FUNDAMENTALS IN THE CRETACEOUS STRATIGRAPHY OF JAPAN

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FUNDAMENTALS IN THE CRETACEOUS STRATIGRAPHY OF JAPAN

By

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Contents

INTRODUCTION

With the hope of elucidating geologic history, or geotectonic development, of the Japanese Islands during the Mesozoic Era, I began work by investigating the Cretaceous areas in the central zone of Kyūsyū, in the course of which, needless to say, new knowledge has been gained[1]. At the same time, I must say that in the course of these studies I keenly felt the need for putting our knowledge of the geological chronology and stratigraphical classification of the country on a more accurate basis than has ever been done before, for which reason I have been studying these fundamental subjects on the Japanese Cretaceous since 1936.

As to the Cretaceous stratigraphy of the Japanese Islands, there have been a number of investigations, of which Dr. H. YABE'S (1927) comprehensive and synthetic study is epochmaking. Summarizing the knowledge up till then of the stratigraphy of the individual Cretaceous districts, he proposed the following general division of the Japanese Cretaceous.

The Ryoseki Epoch of Emergence or marine regression: the Ryoseki Series (Jurasso-Cretaceous or Lowest Cretaceous according to European standard).

The Monobegawa Epoch of Submergence or marine transgression: The Monobegawa Series (approximately Lower Cretaceous according to European standard, the Wealden excluded.)

The Gyliak Epoch of Emergence or marine regression: the Gyliak Series (approximately Cenomanian-Turonian according to European standard).

The Urakawa Epoch of Submergence, or marine transgression: the Urakawa Series (approximately the Senonian, in the broad sense, according to European standard).

More than ten years having elapsed then, much new knowledge has been gained, necessitating revision of some of the old observations. But, notwithstanding the recent additions to our knowledge, further research is necessary in order to gain a fuller and more accurate knowledge of Cretaceous stratigraphy.

With the intention of filling this demand, I have been engaged in stratigraphic investigations of the standard Cretaceous areas in Hokkaidô (Yezo) and Karahuto (Saghalin), in beginning which research, I became aware of the drawbacks and deficiencies in the

1) T. MATUMOTO 1936, 1938, 1939 a, b.

traditional method of stratigraphy, resulting in my resorting to a method of my own device in conjunction with the conventional method. More than five years having elapsed since I began these studies, I shall attempt to describe here the results of my work, and trust they will be of sufficient interest to arouse discussions and criticisms.

Before entering into detailed descriptions, the reader's attention is called to the following salient points in this memoir.

(1) Since, as basis for the present research, I examined a number of typical Cretaceous localities in the meridional zone running through Hokkaidô and Karahuto——standard Cretaceous areas in Japan——observations of these individual localities are first described (Part I).

(2) Based mainly on the facts described in Part I, I have planned a stratigraphic classification that is applicable to the Cretaceous deposits of the meridional region of Hokkaidô and Karahuto. In contrast with the conventional method, I have done the classification in two distinctly separate ways; one the *chronologic division*, based chiefly on biostratigraphic methods, and the other the *stratigraphic classification from the standpoint of facies-development*, which, in turn, shows the changes in geologic conditions in and near the sedimentational area. Chapter I—III and V of Part II consist respectively of such treatments of the subject.

(3) Although for the chronologic study, I have adopted certain principles of biostratigraphy, the way in which these principles are applied has received much attention, and I think I have succeeded in establishing an accurate and detailed chronologic division that is applicable, at least, to the Cretaceous deposits in the meridional zone of Hokkaidô and Karahuto. As to the palaeontologic material, only a short note is given in the first chapter of Part III, full descriptions being reserved for another opportunity.

(4) The results of the other system of classifiication attempted for the Mesozoic rocks of the meridional zone of Hokkaidô and Karahuto are given in Chapter V, Part II. The underlying principle of this classification is new, although it is apparently an extension of what is called *division of strata based on lithological characters*. Because it is my intention to deal with the subject on another occasion, the general principles of the method itself are only briefly presented.

(5) Although the foregoing is a stratigraphic study of the Cretaceous of the meridional zone of Hokkaidô and Karahuto, the problem is not confined to the stratigraphy of this locality. The present investigation is, in reality, an important foundation for the Cretaceous stratigraphy of Japan, while, besides, it may serve as one of the standards for the Cretaceous stratigraphy of the Circum-Pacific and Indo-Pacific regions. In Part III, I shall discuss more concretely these aspects of the subject, although to solve the problem more satisfactorily, further investigations are necessary.

(6) In short, the object of the present study is to formulate a stratigraphy of strict sense and to consolidate the foundation for further investigations in historical geology and, in turn, for more progressive research in the higher problems of geology.

Acknowledgement.——It is a pleasure to record here my debt of gratitude to a number of persons and institutions for their help and support in my work. I wish to mention first of all Prof. T. KATO and Prof. T. KOBAYASHI, both of the Tôkyô Imperial University, under whose special guidance I undertook the investigation dealt with in this paper till March 1939, at the University-Hall (*Daigaku-In*) as a graduate student of the same University. I am indebted also to the late Prof. WATANABE and to Prof. K. SUGI, and Prof. H. MATUSITA of the Kyūsyū Imperial University, who have given me valuable aid since my arrival at Hukuoka, in April 1939, and Prof. S. TSUBOI and other members of the Geologic Institute, Tôkyô Imperial University, who encouraged me much not only during my years at the *Daigaku-In*, but also after I left that Institute.

I wish, further, to express my thanks to Prof. H. YABE, of the Tôhoku Imperial University, for his valuable advices on many important subjects, to Prof. T. NAGAO, Prof. Y. SASA, and Mr. K. OTATUME, all of the Hokkaidô Imperial University, for their valuable suggestions on the geology of Hokkaidô and for placing at my disposal some of their collections, and to Prof. S. NAKAMURA, of the Kyôto Imperial University, for kind permission for free use of the library of the Institute.

I also wish to offer my hearty thanks to Prof. E. KON'NO and to Mr. I. OMURA, from whom I received much assistance and encouragement in numerous ways. I am, likewise, indebted to my

friends, Messrs. S. IJIRI, R. SUGIYAMA, and U. OGAWA, who gave me helpful suggestions and criticisms in regard to the general problem of stratigraphy.

For very great help in my field work, I wish to thank a number of gentlemen, namely Prof. I. SONOBE, Prof. NAKANO, and Mr. S. KOBAYAKAWA, all of the Karahuto Forestry Experimental Station, annexed to the Faculty of Agriculture Tôkyô Imperial University; Messrs. N. KANO and M. KAWASAKI of the Karahuto Government; and Messrs. K. OKUBO, Y. INOUE, N. MORITA, and H. NISI, of the Imperial Forest Bureau.

Finally, I am greatly indebted to the Japan Society for the Promotion of Scientific Research, whose aid has rendered it possible for me to undertake this study.

PART I.

STRATIGRAPHIC COLUMN AND SEQUENCE OF FOSSILS AT SEVERAL IMPORTANT CRETACEOUS LOCALITIES IN HOKKAIDO AND KARAHUTO.

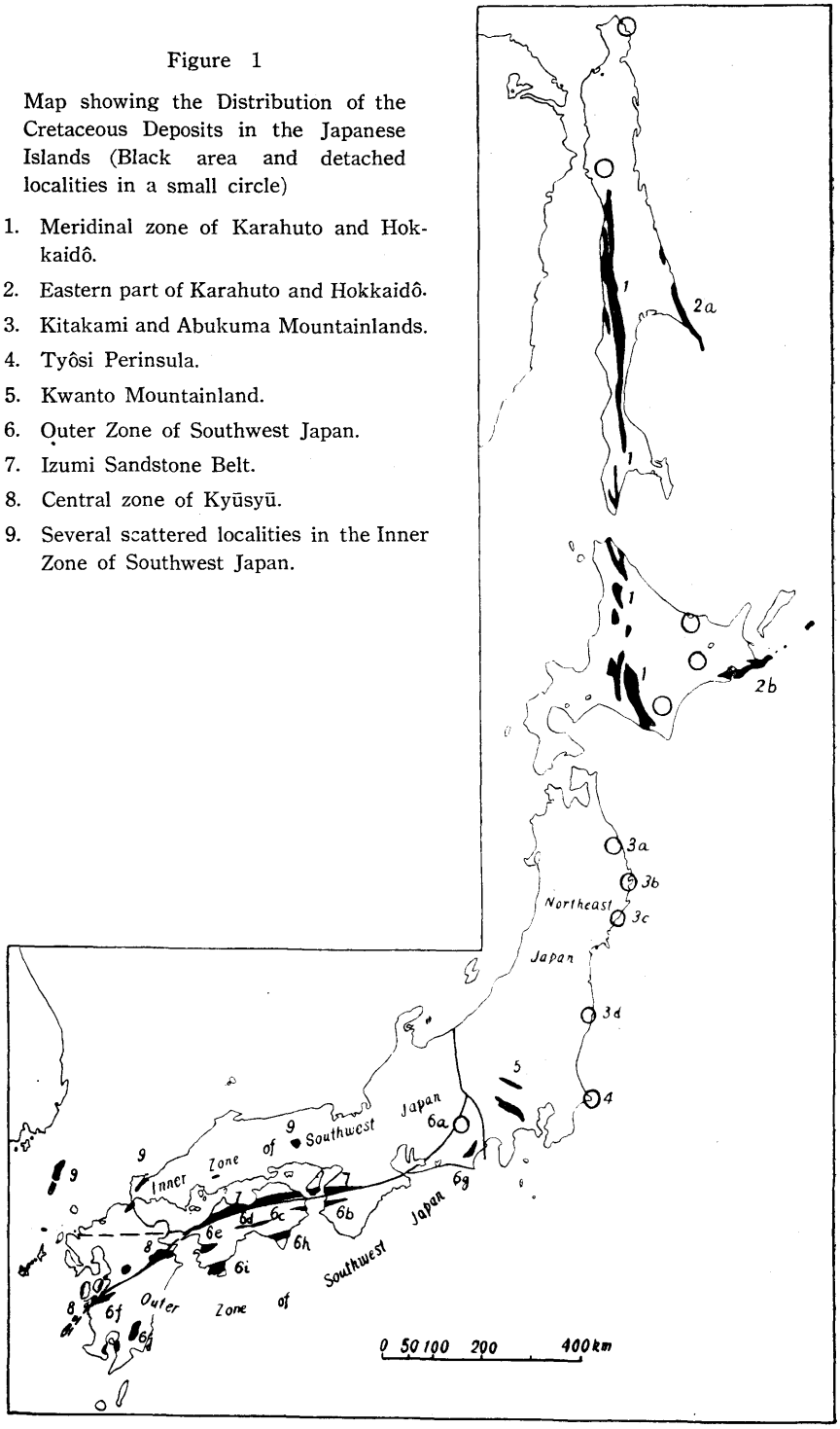
Introductory Statement

In the Japanese Islands Cretaceous rocks are developped considerably widely. The main distributional areas of the Cretaceous deposits are (1) the meridional zone of Karahuto (or Saghalin) and Hokkaidô, (2) the eastern part of Karahuto and Hokkaidô, (3) the Kitakami and Abukuma Mountainlands, either in their basement area and along their marginal zone, (4) the Tyôsi Peninsula, (5) the Kwanto Mountainland, (6) the Outer Zone of Southwest Japan, (7) the Izumi Sandstone Belt along the northern side of the Median Dislocation Line, (8) the Central zone of Kyūsyū and (9) several scattered localities in the Inner Zone of Southwest Japan. These areas are concisely indicated in Fig. 1. The sedimentary rocks are mostly of marine origin and only partially of brackish or continental origin. Among these distributional areas the first mentioned is the one where Cretaceous strata are developed most continuously and contain fossils most abundantly in a suitable state of preservation. Accordingly the stratigraphical study on the Cretaceous of this area may afford a standard not only for the Cretaceous stratigraphy of Japan but also to that of the Circum Pacific or Indo-Pacific realm. But the study has not yet been completed, though important contributions have been made by many investigators such as M. YOKOYAMA, K. JIMBO, H. YABE, S. SHIMIZU, T. NAGAO, S. HANZAWA and other gentlemen. Among the recent works we must note at first the great efforts for the geological survey of the Cretaceous areas made by comparatively young geologists, Y. SASA, K. OTATUME, R. SAITO, W. HASIMOTO, K. SAKAKURA and K. ISIZAKI, M. SAMBONSUGI, etc. A modern paleontological study on the Cretaceous cephalopods of the area had been carried out by late Dr. S. SHIMIZU, formerly a member of the Shanghai Science Institute. But unfortunately the work was brough to a standstill by his sorrowful demise. T. NAGAO published papers from the Hokkaidô Imperial University on some of the molluscan remains of the area, sometimes together with K. ÔTA-

Figure 1

Map showing the Distribution of the Cretaceous Deposits in the Japanese Islands (Black area and detached localities in a small circle)

1. Meridinal zone of Karahuto and Hokkaidô.
2. Eastern part of Karahuto and Hokkaidô.
3. Kitakami and Abukuma Mountainlands.
4. Tyôsi Perinsula.
5. Kwanto Mountainland.
6. Outer Zone of Southwest Japan.
7. Izumi Sandstone Belt.
8. Central zone of Kyūsyū.
9. Several scattered localities in the Inner Zone of Southwest Japan.



TUME. And I myself treated with the fossil *Incoeramus* in cooperation with the former author.

The meridional zone of Hokkaidô and Karahuto is a folded zone now constituting the back-bone of the two islands. And owing to the Tertiary and post-Tertiary crustal movements and denudations, the Cretaceous rocks are detached in several areas, which are more or less meridionally arranged in parallel zones. (Cf. Fig. 2.) The complete investigation throughout the whole of these Cretaceous areas needs further efforts and longer date. But the knowledge obtained at several important localities may afford a pertinent idea to the Cretaceous stratigraphy of the zone as a whole, because these detached data are the records of the deposits originally formed in one continuous areas of sedimentation. The districts which have been studied stratigraphically by the previous investigators are as follows. (ennumerated from north to south. ( ) shows investigators or literatures.[1]) (Cf. Fig. 2.)

(1) Near Alexandrofsk, North Saghalin. (PELEVOI, KRYSHTOFOVICH, KADOKURA, HAYAKAWA, UEMURA, CHITANI, YABE & SHIMIZU 1924)

(2) Valleys of the Koton, the Keton, the Aton and the Hoe, central northern part of the Japanese Karahuto (UEMURA & ISHIZAKI, S. ÔISHI & T. MATUMOTO 1937)

(3) Northern part of the westėrn coast of the Japanese Karahuto. (KAWASAKI and others)

(4) Near Motodomari, central part of the Japanese Karahuto. (ISHIZAKI 1937)

(5) The Odasam Valley, South Karahuto. (K. MURAYAMA)

(6) The Naibuti Valley, South Karahuto. (M. KAWADA 1929. S. SHIMIZU 1929, 1935)

(7) Nisi-notoro peninsula, South Karahuto. (K. MURAYAMA, K. ISHIZAKI & K. SAKAKURA 1937)

(8) The Sôya Coal-field, province of Kitami, northern Hokkaidô. (K. JIMBO, K. WATANABE 1914)

(9) The middle Valley of the Tesio, province of Tesio, central northern Hakkaidô. (K. JIMBO, H. YABE, Y. OKAMURA, Y. MORITA in S. SHIMIZU 1931, TAKEDA-IKEGAMI-HATTORI and YAMANOUTI 1933 MS.)

[1] Literatures cited in Part I are ennumerated at the end.

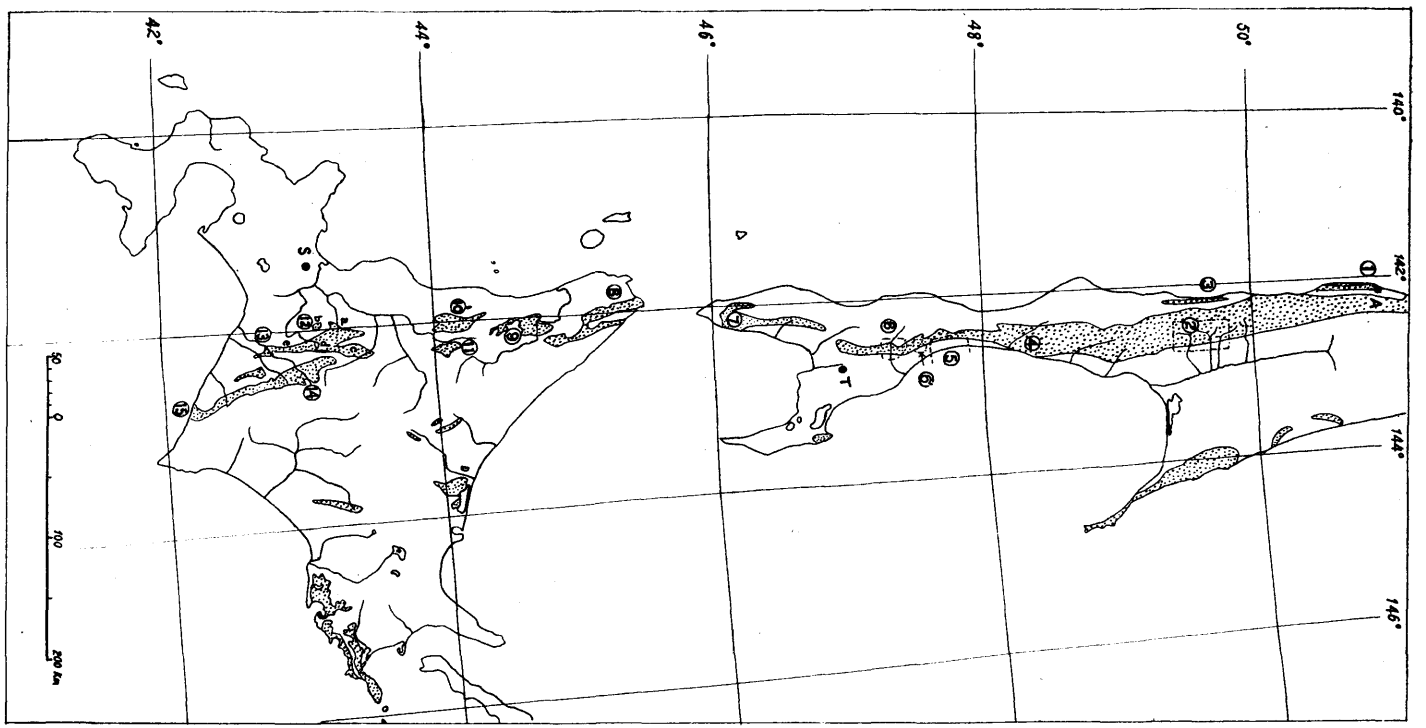


Figure 2

Index Map showing the Important Cretaceous Localities in the Meridional Zone of Hokkaidô and Karahuto (Dotted area is the distributional area of the Cretaceous rocks).

(1) Near Alexandrofsk. (2) Valleys of the Keton, the Aton and the Hoe. (3) Northwestern coast of the Japanese Karahuto. (4) Near Motodomari. (5) Near Odasam. (6) Mid-valley of the Naibuti. (6′) Mide-velley of the Aikawa. (7) Nisinotoro Perinsula. (8) Sôya Coal-field. (9) Mid-valley of the Tesio and the Abesinai district. (10) Obirasibe district. (11) Uryu district. (12) Isikari Coal-field (a: Ikusyunbetu. b: Yubari. c: Asibetu. d: Siyubari. e: Hobetu). (13) Near Hetonai. (14) Yanabe-Kanayama district. (15) Urakawa district. (A) Alexandrofsk. (T) Toyohara. (S) Sapporo.

(10) The Obirasibe (or Opirashibets) district, southern part of province of Tesio. (H. YABE, URABE 1935 MS, Y. SASA 1939)
(11) The Uryu district, northern part of province of Ishikari. (Y. OKAMURA, M. USAMI 1935 MS.)
(12) The Isikari Coal-field, central Hakkaidô. (H.YABE, K. ÔTATUME)
  a. The Ikusyundetu Valley (H. YABE; R. SAITO, T. NAGAO & T. MATUMOTO 1938).
  b. Near Yûbari (H. IMAI, K. ÔTATUME).
  c. The Asibetu Valley and the Hurano district (W. HASIMOTO 1936, E. TAKAHASI 1937 MS.)
  d. The Yûbari Valley (R. SAITO 1932 MS.)
  e. The Hobetu Valley (K. ÔTATUME 1932-1939)
(13) Near Hetonai, along the Mukawa, province of Iburi. (K. ÔTATUME)
(14) The Yamabe-Kanayama district, province of Isikari, central Hokkaidô, (NÔTOMI, YAMANE, MURATA, YABE and HANZAWA, S. WATANABE, M. SANBONSUGI 1937 MS.)
(15) The Urakawa district province of Hidaka (IGARASI 1931 MS., SANBONSUGI 1938)

Indeed the provious works gave important contributions, but many of the investigations that have been found leave much to be desired as to the accurate knowledge of the Cretaceous stratigraphy. With the hope of responding to this necessity, I tried to research more deeply the following districts, which can be regarded as standard localities of the Cretaceous of Hokkaidô and Karahuto.

(1) "The Naibuti district" or the Mid-Valley of the Naibuti, and its adjacent area, southern part of the Japanese Karahuto.
(2) "The Abesinai district" or the Mid-Valley of the Tesio and its tributary Abesinai, Nakagawa-gun, province of Tesio, northern central Hakkaidô.
(3) The so-called Isikari Coal-field, or the western zone of the backbone of central Hakkaidô, along the upper courses of the Ikusyunbetu and of the Yûbari, province of Isikari and the middle Valley of the Mukawa and its tributary the Hobetu (Popets), province of Iburi.
(4) Near Urakawa, province of Hidaka, southern part of central Hokkaidô.

Before entering into the general account of the Cretaceous Stratigraphy of Hokkaidô and Karahuto, I will describe what I observed at each locality concerning the succession and characters of rocks and the sequence and occurrence of fossils. And it may be a basis for developing further problems which shall be treated in Part II and Part III.

Chapter I.

Cretaceous Deposits Along the Naibuti Valley, South Karahuto; with an Additional Observation Along the Valley of Ai-kawa, Adjacent to the North of the Naibuti District.

(Pl. V——IX)

INTRODUCTION

The area which I surveyed is the drainage of the middle course of the Naibuti, in Sakaehama-gun[1], southern part of the Japanese Karahuto[2]. Its dimension is about 10 km from north to south and from west to east, as is illustrated in the map on Pl. V In this area the main course of the Naibuti and its many tributaries form consequent and subsequent valleys meandering through the Cretaceous terrain, and display good and continuous exposures.

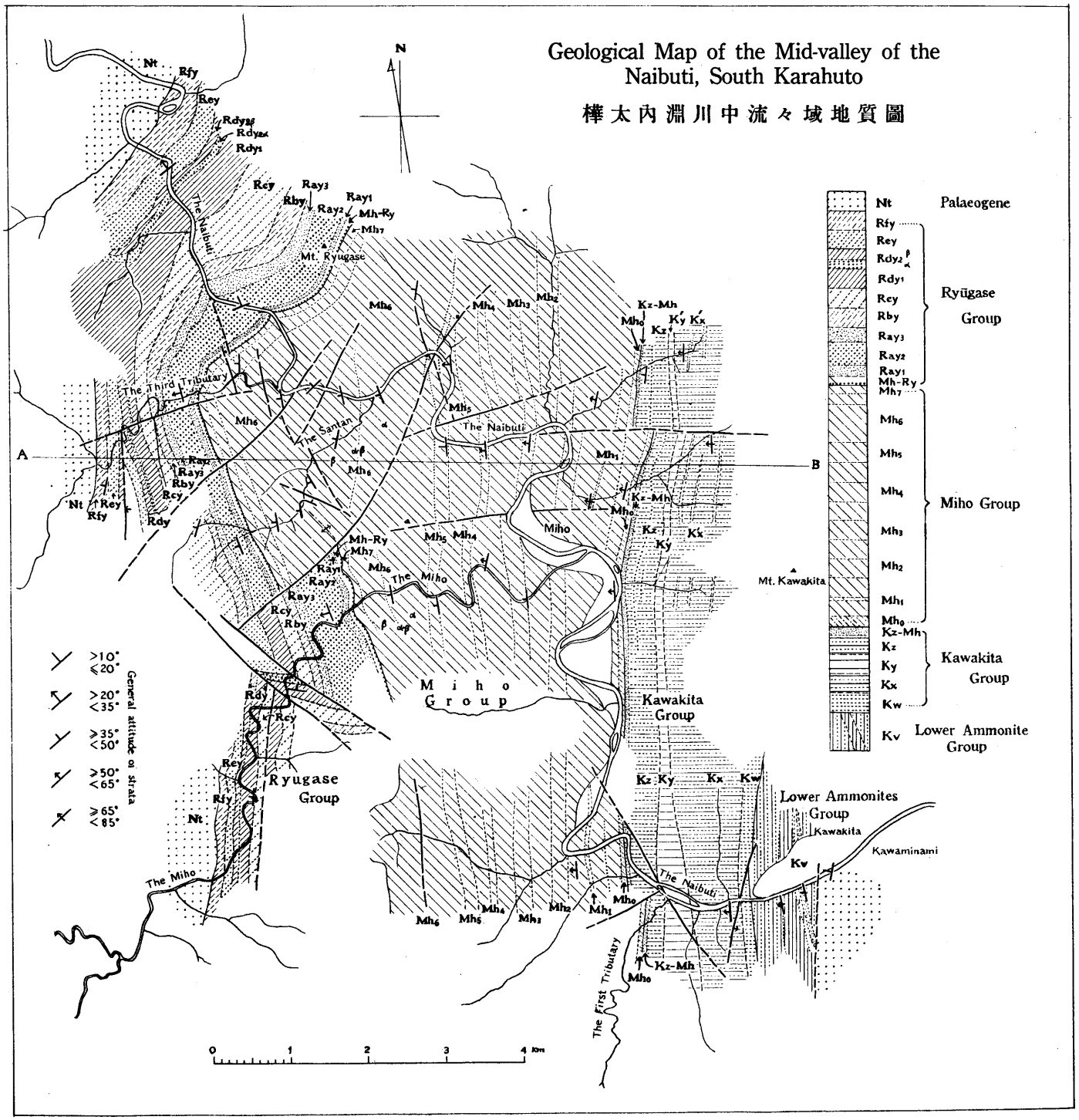
During three months in 1937, I performed a detailed field work throughout this area. I collected fossils metre by metre from strata discriminating horizons as fine as possible. And as there was insufficiency of data concerning the lower part of the succession, a supplemental survey was carried out in autumn of the same year along the middle course of the Ai-kawa, a part of the Forestry Experimental Station annexed to the Tôkyô Imperial University[3]. The latter area situates to the north of the former almost adjacently. The results of my field work was reported preliminary in a concise from on the following papers:

A Biostratigraphic Study along the Naibuti Valley, South Karahuto. (Proc. Imperial Academy, vol. 14, Tôkyô, 1938)

(1) 樺太榮濱郡内淵川中流々域

(2) A small village called Miho (美保) is the center of the surveyed area. It situates about 40 km. NNW of the City of Toyohara (豐原市), the position of the Karahuto Government.

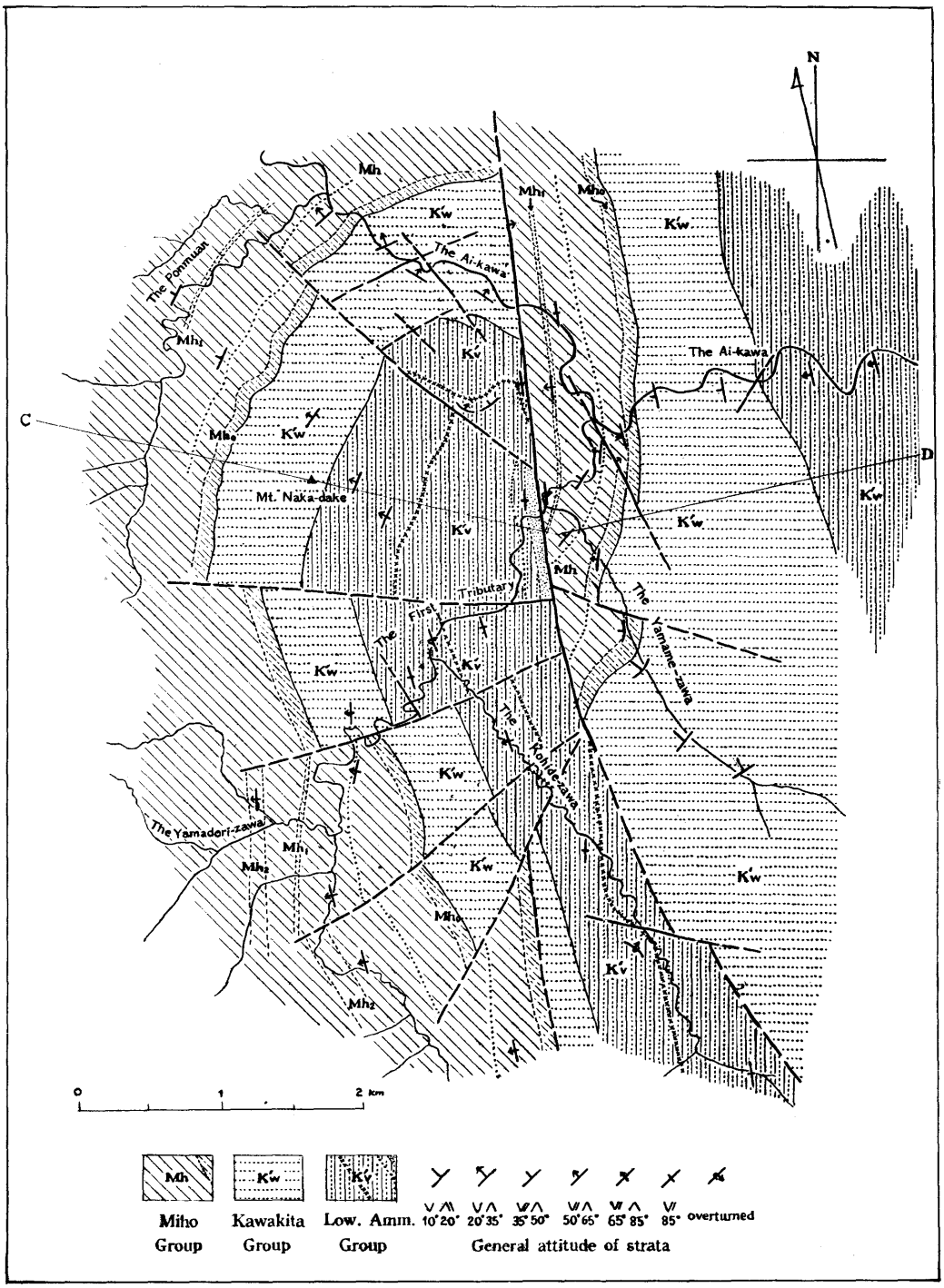
(3) 東京帝國大學樺太演習林相川中流々域


Geological Map of the Mid-valley of the Naibuti, South Karahuto
樺太内淵川中流々域地質圖
N
Nt
Rfy
Rey
Rdy2β
Rdy2α
Rdy1
Ray3
Rby
Ray2
Ray1
Mh-Ry
Mh7
Mt. Ryugase
The Naibuti
Mh6
Mh5
Mh4
Mh3
Mh2
Mh1
Mh0
Kz-Mh
Kz
Ky
Kx
Kw
Kv
The Third Tributary
The Santan
Miho
Mt. Kawakita
A
B
Palaeogene
Ryūgase Group
Miho Group
Kawakita Group
Lower Ammonite Group
M i h o Group
Kawakita Group
Ryugase Group
Lower Ammonites Group
Kawakita
Kawaminami
The Miho
The First Tributary
General attitude of strata
>10° <20°
>20° <35°
≥35° <50°
≥50° <65°
≥65° <85°
0 1 2 3 4 km

Geological Map of the Mid-valley of the Ai-kawa, South Karahuto

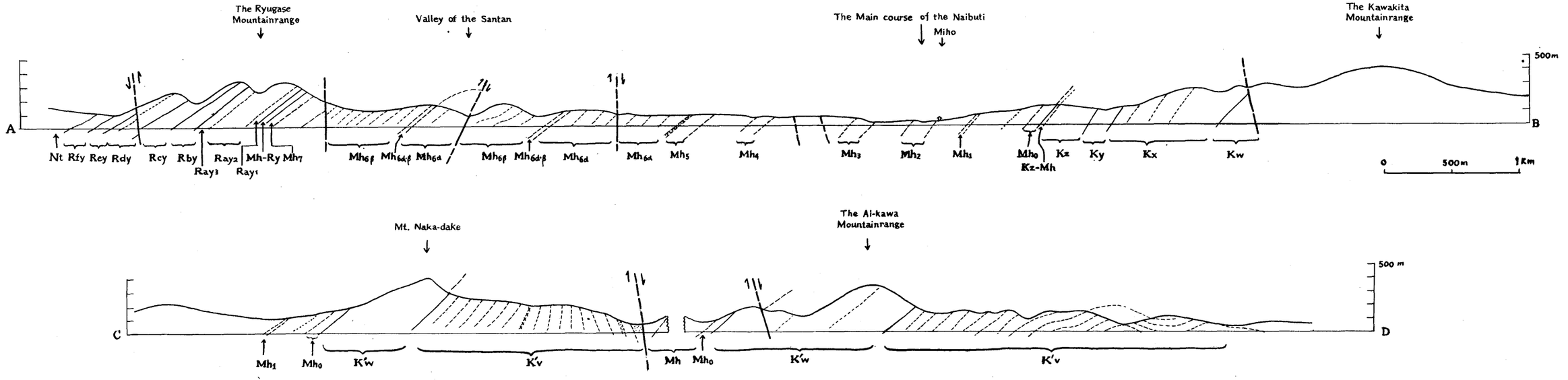
樺太相川中流々域地質圖

T. MATUMOTO: *Cretaceous Stratigraphy* Pl. VI



Geological Profiles of the Naibuti-Aikawa District, South Karahuto

樺太内淵・相川地方地質斷面圖



Geology of Middle course District of the Ai-kawa in Sakhalin, Experimental Plantation of the Tôkyô Imperial University (Jour. of Geography, vol. 50, 1938) (in Japanese)[1]

Concerning the Cretaceous Stratigraphy of the Naibuti district, there are two previous investigations. One is a geological survey of Mr. M. KAWADA[2], and the other is the work of late Dr. S. SIMIZU[3] in connection with his research of cephalopods. Although the results of the two investigations are only briefly reported and seem to disagree with each other, my study was much facilitated by them. And I owed especially to the first investigator, for I had fortunately an opportunity of studying his fossils, a precious and large collection deposited in the Geological Institute, Faculty of Science, Imperial University of Tokyô.

PHYSICAL AND GEOLOGICAL CONDITIONS IN GENERAL.

Topographically the middle course district of the Naibuti can be divided in four belts of a meridional trend. They are as follows from east to west.

(1) Eastern lowland. —— Low hills adjacent to the mountain-range of the second belt, and the fluvial plane along the lower course of the Naibuti and its tributaries.

(2) The Kawakita Range[4]. —— A mountain-range with an altitude of generally 400 m to 450 m. The highest is Mt. Kawakita, being 494.3 m. The Naibuti River crosses the range forming a gorge at a point 2 km west of Kawakita village. The western side of the mountain chain is dissected by a small torrents like the Birin-zawa[5], the Kamogawa[6], and the Yuno-sawa[7].

(3) The intermontane lowland. —— In this area the main course of the Naibuti is meandering and jointed with many larger and smaller tributaries such as, "the third tributary[8], the Santan[9], the Kakure-zawa[10], the Ugui-zawa[11], the Birin-zawa, the Kamo-gawa, the Miho or the "second tributary"[12], the Nisio-zawa[13], the Itino-sawa[14], the Nino-sawa[15], etc.

(1) 東京帝大樺太演習林相川中流々域の地質 (地學雜誌 50巻, 昭 13)
(2) M. KAWADA 1929 (3) S. SHIMIZU 1929, 1935
(4) 川北山嶺 (5) 備林澤 (6) 鴨川 (7) 湯の澤
(8) 第三支流 (9) 三丹川 (10) 隱澤 (11) うぐひ澤
(12) 美保川即ち第二支流 (13) 西尾澤 (14) 十八林班一の澤 (15) 十八林班二の澤

River-terraces are well developed along them, but there is good exposure of basement Cretaceous rocks below the terrace gravels.

(4) The Ryûgase Range[1]. —— This is the southern prolongation of the main back bone of Karahuto. In the area, peak with height more than 500 m or 400 m, such as Mt. Ryûgase or Mt. Kwaseki[2], and Mt. Atago[3] are distributed. The main course of the Naibuti, the third tributary and the Miho cross the range, forming insequent or consequent valleys associated with a gorge or with water-falls.

The Aikawa-district has similar topographic feature. The second belt is wide, including a range of Mt. Naka-dake[4], a branch of the Kawakita Range running southward from Mt. Aikawa[5]. The fourth belt or the western mountain-range is prominent in the district, forming a source region of the Aikawa.

The topographic feature corresponds well to the distribution of rocks. The first eastern belt is occupied by the Quarternary and the Neogene sediments, with which the Cretaceous is in contact by a presumed large fault of N–S trend. The Cretaceous rocks in the area are classified in the following four groups of formations which are accumulated conformably in ascending order.

I Lower Ammonite Group (下部菊石層群)
II Kawakita Group (川北層群)
III Miho Group (Middle and the Upper Ammonite Group (美保層群)
IV Ryûgase Group (Hakobuti Group) (龍ヶ瀬層群)

The first two groups are developed mainly in the second topographic belt, i.e. the Kawakita Mountain-range. The Miho Group occupies the intermontane lowland, and the Ryûgase Group forms the main part of the Ryûgase Mountain-range. The last mentioned is overlain on its western side by the Palaeogene Naibuti Group apparently conformably. But the relation is said generally a parallel unconformity.

In the Naibuti district the strata of the Cretaceous and the Palaeogene have general trend of N–S, and incline homoclinally

(1) 龍ヶ瀬山嶺 (2) 化石山 (3) 愛宕山
(4) 中 嶽 (5) 相川山

westward. The dip is very high in the eastern part but is low or moderate in the western part. Strike faults of N-S trend, other systems of faults in NW, NE, E-S trends are found. They are mostly high angled and are observable on exposures or proved by tracing of beds. Owing to these faults there is repetition, omission, or other displacement of strata, but very great dislocation is not present. Another noteworthy feature in geologic structure is a gentle flexure developped at and near the Ryûgase-gorge. Minor faults or flexures, as illustrated on geologic map, seems accessory to this structure.

Shortly the Cretaceous strata are not so much disturbed as to make it difficult to execute in detail and accurately a biostratigraphic investigation.

The structure the Aikawa district is not much different, from that in the Naibuti except for the presence of a peculiar structure called Aikawa-faults. (cf. geological map on Pl. VI) For fuller account on the geology of this district the reader is requested to refer to the paper cited above.

DESCRIPTION OF STRATIGRAPHY

I. Lower Ammonite Group (="Lower Kawakita Group", MATUMOTO 1938[1]) (Kv)[2]

The exposed lowermost part of the Cretaceous in the Naibuti and Ai-kawa districts are mainly composed of shales and sandstones in frequent alternation and varved black sandy shales. More homogeneous shale or mudstone and stratified sandstones are found in a subordinate amount. Although many concretions of marl are contained, fossil occurs very rarely.

Lithologically and stratigraphically the series of strata is no doubt a portion of what we call the Lower Ammonite Group[3].

The lower limit is unexposed owing to the presence of fault. Only a little more than 500 m are exposed along the Naibuti,

(1) In the former occassion (1938), I gave to this group the name of the Lower Kawakita Group. But as will be later discussed (part II), the Kawakita Group is better to be used only for what I called "the Upper Kawakita Group".

(2) Kv is an abbreviated symbol for the Lower Ammonite Group of the Naibuti and the Ai-kawa districts.

(3) As will be defined later (in Part II), the Lower Ammonite Group is to be used in a revised sense.

between loc. N 4 and N 9, eastward from the Kawakita gorge. Whereas, nearly 1,200 m, are developed in the Ai-kawa district. The typical exposure is along the main course of the Ai-kawa, between loc. I 65 and loc. I 75, and along the first tributary, from loc. I 15 to loc. I 32a. Smaller exposures are found in a small valley running south-eastward from Mt. Naka-dake and along the Titose-zawa[1] (or Kohide-zawa[2]).

