Permian and Jurassic Geosynclines in Japan

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Permian and Jurassic Geosynclines in Japan

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(With 3 text-figures)

INTRODUCTION

In northeastern Japan, Paleozoic rocks (?) occur over wide areas extending from the northern Kitakami massif to southwestern Hokkaido. These rocks are generally barren of fossils, so their detailed stratigraphic relations are obscure. These wide areas have hitherto been regarded as a land or uplifted zone during the Jurassic Period as shown in the Japanese Jurassic paleogeographical map.

Recently, among the so-called Paleozoic rocks, fossiliferous Jurassic deposits have been found in a few places, though their distributions are limited.

The author on the basis of the fresh data recognized a remarkable change of sedimentary facies during the Permian and Jurassic Periods and their mutual relations, and here he will present the data for the contribution to the synthetic study of Paleozoic and Mesozoic formations.

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PERMIAN CHICHIBU GEOSYNCLINE

1. General remarks

The Paleozoic sediments of Japan consist of the Silurian, Devonian, Carboniferous and Permian Systems, among which the Permian System is widely distributed throughout the Japanese Islands, but the Silurian and Devonian Systems are limited, and the Carboniferous System crops out in various places.

The Paleozoic sediments are composed of thick geosynclinal deposits, the basement of which is unknown, and the geosyncline of the Paleozoic Era is commonly called the Chichibu Geosyncline or Honshu Geosyncline. The main geosynclinal deposits are clay-slate and greywacke, basic volcanics also occur in abundance, and many lenses of limestone are developed. There is an abnormal development of chert. These are noteworthy as the characteristic lithologic features.

2. Permian formation of the Kitakami massif

In the southern part of the Kitakami massif, the stratigraphical succession from Silurian to late Permian has been well studied and paleontological zoning established. On the contrary, in the northern part of the Kitakami massif, the Permian System is extensively distributed, but the structure is so complicated that detailed stratigraphical research is difficult.

In the southern part of the Kitakami massif, the Permian System lies with un-

conformity on the Carboniferous System, and is covered with unconformity by the Triassic System. But in the northern part of the Kitakami massif, the Permian System is in fault contact with the Carboniferous but the base is unknown, and it is covered directly and with unconformity by the Upper Jurassic. The absence of the Triassic and Lower-Middle Jurassic formations between them is noteworthy for consideration of the crustal movements.

The Permian formations of the northern part of the Kitakami massif are differnt in rock facies from those of the southern part. From the above-mentioned features, the author recognized that the Permian formations can be divided into four areas from west to east throughout the massif, on the basis of geological structure and rock facies, as follows; (Fig. 1)

(1) Area where limestone predominates (limestone facies).
(2) Area where schalstein predominates (schalstein facies).
(3) Area where chert predominates (cherty facies).
(4) Area where limestone and schalstein interfinger with one another (limestone-schalstein facies).

In the southern part of the Kitakami massif, the Permian formations are character-

