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THE CRETACEOUS BEDS BETWEEN KUHN ISLAND AND CAPE FRANKLIN (GAUSS PENINSULA), NORTHERN EAST GREENLAND

BY

WOLF MAYNC
PH. D.

WITH 70 FIGURES IN THE TEXT AND 4 PLATES

KØBENHAVN
C. A. REITZELS FORLAG
BIANCO LUNOS BOGTRYKKERI
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PREFACE

The present paper dealing with the stratigraphy of the Cretaceous beds between Kuhn Island and Cape Franklin (Gauss Peninsula) is meant to be a second part of my memoir on the Mesozoic Stratigraphy of Northeast Greenland. A monograph on the Jurassic rocks of the same area has already been published (MAYNC 1947).

Because of the Second World War the publication of the present study, too, has been delayed for some years, and its incompleteness especially with regard to paleontological references is due to the fact that the author—spending the last six years in the Dutch East Indies—was, of course, completely cut off from the world during the war and the Japanese occupation of Java. As I have stressed in my paper on the Jurassic stratigraphy and as I wish to emphasize again in the present treatise, this deficiency due to want of the necessary literature on the geology of the Arctic, Russia etc. was quite indispensable. However, while merely a few supplements could be added to my memoir on the Jurassic beds, I have tried to complete the present paper as much as possible during my stay in Switzerland in 1946. It stands to reason, however, that it is still far from being exhaustive, all the more so as we are still in want of faunal lists, the fossils brought home from East Greenland having not yet been determined by the specialists to whom they have been sent[1]). Consequently, I do hope for indulgence on the part of my colleagues all over the world.

Some synoptic preliminary statements of the writer's results on the Mesozoic Stratigraphy have already been published (MAYNC 1938, 1939,

[1]) Quite recently, Dr. L. F. SPATH has published a brief account on the Cretaceous ammonite faunas of East Greenland (SPATH, L. F., 1946, Preliminary notes on the Cretaceous Ammonite faunas of East Greenland. Medd. om Gr., Bd. 132, Nr. 4). It is very much to be regretted that the present stratigraphical work had already been sent to print when L. F. SPATH's interesting report was issued, so that it is impossible to refer to it except in footnotes, unfortunately.

When the present monograph was in print Dr. J. SORNAY, Paris, who is at present engaged in working up our collections of Cretaceous *Inocerami* from East Greenland, has kindly provided me with some preliminary identifications for which I am much indebted to him.

1940), and a detailed study on the late Permian deposits of East Greenland has also appeared (MAYNC 1942).

The present paper will give an account of the actual status of our knowledge of the Cretaceous strata in the above-mentioned region and is largely based upon my own stratigraphical researches.

Particularly, I tender cordial thanks to Dr. L. F. SPATH, London, for having answered most willingly all my inquiries concerning the identification of important ammonites and for having let me have several provisional determinations.

Furthermore, it is my sincere wish to acknowledge my indebtedness to Dr. LAUGE KOCH, Copenhagen, the leader of several Danish scientific expeditions which have thrown so much light upon East Greenland's geological structure and its history. Those two years (1936—1938), during which I had the privilege of roaming through that remote Arctic country as a free explorer, will forever stick in my memory. My thanks to Dr. LAUGE KOCH are also due for his great interest in my investigations and for having kindly put numerous copies of the "Meddelelser om Grønland" at my disposal.

A. SOMMER, preparator in the Geological Department of the University at Berne, Switzerland, was kind enough to take all the photographs of rock specimens illustrating the present work.

Java, summer 1944.
Berne, sommer 1946.

The author.

INTRODUCTION

The expedition of Captain K. Koldewey brought back a collection of fossils which have proved the occurrence of marine Mesozoic deposits in East Greenland. Among this material, secured in 1869—1870 by R. Copeland and J. von Payer, there were also some fossils derived from the eastern coast of Kuhn Island which gave evidence that the sea in Lower Cretaceous times had encroached upon the eastern border of the present-day Greenland continent.

Since then Cretaceous sediments have been met with in different regions of Northeast Greenland. Owing to the lack of time and partly because no interest was taken in stratigraphical and lithological problems, most of the previous explorers were satisfied with the collecting of fossils and their subsequent determination.

It thus became my task to gather as many data as possible on the stratigraphy and facies of the *post*-Devonian deposits of East Greenland and to study in detail all the geological facts which might lead to a distinct conception and synthesis of East Greenland's geological history.

Owing to the Great World War and the author's involuntary isolation in terror-struck Java the writing of a detailed historical chapter had to be given up; besides, this omission is only of little importance as there already exist some thorough summaries on this topic to which the reader is referred (Koch 1929 a, Frebold 1933).

Fig. 1. Index map of Greenland showing A) the area covered by the writer's own investigations; B) and C) the location of the maps given in the text (Figs. 2 and 70).

I. OUTLINE OF THE STRUCTURAL GEOLOGY

The tectonics of the investigated area are dealt with in the reports of A. VISCHER (VISCHER 1938, 1939, 1940, 1943); in the present paper structural problems are merely touched upon as far as is necessary for the understanding of the stratigraphical phenomena. For a detailed description of the tectonics of the region between 74° and 75° N. lat., comprising Clavering Island, Wollaston Foreland, and Kuhn Island, the reader is referred to A. VISCHER's excellent work (VISCHER 1943).

During the Danish expedition in 1936—1938 the study of the tectonics of northern East Greenland was undertaken by A. VISCHER, who, moreover, carried out the geological mapping of the said area. On the other hand, the author of the present memoir performed the task of studying in detail the problems of stratigraphy, facies, and age of the *post*-Devonian beds that had hitherto been disregarded to a great extent.

I am well aware that a still more detailed research would reveal many a fact not yet recognized and would yield further problems for which the answer must still be sought. Nevertheless, it may be said that thanks to our investigations the main features of the *post*-Devonian geology of northern East Greenland could be unravelled, and many points that were doubtful be clarified to a greater or lesser degree.

I wish to take advantage of this opportunity to thank A. VISCHER for the pleasant and successful cooperation in East Greenland which has brought about that our parallel running studies in the field can to-day be combined to a rounded off synthesis.

It stands to reason that certain problems resulting from our surveys have been attacked in common already in Greenland. Hence credit must be given to both of us for having solved them. Thus for instance it was only possible to fix the date of the main phase of the Mesozoic tectogenesis in Wollaston Foreland, i. e. of the cumulative step-faulting of the continental border, after the age of the transgressive synorogenetic beds had been established. At first these were held by the writer to be Valanginian in age, which led to the conclusion that the principal Mesozoic faulting and tilting had taken place in latest

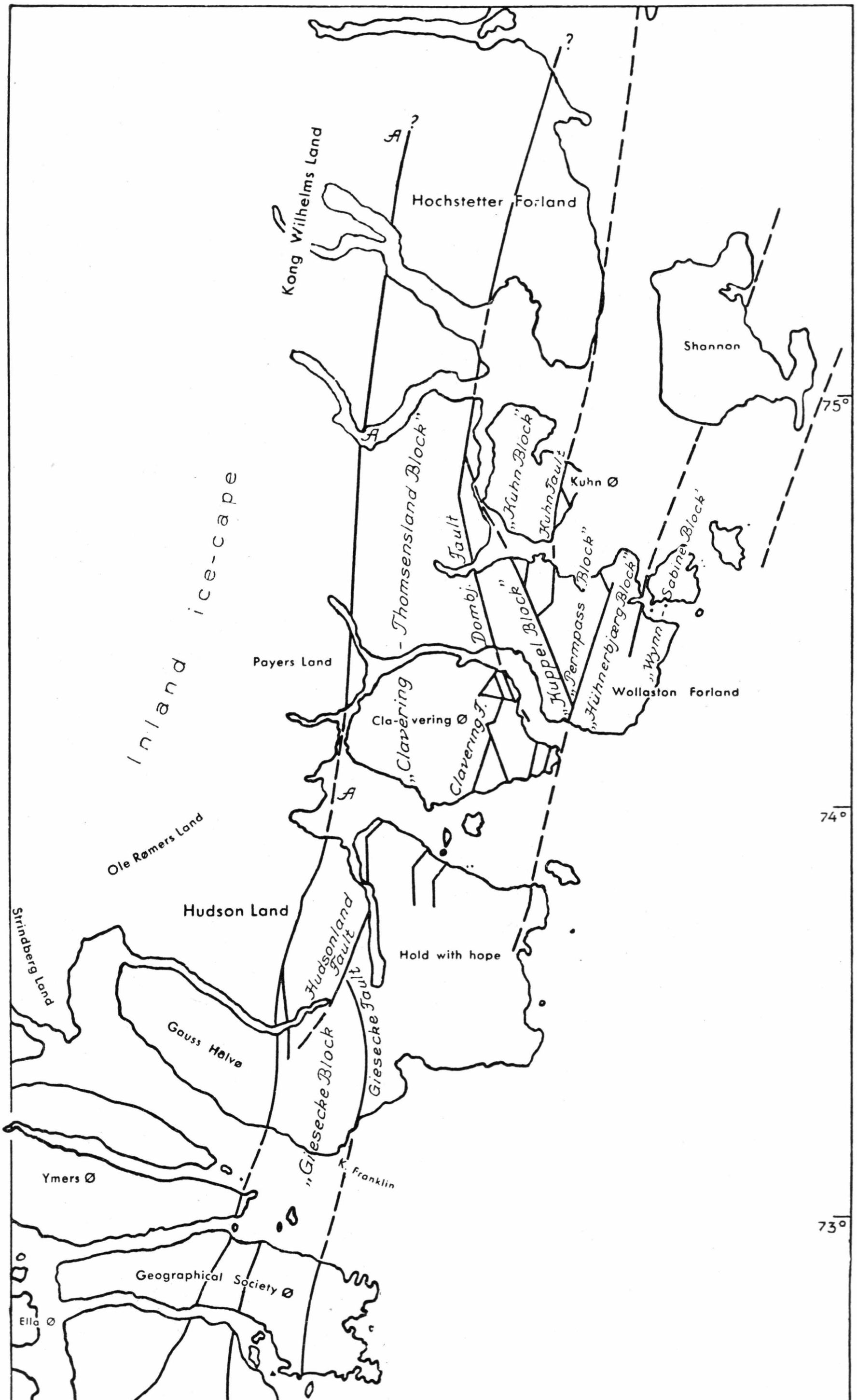

Fig. 2. Tectonic sketch-map of East Greenland showing A. VISCHER's "Main *post*-Devonian Fault" (AA) and other important features of the blockfaulted continental border.

Jurassic or *sub*-Cretaceous times (*vid.* MAYNC 1938, 1940, VISCHER 1940). However, on second thoughts the author realized that this synorogenetic boulder-bearing "Rigi Series" is not Cretaceous but Volgian (Portlandian) in age, and that the chief orogeny already set in at the close of the Kimmeridgian (MAYNC 1947).

It is well known that the Caledonian orogeny in East Greenland has been of very great intensity (*vid.* KOCH 1929a, BACKLUND 1930, 1932, WEGMANN 1935). Since also the Upper Devonian strata have been subject to strong diastrophism that has led to a highly complex structure (*vid.* BÜTLER 1935b, 1939, 1940), it will be clear that posthumous tectonic manifestations of the aforementioned orogeny must have taken place. The Old Variscan orogeny, however, resulting in the folding of the uppermost Devonian beds (G. SÄVE-SÖDERBERGH's "*Remigolepis* Series", "*Arthrodire* Sandstone Series", = "Mont Celsius Series" of H. BÜTLER) was already of less effect. H. BÜTLER speaks of an "Ymer Ø phase". For the slight folding of the Carboniferous formations, including both terrigenous deposits of Dinantian and of Upper Carboniferous (Namurian = Lower Westphalian) age, later phases of the Variscan era must be made responsible.

From this time onwards no folding has taken place in East Greenland. All facts recorded in the course of time evidently point to crustal tensions along the eastern border of the Greenland continent, which might be explained by the inertia of the continental border during a west-drift in accordance with the ideas advanced by A. WEGENER. Instead of the formerly acting compressive stresses plain stretching forces have now become effective. When, at last, the initial wide-arched monocline of the continental border could no longer resist the continuous tension and the limit of breakless deformation had been exceeded, it became dissected by fractures, and relief was attained by faulting. While the faults hade seaward, the different blocks were tilted towards the rigid continent in such a way that the upper surface of a block pushes against the fault scarp of the adjacent block to the west. This structural picture thus fully agrees with that named "Antithetische Schollentreppe" by H. CLOOS (*vid.* CLOOS 1928, 1936, 1939a, 1939b, VISCHER 1938, 1939, 1940, 1943, WAGER 1934).

It must be stressed that such block-faults *en échelon* along the margin of the continent existed already in Devonian time. According to H. BÜTLER the basin of the Devonian deposits of East Greenland was bounded on the west by a fault zone which coincides more or less with the Devonian coast line (BÜTLER 1939). To the east the Devonian province is cut by a major fault termed by A. VISCHER the "Main *post*-Devonian Fault" (VISCHER 1939) which separates the consolidated continental block of the west from the instable eastern blocks (*vid.* BÜTLER 1939, VISCHER

1939, 1940, 1943). However, in accordance with the facts set forth by H. BÜTLER (*op. cit.*) the area between Traill Island and Gauss Peninsula, which is occupied by Devonian formations, should be considered the westernmost tectonic block of the step-faulted continental border. Between this block and the Caledonides in the west (Ymer Island, Strindberg Land, Ole Rømer Land) a fault line of first order occurs (BÜTLER 1935a, 1939, 1940) the origin of which must be dated as far back as Lower Devonian times.

A. VISCHER's "Main *post*-Devonian Fault" running from Milne Land, Scoresby Sound, through the whole of East Greenland up to Germania Land or even farther, was called into existence in Carboniferous time. This is proved by the fact that the continental deposits of the Namurian (= Lower Westphalian) have been laid down along the fault scarp of the eastern "Hudsonland Block" (BÜTLER 1940) and gradually pinch out towards the east. An angular unconformity was observed by the writer to occur between the Carboniferous (Dinantian-Naumrian) and the Permian conglomerate that passes into the marine Zechstein deposits of the Upper Permian (MAYNC 1940, 1942). This datum conspicuously points towards tectonic disturbances (faulting and tilting) which must be Variscan in age.

East of the "Main *post*-Devonian Fault" A. VISCHER has mapped numerous further fault lines which run NNW—SSE or strike NNE—SSW. Both fault systems are synchronous, as they do not intersect but relieve one another.

Owing to the divergence between the "Main *post*-Devonian Fault" running SSW—NNE and the general N—S trend of East Greenland's coast, older structural elements crop out at the coast the farther north we go. In consequence hereof the whole area with *post*-Devonian sediments grows smaller and smaller towards the north. Apparently, the "Main *post*-Devonian Fault" leaves the coast of northern East Greenland in Kronprins Christians Land, North-East Foreland. The coast follows the SSW—NNE strike of the sediments, and the northernmost *post*-Devonian beds seem to crop out in Nakkehoved (*vid.* p. 40).

The outcrops of Caledonian crystalline in the Barths Bjærge and in Muschelbjærg, Hochstetter Foreland, would correspond to the "Thomsensland Block" and the "Kuhn Block" of A. VISCHER, respectively, whereas those in Shannon Island would belong to our "Hühnerbjærg-Permpass Blocks". The exposures of the Caledonides in Great Koldewey Island, Germania Land, Île de France, Franske and Norske Islands are likely to be edges of tectonic blocks that have been laid bare by erosion. Furthermore, gneisses are reported by E. NIELSEN to crop out in Holms Land and Wegeners Islands which are, apparently, overlain by the continental Carboniferous or Permian formations (NIELSEN 1941). The long known Permian beds of Holms Land and Amdrups Land are thus probably the sedimentary cover of a tectonic block which abuts to the west against the alpine mountain region of Prinsesse Caroline-Mathildes Alper and Prinsesse Elisabeths Alper shown by E. NIELSEN (in *loc. cit.*) to consist of strongly folded metamorphic rocks (Caledonides). Adjacent to the west follows a folded series made up of multicoloured dolomite, limestome, and black shale; these deposits are correlated with the "Thule formation" L. KOCH 1916[1]) (*vid.* KOCH 1935) and seem to be bounded by a fault to the west where unfolded fossiliferous limestones of Gotlandian age occupy large areas, which are reported to correspond faunally to the "Offley Island formation" L. KOCH 1917 of North Greenland (NIELSEN 1941).

The region to the east of the "Main *post*-Devonian Fault" between 73° and 75° N. lat. is dissected by faults of younger origin. *Post*-Permian/Triassic, late Jurassic, *post*-Valanginian, *pre*-Aptian, *post*-Albian, and *post*-Basaltic (Tertiary) faults were proved to exist by A. VISCHER and the writer; thus the old fault lines mostly became reactivated in later epochs.

The main phase of Mesozoic faulting (Young Cimmerian or Nevadian Orogeny) in northern East Greenland was lately stated to date back to the Upper Kimmeridgian (MAYNC 1947). Stress is laid upon the fact that the same disturbances have caused the great unconformity at the floor of the *Aucella*-bearing Valanginian from Alaska down to California (*vid.* CRICKMAY 1931).

Local *intra*-Cretaceous movements which must have taken place in the investigated area have been stated by the author (MAYNC 1940). Judging by the angular unconformity detected at Falskebugt, Wollaston Foreland, between the "Falskebugt Beds" (Valanginian) and the overlying Aptian-Albian series these tectonic movements may have occurred in Hauterivian or Barrêmian time.

Due to the *post*-Albian tectonics the Aptian-Albian beds have been tilted and dragged. Their dip at Forkastningspasset (*vid.* p. 119) amounts to 20—30° ESE, 35° NE in Mt. Knolden (*vid.* p. 64), 9—30° ENE in Kronebjærg (*vid.* p. 36), 13° SW at Cape Berlin (*vid.* p. 47), 15° SW in Mt. Gyldenspids (*vid.* p. 52), 8—10° WNW in Gunnsteinsbjærg (*vid.* p. 154) *et cetera.*

Further details on the tectonics of East Greenland are given in a special report by A. VISCHER (VISCHER 1943). It is to be hoped that more papers on the same topic will be published in years to come e. g. by the said author on the region of Hold-with-Hope and the Giesecke Bjærge, and by H. STAUBER on the region farther to the south.

[1]) = "Eleonore Bay formation" L. KOCH 1927 (*pro parte*).

II. LOCAL STRATIGRAPHICAL SECTIONS

A. Kuhn Island.

In 1870 J. von Payer discovered fossiliferous micaceous fine-grained sandstones and light-gray marls on the southeastern shore of the island. Fr. Toula, who worked out the fossil collections brought back by the Koldewey Expedition, cites the following forms:

"*Ammonites payeri* Toula
— *sp. ind.*
Belemnites panderianus d'Orb.
— *absolutus* Fisch.
— *volgensis* d'Orb.
— *sp. ind.*
Aucella[1]) (*Buchia*) *concentrica* Keys. non Fisch.
— — — Fisch. *var. rugosa* Keys.
— — — Fisch. *var. crassicollis* Keys.
— — — Fisch. *var. sublaevis* Keys.
»— — *aff. pallasi* Keys.
Cyprina sp. cf. syssolae Keys."
(Toula 1874, *vid.* Madsen 1904, Koch 1929 a).

Fr. Toula compared this *Aucella* fauna to the Russian *Aucella* beds (late Jurassic-Lower Cretaceous). According to A. P. Pavlov, however, the species *Aucella* (*Buchia*) *concentrica* Fisch. *var. rugosa* (Keys.) Toula is identical with *A.* (*B.*) *piriformis* Lah., and *A.* (*B.*) *concentrica* Fisch. *var. rugosissima* should be referred to *A.* (*B.*) *lamplughi* Pavl.; moreover, also the true *A.* (*B.*) *crassicollis* Keys. was stated by the said author to be present among the fossils described by Fr. Toula (*vid.* Koch 1929 a). A. P. Pavlov thus proved that the fauna in question points towards the zone of *Aucella* (*Buchia*) *crassicollis* Keys. and represents indubitable Lower and Middle Valanginian.

In the same beds L. Koch states to have found *Aucella* (*Buchia*) *cf. syzranicus* Pavl., A. (*B.*) *cf. keyserlingi* Lah., *A.* (*B.*) *piriformis* Pavl., *A.* (*B.*) *cf. lamplughi* Pavl., and *Belemnites sp.* (Koch 1929 a).

These clastic fossiliferous deposits of Valanginian age occurring in the eastern

[1]) The genus *Buchia* (Rouiller) was established in 1845, its synonym *Aucella* (Keyserling) but one year later. In spite of the principle of priority in scientific nomenclature, however, the posterior term *Aucella* has entered the geological literature all over the world, on which account it will have to be maintained. In the present paper, however, both names will be cited (the less current term *Buchia* added within marks of parenthesis).

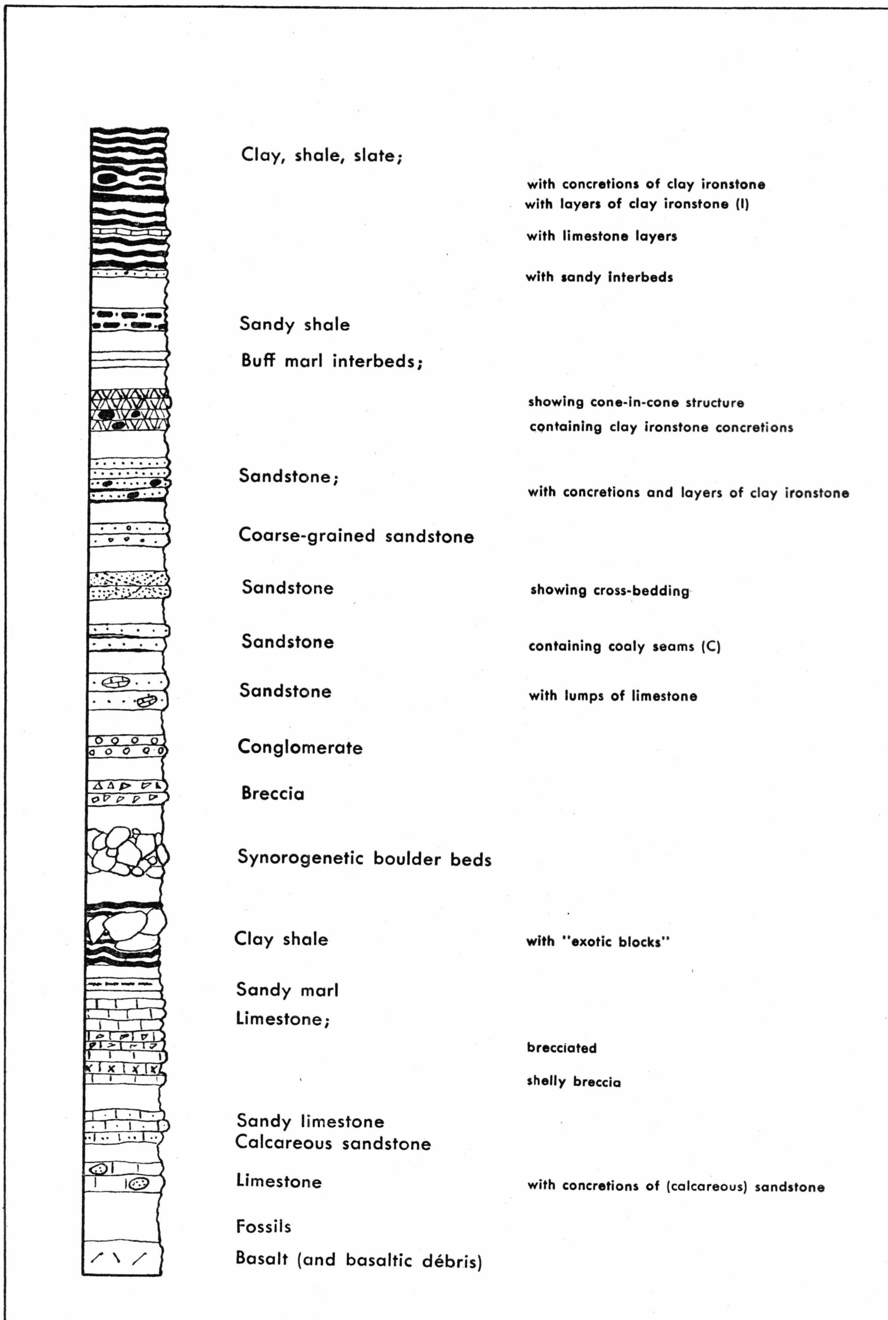

Fig. 3. Explanation of the symbols used in the stratigraphical columns.

portion of Kuhn Island, in Great Koldewey Island, and Wollaston Foreland were named "Cape Hamburg formation" (TOULA 1874) L. KOCH 1927 (KOCH 1929 b), but this term has never become popular in the literature on East Greenland.

In 1930, R. BØGVAD collected a few fossils immediately south of Cape Maurer, partly lying loosely around and partially *in situ*, which were determined by A. ROSENKRANTZ (ROSENKRANTZ 1930 a, BØGVAD & ROSENKRANTZ 1934). Except a spatangid, *Belemnites*, and *Inoceramus cf. ewaldi* SCHLÜT. he described *Lytoceras sp. ind.*, *Deshayesites boegvadi* ROSENKR. 1934 (= *Parahoplitoides cf. deshayesi* (LEYM.) ROSENKR. 1930), and *Sanmartinoceras groenlandicum* ROSENKR. 1934 (= *Aconeceras nov. sp. cf. nisoides* (SAR.) ROSENKR. 1930). According to A. ROSENKRANTZ *Deshayesites boegvadi* ROSENKR. would point to Lower Aptian (Bedoulian) whereas *Sanmartinoceras* (BONARELLI) as well as *Inoceramus cf. ewaldi* SCHLÜT. would indicate Upper Aptian (Gargasian) (*op. cit.*).

The above-cited *Ammonites payeri* TOULA was later on supposed to belong to the boreal genus *Simbirskites* (PAVLOV). A. ROSENKRANTZ, who never doubted this determination, after all, concluded from this find that marine Hauterivian should be represented on Kuhn Island (ROSENKRANTZ 1930a, BØGVAD & ROSENKRANTZ 1934). The occurrence of marine deposits of that age, however, would be very striking, indeed, as we have no evidence at all that beds referable to the Hauterivian should have been deposited on eastern Kuhn Island. The recent investigations of the writer have yielded the positive proof that the Valanginian limestone in the said island is transgressively overlain by fossiliferous marine Aptian (*vid.* p. 21). That the same gap comprising the Hauterivian-Barrêmian is proved to exist throughout the investigated area speaks much in favour of the assumption that the sea had then withdrawn from East Greenland. It is thus altogether likely, even evident, that the identification of this problematical *Ammonites payeri* TOULA with *Simbirskites* (PAVLOV) does not hold true. Besides, the said ammonite is reported to have been found together with *Aucellas* of Valanginian age.

It may be remarked that H. FREBOLD, who formerly showed some scepticism towards A. ROSENKRANTZ' view (FREBOLD 1932a, 1933) lately also affirms the presence of marine Hauterivian in Kuhn Island although there are no new data available to support this hypothesis (FREBOLD 1935b, FREBOLD & NOE-NYGAARD 1938).

The new geological data presented in this paper will—as I hope—settle this question once for all.

Stratigraphical sections.

(*vid.* Pl. I).

Lower Cretaceous deposits are confined to the eastern portion of the island with the exception of a transgressive remnant of the Volgian "Rigi

Series" in the surroundings of "Haakonshytta", southwest Kuhn Island, the uppermost levels of which are already Subcraspeditan (Infravalanginian/Rjasanian) in age.

This slightly hilly region of eastern Kuhn Island built up of Mesozoic sediments is bounded on the west by lofty jagged mountains which are composed of metamorphic crystalline rocks and show a strikingly young dissection with glacial hanging valleys and cirques of truly Alpine aspect. A major fault running N—S forms the boundary between this Caledonian folding range and the eastern downfaulted sedimentary block. The effect of this important fault on the topography is thus an extraordinarily marked fault scarp (see block diagram Pl. 1). Owing to its distinct slope to the southwest this Caledonian zone of central Kuhn Island, which forms the basement of the Jurassic beds in this region, disappears already in northern Wollaston Foreland.

The sediments in eastern Kuhn Island thus belong to a tectonic element of the step-faulted continental border. Of the sedimentary cover of the "Permpass Block" (*vid.* VISCHER 1943) merely the younger Mesozoic is exposed in Kuhn Island, the older beds such as the Lower Kimmeridgian, Argovian, and Callovian-Bathonian, which are known to overlie the crystalline substratum normally, being concealed below sea level.

The lowermost strata visible on the southeast coast, which since their discovery by L. KOCH in 1927 time and again have been referred to as "Portlandian", have recently turned out to be of Kimmeridgian age, having yielded an ammonite-fauna that includes indices of the Upper Kimmeridge Clay of Dorset (SPATH 1936, MAYNC 1940, 1947). After the *locus typicus* the writer has named these strata "Kuhn Beds" (MAYNC 1947).

These dark shales of Upper Kimmeridgian age are transgressively overlain by a light-gray *Aucella* limestone which carries different species of *Polyptychites* and *Dichotomites* and other fossils that can be said to fix its age as Middle Valanginian (Upper Polyptychitan). Higher in the sequence dark shales with clay ironstone concretions are met with where *Inocerami* and other pelecypods, and cephalopods (e. g. *Parahoplitoides/Deshayesites*, *Aconeceratidae*, *Lytoceras*, *Hamites*, *Crioceras*, *Ancyloceras*, *Neohibolites* etc.) indicative of Aptian are quite common.

About 7 km south of Cape Maurer a fault running NW—SE and traceable as far as Brorsons Peninsula, Wollaston Foreland, brings the "Kuhn Beds" together with the overlying Valanginian limestone in contact with the mudstones and shales of the Aptian (*vid.* tectonogram Pl. 1). North of that fault there are no outcrops of rocks older than Aptian.

On the following pages we shall set forth the stratigraphy of the lowermost Cretaceous strata exposed in the southeastern part of Kuhn

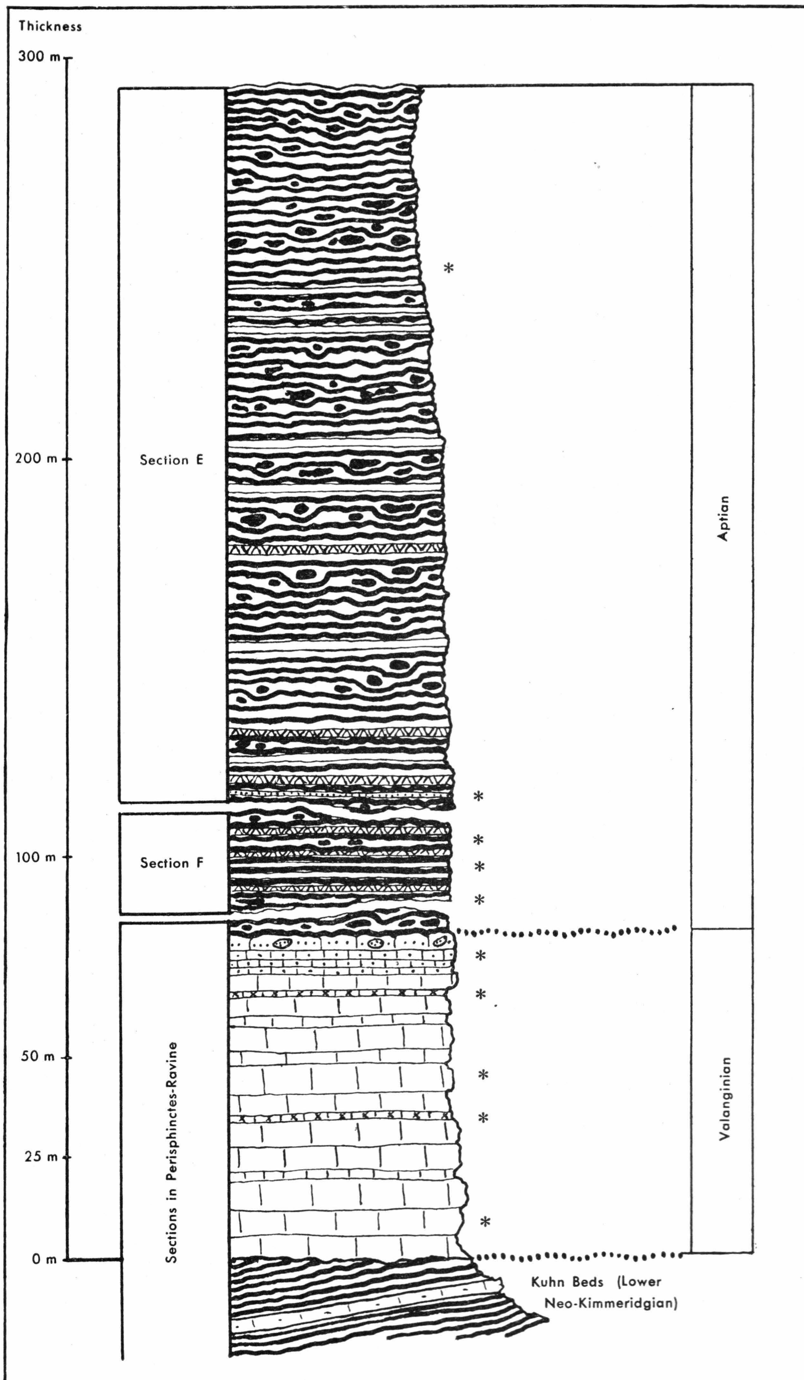

Fig. 4. Combined stratigraphical section of the Cretaceous beds in eastern Kuhn Island.

Island; the sections of the Aptian series in the vicinity of Cape Maurer will be discussed afterwards.

1) In *Perisphinctes*-Ravine (see MAYNC 1947) the dark fossiliferous shales and slates of Upper Kimmeridgian age are surmounted by a

130 m altitude Light-coloured, yellowish weathered *Aucella* limestone. As to its lithological features there can hardly be any doubt that this rock is identical with the limestone exposed immediately farther to the north, on top of the Jurassic "Kuhn Beds", where it carries *Aucella* (*Buchia*) *keyserlingi* LAH., *A.* (*B.*) *piriformis* LAH., *A.* (*B.*) *crassicollis* KEYS. and other guide fossils of the Polyptychitan.

2) Immediately north of *Perisphinctes*-Ravine the following section was set down from above the Danish hut:

Dark slates alternating with layers of limestone (turning yellow on weathering). Farther down the slope (in the very creek) several *Perisphinctidae* e. g. *Pectinatites*, *Pavlovinae* etc., and *Aucellas* were collected *in situ.*

The top layer of these "Kuhn Beds" (= base of the Upper Kimmeridgian, *vid.* MAYNC 1947) consists of a dark ferruginous buff weathering sandy breccia of a high specific gravity (concentration of iron ores) which indicates the Valanginian transgression plane (Fig. 5).

At a height of about 65 m this stratum is unconformably overlain by light-gray or pink slightly silty limestones and marls abounding in *Aucella* (*Buchia*) *piriformis* LAH., *A.* (*B.*) *keyserlingi* LAH., *A.* (*B.*) *crassicollis* KEYS. etc.

70 m Pink-coloured silty limestone with *Belemnites* (?*Acroteuthis sp.*).

100 m *Aucella* breccia, 2—3 m thick, overlain by light-gray occasionally pink-coloured easy weathering limestones, often with a slight content of sand. *Aucellae*, *Belemnites.*

3) A little to the north another section was measured:

0—80 m Débris and snow.

80 m Light-gray or yellow, brownish weathering limestone with *Aucellas.*

100 m Ledge of nodular speckled gray-brownish fossiliferous limestone, its surface turning rough on weathering. 3—4 cm thick. Calcite, pyrite. *Polyptychites spp.*, *Dichotomites petschoraensis* BOG. etc., *Aucella* (*Buchia*) *piriformis* LAH., *A.* (*B.*) *keyserlingi*

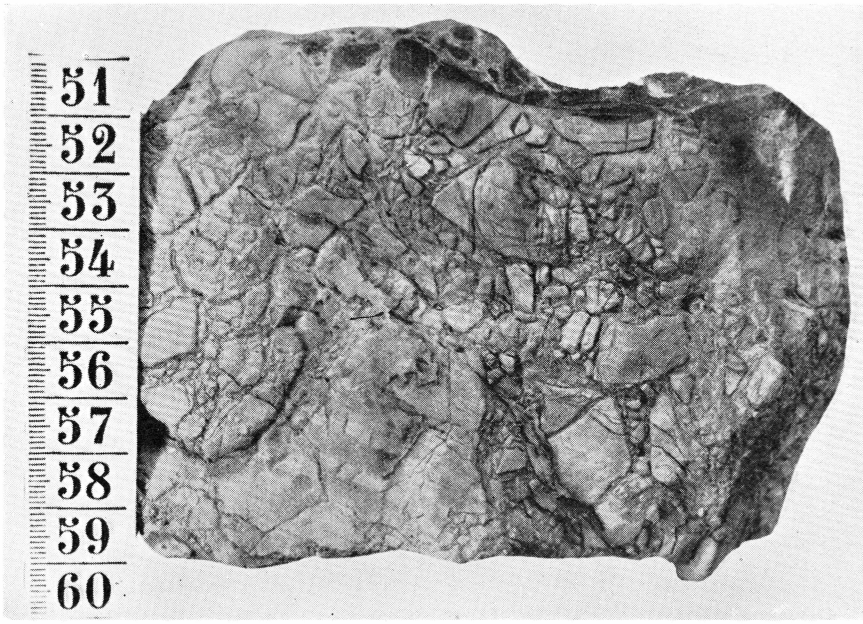

Fig. 5. Brecciated and re-worked top-layer of the Kimmeridgian Kuhn Beds, marking the boundary to the transgressing Valanginian (Polyptychitan) formation.
Perisphinctes-Ravine, southeastern Kuhn Island (about 65 m altitude). Lot. 715 Coll. A. MAYNC.

LAH., *A.* (*B.*) *crassicollis* KEYS., *A.* (*B.*) *cf. sublaevis* KEYS., *A.* (*B.*) *cf. terebratuloides* LAH. etc., ?*Pinna sp.*, gastropods etc.

This fauna clearly suggests a Middle Valanginian age (upper part of Polyptychitan).

Upon this limestone rests again a light-gray one, identical with that in the lower portion of the sequence.

130 m Light-gray or buff-coloured *Aucella* breccia, only a few centimeters thick, containing *Aucellas.*

This characteristic organogenous breccia (shelly limestone) is succeeded by a thin rather dark-gray, red weathering limestone breccia with black shale portions, carrying small pelecypods e. g. *Aucellas*, and dipping at low angles (about 3°) towards the WSW.

135 m Reddish friable marly and calcareous sandstone, rich in iron-oxide, which shows a gray-reddish colour when being freshly broken. It contains numerous small bivalves (*Aucellas* etc.) and attains a thickness of 3—4 m. Grading upwards into a brick-coloured heterogeneous crumbling calcareous sandstone which also carries small-sized pelecypods.

140 m Red soft sandstone containing hard slightly sandy concretions of limestone with lamellibranchs.

These beds from below (80 m) up to 130 m altitude are referable to the Polyptychitan. It seems reasonably certain that also the higher strata bearing small-sized pelecypods must be assigned to the Valanginian, probably to its upper part (Hoplitidan).

At a height of 146 m this reddish formation is immediately over lain by

Grayish sandy shales which contain hard dark-hearted concretions of clay ironstone that turn yellow or orange on weathering. There is not the least doubt that this series which is much better exposed farther to the north, in the surroundings of Cape Maurer (*vid.* p. 25—26), is of Aptian age.

From this section 3) A. Vischer and the Greenlanders collected both ammonites and Belemnites which comprise Valanginian as well as Aptian forms.

The exposed thickness of the Valanginian rocks here in the south-eastern portion of Kuhn Island thus attains 80 m.

Unfortunately the rich faunas collected by the writer have not yet been worked up. The *Aucellas* were partly determined in the field but still await a more thorough study by some paleontologist[1]). All the ammonites secured during the expedition of 1936—1938 were handed over to Dr. L. F. Spath, London, before the war and have not yet been described either. According to a brief statement by L. F. Spath, the Valanginian *Polyptychites-Dichotomites* faunas of Kuhn Island and Wollaston Foreland closely resemble those of the Speeton sequence and of Russia. The above-cited species of *Aucella* (*Buchia*), too, are common to the Polyptychitan of Russia etc., and the age assignment of this group of limestones to the Middle Valanginian (Upper Polyptychitan) is thus beyond all doubt.

Whether the red-coloured beds above the Polyptychitan limestone (135 m to 146 m above sea level) are still to be referred to the Polyptychitan or should be classed as Hoplitidan already, cannot be made out with certainty until the fossils have been examined.

The recent detailed survey has yielded no data at all which may account for the occurrence of rocks of Hauterivian or Barrêmian age in

[1]) In 1946 the large East Greenland collections of *Aucellas* and *Inocerami* that had been brought together in 1936—1938 were sent to Prof. M. Gignoux, Grenoble/France, who had suggested that Dr. M. Breistroffer would study them. Subsequently, the collections were forwarded to Prof. M. Arambourg, Paris, who will undertake the identification of the *Aucellas*. On the other hand, Mr. Sornay, Paris, will be kind enough to work out the *Inoceramidae* in months to come.

Kuhn Island. Among the author's collections there is no cephalopod to be found which might belong to *Simbirskites* (PAVLOV). Accordingly, there is no use any longer of attaching too much significance to one single specimen that has once been wrongly identified as "*Simbirskites payeri* (TOULA)" and, unfortunately, has been lost since. As will be stated below a juvenile specimen of *Ammonites payeri* TOULA was collected by the writer *in situ* in the "Lower Niesen Beds" of Infravalanginian/Rjasanian age (*vid.* p. 96), so the only support of A. ROSENKRANT'Z view is herewith removed once for all.

The overlying beds exposed from an altitude of 146 m upwards until they become mantled by Quaternary deposits are already Aptian in age (compare the sections given on the following pages).

We thus arrive at the conclusion that the Aptian in Kuhn Island rests transgressively upon beds which are Valanginian (Hoplitidan) in age, and that there exists a stratigraphical gap comprising the Hauterivian and Barrêmian. Besides, this superposition of the Aptian(-Albian) series on the Valanginian is proved to hold true in Wollaston Foreland and is by no means exceptional. Neither are the "continental series" of supposed Hauterivian-Barrêmian age nor the marine "*Simbirskites* Beds" (assumed by A. ROSENKRANTZ, H. FREBOLD and others to occur) represented in the investigated area of northern East Greenland[1]). It may be stressed here that locally even a true angular unconformity is found between the Valanginian and the Aptian-Albian e. g. in Falskebugt (*vid.* p. 56).

Sections through the Aptian beds.

4) Slightly north of the dislocation mentioned on p. 17, which has brought about the abnormal contact of late Jurassic-Valanginian rocks and the Aptian, the following

Section F was set down:

Snow and débris.

From an altitude of 30 m upwards the below-described beds crop out:

30 m Black or gray shales interbedded with thin bands and lenses of clay ironstone with a yellow or orange weathered surface. Fragments of crustaceans and sparse other fossils.

Higher follow

black shales with intercalated layers of pale-buff marls, often with cone-in-cone structure, which contain concretions of dark brown, velvety calcareous clay ironstone with remains of

[1]) There exists one single though faint possibility that *post*-Valanginian/*pre*-Aptian beds be present, viz. in the sequence exposed from Kuhnpasset to Aucellabjærget, southwestern Wollaston Foreland (*vid.* p. 86—90).

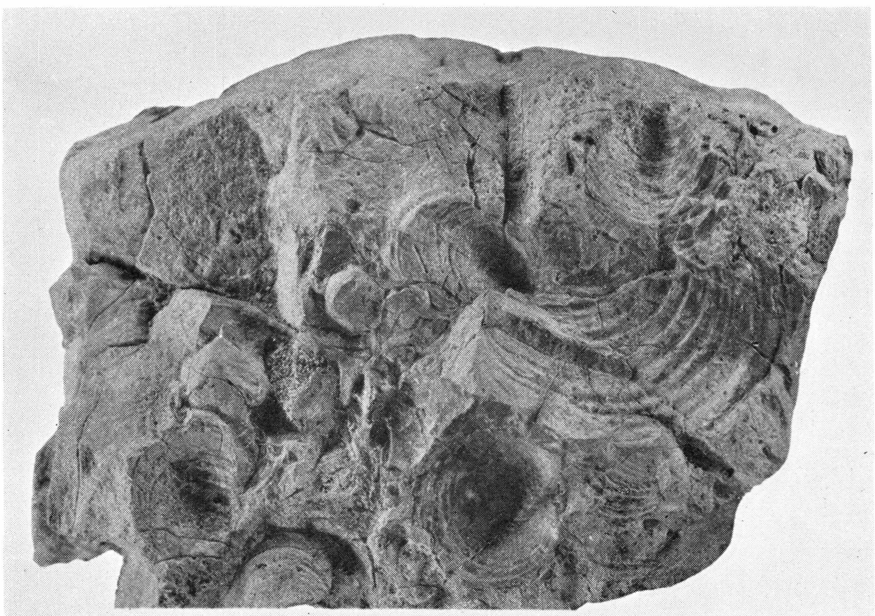

Fig. 6. Brecciated ferruginous limestone concretion with imprints of pelecypods Aptian series.
Sektion E (50 m altitude), eastern Kuhn Island. Lot. 625 Coll. W. Maync.

crustaceans. A few specimens of *Neohibolites* (Stolley) were collected in the shale, moreover some fossil wood.

50 m Black partially marly shales containing small concretions of clay ironstone and clayey limestone.
A few meters higher shales with big concretions of clay ironstone, and interbedded buff marls with cone-in-cone structure are exposed. The shales have yielded one ammonite, and the concretions contain some specimens of *Inoceramus*.
Covered with morainic débris.

E. Nielsen's "Section 1 km north of the Danish huts near Cape Maurer" (*vid.* Frebold 1935b) was set down near by:

47 m Lowermost portion visible: Loose black shale with concretions and layers (of limestone).

56 m Dark shale with limestone layer that thins out laterally. Carries ammonites (?*Crioceras*), *Inoceramus sp. ind.*

74 m (and slightly lower): Shale with limestone concretions bearing pelecypods and an indeterminable Echinid.

5) About 1 km farther to the north Section E was measured:
Snow, morainic débris.

50 m Gray and black slightly sandy crumbling shales with inter-

beds of thin yellowish sandstone containing yellow and reddish weathering, often brecciated iron-bearing concretions of clay ironstone (Fig. 6). These beds have furnished pelecypods, ammonites, belemnites e. g. *Neohibolites sp.*, ?*Nautilus sp.*, echinid spines etc.

Occasionally with some interstratified layers of light-buff marl displaying cone-in-cone structure.

Dip: 6° to the west.

80 m Gray-black sandy and marly shale, which have yielded a few belemnites (*Neohibolites sp.*) and fossil wood sometimes with *Pholas* borings. Large concretions.

90 m Black shales with a buff marly parting. Petrified wood and coal seams.

100 m Black and gray slightly sandy shales containing concretions of clay ironstone with an orange-red weathered surface. Find of a badly preserved ammonite. Occasionally with thin zones of pale-buff marl.

105 m Enclosed in black shale concretions of clay ironstone with specimens of *Inoceramus sp.*

110 m Alluvial deposits and snow.

On the adjacent ravine to the north several exposures of black slightly sandy shale with concretions of clay ironstone containing imprints of *Inocerami* were observed up to an altitude of 190 m.

6) Section D lies immediately north of Section E:

Snow.

80 m Black more or less sandy shale, weathering to small fragments, with some layers of pyrite.

83 m Shale containing large concretions of cavernously weathering clay ironstone and pinching out bands of yellow-gray sandstone.

100 m Black often ashen weathering marly shale with lenses and layers of clay ironstone bearing Aptian ammonites e. g. *Parahoplitoides/Deshayesites sp.*[1]).

E. Nielsen's section "2 km south of the Norwegian station at Cape Maurer" (*vid.* FREBOLD 1935b) corresponds approximately to the lower portion of our profile D which had not yet been exposed in April 1937:

21—33 m Shale with interbeds of limestone and limestone concretions, containing indeterminable ammonites, belemnites, and small *Inocerami*.

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[1]) Identified by L. F. SPATH, London.

33—41 m Formation *ut supra*, carrying plenty of fossil wood, *Ancyloceras sp.*, indeterminable belemnites.
41—49 m Formation *ut supra*, with fossil log and belemnites.
49—56 m Formation *ut supra*, containing fossil wood, bored rock fragments, and ammonites belonging to the family *Aconeceratidae*.

7) Section C was measured along the next creek to the north:

Snow.
40 m Black-grayish friable sandy shale with thin sandstone layers and seams of a fine-grained buff sandstone. Sparse concretions of clay ironstone. Plenty of fossil wood, partly bored.
50 m Interbed of nodular ferruginous limestone lumps showing a breccia structure, partly silicified. 2—3 m thick. *Lytoceras polare* RAVN[1]) and other ammonites.
60 m Shale containing belemnites, arthropoda etc.
65 m Gray and black slightly sandy disintegrating shale, containing
67 m fossil wood. Efflorescent crusts of sulphur in cracks and on the rock's surface.
73 m Gray and black partly sandy shale with interbedded yellow-reddish concretions of large diameters.
78 m Black slightly sandy shale. *Neohibolites sp.*
82 m Shale as below, interstratified with thin gray-yellowish sandstone bands which may
90 m contain tiny coal seams.
100 m Interbed of pale-buff marl showing uneven or undulated bedding planes. 0.3 m.
105 m Black shale with a few layers of buff marl in the lower part. Near the contact with a basaltic dyke the shale has turned into indurated slate and has changed its colour to steel-gray or purple.
110 m Basalt dyke cutting the strata at steep angles.

In summer 1933 E. NIELSEN set down a section "1 km to the south of the Norwegian Station at Cape Maurer" (*vid.* FREBOLD 1935b) which runs between our Sections B and C:

16—32 m Black loose clay slate, with limestone concretions and limestone layers of varying thickness, partially pinching out. *Hamites sp.* etc.
32—53 m Formation *ut supra*, with *Aconeceratidae*, belemnites, and pelecypods.

[1]) Determination by L. F. SPATH, London.

8) Section B.

In the creek immediately southwest of the Norwegian Station at Cape Maurer, which, unfortunately, was largely filled up with snow during my examination,

black shales containing concretions of clay ironstone as well as thin layers of buff marl with cone-in-cone structure were exposed. Only some poor remains of *Inoceramus sp.* and fossil wood could be secured.

9) North of the just mentioned hut where the slope had been blown free of snow (Exposure A) the author observed at a height of

40 m black mica-bearing shale turning crumbling and grayish on weathering, often carrying nodules of pyrite and showing limonitic spots on its weathered surface. Fragments of belemnites. Enclosed in the shale occur light-coloured concretions of calcareous clay ironstone some of which may attain about 30 cm in diameter and weather to polyedric pieces. These concretions are for the most part silicified.

It must have been close by that R. BØGVAD in 1930 collected some loose-lying fossils, *viz.* an Echinid (Spatangid), *Sanmartinoceras groenlandicum* ROSENKR., *Lytoceras sp. ind.*, and *Belemnites sp. ind.* (*vid.* BØGVAD & ROSENKRANTZ 1934).

The following sequence of about 60 m in thickness was observed by R. BØGVAD in a creek near by:

Black-gray shales with interbeds of limestone of a thickness of more than 0.1 m (rocks as found loose with the above-cited ammonites).

Contain limestone concretions with plant-remains and fossil wood.

The shale has furnished sparse belemnites.

About 30 m above the river-bed a limestone layer with *Inoceramus cf. ewaldi* SCHLÜT. was observed, and about 10 m higher a concretion was found bearing *Parahoplitoides/Deshayesites boegvadi* ROSENKR. (*vid. op. cit.*).

E. NIELSEN's "section 100 m north of the Norwegian Station at Cape Maurer" (*vid.* FREBOLD 1935b) was measured in about the same locality:

32—55 m Loose black clay slate, interstratified with thin limestone bands and concretionary layers. *Crioceras sp.*, small *Inocerami*, gastropoda.

55—85 m Black shales with limestone interbeds and limestone concretions, carrying indeterminable pelecypods.

Remnants of Aptian deposits also occur farther south. In the so-called "Middle Section" (M) between *Perisphinctes*-Ravine and Romey Valley the "Kuhn Beds" are transgressively overlain by a

70 m light-coloured sandstone bearing *Inoceramus sp.* and other lamellibranchs. In between there are a few partings of black shale with yellow and red concretions of clay ironstone (*vid.* MAYNC 1947).

In the "Southern Section" (S), about 7 km northeast of Cape Hamburg, some exposures of

black shale with concretions of clay ironstone and interbedded layers of a yellowish coarse-grained sandstone were met with which—judging by their lithological features—may also be referred to the Aptian series (*vid.* MAYNC 1947).

As will be seen, the given sections through the Aptian beds on the east coast of Kuhn Island belong more or less to the same portion of the formation. The combined Sections F and E shown in Fig. 4 reveal this rather monotonous series which attains a visible thickness of 220 m. Its fossils including ammonites, belemnites, pelecypods (mostly *Inoceramus sp.*), and arthropods, obviously point towards Aptian, the cephalopods such as *Parahoplitoides/Deshayesites*, *Sanmartinoceras*, *Lytoceras polare* RAVN, (*Neohibolites*) etc. being index fossils of that stage. The collected specimens of *Inoceramus* mostly seem to belong to the species *I. ewaldi* SCHLÜT. which, too, suggests an Aptian age.

The underlying limestone attaining a thickness of about 80 m in *Perisphinctes*-Ravine, has yielded an abundant fauna which distinctly proves the beds to be of an Upper Polyptychitan age.

Between these two formations a stratigraphical gap is shown to exist which comprises the Hauterivian and Barrêmian; whether the uppermost Valanginian, *viz.* Hoplitidan, is really represented in the pink and red-coloured strata below the Aptian shale series has not yet been proved but is most probable, after all.

Section in Laugeites-Ravine[1]**), southwestern Kuhn Island.**

(*vid.* Fig. 59, Pl. 2).

Because of its decisive importance with regard to the stratigraphy part of this section (which has already been published in my paper on the Jurassic formation (MAYNC 1946)) is reprinted in the present memoir.

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[1]) Name give by the writer to the creek that empties into Fligelys Fjord about 1 km to the northwest of the Norwegian hut "Haakonshytta" (*vid.* MAYNC 1947). It is the only spot in northeast Greenland whence *Laugeites* (*Kochina*) *groenlandica* SPATH has been derived so far.

Up to now *Laugeites*-Ravine and Mt. Niesen, Wollaston Foreland, are the only localities in northern East Greenland where the stratigraphical boundary between the Volgian (Portlandian) and the lowermost Cretaceous (Infravalanginian/Rjasanian) is actually disclosed.

In the spring of 1932 C. TEICHERT collected some loose blocks containing a few fossils which H. FREBOLD has identified as *Perisphinctes* (? *Pavlovia*) *sp. ind. aff. panderi* (D'ORB.) MICH. and *Aucella* (*Buchia*) *mosquensis* (VON BUCH) (FREBOLD 1933). According to the map given by H. FREBOLD (in *loc. cit.*) these fossiliferous blocks must have been found in the vicinity of "Haakonshytta". Owing to the presence of the above-cited *Aucella* species the beds were referred by H. FREBOLD to the "Middle Portlandian" (Lower Volgian).

In April 1937 the author discovered the beds *in situ* and measured a detailed section. The find of *Laugeites* (*Kochina*) *groenlandica* SPATH, *Aucella* (*Buchia*) *cf. volgensis* LAH. etc. allowed a reliable correlation with the "*Lingula* Bed" (and the upper portion of the "Hartzfjæld Sandstone") of Cape Leslie, Milne Land, which are assigned to the "Volgian-?Aquilonian" (ALDINGER 1935, SPATH 1936, MAYNC 1947). Since, however, *Subcraspedites* (SPATH) was found slightly higher in the sequence of Hartzfjæld, the upper part of the "Hartzfjæld Sandstone" is doubtless lowermost Cretaceous in age. According to L. F. SPATH (*op. cit.*) this Cretaceous portion of the "Hartzfjæld Sandstone" probably overlies the Jurassic part with an unconformity.

As will be shown below, the new data evidenced by the stratigraphical investigations do not support this conjecture with regard to Kuhn Island, since the boundary between the latest Jurassic and the lowermost Cretaceous runs within a cyclic sedimentary series where it is hardly admissible to assume an important break in the sedimentation. Furthermore, *Laugeites* (*Kochina*) *groenlandica* SPATH is present throughout the series, also in the uppermost cycle (IV) where it is accompanied by *Subcraspedites* ex gr *plicomphalus* (SOW.)/*S.* (*Tollia*) *stenomphalus* (PAVL.) of the Infravalanginian. That *Laugeites* (*Kochina*) should have been worked up from the underlying rocks is fairly improbable as there is no trace of an erosional gap. Rather do I therefore cling to the idea already foreshown by L. F. SPATH that there is an almost complete gradation between *Dorsoplanites-Laugeites* to *Kachpurites-Craspedites*/*Subcraspedites-Polyptychites* (*vid.* SPATH 1936), in other words, these genera represent a continuous phylogenetic sequence. The occurrence of *Subcraspedites* in the top beds in *Laugeites*-Ravine, even still associated with true *Laugeites* (*Kochina*), bears witness that the latter is still more closely related to the *Craspeditidae* than to the *Pavlovinae*, and that the interval between *Laugeites* (*Kochina*) and *Subcraspedites* is even less than was assumed by L. F. SPATH (*op. cit.*).

On account of *Subcraspedites* being present we may attribute the highest beds in *Laugeites*-Ravine to the Infravalanginian (Subcraspeditan), the more so since the species found by the writer show the greatest resemblance to those from the "Spilsby Sandstone"[1]) of Lincolnshire which, too, is considered lowermost Cretaceous in age (*vid.* KILIAN 1907—1913, SPATH 1924, SWINNERTON 1935, 1941, KIRKALDY 1939). Since the species of *Subcraspedites* from the "Spilsby Beds" closely approach certain forms of the Russian "Rjasan Beds" e. g. *Subcraspedites/Tollia stenomphalus* (PAVL.), *S. spasskensis* (BOG.), and *S. subditus* (PAVL.) we shall designate the age of the "Spilsby Beds" and of the series in *Laugeites*-Ravine as Infravalanginian/Rjasanian.

It has been mentioned in my paper on the Jurassic stratigraphy (MAYNC 1947) that only the uppermost deposits of cycle IV are to be referred to the Infravalanginian/Rjasanian whereas the beds beneath must still be classed as Volgian. It is therefore not necessary, of course, to dwell long on the stratigraphy of that Volgian portion, and we shall thus merely put forth the stratigraphical data revealed near the Jurassic-Cretaceous boundary.

The clastic Volgian series near "Haakonshytta" which the author has shown to rest unconformably upon the "*Amoebites* shales" (Lower Kimmeridgian) can be subdivided into four sedimentary cycles (I—IV) of minor order (compare the table below on p. 31). Each cycle sets in with rather coarse-grained micaceous sandstones, partly with pebbly layers, which gradually pass into a banded series of alternate black sandy shale and yellow-coloured sand. Then follow again coarse-grained sandstones etc. forming the basis of the next cycle above, and so on. The transgression phase of each cycle has been named phase A, the interval of inundation phase B. *Laugeites* (*Kochina*) was stated by L. F. SPATH to occur in phase A of the cycles I, III, and IV.

For further details concerning the cycles I, II, and III the reader is referred to the author's previous treatise (MAYNC 1947).

Below the stratigraphical succession of the cycles III and IV, which are only exposed in *Laugeites*-Ravine, is given.

Section in northern Laugeites-Ravine.

Lower portion of the sequence (*vid.* MAYNC 1947).

65 m (12) Conglomerate and psephitic mica-bearing sandstone carrying numerous specimens of *Pavlovinae* e. g. *Laugeites* (*Kochina*) *groenlandica* SPATH, and *Aucella* (*Buchia*) *cf. volgensis* LAH., *A.* (*B.*) *cf. terebratuloides* LAH. etc.
Thickness amounting to about 12 m.

[1]) According to communications of Dr. L. F. SPATH to the writer.

(13) Yellowish-gray coarse-grained sandstone with several pebble-bearing layers, alternating with black carbonaceous sandy shale. 7 m.

85 m "Banded Series" ("Schiefrige Bänderserie", *vid.* MAYNC *op. cit.*), about 10 m thick.

(14) Alternate coaly crumbling sandy shale and light-coloured sand seams or thin sandstone *laminae*, rich in pyrite and muscovite.

(15) Yellowish-whitish sandstone layer with partings of black shale.

(16) Alternation of carbonaceous sandy shale and zones of yellowish sand or thin sandstone bands (as (14)).

Snow.

95 m (17) Black sandy shale with a

(17a) 2 m interbed of sandstone.

Boundary between cycles III and IV, = limit Volgian-Infravalanginian.

100 m to 110 m (18) Coarse-grained rather thin-bedded sandstone, rich in fossils e. g. *Laugeites* (*Kochina*) *groenlandica* SPATH, *Subcraspedites*, and *Aucellas*.

(19) "Banded series" (as below) with interstratifications of harder gray layers of calcareous sandstone, rich in mica. Fragments of *Aucellas*.

120 m (20) 1.5 m alternate shale and yellow sand ("Banded series"), covered with morainic débris and snow.

In the southern branch of *Laugeites*-Ravine the following sequence was set down:

The lower portion of the section was not exposed (snowed up).

95 m (1) Hard red-brown limonitic sandstone, $x + 0.8$ m.

(2) 2 m bed of "Banded series" (as below in the preceding section).

(3) 0.3 m layer of hard rusty-weathering sandstone.

100 m (4) Whitish mica-bearing sandstone with carbonaceous seams and partings of black sandy shale.

(5) Fine-grained strongly yellow-coloured *Aucella*-bearing sandstone alternating with dark micaceous shale bands. 2.5 m.

(6) 3 m gray rusty-weathering thin-bedded sandstone with an interbed of

(6a) dark carbonaceous calcareous sandstone abounding with fossils e. g. *Pavlovinae* such as *Laugeites* (*Kochina*) *groenlandica* SPATH, *Subcraspedites* ex gr *plicomphalus* (SOW.)/*S.* (*Tollia*) *stenomphalus* (PAVL.), *Aucella* (*Buchia*) *cf. volgensis* LAH. etc.

Stratigraphical table showing the subdivision of the Volgian and Infravalanginian/Rjasanian beds in southwestern Kuhn Island.

Cycle		Member in the stratigraphical sequence *Laugeites*-Ravine		Maximum thickness	Fauna	Age
		Northern	Southern			
IV	Phase B	(19)/(20)	(7)	9 + x m	Not known	Infravalanginian/ Rjasanian Subcraspeditan
	Phase A	(18)	(6) *	10 m	**Subcraspedites* ex gr *plicomphalus* (Sow.)/*S.* (*Tollia*) *stenomphalus* (Pavl.), *Laugeites* (*Kochina*) *groenlandica* Spath, *Aucella* (*Buchia*) *cf. volgensis* Lah. etc.	
III	Phase B	(13)/(17)	(1)/)5)	20.5 m	Not known	Volgian (?Aquilonian)
	Phase A	(12) *	not exposed	12 + x m	**Laugeites* (*Kochina*) *groenlandica* Spath and other *Pavlovinae*, *Aucella* (*Buchia*) *cf. volgensis* Lah., *A.* (*B.*) *cf. terebratuloides* Lah. etc.	
II	Phase B	(11)	Exposures near "Haakons-hytta" *	8 + x m	Not known	
	Phase A	(8)/(10)		7 + x m		
I	Phase B	(6)/(7)		11 + x m		
	Phase A	(1)/(5)		18,5 + x m	**Laugeites* (*Kochina*) *groenlandica* Spath and other *Pavlovinae*, *Aucella* (*Buchia*) *cf. volgensis* Lah. etc.	
Angular Unconformity "*Amoebites* shales (Lower Kimmeridgian)					*Hoplocardioceras decipiens* Spath, *Euprionoceras kochi* Spath, *Amoebites kitchini* Salf., *Rasenia borealis* Spath, *R. orbignyi* (Tornqu.) *etc.*, *Aucella* (*Buchia*) *bronni* Lah. etc.	Lower Kimmeridgian

Snow.

(7) "Banded series" (as below), about 4 m exposed, masked by débris and snow.

The occurrence of *Subcraspedites* in member (6a) is the essential datum that justifies the correlation with the Subcraspeditan (Infravalanginian/Rjasanien).

The section displays that bed (6) probably corresponds to member (18) on the northern tributary of *Laugeites*-Ravine which, too, is rich in fossils.

For this reason we draw the *sub*-Infravalanginian boundary between bed (5) and (6), and (17) and (18), respectively.

It deserves of mention that a break of importance in the sedimentary record is not at all likely; for the facial composition of the strata beneath and above the assumed stratigraphical boundary is quite the same, and e. g. the exposure (7) of "Banded series" on top of the fossiliferous Subcraspeditan bed (6) does not differ at all lithologically from the "Banded series" occurring within the Volgian portion. In view of the stratigraphical facts the conclusion is even arrived at, consequently, that we have to deal here with a continuous normal sequence from the Volgian into the Infravalanginian/Rjasanian.

It cannot be made out where the Jurassic-Cretaceous boundary should be drawn farther to the west in the synorogenic boulder beds of the "Rigi Series", as the few *Aucellas* at hand are poorly preserved and have not yet been identified. Perhaps subsequently, when the East Greenland *Aucella* faunas have been worked up, more facts will be known to be included in a comparison.

B. Sabine and Pendulum Islands.

(*vid.* Fig. 2, 7).

The occurrence of sandy shales, slates, and sandstones beneath the basaltic flows in Sabine and Pendulum Islands was made known by the KOLDEWEY Expedition (1869—1870). Except some floras no fossils were found, and also the Swedish expedition of A. G. NATHORST in 1899 failed to gather any. The exposed rocks were generally referred to the Tertiary (HOCHSTETTER 1874, LENZ 1874, TOULA 1874, NATHORST 1900, *vid.* KOCH 1929 a).

Both these islands belong to the easternmost tectonic unit of the investigated area which has been named "Wynn-Sabine Block" (A. VISCHER). The "Hühnerbjærg Fault", which separates this "Wynn-Sabine Block" from the western "Hühnerbjærg Block" (A. VISCHER), runs nearly N—S along the eastern wall of Hühnerbjærg (P. 630 m) and follows the narrow Strait between Wollaston Foreland and Sabine Island. The effective throw of our "Wynn-Sabine Block" attains a maximum in comparison with the downfaulted blocks farther to the west. In Kuhn Island, for instance, even the Caledonian basement crops out and the overlying Jurassic beds are exposed over wide areas ("Kuhn Block") whilst no older strata than Kimmeridgian have been found to crop out in the surroundings of Albrechts Bugt ("Permpass Block"); only farther to the south, on Permpasset itself, is the basement of this unit exposed,

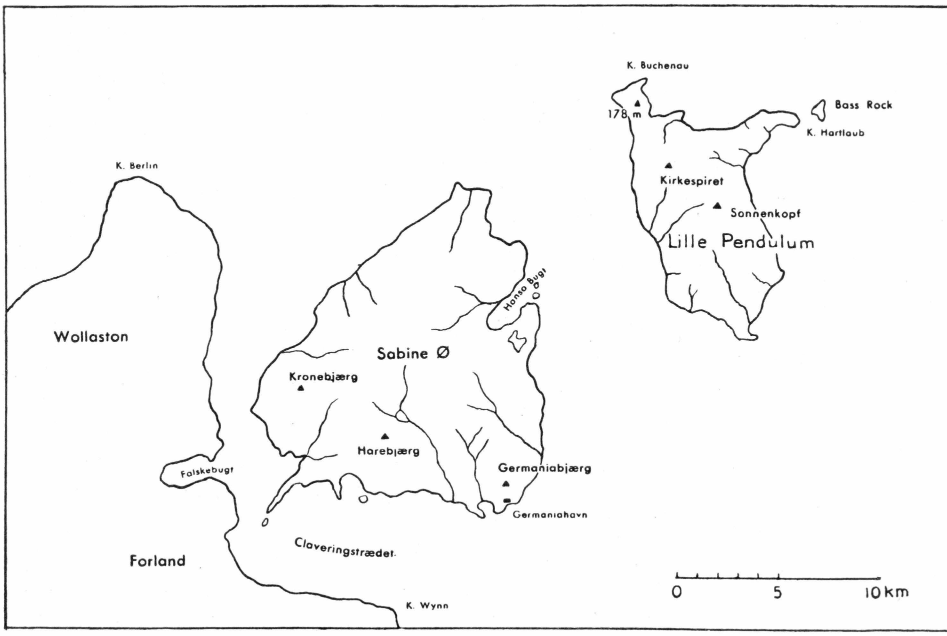

Fig. 7. Sketch-map of Sabine and Pendulum Islands.

viz. Caledonian gneisses, Permian, and a remnant of Jurassic. At Falskebugt we have the last outcrops of the Caledonian crystalline, forming the eastern edge (fault scarp) of the "Hühnerbjærg Block" on the fault plane of which the "Wynn-Sabine Block" has slipped down so far that all strata older than Albian are now concealed beneath sea level.

As is shown on L. Koch's geological map (*vid.* Koch 1929a, Pl. IV) Caledonian rocks play an important rôle in the structure of Shannon Island, and it might be argued whether those old rocks should not be considered the eroded basement of our "Wynn-Sabine Block".

Due to their situation near the fault line, the sediments in the section of Kronebjærg (P. 544 m) in western Sabine Island, i. e. on the downthrown side of the "Hühnerbjærg Fault", dip to the east-northeast at angles ranging between 9° and 30° instead of westwards, having been dragged to that position during the actual offset.

The exposed sequence in the southwestern slope of Kronebjærg is of outstanding interest as it has yielded several specimens of primitive *Hoplitidae* which have not hitherto been found in Greenland and which are of the greatest value for precise correlations. According to a brief statement of L. F. Spath these forms can be placed in the genus *Gastroplites* (Spath) and thus prove the beds in western Sabine Island to be of Middle Albian age (*vid.* MAYNC 1940). The specimens of *Inoceramus* may probably belong to either *I. anglicus* WOODS or to the *concentricus* group.

Sabine Island.

Section on the southwestern face of Kronebjærg (P. 544 m).

(*vid.* Fig. 8).

	Alluvial deposits and débris.
10 m	Black-gray crumbling shales with layers of buff marl (cone-in-cone structure) containing numerous concretions of red and yellow weathering clay ironstone and marly limestone. *Inoceramus cf. anglicus* WOODS, *I.* (*Taenioceramus*) *aff. concentricus* PARK.
20 m	Black shale interstratified with buff marl displaying cone-in-cone structure. Tracks of organisms.
25 m	Black shale containing concretions of clay ironstone with *Inoceramus sp.*
30 m	Layer of buff marl with cone-in-cone structure carrying reddish concretions of clay ironstone.
45 m	Dark shale with partings of whitish or buff marl showing cone-in-cone structure.
50 m	Yellow marl with cone-in-cone structure containing clay ironstone concretions. Partings of black shale.
55 m to 80 m	Black shales with a few partings of buff marl (cone-in-cone structure) bearing numerous concretions of clay ironstone.
80 m to 95 m	Black shales with zones of light-coloured marl disclosing cone-in-cone structure. Concretions and thin bands of clay ironstone.
95 m	Black shales with an interstratified zone of buff marly limestone the surface of which turns rough on weathering. Markings of organisms.
102 m	Black shales and slightly sandy grayish marls (cone-in-cone structure) with red clay ironstone concretions. Occasionally, the marl shows discoloration due to the infiltration of limonitic material. *Gastroplites sp.*
130 m	Dark slate with numerous interbeds of buff marl, partly with well-developed cone-in-cone structure, and containing orange-red weathering concretions of clay ironstone.
135 m to 180 m	Concealed by débris (basaltic rocks).
180 m	Black slate containing concretions of clay ironstone. Some few

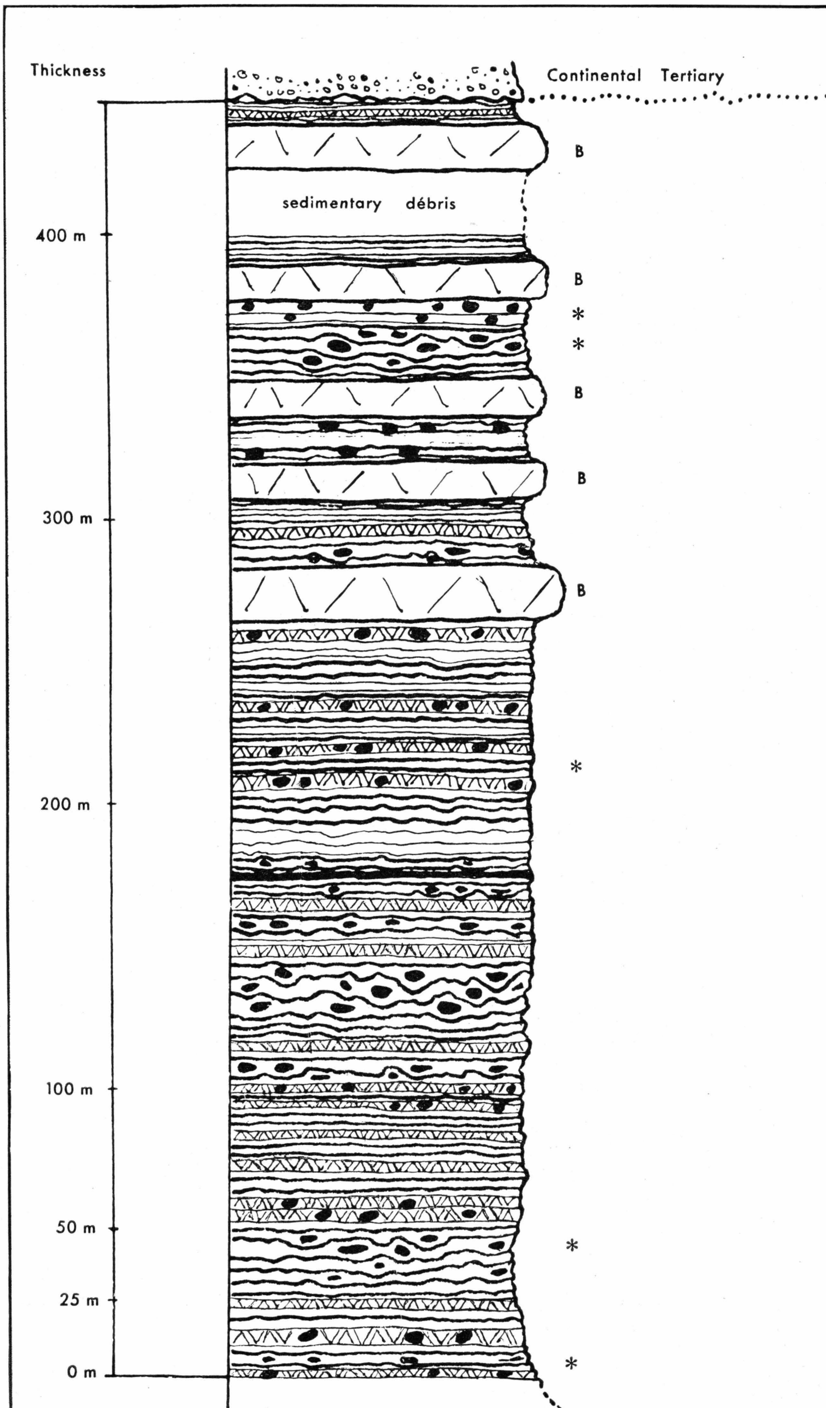

Fig. 8. The Albian beds in Kronebjærg, western Sabine Island.

	partings of buff-coloured marl with cone-in-cone structure as well as some interbeds of sandy marl with ripple-marks and trails of organisms.
190 m to 275 m	Mantled by débris (basaltic rocks).
275 m	Black slates with a few marly partings and embedded concretions of clay ironstone.
280 m to 300 m	Basalt and basaltic débris.
300 m	Black slates with numerous concretions of clay ironstone carrying large-sized specimens of *Hoplitidae* referable to *Gastroplites* (SPATH).
320 m	Layers of buff marl with uneven bedding planes, containing clay ironstone concretions. *Gastroplites sp.*
325 m to 380 m	Débris of basaltic rocks.
380 m to 420 m	Sill of basalt.
420 m	Gray or black slate alternating with more or less sandy buff marl and thin bands of clay ironstone. About 3 m exposed, mostly covered with débris.
435 m to 505 m	Basalt and débris of basaltic rocks.
Summit P. 544 m	Dyke of basalt cutting the plateau basalt at right angle.
	Slightly beneath the top (southern flank) the basalt (? sill) is overlain by
530 m	Black friable slate breaking into chips, in alternation with buff marl showing cone-in-cone structure. About 1 m thick.

These Cretaceous beds exposed near the summit of Kronebjærg are locally surmounted by

light-coloured quartz sandstones and pebble-bearing sandstones carrying an Early Tertiary flora (*vid.* MAYNC 1940).

The Cretaceous series of Kronebjærg attains a thickness of about 380 m to 400 m (this amount is based upon an average dip of 15° ENE).

The above-cited *Hoplitidae* secured at a height of 102 m and 300 m, respectively, have been referred by L. F. SPATH (communication to the writer) to *Gastroplites* (SPATH). It may be added that ammonoids of Albian age have not hitherto been recorded from Greenland, and it is to be hoped that this new find might enable a reliable comparison to be made with species known from the "Folkestone Beds" and the Gault of Lincolnshire etc.

As will be seen, the Aptian and Albian of East Greenland are developed in quite the same facies, *viz.* an alternation between shales, mudstones or slates and buff marls (often showing cone-in-cone structure) carrying reddish or orange weathering clay ironstone concretions. Here and there the deposits may become richer in sand which, however, is no indication for a safe correlation with either the Aptian or the Albian. By reason hereof it is rather impossible to decide in the field whether the sediments in question are of Aptian or Albian age without having any fossils at hand that bear eloquent testimony as to the age. Hence the writer has preferred in his preliminary reports to speak in general of Aptian-Albian (MAYNC 1938, 1939, 1940) or of "*Inoceramus* Beds" when *Inocerami* are rather common. These terms will still be used in the present paper if the precise age cannot be made out by index fossils.

Lithologically identical or similar deposits as have been found to occur in Kronebjærg crop out both in the eastern part of Sabine Island and in Pendulum Island but I failed to detect any fossils. However, *Inoceramus*-bearing shales are recorded by A. VISCHER from the western slope of Harebjærg (P. 579 m), being exposed between 260 m altitude and the floor of the plateau basalt at 350 m (VISCHER 1943). At any rate, the general habitus and facies of those beds on Sabine and Pendulum Islands make me feel justified in assuming that they are Albian. The finding of doubtless Albian fossils in Kronebjærg speaks much in favour of this conception. Besides, one might expect that the ENE dipping series in the said mountain of which about 400 m are exposed would crop out again farther to the east below the plateau basalt as there is no evidence of any longitudinal faults which might account for another possibility of correlation.

These further outcrops of Albian deposits in Sabine and Pendulum Islands will be dealt with in the following pages.

On the southeastern foot of Harebjærg (P. 579 m) the writer found
50 m above sea level dark-gray partly sandy slates turning whitish along the contact with basaltic rocks (dykes), containing lenses of a light-gray medium-grained sandstone and heterogeneous nodular lumps. Away from the contact with the basaltic lavas

the dull-gray beds pass into dark, often purplish or greenish sandy slates which dip slightly to the south.

On climbing Harebjærg from the small lake to the northeast the following sediments were encountered:

Débris of basaltic rocks, and snow.

380 m Gray-greenish slates partly weathering yellow-orange, interstratified with thin layers of reddish fine-grained hematitic sandstone and dark marly limestone. Intrusions of various basalt sills.

425 m Buff marl and marly limestone containing big concretions of clay ironstone weathering red or orange and being locally brecciated. Petrified wood.

Transgressively overlain (sharp boundary) by

430 m continental Tertiary: Light-coloured coarse-grained sandstones, higher up medium-grained ones, and thin interbeds of gray slate. Coaly seams, plant-remains, and fossil wood.

On the western side of Germania Bjærg (P. 302 m) the writer came upon

140 m light-gray or whitish marly slates bearing hard orange-red clay ironstone concretions, and pink and purplish fine-grained quartz sandstones.

Higher up the slope transgressive Tertiary plant-bearing sandstones occur, mostly covered with débris, though.

On the southern flank of Germania Bjærg, slightly above the station Germaniahavn, I observed

45 m black partly sandy marly slates with partings of buff marly limestone carrying fossil wood. Locally, the slate contains lumps of a rather coarse-grained light-gray sandstone.

150 m Psephitic whitish-gray sandstone with concretions (and pebbles?) of clayey limestone, and thin interbeds of chocolate brown, red weathering clay ironstone.

160 m Transgressive conglomerates and sandstones of Tertiary age which show a marked erosional break to their floor.

Near the shore around Hansa Bugt, in the northeastern portion of Sabine Island, the author found some bad exposures of light-gray whitish discoloured slate and buff baked silty slates with limonitic infiltrations, alternating with yellowish sandstone beds bearing red clay ironstone concretions.

Pendulum Island.

(*vid.* Fig. 7).

Black slates containing orange weathering, dark-hearted concretions of clay ironstone, and partings of buff marl with faintly wavy and knobby bedding surfaces were found to occur between Cape Buchenau (P. 178 m) and Kirkespiret (P. 497 m).

The following section was measured in the northwestern slope of Kirkespiret (P. 497 m):

80 m to 100 m Black slate interstratified with light-gray marly shale and interbeds of buff marl carrying red weathering clay ironstone concretions. Bedding more or less horizontal.

150 m to 170 m Black slate; interbeds of buff-coloured marl showing cone-in-cone structure with concretions of clay ironstone and clayey limestone.

170 m Contact with plateau basalt.

On the east coast of the island, *viz.* in the eastern slope of Sonnenkopf (P. 602 m), the strata were measured to dip at an angle of about 12° towards the southwest. The following deposits were met with here:

50 m Black or gray slightly sandy slates breaking into splinters, with interstratified layers of a hard gray or buff limestone and fine-grained sandstone partings.

70 m Fine-grained yellow and greenish sandstones with rust-coloured patches. Fossil wood.

80 m Black slate with yellow-red sandy-marly micaceous *laminae*, containing red weathering maroon concretions of clay ironstone. Interbeds of a gray-greenish impure sandy slate and of mottled sandstones, often showing wavy bedding planes.

110 m Contact with basaltic flows (plateau basalt).

Farther to the south the formation is made up of sandy shales containing interlayers of yellow and brown fine-grained limonitic sandstone, either striped or mottled, and occasionally of lignite-bearing sandstone.

The facial variability of the deposits in Pendulum Island is rather striking. While horizontal strata are exposed in the west (Kirkespiret) the description of which completely accords with that of the Albian sequence in Kronebjærg, Sabine Island, sediments richer in sand crop out beneath the flows of basaltic lavas on the east side of the island. Due to the lack of fossils it is rather difficult to decide whether or not the deposits on either coast are of the same age. It must be stressed, however, that rather sudden changes in composition and facies are frequently displayed in the sediments of Aptian-Albian age. The Albian sequence measured in the western portion of Sabine Island shows a complete lack in sand. On the other hand, sandy shales and slates, sandstones, and even conglomerates were found to occur already south of Clavering Strait, in Gaasedal, in beds which doubtless correspond to those of Kronebjærg (*vid.* p. 64).

It should be borne in mind, however, that the strata in eastern Pendulum Island are inclined to the southwest whereas those in the section of Kirkespiret are horizontal. This might suggest either that the formation in the east with its landward dip is older, possibly of Aptian age, or that the change of dip is due to faulting. Such a fault might be concealed beneath the low-lying basalt formation although none could be proved to crop out, after all.

Quite identical sandy deposits as occur in Pendulum Island are proved to exist in Jackson Island and Home Foreland (*vid.* pp. 131—141).

It may be pointed out that in March 1938 the author happened to discover marine deposits near Cape Hartlaub, north coast of Pendulum Island, which are referable to the Tertiary (MAYNC 1939, 1940). Unfortunately, a blinding blizzard rendered a detailed investigation quite impossible. At the top of black slates carrying orange-red concretions of clay ironstone as well as intercalations of buff sandstone lie conglomeratic beds which bear well-preserved plants e. g. leaves of *Corylus cf. McQuarrii* (FORB.) HEER, *Acer cf. arcticum* HEER etc. as well as mollusks (?*Nucula sp.*, *Cyrena sp.*, *Aporrhais sp.*, corals, etc.). Importance must be attached to the occurrence of small basaltic pebbles in the polygenetic conglomerate that has yielded the above-cited fossils. It thus becomes evident that the beds were laid down after the first extrusions of the basaltic lavas. Up to now no strata referable to the marine Tertiary are known to exist elsewhere in northern East Greenland[1]), only farther south, on Cape Dalton, marine Tertiary occurs (RAVN 1904, 1933, WAGER 1935).

C. Wollaston Foreland.

1) Outer Wollaston Foreland.

As in Sabine and Pendulum Islands marine beds of Aptian-Albian age crop out below the plateau basalt of Wollaston Foreland. Locally,

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[1]) It may be remarked that E. NIELSEN brought back a few fossils (*Yoldia sp.*, *Nucula sp.*, *Barbatia sp.*, gastropods, *Ophiomorpha*) from a series about 350 m thick, of dark-gray and black sandstones he had discovered north of North-East Foreland, in Nakkehoved, in 1939. Owing to the bad state of preservation of these fossils it cannot even be made out whether they are of Cretaceous or Tertiary age, (NIELSEN 1941).

also continental deposits of the Tertiary are intercalated between the Cretaceous and the basaltic flows.

Valanginian rocks are only exposed at Falskebugt where they rest transgressively upon the Caledonian crystalline and are developed in a genuine littoral-clastic facies (= "Falskebugt Beds"). The Valanginian (Upper Polyptychitan) in the common marl/limestone facies occurring in the surroundings of Albrechts Bugt, e. g. in Sumpdalen, Græenseryggen, and Rødryggen, already belongs to the tectonic element of the "Permpass Block", inner Wollaston Foreland, and will thus be dealt with below.

In 1869—1870 the KOLDEWEY Expedition discovered a yellowish fossil-bearing calcareous sandstone on the southern shore of Falskebugt. Basing upon the determination of "*Rhynchonella fissicostata* SUESS" which was stated to have been gathered here the said rock was assigned to the Rhaetic (TOULA 1874, *vid.* KOCH 1929 a). From the same region O. LENZ reports loose-lying coarse-grained coal-bearing sandstones, black slates etc. which he classed as Tertiary (LENZ 1874, *vid.* KOCH 1929 a).

The sandy shales, slates, sandstones, clay ironstones, and marls (partly showing cone-in-cone structure) etc. exposed in Flakkebugt were held by O. LENZ to be likewise of Tertiary age (*op. cit.*). A. G. NATHORST, on the other hand, took them to be Jurassic (NATHORST 1900) probably because a loose block of shaly sandstone containing a cast of some pelecypod ("?*Aucella*") was found here.

In 1926 shales of unknown (probably Mesozoic) age, being associated with the Tertiary basalts, were reported by J. M. WORDIE (Cambridge University Expedition, 1926) to occur between Tyroler Fjord and Cape Berlin.

During his sledge trip from Scoresbysund to Danmarkshavn in 1927 L. KOCH cursorily examined the sediments beneath the basalt of outer Wollaston Foreland, yet he failed in finding any fossils. In analogy with the Jurassic and Lower Cretaceous beds which the said explorer discovered on this journey in inner Wollaston Foreland etc. the strata were mapped as "Undivided Jurassic-Cretaceous" (KOCH 1929 a). According to L. KOCH (in *loc. cit.*) the coal-bearing formation near Cape Borlase Warren should rather be referred to the Mesozoic, not to the Tertiary.

As to the above-mentioned "Rhaetic" beds we may state at once that the listed species of *Rhynchonella* has been misidentified (*vid.* MAYNC 1938, 1940). There is not the least doubt left that Rhaetic strata have never been deposited in northern East Greenland, neither in a marine facies nor in a continental or sub-continental facies like that in the area between Scoresby Sound and Franz Josephs Fjord. The numerous *Aucellae* found by the writer together with various forms of *Rhynchonella*, *Terebratula sp.* and other fossils are closely related to *Aucella* (*Buchia*) *keyserlingi* LAH., *A.* (*B.*) *piriformis* LAH., *A.* (*B.*) *crassicollis* KEYS. etc. and, therefore, point towards Valanginian (MAYNC, *op. cit.*).

The coal-bearing sandstones mentioned from the surroundings of Falskebugt and Flakkebugt were partly assigned to the Liassic and the Tertiary, respectively (*vid.* KOCH 1929a). The writer's investigations

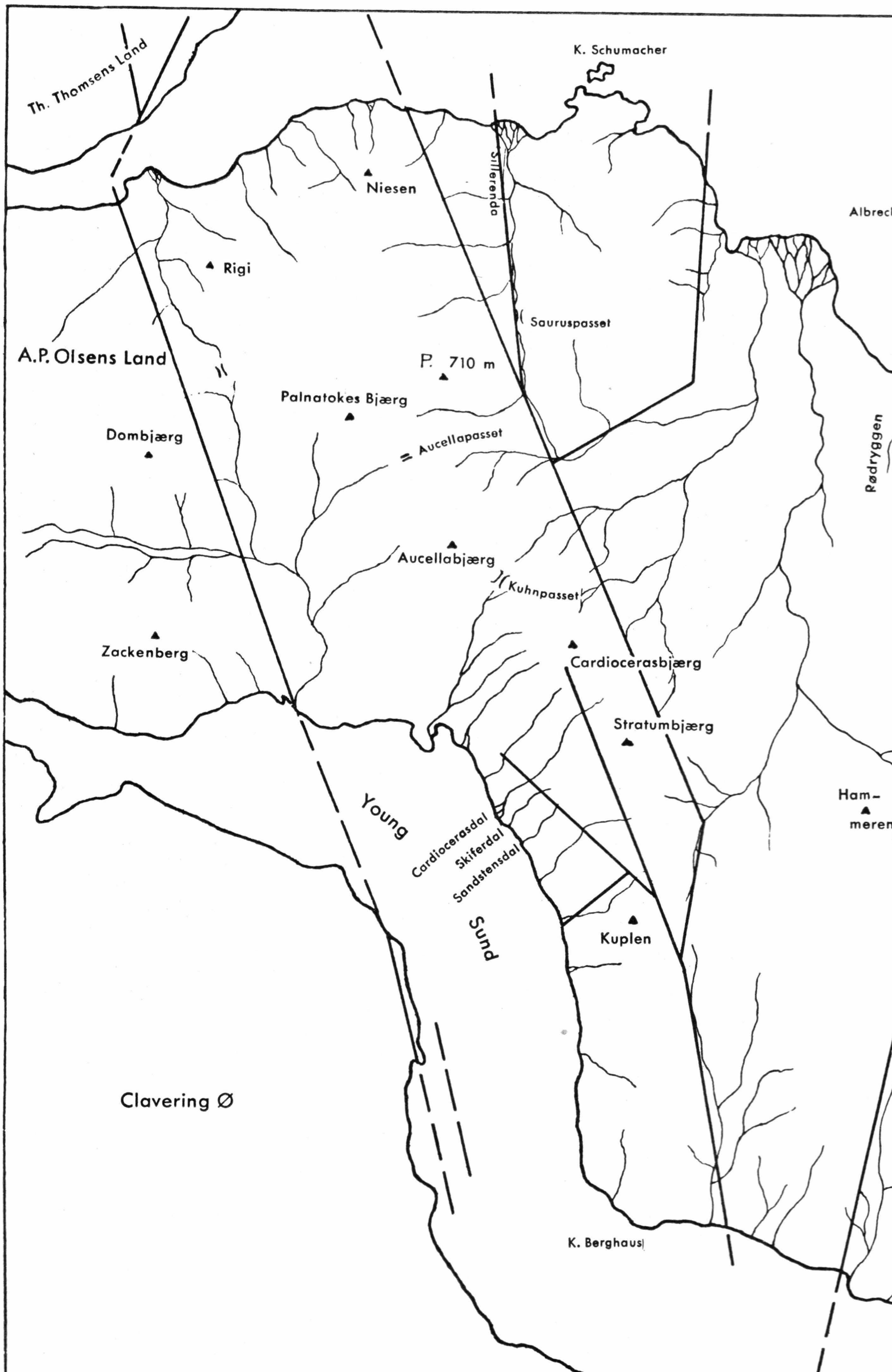

Fig. 9. Map of Wollaston Foreland

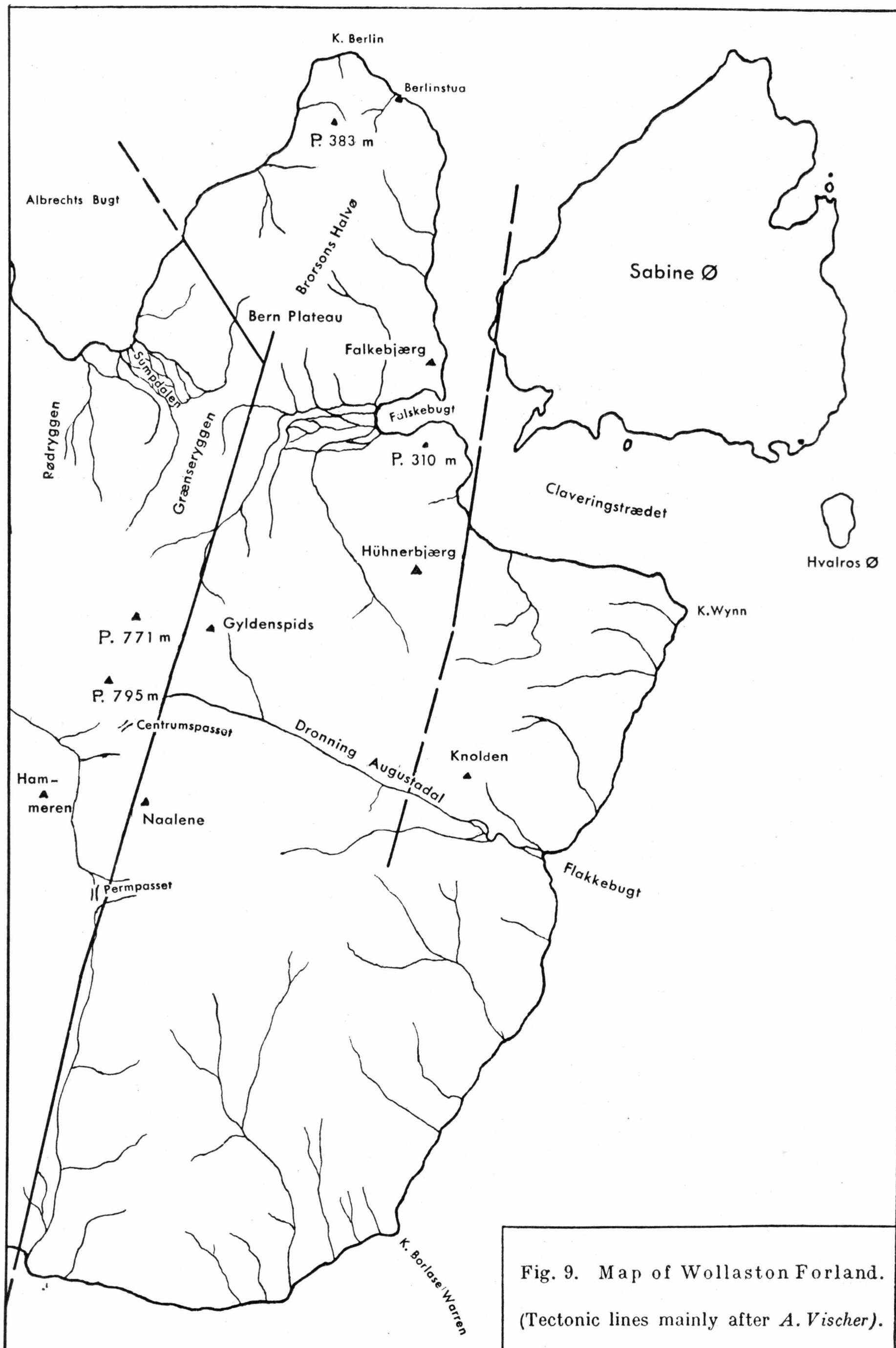

Fig. 9. Map of Wollaston Forland.
(Tectonic lines mainly after *A. Vischer)*.

(tectonics mainly after A. VISCHER).

have revealed, however, that the carbonaceous rocks occurring in thc outer Wollaston Foreland are Tertiary which has a much wider distribution than previously assumed; many new localities were detected between Sabine and Pendulum Islands and Cape Borlase Warren.

Because of their lithological resemblance the sediments in Flakkebugt are correlated by the author with the Aptian-Albian series.

Section at Cape Berlin.

(*vid.* Fig. 10).