In the exposed lowermost part, at loc. I 31b, 32, and 38, there is a compact, dark green sandstone, 30 m thick, partly stratified but partly massive. The rock is fine-or medium-grained contains abundant grains of andesite and glassy rock besides those of quartz and feldspar. Predominance of iron-minerals and chloritic matter is noted. In other parts I found coarse grained sandstone which is apparently tuffaceous.

At a horizon, about 500 m below from the top of the group in the Ai-kawa district, a key bed of several-metres thick is found which is characterized by its hardness and compactness. The rock is siliceous shale or sandstone, containing devitrified glass(?) and highly angular quartz. Part of the layer is an ancient tuff containing splinters of glass (now altered to silica with low double refraction) and pumices. The typical exposure of the key bed is at localities I 22c, I 125, I 169, I 208, I 222, I 227, etc.

Fossils are very poor throughout the formation. Remains of marine organism such as ammonites and *Inoceramus* are rarely found in a shale or in a marly nodule. They are:

1. *Puzosia* (s. str.) *subcorbarica* YABE MS. loc. I 69. Two specimens collected from marly part in varved shales frequently interstratifed with thin layers of fine sandstone at a horizon about 700 m below the top of the Group along the Ai-kawa. One is a middle-aged shell in fairly good preservation, the other is a large and nearly smooth shell of ill-preservation, presumably an old shell of the same species.
2. Ammonites gen. et sp. indet. cfr. *Puzosia* sp. Loc. N 8. A large specimen in bad state of preservation. Shale at a horizon about 250 m below the top of group along the main courose of the Naibuti.
3. "*Placenticeras*" sp. of *warthi* group. Loc. I 22e. A specimen in somewhat unfavourable state of preservation but exhibiting suture-line. Varved shale containing thin lenses and nodules of marl at a horizon about 30 m below the key bed of acidic tufaceous rock mentioned above.

(1) 千歳澤
(2) 小秀澤

4. *Inoceramus* sp. indet. cfr. *I. bohemicus* LEONHARDT. Loc. I 22 e. and I 248. In a marly part of the bed containing "*Placenticeras*". Many individual of *Inoceramus* species are found, some of which has two valves in place.
5. *Inoceramus* sp. indet. Loc. N 4. Shale at the exposed lowermost horizon along the main course of the Naibuti. The specimen is too badly preserved to be determined specifically.
6. Vertebral colum of fish, gastropod and an indeterminable ammonite with a compressed and convergent whorl are found at loc. I 29 from a marly concretion contained by a siltstone a little above the green andesitic sandstone.

II. Kawakita Group, emend. (="Upper Kawakita Group, Matumoto, 1938)

General remarks.——In the Naibuti-Aikawa district and its adjacent area[1], lying on the Lower Ammonites Group, there is a group of formations consisting of sandstones, alternations of sandstone and shale, and with a conglomerate in somepart. When compared with the subjacent or superjacent formation, the deposits are characterized by coarser material and more conspicuous change of facies in horizontal and vertical directions. But they are mainly sediments of marine environment. The uppermost part is somewhat transitional to the succeeding Miho Group. The thickness ranges between 600 m and 1,100 m.

As the group is distributed in the mountain range of Kawakita I have given the entitled name. Previously (in 1938) I used the name in a broad sense, but here it is revised to a restricted sense, being synonymous with the "Upper Kawakita Group" of the former occasion. The reason shall be presented in later chapter. (Part II.)

Stratigraphic sequence and rock-facies.——In the Naibuti district, the group is composed of the following formations in ascending order.

Formation Kw. Greenish grey sandstones, fine to coarse, massive or laminated, sometimes interstratified with thin shale; carbonaceous flakes are contained in the stratification plane; determinable fossils not found; less than 200 m thick. Typical exposures are loc. N 1 and N 303.

Formation Kx. Consists of the following members in alternation: Shale with marly nodules, generally laminated, but sometimes massive and homogeneous; thin alternations of sandstone

[1] Judging from the geological map and exploration of K. MURAYAMA the group seems to continue in the Odasam district, adjacent to the north of the Aikawa district. (村山賢一, 小田寒地方地質調査報告, 昭 8)

and shale; sandstones, forming beds of several metres or less, in thickness; conglomerate or pebble-bearing fine sandstone. Lateral change of facies and existence of locale erosion surface are noteworthy (Fig. 3). Fossils of ammonites and *Inoceramus* are not

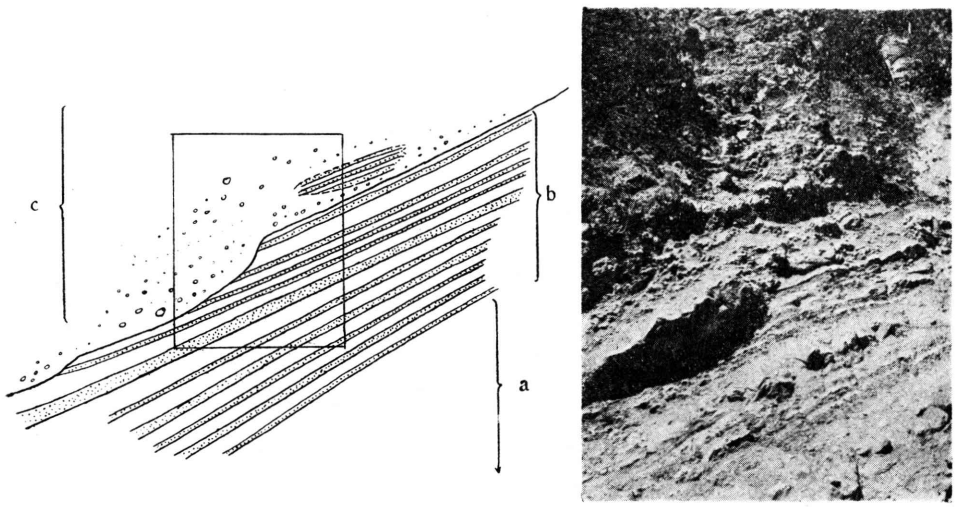


Fig. 3 Local conglomerate showing records of contemporaneous erosion in the Kawakita Group (Loc. N 56–N 58 along the valley of the Kamo-gawa, Formation Kx') a: Mudstone containing nodules of marl and fossils. b: Sandstone and shale in alternation. c: Conglomerate containing pebbles of mudstone and marl.

seldem found in the argillaceous rock. Thickness 600–450 m. Typical exposures, southern part: N 301, N 302; intermediate part: N 96 to N 100; northern part: N 54 to N 64.

Formation Ky. Shale, bluish grey and homogeneous (i.e. "mudstone"), containing nodules of marl in which fossils of ammonites and *Inoceramus* are not uncommonly included. The shale changes laterally to thin bedded alternations of shale and sandstone and gradually passes to the formation Kx or formation Kz. Thickness, 300–150 m. Typical exp., loc. N 305, N 310a, b, N 95, N 49 to N. 53. N 80, N 81, etc.

Formation Kz. A formation consisting of the following members in repetition: Alternations of sandstone and shale, usually thin-bedded, sometimes stratified in medium thickness; Sandstones, light greenish, medium-grained, 5 m, 10 m or more than 10 m in

thickness, massive and sometimes stratified. Local conglomerate occurs in the lower part and coaly shale is intercalated locally. Lateral change of facies is found. Fossiliferous in the upper part. Thickness of the main part of Kz is about 150 m. Its typical exposures are N 44e–N 48; N 77–N 79; N 93, N 94; N 310f.–N 312a, N 313; N 323–N 326.

Lateral change of facies.——The Kawakita Group in the Aikawa district is mainly composed of sandstones, bluish grey in colour, and the more fine-grained sediments are rather poor, though standstones are sometimes interstratified with shale. Local conglomerate containing fragments of littoral bivalves is intercalated in the middle part. Furthermore, the thickness of the group is smaller in the Aikawa area than in the Naibuti district. These differences can be explained as a lateral change of facies owing to some minor difference in the environment of sedimentation, as is easily expected for the coarser deposits of shallow sea.

The lateral change is encountered even within the Naibuti district. Comparing the rock-successions exposed almost continuously along several parallel valleys, such as the first tributary, the main course of the Naibuti, the Yuno-sawa, the Kamo-gawa, and the Birin-zawa, fine grained sediments like formation Ky is thicker and more conspicuous in the souther exposure, while conglomerate and pebble-bearing rock frequently occur in the formation Kx of the northern exposure. Shale is laterally changed to alternations of sandstone and shale which, in turn interfinger with thicker sandstone.

Conglomerate and local disconformity.——Coarse-grained deposits and their sedimentary features in the Kawakita Group, especially in the formations Kx and Kz, deverse brief consideration in connection with stratigraphy and geologic history.

Comparatively thick bed (5 m ±, 10 m ± or more) of sandstone, conglomeratic sandstone or conglomerate is intercalated repeatedly with thin bedded alternations of sandstone and shale, or with shales. The conglomerate, if traced laterally along the strike of bed, gradually decreases its grade and thickness, passing into sandstone or partly sandstone and shale in alternation. Accordingly the bed of the intraformational conglomerate is variable in number.

Within a bed of conglomerate, pebbles are, accumulated more

closely-set in the lower part. Pebbles in this part range widely in size, cobbles and even boulders being sometimes detected.

Besides the pebbles of undoubtedly exotic origin, there are pebbles of rocks quite resembling those of the contemporaneous or just subjacent Cretaceous formation. Most of them are dark coloured shale or fine sandstone and some are marl, but coarser sandstone is rare. A fossil of *Inoceramus* was found in one of these pebbles. Their size is inconstant and their shape is irregular, often angular but not uncommonly somewhat water worn. Similar kind of pebble is sometimes contained also in sandstone of the Kawakita Group.

The exotic pebbles are quite well rounded, being spherical, ellipsoidal and discoidal in shape. Noteworthy is the fact that these are almost exclusively those of pyroxene-andesite or porphyrite, often propyritized or silicified.

This conglomerate lies on thin bedded alternations of shale and sandstone or on shale with marine fossil. And the boundary is sometimes an uneven surface. The relief is usually small but in some case moderate, attaining one metre or so in difference of height. Though the boundary-surface cuts obliquely the underlying beds, the stratification of the superjacent and subjacent deposits is parallel. (cf. Fig. 3)

On the other hand, the conglomerate changes, in some case, laterally to the finer sediments, and there is a bed of shale or sandy shale which contains sporadically rounded pebbles of exotic origin.

Shortly the above described sedimentary features may be a record of minor events within a formation, the conglomerate can be regarded as intraformational, and the uneven surface may show a contemporaneous erosion. But the phenomenon as a whole is important because it seems to suggest a condition during the epoch of the Kawakita Group.

Occurrence of fossils. —— The Kawakita Group is not very fossiliferous as compared with the succeeding Miho Group. But remains of marine shell are not rare in members and formations of comparatively fine-grained sediments. Only the uppermost part forms a fossil-zone (zone Kz–Mh). This fossil-zone seems to be thinned out in the northern exposure (along the Birin-zawa) in Naibuti district and is not encountered in the Ai-kawa district.

So far as the Naibuti district is concerned, the horizon of fossil can be expressed by calling the name of the stratigraphic subdivisions based on rock-facies. But as there is lateral change of facies, the horizon may not closely follow the parallels of the boundary of these subdivisions. For example, the upper part of Kx at the northern exposuse may possibly be the same horizon as the lower part of Ky at the southern exposure. But if we adopt the treatment of the subject in somewhat major scale, there will be no such perturbance. For example, the upper part of the formation Kz is everywhere higher than any part of the formation Ky, or the lower part of Kx is always lower than Ky. Fossil is very poor in the Kawakita Group of the Aikawa-district, where finer sediments are less frequently intercalated. Only fragments of *Anomia* were detected in the middle part of the group.

The following is the name of fossils and their mode of occurrence in each formation.

Kw. Nonfossiliferous, except for fragments of plant remains.

Kx. Nodules of marl included in shale, non-foliated mudstone and alternations of shale and sandstone contain sometimes fossils, some of which are fairly good in preservation.

In the lower part of southern exposures:

Inoceramus sp. indet. cfr. *I. bohemicus* LEONHARDT. (Loc. N 302g) Ammonites gen. et sp. indet cfr. *Parajaubertella kawakitana* MATUMOTO MS. (Loc. N 302e)

In the upper part of the southern exposure:

Phylloceras sp. indet. aff. *tanit* PERVINQUIÈRE (N 503b) *Desmoceras kossmati* MATUMOTO MS. (N 503p)

Jacobites (?) sp. (River pebble of the Imano-sawa)

Kossmaticeratoid Ammonites, gen. & sp. indet, cfr. *Eogunnarites unicum* (YABE) em.

In the northern area:

Parajaubertella[1] *kawakitana* MATUMOTO MS. (common, loc. N 56d, N 97b, N 99d)

Desmoceras sp.

Sandstone in the upper part of the northern area rarely contains

Inoceramus aff. *cripsi* MANTELL (loc. N 55a, N 54.)

Ky. Nodules of marl are rich in the formation and many of

[1] New generic name which is to be established for *P. kawakitana* MATUMOTO MS. and its allied species.

them contain fossils, although not always in a good state of preservation.

Phylloceras sp. indet, aff. *Ph. tanit* PERVINQUIÈRE (Loc. N 49, N 50)

Tetragonites sp.

Parajaubertella kawakitana MATUMOTO MS. (Loc. N 94 bp, N 95, etc.)

Cfr. *Pachydesmoceras denisoni* (STOLICZKA). (Loc. N 305 d, N 49 a)

Desmoceras kossmati MATUMOTO MS. (Loc. N 305 b, N 507 p, N 508)

Inoceramus sp. indet, cfr. *I. cripsi* MANTELL.

Kz. Fossil is almost absent in the lower part of the formation, only a fragment of *Inoceramus* having been detected. On the other hand, the upper part is fossiliferous. Especially the uppermost greenish silty sandstone of 50 m or less thick, is very fossiliferous, forming a fossil-zone together with the superjacent lowermost part (i.e. zone Mho) of the Miho Group. This uppermost part of the Kawakita Group or a transitional zone between the Kawakita and the Miho Groups is here defined as **zone Kz–Mh.** While the name of **zone Kz–1** is used conventionally for the subjacent fossiliferous part. Exposures of zone Kz–Mh: N 44 d, N 92, N 93 a, N 308 e-g, N 312 a_3, b, N 314 a, N 327.; those of zone Kz–1: N 44 e, N 45, N 76, N 93 d, N 307 a, N 312 a_1, a_2, N 326. (All of them are fossil-locality.)

The fossils are found usually in marly nodule or calcareous part of the silty sandstone, and fairly good in preservation. They are remains of mollusca, mostly ammonoids and *Inoceramus*. Other pelecypods and gastropods are very rare. Though the number of species is not very large, the important species (with * in the following list) are represented by numerous individuals.

	Phlloceras cfr. *ellipticum* KOSSMAT	Kz–Mh
*	*Anagaudryceras sacya* (FORBES)	Kz–Mh, Kz–1
	A. sacya var. *laeve* MATUMOTO MS.	Kz–1
	A. sacya var. *plicatocostata* MATUMOTO MS.	Kz–Mh
*	*Desmoceras* (*Pseudouhligella*) *japonica* YABE	Kz–Mh, Kz–1
	Puzosia subcorbarica YABE MS.	Kz–Mh
*	*P. planulata nipponica* MATUMOTO	Kz–Mh, Kz–1
	Holcodiscoides papillaius (STOLICZKA)	Kz–Mh

Turrilites cfr. *acutus* PASSY Kz–1
* *Inoceramus concentricus nipponicus* N. & M. em. Kz–Mh, Kz–1
* *I. yabei subconcentricus* MATUMOTO MS. Kz–1
* *I. yabei constrictus* MATUMOTO MS. Kz–1
I. yabei spengleri MATUMOTO MS. Kz–Mh, Kz–1
* *I. yabei* N. & M. subsp. indet (intermediate form) Kz–Mh, Kz–1

III. Miho Group

General remarks.——The middle or the main part of the Cretaceous deposits of the district consists mainly of grey mudstones rich in marly nodules and in fossils of ammonite, *Inoceramus* and other marine fossils. The thickness is estimated to attain 2,750 m. The group overlies the Kawakita Group conformably and with gradual change of lithic character. The top is also conformable to the superjacent Ryûgase Group. The main distributional area is the wide intermontain lowland in which a village called Miho is situated. The Miho Group here defined almost agrees with what M. KAWADA called the "Miho Bed". It corresponds to the combination of the Upper Ammonites Group and part of the Middle Ammonites Group continued from Hokkaidô. (cf. Part II.)

Rock facies.——The Miho Group is a series of fine-grained and comparatively homogeneous sediments, the main constituent of which is a mudstone. The mudstone is dark grey (under wet condition) or light grey (under dry condition), rather massive without good development of fissility or lamination, and contains numerous concretions of marl (i.e. argillaceous limestone or calcareous mudstone). The nodule is rounded, generally ellipsoidal or sphaerical but sometimes irregular in shape, and is various in size. The small one is 3 or 4 cm. in diameter, while the largest example exceeds 1 m. The concretion contains often fossils of marine organisms, drift woods and other plant-remains. The fossils are sometimes included abundantly with a random orientation or with an orientation subparallel to the plane of sedimentation. In other case they are gathered in a portion of the nodule or around it. Concretion containing only a few fossil is not rare, and the non-fossiliferous one is also common. Fossil is sometimes found in the mudstone itself, but in this case the preservation is generally bad. The marine organisms are *Inoceramus*, cephalopods of the Nautilidae, the Phylloceratidae, the Tetragonitidae, the Gaudryceratidae, the Desmoceratidae including the Desmoceratinze, the Puzosinae,

the Pachydiscinae, and the Kossmaticeratinae, the Scaphitidae and the uncoiled ammonites. And the highly ornamented ammonites and other molluscs are rather rare. Echinoids, corals, brachiopods and crustaceans are inconspicuous, while *Aptychus* of ammonites is not rare.

With the mudstone, thin layers of sandy marl, sandstone and bentonitic rock and beds of sandstone are sometimes intercalated. Among the beds of sandstone, the notable one which can be traced throughout the district is found only at two horizons. The one is in the lower part between zone Mho and zone Mh_1, and the other is in comparatively upper part, at a boundary between zone Mh_5 and zone Mh_6. The sandstone is light greenish grey, in part coarse-grained and contains sporadically the remains of ammonites and *Ostrea*.

As a rare case, a small patch of sands very rich in remains of shell is included within the mudstone. (Loc. N 25, zone Mh_6).

Briefly the Miho Group shows the rock facies of the so-called "Geodenterrain", and may be formed under the tranquil shallow water of open sea. A slow and continuous submergence of the depositional area may have produced a thick series.

The lowest part of the Miho Group is fine sandy mudstones or sandy siltstone, and has a lithological character transitional from the upper part of the Kawakita Group. The rock is somewhat glauconitic and contains numerous fossiliferous nodules.

Horizontal distribution and stratigraphical sequence of fossils.—— For the purpose of biostratigraphical study, the thick sediments of the Miho Group should be divided. As the group is made up of homogeneous mudstone from bottom to top, it is hardly subdivided by means of the easily discriminable criteria such as lithological characteristics. But examining in detail throughout the distributional area of the group, I have found the fact that there are more fossiliferous part and less fossiliferous one within the group. Stratigraphically they alternate repeatedly, and horizontally each of them is traceable along the strike at least within the surveyed area. The comparatively fossiliferous part is in reality what OPPEL called the "faunal-zone." And each fossil-zone[1] is characterized by a definite assemblage of fossils. Thus eight fossil-zone

[1] Exactly speaking the terminology of fossil-zone is better than that of faunal zone. The reason shall be cleared up in Part II.

have been discriminated within the Miho Group, and they are denominated as zone Mho, zone Mh_1, zone Mh_2,..., and zone Mh_7 in ascending order. In practise, the zones are not constant in their thickness and perhaps in their horizonal distribution. And each zone is to be regarded as having a form of lenticular layer. Furthermore, on the intervening part between two fossil-zones there are interspersed fossil localities.

The following is the important feature of the eight fossil-zones and the intervering parts:

Zone Mho This is the lowermost part of the Miho Group, the lithological character of which has been described in the last paragraph of the preceding article. The average thickness is 100 m, and the maximum one attains 150 m. The zone is traceable as far north as the valley of the Ai-kawa, though it decreases in thickness. The important exposures are at localities N 87–91, N 308 b-d, N 309 a-m, and N 314 b-e along the main course of the Naibuti; N 42, N 43, N 44 a-c along the valley of the Kamo-gawa; N 74–76 along the Birin-zawa; 155 a-c, and 157 a along the main course of the Ai-kawa; I 11 b-f along the first tributary of the Ai-kawa; 1253, 1254, and 1259–260 along the Yamame-zawa a branch of the first tributary of the Ai-kawa.

The assemblage of fossils is the same throughout the zone, further subdivision being impossible and unnecessary. It resembles that of the zone Kz-Mh at the top of the Kawakita Group. Though the number of individual is very large, that of the species is not so, The species yielded from this zone is as follows, among which those with * occur abundantly or very commonly.

* *Anagaudryceras sacya* (FORBES)
Zelandites aff. *mihoensis* MATUMOTO (=aff. *dozei* FALLOT)
* *Desmoceras* (*Pseudouhligella*) *japonica* YABE
* *Puzosia planulata nipponica* MATUMOTO MS.
Holcodiscoides papillatus (STOLICZKA)
Jacobites sp.
* *Inoceramus concentricus nipponicus* NAGAO & MATUMOTO em.
* *I. yabei* N. & M. *subconcentricus* MATUMOTO MS.
* *I. yabei* N. & M. *constrictus* MATUMOTO MS.
* *I. yabei* N. & M. *spengleri* MATUMOTO MS.
* *I. yabei* N. & M. subsp. indet (intermediate form)

Intermediate zone between Mho and Mh_1. —— The intermediate part between zone Mh_1 and zone Mho is the mudstone rather poor in fossil, about 300 m to 250 m thick. Few locality of this part has yielded fossils of *Inoceramus*. At a horizon in the middle portion of this division, occur beds of sandstone. This part is 10 m or so in thickness, and is in some place wholy represented by sandstones, rather mossive and only partially laminated (as in exposed at loc. I 51, I 52, I 37, I 251, I 7, I 9, etc.) or in other places a few deds of sandstone, several metres or a few metres thick, are interstratified with shale or with thin bedded alternations of shale and sandstone (as is exposed at loc. N 38, N 73, N 314 h I 100, I 154, etc.). The sandstone is medium-grained, light greenish grey, and generally unfossiliferous. But shell of *Ostrea* has been collected form this rock exposed at loc. I 9. By means of this sandstone-horizon, the intermediate zone is subdivisible into two parts, lower and upper. From the lower part a few specimens of *Inoceramus* cfr. *yabei*. NAGAO & MATUMOTO, *Anagaudryceras sacya* (FORBES) var. *plicatocostata* MATUMOTO MS. and *Puzosia* sp. have been found. (Loc. N 39. N 41). In the upper part, there is sporadic occurrence of *Inoceramus* cfr. *hobetsensis* and *Gaudryceras* sp. juveuile.

Zone $\mathbf{Mh_1}$ This fossil bearing zone occurs about 150 m. above the key bed of sandstone mentioned just above. Typical part of this zone is only 20 m or so in thickness, but we can find it by careful observation. And the detection is facilitated by the key bed below, which is traceable splendidly as is illustrated in geological maps. Furthermore the zone itself contains somewhat sandy siltstone, more or less greenish or glauconitic. Exactly speaking, abundance of fossil is not always uniform thoughout this zone. And the zone seems to be a horizon which links a few lenticular layers of more fossiliferous rock. But at any rate, in spite of its small thickness, this zone is found either in the southern part of the Naibuti district and in the Aikawa district. It comprises fossil localities of N 315 d, and N 317 along the main course of the Naibuti, N 34 along the Kamo-gawa; I 113 along the main course of the Ai-kawa; I 91 along the Pommuan; and I 35 along the first tributary of the Ai-kawa. Following species have been found in this zone. Among them fossil of *Scaphites* occurs abundantly, sometimes many small individuals being contained in a single nodule.

Tetragonites (s.l.) sp. cfr. *Epigoniceras glabrum* (JIMBO)
Gaudryceras denseplicatum (JIMBO) var. *intermedia* YABE emend.
Scaphites (*Yezoites*) *puerculus* (JIMBO)
S. (*Y.*) *puerculus* JIMBO var. *teshioensis* YABE
S. (?) *planus* YABE
Tragodesmoceroides subcostatus MATUMOTO MS. (Immature)
Jacobites sp. indet.
Scalarites scalare. (YABE)
Inoceramus cfr. *hobetsensis* NAGAO & MATUMOTO

Zone Mh_2 The Mudstone of 150 m to 200 m thick which follows the zone Mh_1 is again poor in fossil. Though many concretions of marl are contained in the mudstone, they are mostly barren. Ony a few specimens of *Inoceramus hobetsensis* NAGAO & MATUMOTO, *Anagaudryceras* cfr. *limatum* (YABE) and *Epigoniceras glabrum* (JIMBO) have been found. This part is overlain by the zone Mh_2 which, in turn, is considerably fossiliferous. This zone is 100 m to 150 m thick, and continues from south to north throughout the surveyed area. The typical exposures are loc. N 315g, N 316, N 351–N 356 near the mouth of the Itino-sawa; N 319a-c, N 320, N 124, and N 125 along the main course of the Naibuti; N 338–N 350 along the Ugui-zawa, I1 and others in the Aikawa district. In this zone, thin layers of sandstone or sandy marl is sometimes intercalated with the mudstone, and the nodule of marl has sometimes laminated structure. The assemblage of fossils is the same throughout the zone, and further subdivision appears nonsense. Certain species (with * in the list below) are represented by a considerable number of specimens. Among them large shell of *Inoceramus* of *hobetsensis* group is especially noteworthy.

Neophylloceras subramosum SHIMIZU
* *Epigoniceras glabrum* (JIMBO)
* *G. denseplicatum* var. *intermedia* YABE emend.
Gaudryceras denseplicatum (JIMBO)
Anagaudryceras limatum (YABE)
Zelandites mihoenzis MATUMOTO
Scaphites (*Yezoites?*) *planus* YABE
S. (*Y*) *puerculus* JIMBO and var. *teshioensis* YABE
S. (s. 1.) cfr. *pseudoaequalis* YABE
Nipponites mirabilis YABE

Scalarites scalare YABE
"*Desmoceras*" (s. 1.) sp. juvenile.
Puzosia (s. 1.) sp. indet.
Anapuzosia (*Jimboiceras*) *planulatiforme* (JIMBO)
Pachydesmoceras pachydiscoides MATUMOTO MS.
Romaniceras (?) sp.
Inoceramus concentricus costatus NAGAO & MATUMOTO
* *I. hobetsensis* NAGAO & MATUMOTO
I. hobetsensis nonsulcatus NAGAO & MATUMOTO em.
I. hobetsensis intermedius MATUMOTO MS.
* *I. hobetsensis maximus* MATUMOTO MS.
* *I. iburiensis* NAGAO & MATUMOTO

Zone Mh_3 A little more than 200 m above the zone Mh_2, occurs the next fossil-zone, the zone Mh_3, the thickness of which is, in turn, 150 m or so. The intermediate part between Mh_2 and Mh_3 is somewhat fossiliferous, although the fossil localities are rather interspersed. Furthermore the zone Mh_3 does not differ much from the zone Mh_2 in the assemblage of fossils. Accordingly the discrimination of the two zone is somewhat arbitrary in some place (as along the valley of the Itino-sawa).

The important exposures of the zone Mh_3 are loc. N 121 m, n, N 123 b-d, N 126 b-d along the main course of the Naibuti; N 30 a-n at the lower course of the Miho; N 360–N 363 in the valley of the Itino-sawa.

The following is the list of important invertebrate fossils of this zone. The fossil with (+) is found also in the intermediate part between Mh_2 and Mh_3.

\+ *Neophylloceras subramosum* SHIMIZU
*+ *Epigoniceras glabrum* (JIMBO)
E. epigonum (KOSSMAT) var. *intermedia* MATUMOTO MS.
*+ *Gaudryceras denseplicatum* (JIMBO)
* *Scaphites* (s. 1.) *pseudoaequalis* YABE
Scalarites scalare YABE em.
* *S. mihoensis* MATUMOTO MS.
S. (?) *densicostatus* MATUMOTO. MS.
Cfr. *Nipponites mirabilis* YABE
Tragodesmoceroides subcostatus MATUMOTO MS.
* *Parapuzosia* (*Mesopuzosia*) *indopacifica* (KOSSMAT)

Anapuzosia (*Jimboiceras*) *planulatiforme* (JIMBO)
Pachydesmoceras pachydiscoides MATUMOTO MS.
Inoceramus tenuistriatus NAGAO & MATUMOTO
* *I. teshioensis* NAGAO & MATUMOTO
\+ *I. hobetsensis* NAGAO & MATUMOTO
I. hobetsensis nonsulcatus NAGAO & MATUMOTO em.
I. hobetsensis intermedius MATUMOTO MS.
\+ *I. iburiensis* NAGAO & MATUMOTO
I. (*Sergipia*) *akamatsui* YEHARA.

Zone Mh_4 This zone occurs about 250 m above the zone Mh_3. From the intervening part I have found small number of fossil in an unfavourable state of preservation. The fossil is that of *Inoceramus* cfr. *uwajimensis* Yehara, *I.* (*Sergipia*) *akamatsui* Yehara, *Tetragonites* (s. 1.) sp., and *Gaudryceras* sp. juvenile. On the other hand, concretions of zone Mh_4 contain abundant fossils. Moreover, the assemblage of fossil is characteristic. Accordingly the zone is easily discriminated, though its thickness is only 60 m or so. The typical exposures are loc. N 26 and N 27 of the lower course of the Miho, N 129 on the main course of the Naibuti, and N 368 and N 369 of the Itinosawa. Among its typical invertebrate fossils are the following:

Neophylloceras subramosum SHIMIZU
* *Phyllopachyceras ezoense* (YOKOYAMA)
* *Epigoniceras glabrum* (JIMBO)
Anagaudryceras limatum (YABE)
* *Gaudryceras denseplicatum* (JIMBO)
G. cfr. *tenuiliratum* YABE
Scaphites (s. 1.) *pseudoaequalis* YABE
S. (s. 1.) *yonekurai* YABE
* *Scalarites mihoensis* MATUMOTO MS.
S. (?) *densicostatus* MATUMOTO MS.
* *Nipponites mirabilis* YABE
* *Damesites damesi* (JIMBO)
Parapuzosia (*Mesopuzosia*) *indopacifica* (KOSSMAT)
* *Inoceramus uwajimensis* YEHARA
* *Inoc.* (*Sergipia*) *akamatsui* YEHARA

Together with these marine fossils, plant remains are not rare, among which a fern resembling *Woodwardia* is common.

Zone Mh_5 Strata of about 270 m thickness above the zone Mh_4 is not very rich in organic remains, though fossils of *Gaudryceras denseplicatum* (JIMBO) and *Inoceramus naumanni* YOKOYAMA have been collected from the interspersed localities. Superjacent to this part there is the fossil-zone of Mh_5 of about 100 m thickness. It is best exposed on the main course of the Naibuti near the mouth of its small tributary, the Kakure-zawa. (Loc. N 131 g-n, N 132, N 134 e-h, N 135, N 136 a, b, and N 138 a-e.) Other exposures are found at loc. N 24 of the Miho, and at loc. N 376 and 377 of the Itino-sawa. The zone is represented by the following list and is characterized by the abundance of *Gaudryceras denseplicatum* (JIMBO) and *Inoceramus mihoensis* MATUMOTO MS.

Epigoniceras cfr. *glabrum* (JIMBO)
* *Gaudryceras denseplicatum* (JIMBO)
G. denseplicatum var. *intermedia* YABE em.
G. tenuiliratum YABE
Polyptychoceras sp.
Anapuzosia (*Jimboiceras*) *mihoense* MATUMOTO MS.
Parapuzosia ishikawa (JIMBO) em.
* *Inoceramus mihoensis* MATUMOTO MS.
I. naumanni YOKOYAMA
Nucula, *Parallelodon*, *Propeamusium*, etc.

A little above the zone Mh_5 somewhat notable beds of sandstone are intercalated with the mudstone. The thickest layer among them is more than 5 m. Others are thinner and often interstratified with black shales. The sandstone is light greenish, medium- or coarse-grained, sometimes laminated and with ripple-marks. It contains "clay-galls", carbonaceous flakes being found on the plane of stratification. This sandstone-bearing horizon is rather poor in fossil, though fragments of *Ostrea* and *Gaudryceras* are sporadically distributed in the sandstone and the following species have been collected from the concretions of marl:

Tetragonites (s. l.) sp. juvenile
Gaudryceras sp. juv.
Polyptychoceras sp.
Kossmaticeras (*Yokoyamaoceras*) *jimboi* YABE MS.
Inocerams naumanni YOKOYAMA

This horizon is traceable as a key-bed throughout the area,

although the exposure was not detected in the valley of the Itino-sawa. (Loc. N 133, N 136e, N 137, N 139a-c. N 139f-h, N 155, N 158, N 331a, etc.) And the key-bed is good marking which separates the zone Mh_6 from the zone Mh_5.

Zone Mh_6 This is a considerably thick fossiliferous zone, occupying the upper part of the Miho Group. Its bottom is just upon the sandstone-bearing horizon mentioned above, whereas its top lies far higher place only a little below the boundary of the Miho Group and the Ryûgase Group. The zone estimated to have thickness of 700 or 800 m[1] is more or less fossiliferous, being one of the most prolific part among the Cretaceous strata of Hokkaidô and Karahuto. Often the contained concretion of marl is full of fossils, though less fossiliferous one is not uncommon.

Although I made a careful collection discriminating horizons metre by metre, notable difference has not been detected in the

Table showing fossil-localities of Zone Mh_6

	$Mh_6\alpha$		$Mh_6\alpha$-β	$Mh_6\beta$	Mh_6 (α or β indet)
	α1 (main part)	α2 (Uppermost 70 m.)			
Main course of the Naibuti	N133e-h, N140 (a-l) N140, N141 (a-h)	N142a-g	N142h	N400m-f	N400a-e, N401 a-h (higher than Mh_6 2)
The third tributary			N446 (a-g)	N445-N442	N449-N447
The Santan-gawa	N191-N196	N143-N145 N147, N197-N199, N203	N146, N148, N202, N204, N205	N149, N150, N181-N190, N200, N201, N206-N212	
The Kakure-zawa	N159-N165	?N166, N167	.....	..... N180	Rolled pebbles
The Miho (The second tributary)	N331-N336	N23p-x	N23f-n	N23a-e, N22, N22z, N22-N23p	
The Itino-sawa					N279p. N382-N390

(1) Because of the homogeneity of the constituting rock and owing to the presence of minor faults in the distributional area, the accurate estimation is difficult.

assemblage of fossils from bottom to top throughout the zone. And the subdivision of this thick zone into many subzones seems very difficult upon palaeontological grounds as well as from lithological criteria[1]. Only we can say of lower, middle. and upper part of the zone. The accurate discrimination of these parts is facilitated by a sort of key-bed. Namely, at a certain horizon in the middle part of the zone, thin layer of calcareous sandstone is more frequently intercalated than any other parts. And two parts above and below this small belt are denominated as $Mh_6\beta$ and $Mh_6\alpha$ respectively. The belt itself is symbolized as $Mh_6\alpha$–β. Thus many exposures or fossil localities of zone Mh_6 are put in order as listed on the annexed Table.

Number of fossils yielded from the zone Mh_6 is very large either in species and in individuals. Among its typical invertebrates are the following:

	α	α		α–β	β	α or β
	α 1		α 2			indet
Neophylloceras subramosum SHINIZU ...	+		+	*	*	+
N. aff. *hetonaiense* MATUMOTO MS. ...			+		+?	+
N. compressum MATUMOTO			+(?)			+
Phyllopachyceras ezoense (YOKOYAMA) ...	+		+	*	*	+
Epigoniceras glabrum (JIMBO)	+		*	*	*	*
E. glabrum var. *problematica* MATUMOTO				+	+	+
E. epigonum (KOSSMAT)		+			+	+
Anagaudryceras yokoyamai (YABE) ...			+(?)	+	+	+
Gaudryceras denseplicatum (JIMBO) ...	+		+	*	*	+
G. denseplicatum var. *intermedia* YABE em.					+	+
G. denseplicatum var. *kawadai* MATUMOTO MS.						+(?)
G. tenuiliratum YABE emend	+		+	+	*	+
G. tenuiliratum var. *frequence* MATUMOTO MS.					+(?)	
G. tenuiliratum var. *ornata* YABE			+		+	+
G. striatum var. *paucistriata* MAT. MS....						+
Polyptychoceras obstrictus (JIMBO)		+				+
P. yubarense YABE MS.					+	+

[1] Numerous zoning made by S. SHIMIZU seems very artificial and disagreable with the facts in the field. Species which are arranged in different horizons in his classification often occur from the same bed or even from the same nodule.

P. haradanum (YOKOYAMA) em.				+	+	
P. jimboi MATUMOTO MS.		+	+	+	*	+
Hyphantoceras oshimai (YABE)			+			
Bostrychoceras serpentinum MATUMOTO MS.			+	+	+	+
Neocrioceras spinigerum (JIMBO)					+	
Pseudoxybeleceras quadrinodosum (JIMBO)					+	
Damesites damesi (JIMBO)	+		+	*	*	+
D. semicostatus (YABE)						+
D. sugatns (FORBES)			+		*	
Schlüteria diphylloida (FORBES)					+	
Hauericeras gardeni var. *angustum* YABE			+		+	
Parapuzosia (*Mesopuzosia*) *ishikawai* (JIMBO) em.	+		+	*	*	+
P. (*M.*) *japonica* YABE MS.						+
P. (*M.*) *comacana* MATUMOTO MS. ...	+ (?)		+	+	+	
Kossmaticeras japonicum (YABE MS.) ...					+	
K. (*Yokoyamaoceras*) *jimboi* YABE MS....	+		+			+
Anapachydiscus sutneri (YOKOYAMA) ...			+ (?)			*
A. fascicostatus YABE em.	+		*	+	*	
A. yezoensis (YABE MS.)	+ (cf.)		+		+	+
Eupachydiscus haradai (JIMBO)			+		*	+
Menuites aff. *menu* (FORBES)				+		+
M. naibutiensis MATUMOTO MS.						+ (?)
M. rotalinoides (YABE)						+
Mortoniceras sp.					+	+
Inoceramus ezoensia YOKOYAMA			+ (cf.)	+	+	
I. amakusensis NAGAO & MATUMOTO ...	+		+	+		
I. japonicus NAGAO & MATUMOTO ...				+	+	
I. naumanni YOKOYAMA em.	*		*	*	*	*
I. yokoyamai NAGAO & MATUMOTO ...				+	+	
I. orientalis var. *ambiguus* NAG. & MAT.				+ (cf.)	+	

Zone Mh_7 The uppermost part, 200 m. thick, of the Miho Group is not so fossiliferous as the zone Mh_6. But its upper half, just subjacent to the Ryûgase Group, yields notable assemblage of species. And this highest part of the Miho Group is here called the zone Mh_7. Its typical exposures are loc. N 430 c-f just below the first water-fall of the third tributary of the Naibuti, N 474 at

the Ryûgase gorge of the main course of the Naibuti, and N 21 of the Miho. Following species have been obtained from the zone:

Phyllopachyceras ezoense (YOKOYAMA)
Epigoniceras sp.
Gaudryceras striatum (JIMBO)
Polyptychoceras sp.
Anapachydiscus naumanni (YOKOYAMA)
Eupachydiscus haradai (JIMBO)
Inoceramus orientalis ambiguus NAGAO & MATUMOTO

IV. Ryugase Group (Hakobuti Group s. 1.)

General remarks.—— The upper part of the Cretaceous System displayed in the Naibuti district is a group consisting of the formation of sandstones and that of siltstones or sandy mudstones in several repetitions. It is distributed mainly in the mountain range comprising Mt. Ryûgase and Mt. Atago, and well exposed along the valleys crossing it, such as the main course of the Naibuti, the third tributary, the second tributary (or the Miho), etc. The group is here temporarily called the Ryûgase Group[1].

The group overlies the Miho Group with a conformable relation and is covered by the basal conglomerate of the Palaeogene Naibuti Group apparently conformably. The total thickness is about 650 m.

Stratigraphic sequence.—— As observed along the several valleys mentioned above, no significant lateral change is found in rock-facies of the Ryûgase Group, and the stratigraphical sequence is constant within the surveyed area. The group consists of the following members and formations in ascending order.

Member Mh-Ry The lowest part of the Ryûgase Group or a transitional part of the Miho Group and the Ryûgase Group. Ca. 20 m.

