THE STRATIGRAPHY OF THE PALAEOZOIC ROCKS OF THE FUKUJI DISTRICT, SOUTHERN PART OF HIDA MOUNTAINLAND. (STUDY ON PALAEOZOIC ROCKS OF HIDA I)

By

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CONTENTS

ABSTRACT. The district described comprises the extreme eastern wing of the palaeozoic rocks in the Hida region, central Japan. A survey has revealed a succession ranging from Gotlandian to Permian. The rocks are situated at the marginal area of Hida metamorphic complex, lying north-eastern part of Hida plateau widely. The succession is divided into following units:

Hirayu formation	(middle to upper Permian)
Ichinotani formation	(lower to middle Permian)
Mizuboradani limestone	(middle or upper Carboniferous)
Kansaka limestone	(middle Carboniferous)
Sorayama formation	(? upper Gotlandian to middle Carboniferous)
Fukuji formation	(middle Gotlandian)

Previous Work

Little has been published on the geology of this district. The first geological investigation was conducted by **KOZU** (1911), and a map and report were published in 1911. But his substantial work was devoted as to Norikura volcanoe, therefore he only treated this district as the basement and marginal area of this volcanoe. Under the head of "The rocks of basement" he described the palaeozoic rocks of this district briefly. His stratigraphical divisions and geochronological considerations were unsatisfactory, however, he pointed out very important fact that Favosites and Fusulinid are occured associated with each other from Fukuji limestone. Some years after, in the report of "Eruption of Yake volcanoe" **KATO** (1913) described the brief note of the stratigraphy of this district with a geological map, but his work was not so differ from the former. His observation was so precise that correct distribution of various rocks was shown in the map. **YABE** and **HAYASAKA** (1915) stated in "Palaeozoic corals from Japan, Korea and China", Favosites coral of Fukuji, in the section of *Michelinia* (*Michelinopora*) *multitabulata*:

"From the *Fusulina* limestone of Fukuji, Yoshiki-gori, Prov. Hida, S. KOZU (1911) once found a *Favosites* which owing to its unfavourable preservation can not be specifically determined. ...."

Not until the map had been revised, however, did **NODA** and **SATO** (1917) published the descriptive memoir in "Explanatory Text of the geological map of Takayama 1: 200,000." He divided the palaeozoic rocks of this area, in descending order:

3. Clayslate, graywacke, hornstone alternation
2. Hornstone and limestone (Fossil Zone) with intercalating graywacke and clayslate.
1. Schalstein; adinole slate and crinoid-limestone.
   Schalstein and hornstone alternation.

He merely followed after former author's opinion and did not add any new valuable knowledge. Through preceeding investigations, the geological surveyors made one fundamental and common error—they failed to distinguish some limestones of different age, for example, between the gotlandian Favosites-limestone and the permian Fusulinid-limestone. The lackness of biostratigraphical investigation mislead to join some different limestones depending upon only their lithic character, without any detail observation.

In the fifteen or so years since the gotlandian deposits were firstly recognized in Japan from Kitakami mountainland, north-eastern Japan, its areal extent had been roughly worked out. Its stratigraphical position was determined, and some studies had been made of its palaeontological view point as a result of the work of **ONUKI** (1938) and **SUGIYAMA** (1940). After this, several gotlandian deposits are discovered in Japan, from Shikoku island (**KOBAYASHI** and **IWAYA** 1940, **YABE** and **SUGIYAMA** 1942). **SUGIYAMA** (1941) proposed a plan of correlation, Japanese gotlandian to that of central

China, he suggested that Favosites coral occured from Fukuji limestone was as referable to *Favosites asper* d'ORBIGNY which had been found from KAWAUTI series of Kitakami mountainland. As he correlated KAWAUTI series to Salopian of England and Lojoping of central China, so he considered that Fukuji limestone might belong to such middle gotlandian deposits. Succeedingly, **SHIBATA** (1944) led an excursion into this area, and he agreeded SUGIYAMA's opinion and considered schalstein of this district to gotlandian deposits.

Within the last ten years the study of palaeozoic rocks of Japan has been especially extensive and intensive, owing in part to the search for palaeozoics of Kitakami mountainland, and the knowledge of biostratigraphical and comparative tectonics progress in that fields. **MINATO** (1944) and **ŌKUBO** (1950) and their colleagues advanced some fundamental problems at this area. In spite of such enormous progress the palaeozoics of Hida mountainland had been covered by secret veil of so-called "Chichibu system". In order to find the keys for unlocking old secrets, modern knowledge of the palaeozoics of Kitakami mountainland aided for search this district.

Few years ago, **KAMEI** (1949, 1950) reported the gotlandian deposits and other palaeozoics of this district briefly. **MINATO** (1950, 1951) published some short papers on Hida palaeozoics and showed some Carboniferous and Permian fossils from this district. **TAKANO** (1951) surveyed in the vicinity of Takayama, near this district, and reported some permian fossils. And thus it is clear that there are gotlandian to permian deposits around this district, then some important problems are proposed, such as:

1) The basement of the gotlandian.
2) Relation between palaeozoics and metamorphic complex (Hida metamorphic rock complex)
3) Stratigraphy of Hida palaeozoics.

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Geological Aspect

This district is located at the western foot of Yake volcanoe (Iwo-dake), eastern portion of Kamitakara-mura, Yoshiki-gun, Gifu-ken, central Japan. And geologically, this is the marginal boundary area between Hida metamorphic zone and non-metamorphic zone. The basement complex of this district, mainly constituted with palaeozoic rocks, are covered by andesites of the Yake on the east, while by dacite on the west. And through this district from south to north, the river Hirayugawa (upper stream of the river Takara-gawa) makes an abrasion valley with some developed river terraces. Basement complex is made from palaeozoic rocks, mesozoic rocks, quartz-diorite, quatz-porphyry, gabbroic rocks, sepentine, and crystaline schist. These complex bodies are compricated by faults and foldings. This tectonic structure is followed by so-called mosaic structure, but among them faults of EW, NE and NS directions are distinguishable. Such structural movement might be occured post Jurassic age, for the Jurassic sediments (a part of Tetori series) had taken part in this movement.

Crystalline schist (Gamata schist); This rocks are exposed along the river Gamata-gawa against Kansaka with narrow distribution. They are contacted with palaeozoic rocks by faults. They are garnet-bearing biotite-muscovite-albite-quartz schist, zoisite-plagioclase-amphibolite etc.

Palaeozoics: Limestone, schalstein, sandstone, shale, slate, chert. Detail will be followed.

Mesozoics: Conglomerate-sandstone-shale alternations are distributed near Tochio village. Structure of this beds is N40E 30N on the north and N50E 40S on the south, and they are jammed in older rocks in narrow belt of EW direction, like as 'Graben' structure. Following plant fossils were get at Murakami and Kansaka:

Onychiopsis elongata (GEYLER) YOKOYAMA, *Cladophlebis acutipennis* OISHI, *Cladophlebis* sp., *Equisites* cfr. *ushimaruens* (YOKOYAMA)

According to this association, this beds are considered to belong one of the Tetori series which is widely distributed near Furukawa-machi westwardly.

Quartz diorite; Westwards from Tochio along the river Takara-gawa, a large mass of this rock is exposed. Near Tadenomata palaeozoic schalstein is intruded by this rock, and mesozoic rocks at the back of Tochio. Slight contact phenomena can be observed. Mylonitized facies is exposed between Imami and Tochio along the fault zone with crystaline schist.

Gabbroick rocks: This rocks are exposed chiefly along the river Gamata-gawa, near Kansaka and Murakami associated with EW faults. This is somewhat crushed, but is younger than palaeozoic, mesozoic and quartz diorite.

Serpentine: In the valley of Osobu-dani this rock intrudes rather continuously along the EW direction.

Intermediate dyke rocks: Andesitic dykes and porphyrite dykes are seen over this area. These are almost EW to N40E directions with narrow width.

