Geology under the Kokura Alluvial Plain : with Special Reference to the Tertiary System of the Kokura Coal-field

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Geology under the Kokura Alluvial Plain

—with Special Reference to the Tertiary System of the Kokura Coal-field—

By

Suzuomi TOMITA

Abstract

For the construction of the Bypass of the national road, Route 3, running through Kitakyushu City, underground of the projected route was investigated by means of drilling and other ways. I was fortunate in having a chance to study in detail a lot of boring cores obtained and the subsurface geology of the Kokura alluvial plain covered with thick Quaternary deposits.

The results obtained are illustrated in Figs. 6 and 7, and are summarized as follows:

1) The Tertiary sediments developed under the greater part of the Kokura alluvial plain may be subdivided into three formations: the Yamaga, the Onga and the Ideyama Formation, which may be correlated respectively to the equivalents in the Chikuho Coal-field.

2) The critical relationship between the Onga and the Ideyama formations could not be ascertained because both formations in this area are in contact with each other with the resulting fault named the Usa-machi Fault, and a boring was just downed through this fault.

3) Geological structure of the Tertiary System shown in Fig. 6 might be identified to the "Chikuho Geostructural type" denominated by H. MATSUSHITA (1951).

Introduction

In order to relieve traffic congestion and to reform the national road, Route 3, in Kitakyushu City, Fukuoka Prefecture, a highway named Kitakyushu Bypass is under construction by the Japan Highway Public Corporation for several years. While the construction work of a greater part of the Bypass has been brought to a close, a part of the route between Tomino in Kokura Ward and Hikino in Yahata Ward running through the foot of the Sarakura mountain area is under construction at present. Prior to engineering work on this part, a serial exploration had as usual been done from geological and soil mechanical points of view. Because the thick Quaternary deposits are developed throughout the Kokura alluvial plain, any basement rocks including the Tertiary System could not be normally faced on the surface, and consequently more than 50 drillings were carried on in 1965 to 1967 in the section from Tomino to Shinozaki in Kokura Ward.

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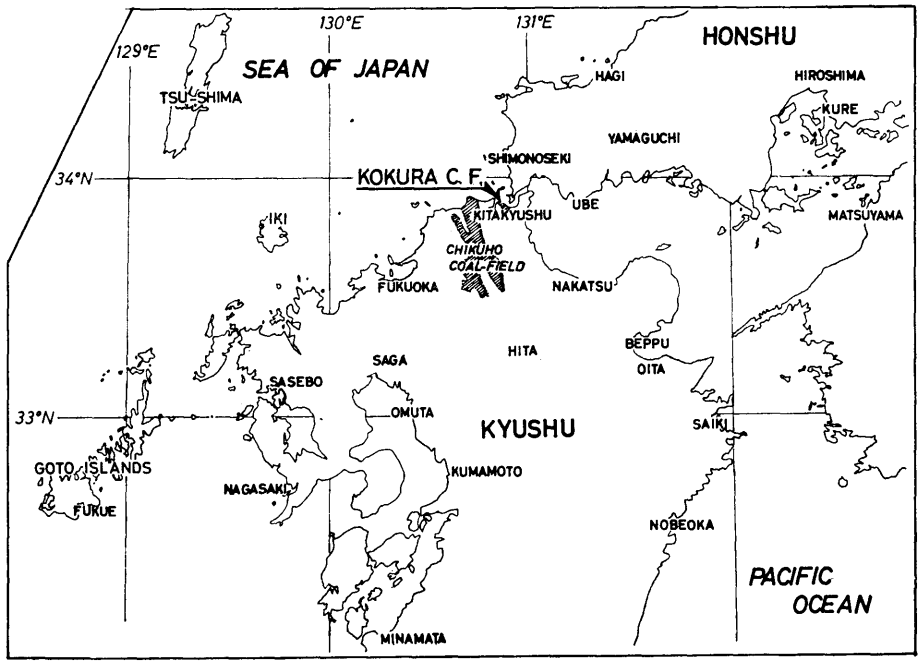

Fig. 1. Regional map.

Until several years ago, a great deal of good coal was produced in this area, which is called the "Kokura Coal-field". The geology of this area may accordingly be presumed from the underground data of these coal mines, but as the mines are mainly situated on the eastern half of the alluvial plain, the geology of the whole area might be more properly interpreted from the numerous drilling records of the Japan Highway Public Corporation.

Fortunately, a chance to study these new data obtained was given to me through the kindness of the Japan Highway Public Corporation. I describe briefly at first the records of drillings and comment in detail on the results obtained.

Acknowledgements

I wish to express my sincere appreciation to Prof. Hisamichi MATSUSHITA of the Department of Geology, Kyushu University for his kind guidance and encouragement, and Associate Prof. Ryohei TAKAHASHI who gave helpful advice, criticism and continuous encouragement and read over the typescript. I am also indebted to Associate Prof. Jyonosuke OHARA of the Department of General Education, Kyushu University, and Associate Prof. Toru IWAHASHI of the Department of Education, Shizuoka University, for their kind suggestions and advice.

Thanks must be also extended to the members of the Kitakyushu Office of the Japan Highway Public Corporation who afforded me an opportunity to do this study, and really cooperated with me.

I. Brief notes on stratigraphy

As described in the Introduction, in a greater part of the Kokura alluvial plain the recent deposit covers the Tertiary coal-bearing sequence which is the most important in the Kokura Coal-field. On the stratigraphy, geologic structure, and other geological features of the Tertiary formations of the coal-field many authors have already reported and discussed, i.e. N. HATAE *et al.* (1949), H. MATSUSHITA (1949, 1953, 1956 and 1957), E. TAKAHASHI (1950 and 1952), R. SAITO (1953, 1956 and 1957), K. HIRAYAMA (1956), K. TAKAHASHI (1957, 1962 and 1966), T. IWAHASHI and J. OHARA (1959), S. MURATA (1959, 1960 and 1961), and M. NODA (1961). Their results have been reviewed and discussed so many times that they are commented on in this paper just briefly.