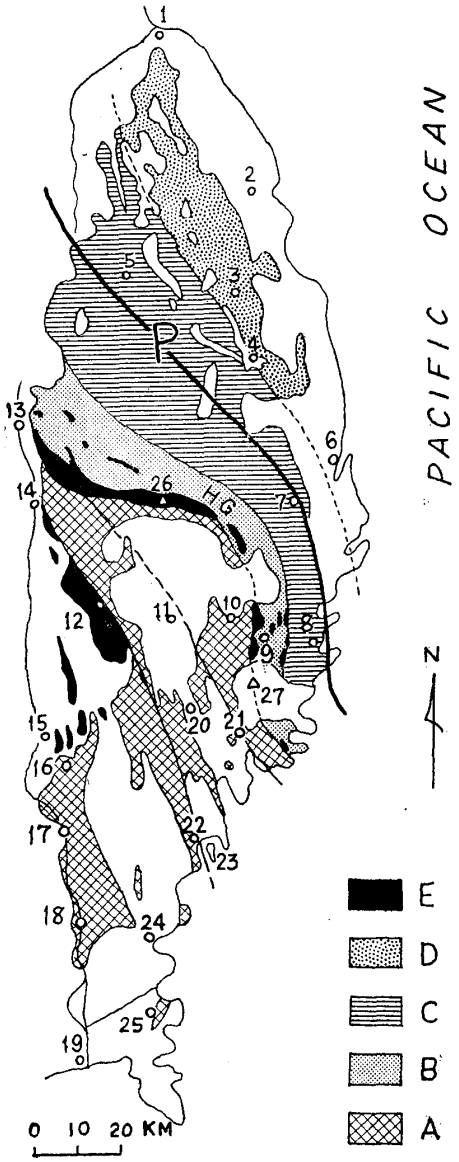

Fig. 1 Facies map of the Permian formations in the Kitakami massif.

A-D Permian formations
A : Limestone facies
B : Schalstein facies
C : Cherty facies
D : Limestone-schalstein facies
E : Serpentine, ultrabasic rocks
P : Central axial part of the Chichibu Geosyncline
HG : Hayachine-Goyozan tectonic zone

1 Hachinohe	15 Motai
2 Kuji	16 Nagasaka
3 Akka	17 Usuginu
4 Iwaizumi	18 Maiya-Toyoma
5 Kuzumaki	19 Ishinomaki
6 Miyako	20 Setamae
7 Toyomane-Hanawa	21 Hikoroichi-Sakari
8 Kamaishi	22 Kesennuma
9 Omatsu	23 Oshima
10 Kamaishi Mine	24 Shizugawa
11 Tono	25 Ogachi
12 Miyamori	26 Hayachine
13 Morioka	27 Goyozan
14 Hizume	

istic in limestone facies, namely, as above-mentioned (1) area. In the northern part of the Kitakami massif, the Permian formations comprise a thick accumulation of clayslate, greywacke, chert, schalstein and limestone, trending in the direction of NS or NW, and is marked with (2), (3) and (4) areas.

A. Southern Kitakami massif

(1) Area where limestone predominates

The Permian System has been well studied and paleontological zoning established. It is divided into the Sakamotozawa, Kanokura and Toyoma Formations in ascending order. The fossils contained are as follows: fusulinid foraminifera (*Pseudoschwagerina-Yabeina* Zones), tabulate corals, tetracorals, cephalopoda, brachiopoda, trilobites, gastropoda, calcareous algae, Plant fragments, etc. They indicate the Lower to Upper Permian in age.

B. Northern Kitakami massif

(2) Area where schalstein predominates

The Permian formations are composed mainly of schalstein, intercalated with black clayslate, conglomerate, limestone, and chert. The schalstein is derived from andesitic and basic lava, tuff-breccia, tuff and tuffaceous sediments.

The limestone at Omatsu and Kogawa yielded *Pseudoschwagerina*, *Parafusulina* and *Lophophyllidium* sp. etc.

(3) Area where chert predominates

The Permian formations are composed mainly of clayslate, greywacke, chert, and sporadically of limestone and schalstein, and also sometimes accompanied by mangan ores.

The limestone at Toyomane, Hanawa and other places in the southwestern part of Miyako, yielded the fusulinid fauna ranging from the *Pseudoschwagerina* to *Neoschwagerina* Zones, corals and calcareous algae, viz., *Pseudoschwagerina*, *Nipponitella*, *Schwagerina*, *Parafusulina*, *Schubertella*, *Neoschwagerina*, *Lophophyllidium*, *Gyroporella*, *Physoporella*, etc.