Quartz porphyry: North-eastern part of this district is occupied by large mass of this rock. This has many variable facies and is one of chief constituents of Hida mountain range.

Volcanics and their debris: Hyperthene-hornblend andesite and mica bearing hyperthene-hornblend andesite of Yake volcanoe, Dacite lava of the west, and their debris (including mud flow) thickly cover the basement. They belong the newest in this district, but dacite lava may less newer than andesite.

Terace deposits: Along the river Hirayu-gawa and the river Takara-gawa, there are well developed terraces. They are namely Odana-plane, Uwajigane-plane, Hitoegane-plane and Murakami-plane, from older to newer. Their constituents are almost pebbles of palaeozoic rocks and volcanic materials.

Stratigraphical Succession

In this district, mainly along the river Hirayu-gawa and in the valley of Osobudani, many various palaeozoic rocks are distributed. They are disturbed by many fault system, but it is capable to distinguish each other from lithological characters. These beds are designated from Gotlandian to Permian from coral-brachiopoda-fusulinid time-scale. To these divisions I gave local names considering lithological-faunal correspondences as in following description. Their thickness are difficult to estimate, but have been given where possible.

(a) Gotlandian

(i) Fukuji formation

Distribution; These lowest beds are very limited in outcrops being confined to four localities (1) at the back of Fukuji village and in the northern slope of Osobu valley, (2) near the junction of the river Takara-gawa and the river Gamata-gawa, (3) at the back of Hitoegane village, (4) near Uwajigane village. They have almost EW or NE strikes and are dipping southwardly, but sometimes vertically. The typical outcrops are seen at the back of Fukuji village and in the lower-stream of Ichinotani valley of Osobudani valley. This outcrops are inserted in the younger palaeozoic rocks with N40E direction, as if they are lifted from deeper zone.

Succession;

Lower member. (c.a. 250 m.).—The dominant constituent is a very compact massive, grey to dark grey coloured limestone. And some part refers somewhat silicious aspect. Under the microscope it appears to be little crystaline structure, but very small brachiopoda are found out. In some part hard medium grained sandstone bearing calcite grains are intercalated. The general aspect of the rock suggests a chemical precipitate, possibly organic (i.e. bacterial) origin, under quiet conditions of sedimentation. The sandstone sediments show the act of disturbing transportation. The exposure of this limestone is confineded only at the back of Fukuji village.

By the way, there is another facies which may equivalent to this lower member, south side of the river Gamata-gawa oppositing to Kansaka, though they are ill exposed. Sandstone, slate and tuffeceous rocks are main constituents. Black bituminous shaly limestone bearing *Favosites* sp. *Heliolites decipens* MACCOY, *Amphipora* sp. overlies above them immediately. This limestone may belong to the middle member of this formation. Definite succession of this beds is unknown, but decendingly vitric tuff, tuffeceous sandstone, conglomerate, black slate, arkose sandstone are followed. Besides some boulder of spilitic rocks are found. Relation between them is very obscure, but black slate and arkose sandstone are in some part rather phylitic or schistose appearance. Conglomerate is composed with round pebbles in the matrix of tuffeceous rocks. The sorts of pebbles are mainly andesitic rock, granitic rocks (Trondnjemite, quartz diorite), amphibolite, sandstone, cherty rock, all of them 3–10 cm. in diameter. They are well sorted and irregular limestone inclusion in the matrix is very interesting. I called such conglomerate to **Murakami conglomerate.** Vitric tuff is very characteristic according to thin bedded feature and its pale greenish compact appearance, probably owe to quiet sedimentation.

Middle member (120 m.).—This fossiliferous beds are composed by mainly limestone, but many other facies are intermingled each other and lateral variations are noticeable. Typical exposures are able to be seen at the lower stream of Ichinotani valley, as is shown followingly in descending order.

(Section A)

	..........Fault..........	
(40)	Serpentine sill..........	ca. 10 m
(39)	Sandstone with conglomerates..........	ca. 20 m
(38)	Silicified basic rock	ca. 10 m
(37)	Silicified basic rock, banded..........	ca. 20 m
(36)	..........Intrusion of basic dyke	5 m
(35)	Silicified basic rock	ca. 20 m
(34)	..........Intrusion of andesitic dyke	5 m
(33)	Silicified basic rock	10 m
(32)	Limestone	ca. 10 m*
(31)	Silicified basic rock	ca. 3 m
(30)	..........Intrusion of andesitic dyke	3 m
(29)	Silicified basic rock	10 m

Middle Member

(28)	Shaly limestone	7.3 m*
(27)	Grey limestone	17 m*
(26)	Impure grey massive limestone	ca. 30 m*
(25)	Grey limestone	4.2 m
(24)	Black shale	3.2 m*
(23)	Dark grey limestone..........	1.5 m
(22)	.... unexposed	2.5 m
(21)	Calcareous sandstone	2.0 m*
(20)	.... unexposed	2.2 m
(19)	Sandstone	2.0 m*
(18)	.... unexposed	2.2 m
(17)	Calcareous sandstone	1.7 m*

(16)	.... unexposed	1.6 m
(15)	Tuffeceous sandstone	4.2 m
(14)	Black shaly limestone	4.5 m*

Lower Member

(13)	Vitric tuff, thin bedded pale greenish	2.3 m
(12)	Coarse calcareous sandstone	7.2 m
(11)	.... unexposed	4.2 m
(10)	Black impure limestone	3.7 m
(9)	Hard purpl'sh limestone..................................	1.7 m
(8)	Black impure limestone	11.2 m*
(7)	Brecciated limestone	0.5 m
(6)	Red slate	0.5 m
(5)	Banded limestone	3.0 m
(4)	Ree slate	3.1 m
(3)	Banded limestone	1.5 m
(2)	Black shale	0.2 m
(1)	Grey limestone ....more than	5.8 m

.... Fault ....

note 1: Every unit is treated as one single bed unit.
note 2: Asterisk shows the occurrence of fossils.

40. Serpentine sill intrudes along NEE faults in Osobu-dani valley, and this run rather continiously associated with serpentinized schalstein.

39. Coarse brownish tuffeceous sandstone with conglomerate which contains sandstone, red slate, tuffeceous rock-, and schalstein-pebbles of granule to pebble size, distributing on the left mountain-slope at the entrance to Ichinotani valley.

38-29. Black to grey silicified basic rocks are widely exposed, they are bedded in some part and are massive in another part. These may be contributed by volcanic origin, for under microscope remaining ophitic texture can be observed. Main components are basic plagioclase, pyroxen, secondary vermiculate quartz grain and vitreous glass. So it may refer to silicified schalstein. Intercalated with these rocks, limestone bearing *Amphipora* sp. (32) is poorly exposed. Fresh intermediate to basic dykes intrude these rocks concordantly.

28. Black shaly bituminous limestone, which comprises corals, brachiopoda etc. is underlain successively. These fossils make several lenticular

form fossil enclosures with about 1–3 m in diameter, but sometimes above and under this enclosure fossils are scattered sporadically.

27–23. Thick massive grey limestone without any remarkable bedding plane. Tabulata corals are occured randomly.

24. Black shale is interbedded between grey limestone distinctly. Many flat-shell brachiopoda are closely embedded. Tracing lateraly, this rock merges into limestone. So the whole feature of this shale may be lenticular shape.

22–15. Calcareous crynoidal sandstone, or calcarenite bearing aboundant crinoid-stems and other fragments are associated with grey to yellow fine tuffeceous massive sandstone.

14. Black limestone bearing bryozoa poorly.

13. Fine compact blue to greenish slaty vitric tuff in thin bedded. This is quite resemble to that of against Kansaka.

12. Coarse calcareous sandstone.

10–1. Hard compact massive limestones comprising some bryozoa scarcely.

6, 4. Red slates are closely related with limestone. In another locality, near Uwajigane, this rock from which Kato (1913) discovered some radiorarian remains is seen associated with schalstein.

