GUIDE-BOOK EXCURSION E–3

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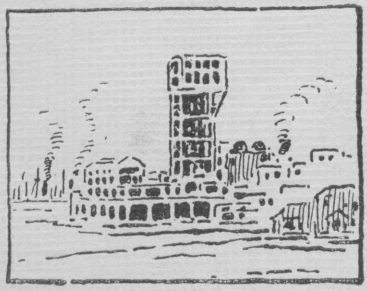
THE MIIKE COAL-FIELD



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JAPAN

THE MIIKE COAL-FIELD

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GEOLOGY OF THE MIIKE COAL-FIELD

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INTRODUCTION

Coal-seams of great importance in Japan (I) are found in the Palaeogene. Of the Tertiary coal-fields, those of Kyûshû and Hokkaidô are the most extensive and valuable, the principal coal-fields in Kyûshû being those of Miiké and Chikuhô. An excursion to the Miiké coal-field affords an opportunity to study the Palaeogene stratigraphy of an area readily accesible and fairly representative of the Palaeogene in Kyûshû.

Kyûshû is the third largest island of Japan, its area, inclusive of its numerous islets, amounting to 40.554.46 sq. km. (2.617.54 sq. *ri*). The coastline of 9.721.80 km. (2.475.46 *ri*), especially in the northern part, is more highly doveloped than elsewhere in Japan.

Geotectonically the island is divisible into three parts (II, III) (Text-Figure 1), the northern, middle and southern, by two important tectonic lines, viz., the Matsuyama (on Shikoku)-Imari Line and the Usuki-Yatsushiro Line. The former line, which is the Median Line of Southwest Japan (IV) separating its Inner Zone from the Outer, dates from the latest Cretaceous time and is no longer apparent on the present land surface, being concealed partly beneath thick Palaeo-

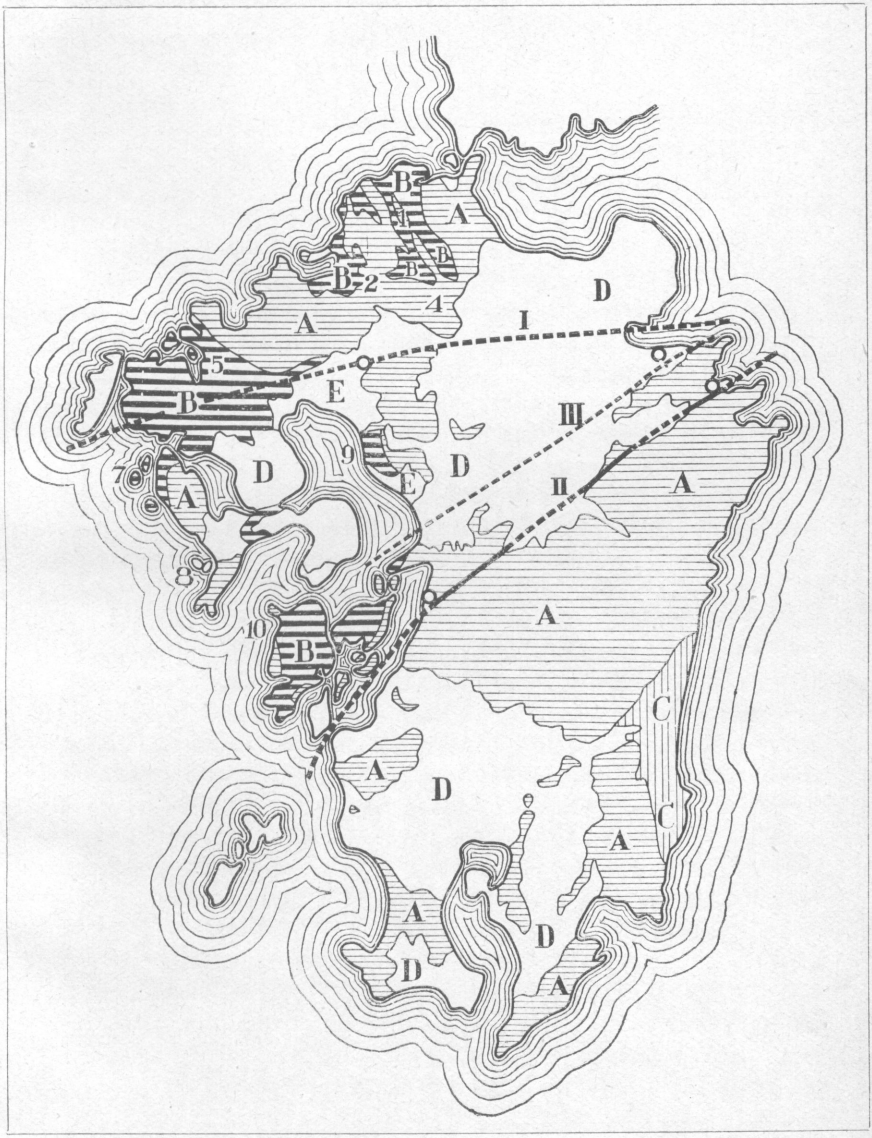
gene deposits and partly beneath volcanic products. The present geomorphology of Kyûshû, on the other hand, is greatly due to the tectonic disturbances, accompanying volcanic activity, of the later- and post-Mizuho Periods with an intervening epoch of planation of the land surface. The tectonic line that is the most conspicuous in the present physiology is the Usuki-Yatsushiro Line, which is marked by the steep northern escarpment of the Kyûshû Range, the backbone of southern Kyûshû.

The Kyûshû Range—part of the Kuma-kii Mountainland of Ferd. v. Richthofen (V) (=the Sohayaki of Prof. B. Kotô (VI)), on Kyûshû —extends from Koshiki-jima northeastward to the Bungo Strait. It culminates on the boundary of the two provinces of Higo and Hiuga in several high points, such as Kunimi-daké (1,739 m.), Eboshi-daké (1,692 m.), Mukosaka-yama (1,684 m.), Shiraiwa-yama (1,646 m.) and Ichibusa-yama (1,722 m.). The Hitoyoshi Basin is a tectonic basin enclosed in this range. The Kuma-gawa cuts its longitudinal valley from Ichibusa-yama southwestward to the Hitoyoshi Basin, whence a deep and picturesque transverse valley extends northwestward to Yatsushiro.

The Kyûshû Range is a part of the Outer Zone of Southwest Japan, and shows the unilateral geological structure characteristic to it ; while Middle Kyûshû comprises two belts, the crystalline schists (the Sambagawa System) on the north and the Cretaceous sediments on the south. The Kyûshû Range from NW to SE is composed of belts of the Palaeozoic sedimentaries of the Chichibu System, and of the Mesozoic (?) formation of slate and sandstone.

In southern Hiuga, where sandstone and shale of the younger Mesozoic and Tertiary ages form a dissected plateau, the structural and physiological trend lines are dominantly N-S. Further west, there are the two large peninsulas of Satsuma and Ôsumi which embrace the beautiful Bay of Kagoshima. The foundation of these peninsulas and of the extensive tract on the north of them is built of the Mesozoic (?) and older rocks; but the surface is covered to a great extent by volcanic ejecta, several violent eruptions having taken place in recent times. Kirishima-yama, situated between Satsuma and Ôsumi, is one of the most celebrated active volcanoes of Japan ; while Karakuni-daké (1,700 m.) and Takachihono-miné (1,574 m.) are two magnificient cones of the Kirishima Group. The volcanic chain of Kirishima commences in this group, and runs south

Fig. 1
~~Plate I.~~



through Sakura-jima, the volcanic island (1,134 m.) in the Bay of Kagoshima, well known for its eruption of January 12, 1914, and then through Kaimon-daké, a perfect cone at the extremity of the Satsuma Peninsula. Further south it reappears in the volcanic islands of Kawanabé-Shichitô (the Seven Islands of Kawanabé), some of which are also active.