Upon the sandy mudstone, the uppermost part of zone Mh_7 of the Miho Group, comes at first

a. Green tufaceous sandstone, volcanic conglomerate and very

[1] M. KAWADA (1929) called the lower half of the group the Ryûgase Sandstone, and the upper half the Shimaiwa Shale. But this treatment does not fit the facts. Here one of the previous formational names is used for the whole group with a great emendation.

coarse-grained quartz sandstone passing gradually upward to muddy sandstone, and then occurs

β. Dark coloured silty rock containing abundantly concretions of calcareous sandstone, followed upward by a bed of sandy rock characterized by its dark green colour and abundance of calcareous concretion. Many of the concretions are barren, but some of them contain marine fossils.

Typical exposures of the member are loc. N 20a, b, and N 21a, b on the middle course of the Miho. N 427, N 428f, and N 429 of the third tributary of the Naibuti, N 216a-c and N 232 along the source of the Santan.

Formation Ray Green sandstone, 270 m thick.

Ray$_1$ (Lower part):

α. Green, medium-or fine-grained sandstones and sandy shale, stratified, richly fossiliferous, 12–13 m thick; typically exposed at loc. N 19, N 426d, N 428d, etc.

β. Bluish greenish fine sandstone, rather massive, containing abundant concretions and marine fossils; 40–10 m.; typically exposed at loc. N 16b, c–N 18, N 426c, and N 467c.

γ. Green medium or coarse sandstones, rich in marine fossils, although fossils sometimes occurring fragmentarily and in patches; less than 20m thick; typically exposed at loc. N 16a, N 426a, b, N 467b, N 217a, b, and N 218a.

Ray$_2$ (Middle part) Coarse sandstones of green colour, in part conglomeratic and rarely intercalating thin lenticular layer of conglomerate; rather massive, partially platy banded or provided with ill-defined cross-bedding; typically exposed at loc. N 14–N 12g-b, at and near the water-fall of Gyokwan-daki[1] of the Miho; N 425–N 422 along the gorge of the Titi-daki[2] of the third tributary; N 467a or the Ryûgase gorge of the main course of the Naibuti; N 218b, N 219, N 220 and N 235 of the source area of the Santan-gawa.

Ray$_3$ (Upper part) Mainly composed of fine sandstone, bluish greenish, with an intercalated bed of coarse sandstone in the lower part and in the middle part; Marine fossils occur frequently; 50–60 m. thck; typically exposed at loc. N 10a-e, N 12a,

[1] 魚鼈瀧　[2] 父瀧

and N 100a along the Miho, N 466 and N 463 on the main course of the Naibuti, N 419b, N 420 and N 421 of the third tributary, and N 221 and N 236 of the Santan-gawa.

Formation Rby Black or dark grey fine-sandy mudstone, containing concretions of purplish black marl in which often fossils of ammonites and other marine organisms are included. Medium sand-graines and flakes of mica are sometimes found in the rock. A little less than 70 m thick. Typical exposures are loc. N 100b on the upper course of the Miho, N 417 and N 419a on the middle course of the third tributary of the Naibuti, N 465c on the main course of the Naibuti, and N 222 and N 223 along the source of the Santan-gawa.

Formation Rcy Sandstones of various coarseness, intercalating silty fine sandstone in the upper part. Thickness 90 m. The following minor subdivisions are comprised:

Rcy_1 Sandstones, greenish light grey or dark green, mainly coarse grained, but sometimes layers of finer sandstone are intercalated; stratification is developed in various thickness; fossil not found; 50–60 m thick; typically exposed at loc. N 100c, d, N 101a N 108w and N 109a along the Miho, N 460f, N 461, N 464, N 465a, b along the main course of the Naibuti, N 416–N414 d-b along the third tributary.

Rcy_2:

α. Bluish silty fine sandstone or dark coloured fine-sandy mudstone, containing nodules and fossils; 10–15 m thick; typically exposed at loc. N109 b-c, N 111 b, N 113 b on the Miho, N 460d along the main course of the Naibuti, N 414a along the third tributary.

β. Dark green or light greenish sandstones, rarely containing fossils; thickness 7–10 m; typically exposed at loc. N 109d, N 111a, N 112b, N 113 and N 115c along the Miho, N 460c on the main course of the Naibuti, and N 413b along the third tributary.

γ. Silty very fine sandstone containing lenticular concretions of marl and somewhat fossiliferous; thickness 15–20 m.; typical exposures loc. N 110a, N 112c, N 116a and N 115d along the Miho, N 458b, c and N 460a, b along the main course of the Naibuti, and N 413 (?) along the third tributary.

Formation Rdy Dark coloured siltstone or fine-sandy mudstone, with an intercalated sandstone in the upper part. Thickness 110 m.

Rdy_1 Dark coloured siltstone or fine-sandy mudstone containing concretions of marl; nearly ten thin layers of marl are intercalated with the sandy mudstone; the concretion often contains marine fossils. Thickness 80 m. Typical exposures are loc. N 110, N 112 d 1–d 9, N 116 a-i, N 115 a, b, N 105 and N 104 along the Miho, N 458 a, and N 457 e along the main course of the Naibuti, N 411 d, c of the third tributary, and N 480–N 484 along the lower valley of the Simayama-zawa.

Rdy_2:

α. Green, coarse grained sandstone, sometines containing granules and pebbles, silty sandstone, and fine sandstone; stratified; calcareous concretions are contained, but fossil has not yet been found. Thickness 20 m or less. Typical exposures are loc. N 112 e, N 114 b-d, N 118 c-e; N 457 d-a; N 411 a, b, N 410, etc.

β. Dark grey fine-sandy siltstone intercalating thin layers of marl; fossil occurs rarely. Thickness 10 m or more. Typical exposures loc. N 114 e, N 118 f,; N 456 e, d; N 409 d, etc.

Formation Rey Greenish grey sandstones, fine to coarse and conglomeratic; stratified in various thickness; frequently tufaceous or pumiceous; drift woods and carbonaceous flakes are contained, but animal remain has not yet been found. About 50 m thick. Typical exposures are at loc. N 119 along the upper course of the Miho, N 456 a, b, N 455 d-b along the main course of the Naibuti, and N 407, N 406, N 405 d, e, along the third tributary.

Formation Rfy Dark grey sandy siltstones containing concretions; sometimes thin layers of sandstone and granule-conglomerate are intercalated; uppermost part is silty fine sandstone; almost barren of fossils. Thickness varies at places, being estimated 40–100 m. The fact may be explained as a result of the Epi-Cretaceous or early Palaeogene denudation. Typical exposures of the formation are found at loc. N 119 b-g along the upper course of the Miho, N 450–N 452 near the mouth of the Hekisui-zawa and N 454 near the mouth of the Akaiwa-zawa, small tributaries of

the Naibuti, and N 405 c-a near the mouth of the Obara-zawa, a branch of the third tributary of the Naibuti.

Sequence and assemblage of fossils. —— Fossils occur in considerable amount from the Ryûgase Group. And, as described above, some formations or members are richly fossiliferous forming a fossil-zone while others are rather poor in organic remains or almost nonfossiliferous. These difference in quantity of fossil may be due to the ecological factor of the original water-body and factors of sedimentation and fossilization. And these features seem to follow approximately the paralleles of rock-facies.

So far as the Ryûgare Group in the Naibuti district is concerned, the lateral change of rock-facies is quite insignificant. Accordingly the horizon of fossil is able to be marked by calling the formational name defined just above. The assemblage of species is different at horizons, the details of which are as follows:

Horizon Mh-Ry. Fossil is not rare in the upper part of member Mh-Ry. The characteristic species are

Eupachydiscus haradai (JIMBO) em.
Patella (s. l.) *gigantea* (SCHMIDT)

and besides them, I have found

Phyllopachyceras ezoense (YOKOYAMA)
Schlüteria diphylloida (FORBES)
Inoceramus orientalis ambiguus NAGAO & MATUMOTO

Zone Ray_1. Lower part of the formation Ray is richly fossiliferous forming an important fossil-zone. This is probably identical with what S. SHIMIZU called the zone of *Inoceramus schmidti*. There is no difference in assemblage of fossils among the subdivision of α, β, and γ. In the following list the one with * occurs abundantly.

Neophylloceras hetonaiense MATUMOTO
Phyllopachyceras ezoense (YOKOYAMA)
* *Epigoniceras popetense* (YABE)
E. glabrum var. *problematica* MATUMOTO
Anagaudryceras ryugasense MATUMATO MS.
Gaudryceras aff. tenuiliratum var. *ornata* (YABE)
* *G. striatum* (JIMBO)
G. striatum var. *picta* YABE
G. striatum var. *lata* MATUMOTO MS.

Zelauidtes kawanoi (JIMBO)
Schlüteria diphylloida (FORBES)
* *Canadoceras kossmati* (YABE MS) em.
C. multicostatum MATUMOTO MS.
Menuites ryugasense MATUMOTO MS.
Pseudoxybeloceras quadrinodosum (JIMBO)
* *P. (Ryugasella) ryugasense* MATUMOTO
Glyptoxoceras (?) sp.
* *Inoceramus schmidti* MICHAEL
* *I. sachalinensia* SOKOLOW with varieties
I. pseudosulcatus NAGAO & MATUMOTO
I. pseudosulcatus var. *elegans* SOKOLOW
* *Anomia* sp.
Lucina (*Myrtea*) and other bivalves
* *Patella* (s. l.) *gigantea* (SCHMIDT) and other gastropods
Brachyopoda

Horizon Ray_2. From the middle part of the formation Ray, only a few large fossils of *Canadoceras kossmati* (YABE MS) em. have been obtained. The uppermost part of Ray_2 yields the species same as those of the superjacent Ray_3.

Horizon Ray_3. The upper member of the formation Ray is characterized by the frequent occurrence of the following three species.

Canadoceras kossmati (YABE MS) em.
C. multicostatum MATUMOTO MS.
Pseudoxybeloceras (?) *kawadai* MATUMOTO MS.

Zone Rby. Formation Rby is considerably fossiliferous and charcterized by the following assemblage of fossils:

Epigoniceras glabrum var. *problematica* MATUMOTO
Gaudryceras striatum (JIMBO)
Polyptychoceras sp.
* *Schlüteria diphylloida* (FORBES)
Canadoceras kossmati (YABE MS) em.
* *C. multicostatum* MATUMOTO MS.
* *Pseudoxybeloceras* (?) *kawadai* MATUMOTO MS.
Inoceramus sp. indet. cfr. *I. ezoense* YOKOYAMA
Parallelodon sachalinensis (SCHMIDT)

Horizon Rcy_1. From the main part of the formation Rcy no fossil has yet been determined.

Zone Rcy_2. Member $Rcy2\alpha$ and $Rcy2\gamma$ in the uppermost part of the formation Rcy are again comparatively rich in fossils. The assemblage of species is somewhat different from that of the zone Rby.

	α	γ
Nautilus sp.		+
Epigoniceras popetense (YABE)	+	+
Anagaudryceras ryugasense MATUMOTO MS.	+	
Gaudryceras striatum (JIMBO)		+
G. crassicostatum (JIMBO)	+	
Canadoceras sp. (cfr. *multicostatum*)		
Pachydiscus (s. s.) *subcompressus* MATUMOTO (aff. *P. gollevillensis* and *compressus*)	+	+
Pachydiscus (s. s.) *japonicus* (SAITO MS.)	+	
Brachyopoda		

Zone Rdy_1. The main part of the formation Rdy is fairly fossiliferous. This zone, 80 m thick, is difficult to be subdivided by means of fossil. The following assemblage of fossils show similarity to that of zone Rcy_2 but differs from that of zone Rby. This zone is the uppermost limit of the vertical distribution of ammonite in South Karahuto.

Neophyllocerass hetonaiense var. *subtuberculata* MATUMOTO
Epigoniceras popetense (YABE) em.
* *Anagaudryceras ryugasense* MATUMOTO MS.
* *Zelandites varuna* (FORBES) var. *japonica* MATUMOTO
Pachydiscus (s. s.) *subcompressus* MATUMOTO MS.
P. (s. s.) sp.
Baculites sp.
Yoldia sp. and other bivalves and gastropods
Brachyopoda

Horizon Rdy_2. No important fossil has not yet been found, though shell of *Acila*, limpet shell, and rhynchonellids have been collected.
Horizon Rey. Unfossiliferous.
Horizon Rfy. Fossil is rare, only remains of pelecypods belonging to *Acila* and others having been detected.

On the constituent materials of the Ryugase Group.——A noteworthy feature of the Ryûgase Group is the presence of pyroclas-

tic materials and the great dependence on the volcanic rocks in the source of its material. As is presented in the stratigraphic succession, one of the most prominent constituents of the Ryûgase Group is the sandstone of dark green or greenish colour. Examining its coarse- or medium-grained representative under the microscope, it has the texture of normal sandstone, the coarse grains being more or less subrounded, but its composition is somewhat peculiar. Grains of quartz is comparatively little in amount, whereas those of feldspar and rock-fragments predominate. The feldspar is the plagioclase of more calcic type and often shows well developed zonal structure. Rock-fragments are mostly those of andesites with hyalopilitic or glassy groundmass. Olivine basalt is sometimes found, while volcanic rock of more acidic type is also found. Furthermore, grains of dark coloured glass or glassy rock is not rare, though some of them are water-worn, and mafic minerals such as hornblende, chlorite (presumably an altered mafic mineral) and biotite are discernible. The cementing matter is carbonates and greenish chlorite-like material.

Shortly the green sandstone of the Ryûgase Group is a greywacke (in the sense of TYRELL or TWENHOFEL). And the true green-sandstone characterized by glauconite is not so prominent as has been accustomed to be considered. But the group does not seem to be quite free from glauconite. And the fossiliferous sandstone depends its green colour either on its volcanic constituents and on glauconite.

Another illustration of the derivation from igneous rock is found in conglomerates. The conglomerate in the lower half of the member Mh-Ry has variation in its thickness and structure. On the exposure in the valleys of the third tributary and the Santan-gawa, the conglomerate forms an irregular lens or patch and contains pebbles, cobbles, and boulders. Sorting and wearing are incomplete, the boulder sometimes exceeding one metre in its maximum dimension. While, on the exposure along the Miho, sandstone containing sporadic pebbles are found at the corresponding horizon. The material of the conglomerate is almost exclusively the effusive rock of dacite or delenite type. And the rock is silicified, chloritized or altered otherwise, and dark grey or green in colour. Sometimes pebble of pyroxene-andesite is found.

Superjacent to this conglomerate there is a very coarse grained

sandstone of white colour. It is the aggregate of quartz grains, some of which shows a coroded figure. The quartz may be related to the acidic effusive rocks. The acidic volcanic rock is also found in the pebbles of conglomeratic layer found at the base of the formation Ray.

Greywacke at other horizons contains pebbles or intercalates local conglomerate. The pebbles are well rounded and mostly those of andesite, although plutonic rock (hornblende-granodiorite) has been discerned.

Primary pyroclastic rock is not abundant in the group. Only the sandstone of formation Rey is remarkably tufaceous. The rock is composed of abundant fragments of glassy rock, splinters of glass and pumice, angular quartz and plagioclase. The glass is frequently altered or devitrified, and its index of refraction is lower than that of canada-balsam. Besides this rock, pumice is found in small amount in the greywacke.

TABLE SHOWING LOCALITIES AND HORIZONS OF EXPOSURES.
IN
THE NAIBUTI DISTRICT.
(Mid-valley of the Naibuti).
(樺太内淵川中流々域)

Locality Number	Horizon	Place-name (Valley)	
N1	Kw	Kawakita Gorge (川北峡谷)	Lower course of the Naibuti (内淵川本流下流)
N2, N3	Tertiary	Kawaminami (川南)	
N4–N9	Kv	Eastward from Kawakita Gorge	
N10, N11	Ray3	Above the water-fall of Gyokwan-daki	Middle course of the Miho, or the Second Tibutary of the Naibuti. (美保川又は内淵川第二支流の中流々域)
N12a/b-g	Ray3/Ray2		
N13	Ray2	Water-fall (魚關瀧)	
N14, N15	Ray2		
N16–N19	Ray1		
N20	Mh–Ry	Below the water-fall	

N21a, b/c. d.	Mh-Ry/Mh7	
N22, N22 z, N22-23	Mh6β	
N23a-e/f-n/m-x	Mh6β/Mh6α-β/Mh6α	
N24	Mh5 (?)	
N25	Mh5—Mh4	Lower course of the Miho (美保川下流々域)
N26, N27	Mh4	
N28, N29	Mh4—Mh3	
N30	Mh3	
N31-N33	Mh2—Mh1	Lower course of the Kamo-gawa (鴨川下流)
N34	Mh1	
N35-N41	Mh1—Mho	
N42, N43	Mho	Middle course of the Kamo-gawa (鴨川中流)
N44a-c/d/e	Mho/Kz-Mh/Kz-1	
N45a/b	Kz-1/Kz	
N46-N48	Kz	
N49-N53	Ky	
N53′-N64	Kx	Upper course of the Kamo-gawa (鴨川上流)
N65-N73	Mh2—Mho	Lower course of the Birin-zawa (備林澤)
N74-N76	Mho	Middle course of the Birin-zawa (備林澤)
N77-N79	Kz	Upper course of the Birin-zawa (備林澤)
N80, N81	Ky	
N82-N85	Kx	
N86	Mho—Mh1	Higasi-Miho (東美保) — Along the eastern side of the main course of the Naibuti. (內淵川本流東側流域)
N87-N91	Mho	
N92	Kz-Mh	At the mouth of the Yuno-sawa — Along the eastern side of the main course of the Naibuti. (內淵川本流東側流域)
N93a/b, c/d	Kz-Mh/Kz-1/Kz	The Yuno-zawa (湯の澤)
N94	Kz	
N95	Ky	
N96-N99	Kx	

Locality Number	Horizon	Place-name (Valley)
N100a\b\c, d	Ray3\Rby\Rcy	Below (下流へ)
N101, N102	Rcy	↑
N103	Rdy2	
N104, N105	Rdy1	Upper course
N106	Rcy2	of the Miho
N107	Rcy?	(美保川上流沿岸)
N108	Rdy?	
N109a\b	Rcy1\Rcy2	
N110	Rdy1	
N111a, b/c-g	Rcy2/Rcy1	
N112a-c\d\e	Rcy2\Rdy1\Rdy2	
N113a, b/c	Rcy2/Rcy1	
N114a-c\d, e\f, g	Rdy1\Rdy2\Rey	
N115a, b/c, d/e, f	Rdy1/Rdy2/Rcy1	
N116	Rdy1	
N117a/b, c	Rdy1/Rcy2	
N118a, b\c-f	Rdy1\Rdy2	
N119a\b-e\f, g	Rdy\Rey\Rfy	↓ Above (上流へ)
N120	Palaeogene Tertiary	
N121a-l\m, n	Mh2—Mh3\Mh3	Near the mouth of the Miho
N122	Mh3—Mh4	
N123	Mh3	
N124	Mh2	····Near the mouth of the Kamo-gawa
N125	Mh2	
N126	Mh3	····Near the mouth of the Birin-zawa
N127, N128	Mh3—Mh4	
N129	Mh4	
N130	Mh4—Mh5	The main course of the Naibuti
N131a-f\g-n	Mh4—Mh5\Mh5	(内淵川本流沿岸)

N132	Mh5—Mh6	
N133a, b\c–h	Mh5—Mh6\Mh6α	
N134	Mh5	
N135	Mh5	
N136a, b\c–e	Mh5\Mh5—Mh6	←Mouth of the Kakure-zawa
N137	Mh5—Mh6	
N138a–e\f–j	Mh5\Mh5—Mh6	
N139	Mh5—Mh6	
N140, N141	Mh6α	
N142 a–g\h	Mh6α2\Mh6α–β	Near the mouth of the San-tan-gawa
N143–N145	Mh6α2	
N146–N148	Mh6α–β	Lower course of the Santan (三丹川下流)
N149, N150	Mh6β	
N151–N154	Mh5	
N155–N158	Mh5—Mh6	Kakurezawa (隠澤)
N159–N165	Mh6α	
N166, N167	Mh6α–β	
N181–N190	Mh6β	Lower course of the Santan.
N191–N196	Mh6α1	Middle course of the Santan (三丹川中流々域)
N197–N199	Mh6α2	
N200, N201	Mh6β	
N202	Mh6α–β	
N203	Mh6α2	
N204, N205	Mh6α–β	
N206–N212	Mh6β	
N213–215	Mh6—Mh7	
N216	Mh–Ry	
N217	Ray1	
N218a\b	Ray1\Ray2	

Locality Number	Horizon	Place-name (Valley)	
N219, N220	Ray2	Upper course of the Santan,—southern branch (三丹川上流，南の澤)	
N221	Ray3		
N222, N223	Rby		
N224-N226	Rcy1		
N231, N232	Mh-Ry	Upper course of the Santan,—northern branch (三丹川上流，北の澤)	
N233	Ray1		
N234, N235	Ray2		
N236	Ray3		
N237	Rby		
N238-N241	Rcy		
N242, N243	Rdy		
N301, N302	Kx	Near the mouth of the Imano-sawa	Along the main cource of the Naibuti.
N303	Kw	Opposite loc. N1	
N304a\b	Kx\Ky	Northern side of Yanagi-sima (柳島の北側)	
N305	Ky		
N306, N307	Kz		
N308a/b-d/e-g	Mh1—Mho/Mho/Kz-Mh	Western border of the Kawakita-Range. (川北山脈の西側)	Along the main valley of the Nibuti
N309a-m\n	Mho\Mh1—Mho		
N310, N311	Kz	The mouth of the Ninosawa (十八林班二の澤出口)	Along the main course of the Naibuti, from the mouth of the first tributary to the mouth of the Nisio-zawa (内淵川本流沿岸)
N312a 1, a2/a3, b	Kz-Mh/Kz-1		
N313	Kz-Mh		
N314a\b-e\f-g	Kz-Mh\Mho\Mho—Mh1		
N315a-c\d\e-g	Mho-Mh1\Mh1\Mh1—Mh2		
N316	Mh2	The mouth of the Itinosawa (十八林班一の澤出口)	
N317	Mh1		
N318	Mho—Mh1		
N319, N320	Mh2		
N322	Ky	Lower course of the	

N323–N325	Kz	First tributary of the
N326	Kz-1	Naibuti
N327	Kz-Mh	（内淵川第一支流下流）
N328a\b	Kz-Mh\Mho	
N329	Mho—Mh1	
N331–N336	Mh6α	Middle course of the Miho（美保川中流）
N338–N350	Mh2	Ugui-zawa（うぐい澤）
N351–N356	Mh2	Below（下流へ）
N357, N358	Mh2—Mh3	↑
N359–N362	Mh3	
N363–N367	Mh3—Mh4	The Itino-sawa（十八林班一の澤）
N368–N371	Mh4	
N372–N374	Mh4—Mh5	
N375–N377	Mh5	
N378, N379	Mh5—Mh6	
N380–N391	Mh6	↓ Above（上流へ）
N400a–e\f–m	Mh6（α? β?)\Mh6β	A little below the mouth of the third tributary along the main course of the Naibuti
N401	Mh6β(?)	（内淵川本流沿岸，第三支流出口の少し下流）
N403, N404	Palaeogene	Near the mouth of the Obara-zawa （小原澤出口附近）
N405a–c/d, e	Rfy/Rey	↓（漸次下流へ）
N406	Rey	
N407a/b–d/e	Rey/Rdy2/Rdy1	
N408	Rdy2	
N409a–c/d	Rey/Rdy2	
N410	Rdy2	Middle course of the Third
N411a, b/c, d	Rdy2/Rdy1	tributary of the Naibuti （内淵川第三支流中流）
N412	Rcy	
N413	Rcy2	

Locality Number	Horizon	Place-name (Valley)
N414–N416	Rcy	
N417	Rby	
N418	Ray3	
N419a/b	Rby/Ray3	
N420, N421	Ray3	
N422–N425	Ray2	Gorge of Titi-Daki and Haha-Daki
N426	Ray1	
N427	Mh–Ry	
N428a–c/d–f	Ray1/Mh–Ry	
N429	Mh–Ry	At the first water-fall
N430a/b	Mh–Ry/Mh7	
N440, N441	Mh6—Mh7	
N442–N445	Mh6β	Lower course of the third Tributary of the Naibuti. (内淵川第三支流下流)
N446	Mh6α–β(?)	
N447–N449	Mn6 (α or β indet.)	
N450a/b	Rfy/Rey	At the mouth of the Hekisui-zawa (碧水澤出口)
N451	Rfy	
N452a\b	Rfy\Palaeogene	
N453	Palaeogene	←Mouth of the Akaisi-zawa (赤石澤出口)
N454a/b, c	Palaeogene/Rfy	
N455a/b–d	Rfy/Rey	
N456a–c/d, e	Rey/Rdy2	
N457a–d/e	Rdy2/Rdy1	
N458a/b, c	Rdy1/Rcy2	
N459	Rcy2	←Mouth of the Simayama-zawa (島山澤出口)
N460a/b–d/e, f	Rdy1/Rcy2/Rcy1	
N461	Rcy1	Along the main course of the Naibuti, above the mouth of the third tributary. (内淵川本流，第三支流出口より上流)
N462	Rby	
N463	Ray3	

N464	Rcy1	
N465a, b/c	Rcy1/Rby	
N466	Ray3	
N467	Ray2	The Gorge of Ryûgase (龍ケ瀬)
N468, N469	Ray1	
N470	Mh6—Mh7 (?)	
N471	Ray2	The Gorge of Ryûgase (龍ケ瀬)
N472	Ray1	
N473	Mh7? or Mh-Ry	
N474	Mh7? or Mh6—Mh7	
N475	Mh6	
N480–N485a	Rdy1	The Simayama-zawa (島山澤) (河田氏記述中の "島岩澤")
N485b–N496	Rdy2	
N497, N498	Rdy1	
N501–N505	Kx (upper part)	Lower course of the Imano-sawa (今の澤下流)
N506–N508	Ky	

TABLE SHOWING LOCALITIES AND HORIZONS OF EXPOSURES ALONG THE MIDDLE COURSE OF THE AIKAWA VALLEY.
（東京帝大樺太演習林相川中流々域）

Locality Number	Horizon	Valley or Place name
I1/I2	Mh2/Mh2-Mh1	The Yamadori-zawa（山鳥澤）
I3/I4	Mh1/Mh1-Mho	
I5-I7	Mh1-Mho	Middle course（中流）, Lower course（下流）, of the first tributary of the Ai-kawa（相川第一支流）
I8a/b, I9	Mh1/Mh1-Mho	
I11a-f/g	Mho/Top of K′w	
I10-I13	K′w	
I14-I19	Kv	
I20-I32a, I38	Kv	
I32b-I34	Mh2-Mh1	
I35	Mh1	
I36-I37, I39	Mho-Mh1	
I51-I54	Mho-Mh1	Near the mouth of the first tributary, The main course of the Aikawa（相川本流中流下半）
I55a-c, I57a	Mho	
I55d, I56, I57b	Top of W′w	
I58-I62	K′w	
I63-I75	Kv	
I86, I91	Mh1	Lower course of the Pom'muan Valley（ポンムアン川下流）
I87-I90	Mh1-Mh2	
I92-I99	Mho-Mh1	
I100/I101	Mho-Mh1/Mho	The main course of the Aikawa, between the mouths of the Pom'muan and the first tributary.（相川本流中流上半）
I102-I112	K′w	
I113	Mh1	
I114, I115	Mho-Mh1	

I121–I124	Mho–Mh2	The Hutamata-zawa (十九林班試驗林二股澤)
I124–I136	Kv	
I150–I157	Mho–Mh1	The Kannon-zawa, a branch of the Pom'muan. (觀音澤)
I158	Mho	
I159–162	K′w	
I163–I172	Kv	A small valley running south-eastward from Mt. Nakadake (中嶽澤—假稱)
I201–I229	Kv	The Kohide-zawa a branch of the first tributary of the Ai-kawa (小秀澤又は千歲澤)
I280–I290	Kv	
I244–I246	Mh2	Upper course of the first tributary of the Aikawa (相川第一支流上流)
I236–I243, I248, I249	Mh1–Mh2	
I251, I252	Mho–Mh1	The Yamame-zawa, a branch of the first tributary of the Ai-kawa (山女魚澤)
I253	Mho	
I254–I257	K′w	
I260, I261	Mho	
I262–I270	K′w	

Chapter II

Cretaceous Deposits along the Abesinai Valley, a tributary of the Mid-Valley of the Tesio, northern central Hokkaidô.

(Pl. X, XI, XII)

INTRODUCTION

The Tesio forms in its middle course a transverse valley crossing the backbone of northern Hokkaidô. The backbone of meridional trend is mainly composed of Mesozoic rocks, and a good display of the fossiliferous Cretaceous strata is found in its western part. This part is mainly occupied by the valley of the Abesinai which runs from south to north and meets with the main course of the Tesio at the western end of the transverse valley. The area belongs to Nakagawa-mura, Nakagawa-gun, province of Tesio[1].

During two months and two weaks in 1938, I engaged myself in the field work with special attention to the stratigraphy of the middle and upper Cretaceous. The result of my field work was reported preliminary at the 46 th Annual Meeting of the Geological Society of Japan[2].

Besides the general geological survey, there is a previous investigation on the Cretaceous stratigraphy of the district made by Mr. Y. MORITA[3]. But the succession of the Cretaceous rocks observed by him was only briefly presented by Dr. S. SHIMIZU[4].

(1) 天鹽國中川郡中川村

(2) 日本白堊系層序の基礎的研究略報 (其の 2) Procedings of the 46 th Annual Meeting of the Geological Society of Japan. (Journ. Geol. Soc. of Japan, vol 46, p. 296, 1939)

(3) Y. MORITA 1930 MS. (4) S. SHIMIZU 1932.

Map showing localities of exposures along the Mid-valley of the Naibuti, South Karahuto

樺太内淵川中流々域踏査略圖

Compiled from the Route Maps drawn to the scale of 1:5,000
All the loc. numbers in this map are to have prefix N.
(Date of survey — Summer 1937)

N

The Naibuti 内淵川本流
The Hekisui-zawa 碧水澤
The Akaisi-zawa 赤石澤
Mt. Ryugase 龍ヶ瀬山
Ryugase 龍ヶ瀬
The Simayama-zawa 島山澤
The Kakure-zawa 隠澤
The Ugui-zawa うぐい澤
The Birin-zawa 備林澤
The Third Tributary 第三支流
The Santan 三丹川
The Kamo-gawa 鴨川
Miho 美保
Gyokwan-daki 魚關滝
The Miho (The Second Tributary) 美保川(第二支流)
The Yuno-sawa 湯ノ澤
The Naibuti 内淵川本流
The Itino-sawa 十八林班一ノ澤
The Nino-sawa 二ノ澤
The Imano-sawa 今ノ澤
The First Tributary 第一支流
Kawakita 川北

General attitude of strata

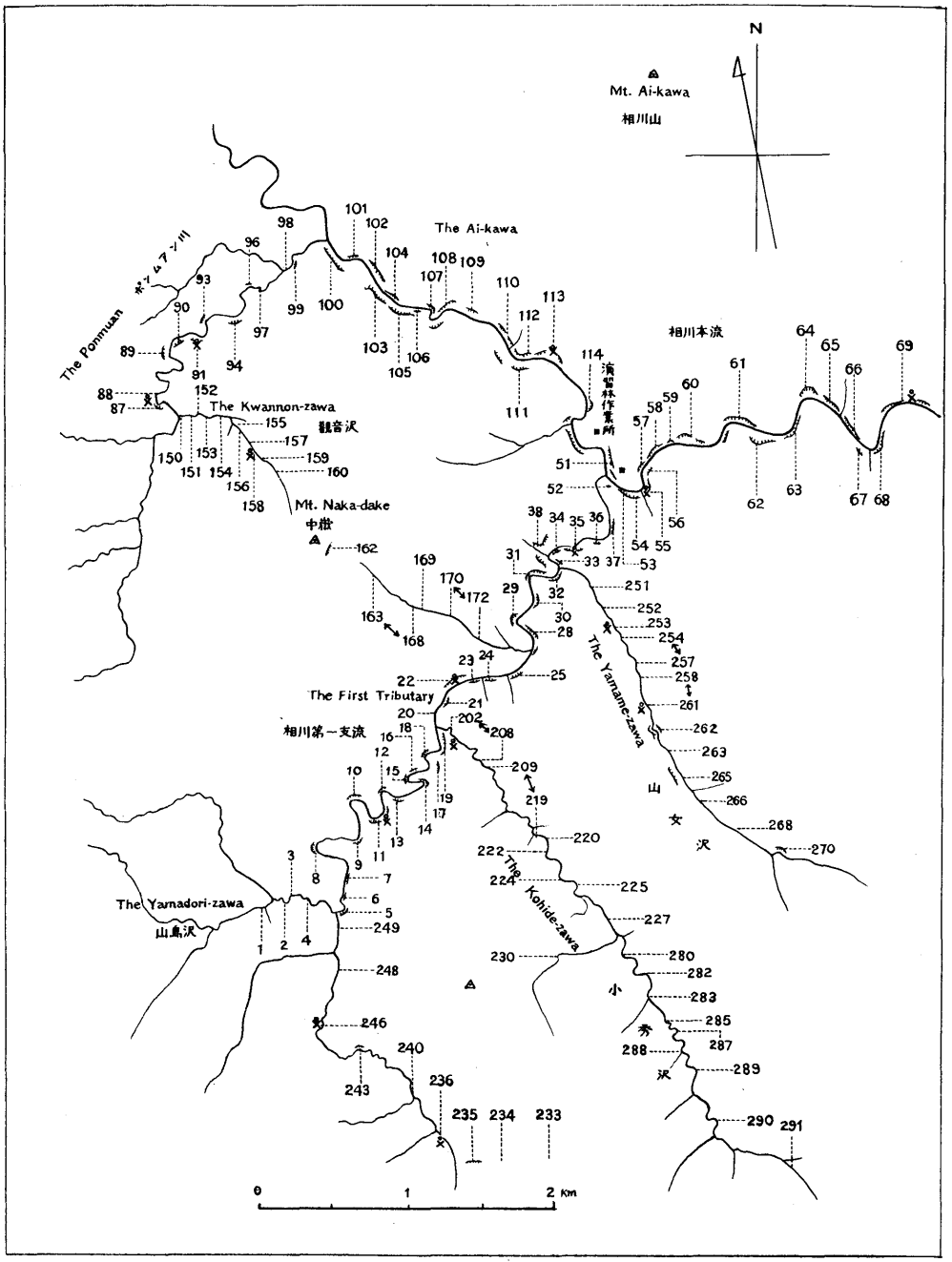
≧10° < 20°
≧20° < 35°
≧35° < 50°
≧50° < 65°
≧65° < 85°
> 85°

0 1 2 3 4 km

Map showing localities of exposures along the Mid-valley of the Ai-kawa, South Karahuto

樺太相川中流々域踏査略圖

Compiled from the Route Maps drawn to the scale of 1:10,000
All the loc. numbers in this map are to have prefix I.
(Date of survey — Summer 1937)



Geological Map of the Abesinai District, Tesio Province, Hokkaidô

北海道天塩國安平志内地方地質圖

Tw Wakkawenbetu Formation (Miocene)
IV Hakobuti Group
IIIe, IIId, IIIc, IIIb, IIIa — Upper Ammonite Group / (Ômagari Formation)
IId (Saku Formation), IIc, IIb-c, IIb, IIa — Middle Ammonite Group
I Lower Ammonite Group
To Oiwake Series (Pliocene)

The Nio-zawa
The Tesio
The Saku-gawa
The Gakko-zawa
Saku
The Sakin-zawa
Tirasinai
The Rubesibetu
The Abesinai
The Tikabunnai
The Tirasinai
The Simarop
The First Tributary
Omagari
Sibunnai
The Osousyunai
The Wakkawenbetu
The Sakaino-sawa
The Kurumi-zawa
The Tanno-sawa

A B C D

N

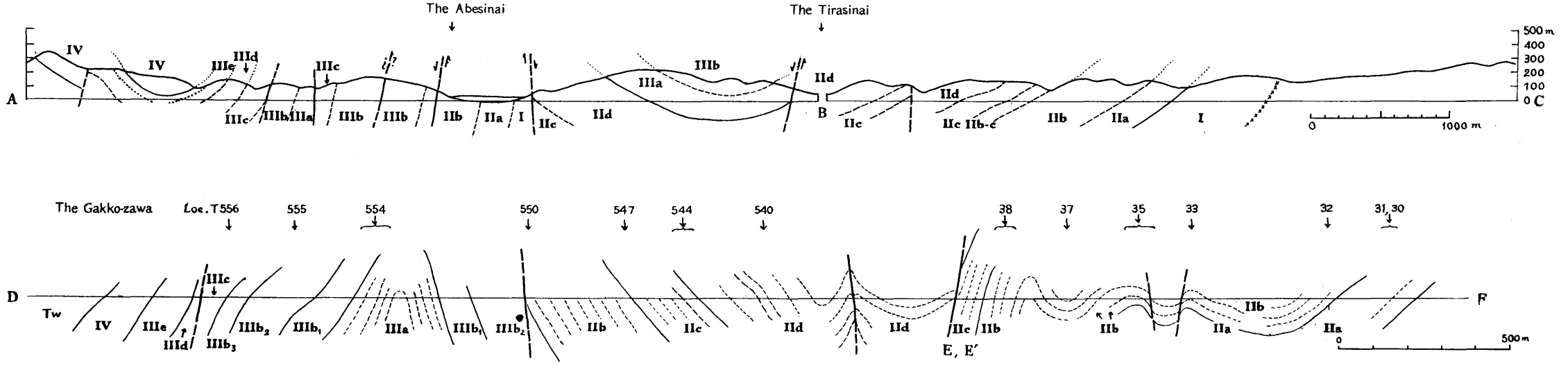
0 1 2 3 4 Km

10° 10°20° 20°35° 35°50° 50°65° 65°85° 85° overturned

General attitude of strata

Geological Profiles of the Abesinai District, Tesio Province, Hokkaidô

北海道天塩國安平志内地方地質斷面圖



PHYSICAL AND GEOLOGICAL CONDITIONS IN GENERAL

Topographically the present district may be divided in four belts of meridional trend. They are as follows from east to west.

(1) The backbone, with the general altitude of from 500 m to 700 m. Mt. Onisasi-dake[1] (738 m) is the chief peak.
(2) The intermediate belt between (1) and (3).
(3) The main valley of the Abesinai.
(4) The western divide, with the general altitude. of 400 m. The ridge is the boundary of Nakagawa-gun and the Tesio-gun.

Owing to the general predominance of vegetation, the exposure of rock is almost always confined to the valley or along the river course. Under this circumstance, the meandering valley of the Abesinai and its many large and small tributaries are important. (The name of the branches are described in the separate map. Pl. *XII*) Smaller tributaries of the Tesio, such as the Tirasinai[2], the Saku[3] (or Sakotan), the Gakko[4] (or the Abesinai-Gakko-no-sawa) and the Nio[5], also present fairly good exposures.

The main geological formations developed in the present district are as follows:

Onisasi Group (鬼刺層群) Cretaceous, possibly iuclusive Jurassic

Lower Ammonite Group	(下部菊石層群)	Cretaceous
Middle Ammonite Group	(中部菊石層群)	
Upper Ammonite Group	(上部菊石層群)	
Hakokuti Group	(函淵層群)	

Neogene

Quarternary (Terrace gravels and alluvial deposit along the river courses)

The Onisasi Group and the main part of the Lower Ammonite Group are developed in the first topographic belt, together with the intruded basic igneous rocks. Other Cretaceous formations occupy the second and the third belts, yielding abundant fossils. So far as the present district is concerned, the Cretaceous strata form a conformable series, though there is still some ambiguity as to the relation of the Onisasi Group and the Lower Ammonite Group. On the other hand the Neogene overlies the Cretaceous

(1) 鬼刺岳 (2) 知良志内川 (3) 佐久川 (4) ガツコー澤 (アベシナイ學校の澤)
(5) 仁尾川

with an unconformity, sometimes lying on the Hakobuti Group and othertimes lying on the Upper Ammonite Group. The unconformity is a parallel one as is observable in the exposures but a considerable gap of time is represented by it. The Tertiary crops out in the fourth topographic belt and is developed further westward, occupying the extensive area in Tesio-gun[1]. The basal part of the Tertiary in the present district is a massive sandstone with a local conglomeratic layer and yields remains of molluscs, echinoids and others. Dr. Y. OTUKA[2] of the Tôkyô Imperial University examined my collection and detrmined the age of the fossiliferous part as Miocene, correlating it to his Chiraipets Formation. Another Tertiary formation probably belonging to the Oiwake Series crops out in a small area near Nio, but its exact relation to the Cretaceous strata is uncertain. The formation is a diatomaceous mudstone yielding some molluscan remains.