The Tertiary rocks which occur in the coal-field are considered to be distributed under the greater part of the down-town area of Kokura and Tobata wards, however, they are never found on the surface in that area except on the hilly part ranging from Itôzu to Hiagari, the extreme west of Kokura Ward. On the small islands, named Mutsure-jima, Uma-shima, and Ai-no-shima scattered in the Hibikinada, off the northern coast of Kitakyushu City, the Tertiary develops quite well, and is taken as the northwards extension of the Tertiary in the Kokura Coal-field. The same series is, furthermore, traced at the west part of Hikoshima, southwest part of Shimonoseki City, the opposite side of the Straits of Kwanmon, and is thought very important for the interpretation of the stratigraphy or geological structure of the Tertiary System.

The basement rocks of the coal-bearing Tertiary sediments are the Paleozoic complex and the Mesozoic rocks. The former is composed of non and/or weakly regionally metamorphosed slates, sandstones, cherts, limestones, tuffaceous rocks and basic igneous rocks. They occupy a main part of the Kiku Peninsula including the Adachi mountain block to the east of the coal-field, and further, the Hirao-dai and Fukuchi-yama mountain region, southern part of Kitakyushu City. These rocks have been studied sporadically by H. YABE (1920), G. IISAKA (1931), H. FUJIMOTO (1935 and 1961), H. TAKEHARA (1935 and 1937), K. KINOSHITA *et al.* (1954), T. YAMASAKI and M. NODA (1955), K. KIYOHARA (1956, 1963a and 1963b), Y. OKAMOTO (1956 and 1958), H. MATSUSHITA *et al.* (1969), and H. URATA *et al.* (1969).

The latter, Mesozoic, on the other hand, was described for the first time by T. KOBAYASHI and I. OTA (1936). Succeeding them, T. KOBAYASHI and K. SUZUKI (1939) researched the same subject and published an excellent result. Afterwards, T. MATSUMOTO (1951 and 1954), Y. OTA (1953, 1955, 1957, 1959, 1960a and 1960b), T. YAMASAKI *et al.* (1956), H. MATSUSHITA *et al.* (1957), Y. UEDA 1957), and A. HASE (1959 and 1960) worked the same Mesozoic deposits from various points of view. They are, anyway, widely distributed on hills and mountains of Kitakyushu City, and consist of conglomerates, sandstones, shales, tuffaceous rocks, pyroclastic rocks, andesitic lavas and acidic intrusive rocks. Standing on their lithological facies, the most of them belong to the Cretaceous Kwanmon Group and are divided into the Wakino and Shimonoseki subgroups in

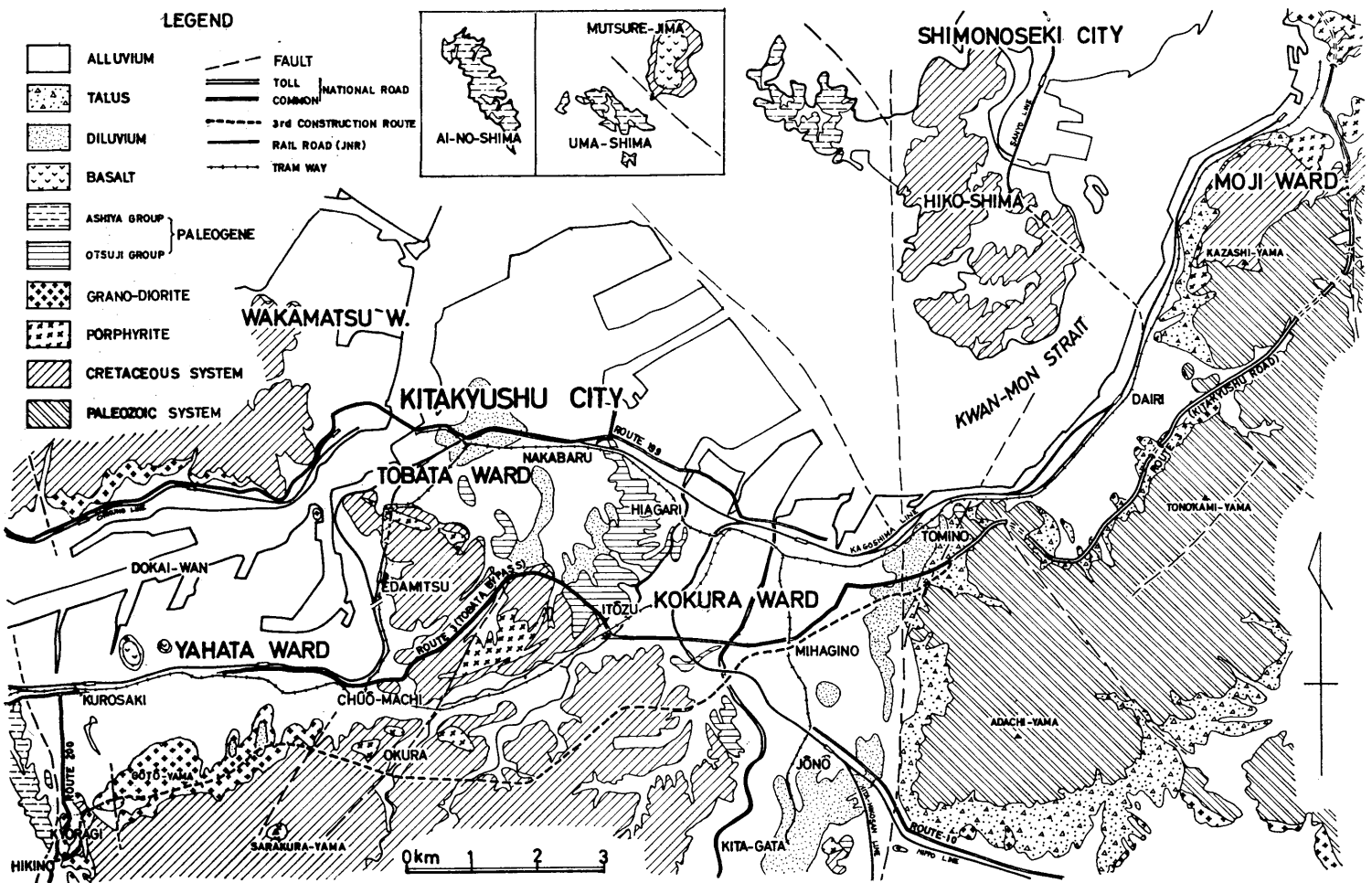

Fig. 2. Simplified geological map of Kitakyushu City.

ascending order, and the other part belongs to the Yahata Formation of the Cretaceous System. To be added to the Mesozoic rocks is the Hirao-granodiorite (T. MATSUMOTO, 1951, Y. KARAKIDA, 1952, T. TOMITA *et al.*, 1957, etc.) : it is of the Late Cretaceous in age, exhibits more or less wide exposures, and influences most of the other Cretaceous System and of the Paleozoic rocks, which are indeed more or less thermally metamorphosed.