The fossils found are listed below:—

Favosites gotlandicus LAMARCK	27, 26.	common
Favosites asper d'ORBIGNY	26.	rare
Heliolites decipens MACCOY	28.	rare in F.E.
Heliolites barrandei (HOERNS)	26.	rare
Striatopora sp.	28.	common in F.E.
Cyathophyllum sp.	28, 27, 26.	common in F.E. (28)
Amphipora sp.	32.	aboundant in F.L.
Atrypa reticularis LINN.	28, 24.	common
Meristina sp.	28.	rare
Rafinesquina sp.	24.	aboundant in F.B.
Clitambonites sp.	24.	common in F.B.
Dalmanella sp.	24.	rare in F.B.
Trilobita pygdium	28.	only one
Crinoid stem.	21, 19, 17, 12.	common in F.E.
Bryozoa	14, 18.	rare.
Pelecypoda, Gen and sp. indet.	24.	rare.

note; F.E: Fossil enclosure, F.B.: Fossil bed, F.L.: Fossil layer

About 300 m west of this exposure following succession can be seen, in descending order:

(Section B)

(15)	Banded limestone	10.5 m*
(14)	Alternation of sandstone and shale	2.5 m*
(13)	.... unexposed	4.8 m
(12)	Limestone	0.9 m
(11)	Coarse grained bluish sandstone	1.4 m
(10)	.... unexposed	2.8 m
(9)	Coarse grained bluish sandstone.......................	5.5 m
(8)	.... unexposed	2.8 m
(7)	Limestone	1.1 m
(6)	Tuffeceous sandstone	1.6 m
(5)	Coarse grained bluish sandstone	2.6 m
(4)	Banded limestone	1.5 m
(3)	.... unexposed	3.2 m
(2)	Banded limestone	1.3 m
(1)	Hard compact fine sandstone	

These banded limestone and alternation of sandstone-shale are made up from alternation of beds which have 15–30 cm. thickness, interbedding thin shaly layers. Fossils are occured from (15) and (14) in the form of fossil layers. They are densely composed from shell fragments and crinoid stems. *Rafinesquina* and *Coenites* are chief elements. This facies may be one of the variation of middle member, and banded appearance or well bedded feature is remarkable.

Immediately above these beds, fossiliferous black bituminous limestones are exposed near the ridge. Every limestones are composed with stromatoporoids and corals, as listed below;

Clathrodictyon tenuilaminatum SUGIYAMA	common
Clavidictyon columnare SUGIYAMA	rare
Amphipora cfr. *cylindrica* SUGIYAMA	aboundant
Tryplasma hayasakai SUGIYAMA	common
Tryplasma ozakii SUGIYAMA	common
Favosites cfr. *forbesi* EDWARDS & HAIME	rare
Favosites cfr. *minor* SHIMIZU & OZAKI & OBATA	common
Coenites triangularis SUGIYAMA	common
Cyathophyllum sp.	common
Actinoceratid.	rare

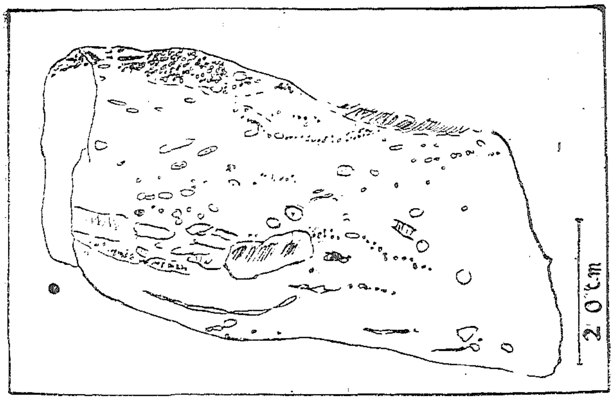

Fig. 1. Sketch of fossil stratification in limestone.

It is interesting fact that this limestone shows fossil stratification (Fig. 1) which is closely resembles cross-lamination filling. It is densely compacted by numerous fossils, but these are arranged roughly parallel with each other. Such feature represents in one instances one phase of a phenomenon that fossils are transported at the time of sedimentation just like as gravels and pebbles.

Fossiliferous limestones are aboundant at the back of Fukuji village, but they are brought from this above stated limestone mass. From this limestone boulder, following fossils are found:

Clathrodictyon tenuilaminatum SUGIYAMA	common
Amphipora cfr. *cylindrica* SUGIYAMA	common
Cyathophyllum sp.	common
Tryplasma sp.	common
Favosites gotlandicus LAMARCK	common
Favosites gotlandicus fukujiensis var. nov.	rare
Favosites cfr. *asper* d'ORBIGNY	rare
Favosites cfr. *forbesi* EDWARD & HAIME	rare
Favosites sp. (a)	rare
Striatopora sp.	rare
Pachypora sp.	rare
Coenites sp.	rare
Heliolites decipens MACCOY	rare
Heliolites bohemicus WENTZEL	rare
Leptaena rhomboidalis (WAHLENB)	rare
Atrypa reticularis (LINN)	rare
Orthoceratid.	very rare
Actinoceratid.	very rare
Gastropoda. Gen. and sp. indet.	very rare

Upper member (ca. 150 m),—This part is mainly composed so called schalstein interbedding conglomerates, sandstone, limestone. In this turn, the term of 'schalstein' is given to dark green volcanic complex rock of andesite, andesitic tuff, tuffeceous sandstone and tuff breccia. These rocks are distributed in and along the valley of Osobu-dani, at the west side of the river Hirayu-gawa against Murakami village, at the back of Hitoegane village and Uwajigane village. Sometimes, they are intruded by micro-gabbro or gabbro porphyrite. Near Murakami, conglomerate of 19 m thickness exposed along the river side. I called it "Murakami conglomerate", owing to the facies resemble to precedingly stated conglomerate of the lower member. This conglomerate is intercalated in massive schalstein, but it lateraly fade away into the later. Angular to subangular pebbles of 3–7 cm in diameters, of basaltic rocks, porphyritic rocks, granitic rocks, sandstone and cherty rocks are cemented in the matrix of red tuffeceous rocks and limestone. Upper part of this conglomerate, limestone matrix are aboundantly developed in lenticular or irregular shape. The arrangement of this limestone is regularly as is shown in Fig. 2, 3. From this limestone part, I gained some fossils, *Favosites sp.* (b), *Clathrodictyon onukii* SUGIYAMA, *Amphipora* sp., brachiopoda and crinoid stems which are same to those from the middle member.

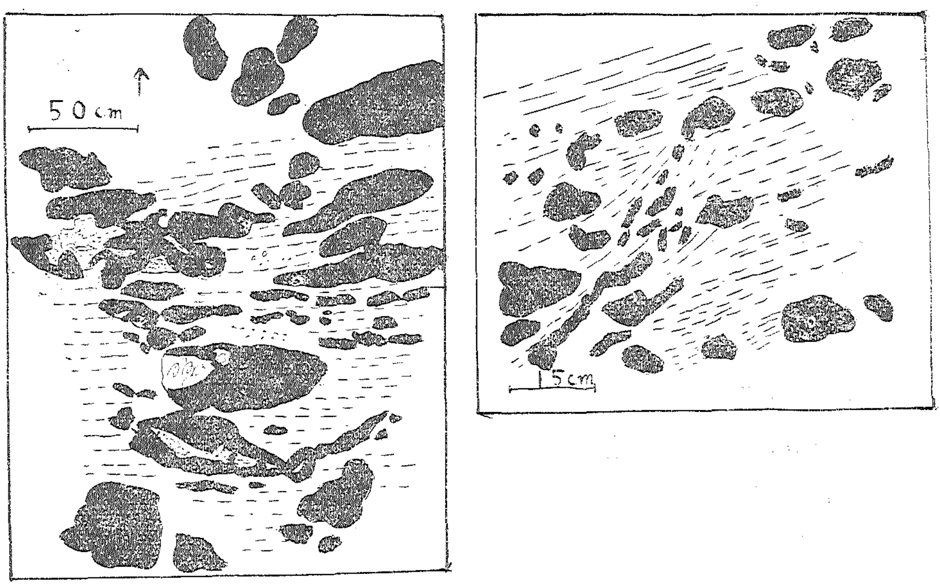

Fig. 2, 3. Sketch of the limestone arrangement in the matrix of Murakami conglomerate. Black part is limestone and blank part is tuff and conglomerates.