In the northern part of Kyûshû, on the other hand, there is the so-called Tsukushi Range, which is a part of the Inner Zone of Southwest Japan (=Japanese Keunlun of Prof. Kotô (VI)). Essentially it is a fragment of Chûgoku, though, strictly speaking, it includes also a part of the Outer Zone. There is very little regularity in the arrangement of its ridges and valleys, and the whole region is apparently divided into many mountains and hilly tracts, though more or less prevailing throughout it are the trend lines, one of which, the NE-SW line, follows the strike of the Mesozoic and older sedimentaries; while the other, the N-S or NW-SE line, follows the trend of the principal dislocations. Southeast of Fukuoka the range is cut in two by the transverse valley of the Mikasagawa: the eastern half consists of detached clusters of low mountains of Mesozoic and Palaeozoic rocks with the intervening depression of the Chikuhô coalfield, while the western half is formed mainly of granitic rocks and culminates in Sefuri-yama (1,055 m.). Westward the northern part of Hizen is an eroded table-land formed of Palaeogene rocks capped by basalt and andesite. In its southern part, an extreme development of the coast-line forms the peninsula of Sonoki, built up of the crystalline schists of the Sambagawa System, and that of Shimabara, occupied by the volcano, Unzen-daké, 1,360 m. high. These two peninsulas are connected with northern Hizen by a tract occupied by the volcano, Tara-daké (983 m.), and Ômura Bay and Ariaké Bay are separated from the open sea. There are many excellent harbours on this coast. Nagasaki (population 265,000), on its picturesque inlet of the Rias type, was first opened to Dutch merchants, and centuries ago was known as the only Japanese port for foreign trade. Now it has large dockyards and is the commercial center of southern Japan. Sasebo is an excellent naval port. Many good anchorages are also found on the northern coast. Fukuoka (143,000), with Hakata harbour in its neighbourhood, is one of the largest towns of Kyûshû and is situated on the beautiful Bay of Hakata. Moji (92,000), situated in the extreme north of Kyûshû on the Strait of Shimonoseki, has deve-

loped rapidly during the past twenty years, as a coal port with a large export trade. Wakamatsu (53,000), southwest of Moji, is also a coal-harbour, and near this city are the Imperial Iron Works of Yawata (116,000) (VII).

The Tsukushi Range and the Kyûshû Range are separated by an extensive volcanic district covering the greater part of Bungo, the southern half of Buzen, and the western half of Higo. In this disirict are many big volcanoes or groups of volcanoes. The active volcano Aso-san, is famous for its large caldera which is 16 km. by 23 km. in its E-W and N-S diameters respectively, and affords one of the most imposing volcanic features of the world. Its central mountain is a cluster of five cones, of which Taka-daké (1,592 m.) is the highest, and Mae-daké (1,323 m.) is always smoking from several pits on its top. North of Aso lies the volcanic group of Kujû-san (1,788 m.), and further northeast, the two volcanoes of Tsurumi-daké (1,375 m.) and Yufu-daké (1,584 m.) stand near the west shore of Beppu Bay; while still another, Futago-yama, (721 m.) occupies the circular peninsula of Kunisaki. Volcanic plateaus of a slightly earlier date occupy a considerable area in the northeastern part of the volcanic district and are believed to be the product of fissure eruption; they are now dissected into fantastic forms in many places, among which the most noted is Yaba-kei in Bungo.

Along the shore of Ariaké Bay extends a comparativeiy wide plain, divided into two parts by the hilly region of Miiké. The north plain is drained by the Chikugo-gawa, the largest river of Kyûshû, and is densely populated, including the two cities of Saga (39,000) and Kurume (59,000); while the southern plain, with Kumamoto (131,000) at its center, is drained by the Shira-kawa from Aso-san and the Midori-gawa which in its upper and middle course flows along the Usuki-Yatsushiro Line, this plain is very fertile and produces rice of the best quality.

OUTLINE OF THE PALAEOGENE STRATIGRAPHY OF KYÛSHÛ. (VIII)

There are nine important coal-fields in Kyûshû, namely, the Amakusa, Takashima, Miiké, Sasebo, Sakito, Karatsu, Fukuoka, Kasuya and Chikuhô: These being distributed in the northern and northwestern part are within the two geotectonical divisions of northern and middle Kyûshû. The coal-fields now occupy more or less widely separated areas and seem to have been independent basins from the beginning;

but in reality, the coal-bearing and other deposits of these coal-fields are very similar in nature, and regular and uniform in the stratigraphical succession, facts which naturally suggest the idea that these formations were not deposited in isolated basins nor under varied local physical conditions—a view still further supported by fossil evidence sufficiently indicating that their deposition must have taken place contemporaneously almost everywhere.

Correlation Table of the Palaeogene of Kyûshû.

Amakusa		Miiké		Takashima		Karatsu and Sasebo		Chikuhō	
						Sasebo Group			
Sakasegawa Group	Sakasegawa Shale Itchōda Sandstone	Manda Group	Yatsuyama Sandstone Kachidachi Sandstone	Ashiya Group	Nakanoshima Beds Okinoshima Beds	Ashiya Group	Hatatsu Shale Hatatsu Sandstone Yukiaino Sandstone Sari Sandstone	Ashiya Group	Wakita Beds Sakamizu Beds Yamaga Beds
Hondo Group	Toishi Beds coal-seams Kyōragi Shale coal-seams	Ōmuta Group	Nanaura Sandstone Upper *Orthaulax* Z. Tōka Sandstone Honsō seam	Takashima Group	Uwahatshaku seam Gomagoshaku seam Bantogoshaku seam Upper *Orthaulax* Z. Jūhatshaku seam Shingoshaku seam	Ōchi Group	Ichimaimono Sanmaimono Beds Kogayama-goshaku seam Sanjaku-Goshaku Beds	Ōtsuji Group	Onga Beds Kusaishi-Honishi Bed Ōnedo-Namae Bed Yoheda-Takae Bed
Miroku Group	Shiratake Sandstone coal-seams Lower *Orthaulax* Z. = *Nummulites* Z.		Komenoyama Beds Komenoyama seams Lower *Orthaulax* Z.		Futago-jima Beds coal-seams Lower *Orthaulax* Z.		Kiuragi Beds Kiuragi seam		Ideyama Beds
Fukami Sandstone	Akasaki Beds		Akasaki Beds		Akasaki Beds		Takubaru Beds	Nogata Group	Uwaishi Beds Takeda Beds Honsō Beds Ōyaké Beds

The lowest complex is the Akasaki, characterised by the frequent intercalation of variegated shales, sandstones and conglomerates. The red and green shales contain calcareous concretions like L-eo

spuppchen at places. No macroscopic fossils of importance have yet been found in it; it is also usually free from carbonaceous layers, except in the part transitional to the complex next above. The Akasaki overlies unconformably the Upper Cretaceous Himenoüra Group in the Amakusa Islands, and older complexes at other places. In the Chikuhô coal-field, the Akasaki is replaced by the Nôgata Group, 500 m.-680 m. thick, including about 20 workable coal-seams; silicified wood is very common. There are two brackish-water shell beds intercalated in this complex, one in the middle and the other in the upper part, while several layers of variegated shale are intercalated near both its base and its top.

The Shirataké Sandstone of Amakusa Kami-shima consists mostly of white arcose sandstone, intercalating a few coal-seams of low quality and a fossil zone (the Lower *Orthaulax* Zone) in its lowest part. This part is represented on Shishi-jima by a nummulitic sandstone with *N. amakusensis-subamakusensis* Yabé and Hanzawa, closely allied to *N. planulatus-subplanulatus*, and *Orthophragmina* cfr. *pratti* Michelin; in age it is either Ypresian or Lower Lutetian. The coaly shale and Lower *Orthaulax* Zone also occur in the Takashima and Miiké coal-fields.

The Shirataké Sandstone is followed upward by an important coal-bearing complex, which is the most extended of the three complexes of similar nature, namely the Hondo Group of the Amakusa Islands, the main part of the Ômuta Group, the Takashima Group and Ōchi Group, in the Miiké Takashima and Karatsu coal-fields respectively, and the Onga Beds of the Chikuhô coal-field; sandstone predominates in the upper part of this complex in all these coal-fields, and also in the Miiké. In the Takashima coal-field, *Sabal* sp. is not uncommon in the lower part of the complex, and *Glyptostrobus ungeri* Heer, *Nelumbium* sp. and *Osmunda lignitum* Giebel in the upper; also Mr. Kryshtofovich once described *Lastrea japonica* Krysht. and *Acrostichium hesperium* Newberry, but the precise horizon from which these were derived is not known. An apparently similar form of *Nelumbium* is also known from an almost equivalent horizon of the Sakito and Karatsu coal-fields. The Upper *Orthaulax* Zone occurs in the middle part (at the top of the "Banto-goshaku") in the Takashima coal-field, and near the base of the Nanaüra Sandstone in the Miiké coal-field.

The coal-bearing complex is overlain by a very thick complex of

marine sandstone and shale, with numerous fossils at various levels. It is known as the Ashiya Group in the Chikuhô, Karatsu, Sakito and Takashima coal-fields; as the Sakasegawa Group in the Amakusa Island; and as the Manda Group in the Miiké coal-field. These two complexes are conformable in the Amakusa Islands, and the Miiké, Takashima, Karatsu, Fukuoka and Chikuhô coal-fields; and unconformable in the Sakito coal-field and the small coal-field of Asakura, in Asakura-gun, province of Chikuzen. In the Sakito coal-field, the marine formation also covers the crystalline schists of the Sambagawa System and likewise granite with conspicuous uuconformity. Shale is dominant in the Manda Group, and especially as in the Sakasegawa Group. *Venericardia nipponica* Yok. and *Crassatellites fuscus* (Yok.) are common in these two areas, while *Venericardia nipponica subnipponica* Nagao and *Crassatellites yabei* Nagao are common in the others. *Aturia yokoyamai* Nagao is another species, characteristic of the Ashiya and Manda groups.

