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STRATIGRAPHY AND GEOLOGICAL STRUCTURE OF THE PERMIAN FORMATIONS OF MT. IBUKI AND ITS VICINITY, CENTRAL JAPAN

By

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Konosuke SATO, Director

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Abstract

The Paleozoic formations of Mt. Ibuki and its vicinity belonging to the middle-lower Permian system, especially their zoning by fusulinids have hitherto been studied by several researchers including the present writer.

The Paleozoic of the Yokoyama district has been divided by the writer (1965) into the following two fusulinid zones, *Parafusulina-Neoschwagerina* zone and *Pseudofusulina* zone.

That of the northern part of the Ibukiyama district is divided by the present writer into four fusulinid zones, namely *Yabeina*, *Neoschwagerina*, *Parafusulina* and *Pseudofusulina* zones.

The southern part of the Ibukiyama district has been divided by M. KOBAYASHI (1957) into four fusulinid zones, *Yabeina*, *Neoschwagerina*, *Parafusulina* and *Pseudoschwagerina* zones.

The Paleozoic of the South lowland district has been divided into two fusulinid zones namely *Parafusulina-Neoschwagerina* and *Pseudoschwagerina* zones by R. MORIKAWA and H. ISOMI (1961).

The *Pseudofusulina* or *Pseudoschwagerina* zone, *Parafusulina* or lower part of *Parafusulina-Neoschwagerina* zone and *Yabeina*, *Neoschwagerina* or upper part of *Parafusulina-Neoschwagerina* zone correspond to Sakamotozawan, Nabeyaman and Akasakan, respectively.

The geological structure of the surveyed area forms a domelike structure. The Paleozoic formations of the Yokoyama district form a monoclinal structure dipping north. The Otohara anticline and isoclinal folding are found in the neighbourhood of Otohara.

The Paleozoic formations of the Ibukiyama district are divided into the calcareous and non-calcareous parts, the latter of which forms in general a monoclinal structure dipping south. On the other hand, the limestone formation of the northern Ibuki mountain range forms an imbricate structure and that of its southern part, an overturned folding.

The calcareous formation and the non-calcareous one make a thrust contact with each other.

The Paleozoic formations of the South lowland district form a monoclinal structure dipping north in the eastern part and a synclinal structure in the western part.

I. Introduction

The Paleozoic formations distributed in Southwest Japan are mainly composed of the two characteristic facies i.e. limestone and non-calcareous facies. The limestone and non-calcareous facies have been named the Akiyoshi and Yamaguchi facies by T. KOBAYASHI (1953), respectively.

The Akiyoshi facies is mainly limestone and intercalated with schalstein (basic volcanics) and chert, while the Yamaguchi facies is mainly composed of sandstone, slate and chert, and

* This report is the main part of the paper entitled "Geological and Paleontological Studies of the Permian Formations of Mt. Ibuki and its Vicinity, Central Japan" which was presented to Kyoto University as the thesis for a degree.

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it is scanty in limestone.

T. KOBAYASHI (1953) has proposed the Oga decken structure from his observation that the Akiyoshi facies rests on the Yamaguchi facies, and he concluded that the geological age of the Oga orogenic movement is early Cretaceous.

The Paleozoic formations in the Ibukiyama district are also composed of the two facies mentioned above.

It was inferred for the first time by M. KOTO (1910) that the large limestone mass of the Ibuki mountain range was thrust over the non-calcareous strata by the low angle thrust. T. TAKEYAMA (1933) and T. SEKI (1939) studied the stratigraphy and geological structure of Mt. Ibuki, and they supported the thrust of the Ibukiyama limestone. H. ISOMI has described stratigraphy and geological structure of the Ibukiyama district in the explanatory text of the geological sheet maps of Ogaki (1955) and Ominagahama (1956), both on a scale of 1: 50,000. On the other hand, a paleontological study of Mt. Ibuki has been attempted by M. KOBAYASHI (1957) and in the South lowland of Mt. Ibuki by R. MORIKAWA and H. ISOMI (1961). And they have made a detailed paleontological description of fusulinids. The geological study of the district to the north of the surveyed area mentioned above has never been made except for the study of the geological structure by S. KAJITA (1963). To fill a part of this blank, the writer (1956) already published the study of the Paleozoic formation of the Yokoyama district in Gifu prefecture.

In this paper the writer will describe the stratigraphy and geological structure of the Paleozoic formation in the Yokoyama and Ibukiyama districts, of which the former has already been published by the writer (1965), and he will publish also a new opinion on the geological structure of the Ibukiyama district.

Concerning the geological structure of the Paleozoic formation of the Ibukiyama district, T. TAKEYAMA (1933) and T. SEKI (1939) described in their reports that the Paleozoic formation of the Ibukiyama district was folded and cut by the Ibukiyama thrust, and further cut by the many later faults.

Shaded portion denotes the Surveyed area

Fig. 1 Index map

By the Paleontological study of M. KOBAYASHI (1957), four fusulinid zones: *Pseudoschwagerina* zone, *Parafusulina* zone, *Neoschwagerina* zone and *Yabeina* zone in the Ibukiyama limestone have been established. On the other hand by R. MORIKAWA and H. ISOMI (1961) two fusulinid zones: *Pseudoschwagerina* and *Parafusulina-Neoschwagerina* zones in the South lowland of Mt. Ibuki have been established. The above-mentioned investigators have greatly contributed to the correlation of the Paleozoic formation in the Ibukiyama district.

The writer (1965) has reported the two fusulinid zones: *Pseudofusulina* and *Parafusulina-Neoschwagerina* zone in the Yokoyama district.

As mentioned above the geological structure of Mt. Ibuki has been discussed by T. TAKEYAMA (1933), T. SEKI (1939) and T. KOBAYASHI (1953) who has especially intimated the klippe by the expression that the exotic thrust block rests on the Yamaguchi group, and its original locality is still unknown.

The present writer who has been engaged in the detailed study of the limestone of the Mt. Ibuki, obtained a different conclusion from the previous author's opinion.

Acknowledgements

The writer has been given both guidance and help by many persons for this study.

The writer especially wishes to acknowledge his indebtedness to Prof. S. MATSUSHITA of Kyoto University for his kind guidance and encouragement given to the writer through this investigation from the beginning, to Dr. N. INAI, the Chief of the Osaka Regional Office of the Geological Survey of Japan for his encouragement, to Dr. T. Otsuka, the Chief of the Nagoya Regional Office of the Survey for his valuable suggestions and cooperation, to Mr. H. ISOMI of the Geology Department of the Survey for his kind criticism, and to the staffs of the Osaka and Nagoya Regional Offices for their help and encouragement.

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II. General Geology

The geology of the surveyed area is mainly composed of the Paleozoic formations belonging to the middle-lower Permian system, and they are divided into limestone and non-calcareous facies by the lithofacies (Fig. 2a, b).

The thickness of the limestone formation ranging from *Pseudoschwagerina* to *Neoschwagerina* zone and that of the non-calcareous formation are 400～500 m and more than 5,000 m respectively.

The limestone facies is distributed in Mt. Ibuki, the north mountain range which forms Mt. Itanami, and Otohara district, and it consists chiefly of predominant limestone and thin intercalations of chert, "schalstein" and slate.

The limestone facies is divided into the Ibukiyama, the Itanamiyama, the Otohara limestone and Iwakurayama formations, and Samegai group based on the difference in the geographical distribution. This limestone facies corresponds to the Akiyoshi facies of T. KOBAYASHI (1953).

The non-calcareous facies is mainly composed of slate, sandstone, chert and "schalstein,,' and is intercalated with limestone, and it corresponds to the Yamaguchi facies of T. KOBAYASHI (1953). The non-calcareous facies is divided into the Tsuchikura, Ibigawa (exclusive of Otohara limestone formation), Kasuga and Itanakodani groups. Besides, the Hanabusayama and Shiroyama formations belong to the non-calcareous facies.

The Myogadani formation of late Triassic age is inserted into the Paleozoic formation by the fault in Kasuga village of the Ibukiyama district.

The Moroka granite (coarse-grained biotite granite) is intruded into the Paleozoic formations in the central part of Mt. Kaizuki. The age of intrusion is unknown, but it may be inferred that the age is not older than late Mesozoic.

The non-calcareous facies shows the monoclinal structure which generally inclines northward in the Yokoyama district except the Otohara anticline and southward in the Ibukiyama district.

The limestone facies in the northern part of the Ibuki mountain range shows an imbricate structure. On the other hand, in Mt. Ibuki the geological structure is an overturned folding.

Though the non-calcareous and limestone formations are separated from each other by the fault, the limestone formations form the block structure in this surveyed area.

The geological structure of the South lowland district is a synclinal structure in the western part and a monoclinal structure dipping north in the eastern part.

In Mt. Ibuki and the northern part of the Ibuki mountain range, the limestone talus develops for example at the west foot of Mt. Ibuki, on the east side of the Otomi cliff, at Sasamata and Nakayama, of which the first one is the widest in distribution (Fig. 2a).

On the other hand, along the south foot of Mt. Ibuki it develops the talus of sandstone and slate, which is a few meters higher than the alluvial plain.

III. Stratigraphy

The Paleozoic formations have different geological structures in the following three districts, Yokoyama, Ibukiyama and South lowland district.

III. 1 Yokoyama district

The Yokoyama district is mainly occupied by the basin of the river Ibi and Mt. Tsuchikura, and includes Sakauchi, Fujihashi, Kuse, Ibigawa and Sugino villages, of which the last belongs to Shiga prefecture and the others to Gifu prefecture.

The Paleozoic formations in this district are divided into the following two groups and one formation i. e. Tsuchikura group, Ibigawa group and Hanabusayama formation.

III. 1. 1 Tsuchikura group

The Tsuchikura group is distributed in the upper basin of the river Hirose, a branch of the river Ibi and to the west of Mt. Tsuchikura. This group is divided into the Tsuchikura (lower part) and the Kadonyu formations (upper part) by the lithofacies (Fig. 2a).

1) Tsuchikura formation

This formation is distributed over the boundary of Shiga and Gifu prefectures which leads from the neighbourhood of the Kamimata valley, belonging to Gifu prefecture, to the Degotsuchikura, Shiga prefecture. The eastern part of this formation is cut by a fault passing near Mt. Tsuchikura.

The Tsuchikura formation with a thickness of about 1,800 m is mainly composed of alternations of chert (gray, red or pale green) and black slate and "schalstein," the last of which is accompanied by a small amount of limestone. Sometimes "schalstein" is intercalated in black slate and accompanied by beds or lens of limestone containing fusulinids. Recently M. KANUMA (1962) reported the finding of *Neoschwagerina margaritae* (SCHWAGER) in this limestone.

The existence of "Mandelstein" indicates that a part of "schalstein" is lava.

Special mention should be made of the remarkable sheared zones which are distributed in this formation. They are located in black slate intercalating chert and are parallel with the strike of the formation. These sheared zones are arranged in echelon. In the black fault clay are scattered chert pebbles, angular or subangular, 2 to 3 cm in size. The ore deposit of the "Kieslager" type which was explored in the Tsuchikura mine is located in these sheared

zones.

The Tsuchikura formation has a general strike of N60～70°E and dip of 70～80°S.

2) Kadonyu formation

This formation is distributed from the boundary between Shiga and Gifu prefectures to Kadonyu, Tokuyama village, Gifu prefecture.

This formation is chiefly composed of medium-grained sandstone and black slate, and is barren of fossils. The black slate facies with lenticular sandstone and chert apparently occupies the lower part of the Kadonyu formation, and sometimes changes into siltstone or fine-grained sandstone. The sandstone facies is apparently developed in the upper part of the Kadonyu formation. The sandstone contains fragments of slate, about 5 mm sometimes 10～20 mm in size. It is intercalated with black slate and pale green chert in the neighbourhood of Kamimata and Nakatsumata valley.

These two parts show the transitional relation to each other. The slate facies is about 500 m thick and the sandstone facies is about 1,200 m. The total thickness is about 1,700 m. The general strike and dip of this formation are N 60°E and 40～60°S, respectively (Fig. 2).

III. 1. 2 Ibigawa group

The Ibigawa group is mainly distributed in the basin of the Ibi and its branch basin. This group is divided from fusulinid zonation into the Gongenyama, Kuse, Sakauchi and Sakamoto formations in descending order. Besides the above-mentioned formations, the Otohara limestone formation is included in this group (Fig. 3).

The area occupied by this group is divided into the western, central and eastern parts by the Hirose and Yokoyama faults.

The Hirose fault separates the western part from the central part, while the Yokoyama fault separates the eastern part from the central part. The Ibigawa group of the west is formed of the Sakamoto, Sakauchi and Kuse formations, its strike and dip being N 60～70°E and 50～70°N, respectively.

This group of the central part consists of the Sakamoto, Sakauchi, Kuse and Gongenyama formations, strike and dip being N40～70°W and 40～70°N, respectively. This group of the east is composed of Otohara limestone and three non-calcareous formations, i. e. Sakauchi, Kuse and Gongenyama formations, strike and dip being N 60～70°W or E–W and 40～70° N, respectively.

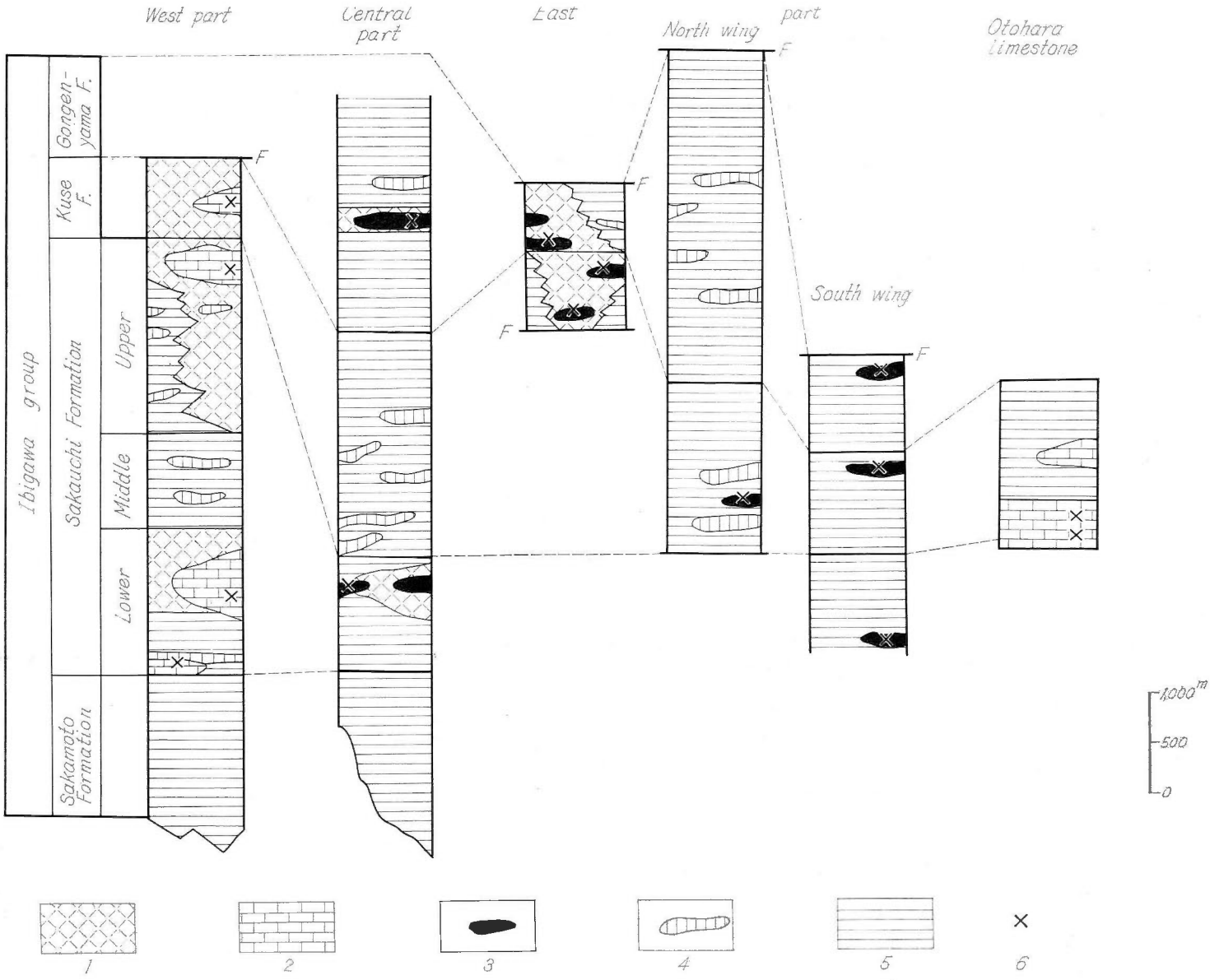
1) Sakamoto formation

This formation distributed in the west and central areas is composed of the black slate formation distributed on the south bank of the Hirose river and is found in the district between Ozori and the west of Sakamoto, and at the east end, this formation is cut by the Yokoyama fault (Fig. 2a).

This formation sometimes contains the lenticular sandstone or alternation of fine-grained sandstone and slate. This formation is intruded by the Moroka granite (biotite granite) in Ozori and the Kantani valley. By the contact metamorphism by the intrusion mentioned above, the silicified zone with a width of 200～300 m and hornfels are formed in this formation. The Sakamoto formation is the lowest part of the Ibigawa group and is overlain conformably by the Sakauchi formation. In the west area, the strike and dip of this formation are N 60～70°E and 50～70°N respectively, while in the east area, they are N 40～70°W and 40～70° N.

2) Sakauchi formation

This formation is distributed in the following districts: east side of the boundary of Shiga and Gifu prefectures, the basin of the Hirose river and the neighbourhood of the Mikura Kuse village, along the Ibi river, Gifu prefecture. The westward extension of this formation is cut by the Tsuchikura fault.



1. Schalstein 2. Limestone bed 3. Limestone lens 4. Chert 5. Sandstone & Slate 6. Locality of occurring Fusulinids

Fig. 3 Columnar section of the Ibigawa group

This formation develops typically in the western area, but its development becomes poor in the eastern area (Fig. 2a).

a) Sakauchi formation of the western area

This formation is divided into lower, middle and upper formations by the lithofacies.

(1) Lower Sakauchi formation

This formation is about 1,000 ~ 1,500 m thick. The lower part is "schalstein" which forms Mt. Yutani, and the upper part is slate. The westward extension of this formation is shut off by the Moroka granite.