0 m	Shore-ice, higher up snow and soil flows.
60 m	Soft black clayey shale alternating with buff marl and marly limestone layers. Lenses and concretions of clay ironstone weathering to red or orange. Interbeds of light-gray coarse-grained, often conglomeratic sandstone carrying red and brownish clay ironstone concretions.
70 m	2 m buff weathering marl showing cone-in-cone structure, overlain by black shale containing large concretions of clay ironstone and silicified limestone.
75 m	Buff or grayish marl with cone-in-cone structure, ripple-marks, worm tubes etc. Interbed of gray knobby sandstone. Overlain by black shale carrying large concretions of clay ironstone.
80 m	Buff marl (cone-in-cone structure).
100 m to 125 m	Whitish knobby medium-grained sandstone beds, partly weathering limonitic and rusty. Occasionally exhibiting ripple-marks etc. (*vid.* Fig. 63). Cropping out in a ledge.
125 m	Black, more or less sandy shale containing big lenses of dark-gray mica-bearing calcareous sandstone.
128 m	Black shale with concretions of clay ironstone. Marl-horizon (cone-in-cone structure).
130 m	Dark-gray calcareous sandstone with coarse angular quartz grains, pea-sized pebbles, and muscovite flakes. Enclosing red weathering concretions of clay ironstone and siderite.
140 m	Gray or olive-coloured marl and shale with interstratified layers of quartzitic sandstone (as below). Carrying a few clay ironstone concretions.
162 m	Bed of gray conglomeratic calcareous sandstone with accessory glauconite, small crystalline pebbles, and clay ironstone in the form of "schliers", concretions, and thin *laminae.* Also "schliers" of buff weathering marly material are present. ?Transgression.
165 m to 190 m	Black mudstones and slates containing red and yellow weathering clay ironstone concretions. A few partings of buff-coloured marl exhibiting cone-in-cone structure.

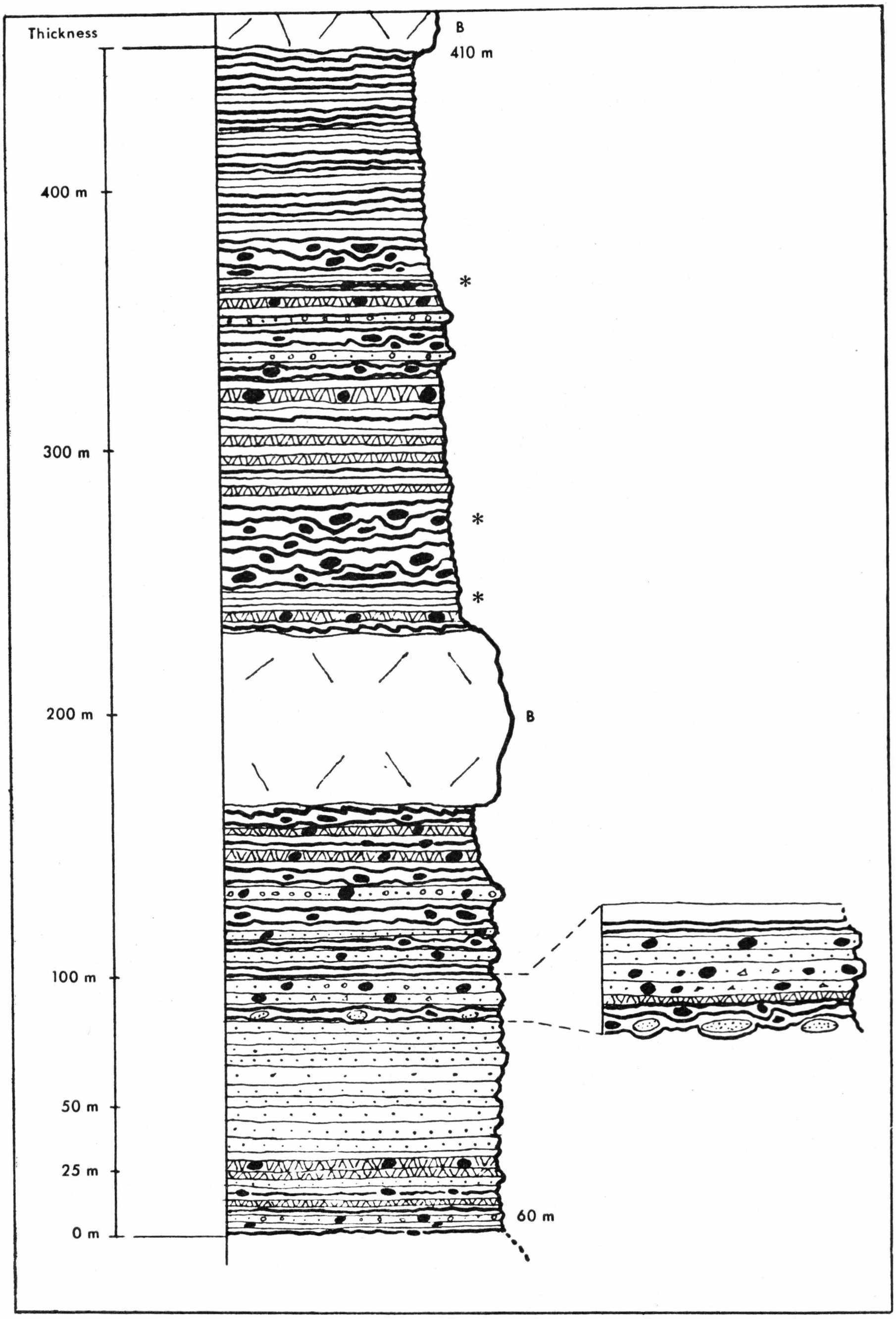

Fig. 10. Stratigraphical section at Cape Berlin, Wollaston Foreland.

190 m to 240 m Basaltic rocks.

240 m Black slate, near the contact with the basalt turning bleached and indurated. Phenomena of mechanical lamination.

243 m Buff marl (cone-in-cone structure) bearing numerous red or yellow-coloured concretions of clay ironstone with *Inoceramus sp.* Interbeds of buff marl without cone-in-cone structure.

250 m to 280 m Black and gray shales with numerous clay ironstone concretions yielding abundant *Inocerami.*

280 m Olive-coloured marl and shale with interstratified zones of buff weathering marl disclosing cone-in-cone structure.

300 m Black shale with interbeds of buff marl, partly displaying cone-in-cone structure, containing clay ironstone. A few partings of gray coarse-grained sandstone.

340 m Black and gray shale with layers of marly limestone containing fossil-bearing concretions of clay ironstone. *Hoplitidae* and *Inoceramus cf. anglicus* (WOODS) ROSENKR.[1]).

360 m Gray slates alternating with buff marl, mostly covered with basaltic débris. Specimens of *Inoceramus sp.* are rather frequent but the rock in which they are embedded has become splintery and friable (contact with basalt).

410 m Floor of the plateau basalt.

In this section at Cape Berlin 390 m of Albian sediments are exposed.

Section east of Cape Berlin.

The beds exposed along the slope east of the Cape belong to a slightly lower portion of the series than that described in the foregoing.

Snow.

20 m Black-gray shale with interbeds of somewhat sandy marl containing *Inoceramus sp.* Intercalations of buff marl (showing cone-in-cone structure, sun-cracks (*vid.* Fig. 65) etc.) which carry reddish weathering concretions and thin partings of clay ironstone. ?*Sanmartinoceras* sp. and other ammonites, *Inoceramus cf. anglicus* (WOODS) ROSENKR.[1]).

40 m Yellow marly limestone bed with an inosculation of psephitic gray mica-bearing sandstone. *Inoceramus sp.*

50 m to 60 m Dark shale containing interbeds of buff marl with red clay ironstone concretions which have yielded abundant though seriously damaged specimens of *Inoceramus spp.* Higher up the succession

[1]) Identified by Dr. J. SORNAY, Paris.

is mostly concealed by débris. An exposure at a height of
140 m displays black slate with buff-coloured marl partings, sometimes showing cone-in-cone structure.
170 m Contact with basalt.

Southwest of Cape Berlin, in the western slope of P. 383 m, the following section was set down:

Covered with snow and talus.
195 m to 210 m Gray or greenish slightly sandy-marly shale with a few partings of buff and brownish marl displaying cone-in-cone structure. A dip of 13° SW was measured.
235 m Shale, slate, with marly partings (as below), interstratified with a layer of marly limestone that contains pockets and clusters of hematitic quartz sand. Passing upwards into
250 m Light-coloured or grayish mica-bearing sandstone with faintly wavy bedding planes. Higher up
275 m Mottled sandstone, rich in limonite, locally carrying greenish clay galls. Near the contact with the basalt the sandstone has become bleached and hardened.
280 m Basalt.

An instructive section was measured in the western slope of Bern Plateau (*vid.* Fig. 11).

At a height of 10 m black slightly sandy shales with interbedded layers of yellow weathering limestone are exposed which have yielded *Amoeboceras spp.*, *Aucella* (*Buchia*) *bronni* Lah. etc. which prove them to be of Kimmeridgian age.

These Jurassic rocks belong to the "Permpass Block", the substratum of which (older Jurassic, late Permian, and Caledonian gneisses) is laid bare on Permpasset (*vid.* Maync 1942). East of Albrechts Bugt, however, the writer actually observed the outcrop of a NW-running fault diverging from the major fault line which strikes NNE-SSW. This fault trends across the sea to southeastern Kuhn Island where it causes the abrupt termination of Kimmeridgian and Valanginian strata against the Aptian beds (*vid.* p. 17). In the latest paper of A. Vischer this branching fault is, curiously enough, replaced by a flexure (Vischer 1943). Since I have myself stood on the splendidly exposed fault-trace about 1 km farther to the south (*vid.* p. 50) I cannot support A. Vischer's new interpretation on this point.

In the present section the exposures below an altitude of about 220 m are poor, the slope being mostly covered with sedimentary talus and basalt débris.

220 m Light-gray or whitish rather fine-grained quartz sandstone with occasional clusters of coarse sand and pebbles. Sometimes

"schliers" of glauconite and fragments of buff-coloured sandy limestones (Jurassic rocks in a remanié state) occur in a clay ironstone matrix. In part the sandstone is mottled and contains sparse layers of yellow weathering clay ironstone. *Serpula*-like tubes, worm trails, etc.

230 m Slightly sandy brownish or gray marly limestone with annelids and tracks of organisms. Partly with well developed cone-in-cone structure and ripple-marks. Overlain by

240 m light-gray coarse-grained quartz sandstone carrying scattered quartzite pebbles of hazel-nut size.

245 m Buff marly limestone containing small concretions and larger lenses of reddish weathering dark-hearted calcareous clay ironstone.

260 m to 290 m Light-gray thick-bedded quartz sandstone.

290 m Gray- or brown-coloured knotty rather crumbling sandstone carrying rare ammonites (*Hoplitidae*). Interbeds and concretionary bands of clay ironstone.

320 m Ditto, with limonitic infiltrations and organic trails.

322 m Sandstone as below (290 to 320 m), having yielded a specimen of a large-sized *Hoplitid.*

The sandstone is continuously exposed up to a height of 360 m.

360 m Gray-yellowish limonitic quartz sandstone, with coarse-grained portions (+ glauconite) and inosculations carrying pebbles of clay ironstone.

370 m to 410 m Gray partially hematitic sandstone with concretions (rarely bands) of clay ironstone.

410 m Gray or bluish friable marly shale bearing concretions and bands of clay ironstone. 4—5 m in thickness.

Overlain by an alternation of gray sandstone layers and steel-gray marly slates with interbeds of marly limestone in their upper part.

Capped by a yellowish sandstone with intercalations of

450 m gray slate, unconformably cut by the plateau basalt.

This sequence is exposed in a thickness of 227 m. In its lower part (up to 220 m) the succession is mostly covered with débris, but along the ridge immediately to the north these lower beds are better exposed (*vid.* Fig. 11):

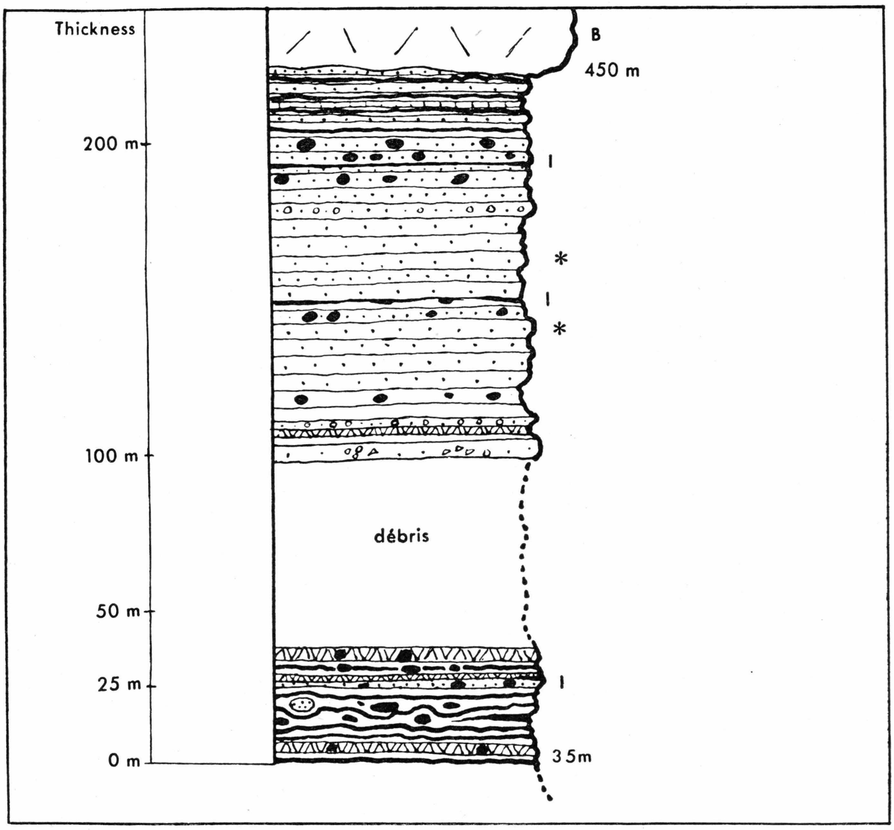

Fig. 11. Stratigraphical section in the western slope of Bern Plateau, Wollaston Foreland.

Snow and débris.

35 m Black shale alternating with buff marl bands often displaying cone-in-cone structure, with embedded small concretions of red weathering clay ironstone.

44 m Black and dark-gray shale containing a few concretions and thin layers of clay ironstone.

60 m Black and gray shale carrying big round clay ironstone concretions. This bed is extremely rich in petrified wood, trunks attaining a length of some metres being by no means rare.

65 m About 4 m thick black-gray shale, slightly sandy, containing large concretions of clay ironstone with a diameter of up to 2 m. Fossil wood was found in great quantities.

Passing upwards into whitish or gray sandstones with rusty zones and interbeds of buff-coloured marl exhibiting cone-in-cone structure. Concretions and thin bands of yellow weathering clay ironstone.

80 m to 100 m Buff marl with well-developed cone-in-cone structure. Interstratified a 4—5 m bed of grayish marly shale carrying red and brown weathering concretions of clay ironstone with indeterminable imprints of ammonites.

Higher up no exposures.

The section below was set down in the southwestern slope of Bern Plateau:

10 m to 190 m Jurassic sequence (*vid.* MAYNC 1947).

190 m Black shales alternating with buff weathering partly brecciated limestone layers carrying *Amoeboceras spp.*, *Aucella* (*Buchia*) *cf. bronni* LAH. etc.

202 m Ledge of sandy limestone with numerous though badly preserved specimens of *Amoeboceras sp.* These beds of Kimmeridgian age dip at angles of up to 60°, in part to the southeast and partly to the northeast (dragging along the above-mentioned fault running NW, *vid.* p. 47) and are in abnormal contact with the Cretaceous series which shows a gentle tilting of a few degrees to the northeast. Near the fault line itself, however, the Cretaceous strata dip slightly towards the fault (flexure).

The Cretaceous sequence is as follows:

207 m Gray and black brittle shales containing orange-red weathering concretions of clay ironstone breaking into polyedric pieces. Thin interbed of plant-bearing shale. A little higher the shale carries lumps of yellowish marl with embedded fossil wood. Find of an ammonite.

Overlain by an alternation of shale and buff marl with cone-in-cone structure (*vid.* Pl. IV, Figs. 3, 4, 5), containing red clay ironstone concretions.

Bed 10 cm thick of fine-grained pink sandstone.

220 m Buff marl showing cone-in-cone structure with 3 m interbed of marly shale carrying numerous concretions of clay ironstone. A few large-sized coarsely ribbed *Hoplitids*.

235 m Gray marly shale with horizons of buff marl (cone-in-cone structure) containing brecciated zones formed by water-currents or wave-action; bored wood.

260 m Slate with concretionary layers of clay ironstone, and buff marl-horizons showing cone-in-cone structure. Concretions of clay ironstone. Sparse pelecypods.

The top beds beneath the basalt are made up of slate with

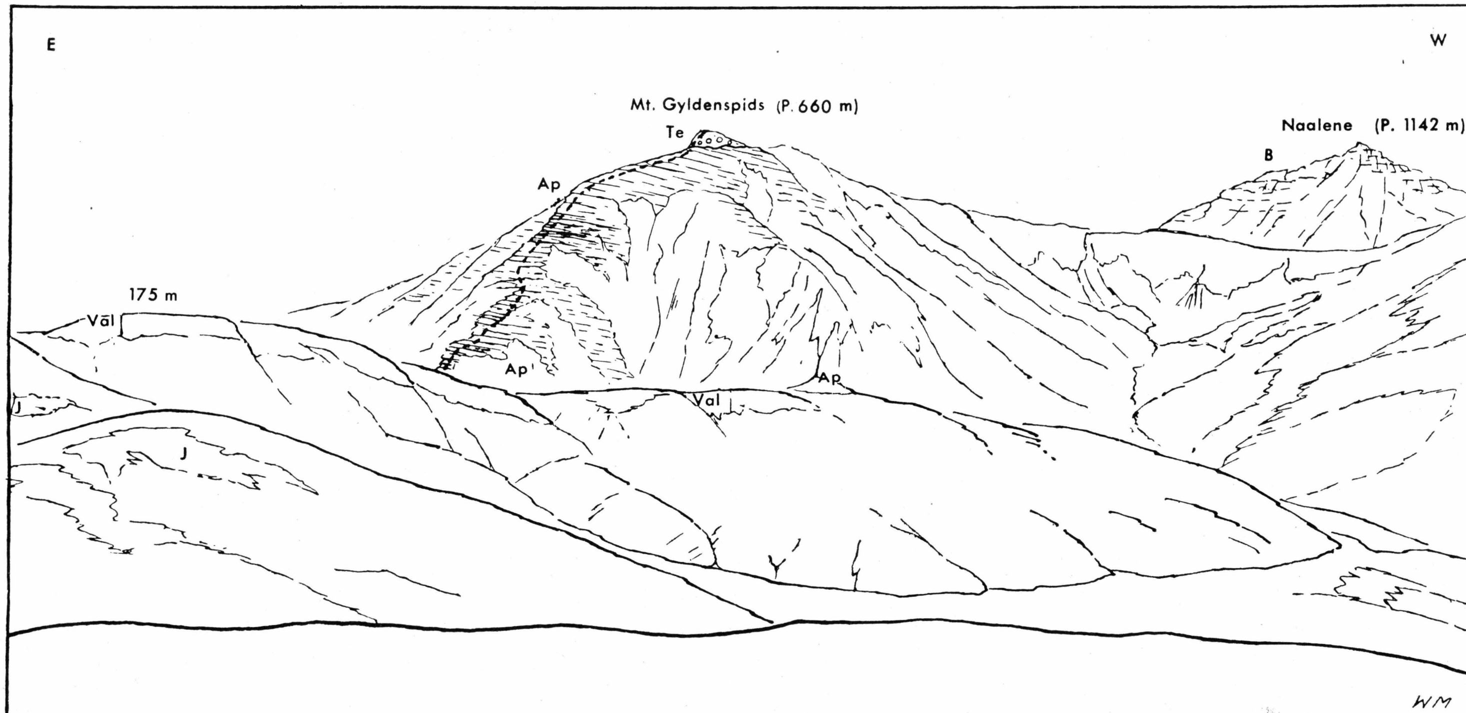

Fig. 12. Mt. Gyldenspids (P. 660 m), Wollaston Foreland, seen from Grænseryggen (field-sketch of the writer). In the foreground Grænseryggen built up of Jurassic shales (J) which are capped by the transgressing Valanginian limestone (Val) and the Aptian beds (Ap). In the background Mt. Gyldenspids, where a thick series of the Aptian-Albian is exposed. The very summit is made up of continental Tertiary deposits (Te) (angular unconformity). The Naalene (P. 1142 m) behind to the right consist of basaltic flows (B). The dashed line marks the measured section (*vid.* Fig. 13).

intercalations of brown or grayish, often limonitic coarse-grained sandstone. Tracks of organisms.

265 m Basalt and its débris.

Owing to the dragging of the Cretaceous member along the above-mentioned fault its exposed thickness cannot be stated. Since gentle dips to the northeast as well as to the southwest were recorded, however, it seems safe to base our computation upon an average horizontal bedding. As a result the exposed thickness of the said Cretaceous formation would amount to about 60 m.

A considerable portion of the Aptian-Albian sequence is exposed on the northern flank of Mt. Gyldenspids[1]) (P. 660 m) (Figs. 12, 13):

Valley-circus. Snow.

200 m Black friable clayey shale interbedded with buff-coloured marl showing cone-in-cone structure. Numerous red and brown weathering clay ironstone concretions and -bands. The measured dips diverge owing to the great fault running east of Grænseryggen vid. Fig. 9), but upon an average dips of about 15° to the southwest prevail.

235 m Buff marl and marly limestone containing concretions of clay ironstone with fragments of *Inoceramus sp.*

240 m Dark shale carrying clay ironstone concretions with *Inoceramus sp.*

260 m to 300 m Black shale with interstratified layers of gray thin-bedded sandstone that also occurs as interbeds within buff marl disclosing cone-in-cone structure.

300 m to 325 m Dark clayey shale with intercalations of gray ripple-marked sandstone beds. A few interlayers of buff-coloured marl with well-developed cone-in-cone structure bearing red weathering clay ironstone concretions.

325 m Grayish and buff marl with cone-in-cone structure, inosculating with red brecciated beds rich in sand, attaining a thickness of 2—3 m. Petrified wood, fragments of *Inoceramus sp.*, and numerous specimens of a small-sized pelecypod (?*Cyrena*).

330 m Buff marl carrying red-coated clay ironstone concretions whence numerous *Inocerami* and some poorly preserved ammonites probably of Aptian age were derived.

Overlain by buff marl with cone-in-cone structure interbedded with gray-coloured sandstone layers carrying *Inoceramus sp.*, and red sandy beds.

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[1]) As to the nomenclature *vid.* MAYNC 1947.

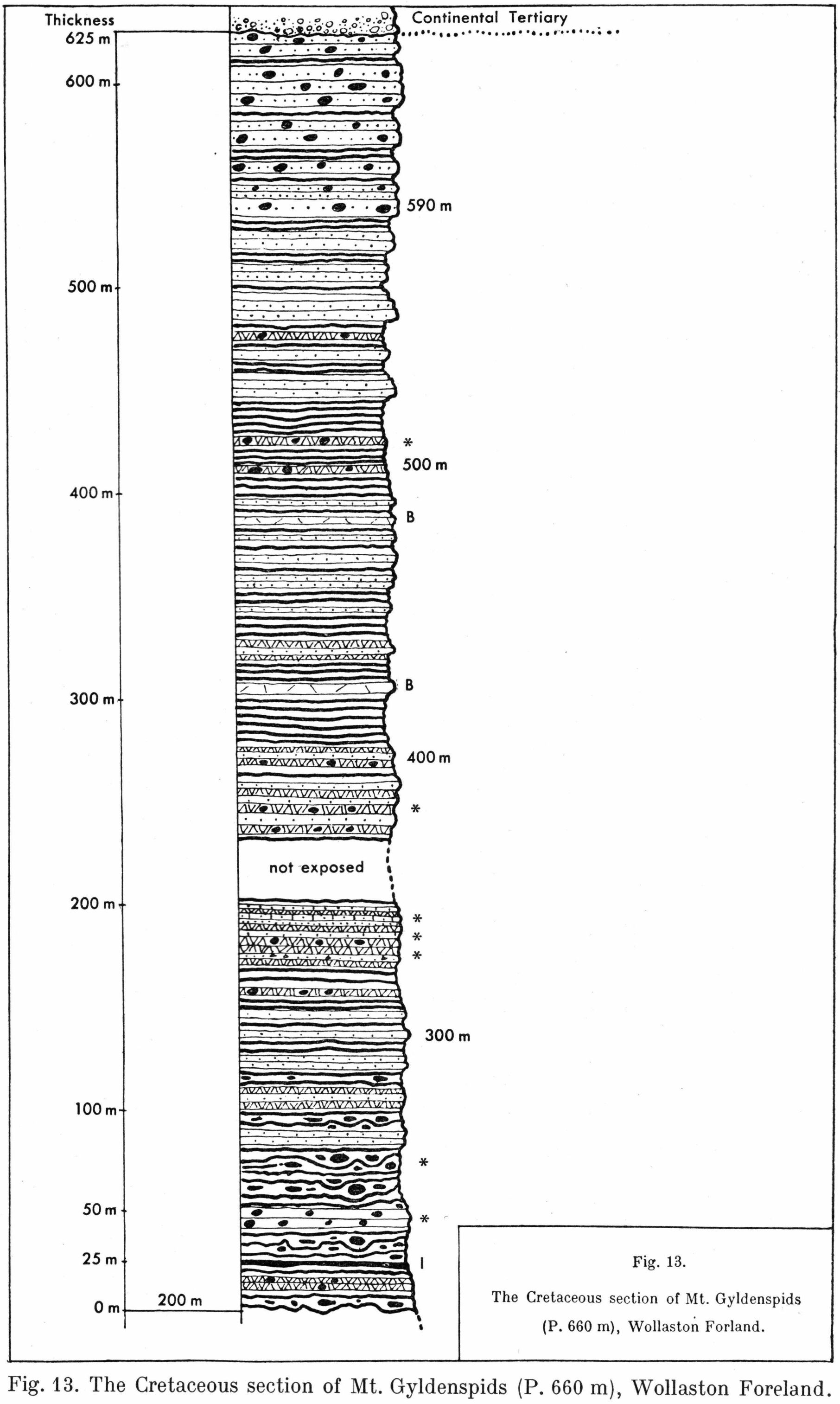

Fig. 13. The Cretaceous section of Mt. Gyldenspids (P. 660 m), Wollaston Foreland.

340 m	Beds as below, with a thin layer of red heterogeneous calcareous sandstone, bearing small lamellibranchs (as below, at a height of 325 m) in abundance. Followed by concretion-bearing shale (the clay ironstone concretions being partially brecciated), carrying fossil wood, carbonaceous plant-remains, pelecypods (as below), *Inoceramus anglicus* (WOODS) ROSENKR., *Inoceramus spp.* Moreover, one specimen of an ammonite was secured here.
342 m	Buff marl exhibiting cone-in-cone structure, with interbeds of gray sandstone and partings of black shale containing concretions of clay ironstone. Rock débris.
370 m to 400 m	Alternation of buff marl, sandstone layers, and black shale with clay ironstone concretions, which have furnished broken specimens of *Inoceramus sp.*
400 m to 420 m	Gray-black crumbling shale, slightly sandy, with worm trails and other tracks.
420 m	3—4 m thick sill of basalt. On its roof lie gray and black slates, showing cleavage and induration near the igneous contact, with an interbed of buff marl (cone-in-cone structure), in alternation with sandstone beds.
450 m to 485 m	Dark slates interstratified with numerous sandstone layers.
485 m	3 m basalt sill.
490 m	Black slate with interbeds of sandstone (as below at 450 m altitude).
500 m to 530 m	Black clayey shale containing buff marl layers with cone-in-cone structure. Embedded brown-orange coloured concretions of clay ironstone. A few *Inocerami.*
530 m to 550 m	Gray sandstone with partings of buff marl and dark shale carrying red weathered concretions of clay ironstone.
565 m	Alternation of rusty-brown sandstone, buff marl, and black shale.
590 m	Sandstone (as below, from 530 m to 550 m) exhibiting limonitic rusty zones and bearing large red or brown weathering concretions of clay ironstone.
600 m to 650 m	Sandstone as in the underlying bed, often turning yellow on weathering, containing red clay ironstone concretions. A few interlayers of gray or black shale.
650 m	Transgressive light-coloured coarse conglomerate which grades

into carbonaceous whitish sandstones etc., carrying a well-preserved Lower Tertiary flora (*vid.* MAYNC 1940).

These continental deposits rest with a marked angular unconformity upon the Cretaceous member.

In the above given section the Aptian-Albian series attains a thickness of 618 m. With regard to its facies the sequence in Mt. Gyldenspids strongly reminds one of that exposed in Brorsons Peninsula (*vid.* p. 44 ff).

The „Falskebugt Beds" (Valanginian).

(*vid.* Fig. 14).

The crystalline and metamorphic rocks (= transformed "Eleonore Bay formation" L. KOCH 1927) cropping out in Falskebugt (Falkebjærg, P. 307 m, P. 310 m south of the bay, and Hühnerbjærg, P. 630 m) belong to the Caledonian substratum of the tectonic unit between the "Permpass Block" and the "Wynn-Sabine Block". This structural element has later been named "Hühnerbjærg Block" by A. VISCHER (VISCHER 1943).

Completely fitting in with the conception of a step-faulted continental border or "antithetische Schollentreppe"[1]), the inlier of Hühnerbjærg is bounded on the east by a considerable normal fault (*vid. sup.* p. 32) whilst its contact with the sedimentary "Falskebugt Beds" in the west is a primary one. In other words, the littoral clastic "Falskebugt Beds" of Valanginian age directly overlie the old land surface of that inlier.

The Caledonian area in Falskebugt thus belongs to the continent "Eskimonia" which in late Paleozoic and eo-Mesozoic times must have extended from southern Wollaston Foreland as far north as 80° N. lat., since Permian and Triassic-Liassic strata have apparently never been deposited in this region (*vid.* MAYNC 1940, 1942, 1947). This assumption is moreover supported by the fact that in regions where upper Jurassic beds were laid down, *viz.* Upper Bathonian-Argovian, Kimmeridgian, Volgian, no pebbles of Permian or early Mesozoic origin have ever been found in the basal conglomerates. The overlap of the Cretaceous upon the Caledonian rocks in Falskebugt bears witness to a continuous emergence throughout the Jurassic here.

The marine fauna of the "Falskebugt Beds" "looks Jurassic rather than Cretaceous"[2]) but the presence of *Aucellas* closely allied to *Aucella*

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[1]) Term applied by H. CLOOS to a set of downfaulted blocks tilted in the opposite direction from the dip of the faults which hade towards the downthrow (CLOOS 1928, 1936).

[2]) Letter of L. F. SPATH, London, to the author.

(*Buchia*) *piriformis* LAH., *A.* (*B.*) *keyserlingi* LAH., *A.* (*B.*) *concentrica* FISCH., and *A.* (*B.*) *crassicollis* KEYS. makes me feel justified in referring the "Falskebugt Beds" to the Lower Cretaceous (Valanginian).

The clastic sediments in question dip at angles of up to 36° to the west. As the dip of the Mesozoic beds as a rule amounts to less than 20° to the west, it may be argued that the high value stated for the "Falskebugt Beds" is due to a slight primary dip such as is found in alluvial cone gravels etc. The westward tilting produced by a subsequent tectogenesis would then have increased this initial amount to the present value.

It may be admitted, however, that such strong tectonic movements of *post*-Valanginian age can only be proved to have taken place at Falskebugt. Otherwise the main phase of faulting and tilting evidently falls in *pre*-Volgian, *viz.* Upper Kimmeridgian, time (*vid.* MAYNC 1947) which, by the way, would speak in favour of a correlation of the "Falskebugt Beds" and the Volgian "Rigi Series".

In any case, we may draw the conclusion that the inlier at Falskebugt was subject to a continuous uplift and warping probably throughout the Jurassic time, which accounts for the complete thinning out of the Jurassic deposits. This, of course, would merely hold true if we do not explain the absence of the Jurassic formations by a later erosional removal.

The Caledonides in Falskebugt thus emerged during the sedi. mentation of the "Falskebugt Beds", and the débris that accumulated along the border of the western sea was exclusively supplied from the subjacent rocks of that massif.

The following sediments were met with in the western face of Falkebjærg (P. 307 m):

50 m Coarse conglomerates containing pebbles of different kind such as gneiss, quartzite, and dark limestone (= reworked "Eleonore Bay formation" L. KOCH 1927). Interbeds of partially coarse-grained gray calcareous sandstone, rich in muscovite and limonite, weathering yellow and bearing solitary pebbles of Caledonian provenience. This sandstone carries *Aucella* (*Buchia*) *ex gr keyserlingi* LAH./*piriformis* LAH., *A.* (*B.*) *cf. crassicollis* KEYS., *Rhynchonella sp.*, *Belemnites* (?*Acroteuthis sp.*), and broken shells.

52 m Pink arkosic sandstone with pebble-bearing partings; contains *Aucella* (*Buchia*) *aff. keyserlingi* LAH. and sparse gastropods.

53 m Light-gray conglomeratic *Aucella*-bearing sandstone, overlain by pinkish sandstone.

60 m Coarse polymictous conglomerates and breccias with weathered

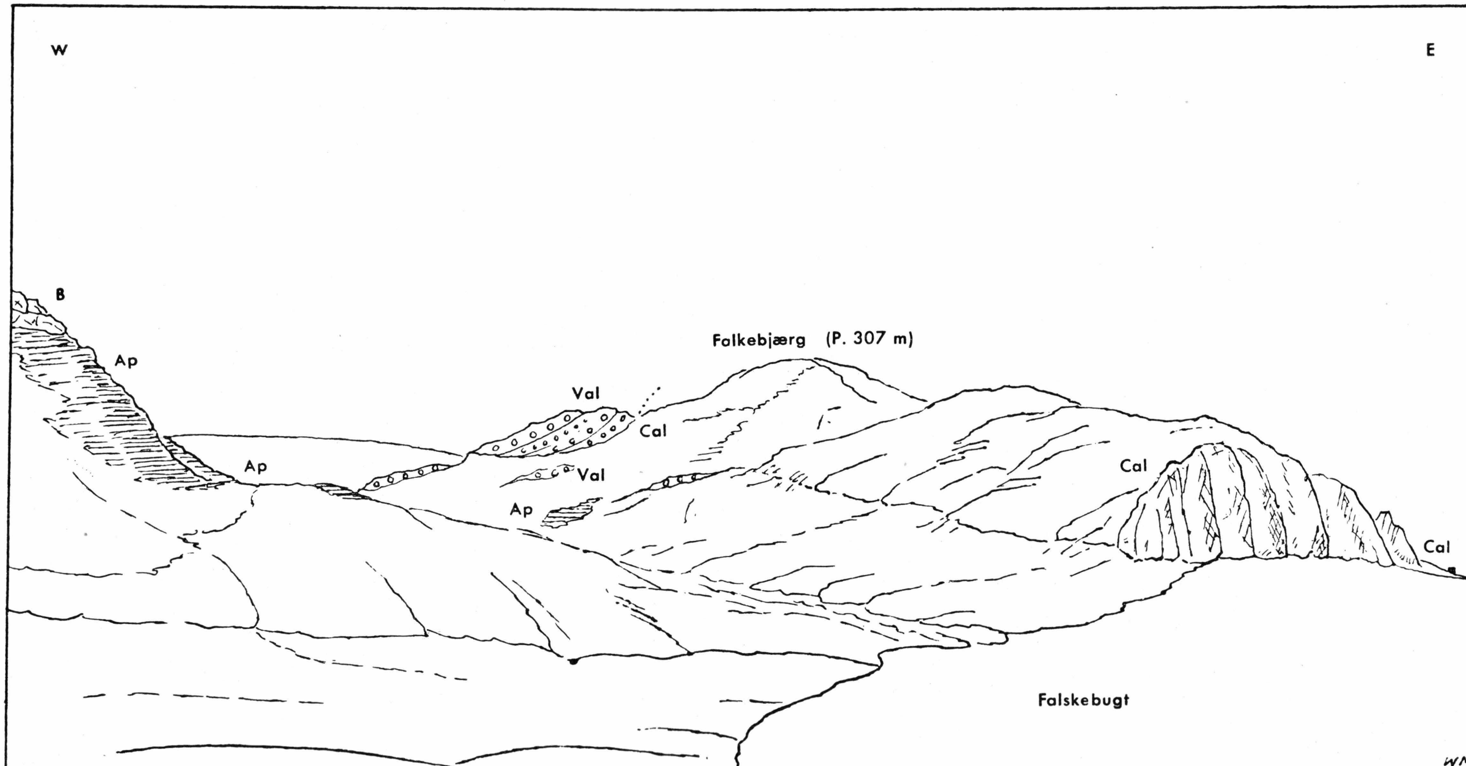

Fig. 14. Field-sketch showing the stratigraphical relations of the Cretaceous formations north of Falskebugt, Wollaston Foreland. Caledonian gneisses (Cal) ("Hühnerbjærg Block") transgressively overlain by the clastic "Falskebugt Beds" of Valanginian age (Val) and the Aptian-Albian series (Ap) of Brorsons Peninsula. B = plateau basalt (Bern Plateau).

	Caledonian boulders as large as a head embedded in a pink-gray calcareous sandstone with some coarser quartz grains.
65 m	Conglomerate (*ut sup.*) with a pink sand matrix that contains *Aucella* (*Buchia*) *spp.* impregnated with hematitic material.
65 m to 80 m	Caledonian basement laid bare by erosion.
80 m to 85 m	Gneiss breccia consisting of an unsorted mass of densely packed angular blocks (*vid.* Fig. 15) of gneiss, aplitic rocks, etc.
	Overlain by
87 m to 95 m	Light-gray rather medium-grained arkosic flaggy sandstone, 3 m thick, and arkosic coarse-grained calcareous sandstone with pebble-bearing beds containing traces of glauconite. Fossil wood, Crinoids, and shell fragments.
95 m	Boulder bed as below at a height of 60 m.
105 m	Coarse conglomerate with large well-rounded boulders (Caledonian rocks) and oval water-worn pebbles with smoothed facets.
130 m to 140 m	Gray arkosic sandstone containing conglomeratic interlayers.
155 m	Light-gray brownish weathering sandstone with pebbly zones, and breccias with angular blocks of reddish quartzite and gneiss. The sandstone carries fossil wood, fragments of shells, and Crinoid stems (*Pentacrinus sp.*).
160 m	Contact with Caledonian para-Crystalline including largely metamorphic rocks (quartzite, folded migmatized conglomeratic gneisses, augengneisses etc.).

In the sandstone at 155 m altitude a dip of 36° to the west was ascertained, and the arkosic sandstone at a height of 87 m shows a dip of 31° to the west.

Owing to landslides and slippings along the bedding planes the exact thickness of these coarse-clastic "Falskebugt Beds" cannot be stated but it may range between 40 and 50 m.

Slides, rock-falls, and autochthonous débris west of Hühnerbjærg (P. 630 m) have brought about a very obscure bedding. Consequently, the accurate thickness of the Valanginian beds south of Falskebugt could not be ascertained either. Nor did I succeed in setting down a detailed section. Roughly the following stratigraphical scheme can be given:

3. Light-gray limestone containing clusters and partings of coarse quartz sand. *Belemnites* (?*Acroteuthis sp.*), oysters e. g. *Alectryonia sp.*

Grading downward into

2. Coarse-grained sandstone with enclosed lumps and "schliers" of light-gray or pinkish silty limestone (*ut supra*) which is characteristic of the Valanginian in the more neritic facies ("Albrecht Bugt Facies"). This member is highly fossiliferous including *Aucella* (*Buchia*) *aff.*

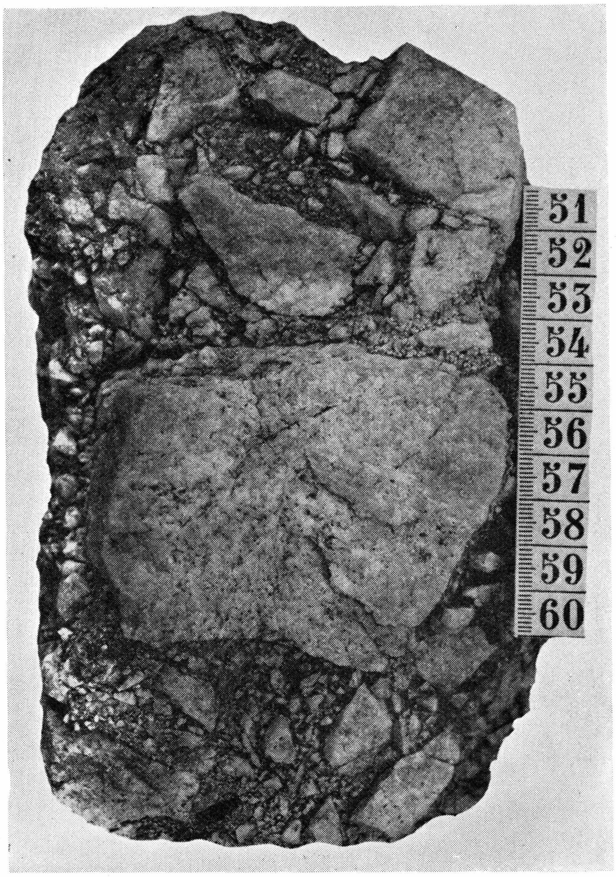

Fig. 15. Coarse polygenetic breccia containing blocks of gneiss, granite and quartzite. = Base of the transgressive "Falskebugt Beds" (Valanginian). Western slope of Falkebjærg, Wollaston Foreland. (Lot. 3 Coll. W. Maync).

keyserlingi Lah., *A.* (*B.*) *cf. piriformis* Lah., *A.* (*B.*) *cf. crassicollis* Keys. etc., *Pecten sp.*, *Lima sp.*, *Terebratula sp.*, *Rhynchonella sp.*, ?*Acroteuthis sp.*, gastropods, Crinoids (*Pentacrinus sp.*), corals etc.

Passing downward into

1. Coarse gneiss breccias containing sharp-edged blocks of gneiss, granites, and quartzite packed tightly upon another and cemented together by a gray coarse-grained arkose matrix. Apparently only a few

metres thick and resting unconformably upon the Caledonian crystalline.

Southwest of P. 310 m, on the southern shore of Falskebugt, the author also found rock exposures, displaying gneiss breccias and coarse-grained sandstones with enclosed limestone fragments, which, too, have furnished *Aucellas*.

Whilst the facial conditions of the "Falskebugt Beds" west of Falkebjærg recall those of the Volgian "Rigi Series" of Wollaston Foreland (*vid.* MAYNC 1947) the fossiliferous limestone beds west of Hühnerbjærg bear a striking resemblance to the Valanginian limestone (Polyptychitan) of Kuhn Island and central Wollaston Foreland. Since, moreover, the *Aucella* fauna from the "Falskebugt Beds" can be matched with that of the *polyptychus* Beds we take them to be contemporaneous.

It may be stressed that the limestone lumps enclosed within the sandstone member of the "Falskebugt Beds" apparently are not embedded pebbles worked up from subjacent rocks but concretion-like bodies that are of approximately the same age as the clastic matrix.

It has already been stated that the "Falskebugt Beds" west of Falkebjærg are inclined to the west at angles ranging between 31° and 36°. The overlying Aptian-Albian series, on the other hand, dips only at low angles of about 6° to the west. As the striking change of dip is by no means due to faulting, we are obliged to interpret this discrepancy as a stratigraphical angular unconformity. During the interval of known extent (Hauterivian-Barrêmian) tectonic movements, *viz.* a tilting of the "Falskebugt Beds" to the west, must have been manifested in the said area. In Upper Cretaceous times (*post*-Albian) the westward tilting of the instable block was still enhanced by fresh tectonic movements, so the Aptian-Albian beds, too, suffered a slight inclination to the west.

A section across the little valley west of Falkebjærg (P. 307 m) up to the basalt-cap of Bern Plateau revealed the following sequence (see Fig. 14:

- 50 m Coarse-clastic deposits of the "Falskebugt Beds" dipping 31° to the west.
- 25 m Black clayey shale with interbeds of buff-coloured marl and marly limestone, partly showing cone-in-cone structure, carrying red-coated concretions of clay ironstone. A dip of 6° to the west was measured here.
- 20 m Alluvial deposits of the river, erratic boulders, and snow.
- Up to 40 m Soil flows and débris.

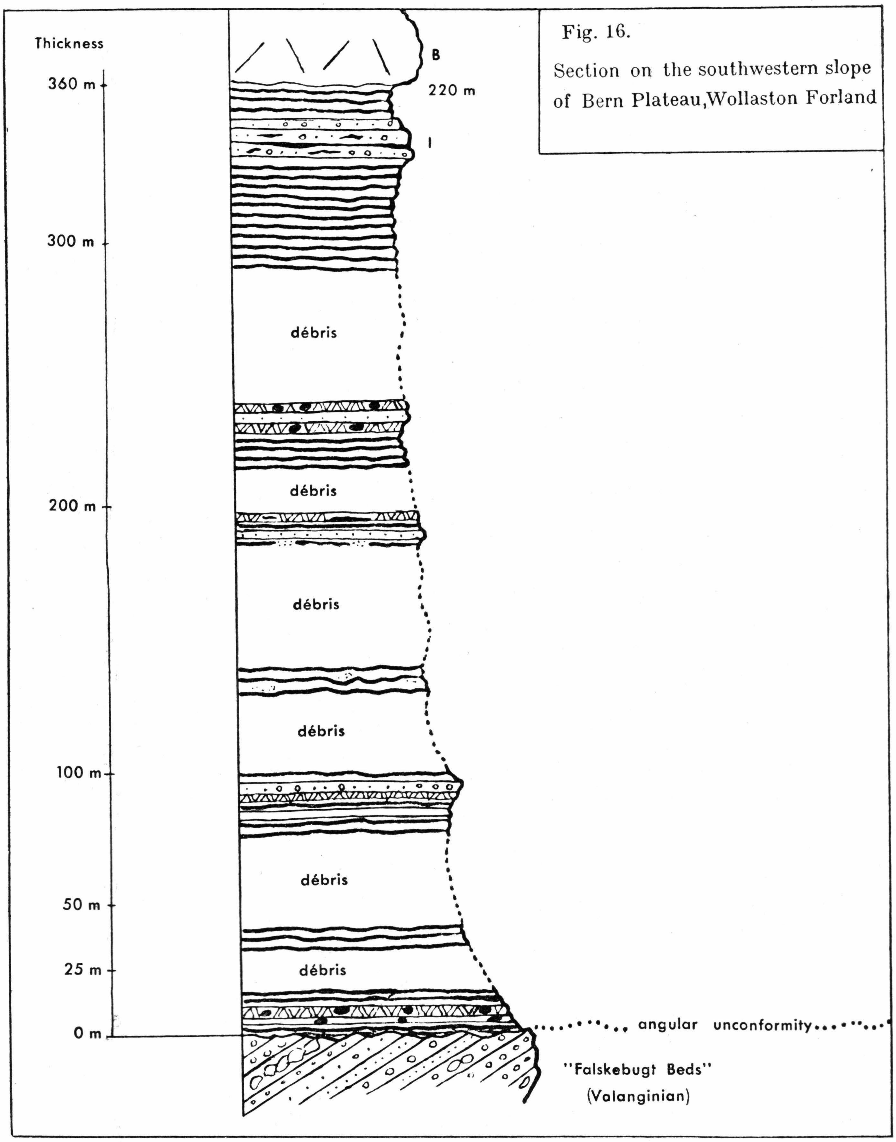

Fig. 16. Section in the southeastern slope of Bern Plateau, Wollaston Foreland.

40 m A few exposures of the bedrock (black clayey shale). The slope is mostly covered with débris.

45 m
to Concealed beneath snow.
60 m

60 m Black slightly sandy shale weathering gray or bluish-gray, with layers of buff marly limestone and marl with cone-in-cone structure.

Thin interstratifications of psephitic limonitic sandstone. Débris.

90 m Gray clayey shale containing "schliers" of washed-in sand, clusters of muscovite flakes, and exhibiting stream-bedding, ripple-marks etc. Débris.

120 m Gray shale with pockets of sand, interbedded with banded mica-bearing sandstone and buff marl (with cone-in-cone structure). Enclosed within the sandstone are concretions and "schliers" of red-brown clay ironstone.

135 m Gray marly shale.

145 m Buff slightly sandy marl disclosing well-developed cone-in-cone structure, carrying red weathering clay ironstone concretions. The marl with cone-in-cone structure sometimes contains muscovite and glauconite and may pass laterally into a gritty grayish sandstone.

180 m Black foliated slate turning gray on weathering, in part with a slight content of sand; tracks of *vermes.*

200 m Black slate with interstratified layers of rusty weathering coarse-grained or psephitic sandstone enclosing orange-red "schliers" and partings of clay ironstone matrix.

210 m Discoloured brittle slate.

220 m Floor of the plateau basalt.

The visible thickness of this Aptian-Albian sequence reaches 360 m.

West of Hühnerbjærg, i. e. precisely in the strike of the beds just described, also black clayey shales with interbeds of buff marl and embedded concretions of clay ironstone are exposed at a height of 60 to 170 m.

Section in Gaasedal.

(*vid.* Fig. 17).

River bed, alluvial terraces.

30 m Black or gray-bluish crumbling slightly sandy slate containing hard concretions of clay ironstone.

33 m Clay shale with interbeds of pale-buff weathering marl showing cone-in-cone structure, carrying clay ironstone concretions. A few partings of yellow weathering sandstone.

35 m Basalt sill.

55 m to 65 m Black, steel-gray or whitish weathering slightly sandy slate with a high muscovite content on the bedding planes. Carries gray and reddish-brown concretions of clay ironstone and yellow-coloured lumps of sandstone. Dips slightly to the southeast. Débris.

70 m Black clay shale with numerous bands of yellow-gray bedded sandstone showing rusty patches, and

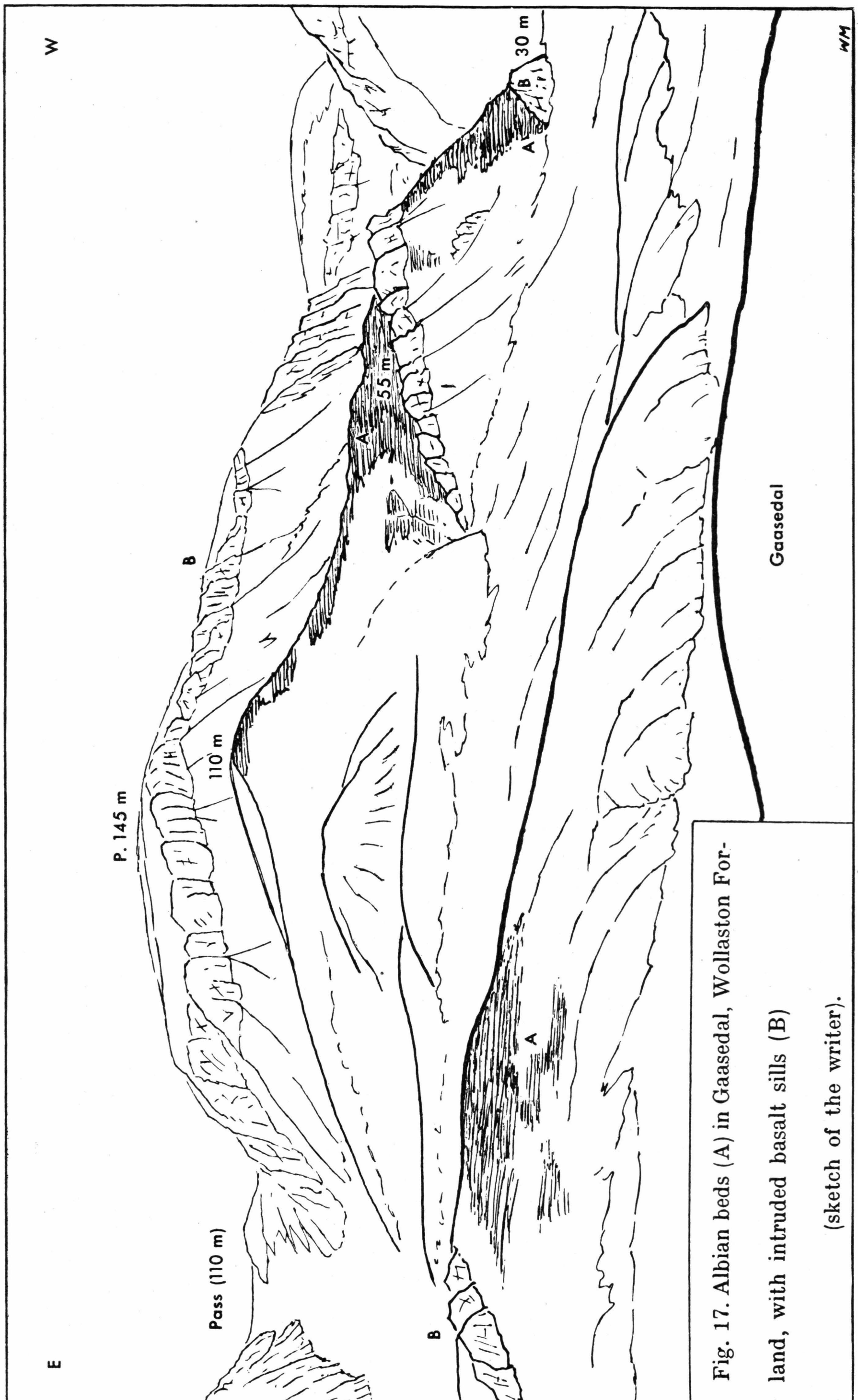

Fig. 17. Albian beds (A) in Gaasedal, Wollaston Foreland, with intruded basalt sills (B) (sketch of the writer).

75 m red-brown muscovite-bearing sandstone with interbeds and concretions of clay ironstone.
90 m Yellow-orange weathering knobby sandstone with conglomeratic interbeds bearing plant-remains and lenticles of coal. Enclosed within are concretions of sandy clay ironstone.
95 m Concealed by snow.
100 m Basalt.

Farther up the valley, at a height of 140 m, black sandy muscovite-bearing slates occur containing red-orange weathering clay ironstone concretions and lumps of yellow sandstone. Conglomeratic interlayers with nut-sized Caledonian pebbles and fragments of brownish sandstone and slate, cemented together by a clay ironstone matrix (*vid.* Fig. 67), are rather striking. The basalt to the south displays joints (fractures), which are often healed up by calcite crystals, (*post*-Basaltic tensions along the old fault lines).

Dronning Augustadalen.

The slopes of this large valley are mostly covered with débris. Therefore, and because the low-lying basalt flows conceal the greater part of the Cretaceous beds, good exposures are scarce.

The following rocks were observed on the south side of Mt. Knolden[1]):

100 m to 130 m Greenish to blue-gray weathering or bleached clay shale containing a few red- and yellow-coated concretions of clay ironstone. More or less horizontal position.
130 m Débris of basalt.
160 m to 200 m Basaltic rocks.
200 m Friable slate, discoloured and foliated by contact metamorphic action, with interbedded layers of brown-weathering calcareous sandstone. Both slate and sandstone interbeds contain red clay ironstone concretions. Dip 35° to the northeast.

This deviating dip is due to an evident flexure along the "Hühnerbjærg Fault". The dragging of the mobile plastic slate series towards the downfaulted "Wynn-Sabine Block" thus registers slight *post*-Albian movements of the tectonic blocks.

Higher up the slope of Mt. Knolden basaltic flows with interstratified clastic sediments of the Tertiary occur.

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[1]) The basalt knoll southwest of P. 434 m has been named Mt. Knolden by A. VISCHER and the writer.

On the south side of Dronning Augustadalen poorly exposed Cretaceous beds, namely black clay shales with interbeds of knobby sandstone and red concretions of clay ironstone, were met with more than once but the slopes are mostly covered with débris.

On climbing Centrumspasset (about 310 m) black clay shales carrying the characteristic redjweathering concretions of clay ironstone were found to occur at an altitude of 170 m to 190 m.

However, fossils were nowhere to be found.

2) Inner Wollaston Foreland.

The Mesozoic beds of the inner Wollaston Foreland were discovered in the spring of 1927 by LAUGE KOCH (KOCH 1929 a).

"Neocomian" strata were then proved to occur on Aucellapasset whence *Aucella* (*Buchia*) *keyserlingi* LAH., *A.* (*B.*) *piriformis* PAVL., and *Hibolites sp.* are cited (*op. cit.*).

In 1929 A. ROSENKRANTZ and his assistants found a coarse-clastic conglomerate without fossils on top of the Jurassic *Belemnites*-bearing shales near Cardiocerasdal. *Aucella* (*Buchia*) *piriformis* PAVL. found in a loose block of shelly breccia among the talus débris of Cardiocerasbjærg indicated the presence of Middle Valanginian. Higher up the slope gray-greenish concretion-bearing clayey shales were met with which yielded *Crioceras cf. gracile* SOK. & BOD. (*non* SINZ.) (= *Tropaeum arcticum* STOLL.) and belemnites. Accordingly, these beds were classed as Aptian (ROSENKRANTZ 1932).

In 1931 H. FREBOLD made a reconnaissance survey of the coastal region of southwestern Wollaston Foreland (Young Sound) upon which certain important conclusions were based concerning both stratigraphy and tectonics (FREBOLD 1932 a). The recent investigations have shown, however, that many of H. FREBOLD's field observations are incorrect. The Jurassic sequence as given by that writer (in *loc. cit.*) is erroneous since the coarse quartzite conglomerate which H. FREBOLD stated to lie upon his Jurassic "*Belemnites* shales" and below the *Cardioceras*-bearing *alternans*-beds has turned out to be a relic of the Valanginian conglomerate which rests unconformably upon the eroded surface of various Jurassic strata (*vid.* p. 83). Although H. FREBOLD himself described *Aucella* (*Buchia*) ex *gr keyserlingi-piriformis* LAH. from this conglomerate but a few months later (FREBOLD 1932 b) and thus classed it as Valanginian, he never explained the wrong stratigraphical sequence he had set down in his former paper. Unfortunately, H. FREBOLD's publications often lack minute stratigraphical precision, which, after all, cannot be replaced by hypothetical discussions at great length and speculations as to how things may have been like.

The thickness of the Valanginian beds in southwestern Wollaston Foreland is estimated by H. FREBOLD to attain about 100 m whilst that of the "Neocomian-Gault" is assumed to be about 300 m (FREBOLD 1932 a).

Because of the branching faulting systems the inner portion of Wollaston Foreland becomes considerably dissected and shows a mosaic structure (*vid.* VISCHER 1939, 1940, 1943).

The outcrops of Caledonian gneisses with the overlying Permian and Jurassic deposits in central Wollaston Foreland represent the substratum of the westward-tilted "Permpass Block" the eastern edge of which has been laid bare by erosion (MAYNC 1942, 1947).

The crystalline rocks of Cape Schumacher, west of Albrechts Bugt, belong to the SW-sloping Caledonian core of Kuhn Island and, therefore, represent the basement of the "Kuhn Block" in western Wollaston Foreland.

The outcrops of gneiss and granite on Cape Berghaus and Mt. Kuplen (P. 506 m) in southwestern Wollaston Foreland (A. VISCHER's "Kuppel Block") must be considered part of the Caledonian basement of Cape Schumacher and central Kuhn Island. However, the connection of these crystalline massifs is broken by a fan of minor faults branching off from the main fault line near Mt. Kuplen. These faults have caused the abrupt termination of the Caledonian ridge slightly north of the said mountain. From here onwards to the north the gneissic fundament remains hidden till it crops out again in the eastern foot of Hohgant (P. 658 m), the region in between being occupied by partially dragged Mesozoic deposits. It is beyond any doubt, though, that both the Caledonian scarps of Cape Berghaus-Mt. Kuplen and Hohgant were primarily linked up with each other and have been separated by a system of transversal faults. That these fault lines near Mt. Kuplen are of late Jurassic age, is proved by the coarse-clastic littoral facies of the overstepping Valanginian beds along the northern margin of the Kuplen-Crystalline which must have been deposited at the foot of such fault scarps or "*falaises*" (*vid.* p. 218 ff.). Contrary to the conception of A. VISCHER the writer is of opinion that the main fault ("Canyon Fault" of A. VISCHER) can be traced farther through Wollaston Foreland into Fligelys Fjord (*vid.* MAYNC 1947).

The sedimentary rocks of the "Kuhn Block" show a regular dip to the west or southwest and abut against the imposing fault scarp of the western crystalline block which has formed the very coast of the Jurassic seas (*vid.* MAYNC 1947).

Section north of Sumpdalen, southwest of P. 428 m (Bern Plateau).
(Fig. 18, 19, *vid.* also VISCHER 1943, Fig. 14, p. 107).

Up to an altitude of 70 m Kimmeridgian strata are exposed which dip at angles of 15° to 20° to the northeast (*vid.* MAYNC 1947).

These Kimmeridgian beds comprise black shales alternating with sandstone layers and sandy limestone bands.

At a height of 70 m the Jurassic is unconformably overlain by

70 m (1) Strongly red-coloured marly shale carrying pyritic nodules, petrified wood, and coal particles.
This zone has a mere thickness of 0.4 m and obviously suggests a marked break in the sedimentation.

Fig. 18. Marl/limestone formation of the Polyptychitan („Albrechts Bugt Facies"), north of Sumpdalen, Wollaston Foreland.
Phot. A. VISHER
Blak shales of Klmmeridgian age (Ki) transgressively overlain by the Polyptychitan (Pol), the „Rødryggen Beds" (RS), and the Aptian series (Ap).

On top of this stratum follow the characteristic beds of the Valanginian (Upper Polyptychitan):

(2) Light-gray silty marly limestone and marl containing nodular lumps and concretions of pink or light-brown weathering hard limestone crowded with fossils. After a brief study L. F. SPATH has pointed out the resemblance of this fauna to that of the *polyptychus* zone of Speeton and Russia but, unfortunately, the definite working out of the East Greenland assemblages has been delayed by the war. Among the forms roughly determined in the field we cite

Polyptychites spp.
Euryptychites sp.
Dichotomites spp.[1])
Acroteuthis sp.
Aucella (*Buchia*) *keyserlingi* LAH.
— — *crassicollis* FISCH.
— — *piriformis* LAH.
— — *spp.*
Collyrites (*Tithonia*) *nov. sp.*[2]) etc. (*vid.* MAYNC 1940).

[1]) Identified by L. F. SPATH, London.
[2]) For the identification of this spatangid I am indebted to Prof. A. JEANNET, Zürich.

This typical light-coloured bed, which contrasts exceedingly well with the underlying set of black Jurassic shales, attains a thickness of merely 4—5 m. It completely agrees with the Upper Polyptychitan limestone and marl of southeastern Kuhn Island which, however, are as much as 70 m thick (*vid.* pp. 19—20).

On top of these gray marls and limestones follow

(3) About 15 m intensely red-coloured calcareous sandstones and sandy impure limestones, which contain interbeds of *Aucella* breccia. Some rare belemnites derived from these red beds show corroded *rostra*.

A cock's-comb ridge formed by a basaltic dyke cuts across the series and has caused a slight baking of the sediments on either side of the igneous sheet.

On top of these red beds rest

(4) Black or gray belemnite-bearing shales with embedded fragments of the underlying red-coloured sandstones and sandy limestones. *Neohibolites sp.*

95 m to 110 m Basalt sill.

110 m (5) Black (near the sill discoloured) slate with bands of buff marl showing cone-in-cone structure, which carry red or yellow weathering concretions of clay ironstone. Slightly higher buff marl layers with a parting of light-gray sandstone are exposed. Débris.

This sequence, though much reduced in thickness, is like that set down in southeastern Kuhn Island (*vid.* pp. 19—20). Here and there the gray Valanginian marl and limestone series ("Albrechts Bugt Facies") is overlain by red sandy beds proving the regression of the sea in Upper Valanginian time. Immediately upon these red-coloured rocks follow the typical marine deposits of the Aptian (*vid.* section in Rødryggen, p. 70). Here also it is evident that the Aptian beds correspond to a new marine ingression as their lowermost portion carries remanié boulders of the underlying red-stained Valanginian series. Nowhere is there the slightest indication of Hauterivian or Barrêmian strata being present. This gap is still more marked in the section measured in Rødryggen, since the black shales with red clay ironstone concretions which immediately overlie the red beds (or "Rødryggen Beds") have yielded an ammonite, *Phylloceras royerianum* (D'ORB.), which fixes the age of the lowermost shale bed as Aptian.

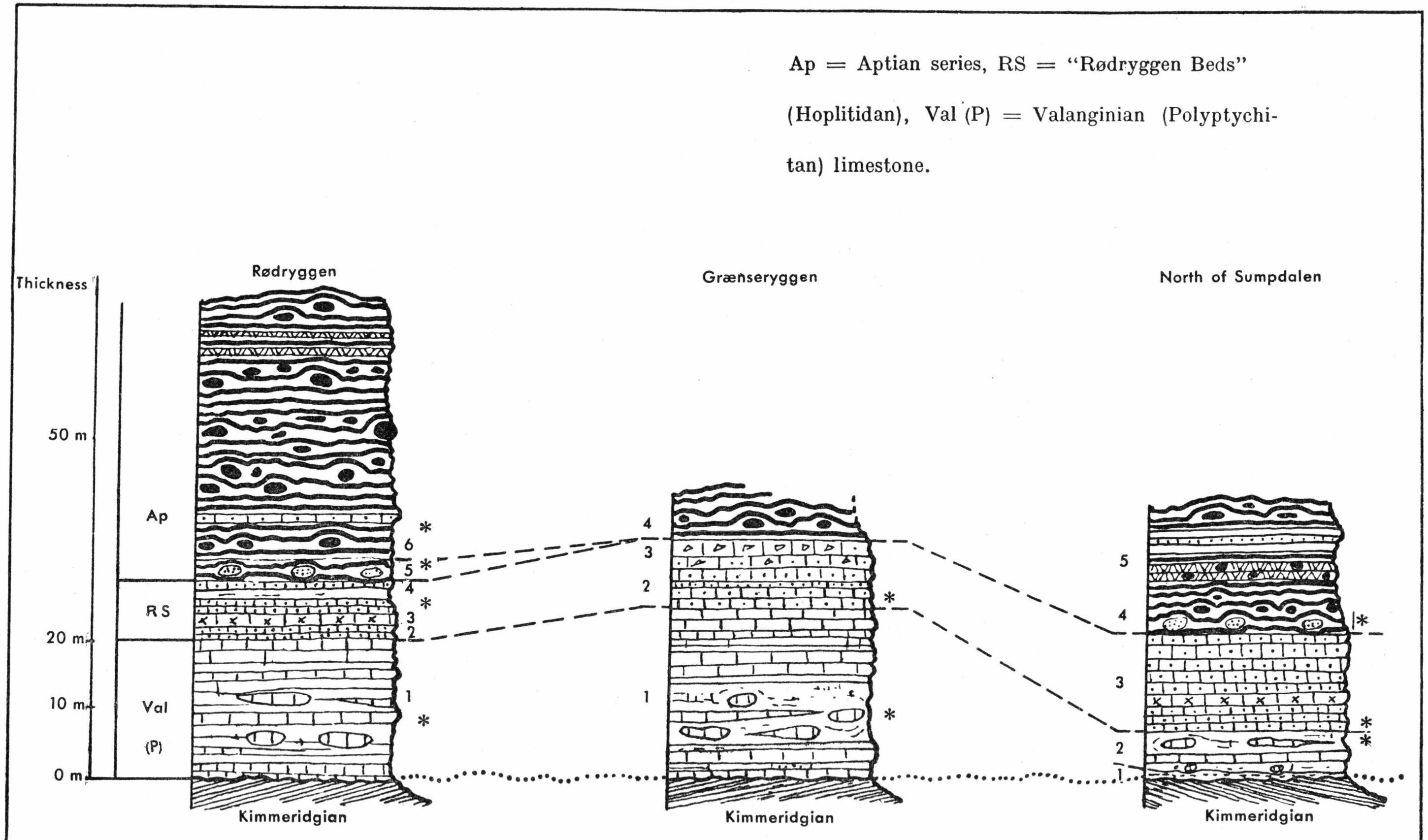

Fig. 19. Stratigraphical sections through the Cretaceous beds southeast of Albrechts Bugt, Wollaston Foreland.

As is shown on the map (Fig. 9) a NNW-running fault branches off north of Sumpdalen. The Valanginian beds which only crop out in the fault wedge are cut off on either side by the said faults. Farther towards Albrechts Bugt the Aptian series is in direct contact with the Jurassic (*vid.* pp. 47—50).

The sudden change in facies from the Valanginian marl and limestone series around Albrechts Bugt (= "Albrechts Bugt Facies") to the coarse-clastic facies of the "Falskebugt Beds" only 6 km farther to the east decidedly points towards a pronounced relief of late Jurassic age (warping of the Caledonian massif in Falskebugt).

Section in Rødryggen (Red Ridge), south of Albrechts Bugt.
(*vid.* Fig. 19 & 20).

Up to a height of 110 m the Kimmeridgian shales (J) are exposed bearing Amoeboceras spp. and *Aucella* (*Buchia*) *ex gr bronni* LAH. (*vid.* MAYNC 1947). They are overlain by the characteristic Valanginian formations that lie flat upon the WSW-dipping Jurassic series (nonconformity).

110 m (1) Light-gray or whitish marl, marly shale, and marly limestone turning pink and silty on weathering. Interbeds and nodules of light-gray limestone and marly limestone.

The fauna derived herefrom includes
Polyptychites spp.
Acroteuthis or *Pachyteuthis sp.*
Aucella (*Buchia*) *keyserlingi* LAH.
— — *piriformis* LAH.
etc.,

and thus suggests Middle Valanginian (upper part of Polyptychitan, Val_1). These beds attain a thickness of 20 m and pass upwards into

130 m (2) Impure limestone and marly limestone with a considerable sand content. Then follow (Val_2) a

132 m (3) 2 m bed of reddish or buff-coloured shell breccia carrying numerous small-sized *Aucellas*, and

(4) about 5 m of strongly red-coloured clayish sands, impure sandy limestones, and brecciated nodular rocks, with interbeds of gray sandy marl[1]).

[1]) These remarkable red beds that come into notice from afar had been observed by LAUGE KOCH from the air and were formerly held to be equal to the Permian "Red Series" of southwestern Wollaston Foreland (KOCH 1935, *vid.* MAYNC 1938, 1940, 1942).

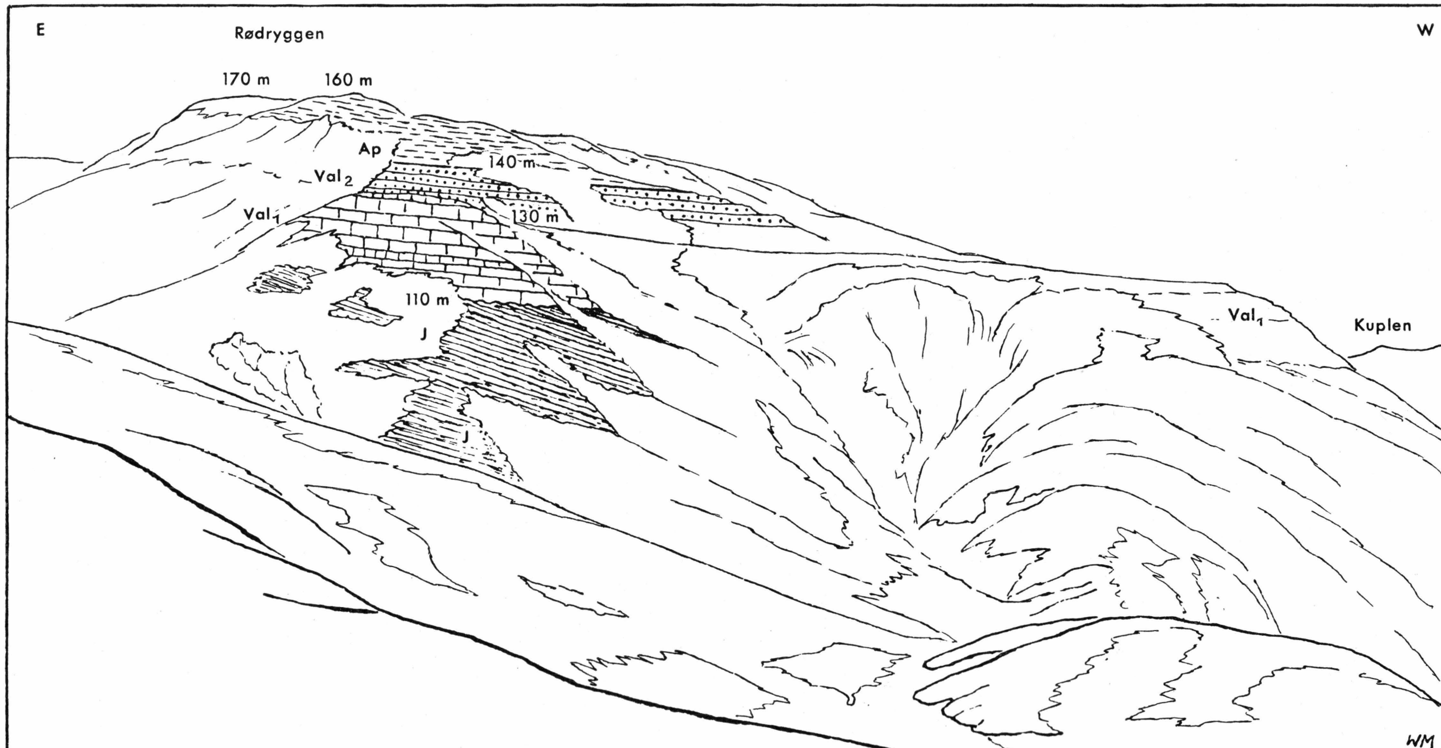

Fig. 20. The Cretaceous beds in Rødryggen (southeast of Albrechts Bugt), Wollaston Foreland (field-sketch of the writer). Slight angular unconformity between Kimmeridgian shales (J) and Valanginian (Upper Polyptychitan) limestonæ in "Albrechts Bugt Facies" (Val_1). On top follow the "Rødryggen Beds") of the Hoplitidan (Val_2) and the overstepping Aptian series (Ap).

Aucellas and belemnites are by no means rare, and fossil wood is rather abundant.

140 m (5) 2—3 m light-gray or greenish marly shale (Ap) containing boulders of brick-coloured sandy limestone. *Neohibolites sp.*

Overlain by

(6) Black sandy shale bearing red-weathering concretions of clay ironstone. Intercalations of buff-coloured sandy limestone.

Here in member (6) the writer secured an ammonite which Dr. L. F. SPATH has identified as *Phylloceras royerianum* (D'ORB.). This find as well as the presence of numerous *Belemnitidae* belonging to the specific genus *Neohibolites* (STOLLEY) bear eloquent witness to the Aptian age of this bed.

150 m Black shale carrying red-coated gray or brownish concretions of clay ironstone with *Neohibolites sp.*

It may be added that the belemnites from here upwards decrease considerably in number, and only some few specimens were found in the higher strata.

170 m Black clay shale with interbeds of buff marl with well developed cone-in-cone structure. Red-brown concretions of clay ironstone.

Apart from the reduced thickness of the light-coloured marl and limestone series (1)/(2) this sequence is in full agreement with that measured in Kuhn Island (*vid.* pp. 19—20); the section north of Sumpdalen (*vid.* pp. 66—68) is almost identical.

For the strongly red-coloured beds (2)/(4) on top of the Polyptychitan in "Albrechts Bugt Facies" the writer herewith proposes the name "Rødryggen Beds" after the type locality in Rødryggen. These regressive strata of Upper Valanginian age (supposed Hoplitidan) are immediately followed by dark shales bearing Aptian fossils, which thus support my former statement of a transgression of the Aptian sea upon the eroded surface of older formations (MAYNC 1938, 1939, 1940), i. e. of a remarkable hiatus in the sedimentation ranging from the Upper Valanginian to the Aptian.

The "Rødryggen Beds" also include the strata exposed in section 3) on southeastern Kuhn Island (135 m to 146 m, *vid.* p. 20), and member (3) of the sequence north of Sumpdalen (*vid.* p. 68). As will be seen on the following pages, also the members (2)/(3) in Grænseryggen, the top beds at 560–570 m in the southern slope of Cardiocerasbjærg, and the beds at a height of 420 m northwest of Kuhnpasset,must be considered to be equivalents of the "Rødryggen Beds".

Section in Grænseryggen, south side of Sumpdalen.

(*vid.* Fig. 19).

The prominent NS-trending ridge north of Mt. Gyldenspids, i. e. south of the water-shed of Sumpdalen, is bounded on the east by a marked fault line that separates the two tectonic units, *viz.* the down-faulted "Hühnerbjærg Block" from the "Permpass Block". On this account the author has proposed to name the said ridge Grænseryggen (Boundary Ridge)[1].

The fault which has been termed "Permpass Fault" (Vischer 1943) strikes SSW—NNE and thus passes slightly west of Mt. Gyldenspids (P. 660 m) towards Permpasset and Blæsedalen. Consequently, the fine Aptian-Albian sequence in the northern flank of Mt. Gyldenspids (*vid.* pp. 52—55) may not be directly linked up with the Cretaceous series exposed in Grænseryggen. Since no beds of Valanginian age crop out in the section of Mt. Gyldenspids, the entire Cretaceous succession cannot be clearly ascertained here. It is improbable, however, that a thick set of sediments should be missing between the two sections mentioned.

The following sequence of strata was observed:

(*vid.* Fig. 12).

80 m to 165 m		Black shales alternating with yellow or red-brown weathering layers of sandy limestone. Dip to the southwest. Corresponding to the similar fossiliferous series in Rødryggen it is beyond doubt that the shales in question, too, are of Kimmeridgian age. Between these late Jurassic shales and the horizontal Valanginian beds atop there exists an angular unconformity.
165 m to 190 m	(1)	Gray and whitish-chalky soft marly limestone containing nodules and thin bands of a harder gray limestone. A few interbedded zones of *Aucella* breccia. The fossils are mostly damaged, though, but fragments of *Polyptychites sp.*, *Acroteuthis* or *Pachyteuthis sp.*, *Aucella* (*Buchia*) *cf. keyserlingi* Lah., *A.* (*B.*) *cf. piriformis* Lah. etc. point towards Polyptychitan.
190 m	(2)	Strongly red-coloured thin-bedded calcareous sandstone with inhomogeneous or brecciated interbeds and layers of red fine-grained marly limestone. Fossil wood, Crinoid stems.
198 m	(3)	Brecciated impure limestone and red calcareous sandstone, directly overlain by

[1]) *Vid.* Maync 1947.

200 m (4) Black clayey shales carrying large concretions of red-
to weathering clay ironstone which show a cellular weather-worn
220 m surface.

Consequently, the given sequence in Grænseryggen fully corresponds to those displayed in Rødryggen and in Cardiocerasbjærg.

Members (2) and (3) represent the regressive "Rødryggen Beds" of Upper Valanginian age whilst (4) must be considered the base of the Aptian series. On the other hand, member (3) may already be taken as a remanié stratum preluding the ingression of the Aptian sea.

On the southern flank of Grænseryggen the *Aucella*-bearing Valanginian limestone and marl series is once more exposed beneath the cap of Aptian deposits, and still farther down the ridge even outcrops of Kimmeridgian shales were established.

Sections on the northeast face of Mt. Hammeren

(Antoinettes Bjærg P. 992 m).

(*vid.* Fig. 21 & 22).

North of the sharp bend of the river that takes its source on Permpasset unmistakable sediments of the Aptian-Albian series were found to crop out:

190 m Black clayey shale bearing red concretions of clay ironstone
to and containing interbeds of mottled sandstone. Subordinate
240 m layers of buff-coloured marl with cone-in-cone structure.

Immediately south of the river the following succession of deposits is exposed (*vid.* Fig. 21):

140 m Black or gray sandy shale with yellow weathering limestone
to layers and interbeds of whitish *Ditrupa*-bearing sandstone.
170 m From the finding of several specimens of *Amoeboceras* (?*Amoebites*) *sp.* we may deduce with certainty that the beds in question are of Jurassic (presumably Kimmeridgian) age (*vid.* MAYNC 1947).

On top of these beds occur

170 m Rusty sandy shales, interstratified with thin partings of sandstone and carrying numerous nodules of pyrite (P).

Overlain by

180 m Black slightly sandy clay shale containing red weathering clay ironstone concretions and fossil wood. Intercalations of buff-coloured marl with cone-in-cone structure. Thickness about 6 m.

Followed by

yellow weathering calcareous sandstones and pure sandstones.

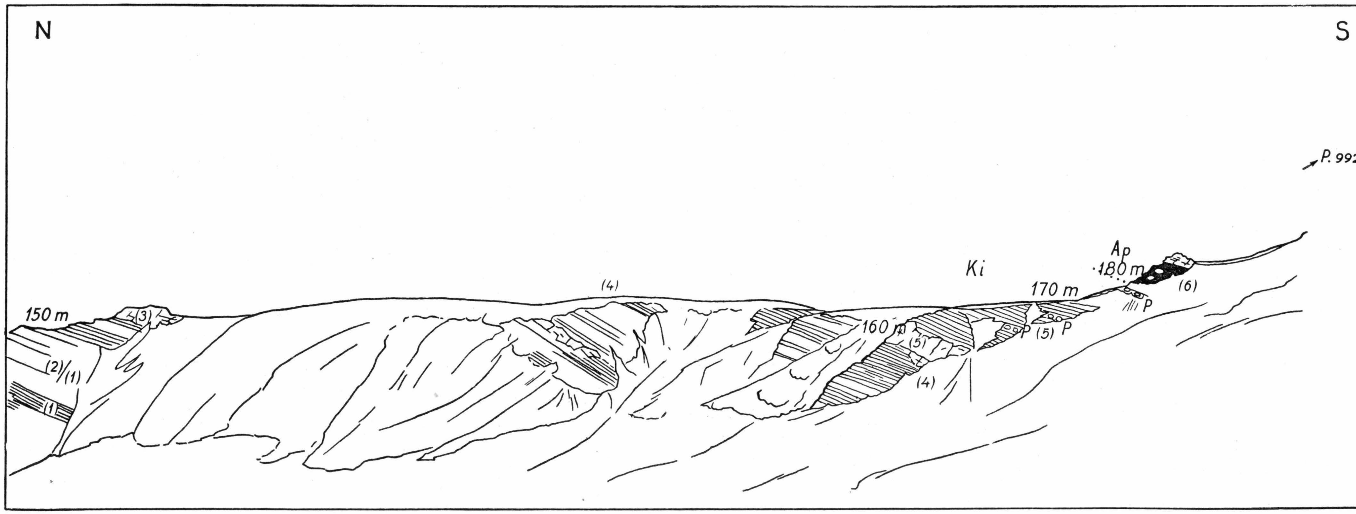

Fig. 21. The stratigraphical boundary between Kimmeridgian beds (Ki) and the Aptian series (Ap) (field-sketch of the writer).

There can be no doubt that the member exposed from 180 m altitude onwards represents the base of the Aptian-Albian series the higher portion of which will be described below. On the other hand, it is obvious that the underlying *Amoeboceras*-bearing shale must be assigned to the Jurassic. In other words, there exists a noticeable break extending from the (?Upper) Kimmeridgian into the Aptian.

Along the river-bed the Aptian-Albian strata thus have become carved out by erosion and a fenster of Jurassic rocks was laid bare. There is not the slightest trace of Valanginian beds, however, and, accordingly, we must assume that they have never been deposited here. The evident absence of Valanginian strata here in central Wollaston Foreland must be explained by a rather strong uplift of this area, i. e. of the "Permpass Block" between Permpasset and Mt. Kuplen (P. 506 m), in lower Cretaceous time. Consequently, we may expect the Valanginian beds to wedge out progressively from Rødryggen and Grænseryggen towards the south. Indeed, the geological map of A. VISCHER shows that the Valanginian actually thins out along Rødryggen and that it is already absent north and northwest of P. 771 m and west of P. 795 m (VISCHER 1943). A regional subsidence in *pre*-Aptian time then allowed the transgressive overlap of the Aptian deposits which accounts for the remarkable fact that the Aptian-Albian series rests non-sequentially upon the Jurassic.

On climbing Antoinette's Bjærg/Mt. Hammeren (P. 992 m) the following section was set down:

210 m	River-bed with exposures of black clayey shale containing reddish concretions of clay ironstone.
240 m to 390 m	Talus cones and débris of basaltic rocks.
390 m	About 25 m thick set of black or gray clayey shale with interbedded layers of strongly yellow weathering sandstone. Red clay ironstone concretions carrying numerous fragments of fossil log. Covered with snow.
430 m	Black shale with embedded clay ironstone concretions bearing broken specimens of *Inoceramus sp.*
440 m	Light-buff marl showing cone-in-cone structure, with enclosed concretions of red clay ironstone which may contain sparse casts of *Hoplitid* ammonites.
450 m to 470 m	Buff marl disclosing cone-in-cone structure, alternating with yellow-coloured sandstone beds. The undulating and knobby bedding planes are often marked by animal tracks. A few partings of black shales contain red clay ironstone concretions with imprints of *Inocerami.*

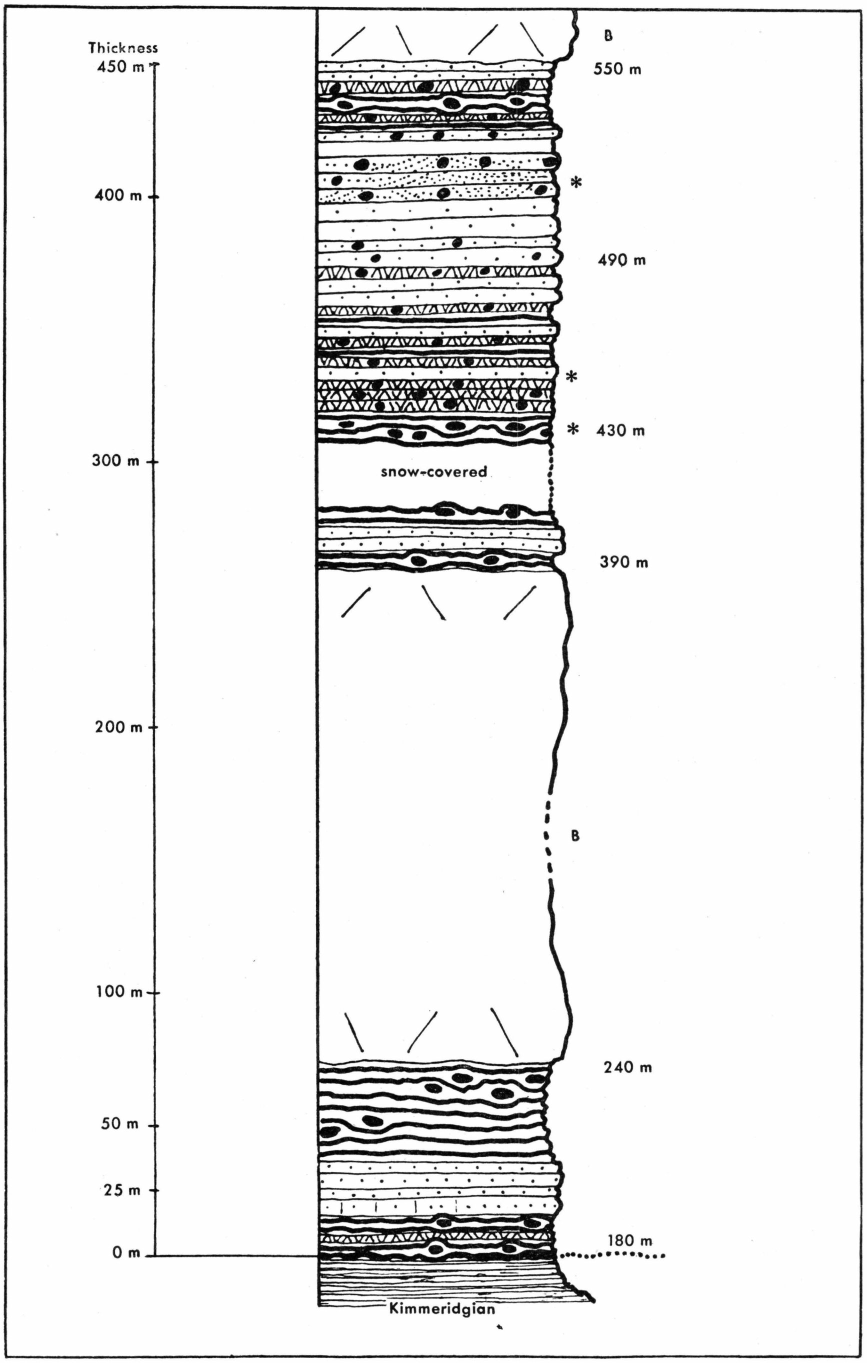

Fig. 22. Stratigraphical section on the southern face of Mt. Hammeren (Antoinette's Bjærg), central part of Wollaston Foreland.

490 m Yellow or mottled sandstone carrying sparse concretions of red clay ironstone.
500 m Yellow coarse-grained knotty sandstone.
510 m Yellow partly psephitic sandstone occasionally displaying current-bedding. Enclosed concretions of clay ironstone with fragments of *Inoceramus sp.*
520 m Black clayish shale with interbeds of sandstone and orange-red clay ironstone concretions.
530 m ditto, with alternating bands of light-buff marl (cone-in-cone structure).
540 m to 550 m Black clayey shale carrying concretions of red clay ironstone. Inosculations of buff marl showing cone-in-cone structure, and yellow weathering sandstone layers which were measured to dip 10° to the west.
550 m Floor of the plateau basalt.

The thickness of the Aptian-Albian series in this section was computed to amount to 265 m.

The late Permian beds discovered by the writer on Permpasset (*vid.* MAYNC 1942) are overlain by a 20 m thick set of reddish or brown conglomerates, arkoses, and ferruginous coarse-grained sandstones which I feel justified in referring to the "Yellow Series" of Bathonian-Argovian age (MAYNC 1947). On its roof follow

390 m (1) Gray or brown-red rusty weathering thin-bedded sandstone (3—4 m thick), bearing indeterminable pelecypods, and
(2) 6 m black light-gray weathering, more or less sandy shale, which is surmounted by
(3) 3—4 m thick sandstone (as (1)), and
(4) Black clayey shale with interbeds of buff-coloured marl layers which carry red concretions of clay ironstone.

Although I failed in finding any fossils that might have allowed to fix the age of the beds concerned, I do not hesitate in assigning them to the Aptian-Albian. The lithological and facial features here recall those of other sections which, moreover, have yielded index fossils of the upper part of the Lower Cretaceous. Especially member (4) is typical of the Aptian-Albian series. It may be admitted, however, that one might perhaps consider the whole set of deposits on top of the Permian to be a sedimentary cycle of the Cretaceous with the coarse deuterogeneous rocks as a transgressive member. But firstly we may stress that such coarse psephites at the base of the Aptian are hardly known from Wollaston Foreland. On the contrary the Aptian-Albian cycle mostly sets in unawares with shales and fine-grained sandstones. Secondly, the concerned conglomerates, arkoses, and sandstones, lying between the Permian and the floor of member (1), bear so great a resemblance to the deposits of the Jurassic "Yellow Series" that such a correlation is by far the more probable (*vid.* MAYNC 1947). Hence we prefer to draw the *sub*-Cretaceous boundary along the foot of member (1).

Stratigraphical sections in Stratumbjærget (P. 657 m).

(Fig. 23 & 24).

The lower portion of Stratumbjærget is built up of an alternation of gray sandy shales and yellow-coloured sandstones which the author has termed "Gray Series" (MAYNC 1947). These strata, which are intermediate between the "Yellow Series" of Upper Bathonian-Argovian age and the "Black Series" (Eo-Kimmeridgian), dip at angles of up to 20° to the west (towards Cardiocerasdalen) and are unconformably overlain by coarse-clastic boulder beds of the Middle Valanginian (*op. cit.*).

The following section was set down on the southwestern face of Stratumbjærget:

260 m Gray plant-bearing shale with layers and enclosed lenses of whitish or yellow sandstone containing *Ditrupa nodulosa* LUNDGR. (= Argovian-Lower Kimmeridgian). Sharp angular unconformity (*vid.* Fig. 23).

265 m Coarse block-breccias and -conglomerates filling depressions and cavities of the Jurassic surface. On the other hand, the holes and cracks in the *pre*-Cretaceous land surface may be filled up with argillaceous ferruginous loam, on top of which lie the transgressive clastics. Embedded in a gray matrix of coarse-grained sand are large boulders and huge complexes of Jurassic rocks showing the primary bedding, which have been worked up from the underlying beds and were laid down again almost *in situ*. Remanié blocks with a solid content of several cubic meters were observed to stand upright and must apparently have tumbled from a near coast into the Valanginian sea. Except for the sandstone boulders and the blocks of plant-bearing shale of Jurassic age crystalline angular blocks of huge dimensions such as biolite-gneiss, amphibolites, banded gneiss etc. are heaped upon each other with intermingled, well-rounded quartzitic pebbles that may vary in size. Also some subordinate flat water-worn cobbles were found among the constituents, and amidst them again angular boulders of Jurassic *Ditrupa*-sandstone etc. Of special interest, however, are embedded lumps of gray or yellowish *Aucella* limestone such as occur around Albrechts Bugt and in

southeastern Kuhn Island. The *Aucellae* derived from these lenses belong to *Aucella* (*Buchia*) *keyserlingi* LAH., *A.* (*B.*) *piriformis* LAH., *A.* (*B.*) *concentrica* FISCH. etc. and thus suggest Polyptychitan. The same species were furthermore detected in pebble-bearing sandstone parts within the block series.

These boulder bed 10—15 m thick is unconformably overlain by

Black clayey shale containing yellow-red concretions of clay ironstone (Aptian).

As to its block facies the boulder bed closely resembles that of the synorogenetic "Rigi Series", Volgian, of inner Wollaston Foreland with which it was formerly correlated and classed as Valanginian (MAYNC 1938, 1939, 1940). Since then it has become obvious, however, that the "Rigi Series" is still of late Jurassic age as it is overlain, in Mt. Niesen, by *cephalopod-* and *Aucella*-bearing Infravalanginian/Rjasanian (*vid.* p. 96). Besides, the Volgian beds completely lack boulders of *Aucella* limestone such as are characteristic of the Valanginian conglomerate.

These conglomeratic Valanginian beds will be included in the general term "Young Sound Facies".

The same clastic Valanginian series is exposed in a more southern ridge (Sandstendalen) of the mountain. Here, too, the *sub*-Cretaceous uuconformity is evident, and the Valanginian is preserved in the form of small relics and caps as were it stuck on to the mountain's flank. In between, the flat-lying clastics have been swept away by erosion and the W-dipping Jurassic beds underneath are laid bare.

The following succession was measured:

Up to

285 m — "Gray Series" of Jurassic age (MAYNC 1947).
Dip: 10—15° WSW.
Angular unconformity.

285 m — Coarse conglomerate with polygenetic mostly well-rounded pebbles of varying size, some of which are as large as a head. Often the pebbles show a weather-worn surface and are crusted by ferruginous loamy material that may contain crystalline grit. The matrix of the conglomerate is made up of a gray-brown calcareous muscovite-sandstone carrying large belemnites (*Acroteuthis* or ?*Pachyteuthis sp.*).

Embedded between the polymictous pebbles are lumps and lenses of a light-gray silty flaggy *Aucella* limestone. Stress may be laid upon the fact that there occur limestone blocks which themselves contain scattered crystalline pebbles or pebbly seams. Among the excellently preserved forms *Aucella*

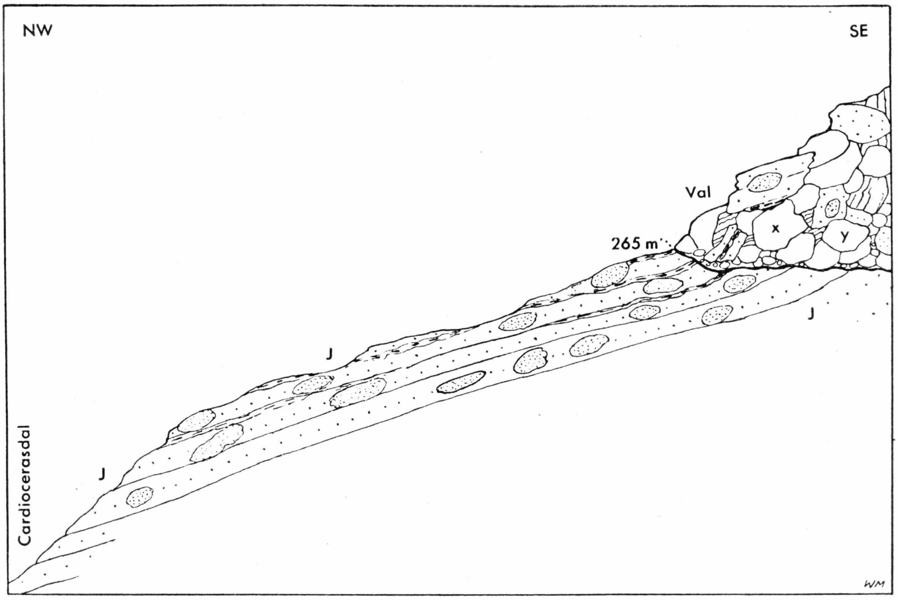

Fig. 23. Field-sketch showing the angular unconformity between the Jurassic (J) and the synorogenetic Valanginian beds (Val) exposed on the western slope of Stratumbjærget, Wollaston Foreland.
J = „Gray Series" (Argovian—Lower Kimmeridgian. x = Block af biotite gneiss. y = Fragment of yellow *Aucella* limestone.