The Quaternary System widely covering the town area of Kokura Ward is divided into the Diluvium and the Alluvium, the former consists of the low-level terraces in Kita-gata–Jôno and Adachi–Tomino areas, and the latter makes up bank deposits along the Murasaki and the Itabitsu rivers and thick talus deposits around the Adachi mountain block.

Distributions of each deposit described above are exhibited in Fig. 2.

II. An outline of the drillings

The route of Kitakyushu Bypass constructed at present* diverges from the Route 3 at Tomino: it traverses the flat area of down-town Kokura and then passes through the hilly part extending over Kokura and Yahata wards and the northern foot of the Sarakura mountain mass and ends at the junction of Route 200 at Hikino. With the exception of the eastern part of the route which passes through the alluvial plain in and around the Murasaki River, the greater part of the passage is through hilly land. For the purpose of studying the lithology and thickness of the underground strata in the plain, about fifty boreholes exceeding 15 to 20 m in depth were put down in 1965 at intervals of 150 to 300 m. Of these boreholes, however, some were located at narrower intervals and put down deeper to 40 m, because it was necessary to obtain a lot of information about goafs of old collieries near the route. Afterwards, in 1967, a few drillings were added to at the eastern part of the route near Tomino, inasmuch as the Quaternary deposits were so well developed that some of the drillings carried out before had not met with basement rocks. To check the extension of goaf which was found in one of the preceding boreholes one supplementary boring was put down near the Adachi Primary School.

With the exception of a few borings drilled into the pre-Tertiary rocks, most of them met, as expected, with the Tertiary under the alluvial deposits. I have investigated all of those records and cores, but for convenience of description, about forty records are picked up and referred to in this paper. They are designated numbers 1 to 40 in numerical order from east to west. Fig. 3 shows the location of cited drillings.

III. Records of drilling cores

As it is not proper but just troublesome to comment on the records and natures of drilling cores in detail, only the matters to be emphasized or to be

* Hereinafter referred to as "the route".

taken into account are mentioned. All the drilling cores below the Quaternary cover fall into seven clearly defined groups from their lithology:

1. Nos. 1–4 (No. 1: 50 m, Nos. 2 and 3: 15 m, and No. 4: 38 m)*

Drillings of this group were carried on at the foot of the Adachi mountain block. It becomes clear then, as supposed before, that several kinds of the Paleozoic, such as slate, hard sandstone, greenish siliceous phyllite and diorite, are lying under the thick Quaternary gravel and sand beds.

At the point of the No. 1 drilling, weathering zone of the Paleozoic is very thick, and indeed about 28 m in thickness is measured. Comparing it with those of other drillings, this fact is noteworthy especially from the civil engineering point of view, but it could not be decided whether it is caused by a merely selective weathering, by paleotopographical factor, or by geotectonic disturbance like a fault.

The Quaternary, which consists of gravel and sand beds and has a thickness of 15 m in No. 1 and 25 m in No. 4 borehole, may be an alluvial fan-deposit derived from the Enmeiji River and also in part a talus deposit of the Adachi mountain block.

2. Nos. 5 and 6 (No. 5: 40 m and No. 6: 20 m)

In both boreholes, the pre-Quaternary rocks are intensely brecciated: in No. 5, hard slate is highly sheared and fault clay is partially intercalated; in No. 6, shale is likewise brecciated and becomes in part clayey. Judging from their lithology, hard slate met with in No. 5 borehole may belong to the Paleozoic, and another one in No. 6 to the Tertiary. Both argillaceous rocks, however, are so highly crushed that a great fault or fracture zone should be running near and around the drilling sites.

The Quaternary deposits of Nos. 5 and 6 borings are also composed of sand and gravel beds intercalating clayey silts, and have 16 m and 13 m in thickness respectively. They are certainly equivalent to a part of the terrace deposits in Tomino–Adachi area.

3. Nos. 7–12 (Nos. 9 and 10: 40 m, others: 20 m)

The cores of sediments beneath the Quaternary show scarce change in lithological facies: They are composed of greenish very coarse- or fine-grained sandstone containing glauconite, and intercalate rarely sandy shale. They may be treated together as a series of the Tertiary sandstone member.

The cover above the Tertiary rocks has a thickness of 5–7 m. As this area was formerly low and damp, and later was filled up artificially with soil, original thickness of the Quaternary deposits cannot be determined.

4. No. 13 (130 m)

Of the cores, except the Quaternary beds, the part from −5.0 m to −21.8 m

* Bored depth; the same shall apply hereinafter. On the ground level of drilling location, and the thickness of the Quaternary System at each boring, refer to Figs. 4, 5c and 7.