The lower Sakauchi formation contains a limestone bed or limestone lens. The limestone is included in "schalstein" and slate. This limestone yields the following fusulinids:

Loc. ISa 7

Pseudofusulina vulgaris (SCHELLWIEN)
Psf. vulgaris var. *globosa* (SCHELLWIEN)
Psf. fusiformis (SCHELLWIEN et DYHRENFURTH [Pl. 2, Fig. 1]
Paraschwagerina sp. B

Loc. ISa 1

Triticites tantula TORIYAMA
Pseudofusulina sp.

(2) Middle Sakauchi formation

This formation is mainly composed of a blackish compact slate with a marked bedding plane. Chert is seldom intercalated in the neighbourhood of Kawakami. However the formation contains a chert bed or chert lens at many places along the Hasso stream. The thickness of this formation is about 1,000 m.

(3) Upper Sakauchi formation

This formation consists of "schalstein" and black slate, and forms Hohare Pass and the southeastern half of Mt. Tsuchikura. The thickness "schalstein" inclusive of thin layers of chert and limestone is very thick at the Hohare Pass and attains to 1,500 m in thickness. However, the "schalstein" becomes very thin in the western part and interfingers with slate. The limestone is grayish white and grayish black in colour, and is sometimes dolomitic.

The limestone contains the following fusulinids:

Loc. ISa 3

Acervoschwagerina sp.
Pseudofusulina kraffti (SCHELLWIEN)

Loc. ITo 1

Paraschwagerina sp. A
Pseudofusulina vulgaris (SCHELLWIEN)
Psf. fusiformis (SCHELLWIEN et DYHRENFURTH)
Psf. kraffti (SCHELLWIEN)

b) Sakauchi formation of the central area

This formation distributed on the south slope of Mt. Tengu and along the Hirose river consists mainly of compact black slates and is accompanied by "schalstein" of about 700 m in thickness. The formation is intercalated with beds of black limestone. On the other hand, limestone intercalated in the slate of the middle basin of the Otani stream contains the following fusulinid:

Loc. ISa 10

Pseudofusulina vulgaris (SCHELLWIEN)
Schwagerina sp. A [Pl. 3, Fig. 9]

In the vicinity of the Hirose fault, this limestone becomes phyllitic. The total thickness of this formation is about 1,500 m.

c) Sakauchi formation of the eastern area

This formation distributed in the vicinity of Mikura has a thickness of about 700 m, and is mainly composed of black slate and intercalations of lenticular sandstone and limestone. The limestone yields the following fossils:

Loc. IMk 1

Schwagerina japonica (GÜMBEL)
Pseudofusulina aff. *tschernyschewi* (SCHELLWIEN)
Acervoschwagerina sp.

Though the schalstein of the Sakauchi formation is remarkably developed in the western part, it becomes gradually thinner eastwards and declines to merely a thin layer of "schalstein" associated with limestone in the eastern part.

In the west this formation is thermally metamorphosed by Moroka granite.

3) Kuse formation

The Kuse formation is distributed in the following district: the neighbourhood of the entrance of the Wanto valley and Mt. Tengu; the vicinities of Tsukumi and Hirao and the wide area in the southern part of Mt. Gongen.

a) Kuse formation of the western area

The formation chiefly consists of "schalstein," intercalation of chert and massive limestone with irregular shape. The limestone yields the following fusulinids:

Loc. ISa 4

Neoschwagerina nipponica (OZAWA) [Pl. 6, Fig. 12]
Schwagerina cf. *hawkinsi* DUNBAR & SKINNER
Pseudofusulina lepida (DEPRAT)
Psf. fusiformis (SCHELLWIEN et DYHRENFURTH)

b) Kuse formation of the central area

This formation has a thickness of 1,400～1,500 m. It is composed of the compact black slate, some intercalations of fine-grained sandstone and thin layers of chert everywhere.

The limestone which occupies a position near the lowest limit of this formation crops out in the upper basin of the Otani stream. It is more or less saccharoidal, therefore fossils are not found in it.

As mentioned above, this formation is non-fossiliferous. However from the lithofacies this formation is inferred to correspond with the fossiliferous Kuse formation in the neighbourhood of Tsukumi of the east area.

c) Kuse formation of the eastern area

This formation develops in the neighbourhood of Tsukumi, in the vicinity of Hirao and in the southern part of Mt. Gongen.

(1) Kuse formation in the vicinity of Tsukumi

The Kuse formation in the neighbourhood of Tsukumi is mainly composed of black slate and intercalations of chert and grayish white limestone. This limestone yields ill-preserved fusulinids as follows:

Loc. IKu 6

Neoschwagerina sp.
Pseudodoliolina sp.
Pseudofusulina sp.

The thickness of this formation is about 1,500～1,700 m.

(2) Kuse formation in the vicinity of Hirao

The Kuse formation in the vicinity of Hirao consists mainly of black slate and is accompanied by sandstone beds or lens and limestone lens. The west end of this formation is subjected to contact metamorphism by Moroka granite.

From the limestone intercalated in this formation occur the following fusulinids:

Loc. IIbhi 1

Parafusulina takeyamai MORIKAWA et ISOMI [Pl. 5, Fig. 4]
Paf. iwasensis MORIKAWA et ISOMI [Pl. 5, Figs. 5, 7, 8]
Pseudofusulina lepida (DEPRAT)
Psf. fusiformis (SCHELLWIEN et DYHRENFURTH)
Psf. cf. *regularis* (SCHELLWIEN) [Pl. 1, Figs. 9, 10]
Psf. cf. *gümbeli* (DUNBAR & SKINNER) [Pl. 2, Figs. 9, 10]
Acervoschwagerina sp.
Schubertalla giraudi (DEPRAT)

This formation is about 500～600 m thick.

(3) Kuse formation in the southern part of Mt. Gongen

The Kuse formation in the southern part of Mt. Gongen is mainly composed of black slate and "schalstein". In "schalstein is contained irregular-shaped massive or lenticular grayish white limestone.

The relation between black slate and "schalstein" is interfingering. From grayish white limestone near the lowest limits of this formation occurs the following fusulinids:

Loc. IKu 8
Parafusulina kaerimizensis (OZAWA) [Pl. 4, Figs. 4, 5, 6]
Schwagerina japonica (GÜMBEL) [Pl. 3, Fig. 4]
Sch. sp. D
Pseudofusulina vulgaris var. *globosa* (SCHELLWIEN)
Psf. cf. *vulgaris* var. *watanabei* (OZAWA et IEE)
Psf. fusiformis (SCHELLWIEN et DYHRENFURTH) [Pl. 2, Figs. 3～5]
Psf. ambigua (DEPRAT)

From the small mass of grayish black limestone distributed in Ozu occurs the following fusulinids:

Loc. IKu 7
Neoschwagerina rotunda (DEPRAT) [Pl. 6, Figs. 13～17]
Pseudofusulina lepida (DEPRAT) [Pl. 3, Fig. 3]
Psf. fusiformis (SCHELLWIEN et DYHRENFURTH)

The thickness of this formation exceeds 800 m.

4) Gongenyama formation

This formation is distributed in the following areas: the neighbourhood of Oya and the north slope of Mt. Gongen; the vicinity of Ozu corresponding to the north wing of the Otohara anticline; the vicinity of Moro corresponding to the south wing of the Otohara anticline.

a) Gongenyama formation in the central area

The Gongenyama formation of the central area is distributed in the vicinity of Ozu and its westward extension is thought to reach Mt. Gojagaike.

This formation with a thickness of about 1,800 m is mainly composed of slate and is intercalated with chert and "schalstein." The limestone is contained in "schalstein and yields the following fusulinids:

Loc. IFu 4
Neoschwagerina margaritae (DEPRAT) [Pl. 8, Figs. 1～3]
Pseudofusulina cf. *lepida* (DEPRAT)
Psf. ambigua (DEPRAT)
Psf. cf. *crassa* (DEPRAT) [Pl. 3, Fig. 1]

b) Gongenyama formation in the eastern area

The Gongenyama formation is distributed in the north slope of Mt. Gongen and in the vicinities of Ozu and Moro.

(1) Gongenyama formation of the north slope of Mt. Gongen

This formation is mainly composed of black slate and "schalstein." Slate contains the

pebbles of chert and sandstone of about 5 cm in size. The limestone intercalated in "schalstein" contains fusulinids as follows:

Loc. IFu 1

Neoschwagerina rotunda (DEPRAT) [Pl. 6, Figs. 18, 19]
Palafusulina edoensis (OZAWA) [Pl. 6, Fig. 1]
Paf. parakinosakii MORIKAWA et ISOMI (Pl. 4, Fig. 2]
Paf. cayeuxi (DEPRAT) [Pl. 3, Figs. 6~8]
Sch. cf. *ibukiensis* KOBAYASHI
Pseudofusulina lepida (DEPRAT)
Psf. ambigua (DEPRAT)
Psf. sp. A
Psf. sp. B

This formation has a thickness of 800 to 1,000 m.

(2) Gongenyama formation in the vicinity of Ozu

This formation consists chiefly of black slate and is intercalated with the chert bed. The formation tends to be rich in chert beds in the upper part and in irregular massive sandstone in the lower one. Though this formation is non-fossiliferous, the formation can be correlated with the Gongenyama formation, because it resembles the Gongenyama formation in the vicinity of Moro in the lithofacies.

(3) Gongenyama formation in the vicinity of Moro

This formation with a thickness of 800 to 900 m consists mainly of black slate and sometimes is intercalated with lenticular fine-grained sandstone. The westward extension of this formation is subjected to contact metamorphism by the Moroka granite, and the uppermost part of the formation is absent owing to the Moro fault.

From the grayish black limestone intercalated in slate occur the following fusulinids:

Loc. IIbMo 2

Neoschwagerina margaritae (DEPRAT) [Pl. 8, Figs. 4, 5]
Ns. craticulifera (SCHWAGER) [Pl. 7, Figs. 4, 5]
Parafusulina takeyamai (MORIKAWA et ISOMI [Pl. 5, Fig. 2]
Pseudofusulina cf. *vulgaris* var. *globosa* (SCHELLWIEN) [Pl. 2, Fig. 8]
Schubertella giraudi (DEPRAT)
Schub. sp. B

4) Otohara limestone formation

The Otohara limestone formation is distributed in the neighbourhood of Otohara, and forms the axial part of the Otohara anticline (MIYAMURA 1965). The limestone forming Mt. Iimori is a part of the south wing of the Otohara limestone formation.

This formation, about 1,500 m thick is composed of limestone intercalated with slate. The limestone changes in some cases into dolomitic limestone. The limestone near the Moroka granite especially becomes dolomite. From the lower part occur the following fusulinids.

Loc. IKu 5

Pseudofusulina kraffti (SCHELLWIEN)
Psf. vulgaris (SCHELLWIEN)
Psf. Fusiformis (SCHELLWIEN et DYHRENFURTH)

From the middle part of this formation are found fusulinids as follows:

Loc. IOt 1

Parafusulina parakinosakii MORIKAWA et ISOMI [Pl. 4, Fig. 1]

Loc. IOt 2

Parafusulina takeyamai MORIKAWA et ISOMI [Pl. 5, Fig. 3]
Paf. sp. A [Pl. 6, Fig. 2]
Paf. okuboensis MORIKAWA [Pl. 3, Fig. 5]

Schwagerina japonica (GÜMBEL)
Pseudofusulina fusiformis (SCHELLWIEN et DYHRENFURTH) [Pl. 2, Figs. 3~5)

From the upper part of this formation occur the following fusulinids:

Loc. IKu 3
Parafusulina iwasensis MORIKAWA et ISOMI
Paf. takeyamai MORIKAWA et ISOMI
Paf. sp. B [Pl. 5, Fig. 9]
Schwagerina cf. *ibukiensis* KOBAYASHI
Sch. sp. B [Pl. 3, Fig. 10]
Sch. sp. C [Pl. 3, Fig. 11]
Pseudofusulina lepida (DEPART)
Psf. sp. A
Schubertella sp. A

III. 1. 3 Hanabusayama formation

This formation crops out at Mt. Hanabusa and its vicinity, and it is bounded by the Yokoyama fault on the westside and by the Hanabusayama fault on the south side. This formation is divided into the lower and upper formations by the lithofacies. The strike and dip are N 40~60°W and 60~70°N, respectively.

1) Lower formation

This formation occupies the southern part of the distribution of the Hanabusayama formation and is well exposed along the Ibi river. It is composed or an alternation of schalstein, red chert and slate. The thickness of this formation reaches about 2,000 m.

2) Upper formation

This formation is distributed in the village of Sugihara and occupies most of Mt. Hanabusa. It is composed of black slate and an intercalation of medium or fine-grained sandstone. Dark red "schalstein" with a thickness of about 400 m is found in the middle part of this formation and is accompanied by chert. The kieslager type ore deposit of the Hanabusa mine is located in this horizon. The thickness of this formation is about 2,700 m.

III. 2 Ibukiyama district

This district occupies Mt. Ibuki and its vicinity which embraces Kasuga village and Sekigahara town belonging to Gifu prefecture as well as Ibuki village of Shiga prefecture.

The geology of this district is divided into the limestone and non-calcareous facies. The Itanamiyama limestone formation belonging to the limestone facies is conformably overlain by the Furuya formation corresponding to the lowest part of the Kasuga group of the non-calcareous facies.

Therefore, a part of the non-calcareous formation shows the upper part of the limestone formations.

The formation of the limestone facies is divided into the Itanamiyama and Ibukiyama limestone formations from the geological structure and geographical distribution.

III. 2. 1 Limestone facies

1) Itanamiyama limestone formation

This formation distributed in the northern part of the Ibuki mountain range is intruded by the Moroka granite on the north and thrust over the Itanakodani group of the non-calcareous facies on the west side. In the south, this formation is cut by the Totani fault, while on the east side, it is conformably overlain by the Kasuga group or cut by the Shirako, Akagama and Yarigasaki faults.

The Itanamiyama limestone formation is chiefly composed of grayish white or grayish black limestone and is intercalated with "schalstein," slate and thin layers of chert (a complex

of schalstein and slate).

From the geological structure and lithofacies, the area occupied by this formation is divided into the following three areas: the Nakayama area, the Kunimitoge area and the Itanamiyama area.

a) Nakayama area

This area is occupied by the northernmost part of the Itanamiyama limestone formation and bounded by the Shirako fault on the west. The Itanamiyama limestone formation of this area is conformably overlain by the Furuya formation of the Kasuga group in the southern part and cut by the Yarigasaki fault in the eastern part.

The Nakayama area is composed of an alternation of limestone and black slate, intercalating lenticular sandstone, schalstein and chert. The limestone forms several layers of about 20 to 30 m in thickness and is dolomitic.

The lower part of the Itanamiyama limestone formation of this area is intruded by the Moroka granite and such skarn minerals as wollastonite and garnet are found in the contact zone. The dolomite distributed in this area is characterized by a banded structure of black and white. Fossils are not found in this dolomite.

The strike and dip of the Itanamiyama limestone formation of Nakayama are N 60～70°E and 60～70°S respectively. The thickness of the Itanamiyama limestone formation in this area is about 1,500 m.

b) Kunimitoge area

This area is separated from the Nakayama area by the Shirako fault, and from the Itanamiyama are by the Ohage fault in the south.

Like the Nakayama area, the strata of this area consist of an alternation of limestone, "schalstein," slate and thin layers of chert, and it has the following stratigraphic succession in descending order.

Slate	150 m
Limestone	100 m
"Schalstein"	100 m
Slate	140 m
Limestone (forming mountain ridges)	
"Schalstein"	

The lowest limestone and "schalstein" rest on the Itanakodani group. Both are separated by the Itanamiyama thrust.

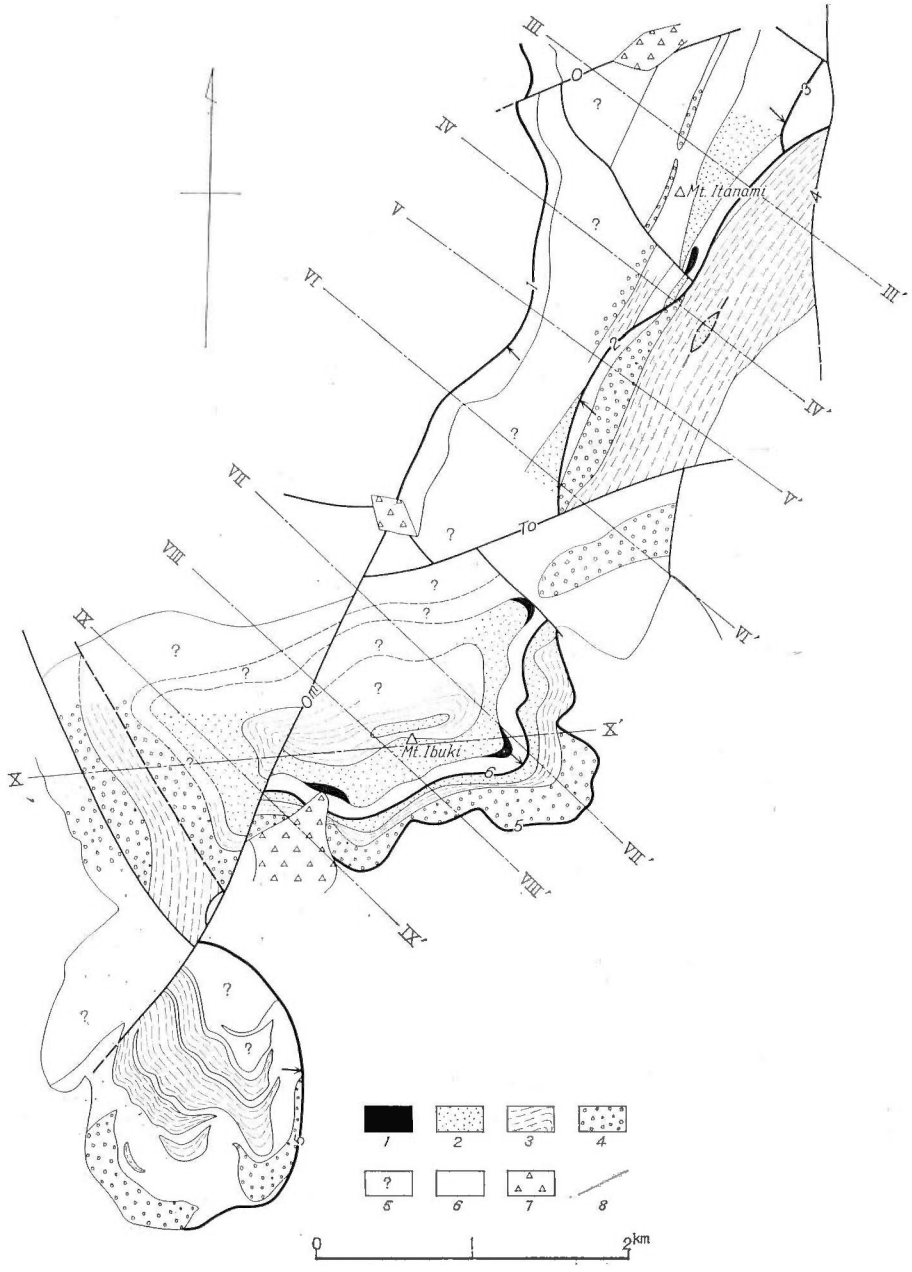
The limestone is subjected to contact metamorphism by the Moroka granite, and changes into a coarse-grained crystalline limestone with skarn minerals. On the other hand, the limestone of the upper horizon is dolomitic and shows the same banded structure as the dolomite of the Nakayama area. Fossils are not found in the limestone formation of this area. The Itanamiyama limestone formation in this area shows the strike of N 50～60°E and dip of 40～60° E and dip of 40～50°S.

c) Itanamiyama area

The Itanamiyama limestone formation of this area is separated from the Kunimitoge area mentioned above by the Ohage fault on the north, while it is thrust on the Itanakodani group of the non-calcareous facies by the Itanamiyama thrust on the west. It is separated from the Ibukiyama limestone formation by the Totani fault on the south, while it is separated from the Furuya formation of the Kasuga group of the non-calcareous facies by the Akagama fault or is conformably overlain by the Furuya formation on the east.