(*Buchia*) *keyserlingi* LAH., *A.* (*B.*) *piriformis* LAH., *A.* (*B.*) *cf. concentrica* FISCH. etc. may be mentioned.

The thickness of this Valanginian relic only amounts to 4—5 m.

Higher up the slope the inclined Jurassic strata crop out.

At 360 m altitude another Valanginian cap was discovered to overlie transgressively the Jurassic (*vid.* Fig. 24).

340 m to 360 m Gray sandy shale carrying *Pachyteuthis panderi* (D'ORB.), with an interbed of yellow sandstone. Jurassic.

360 m (1) 0.1 m zone of limonitic friable sand, crumbling yellow limestone breccia of a reticular weathering, and residuum of weathered rocks. Upon the uneven eroded surface rest 3—4 m of horizontal or slightly NW-tilted conglomerate. The lowermost portion is relatively fine-psephitic (pebbles up to walnut-size) but upwards large boulders of banded gneiss appear heaped upon each other. Except the pebbles of Caledonian origin enclosures of light-gray *Aucella*-bearing limestone are again represented throughout the conglomerate, carrying *Aucella* (*Buchia*) *keyserlingi* LAH., *A.* (*B.*) *piriformis* LAH. etc., and *Belemnitidae.*

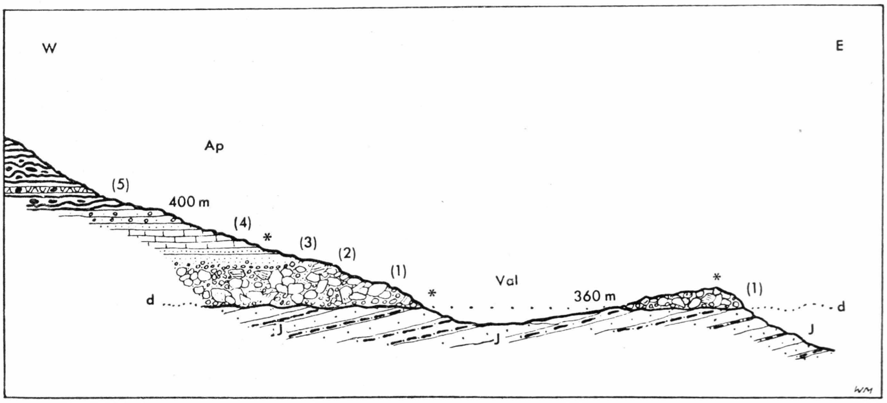

Fig. 24. The transgressive Valanginian beds (Val) overlying unconformably the Jurassic in Stratumbjærget, Wollaston Foreland (field-sketch of the author). The Valanginian is non-sequentially followed by the Aption series (Ap).

The reddish coarse-grained sandy matrix of the conglomerate likewise contains *Aucella* (*Buchia*) ex *gr keyserlingi* LAH. etc., large belemnites, and fossil wood.

This exposure displays exceedingly well the transgressive position of the Valanginian conglomerate. With a marked angular unconformity it overlies the eroded edges of the tilted Jurassic series, and the heterogeneous loamy zone at the floor of the Cretaceous bears evidence of the existing hiatus. Uphill the Jurassic was once more found to crop out beneath the Valanginian conglomerate.

Farther up the following succession was ascertained:

360 m to 380 m		Valanginian conglomerate as (1) below.
380 m	(2)	Brown fine-grained muscovite-bearing sandstone with *fucoid* markings on its bedding planes.
390 m	(3)	Interbed of grayish or yellow-coloured *Aucella* limestone with *Aucella* (*Buchia*) *keyserlingi* LAH. etc.
	(4)	2—3 m conglomeratic sandstone layer.
400 m	(5)	Black soft clayey shale or slate, interstratified with buff-coloured marl bands showing cone-in-cone structure. Both shale and marl carry red or orange weathering concretions of clay ironstone.

Members (1) to (3) are doubtless referable to the Valanginian. The shale member (5), on the other hand, is indubitable Aptian-Albian. Whether the thin layer of psephitic sandstone (4) is to be taken for the base of the Aptian or still is of Valanginian age, cannot be decided.

According to a field-observation made by A. VISCHER the Valanginian wedges out in Stratumbjærget and, consequently, the Aptian beds overlie directly the Jurassic east of the said mountain (VISCHER 1943).

Also in Skiferdal the Jurassic "Gray Series" is unconformably overlain by the Valanginian.

H. FREBOLD has already described this conglomerate (FREBOLD 1932a) but erroneously referred it to the Jurassic; subsequently, however, he determined *Aucella* (*Buchia*) ex *gr keyserlingi-piriformis* LAH. and thus realized the Valanginian age of the clastics in question (FREBOLD 1932b).

Up to a height of 175 m Jurassic beds are exposed.

175 m Coarse conglomerate containing crystalline pebbles of up to 0.3 m in diameter as well as huge complexes of a gray-brown fine-grained sandstone that replaces the conglomerate towards the top. From interbedded limestone blocks *Aucella* (*Buchia*) *keyserlingi* LAH., *A.* (*B.*) *piriformis* LAH. etc. were derived.

200 m Dark and gray-purplish muscovite-sandstone carrying small red-brown concretions of clay ironstone.

Overlain by

Black sandy shale and sand which sporadically contain big blocks of the underlying sandstone with pebbly parts (polygenetic pebbles and fragments of yellow sandstone). Some badly preserved mussels (?*Inoceramus* or ?*Aucellina*).

Débris.

Sections in Cardiocerasbjærg (P. 858 m).

(*vid.* Fig. 25 & 26).

From the lower part of Cardiocerasdalen up to Cardiocerasbjærg the following profile was measured:

180 m to 240 m "*Amoebites* shales" (= "Black Series") of Lower Kimmeridgian age (*vid.* MAYNC 1947).

240 m to 265 m Remnant of Valanginian conglomerate resting with obvious unconformity upon the inclined Kimmeridgian shales. Polygenetic conglomerate and breccia with components of Caledonian crystalline, plates of Jurassic sandstone, and lumps of *Aucella* limestone. This tiny cap of Valanginian looks as if pasted on the Jurassic scenery: All around and up to 440 m height the "*Amoebites* shales" are exposed.

At an altitude of 440 m this Kimmeridgian series is unexpectedly overlain by

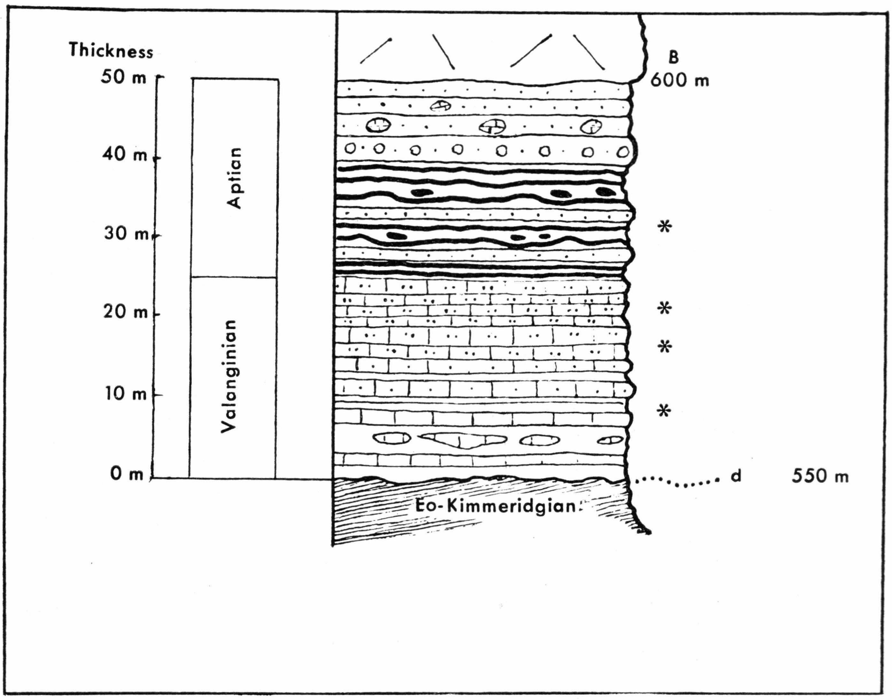

Fig. 25. The Cretaceous sequence in the southern face of Cardiocerasbjærg, Wollaston Foreland.

440 m Valanginian *Aucella* limestone: Light-gray or pinkish limestone and marly limestone carrying *Aucella* (*Buchia*) *piriformis* Lah., *A.* (*B.*) *keyserlingi* Lah., *A.* (*B.*) *concentrica* Fisch. etc. in abundance.

The exact thickness of this Valanginian limestone member (= "Albrechts Bugt Facies") is rather difficult to make out owing to the talus of basaltic rocks. Approximately, it may amount to about 20—25 m since higher up already the specific black slate and clay ironstone concretions with *Neohibolites sp.* of the Aptian were found among the basalt débris.

Another section was set down from farther up the valley to Cardiocerasbjærg:

Up to

550 m Jurassic sequence (*vid.* Maync 1947).

Contact between Kimmeridgian ("Black Series") and Polyptychitan limestone (unconformity):

550 m Light-gray and yellowish soft partly silty marl containing layers and lenses of gray or pinkish limestone crowded with *Aucella* (*Buchia*) *keyserlingi* Lah., *A.* (*B.*) *piriformis* Lah., *A.* (*B.*) *concentrica* Fisch. etc.

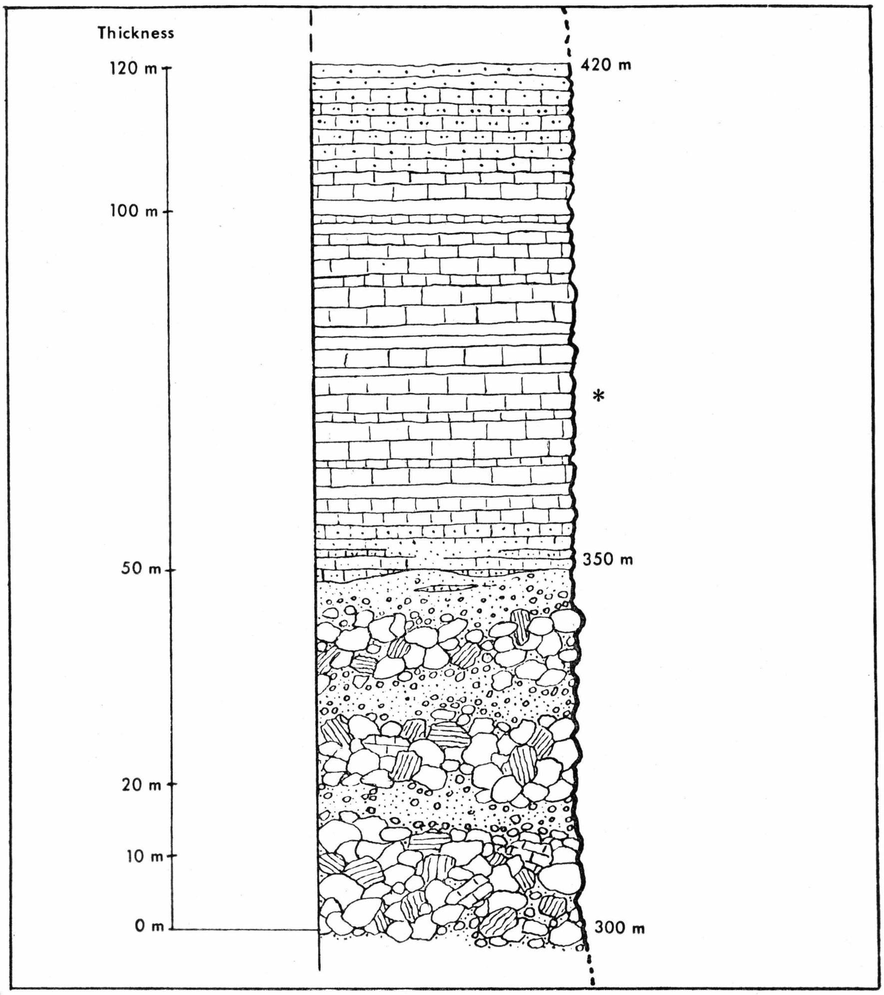

Fig. 26. Columnar section of the Valanginian rocks exposed in the western slope of Cardiocerasbjærg, Wollaston Foreland.

About 10 m above its base the limestone shows a slight red colouring and grades slowly into red weathering silty limestone which also carries *Aucella* (*Buchia*) *cf. keyserlingi* LAH. etc., moreover ammonites and small *Belemnitidae.*

565 m Red or brownish friable sandy limestone and calcareous sandstone with *Belemnitidae.*

570 m Yellow or orange-coloured calcareous sandstone.

575 m Gray or buff clay shale interstratified with sandstone layers.

580 m Clay shale, rich in belemnites, e. g. *Neohibolites sp.*, bearing brown-red weathering concretions of clay ironstone and silicified wood.

590 m 2—3 m gray conglomerate, overlain by gray-brownish calcareous sandstone containing quartzite pebbles of pea-size and clods and lumps of a hard dark-coloured whitish weathering limestone with pyrite nodules. Questionable imprints of *Inoceramus sp.*
600 m Floor of the plateau basalt (Cardiocerasbjærg).

On the west side of Cardiocerasbjærg the writer observed the following succession of sediments:

300 m to 350 m Coarse polygenetic conglomerate and psephitic sandstone. Except for the predominant crystalline boulders blocks of gray or yellowish *Aucella* limestone were met with such as occur in Stratumbjærget and in Skiferdal (= Valanginian in the conglomeratic "Young Sound Facies").
350 m to 400 m Passing gradually into light-gray limestone and marl carrying *Polyptychites spp.*, *Dichotomites sp.*, *Acroteuthis sp.*, and *Aucella* (*Buchia*) *keyserlingi* LAH., *A.* (*B.*) *piriformis* LAH. etc.
420 m On top appear reddish coloured calcareous sandstone and higher up pure sandstone.

The stratigraphical sequence in Cardiocerasbjærg gives evidence that the conglomeratic beds containing blocks of *Aucella* limestone (Valanginian in "Young Sound Facies") normally underlie the true limestone/marl facies of Albrechts Bugt. Since both facies obviously pass into each other there can be no difference in age worth mentioning and we may take them to be more or less contemporaneous deposits of the Middle Valanginian (Polyptychitan).

The same conclusion may be drawn for the Valanginian beds in Stratumbjærget and Skiferdalen (*vid.* pp. 79—83).

According to A. VISCHER the light-gray *Aucella* limestone of the Valanginian is also exposed in the northern slope of Cardiocerasbjærg at an altitude of 380 m.

From the higher red beds ("Rødryggen Beds") east of Cardioceraspass A. VISCHER has brought back small-sized pelecypods.

The Cretaceous sequence from Kuhnpasset up to Aucellabjærget (P. 950 m).

(Fig. 27).

From Kuhnpasset (330 m according the writer's own survey) along the southeastern slope of Aucellabjærget to the floor of the plateau basalt the succession is as follows:

330 m Valanginian beds dipping at angles of 4—5° to the northwest: Light-gray marl and marly limestone containing lumps and thin

layers of yellow-brownish or light-gray limestone. Numerous *Aucellae*, e. g. *A.* (*Buchia*) *keyserlingi* LAH., *A.* (*B.*) *piriformis* LAH. etc.

370 m Brownish muscovite-bearing sandstone, 1—2 m, overlain by light-gray soft marly shale bearing concretions of gray limestone which are rich in *Aucellas* and belemnites (?*Acroteuthis sp.*).

400 m Gray marly shale (as below), carrying belemnites, with enclosed nodules of gray or yellowish limestone which has yielded *Aucella* (*Buchia*) *piriformis* LAH. etc.

420 m Gray or yellowish-reddish soft silty limestone with embedded brownish concretions. Rich in *Aucellas* and belemnites.

430 m to 490 m Yellowish or gray marly limestone and sandy shale containing big lumps of clay ironstone (diameter up to 1 m). *Belemnitidae*, no more *Aucellas*.

490 m to 530 m Dark bituminous light-gray weathering fine-grained sandstone and sandy shale containing small pelecypods and carbonized plant-remains.

530 m 3 m light-gray often rather coarse-grained sandstone with *Serpula sp.*, overlain by a 2 m bed of yellow-grayish sandy shale containing large lumps of calcareous sandstone on top of which follow a gray conglomeratic sandstone layer, and again sandy shale with belemnites.

535 m Gray or brownish-purplish psephitic sandstone containing "schliers" of clay ironstone, inosculating with gray shale (as below) bearing large lenses and concretions of sandy limestone.

The finding of *Lytoceras polare* RAVN[1]) points towards an Aptian age.

540 m Light-gray conglomeratic sandstone carrying big lumps of yellow-gray sandy limestone and sandstone.

545 m Gray, yellowish weathering thick-bedded psephitic sandstone, overlain by a

550 m coarse-grained sandstone with large extremely fossiliferous concretions carrying an Aptian fauna including *Lytoceras polare* RAVN etc., big white-shelled lamellibranchs, ?*Aucellina sp.* etc., gastropods, and fossil wood in great quantities.

Interbeds of light-gray sandy shale.

560 m Ditto, with big fossil-bearing concretions. Large-sized pelecypods.

Then follows a

5 m bed of shale with enclosed big concretions.

570 m Yellow-gray sandy marl and shale containing large concretions and lumps of sandy limestone.

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[1]) Determination by L. F. SPATH (*vid.* MAYNC 1940).

The shale carries evolute ammonites such as *Crioceras* or *Tropaeum sp.*, *Ancyloceras sp.* as well as *Neohibolites sp.*, and petrified wood.

580 m Dark ammonitiferous shale interstratified with slightly sandy concretion-bearing marl.

Overlain by

brownish and gray rather coarse-grained flaggy sandstone with pebbly layers.

590 m to 650 m Brown or purplish coarse-grained thick-bedded sandstone with "schliers" and concretions of yellowish weathering clay ironstone.

650 m to 680 m Gray shale and slate carrying light-gray weathering concretions.

680 m Contact with the basalt-cap of Aucellabjærget (plateau basalt).

The few above-cited fossils prove that both Valanginian and Aptian are represented in the instructive section of Kuhnpasset.

On the pass itself the lowermost portion of the Valanginian limestone series is not yet exposed but from the nearby section on the west side of Cardiocerasbjærg (*vid.* p. 86) we may deduce that here, too, coarse-clastic deposits occur at the base of the Valanginian formation which have been laid down along the fault cliff of the complex "Kuppel Fault".

The Valanginian limestone and marl on Kuhnpasset facially correspond to those developed in the surroundings of Albrechts Bugt and in southeastern Kuhn Island (= "Albrechts Bugt Facies"). Its top beds also show infiltrations of sand, and the light-gray colour turns reddish. We therefore feel justified in referring the stratum exposed at an altitude of 420 m to the "Rødryggen Beds" which we have found to characterize the sequence at the close of the Valanginian stage. As the overlying beds from 430 m onwards show a certain change in composition (occurrence of clay ironstone) and, moreover, the *Aucellas* apparently become extinct, we draw the upper boundary of the Valanginian series at a height of 430 m. The exposed thickness of the Valanginian formations on Kuhnpasset thus attains 120 m.

The sandy deposits between 430 m and 535 m, i. e. a set of sediments of another 120 m thickness, carry a poor and indifferent fauna. It is therefore difficult to determine the age of the beds and it might be argued that Hauterivian or Barrêmian (Simbirskian) were represented here (*vid.* MAYNC 1940). This would be of outstanding importance since A. ROSENKRANTZ, H. FREBOLD, and other authors maintain that these stages or at least part of them are developed in a marine

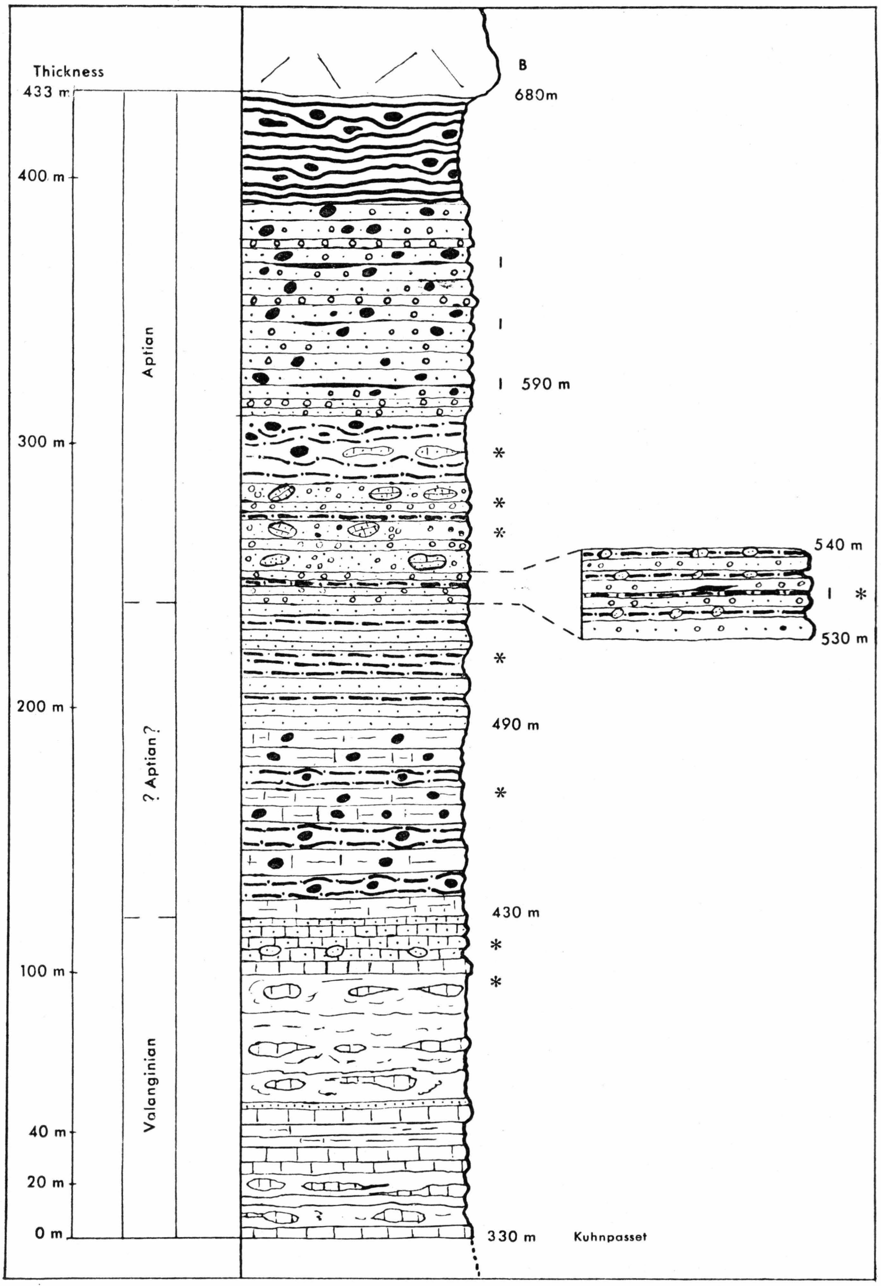

Fig. 27. The Cretaceous sequence exposed from Kuhnpasset up to Aucellabjærget, Wollaston Foreland.

facies in Kuhn Island, and in a "continental" facies in Great Koldewey Island etc., respectively (*vid.* pp. 16, 165 ff., 194—195). That the "marine *Simbirskites* Beds" certainly do not occur in eastern Kuhn Island has been proved by the writer's recent researches.

It may be added, however, that this locality in Kuhnpasset would be the only one in the entire area investigated which the Valanginian sea would not have drained. By reason hereof the author is inclined to include the said beds into the Aptian series until decisive fossils are at hand (*vid.* pp. 194—195).

The teeming new population with *Lytoceras polare* RAVN[1]) appearing from 535 m upwards is of indubitable Aptian age. The facies of the Aptian here in western Wollaston Foreland thus differs from the norm.

The *Crioceratids* occurring at 570 m and 580 m height probably belong to the group of *Crioceras gracile* SINZ. or to *Tropaeum arcticum* STOLL. which would point towards the Bedoulian/Lower Aptian (= Parahoplitoidan SPATH = *deshayesi* zone), or Lower Gargasian (Tropaeuman SPATH). These forms have also been cited from the Aptian of Spitzbergen (*vid.* ROSENKRANTZ 1929 in KOCH 1929a, SOKOLOV & BODYLEVSKY 1931, FREBOLD & STOLL 1937).

The Aptian beds, which here attain a thickness of 310 m, are capped by the plateau basalt.

It should be added that the writer cannot agree with A. VISCHER's view that Tertiary beds occur at the floor of the plateau basalt in southwestern Wollaston Foreland (VISCHER 1943). As is obvious from the sequence on Kuhnpasset the "light-coloured sandy bed at a height of 640 m" (A. VISCHER in *loc. cit.*) is but an interformational layer somewhere within the variegated Aptian series and is overlain by concretion-bearing shale that cannot be assigned to the Tertiary. Granted that the beds undergo a striking change, i. e. the coarseness of the clastic material considerably increases towards the western hinterland until we find large gneiss boulders embedded in the corresponding bed south of Palnatokes Bjærg; but there is not the slightest reason to postulate a Tertiary age on that account. This is only a facial phenomenon and nowhere in inner Wollaston Foreland could there be detected any unconformity to the underlying strata which, first and foremost, marks the lower boundary of the Tertiary throughout the investigated region (*vid.* MAYNC 1938, 1939, 1940).

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[1]) The holotype of *Lytoceras polare* RAVN was established by J. P. J. RAVN (1911) for a new species derived from erratic calcareous concretions which had been collected by the "Danmark Expedition" (1906—1908) in Vesterdalen, Danmarkshavn.

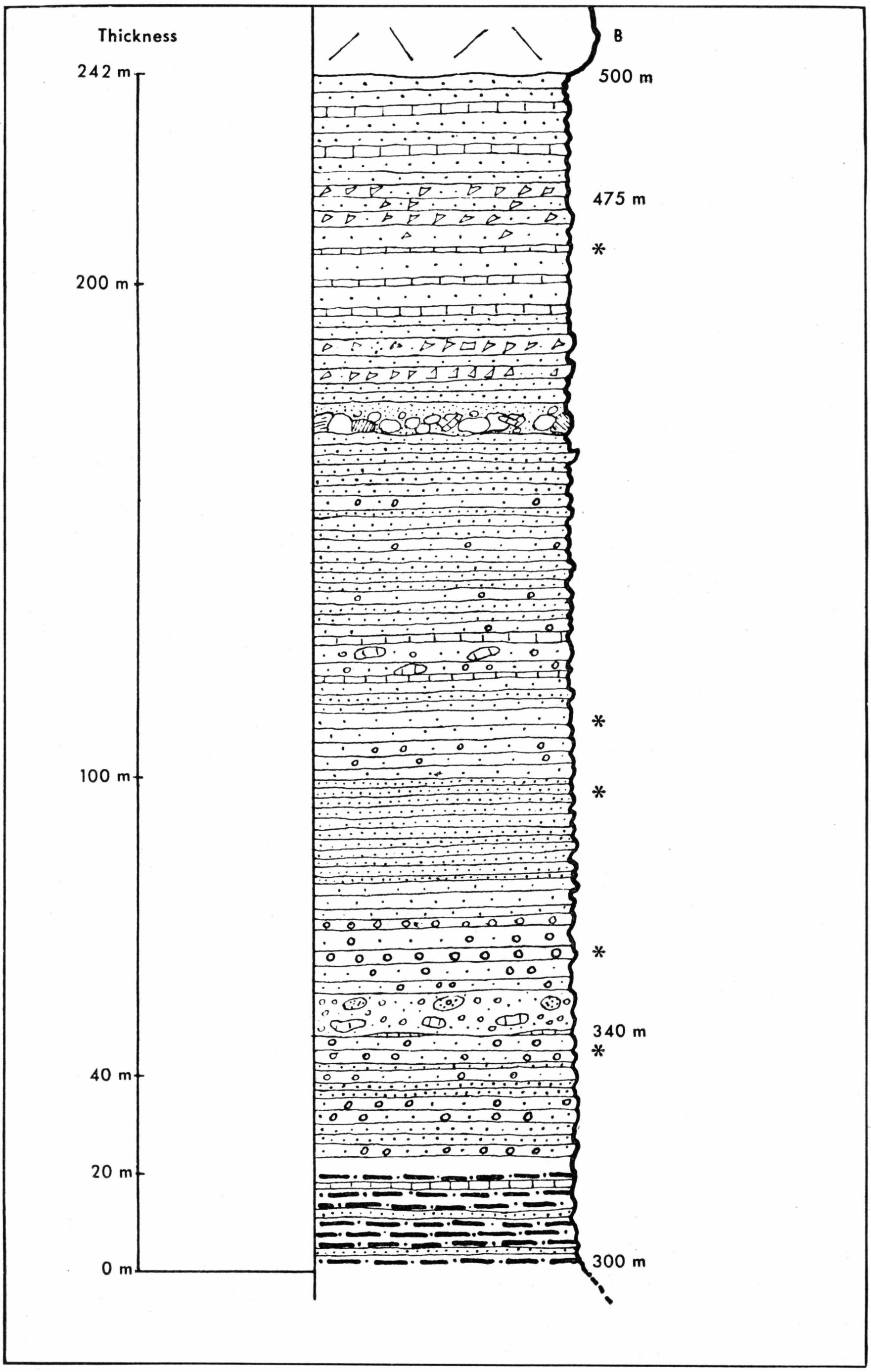

Fig. 28. Section through the Infravalanginian-Valanginian on the east side of Palnatokes Bjærg, Wollaston Foreland.

Section on the eastern flank of Palnatokes Bjærg (P. 1056 m).

(*vid.* Fig. 28).

On climbing the plateau basalt from Sauruspasset (230 m) the following succession of sediments was ascertained:

Snow, débris, and soil flows.

300 m Foliated black or gray sandy shale weathering light-gray with rusty zones (pyritiferous patches). Partings of fine-grained strongly yellow-coloured sand and pyritic seams. Thin interbed of gray, brownish-weathering limestone carrying carbonized plant-remains and wood.

Band of dark soil flows.

320 m Gray conglomeratic muscovite-bearing sandstone alternating with finer-grained calcareous flaggy sandstone beds. Contain well-preserved small *Aucellas*, possibly *Aucella* (*Buchia*) *cf. fischeriana* (D'ORB.).

340 m Coarse-grained muscovite sandstone and conglomerate with limestone layers. Also enclosed lenses and concretions of light-gray or slightly reddish-coloured limestone were frequently observed. Both sandstone and conglomerate carry numerous though badly preserved *Aucellas*.

345 m 2 m layer of gray-reddish psephitic sandstone with large enclosures of coarse-grained *Aucella* sandstone.

350 m Gray or purplish coarse-grained sandstone, rich in muscovite, with several interstratifications of conglomerate. Abounding with *Aucellas* and *Belemnitidae*.

360 m Predominantly reddish flaggy sandstones without any coarser interbeds, and light-gray sandstone, rich in mica, thin-bedded, with imprints of *Aucellas*.

380 m Reddish rather fine-grained sandstone, similar to that exposed at 360 m altitude.

385 m Light-gray often psephitic bedded sandstone, about 6 m in thickness, and reddish *Aucella* sandstone.

395 m Light-gray gritty micaceous sandstone inosculating with light-gray fine-grained platy sandstone with

400 m partings of gray limestone.

Then follow a

gray rather coarse-grained platy sandstone containing small enclosures of light-gray limestone, and within the sandstone a 0.3 m bed of a gray or pinkish-weathering squarely breaking limestone.

410 m to 440 m Reddish flaggy fine-grained sandstone with several interbeds of conglomeratic layers.

440 m Gray-brown muscovite sandstone with crystalline grit and a 6 m bed of coarse conglomerate containing pebbles of up to 0.25 m in diameter (Fig. 29). The pebbles represent quartzites and pink feldspar; also worked up fragments and oval-shaped

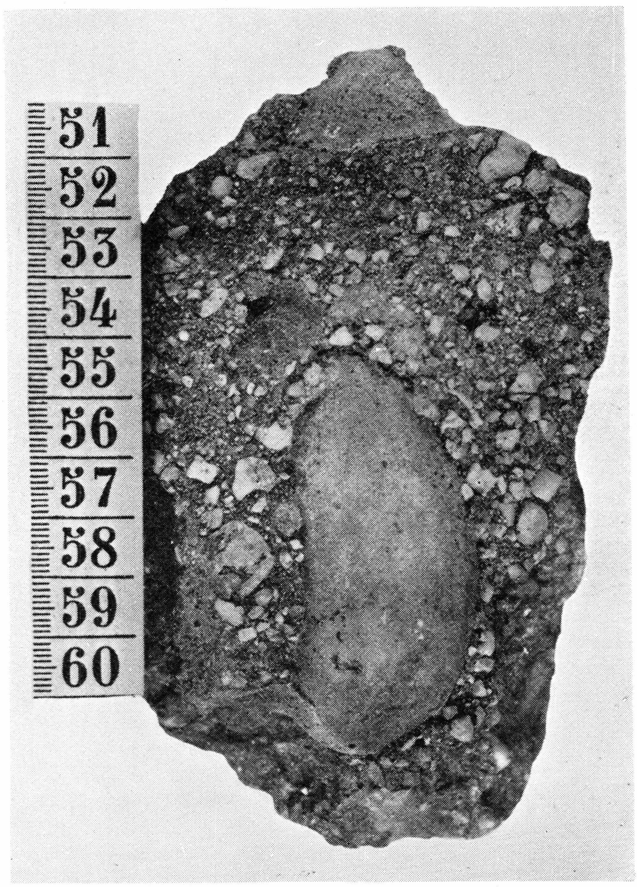

Fig. 29. Pebble-bearing gritty Valanginian sandstone ("Upper Niesen Beds"). Eastern slope of Palnatokes Bjærg, Wollaston Foreland (at 440 m altitude). Lot 1483 Coll. W. Maync.

pebbles of the underlying yellow-grayish limestone were observed. Grading continuously into

445 m reddish rather fine-grained sandstone with animal tracks, interbedded with layers of arkose grit containing coarse angular grains derived from the Caledonian crystalline.

460 m Thin interbeds of red-brown weathering, grayish or dirty-brown

470 m limestone carrying broken belemnites.

475 m Coarse arkose layers within finer-grained arkose.

The uppermost portion of this sequence, which is mostly covered with basaltic débris, is made up of sandstone containing gray limestone enclosures (similar to the member occurring at a height of 460 m and 470 m, respectively).

500 m Floor of the plateau basalt.

This sequence in the eastern slope of Palnatokes Bjærg is bounded on the east by a SSE—NNW running complex fault ("Kuppel-Canyon Fault" as termed by A. VISCHER). The writer has shown that this fault line existed already in late Jurassic time, allowing the transgression of the Volgian "Rigi Series" upon the "Yellow Series" (Upper Bathonian-Argovian) west of the said fault, upon the Kimmeridgian east of it (MAYNC 1947). Contrary to the view of A. VISCHER, however, I refuse to accept the view that this fault dies out in the Canyondalene but feel justified in drawing it through Sillerendal into Fligelys Fjord where its actual throw is shown to amount to at least 2000 m (*op. cit.*).

It is a pity that the section from 300 m downwards was covered with snow and surface débris, and was masked by soil flows. By this reason the very contact with the Kimmeridgian shales could not be observed. Concluding from the fact that these "*Amoebites* shales" in Saurusspasset display a distinct dip to the southwest whilst the beds in the present section are more or less horizontal I assume a stratigraphical overlap (*vid.* Pl. 3).

The lowermost exposed beds in the given profile are most probably to be correlated with the overstepping "Lower Niesen Beds" of Infravalanginian/Rjasanian age (*vid.* pp. 95—96) with which they show the greatest resemblance as to lithology and facies. On the other hand, a correlation with the "Schiefrige Bänderserie" (banded shale series the banding of which is produced by alternate black shale and yellow sand) of the Volgian (*vid.* MAYNC 1947) should not be rejected as unfounded; for both series lithologically resemble each other closely. There is only one difference which seems to speak more in favour of a parallelism with the "Lower Niesen Beds" and that is the intercalation of a limestone layer within the shale member such as occur in the Infravalanginian series in Mt. Niesen. Limestone interbeds are not known to exist in the Volgian beds of the area investigated. Unfortunately, no fossils were found in these lowermost strata that might definitely settle this question; it is to be hoped, however, that the well-preserved *Aucellas* from the overlying beds will help towards a definite decision.

There is no doubt that the higher portion of the succession in Palnatokes Bjærg corresponds to the Valanginian beds of Mt. Niesen ("Upper Niesen Beds").

The sudden strewing of coarser Caledonian detritus into the fine-grained Valanginian sandstones from 440 m upwards (*vid.* Fig. 29) bears witness to the existence of some near-by coast made up of crystalline rocks. For the present it remains obscure where this hinterland lay which could supply those gneiss pebbles, feldspars, arkoses etc. It may be pointed out, however, that such a periodical washing in of crystalline material is also characteristic of the contemporaneous beds in Mt. Niesen (comp. pp. 96—97), between 410 m and 600 m altitude. The fact that the coarseness of the detritic material decreases towards the north suggests that the land was situated south or southeast of Palnatokes Bjærg.

Section in Mt. Niesen (P. 688 m).

(*vid.* Fig. 30).

The deeply cut ravine I (*vid.* Maync 1947) on the north flank of the mountain exhibits the following sequence of flat-lying sediments.

The deposits exposed from near the delta up to a height of about 120 m belong to the late Jurassic, *viz.* the Volgian "Rigi Series" (*vid.* Maync 1947). At 220 m altitude the first interbed of *Aucella* limestone occurs within the clastic series, and at 230 m height another limestone layer is intercalated in a coarse-grained biotite sandstone which is overlain by a fine-grained dark *Aucella* sandstone (*op. cit.*). The *Aucellas* still seem to be closely allied to the species found at "Haakonshytta", southwestern Kuhn Island.

The detailed section is as follows:

Volgian beds (*vid.* Maync 1947).

120 m to 200 m Yellow psephitic obliquely-bedded sandstone with thick conglomeratic layers. On top follow thin beds or seams of black micaceous shale with *laminae* of strongly yellow-coloured sand, then again conglomerate etc. in a rhythmic alternation. The clastic constituents become coarser at higher levels. Higher coarse boulder beds occur containing big well-rounded blocks of Caledonian crystalline and large worked up boulders of the underlying red-brown weathering *Aucella* sandstone (*vid.* Maync 1947). The blocks are closely heaped upon one another; often there is almost no matrix to cement the deuterogeneous boulders together which is otherwise made up of a greenish-gray partly coarse-grained sandstone wherein some obscure *Aucellas* were found. Apart from current-bedding, other irregularities in the sedimentation such as old rock-slides, flexures, and subordinate local faults were frequently observed (*op. cit.*).

220 m Conglomerate with a 0.3 m interbed of hard yellow weathering, gray-brown *Aucella* limestone which pinches out laterally.

230 m Coarse-grained sandstone, rich in biotite, interstratified with an orange weathering limestone band.

Overlain by a

gray or yellowish weathering, dark fine-grained thin-bedded sandstone carrying badly preserved *Aucellas*.

235 m Fine-grained gray or reddish calcareous sandstone interbedded with layers of a hard reddish sandy limestone bearing ammonites and well-preserved *Aucellas*, e. g. *Aucella* (*Buchia*) *cf. volgensis* Lah. and other species. According to L. F. Spath the ammonites are *Berriasellidae* belonging to forms that were hitherto not known to occur in East Greenland, and the beds may be assigned to the Infravalanginian. Carbonized plant-remains and petrified wood are frequent.

248 m Gray-reddish calcareous sandstone with thin interlayers of a yellow weathering limestone which have likewise yielded specimens of a new *Berriasellid* genus of Infravalanginian age (*vid.* Maync 1939, 1940, 1947).

260 m Gray sandy shale with strongly yellow-coloured sand seams, with intercalations

265 m of hard yellow weathering limestone containing *Aucellas* and plant-remains. Soil flows.

315 m Light-gray, orange weathering layers of sandy limestone carrying plant-remains, *Aucellas*, belemnites, and ammonites; overlain by

reddish or brownish sandy shale bearing belemnites, *Aucellas*, which alternate with a few layers of yellow sandy limestone.

380 m Interbedded limestone band with a crushed ammonite which most probably is a juvenile specimen of *Ammonites payeri* Toula (= supposed "*Simbirskites*") (L. F. Spath).

390 m Gray or pink soft shaly marl, marly sandstone, and sandy shale interstratified with a bed of a strongly red weathering limestone which carries small-sized *Aucellas* and poorly preserved ammonites.

400 m Soft gray or pink sandy/marly shale and shaly sandstone with an interbed of orange-yellow *Aucella* limestone. *Aucella* (*Buchia*) *aff. keyserlingi* Lah., *A.* (*B.*) *cf. concentrica* Fisch., *A.* (*B.*) *cf. piriformis* Lah. etc. point towards Middle Valanginian (Polyptychitan).

Overlain by a

410 m Gray or brownish coarse-grained mica- and feldspar-bearing calcareous sandstone with conglomeratic interlayers the polygenetic pebbles of which attain the size of a hazel-nut. Em-

bedded in this coarse-clastic matrix are abundant well-preserved smal *Aucellas*.

In the finer-grained parts numerous specimens of ?*Acroteuthis sp.* were found.

About 5 m higher a layer of
orange weathering limestone containing *Aucellas* is interstratified within the sandstone.

460 m Gray sandstone full of holes (process of weathering) with a fossiliferous zone having yielded ammonites e. g. *Polyptychites sp.* etc. and numerous *Aucellas* ex *gr A.* (*B.*) *keyserlingi-piriformis* LAH.

465 m Gray and pink-coloured sandy/marly shale with a 1 m bed of *Aucella* limestone.

Overlain by
Gray coarse-grained thin-bedded sandstone, rich in muscovite and biotite, of about 10 m thickness, and

530 m light-gray marly limestone (4 m) with limestone layers carrying large *Aucellas* such as *Aucella* (*Buchia*) *piriformis* LAH., *A.* (*B.*) *keyserlingi* LAH., *A.* (*B.*) *cf. sublaevis* LAH., *A.* (*B.*) *cf. concentrica* FISCH. etc., on top of which follow 2—3 m belemnite-bearing sandstone, and yellow weathering *Aucella* limestone.

Superposed by
8 m thick sandstone with intercalations of yellow or gray limestone bands carrying *Aucellas* and belemnites, and
4 m gray-brown weathering knotty sandstone and conglomerate, on top of which follows a thin layer of *Aucella* limestone with *Aucella* (*Buchia*) *cf. concentrica* FISCH. etc.

Covered with snow and débris of a coarse-grained sandstone.

570 m Gray, reddish weathering coarse-grained sandstone with pebbly seams and layers, amounting to 30 m in thickness.

600 m Layer of gray, yellow weathering *Aucella*-bearing limestone which is overlain by sandstone containing large lenses of the underlying coarse-grained sandstone with a diameter of up to 2 m. *Aucella* (*Buchia*) *sp.*

630 m to 650 m 6 m gray, yellowish weathering sandstone, superposed by yellow-grayish *Aucella* limestone with thin-bedded zones.

650 m to 665 m Alternation of sandstone and thin yellow weathering limestone layers. *Aucella* (*Buchia*) *sp.*

665 m to P. 688 m Gray-yellow partly darker coloured limestone showing a high muscovite content on its bedding planes.

Summit P. 688 m	Yellow weathering limestone which has yielded a fragment of an ammonite and *Aucellas*. According to L. F. SPATH the ammonite may be an "early *Lyticoceras*".

This section in Mt. Niesen is of utmost importance as it shows the Volgian and the lowermost Cretaceous series in their normal-stratigraphical succession, which is quite unique for the northern part of East Greenland.

Before the faunas brought home by the writer have beən worked out, the upper limit of the Jurassic cannot be drawn with certainty. With reference to the cursory determinations accomplished in the field by means of the poor literature at hand the *Aucellas* derived from the clastic beds at 100 m and 120 m altitude probably belong to *Aucella* (*Buchia*) *volgensis* LAH., *A.* (*B.*) *mosquensis* (VON BUCH) etc. In southwestern Kuhn Island these *Aucellas* are accompanied by *Pavlovinae* such as *Dorsoplanites aff. panderi* (D'OR.), *Laugeites* (*Kochina*) *groenlandica* SPATH etc. of late Jurassic age (FREBOLD 1933, MAYNC 1939, 1940, 1947)[1]). The *Aucellas* from the horizon at 220 m altitude in the Niesen section apparently include quite similar forms and may still be Volgian species. On the other hand, this level is marked by the first occurrence of limestone layers which are altogether unknown within the Volgian series. With respect hereto the *sub*-Cretaceous boundary is likely to be drawn below the layer of *Aucella* limestone at a height of about 120—200 m.

At any rate it is quite improbable that a gap worth mentioning between the Jurassic and Cretaceous periods exists in the sequence in Mt. Niesen (*vid.* MAYNC 1947).

The fossil-horizon at a height of 235 m represents the lowermost paleontologically based zone of the Cretaceous. The *Berriasellidae* herefrom as well as from the beds exposed at 248 m points towards Infravalanginian/Rjasanian. The form derived from the stratum at 235 m height is being figured by L. F. SPATH under a new name. Some of these *Berriasellids* are identical with the new Infravalanginian forms recorded by H. ALDINGER from southern Jameson Land (ALDINGER 1935, SPATH 1936); the presence of some other types which show certain affinities with forms from the Russian "Rjasan Beds" affirms L. F. SPATH's correlation (*op. cit.*).

With regard to their facies the Infravalanginian beds in Mt. Niesen and in Jameson Land (Crinoid Mt., Mussel River, Horse River) show the greatest resemblance. The banded member at 260 m of the Mt.

[1]) Only the top beds in *Laugeites*-Ravine have turned out to be Infravalanginian/Rjasanian in age, which is proved through the evidence of *Subcraspedites* ex gr *plicomphalus* (Sow.)/*S.* (*Tollia*) *stenomphalus* (PAVL.) (*vid.* pp. 27—32).

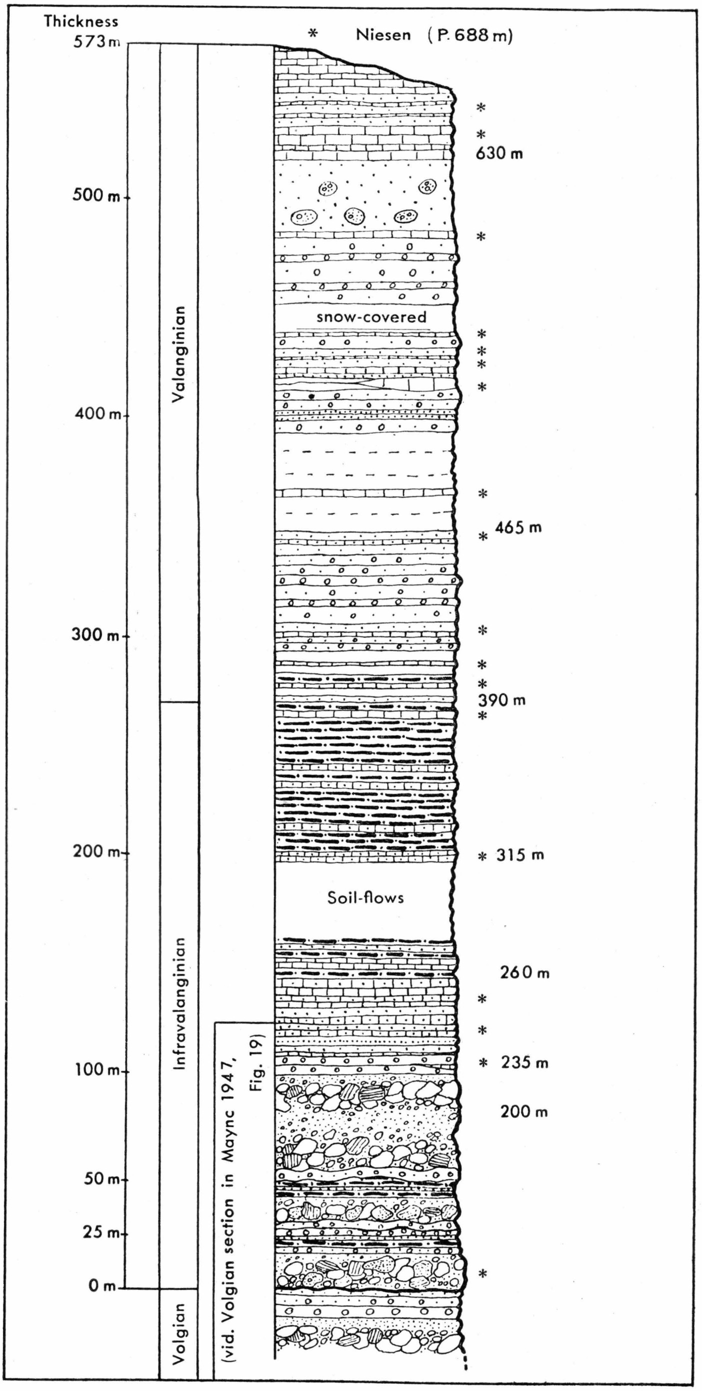

Fig. 30. The sequence Volgian and Infravalanginian-Valanginian (Niesen Beds) in Mt. Niesen, Wollaston Foreland.

Niesen sequence, on the other hand, is lithologically identical with the "Schiefrige Bänderserie" of the Volgian which is exposed near "Haakonshytta", in southwestern Kuhn Island (MAYNC 1947).

The discovery of a specimen of *Ammonites payeri* TOULA *in situ* in beds distinctly below the *Polyptychites*-bearing level finally sheds light on this often discussed form which was considered by a couple of authors to be a Hauterivian *Simbirskites* (*vid.* pp. 16, 166, 178 ff.).

The boundary between the Infravalanginian/Rjasanian and the Polyptychitan ought to be fixed with the help of paleontological data. Basing upon the stratigraphic and facial features as revealed elsewhere in Wollaston Foreland and Kuhn Island, the *Aucella*-bearing beds occurring at an altitude of 390 m or 400 m should already be Middle Valanginian in age ("Albrechts Bugt Facies"). Following this interpretation the thickness of the Infravalanginian/Rjasanian strata in Mt. Niesen would amount to about 170—270 m.

The succession from 390 m or 400 m up to the summit of Mt. Niesen (P. 688 m) is Valanginian in age. Its lower portion agrees rather well with the Polyptychitan, for instance the beds at 390 m, 400 m, 465 m, and 530 m. Intercalated between these marls, sandy shales, and limestones are clastic deposits which indicate rhythmic oscillations during the sedimentation. The numerous *Aucellas* characteristic of both facies-types are presumably identical and referable to the Valanginian. It may be admitted, however, that the *Polyptychites-Dichotomites* fauna seems to be poorly represented in Mt. Niesen but this may merely be due to an inadequate search for fossils.

According to a statement of L. F. SPATH the *Lyticoceras sp.* found on the summit of Mt. Niesen is younger than the various *Polyptychites* and *Dichotomites* of Upper Polyptychitan age but is still Valanginian and does not belong to the species *noricus* ROEM. (Lower Hauterivian) as I have been inclined to think. This *Lyticoceras sp.* would thus point to a Hoplitidan age.

As long as the faunas derived from the Niesen sequence have not been thoroughly studied and, therefore, no accurate data as to their age are available, the writer includes the 300 m thick series on top of the Infravalanginian "Lower Niesen Beds" under the term "Upper Niesen Beds" = Valanginian s. l. (*vid.* MAYNC 1947).

Summing up, it may be stressed that the succession in Mt. Niesen is apparently a continuous one from the Volgian to the Infravalanginian/Rjasanian and possibly to the Hoplitidan. This is of outstanding interest, as elsewhere in northern East Greenland a gap has been proved to exist comprising parts of the Upper Jurassic as well as the lowermost Cretaceous. It has been shown that the main orogenetic movements of the blocks of East Greenland's continental border have taken place in *pre*-Volgian time (MAYNC 1947). This rather intense phase of tectogenesis (Young Cimmerian orogeny) has given rise to structural deformations and a regional uplift into dry land. A sudden stop was put to sedimentation. Whilst considerable thicknesses of the Jurassic beds were being swept away by erosion from the emerged and tilted blocks, a long-stretched shallow basin formed along the fault scarp of the western "Clavering-Thomsensland Block" where the clastic synorogenetic "Rigi Series" of Volgian age was unconformably laid down upon the eroded rock floor. Owing to a persisting uplift of the western hinterland and a subsidence of the downthrown eastern block, respectively, Caledonian boulders of all sizes up to several tons in weight went on slumping from the fault cliff into the marine subsiding trough which has been named "Niesen Fjord" by the author (MAYNC 1947). This narrow sea-way, which has left its Volgian deposits in the joint of the two faulted blocks between Kuhn Island and Clavering Island, also existed in Infravalanginian time, as is proved by the fauna of the "Lower Niesen Beds". The similar facies of the latter and the series near "Haakons-hytta", Kuhn Island, bear evidence that there is not only no break in the marine sedimentation but even a stratigraphical transition with a conformable facies (*vid.* p. 32).

This continuous sequence from the Volgian onwards into the Infravalanginian/Rjasanian and the Upper Valanginian is and will always remain a subject of major interest for the Mesozoic stratigraphy of East Greenland.

D. Clavering Island.

(*vid.* Fig. 31).

In 1926 J. M. WORDIE's Cambridge Expedition found that shales of unknown but probably Mesozoic age are exposed in the eastern portion of the island.

During the sledge-journey of LAUGE KOCH in 1926—1927 black slates were met with below the basaltic flows of the said area. Furthermore, black slates carrying ammonites were found to occur in Basalt Island (KOCH 1929 a, 1929 b). L. KOCH is of opinion that these slates are "Portlandian" in age (*op. cit.*). Unfortunately, nothing is known about the ammonites mentioned and, since they have apparently never been identified, nothing can be deduced about the age of the beds concerned. We hold the view that the slates correspond to those of the Aptian-Albian series. It may be admitted, however, that they might also be referred to the Kimmeridgian shales such as are preserved opposite Basalt Island in Clavering Island (MAYNC 1947).

During his wintering in East Greenland (1929—1930) R. BØGVAD collected a few fossils in the eastern part of the island: Black slates in the Skiferkløften yielded *Inoceramus anglicus* WOODS, and from Björns Elv *Isognomon cf. rauliniana* (D'ORB.) is recorded (BØGVAD & ROSENKRANTZ 1934). According to A. ROSENKRANTZ (in *loc. cit.*) both forms would suggest a Gault age.

In the summer of 1931 A. NOE-NYGAARD and G. SÄVE-SÖDERBERGH spent a few days in Clavering Island. They arrived at the conclusion that a "Lower Sandstone" could be discriminated from an "Upper Sandstone". Basing upon an erroneous induction the "*Inoceramus* shales" containing *Inoceramus anglicus* WOODS were held to lie primarily between the said sandstone-complexes, and on that account the whole set of sediments was wrongly classed as Cretaceous (NOE-NYGAARD & SÄVE-SÖDERBERGH 1932).

A few badly preserved specimens of "Cyrena" led H. FREBOLD to postulate that the "Lower Sandstone" should be compared to the "Wealden Beds" of southern England. According to him the brackish or freshwater "Wealden Facies" which is known to represent the lowermost Cretaceous both in England and the Boulonnais, should not have set in on Clavering Island till the Aptian (FREBOLD 1932 a).

Moreover, A. NOE-NYGAARD and G. SÄVE-SÖDERBERGH discovered "Young Paleozoic Beds" near Djævlekløften developed in a particular facies (NOE-NYGAARD & SÄVE-SÖDERBERGH 1932).

In 1937 the writer succeeded in proving that the misinterpreted "Lower" and "Upper" Sandstones are identical and of indubitable Jurassic age (MAYNC 1938, 1940, 1947). The coastal cliff south of the delta of Dolomitdalen is composed of fossiliferous sandstones of the "Yellow Series" (Upper Bathonian-Argovian) which are unconformably overlain by the Volgian "Rigi Series". The exposure of black slate and shale on the very shore farther south which had been correlated by A. NOE-NYGAARD and G. SÄVE-SÖDERBERGH with the *Inoceramus* shales (in *loc. cit.*) is actually of Kimmeridgian age (*vid.* MAYNC 1947).

The "Young Paleozoic Beds" south of Djævlekløften as reported by the same authors turned out to represent only large Permian (and crystalline) boulders embedded in the mudstone matrix of the Aptian-Albian series (MAYNC 1942, VISCHER 1943).

In the autumn of 1937 A. VISCHER examined an about 60 m thick set of conglomerate, coarse-grained sandstone, and marl, rich in plant-remains and logs, in the Hallebjærgene, western Clavering Island. These beds, which are reported to overlie unconformably the Carboniferous and are surmounted by the plateau basalt, are referred by A. VISCHER to the Tertiary (VISCHER 1943). Were it not for the fact that basaltic pebbles are stated to occur in the conglomerate and that tuffs are associated with the sediments, the writer would rather correlate them with the Aptian-Albian which is developed in quite a similar clastic facies in Stensiös Plateau (Hold-with-Hope). Besides, these coal-bearing sandstone beds are already recorded by O. KULLING and D. MALMQUIST and have been compared to the Aptian formation in Stensiös Plateau (KULLING 1929, MALMQUIST 1932, *vid.* KOCH 1935).

Mesozoic deposits are confined to the eastern portion of the island.

Just as the fault scarp of the crystalline "Thomsensland Block" has put a stop to the Mesozoic transgressions advancing from the east, the "falaise" (fault cliff) of the Caledonian "Clavering Block" formed the coast line of the Jurassic and Cretaceous seas.

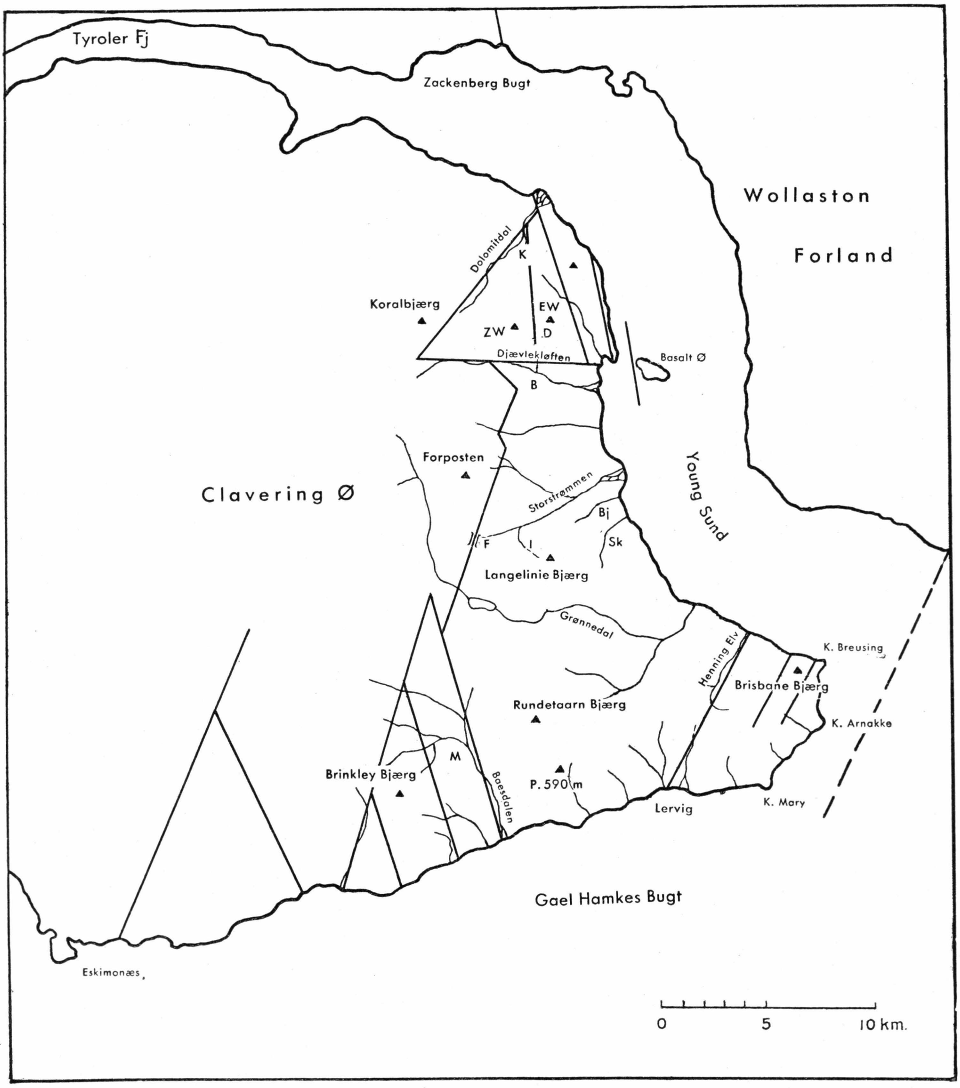

Fig. 31. Sketch-map of Clavering Island (tectonic lines in the main after A. Vischer). B = Boulder Ridge. Bj = Bjørnselv. D = Dislokationsdal. F = Forkastningspasset. I = Inoceramus Elv. K = Kontaktravine. M = Moskusokseelv. Sk = Skiferkløft. EW = Erster Weisse. ZW = Zweiter Weisse.

The fact that the late Permian beds in Clavering Island are for the greater part found to rest upon the edge of the upheaved "Clavering Block", i. e. 600—1100 m higher than on the downdropped eastern block, clearly proves the considerable throw of that fault (*vid.* Maync 1942, Vischer 1943). It schould be borne in mind, however, that still later movements may have increased this throw.

Since in early Mesozoic times the island lay beyond the scope of the northern continent "Eskimonia", marine Lower Triassic beds are developed (KULLING 1929, ROSENKRANTZ 1930, SPATH 1930, 1935a, KOCH 1931, 1935, NIELSEN 1935, MAYNC 1939, 1940, 1942, 1947, STAUBER 1942).

Marine Jurassic has been proved to exist in the northeastern part of the island (MAYNC 1938, 1939, 1940, 1947). On southeastern Clavering Island it has either been stripped away by erosion or is hidden beneath the ground's surface because of the downthrow of the outer tectonic blocks. On the other hand there remains the possibility that marine beds of Jurassic age have never been deposited here analogous to the adjacent region to the south where an immediate marine overlap of the Aptian-Albian series upon the Triassic is displayed. If this alternative should turn out to hold true the southern part of Clavering Island should still be included into our Cimmerian landmass "Neo-Eskimonia" (*vid.* MAYNC 1947).

North of Djævlekløften a remnant of *Aucella*-bearing Valanginian conglomerate was discovered to rest discordantly upon the eroded edges of the Jurassic (MAYNC 1938, 1939, 1940, 1947).

By far the largest portion of the sedimentary area of eastern Clavering Island is occupied by the "*Inoceramus* shales" (Aptian-Albian).

The tectonic structure of Clavering Island is not intricate. The Caledonian rocks comprising the main part of the island represent the fundament of A. VISCHER's "Clavering Block" which bears terrestrial Upper Carboniferous deposits (Namurian) in the west, i. e. in the tectonic groove of Godthaabs Gulf. The "Clavering Block" is bounded on the east by the "Clavering Fault" with its minor branches along which the eastern unit has slipped down. Another faulting-system of SSE—NNW trend diverges north of the SSW—NNE running "Clavering Fault" which accounts for minor tectonic complications. Moreover, a secondary *post*-Cretaceous fault runs rather arbitrarily W—E whereby a trapezoid segment is cut off; in consequence hereof the Jurassic sandstone series (+ Valanginian) crops out like a horst and abuts against the Aptian-Albian south of Djævlekløften. Auxiliary multiple faults branch off from the main fault in southeastern Clavering Island and thus cause the intervening slabs of Permian + Triassic to push against the Cretaceous.

For further details the reader is referred to the latest memoir of A. VISCHER (VISCHER 1943).

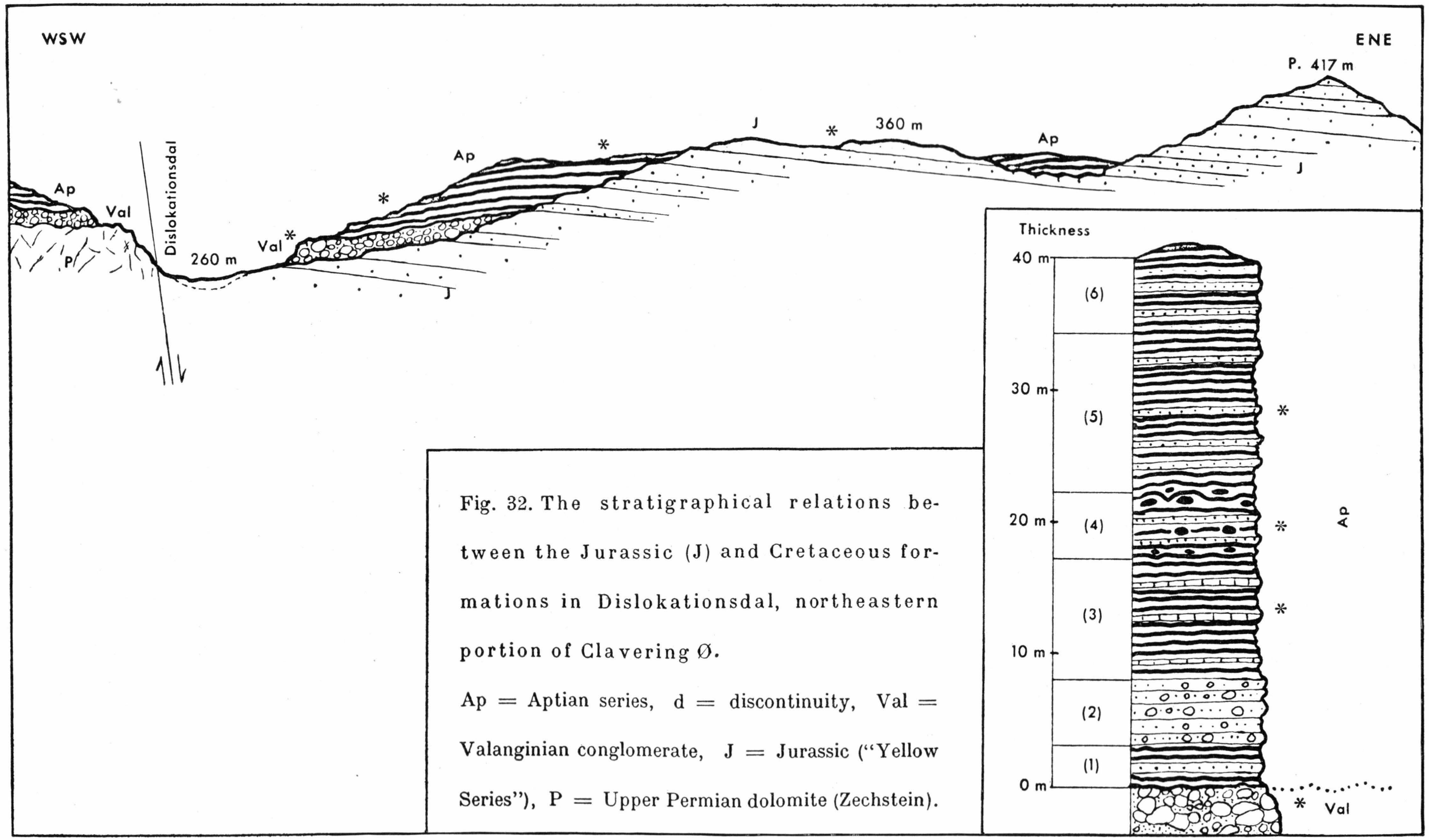

Fig. 32. The stratigraphical relations between the Jurassic (J) and Cretaceous formations in Dislokationsdal, northeastern portion of Clavering Ø.

Ap = Aptian series, d = discontinuity, Val = Valanginian conglomerate, J = Jurassic ("Yellow Series"), P = Upper Permian dolomite (Zechstein).

The remnant of Lower Cretaceous in Dislokationsdalen.
(*vid.* Fig. 32).

The creek cut in between the mountains P. 417 m and P. 465 m[1]) north of Djævlekløften (*vid.* map on p. 103) is named by the writer Dislokationsdalen ("dislocation valley"). As the name suggests, this valley is due to a *pre*-Cretaceous fault line that runs through Kontaktravine into Dolomitdalen (*vid.* MAYNC 1947) and is thus a typical fault valley. The light-coloured Jurassic sandstones of P. 417 m are bounded to the west by Permian, in Kontaktravine even by Caledonian crystalline (*vid.* Fig. 33) which shows that it was the eastern block that slipped down.

In Dislokationsdalen I came upon a relic of Valangininian conglomerate which rests with visible angular unconformity upon the worn surface of the Jurassic beds. The overlying Aptian-Albian series in turn shows a transgressive character as it overlaps the Valanginian or — where the latter is absent — lies directly upon the Jurassic (*vid.* Fig. 32).

At an altitude of 260 m the NE-dipping Jurassic sandstone is nonconformably overlain by an

> *Aucella*-bearing conglomerate dipping 10° to the west. Pebbles of Caledonian crystalline and Permian origin attaining the size of a fist are enclosed within a dark-gray or maroon sandy calcareous matrix which, moreover, contains numerous specimens of *Aucella* (*Buchia*) *keyserlingi* LAH., *A.* (*B.*) *aff. piriformis* LAH. *etc.*

On the other side of the fault a fossiliferous Permian dolomite crops out at a height of 280 m and is superposed by a relic of conglomerate. Predominant among the pebbles are such of Caledonian provenience, e. g. white quartzite, whereas components of Permian dolomite are subordinate. Except for *Pachyteuthis* or *Acroteuthis sp.* no fossils were found.

Whether this conglomerate should be taken to be the base of the Jurassic "Yellow Series" or it corresponds to the Valanginian, cannot be decided with certainty. With regard to the similar conglomerate exposed on the other side of the creek, the recorded *Aucellas* of which point towards the Valanginian, I rather prefer to consider them equivalent, however.

It is at any rate evident that the Valanginian sea encroached upon a distinct relief-landscape.

The psephite remnants on either side of the fault in Dislokationsdalen are overlain by sure deposits of Aptian-Albian age. On the slope leading

[1]) On the map of A. NOE-NYGAARD & G. SÄVE-SÖDERBERGH these points bear the names "Erster Weisse" und "Zweiter Weisse" (NOE-NYGAARD & SÄVE-SÖDERBERGH 1932).

from the valley upward to P. 417 m the following section was set down:

260 m Valanginian conglomerate.
Transgressively overlain by

(1) Black shale showing muscovite-strewn bedding planes, with partings of knobby sandstone containing "schliers" of orange weathering clay ironstone. 2—3 m in thickness.
(2) 5 m red-brown sandstone bearing well-rounded crystalline pebbles of up to fist-size.
(3) Black marly shale with thin limestone bands containing small pelecypods and *Inocerami.*
(4) Black shale with enclosed concretions of clay ironstone. Interbeds of hard sandstone with "schliers" of orange weathering clay ironstone and limestone. Numerous small lamellibranchs (*Nuculidae*) and *Inoceramus sp.* were found here.
(5) Bluish-gray, yellow weathering sandy shale alternating with layers of reddish sandstone rich in muscovite. Tracks of organisms, and pelecypods.
Surmounted by
(6) Black or chocolate-brown marly shale and slate with interstratifications of brown or mottled sandstone carrying enclosures of clay ironstone-matrix.

This set of sediments amounts to about 40 m in thickness.

In a small depression immediately west of P. 417 m the Aptian-Albian rests unconformably upon the Jurassic series of Upper Bathonian-Argovian age (*vid.* Fig. 32). The destructional surface of unconformity is uneven and the eroded edges of the NE-dipping Jurassic sandstone, bearing *Pseudomonotis braamburiensis* Sow., *Pachyteuthis panderi* (D'ORB.) etc., show strong rusty infiltrations. Sometimes they were observed to be enveloped by an intensely yellow-coloured limonitic loam, evidently a residuum of the weathered rocks. On top of this loamy material follow about 3 m of black shale with clay ironstone concretions.

Sections in the surroundings of Kontaktravine (Dolomitdalen).

(*vid.* Fig. 33 & 34).

On the left (southwestern) side of this fault ravine Caledonian gneiss and fossiliferous Permian beds are exposed (*vid.* MAYNC 1942). Near the fault itself a relic of Jurassic sandstone was found to overlie the Permian (MAYNC 1947) but otherwise the transgressing Aptian-Albian series follows directly upon either the Permian or even the Caledonian.

The Cretaceous sequence (1) slightly southwest of the creek is as follows.

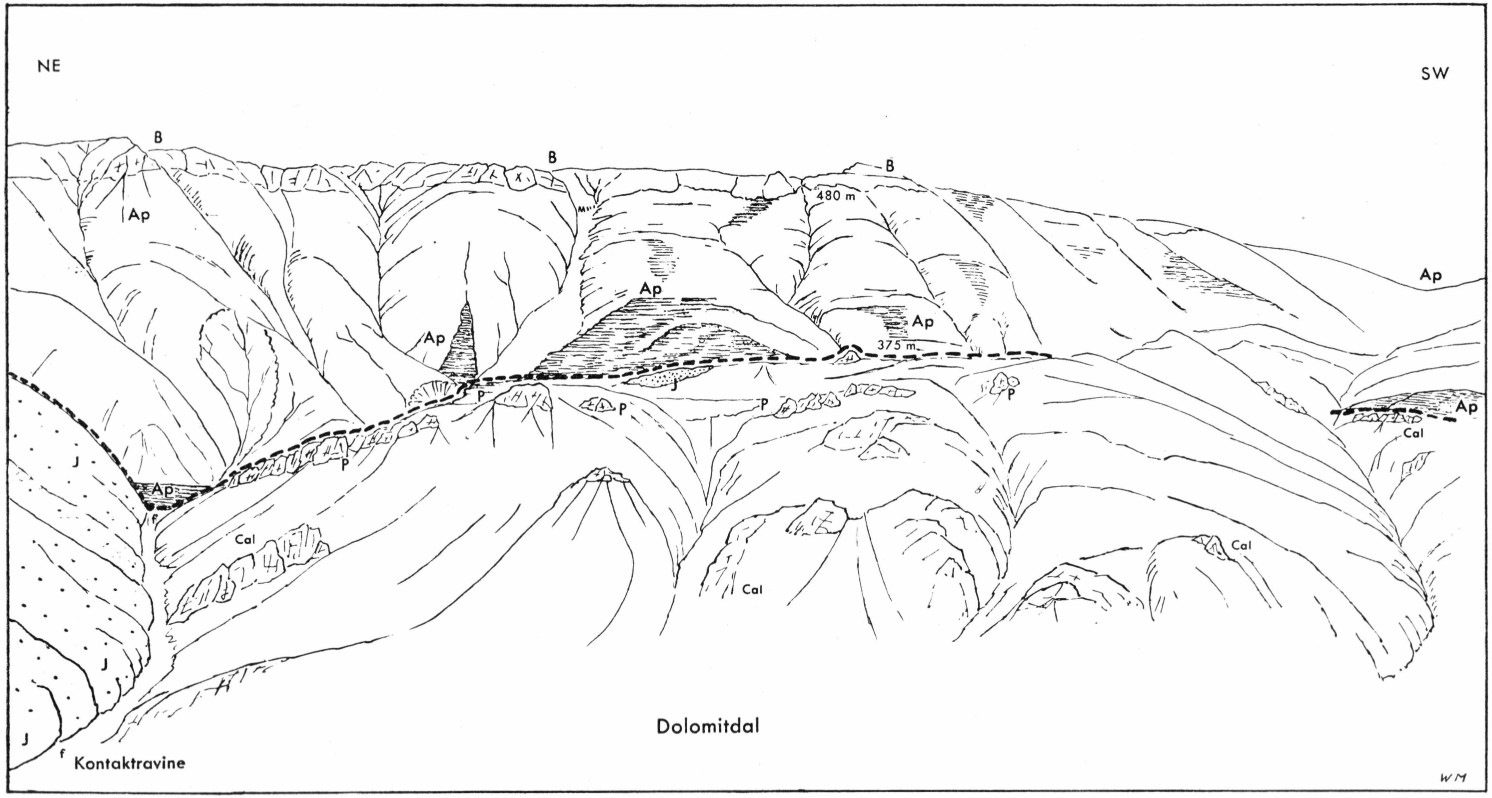

Fig. 33. Geological view of Kontaktravine-Dolomitdalen, northeastern Clavering Island (field-sketch of the author). Legend: Caledonian crystalline rocks (Cal) with overlying remnants of Upper Permian (P) (*vid.* Maync 1942). In the centre (345 m altitude) a remnant af Jurassic (J) fossiliferous sandstone ("Yellov Series", *vid.* Maync 1947). The broken heavy line marks the transgression plane of the Aptian-Albian (Ap). In Dolomitdalen these Cretaceous deposits rest directly upon the Caledonian crystalline (extreme right). The fault (ff) running through Kontaktravine has thrown down the block to the west (extreme left) in late Jurassic times (outcrops of Jurassic sandstone (J)); the Aptian-Albian beds overlie the fault without being disturbed, and are capped by the plateau basalt (B).

Permian *Productus* limestone.

375 m Black shale with numerous enclosed concretions of orange or red weathering clay ironstone.

380 m With interbeds of conglomerate and brown calcareous sandstone bearing concretions and pebbles of clay ironstone. The latter contain scattered quartzite pebbles of the size of a hazel-nut as well as gritty Caledonian detritus. An increase of such clastic material may even lead to a gradually passing of the clay ironstone into psephitic layers.

400 m Coarse-grained sandstone and hard conglomeratic layers with thin interbeds of clay ironstone, which, however, laterally wedge out over a short distance. The enclosed pebbles and crystalline grit are often arranged in the form of "schliers" indicating the existence of currents during the sedimentation. Ripple-marks on the bedding surface point to the same phenomenon. The sandstone and psephite are frequently interstratified with thin bands of black shale containing concretions of clay ironstone.

450 m Black slate and shale with interbeds of buff marl with cone-in-cones (*vid.* Pl. 4, Figs. 1 & 2) which carry numerous red-coated clay ironstone concretions. Near the floor of the plateau basalt (480 m) the slate with thin interbedded limestone ledges is discoloured and indurated.

In the section (2) measured southwest of profile (1) the clastic deposits of the lowermost Aptian were stated to extend to a height of 440 m. There are coarse conglomerates and red-brown or gray-brown knobby sandstones displaying ripple-marks. Furthermore, "schliers", enclosures, and concretions of clay ironstone, a high content of muscovite, plant-remains, pebble-bearing clay ironstones etc. are characteristic of these clastics which show thin intercalations of black shale.

(3) Still farther up the valley (Dolomitdalen) these basal psephites of the Aptian-Albian series were found to rest unconformably upon the Caledonian gneiss:

400 m Crystalline rocks, gneiss etc.

Sharp, well exposed contact with arkose and reddish knobby coarse-grained sandstone with inserted conglomerate beds. About 6 m above the base orange weathering concretions of clay ironstone are embedded within the sandstone.

The stratigraphical facts as recognized in Dolomitdalen give evidence bearing on the transgression of the Aptian-Albian beds over a pronounced relief of the ancient land surface. Whilst it overlies un-

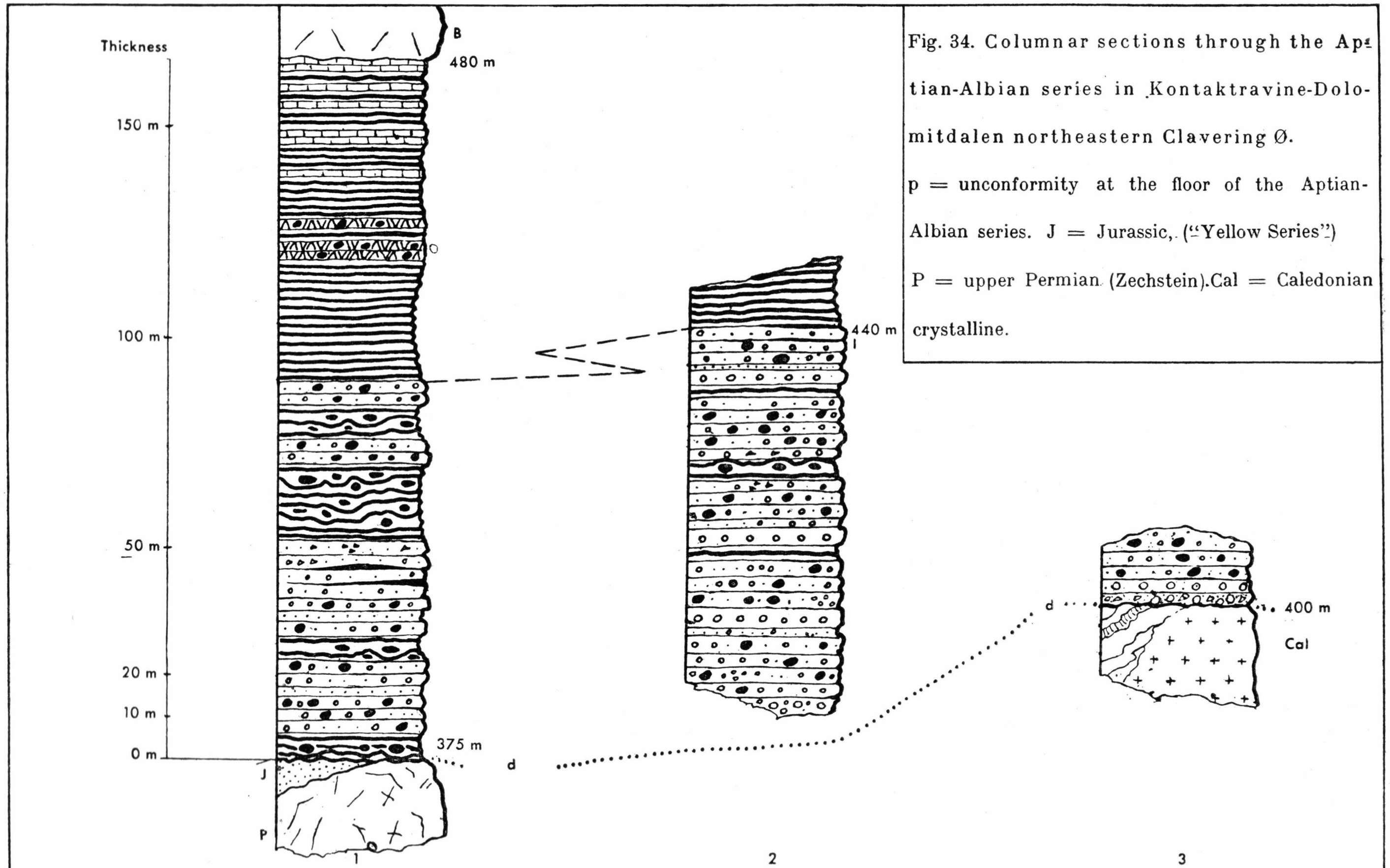

Fig. 34. Columnar sections through the Ap-tian-Albian series in Kontaktravine-Dolomitdalen northeastern Clavering Ø.
p = unconformity at the floor of the Aptian-Albian series. J = Jurassic, ("Yellow Series")
P = upper Permian (Zechstein). Cal = Caledonian crystalline.

conformably the Jurassic in Dislokationsdalen, it oversteps the Jurassic, Permian, or Caledonian gneisses in Dolomitdalen.

As is shown on the following pages, the fault escarpment of the "Clavering Block", especially west of the "Forposten Fault" of A. Vischer, has formed a coastal cliff ("*falaise*") in Aptian-Albian time from which the huge "exotic" boulders of Permian and Caledonian provenience have tumbled down into the muds of the shallow sea.

The Aptian-Albian beds near Djævlekløften.

Near the water-falls of the Djævlekløften proper (= "Devil's gorge") Aptian-Albian strata occur between the Caledonian gneiss and the Tertiary basalt sheet. This basalt is steeply inclined to the east and—as shown by A. Vischer in his memoir (Vischer 1943)—is a continuation of the main basalt sill of eastern Clavering Island which has been injected into the flat-lying Cretaceous sediments. Near the "Clavering Fault" it has been considerably dragged during *post*-Basaltic movements.

The black *Inoceramus*-bearing slates with interbedded layers of light-coloured sandstone rest primarily upon the gneissic rocks. Due to exomorphism along the igneous contact the sediments have been subject to heating, baking, and discoloration.

In Boulder Ridge[1]), south of Djævlekløften, the following section was measured:

Up to a height of 180 m no beds *in situ* are exposed as the slope is covered with surface débris. The rocks lying around chiefly represent red-brown or grayish knobby sandstones and conglomerates such as were found to crop out in Dolomitdalen. "Schliers" of yellow clay ironstone are present both in the sandstone and in the psephites. The sandstones occasionally carry badly preserved casts of *Inoceramus sp.*

180 m 6 m gray-black sandy shale with clay ironstone concretions which sometimes contain quartzite pebbles.
190 m Layer of yellow sandstone with *Inoceramus sp.*
Surface débris.
210 m Gray er yellowish shale and slate with intercalations of yellow-coloured sandstone layers carrying concretions of clay ironstone.
220 m Yellow or reddish weathering sandstone, rich in muscovite flakes, containing dark crimson concretions of clay ironstone with *Ino-*

[1]) Name proposed by the author on account of the immense boulders of Permian and Cryštalline that were found to be stratigraphically embedded in the Aptian-Albian shales. On the geological map of A. Noe-Nygaard & G. Säve-Söderbergh (1932) these beds are coloured as Permian (exposures at 235 m, 250 m, and 300 m, respectively).

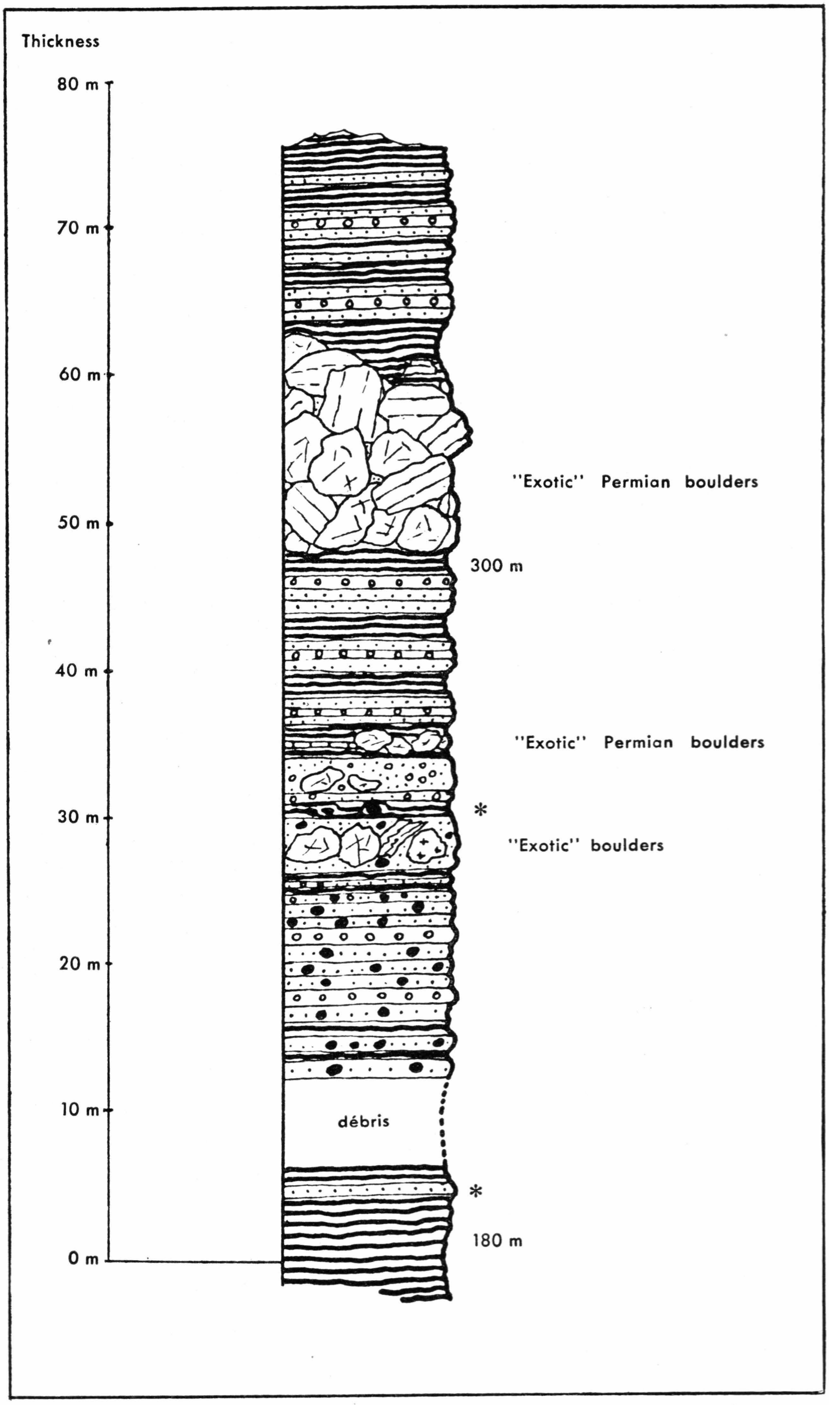

Fig. 35. The Aptian-Albian succession in Boulder Ridge, northeastern portion of Clavering Island.

cerami. Within the sandstone interbeds of conglomerate are frequent.

235 m Red-brown thick-bedded calcareous muscovite sandstone showing infiltrations of clay ironstone, and
1 m bed of dark shale with thin horizons of sandstone and polygenetic conglomerate with clay ironstone cement.

240 m Yellow sandstone with "schliers" of reddish clay ironstone, containing large blocks of pink brecciated Permian limestone with *Productidae* etc., boulders of fossiliferous reddish calcareous sandstone derived from the late Permian "Red Series" (with *Productids*, *Spiriferids*, and corals). In between huge angular blocks of Caledonian crystalline are interbedded, together with fragments of black limestone, ferruginous sandstone, and pebbles of clay ironstone.

This boulder bed is immediately overlain by black shale with interstratified layers of conglomerate. Red-weathering clay ironstone concretions with *Inoceramus sp.* are not rare.

250 m Black shale. Interbeds of gray knobby sandstone carrying clay ironstone in the form of "schliers" and concretions. Pebbly seams, plant-remains. A few large Permian boulders.

260 m Gray-bluish shale alternating with thin limestone bands. Embedded in the fine-grained mudstone matrix are large boulders of *Productus* limestone, and reddish *Spirifer* sandstone of the Permian.

On top of this bed follows a
sandstone with psephitic niveaux. The enclosed clay ironstone concretions carry fragments of *Inoceramus sp.*

270 m to 300 m Black shale with interstratifications of yellow-coloured sandstone with conglomeratic seams and orange concretions of clay ironstone.

300 m Land slide-like accumulation of Permian boulders up to several tons in weight. The pell-mell structure of the down-fallen boulders attaining the size of a house gives evidence of how the conditions of such a boulder sedimentation have been. The boulders of thin-bedded Permian limestone enclosed in the Cretaceous beds are completely unsorted, one lies obliquely, another flat whilst still another large slab projects vertically from the fine-grained matrix. Due to selective erosion the softer Aptian beds have been carved out, leaving the enormous boulders which led A. Noe-Nygaard and G. Säve-Söderbergh to map them as Permian *in situ*, *vid.* Maync 1942 (Fig. 9, p. 35).

A huge stratified Permian boulder of a solid content of about 20 cubic meters was found to stick upright in the yellow ferruginous medium-grained sandstone. It shows obvious infiltrations and pockets of red clay ironstone-material, which has also entered the bedding planes and covers parts of the corroded "karsted" surface. On another block remnants of a yellow ripple-marked sandstone were observed to adbere. Several Permian boulders exibit slightly rounded edges and are smoothly polished, which shows that they were washed and beaten by the surf of the Aptian-Albian sea. Clusters of sandstone-matrix with infiltrations of clay ironstone carrying specimens of *Inoceramus sp.* were found to adhere to another Permian boulder. On the other hand, Permian *Productidae*, *Schizodus sp.* etc. which have fallen from such disintegrating weathered limestone boulders into the Aptian sea became once more embedded together with *Inocerami* (*vid.* MAYNC 1942).

On top of this boulder bed follow

Black slate and shale with numerous interbeds of plant-bearing sometimes pebbly sandstone which contain the usual concretions of red-weathering clay ironstone.

Slightly to the west, i. e. towards the Cretaceous coastal cliff composed of the "Clavering Block"-escarpment, more such Permian boulders were encountered lying amidst black shales with interstratified bands of buff marl with cone-in-cone structure.

Still farther to the west black slates are exposed in which unexpectedly huge angular blocks of Caledonian gneiss as well as boulders consisting of saccharoidal Permian dolomite are buried. It carries much weight as to the sedimentary conditions that the Aptian-Albian slates and shales do not show the least change in facies, as for instance strewn in coarser detritus. By this reason these enormous intraformational boulders enwrapped in strata developed in a pelitic mud-facies are completely strange elements and may therefore be compared to the "exotic blocks" of the Alps (*vid.* pp. 222—223).

As the source of the unwield constituents evidently lay immediately to the west, we conclude that the "exotic" boulder beds are due to periodical land-slides down from the adjacent coastal cliff onto the tidal flat of the Aptian sea (*vid.* Fig. 36). The breaking loose of such boulders obviously happened by jerks and it is thus not far-fetched to assume that tectonic movements of the coast-scarp have caused the rock-falls which have supplied these "exotic" blocks.

It may be remembered that a similar, though much intenser boulder sedimentation took place in late Jurassic times near the scene of orogenetic movements along the same fault scarp. After the main Young Cimmerian faulting the transgressive synorogenetic "Rigi Series" of the Volgian could form at the base of the fault cliff of the "Clavering-

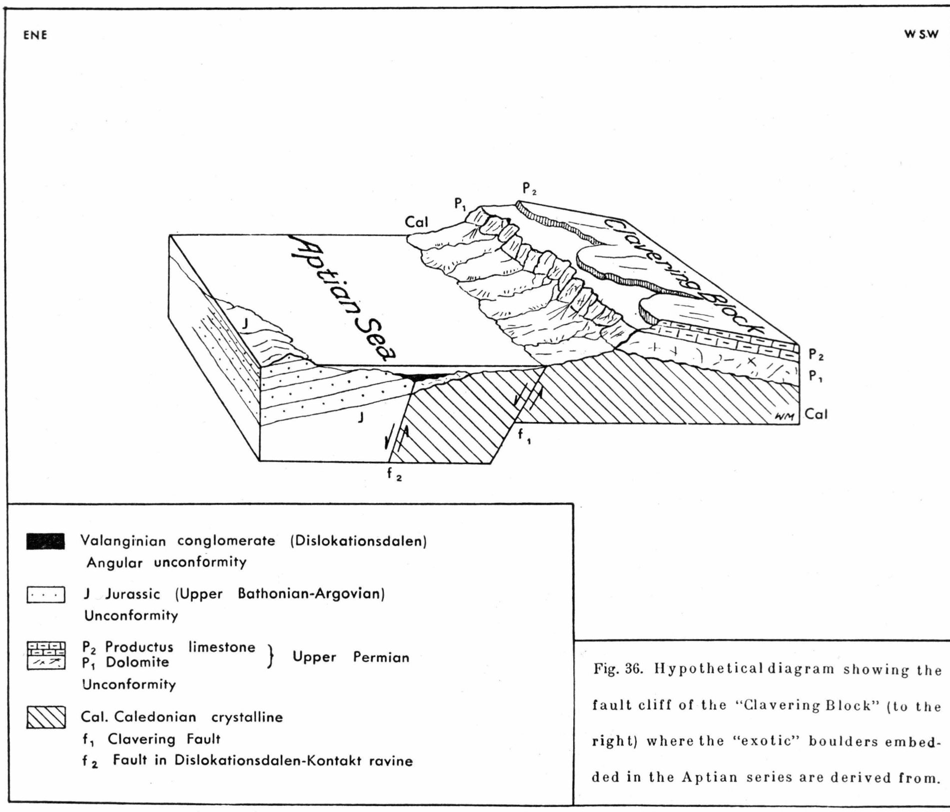

Fig. 36. Hypothetical block diagram showing the fault-cliff of the "Clavering Block" where the "exotic boulders" embedded in the Aptian-Albian series are derived from.