The coal-bearing complex of the Sasebo coal-field is the youngest of its kind in the Palaeogene of Kyûshû, and, resting conformably on the Ashiya Formation, consists of alternations of sandstone and shale with more than twenty intercalated coal-seams. A lower jaw of *Brachyodus japonicus* Matsumoto was found in a coal-seam in its lower part, and is believed by Mr. Matsumoto to be of the lower Oligocene age.

PHYSIOGRAPHY OF THE MIIKÉ COAL-FIELD. (IX)

The Miike coal-field occupies an area measuring about 12 km. N-S by 6 km. E-W. It is flanked on the east by the Shôtai-san ridge, and on the north by the alluvial flat of Ginsuimura, while west and south it faces on the Ariaké Bay. The Shôtai-san ridge rises to a height of 501.4 m. above sea-level and is divided in halves by the transverse valley of the Suwa-gawa. It is composed wholly of granitic rocks, except for the Akasaki Beds which cap the summit of one of its peaks.

The western slope of the Shôtai-san ridge is traversed in both its northern, and its southern parts, by a straight longitudinal furrow, the western side of which forms a narrow accesory ridge parallel to the main one and bears two prominences called Mae-daké (300 m.) and Hi-daké (205 m.).

The Shôtai-san ridge extends further northward, beyond the northern limit of the Miiké coal-field, where it is lower and flat-topped. The main body of the mountain in this part is also composed of granitic rocks, its flat top alone being occupied by the almost level Akasaki Beds. That it is divided into many blocks by a number of faults is indicated by the varying heights of the Akasaki Beds, (Pl. III., fig. 1).

The Miiké coal-field itself (Pl. II) is a hilly land in its north-western and eastern borders, the hilltops varying from 100 m. to 150 m. in height. On the west and southwest this hilly land marges into the coastal platform 30-60 m. high, which is presumably an uplifted ancient delta, moderately dissected, and terraced and cliffed along the valleys and the coast of the Ariaké Bey. This monotony in physiognomy is broken by Hakama-daké near the Manda Mine and Mitsuka-yama near Kachidachi. The former is 120 m. high, and, built of the sandstone and sandy shale of the Manda Group with southwest dip, shows a steep escarpment facing north on the broad valley of the lower Suwa-gawa and a very gentle one southwards. It reminds one of a tilted block, but it is probably an erosion relic, as there is no trace of a fault capable of producing such a pronounced feature on the surface.

Mitsuka-yama (the three Hills) is a name for three conical eminences of mound-like appearance, standing close to one another on an ENE-WSW line. They are 150 m. above sea-level, rising more than 50 m. above the general surface of the ground, which slopes gently southward. These also are probably due to erosion, and appear to be a transversely dissected hogback.

The old Miiké highway runs along the eastern boundary of the Miiké coal-field and near the western foot of the Shôtai-san ridge. It follows the upturned Palaeogene rocks and a series of faults, both of nearly N-S trend, indicating an important line of tectonic disturbance which marks exactly the geological boundary between the Palaeogene rocks of the coal-field and the granite mass of the Shôtai-san ridge. Several small valleys are arranged on the weak line, some draining their waters northward and others southward.

All the streams in the coal-field, except the Suwa-gawa, draw their waters from its interior and the western flank of the Shôtai-san ridge, and are inconspicuous in size, though each forms a well developed system of shallow valleys with a broad alluvial flat. Only the

Suwa-gawa, in its lower course, comes into the coal-field from outside, after traversing the Shôtai-san ridge a little south of Ichino. The present valley of its lower course is broad like those of the other streams in the coal-field, but is far narrower than its former one which is now occupied by a broad terrace, descending from 60 m. westwards to 40 m., composed of volcanic ejecta (the "Aso lava") which once flowed down the valley. The ancient deltaic deposits occupying the southern half of the coal-field are perhaps materials transported by the Suwa-gawa in a still more remote time before its course was established along the present line.

STRATIGRAPHY (X) (Pl. 1)

Table of Formation (Text-Figure 2)

Superjacent Deposits.

unconformity

The Manda Group.

F. The Yotsuyama Sandstone.
E. The Kachidachi Sandstone.

The Ômuta Group.

D. The Nanaüra Sandstone.
The Upper *Orthaulax* Zone.
C. The Tôka Sandstone.
"Honsô" seam.
B. The Komenoyama Beds.
Komenoyama seam and the Lower *Orthaulax* Zone.
A. The Akasaki Beds.

unconformity

Basement Complex.

I. The Basement Complex. The basement complex upon which Palaeogene sedimentaries were deposited in the Miiké coal-field and its adjacent land comprises green schist and phyllites of the Mikabu Series and also granite. These are exposed on the surface nowhere in the coal-field, though the Mikabu rocks of Kuranaga-yama lying just outside of the coal-field to the north, are overlaid unconformably by Palaeogene deposits along the northern foot of that mountain, and likewise the granite ridge of Shôtai-san is partly capped by the same. It is also reported that a trial drilling in Ariaké-mura reached granite at the depth of about 700 m. from the ground-surface.

II. The Palaeogene Deposits. The rock formations that take the essential part in the composition of the coal-field belong to the Palaeogene. In ascending order they are :

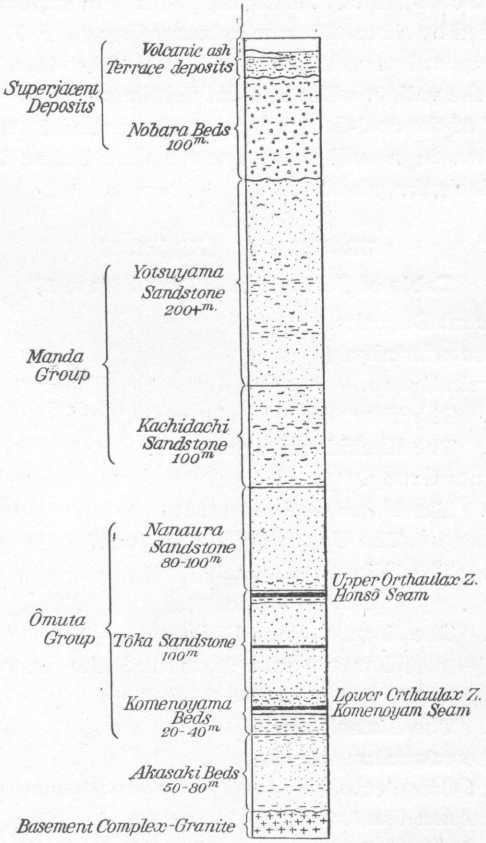


Fig. 2.

A. The Akasaki Beds. This complex comprises green to white sandstone, conglomeratic sandstone and conglomerate, and constantly intercalates reddish purple, bluish and greenish shale at several horizons. Sandstone of this complex is usually medium to coarse-grained and hard, owing to siliceous cement; but there are sometimes fine-grained varieties liable to disintegrate. The conglomerate is also usually hard and compact, with siliceous cement. Most of its

pebbles are of white quartzite and other Palaeozoic and older rocks, mostly 0.5-1.0 cm., rarely exceeding 2.0 cm. in diameter, the interspaces being filled with fine-grained quartz sand. At places the pebbles are rather angular, giving the rock a breccia-like appearance. The shale is almost always coloured, reddish purple, blue and green predominating, it is also often mottled with red and blue. The following is an analysis of a typical sample of reddish purple shale.

Quartz	25.73
Soluble silica	20.32
Al_2O_3	18.64
Fe_2O_3	15.36
CaO	1.20
MgO	0.80
H_2O	14.00
Total	96.05

The sandstone and conglomerate beds vary laterally in texture and are also subject to abrupt changes in thickness. The total thickness of the Akasaki Beds is more than 50 m., and at Kuranaga-yama outside of the coal-field, it attains a thickness of not less than 80 m.

B. The Lower Division of the Ômuta Group: the Komenoyama Beds: 20-40 m. thick. The lower part is mostly shale, intercalating sandstone and conglomerate beds and several seams of coaly shale and coal; the uppermost coal-seam is ca. 3 m. thick, though inferior in quality. There are abundant remains of minute bivalves of lamellibranchiata and crustacea in certain layers; fossils commonly found in and near the Komenoyama seam belong to

Turritella okadai Nagao
T. subbicarinata Nagao
Corbula (*Cunaecorbula*) *kyushuensis* Nagao
Lucina sp.
Modiola sp.
Ostrea sp.