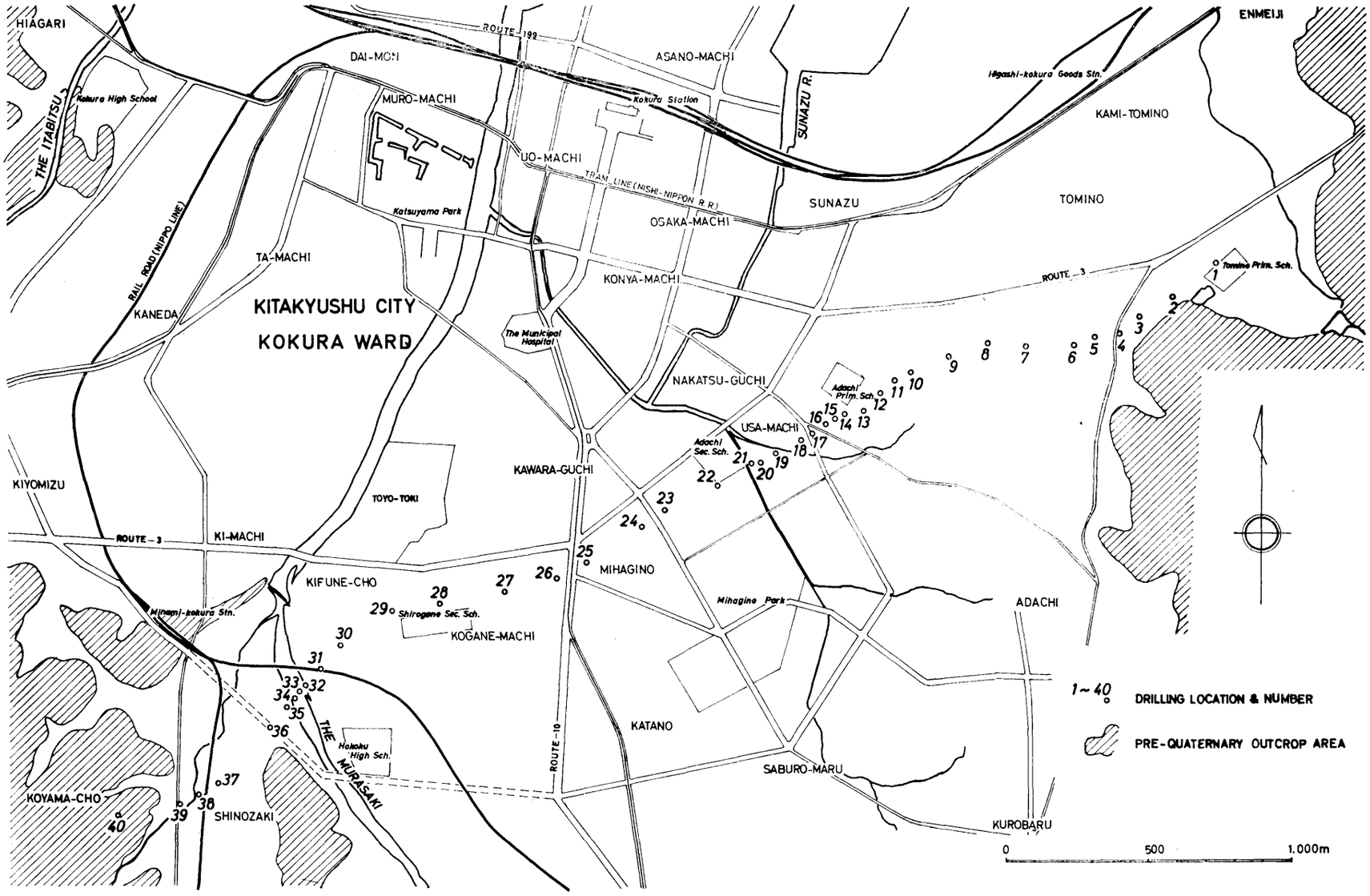

Fig. 3. Drilling locations.

levels* is a series of greenish medium- or very coarse-grained sandstones: it contains abundant marine molluscan fossils in a lower half and includes pebbles at the lowermost part. It is exactly similar to the Tertiary sandstone member of Nos. 7–12 in lithology.

Below the level of −21.8 m, several alternated members of sandstone, sandy shale, siltstone and tuffaceous shale with various thickness continue to the bottom of the borehole, and include many coals and coaly shales, of which two coal seams at −57.6 m and −105.9 m levels are remarkable. Sandstones of these alternated members, except the uppermost part, show dominantly an arkosic facies and contain much coaly matter. It is really noticeable, moreover, that a cave is discovered between −28.3 m and −30.4 m. From core-slime it might be goaf of an old coal mine.

The Quaternary-cover is divided into two members; the upper member consists of sand beds intercalating silt laminae, and the lower one of sand and gravel beds. Gravels of the latter attain approximately boulder size. It is about 5 m in total thickness.

5. Nos. 14–17 (40 m)

The lithofacies in Nos. 14–17 boreholes are similar to those of the coal-bearing formation met with in No. 13. The Tertiary sediments of this drilling group are also accompanied with several coals and coaly shales. Near the bottom of No. 17 borehole, −37 m level, a ftult breccia is well recognized and the adjacent strata show rather steep inclination to about 75°.**

Westward the Quaternary deposit becomes thinner from 5 m to 3 m. It is composed of sand members with gravels, and sometimes intercalated with some silt beds.

6. Nos. 18–39 (Nos. 18–20: 40 m, others: 15 m)

Each drilling core below the Quaternary shows the same lithology; they consists mainly of coarse-grained, non-marine sandstones, pebbly sandstones and granule- or cobble-conglomerates partially inserted with siltstones, sandy shales, coaly shales and also some poor coals. From a general viewpoint, they are monotonous coarse-grained deposits showing no remarked stratification, and their dips cannot be easily measured with a few exceptions; for fine-grained facies, 10°–20° are measured.

A number of faults are met in Nos. 19 and 20 boreholes, but not in others.

The thickness of the Quaternary deposit varies from 3 m to 5 m. The main components of them are clayey silt, gravel and sand beds, but sometimes like at No. 31, they are occupied by only gravel or boulders including sand members, which is thought as old river-deposit. Merely thin sand and muddy silt bed less than one meter in thickness lies at Nos. 32–35 sites, which situate on a river-bed

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* Figures mean the depth from the sea level.

** Dips of strata are estimated by measurement of laminae of boring cores. In Nos. 13–16 boreholes, dips vary from 20° to 30°, but from 50° to 60° in No. 17 except the lowest part mentioned above.

of the Murasaki. To the west of No. 36, no cover of the Quaternary develops with the exception of some regolith or debris.

7. No. 40 (15 m)

This boring directly drilled weathered volcanic sediments and tuffaceous sandstones, which belong to the basement, Shimonoseki subgroup of the Kwanmon Group.

IV. Summarized comment to the drilling records

As mentioned briefly in the last chapter, the Paleozoic rocks are recognized in Nos. 1–5 boreholes, the Tertiary sediments in Nos. 6–39, and the Mesozoic System in No. 40 under the Quaternary deposits. Since the pre-Tertiary rocks were exposed in and around hilly areas near the route, I could not find any novelty to be added in the drilling cores with the one exception of the thick weathered zone met in No. 1 borehole.