Sedimentation;

To the foregoing description now I can add some observation and consideration to the sedimentation of this group. Above described division of upper, middle and lower members is quitely artificial for convenience. And so I tried to observe the mutual relation between facies variation and so-called fossil zone. In the present treatment, however, one very interesting fact can be seen in the middle member (Section A). Namely following divisions are capable from upper to lower, depending upon their own characteristic fossils. (a) Cyathophyllum-Striatopora black shaly limestone. (b) Favosites grey massive limestone. (c) Rafinesquina black shale. (d) Crinoidal calcareous sandstone. (e) Bryozoa black limestone.

These divisions are roughly correspond to rock facies unit, and the boundary between them are represented by either clen cut bedding plane or transitional boundary. Furthermore, observing to their lateral variation, almost in everytime they fade away into other facies or sometimes remain nodule like concreation in other rock. In such case, faunal sequences are confused, intermingles or reversed order. And the relation between rock facies and fossil characters shows some regular form that extremely definite facies are characterized only some definite fossils, but intermediate facies are represented by mixture of several fossil characters.

Then, if it were undertook to compare Section A. to Section B., lateraltransition or interfingure relation between both rock facies might be figured some irregular relation. And from fossil community, divisions which are recognized in Section A. hardly exist in Section B. To fossil occurence, though they are large or small in scale, it is characteristic that fossils are enbedded crowdly, as fossil enclosure, fossil layer and fossil bed (aggregates of fossil layer). (IJIRI & FUJITA, 1948. 1949). It is very rare that any individual occure independantly. Definite fossil community is restricted corresponding to definite rock facies, for example corals to limestone, brachiopoda to shale, crinoid to sandstone.

Therefore, I can not recognize there is some fossil zone which is characterized to some definite fossils indifferent to rock facies. Coclusively:

(1) *Definite fossil community is characterized by definite rock facies.*
(2) *There is no fossil zone indifferent to rock facies.*
(3) *There is no large gap to separate rock facies vertically.*
(4) *Fossil sediments is mainly affected by the transportation.*

From above conclusions it is assumed that these sediments accumulated rather continuously and may be in relative quiet condition presumingly from the lamination of tuff, vertical variation of sediments and fossil occurences. And al o, this is verified from the degree of damage of fossils, for thin shell brachiopoda like Rafi esquina is remained rather perfectly (partly deformed secondarily). Rafinesquina and other brachiopoda are restricted in black shale and in bituminous limestone and had not been suffered strong current action and transportation of long way. On the contrary, corals and stromatoporoid which often make reef are enriched in limestone of well sorted appearance or sporadic form. These fact leads me to assume that such environment was made up from the complex muddy rich condition having less coarser sediments and sedimentation-precipitation of calcareous water condition. Inserted with such condition supply of rather basic volcanic materials are recognized. And it may be thought that associated with this volcanic action (perhaps submarine volcanism) unstable condition of sea floor might take part in the formation of these beds.

Fukuji formation is summarized below:

Upper member.

mainly schalstein, conglomerate, limestone.

Clathrodictyon, Favosites, Amphipora, etc.

Middle member.

black bituminous limestone, black shale, sandstone.

Favosites gotlandicus, F. asper, Heliolites decipens.
Clathrodictyon tenuilaminatum, Amphipora cylindrica
Tryplasma, Cyathophyllum, Stiatopora, Coenites,
Atrypa reticularis, Rafinesquina, etc.

Lower member.

Conglomerate and spilitic rock	vitric tuff
vitric tuff	red shale
black slate, sandstone	Hard massive limestone

Bryozoa, Brachiopoda.

(b) Gotlandian—Carboniferous

(i) Sorayama formation (ca. 550 m) ;—The river side cutting, along the west side of the river Hirayu-gawa, exposes greenish schalstein. Owing to its massive character and lackness of fossil occurence, stratigraphical division is impossible. But roughly, it is divisiable into following rock aspect from upper to lower:

(4) Agglomeratic schalstein
(3) Reddish green schalstein
(2) Hard siliceous blue green schalstein
(1) Dark green schalstein

The lowest dark green schalstein is very calcareous, bearing some limy part. In some part fine laminated sandy part is intercalated in andesitic lava and tuff breccia. Calcareous part or limestone is developed with about 1 m. thickness. Redish green schalstein is made up mostly from meta-andesite and meta-basalt which is intervene by numerous calcite veins. Hard siliceous bluish green schalstein is porphyroid tuff and clastic tuff. Reddish green schalstein and anglomeratic schalstein is chiefly composed with chlorite-hornblend-biotite-porphyrite, hornblend andesite.

This formation is transitional from Fukuji formation, but the upper limits is unknown. Another distribution of this rock can be seen in the valley of Iwatsubo-dani.

(ii) Kansaka limestone;—At south side of the river Gamata-gawa against Kansaka village, there is small occurence of black limestone, partly cherty, exposing badly. This limestone is intruded by gabbro porphyrite on and west, and is contracted with gotlandian limestone of Fukuji formation by the fault on the east.

The only fossils found are listed below;—

Fusulinella bocki (v. MÖLLER)
Fusulinella sp.
Textularia cfr. *gibbosa* d'ORBIGNY
Dibunophylloid coral.
Campophylloid coral.

(iii) Mizuboradani limestone (40 m);—Near Fukuji village, in the valley of Mizubora-dani, there is another black limestone which is comparable or somewhat upper to above described Kansaka limestone. This is contacted with Fukuji Formation and Sorayama group on both side by faults. Some fusulinid fossils are discovered as:

Triticites cfr. *montipora* (EHRENBERG)

Fusulinella sp.
Crinoid stem, etc.

The stratigraphical position of this limestone is very obscure, but in some part this may be seen to be included in Sorayama formation and is overlain by Ichinotani conglomerate which is belong to the basal Permian. And so now I set th's as same horizon as Kansaka limestone or somewhat upper to that. Detail investigation is left in future.

(C) Permian

Along northern portion of the valley of Osobu-dani leading southwards in the upper stream of Ichinotani and Mizuyagatani, there are coral-fusulinid-brachiopoda lim.stone of permian age. Here the rocks are bluish grey limestone which are in places crinoidal. There are some tuffeceous rocks, sandstone, shale and conglomerates in them. They have been distributed EW direction dipping southwardly with high angles.

Overlying the schal.tein which may belong to Sorayama formation is a conglomerate which has been called as Ichinotani conglomerate. Following succession can be seen in the upper stream of Ichinotani valley from upper to lower.

(Section C)

Upper Member

	.... Fault	
(32)	Grey tuffeceous rock	ca. 42 m
(31)	Blue limestone	1.0 m*
(30)	.... unexposed	6.0 m
(29)	Blue limestone	5.5 m*
(28)	.... unexposed	1.0 m
(27)	Blue limestone	2.5 m
(26)	.... unexposed	3 m
(25)	Blue limestone	11.0 m
(24)	.... unexposed	1.0 m
(23)	Shale	1.7 m
(22)	Blue limestone............	8.0 m*
(21)	Tuffeceous rock	2.5 m
(20)	Blue limestone somewhat colitic	2.5 m
(19)	.... unexposed	1.5 m
(18)	Blue limestone	1.5 m
(17)	Tuffeceous rock	2.5 m
(16)	.... unexposed	2.0 m

Lower Member

(15)	Banded limestone	1.5 m
(14)	.... unexposed	2.0 m
(13)	Crinoidal detrial limestone	3.0 m*
(12)	.... unexposed	11.0 m
(11)	Grey limestone	2.5 m*
(10)	.... unexposed	1.0 m
(9)	Grey limestone	3.5 m
(8)	.... unexposed	10.0 m
(7)	Black limestone	8.0 m*
(6)	.... unexposed	4.0 m
(5)	Coarse sandstone	2.5 m
(4)	Fine sandstone	3.0 m
(3)	Thin alternation of sandstone shale.................	6.0 m
(2)	.... unexposed	30.0 m
(1)	Conglomerate and conglomeratic sandstone	9.0 m
(0)	Schalstein	

Blue limestone is massive and ordinary associated with clastic or lithic tuff which is pale yellowish green colore, while black limestone is banded and is interbedded in the shale and sandstone. From this association these beds are divided into upper blue limestone-tuff beds (32)-(16) and lower black limestone-sandstone-shale, conglomerate beds (15)-(1).