The upper part of the Komenoyama Beds mostly comprises bluish to dark gray, fine to coarse-grained sandstones, and intercalates one or two seams of thin coaly shale. It is about 20 m. thick in the northern part of the coal-field, where it is typically developed, while it is reduced to a very thin bed in the southern part and almost to nil in the middle. The sandstones are locally hardened and contain at places molluscan remains in aggregations. At Ipponmatsu, 4 km.

east of Miiké-machi, there is a sandstone, medium- to coarse-grained, greenish in colour and abundant in sand pipes. (Pl. III, fig. 2) Near the base of the subdivision and hence a little above the Komenoyama seam of the lower subdivision, there is the Lower *Orthaulax* Zone containing the following fossils:

	Ipponmatsu	South of Miiké-machi	North of Kanayama
Orthaulax japonicus Nagao	+	+	—
Turritella okadai Nagao	+	+	+
Turritella subbicarinata Nagao	+	—	+
Turritella miikensis Nagao	—	+	—
Melania laevigata Nagao	+	—	—
Natica eocenica Nagao ?	+	—	—
Galerus? sp.	+	—	—
Corbula tumida Nagao	?	—	—
Corbula (*Cunaecorbula*) *kyushuensis* Nagao	—	+	+
Macrocallista ariakensis Nagao	+	+	—
Cardium miikense Nagao	—	+	+

C. The Middle Division of the Ômuta Group: the Tôka Sandstone. The prevailing rock of this group, about 100 m. thick, is a sandstone, mostly white but sometimes light green in colour and arkose, shale in thin layers being rarely interbedded with the sandstone. In the uppermost part, however, the shale is dominant and intercalates sandstone in thin beds and also coal-seams, of which the Miiké Honsô and Rokushaku (Banshita) are most important and are now being worked. The Honsô, 5-25 ft. thick, lies often less than 6 m. below the very top of the Tôka Sandstone, and the Rokushaku, 4-10 ft. thick, occupies a position 3 m. or more lower down. A shale in the middle part of the sandstone contains *Tellina*, *Modiola* and

Corbula (*Cunaecorbula*) *kyushuensis* Nago

while another horizon at the very top contains *Nucula* (*Acila*) and *Tellina*.

The following lines are an extract from Mr. Iwasaki's note on "the bituminous coal of low grade from the Miiké Colliery." (XI) This coal is classed as one of the best in Japan, although the colour is brownish black and the lustre is dull; it lacks regular cleats, and

breaks in the most irregular ways, quite unlike most Japanese coals. Chemically it contains 3% sulphur and 1% nitrogen, and is in part the coal from which W. Smith and J.C. Chorley once extracted 10% of a substance called by them "soluble bitumen." Under the microscope, the whole mass of the coal is dark reddish brown except the light reddish brown part in fluidal arrangement. Quartz grains are very scanty, but calcite veins are common; minute pyrite grains, in groups or in rows, are scattered throughout the coal. It also contains in great numbers minute yellow spherules with high index of refraction. Mr. Iwasaki further emphasizes the homogeneity, the absence of "wood," freedom from "schistosity" and prevalence of fluidal arrangement.

The following are analyses of coal from the Miiké coal-field.

	I	II	III	IV	V
Proximate.					
Water	0.89	0.32	0.31	0.42	0.35
Vol. combust.	44.90	42.74	44.31	44.22	44.21
Fixed carbon	46.98	50.00	45.35	43.96	48.60
Ash	7.23	6.94	10.03	11.40	6.84
Colour of ash	light brown	grayish white	grayish white	light brown	grayish white
Character of coke	coherent, slightly expanding	coherent	coherent	coherent	coherent
Ultimate.					
Carbon	78.43	77.59	73.20	71.14	78.19
Nitrogen	0.85	1.12	0.92	1.06	0.92
Hydrogen	5.75	5.40	5.38	5.64	5.13
Oxygen	4.38	8.95	10.47	10.76	8.92
Sulphur	2.47	3.80	3.75	3.74	3.80
Calorific value	8.191	7.260	9.710	6.655	7.150
Sp. gr.	1.272	1.271	1.291	1.321	1.266

I. Coal of the Honsô seam; precise locality not mentioned. According to information given by the Mitsui Mining Co.

II. Loc. Oura Mine; precise horizon not mentioned. Analysis of the Imperial Geological Survey.

III. Loc. Miyanoura Mine ; precise horizon not mentioned. Analysis of the Imperial Geological Survey.

IV, V. Loc. Nanaüra Mine ; precise horizon not mentioned. Analyses of the Imperial Geological Survey.

D. The Upper Division of the Ômuta Group : the Nanaüra Sandstone. This has a total thickness of 80-100 m.; the sandstone is mostly greenish white, medium- to coarse-grained and often cross-bedded ; though in rare cases it is dark gray, fine-grained and contains glauconite grains. There is no typical conglomerate, though the sandstone sometimes contains pebbles ; carbonaceous layers are also usually wanting in this complex.

A fine dark gray sandstone in the lower part contains marl nodules from the size of a baseball up to that of a football, and is fossiliferous ; this is called the Upper *Orthaulax* Zone, and contains

Orthaulax japonicus Nagao
Natica eocenica Nagao
Melania laevigata Nagao
Cardium miikense Nagao
Tapes? sp.

E. The Lower Division of the Manda Group : the Kachidachi Sandstone. (Pl. III, fig. 3) A 100 m. thick complex mostly consisting of fine-grained sandstone, interbedded with dark green coarse-grained glauconitic sandstone in its upper part ; the glauconitic rock is rich in marine fossils, corals and molluscs, the most common being

Venericardia nipponica Yok.
V. mandaica (Yok.)
Crassatellites fuscus (Yok.)

F. The Upper Division of the Manda Group : the Yotsuyama Sandstone. A complex exceeding 200 m. in thickness, and consisting mostly of sandstone, with subordinate sandy shale and shale. Of sandstone, a dark green coarse-grained glauconitic variety prevails in the lower part, and a fine-, to medium-grained dark to light bluish gray variety, with spheroidal joints on weathering, in the lower and middle ; whereas dark gray sandy shale and shale are dominant in the middle and upper parts. It is fossiliferous, the fossils hitherto found being *Turritella* sp., *Tellina* sp., *Crassatellites fuscus* (Yok.), *Lima* sp., *Venericardia nipponica* Yok., *V.* sp., *Dentalium* sp. and *Pentacrinus ariakensis* Yok.

A shaft sunk at the Manda Mine has shown the following vertical distribution of fossils in the Manda Group as stated by Professor M. Yokoyama :

240 feet	*Terebratula miikensis* Yok.
277 ,,	*Venus mitsuiana* Yok.
280 ,,	*Venericardia nipponica* Yok.
300 ,,	,,
358 ,,	,,
,, ,,	*Crassatellites fuscus* (Yok.)
384 ,,	,,
? 393 ,,	*Lamna* cfr. *cuspidata* Ag.
400 ,,	*Venericardia mandaica* (Yok.)
401 ,,	*Pholadomya margaritacea* (Sow.)
403 ,,	*Pentacrinus ariakensis* Yok.
405 ,,	*Venericardia nipponica* Yok.
,, ,,	*V. mandaica* (Yok.)
,, ,,	*Fusus* sp.
484 ,,	*Xanthilites pentagonalis* Yok.
489 ,,	*Homolopsis japonicus* Yok.
538 ,,	*Cycas fujiiana* Yok.
608 ,,	*Venericardia mandaica* (Yok.)
610 ,,	*Cedroxylon* sp.
613 ,,	*Aturia ziczac* Yok. (=*A. yokoyamai* Nagao)
625 ,,	*Perna nishiyamai* Yok.
650 ,,	*Crassatellites fuscus* (Yok.)
842 ,,	*Venericardia nipponica* Yok.

As the shaft is reported to have reached an eleven-foot coal-seam at 884 ft., the lowest horizon with *Venericardia nipponica* in the above table perhaps can no longer be regarded as belonging to the Manda Group, but may possibly represent the Upper *Orthaulax* Zone of the Nanaüra Sandstone.

It is reported that an igneous dyke, erupted through the Palaeogene rocks in the coal-field, was encountered during mining operations ; but we have no further information as to its lithological and geological character.

III. The Superjacent Deposits (Post-Manda sedimentaries).

a. The Nobara Beds. There is a series of not well consolidated conglomerate, sandstone and shale, in addition to gravel, sand and clay, which constitute the 20-60 m. platform extensively developed in

the southern part of the coal-field. The gravel bed at its base is an almost orderless accumulation of blocks of granite, quartzite and rarely of schistose rocks varying from a few centimeters in diameter to the size of a football. Sand and sandstone are fine- to medium-, and rarely coarse-grained, consisting almost solely of quartz grains, though at places biotite flakes are common. The clay and shale interbedded with the arenaceous layers are bluish, greenish, or gray to white ; sometimes they are highly micaceous. Fossils have not yet been discovered in this complex.