According to H. MATSUSHITA (1949), the Tertiary System of the Kokura Coal-field is divided into two groups, the Otsuji and Ashiya in ascending order. Each group is then further subdivided into Ideyama and Onga, and into Yamaga and Sakamizu formations respectively. Each formation corresponds to the same named formation in the Chikuho Coal-field.*

The sandstone sequence containing marine shell fossils resembles closely the lower member of the Yamaga Formation of the Ashiya Group in the Chikuho Coal-field from lithological point of view. Meanwhile, in another borehole close to the north of No. 13, one of the boreholes omitted in this paper, the fossil remains become smaller in size at the lowermost of the sandstone member. Such a fossil-occurrence** is similar to those in the basal part of the Ashiya Group of the Chikuho Coal-field. The strata showing marine facies are then properly correlated to the Orio sandstone member, the lower part of the Yamaga Formation of the Ashiya Group in the Chikuho Coal-field.

Taking the presence of thick coal seams in the drillinglog and the data*** of the old collieries into account, the coal-bearing sediments in No. 13 borehole and the sandstone and silt members intercalating carbonaceous beds in Nos. 14–17 boreholes must be together a part of the main coal measures of the Kokura Coal-field, the Onga Formation defined by H. MATSUSHITA. In the Onga Formation of the Kokura Coal-field, several workable coal seams are developed and were mined. They are known under the names of Ue-goshaku, Ue-nishaku, Ue-sanjaku, Shita-nishaku, Shita-sanjaku, Shita-goshaku, Doma-goshaku, and Has-

* The greatest coal-field in Kyushu; it develops in the central part of Fukuoka Prefecture, to the west of Kokura Coal-field (Fig. 1).

** The fossils occurred above that horizon were not so small in size. This character was not obvious in the No. 13 drilling core. As only very few specimens of fossils showing fine features were obtained, identification of species is not adequate.

*** But, an existence of disused mine just under the highway site had not been supposed from the published reports.

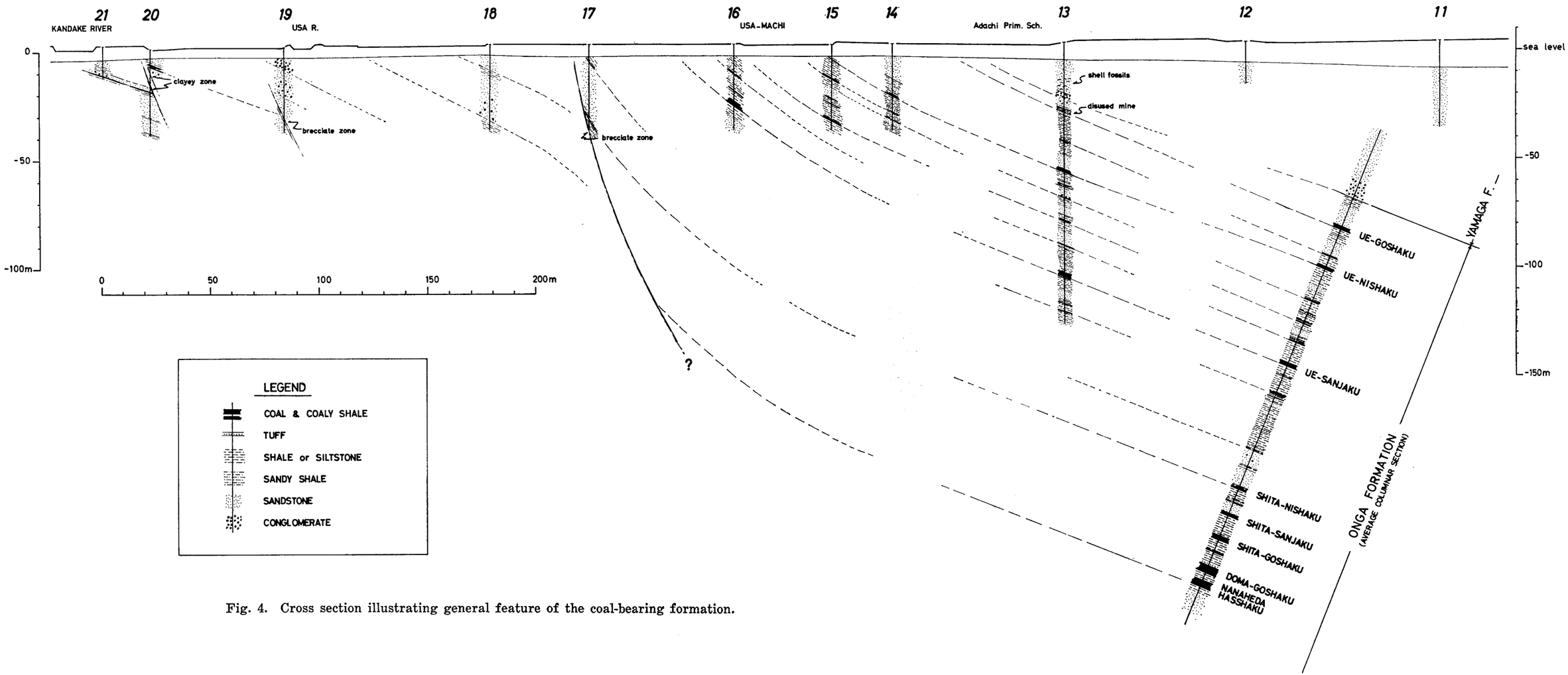

Fig. 4. Cross section illustrating general feature of the coal-bearing formation.

shaku* seams in descending order. According to the data from the old coal mines, it is recognized that the goaf discovered in No. 13 borehole must be the one in the Ue-goshaku Coal Seam, and that remarkable coal beds at −57.6 m and −105.9 m levels in the same borehole are presumably identified to the Ue-nishaku and the Ue-sanjaku seams respectively. As shown in Fig. 5b, the Hasshaku Coal, lowermost workable coal of the Onga Formation, is ascertained by boring in the unmined area. Fig. 6 shows then the calculated outcrop of this coal against the base of the Quaternary cover. Comparing the boring records with the standard succession of the Onga Formation gained from the old Kokura Colliery and taking inclination of strata about 22° into consideration, the succession of the coal measures along the route is drawn as illustrated in Fig. 4.

The lithofacies of the sediments, with which No. 18 or more westward boreholes met, is slightly different from those of the coal measures recognized by Nos. 13–17 drillings. Further, the No. 17 drillinglog shows a brecciate zone at the lowermost part, and several minor faults are also recognized in Nos. 19 and 20 boring cores. It could be presumed, therefore, that the westward extent of the coal measures is bounded by a fault met with No. 17; this is also exhibited in Fig. 4.