Conglomerates are cemented with dark blue sandstone matrix. The included pebbles vary greatly in size from a few centimeter to small grains of 1-2 milimeter. The largest are subangular pieces of grey limestone up to 4 cm. long but very occasionally and are probably derived from the underlying beds. The remaining pebbles are mainly well-rolled portions of sandstone, shale, schalstein usually less than an centimeter length. Found with them are small pebbles of chert, greenish igneous rocks too decomposed to identify with certainty. As the exposures are traced westwards, sometimes disappear and sometimes the pebbles appear to become larger in size as in the valley of Mizuyagatani.

A list of the fossils obtained here is added by the report of MINATO (1950), and whole collection is as below:

Upper member:

Arachnastrea cfr. *molli* (STUCKENBERG)	31	rare
Polythecalis yangtzeensis hidaensis var. nov.		rare

Batostomella sp.	29, 22	common
Parafusulina sp.	24	rare

Lower member:

Cystiphora manchurica forma *kikawai* (YABE et HAYASAKA)	7	rare
Clisaxophyllum sp.	7	common
Pseudoscheagerina cfr. *schllewien* YABE et HANZAWA	11	rare
Pseudoschwagerina sp.	7 ?	
Crinoid stem.	7, 11	common

Another exposure can be seen in the valley of Mizuyagatani, about 1500 m. east. Here the following section have been aquired.

(Section D)

Upper Member

(40)	.... unexposed	
(39)	Blue limestone	4 m*
(38)	.... unexposed	10 m
(37)	Blue limestone	5 m
(36)	.... unexposed	4 m
(35)	Blue limestone	5 m
(34)	.... unexposed	7 m
(33)	Blue limestone	4.5 m
(32)	.... unexposed	1.0 m
(31)	Blue Limestone	3.0 m
(30)	.... unexposed	5.0 m
(29)	Blue Limestone	5.5 m*
(28)	.... unexposed	10.0 m
(27)	Blue Limestone	7.0 m*
(26)	Calcareous tuff	5.0 m*
(25)	Banded black fine sandstone	6.0 m
(24)	Tuffercebus sandstone	5.0 m
(23)	Red tufferceous shale	4.0 m
(22)	.... unexposed	5.0 m
(21)	Banded tufferceous sandstone	10.0 m
(20)	Conglomeratic sandstone	0.8 m
(19)	Black limestone	1.0 m
(18)	Banded tuffeceous rock	6.0 m

Lower Member

(17)	Thin alternation of shale sandstone	2.0 m
(16)	Coarse sandstone..	1.8 m
(15)	.... unexposed	2.0 m
(14)	Alternation of shale sandstone	5.0 m
(13)	.... unexposed	7.0 m
(12)	Coarse sandstone..	3.5 m
(11)	.... unexposed	7.0 m
(10)	Thin alternation of shale sandstone	5.5 m
(9)	.... unexposed	0.8 m
(8)	Thin alternation of shale sandstone	5.5 m
(7)	Coarse sandstone..	3.0 m
(6)	.... unexposed	5.0 m
(5)	Fine sandstone..	3.0 m
(4)	Blue coarse sandstone	5.0 m
(3)	Pebbly sandstone..	7.5 m
(2)	Coarse sandstone..	2.5 m
(1)	Conglomerate	40.0 m
(0)	Schalstein and limestone...	

In this section upper part is represented by blue limestone while lower part shale-sandstone-alternation, sandstone and conglomerate.

Upper limestone yield some fossils.

Sochikineophyllum tenuiseptatum (SOCHKINS)	26, 27	common in F.E.
Parafusulina sp.	33, 39	common in F.E.
Schwagerina sp.	33	rare
Spirifer. (*Spiviferella*) cfr. *salteri* TSCHERNYSCHEW.	27	common in F.E.
Squamularia asiatica CHAO.	26, 27	common in F.E.
Pustula (*Echinoconchus*) sp.	27	common in F.E.
Marginifera sp. indet.	27	common in F.E.
Dielasma sp.	27	common in F.E.
Spirifer sp.	27	common in F.E.
Crinoid stem	26, 27	common in F.E.
Bryozoa	26, 27	common in F.E.

The conglomerate is best seen in a ridge of northern end of Mizuyagatani, but it is sometimes found higher on the hillside as isolated patches The included pebbles are from pebble to cobble size of sandstone, shale, schalstein and hard compact porphyritic rock and green igneous rock. This conglomerate, Ichinotani conglomerate is not uniform, either in grain-size or thickness. But they always come to the lowest part of this group.

(ii) Hirayu Formation

This beds is best seen at the southern portion of this district along the river Hirayugawa, which gives its name to the formation. This is composed mainly with clayslate, sandstone and chert in which few limestone and schalstein are intercalated. On the west of the river Hirayugawa, structure varies from southwardly from NNE, strike-eastward dip to NEE. strike-southward dip, while on the east of this river samely from NNW strike eastward dip to NWW strike-southward dip. This is shown, as a whole, synclinal basin structure opening to the south.

Upper part is exposed along the way from Hirayer Pass to Hiraya, and there is clayslate, limestone, sandstone, black chert alternation. Westwards from Hirayu and along the river Hirayu-gawa these beds are repeatedly exposed. And here thick clayslate and banded milky chert and sandstone are characteristic.

Lower part which is composed with clayslate, fusulinid limestone, sandstone and chert, is seen west of Hirayu-pass, near in the valley of Kaisyodani and southern part of the valley of Osobudani.

And at the latter locality some schalstein bed is intercalated with above stated rocks. The limestone which is outcroped at the west of Hirayu-pass yields some fusulinids, *Schwagerina* sp. etc, and it extends westwardly. Near the junction of the river Hirayugawa and Kaisyo-valley, at the hillside the limestone which yields *Neoschwagerina* cfr. *margaritae* DEDRAT, *Neoschwagerina* sp. and *Parafusulina* sp. is exposed.

This beds is widely distributed to Takayama westwardly, while to Azusagawa eastwardly. Relation to underlying Ichinotani formation is presumely to be successive without any break. The lowest part of this formation is represented by limestone schalstein and sandstone, but in Osobu-dani valley this sandstone facies is partly conglomeratic having some pebbles of granule to coarse sand size. Besides, this sandstone comprises some slate breccia or flakes. This may be the record of the change of environment at the time of sedimentation. But of course, it does not mean the interval in strata, from its intra-formational occurence.

Correlation

It is hardly difficult to establish whole sequence of palaeozoic rocks of this district, owing to their fragmental structure and overlying by lava flow and volcanic detritus. However, the observation and investigation gave for us some chance to correlate the palaeozoic rocks of this district to that of the other districts and to consider some speciality of this district as a part of Hida orogenic zone. I established following divisions of the correspondence to faunal and lithic characters, from lower to upper.

(a) Fukuji formation.
(b) Sorayama formation.
(c) Kansaka limestone.
(d) Mizuboradani limestone.
(e) Ichinotani formation.
(f) Hirayu formation.

(a) Fukuji formation.