Thomsensland Blocks". Enormous boulder beds of several hundred meters in thickness, consisting of Caledonian crystalline rocks heaped closely upon another, then accumulated along the fault in the so-called "Niesen Fjord" (*vid.* Maync 1947).

Section in Inoceramus Elv[1]).

(*vid.* Fig. 37).

The sequence ascertained is as follows.

Soil flows and snow.

280 m Gray knobby rather fine-grained muscovite sandstone with wave-marks and animal tracks. *Inoceramus* casts, crinoids. Enclosed concretions of red-yellow clay ironstone carrying *Inoceramus cf. anglicus* Woods etc.

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1) The small creek carved in the northwestern slope of Langelinie Bjærg (P. 802 m) and joining Storstrømmen at about 240 m altitude (*vid.* Fig. 37) has been named *Inoceramus* Elv by the writer.

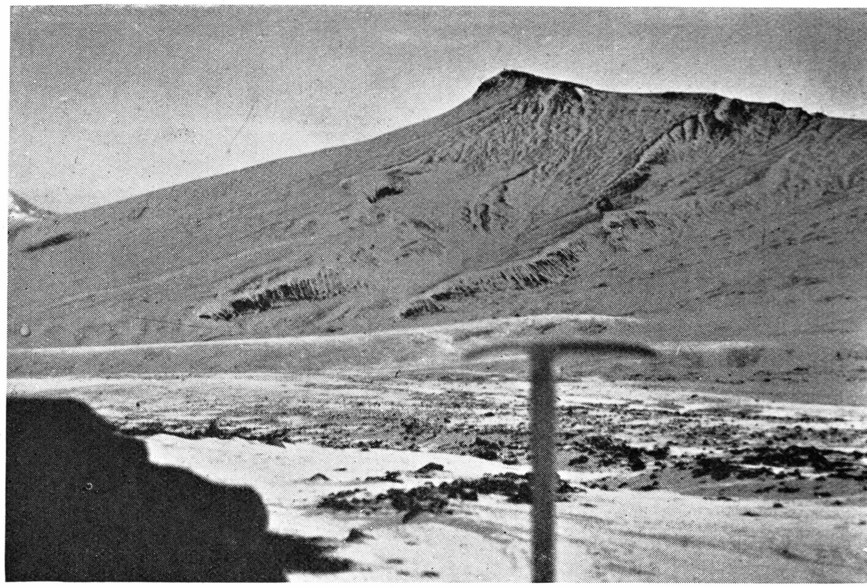

Fig. 37. Langelinie Bjærg (P. 802 m) with *Inoceramus*-Elv, eastern Clavering Island. In the foreground the river bed of Storstrømmen. Phot. W. Maync.

320 m Thick-bedded yellow mica-bearing sandstone with clay ironstone-"schliers".

340 m Buff-coloured marl displaying cone-in-cone structure, with a thin interbed of red clay ironstone.

A few meters higher overlain by

Gray coarse-grained knobby sandstone containing concretions and some rare layers of orange-red clay ironstone.

375 m Dark-gray, yellow weathering sandstone interbedded with buff marl showing cone-in-cone structure, carrying concretions of clay ironstone. *Inoceramus sp.*

390 m Buff marl with cone-in-cones, with layers of coarse-grained sandstone.

400 m Gray fine-grained sandstone with enclosed concretions of *Inoceramus*-bearing clay ironstone.

410 m Light-gray coarse-grained calcareous sandstone with pebbly layers.

Soil flows and surface débris.

450 m to 480 m Black friable slate with interstratifications of buff-coloured marl with cone-in-cone structure.

480 m Interbed of gray medium-grained calcareous muscovite sand-

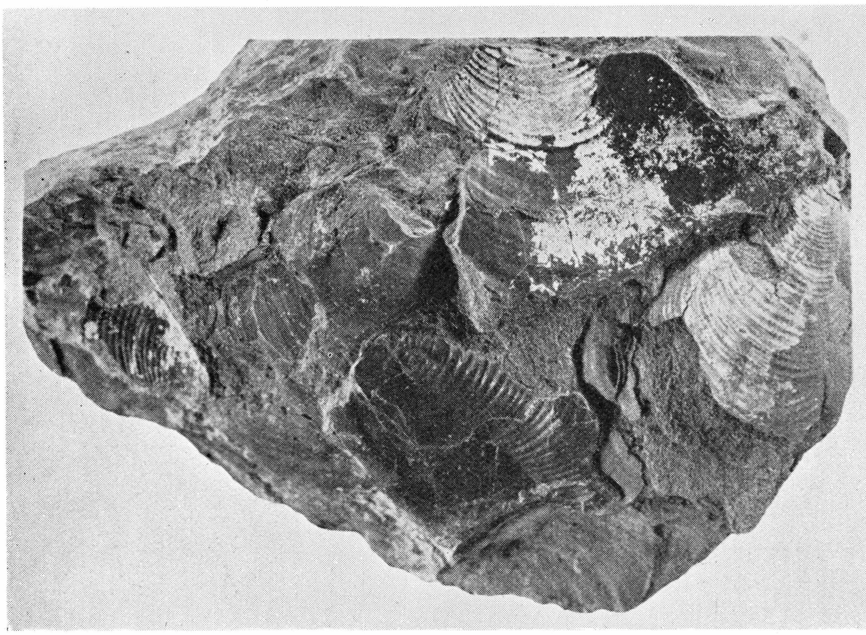

Fig. 38. Pavement bed of *Inoceramus* shells. Section in *Inoceramus* Elv, eastern Clavering Island, at an altitude of 610 m. (Lot. 484, Coll. W. MAYNC). Obviously, the valves accumulated one upon another with the convex side up, thus offering the least resistance to the water-current.

stone with pebble-bearing zones (Caledonian constituents) and "schliers" of yellow-brown clay ironstone.

Surface débris.

540 m to 580 m Coarse-grained or conglomeratic calcareous sandstone with enclosures of light-gray limestone and clay ironstone galls.

Overlain by

580 m Black slate with mica-flakes on the bedding planes, with

585 m Intercalations of dark bituminous impure limestone, rich in plant-remains[1]).

590 m 1 m bed of coarse-grained sandstone, overlain by dark slate.

610 m 8 m interbed of fine-grained calcareous-argillaceous sandstone containing concretions and partings of clay ironstone, with a layer of red-baked psephitic sandstone. Abundant, though badly preserved *Inocerami* (pavement of *Inoceramus* shells, Fig. 38).

Débris of basaltic rocks.

650 m 1 m whitish-discoloured friable maroon clay, rich in carbonized

[1]) Quite an identical stratum was met with near Forkastningspasset, at an altitude of 400 m (*vid.* p. 119).

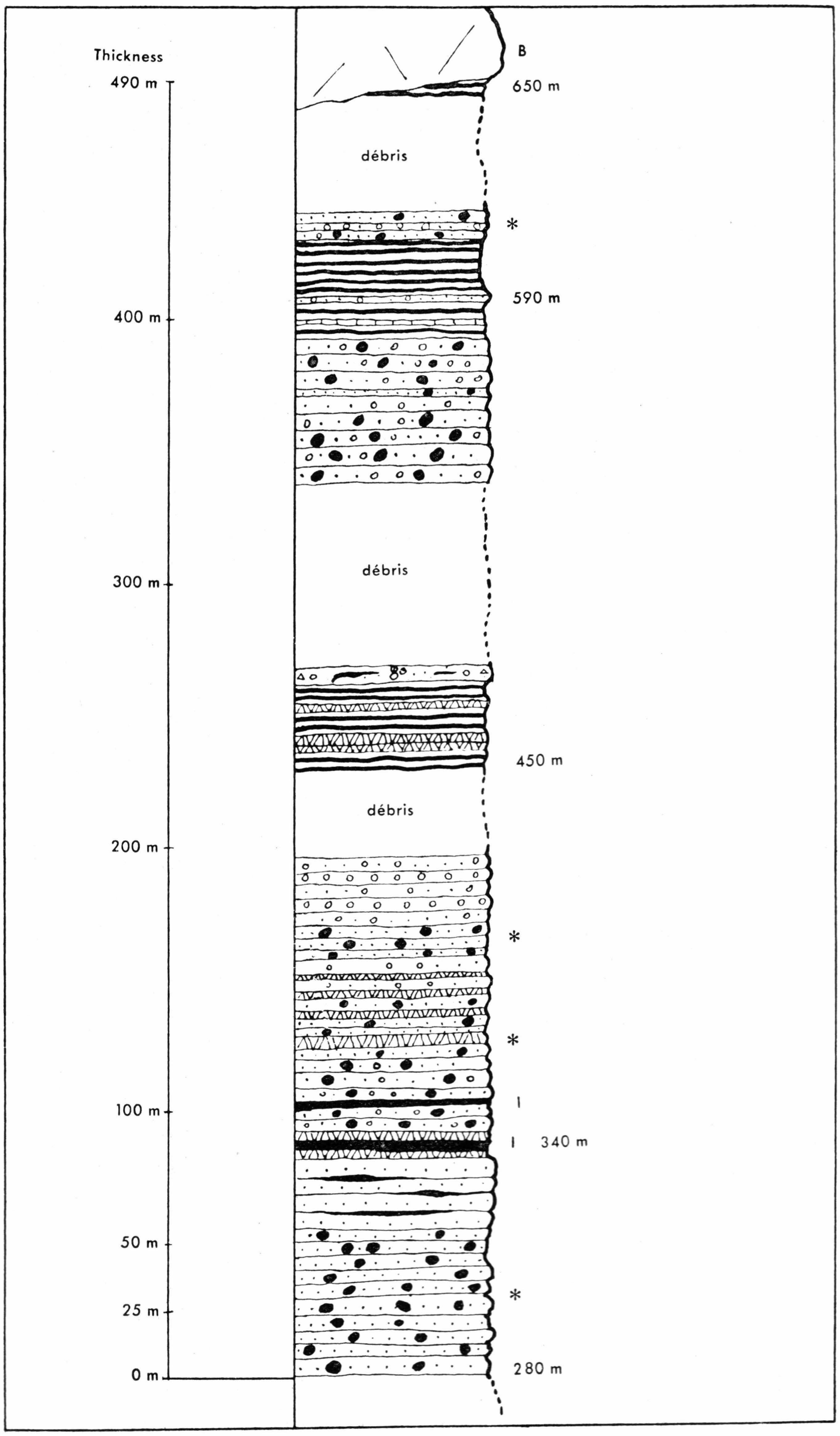

Fig. 39. Stratigraphical section in *Inoceramus*-Elv, eastern part of Clavering Island.

plant-remains, baked by exomorphism, unconformably cut by the plateau basalt.

The slates at 460 m altitude were measured to dip 8—10° to the southeast, which is due to dragging along flexures. Basing upon this dip the exposed thickness of the Aptian-Albian series in *Inoceramus* Elv may amount to 490 m.

The uppermost exposed strata beneath the basalt thus slope below the deposits examined in the southern face of Langelinie Bjærg (*vid.* p. 120). The 156 m thick beds that crop out there between 375 m and 640 m height are, consequently, younger.

The uppermost bed in *Inoceramus* Elv would crop out in the southern section of Langelinie Bjærg at about 350 m altitude.

The sandstone and conglomerate which occur on the west side of the mountain (*vid.* p. 120—121) were found by interpolation to correspond to the coarse-grained sandstone exposed in the southern profile of Langelinie Bjærg at 375 m—385 m altitude.

The psephitic deposits beneath the plateau basalt (400 m—640 m) in the southern slope of the mountain represent the youngest strata of the combined section.

To sum up, the Albian[1]) series exposed in Langelinie Bjærg (P. 802 m) attains a thickness of 646 m.

Exposures on Forkastningspasset.

The pass leading from the lake in Grønnedalen northwards to Storstrømmen Valley has been called Forkastningspasset ("Fault Pass") because it follows the "Forposten Fault".

Immediately west of the pass remnants of Aptian-Albian beds stick to the fault scarp of the "Clavering Block".

The beds dip at angles of 20—30° to the southeast, in other words, they have been dragged by the *post*-Cretaceous tectonic movements along the above-mentioned fault which has raised the "Clavering Block" or lowered the eastern tectonic unit, respectively.

In addition to these sediments relics of a steeply inclined basalt sill were found to adhere to the slope, being separated by the "Forposten Fault" from the Caledonian crystalline.

S l i g h t l y n o r t h o f F o r k a s t n i n g s p a s s e t the following beds were examined.

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[1]) The occurrence of the Albian species *Inoceramus anglicus* Woods in the near-by Skiferkløften and of *Perna* (*Isognomon*) cf. *rauliniana* (d'Orb.) in Björns Elv (*vid.* Bøgvad & Rosenkrantz 1934) points towards an Albian age of the succession.

370 m Black partly gray weathering slate, with a high content of muscovite on the bedding planes, splintering into small slabs.
Interbedded with yellow-brown sandy concretion-bearing layers.

400 m Dark bituminous micaceous limestone layer containing rusty concretions and plant-remains. Lithologically this bed resembles closely the one exposed in the sequence of *Inoceramus* Elv, at a height of 585 m (*vid.* p. 117).

Slightly higher a mottled brownish knobby layer of brecciated sandy limestone occurs containing pyritic nodules, carbonized plant-remains, and fragments of mussels. Associated with black silty muscovite-bearing slate, rich in carbonaceous matter, finely spread pyrite, plant-remains, which is interstratified with thin brownish *laminae* of muscovite sandstone. Interbed of black bituminous rusty weathering limestone-breccia with a high content of pyrite.

510 m Greenish-gray slate alternating with sandstone layers. *Inoceramus sp.* Basalt sill.

540 m to 550 m Greenish-gray or bleached slate, exomorphic.

At 320 m altitude a dark-gray coarse-grained or conglomeratic calcareous sandstone with poor fragments of *Inocerami* was found in Storstrømmen Valley.

The following beds were observed to crop out in the southern slope of Langelinie Bjærg (P. 802 m):

375 m Gray-greenish partly coarse-grained sandstone showing wave-marks, carrying clay ironstone concretions.

385 m Ditto, with *Inoceramus sp.*
Farther up the section is covered with surface débris, mostly consisting of coarse-grained sandstone and conglomerate with subrounded pebbles of greenish quartzite, gneiss, or granite.

About 640 m Strongly yellow weathering coarse calcareous sandstone with pebbly layers, the Caledonian components of which may be as large as a head and partially subrounded. Enclusions of these psephites as well as loose pebbles are also found as xenoliths frozen into the lowermost portion of the basalt sheet.

It is not impossible that the beds from 640 m altitude upward already are of Tertiary age.

In the western slope of Langelinie Bjærg the following deposits were encountered:

About 650 m Yellow-greenish coarse-grained sandstone with conglomeratic layers.

Underlain by a

Yellowish flaggy mica-bearing sandstone bed (0.5 m), with a parting of clay ironstone, lying upon a

Greenish thick-bedded psephitic sandstone carrying orange weathering pebbles of clay ironstone and quartzite.

610 m Yellow uneven weathering, crumbling sandstone with a thin interbed of orange clay ironstone. *Inoceramus sp.*

P. 582 m Gray-greenish slate bearing *Inoceramus sp.*

As to the correlation of the beds exposed on the southern and western side of Langelinie Bjærg with those examined in *Inoceramus* Elv the reader is referred to what has been said on pp. 117—119.

An alternation between

Black, yellowish-gray weathering friable slates, rich in muscovite, and marly limestone layers carrying concretions of clay ironstone is exposed in Grønnedalen (100—130 m altitude). These beds are almost horizontal and are cut through by a basalt dyke.

Exposures in Brisbane Bjærg (P. 486 m).

No good section through the Cretaceous series is available in the easternmost portion of Clavering Island; for owing to the numberless injections of basaltic sills and dykes the country rock displays effects of exomorphism, e. g. mechanical foliation, discoloration, hardening, baking, cleavage etc. almost everywhere. On the other hand, the strata are broken and have undergone monoclinal folding along the faults (flexures). As a result of this *post*-Albian faulting and dragging a gentle bending of the mobile sediments (and the intruded basalt sills) towards the east is evident (Fig. 40).

On climbing Brisbane Bjærg from Henning Elv the following deposits were observed between the basaltic sheets:

180 m Yellow weathering *Inoceramus*-bearing sandstone.

220 m Black slate with clay ironstone concretions containing *Inoceramus sp.* Partly contact metamorphic.

Beneath the basalt sill (capping the sediments west of the summit P. 486 m).

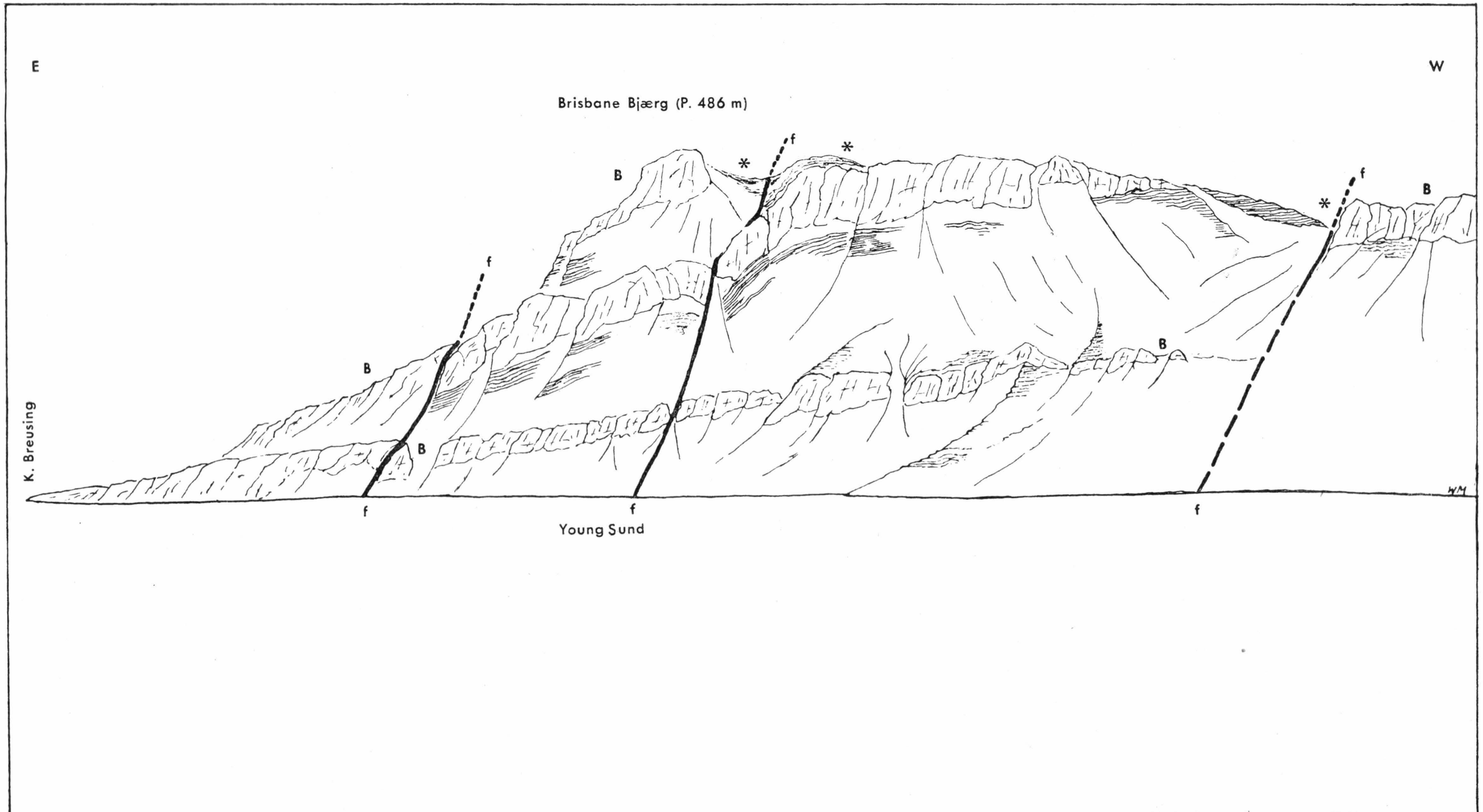

Fig. 40. View of Brisbane Bjærg (P. 486 m), Clavering Island, as seen from Young Sound (field-sketch of the writer). Dragged and faulted slates of the Aptian-Albian series with intruded basalt sills (B). * Fossil localities.

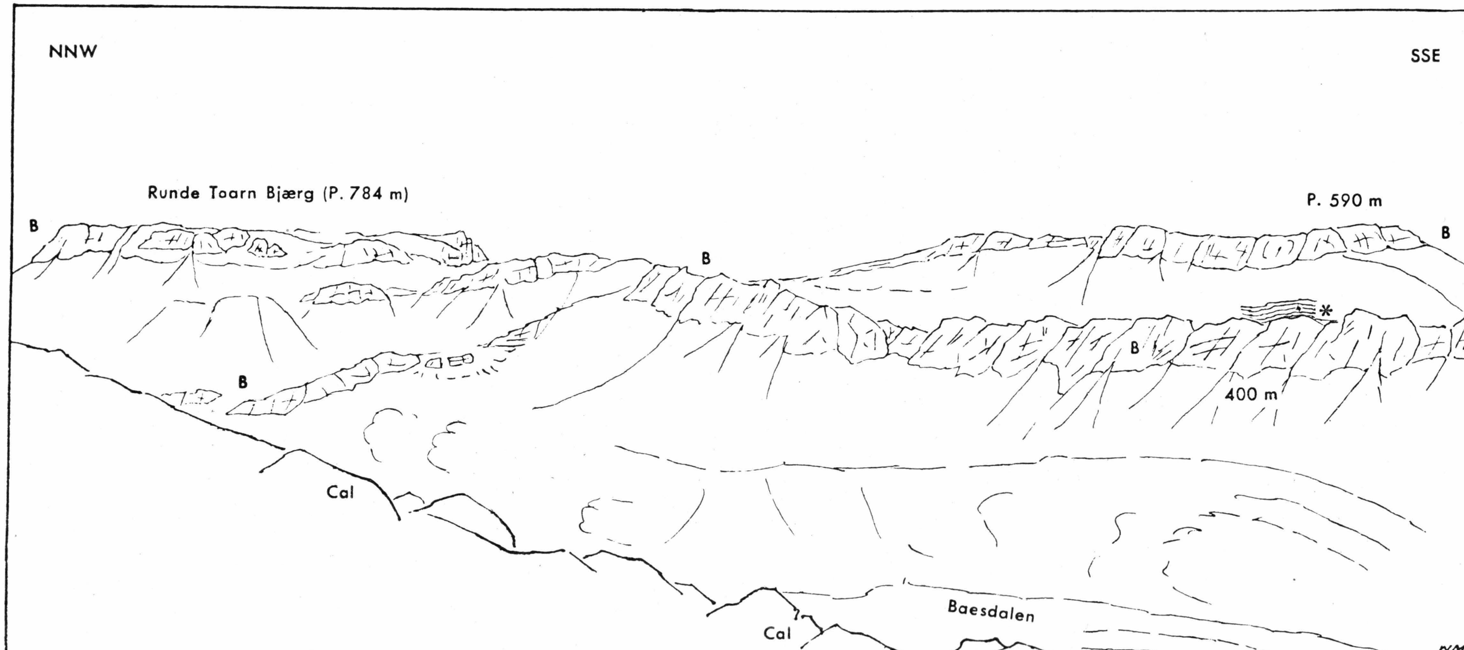

Fig. 41. Field-sketch of Rundetaarn Bjærg (P. 784 m), southeastern Clavering Island, with the fossil-locality * 430 m. Aptian-Albian sediments with intruded basalt sills (B). In the foreground Caledonian crystalline (Cal).

400 m Black slates with interbeds of yellow-greenish sandstone are exposed, with *Inoceramus sp.*

Near the contact with the basaltic rocks the slate shows discoloration, hardening etc.

Overlain by

Mottled hardened slate with seams of orange-yellow sand.

Basalt sill.

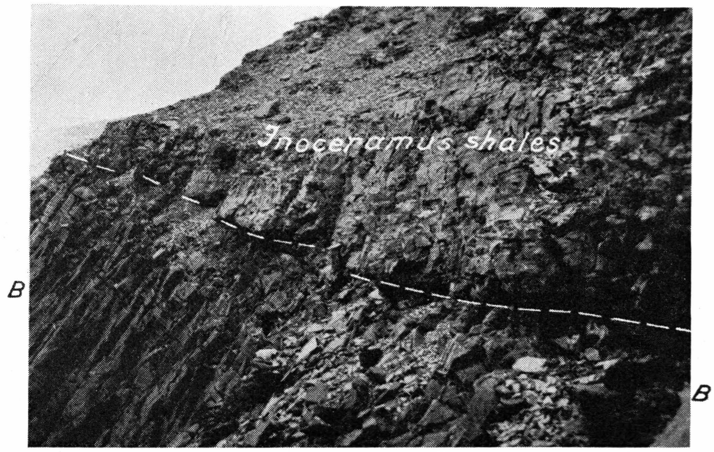

Fig. 42. Fossil-locality of *Inocerami* on Rundetaarn Bjærg, southeast Clavering Island (altitude 430 m). Phot. W. MAYNC.
Foliated baked "*Inoceramus* shale" with an intruded basalt sill (B).

On top of it follows

Greenish-gray hardened splintering slate with brownish polished bedding planes. Fragments of *Inocerami*. Interstratification of a rather fine-grained sandstone with knobby aggregates of pigmental matter.

Below the basalt sill of P. 486 m greenish-gray, spotted slates with *Inoceramus sp.* crop out. East of the summit the sediments have turned into a contact-breccia.

Above Kap Arnakke splintery clay ironstone and coarse-grained or conglomeratic gray sandstones were observed.

South of Kap Breusing, from sea level up to about 90 m altitude, an alternation between black slate and gray sandstone with clay ironstone concretions is exposed. Interbeds of buff marl with cone-in-cone structure are subordinate. Slightly above the shore black slate and thin limestone bands containing clay ironstone partings were met with. A dip of 15° to the southeast was measured here.

Exposure of "Inoceramus Beds" in Rundetaarn Bjærg (P. 784 m).
(Fig. 41 & 42).

A locality extremely rich in *Inoceramidae* was found in the western slope at 430 m altitude (*vid.* Figs. 41 & 42). The succession is as follows:

Gray-yellowish slate carrying yellow concretions of clay ironstone with poorly preserved specimens of *Inoceramus.*
30 m basalt sill.

430 m Black or discoloured yellowish slightly sandy slate and beds exhibiting cone-in-cone structure (*vid.* Pl. 4, Fig. 6), near the igneous contact hardened and baked, and falling to small pieces. Here a large collection of *Inocerami* was brought together including forms both with and without ornamentation. *Inoceramus* (*Taenioceramus*) ex *gr concentricus* Park., *I. cf. anglicus* Woods etc.

Within the slate occur coarse-grained knotty muscovite sandstone layers which likewise carry *Inoceramus spp.*

On the plateau itself a gray thin-bedded calcareous sandstone, rich in muscovite, was found between the basaltic rocks.

? Cretaceous beds in Baesdalen.

East of Moskusokseelv rocks were found to crop out which may probably be referred to the Aptian-Albian series.

40 m greenish and light-gray flaggy calcareous sandstone, hard greenish organogenous-detritical limestone, rich in biotite and muscovite, and hard breccia consisting of dark-gray limestone and greenish-gray marly limestone, rich in muscovite, with bad imprints of pelecypods. Partly pebble-bearing and passing into conglomerate. The well rounded pebbles attaining up to 1 cm in diameter include gray or greenish limestone (as below). Brown shell fragments of badly preserved lamellibranchs (?*Inoceramus* or ?*Claraia*) are rarely met with. In a layer of coarse-grained micaceous sandstone with carbonized plant-remains and coaly matter, interbedded within slates, poor remnants of small pelecypods were secured which possibly correspond to the forms found on Forkastningspasset (*vid.* p. 120).

Further exposures of similar strata were found to occur up to a height of about 100 m.

These ?Cretaceous rocks are visibly separated by faults from the late Permian "*Martinia* limestone" which crops out west of the river-bed. The possibility that these deposits may be Eotriassic in age cannot be flatly denied, however.

E. Hold with Hope and Jackson Island.

Between Cape Broer Ruys and Knudshoved LAUGE KOCH (1927) discovered dark unfossiliferous slates with limestone concretions, which are overlain in Tobiasdalen by light-coloured sandstone with interbeds of clay ironstone (KOCH 1929 a). The latter formation is held by L. KOCH to be of Neocomian age whereas the slate series is compared to the "Portlandian" of Wollaston Foreland and Kuhn Island (*op. cit.*).

The classical Eotriassic occurring along the north coast of Hold-with-Hope was discovered by J. M. WORDIE's Cambridge Expedition in 1926. On top of this formation the clastic "Yellow Series" is distinguished which A. ROSENKRANTZ referred to the Triassic (ROSENKRANTZ 1930 b). L. KOCH, however, justly assigned this "Yellow Series" to the Cretaceous (KOCH 1931); for in the first place it overlies the Eotriassic "*Anodontophora* Beds" with angular unconformity, and secondly the Cretaceous age could be proved by the finding of two ammonites on Stensiös Plateau, *viz. Deshayesites aff. laeviusculus* (V. KOEN.) and a coarsely-ribbed form that belongs to another species of *Deshayesites* (not to *Arethoplites/Sonneratia jachromensis* (NIK.)). In 1931 further fossils were gathered on Stensiös Plateau, among which L. F. SPATH has identified *Pecten aff. orbicularis* SOW. (SPATH 1935 a). In addition the specific Aptian form *Lytoceras polare* RAVN is cited from here (comp. Appendix, p. 227).

This "Yellow Series" of Aptian age was found by L. KOCH to be superposed by black slates and shales. In Home Foreland, moreover, a thick sandstone series was stated to crop out beneath the basaltic flows but no fossils were found that might have allowed any conclusions as to its age (KOCH 1931).

In 1932 C. TEICHERT collected a few fossils in talus accumulations slightly south of the hut at Knudshoved, eastern coast of Hold-with-Hope, and one year later E. NIELSEN also succeeded in finding lamellibranchs in the surroundings of that locality. This faunule described by H. FREBOLD includes the following forms: *Pteria tenuicostata* ROEM., *Pteria*? or *Gervilleia*? *aff. Pteria pectinoides* RAVN, *Inoceramus teicherti* FREB., and *I. geltingi* FREB. According to H. FREBOLD the cited assemblage points towards the Lower Senonian/"Upper Emscherian" (= Lower Santonian) (FREBOLD 1934).

From the sediments of Home Foreland E. NIELSEN also secured a few fossils in 1933, such as *Pteria tenuicostata* ROEM., *Inoceramus sp. ind.*, and indeterminable echinids. Since both localities, Knudshoved and Home Foreland, are thus reported to have *Pteria tenuicostata* ROEM. in common, they are considered contemporaneous, i. e. Lower Senonian, in age (FREBOLD in *loc. cit.*).

The tectonic faulting-structure as unravelled farther to the north, i. e. the dissection of the East Greenland continental border by repetitive normal step-faults, has been found valid by A. VISCHER and the writer also for the region of Hold-with-Hope and Gauss Peninsula.

The Caledonian crystalline of Clavering Island which has been treated by H. G. BACKLUND and A. E. MITTELHOLZER (BACKLUND 1932, MITTELHOLZER 1941) represents the basement of A. VISCHER's "Clavering Block". Due to its southwestern sloping this crystalline disappears in Gael Hamkes Bugt, cropping out for the last time in the Little Finsch Islands.

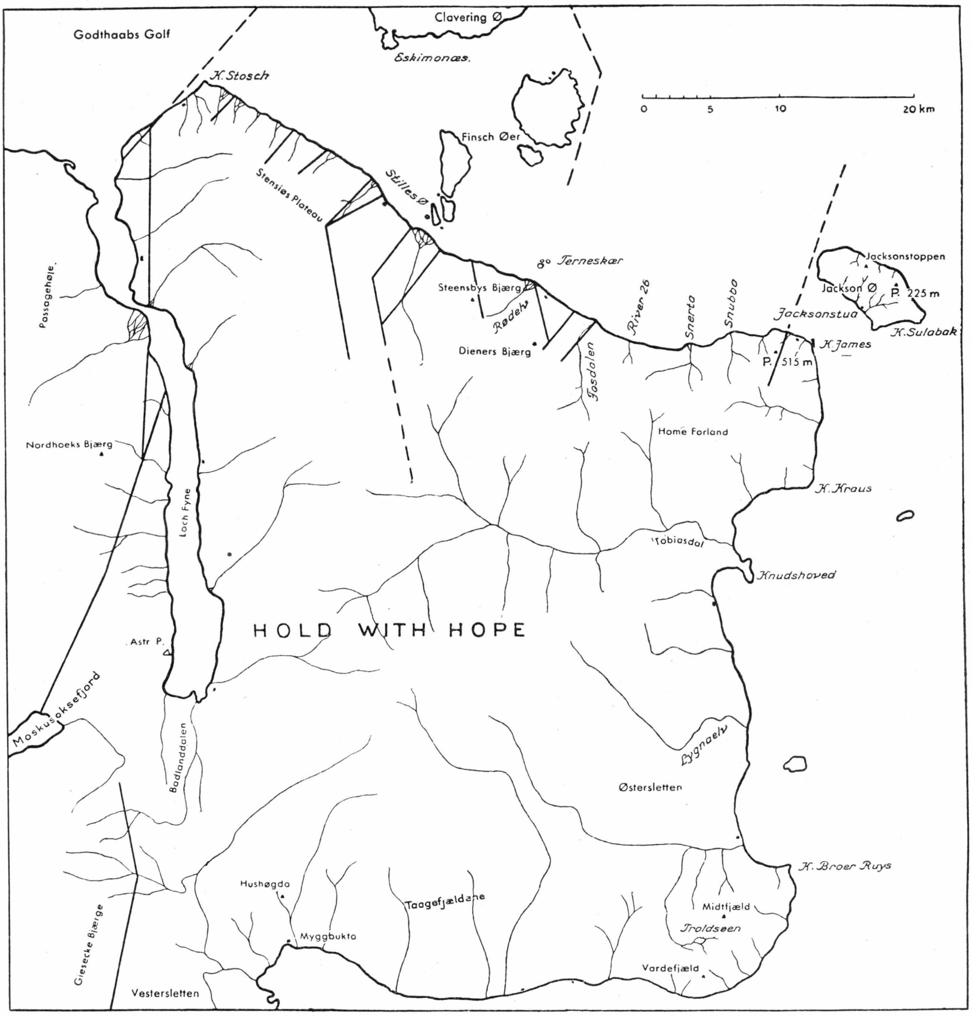

Fig. 43. Sketch-map of Hold-with-Hope with the localities mentioned in the text. (Tectonics after E. Nielsen and A. Vischer).

The western portion of Clavering Island is made up of continental Carboniferous deposits that lie transgressively upon the Caledonian crystalline. To the west this area of Carboniferous "molasse" is bounded by the grand scarp of A. Vischer's "Main *post*-Devonian Fault" which coincides with the Carboniferous coast line. South of Godthaabs Gulf this trough which is filled up with Carboniferous clastics, extends into Hudson Land (Passagehøje) where a primary contact exists with the Caledonian of Nordhoeks Bjærg (P. 1502 m). As is the case in Clavering Island the Carboniferous series of Hudson Land abuts against the fault scarp of the "Main *post*-Devonian Fault" (Nørlund Alper). Farther to the south

Devonian strata are intercalated between the Caledonian and the Carboniferous (*vid.* Säve-Söderbergh 1934, Vischer 1939, 1943, Bütler 1940).

Near the mouth of Loch Fyne the Carboniferous is unconformably overlain by the basal conglomerate of the late Permian which is shown to pass into the "Zechstein" series (Maync 1940, 1942). On top of the Upper Permian beds follow the thick sediments of the marine Lower Triassic.

Due to cumulative step-faults the Permian beds disappear from Stilles Island eastward; the Triassic, which is visibly superposed by the transgressive Aptian series, is downfaulted near Dieners Bjærg from whence merely Cretaceous beds are exposed beneath the basalts (Koch 1931).

Since Hold-with-Hope lay within the range of the Cimmerian landmass "Neo-Eskimonia" (*vid.* Maync 1947), deposits of both Jurassic and Valanginian age are completely absent; only the Aptian overlaps the Triassic beds with *Anodontophora fassaensis* (Wissm.) Münst., which is beautifully displayed in Steensbys Bjærg.

In the investigated area north of Clavering Island it has been possible to fix the date of the main phase of the late Jurassic tectogenesis rather accurately since the Volgian "Rigi Series" of a synorogenetic character overlies the Kimmeridgian (or older Jurassic strata) with an obvious angular unconformity (Maync 1947). As no Jurassic beds at all were deposited in Hold-with-Hope or in the Giesecke Bjærge, this tectonic phase is not actually recorded here. The only evidence bearing on the question of when the faulting has taken place is the statement that the Eotriassic beds dip more steeply to the west than the overlying Aptian series. The main tilting thus falls within the interval *post*-Triassic/*pre*-Aptian, and, in accordance with the observed faulting in uppermost Kimmeridgian time in the north, I have no hesitation in assuming the same epoch for the tectonic manifestations in Hold-with-Hope and still farther southward.

In Home Foreland the low-lying basalt sheet and its talus débris hide large areas of the outcropping Cretaceous. In Clavering Island and Wollaston Foreland *post*-Basaltic movements are recorded by tilting and flexures. In Home Foreland the writer even stated a doubtless *post*-Basaltic fault: At P. 515 m, west of Cape James, the flat-lying basalt sheet is broken along a distinct fault line, to the east of which the basalt slopes rather steeply towards Cape James. To be sure, the whole coast between the said Cape and Cape Kraus is formed by that sloping part of the broken Tertiary plateau basalt.

Section in Stensiös Plateau.

The whole area of northern Hold-with-Hope between Cape Stosch, Tobiasdalen, and Dieners Bjærg (P. 797 m) has been mapped and

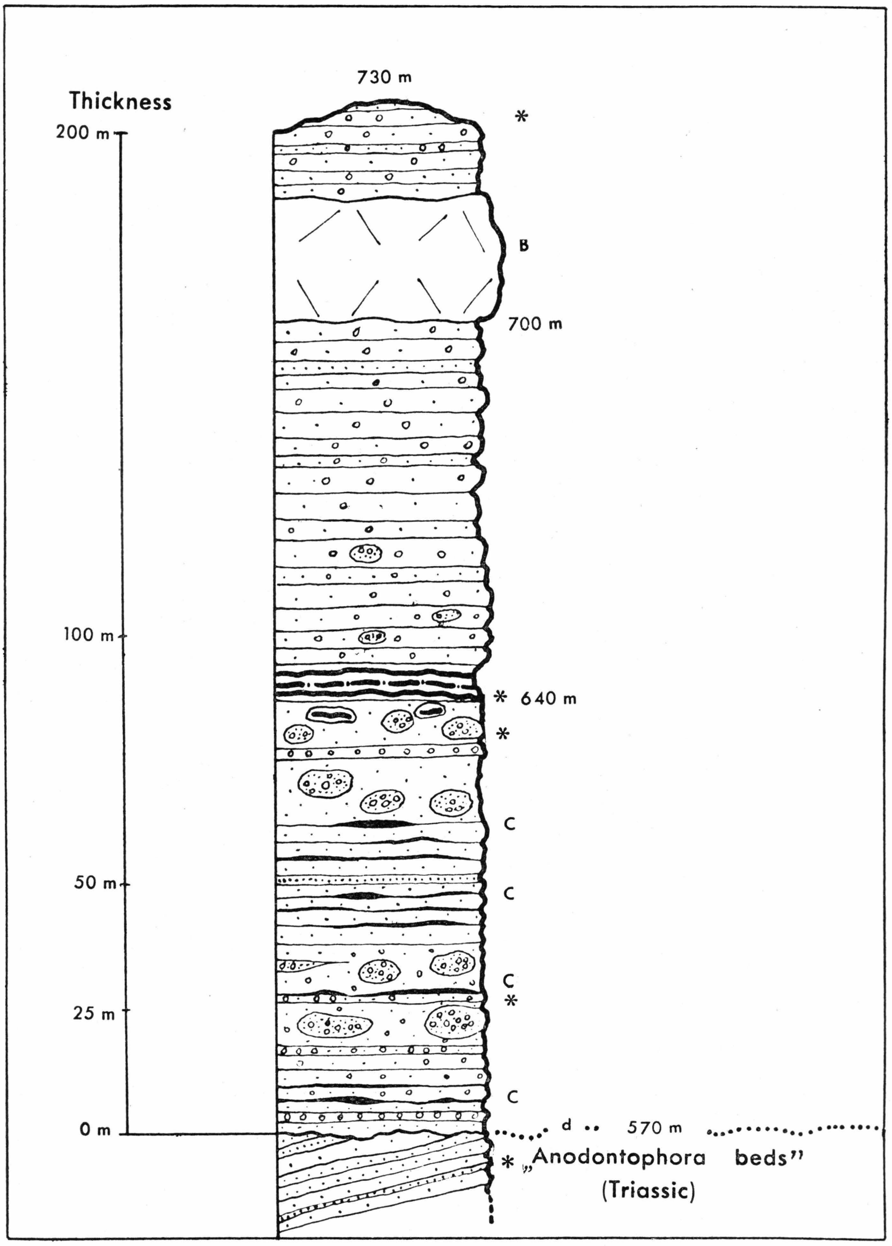

Fig. 44. The Cretaceous beds in Stensiös Plateau, Hold-with-Hope.

thoroughly investigated by L. Koch and E. Nielsen (Koch 1931, Nielsen 1935). On that account the writer has merely set down a few sections in this most instructive region in order to have them at hand for comparison and stratigraphical correlation.

The Cretaceous sequence from above the Norwegian hut "Ørne-reiret", west of Stilles Island, up to Stensiös Plateau is as follows.

Up to 570 m altitude occur brown-purplish sandy and shaly beds carrying *Myalina kochi* Spath, *Anodontophora fassaensis* (Wissm.) Münst. etc. of Triassic age (*vid.* Spath 1930, 1935 a).

Evident angular unconformity and lithologically sharp uneven boundary (transgression).

570 m Light-yellow partly limonitic crumbling micaceous/calcareous sandstone with carbonized plant-remains and scattered pebbles. Interbedded with psephitic layers containing small deuterogeneous pebbles.

Overlain by

whitish or light-yellow friable rather coarse-grained muscovite sandstone with coaly matter and plants. Contains layers and large lenses of brown-purplish crumbling calcareous sandstone and fine-grained plant-bearing sandstone. Rich in muscovite. Pelecypods and belemnites were found in a light-coloured calcareous crumbling mica-sandstone.

600 m Strongly yellow-coloured or whitish sandstone with carbonaceous plant-remains.

610 m 2 m black coaly mica-bearing sandstone.

620 m Yellowish calcareous micaceous sandstone with conglomeratic layers (*vid.* Fig. 45) and embedded lenses of dark-brown rusty coarse-grained sandstone up to 1 m in diameter, with scattered large pebbles of Caledonian provenience.

Overlain by

Yellow friable muscovite sandstone with belemnites, carcarrying large balls of yellow and dark-brown sandstone

640 m (as below), galls of black shale, and conglomeratic horizons. Rich in fossil wood and carbonized plant-remains.

On top follow

5 m of black bituminous partly sandy slate, rich in muscovite, containing pelecypods and plant-remains. A dip of 10° to the southwest was measured.

Surmounted by a

70 m thick set of yellow sandstones interstratified with dark sandstone layers. The formation weathers into peaks and steep rocks and stands in a sheer cliff.

700 m Basalt sill.

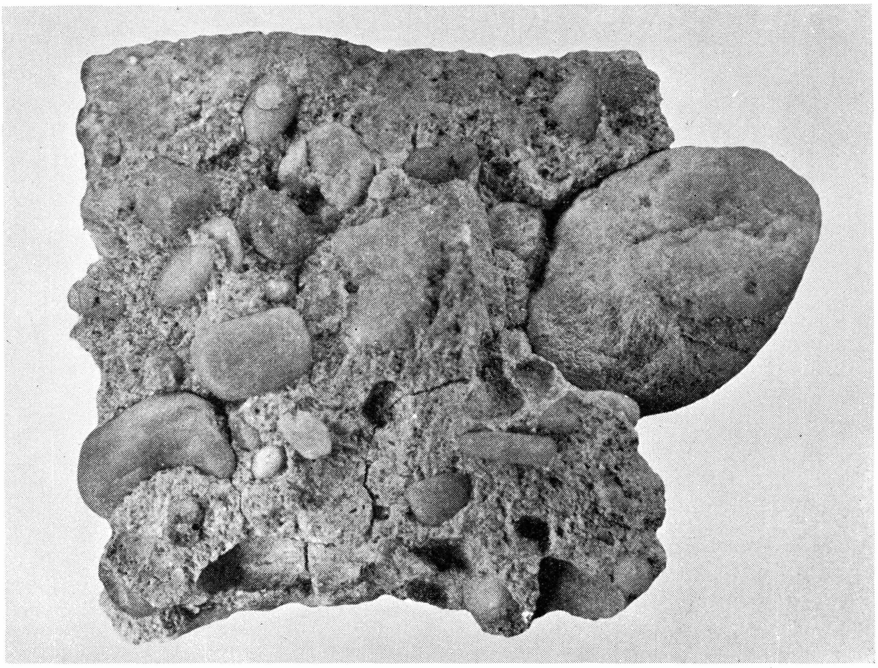

Fig. 45. Interbed of polygenetic conglomerate in the Aptian series. Section in Stensiös Plateau, Hold-with-Hope, at 620 m altitude (Lot. 2660 Coll. W. MAYNC).

730 m Northern top of Stensiös Plateau, made up of the same yellow sandstones as occur at the floor of the sill.

This sandstone series on top of the Triassic is exposed in a thickness of 176 m. Judging from the find of ammonites on Stensiös Plateau (*vid.* p. 128) it has to be correlated with the Aptian. The *Belemnitidae* and poorly preserved lamellibranchs derived from the lower parts of the formation have not yet been identified.

It may be emphasized that the whole lithological-facial aspect of this Cretaceous series is very similar to that of the Jurassic "Yellow Series" (Upper Bathonian-Argovian) of Clavering Island, Wollaston Foreland, and Kuhn Island (MAYNC 1947). Nowhere have Aptian beds in such a conglomeratic-sandy facies been found to occur in the investigated area. Without knowing anything about the above-mentioned occurrence of Aptian fossils, the author would not hesitate to refer the whole sequence to the Jurassic.

Home Foreland.

Section between Fosdalen (River 25) and River 26[1]).

The profile was measured in the ridge immediately east of the section given by E. NIELSEN (*vid.* FREBOLD 1934, p. 13, Fig. 5).

	Snow and surface débris.
45 m	Black sandy muscovite-bearing slate with interlayers of yellow and brownish fine-grained micaceous quartz sandstone carrying red-orange weathering concretions of clay ironstone and clay galls.
70 m	Black slate with clay ironstone concretions; interbeds of yellow fine-grained sandstone.
80 m to 100 m	Gray-black slate containing numerous red clay ironstone concretions and layers of brownish sandstone.
100 m	Yellow-reddish fine-grained thin-bedded muscovite sandstone with reddish bedding planes. Partly displaying rusty-limonitic streaks and spots, and partings of reddish hard quartzite. Bands of orange clay ironstone.
110 m	Alternation of banded sandstone (as below) and black slate dipping slightly to the southeast.
125 m	Streaked sandstone showing carbonaceous bedding planes, and containing orange-yellow clay ironstone concretions.
130 m	Slightly sandy shale with interbeds of yellow weathering thin-bedded sandstone.
145 m	Gray-brown fine-grained sandstone with ripple-marks, knobs, and current-marks (*vid.* Fig. 62).
160 m	Sandy shale with interstratifications of yellowish-grayish knotty sandstone.
180 m to 190 m	Black slate inosculating with yellow-brown sandstone layers.
190 m to 196 m	Basalt sill.
196 m	Indurated dark sandy slate and greenish argillaceous fine-grained sandstone, alternating with whitish discoloured sandstone.
205 m to 240 m	Alternation of black slate and yellow or streaked sandstone. Subordinate concretions of clay ironstone. Higher up light-gray fine-grained platy sandstone of horizontal lay or dipping at low angles to the southeast.
240 m	Plateau.

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[1]) With regard to the nomenclature *vid.* KOCH 1931, map Pl. I.

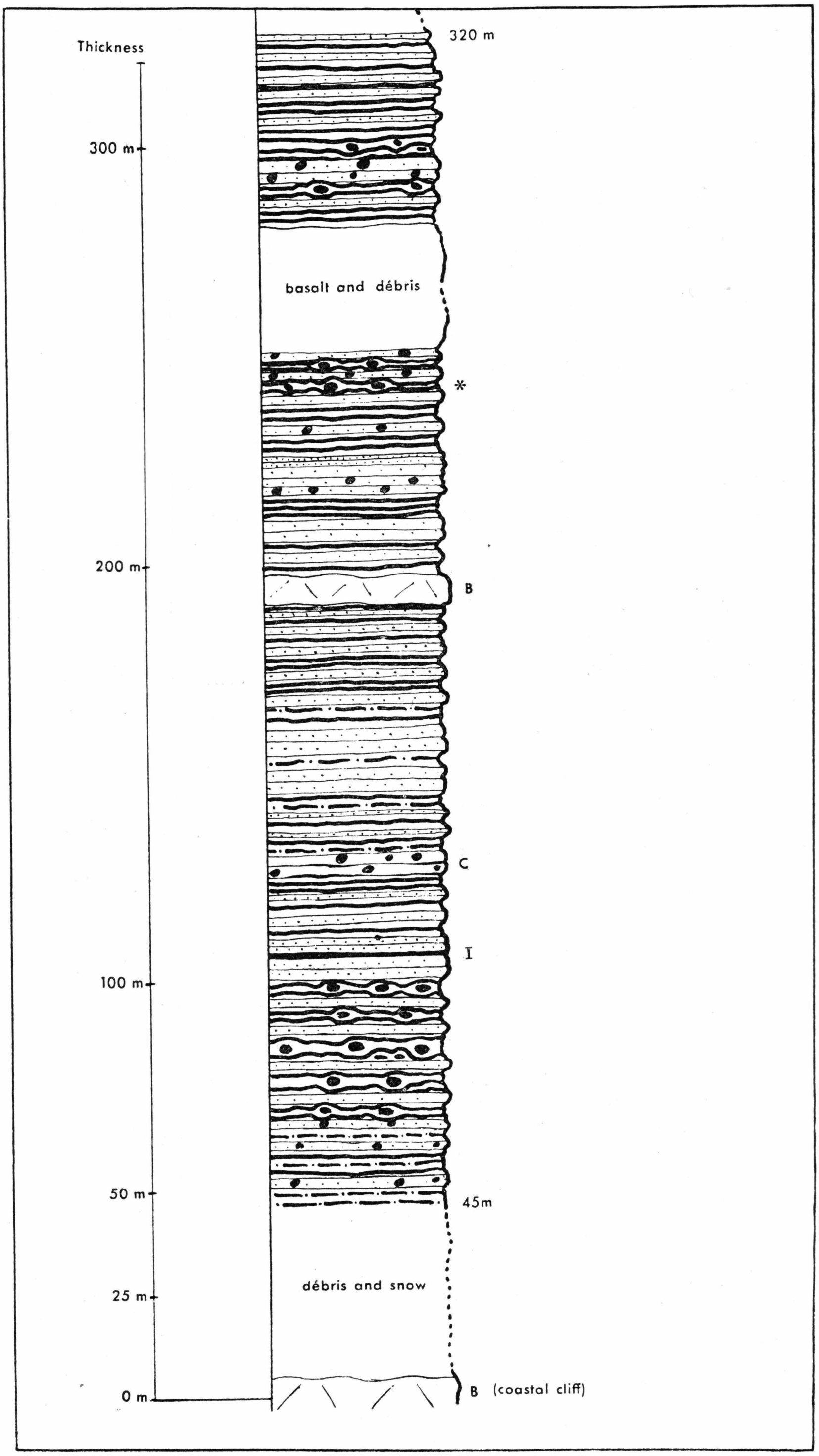

Fig. 46. Columnar section of the "Home Foreland Beds" in the coastal cliff between Fosdalen and River 26 in Home Foreland (Hold-with-Hope).

Slightly farther towards River 26 the upper portion of the sequence is as follows:

240 m	Black slate, yellow-brownish sandstone, and hard streaked sandstone in rhythmic alternation. Red-orange concretions of clay ironstone with *Inoceramus sp.*
	Overlain by
	Black slate containing concretions and thin layers of fine-grained limonitic slightly calcareous sandstone of wood-like aspect, carrying clay ironstone concretions.
250 m to 280 m	Dyke and débris of basaltic rocks.
280 m to 300 m	Alternation of black slate and limonitic streaked sandstone bearing concretions of clay ironstone.
300 m	Black slate with thin interbeds of fine-grained shaly sandstone.
320 m	Black slate with interstratified layers of yellow-grayish sandstone.
	Basalt débris, snow.
About 450 m	Floor of the plateau basalt.

Owing to the change in dip the true thickness of the series cannot be given. Since the angles of dip are only low the exposed thickness may amount to about 300 m.

Corresponding Cretaceous strata are exposed along the shore between River 26 and Snerta River[1]). The black slate being cut through by basaltic dykes, displays exomorphism. A gentle dip to the west was ascertained.

The coast-cliff of Snerta River.

Camp at 35 m altitude. Surface débris.

70 m	Silty black slate intercalated with streaked sandstone bands which carry red-brown concretions of clay ironstone.
95 m	Yellow-brown weathering knobby mottled limonitic ripple-marked sandstone (Fig. 61) containing clay ironstone concretions.
	Overlain by
	Black-gray slate with clay ironstone concretions, interbedded with yellow sandstone which, too, carries concretions of clay ironstone.

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1) The name "Snerta" for the river flowing into the sea between Fosdalen and the Norwegian hut "Røbeckstua" (Cape James) has been taken over from the Norwegian maps as it has no name on the Danish ones.

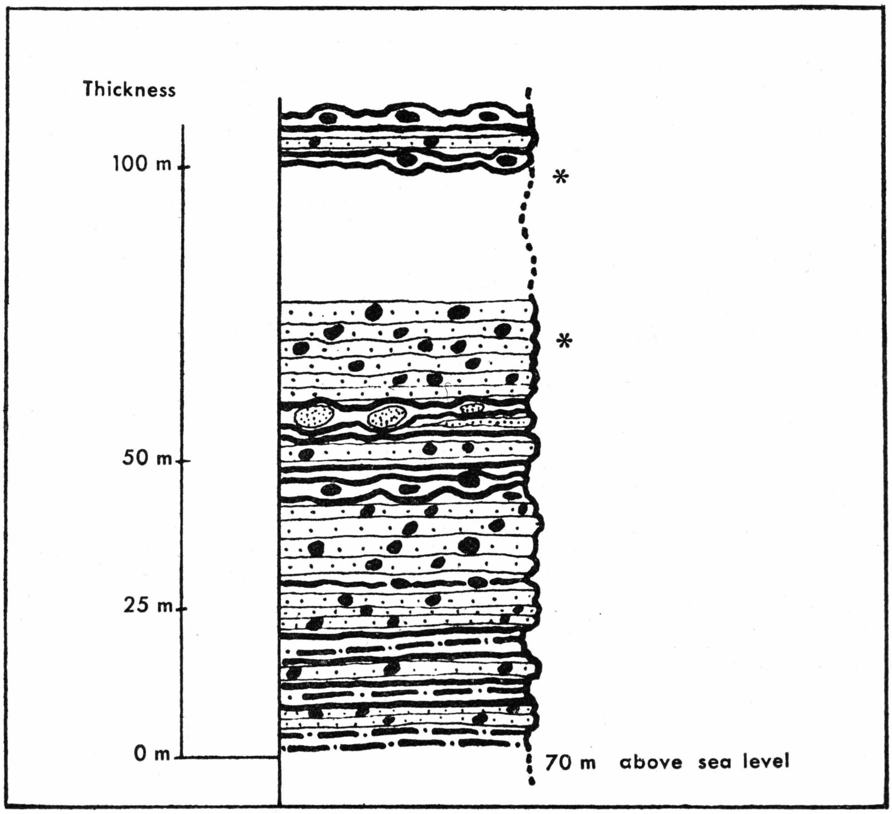

Fig. 47. Stratigraphical section through the "Home Foreland Beds" in the coastal cliff west of Snerta-River, Home Foreland.

125 m Streaked limonitic sandstone layers and -lenses embedded in black slate. Partings, concretions, and "schliers" of clay ironstone material.

130 m Streaked ferruginous sandstone (as below) showing light-coloured concentric rings, with traces of glauconite on the bedding planes and "schliers" of clay ironstone matrix.

135 m Concretions of clay ironstone containing clusters and pockets of quartz grains. Occasionally the concretions are of a conglomeratic texture, i. e. crystalline pebbles are cemented together by clay ironstone matrix.

140 m Layer of gray sandstone with *Inoceramus aff. labiatiformis* STOLLEY.

150 m Débris and erratics (loose boulders of Permian conglomerate).

170 m Black slate with layers of streaked sandstone containing clay ironstone concretions with poorly preserved *Inocerami.* Basalt dyke and débris.

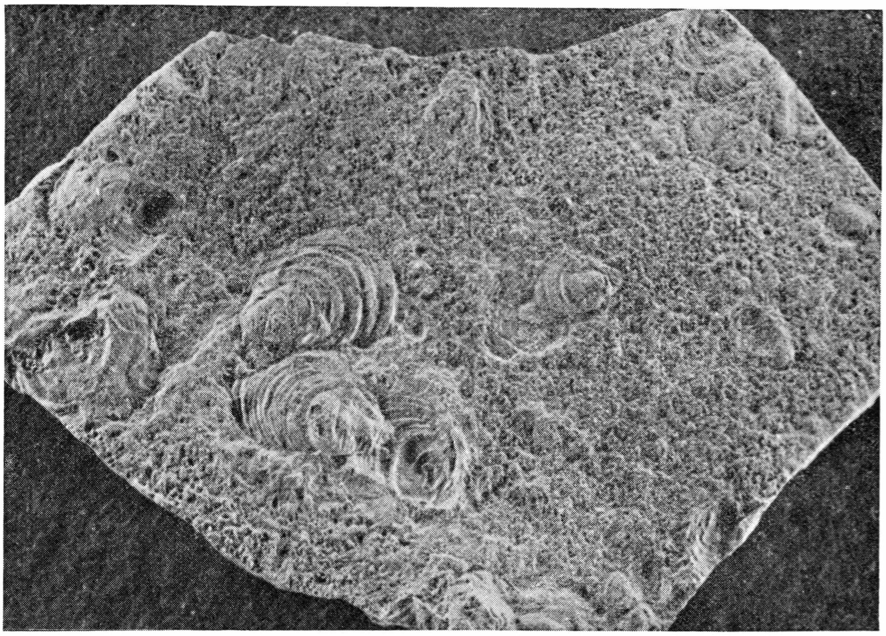

Fig. 48. Marly slate with ?*Aucellinas*, "Home Foreland Beds". Between Snerta and Snubba Rivers, Home Foreland (Hold-with-Hope). Lot. 3178 Coll. W. Maync.

The characteristic concretions of clay ironstone are here mostly enclosed within the sandstone layers that replace the buff marl interbeds—often with cone-in-cone structure—of the northern area. Nevertheless, sandstone layers instead of marls already occur in Wollaston Foreland and Clavering Island. An interbedding of yellow sandstone and thin buff-coloured marl (within the black slate) observed near the camp shows clearly enough the synchronism between those two members. The same replacement of the marl by sandstone beds is visible in the upper portion of the sequence in Jackson Island (*vid.* p. 140).

On the ridge between the rivers Snerta and Snubba[1]) brown-gray or yellow weathering dark sandy marls and slates with numerous casts of *Aucellinas*? are exposed (*vid.* Fig. 48).

As to its lithological-facial features the Cretaceous series exposed below the basalt sheet of Home Foreland shows a surprisingly close resemblance to the "*Inoceramus* Beds" (Aptian-Albian) farther to the north (Maync 1940). According to H. Frebold, however, this sequence, together with the deposits near Knudshoved, is of Lower Senonian age (Frebold 1934).

[1]) The name "Snubba" is indicated on the Norwegian maps for the river debouching about 3 km east of Snerta River.

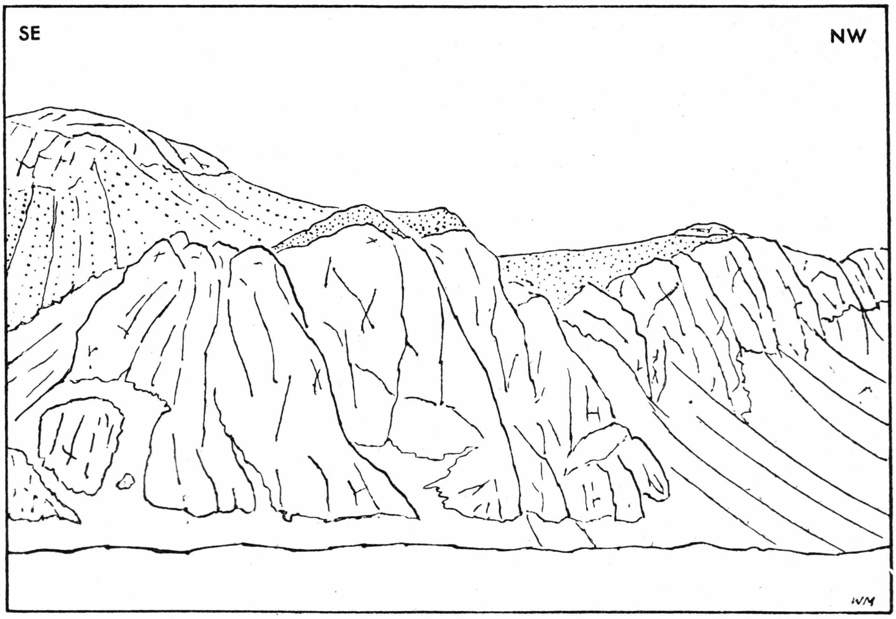

Fig. 49. Young Cretaceous beds (pointed) cut by basaltic rocks. Northeastern corner of Jackson Island.

The whole question concerning the age of these sediments will be touched upon in a subsequent chapter (p. 211 ff).

Until more and better faunas are at hand which convincingly prove the series of Home Foreland to be actually of Senonian age, the writer will desist from a definitive correlation and proposes to term these strata the "Home Foreland Beds".

The Cretaceous deposits in Jackson Island.

(*vid.* Fig. 49 & 50).

In the report of O. Lenz on the investigations carried out by the Koldewey Expedition in 1869—1870 mention is made of a light-gray fine-grained sandstone without fossils, attaining a thickness of up to "800 feet". This sandstone was referred to the "Younger Tertiary" (Lenz 1874, *vid.* Koch 1929 a).

The sediments in Jackson Island are injected and cut through by numerous sills and dykes of basaltic rocks and, consequently, have been strongly affected by exomorphism (Fig. 49). Moreover, they are often disturbed and broken by the extrusive forces. A. Vischer even considers them to be but immense foreign inclusions which have been frozen into the basaltic magma, but this point of view cannot be maintained since the writer succeeded in setting down more than one continuous section.

My two-days' investigation yielded the following results.

Section measured from the Norwegian hut "Jacksonstua" ENE ward towards the interior of the island.

	Débris.
60 m	Black-gray hard sandy clay slate with interbeds of hard dark limestone that turns yellowish or gray on weathering.
	Greenish silty slate.
80 m	Intercalations of knobby yellowish often thin-bedded fine-grained sandstone beds, with *Serpula*, containing yellow weathering concretions of clay ironstone.
	Loose erratic boulders consisting of coarse conglomerate and sandstone.
95 m to 100 m	Basalt sill.
100 m	Gray-yellowish slate with layers of fine-grained calcareous sandstone.
105 m to 140 m	Basalt sill.
140 m	Gray-blackish sandy slate with interbeds of strongly yellow-coloured knotty sandstone.
150 m	Dark friable slate with yellow knobby sandstone layers.
160 m to 180 m	Yellow weathering partly knobby mottled sandstone, gray flaggy sandstone, and limonitic thick-bedded fine-grained banded sandstone. Interbed of gray-greenish spotted hardened clay. Occasionally the various sandstones (bearing concretions of orange-red weathering clay ironstone) show uneven bedding planes covered with "schliers" of quartz grains, and may contain scattered pebbles of white quartzite of a diameter of up to 6 cm. Also the clay ironstone concretions often carry quartz pebbles and may grade into psephitic sandstone. The whole set of varying sandstones is interstratified with black-gray slate (as below).
180 m to P. 190 m	Basalt.

Farther to the north a dip of 7° to the southeast was observed in a yellow-brown ferruginous fine-grained sandstone with infiltrations of clay ironstone material, alternating with gray slate.

After having passed the basalt rocks of Cape Sulabak[1]) the following sediments were found to build up the eastern cliff of the island:

[1]) Southeastern point of the island (according to the Norwegian maps).

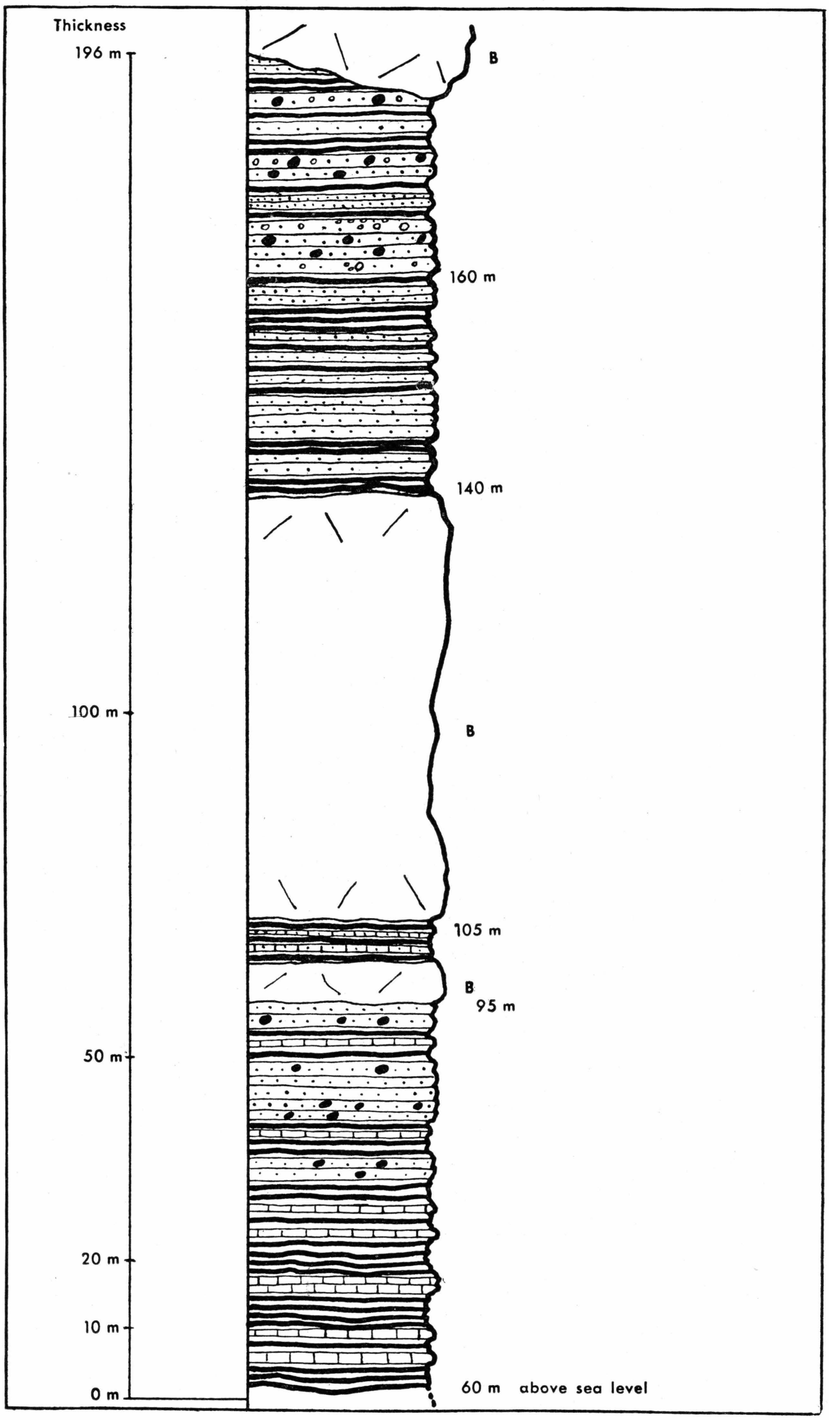

Fig. 50. The Cretaceous section exposed in the interior of Jackson Island.

110 m	Black slate with interbeds of yellow mottled sandstone.
110 m	Gray partly sandy slate with interstratified layers of yellow and pink fine-grained quartz sandstone.
130 m	Yellow or pink fine-grained calcareous sandstone.
170 m	Foliated slate splintering into polyedric pieces, and discoloured, overlain by a basalt sill.

These strata correspond to those encountered in the interior of the island, between 150 m altitude and the basalt sill (*vid. sup.*).

In a small creek cut in east of Jacksontoppen[1]) (*vid.* map Fig. 43) another section was measured which exhibits the characteristic beds of the Aptian-Albian series farther to the north. Dip 15° to the northwest.

20 m to 140 m	Alternation of black slate containing orange-red weathering clay ironstone concretions, and yellow or brownish mottled limonitic sandstone. Subordinate interbeds of pale-buff concretion-bearing marl with well-developed cone-in-cone structure. Fossil wood.
140 m to 180 m	Black slate (as below). The typical interbeds of buff marl with cone-in-cone structure are gradually replaced upward by brownish mottled sandstone beds which carry the concretions of clay ironstone.
180 m to 200 m	Basalt sill.
200 m	Yellow sandstone and spotted reddish-gray sandstone. Near the contact with the basalt the sandstones turn into whitish crumbling sand.

Contrary to the northwestern dip of the underlying slate series the light-coloured sandstones show a distinctly deviating dip ranging between 0° and 8° to the southwest.

Yellow or gray partially baked and discoloured fine-grained argillaceous sandstones with scarce fossil-imprints crop out near the northernmost corner of the island.

Since I failed to find any fossils, decisive conclusions concerning the age of the marine deposits in Jackson Island cannot be drawn.

Facially the beds exposed in the ravine east of Jacksontoppen up to a height of 180 m completely agree with the Aptian-Albian series of the northern area. Above all the buff-coloured marls disclosing cone-in-cone structure occur throughout the "*Inoceramus* Beds" as key-horizons.

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[1]) Name taken from the Norwegian maps.

Here in Jackson Island they are seen to become gradually replaced upwards by sandstone layers.

There is every reason to believe, accordingly, that the sediments in question belong to the same stratigraphical complex.

The other rock exposures in the island are remarkable by their much more sandy facies. Marly interbeds are absent, and mottled limo nitic sandstones such as are widely distributed in Home Foreland (*vid.* pp. 131—136) and in Sabine-Pendulum Islands (*vid.* pp. 34—40) predominate by far. The last-mentioned sediments are assigned by the writer to the "Home Foreland Beds" and the Aptian-Albian series, respectively.

The black slate with interbedded limestone layers that was found to crop out in the interior of Jackson Island entirely corresponds to the sedimentary series discovered in a considerable thickness in Vardefjæld (P. 798 m), near Cape Broer Ruys (*vid.* p. 145), which contain sparse *Inocerami.*

Conformably to the structural principle which has been unveiled by the excellent work of A. Vischer the tilting of the beds near Jacksontoppen to the west is quite normal. The dip to the southeast of the strata in the interior of the island is probably due to a flexure like those found to occur near fault lines. It may thus at any rate be inferred that a hidden fault runs across the island, as for instance in easternmost Clavering Island. This fault would explain the different facies of the deposits on either side. On the other hand, the visible discrepancy of the dips as borne out in the creek east of Jacksontoppen may mark a stratigraphical unconformity. The light-coloured sandstones on top of the basalt sill would then belong to a younger transgressive formation, possibly to the Senonian of Knudshoved, and the stratigraphical boundary would have offered the least resistance to the injection of the basaltic magma. Finally, it may be argued that the abnormal dip of the said sandstone-cap may be simply due to slight displacements caused by the injection of the basaltic lavas. In this connection it may be added that large foreign enclosures or xenoliths of discoloured sandstone were observed to be frozen into the lowermost basalt layers. Reversely, short apophyses of igneous rock were seen to extend into the country rock.

Section at Knudshoved.

(*vid.* Fig. 51).

Since the thawing-season set in all of a sudden and the land became dangerously flooded, my surveys in Home Foreland had to be broken off prematurely at the beginning of June, 1938. On account hereof neither Tobiasdalen nor the surroundings of Østersletten and

Taagefjældene could be investigated. This is much to be regretted as any finding of new fossils would have carried great weight with regard to our stratigraphical correlations and datings.

However, on a reconnaissance sledge-journey late in October 1937 I set down a stratigraphical section at the Danish hut "Knudshoved" whence a few fossils had been brought back by C. TEICHERT in 1932 and by E. NIELSEN in 1933. With a view to the planned detailed investigation the next spring I did not spend much time in searching for fossils, unfortunately.

The sequence immediately above the hut "Knudshoved" is as follows:

20 m (1) Light-gray, yellow weathering friable coarse-grained muscovite sandstone with partings and lenses of black-gray sandy shale. 2 m.

Overlain by

(2) Gray-black coaly crumbling sandy shale and slate, rich in pyrite, with interbedded bands of rusty-yellow sandstone. Red-brown concretions of clay ironstone. About 5 m in thickness.

(3) Light-gray mica-bearing sandstone (as (1)), 6 m, and

(4) Gray-black sandy shale (as below), 1 m. 2 m light-coloured micaceous sandstone, and

(5) 1 m of black sandy slate containing concretions of clay ironstone, with *Inoceramus sp.*, ?*Pteria sp.*, and one specimen of *Nautilus sp.* Fossil wood.

Overlain by

(6) 15 m of light-coloured thick-bedded muscovite sandstone (as
33 m below), locally slightly folded.

Then follow

(7) 1 m bed of black-gray sandy shale, gently folded, and
5 m alternating light-coloured muscovite sandstone and thin bands of black-gray shale.
1 m stratum of yellow-rusty sandstone, and

(8) Black shale with fossil-bearing red-brown concretions of clay ironstone.

40 m
to Morainic débris.
50 m

At a height of 60 m, 70 m, and 75 m, respectively, black slate containing red clay ironstone concretions were seen cropping out between the débris.

80 m Basalt with alternate layers of tuff and basaltic breccia.

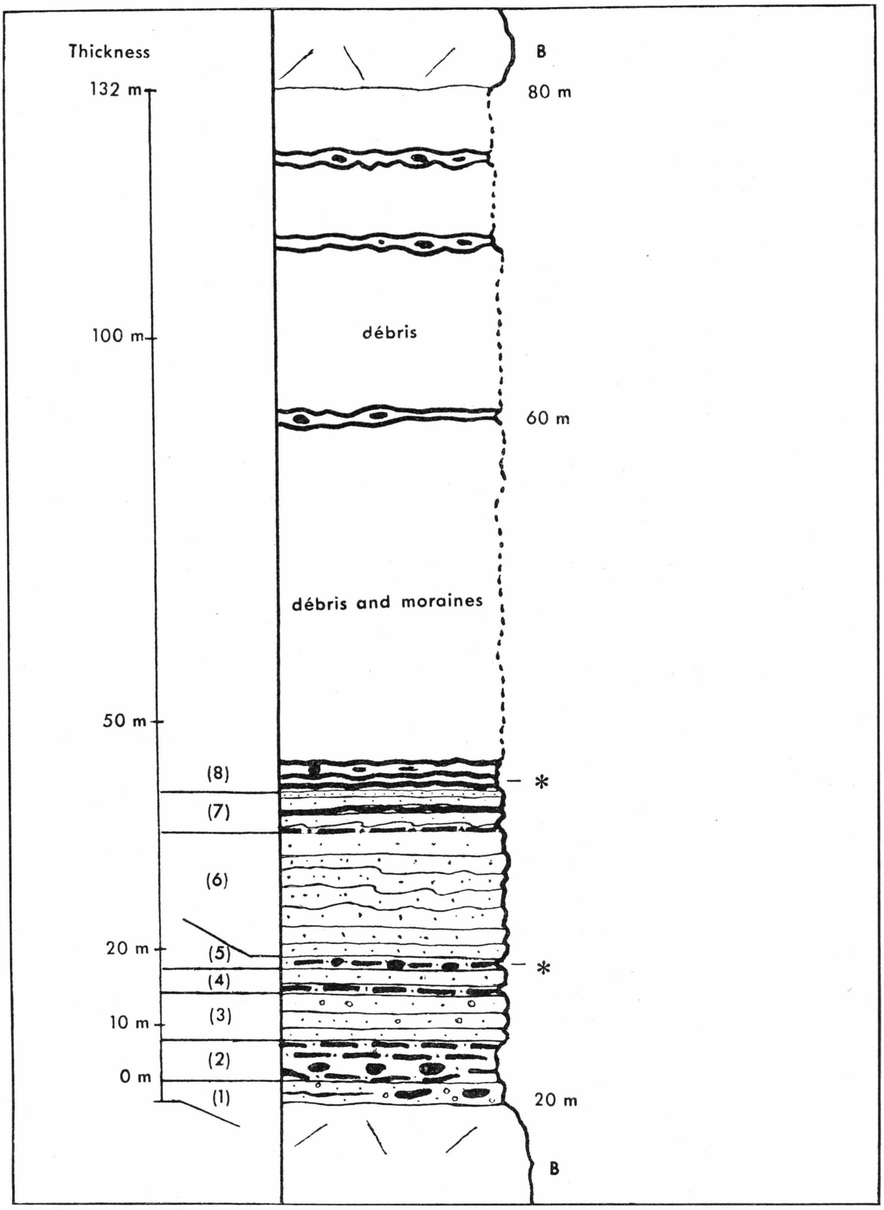

Fig. 51. Stratigraphical section through the Senonian "Knudshoved Beds" at Knudshoved, east coast of Hold-with-Hope.

This sequence discloses a set of deposits reaching 132 m in thickness (average dip amounting to 25° WNW).

C. TEICHERT's unfossiliferous section, measured on March 28th, 1932, lies immediately south of the above-given succession (*vid.* FREBOLD 1934, Figs. 2 & 4). In his opinion this series consisting of about 27.5 m sandstone with subordinate clay ironstone concretions (*op. cit.*, Fig. 4) underlies the fossil-bearing Senonian beds that were found slightly to the south (locality F on Fig. 2, in *loc. cit.*).

Mention should be made of an important fact revealed by A. Vischer during his mapping of Hold-with-Hope. According to him the light-coloured sandy beds of Knudshoved visibly overlie with a thin basal conglomerate the "dark calcareous-marly slates" such as are widely distributed in Home Foreland. The contact between the said formations is exposed "about 2 km south of Knudshoved" (oral communication to the writer).

This would mean nothing else but a transgression of the Senonian "Knudshoved Beds" upon the "Home Foreland Beds". At any rate there seems to be every reason to infer herefrom that the "Home Foreland Beds" are older than the Santonian of Knudshoved. The same conclusion is drawn by the writer by reason of the stratigraphical similarity between the "Home Foreland Beds" and the "*Inoceramus* Beds" (Aptian-Albian) of Clavering Island, Wollaston Foreland, and Kuhn Island (*vid.* p. 135)[1]).

A few exposures of gray or greenish thin-bedded micaceous sandstone with carbonaceous material, plant-remains, and clay partings, which are probably of Cretaceous age, were met with in Lygnaelv by A. Vischer.

On the western shore of Loch Fyne, about 10 km from its head, i. e. about 7 km north of the astronomically fixed point, the author came upon an exposure of sediments probably of Cretaceous age[2]). On top of basaltic rocks (sill) lies a gray or yellow quartz sandstone, rich in muscovite, then follows a whitish crumbling fine-grained quartz sandstone with coaly seams and partings of gray-blackish sandy slate. These 4—5 m thick beds are covered with morainic débris.

Although no fossils were found, the author feels justified in referring the formation to the Cretaceous as it closely resembles the beds reported by A. Vischer to occur in Lygnaelv (*vid. sup.*).

It is, however, possible that the sandstones concerned belong to the Triassic, which slopes down from the Giesecke Bjærge to the north-west according to the tilting of the "Giesecke Block". The latter then abuts against the Caledonian crystalline of Nordhoeks Bjærg along a

[1]) The find of e. g. *Inoceramus aff. labiatiformis* Stoll. in the "Home Foreland Beds" in Snerta River, Home Foreland, obviously supports such a correlation (*vid.* p. 135).

[2]) It may be pointed out that deposits from about the sume localityare already quoted by L. Koch who takes them to be Tertiary or Mesozoic (Koch 1929 a).

fault line that runs NNE—SSW and dies away in a flexure at La Cours Bjærg (*vid.* Fig. 55).

The area of Cape Broer Ruys.

The mountainous hinterland of Cape Broer Ruys was sighted for the first time been by Sir Henry Hudson, who had set out to find the shortest sea-route to Cathay (China) across the North Polar Ocean. On June 22nd, 1607, this famous British explorer had just a glimpse from aboard his ship "Hopewell" of distant snow-covered mountains which were given the name "Holde with Hope" ...

In 1870 the Koldewey Expedition discovered acidic igneous rocks of unknown age near the very cape. A. G. Nathorst, who went ashore at Cape Broer Ruys on July 18th, 1899, only speaks of an old volcano and of red, yellow, and brown rocks such as occur in Jan Mayen Island (Nathorst 1900).

My companion A. Vischer especially devoted a few days to the study of this *post*-Basaltic *sub*-volcanoes, however, none of his results have hitherto been published.

The brief investigation by the writer has proved that a thick sedimentary formation of Cretaceous age has been cut by several acidic intrusive bodies of liparite. Near the contact the sediments have conspicuously turned metamorphic and have even become resorbed in the molten magma. Xenoliths consisting of sediments as well as of basaltic rocks are rather frequent. It may be stressed, however, that the contact metamorphic effect is localized to a rather narrow contact zone and gradually dies out away from it.

Apart from the main intrusions small stocks and dykes occur which are made up of a hemi-amorphous or glassy greenish felsitic rock. Dykes of the latter clearly cut the basalt and are, therefore, younger in age than the widespread regional outpourings of these basaltic flows.

Acidic igneous intrusions of reddish porphyritic rocks (liparite), associated with doleritic basalt, greenish eruptive breccias, tuffs carrying fossil wood and lignite, etc., are moreover known from the area of Mackenzie Bugt (*vid.* Maync 1940). Besides, the doleritic basalt sills are here seen to be cut by dykes of a grayish basaltic differentiate showing phenocrysts of plagioclase in a dense groundmass.

Section on the southern slope of Vardefjæld (P. 798 m).

25 m Basalt and basic amygdaloidal differentiates.

70 m Black slate with interstratified limestone bands and *laminae* of reddish fine-grained sandstone. Due to exomorphism turning yellow, red, and greenish.
Inoceramus aff. anglicus Woods? ?*Serpula.*

110 m Black slate with limestone bands, showing a spheroidal weathering.
A dip of 10° to the northwest was stated here.

120 m Interbeds of greenish probably igneous rock.
Overlain by

130 m 4 m bed of whitish-yellow fine-grained quartz sandstone conspicuous from afar by its contrast of colour.
Then follow again
Black, multicoloured-weathering slate with intercalated limestone layers, with strongly red-coloured thin partings.

155 m Slate and limestone bands (as below) containing intensely rusty weathering red hematitic lumps often showing a sulphurous crust (volcanic ejectamenta?).

180 m Greenish slates and phyllites with numerous injected basalt sills of varying thickness, with enclosions of the country rock.

200 m to 210 m Basalt sill.

210 m to 250 m Black slates with interbedded limestone bands (as below), partly contact metamorphic.

250 m 2—3 m thick basalt sill.
Overlain by

253 m to 320 m Slates (as below) with intruded sills of basaltic rocks.

320 m Dark or multicoloured slate with limestone bands.

325 m 3 m bed of light-yellow sandstone (as below at 130 m altitude), overlain by gray-yellowish slate with limestone layers, and interbeds of red hard clay ironstone.

345 m to 370 m Basalt sill (light-coloured variety).

370 m Light-gray and greenish spotted slate and platy limestone bands (as below), often brecciated and injected by several thin sills of basalt.

400 m Light-yellow sandstone (as below at 325 m, and 130 m), 5 m in thickness, and
2 m greenish-gray slate, again overlain by yellow and whitish sandstone (as below).

430 m Gray-greenish slate with thin limestone layers breaking into polyedric fragments along irregular joints. Cut by swarms of basalt dykes.

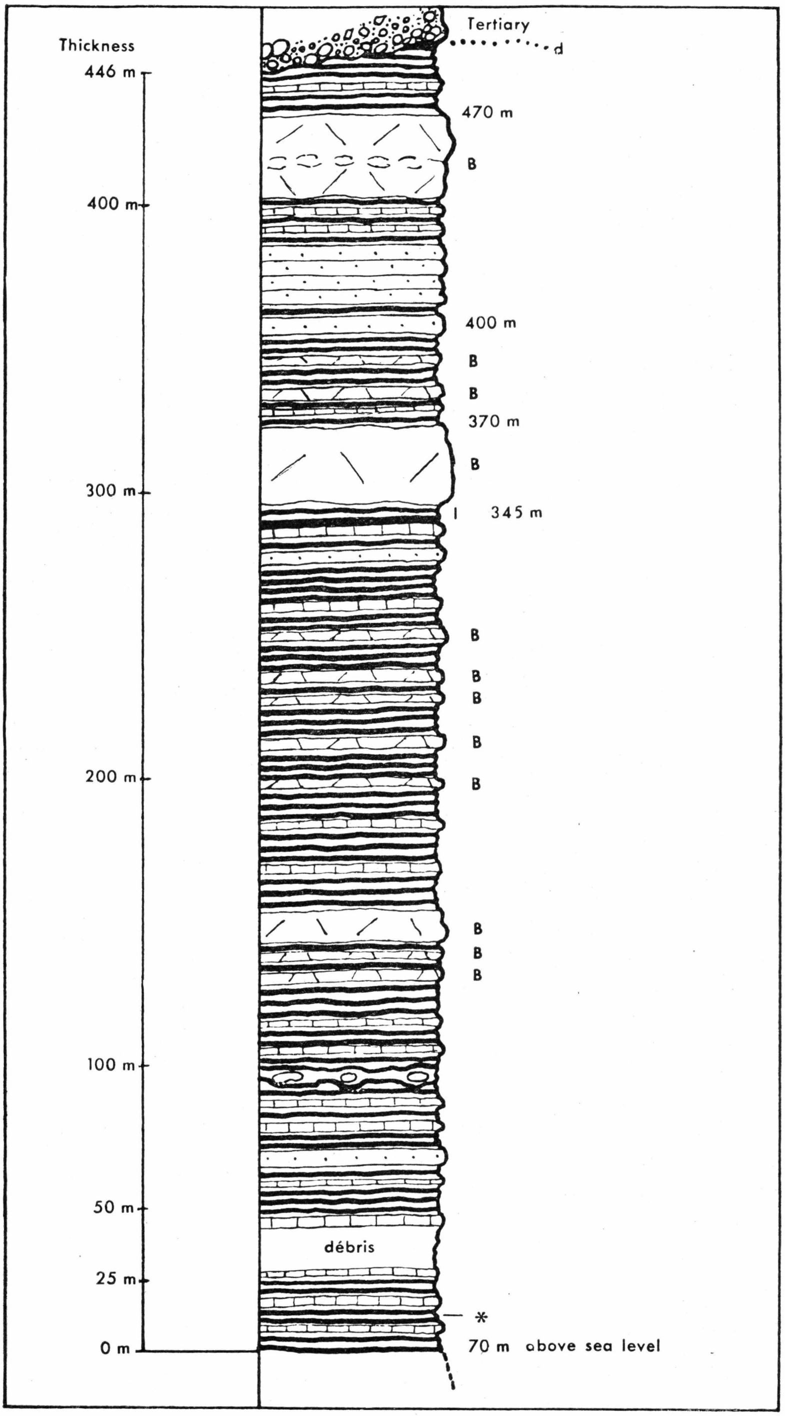

Fig. 52. Columnar section through the Cretaceous series exposed in Vardefjæld (near Cape Broer Ruys), Hold-with-Hope.

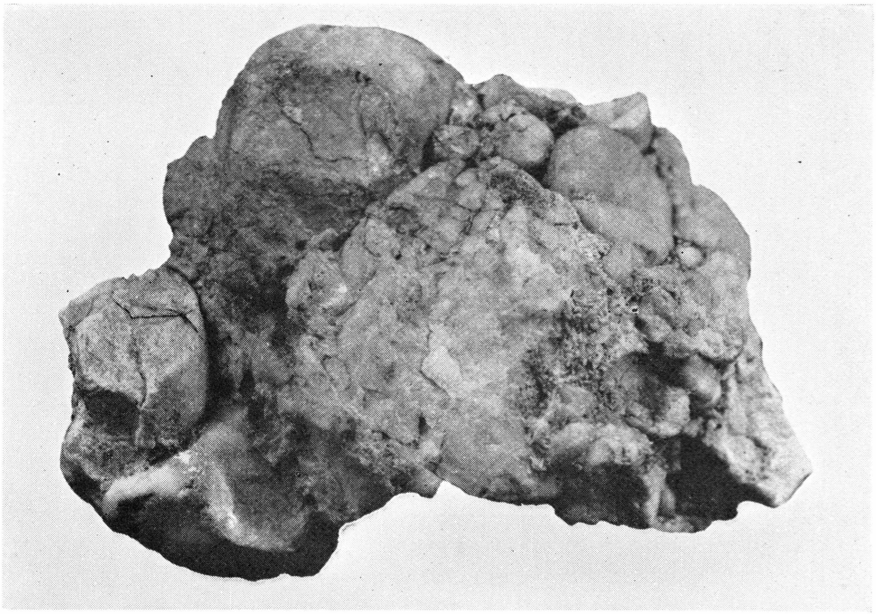

Fig. 53. Coarse light-coloured polymictous conglomerate (= base of the overstepping Tertiery), Vardefjæld (Cape Broer Ruys), Hold-with-Hope, 480 m altitude. Lot 222 Coll. A. VISCHER.

445 m to 470 m	Basalt sill with interbeds of tuff.
470 m	Greenish-gray slates (as below), impure, with cracks. Dipping 6° to the northwest.
480 m	Ditto, dip 14° to the westnorthwest.
	Jagged unconformity to
480 m	Coarse horizontally lying conglomerate (Fig. 53) (Tertiary), effusive breccias (Fig. 54) and tuffs passing into true basalt-breccias. Plateau basalt.

The same series was met with on the southeastern ridge of Vardefjæld, though still more affected by contact metamorphism.

In the surroundings of the small Lake Troldsøen[1]), situated between Vardefjæld (P. 798 m) and Midtfjæld (P. 752 m), a piece of fossil wood was collected in a greenish-gray slate at a height of about 600 m.

To sum up, it may be stated that a series of slates and interstratified limestone bands reaching a thickness of about 350 m is exposed

[1]) This lake is not entered on the Danish map of the Geodetic Institute, Copenhagen, 1937, but is marked on the Norwegian map as "Trollvatnet".

west of the volcanic complex of Cape Broer Ruys which had not been known to exist. Unfortunately, these sediments, which show a normal dip to the northwest, carry very few fossils. This may partly be due

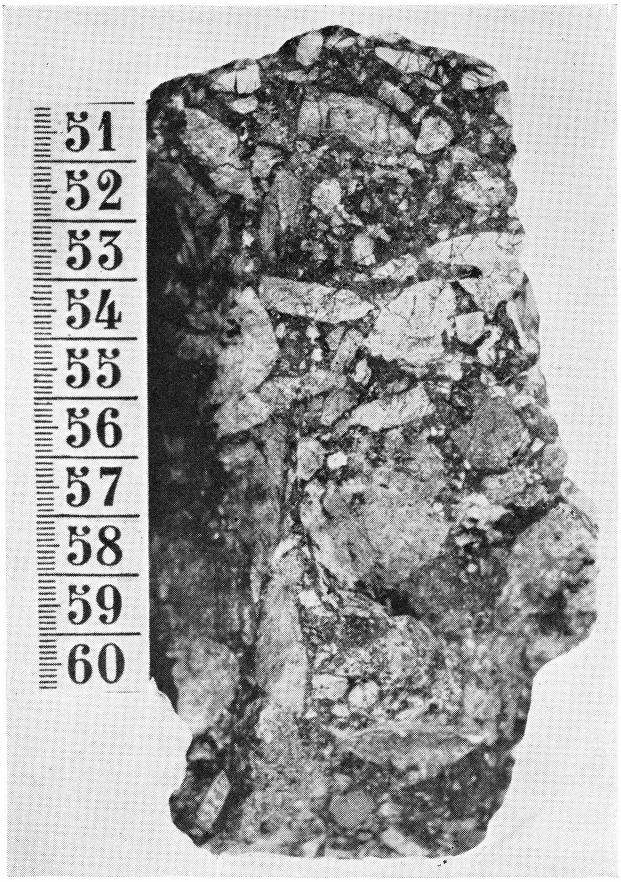

Fig. 54. Basaltic agglomerate with a greenish tuff matrix. Tertiary. Vardefjæld (Capo Broer Ruys), Hold-with-Hope (about 490 m altitude). Lot. 3147 Coll. W. MAYNC.

to the destroying influence of the intruded igneous rocks. A single specimen of *Inoceramus*[1]) was secured from the lower levels of the sequence, and a *Nautilus* was found near Cape Broer Ruys during a sledge-journey of A. Vischer. The finding of an *Inoceramus* establishes the Cretaceous age of the formation. Besides, the same greenish slate series, which is associated with limestone interbands, pale-buff marls with cone-in-cone structure, and orange clay ironstone concretions, was found to occur in the Giesecke

[2]) Dr. J. SORNAY refers the concerned species to *Inoceramus aff. anglicus* WOODS?, which would suggest an Albian age of the slate formation.

Bjærge, Gauss Peninsula, where it is less poor in fossils (*vid.* pp. 154—161). In Jackson Island, too, the same formation is exposed (*vid.* p. 137 ff).

The coarse conglomerate overlying unconformably the slate series at a height of 480 m is assigned to the Tertiary by analogy with that marking the Tertiary basis in Wollaston Foreland and Sabine Island. The basaltic breccia on top of it speaks in support of such a correlation, after all.

F. Giesecke Bjærge
(Gauss Peninsula).

Prior to our investigations in 1938 this mountain range was as good as unexplored; only the southernmost region between Cape Franklin and Margrethedalen which is easy of access was known in its main features (ROSENKRANTZ 1930b, KOCH 1931).

The outcrop of Caledonian crystalline in the eastern foot of the chain was mapped by L. KOCH (KOCH 1929 a). Marine "Upper Carboniferous" was proved by L. KOCH, H. G. BACKLUND, and A. ROSENKRANTZ to overlie transgressively either the Caledonian gneisses or Devonian strata (KOCH 1929 a, BACKLUND 1930, 1932, ROSENKRANTZ 1930 b, 1932). This so-called "Upper Carboniferous" which the author has shown to be actually of late Permian age, has lately been monographed so it is no use touching upon this subject again (MAYNC 1942).

Eotriassic beds were discovered by A. ROSENKRANTZ near Margrethedalen on top of the Permian "Foldvik Creek formation" L. KOCH 1927 (ROSENKRANTZ 1930 b). The sediments occurring in the northern part of the mountain range between the Permian and the basaltic flows, into which numerous basaltic sills have intruded, were mapped by H. G. BACKLUND as "? Tertiary" (BACKLUND 1932). Their Lower Triassic age was established by the writer in 1938 (*vid.* MAYNC 1939, 1940, 1942).

Apart from the Eotriassic in Margrethedalen hardly any Mesozoic beds were known to occur in the Giesecke Bjærge before the writer's researches. However, a specimen of "*Aucella*" collected by W. SOLHEIM on the summit of ? Saxos Bjærg (P. 1050 m)[1]) (*vid.* ORVIN 1930) suggested that Mesozoic might be present (*vid.* FREBOLD 1932 a). On account of that fossil A. K. ORVIN speaks of Jurassic deposits (in *loc. cit.*); the supposed "*Aucella*" was later on described and identified as *Inoceramus sp. ind.* (FREBOLD & NOE-NYGAARD 1938), and H. FREBOLD expressed the opinion (in *loc. cit.*) that it might possibly be identical with the small-sized indeterminable specimen of *Inoceramus* that had been collected by E. NIELSEN in Home Foreland and which would be Senonian in age (FREBOLD 1934). L. KOCH, on the other hand, compares the black slates overlying the Triassic on Østreplateau (Margrethedalen) with the Aptian slates of eastern Clavering Island (KOCH 1935).