The present district is a portion of the median folded zone of Hokkaidô, and has a general tectonic lines of N–S or NNW trend. In the midst of the field, almost along the valley of the Abesinai, there is a remarkable fault of meridional trend. This fault is here conveniently called the Abesinai-fault. On the eastern side of this tectonic line there is a synclinal structure which is associated with a fault. And further eastward, the westwardly homoclinal structure is the general condition; a steep dip being predominant in the first topographic belt though there is some local deviation in the attitude of strata. On the eastern side of this belt, outside of the surveyed area, there seems to be somewhat complicated structure, though the detailed feature is uncertain.

The western area, i.e. the area westward from the Abesinai fault, presents folds (anticlines, synclines and flexures) of minor scale and many transverse faults besides the general westwardly homoclinal structure. The type of the folding is characterized by the upright and closed anticline and the gentle syncline. The axial plane of the anticline is sometimes changed to a fault, and other strike fault is also present. Owing to these geologic struc-

(1) A narrow belt of upper Cretaceous rock containing *Placenticeras* and other fossils is said to be found in this Tertiary area just on the western side of the ridge of the fourth topographic belt.

(2) Y. OTUKA: Miocene Mollusca from the Tesio Province. Hokkaidô. (Japanese Journ. of Geol. & Geogr., vol. 17, nos. 1-2, 1940)

ture, the strata are not necessarily arranged regularly, but their omission or repetition is frequent.

Shortly the structure of the Cretaceous rocks is more complicated in the present district than in the Naibuti district. Accordingly the field can be regarded as being less adequate for the biostratigraphic investigation. But it comprises materials sufficient enough to afford us some important knowledges of the Cretaceous stratigraphy

DESCRIPTION OF STRATIGRAPHY

O. Onisasi Group[1]

The Onisasi group has been recognized in the Mesozoic area of the transverse mid-valley of the Tesio since the investigation of MORITA. The typical exposure of the group is found along the valley of the Onisasi, a tributary of the Tesio. The group is composed of siliceous shales, cherts of grey, gaeenish or red colour greywacke or andesitic sandstones, volcanic conglomerate, and alternating shale and sandstone. Predominance of siliceous sediments and clastic materials derived from basic volcanic rock (mainly pyroxene-andesite) are the characteristic feature of the group. Porphyrites diabase and serpentine rock occur in the distributional area of the group. Some of them is evidently a dike, or an intrusive mass, but we cannot deny the possibility of the presence of igneous rock which is contemporaneous with the Onisasi Group though the exact evidence has not yet been detected.

Fossil is not found from the group, except for the radiolarian remains contained in cherts. MORITA assigned the group provisionally to the Palaeozoic, But there is no positive evidence. From the stratigraphic point of view, the Mesozoic age of the group seems more probable, though the accurate relation should be sought in future or in certain other district.

I. Lower Ammonite Group

Excluding the Onisasi Group of uncertain geological age, the Lower Ammonite Group is the lowest unit of formation among the Cretaceous rocks of the present district. It is mainly composed

[1] As the survey is incomplete in the backbone area, only a brief account is given here for the lower two groups.

of thin bedded sandstones and shales in alternation, its facies being rather that of flysch-type. The thickness is nearly 2000 m. In the lower part sandstone occurs sometimes as a thick bed. The distinction of this group from the Onisasi group is the general scarcity of the siliceous sediments and pyroclastic sediments. As observed along the valley of the Okaonai[1], a small tributary of the Tesio, the attitude of strata are parallel between the two groups. But a conglomerate is associated with the sandstone near the basal part of what I have assigned to the Lower Ammonite Group. It contains pebbles of porpyrites tuff, shale and marl. At any rate the exact point of the boundary is not yet ascertained.

The group is overlain conformably by the Middle Ammonite Group, and there is a gradual change of lithological character between the two. The part where interfingering of sandstone becomes scarce is to be referred to the latter, though within the group there is a member of shale or mudstone with little intercalation of sandstone.

Although shale or mudstone contains concretions and thin lenses of marl, fossil is scarecely found. Only the following species have been determined from the Lower Ammonite Group of the present district.

Phylloceras sp. (cfr. "*Ph.* aff. *tanit* PERVINQUIÈRE")
Anisoceras (s. str.) sp.
Pervinquieria imaii (YABE & SHIMIZU)
Desmoceras sp.
Kossmaticeras (s. l.) sp.
Inoceramus sp.
Echinoid gen. et sp. indet.

The first two species were collected at locality T 82 in the middla part of the group, and the last five species were from loc. T 602 near the top of the group.

Lastly attention should be paid to the member of thin-bedded siliceous shale or chert-like rock found in the middle part of the group. It is an altered tuff and a tuffaceous shale. The former consists essentially of splinters of glass, pumices and fragments of minerals such as quartz, feldspars, and biotite.

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II. Middle Ammonite Group

General remarks.——In the Abesinai district the sediments which follow the Lower Ammonite Group are somewhat different from those in the Naibuti district or those in the western part of the Cretaceous district of Isikari coal-field. They are mainly comparatively fine-grained and homogeneous sediments which contains calcareous or marly concretions and abundant fossils of ammonite, *Inoceramus*, etc. For this group and its extension, I propose the name of the Middle Ammonites Group. In the upper part of the group beds of coarse grained sedimentaries occur frequently, resulting in a formation of minor unit. This unit is here called the Saku formation.

The group is distributed widely in the present district occupying the main part of the second and the third topographic belts. Its total thickness is estimated approximately at 1300 m.

Relation to the Lower Ammonite Group.——So far as the present district is concerned the Lower Ammonite Group and the Middle Ammonite Group are conformable and with gradual but rather rapid change of rock-facies. The continuous exposure which presents the relation is found along the mid-valley of the Tirasinai, along the First tributary of the Sibunnai, and the curved course of the Abesinai about 1 km below the bridge of Itino-hasi. An example of rock-succession from the top of the Lower Ammonite Group to the base of the Middle Ammonite Group is as follows:

1. Varved shales, consisting of laminae or very thin layers of black mudstone and fine sandstone, and sandstone and shale in frequent alternation. (Lower Ammonite Group proper)
2. Shale, with occasional intercalation of laminae and very thin layers of fine sandstone and sandy shale.
3. Mudstone without stratification. (several metres)
4. Mudstones with frequent intercalation of very thin layers of sandstone. (Ca 10 m)
5. Mudstone, bluish dark grey and massive, containing marly concretion. (Middle Ammonite Group proper)

Stratigraphic sequence and rock-facies.——Although the group as a whole consists of comparatively fine-grained sediments containing marine fossils and concretions, different parts are distinguishable on account of detailed features of rock-facies. And the following four formations (in ascending order) are comprised in the Middle Ammonite Group of the Abesinai district:

II a. Mudstone, bluish dark grey, homogeneous, and very fine-grained; concretions of marl are richly contained but the fossils occur rather sparcely.

II b. Fine-sandy mudstones or siltstones, bluish ± greenish dark grey containing calcareous concretions and numerous fossils.

II c. Mudstones like II a. Fine-sandy siltstone is intercalated only in subordinate amount.

II d. (=Saku Formation) Mainly composed of thin bedded mudstone, sandy siltstone fine sandstone in alternation. Sometimes thick beds of sandstone, silty fine-sandstone and mudstone are intercalated and a local conglomerate is contained. Calcareous concretion is common. Generally fossiliferous, and richly so in some part.

The lower half of the group including the formation II a and the main part of II b is constant in its rock-facies, whereas the upper half shows some variation in the thickness of each formation and in the detailed feature of rock-facies. These local differences are represented here as α, β, γ, and δ. Facies α is developed in the northern part, facies β in the northern central part, facies γ in the southern central part and facies δ in the southern part of the field.

Lower half of the Middle Ammonites Group.——

Formation II a. Mudstones, bluish dark grey, without noticeable development of stratification, generally very fine grained and only partly fine-sandy. Sporadically thin layers of light coloured sandstone and white tuff are intercalated. Marly concretions of various size are common, some of them being arranged in a lenticular layer. In the main part of the formation fossil is comparatively poor. Many of the nodules are barren, and if fossiliferous one is found, it contains only a few sporadic fossils. Organic remain is also contained in the mudstone itself, but the preservation is bad. In the uppermost part, the formation becomes fairly fossiliferous like in the succeeding formation II b.

The formation is no less than 250 m thick. Its exposures are loc. T 604——T 606 along the Saku; T 825, T 826, T 832——T 836 in the eastern part of Tirasinai; T 623——T 625 along the mid-valley of the Tirasinai-river; T 30——T 32 on the lowest course of the Gakko-sawa; T 705, T 706 of the Nio-gawa; T 21

at Abesinai; T 352, T 353, T 509——T 513, T 883——T 885 along the valley of the Sibunnai; and T 683, T 596, T 588, T 589, T 860 a, b, T 861 a, T 863 along the main course of the Abesinai.

Formation II b proper. Essentially composed of siltstones or fine-sandy mudstones, and not so fine-grained as in II a; bluish dark grey, and often characterized by green (glauconitic) colour; rather massive but sometimes with shaly fissility or lamination. Fine-grained mudstone (like in II a) occurs in small amount, and thin layer of tuffaceous sandstone is intercalated sparingly. Calcareous or marly concretions are commonly contained. They are various in size, sometimes fossilifereus and othertimes unfossiliferous. But as a whole the formation is rich in organic remains. They are contained abundantly in some of the nodules, not so abundantly but fairly commonly or rather sparingly in some others and in the country rock itself. Most of them are ammonoids of desmoceratids, puzosids, gaudryceratids and bivalves of *Inoceramus*. Aberrant ammonite like *Turrilites* and strongly ornamented form like acanthoceratids are not rare. Remains of young shell as well as mature one occur. Sometimes small driftwood and leaves of land plants are found.

The thickness of the proper part of the formation is constant, being estimated at about 350 m. And the following exposures belongs to this part. T 607——T 609 along the Saku; T 819——T 823 along the Saku-sakin-zawa, T 827——T 831 and T 805——T 809 at the eastern part of Tirasinai; T 707——T 711 along the Nio-gawa, T 33——T 38 along the lower valley of the Gakko-zawa, T 53——T 54 and T 547——T 550 along the middle valley of the same river; T 620——T 625, T 651, T 652 along the mid-valley of the Tirasinai, T 22——T 26 along the small western tributary No. 1 of the Abesinai; T 1——T 7 along the lower valley of the Rubesibetu; T 225——T 232 in the northern valley of the Sibunnai Pass; T 868——T 872 along the Simarop, T 505——T 508, T 880——T 882 along the valley of the Sibunnai; and T 587, T 591, T 861 b-e, T 862, T 324 along the main course of the Abesinai.

Upper half of the Middle Ammonite Group.——

Facies α (Northern part of the field)

Typical succession of formations II b, II c and II d are found in this part.

Formation II c [*α*]. Largely composed of mudstones, more

fine-grained than in II b, bluish dark grey, massive, with rarely intercalated thin beds of white tuff and green fine-sandstone. Marly concretions common, some of them are of characteristically green (glauconitic) colour. The formation is rather poor in organic remains. Thickness 150 m (+)——200 m. Typical exposures are loc. T 610, T 611, T 618, T 619 along the lower valley of the Saku; T 816——T 818 along the Saku-sakin-zawa; T 803, T 804 at Tirasinai; T 39, T 51, T 52, T 544——T 546 along the Gakko-zawa; and T 712——T 715 along the Nio. The uppermost part of the formation II c is fine sandy and is followed by the more coarse-grained facies of II d.

Formation II d [*α*] (Saku Formation). Essentially consisting of alternations of thin-bedden mudstone, sandy siltstone, and fine- or medium-sandstone. Thickness of each stratum is 30 cm or so, and in each bed, fine-sandstone in the lower part passes gradually to sandy siltstone and further upward to shale or mudstone. Sometimes the three kinds of sediments are separated by platy stratification. In some part sandstone-bed of 0.5 m or 1 m (+) thickness is intercalated, and this sandstone is often coarse-grained and pebble-bearing. In other part thick bed (3 m or several metres) of massive sandy mudstone or fine-sandstone occurs. Throughout these sedimentary rocks calcareous concretions are distributed. And some of the nodules are richly fossiliferous, numerous remain of ammonite and *Inoceramus*, together with other bivalves, gastropods, echinoids and a considerable amount of drift-wood or carbonaceous flakes being comprised. Sometimes the country rock itself also yields a fossil commonly. Thickness of the formation is estimated at about 450 m.

As the formation is typically developed near Saku, the entitled name has been introduced. The formation exposes at loc. T 612——T 617 along the lower valley of the Saku; T 811——T 815 along the lower valley of the Saku-sakin-zawa; T 601, T 70——T 74 of the railway cuttings near Saku; T 674——T 679, T 680 (Pl. XX Fig. 3), T 699 on the left side of the Tesio-river opposite to Saku; T 40——T 50, T 540——543 along the mid-valley of the Gakko-zawa, and T 716——T 723 along the mid-valley of the Nio.

Facies β (Northern central part of the field)

In this section, the formation IIb proper, is overlain by the deposits of somewhat intermediate character between IIb and IIc

while the formation IIc is represented by less amount of thickness.

Formation IIb-c [β]. 70——130 m. Lower part, 30——100 m thick, is represented by fine grained mudstone like IIc proper, containing nodules and fossils. Its typical exposures are loc. T 653, T 840——T 843 of the mid-valley of the Tirasinai; and probably also T 27 of the small western tributary no. 1 of the Abesinai. Upper part, 40——30 m, thick, is fine-sandy mudstone or siltstone like in IIb proper, containing nodules and fossils. Its typical exposures are loc. T 655 a, T 844——T 846 of the mid-valley of the Terasinai and T 28 of the small western tributary no. 1 of the Abesinai.

Formation IIc [β] (proper). The thickness is only a little more than 80 m. The rock-facies is same as that of IIc [α], except for the intercalation of sandy siltstone in the middle part. Though the calcareons concretion often of glauconitic colour is abundantly contained, fossil is rare. The exposures[1] are found in the mid-valley of the Tirasinai at loc. T 655 b, T 654, T 656, and T 847——T 850 a.

Formation IId [β] (Saku Formation). The main part is composed of alternations of thin bedded sandstone, sandy shale and mudstone (or shale). Sometimes sandstone is dominant and conglomerate occurs in the lower part. The conglomerate contains pebbles of igneous rocks and sedimentaries such as marl, mudstone and sandy siltstone. These rock is rather poor in fossil-contents. The lowest part, just superjacent to IIc is bluish-greenish-grey sandy siltstone or very-fine-sandstone, rather massive and fairly fossiliferous. Similar massive sandy mudstone and fine sandstone occur at other horizones and are also fairly fossiliferous. The element of fossil is similar to that of IId [α]. The exact thickness of the Saku formation in β-area is hardly estimated because of the presence of fault, but it may exceeds 400 m. The formation is exposed at loc. T 657——T661, T 663, T 664, T 850 b——T 854 in the mid-valley of the Tirasinni, T 29 of the small western tributary no. 1 of the Abesinai, and T 8——T 10 (and probably boulders at T 7 b) of the Rubesibetu valley.

Facies γ (Southern central part of the field)

[1] The formation is not found in the Rubesibetu and the western tributary no. 1 of the Abesinai. This, I think, is due to the omission of strata by a strike fault, though the fault itself is not exposed.

In this part the formation IIc is relatively thick and the facies of the Saku Formation (IId) is somewhat different from the typical one.

Formation IIc [γ]. Mudstones, bluish dark grey, containing concretions of marl and very few fossils. Thin layers of fine-sandstone and white bentonitic tuff are sparingly intercalated. The formation exceeds 250 m in thickness. Typical exposures are at loc. T 331, T332, T 350 and T 351 in the Sibunnai valley, T 236 —— T 239 and T 867d along the Simarop-zawa, and T 404, T 411 in the small eastern tributary of the Abesinai.

Formation IId [γ] (Saku Formation). This follows IIc [γ] with a conformity. Its general character is similar to that of IId [α] but the sandstone is more predominant and the fossil occurs only in certain restricted beds. The following three parts are distinguished: Lower part (d_1) About 100 m. Sandstone and shale in alternation, with an intercalated bed of conglomerate, 4 m. or so thick, containing small pebbles and granules of chert, greywacke sandstones, and dacitic volcanic rock. Massive fine-sandy siltstone and green fine-sandstone are intercalated in a lenticular form and are fairly fossiliferous. The remaining part is poor in fossil contents. The main exposures of the lower member are T 333, T 334, T 338, T 349, T 890——T 894 in the Sibunnai valley, T 240, T 241, T 867a-c, T 875, T 877 along the Simarop-zawa, T 405——T 407, T 412, T 413 in the small eastern valley of southern Abesinai.

Middle part (d_2) 70 m. Mudstone, massive, bluish dark grey, containing marly nodules which is often very fossiliferous. Exposures T 335a T 336, T 342——T 347 of the Sibunnai valley belong to this member.

Upper part (d_3) 250 m. (+)[1] Thin-bedded sandstone, sandy shale and shale (or mudstone) in alternation and thicker beds of sandstone and conglomerate. The sandstone is generally light bluish-greenish-grey, various in coarseness, often with lamination and contains carbonaceous flakes, few marine shell, and calcareous concretions. The conglomerate occurs at the base of this member, at least several meters thick, and is of peculiar character. Its main part has the large amount of matrix which consists of relatively fine-grained sediments such as sandy mudstone or sand

[1] As the member occupies the axial region of a syncline, the true thickness is unable to be determined.

bearing siltstone, although pebbles and cobbles are accumulated locally with little amount of matrix. And, furthermore, we find among the pebbles and cobbles rocks of the Cretaceous formation such as marl, mudstone, sandy siltstone, sandstone occuring as a subangular or subrounded blocks or fragments in a considerable quantity. Rounded cobbles and pebbles of acidic volcanic rocks and porphyrites occur together with them. Fossils are yielded from this conglomerate; they are contained either in the marl occurring as a roundstone and in a calcareous concretional part of the matrix; and the same assemblage of species as that of d_1 and d_2. is shown. This fact, together with the local occurrence of the conglomerate is certainly a record of the local contemperaneous erosion during the age of the Saku Formation, and the conglomerate is an intraformational one. The exposures of the upper member are T 335b, T 338——T 341, T 504——T 500, and T 895——T 897 along the Sibunnai valley.

Facies δ (Southern part of the field)

Although the southern part of the field has not yet been completely investigated, presence of somewhat different condition seems to be open at least in the upper half of the Middle Ammonite Group.[1] Namely, in this area the formation IIc is still larger in thickness, and the facies of the Saku Formation (IId) is again somewhat different.

Formation IIc [δ]. Nearly 300 m thick. Mudstone, bluish dark grey, massive, containing marly nodules among which ellipsoidal one with maximum diameter of ±50 cm (30 cm——60 cm) occurs characteristically. Most of the concretions is barren, but some are fossiliferous, though not prolific. Organic remains are also found in mudstone itself, though in a bad state of preservation. The exposures at loc. T 457——T 459, T 912, and T 913 along the Kurumi-zawa, and T 322, T 323, and T 450 along the main course of the Abesinai belong to this formation. The uppermost part of IIc [δ] is fine-sandy siltstone and is followed conformably by IId [δ] described below.

Formation IId [δ]. The exposed part is 300 m (+).[2] Thin bedded or laminated sandstone, sandy siltstone and shale in alter-

(1) Lower half of the group is not exposed in the surveyed area.

(2) As the formation occupies the axial negion of a syncline, the true thickness is unable to be determined.

nation. The sandstone is various in its grades of coarseness, generally fine or medium, but sometimes very coarse. Pebbles accur often within or around the calcareous concretional part and sometimes form a patch of conglomerate. In other case an isolated pebble is found in the mudstone. Generally fossil is rare, but calcareous concretional part sometimes contains many shells of bivalve. The exposures at loc. T 453——T 456 in the lowest valley of the Kurumizawa, and T 451, T 452, T 460——T 462 along the main course of the Abesinai belong to the formation.

Sequence and assemblage of fossils.——The Middle Ammonite Group is in general considerably fossiliferous, showing a similarity in the mode of fossil-occurrence throughout its whole thickness. Namely, the comparatively fine-grained sediments of the group yield fossils of open-sea molluscs such as ammonites, *Inoceramus*, etc. usually from the contained calcareous concretions and sometimes from themselves. But, as described above, more fossiliferous parts such as the top of IIa, IIb proper and main part of IId are distinguished from the less fossiliferous parts like the main parts of IIa and IIc. And, furthermore, the Saku Formation (IId) comprises shallower facies containing molluscs of sublittoral type besides the more fine-grained sediments of neritic type. Shortly the area had been under the similar environment belonging to the same faunal province during the age of the Middle Ammonite Group, but there may have occured sometimes a minor change in ecological enviroment and sedimentational condition, as well as in factors of fossilization.

Notwithstanding the careful observation and collection, splitting of the group on palaeontological ground is impossible nor in reality. And the change in the sequence of fossil-assemblage is presented in the unit approximately corresponding to the stratigraphic unit of IIa, IIb, IIc and IId, or more definitely only in two parts, lower half and upper half. Noteworthy is the fact that the fossil assemblage of IIc of α area is somewhat different from IIc of other areas as well as from IIb-c of β area. The former is akin to the fossil assemblage of IId, while the latter resembles that of IIb. Accordingly, there is inconsistency between the stratigraphic sequence based on rock-facies and that based on fosil-assemblage. So far as the material from the present district alone is concerned, the question is still open where the boundary of the

chronlolgical division should be drawn. The subject may be treated in Part II.

In the following the fossil-contents of each stratigraphic unit are presented.

IIa. In the main part of the subdivision IIa, fossil is rather poor, whereas the uppermost part is richly fossiliferous. In the mode of fossil-occurrence and in the assemblage of fossils, the latter is essentially similar to the subdivision IIb. But absence of typical *Acanthoceras* should be noted. And furthermore, we recognize the occurrence of *Desmoceras* cfr. *kossmati* MATUMOTO MS from the main part, though the absence of some of the common species of IIb in the main part of IIa may possibly be due to ecological factors and conditions of sedimentation and fossilization. The important species are as follows: (* abundant)

	Uppermost Part	Main Part
Phylloceras velledae (MICHELIN)	+	
Ph. japonicum MATUMOTO MS.	*	
Parajaubertella kawakitana MAT. MS.	+	
Anagaudryceras sacya (FORBES)	+	+ (cfr.)
A. madraspatanum (STOLICZKA)	+	
Zelandites aff. *dozei* (FALLOT)	+	
"*Hamites*" sp.		+
Baculites sp.	+	
Desmoceras cfr. *kossmati* MATUMOTO MS.		+
D. (*Pseudouhligella*) *japonica* YABE	+	+
D. (*P*) *japonica* var. *compressa* MAT. MS.	+	
D. (*P*) *ezoana* MATUMOTO		+ (cfr.)
Maorites compressus MATUMOTO MS.	+	
Neomadrasites (?) *nipponicus* MAT. MS.	+	
Cfr. *Calycoceras* sp. β	+	
Inoceramus sp. indet. cfr. *cripsi* MANTELL		+ (?)

IIb. As has been described, this formation is rich in fossil-contents. And, as listed below, the assemblage of fossils is similar throughout the whole thickness. But if examined in detail, we recognize that among the most common members species of *Acanthoceras* s. str. occur only in the upper part.

	Low.	Mid.	Up.	Detailed horizon indet.
Phylloceras velledae (MICHELIN)...	+			
Ph. japonicum MATUMOTO MS.	*			+
Ph. japonicum var. *subellipticum* MAT. MS. ...				+
Tetragonites (s.s.) sp. nov.? (*T. tetragonus* MS)	+			+
Anagaudryceras sacya (FORBES)	*	*	*	+
A. sacya var. *laeve* MATUMOTO MS.	+			
A. sacya var. *plicatocostata* MATUMOTO MS....				+
A. madraspatanum (STOLICZKA)	+	+		
Gaudryceras subcostatum MATUMOTO	+		+	
Zelandites odiensis (KOSSMAT)	+		+	+
Z. odiensis var. *late-umbilicata* MAT. MS. ...	+			
Z. aff. *dozei* (FALLOT)			+	
Z. *mihoensis* MATUMOTO				+
Desmoceras (*Pseudouhligella*) *japonica* YABE...	*	*	*	+
D. (*P.*) *japonica var. α.*				+
D. (*P.*) *japonica* var. *compressa* MAT. MS. ...				+
D. (*P.*) *ezoana* MATUMOTO MS.	*	+	+	+
D. (*P.*) *ezoana* var. *poronaica* YABE				+(cfr.)
Puzosia nipponica MATUMOTO	+	+	+	
P. aff. *nipponica* MATUMOTO				+
Pachydesmoceras denisoni (STOLICZKA)	+		+	
Gunnarites (?) *unicum* (YABE) em.	+	+		
Holcodiscoides papillatus (STOLICZKA)		+	+	+
Maorites olcostephanoides MATUMOTO MS. ...				+
M. compressus MATUMOTO MS.		+		
Neomadrasites (?) *nipponicus* MATUMATO MS....				+
Acanthoceras orientalis MATUMOTO MS.... ...		*	*	+
A. aff *orientalis* MATUMOTO				+
A. spinosum KOSSMAT			+	
A. cfr. *asiaticum* JIMBO			+	
Cunningtoniceras cfr. *cunningtoni* (SHARPE) var. *cornuta* (KOSSMAT)	+			+
Turrilites (s. str.) *costatus* LAMARCK	+	+		+
T. costatus var. *acutiformis* MATUMOTO... ...	+			
T. (*Meriella*) *acutus* PASSY	+			
Inoceramus concentricus nipponicus NAGAO & MATUMOTO	*	*	*	+

I. yabei subconcentricus MAT. MS. ... ... + + +
I. yabei constrictus MAT. MS. ... ... + + +
I. yabei spengleri MAT. MS. ... ... + + +
I. aff. *cripsi* MANTELL... ... ... + +(?)

IIc. and IIb-c. The following is the list of important species found in IIc [α], IIc [β], IIb-c [β] and IIc [γ].

	IIc [α]	IIb-c low.	[β] up.	IIc [β]	IIc [γ]
Neophylloceras subramosum (SHIMIZU) ...		+			
Phylloceras (s. l.) sp. cfr. *velledae* or *subramosum*.			+		
Tetragonites (s. l.) sp.	+		+		+
Anagaudryceras sacya (FORBES)		+			
A. sacya var. *plicatocostata* MAT. MS. ...	+				
Gaudryceras cfr. *denseplicatum* (JIMBO) ...	+				
Zelandites mihoensis MATUMOTO var. *capricornus* MATUMOTO MS.			+		
Baculites orientalis MATUMOTO MS. (aff. *B. baculoides* MANTELL)	+				
Desmoceras (*Pseudouhligella*) *ezoana* MAT....		+	+		
D. (*P.*) *ezoana* var. *peronaica* YABE			+(cfr.)	+	
D. (*P.*) *japonica* YABE			+		
D. (*P.*) *japonica* var. α....				+	
D. (*P.*) *japonica* var. *compressa* MAT. ...			+		
Maorites olcostephanoides MAT. MS.... ...			+		
Holcodiscoides papillatus (STOLICZKA)... ...			+		
Puzosia nipponica MATUMOTO			+		
P. sp. indet *indopacifica* or *nipponica* ...	+	+			
Parapuzosia (*Mesopuzosia*) *indopacifica* (KOSSMAT)	+(cfr.)		+(cfr.)		
Scaphites (*Yezoites*) *puerculus* JIMBO	+(cfr.)				
Fagesia thevestensis (PERON) = *F. kotoi* (YABE)	+				
Inoceramus concentricus nipponicus NAGAO & MAT.			+	+	
I. yabei constrictus MAT. MS.			+		
I. yabei spengleri MAT. MS....		+		+	
I. tenuistriatus NAGAO & MAT.	+				

Indeed the fact presented in the table shows only the apparent range of species, but the following points should be noticed: (1) The fossil-assemblage is somewhat different between α and β. (2) That of IIc [α] has much affinity to that of IId. (3) That of IIb-c [β] resembles rather that of IIb proper, but it comprises also small number of new elements such as *Neophylloceras ramosum* (MEEK) and *Parapuzosia* cfr. *indopacifica* (KOSSMAT), and is free from certain members characteristic to IIb proper (like *Acanthoceras* s. str. and *Turrilites*). (4) IIc [β] is very poor in fossil-contents; only the basal part yields several number of species which are esentially the same as those of IIb-c [β]. (5) IIc [γ] is almost barren of fossil, and we have no positive material for discussing the range of species.

The fossil-assemblage of IIc in δ-area, as presented in the following list, is noteworthy, for it has affinity to that of IIb and it contains species of *Turrilites* and *Jacobites*.

Anagaudryceras sp. indet. (juvenile)
Hamites (?) sp.
Baculites cfr. *orientalis* MATUMOTO (aff *B. baculoides* MANTELL)
Desmoceras (*Pseudouhligella*) cfr. *japonica* YABE.
D. (*P.*) *japonica* var. *compressa* MATUMOTO MS.
Puzosia (s. l.) indet.
Jacobites sp. nov. (?)
Turrilites (t. l.) cfr. *morisii* SHARPE
Inoceramus cfr. *yabei spengleri* MATUMOTO MS.

IId. The Saku Formation is generally fossiliferous, though the occurrence of the fossil is rather heterogeneous, being very prolific in some part but rather poor in other part. Its assemblage of fossil, as presented in the list below, resembles that of zone Mh 2 and zone Mh 3 of the Naibuti district, although the rock-facies is somewhat different. The subdivision of the formation on palaeontotogical grounds is impossible.

	α	β	γ	δ
Neophylloceras subramosum (SHIMIZU)	+	+	+	
N. compressum MATUMOTO	+			
Phyllopachyceras ezoense (YOKOYAMA)	+		+	
Epigoniceras glabrum (JIMBO) em.	*		*	

E. glabrum var. *sphaeronota* (JIMBO) em. ...	+			
E. glabrum var. *crassa* (JIMBO) em.	+			
E. cfr. *epigonum* (KOSSMAT)	+			
Anagaudryceras limatum (YABE)			+	
Gaudryceras denseplicatum (JIMBO)	*		*	+
Baculites orientalis MATUMOTO MS. (aff *B. baculoides* MANTELL)	+	+		
Scaphites (*Yezoites*) *puerculus* JIMBO	+	+	+	
S. (?) *planus* YABE	+		+	
S. (?) *pseudoaequalis* YABE...			+	
S. yonekurai YABE	+			
Scalarites scalaris (YABE)	+	+		
S. mihoensis MATUMOTO	+	+	+	
S. venustus (YABE)	+			
S. densicostatus MATUMOTO	+			
Nipponites mirabilis YABE	+	+		
Tragodesmoceroides subcostatus MATUMOTO ...	*		*	+(cfr.)
cfr. *Pachydeomoceras pachydiscoides* MAT. MS.	+			
Parapuzosia (*Mesopuzosia*) *indopacifica* KOSSMAT...	+	+	+	
Anapuzosia (*Jimboiceras*) *planulatiforme* (JIMBO)	+	+		
A. (*J.*) cfr. *planulatiforme* (JIMBO)	+	+	+	+
A. sp. (with a comparatively widely separated rib in later age)	+			
Cfr. *Prionotropis teshioensis* YABE. & SHIMIZU				+
Reesidites (= "*Barroisiceras*") *minium* (YABE MS.)...	+			
Inoceramus pedalionoides N. & M.	+			
I. teshioensis NAGAO & MATUMOTO...	*	*	*	
I. hobetsensis hobetsensis	*		*	
I. hobetsensis nonsulcatus	+	+	+	+
I. hobetsensis intermedius	*	+		
I. hobetsensis maximus	+	+		
I. iburiensis NAGAO & MATUMOTO	+		+	
Inoceramus incertus (JIMBO)		+		

III. Upper Ammonite Group

General remarks.——The Sakú Formation of the Middle Ammonite Group is again followed by the comparatively homogeneous

(or monotonous) and fine-grained sedimentary series. This is what is called the Upper Ammonite Group. It consists mainly of mudstones or fine-sandy mudstones which contain calcareous or marly concretions and remains of ammonites, *Inoceramus*, etc. The group is correspondant with the main part of the Miho Group of South Karahuto and its typical representative is found in the Isikari coal-field of central Hokkaidô.

In the present district certain local features are presented within the group. Among them, noteworthy is the intercalation of the formation which is characterized by a frequent occurrence of coarse-grained sedimentary rocks. The formation occurs in the lower middle part of the group and is called here the Omagari Formation.

The relation between the Middle Ammonite Group and the Upper Ammonite Group is a conformity, although rock facies changes rather abruptly from the coarse-grained and stratified sedimentary rock of Saku Formation to the fine-grained and massive rock of the lower part of the Upper Ammonite Group.

The total thickness of the group is estimated at 1000 m or more. The distributional area in the present district is, as illustrated in the geological map (Pl. X), the synclinal region on the eastern side of the Abesinai Fault and the western part of the northern half and the main part of the southern half of the western area (i.e. the area westward from the Abesinai Fault.)

Stratigraphic sequence and rock facies.—— Contrary to the case of the Miho Group in the Naibuti district or that of the typical Upper Ammonite Group in the Isikari coal-field, the rock-facies of the group in the present district is not homogeneous throughout from bottom to top, but there are minor changes. Owing to these minor or local features, we can subdivide the group cf the district into the following formations (in ascending order):

III a: Lower Mudstones, 200 m (+)
III b: Omagari Formation (O. Sandstones), 250 m (±)
III c: Middle Mudstones, 200 m (+)
III d+e: Upper Fine-sandy Mudstones, 400–450 m

The detailed feature of each formation is as follows.

Formation III a. Mudstones, bluish dark grey, rather massive, generally fine-grained and in a small portion somewhat sandy. Sometimes layer of white tuff is intercalated. Numerous large or

small calcareous concretion is contained. Fossil occurs less abundantly but is not rare. It is found either in a concretion or in the country rock itself. Thickness: 200 m or so. Typical exposures are loc. T 702——T 704 along the lower valley of the Nio, T 554 along the upper course of the Gakko-zawa, T 11 and T 12 along the mid-valley of the Rubesibets, T 224 and T 285 north of Omagari and T 325 at Sibunnai along the main course of the Abesinai, T 316——T 318 along the lowest course of the Wakkawenbets, T 430——T 432 along the lower valley of the Sakai-no-sawa, T 592, T 593, T 973, T 974 in the mountainous area on the eastern side of the Abesinai, T 666a-e in the lower valley of the Tirasinai, and T 251——T 259 along the upper course of the Simarop-zawa.

Formation IIIb. (*Ómagari Formation*). This consists of sandstones, sandy mudstones and mudstones. They occur sometimes as a comparatively thick bed (5–10 m) but sometimes forming thin alternations with a frequent stratification. The thick bed is more common in the lower part and the frequent alternation is predominant in the upper part, but the two features are discernible also together with each other. Sandstone is often coarse-grained and passes to granule-conglomerate, but in other case fine-grained, passing gradually to sandy mudstone. The grains are generally well sorted but coarse sand grains and fine sands or silts are sometimes intermingled, and lenses of mud are found in the sandstone. Locally pebble and cobble conglomerate occurs, and isolated pebbles are often scattered in the sandstone or even in the mudstone.

Calcareous concretions are common in the mudstone, but rather rare in the sandstone. Massive sandstone contains commonly the remains of marine shell, although they occur rather sporadically. Sometimes very fossiliferous laminae are intercalated with thin bedded facies. Fossils from the coarse facies are usually those of marine bivalves, scaphopods, gastropods, echinoids, crinoids and fragments of ammonites. The preservation is rather unfavourable. But the fine grained strata yield fossil as in the case of the normal facies of the Upper Ammonite Group.

Noteworthy is the fact that the material of this local formation is largely derived from the andesitic rocks. Namely, the sandstone is usually dark green (or bluish-green) and often weathered to dirty black or brownish black colour. Under the microscope, the

grains are almost exclusively more or less rounded fragments of altered andesites. Thus the rock is a typical greywacke. The pebbles of conglomerate are also those of andesites or porphyrites, and those of re-worked mudstone are not rare.

The thickness of the formation is estimated at 250 m or so, although the presence of fault often makes the exact estimation difficult. The typical exposures of the formation are loc. T 281 ——T 284 (cf. Pl. XX Fig. 5), T 222, T 223, T 263——T 275, T 217, T 326, and T 327 near Ômagari (the derivation of the name of the formation) and near Sibunnai along the main valley of the Abesinai. Other exposures are found at loc. T 302——T 305 along the lower valley of the Wakkawenbets, T 434——T 438 along the upper valley of the Sakai-no-sawa, and T 443——T 447 and T 900 ——T 904 along the valley of the Kurumi-zawa in the southern part of the field; T 952——T 956 along the small western tributary no. 2 of the Abesinai, T 583——T 585 of the Tikabunnai, T 13—— T 15 along the Rubesibets, and T 551——T 553, T 555 along the upper course of the Gakko-zawa in the northern part; and T 682 c-h, T 684 a-d, T 666 h, T 414, and T 244——T 250 in the eastern part of the field.

Formation IIIc. Mudstones, like those of IIIa, bluish dark grey, rather massive and fine-grained, with an intercalation of a remarkable bentonitic white tuff. Calcareous concretions are contained, some of which being characteristic in its ellipsoidal or spherical shape and in its large size (1 m–2 m in maximum diameter). Mode of fossil-occurrence is similar to that in the formation IIIa. Thickness: a little more than 200 m. Exposures are found at loc. T 724——T 737 along the upper course of the Nio, T 684 e-g in the bottom of the syncline on the eastern side of the Abesinai Fault, T 276 and T 260——T 262 near Ômagari and Sibunnai along the main course of the Abesinai, T 213——T 216 and T 940 along the lower valley of the Osousyunai, T 905 b—— T 909 along the upper valley of the Kurumi-zawa, etc.

Formation IIId+e. Fine-sandy mudstones, dark coloured, massive, containing numerous calcareous concretion. As compared with the sediments of IIIa and IIIc or those of the main part of the Miho Group, the upper part of the Upper Ammonite Group in the present district is a little coarse-grained, being usually fine-sandy and in part silty fine-sandstone. Near the uppermost part

occurs a lenticular bed of glauconitic sandstone. The formation is richly fossiliferous, being the most fossiliferous one in the Cretaceous strata of the district. Fossil occur either in the calcareous concretion and in the country rock. Often abundant specimens are found in a nodule. Shortly occurrence of fossil is very similar to that in the upper part (zone Mh_6) of the Miho Group described already.

The thickness of the formation is nearly 400 m or less. And from the assemblage of fossil, it can be divided into two parts of almost equal thickness, lower and upper, each of which is marked here IIId and IIIe respectively.

The exposures of the formation which I examined are as follows:

(1) T 738——T 740 (IIId), along the upper valley of the Nio. (Many calcareous concretions derived from IIId and IIIe are found as a rolled blocks in the same valley.)

(2) Along the upper valley of the Gakko-zawa, there is no good exposure of the formation Several fossiliferous blocks have been collected at loc. T 556 and T 557, and T 55 of the tributary.

(3) T 16, T 17, T 520——T 523 (IIId); T 524——T 526 (IIIe) along the upper valley of the Rubesibets. (Numerous rolled pebble of fossiliferous concretion is found in the same valley.)

(4) T 571, T 572, T 578——T 581 (IIIe); T 582 (IIId) along the upper valley of the Tikabunnai.

(5) T 958——T 961 along the upper valley of the small western tributery no. 2 of the Abesinai.

(6) T 277, T 278b, T 279, and T 280b (IIId); T 278a, w-z, T 280a (IIIe) near the mouth of the Tanno-sawa along the main course of the Abesinai.

(7) T 470 and T 471 (IIId); T 472 (IIId or IIIe indet.); T 473——T 475 (upper part of IIIe) along the lower valley of the Tanno-sawa.

(8) T 208——T 212, and T 942 (IIId); T 205——T 207, T 943, and T 945 (lower part of IIIe or $IIIe_1$) T 202——T 204 and T 946——T 949, T 944r (upper part of IIIe or $IIIe_2$) along the lower valley of the Osousyunai.

(9) T 307——T 311 (IIId); T 312, T 313a, T 313'a, (upper part of IIIe) along the lower valley of the Wakkawenbets. (The forma-

tion is distributed also in the upper valley of the same river, but I have not visited the area.)
(10) T 910, the uppermost Kurumi-zawa.