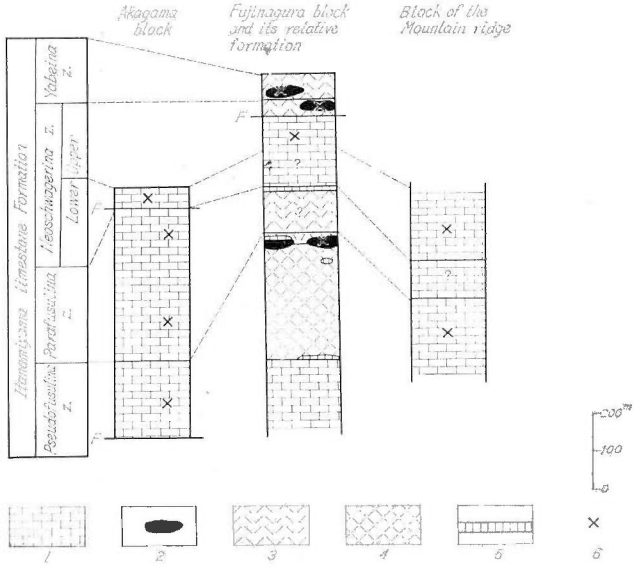
The Itanamiyama limestone formation of this area with a strike of N 50°E and dip of 60～70°S is mainly composed of "schalstein," chert and slate. The "schalstein" and slate form an alternation of millimeter thickness.

This area is divided into the following three blocks: the Mountain ridge, Fujinagura and Akagama blocks (Fig. 5).



(1): *Yabeina* zone (2): *Neoschwagerina* zone (3): *Parafusulina* zone
(4): *Pseudoschwagerina* or *Pseudofusulina* zone (5): Unknown zone
(6): Non-calcareous formation (7): Limestone talus
(8): Shows locations of profiles (Fig. 4c)
1: Itanamiyama thrust 2: Kanayamadani thrust 3: Fujinagura thrust
4: Akagama fault 5: Ibukiyama thrust 6: Upper Ibukiyama thrust
O: Ohage fault To: Totani fault Om: Otomi fault

Fig. 4b Compiled map of the fusulinid zone in the Ibuki mountain range (by M. MIYAMURA)



1. Limestone bed 2. Limestone lens 3. Schalstein & Slate 4. Schalstein
5. Chert 6. Locality of occurring fusulinids

Fig. 5 Columnar section of the Itanamiyama limestone formation

The relation to the neighbouring strata is as follows:

Limestone of the Akagama block (with chert and "schalstein") ..... 700 m
————Kanayamadani thrust (high angle)————
Upper green slate (with limestone and chert) ..... 100 m
Limestone of the Fujinagura block ..... 200 m
Lower green slate (with limestone and chert) ..... 200 m
Schalstein (with chert) ..... 250 m
Limestone of the Mountain ridge block (with schalstein) ..... 400 m
————Itanamiyama thrust (high angle)————

Although the limestone distributed in the mountain ridge is compact and grayish black in color, it becomes coarse-grained limestone near the Ohage fault.

In the limestone of the Mountain ridge block, a few fusulinids are found, though it is ill-preserved, and also in the lowest part of this limestone is sometimes found the crinoid stem but fusulinids are not found.

The fusulinids which have been found in the limestone of this block are mentioned below.

Loc. Ka 86 (lower part)

Pseudofusulina fusiformis (SCHELLWIEN et DYHRENFURTH)

Loc. Ka 88 (upper part)

Neoschwagerina craticulifera (SCHWAGER)

Ns. rotunda (DEPRAT)

Schubertella kingi DUNBAR et SKINNER

The lower green slate intercalated with grayish white or grayish black limestone rests on the "schalstein" of the mountain ridge. From the limestone of this formation is found the following fusulinids:

Loc. Ka 81

Pseudofusulina fusiformis (SCHELLWIEN et DYHRENFURTH)

The limestone of the Fujinagura block is conformably underlain by the lower green slate and tends to become dolomitic in the northern part. Fusulinids are found in the uppermost part of the limestone of this block. They are as follows:

Loc. Ka 71

Neoschwagerina craticulifera (SCHWAGER) [Pl. 7, Fig. 13]

Ns. sp. A [Pl. 8, Fig. 7]

Loc. Ka 72

Parafusulina cf. *kaerimizensis* (OZAWA) [Pl. 5, Fig. 1]

Pseudofusulina fusiformis (SCHELLWIEN et DYHRENFURTH) [Pl. 1, Fig. 1]

Nankinella sp.

Loc. Ka 75

Neoschwagerina craticulifera (SCHWAGER) [Pl. 7, Figs. 10~12]

Ns. rotunda (DEPRAT)

Loc. Ka 76

Neoschwagerina margaritae DEPRAT

Ns. craticulifera (SCHWAGER)

Parafusulina kaerimizensis (OZAWA) [Pl. 4, Fig. 7]

Loc. Ka 77

Neoschwagerina margaritae DEPRAT [Pl. 8, Fig. 6]

The grayish white or grayish black limestone of the upper green slate member yields the following fusulinids:

Loc. Ka 80

Neoschwagerina margaritae DEPRAT

Loc. Ka 22′

Yabeina? sp. [Pl. 8, Fig. 9]

Schubertella sp.

The Akagama block which is thrust on the upper green slate by the Kanayamadani thrust is composed of dolomite or dolomitic limestone, and contains the following fusulinids:

Loc. Ka 9′

Neoschwagerina margaritae DEPRAT

Ns. craticulifera (SCHWAGER)

Ns. nipponica (OZAWA)

Misellina ibukiensis KOBAYASHI [Pl. 6, Figs. 3, 4]

Schubertella giraudi (DEPRAT)

Loc. Ka 30

Neoschwagerina rotunda (DEPRAT)

Schubertella sp. C.

Loc. Ka 45

Neoschwagerina nipponica (OZAWA) [Pl. 6, Figs. 9, 10]

Parafusulina cf. *parakinosakii* MORIKAWA et ISOMI

Loc. Ka 79

Parafusulina kaerimizensis (OZAWA)

Loc. Ka 87

Pseudofusulina fusiformis (SCHELLWIEN et DYHRENFURTH)

Psf. aff. *tschernyschewi* (SCHELLWIEN)

Loc. Ka 89

Neoschwagerina nipponica (OZAWA)

Loc. S 4

Neoschwagerina craticulifera (SCHWAGER) [Pl. 7, Fig. 7]

2) Ibukiyama limestone formation

The Ibukiyama limestone formation forming Mt. Ibuki (1,377 m) is separated from the Itanakodani group of the non-calcareous facies by the Itanakodani fault on the north side and is cut by the Karubidani fault on the east. It is thrust upon the Kasuga group of the non-calcareous facies by the Ibukiyama thrust on the south side and is covered by the limestone talus distributed along the right bank of the Ane river in the west (Figs. 2a, 4a and 4b).

The Ibukiyama limestone formation consists mainly of grayish white or grayish black limestone and "schalstein." Its strike and dip are E–W and 60～70°S on the north slope of Mt. Ibuki, and E–W and 20～30°N on the south slope of the mountain, respectively.

This formation is divided by the fault into four blocks as follows (Fig. 6): Ibukiyama block (Ib), Ueno block (Ue), Taiheiji block (Th) and Suzuoka block (Sz) (Fig. 4a).

a) Ibukiyama block

This block which occupies Mt. Ibuki proper is mainly made of limestone. The lithofacies of the formation is slightly different above and below the alternation bed of chert and "schalstein" with a total thickness of about 50 m on the south slope of the block. Therefore, the part below and above the alternation bed is named A and B type formations respectively.

The limestone formation of A type is intercalated with chert and "schalstein," and is locally dolomitic. On the other hand, in the B type formation, is not found the intercalations similar to those in the A. The alternation bed of chert and "schalstein" above mentioned is not found on the north slope.

Fusulinids occur aboundantly from the limestone on the south slope of this block, whereas they are hardly found on the north slope.

From the A type formation M. KOBAYASHI (1957) has described fusulinids: *Neoschwagerina margaritae* DEPRAT, *Ns. craticulifera* (SCHWAGER), *Ns.* sp., *Verbeekina verbeeki* (GEINITZ), *Pseudodoliolina ozawai* YABE & HANZAWA, *Misellina* cf. *claudiae* (DEPRAT), *Parafusulina sapperi* (STUFF), *Schwagerina japonjca* (GÜMBEL), *Pseudofusulina sekii* KOBAYASHI, *Psf.* sp. *Acervoschwagerina* cf. *kagemoriensis* (FUJIMOTO), *Schubertella kingi* (DUNBAR & SKINNER) and *Schub. giraudi* (DEPRAT).

From the B type formation of the Ibuki block the writer has obtained the following fusulinids:

Loc. Ka 90

Neoschwagerina craticulifera (SCHWAGER) [Pl. 7 Figs. 20～22]

Loc. Ka 91

Pseudofusulina ambigua (DEPRAT)

Loc. Sa 11

Neoschwagerina margaritae DEPRAT

Ns. craticulifera (SCHWAGER) [Pl. 7 Figs. 8, 9]

Ns. rotunda (DEPRAT)

Pseudodoliolina ozawai YABE et HANAZAWA [Pl. 6 Figs. 5～8]

Schubertella kingi DUNBAR et SKINNER

And also from this formation M. KOBAYASHI (1957) described the following fusulinids: *Yabeina* cf. *crascadensis*, *Ya.* sp., *Neoschwagerina margaritae* DEPRAT, *Ns.* cf. *colaniae* OZAWA, *Ns. craticulifera* (SCHWAGER), *Ns. nipponica* OZAWA, *Verbeekina verbeeki* (GEINTZ), *Pseudodoliolina ozawai* YABE & HANZAWA, *Misellina* sp., *Parafusulina sapperi* (STUFF), *Pseudofusulina crassa* (DEPRAT), *Psf. sekii* KOBAYASHI, *Psf.* sp., *Schwagerina japonica* (GÜMBEL), *Schw. ibukiensis* KOBAYASHI, *Schw. gigantojaponica* KOBAYASHI, *Acervoschwagerina* sp., *Rauserella fujimotoi* KOBAYASHI, *Rau.* sp., *Minojaponella* sp., *Codonofujiella* cf. *paradoxica* DUNBAR & SKINNER, *Rugosofusulina ibukiensis* KOBAYASHI, *Schubertella kingi* DUNBAR & SKINNER, *Schub. giraudi* (DEPRAT), *Schub. phairayensis* (COLANI) and *Schub.* sp.

b) Ueno block

This name is given to the small block between Ueno and the Ibukiyama block. This block

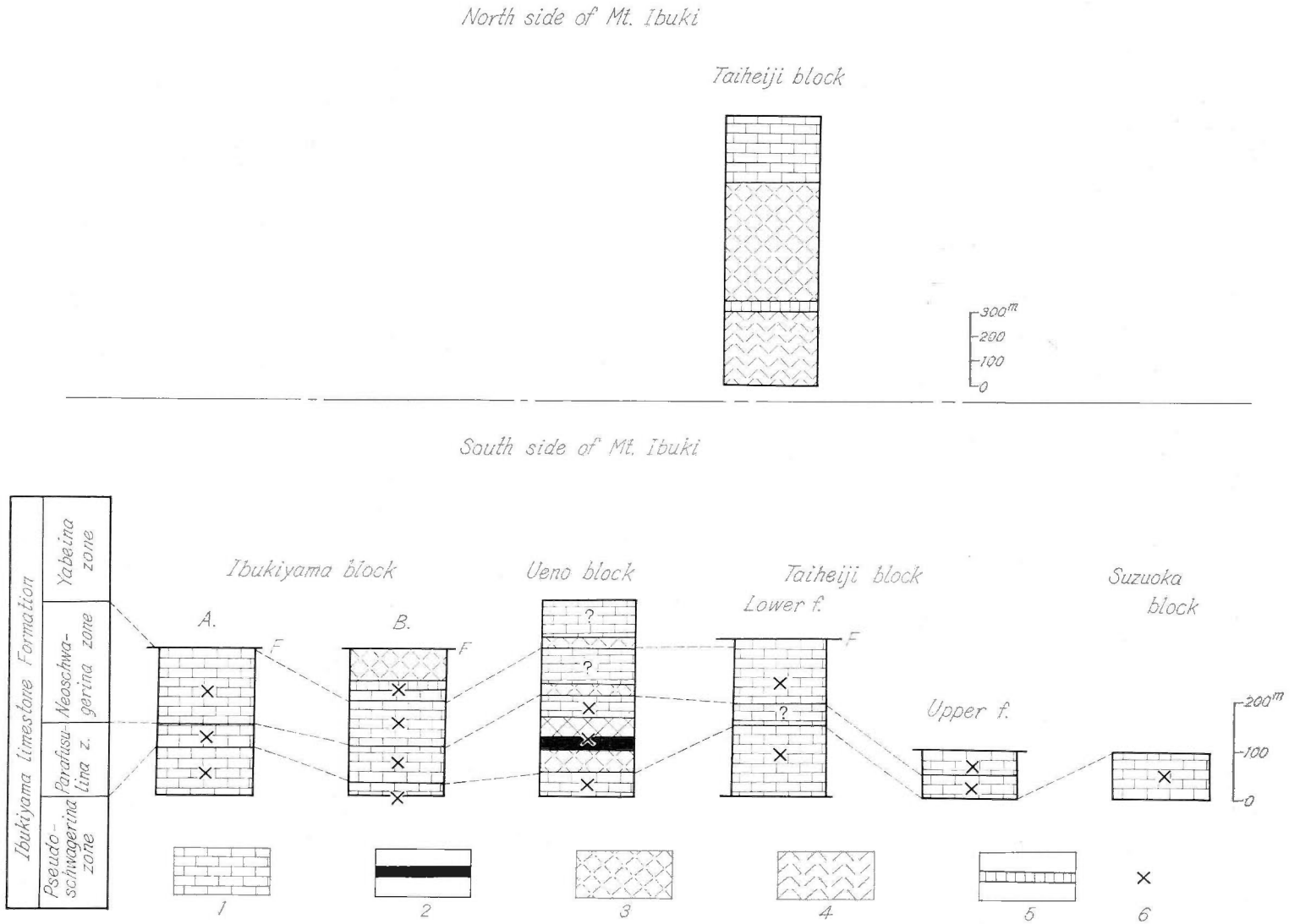


Fig. 6 Columnar section of the Ibukiyama limestone formation

1. Limestone bed 2. Thin Limestone bed 3. Schalstein 4. Schalstein
5. Schalstein & Slate 6. Locality of occurring Fusulinids

is mainly composed of limestone and intercalation of chert and "schalstein."

M. KOBAYASHI (1957) described fusulinids from this block as follows: *Neoschwagerina* cf. *nipponica* OZAWA, *Ns.* sp., *Misellina ibukiensis* KOBAYASHI, *Mis.* sp., *Parafusulina gigas* KOBAYASHI, *Paf. kaerimizensis* (OZAWA), *Paf. sapperi* (STUFF), *Schwagerina gigantojaponica* KOBAYASHI, *Pseudofusulina aganoensis* FUJIMOTO, *Psf. ambigua* (DEPRAT), *Psf. crassitectoria* (DUNBAR & SKINNER), *Psf. gumbeli* var. *pseudoregularis* (DUNBAR & SKINNER), *Psf. larissima* (DUNBAR & SKINNER), *Psf. uenoensis* KOBAYASHI, *Psf.* sp., *Acervoschwagerina* cf. *kagemoriensis* (FUJIMOTO), *Acrv.* sp., *Yangchienia* cf. *compressa* (OZAWA), *Schubertella kingi* DUNBAR & SKINNER, *Schub. giraudi* (DEPRAT), *Schub.* cf. *phairayensis* (COLANI) and *Schb.* sp.

c) Taiheiji block

This block is situated to the immediately west of Ibukiyama block. It is separated from the Ueno block as well as the Ibukiyama block by the Otomi fault.

In the northern half of the block is observed the following stratigraphic succession in ascending order: alternation of slate and schalstein, chert, "schalstein" and limestone. Of them, the first named bed is remarkably disturbed and contains brecciated chert of $3 \sim 5$ cm in grain size.

From the southern half of this block M. KOBAYASHI (1957) described the following fusulinids: *Schwagerina gigantojaponica* KOBAYASHI, *Sch. japonica* (GÜMBEL), *Pseudofusulina sekii* KOBAYASHI, *Psf.* sp. and *Schubertella* sp.

From this block, on its west slope, the present writer also obtained the following fusulinids:

Loc. Ib 2

Neoschwagerina craticulifera (SCHWAGER)
Ns. aff. *craticulifera* (SCHWAGER)
Ns. rotunda (DEPRAT)

d) Suzuoka block

This block is situated to the northeast of the Ibukiyama block and consists of "schalstein" and limestone. The limestone contains Acervoschwagerina and other fusulinids.

III. 2. 2 Non-calcareous facies

The strata belonging to the non-calcareous facies in the Ibukiyama district are divided into the following two groups: Kasuga and Itanakodani groups.

Kasuga group

This group is widely distributed on the east side of the Ibuki mountain range, being separated on the north from the Ibigawa group mentioned above by the Moro fault.