From the vast alluvial plains of Badlanddalen and Vestersletten, between Hold-with-Hope, Foster Bugt, and Loch Fyne, rises steeply the

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[1]) "Vom Gipfel nördlich von der eigentlichen Kap Franklin Spitze" (quotation from ORVIN 1930, p. 25).

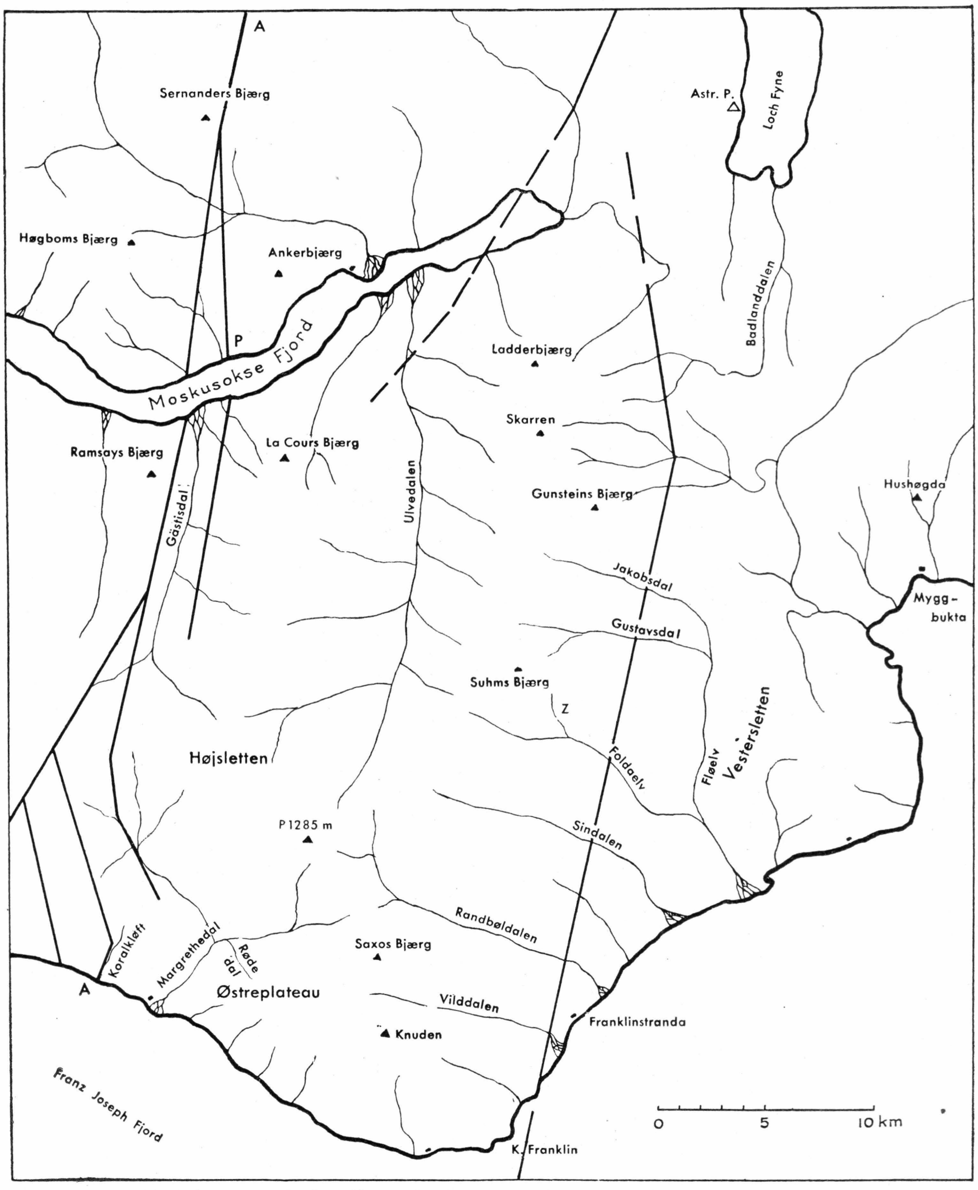

Fig. 55. Sketch-map of the Giesecke Bjærge, Gauss Peninsula (tectonics according to A. Vischer).
AA = Main *post*-Devonian Fault. P = Prospektdal. Z = Zechsteinelv.

almost unknown mountain range of the Giesecke Bjærge with its summits more than 1200 m high.

This morphologically conspicuous rock-wall corresponds to the eastern edge of the "Giesecke Block". Just as the tectonic element of eastern Clavering Island or the "Kuhn Block" farther to the north has slipped down along the grand fault scarp of the "Clavering-Thomsensland Block", the unit of Hold-with-Hope has been downthrown along the important "Giesecke Fault" bounding the "Giesecke Block" on the east. It is this major fault line that causes the striking effect on the topography, i. e. the sharp break in the relief between the lofty mountain range and the flat plains covered with Quaternary deposits

The *post*-Devonian sediments of the "Giesecke Block" display a regular dip to the west-northwest, in other words, the block is tilted landwards such as may be expected according to the revealed block-structure of the northerly region. Still farther to the west the tilted "Giesecke Block" abuts against the fault scarp of another block made up of Devonian rocks which may be termed the "Gauss Block".

Accordingly, the Giesecke Bjærge fit excellently in with our tectonic picture of a set of repetitive step-faults that have disjoined "antithetically" the eastern continental border of Greenland.

Mention has already been made of the connection of the Caledonian crystalline in central Clavering Island with that of Nordhoeks Bjærg, and of the terrestrial Carboniferous deposits of the Hallebjærgene with those building up the Passagehøje in Hudson Land, respectively (*vid.* p. 126 ff).

The Caledonian basement also crops out in the northern Giesecke Bjærge below the overstepping Permian beds. These gneisses, however, may not directly be linked up with the crystalline of Nordhoeks Bjærg since a transversal fault was shown by H. BÜTLER to separate the two massifs (BÜTLER 1939, 1940, VISCHER 1939). This NNE—SSW running fault which, besides, gradually dies away south of Moskusoksefjord in a flexure south of La Cours Bjærg (P. 1042 m), has offset the Caledonian of the "Giesecke Block". Tectonically the crystalline basement cropping out in the northern Giesecke Bjærge would represent a more eastern block were it not for the fact that the main effect of the throw of the "Hudsonland Fault" (Nordhoeks Bjærg) is actually transmitted to the "Giesecke Fault" (*vid.* VISCHER 1939)[1]).

The recent investigations of A. VISCHER and the writer have yielded the result that banded Caledonian gneisses and, moreover, intrusive bodies of granite and quarz porphyry build up the crystalline basement of the northern and central Giesecke Bjærge. Towards the southern end of the mountain range these stocks of acidic igneous rocks gradually show a more and more porphyritic texture with large phenocrysts of feldspar and quartz. At Cape Franklin the texture may be spherulitic-felsitic. These rhyolites of Cape Franklin, which have erroneously been considered

[1]) Irrespective of the difference in strike this phenomenon of displacement with the effect of throw passing over from one fault to another is exhibited e. g. in Wollaston Foreland, between the "Kuhn Block" and the "Kuppel Block" (*vid.* p. 66).

Tertiary in age (Backlund & Malmquist 1935), are to-day recognized as doubtless *intra*-Devonian intrusions (Maync 1940, Vischer 1940). A. Vischer evidently shares the conception that the entire crystalline of the northern Giesecke Bjærge is Caledonian in age (Backlund 1932, Bütler 1939, Vischer 1939) whereas my own investigations have led me to consider part of this crystalline, *viz.* the intrusions of granite, granito-porphyry, spherulitic porphyry, alkalic rhyolith etc. to be evidently of *intra*-Devonian age. Proofs for this point of view are put forward in a special paper (Maync 1949).

An account on the stratigraphy of the Devonian of the Giesecke Bjærge has recently been published (in *loc. cit.*)

Continental deposits of Carboniferous age (Dinantian-Namurian) are preserved in a *graben* at the base of A. Vischer's "Main *post*-Devonian Fault" (Prospektdal-Gästisdal). It is beyond doubt that this imposing fault scarp has formed the western boundary of the tectonic depression in which the detritus from the hinterland has accumulated. To be sure, the terrigenous deposits of the East Greenland Carboniferous, i. e. in western Clavering Island, Hudson Land, Gauss Peninsula, Ymer Island, Geographical Society Island, Traill Island, Scoresby Land, Jameson Land, were exclusively laid down at the base of that fault scarp. The beds have undergone a slight folding which may be dated to the Variscan era.

The Permian beds in the Giesecke Bjærge transgress upon an old Permian peneplain which cuts Caledonian crystalline, folded Devonian and Carboniferous rocks. This marine Upper Permian has already been dealt with in a special paper (Maync 1942).

The Triassic formation of the Giesecke Bjærge will possibly be treated in a monograph on the entire Mesozoic stratigraphy of East Greenland.

Neither in Hold-with-Hope nor in the Giesecke Bjærge are there any traces of Jurassic beds. In consequence hereof the Early Cimmerian landmass "Neo-Eskimonia" is assumed to have extended between 73° and about 74 N. lat. (Maync 1940, 1947).

The lowermost Cretaceous, too, is lacking within the range of "Neo-Eskimonia" which shows that the geokratic period persisted into this system.

The marine beds of Aptian-Albian age unconformably overlie the Eotriassic both in Hold-with-Hope and in the Giesecke Bjærge. The *pre*-Aptian relief has been rough and accentuated, which proves a rejuvenation of drainage and erosion, i. e. positive movements of the area concerned in Lower Cretaceous times; for it is beyond doubt that otherwise the land's surface would have been worn down almost to a peneplain during the whole Jurassic period and the Valanginian epoch.

Admittedly, it looks rather difficult at first sight to discriminate whether this interruption of the erosional or physiographic cycle and the attainment of a new base level is due to epeirogenetic readjustments e. g. crustal, warpings, or to orogenetic disturbances. However, the strong late Jurassic step-faulting that is known to have taken place in the northern area speaks much in favour of the latter.

Proofs of the mountainous *pre*-Aptian morphology are provided by the overlap of the Aptian beds upon Triassic, Permian, or granite, and by the occurrence of "exotic' 'boulders of granite, quartzite, and Permian dolomite embedded in the Cretaceous slate series. As the prototype of such boulder beds within the Aptian-Albian series those in Clavering Island are considered (*vid.* pp. 111—114).

The fault scarp of the eastern "Giesecke Block" still existed in *sub*-Aptian time and formed a "*falaise*"; for near the mouth of some recent valleys such as Jakobsdal, Gustavsdal, and Foldaelv-Sinddalen, Aptian-Albian sediments rest upon the scarp as if stuck to it. Yet the great throw of the "Giesecke Fault" must be due to a *post*-Albian uplift since the same Cretaceous series occurs on top of the "Giesecke Block" at a height of about 1000 m.

A *pre*-Basaltic relief is reflected in the fact that the vast basalt flows of Hold-with-Hope have found a barrier in the said fault scarp. Owing to the tilt of the "Giesecke Block" to the northwest this fault scarp quickly diminishes in height towards the north. Before reaching Loch Fyne the "Giesecke Fault" has died away, and it was through this depression that the lava outpourings spread over the surface of the "Giesecke Block". A *post*-Basaltic upheaval of the latter has considerably increased the former throw to its present-day amount. Furthermore, the fairly youthful stage of topographical history bears witness to this uplift in Tertiary or even Quaternary times.

Section in Gunnsteinsbjærg (P. 791 m)[1].

(*vid.* Fig. 56).

In the lower portion of Jakobsdal[2]) up to about 175 m altitude porphyritic granite crops out which the writer considers an *intra*-Devonian intrusive body within the Caledonian gneisses and Devonian sediments.

175 m to 215 m — Basalt sills probably with a thin interbed of black slate as suggested by such débris.

[1]) This summit in the northern part of the mountain range bears no name on the Danish maps. However, on the Norwegian ones it is entered as "Gunnsteinfjellet" and we can therefore desist from coining a new name.

[2]) With regard to the nomenclature *vid.* MAYNC 1942.

215 m Black partly grayish weathering slate, rich in muscovite, interstratified with thin layers of gray-yellow fine-grained muscovite sandstone. Dip 8—10° to the west-northwest. Two basalt sills 0.4 m thick.

230 m Black slate turning greenish-gray near the igneous contact, with a slight content of sand, rich in muscovite. Carrying poor fragments of *Inoceramus sp.*

Overlain by

slate (as below) with large embedded rounded blocks of granite, granite pegmatites with large muscovite flakes, and quartzite. Moreover, well-rounded balls of muscovite sandstone attaining a diameter of up to 0.3 m are enclosed within the slate. A segment of such a granitic boulder was found in a big limestone concretion. The fine texture of the micaceous slate has not changed at all, so we are obliged to assume that these foreign constituents have tumbled down into the sea from some cliff. Contrary to the "exotic" boulders embedded in the Aptian-Albian shales in Clavering Island (*vid.* pp. 111—115) those in the present sequence are well-rounded and have thus been transported over a long distance. Apart from such foreign blocks sparse concretions of clay ironstone as well as thin bands of the same material occur.

260 m Black or greenish-gray hardened micaceous slate with silty zones (as below) which has yielded some specimens of a large-sized lamellibranch hitherto unknown in the Cretaceous of East Greenland.

262 m to 275 m Basalt sill.

275 m Blackish or greenish discoloured burnt slate with a few thin interbeds of hard limestone.

280 m to 300 m Basalt sill.

300 m to 350 m Greenish discoloured slate with 0.1 to 0.2 m interbeds of limestone (as below). Off the basalt contact the micaceous slate is of a black or grayish colour. At 310 m interbedded nodular layer of black bituminous limestone, rich in muscovite, displaying a high content of pyrite that weathers into rusty patches.

350 m to 370 m Basalt sill.

370 m to 400 m Greenish-gray discoloured slate (as below), with an injected 6 m basalt sill 12 m above the base.

400 m to 420 m Basalt sill.

420 m to 430 m Black slate (as below) containing big well-rounded boulders of mica-bearing sandstone and lumps of Permian dolomitic limestone; furthermore, large limestone nodules and red-brown concretions of clay ironstone. At the base (423 m) the slate contains an interlayer (and pinching out lenses) of flaggy yellow-brown muscovite sandstone showing wave-marks.

430 m to 490 m Basalt sill.

490 m to 500 m Black slate with a few intercalations of mica-bearing brownish sandstone.

500 m Floor of the plateau basalt.

The Cretaceous sediments as disclosed in the section given above are 186 m thick.

Another section was examined in a ridge immediately to the west of the previous profile.

340 m Black-gray muscovite-bearing slate with interbedded limestone bands, containing large rounded blocks of a yellow-reddish rusty weathering muscovite sandstone with "schliers" and enclosures of black-greenish limestone. Furthermore embedded in the slate are huge boulders and sharp-angular blocks of a gray-brown knobby fine-grained sandstone, attaining a length of several meters. In the ravine east of the profile-ridge no such boulders are present in the very same bed.

360 m Black or greenish slate containing large limestone concretions in the cores of which fragments of granite were frequently found. Also quartzitic components were occasionally seen to be surrounded by such a jacket of limestone cement.

360 m to 385 m Sill of doleritic basalt.

385 m Gray-greenish effusive rock, trachytic-andesitic? derivate, being enclosed within the normal basalt, weathering to brown or purplish and showing exfoliation. Embedded in this fine-grained

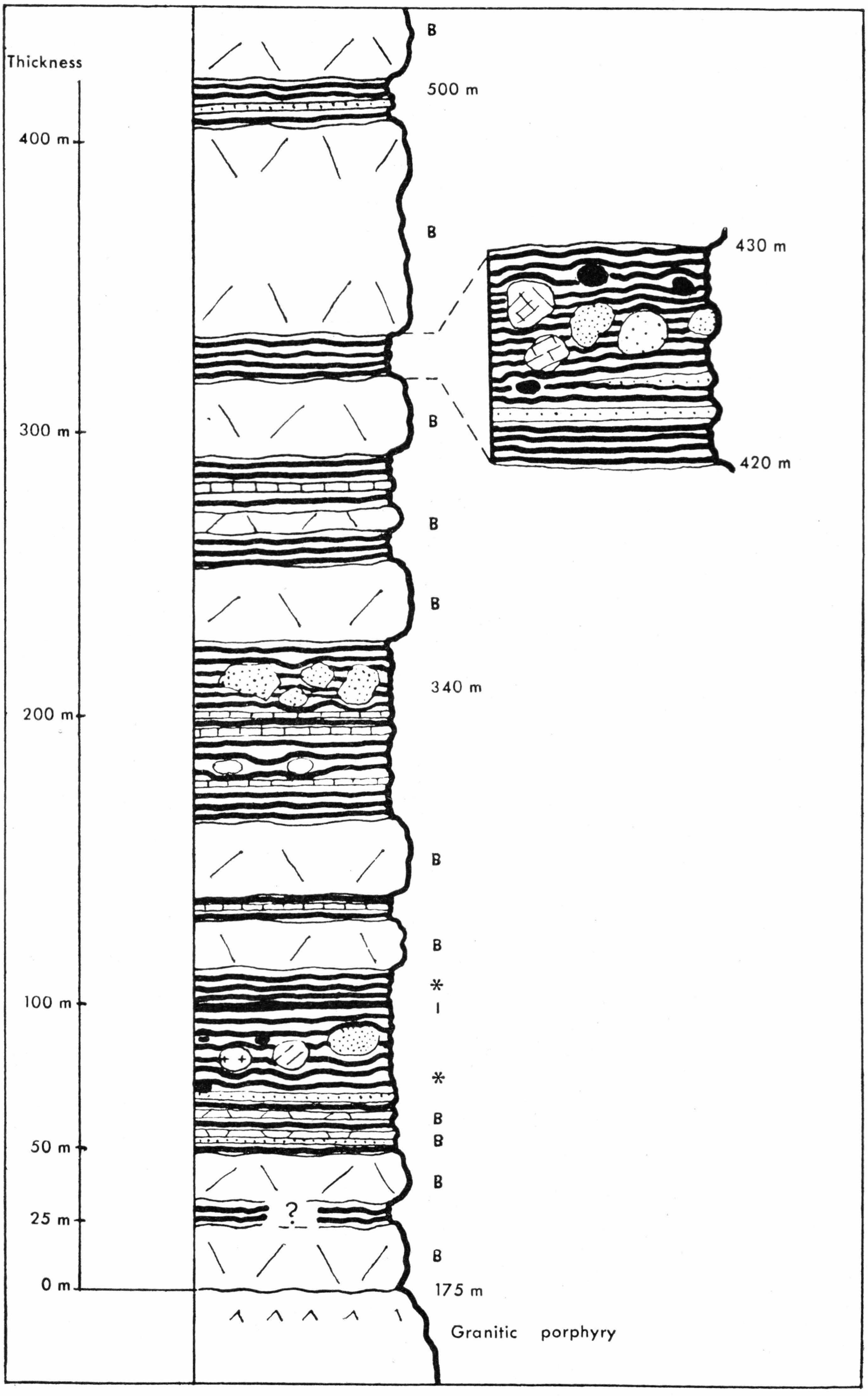

Fig. 56. Stratigraphical section through the Cretaceous beds in Gunnsteinsbjærg (P. 791 m), Giesecke Bjærge.

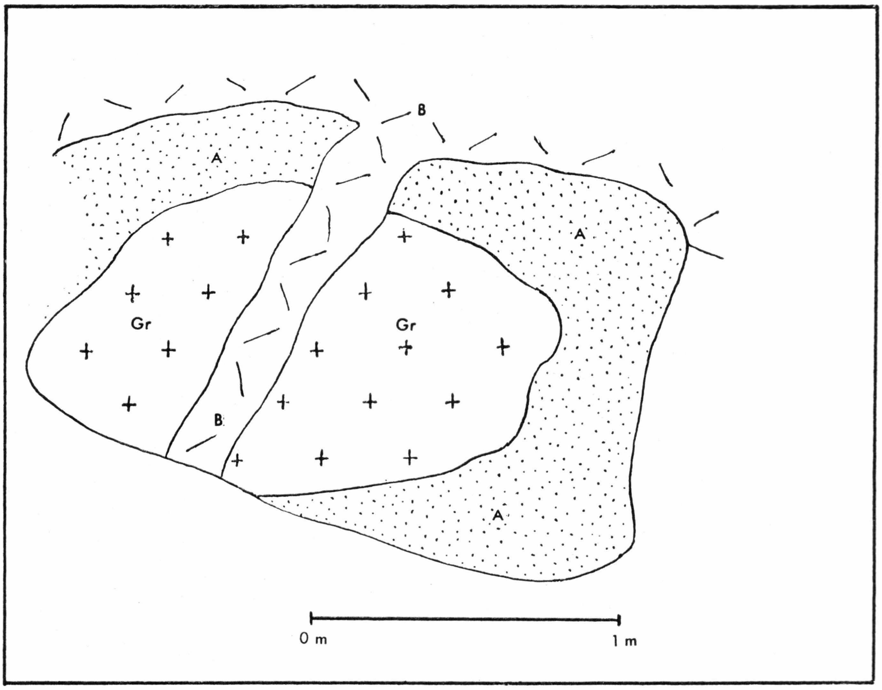

Fig. 57. Enclosure of effusive rock (A) containing a granitic boulder (Gr), frozen into the basaltic magma. North of Jakobsdal, central Giesecke Bjærge.

matrix is a granite boulder attaining 2 m in length which has apparently been carried away by the magma and frozen into it[1]). A dyke of basalt sharply cuts both the enclosed granite and the surrounding more basic rock (see Fig. 57) which shows that the basalt is younger.

On top of the basalt follow

greenish discoloured slate (as below) and another basalt sill of a thickness of 2 m.

Overlain by

greenish slate (as below).

400 m Greenish discoloured slate (as below) with two thin intruded sills of basalt. Embedded within the slate is a large body of the same greenish-gray, purplish weathering rock as occurs at a height of 385 m.

The origin of that rock is still problematic. Unfortunately, the specimens brought back are not at hand for the present

[1]) Another huge complex of porphyritic granite was observed to swim in a basalt sill down in Jakobsdal (at 80 m altitude). The thick basalt sill following the *sub*-Permian boundary in the same valley frequently contains broken off boulders of Permian rocks as xenoliths.

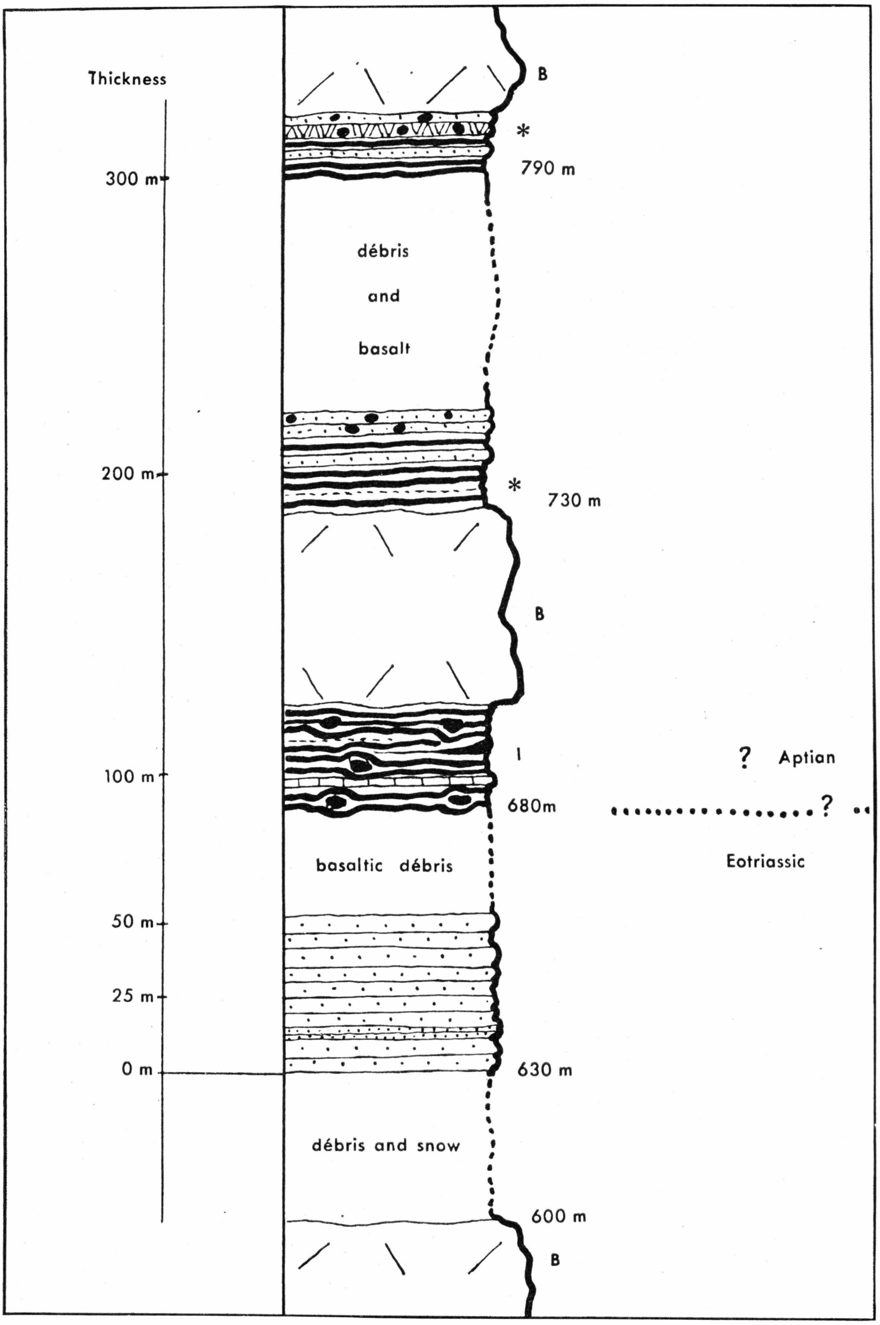

Fig. 58. The Cretaceous series exposed in the southeastern slope of Suhms Bjærg (P. 1250 m), Giesecke Bjærge.

which prevents me from studying them closely. Although the rock had been looked upon in the field as of igneous origin, it may, nevertheless, represent some highly metamorphic Devonian sediment.

Section in the southeastern slope of Suhms Bjærg (P. 1250 m).
(*vid.* Fig. 58).

The Foldaelv in the central Giesecke Bjærge has cut its bed up to a height of 440 m into the *pre*-Permian basement. This consists of banded biotite gneiss (Caledonian) and intruded stocks or small batholiths of an eugranitic rock which the author holds to be of *intra*-Devonian age.

Above these fundamental rocks lies a coarse polygenetic conglomerate of unknown age containing pebbles derived from the Caledonian such as black limestone, white quartzite etc. of the metamorphic "Eleonore Bay formation" L. KOCH 1927. The rounded or subangular pebbles vary in size. A dip of 12—15° to the north was measured in the overlying fine-grained gray or pink ?Triassic sandstone, which in turn is surmounted by a thick basalt sill from 460 m up to about 600 m altitude.

Owing to the bad exposures and the thick surface débris the *sub*-Cretaceous boundary cannot be exactly drawn, the more so since fossils are entirely absent.

630 m	Yellow-gray mostly fine-grained platy sandstone with fine-psephitic layers. Sometimes the sandstone contains "schliers" or ?pebbles of greenish-gray limestone. ?Triassic.
650 m	Knobby sandstone ledge.
660 m	Basalt débris.
680 m	Black slate locally slightly sandy and rich in muscovite, containing thin bands and concretions of orange-red weathering clay ironstone and black limestone. Aptian-Albian.
700 m to 730 m	Basalt sill.
730 m	Black or greenish-gray discoloured partly marly slate, dipping at about 20° to the west-northwest. Interstratified with sandy horizons rich in muscovite flakes, and with thin pebbly seams. *Inoceramus sp.*
740 m	Black slate with sandstone interbeds. Reddish sandstone with "schliers" and red-coated concretions of clay ironstone.
750 m to 790 m	Basalt and surface débris.

790 m Black slate with interlayers of yellow or rusty-brown uneven micaceous sandstone. Moreover, interbeds of pale-buff marl with cone-in-cone structure. Concretions of clay ironstone are enclosed both in the marl and the sandstone interlayers. Numerous specimens of *Inoceramus sp.*

Immediately overlain by plateau basalt.

With all reserve the limit between the Triassic and the Cretaceous formations is drawn in this section at 680 m altitude where the first true sediments of the Aptian-Albian series occur *in situ*.

Identical beds are exposed in Rødedalen and on the northern edge of Østreplateau.

Due to the tilting of the "Giesecke Block" to the westnorthwest the Cretaceous strata, which in Suhms Bjærg are exposed at about 800 m altitude, already occur at 375 m in the surroundings of Margrethedalen.

Rødedalen.

By this name the writer has designated the valley carved into the red Devonian deposits of the "Giesecke Block"'s *cuesta* face, between Saxos Bjærg (P. 1050 m) and Franklinfjæld (P. 1201 m); besides, this valley joins Margrethedalen about 1 km farther to the northeast than is indicated on the Danish map of 1937.

Permian: Brecciated "karsted" dolomite with limonitic material in pockets, and scattered relics of "*Posidonomya* Beds" (*vid.* MAYNC 1942).

Transgressively overlain by

375 m to 380 m Black partially marly shale with interbeds of yellow-brown sandstone containing orange clay ironstone matrix. Enclosed in the shale are numerous red or yellow-coated concretions of clay ironstone which often carry clusters of quartzitic pebbles and muscovite flakes. "Schliers" and infiltrations of clay ironstone substance are also present in interbeds of a fine-grained limonitic muscovite-bearing sandstone containing fragments of *Inoceramus sp.*

The upper portion of the sequence was concealed by snow.

Østreplateau.

On climbing the plateau from the north (Rødedalen) the following sediments were met with.

470 m Black and gray marly shale with interbeds of sandstone, dipping gently to the northwest.

500 m Light-gray discoloured slate carrying *Inoceramus sp.*, and small

pelecypods. Intercalations of black shaly sandstone with a high muscovite content.

In general the shale and slate is rather rich in *Inocerami* but they crumble and fall to small polyedric pieces due to exomorphism and cleavage.

Concretions of clay ironstone were only found in the lower levels of the series (Rødedalen).

With regard to the lithological and facial features the Cretaceous beds as described in the foregoing from the Giesecke Bjærge closely resemble the Aptian-Albian series of other parts of the investigated region.

The black or greenish slates with interbedded limestone bands completely correspond to those exposed in the section of Vardefjæld (*vid.* pp. 145—146); identical sediments have been stated to occur in Jackson Island (*vid.* p. 137 ff).

Farther to the north such interbedded limestone bands within the slates are much rarer. In Clavering Island, for instance, they have been shown to occur in Dislokationsdalen (*vid.* pp. 105—107, in Kontaktravine (*vid.* pp. 107—110), and in Grønnedalen (*vid.* p. 121). Similar beds are reported from Sabine Island (*vid.* pp. 34—36).

The sandstone and pale-buff marl (with cone-in-cone structure) which carry clay ironstone concretions with *Inoceramus sp.*, e. g. in Suhms Bjærg, do not differ at all from these deposits in any other place in the investigated area.

III. SUMMARY OF STRATIGRAPHY AND GENERAL SEQUENCE OF THE CRETACEOUS IN THE INVESTIGATED AREA

(*vid.* Pl. 3).

The numerous stratigraphical sections, given in the foregoing, are believed to speak for themselves, and it will hardly be necessary to discuss them in detail.

Nonetheless, the type-section of Mt. Niesen will be briefly dealt with in the following pages from which the conditions of sedimentation, facies, and paleogeography from the close of the Jurassic onwards into the Cretaceous system may be deduced.

A complete Cretaceous section, which might be taken for a standard succession, is nowhere available in the investigated area. This is due to the late Kimmeridgian orogeny whereby the East Greenland continental border became dismembered into different autonomic blocks. Each of these tectonic blocks has, so to speak, undergone individual movements in different epochs, which accounts for the incompleteness of the sequence of sediments here and there.

The facies diagram attached (Pl. 3) is meant to show the stratigraphical relationships between the comparative sections and will be of help for reliable conclusions to be drawn. It goes without saying that the fossil content of the different formations (as far as it has already been identified!) has carried much weight for our definite correlations (*vid.* Chapter VI).

The less varying stratigraphical-facial conditions in Clavering Island will be explained by Figs. 32 and 33.

The diagrammatic representation on Pl. 3 illustrates the block-faulting en échelon in late Jurassic time. This orogeny can be precisely dated since the youngest strata that have suffered tilting and faulting are the "Kuhn Beds" of lowermost Upper Kimmeridgian age. On the other hand, the first deposits overlapping the newly created land surface are Volgian (Portlandian) in age, and their boulder facies bears witness to a synorogenetic sedimentation, i. e. the tectonic disturbances had not yet come to a close. The main orogenetic phase had thus taken place in late Kimmeridgian time (*vid.* MAYNC 1947).

In consequence of the Young Cimmerian (Nevadian) Orogeny the whole investigated area had turned into land, and denudation and erosion began their work of disintegration and destruction. Only along the foot of the westernmost block, the fault scarp of which had already formed the Jurassic coast, an arm-like sea-way sprang forth even before the tectonic manifestations had died away. As is easily understood, this channel was, indeed, established in the tectonic depression of the "Dombjærg-Clavering Fault" and the fault running through Fligelys Fjord, i. e. where the "Kuhn Block"'s surface joins the high fault scarp of the western "Clavering-Thomsensland Blocks".

Here in "Niesen Fjord" (as the sea-way has been named by the writer, *vid.* MAYNC 1947) the deposition of marine, though bouldery beds continued from the Volgian onwards into the Cretaceous. However, the boundary between the two systems still cannot be drawn within the true boulder beds of the "Rigi Series", the few *Aucellas* being in too bad a state of preservation to allow a reliable zonation. Yet farther off that coastal scarp finer-grained clastics were deposited and the faunas, consequently, had here better ecologic conditions. It is here, in the surroundings of Lindemans Bugt, that we are enabled to draw the limit with certainty basing upon ammonites and *Aucellas.* In southwestern Kuhn Island, *viz.* in *Laugeites*-Ravine, the series shows a rhythmic sedimentation (4 sedimentary cycles) and the *sub*-Cretaceous boundary runs at the floor of cycle III (MAYNC 1947). Both uppermost Jurassic and Subcraspeditan (Infravalanginian/Rjasanian) are here developed in the same facies, and a discrimination is merely possible by help of paleontological evidence (*vid.* Chapter VI). In Mt. Niesen, on the other hand, the limit is fairly sharp. The underlying cyclic beds, which are identical with those of "Haakonshytta" and *Laugeites*-Ravine, pass into a coarse conglomerate the blocks of which consist of Caledonian crystalline and, moreover, of *Aucella* sandstone reworked from the subjacent Volgian beds[1]) (*vid.* MAYNC 1947). The blocks are closely packed upon another just as in the Volgian "Rigi Series". However, we consider this boulder bed to mark the transgression of the Lower Cretaceous; from now on the facial conditions change and the first inosculations of limestone bands occur bearing an Infravalanginian fauna ("Lower Niesen Beds").

The facies diagram shows the Infravalanginian series to overlap the Kimmeridgian with angular unconformity farther to the east, i. e. at the eastern margin of "Niesen Fjord".

A regional submergence of the block-faulted continental border

[1]) A similar conglomerate carrying boulders of *Aucella* sandstone was met with in the glen north of Zackenbergpasset (*vid.* MAYNC 1947).

allowed the Polyptychitan sea (Middle Valanginian) to encroach upon northeast Greenland. Apart from the singular conditions prevailing in "Niesen Fjord" only subaerial erosional forces have been prevalent which have worn down the topography of the tilted blocks and cut off their prominent edges. On that account the Polyptychitan could transgress upon a flattened land which may partly be called peneplained. Nevertheless, the differentiated movements of certain blocks still persisted into the Cretaceous of which the facies of the near deposits bears a distinct stamp, e. g. in Falskebugt, in Stratumbjærget, in Skiferdal, etc.

The fossiliferous limestone series of the Polyptychitan is very characteristic. In order to distinguish it from the more or less synchronous conglomeratic "Young Sound Facies" the writer used to speak in general of an "Albrechts Bugt Facies", a term which will be maintained in future.

As will be seen, the *Polyptychites-Dichotomites* faunas of the beds in question decidedly point to the Upper Polyptychitan. The *Aucellas* preliminarily identified in the field belong to species that are widely distributed in the boreal province (*vid.* Chapters IV and VI).

The occurrence of *Polyptychites sp.* in the "Upper Niesen Beds" (Polyptychitan-Hoplitidan) enables a reliable coordination of the latter with the faunas derived from the Polyptychitan ("Albrechts Bugt Facies").

On top of the Polyptychitan follow strongly red-coloured beds which announce a regression of the Valanginian Sea. The author designates them "Rødryggen Beds" and holds them to be Hoplitidan in age, i. e. Uppermost Valanginian. The poor fauna, often consisting but of dwarfed *Aucellas*, has not yet been identified, though. However, in Cardiocerasbjærg these beds carry ?*Dichotomites sp.* and *Belemnitidae* (*vid.* p. 85).

Between these "Rødryggen Beds" and the next higher deposits of Aptian-Albian age there is an obvious gap, *viz.* a break in the sedimentation. The Valanginian Sea had completely retreated and nowhere in East Greenland did it linger any longer, as has been suggested by A. Rosenkrantz, H. Frebold, and others. I expect the given stratigraphical sections to speak volumes as to this point.

It was A. Rosenkrantz who first claimed that marine strata of Hauterivian age were present in eastern Kuhn Island (Rosenkrantz 1930a, Bøgvad & Rosenkrantz 1934). This assumption was merely based upon the assignment of *Ammonites payeri* Toula (brought back from Kuhn Island in 1870) to *Simbirskites* (Pavlov), which, beyond doubt, is incorrect; *Ammonites payeri* Toula is certainly not a true *Simbirskites* and has been found, moreover, together with *Aucellas* doubtless indicative of Valanginian age. This my opinion is endorsed by L. F. Spath, after all. As may be read from the sequence in eastern Kuhn Island, the fossiliferous Aptian directly overlies the "Rødryggen

Beds" of the uppermost Valanginian, just as anywhere in the investigated area (Sumpdalen, Rødryggen, Grænsedalen, *vid.* pp. 66—74, Cardioceras-bjærg, *vid.* pp. 83—86).

A clue to the age of the problematical "*Simbirskites*" (*Ammonites payeri* TOULA) is now furnished by the finding of an ammonite which L. F. SPATH takes to be a young form of *Ammonites payeri* TOULA[1]). This ammonite was found *in situ* by the author in the "Niesen Beds" of Mt. Niesen, at an altitude of 380 m (*vid.* p. 96). From the above-given data it results without the least doubt that *Ammonites payeri* TOULA (the supposed "*Simbirskites*") is not so late a form as has always been suggested; for it occurs in Mt. Niesen in beds that are distinctly older than Polyptychitan, *viz.* 80 m below the horizon where *Polyptychites sp.* was found *in situ* in the same section. In the light of this new fact the theory of marine Hauterivian (= "*Simbirskites* Beds" *fide* A. ROSENKRANTZ and others) being represented in northern East Greenland cannot be maintained any longer, of course.

The age of the top beds of the Niesen sequence is not quite established. The miserable ammonite collected *in situ* on the summit of Mt. Niesen is probably a *Lyticoceras sp.* (*vid.* p. 98) though still Valanginian in age.

After a geokratic epoch comprising the Hauterivian and Barrêmian a new regional subsidence followed and the Aptian Sea spread over the whole area. The finding of *Parahoplitoides/Deshayesites*, *Lytoceras polare* RAVN, *Phylloceras* (*Cheloniceras*) *royerianum* (D'ORB.) etc. in the series that overlies the Valanginian clearly proves its Aptian age (*vid.* Chapter VI).

The Aptian Sea ingressed upon a land surface in a young stage of topographical development which must be interpreted by *pre*-Aptian movements. In this case it is rather easy to decide whether these movements were of an orogenetic or epeirogenetic nature: The angular unconformity to the Valanginian displayed at the subface of the Aptian beds in Falskebugt, Wollaston Foreland, bears witness enough that it were orogenetic disturbances which gave rise to this new tilting. The sedimentary conditions near the instable fault scarps will be dealt with in Chapter V.

The Aptian-Albian series is developed in a monotonous facies of alternate shales, marls, or sandstones, which contain the specific red-orange weathering concretions of clay ironstone. Without any fossils at hand it is not possible to class the series in the field as belonging either to the Aptian or the Albian.

Cenomanian-Turonian rocks are nowhere recognized in northern East Greenland for which we account positive tendencies (regional warping).

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[1]) Communication to the writer.

Beds of Lower Senonian (Santonian) age were first made known by H. Frebold in 1934 from Knudshoved, east coast of Hold-with-Hope. It has been mentioned in the former chapter that these Senonian "Knudshoved Beds" overlap the "Home Foreland Beds" which may probably be referred to the Aptian-Albian (*vid.* pp. 141—144).

Locally the Cretaceous beds are unconformably overlain by plant-bearing clastics which must be ascribed to the Tertiary and will be discussed in a future paper.

The Cretaceous beds north of 75° N. lat.

a) Shannon Island.

(*vid.* Fig. 59).

In 1929 R. Bøgvad collected a loose block of clay ironstone with *Inocerami* west of the Danish hut at Cape David Gray, south coast of the island. According to A. Rosenkrantz the said fossils belong to *Inoceramus* (*Heteroceramus*) *cf. ewaldi* Schlüt. which is indicative of a Gargasian (Upper Aptian) age (Bøgvad & Rosenkrantz 1934).

One year later slates containing concretions of clay ironstone were met with a Tellplatte, Cape David Gray, and slightly to the northwest black silicified slates were found to occur *in situ* which have turned contact metamorphic near the basalt formation. These exomorphic beds have yielded a single specimen of *Inoceramus cf. anglicus* Woods that suggests an Albian age (*op. cit.*).

Nothing more is known about the Cretaceous series in Shannon Island. Unfortunately, the writer had to give up his planned sledge-journey to this distant island since he became caught in a several days' blizzard at Bass Rock, early in March, 1938.

The investigation of Shannon Island will thus be reserved for future geologists.

b. Great Koldewey Island.

(*vid.* map Fig. 59).

Valanginian (Polyptychitan).

In 1906 and 1908 the "Danmark Expedition" called at the eastern shore of Great Koldewey Island and brought together rather large collections of fossils which were handed over to J. P. J. Ravn for examination and identification. The main part of these collections, however, consists of Jurassic faunas (Ravn 1911, Maync 1947).

According to J. P. J. Ravn's account "Neocomian" beds occur *in situ* in Aucellabjærget (*vid.* map on p. 169). The stratigraphical data as given by H. Jarner, geologist of the "Danmark Expedition", are rather obscure but were cleared up to some extent by J. P. J. Ravn (*op. cit.*).

Farthest south Caledonian gneiss is reported to crop out which is partly overlain by the "*Aucella* conglomerate". This rock consists of huge gneiss fragments "often larger than a man" (RAVN *op. cit.*) heaped upon another and cemented together by a "light-yellow or reddish-brown limestone, which was formed to a very great extent of shells of *Aucellae*" (*op. cit.*). Moreover, a reddish sandstone was found in the conglomerate, though it is not clear whether it occurs in destructive fragments.

Aucellas are very abundant in the limestone matrix and include the following species:

Aucella (*Buchia*) *crassicollis* KEYS.
— — *piriformis* LAH.
— — *concentrica* FISCH.
— — *sp. ind.* ex *gr keyserlingi* LAH.
(RAVN 1911).

The cited forms, which are partly identical with or very closely allied to those recorded by FR. TOULA from eastern Kuhn Island (TOULA 1874), point towards the *polyptychus* zone (Middle Valanginian).

Adjacent to this "*Aucella* conglomerate" follows the so-called "Gneiss conglomerate" which is said to be different in appearance when seen from afar but, nevertheless, seems to grade into the Valanginian conglomerate. A boundary is drawn between the two formations running obliquely at an angle of about 45°, in other words, the "Gneiss conglomerate" is overlain by the *Aucella*-bearing psephites. This "Gneiss conglomerate" includes gneiss fragments as large as a head which are embedded within a reddish sandstone similar to the Callovian sandstone known from Trækpasset (RAVN *op. cit.*); it is this sandstone which is reported to occur in the Valanginian conglomerate (*vid. sup*). Towards the north the enclosed boulders decrease in size and, moreover, the sandstone matrix grades into a reddish-coloured limestone. The "Gneiss conglomerate" passes into a sandstone.

J. P. J. RAVN takes the "Gneiss conglomerate" to be the basal conglomerate of the transgressing sandstone which he considers to be Callovian in age. The "*Aucella* conglomerate" evidently represents the overstepping Valanginian (Polyptychitan) in a littoral facies (*op. cit.*).

The writer has pointed out in a former paper that the "Gneiss conglomerate" might be correlated with the Volgian "Rigi Series" of Wollaston Foreland (MAYNC 1947), and has obviously been deposited along a steep coast which was subject to tectonic movements. The same applies to the "*Aucella* conglomerate", which was, apparently, laid down unconformably in a gulch-like depression where the older conglomerate had already been partly removed by erosion. Lithologically it resembles the

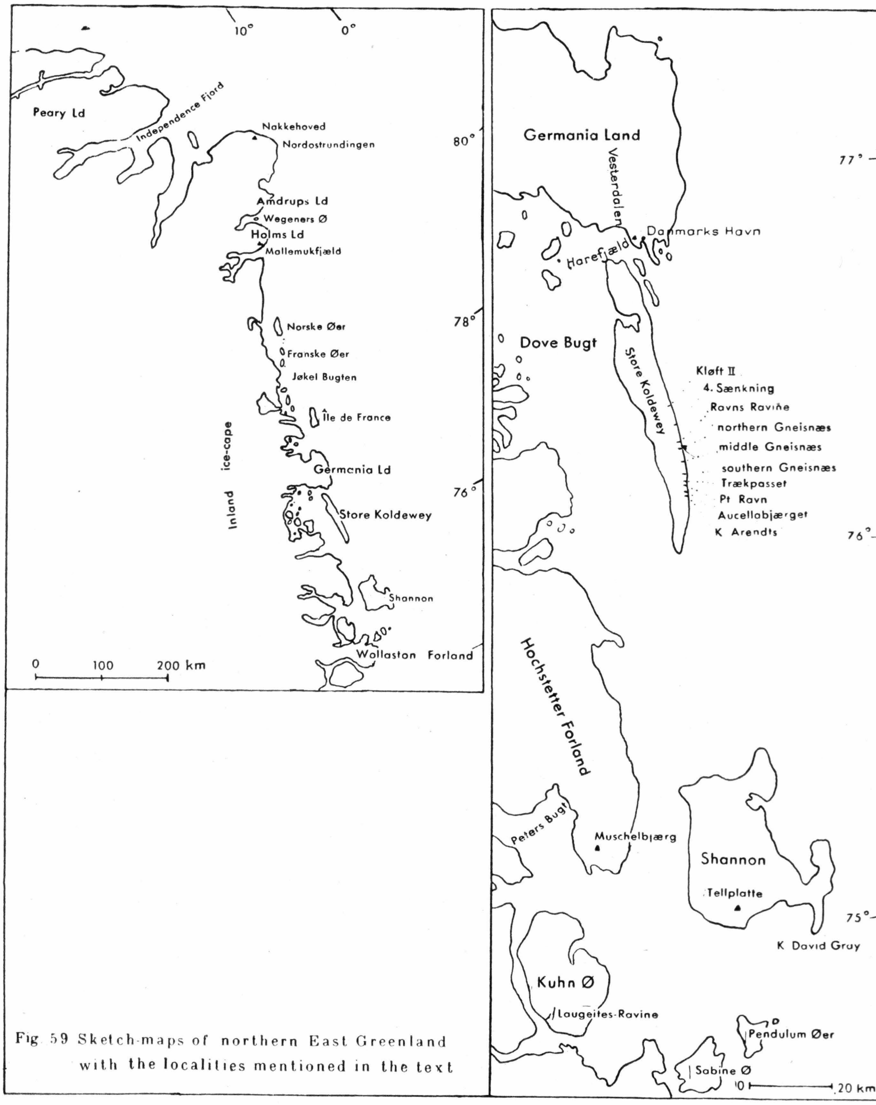

Fig 59 Sketch-maps of northern East Greenland with the localities mentioned in the text

Fig. 59. Sketch-maps of northern East Greenland.

"Young Sound Facies" of the Valanginian in southwestern Wollaston Foreland.

On his sledge-journey in 1927 LAUGE KOCH, too, carried out geological investigations in the island (KOCH 1929a). On his map (in *loc. cit.*) L. KOCH indicates "Neocomian *Aucella* beds" in Aucellabjærget and in Pt. Ravn (P. 135 m), near Trækpasset.

The following section was measured by LAUGE KOCH in Pt. Ravn.

"110—135	meters,	Moraines, probably later re-deposited by water.
103—110	—	Brown hard calcareous sandstone with some *Aucellas*.
99—103	—	Shell-bearing gravel packed with *Aucellas* and ammonites. Collection B.
85—99	—	Clay and fine sand with some *Aucellas*.
65—84	—	Grey coarse sandstone with *Aucellas*, *Ostrea*, and belemnites. Collection A.
50—65	—	Conglomerates with *Aucellas* and water-worn belemnites.
35—50	—	Breccia (arkose) with occasional *Aucellas*.
30—35	—	Granite.
0—30	—	Raised beaches and detritus."

(KOCH 1929a).

This section shows the transgression of the Valanginian upon the granite. The lower portion of the sediments consists of breccia and conglomerate whereas *Aucella*-bearing sandstone etc. make up the higher beds. Accordingly, the lithological-facial and faunal features of the deposits here very much recall those of the more southern region.

A. ROSENKRANTZ has identified the following fossils from L. KOCH's collection A:

Ostrea sp.
Aucella (*Buchia*) piriformis LAH.
— — *keyserlingi* LAH.
Belemnites sp. ind.,

and collection B is reported to include

Aucella (*Buchia*) *piriformis* PAVL.
— — *crassicollis* KEYS.
— — *concentrica* FISCH.
— — *sp.*
Polyptychites (*Euryptychites*) *sp. aff. gravesiformis* PAVL.
(*vid.* KOCH 1929a).

From conglomeratic rocks nearby the following fossils were moreover collected:

Aucella (*Buchia*) *cf. syzranensis* PAVL.
— — *keyserlingi* LAH.
— — *aff. piriformis* PAVL.
Hoplites sp. ind.
(*op. cit.*).

All the faunas mentioned are dated by A. ROSENKRANTZ as Middle Valanginian.

More information concerning the Cretaceous stratigraphy was gained through the survey of E. NIELSEN in the summer of 1933.

According to him indubitable Valanginian beds occur in Ravn's Ravine and in the northern face of the so-called "northern Gneisnæs" (gneiss naze), between the localities "northern Gneisnæs" and "4. Sænkning" of the "Danmarks Expedition".

E. NIELSEN measured the following sections (*vid.* FREBOLD 1935b).

Section in the northern slope of "northern Gneisnæs".

Metamorphic fundament, transgressively overlain by 0.2—0.3 m
65 m rather coarse-grained sandstone, and
4—5 m loose sandstone beds containing fossil wood, *Acroteuthis*, *Aucellas*. Hard sandstone layer with *Aucellas*. Loose gray sandstone of about 2 m in thickness.
81 m Up to 0.4 m thick band of calcareous sandstone with *Perisphinctes sp. ind.*, *Aucellas*.
3 m thick loose gray sandstone beds with badly preserved fossils.
91 m Loose gray mica-bearing sandstone with layers of a harder thinning out sandstone. The top layer has yielded *Perisphinctes sp. ind.*, *Acroteuthis sp.*, and *Aucellas*.

According to a statement of H. FREBOLD the *Aucellas* derived from this succession seem to be identical with those recorded from Pt. Ravn (FREBOLD 1935b).

E. NIELSEN found the Caledonian rocks of the "northern Gneisnæs" to be directly overlain by

Light-coloured loose gravel and sandstones of a thickness of about 25—30 m, on top of which follows a
1 m bed of a gray very coarse-grained sandstone.
Higher up débris (FREBOLD 1935b).

By analogy with the psammitic facies of the Valanginian formation slightly north of this "Gneisnæs" we may assign the same age to this unfossiliferous set of clastics overlying the Caledonian crystalline.

In Ravn's Ravine three sections were measured by E. NIELSEN through the fossil-bearing Valanginian beds. Profile 1 is mostly hidden under surface débris, but successions 2 and 3 give a clear impression of how the basal Valanginian is developed.

Section 2.

49 m Caledonian basement.
Slightly conglomeratic layers, with pebbles 1—2 cm in diameter. The lowermost 0.3 m bed carries petrified wood, *Acroteuthis sp.*, and *Aucella* (*Buchia*) *sp.*

Followed by
very loose shaly gray sandstone.
Predominantly loose sandstone beds, with occasional intercalations of harder sandstone containing sparse *Aucellas*, or with pebbles of calcareous sandstone with a few *Aucellas*.

About 56 m Limestone layer of about 0.1 m thickness, carrying *Inoceramus sp. ind.*, *Terebratula? sp. ind.*

61 m 0.2—0.4 m sandstone layer, with *Inoceramus sp. ind.*, *Terebratula? sp. ind.*
Covered with débris.

H. FREBOLD states (*op. cit.*) that the strata exposed between 49—56 m in height are of Valanginian age whilst those from 56 m upwards represent the transgressing Aptian.

Section 3.

74 m Caledonian basement ("Eleonore Bay formation" L. KOCH 1927).
Overlain by
0.5 m gray mica-bearing coarse-grained sandstone carrying fossils in the lower 0.3 m (*Acroteuthis sp.*). Contains polygenetic pebbles of 1—3 cm in diameter. In the upper part the sandstone is dark-gray and very hard.
1 m light-coloured grayish loose sandstone with sparse *Aucellas* etc.
0.3 m layer of hard sandstone, very rich in fossils, e. g. *Acrothethis sp.*, *Aucella* (*Buchia*) *sp.*, *Avicula sp.* etc.
1 m loose sandstone bed.
1.6 m solid sandstone layer including *Acroteuthis sp.*, *Aucella* (*Buchia*) *sp.*, *Avicula sp.*
2 m loose gray sandstone.

About 80 m 0.2 m calcareous sandstone layer containing frequently rather large blocks consisting of other rock formations. *Aucella* (*Buchia*) *sp.*, *Avicula sp.*
Loose gray sandstone with *Aucella* (*Buchia*) *sp.*, *Avicula sp.*

These Cretaceous beds north of the "northern Gneisnæs" were mapped by L. KOCH as Kimmeridgian (KOCH 1929a).

The Valanginian fossils cited in the above have unfortunately not yet been definitely worked out. However, the fossils determined by A. ROSEN-

KRANTZ from the sequence in Pt. Ravn prove with certainty that the formation is of Polyptychitan age[1]). The quoted species of *Aucella* (*Buchia*) as well as *Polyptychites* (*Euryptychites*) are also characteristic of the Polyptychitan of the region covered in the present paper.

Moreover, it is clearly evidenced by the above-given sections that the Valanginian beds in Great Koldewey Island facially closely recall those farther to the south. Both L. KOCH's section in Pt. Ravn and E. NIELSEN's profiles near the "northern Gneisnæs" and in Ravn's Ravine disclose without the slightest doubt that the Polyptychitan rests unconformably upon the Caledonian basement (KOCH 1929a, FREBOLD 1935b). The same is shown by the writer to be the case in Falskebugt, eastern Wollaston Foreland (MAYNC 1938, 1940; *vid.* pp. 55—60). There is even every reason to believe that the Caledonian composing the backbone of Great Koldewey Island belongs to the same tectonic unit of the step-faulted continental border. The "Falskebugt Beds" have been deposited on the block's dip slope whereas the Valanginian rocks in Koldewey Island have accumulated at the foot of its fault scarp. With regard to its facies the Valanginian in Pt. Ravn strongly resembles the lower portion of our "Falskebugt Beds". The same species of *Aucella* (*Buchia*) are common to both sections, and oysters, which are very rarely found in the Valanginian deposits of East Greenland, occur here and there. Apparently, however, the "Falskebugt Beds" are much richer in fossils.

The Valanginian strata in Pt. Ravn are reported by L. KOCH to be gently inclined (KOCH 1929a), so that their thickness may amount to about 75 m.

The psammitic facies of the Valanginian in Great Koldewey Island, on the other hand, reminds me very much of the "Upper Niesen Beds" in Mt. Niesen the lower part of which, too, is proved by fossils to be Polyptychitan in age. As shown in a former chapter, these "Upper Niesen Beds" were likewise deposited near a Caledonian fault scarp, and the close resemblance of facies is thus not to be wondered at.

The absence of marls and limestones in the Valanginian, which might the compared to the "Albrechts Bugt Facies" in more southern regions, is easily understood when we bear in mind that the beds in Great Koldewey Island were laid down along a shore with prominent capes and indentations (*vid.* FREBOLD 1935b). Yet the marl/limestone facies only occurs off the coast in quiet basins as is stated in Chapter IV.

[1]) A. ROSENKRANTZ's correlation of the *Aucella* beds carrying *Polyptychites* (*Euryptychites*) *aff. gravesiformis* PAVL. with the Lyticoceratan (Lowermost Hauterivian) (*vid.* BØGVAD & ROSENKRANTZ 1934, TEICHERT 1939) is incorrect.

Aptian.

Among the faunas brought back by the "Danmark Expedition" from Great Koldewey Island there were a few new forms which have been described as *Macrodon mylii* Ravn and *Macrodon hagenii* Ravn (Ravn 1911). It stands to reason that J. P. J. Ravn therefore could not fix the age of the beds from which these pelecypods were derived.

H. Frebold has worked out the Aptian faunas collected in 1933 by E. Nielsen (Frebold 1935b) and feels justified in referring them to the Gargasian.

The facts established by E. Nielsen prove that marine Cretaceous deposits in various localities rest directly upon the outcrops of the Caledonian basement, the so-called "Gneisnæs", and that the beds have accumulated in depressions and gullies which had been carved out periodically during Mesozoic erosion phases (*op. cit.*).

In the following the stratigraphical sections measured by E. Nielsen through the Aptian series will be given with the purpose of correlating the formation with that studied in detail by the writer.

1) Section between the "southern" and "middle Gneisnæs".

13 m	Black shale (lowermost bed exposed).
17 m and 20 m	Black shales with large interbedded limestone lenses up to 2 m in length and 0.5 m in thickness. Cone-in-cone structure is often disclosed on the surface of the lenses, which have furnished *Sanmartinoceras pusillum* (Ravn), *Hamites sp. ind.*, *Oxyteuthis*? *borealis* Freb., *Lima rosenkrantzi* Freb., *Inoceramus sp.*, *Dentalium*? *sp.*
About 25 m	Gray coarse-grained sandstone containing a large fossil-bearing limestone lense with *Lytoceras polare* Ravn, *Oxyteuthis*? *borealis* Freb., *Oxyteuthis gracilis* Freb., *Macrodon hagenii* Ravn, *M. mylii* Ravn, *Plicatula kochi* Freb., *Lucina sp. ind.*, *Nucula sp.*, *Inoceramus aff. ewaldi* Schlüt., *Lima ravni* Freb., *Pleurotomaria sp. ind.* II, *Pl. sp. ind.* III, *Fusus*? *sp. ind.*, *Neritopsis nielseni* Freb., *Terebratula sp. ind.*, *Ditrupa aff. decorata* Stoll., *Trochocyathus sp.*, Coral B and C, *Pollicipes sp.*
30 m to 36 m	Gray-black shale containing lenses or 5—10 cm interbeds of coarse-grained fossiliferous sandstone. Both rocks carry limestone concretions. The sandstone has yielded the fauna listed below: *Macrodon hagenii* Ravn, *M. mylii* Ravn, *Opis wegeneri* Freb., *Isocardia erikseni* Freb., *Plicatula kochi* Freb., *Inoceramus aff. ewaldi* Schlüt., *Lima cf. gaultina* Woods,

Nucula friisi Freb., *Neritopsis nielseni* Freb., *Pleurotomaria sp. ind.* I, *Emarginula sp. ind.*, *Terebratula biplicata var. dutempleana* d'Orb., *T. biplicata var. obtusa* Sow., *T. sp. ind.*, *Kingena groenlandica* Freb., *Dentalium? sp. ind.*, *Serpula sp.* I and II, *Ditrupa aff. decorata* Stoll., *Trochocyathus sp.*, *Pollicipes sp.*, fragments of belemnites; fossil wood.

36 m to 41 m Largely limestone lenses, often displaying cone-in-cone-like structure. *Inoceramus sp. ind.*, plant-remains.

41 m to 51 m Black-gray shale with intercalations of a gray sandstone and limestone concretions, rich in plant-remains. The following fauna is recorded by H. Frebold (*op. cit.*): *Oxyteuthis? borealis* Freb., *Belemnites sp. ind.*, *Inoceramus sp. ind.* I, *Lucina sp. ind.*, *Nucula freucheni* Freb., *Macrodon hagenii* Ravn, *Plicatula kochi* Freb., *Lima rosenkrantzi* Freb., *Turnus sp. ind.*, *Neritopsis nielseni* Freb., *Trochocyathus sp.*, Coral B, *Pollicipes sp.*

51 m to 61 m Black-gray shale with an interlayer of coarse-grained sandstone containing lenses of limestone. It yielded *Lytoceras polare* Ravn, *Oxyteuthis? borealis* Freb., *O. gracilis* Freb., *Lima ravni* Freb., *Macrodon mylii* Ravn, *M. hagenii* Ravn, *Plicatula kochi* Freb., *Pecten sp. ind.*, *Scalaria clementina* (d'Orb.), *Pleurotomaria sp. ind.*, *Fusus? sp. ind.*, *Cerithium aff. dupinianum* d'Orb., *Terebratulina aff. striata* Wahlenbg., *Trochocyathus sp.*, and plant-remains.

2) Section north of the "middle Gneisnæs".

62 m 1.2 m gray-brown psephitic sandstone with thin interbeds of shale. The fauna derived from the sandstone includes *Lytoceras polare* Ravn, *Macrodon mylii* Ravn, *Lima rosenkrantzi* Freb., *Lucina sp. ind.*, *Nucula sp. ind.*, *Plicatula kochi* Freb., *Pleurotomaria sp. ind.*, *Terebratula biplicata* Brocchi, Corals.

68 m to 69.5 m Very coarse-grained grayish sandstone standing out in a ledge (1.5 m high). Contains rolled shell-fragments and, moreover, *Lytoceras aff. polare* Ravn, and *Terebratula biplicata* Brocchi.

81 m Hard marl with cone-in-cone structure, attaining at least 0.4 m in thickness. 0.3 m loose coarse-grained sandstone layer. Loose gray-black crumbling shale.

83.5 m to 89 m — Marl showing cone-in-cone structure, in beds of 0.3—0.4 m thickness.
Overlain by loose gray-black shales.

3) Sequence in Ravn's Ravine.

"Profile section 1" was measured by E. NIELSEN through the beds which dip at angles of up to 26° to the east-northeast.

Substratum not exposed.

13 m — Gray-black micaceous loose sandstone with a limestone interbed. Indeterminable specimen of a pelecypod.

15 m to 23 m — Formation as below, carrying *Belemnites*, *Nucula sp. ind. aff. subtrigona* ROEM.; plant-remains.

About 26 m — Gray coarse-grained sandstone, about 0.3 m in thickness, bearing *Sanmartinoceras sp. ind.*, *Lytoceras polare* RAVN, *Nucula sp. ind. aff. subtrigona* ROEM., *Ditrupa sp. ind.*

About 30 m — Limestone layer within 1—2 m thick sandstone beds. The lower sandstone horizon locally passing into a conglomerate containing *Trochocyathus sp.*, and pieces of coal.

About 38 m — Loose gray fine-grained sand. Conglomeratic layers with pebbles more than 1 cm in diameter. About 0.5 m thick. Carries *Crioceras sp. ind.*, *Inoceramus sp. ind.*, *Nucula sp.*, *Macrodon hagenii* RAVN, *Plicatula kochi* FREB., *Opis wegeneri* FREB., indeterminable gastropods, *Terebratula aff. biplicata* BROCCHI, *Trochocyathus sp.*, *Ditrupa aff. decorata* STOLL.
Débris.

In the southern slope of "Kløft II" the succession is as follows:

7 m to 18 m — Black-gray friable shale, with a concretionary interbed at a height of 12 m. Contains *Opis wegeneri* FREB., *Terebratula sp. ind.*, and indeterminable gastropods.

21 m to 51 m — Sandstone, with a fossiliferous bed at the top including *Macrodon mylii* RAVN and *M. hagenii* RAVN.

51 m to 65 m — Loose sand with limestone concretions (layer at an altitude of about 58 m).

65 m to 67 m — Reddish-gray psephitic sandstones with indeterminable fossils.
(*vid.* FREBOLD 1935b).

Summing up, E. NIELSEN's researches in Great Koldewey Island have provided proofs that both the Valanginian and Aptian stages show a transgressive overstep (*vid. op. cit.*). The old Caledonian outcrops are overlain either by Valanginian (Ravn's Ravine, north af the "northern Gneisnæs", Pt. Ravn) or by Aptian (between "Kløft II" and Ravn's Ravine, south of the "southern Gneisnæs", and between the "northern" and the "southern Gneisnæs"). In Aucellabjærget the Valanginian overlaps the Jurassic, and in Ravn's Ravine (section 2) the Valanginian *Aucella* beds are unconformably overlain by the Aptian series (*vid. op. cit.*).

Although the Aptian beds exposed in Great Koldewey Island are but a mere fraction of the thick Aptian-Albian series that is proved to occur farther to the south, a comparison, nevertheless, reveals the greatest conformity. Quite the same lithological properties and facial variety are characteristic of both areas: The formations are isotopic-isopic ones. However, in accordance with the paleogeographical conditions, i. e. with the deposition of the Aptian beds in the very littoral, near the dashing of the waves breaking on shores, where coarse detritus was delivered to the sea, and currents greatly influenced the whole sedimentation, in accordance herewith clay shales are hardly represented in Great Koldewey Island, contrary to the more southern region. Sand and sandstones with conglomeratic layers, sometimes with a thin limestone interbed, largely build up the Aptian formation of Great Koldewey Island. Only from between the "southern" and the "middle Gneisnæs" (*vid.* pp. 174—175) have black-gray shales been recorded (FREBOLD 1935b).

The rich Aptian faunas in Great Koldewey Island chiefly include pelecypods, which is not to be wondered at in view of their littoral habitat. They are, however, mainly recruited by new species. Moreover, there are many faunal elements which are facies-fossils[1]) as for instance *Sanmartinoceras* (BONARELLI) (*vid.* FREBOLD in *loc. cit.*). *Lytoceras polare* RAVN, on the other hand, is an euryhaline form which occurs throughout the whole series notwithstanding the facies.

According to H. FREBOLD the ammonites are not autochthonous elements of the Aptian fauna of Great Koldewey Island but are believed to have floated ashore *post-mortem* from the open sea. They alone allow us to fix the age of the formation in the said island as Aptian (*op. cit.*).

Still one essential point needs a critical examination. L. KOCH has reported a sandstone formation to be exposed between Pt. Ravn and

[1]) Since *Inoceramus* was proved by the writer to occur both in sandy, even psephitic rocks, and in shales, clay ironstone etc., we cannot agree that this genus is a facies-bound form as claimed by H. FREBOLD (in *loc. cit.*).

Cape Arendts (KOCH 1929a) which was observed to overlie the Valanginian succession in Pt. Ravn. A thin interbed carrying fragments of shells is stated to occur in the lower levels of this plant-bearing sandstone series. Higher up follow 60 m of grayish-yellow and purple cross-bedded sandstone and shales containing fossil wood. Finally, on top of the formation two layers of a hard coarse-grained sandstone were detected abounding in well-preserved belemnites which A. ROSENKRANTZ is inclined to refer to *Aulacotheutis*[1]). The thickness of this sandstone group amounts to about 100 m.

Thus it was A. ROSENKRANTZ who conceived the idea that Hauterivian-Barrêmian beds of a continental character should be represented in northern East Greenland (ROSENKRANTZ 1930a), beds which should partly be developed in eastern Kuhn Island in a marine facies ("*Simbirskites* Beds"[2]) of supposed Hauterivian age).

Up to 1935 H. FREBOLD had more than once expressed strong doubts as to the presence of both continental Hauterivian-Barrêmian and the marine "*Simbirskites* Beds" (FREBOLD 1932a, 1933). Yet from this year onwards he (and other authors) all of a sudden were convinced of the justness of A. ROSENKRANTZ's view (FREBOLD 1935a, 1935b, FREBOLD & NOE-NYGAARD 1938, TEICHERT 1939 etc.).

If we approach the problem quite objectively, without any prejudice, there is in the first place no proof at all that the concerned beds in Great Koldewey Island are "continental" ones. Fossil drift-wood and plant-remains are for instance widely distributed in the marine Jurassic and Cretaceous formations of East Greenland and should not be regarded as a criterion for continental sedimentary conditions. The sandstone series in question is of marine-littoral origin, as to which the interbeds with marine fossils give substantial evidence.

On the other hand, there is nothing recorded to allow the conclusion to be drawn that the sandstone formation in question is intermediate between the Valanginian and the Aptian as claimed by H. FREBOLD (FRE-

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[1]) The genus *Aulacoteuthis* of the *Oxyteuthidae* (STOLLEY) is generally accepted to characterize the Lower Barrêmian.

[2]) Up to the present day A. ROSENKRANTZ supports the view that *Ammonites payeri* TOULA, found in eastern Kuhn Island by the KOLDEWEY Expedition (1869—1870), has rightly been designated as *Simbirskites* (PAVLOV) (ROSENKRANTZ 1929, 1930a, BØGVAD & ROSENKRANTZ 1934). The Greenland form in question has even been compared to *Simbirskites* (*Craspedodiscus*) *discofalcatus* (LAH.) from the "Speeton Clay" (PAVLOV & LAMPLUGH 1892, *vid.* BØGVAD & ROSENKRANTZ 1934). The recent investigations carried out by the author in 1937 have proved, however, that neither Hauterivian nor Barrêmian is represented in East Greenland, and that *Ammonites payeri* TOULA (which is no *Simbirskites* at all) occurs in Wollaston Forcland in beds of *sub*-Polyptychitan, *viz.* Infravalanginian/Rjasanian age (*vid.* pp. 95—100, 165—166).

BOLD 1935b). The only reliable datum is the fact that it overlies the Polyptychitan beds between Pt. Ravn and Aucellabjærget. Since no strata of true Aptian age are reported to occur here, it is, of course, objectionable to assume that the sandstone series is *sub*-Aptian. It cannot be inferred from the presence of Aptian beds on top of the Valanginian in Ravn's Ravine that the same succession exists farther to the south since we know the incompleteness of the Mesozoic sequence deposited in Great Koldewey Island. There is every reason to take the concerned psammitic formation to be either another facies of our "Rødryggen Beds" (Hoplitidan) or a sandstone facies of the lower Aptian, after all. As long as the *Belemnitidae* ("*Aulacoteuthis*" *fide* A. ROSENKRANTZ) have not been definitely studied and identified, we cannot place much reliance on them for correlations.

It stands to reason that the writer's conception on this point is merely tentative. It is not the aim of this chapter on the Mesozoic stratigraphy of Great Koldewey Island to solve the existing problems since our field-observations could not be extended as far north as that. Yet we refuse to echo the views of others as long as there is no evidence at hand that it might not be otherwise. If a continental series is proved to occur between the Valanginian and the Aptian, e. g. in Spitsbergen and in Siberia (SOKOLOV & BODYLEVSKY 1931, FREBOLD 1935a, YERMOLAEV 1937, NIKOLAEV 1938a etc.) we cannot conclude that the same must absolutely be found in East Greenland, too[1]).

At any rate the careful field-researches of the writer did not yield the least argument that beds of Hauterivian-Barrêmian have ever been deposited in the area under consideration (*vid. sup.*)

c. Germania Land.

(*vid.* map Fig. 59).

Near the surroundings of its winter-quarters at Danmarkshavn (Germania Land) the "Danmark Expedition" found four loose-lying boulders carrying concretions with Mesozoic fossils which are expected to occur *in situ* in Germania Land or still farther to the north[2]).

J. P. J. RAVN succeeded in recognizing both "Portlandian" and "Lower Cretaceous" forms among these faunas (RAVN 1911).

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[1]) In accordance with the assumption that marine Hauterivian is represented in Kuhn Island (*vid.* sup.) the same stage was supposed to be developed in a marine facies in Novaya Zemlya (*vid.* FREBOLD 1940).

[2]) J. P. J. RAVN is of opinion that these late Mesozoic concretions are derived from "the black slaty clay" that crops out in Jøkel Bay, between 78° and 79° N. lat. (RAVN 1911).

There are 3 localities to be distinguished where erratic boulders have been collected, *viz.* Danmarkshavn, Harefjæld[1]), and Vesterdalen.

According to J. P. J. RAVN the fossiliferous "Neocomian" concretions consist of "a coal-black clayey limestone with few flakes of mica" (*op. cit.*) whereas those bearing "Portlandian" fossils are made up of sandstone.

From Danmarkshavn the following fossils have been determined:

Aucella cf. reticulata (LUNDGR.) RAVN
Aporrhais sp. I
— *sp.* II
"*Garnieria*" *pusilla* RAVN
(= *Sanmartinoceras pusillum* (RAVN)
ROSENKRANTZ 1934).

J. P. J. RAVN referred this small fauna to the "Neocomian" mainly because of the presence of the genus *Garnieria* (SAYN) = *Platylenticeras* (HYATT). However, the listed species of *Aucella* would rather suggest some horizon in the Lower Kimmeridgian.

Since the supposed "*Garnieria*" has turned out to belong to the family of the *Aconeceratidae* (SPATH), *viz.* to the genus *Sanmartinoceras* (BONARELLI), which is specific to the Aptian, J. P. J. RAVN's assiginment cannot be maintained. Nor can the cited "*Aucella*' be identified any longer with this genus.

It may be added that *Sanmartinoceras pusillum* (RAVN) has been found among E. NIELSEN's fossil-material derived from the region between the "southern" and the "middle Gneisnæs", near the base of the exposed Aptian series (*vid.* p. 174).

The concretions collected near Harefjæld have yielded the following fossils:

Aucella (*Buchia*) *mosquensis* (VON BUCH)
Pecten (*Entolium*) *demissum* BEAN (PHILL.)
— — *erraticum* FIEBELK.?
— (*Camptonectes*) *sp.*
Turritella sp.
(RAVN 1911).

This fauna is of indubitable Jurassic age (probably Kimmeridgian, *vid.* MAYNC 1947).

Lithologically different boulders have been brought back from Vesterdalen.

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[1]) Harefjæld is the mountain projecting between Danmarkshavn and Vesterdalen.

The sandstone boulders carry a true Jurassic fauna[1]) (Kimmeridgian-Volgian), but the calcareous concretions have furnished doubtless Aptian forms such as

Lytoceras polare RAVN, and
Sanmartinoceras pusillum (RAVN)
(= supposed "*Garnieria*")
(RAVN 1911).

Both these ammonites may to-day be regarded as index forms to the East Greenland Aptian beds. Above all *Lytaceras polare* RAVN has been found to occur also in Great Koldewey Island, Kuhn Island, and Wollaston Foreland (*vid.* FREBOLD 1935b, MAYNC 1940).

Among the black calcareous concretions originating from the neighbourhood of Danmarkshavn there are two that carry imperfect small-sized "*Aucellae*" (RAVN 1911). J. P. J. RAVN was of opinion that they might possibly belong to *Aucella* (*Buchia*) *terebratuloides* LAH. (*op. cit.*). A. ROSENKRANTZ, however, after having examined the lamellibranchs in question, was convinced that they should be placed into the genus *Crenella* (BROWN). According to him the Northeast Greenland forms should be referred to a related species of *Crenella bella* (Sow.) (BØGVAD & ROSENKRANTZ 1934) which is found in the middle part of the Aptian of England.

[1]) *Oxytoma inaequivalvis* SOW. *var. münsteri* BRONN, *Pseudomonotis? sp.*, *Aucella* (*Buchia*) *cf. reticulata* LUNDGR., *A.* (*B.*) *tenuistriata* LAH., *Pinna sp.*, *Pecten* (*Entolium*) *erraticum* FIEBELK.?, ?*Pecten* (*Camptonectes*) *broenlundi* RAVN, *Modiola sp.*, *Yoldia sp.*, *Macrodon* (*Parallelodon*) *schourovskii* (ROUILL.), *Dentalium nodulosum* LUNDGR. (RAVN 1911).

IV. SEDIMENTATION AND FACIES OF THE CRETACEOUS DEPOSITS

Most of the faults recognized in the explored area have played an important rôle during the sedimentation as their fault scarps have acted as morphological factors. This causal relation between tectonics, stratigraphy, and facies will be discussed in chapter V (p. 218 ff).

The facies diagram (Pl. 3) clearly discloses the overlap of the boreal Polyptychitan sea upon the land that had been drained since the orogeny in late Kimmeridgian-times. Above all it clarifies the divergent conditions that have prevailed simultaneously farther to the west, in the tectonic depression at the base of the fault scarp of the "Clavering Thomsensland Blocks". This shoaly "Niesen Fjord" was already flooded in Volgian time, just after the main step-faulting had taken place (*vid.* Maync 1947). Owing to a continuous slow subsidence marine deposits continued to be accumulated here whilst the eastern blocks were still dry land. Consequently, beds of the Lowermost Cretaceous (Infravalanginian/Rjasanian) were deposited in no other place, and it is therefore that the sequences and faunas of the former "Niesen Fjord" are of outstanding importance for the East Greenland stratigraphy.

The writer has already remarked that the Infravalanginian slightly oversteps older Jurassic strata along the eastern margin of the basin, e. g. in the eastern slope of Palnatokes Bjærg (*vid.* p. 94). Besides, the boulder bed occurring in Mt. Niesen at 120—200 m altitude may be interpreted as the base of that transgression. Though there does not exist any visible break in the sedimentary succession in Mt. Niesen, a discontinuity and then a change in facies mark the Jurassic-Cretaceous boundary. In *Laugeites*-Ravine, southwestern Kuhn Island, this limit, on the other hand, runs within a facially uniform cycled series where a hiatus may hardly be supposed to exist, though we have hitherto no traces showing that the Spiticeratan is represented (*vid.* p. 29 ff).

Infravalanginian/Rjasanian.

The Volgian banded series of alternate black sandy shales, yellow sand, muscovite-bearing sandstone, and *Aucella* sandstone with pebbly interlayers is followed in Mt. Niesen by a set of current-bedded sandstone and conglomerate with shale partings (rhythmic sedimentation). The coarseness of the clastic material evidently increases upwards, and there occur densely-packed boulder beds with Caledonian components and, moreover, large blocks of reworked *Aucella* sandstone of Volgian age. As already stated these boulder beds are looked upon as the base of the Infravalanginian/Rjasanian formation ("Lower Niesen Beds").

Then follow conglomerates and sandstones with the first interbeds of limestone carrying *Aucellas*, e. g. *Aucella* (*Buchia*) *cf. volgensis* Lah. and others, and *Berriasellidae* (partly types which characterize the Infravalanginian of Jameson Land, partly completely new forms not yet described). Furthermore, fossil wood, plant-remains, and carbonaceous matter are by no means rare.

Still higher, *viz.* at a height of 260 m, occur gray sandy shales with seams of yellow sand which facially agree entirely with the Volgian-Subcraspeditan formation near "Haakonshytta", southwestern Kuhn Island. This series, too, is interbedded with limestone bands that have furnished *Aucellas*, ammonites, and belemnites (*vid.* p. 96). Still farther up in the Mt. Niesen section red-brown sandy shales with in-osculations of sandy fossil-bearing limestone are exposed which, at a height of 380 m, have yielded a juvenile specimen of *Ammonites payeri* Toula (= supposed "*Simbirskites*" *fide* A. Rosenkrantz and others).

The gray or pink shales and marls with limestone layers, etc., occurring from 390 m upwards may already be referred to the Polyptychitan.

It has turned out that the top beds of the Volgian series in *Laugeites* Ravine, southwestern Kuhn Island, are Infravalanginian/Rjasanian in age since they contain specimens of *Subcraspedites* (Spath) like those from the "Spilsby Sandstone" of Lincolnshire (*vid.* Chapter VI).

It must be left to future research to solve the problem of drawing the stratigraphical boundaries between the Volgian and Infravalanginian, and the Infravalanginian and Polyptychitan, respectively, within the synorogenetic "Rigi Series" along the western margin of "Niesen Fjord".

With the exception of a still doubtful locality in Traill Island marine Infravalanginian beds are developed in southern Jameson Land, Scoresby Sound (Aldinger 1935, Spath 1936). Otherwise there is no trace at all of Cretaceous deposits here[1]).

[1]) A few badly preserved ammonite-fragments were brought back in 1900 by O. Nordenskjöld from sandstones exposed in Fossil Mountain, central Jameson

According to the results of H. ALDINGER's studies in southern Jameson Land, Infravalanginian beds crop out in Crinoid Mountain, Rauk Plateau as well as e. g. in Mussel- and Horse Rivers (ALDINGER 1935, Pl. 2). The age assignment "? Infravalanginian" (as suggested by L. F. SPATH[1]) is based upon the finding of hitherto unknown ammonites which are associated with others showing affinities to forms from the Russian "Rjasan Beds". Furthermore, *Aucella* (*Buchia*) *volgensis* LAH. is proved to occur (*op. cit.*). H. ALDINGER is inclined to regard these beds as an equivalent of the "Hartzfjæld Sandstone" of Milne Land. To be sure, the find of *Subcraspedites* (*groenlandicus* SPATH) and *Aucella* (*Buchia*) *fischeriana* (D'ORB.) in the upper portion of the "Hartzfjæld Sandstone" discloses its Infravalanginian age with certainty (*vid.* SPATH 1936, MAYNC 1947).

H. ALDINGER gives the following section through the Infravalanginian beds of southern Jameson Land:

Marls and sandstones of unknown age, overlain by

Lower part	Sandy shales with pyrite concretions and plant-remains. About 80 m sandy shales and thin, sometimes concretion-bearing, sandstone layers. Ammonites. Large concretions containing Crinoids, Asterids, ammonites, fossil bored wood.
Upper part	Fossiliferous layer of calcareous sandstone with glauconite, carrying ammonites, belemnites, pelecypods, e. g. *Aucella*, *Trigonia*, *Astarte* etc., and gastropods. About 5 m bed of coarse-grained sandstone with *Aucella* (*Buchia*). Hard cross-bedded coarse-grained micaceous sandstone, partially thick-bedded, containing large concretions. Trails of invertebrates.

The lower portion of this Infravalanginian succession includes about 150 m of sediments, and the upper part attains about 100 m in thickness (ALDINGER *op. cit.*).

Not only with regard to the fossil content but also lithologically

Land, which V. MADSEN has described as "*Olcostephanus* (?*Simbirskites*, PAVLOW & LAMPLUGH) *nov. sp.*" (MADSEN 1904). L. F. SPATH is inclined to refer these forms to *Subcraspedites* (SPATH) or to the *Polyptychidae* (*vid.* SPATH 1932). If these identifications should hold true. they would indicate that marine Lower Cretaceous strata are preserved in the central or northern part of Jameson Land. However, the latest investigations of the whole area of Jameson Land, carried out by H. STAUBER in 1938, have not given the slightest evidence that *post*-Jurassic formations should occur here.

[1]) The new finds of Infravalanginian faunas in southwestern Kuhn Island and Wollaston Foreland have fully confirmed the view of this eminent English paleontologist.

and facially this formation of southern Jameson Land obviously corresponds exceedingly well to the "Lower Niesen Beds" of Wollaston Foreland.

Polyptychitan (Middle Valanginian).

The Polyptychitan of northern East Greenland, between Kuhn Island and Clavering Island, may be developed in two different facies, namely in the "Albrechts Bugt Facies" (marl/limestone series) and the "Young Sound Facies" (conglomeratic facies near instable fault scarps).

The first term was already used by the writer during his field surveys whereas the name "Young Sound Facies" is used for the first time in the present paper.

Before discussing the Middle Valanginian beds and their facies it will be necessary to set some errors straight in A. Vischer's latest memoir (Vischer 1943).

Inconsiderate of the fact that neither the stratigraphical nor the faunal conclusions had yet been drawn A. Vischer put forward his ideas as to the paleogeography of the investigated area in Valanginian time, views that do not hold good, unfortunately.

The said author distinguishes three facies of the Valanginian, *viz.* a "Lindemansbugt Facies", an "Albrechtsbugt Facies", and a "Kuhnpas Facies" (*op. cit.*).

The term "Albrechts Bugt Facies" was created in East Greenland by the writer and is still valid for the gray or yellowish-pink marls and marly shales with limestone bands and -nodules, which overlie directly the Jurassic and bear rich faunas of the Upper Polyptychitan (*vid. Maync* 1938, 1939, 1940, 1947). In accordance with the name given this facies of the Polyptychitan is, first and foremost, developed in the region of Albrechts Bugt, e. g. in Rødryggen, Sumpdalen, Græensedalen, and in southeastern Kuhn Island. Moreover, it is characteristically represented near Cardiocerasbjærg and in Kuhnpasset, southwestern Wollaston Foreland, where A. Vischer felt justified in speaking of his "Kuhnpas Facies". The mere difference in thickness which seems to have been the main reason for A. Vischer to establish his "Kuhnpas Facies" is no valid argumentation for such a conclusion, after all. Besides, A. Vischer includes a set of deposits on Kuhnpasset into the Middle Valanginian. This correlation is not yet proved and I think the beds in question should most probably be assigned to the Aptian (*vid.* pp. 88, 194). It is at any rate inadmissible to assume that the Valanginian beds in Kuhnpasset have been deposited in deeper water than those developed in the "Albrechts Bugt Facies" since both formations resemble each other lithologically very closely. It may only be said that the bottom of the basin in southwestern Wollaston Foreland continued to subside slowly during the sedimentation of the Valanginian, and thus a thicker set of strata was enabled to accumulate without its facies being changed considerably. It is beyond doubt that the marl/limestone series of the Polyptychitan was formed in shallow water.

A. VISCHER's hypothesis of a landmass that is supposed to have extended east of Albrechts Bugt during the Valanginian (*op. cit.*) cannot be shared by the writer. This hypothesis is based on the assumption that Valanginian beds are stratigraphically absent in that area, which, however, is anything but proved. On the contrary, the Valanginian strata are still exposed north of Sumpdalen (*vid.* pp. 66—69) and are visibly cut off by a fault a little farther west. The outcrop of that same fault was discovered in the section on the southwestern slope of Bern Plateau (*vid.* pp. 47 ff.) where the Valanginian is now downfaulted and the Aptian-Albian series lies in tectonic contact with the Kimmeridgian. The apparent absence of the Valanginian beds is thus not a primary phenomenon but is due to a *post*-Valanginian fault, at least to the best of my knowledge.

In a previous memoir the writer concludes that the main part of the "Rigi Series" must be classed as Volgian, not as Valanginian as assumed before (*vid. Maync* 1947). Since A. VISCHER's "Lindemansbugt Facies" actually refers to the Volgian which the author has treated in his Jurassic paper, it is not necessary any more to make this problem the subject of discussion.

It is a pity that A. VISCHER's otherwise reliable work contains such errors and inaccuracies with regard to the stratigraphy, which for a great part must be ascribed to the impossibility of discussing any problems with the author during his stay in occupied Java.

The "Albrechts Bugt Facies" of the Polyptychitan was found to pass laterally into clastic beds.

In the sequence of Mt. Niesen the Polyptychitan, too, is developed in this marl/limestone facies rich in Valanginian *Aucellas.* Farther up, however, coarse-grained sandstones and even conglomerates with interbeds of limestone predominate, which testifies to the growing influence of a near coast upon the sedimentation in "Niesen Fjord". Yet the finding of a specimen of *Polyptychites sp.* in these higher strata shows that they still are of Polyptychitan age. Still higher in the succession the light-gray marly *Aucella*-bearing limestones of the "Albrechts Bugt Facies" occur again being overlain by alternate sandstones and psephites with limestone interbeds, which make up the sequence until the summit of Mt. Niesen (P. 688 m). Since the numerous *Aucellas* brought back from these beds are not yet worked out the writer is not in a position to draw the upper boundary of the Polyptychitan. The *Lyticoceras* *sp.* found on the very summit is unfortunately too poorly preserved to throw more light upon this question.

From Albrechts Bugt the marl/limestone series of the Polyptychitan can be traced to the east. The last outcrops are those north of Sumpdalen and in Grænseryggen (*vid.* pp. 66—70, 73—74). Farther to the east both the Jurassic and the Valanginian beds are downfaulted below the ground's surface and accordingly nothing can be said about the Valanginian facies. However, on the western slope of the projecting core of the "Hühnerbjærg Block" Valanginian rocks were again found to rest directly upon the Caledonian crystalline (Maync 1938, 1940) which are named "Falskebugt Beds" (*vid.* pp. 55—60). Here the Valanginian is developed in a coarse-clastic facies closely similar to that of the Volgian "Rigi Series". Accordingly, the Caledonian inlier of Hühnerbjærg-Falkebjærg must have emerged in Valanginian time. The composition of the "Falskebugt Beds" may be compared to the "Young Sound Facies". The occurrence of fossiliferous Valanginian in such a clastic facies in Falskebugt shows that the "Albrechts Bugt Facies", already much reduced in thickness north of Sumpdalen, grades eastwards into the "Falskebugt Beds".

There is not much to be said about the "Albrechts Bugt Facies". The marls and limestones have been deposited in a shoal sea where, generally speaking, no coarse terrigenous detritus could spread from a near land.

Although the Polyptychitan beds are deposits of an encroaching sea, there is nowhere any trace of clastic basal conglomerates. The transgression phase is mostly marked by a thin limonitic loamy zone carrying pyritic nodules, carbonaceous matter, and petrified wood.

From the local sections given in a previous chapter it appears that the "Albrechts Bugt Facies" of the Polyptychitan consists exclusively of light-gray or pink slightly silty marls and limestones, sometimes nodulous and often turning rough on weathering[1]). In Wollaston Foreland light-gray or whitish soft marly limestones and marly shales are widespread, containing interbedded layers or nodules of limestone such as described above. In general the limestones are rich in *Aucellas* and other pelecypods, belemnites, *Polyptychites sp.*, *Dichotomites sp.* etc.; horizons of shelly limestone and breccias composed of *Aucellas* which have been heaped together are common (*vid.* Fig. 60).

On top of these light-gray or whitish marls and limestones rest mostly red-coloured calcareous sandstones, heterogeneous hematitic

[1]) Loose blocks of gray limestone carrying *Aucella* (*Buchia*) *piriformis* Lah., which were collected in Bjørnedal, Traill Island, show that the Valanginian beds in the "Albrechts Bugt Facies" are also represented in southern East Greenland (*vid.* Frebold & Noe-Nygaard 1938).

breccias, marls, shelly rocks, and concentrations of drift wood etc. These deposits which decidedly point towards a regional warping, i. e. a regression of the Upper Polyptychitan sea, are termed by the writer "Rødryggen Beds" (*vid.* p. 72), These red beds are believed by the author to represent the Hoplitidan (Uppermost Valanginian). Their faunas are composed of small bivalves, *Aucellas*, belemnites, crinoids etc.; in Cardiocerasbjærg they have furthermore yielded an ammonite.

The stratigraphical equivalent of the "Rødryggen Beds" in the standard-section of Mt. Niesen is still unknown. There are no such strata present, but we may assume that they change in facies towards the marine "Niesen Fjord". Possibly the "Rødryggen Beds" are represented by the reddish psephitic sandstones with conglomeratic interbeds that are exposed in the succession of Mt. Niesen at 570—600 m altitude. It is much to be hoped that paleontological considerations will help towards a definite understanding of this important sequence.

It may be added here that nowhere in East Greenland—with the exception of the Polyptychitan in the "Albrechts Bugt Facies"—have limestones been sedimented to such thicknesses during the entire Mesozoic era. Never since late Permian times has such a continuous limestone formation been laid down. This poverty of calcium carbonate of the East Greenland sediments has been ascribed to the high concentration of hydrogen ions in the cold boreal waters (*vid.* Aldinger 1935)[1]). Part of the organic carbon dissolved in the Greenland Sea was not precipitated because of the water's saturation with carbon dioxide which led to the formation of lime bicarbonate. On the other hand, the absence of limestone in the Mesozoic series of East Greenland may be explained by the fact that e. g. the mudstone and shale formations (Kimmeridgian, Aptian-Albian) originated in badly ventilated basins where a surplus of free hydrogen sulphide prevented the lime carbonate in solution from being precipitated (formation of calcium hydrosulphide).

In contrast to the marl/limestone facies, which has only arisen in relatively shallow water free of coastal detritus and turbidity, we may distinguish a coarse-clastic partly even synorogenetic facies of the Valanginian, the "Young Sound Facies".

Beds in the "Young Sound Facies" have been formed within range of instable coasts (fault scarps), e. g. along the northern slope of the "Kuppel Block" (Stratumbjærget, Skiferdal, Cardiocerasbjærg), in "Niesen Fjord", and along the western face of Hühnerbjærg (Falskebugt). Since the deposition of these clastic rocks depended on tectonic movements of

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[1]) However, this theory might only hold good if proofs were at hand that the Mesozoic Greenland Sea has been a cold sea, indeed.

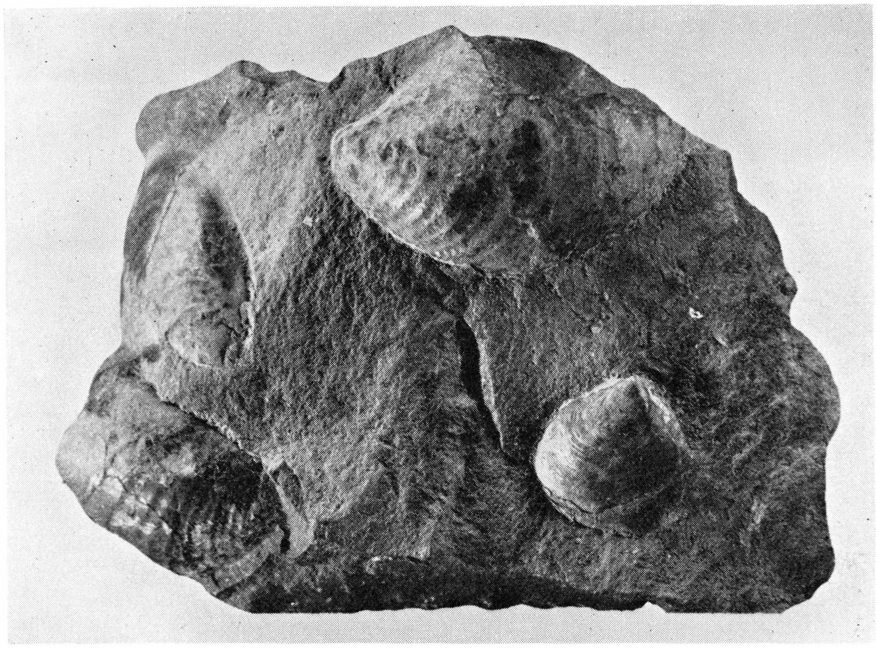

Fig. 60. Aucella limestone of the Polyptychitan („Albrechts Bugt Facies), with *Aucella (Buchia)* ex *gr keyserlingi-piriformis* LAH. Cardiocerasbjærg, Wollaston Foreland (550 m altitude) Lot. 2085 Coll. W. MAYNC.

the hinterland, they will be more closely dealt with in a subsequent part of the present memoir (Chapter V).

The sedimentary conditions of the Valanginian in the "Young Sound Facies" very much recall those of the synorogenetic "Rigi Series" of Volgian age. Here and there coarse boulder beds accumulated at the foot of tectonic cliffs (fault scarps) and here intermingled with the conglomeratic deposits of the encroaching Valanginian sea to a jumble of rock masses.

In Stratumbjærget the jagged line of unconformity is *de facto* visible (*vid.* pp. 79 ff). Deep pockets in the eroded Jurassic surface are filled with ferruginous sands, breccias, or "*bolus*"-clay which grade upwards into unstratified block breccias and -conglomerates. These clastics contain densely packed angular boulders of Caledonian provenience which have tumbled down the coastal "*falaise*". Furthermore, huge angular fragments of the underlying Jurassic sandstones are embedded amidst large well-rounded cobbles of quartzite which are sometimes coated by a weathered crust rich in iron and manganese oxides. Subordinately, oval faceted pebbles are present within the gray psephitic muscovite-bearing cement.