(4) Area where limestone and schalstein interfinger

The Permian formations are composed of an alternation of clayslate, limestone and schalstein, with thin intercalation of chert. The thick limestone in (4) occurs over wide areas, but is generally barren in fossils. The limestone pebbles of the Jurassic conglomerate at Iwaizumi and Kogawa have yielded fossils of fusulinids, etc., viz., *Parafusulina*, *Verbeekina*, and *Neoschwagerina*. The origin of these limestone pebbles are not yet exactly known, but are believed to have been derived from the limestone layer distributed in this area.

3. Permian Geosyncline

In the Kitakami massif, basic and ultrabasic intrusives composing peridotite-serpentine, pyroxenite, hornblendite and gabbro, are distributed in two arc-shaped zones convex toward the Pacific, and the one constituting the main body of Mt. Hayachine stretches southeastwards and enters the Kamaishi district where it changes its direction to north-south.

The limenstone facies area (1), schalstein facies area (2) and cherty facies area (3) are in fault contact with one another, and the schalstein facies area is much disturbed. Especially, the faults and folding axis of the schalstein facies area are marked with the tectonic belt (so-called the Hayachine-Goyozan tectonic belt), along which the above-mentioned basic and ultrabasic rocks are intruded. The fossiliferous Carboniferous limestone is also sandwiched with fault on the eastern side of the schalstein facies area.

The boundary of the southern and northern Kitakami massif is marked with the Hayachine-Goyozan tectonic belt.

The Permian formations of (2), (3) and (4) areas generally strike NS or NW, and

judging from the geological structure and rock facies the deposits are inferred to have constituted a geosyncline which trends NS or NW centering upon the cherty area (3), the limestone facies area (1) and schalstein facies area (2) on the western side of the geosyncline, and the limestone-schalstein facies area (4) on the eastern side (Fig. 1).

JURASSIC YEZO GEOSYNCLINE

1. General remarks

The island of Hokkaido comprises two independent geotectonic units, namely, western Hokkaido and the main part. Under the fossiliferous Cretaceous in the central meridional main part of Hokkaido there are thick, continuous geosynclinal sediments including the so-called Paleozoic (?) or Mesozoic Hidaka Group, the Mesozoic Sorachi Group, and others, and the geosyncline of the Mesozoic Era is called the Yezo Geosyncline. They form the basement complex of the island, and are further divided into two prominent tectonic zones, the "Kamuikotan metamorphic zone" and "Hidaka metamorphic zone".

The Hidaka metamorphic zone occupying a part of the central ridge of Hokkaido elongated in N-S direction and the Kamuikotan metamorphic zone, elongated parallel, is exposed in the west of the Hidaka zone (Fig. 2).

In the western part of Hokkaido, the pre-Tertiary rocks are distributed in various places; they consist partly of limestone lenses, but barren in fossils, and similar in rock facies to those of the northern part of the Kitakami massif. However, their stratigraphy is not well known. Recently, from the limestone lenses, calcareous algae, stromatopora, hexacorals of the Jurassic Torinosu type were reported by Hashimoto and Igo (1961).

2. Hidaka Group

The Hidaka mountain range which extends from north to south as the central axis of the island of Hokkaido, represents a more or less symmetrical structure with migmatic and metamorphic core, and the rocks of the Hidaka metamorphic zone are all regional metamorphic rocks formed by Cretaceous orogenesis, affected by acidic, basic and ultrabasic intrusions. The original rocks of the Hidaka metamorphic zone are mostly thick, monotonous clayslate and sandstone, accompanied with limestone, chert and