These younger deposits are often false-bedded and thin out rapidly in one or other direction ; as a whole, they incline slightly west-, and southwestward and form a fan-shaped coastal terrane. The total thickness of the deposits certainly exceeds 100 m.

b. The materials composing the coastal and river terraces are light brown clay, sand and gravel ; the clay is often tuffaceous, and the gravel includes blocks of andesite, beside those of quartzose rocks.

c. There is a peculiar volcanic deposit about 20 m. in total thickness which forms a terrace along the present valley of the Suwagawa, about 60 m. high, south of Ichino ; and 35 m. high, north of Manda. It is an accumulation mostly of volcanic ash, sand, lapilli and " Aso lava," all derived from the volcano, Aso, being a part of an immense flow, that once came down along the valley from the east through the north of the Shôtai-san ridge.

GEOLOGICAL STRUCTURE

(Text-Figure 3)

The geological structure of the present district is rather simple, the Palaeogene deposits over the greater part inclining gently (4°–10°) southwestward from the northern and eastern borders and seldom being disturbed by noteworthy faults. The northern border of the field is marked by a fault of ENE-WSW trend, and north of this line, the Manda Beds and the uppermost part of the Nanaüra Sandstone are found cropping out at the surface with a dip of SW 12°. The amount of vertical displacement in this fault is estimated to be 200 m.—230 m.

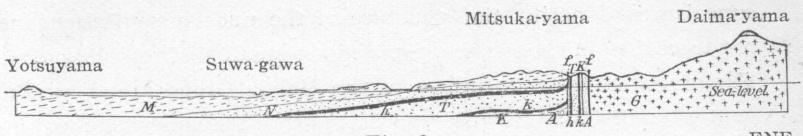


Fig. 3.

Diagramatic Geological Profile Scale 1:50,000 (horizontal).
horizontal : vertical = 1 : 3

G: Granite. *A*: Akasaki Beds. *K*: Komenoyama Beds.
T: Tôka Sandstone. *N*: Nanaüra Sandstone. *M*: Manda Group.
k: Komenoyama seam. *h*: Honsô seam. *f*: Fault.

As already stated under Physiography, along the eastern border of the field, there is a narrow belt of disturbance which is 8 km. long and 100-400 m. wide. There the Palaeogene deposits are upturned or sometimes even overturned. In the greater part of the belt, the structure is monoclinal, the basal Akasaki lying east and is followed westward successively by the overlying Komenoyama Beds and the lowest part of the Tôka Sandstone. In the vicinity of Chayanohara near the northeastern corner of the field, even the upper part of the last complex, with its main coal-seam (Honsô), is involved in this structure. Farther north, where the strike of the strata turns from N-S to E-W, there is the small shallow trough of the Komenoyama Beds and the basal part of the Tôka Sandstone, while a little east of Kôda, there is a small saddle formed by the upper part of the Akasaki Beds and the Komenoyama Beds in the belt of disturbance. South of Fumoto these beds form compressed isoclinal folds, with repetition of strata multiplied by parallel faults.

This belt of disturbance is separated from the granitic mass lying east by a fault in its northern half, and a flexure in the southern, where the boundary between the Palaeogene deposits and the granite is one of unconformity ; further it is limited on the west by another important fault or system of faults, running parallel to the preceeding line of dislocation except in the extreme south, where it deviates slightly to the west.

There are very few noteworthy faults in the northern half of the coal-field ; the following two are well marked and evident on the ground surface : one passing near the Ikeguro pond in the NE-SW direction, and the other passing a little north of the villages of Nakabaru and Kachidachi from E to W.

The southern half of the field being thickly overlaid by the

superjacent deposits, the structure of the underlying Palaeogene is not traceable on the surface, except in a small district lying SW of Fumoto, where the members of the Manda Group are exposed and gently undulated. However, as that part of the valley of the Suwa-gawa cutting the Shôtai-san ridge is certainly a fault-line valley, it is believed by us that the Palaeogene rocks lying deep beneath the deltaic deposits are traversed by the southwestern prolongation of the fault line from northeast to southwest, i. e., in the position roughly represented by the valley of the upper course of the Nakiri-gawa.

ANNOTATED GUIDE

0 km. **Ômuta Station**—Leaving the Ômuta Station, our automobiles follow the road running southward through the city (75,000 Population) to the Manda Mine. To the east and about 25 m. above sea-level is a terrace composed of clay, sand and gravel, mixed with volcanic detritus of the Post-Tertiary. In places under the terrace there are exposed deposits of a light greenish or white, medium-, to coarse-grained sandstone of the Nanaüra Sandstone. A few hundred meters south of the Ômuta Station, there is a low dissected platform consisting of greenish or grayish, fine-grained sandstones and sandy shales of the Manda Group, with the general strike WNW-ESE and the dip 4° to 8° to SSW.

Southward, the road passes through the wide flood-plain of the slightly meandering lower course of the Suwa-gawa which flows westwards. Beyond the valley, there rises the hill called Hakama-daké, 120,4 m. with its steep northern slope facing us. The Manda Mine is situated at its northern foot.

3 km. **The Manda Mine**—is one of the six mines of the Miiké coal-field. At this place, the main coal-seam, "Honsô", lies 268 m. below the surface of the ground and is overlaid successively by the Nanaüra Sandstone and the Manda Group. The fine-grained sandstones and sandy shales, either dark coloured, grayish or bluish, composing Hakama-daké, represent the upper part of

the last group. These rocks, more than 60 m. in total thickness, are well exposed on the face of the cliff (Locality 1), along the northern foot of Hakama-daké ; the average dip is 5° to SSW. There is a small fault, and the rocks on its west side incline 40° to NE. There are carbonized plant fragments in this complex, besides the following invertebrate remains : *Pentacrinus ariakensis* Yok., *Venericardia* sp., *Dentalium* sp. and *Trochus* sp.

From the Manda Mine, our road follows the valley of the Suwa-gawa eastward to Iwamoto. To the north of the broad alluvial flat extends a terrace of volcanic ash in association with Aso lava ; the typical Aso lava ,however, is not exposed here but will be seen later on at Ichino. The present terrace is fringed by small rounded hills of a sandstone of the Manda Group, which also forms the foundation of the terrace itself. To the south, is another terrace of the same nature but with this difference that the sandstone of the Manda Gruop is unconformably overlain by sand and gravel beds, with subordinate clay, of the Nobara Beds, which are in turn covered by volcanic sediments. The Nobara Beds and the Manda Group lying in unconformity are well exposed on the face of terrace cliffs.

7.5 km. At **Iwamoto** (Locality 2), the Manda Group is separated from the Komenoyama Beds by a fault. The boundary is distinctly visible in a small exposure of rocks behind houses along the right side of the road. It is a well defined plane, inclined as steep as and in the same direction with, the overturned variegated shale of the Akasaki Beds, the coaly shale of the Komenoyama Beds in its hanging wall, and the dark green sandy shale of the Manda Group in its foot wall. This last rock is extremely fissile at this place.

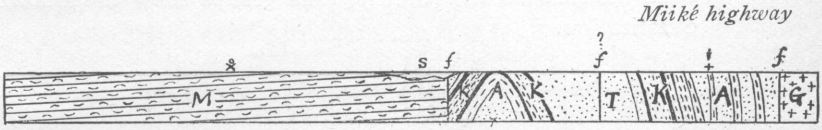
Leaving Iwamoto and proceeding northward on foot, there are good exposures of rocks along the old Miiké highway. We are now in the disturbed belt including the Komenoyama and Akasaki Beds, which are generally upturned.

9 km. Where the Miiké highway crosses over a tunnel on the road from Kôda to Ichino, the Palaeogene rocks are exposed in the following order of succession from west to east. (Locality 3).

Groups	Thickness	
	m.	
	1.3	yellow soft sandstone
	0.3	white coarse-grained sandstone
	0.6	coaly shale
	1.5	coal
	0.6	coaly shale and bluish shale
	0.3	coal
	0.5	dark coloured shale
	0.1	coal
Komenoyama	0.2	dark coloured shale
	0.1	coal
	0.4	coaly shale and shale
	0.3	shale
	0.4	yellow sandy shale
	2.3	platy sandstone alternating with thin layers of shale
	1.0	coaly shale
	2.0	covered
	1.5	bluish shale
	2.4	reddish purple shale
	0.3	bluish sandy shale
	0.4	bluish shale
	0.3	bluish sandy shale
	0.3	bluish shale
	1.0	reddish purple shale
	0.6	bluish shale
	1.7	bluish sandy shale
Akasaki	0.7	reddish purple shale
	0.5	bluish shale
	0.5	reddish purple shale
	0.9	bluish shale
	0.9	bluish sandy shale
	0.8	bluish fine sandstone
	1.0	hard sandstone and conglomerate
	1.3	bluish shale and sandstone
	4.4+	alternations of bluish and reddish purple shale
	?	sandstone with reddish and bluish shale, frequently conglomeratic.