A part of the Tertiary sediments of Nos. 18–39 drillings shows scarcely any lithological variation, and resembles the outcroppings in the hilly area from Itôzu to Hiagari, northwestwards of the route. As the same rocks were also recognized below the Onga Formation at the disused colliery, this part might belong to the Ideyama Formation** of H. MATSUSHITA. Similar lithofacies are also observed in several outcrops near and around Nos. 31–39 drillings, the river-bed of the Murasaki, the Shinozaki hills, and the hills surrounding the Minami-kokura Station of the Japanese National Railway. Owing to T. IWAHASHI and J. OHARA (1959), who studied in detail the Tertiary sediments distributed widely in Kitakyushu City, the sediments in these areas are the equivalents in the Itôzu–Hiagari area, and belong to the Ideyama Formation defined by H. MATSUSHITA.

T. IWAHASHI and J. OHARA subdivided the Ideyama Formation in this field into six members from the cycle of sedimentation as follows:

	thickness
Nakabaru conglomerate member	100 m
Hiagari pebble-bearing sandstone member	35–40 m
Iriguchi sandstone and conglomerate member	65 m
Shimo-itozu conglomerate member	120 m
Kami-itozu conglomerate member	0–75 m
Tenraiji coal-bearing conglomerate member	0–120 m

They set, however, one undivided member at that time, which lies conformably on the other six members.

* Since the Doma-goshaku and the Hasshaku coals are so close to each other, they are sometimes treated as one sequence. In places the latter coal is intercalated with a shale band and splits into the Nanaheda and the Hasshaku coals.

** Various questions about this formation will be discussed in next chapter.

Due to the stratigraphic table illustrated by IWAHASHI and OHARA, the Ideyama Formation of this coal-field is about 700 m in thickness, but the upper part of this formation, about 200 m, reported as the undivided member, is never seen at the surface. By a series of drillings, it is recognized at the first time this part developed widely under the Kokura alluvial plain.

All the Tertiary strata cropped out at the Murasaki River, the Minami-kokura Station, and the Shinozaki areas are together included in the lower part of the Ideyama Formation, and the same rocks at Kita-gata–Ninada area, the extreme south of the Kokura Coal-field, are also the equivalents. From the investigation of boring cores and of outcrops near the route, it is considered that the beds of nos. 31–36 are to be correlated to the Shimo-itozu member, and that the strata of nos. 37–39 borings to the Kami-itozu member. The Tenraiji member, the lowermost of the Ideyama Formation, may thin out southeastwards.

V. Stratigraphical note

Opposite to the stratigraphic scheme of the Tertiary in the Kokura Coal-field established by H. MATSUSHITA (1949), R. SAITO (1957) proposed that the whole formation of the coal-field should be set above the Ashiya Group of the Chikuho Coal-field from the plant fossil remains discovered in the higher part of the Ideyama Formation exposed at Hiagari.* K. TAKAHASHI (1957, 1960 and 1962) studied, on the other hand, the pollen fossils in this district and pointed out that the Onga Formation and the lower part of the Ideyama Formation of the Kokura Coal-field have the similar pollen association to that of the Onga Formation in the Chikuho Coal-field, and that they should be correlated with each other. S. MURATA (1961) is in accord generally with K. TAKAHASHI by the microbiostratigraphical study.

It might well be left unsaid that the Ashiya Group both in the Kokura and Chikuho coal-fields should be correlated to each other from the macro- and microfossil assemblages and also from the lithological facies (S. MURATA, 1961, A. MIZUNO, 1963, etc.).

It is, therefore, a matter to be discussed whether the coal-bearing formation in this coal-field could be correlated to the Onga Formation of the Chikuho Coal-field, since the conformably overlying Ashiya Group of both coal-fields are well correlated with each other. The Onga Formation of the Kokura Coal-field is about 240 m in thickness and recognized not only in the down-town Kokura area but also successionally in the undersea area, west side of the Ai-no-shima, northwestward of the town area (T. IWAHASHI and J. OHARA, 1959). It is generally divided into three members: the upper contains coal beds ranging above the Ue-sanjaku, the lower includes coal seams below the Shita-nishaku, and the middle is barren of workable coals. The same tendency is also recognized in the Onga Formation of the Chikuho Coal-field: it is divided into the upper productive coal member, the middle scanty member, and the lower coal-bearing member.

* He accords with H. MATSUSHITA in the stratigraphical succession.

Regarding the "Ideyama Formation" of the Kokura Coal-field, there are also various opinions: R. SAITO supposed that it is surely the upper or middle Miocene in age; K. TAKAHASHI considered that it is just an equivalent to the series from the Onga Formation to the Ashiya Group in the Chikuho Coal-field; H. MATSUSHITA *et al.* correlated it with the Ideyama Formation of the Chikuho Coal-field. M. NODA (1961) regarded, following K. TAKAHASHI, that the coal bed seen at Kurobaru in Kokura Ward occurred about 150 m below the Hasshaku Coal of the Onga Formation and worked formerly is an equivalent to the seam in the Tenraiji member, which also had been mined at Itôzu. As a consequence he pointed out that the whole of the "Ideyama Formation" above the coal seam at Itôzu, about 500 m or more in thickness, could not be settled into the interval between the Hasshaku and the coal bed at Kurobaru, about 150 m. Based on these various reports, M. NODA published his opinion and said that the lower part of the "Ideyama Formation" should be equivalent to the Onga Formation of the Kokura Coal-field which is also correlated with the Onga Formation of the Chikuho Coal-field. He supposed, moreover, that the upper part may belong to the Miocene in age, and that the relationship between the lower and the upper parts of the "Ideyama Formation" is either fault or unconformity. Afterwards K. TAKAHASHI (1966) published his new opinion that the upper part of the "Ideyama Formation" is correlated with a part of the Ashiya Group of both coal-fields, and that both successions are contemporaneous but have different facies.