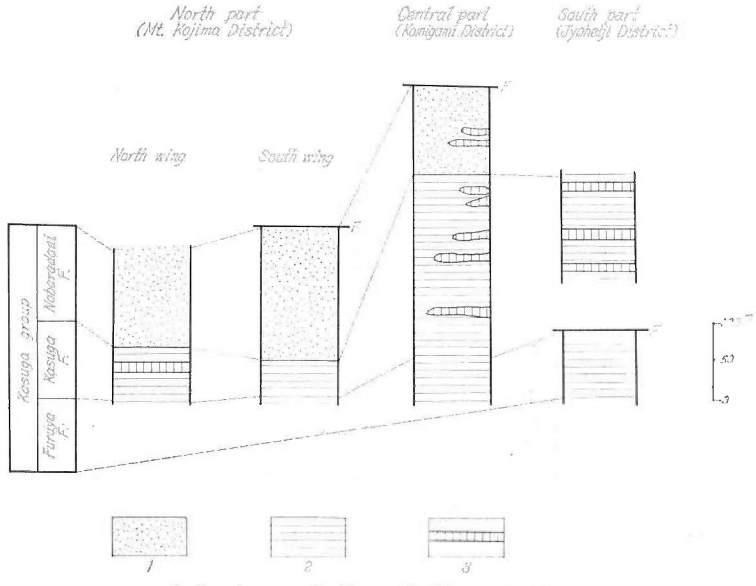
The Kasuga group is divided into the Furuya, Kasuga and Nobaradani formations in ascending order (Fig. 7).

1) Furuya formation

This formation is widely distributed in the basin of the Hase river, i. e., a tributary of the Kasukawa river which runs northward on the east side of the Ibuki mountain range. It is distributed also in the neighbourhood of Yataka situated at the south foot of Mt. Ibuki.

The alternation of sandstone and slate distributed in the Otomi valley and along the mountain road from Ueno to the flank of Mt. Ibuki probably belong to the lower part of the Furuya formation. The Furuya formation is mainly composed of slate and sandstone. Both generally form layers of a thickness of a few meters, but in some cases form alternation beds of a few centimeters thick. The lower part of this formation is dominated by slate as seen at Taniyama, Komigami and Totani. At the latter mentioned two localities, this formation covers conformably the Itanamiyama limestone formation. On the other hand, the upper part of this formation is dominated by sandstone as observed in the neighbourhood of Yataka and in some cases is intercalated with thin layers of chert.

2) Kasuga formation



1. Sandstone 2. Slate 3. Chert F. Fault

Fig. 7 Columnar section of the Kasuga group

The Kasuga formation which was named by T. SEKI (1938) is very widely distributed on the east side of the Ibuki mountain range, and it is mainly composed of chert, sandstone and slate, the first of which is dominant in this formation. That is, individual chert bed in some cases has thickness as large as 50～60 m. In other cases chert forms fine alternations with slate.

Although chert is generally accompanied by slate, it is not accompanied by sandstone. The slate forms an alternation with sandstone or includes sandy slate. Besides, this formation contains medium-grained sandstone with an individual thickness of a few meters.

3) Nobaradani formation

This formation is distributed on the east side as well as the west side of the Shimogare fault. The typical development of this formation is found in the Nobaradani valley and Mt. Kojima. This formation is divided from the lithofacies into the lower massive sandstone bed and upper sandstone and slate bed.

a) Lower massive sandstone bed

This bed consists chiefly of massive sandstone and is accompanied by the slate in the upper horizon. The massive sandstone sometimes contains fragments of slate and when fresh, it is gray in color.

b) Upper sandstone and slate bed

This bed is distributed in the uppermost part of the Nobaradani valley and conformably covers the lower massive sandstone. This bed is chiefly composed of sandstone and slate, and is intercalated with thin layers of chert. The lithofacies remarkably differs from the lower bed and is restricted in distribution.

H. ISOMI (1955, 1956) assigned all the strata on the east side of the Shimogare fault to the Kasukawa formation. However, the lithofacies of the lower part of the Kasukawa formation resembles the Kasuga formation, and the upper part of the Kasukawa formation is similar to the lower massive sandstone bed of the Nobaradani formation. The writer, therefore, has correlated the Kasukawa formation by H. ISOMI to the Kasuga and the lower part of the Nobaradani formation.

H. ISOMI assigned the limestone containing *Neoschwagerina* of Moro to the Kasukawa formation. However, the lithofacies in the neighbourhood of Moro differs from that of the

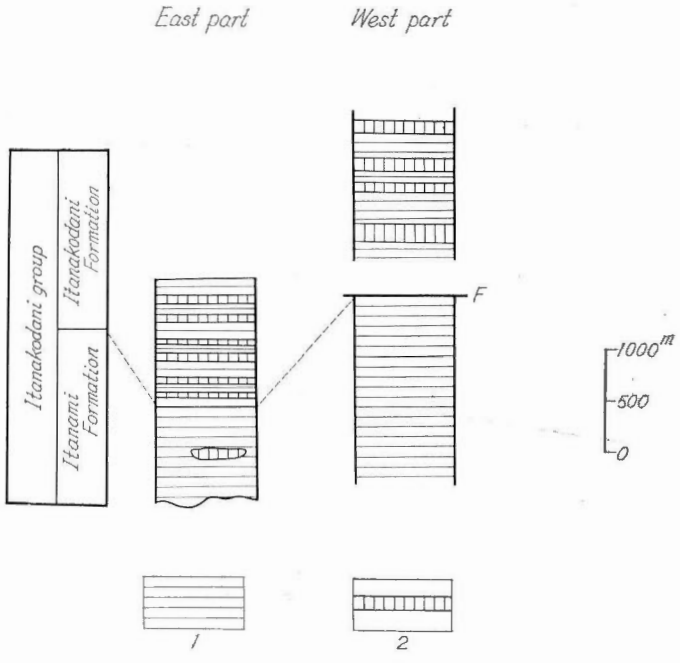


Fig. 8 Columnar section of the Itanakodani group

Kasukawa formation. Accordingly it may rather correspond to the Gongenyama formation of the Ibigawa group.

From these facts, the Kasukawa formation by H. Isomi must be included in the Kasuga and lower part of the Nobaradani formation.

Itanakodani group

This group which is distributed in the basin of the Itanako river, is divided into the Itanami and Itanakodani formations in ascending order. Both are conformable with each other in the neighbourhood of Kunimi pass and are cut by the Karubidani fault in the middle basin of the Itanako river (Figs. 2a, 4a, 8).

1) Itanami formation

This formation distributed in the lower basin of the Itanako river and in the neighbourhood of Kunimi pass consists of slate and sandstone, and is intercalated with some chert layers. The slate and sandstone form in general an alternation of sandstone and slate, but in some cases, slate intercalates the lenticular sandstone. The thicker sandstone sometimes contains fragments of slate.

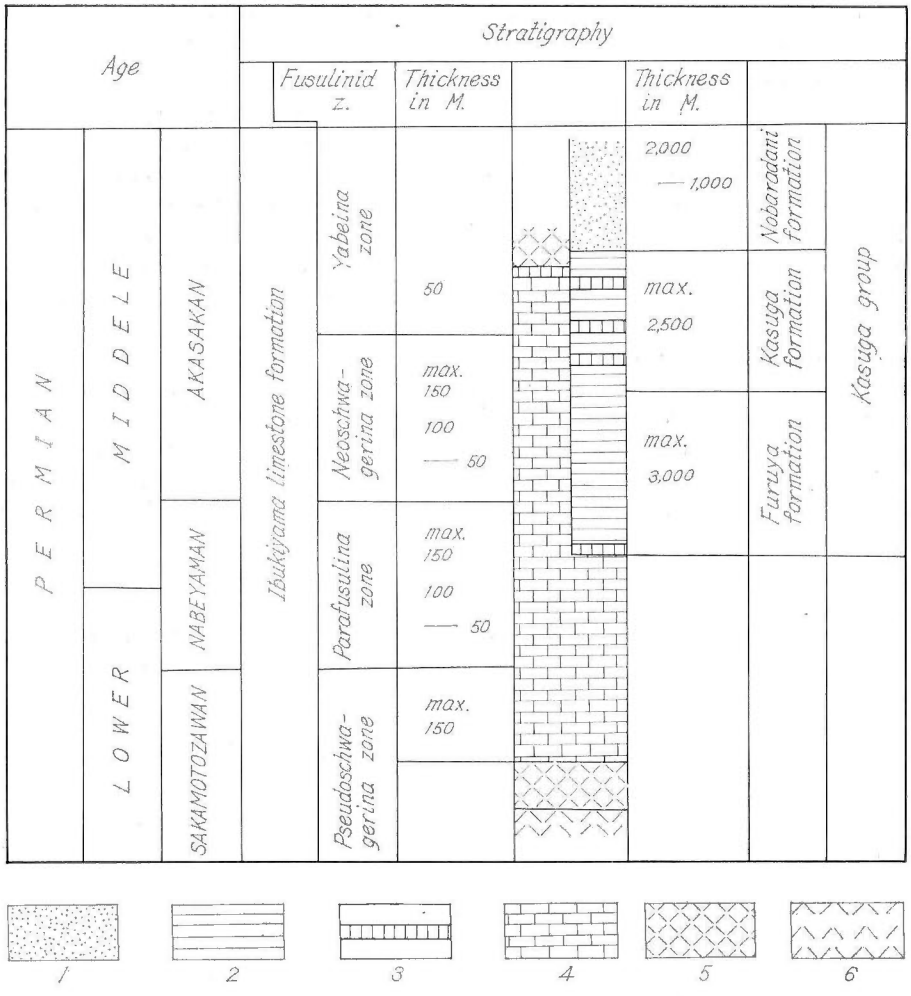
As mentioned above, the lithofacies of the Itanami formation is closely similar to that of the Furuya formation of the Kasuga group. This formation, therefore, must be correlated to the Furuya formation of the Kasuga group.

2) Itanakodani formation

This formation distributed in the middle basin of the Itanako river is dominant in chert and is accompanied by slate and a little sandstone. The lithofacies of this formation is similar to the Kasuga formation.

III. 3 South lowland district

This district situated to the south of Mt. Ibuki (1,377 m) is a hilly land and is divided into



1. Sandstone 2. Slate 3. Chert 4. Limestone 5. Schalstein 6. Schalstein & Slate

Fig. 9 Generalized columnar section of upper Paleozoic of the Ibuki mountain range and its vicinity

the Shiroyama formation, Iwakurayama formation and Samegai group.

III. 3. 1 Shiroyama formation

This formation corresponding to the Matsuoyama formation by H. Isomi (1956) is distributed in the area between the west of Tama and the neighbourhood of Sugawa, and it forms the hilly land of the central part of Mt. Shiroyama.

This formation is mainly composed of sandstone and slate, intercalated with chert. The former two sometimes make up alternations in a thickness of a decimeter order. The sandstone is thick and massive, and jointed. This formation is dominated by sandstone in general and is separated from the Samegai group by a fault.

III. 3. 2 Iwakurayama formation

This formation distributed in the Iwasayama hill east of Oshimizu is composed chiefly

of limestone and chert, and it corresponds to the lower part of the Ibukiyama limestone described by H. Isomi.

1) Iwasayama district

The Iwakurayama formation of this district is composed of limestone in the northern and southern parts of Iwasayama, and both limestone are separated by chert of the central part. The strike and dip of this formation are N 70°E and 30～40°N, respectively.

R. Morikawa and H. Isomi (1961) have described from the limestone of this formation the following fusulinids i. e. *Neoschwagerina nipponica* (Ozawa), *Pseudodoliolina ozawai* Yabe & Hanzawa, *Verbeekina* sp., *Parafusulina iwasensis* Morikawa et Isomi, *Paf. takeyamai* Morikawa et Isomi, *Paf. parakinosakii* Morikawa et Isomi, *Pseudofusulina lepida* (Deprat), *Biwaella omiensis* Morikawa et Isomi, *Codonofusiella* sp. and *Yangchienia* sp.

2) Iwakurayama district

The Iwakurayama formation in this district is composed of an alternation of limestone and chert, and its strike and dip are N 40°E and 50°W, respectively. R. Morikawa and H. Isomi (1961) from the limestone have described the following fusulinids: *Parafusulina parakinosakii* Morikawa et Isomi and *Paraschwagerina gigatea* (White). From the fusulinids mentioned above, the Iwakurayama formation must be correlated to the strata of the Ueno block of the Ibukiyama limestone formation.

III. 3. 3 Samegai group

This group is distributed on the south side of Mt. Ibuki (1,377 m), and forms hilly land. The group consists of the Kiyotaki and Samegai formations, the former being overlain by the latter (Fig. 10).

1) Kiyotaki formation

This formation is mainly composed of chert and intercalation of siliceous shale and is distributed in the neighbourhood of Kiyotaki. As seen in the south of Hongo and the west of Azusa, black slate with thickness of 150 to 200 m develops in the lower part of this formation.

As this formation is barren of fossils, its geological age is unknown, but this formation is conformably overlain by the Samegai formation belonging to the lower part of the lower Permian system. Therefore, it may be assigned to the lowest part of the lower Permian system.

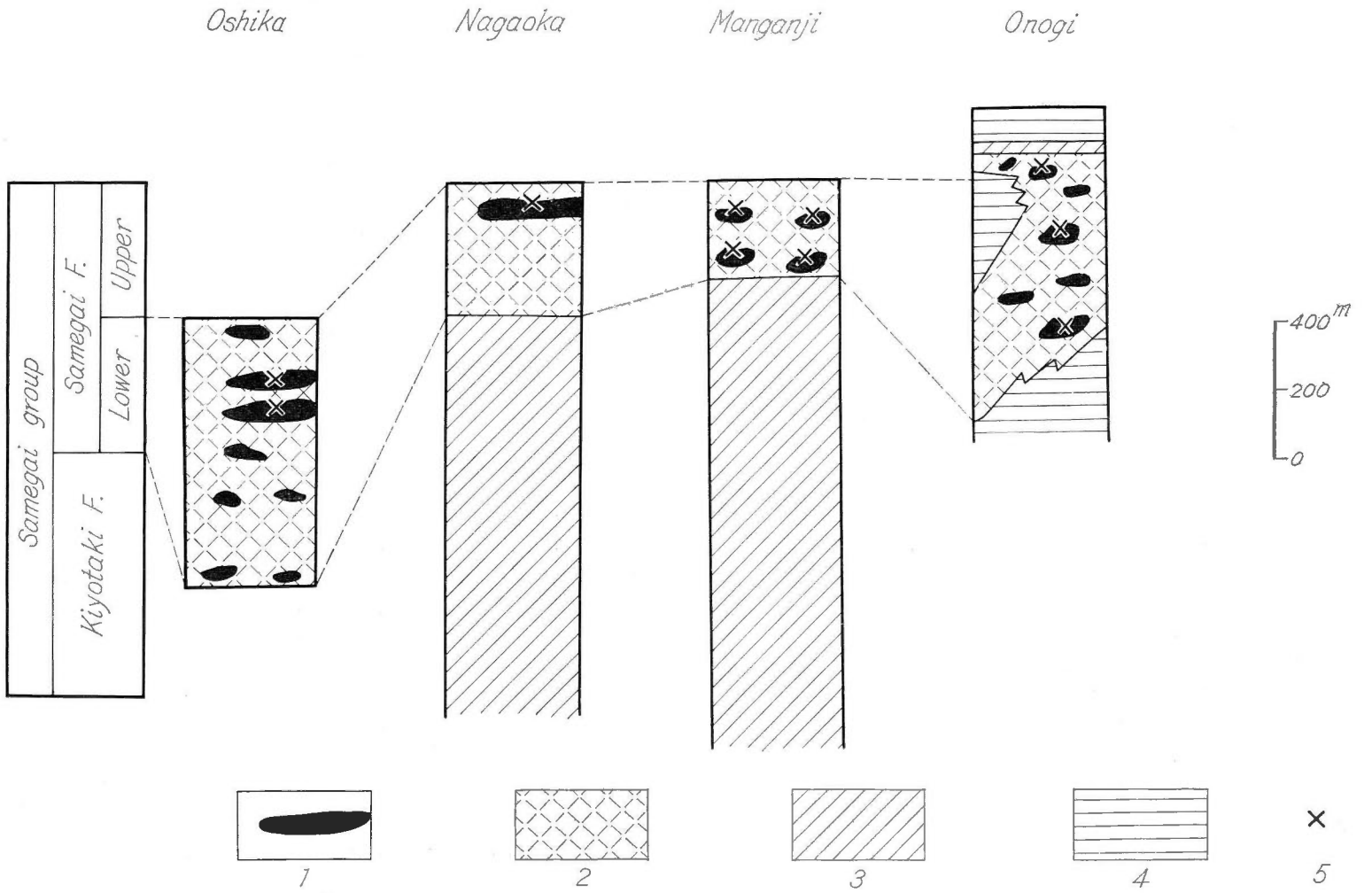
The geological structure of this formation, for example, at Kiyotaki and in the neighbourhood of Donotani is very complicated in the southern area, but general strike and dip of this formation are E–W and 60～70°N. On the other hand, this formation distributed in the hilly land of the north, at Nishiyama, Yuri and Ikeshita dips south at 40～50°. Therefore the geological structure of this formation can be said to be synclinal in general. Also chert formation distributed to the south of Iwakurayama may belong to this formation.

2) Samegai formation

This formation distributed in the Samegai district mainly composed of "schalstein" and lenticular limestone and is conformably underlain by the Kiyotaki formation. The "schalstein" forming the main part of this formation is remarkably weathered in general and is changed into reddish brown clayey or soft rock, and this weathering is intense in the "schalstein" near the limestone. It is often difficult to distinguish the weathered "schalstein" from the weathered slate and sandstone. The "schalstein" is generally dark green in fresh state.

The Samegai formation contains abundant lenticular limestones. The transitional part to the underlying Kiyotaki formation is composed of an alternation of "schalstein" and slate or that of chert and slate. The upper part of the Samegai formation distributed in Onogi and Sugawa changes into slate. Therefore it may be said that the uppermost and lowest parts of this formation tend to be rich in slate and chert.

The Samegai formation is distributed also on the south side of the Issiki fault along the national road Route 21, and is composed of "schalstein" and lenticular limestone.