Sequence and assemblage of fossil.—— As described above, the Upper Ammonite Group in the present district is not necessary uniform from bottom to top in the mode of fossil-occurrence, as well as in rock facies. According only an apparent range is presented at least as to a certain number of species, and the assemblage of fossils in each formation may be an apparent "faunal assemblage." But the observed facts can afford us some important knowledges in connection with the biostratigraphic problem. We notice, at first, that, so far as the assemblage of fossils is concerned, correspondance is found between IIIa (of the present district) and Mh_4 (of the Naibuti district); between IIId and Mh_6, and between IIIe and $Mh_7+Ry-Mh+Ray_1$. Secondary, it is recognized that certain species show longer apparent range than that in the Cretaceous strata of Naibuti district. The examples are *Anapachydiscus* spp., *Hauericeras gardeni* (BAYLEY), and *Damesites semicostatus* (YABE MS.). They occur downward in the formation IIIa together with *Inoceramus uwajimensis* YEHARA and *Anagaudrycears limatum* (YABE). Lastly, the change of fossil-assemblage from IIId to IIIe is apparently rather remarkable. Its detailed feature is observable along a few courses[1], but as the rock-facies is very uniform from the bottom of IIId to the top of IIIe and as the exposures are often discontinuous, we cannot get an accurate knowledge from this district. The subject must be treated at an adequate locality elsewhere. (The Urakawa district described later is the example.) Further deeper treatment of biostratigraphic problem shall be made in part II of this memoir. Here I will show in the list the fossil-contents of each formation.

IIIa. Cfr. *Phyllopachyceras* sp.
Epigoniceras glabrum (JIMBO)
Anagaudryceras limatum (YABE)
Gaudryceras tenuiliratum (YABE) em.
Damesites semicostatus (YABE MS.)
Hauericeras cfr. *gardeni* (BAYLEY)

[1] Along the Osousyunai and near the mouth of the Tanno-sawa along the main course of the Abesinai.

Anapachydiscus sutneri (YOKOYAMA)
A. cfr. *fascicostatus* (YABE & SHIMIZU)
Inoceramus uwajimensis YEHARA em. (very common)
Inoceramus naumanni (YOKOYAMA)

IIIb. Cfr. *Neophylloceras subramosum* (SHIMIZU)
Gaudryceras tenuiliratum YABE em.
Polyptychoceras cfr. *jimboi* MATUMOTO MS.
Parapuzosia ishikawai (JIMBO)
P. comacana MATUMOTO MS.
Anapachydiscus sp.
Pachydiscus (s. l.) sp. cfr. *Mowakites* or *Eupachydiscus* sp.
Mortoniceras sp.
Inoceramus japonicus (NAGAO & MATUMOTO)
Acila hokkaidoana NAGAO
Ostrea sp.
Echinoid, crinoid. (gen. et sp. indet.)

IIIc *Phyllopachȳceras ezoense* (YOKOYAMA)
Epigoniceras glabrum (JIMBO)
E. epigonum (KOSSMAT) (?)
Gaudryceras tenuiliratum YABE em.
G. tenuiliratum var. *frequence* MATUMOTO MS.
Hauericeras gardeni (BAYLEY)
Parapuzosia comacana MATUMOTO MS.
Anapachydiscus suteneri (YOKOYAMA)
A. fascicostatus (YABE & SHIMIZU)
Nowakites aff. *yokoyamai* (JIMBO)
Pachydiscus (s. l.) *sp.*
Inoceramus mukawaensis (OTATUME) NAGAO & MATUMOTO
Inoceramus naumanni (YOKOYAMA)
I. japonicus NAGAO & MATUMOTO

IIId. *Neophylloceras subramosum* (SHIMIZU) *
N. compressum MATUMOTO
N. aff. *hetonaiense* MATUMOTO
Phyllopachyceras ezoense (YOKOYAMA) *
Epigoniceras glabrum (JIMBO) *
G. tenuiliratum (YABE) em. *
G. tenuiliratum var. *frequence* MATUMOTO MS.
G. tenuiliratum var. *substriata* MATUMOTO
G. striatum (JIMBO) var *paucistrata* MATUMOTO

?[1] *Zelandites* cfr. *kawanoi* (JIMBO)
Polyptychoceras haradanum (YOKOYAMA) *[2]
P. jimboi MATUMOTO MS. *
Neocrioceras spinigerum (JIMBO)
Baculites sp.
Pseudoxybeloceras sp.
? *Schlüteria diphylloida* (FORBES)
Damesites damesi (JIMBO) *
D. sugatus (FORBES) em.
Hauericeras gardeni (BAYLEY) *
Parapuzosia ishikawai (JIMBO) em. *
P. comacana MATUMOTO MS.
Eupachydiscus haradai (JIMBO) em. *
Menuites sp. *α.* (*portlocki-menu* group)
M. rotalinoides (YABE)
?[3] *Inoceramus mukawaensis* (OTATUME) NAOAO & MATUMOTO
Inoceramus ezoensis (YOKOYAMA)
I. naumanni (YOKOYAMA) *
I. orientalis var. *ambiguus* NAGAO & MATUMOTO
I. yokoyamai NAGAO & MATUMOTO

IIIe. *Neophylloceras compressum* MATUMOTO
N. aff *hetonaiense* MATUMOTO
Phyllopachyceras ezoense (YOKOYAMA)
Epigoniceras glabrum (JIMBO) var. *problematica* MATUMOTO (lower part)
E. popetense (YABE) em. *
Gaudryceras striatum (JIMBO) *
G. striatum var. *paucistriata* MATUMOTO
Polyptychoceras haradanum (YOKOYAMA) *
P. obstrictum (JIMBO) (lower part)
P. cfr. *jimboi* MATUMOTO (lower part)
Glyptoxoceras (?) *ryûgasense* MATUMOTO MS.
Pseudoxybeloceras sp.
Baculites sp.

(1) As the specimen was collected from the rolled pebble, it is difficult to determined. whether it is eerived from IIId or from IIIe. But the former case seems more probable.

(2) * Very common or abundant.

(3) A specimen found in a rolled block (concretion) of the upper valley of the Nio. Its origin is doubtful, being possibly IIId or IIIc.

Bostrychoceras paucicostatum MATUMOTO MS. *
Schlüteria diphylloida (FORBES) *
Damesites damesi (JIMBO)
Hauericeras gardeni (BAYLEY)
Eupachydiscus haradai (JIMBO) em. *
Canadoceras kossmati (YABE MS.)
C. multicostatum MATUMOTO MS.
Inoceramus ezoensis (YOKAYAMA)
I. orientalis (SOKOLOW)
I. pseudosulcatus (NAGAO & MATUMOTO) *
I. schmidti (MICHAEL) *
I. sachalinensis (SOKOLOW)
Patella (s. l.) *gigantea* (SCHMIDT)
"*Rhynchonella*" sp.

IV. Hakobuti Group (in part)

In the present district, only a portion of the Hakobuti Group is developed, its main part being denudated out by pre-Neogene erosion. The Miocene Wekkawenbets Group overlies the Hakobuti with an apparently parallel unconformity, as observed in the upper valley of the Gakko-zawa and in the lower valley of the Tanno-sawa. The former, furthermore, overlies the Upper Ammonite Group (formation IIIe) with a parallel unconformity in some other place (as exposed in the valley of the Osousyunai and along the Wakkawenbets). Accordingly, the group is much thinner than that in the Isikari coalfield and the Ryûgase Group in Karahuto, its maximum thickness being estimated only at 150 m or so.

The stratigraphic relation between the Upper Ammonite Group and the Hakobuti Group in the district is a conformity, although the depositional condition seems considerably different between the two. But gradual change of facies from the former to the latter is represented, for example, by an intercalation of glauconitic sandstone near the top of the formation IIIe.

So far as the material available in the present district is concerned, the group is made up mainly of the sandstones, usually massive and with only partial bedding, medium-or fine-grained, but in part coarse passing to granule-conglomerate, rarely with intercalation of thin shale. The sandstone is green, calcareous and glauconitic, containing grains of quart and feldspars. Hornblende,

biotite and ore mineral (marcasite ? or pyrite ?) are discernible, and the fragment of andesite is not rare.

The group is very poor in fossil-contents, only a fragment of *Canadoceras kossmati* (YABE MS.) has been collected. Microscopic organic remains also seem to be rare.

The exposures of the group in the present district are found at loc. T 558 and T 559 along the uppermost valley of the Gakko-zawa; T 570 and T 573——T 577 along the upper valley of the Tikabunnai, and T 476, T 477, and T 478a along the Tanno-sawa.

TABLE SHOWING LOCALITIES AND HORIZONS OF EXPOSURES
IN
THE ABESINAI DISTRICT
(北海道天塩國安平志内地方)

Locality-number	Horizon	Place-name
T1——T6	IIb	Lower valley of the Rubesibetu A left tributary of the Abesinai
T7	IIb (upper part)	
T8——T10	IId [β-facies]	
T11, T12	IIIa	(ルベシベツ澤) Middle valley of the Rubesibetu
T13——T15	IIIb	
T16, T17	IIId	
T21	IIa (upper part)	Small western tributary No. 1 of the Abesinai (安平志内林間歩道南側の小澤)
T22——T26	IIb	
T27, T28	IIb-c [β-facies]	
T29 (a-f)	IId [β-facies]	
T30——T32	IIa	Lower valley of the Gakkô-zawa (ガッコー澤下流)
T33, T34	IIb (lower part)	
T35——38, T38′	IIb (upper part)	
T39	IIc (α-facies)	Between the mouths of the 1st & 2nd tributaries of the Gakkô-zawa (ガッコー澤下流, 第一支流出口, 第二支流出口間)
T40——T45	IId (α-facies)	

T46——T50	IId (α-facies)	Lower course of the second tributary of the Gakkô-zawa (ガッコー澤第二支流下流)
T51, T52	IIc (α-facies)	
T53——T55	IIb	
T70——T74	IId [α-facies]	Railway cuttings along the main course of the Tesio, from Saku-Station to Kamizi Station (佐久驛, 神路驛間鐵道線路切割)
T75——T79	I (upper part)	
T80——T88	I	
T89——T92, T95	I	Railway cuttings along the main course of the Tesio, from Kamizi Station to Osasima Station (神路驛, をさしま驛間鐵道線路切割)
T93, T94, T96	Diabase.	
T97——T99	I	
T110——T128	Onisasi Group and Basic igneous rocks	The Onisasi (鬼刺川)
T130——T137	〃 〃	The Okaonai-zawa (岡穂内澤)
T138——T141	I (lower part)	
T200, T201	Tertiary	
T202——T204	IIIe (upper part)	Lower valley of the Osousyunai, a left tributary of the Abesinai (オソウシユナイ澤下流)
T205——T207	IIIe (lower part)	
T208——T212	IIId	
T213——T216	IIIc	
T217	IIIb	
T218	IIIc	Near the mouth of the Osousyunai, along the main course of the Abesinai (アベシナイ川本流沿ひ, オソウシユナイ澤出口附近)
T219, T220	IIIb	
T221——T223	IIIb	Road cuttings near Ômagari along the main valley of the Abesinai (大曲の北方アベシナイ川本流沿ひ道路切割)
T224	IIIa?	
T225——T234	IIb	Small eastern tributary No. 9 of the Abesinai (志文内峠の澤)
T235——T239	IIc [γ-facies]	Lower course of the Simarop-zawa, a tributary of the Abesinai (シマロツプ澤)
T240, T241	IId 1 [γ-facies]	Middle course
T243	IIIa	
T244——T250	IIIb	
T251——T259	IIIa	Upper course

Locality-number	Horizon	Place-name
T260——T262	IIIc	Near Sibunnai, along the main course of the Abesinai (志文内附近のアベシナイ川本流沿岸)
T263, T264	IIIb	
T265	IIIb	A small hill at Ômagari
T266——T268, T268′	IIIb	Near Ômagari, along the main course of the Abesinai (大曲附近のアベシナイ川本流河岸)
T269, T270, T271a	IIIb1	
T271b——T274	IIIb2	
T275\T276	IIIb2\IIIc	A little above the mouth of the Tannosawa, along the main course of the Abesinai
T277	IIId	Near the mouth of the Tannosawa, along the main course of the Abesinai (炭の澤出口附近のアベシナイ川本流河岸)
T278a, x, y, z, w,/b	IIIe/IIId	
T279	IIIb	Somewhat below the mouth of the Tannosawa, along the main course of the Abesinai (炭の澤出口より若干下流のアベシナイ川本流沿岸)
T280a/b	IIIe/IIId	
T281, T282′	IIIb	
T282, T282″	IIIb1	
T283/T284	IIIb2/b1	
T285	IIIa	
T301, T315	IIIb1 (lowest part)	Lower valley of the Wakkawenbetu, a tributary of the Abesinai (ワツカウエンベツ川下流々域)
T302——T306	IIIb	
T307——T310	IIId	
T311	IIId (uppermost part)?	
T312	IIIe	
T313a\b, T314	IIIe\Tertiary	
T316——T313	IIIa	
T319	IIIa	Near the mouth of the Sakai-no-sawa, along the main course of the Abesinai (界の澤出口附近のアベシナイ川本流河岸)
T320, T321	IIIb	
T322, T323	IIc [δ-facies]	
T324	IIb	A little below the mouth of the Wakkawenbetu, along the main course of the Abesinai
T325	IIIa	Near Sibunnai, along the main course of the Abesinai (志文内附近のアベシナイ川本流沿岸)
T326	IIIb	
T327	IIIb2*	
T328	IIIb1	

* possibly inclusive also of the lowest part of IIIc

T331, T332	IIc [γ-facies]	Lower valley of the Sibunnai, a tributary of the Abesinai (志文内川下流々域)
T333, T334	IId1 [γ-facies]	
T335a\b	IId2\d3 [γ-facies]	
T336, T337	IId2 [γ-facies]	
T338——T341	IId3 [γ-facies]	
T342——T347	IId2 [γ-facies]	
T348, T349	IId1 [γ-facies]	
T350, T351	IIc [γ-facies]	
T352, T353	IIa	
T354——T394	I	Upper valley of the Sibunnai (志文内川上流々域)
T400, T401	IIb	Small eastern tributary No. 8 of the Abesinai (アベシナイ川東側の短い支流 No. 8)
T402, T403	IIa	
T404	IIc [γ-facies]	
T405——T407	IId [γ-facies]	
T410\T411	IIb\IIc [γ-facies]	Small eastern tributary No. 7 of the Abesinai (アベシナイ川東側の短い支流 No. 7)
T412, T413	IId [γ-facies]	
T414	IIIb	
T430——T432	IIIa	Lower course (下流) of the Sakai-no-sawa, a tributary of the Abesinai (界の澤)
T433——T436	IIIb1	Middle course (中流)
T437, T438	IIIb2	Upper course (上流)
T439	IIId	
T440, T441	IIIb	
T442, T443	IIIc	A left branch of the Kurumi-zawa (胡桃澤中流の西支流)
T445——T447	IIIb	
T450\T451, T452	IIc\IId [δ-facies]	Near the mouth of the Kurumi-zawa, along the main course of the Abesinai (胡桃澤出口附近のアベシナイ川本流)
T453——T456	IId [δ-facies]	Lower course of the Kurumi-zawa, a tributary of the Abesinai (胡桃澤下流々域)
T457——T459	IIc [δ-facies]	
T460——T462	IId [δ-facies]	Simonôzyo, along the Abesinai (アベシナイ川本流々域下農場)

Locality-number	Horizon	Place-name
T470, T471	IIId (upper part)	Lower course of the Tanno-sawa, a tributary of the Abesinai (炭の澤下流沿ひ)
T472	IIId or IIIe (lowest part)	
T473——T475	IIIe (upper part)	
T476, T477, T478a	IV	
T478b——T485	Tertiary	Upper course (炭の澤上流)
T500——T504	IId [γ-facies]	Lower valley, Middle valley, Upper valley of the first tributary of the Sibunnai (志文内川第一支流々域)
T505——T508	IIb	
T509——T512	IIa	
T513——T519	I	
T520——T523	IIId	Upper valley of the Rubbesibetu, a left tributary of the Abesinai (ルベシベツ澤上流々域)
T524——T526	IIIe	
T527——T529	IV	
T540——T543	IId [α-facies]	Upper valley of the Gakko-zawa, a tributary of the Tesio near Saku. (ガッコー澤上流々域)
T544——T546	IIc [α-facies]	
T547——T550	IIb	
T551	IIIb2	
T552, T553	IIIb1	
T554\T555	IIIa\IIIb	
T556, T557	IIIc (?)	
T558, T559	IV	
T560	Tertiary	
T570	IV	Upper course—Middle course. of the Tikabunnai, a left tributary of the Abesinai (チカブンナイ澤)
T571, T572	IIIe	
T573——T577	IV	
T578——T581	IIIe	
T582	IIId	
T583——T585	IIIb	

T587	IIb (lower part)	
T588a/b, c	IIb/IIa	Along the main course of the Abesinai from the mouth of the Tikabunnai to that of the Rubesibetu （アベシナイ川本流沿ひ，チカブンナイ・ルベシベツ兩澤出口間の露出）
T589, T589′	IIa	
T590a/b, c	IIa/I	
T591	IIb (lowest part)	
T592, T593	IIIa	
T594, T595	IIIb	
T596	IIa (uppermost part)	
T601	IId [α-facies]	—Railway-cutting about 1 km north of Saku Station （佐久驛北方約1粁鐵道切割）
T602, T603	I (upper part)	Lower Valley of the Saku (or "Sakutan" （佐久川下流々域）
T604——T606	IIa	
T607——T609	IIb	
T610, T611	IIc [α-facies]	
T612——T615	IId [α-facies]	
T618, T619	IIc [α-facies]	
T620——T622	IIb (lower part)	Middle course of the Tirasinai （知良志內川中流沿ひの露出）
T623——T625	IIa	
T626——T642	I (upper part)	—Upper course of the Tirasinai （知良志內川上流沿ひの露出）
T651, T652	IIb (upper part)	Middle course of the Tirasinai （知良志內川中流沿ひの露出）
T653	IIb-c [β-facies]	
T654	IIc (lowest p.) [β-facies]	
T655a\b	IIb-c(2)\c [β-facies]	
T656	IIc [β-facies]	
T657——T661	IId [β-facies]	
T662	IIc (?) [β-facies]	
T663, T664	IId [β-facies]	
T666a-e\f-h	IIIa\IIIb	Lower valley of the Tirasinai （知良志內川下流々域）
T667——T674	IId	
T675——T678	IId [α-facies]	At Tirasinai, along the main course of the Tesio （知良志內西部の天鹽川本流南岸）
T679, T680	IId [α-facies]	Lowest course of the Abesinai （アベシナイ川最下流知良志內橋附近）

Locality-number	Horizon	Place-name
T682a, b	IIa	Small eastern tributary No. 1 of the Abesinai (アベシナイ川東側の短い支流 No. 1)
T682c-h	IIIb	
T682h′-m	IIIc	
T683	IIa	Lower course of the Abesinai (アベシナイ川下流)
T684a-d	IIIb	Small eastern tributary No. 2 of the Abesinai (アベシナイ川東側の短い支流 No. 2)
T684e-g	IIIc	
T699	IId [α-facies]	At Saku-bridge along the Tesio (天鹽川本流河岸)
T700	IIb & IIc	At Nio (仁尾) along the Tesio (天鹽川本流河岸)
T701; T750–T754	Tertiary (Oiwake Series)	Lower valley of the Nio (仁尾川下流々域)
T702——T704	IIIa	
T705, T706	IIa (uppermost p.)	
T707——T709	IIb (lower part)	
T710, T711	IIb (upper part)	
T712——T715	IIc [α-facies]	Middle course of the Nio (仁尾川中流沿ひの露出)
T716——T723	IId [α-facies]	
T724——T737	IIIc	Upper course of the Nio (仁尾川上流沿ひの露出)
T738——T740	IIId	
T800——T802	IId (lower p.) [α-facies]	Small tributary No. 1 of the Tesio near Tirasinai (知良志内東部の小い澤 No. 1)
T803, T804	IIc [α-facies]	
T805——T809	IIb	
T810	IId [α-facies]	
T811——T815	IId [α-facies]	Saku-Sakin-zawa (佐久砂金澤)
T816——T818	IIc [α-facies]	
T819——T823	IIb	
T825, T826	IIa (uppermost part)	Small tributary No. 2 of the Tesio, near Tirasinai (知良志内東部の小い澤 No. 2)
T827——T831	IIb (lowest part)	

T832——T836	IIa	
T837	I	
T840——T843	IIb-c (1) [β-facies]	A tributary of the middle course of the Tirasinai (知良志内川中流支流)
T844——T846	IIb-c (2) [β-facies]	
T847——T850a	IIc [β-facies]	
T850b——T854	IId [β-facies]	
T860a, b/c-g, x	IIa/I	
T861a\b-e	IIa\IIb (lower part)	Nenar Itinohasi (a bridge), along the main course of the Abesinai (アベシナイ川本流一の橋附近の河岸)
T862	IIb (lower part)	
T863	IIa (uppermost part)	
T865, T866	IIIa	
T867a-c\d	IId\IIc [γ-facies]	Upper valley of the Simarop, a right tributary of the Abesinai (シマロップ澤上流々域)
T868——T872	IIb	
T873, T874	IIIa	
T875——T877	IId [β-facies]	
T880——T882	IIb	A branch of the first tributary of the Sibunnai (志文内川第一支流の支流)
T883——T885	IIa	
T886	I	
T890——T892	IId1 [γ-facies]	Three small branches of the lower valley of the Sibunnai (志文内川下流の小支流中の露出)
T893, T894	IId1 [γ-facies]	
T895——T897	IId3 [γ-facies]	
T900——T905a	IIIb	Upper valley of the Kurumi-zawa (胡桃澤上流々域)
T905b——T909	IIIc	
T910	IIId (?)	
T911	IIIb	The eastern branch of the Kurumi-zawa (胡桃澤東支流)
T912, T913	IIc [δ-facies]	
T914——T918	IId [δ-facies]	

Locality-number	Horizon	Place-name
T940	IIIc	Three small branches of the Osousyunai, a tributary of the Abesinai （オソウシユナイ澤下流の小支流中の露出）
T941	IIIb	
T942	IIId	
T943——T945	IIIe (lower half)	
T946——T949	IIIe (upper half)	
T950	Tertiary	
T951	IIIa	Small western tributary No. 2 of the Abesinai （アベシナイ川西側の短い支流 No. 2, 一名高木の澤）
T952——T956	IIIb	
T957	IIIc	
T958——T961	IIId & IIIe	
T966——T972	IId	Small eastern tributary No. 5 of the Abesinai （アベシナイ川東側の短い支流 No. 5）
T973——T975	IIIa	

Map showing localities of exposures and the attitude of strata in the Abesinai District, Tesio Province, Hokkaidô

北海道天塩國安平志内地方踏査略圖

Compiled from the Route Maps drawn to the scale of 1:10,000
All the loc. numbers in this map are to have prefix T.
(Date of survey — 1938)

Nio 仁尾
The Nio-zawa 仁尾澤
The Saku-gawa 佐久川
Saku 佐久
The Gakko-zawa 學校澤
The Sakin-zawa 砂金澤
The Tesio 天鹽川
The Rubesibetu ルベシベツ澤
Tirasinai 知良志内
No. 1
No. 2
No. 3
The Tirasinai 知良志内川
The Tikabunnai チカブンナイ沢
No. 5
The Abesinai 安平志内川
No. 7
No. 8
No. 9
The Tarino-sawa 炭ノ澤
Ômagari 大曲
一ノ橋
二ノ橋
三ノ橋
Sibunnai 志文内
The Simarop シマロップ澤
The First Tributary 志文内川第一支流
The Sibunnai 志文内川
The Osousyunai オソウシュナイ澤
The Wakkawenbetu ワッカウェンベツ川
The Sakaino-sawa 界ノ澤
The Kurumi-zawa 胡桃澤

N

0 1 2 3 4 km

General attitude of strata

- ≒ 0°
- ≥ 5° < 10°
- ≥ 10° ≤ 20°
- ≥ 20° < 35°
- ≥ 35° < 50°
- ≥ 50° < 65°
- ≥ 65° < 85°
- > 85°

Geological Map of the Siyubari District, Isikari Province, Hokkaidô

北海道石狩國主夕張地方地質圖

1000m 0 1 2 3 4 Km

N

IIk	Middle Ammonite Group (Main part)	
IIj		
IIi		
IIh		
IIg		
IIf		
IIe		
IId		
IIc		
IIb_2		
IIb_1		
IIa		
If	Lower Ammonite Group	
Ie		
Id		
Ic		
Ib		
Ia		
Oz	Onisasi Group	
Oy		
Ox		
Ow		
Ov		
Ou		
Ot		

Metamorphic Group

Abbr. Terrace gravels

Diabase

IIId	Upper Ammonite Group	
IIIc		
IIIb		
IIIa		
IIs	Middle Ammonite Group (Saku Formation)	
IIr		
IIq		
IIp		
IIn		
IIm		

The Hinata-zawa, The Kitano-sawa, The Siyubari, The Tengu-zawa, The Hikage-zawa, The Masago-zawa, Mt. Tengu-dake, A, B, C

General attitude of strata

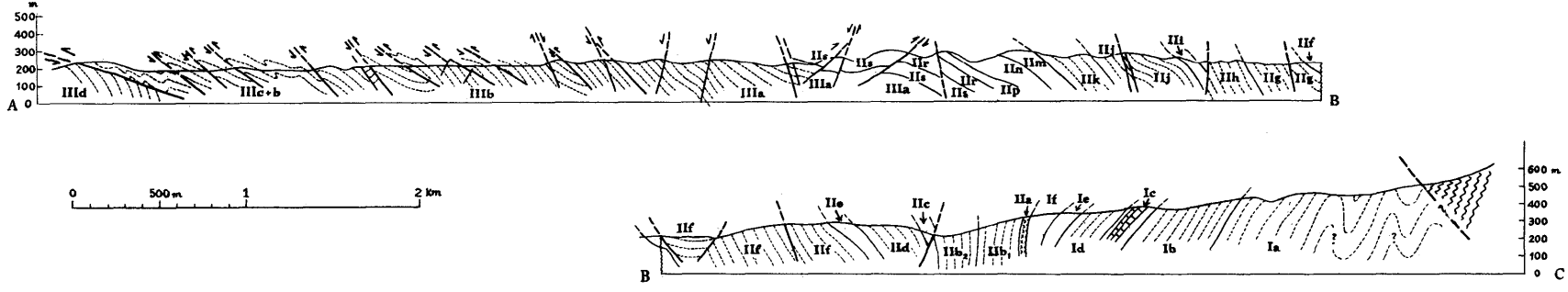
- < 10°
- > 10° ≦ 20°
- > 20° < 35°
- ≧ 35° < 50°
- ≧ 50° < 65°
- ≧ 65° < 85°
- ≧ 85°

Faults or Thrusts

- Low-angled
- Medium-angled
- High-angled
- Vertical
- Presumed

Geological Profile of the Siyubari District, Isikari Province, Hokkaidô

北海道石狩國主夕張地方地質斷面圖



Chapter III

Cretaceous Deposits in the so-called Isikari Coal-field, Central Hokkaidô, with special reference to the Siyubari District and the Hetonai District

Introductory statement

A good display of Cretaceous rocks is found in the so-called Isikari Coalfield or on the western side of the Yûbari Mountain-range, occupying southeastern part of Isikari province and eastern part of Iburi province. The area is cut by many valleys of the tributaries of the Isikari[1], such as the Asibetu[2], the Ikusyunbetu (Ikushunbets)[3], the Yûbari (Yûparo)[4], etc. and the valleyes of the Mu-kawa[5] and its tributary Hobetu (Popets)[6]. It has been visited by many geologists, and YABE'S scheme of stratigraphical division is based mainly on the observation of the area[7]. Recently many geologists, especially members of Hakkaidô Imperial University, engaged in the geological survey[8].

Thanks to the cordial kindness of members of Geological and Mineralogical Department, Faculty of Science, Hokkaidô Imperial University, I have had opportunities of reading the manuscripts and of receiving personal communications. And Mr. ÔTATUME guided me in the field and earnestly discussed on the subject with me. Based on these previous knowledges, I visted a few areas where they are left much to be desired as to certain important problems.

As was clarified already, the area has a complicated geological structure comprising "nappe de recouvrement". And the difference of rock facies or of stratigraphic sequence which is to be found along lateral directions is put in disorder from the original arrangement. Thus the exotic part must be discriminated from the autochthonous one. The Cretaceous strata exposed along the Ikusyunbetu Valley are those which represent the condition of

(1) 石狩川 (2) 蕗別川 (3) 幾春別川 (4) 夕張川 (5) 穂別川 (6) 鵡川

(7) H. YABE 1926, 1927

(8) W. HASHIMOTO 1936, H. IMAI 1924, 1926, T. NAGAO 1931e, 1934, T. NAGAO, K. ÔTATUME, & R. SAITO 1933, T. NAGAO, R. SAITO & T. MATUMOTO 1938, K. ÔTATUME 1932 MS, 1933 MS, 1940, R. SAITO 1932 MS, 1933 MS, E. TAKAHASI 1937 MS, K. UWATOKO & K. ÔTATUME 1933

sedimentation in comparatively western part of the depostional area. To this type may belong the Cretaceous rocks near the town of Yûbari[1] along the valley of Ponhorokabetu[2] and probably those of the Obirasibe (or Opirashipets) district far in Tesio province. These areas have been precisely investigated and little is to be added to the previous knowledge. On the other hand, the strata distributed meridionally on the western side of the Yûbari Range and exposed along the upper valley of the Asibetu, the Si-yubari (Shiyuparo), and the valley of Hobetu are those which represent the condition eastward from the preceding. In this zone I had selected the Si-yubari district (or the upper course district of the Si-yubari) as a typical locality, and surveyed through the area in detail. But the accurate knowledge concerning the stratigraphy of the uppermost Cretaceous is to be sought in other localities, such as the Hetonai district[3] along the Mukawa, the valley of Noborikawa[4] and the gorge of the Yûbari. Based on the previous investigation I visited the localities, and performed deeply a biostratigaphic survey in the first named district.

In the following, I will begin with the description of what I observed in the Si-yubari district and then in the Hetonai district.

A. Succession of Rocks and Sequence of Fossils in the Si-yubari District, central Hokkaidô.

(Pl. XIII, XIV, XV)

Location of the area
Physical and geological conditions in general
A sketch of geologic structure
Description of stratigraphy
- Onisasi Group
- Lower Ammonite Group
- Middle Ammonite Group
- Upper Ammonite Group

Table showing localities and horizons of exposures

LOCATION OF THE AREA

The area which I surveyed is the upper course district of the Si-yubari[5] i.e. the upper and main course of the Yupari. It is

(1) 夕張町 (2) ポンホロカベツ川 (3) 邊富内地方 (4) 登川 (5) 主夕張川

situated at the northeastern portion of Yûbari-gun, province of Isikari[1] and is separated about 20 km northeast ward from the town of Yûbari, a center of the Yûbari colliery. The area is small, maximum dimension being 10 km from north to south, and 13 km from east to west, while minimum dimesion being meridionally less than 5 km and equatorially 5 km. It is a portion of the Yûbari-dake Imperial Forest, occupying the main part of Section Si-yubari[2]. Accordingly the surveyed area is conventionally called here the Si-yubari district.

PHYSICAL AND GEOLOGICAL CONDITIONS IN GENERAL

The upper course district of the Yûbari is topographically divisible in four belts of approximately meridional trend. They are (1) the area of the backbone, (2) the intermontane hills, (3) the consequent valley of the Si-Yûbari, and (4) the western mountain-land. Though the second area is much lower than the first and generally lower than the fourth, its central subzone, as represented by Mt. Ikusyunbetu-dake, has considerable altitudes.

Geologic conditions correspond approximately to the topography. The area of backbone consists of hard rocks. Its northern half is occupied by the Onisasi Group of Jurassic or Jurasso-Cretaceous age and forms the source region of the Siyubari with a grand gorge. Its southern half is the metamophic rocks mainly composed of siliceous phyllites and green rocks. The transitional zone between the backbone and the intermontain hills is the distributional area of the Lower Ammonite Group made up of alternations of sandstone and shale and stratified sandstones. In the intermontain zone and the consequent valley of the Si-yubari, distributed widely shales or mudstones of the Middle Ammonite Group and the Upper Ammonite Group. The uppermost formation of the Middle Ammonite Group is sandy shales with intercalated sandstones, and occupies the middle sub-belt of higher altitudes in the intermontain belt. In the western mountainland we find sandstones, sandy shales and conglomerates of the Hakobuti Group of the uppermost Cretaceous age. Associated with it, there are the formations of Palaeogene Tertiary and the detached patches of the Upper Ammonite Group.

The drainage system of the Si-yubari district follows the par-

(1) 石狩國夕張郡の北東隅　(2) 夕張嶽御料林主夕張區

allel of the geologic structure. Most of the valleys can be classified into two categories: One is approximately parallel to the trend of strata, the other is perpendicular to it. To the former system belong the uppermost course of the Si-yubari, the same river between the mouth of the Hinatazawa and that of Hikagezawa (lower part of the upper course of the Si-yubari), the Hinata-zawa(1), and the middle course of the Hikage-zawa(2). The examples of the latter are the middle part of the upper course of the Si-yubari and the middle course of the same river (between the mouth of the Hikage-zawa and that of the Masago-zawa(3), the lower and the upper courses of the Hikage-zawa, the Tengu-zawa(4) and the Kitano-sawa(5). Along these valleys good exposures of Cretaceous rock are displayed, and the condition is favourable for the survey of stratigraphy.

Along the course of the present rivers, we find terraces with a height of 10 m to 50 m, and terrace gravels upon them. At certain localites in the mountain area of about 500 m altitude, there is another deposit of gravel. The area of backbone is covered with thick talus deposits or fanglomerates containing huge boulders.

A SKETCH OF GEOLOGIC STRUCTURE

Before entering into the description of stratigraphy, I will give a brief account on the geologic structure of the surveyed area, for the ignorance of structure often lead the erronous observation of stratigraphy.

The southern part of the area of back-bone made up of metamorphic rocks and green rocks is presumed to have a complicated structure. But the absence of exposure prevents us from the observation of its detailed feature. The relation between this metamorphic rocks and the Mesozoic strata is also actually unknown, though the accustomed presumption that the former is thrusted up on the latter seems probable.(6)

The Mesozoic strata, occupying the main part of the area, have the general trend of NNE or N–S, and show the approximate order of arrangement that the eastern rock is older than the western.

(1) 日向澤 (2) 日蔭澤中流 (3) 眞砂澤 (4) 天狗澤 (5) 北の澤

(6) The sedimenlary rocks near the presumed thrust are much disturbed and show minor folding and thrusting.

High angled faults of NW or NNW trend and of NEE trend afford local displacements.

In the eastern part, the beds are vertical or incline very steeply. Going westward we find the gradual change of dip with eastward inclination. Thus the reverse succession of strata is the general condition in the area. But frequent occurrence of minor fault results in the omission or repetition of strata in a small scale. Dip is at first 60° or 50°, then westard from the belt comprising lower courses of the Hinata-zawa, Tengu-zawa and of the Hikage-zawa, it is 40° or 30°, and low angle of 10° or 20° is found further westward. Thus the overturning of strata is remarkable. In this western part, as observed along the middle course of the Si-yubari (between the mouth of the Masago-zawa and that of the Hikage-zawa), a number of disturbed zones are distributed, at an approximately similar distance. The zone is a minor thrust or a minor overturned fold of assymmetric shape with general easterly inclination. Owing to this minor structure, a fossil zone (i.e. the zone of *Inoceramus uwajimensis* occurs repeatedly.

A little below the mouth of the Masago-zawa, in the main valley of the Si-yubari, exposed a low angled thrust of somewhat major scale cutting the mudstones of Upper Ammonite Group. This is subparallel to the large thrust plane of "Isikari Nappe" exposed further westward.

DESCRIPTION OF STRATIGRAPHY

The Mesozoic rocks developed in the upper course district of the Yûbari is divisible in the following groups in ascending order:

O.	Onisasi Group	(鬼刺層群)
I.	Lower Ammonite Group	(下部菊石層群)
II.	Middle Ammonite Group	(中部菊石層群)
III.	Upper Ammonite Group	(上部菊石層群)
IV.	Hakobuti Group	(函淵層群)

Attempting to study on the Lower and Middle Cretaceous stratigraphy, I confined my survey to the Si-yubari district where the first three groups and lower part of the fourth group are developed. The Hakobuti Group and a part of the Upper Ammonite Group are distributed westward from the thrustline mentioned just

above, outside of the district. The former has been investigated accurately by previous investigators. And owing to the complicated structure the main part of the Upper Ammonite Group of the area is not adequate for an exact biostratigraphic study. From these reasons, I will omit here the description of them.

O. Onisasi Group

General remarks.——The observed lowest part of the Mesozoic sedimentary rocks of the district is a group of formations characterized by siliceous shale, chert, greywacke and pyroclastic rock. It is distributed in the source area of the Si-yubari, and is clearly the prolongation of what W. HASHIMOTO[1] called the *Naegawa Chert*. From stratigraphic position and from lithologic character, the group is certainly a continuation of the Onisasi Group found in the middle valley of the Tesio, though the intermediate part is not exposed owing to later modifications. The lower limit of the group is not observable in the field, whereas the upper limit is a conformable relation to the superjacent Lower Ammonites Group. The thickness of the exposed part is more than 1200 m.

Stratigraphic sequence and rock-facies.—So far as the observed part in the Si-yubari district is concerned, the Onisasi Group is composed of the conformable series of the following formations and members in ascending order.

Underlying (?) A formation of schalstein, which can be considered as belonging to the Onisasi Group or as a different group of older age. The criterion to determine the two alternatives should be sought in some other district.

——————Exact relation unknown——————

Formation Ot. Hard sandstones, dark grey or light coloured but often with a dirty tint[2], coarse to fine, consisting of badly sorted minerals and rock-fragments of acidic igneous rock. Siliceous shale is found in subordinate amount. Thickness: 200 m or more. Typical exposures: loc. Y 314——Y 317.

Member Ou.. Altered vitric tuff, fragile and soften when weathered, green or red in colour apparently resembling schalstein. Diabasic tuff breccia is found in some part. Thickness: 35 m or so. Typical exposures: loc. Y 310——Y 313.

(1) W. HASHIMOTO, 1936

(2) This dirty whitish material (the so-called Torihun (鳥糞)) may not be original, accordingly can be found on other rock of different formation.

Formation Ov. Purplish red chert, often banded with green or grey chert and accompanied with greywacke sandstone. Thickness: 200 m. Typical exposures: loc. Y 308 and Y 309.

Formation Ow. Dark green greywacke, othen coarse grained and sometimes conglomeratic, massive or stratified, sometimes with intercalated siliceous shales. The sandstone is almost monogenetic, and made up of minerals and rock-fragments of augite andesitė, quartz grain being very rare. Although the fragments of glass and pumice are discernible, there is no positive evidence of their primary origin. And the rock is to be called andesitic greywacke instead of tufaceous sandstone. Thickness: about 100 m. Typical exposure is at loc. Y 307.

Formation Ox. Greenish or whitish chert, calcareous chert and siliceous fine sandstone, intercalating a few layers of dark green greywacke (andesitic) sandstone; generally thin platy stratification is developed; Thickness 230 m. Exposed at loc. Y 304——Y 306, forming a grand gorge.

Formation Oy. Dark green greywacke derived from andesites; sometimes conglomeratic and contains subangular pebbles or or granules of the chert; heavy bedded in some place and thinly interstratified with siliceous shale or chert in other place. Oolitic sandy limestone with coarse grains of andesite is contained in the formation; 70 m thick; typically exposed at loc. Y 303.

Formation Oz. Mainly black shale, and the associated siliceous shale, chert and siliceous fine sandstone; thinly stratified. Thickness about 350 m. Typical exposures are loc. Y 296——Y 302, Y 355——Y 360.

Although these formations are a conformable series, contemporaneous erosion seems to be open, for chert with radiolarian remains are found as subangular pebbles in the intraformational conglomerate of greywacke formation, and the bedding plane of the sandstone at the base of formation Ow is somewhat uneven.

Chert and siliceous shale of each formation contain remains of radiolaria in large or small amount. But megascopic fossil has not yet been found in the group, except for the organic limestone detected by HASHIMOTO (1936) in rolled blocks derived from the distributional area of his Naegawa Chert.

I. Lower Ammonite Group

General remarks.——The Onisasi Group is followed by a group of formations consisting mainly of alternations of shales and sandstonas, This is a section of the Lower Ammonite Group in the revised sense. Sandstone predominates in the lower part. A member of limestone is intercalated in the middle part. The group is exposed along the upper course of the Si-yubari, that of the Tengu-zawa and the source of the Hikage-zawa and its tributaries. The lower limit of the group in the district is observed as conformable to the Onisasi Group with a gradual change of lithic character. The top is overlain by the basal sandstone of the Middle Ammonite Group. So far as the present area is concerned, the group is 1300 m thick and has the succession of strata described just below.