Upon mature consideration of the "Ideyama Formation" in this district including Itôzu and Hiagari areas, it may be said that the "Ideyama Formation" is a series of sequence, in which any remarkable unconformity or any disturbance is not recognized. I arranged the drilling sections as shown in Fig. 5c, taking the distance and the level of each boring site into consideration. According to a comparison of Fig. 5c with Figs. 5a and 5b, it is quite well regarded that the sequence of each sections has the same stratigraphic and lithologic character, and that the members extend southeastward under the Kokura alluvial plain as shown in Figs. 5b, 5c and 6, based on the cycle of sedimentation by IWAHASHI and OHARA. The relationship in which the Ideyama and the Onga formations come in contact is shown in Fig. 4; they contact with a fault.* Based on the distribution of coal beds, the fault has a throw of about 100 m towards the east. The coal bed at Kurobaru discussed by M. NODA is not an equivalent to the seam in the Tenraiji member at Itôzu but may be correlated to any in the undivided member met in Nos. 20–22 boreholes as exhibited in Figs. 5 and 6.

The geological structure of the Tertiary sediments in this field show the so-called "Chikuho-type" proposed by H. MATSUSHITA (1951), which is a common feature in the northern Kyushu coal-fields: the Paleogene System lies unconformably on the basement rocks with dip to northeast in general, is limited to the eastern end by a great fault known under the name of Kokura Fault; the synclinal axis runs in parallel with the Kokura Fault passing the eastern margine of the coal-field. It is thought that the fault is a part of the "Kokura–Tagawa

* tentatively named "the Usa-machi Fault".

Tectonic Line" or the "Kawara Graben" ranging here toward the south (K. KINOSHITA *et al.*, 1954). The brecciated zone proved in Nos. 5 and 6 boreholes might be regarded as an evidence of this fault.

From the results described above, the cross section along the route could be drawn as in Fig. 7.

Concluding remark

Through drilling works operated in the Kokura alluvial plain of Kitakyushu City, a number of valuable data on the Tertiary System of the Kokura Coal-field were acquired. It may be significant that both the succession and the extent of the Ideyama Formation become clear, and that the Usa-machi Fault, bordered by both the Ideyama and the Onga formations under the route, was discovered. In lithological point of view, the Ideyama Formation of this field resembles very closely that of the Chikuho Coal-field, in particular that of the northern district of the latter field. There remain, however, many questions concerning the biostratigraphical problems of the Ideyama Formation indicated and discussed by some authors, since any good paleontological material has not been obtained from the drillings, but I would like to try to solve such problems in the near future.

From the standpoint of civil engineering geology, it should be mentioned that the goaf of old mines may extend rather widely at comparatively shallow depths. It is possible, therefore, that the surface ground may suddenly subside in those areas, affected by the goaf. It is then advisable to reinforce the constructed highway by any suitable engineering method, if it is too difficult to separate the course from the old worked area.

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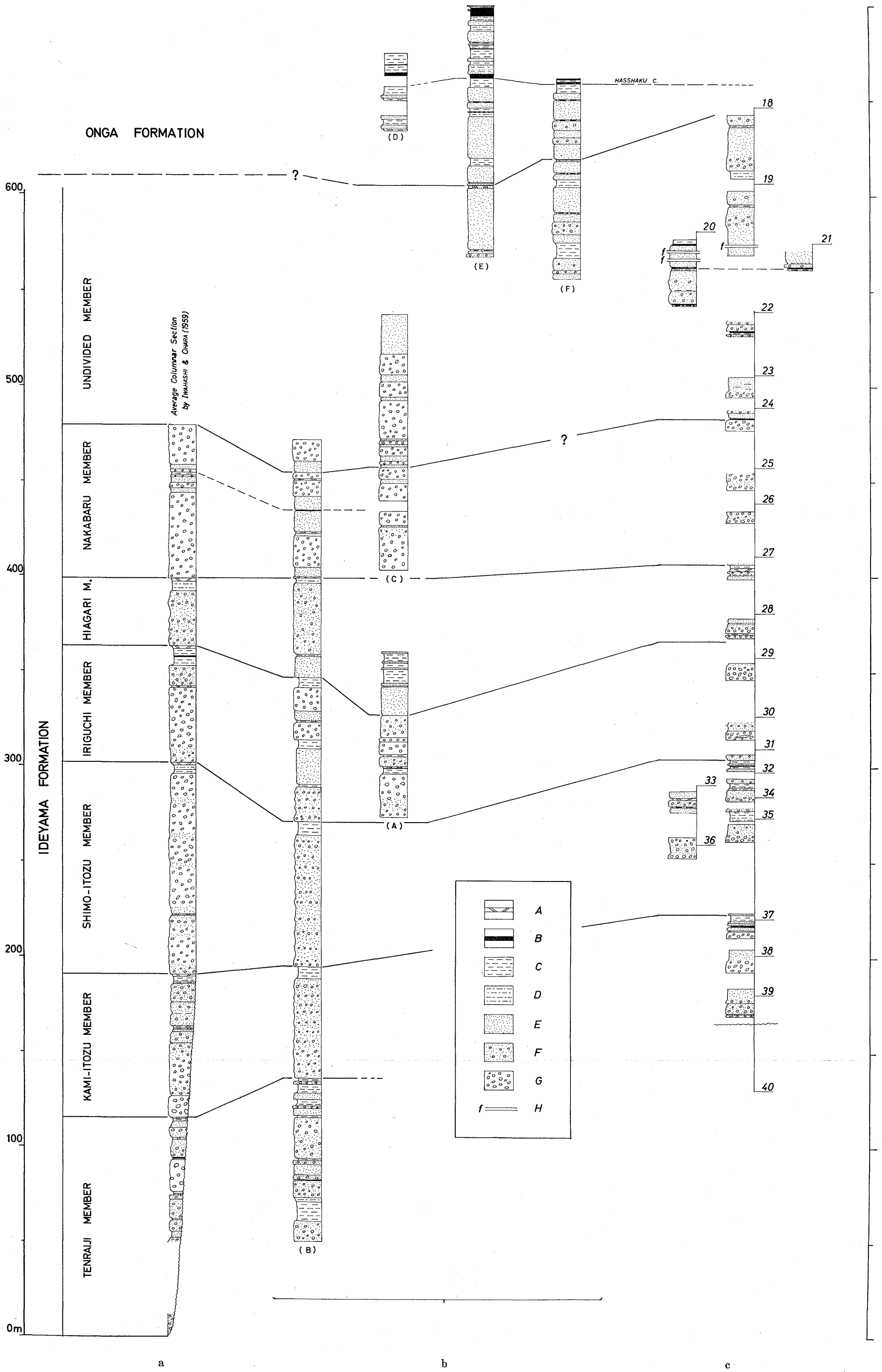

Fig. 5. Columnar section of the Ideyama Formation (5a, average section; 5b, boring sections for coal-research; 5c, boring sections in this time, showing the sea level as underlines of boring number).