1. Limestone 2. Schalstein 3. Chert 4. Slate 5. Locality of occurring Fusulinids

Fig. 10 Columnar section of the Samegai group

R. MORIKAWA and H. ISOMI (1961) have described fusulinids from lenticular limestone belonging to the lower part of this formation: *Misellina ibukiensis* KOBAYASHI, *Pseudofusulina norikurensis* (IGO), *Psf. kraffti* (SCHELLWIEN), *Psf. fusiformis* (SCHELLWIEN et DYHRENFURTH), *Psf. krotowi* (SCHELLWIEN), *Psf. regularis* (SCHELLWIEN), *Psf. bacca* MORIKAWA et ISOMI, *Psf. okafujii* (TORIYAMA), *Acervoschwagerina endoi* HANZAWA, *Paraschwagerina gigantea* (WHITE), *Pseudoschwagerina* (*Zeilla*) *nunosei* HANZAWA, *Biwaella omiensis* MORIKAWA et ISOMI and *Schubertella yadaniensis* MORIKAWA et ISOMI. And also from the upper part of this formation, they described fusulinids as follows: *Neoschwagerina rotunda* (DEPRAT), *Misellina ibukiensis* KOBAYASHI, *Yangchiensis* sp., *Pseudofusulina norikurensis* (IGO), *Psf. fusiformis* (SCHELLWIEN et DYHRENFURTH), *Psf. cushmani* CHEN, *Psf. vulgaris* (SCHELLWIEN), *Psf. bacca* MORIKAWA et ISOMI, *Psf. okafujii* (TORIYAMA) and *Schubertella* sp. etc.

From the quarry of limestone situated to the north of the Samegai station of the Tokaido railway line, the present writer obtained the following fusulinids:

Loc. SASAM 2

Schwagerina cf. *alpina* (SCHELLWIEN)
Pseudofusulina vulgaris var. *globosa* (SCHELLWIEN)
Psf. okafujii (TORIYAMA)
Psf. tschernyschewi (SCHELLWIEN) [Pl. 2, Figs. 6, 7]
Triticites obai TORIYAMA [Pl. 1, Figs. 3, 4]
T. ellipsoidalis TORIYAMA
T. cf. *kuroiwaensis* TORIYAMA [Pl. 1, Fig. 5]
Triticites cf. *noinskyi* var. *paula* TORIYAMA [Pl. 1, Fig. 6]

Further, the present writer got the following fusulinids from the limestone quarry at Issiki:

Loc. SASAM 3

Pseudofusulina krotowi (SCHELLWIEN) [Pl. 1, Fig. 8]
Pseudoschwagerina aff. *muongthensis* (DEPRAT) [Pl. 1, Fig. 7]
Triticites sp.

IV. Stratigraphic Zoning and Correlation

IV. 1 Stratigraphic zoning

The stratigraphic zoning of the various districts of this surveyed area will be described in same way as the description of stratigraphy.

IV. 1. 1 Yokoyama district

The writer (1965) has divided the Paleozoic formation of this district into the following two zones by fusulinids: *Pseudofusulina* zone and *Parafusulina* & *Neoschwagerina* zone.

1) *Pseudofusulina* zone

This fusulinid zone is represented by *Pseudofusulina vulgaris* and *Psf. vulgaris* var. *globosa* and is accompanied by *Triticites tantula* and *T.* cf. *ellipsoidalis* etc.

The Sakauchi formation and the lowest part of the Otohara limestone formation of the Ibigawa group correspond to this fusulinid zone.

2) *Parafusulina-Neoschwagerina* zone

This fusulinid zone is subdivided into the lower and upper parts.

a) Lower *Parafusulina-Neoschwagerina* zone

This fusulinid zone is represented by *Parafusulina kaerimizensis*, *Paf. takeyamai* and *Paf. parakinosakii* and is accompanied by *Neoschwagerina rotunda* and *Ns. nipponica*.

The Kuse formation and most part of the Otohara limestone formation of the Ibigawa group correspond to this fusulinid zone. M. KANUMA (1962) reported *Pseudoschwagerina* sp.,

Parafusulina sp. and *Neoschwagerina nipponica* etc. from the Dego formation outside the present writer's surveyed area. This strata which yielded fossil is evidently equivalent to the lower formation of the Tsuchikura group. Therefore the lower part of the Tsuchikura group corresponds to this fusulinid zone.

b) Upper *Parafusulina-Neoschwagerina* zone

This fusulinid zone is represented by *Neoschwagerina craticulifera* and *Ns. rotunda* and is accompanied by *Neoschwagerina* cf. *margaritae*, *Parafusulina takeyamai* and *Paf. parakinosakii*.

The Gongenyama formation of the Ibigawa group corresponds to this fusulinid zone. From the Tsuchikura formation, *Neoschwagerina margaritae* was reported by M. KANUMA (1961). Therefore, the Tsuchikura formation corresponds to this fusulinid zone.

IV. 1. 2 Ibukiyama district

The zoning in this district will be described separately for the Itanamiyama and Ibukiyama limestone formations (Fig. 4b).

Itanamiyama limestone formation

This formation is divided into the following four fusulinid zones (Fig. 5): *Yabeina*? zone, *Neoschwagerina* zone, *Parafusulina* and *Pseudofusulina* zones.

1) *Pseudofusulina* zone

In this fusulinid zone, there occur *Pseudofusulina vulgaris*, *Psf. fusiformis*, *Psf. regularis* and *Psf.* aff. *tschernyschewi* etc.

The lower green slate formation, the lower part of the limestone formation in the Akagama block and a part of the formation in the mountain ridge block correspond to this fossil zone.

2) *Parafusulina* zone

This fusulinid zone is a fossil zone represented by *Parafusulina kaerimizensis* and *Neoschwagerina nipponica* and is accompanied by *Misellina ibukiensis*, *Schwagerina japonica*, *Pseudofusulina fusiformis*, *Psf. vulgaris* var. *globosa*, *Psf. okafujii* and *Nankinella* sp.

The middle and upper parts of the limestone formation in the Akagama block and a part of the formation in the Fujinagura block correspond to this fusulinid zone.

3) *Neoschwagerina* zone

This fusulinid zone is subdivided into the lower and upper *Neoschwagerina* zones.

a) Lower *Neoechwagerina* zone

This fusulinid zone is represented by *Neoschwagerina craticulifera* and is accompanied by *Neoschwagerina nipponica*, *Ns. rotunda*, *Ns.* sp., *Pseudofusulina ambigua* and *Schubertella kingi*.

A part of the limestone formations in the mountain ridge block and the Akagama block correspond to this fusulinid zone.

b) Upper *Neoschwagerina* zone

This fusulinid zone is represented by *Neoschwagerina margaritae* and is accompanied by *Neoschwagerina rotunda*, *Ns. craticulifera*, *Ns.* sp., *Pseudodoliolina lepida* and *Schwagerina japonica*.

The limestone formation in the Fujinagura block and a part of the upper green slate formation correspond to this fusulinid zone.

4) *Yabeina* zone

In this fusulinid zone, there occur *Yabeina*? sp. and *Schubertella* sp. D. A part of the upper green slate corresponds to this fusulinid zone.

Ibukiyama limestone formation

The Ibukiyama limestone formation has been zoned as follows by M. KOBAYASHI (1957).

Yabeina zone	*Yabeina* subzone
Neoschwagerina zone	*Neoschwagerina margaritae* subzone
	Neoschwagerina craticulifera subzone

Parafusulina zone	*Parafusulina sapperi* subzone *Pseudofusulina ambigua* subzone
Pseudoschwagerina zone	*Acervoschwagerina* subzone

In order to clarify the stratigraphy and geological structure, the author traced the distribution of fusulinid zone over a wide area. In such a study, the "zone" is more suitable than the "subzone".

Therefore the writer has adopted the following zoning (Fig. 6): *Yabeina* zone; *Neoschwagerina* zone; *Parafusulina* zone; *Pseudoschwagerina* zone.

1) *Pseudoschwagerina* zone

This fusulinid zone is represented by *Acervoschwagerina* cf. *kagemoriensis*, *Pseudofusulina* cf. *vulgaris* etc. and is accompanied by *Minojaponella* and *Schubertella* sp.

The lower part of the B type formation of the Ibukiyama block, the lower formation of the Ueno block, the lower formation of the Taiheiji block and the limestone formation of the Suzuoka block correspond to this fusulinid zone.

2) *Parafusulina* zone

This fusulinid zone is represented by *Parafusulina sapperi*, *Paf. kaerimizensis* and *Pseudofusulina ambigua* etc., and is accompanied by *Neoschwagerina* cf. *nipponica*, *Pseudofusulina gümbel*, *Psf. uenoensis* and *Schwagerina* etc.

The A type formation and middle part of the B type formation in the Ibukiyama block, the middle formation in the Ueno block and the lower part of the upper formation in the Taiheiji block correspond to this fusulinid zone.

3) *Neoschwagerina* zone

This fusulinid zone is represented by *Neoschwagerina margaritae* and *Ns. craticulifera* and is accompanied by *Ns. rotunda*, *Pseudodoliolina ozawai*, *Verbeekina verbeeki* and *Schwagerina japonica*.

A part of the upper part of the A type formation in the Ibukiyama block and the upper part of the lower formation and the lower part of the upper formation in the Taiheiji block correspond to this fusulinid zone.

4) *Yabeina* zone

This fusulinid zone is represented by *Yabeina* cf. *katoi* and *Yab. cascadensis* and is accompanied by *Neoschwagerina margaritae*, *Ns. Nscraticulifera*, *Verbeekina verbeeki* and *Pseudodoliolina ozawai*.

The lowest part in appearance of the B type formation in the Ibukiyama block corresponds to this fusulinid zone.

IV. 1. 3 South lowland district

The Paleozoic formation is divided into the following by R. Morikawa and H. Isomi(1961): *Pseudoschwagerina* zone, *Parafusulina-Neoschwagerina* zone.

1) *Pseudoschwagerina* zone

This fusulinid zone yields *Biwaella omiensis*, *Pseudoschwagerina* (*Zella*) *nunosei*, *Paraschwagerina akiyoshiensis*, *Pseudofusulina okafujii*, *Psf. bacca*, *Psf. vulgaris*, *Psf. krotowi*, *Psf. fusiformis* and *Psf. kraffti*. Further the present writer got *Triticities ellipsoidalis*, *T. obai*, *T. kuroiwaensis* and *T.* cf. *noinskyi* var. *paula*.

The lower part of the Samegai formation corresponds to this fusulinid zone.

2) *Parafusulina-Neoschwagerina* zone

In this fusulinid zone, there occur *Neoschwagerina rotunda*, *Ns. nipponica*, *Parafusulina takeyamai*, *Paf. Iwasensis* and *Pseudofusulina lepida*. The upper part of the Samegai formation corresponds to this fusulinid zone.

IV. 2 Correlation

The Paleozoic formation in various districts of the surveyed area can be correlated to each

other as shown in Table 1 by fusulinids and lithofacies. The standard biostratigraphy of this surveyed area has been established in the Ibukiyama limestone formation by M. KOBAYASHI (1957).

Therefore the present writer correlates the Paleozoic formations in various districts of this surveyed area to the divisions of the Ibukiyama limestone formation.

Acervoschwagerina subzone of the Ibukiyama limestone formation yields *Pseudofusulina* cf. *vulgaris* and *Acervoschwagerina* cf. *kagemoriensis* etc.

The *Pseudofusulina* zone in the Yokoyama district and of the Itanamiyama limestone formation and *Pseudoschwagerina* zone in the South lowland district are almost correlated to this fusulinid zone. However, the *Pseudofusulina* zone in the Yokoyama and South lowland districts differ from *Acervoschwagerina* subzone of the Ibukiyama limestone formation in which it is accompanied by *Triticites*.

Pseudofusulina ambigua subzone of the Ibukiyama limestone formation yields *Pseudofusulina ambigua*, *Psf. sekii* and *Psf.* cf. *vulgaris* etc., and *Parafusulina supperi* subzone yields *Neoschwagerina nipponica*, *Ns.* sp., *Parafusulina kaerimizensis*, *Paf. sapperi*, *Schwagerina japonica* and *Pseudofusulina sekii*.

The same fossil assemblage is found in the lower *Parafusulina-Neoschwagerina* zone of the Yokoyama district, in the *Parafusulina* zone of the Itanamiyama limestone formation and in the *Parafusulina-Neoschwagerina* zone of the South lowland district. Each fusulinid zone of three districts mentioned above corresponds to *Pseudofusulina ambigua* and *Parafusulina sapperi* subzones of Ibukiyama limestone formation.

In the *Neoschwagerina craticulifera* subzone by M. KOBAYASHI (1957) there occur *Neoschwagerina craticulifera*, *Ns.* cf. *colaniae*, *Pseudodoliolina ozawai*, *Parafusulina sapperi* and *Schwagerina ibukiensis* etc.

The lower part of the upper *Parafusulina-Neoschwagerina* zone of the Yokoyama district and the lower *Neoschwagerina* zone of the Itanamiyama limestone formation correspond to this subzone. However the lower part of the upper *Parafusulina-Neoschwagerina* zone of the Yokoyama district differs from the *Neoschwagerina craticulifera* subzone of the Ibukiyama limestone in which it is accompanied by *Pseudofusulina lepida*.

The *Neoschwagerina margaritae* subzone yields *Neoschwagerina margaritae*, *Ns.* cf. *colaniae*, *Ns. craticulifera*, *Verbeekina verbeeki*, *Pseudodoliolina ozawai* and *Schwagerina japonica*.

The upper part of the upper *Parafusulina-Neoschwagerina* zone of the Yokoyama district and the upper *Neoschwagerina* zone of the Itanamiyama limestone formation correspond to the *Neoschwagerina margaritae* subzone of the Ibukiyama limestone formation.

The fusulinid zone corresponding to the *Yabeina* zone of the Ibukiyama limestone formation is the *Yabeina*? zone of the Itanamiyama limestone formation.

Next let us discuss the correlation of the non-fossiliferous formations. As mentioned in a preceding paragraph, the Furuya formation which forms the lowest part of the Kusaga group rests conformably on the Itanamiyama limestone formation of the *Parafusulina* zone in the Akagama block. Therefore it is inferred that the Kasuga group corresponds to the *Parafusulina* zone or to a horizon higher than the *Parafusulina* zone.

The Itanami formation, the lower part of the Itanakodani group, is composed of alternations of sandstone and slate, while the Itanakodani formation, the upper part of this group, is composed of chert and slate. The lithofacies of both these formations closely resemble those of the Furuya and Kasuga formations of the Kasuga group, respectively. From this lithological similarity, the Itanakodani group can be correlated to the Kasuga group. Therefore, it is inferred that the Itanakodani group corresponds to the *Parafusulina* zone or to a higher horizon.

Of the Samegai group, the Samegai formation belonging to the *Pseudoschwagerina* zone rests conformably on the Kiyotaki formation. Therefore, it is inferred that the Kiyotaki formation corresponds to the *Pseudoschwagerina* zone or to a lower horizon.

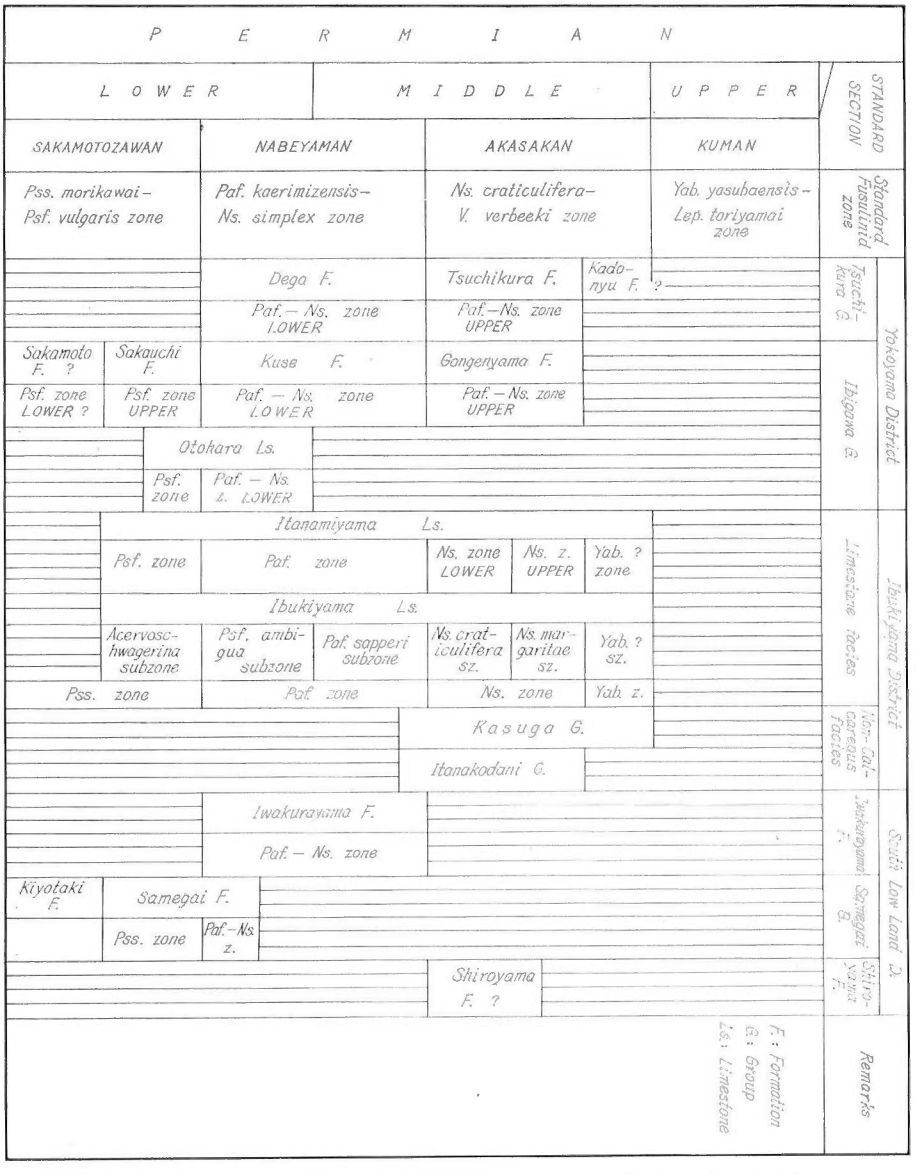


Table 1 Correlation of the Paleozoic formation in Mt. Ibuki and its vicinity

In the surveyed area, the geological age of the Shiroyama formation is unknown owing to the lack of fossiliferous limestone. However K. TAKIMOTO (1936) has reported the occurrence of *Schwagerina japonica* from the "Eastern part of the Chichibu system" which may be a southerly extension of the Shiroyama formation, and assigned the "Eastern part of the Chichibu system" to the middle Permian system. It is dangerous to determine the geological age of the Shiroyama formation based only on a few fossils yielded by the formation. However, the lithofacies of the Shiroyama formation characterized by the dominant sandstone is similar to that of the Furuya formation of the Kasuga group. It may not be improbable to correlate the Shiroyama formation to the Furuya formation.

In the Tsuchikura group, the Kadonyu formation rests conformably on the Tsuchikura

formation containing *Neoschwagerina margaritae*. The Kadonyu formation probably is related to the *Yabeina* subzone of the Ibukiyama limestone formation.