It is consisted with fossiliferous limestone, schalstein, sandstone, shale, conglomerate etc. But it is denied to distinguish several fossil zone in them by characteristic some fossils, from the view point of sedimentation.

Following fossils are occured from this group;—

Stromatoporoids:

Clathrodictyon tenuilaminatum SUGIYAMA, *C. onukii* SUG., *Cavidictyon columnare* SUG., *Amphipora* cfr. *cylindrica* SUG., *Labechia* sp. indet.,

Tetracorals:

Cyathophyllum sp. *Tryplasma hayasakai* SUG., *T. ozakii* SUG. *Tryplasma* sp.,

Tabulata:

Favosites gotlandicus LAMARCK, *F. gotlandicus hukujiensis* var. vov., *F.* cfr. *asper* D'ORBIGNY., *F.* cfr. *forbesi* EDWARD & HAIME., *F.* cfr. *minor* SHIMIZU, OZAKI & OBATA., *F.* sp. (*a*)., *F.* sp. (*b*)., *Striatopora* sp., *Pachypora* sp., *Coenites triangularis* SUG., *Aulopora* sp., *Heliolites decipens* MACCOY., *H. bohemicus* WENTZEL., *H.* cfr. *barrandei* (HOERNES)

Brachiopoda:

Atrypa reticularis (LINN.), *Atrypa* sp., *Leptaena* cfr. *rhomboidalis* (WAHLENB.), *Rafinesquina* sp., *Clitambonites* sp., *Daimanella* sp., *Meristina* sp. indet.,

Bryozoa:

Dianulites ? sp., *Favositella* ? sp.

Nautiloids:
Orthoceratid Gen. and sp. indet., Actinoceratid Gen. and sp. indet.

Gastropoda: Gen. and sp. indet.
Pelecypoda: Gen. and sp. indet.
Trilobita: Gen. and sp. indet.

Above listed fauna, which is taken by the writer as a unit fauna—the Fukuji fauna, has species in 20 genera and their geological range and maximum development is as follows:

		Geological range	Maximum development
1.	*Clathrodictyion*	Cambrian—Devonian	(Gotlandian)
2.	*Clavidictyon*		(Gotlandian)
3.	*Amphipora*	Ordovician—Devonian	(Gotlandian)
4.	*Labechia*	Ordovician—Carboniferous	(Devonian)
5.	*Cyathophyllum*	Ordovician—low. Carboniferous	(Devonian)
6.	*Tryplasma*	Gotlandian—Devonian	(Gotlandian)
7.	*Favositos*	up. Ordovician—Carboniferous	(Gotlandian) (Devonian)
8.	*Striatopora*	Gotlandian—Devonian	(Gotlandian)
9.	*Pachypora*	Gotlandian—Devonian	(Gotlandian)
10.	*Coenites*	Gotlandian—Devonian	(Gotlandian)
11.	*Aulopora*	Gotlandian—Carboniferous	(Devonian)
12.	*Heliolites*	up. Ordovician—low. Devonian	(Gotlandian)
13.	*Favositella*	Ordovician—Gotlandian	
14.	*Dianalites*	Ordovician—Gotlandian	
15.	*Leptaena*	Ordovician—low. Carboniferous	(Gotlandian)
16.	*Rafinesquina*	Ordovician—Gotlandian	(Ordovician)
17.	*Clitambonites*	Ordovician—Gotlandian	(Ordovician)
18.	*Dalmanella*	Ordovician—Devonian	(Ordovician)
19.	*Atrypa*	Ordovician—Devonian	(Gotlandian)
20.	*Meristina*	Gotlandian	(Gotlandian)

There is none which its distribution only in Ordovician or in Devonian, while most of them have its maximum development in Gotlandian, Speaking to the number of individuals, *Clathrodictyon, Amphipora, Tryplasma, Cyathophyllm, Favosites, Striatopora, Heliolites, Atrypa, Rafinesquina* which is representatives of gotlandian are common in number.

Of specifically, *Favosites gotlandicus, Favosites asper, Heliolites decipens, Heliolites bohemicus, Heliolites barrandei, Atrypa reticularis,* which are common in Fukuji fauna, are characteristic specieses of cosmopolitan in middle Gotlandian age.

Comparing them to other gotlandian deposits of Japan, this fauna is quite resemble to Kauauti-fauna of Kitakami mountainlands. But, instead of *Halysites* and *Encrinurus*, this fauna contains some Nautioids and many braihiopoda. SUGIYAMA (1940) considered that the geological age of Kawauti-fauna might be correlate to that of Wenlock limestone of England, Louisville limestone of North America, Lojaping series of middle China, so it is defined as middle gotlandian age. In Kitakami mountainland Group 1 of Takainari series (Kawauti series of Kawauti fauna) is the lowest, and above them fossil barren beds overlie. In my field, fossils are restricted only in limestone of Fukuji group, so I designate the age of this group as middle gotlandian age. To other gotlandian deposits of Japan, namely in Hida, Shikoku, Kyushu, it can be say to be same as such situation. In Hida region, two other localities, upper stream of Kuzuryu river (**ISIOKA & KAMEI** 1950) and Naradani (**KANUMA & HUZIMOTO** 1951) there are as same deposits as Fukuji group characterized by the presence of fossiliferous limestone (*Favosites*, *Heliolite*, *Clathrodictyon*), schalstein and Conglomerate. (Marakami type conglomerate).

(b) Sorayama formation

This thick schalstein formation is quite barren in fossils. Accordingly, it is impossible to determine its geological age, but it is assumingly comparable to upper gotlandian to Carboniferous owing to its overlying above Fukuji formation.

In other locality of gotlandian deposits of Japan such schalstein overlie also on gotlandian group and in Kitakami mountains III Group of Takainari system (middle Devonian) is represented by schalstein. This thick fossil barren group, which may be originated to intense submarine volcanism intercalating limestone deposition shows the speciality of the middle palaeozoic environment of this region.

(c) Kansaka limestone.

According to its fragmental occurrence and ill preserved fossils, it is difficult to clarify its stratigraphical position. This black, partly cherty, limestone yields some fossils

Fusulinella bocki (V. MÖLLER.)
Fusulinella sp.
Texturalia cfr. *gibbosa* d'ORBIGNY
Dibunophylloid coral
Camophylloid coral

The presence of *Fusulinella bocki* (V. MÖLLER), and *Texturalia cfr. gibbosa* d'ORBIGNY may be referable this limestone to Moscovean of Ural, upper and middle part of Atokan series of North America, Huanglung limestone of South china and Nagaiwa series of Kitakami mountainland Japan. So it may set as about Moscovian or middle Pennsylvanian.

(d) Mizuboradani limestone

This limestone yields some following fossils.

Triticites cfr. *montipora* (EHRENBERG)
Fusulinella sp.
Crinoid stem, etc.

The stratigraphical position of this limestone is very obscure, but it may stand on or upper part of Sorayama group to its distribution. But it is doubtless to be underlain to basal permian Ichinotani group. *Triticites montipora* is reported from Uralian of Ural and C3 of Kanto mountainland in Japan.

Recently, the presense of Fusulina zone in Japan has been reported from central Kyushu, (**KANMERA** 1952) and same occurrence has been predicted in Hida region. (**KANUMA** 1951) (**HUZIMOTO** & **KAWADA** 1951) These fact is noticiable to consider the geological age of this Mizuboradani limestone. But detail work is left in future.

(e) Ichinotani formation

Ichinotani formation is divided into upper limestone and tuff member and lower limestone shale-sandstone and conglomerate member. Fossils which are occured from them are following.

From upper member

Soshickineophyllum tenuiseptatum (SOCHIKINE)
Arachnastrea cfr. *molli* (STUCKENBERG)
Polythecalis yangtzeensis hidaensis, var. nov.
Spirifer (*Spiriferella*) cfr. *salteri* TSCHERNYSCHEW
Sprifer sp.
Squamularia asiatica CHAO
Pustula (*Echinoconchus*) sp.
Marginifera sp. *indet.*
Dielasma sp.
Parafusulina sp.
Schwagerina sp.
Batostomella sp.