10 km. (Locality 4) East of Kôda and west of the main road, an anticline of the Komenoyama Beds, with the Akasaki Beds in its core, extends N-S. On its west, a glauconitic Kachidachi Sandstone of the Manda Group inclines gently westwards ; to the east, the Komenoyama, Akasaki and the lower part of the Tôka Sandstone are upturned. The space between the anticline and the upturned strata is unexposed, but their boundary is believed to be a fault (Text-Figure 4). The Kachidachi Sandstone is very fossiliferous at this place, common fossils being

Crassatellites fuscus (Yok.)
Venericardia nipponica Yok.
Venericardia mandaica (Yok.)
Terebratula miikensis Yok.



WSW ENE

Fig 4.

Geological profile of the vicinity of the Kachidachi Mine 1 : 8,000.
G: Granite. *A*: Akasaki Beds. *K*: Komenoyama Beds,
T: Tôka Sandstone. *M*: Manda Group. *S*: Superjacent Deposit.
f.: Faults. ×: Fossil locality.

Comming back to Iwamoto and following the highway farther southward beyond the valley of the Suwa-gawa, there is a terrace of volcanic ash layers extending for 400 m. Then the road runs along the outcrops of superficial deposits, gravel and sand, with a slow southwest dip. To the southwest, is a low hilly land of the loose sandstone and shale of the Nobara Beds, with intercalated layers of sand, clay and gravel. To the east, the upturned Tôka Sandstone, Komenoyama Beds and Akasaki Beds occupy a narrow zone of low hills (Pl. IV., fig. 2), behind which granitic Mae-daké rises to a height of about 300 m., a fore-ridge of higher Shôtai-san (501. 4 m.).

15.5 km. The basal conglomerate of the Nobara Beds is crossed on a low pass lying south of **Fumoto** village ; it is composed mostly of large blocks of granite, with interstitial quartz-sand and clay. Farther south is exposed a grayish green sandy shale of the Manda Group lying unconformably beneath the conglomerate,

and dipping northeastward. After crossing a brook, the road
17.0 km. ascends a gentle slope to the **Fumoto Primary School.** A fault striking NNE-SSW is visible on the road side, separating the basal part of the Tôka Sandstone on its east from the Manda Group on the west. The Manda Group consists at this place of a dark green sandstone and a sandy shale and is folded with the strike approximately N-S and the dip, 40°-60°E and W. The road then follows out-crops of the Komenoyama, overlain by the Tôka Sandstone and underlain by the Akasaki, for 1 km. to a little north of Kanayama. (Locality 5). At a point 150 m. east of the Primary School is visible the contact plane between the Akasaki Beds and the underlying granite a plane of unconformity with a steep westward dip (Pl. IV., fig. 1). At this spot, the Akasaki and Komenoyama groups show the following constitution.

Groups	m.	
Komenoyama	?	yellowish white sandstone ; lower part of the Tôka Sandstone ?
	6.0	shale and thin layers of sandstone in alternation ; intercalated with coal-seams and coaly shales.
	4.5	bluish shale.
	1.0	hard platy sandstone.
Akasaki	12.0	covered.
	66.0	fine-grained sandstone.
	21.0	bluish shale and reddish purple shale in alternation.
	16.0	white sandstone with intercalating layers of reddish purple shale.
	16.0	bluish white sandstone, partly conglomeratic.
granite		

One and a half kilometers north of Kanayama village (Locality 6), the same coal-seams of the Komenoyama Beds crop out several times, the structure here being a compressed isoclinal fold, further disturbed by at least two strike-faults ; the western-

most coal-seams of this 300 m. wide disturbed belt are overlaid by a white, arkose, medium-, to coarse-grained sandstone, the lowest part of the Tôka Sandstone inclining very gently westwards and forming a small hill (60 m. above sea-level).

From Kanayama, we follow the road running northwestward through Nobara to Arao, crossing a low hilly land of the Nobara Beds.

21,0 km. (Locality 7). A road-cutting on the east of **Nobara** shows sand with gravels of the Nobara Beds inclining gently southwestward and unconformably overlying alternations of the sandy shale and sandstone of the Manda Group with N60°E strike and SE 12° dip. (Pl. IV., fig. 3). Near by is a typical exposure of the Nobara Beds, showing the following order of succession,

m.	
0.7	yellow sand
0.4	grayish white clay
0.5	coarse-grained quartz sand with patches of clay
2.0	gray sandy clay
4.0+	yellow conglomeratic sandstone composed of pebbles of quartzose rocks

The same geological and topographical features continue
27.0 km. to **Arao.** On the highway leading from Nagasu to Ômuta, and 2.5 km. north of Arao, is a row of hills, called **Yotsuyama** composed of the Yotsuyama Sandstone of the Manda Group with a very slow dip ; the highest point is 56 m. The main coal-seam, Honsô lies ca. 410 m. below the ground-surface where the Yotsuyama Mine is situated ; numerous fossils were obtained in the Manda Group during the sinking of the Yotsuyama shaft, the most common types being *Venericardia nipponica*, *V. mandaica* and *Crassatellites fuscus*.

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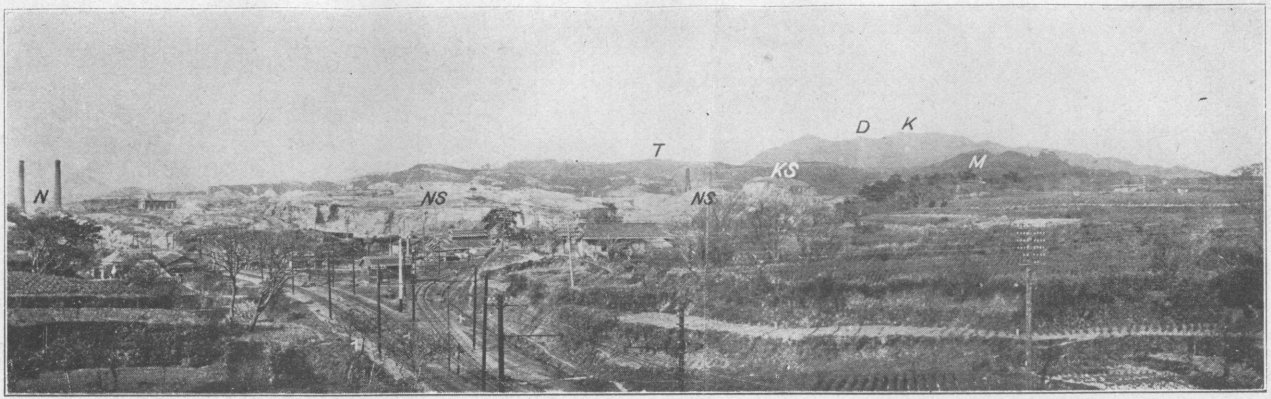


A northeastern and eastern view from a terrace, ca. 25 m., SW. of the Nanaura Mine.

D: Daima-yama (380 m.)
K: Kuju-san (388.1 m.)
M. Mitsuka-yama (150 m.)
N: Nanaura Mine.
NS: Nanaura Sandstone.
KS: Kachidachi Sandstone.
T: Takatori-yama.

Plate III.

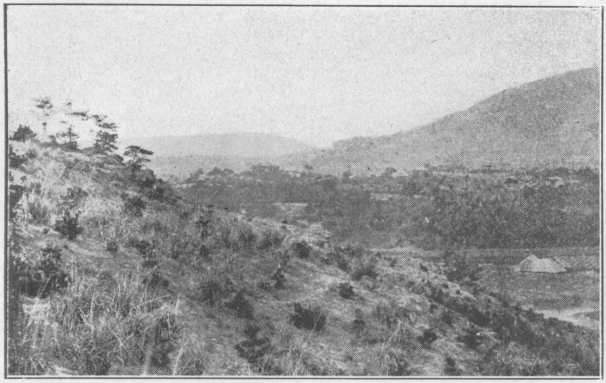


Fig. 1. Northnorth-eastern view from a hill-side, W of Komenoyama. A flat topped mountain, 180 m. high, in Ginsui-mura, at distance; it is a granitic mountain-ridge extending from SW to NE, capped by the neary flat-lying Akasaki Beds. Nearer and right is the northern extremity of the Shôtai-san Ridge; left in front, a hill-side composed of the Tôka Sandstone; extended between these two is a dissected old terrace, 30—40 m., of the Komenoyama Beds.