In the other hand, the Kadonyu formation closely resembles the Nobaradani formation of the Kasuga group in the abundance of sandstone. Therefore the Kadonyu formation may be correlated to the Nobaradani formation.

From the above-mentioned considerations the geological age of the Paleozoic formations in this surveyed area might be as follows (cf. Table 1):

Tsuchikura group: Nabeyaman——Akasakan
Ibigawa group: Sakamotozawan——Akasakan
Otohara limestone formation: Sakamotozawan——Nabeyaman
Itanamiyama limestone formation: Sakamotozawan——Akasakan
Ibukiyama limestone formation: Sakamotozawan——Akasakan
Kasuga group: Nabeyaman——Akasakan
Itanakodani group: Nabeyaman——Akasakan
Iwakurayama formation: Nabeyaman
Samegai group: Sakamotozawan——Nabeyaman
Shiroyama formation: Nabeyaman——Akasakan?

V. Geological Structure

The geological structure of the non-calcareous formations in this area seems to be monoclinal in appearance, but careful observation reveals a considerably complicated structure accompanied by isoclinal folding and faulting. On the other hand, the limestone formation shows an imbricate structure and an overturned folding and these structures are cut by many faults (Figs. 2b, 4c).

The geological structure of the Paleozoic formations in various districts within the surveyed area will be described in the same order as the description of the stratigraphy as follows: the Yokoyama, Ibukiyama and South lowland districts.

V. 1 Yokoyama district

In the Yokoyama district, the Tsuchikura and Ibigawa groups are distributed, both groups being separated from each other by the Tsuchikura fault running from NE to SW.

V. 1. 1 Folding

1) Tsuchikura group

The Tsuchikura group shows a monoclinal structure dipping south at 70～60° and its apparent sequence is in descending order as follows: Dego, Tsuchikura and Kadonyu formations. However, M. KANUMA (1961) has obtained *Pseudofusulina* sp., *Parafusulina* sp. and *Neoschwagerina nipponica* from the Dego formation and *Neoschwagerina margaritae* from the Tsuchikura formation. The order of succession by fusulinids zoning is reverse to the apparent succession. Therefore, this group is concluded to show overturned structure.

2) Ibigawa group

Distribution of the Ibigawa group is divided into eastern, central and western parts by the Hirose and Yokoyama faults.

The geological structure of the eastern part forms the anticlinal structure named "Otohara Anticline" (MIYAMURA 1965) running in the direction of N 60°E. The western extension of this anticlinal axis is obscure on account of the intrusion of the Moroka granite, while the eastern extension may reach the neighbourhood of Wakamatsu outside the surveyed area.

The Otohara anticline shows a symmetrical anticlinal structure having 50～70°N dip on the north wing and 50～70°S dip on the south one. The north wing of this anticline is cut by

the Hanabusayama and Gongenyama faults, which bring about the repetition of the same horizon.

The paleontological data indicate that the same horizon is repeated on the south wing of this anticline, although the south wing has apparently the monoclinal structure dipping south at 50～70°.

From the field observation on the repetition of the same horizon, it cannot be said to be an effect of faulting. Therefore, it is inferred that the south wing of this anticline is accompanied by a small isoclinal folding with the axial plane dipping S.

The geological structure of the central part of the Ibigawa group forms the arc projected to southwest, and the west wing of this arc is cut by the Hirose fault and the east one by the Yokoyama fault. The former wing has a strike of N 40°W and the latter one (has a strike) N 80°W. Both wings form a monoclinal structure having 40～60°N dip. The geological structure of the western part of the Ibigawa group shows the monoclinal structure with attitude of N 70°E and 40～60°N.

V. 1. 2 Faults

1) Tsuchikura fault

The Tsuchikura fault runs from the neighbourhood of Kadonyu situated in the northwestern part of this surveyed area to Degotsuchikura via Mt. Tsuchikura. It separates the Tsuchikura group from the Ibigawa group. Both groups differ from each other in the lithofacies, fusulinid zone and the dip direction.

2) Hirose fault

The Hirose fault runs from Hirose to the west of Kadonyu, and it divides the distribution of the Ibigawa group into the central and western parts. Strike direction is different in these three parts. From the distribution of fusulinids, it is inferred that the central part of the Ibigawa group is displaced to the south, compared with the western part.

3) Yokoyama fault

The Yokoyama fault runs from the neighbourhood of Sugihara to the east of Kantani via Yokoyama. Its south extension is obscure on account of intrusion of the Moroka granite. This fault divides the distribution of the Ibigawa group into the central and eastern parts.

From the distribution of fusulinids it is inferred that the eastern part of the Ibigawa group is displaced relatively southward, compared with the central one. And also the trend of the bedding plane of the eastern part somewhat differs from that of the central one.

4) Moro fault

The Moro fault runs from Moro to the neighbourhood of Uchidani. Its northern extension is obscure on account of the intrusion of the Moroka granite. However, the Moro fault is probably a southerly continuation of the Hirose fault mentioned above. The Moro fault divides the Ibigawa group from the Kasuga groups. Both these groups differ from each other in the trend of the bedding, that is, their strikes are N 60～70°W and N 60～70°E respectively.

5) Gongenyama and Hanabusayama faults

The Gongenyama and Hanabusayama faults run from east to west in the southern and northern parts of Mt. Gongen, respectively. The former causes the repeated occurrence of the same fusulinid zones.

V. 2 Ibukiyama district

As mentioned above, both of the calcareous and non-calcareous facies are distributed in the Ibukiyama district. It has long been known that the limestone formation has been thrust upon the non-calcareous formations. Many former geologists considered that the limestone mass is the klippe, but the present writer has gained the conclusion that it is originally autochthonous.

The geological structure of this district has an important significance on the geotectonics of Southwest Japan. Therefore the geological structure of this district will be described in detail.

V. 2. 1 Folding

1) Kasuga group

The geological structure of the Kasuga group is complicated due to minor folding, but by tracing the Kasuga formation as a key bed, outline of the structure can be known as follows: the Kasuga group has in general the monoclinal structure with a strike of N40～60°E and dip of 60～70°S.

2) Itanakodani group

The geological structure of this group is a monoclinal one with a strike of N 40～50°W and dip of 60～70°S, but repetition of the lower formation of this group (Itanami formation) has been caused by the Karubidani fault in the south part.

3) Itanamiyama limestone formation

As this formation is composed of massive limestone, its geological structure is obscure. But by the strike and dip of the alternative bed, which is composed of limestone, schalstein, chert and slate, its geological structure can be determined.

This formation in the neighbourhood of Nakayama has a monoclinal structure with a strike of N 60～70°E and dip of 60～70°S, while the strike and dip of the formation at Fujinagura are N 40～50°E and 60～70°S, respectively.

Therefore, the geological structure in the northern part of this formation is concluded to form an arc projecting to the northwest and dipping 60～70°S, but this arc is cut in the fan-shaped block by the radial faults i.e. Shirako, Haitani and Ohage etc. On the other hand, tracing the chert in the Akagama block as a key bed, the geological structure of this formation in the southern part may be known. Namely, it is inferred that this formation of the Akagama block with N 60～70°E strike and 60～70°S dip is thrust up on a part of this formation of the mountain ridge and of Fujinagura blocks by the high angle thrust (Kanayamadani thrust). The southern part of the Itanamiyama limestone formation is separated from the Ibukiyama limestone formation by the Totani fault.

4) Ibukiyama limestone formation

The area of this formation is divided by the Karubidani and Otomi faults into the Suzuoka, Ibukiyama, Taiheiji and Ueno blocks.

(1) The formation in the Suzuoka block apparently has a strike of E–W and dip of 20°S.

(2) The formation of the A type formation in the Ibukiyama block is separated from the B type formation by the alternation bed of chert and schalstein. The chert intercalated in the A type formation has a strike of E–W and a dip of 20～30°N. Judging from the fusulinid zonation (*Pseudoschwagerina*, *Parafusulina* and *Neoschwagerina* zones in ascending order), the A type is of normal order. Two facts mentioned above show that the geological structure of the A type formation is monoclinal, dipping N at 20～30° (Figs. 4b, c).

By tracing the chert in the lowest part of the B type formation the geological structure of the B type formation is revealed to be monoclinal, dipping N at 20～30°. The stratigraphical succession of the fusulinid zone of the B type formation on the south slope, (*Yabeina*, *Neoschwagerina*, *Parafusulina* and *Pseudoschwagerina* zone in ascending order), proves that the strata is of reverse order (Fig. 4b).

On the north slope of the Ibukiyama block proper the fusulinid zonation of the B type formation is not known. However the apparent succession of fusulinid zones in the Taiheiji block which is situated immediately on the west is supposed to be the same with that of the northern slope. The apparent succession on the northern slope of the Taiheiji block is *Pseudoschwagerina*, *Parafusulina*, *Neoschwagerina* and *Parafusulina* zones in ascending order (Fig. 4b).

From the above-mentioned facts, the structure of the B type formation is thought to be an

overturned folding. Since the alternation bed of "schalstein" and chert separating the A and B type formation is intensely disturbed, probably the B type formation is thought to be thrust over the A type formation by a thrust (Fig. 4c).

(3) The strike and dip of chert intercalated in the Ibukiyama limestone formation of the Taiheiji block are N20～30°W strike and 10～20°E dip, respectively. The repetition of the fusulinid zone of the limestone formation due to two faults running from NNW to SSE is observed in the western part of the block. The apparent succession of the fusulinid zone in the eastern part is *Parafusulina*, *Neoschwagerina*, *Parafusulina* and *Pseudoschwagerina* zones in descending order. The field observations show that the cause of the repetition of the fusulinid zone is an isoclinal folding, since the remarkable fault has never been recognized (Figs. 4a, b). The alternation bed of schalstein, slate and chert distributed in the northern part of this block has E–W strike and 60°S dip in the east and N 50～60°E strike and 60°S dip in the west.

(4) Strike and dip of chert intercalated in the Ibukiyama limestone formation of the Ueno block indicates that this limestone formation has a monoclinal structure with a strike of E–W and dip of 30°N in general.

V. 2. 2 Faults

1) Itanamiyama thrust

On the west foot of Mt. Itanami the slate of the Itanami formation shows a monoclinal structure, and a structure different from that of the Itanamiyama limestone formation which is directly adjacent to it. The relation between the two formations, therefore, is inferred to be the fault. Since the boundary line is not straight but curves slightly, it may be inferred that it is not a normal fault but a high angle thrust. This thrust is named the Itanamiyama thrust. It can be traced about 4 km from the Kunimi pass to the Karubidani valley on the west slope of the Ibuki mountain range. Its trend is almost N–S. This thrust is cut by the Karubidani fault in the neighbourhood of the Karubidani valley (Figs. 2a, b, 4a, c).

2) Fujinagura thrust

In the neighbourhood of Fujinagura on the east slope of Mt. Itanami, the Itanamiyama limestone formation (Fujinagura block) in the west is separated from the Furuya formation in the east by the fault dipping 40°N. Since the fault line is considerably wavy, the fault is thought to be a high angle thrust (Figs. 2a, 4a). This thrust is named the Fujinagura thrust.

3) Akagama fault

This fault runs through the Furuya formation from the neighbourhood of Nakayama to the Totani valley. In the neighbourhood of Akagama, the Itanamiyama limestone formation (Akagama block) is separated from the Furuya formation by the fault dipping 50° to 60°E. The slate belonging to the Furuya formation is crushed and changes into fault clay in the neighbourhood of the boundary between two fomations. The boundary line between the two formations forms an arc which is slightly projected to the west (Figs. 2a, 4a). This fault is named the Akagama fault.

4) Kanayamadani thrust

In the area between the Akagama valley and the head of the Totani valley on the eastern slope of Mt. Itanami, the Itanamiyama limestone formation of the Akagama block is in disharmonic with the upper green slate formation. In the boundary between the two formations, the upper green slate formation is remarkably disturbed and the "schalstein" with limestone in the lowest part of the Itanamiyama limestone formation is also crushed and accompanied by fault clay in the Kanayama valley. The trend of the limestone formation of the Akagama block is slightly oblique to that of the mountain ridge block. Moreover, the chert in the most east part of the mountain ridge block is notably crushed, and it is mixed with "schalstein" in the most westerly part of the Akagama block.

Their facts indicate that the boundary of both blocks is a fault.

Since the fault is traced like an arc in form, it may be a high angle thrust. This fault can be traced from the vicinity of the Akagama valley to the head of the Totani valley in the NNE–SSW direction, and its southwest extension is stopped by the Totani fault running in the E–W direction near the head to the Totani valley. This thrust is named the Kanayamadani thrust. By the Kanayamadani thrust, the Itanamiyama limestone formation of the Akagama block is thrust westward over the limestone formation of the mountain ridge and Fujinagura blocks and also over the upper green slate formation.

5) Ibukiyama thrust

In the neighbourhood of Yataka at the southern foot of Mt. Ibuki, the Ibukiyama limestone formation lies on the massive sandstone of the Furuya formation. Though a remarkable structural disturbance is not found near the boundary between the two formations, the fault clay develops in the "schalstein" accompanying the limestone. Moreover the rock facies of the Ibukiyama limestone formation and the Furuya formation are remarkably different. The lithological change, which is ascribed to the change of the sedimentary environment of continuous sedimentation, is too rapid. And any positive evidence for unconformity such as conglomerate is not observed. Therefore the contact relation is concluded to be a major fault. Since this fault is traced in an arc which is projected to the east, it is inferred to be a high angle thrust.

At an exposure along the high way which reaches from Tama situated at the southeast foot of Mt. Ibuki to the top of Mt. Ibuki, as pointed out by S. MIZUTANI (1965), the fault showing the high angle is observed between the Ibukiyama limestone formation and the slate of the Furuya formation. The limestone near this fault is remarkably crushed and the slate is intensely disturbed. Though the very plane of the fault can not be traced, the boundary between the two formations runs almost along the contour line at a height of 800～900 m above sea level. Thus it is concluded to be a low angle thrust. This thrust is named the Ibukiyama thrust.

The Ibukiyama thrust is terminated by the Karubidani fault in the east (in the neighbourhood of Sasamata) and is cut by the Otomi fault in the west. The thrust which is inferred to be a part of the Ibukiyama thrust reaches the neighbourhood of Yataka (Figs. 2a, 4a).

6) Upper Ibukiyama thrust

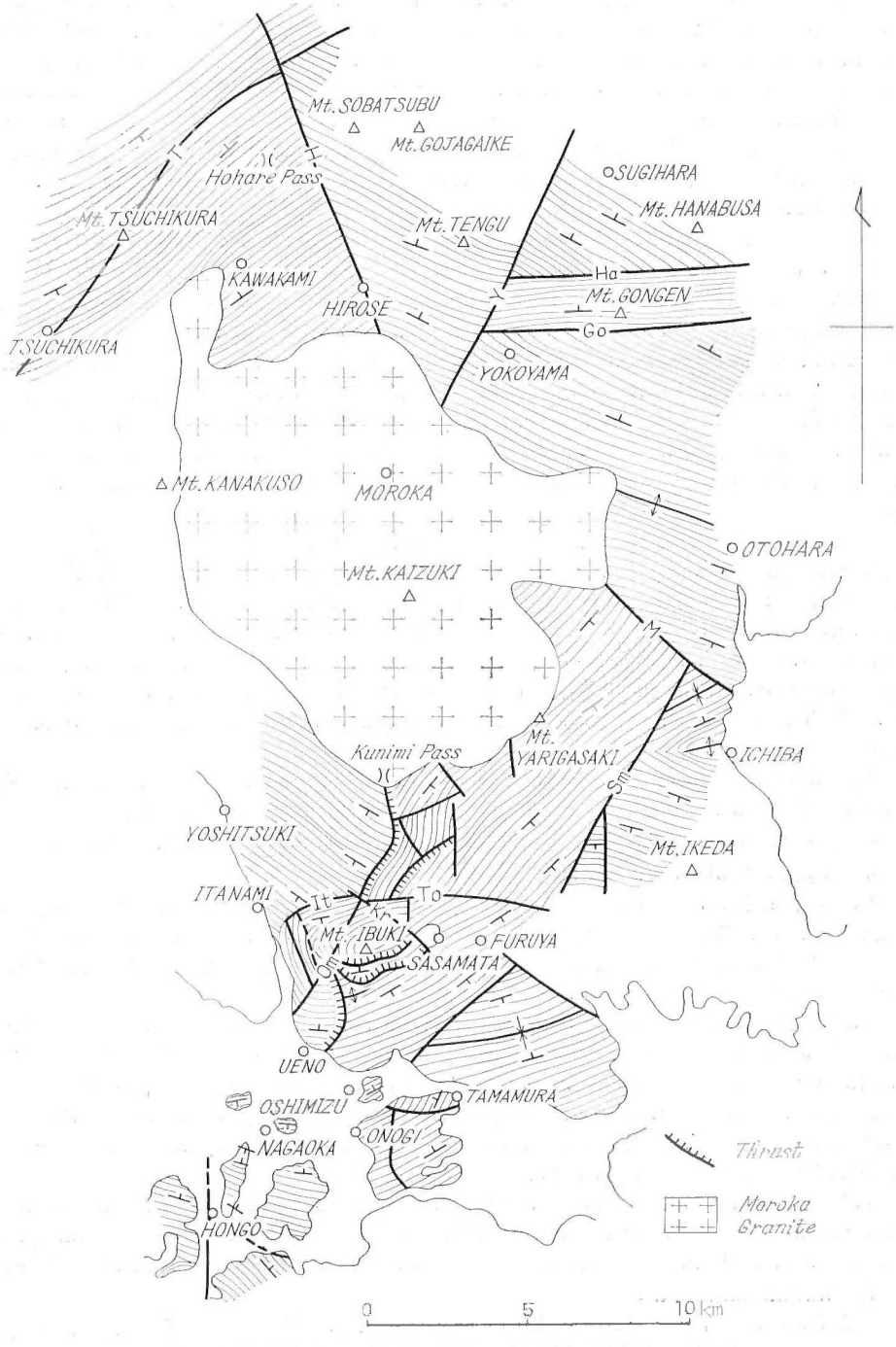
In the Joheiji valley which reaches from Joheiji to the top of Mt. Ibuki the A type and B type formations belonging to the Ibukiyama block are separated by the alternation bed of chert and "schalstein." The alternation bed is thought to belong to the lower part of the B type formation.

Though the relation between both formations seems conformable at a glance, the "schalstein" of the alternation bed is remarkably disturbed. Therefore, the relation between both formations is concluded to be a fault. By the way, the observation on the apparent successions of fusulinid zones in the A type and B type formations, as already mentioned, indicates that both formations have different geological structures. This fact may be a proof against a conformable relation between both formations.