Bryozoa.
Crinoid stem.

From lower member

Cystiphora manchurica forma *Kikawai* (YABE et HAYASAKA)
Clisaxophyllum sp.
Pseudoschwagerina schllewien YABE et HANZAWI.
Pseudoschwagerina sp.
Pseudodoliolina sp.
Crinoid stem.

Cystiphora manchurica forma *kikawai* has been reported from Penhsi formation (middle Carboniferous) of South Manchuria, but the associations of *Pseudoschwagerina* refer this lower member to Sakmarian of Ural and Wolfcampian of North America. In Japan, *Pseudoschwagerina* is reported from every basal permian, so this lower group is referable to Sakamotozawa series, lower Permian.

To upper member, *Arachnastrea* cfr. *molli* has been reported from Penhsi formation of South Manchuria, but others are almost elements of middle Permian, *Polythecalis yangtzeensis* Huang is reported from Chihisia limestone (middle Permian) of South China, and in Japan *P. japonica* YABE & MINATO is also considered middle permian of Shikoku. *Sochikineophyllum tenuisepta-tum* is reported from Artinskian Beds of the Litva River, Russia and in Japan *S. s-hasimotoi* MINATO is reported from Kanokura stage. From above described faunal association this member may refer to Artinskian or lower part of Kanokura stage.

This group has a conglomerate bed in its base. It may be comparable to Sakamotozawa Conglomerate, but appearant break has not been determined. Only sudden change of lithic character, from schalstein facies to sandstone-shale facies may suggests the presence of unconformity.

(f) Hirayu formation

This thick formation is characterized by the presence of clayslate and chert, and in its lower part fusulinid limestone yields *Neoschwagerina* cfr. *margaritae* DEPRAT, which has been found from Indochina, Akaska limestone. Mino and Kanto-mountainland etc. in Japan. This is considered to indicate middle to upper Permian age of this group.

(g) Summary

Above described correlation is summarized in Table I.

TABLE I. GENERAL STRATIGRAPHICAL SUCCESSION

HIRAYU FORMATION. (middle to upper Permian)

Clayslate, Chert, sandstone and limestone

Clayslate, sandstone, limestone and schalstein.

Neoschwagerina margaritae, *Parafusulina*.

ICHINOTANI FORMATION. (lower to middle Permian)

Upper member. Blue limestone and tuff.

Sochikineophyllum tenuiseptatum, *Arachnastrea* cfr. *molli*, *Polythecalis yangtzeensis hidaensis*, *Spirifer* (*Spiriferella*) cfr. *salteri*, *Squamularia asiatica*, *Pustula* (*Echinoconchus*), *Parafusulina*, *Schwagerina*, *Batostomella*.

Lower member. Grey limestone, sandstone shale thin alternation and Conglomerate. *Cystiphora manchurica* forma *Kikawai*, *Clisaxophyllum*, *Pseudoschwagerina* cfr. *schllewien*, *Pseudodoliolina*.

.... *unconformity* ....

MIZUBORADANI LIMESTONE. (middle or upper Carboniferous) Black limestone comprising *Triticites* cfr. *montipara*, *Fusulinella* sp, crinoid.

KANSAKA LIMESTONE. (middle Carboniferous) Black limestone with cherty part. *Fusulinella bocki*, Dibunophylloid coral, Campophylloid coral, *Texturaria* cfr. *gibbosa*.

SORAYAMA FORMATION Thick massive schalstein, fossils are quite barren.

FUKUJI FORMATION. (middle Gotlandian)

Upper member. Schalstein, conglomerate and limestone. Clathrodictyon onukii, Favosites sp.

Middle member. Black bituminous limestone, black shale and crinoidal calcareous sandstone. *Clathrodictyon*, *Amphipora*, *Tryplasma*, *Favosites*, *Heliolites*, *Rafinesquina*, *Atrypa*, etc.

Lower member. Vitric tuff, black slate, sandstone and conglomerate.

Hard massive grey limestone and sandstone.

Brachiopoda.

.... *Fault* ....

GAMATA SCHIST FORMATION. Garnet bearing biotite-muscovite-albite-quatz schist, zoisite-plagioclass-amphibolite.

Problems

(i) *Basement of Palaeozoics*;—The Palaeozoic of this district begins with the Gotlandian sediments, which show an fault contact with Crystalline schist of garnet bearing biotite-muscovite-albite-quartz schist and zoisite-plagioclase amphibolite at the base. And this high grade crystalline schist is considered to the products of regional metamorphism. Therefore, the relationship between both rocks is very interesting. If these rocks brought from deeper zone were caught in the younger rocks along fracture zone, it is very important to determine the stratigraphical relation between the Gotlandian sediments and the Crystalline schist and the age of this metamorphism.

Some years ago, the existence of pebbles of crystalline schist in the Tobigamori formation (Devonian) in Kitakami mountainland was reported. (MINATO, 1946) Same occurence was found from Murakami conglomerate. Of the Gotlandian Fukuji formation of this district, conglomerates which is called Murakami conglomerate contains some granitic rocks (Trondnjemite, quarts Diorite) and crystalline schist (Amphibolite). If these plutonic and metamorphic rocks are not exotic, they will prove the existence of plutonism and metamorphism of pre-Gotlandian age, in Japan. Searching for the "Heimat" of these pebbles, near this district, man can point the widely distributed Hida metamorphic complex. This complex are composed with granit, gneiss and crystalline schist and are distributed from the neck of Noto Peninsula, east to Omi, south to Furukawa-mati and west to Fukui.

To the age of plutonism and metamorphism, KOBAYASHI T. (1941) considered as following:

"The Hida gneiss is overlain by Tetori series unconformably. The Rhaeto-Liassic Kuruma series contains granitic rocks in its conglomerates and some boulders of granitic rocks are so large and aboundant that they can hardly be imagined to have been derived from remote locality. Furthermore, in marked contrast to the Ladinic and older formations, the Noric and younger formations in Japan contain very arkose sandstones in several horizons. These facts as a whole prove that the Hida plutonism occured sometimes during the Triassic period instead of the late Palaeozoic, and that the injected formation, judging from its calcareous nature, was the Akiyoshi group. The injection was followed by intrusion through which the plutonism was completed. Later the igneous and metamorphic rocks were denuded. Boulders of granite were transported into the Kuruma basin and later on the Tetori series was deposited on the Hida gneiss. And still later, another granitic rock which belongs to the Mesoplutonism intruded the Tetori series."

"........ the metamorphosed formation composed of various phylites and schists including the piedmontite schist of the latter locality—Omi-mura, Nishi-kubiki-gun in Echigo—is widely distributed in the northeastern part of the Hida plateau. .... Likewise there are some metamorphic rocks elsewhere in the Yamaguchi terrain which used to be referred to the Mikabu or Sambagawa group but it can now be definitely stated that the metamorphic rocks in the inner zone have genetically nothing to do with the Sambagawa-Mikabu group of the Sakawaiden. On the other hand, it seems reasonable to consider that, together with the Hida gneiss, they reveal the axial core of the Akiyoshiden."

But, recent progress of petrological studies on Hida metamorphic complex suggest that large extent of Hida gneiss is occupied by migmatites including para-gneiss and amphibolite etc. and the phase of metamorphism is not one time but several times. (ISIOKA, 1948., SATO, 1950., KOBAYASHI, H. 1950., 1951) And zonal distribution of gneiss, granit, schist and non-metamorphics is pointed out. (KAME1, ISIOKA, SATO, KOBAYASHI H, 1951) From these facts, it may be forgiven to think that a part of Hida metamorphic rocks belongs to pre-Gotlandian rock.