Stratigraphic sequence and rock facies.—In ascending order the following formations and member are recognized.

Formation Ia. Thin bedded[1] fine-sandstones, frequently interstratified with thin shale, often laminated and containing flakes and fragments of plant remains. The sandstone is comparatively well-sorted, bluish or greenish grey, composed of grains of quartz, feldspars (with anorthoclase), hornstone and a small amount of fragment of andesite. Thichness, a little less than 500 m. Typical exposures, loc. Y 288——Y 295 Y 352——Y 354 along the upper course of the Si-yubari, Y 586——Y 592 along the uppermost Tengu-zawa, Y 678——Y 683 along the uppermost Hikageno-sawa, etc.

The northern continuation of this formation is exposed in Hurano district and called by HASHIMOTO the **Tomitoi Sandstone.** It passes gradually upward to the succeeding formations of the Lower Ammonites Group and has much similarity in lithologic characters to the latter. Consequently the formation is better to be grouped in the Lower Ammonite Group together with other formations.

Formation Ib. Thin alternations of black shale and very fine sandstone, sometimes shale is predominant. Each stratum is usually 5 to 10 cm thick. Although lenticular concretions of marl are contained, the formation is barren of fossil. The concretion

[1] Thickness of each stralum is 5 to 20 cm, and rather rarely 1 m or so.

shows sometimes a banded structure. Thickness, 350 to 380 m. Typical exposures, Y 281 —— Y 287 along the upper course of the Si-yubari, Y 581 —— Y 585 and Y 558 —— Y 560 along the upper courses of the Tengu-zawa.

Formation Ic. In the middle part of the Lower Ammonite Group, member of organic limestone occurs and the rocks adjacent to the limestone are somewhat different from the other part in their absence of frequent stratification. This part including limestone is here treated as formation Ic. It is nearly 100 m thick. Detailed succession of rock observed along the cliff of the Si-yubari (loc. Y 276 —— Y 279) is as follows.

Sandstones gradually passing upward to silty very fine sandstone and then sandy shale, massive, contains minute flakes of carbonaceous matter.

Calcareous sandstone and limestone, upper part is rich in organic remains.

Sandstone, and sandy shale, massive.

Limestone rich in organic remains, such as *Oribitolina*, corals, bryozoa, bivalves, *Nerinea*, and calcareous algae; 30 m or so thick.

Fine sandstone gradually passing upward to mudstone, massive, somewhat calcareous.

The limestone member markedly continues and does not thin out in the present district. It crops out at loc. Y 557 of the Tengu-zawa, Y 186 and Y 725 of the Hatizyu-happan-zawa[1], a tributary of the Hikage-zawa.

Formation Id. Very thin alternations of shale, sandy shale and fine sandstone; sandstone-bed of medium thickness is rarely intercalated; poor in fossil, but molluscan remain occurs rarely; 150 m thick. Typical exposures Y 579 and Y 554 of the Tengu-zawa.

Member Ie. Alternations of sandstone and shale. Sandstone is more predominant and bed of medium thickness (1 m —— 2.5 m) is not rare. It is greenish grey, fine-or medium-grained, and consists of quartz feldspars and grains of volcanic rocks. The intercalated shale is black and sometimes somewhat coaly. The member is only 60 m thick and its lithologic character resembles that of the subjacent group of strata. Accordingly it can be included within the Formation Id.

Typical exposures are loc. Y 273 and Y 274 along the Si-yubari, Y 551 —— Y 553, and Y 578 along the Tengu-zawa, etc.

[1] 八十八班澤

Formation If. Concretionary siltstones or shales with few cephalopod species, in part fine-sandy; 120 m thick; typically exposed at loc. Y 271 and Y 272 along the Si-yubari, Y 575——Y 577 along the Tengu-zawa, Y 631 and Y 632 of the first tributary of the Hikage-zawa Y 673 of the upper course of the Hikage-zawa, Y 718——Y 720 of the Hatizyu-happan-zawa.

The rock-facies of the present formation resembles that of the Middle Ammonite Group rather than that of the Lower Ammonite Group. But from the reason of stratigraphic relation its position is better fixed at the top of the latter.

Occurrence of fossils.——The Lower Ammonite Group is poor in organic remains, except for the organic limestone of its middle part (formation Ic.). I have found *Lima* (*Limatula*) sp. from the formation Id, *Nautilus* (*Cymatoceras*) cfr. *virgatus* SPENGLER, *Tetragonites* cfr. *timotheanus* (MAYOR), *Baculites* sp. and *Propeamusium cowperi* WARING from the formation If. But other formations have not yielded determinable fossils. The limestone contains abundant *Orbitolina discoidea-conoidea* var. *ezoensis* YABE & HANZAWA, corals and calcareous algae. *Ostrea* sp. and *Nerinea* of narrow, extremely high, turreted form are not rare, although the pachyodont pelecypods, *Praecaprotina yaegashii* (YEHARA) and *Toucasia carinata* var. *orientalis* NAGAO, which are the important member of the corresponding limestone in Sorati-gun of the same province, have not yet been found in my collection.

II. Middle Ammonite Group

General remarks.——The group is a thick series of comparatively homogeneous mudstones and sandy siltstones containing concretions of marl and fossils of ammonite, *Inoceramus*, *etcetera*. Sometimes thin layers of fine-sandstone are interfingered with the shales in subordinate amount. At places thin beds of bentonitic white tuff are found. In the upper part sandstones become predominant, alternating with sandy siltstones and shales. This part should be separated from the main part of the Middle Ammonites Group as a formation (Saku Formation), although it is to belong to the group in a broad sense. This formation again passes gradually upward to the mudstones of the Upper Ammonite Group. The base of the Middle Ammonite Group is a layer of coarse sandstone with granules of shale and marl. The sandstone becomes

locally a conglomerate which contains fragments and larger blocks of shale, marl and limestone[1]. These three rocks which quite resemble those of the underlying formations, may be a reworked material. The stratification of the base is parallel to the subjacent strata, but minor irregularity is discernible (cf. Fig. 4). Similar

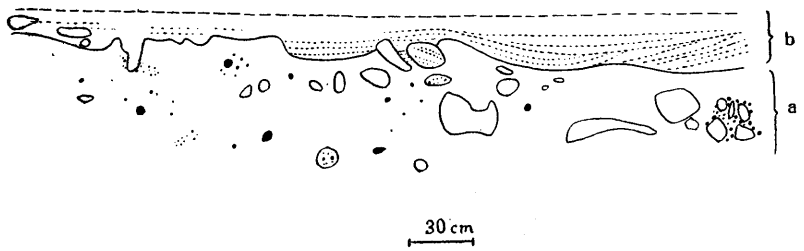


Fig. 4 A sedimentational feature found in the basal member. (II a) of the Middle Ammonite Group. (Loc. Y 270 along the Siyūbari). a: Dark coloured silty fine sandstone containing boulders and cobbles of marl (white in the figure) and calcueous coarse sandstone (dotted) and rounded pebbles and granules of chert (black). b: Sandstone, cross-laminated. Irregular sedimentary plane between a and b is noteworthy.

conglomerate was reported by HASHIMOTO (1936) in the Hurano district adjacent to the north of the present district. From these circumstances I have regarded this member of sandstone as a base of the Middle Ammonite Group, notwithstanding the similarity in lithic character between the superjacent and subjacent parts. The whole thickness of the group including the Saku Formation is estimated 1900 m in the present district. The group is distributed widely in the main part of the investigated area.

Basal member IIa. ——This is the basal coarse sandstone and the succeeding siliceous fine sandstone or siliceous sandy shale. Thickness 50 m, but diminishes to 20 m in the southern area. The basal sandstone is green and greenish grey, very micaceous containing abundantly grains and granules of shale. Grains of quartz, feldspars, and biotite of brownish colour. and fragments of chert or hornstone, andesite, and silicified rock are discernible, while the matrix is a chloritic matter. As was mentioned just above, the sandstone is locally conglomeratic, containing large or small blocks

[1] *Orbitolina*-bearing limestone is found.

of marl, shale and limestone besides the well rounded pebbles of chert and hornstone. The siliceous fine sandstone or sandy shale is usually thin banded, whitish (light greenish greyish), very compact, and made up of angular grains of quartz, plagioclase, biotite, glass and silica with very weak index of refraction, and some opacque mineral. The rock is considered originally tufaceous.

This member is well traced as a key bed, being exposed at loc. Y 269, Y 270 (the Si-yubari), Y 549 and Y 574 (the second water-fall of the Tengu-zawa), Y 630 (the first tributary of the Hikage-zawa), Y 184 (the Hatizyu-happan-zawa), and Y 672 (the Hikage-zawa).

Main part of the group, its subdivision.—The min part of the Middle Ammonite Group, nearly 2400 m thick, is chiefly composed of concretionary shales or mudstones of dark colour resembling those of the Upper Ammonite Group. It is also fossiliferous, although the preservation of fossil is not always good.

Examining carefully the details of lithological characters such as minor difference of fineness of sediments and frequency of the intercalation of thin sandstone-layers, we can distinguish the following sequence of strata in ascending order. The unit of the subdivision may be a formation or a member.

IIb. Shales, with marly concretions and few species of ammonite and *Inoceramus;* a little less than 500 m thick. It is divisible into two parts, lower and upper:

IIb$_1$. Shales, characterized by the predominance of dark coloured sandy siltstone, as exposed at loc. Y 265, Y 266 (the Si-yubari), Y 543 —— Y 547 (the Tengu-zawa), Y 628, Y 629 (the first tributary of the Hikage-zawa), Y 182, Y 183, Y714 —— Y 717 (the Hatizyu-happan-zawa), and Y 669 —— Y 671 (the Hikage-zawa).

IIb$_2$. Bluish grey mudstone, without sandy shale, as exposed at loc. Y 263, Y 264 (the Si-yubari), Y 540 —— Y 542 (the Tengu-zawa), Y 625 —— Y 627 (the first tributary of the Hikage-zawa), Y 179 —— Y 181, Y 710 —— 713 (Hatizyu-happan-zawa), and Y 666b —— Y 668 (the Hikage-zawa).

IIc. Shales with frequent intercalation of thin (10–20 cm) or very thin layers of fine sandstone. Sometimes ripple marks are discernible on the bedding plane of the sandstone. Nodules and lenticular thin layers of marl are included, and sometimes fos-

siliferous, 80 m thick. Exposures are loc. Y 261b, Y 262 (the Si-yubari), Y 536b, Y 537, Y 538, Y 539a (the Tengu-zawa, Y 178 (the Hatizyu-happan-zawa), etc.

IId. Dark grey shales (homogeneous mudstones), concretionary and fossiliferous. 400 m. Typical exposures, loc. Y 258b—— Y 216a (the Si-yubari), Y 534—— Y 536a (the Tengu-zawa), Y 617 —— Y 623 (the first tributary of the Hikage-zawa), Y 176, Y 177 (the Hatizyu-happan-zawa), Y 662—— Y 666a (the Hikage-zawa).

IIe. Black sandy shales, and shale with frequent intercalation of very thin layers of fine sandstone, concretionary and sometimes fossiliferous; 50 m thick; exposed at loc. Y 256—— Y 258a (the (Si-yubari), Y 553 (the Tengu-zawa), Y 615, Y 616 (the first tributary of the Hikage-zawa), Y 175, Y 176 (the Hatizyu-happan-zawa), and Y 655, Y 660, Y 661 (the Hikage-zawa).

IIf. Dark grey shales (homogeneous mudstones), concretionary and fossiliferous. 450 m. Typical exposures, loc. Y 246——Y 255 (the Si-yubari), Y 529—— Y 532 (the Tengu-zawa), Y 156—— Y 169, Y 650—— Y 658 (the middle valley of the Hikage-zawa), Y 170—— Y 174 (the Hatizyu-happan-zawa), and Y 600—— Y 614 (the first tributary of the Hikage-zawa).

IIg. Dark grey shales with frequently intercalating very thin layers of fine-sandstone, concretionary and fossiliferous. Intercalation of sandstone is rather sparse in the southern part. A bed of medium sandstone is found at a horizon. Thickness: 250 m. Typical exposures, loc. Y 242—— Y 245 (the Si-yubari), Y 523—— Y 527 (the Tengu-zawa), Y 152—— Y 154 (the Hikage-zawa). (cf. Pl. XX, Fig. 6.)

IIh. Dark grey shales (homogeneous mudstones), with sparse intercalation of thin sandstone; concretionary and fossiliferous; 250 m thick; exposed at loc. Y 239—— 241 (the Si-yubari), Y 434 (the Kitano-sawa), Y 518—— Y 522 (the Tengu-zawa), and Y 150a, b, Y 151 (the Hikage-zawa).

IIi. Shales frequently interstratified with thin layers of fine-sandstone, poorly fossiliferous; 70 m to 50 m thick, being thicker in the northern exposures. Typical outcrops, loc. Y 431—— Y 433 (the Kitano-sawa), Y 236—— Y 238 (the Si-yubari), Y 516, Y 517 (the Tengu-zawa), and Y 148, Y 150c (the Hikage-zawa).

IIj. Dark grey shales, mainly composed of homogeneous mudstones with only partial intercalation of thin layers of fine-sandstone, concretionary and fossiliferous. Thickness is 150 m (along the valley of the Kitano-sawa) to 250 m (along the valley of the Hikage-zawa). Exposures: loc. Y 429, Y 430 (the Kitano-sawa), Y 234, Y 235 (the Si-yubari), Y 512b —— Y 515 (the Tengu-sawa), and Y 143b —— f, Y 144 —— Y 146a, Y 149 (the Hikage-zawa).

IIk. Shales with more or less frequent intercalation of thin layers of fine-sandstone, concretionary and fossiliferous. Thickness varies from 200 m (in the northern part) to 120 m (in the southern). Exposures: loc. Y 433 —— Y 428 (the Hinata-zawa and the Kitano-sawa), Y 231b, Y 232, Y 233 (the Si-yubari), Y 509 —— 512a (the Tengu-zawa), and Y 141 —— 143a (the Hikage-zawa).

In this formation the amount of the sandstone is less than that of the shale, but it passes gradually upward to the part where sandstone and shale are almost the same proportion. This part is a transition from the main part of the Middle Ammonite Group to the Saku Formation, although conventionally included at the base of the latter.

Fossils of the main part of the Middle Ammonite Group. —— Although the main part of the Middle Ammonite Group is not richly fossiliferous, remains of marine molluscs are yielded from each of the subdivisions described above. The change in assemblage of fossils from bottom to top of this thick sediments is not rapid but very slow and gradual. Relying on the determined species as listed below, only twofold subdivision or at most threefold subdivision seems possible on palaeontological grounds. In the former case, the boundary is at the midst of the fomation IIf, while the three divisions are IIa —— IIe, IIf, and IIg —— II k. For fuller discussion of correlation and age of strata, we must wait for further considerations. And I will treat with that aspect of the subject in Part II of this paper.

TABLE

List of the Important Fossils from the Main part of the Middle Ammonite Group in the Siyubari District.

Phylloceras sp. indet. α (n. sp.? aff. *Ph. tanit* PERV.)	IIc, IIe (?)	IIf	
Phylloceras sp. indet. cfr. *Ph. velledae* (MICH.) or *Ph. japonicum* MAT.			IIj
Tetragonites cfr. *kiliani* JACOB	IIb2, IIc,	IIf1	IIj (?)
Parajaubertella * *kawakitana* MATUMOTO MS.	IIb2, IId, IIe	IIf	
Anagaudryceras sacya (FORBES) em. (including "*Lytoceras*" *imperiale* YABE)		IIf 1, 2	IIIg-IIk
Anagaudryceras sp. indet.	IIb		
Zelandites odiensis (KOSSMAT) em.	IId		IIj
Z. odiensis vor. *lateumbilicata* MATUMOTO MS.			IIj
Anisoceras (s. s.) sp. indet	IIb		IIh (?)
Hamites (s. s.?) sp.	IId		
Baculites cfr. *gaudini* PICTET & CAMPISCH	IIe	IIf (?)	IIh
Desmoceras latidorsatum (MICHELIN)	IId		
Desmoceras kossmati MATUMOTO MS.	IIc-IIe	IIf	
D. (*Pseudouhligella*) *ezoana* MATUMOTO MS.		IIf2	IIg-IIk
D. (*P.*) *ezoana* var. *poronaicum* YABE			IIk
D. (*P.*) *japonica* YABE		IIf2	IIg-IIk
Puzosia cfr. *subcorbarica* YABE MS.	IIb		
P. nipponica MAT. MS.			IIk
Pachydesmoceras sp. indet.		IIf	
Eogunnarites * *unicum* (YABE) em.	IId		
Holcodiscoides papillatus (STOLICZKA)			IIj
Maorites olcostephanoides MATUMOTO MS. (aff. *M. densicostatus* (KILIAN & REBOUL))			IIj
Rauliniceras sp.	IId		
Calycoceras sp. α		IIf	
Calycoceras sp. β			IIj, IIk.
Acanthoceras orientalis MATUMOTO MS.			IIh, IIj, IIk
A. asiaticum JIMBO			IIj

A. cfr. *turneri* WHITE		IIf	
Pervinquieria imaü (YABE & SHIMIZU)	IIc		
Schloenbachia (?) sp. indet.		IIf	
Turrilites (*Meriella*) *bergeri* BRONGNIART	IIIb2		
T. (*M.*) *yabei* MATUMOTO MS. (= *T.* aff. *bergeri* YABE 1904)		IIf	
T. (*M*) *oehlerti* PERVINQUIERE	IIc		
T. (*M*) *acutus* PASSY			IIg
Hypoturrilites (?) aff. *tuberculatus* (BOSC.)	IIb, IId, IIe		
Turriltes (s. s.) cfr. *costatus* LAMARCK			IIk
Inoceramus sp. indet, cfr. *bohemicus* LEONHARDT ...	IIb, IId		
I. concentricus nipponicus NAGAO & MATUMOTO			IIh-IIk
I. yabei subconcentricus MATUMOTO MS.			IIg, IIk
I. yabei constrictus MATUMOTO MS.			IIk
I. yabei NAGAO & MATUMOTO em.			IIj
I. sp. indet., cfr. *moresbyensis* WHITEAVES		IIf	

Saku Formation, *its stratigraphic sequence.*—— The strata of the 400 m thick succeeding the main part of the Middle Ammonite Group have much commons in lithological properties with the latter, but are generally characterized by somewhat coarser sediments. From the grounds of lithological resemblance and of stratigraphical position, this part is unequivocally a continuation of what is called the Saku Formation in the Abesinai district. We can apply the name for the formation of the present district with an extention of the definition.

The formation consists mainly of thin alternations of sandstones, sandy shales, and shales, sometimes one of the three being predominant. The sequence of strata displayed on the Siyubari district is as follows in ascending order.

Member IIm. Thin alternations of sandstone and shale, being a transitional part between the min part of the Middle Ammonite Group and the Saku Formation proper. As obsersed in the valley of the Hinata-zawa, part of the thin alternations passes laterally (i. e. northward in the present exposute) to a thicker

sandstone at the upper horizons of the member. Accordingly sandstone is predominant in the northern area. The part with such a kind of facies is marked here as IIm′. Shale contains concretions and sometimes yields fossils. Thickness: less than 100 m. Typical exposures: loc. Y 140 (the Hikage-zawa), Y 506b —— Y 508 (the Tengu-zawa, above the first water-fall), Y 230, Y 231a (the Siyubari) (IIm′), and Y 421d, e, Y 422 (the Hinata-zawa).

Member IIn. Very fine-sandstone, sandy siltstone, and shale, often passing gradually with one another or being separated with platy stratification; and frequently forms very thin alternations. The rocks are bluish greenish grey, containing large or small calcareous nodules which are sometimes richly fossiliferous. Beds of medium-sandstone, less than 1 m thick are intercalated with the sandy siltstones in the upper half of the member. A layer of whitish calcareous sandstone and that of bentonitic tuff are contained in the same part. Thickness: about 100 m. Typical exposures: loc. Y 137 —— Y 139 (the lowest course of the Hikage-zawa), Y 201 —— Y 212 (the consequent valley of the Si-yubari), Y 500 —— Y 506a (the Tengu-zawa, below the first water-fall), Y 227 —— Y 229 (the upper course of the Si-yubari) and Y 415 —— Y 420, Y 421a —— c (the Hinata-zawa below the water-fall).

Member IIp. Dark grey mudstones without fissility, frequently interstratified with very thin layers (5–10 cm thick) of fine-sandstone; concretionary but rather poorly fossiliferous. A stratum (1 m ± thick) of white bentonitic tuff is intercalated with the mudstone in the lower part of the present member. Thickness ranges from 30 m (southern area) to 50 m (northern area). Typical exposures: loc. Y 136, Y 200 (near the mouth of the Hikage-zawa), Y 213, Y 214, Y 216, Y 223, Y 224 and Y 226 along the main course of the Si-yubari.

Member IIq. Sandy siltstone, very fine-sandstone and shale, Similar to those of the member IIn. Concretions are sometimes richly fossiliferous; 50 m ± thick; typically exposed at loc. Y135 (a little below the mouth of the Hikage-zawa), Y 215, Y 218, Y 219, Y 221, Y 222 along the main course of the Si-yubari, and Y 401, Y 402, Y 460, etc of its small right branches.

Member IIr. Sandstones and sandy shales in alternations, a heavy

bed (several metres thick) of sandstone is intercalated. The sandstone is light bluish greenish grey, fine or medium, comparatively well sorted and has lamination, ripple-marks and dendritic markings. The sandy shale is concretionary and some of the calcareous nodules contain molluscan remains and drifted plant remains. Thickness 70 m. Typical exposures are loc. Y 134 along the middle course of the Si-yubari, Y 403——Y 408 of a small tributary of the Si-yubari, below the mouth of the Hinata-zawa.

Member IIs. Siltstones or sandy mudstones, sometimes with intercalated sandstones in a subordinate amount; dark coloured, concretionary and considerably fossiliferous. The uppermost part gradually passes to the mudstones of the Upper Ammonite Group. Thickness is 50 m or so. Typical exposures: loc. Y 130d, Y 131——Y 133 along the middle course of the Si-yubari.

Fossils of the Saku Formation.——Finer sediments of the Saku Formation is generally fossiliferous, and in spite of general coarsenes of the formation as compared with the main part of the Middle Ammonite Group or Upper Ammonite Group, the important fossils are of similar kind to those of the latter two. Many of the species are represented by numerous individual. The assemblage of species as listed below is characteristic to the present formation. But its difference among six members of the fomation is rather small, if not absent. The attempt of three fold subdivision upon palaeontological grounds may be possible, but it seems to have a local significance. (A deeper investigation on age will be found in Part II.)

TABLE

List of the Important Fossils from the Saku Formation in the Si-yubari District.

Neophylloceras subramosum (SIMIZU)		IIn	IIq-IIs	
Phyllopachyceras ezoense (YOKOYAMA)				(IIn-s)
Epigoniceras glabrum (JIMBO)		IIn, IIp.	IIq-IIs	
Anagaudryceras limatum (YABE)			IIs	
Gaudryceras denseplicatum (JIMBO) em.		IIn, IIp.	IIq-IIs	

Zelandites cfr. *mihoensis* MATUMOTO				(IIn-s)*
Scaphites (*Yezoites*) *puerculus* (JIMBO)		IIn	IIs	(IIn-s)
S. (*Y*) *planus* YABE			IIq, IIs	(IIn-s)
S. (s. l.) *yonekurai* YABE...			IIr	
S. (s. l.) *pseudoaequalis* YABE			IIq, IIs	(IIn-s)
Baculites aff. *baculoides* (MANTELL) (*B. orientalis* MATUMOTO MS.)		IIn	IIq-IIs	
Scalarites scalare (YABE)		IIn	IIq-IIs	
S. venustum (YABE)		IIn	IIq	
S. mihoensis MATUMOTO MS.			IIs	
Bostrychoceras otsukai (YABE)...			IIr, IIs	
B. otsukai var. *multicostatus* (YABE)			(IIq-s)	
Hyphantoceras sp. indet....			IIq	
Desmoceras (*Pseudouhligella*) *ezoana* MATUMOTO MS. ...			IIq, IIs (?)	
Tragodesmoceroides subcostatus MATUMOTO MS....		IIn	IIq-IIs	
Puzosia gaudama (FORBES) var. *orintale* MATUMOTO MS....		IIn, IIp		
P. gaudama var. *intermedia* KOSSMAT		IIn		
Parapuzosia (*Mesopuzosia*) *indopacifica* (KOSSMAT)		IIn	IIq-IIs	
P. (*M.*) *yubarense* (JIMBO)...		IIn	IIq-IIs	
P. (*M.*) cfr. *ishikawai* (JIMBO)...			IIs	
Jimboiceras planulatiforme (JIMBO)...				(IIn-s)
Yokoyamaoceras kotoi (JIMBO)			IIs-IIIa	
Maorites olcostephanoides MATUMOTO MS.	IIm			
Romaniceras yubarense (YABE) MS.			IIq-IIs	
"*Barroisiceras*" (*Reesidites*) *minimum* YABE MS.			IIs	
Inoceramus cfr. *yabei* NAGAO & MATUMOTO em....	IIm			
I. hobetsensis hobetsensis MATUMOTO MS.		IIn	IIq-IIs	
I. hobetsensis nonsulcatus NAGAO & MATUMOTO em.... ...		IIn	IIq-IIs	
I. hobetsensis intermedius MATUMOTO MS.		IIn	IIq-IIs	
I. hobetsensis peculiaris MATUMOTO MS.		IIn	IIq, IIs	
I. hobetsensis maximus MATUMOTO MS.			IIs	
I. iburiensis NAGAO & MATUMOTO		IIp (?)	IIs	
I. cfr. *concentricus nipponicus* NAGAO & MATUMOTO			IIq	
I. concentricus costatus NAGAO & MATUMOTO			IIq	
I. tenuistriatus NAGAO & MATUMOTO		IIn		
I. pedalionoides NAGAO & MATUMOTO				(IIn-s)
I. teshioensis NAGAO & MATUMOTO em.			IIs	(IIn-s)
I. incertus JIMBO em....		IIn		

* ( ) exact horizon unknown

III. Uper Ammonite Group

This is the most familiar facies in the Cretaceous of Hokkaidô. It has the same lithological characters as those of the Miho Group in South Karahuto, consisting mainly of homogeneous and monotonous grey mudstones with marly concretions and rich fossils.

In the present district no local formation occurs within the group, although beds of white calcareous coarse-sandstone is intercalated with the mudstones of the upper part and layers of white bentonitic tuff are found at places. As in the case of the Miho Group, we can discriminate more fossiliferous part and less fossiliferous one. The former is a fossil-zone. Thus the following succession is discernible along the section of the Si-yubari[1].

IIIa. Lowest part of the group, very poor in organic remains, more than 300 m thick[2]. As has already mentioned the top of the Saku Formation (Middle Ammonite Group) passes gradually upward to this part, *Gaudryceras denseplicatum* (JIMBO) *Anagaudryceras limatum* (YABE) and undeterminable species of other ammonite, *Inoceramus*, an echinoid and a coral have been yielded. Typical exposures: Y 123 —— Y 130a, b, c.

IIIb. *Lower fossil-zone.* Properties of rock are same as those of the preceding, but fossil occur abundantly. It is found either in concretions and on a stratification-plane of shales. This fossil-zone is characterized by numerous individual of *Inoceramus uwajimensis* YEHARA and *Anagaudryceras limatum* (YABE). Many of the valves of *Inoceramus* occur with their convex side downward, but the revere is not uncommon. Rarely two valves are in contact, and sometimes fragmental shells gather in some lamina or in patch. From this zone I have determined the following species:

Neophylloceras subramosum (SHIMIZU)
Epigoniceras glabrum (JIMBO)
Anagaudryceras limatum (YABE)
Gaudryceras denseplicatum (JIMBO)
G. *tenuiliratum* (YABE)

(1) As was already mentioned, the complicated stracture prevents us from the accurate biostratigraphic study of the Upper Ammonite Group in the district.

(2) Owing to the frequent occurrence of minor faults and to the homogeneity of rock, we cannot estimate the thickness accurately.

Scaphites sp.
Scalarites mihoensis MATUMOTO MS.
S. (?) *densicostatus* MATUMOTO MS.
Hyphantoceras miotuberculatus MATUMONO MS.
Damesites damesi (JIMBO)
Parapuzosia (*Mesopuzosia*) *indopacifica* (KOSSMAT)
P. (*M*) cfr. *ishikawai* (JIMBO)
Inoceramus uwajimensis YEHARA em.
I. (*Sergipia*) *akamatsui* YEHARA

The assemblage of species is very similar to that of zone Mh 4 of the Miho Group in the Naibuti district.

Typical part of this zone seems less than 100 m thick, and occurs repeatedly owing to the imbrication structure of minor scale. The typical exposures are loc. Y 122, Y 121b, c, Y 120, Y 116, Y 115d, Y 114, Y 113, Y 112b, Y 109, Y 105 (?)[1] Y 104b, c (?), and Y 103b.

IIIc. *The intermediate part.* Between the two richly fossiliferous zones (the lower and the upper fossil-zones), there is and intermediate part where fossil occurs rather sporadically. It is exposed at loc. Y 102, Y 103a, Y 108, Y 110d-f, Y 111 and Y 112a. The following species have been determined:

Neophylloceras subramosum (SHIMIZU)
Phyllopachyceras ezoense (YOKOYAMA)
Epigoniceras glabrum (JIMBO)
Gaudryceras denseplicatum (JIMBO)
Puzosia (s. l.) sp.
Hyphantoceras miotuberculatus MATUMOTO MS.
Hyphantoceras aff. *miotuberculatus* MATUMOTO MS.
Inoceramus cfr. *uwajimensis* YEHARA
I. mihoensis MATUMOTO MS.
I. naumanni YOKOYAMA

IIId. *Upper fossil-zone.* This is the most fossiliferous part. It corresponds to the main part of the so-called *Pachydiscus* Beds. And the occurrence of fossil and assemblage of species very resemble those of the zone Mh 6 of the Naibuti district. The most important species are *Neophylloceras subramosum* (SHIMIZU), *Phyllopachyceras ezoense* (YOKOYAMA), *Epigoniceras glabrum*

[1] This can possibly considered as horizon IIIc.

(JIMBO), *Gaudryceras tenuiliratum* YABE, *G. denseplicatum* (JIMBO), *Polyptychoceras* spp., *Damesites damesi* (JIMBO), *Hauericeras gardeni* (BAILY) *Parapuzosia* (*Mesopuzosia*) *ishikawai* (JIMBO), *Eupachydiscus haradai* (JIMBO), *Inoceramus naumanni* YOKOYAMA, *I. ezoense* YOKOYAMA, *I. japonicus* NAGAO &MATUMOTO, *Scurria cassidaria* YOKOYAMA, etc. And noteworthy is the occurrence of *Scaphites* (s. l.) aff. *gracilis* YABE from this zone.

Preservation of fossil is not always good and, furthermore, strata are somewhat complicated. Therefore, a deeper biostratigraphic investigation of the zone is impossible in this district.

TABLE SHOWING LOCALITIES AND HORIZONS OF EXPOSURES
IN
THE SI-YUBARI DISTRICT
(北海道石狩國主夕張地方)

(※ indicates the occurrence of macroscopic fossils)

Locality Number	Horizon	Place-name (Valley)
Y101	IIId (※)	Railway cutting south west of the fourth bridge
Y102	IIIc (※)	At the fourth bridge
Y103a/b	IIIc (※)/IIIb (※)	
Y104a/b, c	IIIc (※)/IIIb (※)	
Y105	IIIb ? (※)	Middle course of the Si-yubari, from the mouth
Y106a, b|c	IIIb ? (※)|IIIc (※)	of the Masago-zawa to that of the Hikage-
Y108	IIIc (※)	zawa.
Y109	IIIb (※)	(シユーバリ川本流中流,
Y110a-c|d-f	IIIa ?|IIIc (※)	眞砂澤出口より日蔭澤出口迄)
Y111	IIIc (※)	
Y112a\b	IIIc (※)\IIIb (※)	
Y113, Y114	IIIb (※)	
Y115, Y116	IIIb (※)	Near the fifth bridge
Y117—Y119	IIIa (※)	
Y120	IIIb (※)	
Y121a|b, c	IIIa ?|IIIb (※)	

Y122A—Y129	IIIa (※)	Y124 is at the sixth bridge
Y130a/b, c/d	IIIa/III-II (※) /IIs (※)	
Y131—Y133	IIs (※)	
Y134	IIr (※)	
Y135	IIq (※)	
Y136	IIp	
Y137—Y139	IIn (※)	↑Below （下流へ）
Y140	IIm (※)	
Y141, Y142	IIk (※)	
Y143a/b-f	IIk/IIj (※)	
Y144, Y145	IIj (※)	
Y146a/b	IIj (※)/IIi	
Y147	IIh	Lower course of the Hikage-zawa
Y148	IIi	（日蔭澤下流）
Y149	IIj (※)	
Y150a, b\c	IIh (※)\IIi (※)	
Y151	IIh (※)	
Y152—Y154	IIg (※)	
Y155	IIg? IIf?	
Y156, Y157	IIf (Upper part)	↓Above （上流へ）
Y158, Y159	IIf (Upper part) (※)	Near the mouth of the first tributary
Y160, Y161	IIf (Upper part) (※)	Middle course of the Hikage-zawa, below the
Y162, Y163, Y167	IIf (Middle part) (※)	mouth of the second tributary
Y165, Y166, Y168	IIf (Lower part) (※)	（日蔭澤中流, 88 班澤出口より下流）
Y170—Y172	IIf (Lower part) (※)	↑Below （下流 ）
Y173	IIf (Lower part)	
Y174	IIf or IIe	The second tributary of the Hikage-zawa, or
Y175, Y176	IIe (※)	the Hatizyu-happan-zawa
Y178	IIc	（88 班澤）
Y179, Y180	IIb2 (※)	

Locality Number	Horizon	Place-name (Valley)
Y181	IIb2	
Y182, Y183	IIb1	
Y184a/b	IIb1/IIa	
Y185	Id	
Y186	Ic (※)	
Y190	Ia	↓ Above
Y200	IIp	
Y201—Y212	IIn (※)	The Si-yubari, from the mouth of the Hikage-zawa to that of the Hinata-zawa.
Y213, Y214	IIp (※)	（シユーバリ川，日蔭澤出口ヨリ日向澤出口迄）
Y215	IIq	
Y216	IIp	
Y217—Y219	IIq (※)	
Y220	IIr	
Y221, Y222	IIq	
Y223, Y224	IIp (※)	
Y225	IIn (※)	
Y226	IIp	
Y227—Y229	IIn (※)	Below ↑
Y230	IIm′	
Y231a/b	IIm′/IIk	
Y232	IIk (※)	
Y233	IIk or IIj	Upper course of the Si-yubari, upward from the mouth of the Hinata-zawa
Y234, Y235	IIj (※)	（シユーバリ川上流，日向澤出口ヨリ上流）
Y236—Y238	IIi	
Y239—Y241	IIh (※)	
Y242—Y244	IIg (※)	
Y245	IIg or IIf (※)	
Y246—Y249	IIf (upper half) (※)	
Y250—255	IIf (lower half) (※)	

Y256, Y257	IIe	
Y258a/b	IIe/IId	
Y259, Y260	IId (※)	
Y261a/b	IId (※)/IIc	
Y263, Y264	IIb2	
Y265—Y268	IIb1	
Y269, Y270	IIa	
Y271, Y272	If	
Y273, Y274	Ie	
Y275	Id	
Y276—Y280	Ic (※ at Y276)	
Y281—Y287	Ib	
		←Mouth of a tributary
Y288—Y295	Ia	
Y296—Y302	Oz	
Y303	Oy	Uppermost course of the Si-yubari (a grand gorge)
Y304—Y306	Ox	
Y307	Ow	(シユーパリ川源)
Y308, Y309	Ov	
Y310—Y313	Ou, Partly Ov and Ot	
Y314—Y317	Ot	
Y351	Ib	↑ Below
Y352—Y354	Ia	A tributary of the uppermost course of the Si-yubari, (the mouth of which is at loc. Y287)
Y355—Y360	Oz	
Y361, Y362	Ia ?	
Y363—Y365	Oz	↓ Above
Y401	IIq (※)	A small right branch of the upper Si-yubari, a little below the mouth of the Hinata-zawa (57 班, 58 班境の澤)
Y402	IIq\IIr1 (※)	
Y403\Y404\Y405	IIr1\IIr2\IIr3 (※)	
Y406—Y408	IIr	
Y409—Y411	IIq	

Locality Number	Horizon	Place-name (Valley)
Y415—Y420	IIn (※)	Lower course of the Hinata-zawa
Y421a-c/d, e	IIn (※)/IIm′	（日向澤下流）
Y422	IIm′	
Y423, Y424	IIk (※)	
Y425—Y428	IIk (※)	Lower course of the Kitano-sawa, a tributary
Y429, Y430	IIj (※)	of the Hinata-zawa
Y431—Y433	IIi	（日向澤支流北の澤の下流）
Y434	IIh	
Y450	IIp	A small left tributary of the Si-yubari, a little
Y451—Y455	IIn (※)	below the mouth of the Hikage-zawa
Y456	IIm	（101 班の澤）
Y457	IIk (※)	
Y460	IIq (※)	A small right branch of the Si-yubari, a little
Y461—Y467	IIq or IIr1 (※)	above the mouth of the Hikage-zawa
Y468—Y471	IIr or IIs (※)	（55 班, 56 班境の澤）
Y500—Y505	IIn (※)	Below the first-water fall.
Y506a/b	IIn/IIm (※)	Just above the first-water fall.
Y507, Y508	IIm (※)	
Y509—Y511	IIk (※)	Lower course of the Tengu-zawa
Y512a/b	IIk/IIj	（天狗澤下流）
Y513—Y515	IIj (※)	
Y516, Y517	IIi (※)	
Y518—522	IIh (※)	
Y523—Y527	IIg (※)	Lower course of the Tengu-zawa
Y528	IIg or IIf (※)	
Y529—Y531	IIf	

Y532	IIf (lower part) (※)	
Y533	IIe	
Y534, Y535	IId (※)	
Y536a/b	IId (※)/IIc	Middle course of the Tengu-zawa
Y537, Y538	IIc (※)	（天狗澤中流）
Y539a/b	IIc (※)/IIb2 (※)	
Y540—Y542	IIb2 (※)	
Y543—Y547	IIb1	
Y548, Y549	IIa	Just below the second water-fall
Y550	If	
Y551—Y553	Ie	
Y554	Id (※)	A left branch of the upper course of the
Y555—Y557	Ic (※ at Y557)	Tengu-zawa
Y558	Ic+Ib	（天狗澤上流左支流）
Y559, Y560	Ib	
Y561—Y563	Ia	
Y574	IIa	The second water-fall
Y575—Y577	If	
Y578	Ie	The upper course of the Tengu-zawa
Y579	Id	（天狗澤上流）
Y580	Ic	
Y581—Y585	Ib	
Y586—Y593	Ia	
Y594	Altered basalt (Green rock)	A large water-full
Y595—Y597	Ia?	Source of the Tengu-zawa
Y598, Y599	Metamorphosed rocks	（天狗澤源）
Y600—Y606	IIf (upper part) (※)	↑ Below
Y607—Y610	IIf (upper part) (※)	
Y611—Y614	IIf (lower part) (※)	
Y615, Y616	IIe (※)	The first tributary of the Hikage-zawa

Locality Number	Horizon	Place-name (Valley)
Y617—623	IId (※)	(日蔭澤第一支流)
Y624	IId ?	
Y625—Y627	IIb2	
Y628, Y629	IIb1	
Y630	IIa	
Y631, Y632	If (※)	
Y633	Ie	
Y634	Id	↓ Above
Y650—Y654	IIf (lower part) (※)	
Y655	IIe (※)	Middle course of the Hikage-zawa, upward from
Y656—Y658	IIf (lower part) (※)	the mouth of the second tributary
Y659	IIf or IIe (※)	
Y660, Y661	IIe (※)	
Y662—Y665	IId (※)	
Y665a|b	IId|IIb2 (※)	
Y667	IIb2 (※)	
Y668	IIb2 or IIb1 (※)	
Y669—Y671	IIb1 (※)	Uupper course of the Hikage-zawa
Y672	IIa	(日蔭澤上流)
Y673	If (※)	
Y674	Ie	
Y675	Id	
Y676, Y677	Ib? Ia?	
Y678—Y687	Ia	
Y688—Y691	?	
Y700, Y701	IIb2	A small left tributary of the upper course of
Y702	IIb2 ? IId ?	the Hikage-zawa
Y703, Y704	IId (※)	(日蔭澤上流左支流)
Y705	If	

Y710—Y713	IIb2 (欠)	
Y714—Y717	IIb1	A right branch of the second tributary of the
Y718—Y720	If	Hikage-zawa.
Y721	Ie	(88 班澤右支流)
Y722—Y724	Id	
Y725	Ic (欠)	
Y800—Y810	IIId (欠)	Railway cuttings along the lower course of the Si-yubari.