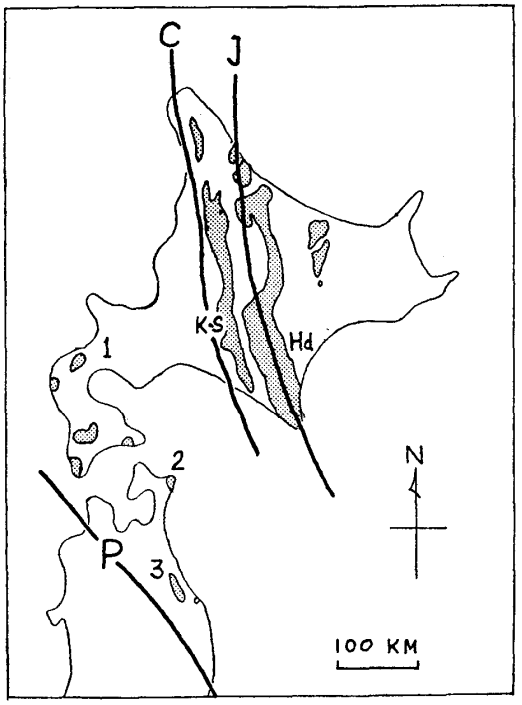

Fig. 2. Distribution of the upper Jurassic formations in the Northern Kitakami massif and Hokkaido.

C: Central part of the Yezo Geosyncline during the Cretaceous
J: Central part of the Yezo Geosyncline during the upper Jurassic
P: Central part of the Chichibu Geosyncline during the Permian
Hd: Hidaka metamorphic rocks and Hidaka Group
K-S: Kamuikotan metamorphic rocks and Sorachi Group
1: Tomarikawa Limestone, Southwestern Hokkaido
2: Shimokita Group, Aomori Prefecture
3: Iwaizumi Formation, Iwate Prefecture

schalstein. Recently, Paleozoic or Mesozoic fossils were reported therefrom by some authors. These rocks are intensely complicated by fault and folding, and are intruded with different kinds of igneous rocks as above-mentioned, and the stratigraphical relations of these rocks are difficult to determine. Thus these have been called the Hidaka Group being referred to the Paleozoic or Mesozoic.

3. Sorachi Group and Kamuikotan metamorphic rocks

The Sorachi Group consists dominantly of basic pyroclastic rocks including lava and dike, sandstone, slate, chert, and in places limestone, and are typically represented by schalstein facies. The rocks of the Kamuikotan metamorphic zone consists chiefly of green schist and black phyllite. Some features of the Kamuikotan metamorphic rocks (green schist facies) are represented in the regional dynamometamorphosed characters of the Sorachi Group.

Radiolarian remains are frequently found from the chert and other siliceous rocks. From the limestone lenses embedded in the Sorachi Group and its equivalents the following fossils have been reported; *Microsolena* sp., *Heptastylopsis asiatica* Yabe and Sugiyama, *Stylina* sp., *Orbicella* sp., *Circoporella semiclathrata* Hayasaka, *Tosastroma* sp., *Parastromatopora* sp., *Milleporidium* ? sp., *Nipponophyx ramosum* Yabe and Toyama, *Pycnoporidium lobatum* Yabe and Toyama, etc.

Owing to the complicated structure and few occurrences of fossils, the detailed stratigraphic sequence, thickness, and age of the group are not well known. At present the group is generally believed to range from Jurassic to early Cretaceous.

4. Pre-Tertiary rocks of southwestern Hokkaido

The pre-Tertiary rocks of southwestern Hokkaido crop out in various places, and are composed of schalstein, quartzite, greywacke, clayslate and limestone. In the Tomarikawa area the apparent thickness of them is 500 meters, and recently from the limestone lenses the following calcareous algae, stromatopora, hexacorals and etc. were reported by Hashimoto and Igo (1961), viz., *Hikorokodium* sp., *Milleporella* sp., *Thecosmilia* sp., *Montlivaltia* ? sp., and *Thamnasteria* ? sp.

5. Shimokita Group, Aomori Prefecture

The Shimokita Group is exposed in the eastern part of the Shimokita Peninsula, Aomori Prefecture, and is divided into the Tatemachi-jima, Kuwabatake-yama, Iwaya and Katasakiyama Formations in ascending order. This group is composed of an alternation of clayslate, sandstone, limestone, chert, partly with schalstein. The limestone has yielded such as Hexacorals, stromatopora and etc.; *Kabya shiriyaensis* Murata, *Calamophyllia* ? sp., *Thecosmilia* ? sp., *Stromatopora* (*Parastromatopora*) *crassifibra* Yabe and Sugiyama, etc.