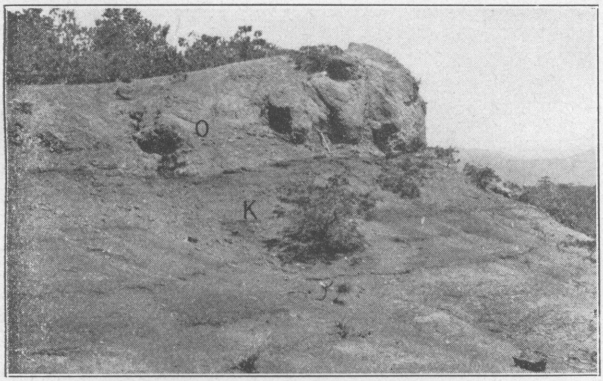


Fig. 2. An outcrop of the Komenoyama coal-seams (K) and the overlying Lower Orthaulax Zone (O), on a mountain-ridge, ca. 200 m., S of Ipponmatsu, Ginsui-mura.

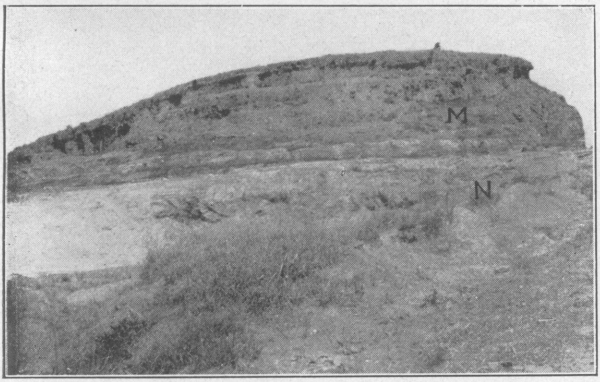


Fig. 3. An artificial cliff of the lowest part of the Manda Group (M), conformably overlying the Nanaura Sandstone (N); the slope from back to front is the stratigraphical boundary plane; half middle way from the Nanaura Mine to the Kachidachi Mine.

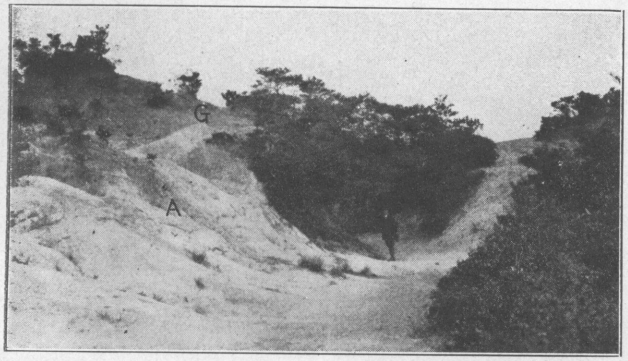


Fig. 1. East of the Fumoto Primary School, the Akasaki Beds (A) in front unconformably overlying granite (G); the boundary is indicated by a man on foot.

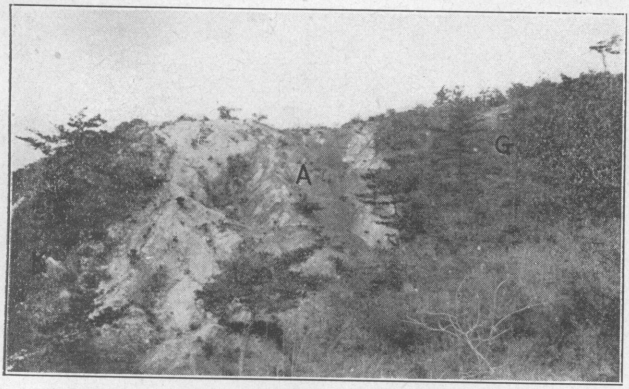


Fig. 2. East of Fumoto village, the Komenoyama Beds (K) (extreme left) and the Akasaki Beds (A) (middle), both in an almost upright position, in unconformable contact with granite (G) (extreme right.)

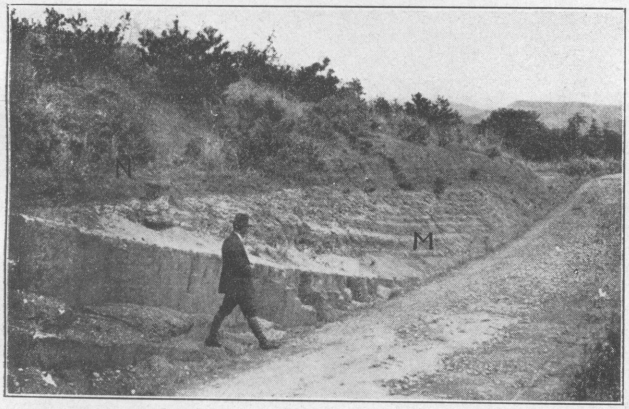
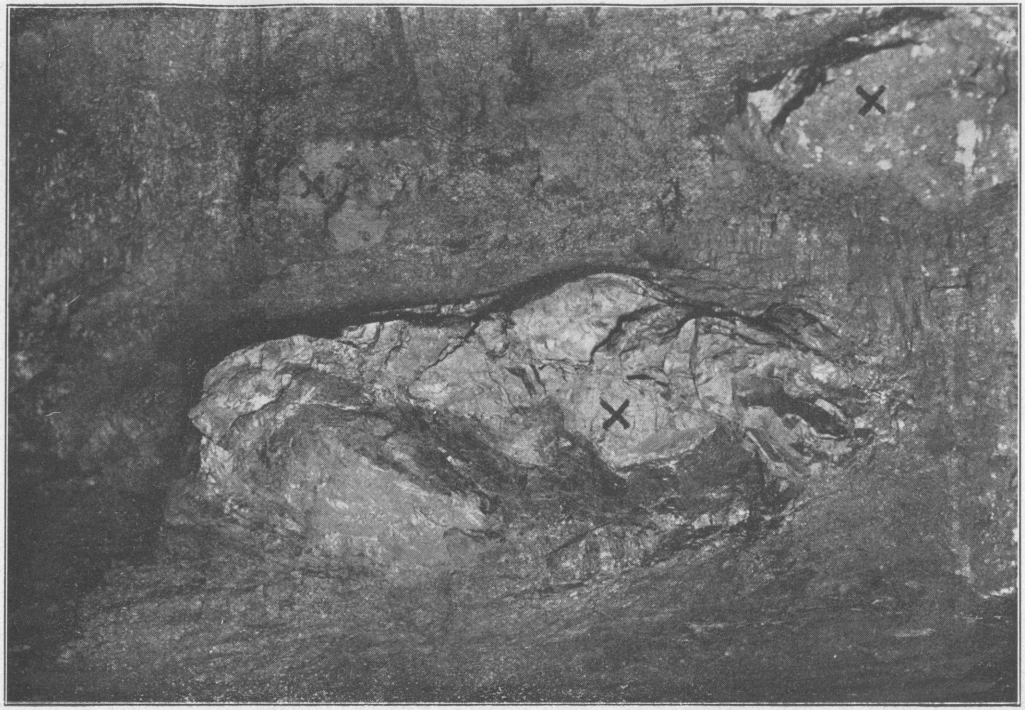
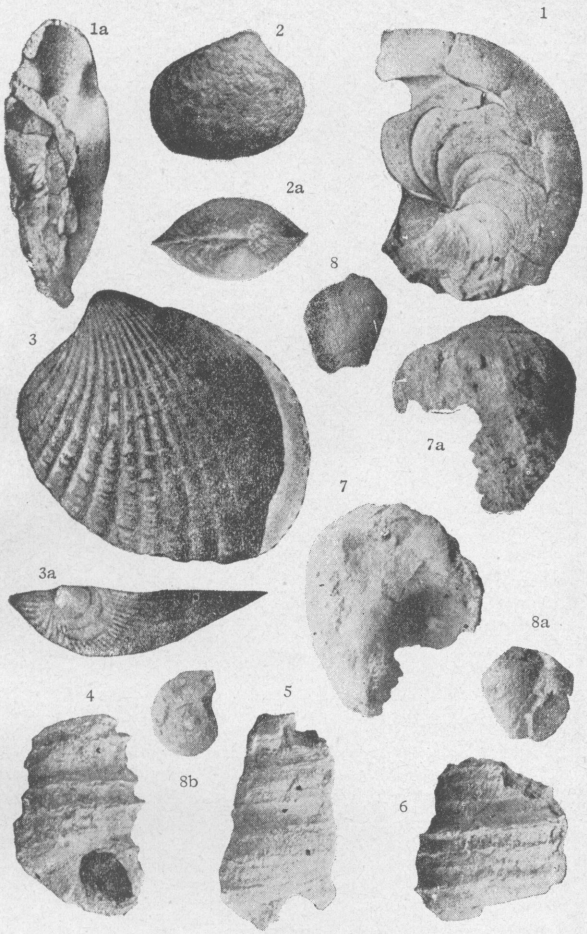


Fig. 3. East of Nobara Village, on the road, thin bedded alternation of sandstone and sandy shale of the Manda Group (M) unconformably overlaid by sand with gravels of the Nobara Bebs (N).



Partly silicified and partly carbonized woods (X) embedded in the Honso seam.

Plate VI.



Important Fossils of the Ōmuta and Manda Groups.