This fault is traced from east to west parallel to the Ibukiyama thrust mentioned above, almost parallel to the contour line at a height of 1,100 m above sea level, and it is interpreted to be a low angle thrust (Figs. 2a, 4a). This thrust is named the upper Ibukiyama thrust.

7) Itanakodani fault

This fault runs in an E–W direction on the north slope of Mt. Ibuki, forming an arc projected northward and is terminated by the Karubidani fault in the east, and is cut by a N–S fault in the neighbourhood of Okubo in the west. This fault is thought to be of a high angle with a dip of 60°S to 80°S. The alternation bed of "schalstein" and slate belonging to the lower part of the Ibukiyama limestone formation of the triangle-shaped block is intensely disturbed. The fault zone contains breccia consisting of chert, sandstone and slate. And also the



It: Itanakodani fault
Y: Yokoyama fault
M: Moro fault
Om: Otomi fault
T: Tsuchikura fault
Ha: Hanabusa fault
Sm: Shimogare fault
Kr: Karubidani fault
H: Hirose fault
Go: Gongenyama fault
To: Totani fault

Fig. 12 Map showing the outline of the geological structure in the vicinity of Mt. Ibuki

Itanakodani group belonging to the non-calcareous facies in the north is remarkably crushed and disturbed near this fault.

V. 3 South lowland district

In the South lowland, the Shiroyama formation and Samegai group are distributed. In the eastern part of this district the Shiroyama formation has a monoclinal structure with strike of N 50°E and dip of 50～60°N and forms a block bounded by faults. In the western part of this district, the Samegai group occupies the axial part of a synclinal structure with a strike of N70°W or E–W and dip of 50～70°N on the south side and with strike of E–W and dip of 50～70°S on the north side. In the north of Mt. Shiroyama, the Iwakurayama formation forms a monoclinal structure with a strike of N40°E and dip of 50°N. The Samegai formation distributed in the neighbourhood of Samegai and Azusa has a monoclinal structure with a strike of N 50～60°W and dip of 60～70°N.

As mentioned above the general aspects of the geological structure of the Paleozoic formation in this district is characterized by an arc projected southward. In the eastern part of this arc, the arc structure is complicated due to many faults. While the western part of the arc exhibits a synclinal structure. The Samegai formation appears also on the south side of the Issiki fault, which bounds the southerly limit of this structural unit.

V. 4 Summary of the geological structure

The geological structure of the Paleozoic formation of the surveyed area is summarized as follows: the Paleozoic formation of the Yokoyama district located to the north or northeast of the Moroka granite has a strike of N 70°E or N 40～70°W and dip of 40～70°N; that of the Ibukiyama district situated to the south or southeast of the Moroka granite has a strike of N 40～60°E or N 40～50°W and dip of 60～70°S; that of the South lowland district form an arc projecting southward.

On the whole, these structures can be said to form a dome-like structure around the Moroka granite (Fig. 12). The thrust of the Ibuki mountain range may be nothing but an extreme case of the diastrophism that formed the fault cutting the dome-like structure.

VI. Argument against "Klippe" of the Ibuki Mountain Range

The limestone formations of the Ibuki mountain range seem to form klippe in appearance. The former theory that the limestone is an exotic outlayer (klippe) of calcareous Paleozoic, being brought from the north by a thrust and resting on the non-calcareous Paleozoics, can not be accepted for following reasons.

1) As pointed out by H. Fujimoto, M. Kanuma and H. Igo (1962) the limestone and non-calcareous formations are interpreted to have been deposited on the submarine bank formed by volcanic and in the deeper part around the bank, respectively. The limestone facies and the non-calcareous facies are considered to have adjoined and coexisted throughout the sedimentation (Fig. 13). As pointed out by H. Isomi (1956) the clastic deposit of the limestone formation in the neighbourhood of Nakayama is similar to that of the non-calcareous formation. Both facies are transitional to each other.

2) As mentioned in the chapter of stratigraphy, the Itanamiyama limestone formation in the neighbourhood of Nakayama is conformably overlain by the Furuya formation of the Kasuga group. T. Seki (1939) and H. Isomi (1955) ascribed the structural disturbance in the Totani valley to thrusting.

However in the neighbourhood of the Totani valley both the Itanamiyama limestone

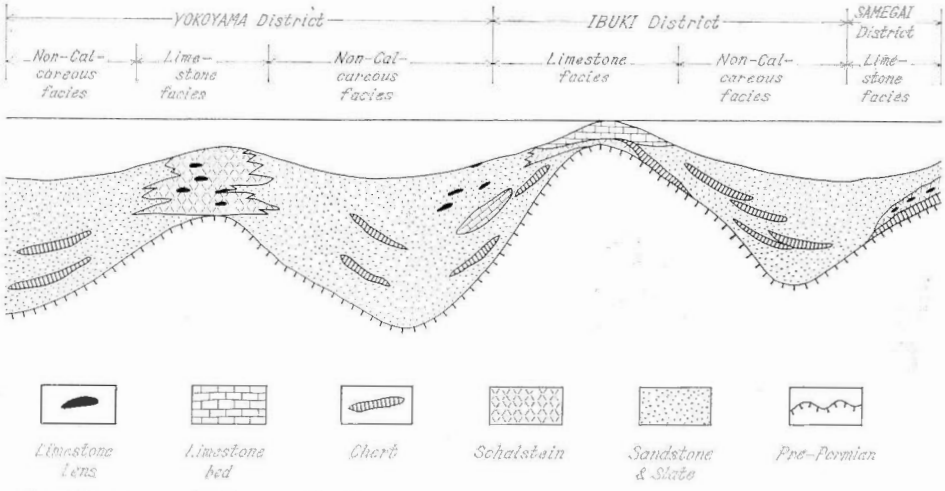


Fig. 13 Schematic diagram showing the relation of lithofacies of the Paleozoic formation in the vicinity of Mt. Ibuki

formation (Akagama block) and the Kasuga group (Furuya formation) have a strike of N40～60°E and dip of 40～60°S, and both formations can be concluded to be in conformable relation with each other. Therefore the abnormal structure described by them is only due to a minor folding and has nothing to do with the supposed thrust between the two formations of different lithofacies.

3) The thrusts in the Ibuki mountain range are high angle thrusts except for the Ibukiyama thrust (Figs. 2b, 3c, 14). Accordingly, it is more natural to relate these thrusts to intense folding than klippe. The origin of the low angle thrust named the Ibukiyama thrust is explained in Fig. 14. The geological structure of the Itanamiyama limestone formation is inferred to represent an incipient stage of development of folding, while the geological structure of the Ibukiyama limestone formation shows an advanced stage. The geological structure of both limestone formations can be thought to belong to the same tectonic movement, and to have originated from a folding accompanied by a thrusting of the autochthonous limestone.

4) As an argument for the exotic nature of the limestone formation of the Ibuki mountain range T. KOBAYASHI (1953) mentioned that the Noric strata (Myogadani formation) located in Myogadani valley, in spite of its location comparatively near the limestone strata of the Ibuki mountain range, does not contain the limestone pebble of a limestone formation. However, this situation can be explained as follows:

(1) Though the Paleozoic formation of the Ibuki mountain range already emerged at the time of sedimentation of the Myogadani formation, it was not the source area of the sediments of the Myogadani formation.

(2) When the Myogadani formation was deposited, the Paleozoic formation of the Ibuki mountain range had not formed the emerged land yet.

Therefore, T. KOBAYASHI's argument for "klippe" can not be accepted. In short, the present author concludes that the limestone formation of the Ibuki mountain range is not klippe, but autochthonous.

The thrusting movement of the Ibuki mountain range has been concluded by T. KOBAYASHI (1953) to belong to the "Oga phase" of the early Cretaceous age which brought about the Oga thrust in the Chugoku district of the Inner Zone of Southwest Japan. But in the surveyed area there is no evidence which indicates the geological age, so that the geological age

of the thrusting movement of the Ibuki mountain range can only be said to be Mesozoic.

The limestone talus distributed at the foot of Mt. Ibuki, at Taiheiji and Sasamata, consists exclusively of limestone breccia. M. KOTO (1910) concluded that the limestone talus in question was formed by a brecciation due to the thrusting. If the limestone talus is formed by a brecciation due to the thrusting, it is expected to contain the breccia of the non-calcareous members i. e. sandstone, slate and chert. However such a case has never been found in field, as is pointed out H. ISOMI (1956). Accordingly the limestone talus is obviously talus deposits formed after the thrusting and faulting, and has nothing to do with the thrusting.

VII. Summary and Conclusion

1. The Paleozoic formations of this surveyed area are classified by the lithofacies, the geological structure and the fusulinid zone, as follows:

Limestone facies: Otohara, Itanamiyama and Ibukiyama limestone formations, Iwakurayama formation and Samegai group.

Non-calcareous facies: Tsuchikura, Ibigawa, Kasuga and Itanakodani groups. Shiroyama and Hanabusayama formations.

2. The Paleozoic formations of this surveyed area belong to the middle-lower Permian system and are correlated to Sakamotozawan, Nabeyaman and Akasakan. That is:

Tsuchikura group: Nabeyaman——Akasakan
Ibigawa group: Sakamotozawan——Akasakan
Otohara limestone formation: Sakamotozawan——Nabeyaman
Itanamiyama limestone formation: Sakamotozawan——Akasakan
Ibukiyama limestone formation: Sakamotozawan——Akasakan
Kasuga group: Nabeyaman——Akasakan
Itanakodani group: Nabeyaman——Akasakan
Iwakurayama formation: Nabeyaman
Samegai group: Sakamotozawan——Nabeyaman
Shiroyama formation: Nabeyaman——Akasakan?
The correlation among these groups is shown in Table 1.

3. The geological structure. The Paleozoic formations of this surveyed area can be said to form a dome-like structure. The dome-like structure is cut by many faults. The Ibigawa group forms the Otohara anticline and is isoclinally folded on the north side of the Moro fault.

4. The Itanamiyama limestone formation exhibits the imbricate structure and the Ibukiyama limestone formation shows an overturned folding. From the viewpoint of structural evolution, the former represents a premature stage, and the latter shows the advanced stage of the one and the same folding movement. The geological structure of both limestone formations might originate from the folding accompanied by a thrusting of the autochthonous limestone.

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伊吹山とその付近の二畳紀層の層序と地質構造

宮村　学

要　旨

伊吹山とその付近に分布する二畳紀層は，石灰岩相と非石灰岩相とからなり，両相は互に隣接し堆積作用を通じて共存した。したがって石灰岩相は exotic なものとは考えられない。石灰岩相には乙原・伊吹山・板並山の各石灰岩層，岩倉山層および醒ケ井層群が属している。

非石灰岩相には土倉・揖斐川・春日・板名古谷の各層群と城山・花房山の各層が属している。

これらの二畳紀層のほとんどは *Pseudoschwagerina* zone から *Neoschwagerina* zone までに属し，一部は *Yabeina* zone に属している。当地域の地質構造はドーム状をなし，多くの断層によって切られている。伊吹山系に見られる衝上はそのもっとも激しい場合と考えられる。

伊吹山系に見られる衝上は，過褶曲に起因するものであって klippe とは考えられない。板並山石灰岩相は覆瓦構造を示し，伊吹山石灰岩層は逆転褶曲を示している。両者は異なった構造形態を示しているが，同じ一つの褶曲運動に起因する。

板並石灰岩層の地質構造は初期の構造発達の段階を示し，伊吹山石灰岩層のそれはその進行した段階を示しているといえる。

Appendix

List of place, mountain, valley and river names used in this article showing the comparison between the names written in Roman letters and those written in Chinese characters.

1) Place names

Azusa	梓	Nakayama	中山
Degotsuchikura	出口土倉	Nishiyama	西山
Donotani	堂ノ谷	Okubo	大久保
Fujikawa	藤川	Onogi	大野木
Fujinagura	藤名倉	Osai	尾西
Furuya	古屋	Oshika	大鹿
Hirao	広尾	Oshimizu	大清水
Hirose	広瀬	Otohara	乙原
Hisaka	日坂	Oya	親
Hongo	本郷	Ozori	大草履
Ibuki	伊吹	Ozu	小津
Ichiba	市場	Sakamoto	坂本
Ikeshita	池下	Samegai	醒井
Issiki	一色	Sasamata	笹又
Itanami	板並	Shimogare	下ケ流
Iwakurayama	岩倉山	Shirako	白川
Iwasayama	岩佐山	Shirakura	白倉
Joheiji	上平寺	Sugawa	須川
Kadonyu	門入	Sugihara	杉原
Kashiwabara	柏原	Taiheiji	太平寺
Kawajiri	川尻	Tama	玉
Kawakami	川上	Taniyama	谷山
Kibiyu	鬼姫生	Teramoto	寺本
Kiyotaki	清滝	Tonokura	塔の倉
Komigami	小宮神	Totsukumi	外津久見
Manganji	万願寺	Tsuchikura	土倉
Mikura	三倉	Tsukumi	津久見
Mitsuka	美束	Ueno	上野
Moro	室	Yataka	弥高
Moroka	諸家	Yokoyama	横山
Nagaoka	長岡	Yuri	油里
Fujihashi	藤橋	Kuse	久瀬
Ibi	揖斐	Sakauchi	坂内
Ibuki	伊吹	Santo	山東
Kasuga	春日	Tokuyama	徳山

2) Mountain and pass names

Gojagaike	五蛇池	Kanakuso	金糞
Gongen	権現	Kojima	小島
Hanabusa	花房	Kunimi Pass	国見峠
Hasso Pass	八草峠	Shiroyama	城山
Hohare Pass	ホハレ峠	Sobatsubu	蕎麦粒
Ibuki	伊吹	Tengu	天狗
Iimori	飯盛	Tsuchikura	土倉
Itanami	板並	Yarigasaki	鎗ケ先
Kaizuki	貝月	Yutani	湧谷

3) Valley and river names

Akagama V.	赤釜谷	Kurozu V.	黒津谷
Ane R.	姉川	Mitakura V.	三田倉谷
Haitani V.	逃谷	Nakatsumata V.	中ツ又谷
Hase R.	長谷川	Nobara V.	野原谷
Hasso R.	八草川	Otani V.	大谷
Hirose R.	広瀬川	Oya V.	親谷
Ibi R.	揖斐川	Ozu V.	小津谷
Itanakodani V.	板名古谷	Shirakawa R.	白川
Kamimata V.	神又谷	Totani V.	戸谷
Kanayama V.	金山谷	Uchidani V.	内谷
Kantani V.	寒谷	Wanto V.	椀戸谷
Kasukawa R.	粕川		

PLATES

AND

EXPLANATIONS

(with 8 Plates)

Figure 1 *Nankinella* sp., 1, oblique axial section, × 100
Loc. Ka72

Figure 2 *Schubertella kingi* DUNBAR & SKINNER, 2, axial section, × 100
Loc. Ka22

Figures 3, 4 *Triticites obai* TORIYAMA, 3, 4, axial sections, all × 10
Loc. SASAM2

Figure 5 *Triticites* cf. *kuroiwaensis* TORIYAMA, 5, axial section × 10
Loc. SASAM2

Figure 6 *Triticites* cf. *noinskyi* var. *paula* TORIYAMA 6, axial section × 10
Loc. SASAM2

Figure 7 *Pseudoschwagerina* aff. *muongthensis* (DEPRAT), 7, axial section × 10
Loc. SASAM3

Figure 8 *Pseudofusulina kotowi* (SCHELLWIEN), 8, axial section × 10.
Loc. SASAM3

Figures 9, 10 *Pseudofusulina regularis* (SCHELLWIEN), 9, 10 axial sections all × 10
Loc. IIbHil

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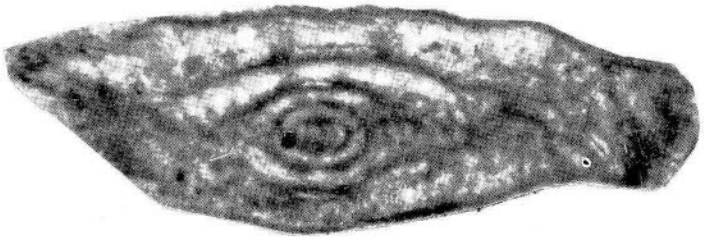

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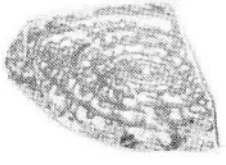

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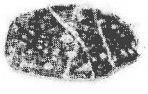

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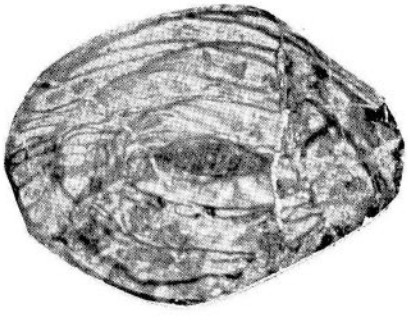

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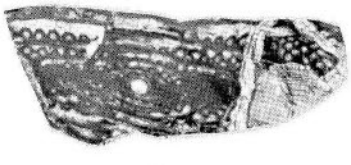

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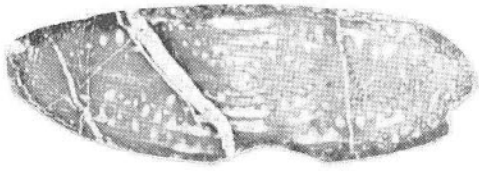
Figures 1～5 *Pseudofusulina fusiformis* (SCHELLWIEN et DYHRENFURTH), 1～5, axial sections all × 10
Loc. 1, ISa7; 2, IKu8; 3, 4, 5 IOt2

Figures 6, 7 *Pseudofusulina tschernyschewi* (SCHELLWIEN), 6, 7, axial sections all × 10
Loc. SASAM2

Figure 8 *Pseudofusulina* cf. *vulgaris* var. *globosa* (SCHELLWIEN), 8, slightly oblique section
Loc. IIbMo2

Figures 9, 10 *Pseudofusulina* cf. *gümbeli* (DUNBAR & SKINNER), all axial sections × 10
Loc. IIbHi 1



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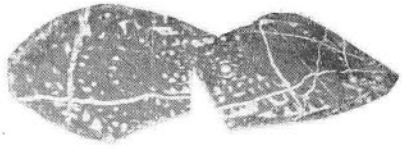

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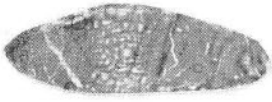

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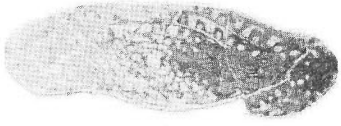

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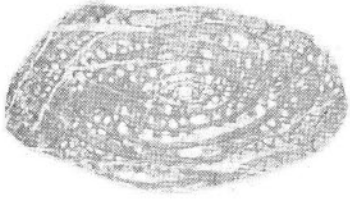