The stratigraphy and paleontology of the Shimokita Group is described by Murata in another article of this Memorial Volume.

6. Iwaizumi Formation, Iwate Prefecture

The Iwaizumi Formation in the northern Kitakami massif is distributed at Iwaizumi an inland area and in the western part of Omoto on the Pacific side, both in Shimohei-gun, Iwate Prefecture. This formation is composed of clayslate, sandstone, conglomerate, limestone, and schalstein, and attains more than 570 meters in thickness.

The limestone pebbles of the conglomerate have yielded such fossils as hexacorals, spongiomorphoid corals, stromatopora, and others; *Microsolena* sp., *Thamnasteria* sp., *Stylosmilia* sp., *Spongiomorpha* sp., and *Stromatopora* sp.

7. Jurassic Geosyncline

The fossils from the Sorachi Group in the main part of Hokkaido, the pre-Tertiary rocks of Tomarikawa in western Hokkaido, the Shimokita Group in Aomori Prefecture, and the Iwaizumi Formation in Iwate Prefecture as already mentioned are similar to those of the upper Jurassic Torinosu limestone on the Pacific side of southwestern Japan. The

Hidaka Group has hitherto been assigned to the Paleozoic (?), but there is no evidence. It has also been expressed by some geologists that the original rock of the Hidaka metamorphic zone is of upper Jurassic–early Cretaceous age and equivalent to the Kamuikotan metamorphic zone.

From the above-mentioned, the author infers that the Jurassic formations and other basement rocks can be divided into three areas from west to east throughout the island, on the basis of geological structure and rock facies, as follows; (Fig. 2)

(1) Area where limestone predominates (Southwestern Hokkaido).

(2) Area where schalstein predominates (Kamuikotan metamorphic zone or Sorachi Group).

(3) Area where clayslate and sandstone predominates (Hidaka metamorphic zone or Hidaka Group).

Thick monotonous sediments of the basement complex in the island of the Hokkaido are the characteristics of the geosynclinal sediments, and judging from the geological structure and rock facies the basement complex is inferred to have constituted a geosyncline which trends NS or NNW centering upon the clayslate and sandstone facies area of Hidaka zone (3), and the limestone facies area (1) and schalstein facies area or Kamuikotan zone (2) represent the western side of the geosyncline. It is evident, therefore, that in the northern Japan, extending from the northern Kitakami massif to the island of Hokkaido, there existed a geosyncline centering upon the Hidaka zone in Late Jurassic, and is called the Yezo Geosyncline. The central part of the Yezo Geosyncline was transformed by the Epi-Sorachi Orogeny in the Cretaceous.

CONCLUSION

1. In the known parts of the Paleozoic formations in Japan, Permian rocks are predominant and composed of thick, geosynclinal deposits. The geosyncline is commonly called the Chichibu or Honshu Geosyncline.

Permian formations are extensively distributed in the Kitakami massif, and the rock facies differ from west to east throughout the massif, namely, (1) limestone facies area, (2) schalstein facies area, (3) cherty facies area, and (4) limestone-schalstein facies area.

Permian formations are inferred to have constituted a geosyncline which trends NS or NW centering upon the cherty facies area (3), and the limestone facies area (1), schalstein facies area (2) represent the western side of the geosyncline and the limestone-schalstein facies area (4) the eastern side (Fig. 1).

2. A wide area in northesatern Japan, extending from the northern Kitakami massif to southwestern Hokkaido has hitherto been regarded as probably a land area or an uplifted zone during the Jurassic age. However, fossiliferous marine Jurassic deposits were recently found in the several places, separated from one another, and the fossils are similar to those of the Torinosu limestone in the outer zone of southwestern Japan.