Fig. 1. *Aturia yokoyamai* NAGAO (copys of A. zigzag Sow. in Yokoyama's paper).
Loc. Manda shaft. Hor. Manda Group.

Fig. 2. *Venericardia nipponica* YOK. (copys from Yokoyama's paper.)
Loc. Manda shaft. Hor. Manda Group.

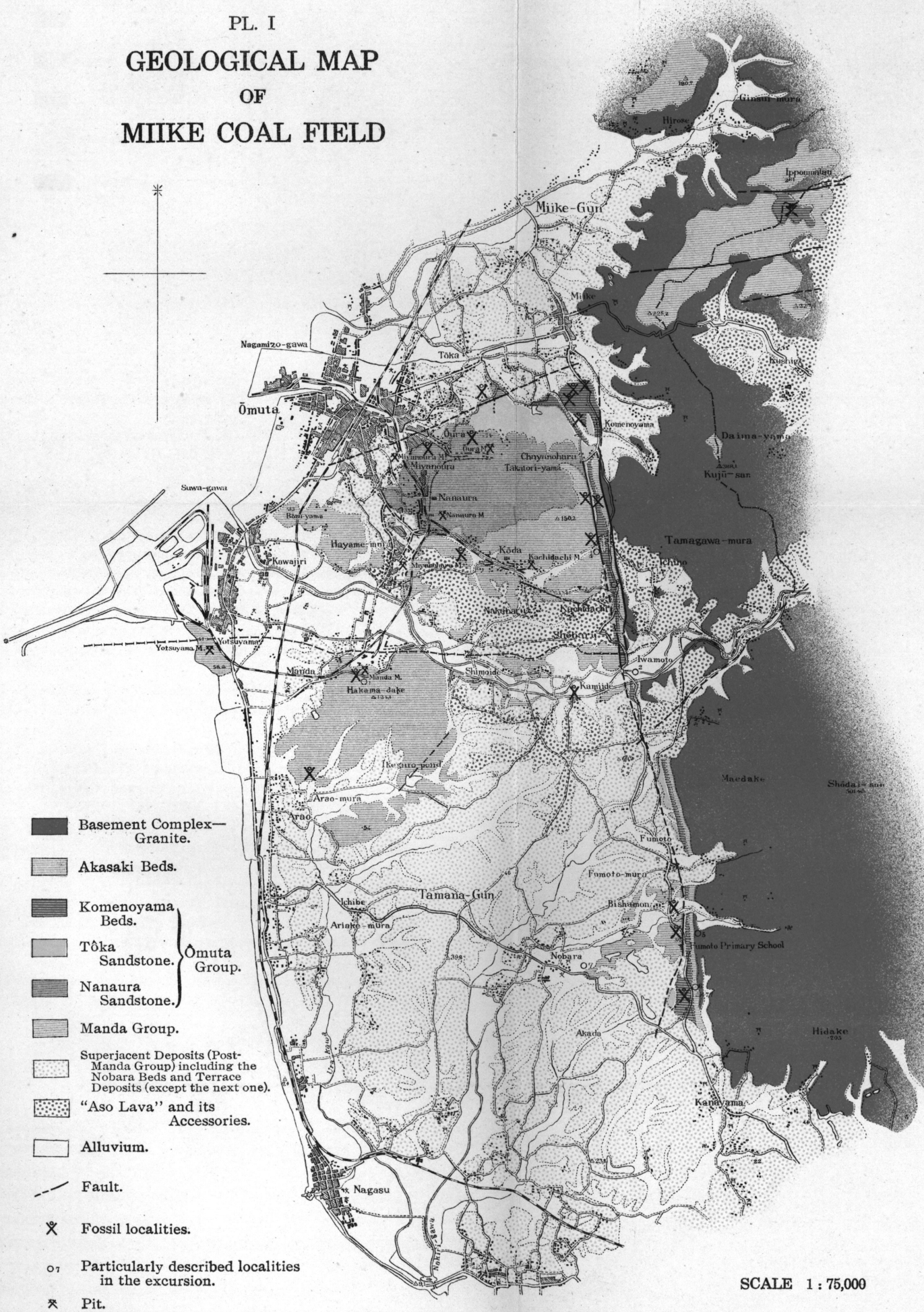
Fig. 3. *Crassatellites fuscus* (YOK.).
Loc. Manda shaft. Hor. Manda Group.

Figs. 4, 5, 6. *Turritella okadai* NAGAO.
Loc. Miike-machi. Hor. Ōmuta Group; the Lower Orthaulax Zon.

Figs. 7, 8. *Orthaulax japonicus* NAGAO.
Loc. Miike-machi. Hor. Ōmuta Group; the Lower Orthaulax Zon.

PL. I

GEOLOGICAL MAP
OF
MIIKE COAL FIELD



SCALE 1 : 75,000

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THE MIIKE COLLIERY

By Hidenosuke Sano

Location.—The Miiké Colliery is situated on the northeastern shore of the Bay of Ariaké, in Kyûshû, the concession extending over the two provinces of Chikugo and Higo. The Government Railway line runs in the vicinity of the mines and is connected with the Mitsui mining railway system.

History.—According to local tradition, the discovery of this coal deposit was made as early as the year 1468. The colliery is now in the possession of the Mitsui Mining Company.

Area of concession.—About 80,000 acres, or 5 miles E-W by 13.5 miles N-S.

Annual production :—

Year	Output in metric tons
1925	2,152,771
1924	1,834,118
1923	1,872,261
1922	1,766,896
1921	1,626,927

Coal-Seams.—Nine seams are found in the coal-measures (the Tertiary Formation), of which Seam No. 1 is the most important, averaging 8 ft. in thickness and measuring 25 ft. in parts, dipping about 5.5° to S-W. The interval between Seams No. 1 and No. 2 (5 ft. in aver. thickness) ranges from 10 ft. to 20 ft. and the Upper Seam (5 ft. in aver. thickness) is situated about 275 ft above Seam No. 1. Of them only Seam No. 1 is now being worked. According to the Yotsuyama sinking the strata consist of layers of sandy shale and sandstone, the thickness of one layer sometimes reaching about 100 ft. Common shale or conglomerate seldom occurs. Silicified wood is sometimes found in the coal-seam.

Quality of coal.—The coal is bituminous, giving the following analysis :

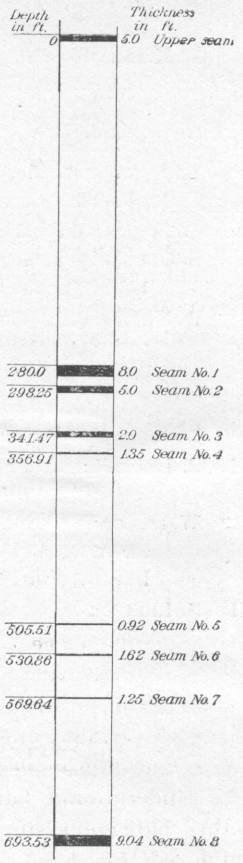

Fig. 5.
Section of coal seams in the Miiké coal-fields.

Analysis (per cent) of coal from Seam No. 1.

Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	Nitrogen
0.89	44.90	46.98 yielding good coke	7.23	2.47	0.85

Mining.—The five working mines are as follows :

Mine	Worked by	Depth of Shaft
Miyanohara	shaft	468 ft.
Kachidachi	shaft	391
Miyanoura	shaft	176
Manda	shaft	896
Yotsuyama	shaft	1,350

The annual output from these mines totals about 2,000,000 tons. The coal is mined by the bord-and-pillar system. Coal-getting is generally done by hand, but cutting by machinery is also used. The goaf is filled by the hydraulic stowing method with sand, clinker, slag, etc.

The Miiké are heavily watered mines, it being found necessary to pump out about 2,000 cb. ft. of water per minute in ordinary times and nearly double that amount in wet seasons. To contend with this enormous quantity of water, many pumps of various types, such as Davey's pumping engines, duplex steam pumps, turbine pumps driven by low-pressure steam turbines and various types of electric pumps, are in use.

For main ventilating purposes Guibal, Champion, Walker, Sirocco, Rateau, and Jeffrey fans are installed.

The mines are mostly free from any kind of explosive gas, but to avoid possible emergencies, Wolf safety lamps, Seippel safety lamps, and Edison electric safety lamps are generally used.

Underground haulage is done by the endless-rope and direct acting haulage system. Horses and electric locomotives are also employed for level underground transportation. For shaft-work many steam or electric winders have been erected, of which the latest is the electric winder in the concrete headgear installed at the Yotsuyama Pit.

The mine workers all told number about 15,000, including both underground and surface hands.

Preparation of coal.—Each mine is provided with a screening plant.

All nuts and some fines are cleaned by washers.

Miiké Workshops.—For purposes of repairing and manufacturing mine and other machinery, a well-equipped central workshop is established at Ômuta, where about 1,500 workers are employed.

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