The discovery of probable unconformity in the upper part of the Kuzuryu river between and Gotlandian deposits (Kamianauma formation) and the older spilite group (Ise formation) support above opinion. (KAMEI, ISIOKA, SATO, KOBAYASHI H, 1951). Here the Murakami conglomerate which belongs to the Kamianauma formation over lies spilite closely related crystalline schist. This is the reason to think the Hida metamorphic rocks as the basement of Palaeozoic of Japan.

The age-known oldest rock in Japan is the Gotlandian sediments. This is distributed all over from Kyusyu to north-eastern Japan. All of them are represented by limestone facies and middle Gotlandian fauna, it may probably be related to world-wide middle Gotlandian transgression. In Japan, Devonian-Gotlandian boundary is very obscure, but instead of them intense volcanism begins from upper Gotlandian age. In Kitakami mountainland its acme reaches in middle Devonian and continues to lower Carboniferous. Basic volcanic rocks are aboundant in upper Fukuji formation and Sorayama formation of this district, and conglomerates are developed in Fukuji formation. From these evidences, basic volcanism of Gotlandian and Devonian age may be referable to STILLE's "Initial Geosynklinale Magmatismus" of Chichibu geosyncline, if the Gotlandian deposits were the lower most sediments in Chichibu geosyncline,

(ii) *Permian—Carboniferous boundary*—In this district Permian—Carboniferous boundary is represented by Ichinotani conglomerate. This conglomerate is well developed only in this district, but is thinning out westwardly, near Takayama. And no remarkable discordance can be seen in that area. Overlying this conglomerate *Pseudoschwagerina* bearing grey limestone exposes, and it also yields some corals like *Cystiphora manchurica forma kikawai* which has been found from Penhsi formation of middle Carboniferous in south Manchuria. But this limestone exposes continuously to m ddle Permian limestone. Underlying Sorayama formation is quite barren in fossils, and Mizuboradani limestone bearing *Triticites cfr. montipara* and Kansaka limestone which yields *Fusulinella bocki* are fragmental occurence.

For a long time many authors have postulated the lackness of Uralian deposits in Japan, South Manchuria and North China (HANZAWA, 1938, HUZIMOTO, 1941, NODA, 1950), and in Kitakami mountainland remarkable discordance was recognized between Moscovian and Sakmarian, (NAGAO & MINATO 1942) To this intervals, the name of "The Setamai folding" is given. It is important to determine whether such folding correspond to the Setamei folding exist or not in Hida mountainland. I compare the above stated Ichinotani conglomerate to the Sakamotozawa conglomerate, but it is very questionable to the character of this boundary. Recently, the existence of Triticites zone is reported in Omi, boundary area of Mino- Hida and central Kyushu. (HUZIMOTO & KAWADA, 1951, KANUMA, 1951, KANMERA, 1952.) Such occurence requests to testify the Mizuboradani limestone in detail. The key to solve this problem is the detail investigation of Mizuboradani and to trace the Ichinotani conglomerate lateraly to westwards.

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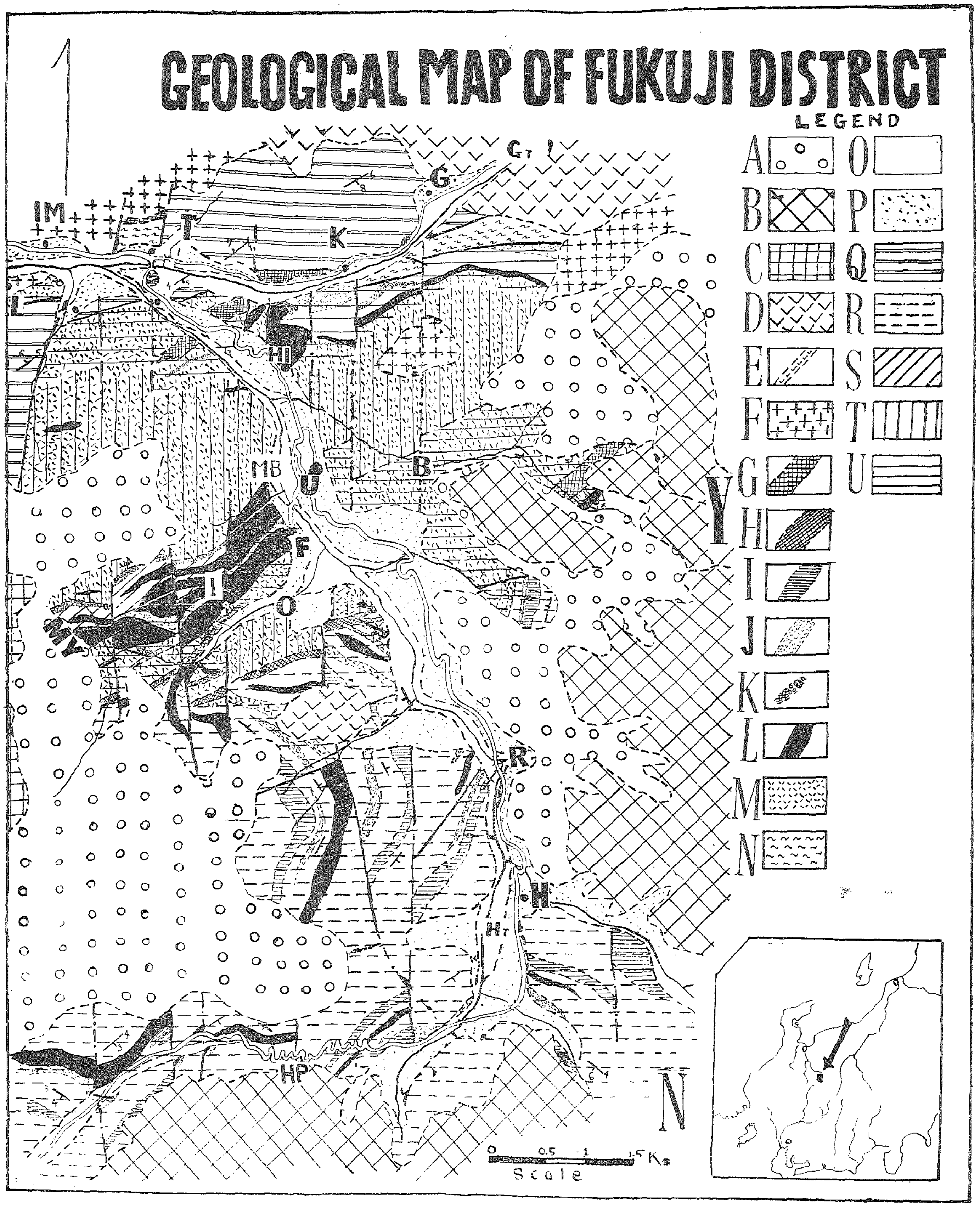

EXPLANATION OF PLATE

Geological Map of Fukuji district, Kamitakara-mura, Yoshiki-gun, Gifu Prefecture, Japan.

Localities. F: Fukuji village, G: Gamata village, Gr: Gamata river, H: Hirayu village, HI: Hitoegane village, HP: Hirayu Pass, Hr: Hirayu river, I: Ichinotani valley, IM: Imami village, K: Kansaka village, MB: Mizuboradani valley, MY: Mizuyagatani valley, N: Northern slope of Norikura volcano, O: Osobudani valley, T: Tochio village, U: Uwajigane village, Y: Yake volcano, A: Kaisyodani valley, B: Iwatsubodani valley, R: Sakai-Bashi, L: Tadenomata, M: Murakami village.

Legend. A: Volcanic debris, B: Andesite, C: Dacite, D: quartz-Porphyry, E: Dyke rocks, F: quartz-Diorite, G: Gabbro porphyrite, H: Serpentine, I: Chert, J: Sandstone, K: Conglomerate, L: Limestone, M: Schalstein, N: Crystaline schist, O: River gravels. P: Terrace deposits, Q: Mesozoic rocks, R: Hirayu formation, S: Ichinotani formation, T: Sorayama formation, U: Fukuji formation.