3. Jurassic rocks in the island of Hokkaido are characteristic of geosynclinal sediments. The geosyncline is called the Yezo Geosyncline. The rock facies differs from west to east throughout the island, namely, southwestern Hokkaido where is distributed the limestone-rich facies area (1), Kamuikotan zone or schalstein facies area (2), and Hidaka zone or the clayslate-sandstone facies area (3).

Jurassic formations of the island are inferred to have constituted a geosyncline which trends NS or NNW centering upon the Hidaka zone (3), and western Hokkaido (1) and the Kamuikotan zone (2) represent the western side of the geosyncline, whereas the eastern side of the geosyncline is not yet known (Fig. 2).

4. As a whole, the Jurassic rocks in the northern Kitakami massif and southwestern Hokkaido resemble those of the outer zone in southwestern Japan, but the rocks

of the Kamuikotan zone and Sorachi Group are characterized by materials produced by violent submarine volcanisms.

5. The schalstein facies, as above-mentioned the Hayachine-Goyozan zone of the Kitakami massif and the Kamuikotan zone of the island of Hokkaido, were developed in a particular tectonic zone. These facts in the sedimentary basin are significant to know the relation between the down sinking of the central area in the geosyncline and the upward movement of the continental side of the geosyncline. So it is rather preferable to take the view that there was a zone of submarine volcanism as a primodial state of the Hayachine-Goyozan zone or the Kamuikotan zone (Fig. 3).

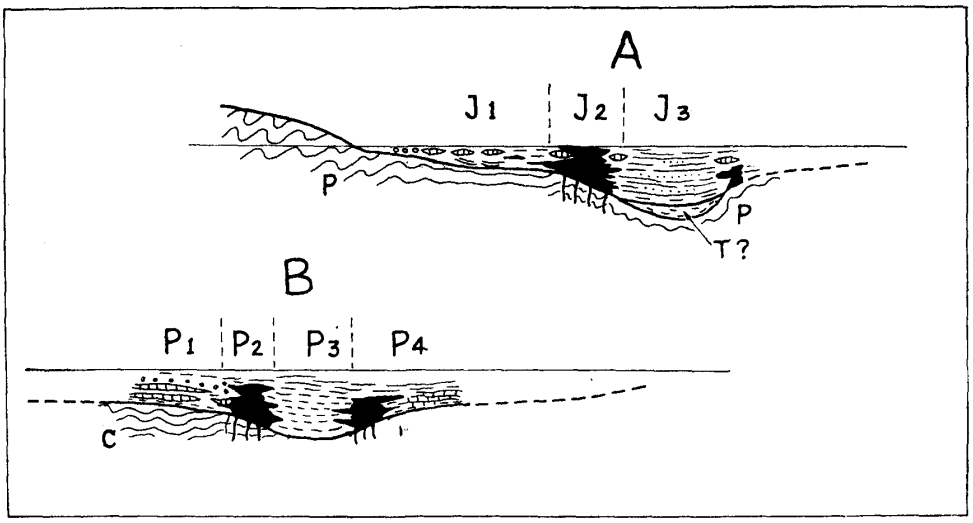

Fig. 3 Diagrammatic restoration of the Yezo and Chichibu Geosynclines.
A : Jurassic Yezo Geosyncline
B : Permian Chichibu Geosyncline
C : Carboniferous
P : Permian
T : Triassic
J_1 : Limestone facies area
J_2 : Schalstein facies area (Kamuikotan zone and Sorachi Group)
J_3 : Clayslate-sandstone facies area (Hidaka zone and Hidaka Group) (Central part of the Yezo Geosyncline)
P_1 : Limestone facies area
P_2 : Schalstein facies area (Hayachine-Goyozan tectonic zone)
P_3 : Cherty facies area (Central part of the Chichibu Geosyncline)
P_4 : Limestone-schalstein facies area

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