Included into the deuterogeneous constituents are lumps of a gray or yellowish *Aucella* limestone which is indistinguishable from the widely distributed fossil-bearing limestone of the Polyptychitan ("Albrechts Bugt Facies"). It should be stressed, however, that on the whole we have not to deal with pebbles or boulders worked up from subjacent rocks (as might be thought at first sight) but with enclosures and lenses which are contemporaneous or penecontemporaneous with the matrix[1]). Never did I observe any rounded limestone block the shape of which might have suggested a handling by running water. That these limestone lumps are as a rule no destructional rock fragments, is proved by the fact that the numerous *Aucellas* show not the least trace of being blunted or rounded either but are considerably well preserved. The fact that clusters crowded with Caledonian pebbles may frequently be found within the limestone blocks speaks likewise in favour of a synchronism. The *Aucella* faunas derived from the limestone components as well as from the conglomeratic matrix are, apparently, identical and point towards the Polyptychitan.

Closely related facially to the coarse clastics is the rock formation of the "Falskebugt Beds" in eastern Wollaston Foreland which overlies the Caledonian gneisses north and south of Falskebugt (*vid.* pp. 55—60). Here, too, coarse gneiss breccias and polymictous conglomerates occur apart from arkoses and fossiliferous sandstones. In Hühnerbjærg the gneiss breccias grade upward into coarse-grained sandstones carrying lumps of light-gray or pink limestone which cannot be distinguished from that of the Valanginian formation in the "Albrechts Bugt Facies". These limestone lumps bear the most variegated Valanginian fauna hitherto found in East Greenland, and also the sandstones are rich in fossils. The two members have for instance *Aucella* (*Buchia*) ex *gr keyserlingi Lah.* or *piriformis Lah.*, *A.* (*B.*) *crassicollis Keys.* etc., *Rhynchonella sp.*, *Pecten sp. et cetera* in common and are thus contemporaneous.

The sandstones pass upward into a true limestone formation built up of limestones completely identical with those occurring below as embedded lumps. On the other hand, the limestone beds contain clusters of coarse quartz sand and even pebbly seams. This interrelation of limestone and terrigenous detritus shows emphatically that there is no difference in age between tho two rock members.

It may be stressed that the same transition from the clastic facies to the Polyptychitan limestone was observed in Cardiocerasbjærg and Palnatokes Bjærg.

Unfortunately, it is not possible to record the primary thicknesses

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[1]) It is beyond a doubt, for instance, that the limestone block with *Isastraea sp.* of which H. FREBOLD has given a reproduction (FREBOLD 1932b, Fig. 11, p. 32) has undergone transportation.

of the Valanginian beds as for the most part they are merely preserved as remnants. After all, a break in the sedimentation or an interval of erosion exists between the Valanginian and the overlapping Aptian-Albian deposits during which portions of the Lower Cretaceous formations were swept away. To be sure, we have even proofs of local tectonical movements of the "Hühnerbjærg Block" having taken place in *post*-Valanginian/*pre*-Aptian time, which, of course, just rejuvenated the erosion. That the Aptian sea spread over a strongly modeled landscape has already been mentioned above.

In the quiet Polyptychitan sea, away from the littoral zone with its accumulations of terrigenous detritus, the primary thickness of the deposited limestone series ("Albrechts Bugt Facies") is, of course, much less than that of the coarse clastic beds with large boulders heaped upon another. In southeastern Kuhn Island its thickness amounts to 70 m, in Grænseryggen to 25 m, and in the section of Rødryggen to 20 m, + about 10 m for the thickness of the "Rødryggen Beds", respectively. North of Sumpdalen the Polyptychitan limestone has dwindled away to a thickness of mere 5 m (+ 15 m "Rødryggen Beds"). On commenting the section of Mt. Hammeren (Antoinette's Bjærg) stress has been laid upon the entire absence of Valanginian beds (*vid.* p. 76). Mention has been made of A. Vischer's field-observation that the Valanginian visibly pinches out progressively south of Rødryggen in such a way that the lower fossiliferous beds peter out southwards and younger strata overlie the Jurassic (Vischer 1943). North of Mt. Hammeren, finally, the Aptian-Albian oversteps the Kimmeridgian shales (*vid.* Fig. 21). To explain this stratigraphical overlap it is quite indispensible to assume that the "Permpass Block" with its dissected cover of Jurassic deposits was already tilted to the northwest (due to the late Cimmerian Orogeny) and formed a coast of the Polyptychitan sea.

The thickness of the clastic formations of the Valanginian is likewise far from being constant owing to the *intra*-Cretaceous erosion. In Skiferdal only 25 m of the Valanginian is exposed, on the western slope of Stratumbjærget it is exposed from its base up to the normal contact with the Aptian to a thickness of only 10—15 m. On the ridge southwest of the same mountain the Valanginian conglomerate is preserved in two relics at an altitude of 285 m and 360 m, respectively. The thickness of the lower exposure is only 4—5 m, that of the higher remnant 20 m (+ about 15 m of sandstone with interbeds of *Aucella* limestone). It should be borne in mind, however, that the position of the Valanginian formation is almost horizontal, so that each stratum abuts against the inclined Jurassic surface. This should, of course, be taken into account when we compute the total thickness of the Valanginian which thus amounts to about 100 m. In Cardiocerasbjærg, on the other hand, the conglomeratic Valanginian attains a thickness of 25 m, *viz.* from 240 m to 265 m altitude. At a height of 440 m, however, we find about 25 m of Polyptychitan limestone to overlie the Kimmeridgian. With a view to what has been said about the angular unconformity between the Jurassic and Cretaceous in Stratumbjærget, we are obliged to consider both occurrences as part of the same Valanginian sequence the middle portion of which has fallen a victim to erosion in late geological times. In consideration hereof the thickness of the Valanginian in Cardioceras-bjærg amounts to at least 200 m. In the western face of the mountain only 50 m clastics and about 70 m *Aucella* limestone are exposed.

In "Niesen Fjord", where no hiatus has been found to exist within the Volgian-Cretaceous sequence, the Infravalanginian/Rjasanian sets in at about 200 m height. The beds forming the summit of Mt. Niesen (P. 688 m) are still Valanginian in age (*vid. sup.*), so that the exposed thickness of the Valanginian here reaches about 570 m.

The "Falskebugt Beds" of Valanginian age may attain a thickness of 40—50 m whilst the remnant of Valanginian conglomerate in Clavering Island is but 5 m thick.

Beds of Valanginian age have been described by the author from Kuhn Island, Wollaston Foreland, and Clavering Island. Contemporaneous rocks occur in Traill Island (FREBOLD & NOE-NYGAARD 1938) and Geographical Society Island (STAUBER 1940), but nothing is known about their stratigraphy. Only a gray limestone carrying *Aucella* (*Buchia*) *piriformis Lah.* is recorded from southern Traill Island (FREBOLD & NOE-NYGAARD 1938) which testifies that Valanginian in the "Albrechts Bugt Facies" must be developed as far south as that.

Still north of the area considered in the present report, namely from Great Koldewey Island, Valanginian was recorded long ago (RAVN 1911; *vid.* pp. 167—173).

Hoplitidan (Upper Valanginian).

Whilst the Polyptychitan evidently corresponds to a marine transgression of wide extent there is information at hand that this sea soon afterwards receded from northern East Greenland, not to advance again until Aptian time.

In the whole region around Albrechts Bugt and in the vicinity of Cardiocerasbjærg we found the light-gray or yellowish marl/limestone series of the Polyptychitan to be conformably overlain by red beds to a maximum thickness of about 15 m. The term "Rødryggen Beds" is proposed for this regressive series, after the type locality Rødryggen in Wollaston Foreland, south of Albrechts Bugt (*vid.* pp. 70—72).

The "Rødryggen Beds" are made up of strongly red coloured sandstones, calcareous or marly sandstones, breccias, and clayish sands, occasionally, e. g. in eastern Kuhn Island, containing limestone concretions and interbeds of shell breccia (?*Aucellas*). Small bivalves and weathered belemnites are not rare and indicate that the red beds are still of marine origin. The same reddish sandy limestones on top of the Polyptychitan limestones in Cardiocerasbjærg carry? *Neohibolites sp.*, which shows that the forming of red beds locally even lasted into the Aptian. The finding of an ammonite in the extreme top bed of the Polyptychitan limestone in Cardiocerasbjærg which L. F. SPATH holds to be "Aptian" in age[1]), would provide unsuspected support for this conception.

The rather abrupt facial change from the underlying limestone formation to the "Rødryggen Beds" suggests that an epeirogenetic regional uplift has taken place leaving the tectonic structure intact. This slow elevation of the sea bottom caused a gradual shoaling and shrinking of the Upper Valanginian sea. The sedimentary conditions must have been such as to favour oxidation since the beds are stained red by finely distributed hematite. Too less decaying organic matter must thus have been at disposal that might have caused a reduction of this ferric iron. Possibly the "Rødryggen Beds" include more or less eluvial deposits, i. e. they represent an insoluble weathering-residue, decomposed *in situ* on top of the limestone formation such as e. g. the present-day "*terra rossa*". The occurrence of weather-worn *rostra* of belemnites in the "Rødryggen Beds" north of Sumpdalen (*vid.* p. 68) is possibly due to corrosion *in situ*, and the belemnites should not, therefore, necessarily be taken for older reworked ones.

We may at any rate assume a general retreat of the sea at the close of the Valanginian stage. This retirement and the following restoration of continental conditions clearly explain the primary stratigraphical gap in northern East Greenland, comprising the Hauterivian-Barrêmian.

It is not yet known which formation of the "Upper Niesen Beds" corresponds to the "Rødryggen Beds" of the outer region. As is shown on the facies diagram of the Lower Cretaceous (Pl. 3) we must expect the red beds on top of the Polyptychitan around Albrechts Bugt to grade into a lithologically different series towards the west. The existence of true Polyptychitan in the sequence of Mt. Niesen is proved by the presence of *Aucellae* and a specimen of *Polyptychites sp.*, but the overlying beds are entirely different from the "Rødryggen Beds". It is, however, not farfetched to assume that the red beds in "Niesen Fjord" are represented by another facies; maybe they are comprised in the thick alternation of sandstones and conglomerates with *Aucella*-bearing limestone bands (*vid.* p. 97). Be that as it may, it is beyond doubt that the top layers in

[1]) Letter to the writer.

the Niesen sequence are of *post*-Polyptychitan age, and since no gap in the sedimentary record can be ascertained it will be obvious that the "Rødryggen Beds" are here replaced by another facies. The paleontological studies on the *Aucella* faunas of northern East Greenland will possibly bring to light some new data by means of which this question may be settled.

The clastic Valanginian rocks of the "Young Sound Facies" pass upwards into a reddish-gray micaceous sandstone that carries small concretions; then follows the shale series of Aptian age (*vid.* p. 82—83). In Stratumbjærget the Valanginian conglomerate is likewise overlain by muscovite sandstone which is superposed by a few meters of *Aucella* limestone and of a 2—3 m thick conglomeratic sandstone (= base of the Aptian series). The succession in Kuhnpasset shows somewhat peculiar features: On the usual light-gray Polyptychitan limestone lies a yellowish or reddish silty limestone containing brownish concretions, which probably corresponds to the "Rødryggen Beds". Then follows a formation about 120 m thick (from 430—530 m height) the age of which is not fixed yet. This series consists of marly limestone and sandy shale bearing large lumps of clay ironstone. The exuberant *Aucella* fauna has apparently become extinct, the only fossils observed here were belemnites. These 70 m beds are overlain at a height of 490 m by alternate dark bituminous fine-grained sandstones and sandy shales, almost attaining 50 m in thickness, carrying small lamellibranchs and carbonized plant-remains. After a thin layer of a psephitic sandstone comes a 2 m stratum of sandy shale with embedded lumps of calcareous sandstone, then another conglomeratic layer and sandy belemnites-bearing shales. Only from here upwards, at 535 m altitude, appears a profuse Aptian fauna (including *Lytoceras polare*, Ravn etc.) in conglomeratic-psammitic beds that alternate with gray sandy shales such as occur below (490—530 m). Characteristic are large concretions made up of a more or less calcareous sandstone crowded with fossils.

The age assignment of this formation which is intermediate between the Polyptychitan and Aptian, is rather puzzling. Facially its lower portion still resembles the Valanginian whereas its upper third decidedly corresponds in facies to the Aptian. Basing firstly upon the complete absence of *Aucellas*, which are found in such abundance in the underlying Valanginian, and secondly upon the sudden appearance of the specific clay ironstone concretions, we draw the boundary Valanginian/Aptian for the present with all reservation at a height of 430 m.

The adherents of the view that Hauterivian or Barrêmian is represented in northern East Greenland will certainly be justified in pointing to the sequence in Aucellabjærget which might possibly support their idea, after the recent stratigraphical researches in Kuhn Island have entirely failed in doing so. They may be right, it admits of no denial; yet I am still unwilling to accept this view because nowhere else in the thoroughly explored region has the least bit of deposits been detected that might be Hauterivian or Barrêmian in age. On the contrary, there is everywhere strong evidence in support of a marine regression of the Upper Polyptychitan-Hoplitidan sea and a readvance on the continental domain only in Aptian time. On account hereof we object to the idea of a more or less continuous sequence from the Valanginian into the Aptian and refuse the formation to be classed as Hauterivian or Barrêmian. Very likely our generalizations will hold good. It would be too alluring, too seductive simply to assume that marine conditions existed in a single spot, conditions which are objected to wheresoever by all the geological facts available. And yet, did not exceptional, namely marine conditions, persist in "Niesen Fjord" during the Volgian-Infravalanginian when the sea all around had long ago retired?

We are thus still unable to give a clear-cut answer to this question, yet we feel sure that this interesting problem will be solved in years to come by subtile stratigraphical studies and paleontological reasoning.

Aptian-Albian.

It is a reasonable conjecture that the "Rødryggen Beds" must partially be taken to be the product of the regressing Hoplitidan sea. From the Upper Valanginian onwards marine sedimentation had come to a stop; the Lower Neocomian sea had retreated beyond the limits of present-day East Greenland.

It is difficult to make out what came to pass in Hauterivian-Barrêmian times. The slow regional emergence in the late Valanginian delivered the former sea bottom to the destructive work of subaeric decomposition and disintegration. The rocks were being worn down and, consequently, we are and shall forever be unable to tell how thick for instance the "Rødryggen Beds" originally were. What we see to-day are but the residual remains that were somehow prevented from being removed.

Certainly, erosion must have been weak within the range of the former Valanginian sea basin (Albrechts Bugt). As a whole the rising was due to epeirogenetic movements, and the flat-lying Valanginian beds emerged as a plain. Yet where the uplift was less moderate or where movements of formerly faulted blocks took place, which caused a new physiographical cycle to set in, the erosional forces could cut more deeply and irregularly; residual hills were formed and the relief grew more rugged than elsewhere.

There is evidence concerning a true local tilting which resulted in a *sub*-Aptian angular unconformity. This tectonic movement is evidenced in Falskebugt, eastern Wollaston Foreland, where there is an angle of about 24° between the Valanginian and the Aptian strata (*vid.* p. 60).

It is beyond doubt that the Aptian stage shows transgressive features. The sea advanced from the east and flooded a differently moulded landscape. Where the Polyptychitan sea had spread (surroundings of Albrechts Bugt) the surface of unconformity is straight and even (disconformity). Yet near the instable blocks, where the Valanginian is developed in a psephitic or even synorogenetic facies, a strong *sub*-Aptian relief is obvious, as for instance in Dislokationsdalen (*vid.* Fig. 32) and in Kontaktravine (*vid.* Fig. 33). Here the *pre*-Aptian erosion has removed a thick cover of older sediments, so that the Aptian sea could encroach upon Valanginian, Jurassic, Permian, or even upon the Caledonian basement. In Hold-with-Hope the Aptian formation rests upon Eotriassic, and in the Giesecke Bjærge it overlies either Triassic and Permian deposits, or Devonian intrusives (*vid.* e. g. KOCH 1931, NOE-NYGAARD & SÄVE-SÖDERBERGH 1932, FREBOLD 1935b, MAYNC 1938, 1939, 1940).

We cannot do without an epeirogenetic subsidence "*en bloc*" that enabled the Aptian sea to expand landward. This submergence of the *pre*-Aptian landscape must have been a quick one since clastic basal beds of the Aptian with coarse products of erosion are mostly absent. As a rule the older Cretaceous surface became directly covered with black mud. Instead of a transgression we should, therefore, rather speak of an ingression of the Aptian sea which quickly buried the destructional landscape. Old drowned hills and valleys have been found in Clavering Island, Wollaston Foreland, and in the Giesecke Bjærge (compare the stratigraphical sections, Chapter II).

There are evident stratigraphical data at hand which are indicative of the marine overlap of the Aptian series.

On either side of Young Sound the lower portion of the Aptian-Albian formation is made up of psephitic sandstones that rest unconformably upon the Valanginian, Jurassic, Permian, or Caledonian. Farther to the north the Aptian sets in rather unawares with shales. Yet at different localities there are incontestable signs that the subjacent rocks have been worked up and may occur as pebbles, blocks, or lumps in a remanié state in the basal beds of the Aptian series. For instance in Sumpdalen and Rødryggen the lowermost stratum of the Aptian shale formation (with *Neohibolites sp.*) contains reworked fragments of the characteristic underlying "Rødryggen Beds". In Grænseryggen the top layer of these Valanginian red beds is brecciated and considerably corroded, and north of Mt. Hammeren (Antoinette's Bjærg) the base of the Aptian is marked by a ferruginous-rusty zone with nodules of pyrite. The black sandy shale at the floor of the Aptian formation in Skiferdalen carries remanié blocks of the underlying Valanginian beds etc.

As these lowermost shales, e. g. in Kuhn Island, Sumpdalen, and Rødryggen, already contain *Neohibolites sp.*, and in the last-mentioned locality moreover *Phylloceras royerianum* (d'Orb.), their age is indubitable Aptian.

The whole sedimentary type of the Aptian-Albian series sometimes resembles that of the Jurassic "Black Series" where also black shales predominate (*vid.* Maync 1947). Instead of the fossiliferous limestone concretions and limestone layers of the "*Amoebites* shales" the Aptian contains concretions or thin bands of red-orange weathering clay ironstone.

Mostly there occur black shales, marly shales, and slates, with a varying content of silt and sand, which carry mostly small concretions of hard clay ironstone. Interbeds of clay ironstone material are subordinate. Very frequent are interstratified layers of pale-buff marl which may disclose a typical cone-in-cone structure and contain, also, the characteristic clay ironstone concretions. These intercalated marls may be superseded by yellow or brown, partly mottled sandstones or even by conglomeratic layers.

This pelitic formation has obviously been deposited as a more or less bituminous mud, clay, and estuarine ooze. A broad tidal flat must have extended along the coast which was laid bare to a great extent at low tide. The sedimentary conditions may thus have been very much like those in the recent North Sea where tidal mud, a water-soaked slime, clay, and silt, is known as "Wattenschlick".

The sedimentation may have been as follows.

Loaded with suspended mud particles the flood tide advanced upon the drying tidal flat at rather great speed. At the tidal turn there was a moment of stagnation and the suspended matter was dropped. A thin layer or *lamina* of muddy material was laid down when the waters were falling, and the water-soaked platform was accordingly exposed to the drying effect of the sun and air till it was anew progressively overflowed at the following flood tide.

When being drained the mud-plain exhibited quite the same features as a tidal flat does to-day. Of course, it was no ideal flat but subdivided by gravel-crested banks and sandy offshore bars, with sheltered basins containing slack water and troughs washed out by the tidal scour lying between. To be sure, the recent North Sea for instance exhibits a mere depth of 15 m at the Dogger Bank whereas near the Norwegian coast her maximum depth amounts to 637 m (*vid.* Lüders 1939). Due to this *sub*-marine topography the pelites that had been deposited possibly became reworked subsequently and were carried away by currents or the tide to be redeposited elsewhere in quiet depressions[1]).

Of course, we are ignorant of the amplitude of the tidal water in Aptian times. The present-day's amount in East Greenland is about

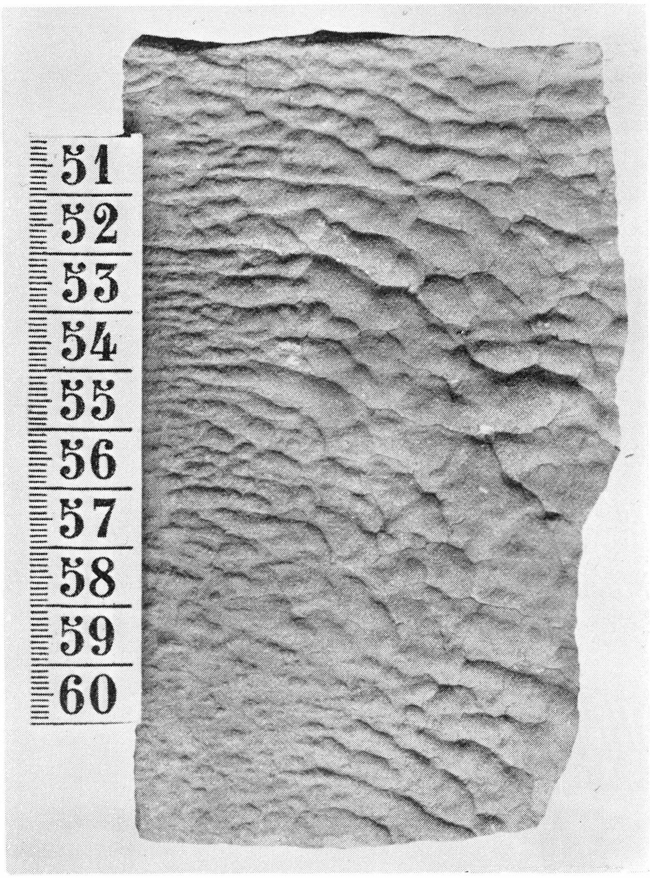

Fig. 61. Mottled limonitic sandstone layer displaying ripple-marks; interstratified in the shales of the "Home Foreland Beds", Snerta River, (95 m altitude), Home Foreland (Hold-with Hope). Lot 3170 Coll. W. MAYNC.

1 m only (*vid.* MADSEN 1936) which is not much as compared with a spring tide of 4—7 m as recorded e. g. from the North Sea (*vid.* LÜDERS 1939). Hence we do not know to how great an extent reworking and redeposition have been of influence during the sedimentation of the Aptian formation.

The East Greenland Aptian-Albian series attains considerable thick-

[1]) The extensive studies of recent sediments have clearly shown that the bottom configuration of a sea is the principal factor governing the sedimentation, not the bathymetrical conditions; the distribution of deposits is thus not simply

nesses which I compute to more than 2000 m (*vid.* p. 210). This is not so tremendous an amount as one would believe at first on considering that reported from the recent North Sea. In Jade Bay (Wilhelmshaven), for instance, 7.3 m of sediments are proved to have been deposited in the course of only 3 years, and near Cuxhaven even 3 m of mud are being laid down per year! (*vid.* HÄNTZSCHEL 1939).

Partially the Aptian deposits of East Greenland may be interpreted

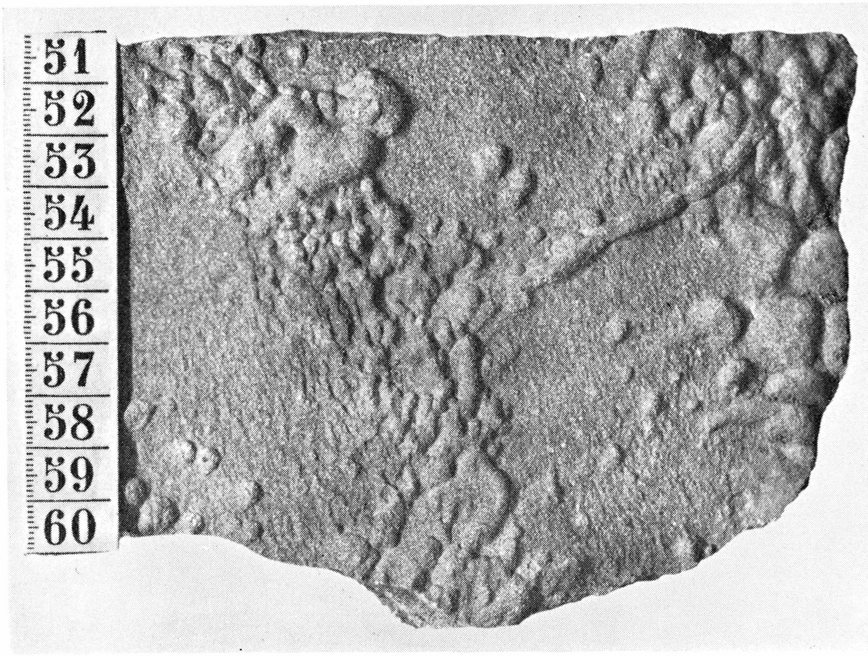

Fig. 62. Flow-marks on the surface of a fine-grained sandstone layer (interbedded in the shales of the "Home Foreland Beds"). Between Fosdalen and River 26 (145 m altitude) in Home Foreland (Hold-with-Hope). Lot 3161 Coll. W. MAYNC.

as estuarine muds which were precipitated in quiet waters as a result of the coagulation of emulsoids poured into the saline sea. However, such a derivation of clay substance can only be expected near areas where shales and slates already occur; this is e. g. the case in

due to hydrodynamic forces, and the axiom of a gradual decrease of the coarseness of the detritus seawards does not always hold good (*vid.* LÜDERS 1939, STETSON 1939, and others). Or if a sorting according to the constituents has taken place it may become blurred subsequently by tides and currents which carry the fine-textured fraction again landwards. It is thus geographical and meteorological factors, e. g. the topography of the coast, debouching rivers, wind, currents *et cetera*, that are of outstanding importance for the sedimentation, facies, bedding, and so forth (*vid.* HÄNTZSCHEL 1936).

central Wollaston Foreland where a thick shale formation of Kimmeridgian age is known to exist which might have supplied the muddy material.

We thus regard the Aptian-Albian series as consisting of near-shore

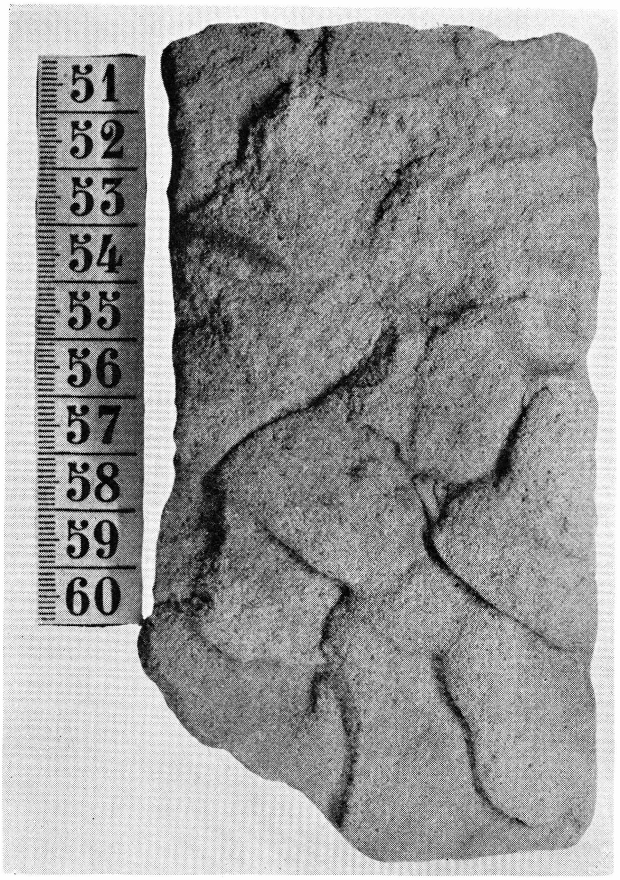

Fig. 63. "Buckled" ripple-marked sandstone layer, intercalated between marl horizons with cone-in-cone structure. Aptian-Albian series Cape Berlin, Wollaston Foreland. (100—125 m altitude). Lot 1564 Coll. W. Maync.

deposits on tidal flats. As will be shown later, this view is fully supported by the widely distributed interbeds of marl displaying cone-in-cone structure, a structure which is most plausibly explained by B. M. Shaub's theory, *viz.* that it is due to the gradual drainage of watersoaked ground (*vid.* p. 208). Indeed, this tidal belt has been partly and periodically exposed to the atmosphere at ebb-tide (*vid. sup.*).

The Aptian-Albian sediments disclose a great many more features which strengthen the writer's conception as to their origin on tidal flats.

Ripple-marks for instance are to be seen almost everywhere in the formations (*vid.* Fig. 61). These marks are being formed to-day on tidal flats when there is a slight change of velocity of the water flowing over water-soaked ground (*vid.* HJULSTRÖM 1939). Hereby innumerable

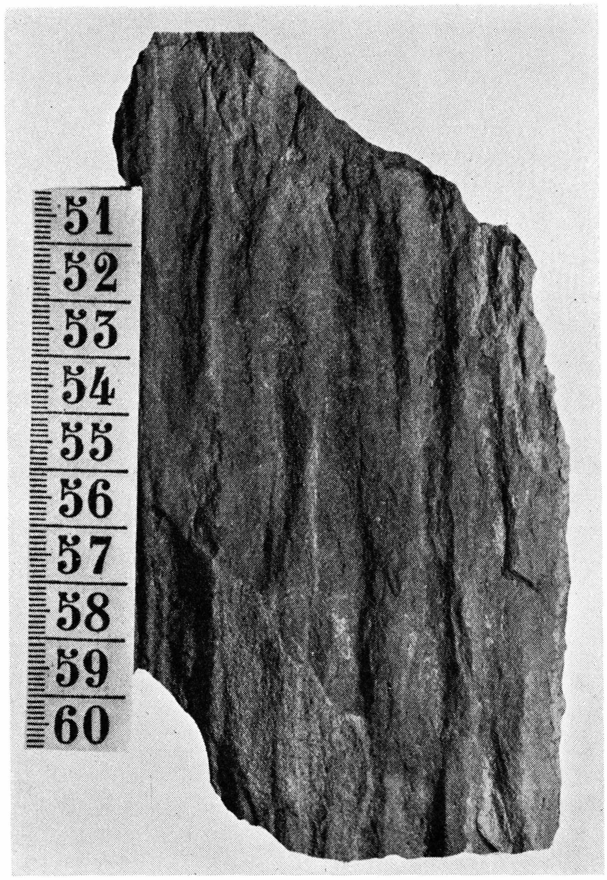

Fig. 64. Wood-like ripple-marked sandstone, interbedded in the shales of the "Home Foreland Beds". Near River 26 (240 m altitude) in Home Foreland, Hold-with-Hope. Lot 3167 Coll. W. MAYNE.

tiny parallel ridges appear running at right angles to the tidal current, conformably to the physical law of HELMHOLTZ which claims wave motions to form in the contact surface between two media of different specific gravity and velocity. If the waters become more agitated the ripple-marks are, of course, obliterated, the bottom becomes flattened, and clay and silt particles are stirred up and carried off as suspensions.

Apart from true ripple-marks the East Greenland Aptian-Albian beds show other peculiar features such as current-marks, wave-marks, rill-marks, scoured grooves *et cetera* (*vid.* Figs. 62—64). Some knobby irregular elevations and oddly shaped buckles such as are displayed in Fig. 62, may either be due to a drop-like flowing of water-soaked unconsolidated sand, or may represent sand-filled rill-marks. H. RÜCKLIN for instance mentions quite similar marks from the Triassic "Muschelkalk" (Saar region) as is shown by a comparison of his Figure 5 (RÜCKLIN 1938, p. 100) and an East Greenland rock spec-

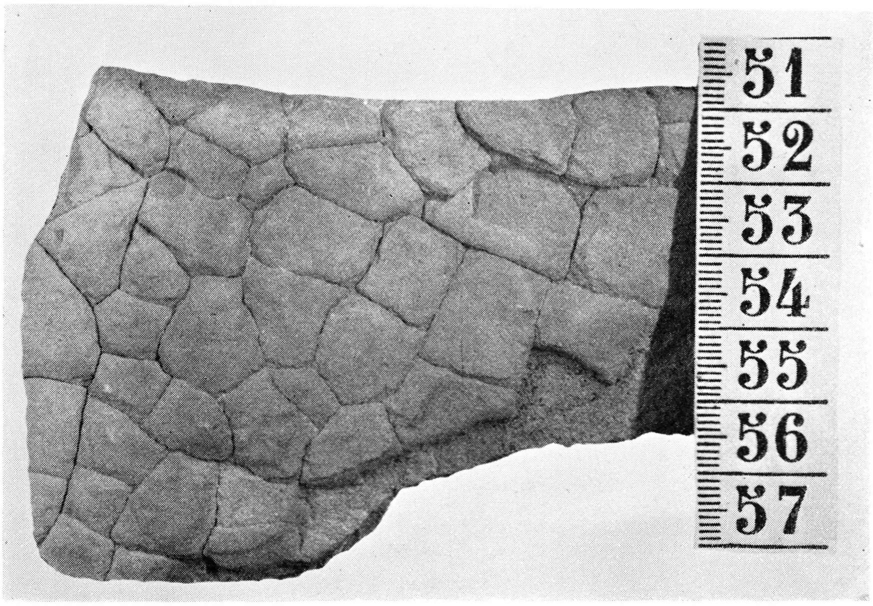

Fig. 65. Polygonal sun-cracks. Aptian-Albian series, east of Cape Berlin, Wollaston Foreland.

imen (Fig. 62). Identical irregularities of the bedding planes have been described, e. g. by H. STAUBER from Triassic beds of southern East Greenland ("Cape Biot Formation" L. KOCH 1927), which, too, were evidently deposited on an old tidal flat (*vid.* STAUBER 1942).

The other criteria of the Aptian-Albian series, *viz.* uneven bedding planes, stream-bedding, interbeds of coarser detritus or limonitic sandstone layers, "schliers" and clusters of angular quartz grains or muscovite flakes, brecciated marls (stirred up in an unconsolidated state by the invading tide), lenticles of coal, plant-remains, logs of fossil (bored) wood etc., speak decidedly in favour of a near-shore formation. Sun-cracks, for instance, can only form in drying up shrinking clay and silt, in other words, at low water on the tidal flat (*vid.* Fig. 65).

The Aptian beds harbour a true littoral biota, a fact which has already been emphasized by H. FREBOLD (FREBOLD 1935b). The main faunal elements occurring in the investigated region are pelecypods

(*Inoceramus* etc.). Crustaceans, Vermes (*Serpula*, *Fucoids* etc.), which have left their tracks and burrows, are inhabitants of the beach. These fossil trails generally use to be well preserved in the deposits of the tidal flats, especially near the high-water line, where they have most time to harden and may, therefore, escape the destructional forces of the next incoming tide.

It was H. FREBOLD (*op. cit.*) who conceived the idea that the ammonites present in the Aptian beds of Great Koldewey Island have drifted ashore *post-mortem* from the open sea. The facial peculiarities that have come to light through our investigations fully confirm this view. It is beyond a doubt that these cephalopods could not have lived in such an amphibious habitat as a tidal flat. After their death the shells were filled with air and could thus float about until they were seized by a tidal wave and thrown on to the littoral platform where they became buried (*vid.* FREBOLD 1935b).

Often the shales are fairly rich in pyrite, e. g. in Kuhn Island, which must be explained by stagnation and insufficient ventilation of certain parts of the Aptian sea. Obviously these beds formed in enclosed bays and coves where dissolved chemical iron compounds could easily be precipitated owing to a large quantity of hydrogen sulphide (set free by the decomposition of organic matter). This colloidal/gel-like ferrous sulphide (hydrotroilite) is later on transformed into the disulphide (pyrite).

In Kuhn Island the writer sometimes observed efflorescent crusts and films of sulphur on the surface and in cracks of the shales. This phenomenon is due to the chemical decomposition in the uppermost levels of the Arctic soil where the act of thawing allows the circulation and the rise of mineral solutions through capillary attraction. The intense insolation during the polar day may lead to evaporation and, consequently, to a crystallization of minerals such as sulphur, gypsum, alum, sulphate of soda, *et cetera.*

To be sure, the mudstones such as are here recorded from the Cretaceous of East Greenland are generally formed in large areas of continental shelves (shoal-water platform of the continental border). These muddy deposits mostly occur close inshore; for it is near the high-water level that the velocity of the tide has considerably decreased and where even the finest suspensions will therefore be dropped (*vid.* HÄNTZSCHEL 1936). In this connection it may be borne in mind that the recent Barents Sea washing the border of the Eurasian continent represents the broadest known shelf in the world, its width amounting to about a thousand kilometers or, Franz Joseph Land included, to more than 1600 km (*vid.* NANSEN 1928). This shelf platform of the Barents Sea between the Kola Peninsula, Novaya Zemlya, and Eastern Spitsbergen, is, indeed, for the largest part covered with black clay and silt (SHEPARD 1939).

It may be stressed that the continental shelf of the present East Siberian Sea, too, attains a breadth of more than 600 km and a depth of only 20—40 m. The North Sea shelf, which we have already spoken of, almost reaches the same breadth as the epicontinental Barents Sea.

Another shelf region where a broad flat of about 35 km mainly consists of silt and clay is that near New York (Long Island). Sand is here deposited only 36 km off the shore at a depth of merely 43—59 m (STETSON 1939).

Also the huge flat plain of the Mississippi River delta is exclusively built up of silt (60 %), clay (11 %), and fine sand (29 %) (RUSSELL & RUSSELL 1939).

Most characteristic of the Aptian-Albian formation is the occurrence of clay ironstone concretions, which may even be regarded as an index to that series when fossils are lacking.

Clay ironstone is a clayey gel which contains finely distributed iron ores. Its genesis is for the greater part due to primary factors of sedimentation and may—at least with respect to its occurence in the Greenland Aptian-Albian series—not be taken for a *post*-diagenetical process.

Most natural waters contain dissolved iron, e. g. ferrous (bi) carbonate or salts of organic acids, which is derived from decomposed (weathered) iron-bearing minerals. Through oxidation the ferrous state is transformed into ferric compounds, *viz.* iron oxide, hydroxide, or hydrates, of which hematite (Fe_2O_3), limonite ($2\,Fe_2O_3 \cdot 3\,H_2O$) and other iron ores are the most wide-spread precipitations (bog-iron ore). These ores may be precipitated together with colloidal clay suspensions that are poured into the sea with debouching rivers; for the colloidal suspensoids will be discharged through the electrolysis of the sea-water, and the dispersed particles will coagulate to an amorphous gel. It is possible, however, that iron-depositing bacteria may contribute to the formation of bog-iron ore etc. These bacteria may accomplish the reduction of ferric hydrates, e. g. limonite to ferrous iron, which will combine with carbonic acid to soluble iron bicarbonate. Through exposure to the air, i. e. oxidation, the latter will be precipitated again as ferric hydrate or hydroxide.

On the other hand, ferruginous solutions formed on a near land due to weathering may gradually concentrate in enclosed basins, together with iron oxides and hydrates in a colloid state. These iron compounds may subsequently be adsorbed by the clay and mud substances precipitated, which will give rise to clay ironstone. This process goes under the name adsorptive metasomatism (*vid.* ANDRÉE 1924).

Yet the precipitated clay ironstone material is not equally disseminated in the East Greenland sediments but mostly concentrated around foreign *nuclei*, e. g. fossils, pieces of wood, rock fragments etc.[1]). On account hereof these objects gradually became coated by clay iron-

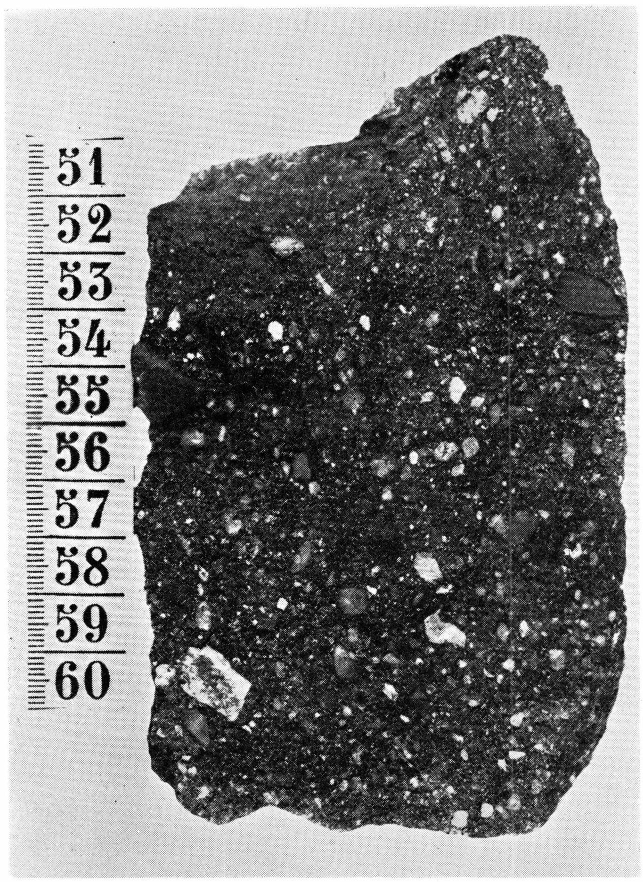

Fig. 66. Conglomeratic clay ironstone with Caledonian pebbles. Aptian-Albian series, Boulder Ridge, eastern portion of Clavering Island (at about 235 m altitude). Lot 2192 Coll. W. Maync.

stone cement, and in this way concretions could form. Subordinately, layers and partings of clay ironstone were laid down.

At any rate both the clay ironstone concretions and the shale series are of syngenetic origin, and the multiform concretions have not been formed secondarily through percolating iron solutions. The regional

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[1]) According to R. Bøgvad the black shales in eastern Kuhn Island contain iron compounds (Bøgvad & Rosenkrantz 1934).

occurrence of clay ironstone concretions throughout the Aptian-Albian and Senonian stages is adverse to such a conception.

Another fact which may display the syngenetic origin of the clay ironstone and the shale formation is the common occurrence of clastic detritus, e. g. clusters and pockets of washed-in quartz sand, crystalline grit, Caledonian pebbles etc. (*vid.* Figs. 66 & 67) in both rocks. The actual transition from clay ironstone with strewn-in detritus into psam-

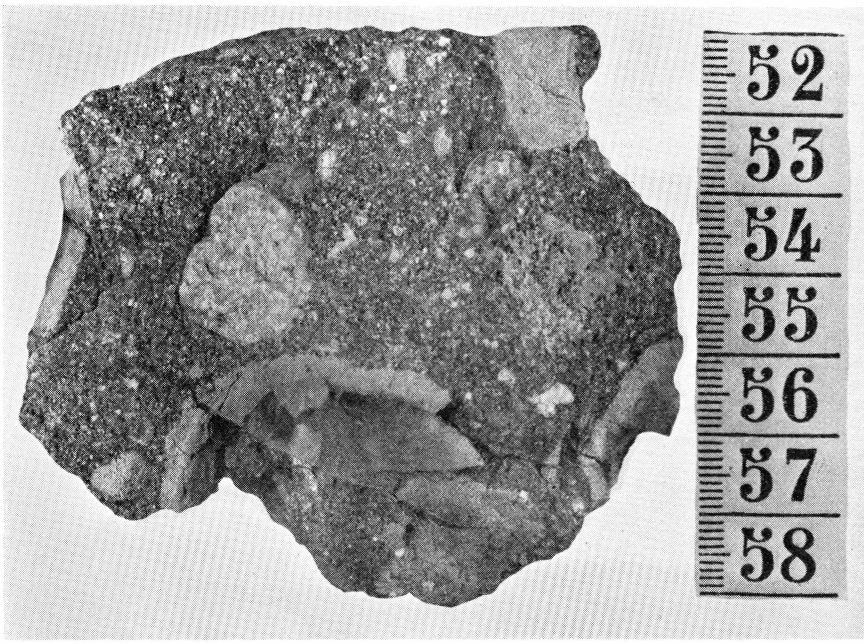

Fig. 67. Psephite containing crystalline pebbles and fragments of remanié slate in a clay ironstone matrix. Albian Gaasedal, Wollaston Foreland (140 m altitude). Lot 2637 Coll. W. MAYNC.

mitic or psephitic layers containing "schliers" and galls of clay ironstone also bears clear evidence of their synchronism. Finally, small pebbles of clay ironstone that were found to be embedded in Aptian sandstones show impressively that the clay ironstone substance cannot be a subsequent sedimentary formation.

Most typical of the Aptian-Albian series are the numerous interbeds of cream-coloured or buff marl layers which extremely often disclose cone-in-cone structure (*vid.* Pl. 4).

Such marls with cone-in-cones were already observed by A. G. NATHORST in 1899 in Flakkebugt, east coast of Wollaston Foreland, where they are reported to be associated with clays, shaly sandstones, and clay ironstones (NATHORST 1900). Furthermore, a black-gray shaly limestone displaying cone-in-cone structure was met with by R. Bøgvad in 1929 near Björns Elv, northeastern Clavering Island (Bøgvad & Rosenkrantz 1934). Finally, cone-in-cone structure was reported in 1933 from the Aptian beds of Great Koldeway Island by E. Nielsen whence it is stated to occur in the whereabouts of the "middle" and "northern Gneisnæs" (see the present paper, pp. 175—176).

In the entire area investigated by the writer cone-in- cone structure is exceedingly common in the Aptian-Albian series. Together with the red-orange concretions of clay ironstone this peculiar structure forms a most conspicuous criterion for these Cretaceous beds (see the local stratigraphical sections pp. 160—162). Emphasis must be laid upon the statement, however, that the marls with cone-in-cones do not characterize any key beds nor a constant portion of the *post*-Valanginian strata but may be found throughout the formations. It may be stressed, however, that cone-in-cone structure was observed by the author to occur exclusively in the pale-buff weathering argillaceous marl interlayers.

The term cone-in-cone structure is applied to a structural phenomenon exhibiting numerous juxtaposed cones with smaller ones inserted tightly into one another, the axes of which stand normal to the bedding planes. The *apices* of the cones point in zigzag towards each other so that the bases are turned towards the bed's surface and subface, respectively (*vid.* Pl. 4, Fig. 1, 3, 5).

The bases of the cones, appearing as concentric circles on the bedding surface, are mostly covered with small mammiform knots (*vid.* Pl. 4, Fig. 4). Moreover, the inner slope of the cones always displays the intersections of the smaller cones being telescoped into each other (Pl. 4, Fig. 2). The intersectional base-lines use to stand out as finely sawed or undulatory festoons. A film consisting of fine black clay or of a bituminous silty matrix usually covers the cones' *generatrices* (*vid.* Pl. 4, Figs. 1 & 2), and near or on the *apex* coarser particles, e. g. quartz grains and even tiny pebbles, were observed. The cones may vary in size yet on an average their base shows a diameter of about 10 cm. Besides, communicating cones grown together are by no means rare (*vid.* Pl. 4, Fig. 2). Rather often the author came upon incomplete cones or simple funnels the inner side of which exhibited signs of wrinkling (ripple-marks) or a minute crumpling (*vid.* Pl. 4, Fig. 6).

The genesis of this peculiar structure has been subject to much discussion at less or greater length in the geological literature, and the theories of a *post*-diagenetic *versus* a primary-sedimentary origin have often been argued about. The hypotheses as to the formation of cone-in-cone structure will be briefly reviewed in the following pages.

Of course, we can desist from dealing with all the ideas conceived as to the origin of this structure, e. g. that it should be due to the escape of gases from mud *et cetera.*

A great many geologists combine the cone-in-cone structure with shearing stresses which are exerted *post*-diagenetically by the increasingly thick load of the superincumbent sediments (TARR 1922, 1932, *vid.* SHAUB 1937, CAYEUX 1935, HENDRICKS 1937, DENAEYER 1939a, 1939b, 1945). This compressional force that is effected perpendicular to the bedding planes would meet with unequal resistances (different elasticity and flexibility of the rocks to be deformed) and would be relieved by shear planes. Since the theoretical surface of shearing is that of the least resistance, *viz.* of a cone, this normal stress would, therefore, give rise to cone-in-cone structure. The origin of this structure would thus be a dynamical phenomenon, and is probably accompanied by molecular transformations according to mineralogical principles (*vid.* CAYEUX 1935, DENAEYER 1945). Formerly, the presence of calcium carbonate was considered the *conditio sine qua non* for the formation of cone-in-cone as it was assumed to crystallize due to the stress and to allow thus a flow or gliding on the cleavage planes of the crystals; yet since it has become obvious that cone-in-cone structure can occur without calcite being present at all this conception cannot hold true. The detrital grains and the clayey film mostly covering the cones' surface are regarded as impure matrix transported during the mechanical influences along the planes of the least resistance (*vid.* CAYEUX 1935, DENAEYER 1939a, 1939b, 1945).

It goes without saying that cone-in-cone structure would occur almost everywhere were it merely the result of the weight of the overlying rock formations. However, this is not the case and in East Greenland, for instance, cone-in-cone structure is not even developed throughout the same marl-bed but may occur here and be absent a few meters away, although there is quite the same overburden of sediments, after all. On account hereof this peculiar structure cannot be the mere result of compressional stresses on consolidated beds.

It was B. M. SHAUB who developed another view as to the genesis of cone-in-cone structure (SHAUB 1937).

Basing upon the principle of actuality B. M. SHAUB turned to recent sediments and arrived at the following conclusions.

Cone-in-cone structure was observed to originate when water-soaked ground is being drained gradually. At first only a few scattered funnels will form but in the course of time more and more will spring forth until a large area may be covered with cones. The drainage is due to a difference of the hydrostatic pressure-potential.

The slowly sinking water level will be registered on the inner surface of the cones by fine isochronous marks and minute ripple-marks (*vid. sup.*, Pl. 4, Fig. 2, 3, 6). Fine drying up mud particles may drizzle along the inner slopes of the cones which will give rise to smaller cones, and the crumbling away of larger portions may bring about the junction of formerly isolated cones. The film adhering to the outer surfaces of the cones must be taken for a *residuum* of clayey material that was left by the percolating mud-laden water; the same may, of course, be said of the stray quartz grains and other coarse rock fragments which are sometimes found sticking to or near the cones' *apex*.

When water-soaked mud is quickly drained, only cracks due to drying will form (*vid.* SHAUB 1937).

Although there still remain some unsolved problems, e. g. the question of how the lower overturned cones are formed, we can thus fully share the standpoint of B. M. SHAUB that the origin of cone-in-cone structure is due to a *pre*-diagenetical process when the marly clay had not yet hardened. If the load of overlying rocks would really be enough to bring about cone-in-cone structure, the latter would for instance be widely distributed in the isopical Jurassic "*Amoebites* shales" or "Black Series", whence, however, it is entirely unknown.

A genesis of the cone-in-cone structure as suggested by B. M. SHAUB thoroughly agrees with all the conditions in Aptian-Albian times.

To sum op, the cone-in-cone structure of the Cretaceous marls in East Greenland is a result of slow periodical drainage at low tide on the tidal flat. The neatly shaped cones on the flat were buried by the soft muds carried along with the high tide and were thus preserved up to the present time.

It stands to reason that the weight of the superimposed deposits must have been of some importance for the diagenesis of the lower beds, though only in so far as to favour mechanical consolidation, the squeezing out of water, and possibly cementation. Doubtless the stress may sometimes have flattened the *apices* of the cones, as is e. g. reported from Silurian slates of Missouri, where cones with an *apical* angle of up to 162° occur whilst the unaffected ones as a rule disclose angles ranging between 70° and 110° (HENDRICKS 1937).

Apart from the pelitic formations which have been described in the foregoing the Aptian-Albian series of East Greenland includes rocks made up of coarser detritus.

In Kuhn Island merely subordinate sandstone layers are interbedded in the Aptian shales, and in the Albian sequence of western Sabine Island psammitic beds are entirely absent. On the other hand, limonite-stained sandstones form a great portion of the Cretaceous sedimentary succession both in Pendulum Island and in Brorsons Peninsula. The sections in Bern Plateau even consist predominantly of coarse-grained sandstones and conglomerates. Also in central Wollaston Foreland thick interbeds of sandstone occur frequently, e. g. in the sections of Mt. Hammeren (Antoinette's Bjærg), Mt. Gyldenspids, Kuhnpasset, Aucellabjærget, etc. In Clavering Island coarse-grained sandstones as well as conglomerates are common in the Aptian-Albian series and characterize not only the overstepping basal beds. The sequence in Stensiös Plateau is entirely built up of psammitic rocks with psephitic layers whilst shales again preponderate in the Giesecke Bjærge.

It thus becomes obvious that the configuration of the coast and local factors of sedimentation are conclusive for the facies of the Aptian-Albian series, not the bathymetrical conditions.

The considerable content of coarser detritus in the Cretaceous rocks of Brorsons Peninsula is due to a borderland (inlier) at Falskebugt (emerged edge of the Hühnerbjærg Block" of A. Vischer); also the psammites occurring in the interior of Wollaston Foreland were probably formed owing to a spreading of clastics from this island. The Caledonian crystalline of Clavering Island probably supplied the coarse detritus stated to mark the Aptian-Albian formations in the eastern portion of the island and in Stensiös Plateau, Hold-with-Hope.

On the whole we recognize that the old faulted blocks or their fault scarps, respectively, have influenced the sedimentation in Cretaceous times as outstanding paleogeographical elements, just as they have been of importance for the facial composition of the Volgian "Rigi Series" etc. (*vid.* Maync 1947). This causal relation between sedimentation and tectonic movements is furthermore proved by the occurrence of intraformational "exotic" boulders within the Cretaceous shale series of eastern Clavering Island, the large blocks of which were undoubtedly supplied by the fault scarp of the "Clavering Block". In the following chapter the bearing of orogenetic movements on the sedimentation in adjacent areas will be dealt with in some detail (*vid.* pp. 218 ff.).

In summary, the sedimentary conditions furnish evidence that the Aptian-Albian formations are deposits of a shallow littoral sea, of a tidal flat, which even lay bare for a great part at low tide. Chiefly black mud and silt containing clay ironstone concretions were deposited, mostly with alternate marly interbeds or sandstone layers. Near the coastal fault-cliffs coarse detritus or even boulder beds were being formed.

Because of the emersion and the following denudation in *post*-Albian time the primary thickness of the Aptian-Albian series cannot be stated. Beyond doubt the *pre*-Basaltic erosion has removed another large portion of the Cretaceous formations.

The exposed total thickness of the Aptian-Albian beds amounts to more than 2000 m[1]). In Mt. Gyldenspids a sequence from the Aptian (Albian) into the Tertiary is exposed (*vid.* pp. 52—55). However, the unconformable position of the Tertiary cap upon the Cretaceous proves the existence of an erosional interval of considerable extent. To-day the thickness of the formation still amounts to 618 m. The Albian beds exposed in Kronebjærg, western Sabine Island, represent a series of shales about 400 m thick, whereas the Aptian-Albian series in Langelinie Bjærg, eastern Clavering Island, is exposed in a thickness of about 650 m (*vid.* pp. 117—119). In Stensiös Plateau, Hold-with-Hope, only 170 m of the Cretaceous beds are preserved, and in Gunnsteinsbjærg (Giesecke Bjærge) the thickness of the Aptian-Albian beds is computed to 186 m.

It is not possible to decide in the field whether the Cretaceous (*post*-Valanginian) beds are Aptian or Albian in age since both stages are developed in one comprehensive series of homogeneous facial composition. Paleontological evidence, however, especially with regard to the ammonites, seems to carry much weight for the discrimination of these two stages (*vid.* Chapter VI).

Senonian.

Facially quite corresponding beds are exposed at Knudshoved, eastern coast of Hold-with-Hope, which, however, have been assigned to the Lower Senonian owing to the presence of *Pteria tenuicostata* Roem. and large *Inocerami* belonging to the group of *Inoceramus* (*Beloceramus*) *cardissoides* Goldf. (Frebold 1934).

There is nothing known as to the geographical distribution of these "Knudshoved Beds", and I still refuse to correlate e. g. the Cretaceous formation of Home Foreland with the Senonian series known with certainty only from the locality Knudshoved (*vid.* pp. 131—144).

Mention has already been made of the transgressive overlap of the "Knudshoved Beds" upon the "Home Foreland Beds", a fact which shows distinctly, indeed, that a break in the sedimentary record exists here, in other words, the "Home Foreland Beds" must be *pre*-Senonian.

The precise age of the "Home Foreland Beds", however, cannot be made out yet. At any rate they are seen to overlie the Cretaceous

[1]) A computation of the undisturbed sequence exposed in Brorsons Peninsula, from Cape Berlin to the fault line running from Sumpdalen across Albrechts Bugt gives a thickness of about 1500 m (breadth of outcrop measured perpendicularly to the strike: 8—9 km; dip of beds: on an average 10° to the southwest). The section at Cape Berlin attains a thickness of 390 m but it must be kept in mind that the base of the series is nowhere found to crop out here. Conformably to the evident slope of the crystalline core of the "Hühnerbjærg Block" in Falskebugt towards the northwest we may assume a thickness of several hundred meters for the lower portion of the Aptian series (from its base to the oldest visible strata east of Cape Berlin).

series of Stensiös Plateau in Rødelv, between Steensbys Bjærg and Dieners Bjærg (*vid.* p. 128). The clastics building up Stensiös Plateau are referable to the Aptian which is proved by the occurrence of *Deshayesites aff. laeviusculus* (V. KOEN.), *Deshayesites sp.* and *Lytoceras polare* RAVN (*vid.* appendix, p. 227). Consequently, the "Home Foreland Beds" may still be Aptian-Albian in age. Until further evidence has been produced, we refrain from a definite correlation, however.

To be short, there are thus three formations of the younger Cretaceous to be distinguished for the present, *viz.* the Aptian-Albian series or "*Inoceramus* Beds", the "Home Foreland Beds", and the "Knudshoved Beds" (Senonian).

It has been mentioned in the foregoing that the "Home Foreland Beds", too, are reported by H. FREBOLD to have yielded *Pteria tenuicostata* ROEM., on which account they were included into the Senonian of Knudshoved (FREBOLD 1934). Owing to the stratigraphical data that have been brought to light during the Danish expedition of 1936—1938, however, certain objections have been raised against such a parallelisation (MAYNC 1940). The beds bear too striking a resemblance to the Aptian-Albian series of Clavering Island, Wollaston Foreland etc. Curiously enough, fragments of *Inocerami* were found more than once in the "Home Foreland Beds", though not a single specimen of a *Pteria*. We feel strongly tempted to ask, therefore, whether the specimen of *Pteria tenuicostata* ROEM. which is reported to have been collected in Home Foreland by E. NIELSEN (*vid.* FREBOLD 1934), might not *de facto* be derived from Knudshoved and has been cited erroneously from Home Foreland?

The assumption is at any rate justifiable that the Aptian-Albian series, the "Home Foreland Beds", and the thick set of slates near Cape Broer Ruys may turn out to be more or less equal and that only the "Knudshoved Beds" will represent Senonian[1]).

The "Home Foreland Beds" cropping out beneath the basaltic flows of Hold-with-Hope (Home Foreland) and Jackson Island attain a visible thickness of about 300 m (*vid.* p. 134). Lithologically they consist of a manifold alternation between black sandy shales or slates and interbedded layers of yellow-reddish sandstone, with clay ironstone concretions. Mostly the sandstones being rich in limonite exibit a finegrained texture and weather into knobby wood-like beds. The embedded clay ironstone concretions sometimes carry poorly preserved *Inocerami*.

Very similar deposits were encountered in Jackson Island. The slates, sometimes with a remarkable content of lime carbonate (marls),

[1]) The presence of *Inoceramus aff. labiatiformis* STOLLEY in Snerta River, Home Foreland (*vid.* p. 135) and of *Inoceramus aff. anglicus* WOODS? in Vardefjæld, Cape Broer Ruys (*vid.* p. 145), which were quite recently identified by Dr. J. SORNAY, Paris, seems fully to support this my point of view.

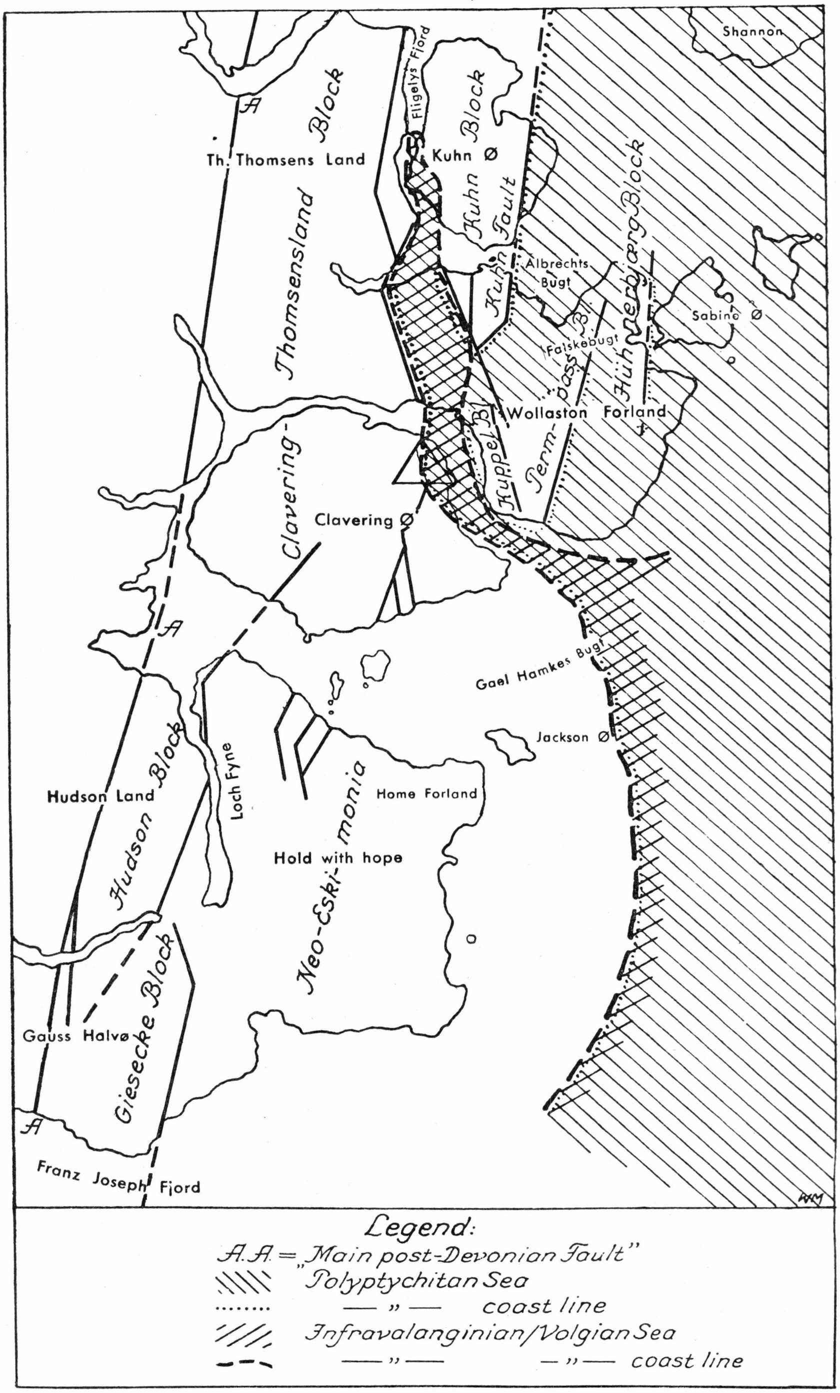

Fig. 68. Paleogeographical sketch-map showing the supposed distribution of land and sea during the Volgian-Infravalanginian ("Niesen Fjord") and Polyptychitan.

may be interstratified with true limestone layers. Moreover, marls with well developed cone-in-cone structure and uneven wood-like sandstone beds, containing coarse washed-in quartz grains or even quartzitic pebbles, occur here.

In the region of Cape Broer Ruys the sequence is mainly made up of shales and slates with limestone interlayers. Sandstones and clay ironstone concretions are rather rare.

The "Knudshoved Beds", on the other hand, exhibit a more psammitic facies. Dark brittle sandy shales, often with enclosed clay ironstone concretions, alternate with layers of light-coloured micaceous sandstone. Farther up in the succession inosculate marly shales carrying clay ironstone concretions. In the hastily examined coastal cliff at Knudshoved these beds are exposed to a thickness of 132 m.

Our stratigraphical-facial studies have yielded the results that Cretaceous deposits are widespread between Hochstetterbugten and Franz Joseph Fjord (region between 75° and 73° N. lat.). Contrary to the Scoresby Sound District (70° to 72° N. lat.), where no marine beds have been deposited since Volgian-Infravalanginian times, epeirogenetic downwarps and uplifts "*en bloc*" have turned out to have happened at successive stages of the Cretaceous era in the parageosyncline of northern East Greenland. Transgressions and regressions of the seas are registered by the stratigraphical sequence which has been established in detail by the author. However, also orogenetic *intra*-Cretaceous movements have affected the chronological history of northern East Greenland which is shown by interformational angular unconformities (*post*-Volgian, *pre*-Aptian, *post*-Albian, *pre*-Senonian(?), *pre*-Tertiary). Certain fault scarps of the tectonic blocks are proved to have acted as coast lines of the continent or of islands, Inliers, or borderlands, and have often influenced the sedimentation to a great extent. Several of them have had their own geological history, and the former conception (*vid.* FREBOLD 1932a etc.) claiming a uniformity of the Mesozoic marine transgressions must be disposed of. In a subsequent work, however, H. FREBOLD supports the idea of autonomical blocks which have suffered individual movements in the course of time (FREBOLD 1933). This view, shared by L. KOCH, H. G. BACKLUND, and others, has turned out to hold good. The latest theory put forth by numerous authors, e. g. L. KOCH, H. G. BACKLUND, H. FREBOLD, *vid.* KOCH 1935) claims the existence of Variscan bucklers or shields (called "ovals" by H. G. BACKLUND & D. MALMQUIST 1935) with raising tendency, and negative crustal elements in between. This way of interpretation cannot be supported as explained by A. VISCHER and the writer (*vid.* Chapter I). All the basins or fields the bottoms of which have subsided considerably

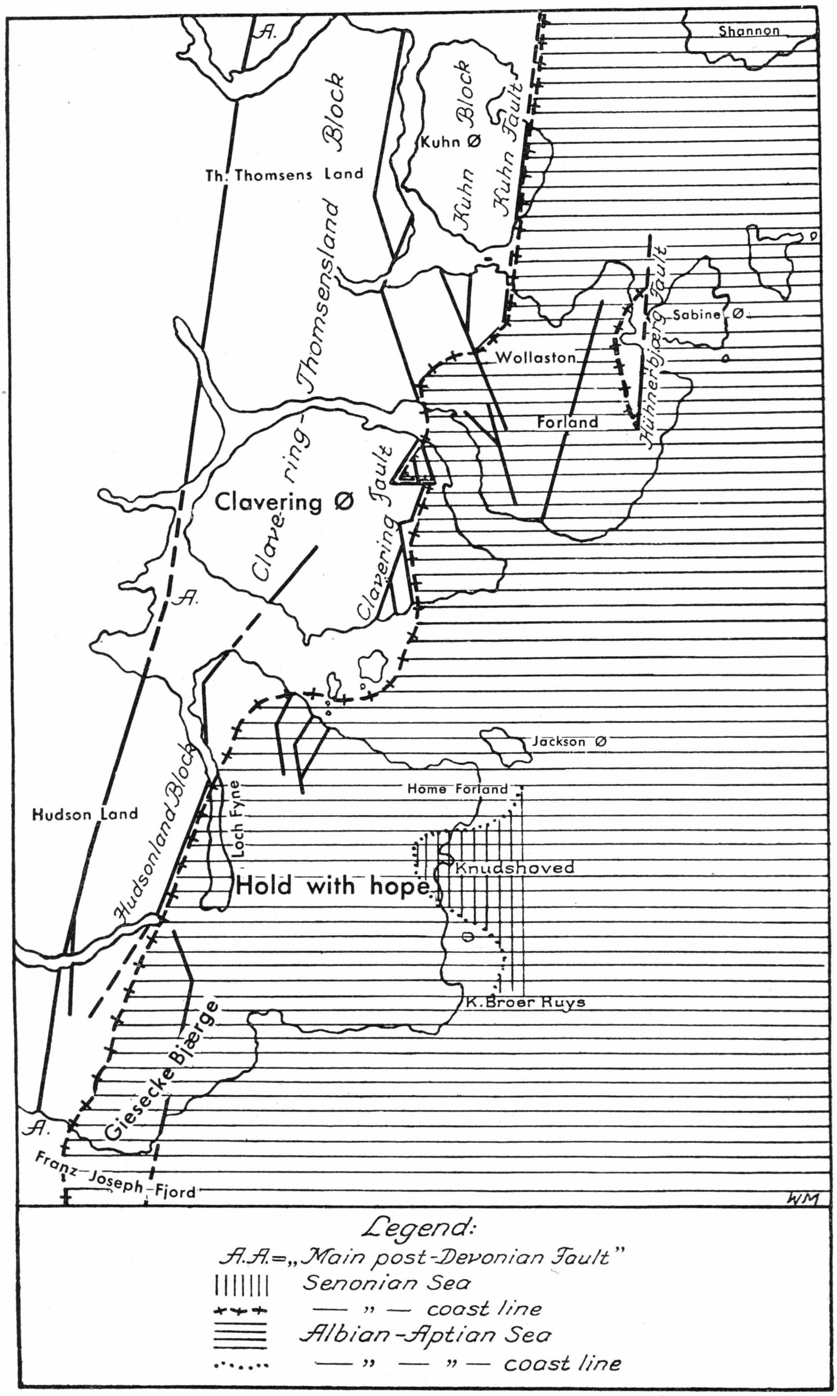

Fig. 69. Paleogeographical sketch-map showing the supposed distribution of land and sea during the Aptian-Albian and Senonian.

NB: In the legend the symbols indicating the two coast lines have been interchanged.

during the Mesozoic are due to tectonic mobile depressions lying at the base of instable fault scarps which had so important a bearing on the sedimentation of the thick Mesozoic formations.

Because of certain misunderstandings and misinterpretations I consider it necessary to replace A. VISCHER's paleogeographical sketch-map of the Valanginian by another one which is founded on the latest stratigraphical and paleontological evidence (Fig. 68). Fig. 69 shows the distribution of land and sea during the younger Cretaceous.

The unambiguous tectonic depression between the fault scarp of the "Clavering-Thomsensland Blocks" and the downthrown "Kuhn-Kuppel Block" was occupied in late Jurassic time by the marine "Niesen Fjord"; here alone were beds of Volgian age deposited (*vid.* MAYNC 1947) which leads us to the assumption that both the "Kuhn Block" and the "Kuppel Block" were then still linked up with one another, and that the down-faulting of the "Permpass Block" only took place at the dawn of the Cretaceous; for Volgian sediments are entirely absent in the sedimentary record of the outer tectonic blocks. That these beds, if they have ever been deposited, should have been completely removed without leaving the slightest vestige is hard to believe. We may rather take the view that the narrow channel of "Niesen Fjord" has been in connection with the open sea in the south (via Young Sound), in accordance with the strike of this tectonic groove and the general dip of the tilted blocks to the southwest.

The Volgian beds are conformably overlain by (or pass into) the "Lower Niesen Beds" which are proved to be Infravalanginian/Rjasanian in age. This formation was not deposited, either, beyond the marine gulf of "Niesen Fjord".

In Infravalanginian time the whole region east of the "Kuhn Fault" received a downward warping and the connection between the "Kuhn Block" and the "Kuppel Block" was interrupted, so that the Polyptychitan sea could invade the land-locked "Niesen Fjord".

Near the edges of instable blocks coarse-clastic deposits were being formed, but farther off, in the surroundings of Albrechts Bugt, a limestone/marl facies could develop. The Albrechts Bugt of our days thus existed already in Mesozoic times. The "Permpass-Kuppel Blocks" in central Wollaston Foreland were still dry land, which is evidenced by the gradual wedging out of the Valanginian beds towards the south (*vid.* p. 191).

The Caledonian massif ("Hühnerbjærg Block") in Falskebugt, which is bounded to seaward (east) by a fault line, rose from the Valanginian sea as an island. Along its western shore clastic and synorogenetic rocks were being laid down, which pass in a western direction into the organic limestone facies.

Vertical movements in Upper Valanginian time displaced the shores, the sea slowly withdrew from northern East Greenland. The "Rødryggen Beds" (Hoplitidan) are deposits of the shrunken Polyptychitan sea but their high content of iron-oxide speaks in favour of a long period of subaeric weathering.

With the Aptian stage the sea readvanced upon the quickly subsiding land (Fig. 69). Again the fault scarp of the "Kuhn Block" coincided with the coast. From here the limit of the sea probably ran southwestward across Wollaston Foreland. The striking paleogeographical element of "Niesen Fjord" had now vanished. At the fault scarp of the "Clavering Block" (A. Vischer's "Dombjærg Fault") the shore swung round crossing the present Young Sound at right angle and following the complex "Clavering Fault". Except for the island formed by the gneiss-dome at Falskebugt the whole of Wollaston Foreland was flooded and the "Kuppel-Permpass Blocks", too, had submerged.

South of Clavering Island the Aptian sea had occupied the present Gael Hamkes Bugt, Hold-with-Hope, and the Giesecke Bjærge nearly as far to the west as Margrethedalen.

The deposits of the Aptian and the Albian, respectively, cannot yet be discriminated in the field. Where a separation based upon paleontological considerations is not beyond any doubt we favour to speak summarily of an Aptian-Albian series or of "*Inoceramus* Beds".

Formations which might be referred to the Cenomanian or Turonian have hitherto not been recognized in the area covered by the writer's studies.

Until more paleontological information has become available from the "Home Foreland Beds", which crop out along the northern coast of Hold-with-Hope, we prefer not to identify them with the Senonian "Knudshoved Beds" as has been done by H. Frebold (Frebold 1934), since they and the Aptian-Albian series considerably resemble each other lithologically and facially. Besides, the overstepping character of the "Knudshoved Beds" upon the "Home Foreland Beds" clearly indicates a difference in age.[1])

Depostis of Senonian, *viz.* Santonian, age are apparently confined to the east coast of Hold-with-Hope, which leads to the view that the distribution of land and sea in Upper Cretaceous, Tertiary, and Quaternary times coincides more or less with the present-day contours. Accordingly, since Aptian-Albian times negative epeirogenetic movements have never again affected northern East Greenland, submergences which might have allowed the Greenland Sea to overflow large areas of the continental border.

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[1]) *Vid.* the remarks on p. 212.

V. BLOCK-FAULTING AND ITS BEARING ON THE SEDIMENTATION

The stratigraphical investigations carried out by the writer clearly show that in Valanginian time continental areas, *viz.* the emerged edges of tectonic blocks, extended as topographical elements to the west, northwest, and east of Wollaston Foreland. Near the fault scarps of these instable blocks coarse-clastic or even synorogenetic sediments were being heaped up, whereas away from them, in central Wollaston Foreland, fossiliferous limestones and marls went on being laid down in the quiet basin of Albrechts Bugt. Moreover, in the subsiding trough of "Niesen Fjord" thick marine deposits from the Volgian onwards into the Infravalanginian/Rjasanian-Polyptychitan-Hoplitidan could accumulate, the facies of which is an intermediate one.

I shall desist from repeating myself with regard to the tectonics and refer the reader to the abstract given above (Chapter I).

East of A. Vischer's "Main *post*-Devonian Fault" a great many other faults are exposed the scarps of which may have formed coast lines at successive stages during the Mesozoic era. None of the *post*-Devonian marine transgressions seems to have reached beyond the "Main *post*-Devonian Fault".

The continental or *sub*-continental Carboniferous beds accumulated in depressions at the foot of this fault scarp where the supply of terrigenous materials was plentiful. Phytostratigraphically the beds exposed in western Clavering Island and in the Passagehøje, Hudson Land, belong to the Namurian (= Lower Westphalian) whereas those cropping out in Prospektdal and Gästisdal are referred to the Dinantian (*vid.* Kulling 1929, Halle 1931, Malmquist 1932, Säve-Söderbergh 1934).

In Mesozoic times, already, outer fault scarps put a stop to the advancing seas. North of the land "Neo-Eskimonia" (Maync 1947), *viz.* in eastern Clavering Island, Wollaston Foreland, Th. Thomsens Land, Hochstetter Foreland, Great Koldewey Island *et cetera*, the late Jurassic sea was bounded on the west by prominent fault cliffs[1]). The Upper Jurassic synorogenetic "Rigi Series" that was deposited in the so-called "Niesen Fjord" bears evidence of having been formed under the influence of tectonic disturbances (Maync 1947).

The conditions governing the sedimentation of the Cretaceous deposits were of a simular nature,

The Middle Valanginian (Polyptychitan) sea transgressed over tilted and eroded beds of different age. In Falskebugt its strata rest unconformably upon the Caledonian fundament and display a coarse-clastic facies which evidently is a result of tectonic movements of A. Vischer's Hühnerbjærg Block".

Only in the late Jurassic "Niesen Fjord", western Wollaston Foreland, were marine deposits of the lowermost Valanginian laid down. There is no marked break in the sedimentary record between the Volgian and the "Lower Niesen Beds" (Infravalanginian/Rjasanian), yet towards the east, *viz*, in the area of Sillerendal (Palnatokes Bjærg), the overstepping character of the latter upon Lower Kimmeridgian is most probable (*vid.* p. 94).

The conditions of sedimentation in the domain of "Niesen Fjord" during the Volgian have been dealt with in a rather detailed account on the Jurassic stratigraphy of northern East Greenland (Maync 1947). There I gave proofs that considerable orogenetic movements have taken place in the uppermost Kimmeridgian (Young Cimmerian or Nevadian diastrophism). The continental border was broken and offset by faults of a general north-south trend, the different blocks slipped past each other and, at the same time, became tilted westwards. In that way the inclined superface of the one block came to push against the fault scarp of the higher western block. On account of the westward dip of the strata capping the inclined blocks the intersection with the fault outcrop to the west thus marks an obvious tectonic depression which immediately became flooded by an encroaching sea. Such a tectonic groove formed by the junction of the tilted "Kuhn Block" and the fault cliff of the "Clavering-Thomsensland Blocks" was found to exist in westernmost Wollaston Foreland. At the close of Jurassic time, after the main tectonic manifestations had come to an end, the sea advanced anew upon East Greenland, following the above-mentioned groove, and thus a marine trough formed here leaving its deposits ("Niesen Fjord").[2]). Owing to

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[1]) The idea of L. Koch that Mesozoic coast lines are partly preserved in recent cliffs, e. g. in Hochstetter Foreland and Clavering Island (Koch 1929a, 1931, 1935), has been subject to much unjust criticism but is fully confirmed by the latest investigations.

[2]) This tectonic groove has given rise to the forming of the recent Fligelys Fjord.

the preceding late Cimmerian orogeny of a faulting nature these beds known as the "Rigi Series" rest with an obvious angular unconformity upon the inclined Kimmeridgian strata. That the tectonic movements of the different blocks had not come to a close, however, is shown by the synorogenetic facies of these Volgian beds.

On top of this coarse-clastic series of Mt. Niesen the writer discovered calcareous sandstones with limestone partings carrying *Berriasellidae* and *Aucella* (*Buchia*) *cf. volgensis* Lah. etc., a fauna closely similar to that of the Infravalanginian of Jameson Land and of the Russian "Rjasan Beds". Besides, specimens of true *Subcraspedites* (Spath) with the species *S. plicomphalus* (Sow.) and its allies were collected by the author *in situ* in *Laugeites*-Ravine, Kuhn Island, which furthermore established a correlation with the Infravalanginian (Subcraspeditan) of Lincolnshire (*vid.* Chapter VI).

The *Aucella* faunas higher up in the sequence point to a Polyptychitan age. It may thus be assumed that the sedimentation in "Niesen Fjord" was going on during Volgian-Infravalanginian and Valanginian times.

While thus the whole sedimentation in this trough during the Upper Jurassic is typically of a synorogenetic character, i. e. the beds were being formed before the tectonic movements had come to a stop, the facies of the Cretaceous rocks is coarse-clastic, and real boulder beds are sparser; on the other hand calcareous sandstones and limestone layers inosculate. The "Upper Niesen Beds" (Polyptychitan-Hoplitidan) consist of alternate limestone/marls and coarse-grained sandstones, and, therefore, indicate oscillations in the sedimentation, in other words, they reflect slight movements of the adjacent western block.

Stress has already been laid upon the coarse-clastic or even synorogenetic character of the Valanginian beds developed in "Young Sound Facies" which are isopic-isotopic to the "Falskebugt Beds". The Valanginian in northeastern Clavering Island, too, is represented in a conglomeratic facies.

These clastics could only form within the range of prominent instable blocks, *viz.* the "Kuppel Block", "Clavering Block", "Hühnerbjærg Block", which proves anew that the Young Cimmerian tectogenesis was not yet on the decline but still manifested during the sedimentation of the Lower Cretaceous. At Falskebugt we have even evidence bearing on a *post*-Valanginian (*pre*-Aptian) displacement, documented by an angular unconformity between the Valanginian and Aptian formations (*vid.* pp. 55—60).

The considerable thicknesses of the Valanginian block-breccias and conglomerates overlying the Jurassic rocks in southwestern Wollaston Foreland suggest that subsiding tendencies prevailed in the said area of sedimentation, whereas positive, possibly jerky movements were characteristic of the coastal blocks. However, the transition of the clastic beds upwards into the adetritical limestone facies ("Albrechts Bugt Facies"), e. g. in Cardiocerasbjærg, clearly substantiates that the tectonic movements of the "Kuppel Block" soon died away and allowed a quiet sedimentation to take place. Contrary hereto the Valanginian in the southern face of Cardiocerasbjærg is developed from its base onwards in the limestone/marl facies. This fact can be explained by the overstepping character of the Valanginian horizons upon an eroded surface. On the other hand, we must keep in view that the complex "Kuppel Fault" which runs right into Cardiocerasbjærg has probably caused a facial difference in so far as boulder beds were being formed near a fault scarp (Stratumbjærget), *Aucella* limestone farther off. No doubt, the region of Stratumbjærget represents the margin of the Valanginian basin since the Valanginian thins out towards the east (Vischer 1943).

The stratigraphical data as borne out by the sequence from the Kuhnpasset to Aucellabjærget (*vid.* pp. 86—90) might induce one to assume the existence of a relic basin of the regressive Valanginian (Hoplitidan) sea, since a 120 m thick intercalary succession of marine strata was found to occur between the "Rødryggen Beds" (Upper Valanginian) and the concretionary beds at a height of 535 m (the age of which is fixed by a rich fauna as Aptian). This series may already belong to the Aptian (as assumed by the writer), but the possibility of an older age, e. g. Hauterivian or Barrêmian is not quite rejectable. However, a definite conclusion concerning this question cannot yet be arrived at (*vid.* p. 194).

Just as was the case in Volgian and Valanginian times certain fault scarps formed coast lines during the Aptian-Albian (Maync 1938, 1940). The Valanginian sea, too, had been bounded on the west by the soaring fault cliff of the "Thomsensland-Clavering Blocks", a coast which has persisted throughout the Mesozoic era, after all.

In Aptian time already fault scarps of outer tectonic blocks rose from the sea. In Hochstetter Foreland, for instance, Cretaceous beds are entirely lacking but they are known to occur in Shannon Island; it is altogether likely that the prolongated "Kuhn Fault", or more precisely the fault scarp of the "Kuhn Block", has formed an insuperable hindrance for the advancing Cretaceous seas. In Kuhn Island this block bears no strata younger than Volgian-Infravalanginian either, nor are *post*-Valanginian beds found to occur in northern Wollaston Foreland. One is led to believe, consequently, that the "Kuhn Fault" existed as a long-stretched "*falaise*" which bordered the Aptian sea to the west (see paleogeographical map, Fig. 69). Both eastern and central Wollaston Foreland were overflowed, however, and this sea has pushed far into

Young Sound across southwestern Wollaston Foreland. The psammitic facies of the Aptian series in Aucellabjærget bears witness of the near-by land in the north, and there is no trace left of the Jurassic-Lower Cretaceous "Niesen Fjord".

The fault scarp of the "Clavering Block" formed an imposing morphological element in Jurassic as well as in Cretaceous times.

Because of the tilting of the "Clavering Block" to the southwest the Aptian sea could advance far towards the west in the area of Gael Hamkes Bugt; yet the clastic facies of the coal-bearing Aptian-Albian beds in Stensiös Plateau show that these deposits were sedimented close to a shore.

Hold-with-Hope was entirely flooded by the Aptian-Albian sea which reached as far to the west as the Giesecke Bjærge and followed the present-day Franz Josephs Fjord almost to the "Main *post*-Devonian Fault". The investigations of H. Stauber have yielded the result that the Aptian-Albian sea was likewise denied access to the west by protruding fault scarps (Stauber 1938, 1939).

Whilst the Volgian "Rigi Series" in the western part of Wollaston Foreland is exclusively represented in a synorogenetic facies and the Valanginian, too, sometimes exhibits a similar block facies, the spreading of boulders during the sedimentation of the Aptian series was by far less frequent. Only locally and periodically did instable fault scarps deliver boulders into the sea. It was only exceptionally that block masses slumped down the coastal cliff, due to tectonic movements by jerks, and became embedded in huge clusters within the muds largely making up the Aptian-Albian formation. Boulder Ridge, in the northeastern portion of Clavering Island, will always occupy a foremost position with regard to this boulder sedimentation, will be a paradigm for so sudden a fall and heaping up of landslide débris in pelitic deposits.

Because these angular boulders facially represent altogether foreign bodies within the clayey shale series we feel justified in applying the term "exotic blocks" (*vid.* p. 114). Certainly the reader will be just as struck by the presence of such large "*facies-alien*" boulders of foreign provenience (Caledonian gneiss, Permian rocks) as for instance by the big angular gneissic and granitic blocks that are strewn into the pelagic limestone of the Alpine "Falknis Breccia" (Upper Jurassic) or by any other East-Alpine deposits the facies of which displays such synorogenetic "infections". An unprecedented example of this periodical boulder bed-sedimentation is the occurrence of the classical "exotic blocks" within the so-called "Wildflysch" of the Alpine ultrahelvetic domain, where polygenetic blocks of a solid content of thousands of cubic meters have fallen from a crystalline threshold into the shallow Tertiary Sea (*vid.* Heim 1916—1922 etc.).

Apart from Boulder Ridge, Clavering Island, such boulder beds within the Aptian series have been discovered by the writer in the Giesecke Bjærge (Gunnsteinsbjærg, *vid.* pp. 154—157). Similar block-carrying beds were moreover found in the Aptian of southwestern Wollaston Foreland, *viz.* at the floor of the plateau basalt of Palnatokes Bjærg[1]). This occurrence of gneiss boulders is not to be wondered at if we bear in mind the immediate neighbourhood of the great fault scarp of the "Clavering-Thomsensland Blocks" which, of course, has supplied those unwieldy boulders.

[1]) Mapped by A. Vischer as "Paleocene-Eocene" (Vischer 1943).

VI. REMARKS ON THE CRETACEOUS FAUNAS OF EAST GREENLAND, AND THEIR AGE AND RELATIONSHIPS WITH OTHER BOREAL ASSEMBLAGES

The aim of the present paper is, first and foremost, to provide a treatise on the stratigraphical and facial problems of the Cretaceous formations of northern East Greenland. It stands to reason, however, and is—as I hope—brought out by the foregoing chapters, that such a stratigraphical work must be solidly founded on paleontological evidence. For this reason a brief reference to the Cretaceous faunas of East Greenland, however deficient our knowledge may be, will be given in the following pages.

Thanks to L. F. SPATH's masterly memoirs (SPATH 1932, 1935b, 1936) the late Jurassic faunas of southern East Greenland are thoroughly known, and the writer has tried to unravel the relationships of the Jurassic beds between that well-known area and the northern region where there is still slender evidence bearing on the faunas, unfortunately (MAYNC 1947).

With regard to the Cretaceous faunas of East Greenland, however, there is no such standard-work at hand on which further studies may be based since Cretaceous beds (except Infravalanginian) are entirely lacking in the more easily accessible southern district of Scoresby Sound. On the other hand, the scattered Cretaceous fossils formerly brought back from northern East Greenland have never been studied in a thorough systematical way, and the faunas are thus poorly known.

Due to the courtesy shown me by Dr. L. F. SPATH, London, I am, fortunately, in a position to endorse my stratigraphical results in some respects by faunal evidence. Attention must be drawn to the fact, however, that the Cretaceous cephalopod faunas of East Greenland are only beginning to be understood. There are several ammonites and belemnites among the writer's collections that have never hitherto been recorded from East Greenland and, moreover, several new not yet described genera or subgenera are reported to be present by L. F. SPATH.

Stages		Ages	Fossilien aus Ostgrönland	Fundpunkte
Albien			*Inoceramus anglicus* WOODS	Clavering Insel Shannon Insel
Aptien	Gargasien	Parahoplitan	*Sanmartinoceras groenlandicum n. sp.*	Kuhn Insel
			"Garnieria" pusilla RAVN	Danmarks Havn
		Tropaeuman	?*Tropaeum cf. arcticum* STOLLEY	Wollaston Foreland
			?*Inoceramus cf. ewaldi* SCHLÜTER	Shannon Insel
	Bedoulien	Parahoplitoidan	*Deshayesites boegvadi n. sp.*	Kuhn Insel
			Deshayesites cf. laeviusculus v. KOENEN	Hold with Hope
		Parancyloceratan	—	
Barrêmienn		Heteroceratan	—	
		Paracrioceratan	—	
Hauterivien		Haplocrioceratan	—	
		Simbirskitan	*Simbirskites payeri* TOULA	Kuhn Insel
		Crioceratan	—	
		Lyticoceratan	?*Euryptychites aff. gravesiformis* PAVLOW	Koldewey Insel
Valanginien		Hoplitidan	—	Koldewey Insel
		Polyptychitan	Aucellenschichten	Kuhn Insel
		Platylenticeratan	—	Wollaston Foreland
Infra Valanginien		Subcraspeditan	?*Subcraspedites sp.*	Nördliches Jamesonland
		Spiticeratan	—	

In order to draw definite parallels one therefore has to await L. F. SPATH's publications on this topic.

It is much to be hoped that this still incomplete memoir will be replaced by a well-founded review of everything known concerning the stratigraphy and paleontology of the East Greenland Mesozoic; this will be possible when the clash of arms has died away for good and all and scientific research will again be held in greater regard.

The table above, p. 225, published by A. ROSENKRANTZ (BØGVAD & ROSENKRANTZ 1934, p. 23) shows the latest compilation of our knowledge of the East Greenland Cretaceous stratigraphy before the Danish Expedition in 1936—1938. H. FREBOLD's treatise on the Aptian beds of Great Koldewey Island and their fauna (FREBOLD 1935b) is not yet taken into consideration in this table.

The Cretaceous faunas of East Greenland as far as they are known for the present are listed below; however, only those forms which carry any weight as regards stratigraphy and correlation will be discussed at some length.

Appendix.

While the present stratigraphical paper was already in press L. F. SPATH published a preliminary account on the Cretaceous Ammonite Faunas of East Greenland (SPATH, L. F., 1946, Preliminary notes on the Cretaceous Ammonite Faunas of East Greenland. Medd. om Gr., Bd. 132, No. 4) which, with a view to its importance for stratigraphical correlations, must be taken into consideration as a valuable supplement to this memoir.

Infravalanginian forms.

From the conglomeratic basal bed of cycle IV in *Laugeites*-Ravine, southwestern Kuhn Island (*vid.* pp. 30—31)

Subcraspedites aff. plicomphalus (SOW.)
and *Subcraspedites cf. stenomphalus* (PAVL.)

are listed, and from the Infravalanginian "Lower Niesen Beds" (*vid.* p. 96).

Ammonites gen. nov. I *sp.* a (at 235 m altitude)
Ammonites gen. nov. I *sp.* b
Ammonites gen. nov. II *sp. nov.* (248 m altitude)
and *Tollia payeri* (TOULA) (at 380 m altitude).

Valanginian forms.

Polyptychites cf. euomphalus v. KOEN. is

recorded from the "Upper Niesen Beds" (at a height of 460 m, *vid.* p. 97), and from the top of Mt. Niesen (P. 688 m)

Lyticoceras sp. ind. (*vid.* p. 98).

From the Polyptychitan deposits exposed in the surroundings of Albrechts Bugt mention is made of

Polyptychites (9 species)
Euryptychites (1 species)
Dichotomites (4 species)
Neocraspedites (4 species)
Lytoceras sp.
and *Ammonites gen. nov.*

Aptian forms.

In the *Lytoceras polare* fauna from above Kuhnpasset, Wollaston Foreland (*vid.* pp. 87—88) L. F. Spath has identified

Ancyloceras
and *Cymatoceras aff. radiatum* (Sow.) *sp.*

From the Aptian series of eastern Kuhn Island the following forms are listed:

Lytoceras polare Ravn
Lytoceras sp. nov.? *aff. phestum* Math. *sp.*
Deshayesites boegvadi Rosenkr.
Ancyloceras aff. matheronianum (d'Orb.)
Neohibolites sp.
and "*Rhynchonella*" *antidichotoma* Buv.,

and from "1 km south of Cape Maurer"

Sanmartinoceras spp. (*pusillum* (Ravn) = ?*groenlandicum* Rosenkr.)
?*Pascoeites sp.* (?*crassus* Spath)
Ancyloceras spp.
and ?*Tonohamites spp.*

Tropaeum arcticum Stoll. is mentioned from the Aptian beds "east of Albrechts Bugt", Wollaston Foreland.

The well-preserved specimen of *Phylloceras rouyianum*[1]) (d'Orb.) is derived from the lowermost portion of the Aptian series in Rødryggen (*vid.* p. 72).

The ammonites collected in Stensiös Plateau, Hold-with-Hope (*vid.* p. 126) are referred to

Deshayesites aff. laeviusculus (v. Koen.)
and *Deshayesites sp. ind.* (not *Arcthoplites*).

Moreover,

Deshayesites sp.
and *Lytoceras polare* Ravn are recognized.

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[1]) In the determination of my East Greenland cephalopods with which Dr. L. F. Spath was kind enough to provide me, mention is made of *Phylloceras royerianum* (d'Orb).

Albian forms.

Gastroplites spp. nov.?

are listed from the Albian sequence in Kronebjærg, western Sabine Island (*vid.* pp. 34—36) and from Cape Berlin, Wollaston Foreland (*vid.* p. 46).

1) Infravalanginian Rjasanian.

Fossils pointing towards the lowermost Cretaceous zones have previously been unknown in northern East Greenland.

Up to now the following forms have been proved to be represented among the writer's collections[1]):

* *Laugeites* ("*Kochina*") *groenlandica* SPATH
** *Subcraspedites* ex *gr plicomphalus* (SOW.)
** *Subcraspedites* ex *gr stenomphalus* (PAVL.)
** *Berriasellidae nov. gen.* (*pro parte*)
* *Rjasanites?*
Ammonites payeri TOULA
* *Aucella* (*Buchia*) *cf. volgensis* LAH.
— — *cf. ?fischeriana* (D'ORB.)
etc.

The genus *Laugeites* ("*Kochina*") (holotype: *Kochina groenlandica* SPATH) of the *sub*-family *Pavlovinae* (SPATH) has been established by L. F. SPATH in 1936 for a finely-ribbed type of *Dorsoplanites* (SEMENOV) derived from the "*Lingula* Bed" ("Hartzfjæld Sandstone") of Milne Land, Scoresby Sound (SPATH 1936). This form is believed to be typical of the highest levels of the Volgian (Aquilonian) and is closely related to *Laugeites* ("*Kochina*") *schtschourovskii* (NIK.) of Russia, the suture-line of which, on the other hand, is hardly different from that of *Subcraspedites preplicomphalus* SWINN. from the "Spilsby Sandstone", a form that exhibits a great resemblance to the Infravalanginian *Subcraspedites spasskensis* (BOG.) (*vid.* SWINNERTON 1935, SPATH 1936). According to L. F. SPATH (*op. cit.*) *Subcraspedites groenlandicus* SPATH from southern East Greenland (Milne Land) is furthermore comparable to the Cretaceous forms, e. g. *Subcraspedites primitivus* SWINN. from the "Spilsby Sandstone" and *Subcraspedites aff. subditus* PAVL. (non TRAUTSCH.) (= *Subcraspedites claxbiensis* SPATH) from the "Claxby Ironstone (Lincolnshire).