Explanation: **A**, tuff or tuffaceous shale
B, coal or coaly shale.
C, shale or siltstone.
D, sandy shale.
E, sandstone.
F, conglomeratic sandstone.
G, conglomerate.
H, fault.

Boring locality of b: (A), Saienba.
(B), the old mouth of the Itabitsu.
(C), Sumitomo Steel Works.
(D), Do.
(E), river bed of the Sunazu
(F), Saburô-maru.

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Appendix

Alphabetical list of place names, with Japanese writing

Ai-no-shima ..... 藍　島
Adachi ..... 足　立
Enmeiji River ..... 延命寺川
Hiagari ..... 日　明
Hikino ..... 引　野
Itabitsu River ..... 板樋川
Itôzu (Itozu) ..... 到　津
Jôno ..... 城　野
Kita-gata ..... 北　方
Kitakyushu City ..... 北九州市
Kokura ..... 小　倉
Kurobaru ..... 黒　原
Murasaki River ..... 紫　川
Mntsure-jima ..... 六連島
Ninada ..... 蜷　田
Sarakura ..... 皿　倉
Shinozaki ..... 篠　崎
Tomino ..... 富　野
Uma-shima ..... 馬　島
Usa-machi ..... 宇佐町
Yahata ..... 八　幡

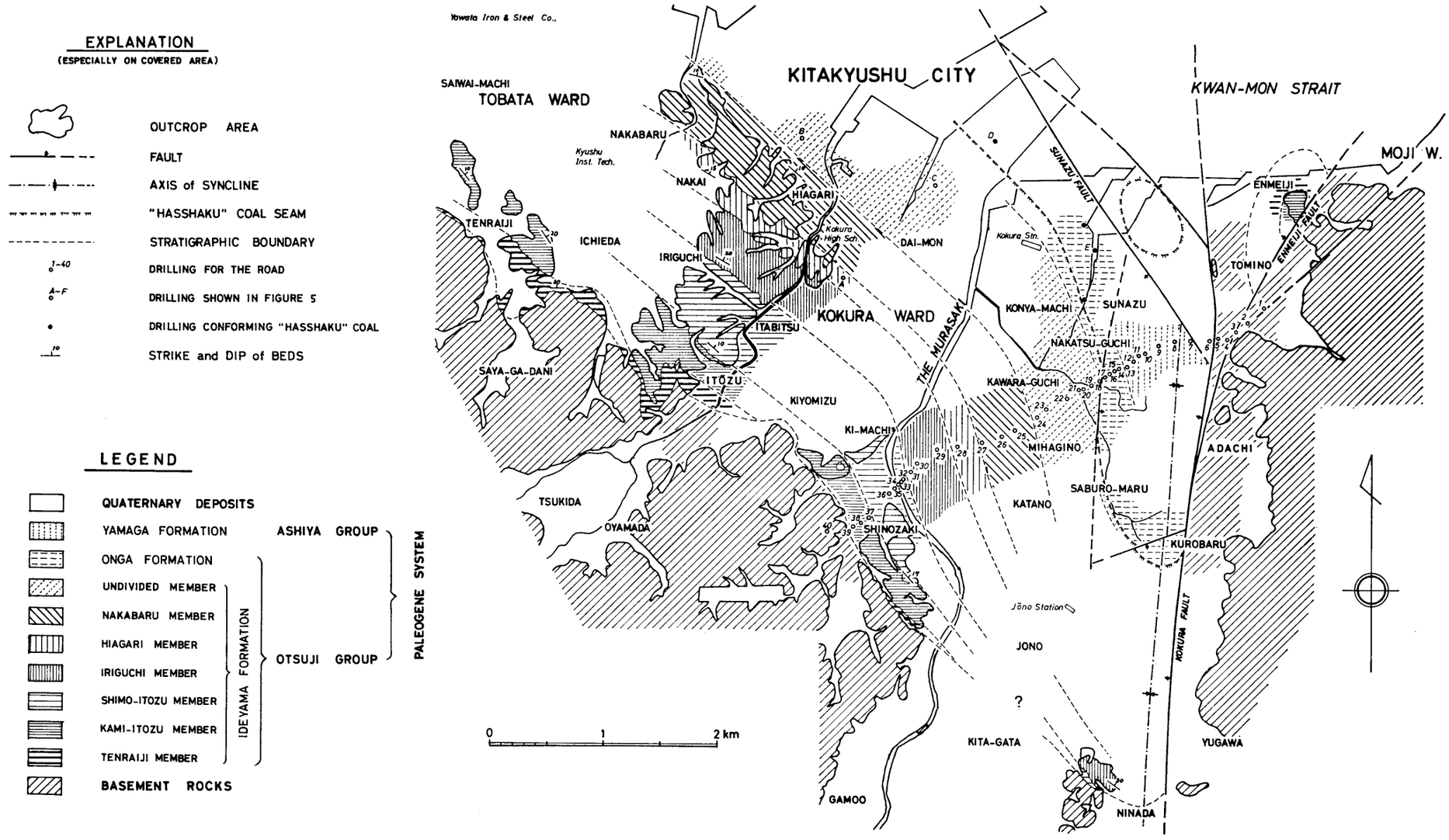

Fig. 6. The Kokura Coal-field, showing calculated outcrops against the base of the Quaternary cover.

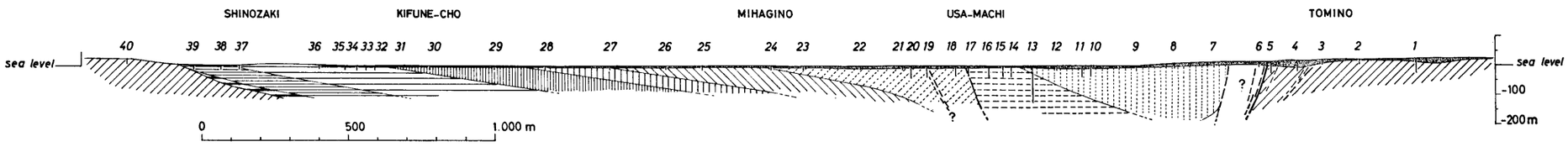

Fig. 7. Cross section along the route. (legend, refer to fig. 6)