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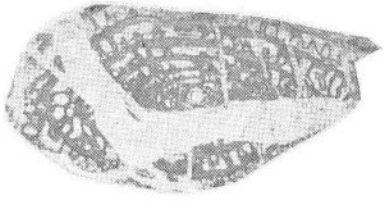

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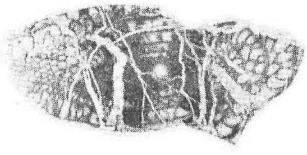

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Figure 1 *Pseudofusulina* cf. *crassa* (DEPRAT), 1, tangential section × 10
Loc. IFu4

Figures 2, 3 *Pseudofusulina lepida* (DEPRAT), all axial sections × 10
Loc. 2, IKu3; 3, IKu7

Figure 4 *Schwagerina japonica* (GÜMBEL), 4, axial section × 10
Loc. IKu8

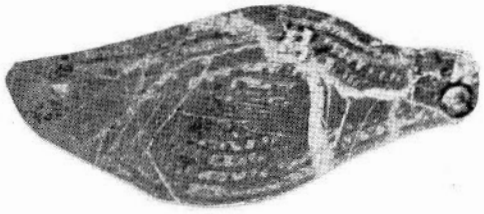
Figure 5 *Parafusulina okuboensis* MORIKAWA, 5, axial section × 10
Loc. IOt2

Figures 6~8 *Parafusulina cayeuxi* (DEPRAT), 6, axial section; 7, oblique section; 8, sagittal section all × 10
Loc. 6~8, IFu1

Figure 9 *Schwagerina* sp. A, 9, axial section × 10
Loc. ISa10

Figure 10 *Schwagerina* sp. B, 10, axial section × 10
Loc. IKu3

Figure 11 *Schwagerina* sp. C, 11, slightly tangential section × 10
Loc. IKu3



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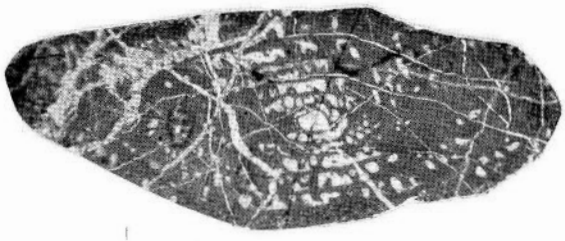

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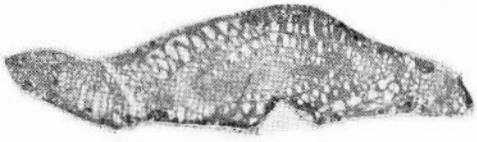

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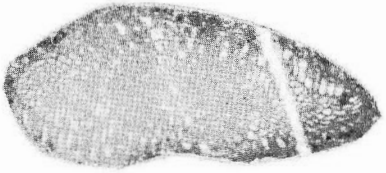

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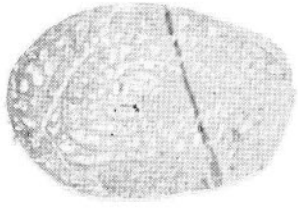
Figures 1～3 *Parafusulina parakinosakii* MORIKAWA et ISOMI, 1～3 oblique section all × 10
Loc. 1, IOt1; 2, IFu1; 3, IOt2

Figures 4～7 *Parafusulina kaerimizensis* (OZAWA), 4, oblique section; 5, 6, axial sections; 7, tangential section all × 10
Loc. 4～6, IKu8; 7, Ka76



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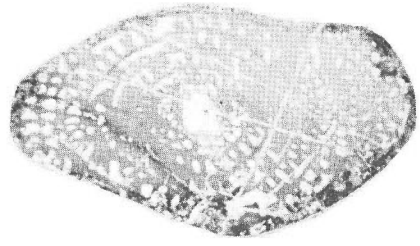

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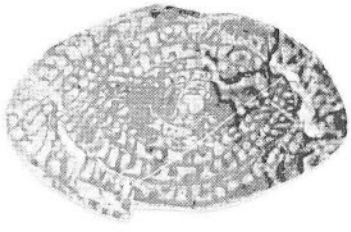

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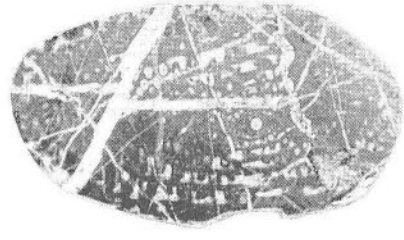

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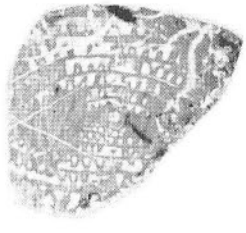

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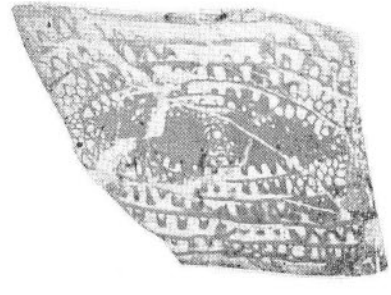

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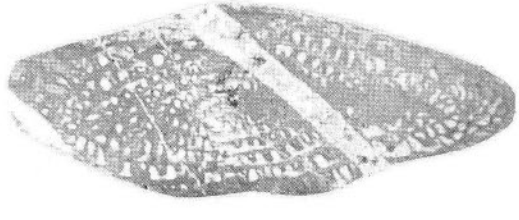

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Figure 1 *Parafusulina* cf. *kaerimizensis* (OZAWA), 1, axial section × 10
Loc. Ka72

Figures 2～4 *Parafusulina takeyamai* MORIKAWA et ISOMI, 2, 3, 4, axial sections all × 10
Loc. 2, IIbMo2; 3, IOt2; 4, IIbHi1

Figures 5～8 *Parafusulina iwasensis* MORIKAWA et ISOMI, all axial sections × 10
Loc. 5, 7, 8, IIbHi1; 6, IKu3

Figure 9 *Parafusulina* sp. B, 9, axial section × 10
Loc. IKu3

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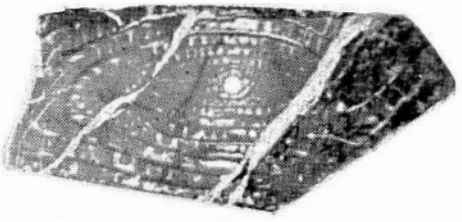

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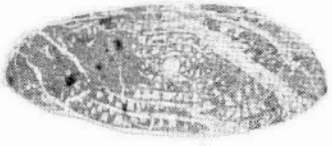

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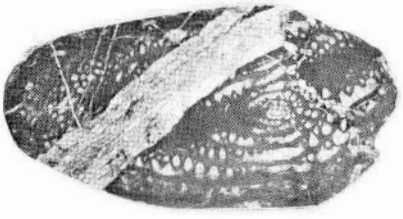

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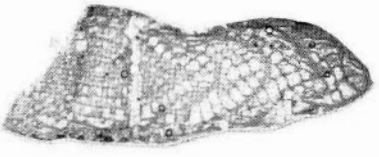

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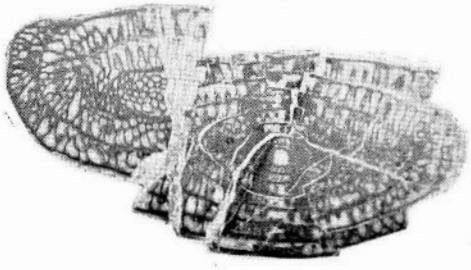

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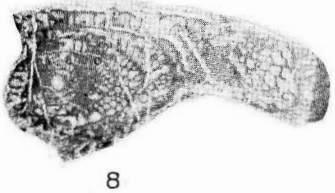

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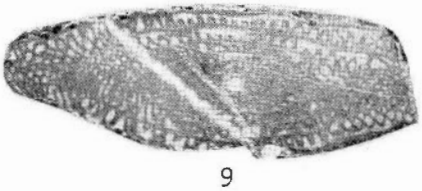

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Figure 1 *Parafusulina edoensis* (Ozawa), 1, axial section × 10
Loc. IFu1

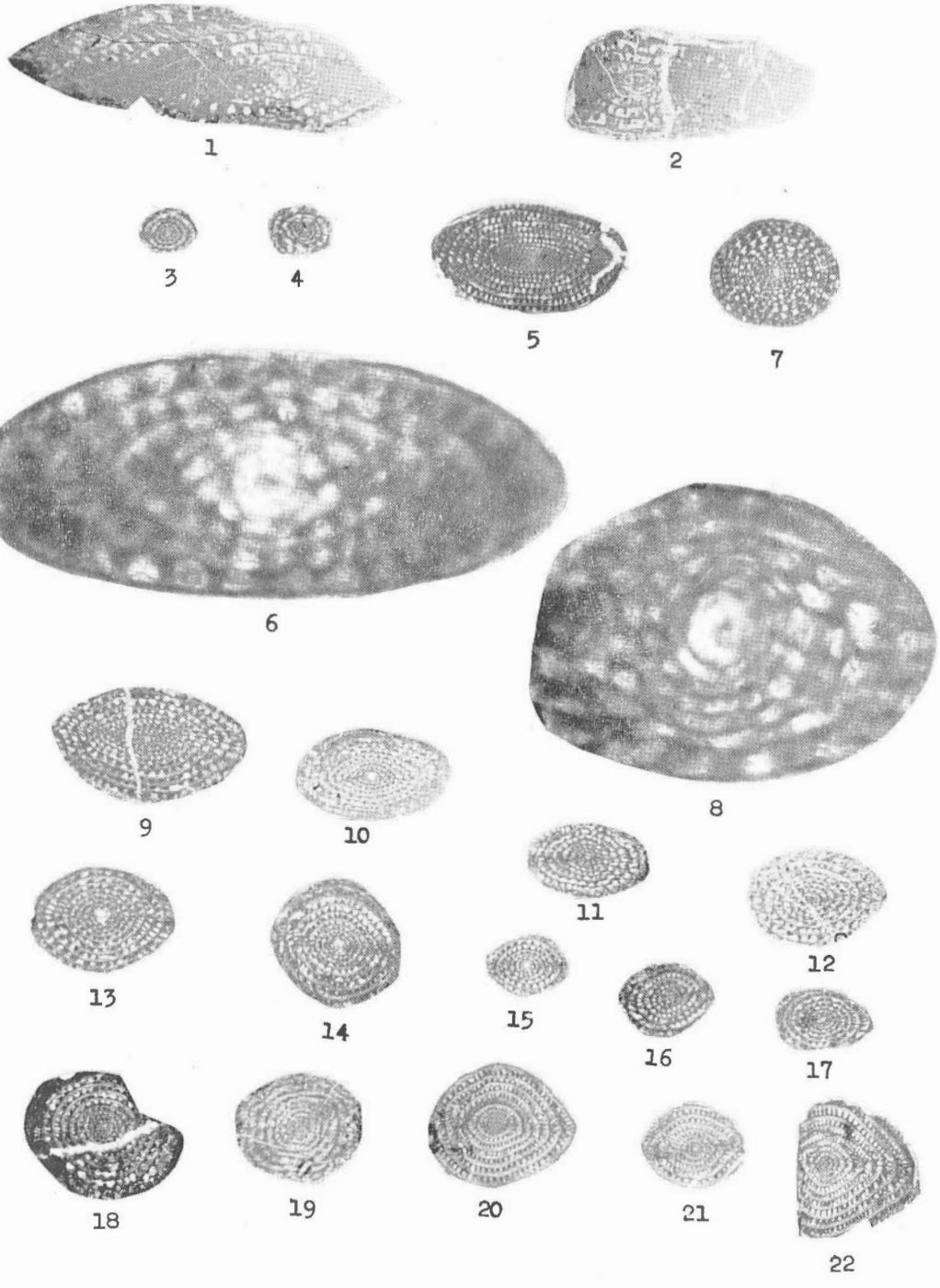
Figure 2 *Parafusulina* sp. A, 2, axial section × 10
Loc. IOt2

Figures 3, 4 *Misellina ibukiensis* Kobayashi, all axial sections × 10
Loc. Ka9′

Figures 5～8 *Pseudodoliolina ozawai* Yabe & Hanzawa, 5, 6, axial sections; 7, 8, sagittal sections 5, 7, × 10; 6, 8, × 100
Loc. Sall

Figures 9～12 *Neoschwagerina nipponica* (Ozawa), 9～11, axial sections; 12, slightly tangential section × 10
Loc. 9, 10, Ka45; 11, Ka9′; 12, ISa4

Figures 13～22 *Neoschwagerina rotunda* (Deprat), all axial sections × 10
Loc. 13～17, IKu7; 18, 19, IFu1; 20, 21, Sall; 22, Ib2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Figures 1～3 *Neoschwagerina rotunda* (DEPRAT), 1, axial section; 2, 3, sagittal sections all × 10
Loc. 1, Ib2; 3, 4, IKu7

Figures 4～22 *Neoschwagerina craticulifera* (SCHWAGER), 4, 5, 7～11, 13～22, axial sections; 12, 21, sagittal sections all × 10
Loc. 4, 5, IIbMo2; 7, S4; 8, 9, Sall; 10～12, Ka75; 13, Ka71; 14～19, Ib2; 6, 20—22, Ka90


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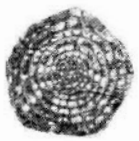
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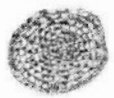
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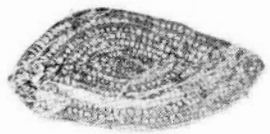
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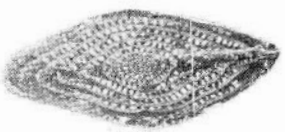
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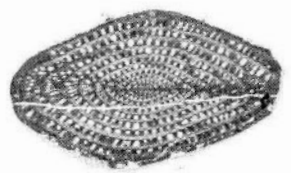
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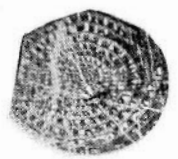
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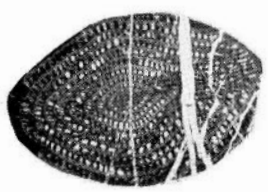
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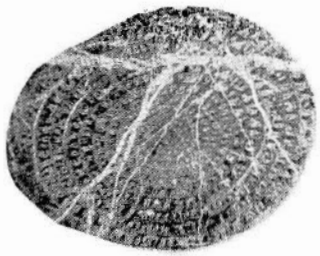
Figures 1～6 *Neoschwagerina margaritae* DEPRAT, all sagittal sections × 10
Loc. 1～3, IFu4; 4, 5, IIbMo2; 6, Ka77

Figure 7 *Neoschwagerina* sp. A, 7, axial section × 10
Loc. Ka71

Figure 8 *Neoschwagerina* sp. B, all sagittal section × 10
Loc. Ib2

Figure 9 *Yabeina*? sp., 9, sagittal section × 10
Loc. Ka22′



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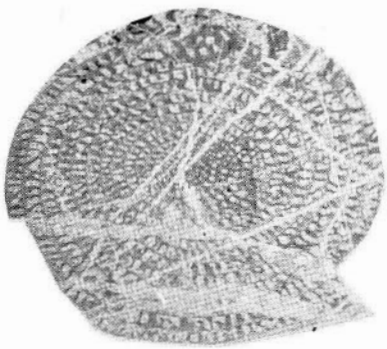

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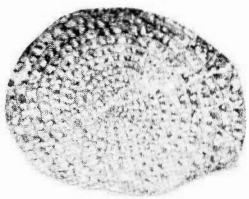

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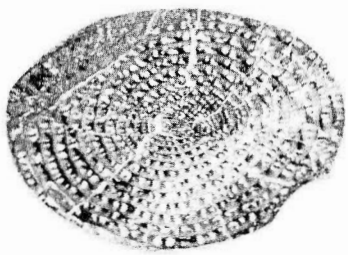

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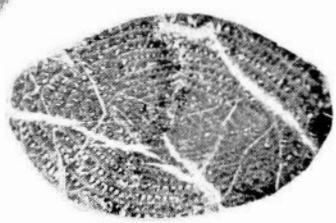

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地質調査所報告は1報文について報告1冊を原則とし，その分類の便宜のために，次のようにアルファベットによる略号をつける。

A．地質およびその基礎科学に関するもの
- a．地　質
- b．岩石・鉱物
- c．古生物
- d．火山・温泉
- e．地球物理
- f．地球化学

B．応用地質に関するもの
- a．鉱　床
- b．石　炭
- c．石油・天然ガス
- d．地下水
- e．農林地質・土木地質
- f．物理探鉱・化学探鉱および試錐

C．そ の 他

D．事業報告

As a general rule, each issue of the Report, Geological Survey of Japan will have one number, and for convenience's sake, the following classification according to the field of interest will be indicated on each Report.

A. Geological & allied sciences
- a. Geology
- b. Petrology and Mineralogy
- c. Paleontology
- d. Volcanology and Hot spring
- e. Geophysics
- f. Geochemistry

B. Applied geology
- a. Ore deposits
- b. Coal
- c. Petroleum and Natural gas
- d. Underground water
- e. Agricultural geology and Engineering geology
- f. Physical prospecting, Chemical prospecting & Boring

C. Miscellaneous

D. Annual Report of Progress

地 質 調 査 所 報 告

第 219 号

高橋　稠：地下水地域調査にみられる水温の総括的研究，1967

第 220 号

斉藤正雄：北海道の鉄資源，1967

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第 223 号

片田正人：長野県木曾地方北部の領家変成帯，1967

REPORT, GEOLOGICAL SURVEY OF JAPAN

No. 219

Takahashi, S.: On the ground water temperature in Japan, 1967 (in Japanese with English abstract)

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Saito, M.: On the iron resources of Hokkaido, Japan, 1967 (in Japanese with English abstract)

No. 221

Bamba, T. & Sawa, T.: Spilite and associated manganiferous hematite deposits of the Tokoro district, Hokkaido, Japan, 1967 (in English)

No. 222

Hoshino, K.: Fracture system of Oshima Island, Kyūshū: A study of jointing in brittle sedimentary rocks, 1967 (in English)

No. 223

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Miyamura, M.

Stratigraphy and Geological Structure of the Permian Formations of Mt. Ibuki and its Vicinity, Central Japan

Manabu MIYAMURA

地質調査所報告, No. 224, p. 1～41, 1967

15 illus., 8 pl., 2 maps.

The stratigraphy and geological structure of the Permian formations of the Yokoyama, Ibuki and South lowland districts were investigated. Moreover, the development of the geological structure of the Ibuki mountain range was discussed.

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