The view of L. F. SPATH (in *loc. cit.*) that *Laugeites* ("*Kochina*") is

[1]) The asterisked forms (*) indicate those recorded for the first time from northern East Greenland; those marked by two asterisks (**) had not hitherto been found in East Greenland.

a forerunner of the *Craspeditidae* (SPATH), e. g. of *Kachpurites* (SPATH)[1]) and *Subcraspedites* (SPATH)[2]), is now clearly confirmed by the new find of *Laugeites* ("*Kochina*") *groenlandica* SPATH and *Subcraspedites* (ex *gr plicomphalus/stenomphalus*) together in cycle IV of the series in *Laugeites*-Ravine, southwestern Kuhn Island (*vid.* pp. 30—31). There is even every reason to declare, accordingly, that there is a still closer relation between *Laugeites* ("*Kochina*") and the family *Craspeditidae* (*Subcraspedites* etc.) than between the former and the Jurassic *Pavlovinae.* At any rate there exists a continuous phylogenetic sequence from *Dorsoplanites* to *Laugeites* ("*Kochina*")-*Craspedites*-*Kachpurites*-*Subcraspedites*-*Polyptychites* which is doubtless of outstanding importance for stratigraphical correlations (*vid.* MAYNC 1947). Whilst the *Craspeditids* with such well-known forms as *Kachpurites fulgens* (TRAUTSCH.) (NIK.), *Cr. fragilis* TRAUTSCH., *Cr. subfulgens* NIK., *Cr. okensis* (D'ORB.), *Cr. catenulatum* TRAUTSCH. (= *Garniericeras* (SPATH)), *Cr. subditoides* (D'ORB.), *Cr. subditus* TRAUTSCH., *Cr. subclypeiformis* MIL., *Cr. nodiger* TRAUTSCH., *et cetera* are still taken to be Upper Volgian (Aquilonian) forms, the genera *Subcraspedites* (SPATH) and *Paracraspedites* (SWINNERTON) already represent elements of the lowermost Cretaceous, *viz.* Infravalanginian-Subcraspeditan/Rjasanian (*vid.* v. BUBNOFF 1926, SWINNERTON 1935, SPATH 1936, NALIVKIN 1937a, etc.).

In the following pages mention will be made of certain faunas outside East Greenland which, too, belong to the boreal province and which will serve as a basis for our comparative discussion.

In England, *viz.* in the famous sequence of Speeton and Lincolnshire, the Infravalanginian (Subcraspeditan) beds are developed in a very similar way.

In Lincolnshire the lowermost marine beds of the transgressive Cretaceous series on top of the Kimmeridge Clay carry an ammonite fauna slightly earlier than any found in Speeton.

The normal contact between the "Spilsby Beds" and the Kimmeridge Clay (with *Pectinatites pectinatus* (PHILL.)) in Lincolnshire is exposed in Lymn Valley (SWINNERTON 1941). At the very base of the Cretaceous lies a phosphatic pebble bed, containing reworked Kimmeridgian fossils and marcasite nodules, which shows the overlapping character of the system, in other words, a gap in the sedimentary record. Then follows the "Spilsby Series" with a basement bed (C) and the proper "Spilsby Sandstone" (D) consisting of glauconitic clayey sands with coarse ferruginous grit, pebbly layers, bored lignite *et cetera.* The maximum thickness of this sandstone bed is reported to amount to

[1]) Lectotype: *Ammonites* (*Neumayria*) *fulgens* (TRAUTSCH.) NIK.
[2]) Lectotype: *Ammonites plicomphalus* SOW.

about 22 m (*vid.* SWINNERTON 1935, 1941). From boulders of the lowermost 3 m bed H. H. SWINNERTON records *Subcraspedites*, and the basement bed (C) has yielded the following forms:

Subcraspedites cf. precristatus SWINN.
— *cf. subundulatus* SWINN.
— *preplicomphalus* SWINN.
Paracraspedites stenomphaloides SWINN.
— *bifurcatus* SWINN.
? — *trifurcatus* SWINN.
(SWINNERTON 1935).

The overlying bed (D) of the "Spilsby Series" is characterized by the below-listed species of *Subcraspedites* (SPATH):

Subcraspedites primitivus SWINN.
— *precristatus* SWINN.
— *cristatus* SWINN.
— *subundulatus* SWINN.
— *parundulatus* SWINN.
— *subpressulus* (BOG.)
(*op. cit.*).

Apart from these ammonites the following fossils are reported to occur in the "Spilsby Sandstone":

Acroteuthis lateralis (PHILL.)
— *sublateralis* SWINN.
— *subquadratus* (ROEM.)
— *cf. subquadratus* (ROEM.)
— *mosquensis* (LAMPL.)
— *explanatoides* (PAVL.)
— *festucalis* SWINN.
(SWINNERTON 1935, 1941).

Moreover, *Aucellas*, e. g. *Aucella* (*Buchia*) *volgensis* LAH. etc. are typical of the "Spilsby Beds".

According to H. H. SWINNERTON (in *loc. cit.*) the formerly cited specimen of "*Craspedites nodiger*" must be identified with *Subcraspedites cristatus* SWINN. *Subcraspedites aff. subditus* PAVL. (non TRAUTSCH.) has been named *Subcraspedites claxbiensis* SPATH whereas *Craspedites subditus* PAVL. (non TRAUTSCH.) *var.* from the "Spilsby Sandstone" (which seems to belong to the *subpressulus* group) has been designated as *Subcraspedites lamplughi* SPATH (SPATH 1936). *Subcraspedites preplicomphalus* SWINN. represents a close ally of the widely distributed index-form *Subcraspedites spasskensis* (BOG.) and, apparently, also of *Laugeites* ("*Ko-*

china") *schtschourovskii* (NIK.) (*vid.* SPATH 1936), whilst *Paracraspedites stenomphaloides* SWINN. very much resembles *Subcraspedites stenomphalus* (PAVL.) and the Rjasan form "*Olcostephanus*" *subtzikwinianus* BOG. (SWINNERTON 1935).

According to L. F. SPATH (*op. cit.*) *Subcraspedites groenlandicus* SPATH is comparable to *Subcraspedites primitivus* SWINN. or to *Subcraspedites claxbiensis* SPATH from the "Spilsby Beds", and to some degree to *Subcraspedites bidevexus* BOG. from the Russian "Rjasan Beds", and to "*Nikitinoceras*" (?*Tollia*) *sosnovskii* SOK. from Novaya Zemlya.

It thus becomes evident that the above-mentioned forms of *Subcraspedites* (SPATH) are closely related to each other, and the great affinities with certain types from the "Rjasan Beds" (Infravalanginian) shows distinctly that both the faunas from Lincolnshire and central Russia are offsprings from a common boreal province (*vid.* SWINNERTON 1935, KIRKALDY 1939, and others). Contrary to the "Spilsby Beds" and the Speeton sequence the "Rjasan Beds" furthermore contain several forms obviously derived from the southern Tethys Sea, e. g. *Berriasellidae* (*Rjasanites rjasanensis* (LAH.), *R. subrjasanensis* (NIK.) etc.); accordingly there must have existed a marine connection. The very same is now evidenced in East Greenland, whence a couple of *Berriasellids* (partially new forms) have been brought back by the writer from the "Lower Niesen Beds" of Infravalanginian/Rjasanian age[1]).

Since the *Subcraspeditids* derived from *Laugeites*-Ravine, southwestern Kuhn Island, belong to the group of *Subcraspedites plicomphalus* (Sow.) and *Subcraspedites/Tollia stenomphalus* (PAVL.), they, too, are thus akin to those occurring in the "Spilsby Beds".

There is no trace of the Platylenticeratan ("*Garnieria* Beds") either in Lincolnshire or in East Greenland.

At Speeton the Kimmeridge Clay is non-sequentially overlain by a "Coprolite Bed" (E) which includes rolled ammonites of Kimmeridgian age, e. g. ?*Virgatosphinctoides* (*vid.* ARKELL 1933, KIRKALDY 1939), on which account it was formerly taken for *pre*-Cretaceous (PAVLOV & LAMPLUGH 1891, VON KOENEN 1902, and others). To-day these basal beds are correlated with the Subcraspeditan, *viz.* with the zones of *Subcraspedites spasskensis* (NIK.), *Tollia tolli* PAVL., and *Subcraspedites/Tollia stenomphalus* (PAVL.) (*vid.* KILIAN 1907—1913, SPATH 1924, ARKELL 1933)[2]).

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[1]) With regard to the occurrence of the late Infravalanginian form *Ammonites payeri* TOULA, which up to now had wrongly been assigned to *Simbirskites* (PAVLOV), the reader is referred to the foregoing chapters III and IV.

[2]) According to other authors the lowermost bed of the Speeton series is Polyptychitan in age (*vid.* BOSWELL 1929, STOLLEY 1937).

Then follows a set of about 10 m clay that corresponds to the Platylenticeraten (zones of *Platylenticeras* (*Garnieria*) *heteropleurum* (N. & UHL.), *P.* (*G.*) *gevrili* (D'ORB.), and *P.* (*G.*) *marcoui* (D'ORB.)) but, at higher levels, already carries *Polyptychites spp.* (*vid.* BOSWELL 1929, ARKELL 1933). *Acroteuthis lateralis* (PHILL.) and *Aucella* (*Buchia*) *volgensis* LAH., *A.* (*B.*) *keyserlingi* LAH. etc. are also reported to occur.

In Northwest Germany (Hils area, Brunswick/Hannover), where Cretaceous beds with true boreal affinities are known to overlie the Wealden freshwater deposits, the marine transgression ("Hils Conglomerate") likewise only took place in Platylenticeratan time as is evidenced by the occurrence of *Platylenticeras* (*Garnieria*) *heteropleurum* (N. & UHL.), *P.* (*G.*) *gevrili* (D'ORB.), and *P.* (*G.*) *marcoui* (D'ORB.). According to the list given in 1881 by M. NEUMAYR & V. UHLIG these forms are associated with a considerably younger ammonite fauna of Upper Valanginian(-Hauterivian) age[1]) which might lead to the view that they are reworked. Since, however, all the later authors such as A. VON KOENEN, E. STOLLEY, and others have been able to chronologize the "Hils Beds" and the Lower Cretaceous of southern France etc. we may assume that the first assemblages from the "Hils Conglomerate" have been mixed ones, derived from different horizons.

On account of the fact that the marine Platylenticeratan beds (which are not represented in Lincolnshire) locally alternate with freshwater strata in Wealden facies, it appears that the uppermost portion of the Wealden beds of northern Germany corresponds to the "Spilsby Sandstone" (Infravalanginian/Berriasian). The same parallel is suggested by the occurrence of *Platylenticeras* (*Garnieria*) *heteropleurum* (N. & UHL.) in the Lower Valanginian of southern France (*vid.* KILIAN 1907—1913, STOLLEY 1937, ARKELL 1933).

From the higher levels of the "*Garnieria* Beds" (Platylenticeratan) upwards there occurs *Polyptychites diplotomus* v. KOEN. (VON KOENEN 1902, KILIAN 1907—1913), and on this account E. STOLLEY classes the "*Garnieria* Beds" as Middle Valanginian and, consequently, includes the Infravalanginian + Lower Valanginian into the Wealden (STOLLEY 1937).

The higher "Hils Clay" is regarded as equal to the "Speeton Clay" (SPATH, *vid.* ARKELL 1933).

Near Tomaszow on the Pilica River, southwestern Poland, the Portlandian with "*Provirgatites*" *scythicus* (VISCHN.) *et cetera* is reported

[1]) E. g. *Dichotomites bidichotomus* (LEYM.), *Neocomites amblygonius* (N. & UHL.) (= *Lyticoceras noricum* (ROEM.)), *N. oxygonius* (N. & UHL.), *Astieria astieri* (D'ORB.), *Leopoldia ottmeri* (N. & UHL.), *Acanthodiscus radiatus* BRUG. etc. (NEUMAYR & UHLIG 1881).

by J. LEWINSKI to be superposed by a relic of Wealden (limestone and serpulite containing a brackish impoverished fauna), on top of which follows a layer about 1 m thick of ferruginous oolite, clay, and sand, carrying e. g. *Rhynchonella valangiensis* DE LOR., oysters, etc. (Infravalanginian). This bed is overlain by dark clay (2 m) bearing a rich mollusk fauna and, moreover, *Platylenticeras (Garnieria) cf. gevrili* (D'ORB.), *P. (G.) marcoui* (D'ORB.), and sparse *Polyptychites.* This stratum of Lower Valanginian age (Platylenticeratan) is followed by a relic bed containing abundant though broken specimens of *Polyptychites spp.*, and, besides, *Saynoceras verrucosum* (D'ORB.) (Polyptychitan-Hoplitidan) (LEWINSKI 1931, 1932).

Apart from the reduced thickness this sequence thus fully agrees with those of northwestern Germany and Speeton.

In central Russia (area of Moscow-Rjasan-Simbirsk), where, apparently, a continuous marine sedimentation from the Jurassic into the Cretaceous system has taken place[1]) in the gulf that extended southwards from the Polar Ocean, the Upper Volgian deposits (zone of *Craspedites nodiger* TRAUTSCH. etc.) are conformably overlain by the so-called "Rjasan Beds". This formation of Rjasanian age, consisting of glauconitic and phosphatic sands and sandstones, is correlated with the Infravalanginian (zone of *Thurmannites boissieri* (PICT.) of the Tethys Sea since it is followed by beds carrying e. g. *Platylenticeras (Garnieria) marcoui* (D'ORB.) which is found in southeastern France on top of the *boissieri* zone (*vid.* KILIAN 1907—1913). North of the town Simbirsk, where the Rjasanian locally corresponds to a slight transgression, also *Platylenticeras (Garnieria) gevrili* (D'ORB.) and *P. (G.) heteropleurum* (N. & UHL.) are recorded.

Generally the Rjasanian is subdivided into two zones, *viz.* a lower one with *Berriasella (Rjasanites) rjasanensis* LAH., and an upper one with *Subcraspedites spasskensis* (NIK.).

From the Lower Rjasanian (*rjasanensis* zone) S. VON BUBNOFF cites the below-listed fossils (v. BUBNOFF 1926):

Berriasella (Rjasanites) rjasanensis LAH.
Berriasella subrjasanensis NIK.
Hoplites swistonianus NIK.
— *hospes* BOG.
— *transfigurabilis* BOG.
— *inexploratus* BOG.

[1]) However, L. F. SPATH is inclined to support the view that there exists a break in the sedimentation between the Upper Volgian and the "Rjasan Beds" since the ammonite faunas of both stages show rather different features (SPATH 1936).

Belemnites russiensis d'ORB.
Acroteuthis lateralis (PHILL.)
— *subquadratus* (ROEM.)
Aucella (Buchia) subokensis PAVL.
— — *okensis* PAVL.
— — *volgensis* LAH.
— — *fischeriana* (d'ORB.)
— — *mosquensis* (v. BUCH)
— — *trigonoides* LAH.
— — *terebratuloides* LAH. etc.

From the *spasskensis* zone (Upper Rjasanian) the following fauna is enumerated by S. VON BUBNOFF (in *loc. cit.*):

Subcraspedites spasskensis (NIK.)
— *suprasubditus* BOG.
— *pressulus* BOG.
— *subpressulus* BOG.
—/*Tollia stenomphalus* (PAVL.)
"*Olcostephanus*" *subtzikwinianus* BOG.
Tollia simplex (BOG.)
Polyptychites craspeditoides GIRM.
Acroteuthis lateralis (PHILL.)
— *subquadratus* (ROEM.)
Aucella (Buchia) volgensis LAH.
— — *inflata* TOULA
— — *surensis* PAVL.
— — *andersoni* PAVL.
— — *lahuseni* PAVL.
— — *bulloides* LAH.
— — *crassa* PAVL.
— — *elliptica* PAVL.
— — *jasykovi* PAVL.
— — *spasskensis* PAVL,
— — *subokensis* PAVL. etc.

Higher in the sequence appear *Platylenticeras* (*Garnieria*) *marcoui* (d'ORB.), *Polyptychites hoplitoides* (NIK.) etc., and then the "*Polyptychites* Beds" (*vid.* KILIAN 1907—1913, VON BUBNOFF 1926).

In Oka and Petchora River the same succession with the same typical faunas, e. g. *Subcraspedites spasskensis* (NIK.), *Tollia simplex* (BOG.) etc., is stated to be exposed (*vid.* FREBOLD 1930, NALIVKINE 1937 a).

On the eastern face of the Ural Mountains Infravalanginian/Rjasanian is proved to occur by the precence of *Subcraspedites spasskensis* (NIK.), *Tollia sp.*, *Acroteuthis lateralis* (PHILL.) etc., and the Middle Valanginian is represented by *Polyptychites cf. lamplughi* PAVL. etc. (OBRUTSCHEW 1926, SIRIN & SHMAKOVA 1937, VOLKOV & JACJUK 1937b).

The stratigraphy of Siberia is still too little known to allow a reliable comparison of different zones, yet there is evidence of Infravalanginian/Rjasanian beds being represented.

Blanfordia (= *Blanfordiceras* (SPATH)), which for instance is reported from the region of Tobolsk, is a typical Asiatic ammonite genus indicative of Berrisasian (Infravalanginian) that occurs e. g. in the Middle "Spiti shales" of the Himalayas. *Ostrea leymeriei* DESH. which is cited from the same locality in Western Siberia already points to higher Cretaceous stages.

From the Prontchitchew Mountains, between Anabara and Olenek River, Infravalanginian/Rjasanian with *Tollia tolli* PAVL., *T. tolmatschevi* PAVL. etc. is known (OBRUTSCHEW 1926). Rich *Aucella* faunas are derived from Olenek River (*op. cit.*) part of which points decidedly towards the Infravalginian, including e. g. *Aucella* (*Buchia*) *volgensis* LAH., *A.* (*B.*) *terebratuloides* LAH., *A.* (*B.*) *bulloides* PAVL. etc. From Balkalak River, a tributary of Olenek River, an Infravalanginian/ Rjasanian fauna with *Aucella* (*Buchia*) *fischeriana* (d'ORB.), *A.* (*B.*) *lahuseni* PAVL., *A.* (*B.*) *volgensis* LAH., *A.* (*B.*) *cf. okensis* PAVL., and *A.* (*B.*) *terebratuloides* LAH. is reported, and *Aucella* (*Buchia*) *volgensis* LAH., *A.* (*B.*) *fischeriana* (d'ORB.), *A.* (*B.*) *lahuseni* PAVL., and *A.* (*B.*) *trigonoides* LAH. are recorded from Bulun on Lena River (OBRUTSCHEW 1926). Marine *Aucella*-bearing deposits of Volgian-Valanginian age have moreover been discovered in the Khara-ulakh Mountains, east of Lena River (*vid.* NIKOLAEV 1938a, 1938b). Infravalanginian/Rjasanian is furthermore proved to occur in Seimchan/Kolyma River by the presence of *Aucella* (*Buchia*) *okensis* PAVL., *A.* (*B.*) *cf. elliptica* PAVL., *A.* (*B.*) *cf. terebratuloides* LAH., *A.* (*B.*) *jasykovi* PAVL. etc. (*Bodylevsky* 1937?). From Anadyr River and the Pekulney Mountains W. A. OBRUTSCHEW mentions *Aucella* (*Buchia*) *volgensis* LAH., and *A.* (*B.*) *bulloides* LAH. (OBRUTSCHEW 1926). Along the rivers Main and Orlovka in eastern Siberia the Volgian beds, carrying *Aucella* (*Buchia*) *paradoxa* SOK., *A.* (*B.*) *fischeriana* (d'ORB.), *A.* (*B.*) *andersoni* PAVL., *A.* (*B.*) *stantoni* PAVL. etc., are conformably overlain by deposits the fauna of which points towards Rjasanian. B. N. ELISEEV cites for instance *Aucella* (*Buchia*) *okensis* PAVL., *A.* (*B.*) *cf. subokensis* PAVL., and *A.* (*B.*) *terebratuloides* LAH. (ELISEEV 1936). *Aucella* (*Buchia*) *cf. volgensis* LAH. and *A.* (*B.*) *cf. terebratuloides* LAH. are cited from Amur River (OBRUTSCHEW 1926).

Marine deposits of Infravalanginian/Rjasanian age are also developed in Novaya Zemlya as is proved by the presence of *Subcraspedites spasskensis* (NIK.), *Tollia novosemelica* SOK. (= *T. tolli* PAVL.), *T. simplex* (BOG.), *Polyptychites* (?*Tollia*) *sosnovskii* SOK., and *Aucella* (*Buchia*) *terebratuloides* LAH. (*vid.* FREBOLD 1930). *Platylenticeras* (*Garnieria*) *cf. gevrili* (d'ORB.), cited by A. A. PETRENKO, is, of course, not indicative of Lower Volgian as is believed (*vid.* PETRENKO 1936), but points to the Lower Valanginian (Platylenticeratan).

In Franz Joseph Land the Cretaceous is for the most part represented by a plant-bearing series of supposed Hauterivian-Barrêmian age (*vid.* FREBOLD 1935a) which the writer is inclined to refer to the Aptian-Albian (*vid.* pp. 248—257). T. N. SPIŽARSKIJ, nevertheless, lists marine Valanginian fossils together with a Volgian fauna (SPIŽARSKIJ 1937) and mention is made of *Polyptychites sp.* from Hooker Island (OGNEV 1933).

Infravalanginian/Rjasanian beds are also exposed in western Spitsbergen, *viz.* in the region of Icefjord (Cape Festning, Sassen Bay, Advent Bay).

In Cape Festning, whence a thick continuous sequence from the Jurassic into the Lower Cretaceous is recorded, the following Infravalanginian forms are cited from bed 21 (consisting of dark marly shale):

Aucella (*Buchia*) *cf. lahuseni* PAVL.
— — *volgensis* LAH.
— — *surensis* PAVL.
— — *trigonoides* LAH.
— — *okensis* PAVL.
— — *terebratuloides* LAH.
— — *elliptica* PAVL.

(SOKOLOV & BODYLEVSKY 1931).

From the same layer *Aucella* (*Buchia*) *keyserlingi* LAH. is mentioned which is already a characteristic form of the Polyptychitan (FREBOLD & STOLL 1937). Since, however, the following bed 22 has yielded *Aucella* (*Buchia*) *cf. okensis* PAVL. and *A.* (*B.*) *cf. subokensis* PAVL. (*vid. op. cit.*) and, on account hereof, should still be assigned to the Infravalanginian, we cannot attach much weight to that single species here. Bed 22a may already be Polyptychitan in age, having furnished e. g. *Polyptychites aff. quadrifidus* v. KOEN., but, on the other hand, still includes for instance ?*Tollia sp.* and *Aucella* (*Buchia*) *terebratuloides* LAH. (*op. cit.*). Only bed 22b is indubitable Polyptychitan in age.

From bed 20 H. FREBOLD & E. STOLL (in *loc. cit.*) record *Subcraspedites cf. subpressulus* BOG.[1]) which—if it is not misidentified—clearly indicates the presence of Rjasanian (zone of *Subcraspedites spasskensis* (NIK.)); mention should be made of the fact, however, that fossils of late Jurassic (Lower Volgian) age are listed from the same layer, *viz. Virgatites? sp.*, "*Provirgatites*" *aff. scythicus* (VISCHN.), and *Aucella* (*Buchia*) *mniovnikensis* PAVL. which may possibly have been reworked.

From Sassen Bay D. SOKOLOV & Y. I. BODYLEVSKY record *Aucella* (*Buchia*) *volgensis* LAH., *A.* (*B.*) *lahuseni* PAVL., *A.* (*B.*) *cf. okensis* PAVL., and *A.* (*B.*) *cf. terebratuloides* LAH., and from Advent Bay (west of Cape Delta) *Subcraspedites cf. subpressulus* BOG., *Aucella* (*Buchia*) *volgensis* LAH., *A.* (*B.*) *okensis* PAVL., *A.* (*B.*) *lahuseni* PAVL., *A.* (*B.*) *fischeriana* (d'ORB.), and other mollusks (SOKOLOV & BODYLEVSKY 1931).

An earlier determination of *Platylenticeras* (*Garnieria*) *marcoui* (d'ORB.) from Spitsbergen is doubted by the said authors (in *loc. cit.*).

Beds of Infravalanginian age are not known to occur in King Charles Land.

Marine deposits of Infravalanginian/Rjasanian age are lacking throughout Alaska[2]), and it was only the boreal *Aucella* Sea of the Polyptychitan (with *Aucella* (*Buchia*) *piochii* GABB, *A.* (*B.*) *crassicollis* KEYS., and *A.* (*B.*) *concentrica* FISCH. etc.) that transgressed over the land after a regional submergence. Owing to the Nevadian (= Young Cimmerian) Orogeny, which has also caused the marked unconformity in northern East Greenland between the Kimmeridgian shales and the synorogenetic "Rigi Series" of Volgian age (*vid.* MAYNC 1947), due to this tectogenesis, there is a great angular unconformity at the floor of the Cretaceous beds from Alaska down to California (*vid.* MARTIN 1926, CRICKMAY 1931). The *Aucella* beds rest on late Jurassic strata along the Pacific coast, yet in the interior of Alaska they overlap the Triassic or Paleozoic formations (MARTIN 1926).

2) Polyptychitan (Middle Valanginian).

The fossils listed below are hitherto known from the Polyptychitan of East Greenland[3]).

[1]) In a former paper (1928) H. FREBOLD, moreover, has determined *Subcraspedites cf. pressulus* BOG., another Rjasanian form (*vid.* SOKOLOV & BODYLEVSKY 1931).

[2]) *Aucella* (*Buchia*) *cf. fischeriana* (D'ORB.) is recorded from graywacke-rocks of the "Naknek formation" in Chichagov and Baranov Islands, southeastern Alaska (MARTIN 1926). If this determination actually holds true this find would be suggestive of either Upper Volgian (Aquilonian) or Infravalanginian/Rjasanian.

[3]) The fossils marked by an asterisk (*) had not been found previously in the Valanginian of East Greenland.

Polyptychites spp.
Euryptychites sp.
Euryptychites aff. gravesiformis (Pavl.)
* *Neocraspedites spp.*
* *Dichotomites petschoraensis* Bog.
* *Dichotomites spp.*
* *Lytoceras sp.*
Acroteuthis sp. ex *gr lateralis* (Phill.)
Acroteuthis (?*Pachyteuthis*) *sp.*
"*Belemnites panderianus* d'Orb.
— *absolutus* Fisch.
— *volgensis* d'Orb.
— *sp. ind.*"
} recorded by F. Toula, 1874, from Kuhn Island
Aucella (*Buchia*) *concentrica* Fisch.
— — *cf. concentrica* Fisch.
— — *piriformis* Pavl.
— — *piriformis* Lah. (non Pavl.)
— — *cf. piriformis* Pavl.
— — *crassicollis* Keys.
— — *keyserlingi* Lah.
— — *cf. keyserlingi* Lah.
— — *cf. lamplughi* Pavl.
— — *cf. sublaevis* Keys.
— — *cf. syzranensis* Pavl.
Avicula sp.
?*Pinna sp.*
Ostrea sp.
* *Alectryonia. sp.*
* *Lima sp.*
* *Pecten sp.*
* *Rhynchonella sp.*
* *Terebratula sp.*
* Gastropoda
* Corals (*Isastraea*, *Trochocyathus*)
* *Pentacrinus sp.*
* *Collyrites* (*Tithonia*) *nov. sp.*

Hoplitidan (Upper Valanginian):

* *Lyticoceras sp.*
Aucella (*Buchia spp.*

This fauna is clearly related to other Valanginian assemblages of the boreal province.

In Lincolnshire, the Subcraspeditan "Spilsby Beds" are non-sequentially followed by the so-called "Claxby Beds" which correspond to the Polyptychitan-Hoplitidan[1]) (Middle and Upper Valanginian) its uppermost portion, however, being already Lower Hauterivian in age (*vid.* Spath 1924, Arkell 1933, Swinnerton 1935).

The "Claxby Beds" are subdivided into "Lower Ironstone", "Hundleby Clay", and "Upper Ironstone", and attain a thickness of 7—8 m (Swinnerton 1935, 1941).

The lower part of the "Claxby Beds", viz, the "Lower Ironstone" and "Hundleby Clay", carries *Acroteuthis lateralis* (Phill.) and, moreover, a *Polyptychites-Dichotomites* fauna[2]) which is equal to that of the "Lower Speeton Clay", whilst the fossils from the "Upper Ironstone" including e. g. *Acanthodiscus radiatus* Brug., *Lyticoceras noricus* (Roem.), *L. oxygonius* (N. & Uhl.), *Neocomites regalis* (Bean), *Distoloceras hystrix* (Phill.), *Asteria asteri* (d'Orb.), *Hibolites jaculum* (Phill.) etc. fix its age as Lyticoceratan or lowermost Hauterivian (Spath 1924, *vid.* Swinnerton 1935). After a stratigrapical gap follows the "Tealby Series" marked by an abundance of *Simbirskites* (Pavl.), e. g. *Simbirskites* (*Craspedodiscus*) *speetonensis* Y. & B., *Holcodiscus rotula* (Sow.), *Simbirskites* (*Craspedodiscus*) *phillipsi* (Roem.), *S.* (*C.*) *progrediens* (Pavl.) *S.* (*C.*) *umbonatus* (Lah.), *S.* (*C.*) *discofalcatus* (Lah.) etc., and *Hibolites jaculum* (Phill.), *Aulacoteuthis absolutiformis* (Sinz.), *A. speetonensis* (Lampl.), *Oxyteuthis brunsvicensis* (Stromb.) etc. (Kilian 1907—1913, Spath 1924, Arkell 1933, Swinnerton 1935).

The ammonite fauna (Polyptychitan) of East Greenland closely recalls the *Polyptychites-Dichotomites* fauna of the "Claxby Beds" and that of Speeton.

The "Upper Niesen Beds" of Wollaston Foreland are compared to the Polyptychitan-Hoplitidan; the poorly preserved specimen of an "early *Lyticoceras*" (L. F. Spath) found in the extreme top layer of the formation is not yet referable to *Lyticoceras noricus* (Roem.) etc. but, according to L. F. Spath, is still Valanginian in age (*vid.* p. 98). Since more ammonites may, of course, be supposed to occur in these beds it is much to be hoped that decisive finds will be made here in years to come.

In the Speeton sequence the Platylenticeratan is overlain by fossiliferous beds which correspond to the Polyptychitan.

Most of the ammonite zones established by L. F. Spath (1924) are recognized except e. g. the zone of *Polyptychites brancoi* (N. & Uhl.).

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[1]) According to W. J. Arkell, however, the Hoplitidan is lacking and corresponds to a break in the sedimentation (Arkell 1933).

[2]) *Polyptychites beani* Phill., *P. keyserlingi* (N. & Uhl.), *P. blakei* Pavl., *P. marginatus* Phill., *Euryptychites gravesiformis* (Pavl.) etc.

According to L. F. SPATH the *Polyptychites-Dichotomites* fauna of northern East Greenland agrees well with the *polyptychus* beds of the Speeton sequence (*vid.* MAYNC 1940).

The following forms are for instance represented in the Polyptychitan of Speeton: *Polyptychites polyptychus* KEYS., *P. keyserlingi* (N. & UHL.), *P. lamplughi* PAVL., *P. ramulicosta* PAVL., *P. stubendorfi* SCHMIDT (= *P. quadrifidus* BEAN *pars*), *P. vogulicus* PAVL., *P. diptychus* KEYS., *P. ascendens* v. KOEN, etc., *Dichotomites sphaericus* (v. KOEN.), *D. biscissus* (v. KOEN.), *D. terscissus* (v. KOEN.), *D. bidichotomus* (LEYM.) etc., *Acroteuthis lateralis* (PHILL.), *A. subquadratus* (ROEM.), *Aucella* (*Buchia*) *keyserlingi* LAH., *A.* (*B.*) *crassicollis* KEYS. *et cetera* (*vid.* VON KOENEN 1902, KILIAN 1907—1913, SPATH 1924, STOLLEY 1937).

However, there is evidence that the sedimentation was disturbed or even interrupted, which is borne out e. g. by a nodule bed with phosphatized fossils; that we have to deal here with a "condensed layer" is proved by the common occurrence of Valanginian and Lower Hauterivian fossils (*vid.* KIRKALDY 1939).

The Hoplitidan is marked by a different fauna including for instance *Hoplitides heteroptychus* DANF., *Asteria psilostoma* (N. & UHL.), *Arnoldia arnoldi* (PICT.), *Saynoceras verrucosum* (d'ORB.), *Kilianellla roubaudiana* (d'ORB.) (= *K. pexiptychus* (UHL.)) etc. (*vid.* KILIAN 1907—1913).

The younger (C) and lowermost (B) beds in the sequence are Hauterivian in age, including for instance *Acanthodiscus radiatus* BRUG., *Lyticoceras noricus* (ROEM.), *Distoloceras hystrix* (PHILL.), and still higher *Simbirskites* (*Craspedodiscus*) *spp.*

In northwest Germany the top layers of the Platylenticeratan carry *Polyptychites diplotomus* v. KOEN. (*vid.* VON KOENEN 1902) which is considered the basal zone of the Polyptychitan[1]) (*vid.* SPATH 1924 etc.).

The overlying "*Polyptychites* Beds" contain a rich fauna consisting e. g. of *Polyptychites bullatus* v. KOEN., *P. brancoi* (N. & UHL.), *P. keyserlingi* (N. & UHL.) (= *P. convolutus* v. KOEN.), *P. clarkei* v. KOEN., *P. marginatus* (N. & UHL.), *P. quadrifidus* v. KOEN., *P. aff. beani* PHILL., *P. ascendens* v. KOEN., *P. suessi* v. KOEN., *Neocraspedites semilaevis* (v. KOEN.), *Acroteuthis lateralis* (PHILL.), *A. subquadratus* (ROEM.), *Aucella* (*Buchia*) *keyserlingi* LAH. etc. (*vid.* VON KOENEN 1902, KILIAN 1907—1913, STOLLEY 1937). Higher up such forms as *Polyptychites obsoletecostatus* (N. & UHL.), *P. grotriani* (N. & UHL.) etc. are represented.

[1]) E. STOLLEY, however, still includes the *diplotomus* zone into the "*Garnieria* Beds" (Platylenticeratan); the higher "*Polyptychites* Beds" are assigned to the Middle Valanginian, the "*Dichotomites* Beds" to the Upper Valanginian, respectively (*vid.* STOLLEY 1937).

According to E. STOLLEY the "*Polyptychites-Dichotomites* Beds" are moreover characterized by a mutation-sequence of *Acroteuthis*; *Acroteuthis subquadratus* (ROEM.) is typical of the "*Dichotomites* Beds" and the following "*Arnoldi-Astieria* Beds" (STOLLEY 1937).

The "*Dichotomites* Beds" include e. g. *Dichotomites nucleus* (ROEM.), *D. sphaericus* (v. KOEN.), *D. praelatus* (v. KOEN.), *D. polytomus* (v. KOEN.), *D. ramulosus* (v. KOEN.), *D. biscissus* (v. KOEN.), *D. tardescissus* (v. KOEN.), *D. terscissus* (v. KOEN.), *D. perovalis* (v. KOEN.), *D. bidichotomus* (LEYM.) etc. The occurrence of *Neocomites* ex *gr longinodus* (N. & UHL.), *Saynoceras verrucosum* (D'ORB.), *Arnoldia arnoldi* (PICT.), *Astieria psilostoma* (N. & UHL.), *A. multiplicata* (N. & UHL.) (= *A. ventricosa* (v. KOEN.) = *A. atherstoni* (SHARPE)) etc. in the "*Arnoldi-Astieria* Beds" is indicative of Hoplitidan (Upper Valanginian).

Then follows the Lyticoceratan (lowermost Hauterivian) with *Lyticoceras noricus* (ROEM.), *L. oxygonius* (N. & UHL.), *Astieria astieri* (D'ORB.), *Distoloceras cf. hystrix* (PHILL.) etc. and then the "*Simbirskites* Beds" with *Simbirskites* (*Craspedodiscus*) *phillipsi* (ROEM.) etc., *Hibolites jaculum* (PHILL.), *Oxyteuthis hibolitiformis* STOLL. etc. (*vid.* STOLLEY 1937).

According to J. LEWINSKI the Polyptychitan has not yet been recognized with certainty in southwestern Poland[1]). Though *Polyptychites* occurs in great numbers, e. g. ?*P. nucleus* (ROEM.), it is associated with *Saynoceras verrucosum* (D'ORB.), *Hoplitides* (*Leopoldia*) *aff. gibbosus* v. KOEN., *Lyticoceras amblygonius* (N. & UHL.) (= *L. noricus* (ROEM.)), *Neocomites neocomiensis* (D'ORB.) etc. which suggest a Hoplitidan age. The Polyptychitan-Hoplitidan beds have therefore been reduced to a thickness of merely 4 m (LEWINSKI 1932).

Higher in the succession *Astieria* etc. and for instance large-sized specimens of *Exogyra sinuata* SOW. (such as are common in the "Upper Claxby Beds" of Lincolnshire) are cited, and from still higher levels *Simbirskites sp.* (LEWINSKI 1931, 1932). These beds would thus already correspond to the Hauterivian.

The Polyptychitan of Russia is characterized by rich faunas which are closely allied to those from Lincolnshire, Speeton, and the Arctic.

The following forms may be cited here: *Polyptychites polyptychus* KEYS., *P. keyserlingi* (N. & UHL.), *P. syzranicus* PAVL., *P. expansus*

[1]) Member (f) of J. LEWINSKI's section at Tomaszow is marked by *Saynoceras verrucosum* (D'ORB.) and, furthermore, by numerous broken specimens of *Polyptychites*; it is therefore quite probable that the Polyptychitan is preserved here only in a remanié state.

(Bog.), *P. triptychiformis* (Nik.), *P. lgowensis* (Nik.), *P. glaber* (Nik.), *P. stubendorfi* Schmidt, *P. vogulicus* Pavl., *Euryptychites gravesiformis* (Pavl.), *Dichotomites beani* (Pavl.), *D. bidichotomus* (Leym.) etc., *Acroteuthis lateralis* (Phill.), *Aucella (Buchia) keyserlingi* Lah., *A. (B.) crassa* Pavl., *A. (B.) uncitoides* Pavl., *A. (B.) solida* Pavl., *A. (B.) lamplughi* Pavl. etc. (*vid.* von Koenen 1902, Kilian 1907—1013, von Bubnoff 1926).

Apparently, the sedimentary record of the Lower Cretaceous of Russia is incomplete; the Hoplitidan is hardly developed throughout, although mention is made for instance of *Arnoldia cf. arnoldi* (Pict.) and *Neocomites neocomiensis* (d'Orb.) being present (*vid.* Kilian 1907—1913)[1]). The Lyticoceratan is not yet recognized whereas the Upper Hauterivian/(Lower Barrêmian)[2]) (= "Simbirskian") mostly shows a transgressive character. These typical "*Simbirskites* Beds" carry a specific fauna including e. g. *Simbirskites (Craspedodiscus) speetonensis* Y. & B., *S. barboti* Lah., *S. umbonatiformis* Pavl., *S. polivnensis* Pavl., *S. coronatiformis* Pavl., *S. elatus* Trautsch., *S. (Speetoniceras) inversus* Pavl., *S. (S.) subinversus* Pavl., *S. (Craspedodiscus) progrediens* Pavl., *S. (C.) discofalcatus* Lah., *S. umbonatus* Lah., *S. (Speetoniceras) versicolor* Trautsch., *S. decheni* (Roem.) etc. The overlying belemnite-bearing beds with *Oxyteuthis jasykovi* (Lah.), *Aulacoteuthis speetonensis* (Pavl.), *A. absolutiformis* (Sinz.), *Oxyteuthis brunsvicensis* (Stromb.) are already Lower Barrêmian in age (*vid.* Kilian 1907—1913, von Bubnoff 1926, Stolley 1937).

The *Polyptychites-Dichotomites* faunas of East Greenland clearly correspond to that mentioned above from Russia (*vid.* Maync 1940). The Hauterivian "*Simbirskites* Beds" of Russia, Lincolnshire, Speeton, Northwest Garmany etc., however, have wrongly been stated to occur also in East Greenland as is put forth in the former chapters. Besides, we may emphasize that there is no reliable evidence at hand of *post*-Valanginian/*pre*-Aptian beds being developed anywhere in the Arctic regions.

Rich Valanginian faunas are reported from Siberia. From Yenissei River, for instance, *Polyptychites polyptychus* Keys. and *P. diptychus* Keys. are mentioned which point to the Polyptychitan (Obrutschew 1926). Another fauna of Polyptychitan age is stated from the islands Preobrashenie and Begitchev, Khatanga Bay, including *Polyptychites cf. polyptychus* Keys., *P. diptychus* Keys. (*var. sibirica*), *P. ramulicosta*

[1]) The Polyptychitan + Hoplitidan correspond to Nikitin's "Petchorian".

[2]) According to E. Milanowski the Russian "*Simbirskites* Beds" only represent the Hauterivian, and only the "*Belemnites* Beds" should be assigned to the Barrêmian (Milanowski 1940, *vid.* Polutoff 1943).

PAVL. etc., *Aucella* (*Buchia*) *bulloides* LAH., *A.* (*B.*) *unshensis* PAVL., and other mollusks (in *loc. cit.*).

The following forms recorded from the Prontchitchev Mountains, between Anabara and Olenek River, likewise are Polyptychitan in age: *Polyptychites ramulicosta* PAVL., *P. stubendorfi* SCHMIDT (= *P. quadrifidus* BEAN *pars*), *P. cf. ovatus* PAVL., *P. cf. polyptychus* KEYS., *Euryptychites gravesiformis* (PAVL.), *E. czekanowskii* (PAVL.), *E. globulosus* (v. KOEN.) etc. Apparently, also deposits of Hoplitidan age are present here containing e. g. *Asteria tönsbergensis* (WEERTH), *A. oerlinghusanus* (WEERTH) (OBRUTSCHEW 1926), forms that were made known by O. WEERTH from Lippe in northwestern Germany (WEERTH 1884, *vid.* VON KOENEN 1902).

In Olenek River Polyptychitan is proved by *Aucella* (*Buchia*) *keyserlingi* LAH. *var. rugosa* (= *A.* (*B.*) *concentrica* FISCH.), *A.* (*B.*) *crassicollis* KEYS., *A.* (*B.*) *sublaevis* KEYS., *Polyptychites stubendorfi* SCHMIDT etc. (OBRUTSCHEW 1926). In Balkalak River, an affluent of Olenek River, Middle Valanginian is represented by *Aucella* (*Buchia*) *uncitoides* PAVL., *A.* (*B.*) *tolli* SOK., *A.* (*B.*) *keyserlingi* LAH., *A.* (*B.*) *crassicollis* KEYS., *A.* (*B.*) *inflata* TOULA, *A.* (*B.*) *crassa* PAVL., and *A.* (*B.*) *obliqua* TULLB. (*op. cit.*).

Euryptychites czekanowskii (PAVL.) and *Aucella* (*Buchia*) *keyserlingi* LAH. *var. majuscula* (= *A.* (*B.*) *piriformis* LAH.) are mentioned from the area between Olenek and Lena River; from the latter *Polyptychites cf. diptychus* KEYS. is moreover recorded.

Aucella (*Buchia*) *inflata* TOULA and *A.* (*B.*) *keyserlingi* LAH. fix the age of the beds overlying the Infravalanginian/Rjasanian in Amur River as Polyptychitan (OBRUTSCHEW 1926).

In Novaya Zemlya the occurrence of Polyptychitan beds is suggested by the find of *Polyptychites hoplitoides* (NIK.), *P. diptychus* KEYS., *P. diptychoides* PAVL., *P. anabarensis* PAVL., *Aucella* (*Buchia*) *keyserlingi* LAH., *A.* (*B.*) *piriformis* LAH., *A.* (*B.*) *cf. crassicollis* KEYS., and *A.* (*B.*) *cf. sublaevis* KEYS. (*vid.* FREBOLD 1930, BODYLEVSKY 1936).

Spitsbergen.

Beds 22b and 23 (+ locality "Creek VII") in the sequence of Cape Festning (Icefjord) have yielded a genuine fauna of Polyptychitan age: *Polyptychites* (*Dichotomites*) *perovalis* v. KOEN., *P.* (*D.*) *cf. perovalis* v. KOEN., *P. cf. infundibulum* v. KOEN., *P. aff. keyserlingi* (N. & UHL.) (= *Euryptychites czekanowskii* FREB.), *P. cf. ramulicosta* PAVL., *P. ?hoeli* FREB., *P. cf. variisculptus* PAVL., *P. aff. variisculptus* PAVL., *P. aff. tscherskii* PAVL., *P. aff. ovatus* PAVL., *P. spp. nov.*, *Euryptychites cf. gravesiformis* (PAVL.), *E. sp.*, *Dichotomites petschoraensis* BOG., *D. cf.*

petschoraensis BOG., *D. beani* (PHILL.), *D. cf. bidichotomus* (LEYM.), *Lytoceras nov. sp.*, *Aucella* (*Buchia*) *obliqua* TULLB., *A.* (*B.*) *cf. obliqua* TULLB., *A.* (*B.*) *cf. inflata* TOULA, *A.* (*B.*) *cf. unshensis* PAVL., *A.* (*B.*) *sublaevis* KEYS., *A.* (*B.*) *cf. sublaevis* KEYS., *A.* (*B.*) *contorta* PAVL., *A.* (*B.*) *keyserlingi* LAH., *A.* (*B.*) *keyserlingi mf. terebratuloides* LAH., *A.* (*B.*) *terebratuloides* LAH., *A.* (*B.*) *cf. tolli* SOK., *A.* (*B.*) *bulloides* LAH., and *A.* (*B.*) *cf. piriformis* LAH. (*vid.* FREBOLD 1928, 1929, SOKOLOV & BODYLEVSKY 1931, FREBOLD & STOLL 1937).

From a locality south of Hekla Harbour D. SOKOLOV & Y. I. BODYLEVSKY record *Polyptychites keyserlingi* (N. & UHL.), *P. aff. orbitatus* V. KOEN., *P. cf. ?hoeli* FREB., and *P. sp.* (SOKOLOV & BODYLEVSKY 1931).

Aucella (*Buchia*) *crassicollis* KEYS. was found in a thick series of black shales that are exposed in Storfjord in southeastern Spitsbergen (*vid.* FREBOLD 1935a).

The Polyptychitan beds in the section of Cape Festning (*vid. sup.*) are followed by a series (members 24/28) bearing an entirely different fauna; the forms listed below are reported to occur:

Belemnites sp.
Arca nana (LEYM.) D'ORB.
— *cf. nana* (LEYM.) D'ORB.
Modiola cf. strajeskiana D'ORB.
— *cf. matronensis* (D'ORB.)
— *sp.*
Nucula sp.
Panopaea? sp.
Macrodon? sp.
Perna sp.
Pecten cf. orbicularis SOW.
— (*Camptonectes*) *cf. cinctus* SOW.
— — *cf. spitzbergensis* LUNDGR.
— — *aff. spitzbergensis* LUNDGR.
— (*Entolium*) *sp.*
—? *sp.*
Leda cf. deGeeri LUNDGR.
— *cf. seeley* GARDN.
— *sp.*
Scurria? sp.
Avellana? sp.
Ditrupa decorata STOLL.
— (?*Dentalium*) *lindstroemi* LUNDGR.
— *sp.*
—? *sp.*
(SOKOLOV & BODYLEVSKY 1931, FREBOLD & STOLL 1937).

These strata are believed by D. SOKOLOV & Y. I. BODYLEVSKY (in *loc. cit.*) to represent Upper Valanginian-Lower Aptian; H. FREBOLD & E. STOLL go still further, feeling justified in referring this fauna to the "Upper Valanginian, *viz.* to the *terscissus-bidichotomus* zones" (*op. cit.*) which, to be sure, is quite objectionable; for e. g. *Modiola strajeskiana* D'ORB. is found in the Jurassic (Bathonian-Argovian, Volgian) of East Greenland and in the Kimmeridgian of Spitsbergen (*vid.* MAYNC 1947) as well as in the Aptian formation of Spitzbergen, *viz.* in the beds overlying the deposits in question (SOKOLOV & BODYLEVSKY 1931). The same Aptian layers have moreover furnished *Leda cf. deGeeri* LUNDGR., *Pecten orbicularis* SOW. and *Ditrupa decorata* STOLL.[1]) (*vid.* SOKOLOV & BODYLEVSKY 1931, FREBOLD 1935a). *Arca nana* D'ORB. (= *Cucullaea nana* LEYM.) very closely approaches *Arca cottaldina* D'ORB. of the Albian (D'ORBIGNY 1843, PICTET & CAMPICHE 1864—1867), and *Modiola matronensis* (D'ORB.) is found in the Aptian-Albian of France etc. *Pecten* (*Camptonectes*) *cinctus* SOW., on the other hand, is an ubiquitous Cretaceous form ranging from the Valanginian up into the Aptian (KILIAN 1907—1913), and *Pecten orbicularis* SOW. which was for instance derived from the Aptian series of Stensiös Plateau (*vid.* p. 126) even ranges into the Upper Cretaceous. It is thus altogether impracticable to base a reliable age assignment upon this long-ranging fauna or even to refer it to a well-defined paleontological zone. I am of opinion that this fauna is already Aptian in age because several forms are still found higher up in the succession where they are associated with indubitable Aptian-Albian fossils (*vid.* pp. 266—268). To be sure, the flora of the "continental series", which inosculates between this marine Aptian[2]) and the lower beds with the above-listed fauna, has hitherto been referred to the Upper Valanginian-Hauterivian-Barrêmian (*vid.* ROSENKRANTZ 1930a, FREBOLD 1935a, 1935b, FREBOLD & NOE-NYGAARD 1938, TEICHERT 1939). However, it must be borne in mind that this flora has a wide vertical distribution and may as well be of Aptian age (*vid.* p. 248 ff.).

From Mt. Tordenskjöld, King Charles Land, light-coloured fossiliferous marls bearing a rich Valanginian (Polyptychitan) fauna of *Aucellas* and belemnites is reported to occur (FREBOLD 1935a, BLÜTHGEN 1936) including for instance *Aucella* (*Buchia*) *crassicollis* KEYS., *A.* (*B.*)

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[1]) *Ditrupa aff. decorata* STOLL. is also mentioned from the Aptian series in Great Koldewey Island, northern East Greenland (*vid.* p. 174—176).

[2]) Coal-bearing deposits are also reported to underlie marine beds of Aptian-Albian age in Kirov Island (Kara Sea) and in the New Siberian Islands (YERMOLAEV 1937). The precise age af the thick continental plant-bearing formations in Siberia, Hudson Bay area, Alaska etc. could not yet be ascertained, but is regarded as "Jurassic-Lower Cretaceous" (*vid.* p. 248 ff.).

keyserlingi LAH., *A.* (*B.*) *bulloides* LAH., *A.* (*B.*) *piriformis* LAH., *A.* (*B.*) *terebratuloides* LAH., *A.* (*B.*) *costata* BLÜTHG., *A.* (*B.*) *nathorsti* BLÜTHG. etc., *Acroteuthis subquadratus* (ROEM.), *A. explanatoides* (PAVL.), *A. pseudopanderi* (SINZ.), *A. breviaxiformis* (POMP.), *Oxyteuthis brunsvicensis* (STROMB.), *Hibolites jaculiformis* POMP., *Pseudohibolites nathorsti* (POMP.) etc. (*op. cit.*). As may be seen at once these determinations are not to be relied upon, however, as this fauna would be quite a heterogeneous one including forms of Valanginian, Hauterivian, and Barrêmian age. According to E. STOLLEY many of J. BLÜTHGEN's new forms are apparently only due to pathological differences and to results of convergence which, of course, may not be taken for stages of phylogenetic development (STOLLEY 1938). "*Pseudohibolites*" (*fide* BLÜTHGEN), with the lectotype *Hibolites nathorsti* POMP., for instance, must be rejected as a new genus, and neither *Oxyteuthis* (STOLLEY)[1] nor e. g. *Acroteuthis subquadratus* (ROEM.) are represented here (STOLLEY *op. cit.*). E. SCHWEGLER is of opinion that all the forms described by J. BLÜTHGEN from King Charles Land are Valanginian in age (SCHWEGLER 1939).

Transgressing *Aucella*-bearing beds of Valanginian (Polyptychitan) age have been deposited almost everywhere in Alaska (*vid.* BROOKS 1906, PRINDLE 1911, CAIRNES 1916, 1917, MOFFIT & MERTIE 1923, MARTIN 1926, CAPPS 1927, SMITH & MERTIE 1930, MERTIE 1930, 1938, MOFFIT 1938). Also in Cascade Range, British Columbia, a Lower Cretaceous *Aucella* conglomerate is reported to overlie unconformably the late Jurassic formations (CRICKMAY 1931).

As a rule *Aucellas* are the only fossils present in the Lower Cretaceous rocks of Alaska, and a lower zone characterized by *Aucella* (*Buchia*) *piochii* GABB can, apparently, be distinguished from a slightly higher level carrying *Aucella* (*Buchia*) *crassicollis* KEYS.

In Pybus Bay, Admirality Island, the Valanginian series rests unconformably upon Permian rocks and includes forms as *Aucella* (*Buchia*) *piochii* GABB, *A.* (*B.*) *crassicollis* KEYS., *A.* (*B.*) *spp.*, *Gryphaea sp.*, ?*Inoceramus sp.*, "*Phylloceras*" *sp.* (MARTIN 1926). From the Nutzotin Mountains, southeastern Alaska, and from the Nushagak District, *Aucella* (*Buchia*) *crassicollis* KEYS. and other pelecypods are cited from the Valanginian (CAIRNES 1916, MARTIN 1926, MERTIE 1938). The same species is mentioned from the region of Kuskokwim River, north of Bristol Bay, from the "Koyukuk Group" of central Alaska, and from the "Anaktuvuk Group" of the north (MARTIN *op. cit.*). *Aucella* (*Buchia*) *cf. piochii* GABB is found in the "Staniukovich shale" of western Alaska

[1]) *Oxyteuthis* (STOLLEY) appears but in the "*Simbirskites* Beds" (Upper Hauterivian) with the species *O. hibolitiformis* STOLL. (STOLLEY 1937, 1938, *vid.* DACQUÉ 1942).

Peninsula, and *Aucella* (*Buchia*) *crassicollis* KEYS., *A.* (*B.*) *concentrica* FISCH., and other lamellibranchs are enumerated from the overlying "Herendeen limestone" (MOFFIT & MERTIE 1923, MARTIN 1926). In the Upper Matanuska Valley beds with *Aucella* (*Buchia*) *crassicollis* KEYS., *A.* (*B.*) *cf. crassicollis* KEYS., *Belemnites spp.* occur (MARTIN 1926, CAPPS 1927). The same species of *Aucella* (*Buchia*) is reported from strata at Etivluk River, northwest Alaska, where it is associated with "*Holcostephanus*" (*Polyptychites*?) *sp.* (SMITH & MERTIE 1930). From the boundary region between Alaska and Yukon *Aucella* (*Buchia*) *piochii* GABB, *A.* (*B.*) *crassicollis* KEYS., *A.* (*B.*) *cf. crassicollis* KEYS., *A.* (*B.*) ?*concentrica* FISCH., *A.* (*B.*) *spp.*, ?*Perisphinctes sp.*, *Belemnites spp.*, *Inoceramus sp.*, *Astarte sp.*, *Ostrea sp.*, etc. are cited (CAIRNES 1916, 1917, MARTIN 1926, MERTIE 1930).

In Chitina Valley, southern Alaska, the nearly 2000 m thick clastic "Kennicott formation" that overlies unconformably the Triassic, carries a rich fauna, which, however, includes forms of different stratigraphical stages. *Oppelia*, *Idoceras*, *Aspidoceras*, *Amoeboceras*, *Perisphinctes*, *Belemnopsis* ex *gr canaliculatus* (SCHLOTH.) etc. (*vid.* MOFFIT 1938) doubtless bear evidence of Jurassic stages (Kimmeridgian) being represented[1]) whereas *Aucella* (*Buchia*) *cf. piochii* GABB, *A.* (*B.*) *cf. crassicollis* KEYS. point towards a Polyptychitan age. On the other hand, the presence of *Tetragonites cf. timotheanum* (MAY.), *Baculites cf. teres* FORB., *Inoceramus* (*Taenioceramus*) *cf. concentricus* PARK., *I. sulcatus* PARK., *Aucellina*[2]) *cf. gryphaeoides* (SOW.) etc. is indicative of an Albian age.

Of more than usual interest is the flora derived from this "Kennicott formation" as it contains a number of species characteristic of the so-called "Continental-limnic Series" of Spitsbergen, King Charles Land, Franz Joseph Land etc., which is generally classed as Hauterivian-Barrêmian, but which is probably of Aptian-Albian age (*vid. inf.*).

Contrary to the conception of A. ROSENKRANTZ, H. FREBOLD, and other scientists (*vid.* pp. 178—179) no deposits of Hauterivian or Barrêmian age could be proved to occur anywhere in the region of East Greenland covered by the writer's studies.

The formerly assumed marine "*Simbirskites* Beds" of Kuhn Island do not exist at all, and the supposed *Ammonites payeri* TOULA certainly

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1) These Jurassic fossils, however, have not been found in lots containing Cretaceous forms.

2) Originally identified as "*Aucella pallasi* KEYS.". However, since this *Aviculid* was found in lots containing indubitable Cretaceous fossils such as *Gaudryceras*, *Holcodiscus* (?*Spitidiscus*), *Puzosia*, *Tetragonites sp.*, *Inoceramus* (*Taenioceramus*) *cf. concentricus* PARK. etc., it must be referred to the Cretaceous subgenus *Aucellina* (POMPECKJ) (*vid.* MARTIN 1926).

may not be referred to A. P. PAVLOV's genus *Simbirskites*; besides, a juvenile specimen of the said ammonite was brought back from the "Lower Niesen Beds" of Wollaston Foreland which are Infravalanginian in age. Norther is there any trace of "continental" beds of Lower Cretaceous age, but everywhere in the investigated area (possibly with the exception of the sedimentary sequence on Kuhnpasset, *vid.* pp. 87—90, 194—195) the marine Valanginian formations are transgressively overlain by the unmistakable marine Aptian series.

3) Plant-bearing beds of Aptian-Albian age.

In Spitsbergen, King Charles Land, Franz Joseph Land, Siberia, and Alaska plant-bearing beds are known to be widely distributed which were formerly held to be Jurassic in age but which are now considered to represent Lower Cretaceous for a great part.

It is, of course, very difficult to determine the age of a formation merely on a phytostratigraphical basis since the vertical range of most Mesozoic plant species is by far less known than that of marine invertebrate faunas. On the other hand, we must be aware that the Lower Cretaceous floras still bear an obvious Jurassic stamp (with their ferns, cycadophytes, and gymnosperms) and still belong to the same genera. The conspicuous class of the *Angiospermae*, e. g. the *Dicotyledones*, are still lacking and only appear in the higher Cretaceous. The *Gymnospermae* and *Pteridophyta* of which the Lower Cretaceous floras consist are thus descendants, remains of those elements that have been endemical since Rhaeto-Liassic or Dogger times. Furthermore, it must be borne in mind that our views as to the geological age of many a formation have undergone considerable changes in the course of time, and that the present-day status of stratigraphical knowledge allows more reliable comparisons to be drawn.

It is not the place to discuss here the Arctic and *sub*-Arctic late Mesozoic floras at great length; we even could not do that, after all. Notwithstanding, we will briefly point out some essential data which may be of importance for a comparative study.

The beds 24/28 of the Cape Festning section, Spitsbergen, which immediately overlie the *Aucella*-bearing Polyptychitan carry a true marine fauna (*vid.* pp. 244—245). These strata are superposed by the so-called "Continental Series" containing a rather rich flora which was regarded as Jurassic (NATHORST 1897). However, it turned out subsequently that its age must be younger still, *viz.* Lower Cretaceous. E. W. BERRY has assigned it to the Wealden (BERRY 1911). Since the discovery of marine Valanginian below this series the beds had to be looked upon as *post*-Valanginian. Hitherto this plant-bearing series of Spitsbergen, King Charles Land, and Franz Joseph Land, including the "*Elatides*"-, "*Pityophyllum*"-, and "*Gingko* Beds", was supposed to correspond to the Upper Valanginian, Hauterivian, and Barrêmian or at least to portions of it (*vid.* SOKOLOV & BODYLEVSKY 1931, FREBOLD 1935a, FREBOLD & STOLL 1937).

This late Mesozoic flora of Spitsbergen is listed below.

Phylum Pteridophyta
Order *Filiciales*
Rhizomopteris sp. NATH.
Cladophlebis sp. A, B
Gleichenia sp. NATH.
Taeniopteris lundgreni NATH.
Dioonites (*Scleropteris*) *pomelii* SAP.
Sphenopteris(?) *deGeeri* NATH.
— *thulensis* HEER
— *sp.* A, B
Thinnfeldia arctica HEER
Order *Equisetales*
Equisetites sp.(?) NATH.
Order *Lycopodiales*
Lycopodites sewardi NATH.

Phylum Spermatophyta
Class Gymnospermae
Order *Cycadales*
Anomozamites? *bifidus* HEER
Nilssonia öbergiana HEER
Podozamites lanceolatus (L. & H.) BRAUN
— — *eichwaldi* (SCHIMP.) HEER
Order *Gingkoales*
Baiera graminea NATH.
— *spetsbergensis* NATH.
— *pulchella* HEER
— *longifolia* HEER
— *cf. spectabilis* NATH.
Gingko digitata BRONGN.
— *huttoni* (STERNB.) HEER
Czekanowskia sp.
Order *Coniferales*
Cedroxylon cavernosum (CRAM.) SCHENK
— *pauciporosum* (CRAM.) SCHENK
Xenoxylon phyllocladoides GOTH.
Elatides curvifolia (DUNKER) NATH.

Pinites (*Pityostrobus*) *conwentzi* NATH.
— (*Pityophyllum*) *lindstroemi* NATH.
— — *microphyllus* HEER
— — *nordenskiöldi* HEER
— — *staratschini* (HEER) NATH.
— — *cf. solmsii* (SEW.) NATH.
— (*Pityospermum*) *cuneatus* NATH.
— — *sp.* NATH.
— (*Pityolepis*) *pygmaeus* NATH.
— — *tsugaeformis* NATH.
— (*Pityocladus*) *sp.* A, B
Drepanolepis angustior NATH.
— *rotundifolia* (HEER) NATH.
Feildenia nordenskiöldi NATH.
Pagiophyllum? *sp.* NATH.
Phoenicopsis angustifolia HEER
— *speciosa* HEER
Schizolepis cylindrica NATH.
— ? *retroflexa* NATH.
Stroblites heeri NATH.
Stenorhachis? *clavata* NATH.
— *triolatus* HEER
Carpolithus hyperboreus HEER
— *sp.* A, B, C.
(NATHORST 1897, WARD 1905, BERRY 1911).

In addition the following forms are cited from King Charles Land and Franz Joseph Land (*vid.* FREBOLD 1935a):

Phylum Pteridophyta
Order *Filiciales*
Sphenopteris johnstrupi HEER

Phylum Spermatophyta
Order *Cycadales*
Desmiophyllum sp.
Pterophyllum sp.
Order *Gingkoales*
Gingko polaris NATH. *var. pygmaea*
— *sp.*
Czekanowskia cf. rigida HEER
Order *Coniferales*
Taxites cf. gramineus HEER

Elatides? sp. cf. Onychiopsis elongata BRONGN.
Pinites (Pityanthus) sp.
— *(Onychiopsis) cf. maakianum* HEER
— *nanseni* NATH.

The fossil wood from the Cretaceous beds of King Charles Land includes the following forms: *Anomaloxylon magnoradiatum* GOTH., *Cedroxylon transiens* GOTH., *C. cedroides* GOTH., *C. phyllocladoides* GOTH., *Cupressinoxylon cf. McGeei* KNOWLT., *Phyllocladoxylon sp.* GOTH., *Piceoxylon antiquis* GOTH., *Protocedroxylon araucarioides* GOTH., *P. extinctum* GOTH., *Thylloxylon irregulare* GOTH., and *Xenoxylon latiporosum* (CRAM.) GOTH. (*vid.* BERRY 1911).

According to E. W. BERRY *Sphenopteris sp.* A from Spitsbergen (*vid. sup.*) is a close ally to the widespread form *Onychiopsis psilotoides* (STOKES & WEBB) WARD which occurs e. g. in the Aptian-Albian beds of Portugal, of the Black Hills (Wyoming, south Dakota), on Cape Lisburne (Alaska), in the "Potomac Group" etc. *Cladophlebis sp.* A is similar to *C. albertsii* (DUNKER) BRONGN. which is known, for instance, from the Albian "Kome Beds" of Nugssuak Peninsula, West Greenland. *Cladophlebis sp.* B reminds of *C. browniana* (DUNKER) SEW., a species from the "Upper Knoxville Beds", where it is associated with *Cladophlebis alata* FONT., *Gleichenia nordenskiöldi* HEER, *Onychiopsis psilotoides* (STOKES & WEBB) WARD, *Sequoia reichenbachi* (GEIN.) HEER etc. and a few *Dicotyledones*. *C. browniana* (DUNKER) SEW. even ranges as high as the West Greenland "Atane Beds" (Cenomanian). The species of *Baiera* (BRAUN) listed above from Spitsbergen intimately resemble *B. foliosa* FONT. from the "Potomac Group" (WARD 1895, 1905, BERRY 1911).

Podozamites lanceolatus (LINDL. & HUTT.) BRAUN, on the other hand, is a species of great vertical range and is cited from the Dogger onwards to high up in the Cretaceous. L. F. WARD mentions it for instance from the Jurassic of Oregon, together with *Baiera pulchella* HEER, *Gingko digitata* (BRONGN.) HEER, *G. huttoni* (STERNB.) HEER, *Pinites nordenskiöldi* HEER etc., and from the Lower Oolite of Yorkshire (WARD 1905). On the other hand, the same form is listed from Upper Cretaceous beds of central Alaska and the Yukon area, where it is associated with *Asplenium foersteri* DEB. & ETT., *A. johnstrupi* HEER, "*Pecopteris arctica* HEER"?, *Nilssonia spp.*, *Gingko digitata* (BRONGN.) HEER, *G. concinna* HEER, *Nageiopsis angustifolia* FONT., *Sequoia rigida* HEER, *S. ambigua* HEER, *S. reichenbachi* (GEIN.) HEER etc. and with an abundance of genuine *Dicotyledones* (MARTIN 1926); the occurrence of e. g. *Inoceramus* (*Mytiloides*) *cf. labiatus* SCHLOTH. (and other pelecypods) in the same beds allow a safe correlation with the Turonian.

Gingko digitata BRONGN. even appears in latest Paleozoic times and ranges throughout the Triassic and Jurassic into the Upper Cretaceous. The genera *Thinnfeldia* (ETTINGHAUSEN), *Nilssonia* (BRONGNIART), *Anomozamites* (SCHIMPER), and *Czekanowskia* (HEER) are recorded from Rhaetic beds upwards throughout the Jurassic and Lower Cretaceous.

Quite a number of the Cretaceous plants enumerated above from Spitsbergen are represented in the "Corwin formation" of Cape Lisburne, northwest Alaska, which was for a long time taken to be Jurassic (*vid.* WARD 1905, KNOWLTON 1914, 1919, MARTIN 1926). The following forms may be listed from this Alaskan locality:

Coniopteris hymenophylloides (BRONGN.) SEW.
— *burejensis* (ZAL.) SEW.
Cladophlebis huttoni (DUNKER) FONT.
— *alata* FONT.
— *vaccensis* WARD
Onychiopsis psilotoides (STOKES & WEBB) WARD
Equisetum collieri WARD
Podozamites lanceolatus eichwaldi (SCHIMP.) HEER
— *lanceolatus* (L. & H.) BRAUN
Otozamites giganteus THOMAS
Zamites megaphyllus (PHILL.) SEW.
Baiera gracilis (BEAN) BUNB.
Gingkodium? alaskense FONT. (= *Baiera palmata* HEER)
Gingko digitata (BRONGN.) HEER
— *huttoni* (STERNB.) HEER
Phoenicopsis speciosa HEER
— *angustifolia* HEER
Elatides curvifolia (DUNKER) NATH.
Pagiophyllum kurrii (POMEL) SCHIMP.
— *steenstrupi* BARTH.?
Pityophyllum nordenskiöldi (HEER) SEW.
Feildenia nordenskiöldi NATH.
(*vid.* WARD 1905, KNOWLTON 1914).

Stress had been laid upon the striking resemblance between this "Jurassic" flora of Cape Lisburne and that of Amur Land, Siberia, and many of the listed species are represented here and there, e. g. *Coniopteris hymenophylloides* (BRONGN.) SEW., *C. burejensis* (ZAL.) SEW., *Podozamites lanceolatus eichwaldi* (SCHIMP.) HEER, *P. lanceolatus* (L. & H.) BRAUN, *Gingko digitata* (BRONGN.) HEER, *Phoenicopsis speciosa* HEER, *Ph. angustifolia* HEER, *Elatides curvifolia* (DUNKER) NATH., *Pityophyllum nordenskiöldi* (HEER) SEW. etc. (*vid.* KNOWLTON 1914, 1919).

O. HEER classed this Siberian flora as Bathonian. Several forms are also mentioned from the Middle Jurassic of Kharkov, Caucasia, Mongolia, and Turkestan, such as for instance *Coniopteris hymenophylloides* (BRONGN.) SEW., *Cladophlebis huttoni* (DUNKER) FONT., *Podozamites lanceolatus* (L. & H.) BRAUN, *Otozamites giganteus* THOMAS, *Gingko digitata* (BRONGN.) HEER, *Phoenicopsis angustifolia* HEER, *Elatides curvifolia* (DUNKER) NATH. (*op. cit.*). From the Rhaetic-Liassic of Bornholm *Podozamites lanceolatus* (L. & H.) BRAUN, *Gingko digitata* (BRONGN.) HEER, *Phoenicopsis angustifolia* HEER, *Pagiophyllum kurrii* (POM.) SCHIMP. etc. are cited, and *Coniopteris hymenophylloides* (BRONGN.) SEW., *Zamites megaphyllus* (PHILL.) SEW., *Gingko digitata* (BRONGN.) HEER, *Elatides curvifolia* (DUNKER) NATH. etc. are common in the Great Oolite (Bathonian) of England. With a view to these relations it seemed safe, after all, to assume a Bathonian-Oxfordian age for the Alaska series of Cape Lisburne (KNOWLTON 1914).

Later collections made near Cape Lisburne yielded moreover

Dicksonia saportana HEER
Cladophlebis vaccensis WARD
Taeniopteris sp.
Onychiopsis psilotoides (STOKES & WEBB) WARD
Otozamites beani (L. & H.) SEW.
Baiera gracilis (BEAN) BUNB.
Gingkodium? *alaskense* FONT. (= *Baiera palmata* HEER)
Gingko huttoni (STERNB.) HEER etc.
and *Dicotyledonous* leaves (WARD 1905, MARTIN 1926).

The unexpected finding of *Angiospermae*, namely dicotyledonous leaves, among the ancient *Pteridophyta* and *Gymnospermae* of Cape Lisburne ("Corwin formation") reveals without the least doubt, however, that this flora is *post*-Jurassic in age and may be compared to the "Upper Potomac Group" of the North Atlantic States (Maryland, Virginia, Carolina)[1]).

This example, indeed, shows with great clearness that the Jurassic and Lower Cretaceous floras are but of little stratigraphical value and that an age assignment which is only based upon phytostratigraphical results cannot be taken for reliable, after all.

It would of course carry us too far to list here this rich "Potomac flora"; we only wish to put forward the reason why we arrive at the fairly safe conclusion that the Spitsbergen floras may be Aptian in age as well.

[1]) L. LESQUEREUX (1887—1888) long ago supported the view of a "Neocomian" age of the Cape Lisburne flora (*vid.* KNOWLTON 1914).

The "Potomac Group" is subdivided into a lower series, the "Patuxent formation", a middle one, the "Arundel formation", and an upper one, the "Patapsco formation". Whilst the floras of the lower formations are still characterized by ferns, cycads, and conifers, the "Patapsco formation" already contains genuine *Dicotyledones*. The "Patuxent" and "Arundel formations" are referred to the Neocomian-Barrêmian, generally, whereas the "Patapsco formation", which rests unconformably upon the underlying series, is assigned to the Albian (CLARK, BIBBINS & BERRY 1911).

There is no difference worth mentioning between the floras of the "Patuxent" and the "Arundel formations", respectively, since both series have a great number of species in common. The flora of the "Patapsco formation", however, is distinctly different from those of the subjacent formations: old dominant types persisting throughout the Jurassic and the Lower Cretaceous extinct with the dawn of the "Patapsco" and, on the other hand, the Neo-Cretaceous flora with its abundance of *Angiospermae* is introduced. 30 % of the "Patapsco" flora already consist of *Angiosperms*. With the exception of one single form, *viz. Populus*, which is also represented in the West Greenland "Kome" flora of supposed Albian age, *dicotyledonous* leaves are still entirely lacking in the "Arundel formation", for instance (BERRY 1911).

It may be pointed out that undoubted *Angiospermae* all over the world do not appear until the Aptian-Albian times.

There is further evidence at hand that the Cape Lisburne flora of northern Alaska belongs to a rather high stage of the Cretaceous system.

The so-called "Kennicott formation" of Chitina Valley, which is closely related to the "Corwin formation" and has a number of plant species in common with the beds of Cape Lisburne (*vid.* PAIGE, FORAN & GILLULY 1925, MARTIN 1926)[1]), has turned out to be not Jurassic at all, as was generally assumed, but has yielded an invertebrate fauna of genuine Cretaceous (Albian) age. Apart from a few Valanginian fossils such as *Aucella* (*Buchia*) *cf. piochii* GABB, *A.* (*B.*) *cf. crassicollis* KEYS. etc. G. C. MARTIN lists for instance *Inoceramus sulcatus* PARK., *I.* (*Taenioceramus*) *cf. concentricus* PARK., *I. spp.*, *Aucella cf. gryphaeoides* (SOW.), *Baculites cf. teres* FORB., *Tetragonites cf. timotheanum* (MAY.), *Gaudryceras sacya* (FORB.), *Phylloceras cf. ramosum* MEEK, *Anisoceras cf. armatum* (SOW.), *Puzosia sp.* etc. (MARTIN 1926). Nearly all these forms are known to occur, for instance, in the "Haida formation" of the

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[2]) G. C. MARTIN enumerates for instance the following flora from the Cretaceous "Kennicott formation": *Cladophlebis spp.*, *Zamites megaphyllus* (PHILL.) SEW., *Otozamites beani* (L. & H.) SEW., *Podozamites sp.*, *Gingko schmidtiana* HEER, *Baiera palmata* HEER, *Taxites zamioides* (LECK.) SEW., *Elatides curvifolia* (DUNKER) NATH. *Pinites nordenskiöldi* HEER etc. (MARTIN 1926).

Queen Charlotte Islands, British Columbia, and *Tetragonites timotheanum* (MAY.) and *Gaudryceras sacya* (FORB.) are found in the upper portion of the "Horsetown formation" (Aptian-Albian) of the "Knoxville beds" (*op. cit.*). *Tetragonites timotheanum* (MAY.), *Hamites* (*Anisoceras*) *armatum* (SOW.) etc. are furthermore listed from the Upper Albian (Vraconian) of southern France (BREISTROFFER 1940), the first-mentioned form—together with *Gaudryceras sacya* (FORB.), *Baculites teres* FORB. etc.—from the Indian "Utatur Group" and also from Anadyr Land, east Siberia, whence it is reported to be associated with other Upper Albian fossils such as *Stoliczkaia dispar* (d'ORB.), *Turrilites cf. costatus* LAM.[1]) etc. (ELISEEV 1936). *Anisoceras armatum* (SOW.) moreover occurs in the Upper Albian of Madagascar (COLLIGNON 1932). *Inoceramus* (*Taenioceramus*) *concentricus* PARK. is an ubiquitous species of the Albian stage which is listed e. g. from the Middle and Upper Albian of southern France (KILIAN 1907—1913), northwest Germany (RIEDEL 1938a, DACQUÉ 1942), of the Helvetic region of the Alps, of the Caucasus, the Crimea, Turkestan (*vid.* DACQUÉ 1942), of the Tatras (Passendorfer 1930), of the central Andes of Perù (STEINMANN 1929, HARRISON 1943), from the Albian "Napo limestone" of Ecuador (WASSON & SINCLAIR 1937, GERTH 1941). R. HEINZ lists the same form from the Upper Albian (zone of *Pervinqueria inflata* (SOW.)) of Madagascar and Zulu Land (HEINZ 1932b, 1933a). The range of *Inoceramus sulcatus* PARK. is the same.

Since these invertebrate fossils from the "Kennicott formation" of Alaska are derived from beds which inosculate intimately with the plant-bearing layers, there cannot be the least doubt left that this supposed "Jurassic" flora must actually range as high as the Albian.

Another plant-bearing formation corresponding to the "Potomac Group" of Maryland, Virginia, and Carolina has moreover been known for years to occur on Nugssuak Peninsula, West Greenland (*vid.* Fig. 70)).

These "Kome Beds" (as the series is termed) are made up of black shales which rest transgressively upon gneiss and crop out on the north coast of the peninsula between Kûk (Kome) and Niakornat (STEENSTRUP 1893, RAVN 1918).

The rich flora derived from these "Kome Beds" has been described by O. HEER (HEER 1883). The most characteristic forms are listed below.

Order Filiciales

Dicksonia johnstrupi HEER

[2]) * *Cladophlebis albertsii* (DUNKER) HEER

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[1]) *Turrilites costatus* LAM., however, might already indicate Cenomanian.

[2]) The asterisked forms (*) are still found in the higher "Atane Beds" (Cenomanian) and those marked by two asterisks (**) range even into the "Patoot flora" of Upper Senonian age.

* *Asplenium dicksonianum* HEER
* — *nordenskiöldi* HEER
Sphenopteris gevrilliodes HEER
— *lepida* HEER
Pecopteris arctica HEER
* — *borealis* HEER
— *hyperborea* HEER
Gleichenia rigida HEER
* — *gracilis* HEER
** — *gieseckiana* HEER
** — *zippei* (CORDA) HEER
— *thulensis* HEER
— *nordenskiöldi* HEER

Order *Equisetales*
Equisetites grønlandicus HEER

Gymnospermae

Order *Cycadales*
Anomozamites cretaceus HEER
Zamites arcticus GOEPP.
— *speciosus* HEER
Pterophyllum concinnum HEER

Order *Gingkoales*
Baiera cretosa SCHENK
Gingko arctica HEER
Czekanowskia dichotoma HEER

Order *Coniferales*
* *Pinites sp. div.*
* *Thuyites sp. div.*
* *Sequoia reichenbachi* (GEIN.) HEER
* — *ambigua* HEER
** — *rigida* HEER
etc.

Angiospermae

Monocotyledones
Poacites borealis HEER
Cyperacites hyperboreus HEER
— *arcticus* HEER
Eolirion primigenium SCHENK
Fasciculites grønlandicus HEER

Dicotyledones
Populus primaeva HEER

O. HEER took this "Kome flora" to be "Urgonian"[1]) but, since it already contains a true *dicotyledonous* element, *viz. Populus primaeva* HEER, it was subsequently referred to the Albian, and compared to the "Patapsco formation" of the "Potomac Group" (*vid.* BERRY 1911, RAVN 1918). The overlying Cenomanian "Atane Beds" with their variegated *dicotyledonous* flora cannot be classed as Senonian, as J. P. J. RAVN and others were inclined to assume, since they are surmounted by marine shales of probably Turonian age (*vid.* p. 274). The "Patoot Beds" finally represent the Upper Senonian (*vid.* HEER 1883, RAVN 1918, ROSENKRANTZ and others 1940).

These Upper Cretaceous beds of West Greenland have moreover yielded marine invertebrate faunas (*vid.* pp. 274—282).

Owing to the considerable isolation of the vast Arctic geosyncline, which only stood in deficient connection with more southern seas through narrow gulfs, the Lower Cretaceous faunas of the boreal province evidently bear an individual stamp. The predominant genera of which this fauna is made up, e. g. *Subcraspedites*, *Neocraspedites*, *Tollia*, *Polyptychites*, *Dichotomites*, *Simbirskites*, *Acroteuthis*, *Aucella* (*Buchia*), etc., are not represented in Tethyan faunas or, at any rate, occur merely as scattered peregrine elements in a few numbers. In a former paper the author has sketched these relations of the Jurassic Seas and the mutual immigrations of faunal constituents (MAYNC 1947).

Since conditions in Lower Cretaceous times were very much alike a repetition will not be necessary.

With the dawn of the Aptian, however, the boreal sea had ingressed and joined across France with the Mediterranean Tethys. On the other hand, the Valanginian gulf, which had encroached from the Arctic Ocean upon central Russia as far south as Moscow and Rjasan already in Barrêmian time, advanced farther south and thus became a unit with the likewise transgressing Tethyan Sea. Moreover, a connection with the sea covering parts of Poland and Germany was brought about. It stands to reason that a general mixture of faunas was rendered easy by these paleogeographical changes and marine transgressions which heralded the most extensive thalattocratic epoch ever known. In other words, the Younger Cretaceous faunas have grown cosmopolitic and those from the Arctic domain do not differ much from contemporaneous assemblages of the Tethyan or Pacific Geosynclines any longer.

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[1]) The "étage Urgonien" (A. D'ORBIGNY 1850) comprises the Barrêmian-Aptian stages.

4) Aptian-Albian.

The table below shows the Aptian fauna of northern East Greenland as far as it is already known for the present (the asterisked forms (*) are new to East Greenland). Additional forms are listed in Appendix, pp. 227—228.

Lytoceras polare RAVN
— *sp.*
— *sp. ind. aff. polare* RAVN
* *Phylloceras royerianum* (D'ORB.)
Deshayesites aff. laeviusculus (V. KOEN.)
— *boegvadi* ROSENKR.
* — *cf. deshayesi* (LEYM.)
— *sp.*
Crioceras cf. gracile SOK. & BOD. (= *Tropaeum arcticum* STOLL.)
—? *sp. ind.*
Tropaeum cf. arcticum STOLL. (or *Crioceras sp.*)
— *sp.*
Ancyloceras sp.
Hamites sp.
— *sp. ind.*
Sanmartinoceras groenlandicum ROSENKR.
— *pusillum* (RAVN)
— *sp.*
— *sp. ind.*
* Other Ammonites not yet identified
* *Nautilus sp.*
* *Neohibolites spp.* ex *gr ewaldi* (STROMB.)
* — ex *gr semicanaliculatus* (BLAINV.)
"*Oxyteuthis*" *gracilis* FREB.
—? *jarneri* FREB.
—? *borealis* FREB.
Belemnites sp. ind.
Inoceramus (*Heteroceramus*) *cf. ewaldi* SCHLÜT.
— — *aff. ewaldi* SCHLÜT.
— *spp.*[1])
— *sp. ind.* I, II, III

[1]) Dr. J. SORNAY, Paris, to whom the East Greenland *Inoceramidae* were handed over for examinaticn, has had the kindness to inform me that the following species could hitherto be identified among my collections:

Inoceramus anglicus (WOODS) ROSENKR.
— *aff. anglicus* (WOODS) ROSENKR.
— *cf. anglicus* (WOODS) ROSENKR.
— *aff. labiatiformis* STOLL.

* ?*Aucellina sp.*
* ?*Cyrena sp.*
Crenella cf. bella (Sow.)
Lima ravni Freb.
— *rosenkrantzi* Freb.
— *cf. gaultiana* Woods
Pecten cf. orbicularis Sow.
— *sp. ind.*
Perna (*Isognonom*) *cf. rauliniana* (d'Orb.)
Plicatula kochi Freb.
Nucula friisi Freb.
— *freucheni* Freb.
— *sp. ind. aff. subtrigona* Roem.
— *sp. ind.*
Macrodon mylii Ravn
— *hageni* Ravn
Opis wegeneri Freb.
Isocardia erichseni Freb.
Lucina? sp. ind.
Turnus? sp. ind.
Terebratula biplicata Brocchi
— *sp. ind.*
—? *sp. ind.*
Terebratulina? aff. striata Wahlg.
Pleurotomaria sp. I, II, III
Emarginula sp. ind.
Neritopsis nielseni Freb.
Scalaria clementina (d'Orb.)
Cerithium? aff. dupinianum d'Orb.
Fusus? sp. ind.
Trochocyathus sp. (= *Thecocyathus? fide* A. Rosenkrantz)
Serpula sp. I, II
Ditrupa aff. decorata Stoll.
Dentalium? sp. ind.
Pollicipes sp.
Echinids
Crinoids etc.

(Koch 1931, Rosenkrantz 1932, Bøgvad & Rosenkrantz 1934, Frebold 1935b, Spath 1935a).

This fauna is derived from the region between Germania Land and Gauss Peninsula, i. e. about 76°—73° N. lat.

Nothing definite is hitherto known from the Aptian-Albian formations in Geographical Society and Traill Islands. H. STAUBER merely speaks of "Lower Cretaceous", *viz.* of marls carrying *Inocerami*, *Pterias*, and *Lytoceras*, from the northern island (STAUBER 1938). In a later report mention is made of "dark marls and sandy shales with *Aucellas*, *Inocerami*, Ammonites, Belemnites, Echinids, and pelecypods" (STAUBER 1939). Apparently, both Valanginian and younger Cretaceous deposits are thus represented, yet nothing has been published either on the stratigraphy or on the collected faunas[1]).

In the main the above-listed invertebrate fauna of northeast Greenland includes only new species, which, therefore, do not tell much as to the age. The following forms may be considered indicative of an age assignment:

Lytoceras polare RAVN
Sanmartinoceras (BONARELLI)
Deshayesites deshayesi (LEYM.)
— *laeviusculus* (v. KOEN.)
— *boegvadi* ROSENKR.
Phylloceras royerianum (D'ORB.)
Tropaeum arcticum STOLL.

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[1]) In his brief report on the Cretaceous ammonites published when the present paper was already in press (*vid.* p. 226) L. F. SPATH gives a couple of determinations of important forms derived from southern East Greenland.

A rich *Leymeriella* fauna (Lower Albian) was secured by H. STAUBER near Sveresborg, south coast of Geographical Society Island, including

Puzosia (*Callizoniceras?*) *sp.*
Beudanticeras cf. hulense AND.
Leymeriella aff. tardefurcata (D'ORB.)
— *aff. rencurelensis* (JAC.)
Arcthoplites cf. jachromensis (NIK.)
— *sp. nov.*

A somewhat later fauna was derived from south of Mt. Laplace, Geographical Society Island, containing

Puzosia (*?Beudanticeras*) *sp. nov.*
Dipoloceras sp. (*subdelaruei* group)
Euhoplites spp. (*opalinus* group)
Dimorphoplites sp.
Arcthoplites sp. juv.

In the surroundings of Kistenstock, Geographical Society Island, the below-listed poorly preserved assemblage was brought together by H. STAUBER:

Puzosia (*Beudanticeras?*) *sp.*
— *sp.*
Beudanticeras sp.
Lytoceras sp.
?Hysteroceras sp. juv.
?Euhoplites sp. ind.
Hamites? sp. ind.

Neohibolites (Stolley)
Inoceramus (*Heteroceramus*) *ewaldi* Schlüt.
Lima gaultiana Woods
Crenella bella (Sow.)
Scalaria clementina (d'Orb.)
Perna (*Isognomon*) *rauliniana* (d'Orb.)
Terebratula biplicata Brocchi.

Lytoceras polare Ravn is a species which was established by J. P. J. Ravn for a specimen derived from Vesterdalen at Danmarkshavn, northeast Greenland (Ravn 1911). It has since been recorded from Aptian beds of Great Koldewey Island (Frebold 1935b) and is now cited from the Aptian series of eastern Kuhn Island and Wollaston Foreland.

The same may be said of **Sanmartinoceras** (Bonarelli). *Sanmartinoceras groenlandicum* Rosenkr. 1934 (= *Aconeceras nov. sp. cf. nisoides* (Sar.) Rosenkr. 1930) is a species derived from the Aptian beds of Cape Maurer, eastern Kuhn Island (Bøgvad & Rosenkrantz 1934), and *Sanmartinoceras pusillum* (Ravn) (= *Garnieria pusilla* Ravn 1911) is reported from Vesterdalen, Germania Land (Ravn 1911) and from the Aptian deposits of Great Koldewey Island (Frebold 1935b). It appears from E. Nielsen's sections in Great Koldewey Island (*vid.* pp.174—176) that *Sanmartinoceras* and *Lytoceras polare* Ravn may occur in the same layers, and that e. g. *Sanmartinoceras pusillum* (Ravn) was found in the lowermost exposed portions of the Aptian series, below the cited species of *Lytoceras*.

The genus *Sanmartinoceras* (Bonarelli) is reported to be confined in Eastern Australia to the Upper Aptian, Gargasian (*vid.* Frebold 1935b), yet the species *Sanmartinoceras patagonicum* Bon., which is closely related to *S. groenlandicum* Rosenkr., is for instance recorded from Cenomanian strata of Patagonia, being associated with *Scaphites*, *Neohibolites*, *Aucellina* etc. (*vid.* Gerth 1941). On the other hand, *Deshayesites deshayesi* (Leym.) and its varieties *consobrinus* (d'Orb.), *consobrinoides* (Sinz.), *boegvadi* Rosenkr. etc. are generally accepted to be an index to the Lower Aptian (Bedoulian). However, since the Aptian beds near Cape Maurer, Kuhn Island, have yielded *Sanmartinoceras groenlandicum* Rosenkr., *Lytoceras polare* Ravn etc. as well as *Deshayesites cf. deshayesi* (Leym.) *boegvadi* Rosenkr. the vertical range of *Sanmartinoceras* (Bonarelli) must doubtless be extended (Lower Aptian-Cenomanian).

Deshayesites deshayesi (Leym.) is an ubiquitous form which is, for instance, listed from the Bedoulian of southern France together with *Para-*

hoplitoides weissi (N. & UHL.), *Ancyloceras hillsi* Sow., *A. matheronianum* D'ORB. etc. (KILIAN 1907—1913); from the "Upper Speeton Clay" (bed B) of Yorkshire; from the fossiliferous Aptian "Sutterby Marl" of Lincolnshire where it is associated with *Parahoplitoides fissicostatus* (PHILL.), *D. aff. laeviusculus* (v. KOEN.), *Aconeceras* (*Adolphites*) *nisoides* SAR., *Neohibolites ewaldi* STROMB. etc. (*deshayesi* zone of the Lower Aptian) (SWINNERTON 1935). On the island Wight the Wealden is transgressively overlain by the Lower Aptian "Atherfield Clay" bearing *D. deshayesi* (LEYM.), *Tropaeum bowerbanki* (Sow.), *Panopaea gurgitis* BRONGN., *Perna mulleti* DESH., *Exogyra sinuata* Sow. etc. (BOSWELL 1929). The "Hythe Beds" of Dorset (Tropaeuman) carry a corresponding ammonite fauna (KIRKALDY 1939). *D. deshayesi* (LEYM.) is furthermore a typical constituent of the German "Upper Hils Clay" (Bedoulian) where it is accompanied by *Parahoplitoides weissi* (N. & UHL.), *P. bodei* (v. KOEN.), *D. laeviusculus* (v. KOEN.), *Aconeceras* (*Adolphites*) *nisum* (D'ORB.), *A. trautscholdi* (SINZ.), *Cleoniceras martini* (D'ORB.), *Tropaeum bowerbanki* (Sow.) etc. (NEUMAYR & UHLIG 1881, VON KOENEN 1902, KILIAN 1907—1913, RIEDEL 1938 a). *Deshayesites deshayesi* (LEYM.) is moreover widespread in the region of Moscow, Simbirsk, Syzran etc. (VON BUBNOFF 1926, NALIVKINE 1937 a), and is recorded from the Lower Aptian of the Caucasus and Persia where it occurs together with *P. consobrinoides* (SINZ.), *P. weissi* (N. & UHL.), *Neohibolites semicanaliculatus* (BLAINV.) (*vid.* DACQUÉ 1942). H. BESAIRIE cites it from the Aptian of Madagascar (BESAIRIE 1932), W. KILIAN from Kuchh (British India), Queensland, and New South Wales (KILIAN 1907—1913). Several species of *Parahoplitoides* (SPATH) ex *gr deshayesi* are moreover present in the "Barr-Argonaut Zones" (Bedoulian) of California and Oregon (*vid.* DACQUÉ 1942). The Aptian beds of Venezuela and Trinidad have yielded *D. deshayesi* (LEYM.), *P. consobrinus* (D'ORB.), *P. consobrinoides* (SINZ.), *P. weissi* (N. & UHL.), *Cleoniceras martini* (D'ORB.), *Neohibolites*? ex *gr ewaldi* STOLL., *Orbitolina* etc. (LIDDLE 1928, RENZ 1942).

Deshayesites laeviusculus (v. KOEN.), a related species of which has been identified from the Aptian series of Stensiös Plateau, Hold-with-Hope, is a form that was described by A. VON KOENEN from the *deshayesi* zone (Lower Aptian) of northern Germany (VON KOENEN 1902). It is an intimate ally to *Parahoplitoides consobrinoides* (SINZ.) from the Volga and is stated to be associated with *P. bodei* (v. KOEN.), *Cleoniceras martini* (D'ORB.), *Tropaeum bowerbanki* (Sow.) etc.

Parahoplitoides/Deshayesites boegvadi ROSENKR. (= *P. cf. deshayesi* (LEYM.) ROSENKR. 1930), which was found by R. BØGVAD at Cape Maurer, eastern Kuhn Island, (BØGVAD & ROSENKRANTZ 1934) is comparable to the cosmopolitan species *Deshayesites deshayesi* (LEYM.) and to *P. consobrinus* (D'ORB.), and *P. consobrinoides* (SINZ.) of the *deshayesi* zone (Bedoulian).

Deshayesites (KASANSKI)/*Parahoplitoides* (SPATH) is furthermore mentioned from the Cretaceous of Mackenzie Bay, Arctic Canada, which overlies unconformably the Paleozoic formations (*vid.* KINDLE 1939).

Phylloceras royerianum (D'ORB.) (genotype: *Ammonites royerianus* D'ORB.), which is now recorded for the first time from East Greenland and even from the Arctic regions at all, is a widespread form of the Lower and Upper Aptian of France, northern Africa, Zulu Land etc. Its suture-line already resembles that of *Douvilléiceras* (*Douvilléiceras royeri* (D'ORB.) KIL.). Whilst *Phylloceras royerianum* (D'ORB.) and *Cheloniceras cornueli* (D'ORB.) are diagnostic species of the Aptian, *Ch. martini* (D'ORB.) still ranges into the Lower Albian (*vid.* D'ORBIGNY 1843, ROMAN 1938).

Cheloniceras reesidei AND. and *Ch. irregulare* AND. are known e. g. from the uppermost Gargasian of California and Oregon (ANDERSON 1938). *Ch. hambrovi* (FORB.) occurs in the "Atherfield Clay" (Isle of Wight), together with *Deshayesites deshayesi* (LEYM.) (*vid.* KIRKALDY 1939), and *Ch. sp.* is reported from the "Sutterby Marl", associated with *Deshayesites aff. laeviusculus* (v. KOEN.), *Aconeceras* (*Adolphites*) *nisoides* (SAR.) etc. (SWINNERTON 1935). *Ch. gottschei* (KIL.) is for instance a species of the Aptian deposits of the Lebombo region, South Africa, where it is accompanied by *Aconeceras* (*Adolphites*) *nisoides* (SAR.) *et cetera* (*vid.* KRENKEL 1928).

The form **Tropaeum arcticum** STOLLEY was established in 1912 by E. STOLLEY for a specimen derived from the supposed Jurassic "*Ditrupa* Beds" in Advent Bay, Spitsbergen (*vid.* FREBOLD 1935a). The same species is represented in the Aptian portion of the sequence at Cape Festning (beds 32—39), Icefjord, and had been described as *Crioceras* ex *gr gracile* (SINZ.) (SOKOLOV & BODYLEVSKY 1931). According to H. FREBOLD it is associated here with "*Oppelia*" (*fide* H. FREBOLD 1928) which, however, was subsequently referred to as *Aconeceras aff. nisoides* (SAR.) (FREBOLD 1935a). Moreover, *Hoplites sp.* (*ind.*) is cited from these Aptian beds (FREBOLD 1935a, FREBOLD & STOLL 1937).

Neohibolites (STOLLEY), too, is a cosmopolitan representative of the Aptian-Albian (and Cenomanian) the different species of which are of great importance for the stratigraphy as they belong to a phylogenetic sequence (see the fundamental memoirs of E. STOLLEY).

The table below shows the geological range of the most valuable species of *Neohibolites* (STOLLEY).

Neohibolites ultimus (D'ORB.) — *intermedius* ERNST — *stolleyi* ERNST	Upper Albian
— *minimus* (LIST.)	Middle Albian
— *minor* STOLL. — *strombecki* MÜLL. — *wollemanni* STOLL.	Lower Albian
— *inflexus* STOLL. — *clava* STOLL. — *duvaliaeformis* STOLL. — *ewaldi* (STROMB.)	Upper Aptian
——— *deshayesi* zone ———	
Parahoplitoides bodei (v. KOEN.) + *Oxyteuthis depressus* STOLL.	Lower Aptian

(*vid.* STOLLEY 1908, 1911, 1919, 1937, 1939).