B. Succession of Rocks and Sequence of Fossils of the Uppermost Cretaceous of the Hetonai District, province of Iburi, southern central Hokkainô.

(Pl. XVI, XVII)

Location of the area
Previous works. Geological conditions in general.
Description of stratigraphy
  Upper Ammonite Group
  Hakobuti Group
Table showing localities and horizons of exposures

LOCATION OF THE AREA

The Hetonai district here called is the neighbourhood of Hetonai Town, in Yuhutu-gun, eastern part of Iburi province[1], and is a portion of the Mu-kawa valley[2]. The Hetonal Town is about 128 km south-east of Sapporo, and the Hokkaidô Railway Company Line runs between them.

In this area the southern extension of the Cretaceous rocks of the so-called Isikari coal-field is developed forming a comparatively narrow belt of about 4 km in breadth.

PREVIOUS WORKS. GEOLOGICAL CONDITIONS IN GENERAL

Through the works of previous investigators, especially of K. OTATUME, geological conditions of the district are precisely known.

The Cretaceous rocks occupying the main part of the district is mostly the uppermost division, the Hakobuti group, and partly the Upper Ammonite Group. They are overlapped unconformably on both the eastern and western sides by the Neogene Poronai Series. This series covers, at its eastern end, the metamorphic rocks of unknown age with an unconformity.

Near the western margin of the area, a large high-angled fault called Hetonai Fault runs meridionally. And on the eastern side of the fault, strata are arranged in a reversed order owing to an intensely overturned folding.

The Hakobuti Group of the present district was called by the previous author the Hetonai Group. And he has subdivided the group as follows in ascending order:

(1) 膽振國 勇拂郡 邊富內 (2) 鵡川

Map showing localities of exposures and attitude of strata in the Siyubari District, Isikari Province, Hokkaidô

北海道石狩國主夕張地方地質踏査略圖

Compiled from the Route Maps drawn to the scale of 1:5,000
All the loc. numbers in this map are to have prefix Y.
(Date of survey—Summer 1939)

N

北ノ澤 The Kitano-sawa
日向澤 The Hinata-zawa
シユーパリ川 The Siyubari
天狗澤 The Tengu-zawa
日蔭澤第一支流 (First Tributary)
八十八度澤 (Second Tributary)
日蔭澤 The Hikage-zawa
眞砂澤 The Masago-zawa
小槍澤 The Komaki-zawa

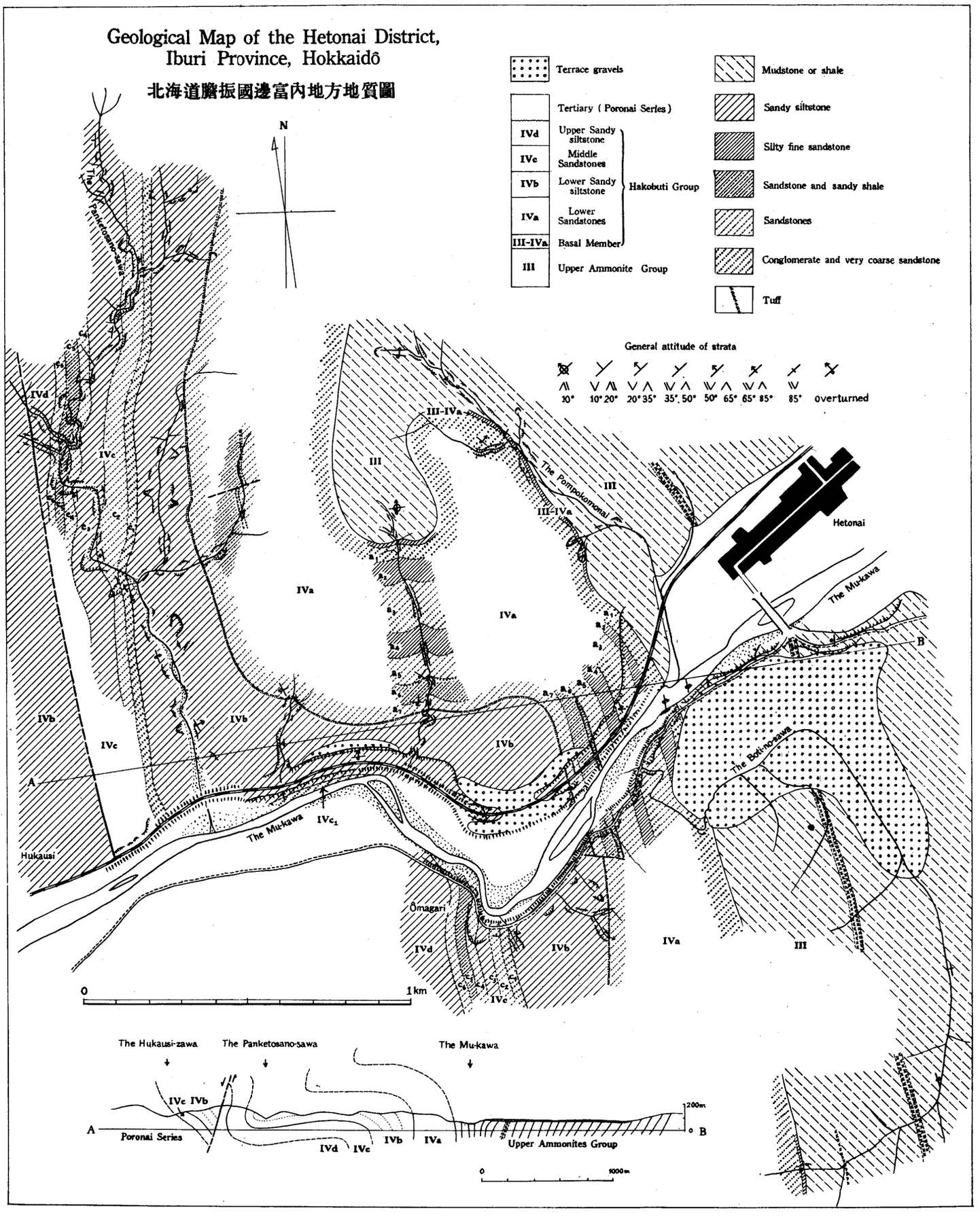
General attitude of strata

± 0° | V 5°-10° | V 10°-20° | V 20°-35° | V 35°-80° | V 30°-65° | V 65°-85° | V 85°

Faults or Thrusts

Vertical | High-angled | Medium-angled | Low-angled

1000 m 500 m 0 1 2 3 4 km


Geological Map of the Hetonai District,
Iburi Province, Hokkaidô
北海道膽振國邊富内地方地質圖
Terrace gravels
Tertiary (Poronai Series)
IVd Upper Sandy siltstone
IVc Middle Sandstones
IVb Lower Sandy siltstone
IVa Lower Sandstones
III-IVa Basal Member
Hakobuti Group
III Upper Ammonite Group
Mudstone or shale
Sandy siltstone
Silty fine sandstone
Sandstone and sandy shale
Sandstones
Conglomerate and very coarse sandstone
Tuff
General attitude of strata
10° 10°20° 20°35° 35°50° 50° 65° 65°85° 85° overturned
N
The Panketosano-sawa
The Pompokomonai
Hetonai
The Mukawa
The Bati-no-sawa
Hukausi
Ômagari
0 1km
The Hukausi-zawa
The Panketosano-sawa
The Mu-kawa
Poronai Series
Upper Ammonites Group
200m
0
1000m

Lower Hetonai Formation
Upper Hetonai Formation
- Lower Sandy shale
- Hukausi Sandstone
- Upper Sandy shale
- (The superjacent Sanusibé Sandstone is eroded out.)

The lithology of each formation and member was described precisely by K. UWATOKO & K. OTATUME (1933) in connection with the oil bearing sedimentary rocks. The list of fossils in their paper is provisional and incomplete. But subsequently the molluscan remains (excepting *Inoceramus* and cephalopods) were studied and described by T. NAGAO & K. OTATUME (1938).

In reality, the Hakobuti Group of the present district yields fossils more abundantly than that of any other areas of Hokkaidô. Moreover, the exposure of rock is very good. So I visited there, with a purpose of obtaining further accurate biostratigraphic knowledge in special connection with ammonites and *Inoceramus*.

DESCRIPTION OF STRATIGRAPHY

The Cretaceous rocks displayed in the present area are a portion of those widely developed in the so-called Ishikari coal-field district, and are to be classified as follows:

III. Upper Ammonite Group (上部菊石層群)
IV. Hakobuti Group. (函淵層群)
- a. Lower Sandstones
- b. Lower Sandy siltstones
- c. Middle Sandstones (=Hukausi Formation)
- d. Upper Sandy siltstones

The Upper Sandstones Formation or the Sanusibé Sandstones is absent in this district, for it was eroded out by the pre-Neogene erosion.

The following is the description of each formation observed chiefly along the section of Hetonai.

III. Upper Ammonite Group (in part)

A portion of the Upper Ammonite Group occurs in the dis-

trict below the Hakobuti Group with a conformable relation. As observed in other areas, it consists of comparatively homogeneous mudstones rich in marly nodules and marine fossils. A bed of whitish tuff and tufaceous sandstone, with a thickness of 25 m to 30 m, is found at a horizon about 200 m below the top of the group, and much thinner beds of white tuff are sometimes found. The very thin lenticular layers of marl is intercalated with the mudstones, and the marly concretions are often arranged in a bed-like form. Some of the concretion is fossiliferous, and, so far as the upper part of the group with thickness of 300 metres arec on cerned, the following is the important species among the contained fossils.

Neophylloceras subramosum SHIMIZU
Phyllopachyceras ezoense (YOKOYAMA)
Gaudryceras denseplicatum (JIMBO)
G. tenuiliratum YABE and var. *frequence* MATUMOTO MS.
G. striatum (Jimbo) var. *paucistriata* MATUMOTO MS.
Epigoniceras glabrum (JIMBO)
Damesites damesi (JIMBO)
D. sugatus (FORBES) em.
Anapachydiscus sutneri (YOKOYAMA)
Eupachydiscus haradai (JIMBO)
Menuites sp.
Hauericeras gardeni (BAILEY)
Parapuzosia (*Mesopuzosia*) *ishikawai* (JIMBO)
Polyptychoceras spp.
Glyptoxoceras (?) sp.
Bostrychoceras serpentinum MATUMOTO MS.
Inoceramus naumanni YOKOYAMA
I. ezoensis YOKOYAMA
I. japonicus NAGAO & MATUMOTO

IV. Hakobuti Group

General remarks.——This is a group consisting of the formation of sandstones and the formation of the sandy siltstones in several repetitions, and conglomerate occurs in subordinate amount. As compared with the Hakobuti Group (or "Hakobuti Sandstone") of the Isikari coal-field proper, the original locality of the group,

that of the present district has larger amount of sandy siltstone and contains more numerous marine fossils. In this respect, the condition resembles in some degree that of the Ryûgase Group of South Karahuto. Furthermore, the group is thicker in the present district than in the Isikari coal-field, the thickness attaining 800 m even if the eroded uppermost part is excluded.

The stratigraphic relation between the Hakubuti Group and the Upper Ammonite Group is conformable, and the gradual but rapid change of sedimentational condition is apparent.

Stratigraphic sequence.——

Basal member (III-IVa) This is a transitional part from the Upper Ammonite Group to the Hakobuti Group. It is represented by sandy mudstone and very fine sandstone, bluish grey and rather loose, containing numerous calcareous nodules. The nodules are usually 20 cm to 40 cm, sometimes 1 m in maximum dimension, and often laminated and disk-like in shape. They are more or less fossiliferous, sometimes containing abundant shells aggregated in certain laminae. Fossils are also found in the surrounding rocks sometimes in a scattered form and sometimes arranged in a certain layer. The species are mostly those of marine molluscs, including bivalves, gastropods and ammonites.

This basal part is thin, attaining only several metres at the typical exposures along the Ponpokomonai (loc. H. 79c, H 81b, H 83b, etc.). Another good exposure of the transitional part from the Upper Ammonite Group to the Hakobuti group is found near Osatinai in Saru-gun, province of Hidaka[1], along the middle course of the Sarugawa, where the Cretaceous rocks spreads southwards from the Hetonai district. Here the basal member is estimated at 13 m thick. (Loc. H 100c.)

Lower Sandstones (IVa) This is the part which has been called the Lower Hetonai Formation by previous investigators. The formation is characterized by coarser sediments of littoral or sublittoral origin. It is mainly made up of sandstones of various coarseness, somewhat gritty, sometimes cross-laminated and in part rudaceous, being associated with a subordinate amount of sandy shale. Coaly shale containing plant remains is intercalated. The drift of plant remain is rather common, while occurrence of marine

[1] 日高國沙流郡長知內

shell is limited in a restricted part. The latter is the species of *Ostrea*, *Pedalion* and *Inoceramus*.

The thickness of the formation is about 300 m. It may be subdivided at this locality into six members, coarser one and relatively finer one in alternations.

a1. Sandstones, medium to coarse, sometimes very coarse and pebbly; remains of *Inoceramus*, *Ostrea*, *Pedalion* and *Patella* (s. l.) occur sporadically. This member lies conformably on the basal member (III-IVa) with a gradual but rapid change of lithologic character. Thickness: 20 m. Typical exposures: loc. H6, H79d, H81c, H83c; H100d, etc.

a2. Silty very-fine-sandstones, bluish greenish dark gray; marine molluscan remain is rarely found. Thickness: 20 m. Typical exposures: loc. H7a, H83d, H24g, etc.

a3. Sandstones of various coarseness, rudaceous in the upper part, and beds of coaly shale are intercalated in the middle part. On the exposure at Osatinai remains of *Inoceramus* occur abundantly in the lower part. Thickness: 70 m. Typical exposures: loc. H7b-f, H8, H17, H24e, f; H100f.

a4. Silty fine-sandstones, dark gray, containing carbonaceous flakes. Remains of *Inoceramus* are yielded. Thickness: 40 m. Typical exposures: loc. H9a, H18a, H24d, etc.

a5. Sandstones, mainly medium to coarse, rarely pebble-bearing. Basal part is interstratified with silty fine sandstone and is somewhat loose. Superjacent to it, bed with abundant casts of *Inoceramus schmidti* var. *mirabilis* (formerly misidentified as *I. japonicus*) occurs and a little above this bed, follow a coaly shale, a coal, and a flinty shale (tuff?) with remains of *Nilssonia* and other plants. (Pl. XX Fig. 4) Thickness: 40m. (+). Typical exposures: loc. H9b-d, H18b-f, H24c.

a6. A bed of pebble-bearing very coarse green sandstone and conglomerate at the base. Main part is represented by fine-sandy siltstone and fine-sandstone in difinite or indefinite alternation. Layer of coarser sandstone is subordinate. Tuff and tufaceous sediments are not uncommon. Thickness: ca. 60 m. Typical exposures: loc. H9e, H10a, H19, H24b, H54, etc.

a7. Sandstones, medium or fine-grained. A bed of coaly shale occurs near the top. Thickness: 30m. or 50m. Typical exposures: loc. H10b-e, H19, H24a, H55, etc.

Lower Sandy siltstones (IVb) This formation lies conformably on the Lower Sandstones and begins with a glauconite sandstone (of 3 m ± thick) at the base. The main part is represented by sandy siltstones and silty sandstones, dark gray and brownish when wheathered, rich in carbonaceous matter, and concretional. Driftwoods and remains of marine mollusca are often contained in the calcareous nodule, and a lens of coquina is rarely found. The total thickness of the formation attains 300 metres. Typical exposures are loc. H 11, H 12, H 21a, H 22, H 26–H29, H 46, H 47, H 50, H 51, H52a, H 56–H59, H 69a-g, etc.

Middle Sandstones (IVc) or Hukausi Sandstones. This formation is made up of light coloured sandstones and conglomerates in the lower part and of greenish, medium to very fine-sandstone of shallow sea in the main part. The main part resembles the typical part of the Middle Cretaceous *Trigonia* Sandstone of the Isikari coal-field in lithologic character and contains remains of marine molluscs. The sandstone is well-sorted, massive or laminated, and the intercalated conglomerate is also well-sorted, containg well-rounded pebbles. On the other hand, the lowest part has somewhat different properties. The total thickness is 150 m to 160 m. The detailed succession of rocks is as follows.

c1. The uppermost part of the Lower Sandy siltstones passes gradually upward to the basal part of the Hukausi Sandstone. The transitional part is represented by fine to medium sandstones, sometimes silty, rather loose and contains thin layers of bituminous shale and carbonaceous matter. This sand is oil-bearing as has been described by UWAKOTO & ÔTATUME (1933). The succeeding part is conglomerate and pebbly sandstone, weathered to limonitic colour. Its structure and texture resemble those of deltaic forset deposits. Thickness: 30 m or so. Typical exposures: loc. H 13, H 21 b-f, H 22, H 45, etc.

c2. Sandstones, bluish greenish gray or dark green, mainly medium and partly fine or coarse and containing isolated pebbles. Fossils of bivalve are found in certain layers. Thickness: 20 m. Typical exposures: loc-H 14 a, H 33 a, H 34, H 44, H 48, etc.

c3. Fine-sandstones and sandy siltstone, bluish (± greenish) gray, and brownish when weathered, containing calcareous nodules and patches of calcareous sandstone; fossiliferous. Thickness: 50 m to 60 m. Typical exposures: loc. H 14b, H 33b-d, H 35, H 36a, H37a, H 42a, H 43, etc.

c4. Sandstones, more or less greenish, medium or fine, in part coarse, and with a few conglomeratic laryers. Molluscan remains are common in the lower part but rather scarce in the upper part. Thickness: 25 m. Typical exposures: loc. H 14c, d, H 36b, H 37b, H 40, H 42b, etc.

c5. Sandy siltstone, fine-sandstone and medium-sandstone in repetitions, 20 m thick, typically exposed at loc. H 14e, H 37c, H 41, etc.

c6. Medium sandstones, bluish greenish or dark green, rich in remains of marine bivalve in some part; about 15 m thick; typically exposed at loc. H 14 f, H15a, H 37 d, H 41, etc.

Upper Sandy siltstons (IVd) This formation is represented by sandy siltstones, dark grey, a little glauconitic and containing calcareous concretion, which is sometimes fossiliferous. Layer of sandstone and even conglomerate is intercalated at a few horizons. Owing to the presence of fault and unconformity, the whole thickness of the formation is not represented in the present district. Example of exposures are loc. H 15b, H 39h, etc.

On the constituent materials.——Concerning the sedimentary petrography of the Hakobuti Group in the Hetonai district, we have a detailed description in the paper of UWATOKO & OTATUME (1933). They concluded that the possible sources of the sediments are partly acidic sedimentary and igneous rocks and are partly effusive rocks. I myself also examineds a certain number of specimens and have confirmed the conclusion.

Throughout the whole thickness of the Hakobuti Group in the present district, the chief constituents of sandstones are those of quartz, felspars and small fragments of effusive rocks. The latter are mostly fragments of andesite, and partly those of basalt, glass, pumice, and mafic minerals. These effusive rocks are sometimes large and sometimes small in amount, although not so abundant as in the greywacke of the Ryûgase Group of the Naibuti district.

Pebbles of conglomerate are also those of altered andesite, dacite and liparite, besides the older sedimentary rocks.

The direct evidence of the igneous activity contemporaneous with sedimentation is found in tuff or tuffaceous rock, although it occurs at a few horizons forming a comparatively thin bed. Occurrence of tuff in the just subjacent Upper Ammonite Group was already described.

Sequence and assemblage of fossils.——As has been mentioned by the previous investigators, the Hakabuti Group yields usually little amount of organic remain, but in the Hetonai district and in the adjacent areas it is fairly fossiliferous. But the occurrence of the fossils is not necessary constant throughout the whole thickness. Namely, some of the formations or members are considerably rich in fossil contents, whereas others are very poor; furthermore, species are rather of heterogeneous kind. The facts may probably be due to the conditional differences in the ecological phenomena as well as in the processes of sedimentation and fossilization.

The yielded fossils are mostly the remains of marine molluscs. Among them cephalopods are restricted in the formation of a certain kind of facies, while *Inoceramus* occurs from almost every formation, without consciousness of difference in lithologic character. Other molluscan remains are comparatively large in number of specimens, in strong contrast to the Upper Ammonite Group.

Following is the assemblage of fossils and its sequence obrerved in the present district.

III–IVa. The richly fossiliferous basal member forms a fossil zone, the fossil-assemblage of which shows similarity to that of the division IIIe of the Abesinai district and that of division Mh–Ry and zone Ray1 of the Naibuti district. It is characterized by the following species:

Inoceramus orientalis SOKOLOW
I. orientalis var. *ambiguus* NAGAO & MATUMOTO
I. pseudosulcatus NAGAO & MATUMOTO
Phyllopachyceras ezoenense (YOKOYAMA)
Gaudryceras striatum (JIMBO)
Epigoniceras popetense (YABE) emend.
Damesites cfr. *damesi* (JIMBO)
Schlüteria diphylloida (FORBES)
Eupachydiscus haradai (JIMBO)
Pseudoxybeloceras (*Ryugasella*) *ryugasense* MATUMOTO MS.
Bostrychoceras sp.

Besides these, we find the species such as *Nucula* (*Acila*) *hokkaidoensis* NAGAO, *Yoldia hakobutsensis* NAGAO & ÔTATUME, *Parallelodon* (*Nanovavis*) *sachalinensis* (SCHMIDT), *Trigonia subovalis* (JIMBO), "*Aphrodina*" *pseudoplana* (YABE & NAGAO), *Spisula* (*Cymbophora*) *ezoensis* YABE & NAGAO var. *hetonaiensis* NAGAO & ÔTATUME, etc., most of which has been informed by NAGAO & ÔTATUME (1938).

IVa. Occurrence of fossil in the Lower Sandstone Formation is rather heterogeneous. Fossils are sometimes aggregated in a thin lenticular layer and sometimes scatter in a certain bed. Among the species of invertebrates I have identified the following.

Inoceramus orientalis SOKOLOW
I. schmidti MICHAEL var. *mirabilis* NAGAO & MATUMOTO
Parallelodon (*Nanovavis*) *sachalinensis* (SCHMIDT)
Pedalion sp.
Patella (s. l.) cfr. *gigantea* (SCHMIDT)

The second species was misrecorded by NAGAO & ÔTATUME (1938) as *Inoceramus japonicus* NAGAO & MATUMOTO. According to ÔTATUME, he has collected *Eupachydiscus haradai* (JIMBO) from the lower part of the formation at Osatinai.

In the formation like the present one which has rock-facies as described in the preceding article, we may hardly expect to have numerous species of marine organism. And this defect of record may afford an apparent gap in the sequence of fossils from the Basal member to the Lower Sandy siltstone (IVb).

IVb. The Lower Sandy siltstone is fossiliferous throughout the formation. Among the important species of invertebrate, the following has been found. (One with * occurs commonly.)

* *Neophylloceras hetonaiense* MATUMOTO MS.
* *N. hetonaiense* var. *neraforme* MATUMOTO MS.
* *N. hetonaiense* var. *subtuberculata* MATUMOTO MS.
Anagaudryceras ryugasense MATUMOTO MS.
* *Epigoniceras popetense* YABE and var. *frequence* MATUMOTO
Bostrychoceras awajiense (YABE) emend.
Glyptoxoceras cfr. *indicum* (FORBES)
* *Damesites hetonaiensis* (SAITO MS)
Canadoceras compressum MATUMOTO MS
* *Pachydiscus* (s. s.) *japonicus* SAITO MS.
P. (s. s.) aff. *egertoni* (FORBES)
Hauericeras rembda (FORBES)
Inoceramus shikotanensis NAGAO & MATUMOTO

Besides them NAGAO & ÔTATUME (1938) informed the occurrence of bivalves and snails such as *Nucula* (*Acila*) *hokkaidoensis* NAGAO, *Yoldia hakobutsensis* NAGAO & ÔTATUME, *Parallelodon* (*Nanovavis*) *elongatus* NAGAO & ÔTATUME, *Trigonia subovalis* JIMBO, *Solemya* cfr. *angusticaudata* NAGAO, *Anisomyon ezoensis* NAGAO & ÔTATUME, *Helcion* (?) *problematicus* NAGAO & ÔTATUME, *Pseudoperissitys bicarinata* NAGAO & ÔTATUME, etc., And in my collection some other species seems to be added.

IVc. The main part of the Middle Sandstone is of a neritic facies sometimes containing marine mollusca. But fossil of ammonite has not yet been found. The species of *Inoceramus* are:

Inoceramus hetonaianus MATUMOTO MS.
I. sp. indet. cfr. *shikotanensis* NAGAO & MATUMOTO

The fossils described by previous investigators (NAGAO & ÔTAVUME 1938) are *Yoldia hukobutsensis* NAGAO & ÔTATUME, *Trigonia subovalis* JIMBO, *Periplomya elliptica* NAGAO & ÔTATUME,

Cyprimeria (?) sp., "*Aphrodina*" cfr. *pseudoplana* (YABE & NAGAO), and *Solarium* (?) sp.

IVd. Only a small number of fossil has been collected from the Upper Sandy siltstone. And the following three species are important.

Neophylloceras compressum MATUMOTO MS.
Pachydiscus (s. s.) *japonicus* SAITO MS.
Inoceramus hetonaianus MATUMOTO MS.

The above described knowledge on the sequence and assemblage of fossils in the Group may afford us an important basis for the biostratigraphic definition of the uppermost Cretaceous age. The subject is to be treated with in Part II of this memoir.

TABLE SHOWING LOCALITIES AND HORIZONS OF EXPOSURES
IN
THE HETONAI DISTRICT

(北海道膽振國邊富內地方)

Locality Number	Horizon	Place-name
H1, H2	III	Eastward from Hetonai-bridge
H3	III (Tuff-bed)	Southern end of Hetonai-bridge
H4, H5	III	
H6	IVa	
H7a\b-f	IVa2\IVa3	On the southern side of the Mukawa,
H8	IVa3	from Hetonai-bridge to Ômagari
H9a\b-d\e	IVa4\IVa5\IVa6	(鵡川南岸, 自 邊富內橋 至 大 曲)
H10a\b-e	IVa6\IVa7	
H11	IVb	
H12	IVb	
H13	IVc1	Ômagari
H14	IVc1-IVc6	
H15a\b	IVc6\IVd	

Locality Number	Horizon	Place-name
H16	IVa1, 2	On the northern side of the Mukawa, from
H17	IVa3	Hetonai to the Panketosa-no-sawa, mostly the
H18a\b-f\g	IVa4\IVa5\IVa6	railway cutting.
H19a-f\g-i\j	IVa6\IVa7\IVb	(鵡川北岸 — 主として鐵道切割)
H20	IVb	自 邊富内
H21a\b-f	IVb\IVc1	至 パンケトサの澤
H22	IVb	
H23	IVb, IVa7	A small valley at the western } end of the
H24a, b, ··· h	IVa7–IVa1	A small valley at the eastern }
H24i/j	III-IVa/III	cliff of loc. H22.
H25a|b-e	IVb|IVc	Railway cutting, west of the Panketosa
H26—H30	IVb	Lowest course of the Panketosa-no-sawa.
H31a\b	IVb\IVc	(パンケトサの澤下流)
H32, H32′	IVc (c1, c2, c3,)	
H33a\b-d	IVc2\IVc3	
H34\H35	IVc2\IVc3	Middle course of the Panketosa-no-sawa
H36a\b	IVc3\IVc4	(パンケトサの澤中流)
H37a, b, c, d	IVc3, c4, c5, c6	
H38a-c|e	IVc2, c3|IVb	
H39a-h|i	IVc4–c6\IVd|IVb	(A small tributary)
H40	IVc4	
H41a\b	IVc5\IVc6	
H42a\b	IVc3\IVc4	
H43, H43′	IVc3	Upper course of the Panketosa-no-sawa
H44, H48	IVc2	(パンケトサの澤上流)
H45	IVc1	
H46, H47	IVb	

H50, H51	IVb	
H52	IVb/IVa7	A left tributary of the Panketosa-no-sawa
H53—H55	IVa(6,7)	(パンケトサの澤中流左支流)
H56—H59	IVb	
H60	IVb/IVa	
H61—H65, H67	Poronai Formation	
H66	IVc	'The Hukausi-zawa
H68	IVc\Poronai Form.	(深牛澤)
H69a-g/h	IVb/IVa7	
H72—H74	III	Upper course of the Boti-no-sawa
H75	III\III-IVa\IVa	(墓地の澤上流)
H77a, b,	Block derived from IVa and III-IVa	
H78	III	The valley of the Pompokomonai, north-west
H79a, b\c\d	III\III-IVa\IVa1	of the Hetonai
H80a, b	Block derived from III and III-IVa	(ポンポコモナイの谷)
H81a\b\c	III\III-IVa\IVa1	
H83a\b\c\d	III\III-IVa\IVa1\IVa2	
H82, H84—H88	III	
H100a	Tuff-bed in III	Porokesyomap, near Osatinai along the Saru-
H100b	III	gawa, Saru-gun, Province of Hidaka
H100c	III-IVa	(日高國沙流郡幌去村ポロケシオマップ沙流川北岸道路切割)
H100d-f	IVa1-IVa3(?)	

Chapter IV

Upper Cretaceous Deposits of the Urakawa District, Southern Central Hokkaidô

(Pl. XVIII, XIX)

INTRODUCTORY REMARKS

The neighbourhood of Urakawa[1], province of Hidaka, Hokkaidô is famous for the prolific yielding of Cretaceous fossils. The area[2] is situated on the sea shore about 45 km. northwest of Cape of Erimo[3] where the southern end of the backbone of Hokkaidô submerges in the Pacific Ocean. It is the southernmost distributional area of the fossiliferous Cretaceous deposits on the western side of the Central Range of Hokkaidô.

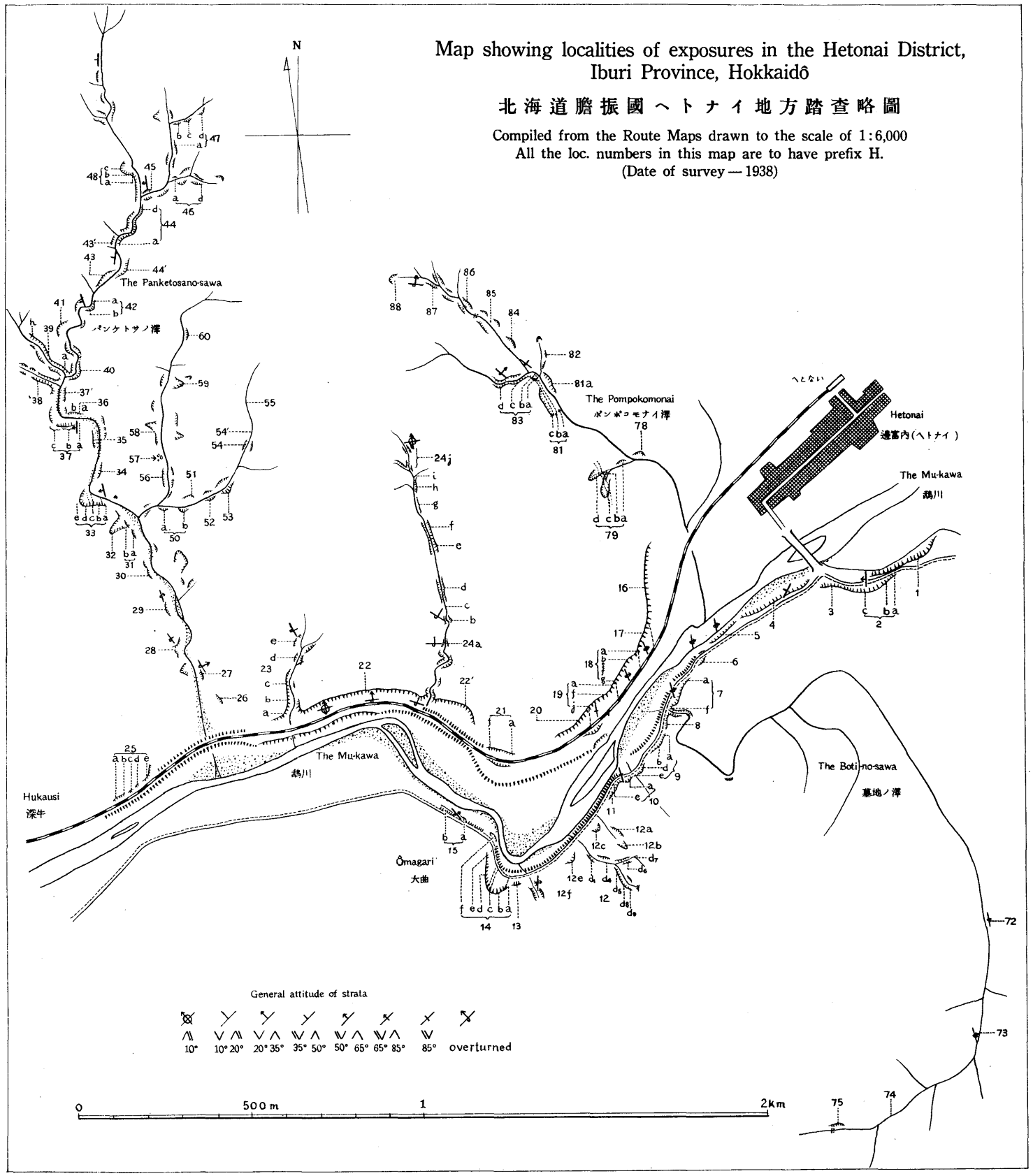
The fossils from this district were described and illustrated, together with those from other Cretaceous district, in 1890 by Dr. M. YOKOYAMA and in 1894 by Dr. K. JIMBO. Since that time many geologists and palaeontologists visited the area and collected fossils. Concerning geology or stratigraphy of the district, we have owed much to T. IKI (1911), Y. IGARASHI (1931 MS.), and Y. TAKENOUTI & M. SANBONSUGI (1938). The result of the second investigation made under the guidance of Prof. H. YABE and Dr. S. SHIMIZU of the Tôhoku Imperial University had not been published, but I had opportunity of reading the manuscript owing to the kindness of the director of the Institute.

Middle Cretaceous deposits including the Lower Ammonite Group and the *Trigonia* Sandstone were ascertained by recent research of SAMBONSUGI to develop in the district besides the hitherto well-known Upper Cretaceous. But the sequence of fossils in the Cretaceous rock of the Urakawa district is much less complete than in other districts already described. The rich fossils

(1) 北海道日高國浦河町附近

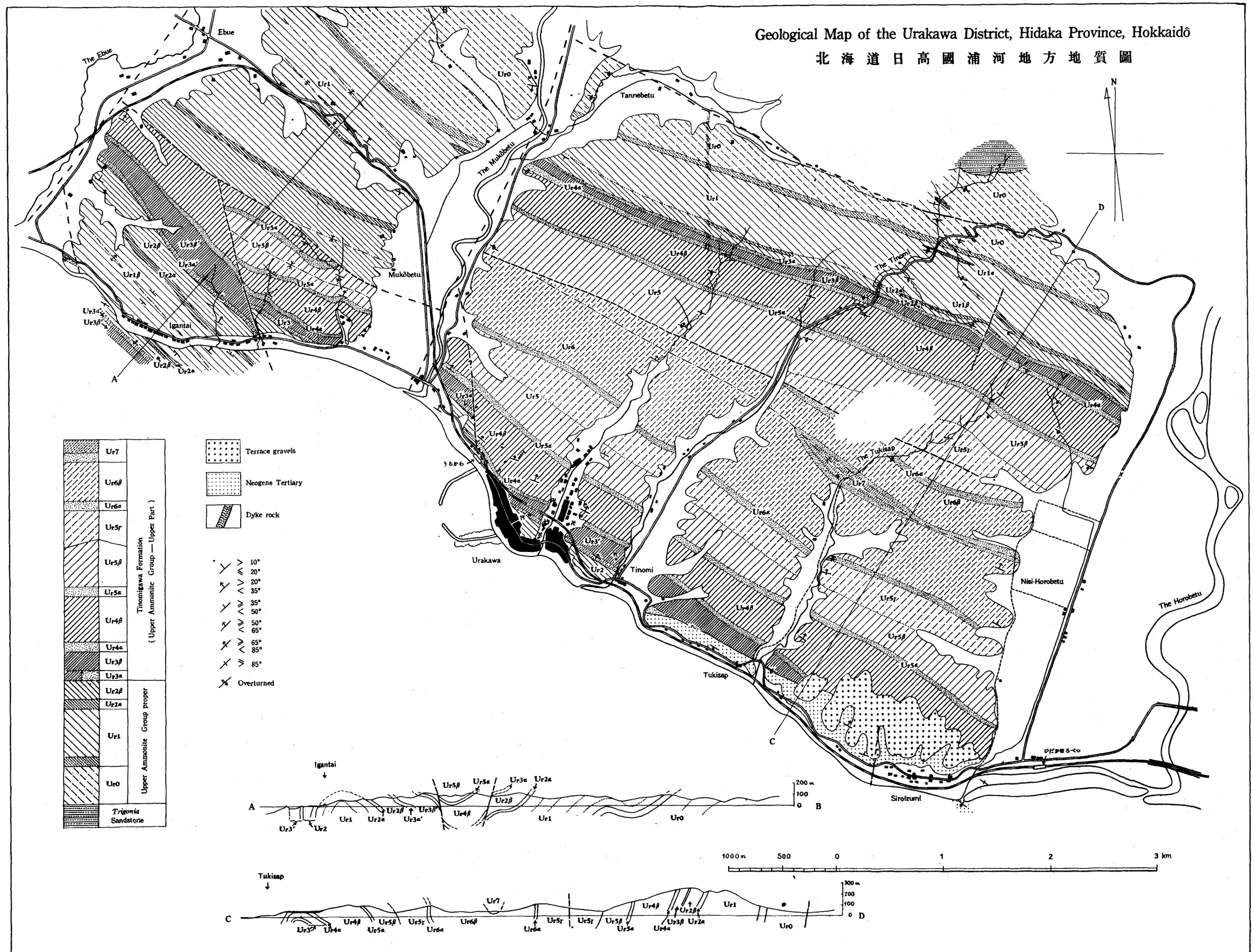
(2) Urakawa is a local town which is communicated with Sapporo (札幌) by the railway via Tomakomai (苫小牧).

(3) 襟裳岬


Map showing localities of exposures in the Hetonai District, Iburi Province, Hokkaidô
北海道膽振國ヘトナイ地方踏査略圖
Compiled from the Route Maps drawn to the scale of 1:6,000
All the loc. numbers in this map are to have prefix H.
(Date of survey — 1938)
N
The Panketosano-sawa
パンケトサノ澤
The Pompokomonai
ポンポコモナイ澤
Hetonai
遠富内(ヘトナイ)
The Mu-kawa
鵡川
Hukausi
深牛
Ômagari
大曲
The Boti-no-sawa
墓地ノ澤
General attitude of strata
10° 10°20° 20°35° 35° 50° 50° 65° 65° 85° 85° overturned
0 500 m 1 2km

Geological Map of the Urakawa District, Hidaka Province, Hokkaidô

北海道日高國浦河地方地質圖



are yielded only from the restricted part of the Upper Cretaceous formation, whereas in the remaining parts organic remains are rather scanty. Accordingly the district is not adequate to carry on biostratigraphic study throughout the whole series of deposits. But so far as the fossiliferous part is concerned I hoped to acquire the accurate knowledge, for the knowledge of previous works is incongruent with that of my works made in Naibuti, Abesinai, Isikari and Hetonai districts. So I selected the typical area where fossiliferous Upper Cretaceous is exposed and surveyed during summer in 1940. The investigated area is small, as is indicated on geological map, with a length of 10 km along the coast and a breadth of less than 5 km landward.

PHYSICAL AND GEOLOGICAL CONDITIONS IN GENERAL

Geology of the southern part of the Central Mountain-range of Hokkaidô has not been fully investigated. According to the previous knowledges, expecially to the recent one obtained by the geologists of Hokkaidô, the range has a geologic structure with general trend of NW-SE. Its axial part is occupied by plutonite of granite, diorite and gneiss, and westward from the axis we find an approximately zonal arrangement of the sedimentary series from older to younger. The older formations are ambiguous in their age and in their exact relation to the unequivocal Cretaceous sedimentary rocks. The outermost formation of the former is mainly composed of "schalstein" with subordinate cherts and limestones and is said to have resemblance with the Onisasi Group. On the western side of this formation distributed the Lower Ammonite Group, *Trigonia* Sandstones and the Upper Ammonite Group. The Mesozoic rocks are covered unconformably with the Neogene Tertiary.

