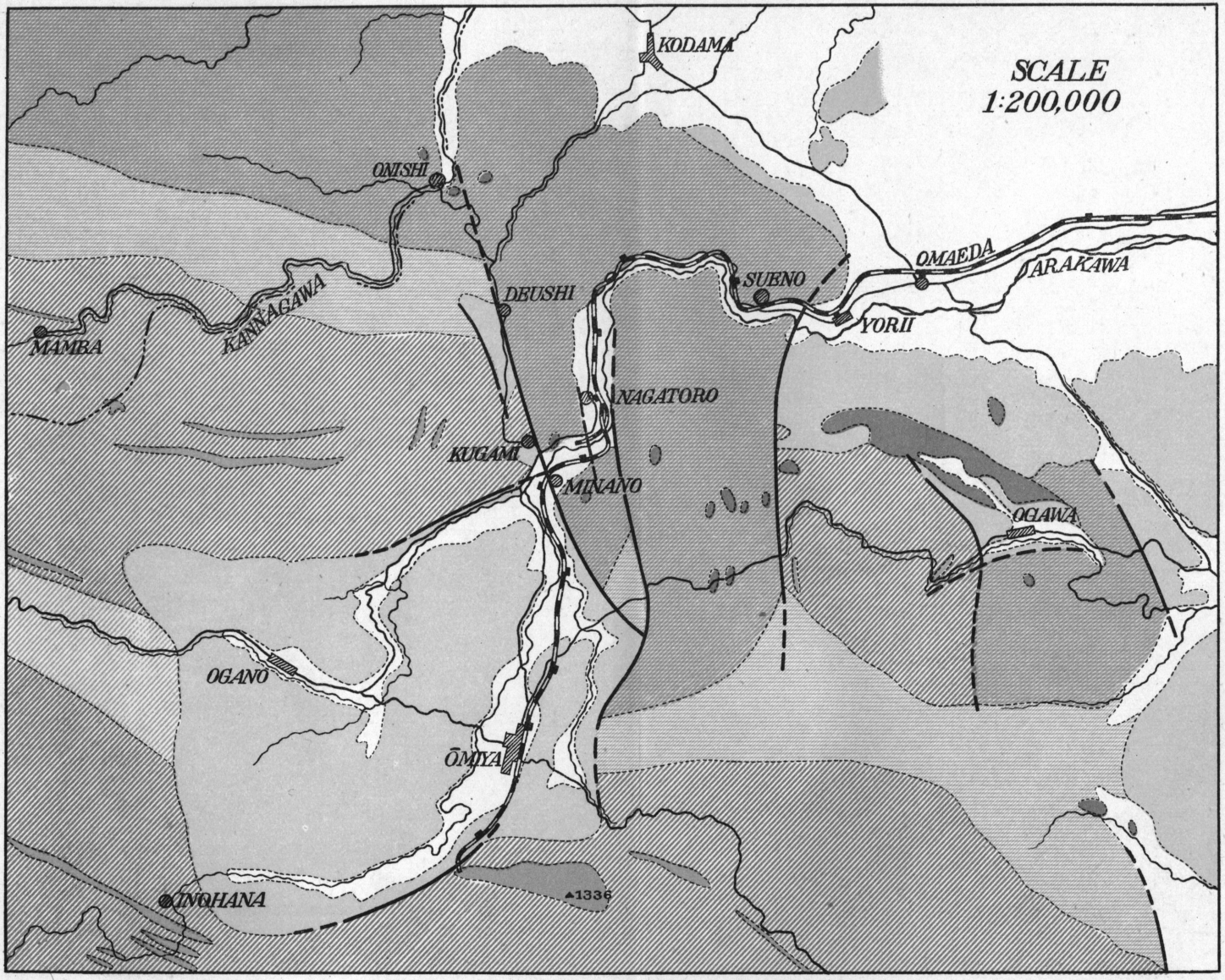


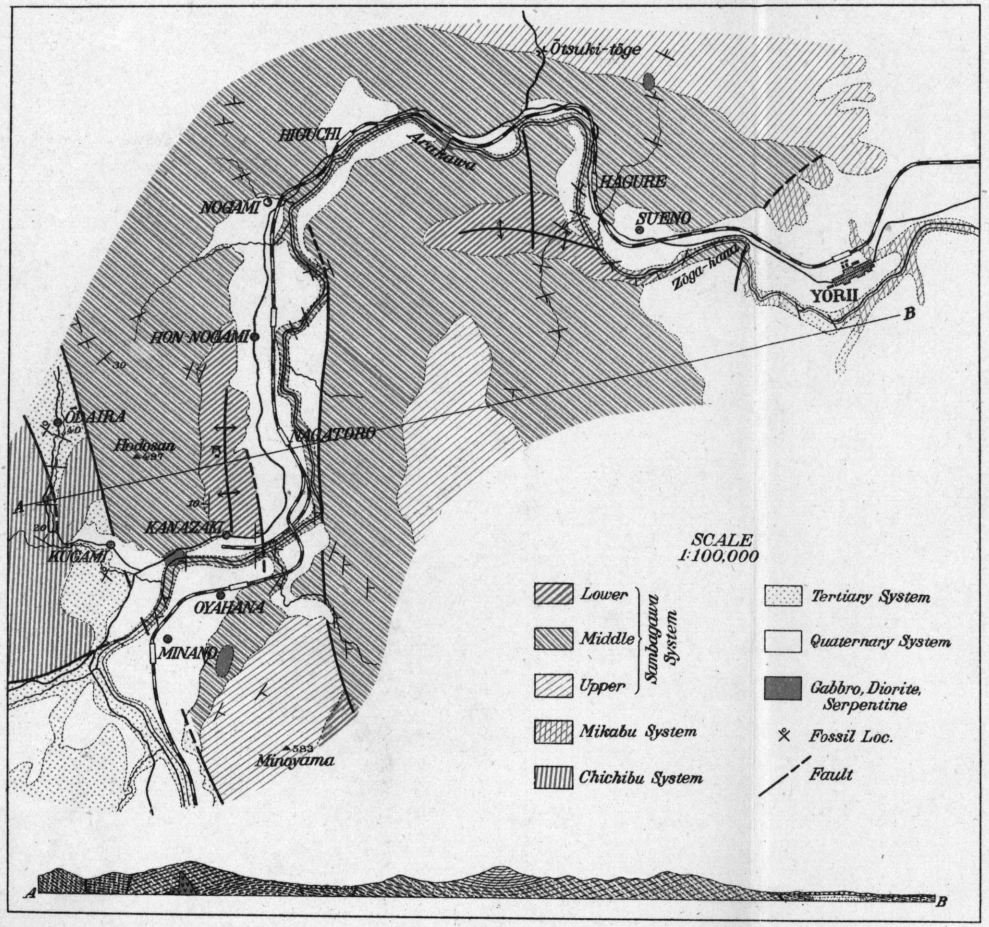
Fig. 4. Fault-scarp at left, Nagatoro.

GEOLOGICAL MAP OF THE CHICHIBU DISTRICT.



GUIDE MAP TO NAGATORO

PL. II.



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