Neohibolites ewaldi (STROMB.) is frequently found in the Aptian beds of Great Britain; in northern Germany it is associated with *Deshayesites sp.*, *Aconeceras* (*Adolphites*) *cf. nisoides* (SAR.) (RIEDEL 1938a). *Neohibolites ewaldi* (STR.), *N. duvaliaeformis* STOLL., *N. clava* STOLL., and *N. inflexus* STOLL. are e. g. represented in the Aptian, *N. wollemanni* STOLL., *N. strombecki* MÜLL., and *N. minimus* (LIST.) in the Albian of the Pontic Range, Turkey (FUCHS 1938). *N. minimus* (LIST.) is a widespread species of the Middle Albian, being represented for instance in the "Upper Speeton Clay", in the "Red Chalk" of Lincolnshire, in the Albian of Tomaszov, southwestern Poland, etc. (*vid.* BOSWELL 1929, SWINNERTON 1935, LEWINSKI 1932). *N. semicanaliculatus* (BLAINV.) is recorded from both Aptian and Albian beds: In southern France e. g. it is present in Gargasian deposits, together with *Aconeceras* (*Adolphites*) *nisum* (D'ORB.), *Cleoniceras martini* (D'ORB.) etc. (*vid.* KILIAN 1907—1913); on Trinidad it is reported to occur together with *N. aptiensis* (KIL.) and *N.* ? ex *gr ewaldi* (STR.) in the Aptian "Maridale Marl" (*vid.* RENZ 1942). From Mangyschlak, the Caucasus, and Persia this species is also cited from Aptian formations where it is associated with *Deshayesites deshayesi* (LEYM.), *Parahoplitoides consobrinoides* (SINZ.), *Cleoniceras martini* (D'ORB.), *Ancyloceras hillsii* (SOW.), *A. bowerbanki* (SOW.), *Crioceras gracile* SINZ. *et cetera* (*vid.* KILIAN 1907—1913, DACQUÉ 1942), but, on the other hand, it occurs in Albian beds, which is proved by the presence of *Beudanticeras beudanti* (Brongn.), *Sonneratia dutempleana* (d'Orb.), *S. jachromensis* (Nik.), *Inoceramus salomoni* d'Orb., *I.* (*Taenioceramus*) *concentricus* Park. etc. (Dacqué 1942). *N. cf. semicanaliculatus* (Blainv.) and *N. aff. minimus* (List.) are moreover recorded from Albian strata in Patagonia (*vid.* Gerth 1941).

Inoceramus (Heteroceramus) ewaldi Schlüt. which was also found in Shannon Island, northeast Greenland, is a species of the Aptian occurring e. g. in the zone of *Cleoniceras martini* (d'Orb.) in Westfalen, Germany.

Lima gaultiana Woods. in a species of the Albian and *Crenella bella* (Sow.) is reported to occur in the Middle Aptian of England (*vid.* Bøgvad & Rosenkrantz 1934).

Perma (Isognomon) rauliniana (d'Orb.) is found both in Aptian and Albian beds. W. Kilian lists it e. g. from the Bedoulian of the Ardenne Department, France (Kilian 1907—1913), and in the Swiss Alps it is recorded from the Urgonian limestone, together with *Neohibolites semicanaliculatus* (Blainv.), and also from the Lower Albian (Leymeriellan) in deposits containing furthermore *Inoceramus* (*Taenioceramus*) *concentricus* Park., *I. sulcatus* Park. etc. (Ganz 1912). From the High Tatra (Beskids) it is reported to occur together with the same species of *Inoceramus*, and, moreover, with *Inoceramus cf. anglicus* Woods, *Leymeriella dentata* (Sow.), *Neohibolites minor* Stoll., and *N. minimus* (List.), thus in the Middle and Upper Albian (*vid.* Passendorfer 1930).

Terebratula biplicata Brocchi is closely similar to *T. dutempleana* d'Orb. (described as *T. biplicata* Sow. 1815) which is of common occurrence in the Albian formations of France (*vid.* d'Orbigny 1843, Kilian 1907—1913) but which is e. g. even mentioned from deposits as young as Upper Senonian (Basse 1931).

Scalaria clementina (d'Orb.) is another Albian form that is cited from the basin of Paris and the Tethys Sea (*op. cit.*); according to H. Frebold it is, moreover, found in Germany, in the zone of *Leymeriella tardefurcata* (Leym.), i. e. in the Lower Albian (*vid.* Frebold 1935b).

The lowermost Aptian-Albian beds represented in Spitsbergen have yielded the below-listed pelecypod fauna.

Beds 24/28:

Belemnites sp.
Arca nana (LEYM.) D'ORB.
— *cf. nana* (LEYM.) D'ORB.
Modiola cf. matronensis (D'ORB.)
— *cf. strajeskiana* D'ORB.
— *sp.*
Nucula sp.
Panopaea? sp.
Macrodon? sp.
Leda cf. deGeeri LUNDGR.
— *cf. seeley* GARDN.
— *sp.*
Pecten cf. orbicularis SOW.
— (*Entolium*) *sp.*
— (*Camptonectes*) *cf. cinctus* SOW.
— — *cf. spitzbergensis* LUNDGR.
— — *aff. spitzbergensis* LUNDGR.
—?
Perna sp.
Scurria? sp.
Avellana? sp.
Ditrupa decorata STOLL.
— (*Dentalium?*) *lindstroemi* LUNDGR.
— *sp.*
—? *sp.*

(SOKOLOV & BODYLEVSKY 1931, FREBOLD & STOLL 1937).

Bed 28 (with *Belemnites sp.*, *Pecten* (*Entolium*) *sp.*, *P.* (*Camptonectes*) *aff. spitzbergensis* LUNDGR., *Leda cf. deGeeri* LUNDGR., *L. cf. seeley* GARDN., *L. sp.*, *Macrodon? sp.*, *Ditrupa? sp.*) is overlain by the "Continental Series" which is supposed to correspond to the Upper Valanginian-Hauterivian-Barrêmian but which the writer rather refers to the Aptian, however (*vid.* p. 245 ff.). Not only does the presence of *Arca nana* (LEYM.) D'ORB., *Pecten cf. orbicularis* SOW., *Modiola cf. matronensis* (D'ORB.) etc. clearly suggest an Aptian-(Albian) age but most of the cited forms are also common in the marine beds that overlie these plant-bearing deposits where they are associated with genuine Aptian-Albian fossils such as *Tropaeum arcticum* STOLL., *Aconeceras* (*Adolphites*) *aff.* nisoides (SAR.), *Cyprina aff. saussurei* (BRONGN), *Cucullaea glabra* (SOW.), *Leda mariae* (D'ORB.), *Inoceramus aff. labiatiformis* STOLL., *Aucellinae* ex *gr caucasica* (VON BUCH) and *A. gryphaeoides* (SOW.).

The following fauna is known from the Aptian-Albian formation (beds 32—45) which surmounts the "Continental Series" (28a—31) at Cape Festning, Spitsbergen:

Bed 32: *Tropaeum arcticum* STOLL.
Inoceramus cf. spitzbergensis STOLL.
— *cf. labiatiformis* STOLL.
— *sp.*
Leda mariae (D'ORB.)
—? *sp.*
Mytilus sp.
Protocardium sp.
Panopaea cf. irregularis D'ORB.
Cyprina? sp.

Bed 33: *Belemnites sp.*
Ditrupa decorata STOLL.

Bed 34: *Cucullaea glabra* (SOW.)
Leda mariae (D'ORB.)
Cyprina? sp.
Pleuromya? sp.

Bed 35: *Nucula? sp.*
Leda angulatostriata BOD.
— *mariae* (D'ORB.)
— *sp.*
Cyprimeria parva (SOW.)
Modiola cf. strajeskiana D'ORB.
Thracia sp.
Solecurtus cf. pelagi (D'ORB.)

Bed 36: *Nucula planata* DESH.
— *sp.*
Leda cf. angulatostriata BOD.
— *cf. deGeeri* LUNDGR.
—? *sp.*
Lucina aff. obliqua GOLDF.
Cyprina? sp.
Cyprimeria? sp.
Rhynchonella nov. sp. BOD.

Bed 37: *Nucula planata* DESH.
Leda angulatostriata BOD.

Bed 38: *Aconeceras (Adolphites) aff. nisoides* (SAR.)
Crioceras sp.

Nucula? sp.
Leda angulatostriata BOD.
— *mariae* (D'ORB.)
—? *sp.*
Pecten orbicularis SOW.
— *cf. validus* LINDSTR.
Turbo sp.
Ditrupa decorata STOLL.
— *sp.*
Dentalium? sp.

Bed 39: *Tropaeum arcticum* STOLL.
Panopaea cf. recta D'ORB.

Bed 40: *Hoplites sp.*
Nucula sp.
Leda angulatostriata BOD.
Astarte sp.
Inoceramus? sp.
Pecten orbicularis SOW.

Bed 41: *Leda sp.*
Astarte sp.
Pinna sp.
Natica? sp.

Bed 42: *Nucula sp.*
Astarte? sp.
Pecten? sp.
Aucellina ex *gr causasica* (VON BUCH)/*gryphaeoides* (SOW.)
Cardium cf. lanceolatum REUSS.
Cyprina aff. saussurei (BRONGN.)
—? *sp.*
Ditrupa decorata STOLL.
— *notabilis* (EICHW.) SINZ.
— *sp.*

(SOKOLOV & BODYLEVSKY 1931, FREBOLD 1935a, FREBOLD & STOLL 1937).

From the Aptian beds in Advent Bay, Spitsbergen, *Tropaeum arcticum* STOLL., *Inoceramus labiatiformis* STOLL., and *I. spitzbergensis* STOLL. are recorded by E. STOLLEY (STOLLEY 1912, *vid.* FREBOLD 1935a). D. SOKOLOV & Y. I. BODYLEVSKY list ?*Deshayesites sp.*, *Pecten orbicularis* SOW., *Aucellina cf. pompeckji* PAVL., *A. aptiensis* POMP., and *Leda angulatostriata* BOD. from Bell Sound (SOKOLOV & BODYLEVSKY 1931).

In Storfjord, eastern Spitsbergen, the "Festning Sandstone" of the "Continental Series" is overlain by a wood-bearing conglomerate and Aptian-Albian deposits carrying *Inoceramus aff. labiatiformis* STOLL., *Aucellina aff. caucasica* (VON BUCH), *A. aptiensis* POMP., *Leda angulato-striata* BOD., and *Ditrupa decorata* STOLL. (*vid.* FREBOLD 1935a).

According to H. FREBOLD *Tropaeum arcticum* STOLL. points to the Lower Aptian whereas *Aconeceras* (*Adolphites*) *nisoides* (SAR.) would suggest a higher horizon of the Aptian (FREBOLD 1935a); however, since *Aconeceras* (*Adolphites*) *aff. nisoides* (SAR.) was found in bed 38 of the Cape Festning sequence, and *Tropaeum arcticum* STOLL. in bed 32 as well as in member 39, this assumption cannot hold good, evidently.

The lamellibranch fauna does not fix the age of the series precisely but all the forms hitherto known do not speak against an Aptian-Albian assignment, after all.

Panopaea recta D'ORB., *P. irregularis* (D'ORB.), and *Nucula planata* DESH. are of "Neocomian" age, whilst e. g. *Leda mariae* (D'ORB.) seems to be restricted to the Albian (D'ORBIGNY 1843, PICTET & CAMPICHE 1864—1867).

Cucullaea glabra (SOW.) ranges from the Upper Aptian into the Lower Albian (*vid.* PICTET & CAMPICHE *op. cit.*) whereas *C. glabra* PARK. is cited from the Russian Albian (*vid.* VON BUBNOFF 1926) and from the Middle Albian of Kent, where it is associated with *Douvilléiceras mammillatum* (SCHLOTH.), *Cleoniceras aff. cleon* (D'ORB.), *Panopaea gurgitis* BRONGN., *Inoceramus cf. anglicus* WOODS, *I. salomoni* D'ORB. etc. (BROWN 1941).

Cyprina saussurei (BRONGN.) is found in the Lower Aptian of southern France and in the "Lower Greensand" of Atherfield (PICTET & CAMPICHE 1864—1867).

Solecurtus pelagi (D'ORB.) occurs in the Neocomian beds of central France and the Tethys area (*vid.* D'ORBIGNY 1843) but is e. g. listed by F. J. PICTET & G. CAMPICHE (*op. cit.*) from the Cenomanian of the Jura Mountains.

Aucellina gryphaeoides (SOW.) is cited from the Gargasian (KILIAN 1907—1913) as well as from the Middle and Upper Albian of southern France (BREISTOFFER 1941), also from the Upper Albian of northern Germany (*vid.* RIEDEL 1938a, STOLLEY 1939). Both *A. gryphaeoides* (SOW.) and *A. cf. aptiensis* (D'ORB.) are recorded from the Upper Albian of Poland (LEWINSKI 1932) and even from the Cenomanian of Podolia; the former species is moreover present in the Cenomanian beds of Saxony, being associated with *Inoceramus* (*Gnesioceramus*) *crippsi* MANT. (*vid.* DACQUÉ 1942). From Anadyr Land, Tchuktchis, *Aucellina gryphaeoides* (SOW.) and *A. pompeckji* PAVL. are reported from the "*Concentricus* Beds" (Lower Albian) ELISEEV 1936). *Aucellina caucasica* (VON BUCH) occurs in the Albian of Russia and of the Caucasus (*vid.* BREISTROFFER 1941, DACAUÉ 1942), and related species are even stated from the Albian-Senonian deposits of Patagonia (*vid.* GERTH 1941). *Aucellina aptiensis* (D'ORB.) is known from the Upper Aptian of northwest Germany (*vid.* DACQUÉ 1942) whereas the species *A. quaasi* WOLL., *A. major* WOLL., and *A. maxima* WOLL. characterize the Lower Albian of Germany (Hannover) and of southern France (BREISTROFFER 1941, DACQUÉ 1942).

Albian.

It has already been mentioned that a discrimination of the Aptian and Albian stages in East Greenland is not possible without paleontological finds at hand. As, moreover, several of the aforementioned fossils have a fairly great vertical range, a sure decision as to the age cannot always be made.

However, the following forms only appear with the Albian:

Gastroplites spp.[1]) *nov.?*
Sonneratia cf. jachromensis (NIK.)[2])
Inoceramus/Actinoceramus (*Taenioceramus*) *aff. concentricus* PARK.
— *anglicus* WOODS
— *spp.*
Lima gaultiana WOODS

Sonneratia jachromensis (NIK.) is, for instance, represented in the Middle Albian of central and east Russia, together with *Sonneratia dutempleana* (D'ORB.), *Beudanticeras beudanti* (BRONGN.) etc. (*vid.* VON BUBNOFF 1926). In the Middle and Upper Albian deposits of Mangyschlak Peninsula (Caspi Sea) *Sonneratia jachromensis* (NIK.) is associated with *Douvilléiceras mammillatum* (SCHLOTH.) and *Callihoplites auritus* (SOW.), respectively (*vid.* DACQUÉ 1942). *Sonneratia dutempleana* (D'ORB.) occurs in the Albian of southern France (*vid.* KILIAN 1907—1913) and is also reported from the Middle Albian formations of the Caucasus and Persia, together with *Neohibolites semicanaliculatus* (BLAINV.), *N. minimus* (LIST.), *Inoceramus* (*Taenioceramus*) *concentricus* PARK. etc. (*vid.* DACQUÉ 1942). A "*Sonneratia* Bed" is also known at the base of the Hoplitan (*mammillatus* zone) of Folkestone containing for instance *S. kitchini* SPATH, *Douvilléiceras sp.*, etc. (*vid.* CASEY 1939).

[1]) Recorded for the first time from Greenland. The genus **Gastroplites** was established by L. F. SPATH for a form belonging to the primitive *Hoplitidae* represented in the Middle Albian of Folkestone, England, e. g. by *G. cantianus* SPATH (*vid.* BREISTROFFER 1940). *Gastroplites* (SPATH) was believed to be derived from an Arctic or *sub*-Arctic stock which, to be sure, is now evidenced by its occurrence in northern East Greenland (*vid.* pp. 34—37).

[2]) The *Hoplitid* genus *Sonneratia* (BAYLE) was erected for the group of *Ammonites dutempleanus* D'ORB., a diagnostic species of the Albian (Hoplitan).

In Bell Sound, Spitsbergen, some poorly preserved ammonites are referred to as "*Sonneratia? cf. jachromensis* (NIK.)" (SOKOLOV & BODYLEVSKY 1931). Otherwise, deposits of Albian age have not been found in Spitsbergen, King Charles Land, and Franz Joseph Land, having probably been removed by erosion in *pre*-TERTIARY time (*vid.* FREBOLD 1935 a).

A dubitable specimen of a *Sonneratia* (BAYLE) was secured near Pomorskaya Colony, Novaya Zemlya (SALFELD & FREBOLD 1924, *vid.* SOKOLOV & BODYLEVSKY 1931, FREBOLD 1930) which would thus indicate Albian, not Aptian as stated by the said authors.

Sonneratia? sp. is also recorded from the "Nulato formation", Yukon, together with *Inoceramus* (*Mytiloides*) *cf. labiatus* SCHLOTH. etc. (*vid. inf.*). *Sonneratia rogersi* HLL. & AMB. is an Albian species ("Le Conte Zone") of California and Oregon (*vid.* ANDERSON 1938).

In the main, the Albian rocks of the boreal domain are characterized by the occurrence of *Inoceramidae* which mostly belong to or near the cosmopolitan species *Inoceramus-Actinoceramus* (*Taenioceramus*) *concentricus* PARK. This form is e. g. stated to occur in Kodiak, west Alaska (*vid.* CAPPS 1937 a) and in Chitina Valley (*vid.* p. 247). It is also found in Pengina Bay, Kamtchatka (BODYLEVSKY 1937?).

Other widely distributed Albian species are *Inoceramus sulcatus* PARK., *I. anglicus* WOODS, *I. salomoni* D'ORB. etc.

Lima gaultiana WOODS is restricted to the Albian stage (*vid.* p. 265).

According to Y. I. BODYLEVSKY & L. D. KIPARISOVA the marine transgressions of the Albian flooded large areas of the old continental nuclei of Arctic Russia and Siberia (BODYLEVSKY & KIPARISOVA 1937). In Anadyr Land, Tchuktchis, beds of Lower Albian age carrying *Inoceramus* (*Taenioceramus*) *concentricus* PARK., *Aucellina pompeckji* PAVL., *A. gryphaeoides* (SOW.) etc. rest with angular unconformity upon the *Aucella*-bearing Valanginian formations; the Middle Albian beds have only yielded *Puzosia sp.*, *Cleoniceras sp.*, whereas the Upper Albian is e. g. proved by guide-fossils such as *Stoliczkaia dispar* (D'ORB.), *Tetragonites timotheanum* (MAY.); *Inoceramus* (*Taenioceramus*) *concentricus* PARK. is still represented here (*vid.* OBRUTSCHEW 1926, ELISEEV 1936).

Beudanticeras sp. found in the Cretaceous deposits which rest directly upon the Paleozoic rocks in Mackenzie Bay, Arctic Canada (*vid.* KINDLE 1939), proves the presence of the Albian stage.

5) Cenomanian-Turonian.

Cenomanian and Turonian deposits have not hitherto been recognized in the sedimentary sequence of northern East Greenland, only in Lower

Senonian time did the sea once more advance upon small portions of the present-day land.

Marine Cenomanian, which is for instance recorded from the Pekulney Mountains and from Anadyr Land, east Siberia (*vid.* ELISEEV 1936), is hardly known from the Arctic regions whereas beds of Turonian age seem to occupy larger areas.

A very conspicuous element of the Lower Turonian faunas is e. g. *Inoceramus* (*Mytiloides*) *labiatus* SCHLOTH. which has been found almost all over the world; other widespread species are *Inoceramus cuvieri* Sow. and *I.* (*Orthoceramus*) *lamarcki* PARK. (Middle Turonian).

I. (*Mytiloides*) *cf. labiatus* SCHLOTH. is for example cited from Yenissei River, being associated with *I.* (*Orthoceramus*) *lamarcki* PARK. (ALEKSANDROV 1939), and the last-mentioned species also occurs near the Seimchan/Kolyma Rivers (BODYLEVSKY 1937 ?). *I.* (*Mytiloides*) *cf. labiatus* SCHLOTH. and *I. cf. cuvieri* Sow. (= *I.* (*Stolleyiceramus*) *schloenbachi* BOEHM) appear in the Turonian of Anadyr Land and Kamtchatka (*vid.* OBRUTSCHEW 1926). *I.* (*Mytiloides*) *cf. labiatus* SCHLOTH. is also rather common in the Upper Cretaceous of Alaska and is e. g. recorded from the "Matanuska formation" which overlaps the Valanginian in Matanuska Valley (MARTIN 1926, CAPPS 1927); here it is reported to occur together with *Inoceramus* (*Cordiceramus*) *undulatoplicatus* ROEM., *Phylloceras ramosum* MEEK, *Tetragonites timotheanum* (MAY.), *Gaudryceras spp.*, *Desmoceras sp.*, *Baculites sp.*, *Hamites sp.*, *Anisoceras sp.* etc. Apart from the *Inocerami*, however, this fauna rather suggests an Albian age; *Inoceramus* (*Cordiceramus*) *undulatoplicatus* ROEM., on the other hand, would be indicative of the Lower Senonian/"Emscherian" being also represented for instance in the "Chignik formation" of Alaska Peninsula. In the Rampart-Tanana district, Lower Yukon region, *Inoceramus* (*Mytiloides*) *cf. labiatus* SCHLOTH. and other lamellibranchs are associated with *Gingko sp.* and a *dicotyledonous* flora (*vid.* MARTIN 1926). Furthermore, the same species of *Inoceramus* and numerous other mollusks as well as a flora including *Nilssonia sp.*, *Podozamites lanceolatus* (L. & H.) BRAUN, *Sequoia ambigua* HEER, *S. reichenbachi* (GEIN.) HEER, and *dicotyledonous* elements e. g. *Platanus heeri* LESQ., *Credneria sp.*, *Acer sp.*, *Viburnum sp.* etc. are recorded from the "Nulato formation" of the lower Yukon. Together with *Inoceramus* (*Dactyloceramus*) *cf. digitatus* Sow. (or. *I.* (*Cordiceramus*) *undulatoplicatus* ROEM.) the species *labiatus* is also cited from the Kuskokwim Mountain. L. M. PRINDLE mentions it from the Mount McKinley region (PRINDLE 1911) *et cetera.*

However, none of these forms has hitherto been proved to occur in East Greenland[1]).

[1]) In L. F. SPATH's preliminary account on the Cretaceous ammonites of East Greenland (*vid.* p. 226ff.) which unfortunately, appeared after the present paper

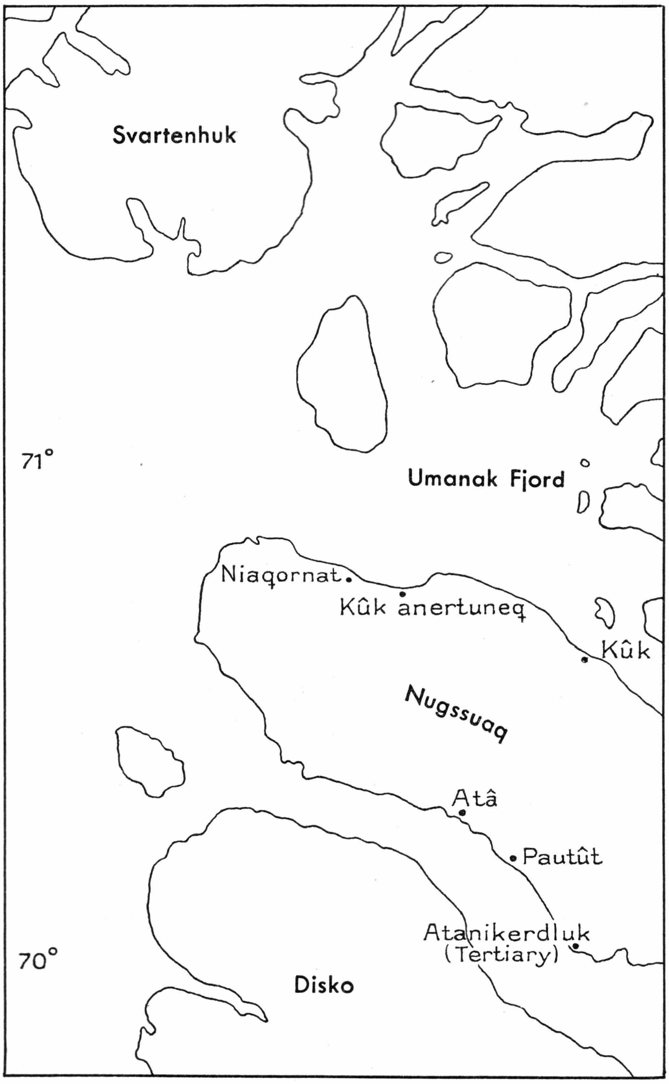

Fig. 70. Sketch-map showing the principal Cretaceous localities on Nugssuak Peninsula, West Greenland, Pautût = Patoot.

In West Greenland, on the other hand, beds of Cenomanian-Turonian age are developed in a limnic-continental facies, though.

had been ready for press and thus can only be referred to in footnotes, mention is made for the first time of genuine Cenomanian and Turonian forms. *Schloenbachia psp.*, *S. subvarians* Spath were found near Mt. Laplace, Geographical Society Island, whereas other specimens are derived from the neighbourhood of Bjørnedal (west of Forchhammers Bjærg), south coast of Traill Island. Upper Turonian is indicated by the presence of *Scaphites aff. lamberti* (de Gross.) and *Prionotropis cf. woolgari* (Mant.) Meek.

Here the Albian "Kome Beds" (*vid.* pp. 255—257) are followed by the "Atane Beds" which carry an abundant *dicotyledonous* flora with a great number of species common in the Cenomanian "Quader Sandstone" of Saxony and Bohemia (Heer 1883). O. Heer, therefore, referred it to the geological interval between the Albian and the Senonian, i. e. the Cenomanian-Turonian (in *loc. cit.*).

The overlying Senonian series have yielded a characteristic invertebrate fauna which was identified and described by P. de Loriol, J. P. J. Ravn, and others (de Loriol 1882, Steenstrup 1893, Ravn 1918).

The Danish "Nugssuak Expedition" (1938—1939) has furnished some new data with regard to the stratigraphy of this West Greenland Cretaceous (*vid.* Rosenkrantz and others 1940).

The "Atane Beds" consisting of freshwater and continental deposits rest with a gentle unconformity upon the "Kome Beds" and are in turn transgressively overlain in northern Nugssuak Peninsula by a marine formation with a conglomeratic layer at its base. On the south coast a more limnetic facies predominates the upper portion of which carries the well-known Senonian "Patoot flora". A *post*-Senonian unconformity and a basal conglomerate mark the overstepping Danian (*op. cit.*).

It has now turned out, however, that the marine black shales with limestone concretions on top of the "Atane Beds" represent ?Turonian and Senonian as well; for several specimens of *Parapuzosia*? *sp.* were detected on the north coast of Nugssuak Peninsula which A. Rosenkrantz (in *loc. cit.*) holds to be suggestive of a Turonian age. On this account the conception of J. P. J. Ravn that the "Atane Beds" might already be referred to the Senonian (*vid.* p. 257) cannot hold true.

Scaphites ex *gr ventricosus* Meek & Hayden found in Svartenhuk Peninsula points towards the Turonian-Lower Senonian.

Higher up follows the marine Senonian (Santonian) sequence bearing the characteristic "Patoot flora".

6) Senonian.

Up to now there is only one locality in northern East Greenland, *viz.* Knudshoved (east coast of Hold-with-Hope), where late Cretaceous deposits are known to occur with certainty (*vid.* pp. 141—144).

We have already pointed out that these "Knudshoved Beds" transgressively overlap the "Home Foreland Beds" of supposed Aptian-Albian age, and that, consequently, a stratigraphical break is present.

H. Frebold, who has examined the sparse fauna of Knudshoved (brought back in 1932 and 1933), lists the following forms:

Pteria tenuicostata Roem.
—? or *Gervilleia aff. Pteria pectinoides* Ravn

Inoceramus teicherti FREB.
— *geltingi* FREB.
(FREBOLD 1934).

The cited *Inoceramus* species are new ones, to be sure, but they are referred by H. FREBOLD (in *loc. cit.*) to the group of *Inoceramus* (*Beloceramus*) *cardissoides* GOLDF. which is a quite specific species of the Lower Santonian/"Upper Emscherian" (*vid.* table on p. 279). If this comparison holds true the "Knudshoved Beds" would, indeed, be somewhat older than the "Patoot Beds" of Nugssuak Peninsula, West Greenland (*vid.* p. 278).

Pteria tenuicostata ROEM., on the other hand, is a typical element of the Senonian faunas, though it is not confined to any *sub*-stage. In central Russia, for instance, it is common in deposits carrying *Belemnitella praecursor* STOLL., *Actinocamax verus* MILL. (*var. fragilis* ARKH.) (*vid.* VON BUBNOFF 1926) which may be referred to the Upper Santonian; for the higher beds are characterized by *Belemnitella mucronata* SCHLOTH. whereas the underlying formations correspond to the Lower Santonian, bearing e. g. *Inoceramus* (*Beloceramus*) *cardissoides* GOLDF. and *I.* (*Strebloceramus*) *pachtii* ARKH.

In Zighan River, southern Urals, *Pteria tenuicostata* ROEM. occurs together with *Inoceramus spp.*, *Belemnitella sp.*, *Actinocamax sp.* in beds which, too, are referred to the Upper Santonian (NALIVKIN 1937c). On the eastern slope of the Ural Mountains, *viz.* in the Usa region, the same species is mentioned in company with *Inoceramus sp.*, *Actinocamax* ex *gr verus* MILL., *Scaphites sp.*, *Baculites sp.* (*vid.* VOLKOV & JACJUK 1937b). In western Siberia, *viz.* in the Yenissei basin, *Pteria tenuicostata* ROEM. is recorded together with *Inoceramus* (*Beloceramus*) *cardissoides* GOLDF. in the transgressing deposits of Lower Santonian age (*vid.* BODYLEVSKY & KIPARISOVA 1937, MOOR 1937, ALEKSANDROV 1938). In Anadyr Land, Tchuktchis, *Inoceramus* (*Strebloceramus*) *lobatus* GOLDF. is represented (*vid.* ELISEEV 1936), a form which is also suggestive of the Lower Santonian.

Curiously enough, *Pteria tenuicostata* ROEM. is not listed from the Senonian deposits of West Greenland and Alaska. However, the recorded *Avicula nebrascana* (EV. & SHUM.) (*vid.* p. 277) closely resembles the species *P. tenuicostata* ROEM., so that we must still refrain from drawing final conclusions concerning this point.

In summary, *Pteria tenuicostata* ROEM. is thus recorded from both Lower and Upper Santonian beds. The common occurrence of this form and representatives of *Inoceramus* (*Beloceramus*) ex *gr cardissoides* GOLDF. at Knudshoved would rather point towards the Lower Santonian. However, nothing definite can be stated, since *Inoceramus teicherti* FREB.

and *I. geltingi* FREB. are reported to be only akin to and not identical with the species *cardissoides*. On this account the "Knudshoved Beds" may represent Upper Santonian as well (*vid.* FREBOLD 1934), and a correlation with the "Patoot Beds" is by no means impossible, after all.

We are not yet in a position to state anything definite about the stratigraphy of late Cretaceous (Senonian) formations in southern East Greenland since no reports have hitherto been published on this subject. However, beds carrying large-sized *Inocerami* and *Pterias*, which are referred by H. STAUBER to the "Upper Cretaceous" of Hold-with-Hope, seem to occupy large areas in Geographical Society Island (STAUBER 1938).

Alaska. Lower Senonian is e. g. evidenced in Matanuska Valley, southern Alaska, by *Inoceramus* (*Dactyloceramus*) ?*digitatus* Sow. and *I.* (*Cordiceramus*) *undulatoplicatus* ROEM. (MARTIN 1926, CAPPS 1927). *I.* (*Cordiceramus*) *undulatoplicatus* ROEM., the zone fossil of the lowermost Santonian, is moreover represented in the "Chignik formation", Alaska Peninsula, where it is associated with an abundant *dicotyledonous* flora, *Pachydiscus spp.* and a couple of mollusk distinctive of the "Chico-Nanaimo formations" of the Pacific coast of North America and of Vancouver Island (*vid.* MARTIN 1926). In Chitina Valley, *viz.* in Chititu and Young Creek, the presence of Upper Senonian beds was proved by the finding of *Baculites cf. anceps* LAM., *Pachydiscus spp. et cetera* (*op. cit.*). Upper Cretaceous deposits bearing *Inocerami*, *Scaphitessp.* etc. are also reported to superpose unconformably the older formations in northwest Alaska (SMITH & MERTIE 1930).

The marine sequence between the Cenomanian "Atane Beds" and the *sub*-Danian unconformity on the north coast of Nugssuak Peninsula, West Greenland, was recently recognized as including ?Turonian and different *sub*-stages of the Senonian (ROSENKRANTZ and others 1940).

Turonian or Lower Senonian/"Emscherian" (= Coniacian-Lower Santonian) which was not known to be represented in West Greenland (contrary to East Greenland) is probably indicated on Svartenhuk Peninsula by *Scaphites* ex *gr ventricosus* MEEK & HAYDEN, which occurs e. g. in Canada in the Lower Santonian, on top of the Turonian beds with *Inoceramus* (*Mytiloides*) *labiatus* SCHLOTH. etc. (*vid.* MCLEARN 1937). On the other hand, the same species is for instance cited from the "Benton formation" ("Colorado Group") of Colorado and New Mexico where it is associated with *Inoceramus* (*Mytiloides*) *labiatus* SCHLOTH., *I. fragilis* HALL & MEEK, *Baculites sp.* etc. (LEE & KNOWLTON 1917). Also in Texas *Scaphites ventricosus* MEEK & HAYDEN is mentioned from indubitable Turonian deposits, *viz.* the "Eagle Ford shale", which underlies the "Austin Chalk" of the Lower Senonian (Coniacian-Lower Santonian[1]) (*vid.* DEUSSEN 1924).

From the younger beds, *viz.* Upper Senonian, P. DE LORIOL and J. P. J. RAVN have listed a mollusk fauna (DE LORIOL 1882, RAVN 1918); however, only a few constituents can serve for an age assignment since many of the cited forms allow merely a generic identification or, on the other hand, belong to new species.

The following forms described from West Greenland have been found in the Upper Cretaceous "Montana Group" of the USA and Canada, *viz.* both in the "Fort Pierre Group" and in the overlying "Fox Hills Group":

Discoscaphites nicolleti (MORT.) RAVN
Avicula nebrascana (EV. & SHUM.)
Nucula cancellata MEEK & HAYDEN
Leda bisulcata MEEK & HAYDEN
Lucina occidentalis (MORT.)
Neaera moreauensis (MEEK & HAYDEN)
Dentalium gracile HALL & MEEK
— (*Entalis*?) *pauperculum* MEEK & HAYDEN
Natica (*Lunatia*) *concinna* HALL & MEEK[2]).

Hemiaster humphreysianus MEEK & HAYDEN, which is commonly found at the locality Patoot, together with *Avicula nebrascana* (EV. & SHUM.), is a conspicuous element of the "Fort Pierre Group", whereas the West Greenland species *Nucula planimarginata* MEEK & HAYDEN, *Solenomya subplicata* (MEEK & HAYDEN), and *Corbula inornata* MEEK & HAYDEN are represented in the "Fox Hills Group".

Among the new forms derived from West Greenland *Pecten ataensis* DE LOR.[3]), *P. pfaffi* RAVN, *Astarte steenstrupi* DE LOR., *Dentalium groenlandicum* RAVN, *Actaeon cretacea* GABB etc. may be mentioned.

One of the most important fossils bearing on the stratigraphy is *Discoscaphites nicolleti* (MORT.) RAVN which occurs in the localities Niakornat and Kûk angnertunek, north coast of Nugssuak Peninsula. This species is most probably identical with the European *Discoscaphites roemeri* (D'ORB.) BRAUNS which is diagnostic of Senonian. In the "Fox Hills Group" *Discoscaphites nicolleti* (MORT.) is associated e. g. with *Sphenodiscus lenticularis* OWEN, a form which is specific of the uppermost

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[1]) With *Mortoniceras texanum* (ROEM.), *Inoceramus* (*Cordiceramus*) *undulatoplicatus* ROEM., *I.* (*Gnesioceramus*) *crippsi* MANT., *I.* (*Cataceramus*) *balticus* BOEHM, *I.* (*Sphenoceramus*) ex *gr. patootensis* DE LOR. *et cetera.*

[2]) *Vanikoro ambigua* DE LOR. (non MEEK & HAYDEN) (*vid.* DE LORIOL 1882) is identical with *Natica* (*Lunatia*) *concinna* HALL & MEEK (RAVN 1918).

[3]) = *Pecten* (*Amussium*) *ignoratus* RAVN and *P. striatissimus* RAVN (*pro parte*).

Cretaceous represented in the "Navarro formation" (Maestrichtian) and the "Ripley formation" (Uppermost "Gulf Series") of North America (*vid.* DEUSSEN 1924).

However, it is not only common in the upper portion of this stage[1]) but *Discoscaphites roemeri* BRAUNS as well as *Holcoscaphites* ex *gr binodosus* (ROEM.) are also cited e. g. from the Lower Senonian, *viz.* Lower Santonian, of Germany, being accompanied by *Inoceramus* (*Citharoceramus*) *cycloides* WEGN., *I.* (*Strebloceramus*) *lobatus* GOLDF., *I.* (*Cordiceramus*) *cordiformis* SOW., *I.* (*Cinclidoceramus*) *pinniformis* WILL., *I.* (*Beloceramus*) *cardissoides* GOLDF., *Hauericeras clypeale* SCHLÜT., *Placenticeras syrtale* MORT., *Actinocamax westfalicus-granulatus* STOLL., *A. verus* MILL. *et cetera* (RIEDEL 1938a, 1938b).

"*Scaphites sp.*" mentioned by J. P. J. RAVN from Niakornat (RAVN 1918) is a close ally to *Scaphites nodosus* OWEN which occurs for instance in the "Pierre shale" of Colorado, on top of the "Benton formation" (Turonian).

As to the small faunal assemblage derived from the locality Patoot, south coast of Nugssuak Peninsula, mention was also made of three new species of *Inoceramus* which were designated as *Inoceramus steenstrupi* DE LOR., *I. patootensis* DE LOR., and *I. groenlandicus* DE LOR. (DE LORIOL 1882). Clearly enough, nothing concerning the age could be deduced from these new forms yet P. DE LORIOL supposed the "Patoot Beds" to be slightly younger than those of Niakornat etc. (*op. cit.*). It was not till the finding of the same species in better known regions that their stratigraphical value became obvious. To-day we know for sure that both *Inoceramus steenstrupi* DE LOR. and *I. patootensis* DE LOR.[2]) are indices to the Upper Santonian, the last-mentioned species being indicative of its uppermost part.

According to R. HEINZ's classification of the *Inoceramidae* both West Greenland species are referable to the family *Sphenoceramidae* (HEINZ).

It is R. HEINZ to whom we owe a thorough systematic study of the *Inoceramidae* by means of which a reliable stratigraphical correlation all over the world has become possible (*vid.* HEINZ 1928, 1932a, 1932b, 1933a, 1933b).

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[1]) *Holcoscaphites binodosus* (ROEM.) is, for instance, found in the Upper Santonian beds of Schonen, south Sweden, associated with *Inoceramus* (*Sphenoceramus*) *lingua* GOLDF., *Actinocamax verus* MILL., *A. granulata* (BLAINV.), in other words, in deposits which—with regard to the age—fully correspond to the West Greenland "Patoot Beds". *Discoscaphites roemeri* (D'ORB.) and *Holcoscaphites constrictus* (SOW.) occur together with *Belemnitella mucronata* SCHLOTH. in the higher Campanian-Maestrichtian. *Holcoscaphites geinitzi* (D'ORB.), on the other hand, is a Turonian form.

[2]) *Inoceramus groenlandicus* DE LOR. is probably but a fragmentary specimen of *I. patootensis* DE LOR. (RAVN 1918).

The table below shows the most important *Inoceramus* species and their vertical range (*vid.* HEINZ, *op. cit.*):

Stratigraphy of the Upper Cretaceous Sequence based upon the range of diagnostic *Inoceramus* species (according to R. HEINZ, *op. cit.*).

<table>
<tr><td rowspan="7">Senonian</td><td rowspan="3">Upper</td><td>Maestrichtian + Upper Campanian ("Mucronaten-Senon")</td><td>I. (Cataceramus) europaeus Hz.
I. (Mimoceramus) helgolandicus Hz.</td><td rowspan="2">I. (Boehmiceramus) irregularis D'ORB.</td></tr>
<tr><td>Lower Campanian ("Quadraten-Senon")</td><td>I. (Cataceramus) balticus BHM.
I. (Sphenoceramus) cimbricus Hz.</td></tr>
<tr><td>Upper Santonian ("Granulaten-Senon")</td><td>I. (Sphenoceramus) patootensis DE LOR.
I. (Sphenoceramus) lingua GOLDF.
I. (Sphenoceramus) steenstrupi DE LOR.</td><td>I. (Cinclidoceramus) pinniformis WILL.</td></tr>
<tr><td rowspan="4">Lower</td><td rowspan="2">Lower Santonian ("Upper Emscherian")</td><td colspan="2">I. (Cordiceramus) cordiformis SOW.
I. (Beloceramus) cardissoides GOLDF.
I. (Strebloceramus) lobatus GOLDF.
I. (Strebloceramus) pachti ARKH,</td></tr>
<tr><td colspan="2">I. (Cordiceramus) undulatoplicatus ROEM.
I. (Boehmiceramus) regularis D'ORB. etc.</td></tr>
<tr><td rowspan="2">Coniacian ("Lower Emscherian")</td><td colspan="2">I. (Dactyloceramus) digitatus SOW.
I. (Volviceramus) involutus SOW.</td></tr>
<tr><td colspan="2">I. (Cymatoceramus) koeneni MÜLL.
I. (Orophoceramus) kleini MÜLL. etc.</td></tr>
<tr><td rowspan="4">"Luneburgian" (Heinz)</td><td rowspan="3">Turonian</td><td>Upper</td><td colspan="2">I. (Stolleyiceramus) schloenbachi BHM.</td></tr>
<tr><td>Middle</td><td>I. (Proteoceramus) ernsti Hz.
I. (Striatoceramus) striatoconcentricus GÜMB.
I. (Striatoceramus) hoepeni Hz.
I. (Orthoceramus) lamarcki PARK.</td><td rowspan="2">I. (Inaequiceramus) inaequivalvis SCHLÜT.</td></tr>
<tr><td>Lower</td><td>I. (Mytiloides) labiatus SCHLOTH.</td></tr>
<tr><td colspan="2">Cenomanian</td><td colspan="2">I. (Crioceramus) pictus SOW.
I. (Smodingoceramus) virgatus SCHLÜT.
I. (Gnesioceramus) comancheanus CRAG. etc.</td></tr>
</table>

Accordingly, *Inoceramus* (*Sphenoceramus*) *steenstrupi* DE LOR. and *I.* (*S.*) *patootensis* DE LOR. are by far the most valuable fossils hitherto at hand from West Greenland, being restricted to the Upper Santonian, Stratigraphical subdivision and correlation

			Stages		Ages			
Upper Cretaceous	Senonian	Upper	Maestrichtian/ Campanian					
			Upper Santonian					
		Lower	Lower Santonian					
			Coniacian					
			Turonian					
			Cenomanian	Upper...	Acanthoceratan			
				Lower...	Schloenbachian			
Lower Cretaceous			Albian	Upper...	Pleurohoplitan Inflaticeratan			
				Middle ..	Anahoplitan Hoplitan			
				Lower...	Leymeriellan Acanthoplitan			
	Neocomian s. l.		Aptian	Gargasian	Parahoplitan Tropaeuman			
				Bedoulian	Parahoplitoidan Parancyloceratan			
			Barrêmian	Upper...	Heteroceratan			
				Lower...	Paracrioceratan			
		Neocomian s. str.	Hauterivian	Upper...	Hoplocrioceratan Simbirskitan			Simbirskian
				Lower...	Crioceratan Lyticoceratan			Petchorian
			Valanginian	Upper...	Hoplitidan			
				Middle ..	Polyptychitan			
				Lower...	Platylenticeratan			
			Infravalanginian		Subcraspeditan Spiticeratan	Wealden Facies	Tithonique/ Berriasian	Rjasanian
Jurassic			Portlandian		Aulacosphinctean/ Berriasellidan	Purbeckian		Aquilonian (Upper Volgian)

he Cretaceous beds of northern East Greenland.

U.S.A./Canada						West Greenland		Northern East Greenland	
Navarro-Ripley	Gulf Series	Colorado-Montana	Fox Hills			Patoot	Scaphites Beds on Svartenhuk Peninsula		
Taylor			Fort Pierre						
Austin								Knudshoved Beds	
Eagle Ford									
Woodbine	Comanche Series	Dakota				Atane Beds			?
Washita				Patapsco	Horsetown	Kome Beds		*Inoceramus* Beds	Home Foreland Beds
Fredericksburg									
Trinity			Potomac	Arundel				(Aptian-Albian series)	?
				Patuxent	Knoxville			?	
								Rødryggen Beds	Upper Niesen Beds
				Morrison				Albrechts Bugt-Young Sd. Facies/Falskebugt Beds	
									Lower
								?	
								Rigi Series (Volgian)	Beds in *Laugeites*-R.

whereas e. g. *Discoscaphites nicolleti* (MORT.) RAVN ranges from the Lower Santonian up into the Uppermost Senonian.

The very same formation of Patoot which has yielded this marine invertebrate fauna of Upper Santonian age also contains the well-known *dicotyledonous* "Patoot flora" which O. HEER regarded as transitional between the Senonian and the Tertiary (HEER 1883). Several plant species from the "Patoot Beds" are diagnostic of the European Senonian, others have persisted from the stock of the Cenomanian floras, whilst five species are only known from the lowermost Tertiary (*op. cit.*).

The marine Santonian beds of West Greenland are reported by A. ROSENKRANTZ to be unconformably overlain by the transgressing deposits of Danian-Paleocene age (ROSENKRANTZ and others 1940).

Cretaceous beds of *post*-Santonian age are not hitherto known from East Greenland.

The Upper Cretaceous sea which once advanced upon the easternmost portion of Hold-with-Hope and, apparently, also upon Geographical Society Island, soon withdrew again. Never again did its surf beat some bit of the Greenland continent of our days, and never again did the present-day outlines of land and seas, forelands and fjords, become altered.

Herewith we have come to a close.

The stratigraphy of the Cretaceous sedimentary succession of northern East Greenland has been discussed in detail whilst its faunas —still deficiently known—could only be slightly entered upon. Our knowledge is still too limited, and we must await the morrow's progress. An exhaustive monograph based upon all the Mesozoic faunas ever brought back from East Greenland is going to be written in still unborn times.

The Cretaceous sequence dealt with in the foregoing clearly reflects the geological history of northern East Greenland during the late Mesozoic era. In an impressive way does it document the restless pulsation of the sea, the often repeated change of its encroachments and recedings, the alternation between sedimentation and erosion, between upbuilding and destruction. Indeed, manyfold were the geological events recorded in *post*-Devonian times along the margin of the boreal geosyncline in northern East Greenland which it has been the writer's thankworthy task to decipher.

List of papers referred to

1. ALDINGER, H., 1935, Geologische Beobachtungen im obern Jura des Scoresbysundes (Ostgrönland). Medd. om Gr., Bd. 99, Nr. 2.
2. ALEKSANDROV, D. K., 1938, New data on the Neogene and Upper Cretaceous sediments of the lower part of the Yenisei River. Bespr. Geol. Zentralbl., Abt. B, Bd. 14.
3. — 1939, Das Mesozoikum des Unterlaufes des Flusses Jenissei. Trans. Arctic Inst. of the USSR, Vol. 121, Leningrad (Russian). Bespr. Geol. Zentralbl., Abt. A, Bd. 67 (1940) Bespr. No. 2470. Furthermore in: Geol. Jahresberichte, herausgeg. v. S. v. BUBNOFF, IV. Bd., B, Regionale Geologie, 2, Bericht über die Jahre 1939 und 1940. 1943.
4. ANDERSON, F. M., 1938, Lower Cretaceous deposits in California and Oregon. Spec. Paper No. 16, Geol. Soc. of America, Washington.
5. ANDREE, K., 1924, Das Meer und seine geologische Tätigkeit. In: SALOMON, W., Grundzüge der Geologie, Bd. I, pp. 361—533.
6. ARKELL, W. J., 1933, The Jurassic System in Great Britain. Oxford, at the Clarendon Press.
7. BACKLUND, H. G., 1930, Contributions to the geology of northeast Greenland. Medd. om Gr., Bd. 74 (XI).
8. — 1932, Das Alter des "Metamorphen Komplexes" von Franz Josef Fjord in Ost-Grönland. Medd. om Gr., Bd. 87, Nr. 4.
9. — & MALMQUIST, D., 1935, Zur Geologie und Petrographie der nordostgrönländischen Basaltformation. II. Die sauren Ergussgesteine von Kap Franklin. Medd. om Gr., Bd. 95, Nr. 3.
10. BASSE, E., 1931, Monographie paléontologique du Crétacé de la Province de Maintirano, Madagascar. Gouv. Gén. de Madagascar et Dépendences. Service des Mines, Tananarive.
11. BERRY, E. W., 1911, The Lower Cretaceous Floras of the world. In: The Lower Cretaceous deposits of Maryland. Maryland Geol. Survey, Baltimore.
12. BESAIRIE, H., 1932, Fossiles caractéristiques du Nord et du Nord-Ouest de Madagascar. Gouv. Gén. de Madagascar et Dépendences. Ann. Géol. Service des Mines, fasc. 2, Tananarive.
13. BLÜTHGEN, J., 1936, Die Fauna und Stratigraphie des Oberjura und der Unterkreide von König-Karl-Land. Diss. Greifswald. Bespr. Geol. Zentralbl., Abt. A, Bd. 60, Nr. 1 (1937), Bespr. No. 1931.
14. BODYLEVSKY, Y. I., 1936, On the Jurassic and Lower-Cretaceous Fossils from the Collection of A. PETRENKO from Novaya Zemlya. Trans. Arctic Inst. of the USSR, Vol. 49, Leningrad (Russian). Bespr. Geol. Zentralbl., Abt. A, Bd. 60 (1937).
15. — 1937?, On some faunas from the Cretaceous of the Kolyma Land and of Western Kamtchatka. "Dalstroi" (1), 5. Bespr. Geol. Zentralbl., Abt. A, Bd. 63 (1938), No. 1, Bespr. No. 988.

16. BODYLEVSKY, Y. I. & KIPARISOVA, L. D., 1937, Stratigraphy of the Mesozoic deposits in the Arctic Region of the USSR Intern. Geol. Congr., XVII Session USSR, Abstracts of papers.
17. BØGVAD, R. & ROSENKRANTZ, A., 1934, Beiträge zur Kenntnis der unteren Kreide Ostgrönlands. Medd. om Gr., Bd. 93, Nr. 1.
18. BOSWELL, P. G. H., 1929, Cretaceous. In: EVANS, J. W. & STUBBLEFIELD, C. J., 1929, Handbook of the Geology of Great Britain. London.
19. BREISTROFFER, M., 1940, Révision des Ammonites du Vraconien de Salazac (Gard) et considérations générales sur ce sous-étage albien. Trav. du Lab. de Géol., Grenoble, Tome XXII (Années 1938—1939).
20. — 1941, Sur la présence d'*Aucellines* dans l'Albien Inférieur de la Nerthe (Bouches-du-Rhône). Compte rend. somm. Soc. Géol. de France, No. 13.
21. BROOKS, A. H., 1906, The geography and geology of Alaska; a summary of existing knowledge. Dep. of the Int., U. S. Geol. Survey, Prof. Paper No. 45. Washington.
22. BROWN, E. E., 1941, The Folkestone Sands and base of the Gault near Wrotham Heath, Kent. Proc. Geol. Assoc. of London, Vol. LII, part I.
23. BUBNOFF, VON S., 1926, Geologie von Europa, Bd. I. In: Geologie der Erde. Bornträger, Berlin.
24. BÜTLER, H., 1935a, Some new investigations of the Devonian stratigraphy and tectonics of East Greenland. Medd. om Gr., Bd. 103, Nr. 2.
25. — 1935b, Die Mächtigkeit der kaledonischen Molasse in Ostgrönland. Mitt. Natf. Ges. Schaffhausen (Schweiz), Bd. XII, No. 3.
26. — 1939, Übersicht der devonischen Bildungen nördlich des Davysundes in Ostgrönland. Mitt. Natf. Ges. Schaffhausen (Schweiz), Bd. XVI, Jahrg. 1940.
27. — 1940, Das devonische Faltungsgebiet nördlich des Moskusoksefjordes in Ostgrönland. Medd. om Gr., Bd. 114, Nr. 3.
28. CAIRNES, D. D., 1916, District Upper White River Yukon. Canada, Ministère des Mines, Comm. Géol. Mém. 50, No. 51. Sér. Géol. Ottawa.
29. — 1917, La frontière internationale Yukon-Alaska entre les rivières Porcupine et Yukon. Idem, Mém. 67, No. 49.
30. CAPPS, ST. R., 1927, Geology of the Upper Matanuska Valley, Alaska. Dep. of the Int., U. S. Geol. Survey, Bull. 791.
31. — 1937a, Kodiak and vicinity Alaska. Dep. of the Int. U. S. Geol. Survey, Bull. 868 B.
32. — 1937b, Kodiak and adjacent islands, Alaska. Ibid., Bull. 880 C.
33. CASEY, R., 1939, The Upper part of the Lower Greensand around Folkestone. Proc. Geol. Assoc. of London, Vol. L, part 3.
34. CAYEUX, L., 1935, Les roches sédimentaires de France. Roches carbonatées. Masson & Cie., Paris.
35. CLARK, B. WM., BIBBINS, A. B. & BERRY, E. W., 1911, The Lower Cretaceous deposits of Maryland. Maryland Geol. Survey, Baltimore.
36. CLOOS, H., 1928, Über antithetische Bewegungen. Geol. Rundschau, Bd. XIX.
37. — 1936, Einführung in die Geologie. Ein Lehrbuch der innern Dynamik. Berlin.
38. — 1939a, Zur Tektonik der Ostküste von Grönland. Mitt. Natf. Ges. Schaffhausen (Schweiz), Bd. XVI, Jahrg. 1940.
39. — 1939b, Hebung-Spaltung-Vulkanismus. Geol. Rundschau, Bd. XXX, Zwischenheft 4a.
40. COLLIGNON, M., 1932, Les Ammonites pyriteuses de l'Albien supérieur du Mont Raynaud à Madagascar. Gouv. Gén. de Madagascar et Dépendences, Ann. Géol. du Service des Mines, fasc. 2, Tananarive.

41. Crickmay, C. H., 1931, Jurassic History of North America: its bearing on the development of continental structure. Proc. of the Americ. Philosoph. Soc., Vol. LXX, Nr. 1. Philadelphia.
42. Dacqué, E., 1942, Leitfossilien, 8. Lieferung: Wirbellose der Kreide. Bornträger, Berlin.
43. Denaeyer, M., 1939a, A propos des gradins concentriques propres à la structure cone-in-cone. Compte rend. somm. séances Soc. Géol. de France, 1939, fasc. 11.
44. — 1939b, Les "cône-in-cône" de la Lufubu (Maniema, Congo Belge). Bull. Soc. Géol. de Belgique, tome 62, Nos. 10—11.
45. — 1945, Essai d'une théorie mécanique de la structure cone-in-cone. Bull. Soc. Géol. de France, tome 15, 5me sér., fasc. 1—3.
46. Deussen, A., 1924, Geology of the coastal plain of Texas West of Brazos River. Dep. of the Int., U. S. Geol. Survey, Prof. Paper No. 101, Washington.
47. Edelstein, J., 1937, Aperçu général de la structure géologique du pays de Krasnoiarsk. Intern. Geol. Congr. XVII Session USSR, Abstracts of Papers.
48. Eliseev, B. N., 1936, Anadyr Land. Contributions to the Geology and Mineral Resources. Trans. Arctic Inst. of the USSR, Vol. 48, Leningrad. Bespr. Geol. Zentralbl., Abt. A, Bd. 61 (1938), Bespr. No. 140.
49. Frebold, H., 1928, Stratigraphie und Palaeogeographie des Jura und der Unterkreide Spitzbergens. Centralbl. f. Min. etc., Abt. B, No. 1.
50. — 1929, Ammoniten aus dem Valanginien von Spitzbergen. Skrifter om Svalbard og Ishavet, No. 21. Oslo.
51. — 1930, Verbreitung und Ausbildung des Mesozoikums in Spitzbergen. Ibid., No. 31. Oslo.
52. — 1932a, Grundzüge der tektonischen Entwicklung Ostgrönlands in postdevonischer Zeit. Medd. om Gr., Bd. 94, Nr. 2.
53. — 1932b, Die Lagerungsverhältnisse der Unterkreide im nördlichen Teil von Ostgrönland und die Frage der prätertiären Fjordanlage. Medd. om Gr., Bd. 84, Nr. 6.
54. — 1933, Untersuchungen über die Verbreitung, Lagerungsverhältnisse und Fauna des oberen Jura von Ostgrönland. Medd. om Gr., Bd. 94, Nr. 1.
55. — 1934, Obere Kreide in Ostgrönland. Medd. om Gr., Bd. 84, Nr. 8.
56. — 1935a, Geologie von Spitzbergen, der Bäreninsel, des König Karl- und Franz-Joseph-Landes. In: Geologie der Erde, Bornträger. Berlin.
57. — 1935b, Marines Aptien von der Koldewey Insel (nördliches Ostgrönland). Medd. om Gr., Bd. 95, Nr. 4.
58. — & Stoll, E., 1937, Das Festungsprofil auf Spitzbergen. III. Stratigraphie und Fauna des Jura und der Unterkreide. Skrifter om Svalbard og Ishavet, No. 68. Oslo.
59. — & Noe-Nygaard, A., 1938, Marines Jungpalaeozoikum und Mesozoikum von der Traill-Insel (Ostgrönland). Medd. om Gr., Bd. 119, Nr. 2.
60. — 1940, Der geologische Bau Nowaja Semljas und seine Beziehungen zu anderen Gebieten im Lichte neuerer Forschungen. Geol. Rundschau, Bd. XXXI.
61. Fuchs, Br., 1938, Beitrag zur Kenntnis der Kreide von Ekinveren bei Sinop. Zeitschr. Deutsch. Geol. Ges., Bd. 90, Heft 1.
62. Ganz, E., 1912, Stratigraphie der mittleren Kreide (Gargasien, Albien) der oberen helvetischen Decken in den nördlichen Schweizeralpen. Zürich.
63. Gerth, H., 1941, Geologie Südamerikas. In: Geologie der Erde. Bornträger, Berlin.

64. HALLE, T. G., 1931, Younger Palaeozoic plants from East Greenland. Medd. om Gr., Bd. 85, Nr. 1.

65. HÄNTZSCHEL, W., 1936, Die Schichtungs-Formen rezenter Flachmeer-Ablagerungen im Jade-Gebiet. Senckenbergiana, Bd. 18, Nr. 3/6.

66. — 1939, Tidal flat deposits (Wattenschlick). In: TRASK PARKER, D., Recent marine sediments. Published by The Americ. Assoc. of Petr. Geol. Tulsa, Oklahoma, U.S.A.

67. HARRISON, J. V., 1943, The geology of the Central Andes in part of the Province of Junin, Peru. The Quarterly Journ. of the Geol. Soc. of London, Vol. XCIX, parts 1 & 2.

68. HEER, O., 1883, Oversigt over Grønlands fossile Flora. Medd. om Gr., Bd. 5, 1893.

69. HEIM, ALB., 1916—1922, Geologie der Schweiz.

70. HEINZ, R., 1928, Das Inoceramenprofil der oberen Kreide Lüneburgs. 21. Jahrb. Niedersächs. Geol. Ver., Hannover.

71. — 1932a, Aus der neuen Systematik der Inoceramen. Mitt. aus dem Min.-Geol. Staatsinstitut in Hamburg, Heft XIII.

72. — 1932b, Sur les Inocérames de Madagascar. Gouv. Gén. de Madagascar et Dépendences, Ann. Géol. du Service des Mines, fasc. 2, Tananarive.

73. — 1933a, Inoceramen von Madagascar und ihre Bedeutung für die Kreide-Stratigraphie. Zeitschr. Deutsch. Geol. Ges., Bd. 85, Heft 1.

74. — 1933b, Einige Fragen aus der vergleichenden Oberkreide-Stratigraphie. Zeitschr. Deutsch. Geol. Ges., Bd. 85, Heft 1.

75. HENDRICKS, T. A., 1937, Some unusual Specimens of Cone-in-Cone in Manganiferous siderite. Americ. Journal of Science, 5th series, Vol. XXXIII, New Haven, Conn.

HJULSTRÖM, F., 1939, Transportation of detritus by moving water. In TRASK PARKER, D., Recent marine sediments. Published by The Americ. Assoc. Petr. Geol., Tulsa, Oklahoma, U.S.A.

76. KILIAN, W., 1907—1913, Lethaea geognostica, II. Teil. Das Mesozoikum. 3. Band: Kreide. Erste Abteilung: Unterkreide (Palaeocretacicum).

77. KINDLE, E. M., 1939, Geology of the Arctic Archipelago and the Interior Plains of Canada. In: Geology of North America, edited by R. RUEDEMANN & R. BALK. In: Geologie der Erde, Bornträger. Berlin.

78. KIRKALDY, J. F., 1939, The history of the Lower Cretaceous Period in England. Proc. Geol. Assoc. London, Vol. L, part 3.

79. KNOWLTON, F. H., 1914, The Jurassic flora of Cape Lisburne, Alaska. Dep. of the Int., U. S. Geol. Survey, Prof. Paper No. 85 D.

80. — 1919, A Catalogue of the Mesozoic and Cenozoic plants of North America. Dep. of the Int., U. S. Geol. Survey, Bull. 696.

81. KOCH, L., 1929a, The Geology of East Greenland. Medd. om Gr., Bd. 73, Nr. 2.

82. — 1929b, Stratigraphy of Greenland. Ibid.

83. — 1931, Carboniferous and Triassic stratigraphy of East Greenland. Medd. om Gr., Bd. 83, Nr. 2.

84. — 1935, Geologie von Grönland. In: Geologie der Erde. Bornträger. Berlin.

85. KOENEN, VON A., 1902, Monographie der Fauna des Neocoms. Geologischer Teil. Abh. Preuss. Geol. Landesanstalt, n. F., Heft 24.

86. KRENKEL, E., 1928, Geologie Afrikas. 2. Teil. In: Geologie der Erde. Bornträger. Berlin.

87. KULLING, O., 1929, Stratigraphic studies of the geology of Northeast Greenland. Medd. om Gr., Bd. 74, 1930.

88. Lee, W. T. & Knowlton, F. H., 1917, Geology and Paleontology of the Raton Mesa and other regions in Colorado and New Mexico. Dep. of the Int., U. S. Geol. Survey, Prof. Paper 101, Washington.
89. Lewinski, J., 1931, Sur le Néocomien en Pologne. Soc. Géol. de France, compte rend. somm. séances, No. 1.
90. — 1932, Das Neokom in Polen und seine paläogeographische Bedeutung. Geol. Rundschau, Bd. XXIII.
91. Liddle, A. R., 1928, The geology of Venezuela and Trinidad. J. P. McGowan Publisher, Fort Worth, Texas.
92. Loriol, de P., 1882, Om fossile Saltvandsdyr fra Nord-Grønland. Medd. om Gr., Bd. 5. 1893.
93. Lüders, K., 1939, Sediments of the North Sea. In: Trask Parker, D., Recent marine sediments. Published by The Americ. Assoc. Petr. Geol., Tulsa, Oklahoma, U.S.A.
94. McLearn, F. H., 1937, The fossil zones of Upper Cretaceous Alberta shale. Trans. R. Soc. Canada, IV, Geol. Ser. III, Vol. 31. Ottawa.
95. Madsen, H., 1936, Investigations on the shore fauna of East Greenland with a survey of the shores of other Arctic regions. Medd. om Gr., Bd. 100, Nr. 8.
96. Madsen, V., 1904, On Jurassic Fossils from East-Greenland. Medd. om Gr., Bd. 29, 1ste Afd. (VI).
97. Malmquist, D., 1932, Zur Kenntnis der Oberkarbonischen Sedimente der westlichen Clavering Insel, Ostgrönland. Medd. om Gr., Bd. 94, Nr. 6.
98. Martin, G. C., 1926, The Mesozoic Stratigraphy of Alaska. Dep. of the Int., U. S. Geol. Survey, Bull. 776.
99. Maync, W., 1938, Stratigraphie der postdevonischen Ablagerungen der Clavering Insel und des Wollaston Vorlandes. Medd. om Gr., Bd. 114, Nr. 1.
100. — 1939, Übersicht über die postkarbonische Stratigraphie Ostgrönlands zwischen 73° und 75° Lat. N. Mitt. Natf. Ges. Schaffhausen (Schweiz), Bd. XVI, Jahrg. 1940 (Nr. 10).
101. — 1940, Stratigraphie des Küstengebietes von Ostgrönland zwischen 73°—75° Lat. N. Medd. om Gr., Bd. 114, Nr. 5.
102. — 1942, Stratigraphie und Faziesverhältnisse der oberpermischen Ablagerungen Ostgrönlands. Medd. om Gr., Bd. 115, Nr. 2.
103. — 1947, Stratigraphie der Jurabildungen Ostgrönlands zwischen Hochstetterbugten (75° N.) und dem Kejser Franz Joseph Fjord (73° N.). Medd. om Gr., Bd. 132, Nr. 2.
104. — 1949, On the *pre*-Permian basement of the Giesecke Mountains (Gauss Peninsula), northern East Greenland. Medd. om Gr., Bd. 114, Nr. 2.
105. Mertie, J. B., 1930, Geology of the Eagle-Circle District, Alaska. Dep. of the Int. U. S. Geol. Survey, Bull. 816.
106. — 1938, The Nushagak Distrikt, Alaska. Ibid., Bull. 903.
107. Moffit, F. H., 1938, Geology of the Chitina Valley and adjacent area, Alaska. Ibid., Bull. 894.
108. — & Mertie, J. B., 1923, The Kotsina-Kuskulana District, Alaska. Ibid., Bull. 745.
109. Moor, G. G., 1937, Abriss der Geologie der sibirischen Plattform und der angrenzenden Faltenstrukturen. Arctic Inst. of the USSR, Vol. 87, Teil I. Leningrad. Bespr. Geol. Zentralbl., Abt. A, Bd. 64, Nr. 1 (1939), Bespr. No. 901.
110. Nalivkin, D. V., 1937a, Moscou to Kuibyshev. Intern. Geol. Congr. XVII Session USSR, Abstracts of Papers.
111. — 1937b, Introduction to "The Permian Excursion", southern part. Ibid.
112. — 1937c, The Sterlitamak Crossing of the South Ural. Ibid.

113. NANSEN, F., 1928, The oceanographic problems of the still unknown Arctic regions. In: Problems of Polar Research, a series of papers. Published by The Americ. Geogr. Soc., special publication No. 7. New York.
114. NATHORST, A. G., 1897, Zur Mesozoischen Flora Spitzbergens. Kgl. Svenska Vetensk.-Akad. Handl., Bd. XXX, No. 1.
115. — 1900, Två somrar i Norra Ishafvet, Kung Karls Land, Spetsbergens kringsegling. Spanande efter Andrée i Nordöstra Grönland. Förra och senare delen. Stockh.
116. NEUMAYR, M. & UHLIG, V., 1881, Ueber Ammoniten aus den Hilsbildungen Norddeutschlands. Palaeontographica, Bd. XXVII. Cassel.
117. NIELSEN, E., 1935, The Permian and Eotriassic Vertebrate-bearing beds at Godthaab Gulf (East Greenland). Medd. om Gr., Bd. 98, Nr. 1.
118. — 1941, Remarks on the map and the geology of Kronprins Christians Lan d Medd. om Gr., Bd. 126, Nr. 2.
119. NIKOLAEV, I. G., 1938a, Materials on the geology and Mineral Deposits in the southern part of the Kharaulakh Mountains of the USSR. Trans. Arctic Inst. of the USSR, Vol. 107, Leningrad. Bespr. Geol. Zentralbl., Abt. A, Bd. 67 (1940), Bespr. No. 1807.
120. — 1938b, Data on Geology and Mineral Deposits of the Kharaulakh Range. Trans. Arctic Inst. of the USSR, Vol. 99, Leningrad. Bespr. Geol. Zentralbl., Abt. A, Vol. 67 (1940), Bespr. No. 1803.
121. NYGAARD-NOE, A. & SÄVE-SÖDERBERGH, G., 1932, Zur Stratigraphie der Nordostecke der Claveringinsel (Ostgrönland). Medd. om Gr., Bd. 94, Nr. 3.
122. OBRUTSCHEW, W. A., 1926, Geologie von Sibirien. Fortschritte der Geologie und Palaeontologie, Heft 15. Bornträger, Berlin.
123. OGNEV, V. N., 1933, The Upper Jurassic fossils from Hooker Island on Franz Joseph Land. Trans. Arctic Inst., Vol. 12, Leningrad (Russian). Bespr. Geol. Zentralbl., Abt. A, Bd. 60, Nr. 1 (1937), Bespr. No. 1930.
124. ORBIGNY, 'D A., 1843, Paléontologie Française. Terrains Crétacés. Paris.
125. ORVIN, A. K., 1930, Beiträge zur Kenntnis des Oberdevons Ostgrönlands. Skrifter om Svalbard og Ishavet, Nr. 30. Oslo.
126. PAIGE, S., FORAN, W. T. & GILLULY, J., 1925, A Reconnaissance of the Point Barrow Region, Alaska. Dep. of the Int., U. S. Geol. Survey, Bull. 772.
127. PASSENDORFER, E., 1930, Etude stratigraphique et paléontologique du Crétacé de la Série Hauttatrique dans les Tatras. Trav. Serv. Géol. de la Pologne. Warschau.
128. PETRENKO, A. A., 1936, Materials on the geology of the Western Coast of Novaya Zemlya between Matochkin Strait and Domashnaya Bay. Trans. Arctic Inst. of the USSR, Vol. 57, Leningrad. Bespr. Geol. Zentralbl., Abt. A, Bd. 67 (1940), Bespr. No. 1809.
129. PICTET, F. F. & CAMPICHE, G., 1864—1867, Description des fossiles du terrain Crétacé des environs de Sainte-Croix. Mat. pour la Pal. Suisse, 4me sér., 3me partie.
130. POLUTOFF, N., 1943, Europäisches Russland. In: Geologische Jahresberichte, herausgeg. v. S. v. BUBNOFF, IV. Bd., B. Regionale Geologie 2, Bericht über die Jahre 1939 und 1940.
131. PRINDLE, L. M., 1911, The Mount McKinley Region, Alaska. Dep. of the Int., U. S. Geol. Survey, Prof. Paper No. 70. Washington.
132. RAVN, J. P. J., 1904, The Tertiary fauna at Kap Dalton in East-Greenland. Medd. om Gr., Bd. 29, 1ste Afdel., III.
133. — 1911, On Jurassic and Cretaceous fossils from North-east Greenland. Medd. om Gr., Bd. 45.

134. Ravn, J. P. J., 1918, De marine Kridtaflejringer i Vest-Grønland og deres Fauna. Medd. om Gr., Bd. 56.
135. — 1933, New Investigations of the Tertiary at Cape Dalton, East Greenland. Medd. om Gr., Bd. 105, Nr. 1.
136. Renz, H. H., 1942, Stratigraphy of northern South America, Trinidad, and Barbados. 8th Americ. Sc. Congr., Proc., Vol. IV, Geol. Sciences, Washington, D.C.
137. Riedel, L., 1938a, Der Westrand der Pompeckj'schen Schwelle zur Kreidezeit in Hannover. Zeitschr. Deutsch. Geol. Ges., Bd. 90, Heft 1.
138. — 1938b, Ueber die Altersstellung der Eisenerz-Konglomerate von Gross-Bülten, Broistedt und Damme. Ibid.
139. Roman, F., 1938, Les Ammonites jurassiques et crétacées. Masson & Cie., Paris.
Rosenkrantz, A., 1929, Preliminary account of the Geology of the Scoresby Sound District. Medd. om Gr., Bd. 73 (2).
140. — 1930a, Neue Fossilfunde in der Unterkreide Ostgrönlands nebst einer Übersicht über das Mesozoikum der Kuhn Insel. Medd. fra Dansk Geol. Forening, Bd. 7. København.
141. — 1930b, Summary of investigations of younger Palaeozoic and Mesozoic strata along the East coast of Greenland. Medd. om Gr., Bd. 74 (XIV).
142. — 1932, Geologiske Undersøgelser i Øst-Grønland Sommeren 1929. København.
143. — & others, 1940, Den Danske Nûgssuaq Ekspedition 1939. Medd. fra Dansk Geol. Forening, Bd. 9, Hefte 5.
144. Rücklin, H., 1938, Strömungs-Marken im Unteren Muschelkalk des Saarlandes. Senckenbergiana, Bd. 20, Nr. 1/2.
145. Russell, R. J. & Russell, R. D., 1939, Deposits associated with strand line. Mississippi River delta sedimentation. In: Trask, Parker D., Recent marine sediments. Published by The Americ. Assoc. Petr. Geol., Tulsa, Oklahoma, U.S.A.
146. Schwegler, E., 1939, Über einige aus dem schwäbischen Jura bis jetzt nicht beschriebene Belemnitenformen. Centralbl. f. Min. etc., Abt. B, Jahrg. 1939.
147. Shaub, B. M., 1937, The Origin of Cone-in-Cone and its bearing on the origin of concretions and septaria. Americ. Journal of Science, 5th series, Vol. XXXIV. New Haven, Conn.
148. Shepard, F. P., 1939, Near-shore sediments/hemipelagic deposits. Continental shelf sediments. In: Trask Parker D., Recent marine sediments. Published by The Americ. Assoc. Petr. Geol., Tulsa, Oklahoma, U.S.A.
149. Sirin, N. A. & Shmakova, G. V., 1937, Geological description of the Southern Portion of the Voila River-Basin. Trans. Arctic Inst. of the USSR, Vol. 74, Leningrad. Bespr. Geol. Zentralbl., Abt. B, Bd. 14 (1939).
150. Smith, P. S. & Mertie, J. B., 1930, Geology and Mineral Resources of northwestern Alaska. Dep. of the Int. U. S. Geol. Survey, Bull. 815.
151. Söderbergh-Säve, G., 1934, Further contributions to the Devonian stratigraphy of East Greenland. II. Investigations on Gauss Peninsula during the summer of 1933, with an appendix: Notes on the geology of the Passage Hills (East Greenland. Medd. om Gr., Bd. 96, Nr. 2.
152. Sokolov, D. & Bodylevsky, Y. I., 1931, Jura- und Kreidefaunen von Spitzbergen. Skrifter om Svalbard og Ishavet, No. 35. Oslo.
153. Spath, L. F., 1924, Ammonites of Speeton Clay etc. Geol. Magazine, Vol. 61. London.

154. Spath, L. F., 1930, The Eotriassic Invertebrate fauna of East Greenland. Medd. om Gr., Bd. 83, Nr. 1.
155. — 1932, The Invertebrate faunas of the Bathonian-Callovian deposits of Jameson Land (East Greenland). Medd. om Gr., Bd. 87, Nr. 7.
156. — 1935a, Additions to the Eo-Triassic Invertebrate fauna of East Greenland. Medd. om Gr., Bd. 98, Nr. 2.
157. — 1935b, The Upper Jurassic Invertebrate faunas of Cape Leslie, Milne Land. I. Oxfordian and Lower Kimmeridgian. Medd. om Gr., Bd. 99, Nr. 2.
158. — 1936, The Upper Jurassic Invertebrate faunas of Cape Leslie, Milne Land. II. Upper Kimmeridgian and Portlandian. Medd. om Gr., Bd. 99, Nr. 3.
159. Spižarskij, T. N., 1937, Geologischer Abriss des Franz-Josef-Landes und der Viktoria Insel. Explanatory note to the Geological Map of the northern part of the USSR. Arctic Inst. of the USSR, Vol. 87, Leningrad. Bespr. Geol. Zentralbl., Abt. A, Bd. 67 (1940), Bespr. No. 1811.
160. Stauber, H., 1938, Stratigraphische Untersuchungen postdevonischer Sedimente auf den Inseln Traill und Geographical Society. Medd. om Gr., Bd. 114, Nr. 1.
161. — 1939, Geologie des südlichen Teiles der postdevonischen Zone von Ostgrönland. Mitt. Natf. Ges. Schaffhausen (Schweiz), Bd. XVI, Jahrg. 1940, Nr. 12.
162. — 1940, Stratigraphisch-Geologische Untersuchungen in der ostgrönländischen Senkungszone des nördlichen Jameson Landes. Medd. om Gr., Bd. 114, Nr. 7.
163. — 1942, Die Triasablagerungen von Ostgrönland. Medd. om Gr., Bd. 132, Nr. 1.
164. Steenstrup, K. J. V., 1893, Om Forekomsten af Forsteninger i de kulførende Dannelser i Nord-Grønland. Medd. om Gr., Bd. 5.
165. Steinmann, G., 1929, Geologie von Peru. Heidelberg.
166. Stetson, H. C., 1939, Summary of sedimentary conditions on the continental shelf of the east coast of The United States. In: Trask Parker D., Recent marine sediments. Published by The Americ. Assoc. Petr. Geol. Tulsa, Oklahoma, U.S.A.
167. Stolley, E., 1908, Die Gliederung der norddeutschen unteren Kreide. Centralbl. f. Min. etc.
168. — 1911, Beiträge zur Kenntnis der norddeutschen unteren Kreide. Die Belemniten des norddeutschen Gaults. Kokens Geol. und Pal., Abh., Bd. 10. Jena.
169. — 1919, Die Systematik der Belemniten. 11. Jahrb. d. Niedersächs. geol. Ver., Hannover, Geol. Abt. d. naturhist. Ges. Hannover.
170. — 1937, Die Gliederung des norddeutschen marinen Unterneokoms. Centralbl. f. Min. etc., Abt. B, Nr. 1 (Jahrg. 1937).
171. — 1938, Zur Kenntnis der arktischen Belemniten von König-Karls-Land. Centralbl. f. Min. etc., Abt. B, Jahrg. 1939.
172. — 1939, Stratigraphie des norddeutschen Obergaults usw. Neues Jahrb. f. Min. etc., Abt. B. Beil. Bd. 78.
173. Swinnerton, H., 1935, The rocks below the Red Chalk of Lincolnshire, and their Cephalopod faunas. The Quarterly Journ. of the Geol. Assoc., Vol. XCI, part 1.
174. — 1941, Further observations on the Lower Cretaceous rocks of Lincolnshire. Proc. Geol. Assoc. London, Vol. LII, part 3.
175. Teichert, C., 1939, Geology of Greenland. In: Geology of North America, edited by R. Ruedemann & R. Balk. In: Geologie der Erde. Bornträger, Berlin.

176. Toula, Fr., 1874, Allgemeine Uebersicht der geologischen Beschaffenheit Ostgrönlands. Ferner: Beschreibung mesozoischer Versteinerungen von der Kuhn Insel. In: Koldewey, K., 1874, Die zweite deutsche Nordpolarfahrt in den Jahren 1869 und 1870. Leipzig.
177. Vischer, A., 1938, Tektonik der postdevonischen Formationen der Clavering Insel und des Wollaston Vorlandes (Ostgrönland 74—75° N. Br., 19—21° W. Gr.). Medd. om Gr., Bd. 114, Nr. 1.
178. — 1939, Ergebnisse von Studien über die postdevonische Tektonik zwischen Hochstetter Bucht und Franz Josephs Fjord während der Zweijahresexpedition 1936—1938. Mitt. Natf. Ges. Schaffhausen (Schweiz), Bd. XVI, Jahrg. 1940 (9).
179. — 1940, Der postdevonische Bau Ostgrönlands zwischen 73° and 75° N. Br. Medd. om Gr., Bd. 114, Nr. 4.
180. — 1943, Die postdevonische Tektonik von Ostgrönland zwischen 74° und 75° N. Br. Medd. om Gr., Bd. 133, Nr. 1.
181. Volkov, S. N. & Jacjuk, N. V., 1937a, Abriss der Geologie des Timan. Explanatory note to the Geological Map of the Northern part af USSR. Trans. Arctic Inst. of the USSR, Vol. 87, Leningrad. Bespr. Geol. Zentralbl., Abt. A, Bd. 67 (1940), Bespr. No. 1801.
182. — 1937b, Abriss der Geologie des Polarurals. Ibid., Bespr. No. 1802.
183. Wager, L. R., 1934, Geological investigations in East Greenland. Part I, General Geology from Angmagssalik to Kap Dalton. Medd. om Gr., Bd. 105, Nr. 3.
184. — 1935, Geological investigations in East Greenland. Part II: Geology of Kap Dalton. Medd. om Gr., Bd. 105, Nr. 1.
185. Wasson, Th. & Sinclair, H. J., 1937, Exploraciones geologicas en el este de Los Andes del Ecuador, Año II, Tomo II, Numeros 18, 19, 20 (Agosto, Septiembre, Octubre de 1937).
186. Wegmann, C. E., 1935, Preliminary report on the Caledonian Orogeny in Christian X's Land (Northeast Greenland). Medd. om Gr., Bd. 103, Nr. 3.
187. Yermolaev, M. M., 1937, Abriss der Geologie der Inseln des zentralen Teiles des Karischen Meeres. Trans. Arctic Inst. of the USSR, Vol. 87, Leningrad. Bespr. Geol. Zentralbl., Abt. A, Bd. 64, Nr. 5 (1939).

Færdig fra Trykkeriet den 3. Juni 1949.

PLATES

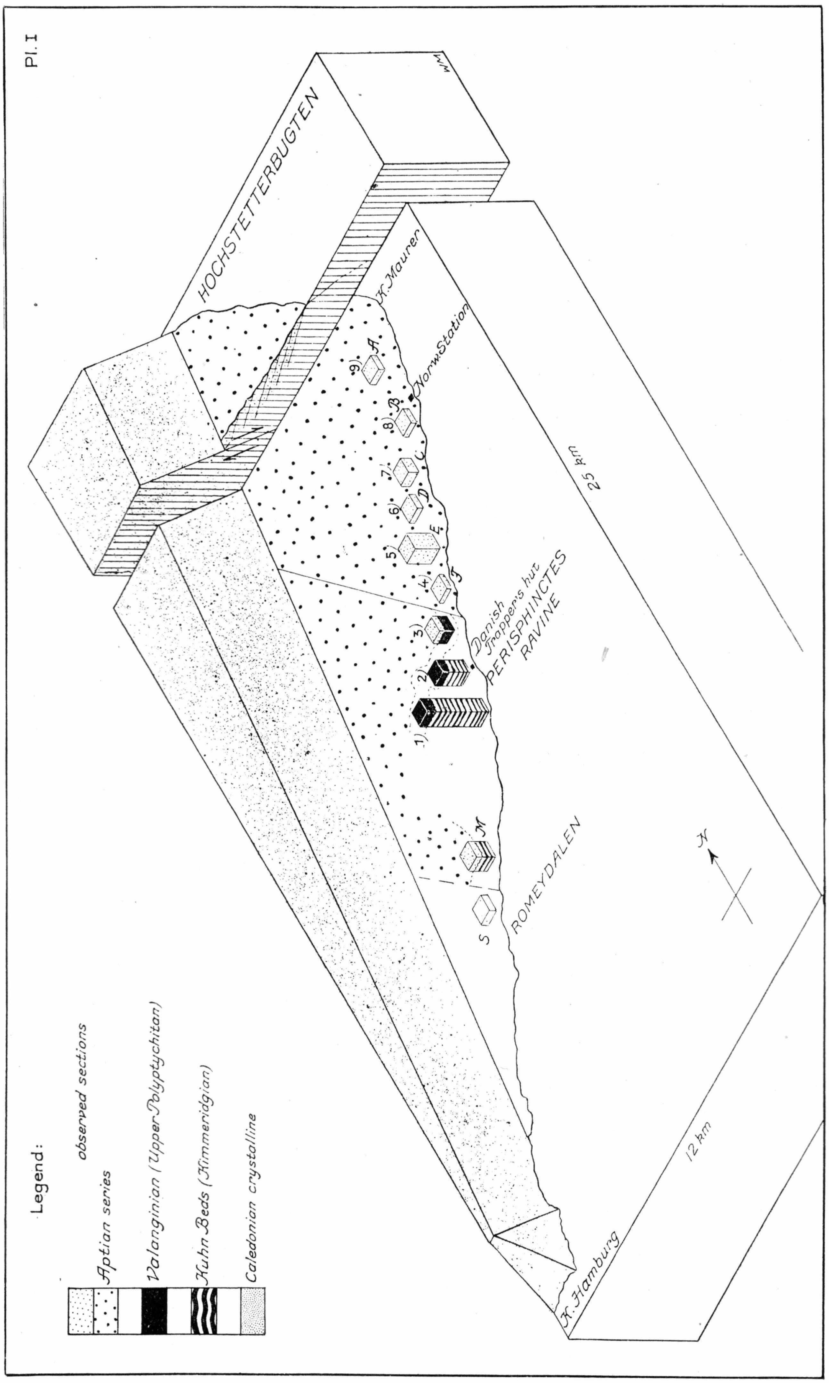
Plate 1.

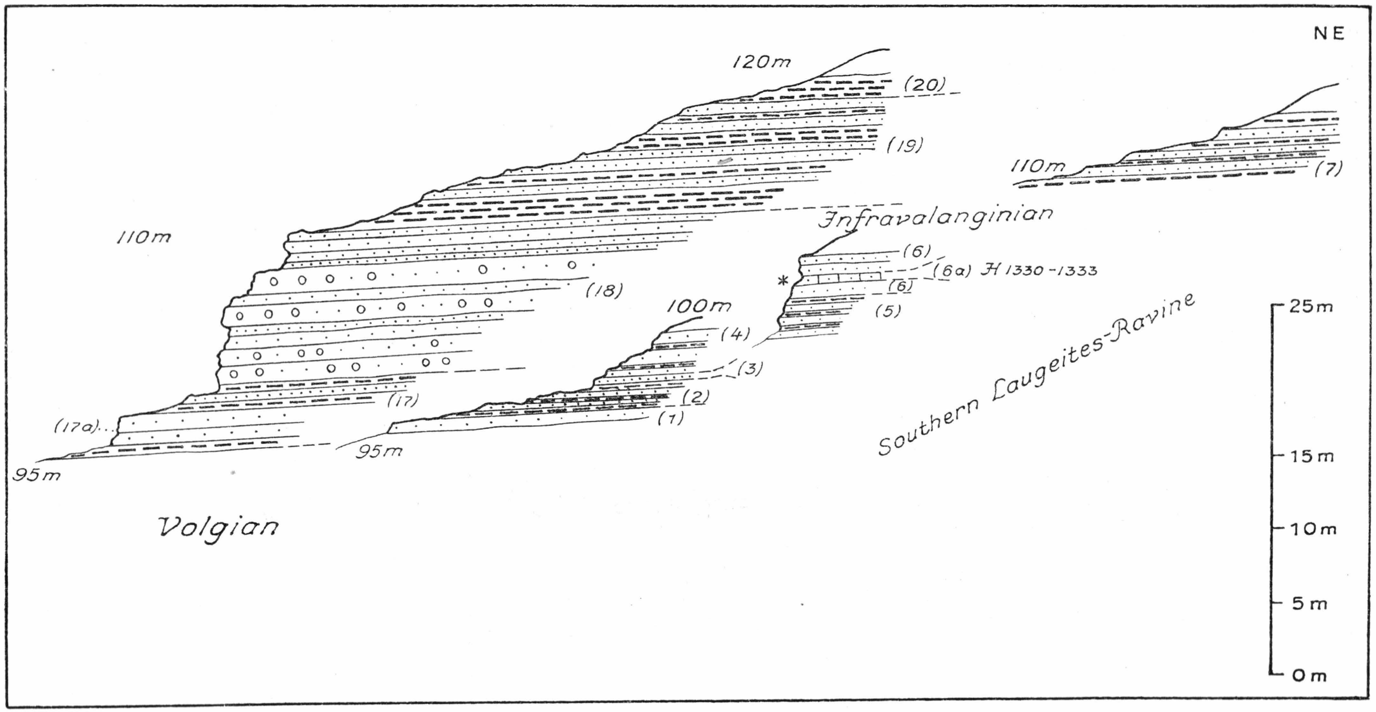
Stereogram showing the eastern portion of Kuhn Island, East Greenland, with the location of the measured sections through the Cretaceous formations along the shore (isometrical projection).

Context. In the background the Caledonian gneisses ("Kuhn Block") of central Kuhn Island (gray). The sediment-covered "Permpass Block" (eastern portion of the island) has slipped down in late Jurassic time along the imposing fault scarp ("Kuhn Fault" A. VISCHER's). A fault of minor order running NW—SE branches off from this main fault line, downthrowing the northern side so that no older beds than Aptian (stippled) are exposed here. On the south side of the fault, *viz.* in the surroundings of *Perisphinctes*-Ravine, Valanginian (black) and even the Kimmeridgian "Kuhn Beds" (ruled) crop out (*vid.* MAYNC 1947).

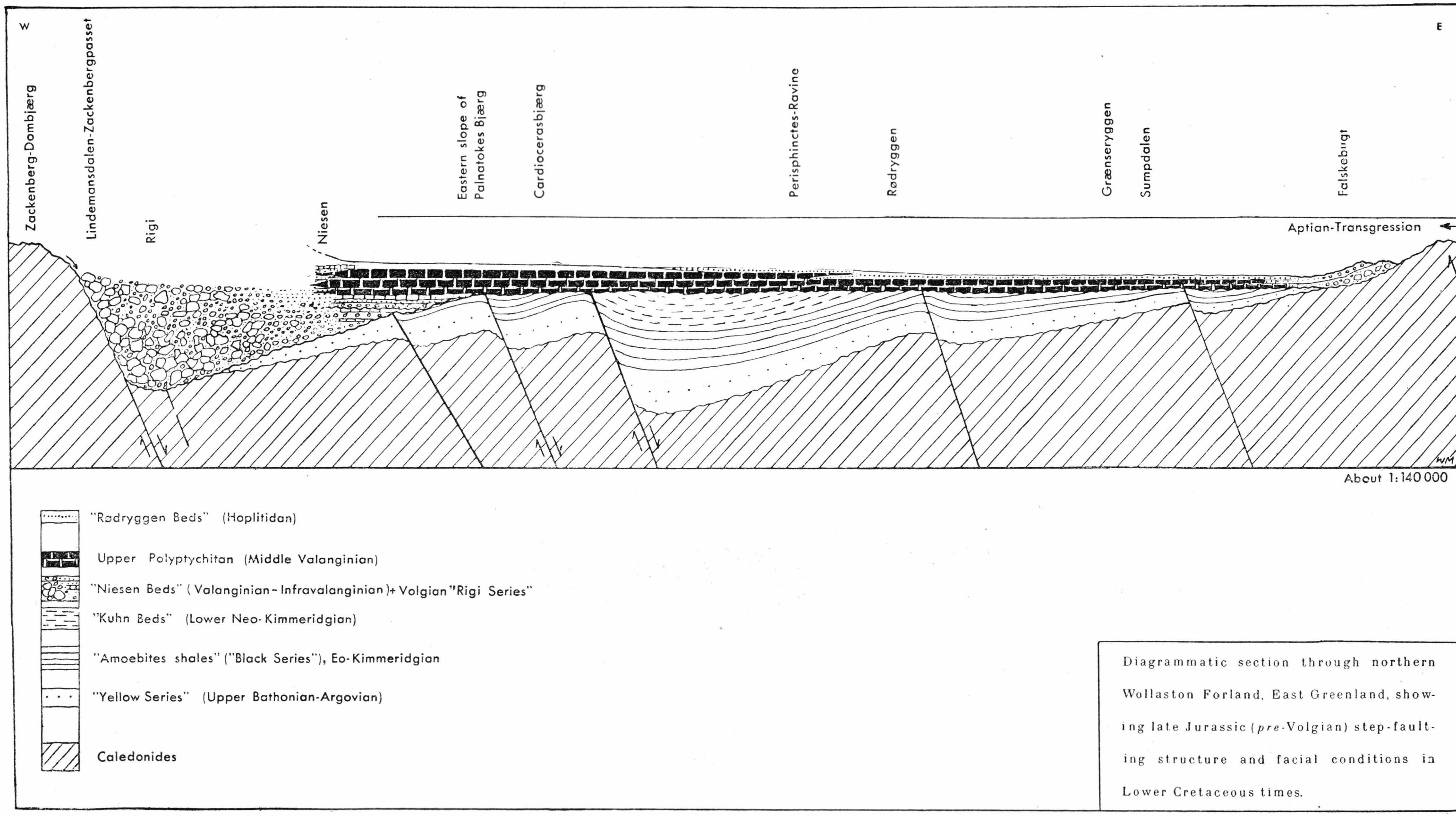
In the "Middle Section" (M) north of Romeydalen the Aptian series directly oversteps the Jurassic.

The deposits exposed still farther to the south in the "Southern Section" (S) are referable to the Aptian; consequently, an inferred fault line is drawn between the sections (M) and (S).


Pl. I
HOCHSTETTERBUGTEN
K. Maurer
Norw. Station
Danish Trappers hut
PERISPHINCTES RAVINE
ROMEYDALEN
25 km
12 km
N
K. Hamburg
Legend:
observed sections
Aptian series
Valanginian (Upper Polyptychitan)
Kuhn Beds (Kimmeridgian)
Caledonian crystalline



Stratigraphical section in *Laugeites*-Ravine, southwestern Kuhn Island.



Diagrammatic section through northern Wollaston Foreland, East Greenland, showing late Jurassic (*pre*-Volgian) step-faulting structure and facial conditions in Lower Cretaceous times.

Plate 3.

Plate 4.

Cone-in-cone structure in the Aptian-Albian deposits of northern East Greenland.

Juxtaposed cones (buff-coloured argillaceous marl) standing normal to the bedding plane (parting of black clay) (*vid.* Fig. 1 & 3). Remnants of black clay matrix adhering to the outer surfaces of the cones are visible in Figs. 1 and 2.

Fig. 2 displays the inner slope of a couple of joined cones showing the intersectional base-lines (= successive marks of water-level). The same minute wrinkles are exhibited in Fig. 6 which discloses the initial stage of the formation of cone-in-cones (slumping of the water-soaked mud and origination of simple funnels).

Fig. 4 shows the warty surface, Fig. 5 the subface (with small-sized protruding apices) of a cone-in-cone layer.

Fig. 2 shows the back of the specimen reproduced in Fig. 1 (Lot 2445 of the author's collection, derived from Kontaktravine, eastern Clavering Island, *vid.* p. 109).

Figs. 3, 4, and 5 show the different sides of the same rock specimen (Lot 1547 Coll. W. Maync) derived from the southwestern face of Bern Plateau, Wollaston Foreland (*vid.* p. 50).

Fig. 6 represents Lot 113 (Coll. W. Maync) from Rundetaarn Bjærg, eastern Clavering Island (*vid.* p. 125).

All the rock specimens are reproduced in about natural size.

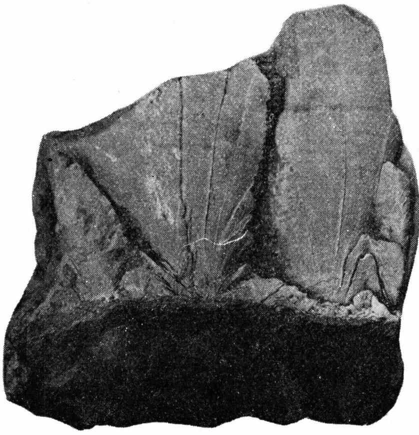


Fig. 1

Fig. 2

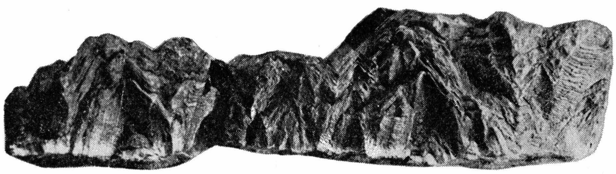


Fig. 3

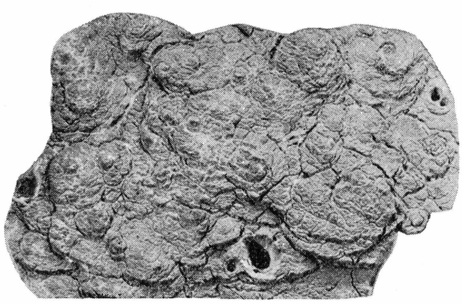


Fig. 4

Fig. 5

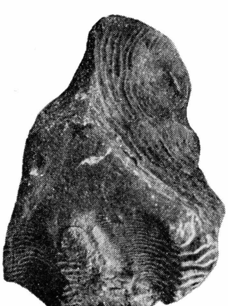


Fig. 6

Pl. IV. Cone-in-cone structure in the Aptian-Albian deposits of northern East Greenland.