The neighbourhood of Urakawa is a portion of the southwestern side of the Central Range 20 to 25 km away from the backbone and is a coastal area occupied by hills and low mountains. In a nirection vertical to the general structural trend, are developed the major valleys of the Motourakawa(1) and the Horobets(2), and the smaller valleys of the Ebue(3) and the Mukobets(4). They are falt-line valleys which divide the area in several structural blocks. The Upper Cretaceous Upper Ammonite Group occupies

(1) 元浦川 (2) 幌別川 (3) 繪笛川 (4) 向別川

the area with a length of 20 km along the coast from the mouth of the Motourakawa to Syamani[1] and a breadth of 5 km (±). And the narrow distribution of Neogene[2] is found in a portion along the sea-shore.

The area occupied by the upper Cretaceous sedimentaries have the folded structure with a synclinorium and "Blattverschiebungen". The general trend of strata is NW–SE or NWW–SEE. Differences are found block by block in the detailed form of folding, the position of axis, presence or absence of strike fault and other minor features. The details are expressed on the geological map and in the geological profile (pl. XVIII). Besides the sedimentary rocks, we find small dikes of monchiquite cutting the Cretaceous here and there.

Owing to the topography of low relief, the exposure of rock is not good in the district except for certain local places. Accordingly the stratigraphic position of some of the fossil-localities are unable to be determined exactly, and the meter by meter collection of fossil is impossible in some case. Two blocks, one "the Urakawa block" between the valleyes of the Horobets and the Mukobets, the other "the Ikandai (Igantai)[3] block" between the valleys of the Mukobets and the Ebue, have offered us the material enough to study the problem, although good exposures are restricted to the coastal region and to the upper valleys of the small rivers such as the Urakawa, the Tinomi[4], and the Tukisap[5] and, moreover, some of the cliffs have suffered from the indiscriminate collection of the contained fossils.

STRATIGRAPHY OF THE UPPER AMMONITE GROUP OF THE DISTRICT

General account.—— The Upper Ammonite Group of the Urakawa district is, like that of other districts, composed mainly of comparatively fine-grained sedimentary rocks of rather monotonous and homogeneous character and contains calcarceous nodules which are sometimes fossiliferous. The fossils are mainly those

(1) 様似

(2) The Neogene consists of ill-sorted conglomerates and cross-laminated very coarse sandstone at its base and compact, massive siltstones containing containing concretions. It was considered to have a fault-relation with the Cretaceous, but a marked unconformity was discovered recently by K. ÔTATUME.

(3) 井寒臺 (4) 乳呑川 (5) 月寒川

of marine organisms like ammonoids, *Inoceramus*, and other molluscs. The thickness is estimated approximately 2,500 m.

Examining in detail, the group is not homogeneous throughout the whole thickness from bottom to top, but a certain degree of difference is found in some part. Generally speaking, in the lower half fine-grained mudstones are predominant, while in the upper half sandy siltstones considerably replace mudstones and the intercalation of sandstone is more frequent. On account of these features the Upper Ammonite Group of the district is divisible into two parts, the lower part or the Upper Ammonite Group proper and the upper part or the **Tinomigawa Subgroup**[1]. As will be clarified later (Part II and Part III) the latter chronologically corresponds to the Hakobuti Group proper of the Isikari coal-field but has much affinity of facies with the Upper Ammonite Group proper.

We must, furthermore, note the following minor characters. (1) The lower part includes sandy siltstone at a certain horizon, whereas the upper part comprises the formation as fine and homogeneous as that of the lower part. (2) Member of sandstones (with subordinate conglomerates and the alternating shale and sandstone) occurs at several horizons. (3) Occurrence of fossil is not uniform throughout the whole thickness; there are very fossiliferous layer, while some part is scanty of organic remains, although the lithologic character presents no noticeable difference between the two. Depending on these minor features, further subdivision is possible as will be described below. The subdivisions are here marked as Ur_0, Ur_1... and Ur_7 according to the ascending order of stratigraphic sequence. (More detailed subdivision is represented by using α and β). Comparing the northern and southern wings of the synclinorium, the details of lithology in some of the subdivisions are different, although the difference is not great.

In the following, I will describe the subdivisions in an ascending order in connection with their rock-facies or lithological characters, occurrence and assemblage of fossils, typical exposures, etc. The succession of rock and sequence of fossil in the Upper Ammonite Group of the district may thus be presented.

[1] The name of the Tinomigawa Formation (乳呑川層) was used by IGARASI in his manuscript. His term is adopted here with an emended definition.

Lower part (Upper Ammonite Group proper)

Subdivision Uro_0. Mudstones or shales, bluish dark grey; beds of white tuff is sometimes intercalated. Large or small concretion of marl is contained, but the concretion is almost always barren of fossil. The lower part is interstratified with thin layers of fine-sandstone and passes down to the sandstone and shale of the *Trigonia* Sandstone Group. The upper limit of the subdivision is conventionally defined below the First Sandstone Member of subdivision Ur_1. The thickness seems to be approximately 500 m. The distributional area in the district is the uppermost valley of the Tinomi[1], the lower valley of the Tannebets[2] and part of Ebue.

The subdivision is scanty of fossil, only the following two species have been collected from loc. U 58 and U 634 respectively.

Inoceramus cfr. *hobetsensis* NAGAO & MATUMOTO

Inoc. teshioensis NAGAO & MATUMOTO

Subdivision Ur_1

First Sandstone Member. In the midst of the Upper Ammonite Group proper of the district there is a member of sandstone about 70 m thick. The member consists of thick beds of medium to coarse sandstones and layers of laminated sandstones alternating with black shale. The latter is subordinate and the laminated part contains minute carbonaceous flakes. The heavy bedded sandstones contains a characteristic spherical calcareous concretions. The sandstone is well traced as a key-bed in the field and typically exposed at loc. U 161 (second branch of the upper valley of the Tinomi), U 57 (a hill of shrine at Tannebets), U 632 (western part of Mukobets) and U 679 (railway cutting in the valley of the Ebue). No determinable organic remain has been found in the member.

I think it reasonable to divide the Upper Ammonite Group by this member, placing it at the base of the subdivision Ur_1. As several members of sandstone occurs in the upper Cretaceous of the district, I prefer to use a conventional name as entitled above.

Main part of Ur_1 consists of dark grey mudstones or shales sometimes interstratified with thin layers of very fine sandstone. Siliceous tuffite or white tuff is found at horizons. The mudstone

[1] 乳呑川源流々域　　[2] タンネベツ下流の谷

contains marly nodules which are only rarely fossiliferous in the lower part but often very fossiliferous in the upper part. The lower less fossiliferous part may be marked as $Ur_1\alpha$ and the upper fossiliferous part may be marked as $Ur_1\beta$, although a sharp boundary cannot be determined between the two. The whole thickness of the main part of Ur_1 is estimated about 500 m.

The subdivision is distributed in the northern mountanous zone of the Urakawa block and in the area between Ebue and Mukobets of Ikandai block. Zone $Ur_1\beta$ is found, furthermore, in the axial region of an anticline along the coast of Ikandai.

From the fossil localities of subdivision $Ur_1\alpha$ (U 135, U 161 p, U 164, U 165 p, U 166 p (pars). U 616, etc.), I have collected the following species.

Inoceramus cfr. *ezoensis* YOKOYAMA
Inoc. naumanni YOKOYAMA em.
Gaudryceras denseplicatum (JIMBO)
G. tenuiliratum YABE em.
Damesites semicostatus (YABE MS.)
D. sp. juvenile cfr. *damesi* (JIMBO)
Bostrychoceras (*Hyphantoceras*) *miotuberculatum* MATUMOTO MS.

The subdivision $Ur_1\beta$ forms a fossil zone which contains a large number of fossils and a characteristic assemblage of species. Fossils have been collected from exposures loc. U 140, U 141, U 142, U 143, U 166 (?), U 134, U 504, U 505, U 506, U 595, U 596, etc. and the boulders of concretion derived from these outcrops. And they are classified into the following species, among which those with * are represented by the especially abunant individuals.

* *Inoceramus ezoenis* YOKOYAMA
Inoc. ezoensis var. *vanuxemiformis* NAGAO & MATUMOTO
* *Inoc. amakusensis* NAGAO & MATUMOTO
Inoc. japonicus NAGAO & MATUMOTO
Inoc. aff. *pilvoensis* SOKOLOW
* *Inoc. naumanni* YOKOYAMA em.
Inoc. orientalis var. *ambiguus* NAGAO & MATUMOTO
* *Scurria cassidaria* (YOKOYAMA)
Neophylloceras subramosum SHIMIZU
Phyllopachyceras ezoense (YOKOYAMA)
Epigoniceras glabrum (JIMBO) em.

E. sp. indet. aff. *cala* (FORBES)
Anagaudryceras yokoyamai (YABE) em.
* *Gaudrycems denseplicatum* (JIMBO)
G. denseplicatum var. *kawadai* MATUMOTO MS.
* *G. tenuiliratum* YABE em.
G. tenuiliratum var. *frequence* MATUMOTO MS.
G. tenuiliratum var. *substriata* MATUMOTO MS.
G. cfr. *striaium* var. *paucistriata* MATUMOTO MS.
Zelandites cfr. *kawanoi* (JIMBO)
* *Damesites damesi* (JIMBO)
D. semicostatum (YABE MS.)
* *D. sugatus* (FORBES) em.
Schlüteria cfr. *diphylloida* (FORBES)
Hauericeras gardeni BAYLEY
* *H. gardeni* var. *angustum* YABE em.
* *Parapuzosia (Mesopuzosia) ishikawai* (JIMBO) em.
Eupachydiscus haradai (JIMBO) em.
Anapachydiscus sutneri (YOKOYAMA)
A. naumanni (YOYOYAMA) em.
Menuites sp. aff. *M. menu* (FORBES)
Polyptychoceras obstrictus (JIMBO) em.
* *P. pseudogaultinum* (YOKOYAMA) em.
* *P. haradanum* (YOKOYAMA) em.
P. jimboi MATUMOTO MS.
P. sp. indet. cfr. *P. yubarensis* (YABE MS.)
Pseudoxybeloceras sp. cfr. *P. sanushibense* (YABE MS.)

Subdivision Ur_2 Near the top of the Upper Ammonite Group proper in the present district, we find somewhat fine-sandy mudstones comprising beds of fine-grained glauconitic sandstone. This part is 30 m thick in the northern wing and 50 m or more thick in the southern wing of the synclinorium. It is again followed by finer and more homogeneous mudstones of the typical facies of the Upper Ammonite Group, although a layer of glauconitic silty fine-sandstone and a bed of white tuff are intercalated in the mudstones. The thickness of the upper part is 100 m (in the northern wing) or 150 m (in the southern wing). These parts contains nodules of marls and in general richly fossiliferous, being characterized by a definite assemblage of fossils. Thus we can define

the subdivision Ur_2 at the uppermost horizon of the Upper Ammonitie Group proper of the district. And the lower and the upper parts of the unit are here conventionally marked as $Ur_2\alpha$ and $Ur_2\beta$ in the northern wing and $Ur_2\alpha'$ and $Ur_2\beta'$ in the southern wing.

The distributional areas of the subdivision Ur_2 are, as presented on the geological map, a part of the upper valleys of the Tinomi, a part of the coastal region of Ikandai, the central zone of the Ikandai block, a part of Urakawa-town, and the western part of Utoma[1].

Fossils of the subdivision are preserved either in concretion of marl and in the country rock. The members, as listed below, are mainly those found also in the zone $Ur_1\beta$, although a number of new elements are found. The assemblage of fossil is, therefore, of intermediate character between that of the subjacent part (subdivision Ur_1) and that of the superjacent part (Ur_3 and Ur_4). Shortly the subdivision Ur_2 forms a fossil-zone, many of its species being represented by abundant individuals. Among the four subdivisions of Ur_2 (α, α', β, β') there is no noticeable difference in fossil-assemblage.

The exposures of the zone Ur_2 from which I have collected fossils are as follows:

α: U 144, U 145, U 153, U 154;
α': U 3, U 13 (?), U 508, U 511, U 601, U 617 (?); (Utoma 4, 5)
β: U 146, U 147, U 149, U 150, U 151, U 152;
β': U 509, U 510a, U 512, U 513, U 600 (a, b, c), U 618 (?)

Among the fossiliferous blocks near these localities, those whose origin were determinable are

α: U 144 p1—p5, U 145 p1, p2, U 149 p1, p2, U 150 p1, p3, p8, p14, p21, U153 p1—p8, U 154 p1—p7;
α': U 600 c 38 (?);
β: U 146 p1—p3, U 147 p1—p3, U 149 p3, p4, U 150 p2, p5, p6, p7, p9—p13, p15—p20, U 151 p, U 152 p;
β': U 600 c2, c3, c4, c6, c12, c13, c21, c25, c27—c34, c37, U514 p.

From the cliffs of Urakawa town, where this zone is exposed, I have collected few fossils, because nodule is at present very poorly contained in the exposure owing to the previous collection.

(1) 鵜苫

The following species have been determined among my collection from the zone Ur_2. (Those with * is the most abundant and characteristic)

* *Inoceramus ezoensis* YOKOYAMA
Inoc. amakusensis NAGAO & MATUMOTO
Inoc. balticus BOEHM (s. l.)
Inoc. (*Endocostea*) sp.
Inoc. naumanni YOKOYAMA em.
* *Inoc. orientalis* SOKOLOW
* *Inoc. orientalis* var. *ambiguus* NAGAO & MATUMOTO
* *Inco. pseudosulcatus* NAGAO & MATUMOTO
* *Inoc. pseudosulcatus* var. *miosulcatus* MATUMOTO MS.
Inoc. pseudosulcatus var. *elegans* SOKOLOW
* *Scurria cassidaria* (YOKOYAMA)
"*Patella*" *gigantea* (SCHMIDT) var.
Neophylloceras subramosum SHIMIZU
N. compressum MATUMOTO MS.
N. hetonaiense MATUMOTO MS.
Phyllopachyceras ezoense (YOKOYAMA)
* *Epigoniceras glabrum* (JIMBO) em.
E. glabrum var. *sphaeronota* (JIMBO)
* *Anagaudryceras yokoyamai* (YABE) em.
* *Gaudryceras denseplicatum* (JIMBO)
G. tenuiliratum YABE em.
G. striatum (JIMBO) em.
G. striatum var. *lata* MATUMOTO MS.
Zelandites kawanoi (JIMBO)
* *Damesites damesi* (JIMBO)
D. semicostatus (YABE MS.)
D. sugatus (FORBES) em.
D. sugatus var. *intermedius* MATUMOTO MS.
Schlüteria diphylloida (FORBES)
Hauericeras gardeni (BAYLEY)
H. gardeni var. *angustum* YABE em.
Parapuzosia (*Mesopuzosia*) *ishikawai* (JIMBO) em.
P. (*M*) cfr. *japonica* (YABE MS.)
Kossmaticeras (*Yokoyamaoceras*) *jimboi* (YABE MS.)
K. (*Y.*) aff. *paravati* (STOLICZKA)

* *Eupachydiscus haradai* (JIMBO) em.
Anapachydiscus sutneri (YOKOYAMA)
* *A. naumanni* (YOKOYAMA) em.
Menuites cfr. *menu* (FORBES)
M. aff. *rotalinoides* (YABE)
Polyptychoceras obstrictus (JIMBO) em.
P. haradanum (YOKOYAMA) em.
P. cfr. *yubarensis* (YABE MS.)
P. jimboi MATUMOTO MS.
Gluptoxoceras tenuisulcatum (FORBES)
G. sp. indet. cfr. *G. indicum* (FORBES)

Upper part of the Upper Ammonite Group of the Urakawa district (Tinomigawa Subgroup)

Subdivision Ur_3

Second Sandstone Member ($Ur_3\alpha$, α') The upper limit of the Upper Ammonite Group proper of the present district is to be defined below the Second Sandstone Member. This member is 10 to 20 m thick sandstones and conglomerate in the northern wing of the synclinorium, whereas it is represented in the southern wing mainly by alternations of sandstones and shales with a thickness of 50 m or more. The relation between the subdivisions Ur_2 and Ur_3 is conformable, although a certain kind of change in sedimentational condition may have been taken place at the boundary.

The Second Sandstone Member in the northern wing, here marked as $Ur_3\alpha$, is typically exposed at localities U 49, U 132 and U 148. The conglomerate of the member forms lenticular layers, which are intercalated in the sandstone or passes gradually to the pebble-bearing sandstone. The conglomerate is sorted in a considerable degree containing well rounded pebbles and few cobbles of cherts, hornstones, compact sandstones and acidic volcanic rocks. The conglomerate as well as the sandstone sporadically contains fossils of marine shell which is either fragmentary or not. And the following species have been identified.

Inoceramus orientalis SOKOLOW
Inoc. pseudosulcatus NAGAO & MATUMOTO var. *elegans* SOKOLOW.
Inoc. cfr. *ezoense* YOKOYAMA

Patella (s. 1.) *gigantea* (SCHMIDT)
Phyllopachyceras ezoense (YOKOYAMA)
Gaudryceras striatum (JIMBO) em.
Canadoceras kossmati (YABE MS.) em.

The southern equivalent of the Second Sandstone Member, here marked as $Ur_3\alpha'$, is best exposed at localities U 510 b, c, U 519, U 524, U 525, and U 526, at Utoma and at loc. U 2 c, d of Urakawa. In the member the alternations of sandstones and shales are dominant, but a thick bed of massive sandstone is found in some part. Strata of the former are usually thin (less than a half metre) and the sondstone is often laminated. Fossils have been collected from the sandstone, sandy siltstone and the concretionary part, although they are not distributed abundantly and uniformly throughout the member. Among the typical ones are the following:

Inoceramus orientalis SOKOLOW
I. schmidti MICHAEL
Canadoceras kossmati (YABE MS.) em.

Main part of subdivision Ur$_3$ ($\mathbf{Ur}_3\beta$) The Second Sandstone Member is followed by fine-sandy siltstones (or mudstones) of dark colour. The upper limit is below the Third Sandstone Member, which, in turn, is to be placed at the base of the subdivision Ur_4. The whole thickness is 40 m to 60 m. The subdivision is exposed, together with the Second Sandstone, adjacent to the subdiv. Ur_2 on its southern or northern side.

Fossils are contained fairly commonly, if not abundantly. The important fossil localities are U 131 and U 510 d. And some of the fossiliferous blocks collected at loc. U 610 c (c5, c7, c8, c10, c11, c15, c16, c20, c22, c23, c24, c26, c35, c36) are cetainly those derived from Ur_3. As in the case of zone Ur_2, no fossil of this subdivision has been collected at Urakawa, though the list of composite nature presented by previous investigator suggests the yielding in former occassion.

The species that I have determined are as follows:

Inceramus sp. cfr. *ezoense* or *balticus*
Inoc. orientalis SOKOLOW
Inoc. orientalis var. *ambiguus* NAGAO & MATUMOTO

* *Inoc. schmidti* MICHAEL
Inoc. sachalinensis SOKOLOW
Scurria cfr. *cassidaria* YOKOYAMA
Neophylloceras compressum MATUMOTO MS.
Phyllopachyceras cfr. *ezoense* YOKOYAMA
Epigoniceras popetense (YABE) em.
Gaudryceras striatum (JIMBO) em.
G. crassicostatum (JIMBO)
Schlüteria diphylloida (FORBES)
Damesites sp. indet. cfr. *damesi* (JIMBO)
Eupachydiscus haradai (JIMBO)
Canadocera kossmat (YABE MS.) em.
Menuites aff. *portlocki* (SHARPE)
Pseudoxybeloceras (*Ryugasella*) *ryugasense* MATUMOTO MS.
Baculites sp.

Subdivision Ur_4

Third Sandstone Member ($Ur_4\alpha$) This is a member of sandstone at the base of the subdivision Ur_4. It is about 30 m thick, consisting mainly of medium-grained sandstone, well sorted, light bluish greenish, and massive though there is partial lamination. Lenticular layer of conglomerate is found in subordinate amount. It is also well sorted, containing well rounded pebbles of those rocks such as found in the pebbles of the Second Sandstone Member. At the base of this sandstone or conglomerate there is no significant break of sedimentation.

The member is a good key-bed in the field, its chief exposures being found at localities U 8, U 10, U 27, U 48, U 54, U 55, U 130, U 206, U 247, U 272, U 501, U 539, etc. The sandstone contains fossils sporadically, *Inoceramus orientalis* SOKOLOW, *Inoc. schimidti* MICHAEL, and its variety *mirabilis* NAGAO & MATUMOTO being found. An external mold comparable to that of *Pseudoxybeloceras* (?) *kawadai* MATUMOTO MS has been detected.

Main part of Ur_4 ($Ur_4\beta$) Mudstones or siltstones, generally very-fine sandy, bluish (± greenish) dark grey and weathered to brownish (ferruginous colour), and contains calcareous concretions of ellipsoidal or sphaerical shape. The rock is usually massive, but is part shaly and in some part a layer of glauconitic silty sandstone is intercalated.

The present subdivision is well defined between the top of the Third Sandstone Member and the base of the Fourth Sandstone Member. Its thickness is estimated about 300 m in the northern wing, while 250 m to less than 200 m in the southern wing. It is distributed in the southern side of the northern mountainous zone of the Urakawa block, in the main part of the southern wing of the same block and in the middle zone of the Ikandai block.

Fossils are fairly common throughout the subdivision, they are contained either in calcareous nodules and in the country rock. The preservation is good in the former case and usually not good in the latter. Either the adult specimens and the immature ones occur, and the shell is not fragmentary.

The localities where I have collected the fossils of this subdivision are U 9, U 18, U 21, U 45, U 47, U 123——U 128, U 246, U 252, U 271, U 542 and U 621.

The following are the important species, among which those with * are very characteristic and represented by numerous specimens. And, although the subdivision is not very laxuriant of fossil, it can be regarded as a fossil-zone.

Inoceramus orientalis SOKOLOW
* *Inoc. schmidt* MICHAEL
Inoc. sachalinensis SOKOLOW
* *Patella* (s. l.) *gigantea* (SCHMIDT)
Helcion sp.
Neophylloceras subramosum SHIMIZU
N. hetonaiense MATUMOTO MS.
Phyllopachyceras ezoense (YOKOYAMA) em.
Epigoniceras popetense (YABE) em.
E. popetense var. *laeve* MATUMOTO
Anagaudryceras sp. indet. aff. *A. ryugasense* MATUMOTO MS.
* *Gaudryceras striatum* (JIMBO) em.
G. crassicostatum (JIMBO) em.
Zelandites kawanoi (JIMBO)
Z. sp. indet. n. sp. (?)
Schlüteria diphylloida (FORBES)
Hauericeras sp. indet.
Pachydiscus cfr. *wittekindi* (SCHLUETER)

Eupachydiscus haradai (JIMBO) em.
* *Canadoceras kossmati* (YABE MS.) em.
* *Pseudoxybeloceras* (*Ryugasella*) *ryugasense* MATUMOTO MS.
Bostrychoceras paucicostatum MATUMOTO MS.
Baculites (s. str.) sp.
Metaplacenticeras cfr. *subtilistriatum* (JIMBO)

Subdivision Ur_5 This is composed of the sandstone member ($Ur_5\alpha$) at the base, lower fine sandy siltstones ($Ur_5\beta$), and the upper mudstones ($Ur_5\gamma$).

Fourth Sandstone Member ($Ur_5\alpha$) This resembles in lithological character the Third Sandstone Member. The thickness is 20 m or so. As a key bed the member is traced in the field, and the exposures are found at localities U 24, U 33, U 34, U 44, U 114, U 121, U 225, U 269, U 543, U 622, U 626, etc. The sandstone is rather massive in the main part, but stratified in the upper and lower parts. It is fossiliferous especially in the stratified portion. And the following three species have been determined.

Inoceramus schmidti MICHAEL
Inoc. orientalis SOKOLOW
Patella (s. l.) *gigantea* (SCHMIDT)

Lower Sandy Siltstones ($Ur_5\beta$) The Fourth Sandstone passes gradually upward to silty very fine sandstone and then fine sandy siltstones. The main part of this subdivision resembles in lithic character subdivision $Ur_4\beta$ described above. But examining in detail the rock is a little heterogeneous; mudstone predominates in some part, and fine silty sandstone becomes dominant in other part, furthermore, a remarkable bed of green sandstone is intercalated as observed at loc. U 42 c of the valley of Urakawa.

The surface-distribution of the subdivision is found on both wings of the central zone of Urakawa block and a narrow area of synclinal axis in the southeastern portion of the Ikandai block.

Thickness varies from 230 m to 350 m, the fact may be due to the obliqueness (or heterochronism) of the boundary of the sandy siltstones of $Ur_5\beta$ and more fine-grained mudstones of $Ur_5\gamma$.

Fossils are fairly common and locally very rich in the lower part of $Ur_5\beta$, but are rather rare in the upper part. They are found either in rock and in the contained calcareous concretion. The localities from which I have detected fossils are U 226, U 238,

U 239, U 240 (?), U 623, U 624 (lower part) and U 53, U 110, U 266 (upper part). As listed below, the fossil-assemblage of this subdivision is not much different from that of zone $Ur_{4l}\beta$.

Inoceramus ezoensis YOKOYAMA
Inoc. cfr. *balticus* BOEHM
Inoc. orientalis SOKOLOW
Inoc. schmidti MICHAEL
Inoc. cfr. *sachalinensis* SOKOLOW
Patella (s. l.) *gigantea* (SCHMIDT)
Phyllopachyceras ezoense (YOKOYAMA)
Epigoniceras popetense (YABE) em.
Gaudryceras striatum (JIMBO)
Schlüteria diphylloida (FORBES) em.
Canadoceras kossmati (YABE MS.) em.
Polyptychoceras pseudogaultinum (YOKOYAMA) em.
Psudoxybeloceras sanushibense (YABE MS.)
P. aff. *quadrinodosum* (JIMBO)
P. (*Ryugasella*) *ryugasense* MATUMOTO MS.
Glyptoxoceras sp. indet. cfr. *G. indicum* (FORBES)
Bostrychoceras paucicostatum MATUMOTO MS.
B. cfr. *awajiense* (YABE) em.
Baculites sp.

Upper Mudstones ($Ur_5\alpha$) Upper half of subdivision Ur_5 is the mudstone quite resembling that of the typical Upper Ammonite Group. But the fossil is rare and numerous nodule of marl is almost barren. In some part a lens of marl containing small rounded pebbles and fragments of shell is intercalated.

The subdivision is distributed adjacent to $Ur_{5l}\beta$ in the axial region of the synclinorium in the Urakawa block. The approximate thickness is 250 m or so.

As the exposure is bad in the axial region of the synclinorium where the uppermost part of the Cretaceous of the district is to be found, we cannot get an accurate knowledge. But the following sequence of strata seems to follow the already described formations.

Subdivision Ur_6

Fifth Sandstone Member ($Ur_6\alpha$) Medium to coarse sandstones,

stratified in part, and comprises strata of calcareous compact sandstone. Thickness of the member is uncertain, although exceeds 10 m at least and possibly attains 50 m. Typical exposures are localities U 255 and U 262 along the valley of the Tukisap.

Main part ($Ur_6\beta$) Mudstones, bluish dark grey, usually monotonous and homogeneous, but partly banded and compact, being better called shales. So far as the observed exposures are concerned, conceretion of marl is rather scarcely contained. The formation is not rich in fossil, only the deformed specimens of *Inoceramus* ammonoids and echinoids being found in the shale. From the fossil localities of U 230 and U 232, I have determined the following species.

Inoceramus orientalis SOKOLOW
Pecten (*Propeamusium*) sp.

The thickness of the subdivision may be 300 m or so.

Subdivision Ur_7 The Sixth Sandstone Member ($Ur_7\alpha$) and the succeeding sandy mudstone ($Ur_7\beta$) are the observable uppermost formation of the Cretaceous of the present district. It occupies a narrow belt along the axis of synclinorium in the Urakawa block, crossing the middle valley of the Tukisap. The upper limit is unknown owing to the erosion.

The sandstone is massive, bluish light grey, medium to very coarse and rarely contains fossil shell.

The fine sandy mudstone contains fossils, as observed at loc. U 260. The determined species are:

Inoceramus orientalis SOKOLOW (forma β)
Patella (s. l.) *gigantea* (SCHMIDT)

TABLE SHOWING LOCALITIES AND HORIZONS OF EXPOSURES
IN
THE URAKAWA DISTRICT *
(北海道日高國浦河地方)

Exposure-number	Horizon	Place-name
U2b	Ur2β′	Urakawa (浦河町)
U3	Ur2α′	
U7	Ur3β	
U8a\b	Ur4α\β	
U9	Ur4β	
U13	Ur2α′ (?)	
U18, U21	Ur4β	
U25	Ur2α′	
U34	Ur5α	
U43	Ur5β	Upper valley of the Urakawa (浦河の谷上流々域)
U45—U47	Ur4β	
U48	Ur4α	
U50	Ur3α	
U53	Ur5β	Cutting of the road between Urakawa and Tannebets (浦河・タンネベツ間道路切割)
U58	Uro	Tannebets (タンネベツ)
U110	Ur5β	Upper vallaey of the Tinomi (乳呑川上流々域)
U123—U128	Ur4β	
U130	Ur4α	
U131	Ur3β	
U132	Ur3α	
U133	Ur2β (top)	
U134	Ur1β	(A small right branch) (乳呑川上流右小支流)
U135	Ur1	

* Fossil-localities alone are listed.

U140—U143	Ur1β	
U144, U145	Ur2α	
U146, U147	Ur2β	"Syakin-zawa", a tributary of the upper valley of the Tinomi
U148	Ur3α	(乳呑川上流支流 "砂金澤"一假名)
U149—U152	Ur2β	
U153, U154	Ur2α	
U159	Ur3α (? possibly 4α)	
U164, U165	Ur1α	"Dani-no-sawa", a small left tributary of the upper Tinomi
U166	Ur1β	(乳呑川上流小支流 "だにの澤"一假名)
U208	Tertiary	Between Tukisap and Porosyuma (月寒・ポロシユマ間)
U220	Tertiary	Siroizumi (白泉)
U226	Ur5β	
U230, U233	Ur6β	
U238, U239	Ur5β	Nisihorobetu (西幌別)
U240, U246	Ur4β	
U247	Ur4α	
U252	Ur4β	
U260	Ur7	Valley of the Tukisap (月寒川流域)
U266	Ur5β	
U270, U271	Ur4β	
U503	Ur1 or 2	
U504, U505	Ur1β and blocks of Ur2α′, Ur2β′	
U506—U507	Ur1β	Wave-cut bench on the coast of Ikandai (井寒臺海岸海蝕臺)
U508 a\b, c	Ur1β\Ur2α′	
U509	Ur2β′	
U510 a\b-d	Ur2β′\Ur3α′	
U511	Ur2α′	Valley of the Ikandai (井寒臺川)
U512 U512r, U513	Ur2α′\Ur2β′	

Exposure-number	Horizon	Place-name
U540, U542	Ur4β	Ikandai-gakko-zawa （井寒臺國民學校の澤）
U595, U596	Ur1β	Road-cutting to the west of Ikandai （井寒臺西方道路切割）
U600 a, b; c	Ur2β′ and block of Ur2β and Ur3	Wave-cut beach on the boast to the west of Ikandai （井寒臺西方の海蝕臺）
U601	Ur2α′	
U603, U604	Ur2β′-3	Eastern side of the lower valley of the Ebue （繪笛川下流々域東側）
U605	Ur4β	
U616	Ur1	Mukobetu （向別）
U617	Ur2α(?)	
U618	Ur2β(?)	
U621	Ur4β	Hattori Stock-farm near Mukobetu （向別附近服部牧場）
U622, U626	Ur5α	
U623—U625	Ur5β	
U627	Ur4β	
U634	Ur0	Western bank of the Mukobetu （向別川西岸）

List showing the original horizon of the fossiliferous blocks (The block, the origin of which is uncertain, are omitted here)

U45p, U46p, U47p	: Ur4β
U134p	: Ur1β
U140p—U143p8	: Ur1β
U144p1—p8, U145p1, p2	: Ur2α
U146p1-p3, U147p1-p3	: Ur2β
U147p4, U149p1, p2,	: Ur2α
U149p3, p4,	: Ur2β
U150p1, p3, p8, p14, p21,	: Ur2α
U150p2, p5, p6, p7, p9-p13, p15-p20, U151p, U152p	: Ur2β
U150p4	: Ur3α
U153p1-p8, U154p1-p7	: Ur2α
U161p, U164p, U165p,	: Ur1α
U240p,	: Ur4β

U504p,	: Ur1β & Ur2β′
U510p,	: Ur1β or Ur2β′ or Ur3′
U514p,	: Ur2β′
U600 c2, c3, c4, c6, c12, c13, c21, c25, c26–c34, c37,	: Ur2β′
U600ap, U600 c5, c7, c8, c10, c11, c15, c16, c20, c22, c23, c24, c26 c35, c36,	: Ur3
U600 c38	: Ur2α′ (?)
U600 c14	: Ur2β′ or Ur3

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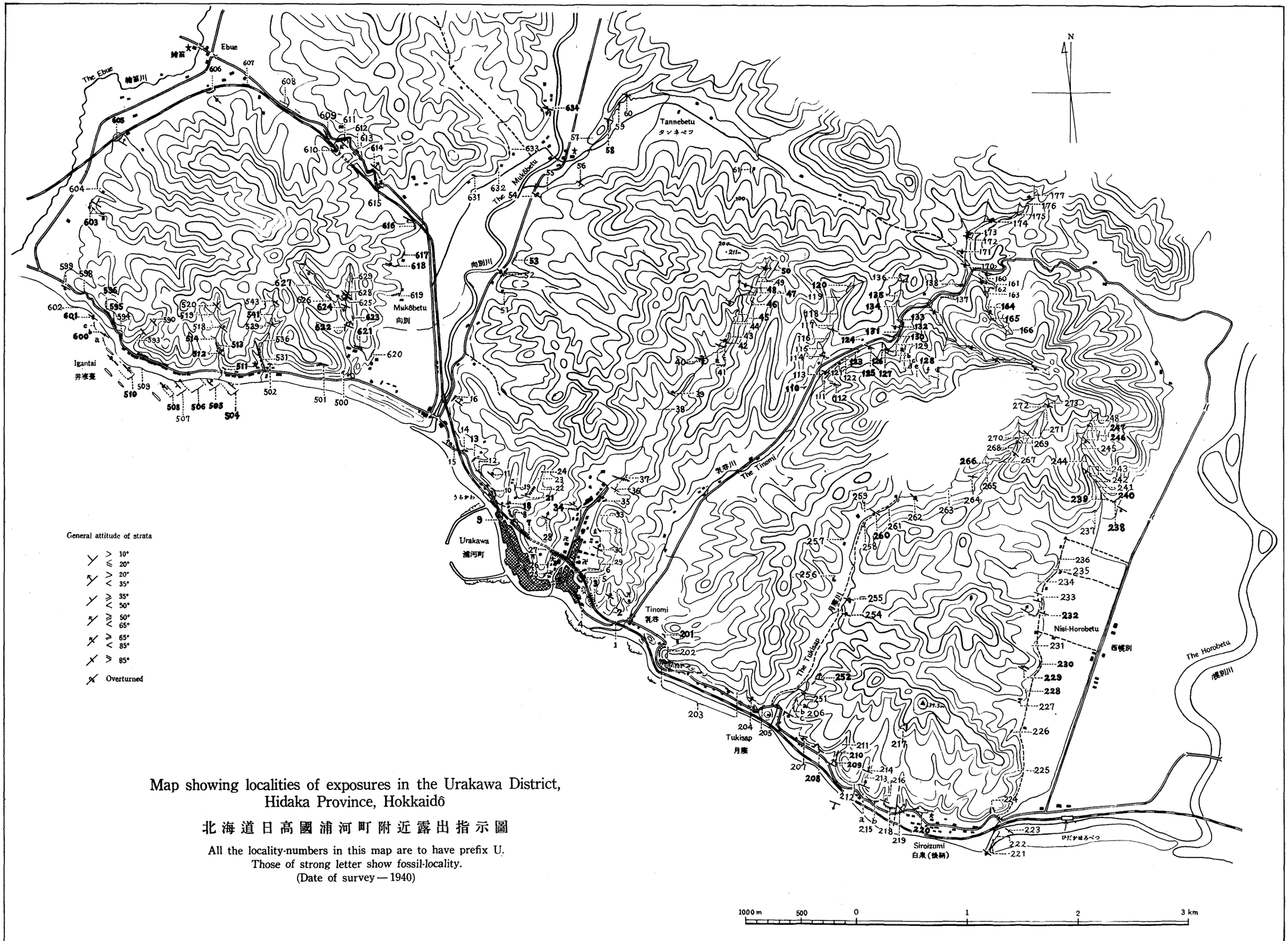
(Part I completed
Part II and III to be continued)



Map showing localities of exposures in the Urakawa District, Hidaka Province, Hokkaidô

北海道日高國浦河町附近露出指示圖

All the locality-numbers in this map are to have prefix U.
Those of strong letter show fossil-locality.
(Date of survey — 1940)

Examples of exposures of the Cretaceous strata

Fig. 1. Zone Mh 6 of the Miho Group (Upper Ammonite Group) at loc. N 23 along the Miho in the Naibuti district.

Fig. 2. Formation Rdy of the Ryūgase Group at loc. N 110 along the Miho in the Naibuti district.

Fig. 3. Saku Formation of the Middle Ammonite Group at loc. T 680 along the Abesinai, Tesio Province.

Fig. 4. Sandstone-bed containing fossil of *Inoceramus schmidti* var. *mirabilis* NAGAO & MATUMOTO, belonging to the Lower Sandstone (Subdiv. IV a5) of the Hakobuti Group in the Hetonai district.

Fig. 5. Ômagari Formation at loc. T 283 along the Abesinai, Tesio Province.

Fig. 6. Subdivision II g of the Middle Ammonite Group at loc. Y 243 along the Si-yubari, Isikari Province.

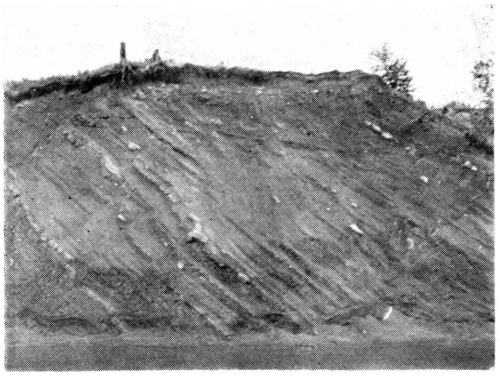


Fig. 1

Fig. 2

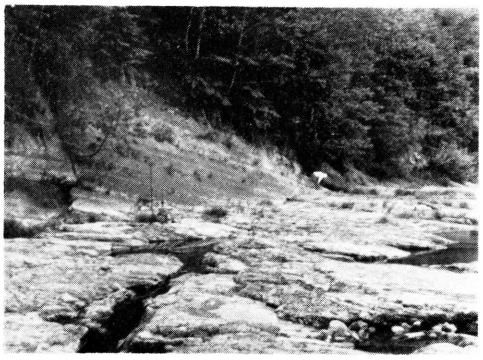


Fig. 3

Fig. 4

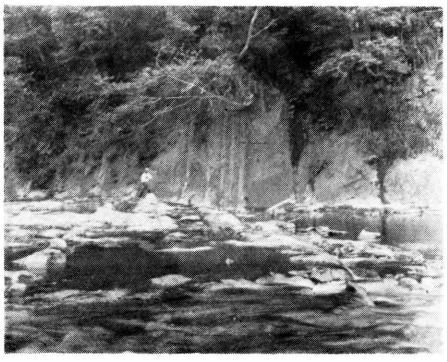


Fig. 5

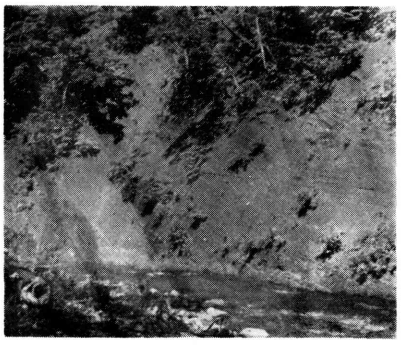


Fig. 6

T. MATUMOTO Photo.